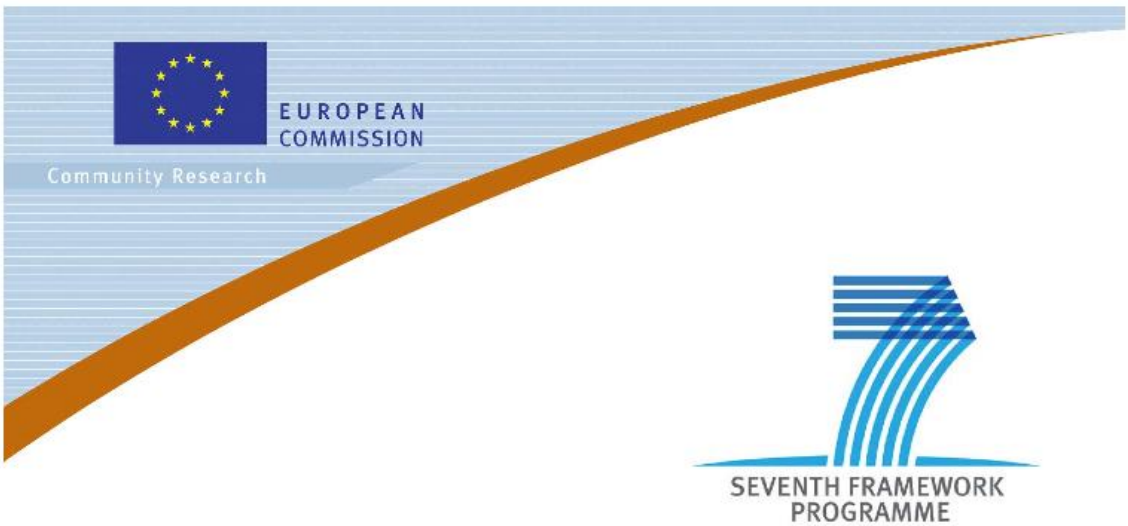

Private Public Partnership Project (PPP)

Large-scale Integrated Project (IP)

D.11.1.2: FI-WARE Market and Competition Analysis

Project acronym: FI-WARE

Project full title: Future Internet Core Platform

Contract No.: 285248

Strategic Objective: FI.ICT-2011.1.7 Technology foundation: Future Internet Core Platform

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1.1 Executive Summary

Continuing with 11.1.1.b, in which a preliminary indication of the market situation that justifies the introduction of the FI-WARE concept was presented, **this paper describes 3rd Platform as the new basis for competition in ICT** as well as its main technological elements according to market demand.

As we enter 2013, the 3rd Platform including its core technologies, its new strategic customer segments, and its radically new rules for success is right in the center of the market, sitting in our metaphorical laps. **The battle for the IT industry as a whole, as of now, is almost completely about this battle for the 3rd Platform**

This analysis describes the desired capabilities and building blocks that need to be established for such a platform. It also offers an analysis of market trends and existing solutions, in order to establish a future vision and solutions, as well as outlining the business potential of such solution

The new basis of competition and the superiority of ecosystem economics, and technology is just one part of a much more complex puzzle. **Therefore, the actual level of competition should be between ecosystems**. This change in the level of analysis requires **a change in factors to be analyzed and a new regulatory tool box for policy makers and regulation authorities**

Additionally, for enterprises, **the greatest business value from the transition to the 3rd Platform will come from the new generation of industry solutions** and services just starting to emerge on top of the platform

The objective of this new version of market analysis is to apply the new **insights to broaden and deepen the analysis of FI-WARE's own business ecosystem**, and relate the present high level view of this ecosystem to the more specific analysis within the GE chapters.

Our work within FI-WARE should **contribute to the expansion of the service economy by creating an IT infrastructure for Business Services where services become accessible, discoverable, composable, easily deployable, a**nd ultimately tradable on the Internet. In doing so, our work helps the service sector to generate new value added services, develop innovative business models, and establish new business value chains

1.2 About this Document

This document has two parts: first it provides an analysis, relatively general, of the emergence and market potential of 3rd platforms in the ICT industry. In this study we analyze the desired elements of this platform according to technological trends and market demands, exploring the business opportunities, benefits, potential business models. Finally, we identified the first Instances or GEs combinations with major demand into the market

Secondly, we analyzed the platform competition and the ecosystem engineering, main challenges, potential business models, success and constraints factors and we conclude with the identification of main applied ecosystems for the Future Internet Applications.

Finally, we analyze the European Context to the expansion of the service economy within the EC, main European policies, regarding Future Internet, involvement of SMEs and entrepreneurs, Smart Cities…as well as the main regulatory barriers to overcome.

1.3 Intended Audience

As this deliverable contributes to defined FI-PPP Programme level activities the perspective and needs of FI-WARE and the FI-WARE consortium and related stakeholders are the addressed audience. As the dissemination level is "PP" (FI-PPP private) there is no plan to release this document to external parties.

1.4 Context of Chapter WP11 Exploitation

This work package focuses on a series of activities that identifies, create and work towards the exploitation and standardization opportunities of the FI-WARE project results. This work package approaches exploitation of the FI-WARE results from the point of view of the partners of the FI-WARE consortium, both individually and as a project. It does not intend to replace or overlap exploitation activities at the Future Internet Public Private Partnership Programme level, but to complement in a synergetic way the work that other projects within Usage Areas will do in terms of take up of the generic enablers provided by FI-WARE., therefore complementing the perspectives of the partners of this project and the related stakeholders in the ecosystems they represent.

The exploitation of FI-WARE results is not based on a purely technological approach (technology push) but on the needs and requirements of the future “customers” and “users” of FI-WARE enablers. As a result, both supply and demand are meet within this WP.

With that in mind the project’s exploitation activities have as main objectives the:

- Definition of project outcomes from an exploitation point of view, including identification of stakeholders and different typologies of users that will make use of FI-WARE
- Systematic analysis and continuous monitoring of market situation and trends
- Definition of overall and individual exploitation plans
- Definition of a framework for IPR and licensing management
- Definition of a Sustainability Plan for FI-WARE results
- Policy and Regulation Considerations
- Feedback of adjustments to project plan if necessary and promotion of the FI-WARE Testbed as an Open Innovation Lab
- Business oriented communication and training activities to increase market awareness and impact
- Definition and implementation of a standardization strategy that will enable adoption and achievement of the project goals and ambitions
- Definition of impact indicators and management of those along the project duration

This WP also supports and runs the project-level Standardization Committee that is in charge of the overall strategy, planning and execution of the Standardization activities.

1.5 Structure of this Document

The document is compiled in MS word and was prepared in the private wiki of the exploitation work package; eventually this will be uploaded to the `fi-ware-review` FI-WARE wiki

1.6 Acknowledgements

The current document has been elaborated using a number of collaborative tools, with the participation of Working Package Leaders and as well as those industrial partners' business people in their teams they have decided to involve.

1.7 Keyword list

FI-WARE, PPP, Market Analysis, Generic Enabler, I2ND, Cloud, IoT, Data/Context Management, Applications/Services Ecosystem, Delivery Framework, Security, Developers Community and Tools, ICT

1.8 Changes History

Release	Major changes description	Date	Editor
0.1	Table of Contents	01/04/2013	Juan Bareño (Atos)
0.2	Content	10/04/2013	Juan Bareño (Atos)
0.3	First Version	19/04/2013	Juan Bareño (Atos)
0.4	Second Version	23/04/2013	Juan Bareño (Atos)
0.5	Including feedback form WPLs	10/05/2013	TID, SAP, TI, IBM, FT, Thales
0.6	New reviewed version	15/05/2013	Juan Bareño (Atos)
0.7	Final Review	17/05/2013	TID and Atos
0.8	Include final comments	20/05/2013	Juan Bareño (Atos)

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2 General analysis

Over the next decade we will continue with advances in cloud computing, big data, and open data and we will see **50 billion devices connected through machine to machine communication,** which will foster the industrialization of the Internet.

- **The Cloud computing wave**. Cloud computing is a major trend in today's IT market. It has been defined by the National Institute of Standards and Technology (NIST) as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". **The development of mobile access to the Internet and the importance of data center and Cloud-related traffic to today's** Internet have highlighted a set of issues related to mobility management, interface multiplicity, latency and traffic management in a network that has evolved from a rather homogeneous infrastructure to an assembly of links that differ heavily in terms of stability, capacity and latency.
    - **Alternative Delivery Models** may seem to be a somewhat bland descriptor for the soon-to-be-predominant Cloud wave, but it has been deliberately used as a neutral term. Despite significant adoption of Cloud delivery and commercial models, little progress has been made in Cloud Orchestration: the ability for an application to be executed across several independent Clouds while maintaining service levels and overall integrity of operation, even in the case of failure of specific cloud components. Hybrid, dynamic and hyper-connected delivery models have now triggered the need for Cloud Messaging to enable business processes to be seamlessly distributed across several Cloud platforms.
- **Big Data Management is becoming a key issue in the IT world**. Several major changes in the IT world have dramatically increased this rate of **data storage and processing needs** growth. The first was the expansion of the Internet that allows global access to huge amounts of information and led to a need for efficient tools, typically search engines, to process it. The second was the rise of Web 2.0, which offers everyone the ability to generate and share their own data (i.e. blogs, YouTube, Facebook, etc.). Next will probably be the development of the Internet of Things, and Context-Aware Computing (CAC), which will bring data storage requirements and associated information processes to an even higher level. Computer capabilities have not increased fast enough to meet these new requirements. When data is counted in terabytes or petabytes, traditional data and computing models can no longer cope. **To deal with it, the Open Source world is providing numerous solutions,** often powerful, but often immature as well
- **The rise of machine-to-machine (M2M).** The Internet of Things will put a lot of objects at the reach of computers and services through the use of the Internet, provided that appropriate addressing and protocols are used to connect to them, discover the services they can offer and the data they may provide. Intel predicts that in a decade the Internet of Things will be a $1,5 trillion-a year-business-just form technology point of view. But on top of that there will be another $2 trillion annually in new services.
    - **It is clear that Big Data and the Internet of Things** will have a fundamental impact on the way businesses are managed in the future, the way that we interact with our cities and urban areas, and our day-to-day life as consumers.
- **Economy of Internet Applications** is one of the most disruptive elements. The greatest business value will come from the new generation of industry solutions and services just starting to emerge on top of the 3rd Platform. IDC predicts that, worldwide, enterprises will spend $65 billion on industry-specific solutions in 2013, with a rapidly increasing number of them **leveraging cloud services, mobile devices, Big Data, and the other elements of the 3rd Platform.** IDC expect this to grow to nearly $100 billion in the next three years as businesses use these technologies and solutions to create new products and services and redefine existing customer relationships. IDC sees the greatest activity, and opportunities, in the areas of public safety, smart buildings,

merchandising analytics, Omni channel retail, connected health, smart cities, personalized medicine, and smart government services.

- **Identity and Access Management**: has evolved into 'Security', largely driven by additional demands arising from Working Environment considerations, particularly with the impact of consumerization and Bring Your Own Device (BYOD) into the workplace (BYOD being not just about devices, but about adapting business behaviors to personal and societal behavior shifts). Another driver is the increase in cyber-crime (at individual or collective levels, directed at public and private organizations).In the private environment, the security and privacy challenge increases, due to the explosion of user related data (both personally created and contextually generated) and how it is used

Additionally, Innovative network models and architecture building on software-defined networks will provide an open, programmable platform allowing a range of new personalized services, dynamic and flexible allocation of capacity and an enhanced user experience with the social element at the center of the network. Networks can move from closed, static pipes to trading spaces for cloud-based applications over a virtualized, tailored "my network".

- By making technology available to all, **open source spreads and shares knowledge, allowing for local customization and adaption to meet local market needs in a globalized economy**. This is particularly important in emerging markets, where developers and engineers rely on open source to bridge the digital gap and create tools, applications and jobs at a local level.
- **Being open to all brings down the cost of innovation whilst speeding up the time to market, a crucial factor in today's IP based ecosystem**. The ease with which products or services can be trialed (and then adapted) in changing markets, the flexibility that cross-company, cross border collaborations can allow, and the lack of software licensing fees reduce critical costs and drive innovation to scale. Open source code is also visible, making it secure, auditable and simple to assess for quality of service.

Open source development is booming as emerging markets, local entrepreneurs and consumers across the globe are empowered. As an all-but unstoppable force, **open source development should be wholeheartedly embraced**. This necessitates the adoption of open standards based on mutual respect for autonomy, transparency and intellectual property rules in a new culture of collaboration. Software defined networks enable development to flow, particularly in the customer and business spaces which drive the value of the network - and where most innovation is already open source. It is, as ever, a question of **balance:**

- Between speed to market and standardization to ensure international operability,
- Between local needs and global markets and between collaboration and respect for intellectual property.

Finally, technology is evolving at a pace where the emergence of Multi-purpose Transactional Platforms will become more a business than an IT challenge.

- The challenge of assigning **monetary values to insights derived from context data** is key in creating value ecosystems based on multi-purpose transactional platforms. It is obvious to investigate cross market collaboration for growth as the specialization and industrialization driven by the crisis in the last few years only concentrates on cost efficiency
- **Business-enabling platforms are one trigger for this new kind of collaboration**. Motivating market players to collaborate on a common platform is the foundation for the next generation of Internet-based services. As this Internet application and service revolution continues, successful multi-purpose transactional platforms can unlock long term and sustainable revenue streams yet to be identified

There is a simultaneous move towards consolidation. Vertical sectors from broadcasting to government services and health are forcing **new convergence models as the benefits of technological developments such as cloud applications, M2M and virtualized networks take hold**.

- The way forward is often through sometimes surprising **partnerships within the industry**, with government and with other sectors. Information, research, revenue and networks must be shared to maximize value and benefit for all.
- Cooperation is essential to drive cyber security, e-Health and broadband at scale; **collaboration is at the heart of open source development and innovatio**n; only by engaging and working together can the trust frameworks be created that will mitigate privacy concerns and allow data to flow.
- This disconnect is enforced by the **cultural and generational gap between OTTs, developing applications in the fast-paced, consumer-based IP world, and traditional operators**. The timescales for investment, product life cycles and business models are dramatically out of sync; policy makers and regulators are often unaware of the extent of transformation within the industry; and development is in danger of being stifled or delayed beyond market viability.

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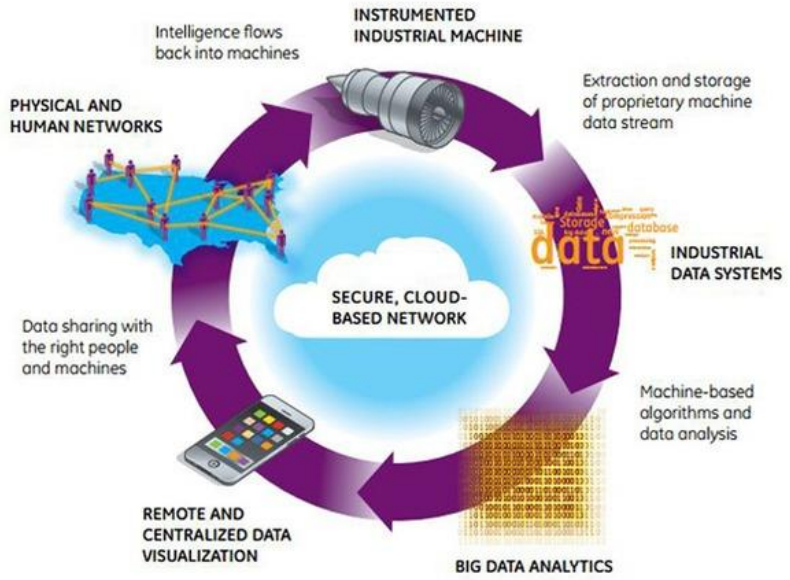

Figure 1: Platform Vision

IT Industry Shifts into full-blown competition on the 3rd Platform. As we enter 2013, the 3rd Platform including its core technologies, its new strategic customer segments, and its radically new rules for success is right in the center of the market, sitting in our metaphorical laps. The battle for the IT industry as a whole, as of now, is almost completely about this battle for the 3rd Platform.

Enterprises will spend $65 billion on 3rd Platform industry specific solutions in 2013, with a **rapidly increasing number of them leveraging cloud services, mobile devices, Big Data, and the other elements of the 3rd Platform.** IDC expect this to grow to nearly $100 billion in the next three years. For enterprises, the greatest business value from the transition to the 3rd Platform will come from the new generation of industry solutions and services just starting to emerge on top of the platform.

Figure 2: The IT Industry's 3rd Platform for Growth and innovation

By 2020, when the ICT industry generates $5 trillion in spending, over $1.3 trillion more than it does today, **40% of the industry's revenue and — incredibly — 98% of its growth will be driven by 3rd Platform technologies that today represent just 22% of ICT spending.**

The most important trends and events in 2013 will cluster around mobility, cloud services, social technologies, and Big Data, as well as emerging high value industry solutions built on top of them, and the vendors (e.g., service providers and industry PaaS providers) and customers (e.g., consumers, SMBs, line-of- business executives, and emerging market customers) that will play leading roles in much of the next eight years' growth.

Much of the growth in software, services, and hardware sectors will be driven by double-digit growth rates in the 3rd Platform foundations of mobile, cloud, big data, and social technologies and services as growth shifts away from 2nd Platform markets.

- The major changes mentioned previously the growth of mobile devices and platforms, the expanding adoption of SaaS and other cloud services (including more deeply into SMBs), and the growing adoption of PaaS as a center for innovation (often with partners) — as well as the social and Big Data technologies discussed in subsequent predictions, will continue to drive profound changes in the datacenters and enterprise IT organizations supporting these 3rd Platform solutions

In the upcoming years, vendor and IT users should develop deep competence in all of these technologies, **cloud services, mobile devices, social technologies, or the other core elements of the 3rd platform**, and align with the emerging and radically different following "rules" of the **3rd Platform marketplace**:

- **Urgency is required**: the 3rd Platform is already here. In many of our predictions, we point out that 3rd Platform technologies have either already eclipsed 2nd Platform technologies (mobile devices) or are approaching that point (SaaS) and so they must be the priority now, even at the risk of the cannibalization of 2nd Platform franchises.

- **A platform (and community) vision and strategy are essential**. Platforms and the communities around them are essential components of a successful 3rd Platform strategy. The ability to compete in the new marketplace depends on collaborating with others to augment and amplify each other's value and dramatically broaden distribution. Lack of a solid platform strategy means isolation and marginalization in the new marketplace.
- **Quickly reaching massive scale is mandatory**, a critical ingredient of any platform strategy; scale helps attract a critical mass of developers, solutions, and customers to your platform.

Consequently, ICT Industry is challenged to find new and additional value in using platforms and data in different ways driven by the ever faster changing business and consumer scenarios. This is forced by the explosion in valuable consumer services and associated commercial models. The **resulting new business models blur the traditional industry borders** and question the commercial models as they are known today.

Supported through cloud computing adoption, growing social networks and an explosion in mobile device adoption, the Information and Communication Technologies **(ICT) Industry further explores the value of data,** in an effort to monetize and capitalize on the wealth of data**, the 'data gold'**. Especially we see a growing interest in the data generated by collaborations between business partners and the value that is derived from connecting together data owned by any given partner in the chain. **Nowadays a huge amount of data is collected**, sometimes without a defined outcome of quantifiable value for either a consumer or business.

- **The Internet of Things concept;** leveraging data gathered by sensors embedded in countless devices will further strengthen the richness of information that can be generated from transactional platforms**.**
- And on top of these different sources of data coincide with the emergence **of Big Data Management and new data analytics technologies,** increasing the probability of finding meaningful insights from huge amounts of data generated by myriad applications and sensors.

In short, the technological landscape has developed to the point where it is clear that **Big Data presents tremendous opportunities for organizations and enterprises to develop and improve customized services and experiences delivered to customers** by capturing, processing and analyzing data from an increasing range of sources. Additionally, it is clear that data gleaned from M2M devices must also be incorporated into Big Data analyses.

Accordingly, Platforms and the communities around them are essential components of a successful 3rd platform strategy (cloud, mobile, social, Big Data/analytics and M2M capabilities). Lack of a solid platform strategy means isolation and marginalization in the new marketplace.

3 Desired elements of the 3rd Platform according to current technological and market trends

This analysis describes the desired capabilities and building blocks that need to be established for such a platform. It also offers an analysis of market trends and existing solutions, in order to establish a future vision and solutions, as well as outlining the business potential of such solution.

Today, there is significant pressure on lines of business to create new business value based on mobile, social, big data, and analytics capabilities. These new applications are fueled by the emergence of new, highly iterative development models that use service composition, open architectures, open source components, and polyglot programming models to rapidly deliver solutions. In the upcoming years, vendor and IT users should develop deep competence in all of these technologies, **cloud services, mobile devices, social technologies, M2M or the other core elements of the 3rd platform**, and align with the emerging and radically different following "rules" of the **3rd Platform marketplace**

Additionally, for enterprises, the greatest business value from the transition to the 3rd Platform will come from the new generation of industry solutions and services just starting to emerge on top of the platform. We will describe practical examples on how **building blocks could be exploited by entrepreneurs in IT emerging areas** such as smart cities, safety, logistics of people and things, energy management, content delivery, manufacturing, smart agriculture production… For enterprises, the greatest business value from the transition to the 3rd Platform will come from the new generation of industry solutions and services just starting to emerge on top of the platform.

3.1 Cloud Computing is opening up huge avenues of innovation

Cloud computing is changing the way we think about technology. Consumers are using the cloud to store music. Startups are turning to cloud to get up and running without huge investments. Big businesses and governments are relying on clouds to make more data more accessible. **Cloud computing is changing how business and society run, and it's opening up huge avenues of innovation**. We are looking at how developers are now combining systems of record with systems of engagement, and we see a new style of cloud-based application emerging**. These are systems of interaction**.

These new applications are fueled by the emergence of new, highly iterative development models that use service composition, open architectures, open source components, and polyglot programming models to rapidly deliver solutions. Two additional trends are key enablers for this new style of applications:

- Notably DevOps and Cloud-based PaaS offerings, such as Heroku, Cloud Foundry, and OpenShift. DevOps **enables clients to deliver business outcomes in an agile, iterative, and incremental fashion**: applications are delivered in days or weeks, rather than the typical months or years.
- Finally, to achieve such development efficiencies, **PaaS technologies are evolving that enable developers to quickly assemble substantial middleware components** hosted in the Cloud extremely quickly (in seconds).

Multi-tenant, elastic ("cloud native") software services are the fuel of this style of development. While there are certainly lots of proprietary offerings that attempt to cover various aspects of this new style of development and operations, we have observed that the *open* offerings deliver real value to the customer, and are more likely to be embraced by developers.

By changing how business and society run, **cloud computing is opening up huge avenues of innovation.** Developers are now combining systems of record with systems of engagement, and a new style of cloud-based application is emerging systems of interaction. **For these applications to be sustainable, cloud computing needs to be built on open source and open standards** which drastically boost innovation across the **entire ecosystem**, and enables creation of highly complex and capable custom-built solutions using solely open source technologies. This also creates a new market of services specializing in building such solutions in the enterprise.

The objective for the open source software (OSS) offering is to attract third parties that will unite their efforts to enable the offering to catch up with more established solutions, based on a positive feedback loop whereby attracting a partner strengthens the technology, which enables it to attract more partners.

3.1.1 Cloud Computing Market

The growth of the cloud is a worldwide phenomenon. Cloud computing offers a novel approach for utility computing with unprecedented flexibility, agility and scalability. The analysts indicate that the demand for all types of cloud services (IaaS, PaaS and SaaS) is growing in all regions. According to recent evaluations from market analyst Gartner (Figure 3), worldwide spending on software-as-a-service will grow linearly from US$14bn to US$26bn between 2012 and 2016, whilst Infrastructure-as-a-service will grow exponentially, quadrupling from US$6bn to US$24bn in the same period.

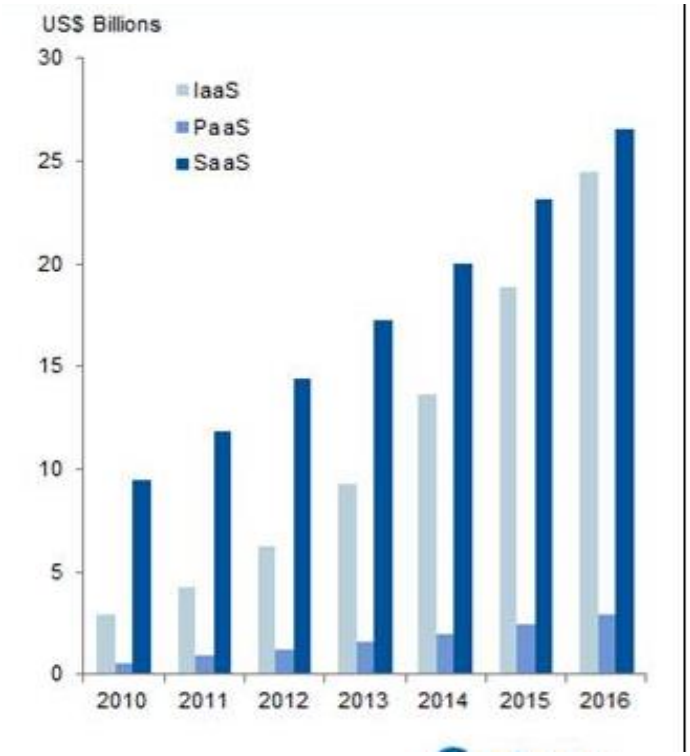

Figure 3: Cloud Computing Forecasts from Gartner

Cloud computing first emerged in the form of Infrastructure-as-a-Service (IaaS), boosted by the birth of Amazon Web Services (AWS). AWS began offering IT infrastructure services to businesses in the form of web services in 2006. At the same time, Salesforce.com was offering Software-as-a-Service (SaaS), based on the idea of application service provision (ASP). Its offering included a customization layer, force. com. Soon, driven by the existence of force.com and the entrance of Google's App Engine, the market erupted and it became clear that there was a need for a middleware layer (Platform as a Service – PaaS) between IaaS and SaaS. **PaaS enables the simplified consumption of Cloud infrastructure and**

supports the viability of more complex and configurable Cloud applications. NIST1 defines Platform-as-a-Service as, "The capability provided to the consumer to deploy onto the Cloud infrastructure consumer created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying Cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application hosting environment."

Gartner anticipates that "**the worldwide enterprise market for PaaS platforms will grow from $900 mil. Spent in 2011 to $2.9 bill. in 2016, representing a 26.6 percent CAGR** (combines annual growth rate). Growth rates per PaaS sub-segment include: Application Development (22%), Database Management Systems (48.5%), Business Intelligence Platforms (38.9%), and Application Infrastructure and Middleware (26.5%). Application Infrastructure and Middleware is expected to be the largest revenue source in PaaS for the next four years." Gartner reports that this sub-segment generated $649 mil. in 2011 and projects it to grow to $2.1 bil. in 2016, generating a 26.5 percent CAGR. With 76 percent of the entire 2012 public Cloud estimated to be in the BPaaS (Business Process-as-a-Service) segment, it is clear that Gartner sees strong interest from enterprise clients to spend in this area. It can therefore be said that while the standalone PaaS business will remain relatively small within the overall Cloud market, the ratio of the PaaS value embedded in SaaS and BPaaS revenues is becoming significant.

- **IDC predicts that 2013 will see an explosion in "industry platform as a service"** offerings cloud platforms (and developer communities around them) focused on supporting solutions for specific industries. The number of these industry-focused public platforms less than 100 in 2012 will increase tenfold by 2016. An industry PaaS involves an IT service provider or, increasingly, a player from within the industry itself, creating a cloud-based shared services environment tailored to the needs of the specific industry, and on which a community of additional industry-focused solution developers develop and deploy a wide range of industry-targeted value-add solutions and services.
- **Horizontal PaaS will become more commoditized**. As value migrates "up the stack" to high-value industry solution platforms and ecosystems, the world of horizontal PaaS that is, cloud platforms that are targeted more broadly across many industries and solutions, such as salesforce.com's Force.com, Microsoft's Azure, Amazon.com's Amazon Web Services, and IBM's SmartCloud Application Services will become more commoditized.
- IDC predicts the **growth in adoption of horizontal PaaS platforms built on open source** based infrastructure stacks (like OpenStack and CloudStack), packaged with open source developer frameworks, tools, and services. The rise of these more "open" horizontal PaaS offerings will challenge platforms with a more traditional vendor-proprietary middleware heritage. The broader use of more open PaaS technologies does not mean that PaaS vendors are trapped in a world of diminishing differentiation. What it does mean is that horizontal PaaS vendors to increase their value (and "stickiness") need to follow the value up into the industry PaaS world by creating their own industry-specialized PaaS capabilities and ecosystems, and by building partnerships with industry PaaS partners like the ones mentioned previously. "Stickiness" and market power in the PaaS world will come less from proprietary lock-ins to tightly controlled technologies and APIs and more from adding value on top of more open technologies (creating the "best" implementation of largely open platforms) and cultivating a large-scale high-value community of solution developers (often industry focused) on top of your platform.

In two years, the cloud-computing-enabled enterprise will have the enviable luxury to take much for granted, including accelerated time to market, seamless deployment, true polyglot coding and agile-as-you-want development. Think of private PaaS as cloud middleware for the enterprise Platform-as-a-Service technology for on-premise service delivery behind a firewall, or an operating system for an enterprise private cloud. Here are **six ways private PaaS will change the enterprise cloud space by 2015**:

- **Mobile apps will drive enterprise cloud and private PaaS adoption**: Two years from now, the biggest driver for cloud adoption won't be traditional applications, it'll be mobile apps. Disparate workforces already make Bring Your Own Device (BYOD) a cost of doing business for the enterprise:

More types of enterprise work will require more types of mobile applications. And that will burden IT leaders mandated with managing the cloud. To retain control (and sanity), those IT leaders will embrace private PaaS technologies to provide integrated application management of mobile (and Web and cloud) applications.

- **Private clouds will dominate the enterprise market for now** but hybrids will win in the end. Marketers spin idealized tales of cross-cloud hybrid love, with capacity-enabling bursts to the public cloud, easy multi-datacenter application administration, better security management, and redundancy/failover operational models abstracted from the developers and employees doing the actual work.
- **In 2015, private PaaS technologies will offer even easier administrative control**, support for development in any language, seamless integration to corporate applications (particularly big-data databases), and hybrid cloud capabilities. Both developers and cloud managers (DevOps) collaborating.

3.1.2 Cloud Computing Trends

Cloud hosting is particularly appealing to SMEs and start-ups wanting to offer some new and innovative service over the Internet. Actually, it offers SMEs general purpose computing resources that they can consume (and pay) according to their needs and capabilities, e.g. they can start small and grow as the service they offer becomes successful. All this is achievable without the need for large initial investment in the infrastructure. This in turn gives the **SMEs a possibility to competitively price their offerings since there is no need to recover a huge initial capital investment in infrastructure** and, in addition, the on-going operational expenses are lowered thanks to the pay-as-you-go model.

Today, there are two clear trends in the cloud computing market:

- Growing adoption **of the full cloud computing paradigm**, as exemplified by public clouds; and,
- **The appearance of private clouds**, i.e., the adoption of the cloud ideas and technologies internally within companies. The latter approach is especially appealing for large companies that are already operating large data center infrastructures. On one hand, they are still reluctant to fully adopt the cloud hosting model and rely solely on external providers for their IT needs (due to various factors such as security and privacy as well as performance and availability guarantees). On the other hand they do want to benefit from advantages that **cloud computing paradigm introduces in terms of cost and flexibility. Such a trade-off also introduces a hybrid approach where private clouds incorporate facilities to burst workload on public clouds (cloud bursting),** This approach is not only fundamental for large companies but is increasingly gaining momentum among SMEs who need to gain the necessary confidence on the Cloud promise prior the full outsourcing of their computing infrastructures.

However, as the IT infrastructure moves from being owned and managed by the service providers to being hosted on the cloud, the cloud hosting companies become a critical part of their customers' businesses This creates a dependency relationship that could even lead to unhealthy and undesirable situations such as vendor lock-in, if the necessary safeguards in terms of technology, market offerings and warranties are not in place. **Moreover, the cloud hosting market is still limited to a few, very dominant, large companies with proprietary solutions**. The lack of a competitive and open market for cloud hosting providers, in turn, slows down the adoption of the cloud paradigm and the economic benefits embodied in it. For the success of the **Internet-based service economy it is crucial that cloud hosting does not become a market limited to a few strong players**, and that future cloud hosting is based on open standards and support interoperability and portability.

Such is the domination of VMware and AWS that competitors have been trying to band together **around open source projects** to mount **a credible defense**. To start with, these competitors were small startups, such as Abiquo, Cloud.com, and Eucalyptus, whose projects attracted limited attention (with the exception of Eucalyptus). **However, this has clearly changed with the emergence OpenStack and CloudStack**. Both target private as well as public clouds. The handing over of CloudStack to ASF was a smart move because although many will continue to pitch CloudStack and OpenStack against each other, the two open source initiatives are likely to strengthen one another, and the market is large enough to accommodate both. OpenStack helps the IaaS industry remain open and competitive, as will CloudStack and CloudPlatform and their ecosystems in the making. Both OpenStack and CloudStack are available for anyone to try. Neither will replace VMware in public and private cloud, but they will increasingly complement VMware as large cloud services providers and enterprises adopt a dual open source/VMware strategy that will keep both sides on their toes

- **IaaS vendors are now pushing up the Cloudstack to offer added-value PaaS programming frameworks on top of their infrastructure**, in order to overcome the threat of increasing infrastructure commoditization. SaaS vendors are also offering platform tools to tailor their on demand portfolio with the intention of creating customer loyalty and establishing a wider market for their offering. As in any market for an emerging technology, there is a **truly diverse array of capabilities being offered by PaaS providers,** from supported programming tools (languages, frameworks, runtime environments, and databases) to various types of underlying infrastructure, even within the capabilities available for each PaaS

- **OpenStack is emerging as the de facto open source private cloud framework**. The OpenStack cloud computing software platform is the fastest-growing project in the history of open source. OpenStack Grizzly, the seventh major milestone release of OpenStack in less than three years, has become generally available after six months of active development, delivering powerful new features and some 7,620 patches contributed by 517 contributors globally. Grizzly, incorporates the three major components for building a cloud: compute, storage and network and is about making OpenStack scale and integrate with existing systems more easily. Users can now manage multiple OpenStack clouds through a single console; there are new drivers that ensure it is compatible with a wide range of products commonplace in the enterprise market, from vendors such as HP, IBM, VMware, NetApp and Red Hat, among others. Today, with over 189 organizations and over 9,100 individuals participating, OpenStack is the largest active open source, cloud project community in the world. This massive global collaboration of developers and cloud computing technologists is working to produce a ubiquitous Infrastructure as a Service (IaaS) open source cloud computing platform for public and private clouds. **OpenStack is well poised to deliver massive portability and interoperability for IaaS applications.**

Open source is a major trend in the IaaS market. Open source opens up all cloud markets, not just the IaaS market. VMware, owing to its status as a server virtualization giant, has no incentive to open source its technology. On the other hand, in the same way Cloud.com then Citrix are leveraging open source to elbow their way into the IaaS market, VMware has open sourced its Cloud Foundry platform as a service (PaaS) technology to elbow its way into the PaaS market.

Expectations within the Platform-as-a-Service market are that there will be significant changes. Users, providers, and industry analysts are all still evaluating the current state of play and although they all see a need for improvement, the point at which stability will be reached in the areas of feature set, architecture, and pricing models is still a topic of debate. Despite this, there are a number of identifiable trends, driven primarily by the needs of different user groups and the motivation for PaaS providers to address this market space. There are two primary user groups that benefit from using Cloud at the PaaS level (compared to at an IaaS level): Enterprises with their own internal software development activities and independent software vendors (ISVs) interested in selling SaaS services on top of a hosted PaaS.

- **Enterprises expect several benefits from PaaS, primarily from standardizing around a specific platform**. In many software development organizations (regardless of whether the programming is done in-house or by a third party) development projects make use of a very heterogeneous toolset. This tends to increase the overall cost for development and deployment, and also reduces the flexibility of

team members who may need to work on several different projects at once. Ideally, enterprises should focus on one, or maybe two, different platforms to decrease costs (the use of two platforms may help avoid lock-in) allowing them to more easily transition to another platform if they become unhappy with the predominant platform. Enterprises will also want to increase the speed that finished applications can be reliably deployed. Similar to their logic for deploying IaaS, they may prefer to begin with a private PaaS infrastructure which can then be extended into the public Cloud depending on the nature of the application and the company's overall Cloud strategy.

- **In spite of the long-term desire to have the option to use a public Cloud provider, heavy integration features may still be required for existing and legacy application sets**. Enterprises tend to have a large installed base of existing applications and PaaS must be able to integrate easily into those existing applications. In addition, development teams must be able to start using PaaS easily. This means it must be inexpensive and teams must be knowledgeable in their domains in order to start using the new PaaS environment. Not only must PaaS frameworks fit current development models, but where possible, should offer additional features that address the specific market that the enterprise is operating in. For example, in the financial services market a PaaS with increased feature sets for security, transactional processing, and data mining may be an absolute necessity. Private PaaS vendors (i.e. companies who sell software enabling a private PaaS environment for their customers) are already moving toward:
    - Increasing the ability to interface with legacy applications.
    - Increasing support for automated deployment.
    - Adding features/methods for reaching higher availability levels.
    - Achieving market-tailored 'verticalization' of features.
- Trends in the PaaS space will address these users and scenarios. **Public PaaS feature sets will address ISVs' needs by offering additional marketplace features and focusing on the ability to sell and market applications**. As usual in 'land grabs' of emerging and growing markets, where large players try establishing themselves early on as market leaders, PaaS hosts have not invested substantial effort in standards, instead rely on establishing their platform as the de facto industry standard in order to solidify their long-term position. It remains to be seen how quickly the market will address the desire for standardized interfaces that will allow SaaS application developers to quickly switch between public PaaS providers. Private PaaS vendors will address other issues based on the needs of their end users. They will focus on improving the robustness of the runtime/productive environment and on decreasing development costs for new applications. Similar to the classic middleware market, feature set expansion will emerge in areas of orchestration and business process automation (in this case, Cloud orchestration).

3.1.3 Evaluation of Cloud Providers

As pointed out earlier in this analysis, **there are several solutions for cloud computing focusing on different areas and ranging from hardware resource outsourcing to user services providing**. Each solution presents a different vision about cloud architecture and implementation. Moreover, each approach has an implication that directly impacts its business model: the closer to the hardware level, the more options a user can handle but at the cost of having to configure her cloud (more configuration flexibility).

Amazon EC2 and IBM Capacity on Demand (CoD) are solutions that offer to their users this configuration flexibility. In this business model, users can choose and configure computational resources at the hardware level and OS levels. At the other extreme, solutions like Google App Engine and Windows Azure, try to turn development easy to their users, but at the same time, confine them to specific APIs and software platforms. Moreover, solutions like JoliCloud are more limited as they offer a single service (operating system). In the middle, there are solutions that offer a middleware-like approach to users, where the hardware resources can be configured and handled subject to some restrictions and where applications can also be developed. All the presented open-source solutions and the cited commercial solutions are

categorized into the following Figure. The graphic compares solutions and their business model (hardware, middleware and user level) according to configuration flexibility.

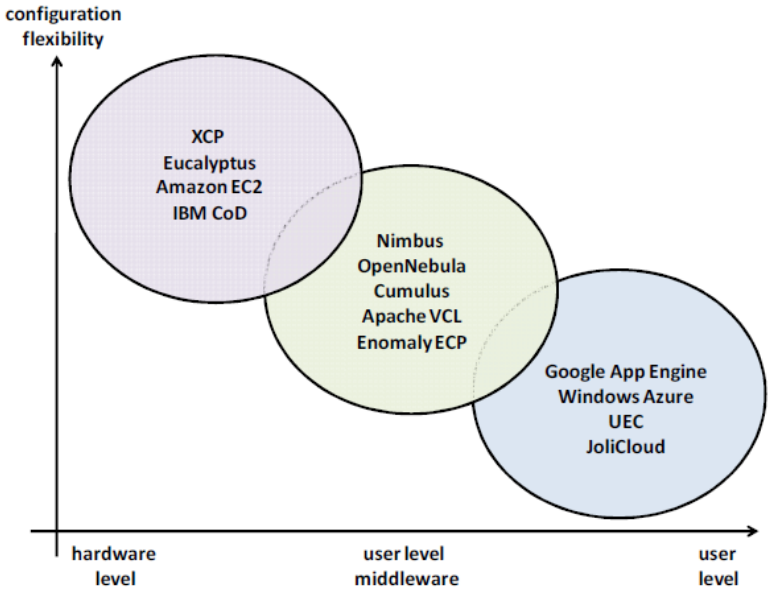

Figure 4: Cloud Computing Solutions

Finally, the following table presents **a comparative board of the open source cloud solutions** described in this paper, in terms of the service type (IaaS, PaaS, and SaaS), the main characteristics, and the infrastructure technologies. The table also cites some users of each cloud solution

Solutions	Service	Main Characteristics	Infrastructure	Used by
XCP	IaaS	Only a tool for automatic maintenance of clouds	Xen	XCP community
Nimbus	IaaS	Aims to turn legacy clusters into IaaS Clouds	Xen hypervisor and KVM	Brookhaven National Labs[9]
OpenNebula	IaaS	Policy-driven resource allocation	Xen hypervisor	Cumulus Project
Eucalyptus	IaaS	Hierarchical Architecture	Xen hypervisor and KVM	UEC
TPlatform	PaaS	Focus on web text mining applications	TFS, BigTable and MapReduce	TPlatform Project[10]
Apache VCL	SaaS	Internet access for several applications	VMware	Educational[11] and Government[12] users
Enomaly	IaaS	Open version is focused in small clouds	Xen, KVM and VirtualBox	Several companies[13]

Table 1: Comparison between Open-Source Cloud Computing Solutions

VMware dominates the IaaS market from an inside out perspective, expanding from private to public clouds. **AWS does so from an outside in perspective**, expanding from public to private clouds, both directly via its virtual private cloud offering and via Eucalyptus Systems for private clouds. **The two**

companies dominate the IaaS market to such an extent that most of their competitors have decided against tackling them on their own. Instead they have sought to combine forces within the context of open source projects.

Rackspace launched the OpenStack open source project to compete against AWS, and **Abiquo, Eucalyptus, and Joyent have open sourced their technology** with a view to compete with VMware and/or AWS. The objective for the open source software (OSS) offering is to attract third parties that will unite their efforts to enable the offering to catch up with more established solutions, based on a positive feedback loop whereby attracting a partner strengthens the technology, which enables it to attract more partners.

- **Regarding OpenStack, Grizzly, incorporates the three major components for building a cloud**: compute, storage and network and is about making OpenStack scale and integrate with existing systems more easily. Users can now manage multiple OpenStack clouds through a single console; there are new drivers that ensure it is compatible with a wide range of products commonplace in the enterprise market, from vendors such as HP, IBM, VMware, NetApp and Red Hat, among others.
- The **OpenStack platform has matured** to a point where enterprises can start to reliably use it to power next-generation computing workloads on their own private clouds.

	DIY OpenStack	OpenStack Distro	Turnkey System
Product Roadmap w/ Upgrades	None	OpenStack Software Only	Entire OpenStack System
Hardware Certification	None	Yes	Yes
Support	None	Software Only	Full Stack
Cost Transparency	Low (Unknown Costs)	Medium (Some Known)	High (Known Costs)
Deployment Timeline	Unpredictable (Months/Years)	More Predictable (Months)	Predictable (Days/Weeks)
Deployment Complexity	High	Medium	Low

Figure 5: OpenStack Product Landscape

Continuing up the stack, the industry is exploring a number of open alternatives for the compositional PaaS fabric, including OpenShift and Cloud Foundry. Each offers similar characteristics when it comes to support for a wide variety of runtime environments (including Java, JavaScript, Python, Ruby, etc.), popular frameworks (such as Node.js, Tomcat, and Ruby on Rails, etc.), and a rich variety of services (NoSQL databases, queuing, messaging, caching, analytics, social media, big data, etc.) and which **offer an open architecture for the incorporation of additional runtime environments, frameworks, and services.** Below is an analysis of the main features of existing Cloud PaaS offerings with a comparative analysis made among them.

- AWS Elastic Beanstalk: Elastic Beanstalk, currently in Beta version, is built on top of existing AWS' services. It targets Java developers using the Apache Tomcat software stack and enables the direct upload of a J2EE application. AWS Elastic Beanstalk allows the user to control the core elements of underlying infrastructure. Flexibility is offered for the selection of the appropriate Amazon EC2 instance type and the selection of database options. The integration of AWS Elastic Beanstalk with the

AWS Auto scaling service provides the interesting capability of automatically scaling applications up or down, enabling automatic handling of peaks in the application's workload and traffic.

- CloudBees: CloudBees allows the building, testing, and deployment of Java web applications in the Cloud. It consists of DEV@Cloud, a framework that not only enables the deployment of an application in the Cloud like a traditional PaaS, but also continuous integration of a project in the Cloud, and RUN@Cloud that offers support for the deployment and administration of Java applications in the Cloud. RUN@Cloud also offers traditional application server functionality, providing load balancing, scalability, and high availability for web apps. CloudBees includes an Ecosystem of tools from partner companies, some of which are provided free of charge.
- Cloud Foundry: Cloud Foundry, a VMware-led project, is the world's first 'open' PaaS offering. It provides a platform for building, deploying, and running Cloud apps using Spring for Java developers and other JVM languages/frameworks, including Rails, Sinatra, Node.js, Groovy, Grails, and Scala. Cloud Foundry is an application platform which includes a self-service application execution engine; an automation engine for application deployment and lifecycle management; a scriptable command line interface (CLI) for integration with development tools to ease development and deployment processes; an open architecture for quick development framework integration; an application services interface; and a Cloud provider interface. One of the core tenets of Cloud Foundry is that it is free from underlying infrastructure. This gives users the option to use their existing infrastructure (desktop, data center and private Clouds) whilst still leveraging all the benefits of PaaS.
- Google AppEngine: Google App Engine is a PaaS offered by Google. Its main value proposition is that developers can quickly build small applications locally (on developer machines) and deploy them to the Cloud in the same environment that powers Google applications. It offers fast development and deployment and simple administration. Supported languages are currently Java, Python, and Go with an appropriate Software Development Kit available for each. This platform provides an execution environment where applications run on a virtualized technology foundation that scales automatically on demand. Google AppEngine is often criticized for not providing transparency to the user to allow control of the infrastructure it uses. Developers do not have direct control over resource allocation because the underlying system and hardware resources are masked by the AppEngine layer depending on the degree to which they rely on direct access to Google data persistence.
- Microsoft Windows Azure: The Windows Azure Platform is a PaaS for applications built using the .NET framework. The platform consists of various on-demand services hosted in Microsoft data centers and commoditized through three product brands:
    - ``Windows Azure: an operating system providing scalable compute and storage facilities.
    - ``SQL Azure: a Cloud-based, scale-out version of SQL Server.
    - ``Windows Azure AppFabric: a collection of services supporting applications both in the Cloud and on premise.

  The Windows Azure Platform provides an API (application programming interface) built on REST, HTTP, and XML that allows developers to interact with the services provided by Windows Azure. It also provides a client-side, managed class library which encapsulates the functions for interacting with services, and it integrates with Microsoft Visual Studio allowing it to be used as the IDE (integrated development environment) to develop and publish Azurehosted applications. Simple applications that just use web pages, web services, and SQL Azure Database can be moved between on-premise data centers to the Azure Services Platform with minor configuration changes. However, applications that take advantage of other Azure Services and Cloud-specific features of Windows Azure, like Blobs, Tables, Queues, and Worker roles, require rewriting specifically for the target platform.

The following table provides a comparison of the platforms studied:

PaaS Diversity/Type	AWS Elastic Beanstalk	CloudBees	Cloud Foundry	Google AppEngine	Microsoft Azure
Programming Languages	Java	Java, Grails, JRuby, Coldfusion, Scala	Java, Ruby, Node.js, Scala	Phyton, Java, GO	C#, Java, PHP, Ruby
Runtime Environment	Apache Tomcat	JVM based		Jetty	Windows Azure
Supported Frameworks	-	Spring	Spring, Rails, Sinatra, Groovy, Scala	Django	.NET
Database and Data Types	Amazon RDS, Amazon SimpleDB, Microsoft SQL Server, Oracle	MySQL	MySQL, Redis and MongoDB	SDK	SQL Azure
Development Tools	AWS Toolkit for Eclipse	IDE,SVN	Cloud Foundry integration Extension for Eclipse and STS	Web, API	SDK
PaaS Controlling	Web CLI, API	Web CLI, API	Web, API	Google Apps Support	Web
Tools and Plugins	New Relic	Sauce Labs Ondemand, JFrog, SonarSource, New relic, Cloudant			
Infrastructure Portability	-	Amazon, OpenStack, vSphere	Free from the underlying infrastructure, can be used for private Cloud and AWS		
Payment Model	PaaS not charged, payment on pay per use of underlying AWS resources used (EC2, S3)	Combination of subscription + pay per use based on services usage	Under establishment	PaaS not charged. Basic hosting with limitations, free of charge. Additional services under pay-per-use + subscription model	Access control and Service bus per transaction,

Current PaaS offerings also fit into at least one of the following classifications[5,6]:

Classification	Description	Examples
SaaS with extensions	Customize and extend the capabilities of a SaaS application.	Force.com
Purpose-built PaaS	A framework that simplifies the development of a specific class of applications.	Microsoft Windows Azure
PaaS tied to an application paradigm	Provides general capabilities, but supports only one programming model or development/deployment environment.	CloudBees, OpenShift Google AppEngine
PaaS tied to an IaaS Cloud	May provide general capabilities, but can be used only in the context of a determined IaaS Cloud; either a single public Cloud or a single type of private Cloud infrastructure.	Cloud Foundry AWS Elastic Beanstalk

Figure 6: Evaluation of PaaS providers

There are clear differences with the PaaS offerings, in terms of supported programming tools (languages, frameworks, runtime environments and databases), underlying infrastructure (private/public IaaS Clouds), and even the application administration toolsets available for each. With regards to programming tools, providers often follow the strategy of supporting as many languages and frameworks as possible in order to attract multiple programmer communities.

Not surprisingly, Java EE is widely adopted for web application development; it is currently supported by Google AppEngine, CloudBees, Cloud Foundry, and VMforce from Salesforce. com, amongst others. The management of the underlying infrastructure is also diverse. Cloud Foundry and CloudBees, for example, can use private or public IaaS and even support a degree of federation, or Cloud bursting, among providers. Some PaaS offerings are bound to specific IaaS offerings, i.e. AWS for AWS Elastic Beanstalk or Engine Yard, while others like OpenShift support interoperability among IaaS providers. In some cases, developers need to manage a directly generated, virtual infrastructure, in other cases, such as with Google App Engine, this process is completely transparent.

There is one common characteristic; **PaaS users are currently bound to the specific platform they use**, making portability of software (and data) created on top of these platforms difficult in some cases.

3.1.4 Business Opportunities

The impact of Cloud Computing on a commercial or not-for-profit organization's strategy is expected to be significant, but is still an area of much debate and experimentation. There are companies that have already been using Cloud as the primary means of doing business, but it is still too early to predict whether or not these models are sustainable (although they seem to be very profitable).

In particular, we see a huge ecosystem developing around OpenStack foundation, with lots of vendors building new offerings and business models, and using OpenStack in conjunction with many additional technologies in production, building solutions which couldn't have existed previously. The value moves from individual components, which become commodity and available to everyone, to solutions, services around integration, support, etc

The business benefits and strategic viability may be reasonably clear when considering an infrastructure Cloud or a software Cloud, but not so clear if looking at Platform-as-a-Service. Firstly, it is unclear what the platform's contribution is to the business strategy and secondly, the platform architecture's impact on the business model is not well defined. Because **the platform resides in the middle layer, it bridges the gap between functionality and the underlying technology**; it is linked to the technology and at the same time defines the available functionality of the application running on top of it that the user experiences. **For Platform-as-a-Service, it is not enough to provide these capabilities to the end user of the application; these capabilities must also be given to the application developer**. This places PaaS users into two categories: Software developers and Software consumers.

This opens up business opportunities for the provision of PaaS to companies in need of **a Cloud platform to develop generic business applications**, as well as the direct provision of PaaS to end users to build specialized applications to be used only within one company for a single specialized task. **This discloses PaaS as a toolbox that allows 'end users' to carry out quick-and-dirty programming, assuming that the platform is rich enough to provide most required components**. In this way, PaaS could even fit a specific vertical market as it could be enriched with the generic components for that market already preloaded.

We will see an explosion in industry PaaS (public platform as a service) offerings as the market moves up **the software stack and "horizontal" PaaS becomes commoditized by platforms** built on open source-based infrastructure.

- **In industry PaaS, cloud-based shared services environments are being tailored to the needs of a specific industry**, while additional industry-focused solution developers are developing and deploying a range of industry-targeted value-added solutions and services on these platforms. Examples of emerging industry PaaS include: NYSE Capital Markets Community Platform in financial services; numerous health information exchanges in healthcare; and Johnson Controls' Panoptix App Marketplace in smart energy.
- **The trend toward industry-specific solutions will be further driven by the increased participation of line of business (LoB)** executives in IT investment decisions. In 2013, nearly 60% of new IT investments will directly involve LoB execs (with them as the decision maker in 25% of the investments). As a result, IDC expects that businesses will spend $65 billion on industry-specific solutions in 2013, with a rapidly increasing number of them leveraging 3rd Platform technologies. This figure will grow to nearly $100 billion in the next 3 years as businesses use these technologies and solutions to create new products and services, and redefine existing customer relationships.
- **All of the trends outlined above – increased use of mobile devices and apps and the migration toward SaaS and industry PaaS** – will also drive profound changes in the datacenters and IT organizations supporting these 3rd Platform solutions. Here, converged systems (combining server, storage and network systems together with the software to manage them) and software-defined

networking will transition from market hype to market reality in 2013 with enterprise datacenter and cloud-provider use cases coming to market and getting deployed. Both nascent datacenter technologies will show explosive growth in 2013, reaching a remarkable 30-35% penetration in the datacenter by 2016.

Additionally, There are two businesses models for online/cloud storage that we primarily see today**:**

- The utility model, where usage is metered at a per-GB rate. Transfer and storage are separate line items, as are accesses and updates (e.g., GET/POST/PUT operations). This is more of a true cloud-like service.
- The "quota" model, where storage is offered in blocks or quotas (50GB, 100GB, etc). This is usually a flat rate and will include all the items metered in the utility-model above, with overage charges for exceeding the quotas. This is less of a cloud service and more of an online storage service.
- Service layers can be offered on top of the infrastructure for additional fees - support, management, specialized access methods (e.g., special backup software).
- Performance or other service level guarantees are a way to increase revenue. Premium pricing for guaranteed level of performance, etc.
- Other value-added services can generate additional revenue. Special features, interconnectivity with other services, integration with third-party services, etc.

3.1.5 Cloud Computing Benefits

By integrating OpenStack with our implementation of automated monitoring and configuration tools, which increase our automation of resource management, we are now able to deliver:

- Rapid provisioning of new capacity for application developers
- Support for an active/active application design that through greater redundancy and automation enables us to make faster progress toward our goal of zero downtime for cloud architected applications
- Shorter software upgrade cycles enabling faster implementation of the latest improvements, features and functionality, leading to more state-of-the-art, consumable cloud services
- Improved service levels and compliance

Even without consideration of future business scenarios, it is clear that **utilizing PaaS brings immediate business benefits and opportunities for development communities**:

- Convergence of frameworks, and improvement of user management and of framework deployment.
- Facilitation of collaborative work between teams.
- Possibility to develop and test Cloud-ready applications.
- Immediate provisioning of environments for a new project.
- Immediate decommissioning of no longer needed environments.
- Improved management of licenses.
- No more fixed assets for computing and storage.

In addition**, applications built on mature platforms will accelerate business strategy change to accommodate a more flexible and sustainable application landscape**. We believe that most core internal processes have ‘good enough’ IT and automation capability. Calling on mature PaaS will enable organizations to focus on strategic issues, because:

- It offers a response to the **increasing speed of business and the necessity to be 'first-to- market'**. A capable PaaS platform will potentially allow a significant shortening of the time-to-market for applications.
- The nature of PaaS enables it to **bridge technology and user functionality with all kinds of built-in capabilities for billing, orchestration of workflow, auditability**, and compliance reporting. That facilitates a focus on better and more flexible interfaces for users, specifically when coupled with mobile devices.
- The same PaaS capabilities will allow for a built-in **connection between real-time business data and the business intelligence** that can be derived from historic data and other data mining technologies.
- Finally, through inheritance of the underlying Cloud aspects, PaaS will force the business strategy to become service-driven. Based on these viewpoints, **PaaS enables an IT services company to provide both a generic platform and a very specialized environment for developers**, for general purpose development and for specialist developers alike.

It also allows an IT services company to provide a flexible IT infrastructure layer, and makes possible the concept of all applications having a common messaging infrastructure, allowing for reduced overhead, and uniform communication, reporting, provisioning and billing.

3.1.6 Conclusions

We have learned through our experience that **open source and standards allow developers to share information more quickly and easily, and at lower costs**. This leads to greater innovation. We are at an inflection point. We're focusing the industry on important standards for interoperability, and their open source reference implementations will:

- Ensure that end users have a strong voice in establishing and adopting cloud computing paradigms
- Reduce barriers of entry into cloud computing, such as development skills and freedom of choice
- Increase the long-term viability of today's cloud investments
- Prevent unnecessary architectural complexity and fragmentation

Having a **variety of highly innovative and open technologies drastically boosts innovation across the entire ecosystem**, and enables creation of highly complex and capable custom-built solutions using solely open source technologies. This also creates a new market of services specializing in building such solutions in the enterprise. In particular, **we see a huge ecosystem developing around OpenStack foundation**, with lots of vendors building new offerings and business models, and **using OpenStack in conjunction with many additional technologies in production, building solutions which couldn't have existed previously**. The value moves from individual components, which become commodity and available to everyone, to solutions, services around integration, support, etc. Consequently we recommend the following:

- **Take advantage of open source software**. The open source movement has moved from the periphery of the IT industry to weave itself into its very heart. An increasing number of enterprises, both small and large, are taking advantage of open source software, both directly and indirectly (when the commercial software they buy relies, in part, on open source components). Those that shun open source software are increasingly at a disadvantage.
- **Take advantage of the growing array of technologies at your disposal**: CloudStack and OpenStack open source technologies are available for anyone to try or adopt. There are also many other open source IaaS offerings available to test, including those from Abiquo, Eucalyptus, and Joyent. Enterprises should take advantage of this and share their conclusions.
- **Try CloudStack and OpenStack**: Although many like to pitch them against each other, the reality is that both **CloudStack and OpenStack provide a useful alternative to existing private and public**

IaaS platforms, both open source and proprietary, from a variety of providers, including large vendors such as AWS and VMware, as well as small startups such as Abiquo and Eucalyptus.

Although standalone PaaS business is relatively small within the current overall Cloud market, it is clear that it constitutes a clear opportunity for IT service providers within the relatively short term. PaaS users have current and emerging need sets which must be addressed by PaaS in the near future in order to enable applications to exploit the full potential of Cloud:

- Increased ability to interface with legacy applications.
- Increased support for automated deployment.
- Added features/methods for reaching higher availability levels.
- Interoperability at all levels.
- Market-tailored 'verticalization' of features; adaptation of the platform to tailor it for specific uses.

We will see an explosion in industry PaaS (public platform as a service) offerings as the market moves up **the software stack and "horizontal" PaaS becomes commoditized by platforms** built on open source-based infrastructure.

3.2 Big data: How the revolution may play out?

Until the end of the 1990s, computer performance increased rapidly enough to meet growing data storage and processing needs. However since then, several major changes in the IT world have dramatically increased this rate of growth. The first was the expansion of the Internet that allows global access to huge amounts of information and led to a need for efficient tools, typically search engines, to process it. The second was the rise of Web 2.0, which offers everyone the ability to generate and share their own data (i.e. blogs, YouTube, Facebook, etc.). Next will probably be the development of the Internet of Things, and Context-Aware Computing (CAC), which will bring data storage requirements and associated information processes to an even higher level. Computer capabilities have not increased fast enough to meet these new requirements. When data is counted in terabytes or petabytes, traditional data and computing models can no longer cope.

The first companies to face this issue were the big Internet players: Providers of search engines and web portals, and major e-commerce players. Their answer was to develop solutions that feature horizontal scalability; that are able to scale information to arbitrarily large clusters of computers and enable performance to grow linearly with the size of these clusters. At the beginning, these solutions were specifically developed and designed in house to run internally. Then, in order to share efforts, some open sourced their solutions and started working collaboratively on them. As a result, Open Source solutions are at the forefront of massive data management.

Big Data Management is becoming a key issue in the IT world. To deal with it, the Open Source world is providing numerous solutions, often powerful, but often immature as well. In this paper, we focus on two major technologies: NoSQL solutions and MapReduce frameworks. We provide a general description of the principles behind these technologies, an overview of some of the available solutions and we discuss their capabilities and their limits.

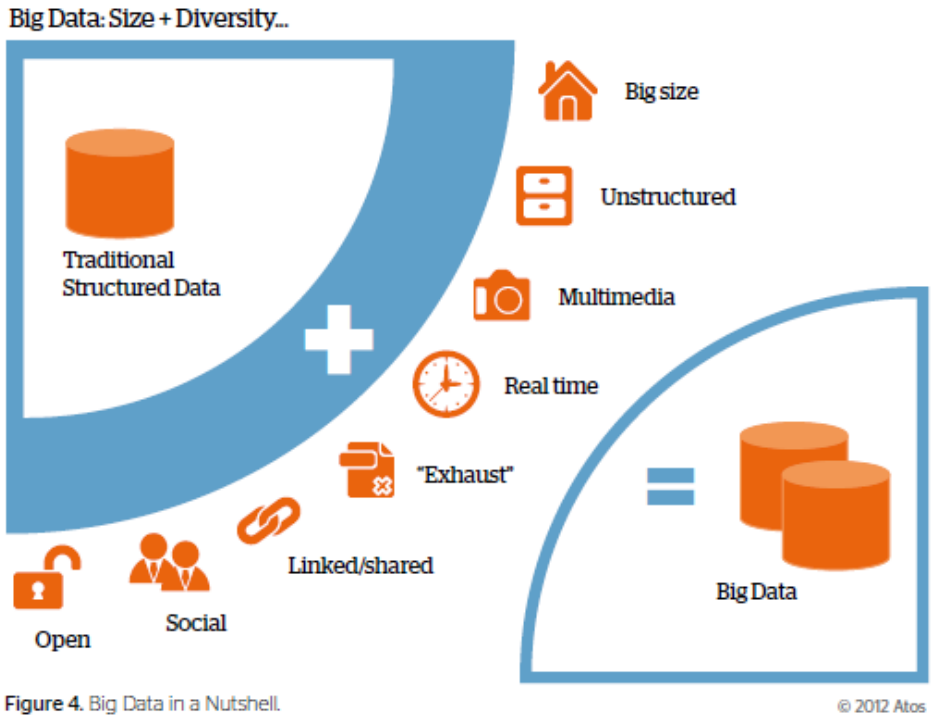

Figure 7: Big Data in a Nutshell

Most corporate big data projects are in their infancy. As a result, many are looking to combine data warehouse information with other data to be prescriptive. Together experience, sales and analytics. Social media and multiple channels also mean that companies need to look for patterns in streaming data.

- When pitching big data to business leaders you need to start with this question: What business questions need to be answered?
- Hadoop clusters are surfacing everywhere in corporate America.
- Governments and the ability to provide datasets can create entire industries. Under this theory, governments will essentially be data providers as one of its primary functions.
- Data analytics as a service and data visualization as a service will become commonplace. Third party vendors will move toward big data as a service to make it consumable for the masses. Tech vendors to go this route are likely the big market share leaders today (IBM, SAP, Oracle, Salesforce.com).

Big Data is a business enabler and its benefits multiply when aggregated with other emerging disruptive technologies. For example, combining Big Data, Pattern Based Strategy and Cloud technologies provides a model for **"Data Analytics as a Service**". From a business perspective, "patterns of value" will map themselves to concrete use cases, some general and some industry-specific. The more transformative gains will come from beyond the "Business as usual, only with more data" models. Concepts like Data Transparency, Personal Data, 'Data as a Service', and Pattern-Based Strategy will alter the way business works and even encourage the creation of new businesses

3.2.1 Big Data´s Market

Big Data will generate "big numbers" in 2013 as data volumes continue to mushroom and Big Data analytics investments boom:

- **The "digital universe" will expand by almost 50%, reaching 4ZB**. In 2013, IDC predicts that the "digital universe" the total of all digital data created (and replicated) will reach 4ZB, almost 50% more than 2012 volumes and nearly a quadrupling of 2010 volumes. And by the way given the rapid emergence of new data capture and generation technologies and solutions, it's almost certain that we're underestimating the volume and growth.
- **The Big Data investment/M&A focus will shift, with "discovery" and predictive analytics hot spots**. Spending on Big Data technologies and services will reach nearly $10 billion in 2013, on the way to over $20 billion in 2016. In the past several years, we've seen about 65–70% of VC funding on the infrastructure and information management layers of the Big Data stack. In 2013, IDC predicts a shift of VC funding and M&A toward **the upper half of the Big Data stack: analytics and discovery tools and analytic applications.** There's already been some activity from IBM, SAP, and Oracle, but we predict acceleration in this investment focus, with emphasis **on tools and applications that go way beyond "search" to graph analytics associated with "discovery" and finding hidden relationships/patterns**. The growing focus is on technologies that incorporate advanced analytics functionality, including predictive analytics. Recent VC funding recipients include Ayasdi, Medio Technologies, and AgilOne all founded on the basis of applying advanced analytics such as machine learning and topology analysis to Big Data. In the M&A area, we expect visual discovery, predictive analytics, and text and rich media analytics market segments to be scanned for new acquisition targets by larger vendors such as Microsoft, IBM, Oracle, SAP, EMC, Dell, and Hitachi.

Finally, big data will continue on its growth path, with investment in technologies and services growing to nearly $10 billion in 2013. But the focus of this investment will see an important shift in 2013, as more VC funding and M&A goes toward the upper half of the big data stack: analytics and discovery tools, and analytic applications. **IDC expects predictive analytics will be a particular hot spot in the months to come.**

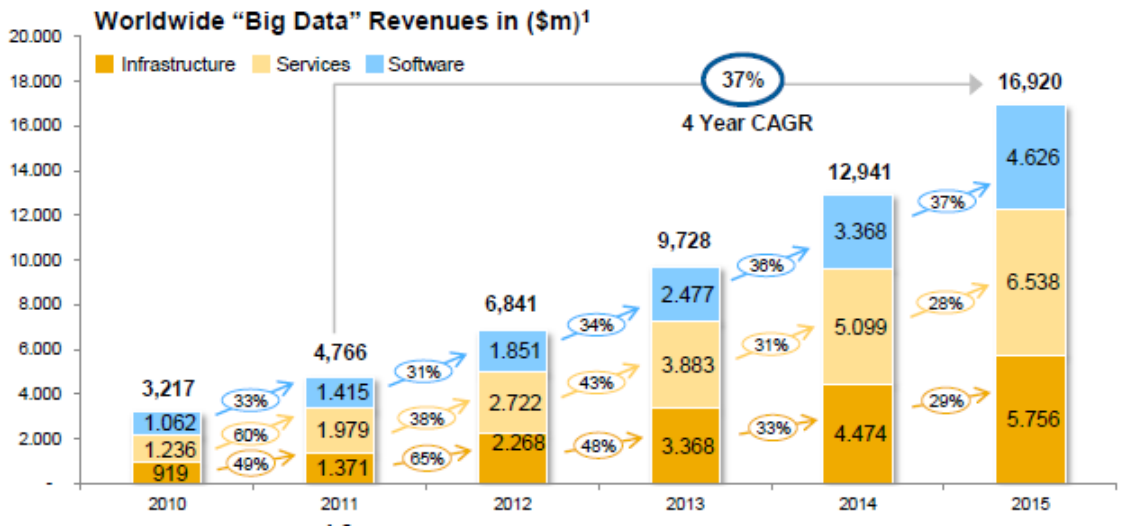

Figure 8: Worldwide "Big Data" Revenues

- Hadoop/MapReduce ecosystem growth accelerates as vendor-supported tools and certified configurations emerge.
- "Big Data" services opportunities will span a broad range of IT, analytics, and business process-related professional services
- Storage growth driven by adoption of commodity systems for Hadoop clusters; future demand driven by customers looking to do analytics on archived data sets

3.2.2 Big Data´s Trends

By the end of 2012 more than 90 percent of the Fortune 500 will likely have at least some BD Initiatives under way. Industry revenues will likely be in the range of $1-1,5 billion**. But industry is still in its infancy**.

Historically most of the world´s accessible data has been located in traditional relational databases accessed and managed with a certain set of tools and analyzed and reported on with business intelligence software. The ability of those tools and software applications to cope with larger and larger datasets has grown over time (social networks, real time consumer behavior, mobility, sensor networks and other data generating sources have caused many organization data warehouses to overflow) but in general **any set of data that was viewed as being "too big" or needing results "too fast" was seen as requiring an entirely new set of tools, most commonly referred to as big data tools.**

Not surprisingly, the first movers were Internet companies: in fact the most popular big data tools are being built on top of software that was originally used to batch process data for search analysis. The fast followers sectors are likely to be public sector, financial services, retail and entertainment and media. Big Data is still early in the adoption cycle of Big Data technologies, and most of the companies who are doing Big Data do not disclose their spending. **Another barrier is that Big Data work is primarily based on open source code**: the initial software is free and the real spending comes from internal IT staff adapting the code.

Big Data´s potential is likely to pivot on context: when organizations recognize that Big Data´s ultimate value lies in generating higher quality insights that enable better decision making, interest and revenues should accelerate sharply. **An 'Ecosystem' of new data management tools is taking shape**, covering the various layers of the data stack in the enterprise and delivering a 'Total Data' approach. This 'layered stack' will be complemented with specific tools and methodologies to handle critical aspects of Policy Governance, including security, privacy and IP protection. Overseeing it all, an overarching Data Strategy approach needs to be developed.

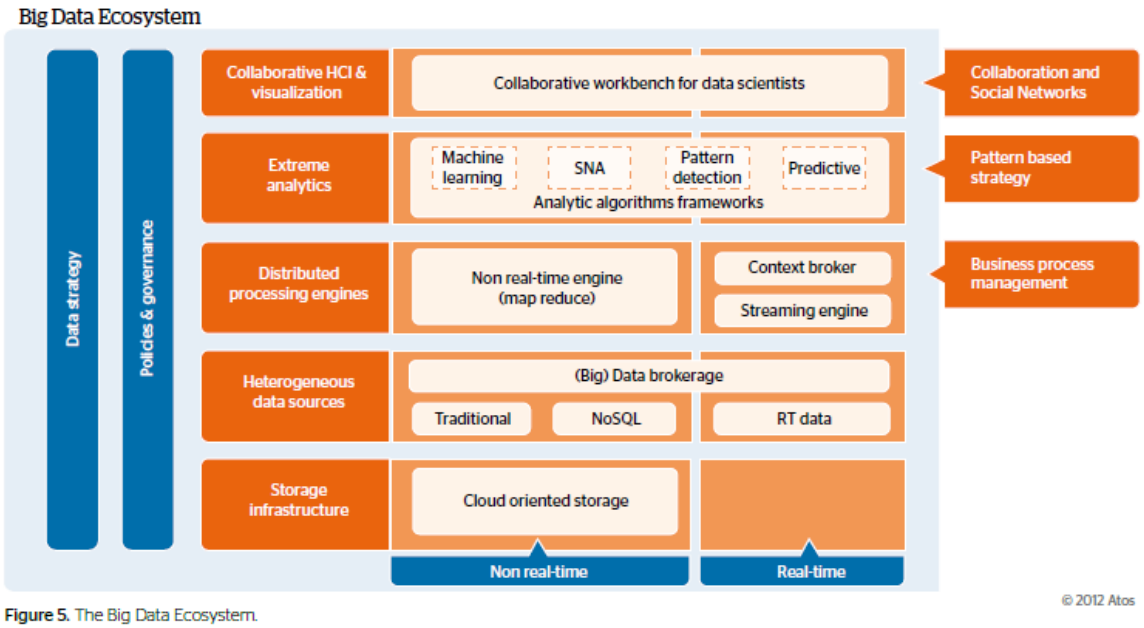

Figure 5. The Big Data Ecosystem.

Figure 9: Big Data Ecosystem

Clearly, we're in a big data hype cycle that we put on par with the Linux and open source software craze in the late 1990s and early 2000s. Back then, Linux was going to change the world, kill Microsoft and other things. In many respects, Linux and open source software (Android for instance) did change everything. But open source software became commonplace in every data center and now is take for granted. The revolution happened, but we just stopped talking about it as much. Cloud computing is playing out in a similar fashion

Big data will follow this cycle too. Sure, millions of jobs will be created. Companies will also reinvent their industries. The vendor pecking order will be altered as startups like Cloudera become the new Red Hats. **There will probably be a big data backlash of some sort.** Here's the big data progression as we look ahead.

- **2013**: Those 2012 pilots become production systems. Every vertical will have a big data success story. Oddly enough, success stories will be everywhere. Why? The big data projects are initiated by the business CEOs, CFOs, CMOs---and IT is seen as an enabler not a cost center.
- **2014:** Based on 2013 success stories and customer case studies, the fast followers will enter the big data game. Industries will all follow a big data playbook. Initially, these early returns will look good. Companies will primarily focus on internal data because there's a lot to mine there. Incorporating external data will be a nice to have, but nothing more at this stage.
- **2015:** Companies will begin to look at external data in their big data plans. Before 2015, consumer facing companies spent the most time with external information and using it. Every analytics and data warehousing stack will have a Hadoop cluster and big data layer. Technologies like Hadoop cease to be a focus because they remain important, but fade into the software stack as a given. Big data mergers and acquisitions pick up steam.
- **2016:** By this point, big data is seen as a utopia of sorts and now companies have to start really thinking about the data and avoiding errors and correlations that aren't meaningful. There will be spectacular errors as companies incorrectly reject hypothesis, adopt other ones and mistakenly conclude that there are relationships between data that are meaningful.
- **2017**: Cloud combines with big data and data warehousing as a service, analytics as a service and data as a service become the norm. Few companies actually think of building their own Hadoop clusters doing the integration work. Big data infrastructure is just there. Note: 2017 is a guess on when these big data as a service effort will be common to the masses. The big data as a service game is starting now, but will hit critical mass later.

3.2.3 Evaluation of Big Data´s providers

Open Source relational databases are high performance tools that have reached a high level of maturity. These databases include a lot of features that Atos' customers require and that NoSQL solutions do not currently provide without additional client code. Typical examples include rollback capabilities, backup, and right management. In addition, consistency, as explained later in this paper, is not an issue. NoSQL solutions are comparatively recent, have evolved quickly, but are generally considered to still be immature. They are used in production for large-scale projects; however feedback tends to show that their usage is still considered experimental. Using NoSQL solutions requires specific expertise so, often, companies using them bring in the experts who developed the solution for help.

The most well-known and recognized NoSQL solutions are being considered:

- HBase - Clone of Google BigTable, adapted to massive data storage based on Hadoop, developed by Powerset (acquired by Microsoft), and used by Yahoo and Microsoft.
- Cassandra - Similar to HBase, developed by Facebook.
- Hypertable - Clone of HBase claiming higher performance, supported by Baidu.

- Voldemort - Pure key-value store, oriented toward low latency, high performance, adapted to medium-sized clusters, developed by LinkedIn.
- Membase - Based on Memcache, developed by Zynga.
- MongoDB - Designed for storing semistructured documents, developed by 10gen.
- CouchDB - Another document-oriented data store, similar to MongoDB.

Four NoSQL data models exist:

- Key-value stores: use the most basic NoSQL data model. Key-value stores are distributed, persistent hashtables. Data is stored in small chunks (bytes or megabytes) and linked to a key. Data can be retrieved using this key. Among the NoSQL solutions investigated, Voldemort and Membase are key-value stores.
- Column-oriented data stores: are similar to key-value stores, except that they use bidimensional keys (rows and columns) with data stored in columns. As a result, the data stores are optimized for accessing blocks of consecutive elements in the same columns. The ancestor of column-oriented data stores is Google BigTable, which is used by Google to store a complete copy of the Internet. The most well-known Open Source NoSQL solutions are based on this data model: Cassandra, HBase, and Hypertables.
- Document-oriented data stores are also based on key-value stores, but the data associated with each key is a semi-structured document (typically JSON or XML). Advanced queries based on specific properties of these semi-structured documents are available. MongoDB is the most widely used document-oriented database.
- Graph-oriented databases are designed to store and query graph-structured data. The main graph-oriented database is Neo4

All NoSQL solutions claims to reach high levels of performance and high levels of scalability, although the few benchmarks available do not seem reliable, in particular because they are often contradictory. Atos' ongoing evaluation of NoSQL solutions includes measuring the performance of a cluster of five quad-core servers on which each of the cited NoSQL solutions has been installed. Performance is measured by the number of queries per second that the system can handle in various scenarios: Read only, read-write, updates, read while load balancing, etc. Preliminary results show that:

- Voldemort, which advertises very high performance and availability, but at a price in terms of data consistency, actually performs much better than other solutions.
- HBase, Cassandra, Membase, and MongoDB achieve similar results.
- CouchDB does not scale properly and performs much worse than other solutions.

However, it should be made clear that raw performance on a small cluster only provides partial information about real performance on a system: No indication about a solution's ability to scale on larger clusters is given.

Open Source Solutions Summary

	Cassandra	HBase	Voldemort	Membase	MongoDB	CouchDB
Type	Column-oriented	Column-oriented	Key-value	Key-value	Document-oriented	Document-oriented
Maurity	***	***	***	*	***	**
Support	****	****	***	*	***	***
Typical use	Massive amount of data	Massive amount of data	Heavy load	Heavy load	Rich querying, Heavy load	Rich querying
Typical cluster size	Up to hundreds of servers	Up to hundreds of servers	Up to tens of servers	Up to tens of servers	Up to tens of servers	Some servers
Specific multi-site management	Yes	Yes	No	No	Yes	No
Map.reduce processing support	Yes	Yes	No	No	Yes	Yes
Performance	***	***	*****	***	***	*

Figure 10: Open source Solutions

The Map Reduce Framework

MapReduce is a framework which provides the necessary tools to distribute processing tasks to an arbitrarily large cluster of computers. It was developed by Google for internal use. Google published its principles, which have since been implemented in several Open Source tools, in particular in Apache Hadoop.

In the MapReduce Framework, every data processing task is divided into two steps: the Map step and the Reduce step. In the Map step, the task is divided into independent subtasks which are executed in parallel by Map processes, running on distinct servers. In the Reduce step, results of the Map processes are recursively merged by Reduce processes, which also run in parallel on distinct servers, until the final result is computed.

For example, assume one wants to count the number of occurrences of some given strings in a NoSQL database. A split process divides the problem into autocontent data using specific criteria. In this case, the data are sentences. Each Map process counts the number of occurrences of each of the strings in a single data node. Each Reduce process adds up the outputs of Map processes for a given string.

Hadoop and the Hadoop Ecosystem

Hadoop, and its ecosystem, is the main distributed-computing framework. It is an Open Source project supported by the Apache Foundation. Its main contributor is Yahoo, but most big players use it, including Microsoft, EBay, Google, Facebook, Amazon, Rackspace, and many others.

Hadoop includes a file system; Hadoop Distributed File System (HDFS), which allows file storage on large clusters of data nodes in a transparent way. It is a file storage system which can handle a limited number of (potentially big) files (not more than a number of millions before memory issues appear), and therefore cannot be considered to be a NoSQL solution. However, it is suitable for many data storage tasks, as long as the data can be stored sequentially. In particular, it is perfectly suitable for data stream storage, for example, for log storage. Hadoop includes a MapReduce implementation in Java.

Hadoop comes with a set of tools, called the Hadoop ecosystem, which include:

- Pig and Hive - two high-level languages built over Hadoop MapReduce that hide its complexity. These tools allow users to write basic distributed data processing tasks quickly without any knowledge of distributed computing. It is estimated than 30 percent of Hadoop jobs run at Yahoo are actually Pig jobs.
- ZooKeeper, an administration tool for large Hadoop clusters.
- HBase, the Hadoop NoSQL solution built on top of HDFS, already mentioned above.

What is Hadoop used for?

Hadoop is usually used by companies to run batch computations, in order to analyze stored data. Typical applications are:

- Data mining – To get relevant information about users' behaviour, anomalies in a system, suspicious network access, etc. where terabytes of logs are stored.
- Image processing – When basic image processing services, like resizing and conversion, or more advanced processing services, like facial recognition, are provided to website users and millions of images have to be processed.
- Web crawling – When an application is being run, typically a specialized search engine, that needs to process large parts of the Internet, a Hadoop cluster can help.

It should be noted that the MapReduce algorithm in general, and Hadoop in particular, have been written with batch computation in mind, and are **therefore not suitable for real-time computation**. When real-time results are required, answers to queries should be based on results already computed and stored in a NoSQL database. Recently, a new generation of distributed computing frameworks designed for real-time computation has been introduced. These include Google Caffeine and Yahoo S4, the latter has, interestingly, been open sourced by Yahoo. Yahoo S4 is presented as an Open Source distributed-stream processing platform. It is still an immature tool (still in alpha version), but is already seen by many as the future of Open Source distributed computing. Until recently, only a couple of big Internet players were concerned by the issue, but things are changing fast and now more companies have to handle massive amounts of data.

3.2.4 Business Opportunities

After years of struggling to capture and manage growing data volumes, **service providers across the globe are realizing that Big Data is a great business opportunity:**

- Storage costs rising: The first challenge resulting from this growth is the operational aspect: how can service providers manage all of this data? Where will they store it, how can they secure it and how will they back it up? The reality is that without a significant change in their approach to data and operations in general, service providers will realize that the economics of the business simply don't add up. Although the cost to store a gigabyte of data is declining, data usage is increasing to such a degree that the hardware spend required to keep up with that demand is actually continuing to rise. According to Barclay's Capital, data stored by businesses is expected to increase by 42 percent in the five-year period finishing in 2014, which will cause storage spending by those organizations to increase by nine percent during that same period. So as service providers look at their operational environment, **we can expect to see an increasing focus on architecture, and applications and systems that are Big Data-aware.**
- Business upside: But we're still in the early stages. After years of struggling to capture and manage growing data volumes, service providers across the globe are now starting to realize that although Big Data is an operational challenge, it is also potentially a great business opportunity. We've already seen several examples in the service provider industry. **Telefónica UK recently launched Dynamic**

Insights, a global Big Data business unit. Smart Steps, Dynamic Insights' new app, helps track crowd movements in specific areas, with the ability to query details such as gender, while blocking knowledge of specific users (to uphold privacy standards). This information has already been used to help determine optimal locations for retail stores.

- Getting predictive: Telenet in Belgium is using predictive analytics for a more targeted customer approach, by analyzing specific details about customers and providing the insight to sales personnel. Telenet used its large amount of historical customer data to turn its customer care call center into a key part of the company's business. Sales following a customer call doubled within six months after applying these new methods. Amazon is of course one of the pioneers in the broader business environment in terms of analyzing data and driving predictions. **Big data is not only about analytics, it's about the whole pipeline. So when you think about big data solutions, you have to think about all the different steps: collect, store, organize, analyze and share**.
- What it means for service providers: Big Data is a chance for service providers to regain **the lead in customer experience by building operations that are ready to capture data and adding analytics to offer proactive and contextual experiences**. As they learn more about users' behaviors and tendencies, service providers will be able to create new monetization opportunities while pleasing their end customers.

Big data has the potential to revolutionize management. Simply put, because of big data, managers can measure, and hence know, radically more about their businesses, and directly translate that knowledge into improved decision making and performance. Of course, companies such as Google and Amazon are already doing this. After all, we expect companies that were born digital to accomplish things that business executives could only dream of a generation ago. **But in fact the use of big data has the potential to transform traditional businesses as well.**

We've seen big data used **in supply chain management** to understand why a carmaker's defect rates in the field suddenly increased**, in customer service to continually scan and intervene in the health care practices** of millions of people, in planning and forecasting to better anticipate online sales on the basis of a data set of product characteristics, and so on. Here's three example of using new flows of information to radically improve performance.

Case #1: Using Big Data to Improve Predictions

Minutes matter in airports. So does accurate information about flight arrival times: If a plane lands before the ground staff is ready for it, the passengers and crew are effectively trapped, and if it shows up later than expected, the staff sits idle, driving up costs. So when a major U.S. airline learned from an internal study that about 10% of the flights into its major hub had at least a 10-minute gap between the estimated time of arrival and the actual arrival time — and 30% had a gap of at least five minutes — it decided to take action.

At the time, the airline was relying on the aviation industry's long-standing practice of using the ETAs provided by pilots. The pilots made these estimates during their final approach to the airport, when they had many other demands on their time and attention. In search of a better solution, the airline turned to PASSUR Aerospace, a provider of decision-support technologies for the aviation industry.

In 2001 PASSUR began offering its own arrival estimates as a service called RightETA. It calculated these times by combining publicly available data about weather, flight schedules, and other factors with proprietary data the company itself collected, including feeds from a network of passive radar stations it had installed near airports to gather data about every plane in the local sky.

PASSUR started with just a few of these installations, but by 2012 it had more than 155. Every 4.6 seconds it collects a wide range of information about every plane that it "sees." This yields a huge and constant flood of digital data. What's more, the company keeps all the data it has gathered over time, so it has an immense body of multidimensional information spanning more than a decade. RightETA essentially works by asking itself "What happened all the previous times a plane approached this airport under these conditions? When did it actually land?"

After switching to RightETA, the airline virtually eliminated gaps between estimated and actual arrival times. PASSUR believes that enabling an airline to know when its planes are going to land and plan

accordingly is worth several million dollars a year at each airport. It's a simple formula: Using big data leads to better predictions, and better predictions yield better decisions.

Case #2: Using Big Data to Drive Sales

A couple of years ago, Sears Holdings came to the conclusion that it needed to generate greater value from the huge amounts of customer, product, and promotion data it collected from its Sears, Craftsman, and Lands' End brands. Obviously, **it would be valuable to combine and make use of all these data to tailor promotions and other offerings to customers, and to personalize the offers to take advantage of local conditions.**

Valuable, but difficult: Sears required about eight weeks to generate personalized promotions, at which point many of them were no longer optimal for the company. It took so long mainly because the data required for these large-scale analyses were both voluminous and highly fragmented — housed in many databases and "data warehouses" maintained by the various brands.

In search of a faster, cheaper way, Sears Holdings turned to the technologies and practices of big data. As one of its first steps, **it set up a Hadoop cluster**. This is simply a group of inexpensive commodity servers whose activities are coordinated by an emerging software framework called Hadoop (named after a toy elephant in the household of Doug Cutting, one of its developers).

Sears started using the cluster to store incoming data from all its brands and to hold data from existing data warehouses. It then conducted analyses on the cluster directly, avoiding the time-consuming complexities of pulling data from various sources and combining them so that they can be analyzed. This change allowed the company to be much faster and more precise with its promotions.

Case #3: Healthcare Opportunity

The medical industry has had data for generations: clinical studies, insurance data, hospital records. But the health care industry is now awash in data in a way that it has never been before: from biological data such as gene expression, next- generation DNA sequence data, proteomics, and metabolomics, to clinical data and health outcomes data contained in ever more prevalent electronic health records (EHRs) and longitudinal drug and med ical claims. We have entered a new era in which we can work on massive datasets effectively, combining data from clinical trials and direct observation by practicing physicians (the records generated by our $2.6 trillion of medical expense). When we combine data with the resources needed to work on the data, we can start asking the important questions, the Wanamaker questions, about what treatments work and for whom.

The opportunities are huge: for entrepreneurs and data scientists looking to put their skills to work disrupting a large market, for re searchers trying to make sense out of the flood of data they are now generating, and for existing companies (including health insurance companies, biotech, pharmaceutical, and medical device companies, hospitals and other care providers) that are looking to remake their businesses for the coming world of outcome-based payment models. Among the possibilities:

- Network optimization.
- Fraud detection.
- Seeing what the customer experiences.
- Healthcare simulations.
- Consumer focused marketing efforts require more social networking analysis and predictive capabilities. Consumer data is inherently unstructured.
- Travel and expense management to make intelligent decisions about costs. For instance, a company could notice it is sending too many people to one conference with aggregated data across 200,000 employees.
- Marketing support and tracking of attrition rates in a subscriber-based business.

- Closer ties between partners and suppliers via collaborative data and insight sharing.

3.2.5 Big Data benefits

Big Data has numerous potential benefits. Specific characteristics of each vertical sector may differ, but some concrete business patterns are already attracting attention.

- High-resolution Customer Knowledge derived from a complete "data footprint".
- Advanced Forecasting from Pattern Based Strategy and AI-based Predictive Analytics.
- Hidden Business Pattern Detection, for example in enhanced fraud detection.
- Enhanced Automation in Machine-to- Machine systems, for quicker response.
- Transparency using enhanced data availability from OpenData models.
- Enhanced Data Experimentation validating hypotheses by data, rather than "gut feel".
- Innovative New Business Models such as Data as a Service (DaaS) providers

In addition, we believe that emerging fields, like Internet of Things and Context-Aware Computing, which necessarily involve the ability to manage lots of data, **will become key fields in the near future**.

3.2.6 Conclusions

We believe there is a more fundamental transformation of the economy happening. We've become convinced that almost no sphere of business activity will remain untouched by this movement. **Without question, many barriers to success remain**.

- There are too few data scientists to go around.
- The technologies are new and in some cases exotic.
- It's too easy to mistake correlation for causation and to find misleading patterns in the data.

The cultural challenges are enormous, and, of course, **privacy concerns are only going to become more significant**. But the underlying trends, both in the technology and in the business payoff, are unmistakable

Big Data´s potential is likely to pivot on context: when organizations recognize that Big Data´s ultimate value lies in generating higher quality insights that enable better decision making, interest and revenues should accelerate sharply. **An 'Ecosystem' of new data management tools is taking shape**, covering the various layers of the data stack in the enterprise and delivering a 'Total Data' approach. This 'layered stack' will be complemented with specific tools and methodologies to handle critical aspects of Policy Governance, including security, privacy and IP protection. Overseeing it all, an overarching Data Strategy approach needs to be developed.

NoSQL and distributed-computing technologies provide immature yet powerful solutions to Big Data challenges. Understanding their capabilities and their limits are key. Interestingly, most of these solutions are Open Source. This usually means that users do not depend on a single vendor, but that a higher level of expertise is required.

3.3 The Internet of Things: Becoming reality

In just the last few years, we have moved beyond simply using our machines to connect with other people and can now program them to connect directly to one another, allowing for the collection and processing of information on an unprecedented scale. The new connectivity of both physical infrastructure and devices is being referred to as the 'Industrial Internet', or the 'Internet of Things', while the technology that facilitates this connectivity is most commonly called 'Machine-to-Machine' (M2M).

The Internet of Things will consist primarily of machines talking to one another, with computer-connected humans observing, analyzing and acting upon the resulting 'big data' explosion. **Here's how the next internet revolution is shaping up**

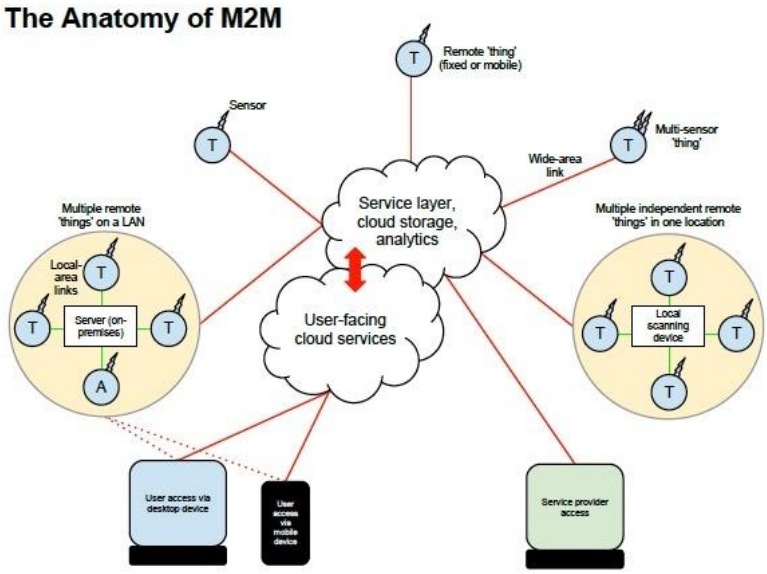

Figure 11: The anatomy of M2M

As the internet and in due course the worldwide web developed, more kinds of (increasingly mobile) computing devices became connected, and web servers delivered ever richer content with which they could interact. Although this first internet/web revolution changed the world profoundly, **the next disruptive development, in which the majority of internet traffic will be generated by 'things' rather than by human-operated computers,** has the potential to change it even more.

This 'Internet of Things' (IoT), or more prosaically 'Machine to Machine' (M2M) communication, is well under way after all, microprocessors are to be found in all manner of 'things': domestic white goods, cars, credit cards, your passport, your family pet, the CCTV camera in your street, the lift (elevator) in your office and many more. Add the magic ingredient of **internet connectivity** (or the ability to be read by an internet-connected device), bake with **applications and services that make use of the data gathered by this vastly expanded network,** and you've cooked up another technology revolution

By 2020, there will be 12.5 billion M2M devices globally, up from 1.3 billion devices today (Hatton 2012). To put this in perspective, mobile Internet use, which is also fast becoming a part of our daily experience, is growing at only a fraction of the rate of M2M, and the 400 million mobile Internet users of 2007 are predicted to grow to two billion users by 2015 (Richmond 2011). This continued rise in connectivity will not only improve our lives, it will also generate substantial economic benefits. The M2M industry is projected to maintain 23 percent annual growth rates over the next decade, and what is today a $121 billion business will be worth $948 billion by 2020 (Hatton 2012).

Moreover, these technologies provide an unprecedented opportunity to improve society's resource and time efficiency. The connected machines of the Industrial Internet are capable of generating both cost

savings and new revenues that in total could add $10–15 trillion to global GDP the current size of the U.S. economy over the next 20 years (Evans & Annunziata 2012). Better still, across many industries M2M technologies will reduce the amount of energy or fuel required to get the job done, lowering greenhouse gas (GHG) emissions without constricting production, consumption, or economic growth. **M2M applications in the Energy, Transportation, Built Environment and Agriculture sectors** are the most promising, each offering the potential for profitably reducing GHG emissions

Whether the Internet of Things comes to pass in a satisfying way will depend critically on **how the emerging M2M ecosystem is architected. M2M and the Internet of Things have huge potential, but currently comprises a heterogeneous collection** of established and emerging, often competing, technologies and standards (although moves are afoot here). This is because the concept applies to, and has grown from, a wide range of market sectors.

Historically, application development is done either in-house by the enterprise or through an SI [systems integrator]. **Enterprises then build or source their own M2M platform, and then they buy connectivity through the mobile operators**. It is pretty much the same situation today: a fragmented marketplace. There is no single, one-stop shop. The market is fragmented and there are very few standards [and] you literally have hundreds of small developers, you have the [network] operators, you have the hardware manufacturers, and you have customers in the marketplace who are just beginning to understand what M2M is. So, our view is that **the criticality of partnerships is really important**.

M2M can, in many instances, be tied back to a hard return on investment (ROI), as well as helping to deliver back to the business stronger Business Intelligence, driving customer engagement, cost saving, **business process efficiencies, innovation, and potential new revenue streams.**

3.3.1 M2M Market: a Growth Market

The M2M market itself is measured in revenue, connections, devices, and efficiency increases. This last metric is what gives M2M such great potential to reduce greenhouse gas emissions.

- **Revenue:** Based on several external surveys Intel expects 15 billion connected devices in 2015 Cisco expects 25 billion devices connected in 2015, and Ericsson plans are around 50 billion connected devices in ten years. Over the next seven years, M2M technologies are projected to experience up to 20 percent annual growth rate, rising from $121 billion in annually derived revenue in 2012 to become a $948 billion business by 2020 (Hatton 2012).
- **Connections:** The global number of wireless connections used for M2M devices is growing at an astronomical rate. In 2011, the number of connections used for M2M increased by 37 percent to 108 million, with the strongest growth rates of up to 64 percent seen in the Asia-Pacific region (Berg Insight 2012). Europe is expected to claim the biggest market share, boasting a projected 3.5 billion M2M connections by 2020 (Hatton 2012). In Europe, in 2012 M2M market is up to 140 million specific devices and would grow by 30% each year to reach 370 million specific devices in 2015. (Idate 2013)
- **Devices:** We can expect to see 12.5 billion M2M-capable devices in the world by 2020. Most of these devices will be in China, which is leading the way in incorporating M2M into its nation's infrastructure (Hatton & Morrish 2011).
- **Efficiency and Carbon Reductions:** The most recent modeling predicts that ICT could save over 9.1 Gt CO2e by 2020 as a result of efficiency gains in the world's key economic sectors (BCG & GeSI 2012). Energy, Transportation, the Built Environment, and Agriculture sectors each offer the potential for profitably reducing GHG emissions by at least 1.5 Gt CO2e, each by 2020 (BCG & GeSI 2012).

Machine-to-machine communication is seen by technologists, analysts and major companies across the world as **the next great tool to revolutionize business**. However, predictions for the size of the market vary and uptake, so far, has been limited. The latest Machina Research report predicts the M2M market will grow from $200bn in 2011 to $1.2 trillion in 2022

Figure 12: M2M Opportunity

Global M2M connections will increase from two billion at the end of 2011 to 18 billion at the end of 2022. Connections will be dominated by two sectors: consumer electronics including cameras, music players and TVs) and intelligent buildings (e.g. security and HVAC systems). Short range technology will dominate: over 70% of M2M devices will be connected by short range technologies, mostly WiFi. Cellular/wireless wide area network (WWAN) connections will grow from 146 million at the end of 2011 to 2.6 billion in 2022.

The most important WWAN sector is Automotive (including pay-as-you-drive insurance, emergency/eCall and security and tracking), accounting for 60% of connections. At the end of 2011 M2M accounted for 2% of cellular connections. By 2020 this will reach 22%. In terms of revenue, M2M will grow from USD200 billion in 2011 to USD1.2 trillion in 2022, a CAGR of 18%. **Two-thirds of the revenue opportunity is accounted for by devices and installation, and one-third by M2M services**.

3.3.2 Internet of Things: Trends, Challenges and Barriers

Historically, M2M applications were developed to increase the productivity of industrial resources, whether the resource was a fleet of delivery trucks or a remote gas pipeline. Currently M2M technologies are enabling more broad-based and consumer-focused applications that have the potential to make a big impact on choices we make in our daily lives that will have positive benefits to individuals and society**. The IoT breakthrough will happen when developers will provide application for end-users, hiding the physical world related to M2M connectivity.**

The M2M industry has become more prominent, primarily because of the widespread availability of wireless connectivity (3G, LTE), declining prices of M2M modules, regulatory pressures and incentives for certain industries such as smart grids. M2M is enjoying a renewed interest from mobile operators in pursuit of new markets and applications to improve revenues and profit margins. Recent **standardization efforts are also emerging through 3GPP, IEEE, FIA and ETSI**.

Today, if an enterprise decides that IoT can help it make money, differentiate from competitors, provide better customer service, or save money, etc., it often **must conduct separate transactions with an integrator, application provider, module provider and connectivity provider, among others**. The high number of moving parts threatens the viability of the project due to vendor management complexity, uncertain costs, difficult-to-enforce service-level agreements (SLAs) and other challenges. What companies

desire, however, **is the ability to go to one provider for all their needs and pay a fixed price for extended periods of time**

Moreover, Telenor, Sierra Wireless and Vodafone have already started providing platforms that integrates IT applications and infrastructure with the mobile operator's network .We can conclude that the M2M paradigm **is deemed to open new markets and create new streams of revenue for device manufacturers, application developers and mobile network operators**.

However connected objects are still in their early stages and there are still **many challenges to be overcome before the benefits of connected objects can be fully realized.**

- Addressing and Tagging: The IoT should be able to tag or address about 50 to 100 trillion objects. To achieve this, the current IPv4 protocol will be insufficient. A key challenge is to agree on a common way of addressing and identifying objects. If it seems also **important to have unique UIDs** (user ids), even for mass- produced objects (i.e. all objects coming out of a factory will have their own unique UID, not a common one) **the major issue to assume a real take-up is interoperability between existing standards and their naming systems**. The relationship between objects, such as raw material (one UID) becoming refined material (another UID) or parts (each with their own UID) that are then assembled as a car (again a different UID) also needs to be considered to enable us to follow these relationships and thus maintain traceability.
- Connectivity: When dealing with the IoT, one usually concentrates on the devices themselves. Connectivity is often missed, which is a big mistake. Connectivity in the IoT will mostly be wireless, using many possible solutions (Wi-Fi, GPRS, 3G, WirelessHART, Zigbee, Bluetooth, etc.) As each of these solutions has different pros and cons, they will likely all coexist in the future. (Zigbee requires very little power, but has a limited range; 3G has almost complete coverage, but is expensive both in terms of hardware and usage). When using 3G, there is usually a cost associated with the usage of data transmission. It is therefore important to optimize communication with devices. An adaptive ad-hoc network with mesh-routing capabilities is also a promising answer for the connectivity issue. In such a network, each 'object' is also a router capable of routing messages from and to other sensors. Such an approach allows the connectivity cost to be reduced and also simplifies the deployment phase. However, objects need to have more computing power in order to act as 'gateways'.
- Openness and Data Model Standards: Today, many examples of connected objects exist and some are already in production, like automatic meter reading, customer electronics, etc. All rely on a vertical and closed ecosystem But this represents a short-term vision, as history has always shown that Challenges more standardization and openness creates new ecosystems, with many more opportunities for all actors in the end. If all connected objects and sensors were to be accessible in a more 'open' and 'standard' way, then, the same objects would have more than one 'connected usage'. That would be a good incentive for end users to exploit the opportunities provided by more connected objects which in turn would be an incentive for service providers to develop new services using these objects. The 'extra cost' for a connected object would be shared by all the services and functionalities brought by its open connectivity. There are two major areas of standardization for the IoT:
    - Semantic: This will describe how to provide a translation system to communicate with objects and what to expect from them. As there could be many different kinds of objects, which are possibly (and hopefully) long lasting, then the semantic must be time-proof.
    - Communication protocols: A global standard protocol, identification and addressing scheme for bridging the last mile from the Internet to the smart object would be required. For the IoT to be adopted widely, a standard needs to be established which serves as guidelines for individual implementations and interactions between them.
- Security and Privacy (vs. Simplification)
    - Security: One of the key components used in the existing IoT, RFIDs, are the ones most susceptible to attack. The situation becomes more difficult when the attack is of an active nature. Secure identifying protocols are being developed to counter these threats. Another alternative is to provide tagged devices with unique UIDs. As the device transitions from one

phase to another, the UID associated with the device also changes. This also calls for other devices and actuators in the 'trusted' network to be made aware of the device have changed UID.

- Privacy- One of the main concerns that the IoT has to address is privacy. The most important challenge in convincing users to adopt emerging technologies is the protection of data and privacy. Concerns over privacy and data protection are widespread, particularly as sensors and smart tags can track users' movements, habits and ongoing preferences. Invisible and constant data exchange between things and people, and between things and other things, will take place unknown to the owners and originators of such data. IoT implementations would need to decide who controls the data and for how long. The fact that in the IoT a lot of data flows autonomously and without human knowledge makes it very important to have authorization protocols in place to avoid misuse of data. To promote a more widespread adoption of the technologies underlying the IoT, principles of informed consent, data confidentiality and security must be safeguarded. Moreover, protecting privacy must not be limited to technical solutions, but encompass regulatory, market based and socio-ethical considerations. Unless there are concerted efforts involving all government, civil society and private sector players to protect these values, the development of the IoT will be hampered if not prevented. It is only through awareness of these technological advances, and the challenges they present, that we can seize the future benefits of a fair and user-centric IoT. **Users involved with smart things should be able defining their own privacy rules and delegate access rights to relevant applications.**

- Hardware: The price and availability of the required hardware is today the key challenge preventing companies and end users from having more 'connected objects'. Today the limitations on the hardware are:
  - Battery life and energy harvesting: Having connected objects can ease everyday life, but if one has to 'think' of recharging all everyday objects, it will become too much work compared to the benefit. **New technologies would emerge to harvest energy and manage a new energy consumption cycle**.
  - Hardware size: the new connected objects should not be much bigger than their non-connected counterparts.
  - Radio connectivity: this element is of course crucial. If a user is using a Smart Thing, which is becoming quite cheap and may not require batteries, then they will have to install extra equipment to 'discuss' with objects.
- Architecture: Analysts differ on the kind of architecture that the IoT would use.
  - Would it be event-driven or model-driven?
  - Would it be a combination of both?
- Model-driven and functional approaches will coexist with new approaches able to handle exceptions and unusual evolutions of processes. It can be expected that there will be more than one logical sensor/actuator network where things communicate directly with server applications. There will be many fields of independent sensor/actuator (sub) nets, for example a subnet of smart electricity meters of a utility company or a subnet of air pollution measurement points in a city. The subnets will be managed by independent operators that provide their data to cloud services over the Internet, either themselves or via mediators. The role of the mediator is to provide a uniform interface for all sensors and actuators and their heterogeneous interface technologies. Different Complex Event Processing (CEP) and Business Process Management (BPM) models also need to be considered when deciding on the overall architecture for the system. Data and context brokers aggregate and correlate events that draw attention to changes in sensor measurements. They operate like complex event processors and can initiate actions to trigger functions in IoT applications or to control actuators, depending on conditions met in the stream of events. IoT applications use the aggregated results derived from event streams. **In parallel, local actions should be executed immediately and only relevant events should be**

collected and stored. This approach would also support a more secured and private Internet of Things.

- Computing Power: The real-time nature of the IoT also poses a challenge in the amount of computing power required since about 50 to 100 trillion objects would share data. This is completely different from a normal desktop where a user uses a computer for a specific need. Contemporary computing models based on human-computer interaction are inadequate and inappropriate for ubiquitous computing. Vastly parallel systems capable of performing calculations orders of magnitude higher would be required. Cloud computing enables dynamic distribution of workload among elements of the cloud based on the availability of storage and computing facilities

Machine-to-machine market still utilizes traditional user-pay models that are unlikely to work, and may face legal risks involving privacy as well as regulatory hurdles in different countries, industry watchers note. The machine-to-machine (M2M) market faces not only technical challenges in implementation and interoperability, but also **business issues related to pricing, potential breach in user privacy and regulations in different countries, industry watchers note.**

M2M is a "huge potential market". Nevertheless, existing **M2M solutions are highly fragmented and dedicated only to singular applications,** and this also results in slow development of the global M2M market. **We identify the following Key Barriers to Scaling M2M Technologies**

- **Fragmented Value Chain:** Mobile Network Operators (MNOs) are key players in M2M, and have the advantage of controlling connectivity, but they often rely on various other players to bring a complete solution to market. This prevents clients from buying a finished, turn-key product system and makes it difficult for end-retailers to even offer one. **The innovative ecosystem is based on many SMEs around the world which are pushing their own de-facto standards**
- **Lack of Universal Standards:** A variety of organizations are working on the creation of standards for M2M applications and hardware. However, these efforts have been slow going and fragmented. The lack of standard parameters for M2M components, data, and service layer, across sectors or even within specific industries, makes it hard to integrate M2M technologies broadly or to speed time to market. Lack of such standards also stifles software application development and exacerbates value chain fragmentation.
- **Lack of Performance Data:** Potential clients need to understand the value proposition for technologies often requiring significant upfront investment. Examples of M2M successes are numerous, but actual data and analytics for making projections and monitoring results have not been fully integrated into products or sales.
- **Communication and Marketing Challenges:** Companies offering M2M solutions need to be able to communicate the benefits of implementing an M2M system to various entities within a potential client company, from the procurement manager to the CFO. Not only a lack of data but also a lack of strong marketing angles is hurting the M2M industry's ability to communicate the value proposition of M2M systems to potential clients.
- **Incompatible Sales Models and Long Sales Cycle:** Clients continue to report that pricing remains too high, indicating a problem with sales models. Finally, the companies offering M2M 'don't live for its revenue', as they view connectivity as their core business. As a result, not enough effort has been made to adapt internal sales and marketing models to M2M.

The Key Recommendations Proposed for Overcoming These Barriers

- Value Chain Integration and Unified M2M Partnerships: Creative partnerships and Mergers & Acquisitions (M&A) are required if the market is to be able to unilaterally offer M2M solutions. In the meantime, alternative business models and new marketing strategies, as outlined in our other recommendations, can be used to accelerate growth and improve profit margins.
- Industry Cohesion on Standards: Many organizations are working on standardization. These efforts need both leadership and consolidation. There is an opportunity for telecoms companies to take the lead here and convene the world's experts in the field to work together on this important issue

- Measuring Data and Leveraging its Value: Companies offering M2M solutions must work to build data collection and analytics into their offerings. By creating new tools or updating existing ones to provide both robust metrics and case studies, companies offering M2M solutions can help to make their value more apparent to potential clients. Calculating return on investment (ROI) should be a central goal of this work, as should constantly improving the efficiency of the M2M solutions themselves. There is also a large untapped opportunity to collect and monetize the vast amounts of data generated by M2M devices. This could take the form of an entrepreneurial venture, or a data clearing house created by the telecoms industry.
- Familiar Strategies for New Products: Companies offering M2M solutions could take steps to make M2M an aspect of their core business, and they must innovatively upgrade the M2M business model. Integrating M2M business lines with existing marketing approaches and using analogies from other industries to increase sales are some ways that companies could accomplish this task.
- Innovative New Business Models and Sales Strategies: Companies offering M2M solutions should implement strategies that incentivize sales internally and/or increase uptake externally. These strategies could take many forms, including financial incentives, 'gameification', or inter-corporate campaigns crafted around major events. Creating a new level of industry cohesion on communication will also be key. The industry needs to create forums to discuss and co-ordinate efforts to increase the deployment of
- M2M technologies, improve its value proposition, and develop a common language to describe its benefits that resonates with customers. Telecoms companies can take the lead on this.

Summarizing, while there are many different ways to connect M2M devices to the Internet, **service providers are deploying their products without considering interoperability**, thinking only about how they should sell devices to consumers. He urged these market players to move and think beyond this mentality.

Other barriers to entry will be less technical and more **about the applications that M2M technology will be used in.** Some industry sectors will be slower to adopt M2M technologies than others, the first to use such technology would continue to be utilities, while manufacturers for white goods could follow, but emphasized that any vendor entering the market **will need to have a very strong business case.** The traditional "user pay" model also does not work on end-users when it comes to M2M, consumers would not be willing to pay for a medicine bottle with device-tracking capabilities and be charged 20 cents every time it is opened. The economic model must now take into account the avoided costs of service delivery. There is no value proposition and consistency in business cases that the end-users can see.

The pervasive nature of monitoring and collection with M2M could lead to privacy and data security issues, bringing up concerns about the use and disclosure of the user's personal information. There are also possibilities for personal information to be used to market good and services based on individual's behavioral patterns and preferences. Data protection regulations may help restrict the delivery of personal data to M2M and additional regulatory issues such as those involving roaming, operators collaborate with others across the globe to provide wider roaming coverage, and as a result, the location of M2M devices running on these networks may not always be identified. As such, operators may not be able to comply with service level agreements stipulated by their local regulators. **Anonymization of data along the whole communication chain would also emerge as a new challenge**, to better manage his own privacy; end user will request more and more mechanisms to monitor what he publishes and how this content is published.

With the introduction of new devices and technology, the type of attacks that businesses will experience are also going to change. One of the new challenges that businesses will have to face is the need to increase their focus on physical attacks on devices, such as those in remote locations. **New "deny of service" attacks will happen and M2M hardware could enhance new botnets structures.**

With the 30 billion to 50 billion devices predicted for 2020, a large part of the problem will be the management of each individual end point, and the complexity that comes with that. Another security issue

that could bring M2M to a halt is **the lack of skilled, experienced implementers when it comes to rolling out a fleet of M2M devices.** Because it is such a relatively new area for certain businesses, those that are currently doing it haven't learned the important lessons from the failures of SCADA systems in the utilities space. **OPC Foundation tries to define a new architecture** which will assume security from data collected in industrial automation hardware to cloud services

Existing cross-borders commercial offers do not include high level services which could be hosted in cloud because of the heterogeneity between European regulation systems and data privacy rules. More and more M2M and IoT customers are focusing on this issue and especially the "Patriot Act" which could strongly impact the take-up of this promising business.

M2M needs a common framework on which all services and devices can interoperate and scale, and be efficient and widely available. **A standardized M2M service platform** will speed up the development of the M2M market. **Applications can share a common infrastructure environment and network transitions within its horizontal architecture**, while standardized software and hardware interfaces and protocols will ensure the interoperability of all system elements.

This is why major standards development organizations, including the ETSI, agreed on a common M2M service layer, oneM2M, as part of a global initiative to drive M2M standardization. This will **develop globally agreed M2M end-to-end specifications and reports**, with a focus on service layers using common use cases and architecture principles. **The emerging association OneM2M is a worldwide initiative**, from Asia to America including Europe to reach an industrial consensus on interoperable standards and technologies, using especially ETSI-M2M standard as reference model.

3.3.3 M2M vendors in EMEA

M2M communication can deliver remote monitoring and control in many areas, including buildings, the healthcare system, utility grids, supply chain logistics, the automotive industry, agriculture and more. This makes it a huge commercial opportunity for a variety of businesses, including mobile network operators, sensor makers and systems integrators. Consequently, if you're looking to kick off an M2M project, there are a great many vendors to consider. It covers a number of leading vendors in the EMEA region that provide M2M services ranging from devices to connectivity to full-scale systems integration.

Mobile Network Operators	Company Profile	M2M products & services	Target
Deutsche Telekom	• DT established an international M2M Competence Center in 2010, focusing on M2M products and services in nine market segments: Energy, Vehicle Telematics, Health, Retail & Commerce, Industrial Automation, Public Sector, Security, Transport and Logistics, and Consumer Electronics.	• The company offers services ranging from M2M connectivity to specific end-to-end M2M solutions, and operates an extensive partner program • FeaM2M end-to-end (E2E) Solutions, M2M Consulting Services, M2M Connectivity, M2M Services	• Target markets Enterprise, SMB • Geographical region EMEA, the Americas, China, Japan, Indonesia
orange	• Orange Business Services offers a broad set of M2M solutions, targeting markets including smart metering, healthcare, automotive telematics, smart grids, fleet management, smart offices and smart buildings.	• Featured M2M products & services Global Service Management, M2M Connectivity	• Target markets Enterprise, SMB • Geographical region Global
Telefónica	• Telefonica is a leading M2M connectivity and solutions provider. It has key partnerships with other network operators and with M2M platform provider Jasper Wireless, giving it a global reach.	• Featured M2M products & services Managed Connectivity, Transport, Utilities and Sustainability	• Target markets Enterprise, SMB • Geographical region Global
vodafone	• Vodafone has Europe's largest network footprint and the largest number of M2M connections, with more than 9 million total. • The company has a global team of 150 employees built to serve enterprises, with dedicated personnel both within and outside its network footprint.	• The group includes regionally based sales teams, vertically focused business development personnel, a solution architect team to help customers build M2M solutions, a service delivery team and a commercial team. • Truly E2E solutions are not a major focus for Vodafone; it is happy to leave complex integration work to partners	• Vodafone has shown a strong commitment to building a high-scale business • Strategic relationship with Hyundai for the auto manufacturer's next-generation service plans and a deal with BMW—a major win.

Specialist Wireless Networks	Company Profile	M2M products & services	Target
	• Neul is a Cambridge, UK-based company specialising in 'white-space' radio communications, which exploits the gaps (white spaces) between frequencies allocated to TV channels and other unused radio spectrum.	• Featured M2M products & services NeulNet • NeulNet supports up to 16Mbps over a 10km range with "excellent in-building penetration".	• Target markets Enterprise, SMB • Geographical region UK
	• France-based SIGFOX uses ultra-narrowband (UNB) technology to deliver low-throughput (up to 1Kbps), long-range (up to 40km) wireless communication for M2M devices. Having launched its network in June 2012, the company secured €10m in series B funding, led by Intel Capital, in September	• Featured M2M products & services Technology, SIGFOX offer	• Target markets Enterprise, SMB • Geographical region France

Sensor Vendors	Company Profile	M2M products & services	Target
	• Headquartered in the Netherlands, Gemalto is a global digital security solutions company with an extensive M2M portfolio centred around wireless modules (Cinterion) and an M2M service delivery platform (SensorLogic).	• Featured M2M products & services M2M World (Cinterion), M2M Cloud Platform (SensorLogic)	• Target markets Enterprise, SMB • Geographical region Global
	• Libelium formed in 2006 as a spin-off from the University of Zaragoza, and has since sold its modular sensors and wireless networking technology into over 45 countries worldwide.	• Featured M2M products & services Waspmote, Meshlium. • The company also offers training and consultancy services to help customers deliver cost-effective M2M solutions.	• Target markets Enterprise, SMB • Geographical region EMEA
	• Best known as a maker of mobile broadband devices, Sierra Wireless also creates embedded wireless modules and gateways for the M2M market, along with an M2M-focused cloud platform.	• Featured M2M products & services AirPrime Embedded Wireless Modules, AirLink Intelligent Gateways, AirVantage M2M Cloud, Sagemcom M2M	• Target markets Enterprise, SMB • Geographical region Global

Systems Integrator	Company Profile	M2M products & services	Target
WIRELESSLOGIC	• UK-based Wireless Logic is a leading M2M aggregator, supplying airtime, connectivity and management tools, plus a range of value-added services. The company claims over 4,000 customers, spanning a wide range of vertical markets.	• Featured M2M products & services Airtime, Connectivity, Monitoring & Control	• Target markets Enterprise, SMB • Geographical region Europe

Connected Device Platform Providers	Company Profile	M2M products & services	Target
Jasper wireless	• Mountain View-based Jasper Wireless provides network operators with a ready-made cloud-based platform with which to launch, run, optimize and expand their M2M businesses.	• Featured M2M products & services Enterprise Platform, Operator Platform, Acquisition Engine	• Target markets Enterprise, SMB • Geographical region Global
wyless	• Founded in 2003, Boston-based Wyless offers end-to-end M2M solutions and services, based on a multi-carrier global wireless network, advanced management software and a suite of M2M services.	• Featured M2M products & services Global managed network, Porthos M2M management software	• Target markets Enterprise, SMB • Geographical region Global

Table 2: M2M Vendors Profile

3.3.4 M2M is about developing new business opportunities

The **technology is moving beyond its decades of use in utilities, transport, and heavy industry** into the mainstream, empowering CIOs to deliver real value, cost savings, and innovation to management and their wider organizations.

Now that networking equipment a simple SIM card or RFID chip, in the case of M2M and wireless carriage have dramatically decreased in cost, and wireless coverage, speed, and capacity have increased, we can now embed connectivity into the "things" we use in our day-to-day lives. That translates to new business intelligence (BI), operational efficiencies, and revenue-generating opportunities.

- **In the transport and logistics sector**, this means that pallets and packages are able to communicate their location, allowing for real-time parcel tracking. The same application of M2M also allows the public to gain real-time updates on how far away their train, ferry, or bus is.

- **In the healthcare sector**, M2M devices worn by patients enable real-time monitoring of vital statistics or the dispensing of medication. In retail, M2M provides better point-of-sale data, as well as better shopping experiences through personalized digital signage.
- **In the utilities sector, too, M2M powers innovation through smart meters in homes that provide near-real-time data** to consumers on their usage. M2M devices are also deployed throughout power, gas, and water networks, which allow for better visibility on outages, spikes in demand, and supply routing.

APAC (Asia pacific) and Europe lead M2M implementation, as with the level of importance they place on M2M, US companies lag behind European and APAC organizations in M2M implementations. Nearly one quarter of respondents in Europe (23.2 percent) and APAC countries (24.5 percent) currently use M2M technology, and almost a quarter more (25.6 and 22.6 percent, respectively) have an M2M implementation project underway or plan to start one in the next 12 months.

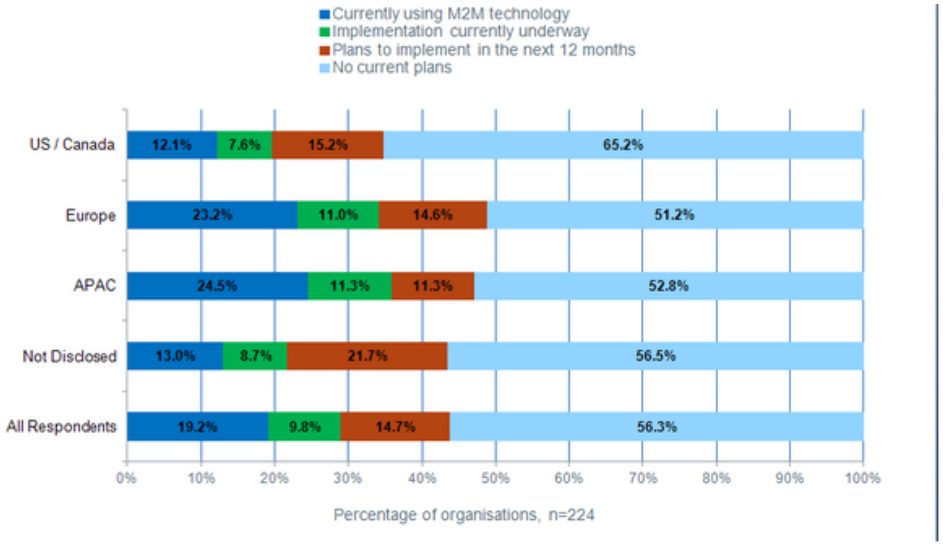

Figure 13: M2M Implementation plans by region

Energy, IT, and transportation lead M2M implementations: Of the respondents who currently use M2M technology or plan to do so in the next 12 months, energy, IT, and transportation top the list of M2M uses. 48 percent say they're using (or planning to use) an energy-related M2M technology, such as smart metering or wirelessly connected grid assets. IT and network monitoring applications are second on the list with 46.9 percent. Automotive, transportation, and logistics are third with 43.9 percent.

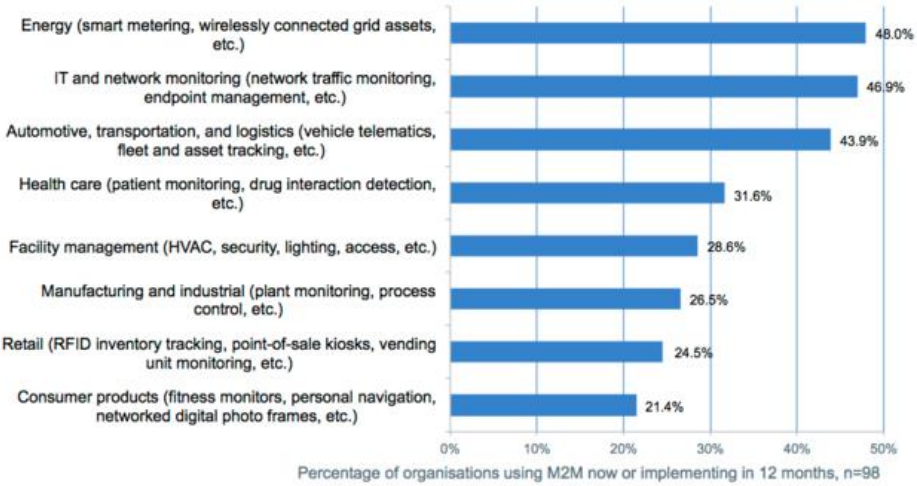

Figure 14: M2M technologies currently being used

New business opportunities and service/product improvement top M2M priority list: According to our survey, most are looking for new business opportunities and ways to improve their existing processes and products. We asked respondents to rate the importance of several factors in their organization's decision to implement M2M technology, with a score of 1 being not at all important and 5 being very important.

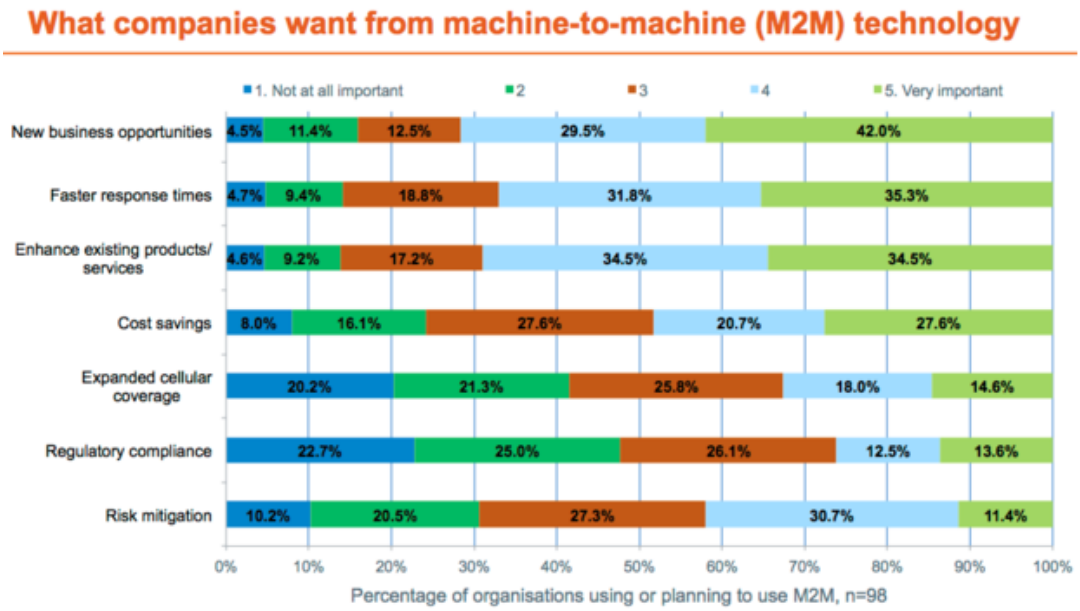

Figure 15: What companies want form M2M Technology

IT Opportunities in Integration Solutions Data Collection and Brokerage Connected objects would generate an incredible amount of data to be transferred, processed and stored. If historical data also needs to be stored, this problem is multiplied many-fold. Datacenters would need to scale accordingly to handle this. This presents **a great opportunity in the field of data collection and brokerage**. With technological advances in the field of cloud computing, it may be a viable solution to the data storage and processing problem.

- With the huge amount of data generated, the brokerage platform also needs to be able to provide expiration of data. It should be possible to configure timelines for the data to expire and for the data to be archived.
- The real-time nature of the IoT places a huge demand on the processing capabilities of a data broker. Quantum computing can play a major role in addressing this issue.
- A 30-qubit quantum computer would equal the processing power of a conventional computer that could run at 10 teraflops. Quantum Computing is a relatively recent development, but quite a few successful experiments have been carried out.

A concrete example for data collection and brokerage, today, is the Pachube community. Pachube is a small start-up which has created a community of people sharing their entire sensor data. All data published on Pachube is publicly available.

As seen above, **vast amounts of data would be generated by the IoT, much of which would be needed in decision support situations**. Automation tools would be required to go through the data and help provide decisions and predictive analysis. At the same time, there is also a need to share and present the data to support human decision making. **Collaborative Decision Making (CDM) is an approach that facilitates decision-making functions** Opportunities by providing timely and accurate information essential for operational planning. This data can also be used to formulate 'Pattern-Based Strategies' by analyzing usage and consumption patterns. It provides the facility for predictive analysis in the event of unforeseen circumstances or disruption to operations and processes. This would be an asset to the aviation

industry where expensive buffers are incorporated into scheduling to absorb the consequences of unforeseen circumstances. It would translate roughly into a couple of million Euros saved per year.

Additionally, seamless integration of smart devices will play a vital role. For IT companies, there is an opportunity to provide an integration backbone platform:

- Supporting different communication standards and protocols operating at different frequencies.
- Allowing different architectures centralized or distributed.
- Able to communicate with other networks.
- That should offer a high-level interface supporting Web-Service standards.
- Real-time service-oriented architecture (SOA) would be a promising solution. It will help if each device offers its functionality as a standardized service that allows other systems to discover the services dynamically and invoke them easily.

IoT innovation will bring a new dimension to the existing business models across all sectors. Opportunities exist in many sectors, some of which are illustrated below. Although this doesn't cover all sectors, it provides an overview of how users of today's Internet will move into the IoT.

- Smart Cities: Smart Cities aim to make public service infrastructures and business processes significantly smarter (i.e. more intelligent, more efficient, more sustainable) through tighter integration with Internet networking and computing capabilities. Sensors deployed throughout the city gather information about goods consumed, facilities used and other information pertaining to the life of the community. This information is given to the city council to take appropriate steps to improve the quality of life in the city.
- Automotive Industry: Some limited connecting capabilities have been seen appearing in high-end cars in the past years, for instance, real-time traffic information. Expanding these capabilities to make the car a truly connected object will allow it to contact the manufacturer to diagnose a malfunction in real-time, or even better, anticipate it; be informed of road hazards; negotiate charging prices with power stations7; and book maintenance operations. Vehicle-to-vehicle (V2V) communication will open the road to collaborative driving, addressing traffic issues from a global, rather than an individual standpoint, and will help find optimal solutions, relieving congestion and also averting collisions, leading to a decrease of road casualties. Google is developing self-piloted cars that are able to run 1,000 miles without human aid and about 14,000 miles with minimum human intervention.
- Aviation Sector: In the aviation sector, the IoT can provide system status monitoring for aircrafts via sensors that measure various conditions, such as pressure, vibration, temperature, etc. This data then provides access to trends, maintenance planning and condition-based maintenance. RFID tags could be used for aircraft parts helping to prevent counterfeiting. At least 28 accidents or incidents in the United States have been caused by counterfeits. There is important ongoing research about intelligent materials especially for aviation. These materials can detect and communicate with the maintenance team when the structure is damaged. Efficiency at airports could be achieved by providing luggage tagged with RFID which helps in tracking the movement of luggage during transit
- Energy Sector: In the energy sector, the IoT will help manage and monitor energy consumption. Smart appliances will be able to operate optimally, conserving energy and at the same time satisfying the end user's need. Smart meters will send signals to customers to regulate their power consumption. This would result in lower power consumption and also lessen the burden on existing sources of energy. Sensors placed at strategic nodes in a gas pipeline would send signals to the control center informing the controller about the pressure and volume of gas flowing through at the node at a given time.
- Manufacturing: A lot of manufacturing companies are making use of RFID for tracking and tracing. Managing inventory is improved and easier. Tagging a device also helps to avoid counterfeiting. Sensors attached to products can give information about their health allowing the user to decide when that device should be recycled. The Ford factory in Cologne, Germany, currently uses bar codes tagged to the hood of a car to help determine the make of the car during production. The robots on the assembly line read the information on the bar code and then determine which parts are needed for that

particular car. The parts are then sourced from the inventory. This allows Ford to use the same assembly line to manufacture different cars.

- Industrial automation: these machines support all the previous activities and their specificity is that all sectors required a long-life cycle and ICT choices which will be available in 20 years. Deploying some critical system for Water management, tunnel air recirculation or less critical system but CAPEX consuming packaging machines or automotive industry robots are high challenges and connecting them to really implement smart grid environment is a higher challenge. To include all industrial automation systems with new ones is currently a main objective for this sector which will support emerging M2M services in a near future.

3.3.5 M2M ecosystem

Currently, the Internet of Things is closely associated with RFID technology and industrial applications. The success of these applications and the commercial drivers behind them has created a huge momentum that pushes technical developments and public discourse in one direction. Unless we will fully expand the discussion and assign the **needs, desires and fears of ordinary citizens as much importance as the requirements of industrial players there is the danger that the Internet of Things falls short of its potentials**. According to the Open Source Sensing Foundation "a long and expensive battle is looming" over privacy, accuracy, ownership and sovereignty "between those using sensors to collect data and those whose data is being collected"

In contrast to von Hippel's notion, which refers to **open-source development and the ability to replicate and adapt a product**, the iPhone innovation network does not compel users to make their innovations openly accessible to other users. **Instead, the transfer of innovation among users is facilitated by a two-sided market (realized by the App Store),** with user/developers on the one side and users-only on the other. The network effects realized by this market enable the effective transfer of ideas (in the form of applications) and the effective recruitment of users for application that require large user populations to become successful (for example, crowd sourcing and participatory sensing applications).

In this new M2M ecosystem, relationships between the various stakeholders need to be established in order to define, among other things, the roles of the partners, the interfaces between the parties, the business logic and the revenue streams. For instance, Ballon proposes four different types of platforms oriented around their relative control over the customer relationship on the one hand, and the control over crucial tangible and intangible assets that make up the value proposition on the other. This paper proposes a **number of value chain scenarios for M2M product creation and differentiation through a platform** wherein application developers, devices manufacturers and mobile network operators take more or less active roles, i.e. control customer relationship and control the assets that compose the value proposition of the platform.

In order to enable this key purpose a number of ecosystem players must be exist: platform providers, application providers, application store, and a smart appliance store, among others. Platform providers compete with each other for the **best smart-home solution**, independent developers **create and market smart-home applications built on top of these platforms**, and distributors **collect and bundle applications. The smart-home ecosystem** must be supported by a corresponding technical infrastructure that supports the ability of owners/inhabitants to adjust and improve their home's working, and supports the implied business relations between commercial players. An example of such a smart home infrastructure consists of the following components:

- Smart-home software platform: this platform provides software abstractions to all subsystems and services of a smart-home, much in the same way an operating systems does for a computer. Sensor and actuators: these represent the basic infrastructure for activity recognition and automation. Smart appliances: these include (future versions of today's) appliances like stove, dishwasher, lights, etc.
- Interfaces and controls: This category includes everything that allows inhabitants to control a smart-home and includes simple switches, digital displays etc. Smart-home applications: applications are the loci of end-user functionality and units of end-user development

Ecosystems are enablers of innovation. They channel demand from the end-user to distributors and providers, encouraging them to develop innovative products in response. Similarly, ecosystems make it possible for user innovations to emerge, to be disseminated and to find a receptive audience of like-minded people. We argue that a properly "configured" user-centered ecosystem can do for innovation in smart-homes what the iPhone ecosystem has done for innovation in the mobile space.

Smart home and IoT ecosystems are more complex than the iPhone ecosystem for a number of reasons:

- IoT products may be physical as well as digital, and not just software applications.
- Much of the value of the IoT depends on data captured by embedded sensors, for example data about energy consumption. Data may itself become a tradable commodity in an IoT market, so that users may be able to sell their data to other ecosystem actors.
- An **IoT market will involve many more partners than the relatively straightforward two-sided market** for iPhone applications. Just as a home is constructed and maintained by electricians, painters and plumbers we can expect an IoT ecosystem to involve many specialized players and perhaps multiple specialized markets

Ecosystem approaches are increasingly gaining attention in software business research but so far have not been applied to the Internet of Things. While local IoT ecosystems certainly exist in the industrial realm, for example associated with specific RFID system and platforms, **they are not open to individuals in the same way the iPhone ecosystem is and thus do not support user-led innovation**. Empowering end-users to create their own smart Internet-of-Things **experiences requires ecosystems that remove barriers for creation and distribution**. In the following we highlight **five key challenges for the emergence/purposeful creation of user-centered IoT ecosystems.**

Challenge 1: Understanding and supporting user innovation touch points

User innovation in the smart-home example can occur in many ways: by developing innovative smart-home applications, by creating or modifying smart objects and appliances, by upgrading the sensor/actuator infrastructure etc. The challenge is to identify these innovation touch points and to provide adequate tools. Application development can be supported in the traditional by providing software toolkits.

- How do toolkits look like for modifying smart appliances?
- How can these modifications be disseminated to other owner/users in effective ways?
- How can sharing of user-generated physical artifacts be supported by the ecosystem?

Challenge 2: Understanding the characteristics of open innovation platforms

Platforms are at the heart of many hardware/software ecosystems and will likely play an important role for the IoT. The challenge is to understand what makes a compelling IoT platform from a business and engineering point of view.

- What abstractions should these platforms expose to maximize adoption and innovation?
- IoT platforms are complex in that they must dynamically integrate sensors and actuators as well as smart objects. How do these platforms manage interoperability between components and products from different vendors?

Challenge 3: Understanding user incentives

Incentives are at the core of user innovation. On the one extreme, user/developers may simply value the process of innovating because of the enjoyment or learning that it brings them; on the other extreme, they may be able to monetize their innovation by selling products on an open market place. The sensor richness of the Internet of Things adds novel trading and monetization opportunities related to user-generated data.

- What are suitable monetization strategies for user-generated data?
- How can users resolve the conflict between maintaining privacy and realizing potential value of data?

- How can users trade or collect user-generated data without involving monetary transactions?

Challenge 4: Identifying IoT business models

IoT ecosystems create opportunities for novel business relationships and business models. Would a future smart appliance that provides information about its use back to the manufacturer be sold like appliances today, would it be rented on per-usage basis or would it be provided for free in return for access to user-generated data? The challenge is to identify new business models related to smart physical objects and to develop technical means for supporting them within the ecosystem (for example by facilitating capture and transmission of user data between smart-home and appliance manufacturer). As of now we do not know how to price the value of IoT services and applications in an open market place. **We do not have business models that would allow IoT vendors to compete by functionality, service level or quality**.

Challenge 5: Identifying and mapping potential open IoT ecosystems

Smart-homes are just one IoT example of where an ecosystem approach could be beneficial. The challenge is to **identify other domains, in which ecosystems may emerge, to map them out in terms of technical components and business actors**, and to understand how they will support market-based and user-led innovation. **Software ecosystems can be defined on different system levels (platforms, applications, languages …) thus there is an almost unlimited variety of possible ecosystems**. Relevant research has not yet been applied in an attempt to create an environment that encourages user innovation in the context of the Internet of Things.

Addressing these five challenges requires interdisciplinary, collaborative research in computer science, software engineering, software business management, and economics. Most of the raised questions are not new, but they will gain renewed importance and require new answers in a world of physical/digital products and sensor-rich environments.

Concerns about the direction of the development of the Internet of Things are rising. In order to supplement the influence of industrial **IoT players we need to look for ways to foster user innovation in a similar way to what the iPhone ecosystem has achieved for mobile computing**. As IoT end users are empowered to create and share their own innovations they will become producers in a newly emerging ecosystem in which users/developers and companies can fruitfully cooperative. **We argue that decisions about platforms and business models must go hand-in-hand. Most importantly, we see market-based innovation and user-led innovation as necessary complements for the way forward in developing the Internet of Things.**

M2M Ecosystem examples

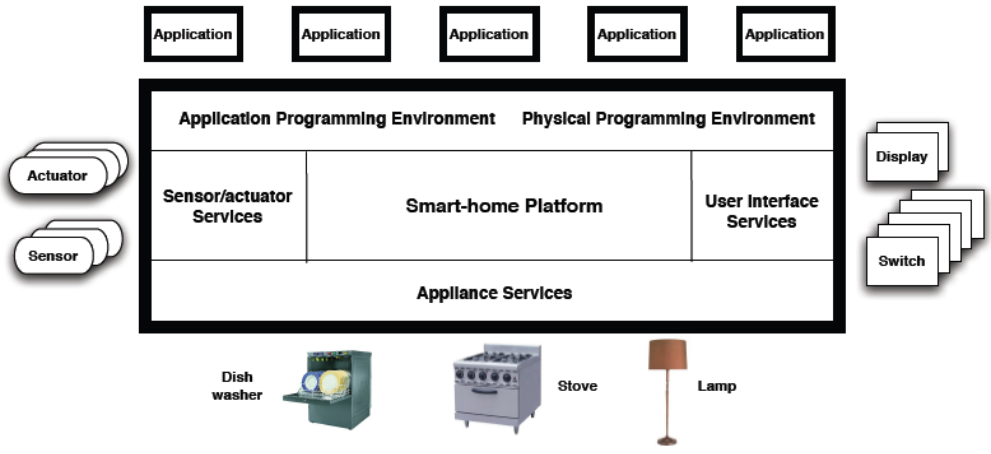

Figure 16: IoT Ecosystems for Smart-homes (technology)

UC 1 - Home Energy Management System (HEMS)

Spurred by recent advances in M2M technologies, Smart Grid (SG) smart meters are expected not to require human intervention in characterizing power requirements, energy distribution and collecting energy consumption data. In this use case we take a scenario of a home energy management system which is capable of reducing global energy consumption by more intelligent control of the heating equipment, while still allowing the home tenants full control over their energy bill. A mobile application is developed which monitors the HEMS and facilitates for the two-way communication between devices and the gateway, device control and information delivery of energy consumption. The HEMS maybe be tailored to suit the needs of the tenant automatically through intelligent control systems

UC2 - mhealth Applications

In this use case we look at the telemedicine developments, driven by M2M which promise to make diagnosis and treatment more manageable. Intelligent devices worn by or implanted in patients offer continuous remote monitoring of biological data that removes the barriers of distance and makes medical knowledge more accessible to a large number of people. Geographically dispersed populations can be diagnosed and treated immediately without the need for them to travel to distant medical facilities, while the elderly can retain the freedom to live their lives at home without the need for institutionalization or becoming a burden to their families.

Patient sensors provide data for doctors treating chronic illnesses such as cardiac disease, high blood pressure, diabetes and obesity. Continuous two-way data feeds over the M2M network provide detailed monitoring information. This allows doctors to spot early warning of medical deterioration and apply treatment earlier. Mobile applications which offer easy access to the patient records are developed by the device manufacturer or independent developers.

The main stakeholders considered relevant for this discussion are:

- Device manufacturer: the entity that develops and builds CE devices or other devices considered relevant in the M2M ecosystem, e.g. sensors, etc.
- Mobile Network Operator (MNO): the entity that provides mobile network connectivity to a device.
- Application Developer: designs and develops an application that explores the capabilities of a device or integrates information from different sources.

This entity can be represented by an individual or an organization.

- Application Integrator**:** the entity that, on one side, provides to developers an ecosystem for hosting and running applications, and on the other side, integrates and provides applications in the user environment e.g. Apps Store and Android Market**.**
- Consumer: the consumer holds a CE device and enabled with a mobile access subscription makes use of an M2M application

Although selling applications directly to consumers seems a reasonable business scenario for application developer or application integrators, **a close cooperation with MNOs would be beneficial to guarantee platform adoption due to their large customer base and control over customer data.**

- On one hand, **applications can be charged to consumers on a one-time fee or pay per usage basis and on a pay per number of users basis to MNOs**, on the other hand. Additional license fees or exclusivity contracts could also be negotiated with MNOs.

- **In the second scenario, the application integrator could also charge developers for access to the platform** on the basis of resource consumption, access to particular APIs or on a monthly fixed fee.

The application integrator may strengthen its relationship with application developers and the value proposition of the platform towards developers by offering attractive revenue sharing contracts. A fast way to establish this platform could involve simply the expansion of an existing platform to incorporate M2M applications, avoiding high investments and risks**. Innovation is a responsibility of the application developers/designers in this case**. It should be mentioned that **the main potential bottleneck of these scenarios is the lack of cooperation between platform owners and device manufacturers**,

preventing developers to get access to hardware-specific APIs. In this scenario the barriers to entry for a tech entrepreneur (developer) are low.

A two-sided business model and enable the MNO to collect revenues from selling applications to consumers and from application developers or manufacturers using the platform to host and market applications. Platform adoption by developers and manufacturers would mainly depend **on an open platform and attractive revenue sharing rates**. In these scenarios developers and manufacturers collect revenues from one or several MNOs. **However, compared to developers, manufacturers could actually have more bargaining power, since they control the underlying access layer to CE devices**, resulting in both actors trying to exert a certain control over each other.

3.3.6 The main Benefits of M2M Technologies

We identified the following:

- Across a variety of sectors, the incorporation of M2M technologies into a company's operations will increase profits by improving efficiencies of energy, time and resources, and by reducing waste.
- The M2M industry itself is a growth market for companies along its value chain, and it supports a variety of other growth sectors, such as the IT industry, providing numerous new jobs and revenue.
- M2M technology can help the world 'do more with less' and represents an opportunity to meet the needs of a growing world. In particular, it can help us to address both higher energy demands and the challenges of urbanization.
- M2M can reduce our use of fossil fuels, helping to support emissions reduction goals at the national and international levels.
- M2M can provide numerous co-benefits in many industries, including improved safety and reliability.

3.3.7 Conclusions

There are many different ways to connect M2M devices to the Internet, **service providers are deploying their products without considering interoperability**, thinking only about how they should sell devices to consumers. He urged these market players to move and think beyond this mentality. The pervasive nature of monitoring and collection with M2M could lead to privacy and data security issues, bringing up concerns about the use and disclosure of the user's personal information. There are also possibilities for personal information to be used to market good and services based on individual's behavioral patterns and preferences. **Data protection regulations may help restrict the delivery of personal data to M2M and additional regulatory issues** such as those involving roaming, operators collaborate with others across the globe to provide wider roaming coverage, and as a result, the location of M2M devices running on these networks may not always be identified. As such, operators may not be able to comply with service level agreements stipulated by their local regulators.

Existing cross-borders commercial offers do not include high level services which could be hosted in cloud because of the heterogeneity between European regulation systems and data privacy rules. More and more M2M and IoT customers are focusing on this issue and especially the "Patriot Act" which could strongly impact the take-up of this promising business.

M2M needs a common framework on which all services and devices can interoperate and scale, and be efficient and widely available. A standardized M2M service platform will speed up the development of the M2M market. Applications can share a common infrastructure environment and network transitions within its horizontal architecture, while standardized software and hardware interfaces and protocols will

ensure the interoperability of all system elements. This is why major standards development organizations, including the **ETSI, agreed on a common M2M service layer, oneM2M, as part of a global initiative to drive M2M standardization.** This will develop globally agreed M2M end-to-end specifications and reports, with a focus on service layers using common use cases and architecture principles.

The emerging association OneM2M is a worldwide initiative, from Asia to America including Europe to reach an industrial consensus on interoperable standards and technologies, using especially ETSI-M2M standard as reference model.

Whether the Internet of Things comes to pass in a satisfying way will depend critically on **how the emerging M2M ecosystem is architected. M2M and the Internet of Things have huge potential, but currently comprises a heterogeneous collection** of established and emerging, often competing, technologies and standards (although moves are afoot here). This is because the concept applies to, and has grown from, a wide range of market sectors. The market is fragmented and there are very few standards [and] you literally have hundreds of small developers, you have the [network] operators, you have the hardware manufacturers, and you have customers in the marketplace who are just beginning to understand what M2M is. So, our view is that **the criticality of partnerships is really important**

The key to the success of the M2M and IoT business will be a focus on the value created for the end users, new collaborative business models and ecosystems where all participants can be successful. Stakeholders need to build consortiums which have sufficient clout together to negotiate and position the innovative business models into market. Although restricted to a specific set of technical cases, these scenarios can also be extrapolated and applied on more generic deployments and seem to have real-life applicability**. Apart from the business configuration, there is however other issues that influence synergies** that should be considered when planning strategies to efficiently deliver M2M devices to consumers which include:

- Current standardization efforts by 3GPP, IEEE and FIA.
- Regulatory constraints and incentives.
- Harmonizing of roaming prices for MNOs.
- Promoting the alignment between MNOs, device manufacturers and application developers by clear communication of the market and research opportunities.
- Security and privacy issues related to information sharing and collaboration with third-party stakeholders.

In conclusion, the Internet of Things, powered by Machine-to-Machine communication, is already with us, but remains a massive opportunity. Properly implemented, it can retool large parts of the world for better efficiency, security and environmental responsibility and of course it can generate potentially huge amounts of business for the IT companies that will build and run the systems involved.

Many technology sectors stand to benefit from this new world order, including mobile network operators and fixed broadband providers, system integrators, cloud service providers, mobile app developers, sensor and wireless infrastructure vendors, and purveyors of Big Data infrastructure and analytics. In an ideal world, **M2M equipment will interoperate smoothly, service providers will compete on a level open-standards playing field without attempting to lock customers into their ecosystems**, and the Internet of Things will develop with the same explosive inventiveness as did the original internet. **The momentum of the Internet of Things is now building**. The Internet changed our lives, and the Internet of Things will change us again.

3.4 Economy of Internet Applications

IT is challenged to find new and additional value in using platforms and data in different ways driven by the ever faster changing business and consumer scenarios. This is forced by the explosion in

valuable consumer services and associated commercial models. The resulting new business models blur the traditional industry borders and question the commercial models as they are known today.

Supported through cloud computing adoption, growing social networks and an explosion in mobile device adoption, the Information and Communication Technologies (ICT) **Industry further explores the value of data, in an effort to monetize and capitalize on the wealth of data, the 'data gold'**. Especially we see a growing interest in the data generated by collaborations between business partners and the value that is derived from connecting together data owned by any given partner in the chain.

Nowadays a huge amount of data is collected, sometimes without a defined outcome of quantifiable value for either a consumer or business. **The Internet of Things concept; leveraging data gathered by sensors embedded** in countless devices will further strengthen the richness of information **that can be generated from transactional platforms.** And on top of these different sources of data coincide with the emergence **of Big Data Management and new data analytics technologies, increasing the probability of finding meaningful insights** from huge amounts of data generated by myriad applications and sensors.

In the upcoming years, vendor and IT users should develop deep competence in all of these technologies, **cloud services, mobile devices, social technologies, or the other core elements of the 3rd platform**, and align with the emerging and radically different following "rules" of the **3rd Platform marketplace**

3.4.1 Apps Market: The Battle for the 3rd Platform

As we enter 2013, the 3rd Platform including its core technologies, its new strategic customer segments, and its radically new rules for success is right in the center of the market, sitting in our metaphorical laps. The battle for the IT industry as a whole, as of now, is almost completely about this battle for the 3rd Platform.

Enterprises will spend $65 billion on 3rd Platform industry specific solutions in 2013, with a rapidly increasing number of them leveraging cloud services, mobile devices, Big Data, and the other elements of the 3rd Platform. IDC expect this to grow to nearly $100 billion in the next three years. For enterprises, the greatest business value from the transition to the 3rd Platform will come from the new generation of industry solutions and services just starting to emerge on top of the platform.

By 2020, when the ICT industry generates $5 trillion in spending, over $1.3 trillion more than it does today, **40% of the industry's revenue and — incredibly — 98% of its growth will be driven by 3rd Platform technologies that today represent just 22% of ICT spending.**

The most important trends and events in 2013 will cluster around mobility, cloud services, social technologies, and Big Data, as well as emerging high value industry solutions built on top of them, and the vendors (e.g., service providers and industry PaaS providers) and customers (e.g., consumers, SMBs, line-of- business executives, and emerging market customers) that will play leading roles in much of the next eight years' growth.

- The rise of "industry PaaS": The number of industry focused public cloud services platforms — less than 100 in 2012 will increase tenfold by 2016. This marks a strategic shift in what real value PaaS will deliver to the market (business and consumer services, not "IT"), and who the key PaaS players will be (leading companies within the served industry, not just IT vendors).
- Big Data — from search to discovery and prediction: Spending on Big Data technologies and services will reach nearly $10 billion in 2013, on the way to over $20 billion in 2016. Growing emphasis is on tools and applications that go way beyond "search" to graph analytics associated with "discovery" and finding hidden relationships/patterns.

Rising 3rd Platform market leaders: 3rd Platform markets and technologies will drive big share shifts, such as smartphones, SaaS (versus packaged software), and cloud servers (versus physical servers

- The days for vendors to simply share "strategic road maps" for cloud, Big Data, mobility, and other 3rd Platform offerings without having real, highly competitive offerings will be over in 2013. Vendors' ability (or inability) to effectively and aggressively compete on the 3rd Platform right now even at the risk of cannibalizing their own 2nd Platform franchise will reorder leadership ranks within the IT market and ultimately beyond it within every other industry that uses technology.
- Strategic customer communities: In 2013, the accelerating shift to the 3rd Platform will continue to raise the profile of key customer communities that are driving industry growth and redefining the design points of successful offerings. **Scale is an essential element for success in the 3rd Platform**, and capturing the business of small and medium-sized businesses will be key to achieving scale. Vendors that ignore, or fail to achieve success with, small and medium-sized businesses will fight an uphill battle in the 3rd Platform era**.**

Much of the growth in software, services, and hardware sectors will be driven by double-digit growth rates in the 3rd Platform foundations of mobile, cloud, big data, and social technologies and services as growth shifts away from 2nd Platform markets.

- The major changes mentioned previously — the growth of mobile devices and platforms, the expanding adoption of SaaS and other cloud services (including more deeply into SMBs), and the growing adoption of PaaS as a center for innovation (often with partners) — as well as the social and Big Data technologies discussed in subsequent predictions, will continue to drive profound changes in the datacenters and enterprise IT organizations supporting these 3rd Platform solutions

For enterprises, the greatest business value from the transition to the 3rd Platform will come from the new generation of industry solutions and services just starting to emerge on top of the platform.

- **Investments in a new generation of 3rd Platform "intelligent industry solutions**" will near $100 billion by 2016. IDC predicts that, worldwide, enterprises will spend $65 billion on industry-specific solutions in 2013, with a rapidly increasing number of them leveraging cloud services, mobile devices, Big Data, and the other elements of the 3rd Platform.
    - IDC expect this to grow to nearly $100 billion in the next three years as businesses use these technologies and solutions to create new products and services and redefine existing customer relationships. IDC sees the greatest activity, and **opportunities, in the areas of public safety, smart buildings, merchandising analytics, Omni channel retail, connected health, smart cities, personalized medicine, and smart government services**.
- **Retailers' 3rd Platform solutions supporting "show rooming**" will drive nearly $2 billion in 2012 holiday sales. IDC predicts that almost 50 million U.S. shoppers will engage in "show rooming" **(using their smartphones in retail stores to comparison shop)** this holiday season, up from just 20 million last year.
- **The explosion of new industry solutions will dramatically shift who the IT buyer is.** IDC predict that a direct result of this business innovation on the 3rd Platform creating a wider variety of new solutions targeted at new business opportunities and challenges will drive a profound shift in which the buyer of IT is. IDC research indicates that 58% of new IT investments in 2013 will involve direct participation by line-of-business executives, most notably by those in charge of customer-facing front-office functions. IDC predicts that by 2016, that number will rise to 80% of new IT investments, with LOBs taking the lead decision-maker role in half or more of those investments.

3.4.2 Apps Trends: Multi-side markets

Increasingly businesses in all industries have to cope with dynamic and unstable markets that are influenced by globalization, continuous mergers and acquisitions, disruptive innovations and adaption to customer preferences while at the same time complying with ever-evolving legislations. All of this has to

be done in an **extremely competitive market which is putting unprecedented pressure on reducing cost and the time to market for new products and services**.

This pressure evolves to completely reorganized value chains in different markets, making the value creation process **change from a linear, supplier-customer relation to one where multiple stakeholders cooperate in an ecosystem model to generate value**. **This ecosystem view on value generation differs from the traditional, linear supply chain models in many ways**; one of the main differences being that value can be found in addition to a traditional product-for-money exchange, **moving to a new model in which collaboration of different types of stakeholders in the ecosystem can generate overall positive gains for the ecosystem as a whol**e, without diminishing the prospects for any of the players. One of the ways to reach this everybody-wins-scenario is through the collaboration between the stakeholders.

This is a practice becoming more and more visible all over the world. Especially after the rise of Web 2.0, **people learned to perceive value in voluntarily giving information to communities**; blogs, social networks and others, while at the same time are able to derive information from those sources for their own personal good.

With this change in information sharing and using now becoming a undeniable trend in the behavior of the consumer, it is only natural for businesses to start behaving in a similar way**, while counting on participating consumers at the end (and beginning) of the value chains**. This change creates the required conditions for **new application-types using an existing concept: the transactional platforms**

In the upcoming years, vendor and IT users should develop deep competence in all of these technologies, **cloud services, mobile devices, social technologies, or the other core elements of the 3rd platform**, and align with the emerging and radically different following "rules" of the **3rd Platform marketplace**:

- **Urgency is required**: the 3rd Platform is already here. In many of our predictions, we point out that 3rd Platform technologies have either already eclipsed 2nd Platform technologies (mobile devices) or are approaching that point (SaaS) and so they must be the priority now, even at the risk of the cannibalization of 2nd Platform franchises.
- **A platform (and community) vision and strategy are essential**. Platforms and the communities around them are essential components of a successful 3rd Platform strategy. The ability to compete in the new marketplace depends on collaborating with others to augment and amplify each other's value and dramatically broaden distribution. Lack of a solid platform strategy means isolation and marginalization in the new marketplace.
- **Quickly reaching massive scale is mandatory**, a critical ingredient of any platform strategy; scale helps attract a critical mass of developers, solutions, and customers to your platform.
- **Consumerization is penetrating all aspects of 3rd Platform IT**. This is happening not just at the end-user edge of the market (i.e., mobile devices) but increasingly at the core of IT operations. And, given the importance of scale and community, consumerization strategies for enterprise IT vendors and IT organizations are not just about having consumer-like technologies (e.g., enterprise imitations of Facebook or Dropbox); they're about supporting and adopting the specific technologies and offerings that consumers are actually using.
- **Embracing and prioritizing newly strategic customer segments is essential**. Success in the 2nd Platform era was about designing offerings for, and establishing relationships with, IT executives in large enterprises, primarily in developed economies. In the 3rd Platform era, success will be about developing offerings for, and relationships with, a whole new set of strategic customer segments:
    - SPs: A fast-growing route to market for large portions of the IT market and the essential proving ground for market-leading scale, performance, and costs
    - SMBs and consumers: Segments that are increasingly defining the standards for scale, simplicity, and superior customer experience
    - LOB executives: Executives who are generally not interested in buying IT but in the course of buying 3rd Platform industry/business solutions and services will in fact be huge buyers of "under the covers" IT

- **The number of customers for virtual/cloud offerings is exploding**. Vendors that sell virtual offerings (e.g., cloud services) which include most suppliers in the IT market must get ready for a massive expansion in the number of customers, channels, relationships, and transactions they can support. To compete, as noted previously, unprecedented scale will be required and that means serving many more customers. As a consequence the following packaged application providers like IBM, Microsoft, and Oracle become software as a service (SaaS) providers themselves, they will increasingly battle with SaaS pure plays like Salesforce.com and Workday for leadership in some of the major application software markets.

Two-sided Markets

In traditional business, relationships often have a supplier-customer nature (1:1), money flows in one direction while goods or services flow in the opposite direction. In the economic theory of the two-sided markets), the value flow is made possible by a platform, which combines two different markets (referred to as Side 1 and Side 2). A **value exchange is established by introducing the platform between the different categories of the market participants**. There are various examples like credit card platforms (linking the merchants and customers), broadcasters (linking the advertisers and consumers) or gaming platforms (linking the developers and gamers).

- **The more the adoption by both sides of participants grows (in a balanced way), the more valuable the platform becomes**. If the participants positively influence each other in their growth this is called the 'network effect'. This network effect moves the price/quantity relation in a positive direction for both market sides; for example the more people are using a certain gaming console, the more it attracts developers to create new games, which in turn attracts more gamers to buy this console and games for it.
- **Based on the economic theory of two-sided markets**, most communities are grown by keeping the consumer access free of charge (this is called the Freemium model of Internet services). By growing the user population rapidly, the market participants gain value through the network effect. Thus the demand increase is in this case not only influenced by traditional dimensions like price, quantity and quality, in addition it is influenced by the other side of the market as well.
- **This theory can also be applied to Social Networks**. In these platforms the users do not pay for access. As a result the classical micro economic demand increase is significant bigger. The cost for the user is not a monetary expense, rather a willingness to allow the platform to reuse its personal data, on an anonymously aggregated or individualized basis.

The theory of the two-sided market also proves that a platform has to deliver a certain level of monetized value (the platform capital) to the market sides to enable the network effect. With other words you cannot start such a platform by providing only a Freemium model to each side, even if this would grow the two sides very fast. **Ignoring that fact resulted in the monetization problems of many Internet platforms**.

Multi-sided Markets

When dealing with information-based platforms the presented **concept of two-sided markets can evolve into multi-sided markets.**

- **The collection of data through transactional and social platforms can bring multiple use cases for different stakeholders into the same information domain**. These platforms will bring the ability to cross-link data coming from different contexts and create value from such linkage. An activity that creates more value than the mere sum of the values that can be derived from each market individually. **These platforms can evolve into real value networks or ecosystems in which one business in one market stimulates the business** in another market by sharing anonymous information and, eventually, the customer access. The upside is the trust can be built slowly step by step in sharing more and more information. **The downside is that trust and the entire new value can be destroyed by one single unwanted privacy violation of consumer or business data.**

- Consumer behavior is a major source of value in the multi-sided platforms and is also of interest for the other market participants in the same sector, but more easy to share with market participants of the other side or other sector. **Nevertheless it is a challenge to balance privacy, user experience and business value.**

These value ecosystems will not only influence the collaboration between the competitors in one market, but will also force a cross sector collaboration based on shared information. The multi-sided markets will transform into what we call the Multi-purpose Transaction Systems. **The adoption of the right business model is essential for these platforms to flourish**. Stakeholders on all sides of the markets, as well as the platform owner itself, **must have the right incentives**. **Only in the case of generated value for all participants an ecosystem of values becomes alive**. In essence the value of a two-sided market - or a multi-sided market here, is **not only defined by the amount of money charged by the platform, it is defined by the services or the information exchanged in between the participants** of the different markets.

In identifying the alternative business models for Multi-purpose Transactional Services, we look into the Internet business models as a source for solutions. Like in other sectors, the current Internet business has different contracting models that are continuously evolving. These range **from traditional fixed pricing models, subscriptions and usage or transaction-based fees to the more recent like the Freemium, assurance or success-based models.**

Business models will not only be based on money exchanging hands, but value that is exchanging ownership. **In two-sided markets it is common to keep one of the sides free (Freemium) of charge in order to stimulate enough growth to start the network effect**. This is typically the case when it is necessary to attract consumers to the services and the platform behind it. Consumers are usually making their adoption decisions very much driven by pricing and choose other alternatives in case of fees charged for services.

Business models do not need to have the same revenue model for all where it interfaces. The business model that suits each participant's best interest will be a combination of different revenue models mentioned below.

- **Freemium Business Models Today**: Pioneered by the open source community and driven by the success of free consumer services, the most common models for consumers are the Freemium models. These models, which have proved to be extremely successful in building large communities very fast, establishing brands with a worldwide reach in weeks or months. They influence the consumers to accept advertising. But the challenge remains how to monetize these models, as similar services are just one click away. Some attempts to simply charge the consumer have failed, even resulting in a breakdown of entire platforms or brands in weeks or months. Although consumers are paying substantial prices for physical products, they are really reluctant to pay for online service offerings, as demonstrated by the attempt of the media industries to switch to paid subscriptions. Users expect digital services to be available for very little or for free. This expectation is reinforced by many companies (Facebook, Google, Twitter, LinkedIn, etc.) giving away much of their service offerings for free and recovering their cost in other ways. Anderson provides the taxonomy of current free products and services models:
    - **Freemium model**: The content, services and software are available in multiple models of use, including a basic free offering. In this model, a small percentage of the customers pay for the service which covers the overall cost of the platform/services. Skype is the perfect example. Many applications in today's - now ubiquitous App markets or 'App Stores', pioneered by Apple as a platform to sell or make available content for its products, are also Freemium in a sense that they have a free version with less features and a paid one with full functionality.
    - **Free-through-advertising model**: Content, services and software are offered for free, because advertisers are willing to pay for access to specific user communities as additional sales channel. Some examples are Yahoo's pay-per-page view banners, Google's pay-per

click text ads and Amazon's pay-per-transaction affiliate ads. Consumers accept that personal data is used for one-to-one marketing.

- **Traditional cross-subsidized model:** Products and services are offered for free while they persuade customers to pay for additional services. For example, Google's AdSense product enables any web site to become affiliates to other providers who wish to advertise their products and services.
- **Low-cost model:** Products or services are offered for free for a limited period or with limited capabilities. In these cases, the service or content is effectively a promotional marketing tool. Many applications are offered for free for a limited period to attract trial users who subsequently buy it (try before you buy model!).
- **Gift-economy model:** Some offerings are free because the providers gain some non-monetary value, usually recognition, out of the process. For example, Wikipedia contributors or popular bloggers provide their services as gifts to the community

- **Pay-per-Use Models:** Today Pay-per-use models are now established in many areas. The user pays a price based solely on actual usage, such as price per minute calls on a landline phone. In ICT platform businesses, these models are enabled by shared, pooled and scalable infrastructures and multi-tenant applications and services. These models are not entirely new (embryonic approaches appear in the late 1970's with Grid Computing), **but cost benefits combined with agility (elasticity and time to market) means they are becoming more popular now and likely to dominate the ICT industry in the future.** A pay-per-use model could be used in one of the sides in Multi-purpose Transactional Platforms (for instance, a business partner wishing to participate in the usage of data generated by the platform), while other sides are tied to the platform by other models or more traditional models.
- **Subscription Business Model**: Unlike Software as a Service (SaaS), that is defined as a pay-per-use model for software, the subscription business models **are not based on actual usage but on a fixed fee over a period of time. The fees are incurred regardless of whether the service is consumed or not**. The benefits for the provider in this type of model is that they are assured of constant source of revenue, while understanding in advance the number of subscribers to a service making capacity management a less challenging task. From a subscriber's point of view, this model is convenient if the usage of the service is constant while the pay-per-use model may be more attractive if the service is used occasionally or in volatile quantities

3.4.3 Apps Ecosystem: The Evolution Path

For the future Multi-purpose Transactional Systems will have **to accommodate an ecosystem of companies with different business interests participating in the multi-sided platform**(s). This is an approach that allows for a balance between cost and business benefits for those involved, with a consequence that no single partner has to finance the entire platform.

On Multi-purpose Transaction Systems, companies from different sectors of the economy may derive different kinds of value from using the platform, and the use cases themselves may vary, **requiring different contributions and business models for each player.**

The Multi-purpose Ecosystems in the vast majority will consist of stakeholders with different business interests or complementary ones. This will happen because if the platforms are to be shared by competitors, information privacy issues could jeopardize shared interests of the sides and thus the potential value for leveraging the re-use of information.

Any platform that needs to include the end consumer at any point in the value chain can attract them by offering a greater user experience because of the free nature of the service, **in exchange for the voluntary disclosure of some private information, such as geo-localization or preferences.**

After the standardization of ERP, SCM and CRM processes, **building sustainable business models based on fast growing communities in the Internet is the next big organizational challenge**.

We envision that creating these business models in Multi-purpose Platforms will happen in steps, as described by a four level maturity model:

- **Tailored Solutions**: Most of the business ICT landscapes today are individually developed or customized solutions, operated on a customer-owned infrastructure supporting individual business processes. This variant is the one with the best end-user experience, but also produces the highest costs. The time for adoption can become a problem and changing legacy applications can produce unpredictable side effects. Opening the application to a broader consumer audience via the Internet could lead to inadequate consumption of infrastructure capacity. New rules and regulation needs can trigger demand for high maintenance and innovation budget. Ideally, this model should only be chosen by the business where the solution supports a unique selling proposition in the market.
- **Multi-tenant Platforms**: Forced by the upcoming re-use paradigm in software development and standardization driven by Cloud Computing, especially in terms of business support functions, platforms capable of supporting more than one tenant came into the market. The market penetration happens in waves. The first wave offered a lot of ASP (Application Service Provider) solutions during the Internet boom at the turn of the century. Today we see the second wave, driven by Cloud Computing. Enabled by virtualization and multi-tenancy cloud is now the common approach for infrastructure and at application level. Application, data and systems are strictly separated for each tenant, while system management, code and hardware are shared in order to provide cost reduction. Cloning an entire application and system for a second tenant is the easiest way to enable multi-tenant platforms. More sophisticated methods of sharing data or better information add more value but complexity too.
- **Closed Value Networks**: There is business information generated out of data collected already and ready to be shared, that is of value for different participants of Multi-purpose Transactional Platforms. Most companies are too busy to find their own value in data while not realizing the potential value of information for other platform participants outside their particular sector of industry. And there is value without diminishing the own value. Best example is the anonymized user or consumer behavior. This can be strengthened by the fast growing consumer community described already. They obtain their attractiveness and value by sharing the data collected from the user. The rules on how to share and build communities are becoming more sophisticated but still haven't reached a level feasible enough for business purposes. **There is a huge untapped potential value in existing multi-tenant platforms. By enhancing these platforms with the context broker platform and consequently collecting and sourcing context data, this potential value can be brought to life**. The additional value could be for the intended purpose of the platform or for completely new purposes even in different sectors. The value networks in this case would have to be previously planned and built for specific usages, having B2B contracts negotiated on a case by case basis between the different actors.
- **Consumer Community**: The easiest way to build large communities is shown today in social networks. Most of the offers are free of charge to attract users in the hope of the network effect. However, monetization is still a challenge and the use for business reasons under discussion. Moreover, privacy issues arise more and more as technology usage deepens. We believe that society and business' learning curves around social networks are still going to evolve. A more sustainable development could start with established multi-tenant platforms leveraging the value of context or meta data for existing customers. There is an upside potential of leveraging the value of context data even outside the original intended sector or industry. When the conditions are ripe for a future leap into creating a consumer community fueled Multi-purpose Platforms, these will be leveraged by loosely coupled data and applications, built on top of the original platform in a flexible way to generate further insight, as much as Facebook currently opens its API for application developers to sell their own apps inside the Facebook platform taking a percent of the developers revenues.

The first and second levels are already well covered by various market players today. **Multi-purpose Transactional Services begin at the third level, and future evolution will take it to the fourth level.**

3.4.4 Building the Business Model for Multi-purpose Transactional Services

Value networks are a new approach to stimulate additional and new business and introduce a different style of business collaboration. With the 3by3 method a mix of existing methods it is easy and fast to investigate and elaborate value networks and to prove the data ecosystems.

It starts with a simple three step description of the idea.

- The first step describes the intended benefit of the platform for a consumer or user, as the user experience is key in each approach.
- The second step describes and concentrates on additional meta data or context data collectable to generate additional value.
- The third step describes the value for the participants.

Based on this description and inspired by the 'Board of Innovation' the revenue and value streams of at least three ecosystem participants can easily be visualized in the second phase. In the third phase the benefits for the consumers and the business in the simplicity and control model are concluded.

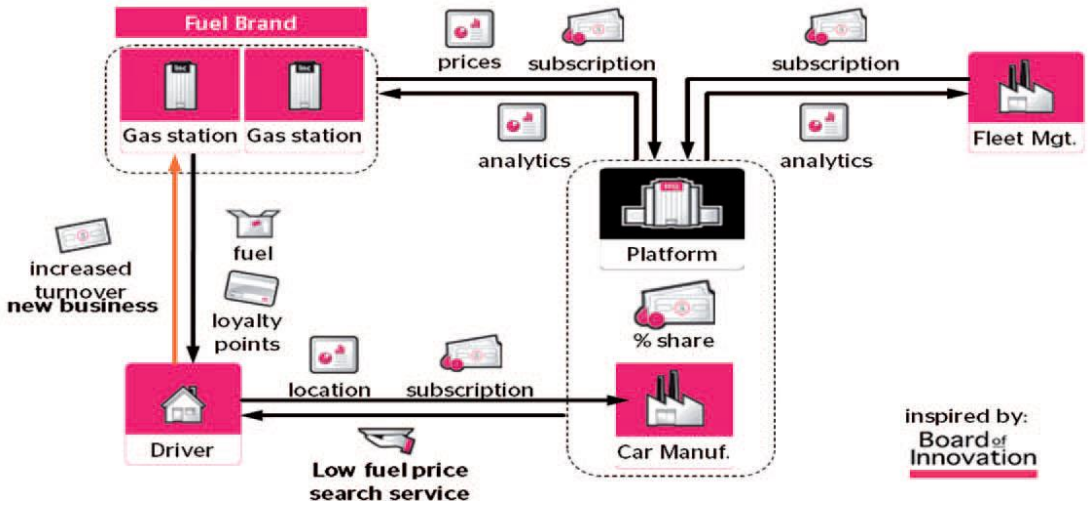

Figure 17: The graphical business model- http://www.boardofinnovation.com/

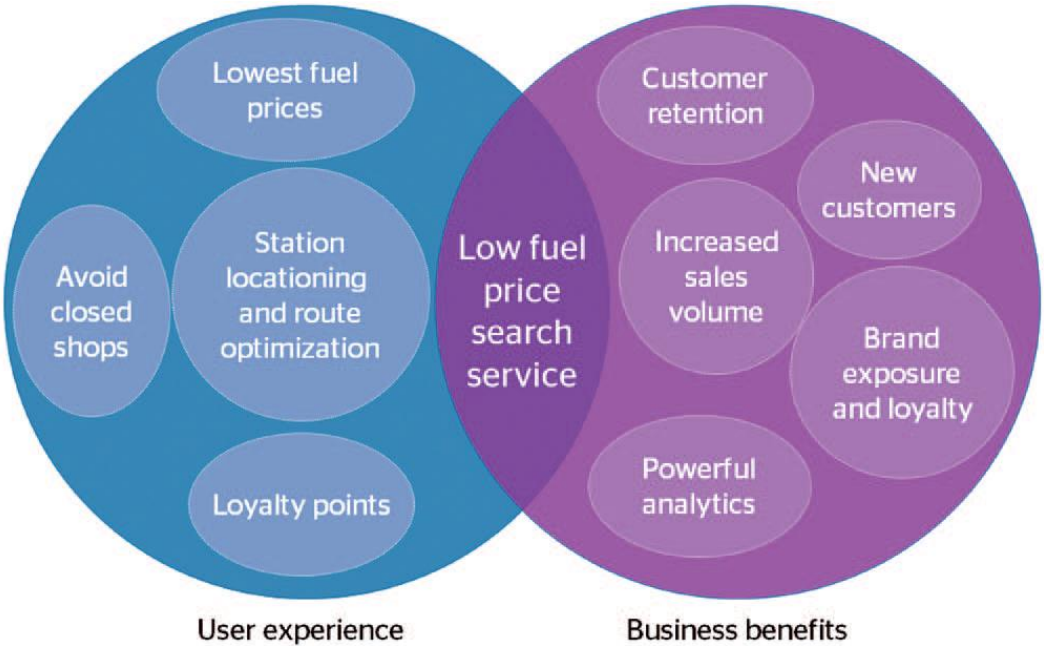

Figure 18: The simplicity and control conclusion

This method makes it possible to explore the value of a platform for the consumer and the participating market actors. In the concrete business case shown above, the market actors are all car related, but you might also think of completely different sectors like Insurance. Driven by new tariffs insurance companies see value in behavioural data collected from consumers, so they are willing to participate in such a platform. **The challenge is the acceptance by the consumer to use the context data collected for different purposes**.

After the positive evaluation of an opportunity by the 3by3 method the documented business case can be presented to potential partners demonstrating the value in participating in such a network. **General criteria for business ideas** to match the concept are:

- The additional investment to integrate a new partner into the value network should be small (less than 20% of the original investment to build the initial platform).
- Information to be used by additional market actors with propositions/products that are complementary to those that are already using the platform, and not direct competitors (Rationale: In case of direct competitors the re-use is only accepted in the case of commodity services, it ends up in multi-instance platforms not in value networks).
- The level of collaboration and sharing for new partners should be chosen in a way that not every existing partner in the ecosystem has to agree first. So a clear set of rules is defined to balance the attractiveness for new partners to join and the privacy of data of the existing participants.
- Resulting in a set of already agreed approaches and a detailed discussion on an individual base, which puts the negotiation into levels. Comparable with the discussion in the case of re-use, one to agree the common functions and one to start the concrete use.

3.4.5 Conclusions

In the upcoming years, vendor and IT users should develop deep competence in all of these technologies, **cloud services, mobile devices, social technologies, or the other core elements of the 3rd platform**, and align with the emerging and radically different following "rules" of the **3rd Platform marketplace**

The adoption of the right business model is essential for these platforms to flourish. Stakeholders on all sides of the markets, as well as the platform owner itself, **must have the right incentives**. **Only in the case of generated value for all participants an ecosystem of values becomes alive**. In essence the value of a two-sided market - or a multi-sided market here, is **not only defined by the amount of money charged by the platform, it is defined by the services or the information exchanged in between the participants** of the different markets

After the standardization of ERP, SCM and CRM processes, **building sustainable business models based on fast growing communities in the Internet is the next big organizational challenge**.

There is a huge untapped potential value in existing multi-tenant platforms. By enhancing these platforms with the context broker platform and consequently collecting and sourcing context data, this potential value can be brought to life. The additional value could be for the intended purpose of the platform or for completely new purposes even in different sectors. The value networks in this case would have to be previously planned and built for specific usages, having B2B contracts negotiated on a case by case basis between the different actors.

One of the successful approaches to evolve platforms into new value areas are app markets or stores. They have brought the one time fees down to an acceptable level for the consumer. In most cases a certain percentage of the revenue is agreed for the platform provider to secure the platform. **Some of the platforms are closed in terms of participants,** with rules and regulations, especially around technical API's, that are proprietary and closed. **So the provider prevents sometimes the participants from switching in between platforms (multi-homing) and achieves vendor and consumer lock-in or retention**. They concentrate on applications and provide the data (sometimes) for free (e.g. maps). The value to be investigated should not be concentrated only on the application or the functions to manipulate the data. **Even if this is the interface for the consumer, the real value is in the data itself or more precisely what can be done in a new context**

3.5 Interface to the Network and devices: How the mobile revolution is challenging open source user interfaces

A very fundamental need by any kind of Future Internet users (being citizens, enterprises or industrial processes) is seamless access to Future Internet services, guaranteeing high performance, optimal user experience, full seamless mobility, and security and privacy across heterogeneous network technologies. For this it is necessary to have standardised interfaces to provide the possibility for network virtualisation and to get access to control and policy mechanisms for dynamic network configuration and management of the network service provider infrastructures.

In the past couple of years, a powerful paradigm shift has occurred in user experience (UX) design. UX designers used to focus on desktop users but now, mobile devices and mobile users are at the centre of attention. The evidence for the importance of this paradigm shift is stifling. Most importantly, this shift is not exclusive to consumer software or proprietary software; **enterprise and OSS vendors have now begun creating their user interfaces with a mobile approach in mind, too**. The mobile revolution has shown users how a simple experience can be much more satisfying than complex and crowded interfaces.

The paradigm shift from desktop to mobile has put UX design in the spotlight, because the mobile revolution has shown users and designers that a quality UX can be done in a much simpler and more effective way. Nowadays, mobile users expect a flawless interface that caters to their needs and gives them a seamless and intuitive experience.

3.5.1 Market

Morgan Stanley predicts that by 2014, mobile users will exceed desktop users. This will lead to a significant increase in devices. For example, home appliances and TVs, but also in-car entertainment, all of them will be connecting to the internet. This means, that more people, using more devices will lead to over 10 billion connected devices by 2015 – 2.5x today‘s rate. The increasing diversity and fragmentation of connected devices makes difficult to have a commonly agreed esteem of growth; for instance, according to the GSMA, a worldwide association of mobile operators and related companies, there are already 9 billion connected devices in the world today. By 2020, there will be 24 billion and over half of them will be non-mobile devices such as household appliances. The GSMA estimates that connected devices will be a US$1.2 trillion market by 2020.

The diversity and fragmentation in the offer of connected devices, both in terms of hardware capabilities and software platform, **is one of the reasons of the overall increasing of their market sha**re and one of the reasons that makes the Future Internet a real technology foundation for all the other future innovation. It’s evident, however, that even though a wide offer is positive stimulus for the market, **the technical differences between devices also are a great challenge for all the application and service developers.**

A further step in creating a common developing platform has emerged, by offering libraries specifically designed to overcome the limitation of **using pure HTML5/JavaScript**; these new libraries offer a wide set of functions written and optimized in the native language for all main OS, to guarantee good performance and the most uniform and predictable appearance of graphical elements and interactions used in the applications**. The set of API provided are typically accessed using JavaScript**, and the library are maintained and updated to support the changes in the device technologies and software.

The purpose of the Interfaces to network and Device Generic Enablers is to offer a more uniform set of functions to device and network capabilities, extending and providing a uniform set of developer accessible API. These GEs will provide a more consistent way to write applications able to provide also more efficient interactions with the users and the network capabilities and policies.

Regarding Cloud Edge/Proxy. Users own and use more and more complex home networks connecting many consumer electronic devices and broadband home gateways providing more and more advanced functionalities. The interface and interoperability between all these devices is still a challenge, even after years of development of interoperability standards such as UPNP or DLNA. In the future, gateways will be further extended to specifically include cloud functionality, e. g., in the form of “nano data centres” or “advanced home hubs” that support private cloud functions, execution of downloadable applications in virtualised environments, advanced storage, intelligent content distribution, or translation to local IoT-related networks.

For the time being Cloud Proxies is not yet a well-defined market sector. Telecommunication equipment providers are positioning themselves by extending the capacities of advanced internet gateways and other communications equipment (e.g. set-top-boxes) with Cloud interfaces, P2P services and advanced APIs allowing to shield applications from complexity in homes (and vice versa).

Meanwhile actors of the consumer electronics market (such as suppliers of NAS’, Apple, Samsung, etc…) are also expected to enter the market with new versions of existing products (e.g. Apple Time Capsule) or full-fledged new products providing similar functions.

3.5.2 Interface to the Network Trends

Cross-platform tools (CPTs) allow developers to create applications for multiple platforms - usually mobile, but increasingly tablets or TV screens - from almost the same codebase or from within the same design tool. CPTs reduce the cost of platform fragmentation and allow developers to target new platforms

at a small incremental cost. More importantly, cross-platform tools allow software companies targeting multiple platforms to reuse developer skills, share codebases, synchronize releases and reduce support costs. **Multi-platforms development is a major challenge. For a solo developer there is so much they need to look at**. You can use crossplatform tools like PhoneGap but it's not that simple, there is a lot of tweaking to be done. Going native can also be hard, it takes a lot of time and patience. HTML5 will help things go in the right direction.

Thanks to so-called network effects, Apple and Google have built huge barriers to entry for competitors However, just as the Apple/Google duopoly began to look impenetrable, a major disruption is flattening the playing field for competitors like Microsoft's and Samsung's Bada: **cross-platform tools are letting developers target multiple platforms with low incremental costs and high levels of code reuse**. Simply put, cross-platform developer tools (CPTs) allow developers to create applications for multiple platforms from almost the same codebase or from within the same design tool.

The impact of CPTs is twofold; they can **reduce entry barriers to mobile development** and, if successful, **reduce exit barriers ('lock-in')** that users face when migrating to a new platform.

- **Democratization of development:** First, cross-platform tools allow developers to reach platforms they otherwise could not. CPTs lower entry barriers, for example allowing web developers to create native smartphone apps using only HTML and JavaScript. They can provide easy-to-use languages and development tools, and facilitate modular development and software component reuse.
- **Reducing developer lock-in:** The second impact of cross-platform tools is strategic. CPTs reduce platform exit barriers, i.e., "developer lock-in." For example, they make it easier for a developer to code for Android and Windows Phone 7 at the same time as iPhone. App ecosystems compete in four arenas: the number of apps listed, availability of top apps, time-to-market (an app rarely appears at the same time across all platform app stores) and overall app quality. **In theory, cross-platform tools make it far easier for platforms with weaker network effects** (e.g., Bada) to compete, by allowing developers to code for Bada essentially at the same time as they code for Android. In other words, cross-platform tools can **help smaller platforms to compete not just in number of applications, but also app availability, time-to-market and quality**.

Cross-platform tools have emerged as a solution to the problem of device and platform fragmentation. Java ME was supposed to address the tens of proprietary operating systems powering phones in the 2000s – but developers wound up having to support over 200 device variants (SKUs), just to reach 80% of the installed device base in any one country. Mobile web sites were another "lowest common denominator" approach hampered by poor browser conformance to web standards; even today, Internet Explorer on Windows Phone supports only half of the HTML5 features supported by Apple's Safari on iDevices.

Besides fragmentation across devices, platform fragmentation is very pronounced. Take for example a small apps company developing for iOS, Android and Windows Phone 7. They would have to employ three teams of developers, as often, skillsets don't mix. They would have to maintain three different codebases, and synchronize feature additions and bug fixes across the three. This is a daunting challenge, and one reason why many apps are launched across stores with months of delay. Furthermore, quality and design consistency will vary when multiple developer teams are involved, and especially when the development for a new platform is outsourced to a third party. **Support costs are also difficult to contain when developing for multiple platforms,** as developer documentation needs to be built for three platforms, as does the internal customer support documentation. **Cross-platform tools therefore can provide major time-to-market advantages and cost savings to a software house**.

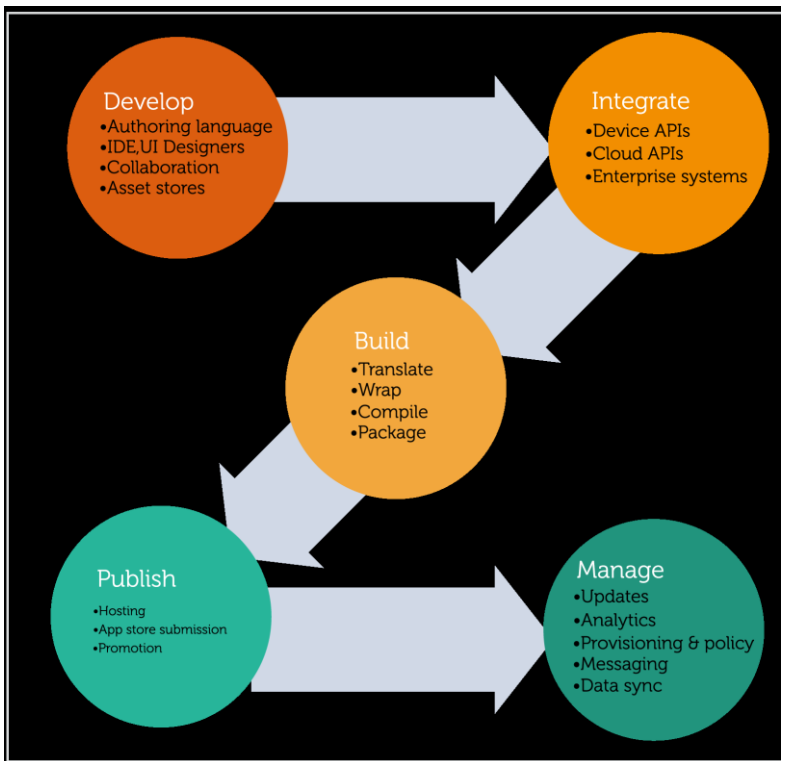

Figure 19: Cross Platform Approach

1. **Develop.** Cross-platform tools offer a plethora of authoring languages, from entry-level, simplified languages like LiveCode or Lua (e.g., Corona, DragonRad, Moai and Unity), to web languages HTML, CSS and JavaScript (e.g., Appcelerator, Application Craft, Kony, Spot Specific) to mid level languages like Java and C# /.NET (e.g., Xamarin MonoTouch) to more low level languages such as C++ (e.g., Qt, MoSync, Marmalade, Aqua Platform). Many tools offer a visual drag-and drop environment (e.g., Games Salad, Yo Yo Games Maker, LiveCode, Appcelerator, Spot Specific). Others have only a restrictive template-based app development process (e.g., iBuild App, Wix Mobile). Other tools target developers in specific segments; for example, Impact JS and Lime JS JavaScript frameworks target games developers, while RhoMobile and Worklight target enterprise developers.

   This gamut of CPT authoring languages caters to the entire spectrum of app developers, from scripters to seasoned web developers, and from creative designers to hardcore software developers**.**

   - The IDE (integrated development environment), emulator and debugger are core parts of the Develop stage. The open source IDE Eclipse is most often used as a basis, as the development environment is crossplatform itself across PC, Mac and Linux. On top of Eclipse, vendors provide additional plugins and emulators. Some vendors offer an install-free, web-based development environment specially designed for enterprise developers or designers working for a brand.
   - Unity, Appcelerator and RunRev provide marketplaces where designers and developers can sell components and assets with the aim of helping others to speed up their development cycle with off-the-shelf components. Sencha soft-launched a similar component marketplace in November 2011, while Corona and Marmalade host a template repository and code community, respectively.

2. **Integrate**. This stage is about integrating with native device capabilities, cloud APIs and enterprise databases. To integrate with native device capabilities, a popular approach is to use JavaScript alongside the PhoneGap APIs and library, all of which are bundled together in a hybrid-native application. Worklight, AppMobi, Feedhenry and BKrender include PhoneGap functionality within

their tools. MoSync and Qt use a similar approach of wrapping native APIs with an abstracted set of platform-independent APIs that the developer can call irrespective of the end platform being targeted. To integrate with native device capabilities, developers use the set of APIs defined by the tool in the tool's coding language – for example JavaScript, Lua, LiveCode or C++. Similar functions on each target platform usually share the same tool-level API, allowing for a high level of code re-use for the business logic, but less so for the UI or hardware-specific features. For example, Mono Touch and Mono for Android do not share common UI APIs, nor do all devices feature APIs map cleanly from one device to another. Apps can call the device functionality at runtime, with the call either translated at compilation, or passed through the bridge that the runtime provides to the underlying platform.

Connecting to **cloud APIs** is another major part of the integration process. Cloud APIs are turning into a market segment of their own. Social gaming networks have become increasingly important to mobile developers, and this is not just Facebook or LinkedIn. The Apple Game Center, OpenFeint, Scoreloop, Skiller, Papaya Mobile and Swarm provide cloud-based APIs for social gaming. Social APIs are only a small part of the picture. There are over 14 vendors providing **in-app billing and virtual goods platforms,** including Bango, Social Gold and Paythru; more than **27 selling sales analytics tools** such as App Annie, Distimo and Flurry; more than **eight offering app diagnostics** tools such as Bugsense and Testflight. There are, of course, signs of consolidation. Appcelerator in particular has its own analytics and monetization platform and acquired Cocoafish to integrate social sharing and push messaging features.

Application platforms targeting enterprise (B2B) developers often provide services for **managing database connectivity**. RhoMobile offer the RhoConnect mobile app integration server, which provides data synchronisation by pushing out updates to the device as they happen on the backend. CPT offered by Antenna, Feedhenry, and Worklight provide similar integration middleware. Other notable cross-platform tools dedicated to enterprise development are Stackmob, Oracle (ADF), Aperra and Sybase (Unwired Platform).

3. **Build**. There are a number of different approaches for building the application. The two most popular are: compiling the code and UI templates directly to native platform binaries; or, packaging code in a native shell and interpreting through a runtime, which could be a 'naked browser' packaged with the code, or even the device's own browser rendering engine
4. **Publish**. Publishing an app involves submitting it to the native app store (e.g., Apple App Store or Android Market) or publishing internally with the option of hosting on a private enterprise app store (e.g., with Feedhenry, Antenna, RhoMobile or Worklight). Many CPT products help to manage the App store publishing process to some degree; these include Sencha 2.0, AppMobi's PhoneGap XDK, and RhoMobile's RhoHub. Some vendors such as Appcelerator LiveCode and Corona will showcase apps on their websites, while Unity (with 'Union') also provide support for publishing to additional platforms.
5. **Manage**. "App management" functionality is typically offered by enterprise-targeted CPTs (e.g., Worklight, RhoMobile, Antenna, Feedhenry). It may include push messaging and data flow management, along with remote (un)installation, policy management, and inventory management. Management of commercial apps adds performance tracking (i.e., analytics tools) that may be provided by vendor partners.

CPTs are paving the way for HTML5 to become not a platform, but the mainstream development technology for smartphone apps. HTML5 has yet to really become a platform; it lacks essentials like implementation consistency, mainstream distribution channels (a.k.a. app stores), and any means of micro-monetization other than mobile ads. Yet, thanks to cross-platform tools, HTML5 (including JavaScript) is making mobile app inroads. There are **tens of tools aimed at helping web developer's use existing skills to build 'native' or 'hybrid' smartphone apps**. Those discussed in this report include Appcelerator, PhoneGap, Rhodes, Sencha 2.0 and Worklight. Meanwhile, mobile frameworks are arriving that aim to help web apps offer a "near native" user experience. These include jQuery Mobile, Sencha, iUI, and for gaming Impact.js.

If localizing an app for another market only requires the translation of some text, then it is cheap and easy to outsource to a specialist. Where the content is of international relevance then expanding across major European languages may fall into this category. However, in many cases, localization is less about translation and more about the entire app experience. There are more complex challenges than just translating the text when localizing an app. For example, Chinese or Arabic localizations will often need layout changes and adaptation of the colour scheme to cultural nuances. Iconography often needs to be revised for each region.

- Two of the very largest markets in terms of reach (China) and revenue (Japan) are particularly difficult to localize for without expert local knowledge. If the difficulties can be overcome then the potential rewards are significant.

For those interested in slightly longer term investments, the greatest growth internationally is mainly in emerging markets, although many of these currently have very low revenues. Getting established in such markets early can help establish a reputation (and store ranking) in advance of an almost certain future growth in the user base. When looking to expand to such markets it's important to consider the local platform market shares, the typical level of device & network capabilities and the types of content or services that are popular. For example, an HD video streaming application is unlikely to reach a very large fraction of the audience in India!

Whether your localization needs are simple or complex there are a range of tools and service providers available to help. Identifying and sourcing local content (news, reviews, or service partnerships) may prove a challenge for global developers looking to target local markets. **Local developers are in a much better position to understand and thereby optimise for local nuances a**nd work with local partners in their markets. Where foreign market opportunities are significant and the localization challenges are great it may make sense to find a local developer to partner with.

3.5.3 Evaluation of Interface to the Network Providers

Seven of the world's leading telecoms network operators (AT&T, BT, DT, Orange/FT, TI, Telefonica, and Verizon) have initiated a new group for the promotion of virtualization of network functions. Meanwhile, they have been joined by 52 other network operators, telecom equipment vendors, IT vendors and technology providers to create the **ETSI Industry Specification Group (ISG) for Network Functions Virtualization (NFV)**. Today, network operators' networks are populated with a large and increasing variety of proprietary hardware appliances. To launch a new network service often requires yet another variety and finding the space and power to accommodate these boxes is becoming increasingly difficult; compounded by the increasing costs of energy, capital investment challenges and the rarity of skills necessary to design, integrate and operate increasingly complex hardware-based appliances. Moreover, hardware-based appliances rapidly reach end of life, requiring much of the procure-design-integrate-deploy cycle to be repeated with little or no revenue benefit. Network Functions Virtualization aims to address these problems by leveraging standard IT virtualization technology to consolidate many network equipment types onto industry standard high volume servers, switches and storage, which could be located in data centers, network nodes and in the end user premises.

All major network equipment providers (e.g. ALU, Cisco, NSN) are planning to enable their hardware to support Network Function Virtualization and (more general) Software Defined Network (SDN) functionalities. Network operators believe that these technologies enable them to provide new network functionalities faster in order to reduce the innovation cycles and costs.

Cloud Proxy

As explained earlier in this section, the Cloud Edge market is not yet well defined. We consider that the players from the Internet access market, providing solutions to Network/telecommunication operators and Internet services providers will enter this market by supplying advanced Internet gateways. We believe that

the actors from the consumer electronics market are also in a good position to design new Cloud Edge products or to include Cloud Edge functionalities in existing products. Below list gives an overview of the main players of each of these markets.

Top Vendors
Telecommunication suppliers
Huawei
Pace
Motorola
ZTE
Technicolor
Consumer electronics suppliers.
Apple
Samsung
Logitec

Network Management Systems

Top Vendors	**Description**
Ericsson	Strong in network management system market, focus on mobile hardware and software
Alcatel-Lucent	Strong in residential broadband markets, increasing market shares in mobile market
Huawei	Strong in business data services network management system market
Nokia Siemens Networks	Strong in mobile broadband network management system market, acquisition of Motorola business has enforced market position
Cisco	Strong in IP network management system market, increasing progress in residential broadband market

Table 3: Network Management Systems Vendors

Open Networking Components for Software Driven Networking (SDN)

All big network element providers offer provider-specific network management software which can be used to achieve the anticipated benefits of software driven networking. Some other companies are actively promoting open networking (presented e.g. on the last Open Networking Summit, mid April 2012, see http://opennetsummit.org/index.html).

Top Vendors	Description
Juniper Networks	promotes QFabric as a solution for SDN, Codonis (large DC provider) uses that (but they are also looking for OpenFlow-based solutions) http://www.juniper.net/us/en/)
NEC	promotes OpenFlow-based SDN solution (supports network virtualization). One of the Japanese carriers will use this to deploy a world-wide virtual network solution soon. (http://www.nec.com/en/global/prod/pflow/index.html)
Nicira	develops Open vSwitch, offers "Nicira Network virtualization platform (NVP)" software(http://nicira.com/)
Big Switch Networks	transforms today's networks into open software-defined networks, focuses on network controller http://www.bigswitch.com/our-solution/ and http://floodlight.openflowhub.org/)

Table 4 Open Networking Components for Software Driven Networking Providers

Evolved Packet Core – Implementations

In the framework of the I2ND chapter, it is planned to extend the Evolved Packet Core (EPC). Since the EPC is a standardised system concept by 3GPP and most of the internal interfaces are standardised. We have decided to choose the license bound open source implementation from Fraunhofer Gesellschaft as the implementation environment because it is possible to do the implementation in an easier way. It is planned to develop and implement, and extend existing implementations based on the standard from 3GPP. With this the concepts can be used and adapted to the implementations of other vendor implementations.

Top Vendors	Description
Ericsson	SRC:http://www.ericsson.com/campaign/evolved_packet_core/epc/index.html • Smooth integration while legacy systems will not be touched • First time brought out in 2009 with the help of TeliaSonera

	• Ericsson has a market share of 40% in GSM&WCDMA
Huawei	SRC:http://www.huawei.com/en/solutions/broader-smarter/hw-094052.htm • Fast deploy via SingleRAN, SingleEPC and SingleOSS • CS Fallback • E2E Tracing/Tracking for diagnosis • Intelligent Coverage Map • Policy Control + Service Profile Identities (for users)
Nokia Siemens Networks	SRC: http://www.nokiasiemensnetworks.com/portfolio/products/evolved-packet-core • Liquid Radio Access Network (Active Antennas, Baseband Pooling) • Products: • Flexi Network Gateway for diff. kinds of Access Technologies + Session Management • Flexi Network Server: SGSN/MME Server • PCS-5000: Policiy Control Service + QoS
Alcatel Lucent	SRC: http://www.alcatel-lucent.com/wps/portal/Solutions/detail?LMSG_CABINET=Solution_Product_Catalog&LMSG_CONTENT_FILE=Solutions/Solution2_Detail_000190.xml • Support 2G/3G + LTE Access (BTS,NodeB, eNodeB) • EPC is here called Ultimate Wireless Packet Core (incl. SGW,MME/SGSN, PCRF, PGW/GGSN) Additional IMS for converged IP NetworkProducts: • 7750 SR: GPRS/WCDMA, GGSN and LTE EPC Gateway, user plane functions, 10GigE line + Packet Inspection • 9471 WMM: Wireless mobility management functions of 2.5G/3G

	SGSN + LTE MME • 5780 DSC: Subscriber / Policy Control • 5620 SAM: OAM and Management Planes, E2E wireless management solution
Fraunhofer Gesellschaft (Open Source project)	SRC: http://www.openepc.net/project_info/features/index.html • Use of Open Standards, Open Interfaces, Open Protocols and Flexible Configuration • Different License models like binary, open source and prototypes • Features: Core Network Mobility Management, Core Network Support for LTE Access, • Core Network Support for Other 3GPP Accesses, AAA for non-3GPP Accesses, Policy and Charging Control, Offline Charging System, Subscription Management, AAA Signaling Routing, Client Mobility Support, Additional EPC Demonstration Enablers and Protocol Stacks • Long term development with increasing functionalities per release • Rel. 3 Features: 2G/3G access emulation, Charging Control System, Non-3GPP AAA Functionality, eNodeB emulation for LTE access, truly seamless handovers, IP flow view for diagnosis

Table 5 Evolved Packet Core Vendors

3.5.4 Business Opportunities

The **Cloud Proxy Generic Enabler takes advantage of its unique location in between the WAN and the various home networks** (LAN, home automation networks …). Being connected to the WAN allows Cloud-based applications to directly interface with it ("cloud-proxy" feature: parts of the cloud application can be ran internally to the Cloud Edge) and the fact it is also connected to the LAN and home-automation networks allow the implementation of applications that need continuity of service (if the WAN connection falls down) and real time responses.

To some extent, the **Cloud Edge can be seen as a subset of traditional home gateways** and the targeted markets are almost the same:

- **B2B markets:** most of the home-gateways / internet boxes are not owned by the end-user but provided (rented sometimes) by the xDSL, FTTH or cable operator (can be the Telco). The business model for Cloud Edge manufacturers is likely to continue to be a B2B one.
- **Retail markets**: a market for boxes that are directly purchased by end users also exists. Sometimes, these boxes already provide extra features like NAS (storage), content streaming etc … These boxes must embed features that are appealing for users because of a competitive market (the more features, the best ratio between performance and cost are key factors for users to purchase one or another box).

In both case, the importance of having **a standardized API is very important because the applications running on the Cloud Edge will be provided by 3rd parties and must run on any box**. This application market is also a very important business opportunity. 2 kinds of applications can be envisioned:

- **Pure "cloud proxy" applications**: these are the applications that will take the most out of the Cloud Edge. An example is the heating regulation system (home automation): a fancy application can run in the cloud and can allow users to setup their heating system from anywhere with any device and can also provide advanced features (link with weather forecast, energy company …). A part of the application can run inside the Cloud Edge (the temperature regulation part). This local part can continue working even if the data link is not working thus providing a good continuity of service. That sort of application can be either sold or can be part of a service contract with the 3rd party.
- **Local applications**: these are more "legacy" applications that are using the Cloud Edge as a IaaS platform to locally execute local-interest applications (for example, a NAS (file server), a printer spooler, a local web server, a content streaming (Dlna?) server etc …). These applications can be sold by 3rd parties.

There are currently security differences between web pages and HTML5 based installed web applications (Phonegap, Firefox OS etc.). Such security differences limit web page access to native device functionality. This is a necessary security precaution. This precaution increases the cost of installed application development in two key ways:

1. It increases the cost of web application development by prohibiting installed web application developers from leveraging all of the development tools available to web page developers.
2. It necessitates the web developers re-write their JavaScript to leverage installed application APIs

There is a business opportunity in providing web developers with solutions to these two issues. The **CDI component from I2ND addresses these, by providing a common API across installed application and web pages.**

It is expected that **Software defined Networks (SDN) and Network Function Virtualization (NFV) have the potential to revolutionize network infrastructure** as dramatically as cloud computing and virtualization is changing the IT world today. The key resides in the combination of SDN and NFV to enable network functionalities to become reconfigurable and controllable by SW, thus increasing the flexibility and lifetime of the networks. Networks can more easily and cost-efficiently be adapted to even fast changing service needs and traffic volumes. Services, network SW, and HW innovation cycles become decoupled improving the investment efficiency for the operators. New services with not yet known requirements on the infrastructure can be introduced faster.

This enables new business models to network and service providers. Combining the strength of the network provider in knowing the network architecture and providing this information to other business partners like content provider and service provider enables new business models for delivering cloud and network services in an always best experience (always best connect and best service) to the customer

3.5.5 What is the correct service ecosystem approach by Network providers for an Application Enablement Environment?

To fully capitalize on the explosive demand for advanced services and applications, network providers must **shift to new business models that support an Application Enablement environment**. Such a paradigm shift will allow them to leverage their value add network capabilities to grow new revenues.

Cultivating a Developer Ecosystem: Understanding their needs

The new Telco business models required must be built on a **foundation of cooperation and partnership with third party application and content providers** (ACPs) who facilitate the development of advanced applications and services end users want. In such an ecosystem, network providers are best served by **encouraging developers to create new applications**, such as mobile and multi-screen video, visual messaging, user-generated TV, and multiplayer gaming, because their success drives network providers' success.

But having accepted the new reality, network providers are still left wondering just **what the key requirements are for a developer-friendly network environment.** To find the answer, we conducted an analysis determine what the pain points are in the development process.

Time is the key to profitable development: Speed and support make development easier

For ACPs, **efficiency is the key**. The easier it is to develop an application, the more likely it is that ACPs will bring the application to market. Further, the easier it is to develop the application mechanics, **the more time the developer will be able to devote to what makes the application special.** And the easier it is to establish a cash flow, the quicker an ACP will be able to establish itself as a sustainable development company.

Specifically, developers want ease of programming, which translates into less development time, converts to faster production of an application, and yields a compressed revenue cycle for paid applications. As a result, ACPs often make their time investment decisions by carefully **weighing the balance between speed and support, and standardization and reach**.

Speed-to-market is a critical requirement for all ACPs. Therefore, to attract developers, network providers must make the development process easier and provide effective support. With the right support system developers can focus on developing, thereby ensuring that services and applications get to market quicker.

For example, developers invest significant time in validating software and securing subscriptions. To speed this process, network providers can offer **APIs that allow reuse of the billing relationship** already established with end users. In addition, **they can provide real-time presence/location information** without taxing device or application performance.

In this context, network providers become suppliers to the software development community. They evolve from being a bit-pipe supplier to becoming a partner with the developer where developer success results in increased communications demand. As such, **network providers are encouraged to find ways to share the risk of development.**

- This can be achieved by **reducing up-front costs and risks by allowing free use of APIs during testing.**
- And to further speed development, network providers can o**ffer efficient and effective marketing tools and enhanced support options for application testing, certification and approval**. These processes can be streamlined to eliminate long and complicated procedures and **include direct feedback about applications while they are in Beta.**

Streamlining processes creates a developer-friendly network

Network providers can **create a more developer-friendly network that facilitates the shift from access-centric, connectivity-based business models to application-centric**, ACP ecosystem-based business models that fully leverage the network's value. And in doing so, they can capitalize on the explosive end

user demand for advanced applications and services. **Ultimately, a more developer friendly network benefits all players**.

- **Network provid**ers benefit from monetizing network capabilities in new ways and, in so doing, creating new revenue streams.
- **Developers** benefit from having access to these previously concealed network capabilities to deliver improved functionality and more valuable applications. Finally, end users benefit from a richer and better experience and this provides greater value to everyone.

Finally, there is no one final business model for an app development company. Listing out offerings, strategies, operational processes, etc. should be filed under a specific question about those aspects of a business model. What we try to highlight here, though, is **the general ideas needed to create value, capture customers, and deliver to those customers in an app development company.**

- **(Reaching Customers**) you can hire a Public Relations consultant to give you direction in getting your name out. Facebook and Social Media is also a powerful resource in finding new customers..
- **(Differentiation)** One of the toughest things about differentiating an app development company is that anyone can compete on engineering. Thousands of agencies with the same engineering skill sets as you, how do you stand out?. Speed of development is a tough sell because there will always be someone else out there who either can or will claim to be able to do it faster. In the same vein, code quality is also something that is a) expected and b) something every firm will claim, with varying degrees of success.
- **(Pricing)** it all depends on your customers, your staff, and the total costs of your business (with the majority being in employee costs).
- **(Selling)** there should be a process in place for creating one that you use with every customer; Also, you should have a printed portfolio explaining past clients, pricing explanations, and a bio sheet that gives them some information about yourself and your company.
- **(Delivery)** This is fairly straightforward for an App development company. Hosted servers, source control repositories, and getting your app in the various app stores. Finally, we would suggest offering a support contract to allow the client to continue to do business with their product without worry after you deliver.
- **(Support)** In an app development company, you should set up automated alerts when services go down, automated e-mails when exceptions occur, and bug tracking software to allow your clients an easy channel to funnel requests into your maintenance pipeline. Be sure to keep an eye on customer reviews in the app store as well to get a feel for what might need to change in the delivered **product.**
- **(Customer Satisfaction)** This is largely up to you to innovate.

<u>Dimensions to consider to create a proper Business Model</u>

Traditionally, development companies will **build internal business applications and applications that will be products for sale**. One can cost either through projected engineering man months + administrative costs or by bulk pricing for an overall deliverable. **Most platforms started by solving a unique use case** in a really effective way that was significantly better than the previous alternative for a specific target audience. Once that **use case got critical mass within their target audience, they were able to extend their relationship into a platform relationship**. e.g. the ipad was a result of the app store and the iphone which were a result of itunes and the ipod... facebook started by seeing who was hotter in your class and connecting with your classmates. **Anyway, even at the scale of an Amazon or Apple, platform businesses rarely work out to be a gateway to massive new revenue streams**. For example, the iTunes/App business from Apple is break-even Apple does not actually make any real money from the App store. Apple has stated that the **only value of their app platform is to drive demand for their hardware**

There are a few dimensions to consider:

1) Subsidizing/Creating one-side : Platforms are akin to 2-sided markets. In order for side A to come, side B must come - giving you a chicken and egg problem (for example - for App developers to build on Facebook, there must be sufficient number of users on Facebook that they can target). This generally means that one side of the platform needs to be heavily subsidized or created - i.e. user's join/use for free - and thereby creates incentive for developers to build apps for these users. In the case of iOS - Apple created a beautiful phone that has huge demand - giving app developers access to millions of users that they could target in a monetizable way.
2) Longevity: generally platforms live longer than non-platforms probably because there is a more inter-connected eco-system that takes longer to kill. I.e. in the case of Facebook - users are not likely to go somewhere else very quickly since there is a critical mass of content and apps that exist on Facebook

3.5.6 Conclusions

Morgan Stanley predicts that by 2014, mobile users will exceed desktop users. This will lead to a significant increase in devices. **The diversity and fragmentation in the offer of connected devices**, both in terms of hardware capabilities and software platform, **is one of the reasons of the overall increasing of their market sha**re and one of the reasons that makes the Future Internet a real technology foundation for all the other future innovation. It's evident, however, that even though a wide offer is positive stimulus for the market, **the technical differences between devices also are a great challenge for all the application and service developers.**

A further step in creating a common developing platform has emerged, by offering libraries specifically designed to overcome the limitation of **using pure HTML5/JavaScript**; these new libraries offer a wide set of functions written and optimized in the native language for all main OS, to guarantee good performance and the most uniform and predictable appearance of graphical elements and interactions used in the applications**. The set of API provided are typically accessed using JavaScript**, and the library are maintained and updated to support the changes in the device technologies and software.

The purpose of the Interfaces to network and Device Generic Enablers is to offer a more uniform set of functions to device and network capabilities, extending and providing a uniform set of developer accessible API. These GEs will provide a more consistent way to write applications able to provide also more efficient interactions with the users and the network capabilities and policies.

The **Cloud Proxy Generic Enabler takes advantage of its unique location in between the WAN and the various home networks** (LAN, home automation networks …). Being connected to the WAN allows Cloud-based applications to directly interface with it ("cloud-proxy" feature: parts of the cloud application can be ran internally to the Cloud Edge) and the fact it is also connected to the LAN and home-automation networks allow the implementation of applications that need continuity of service (if the WAN connection falls down) and real time responses

3.6 Security

As Social Networks remove the enterprise boundaries of data usage and Mobility and Cloud Computing break down the concept of defined physical location, **a new approach to dealing with IT security is required.**

Securing information now involves the use of disparate and distributed IT components as well as data sharing amongst relevant stakeholders. This requires a relationship of trust, such that proprietary, sensitive or personal information, shared voluntarily, will not be publicly disclosed. **Sensitive data must be adequately protected during this sharing proces**s. Stakeholders must be assured that information will not be used other than for the purpose intended.

Confidentiality, integrity and availability are core elements and expected norms for IT applications and data security. Traditionally these requirements have been met by combinations of procedural, logical and physical controls. However new trends in the nature and consumption of IT systems and the often unmanaged distribution of the data they hold, are rendering established approaches to security inadequate or inappropriate.

Hardware and software components are no longer used in the context of a single organization. Instead, they can be reused in many scenarios. As the separation of private and business use becomes ever more blurred, communities of collaborating organizations are established and service delivery is disaggregated across multiple providers. There are no longer clearly defined operational borders supporting a classical view of security governance and control.

In this new paradigm, each service has to be self-contained, ensuring that any access to its associated resources is authorized and appropriate, whatever the context and route of that access

Attention is also being drawn to **the security of IT systems embedded in or controlled by non-ICT systems.** The paradigm change relates to how security standards and best practices will apply and adapt for services created from aggregated components of different origin. **Identity authentication, access control and auditing are key and data loss prevention becomes critic**al when consumerization is pushing ever more data onto user owned devices.

Increased portability of data from cloud services, user owned devices etc. bring the increased risk of unintended exposure, misuse and loss or alienation. Ensuring separation of private and corporate data when using devices like laptops, tablets and even smartphones, will help ensure confidentiality. Automated data obsolescence or wiping once a given user no longer has rights to it, are also required to maintain integrity. Because of the potentially transient nature of the devices, applications and users that access any given data, security mechanisms have to be aligned to the data itself. **Advances in identity management (particularly biometrics) and cryptography will enable the security of data in each of component subsystem** (whatever and wherever they may be), restricting usable access to authenticated and authorized users.

3.6.1 Market

Cyber-security threats are significant and growing concern.The World Economic Forum (Global Risks 2012 – Seventh Edition) rapports that the impacts of crime, terrorism and war in the virtual world have yet to equal that of the physical world, but there is fear that this could change. With over five billion mobile phones coupled with internet connectivity and cloud-based applications, daily life is more vulnerable to cyber threats and digital disruptions.

The cyber-attacks are part of Top 5 global Risks in terms of likelihood, for 2012:

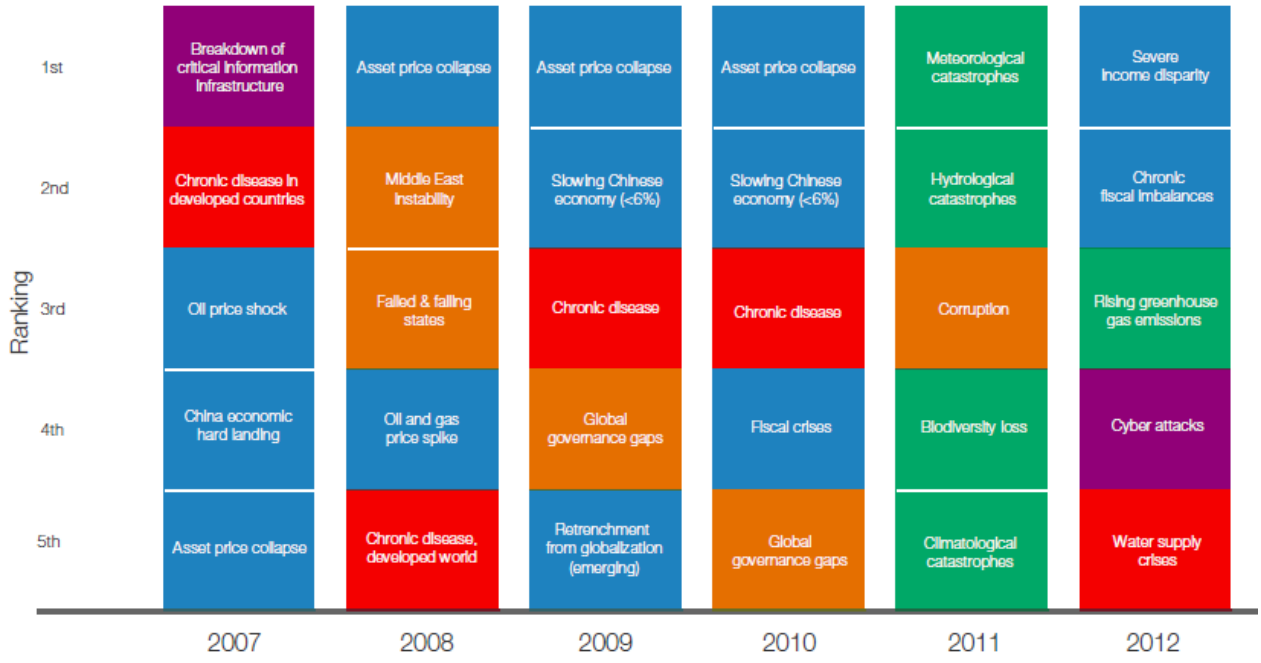

Figure 20: The World Economic Forum-Global Risks 2012

Individuals, businesses and nation states are depending more and more heavily on data and systems in the virtual world. Thirty-five per cent of the global population is online, up from 8% just 10 years ago. **Perhaps the more significant shift lays in the rapid growth in "the internet of things" the high-speed communications network composed of electronic devices rather than people.**

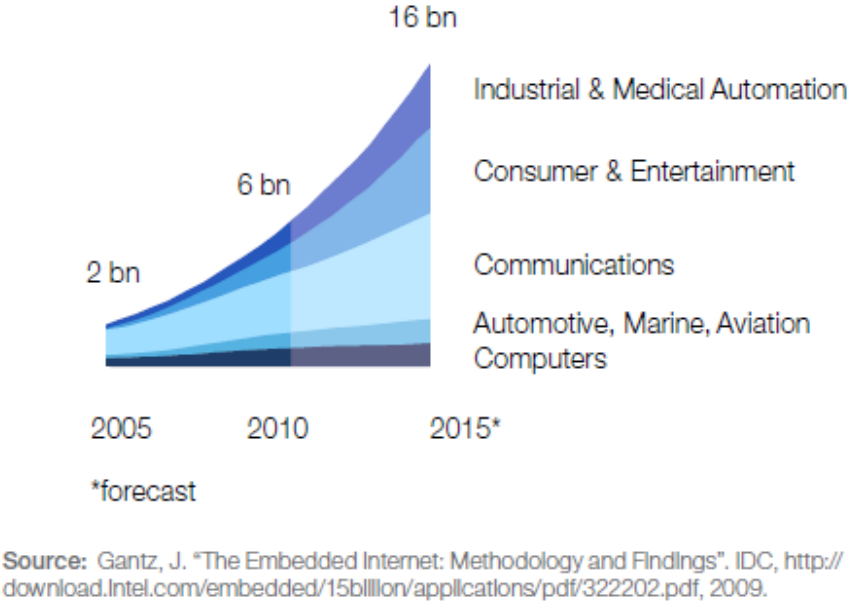

Figure 21: The Internet of Things devices estimations

Currently there are five billion devices or "things" connected and remotely accessible through the internet, from cars, kitchen ovens and office copiers, to electrical grids, hospital beds, agricultural irrigation systems and water station pumps. The number of devices connected on the internet is expected to reach 31 billion in 2020. Many potential benefits are obvious. For example, smart meters monitor use of

domestic electricity consumption and feed this information back to providers, who can use it to make management of electricity supply significantly more efficient. **The downside is that, once an information link is created between a user's electricity meter and the grid, there is a theoretical risk of a user being able to hack into the grid via their meter and sabotage an area's electricity supply**. Connectivity also allows for amplification; attacks that would have been isolated incidents in the physical world can achieve a cascading effect through connectivity.

Businesses are increasingly worried about targeted attacks which aim to sabotage or steal data from their systems. **These so-called "advanced persistent threats" (APT) are driving corporate information security spending globally**. Companies are increasingly aware of cyber threats but are not necessarily sure how to address them. A recent study reported that companies feel both more informed about cybercrimes, but less confident in their existing cyber security measures than ever before. Reliable indicators of the financial impact of cyber-attacks are hard to come by. Most reports reference the same figures – those provided by the Ponemon Institute– which estimated the cost of crime for a sample of 50 large US companies would increase 44% between 2010 and 2011. The median cost of those attacks was US$ 5.9 million per year, an annual increase of 56%.

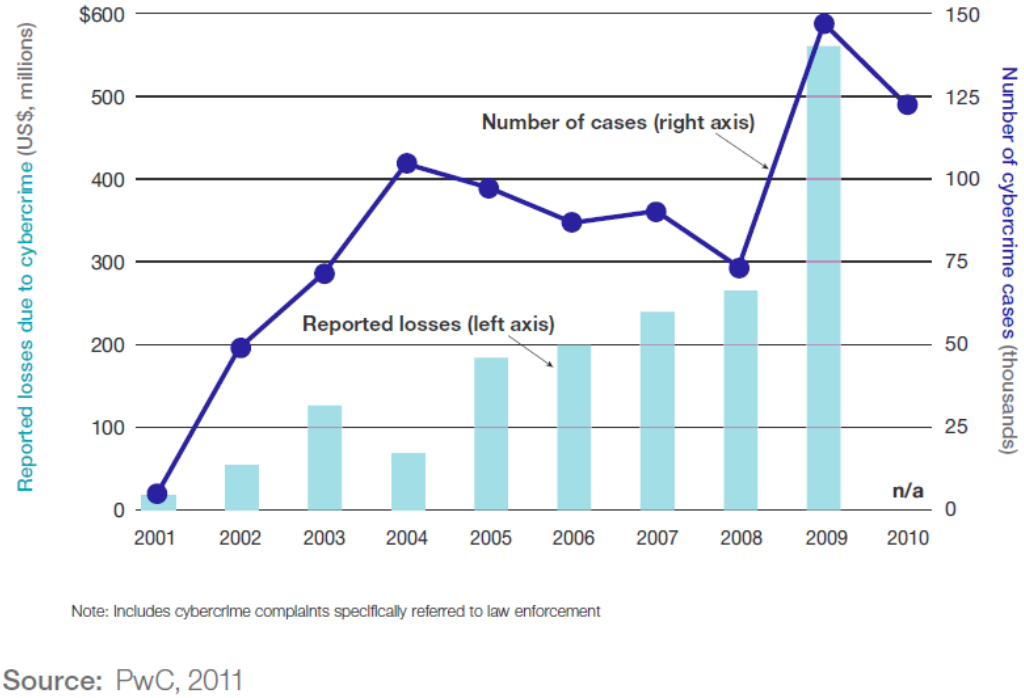

Figure 22: Cost and Incidence of Cybercrime in the US

The figure above suggests that cyber risks constitute a significant threat to businesses, but more information is needed to allow businesses to gauge the extent of the risk since many remain un- or under-reported.

It is possible that the impact of cybercrimes on companies goes under-reported, as victims prefer not to disclose that their systems have been compromised. However, the fact that cybercrime is more frequently in the news suggests this is changing. **There is a growing market for cyber risk insurance, covering risks ranging from computer security liability to business interruption, cybercrime and cyber extortion**. The annual gross written premium for cyber risk-related insurance is US$ 500 million, with the market so far mostly in the United States. This is projected to grow over the next decade, especially due to recent regulatory and legal changes. For example, the US Securities & Exchange Commission (SEC) guidance released in October 2011 indicated that a computer breach should be viewed as a potential

material event requiring disclosure regardless of whether the breach involved release of confidential data or not. The European Union and Asia have begun to adopt similar breach notice laws.

The related constellation of global risks in this case highlights that incentives are misaligned with respect to managing this global challenge. Online security is now considered a public good, implying an urgent need to encourage greater private sector engagement to reduce the vulnerability of key information technology systems. Successful acts of sabotage require the greatest resources and technical sophistication – so much so that most experts consider them currently attainable only by highly organized and well-resourced actors such as nation states.

Gartner expects the cloud-based security services market to reach $4.2 billion by 2016. "Demand remains high from buyers **looking to cloud-based security services to address a lack of staff or skills**, reduce costs, or comply with security regulations quickly," said Eric Ahlm, research director at Gartner. "This shift in buying behavior from **the more traditional on-premises equipment toward cloud-based delivery models offers good opportunities for technology and service providers with cloud delivery capabilities**, but those without such capabilities need to act quickly to adapt to this competitive threat."

A January 2013 Gartner survey **on security spending shows high demand from security buyers for cloud-based security service offerings.** Security buyers from the U.S. and Europe, representing a cross section of industries and company sizes, stated that they plan to increase the consumption of several common cloud services during the next 12 months. The highest-consumed cloud-based security service is email security services, with 74 percent of respondents rating this as the top service.

However, as indicated in the Gartner rapport (Magic Quadrant for Security Information and Event Management - Gartner RAS Core Research Note G00212454, Mark Nicolett, Kelly M. Kavanagh, 12 May 2011, RV4A105172012), **during the 2010, demand for SIEM (Security Information Event Management), technology has remained steady**. During this period, the number of Gartner inquiry calls from end-user clients with funded SIEM projects matched levels of the previous 12 months, and most vendors have reported increases in customers and revenue. The SIEM market grew from $858 million to $987 million, achieving a growth rate of 15%. In North America, there continues to be many new deployments by smaller companies that need log management and compliance reporting. There are also new deployments by larger companies that are conservative adopters of technology. Both of these customer segments place a high value on deployment and operational support simplicity. **Some large companies are also re-evaluating SIEM vendors in order to replace SIEM technology associated with partial, marginal or failed deployments**. During this period, there has been a stronger focus on security-driven use cases from new and existing customers. There is growing demand for SIEM technology in Europe and Asia/Pacific, driven by a combination of compliance and threat management requirements. The security organization often wants to employ SIEM to improve capabilities for external and internal threat discovery and incident management. As a consequence, there are requirements for user activity and resource access monitoring for host systems and applications, as well as requirements for the early detection of data breaches.

The SIEM market is mature and very competitive. In the current market, vendors are expanding the scope of their SIEM offerings to include additional capabilities in adjacent areas (such as file integrity monitoring, vulnerability assessment, security configuration assessment and data access monitoring), and proactively marketing those capabilities to their prospects and customers.

But as Billy Smith (DELL SecureWorks, VP, Sales Engineering - 2013) pointed out, today only a few companies are offering 24x7x365 enterprise-wide security monitoring services and even fewer include monitoring events from firewalls and network-based and host-based intrusion detection systems as well as the logs and alerts from routers, switches, anti-virus, and content scanning applications, backup applications, PBXs, and critical Unix and NT servers including but not limited to web servers, FTP servers, and mail servers. In the future enterprise security monitoring will incorporate security events from physical security devices such as card readers, motion detectors, and cameras, security alarms from secured doors

and gates, fire alarms and climate control sensors. Each device or application listed above can generate hundreds of lines of logs daily. A majority of the events logged are not security related so surveillance of specific security events is difficult and time consuming. For the typical system administrator, network administrator, and/or security officer, the task of reviewing logs is not a reality and monitoring events in real-time is impossible, day-to-day system maintenance demands too much time. Companies just do not have a 24x7x365 information technology staff to perform real-time monitoring and response. "Off business hours" monitoring becomes particularly difficult or nonexistent. Internal and external hackers are well aware of this vulnerability.

3.6.2 Security Trends

Identity and Access Management: has evolved into 'Security', largely driven by additional demands arising from Working Environment considerations, particularly with the impact of consumerization and Bring Your Own Device (BYOD) into the workplace (BYOD being not just about devices, but about adapting business behaviors to personal and societal behavior shifts). **Another driver is the increase in cyber-crime** (at individual or collective levels, directed at public and private organizations).In the private environment, **the security and privacy challenge increases, due to the explosion of user related data** (both personally created and contextually generated) and how it is used

A number of governments are already considering multi-purpose electronic citizen ID cards. This will further break down system and data integration barriers, as business access to trustworthy, "citizen centric" information becomes available. **The value of context information is the basis for a number of emerging business models** where companies seek to utilize and monetize personal context information regarding underlying preferences or specific circumstances, even where the affected individuals would never agree to such use.

How are the ownership, confidentiality and even integrity of such information to be assured? There is no clear model yet, evidenced by the frequent failures of privacy, particularly in Social Networks but occasionally involving sensitive government or banking data. In many instances, extracting contextual value from data is beneficial to both parties involved, especially where necessary and targeted services are offered, but the point where such exploitation of context becomes an invasion of privacy has yet to be determined.

Additionally, the security features of an app are often ignored in the rush to get a new product to market. We naturally tend to focus more on what an app should do, rather than what it shouldn't. Making sure that an app doesn't have security flaws is a difficult and potentially expensive process. There are no automated tests to ensure user data hasn't been left vulnerable or that passwords aren't sent or stored unencrypted. However, **the costs of implementing security features and adding security testing to your development process** are much smaller than the potential costs of a major security breach.

- Problems with payments: For some types of app the consequences of this are more obvious and there are even standards in place to try to ensure a minimum level of security; any application which handles payment card details needs to process that data securely as specified by the Payment Cards Industry. However, PCI standards compliance is only audited for large merchants. Smaller merchants self-certify compliance. If an app or service for a small merchant was compromised, resulting in abuse of payment card data, then any non-compliance discovered could result in significant fines or even liability for any fraudulent payments. Merchants who add interfaces to their existing payments infrastructure to support mobile apps need to be particularly careful – new attacks can be made possible when the payment authorization occurs on a native mobile client, rather than a website.

  Even for apps selling digital goods via in-app purchase there are still payment security issues to consider. The stakes are nowhere near as large but attackers can still impersonate the official store

provider servers and simulate in-app purchases without any genuine payment. Apple's system was compromised in this way last summer and there was another hack reported for payments on Google Play just before Christmas (no link because, although it was only for rooted devices, we're not aware of a fix in place yet – indeed it may even be a scam to get users to install malware).

- Losing data can cost you even more: For enterprise app developers, being associated with a major security breach could mean the end of your business. A harmful loss of data for a client could see valuable market data go to the competition, or even key employees**.** You would lose their trust (and business) and if the breach is sufficiently public you could lose the trust of all potential future clients as well. The larger a company the more vital it is that they implement good security practices. For consumer apps, leaking user data to attackers has direct costs in terms of service downtime whilst fixing security holes (usually in a hurry with the aid of expensive experts), notifying those affected and possible compensation. There are also more serious indirect costs in terms of lost trust and users. Again here, the larger the user base, the more attractive the app is to attackers and the more serious any breach.

Investments in security therefore need to be proportional to the risks. How many users are involved and the value of data stored should determine the level of effort required to ensure that data is safe. Not knowing about the security implications of your application and its use of user data is somewhat like driving without insurance. Everything is fine until the unthinkable happens – then it's likely that lots of innocent people suffer and you get into a lot of trouble. The technical details of app security are beyond the scope of this site, but they shouldn't be out of scope for your app if it deals with any user data or payments

A further security trend is to apply protection to application layer items (Content Based Security) which is consistent with the trend towards dynamic security mentioned previously. Application-level security protects information at rest or in flight and is independent of the storage media or communications channel. Prior work on CBS in Digital Rights Management has focused on copyright protection and prevention of unauthorized use of content but CBS can be applied more generally to provide cross-domain information sharing across multi-domain interconnected networking infrastructures where each domain is managed by a separate administration authority.

3.6.3 Evaluation of Security Providers

Several SIEM vendors are beginning to position their technologies as "platforms" that can provide security, operations and application analytics. We now include an evaluation of the platform capabilities of SIEM technologies, but the weight we place on the capability is limited by the degree to which clients express requirements in this area. Most companies expand their initial SIEM deployments over a three-year period to include more event sources and greater use of real-time monitoring. SIEM vendors have large existing customer bases, and there is an increasing focus on selling more SIEM technology into existing accounts.

According to the Gartner (Magic Quadrant for Security Information and Event Management - Gartner RAS Core Research Note G00212454, Mark Nicolett, Kelly M. Kavanagh, 12 May 2011, RV4A105172012) organizations should consider SIEM products from vendors in every quadrant of this Magic Quadrant based on their specific functional and operational requirements. Product selection decisions should be driven by organization-specific requirements in areas such as the relative importance of compliance and threat management; the scale of the deployment; SIEM product deployment and support complexity; the IT organization's project deployment and technology support capabilities; identity, data and application monitoring requirements; and integration with established applications, data monitoring and identity management infrastructure.

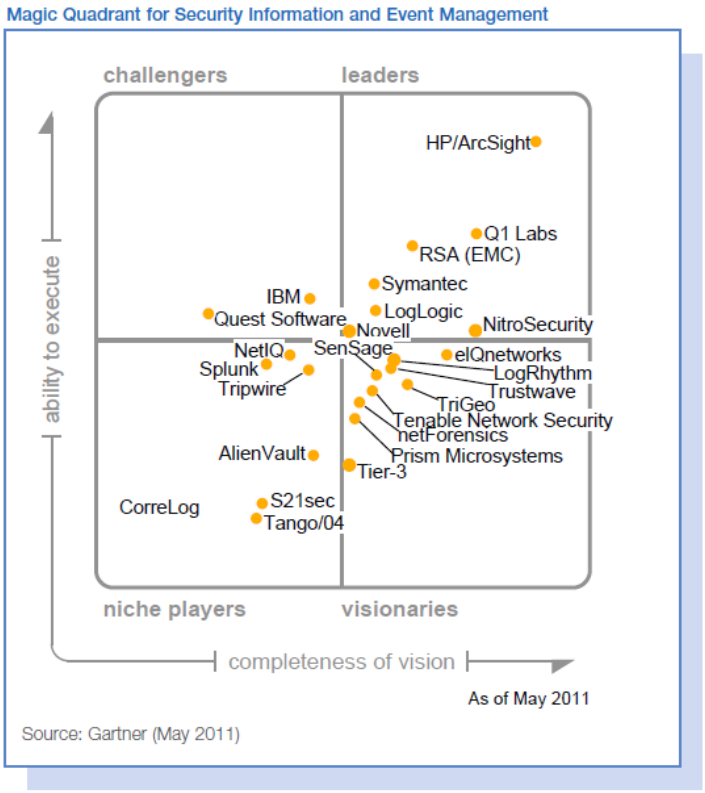

Figure 23: Magic Quadrant for Security Information and Event Management

Twenty-five vendors met Gartner's inclusion requirements for the 2011 SIEM Magic Quadrant. Sixteen are point solution vendors, and nine are vendors that sell additional security or operations products and services. **Because SIEM technology is now deployed by a broad set of enterprises, vendors are responding with a shift in sales and product strategies**. SIEM vendors are increasingly focused on covering additional use cases so that they can continue to sell additional capabilities to their existing customer bases. Large vendors are positioning SIEM as a platform that can unify adjacent security and operations technologies within their portfolios. Many SIEM vendors are developing sales channels that can reach the midsize market in North America. Sales effectiveness in Europe and Asia/Pacific is becoming increasingly important as SIEM deployments increase in these regions.

Some SIEM technology purchase decisions are non-competitive because the technology is sold by a large vendor in combination with related security, network or operations management technologies. RSA (EMC) is executing a strategy to integrate its SIEM technology with its storage, governance, risk and compliance (GRC), and security portfolio. IBM and Novell have integrated their SIEM products with related identity and access management (IAM) offerings, and are selling their SIEM solutions as part of an IAM-related deal. Symantec sells SIEM to large enterprises that use its endpoint security products, and has integrated its SIEM and IT governance, risk and compliance management (GRCM) offerings. NetIQ has integrated its SIEM technology with its security configuration management and file integrity monitoring technologies. HP's development strategy for ArcSight includes use of the technology to unify monitoring across its security portfolio and integration with its operations management technologies.

Several vendors are not included in the Magic Quadrant because of a specific vertical market focus and/or SIEM revenue levels:

- FairWarning provides privacy breach detection and prevention solutions for the healthcare market that entail user activity and resource access monitoring at the application layer.

- AccellOps provides event monitoring for IT operations and IT security, and is expanding its support for the security monitoring use case.

A few vendors sell solutions that are based on licensed SIEM technology. Q1 Labs licenses its technology to vendors that implement its technology on their own appliances, and add specific integrations with their respective management infrastructures. The Enterasys Security Information & Event Manager appliance delivers workflow integrations with Enterasys Network Access Control and NetSight Automated Security Manager. The Juniper Networks Security Threat Response Manager is an appliance solution that uses the QRadar technology, and is also integrated with Juniper's policy management subsystem. SenSage licenses its SIEM technology to Cerner, which has integrated it with its packaged healthcare applications for application activity monitoring and audit.

As Billy Smith (DELL SecureWorks, VP, Sales Engineering - 2013) says so well, some vendors do provide tools to condense their product events and logs, but even with these tools it is nearly impossible for an administrator to find time to monitor a security system, enterprise-wide. Most of these consolidation tools are vendor specific. Vendor A's tool can only be used to accept logs or events from Vendor A's products while Vendor B's tools can only be used to consolidate Vendor B's products. The reason for this is that Vendor A's products and Vendor B's products log event information differently. This situation forces administrators to have many different tools to monitor logs and event information throughout their enterprise. Today, there are only a few companies that provide vendor independent log and event consolidation solutions, but these solutions demand an extensive amount of customization to be useful in monitoring security events enterprise-wide.

Along with lack of time and vendor independent tools, false positives are another reason why enterprise security monitoring in not easy. A false positive is when an event triggers a security alert, but the event is not security related. There has been a lot of discussion over the last year regarding intrusion detection systems and false positives. In order to have extensive vision on a host or network, a host-based or network-based intrusion detection system needs to be configured loosely so that a high number of false positives are generated. The problem with this is that many administrators do not have the time or knowledge to research the quantity of events generated by these loosely configured intrusion detection systems. Host-based and network-based intrusion detection systems are only two types of devices that generate false positives. Many other security devices produce them as well.

3.6.4 Business Opportunities

Information security is a pillar of sustainable business. An organization that is unable to demonstrate effective governance and control will quickly lose credibility. Loss of profit due to poor security implementations and regulatory non-compliance is a greater commercial concern than ever before. To stay compliant and secure in emerging complex environments needs a reliable view of the total and current system state. The need for professional SIEM Systems (Security Information and Event Management) will rapidly increase.

For federated and pan-organization control, a **centralized, trusted authentication broker might be required**, particularly as IT services move further in the direction of "pay on demand". With relatively low value transaction charges and even micro-payments, there is a need for security around such delivery models to be cheaper, faster and easier to apply. **Security itself becomes a core part of the "as a service" stack.**

As well as security related to corporately owned data, **the security and privacy of data derived from an individual's application or data usage context is also necessary**. Context can be used to improve security (e.g. abnormal user behavior as a sign of access control being compromised), but context can also massively complicate security control. Knowledge of the "who, where, when and how" regarding usage of data, could well be as valuable or as sensitive as the data itself.

3.6.5 Conclusions

In the rapidly evolving world of Business Technology, the provision of adequate security solutions is more important than ever. New approaches to security need to be adopted to respond to the challenges of multi-device, location agnostic and context aware system usage. The understanding of data privacy in the overall environment of business and private usage will be an important factor in determining a security management strategy.

Security is facing a paradigm change moving from static to dynamic security. Whereas so far security solutions have been provided once defined by the architecture, security solutions now can also be thought of at the design-time of the architecture itself; i.e. security becomes an integral part of the service architecture. The servicification trend when applied to Security has called in turn for a ―Service Vision of Security where core security services (i.e. IAM, Privacy) are defined and orchestrated, at run time, with others (adhering to the basic security architecture provided) to meet the security needs of the specific usage areas' applications. So far no initiative has addressed this new trend.

A further security trend is to apply protection to application layer items (Content Based Security) which is consistent with the trend towards dynamic security mentioned previously

3.7 A new era of Combined Applications

Big Data and Cloud, two of the trends that are defining the emerging Enterprise Computing, show a lot of potential for a new era of combined applications. The provision of Big Data analytical capabilities using cloud delivery models could ease adoption for many companies, and in addition to important cost savings, it could simplify useful insights that could provide them with different kinds of competitive advantage. **Data Analytics as a Service (DAaaS)** represents the approach to an extensible platform that can provide cloud-based analytical capabilities over a variety of industries and use cases. Beyond that DAaaS puts analytics as a first-level element component in a new vision of Enterprise Computing which makes extensive usage of the advantages of Cloud technologies.

The combination of M2M and Big Data could produce excellent everyday benefits in the not-too-distant future. We have grouped these concepts together, since Big Data analytics within M2M really only exists within the context of heterogeneous information sources which can be combined for analysis. And, in many ways, the Internet of Things can be defined in those exact same terms: as a network of heterogeneous devices. **It is clear that Big Data and the Internet of Things will have a fundamental impact on the way businesses are managed in the future**, the way that we interact with our cities and urban areas, and our day-to-day life as consumers.

A very promising combination is expected to be the Cloud Proxy in conjunction with IoT functionalities like the IoT Gateway: a cloud proxy hosting an IoT Gateway can be a device which is hosted at every home, and can open to a market of home-based applications which let the user interact with their devices and Things at home (e.g. home automation, energy-monitoring and control applications, etc).

3.7.1 Data Analytics as a Service: unleashing the power of Cloud and Big Data

Data Analytics as a Service can be applied to multiple use cases and industries even as the analytic approaches to different scenarios may vary considerably. Beyond that DAaaS puts analytics as a first-level element component in a new vision of Enterprise Computing which makes extensive usage of the advantages of Cloud technologies.

- Along these lines, **Data Analytics as a Service (DAaaS) represents the approach to an extensible platform that can provide cloud-based analytical capabilities over a variety of industries and use cases.** From a functional perspective, the platform covers the end-to-end

capabilities of an analytical solution, from data acquisition to end-user visualization, reporting and interaction. Beyond this traditional functionality, it extends the usual approach with innovative concepts, like Analytical Apps and a related Analytical Appstore. In addition, the platform supports the needs of the different users who interact with it, including those of the emerging 'Data Scientist' role.

- Architecturally, and due to the intrinsic complexities of analytical processes, the implementation of **DAaaS represents an important set of challenges, as it is more similar to a flexible Platform as a Service (PaaS)** solution than a more fixed Software as a Service (SaaS) application. Aspects like the PaaS internal architecture, the distinction between real-time vs. non real-time processing, the specific characteristics of the Analytic Services, the needs for data storage and modeling, the delivery over hybrid cloud models and several others, make its design a complex challenge.

Big Data can be a tough proposition for many companies as conventional tools and on-premise techniques could be the wrong approach. To ease many of these "pain points" another transformative trend has entered the market place - Cloud Computing and the continuous movement towards a Utility ICT model. So instead of deploying complex solutions in-house, companies can take advantage of services provided by third parties, using economic models that offer them flexibility and adaptability to the changing needs of their environment.

It's easy to understand that the combination of Big Data with Cloud can ease the adoption of advanced analytic capabilities over the bigger and more heterogeneous data sources that companies need to handle, letting companies benefit of the insights derived from it. Value is in the data itself, and not in the technology that is used to process it. **What companies need is not the deployment of a complex Big Data infrastructure and the associated capital investment**, but the access to the services that provide advanced Data Analytics on their data now and in the future. Providing this service in a flexible and scalable format is the main purpose of Data Analytics as a Service.

Data Analytics as a Service (DAaaS) is an extensible analytical platform provided using a cloud-based delivery model, where various tools for data analytics are available and can be configured by the user to efficiently process and analyze huge quantities of heterogeneous data.

Customers will feed their enterprise data into the platform, and get back concrete and more useful analytic insights. These analytic insights are generated by Analytical Apps, which orchestrate concrete data analytic workflows. These workflows are built using an extensible collection of services that implement analytical algorithms; many of them based on Machine Learning concepts. The data provided by the user can be enhanced by external, 'curated' data sources.

The DAaaS platform is designed to be extensible, in order to handle various potential use cases. One concrete case of this is the collection of Analytical Services, but it is not the only one. For example, the system can support the integration of very different external data sources. To enable DAaaS to be extensibility and easily configured, the platform includes a series of tools to support the complete lifecycle of its analytics capabilities

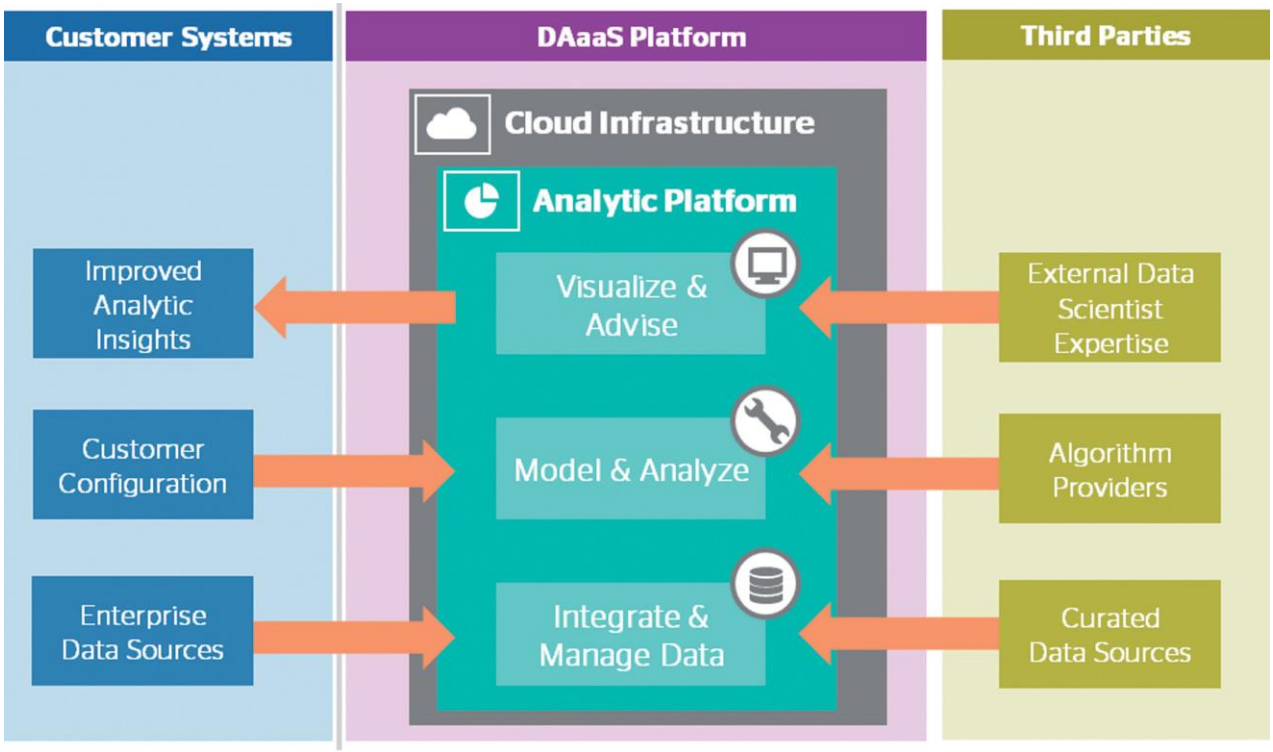

Figure 24: Open the customer via the value of your meta data generated or context information collectable

The DAaaS platform is intended as a horizontal platform that can be used in quite different vertical sectors. So it is designed to be a generic, extensible platform. One point where this generic approach raises important issues is regarding Data Storage and Modeling. Basically, the base storage technology needs to:

- Be able to represent and store different kinds of data.
- Be capable of storing huge volumes of data in a distributed manner.

Integrate those data models with the processing layer so analytical services can process information with the required performance.

- Provide strong multi-tenancy capacities.
- Satisfy strict security requirements.

There are several potential data storage engines or databases in existence that could satisfy this requirement. They belong to what has been called NoSQL databases, a varied set of solutions that provide very different approaches to data representation and storage: document-oriented, key-value, column oriented, network-oriented, etc. Each solution has its strong points and weakness, mostly because they fit some specific kind of data models better.

So the DAaaS platform has to choose between two options:

- Select one data storage option and adapt it to be used in all the potential cases.
- Open the possibility of using distinct data storage technologies.

This second option, being better adapted to the distinct potential data sources, introduces an important level of complexity in the architecture.

In the first case the choice of a specific model can be difficult. For example in the DAaaS Proof of Concept, that the Atos Scientific Community has developed, HBase (part of the Hadoop project), a column oriented database, was selected; HBase provided a good option to represent different kind of data, especially those related to Time Series information.

In any case the DAaaS platform must be designed for reusability at the Data Modeling Layer and to external layers: to the Acquisition Layer and to the interfaces to the analytic services in the Analytics layers.

The Analytic Services are the basic building blocks of the analytical capabilities of the system. The basic idea here is to implement a component architecture in which the interfaces to external systems are clearly defined so extensions (Services) can be implemented. We can distinguish several types of interfaces:

- Interfaces to the storage layer to access the information they should operate with.
- Interfaces to return results back to other components or as final results.
- Interfaces to configure or model the analytical services for execution.
- Utility interfaces for example, interfaces for monitoring the execution of the system.

As previously stated, these analytical services have a defined scope taking charge of one specific or 'atomic' analytic operation. For meaningful analytic capabilities, there will be a workflow of operations that it is coordinated by the Analytic Framework element. We have called these workflows Analytical Apps. The components (analytic services) and the Analytic Frameworks are designed to run in a distributed manner using the base capabilities of solutions like Hadoop Map-Reduce, Spark, or Storm.

Technically, these building blocks can use different technical approaches, some of them based in Statistical and Machine-Learning techniques, such as Artificial Neural Networks, Bayesian networks, Support Vector Machines, Regression Analysis, etc.

From a base technologies perspective, in order to support a DAaaS solution a complete Big Data stack needs to be implemented, in a way that it can run over a cloud platform and maintaining the intrinsic characteristics of clouds, like on-demand services, rapid elasticity, multi-tenancy, measured service, etc. This can be quite complex in itself.

First, a big data stack is composed by many overlaid elements. There is the possibility of combining several elements from recognized projects:

- As base data storage we have the multiple options seen before when discussing about the modeling issues: NoSQL (like HBase, Cassandra, MongoDB or Neo4J), In-Memory databases like SAP HANA, 'legacy' MPP databases and even some other more 'exotic' alternatives.
- For the distributed processing capabilities needed to manage big volumes of data, Hadoop is the actual standard platform. However, potential alternatives may exist like those based in In-Memory computing (Spark) or real-time alternatives (Storm, Akka).
- On top of that analytical services can be implemented using different computing languages, some more traditional (Java), some emergent (Scala) and some specific to statistics (R). Base libraries, like Apache Mahout, or MADlib, try to provide reusable building blocks for some typical algorithm implementations.
- Finally visualization applications can be based in multiple tools, some low level (d3.js) and some linked to traditional BI solutions (Tableau, Qlikview, Pentaho…).

It is easy to see that the integration work needed for a complete solution can be quite significant. But also, making this stack a 'well-behaved' cloud platform adds to this complexity. For example, the most popular Big Data project now, Hadoop, was originally designed to run in non-virtual environments especially in what it refers to its data storage capabilities. Performance can suffer degradation in a virtualized environment and this can be important for a DAaaS solution. To overcome this cloud technology providers are adapting the Hadoop platform to run properly in a virtualized environment, like VMware's Project Serengeti, Amazon Elastic Map Reduce or Microsoft's optimized version of Hadoop for Azure.

Data Analytics as a Service, as a general analytic solution, has potential use cases in very different vertical sectors. Some concrete scenarios include:

- In the Oil & Gas sector, companies could deploy predictive maintenance solutions for device fleets in remote installations, without deploying very complex solutions in-house. The solution could be rented for short-term specific analysis.
- In the Electrical Utilities sector, DAaaS is the basis of a specific solution to detect Non-Technical Losses, which cover among others, fraud detection. The customer can upload SmartMeter information into the system where it is processed by specific analytical services created and configured by experts in this kind of business analysis.
- In SmartCities solution, the DAaaS service provides analytic capabilities for the very different data sources that are provided by the city, like the sensor networks deployed in the city. As many cities are under big cost-reduction pressure, DAaaS could provide a very cost effective solution.
- In Retail, a DAaaS model can be used for campaign management and customer behavior. This could include the customer internet activities and also activity in physical stores via the customers' mobile devices.
- In Manufacturing, DAaaS can use the ever growing data coming from connected fabrication machines and when matched with demand it can allow optimal production with minimizing scrap and redundancies.

The main benefit of the DAaaS is to lower the barrier of entry to advanced analytical capabilities, without demanding that the user commits to large internal infrastructures and human resources to the project. Instead of a complex custom project the customer follows simpler steps:

- Data Scientists working for the organization explore the AppStore for an Analytical App that fits the problem.
- They rent the Analytical App for a specific time or quantity of data.
- They configure the Analytical App to its needs including, for example, the usage of external data sources provided by the DAaaS.
- Then the data is fed from the internal systems to the Analytical App.
- The SMEs in the company validate the results and even enhance them with some customization.
- Outcomes are available for all other uses.

Compare this with the typical internal Big Data project:

- Data Scientists need additional resources to design and implement the solution.
- Installs a complete Big Data infrastructure based in some complex technology like Hadoop.
- Implements complex analytical processes in low-level languages becoming in reality an expensive coder.
- Integrates the new system with your enterprise systems with more development effort.
- Examines the results and reiterates until achieving success

Certainly using DAaaS may not be as direct as using other kinds of SaaS software. Any analytical process demands certain preparatory work: explore initial data, define analytical processes, implement and validate results using test data and optimize it as new data comes. But even so, effort is diminished. And that is without taking into account the benefits of a Cloud delivery model: no upfront costs in infrastructure and a pay per usage model allow experimentation or even temporal usage scenarios.

Technically we've seen the complex issues that the implementation of a functionally complete Big Data Analytics solution needs to overcome, if developed internally by an organization. So a DAaaS solution minimizes this technical complexity even more if it is properly designed to manage a hybrid cloud model, for those cases where information needs to be on-premises.

Also there is the issue of expertise scarcity: Data Science is hard and expert resources are not easily available. DAaaS doesn't eliminate the need for Data Scientists but alleviates some of the problems as

some pre-packaged applications are provided for specific use cases. In addition to providing a DAaaS platform, analytic services companies can offer to their customers' access to Data Scientists on demand. This way combining a growing collection of Analytical Services and Data Scientist expertise, the richness of the platform and the value for customers grows.

However hyped it may be currently Big Data is certainly a business changing trend, as the facts are evident: **the data explosion is real and some companies have shown clear competitive advantage by creating and implementing new analytic capabilities over previously unused data**. But getting this kind of capability may be not easy for some companies. Here the flexibility that Cloud delivery models bring can simplify adoption for some companies and even those that could have the resources to implement it internally can obtain significant cost advantages with DAaaS.

3.7.2 How M2M and Big Data will combine to produce everyday benefits

The combination of M2M and big data could produce excellent everyday benefits in the not-too-distant future. Collecting data from a small-scale fleet of repair trucks through to a million-strong network of smart meters then feeding that data through a processing system to deliver detailed business information is another major benefit of M2M. That could be used by an electricity provider to gain very detailed information on when spikes in electricity demand occur, and what usage patterns are, whether there are more optimal distribution paths, whether there is or has been an outage in a certain area, whether there is maintenance needed, that kind of information is delivered through M2M, and has a powerful effect on how well your business operates."

Gartner said that M2M is also being used to drive closer customer relations. Through enabling new cars with M2M, automotive manufacturers and dealers are able to actively inform customers of when tire wear is occurring, or when engines or other components are failing or due to be changed. Similarly, office equipment that's outfitted with M2M such as a multi-function printer (MFP) can keep track of component wear and ink-cartridge use. When the time is right, it can automatically order a new cartridge, or request that a technician be dispatched to give it a service.

The result is that M2M can help deliver a painless service, or create the sensation that the service supplier is actively engaged in the customer relationship.

As M2M and connected devices becomes more prevalent in the U.S. healthcare market, the amount of data being passed back and forth is growing. **Allowing data to flow freely from one hospital to the next can help improve patient outcomes while reducing overhead costs**. However, that is easier said than done. With a large number of information technology available for healthcare, creating a national infrastructure with common platforms and policies can be challenging to say the least

It is also clear that we are not going to move directly from our current, essentially unconnected and siloed world directly to a brave new world of Big Data and the Internet of Things. There must be some stepping stones along the way.

3.7.3 Interface to the Network and Devices combination

A very promising combination is expected to be t**he Cloud Proxy in conjunction with IoT functionalities like the IoT Gateway**: a cloud proxy hosting an IoT Gateway can be a device which is hosted at every home, and can open to a market of home-based applications which let the user interact with their devices and Things at home (e.g. home automation, energy-monitoring and control applications, etc).

Probably the best combination of instance with business potential could be offered **by CDI+S3C in conjunction with Apps GEs (especially the editors),** in terms of capabilities to easily creating innovative

applications to be run on the terminals which exploit both the device (CDI) and network (S3C) capabilities. In the latter case it is however a combination which hardly could eb sold together, as the S3C functionality is usually accessed as service capability offered e.g. by a network operator, who might not be providing the CDI as well (CDI is rather a sort of SDK for developing apps on the terminal).

Finally, **one full I2ND internal combination is given by NEtIC and S3C**: the networking functionality offered by NetIC are typically exploited by those who also use S3C, even more it this latter which suitably use the capabilities of NetIC to provide efficient and more flexible networking services that can be exposed through S3C.

4 The new basis of Platform competition and the superiority of Ecosystem economics

A platform is a set of stable elements (e.g., physical components, operating-system software, and standards) that allow the development of interchangeable, complementary components. Examples of platforms are VHS, Microsoft Windows, Facebook, and the Apple iPhone. The success of a platform depends to a large extent on the variety and quality of complementary components. Microsoft windows was successful because it had the largest number of applications available compared to other operating systems. Boudreau analyzed the effect of three different platform strategies:

a) Having a closed platform,

b) **Opening the platform for complementary services**, and

c) Giving up the control of the platform.

He analyzed the effect of these platform strategies for 21 handheld computing systems on new device development between 1990 and 2004. He found that strategy b produced a fivefold increase in new handheld devices compared to strategy a. Strategy c still had a positive effect but was an order of magnitude smaller.

The evolution from business environment to business ecosystem results from cooperation: both companies and other organizations leverage new ideas, satisfy customers, and create new products and services through open innovation systems. This increasingly networked structure has shifted the focus of competition away from the management of internal resources, to the management of capabilities outside the direct ownership and control of the firm. Here precisely lies the challenge of open innovation.

4.1 Platform and interoperability

Business ecosystems do not rely on a transaction or ownership logic but to on an access and usage logic (RIFKIN, 2000). **In many business ecosystems, transactions are not associated with the transfer of property rights on tangible commodity, but instead with access to intangible services.**

This is especially true in **ICT sectors where business ecosystems depend heavily on business partners (for instance, independent developers) and other ICT companies**. The links between members are used by the focal firm to enrich and to strengthen its platform. In this sense, platforms become open architectures enabling members of an ecosystem to access and use resources to develop new services that may interact and enhance those already available on the platform. This approach gives **incentives for some firms to explore new strategic options and implement very innovative business models.** Thus, shifting the focus from ownership to the concept of openness requires a special attention to the technological devices such as platform in coordinating partners' relationships within business ecosystems.

All these arguments tend to show that a business ecosystem managed by a keystone player is well-fitted for open innovation purposes. Since platforms are repositories of knowledge (both tacit and explicit), potential contributors need access to build their own business model and value proposition. As ICT-based collaborations become the rule, i**nteroperability between business partners has become a necessity for many ecosystems.** Basically, interoperability refers to the **ability of various ICT systems and organizations to exchange data and to share information and knowledge in a reciprocal way** (GASSER & PALFREY, 2007).

Interoperability should be considered as prerequisite for open innovation: it enables enterprises to build collaborative relationships, access useful knowledge, develop and deliver new products and services, strengthening the development of business ecosystems.

Technically, platforms are composed of subsystems and interfaces on which an organization and its external partners can build specific applications or services targeting different users. They are modular systems. BALDWIN & CLARK (2000) argue that the decomposition of a system into modules (or subsystems) relies on the partitioning of information into visible design rules and hidden design rules. The visible design rules are:

- **An architecture** specifying which modules will be part of the systems and what their function will be,
- **Interfaces** describing how the modules will interact and communicate,
- **Standards** ensuring module's conformity with other modules.

The visible design rules consist of explicit knowledge that needs to be shared and communicated. In contrast, the hidden design rules consist of tacit knowledge that is encapsulated within the modules (as software) and doesn't need to be communicated. It is very important to understand that accessing the core of the platform - hidden design rules - make it possible for the partners to execute software as a service but doesn't give them property rights on that module nor access to the source code used to build this module or component**.**

In many cases, the interfaces between subsystems - such as APIs (Application Programming Interface) - are more important than the subsystems themselves. Today's platforms aren't about controlling hardware resources, applications and information. Instead, they are going to be around access to bundle of services and contents tuned for communities, strengthening collaboration and knowledge between partners.

4.1.1 Platforms strategies play a crucial role in open innovation.

The development of platforms shapes the nature of relationships between partners engaged in an open innovation process. The more the platform is open, the more it will enhance collaboration between business partners. These platforms generate more innovative opportunities for the business ecosystem when they rely on open and modular architecture rather than on a monolithic one. In this context, network externalities are at the very core of the open innovation dynamic. Platforms combine software stacks that can be used by other companies to innovate their business that in turn will bolster Amazon's platform in a self-reinforcing cycle, spreading its knowledge into its ecosystem.

Is there a fierce competition between Apple, Microsoft and Google or between their own ecosystems? Business ecosystems could be defined as a new model of firms' organization, both vertically and horizontally disintegrated. Niche players in a business ecosystem serve the objectives of the focal firm: beating the competing business ecosystem or exploring the environment outside the ecosystems.

In this sense, all the players in a particular business ecosystem loose a part of their autonomy: they act as a whole and unique entity. Inside the business ecosystems, non-economic factors, such as power structure and underlying history, play significant roles in driving the business ecosystem development: **inter-organizational relationships are not fixed by market competition** but rather by the will of the focal firm. Therefore, the actual level of competition should be between ecosystems. This change in the level of analysis requires **a change in factors to be analyzed and a new regulatory tool box for policy makers and regulation authorities**

Openness is a fundamental characteristic of multi-sided platforms. Such platforms are designed with open APIs to lower barriers to entry and drive acquisition of diverse ranges of partners that produce valuable apps, hardware accessories and other complements to the platform. **Successful platforms at the same time are closed (integrated) around core businesses of their owners**. In other words, **openness is needed to create the ecosystem of complements. Integration or "closed-ness" is needed to capture value** by the ecosystem owners.

- For example, **Apple is open towards app developers, but much closed around its core business of consumer electronics**. Google is open to web developers, but closed around their computing infrastructure and search ranking algorithm. The same holds true for companies like Facebook, Amazon, Netflix, Microsoft, and many other ecosystem owners. **Clear understanding which**

parts of the value chain need to be open, and which closed, is an important source of competitive advantage.

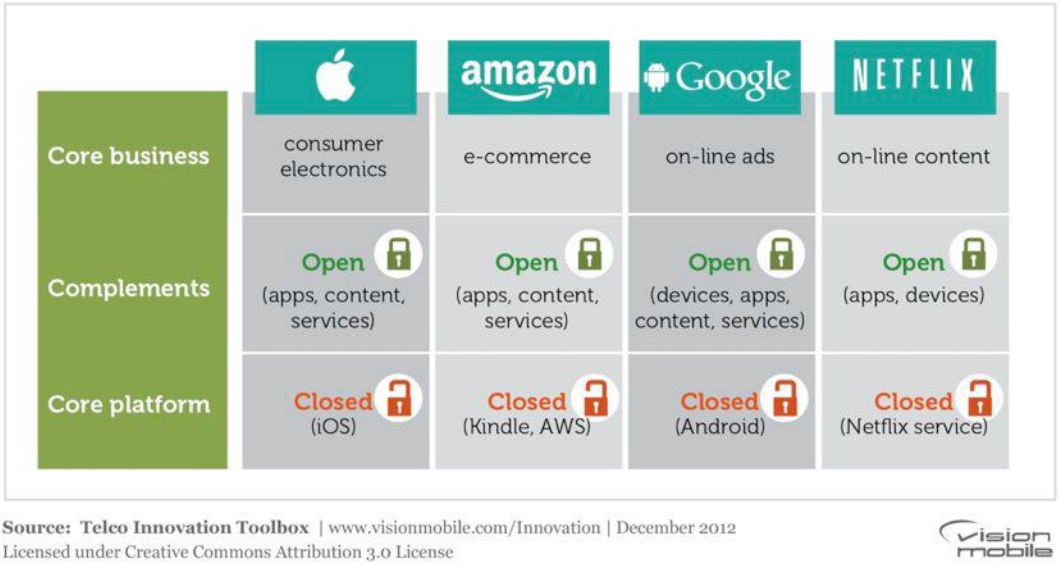

Figure 25: Openness is a Key part of complement strategy

Companies that make the mistake of being open around their core business end up surrendering their ability for meaningful differentiation, and are forced to compete on price. For example, all the noble speak about "openness" did not help Nokia to make Symbian a viable alternative to iOS and Android. This is because Nokia made Symbian open at the level of the core platform, exactly where Nokia as an OEM needed to be integrated (closed). Nokia needed to focus on making Symbian "open" and attractive to developers, not to other handset makers**. Integration around the core business is necessary to deliver unique value, elevate barriers to entry and achieve sustained profitability**. For example, Telco API initiatives better be focused on creating unique value to the Telco's subscribers, thus establishing lock-in and barriers to entry around core Telco services.

Open-source software (**OSS**) is computer software that is available in source code form: the source code and certain other rights normally reserved for copyright holders are provided under an open-source license that permits users to study, change, improve and at times also to distribute the software. Open source software is very often developed in a public, collaborative manner. **"How do companies make money from Open Source then?"** through selling consulting/training services, selling a dual-license (where a restrictive Open Source license is free, but a permissive commercial license comes with a fee), or creating a platform upon which you sell other code (widget frosting).

- **Open Source thrives on a thriving community of users and developers.** Open source projects that come out of companies have a considerable amount of credibility. You know the company is going to continue backing the software and promoting it and you know they are using it at their own company and therefore have a vested interest in seeing it succeed. For example, Facebook does a great job of open sourcing their tech, so I feel better using it.
- **Platform openness invites developer participation but sacrifices direct sales.** Bundling enhancements early drives developers' away but bundling late delays platform growth. Ironically, developers can prefer sponsored platforms to unmanaged open standards despite giving up their applications. Results can inform antitrust law and innovation strategy

4.1.2 Rethinking Business Models

The services industry scales solutions by employing more people. Our traditional models have relied on creating new inventory within the business to solve customer problems. **The internet allows the creation of online platforms that enable creation of new sources of inventory external to the business**. While the industrial approach to scaling supply involves scaling business operations, the platform approach **focuses on growing an ecosystem of external 'co-suppliers'.**

- Traditionally, the transportation problem has been solved by creating and selling new cars (Ford) or adding more cars to a fleet (Avis). A platform-based approach like Lyft connects commuters with vehicle owners interested in making some extra money. In doing so, an entirely new source of supply is created. Avis's acquisition of Zipcar is testimony to the growing importance of a platform-based approach.
- Hotel chains solve the traveler accommodation problem by creating new hotels around the world. Airbnb solves the same problem without investing in any inventory within the business. Instead, Airbnb enables anyone with a spare room and a mattress to run their own BnB and benefit from a global market of travelers.

Platform models are difficult to get off the ground because **the business does not have direct control over the creation of inventory** and many platforms fail in spite of investing in technology because they fail to generate supply**.** However, **platforms that have succeeded in reaching critical mass have often disrupted traditional businesses and created entirely new consumer markets**

There are two ways to rethink work in the context of your business:

- Leveraging third-party platforms: The rise of services marketplaces like eLance, oDesk and, more recently, Gigwalk, has powered the growth of the freelance economy. Adobe's recent acquisition of Behanceunderscores the importance of platforms enabling the freelance economy. The cloud-enabled workforce is a model gaining gradual traction and is likely to affect both core as well as support functions in any business. Tapping into this distributed workforce can enable a business to get work done, without the overheads associated with an in-house workforce.
- Creating an ecosystem of producers: A far more disruptive, though challenging, way to leverage networks is to restructure your business as a platform connecting producers and consumers directly. The mobile applications industry is already being restructured around this new normal. While app developers traditionally worked for companies like Nokia, the rise of the iPhone and Android app store, coupled with the downsizing of companies like Nokia has restructured the concept of work in this industry. These former in-house app developers for Nokia now participate on the iPhone and Android app store.

Businesses that leverage this strategy need to create the right incentives for the external producers. Apple, for example, succeeded with the iPhone app store because it provided a better revenue share than the carriers.

4.2 A service economy develops around app ecosystems

The mobile development landscape has undergone a massive transformation since the early days of the iOS and Android platforms. **However in the early stages developers faced a limited supply of tools and services** to assist them with crossing platforms, beautifying the UI, bridging fragmentation, integrating with ad networks or analyzing user behavior. They had to create most of the building blocks from scratch using their own means. **As mobile application development continues its growth from 100,000s to millions of apps** and across the developer journey, there is now a tool for (almost) every developer need, from app testing to ratings management.

The app economy is evolving towards a service economy where developers can pick from a range of tools and services to assist them along the plan develop market journey. **Third-party developer services,** ranging from user analytics, location APIs, bug-tracking tools, app-store optimization services, and cross-promotion networks

4.2.1 The superiority of ecosystem economics

In the new basis of competition, ecosystems like Apple iOS or Google Android have become the focal point for service creation and distribution**,** ironically with help from Telco in the form of device subsidies. In the space of five years, ecosystems have mushroomed to take control of what took telcos nearly 30 years to build.

- Apple, Google, Facebook, Amazon and many other Internet players are in the center of value networks **connecting the core business of the platform owner** (e.g., hardware sales for Apple) **with an array of complements, such as developers, media, brands and Telco**. As such, **they are carefully designed to drive the core business of the ecosystem owner**. Complements are products that are consumed with and add value to the core product of the ecosystem owner.

Ecosystem economics describe how the core product (e.g., iDevices or Google ads) becomes more and more valuable, as the numbers of developers and users around it grow. **Ecosystem economics are driven by network effects and lock-in**.

- IPhone apps attract Apple users, who in turn attract more developers, who make more apps, which attract even more users, and so on. **This network effect between developers and users drives the explosive growth of the iOS platform**. Lock-in creates natural "walled gardens," as users develop habits around apps, while developers are locked-in by high switching costs created by their investments into the platform.

Ecosystem economics are often misperceived as simple two-sided business models that need to profit not only from users, but also from developers. This couldn't be further from the truth. **Developers, much like any complement**, drive sales of the core product, and as such need to **be viewed as partners**, not as a source of direct profit.

- **For example, Apple runs a very successful consumer electronics business**. About 80% of Apple's profits in Q3 2012 derived from products running its iOS operating system. Flexibility and choice underpin the iOS value proposition"There is an app for that," in the words of Apple advertising. Today, the company lists more than 700,000 apps in the Apple App Store. Given that the app economy has become a multibillion dollar business, it is tempting to believe that apps are now a lucrative multi-billion dollar content business for Apple. **In reality, the company runs the App Store at just above breakeven**. App Store revenues are used by Apple to subsidize testing and hosting of hundreds thousands of free apps and billions of free app downloads, over 80% of app downloads are free (including Facebook, Instagram, and many other apps). In other words, the App Store is not designed to generate profits from content sales, but rather is a key enabler for the app economy that produces critically important complements
- **Google Android ecosystem is built on very similar principles**. It treats developers as partners who create vitally important complements. Google's core business is online ads, and the Android ecosystem is optimized to drive eyeballs to Google properties and deepen its consumer intelligence. As opposed to Apple, **Google prioritizes user reach over user experience, and makes Android freely available to the broadest range of handsets**.

In most developed mobile markets, operators are playing a supporting role within the iOS and Android ecosystems. Operators take on the financial burden of device subsidies, which reduces the cost of acquiring the smartphone users -- all in exchange for upselling users into higher-ARPU data plans. **While Telco finance the expansion of smartphones, Apple and Google are taking over the customer "ownership" and creating strong user lock-in that surpasses that of operator brands**. Ecosystems are much better at delivering choice and flexibility, the new basis of competition. This is due to their global scale and vast developer reach.

As iOS and Android have reached critical mass, and established well-entrenched market positions, operators need to look for **ways to build unique user value atop the platforms rather than competing with OTT players**. Such "**over-the-platform" innovation can indeed create new revenue streams**, but even more importantly it offers **opportunity to create unique differentiation relative to local competitors and avoid competition on price.**

Opportunities for such differentiation exist in the areas where platforms are inherently weak, or have little motivation to compete. These include **local presence, user targeting and reach**. **An example is M2M. It holds the potential to create a vibrant ecosystem of users and solution providers,** thereby establishing strong network effects and lock-in. Telco can become the central force in this emerging ecosystem if they learn to engineer the ecosystems to their advantage. **By looking at M2M through the lens of ecosystem economics, operators will see opportunities** that are much bigger than just selling modems and data connections**.**

4.2.2 Ecosystems as a new distribution channel

Direct distribution networks made perfect sense when operators competed based on the reliability and scale of a small set of services. Competing on choice and flexibility requires solutions that address thousands of user needs for each walk of life. Moreover, **user expectations constantly continually evolve, making it practically impossible for a single company to predict and satisfy a wide spectrum of user needs**.

Figure 26: Developers only way to cater to millions of users

In the previous two decades, mobile phone users expected four basic "apps": voice, text, contacts and camera. Now, they expect availability of hundreds of thousands of apps. Companies like Google, Netflix, Facebook, Amazon and even FedEx realize that **the only way to compete on choice and flexibility is to create an ecosystem of tens of thousands of partners around their core product**.

- For example, Netflix started as a direct mail DVD rental company and expanded into video streaming services. To compete based on choice and flexibility, **Netflix created an ecosystem of device partners and developers around its video streaming service.** This ecosystem takes Netflix services into over 800 device types and allows 80,000 Netflix Open API developers to add value by experimenting with new discovery methods and use cases.

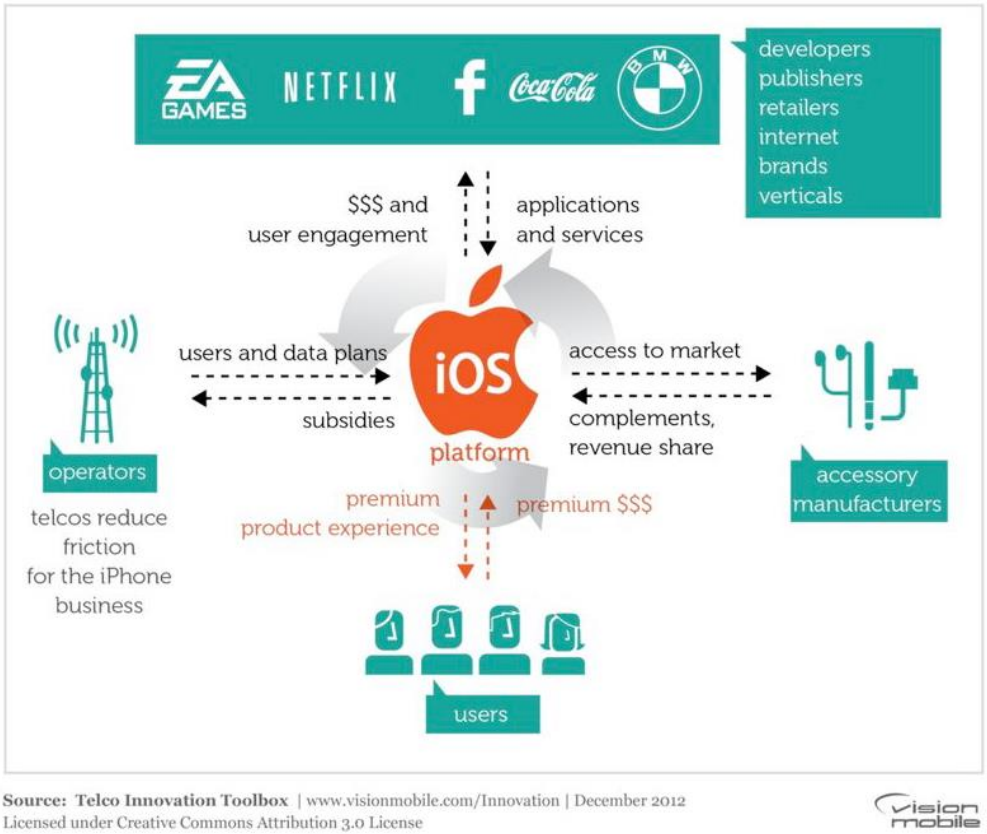

Figure 27: Ecosystem scheme

In effect, ecosystems are a new distribution channel similar to "value added resellers". In the case of Telco, ecosystem partners are the resellers that will push Telco services, to new users, new usage models and new market niches. **The key advantages of this newfound distribution channel are the ability to create solutions for many small user niches customization**, as well as engage in experimentation to discover new needs and opportunities.

Building an ecosystem amounts to offloading many of the costs and risks of entrepreneurship to value-added resellers by doing that, the value of the ecosystem as a whole can grow far beyond what a Telco could create on its own. **In effect, external partners, be it developers or service providers, become investors in the ecosystem,** subsidizing the expansion of the business.

But what is a developer? The reality is that the developer ecosystem is a complex mosaic of large and small companies, communities and individuals. VisionMobile's **developer segmentation model classifies developers into eight categories** that differ according to developer motivations and commercial drivers. Some developers are after direct monetization (e.g. ZeptoLab, the author of popular Cut the Rope game), some are after user reach (e.g. Facebook), and yet others are looking to extend their non-mobile products and services (e.g. Nike, DropBox or FedEx).

Developer Segments	Motivations & drivers
Hobbyists	Fun and coolness
Explorers	Opportunity and ancillary income
Hunters (pro developers)	Profits from apps
Guns-for-hire	Probability of winning a project
Brands and verticals	Brand affinity and user engagement
Digital content publishers	Access to large addressable market
Venture-backed startups	Attracting investment and achieving exit
Corporate IT	De-risking and information security

Figure 28: Developer Segments

Developers should be offered assistance to scale and deepen their business, by using the correct "business model polarity". Instead of charging developers upfront and creating unnecessary friction to experimentation and API adoption, **software providers need to align the business model of the API with those of developers**.

- **For example, Facebook and LinkedIn are both social networks**. The two, however, are driven by rather different business models. The alignment of API business model with Facebook will mean helping Facebook drive user acquisition and user engagement. The alignment of API business model with LinkedIn will mean helping users make valuable business connections. Most developers **face fierce competition in the platform app stores, and are in direct need of differentiation and competitive advantage**. Telcos can attract developers by affording them realized by Telco APIs **in their three business layers: access, services and distribution**.

4.2.3 Ecosystem engineering

The new basis of competition is defined by ecosystem economics, and technology is just one part of a much more complex puzzle**. Platform owners run their ecosystems of users and developers by means of five ingredients and two control points.**

Successful application platforms have **five key ingredients**:

1. Software foundations: a rich set of APIs with managed fragmentation and a toolset for creating apps
2. Community of developers writing to the same set of APIs to spur innovation and cater to diverse use cases
3. Distribution (reach) across handsets, operators and regions
4. A means of monetization, such as ads or micropayments
5. A means of retailing content (discovery, promotion, search and social)

The next diagram details the five key ecosystem ingredients, their product success factors and the competences needed to bake each ingredient into the recipe.

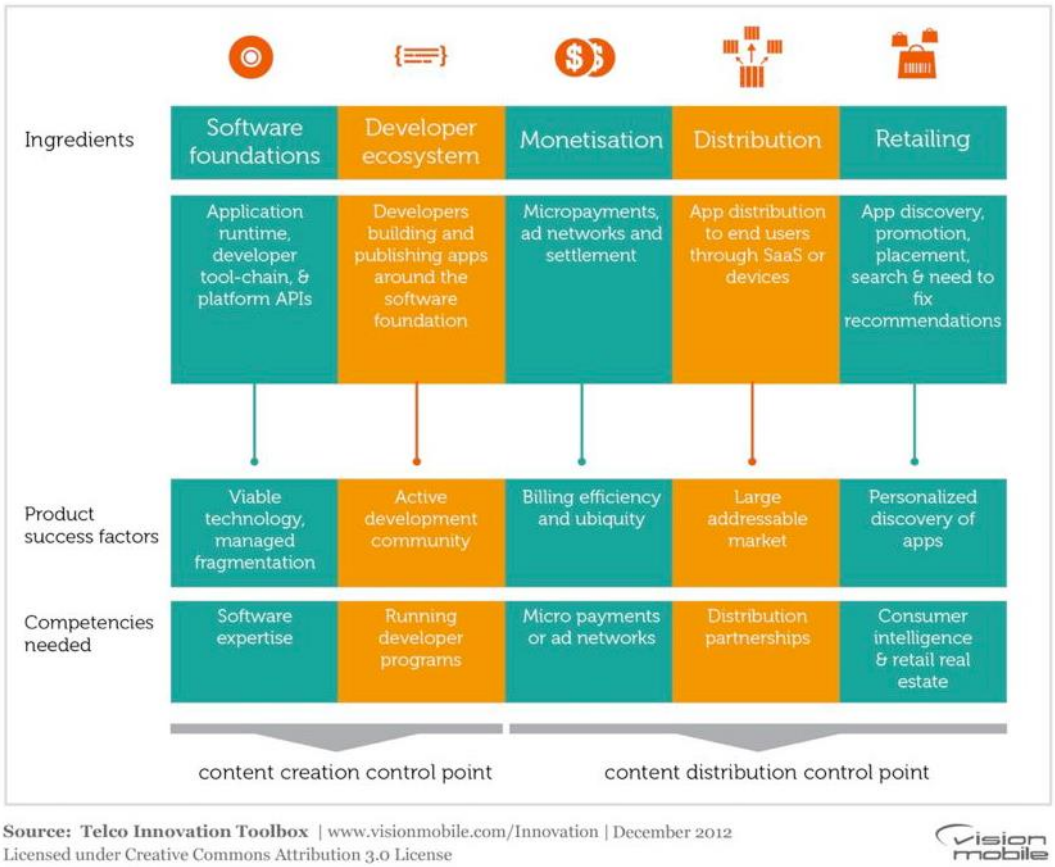

Figure 29: Five ecosystem ingredients

Platform owners control their ecosystems of users and developers by means of two control points. These points exist at the opposite ends of the value-chain.

- Firstly, platform owners control **content creation by locking developers into a proprietary API.**
- Secondly, platform owners control **content distribution by gating how apps are distributed to and discovered by end users.**

These two control points allow platform owners **to amplify the network effects by reducing friction to on-boarding of developers and users**.

If you **are successful in building a platform that has wide adoption by 3rd party developers** then it rapidly increases the value of the underlying service at a far greater rate than you could do with your own internal resources. Apple revolutionized mobile phones by creating an app platform, and they were then able to leverage that success and create the iPad and a whole new market. It was the App Store and the wide adoption by developers that made all of that possible. So it stands to reason companies in other markets (Samsung, Intel, Google etc) would want to try to replicate that success. And of course, create a badass product with effective engagement, re-engagement, and viral design.

- **1) Create tools of self-expression which are really easy to use:** there is no bigger incentive for users than the ability to spread their creations, beliefs and causes in a manner that weren't possible before.
- **2) Target a micro-universe:** Find a micro-universe which contains your early sophisticated users.
- **3) Be shareable and embeddable:** ensure that what gets created on your platform can get shared where your savvy users want to share it, namely on blogs and niche forums.
- **4) Seed the community:** Platform usage requires investment; you set up a profile, you browse around... it takes time. Users won't invest if they don't see activity.

- **5) Get a marquee player or seed your own content**: An extension to the above point, sometimes, signing up a top-notch producer can help draw consumers in.

4.2.4 The Six Biggest Challenges for App Businesses

Here we discuss six of them, with some basic tips on what to do about them. The challenges are split between marketing and post-launch app and user management.

The three biggest **marketing challenges** were:

- Keeping users engaged: Keeping users engaged was the challenge cited most often overall; this is consistent with data from analytics firm Flurry, who report that user engagement falls sharply over time, with only 24% of consumers continuing to use an app after three months from download. Developers must focus on tracking user engagement & usage patterns rather than just on downloads.
- Targeting the right users: The second most oft-cited challenge is targeting and getting through to the right users mostly because existing app stores offer little in the way of user targeting. App stores have little incentive to share customer data with app developers additionally app store owners are loath to jeopardize user privacy contracts. The inaccessibility of customer information will likely remain a thorny issue, and one that hampers developers' marketing potential. Try to reach the right users for your app wherever they are currently, via blogs, forums and more traditional media. Arrange cross-promotions with similar but complementary apps. Experiment with alternate discovery solutions and find out what works for your app.
- Identifying the right revenue model: Developers were becoming increasingly confused about which revenue model to use. There are over 10 revenue models to choose from and no guarantees as to which revenue model will work best in the long run in terms of reach vs. monetization. Moreover, the revenue model needs to be optimized to the platform and app category. The decision should also take into account factors such as customer paying propensity (which varies across platforms), competitor pricing and positioning (which varies by app category). Overall, we found that pay-per download was the revenue model used most frequently followed closely by advertising. Wherever possible, additional advice is to try some sort of freemium or virtual goods model using in-app purchases. The growth of in-app purchase revenues across iOS and Android is significantly outpacing paid downloads.

The three biggest **post-launch challenges** were:

- Tracking bugs and errors: There is no direct feedback channel between users and developers, and no out-of-box means to monitor the performance of an app. The first line of defence here is to remove as many errors as possible before launch, both through good engineering practices during development and extensive beta testing. The second line of defense comes in the form of crash analytics and bug tracking services. These services track app errors by monitoring crashes and reporting the type of error, platform, device and environmental variables like location, time and transaction flow. As such, they can provide useful insights, helping find and fix errors before they drive users away.
- Updating applications in the field: On iOS the process requires full certification and approval by Apple, plus explicit opt-in by the user. On Android, the update process can be automatic and near-instantaneous. This however requires that users opt-in for automatic updates for specific applications. In effect, these challenges with the update process on both iOS and Android increase the average application "age" and escalate both code maintenance and customer support costs for developers. One option here is to track application versions via analytics and send push notifications to users with sufficiently old versions, highlighting the benefits of updating to the latest version

- Getting users to review your app: Last but not least, another frequent post-launch challenge was getting users to review apps. At the same time, there have been some success stories of apps boosting their review numbers, usually by nagging users after they have used the app for some time

4.2.5 The "On boarding" Problem

With some types of mobile app, getting a user to download it is just the beginning of the problem. **The more steps a user has to go through before they can start using an app**, the less likely they are to complete the signup process. Getting this wrong can catastrophically alter the economics of user acquisition.

Anecdotes from various apps with even larger audiences suggest this is a fairly typical drop-out rate if users need to sign-in/register for the app when they don't already have an account. **If it's possible to let the user start using at least parts of the app** (e.g. browse around some content) without signing in) then it's a good idea to enable that option. A social network sign-in screen that lets the app trawl details from other networks you belong to should be contrasted with allowing users to sign-in to your app with an account they already have elsewhere via OAuth. The latter can actually reduce friction in on boarding significantly without going overboard on permissions you can fetch lots of user info from their existing account.

Google now allows developers to give users trial subscriptions. Google, looking to make consumers more willing to surrender their credit card information, is introducing trial subscriptions for apps in the Google Play Store. It's difficult to say whether or not Google's new policy will encourage people to subscribe to premium content, but at least they're reducing friction to pay for apps, which is always a good thing

4.2.6 The changing landscape of app discovery

The explosive growth of app ecosystems is creating serious bottlenecks in app discovery that only popular apps can overcome. Having 700,000 apps is great for platform vendors, but not so great for developers, whose apps are lost in the heap. **One of the greatest marketing challenges facing developers is being discovered**, i.e. breaking through app store congestion and in front of user eyeballs. With Google Play and App Store now reporting over 700 thousand listed apps, browsing through these is ineffective, if at all possible. In fact, large app stores and the entire mobile application space increasingly resemble the web when it comes to discovering content. App discovery is a challenge for both publishers and users. However, their incentives are often misaligned: publishers want their content in the field of view of every potential customer while users want their field of view clutter-free and occupied by what's relevant to them. Balancing these incentives is tough.

Fortunately, there is **a host of tools and services available for developers to promote and market their apps** although selecting the right ones among these can be a challenge. Marketing tools include:

- Cross-promotion networks (e.g. AppCircle, Chartboost),
- Incentivized downloads (e.g. TapJoy),
- Vertical/specialist app stores (e.g. Happtique),
- Reviewer networks (e.g. AppFriday),
- Ad-networks, deals of the day services (e.g. AppGratis),
- Recommendation services (e.g. Hooked),
- review sites (AppAdvice),
- Non-native marketplaces (e.g. GetJar and carrier app stores) to name just a few.

For most developers, particularly those new to the app economy, there is a steep learning curve to climb when marketing apps, quite steeper than getting to grips with a new development environment. Before selecting a promotion channel developers should research alternatives. On several occasions,

simple, free strategies may work quite well: **dropping the price of your app or making it free for a period of time is likely to be picked up by a number of sites that will then showcase your app for free**.

4.3 The App Developer Journey

The reality is that the developer ecosystem is a complex mosaic of large and small companies, communities and individuals. VisionMobile's developer segmentation model classifies developers into eight categories that differ **according to developer motivations and commercial drivers**. Some developers are after direct monetization (e.g. ZeptoLab, the author of popular Cut the Rope game), some are after user reach (e.g. Facebook), and yet others are looking to extend their non-mobile products and services (e.g. Nike, DropBox or FedEx).

App developers today have over 500 third party tools (APIs, SDKs, components) to choose from, catering to every stage along the developer journey. These tools lower barriers to entry, reducing development costs, smoothing the learning curve, multiplying go to market channels and streamlining marketing.

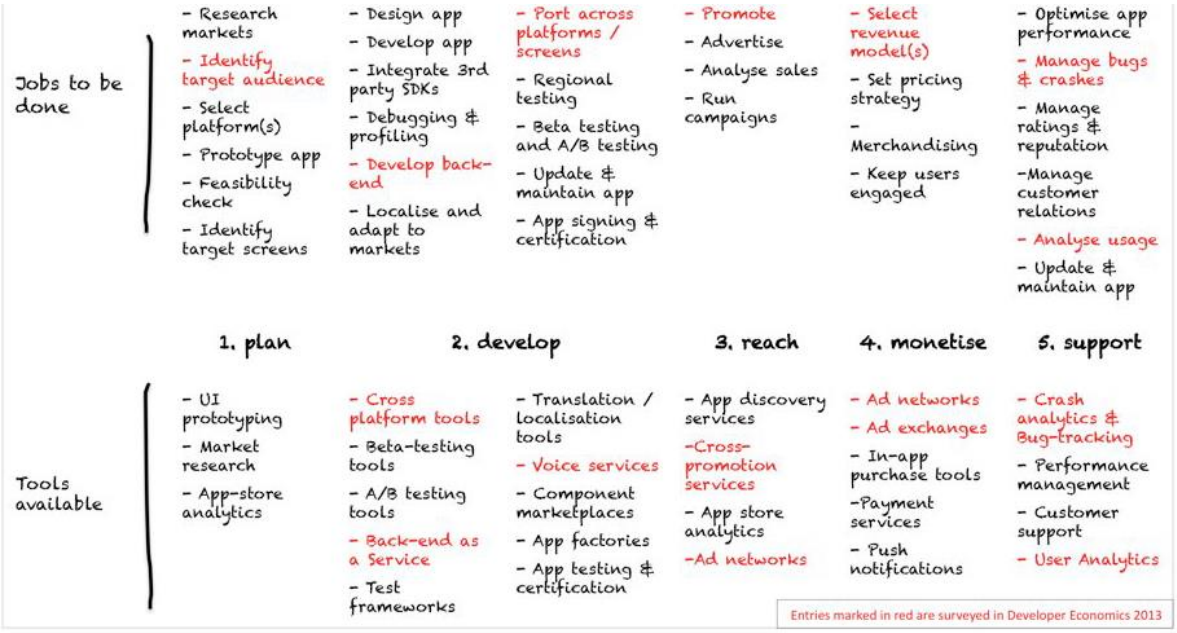

Figure 30: The App Developer Journey

Developer tools have become a major platform differentiator and a developer attractor. Developers today have at their disposal an abundance of tools including app store analytics, user analytics, cross-platform tools, crash analytics, marketing and monetization tools, all of them with zero entry-level pricing. We have been researching the SDK economy for the past few years, and have been tracking a growing number of (currently) developer tools categories.

Ad Networks	AdColony AdMarvel AdMob AdWhirl Airpush	Apple (iAd) Burstly Fiksu Flurry InMobi	Inneractive JumpTap Lead Bolt MillenialMedia mOcean Mobile	MobClix Nexage mopub Smaato warp.ly
Back-End as a Service	ACS Applicasa Apstrata Buddy CloudMine	CloudyRec Deployd FeedHenry iKnode Kinvey	kumulos mobDB Parse ScottyApp sencha.io	StackMob Usergrid (Apigee) Trestle (Flurry) QuickBlox
Bug Tracking	Airbreak Apphance	BugSense Crashlytics	Crittercism Hockey App	TestFlight Usermetrix
Cross-Platform Tools	Adobe AIR Appcelerator AppMobi Brightcove	Corona Marmalade Mono	MoSync PhoneGap Qt	RunRev Sencha Unity
Cross-Promo Networks	adDash AdDuplex AppCircle (Flurry) Applifier AppFlood (Papaya)	Chartboost clashmedia Fiksu G6Pay	GreatPlay Network Jampp maudau RevMob	SponsorPay Tapjoy W3i Wavex (6waves)
User Analytics	Apsalar Bango Distimo	Flurry Google Localytics	MobClix mopapp	Testflight Live (Burstly) UserMetrix
Voice Services	AT&T Deutsche Telecom FonYou GetVocal HarQen	Hoiio Ifbyphone IOVOX Jaduka Microsoft	OneAPI Sendflow Skype Telefonica Teleku	TringMe Tropo Twilio Verizon Vivox

Table 6: Developer Tools Landscape

Developers are often at a loss when it comes to selecting the right tool or partner among the hundreds of services available to them. Cost is just one variable in the selection process but quite often, it is not the most crucial. The reliability of a service, the regional reach, key metrics (such as eCPM or fill rates), as well as the flexibility to adapt to the developer's needs are sometimes more important than cost, particularly when developers invest time, money and resources to integrate a third-party service with their apps.

Ad services mainstream, Advertising is the most popular revenue model, while ads can also act as a promotion channel that facilitates app discovery. User analytics and cross platform tools follow in popularity with a longer tail formed by developers of crash analytics, BaaS, cross promotion networks and voice services.

- **Google's AdMob, is clearly the dominant mobile ad platform**. AdMob has recently expanded to ad exchange services, a move that aims to counter the threat that ad exchanges pose for Google.
- **PhoneGap and Appcelerator lead developer mindshare across 100+ cross platform tools**.. With over 100+ cross platform tools available, the choice for developers can be a challenge.

Amidst differentiating features for CPTs are access to native APIs, performance optimisation and the ability to reproduce native UI elements on each platform.

- **The user analytics duopoly:** Google and Flurry are well ahead of competition. User analytics services are becoming increasingly important as a tool to optimise app engagement and reach, and act as a proxy for user feedback. Usage of analytics serves as an indicator of the level of competition among developers on different platforms.
- **Parse leads Backend-as-a-Service tools** but competition for second spot is heating up as BaaS rises in popularity. As mobile apps become more sophisticated, so the need increases for back-end features like managing users, introducing social features, or synchronizing cloud data.
- **TapJoy is the leader in cross-promotion network** mindshare. Cross-promotion networks (CPNs) are used by developers both as a means for promoting their apps by means of free traffic exchange across apps, ads paid by cost-per-app-install or in some cases incentivised installs. CPNs are also used as a revenue model, for developer acting as inventory publishers.
- **Voice APIs**, Voice-enablement leaders Twilio and Voxeo have been much popular within web developer circles, with Twilio rising once in late 2011 to a top-10 API provider ahead of Facebook, as tracked by ProgrammableWeb. Telcos like AT&T, Verizon, Telefonica and Deutsche Telekom have also released voice APIs in 2012 in a move to extend telephony assets into new revenue generating voice use cases.

The Developer tools universe expands and consolidates. The Business to Developer (B2D) market, has seen a continual expansion in the last three years, with a flurry of B2D startups emerging to address the ever increasing developer needs. **Consolidation to continue to 2015, led by mobile marketing and enterprise.** We expect the trend of consolidation of the tools landscape to continue unabated until 2015, six years after the B2D market for apps was born, while expansion will focus only on **unaddressed developer tools sectors in the post-launch phase of the developer journey**. We expect two main clusters of developer tools to lead the consolidation:

- **Firstly, marketing tools**, as the discovery bottleneck will only worsen as we go from 1.5M to 10M apps, and while the Apple and Google stores continue to dominate app distribution.
- **Secondly, Enterprise Mobile Services**, which are creating revenue, demand for vendors to mobilise their intranets, and to allow employees to bring their own device (BYOD) to work. Unlike the consumer apps space, enterprises have a substantial IT budget per employee, and very stringent requirements for data security, identity management, backend systems integration, and support-level agreements.

4.4 App Business Model

Developers have a range of options to choose from when it comes to generating revenue. This choice is, to some extent, dependent on business model, scale and target market. Which revenue models are most popular, and which are most profitable

Developers have a lot to improve in planning their app business. The most revenue-generating app planning strategies are those that extend an app either into verticals or different geographies. To some extent, these strategies rely on an already established and successful business: apps that have been tried and proven in at least one market and are generally less risky options or “low hanging fruit” for developers.

4.4.1 Platform monetization or Revenue models

While monetizing a business network, community or marketplace, a successful company would be one which knows what the central proposition of the product is and would know how to monetize that particular proposition. It doesn't take a genius to figure out that **the central proposition for a marketplace is the transaction** happening between two parties on it**. Revenue models** in order of how close or far they are from the central theme of the site would be:

1. **Transaction-based revenue models**: Directly monetizes the transaction. The best ones even monetize the volume of the transaction. *E.g. ODesk, which monetizes volume of the transaction by billing by the hour for service provided Cyworld: A social network where SOHOs set up shop and sell to customers, a cut of which goes to the network*
2. **Lead generation-based model**: Monetizes the interaction but fails to create value out of the*life-time value* in the transaction. E.*g Justdial on voice. Yes, it does connect the SMB to the customer but potentially loses out on the ability to continue monetizing it on an ongoing basis.*
3. **Value-added service model**: Monetizes off the interaction, but not off the transaction. Monetizes secondary services that may be offered to the community while actual transactions are free thereby encouraging people to transact more and hence use the VAS more often.*E.g. One of the many monetizing models on Alibaba*
4. **Subscription model**: Monetize one-time or once a year on a float subscription irrespective of number of transactions. This only monetizes the users in the community offering them special privileges but fails to monetize all the activity.*E.g. Indiamart*
5. **Advertising model**: In my opinion, a very poorly thought out business. Anyone owning transactions and interactions and monetizing only the users (or the nodes) would be wasting his asset. You might as well get this done as a media company.

There has been **substantial innovation on revenue models**, which continues unabated. First there were pay-per-download and freemium models, then purchase intermediation for partners and affiliates. The latest innovation is product placement, taking the well-established marketing practice pioneered in Hollywood into the mobile app domain. The next table lists the 11 mainstream revenue models practiced in mobile apps, alongside their respective revenue sources.

Revenue Source	Revenue Model
Consumers	Pay per download (one-off payment for an app, book or magazine). in-app purchasing (for app features, game levels or virtual goods). Subscriptions (recurring monthly payments). Freemium (free download, pay to upgrade).
Businesses	Commissioned applications (applications made for hire).
Ad networks or brands	In-app advertising (currently the revenue model used most frequently by developers). Product placement (e.g., Coke-branded soft drink appearing in a game)
Partners & affiliates	Purchase intermediation (share from enabling third party transactions, e.g., in case of search app).
Handset Makers or Platform owners	Per-unit royalties (for pre-loading an app on handsets). Distribution exclusivity deals (for exclusive app distribution via an app store).
Angels or VCs	Investors providing capital in return for equity, often the "revenue model" of startups.

Table 7: Mainstream revenue models practiced in mobile apps

The analysis of revenue models and revenue potential per platform above is far from static. In fact, the viability of a revenue model can change dramatically in a matter of weeks. It's important to keep a constant eye out for trends in your sector. One trend is to move from a pay-per-download model to making the app initially free (freemium or in-app purchase model). This is especially the case for apps where users discover the value over time (e.g. trying out a new game and getting hooked to it), or where the value of using the app actually increases over time (e.g. services like Dropbox and Evernote). A good perspective on this issue can be found here. Another factor is that in-app purchases allow users to spend as much as they want, causing IAP apps to dominate the top grossing charts.

4.4.2 Planning your development costs

The bar for successful apps is high: if you want your app to stick out among a million others, it needs to be well designed, user friendly and working flawlessly. All of this comes at a cost. In this chapter, we give an indication of the types of costs you need to take into account when planning your app. Here are some costs you need to take into account.

- **Tools:** Computer cost, developer registration fees and tools licenses.
- **UX design:** Storyboards, user interaction and graphic design typically make up 25% of total app cost. Also think about audio and special effects, especially for games.
- **Development & Debugging:** The bulk of app production costs (upwards of 55%).. Practically speaking, the cost of person-hours devoted to the project. We researched average and "identified average" pay rates for different types of developers on oDesk, which claims to be the largest outsourcing hub connecting freelance developers with clients. We found that highly qualified developers demand on average $30/hr for iOS, $27.50/hr for BlackBerry and Windows Phone, $26/hr for Java, and $24.70/hr for mobile web development. Note that these figures are averages across several countries and rates can vary significantly by country. iOS skills generally attract higher hourly rates, while mobile web skills, being more abundant, are valued at lower rates.
- **QA & testing:** Making a flawless app requires testing it under realistic conditions. Apart from testing man-hours, costs here can include devices to test on, testing services and usability testing.
- **Back-end and operations:** Back-end costs vary depending on the application's requirements – from lightweight (user management services on Appcelerator, Spire.io or Parse.com) to heavy (applications written from scratch on Amazon Web Services (AWS) or Google App Engine). Hosting and service costs for connected apps can be very significant long term and may even limit revenue model choices.
- **Maintenance:** Typically 10% of the initial app cost, on an annual basis
- **Marketing:** We estimate that marketing costs average 10% of app production expenses, although it can easily scale to half of the production costs for larger software operations. In practice, marketing costs differ based on the developer segment – hobbyists and explorers will use Facebook as the lowest hanging fruit, whereas professional app developers will use more sophisticated and premium channels such as professional PR services and incentivized downloads.
- **Project management:** Account for some overhead to manage your team. This is especially relevant when outsourcing parts of the design, development and testing process.
- **Localization:** When bringing your app to foreign markets, translation can be an important cost. Localization is an ongoing process, so plan extra costs with each update to your app

4.4.3 A Comparison of Inter-Organizational Business Models of Mobile App Stores

The analysis of the app store ecosystems allows a differentiated view on the different strategies of the app store owners. Additionally, we look at the impact of network effects, economies of scale, platform differentiation, quality assurance, and transaction costs on the design of mobile application markets.

This theoretical model allows a deeper discussion about the design choices and success factors in the different app store cases. Based on our analysis, we expect that the open versus closed models discussion becomes less relevant **so called open platforms have closed aspects as well as the other way around - and that competitive differentiation and segmentation strategies will become increasingly critical** in order to strengthen the competitive positioning of the different app store platforms

When comparing the different app store business models, one can conclude that they are all essentially the same. The business models are about creating an app marketplace platform connecting app developers and app users where the platform owner gets a share of the sales, irrespective of how open or closed the platform is. However, on a more detailed business model (e.g., value proposition) component level, differences can be seen, such as:

- The fact that RIM mainly focuses on business users;
- Apple's more strict verification approach strengthens its exceptional user experience and quality focus; and
- Google's approach with different hardware providers and less strict verification supports a best value for money, mass market strategy.

We expect that once the sector further matures, this kind of competitive differentiation and segmentation will be increasingly important for each platform owner in order to strengthen its position, just as in other more mature markets and industries.

New players from different industries have also started offering their own app stores, such as **online retailer Amazon, who wants to offer its own walled garden app store for Android phones** (with dynamic pricing mechanisms), or consumer electronics companies like Philips with its Net TV app store that also sells its Net TV concept to other consumer electronics companies. The emergence of all these different app stores may also lead to price competition on the app level (cf. competing supermarkets). On the other hand, we also see that current mobile app store owners are trying to broaden their markets by focusing on TV users (cf. Google TV and Apple TV) and generic computer users (cf. Apple's App Store for Mac computers), to name a few.

According to the evolutionary theory of innovation an open platform that allows the free innovation of complementary components has an advantage compared with a centralized planning approach. An app store allows the creation of numerous apps for a platform, applications that the device manufacturer or operating systems developer might not invent by themselves. The opening of certain platform elements for third-party innovation can be called an innovation platform or an open innovation strategy

- **However, in a platform ecosystem, the control of two or more elements of the ecosystem allows an easier and faster change** of these elements compared with a situation where these elements are controlled by different parties who need to coordinate the changes of the elements. An example is Apple, who controls both the iPhone and its iOS operating system. This allowed Apple to invent the concept of multi-touch interfaces more quickly, because it could innovate on both the hardware and software side. We call this advantage of the control of different platform elements innovation economies of scope. It seems that in newly formed platforms, innovation economies of scope are prevalent because the ecosystems lack stable standards for open innovations. When a platform ecosystem matures, standards emerge and open innovations are possible on top of these platforms. However, from the analysis of the app store value networks, we can see that a mobile platform ecosystem could have a closed, integrated approach that fosters innovation economies of scope for some elements, and at the same time an open innovation strategy for other elements.

- **The evolution of software ecosystems is the result of the popularity and adoption of common architectural development for multiple product development** and represents a significant shift in traditional software development style and process methodology. Currently several organizations are in practice with this new process model that embraces business as one of its central factors and have thrived as a result. There can be no doubt that the development of software ecosystems have caused major players in the software industry to rethink their operating practices and engage with third parties, opening their platforms to external entities to attain business objectives. In this paper we examine four of the organizations that are at the forefront of software ecosystem adoption, specifically for mobile devices and explore their business development models. This investigation explores and compares their business process models in terms of how they engage with the external players in order to develop and distribute software and services in this changing marketplace. The study found some commonalities as well as some salient differences in their business processes and presents an assessment of the health of each mobile OS-centric ecosystem. We conclude that this study will help in further aiding understanding of the business process role in this area of ecosystem software.

	Registration	Development	Testing & Support	Distribution
Apple	Individual ($99/yr)	No Restrictions	Full Support & Apple Testing	Full
	Company ($99/yr)	No Restrictions	Full Support & Apple Testing	Full
	Enterprise ($299/yr)	In-house use only	Full Support & Self Testing	In-house Only
	University (Free)	Academic Use only	Limited Support & No Testing	Not Allowed
	Developer (Free)	Experience Use only	No Support & No Testing	Not Allowed
Google	Developer ($25 one off payment)	No Restrictions	Limited Support & No Testing	None
Nokia	Developer ($79 one off payment)	No Restrictions	Full Support & Nokia Testing*	Limited (20 Applications)
Blackberry	Developer ($299 per 10 applications)	No Restrictions	Full Support & Blackberry Testing	Limited (10 applications)

Table 8: An overview of the 4 assessment elements for the Apple, Google, Nokia and Blackberry SECOs

The App Store Business Model

In designing access to the App Store, Apple has adopted a blended approach, **encouraging software developers to become involved by offering significant access to their underlying platform through APIs** whilst retaining effective control of their products, whilst Apple continues to garner criticism for having a closed operating system on its devices.

Joining the Apple SECO (Software Ecosystem) is a multi-staged process; developers must register with Apple as a Developer in one of four classes; Individual; Company; Enterprise; or University. Apple draws a distinction between Company, an entity that wishes to develop applications for general sale and Enterprise, an entity that wishes to develop applications for internal organizational use. It is also interesting to note that Apple imposes the same requirements on both Individual and Company classes of developer, both in terms of cost to join the SECO and division of sales revenue. Apple also opens its SECO actors who are not initially concerned with developing software or services for financial gain. Two reduced access classes of actor are available, University and Developer, which offer access to the APIs for iPhone, iPod and iPad but do not enable software creators to market their applications through the App store (these classes have additional feature reductions in terms of access to Apple Support). Joining the developer program (the Apple SECO) for these latter classes of membership is free of cost while the former classes of membership who which to develop applications for commercial purposes are required to pay membership fees which range from $99 to $299 per annum.

Membership as a commercial developer of the Apple App Store brings access to Apples SDK, resources, forums, technical support (limited to two incidents per year) and test benches for Apple

products (iPhone, iPad and iPod). Following developer testing using the available tools, applications are submitted for inclusion within the App Store, at which point they are tested and assessed by the application test team at Apple. The process is rigorous with many applications being rejected due to breach of conditions or lack of functionality. In such cases feedback is provided to the developers for improvement or modification of their application. Upon successful test completion the developers are enable to sell their applications to the public through the App store. Apple's business model splits the revenue from the sale of applications 70/30 (developer/Apple), with the developer responsible for setting the pricing structure for their creation. In addition Apple does not enforce any overhead charges with no hosting or marketing fees associated with the sale of application through the App store.

Apple's business model for the App store is both simple and complex as it carefully nurtures potential developers by allowing them free access to basic platform components allowing them to build their skill set. They also encourage the use of their core products in university courses by providing access to developer forums, SDKs and collaborative tools (Development team creation tool) thereby reaching a high number of future actors. However, the model also strictly controls deployment through:

- Rigorous testing of applications and places a number of barriers on entry including,
- Comparatively high joining costs (an annual subscription),
- Limited API access and tightly regulated and
- Limited channel (App Store only) distribution.

Google Android Market Business Model

The Google model treats all developers as a single class of actor, making no distinction between individual developers and commercial entities.

- In order to register as a developer Google requires a single one off payment of $25 and agreement to their Market terms and conditions.
- The Android SDK provides developers with access to APIs and also development tools such as the emulator.
- The Android model allows developers to create applications which they can then distribute via the Android Market, directly via ftp or websites or alternatively via third parties.

Following registration as an Android Developer, applications are developed and uploaded to the Market; Google enforces no testing beyond that of developer testing. Google will however investigate complaints from users regarding error prone applications or those applications that cause offence to users. When uploading applications to the market developers have the choice of making their applications freeware or paid and in the case of paid applications revenue is divided 70/30 between the developer and Google. Google imposes no charges on free applications that are uploaded to the Android Market. Furthermore no marketing, hosting or transaction fees are levied on any application submitted to the market (fees are included in the 30% split for paid applications).

The opportunity to engage with the Google Android Market is however restricted by geographical location. In order to develop and sell (paid) applications developers must be resident in one of nine prescribed countries. Developers outside of these areas are currently unable to develop and sell applications via the Market. In addition to the geographical restrictions, Google also require that developers who wish to sell the applications must also navigate through the process of becoming registered Google Checkout Merchants. This requirement makes the process of selling applications more complex as individuals are required to register and ensure that they comply with the taxation requirement of their country of residence.

Free applications are less constrained both in terms of their development location geographically speaking and also in as much as they are free and do not require the complex Checkout Merchant account. The ability to develop and distribute free applications is limited to 147 countries. Confusingly developers in these countries may be able to develop and distribute free applications; however, they may not be able to download free applications from the Market in their own country. For example developers in Algeria can

create, upload and publish free applications, but are not permitted to download applications from the very same Market under Google's current operating practices. Despite being technology follower in terms of market entry Google's Android OS and its associated Market has demonstrated significant growth over the past year. This is doubtless due the open nature of Androids' OS that enables considerable engagement for developers. This is especially true when considering the delivery channels from Android Apps, which are not constrained to within the Android Market. Indeed it is possible for developers to download the SDK from Google without registering as a developer, create applications and offer them for sale (or freely) though their own web presence or a third party.

Amazon Business Model

At the end of 1996, Amazon launched its Amazon Associates Program. Within ten years, the number of associates jumped from 4,000 to 1,000,000 . This program was primarily a means to acquire new customers and thereby boost traffic and product sales on Amazon's site. In return,

Amazon gave its affiliates a revenue share. From 1994 to 2002, **Amazon developed numerous partnerships and created its own business ecosystem through the attractiveness, the success and the growing reputation of its retailer platform**. Amazon became progressively a cyber-market allowing new businesses to offer products on its own website or alternatively allowing new businesses to use its existing technology and features under their own brand name to develop their online activities. **Amazon became a true keystone player in its ecosystem, but innovation was still in-house oriented.**

Today, **many firms, independent developers and middleware integrators use these Web services to interact with Amazon's platform, creating a business ecosystem very suitable for open innovation**. In 2005, Amazon also decided to expand the scope of its Web services delivering storage capacity and computing power to other companies. Amazon's partners can rent space on Amazon's platform to run a business, or rent out its transaction capabilities to sell things and collect money, or rent pieces of its warehouses and distribution system to store and ship items - or all of the above. What this means for business is that a company like Amazon will be able to connect its own services to those of its partners not only improving the way both sides interact and collaborate, but also transforming the way they develop, make, and distribute products. The Amazon case study provides powerful insights into ICT-based open innovation models.

Three layers appear in the open innovation strategy of Amazon. First, **Amazon opened up its platform and ICT infrastructure through Web services**. Secondly, it **acts as an incubator for e-businness**. Thirdly, the company **expands the use and finally the reputation of its platform thanks to Amazon certified integrators.** This enhances the attractiveness of the whole platform and hence value creation opportunities.

The breadth of AWS innovation over the last six years is evidence of Amazon's continued technology leadership in e-Commerce. During that time, **Amazon has delivered about ten different Web services that have created significant opportunities for their business partners**, and offer customers real business value. However, using AWS requires a deep knowledge of software development and application integration solutions.

The tasks involved with seamlessly interoperating with Amazon's API and keeping current with the new Web services being developed by the company can be provided by Amazon Certified Integrators (ACI).

Basically, these ACIs automate the e-Commerce process, providing a streamlined and efficient business operation for merchants integrating with Amazon's platform. Today, some of these ACIs specialize in developing innovative solutions based on a particular AWS such as FreshBooks (Amazon FPS), RightScale (Amazon EC2) or ElasticDrive (Amazon S3).

The main advantage of integrators is to remove the complexity of integration making it simple, fast and cost-effective to add Amazon.com as a channel. Thanks to these integrators, Amazon can draw on external resource and best practices to amplify the value of its own innovation assets, spreading its technology within its business ecosystem. Amazon can tap into these external technology sources to strengthen its two businesses: e-retailer and ASP.

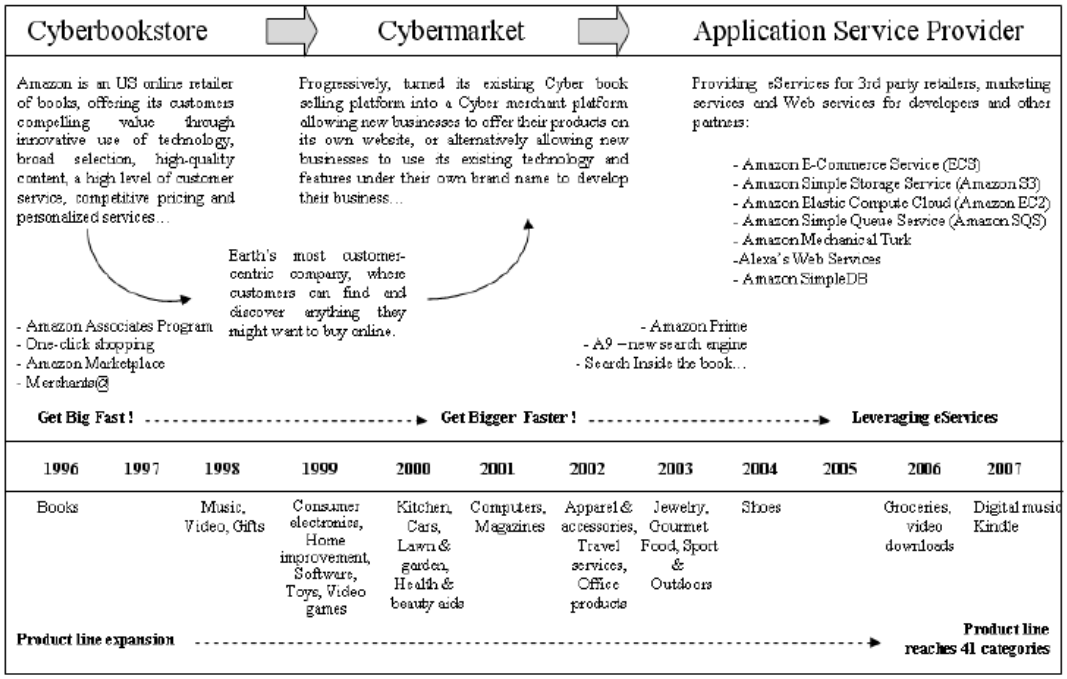

Figure 31: The Evolution of Amazon Business Model

4.5 The success factors for app store-like platform businesses from the perspective of third-party developers

A platform business, such as Apple Inc.'s App Store, refers to a Web-based business in which anyone can participate and make profits by taking advantage of, with few restrictions, resources and infrastructures of the host firm operating the platform. Such businesses are enabled and thrived primarily by participation of third-parties in the business value chain. Perceiving that in the context of App Store-like businesses, outside application developers' participation and **their development practices are crucial for the success of the platform business**, we attempted to identify factors that influence developers' intention to develop applications frequently.

To our knowledge, the sustainability of an App Store-like business will largely depend on the number of high-quality new applications. A large pool of applications is able to lure various users continuously and thus attract more outside developers to the platform, resulting in additional applications and more visitors to the store that is, a virtuous cycle forms. In line with this, we expect that accounting for the development practices of outside developers will provide a stepping-stone to advance understanding of primary factors for the successful App Store-like business.

Our results indicated that for the dedication-based mechanism, benefit-sharing attractiveness, market demand for applications, usefulness of development tools, and review process fairness have **positive impacts on intention to develop** frequently through developer satisfaction. **For the constraint-based** mechanism, learning and set-up cost positively affect termination cost, in turn increasing dependence of developers

4.5.1 Dedication-Based Factors from Third-Party Developers' Perspectives

In this study, we aim to identify critical factors that positively influence outside developers' intention to develop applications on the platform. The empirical analysis of our dual model makes an important contribution as it introduces a set of primary factors for the business, which provide insights to the business provider. We suggest that to maintain sufficient applications on the platform, the platform providing firm should consider important factors from the **third-party developers' perspectives, such as benefit-sharing policy, quality of development tool, usefulness of online forum, fairness of review process, learning costs, and set-up costs**.

- *Benefit-Sharing Attractiveness*: refers to the degree to which third-party application developers favor the App Store-like business' policy of sharing benefits with developers for instance, a ratio of three (Apple Inc.) to seven (third-party developers). All participants in a market desire to obtain as much profit as possible from ongoing transactions with partners. Likewise, outside developers want to receive a large portion of the profits when their own applications are sold on App Store-like platform.
- *Market Demand:* We define *market demand* as the extent to which users demand applications supplied by third-party developers. High demand for a particular application is the critical characteristic of App Store-like business that could bring developers great monetary benefits, making them want to continue the business.
- *Perceived Usefulness of Development Tools:* *Perceived usefulness* of development tools is referred to as the degree to which a development tool, such as a software development kit (SDK) offered by the platform-operating firm, is perceived as useful by developers for their work performance. An SDK enables third-party developers to work effectively and efficiently, reducing time and costs incurred during the process of application development. Given that iPhone applications must be written by using a particular programming language (i.e., Objective-C), a free iPhone SDK is likely to be useful to those who are unfamiliar with the language. One of our interviewees described his relevant experience to us like the below:
- *Perceived Usefulness of Online Forums:* The official online forum is a sort of supporting service that the platform business company offers to outside application developers. In general, online forum users share useful information via forums. In a similar vein, third-party application developers can exchange useful information as to application development on the given forum. Particularly, if developers address problems by means of expertise provided by the official forum, their commitment to the business relationship is more likely to increase. Consequently, useful online forum can be one of the ingredients that make developer inclined to stay in the existing relationship.
- *Review Process Fairness:* Pointed by most of our interviewees, procedural fairness such as review process fairness is one of the critical social factors in the App Store business. *Review process fairness* is defined as the extent to which third-party developers perceive the process of evaluating applications as impartial. After finishing development, outside developers submit their application to the firm for being approved to be published. This is among the most sensitive issues for the third-party developers. It is thus possible that when the firm maintains objective evaluation policies over all of applications, the developers are satisfied with the business relationship, and positive cognitive and affective reactions toward the firm arise.

4.5.2 Constraint-Based Factors from Third-Party Developers' Perspectives

For the constraint-based mechanism, learning and set-up cost positively affect termination cost, in turn increasing dependence of developers

- *Learning Costs:* Developing an application for a particular platform may require developers to learn a new programming language as well as how to handle SDK. Most of our interviews revealed that they had to learn the unfamiliar programming language for iPhone application development. Learning new application development skills is a type of transaction-specific investments because the skills may be useless when an existing relationship terminates. Therefore, when the learning costs already spent are high, the developers are likely to feel that they are constrained to the relationship.
- *Set-up costs* are referred to as physical or mental efforts and investments needed to start a new relationship. Because Apple Inc. requires Mac OS for the development of iPhone applications, third-party developers who want to develop iPhone applications have no choice but to purchase a Mackintosh computer. Moreover, a developer must go through formalities to become an iPhone application developer. All of these efforts and investments may become almost meaningless when the relationship with Apple Inc. ends. Thus, set-up costs devoted to a relationship can act as a constraint in a decision to terminate the relationship.

Construct	Items	Reference
Benefit-Sharing Attractive-ness	The profit distribution policy is acceptable considering my (our) effort spent to develop my (our) applications.	Kumar (1995) Martin et al. (2009)
	Compared to other companies' policies, Apple Inc.'s profit distribution policy (i.e., developer 7: Apple Inc. 3) is attractive.	
	Apple Inc.'s profit distribution policy is fair.	
PU of Develop-ment Tool	Using iPhone SDK enhances my (our) effectiveness when I (we) develop an application that has features I (we) want.	Davis (1989)
	Using iPhone SDK enhances my (our) productivity when I (we) develop an application that has features I (we) want.	
	Using iPhone SDK improves my (our) performance, when I (we) develop an application that has features I (we) want.	
PU of Online Forum	Using the online community forum enhances my (our) effectiveness when I (we) develop an application.	Davis (1989)
	Using the online community forum enhances my (our) productivity, when I (we) develop an application.	
	Using the online community forum improves my (our) performance when I (we) develop an application.	
Market Demand	Many iPhone/iPod users download iPhone applications.	Kaufman (2006)
	Demand is strong for iPhone applications.	
	The category that iPhone applications belong to is growing quickly.	
Review Process Fairness	Apple Inc.'s application review processes are fair.	Kumar (1995) Martin et al. (2009)
	Apple Inc.'s application review processes are objective.	
	Apple Inc.'s application review processes are fast.	
Set-up	It takes time to go through steps of the enrolment as an iPhone developer, and to develop applications.	Burnham et al. (2003) Chiou (2009)
	There are a lot of formalities involved in enrolment as an iPhone developer and in application development.	
	I (We) have made significant investments in resources dedicated to my (our) relationship with Apple Inc.	
Learning	Learning to use SDK features offered by Apple Inc. took a lot of time and effort.	Kim and Son (2009)
	I (We) spent a lot of time and effort to learn how the SDK works.	
	Learning App Store business for Apple Inc. took a lot of time and effort.	
	Learning the fundamentals of App Store business of Apple Inc. took a lot of time and effort.	
	Learning to use Objective-C features took a lot of time and effort.	
	I (We) spent a lot of time and effort to learn how Objective-C works.	
Satisfac-tion	I (we) am (are) delighted with my (our) overall relationship with Apple Inc.	Leuthesser (1997)
	It is a pleasure developing iPhone applications.	
	Apple Inc. is a good company to do business with.	
Termina-tion Cost	It would be hard for me (us) to end relations with Apple Inc. right now, even if I (we) wanted to.	Kim and Son (2009)
	If I (we) stopped developing iPhone applications, I (we) would waste substantial time, energy and effort that have gone into developing applications.	
	If I (we) stopped developing applications on App Store, I (we) would waste substantial money that has gone into developing iPhone applications.	
Depend-ence	It would be difficult for me (us) to replace Apple Inc. in the online application store area.	Ganesan(1994)
	I (We) am (are) dependent on Apple Inc. for sales in the online application store area.	
Intention to Develop Frequently	I (We) plan to develop iPhone applications frequently in the future.	Troy(2007)
	I (We) intend to develop iPhone applications frequently in the future.	
	I (We) expect that I (we) will develop iPhone applications frequently in the future.	

Table 9: Measures defined for each app process

4.6 Conclusions and Lessons Learned

As ICT-based collaborations become the rule, i**nteroperability between business partners has become a necessity for many ecosystems.** Basically, interoperability refers to the **ability of various ICT systems and organizations to exchange data and to share information and knowledge in a reciprocal way**

Interoperability should be considered as prerequisite for open innovation: it enables enterprises to build collaborative relationships, access useful knowledge, develop and deliver new products and services, strengthening the development of business ecosystems.

Today's platforms aren't about controlling hardware resources, applications and information. Instead, **they are going to be around access to bundle of services and contents tuned for communities**, strengthening collaboration and knowledge between partners.

In this sense, all the players in a particular business ecosystem loose a part of their autonomy: they act as a whole and unique entity. Inside the business ecosystems, non-economic factors, such as power structure and underlying history, play significant roles in driving the business ecosystem development: inter-organizational relationships are not fixed by market competition but rather by the will of the focal firm. **Therefore, the actual level of competition should be between ecosystems**. This change in the level of analysis requires a change in factors to be analyzed and a new regulatory tool box for policy makers and regulation authorities

Successful platforms at the same time are closed (integrated) around core businesses of their owners. In other words, openness **is needed to create the ecosystem of complements**. Integration or "closed-ness" is needed to capture value by the ecosystem owners.

The final objective is to depict strategic dependencies between software vendor, third party developers, and end-users, and to help explore and reason about alternate ways for achieving strategic goals for each actor. We compare the buyer-supplier relationships in the traditional software supply chain to the open ecosystem format from a mobile platform vendor's perspective**.**

Recently many companies **have adopted the strategy of using a platform to attract a mass following of software developers as well as end-users, building entire "software ecosystems**" around themselves, even as the business world and the research community are still attempting to get a better understanding of the phenomenon.

- **In the traditional software supply chain,** the software vendor provides both the platform and a range of applications to the end user.
- **In an open ecosystem, the software vendor provides a platform, but relies mainly on third party developers to create new value (through platform-specific applications) for the end-user**, aiming to attract a large number of developers and end-users around the platform it provides.

Dependencies among the actors are more complex in an ecosystem than in the supply chain case. For an ecosystem to succeed, the software vendor needs to have a **deep understanding of the rationales of the developer.**

The software vendor provides platform software to the developer and the end-user, while depending on the developer to develop creative applications for the platform. In addition to platform support and maintenance, the vendor also provides the market channel for selling developer's applications. When the end-user acquires applications from the market channel, the vendor will have revenue share (in some form) on the purchase from the developer, while the developer is responsible for supporting and maintaining the applications. **Moreover, since both are users of the platform, the software vendor needs to achieve both developer satisfaction and end-user satisfaction**. Note that the **software vendor can still integrate OEM components to its platform**, rather than to build it all by itself.

In order to be profitable, the developer not only needs to use the right platform but also to create the right applications. Adopting available open platform from the software vendor is one efficient way for developer to monetize the ecosystem, **but the platform should have the potential for big market, and is easy to use from the developer's point of view**. While ease of use of the platform can minimize the effort

by developers to contribute and therefore help to improve the developer's satisfaction, it is the big market that drives profitability and ultimately satisfies the developer.

Furthermore, the developer depends on the software vendor to provide a powerful platform and fair condition for using the platform. **The developer also wants to be visible to the end-user through the market channel, allowing its applications to get to market quickly**. The end-user now relies on the developer to provide attractive applications that have variety and good quality, rather than relies on the software vendor for these.

In adopting an open ecosystem strategy we see that the software vendor emphasizes different business goals and chooses different ways to achieve them, compared to the traditional supply chain. Supplying platform to developer not only helps the software vendor increase platform gravity, which increases customer lock-in, but also achieves diversity in platform-specific applications and drives fast innovation. Diversity and innovation contribute to perceptions of high value by both existing and new customers. Similar to the traditional software supply chain, time to market is fast and satisfaction management contributes to attaining large customer. However, this approach does reduce the vendor's flexibility in modifying the platform once the platform is adopted on a large scale.

In the open ecosystem, the developer is both a (platform) customer and an (application) supplier. In the supply chain, supplier is usually hidden behind the software vendor and has no influence over the end-user. In the open ecosystem case, while still having no control over the end-user, developer is largely visible and directly connected to the end-user

If you are successful in building a platform that has wide adoption by 3rd party developers then it rapidly increases the value of the underlying service at a far greater rate than you could do with your own internal resources. Apple revolutionized mobile phones by creating an app platform, and they were then able to leverage that success and create the iPad and a whole new market. It was the App Store and the wide adoption by developers that made all of that possible. So it stands to reason companies in other markets (Samsung, Intel, Google etc) would want to try to replicate that success. For this purpose we describe the main guidelines:

Opportunities for differentiation exist in the areas where platforms are inherently weak, or have little motivation to compete. These include **local presence, user targeting and reach**. Over the longer term, Telco can look for ways to **build parallel ecosystems**, using pages from the ecosystem economics textbook.

- **An example is M2M. It holds the potential to create a vibrant ecosystem of users and solution providers,** thereby establishing strong network effects and lock-in. Telcos can become the central force in this emerging ecosystem if they learn to engineer the ecosystems to their advantage.
- **By looking at M2M through the lens of ecosystem economics, operators will see opportunities** that are much bigger than just selling modems and data connections.

5 Innovation Ecosystems where exploit FI Technologies

In this chapter e analyze the potential Innovation Ecosystems where exploit the previously identified Future Internet technologies:

- **Smart Cities are considered as open innovation ecosystems** and playgrounds to exploit the opportunities of the Future Internet.
- Additionally, the **envisioned services and application developed within FI-PPP will be distributed across various market sectors** ranging from logistics to manufacturing to healthcare. Success of FI-PPP services and applications in European markets can be evaluated based on the size of its "target" market sector
- The **Smart Home** becomes "intelligent" as it offers a wide array of new applications from home automation (home security, comfort and entertainment), home cloud (management of content, productivity, sensors data used or produced at home), and e-Health services.

5.1 Smart Cities

Smart Cities arise from the shift that is occurring in the information and communication technology (ICT) industry to a new technology platform for growth and innovation. This 3rd platform is built on mobile devices and apps, cloud services, mobile broadband networks, Big Data analytics, and social technologies and has given rise to an explosion of new products and solutions built on this platform. Smart Cities is one such solution. Cities around the world are facing increasing populations and the challenges urbanization brings traffic, pollution, resource constraints, water scarcity and sanitation concerns, public safety issues, and more demands on education, healthcare, and social services institutions. As cities operate in a globally competitive environment for workers, tourists, and businesses **the ultimate goal of Smart City initiatives is to attract businesses and citizens for a vibrant city economy.** To do this, cities must tackle these urban challenges through coordinated and focused investment.

The vision of Smart Cities is to provide more inclusive, secure, efficient, and effective services to citizens, thus ensuring the livability and sustainability of the wider city community. Smart City solutions integrate information and operations within and between city systems and domains and engage with citizens, businesses, and the broader community in new ways. Following with the above mentioned need for "smarter" infrastructures", cities offer an ideal platform for ICT and other Industries to integrate and test concepts to serve Europe's future sustainability:

- 80% population lives in cities
- Population living in urban areas keeps increasing.
- Size and complexity of cities keep increasing.
- Problem: sustainability (inadequate transport systems, inadequate utility services, inadequate social services….).

Cities have a key role to play in a near future as facilitator to build quickly smart environments using public and private connected things, to support physical implementation in our daily environment and to propose **new networks capabilities in urban areas.**

Future Internet offers solutions to many challenge that cities face; community building, mobility, efficient service provisioning, new applications and services, rethinking utilities, culture and the built environment. Cities provide a unique opportunity to the Future Internet; they offer real challenges, real users at a high density, realistic societal, organizational and operational structures, self-sufficient governance and decision making.

- To facilitate the creation of efficient innovation ecosystems that develop services and applications making use of information generated by users (e.g. through social networks) or captured from sensors (Internet of Things).
- To stimulate demand for innovative services and applications based on next generation access (NGA) networks.

5.1.1 Smart City Market

The Smart City movement is emerging and growing as a significant force of innovation and investment at all levels of government. To assist government organizations and the vendors that serve this market, IDC Government Insights' global Smart City analyst team has identified **the following top predictions for 2013** that will most heavily influence the direction and magnitude of technology investment, management, and evaluation.

- In 2013, 70% of worldwide spending on Smart City projects will be focused on energy, transportation, and public safety and 90% of these will be at least partially funded by national or international government.
- Worldwide spending on Smart water solutions will reach $1.8 Billion in 2013.
- Smart City Information Challenges will begin to be framed as Big Data Issues
- Local Government will remain in the research and evaluation stage regarding Machine to Machine, with Growth in very specific city functions mostly for medium-sized to large cities.
- Cities with Open Data Initiatives will drive 50% more private citizen, and crowd sourced mobile applications.

Globally, around 70% of the Smart City investment will be focused on *smart* grids and *smart* buildings, intelligent transportation systems, and *smart* public safety. As the Smart City movement develops, government leaders are focusing Smart City investment in those functions and service domains that can drive the most benefits quickly in terms of livability, economic development, and sustainability.

Citizen quality of life priorities are focused around these issues more reliable transportation to and from work, schools, shops and hospitals, safer neighborhoods and urban centers, and conserving and using resources most efficiently. And even the best-run cities in the world have problems with traffic, crime, and pollution. This is not to say that education, healthcare, and social services are not significant in their impact on citizen quality of life they have a great deal of impact. However, these areas often require more profound reforms and transformations of business processes, funding models, and cultural habits. Energy, transportation, and public safety involve stakeholders that are showing more interest in new business models (like private and public transportation or private utilities) or have a command-and control culture, as with law enforcement, that can push change more quickly.

In cities, water infrastructure modernization will be a key driver of investment. Water pipes that are outdated have more leaks and are more prone to contamination. Water usage is also a significant cost for cities and their citizens, and while complete infrastructure hauls may not be financially feasible, smart technologies like water pressure sensors can alert utilities to leaks or changes in water flow, resulting in quicker repairs and less water waste. This is not only an environmentally sustainable practice for Smart Cities but also a financially sustainable practice as water costs can be significantly reduced from these types of smart water investments. **Smart meters at the citizen/consumer level will increase in use to help households be aware of their water consumption and reduce water** use. Cities are also very vulnerable to natural disasters involving water since most are located on or near bodies of water. Cities can be heavily impacted by flooding or rising water tables. Smart water technologies will be used to improve city resiliency by providing information on flooding defense infrastructure like levees and by helping coordinate emergency response.

Changes in technologies, such as machine-to-machine (M2M) solutions, in the public safety and transportation areas will begin to push cities to frame their technology challenges in the context of Big Data. The convergence of intelligent devices and social networking means that there is simply too much information to assimilate, and operators cannot rely on experience or intuition to make decisions. The old cause-and-effect mental models become outdated quickly, while the demand to respond faster and with greater insight to ongoing internal and external events is increasing. For example, **the challenges of data management and analytics in transportation management centers** (TMCs) with the rise of connected vehicle and next-generation traveler information technologies will likely overwhelm organizations not using Big Data and analytics solutions. In public safety, physical information security management (PSIM) with next-generation 911/112 gives rise to similar challenges.

Big Data paves the way for better analytics and ultimately better decision making and timely action, a key tenet in Smart Cities. Key questions local government organizations should be asking themselves are:

- Which technologies should be implemented and which standards adopted to handle emerging new markets like connected vehicles?
- Will Big Data and analytics replace current investment?
- How should data warehousing architecture change?
- What new skills do we need to leverage Big Data and analytics to fulfill our mission?

From a technology perspective, government opportunities are emerging across the entire technology stack, with the current opportunities predominately in the data organization and management, analysis and discovery, and decision support and automation interface. **Overall, the M2M market is an emerging segment, and we are only at the beginning**. We can see consumer M2M applications taking off and some early adopters in industries that impact local government such as the automotive industry and connected vehicles or in healthcare with patient home healthcare monitoring via sensors and other devices. Specifically, in the near term, **we see the following areas as most relevant for local government use and adoption**:

- Fleet management, especially in public transportation
- Remote asset management
- Connected vehicles
- Smart meters
- Digital signage
- Healthcare monitoring
- Public safety — situational awareness

There are examples of these uses already. Singapore and some cities in China already are using sensors on buses **to manage and predict bus routes and provide route and traffic information to citizens and transport operators.** There are increased uses of water sensors in Thailand, following the floods there. A bridge catastrophe in Minnesota in the United States has resulted in new bridges equipped with sensors to monitor structural integrity. Connected vehicles appear to be the next frontier, with IDC predicting that 50% of autos shipped will display phone-sourced media by 2020. Even more immediate is **the measure adopted by the European Commission that will require eCall systems embedded** in all new models or cars and light vehicles starting in 2015. This eCall system will automatically dial the 112 emergency numbers in the event of an accident and communicate your location to the emergency call center.

M2M technologies directly tie in to the importance of Big Data and analytics investments, such as complex event processing (CEP) to track and analyze events as they happen and decision-making tools that use visualization and other techniques to help workers make meaningful decision. These

solutions extract the important information from the transactional data, which leads to improved processes and decision making and better government services delivery. Cities that can realize the value of M2M solutions will tend to be larger, and we will see more pilots from these cities. As these cities and other local government entities research M2M, careful consideration will need to be made around privacy concerns, what data is collected and what data is retained and for how long, SLAs of systems, **how to use M2M in conjunction with cloud, location-based services and social networks, what standards or proprietary solutions to consider, and how to adapt the business processes that provide the wrapper for the use of M2M data.**

The strategy requires agencies to use machine-readable information and mobile information and shared services; make open data, content, and Web application programming interfaces (APIs) the new default; and make existing high-value data and content available through Web APIs. Providing information through Web APIs helps government architect for interoperability and openness and makes data more usable within agencies, between agencies, and by citizens, driving a more customer-centric government.

This strategy also requires efforts to engage a community of coders by educating them on available data and APIs and motivating citizens to use it to solve city challenges and fill in services where none exist. In the United States and the United Kingdom, we have seen the use of challenges and hackathons where small prizes worth the effort are granted as well. A great example of this is the approach New York City (NYC) has taken first, it identified a very clear open data strategy; the city has 900 data sets on its NYC Open Data platform. Next it held hackathons the first two had over 200 participants. The city also created challenges with 96 submissions to NYC BigApps 3.0 and over 600 ideas entered to NYC Big Apps Ideas Challenge. The result has been a myriad of apps developed and the use of NYC's APIs in 15 other hackathons.

An open data strategy serves to relieve some of the burden of app development and maintenance from local government along with promoting a vibrant digital sector. Given the pace of the mobile application life cycle platforms can be upgraded every six months and over 45% of mobile app budget goes toward maintenance local governments need to think carefully about their role in app development and decide on their sourcing strategy for skills and capabilities. Cloud, open data and the private sector, citizens, and crowdsourcing are all part of this mobile app sourcing mix governments must consider and will be major themes for city government in 2013.

In Central and Eastern Europe, up to now, **creating mobile apps to facilitate service or connect citizens to publicly available data has been idiosyncratic at best.** One example is the Clean Skies app created in the Czech Republic that syncs real-time air quality data from the hydro meteorological institute with the users' GPS system to tell them how the air will be any given day. However, this is going to change in the next few years**. In most of the CEE region, smartphones already outsell PCs**. In Russia, smartphones are likely to outsell PCs in 2013. This proliferation will lead to both increased citizen expectations, putting **pressure on government entities to develop mobile apps key constituents can use to access or utilize their services**, and we will see more movement in citizen-led app development as well.

In 2013, we expect to see more services provided on mobile devices because the citizen world is rapidly becoming mobile and devices are going to be the default gateway to accessing the Internet. Some examples of the use of mobile and social apps to improve the lives of citizens that will be important in 2013 are:

- Emergency alerts and crisis response communications and situational awareness
- Nonemergency services tools (like 311 numbers in the United States and Canada or SeeClickFix type apps)
- Parking apps
- Tourist and visitor information apps
- Transportation information for public transportation or traffic rerouting

- Social sentiment analysts to monitor public reaction/perception
- Crowd sourced fund-raising for local projects and managing neighborhood areas

This worldwide set of Smart City predictions is a list of prioritized business drivers and technology trends that we believe will shape the local government IT landscape in the context of an economically and socially challenging 2013 time. According to the predictions report, smart cities budget is likely to continue flowing into energy, transportation and public safety as municipalities work out the kinks on low hanging fruit, like phasing in hybrid buses. Data shows that approximately half of those initiatives will be initiated at the line-of-business or city-function level.

- Notably, the organization predicts worldwide spending **on smart water solutions will reach $1.8 billion** this year alone.
- **Much of the rest of the work on smart cities will come in the form of big and open data projects**, with much of that growth being driven by cities that already have initiatives underway.
- **Social Networks, IoT and Cognition as enabling technologies for Smart Cities.**

Evolving the underlying City-ICT infrastructure towards an infrastructure enabling ubiquitous and wide access to smart media; sensor and actuator services is mandatory for the realization of this vision. Therefore, most smart cities are nowadays **deploying IoT (Internet-of-Things) technologies as a means of interfacing with the physical world, acquiring information about the city's context**, while also controlling resources. At the same time, the emerging social networks and social media technologies are enabling citizens' and other stakeholders (e.g., city authorities, businesses) participation in smart city applications.

- **Seamless interaction of objects, sensors, and computing devices (IoT)** requires powerful networking environments and sophisticated data aggregation and processing technologies, given the amount of input data that sensing and (multi)media technologies are making available.
- **Cognitive management of the interaction among data sensors, actuators, smart devices,** (multi)media data streams and all kinds of ICT objects are also key enablers for seamless orchestration of services providing effective, efficient and secured human-to-object and object-to-object interactions, while ensuring minimal user exposure to complexity.

Special emphasis will be paid in the discussion and validation of end-user and business requirements associated with ICT-enabled smart cities ecosystems. New programs will have mobile as a growing component and focus in on public-private-partnerships or risk-reward-sharing partnerships in order to find sustainable funding models as budget sizes are unlikely to increase in the foreseeable future.

5.1.2 Smart City Business Opportunity

IoT, social networks and cognitive technologies are already combined in various ways in the scope of several smart cities applications, including:

- **(A) Smart homes** (e.g. Security, HVAC, Lighting, Entertainment, Energy Management, Assisted Health Care and Aging),
- **(B) Smart buildings and Infrastructure** (e.g Building automation technologies, Building Management Systems, Structural health monitoring,- like vibration and material condition,- in Buildings, Structures and Historical Monuments),
- **(C) Smart energy management** (e.g. Smart Meter, Smart Grid, Software & Hardware),
- **(D) Smart industrial automation** (e.g. Industrial Control Systems, Field Devices, Manufacturing Execution Systems, Supply Chain Control, Smart Product Rotation and Restocking Management),

- **(E) Smart citizen services** (e.g. smart healthcare, education and water management, Waste Management, Smart Lighting, NFC Payment processing based in location or activity duration for public facilities),
- **(F) Smart transport** (e.g. traffic management systems, integrated supervision market, passenger information, ticketing and parking management) and
- **(G) Smart security** (e.g. urban security, critical infrastructure protection, ID management and cyber security).

5.2 Smart Industry

The **envisioned services and application developed within FI-PPP will be distributed across various market sectors ranging** from logistics to manufacturing to healthcare. Success of FI-PPP services and applications in European markets can be evaluated based on the size of its "target" market sector. **Figure** following Figure provides us with a comprehensive view of the European economy segmented into 9 basic sectors. The "target" sectors are further ranked by the value of the Gross Value Added (GVA) they contribute to the EU27 economy.

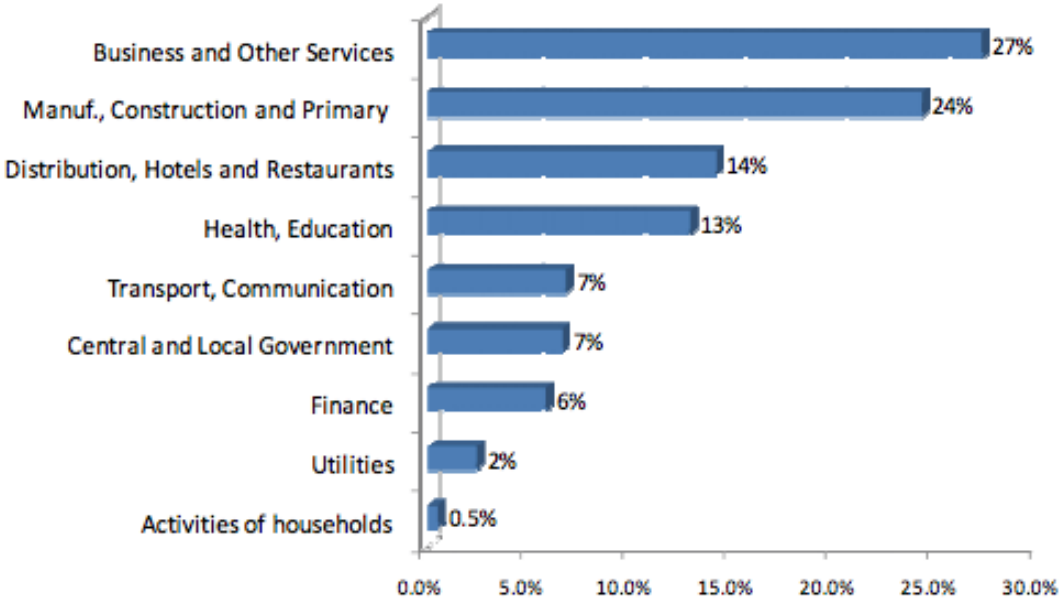

Figure 32: Gross Value Added by Sector, 2009, EU EConomy 1

Business related services and Manufacturing sectors together contribute more than 50% of EU27 economy. Therefore, FI-PPP services and applications geared towards Business related services and manufacturing sectors could foresee a greater and more matured market landscape. Even a marginal impact of FI-PPP service and applications in these sectors has high relevance for the overall economic system[2].

[1] Source: Eurostat

[2] http://fi3p.eu/assets/pdf/FI3P%20D2%20-%20EU%20Internet%20Industry%20and%20Market_Final.pdf

Distribution, Hotels and Restaurants include supply chain in retail, eCommerce options in wholesale trades, restaurants and hotels. This sector when combined with Healthcare and Transport attribute to 32% of Gross Value Add. Central and local government contribute around 7%, and Finance around 6%. Although the size of their contribution is smaller when compared to aforementioned sectors, infusion of FI-PPP services and applications in Government could potentially result in multiple indirect impacts: good governance, efficient processes, transparency etc.

5.2.1 The Business Challenges and Opportunities

In this chapter we explore the Internet growth opportunity by vertical sector where we can check that the main opportunities are concerning Utilities, concretely M2M technology, such as smart metering or wirelessly connected grid assets, followed by health sector, concerning Tele care and patient data management

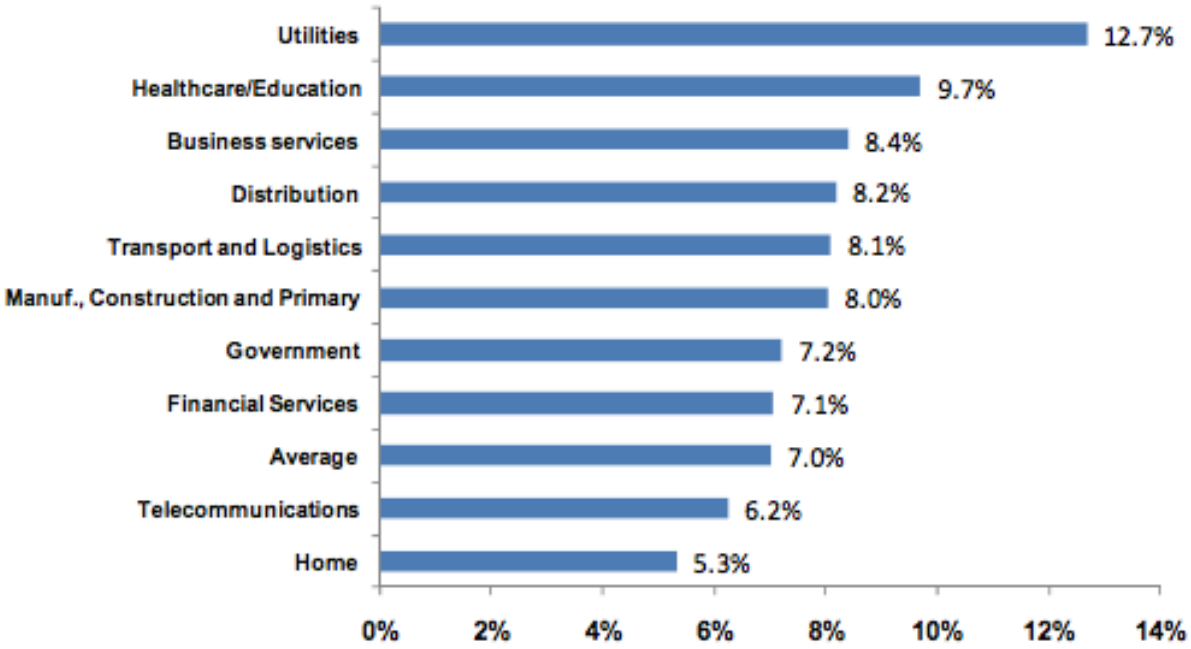

Figure 33 Compound Annual Growth Rate (2010-2014) of the Internet market by vertical sector

Typically, **smart living services are delivered to households through service platforms**. Service platforms can be seen as hardware, software, network infrastructure or even a combination of them that host a set of core functions (e.g. data storage, processing power, intelligent decision-making component) deployed by service providers to build, run and deliver value-added services to customers. **The vision of smart living is to facilitate comfort living for consumers by providing several ICT-enabled services** that combine value drivers of health, energy, security and entertainment services.

- **Looking at energy sector**, for instance, considerable attentions especially from governments are given to **smart metering** and energy management services in an attempt to enable consumers to proactively control and manage their energy consumption, reduce their electricity bills and benefit the environment. The smart meter is the most well-known service platform in the energy sector that is intended to raise awareness of electricity consumption of consumers and stimulate energy saving behavior

- **In the health sector, increasing costs of healthcare and elderly care services** has triggered many service providers to explore new ways of service offering. Healthcare service platforms are responsible for exchanging data between household and service providers. The data is collected from connected devices and sensors (e.g., camera, portable wireless devices, motion, Infrared and/or wearable sensors, and blood sugar or heart rate readings) at home. The core functions on the service platform are used to send real-time information from home to health-care service providers. Then, depending on the status, service providers can deliver specific e- health services to a household through a device at home, internet, or mobile phone. Patient data via sensors collected can be used in various ways by the patient's family, the heath care provider, the medical practitioner, the health insurance, etc. Pharmacy chains could offer loyalty discount and home delivery services of medicine goods for patients with chronic illness.
- **Entertainment and Communication Service Platforms:** ICT advancement and increasing broadband connection to houses have motivated many content providers to provide online and on-demand audio and video services, like Amazon Instant Video, Blockbuster on Demand. The growing demands for the Internet TVs and increasing amount of online contents have also triggered many leading electronic manufacturer to deploy internet-enabled service platforms (e.g. Google TV, Yahoo TV) on their TVs to make them smarter. Such TVs acts as service platforms and eliminate the need for set-up boxes or any other devices

There is room for additional value creation in other sectors. For example:

- **In Retail:** Based on smart shopping, re-selling information about which consumers did not buy the product they had been searching for can make a business case for manufacturers or retailers to push promotions, ads or discounts to help close sales. As before, but in an aggregated fashion (not real time) to contribute to manufacturer's and retailer's market intelligence. The type of information on the current non-customers of a company can generate powerful insights for product innovation.
- **In Transportation (Goods):** Platforms to track vehicles for professional transportation companies could be used by insurance companies to determine aggregated level of risk for given roads or highways (robbery risk, accident risk, etc.) and to take mitigating actions to reduce overall costs associated to events.
- **Public Transportation:** Adopting smartphone integrated payment methods for automatic fare collection is 'just' a technology upgrade of the intended platform purpose. However, it creates additional information that can be used for detailed capacity planning as the detailed information time and station of begin and end of journey of passengers can be collected; That could also be used by retailers operating shops in subway stations, in real time by pushing SMS ads to passengers passing by (real time, context-based), or preordering, or in aggregated way to allow for better insight into potential consumers and plan product mix at point of sale, pricing, promotion tactics, etc.

As the interests and the value generated for each stakeholder is different so are the transactions, cross-sector collaboration is poorly initiated by only sharing the costs e.g. in Cloud Computing. As a result, recent examples have shown that the value networks are not funded by the business, as they are not necessarily aware of how their own requirements may facilitate the creation of value for other sectors. But they could be identified by platforms providers as the similarities between the needs of the different sectors.

5.2.2 M2M opportunity

According to Frost & Sullivan, the areas driving this growth will be the automotive industry, with new 'smart' cars; utility companies with smart grids; healthcare and security, along with home automation. Machine Research, meanwhile, puts the top growth-driving vertical markets in the following order: intelligent buildings, consumer electronics, utilities, automotive and healthcare.

According to Cisco, the next nine billion or so devices connected to the internet in 2020 will use M2M technologies. Many of these devices will be used to link the physical world to the internet via sensors that take readings from their local environment and output the information up into the cloud.

The technology is moving beyond its decades of use in utilities, transport, and heavy industry into the mainstream, empowering CIOs to deliver real value, cost savings, and innovation to management and their wider organisations.

Now that networking equipment — a simple SIM card or RFID chip, in the case of M2M and wireless carriage have dramatically decreased in cost, and wireless coverage, speed, and capacity have increased, we can now embed connectivity into the "things" we use in our day-to-day lives. That translates to new business intelligence (BI), operational efficiencies, and revenue-generating opportunities.

In the transport and logistics sector, this means that pallets and packages are able to communicate their location, allowing for real-time parcel tracking. The same application of M2M also allows the public to gain real-time updates on how far away their train, ferry, or bus is. **In the healthcare sector,** M2M devices worn by patients enable real-time monitoring of vital statistics or the dispensing of medication. **In retail, M2M provides better point-of-sale data**, as well as better shopping experiences through personalised digital signage. We analyse M2M potential applicability in the following sectors:

- **Homes**: Perhaps the canonical example of the Internet of Things (and the stuff of many a cheesy futurist visualization) is the 'smart home'. The components include sensor-equipped white goods, security, lighting, heating, ventilation and entertainment devices, among others, all connected to a local server or gateway, which can be accessed by the appropriate service providers — and, of course, the home owner. Link AlertMe
- **Healthcare**: Healthcare is another prominent M2M application, and comes under various banners including e-health, m-health, telemedicine and assisted living. Patients with non-life-threatening conditions can be issued with sensors (for blood pressure, or blood sugar levels for example), sent home and monitored remotely by medical staff — and can often be shown how to interpret the data themselves. This will free up hospital beds and physicians' time for more urgent cases. More generally, consumer-oriented sensors such as the Fitbit can encourage people to adopt healthier lifestyles, helping to keep them out of the doctors' surgeries and hospital beds in the first place. Link mHealth Alliance
- **Buildings**: The smart home is a subset of the 'smart building' — which could be an office, a hotel, a hospital, a manufacturing facility, a retail store or any other public structure. All such buildings consume energy through heating, ventilation and air-conditioning (HVAC) systems, and building automation systems can capture and analyse data from all relevant equipment, allowing cost-saving energy solutions to be created and implemented. Depending on the particular building, other subsystems that can be 'smartened' include structural health, access control and security, lighting, water, lifts, fire and smoke alarms, power and cooling for IT infrastructure. Given the resources consumed by today's buildings (40 percent of the world's primary energy, according to The World Business Council for Sustainable Development), the potential monetary savings and environmental benefits on offer in this sector are immense. Link Smarter Buildings (IBM)
- **Manufacturing**: There are many reasons why 'smart' manufacturing is a good idea: digital control systems, asset management and smart sensors can maximise operational efficiency, safety and reliability, while integration with smart building systems and smart grids can optimise energy consumption and reduce carbon footprint. And, of course, the smarter the manufacturing process, the quicker it can respond to changing customer demand. It's no surprise to find that smart manufacturing is seen by western politicians as a way of increasing competitiveness in global markets, although there's no technical reason why Chinese manufacturers, for example, couldn't adopt the same processes. Link Smart Manufacturing Leadership Coalition
- **Automotive & transport**: Today's cars routinely bristle with sensors and computing equipment, covering everything from engine management to navigation to 'infotainment'. Automobiles are rapidly becoming connected, context-aware machines that know where they are, where other vehicles are (both locally and in terms of regional traffic), who is driving (via driver face recognition) and how they are driving, and can warn of impending mechanical or other problems, and automatically summon roadside

assistance or emergency services if necessary. A 'smart' car can be remotely tracked or immobilised if stolen, and new business models such as 'pay-as-you-drive' insurance can be implemented. The roads the cars drive on will become smarter too: in towns and cities, lamp-post-mounted sensors can monitor parking spaces, for example, and also warn drivers of congested areas. Link Transforming the In-Vehicle Experience with Connectivity and Context Awareness (Intel)

- **Supply chain**: Given that passive RFID tags cost only a few cents, it's no surprise to find that M2M technology features heavily in supply chain management: the ability to track, in real time, raw materials and parts through manufacturing to finished products delivered to the customer has obvious appeal compared to patchy data delivered by irregular human intervention. Fleet management systems have long made use of GPS tracking, but cellular-equipped sensors can also monitor the condition of sensitive consignments (temperature for perishable food, for example), or trigger automatic security alerts if a container is opened unexpectedly. Link Perfect intersection: M2M and the supply chain
- **Retail**: The sharp end of the supply chain — retail — is fertile ground for M2M technology, applying to areas such as in-store product placement and replacement, kiosks and digital signage, vending machine management, parking meters and wireless payment systems. Link M2M Retail Solutions (Verizon)
- **Field service**: Consumer devices, business equipment and industrial plants can all, obviously, suffer faults that require repairing. If these things are all 'smart', delivering real-time status reports to the internet, then field-service operations can be booked quicker, engineers can be equipped with the correct parts and manuals, and site visits can be scheduled efficiently. Link Sierra Wireless Field Service solutions
- **Utilities (smart metering and grids)**: Smart meters for electricity, gas and water, and the smart grids they create, form a major component of the M2M market. Real-time data on resource consumption down to the household level allows utilities to manage demand and detect problems efficiently, while householders can save money by optimizing their usage patterns. Links Smart grids — transforming local networks / Current Cost
- **Security & surveillance**: Most people are rightly wary of the Orwellian aspects of widespread automated security and surveillance technology, but there are also plenty of benefits to be had. Smart buildings, including smart homes, can have connected smoke detectors that alert emergency services when triggered, and activate only the appropriate suppression systems; connected burglar alarms can immediately identify the point of entry and motion sensors can track an intruder's progress in real time (the same sensors can identify and track legitimate occupants via wireless access-control systems). Link Centra Security Services
- **Environmental monitoring**: M2M technology has great potential when it comes to monitoring natural or man-made environments. Suitably placed sensors can provide early warning of pollution, forest fires, landslides, avalanches and earthquakes, for example. More generally, air, water and soil quality can be remotely monitored in places of interest, and changes in the abundance and distribution of key species (wildlife or pests) tracked and changes to their habitats logged. Links Slip Surface Localization in Wireless Sensor Networks for Landslide Prediction (PDF) / Habitat monitoring with wireless sensor networks (PDF)
- **Agriculture**: Smart agriculture is a growing field (as it were), with M2M technology available to track the location and condition of livestock, monitor the growing conditions of crops, and optimise the performance of farm equipment (using precise geolocation to minimise wastage in crop-spraying operations, for example). High-value crops can be monitored by wireless sensors for a range of parameters (air temperature, humidity, soil temperature, soil moisture, leaf wetness, atmospheric pressure, solar radiation, trunk/stem/fruit diameter, wind speed and direction, and rainfall), with real-time data gathered by an on-site gateway, sent to the cloud and accessed via internet-connected PCs or smartphones. This information allows irrigation and other agricultural interventions to be precisely matched to local growing conditions. Links Smart Agriculture project in Galicia to monitor vineyards with Waspmote / Cows can text with M2M

- **Military**: Any world-changing technology is likely to have its darker applications, and M2M is no exception. Many military applications simply involve ruggedized and security-hardened versions of existing technologies, and this will apply to M2M as much as any other sector. Areas of particular interest to those in uniform are likely to be security and surveillance, transportation and logistics, healthcare and environmental monitoring.

The incorporation of M2M technologies into a company's operations will increase profits by improving efficiencies of energy, time and resources

- **Energy:** M2M could save over 2.0 Gt of CO2e by 2020 in the Energy sector by facilitating the adoption of 'smart grid' technologies for users large and small, including smart meters and demand-response systems. M2M can also improve the efficiency of energy production and transmission, and can further reduce emissions by facilitating the switch to renewables.
- **Transportation:** M2M could save nearly 1.9 Gt of CO2e by 2020 in the Transportation sector by optimizing routes of planes, trains, trucks, and ships to ensure that people and goods are moved as efficiently as possible (BCG & GeSI 2012).
- **The Built Environment**: M2M could save 1.6 Gt of CO2e by 2020 from the Built Environment sector by increasing the energy efficiency of building systems, including heating, cooling and ventilation, lighting, electronics and appliances, and security systems (BCG & GeSI 2012).
- **Agriculture:** M2M could save another 1.6 Gt of CO2e by 2020 in the Agriculture sector by reducing deforestation, managing livestock, and increasing the efficiency of planting, seeding, harvesting, fertilizer application and water use—allowing more food to be grown with fewer resources and saving money for farmers (BCG & GeSI 2012).

5.3 Smart Home

A Smart Home is a home or building that is equipped with a special connected platform enabling its occupants to remotely control and **program an array of automated home electronic devices**. The Smart Home becomes "intelligent" as it offers a wide array of new applications from home automation (home security, comfort and entertainment), home cloud (management of content, productivity, sensors data used or produced at home), and e-Health services.

Homes, and the way we live and behave in them, have changed dramatically in the past ten years. Today, fundamental trends have emerged to drive the take-up of Smart Homes:

- Societal trends – Society is ageing; in 2020, a fifth of the European population will be over 65 years old and single parent families are expected to represent 21 percent of total families, increasing demand for new services in the home.
- Digital addiction – Forecasts predict there will be on average 3.6 screens per person in Europe in 2015 (including smartphones and tablets) versus 1.7 in 2000. This development is a strong enabler for Smart Home applications as portable devices are the perfect counterparts (as controllers) for smart applications in the home.
- Strong push by large players positioning homes at the center of the digital ecosystem – A wide range of leading players are entering the Smart Home market, including Over-the-top players (such as Google and Microsoft) offering applications and operating systems, telecom and utility service providers (such as Telefonica, E.ON and GDF Suez) managing the customer relationship, and appliance manufacturers (such as Philips, and LG with the LG Homnet) providing Smart Home devices

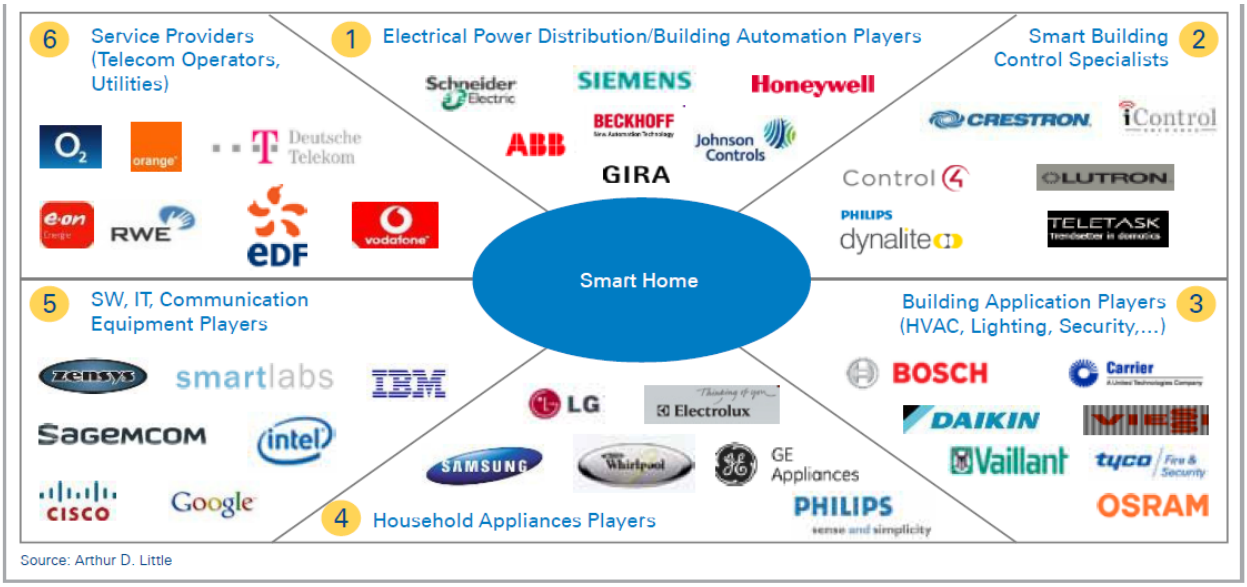

Figure 34: Smart Home has become a hot topic and players from various industries are now placing their bets

There is a window of opportunity today, as these trends are developed enough to make Smart Home a potential business. **Based on various projects, Arthur D. Little estimates that Smart Home revenues will grow by 12 percent a year until 2020 in Europe**. This revenue sizing includes both direct revenues, such as home automation services/products, and indirect revenues, such as the maintenance of the new devices/services.

It should be recognized that Smart Home markets are still in an embryonic phase and many players are entering the market. Telcos are one of them, and should act now in order to capitalize on the opportunity.

The Smart Home market is composed of four major segments, which we will explore in the following sections:

- Home automation/security: The primary challenge for home automation is the existing disparity of technologies (e.g. power line versus wireless networks, diversity of protocols and platforms). Players are developing alliances and partnerships along the value chain to promote and develop their platform. Telecom operators' main entry points are their primary assets, namely the home network (broadband access, set-top boxes, cloud storage and other connectivity layers) and related services, such as field service staff and network management capabilities (i.e. field staff capable of supporting a home network). They could also extend to home security and alerting, often with the objective of developing a presence in home control and automation
- Home assistance: Home assistance refers to configuration, maintenance, repair and support services available for digital home devices, such as PCs, TVs, audio sets, video players, game consoles and networks. Home assistance can be divided into two sub-segments: in-home assistance, through the physical presence of support staff, and remote assistance, which is managed through the remote control of the device by a off-site technician. This market is expected to grow at a pace of 5 percent per year to 2020. Despite strong market drivers, such as home digitization, teleworking and "home shoring" (home-based employees), there are still barriers to further development, such as privacy concerns, poor offers and few successful business models
- Home cloud: Home cloud covers three main types of digital data: content (video, music, and pictures), productivity (email, documents and contacts) and sensors (data collected through Smart Home devices, such as smart meters and e-Health devices). Home cloud solutions allow new ubiquitous and collaborative usages, but raise concerns about the management of data. This market is driven by the increasing amount of data, mainly video, leading to a strong demand for remote storage and access.

Despite some inhibitors, such as privacy and trust, the market is expected to grow at a strong pace of 50 percent per year.

- e-Health: A wide variety of actors, such as telecom operators, device manufacturers and big pharmaceutical companies, are playing in the e-Health market with two market strategies: a mass market approach, such as Wii Fit or Withings – a WiFi body scale, addressing mainly B2C markets, and a niche market strategy, such as electronic patient records and patient remote monitoring, as a B2B (or B2B2C) market.

We believe that Telco operators and other Smart Home actors should participate in alliances when available and should also **promote hybrid Smart Home platforms with applications close to their core business but also other services offered by external providers**. An example is PCCW in Hong Kong, which has built its digital home solutions around open models enabling a whole range of innovative functions from other players, such as MOOV, Android, etc. In this case, which we see actually as an opportunity, operators will be in a position to leverage not only their assets to offer their own solutions, but also to integrate external solutions and facilitate the digital life of their customers. By doing so, they would **generate new revenue streams and also improve the stickiness of customers to their existing services**.

6 European Context and Initiatives concerning Future Internet

This section explores the European context to check which factors can be barriers or could empower the future of Smart Applications in the Future Internet. We take into account:

1. EU policy development and regulatory issues concerning the FI PPP
    - CONCORD Working Group
    - Policy and Regulatory emphasis in the FI-PPP
    - Digital Agenda for Europe
    - Horizon 2020
    - FI3P Study related to Policy and Regulatory change
2. 3rd Platform regulatory issues
    - European Patent System
    - Standardization
3. Specific initiatives and topics
    - Future Internet and entrepreneurship stimulation
    - Web Economy and Web Entrepreneurship
    - Regional innovation ecosystems boosting SMEs
    - Smart Cities
4. Selection of policy and regulatory challenges for FI-PPP
5. Policies to exploit the opportunities of the Future Internet

6.1 EU policy development and regulatory issues concerning the FI PPP

The FI-PPP Working Group on Policy, Regulation and Governance (WG-PRG), facilitated by the CONCORD project, aims to provide contributions and support debates related to the EU policy development and regulatory issues concerning the Future Internet. To this end, the WG establishes relations with relevant bodies and organizations at EU and member states level and elsewhere. Expected outcomes of the work of this WG include position papers and recommendations regarding the necessary evolution of Future Internet related policies and regulations enabling the operation of a distributed Future Internet platform across Europe with the perspective of creating a market for trusted and secure e-services e.g. related to public sector priorities

The over-all FI-PPP is expected to create impacts in this respect: a comprehensive approach towards **regulatory and policy issues such as interoperability, openness, standards, data security and privacy** within the context of the Future Internet usage scenarios. The work also addresses the required **methodologies, procedures and best practices needed to address transnational aspects** where a high degree of public-private co-operation is needed. Participation of the public sector in the FI-PPP will be a key asset to progress in these non-technological issues

Part of this policy work, especially now that FI-PPP Phase II starts as of April 2013, will also be related to **SME oriented measures including innovation actions aimed at local and regional innovation ecosystem** levels. In particular we are aiming to **support and join the European Web Entrepreneurship Strategy as part of the Digital Agenda and Horizon 2020 priorities**.

- It is important to identify other European industry policies that are relevant in this context, what industry or economic stakeholders are relevant, what non-economic actors are involved.
- Also it is important to establish close relations with European Commission policy makers, notably DGs other than CONNECT and towards the EP, supporting the socio-economic importance of ICT, Internet and the web

Point of departure is to **underline the complementary role of Future Internet-related policies**:

- To actively create societal and economic opportunities in terms of innovation, growth and market development, and
- To establish and restructure the regulatory and instrumental conditions to exploit such opportunities. The second chapter starts with presenting an overview of current EU policy initiatives Digital Agenda and Horizon 2020 as related to the Future Internet and FI-PPP, then looks into several issues regarding convergence, regulation and development towards an Internet economy

6.1.1 Policy and Regulatory emphasis in the FI-PPP

Through its platform, infrastructure and use case projects the FI-PPP also generates insights in which enabling conditions e.g. as regards regulatory frameworks or accompanying policies should be established in order to achieve its targeted impacts. In this context the FI-PPP creates awareness and proposes building blocks for a comprehensive approach towards FI-PPP related regulatory and policy issues. In this regard the FI-PPP must connect to actions related to the Digital Agenda (e.g. regarding SMEs and entrepreneurship) and policies and regulations prepared by other Directorates.

FI-PPP vs. other initiatives Policy and regulation levels	FI-PPP role towards new policy and regulatory frameworks	Role of other initiatives or entities creating new policy and regulatory frameworks
Conditions setting	Awareness creation regarding required conditions, instruments, frameworks (e.g. for operating distributed Internet platforms, based on FI-PPP project experiences, or for innovative PPP governance models) Proposing building blocks and requirements for comprehensive regulatory and policy frameworks (for operating distributed Internet platforms)	Existing policy and regulatory frameworks e.g. market regulation, IPR, privacy (etc) Digital Agenda initiatives for re-regulation, market stimulation and innovative policy frameworks Initiatives and instruments foreseen in the context of Horizon 2020 European Patent System
Opportunity creation	FI-PPP's PPP model towards development, validation and valorisation of technologies, applications, infrastructure components, business models FI-PPP's entrepreneurial and SME oriented activities	CIP ICT-PSP: smart city and future internet living lab pilots FP7-ICT, Horizon 2020 (longer term research and innovation) Digital Agenda (e.g. Web entrepreneurs, SMEs) Regional and national initiatives regarding SMEs innovation

Table 10: Policy and regulatory emphasis in the FI-PPP

The most relevant general EU policy initiative related to the Future Internet is Horizon 2020, and as part of that the Digital Agenda for Europe initiative. These are wide-ranging longer term initiatives. The FI-PPP's impact will strongly benefit from resolving the policy and regulatory bottlenecks and spearheads identified in these initiatives. The FI-PPP also explicitly contributes to achieving some of the goals of these initiatives.

6.1.2 Digital Agenda for Europe and related actions

The over-all aim of the Digital Agenda initiative (as part of Horizon 2020 strategy) is to "deliver sustainable and social benefits from a digital single market based on fast and ultra-fast internet and interoperable applications".[3] The Digital Agenda recognizes seven major challenges:

1. Fragmented digital markets;
2. Lack of interoperability;
3. Rising cybercrime and low trust;
4. Lack of investment in networks;
5. Insufficient R&D;
6. Lack of skills;
7. Fragmented answers to societal questions.

The Digital Agenda initiative is highly relevant for the FI-PPP as it deals with multiple policy aspects that are transversal to the ecosystems of FI-PPP projects. The different pillars address cross-cutting issues of key importance for FI-PPP, such as **e-business, standardization, trust, interoperability, security, privacy and other.**

As noted, several of these policy and regulatory challenges are very relevant to the core issues worked on in the FI-PPP which requires such **policy and regulatory innovations in order to bring success**. In turn, the FI-PPP generates some specific contributions to resolving these challenges e.g. with respect to SMEs and web entrepreneurs. The FI-PPP works on technologies and solutions that respond to the issues and bottlenecks identified in the Digital Agenda, in particular those addressing fragmented digital markets, lack of interoperability, and missed opportunities in addressing societal challenges. The solutions developed by FI-PPP in several cases require further policy and regulatory innovations, e.g. with respect to managing access to data in supply chains, and generally with respect to operating distributed Future Internet platform. The FI-PPP in itself does not resolve these policy and regulatory challenges; rather it will define them, including the new challenges ahead, and create awareness with policy makers and standards organizations

Regarding innovation[4], the Digital Agenda and Innovation Union initiatives are somehow related with this topic through the potential collaboration between the FI-PPP programme and the EIT (http://eit.europa.eu/), in particular the EIT ICT Labs (http://eit.ictlabs.eu/). Very recently it was discussed a new horizon for the EIT[5] and were proposed four new KICs (Knowledge and Innovation Communities), apart from the existing three KICs on Climate, Sustainable energy, and ICT. These new KICs are for example in the fields of health and demography and urban mobility, which are of interests from the environmental domain to look for cross-cutting applications (e.g. health-environment, transport-environment, and energy-environment).

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[3] See: http://ec.europa.eu/digital-agenda/digital-agenda-europe

[4] The suggestions in this paragraph were kindly provided by Mr. Carlos Granell, JRC-EC.

[5] http://europa.eu/rapid/press-release_SPEECH-12-790_en.htm

6.1.3 Horizon 2020

Particularly relevant for the FI-PPP is Horizon 2020' emphasis on innovation ecosystems. Regarding ICT-based e-infrastructures, "**the aim is to achieve by 2020 a single and open European space for online research where researchers enjoy leading-edge, ubiquitous and reliable services for networking and computing, and seamless and open access to e-Science environments and global data resources**". Horizon 2020 stresses the need to foster the innovation potential of research infrastructures and their human capital. Innovation should be stimulated, both in the infrastructures themselves and in their supplier and user industry, by developing R&D partnerships with industry, by stimulating the use of research infrastructure by industry e.g. as experimental test facilities or knowledge-based centers and by encouraging the integration of research infrastructures into local, regional and global innovation ecosystems. Also, Horizon 2020 promotes the use of research infrastructures to be leveraged for public services and social innovation. Throughout the Horizon 2020 there is much emphasis on the demand side, the need to engage users to create more innovation-friendly markets, and it is stated that the ICT-specific research infrastructures include living labs for large-scale experimentation and infrastructures for underlying key technologies and their integration in advanced products and innovative smart systems.

This will require actions aimed at enhancing the effectiveness, impact and sustainability of Future Internet assets such as test bed facilities, software and technologies (the FIRE programme considers comparable issues. The gaps between the technologies presently offered in FIRE as testbeds, and the gaps between the layers in which its communities have formed are large. For example, the gaps between wired and wireless networking, between networking researchers and cloud application developers, and between both sorts of developers and end user input all require bridges that do not exist today, and scenarios and user requirements to shape and drive those bridging activities.)

Particular relevant for FI-PPP, the perceived gap between future internet technology push and the demand pull of user empowered and **open innovation actually points to the importance of value networks as ecosystems within the Future Internet**. Their emergence may considerably accelerate the exploitation and sustainability opportunities of future internet facilities as developed by FI-PPP (and FIRE). Enhancing the role of user involvement in relation to both Future Internet experimental research (FIRE) and Future Internet Use Cases (FI-PPP) is one challenge for the years to come. Projects building on Future Internet and Internet of Things technologies are already taking this up. New models of collaboration and synergy between future internet facilities and use case oriented projects in open innovation settings should therefore be further developed and some good examples already exist.

Related policy challenges of relevance for FI-PPP include smart cities and regions (smart specialization), as well as boosting business impact and entrepreneurship. FI-PPP (and also FIRE) will need to engage industrial actors and SMEs into the development of technologies and facilities, in order to tackle the identified challenges of knowledge transfer from research to business and research based entrepreneurship. This requires new forms of partnerships and concrete business models ensuring future sustainability.

6.1.4 FI3P study related to Policy and Regulatory change

The FI3P study (Rand Europe, 2012) was set up to estimate the potential economic and societal contributions of the European Internet industry as well as the impacts of EU support for a Future Internet Public Private Partnership (PPP). The FI3P project provides an analysis of the European Internet sector and its evolution in the period 2012-2014. The report analyses the main actors, among which the traditional actors in the telecommunications, IT and software sectors as well as the emerging sectors in the "Web Ecosystem". One of the conclusions is that in order to gain competitiveness in the Web ecosystem, EU actors need to overcome current bottlenecks and exploit web-based innovation, launch new services and applications and expand in new markets. The EC might help in supporting the development of open web platforms and removing regulatory barriers to new applications and services. The report's general conclusion is that the interaction between technology innovation and demand evolution will be the major factor shaping take-up and adoption of the Future Internet.

The report describes how the balance between stakeholders governing the Internet is shifting and how this may have unforeseen consequences. Commercial players and users will have a much greater say in the governance of the Internet, while the small community of developers will see its influence reduced. A possible consequence of greater influence of commercial players can be seen in the debate around Net Neutrality, which may result in tiered fees structures for Internet traffic, privileging business traffic. But also the growing attempts my many governments to build fences and barriers around parts of the Internet may put at risk the openness and universality of the current Internet environments. They identified a long list of barriers to global competitiveness of the EU, which can be clustered in three categories:

- limited access to inputs
- obstacles to innovation; and
- economic, cultural and legal impediments to effective market competition and cooperation

6.2 3rd Platform Regulatory issues

As convergence of network platforms, content and business models proceeds, regulatory challenges associated with convergence are significant, e.g. networks can handle many types of converged services which means a shift in the way broadcasting and telecommunications is regulated. Emphasis of regulation is on stimulation of competitiveness. Insight is needed into the impact of convergence on competition, the regulatory and policy issues of network infrastructure and services, the promise of multi-platform competition, and the implications of greater connectivity, pricing, sustainable competition, investment and innovation. The Policy Brief is also explaining how the Internet drives innovation and business models: the Internet is transforming platforms for delivering content e.g. changing towards participative networks. The policy challenge is to encourage innovation, growth and change and develop governance that does not stifle creativity or affect openness of the Internet as dynamic platform for innovation. Preventing cyber-criminality and protecting privacy are important concerns. Additionally, in this context there is a need for policies that address abuse of data collection (Internet of Things), stimulate the Internet in driving productivity and act as platform for innovation

Among the list of general policy making principles proposed are the following that seem relevant for FI-PPP:

- Promote the open, distributed and interconnected nature of the Internet.
- Promote investment and competition in high speed networks and services.
- Promote and enable cross-border delivery of services.
- Ensure transparency, fair process and accountability.
- Promote creativity and innovation.
- Encourage co-operation to promote Internet security.

In this sense, all the players in a particular business ecosystem/platform loose a part of their autonomy: they act as a whole and unique entity. Inside the business ecosystems, non-economic factors, such as power structure and underlying history, play significant roles in driving the business ecosystem development: inter-organizational relationships are not fixed by market competition but rather by the will of the focal firm. **Therefore, the actual level of competition should be between ecosystems**. This change in the level of **analysis requires a change in factors to be analyzed and a new regulatory tool box for policy makers and regulation authorities**

Probably the **most of relevance for FI-PPP is how to benefit from convergence and at the same time ensure that competition** is fostered increasing the **transparency of bundled offers** and **avoiding customer lock-in** and abuse of market power by large operators.

In relation to FI-PPP, a main issue here is what **the necessary regulatory evolution is to make possible to operate a distributed Future Internet platform across Europe**, with a perspective of an internal market for trusted and secure e-services (stated in the FI-PPP Work Programme). The Core Platform is conceived

as an open network and service platform as specification of API's supported by Generic Enablers (software components) will be open and royalty-free. Access Rights to Fore ground, and for Background and Side ground needed for the use of any Foreground, outside FI PPP program activities will be granted on Fair and Reasonable and Non-Discriminatory (FRAND) Conditions. **Issues that may potentially be addressed in terms for regulation and policy include the role of core platforms in competition,** access conditions to critical components and interfaces, and business model aspects of exploitation of the core platform. Could such publicly-funded core platforms distort competition? Does it create lock-in conditions?

6.2.1 European Patent System

The overall growth in patent applications can be attributed to several factors, including increased technological complexity (Hall, 2004; Heller & Eisenberg, 1998). There is some disagreement as to whether this is a result of the explosive growth in innovation in sectors like the ICT and biotechnology industry, or if it is more akin to a situation where firms have sought to establish increased property rights without dramatically increasing their overall levels of innovation (Bessen & Meurer, 2008b). According to studies in the US, this has led to both a decline in patent quality and an increase in patent litigation (Bessen & Meurer,2005). In addition, the pendency period of applications has increased dramatically, almost doubling from 19 months in the early 1990s to 34 months in 2010 (Rai, Graham, & Doms, 2010). If these elements also applied to other patent systems such as the European one, they would create uncertainty and could undermine the ultimate goal of the patent system, which is to spur innovation. **Uncertainty in the patent system has a counter-intuitive effect; instead of using it less**, firms are choosing to file for more patents, either to fend off perceived threats or to take advantage of the weakness in the system (Hargreaves, 2011).

Having many patents is not a problem in and of it. **Failures arise when economic players cannot develop their business, or market players abandon their innovation activities** due to an inability to assess the validity of their intellectual property. Thus, one theme that was raised repeatedly was uncertainty over the freedom to operate (in the general rather than the legal sense), or uncertainty about the transaction costs necessary to develop and commercialize a product. In fact, the reason for the prevalence of patent lawsuits may have much to do with the effectiveness of patent offices' review processes. This may take the form of pendency and quality – and is not restricted to the US, according to the participants; even if the US system seems to magnify these problems, they are evident in Europe as well.

Finally, on December, 2012, the European Union sealed an agreement for the creation of a single patent system across 25 countries, bringing to an end decades of argument. The measure aims to boost competitiveness and innovation as it reduces red tape for inventors and brings patent costs in line with other economies like the U.S. and Japan. **The new patent should come into force in 2014,** and a new unified patent court will be set up in Paris with some specialist services located in London and Munich.

The introduction of the unified patent system should make European patents more valuable and **it will give innovators around the world a very valuable form of commercial protection over a marketplace of around 500 million people**. The new patent regime covers all EU nations with the exception of Italy and Spain. The two countries backed out of the agreement over a decision to limit the number of languages to English, French and German.

6.2.2 Standardisation

FI-WARE Project partners continually study the actual standards and consider when/how to contribute FI-WARE research into new standards/protocols in order to (a) avoid "re-inventing the wheel", (b) make the most efficient use of past developments, and (c) help educate/move technology state-of-the-art towards the advantages inherent in FI-WARE.

This Standardization Plan describes the status of the relevant parts of the global standardization landscape, and plans related to FI-WARE activities. It is a "living document" which will be updated as work progresses during the life of the project.

One of the Strategic goals of FI WARE project is to liaise between the project and relevant standardization bodies in order to:

- a) To keep the project up-to-date with respect to the discussions in the standardization bodies;
- b) To support the submission of contributions from the project in a coordinated way. The aim is to ensure active contribution of specifications leading to open standardized interfaces

Basically the standardization strategy adopted by FI WARE is following a number of them to stay aligned with the latest evolution and incorporate them in the specifications of our GE and their implementation.

6.3 Specific Initiatives and topics

The role of FI-PPP, facilitated by CONCORD, in this respect could be in the identification of a number of steps and activities which relate to SMEs innovation ecosystems and initiating Web entrepreneurship actions based on FI-PPP assets. These assets include: use of FI-PPP test bed facilities, FI-PPP project networks, and knowledge & technology assets such as open source software components.

6.3.1 Future Internet and entrepreneurship stimulation

A priority challenge is the need to link promising future internet enabled platforms and commercial potential in order to create business impact and entrepreneurship. Some interesting examples exist abroad. The NSF I-Corps program brings together the technological, entrepreneurial and business know-how to accelerate the exploitation of technologies. Another recent initiative is the Canadian Digital Accelerator for Innovation and Research (DAIR), initiated by CANARIE, which is a “digital sandbox” where high-tech innovators – SMEs - can rapidly design, validate, prototype and demonstrate new technologies for world markets[6]. FI-PPP (and also FIRE) will need to increasingly engage industrial actors and SMEs into the development of technologies and facilities, in order to tackle the identified challenges of knowledge transfer from research to business and research based entrepreneurship. This requires new forms of partnerships and concrete business models ensuring future sustainability.

6.3.2 Web Economy and Web Entrepreneurship

Action 54 of the Digital Agenda is to Develop a new generation of web-based applications and services. The main problem is that Europe counts much fewer start-ups founded by web entrepreneurs and the ones that are created rarely grow to global leaders. During 2012, a number of targeted actions have been undertaken to address this issue, e.g. TechAllStars campaign, OpenIdeo, Awards. However more needs to be done in terms of promotion of web entrepreneurship, strengthen the web start-up ecosystem and bring stakeholders together to pool resources. Regarding FI-PPP, it is planned that Call 3 (open 16 May 2013 and closed 10 December 2013) will provide opportunities for small and innovative tech start-ups to develop new web-based services and applications. Besides, there is a need to enhance the innovation ecosystem at local and regional level for such web entrepreneurs including a role for venture capital. The new Horizon 2020 program will stimulate innovative SMEs, including Web entrepreneurs buy facilitating access top risk

[6] See: www.canarie.ca/en/dair. This program has started December 2011.

capital or specific pilot projects and prizes and the sue of the SME instrument for support to promising start-ups.

The staff working paper "Strengthening the Competitiveness of the EU Web Economy" (concept, June 2012) identifies some bottlenecks e.g. EU funding instruments are too slow and EU-wide platforms for grassroots collaboration (such as Entrepreneurship hubs) is missing. Also the current innovation ecosystems suffer from fragmentation. The paper proposes an EU framework which includes several pillars such as 1. Catalyst/networking activities (networks of hubs, open collaboration spaces), 2. Awareness creation activities, 3. Training and education developing close links between entrepreneurs and universities. Recently, the EC launched a consultation for Web Entrepreneurship Support Actions closing December 2012.

6.3.3 Regional innovation ecosystems boosting SMEs

The more general issue is to strengthen regional innovation ecosystems. One action for FI-PPP is to establish and strengthen the (cross-) regional innovation ecosystems around FI-PPP projects towards longer term sustainability. FI-PPP Call 1 and 2 projects should mature into networks or clusters of companies, SMEs and academic institutes in cities and regions acting as breeding grounds for SMEs and web entrepreneur initiatives. Access to infrastructure, platforms, software components and knowledge generated by FI-PPP projects should be easily available. Regional and national initiatives regarding entrepreneurship and innovation should be integrated with FI-PPP key project clusters.

Second and elaborating on the former is to establish collaboration based on FI-PPP assets with existing, promising regional entrepreneurship activities around innovation centres, science parks, venture labs and comparable business creation activities. Local collaboration agreements can be created that provide the open access to and use of FI-PPP assets to start-ups who in turn may contribute to these assets e.g. developing advanced software components or technologies, or using FI-PPP assets in commercialised products and services. Such collaboration can be facilitated with EIT ICT-Labs activities or with local / regional entities (CONCORD is arranging cooperation with EIT ICT-Labs). In terms of funding such collaboration, different sources of public and private funding can be combined (public funding at national, regional, EU-level and also Structural Funds).

Third, and related to the former, FI-PPP Call 3 opening in May 2013 is expected to provide opportunities for small and innovative tech start-ups to develop new web based services and applications.

6.3.4 Smart cities as innovation ecosystems

Smart cities are increasingly considered as user driven innovation environments, providing opportunities for testing Future Internet technologies in living lab settings. The FIREBALL Support Action (www.fireball4smartcities.eu) has promoted Smart Cities as innovation ecosystems for future internet research, bringing together the communities of future internet, living labs and smart cities. In addition, the concept of smart regions gains importance in smart specialization strategies. This illustrates the importance of future internet experimentation and use case projects within the context of innovation policy for achieving synergies and impact through collaboration across regional and national boundaries and through transnational approaches. Maybe less focusing on cities FI-PPP might emphasize "smart connectedness" in business and societal networks of all kinds. An issue is how this fits in current policies regarding smart cities and regional specialization and if there would be a need for a more diverse set of policies.

Smart Cities are considered as open innovation ecosystems and playgrounds to exploit the opportunities of the Future Internet[7]. Cities and urban areas in general are also considered as critical for getting the Digital Agenda up and running. They have both critical mass and local engagement that is important in getting pilot projects running. The Internet provides platforms and tools that facilitate the engagement of citizens to shape their city. The role of cities as innovation ecosystems has been underlined in several CIP ICT-PSP projects, FP7 projects such as Smart Santander, as well as in FIREBALL support action (www.fireball4smartcities.eu) and also in the FI-PPP. See also the Commission communication on Cities and the Digital Agenda (Kroes, 2010).

6.4 Selection of policy and regulatory challenges for FI-PPP

The Future Internet gives rise to a wide range of new challenges regarding policy, regulation and governance. Making FI-PPP, and the Future Internet, to a success requires on the one hand the **removal of policy and regulatory bottlenecks** (for example those that hinder innovation), and on the other hand the creation of new policies and regulatory frameworks as well. Especially at the European level there is opportunity and need for restructured policy and regulatory frameworks.

Some of the challenges are highly domain-related (e.g. specific Future Internet-related policies and regulations for sectors like media, logistic supply chains, energy or health). **Other challenges are more horizontal and generic**. These horizontal challenges are still quite diverse. They include security and privacy issues, availability and access to network infrastructure and to critical parts of the infrastructure, the functioning of entrepreneurship and innovation ecosystems etc.

The present paper is concluded in this section with a short elaboration or outlook on specific policy and regulatory challenges to be covered by the FI-PPP.

6.4.1 Open Internet and Net Neutrality

A recent European Commission communication addresses the Open Internet and net neutrality in Europe. (European Commission, 2011). Net neutrality concerns how best to preserve the openness of the Internet platform. Much of the debate centres on traffic management, used by network operators to ensure efficient use of their network and high quality of service. This also may give rise to blocking or degrading legal services which compete to their own services. The Commission has set in place a framework of principles for net neutrality. A revised EU electronic communications framework has been developed which is transposed into national law, but more stringent measures could be taken.

6.4.2 Cloud Computing

One of the areas of high importance in the Digital Agenda is cloud computing. The Digital Agenda aims to promote the right conditions for citizens and businesses to benefit from this. An online consultation has been running in 2011 and feeds the European Cloud Computing Strategy (2012). The survey also seeks feedback on policy issues such as data protection and liability (in particular in cross-border situations), legal and technical barriers, standardization and interoperability solutions, uptake of cloud services. The recently published **Cloud strategy includes three key actions: standards, contract terms and conditions**, and European Cloud partnership as well as a number of flanking actions.

[7] The FIREBALL Support Action has explored this area of Smart Cities, Future Internet and Living labs. See: http://www.fireball4smartcities.eu/ where a White Paper on Smart Cities as Innovation Ecosystems Sustained by the Future Internet (2012) can be downloaded.

- In case of **virtual network provision** or **cloud computing**, routing of connections (and related backup connections) may be subject to legal restrictions concerning traversal of areas under different laws (with respect to, for example, privacy, digital rights management, lawful interception, public emergency handling).
- Another topic regarding **cloud computing includes the risks and benefits of virtual access to information. Stricter privacy requirements that favour local-only storage of data** may be an additional obstacle to the current approach**,** as it would place data even further away from the computational infrastructure.

Trust and consequentially security concerns are one of the top obstacles that hinder Cloud Computing adoption today

6.4.3 Privacy

A further topic is **privacy** in relation to private and sensitive customer data, events and contexts. Sensible data of citizens and objects has to be stored and managed fulfilling security, integrity and accessibility rules as established by the concerning authorities. **Internet of Things** is a dedicated topic for vertical areas where dominant players impose their views and would not share data. In this context, data property is a major concern that could provide serious gaps across European countries depending how national regulation processes would support the deployment of new technologies

Dangers of data, data is held, distributed and analysed globally rather than locally, with **no clear jurisdiction or established regulatory framework to deal with any disputes.** Additionally, targeted advertising may be disruptive or intrusively personal; and searches based on behavioural analysis models return restricted data, limiting exposure to new information and the spread of knowledge globally.

- **Access to business data**. Key conditions of international trade are related to data. Regulatory approaches related to data (access, privacy, security) are different across countries, which affects companies doing business in such countries.
- **Data and privacy breach.** Data stored in could-based systems are vulnerable for privacy breach e.g. tracking down individuals.
- **Data quality**. Quality of data is an issue, especially when data is generated by sensors and people are acting upon this data.

6.4.4 Open Data policies

Open Data is a relatively new development but has received a lot of bottom-up as well as policy interest. Many initiatives have been launched by cities and national governments. The UK open data white paper stresses the importance of open data (e.g. geo-data, environmental data, health-related data) for development of innovative products and services in a wide range of domains. However there still appear to be barriers and drivers of open data policy implementation (Huijboom and Van den Broek, 2011). One of the bottlenecks is governments' reluctance to adopt open data strategies. FI-PPP could help developing effective open data strategies however the thematic of open data then should more explicitly be part of the next FI-PPP phases 2 and 3.

The concept of Open Data emerged some years ago but was not so well-known from a business point of-view. The definition of Open Data can be summarized by the statement ***"A piece of data is open if anyone is free to use, reuse, and redistribute it — subject only, at most, to the requirement to attribute and/or***

share-alike."[8] and one of the key event which boosted the communication around Open Data is the nomination, by the British Prime Minister, in June 2009, of Tim Berners-Lee to support the British Government at making data more open and accessible on the Web through data.gov.uk.

Nowadays, Open Data websites are emerging everywhere around the world:

Figure 35: Open Data map (www.data.org)

At the European level, many countries have put in place an Open Data strategy during the last two years:

Website	Country	Launched date	Languages
data.norge.no	Norway	April 2010	Norwegian
data.belgium.be	Belgium	September 2011	Dutch/English/French/German
data.overheid.nl	Dutch website	October 2011	Dutch
dati.gov.it	Italy	October 2011	Italian
datos.gob.es	Spain	October 2011	Spanish/Spanish Regional languages/English
data.gouv.fr	France	December 2011	French
opendata.ee	Estonia	Mars 2011	Estonian/English
dados.gov.pt	Portugal	November 2011	Portuguese
ate.gov.md	Moldavia	October 2011	Romanian/English/Russian
data.gv.at	Austria	April 2012	German

[8] http://opendefinition.org/

www.opendata.cz	Czech Republic	2012	Czech/English
www.portalu.de	Germany	February 2013	German/English
digitaliser.dk	Denmark	January 2013	Danish
open-data.europa.eu	EU	2013	23 languages

Table 11: European Open Data websites

6.4.5 Telecommunication networks, services and content policy

During the nineties, telecommunication policy and regulation has emerged as a highly important area at national and European level, addressing key issues in competition and market dominance, access and interconnection, privatisation and ownership as related to fixed and wireless telecommunications networks. The Internet and related industry and market transformation has added a new wave of discussions regarding broadband stimulation, privacy, security, property rights whereas at the same time competition and market dominance issues remain of importance. An area of particular importance is open internet and net neutrality. A key issue here is the ability of end-users to access and distribute information or run applications and services of their choice, to preserve the openness of the Internet as platform. A European Commission communication on "The Open Internet and Net Neutrality in Europe" (2011) further elaborates the different policy directions addressing competition, traffic management, consumer protection and other. While the topic is not of direct relevance to FI-PPP it may have some relevance in relation to the FI-PPP core platform activity, this needs further study.

6.4.6 Security

On-line relationships between customers and suppliers, in particular for ensuring **secure on-line transactions**. This would require a reinforced network and information security policy. Existing regulations are very much dependent upon the service provided online from the supplier to the consumer.

Cybercrime and cyber law issues include threats such as phishing, cracking, cyber terrorism. In France, the accessing or remain fraudulently, in whole or part of a "system of automated data processing" is an offense punishable by two years' imprisonment and a 30,000 euro fine (cp. , s. 323-1, paragraph 1) and any attempt is punishable in the same (cp., art. 323-7).

6.5 Policies to exploit the opportunities of the Future Internet

The FI3P report (2012) estimates the potential economic benefits of the FI-PPP programme, which are potentially limited by barriers to competitiveness, most of them relevant to SMEs and startups. The report identifies a number of specific barriers to achieving the benefits and links them to FI-PPP. Barriers identified in the different sectors include insufficient access to inputs, obstacles to innovation, barriers to market competition and cooperation (economic, cultural, legal):

- Insufficient access to financial capital;
- Insufficient investment in innovation;
- Limitations regarding the size of a company and its home market;
- Impediments regarding the cooperation of the Internet industry with other industries;
- Economic barriers regarding entry and interoperability; and
- Demand-side barriers, notably lock-in, attitudes to new technology and trust.

Measures are proposed to overcome barriers to really achieve the potential benefits. Some of these policy recommendations include the following:

- Emphasis on SMEs and start-ups.
- New assets and financial partnership models are needed to support the transformation of Europe into a leading competitive player in the emerging, Internet- and service-based global economy.
- National and European infrastructure initiatives must be “joined up” to produce effective complementarity and to encourage pro-innovation and pro-competition investment and growth by all sizes of firm and all sectors of the European Internet economy.
- Europe’s competitiveness may hinge on near-universal access to advanced communications and computing services as well as to high-speed broadband.
- Dynamic and diverse Future Internet businesses need new forms of legal identity.
- To succeed in the global Internet Economy, Europe's Digital Single Market needs internal defragmentation in legal and regulatory terms.

The report does not explicitly address the relevance of FI-PPP technologies in relation to current policy and regulatory debates e.g. net neutrality or access to critical infrastructure.

7 Consolidation

This chapter summarises schematically the findings and conclusions of FI WARE research work, under a market perspective as explained in preceding chapters.

The main conclusion of the document is that the success of the FI-WARE concept will depend very much on the use of the adequate technological solutions and its ability to engage small and medium developers to use the different tools FI-WARE is going to provide. In the end, FI-WARE success will depend on the success of the applications that are going to be developed on top. FI-WARE will succeed if the developers using FI-WARE succeed.

The experiments and use trials, and the involvement of European cities, Industry –and other communities (SMEs, entrepreneurs...) in the experiments will be crucial.

The following factors are crucial:

- **Stakeholders' engagement**: as shown in section above, stakeholder's involvement depend on the availability, willingness and agreements for each part of the process. The key to the success will be a focus on the value created for the end users, new collaborative business models and ecosystems where all participants can be successful.
- **Use of trials**: it is important to have and show them to possible customers, both internally and oversees, as already referred.
- **Management and Leadership**: global vision and understanding of interrelationships, influence factors and management needed is necessary to organise Smart City and Industry projects based on Future Internet.
- **Open Data:** There are many risks around Open Data and their potential use and this is a specific regulation issue for the European Commission providing European guidelines and common understanding on what are Open Data and best practices to use them, including privacy aspects

7.1 Consolidation tables

Inspired on the list of functionalities and on the list of benefits, the following table summarizes the market trends, business opportunities and the expected impact.

Market trend	Opportunity	Impact
Cloud		
A huge ecosystem developing around Open Stack foundation	Lots of vendors building new offerings and business models, and using OpenStack in conjunction with many additional technologies in production, building solutions which couldn't have existed previously. The value moves from individual components, which become commodity and available to everyone, to solutions, services around	Rapid provisioning of new capacity for application developers Shorter software upgrade cycles enabling faster implementation of the latest improvements, features and functionality, leading to more state-of-the-art, consumable cloud services Improved service levels and compliance

	integration, support, etc	
An explosion in industry PaaS (public platform as a service) built on open source-based infrastructure	This opens up business opportunities for the provision of PaaS to companies in need of a Cloud platform to develop generic business applications, as well as the direct provision of PaaS to end users to build specialized applications to be used only within one company for a single specialized task	Convergence of frameworks, and improvement of user management and of framework deployment. Facilitation of collaborative work between teams. Possibility to develop and test Cloud-ready applications. No more fixed assets for computing and storage
Big Data		
An 'Ecosystem' of new data management tools is taking shape, covering the various layers of the data stack in the enterprise and delivering a 'Total Data' approach	This 'layered stack' will be complemented with specific tools and methodologies to handle critical aspects of Policy Governance, including security, privacy and IP protection. Overseeing it all, an overarching Data Strategy approach needs to be developed.	Providing advanced tools for management or complementary functions Provides a full set of innovative features
Big Data´s potential is likely to pivot on context	Emerging fields, like Internet of Things and Context-Aware Computing, which necessarily involve the ability to manage lots of data, will become key fields in the near future	In generating higher quality insights that enable better decision making, interest and revenues should accelerate sharply
Internet of Things		
The key to the success of the M2M and IoT business will be a focus on the value created for the end users, new collaborative business models and ecosystems where all participants can be successful	The high number of moving parts threatens the viability of the project due to vendor management complexity, uncertain costs, difficult-to-enforce service-level agreements (SLAs) and other challenges. What companies desire, however, is the ability to go to one provider for all their needs and pay a fixed price for extended periods of time	The IoT breakthrough will happen when developers will provide application for end-users, hiding the physical world related to M2M connectivity
Apps		

The Service industry has become the biggest employer in Europe and tends to be a critical force to ensure economic growth. The adoption of the right business model is essential for these platform/ecosystems to flourish.	For the expansion of the service economy by creating an IT infrastructure for Business Services where services become accessible, discoverable, composable, easily deployable, and ultimately tradable on the Internet. Stakeholders on all sides of the markets, as well as the platform owner itself, must have the right incentives. Only in the case of generated value for all participants an ecosystem of values becomes alive.	Helps the service sector to generate new value added services, develop innovative business models, and establish new business value chains
Interface to the Network and Devices		
The diversity and fragmentation in the offer of connected devices	A further step in creating a common developing platform has emerged, by offering libraries specifically designed to overcome the limitation of using pure HTML5/JavaScript	Cross-platform tools are letting developers target multiple platforms with low incremental costs and high levels of code reuse
The Cloud Proxy Generic Enabler takes advantage of its unique location in between the WAN and the various home networks (LAN, home automation networks …).	Being connected to the WAN allows Cloud-based applications to directly interface with it ("cloud-proxy" feature: parts of the cloud application can be ran internally to the Cloud Edge)	Allow the implementation of applications that need continuity of service (if the WAN connection falls down) and real time responses.
Security		
Cyber-security threats are significant and growing concern.	With over five billion mobile phones coupled with internet connectivity and cloud-based applications, daily life is more vulnerable to cyber threats and digital disruptions. There is a growing market for cyber risk insurance, covering risks ranging from computer security liability to business interruption, cybercrime and cyber extortion	Reduce the loss of profit due to poor security implementations and regulatory non-compliance is a greater commercial concern than ever before.
Instances or GEs combinations		
Big Data and Cloud	The combination of Big Data	Providing this service in a

	with Cloud can ease the adoption of advanced analytic capabilities over the bigger and more heterogeneous data sources that companies need to handle, letting companies benefit of the insights derived from it.	flexible and scalable format is the main purpose of Data Analytics as a Service. Reduce the associated capital investment of the deployment of a complex Big Data infrastructure
The combination of M2M and Big Data	Collecting data from a small-scale fleet of repair trucks through to a million-strong network of smart meters then feeding that data through a processing system to deliver detailed business information is another major benefit of M2M	Allowing data to flow freely from one hospital to the next can help improve patient outcomes while reducing overhead costs. Gain efficiency by electricity provider to gain very detailed information on when spikes in electricity demand occur
Cloud Proxy in conjunction with IoT functionalities like the IoT Gateway	A cloud proxy hosting an IoT Gateway can be a device which is hosted at every home, and can open to a market of home-based applications which let the user interact with their devices and Things at home	Home automation, Energy-monitoring and Control applications.
Smart Cities		
Smart Cities is the most promising business case because there is an actor of the value chain who has benefits to push openness between vertical sectors.	They are currently the first customers who claim for multi-standards platforms to monitor sensors and collect data in a homogeneous way: from pollution to noise, from traffic to smart grid, from waste to water sewage.	The major advantage of Smart Cities market is that a kind of competition between Smart Cities will accelerate this emerging market and creativity would always emerge because of some local specific needs from cities and citizen.
Smart Industry		
The technology is moving beyond its decades of use in utilities, transport, and heavy industry into the mainstream	The main opportunities are concerning Utilities, concretely M2M technology, such as smart metering or wirelessly connected grid assets, followed by health sector, concerning Tele care and patient data management	The incorporation of M2M technologies into a company's operations will increase profits by improving efficiencies of energy, time and resources That translates to new business intelligence (BI), operational efficiencies, and revenue-generating opportunities
Smart Home		
Strong push by large players positioning	The Smart Home becomes "intelligent" as it offers a	The vision of smart living is to

homes at the center of the digital ecosystem	wide array of new applications from home automation (home security, comfort and entertainment), home cloud (management of content, productivity, sensors data used or produced at home), and e-Health services.	facilitate comfort living for consumers by providing several ICT-enabled services that combine value drivers of health, energy, security and entertainment services.

Table 12: FI WARE Research and Market Analysis conclusions

Ultimately the key to success in the **Future Internet will be to identify value propositions that attract consumers for profitable (or at least sustainable) services**, where current business, operational or technical barriers can be overcome through the use of Future Internet technology. Overcoming barriers should enable value propositions that are novel and hence more attractive that existing 'current Internet' services. One of the most important considerations is therefore to identify how FI-PPP participants will distinguish themselves from current Internet businesses and services, and what technical capabilities they need to overcome barriers to achieving this.

The **following table summarises barriers** found and propositions for its management from the analysis done in the exploitation task of FI WARE.

Objective	Barrier/competition	Recommendation/Workaround
User adoption	Complex system, heterogeneous, innovative, disperse knowledge and experiences... Disaggregation, disinformation are barriers for the whole process. Also in time to execute	• Need to address more applications and scale up facilities. • Need to promote FI benefits: e.g. privacy, reliability, transparency, etc. Consistent cross-border content regulation.
Trust and security	May lack basic security to minimise threats to user privacy or to resist cyber-attacks. Basic security is mostly OK. User privacy still a concern, as is cyber-crime against users	• FI infrastructure operators must find ways to defend their infrastructure from malicious attacks and to ensure legitimate users will not be harmed if they use the infrastructure (i.e. to make the infrastructure secure and trustworthy).
Data Privacy	The machine-to-machine (M2M) market faces not only technical challenges in implementation and interoperability, but also	• European Legal Framework guaranteeing privacy harmonized across Europe • Data protection regulations may help restrict the delivery of personal data

	business issues related to pricing, potential breach in user privacy and regulations in different countries, industry watchers note. Existing cross-borders commercial offers do not include high level services which could be hosted in cloud because of the heterogeneity between European regulation systems and data privacy rules.	to M2M • More and more M2M and IoT customers are focusing on this issue and especially the "Patriot Act" which could strongly impact the take-up of this promising business.
Standardization	M2M needs a common framework on which all services and devices can interoperate and scale, and be efficient and widely available	• The emerging association OneM2M is a worldwide initiative, from Asia to America including Europe to reach an industrial consensus on interoperable standards and technologies, using especially ETSI-M2M standard as reference model.
Application support	Many existing FI infrastructures were designed for a single application or class of applications. This places a limit on the value they can deliver. Infrastructures must become easier for applications to use individually and in combinations. This requires greater levels of interoperability Technical access is not a problem, but user lock-in and monopolies are a concern.	• Improved support for applications • Cloud Computing Strategy should help normalise technical interfaces and business terms and processes.
Continuation of fostering the interaction between the European industries, ICT and sectors	Regulatory environment for application sectors have to support an investment friendly environment for positive business cases for new FI-solutions, identified barriers to be removed	• Innovative New Business Models and Sales Strategies • Achieving a mutual understanding • Addressing additional industrial branches (e.g. Industry Automation, Healthcare) • Establish the basis for a sustainable Vertical IT approach
Infrastructure Sustainability	Crisis. Lack of money, no convincement of investors	• Check European funds • Associate with other stakeholders in a

	Some infrastructures may continue to be largely or wholly supported by public funds where the need for them is clear but the market context makes commercial operation unfeasible	share investment-benefits ratios

Table 13: FI WARE barriers and recommendations

7.2 Impact on European challenges FIWARE´s research value proposition

The app economy is evolving towards a service economy where developers can pick from a range of tools and services to assist them along the plan – develop – market journey. Apple, Google, Facebook, Amazon and many other Internet players are in the center of value networks **connecting the core business of the platform owner** (e.g., hardware sales for Apple) **with an array of complements, such as developers, media, brands and Telco**. As such, **they are carefully designed to drive the core business of the ecosystem owner**. Complements are products that are consumed with and add value to the core product of the ecosystem owner.

- **Technological shift**

Technology is evolving at a pace where the emergence of Multi-purpose Transactional Platforms will become more a business than an IT challenge. The challenge of assigning monetary values to insights derived from context data is key in creating value ecosystems based on multi-purpose transactional platforms.

Next Generation of Internet Based Services, business-enabling platforms are one trigger for this new kind of collaboration. Motivating market players to collaborate on a common platform is the foundation for the next generation of Internet-based services. As this Internet application and service revolution continues, successful multi-purpose transactional platforms can unlock long term and sustainable revenue streams yet to be identified.

To fully capitalize on the explosive demand for advanced services and applications, network providers must shift to new business models that support an Application Enablement environment. Such a paradigm shift will allow them to leverage their value add network capabilities to grow new revenues.

- **Open Innovation**

Platforms strategies play a crucial role in open innovation. The development of platforms shapes the nature of relationships between partners engaged in an open innovation process. **The more the platform is open, the more it will enhance collaboration between business partners**. These platforms generate more innovative opportunities for the business ecosystem when they rely on open and modular architecture rather than on a monolithic one. In this context, network externalities are at the very core of the open innovation dynamic. Platforms combine software stacks that can be used by other companies to innovate their business that in turn will bolster Amazon's platform in a self-reinforcing cycle, spreading its knowledge into its ecosystem.

Interoperability should be considered as prerequisite for open innovation: it enables enterprises to build collaborative relationships, access useful knowledge, develop and deliver new products and services, strengthening the development of business ecosystems.

Successful platforms at the same time are closed (integrated) around core businesses of their owners. In other words, **openness is needed to create the ecosystem of complements**. Integration or "closed-ness" is needed to capture value by the ecosystem owners.

- **Ecosystems competition: New regulatory tool box for policy makers and regulation authorities is needed**

Today's platforms aren't about controlling hardware resources, applications and information. Instead, they are going to **be around access to bundle of services and contents tuned for communities**, strengthening collaboration and knowledge between partners.

In this sense, **all the players in a particular business ecosystem loose a part of their autonomy**: they act as a whole and unique entity. Inside the business ecosystems, non-economic factors, such as power structure and underlying history, play significant roles in driving the business ecosystem development: inter-organizational relationships are not fixed by market competition but rather by the will of the focal firm. **Therefore, the actual level of competition should be between ecosystems**. This change in the level of analysis requires a change in factors to be analyzed and a new regulatory tool box for policy makers and regulation authorities

- **"Data Gold"**

At a time of massive data proliferation, of major economic uncertainty, of growing cyber threats and of rampant deindustrialization, understanding what Europe should plan for be in R&D or policy terms, becomes vital.

IT is challenged to find new and additional value in using platforms and data in different ways driven by the ever faster changing business and consumer scenarios. This is forced by the explosion in valuable consumer services and associated commercial models. The resulting new business models blur the traditional industry borders and question the commercial models as they are known today.

Supported through cloud computing adoption, growing social networks and an explosion in mobile device adoption, the Information and Communication Technologies (ICT) Industry further explores the value of data, in an **effort to monetize and capitalize on the wealth of data, the 'data gold'**. Especially we see a growing interest in the data generated by collaborations between business partners and the value that is derived from connecting together data owned by any given partner in the chain.

Nowadays a huge amount of data is collected, sometimes without a defined outcome of quantifiable value for either a consumer or business. **The Internet of Things concept; leveraging data gathered by sensors embedded in countless devices will further strengthen the richness of information** that can be generated from transactional platforms. And on top of these different sources of data coincide with the emergence of Big Data Management and new data analytics technologies, increasing the probability of finding meaningful insights from huge amounts of data generated by myriad applications and sensors.

This previous analysis starts with the economic theory behind it, shows the taxonomy of possible business models and gives some thought-provoking impulses on how to investigate and **extend the value of data without violating the consumer's privacy**. It is obvious to investigate cross market collaboration for growth as the specialization and industrialization driven by the crisis in the last few years only concentrates on cost efficiency

- **Improvement of the economic balance and employment**

Economy of Internet Applications is one of the most disruptive elements. The greatest business value will come from the new generation of industry solutions and services just starting to emerge on top of the 3rd Platform. IDC predicts that, worldwide, enterprises will spend $65 billion on industry-specific solutions in 2013, with a rapidly increasing number of them **leveraging cloud services, mobile devices, Big Data, and the other elements of the 3rd Platform.** IDC expect this to grow to nearly $100 billion in the next three years as businesses use these technologies and solutions to create new products and services and redefine

existing customer relationships. IDC sees the greatest activity, and opportunities, in the areas of public safety, smart buildings, merchandising analytics, Omni channel retail, connected health, smart cities, personalized medicine, and smart government services.

The **Service industry has become the biggest employer in Europe** and tends to be a critical force to ensure economic growth. Our work within FI-WARE contributes to the expansion of the service economy by creating an IT infrastructure for Business Services where services become accessible, discoverable, composable, easily deployable, and ultimately tradable on the Internet. In doing so, our work helps the service sector to generate new value added services, develop innovative business models, and establish new business value chains.

8 Conclusions

IT Industry Shifts into full-blown competition on the 3rd Platform. As we enter 2013, the 3rd Platform including its core technologies, its new strategic customer segments, and its radically new rules for success is right in the center of the market, sitting in our metaphorical laps. **The battle for the IT industry as a whole, as of now, is almost completely about this battle for the 3rd Platform**

This analysis describes the desired capabilities and building blocks that need to be established for such a platform. It also offers an analysis of market trends and existing solutions, in order to establish a future vision and solutions, as well as outlining the business potential of such solution.

Today, there is significant pressure on lines of business to create new business value based on mobile, social, big data, and analytics capabilities. These new applications are fueled by the emergence of new, highly iterative development models that use service composition, open architectures, open source components, and polyglot programming models to rapidly deliver solutions. In the upcoming years, vendor and IT users should develop deep competence in all of these technologies, **cloud services, mobile devices, social technologies, M2M or the other core elements of the 3rd platform**, and align with the emerging and radically different following "rules" of the **3rd Platform marketplace**

Additionally, for enterprises, the greatest **business value from the transition to the 3rd Platform will come from the new generation of industry solutions and service**s just starting to emerge on top of the platform. We will describe practical examples on how **building blocks could be exploited by entrepreneurs in IT emerging areas** such as smart cities, safety, logistics of people and things, energy management, content delivery, manufacturing, smart agriculture production…

The Service industry has become the biggest employer in Europe and tends to be a critical force to ensure economic growth. Our work within **FI-WARE contributes to the expansion of the service economy by creating an IT infrastructure for Business Services where services become accessible**, discoverable, compassable, easily deployable, and ultimately tradable on the Internet. In doing so, our work helps the service sector to generate new value added services, develop innovative business models, and establish new business value chains.

As ICT-based collaborations become the rule, **interoperability between business partners has become a necessity for many ecosystems.** Basically, interoperability refers to the **ability of various ICT systems and organizations to exchange data and to share information and knowledge in a reciprocal way**

Interoperability should be considered as prerequisite for open innovation: it enables enterprises to build collaborative relationships, access useful knowledge, develop and deliver new products and services, strengthening the development of business ecosystems.

In this sense, **all the players in a particular business ecosystem loose a part of their autonomy**: they act as a whole and unique entity. Inside the business ecosystems, non-economic factors, such as power structure and underlying history, play significant roles in driving the business ecosystem development: inter-organizational relationships are not fixed by market competition but rather by the will of the focal firm. **Therefore, the actual level of competition should be between ecosystems**. This change in the level of analysis requires **a change in factors to be analyzed and a new regulatory tool box for policy makers and regulation authorities**

Ecosystem economics describe how the core product (e.g., iDevices or Google ads) becomes more and more valuable, as the numbers of developers and users around it grow. **Ecosystem economics are driven by network effects and lock-in.** Ecosystem economics are often misperceived **as simple two-sided business models** that need to profit not only from users, but also from developers. This couldn't be further from the truth. **Developers, much like any complement**, drive sales of the core product, and as such need to **be viewed as partners**, not as a source of direct profit.

The new basis of competition is defined by ecosystem economics, and technology is just one part of a much more complex puzzle**.** Opportunities for such differentiation exist in the areas where **platforms are inherently weak,** or have little motivation to compete. **An example is M2M. It holds the potential to create a vibrant ecosystem of users and solution providers,** thereby establishing strong network effects and lock-in. Telco can become the central force in this emerging ecosystem if they learn to engineer the ecosystems to their advantage.

9 Glossary

API	Application Programme Interface
APK	Android Package,a packaging file format for the Android mobile operating system
B2B	Business to Business
B2B VAS	B2B value-added services
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CES	The International Consumer Electronics Show
CRM	Customer Relationship Management
FTTH	Fibre to The Home
G.E.	Generic Enabler
HTML	HyperText Markup Language
I2ND	Interface to Networks and Devices
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IDM	Identity Management
IMS	IP-Multimedia Subsystem
IoC	Internet of Cloud
IoS	Internet of Services
IoT	Internet of Things
ISPs	Internet Service Providers
LTE	Long Term Evolution
M2M	Machine to Machine
NaaS	Network as a Service
OPEX	Operating Expenses
PaaS	Platform as a Service
PC	Personal computer
QoS	Quality of Service
RCS	Rich Communications Suite
RFP	Request for Proposal
ROI	Return on Investment
SaaS	Software as a service
SDK	Software Development Kit
SES	Software Enabling Services

SI	industry solutions
SIEM	Security Information and Event Management
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SME	Small and Medium-Sized Enterprise
SMS	Short Message Service
SSO	Single sign-on
SWOT	Strengths, Weaknesses, Opportunities and Threats
TMT	Technology, Media, Telecommunications
UI	User Interface
USB	Universal Service Bus
VoIP	Voice over Internet Protocol
WAC	Wholesale Applications Community
XaaS	Everything as a ServiceThis is a section within section 1.1

10 References

- Report - M2M Global Forecast and Analysis 2011-22. Authors: Jim Morrish, Director, Emma Buckland, Principal Analyst and Matt Hatton, Director
- White Paper - Big Data in M2M: Tipping Points and Subnets of Things
- This blog post was excerpted from the authors' upcoming article "Big Data: The Management Revolution," which will appear in the October issue of Harvard Business Review.
- Anderson C (2009) Free: the future of a radical price. Hyperion, New York
- Kelly Lyons, Paul Messinger, Run Niu, Eleni Stroulia, A tale of two pricing systems for services, Information Systems and E-Business Management (25 November 2010), pp. 1-24.
- Redefining Software Platforms - How PaaS changes the game for ISVs, http://ippblog.intuit.com/blog/2009/10/redefining-software-platforms---how-paas-changes-the-game-for-isvs.html,
- "Cloud Orchestration, a real business need" by Wechalekar, Juan Ferrer & Albada Jelgersma, March 2011.
- IDC Predictions 2013 Competing on the 3rd PlatformWC20121129
- IDC Government Insights: Worldwide Smart City 2013 Top 10 predictions.
- Atos Scientific Community Papers:
    - Ascent: Economy of Internet Applications
    - Open-Source-Solutions Big Data Management
    - Internet of Things
    - PaaS_Making_the_most_of_Clouds
    - Data Analytics as a Service: unleashing the power of Cloud and Big Data
    - Ascent:Journey2016
- Machine to Machine Technologies: Unlocking the potential of a $1 trillion Industry: Matt Cullinen
- Cultivating a Developer Ecosystem: Understanding their needs- By Jerry Power, Strategic Marketing, Alcatel-Lucent
- VisionMobile-Developer-Economics-2013
- VisionMobile_Cross-Platform_Developer_Tools_2012
- VisionMobile-Telco-Innovation-Toolbox-Dec-2012
- Cocreation of value in a platform ecosystem: the case of enterprise software- Marco Ceccagnoli and Chris Forman
- Machina_Research_White_Paper_M2M_Big_Data
- Platform Competition in Two-Sided Markets- Jean-Charles Rochet and Jean Tiroley
- Dynamic Structures of Control and Generativity in Digital Ecosystems Service Innovation: The Cases of Apple and Google Mobile App Stores-Ben Eaton, Carsten Sorensen
- Structural Analysis and Visualization of Ecosystems: A Study of Mobile Device Platforms- R .C. Basole

- The success factors for app store-like platform businesses from the perspective of third-party developers: an empirical study based on a dual model framework- Hyung Jin Kim, School of Business, Yonsei University, Seoul, South Korea,
- Open Innovation within Business Ecosystems: A Tale from Amazon.com: Thierry ISCKIA & Denis LESCOP. Institut TELECOM, Evry, France
- Six Challenges in Platform Licensing and Open Innovation- Geoffrey PARKER & Marshall VAN ALSTYNE- Tulane University and Boston University / MIT
- Value Chain scenarios for M2M Ecosystem- Oswald Jumira, Riaan Wolhuter. MIH Media Lab, University of Stellenbosch