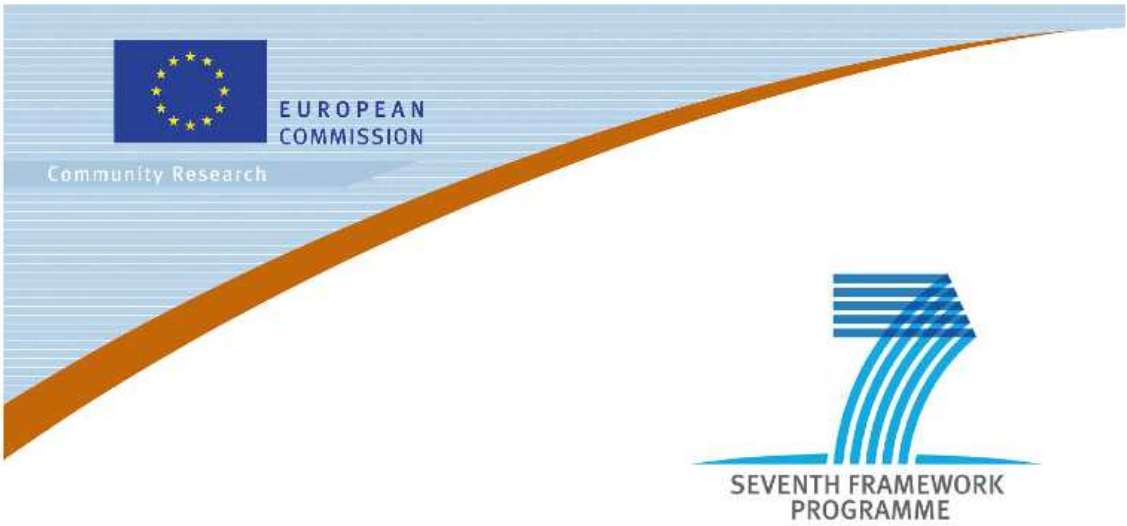

Private Public Partnership Project (PPP)

Large-scale Integrated Project (IP)

D.11.1.3: FIWARE Market and Competition Analysis

Project acronym: FIWARE

Project full title: Future Internet Core Platform

Contract No.: 285248

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1.1 Executive Summary

Following with 11.1.2., in which a preliminary **indication of the 3rd Platform as the new basis for competition in ICT** as well as its main technological elements according to market demands. Following with the mentioned new basis of competition and the superiority of ecosystem economics. The objectives of this new version of market analysis are:

- Continue to analyze **ICT Market situation** and **what is next for European App Economy:**
    - In relation with Cloud, IoT, Open Data, Smart Device, Security, Open Source.
- Deepen on how to **deliver a platform for rapid application development** and how to **create an ecosystem.**
- Analysis of the **Platform Market Positioning and of the Platform sustainability**: Foundation and Building a Community
- Analysis of the exploitation of **FI technologies in the main potential market sectors**
    - Smart Cities, Smart Industry and Public Sector, Smart Home and Smart Social
- **European Policy Opportunity**: The policy and regulatory analysis in relation to the specific themes (Data protection, Cloud computing, etc.) and the description of the conditions to create a successful EU App ecosystem.

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, Smart Industry 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 FIWARE and the FIWARE 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 FIWARE project results. This work package approaches exploitation of the FIWARE results from the point of view of the partners of the FIWARE

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 FIWARE., therefore complementing the perspectives of the partners of this project and the related stakeholders in the ecosystems they represent.

The exploitation of FIWARE results is not based on a purely technological approach (technology push) but on the needs and requirements of the future "customers" and "users" of FIWARE 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 FIWARE
- 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 FIWARE results
- Policy and Regulation Considerations
- Feedback of adjustments to project plan if necessary and promotion of the FIWARE 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` FIWARE wiki

D.11.1.3 FIWARE Market and Competition Analysis

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

FIWARE, 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	19/03/2014	Juan Bareño (Atos)
0.2	First Version	30/03/2014	Juan Bareño (Atos)
0.3	Contribution from Leaving Partners	30/05/2014	All leaving partners in M36
0.4	Second Version	30/06/2014	Juan Bareño (Atos)
0.5	Third Version	30/09/2014	Juan Bareño (Atos)
0.6	Fourth Version	15/11/2014	All WPL Leaders
0.7	Firth Version	15/12/2014	Juan Bareño (Atos)
0.8	Sixth Version	30/12/2014	Juan Bareño (Atos)
0.9	Seventh Version	30/12/2014	Juan Bareño (Atos)
0.10	Eighth Version	08/01/2015	Juan Bareño (Atos)
0.11	Final Version	13/01/2015	Juan Bareño (Atos)

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2 General Analysis

We are living in an increasingly connected world. By the year 2020 it is expected that most things will, in some way, be connected to the Internet: be they phones, cars, houses, citizens, customers etc. The possibilities that arise from having such an interconnected world are very exciting and will open the door for transforming the way that we do business. There will also be a trend towards more devices, applications and data sources being connected to and serviced from the cloud.

This evolution of the Internet is nurtured by steady evolution of ICT technology. The invention of Cloud Hosting technologies are foundational to this vision, as they turn the Internet into an environment in which anyone can communicate, consume and provide services, provide and run applications, and store and access data, Information, and Knowledge no matter what device, no matter what location, no matter what time. This emerging Internet-Computer is backed by (nearly) unlimited resources, which can be consumed on-demand, self-serviced, and are paid-per-use, that is only for actual use.

This Internet-Computer is not only based on Cloud Hosting capabilities, but will emerge alongside of **a rich set of enablers that facilitate the development of applications, which implement novel and innovative services,** or help to optimize existing and future processes. Examples of these enablers are those enabling the **Internet of Things**, or those enabling real-time gathering of data, and the analysis huge of amounts of data, since recently also known as **Big Data**.

The evolution of the Internet-Computer is still in its infancy and many of its inherent features and enablers still exist in isolation. The integration of these enabling components, however, will result in an Operating System for the Internet-Computer. The Internet-Computer, based on an Operating System that is made of a set of interoperable enablers, will turn into a platform that not only provides the kernel to manage resources and basic primitives for applications to run, but also a rich library of Generic Enablers supporting the easy and seamless development of innovative applications as those envisaged by Future Internet.

This business domain will see many players trying to integrate as many enablers as possible to define and own an instance of these Operating Systems, with the intention to convert it into a de-facto but proprietary standard Operating System of the Future Internet. The Internet has flourished due to its openness, and this needs to be preserved. **Openness is the right and only direction to take, in our opinion.**

For the past five years, IDC has predicted and chronicled the IT industry's new era with **the emerging of the "3rd Platform" for innovation and growth**, and it is built on the **four technology pillars of cloud, mobile, big data, and social networking a**nd the creative and innovative ways that businesses are using them. **This 3rd Platform is fundamentally a business platform**.

A key concern for both business and IT stakeholders who want to reinvent their organization as an adaptive digital enterprise is how they can consistently **deliver new and better digital experiences for their customers faster than their competitors.** PaaS is critical to driving business innovation through software because it enables organizations to move from a few large application updates per year to smaller updates delivered much more frequently. **Getting to market faster with new innovations for customers enables adaptive digital enterprises to pull away from their competitors**.

Open innovation is also an important aspect in the Future Internet evolution. It is becoming apparent that open relationships between customers, partners and even competitors can stimulate innovation that

would otherwise be constrained by the organizational boundaries. **Open Data is core to establishing this trust ecosystem for innovation.**

Collaborative development and open source software are defining the next generation of the enterprise and are offering developers and users unprecedented opportunity to innovate. Additionally the **Open standards in the Internet of Things (IoT) are challenging closed platform approaches**, while wearables and other consumer and lifestyle technology are opening up new ecosystems and opportunities. The proliferation of devices with communicating actuating capabilities is bringing closer the vision of an Internet of Things, where the sensing and actuation functions seamlessly blend into the background and new capabilities are made possible through access of rich new information sources. **IoT is an ideal emerging technology to influence the application domain by providing new evolving data** and the required computational resources for creating revolutionary apps.

Almost every company is becoming a software company. By considering business and operating models pioneered by the software industry and tailoring them to their own needs, **organizations can lower their costs, boost performance, and turn software into a competitive advantage.** Software is becoming critical for almost every company's performance.

The opportunities to improve efficiencies and create valuable new business models associated with the Industrial Internet are vast. To do so, however, requires the development of specialized platforms, data models and analytic capabilities to meet the many unique and critical requirements associated with industrial data, workloads, and processes. The companies that make up the industrial sectors, manufacturers of industrial equipment and technology vendors must work together to **develop the platforms and technologies needed to leverage the Industrial Internet**, with particular attention paid to the opportunities and requirements outlined above**.** Additionally beyond technology requirements**, policy and legal issues must also be addressed** to fully leverage the Industrial Internet.

For Europe, the extent and pace of these changes will depend not just on the market but also the **European policy environment** and, as Vision Mobile recommend, there are a number of areas where we believe **governments in Europe can make a difference and support the App Economy:**

- Facilitating access to government data for developers, e.g. mapping, meteorological and real time public transport data as well as information on community level services.
- Enhancing connectivity by making more spectrums available for wireless services.
- Advancing the European single market in intellectual property and communications.
- Embracing app-driven innovation across all sectors, e.g. health, education, enterprise, lifestyle.
- Ensuring a flexible and supportive business environment for start-ups and entrepreneurs.

3 Analysis of the main Technology components required for the App Enablement Platform

The history of the technology industry has largely been defined by individual companies building software behind closed doors. Today, thanks in part to the path that Linux has blazed, software is increasingly built collaboratively. This is resulting **in better software, more innovation and faster realization of new technologies.** This is nowhere more evident today than in the cloud. This open approach to building software **is advancing cloud computing at an accelerated pace** and customers have the opportunity to invest in a strategic platform that is open from the ground up.

The cloud is emerging as one of the most important new technology platforms in decades, and it represents a unique inflection point, one that offers **unprecedented choice for both developers and users**. Developers are more engaged to build what they want, how they want, all by using the best software from a variety of projects. Users are getting involved in the development of these technologies unlike ever before, they're taking an active interest in how technology will be applied as they build it and **are collaborating with other users of that technology. Consider Netflix, Amazon and Salesforce as just a few examples**.

The open cloud, like Linux, is fueling dramatic enterprise innovation and growth, which in turn is spurring a worldwide transformation of the technology landscape. The flurry of innovation is resulting in a variety of **different open cloud technologies** across a very tall stack of software, which can easily lead to confusion.

- The **open cloud** is one in which every component, from the software to the APIs used by application developers, is **open to vendors, developers and customers alike**. While proprietary cloud vendors promote their open APIs, an open cloud cannot be constructed from closed components. **APIs that are open today, after all, may be closed tomorrow, unless the code is available.**
- **Components of the open cloud** today share a couple of key characteristics. Most obviously, they are released under an **open-source license**; this can be a reciprocal-style license such as the GPL used by the Linux kernel or an alternative like the Apache or MIT licenses. While the licenses carry with them different obligations, they all guarantee full and unrestricted access to the project's codebase.
- **While the code is critical**, **the community around the project is of equal long-term importance**. To ensure the ongoing viability of a given project, it must h**ave an ecosystem in terms of contributors and users that work overtime to support it**. It is this community that is most likely to enable the **initial experimentation and proof-of-concept** build-outs that represent the first steps towards an open cloud.

Building upon an open cloud provides all the **same benefits as the rest of the universe of open source software**, such as:

- Improved code quality of the underlying cloud implementation;
- Insurance against lock-in as well as the failure of your cloud provider;
- Increased security, with the ability to fix vulnerabilities yourself; and
- Freedom from mandatory licensing costs; among others.

Collaborative development and open source software are defining the next generation of the enterprise and are **offering developers and users unprecedented opportunity to innovate**.

Additionally the **Open standards in the Internet of Things (IoT) are challenging closed platform approaches**, while wearables and other consumer and lifestyle technology are opening up new

ecosystems and opportunities. **The proliferation of devices** with communicating–actuating capabilities is bringing **closer the vision of an Internet of Things**, where the sensing and actuation functions seamlessly blend into the background and new capabilities are made possible through access of rich new information sources. **IoT is an ideal emerging technology to influence the application domain by providing new evolving data and the required computational resources for creating revolutionary apps**.

As PTC Inc. comments, the world has seen a series of technology innovations that make the IoT both technologically and financially feasible today. Technology innovations across computing and communication infrastructures, as well as the things themselves, have converged after all, the Internet now connects the car, the home appliance, and the office building.

- **Computing Infrastructure**: Data capture and analytics tools and new business and software applications create new forms of value
    - **Expanded Data Storage Capabilities**: This technical innovation has supported increased data creation. In fact, 90 percent of the world's data has been created in the last two years alone
    - **Increasing Processor Performance/Efficiency**: In these twenty years, CPU power consumption increased by 10x while CPU processing performance exploded by 47x
    - **Evolution of Cloud Computing/Big Data Tools**: Gartner projects that the Infrastructure as a Service (IaaS) industry will grow by 41 percent through 2016 to become a 24 billion dollar industry. **Emerging frameworks like Hadoop**, a data processing framework and distributed file system, promote efficient analysis of ever-growing data sets

As this ecosystem, **Internet of Things (IoT),** converges with major trends like **cloud computing and Big Data,** businesses need to be prepared to securely address the new wave of connected intelligent device and protect the data that comes with them.

Europe is lagging behind USA, so after prior proprietary attempts, **an Open platform approach will help to remove the barriers to growing innovation** and **energize developers and entrepreneurs to build the applications and businesses** of the future Open approach (system, quick innovation) and not to lose **the IoT opportunity.**

This analysis describes the desired capabilities and building blocks that need to be established for such open 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 that will come from the **new generation of industry solutions and services just starting to emerge on top of the platform**.

3.1 Cloud Computing

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**. **The open cloud, like Linux, is fueling dramatic enterprise innovation and growth, which in turn is spurring a worldwide transformation of the technology landscape**. The flurry of innovation is resulting in a variety of different open cloud technologies across a very tall stack of software

What really changed **the way people thought about public clouds, from both a service delivery perspective and an architectural perspective, was Amazon Web Services**. Amazon broadened virtualization beyond single servers to entire datacenters, in a highly automated and super-scale fashion. In this manner, Amazon provided much of the inspiration for the resulting cloud software platforms market. **The cloud system software market is diverging into two primary classes:**

- One, a public cloud–inspired model that was **pioneered by Amazon**
- **The other primary type of cloud system software is an evolution of traditional enterprise server** virtualization seen more in private cloud deployments.

The battle for the cloud system software market is building as virtualization evolves into IaaS clouds. Open Stack has several key technology and business challenges to address as it competes for the open cloud throne. If it can successfully navigate these challenges, Open Stack can be a significant player in the cloud market and disrupt and spread out in a variety of ways much like Linux did before it.

3.1.1 Cloud Technology: Virtualization evolves into IaaS clouds with Open Stack attracting much of the attention

We are living in an increasingly connected world. By the year 2020 it is expected that most things will, in some way, be connected to the Internet: be they phones, cars, houses, citizens, customers etc. The possibilities that arise from having such an interconnected world are very exciting and will open the door for transforming the way that we do business. There will also be a trend towards more devices, applications and data sources being connected to and serviced from the cloud. As a result, enterprises will look to **release themselves from some of the constraints of on premise hosting and dedicated application stacks**, instead **adopting cloud computing a**pproaches to enable links into the wider connected world.

However, in many cases, cloud strategies have to vary according to specific business applications or processes, since there is rarely a one size fits all solutions. This can lead to **complex hybrid delivery models, where workflows and data flows may span multiple public and / or private clouds**. Process inefficiencies and disconnects arising from the **implementation of disaggregated cloud services** present a significant risk to the integrity of established business operations. "**Cloud Orchestration" focused primarily on the concept of orchestrating the business processes and end-to-end services** in a multi-cloud environment, harmonizing workflows independently of the underlying infrastructure.

With the advent of smartphones, tablets and other intelligent devices that are now participating in the complete enterprise ecosystem, **interaction patterns between cloud components and service consumers become even more complex.**

A key concern for both business and IT stakeholders who want to reinvent their organization as an adaptive digital enterprise is how they can consistently deliver new and better digital experiences for their customers faster than their competitors. **PaaS is critical to driving business innovation** through software because it enables organizations to move from a few large application updates per year to smaller updates delivered much more frequently. **Getting to market faster with new innovations for customers enables adaptive digital enterprises to pull away from their competitors.**

The cloud is emerging as one of the most important new technology platforms in decades, and it represents a unique inflection point, one **that offers unprecedented choice for both developers and users**. Developers are more engaged to build what they want, how they want, all by using the best software from a variety of projects. Users are getting involved in the development of these technologies unlike ever before, resulting in a change in culture that is referred to as DevOps. They're taking an active interest in how technology will be applied as they build it and are collaborating with other users of that technology. Consider Netflix, Amazon and Salesforce as just a few examples.

Virtualization continues to be an important technology and foundation for cloud. However, the hypervisor is commoditizing, and the virtualization market today is moving to a layer of software above the hypervisor called cloud system software. While a hypervisor abstracts the resources of a single server, **cloud system software abstracts across large pools of compute, storage, and networking**. These

resources are wrapped into cloud APIs, managed in an automated fashion, and made available through Web portals. Cloud providers have used this approach to build their public clouds, and now this type of software is becoming widely available in the market for enterprises **to deploy on premises and create infrastructure-as-a-service (IaaS) private clouds.**

As IDC consider, cloud is often defined in many different ways, but at its essence, it is a **delivery model for IT that provides elastic, agile services in an on-demand, pay-as-you-go fashion.** However, a service model doesn't necessarily imply that a new architecture is needed. **For example, a very small-scale cloud can be implemented using a traditional virtualized infrastructure with a Web portal on top**. However, to accommodate more complex and large-scale deployments, many are beginning to use different architectures that are specifically designed for cloud.

- While **virtualization is generally considered a foundation for cloud**, it is not always so. Many public software-as-a-service (SaaS) clouds today don't use virtualization, instead providing high levels of service and performance using clusters of bare-metal servers. This is made possible when an application's requirements are well-known and capacity increments are measured in whole servers or racks.
- What really changed **the way people thought about public clouds, from both a service delivery perspective and an architectural perspective, was Amazon Web Services**. Amazon broadened virtualization beyond single servers to entire datacenters, in a highly automated and super-scale fashion. In this manner, Amazon provided much of the inspiration for the resulting cloud software platforms market.
- **For private clouds, the inspiration came from server virtualization**. Virtualization management frameworks were extended into private cloud frameworks and provided a path to evolve virtualization deployments into private cloud deployments. The underlying system software for these clouds consisted primarily of operating systems and hypervisors.
- Most cloud system software solutions act as an overlay **to existing virtualization and management infrastructure,** replacing the user's management interface with one that provides a higher level of abstraction. This gives the user the ability to orchestrate low-level resources into pools and often provides higher-level cloud APIs that other management software can use. Existing virtualization vendors and open source projects added these concepts to their platforms, and new vendors and open source projects designed using these principles have begun to emerge.

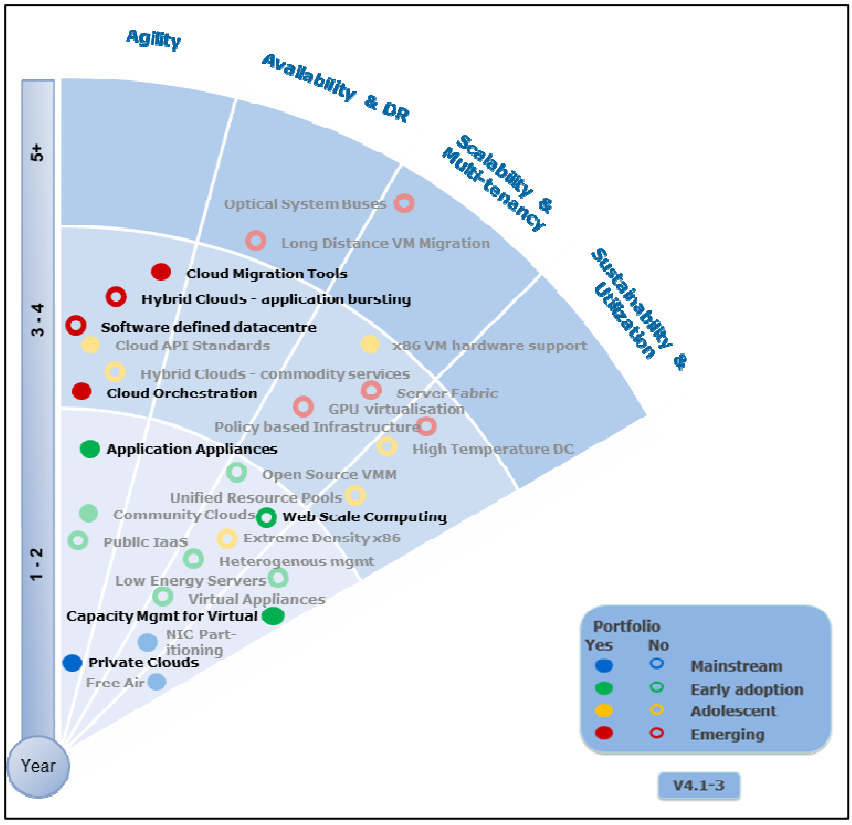


Figure 1: Cloud Computing Solutions

The open cloud, like Linux, is fueling dramatic enterprise innovation and growth, which in turn is spurring a worldwide transformation of the technology landscape. The flurry of innovation is resulting in a variety of **different open cloud technologies across** a very tall stack of software, which can easily lead to confusion. **Open source has long dominated public cloud platforms for many reasons**:

- **Cost.** Many public clouds target consumers with free or low-cost services, and in the enterprise space, Amazon redefined the computing market with its utility-like model. Using open source software allows providers to create business models that can meet these economic requirements. The lower cost to operate is due to the provider's ability to self-support infrastructure and implements purpose optimized solutions.
- **Customizability**. The software services of a cloud are the core and intellectual property of a cloud provider's business. Creating unique services at a reasonable cost often requires extensive customizability, and open source software enables this to happen.
- **Full visibility**. Having access to the source code allows cloud service providers to fully understand and debug the software if needed. Some providers that use open source never become heavily involved in modifying or developing the code, simply using vanilla builds of the software. However, many make use of access to the source code in order to self-support and customize the software because many cloud providers do not use a commercially supported version. Access to the source code allows providers to fully understand how the software works, tune performance, build custom software around it, and track down problems where they occur.
- **Collaborative development model.** The Linux and open source software communities have proven that they can build quality software and build it very quickly, and customers benefit from this virtuous cycle of development. Providers can be fully vested in the technology running their cloud systems and have direct access to the people building it. Open development in the cloud is

one of the ways that the industry is addressing the increasing complexities of computing faster and more efficiently.

A strong community can also help preserve the goals of an open cloud. Lock-in has been a pervasive issue since the dawn of IT, and **cloud has the potential for greater abuse and lock-in than ever.** On the commercial side, they offer inherent transparency, multiple alternatives, and a self-policing community that ultimately serves the needs of everyone. **Cloud computing is changing the IT market** in a multitude of ways.

- **Public clouds** are changing the way enterprises deploy computing resources, and private clouds are changing how enterprises approach their own IT.
- **Open source software** has played a leading role in the development of public clouds and now is moving into the private cloud space. Most open source cloud software builds on existing open source (Xen and KVM) or proprietary hypervisors and operating systems (Linux) by developing a new complementary class of software that IDC terms "cloud system software.
- **Cloud system software provides abstraction and APIs at a higher level than a hypervisor**. Open source cloud system software such as CloudStack, Eucalyptus, and OpenStack allows enterprises **to build "Amazon style" clouds in their own datacenters**.

OPEN CLOUD PROFILES	ACTORS	DESCRIPTION	KEY CONTRIBUTORS	COMMERCIAL SUPPORT	LICENSE, LANGUAGE and LINES of CODE	KEY USERS
HYPERVISOR & CONTAINER	KVM	KVM is a lightweight hypervisor that was accepted into the Linux kernel in February	HP, IBM, Intel, NetApp, Red Hat	HP, IBM, Red Hat	GPL, C(95%)	
	XEN	Xen is a cross-platform software hypervisor that runs on platforms such as BSD, Linux and Solaris.	AMD, Bromium, Calxeda, CA Technologies, Cisco, Citrix, Intel,	Citrix, Oracle	GPL, C(78%), 507.000	Amazon, Rackspace, Verizon
IAAS	CloudStack	CloudStack is an open source IaaS platform with Amazon Web Services (AWS) compatibility.	Citrix Basho, Citrix, Cloudera , Spotify, SunGard, WebMD	Citrix	Apache 2, Java (67%) and 2.7MM lines of code	Alcatel Lucent, BT, Datapipe, Edmunds.com, Gilt, IBM (Softlayer), Grid5000, NTT, Spotify, TATA Communications, Terramark, TomTom, Verizon, WebMD, Zynga
	Eucalyptus	Eucalyptus is an open-source IaaS platform for building AWS-compatible private and	Eucalyptus Systems	Eucalyptus Systems	GPLv3, Java (49%) and 1.4MM lines of code	App Dynamics, FDA, NIST, Nokia Siemens Network, Puma, Riot Games
	OpenNebula	OpenNebula is an open-source IaaS platform for building and managing virtualized enterprise data centers and private clouds	C12G Labs	C12G Labs, inovex, Logica, Netways, Terradue	Apache 2, C++ (32%) and 190.000 lines of code	Akamai, BBC, Blackberry, CentOS, China Mobile, Deutsche Post E-Pos, European Space Agency, FermiLab, Produban - Santander Group, SARA Supercomputing Center
	OpenStack	OpenStack is an open source IaaS platform, covering compute, storage and networking.	eNovance, HP, IBM, Intel, Mirantis, Rackspace, Red Hat, SUSE, Vmware	Canonical, Cisco, Cloudscaling, Hastexo, HP, IBM, Mirantis, Rackspace, Red Hat, SUSE	Apache 2, Python (63%) and 1,69MM lines of code	Best Buy, CERN, Comcast, eBay, Deutsche Telekom, HP, MercadoLibre, PayPal, Rackspace, Sony, Wikimedia, Workday
PAAS	CloudFoundry	Cloud Foundry is an open Platform-as-a-Service, providing a choice of clouds, developer frameworks and application services.	ActiveState, AppFog, IBM, Pivotal	ActiveState, AppFog, IBM, Pivotal	Apache 2, Ruby (36%), JavaScript (33%) and 578.000 lines of code	Baidu, GE, Rakuten DOCKER.IO
	Docker	Docker is an open-source engine for building, packing and running any application as a lightweight container and is built upon the LXC container mechanism included in the Linux kernel.	dotCloud	dotCloud	Apache 2.0, GO (63%) and 28.000 lines of code	Cloudflare, eBay, Mozilla, Uber
	OpenShift	OpenShift is Red Hat's Platform-as-a-Service offering. OpenShift is a cloud application platform where application developers and teams can build, test, deploy, and run their applications in a cloud environment	Red Hat	Red Hat	Apache 2, Ruby (52%) and 152.000 lines of code.	Accenture, Cloud9.io, PayPal, Roche
PROVISIONING AND MANAGEMENT	Chef	Chef is a configuration-management tool, controlled using an extension of Ruby.	Opscode	Opscode	Apache 2, Ruby (95%) and 102.000 lines of code.	ancestry.com, IGN, LAN Airlines, University of Minnesota, Voxel
	Puppet	Puppet is IT automation software that helps system administrators manage infrastructure throughout its lifecycle.	Puppet Labs	Puppet Labs	Apache 2, Ruby (98%) though PuppetDB is written in Clojure and 295.000 lines of code.	eBay, Google, JP Morgan Chase, Twitter, Viacome
	Salt	Salt is a configuration management tool focused on speed and incorporating orchestration features.	SaltStack	SaltStack	Apache 2, Python (83%) and 82.000 lines of code	Cars.com, HP Cloud, Hulu, LinkedIn
	Vagrant	Vagrant is an open source tool for building and managing development environments, often within virtual machines	Mitchell Hashimoto	HashiCorp	MIT, Ruby (100%) and 19.000 lines of code	BBC, DISQUS, Expedia, Mozilla, O'Reilly
	Juju	Juju is a service orchestration management tool.	Canonical	Canonical	AGPL, GO and 196.000 lines of code	ScraperWiki
	oVirt	oVirt provides a feature-rich management system for virtualized servers with advanced capabilities for hosts and guests	Canonical, Cisco, IBM, Intel, NetApp, Red Hat, SUSE	IBM, Red Hat	GPL, Python (69%) and 206.000 lines of code	Primarily hosting companies, research institutions and universities, and small businesses.
STORAGE	Ceph	Ceph is a distributed object store and file system.	Inktank	Inktank	LGPL, C++ (81%) and 387.000 lines of code	Bloomberg, Dreamhost, eBay
	GlusterFS	GlusterFS is a scale-out, distributed file system. It is developed by the Gluster community, a global community of users, developers and other contributors	Citrix, DataLab, Harvard FAS Research Computing, Harvard University, Hortonworks, Intel, Open Source Lab at	Red Hat, Scalable Informatics	Dual-licensed under GPL v2 and LGPL v3+, C (92%) and 588.000 lines of code	Box.net, Intuit, Harvard FAS Research Computing, Pandora, Samsung
	Riak CS	Riak CS is an open source storage system built on top of the Riak key-value store	Basho	Basho	Apache, Erlang (94%) and 24.000 lines of code	Yahoo Japan

Table 1 Open Cloud Profiles

The cloud system software market is diverging into two primary classes. One, a public cloud–inspired model that was **pioneered by Amazon**:

- Is designed for maximum scale and cost efficiency
- Focuses on availability by zones instead of by Virtual Machine (VM), with more of the availability responsibility as part of the application architecture
- Provides cloud services such as object storage, elastic scaling, load balancing, and database

- Leans toward commodity hardware
- Focuses on new apps written for cloud environments
- Is designed to create types and levels of services, which apps are then written to utilize

The other primary type of cloud system software is an evolution of traditional enterprise server virtualization seen more in private cloud deployments and:

- Is compatible with existing applications
- Focuses on making sure mission-critical VMs never go down, with availability primarily a function of the infrastructure
- Accommodates enterprise hardware and architectures (SANs, VLANs, etc.)
- Is designed and tuned to meet individual application requirements

Traditional enterprise players like VMware and Microsoft are strong in the private cloud market, evolving their virtualization install bases into clouds. **Newer open source cloud projects like Open Stack, Cloud Stack, and Eucalyptus were started to create Amazon-style public clouds**. As these vendors mature, each is beginning to pick up characteristics of the other, allowing customers to deploy both styles of cloud with the same software platform and more hybrid styles with characteristics of public and private types.

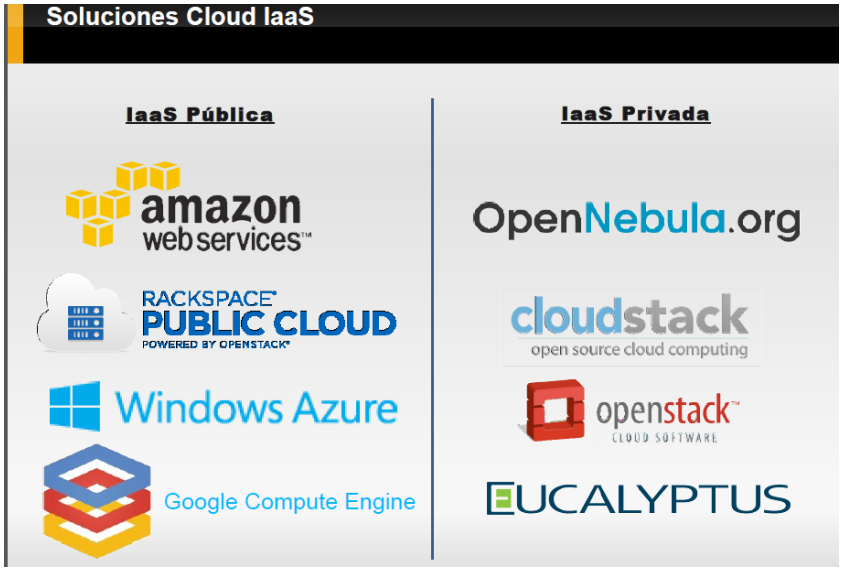


Figure 2: IaaS Cloud Solutions

The battle for the cloud system software market is building as virtualization evolves into IaaS clouds. Established proprietary virtualization vendors like VMware and Microsoft have a big enterprise presence and want to convert that into cloud business. On the open source side, there are no less than four major projects competing for resources, **with Open Stack attracting much of the attention.** Open Stack has built a tremendous amount of momentum and industry support. Findings include:

- **Open Stack is emerging as the de facto open source private cloud framework**. Open Stack 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. **Open Stack is well poised to deliver massive portability and interoperability for IaaS applications.**

- **Open Stack is an open source IaaS platform, covering compute, storage and networking, with several key technology and business challenges** to address as it competes for the open cloud throne. If it can successfully navigate these challenges, Open Stack can be a significant player in the cloud market and disrupt and spread out in a variety of ways much like Linux did before it.

Open Stack is an open source cloud system software project that has broad participation from the IT industry. Open Stack is proven software that is currently being used by a growing number of enterprises, service providers, VARs, research institutions, and other organizations deploying large-scale cloud computing operations. It is fully multi-tenant to support IaaS and other cloud models and can scale to thousands of compute nodes. Multiple network models, block storage options, and hypervisors are supported. A six-month community-supported development cycle adds new features. **Open Stack consists of several core modules a**nd has established a process to incubate and develop new modules that can extend functionality.

- **One of the main goals of being an open cloud system is interoperabil**ity, with the idea that clouds built on Open Stack should have a reasonable level of portability between them. Because Open Stack is open source, the inner workings of an Open Stack cloud and its APIs are fully transparent and anyone can participate in the development process if they choose to.

- **As with previous open source projects such as Linux, Open Stack is becoming available in a wide range of forms**. It is used by service providers to produce finished cloud services, embedded into appliances and converged infrastructure, as well as developed into commercially supported software offerings. With tremendous momentum and industry backing, Open Stack is poised to become a major factor in the emerging cloud system software market. Drawing on its experience and methodology with enterprise Linux, Red Hat is bringing to market a commercially supported and tested version of Open Stack, which will target customers that want an enterprise-ready distribution of Open Stack.

- Because Open Stack is open source, **Telcos and Hosters don’t have to lock into a single, proprietary vendor strategy**. In fact, they are able to point their own technicians and developers at creating a cloud infrastructure that delivers differentiated IaaS offerings that fit their own business model. For example, they can hook Open Stack into their data center environment and billing systems.

- Besides offering compelling technology, **Open Stack offers real cost advantages**. The code is open source; there are no licensing fees. That immediately reduces costs and increases profit margins. It also allows telcos to take control of their service offerings by eliminating reliance on any single vendor that has its own business strategy to promote. There are currently over 100 leading companies around the world participating in the Open Stack community**.**

According to IDC , many factors will contribute to **the success of Open Stack** in the market over the next few years:

- **The hypervisor**. Cloud providers deploying Open Stack will, for reasons of cost and support with Open Stack, continue to use primarily KVM and Xen open source hypervisors. This may reduce the desire for enterprise customers to use their existing hypervisors and go with open source KVM or Xen, which don't enjoy the market share of proprietary software today in the enterprise market.

- **APIs, openness, and lock-in.** Open Stack has developed its own open API as part of the project. Cloud APIs have been a big focus of the industry, with controversy over openness, standards, Amazon APIs, and lock-in:

    - **Amazon Web Services (AWS)** is the most popular public cloud service today, and many see the Amazon APIs as the de facto APIs that others need to adopt. While compatibility with the Amazon APIs is one aspect, using the Amazon as the core API for a developing cloud platform is simply unfeasible. **The Amazon APIs are the intellectual property of Amazon, and the development of those APIs is controlled fully by Amazon**. A project like Open Stack cannot innovate against APIs that a third party controls. However, **Open Stack** as well as other open source cloud projects **do provide varying levels of Amazon API compatibility, allowing them to interface with AWS.**

    - **One of the core tenets of Open Stack API openness** is that the community develops the API under a transparent and collaborative process, with the results being fully open source. It is expected that multiple cloud providers implementing Open Stack will have at least a base level of interoperability with each other. Lock-in is a problem that isn't fully solvable today, but Open Stack addresses the problem as well as practically possible.

- **Deployment and support model**. The pace of Open Stack is blistering, with new releases every six months. In this early innovation cycle of cloud, where each release brings significant new features and enhancements, there are no minor releases. In general, the pace of cloud is much faster than enterprise IT:

    - **Upgrades have been an unaddressed problem for Open Stack**. There is no built-in mechanism for non-disruptive upgrades, and each upgrade often breaks things with previous versions. Even if the upgrade problem can be solved in time and made non-disruptive, it's not clear that enterprises can follow the Amazon and Google model of continuous deployment. Enterprises are generally very conservative and like to extensively test, deploy, and then support a product for a very long time.

- **A public cloud provider**. Open Stack was originally developed from the point of view of a public cloud provider.

    - While the software is being adapted to meet the needs of enterprise public cloud, that ecosystem will take time to build.. Focusing on the emerging opportunity, the new Amazon-style applications, rather than trying to chase legacy compatibility, may be the right use of resources.

    - Much of the market today is confused over the difference between virtualization and cloud, much less the difference between cloud architectures, so expectations and use cases will have to be set accordingly.

The ecosystem is critical for any platform, and the Open Stack ecosystem has been growing very rapidly. Like Linux, much of the software ecosystem is involved in packaging Open Stack into supported distributions. To make the software consumable by enterprises, significant resources need to be invested in documentation, patching, making the install easy, and so forth. **Key players:**

- **Canonical (Ubuntu):** Ubuntu is currently the most popular distribution of Open Stack, as Ubuntu has played a very large and important role in the early Open Stack community and that has led to a lot of Open Stack credibility.

- **Red Hat:** Red Hat's Open Stack distribution will be an add-on to RHEL and focus on making Open Stack enterprise ready and consumable. Open Stack will be the base IaaS layer, with CloudForms layered on top to enable use and management of different cloud types. Open Shift, a PaaS layer, can be added to for application development functionality.

- **Nebula:** Nebula, a start-up created by one of the original Open Stack founders, is pursuing an appliance model to make Open Stack more approachable. The idea is that customers will buy an Open Stack controller appliance, which will front industry-standard servers to create an Open Stack cloud. The company is in beta mode, with no publicly announced date for availability of the product.

- **Cloudscaling**. Cloudscaling is one of the newest Open Stack start-ups. It is enhancing Open Stack in several ways beyond the core Open Stack technologies. Cloudscaling adds proprietary add-on modules to enhance Open Stack such as application management, topology management, monitoring, performance optimization, security, and availability. It is also noted for its work in public cloud federation, adding Google Compute Engine and Amazon support. Outside of the pure distributors, **other significant vendors are heavily involved in OpenStack**:

    - **Rackspace.** As one of the creators of Open Stack, Rackspace is a particularly visible member of the ecosystem. It uses Open Stack to power the Rackspace Cloud, which offers core Open Stack services as well as Rackspace-enhanced services. It is positioned as the open alternative to Amazon.

    - **Cisco**. Cisco is contributing heavily to the networking code in Open Stack and integrating Open Stack with its UCS servers and networking gear.

    - **IBM**. IBM has been a big backer of open source projects such as KVM and Linux, so its considerable support of Open Stack is no surprise. Open Stack may become embedded into some IBM products as integrated software for some use cases, but it will also likely use commercial distributions from longtime partners like Red Hat and SUSE.

    - **HP.** HP made one of the largest early commitments to Open Stack, using it to power its CloudSystem. HP's public CloudSystem cloud is based on Open Stack and enhanced with additional HP software and services. The company is focused on being price competitive with Amazon while providing an enterprise-grade cloud.

    - **NetApp.** Networked storage is standard for most enterprises, but Open Stack was originally developed for cloud providers that often use direct-attached storage. NetApp has been contributing to Open Stack to add support for NetApp storage hardware and technologies.

3.1.2 Cloud Computing: Platforms Consolidate, Innovation Explodes

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**.

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**.

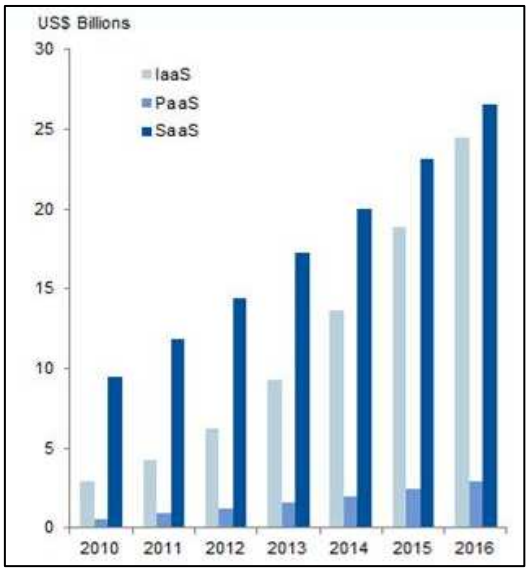


Figure 3: Cloud Market demand. Source: Gartner

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

In this chapter we outline the major recent developments in this field, distinguishing between **3 main hosting models.**

- The most “basic” one is to **host entire servers (typically virtual),** as well as corresponding block storage volumes, and networks connecting between the different application components. In this model the provider provides basic resources, and the rest is done by the application owner.
- The second model **adds extra level of aggregation and automation on top of individual resources**, moving to a more holistic approach to managing collections of resources used by a software stack.
- **The third model assumes higher level of abstraction to host application components**, such as containers of specific programming language.

These three models facilitate a rapidly growing ecosystem of various technologies and commercial offerings. We outline here the most important:

- **The most “basic” model is to host entire servers (typically virtual)**, as well as corresponding block storage volumes, and networks connecting between the different application components. In this model the provider provides basic resources, and the rest is done by the application owner.
    - **In the public cloud space, the leading commercial vendors providing this kind of offering are Amazon with Elastic Compute Cloud (EC2**), Rackspace, Google with Google Compute Engine (GCE) and IBM with SoftLayer.
    - **In the private cloud space, the leading vendor is VMware**. However, **the most disruptive and notable trend in the IaaS space is the evolution of OpenS tack** the rapidly growing open source 'infrastructure as a service' cloud middleware, jointly developed by hundreds of commercial companies across industrial sectors, and rapidly adopted by many vendors for both public and private cloud offerings (notably Rackspace, HP, IBM, and many others).
- **The second model adds extra level of aggregation and automation on top of individual resources,** moving to a more holistic approach to managing collections of resources used by a software stack.
    - Key vendors that provide offerings in this space include VMware (with vCloud Director), Amazon (with CloudFormation and OpsWorks), RightScale, IBM (with PureApp), Gigaspaces (with Cloudify). **While most of the solutions above are proprietary, this market segment undergoes significant changes with the introduction of orchestration capabilities in Open Stack**, and their growing wide adoption and support by the vendors who are invested in Open Stack ecosystem. **Being open source, Open Stack shifts the business model of many vendors from focusing fee-based value-add features to emphasis on services and support** (which is a common practice in the open source world).
- **The third model assumes higher level of abstraction to host application components, such as containers of specific programming language**. This model is **commonly known as 'Platform as a Service' (PaaS)**.
    - The key vendor in this space are Microsoft, with Azure, providing both public and private cloud offerings, as well as Google with Google App Engine, following public cloud model. There are multiple open source initiatives addressing the PaaS needs. The most notable is CloudFoundry, established by VMware and now evolving into a full-fledged community project with many companies joining (including IBM, HP, Rackspace and SAP).
    - In addition, there is a new initiative to develop 'native' PaaS capabilities in Open Stack (code name Open Stack Solum), leveraging PaaS-level services which are already part of Open Stack ecosystem (queueing, data processing, etc). The latter is at initial evolution

stages, but given the Open Stack community momentum, it is likely to become a significant technology going forward.

As briefly outlined above, these three models facilitate a rapidly growing ecosystem of various technologies and commercial offerings.

	Advantages	Downsides
VMware vCloud	-Battle tested -Comprehensive feature set -Widest support amongst app vendors	-Expensive -Lacks interoperability -Lacks integration
Open Stack	-Free -Large community -Wide integration with storage, network and compute technologies	-Lacks enterprise features -Difficult to deploy and configure -Lacks interoperability
CloudStack	-Free -Supported by Citrix and friends -Battle tested and scalable	-Smaller community -Fewer server, network and storage devices supported -Less flexibility
Amazon EC2	-Cheap for some workloads -Rapid deployment -Infinite scalability	-Expensive for some workloads -Limited control -Compliance concerns

Table 2 Cloud Market demand. Source: Gartner

The cloud competition has been more of a chase than a race**, as Amazon Web Services maintained a sizeable lead** over other cloud providers**. Google, however, has closed the gap.**

- **Docker and its promise of portability across platforms** have become some of the most talked about ideas in cloud computing, despite being around for just 18 months. Google is leading one of the most prominent open source efforts around the container technology with its Kubernetes project, while seemingly every other cloud vendor, from AWS to VMware, supports Docker.
- And while questions remain about their long-term role in the enterprise, legacy vendors such as **IBM, VMware and HP continue to trumpet open source initiatives such as Cloud Foundry and Open Stack.**

AWS enjoys a first-mover advantage since its cloud has been running for years. As a result, it enjoys a much larger partner ecosystem of software-as-a-service, or SaaS, applications and optimization services that are built to run seamlessly on the AWS cloud. Azure, however, is newer, and the report says that it still sports some feature gaps in security functionality and networking. Its partner network is also still growing.

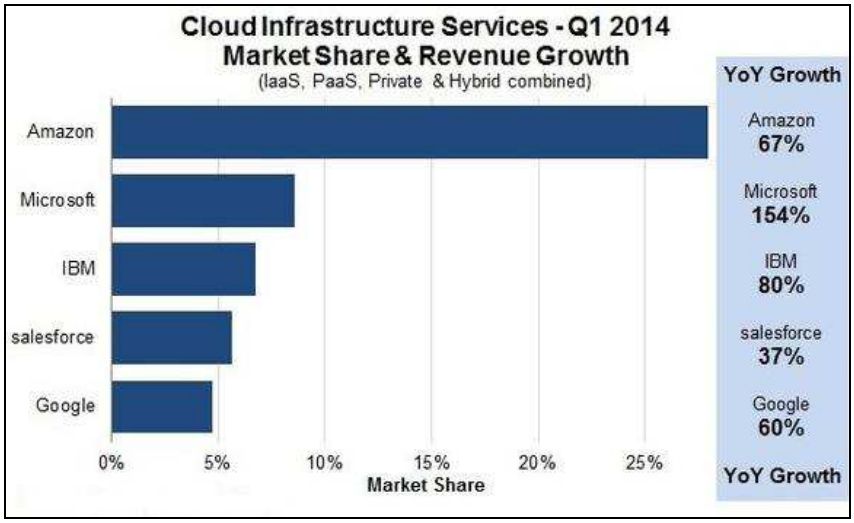


Figure 4: Cloud Infrastructure Services. Source: Synergy Research Group.

Amazon's cloud computing service, AWS, has more than five times the combined capacity of its next 14 rivals, according to a research report by Gartner. But the Gartner report argues that **Amazon has reached a staggering level of dominance in enterprise-level computing services for big companies**

The below ''Magic Quadrant'' from Gartner shows AWS' leading position **in cloud IaaS**. Only Microsoft was ranked in the ''market leaders'' quadrant with AWS. The Gartner report noted that the other vendors are still far behind AWS and Microsoft Azure.

Figure 5: Cloud IaaS Gartner´s Magic Quadrant. May 2014

IDC predicts that in 2014, cloud spending including cloud services and the technology to enable services will grow a remarkable 25%, reaching over $100 billion. **Over 75% of that spending will skew toward public (multi-enterprise) clouds rather than private clouds for one simple reason**: that's where the next generation of enterprise applications and solutions are being developed.

- **Escalation setting the stage for consolidation among IaaS players**. IDC predicts that Amazon, Microsoft, IBM, HP, and others will dramatically escalate their cloud datacenter deployments in 2014. Amazon will continue to expand its very large footprint to 30 or more availability zones

(from today's 26), particularly where it has gaps in Latin America and Asia. Cloud is a scale and liquidity game and players without massive scale will be uncompetitive, missing out on major customer opportunities. **IDC predicts that by 2017, there will be just six to eight major global players in IaaS**, perhaps fewer, based on which companies are willing to invest massive capital into a global cloud delivery capability. They will come from among the three big "integrated stack" providers (Amazon Web Services, Google, and Microsoft) plus a small number of major players **around two or three of the open ecosystem platforms which include OpenStack, VMware, and CloudStack** (each vying to become "the Android of the cloud platforms"). If the **"NSA/Snowden effect" and/or "data sovereignty" requirements lead to country and regional governments legislating/regulating in favour of local cloud providers**, and effectively against the global players' cloud offerings, we could see acceleration of global players establishing local presence in more countries as well as opportunities for a significant number of regional players catering to region-specific requirements.

- In 2014, it will become even clearer that **value is migrating from pure IaaS toward IaaS with PaaS capabilities**. IaaS providers with no PaaS services including development, testing, staging, deployment, and ongoing monitoring and management and no ecosystem of developers and solutions will be unable to meet the requirements of both enterprise customers and commercial cloud app/SaaS developers.
- **IDC predicts that by 2017, 80% or more of new cloud solutions (and developers) will be hosted on (and aligned with) the top 6 of these competing platforms**.A key differentiator in this battle will be cloud resource scale, or "cloud liquidity." It's one thing to have the right PaaS/marketplace, but if the customer doesn't have confidence in its provider's ability to meet projected capacity needs in a timely fashion, it will look elsewhere.
- **In 2014 and 2015, we'll see a battle for developers** play out in the cloud, much like the one between Android, iOS, and Windows for mobile apps and developers. Amazon, Microsoft, salesforce.com, Google, IBM, Oracle, SAP, Pivotal (formed by EMC and VMware), HP, and others know that new cloud apps will fuel the industry's growth, and **these platform players want developers to host their innovative new apps and solutions on their PaaS/marketplace**. IDC predicts that over the next four years, we'll see **a tenfold growth in the number of "apps" in the cloud, driven by a tripling of the number of "developers"/contributors** to cloud app ecosystems.

Open Stack has emerged as the leading open Infrastructure as a Service (IaaS) platform for private and public clouds. With an Open Stack platform, developers can provision cloud environments on demand, without assistance from IT, thus **removing any infrastructure barriers to innovation**. Early adopters such as Despegar.com, the largest online travel firm in Latin America, have already deployed OpenStack to speed time to market for new features and services.

Regarding Open stack, Market Monitor service expects total **Open Stack related revenue to break the $1bn barrier by 2015**. While revenue overwhelmingly comes from the service-provider space, an uptick in revenue is expected from all sectors, especially from Open Stack distributors and turnkey products serving primarily enterprises.

- **Service providers, companies that host private and public cloud platforms based fully or in part on the Open Stack architecture and its APIs**, provide the majority of Open Stack revenue. Rackspace alone accounts for approximately 65% of our total Open Stack 2014 market share. As competition increases and more sophisticated users embrace distributors to build their own OpenStack clouds, we are forecasting a decline in Rackspace's overall share. Among the other service provider are 99Cloud, AMAX Information Technologies (CloudMax), Aptira, Blue Box, Coraid, DreamHost, eNovance, Ensim, Globe Telecom, HP, IBM, Internap, iWeb, KIO Networks, Media Temple (Go Daddy), Newvem (Datapipe), OVH, United Stack, VEXXHOST and VMUnify. We highlight the following Open stack offerings:

  - The hosted managed private cloud model, provided now by such vendors as IBM and Rackspace (the client gets a dedicated installation of OpenStack, at provider's premises, managed & administered by the provider)
  - Bare-metal cloud (providing bare-metal machines rather than VMs), provided now by such vendors as IBM, Rackspace and Internap.

- **The Open Stack distributors** are the next largest sector in terms of overall revenue $119m by 2015. As they did with Linux throughout the last decade, enterprises are increasingly engaging vendors with a supported version of OpenStack rather than opting to consume the source code directly. The largest Linux distributors have all announced supported OpenStack distributions. Among this group are Red Hat, SUSE and Canonical, as well as Spanish startup StackOps.

Given that it is viewed as a viable platform for continuous integration, **continuous deployment and devops, Open Stack is also leveraged as the IaaS for PaaS.**The pressure on enterprise organizations to iterate and deploy software and services faster forces a dramatic change in approach in both process and technology **opening the door for OpenS tack**. Organizations seeking continuous integration and continuous deployment processes, widely known as devops, view OpenStack as an ideal technology and ecosystem to support it.

Open Stack with other clouds, whereby vendors support Open Stack alongside other options, such as Amazon Web Services and CloudStack, include Enstratius (Dell), Nimbula (Oracle) and Rightscale. This group represents the smallest piece of the overall pie. However, as enterprises embrace hybrid clouds and leverage the 'best execution venue' for specific use cases**, these vendors are well positioned to help enterprises and SMBs make those decisions. We expect 68% growth from this sector in 2014.**

Overall, the cloud's growth rate will increase driven by confidence in the cloud approach, better tools, stability and **completeness in the Open Stack family of modules**, as well as more powerful, yet cheaper hardware. Legacy processing will speed up its transition to the cloud in the face of overwhelming operational cost arguments. The ability to build agile hybrid clouds will trickle down to the mid-tier and boost cloud adoption. There will be more **emphasis on connecting cloud services so companies can effectively manage their assets**. Integration and consulting services will thrive and **Open Stack will emerge as the leader in this space.** Amazon Web Services will try to push further into the enterprise market and have some success.

3.1.3 Cloud Business Dimension: A Marketplace for business customers

With the **Internet continuing to evolve as a primary communication channel** between providers and consumers of services, **the connection with cloud is potentially limitless**. Gartner is anticipating a growth in cloud services this year (2014). The company estimates that the public cloud services market will grow 18.5 per cent this year to $131 billion worldwide, and predicts that from 2013 through 2016 $677 billion will be spent on cloud services worldwide, which represents an **opportunity for emerging stores focused on selling applications and services based on cloud services**.

Moreover, all signs point to app marketplaces becoming the standard for small and medium-sized businesses (SMBs) cloud adoption. In cloud business, marketing and sales have their own laws. Entirely new sales structures have to be developed and staffed, and some companies have already started to build their own ecosystem and partnerships where SMBs or governmental bodies will shop in the future**: the "Cloud Store", a marketplace for business customers a**nd a powerful sales channel that will represent the go-to-market for software in the near future: via every channel and with all available resources.

On the other hand, **software providers can become cloud ready within just a few days, enabling them to expand their market reach without high entry costs or investment**. This represents a huge advantage,

especially for SMBs, since cloud stores could offer the highest security standards, thus enabling smaller companies to offer higher standards than ever before to their customers. **A change in IT procurement has begun with the availability of online catalogue of cloud-based services.** Cloud stores will surely drive much faster adoption of cloud services, and provide deeper insights for SMEs, creating a more competitive market in the cloud domain.

What follows are three relevant examples of working **cloud stores targeted at the public sector and the SMBs respectively:**

- **CloudStore**: Targeted at the UK public sector, CloudStore is one of the first app store of its kind in the world and the first in the UK for public sector ICT procurement. The Cloud Store was offering more than 800 suppliers and more than 7,000 services across all types of cloud service models, including public, private and hybrid, and under four lots: IaaS, PaaS, SaaS, and Specialist Cloud Services (SCS) such as configuration, management and monitoring. Through this governmental application procurement site, SMEs across the UK get a chance to sell IT services to the public sector alongside major companies, at the same time that delivers savings to the Government.
- **Fujitsu Cloud Store:** All Fujitsu Cloud Store processes can be used for your own business. The Fujitsu Cloud Store can be used with your own sales engine. Integrating the subscription processes into your website is also planned. In October 2012, just after its launch, the Fujitsu Cloud Store had more than 50 partners, 60 apps (e.g. the Open-Xchange email and collaboration suite), 250 customers and 700 users.
- **My Cloud Store**: is the one-stop-shop for a range of New Zealand's small business software (business, IT and productivity apps). Business solutions are provided as online cloud (SaaS) based services, on a monthly subscription basis. The current offering includes customer relationship Management (sales force), point of sale (vend), mail security (SMX), payroll (SmartPayroll), project Management (Workflow Max), Mobile device Management (airwatch), online accounting, invoicing, Billings and banking (Xero), data backup (iBus), inventory Management (Unleashed), Office suite (MS Office 365), performance Management (CBS) and job Tracking, scheduling and dispatching (vWorkApp).

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.

3.1.4 Legal Dimension: Local Data Centers to ensure Data Privacy Regulation

Due to the slower cloud adoption rate for Europe, largely because of data sovereignty issues that have kept some European companies out of the public cloud, **Open Stack is being deployed not to displace AWS but as a private cloud solution right from the start.** Given that scenario, we believe Open Stack adoption in Europe will continue to accelerate.

The European market is quite different from the US cloud market in that customers prefer to go with **someone local to ensure data privacy regulations** are met

- A recent survey by the Cloud Security Alliance which showed that **10 percent of its member respondents indicated that they had cancelled a project with a US-based cloud provider**, and more than half said they would be **less likely to use a US-based cloud service after learning of the NSA's PRISM program**.
- **Transparency in the cloud has been top of mind for Europeans** as well

While some industry watchers think concerns about the U.S. National Security Agency (NSA) will fade in most of Europe, Germany is an exception.

- Its laws against personally identifiable information leaving the country are strongest among European Union (EU) countries and its reaction to the Snowden revelations about the NSA's PRISM surveillance program have been among the strongest.
- **With data localization pressures mounting**, one cloud consultant with international clients said Amazon Web Services (AWS) may need to build a data center in Germany to win business there.

On the other hand, **AWS emphasized the need for strong encryption** regardless of where data is stored.

3.1.5 Conclusions

As companies continue to look for ways to quickly provide or expand their cloud service offerings, without extending technology investments and IT overhead, they are increasingly **turning to IaaS. Telcos and hosters** are well positioned to meet increasing market demand for cloud services with infrastructures that allow their clients to quickly access **on-demand resources without extending their own data centers**. However, in order to remain competitive with differentiated offerings that perform and scale to demands, **they require agile, cost-effective cloud platforms.**

Open source cloud software has been tremendously successful in public clouds and is now poised to penetrate the enterprise private cloud market. While some private cloud solutions will evolve from existing virtualization deployments, an equally large part of the market will be built "greenfield" using **cloud system software and embedded virtualization technology**. Open source software, Linux, open standards, and open APIs are all strongly viewed as being crucial characteristics of an open cloud. **For open cloud to be successful, a strong community and ecosystem is one of the top factors in maintaining openness and increasing adoption.**

Open Stack is an exciting new development in the cloud system software market, offering an open alternative to proprietary systems. While cloud interoperability and portability are still extremely difficult problems to solve, Open Stack is the largest and most concerted effort by the industry to address these issues, and the results are promising. Red Hat is applying its experience in commercializing open source Linux for the enterprise and its methodology to Open Stack, which will be of interest to customers seeking a supported, open cloud solution

Open Stack is on the verge of reaching critical mass. Major Open Stack clouds have just launched, intending to test Amazon's early lead in the public cloud market with price-competitive offerings that are billed as open and compatible alternatives. While the transition to public cloud could take a generation to fully realize, this is **the first concerted effort by the industry to compete against Amazon**.

Opportunities

- **Demand for cloud.** As the industry transitions to cloud computing, whether public or private, the demand will grow for **cloud system software such as Open Stack that provides the foundational infrastructure.**

- **Commercialization of Open Stack.** Open source software is widely deployed, but many customers will want a supported enterprise version. Red Hat's reputation and previous track record with Linux will likely draw interest **from those seeking a supported Open Stack distribution**.
- **Cloud interoperability and portability.** Cloud computing, while extremely attractive to customers for a variety of reasons, comes with concerns about openness and lock-in. **Open Stack is a concerted effort by many industry participants to provide an interoperable and open cloud platform** that will help address the problem of workload migration in a hybrid scenario, from cloud to cloud.

Challenges

- **Cloud interoperability and portability.** Interoperability is a key goal and value proposition of Open Stack, but fragmentation among distributions and implementations is an issue. Another issue is the level of interoperability and portability that should be developed to non-Open Stack clouds.
- **Monetizing public cloud providers.** Very large providers tend to use self-supported open source and **not pay for commercial versions or support**. Enterprise private clouds also tend to use licensed, supported software, but the eventual split of private versus public cloud computing isn't known yet.
- **New deployment and support model.** Open Stack vendors and customers need to transition to a different model for cloud that includes continuous innovation and deployment. That means **cloud system software products may have a different life cycle than traditional enterprise software** and require more frequent upgrades.
- **Cloud system software maturity.** Open Stack and cloud system software are still **in their beginning stages.** Many features, compatibility, or stability may be missing and will take time to develop and mature.

Due to the slower cloud adoption rate for Europe, largely because of data sovereignty issues that have kept some European companies out of the public cloud, **Open Stack is being deployed not to displace AWS but as a private cloud solution right from the start.** Given that scenario, we believe Open Stack adoption in Europe will continue to accelerate.

3.2 Big Data Explodes and Creates new Data-Centered Analytics and Content Services

The continuous and tremendous growth of data volume, the better accessibility of data, and the availability of powerful IT systems have led to intensified activities around Big Data. **Companies and open source communities have been very successful in developing powerful tools to collec**t, store, process, analyses, and visualize huge amounts of data. **Open data initiatives have been launched to provide broad access to data from public sector and sciences.**

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 (two major technologies: **NoSQL solutions and Map Reduce frameworks**).

Big Data is not only about dealing with high volumes of data.

- Big Data refers also to the variety of data sets covering structured and unstructured data; to velocity and the way how quickly data and in particular real-time data can be processed; and
- To veracity addressing the integrity of data and the extent to which data can be trusted.

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.

- **Hadoop clusters** are surfacing everywhere in corporate America.
- **Governments and the ability to provide datasets**. 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)

In 2014 and beyond, **Cloud platforms without a rich variety of Big Data analytics and management services will fail to attract developers**. Conversely, Big Data analytics and management software tools that are not optimized for consumption in the cloud will be quickly marginalized by cloud platform–based competitors

- IDC predicts that over the next three years, **80% or more of the new "killer apps" emerging on the 3rd Platform will be data intensive.** The implication is that it is imperative that the cloud platform providers battling for developers/innovators offer an increasingly rich variety of "Big Data" services

3.2.1 Technology: Big Data´s most relevant Technologies and Ecosystems

Unprecedented and unrelenting growth in the volume of available data, in both structured and unstructured forms, is concentrating attention **on No SQL data bases and Map Reduce architectures**. Big Data reflects the **complex nature of mixing database, architecture and cloud considerations**.

Big Data is driven by digitization, providing new information insights from which decisions can be taken, i.e. creating new information from the vast quantity of information that people produce as well as consume. However, **Big Data is also driven by a progressively more tailored information consumption** from the end users in terms of when, how and what information they want to consume.

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.

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

This is why **Big Data is also considered to be part of a wider ecosystem** in which its **linkage to Data Brokerage components and Context Aware computing systems plays an important role**.

- Data Brokerage provides the set of techniques and tools necessary to mash up and manage information coming from different data sources.
- Context Aware computing, in turn, provides users with contextual data (localization, schedule, communities, presence, etc.) to enable relevant, real time decisions that improve their user experience.

Future Internet services and applications are evolving to be tailored to user preferences and environment; enablers for events and context acquisition and storage, data processing, algorithms for extracting rich information and profiling engines, will play an essential role to foster this evolution. In this section we explore the current state of the **most relevant technologies involved in Data/Context Management Services and how these technologies are positioned in the current market**:

- **Context Information**: Gathering and publishing context information in real time from heterogeneous data sources and pervasive related information to be used for Future Internet applications development, and in particular, when it includes **Data coming from Telco services and Internet of Things**, require a **common RESTful based interface** that reduces the access complexity to this information.
- **Multimedia information:** The arena of interactive multimedia is currently very active with thousands actors and technologies. However, **most current solutions** (e.g. Youtube, Skype, Facetime, WebEx, Vidyo, etc.) **take the form of services or APIs**, which does not offer the necessary flexibility for the creation of complex applications involving advanced features such as computer vision, augmented reality or group communications. In addition to this, **those services create interoperability barriers and restrictions**, which are incompatible with the needs of small players such as SMEs or individual developers. This situation has been detected by large IT players, and a novel **set of fully open APIs are being created under the WebRTC umbrella.** WebRTC is devoted to the creation of a real-time multimedia communication platform for the WWW. **WebRTC standards are currently under a heavy standardization efforts** both at the **W3C and at the IETF technology**.
- **Data Analysis**: Unstructured data is defined as all the set of data that do not follow a predefined data model. This kind of data comes in different formats (text, document, image, and video) and its amount is by far greater than structured data. According to a 2011 IDC study, **the 90 percent of all data created in the next decade will be unstructured data.**
- **Big Data Analysis**: The Big Data analysis revolutionized the concept of data storage and insights generation. The quick information growth did the **traditional storage systems become insufficient and slow to access,** and at the same time such a vast amount of data demanded **new analysis paradigms beyond SQL** and the machine learning techniques. **Google and its MapReduce concept** (with the help of another old concept, the distributed file systems) covered that gap, and a lot of implementations saw the light, **being Hadoop and its ecosystem the most widely used and commented one.** Nevertheless, despite of this revolution, not all the problems were solved and **new gaps derived from the use of MapReduce and the distributed file systems.**
    - The first issue the Big Data analysts had to face was **the processing of other type of data different than the batch processing**: the real time generated data. It could not be processed by MapReduce-like applications since this kind of data it is rarely stored, thus **new solutions like Storm and Spark found their place**. Other implementations focused on finding insights in the data while they **are stored for the batch a**nalysis; it is the **case of Flume**.

  - Other problems are related **to the infrastructure supporting the Big Data environment**, due to the software stack and the infrastructure deployment are strongly decoupled. On the one hand, the scalability is in the DNA of the Big Data. That is the reason why the distributed file systems are used, in order **to scale when storing data, and that is the reason the data processing is distributed among the nodes of the cluster as well**. On the other hand, anti-affinity feature tends to distance too much the nodes storing blocks of the same file, penalizing the data analysis. Currently, **Hadoop is increasingly used as an enabler of certain types of NoSQL distributed databases,** which can a**llow for data to be spread across thousands of servers with little reduction in performance.** NoSQL databases are widely used in Big Data and real-time web applications

- **Events Processing**: One of the key aspects **regarding IoT** copes with the proliferation of a huge amount of sensors and other small-scale devices (i.e. RFID tags) that seamlessly interact within their environment. These nets of sensors produce large volume of data in an unpredictable and burst way. This way, there exist **a great number of multidisciplinary applications** that deal with these data and must eventually react to interesting phenomena occurring in the input stream. Future Internet demands to **build new infrastructures that can seamlessly and efficiently meet the requirements of such demanding applications**.

Additionally market evolution has shown that Data processing and storage costs have decreased by a factor of more than 1,000 over the past decade. Powerful analytical techniques have emerged. And new technologies like **Hadoop and MapReduce mean that data no longer have to be stored in rigidly structure** form to be processed (a costly, labour-intensive proposition). Now information can reside in whatever form it naturally takes in geographically dispersed data centers or in the cloud. The computation capabilities are also spread across a potentially endless number of servers (generally referred to as a Hadoop cluster) by **using the Map Reduce computational model**. It has been a game-changer in **supporting the enormous processing needs of Big Data**. Most of the **supporting tools and storage architectures are now Open Source** (Hadoop, Hive, Spark, Shark, HBase, Riak, Titan, etc.), levelling the playing field for tool vendors in this field.

Big Data and analytics will continue to be a key constituent of infrastructure spending as businesses undergo a transformation to being data driven. To that effect, businesses are seeking newer data sources with the goal of seeking correlation and causality patterns. They are also storing this data longer, even data that has been analyzed before, as they move from search-based analytics to discovery-based analytics. This data-driven transformation means that the infrastructure spending is not just to accommodate this data deluge but also to support **newer open source–based analytics platforms like Hadoop that present their own set of challenges in the datacenter.** As an example, platforms like Hadoop lack enterprise-grade resiliency and data management capabilities. Therefore, businesses that need the functionality of Hadoop but cannot afford to compromise on service-level objectives are **forced to augment their Hadoop deployments** with commercial add-on solutions**. The implementation of analytics platforms like Hadoop impacts** the choices businesses have to make with respect to their infrastructure and data management. Such infrastructure needs to support:

- A scale-out compute platform that leverages commodity components but also doubles as an economically feasible persistent storage platform
- Structured and unstructured data sets that are associated with NoSQL, MPP, and traditional SQL databases
- Data management systems like file systems that augment or replace the native capabilities of the platform itself
- The capture and collation of data from multiple sources, including high-speed streaming

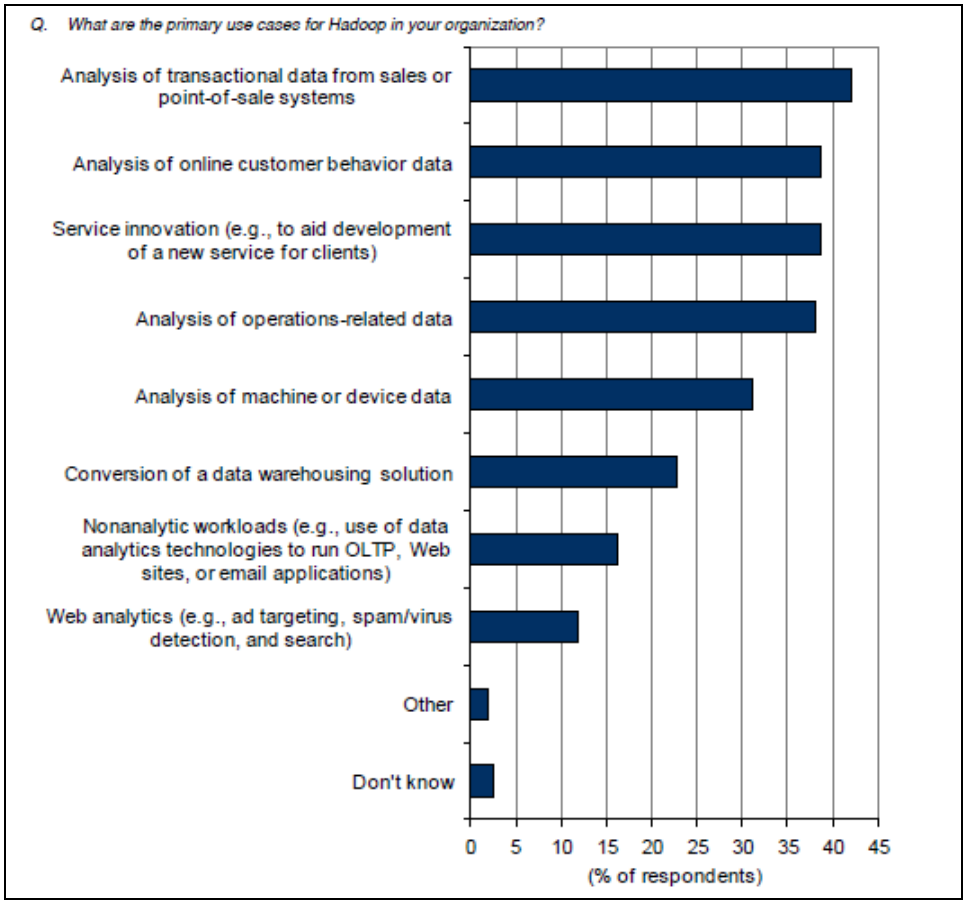


Figure 6: Primary Use Cases for Hadoop. IDC August 2013

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,

Hadoop is the leading open source platform for storing, processing and accessing large data sets across clusters of computers, and **Open Stack is the leading open source framework for building and managing private, public and hybrid Infrastructure-as-a-Service (IaaS) clouds**:

- Since Hadoop is net-new workload for most organizations, **Hadoop on Open Stack** provides the perfect "greenfield" use case for those looking **to start a new on a platform that makes sense**.
- Moreover, **Hadoop and Open Stack are open source technologies designed for scale-out architectures that can be cost effectively deployed.** Finally, since Hadoop can be complex to get started with, taking advantage of the operational agility and deployment choice that Open Stack enables will go a long way to jumpstarting those interested in deploying big data on cloud.

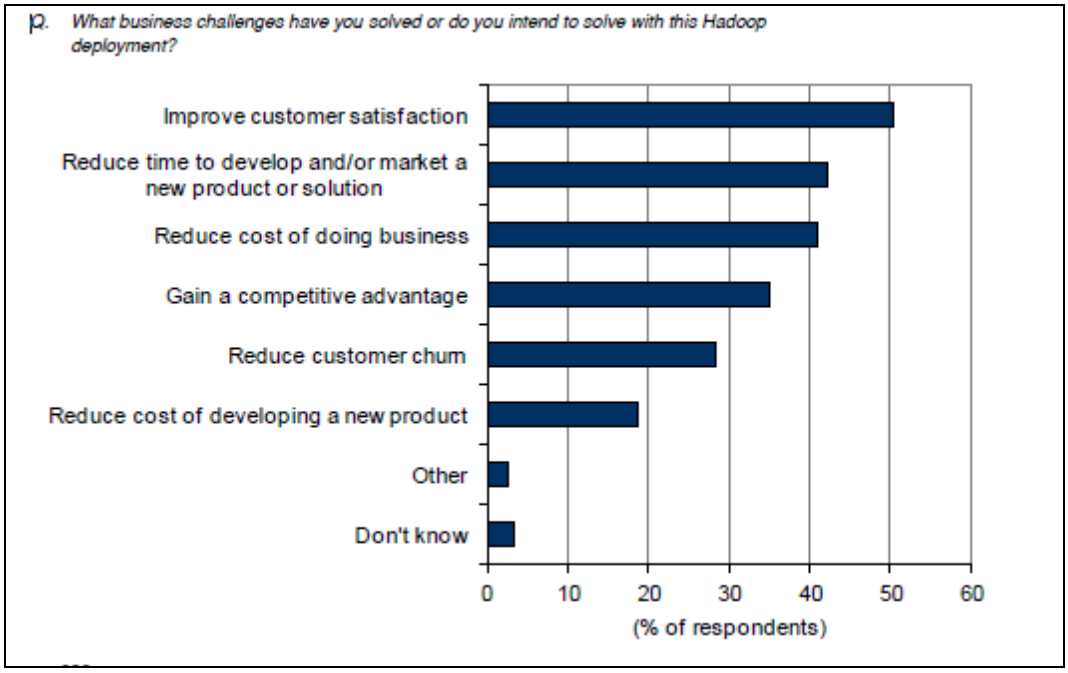


Figure 7: Business Challenges Solved by Hadoop. IDC August 2013

Additionally the use of Open Data is a relatively recent phenomenon but, as with many technological advances, it is growing in relevance and prevalence. Yet while the benefits of open data are significant, the success of open-data programs is not guaranteed. For government to serve as an open-data provider, catalyst, user, and policy maker in an effective and sustainable way, it needs to have the right people, tools, and systems in place. We are **encouraged that governments around the world have taken steps to develop responsible and robust open-data programs**, and we hope government leaders and stakeholders across the spectrum of business, citizens and consumers, the media, increasingly engage in the conversation, invest in the work, and promote open data in a way that helps unlock economic and societal benefits. **Open Data, Big Data and also Open Government** are three different areas which are however related to each other, and **foster the Open Innovation ecosystem** required for the Future Internet evolution:

- Big Data essentially describes very large datasets; however today Big Data is may **not seem so big in a few years when data analysis and computing technology improve**.
- **Open Government is a combination of ideas**: it includes collaborative strategies to engage citizens in government; government releasing data about its own operations, like federal spending data; and government releasing data that it collects on **issues of public interest, such as health, environment, and different industries.**
- **Open Data is accessible public data that people, companies, and organizations can use to launch new ventures,** analyse patterns and trends, make data-driven decisions, and solve complex problems. All definitions of Open Data include two basic features:

- **The data must be publicly available for anyone to use**, and it must be licensed in a way that allows for its reuse. Open Data also should be relatively easy to use, although here there are gradations of "openness."
- And there's general agreement that **Open Data should be free of charge** or cost just a minimal amount. Despite there are already several commercial and open source solutions for Open Data, and that there are already many public administrations all over the world offering open data, there are **several obstacles that prevent it from being widely used: poor data quality**, **privacy risks**, deployment and availability limitations, difficulties to access not free data, or lack of skills to harvest or use it. Moreover, open data initiatives usually refer to static datasets. There is an important gap related to real time consumption of Open data and Open media. The **NGSI and WebRTC APIs of Context Broker and Stream Oriented GEs** are the answers to those limitations.

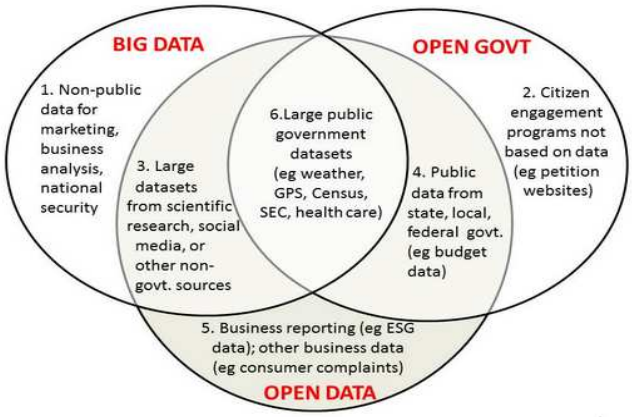


Figure 8: Open Data, Big Data and Open Govt.

Starting with the basic descriptions mentioned above, the intersection of these three concepts defines the six subtypes of data shown on the diagram. (There's no separate category for the intersection of Big Data and Open Government anything in that category is also Open Data.) Here are **characteristic examples** of each, referring to the numbers above:

- **Big Data that's not Open Data.** A lot of Big Data falls in this category, including some Big Data that has great commercial value. All of the data that large retailers hold on customers' buying habits, that hospitals hold about their patients, or that banks hold about their credit-card holders, falls here. It's information that the data-holders own and can use for commercial advantage. National security data, like the data collected by the NSA, is also in this category.
- **Open Government work that's not Open Data**. This is the part of Open Government that focuses purely on citizen engagement. For instance, the White House has started a petition website, called we the People, to open itself to citizen input. While the site makes its data available, publishing Open Data beyond numbers of signatures is not its main purpose.
- **Big, Open, Non-Governmental Data**. Here we find scientific data-sharing and citizen science projects like Zooniverse. Big data from astronomical observations, from large biomedical projects like the Human Genome Project, or from other sources realizes its greatest value through an open, shared approach. While some of this research may be government-funded, it's not "government data" because it's not generally held, maintained, or analysed by government agencies. This category also includes a very different kind of Open Data: the data that can be analysed from Twitter and other forms of social media.

- **Open Government Data that's not Big Data**. Government data doesn't have to be Big Data to be valuable. Modest amounts of data from states, cities, and the federal government can have a major impact when it's released. This kind of data fuels the participatory budgeting movement, where cities around the world invite their residents to look at the city budget and help decide how to spend it. It's also the fuel for apps that help people use city services like public buses or health clinics.
- **Open Data not Big, not from Government**. This includes the private-sector data that companies choose to share for their own purposes for example, to satisfy their potential investors or to enhance their reputations. Environmental, social, and governance (ESG) metrics fall here. In addition, reputational data, such as data from consumer complaints, is highly relevant to business and falls in this category.
- **Big, Open, Government Data**. These datasets may have the most impact of any category. Government agencies have the capacity and funds to gather very large amounts of data, and making those datasets open can have major economic benefits. National weather data and GPS data are the most often-cited examples. Census data, and data collected by the Securities and Exchange Commission and the Department of Health and Human Services, are others. With the new Open Data Policy, this category will likely become larger, more robust, and even more significant.

3.2.2 Market: Big Data´s Opportunity

The size of the all digitized information created, replicated, and consumed in a year will continue to explode, growing annually by 50% to about 6ZB (6 trillion terabytes), driven **by the explosion in mobile devices, apps, social media, and the Internet of Things**. The quest to drive **valuable insights and real-time decision making from this data avalanche** will drive massive investments, shape the future of the cloud, and create **new data-centered analytics and content services.**

The continuous and tremendous **growth of data volume, the better accessibility of data, and the availability of powerful IT systems** have led to intensified activities around Big Data.

- **Companies and Open Source communities are developing powerful tools** to collect, store, process, analyse, and visualize huge amounts of data.
- **Open Data initiatives** have been launched to provide broad access to data from public sector and sciences.

The resulting economic value of Big Data is also shown in many market studies e.g. one forecast expects the **global Big Data market to exceed $47 billion by 2017, which translates to a 31%** Compound Annual Growth Rate **(CAGR)** over the five year period 2012-2017.

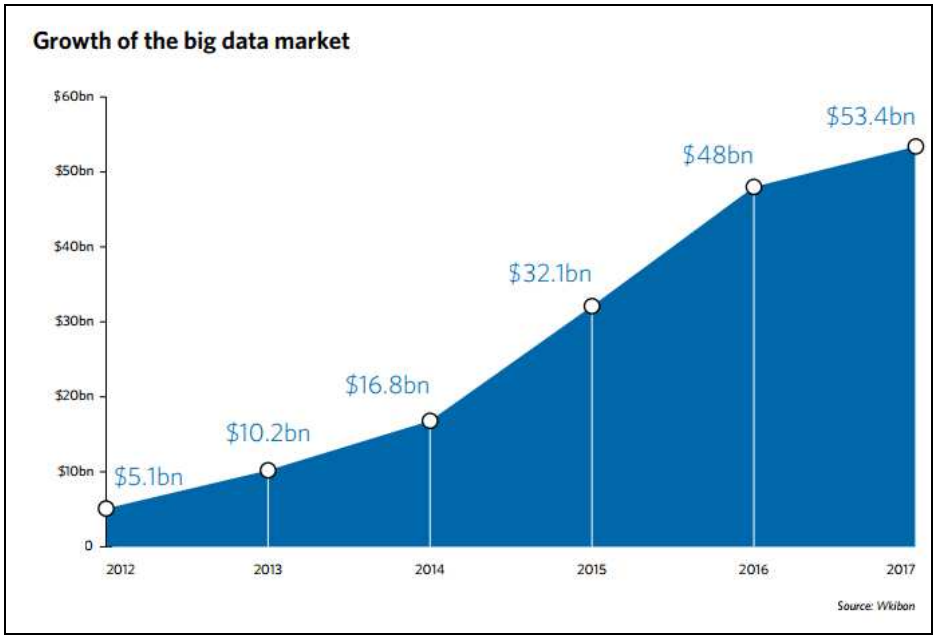


Figure 9: Growth of the Big Data Market. Source: Wikibon

Big Data represents a fast-growing multibillion-dollar worldwide opportunity. The widespread adoption of Big Data technologies is continuing at a rapid pace. Findings in this Big Data technology and services market forecast include:

- **Big Data spending will explode and shift toward analytic tools and solutions**. Given the current focus on the **apps build out on the 3rd Platform**, it should be no surprise that growth will shift from the infrastructure and **data management layers to the analytic tools and application layers**.
- **IDC expects the Big Data technology and services market to grow** from $14 billion in 2014 to $23.8 billion in 2016. This represents a **compound annual growth rate (CAGR) of 31.7%** or about **seven times that of the overall information and communication technology (ICT) market**. Opportunities for vendors will exist at all levels of the Big Data technology stack including infrastructure, software, and services and via an **on-premises or cloud delivery model.**
- **IDC predicts that over the next three years, 80% or more of the new apps emerging on the 3rd Platform** will be **data intensive** that is, they will leverage huge volumes of data and/or real-time data streams. The implication are the following:
    - **Cloud platform providers battling for developers/innovators** offer an increasingly rich variety of "Big Data" services. 2013 saw increasing activity, **with major moves from AWS, IBM, Microsoft, salesforce.com, SAP, and Oracle**. Cloud platforms **without a rich variety of Big Data analytics and management services will fail to attract developers**.
    - **Big Data analytics services will see explosive growth**. Demand for Big Data analytics skills will continue to significantly outstrip supply in 2014, creating big opportunities for vendors to provide an increasing variety of analytics services (many of them cloud based). IDC predicts that **over the next three years, there will be at least a threefold increase in the number of these players** and services many of these new players and offerings will have **an industry-specific focus.**

Additionally, Open Data has the potential not only to transform every sector of the economy but also to **unleash more than $3 trillion in global economic value annually** and Government has a critical role to play.

- **Institutions and companies across the public and private sectors** have begun to release and share **vast amounts of information in recent years**, and the trend is only accelerating. Yet while some information is easily accessible, some is still trapped in paper records.
- **Through these different channels**, new information is made available across the public and private sectors, to scientists, citizens and enterprises, all of whom are then able to benefit from each other's activities in a growing network effect:
    - Uses of open data within government for innovation and efficiency proving the value of open data within the public sector;
    - Improvement in public service delivery;
    - Examples of open data utilisation for policy making purposes;
    - New approaches for public sector information processing and visualisation;
    - Open data and citizen participation in information gathering / crowdsourcing;
- **Data may be free or come at a cost.** And there are tremendous differences in reuse and redistribution rights. In short, there are degrees when it comes to just how "open" data is and, as a result, how much value it can create

3.2.3 Economic Dimension: Optimizing Business Processes and Driving Innovation

The potential of Big Data and analytics projects to optimize business processes, to drive product and service innovation, and to enable enterprise controls has never been greater. New businesses are emerging based on harvesting Big Data and providing new, combined data and analytic services; disruptive change is being implemented in **industries ranging from healthcare and retail to oil and gas and law enforcement.**

As the number of organizations looking to business analytics and Big Data technology grows, so does the need for help in defining **best practices around strategy**, staffing, and analytic processes as well as the use of **ever-growing technology options for monitoring, integrating, cleansing, organizing, analyzing, and acting on the results of multi-structured data.**

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.** Examples of **analytics-driven activities include service innovation, customer experience improvements**, detection and remediation of anomalies, and reduction of time to market for goods and services. **To meet the need for analytics-driven activities, businesses are collecting, analyzing, and storing more data, often from sources that did not exist a few years ago**. They are also implementing newer workflows that allow them to quickly and **continuously assess the results of these analytics platforms** and change their business functions accordingly. This means that **newer analytics platforms like Hadoop have to be more agile than their predecessors** and need to support continuous value derivation loops implemented via these Big Data workflows**.**

Indeed these are **exciting times in the information management world**, and the era of Big Data has truly arrived social media interactions, real-time sensory data feeds, geospatial information and other new data sources are presenting organizations with a range of challenges, but also significant opportunities. **Business users are struggling to make sense of the data and try to find the patterns that enable them to**

create new products and services for their customers. At the same time, IT executives are challenged to provide a powerful infrastructure that can capture, manage and store this data as efficiently as possible.

- **Big Data provides significant opportunities for enterprises to impact a wide range of business processes**. There are opportunities to optimize operations by identifying inefficiencies or by applying predictive analytics to anticipate events such as customer churn, product failure or quality degradation, and financial fraud. There are opportunities to innovate by harnessing Big Data to develop and introduce new services and products, and there's the opportunity to better comply with regulations by using Big Data technology to store, access, and correlate information.
- **To capitalize on the Big Data opportunities and address the challenges, organizations need to consider a wide range of technology and services**. Technology can include relational and non-relational data management tools, data integration and aggregation software, analytic and discovery software, data visualization tools, and a range of prepackaged analytics applications. Services can include everything from Big Data strategy development, metrics identification, and skills augmentation to systems integration and infrastructure management.

By 2020, Innovation will allow extending the capability to use and exploit Big Data to other economic sectors in **Europe therefore maximising the cross-sector value of data**. The following are examples of those sectors that are especially promising with regard to Big Data:

- Healthcare: Applications range from comparative effectiveness research to the next generation of clinical decision support systems which make use of comprehensive heterogeneous health data sets as well as advanced analytics of clinical operations. Of particular importance are patient involvement, privacy and ethics.
- Mobility, transport and logistics: Urban multimodal transportation is one of the most complex and rewarding Big Data settings in the logistics sector. In addition to sensor data from infrastructure, vast amounts of mobility and social data are generated by smart phones, C2x technology (communication among and between vehicles) and end users with location-based services and maps. Big Data will open up opportunities for innovative ways of monitoring, controlling and managing logistics business processes. Deliveries could be adapted based on predictive monitoring, using data from stores, semantic product memories, internet forums, and weather forecasts, leading to both economic and environmental savings.
- Energy: The digitization of the energy system from production, to distribution, to smart meters at the consumer enables the acquisition of real-time, high-resolution data. Coupled with other data sources, such as weather data, usage patterns and market data, accompanied with advanced analytics, efficiency levels could be increased immensely. Existing grid capacities could be better utilized and renewable energy resources could be better integrated.
- Public Sector: Big Data Value will contribute to increase efficiency in public administrations processes. The continuous collection and exploitation of real-time data from people, devices and objects will be the basis for smart cities, where people, places and administrations get connected through novel ICT services and networks. In the physical and the cyber-domain, security will be significantly enhanced with Big Data techniques; visual analytics approaches can be used to allow algorithms and humans to cooperate. From financial fraud to public security, Big Data will contribute to establish a framework that enables a safe and secure digital economy.
- Media and Content: By employing Big Data analysis and visualization techniques, it will be possible to allow users to interact with the data, and have dynamic access to new data as they appear in the relevant repositories. Users would also be able to register and provide their own data or annotations to existing data. The environment will move from, few state-orientated broadcasters to a prosumer approach and where data and content is linked together blurring the lines between data sources and modes of viewing. Content and information will find organisations and consumers rather than vice versa and overall the impact will be a seamless content experience.

- Manufacturing and production: With industry's growing investments into smart factories with sensor-equipped machinery that is both intelligent and networked (Internet of Things, Cyber-Physical Systems), the production sectors in 2020 will be one of the major producers of (real-time) data. The application of Big Data to this sector will bring efficiency gains and predictive maintenance. Entirely new business models are expected since the mass production of individualized products becomes possible and for which consumers may have direct access to influence and control it.
- Retail: Digital services for customers provided by smart systems will be essential for the success in the future retail business. The retail domain will especially be focused on highly efficient and personalized customer assistance services. Retailers are currently confronted with the challenge to meet the demand of a new generation of customers who expect information to be available anytime and anywhere. New intelligent services that make use of Big Data will allow a new level of personalized and high-quality Efficient Consumer Response (ECR).
- Environment: Better understanding and managing of environmental and geospatial data is of crucial importance. Environmental data helps to understand how our planet and its climate are changing and also addresses the role humans play in these changes. The European Earth observation programme, Copernicus, aims to provide reliable and up-to-date information on how our planet's climate is changing to provide a foundation which will support the creation of sustainable environmental policies. In addition, the EU project Galileo will be a global network of satellites providing precise timing and location information to users on the ground and in the air

3.2.4 Legal Dimension:

By the end of this decade, data business has become a key industry in Europe developing products and services around data itself, the analysis of data, and by using the insights gained by analyzing data. Data-driven applications will help companies to design better products, to improve their business plans, and to create new business models. They will help governments to implement policies more effectively and individuals to improve the quality of their lives. People will trust those data-driven applications and will use them broadly.

- **Big Data will have become a key economic asset**. The value of a data source will increase with the discovery of previously unknown information as well as by using the data source in a growing number of Big Data use cases. A data market will have emerged defining price models for data repositories and enabling data owners and brokers to capitalize on their data.
- **European and national regulations will have been adapted to the needs of the data-driven economy and society.** A modern, robust and flexible intellectual property rights framework for handling complex issues related to ownership and licensing in combination with standards and knowledge based approaches will have facilitated the interoperability and the exchange of data across Europe. **A truly modernized legal framework will have been provided for a high level of data protection while leaving sufficient flexibility to business and innovation**. A European digital single market for pan-European Big Data Value services and applications will have emerged

Although there are strong reasons for **Europe to take advantage of the Big Data market development**, there are seemingly **barriers that block the creation of strong data driven ecosystems** that foster the uptake of Big Data opportunities for Europe:

- **Big Data technologies, applications and services are complex**, complicated to deploy and usable by experts only.
- **Data sources are not yet broadly available and easily accessible for developing innovative solutions** making intelligent use of data.

- **National laws and policies are fragmented and incoherent and make it difficult to exchange data** and to deploy data-driven applications across borders.
- **There are concerns with regard to security, privacy, and data protection** which negatively impact the trust in services built on the analysis of large data sets.

Those barriers and risks can be addressed successfully only in a holistic way and in a joint effort involving policymakers and the many different stakeholders from the Big Data Value chain. The creation of a strong and vibrant data ecosystem in Europe is crucial and it is one of the few **last chances for Europe's software industry to take a true leadership.**

A favorable **Regulatory Environment** will be paramount to foster take up of Big Data technology and solutions. Issues to be addressed include:

- Identification of issues from data acquisition, ownership of raw data, processed data, augmented data, aggregated data;
- Liability of data analysis, to deal with potential damage caused by incorrect analysis
- Measurement the value of data, the succession of data rights and the legacy of stored data for new, merged or bankrupt companies;
- Delete mechanisms, policies for data processing and data usage.
- Identifying the barriers with regard to ownership of data and intellectual property rights incl. copyright and access rights

Additionally, most technology standards for Big Data processing technology are *de facto* standards that are not prescribed (but at best *de*scribed after the fact) by a standards organisation. **The most prominent example is, of course, Hadoop and Map/reduce**. However, the **lack of standards is a major barrier**. The large range of choices coupled **with the lack of standards for querying the data makes it harder to exchange data stores** as it may tie application specific code to a certain storage solution.

Indeed Europe needs to further work on a globally competitive framework for data privacy, security, IP, ownership and liability, which would leave flexibility to business to develop innovation while preserving privacy and security of individual citizen and businesses. Additionally **standardization is essential to the creation of a Data Economy, de-facto standards for technologies and for data, notably for interoperability**. Europe has a great opportunity for global leadership with a legislation that **both renews its commitment to privacy and embraces innovation**.

3.2.5 Conclusions

Big Data is one of the key assets of the future. Strategic investments by industry, the public sector and governments, accompanied by forward-looking policies, will enable Europe to take the lead in the global data economy.

- **Value creation from Big Data will be a major driver that will transform the 21st century society**, from healthcare to education, from energy to water management, from entertainment to mobility, in all sectors Big Data Value will be a key factor in fuelling innovation, developing new business models, supporting productivity growth, and coping with societal challenges.
- **A favourable Regulatory Environment will be paramount to foster take up of Big Data Value** technologies and solutions. Standardisation is essential to the creation of a Data Economy, de-facto standards for technologies and for data, notably for interoperability.

Regarding Technology/ Platform Services, due to this Big Data exploding, cloud platform providers battling for developers/innovators offer an increasingly rich variety of "Big Data" services. Cloud

platforms **without a rich variety of Big Data analytics and management services will fail to attract developers.** Regarding Open Source Platforms for storing, processing and accessing large data sets across clusters of computers, **Hadoop is the leading open source platform** and together with **OpenStack, the leading open source framework for building and** managing private, public and hybrid Infrastructure-as-a-Service **(IaaS) clouds**, provides the perfect "greenfield" use case for those looking **to start a new on a platform that makes sense** and **that can be cost effectively deployed.**

In addition, within all industrial sectors**,** it became clear that not the availability of technology **but the lack of business cases and business models is hindering the implementation of Big Data applications**. Usually, a business case needs to be clearly defined and convincing before new applications are initiated. However, in the context of big data applications, the development of concrete business case is as inferred a very challenging task. This is due to two reasons.

- First, as the impact of big data applications relies on the aggregation of not only one but a large variety of heterogeneous data sources beyond organizational boundaries**, the effective cooperation of multiple stakeholders with potentially diverging or at first orthogonal interests is required**.
- Secondly, existing approaches for developing business models and business cases usually **focus on single organizations and do not provide guidance for dynamic networks of multiple stakeholders**.

Finally the use of Open Data is a relatively recent phenomenon but, as with many technological advances, it is growing in relevance and prevalence. We are **encouraged that governments around the world have taken steps to develop responsible and robust open-data programs**, and we hope government leaders and stakeholders across the spectrum of business, citizens and consumers, the media, increasingly engage in the conversation, invest in the work, and promote Open Data in a way that helps unlock economic and societal benefits.

3.3 Internet of Things Accelerates 3rd Platform Growth

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 '**Internet of Things', while the technology that facilitates this connectivity is most commonly called 'Machine-to-Machine' (M2M).** From end-user and applications point-of-view, the most interesting part is the **availability of new information related to a dedicated and contextual potential use** which will enhance the delivery of new kind of services.

The Internet of Things (IoT) and the rise of a machine to machine (M2M) ecosystem have been long anticipated. As this ecosystem converges with major trends **like Cloud computing and Big Data**, a whole new crop of 3rd Platform solutions will drive the next decade of IT industry growth, there will be one other very important growth accelerator for the 3rd Platform IT industry: the radical **expansion of the 3rd Platform's edge** beyond smartphones, tablets, and PCs **to the so-called Internet of Things**.

In the market for connected things, complexity defines the challenge. Every machine, sensor, and communication device requires assessment to determine the best set of hardware and software components to **extract and transport relevant machine data from the connected object to an application**. This problem by itself supports a whole industry of system integrators, IT and industrial services providers, consulting firms, OEMs, operators, and internal product and IT teams. But it also has given rise to suppliers of **platforms and middleware intended to simplify collection and normalization of machine data for M2M/IoT applications.**

IoT middleware platforms continued to gain momentum in 2014 as a critical element in the IoT solution enablement and nowhere are this trend more evident than in the **Application Enablement Platform (AEP) market**. The core value proposition of these platforms is **to ease connectivity, device management, and**

data collection activities of any IoT solution. The year 2014 saw three important trends which are **validating the value of these platforms**: first, the number of AEP vendors has expanded and some of the longstanding players, ILS, Axeda, and ThingWorx, were acquired demonstrating AEP market value and momentum; secondly, GE recently announced it would make its Predix platform available for 3rd party use further demonstrating the value of **IoT middleware platforms for the Industrial Internet**.

The benefits of IoT can be huge, wherefore companies setting up new business models**,** leveraging the generated data and creating service models on top of it. The deployment and use of technology delivers business value across the facilities, functions and activities comprising the supply chain, such as improved resiliency and efficiency, sustainable energy usage (smart grid), distributed production, and a return to localized manufacturing. The Third Industrial Revolution is picking up speed as **Open standards in the Internet of Things (IoT) are challenging closed platform approaches**.

3.3.1 Technology: Simplify collection and normalization of machine data for M2M/IoT applications.

According to PTC Inc. research, the world has seen a series of technology innovations that make the IoT both technologically and financially feasible today. Technology innovations across computing and communication infrastructures, as well as the things themselves, have converged after all, the Internet now connects the car, the home appliance, and the office building.

- **Computing Infrastructure**: Data capture and analytics tools and new business and software applications create new forms of value
    - **Expanded Data Storage Capabilities**: This technical innovation has supported increased data creation. In fact, 90 percent of the world's data has been created in the last two years alone
    - **Increasing Processor Performance/Efficiency**: In these twenty years, CPU power consumption increased by 10x while CPU processing performance exploded by 47x
    - **Evolution of Cloud Computing/Big Data Tools**: Gartner projects that the Infrastructure as a Service (IaaS) industry, will grow by 41 percent through 2016 to become a 24 billion dollar industry. Emerging frameworks like Hadoop, a data processing framework and distributed file system, promote efficient analysis of ever-growing data sets
- **Communication Infrastructure:** Wired and wireless (Wi-Fi, 4G, Bluetooth, Zigbee) networks connect Things to the Computing Infrastructure and each other.
    - **Evolution of Connectivity:** The expanding 4G LTE wireless broadband network has 100 Mbps downstream and 50 Mbps upstream rates, while emerging wireless technology standards, such as ZigBee, enable cost and power efficient wireless networking over long distances through mesh networks
    - **Introduction of IPv6 Address Scheme**: In response to the need for an address pool to support the exponential growth of Things connecting to the Internet, the IPv6 was created.
    - **Ubiquity of Connectivity:** Chipmakers are now designing connectivity directly into the hardware, (e.g., SSL encryption), reducing the demands on software code. For example, public Wi-Fi hotspots are expected to grow 350 percent by 2015.
- **Things:** Smart, connected products and other Things combine processors, sensors, and software with connectivity.
    - **Miniaturization and Efficiency of Components**: Advances in production technology and chip architecture enable manufacturers to embed components without diminishing the user experience.

- **Declining Prices of Processors, Sensors and Components**: Economies of scale from production of devices such as smartphones, for example have depressed the cost of sensors and processors.
- **Software Development Frameworks:** Demand for software delivered inside and alongside the product and the business applications needed to deliver value-add solutions is increasing dramatically.

Huge volume of data is also the promise and the big challenge of IoT, promise of new information build on top of these data, and **a big challenge because of associated communication and storage requirements.** To ensure that knowledge generated by the IoT will be modular and re-usable across domain-specific boundaries, **IoT resources have to be interoperable at the communication layer, supporting the co-existence of a variety of existing and emerging communication technologies**. Interoperability requirements need to be also guaranteed at the service level, ensuring the smooth integration of IoT resources into the service layer of the Future Internet.

- In the emerging market, some industrial solutions are emerging, focusing on the need **to integrate or to interface many existing and specific standards and managing a new silo to assume security and privacy for data** collected from all connected things.
- At least two international business actors are following the same approach, using **gateways to federate standards and protocols and collecting raw data**, while monitoring the whole process with services **hosted in the cloud**. These two business actors are **Axeda and Digi**.
  - **Axeda** claims to deliver a secured solution by keeping a full control of its proprietary and closed solution.
  - **Digi International**, similarly, proposes a **fully integrated platform but in a much more modular system** where, depending on initial technologies, customers can use several building blocks, which are similar to Generic Enablers, to compose their own gateway, and then compose their backend services which **are always integrated in cloud services**.
  - In another way**, Xively (https://xively.com/), launched at early 2013, is the second evolution of Pachube,** free internet service to manage Internet of Things. Xively is now a commercial offer but not related to any specific hardware, providing management of connected objects in the cloud, using Rest interfaces.

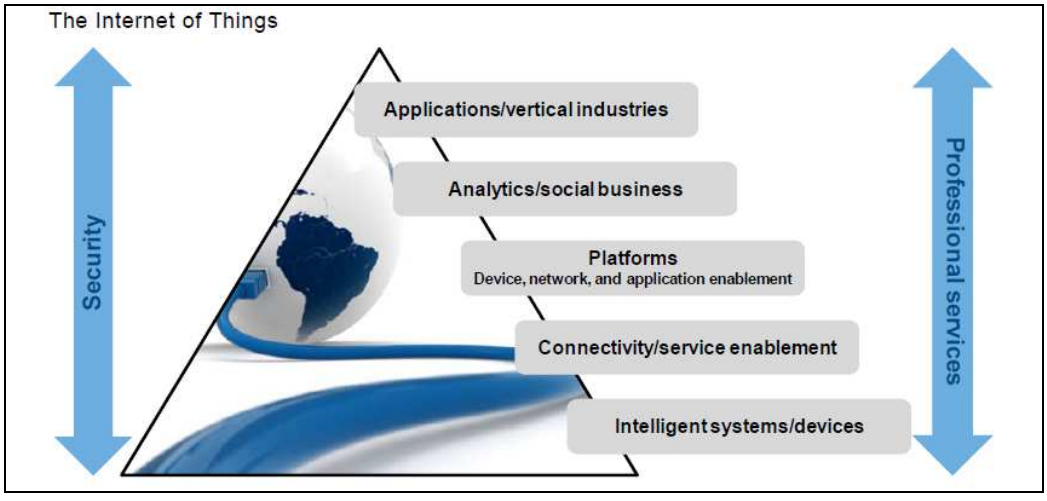


Figure 10: The Internet of Things. Source: IDC 2014

Deploying end-to-end M2M/IoT solutions and being able to manage an increasing range of applications becomes the next challenge for enterprises. Providing a dedicated enterprise platform and toolset, and

enabling the re-use of components by the enterprise, enhances the ability of enterprises to manage the growing range of applications.

Enterprises should look to platforms designed as horizontal M2M/IoT application platforms where many of the **core application elements are reusable and managed from the single platform**. These reusable features should include integrations with device management, connectivity management, and service enablement.

With application components available for devices, enterprise systems, protocol adapters, provisioning systems, cloud services, custom widgets, analytics, etc., **application developers are able to evaluate and test various configurations**, and identify the most appropriate options for their **end-to-end solutions**. For example, application developers could assemble components from an application marketplace to integrate data analytics tools to capitalize on emerging opportunities in Big Data.

Creating such an applications marketplace for device manufacturers, service enablers and system integrators would accelerate the integration of things, systems, and people, and deliver a "complete platform" for M2M and IoT, managing application development, partnerships and end-to-end deployments in one intelligent and intuitive solution.

Other forces will play a role in growth of M2M/IoT application enablement platforms (AEP), including greater acceptance of cloud services, the attractiveness of new business models for machine leasing (Machine as a Service), warranties, and SLAs, "free to try" platform offers, and cheaper communication devices and connectivity costs. However, an equally important, if not more important force driving the growth of these application enablement platforms (AEP)**, is evolution of the supplier ecosystem**

Despite the vast opportunity for merchant-market AEP solutions, the market at present is nascent, small, and comprised of a variety of vendors coming to the market from differing backgrounds. ABI Research counts over 30 companies currently active in this space, ranging from pure-play providers like Axeda, ILS Technology, and ThingWorx, to M2M module and modem suppliers like Digi International, Sierra Wireless, Novatel Wireless, and Eurotech, to core network infrastructure providers like NSN and NEC.

However, there is clear opportunity for consolidation going forward, as more suppliers are augmenting their capabilities to **offer nearly one-stop shop services,** and ABI Research expects that as the **M2M market becomes ever more mainstream.**

3.3.2 M2M Market: Applications will become the critical enablers of value in the M2M and IoT world.

The momentum behind IoT derives from macroeconomic trends, as well as trends that impact specific industries or groups of adopters. Key factors include the following:

- **High labor costs:** It typically costs at least three times more for a human to perform a task than a machine. Intelligent systems can now perform many tasks that require intelligence and situational awareness, such as utility meter reading, smart building monitoring, power management, and so on.
- **Huge real-time demand for Big Data**: Data has become the new currency of business, and intelligent systems can supply both the raw material and sophisticated, real-time analytics that shape and guide more intelligent business decisions.
- **The cloud**: Intelligent systems can be both an on-ramp to the cloud and a means of exploiting the cloud's potential. Through IoT, businesses can develop new services and offer them through software-as-a-service (SaaS) models, creating new efficiencies and economies

The growth of connected devices in M2M and the Internet of Things including sensors, devices, and systems is set to be pervasive and to extend into all aspects of our society. Machina Research estimates

that the number of M2M connected devices will grow from 3.5 billion in 2013 to 22.2 billion by the end of 2023, representing more than a six-fold growth in the period.

This vast estate of sensors, devices and systems will be developed and deployed hand-in-hand with an extensive, diverse and **innovative range of M2M and IoT applications** including personal healthcare monitoring solutions, construction site surveillance systems, smart meters, connected cars, remote monitoring solutions for manufacturing, and agricultural equipment, to name but a few.

The market for machine-to-machine (M2M) solutions is changing. Solutions are shifting **from point-to-point, vertical industry focused solutions to the Internet of Things (IoT)** where more and more connected devices will be "talking" to other things, people and systems, in new and in some cases, unpredictable ways. This change is ushering in a new era of innovative applications that drive value, and will necessitate dramatic changes in application development. From **integrating edge devices and connecting back-end systems, to managing such complex areas as security, data storage, business rules and user identity** through one development flow with deep programming expertise, the traditional approach to application development will need to change. Given the **expected scale of connected things, quicker and more intuitive application development approaches will be required**.

One of the drivers of this change is a shift in focus, moving from simply "connecting devices" for monitoring purposes to a focus on driving deeper business insights through data management and data analytics. In traditional M2M solutions, device and connectivity management were the priorities. With data management becoming a growing priority for enterprises, the focus has shifted to data management through applications. How data is shared and analyzed across multiple applications as a reusable and valued enterprise asset becomes a primary differentiator for enterprises.

Analysts predict the market will grow with a double-digit compound annual growth rate (CAGR). The challenge is to translate the intelligence in connected embedded devices into new products and services that solve customer problems, drive customer engagement and loyalty, and deliver even higher value to the economy. **Analysts are unanimous about one aspect of IoT, the opportunity is huge**.

- **Connected M2M devices are predicted to grow significantly** from 3.2 billion devices in 2013 to 18.5 billion connected devices in 2022, a **CAGR of 21.5%.** When adding in PCs, tablets and handset data devices, these figures are set to grow from 11.5 billion in 2013 to a staggering 30.2 billion connected devices in 2022.
- **The massive rise of data traffic in the next couple of years** caused by the accruing number of devices sending information indicates clearly the need for an intelligent cloud-based management of data streams. **A forecast for 2018 from Cisco states that global M2M traffic will grow to 907.5 petabyte monthly**. The relative share of M2M-related traffic in total mobile traffic will increase from 1% at the end of 2013 to 6% in 2018.
- **IoT and the Cloud**. Within the next five years, **more than 90% of all IoT data will be hosted on service provider platforms as cloud computing** reduces the complexity of supporting IoT Data.
- IDC forecasts that the volume for **embedded systems will outpace any other mainstream system type,** reaching 8.9 billion unit shipments by 2015 with 75 percent of revenue opportunity.
- Machine-to-Machine (M2M) technology adoption is also spiraling upward: There are already **more than a billion M2M devices at work in sensors, smart meters, industrial control systems**, mobile healthcare assets, video surveillance systems, automotive and telematics solutions, smart buildings, and more.
- In fact, **Gartner predicts that the total economic value add for the Internet of Things will be US$1.9 trillion dollars in 2020**, benefiting a wide range of industries, such as healthcare, retail, utilities and

transportation. In the midterm (over the next 12 to 36 months), Gartner expects to see a shift **from niche implementations to a more coherent, widespread and integrated Internet of Things**.

New market forecasts from ABI Research show that the revenues from the **Internet of Things (IoT) application enablement platform (AEP)s** grew by 28% in 2014**. By end-2020, the revenue base will exceed US$1.4 billion, led by applications for remote monitoring and control.**

- Amid all the market noise surrounding IoT platforms. **A growing number of companies are developing and deploying IoT applications**, but much of the technology stack comes from internal teams and system integrators. **Third-party platforms have a high upside**, but today the reality is that the vast majority of enterprises have yet to either fully commits to an IoT strategy or determine the best way to execute one.
- **In the AEP market, 2014 was marked by the emergence of PTC** as a somewhat unexpected IoT champion, following its **acquisitions of Thingworx and Axeda**. Another interesting development was **LogMeIn repositioning its Xively platform from a pronouncedly horizontal "AWS for IoT**" to a more traditionally inclined solutions provider. Meanwhile, one of the original AEP pioneers, ILS Technology, was integrated into its new owner, Telit. Currently, the most pressing strategic topic is GE's announcement to open up its Predix platform to the products of other manufacturers.
- **IoT partnerships will emerge among disparate vendor ecosystems**. To create momentum, new industry partnerships will emerge as traditional IT vendors (i.e., Microsoft, IBM, HP, Dell) begin to accelerate their partnership with global service providers (i.e., AT&T, Telefonica, Verizon, Vodafone) and semiconductor vendors (i.e., Intel, Qualcomm, Samsung) **to create integrated offerings in the consumer electronics space**. These new partnerships will **accelerate the number of connected devices, expand the intelligent systems that manage the sensors** (a goal for the microprocessor vendors), and create integrated solutions offerings for the business services organizations of the IT players.
- Look for the **Chinese government and industry to play a very active role in IoT development and adoption. Open source minded** China will be a key player in the Internet of Things. As IoT players develop strategies and solutions in 2014, keeping an eye on China — as a key market and a seed bed for new technologies and competitors will be extremely important.

The market opportunity for providers of applications in M2M and IoT, as defined by Machina Research, amounts to a significant USD397billion in services alone by 2022 (see Figure 12). For users of M2M solutions, these applications unlock significant market opportunities to remain competitive within their market spaces, provide customers with benefits of new and improved services, potentially reduce the costs to deliver those services, and create new revenue opportunities.

The challenge of increasing data volumes and delivering on the opportunities associated with applications in M2M/IoT will depend on three critical areas: **application development, application management and scalability, all integrated and managed within a single M2M/IoT platform**.

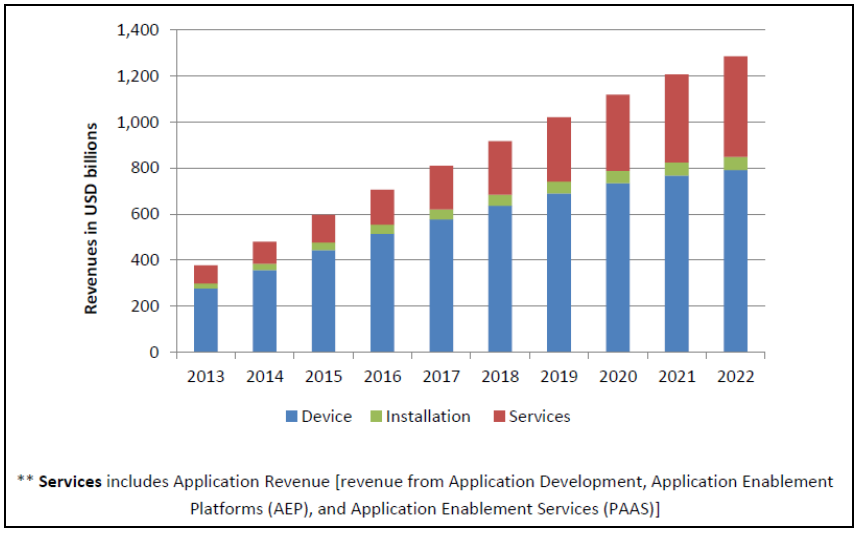


Figure 11: Revenues for M2M service providers. Source: Machina Research 2013

The IoT/M2M market is growing quickly, but the development of this market will not be consistent across all vertical markets. Industries that already "understand" IoT will see the most immediate growth, such as industrial production/automotive, transportation, and energy/utilities. However, all verticals will reflect great opportunity. IoT is a derivative market containing many elements, including horizontal IT components as well as vertical and industry-specific IT elements. It is these vertical components where IT vendors will have to distinguish themselves to address industry-specific IoT needs.

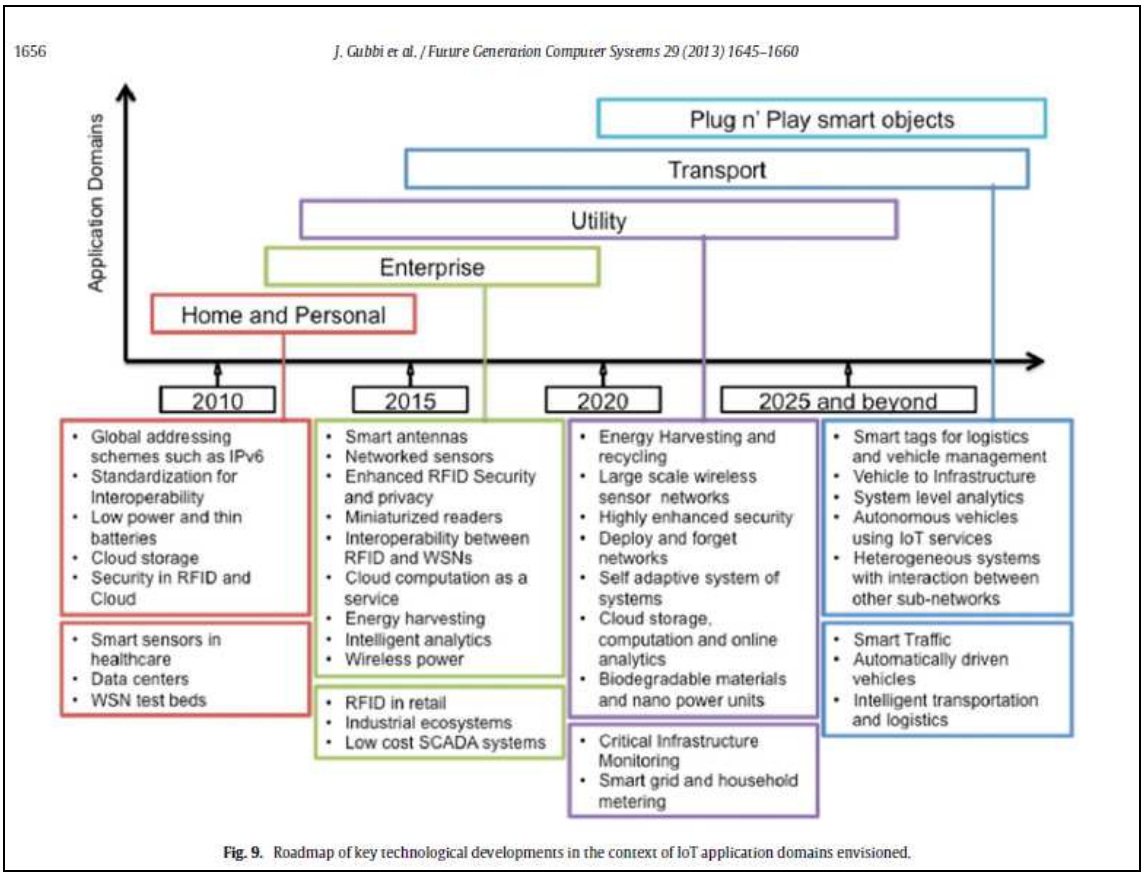


Figure 12: Roadmap of Key technological developments in the context of IoT application domains envisioned

3.3.3 Economical dimension: Rapid Application enablement and extensibility competitive advantage in M2M/IoT application platforms

Application development will be a top priority. In development trends, similar to those in the mobile enterprise application industry, enterprises will look to application platforms that deliver disruptive approaches to application development, avoiding more traditional and siloed M2M application development approaches where every application development and enhancement was a complex and time-consuming activity.

- **To maintain competitive advantage, enterprises will need to integrate and analyze data from different systems including the growing base of connected devices and sensors**. Leveraging their assets and tapping into new insights from data analysis, enterprises will aim to achieve new levels of efficiency, and deliver new and improved services and products for customers, generating longer-term relationships and potentially new revenue streams.
- **As applications ultimately underpin the strategic objectives of connected enterprises, the advantages of rapid application enablement will be crucial to accelerate time-to-value**. Enablers such as application "assembly" (as compared to traditional development approaches), and component re-use, when coupled with ease and efficiency in usability and supportability, deliver a more efficient use of development resources and a greater focus on innovative new business processes. Also **a ready-made ecosystem of partners enables end-to-end solutions to be deployed with a quicker time-to-market advantage.**
- And as enterprises and business models evolve, these **applications will need to be increasingly accessible and extensible to other systems such as enterprise resource or cloud services**, and underlying M2M/IoT application platforms will need to support this extensibility.

In the new application development environment, enterprises should seek quicker development routes. This is potentially achievable from codeless programming, application component reuse, and available toolkits, **allowing programmers to spend more time on the business logic of the applications** rather than challenges of interfaces to various devices, connectivity options and systems.

Compared to the mobile enterprise application industry, M2M/IoT application platforms will need to address a substantially greater number of different devices, users and processes. Application management will be critical in maintaining and managing different firmware and software versions and updates, and most important, maintaining updated integration components to ensure end-to-end integrations. **Securing partnerships with a wide range of service providers** will be a critical element of the forward looking M2M/IoT application platform.

As applications move from managing data from hundreds and thousands of devices to millions and billions, managing the flow of transactions and events at various levels and speeds will raise the issue of scalability as a priority. **Application platforms will require a robust and reliable approach to scalability**.

One of the common challenges for enterprises looking to implement M2M solutions is addressing the fragmented nature of the market. Enterprises have a core industry focus such as manufacturing, retail, or agriculture, and will traditionally implement required operational M2M solutions for that industry through IT departments. These solutions require working closely with a host of global partners and third-party suppliers, and integrating a variety of devices, connectivity technologies, platforms and applications, and systems. **Application development for the enterprise in this environment remains a complex and time-consuming effort** with potentially longer term and increasingly expensive development processes.

Enterprises may also require additional M2M solutions for areas such as fleet management, access solutions, security and building management, which may not form part of their core business but assists business operations. Managed in the siloed and traditional approach of M2M application development, each instance would have its own development process with limited reuse of programming techniques

from other applications. **Where ready-made ecosystems of partners may appear** to offer a limiting scope to the options of the enterprise, these ecosystems do provide substantial benefits in addressing and removing some of the technical complexities faced by enterprises in application development.

M2M/IoT application platforms with established ecosystems of partners will have worked with those partners to develop the necessary toolkits to connect devices, sensors, back-end systems and other applications in a seamless and easy to integrate approach for developers, enhancing rapid application development.

Application extensibility and an applications marketplace offers enterprises an opportunity to address an otherwise fragmented M2M/IoT market space in a structured and comprehensive way, a necessity as the volumes of devices and sensors, and "talking things" grows.

Focus on the **measurable and material improvements in revenue, efficiency or profitability that might arise from the ability to better monitor, manage and control remote assets**. Gartner believes IoT creates business cases in three key areas**: in operational technology, the digital supply chain and customer interactions**. The relative importance of each area and the enterprise's specific needs will vary significantly by industry, so an industry perspective is needed as well.

- **Operational technology**: The intersection between these intelligent operational technologies, the Internet and IT is expanding, making operational technology (OT) a major part of the IoT. Not only manufacturing and industrial equipment, but also facilities (for example, office buildings and conference centers) hold potential value for OT to optimize facility utilization and energy use.
- **Digital supply chain**: Companies selling new Internet-connected smart goods and devices will see their supply chains evolve even further, creating new opportunities for selling additional products and services. While this trend has centered so far on the delivery of high-cost and complex products, lower costs for embedded intelligence and standardized IoT approaches will bring lower-cost and less-complex products.
- **Customer interactions**: There has been an explosion in individuals' use of technology in everyday life via Web-based services (for example, social networking), mobile devices (smartphones and tablets) and intelligent products (for example, smart TV and telematics).

The retail sector witnessed the single biggest disruption with e-commerce and online retail. IoT has the potential to cause a similar disruption to the retail and e-commerce space, and can fundamentally alter the way the sector is operating today. IoT provides retailers **with a wide range of options to make their operations more efficient and provide significantly higher value** to their consumers, including:

- Supply chain, inventory, logistics and fleet management are perhaps the areas where the impact will be most felt, at least in the initial years. Existing technologies such as bar coding and radio-frequency identification (RFID) already let retailers monitor their inventories. IoT will enable this to be taken to the next level with significantly more data coming in the monitoring systems and products moving through the supply chain. This can considerably improve supply chain efficiencies and enable leaner inventories. Large retailers such as Walmart are already using IoT for supply chain and inventory management.
- IoT is already showing signs of revolutionizing the way retailers interact with their customers when it comes to real-time analytics and promotions. This is where big data and IoT meet, and the possibilities can be endless. Using a mix of connected devices at the store as well as customer data, retailers can tailor make promotions and experiences for customers. In many ways IoT will enable brick-and-mortar retailers to have the kind of real-time customer information that online retailers always had.

For manufacturers, the implications of this emerging "Internet of Things" are huge. According to a recent McKinsey Global Institute report, the Internet of Things (IoT) has the potential to unleash as much as $6.2 trillion in new global economic value annually by 2025. The firm also projects that 80 to 100

percent of all manufacturers will be using IoT applications by then, leading to potential economic impact of as much as $2.3 trillion for the global manufacturing industry alone. Niche Market Opportunities

- Sensors in Automotives-Applications and Technology Roadmap
- Sensors in Process Industry
- Sensors in Alternative Power Generation from Renewable Sources
- Sensors in the Smart Grid-Sensor Functionality in Transmission Systems
- Sensors in Medical Applications-Base Sensors to Smart Pill
- Biosensors Market-Application to Technology Possibilities

The Internet of Things market today is often viewed as a collection of vertical solutions addressing well-understood needs of known customers, much like the smartphone players of pre-iPhone era – Nokia, Microsoft and BlackBerry.

- **Forward-looking companies are basing their strategies on building communities of Internet of Things entrepreneurs**. We also show how you can not only build such communities, but turn them into a profitable business with developer-centric business models.
- **One of the key lessons from the hyper-growth of mobile is that looking beyond existing customers** and their immediate needs can unlock new demand and create huge markets. In fact, the same steady stream of developer-driven innovation is already emerging in IoT.

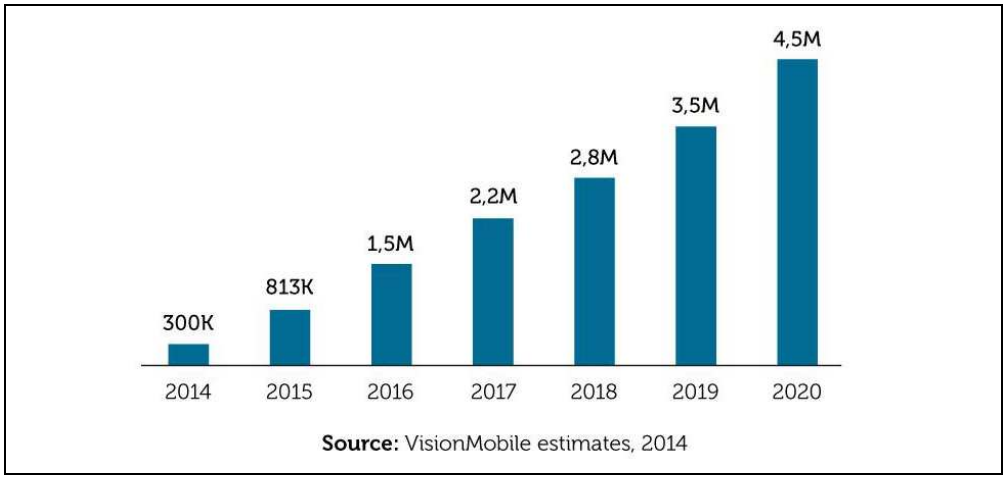


Figure 13: The Number of IoT Developers 2014-2020. Source: Vision Mobile June 2014

These wide-ranging and often unexpected devices, services and apps that come **from a growing community of Internet of Things** developers is the main factor that will drive demand for IoT to unseen heights. **The future leading IoT platforms will win by connecting developers and users in an IoT marketplace**. IoT developers need access to an attractive addressable market to build a sustainable business on top of the platform.

3.3.4 Legal Dimension: Overcoming the Barriers

The benefits of IoT and M2M can be tremendous, wherefore companies setting up new business models, leveraging the generated data and creating service models on top of it. The opportunities of earning money seem to be infinite. But there are a couple of major challenges to solve, in order to make the collection and provision of information as efficient as possible.

- To prevent data flooding as a result of the unstructured communication between billions of devices
- To prevent the grow of large but encapsulated sensor networks (walled gardens), where only specific and predefined devices can interact
- To push the creation of virtual sensors forward as they are providing the possibility to derive, generate and finally correlate information from sensors, as a direct result of the integration of numerous devices

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.

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

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.

3.3.5 Conclusions

The proliferation of devices with communicating–actuating capabilities is bringing closer the vision of an Internet of Things, where the sensing and actuation functions seamlessly blend into the background and new capabilities are made possible through access of rich new information sources. **The capabilities created and data generated by this new generation of smart, connected products** requires new thinking about the enterprise applications and the connected ecosystem to optimize current business processes, drive better decision-making, and expand areas of innovation.

Application development will be a top priority. In development trends, similar to those in the mobile enterprise application industry, enterprises will look to application platforms that deliver disruptive approaches to application development, avoiding more traditional and siloed M2M application development approaches where every application development and enhancement was a complex and time-consuming activity.

Deploying end-to-end M2M/IoT solutions and being able to manage an increasing range of applications becomes the next challenge for enterprises. Providing a dedicated enterprise platform and toolset, and enabling the re-use of components by the enterprise, enhances the ability of enterprises to manage the growing range of applications.

Other forces will play a role in growth of M2M/IoT application enablement platforms (AEP), including greater acceptance of cloud services, the attractiveness of new business models for machine leasing (Machine as a Service), warranties, and SLAs, "free to try" platform offers, and cheaper communication devices and connectivity costs. However, an equally important, if not more important force driving the growth of these application enablement platforms (AEP)**, is evolution of the supplier ecosystem**

Despite the vast opportunity for merchant-market AEP solutions, the market at present is nascent, small, and comprised of a variety of vendors coming to the market from differing backgrounds. However, there is clear opportunity for consolidation going forward, as more suppliers are augmenting their

capabilities to **offer nearly one-stop shop services,** and we expect that as the **M2M market becomes ever more main stream.**

3.4 Economy of Internet Application:

The economy of internet applications supports the **whole service live cycle spanning from creation and composition of services to provisioning and distribution**, finally **leading towards monetization and revenue sharing.**

The vision of the Application Ecosystem Chapter is about support for service and application based value chains in a Future Internet, created and executed by a multitude of players and their potential interactions This Future Internet vision foresees the trading of services, the bundling of services and finally leads towards the automatic offering, delivery and execution of services.

- The addressed kind of service ecosystems is “a game of many” where Service Providers offer their services in particular business domains (shown as marketplaces) and towards consumers or “clients”.
- While in the traditional model a business domains would have been closed and governed by proprietary mechanism, the new Future Internet breaks ups these boundaries and allows cross-business domain interactions.

3.4.1 Application Stores: Innovative Revenue Share Models are required

The App Economy, while successful, is still at a nascent phase. **Mobile and apps today are at a stage of Development that is analogous to the internet pre-broadband**. This is changing in a number of ways:

- **Smart device ownership is growing and may become almost universal in the near future**. If that happens, the transformation of business and government services will accelerate. **Ubiquity would also increase the benefit to all users,** especially for applications involving network effects (e.g. communications, social networks, mobile commerce).
- **The capability and diversity of apps is growing with technology advancements and use of cloud computing**. Apps are being developed to meet niche needs in a global market, which may not have been viable previously due to high costs and discovery barriers.
- **Wireless connectivity is improving with 4G rollout.** Coverage is expanding, along with enhancements in quality of service (speed, capacity, latency). LTE (4G) with additional spectrum is changing this while offering lower costs per bit carried and enhancing the potential of the App Economy **through ubiquitous connectivity and cloud services**

Application/service developers and providers are faced with the challenge to build smart applications that cover consumer’s needs. From a development perspective, such applications and services should be built on top of **powerful but easy to use APIs, be based on standards and offer flexible deployment and provisioning means** (e.g., many devices, multi-tenant architectures, global scalability, and on-demand provisioning) and management frameworks (e.g. in the Internet of Things). Additionally, **they should exploit economies of scale and protect investments in the long run.** Finally, the ability to combine applications from different sources needs **innovative revenue sharing models** across partners and potentially also customers (e.g. crowd-sourcing) which have to be adapted dynamically as market conditions change.

Amazon, Google and other Internet players have already demonstrated how an innovative combination of business models, Internet-based platforms, and marketplaces can lead to a successful monetization of offerings. However, while **marketplaces and business models** have experienced a relevant

development on certain proprietary domain-specific platforms operated by a single provider, the **open innovation in the apps/services space is still in its infancy**, thus maintaining high entry barriers for smaller players to the Internet business ecosystem

Nowadays, there are several examples where revenue distribution is needed.

- The best known examples are Apple Application Store and Google Play, which **pay a percentage of the incomes from an application download to its developer.** Another example relates to Telco API usage, as in Telefónica's BlueVia or Orange's Partner, in which application developers receive a revenue share for the usage of Telco APIs by the final users.
- **In addition, some of these players are offering their business capacities to third parties**. For instance, Amazon DevPay takes care of billing and accounting, on behalf of service providers, applications developed on top of Amazon Web Services. Thus, Amazon DevPay facilitates the trading of digital goods to smaller players such as ISVs and SMEs. In exchange, Amazon retains a share of the revenues generated by selling these applications.
- **Another emerging area is Operator Billing (also known as Carrier Billing),** which allows customers to pay application downloads using their telephone bill. For instance, Telefonica is offering this capability, by means of its BlueVia platform, which is already integrated with widely used marketplaces like Google Play and Windows Phone Marketplace. Note that a critical component of Operator Billing is financial settlement whereby revenue shares are paid out to stakeholders, refunds are handled and a reconcilement process is carried out.

Based on the above, we can conclude that, **in the Future Internet, there is a need to manage in a common way how to distribute the revenues produced by a user's charges for the application and services consumed**. Independent of service type, composite services, based on the aggregation of multiple atomic (from the viewpoint of composition) services, are expected to play an important role in applications and services ecosystems. **Beyond the complexities of the management of composite services (design, provisioning, etc.), there is a complex issue to solve when dealing with the business aspects**. Both composite and atomic services must be accounted, rated and charged according to their business model, and each of the service providers must receive their corresponding payment. When a consumer buys/contracts an application or service, he pays for its usage. **This charge must then be distributed and split among different actors involved** (for instance, store or marketplace owner retains part of the revenue while application and mash-up developers are paid out the corresponding revenue share).

The following **Table 3** collects a subset with the most prominent ones, along with some others that recently passed away and whose occurrence in the table intends to capture unsuccessful business models (e.g. most of them were operated by telecommunication operators).

Table 3 Selection of mobile application stores

	Device Manufacturer	OS Developer	Network Operator	Component Manufacturer	Independent
Apple App Store (http://www.itunes.com/appstore/)					
RIM Blackberry App World (http://appworld.blackberry.com/webstore/)					

Nokia Ovi Store (https://store.ovi.com/)					
Palm App Catalog					
Samsung Apps Store (http://apps.samsung.com)					
LG Application Store (http://www.lgappstv.com)					
Dell Mobile Applications (http://dellmobileappstore.com)					
Google Play (Android Market) (https://play.google.com/store)					
Windows Phone Marketplace (http://www.windowsphone.com/en-us/store)					
Java Store (http://java.apps.opera.com)					
Verizon VCast (passed away on January 2013) (http://www.verizonwireless.com/)					
T-Mobile Web2go (precursor) (http://developer.t-mobile.com/site/global/resources/network/web2go/p_web2go.jsp)					
Vodafone 360 (passed away on January 2012) (http://www.360.com/.)					
ATT AppCenter (https://appcenter.wireless.att.com/)					
Sprint Digital Lounge (https://manage.sprintpcs.com/digitallounge/home)					
Orange App Shop (http://www.orangepartner.com/articles/distribution-channel-app-shop#.UZFDpivOQ7Q)					
Intel AppUp (http://www.appup.com/index)					

Qualcomm BREW Apps Store					
MediaTek App Store					
GetJar (http://www.getjar.com)					
Amazon AppStore (https://aws.amazon.com/marketplace)					
Mobango (http://www.mobango.com)					
Cherokee Market (http://cherokee-market.com)					

From the perspective of their ownership, these stores can be classified into mobile app stores from device manufacturers, OS and software platform developers (including Java and Chrome), telecommunication operators, component manufacturers, and independent app stores. Mobile application stores are very attractive for these organizations for several reasons. On the one hand, they promise tremendous growth. On the other hand, mobile application stores are crucial in the competition of mobile platforms.

From the perspective of their business model, they can be classified in those following a closed model, which includes both failed approaches (e.g. Compuserve and KPN iMode) and successful ones (e.g. the Apple App Store, a relatively closed approach), and those following an open model (e.g. Google Play, a relatively open approach). Apparently, the main question for successfully commercializing mobile services is therefore not whether to choose a purely open or closed approach. **Other factors like impact of network effects, economies of scale, platform differentiation, quality assurance, and transaction costs have influence on the design of successful mobile app markets**.

A different approach, also based on the target business model, is to classify them in three different groups depending on the role played by the service providers. Just as the recent history of mobile content sales, the first app stores were largely driven by two business models commonly known **as on-portal and off-portal, both of which require service provider support.** The on-portal business model requires the service provider to manage all aspects of content provisioning, marketing, consumer discovery, content delivery and consumer care. It also requires the service provider to maintain systems and resources to support each of these functions. The common off-portal business model requires the service provider to support a short code messaging service (SMS) and a payments service to businesses that market directly to consumers via media such as the web, TV, radio or magazines.

The primary value added to the off-portal business by the service provider is the ability to collect payments from a consumer without extra data entry through the device, a significant benefit when working with mobile devices and impulse sales. To address off-portal business models, service providers either put in place the necessary systems and work directly with third parties or, more often, service providers work through aggregators (like Open Market in the U.S.) who carry most of the operational burden, and offer to third parties the extra benefit of consolidating access to multiple service providers within a given market.

With the advent of Apple App Store-like models, a new business model takes shape: the "non-portal" model, where the service provider does not have a front stage role in the content or application sales transactions. Although they benefit from an increase in mobile data usage, they are witnessing the control over more and more elements of the mobile purchasing experience being wrested from their

hands in favour of the on-device content and application stores. The service provider is not even required for payment services. **Credit card accounts are provisioned independently with the customers (e.g. using iTunes).**

In Apple App Store-like models, developers can easily on board with a simple, straightforward revenue share contract and can rely on the availability of broadband over WiFi or the cellular network. They can access a number of APIs (e.g. iPhone API) including an in-app purchasing API. Most existing application stores have also demonstrated the power of opening the OS directly to developers. Camera, GPS and touch-screen capabilities enhance applications to the extent that customers get "locked into" using the device. In simple terms, **App Store-like models unlocked the revenue potential of the mobile application ecosystem, a move that has profited almost every link in the mobile value chain**.

The success of a mobile platform depends on the successful design of a viable mobile ecosystem of related services and components. Apple App Store and Google Play (Android market) remain the two biggest app stores.

There is also a shift from one-off fees to in-apps revenue models. 35% of the revenue from the top 10 publishers comes from in-apps revenue models **Error! Reference source not found.**.

The following **Table 4** offers a comparison of various app store models. The table demonstrates the differentiating factors in today's application store competitive arena. **Service providers can bring several valuable assets to create a killer application platform that would be attractive to the developer and content partner community.**

Table 4 Comparison of selected app store models

	Operating System (OS) Specific or On-Device Application Store (e.g. Android, Apple, RIM)	White-Label Application Store (e.g. Handango)	Service Provider Application Store
Third Party access to APIs	OS-specific (e.g. memory, data management, media playback, address book, GPS, camera)	OS-specific	Service provider-specific (e.g. location, presence, CRM data, call management, address book)
Distribution Channels	> Web > On-device store > Mobile portals > Enterprise program	> Web > Partner on-device stores > Partner mobile portals > Direct sales	> Web > Mobile portals (via on-device "Download" icon)
Consumer Billing Options	Third party (e.g. PayPal, CheckOut, iTunes, credit card, etc.)	Third party (e.g. PayPal, CheckOut, iTunes, credit card, etc.)	Service provider billing
Developer Business Models Supported	> Direct application sales > Advertising > In-app content sales	Direct application sales	Direct application sales
Developer Support	> Online resources > Conferences and events	> Business development > Marketing > Sales > IT	> Online resources > Conferences and events
Personalization Support	In some cases (e.g. Nokia)	No	No

Other classification criteria include pricing support (free, single payment, subscription, pay per use), **payment options** (credit card, PayPal, bank account, own proprietary system e.g. Google wallet), **supported products** (apps, digital services, non-digital products e.g. goods, non-digital services e.g. website design, source code or API access). The following **Table 5** offers a comparison of various app stores according to these criteria.

Table 5 comparison of various app stores according to selected criteria

	Apple App Store	MS Azure store	Google play	AWS marketplace	VM solution exchange[1]	Hubspot marketplace[2]	Binpress[3]
Pricing support							
Free							
Single payment							
Subscription							
Pay per use							
Payment options							
Credit card							

[1] https://solutionexchange.vmware.com/store, https://aws.amazon.com

[2] http://marketplace.hubspot.com/, https://app.hubspot.com/market/front/list, https://services.hubspot.com/

[3] http://www.binpress.com/

Paypal account							
Bank account							
Own proprietary system			Google Wallet				
Supported products							
Apps							
Digital services							
Non-digital products (e.g. goods)							
Non-digital services (e.g. website design)							
Source code							
API access							

The table also shows the recent proliferation of cloud-vendor stores:

- AWS Marketplace is an online store that allows customers to purchase AMI images with any kind of software ready to be deployed using the EC2 service.
- VMware solution exchange: is an online store that allows buying VMware virtualization software as well as applications compatible with VMware products.
- Microsoft azure store is part of the Microsoft cloud platform and allows purchasing both software to be deployed in the cloud infrastructure and apps for the management dashboard.

Other examples of app stores considered in the table are Hubspot and Binpress. Hubspot marketplace is an online store divided into two main parts, the apps marketplace allows buying apps that can be plugged into the hubspot software and the services marketplace allows contracting any kind of service offered by a provider company allowing the direct contact with them. Binpress is an online store that allows software developers to buy and sell source code.

3.4.2 Market: The business app market will double in size by 2016

Vision Mobile estimates that more than $28 billion were spent on apps by businesses and professional users in 2013. We forecast that the business and productivity market will reach $58 billion by 2016. This report aims to highlight developer opportunities and forecast the size of the business and productivity app market.

Apps have had a profound effect on consumers' lives in the past few years. Post-PC devices, off-the-shelf mobile apps and growth in SaaS and cloud are driving a mobile revolution. **Enterprises are mobilizing business processes, web assets, their workforce policies, plus marketing and sales channels**. Mobile is fulfilling new and existing use cases in the enterprise, such as:

- Mobilizing workforce and business processes
- Extending availability of cloud services to anytime and anyplace
- Extending or opening up new marketing & sales channels
- Enabling flexible logistics and resource management
- Mobilizing business intelligence

These changes are creating numerous opportunities for developers, platform vendors, OEMs and verticals.

- **A key driver will come from mobile SaaS adoption among SMBs** (small & medium businesses) in HR, ERP, CRM and messaging platforms. At the same time productivity apps and services (Box, Evernote, Google docs, Zoho) used by professionals inside and outside of the workplace are becoming commonplace.
- **Vertical app markets, such as Healthcare and Education are also starting to form**, paving the way for specialist app vendors and industry-focused marketplaces.

We can still identify a number of areas that currently attract considerable attention among businesses and where we see future value being unleashed in the business & productivity market:

- Vertical apps: Specialized industry apps such as healthcare, real estate, finance or automotive. Vertical specialization provides a great opportunity for differentiation and for building strong brands as the app economy diffuses into every single industry. For independent developers, specialization is a means to capture a niche and survive the discoverability labyrinth.
- Productivity/BYO: Apps that cross the boundaries between private-use and work-use, such as storage, lists, calendars, office-type apps are key drivers behind the consumerisation of enterprise IT. Once into an organization or an enterprise app store, such apps can spread rapidly within organizations.
- Mobile SaaS: Software-as-a-Service, delivering CRM, HR, ERP, BI services to small businesses and large enterprises is a booming sector. Mobile apps extend these capabilities much further by allowing anytime/anyplace access to these core business services.
- Custom apps/services Bespoke mobile solutions delivered outside of app stores will continue to take the lion's share of revenues within the business and productivity app market. As we discussed, the dominance of this model will erode during the next few years as app store purchases increase among enterprises.
- MDM/MAM: Apps and services that tackle security and complexity of the decentralized IT department are already essential for any enterprise that adopts BYO policies. More sophisticated app & device management models, that tackle some of the key issues associated with this trend (e.g. managing private/work services, remote deletion of work content) will continue to be hot areas in the next few years

The app economy has been growing at a tremendous rate over the past few years and will continue to do so in the near future, growing by 27% annually up to 2016. To date, growth has been mostly fuelled by rapid adoption of smartphones and tablets among consumers, globally. But bring-your-own trends and developments in enterprise mobility are turning **the business and productivity sector into a major**

growth factor for the overall app economy. We expect that the business and productivity market will grow to $58 billion by 2016.

The diffusion of 3rd generation smart mobile devices and apps started from consumers and then spread to the workplace. **As a result, the consumer app market today is larger than the business & productivity market, but both are poised to grow rapidly in the following years**. The consumer market is fuelled by a maturing user base and rising smartphone penetration. The business market is growing as a result of post-PC devices making their way into the **enterprise and mobile apps and cloud services becoming a key part of enterprise IT services.**

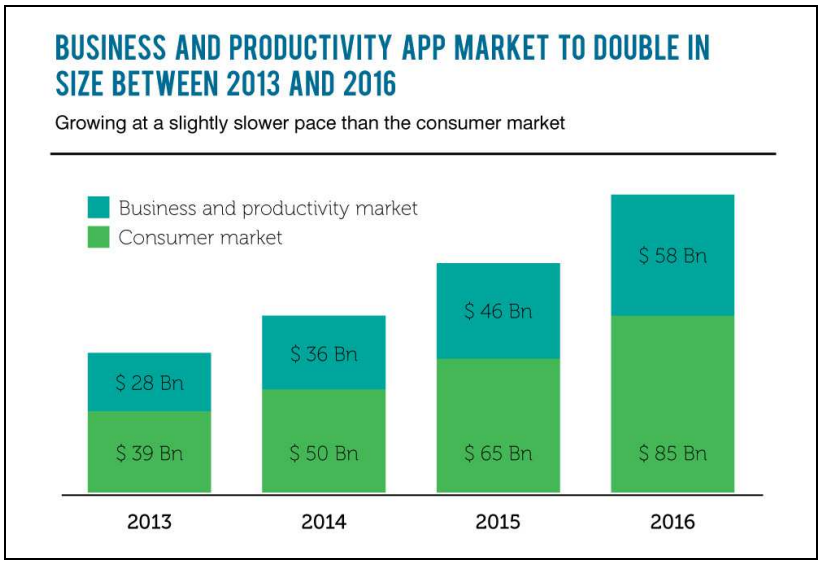


Figure 14: Business and Productivity Apps. Source: VisionMobile

While the consumer app market is, and will likely remain bigger than the business market up to 2016, Vision Mobile suggests that the business & productivity market presents better opportunities for building a sustainable business and providing long-term value and user engagement. **The business and productivity market has fewer developers competing for the revenue pie** and at the same time more developers that generate very high revenues.

Vertical app markets present great opportunities for organizations and developers that want to differentiate themselves by specializing and competing in specific industry sectors or enter the app economy by utilizing existing industry expertise. **The business and productivity market is clearly quite different to the consumer market, providing a different set of opportunities**:

- It is currently **a less competitive market** where demand outstrips supply
- Business apps are built around **more solid business models**, often extending successful desktop/cloud services
- It has a **more sophisticated developer base**, with more experienced developers

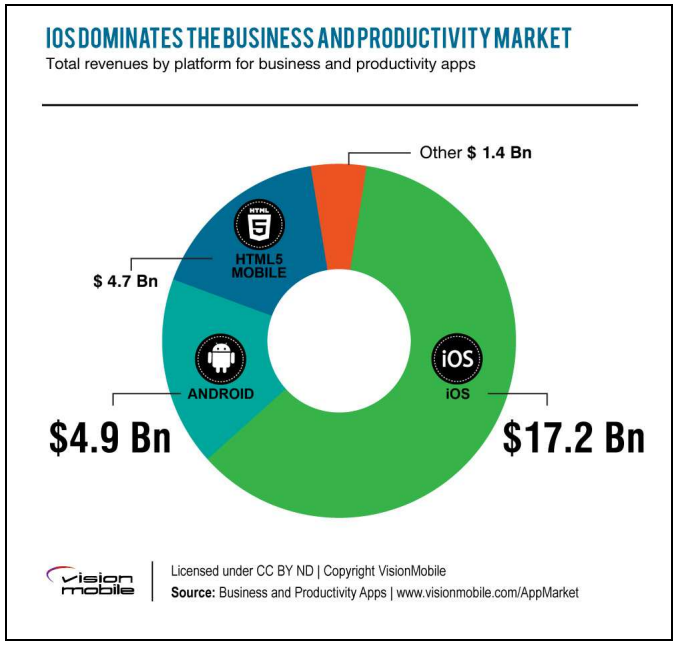


Figure 15: Business and Productivity Apps. Revenues by Platform. Source: Vision Mobile

These figures seem somewhat surprising given **the dominance of iOS in the business and productivity market**: if you are developing app in the business and productivity, it makes sense to prioritize iOS which generates most of the revenues in this market.

Vision Mobile forecasts that the business and productivity app market will double in size between 2013 and 2016, growing from $28 billion to $58 billion. Developers that want to establish a strong presence in this market should start building their business and partnerships today, in order to leverage this growing opportunity. **This growth is driven by fundamental changes taking place in the workplace, which is being transformed by post-PC devices and mobile apps**.

In 2014, North America continues to lead the App economy both in terms of total revenue generated from sales within the region and in terms of output.

- **Vision Mobile estimates that in 2013, sales in North America accounted for 42% of global app sales** (including services and contract development) but we expect this to decrease to 33% in 2016 as **growth in Asia, Latin America and Africa accelerates.**

- **Europe is the second largest consumer of apps & related services, by sales value, accounting for 28% of global app sales in 2013**. But it will be overtaken by Asia in 2016 as smartphone sales soar in the region.
- **Developers should also be keeping an eye at Latin America and Middle East and Africa**, which together accounted for just 13% of the app economy in 2013 but will grow to 19% in 2016.

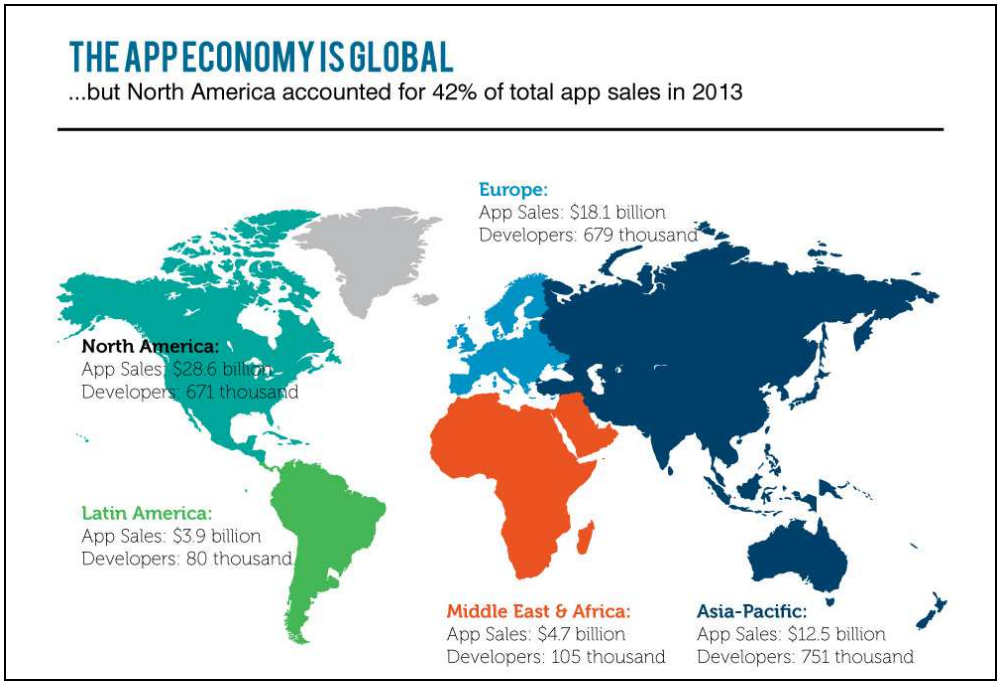


Figure 16: Business and Productivity Apps. Global Sales. Source: Vision Mobile

3.4.3 Business Dimension: Transforming of Industry Sectors or Verticals.

The rise of apps is transforming the business environment across different segments of the economy. The most obvious case is in **the media and entertainment industries** where the internet has provided new ways of aggregating and delivering digital goods and services to consumers (e.g. over-the-top services and apps like Spotify, Netflix and YouTube). These have contributed to the disruption of traditional business models, increased competition and paved the way for new market entrants. **Another example is the "sharing economy" phenomenon** in which the internet and apps facilitate sharing of unused or underused resources and assets from cars (e.g. ZipCar) and homes (e.g. Airbnb, CouchSurfing) to clothes and human resources.

Mobile apps are becoming big business. Analysts estimate that app-related revenues reached $25 billion last year, on the way to more than $70 billion by 2017. App developers and the Apple and Google app stores aren't the only ones profiting from this boom. **A small but growing portion of app revenues comes from organizations making their data available through application programming interfaces** (APIs) gateways that, among other things, enable third-party app developers to leverage a company's aggregated data or selected services:

- Under the pay-per- use model, a company makes its transactional data available to third-party apps that, for example, compare prices or analyze customer behavior.
- Subscription models are similar, but fees accrue during a subscription period rather than per use.
- Resource-usage and revenue-sharing models typically generate sales of a company's own products (for example, on an online storefront), from which the app developer too gets a cut.

Additionally, the number of app developers using business models that don't rely on app store payments is increasing:

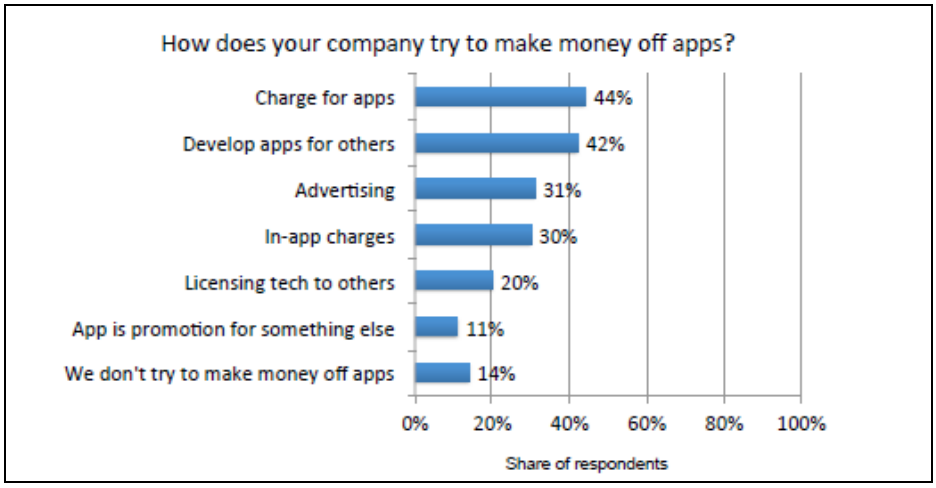


Figure 17: Source: Gigacom Research EU independent developer's survey. 4Q2013

- **App store payments and advertisers:** The next most popular revenue models, **in-app advertising, paid downloads, in-app purchases and freemium are all relying on directly monetising an app**. Together they are the four most risky models with the lowest chances of profit. Paid downloads are the least successful revenue model. Despite the advantages of the in-app purchase model, it's still quite far behind other models.
- **Selling services:** Subscriptions are the next most popular and also relatively low risk and successful. However, implementing subscription based services is usually more complex than selling apps or virtual goods. Many subscription based businesses are simply using an app to sell subscription content. Another interesting possibility for developers in this area is to resell generic cloud services by adding value on top. Others include tools or services that help developers design, build, market or monetise their apps. This is one of the lower risk models with a good probability of profit.
- **Selling stuff:** Apps that make money through e-Commerce are the most successful in terms of making comfortable profits and have by far the lowest risk of making a loss. Most developers using this model had existing e-Commerce businesses and have just added mobile apps as another sales channel.
- **Royalties or licensing:** This is inherently a higher risk strategy with bigger rewards for success. It usually involves building a product for large companies or even OEMs.
- **Build a business, not just an app:** The app stores made it really easy for developers to sell software to a very large audience for the first time. Outside of the VC-funded startups, developers that succeed will be the ones that think about where their revenue will come from before they've started building the app.

3.4.4 Legal Dimension

As we have seen above, managing composite services and making them available to users raises brings in several complexities, ranging from design to provisioning to more business-related aspects. The creation of a third platform marketplace, where several stakeholders need to successfully cooperate while preserving their specificities (in 28 countries), raises potentially critical legal issues at different levels.

One crucial aspect regards **intellectual property**. As stated by the European Commission, in our growing knowledge-based economies the protection of intellectual property is important not only for promoting innovation and creativity, but also for developing employment and improving competitiveness (http://ec.europa.eu/internal_market/intellectual-property/). Intellectual property covers two areas: industrial property and copyright.

- **Copyright**. It is important to exercise considerable caution where material is taken from a third party source without permission, as their activities are likely to amount to an infringement of copyright and/or database rights. Copyright infringement will occur if the whole or a substantial part of a copyright work is copied or adapted without the copyright owner's consent. This concept may also vary across European countries since there may be more and less restrictive definitions of what can be considered "substantial".
- **Usage of data**. Data may also be protected by copyright and, additionally or in the alternative, by database rights. Again, this may vary across countries. These aspects should be taken into account when building composite applications.
- **Industrial Property/Patents**. The EU approach is that "a strong industrial property rights system is a driving force for innovation, stimulating R&D investment and facilitating the transfer of knowledge from the laboratory to the marketplace" (http://ec.europa.eu/internal_market/indprop/rights/index_en.htm). The marketplace and application composition platform should not facilitate IP infringements, quite the opposite. It is therefore important to find a tradeoff between the protection of intellectual property and consumer privacy versus fair-use and the free flow of information through applications.

Another important legal implication comes from the combination of GEs that follow different business models.

- **Business models**. As discussed in previous sections, pay-per-use business models have been growing in popularity (see analysis on app stores and service stores). When a consumer buys/contracts an application or service, he pays for its usage. Both composite and atomic services must be accounted, rated and charged according to their business model, and each of the service providers must receive their corresponding payment. In other segments, more traditional license-based business models are currently enforced. It may happen that different types of business models, pay-per-use and license-based, are enforced in the same composite application because single applications enforce different business models. Therefore, a demanding challenge for enabling the ecosystem of applications is the harmonization of business models, especially within the same composite application.

From the above considerations, we can advocate the need for an EU regulatory framework, which is able to mediate and find suitable legal collaboration patterns between different stakeholders (and their countries), while avoiding imposing too strict limitations to the characterizing modus operandi of the marketplace. In fact, it is likely that several issues that are typical of any marketplace (be it digital or in the physical world) would be subject to debate within the EU, in order to find a viable policy that protects individual rights while encouraging the development of applications in the marketplace.

3.4.5 Conclusions

The app economy to date has been powered by consumer usage of mobile devices and social networks. This consumer behavior has **driven an enterprise and business to business halo effect**. A number of behavior and market specific factors **will drive continued growth in the app economy**, including:

- A modest spread of apps store revenues beyond games
- Growth in number of app developers (including transitioning of other ICT skills and new entrants)
- Growth of consumer adoption of connected devices in emerging markets

A number of **potential risks and growth inhibitors also exist**. These include:

- The possibility that the consumer app market will not meaningfully expand outside games

- The deterioration in paid app revenue in favor of in-app purchasing, making it difficult for non-game companies to monetize their apps
- The risk that the app economy is a bubble market that lacks the economic infrastructure for long-term sustainability
- The difficulty of new entrant developers being discovered by users on the increasingly cluttered app platforms, thus reducing success rates and slowing the influx of capital.

Application/service developers and providers are faced with the challenge to build smart applications that cover consumer's needs. From a development perspective, such applications and services should be built on top of **powerful but easy to use APIs, be based on standards and offer flexible deployment and provisioning means** (e.g., many devices, multi-tenant architectures, global scalability, and on-demand provisioning) and management frameworks (e.g. in the Internet of Things). Additionally, **they should exploit economies of scale and protect investments in the long run.** Finally, the ability to combine applications from different sources needs **innovative revenue sharing models** across partners and potentially also customers (e.g. crowd-sourcing) which have to be adapted dynamically as market conditions change.

The choice of the right business model both in the role of a provider of an offering or in the role of a customer of an offering is very important but very difficult since many new business models still need to prove their added value and constant revenue generation capability. One very successful example of new business models in the application and services ecosystems markets is the emergence of application stores or service stores with their search-buy-use model in the recent years. There, application or service providers are connected to customers for their offerings through internet-based marketplace with a set of diverse possible business model designs. In the years to come the different stakeholders of business ecosystems need to be able to develop a good competence skill in these relevant areas of business frameworks for service-based or application-based ecosystem platforms in the Future Internet.

Amazon, Google and other Internet players have already demonstrated how an innovative combination of business models, Internet-based platforms, and marketplaces can lead to a successful monetization of offerings. However, while **marketplaces and business models** have experienced a relevant development on certain proprietary domain-specific platforms operated by a single provider, the **open innovation in the apps/services space is still in its infancy**, thus maintaining high entry barriers for smaller players to the Internet business ecosystem

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

The need **of common, standardized set of Interfaces to networks and devices** plays a key role for a convergent, interoperable Future Internet. The state of the art of interfaces to network is extremely complex, due to the high heterogeneity and due to the high number of functions a communicating device and a network can feature.

The current trend in **network deployments is towards achieving large synergies with software engineering technologies.** This is mainly realized through the adoption of heterogeneous technologies which rely on three large directions for software based developments:

- **Network Functions Virtualization** providing the means for automatic deployments and management of network functions which are deployed on top of common hardware platforms and opening the market for offering comprehensive, customized network systems as a service,

- **Subscriber-adaptable communication mechanisms** providing the methods to highly customize the subscriber communication reducing the overhead of the used resources very close to the minimal limit of resources which can be deployed.
- **Software defined networking** providing the means to abstract the network control and management a programmable control plane and thus abstracting the network complexity.

From a device perspective, these initiatives are **doubled by a new generation of device features and the specific applications**. Particularly a new market appeared for **providing an increasing number of applications for enterprise networks** which are following specific and highly heterogeneous communication characteristics along with the development of the classic and Over-the-top massive subscriber Telco market. Technically these **applications provide a front-end experience for the enterprises existing back end infrastructure.** As applications project the sponsoring organisations brand to the consumer it is important that:

- **Reach as a many devices as possible**: A standardised approach to creating cross device applications is required, from the application runtime perspective as well as from the perspective of using the communication features of the devices.
- **Are affordable to construct and support**: A simple and straight forward method of creating distributed applications, with logic both within the cloud and on the mobile device working together seamlessly. Additionally, it requires an autonomous fully trusted means for the installation of the application, the basic calibration and sanity checks as well as the automated updates.
- **Provide a rich, reliable user experience**: A method of ensuring that an application running across a network gets the resources it needs when they are available. Additionally, ensuring that the multiple applications on the device are scheduled to use the network resources in a coherent manner

3.5.1 Technology

The Network Functions Virtualization (NFV) presumes that a large part of the network functions will be realized as software, dynamically deployed and managed on top of common hardware platforms including servers, storage and network components, such as switches and routers which overall are representing also the basis of cloud infrastructures. Specifically, **NFV addresses the development of a comprehensive ecosystem** in which the various actors are providing their specific value added including the following major areas:

- **Infrastructure** – the infrastructure includes the hardware as well as the virtualisation enablement software (such as hypervisors or virtual switches), enabling the construction of a common hardware infrastructure;
- **Virtual Network Functions** – the porting of the network functionality currently running on dedicated hardware to the common infrastructure;
- **Network Management and Orchestration** – providing the means to automate the allocation of the infrastructure resources, the support for orchestrating how the specific resources are allocated depending on the service characteristics as well as the means for directly managing the parameters of the network functions.

In this context **the dynamic interface to the networks, also known as the cloud middleware**, as defined in the FI becomes highly important representing the main mechanism through which customized services can be deployed **using all the specific characteristics of the cloud**: elastic scaling, on-demand, pay-as-you-go, etc.

Additionally, with moving cloud infrastructures to the subscriber environment, a new higher level of network configurability is achieved directly to the infrastructure through the comprehensive network management and orchestration, **through a set of APIs to the network cloud functions as well as towards**

cloud proxies and local cloud infrastructures. This set of APIs enables the network function placement and the realization of virtual networks between the different network functions.

- Its main benefit is **the transfer of network services from dedicated hardware to commonly used platforms for multiple applications**, enabling a larger deployment of various heterogeneous applications realized as software.
- However, **the APIs in this specific area are currently vendor dependent**, especially in the area of customer premises cloud infrastructures, limiting their development and acceptance by the application developers' community.

In **the field of cloud proxy architectures, many cloud systems have emerged**. Approaches aim to push **open interfaces for service access**, QoS and security to allow proxies to assume a diverse set of roles unlike other systems in which network nodes either **compute, route, serve data, or invoke services**. The introduction of **interfaces to manage intelligent connectivity among cloud proxies** is a key to boost the performance and **reliability of distributed data intensive multi-cloud applications** as well as in the implementation of **customized networks between the cloud proxies and the infrastructure**.

The **operator network and the connected devices are currently managed through a large set of automatic control features**, which are reacting to applications and network triggers, make decisions and adapt the connectivity of mobile devices.

- This includes the usage of the **mobile device features by applications**, as well as the realization of the connectivity between devices and application servers.
- **Connectivity includes features such as access network through which the communication is realized**, the end-to-end QoS, the security features, seamless mobility and inter-operator connectivity as well as basic service interfaces for SMS and voice services.
- **For the mobile device features,** there is a strong interest from the application developers' community **to reduce the cost of developing reliable applications which work across a range of platforms**. This has driven an interest in having **access to device features through a unique set of APIs**, independent of the device architecture and operating system, enabling the easiness of development of specific applications. The greatest challenge is the high level of heterogeneous features as well as the acceptance by the community of such APIs. For the heterogeneity, a single set of APIs should be considered and there are several attempts in the state of the art in this direction. For the acceptance of the community**, the current APIs had a low success rate as they were locking applications** towards a specific core network platform**.**

The advent of HTML 5 has however created a big change in the development of applications, as Web applications are evolving into rich and flexible environments where users can easily access documents, publish content, listen to music, watch videos, draw pictures, and play directly via browser. **The HTML5 adoption aims to overcome interoperability and portability limitations**, which are still currently faced by the users and the developers, due to fragmented platform availability and different development paradigms they adopt. **One of the benefits of the approach is that many more platforms already support**, or at least are going to support, web based environments (browsers, web-runtimes) and languages (HTML5, CSS3, JavaScript). This broad and implicitly agreed support for web technologies is producing a massive offer of applications, along with the materialization of new platforms entirely based on web standards.

The most important **benefits of the web based project development** can be summarized by the following points:

- **Cross-platform.** This is the main feature why developers have originally turned into web technologies looking to fulfil the promise of coding once and deploy everywhere. As some of the other advantages of the web, cross-platform is in its nature, as it is meant to run on any device (hardware) and operating system (software). The web can be accessed from a PC, Mac, laptop, desktop, mobile

device, smart watch, car and even home appliance. We know one thing for sure about any futuristic new device: it will be able to access the web.

- **Full technology stack**. This is a feature that goes hand in hand with cross-platform as its goal is to ease the process of building a product for developers. Web technologies can be used full stack, from client to server, thanks to platforms like Node.js (http://nodejs.org). Many products need a desktop based UI/UX and their mobile versions could be developed using the same technologies and reusing plenty of the same code. Same thing happens in the server side as many data structures and even algorithms can be reused speeding up development cycles, lowering possible mistakes and bugs and increasing maintainability in the long run.
- **Open standards approach**. This is more important than meets the eye. There have been various technologies in the past that made the cross-platform promise but did not completely deliver. Amongst other reasons, they failed because of being closed and tied to a specific company. Open standards allow both vendors and developers to contribute and improve the final product. This is one of the key success factors of the web. There is no head controlling it so it can evolve according to the needs and interests of many.
- **Big developer community.** The web is also driven by its developer community, one of the biggest as it involves front-end and back-end developers that are always providing new tools and support. Mobile is the frontier to conquer but there is no doubt the web has won on desktop environments. There is no company, product or service that doesn't have presence on the web both directly or indirectly. This whole ecosystem of applications is developed by a thriving community of developers that not only need to understand the backend side of the equation but also how browsers and client side technologies work.

The list of the benefits of the web is much longer, and it might push a developer to implement a project by using it, as it appears to be everywhere, anytime and with the option of using the same technology full stack. It is however a fact that web technologies are not widely used in many scenarios (especially when it comes to mobile), as there are not only benefits by also challenges that developers need to overcome, and indeed other sources show that the interest in HTML5 of mobile app developers slipped a bit in the past months (www.techworld.com) due to the difficulties in adopting it. The main challenges encountered include:

- **Cross-platform involves markets, stores, destination sites**, in addition to devices and operating systems. It is not as easy as expected coding once and deploying everywhere. Handling the particularities of each deployment scenario can be tricky. **Cross-platform does not really mean same code or user interface/user experience**. Mobile devices have inherent particularities like the different input method (touch screens) and limited screen resolutions that must be taken into account. Also, users on mobile are used to different set of interaction paradigms especially when it comes to social media integration or access to native features. Mobile device memory, performance and feature limitations should also be taken into account.
- **Browser feature fragmentation.** Although the open standard approach of the web is a fundamental benefit, their adoption relies on browser vendors that have their own agendas, as they are private companies in the end. Standardization takes time too and it is important to take that into account if a feature is a must inside a project. Low performances especially on mobile. Execution speed has been one of the main problems holding HTML5 back as a widely used cross-platform app and game development technology.
- **Access to the native features on each platform**. The web, as many other technologies before it, because of its cross-platform nature could be limited in its access to platform-specific features. This is a fact and in many cases, a limitation. Either way, the huge support that the web has over the whole technology community makes it a primary target for the adoption of new products and technologies.

The benefits of HTML5 are however well recognized. **HTML5 aims to become the ubiquitous platform for the web.** The devices of the future might support software languages like C, Java, Swift or a new language, but the common denominator will always be the web; web developers can use a well-known and widely adopted set of technologies to build rich web applications that will natively work across different mobile devices. As described, HTML5 has advantages and limitations, therefore it is important knowing how to leverage the former and overcome the latter.

- **Additionally, through a common API towards the connectivity and basic multimedia features**, the application developers are able to customize their service depending on the momentary available network resources.
- **Most mobile applications provide a window on to the suppliers cloud powered backend servers**. However there are few platforms which address this. Rather developers typically build a back end system and a set of APIs. These APIs are then consumed by the mobile application. The additional time and effort to create well defined APIs introduces time and costs both for the construction of the application and for its maintenance. Some MBaaS (Mobile Back end as a Service) companies exist to try to mitigate this issue, however they effectively lock the developer into their own technology stack, and technology provider. Some MBaaS such as FeedHenry provide a node.js (JavaScript) environment for cloud development, and then provide a HTML5 (JavaScript) application development solution. Reducing the developer skillset and knowledge base required to create an application, and hence **reducing the cost of application development**.

The software defined networking (SDN) paradigm proposes a new model of controlling the network features by logically centralized control functions realized as software and by a common API towards the physical and virtual network resources. The logically centralized control functions are able to abstract the different data path functions implementation, to integrate different transport level management from optic fibre physical connections, to link and network level management and up to application based load balancing and high availability features. Additionally, the functions of control and monitoring can be realized through the same paradigm, allowing for simple management of the transport network features.

SDN is an approach to networks that enables applications to converse with and manipulate the control software of virtualized network functionalities and resources. SDNs comprise applications, control software, and interfaces to services that are hosted in an overlay or logical/virtual network as well as those possibly same components that comprise the underlying physical network.

More importantly, **an open source based SDN platform** provides a widely adopted API (Application Programming Interface) ecosystem, which can be used to automate multi-tier system configuration and optimization, including security and optimization appliances used between the tiers. That means data itself can often be managed in a smarter and more efficient way at the network level — sent where it's needed, or blocked if it's deemed a security threat.

The key computing trends driving the need for SDN:

- **Changing traffic patterns:** Applications that commonly access geographically distributed databases and servers through public and private clouds require extremely flexible traffic management and access to bandwidth on demand.
- **The "consumerization of IT**": The Bring Your Own Device (BYOD) trend requires networks that are both flexible and secure.
- **The rise of cloud services**: Users expect on-demand access to applications, infrastructure, and other IT resources.
- **"Big data" means more bandwidth**: Handling today's mega datasets requires massive parallel processing that is fueling a constant demand for additional capacity and any-to-any connectivity.

The limitations of conventional networks:

- **Complexity that leads to stasis:** Adding or moving devices and implementing network-wide policies are complex, time-consuming, and primarily manual endeavors that risk service disruption, discouraging network changes.
- **Inability to scale**: The time-honored approach of link oversubscription to provision scalability is not effective with the dynamic traffic patterns in virtualized networks—a problem that is even more pronounced in service provider networks with large-scale parallel processing algorithms and associated datasets across an entire computing pool.
- **Vendor dependence**: Lengthy vendor equipment product cycles and a lack of standard, open interfaces limit the ability of network operators to tailor the network to their individual environments.

With the progress towards the 5G networks, there is a large interest into the deployment of smaller size, high customized network infrastructures addressing a large number of industry requirements.

- **The deployment of LTE networks** across the world representing the most successful and virtually the only wireless technology of the 4G, brought a comprehensive end user subscribers data market in which Future Internet services can be installed and deployed from either the mobile operators, in agreement with the mobile operators or over the top, practically providing the support for the overall mobile communication.
- However, during the **increase of the network capacity and the better usage of the wireless spectrum in order to provide lower delay**, high bandwidth communication for the subscribers, a set of technology decisions were taken which limits the usage of 4G towards other types of devices. For example, while increasing the network capacity for human controlled devices and with guaranteed radio resources, the system lost the capacity for automatic sharing of the radio resources and thus drastically reducing the number of connected devices.
- Additionally, as the system addresses only human subscribers that have **a uniform behaviour enabling traffic-engineering mechanisms**, the EPC/LTE system was optimized to function for a certain average subscriber level requiring only a minimal reconfiguration level, and thus ultimately treating devices in the same way. This resulted in a much optimized system in which predictable network performance can be assumed by the applications including QoS, security and reliability of communication.
- With the evolution towards 5G, the technological advancements of 4G will be further refined and additionally for **providing larger capacity and eventually with lower delay in very dense network areas.** As the theoretical spectral efficiency is almost reached, the new 5G radio will be combined with LTE and Wi-Fi networks into single convergent network architecture, thus requiring a set of APIs for a coherent deterministic experience over the overall system.
- Additionally, for becoming highly profitable and thus for having enough resources for an efficient technology growth, **the 5G ecosystem will address not only the human subscriber communication**, but also two highly differentiated types of markets: the environment automation, giving the subscribers the means for controlling their surroundings and to immerse into remote real environments and the enterprise and professional market which requires higher availability and reliability. 5G aims to provide support for these highly heterogeneous services. For this, a set of reconfigurable APIs, which address the different levels of the technology, are required in the form of interface from the applications to the networks and devices. Specifically, these APIs have to be defined by the application providers and for the applications in order to **have a suitable overall network ecosystem.**

In conclusion, the interfaces to the networks and devices can be regrouped into transport, connectivity and virtual infrastructures levels, usually accessed through very sparse APIs. **In order to be successful, a Future Internet platform has to be able to attract the application developers' towards using these APIs**.

3.5.2 Market

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.

There is no greater motivator than opportunity, and SDN marks the largest business opportunity in the networking industry since its inception. Recent reports estimate the business impact tied to SDN could be as high as $35 billion by 2018, which represents nearly 40 percent of the overall networking industry. While the marketing hype makes it seem like adoption will be immediate, it will ultimately take some time. **SDN isn't just a technology change; it represents a transformation of an entire industry**.

- There will be **organizational hurdles as IT silos collapse, tools and processes that must transition**, and a workforce that must acquire new skills to be capable of operating in a highly orchestrated and automated environment. Ironically, this means the largest dependency for SDN to succeed is on the very people who demand it.
- Trends such as **user mobility, server virtualization, IT-as-a-Service**, and the need rapidly to respond to changing business conditions, place significant demands on the network, demands that today's conventional network architectures can't handle. **Software-Defined Networking provides a new, dynamic network architecture** that transforms traditional network backbones into rich service-delivery platforms.
- **The future of networking will rely more and more on software, which will accelerate the pace of innovation for networks as it has in the computing and storage domains**. SDN promises to transform today's static networks into flexible, programmable, platforms with the intelligence to allocate resources dynamically, the scale to support enormous data centers and the virtualization needed to support dynamic, highly automated, and secure cloud environments. With its many advantages and astonishing industry momentum, SDN is on the way to becoming the new norm for networks.

SDN is already fact of life. Some existing SDN related news on deployments and developments:

- **NEC has the first Open Flow** compliant switch (https://www.opennetworking.org/news-and-events/press-releases/1184-open-networking-foundation-awards-nec-first-openflow-conformance-certification);
- **Google has announced that they apply SDN principles** in their backbone network (and actually they are not waiting for the industry to come up with standard solution (e.g. Open Flow), but has their proprietary solution;
- **AT&T announced that they start to their "2.0 network**" starting next year (2015)

The telecom industry also triggered a boost to the deployment of SDN, with the creation of NFV. 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.

With the ETSI NFV initiative, all the major operators have initiated the porting of their infrastructure towards a cloud supported one. After the initial Proof-of concepts, at this moment, the first vendor selections are executed. Through this the operators are able to align their infrastructure and at the same time to define the requirements for the next generation level. Consequently, all the major equipment providers are following this trend having initial products into the domain including Nokia, ALU, Ericsson, Huawei, ZTE, NEC, Cisco, etc.

Additionally, due to the breaking of the monolith structure of the network and to the flexibility shown by the operators in terms of reliability and security support in the network, a new set of vendors are joining this environment providing new innovative services such as Polaris, Connect'M, Contextstream, Core Network Dynamics, Maverick, Quortus, etc.

These operator initiatives are supported by cloud based developments of infrastructure and operating system companies which are developing the underlying cloud infrastructure including the OpenStack supported by HP, IBM, Junpier, Dell, etc., OpenDayLight supported by Cisco, Juniper, etc.and VMWare from platform perspective as well as Red Hat and Ubuntu from the operating system perspective.

An out most important, currently underdeveloped due to the low initial implication of highly experienced Telco vendors, is the networking part. This includes the support for differentiated, customized services, beyond the basic best-effort homogeneous network currently supported.

Aligning with this environment, the major dedicated network equipment providers are currently developing dedicated components, which are controlled through common interfaces such as Broadcom, Samsung, Texas Instruments, etc. through this being able to provide an underlying networking infrastructure functionality for the programmable dynamic NFV deployments.

In order to be able to provide an open ecosystem in which all the market stakeholders can benefit, there is a strong need for a common understanding in the form of capacity description for common and value added services and of common APIs for interaction between the different functional levels providing an open basis for interoperability**.**

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

For what concerns the app developments, 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.

Gartner Says by 2016, More Than 50 Percent of Mobile Apps Deployed Will be Hybrid

- **To address the need for mobile applications, enterprises are looking to leverage applications across multiple platforms**. The advantages of the hybrid architecture, which combines the portability of HTML5 Web apps with a native container that facilitates access to native device features, will appeal to many enterprises.
- **The need for context awareness in mobile applications has increased with the capabilities of mobile devices, causing developers to consider both hybrid and native architectures**. For applications to leverage location information, notification systems, mapping capabilities and even on-device hardware such as the camera, the applications need to be developed using either hybrid or native architectures. This has caused enterprise developers to consider alternatives to Web application development

Flurry, a mobile analytics company, reported that the 90% of iOS applications are free at the point of download, with a further 6% being less than $0.99USD, http://www.theguardian.com/technology/appsblog/2013/jul/19/apps-pricing-trends-flurry-advertising. The cost of developing applications is being offset by either advertising, in-application purchases or by corporate sponsorship (e.g. "free" applications from well-known brands). All of these types of applications depend on cloud back ends to supply adverts, additional content for purchase, or access to the backend functionality from sponsored applications. For these applications an easy and cost effective method of not only creating on device application, but also the back end, cloud hosted functionality is important.

- Applications relying on cloud back ends, are highly susceptible to revenue drop during period of connectivity lost; no network = no adverts, no content, and potentially no functionality. These applications therefore require a reliable network connection to be profitable and to sustain the market place.

3.5.3 Business Dimension: Vertical Markets

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.

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. Two kinds of applications are 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.

CDI offers a solution which is at the moment exceeds that provided by either MBaaS (Mobile back end as a Service) services such as Parse, Appcelerator, FeedHenry and AnyPresence, or by JavsScript API frameworks such as PhoneGap, Titanium, Sencha Touch, or Kendo UI.

- While JavaScript frameworks such as PhoneGap, Titanium, Sencha Touch et.al. provide a set of APIs for accessing mobile functionality, none of these also address the issue of developing applications which run on both the cloud and on a mobile device.
- MBaaS attempt to provide a full vertical solution to application creation, and cloud logic and data storage. Almost every one of these companies bases their solution on open standards, but with priority APIs. While FeedHenry supports JavaScript both on the client and on the handset the developer will be locked into using FeedHenry's priority remote procedure call functionality.

- CDI offers an open, well documented interface specification of both the mobile device APIs, and the remote procedure call structure. Allowing its technology to be adapted by a range of suppliers. CDI also provides additionally functionality which allows an application developer to ensure that the content they provide from the cloud to the handset is delivered reliably and in provides a great user experience. It address all aspects of modern application development from front end functionality through the network to the back end cloud logic.

In cloud solutions, networking as a technology class has typically not kept pace with the rest of the architecture. Although virtual servers can be created on demand, and resources like processing power and storage can be allocated to them dynamically as needed, there is often no optimized control of network bandwidth. SDN enables end-to-end based network equipment provisioning, reducing the network provisioning time from days to minutes, and distributing flows more evenly across the fabric allowing for better utilization. **The NetIC Generic Enabler** will play the role of a facilitator to easily exploit the network programmability paradigm with the aim to management complex network infrastructures while guaranteeing a desired level of QoS and QoE. It is however recognised that attracting the application developers' towards using the network APIs requires a full support by the network providers.

With the evolution towards 5G, the major network operators are aiming to attract to their infrastructures a high number of heterogeneous vertical markets such as industrial and factory communication, energy networks, transportation (trains, naval and airplanes), as well as providing a communication basis for enterprises. Additionally, there is a high interest into supporting high availability networks such as eHealth and critical infrastructures. From this perspective, the network and devices APIs are not addressing a completely opened market in which any company can immediately join, but an environment in which the APIs are used based on business relationships and share of liabilities.

Even though requiring a higher investment at the beginning, it is foreseen that in such an environment, it is easier for new comer companies to join as there is a not yet established ecosystem and as the relationships are based on initiating and maintain trust between the integrator and the network functions developers.

3.5.4 Legal Dimension

Any connected application which runs on a mobile handset will have access to a plethora of personal information. Contacts and address books, photos, location and call history all provide insights into the person lives of a mobile devices owner. Therefore data privacy is both a moral and legal requirement for any CDI application developer.

CDI developers should take care to confirm **with the relevant data protection legislation** in operation in the markets in which their application is available.

For network virtualization (SDN) possible legal issues might emerge in two cases:

- if the traffic carried by the (virtualized) network is related to DRM (e.g. content provider is allowed to distribute media in a specific country only), or
- to emergency (e.g. an emergency call)

Then even though virtualization hides the physical servers and links forwarding the traffic, it must be ensured that the physical links do not cross country borders.

From an overall system reliability perspective, **there is a need for revaluating the roles of the different infrastructure providers.** Specifically for opening vertical markets, there is a need for understanding where is the liability maintained. The liability can reside with the operator (as the bid winner for the spectrum frequencies), with the network infrastructure equipment vendors (currently receiving the reliability from the operators through the vendor selection process), with the cloud vendors (currently having very low SLAs for the services) with the application developers or simply with a best effort type of

service. The interfaces to the network and devices in this situation define a common technical ground on which these liability items can be settled.

3.5.5 Conclusions

The need **of common, standardized set of Interfaces to networks and devices** plays a key role for a convergent, interoperable Future Internet. 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.

In order to be able to provide an open ecosystem in which all the market stakeholders can benefit, there is a strong need for a common understanding in the form of capacity description for common and value added services and of common APIs for interaction between the different functional levels providing an open basis for interoperability**.**

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

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.

In this context **the dynamic interface to the networks, also known as the cloud middleware**, as defined in the FI becomes highly important representing the main mechanism through which customized services can be deployed **using all the specific characteristics of the cloud**: elastic scaling, on-demand, pay-as-you-go, etc.

Additionally, with moving cloud infrastructures to the subscriber environment, a new higher level of network configurability is achieved directly to the infrastructure through the comprehensive network management and orchestration, **through a set of APIs to the network cloud functions as well as towards cloud proxies and local cloud infrastructures.** This set of APIs enables the network function placement and the realization of virtual networks between the different network functions.

3.6 Security: The rising strategic risks of cyber attacks

When "everything is becoming digital," private, public, and civil institutions become more dependent on information systems and more vulnerable to attack by sophisticated cybercriminals, political "hacktivists," nation-states, and even their own employees. As a result, all of our institutions will have to make increasingly thoughtful trade-offs between the value inherent in a hyper connected world and the risk of operational disruption, intellectual property loss, public embarrassment, and fraud that cyber-attacks create.

More and more business value and personal information worldwide are rapidly migrating into digital form on open and globally interconnected technology platforms. As that happens, the risks from cyber-attacks become increasingly daunting. Criminals pursue financial gain through fraud and identity theft; competitors steal intellectual property or disrupt business to grab advantage; "hacktivists" pierce online firewalls to make political statements.

Companies are struggling with their capabilities in cyber risk management. As highly visible breaches occur with growing regularity, most technology executives believe that they are losing ground to attackers. Organizations large and small lack the facts to make effective decisions, and traditional "protect the perimeter" technology strategies are proving insufficient. Most companies also have difficulty quantifying the impact of risks and mitigation plans. Much of the damage results from an inadequate response to a breach rather than the breach itself.

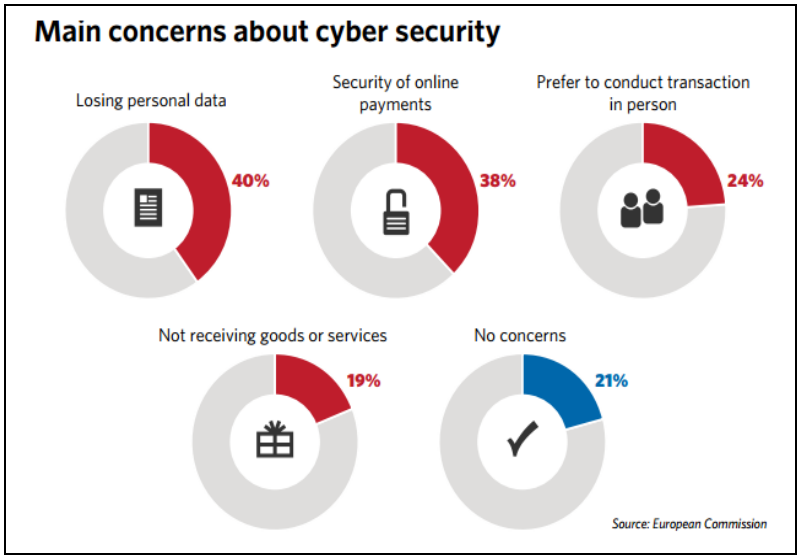


Figure 18: Main concerns Cyber Security. Source: European Commission

Monitoring is an essential function of security. As such it has been and still is a very hot topic for both industry and academics. Security monitoring is concerned with the definition, collection, analysis and correlation of all data in a system so as to identify anomalous behaviour linked to security violations. In the area of data collection, multiple solutions exist today on the market for network level data at various granularities.

Security by design is another important security trend in an increasingly changing world with multiple interconnected devices. BYOD (Bring Your Own Device) is making significant inroads in the business world, with about 75% of employees in high growth markets. BYOD brings new benefits such as the increase of employee's productivity, morale and convenience by using their own devices and makes the company look like a flexible and attractive employer. But also, **it brings new security threats that could result in data breaches.** To control these new threats, a **continuous reconfiguration of the security mechanisms is required taking into account the context (device, network, type of access…)** to adapt them to the current environment.

3.6.1 Technology: Cyber Security Monitoring

The cyber security threat picture of an infrastructure will always be evolving due to the facts that new methods and motivations of performing an attack emerge (cf. Figure 19 : The Cyber Kill Chain**)** , the users will be in changing operating conditions and the services themselves will be updated. Within a composite service, each individual service component will have a fluctuating threat picture, and we need mechanisms to detect, describe, notify and finally react to such changes. **In order to have a cyber-resilient infrastructure, we need to be informed about relevant threats** at design-time and run time, to implement adapted countermeasures and to evaluate their impact before application.

Threats that are unknown to developers can easily result in information leakage and open "back-doors" that attackers may exploit. At runtime, traditional networking-based threat monitoring and detection have been provided by firewalls and intrusion detection systems. **A large research community, which investigates multiple methods ranging from standard attack signatures in Intrusion Detection** and/or Prevention Systems, together with security assessment tools [SNORT] and advanced mathematical models [METROSEC] to multiple statistical approaches, covers this area.

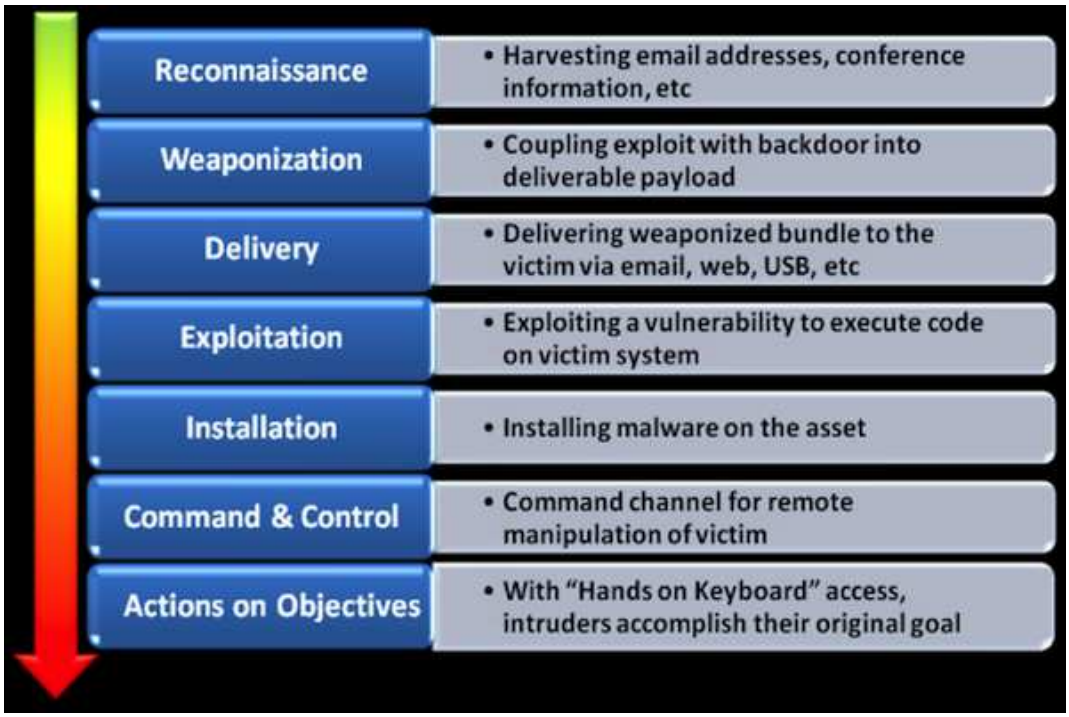


Figure 19 : The Cyber Kill Chain

The Internet is omnipresent and companies have increasingly put critical resources online and thus have been exposed to security flaws. This has given rise to the activities of cyber criminals, and virtually all organizations face increasing threats to their networks and the services they provide.

- **Traditional intrusion prevention techniques, such as firewalls, access control and encryption**, have failed to fully protect networks and systems from increasingly sophisticated attacks and malwares.
- **To monitor IS "management" or industrial, current SIEM are based on a NAC model type** (Normalize, Aggregate, Correlate) processing events emitted by probes (or logs) with the same characteristics than big data flow: varied variables, dense and structured. However, many events from complex and targeted attacks do not exhibit simple structure, so that the definition of an attack signature remains a burden. The use of expert knowledge is then essential.

It is therefore desirable to define a model that will detect, identify and characterize complex attacks. This model is one of the main obstacles to the development of security monitoring solution, as the attackers themselves also benefited flows of "big data" to significantly refine their procedure. Especially for the social engineering phase, one key factor of their success, they can develop targeted attacks in context, distributed in time and space to make them stealthier. **Such attacks have become formidable** [DIVYA2013, CHECK2014, MANDIANT-APT1, KASPER-MASK, SOURCE-APT] and speak **in favor of centralized management of security events.**

The performance of a security monitoring solution is generally estimated by the rate of false positives and / or false negative; it depends entirely on the accuracy of the rules and more generally its knowledge model. Knowledge involved in the monitoring, diagnostic and remediation activities of security experts. They can be grouped into two categories:

- (A) Anomaly detection - learned from AI tools, eg heuristic anti-virus, and
- (B), Designed or configured by human experts - the signatures, firewall rules or anti-virus. **For a SIEM**, knowledge of "signature" or "rules" type is gained from prior experiments or external knowledge:
    - 1) laws (duration of logs preservation),
    - 2) standards (recommendations or good practices, ISO 27001),
    - 3) Observatories such as CERT vulnerability bulletins.
- To express the rules, **the expert uses programming and security-domain skills,** which usually makes their development costly in time and resources, error-prone and without guarantee their expected return on investment.

We are convince that in the current threat environment, rapid communication of threat information is the key to quickly detecting, responding and containing targeted attacks. On the other hand, th**e Security Monitoring tries to offer improvements in terms of performance and adaptability for the analysis and correlation of security data** what can be critical in environments with huge volume of data.

Identity and Access Management

According to Future Internet needs/demands, Identity Management (IdM) GEs are intended to be improved in two main directions.

- First, to **address new demands or demands not yet answered** (e.g. identity management of things).
- Second, **couple with Privacy GE(s) to further develops privacy-enhanced Identity** addressing some of the requirements not yet answered and enabling new usages.

A robust infrastructure for identity and access management (IAM) as well as access control enforcement is critical in any large information system today (and so Future Internet), where sensitive data and resources in general are at risk. Therefore, to achieve a complete IAM infrastructure, we need to **combine the Identity Management GE with a solution for access control policy management and enforcement, such as the Access Control GE**.

- The **Access Control GE targets the state of the art** in this domain by relying on a state of-the-art standard for access control: XACML (eXtensible Access Control Markup Language).
- **XACML attempts to solve** the issue that access control is usually enforced by many devices and applications using different and proprietary languages.

In this context, a globally consistent security policy enforcement is incredibly hard to achieve; and even then, very difficult to adapt to new requirements, all the more because such specific policy languages are quite limited in terms of expressiveness. **If you do not have a globally consistent policy, you have a challenge for end-to-end auditing as wel**l, i.e. verifying the compliance of your system to your policy.

Privacy

Privacy protection allows using digital identities without exposing these identities to privacy threats such as **traceability** (the digital traces left during transactions), **linkability** (profile accumulation based on the digital traces), **unsolicited marketing** (spamming), and **loss of control over personal data and identity theft.**

- The core of a privacy enabled (PE) identity system consists of an issuer component, which hands out PE credentials to a user, and a verifier component, which is used by service provider (e.g. an e-shop) **to verify the credentials received by a user**. However, additional components are needed

to make such a service really trustworthy and useful. For instance, it may be desirable to de-anonymize a user (his credentials) under certain conditions, for instance if he is strongly suspected to have committed a criminal act using PE credentials.

Trust

The level of trust in a system may be too high or too low compared with **the actual trustworthiness (security) of the system.** This imbalance is a barrier to trustworthy system adoption:

- If the users trust the system too much (i.e. assume it is more trustworthy than is actually the case), they are exposing themselves to risks and may suffer harm, which can also reduce their level of trust in any system in future;
- If the users trust the system too little (i.e. assume it is less trustworthy than is actually the case), they are failing to benefit from using the system in high-value applications.

Therefore, a critical contribution to reverse the trend towards lower trust in the Future Internet is to support **a balance between the level of trust and the level of trustworthiness of services and applications**.

3.6.2 Market

According to the Verizon 2014 data breach investigations report, the year 2013 may be tagged as the "year of the retailer breach," but a more comprehensive assessment of the InfoSec risk environment shows it was a year of **transition from geopolitical attacks to large-scale attacks on payment card systems**.

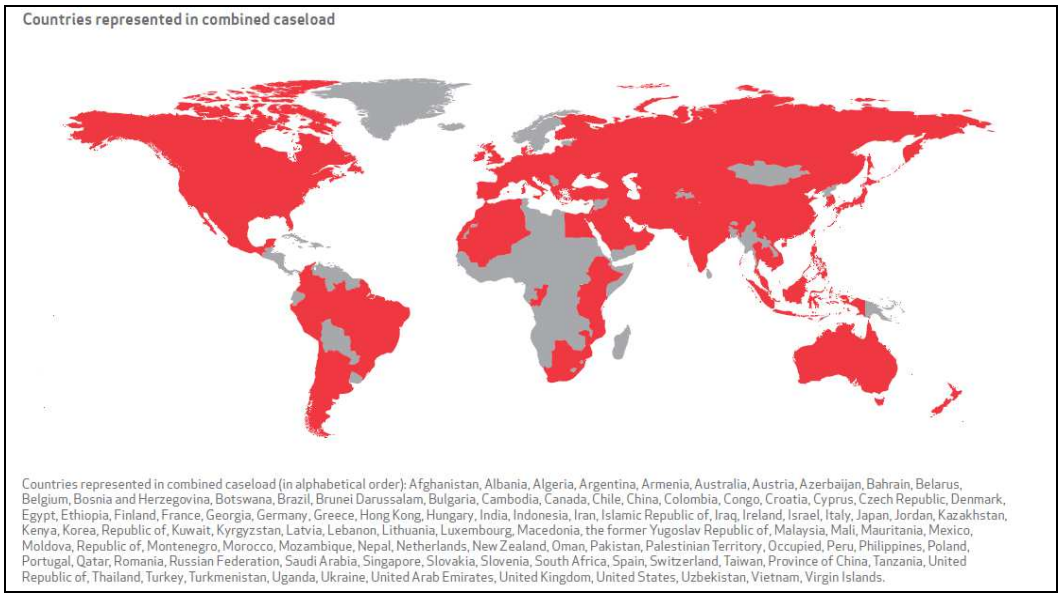


Figure 20 : Countries represented in combined caseload

Several analyses agreed on the fact that the global cyber security market is dominated by North America, with the US being the largest defense spender in the world. Market research Reports mentions that, overall, North America is set to spend US$93.6 billion on cyber security during the next decade. Despite the scheduled budget cuts, **Europe represents the second-largest market, with the total cyber security market valued at around US$24.7 billion**, offering a potentially attractive investment opportunity for suppliers. Asia-Pacific is projected to spend an estimated US$23.2 billion on cyber security during the forecast period, followed by the Middle East and Latin America with US$22.8 billion and US$1.6 billion respectively.

Markets and Markets highlight the **major forces driving this market**, which are:

- The rapid adoption of cloud-based services,
- Wireless communication along with strict government mandates and
- Increasing cyber-crimes in public utilities industries.

Hence, the ratification for cyber security solutions is increasing to combat the advanced and sophisticated threats created by professional adversaries. Also, **cloud service providers and verticals such as energy, oil and gas, and education are expected to adopt solutions for cyber security** more readily because of growing cyber-crimes which may cause the loss of intellectual and financial assets and may tarnish the national infrastructure and economy.

The cyber security market is estimated to grow from $95.60 billion in 2014 to $155.74 billion by 2019, at a Compound Annual Growth Rate (CAGR) of 10.3% from 2014 to 2019. In the current scenario, **aerospace, defense, and intelligence vertical continues to be the largest contributor to cyber security solutions.** In terms of regions, NA is expected to be the biggest market in terms of revenue contribution, while the APAC and MEA regions are expected to experience increased market traction in due course.

Various **services of the Cyber Security Market:**

- Consulting
- Design and Integration
- Risk and Threat assessment
- Managed security service
- Training and Education

The Gartner forecasts that the information security market will grow 8.1% in revenue terms in 2014, with the **data loss prevention segment recording the fastest growth** — 16.9%.

Key Actors:

- AccelOps
- AlienVault
- BlackStratus
- EMC (RSA)
- EventTracker
- Finmeccanica
- HP
- IBM Security
- Lockheed Martin
- LogRhythm
- McAfee
- NetIQ
- Northrop Grumman
- SolarWinds
- Splunk
- Tenable Network Security

- Tibco Software
- Trustwave

Coming challenges

At the cyber-security world summit held in 2010, security experts raised credible issues such as **crashing power grids, stalled air control towers, hospital infrastructure being rendered useless, and national defenses being susceptible to outside attack**. New technologies such as cloud computing, social networking, and the proliferation of mobile devices have also resulted in an increase of cyber-attacks. The governments of the UK, the US, France, Belgium, Germany, and India have stated that their systems and networks were infiltrated by criminal networks. **Such incidents are expected to augment a sustainable demand for cyber security over the forecast period.**

Identity and Access Management

According to Markets and Markets, "*the IAM market is estimated to grow from $5.13 billion in 2013 to $10.39 billion in 2018. This represents a Compound Annual Growth Rate (CAGR) of 15.1% from 2013 to 2018. In terms of regions, North America is expected to be the biggest market in terms of revenue contribution, while emerging economies such as Asia Pacific (APAC) and Middle East and Africa (MEA) are expected to experience increased market traction with high CAGRs, in the due course*".

According to Forrester, the major vendors in the IAM market (2013) are the following:

- Leaders: CA Technologies, NetIQ;
- Strong performers: Ping Identity, IBM, Oracle, Aveksa, Courion, Dell;
- Contenders: SecureAuth.

Forrester's analysis focused addressed primarily on premise solutions but also looked at associated cloud-delivered capabilities (SaaS). However, focusing only on SaaS solutions, we discover the market of IAM *as a Service* (IDaaS), where the market leadership quite differs from the on-premise IAM market according to Gartner's magic quadrant:

- Leaders: Ping Identity, Covisint, Okta;
- Challengers: OneLogin;
- Visionaries: CA Technologies, Centrify, Lighthouse Security Group.

Gartner predicts that IDaaS will be the preferred delivery model for IAM for 20% of IAM purchases by the end of 2017, up from less than 10% in 2014. KuppingerCole [3] defines another emerging market segment closely related to IAM: Dynamic Authorization Management (DAM). KuppingerCole identifies **the following competitors in the DAM market**:

- Leaders: Oracle, IBM, Axiomatics;
- Challengers: Axway, NextLabs, WSO2, Access Sentinel, Jericho Systems, Evidian, CionSystems, CrossIdeas.

Finally, Gartner IAM research team **made seven predictions for the IAM to come true by year 2020**:

1. *Every user is a consumer: the majority of user access will be shaped by new mobile and non-PC architectures that service all identity types regardless of origin.*
2. *A competitive marketplace for identities: most digital identities interacting with enterprises will come from external identity providers through a competitive marketplace.*
3. *The death of least privilege: By 2020, most enterprises will allow unrestricted access to non-critical assets, up from less than five percent today, reducing spending on IAM by 25 percent.*

4. *Legacy pricing models implode: By end of 2020, overall IAM product and pricing will drop by 40% relative to today in real terms.*
5. *Attributes are "how we role": By 2020, the majority of enterprises will use attribute-based access control (ABAC) as the dominant mechanism to protect critical assets, up from less than five percent today.*
6. *Identity intelligence finally gets a brain: By year-end 2020, identity analytics and intelligence (IAI) tools will deliver direct business value (beyond Access and Governance tools) in 60% of enterprises, up from <5% today.*
7. *Managing identity includes the Internet of Things: By 2020, the Internet of Things will redefine the concept of identity management to include what people own, share, and use.*

The IIA (Institute of Internal Auditors) identifies the following as the major business drivers for IAM:

- Improved regulatory compliance;
- Reduced information security risk;
- Reduced IT operating and development costs;
- Improved operating efficiencies and transparency;
- Improved user satisfaction;

3.6.3 Business dimension

Concerns about cyber-attacks are starting to have measurable negative business implications in some areas. There is noticeable concern, as well, that **cyber-attacks could slow down the capture of value from cloud computing, mobile technologies, and health-care technologies**. In an environment where a solid cyber resilience ecosystem accelerates digitization, the private and government sectors would **increase their use of public cloud technologies, with enhanced security capabilities allowing widespread deployment for noncritical workloads**. However, in an environment of stepped-up cyber-attacks, public clouds would be underutilized, given increased **fear of vulnerabilities and higher costs from compliance with stricter policies on third-party access to data and systems**. Such problems would delay the adoption of many systems and **reduce the potential value from cloud computing.**

There are multiple scenarios for how the cybersecurity environment could evolve over the next five to seven years. However, if attackers continue to get better more quickly than defenders, this could result in a world where a "cyber backlash" decelerates digitization. In this scenario, **a relatively small number of destructive attacks reduce trust in the economy, causing governments to impose new regulations and institutions to slow down the pace of technology innovation.** As a result, **the world would capture less potential value from big data, mobility, and other innovations by 2020** the ultimate impact will be in lost productivity and growth.

Threats in the online sphere have the potential to inflict the greatest damage to trust and confidence. A Eurobarometer poll from November 2013 found that *37% of those surveyed were concerned about the misuse of their personal data in online activities; 35% were concerned about the security of online payments*. Globally, victims' annual losses from cyber-crime activities are huge. In addition to the economic damage from cyber-crime**, the integrity of information networks can be attacked by criminals**, enemy governments or malicious hackers. As so **many essential services, such as energy, transport and finance depend on secure networks**; attacks that impair the functioning of networks can have serious financial consequences. In May this year, the website of the Belgian foreign ministry was hacked.

The EU launched a cyber-security strategy in early 2013 to address shortcomings in the current system. Not all member states had a dedicated cyber-security strategy in place; only a few member states were co-operating to tackle cross border threats and many companies were failing to ensure adequate

safeguards against cyber-attacks. **The network information security directive, which has been agreed by the European Parliament but has yet to approve by member states**, requires all member states to set up a national cyber-security strategy including **Computer Emergency Response Teams (CERTS) to react to attacks and security breaches**. National authorities will be expected to share information to improve the reaction to attacks, which are often targeted at several member states at the same time. Companies that operate network infrastructures would have to inform national authorities about attacks, whether or not a breach had taken place.

Effective cyber-security strategies are essential to address citizens' concerns about online security. Individuals will be wary of making credit card purchases or using online banking if they feel that they are vulnerable to data breaches or identity theft online among law enforcement bodies. **The EU has launched the European Cyber Crime Centre within Europol to deal with international threats and co-operation with a particular focus on addressing organized crime and online fraud**, child sexual exploitation and network security.

3.6.4 Legal Dimension

These key features, Security monitoring and Identity and Access Management, have to deal **with private data and have thus to complain to the corresponding laws at each step of their processing.** Private data definition may vary according to the country; the French CNIL by example mention that:

- **Constitute a private data any relative information for one person physical identified or which can be identified**, directly or indirectly, in reference to a number of identification or to one or several elements of his/her own. To determine if a person is recognizable, it is advisable to consider all the ways to allow its identification which have or accessible to the person in charge of the data processing or any other person.
- **Constitute a personal data processing any operation or any operations concerning such data**, whatever is the used process, in particular the collection, the recording, the organization, the preservation, the adaptation or the modification, the extraction, the consultation, the use, the communication by transmission, broadcasting or any other kind of provision, the correlation or the interconnection, as well as the locking, the deletion or the destruction.
- **Constitute a file of personal data any structured and stable set of accessible personal data** according to determined criteria.

In such a perspective legal issues impact IAM solutions at various levels if we look at IAM vendors addressing the EU market:

- **International level**: Companies from the European Union often control companies outside the EU; and vice versa, companies from outside the EU, US companies for instance, often control companies in the EU. Moreover, with the emerging trend of IAM as a Service, European IAM vendors may offer IAM services directly to a company outside the EU. In both cases, IAM vendors in the EU may be impacted by laws made outside the EU**. A typical example is the Sarbanes-Oxley Act of 2002 (SOX), a US federal law for boards and management of US public companies** as well as accounting companies. SOX compliance requires ensuring the confidentiality, integrity and availability of certain information, as well as audit and logging of events in the IAM solution.
- **EU level:** IAM solutions handle a great deal of personal data. Yet, the EU has legislated to protect the privacy of the EU citizens and therefore the processing of their personal data, mostly through two directives:
    - The Data Protection Directive (95/46/EC) that mandates seven principles (notice, purpose, consent, security, disclosure, access, accountability) on personal data processing.

- The Data Retention Directive (2006/24/EC) that adds some requirements on the citizen's data retention period.

- **National level:** Directives at the EU level have been or are in the process of being implemented by each EU member, depending on the country. However, each country may have specific legislation that complements or overrides such directives on specific aspects. Therefore, IAM vendors may have to address specific regulatory compliance requirements depending on the customer's location.

3.6.5 Conclusions

Digital technology touches virtually every aspect of daily life today. Social interaction, healthcare activity, political engagement or economic decision-making digital connectivity permeates it all, and the dependence on this connectivity is growing swiftly. Greater reliance on a networked resource naturally makes us more interdependent on one another. As the new, shared digital space evolves, the collective imperative is to **develop a common set of expectations to address systemic risks, and to define not only the roles but also the responsibilities of all participants in the cyber ecosystem.** The obligations will encompass several key issues, **from privacy norms to Internet governance policy,** but the collective ability to manage cyber risks in this shared digital environment is fundamental. It forms the crux of cyber resilience.

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.

Lack of national coordination can lead to redundant policy and legislation, thereby hindering economic growth and development**.** The recommendations are the following:

- **Each nation connected to the Internet should have a comprehensive and transparent national cyber strategy** that is integrated and harmonized with the strategies and procedures across all domestic and international policy.
- As each body and organization has a role, it is crucial that **the strategies developed incorporate the private and civil sectors, as well as leverage economic and security issues, among other tools**, to drive the adoption of initiatives. The focus on incentives driven by the government and independent providers should be enhanced.
- Finally, **a competent institution is needed to be responsible for the successful implementation and rollout of the national strategy**. An identifiable, responsible institution will offer transparency to stakeholders in the process. Not having a resource to consult often leads to challenges of ownership, function and action, the research highlighted.

4 Delivering a Platform for rapid application development and learning how to create an ecosystem.

Empowered by constant connectivity, the rise of social networks, and an increasing amount of software in products, companies are seeing new options in the way they interact with customers and develop and release products. **They are speeding up cycle times and shortening learning curves by testing new products** or ideas with consumers using mock-ups, computer generated virtual products, and simulations. This allowed companies to **get to market faster and improve their ability to respond to competitors' changes.**

Almost every company is becoming a software company. By considering business and operating models pioneered by the software industry and tailoring them to their own needs, organizations can lower their costs, boost performance, and turn software into a competitive advantage

The most successful IT teams begin by addressing the internal constraints on their ability to deliver the innovation promised by **key technology trends, such as cloud computing, mobility, Big Data, and the Internet of Things.**

IT must develop a **new way of dealing with the rest of the organization based on collaboration, stakeholder management, and engagement with those that consume the services**. Some IT organizations already have the basis for a new kind of relationship with the business, but others need to change the way they function. This will **build the foundations for an IT function that supports and enables innovation**, rather than one that is perceived as a barrier to change.

Delivering a platform with rapid application development, a ready-made **ecosystem of partners**, and a **marketplace of application** components creates a new and disruptive approach to more time-consuming and increasingly costly application development and deployment approaches and opens many doors and market opportunities. **Organizations must find ways to broaden their ecosystems** to include start-ups. Machina Research recommends the following:

- **Opening the Applications market to the small and medium sized business (SMB) space**. Significantly reduced application development times, available application components and toolkits, lower costs and the underlying more pervasive base of connected devices in an IoT world will shift and introduce the market towards the small and medium businesses, both as innovators (start-ups) and adopters of IoT solutions.
- **Creating application development communities.** As in the mobile space, the opening of programmer toolkits enables a new group of application developers to grow the market. Where before, application development will have been for a very specific and limited scale purpose, the advent of IoT application platforms opens huge opportunities for application development communities to develop comprehensive solutions that not only address the immediate application requirements of an enterprise or market segment but also allows for a wider and more innovative market space to evolve.
- **Exploring revenue sharing models.** Where collaborative service models emerge, there is also the opportunity and perhaps need for new business models to develop, and enabling end-to-end IoT solutions opens the opportunity for revenue sharing models.

4.1 Ecosystem Creation

About 20 years ago, software's use within organizations was largely confined to big transactional systems in the data centre. Now, it underpins **nearly every function in every industry**. Software spending has grown accordingly, jumping from 32 percent of total corporate IT investment in 1990 to almost 60 percent in 2011, according to Mckinsey. That reality introduces **new competitive dynamics**. Managers have to worry about competitors, within ever-faster cycle times, upcoming from such software-enabled techniques **as rapid prototyping and real-time testing.** They must also **be mindful of network effects**, since customers can become **accustomed to working with a certain platform** and be slow to switch**.**

Success in the software industry has long been influenced, and often driven, by the ecosystem of developers, plug-ins, software-development kits and application-programming interfaces (APIs) and add-ons that drive added value and increase stickiness for products. Similarly, companies in other industries need to think expansively and include upstream suppliers as well as downstream vendors or consumers, and focus on how each part of the value chain integrates into the new platform.

Software vendors lack the perspective to develop software within a software ecosystem. The inability to function in a software ecosystem has already led to the demise of many software vendors, leading to loss of competition, intellectual property and eventually jobs in the software industry. **The success of a software product depends not only on the quality of the functions it provides but also on the success of its interdependent hardware, software, and other players within its ecosystem**. The software ecosystem studied thus far has largely ignored the importance of the market, which is the ecosystem's energy source. The market affects all players in the ecosystem, determining whether the software product can succeed. **We analyse this market-driven software ecosystem in both the open source and mobile computing communities.**

At a technical level, developers want simple ways to integrate their software with a platform. When a new API comes out, it often doesn't come with the right set of tools for developers to quickly discover, evaluate, and begin engaging with that API.

Platforms allow developers to make money, by helping to get software into customers' hands. They do that by creating popular app stores, helping with marketing, creating awareness, and of course by selling a lot of devices or host apps.

The lesson for vendors is that they have to give developers both a technical reason to commit to a platform as well as a business reason (with financial reward).

Vendors need to treat their APIs as a product that is marketed to the developers they want to attract. API providers should start with messaging and branding of their API .**This relies on the ability of an API to be discovered and marketed appropriately**, but once you've cleared this hurdle you need to really quickly **provide an easy on boarding process for developers to start using it.**

But marketing a platform to developers isn't like selling to customers. **Developers are not a business model, they don't pay you; you pay them or your customers pay them.**

- The most important thing is to make developers believe that they **are building for the next ubiquitous, exciting platform**. You want to establish a bit of a gold rush mentality where being early is significantly better than being late to the party.
- **Developer recruitment efforts can use all the traditional ways to get attention**, you will never meet a developer who could resist a free t-shirt or coffee mug, but some think more creatively.
- **Open source can be your friend**. Those who want to attract developers should look for open-source projects that would be complementary to your platform, and sponsor or contribute code to the project to make it usable with your platform.

4.1.1 Technology Support and Transparency

First of all, on the technology side, we need open and royalty-free component specifications to provide transparency and thus enable trust. These components can be implemented by anyone and albeit the functional scope is well-defined, such an open approach still preserves the principle of differentiations, by means of non-functional qualities first, and by innovative combinations of components second. **Along with open and royalty free specifications comes the need for standard Application Programming Interfaces** as a warrant to secure access to the full innovation potential by users, that is application developers in SMEs, Web-Entrepreneurs, and also large industry players across all non-ICT and ICT sectors.

At a technical level, developers want simple ways to integrate their software with a platform. When a new API comes out, it often doesn't come with the right set of tools for developers to quickly discover, evaluate, and begin engaging with that API.

To secure application platforms for the future platform providers will need to focus and build on two **additional challenging points**:

- **Application management:** Application management is the maintenance and management of different firmware and software versions and updates of the applications as well as the maintenance and management of updated application components to ensure end-to-end integrations. In markets where more and more things will be connected, and more and more applications will be deployed to deliver value, managing the growing range of versions and updates of the software solutions will become a significant challenges for any platform provider.
- **Scalability:** The change in scale, from point-to-point, vertical industry focused solutions to the Internet of Things where more and more connected devices will be “talking” to other things, other people and other systems is what will drive the importance of applications in the emerging IoT markets. Being able to scale solutions, not only in terms of connecting to many more devices but also being able to manage significantly more transactions and events, more complex enterprise integration, and manage more users and user groups will become the challenge for all platform providers in the coming future but as noted, with the challenges come the huge opportunities and benefits for enterprises.

Some elements of a **Developer program** are almost checkbox items:

- Self-service access to developer materials, such as API documentation
- Developer programs available 24x7
- Lots of sample code that's simple to try out
- Quality tech support (specific to developer issues) with quick turnaround, by e-mail, phone, and other media (such as IRC).

4.1.2 Building Community

One important option at least for those companies willing to make an investment is **computer-based and classroom training**, or at least face-to-face developer gatherings **where developers can help each other, share ideas, and socialize.** But more than anything else, perhaps, is **the need to create a developer community, or to connect with existing ones**.

For understanding **the value of community and collaboration** the following aspects are needed:

- **It's important to give people a reason to participate**, because many are self-started when they get here. This level of visibility into the project keeps people contributing and everyone knows where we are going.
- **Project transparency is the most influential aspect that attracts contributors**; that means giving a clear indication of roadmaps and the project's direction. Nobody knows what you're trying to achieve without roadmaps, good forums, collaboration, and continuous conversations between regular contributors and the software's users.

It is a challenge to establish a project community. All communities start with users, attracted by the software's packaging and branding, or word–of–mouth recommendations. A real community building can happen and take place from the moment the platform/system is ready, presentable, and usable

4.1.3 Exploring Revenue Sharing Models

Innovative companies in other industries are experimenting with **ways to combine products, services and data to create entirely new businesses often with software playing a critical role** in knitting together or enabling these new models. **In the data-driven economy, deployment models and value streams involve several players exchanging different types of value.** The party who is benefiting from a value-added service no longer needs to be the one who is paying for the service. **This requires smart solutions and new business models which prevents value loss along the process of providing data-intense services**.

More and more partners are involved in the end-to-end service delivery chain, therefore to operate both elements successfully**.** Operators need a flexible and open environment. **Open Source has expanded use of software and changed the landscape of software development and distributions as it facilitated sharing, and in doing so, has undermined established 'business models'**. No single new model, or 'magic bullet', is apparent in any of successful OSS initiatives. Instead there is the need to exploit a range of different routes to market and sustainability. It's clear that Open Source by itself cannot be considered a business model. **Common models are:**

- **The community model**: the costs of sustaining the product or service are covered by building a community of users and industry partners who agree to cooperate on development work and maintenance because of their shared interest in an extended life for the product. Products maintained in this way tend to have a wide applicability, such as Apache.
- **The subscription model**: users pay subscription costs to an external body in order to support central maintenance and support. SAKAI and Linux Red Hat software are supported in this fashion.
- **The commercial model**: users choose to adopt and pay for a 'commercialized' version of a piece of software, normally to gain guaranteed support, maintenance and service models.

To build-up a viable business model, key elements should be taken into account. These refer to different domains: business, technical, financial and service. Applying a Strategic Fit CANVAS-like approach the main business model elements would include:

- **Business Architecture**: Key elements are:
    - *Ecosystem management*: building and expanding the ecosystem, exploiting the opportunities of multi-sided markets.
    - *Business Roles*: Identification and assignment of roles to players within the business architecture. Who does what?
    - *Customer relationship*: Building, managing and maintaining customer relations. This element will also be covered in the organisational architecture.

  Implementing the business architecture requires organisational, legal, managerial arrangements.

- **Technical architecture and activity structure:** Refers to the technical structure of the service operation and the way different partners provide and integrate different parts of the service. It includes the activity structure in terms of infrastructures, resources and processes generating the services offering.
    - *Ownership of components*: Systems, platforms and artifacts that connect to each other for service provision.
    - *Intra-operability (within the system)*: This refers to the particular distribution, control and functionality of components across the system in order to deliver a specific application or service.
    - *Inter-operability (outside the system)*: It refers to the ability of systems to directly exchange information and services with other systems.
    - *Activity structure*: the processes and activities of the value chain as a service business, including service offering, customer relations, logistics, management and other.
- **Financial architecture**: The financial architecture deals with the financial arrangements between the partners in terms of cost structure of platform´s activities and revenue generation based on pricing and licensing strategies. It is essential that the financial architecture exploits the inherent multi-sidedness.
    - *Cost structure*: Relating to the activity structure, the provision of resources and the business roles, costs need to be made in order to implement all the roles required for the value network.
    - *Revenue sharing*: The revenues come in at the customer side, but all partners need to be compensated. The compensation does not need to be proportional to the costs made, but it should at least cover them for each partner.
    - *Revenue model:* There are many ways to create revenue: direct sales to customers, some kind of two- or multi-sided market scheme, freemium, cross-selling, advertisements, etc. Here, different pricing and licensing models should be considered as well.
- **Service Architecture**: This is about the offering of products and services by the platform and the value offered to the customer. Underlying is the identification of customer groups and their needs to be addressed by Platform's services, including market analysis.
    - *Value proposition*: The value proposition is about the Platform product and service offering and their value added: the reasons why customers should acquire the service.
    - *Positioning:* Often, there are many solutions to the same problem. Platform service needs to differentiate itself from competitive offerings. I.e. Open-source
    - *Customers:* Target customer segments and their needs. as B2B service-platform.
    - *Engagement:* End-customers can be offered varying degrees of involvement.

Amazon, Google and other Internet players have already demonstrated how an innovative combination of business models, Internet-based platforms, and marketplaces can lead to a successful monetization of offerings. However, while **marketplaces and business models** have experienced a relevant development on certain proprietary domain-specific platforms operated by a single provider, the **open innovation in the apps/services space is still in its infancy**, thus maintaining high entry barriers for smaller players to the Internet business ecosystem

5 Transforming Sectors: Demand and Impact

Future Internet Platform arises 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. This platform will **address the following solutions/innovation ecosystems**:

- **Smart Cities are considered as open innovation ecosystems** and playgrounds to exploit the opportunities of the Future Internet.
- **Smart Industry:** the envisioned services and application developed within FI-PPP will be distributed **across various market sectors ranging from logistics to manufacturing**. (e.g. Industrial Control Systems, Field Devices, Manufacturing Execution Systems, Supply Chain Control, Smart Product Rotation and Restocking Management).
- **Smart Society:** the best applications that provide benefits to society, linked to education, health and inclusion, or to promote the construction of a society with better living conditions.
- 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. (e.g. Security, HVAC, Lighting, Entertainment, Energy Management, Assisted Health Care and Aging),

5.1 Smart Cities

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 propose of Smart City is to increase the quality of life of its citizens through the use of intelligent technology (Big Data, IoT and M2M, sensors, mobile technologies, visualization, 3D, cloud platforms, open data platforms), improving the quality and efficiency of services provided by both, public bodies and companies, in order to produce an economical and environmental sustainable city's development.

From sensors and hardware, technology RDFI or augmented reality that allows data are captured from the city; M2M technologies for the transmission of information, data repositories, or Big Data technology that enables storing, analysing and visualization of large volumes of data, we find open source solutions, that in some cases, like in the field of Big Data, are leading the way to the rest of the solutions.

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

- **(A) 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),
- **(B) Smart transport** (e.g. traffic management systems, integrated supervision market, passenger information, ticketing and parking management) and
- **(C) Smart security** (e.g. urban security, critical infrastructure protection, ID management and cyber security).

- **(D) 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),
- **(E) Smart Energy Management** (e.g. Smart Meter, Smart Grid, Software & Hardware),

The ultimate goal is to satisfy the increasingly demanding and complex needs of citizenship, making the best use of resources, which are in turn, increasingly scarce and diminishing.

Smart City does not build more intelligent energy production plants, which makes is to deploy a smart grid for more efficient consumption and provides its buildings with energy generation systems for sustainable consumption. As we discussed below, **the Smart City develops the necessary social, technological and cultural conditions for new services and technology-based applications can be developed efficiently, easily, security and confidence.**

Smart City apps are characterized by being aimed to empowering citizenship and long tail markets, and they usually include elements as crowdsourcing. Smart city applications could have the following elements:

- Sensible: sensors sensing the environment
  - Connectable: A networking devices bring the sensing information to the web;
  - Accessible: The broader information of our environment is published on the web, and accessible to the user (web);
  - Ubiquitous: The user can get access to the information thought web, but more importantly in mobile any time, any place (mobile);
  - Sociable: The user can publish the information though his social network
  - Sharable: The object itself must be accessible and addressable (not just the data) in a true peer to peer networked manner.
  - Visible/augmented: To retrofit the physical environment, make the hidden information seen not only through mobile device by individual but seen in naked eyes in more border range of the physical places like street signs.
- Smart City's enablers: There are several areas of interest that are being researched and developed in the intelligent city context. Currently, the Smart City services and apps focus on these topics5.
  - Energy consumption and transport improvement.
  - Technology and innovation, which is turning cities and their actors in sensors, capable of communicating their needs and respond to certain scenarios in real time;
  - Smart society and collaborative city, as a result, among other factors, of the adoption by the citizenship of new technologies (for example the smarthpones), that is drawing a scene to empower citizens in the public arena and to drive participation of citizens in innovation processes.
  - The environment, through research into new energy sources, reduced water consumption and waste emission reduction, etc.
  - Urban planning and building, refocusing on building cities on a human scale.
  - Mobility, based on a new paradigm derived from climate change that focus on new solutions based on technology infrastructure services, electricity, multimodal mobility, and space and shared services.
  - Governance and the economy, because of local authorities face with the high demands of its citizens, whose capacity to influence in the city government has increased.

- Engagement and citizen participation
    - Open access to Data
    - Technologies of the Future Internet
    - and the City's development as advance innovation ecosystems

The opening of data generated by the city, and in the city, is the starting point for the emergence of innovative initiatives capable to provide services and applications based on information technology, which facilitate new relationships between citizens and their government. At the same time, open data enables the emergence of new businesses based on the transformation of a large amount of information into knowledge8. That is one reason, together with transparency and good governance that has made that Open Data initiatives will be extend around the world. Inhabitants of the city with their Smartphones, cars, social media accounts, houses, offices, energy consumption, etc., leave "Big" footprints of information everywhere. Cities have these large amounts of data or "Big Data" in each corner: smart meters, RFID tags, security cameras, Foursquare, transportation centres, Smartphones, research centres, logistic enterprises, sensor networks, car devices, etc., and where there is big data, there is knowledge to be discovered and new possibilities for innovation.

Open data refers not only to the opening of public sector data which would be available to society on public platforms, but would also extend to the data produced by citizenship and private companies who share their data with the authorities, whom share their public data with the city.

Cities, to address their challenges, are opening their data and deploying open source methodologies which let people, community, and their organizations to develop contents and applications that result in social and technological innovation and economic growth.

In the City, understood as a system of innovation, participate all value chain actors: university, government, business and citizens work together to create joint projects. In this type of city, the infrastructure, platforms and evaluation methodologies are available to all these actors, offering better equality and boosting and supporting innovation where it can be developed with more probability, in many cases in small, medium or very small companies.

From the technological point of view, the service delivery platforms of Smart City will be the common technological base of the city. These platforms provide a set of modules that are common to multiple services offered as part of the Smart City project**. These platforms are horizontal and scalable, and allow offer safety and privacy guaranteed services.**

If we want to make the city a place of innovation, Smart City infrastructures should support Open Standards and interoperability with Open Source technologies. **So Open Source technologies facilitates on the one hand, the configuration of the Smart City from the technological point of view**, and at the same time, provides a participative, collaborative and open model of social development, in which different stakeholders can work together to solve complex problems taking into account all angles: technological, social or political.

5.2 Smart Industries

As IDC explain, in the past few years, continued advances in information and communications technology (ICT) are facilitating dramatic changes, such as the **development of ubiquitous mobile broadband, tremendously powerful smartphones, and the deployment of billions of autonomous devices and sensors**. Cumulatively, these advances are also helping to drive the emergence of several other powerful new technology fields, such as **cloud computing, big data, mobility, social business, and the Internet of Things (IoT),** which IDC considers to be the pillars of the new "3 rd Platform" of ICT innovation.

Such developments have been many years in the making, but they are now becoming sufficiently widespread and mature for enterprises to take action. And, as companies deploy such technologies, they are not just updating their ICT systems but are, most importantly, **using them to drive innovation across their business models and operational processes, products, and strategies**. As such, 3rd Platform technologies are enabling the digital transformation of enterprises.

According to the Harvard Business Review, **IT is becoming an integral part of the product itself**. Embedded sensors, processors, software, and connectivity in products (in effect, computers are being put inside products), coupled with a product cloud in which product data is stored and analyzed and some applications are run, are driving dramatic improvements in product functionality and performance. **Massive amounts of new product-usage data enable many of those improvements.**

The powerful capabilities of smart, connected products not only reshape competition within an industry, but they can expand the very definition of the industry itself. The competitive boundaries of an industry widen to encompass a set of related products that together meet a broader underlying need. The function of one product is optimized with other related products. For example, integrating smart, connected farm equipment such as tractors, tillers, and planters can enable better overall equipment performance.

The basis of competition thus shifts from the functionality of a discrete product to the performance of the broader product system, in which the firm is just one actor. The manufacturer can now offer a package of connected equipment and related services that optimize overall results. Thus in the farm example, the industry expands from tractor manufacturing to farm equipment optimization.

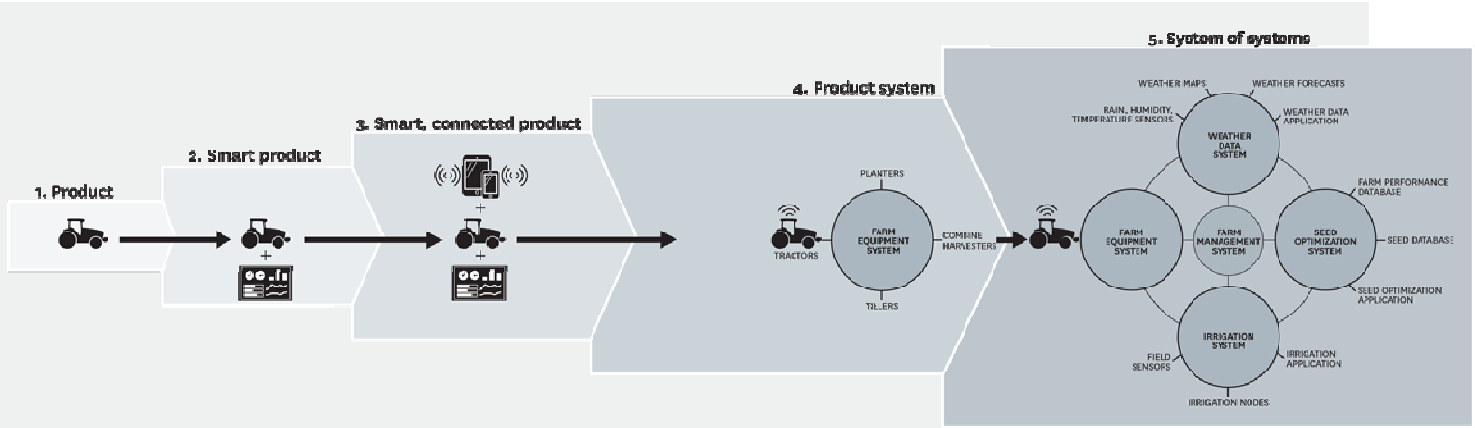


Figure 21 : Redefining Industry Boundaries. Harvard Business Review

Companies are adopting the new wave of information and communications technologies, such **as cloud-based services, mobility, big data/analytics, and social business, to transform their businesses, gain competitive advantages, increase efficiency, generate new opportunities and new markets**, support business growth, develop new products and services, and drive new profits (improve the bottom line).

As these **digital technologies, Cloud, Big Data, IoT, gain momentum**, they are profoundly changing the strategic context: altering the structure of competition, **the conduct of business, and, ultimately, performance across industries**:

- **Staggering amounts of information** are accessible as never before from proprietary big data to new public sources of open data.
- **Analytical and processing capabilities** have made similar leaps with algorithms scattering intelligence across digital networks, themselves often lodged in the cloud.
- **Smart mobile devices** make that information and computing power accessible to users around the world.

Additionally, digitization often lowers entry barriers, causes value chains to disaggregate, creating openings for focused, fast-moving competitors and provides the following benefits:

- Enhancing interactions among customers, suppliers, stakeholders, and employees. For many transactions, consumers and businesses increasingly prefer digital channels, which make content universally accessible by mixing media (graphics and video, for example), tailoring messages for context (providing location or demographic information), and adding social connectivity (allowing communities to build around themes and needs, as well as ideas shared among friends).
- Improving management decisions as algorithms crunch big data from social technologies or the Internet of Things. Better decision making helps improve performance across business functions for example, providing for finer marketing allocations (down to the level of individual consumers) or mitigating operational risks by sensing wear and tear on equipment.
- Enabling new business or operating models, such as peer-to-peer product innovation or customer service. New business or operating models can also disintermediate existing customer supplier relations for example, when board-game developers or one-person shops manufacture products using 3-D printers and sell directly to Amazon.
- Digital technologies create near-perfect transparency, making it easy to compare prices, service levels**,** and product performance: consumers can switch among digital retailers, brands, and services with just a few clicks or finger swipes.
- Digital businesses reduce transaction and labour costs, increase returns to scale from aggregated data, and enjoy increases in the quality of digital talent and intellectual property as network effects kick in.
- As digital forces reduce transaction costs, value chains disaggregate. In the travel industry, new portals are assembling entire trips: flights, hotels, and car rentals. The standalone offerings of third parties, sometimes from small companies or even individuals, plug into such portals. These packages are put together in real time, with dynamic pricing that depends on supply and demand. As more niche providers gain access to the new platforms, competition is intensifying.

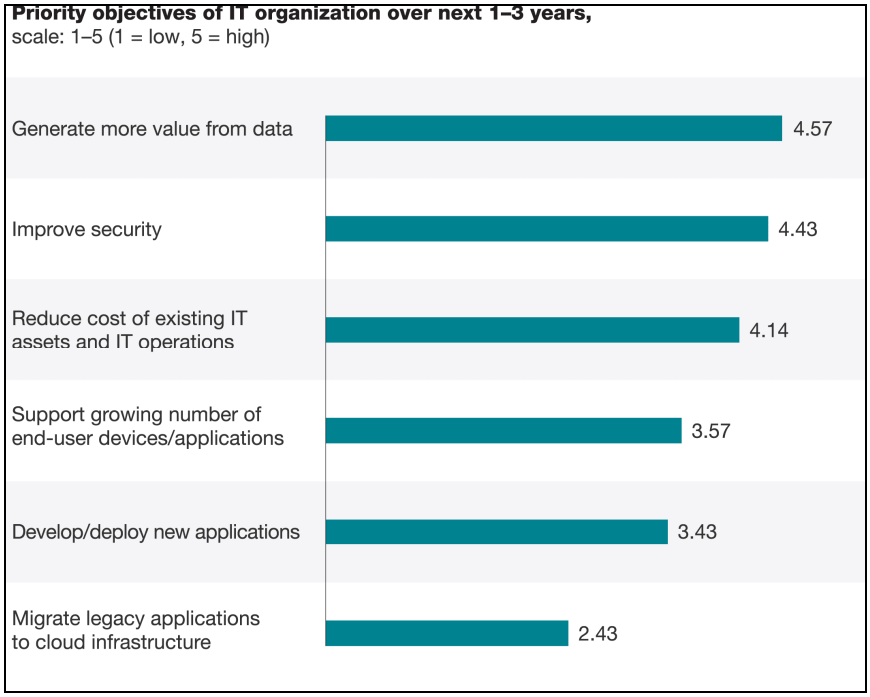


Figure 22: Priority Objectives of IT organization over next 1-3 years. Source: Mckinsey

Following that, Smart applications of ICT such as Smart grids, Smart logistics and Smart factories will be widely deployed. Ubiquitous broadband access, mobile technology, social media and the generalised use of machine-to-machine (M2M) communication have contributed to the explosion of generated data. It is estimated that a significant part of this data will include valuable information. **Extracting this information and using it in intelligent ways will revolutionize decision making in businesses, science**, and society enhancing companies' competitiveness and leading to new industries, jobs and services

- **Big Data and data-driven decision making will help companies to create new business models and products** to gain efficiency while at the same time providing better services and acting environmentally more responsibly. **The collection and analysis of data from smart phones and IoT based environments such as traffic control systems** will enable improvements in personalized services and applications and the creation of **new services and business models around personalization**
- **The Internet of Things (IoT) is not just a technology, or a system, or architecture, it is mainly a business case**, and requires a combination of all these pieces to fulfil its promise, which is a smarter way to do business. A major use case for IoT is predictive and preventive maintenance. **The ability to accurately diagnose and prevent failures in real time is a major advantage for companies and is vital for critical infrastructure applications.** A failure of high-tech machinery and equipment can prove to be highly expensive in terms of repair costs, in addition to lost productivity from the resulting downtime. Historically, technicians have been sent to carry out routine diagnostic inspections and preventive maintenance according to fixed schedules, which can be a costly and labour-intensive process with little assurance that failure will not occur between inspections.

A key aspect of the 3rd Platform is that it's not just about mobile, social, cloud, or Big Data taken in isolation. The real key is weaving together two or more of these technologies to **create high-value industry solutions**. **The lion's share of new 3rd Platform solutions for the enterprise will focus on industry specific needs**. This section describes **a few of the innovative new solutions that leaders in the retail, financial services, telecom, healthcare, and government industries** are using to revamp their business models, enable digital transformation, and drive new sources of competitive advantage.

- **Retailers are bringing the benefits of online and mobile into the store:** Some of the world's largest retailers are using 3rd Platform solutions to transform their business models. These solutions use a combination of 3rd Platform technologies to completely rethink the customer's experience. Future plans call for the retailer to use Big Data to view the shopper's history, the products purchased in combination with other products, the impact of promotions, and the day of the week and time of day purchases are made. It will tap into social technologies to make recommendations based on what customers' friends or people with similar characteristics purchased. Of course, this is all powered by cloud technologies. This 3rd Platform approach has already begun paying benefits. By providing contextually aware information to customers on their mobile devices, the retailer believes it is delighting customers and increasing its share of wallet.
- **Financial Services Companies are revamping Payments using 3rd Platform Solutions.** The 3rd Platform is also having a profound impact on the financial services industry. A good example is the payments sub industry. Today, providers are starting to use the information available through payment operations as a source of competitive advantage. Owning the payment relationship and data gives financial services providers an important link to the customer, and 3rd Platform payment mashups are emerging to leverage this information. Providers are using Big Data to gather and analyze vast quantities of information, including information obtained through social networks, and taking advantage of cloud as a deployment mechanism. And they are increasingly offering payment services through customers' mobile devices. Cloud is playing a critical role in the development of mobile wallets. Financial services companies are also using the 3rd Platform to team up with retailers to offer banking services through mobile phones,

- **Telecommunications Firms Using 3rd Platform to gain greater relevance.** In previous decades, it was sufficient for telecommunications companies to exact economic rents simply by charging for the pipelines that carry voice and data. But today telecommunications providers are fighting not to become a commodity and are looking to digital transformation to better monetize their unique role in the value chain

  One innovative initiative being pursued by a United States–based carrier consists of a mobile advertising service designed to make advertising more personalized and relevant to customers. This service uses a combination of 3rd Platform technologies, including Big Data, to package information on its tens of millions of customers (on an opt-in basis) into demographic data, behavioral data, and location data. This enables advertising agencies to develop better-targeted campaigns and provide more relevant ads to consumers. In another example, a major European-based mobile operator is working to remain relevant to subscribers who are engaging in "over the top" social network sites. This provider is partnering with social networks; using Big Data to help social network providers better understand the profile of the Telco customers who use their sites. With these new offerings, telecommunications companies are carving out a niche unique to their role in the value chain, deepening their relationship with customers, and increasing their average revenue per user (ARPU).

- **Healthcare Using 3rd Platform Solutions to provide information to patients at key decision points.** The healthcare industry in the United States is currently undergoing a rapid transformation, driven by new business models inspired by the introduction of government incentives for meaningful use of IT, the implementation of electronic records and technologies, and the passage of healthcare reform legislation in 2010. These changes moved business models from fee-for-service models toward fee-forvalue incentives, inspiring more collaboration between providers and payers. 3rd Platform solutions are playing a key role in this transformation. Industry-specific solutions are being developed leveraging cloud-based portals, analytics, and mobile to tighten patient engagement and drive surprises out of the process. The goal is to improve the quality of care and outcomes while reducing costs.3rd Platform mashups are being used to engage patients with information to help them make the best choice with regard to key health-related decisions. Using predictive analytics enabled by Big Data, mobile, social, and cloud services, healthcare providers are helping patients change their behavior through the use of reminders, social influence, and education.

- **Leading-Edge Government Agencies Using 3rd Platform to Improve Services and Reduce Costs.** Government agencies contain some of the most advanced and some of the most lagging IT systems in the world. While government sectors such as defense, security, and space are among the earliest adopters of 3rd Platform technologies such as Big Data and cloud, other agencies are firmly rooted in the 2nd Platform paradigm. Many agencies' IT environments contain duplicate legacy systems, resulting in low asset utilization, resources with fragmented demand and that do not scale, and systems that are difficult to manage and maintain. In response, a number of government agencies are beginning to implement 3rd Platform technologies in a bid to address inefficiencies while improving government service delivery.

  - One example at the national government level is the U.S. Department of Agriculture (USDA), which recently **launched a private cloud service for other federal government agencies that need to implement IT solutions consistent with federal information security standard**s. By offering other government organizations the benefits of cloud computing, including on-demand provisioning, resource pooling, elasticity, network access, and measured services, the USDA is facilitating the ability of government organizations to efficiently meet demand from citizens for better services delivered more quickly.

- An example at the state/regional level is a recent initiative by the Washington State Department of Labor and Industries, which is using **Big Data to analyze data sets across multiple government systems** and agencies to detect possible instances of fraud in its workers' compensation program. The initiative has been so successful in its ability to recover millions of dollars each year that it is on track to pay for itself in less than 24 months.
- At the local government level, the **Domain Awareness crime monitoring system** was recently developed by New York City in conjunction with Microsoft. It uses **Big Data to better collect, disseminate, and analyze data in real time using a series of mobile and intelligent devices** including cameras, license plate readers, and other resources around the city. This system not only is improving the ability to fight crime but also is providing an innovative new revenue stream for the city. Under the deal, Microsoft has the rights to remarket the offering to other cities and local governments, with New York receiving 30% of the proceeds.

The 3rd Platform is being used to digitally transform entire industries and develop major new sources of competitive advantage. Hundreds of thousands, if not millions, of industry-specific cloud service platforms and marketplaces will emerge, and the highest-value technologies and solutions will be found in these locations. **Combinations of 3rd Platform technologies will transform and already are transforming industries such as retail, financial services, telecommunications, healthcare, and government**.

Think of this as the long-anticipated period in which virtually ach **industry gets "Amazoned" in its own way.** These disruptions will manifest themselves as cannibalization of cash cows, slowed growth, squeezed margins, and declining market share. This threat and opportunity makes it imperative that **senior management become much better versed about the 3r Platform and its possibilities in their own business and industry.**

5.3 Smart Home

"Smart homes" refer to residences equipped with computing and information technology devices that anticipate and respond to the needs of the residents, thus, working towards enhancing their comfort, convenience, security, and entertainment through the upgrade of technology within the home. The concept of smart homes has been around for a while now; such homes have always been a dream of homeowners and, presently, a lot of developments and regulatory initiatives are taking place with regards to the same.

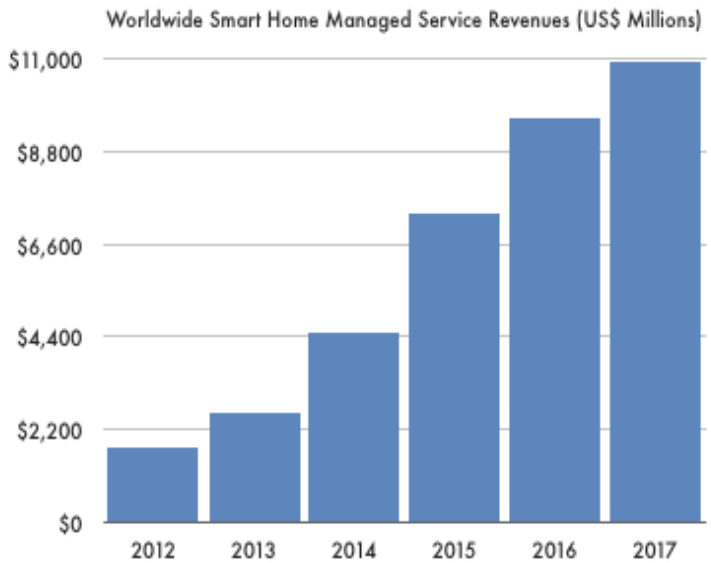


Figure 23: Worldwide Smart Home managed Service Revenues (US$ Millions)

The growth of the market in the coming years is expected to be remarkable, with revenues estimated to reach $51.77 billion by 2020, at an estimated CAGR of 17.74% from 2013 to 2020. The major players in this industry are Siemens AG (Germany), Schneider Electric S.A. (France), ABB Ltd. (Switzerland), Ingersoll-Rand PLC (Ireland), Tyco International Ltd. (Switzerland), Emerson Electric Co. (US), Legrand S.A. (France), Crestron Electronics, Inc. (US) , Lutron Electronics, Inc. (US), Control4 Corporation (US), and more.

According to the Smart Homes Market report, the major drivers for the Smart Homes Market include energy saving, increasing ageing population, regulatory initiatives by governments, and more. The introduction of smart meters to conserve energy is another growth opportunity for the market. Also, the smart electronic devices such as washing machine, refrigerators, air-conditioner, vacuum cleaner, smart TV, and the likes are going to drive the market. According to a recent report from Next Markets Insights, It's these new smart home service offerings from the big Telco and cable providers that will help **drive the smart home services market from under $2 billion worldwide in 2012 to $10.9 billion by 2017.**

The European Connected and Smart Home product market grew by almost 19% in the period 2010-2012 to reach just over €510 million and **is estimated to grow by 8% in average each year until 2015**.

The current Connected & Smart home market still remains a niche high-end market, with penetration in light commercial applications growing since 2010. Residential consumer awareness has been increasing across Europe, not least due to the widening popularity of smart phones/tablets and their role as possible user interfaces (via apps) in smart home solutions. **Nevertheless, in these austere times in Europe the high cost of the smart home solution prevents these solutions from reaching the mass market**.

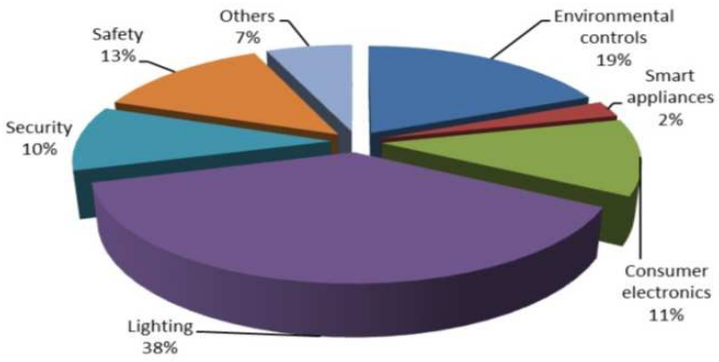


Figure 24: Smart home market applications. Source: BSRIA Smart Home Study 2013

Lighting controls is the main application. Environmental controls became the second largest application in Europe, as customers have been increasingly worried about their energy bills and to prevent wasting energy. Assisted living home is an important market in the Netherlands with the financial support from the Government.

Broadly the **smart home market can be segmented into three areas**:

- **Smart home products**: In 2010 Europe's smart home market, including products along with the system integration (design, installation, wiring, customized programming, etc.) and installation labor, was valued at €529.6 million. This is up 18% from the €448.3 million of 2008.

  Field devices have the largest share in the smart home product market (€174.9 million). These include different kinds of sensors (motion, light, temperature) and actuators (blinds, curtain, window, door, water valve). The user interface is the second largest category (€90.8 million). The most common user interface devices are LED touch panel type that acts as a central control panel, smaller LED with buttons, and simple push buttons. As LEDs become more affordable and because they are extremely flexible, larger LED touch panel devices will become popular. As smartphones and tablet PCs (e.g. iPhone, iPad, etc.) are becoming more popular, these are turning into a second user interface. Many manufacturers are launching new apps to turn these smart devices into another control on the smart home system. The industry is still puzzling about the future trend, whether these smart IT devices are going to be a substitute to the traditional user interface or complementary.

  Consumers today also use more (mobile) internet access, and smart home systems are latching on to this trend by enabling control over IP. There are more gateways or web server devices added onto the smart home system to allow remote control via internet. These kinds of products are grouped in the 'others' category (€54.7 million).

- **Home energy management:** Europe's HEMS market was valued at €30.5 million in 2010. Like the smart home market, Germany has the biggest share. There are also many activities in the UK, but HEMS is still very low profile in Switzerland, the Netherlands, Sweden and Norway.

  The market is still at an early development stage. Most of the sales of HEMS products are for testing or pilot projects. In 2011, we started to see a market establishing in the UK and Germany. But even in countries like Italy, Sweden and Finland, where smart metering has been or is being fully implemented, a HEMS market still does not exist. Energy suppliers play an important role in this market, although their strategy and direction are still unclear. At the moment, they are still running tests on products and looking for a proper business model. The market also needs to wait for the rollout of smart metering to come on track. Currently, only about 10% of households in Europe have smart meters installed.

  It is expected the market will remain at a developing stage until 2014/15. Thereafter the HEMS market should become established, with a well-defined supply chain and product standards.

  There are several new HEMS products being developed by small scale start-up companies. Their main strategy is to partner with energy suppliers to supply the HEMS products. Many of these companies are developing their products based on ZigBee technology. The forecast for the HEMS market is positive. According to the latest report by GTM Research, *Home Energy Management Systems: Vendors, Technologies, and Opportunities, 2013-2017*, the U.S. HEMS market is forecasted to be worth over $4 billion by 2017.

- **Residential environmental controls**: The product market was valued at €86.2 million in 2010. These include intelligent thermostats, automatic radiator valves, sensors, and electric heating control systems (energy managers).Surprisingly, the market for gas heating controls is heavily dominated by DIY products. A large number of products are sold to consumers via retail and online channel directly.

References to the market potential of the targeted technologies:

- Remote Monitoring, Control and Security to Propel **Global Smart Home Market to 160 Million Homes Worldwide** to Have Smart Systems by 2017
  (Strategy Analytics)
- The **global smart home industry** is projected to surge to from $16.9 billion in 2011 to **$35.6 billion by 2016** *(Markets & Markets).*
- ***16% broadband households in the world will have at least one smart home system*** *by 2017 (Strategy Analytics).*

- It's these new smart home service offerings from the big telco and cable providers that will help drive the **managed smart home services market** from under $2 billion worldwide in 2012 to **$10.9 billion by 2017**. (NetMarket insights)
- **Traditional security monitoring services** have been on the market for decades, yet the adoption rate is limited to 15-20% of households. The addition of home automation features and self-monitoring solutions is expected to **grow the market by 50% over the next decade** *(Parks associates)*

5.4 Smart Society

The **best applications that provide benefits to society, linked to education, health and inclusion**, or to promote the construction of a society with better living conditions.

- **Healthcare.** Applications range from comparative effectiveness research where the clinical and financial effectiveness of interventions are compared, to the next generation of clinical decision support systems which make use of comprehensive heterogeneous health data sets as well as advanced analytics of clinical operations. Of particular importance are patient involvement, privacy and ethics.

Figure 25: Health Monitoring. Source: Atos.

- The healthcare domain requires **improved efficiency as well as improved quality of care**. Today, efficiency of care and quality of care are two opposing requirements: The more information is available about a patient health history and status, the more individualized the treatment decision can be made, which automatically leads to an increased quality of care. However, without big data technology, i.e. means for automatically analyzing large amounts of heterogeneous health data, improved quality of health care services will always lead to increased cost of care, as individualized treatment paths cannot be standardized and thus are likely to become very labour and cost-intensive.
- **Remote monitoring** will improve the lives of people with chronic diseases while simultaneously driving down healthcare costs. For operators, this could mean becoming a trusted third party or a mediator for providing such services via mobile apps, or saving, storing and forwarding personal health data to health companies. **Such systems can significantly reduce healthcare costs** and many health operators are interested in subsidizing their deployment and use. Tele health will be one of the most important categories of medical care in the 21st century because it encompasses both preventative and curative aspects. It also benefits patients where access to healthcare is affected by distance or a lack of local specialists. Tele health technologies have already clearly demonstrated their value for reducing hospitalizations and ER visits, while improving the patient outcomes and quality of life.
- **Regarding Education Challenge:** Information communication technology (ICT) in education is promoted and infrastructure is distributed. It is the way for 21stCentury learning: education is everyone's right, and easy access must be possible by anyone, anytime, anywhere, and any form.

  Employing ICT, particularly smart technology, is not simply providing technology to schools, is to meant to enable innovative instructional cultures, to provide different approaches to instruction, allow different evaluation processes, support new interaction among learners, and inevitably this new culture can lead to new ways of pedagogy.

6 Platform Market Positioning

Currently, there are **two large application enablement platforms**; on the one hand, is **Amazon Web Services and, second, Google**. **Both are American and private.**

Regarding all the market noise surrounding IoT platforms, a growing number of companies are developing and deploying IoT applications, but much of the technology stack comes from internal teams and system integrators. **Third-party platforms have a high upside.** 2014 was marked by **the emergence of PTC** as a somewhat **unexpected IoT champion**, following its **acquisitions of Thingworx and Axeda**. Another interesting development was **LogMeIn repositioning its Xively platform,** the second evolution of Pachube, **from a pronouncedly horizontal "AWS for IoT**" to a more traditionally inclined solutions provider. Meanwhile, one of the original AEP pioneers, ILS Technology, was integrated into its new owner, Telit. Currently, the most pressing strategic topic is **GE's announcement to open up its Predix platform** to the products of other manufacturers. **Most of them are American and private.**

Nevertheless, some of the most important Smart City Platforms are European. To achieve these objectives some of these projects are using **open source technologies** and methodologies and releasing their solutions, fully or partially, as open source. **The same approach will be required in the Smart Industry** with upcoming of the **IoT growing market.**

6.1 EU Smart City Platforms and Services: Open Source Technologies.

According to the CENATIC ("*Observatorio Nacional del Software de Fuentes Abiertas")* Research, **some of the most important Smart City Platforms aim to develop common platforms** and services at European level that enable the development and deployment of Smart Cities and the p**rovision of Future Internet-based services, are European**. To achieve these objectives some of these projects are **using open source technologies** and methodologies and releasing their solutions, fully or partially, as open source. Below the *CENATIC* describe some of these projects.

- **Smart Objects for Intelligent Applications (Sofia);** Sofia is an R+D+I project developed between 2009 and 2011 as part of the ARTEMIS Joint Technology Initiative (JTI). Aiming to connect the physical world to the information world the project has developed a platform based Semantic Web technology, interoperability and intelligent sensor networks, which allows automation of cities, buildings and cars, as well as providing intelligent and personalized services, such as location, context information or motion detection through mobile devices.
- **Webinos**: Webinos is an EU funded project aiming to deliver an Open Source Platform and software components for the Future Internet in the form of web runtime extensions, to enable web applications and services to be used and shared consistently and securely over a broad spectrum of converged and connected devices, including mobile, PC, home media (TV) and in-car units. A foundation is planned to continue the work after the end of the project in August 2013, building upon an affiliates program launched in August 2011 that seeks to attract additional organizations to help with work on specifications and platform development.
- **Open Cities: OSN Platform**: Open Cities are a project co-founded by the European Union that aims to validate how to approach Open & User Driven Innovation methodologies to the Public Sector in a scenario of Future Internet Services for Smart Cities. It will do so, by leveraging existing tools, trials and platforms in Crowdsourcing, Open Data, Fiber to the Home and Open Sensor Networks in seven major European cities: Helsinki, Berlin, Amsterdam, Paris, Rome, Barcelona and Bologna. In the scope of this project it has been

developed the Open Sensor Network Platform which is distributed under the Apache License 2.0, and that allows the storage of data from both static and dynamic sensor network, and provides the necessary tools to developers so they can build applications and services from these data.

- **PEOPLE: Smart Cities for Smart Innovation**: PEOPLE is another public- private partnership project funded under the ICT Policy Support Programme (ICT PSP) as part of the Competitiveness and Innovation Framework Programme by the European Community, in the area of Smart Cities. PEOPLE is focused on services and applications for Smart Cities, in particular, the project has launched sixteen open sources, innovative internet-based services in four European cities: Bilbao (Spain), Bremen (Germany), Thermi (Greece) and Very sure Seine (France). PEOPLE's internet-based services are integrated, composed and deployed from data coming from the urban ecosystem, for this reason, an Open Data Model and flows of information to service providers have been defined in the project. The source code of all these services and applications is available as open source, and for most of the projects it has been created a community. The objective is that these solutions can be shared at pan-European level. Some of the smart open source deployed by PEOPLE are shown below:
    - HoyRespiro: The service provides georeferenced information on air quality, pollen levels and weather.
    - 3DWalkingTour: Is a website with provide a 3D video tour.
    - GeoCur: The service provides georeferenced information on activities and courses in the city of Bilbao.
    - Local Information Service: The application provides traffic information, bus schedules, and weather and air quality.
    - Improve your city: The application allows citizens to report problems detected in the city using Internet (pc, smartphone). The tool centres on a web-based map that displays all user comments. Users may add comments, suggest solutions, or add video and pictures and they can be informed about the solving stage of the reported problem. E-mail alerts are also available
    - Virtual City Market: This application represents the marketplace of Thermi and is targeting on offers, promotions and discounts. Access to shops is made through PCs, mobile phones, screens and quick response (QR) codes embedded in the physical space of the city center. Information about local businesses and professionals is available through a digital inventory, which will operate in the city center. Finally, the virtual marketplace can incorporate social networks'characteristics allowing visitors to rate products and services as well as to suggest offers to their friends.
    - Tool to find car parks paragraph: The tool provides real-time information about the availability of parking in the car parks of the city centre, both available as price. An application is accessed via web or smartphones.
    - SenseTheCity: The application involves the installation of wireless sensors that measure air pollution and send measurements to a central hub. Data are presented to citizens on digital and physical displays, screens and balloons at different locations.
- **ICOS: Open Source Community for Smart Cities**: In the scope of the project PEOPLE has also developed an interesting initiative called ICOS-Intelligent /Smart Cities Open Source Community. ICOS stands for Intelligent Cities Open Source, a community of developers, planners, engineers, and users working in the field of intelligent / smart cities. ICOS is addressed to anyone interested on intelligent/smart cities development and looks for applications and solutions which have been successfully implemented in other cities. In the technology supply side, the community addressed to developers wishing to disseminate the

applications and solutions they have created. In the demand side, ICOS is addressed to city authorities, infrastructure and utilities managers, and city stakeholders wishing to use smart city solutions in order to increase the competitiveness, cohesion, and sustainability of the city.

- **City Service Development Kit**: CitySDK: In the field of the Smart City services provision we find CitySDK36, set of open source tools for the development of digital services in the cities. CitySDK is the unifying parts between various smart city software/hardware platforms and the end-user application developers – "whatever the Developers need to get pan-European Smart City Applications created easily" – in this sense it is a socio-technological ecosystem platform with software unification approach. The toolkit comprises of open and interoperable digital service interfaces as well as processes, guidelines and usability standards. Besides, it works as an app store which facilitates the transfer of Smart City applications from one city to another city. CitySDK enables a more efficient utilization of the expertise and know-how of developer communities to be applied in city service development.

  CitySDK works with 22 public and private partners, from eight European cities as: Helsinki, Barcelona, Amsterdam, Manchester, Lamia, Estambul, Lisboa and Roma. In the project includes the practical application of this set of open source tools in the fields of participation, mobility and tourism, where several services will be developed as we can see below:

  - Smart participation: The Smart Participation Lead pilot is implemented firstly in Helsinki, and afterwards the concept will be expanded to other cities. The purpose of the pilot is to create an open interface that acts as an issue-reporting channel between the citizens and the civil servants. The pilot is based on the Open31138 technology, which is a standardized protocol for location-based collaborative issue tracking. This protocol has a wide variety of open source technology for its implementation.
  - Smart Tourism: The pilot, implemented in Lisboa, focuses on creating location-based mobile services for tourists. The ultimate goal is to create a European-wide market for tourism applications based on Open Data made available by public or private entities. From the technological point of view, the main output of the Tourism pilot will be the final API to access Points of Interest (POI), Routes and Events information that, once deployed, will allow effortless transfer of applications among cities using CitySDK. The Smart Tourism Pilot uses cities' existing open data and open interfaces, as well as crowd sourced information regarding POIs and Events.
  - Smart Mobility: The Smart Mobility domain piloted in Amsterdam aims to create services based on real-time traffic data combined from multiple sources. Services might be used for choosing the most suitable transport option, informing fellow travellers of traffic jams or the best coffee in town while waiting for a bus. The open source "Personal Travel Assistant" is a mobile application that assists the citizens based on geo-location, preferences and the real-time crowd-sourced information from the public transport and traffic situation.

Outside the scope of the European projects there are other initiatives related to Smart Cities platforms and applications that we would like to point.

- **Waspmote: Open Source Sensor Platform for IoT:** Waspmote, Wireless sensor networks platform, developed by the Spanish company Libelium, is an example of open source platform capable of dealing with different technologies, communication protocols and sensor databases, capable to deal with different technologies, communication protocols and sensors databases, which enables developers to design and deploy sensor applications for the Smart City. Waspmote is a horizontal and scalable platform, especially oriented to developers, and it works with different protocols (ZigBee, Bluetooth,3G/GPRS) and frequencies (2.4GHz, 868MHz, 900MHz) being capable of getting links up to 12km. It counts with and hibernate mode of 0.7uA which allows saving battery when it is not transmitting. More than 50 sensors already

available (humidity, temperature, radiation, infrared, etc.) and a complete open source IDE (API libraries + compiler) made really easy to start working with the platform. Waspmote has more than 2,000 developers worldwide, and hundreds of applications have been developed. Some examples of Smart City services deployed with the Waspmote platform are:

  - Smart Parking in Santander: Monitoring of parking spaces availability in the city.
  - PRETESIC in Valencia: Monitoring of sanitary sewer in real-time, measuring the quality of water and testing if the system work properly.
  - RESCATEME, in Salamanca: Monitoring Air Pollution
  - SISVIA- Environment Monitoring, in Asturias to detect forest fires.

- **Code for America Commons (CfA Commons):** In the U.S. we found the project Commons Code for America. Launched in 2011 as Civic Commons and incubated as a collaborative experiment in civic innovation in partnership with Open Plans, the CfA Commons has evolved to become a standalone, ongoing product offering at Code for America. The basic premise is that governments can make better use of scarce technology dollars by working together to solve common problems. The objective of the project is help authorities to share their solutions, knowledge, and best practices. The Code for America Commons is an information product, made up of the Commons app directory and the Commons Wiki knowledge base.

  The Civic Commons Marketplace, currently in private beta, aligns cities around the technologies they buy and build by fostering an engaged community of government decision-makers, organizations, and vendors. The market classifies the apps by type of software (CMS, data integration, HRM, etc.), functionality, or license. Also it show a ranking of the most used solutions. Actually there are 72 applications with open source licenses (GPL, Apache, MIT and BSD).

- **Open City: Open data Apps for Civil Society**: Also in the U.S. but at local level, specifically in the city of Chicago, there is an interesting citizenship initiative called Open City that is a group of volunteers that create apps with open data to improve transparency and citizen understanding of our government. Actually, they have developed ten open source apps, with the MIT license. Some of these apps are:

  - 2nd City Zoning is an interactive map that lets you find out how your building is zoned, learn where to locate your business and explore zoning patterns throughout the city. To make Chicago's zoning code digestible by humans; we took inspiration from one of our favorite games: Sim City 2000.
  - How Business is: How's Business provides a dashboard of Chicago's local economy. It uses open data from the City of Chicago, the Bureau of Labor Statistics and the Woodstock Institute to show how several economic indicators have been trending since 2005

6.2 Smart Industry: Application Enablement Platforms and the need of partnership ecosystems

The emergence of many industry-focused innovation platforms and ecosystems. There are currently a relatively small number of these platforms, but **over the next two years, we'll see many dozens to hundreds of these emerge.** A core strategy for competing in these disrupted and reinvented industries is to create **an industry-focused innovation/solution platform, one that attracts and enables large communities of innovators**. Currently, there are two large application enablement platforms; on the one hand, is Amazon Web Services and, second, Google. **Both are private.**

As IDC predicts, Amazon will continue to gain more of the IT industry. This may be, by far, the easiest prediction for 2014: Amazon Web Services (AWS) will continue to expand into many more IT offering

areas. Further, it is aggressively **targeting opportunities** that were formerly the domain of large professional services firms and ISVs, including **datacenter migration, application migration, and Web application and site migration**. And it's providing these with the same very disruptive cloud pricing as its infrastructure services. There's no reason to believe AWS will slow down in **picking off more profitable corners of the IT industry and delivering them in a very competitive 3rd Platform model**.

Google will continue to address the enterprise IT market. Google is certainly wide awake in the core markets in which it currently plays (and dominates). But, unlike Amazon, it has been remarkably dormant in the IT marketplace even though it shares many of the same 3rd Platform strengths its neighbor to the north has wielded so disruptively in the IT market for the past five years. **Google Enterprise has grabbed a large share of enterprise IT email and collaboration business with Google Apps**, and earlier this year it rolled out an infrastructure-as-a-service offering (Compute Engine, Cloud Storage) and **made enhancements to its platform-as-a-service offering** (App Engine). But Google has thus far had an **underwhelming presence in the transforming enterprise IT marketplace**. In 2015, IDC expect Google to "wake up" and respond to the 3rd Platform IT opportunity with more focus and urgency or risk being boxed out of a market in which it surely should be vying for leadership, especially **given the industry's growing Big Data centricity**.

Incumbent IT suppliers will more urgently strip down, and reconfigure, their businesses for the fight. In 2015, the companies that won market leadership in the 2nd Platform era and are the incumbents in most customer sites today, will even more aggressively reconfigure themselves for **the fight for the 3rd Platform marketplace**: acquiring **more 3rd Platform competencies** and divesting diminishing return businesses (or businesses that are marginal to the new core). Companies likely to be very active acquirers and divestors in 2015 include **Microsoft, IBM, HP, Dell, EMC, Cisco, Oracle, SAP, AT&T, and Verizon**

Additionally and regarding all the market noise surrounding IoT platforms, a growing number of companies are developing and deploying IoT applications, but much of the technology stack comes from internal teams and system integrators. **Third-party platforms have a high upside**, but today the reality is that the vast majority of enterprises have yet to either **fully commits to an IoT strategy** or determine the best way to execute one**.** In the **Application Enablement Platform market, 2014 was marked by the emergence of PTC** as a somewhat unexpected IoT champion, following its **acquisitions of Thingworx and Axeda**. Another interesting development was **LogMeIn repositioning its Xively platform,** the second evolution of Pachube, **from a pronouncedly horizontal "AWS for IoT**" to a more traditionally inclined solutions provider. Meanwhile, one of the original AEP pioneers, ILS Technology, was integrated into its new owner, Telit. Currently, the most pressing strategic topic is **GE's announcement to open up its Predix platform** to the products of other manufacturers.

IoT partnerships will emerge among disparate vendor ecosystems. To create momentum, new industry partnerships will emerge as **traditional IT vendors** (i.e., Microsoft, IBM, HP, Dell) begin to accelerate their partnership with **global service providers** (i.e., AT&T, Telefonica, Verizon, Vodafone) and **semiconductor vendors** (i.e., Intel, Qualcomm, Samsung) to create integrated offerings in the consumer electronics space. These new partnerships will **accelerate the number of connected devices, expand the intelligent systems that manage the sensors** (a goal for the microprocessor vendors), and create **integrated solutions offerings for the business services organizations of the IT players**.

Look for the **Chinese government and industry to play a very active role in IoT development and adoption. Open source minded** China will be a key player in the Internet of Things. As IoT players develop strategies and solutions in 2014, keeping an eye on China as a key market and a seed bed for new technologies and competitors will be extremely important.

Deploying end-to-end M2M/IoT solutions and being able to manage an increasing range of applications **becomes the next challenge for enterprises**. Providing a dedicated enterprise platform and toolset, and enabling the re-use of components by the enterprise, enhances the ability of enterprises to manage the growing range of applications. **Enterprises should look to platforms designed as horizontal M2M/IoT application platforms** where many of the core application elements are reusable and managed from the

single platform. These reusable features should include integrations with device management, connectivity management, and service enablement.

7 Platform sustainability: Foundation and Building a Community.

The information economy is a large market. Software is one of the key elements driving ICT's role in the economy, and **the structure, competitiveness, performance of the ICT industry has potential to be strongly affected by Open Source Software**.

Open source software projects and communities around them have created software ecosystems where companies and individual developers join their efforts. Both companies and communities can benefit from these ecosystems. We think that building an **open source community and ecosystem is in itself a motivation** for companies and that the models should reflect that

Although the benefits of having OSS components available are well-known, their successful **reuse implies many challenges**. In the *"Open Source Ecosystems: Diverse Communities Interacting"* book authors identify the following main issues that should be faced to improve OSS components selection:

- **The rapid changes and growing nature of the OSS marketplace**. New components and technologies are continuously offered, but also new and improved versions of existing components are frequently released.
- **The lack of standards for describing OSS and huge of information diversity**.
- **The influence of Experience on the selection process**. There is a demanding need to effectively deal with the inherent subjectivity of the information.

OSS usage in small and large businesses is a widespread and ever-growing phenomenon. An Accenture survey (2010) on 300 blue-chip firms found that half of the respondents are fully committed to Open Source.

- **Quality and improved reliability are considered as the key benefits to Open Source programs**. A total of 70% of the surveyed businesses, in fact, cites improved reliability, and 69% says they are finding better security and bug fixing.
- **Cost reduction is another huge driver:** the 71% of the respondents, in fact, says they believed they could save in software maintenance costs; they also cite savings in total cost of ownership and development costs.

The key initiatives supported by the use of OSS are: data management and integration; application development, integration, architecture, governance and/or overhaul. Other key initiatives supported by OSS were business process improvement or re-engineering; security, risk and/or compliance; data center modernization and consolidation; and virtualization.

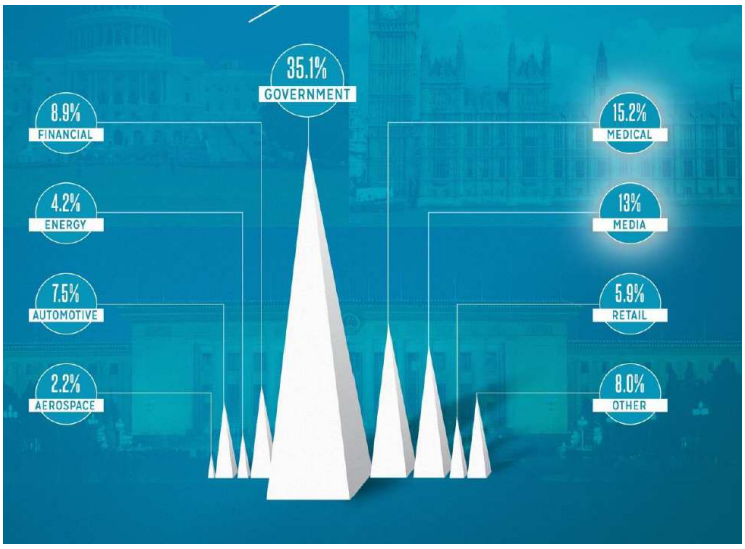


Figure 26: Industries adopting Open Source (source: BlackDuck)

The last few years have also seen the growth of services based around Open Source, services offered both by **Open Source software vendors and free software services companies in such emerging areas as cloud computing (IaaS, PaaS), social platforms and big data.**

The use of OSS products is considered as one of the main ways to leverage firms' costs and to **avoid the vendor-lock in caused by proprietary software.** In addition to their direct use, OSS components can also be reused **to develop other software systems**.

Despite offering significant potential, among which the most important is the reduction in time and cost of development, OSS use and reuse may cause some problems to the organizations and to the developers/integrators, which often stop them from exploring the opportunities offered by OSS.

Another problem that developers/integrators face is what we call the "asymmetric information issue". Selecting an OSS component, in fact, is very difficult, since **the OSS marketplace is very large, uncontrolled, and complex.** There exist, in fact, thousands of Internet web based search engines, that allow the **access to a large number of components but do not help developers/integrators in looking for all the information he often needs**, as inter-dependencies, standard descriptions of the components and trustworthiness of the component.

7.1 Open Foundation: The main vehicle to articulate the platform sustainability.

The results of the market research carried in this deliverable show that **the information economy is a large market, whose performance has been strongly affected by the advent of Open Source Software**. The users of OSS are very diverse and range from public bodies to small and big firms, passing through a vast amount of individual users.

In Europe, about a half of the companies use OSS and the main reason for choosing it is linked with a lower "total cost of ownership" and lower acquisition costs as the key advantages over commercial software. With reference to the public sector, too, the use of OSS is widespread, even if a large share of OSS users is often "unaware users". Either way, both in the private and in the public sectors there are concrete plans to increment the use of Open Source software systems in the next years, therefore highlighting a very positive trend for the future, supported also by a wide range of public policies in favor of OSS usage.

There is also an overlapping relationship between “developer” and “user”, where development and IT teams are using OSS solutions within their product or in-house portfolio, and the user communities themselves are contributing back to the code. **The sum of this dynamic sees a vast majority of IT-related organizations integrating OSS into key solutions of their portfolios - up to 95% in 2016 according to Gartner.**

To face the growing demand of OSS, the number of developers and integrators is constantly growing over time. Engagement in OSS development and integration has very different characteristics and motivations. OSS developers and integrators, in fact, range from single individuals with different kinds of expertise in the IT field, to firms of different sizes who decided to explore the OSS business for different purposes, ranging from pure economic reasons to questions related to the good opportunities linked with the involvement in the OSS community. We are now seeing a shift **from the single-vendor OSS strategy of old, to a more community focused model, allowing developers to leverage the talent reaching far outside their own organization.**

However, despite this growth, today **there still exist certain risks to address** while developing and/or integrating OSS:

- The necessity to check all the licenses types underlying an OSS, since improperly managed Open Source code could result in copyright infringement with legal and financial consequences;
- The difficulty in finding the right OSS component needed, and the difficulty in finding the correlations among different OSS in a variety of forges and other online sources;
- The long time needed to understand the OSS project structure and dependencies, in order to further use it as components for new Open Source or commercial solutions.

In order to support organization interacting with OSS solutions, initial supporting software and services foundation have launched in recent years, such as Apache, Eclipse, Debian and Openstack

7.1.1 Apache Software Foundation

The Apache Software Foundation (ASF) is a non-profit organization incorporated in the United States of America and was formed primarily to:

- Provide a foundation for open, collaborative software development projects by supplying hardware, communication, and business infrastructure
- Create an independent legal entity to which companies and individuals can donate resources and be assured that those resources will be used for the public benefit
- Provide a means for individual volunteers to be sheltered from legal suits directed at the Foundation's projects
- Protect the 'Apache' brand, as applied to its software products, from being abused by other organizations

Unlike other software development efforts done **under an open source license**, the Apache Web Server was not initiated by a single developer (for example, like the Linux Kernel, or the Perl/Python languages), but started as a diverse group of people that shared common interests and got to know each other by exchanging information, fixes and suggestions.

When the group felt that the person had "earned" the merit to be part of the development community, they granted **direct access to the code repository**, thus increasing the group and increasing the ability of the group to develop the program, and to maintain and develop it more effectively.

The Foundation structure

As the Apache Web Server started to grow in market share and popularity, due to synergy of its technical merit and to the openness of the community behind the project, people started to create satellite projects. **Influenced by the spirit of the community they were used to**, they adopted the same traditions of community management.

The foundation is governed by the following entities:

- Board of Directors (board) governs the foundation and is composed of members.
- Project Management Committees (PMC) governs the projects, and they are composed of committers. (Note that every member is, by definition, also a committer.)

The board has the faculty to terminate a PMC at any time by resolution.

- **Officers:** The Officers of the Apache Software Foundation oversee the day-to-day affairs of the Foundation. The officers are elected by the Board of Directors.
- **Roles:** The meritocracy enables various roles:
    - **User:** A ***user*** is someone that uses our software. They contribute to the Apache projects by providing feedback to developers in the form of bug reports and feature suggestions. Users participate in the Apache community by helping other users on mailing lists and user support forums.
    - **Developer:** A ***developer*** is a user who contributes to a project in the form of code or documentation. They take extra steps to participate in a project, are active on the developer mailing list, participate in discussions; provide patches, documentation, suggestions, and criticism. Developers are also known as ***contributors*.**
    - **Committer:** A ***committer*** is a developer that was given write access to the code repository and has a signed **Contributor License Agreement (CLA)** on file. They have an apache.org mail address. Not needing to depend on other people for the patches, they are actually making short-term decisions for the project. The PMC can (even tacitly) agree and approve it into permanency, or they can reject it. Remember that the PMC makes the decisions, not the individual people.
    - **PMC Member:** A ***PMC member*** is a developer or a committee that was elected due to merit for the evolution of the project and demonstration of commitment. They have write access to the code repository, an apache.org mail address, the right to vote for the community-related decisions and the right to propose an active user for committer ship. The PMC as a whole is the entity that controls the project, nobody else.
    - **PMC Chair:** The ***Chair*** of a Project Management Committee (PMC) is appointed by the Board from the **PMC Members**. The PMC as a whole is the entity that controls and leads the project. The Chair is the interface between the Board and the Project.
    - **ASF Member:** An ***ASF member*** is a person who was nominated by current members and elected due to merit for the evolution and progress of the foundation. Members care for the ASF itself. This is usually demonstrated through the roots of project-related and cross-project activities. Legally, a member is a "shareholder" of the foundation, one of the owners. They have the right to elect the board, to stand as a candidate for the board election and to propose a committer for membership. They also have the right to propose a new project for incubation (we'll see later what this means). The members coordinate their activities through their mailing list and through their annual meeting.

- **Project Management and Collaboration:** The Apache projects are managed using a collaborative, consensus-based process. We do not have a hierarchical structure. Rather, different groups of contributors have different rights and responsibilities in the organization. Since the appointed Project Management Committees have the power to create their own self-governing rules, there

is no single vision on how PMCs should run a project and the communities they host. At the same time, while there are some differences, there are a number of similarities shared by all the projects:

The Foundation Incubator

In order for new projects to be created, the ASF created a **project called Incubator which is responsible to help new efforts to join the foundation.**

Since the meritocratic rules operate across the ASF from bottom to top, it is vital for the long-term stability of such a form of government, that the initial set of committers has to know very well the dynamics of such a system, as well as share the same philosophical attitude toward collaboration and openness that the ASF expects from its projects. **The incubator is responsible for**:

- Filtering the proposals about the creation of a new project or sub-project
- Help the creation of the project and the infrastructure that it needs to operate
- Supervise and mentor the incubated community in order for them to reach an open meritocratic environment
- Evaluate the maturity of the incubated project, either promoting it to official project/ sub-project status or by retiring it, in case of failure.

It must be noted that the incubator (just like the board) does not perform filtering on the basis of technical issues. This is because the foundation respects and suggests variety of technical approaches. It doesn't fear innovation or even internal confrontation between projects which overlap in functionality.

The incubator filters projects on the basis of the likeliness of them becoming successful meritocratic communities. The basic requirements for incubation are:

- A working codebases, over the years and after several failures, the foundation came to understand that without an initial working codebase, it is generally hard to bootstrap a community. This is because merit is not well recognized by developers without a working codebase. Also, the friction that is developed during the initial design stage is likely to fragment the community.
- The intention to donate copyright of the software and the intellectual property that it may contain to the foundation, this allows the foundation to obtain an irrevocable and permanent right to redistribute and work on the code, without fearing lock-in for itself or for its users.
- A sponsoring ASF member or officer, this person will act as the main mentor, giving directions to the project, helping out in the day-to-day details and keeping contact with the incubator PMC.

The incubation period normally serves to estimate whether or not. The project is able to **increase the diversity of its committer base and to play with the meritocratic rules of the foundation.** It might seem rather easy to achieve, but it must be remembered that in a volunteer and highly selective environment, attracting new committers is not automatic. **Diversity of committer ship is important for two main reasons:**

- It gives long term stability to the project development: in fact, with all the developers affiliated to the same entity, the chance of seeing all of them moving away from the project at the same time is much greater than with a community of individuals affiliated to unrelated entities.
- It gives a greater variety of technical visions: something that guarantees a better adherence to environment and user's needs, thus a higher change of finding real-life use of the software.

Within the first 10 years of operation, the ASF represents one of the best examples of an open organization that has found balance between structure and flexibility.

- They have grown from 200 committers to around 3000, and that number continues to grow on a daily basis.
- They have been able to create several software products that are leaders in their market.
- They have also been able to find balance between openness and economic feasibility.

ASF´ Sponsorship

The Apache Software Foundation provides support for the Apache community of open-source software projects. The Apache projects are characterized by a collaborative, consensus based development process, an open and pragmatic software license, and a desire to create high quality software that leads the way in its field. They consider themselves not simply a group of projects sharing a server, but **rather a community of developers and users.**

The ASF provides the infrastructure for the projects - the mailing lists, code repositories, bug tracking systems, etc. While all of the administrative effort is currently through unpaid volunteers, they need financial assistance to purchase bandwidth and keep their servers running.

Sponsorship also shows your support for Open Source and provides you the opportunity to "give back" to the community. Finally, since the ASF is non-profit organization, sponsorship provides attractive tax benefits.

The Apache Software Foundation comprises over 100 top level projects, over 400 active members, over 2000 committers and countless contributors and users. They are responsible for millions of lines of code and the 35+ servers which make up our infrastructure. They also have the normal business operating expenses which go with any organization. These include:

- Bandwidth costs
- Servers and hardware
- Legal and Accounting
- Normal office expenses
- Marketing and PR
- Sub-contractors for administrative and secretarial duties

Funding will allow them to perform pro-active hardware procurement, enhance their community outreach, sponsor developer hackathons and user groups, and perform non-code related improvements to projects such as better documentation and more comprehensive websites

7.1.2 Eclipse Foundation: A Unique Model for Open Source Development

Eclipse is a community for individuals and organizations who wish to collaborate on commercially-friendly open source software. **Its projects are focused on building an open development platform comprised of extensible frameworks**, tools and runtimes for building, deploying and managing software across the lifecycle. The Eclipse Foundation is a not-for-profit, member supported corporation that hosts the Eclipse projects and helps cultivate both **an open source community and an ecosystem of complementary products and services.**

The Eclipse Project was originally created by IBM in November 2001 and supported by a consortium of software vendors. The Eclipse Foundation was created in January 2004 as an independent not-for-profit corporation to act as the steward of the Eclipse community. The independent not-for-profit corporation was created to allow a vendor neutral and open, transparent community to be established around Eclipse. Today, the Eclipse community consists of individuals and organizations from a cross section of the software industry.

The Eclipse Foundation is funded by annual dues from our members and governed by aBoard of Directors. Strategic Developers and Strategic Consumers hold seats on this Board, as do representatives elected by Add-in Providers and Open Source committers. The Foundation employs a full-time professional staff to provide services to the community but does not employ the open source developers, called committers, which actually work on the Eclipse projects. Eclipse committers are typically employed by organizations or are independent developers that volunteer their time to work on an open source project.

In general, the **Eclipse Foundation provides four services to the Eclipse community**:

- IT Infrastructure,
- IP Management,
- Development Process, and
- Ecosystem Development.

Full-time staffs are associated with each of these areas and work with the greater Eclipse community to assist in meeting the needs of the stakeholders.

- **IT Infrastructure:** The Eclipse Foundation manages the IT infrastructure for the Eclipse open source community, including Git code repositories, Bugzilla databases, development oriented mailing lists and forums, download site and web site. The infrastructure is designed to provide reliable and scalable service for the committers developing the Eclipse technology and the consumers who use the technology.

- **Intellectual Property (IP) Management:** An important aspect of Eclipse is the focus on enabling the use of open source technology in commercial software products and services. They consciously promote and encourage software vendors to use Eclipse technology for building their commercial software products and services. This is made possible by the fact that all Eclipse projects are licensed under the Eclipse Public License (EPL), a commercial friendly OSI approved licensed.

  The **Eclipse Foundation also undertakes a number of steps to attempt to ensure the pedigree of the intellectual property** contained within Eclipse projects.

  - The first step in the due diligence process is trying to ensure that all contributions are made by the rightful copyright holder and under the Eclipse Public License (EPL). All committers are required to sign a committer agreement that stipulates all of their contributions are their original work and are being contributed under the EPL. If a committee is sponsored to work on an Eclipse project by a Member organization, then that organization is asked **to sign a Member Committer Agreement to ensure the intellectual property rights of the organization are contributed under the EPL.**

  - The second step is that the source code related to all contributions which are developed outside of the Eclipse development process are processed through the Eclipse

Foundation IP approval process. This process includes analyzing selected code contributions to try to ascertain the provenance of the code, and license compatibility with the EPL. Contributions that contain code licensed under licenses not compatible with the EPL are intended to be screened out through this approval process and thus not added to an Eclipse project. **The end result is a level of confidence that Eclipse open source projects release technology that can be safely distributed in commercial products**.

- **Development Community Support:** The Eclipse community has a well-earned reputation for providing quality software in a reliable and predictable fashion. This is due to the commitment of the committers and organizations contributing to the open source projects. The Eclipse Foundation also provides services and support for the projects to help them achieve these goals.

  The Foundation staff help implement the Eclipse Development Process. This process **assists new project startup and ensures that all Eclipse projects are run in an open, transparent and meritocratic manne**r. As part of this process, the Foundation organizes member community reviews for projects to ensure consistent interaction between the projects and the broader membership.

  The Eclipse community organizes an annual release train that provides a coordinated release of those Eclipse projects which wish to participate. The release train makes it easier for downstream consumers to adopt new releases of the projects because 1) all the projects are available on the same schedule, so you don't have to wait for independent project schedules, and 2) a level of integration testing occurs before the final release to help identify cross project issues.

- **Ecosystem Development**: A unique aspect of the Eclipse community and the role of the Eclipse Foundation are the active marketing and promotion of Eclipse projects and wider Eclipse ecosystem. **A healthy vibrant ecosystem that extends beyond the Eclipse open source community to include things like commercial products based on Eclipse**, other open source projects using Eclipse, training and services providers, magazines and online portals, books, etc, are all key to the success of the Eclipse community.

  To assist in the development of the Eclipse ecosystem, the Eclipse Foundation organizes a number of activities, including **co-operative marketing events with Member companies, community, online resource catalogs** (Eclipse Marketplace and the Eclipse YouTube Channel), bi-annual Members meetings and other programs to promote the entire Eclipse community.

The Eclipse Foundation has been established to serve the Eclipse open source projects and the Eclipse community. As an independent not-for-profit corporation, the Foundation and the Eclipse governance model ensures no single entity is able to control the strategy, policies or operations of the Eclipse community. **The Foundation is focused on creating an environment for successful open source projects and to promote the adoption of Eclipse technology in commercial and open source solutions.** Through services like IP Due Diligence, annual release trains, development community support and ecosystem development, the Eclipse model of open source development is a unique and proven model for open source development.

7.1.3 Debian

The Debian Project is an association of individuals who have made common cause to create a free operating system. **This operating system that we have created is called Debian.**

Debian was begun in August 1993 by Ian Murdock, as a new distribution which would be made openly, in the spirit of Linux and GNU. Debian was meant to be carefully and conscientiously put together, and to be maintained and supported with similar care. It started as a small, tightly-knit group of Free Software hackers, and gradually grew to become a large, well-organized community of developers and users. Available in 70 languages, and supporting a huge range of computer types, Debian calls itself the "universal operating system".

An operating system is the set of basic programs and utilities that make your computer run. **At the core of an operating system is the kernel.** The kernel is the most fundamental program on the computer and does all the basic housekeeping and lets you start other programs.

- **Debian systems currently use the Linux kernel or the FreeBSD kernel.** Linux is a piece of software started by Linus Torvalds and supported by thousands of programmers worldwide. FreeBSD is an operating system including a kernel and other software.
- A large part of the basic tools that fill out **the operating system come from the GNU project;** hence the names: GNU/Linux, GNU/kFreeBSD, and GNU/Hurd. These tools are also free.

Debian comes with over 37500 packages (precompiled software that is bundled up in a nice format for easy installation on your machine), a package manager (APT), and other utilities that make it possible to manage thousands of packages on thousands of computers **as easily as installing a single application. All of it free**.

- Although Debian believes in free software, there are cases where people want or need to put non-free software on their machine. Whenever possible Debian will support this. There are even a growing number of packages whose sole job is to install non-free software into a Debian system.
- Debian will run on almost all personal computers, including older models. Each new release of Debian generally supports a larger number of computer architectures. For a complete list of currently supported ones, see the documentation for the stable release.
- Almost all common hardware is supported. If you would like to be sure that all the devices connected to your machine are supported, check out the Linux Hardware Compatibility HOWTO.
- Debian is produced by almost a thousand active developers spread around the world who volunteer in their spare time. Few of the developers have actually met in person. Communication is done primarily through e-mail (mailing lists at lists.debian.org) and IRC (#debian channel at irc.debian.org).

Debian is made collaboratively by many people spread around the world. Packaging work is usually contributed by both Debian Developers (DD) (which are full members of the Debian project) and by Debian Maintainers (DM). Here you can find both the list of Debian Developers and the list of Debian Maintainers, together with the packages they maintain.

The Debian Project consists of volunteers, and we are generally looking for new developers who have some technical knowledge, an interest in free software, and some free time.

7.1.4 Open Stack: Open source software for creating private and public clouds.

Open Stack is an open source collaborative project addressing to companies, cloud providers, research community, open source collaborators and developers, to build and manage public and private clouds. It consists of several projects each aimed to provide different types of resources such as: compute, storage and networking. Apart from those, Open Stack facilitates an authentication and user access component, as well as a portal for easy access and visual management of the cloud resources.

Founded by Rack space Hosting and NASA, Open Stack has grown to be a global software community of developers collaborating on a standard and massively scalable open source cloud operating system. The objective is to provide a ubiquitous tool and standard hardware for organizations and private entities to create data centers and deploy their large-scale cloud infrastructure and services.

Open Stack is released under the Apache 2.0 license to boost further collaboration and innovation in open source code for a global cloud computing ecosystem. Moreover it provides Open Stack APIs standards and after its appearance it has become the largest open source project in less than a year period. Just for illustration, when it appeared, the Open Stack community registered 217 active developers and 80 contributing companies by the end of June 2010. Now, Open Stack community has collaborated with more than 150 companies and 2600 people registering a further increasing potential

In July 2010, cloud infrastructure developer Rackspace® and NASA opened their code bases under the name Open Stack™ to provide an open source operating system that provisions and manages large cloud infrastructures that include virtual machines. Users benefit from a redundant and scalable platform on which to build their private, public, or hybrid clouds.

Because Open Stack is open source, Telco and hosters don't have to lock into a single, proprietary vendor strategy. In fact, they are able to point their own technicians and developers at creating a cloud infrastructure that delivers differentiated IaaS offerings that fit their own business model. For example, they can hook Open Stack into their data center environment and billing systems.

Open Stack provides an open and extensible operating environment for cloud infrastructure that offers:

- **Modular design**: Open Stack is a collection of separate modules or services all under the same umbrella. These services can be used to create pools of processing, storage, and networking resources, all managed through a dashboard that gives administrators control while empowering users to provision resources through a Web interface. Although the component modules are designed to work together, you are free to choose only the components you need.
- **Public roadmap**: Open Stack software releases are named alphabetically: Austin was first, followed by Bexar, Cactus and so on, with the Juno release planned for October 2014. The roadmap is aggressive, with a new release every six months. Each release typically includes new features and new modules, and may include projects in "incubation" for future releases.
- **Packaged distributions:** The analogy between Open Stack and Linux extends to include a very similar distribution model. Just as companies such as Red Hat and SUSE created packaged Linux distributions, a dozen or more Open Stack providers, including Red Hat, SUSE, Mirantis, Rackspace, and Metacloud, are creating packaged versions of Open Stack.
- **AWS compatibility:** Many of the various services that Open Stack provides compute, storage, networking, and so on are API compatible with their equivalent AWS capabilities. If you have an application that runs on AWS, you can run the application in any Open Stack environment, including your on-premises data center

Open Stack is proven software that is currently being used by a growing number of enterprises, service providers, VARs, research institutions, and other organizations deploying large-scale cloud computing operations. It is fully multi-tenant to support IaaS and other cloud models and can scale to thousands of compute nodes. Multiple network models block storage options, and hypervisors are supported. A six-month community-supported development cycle adds new features.

Open Stack software controls large pools of compute, storage, and networking resources throughout a datacenter, managed through a dashboard or via the Open Stack API. Open Stack works with popular enterprise and open source technologies making it ideal for heterogeneous infrastructure.

Hundreds of the world's largest brands rely on Open Stack to run their businesses every day, reducing costs and helping them move faster. **Open Stack has a strong ecosystem, and users seeking commercial support can choose from different Open Stack-powered products and services in the Marketplace**.

The software is built by a thriving community of developers, in collaboration with users, and is designed in the open at our Summits.

- Open Stack has an Open and Transparent Governance model, and welcomes your feedback.
- Open Stack also has an Ambassador Program, with representatives around the world: Marcelo Dieder, Erwan Gallen, Tristan Goode, Akihiro Hasegawa, Kenneth Hui, Márton Kiss, Ye Lu, Kavit Munshi, Kavit Munshi, Sean Roberts, Michael Still and Akira Yoshiyama.

Today, with over 189 organizations and over 9,100 individuals participating, Open Stack 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.

Market Monitor service expects total **Open Stack related revenue to break the $1bn barrier by 2015**. While revenue overwhelmingly comes from the service-provider space, an uptick in revenue is expected from all sectors, especially from Open Stack distributors and turnkey products serving primarily enterprises.

- **Service providers, companies that host private and public cloud platforms based fully or in part on the Open Stack architecture and its APIs**, provide the majority of Open Stack revenue. Rackspace alone accounts for approximately 65% of our total Open Stack 2014 market share. As competition increases and more sophisticated users embrace distributors to build their own Open Stack clouds, we are forecasting a decline in Rackspace's overall share. Among the other service provider are 99Cloud, AMAX Information Technologies (CloudMax), Aptira, Blue Box, Coraid, DreamHost, eNovance, Ensim, Globe Telecom, HP, IBM, Internap, iWeb, KIO Networks, Media Temple (Go Daddy), Newvem (Datapipe), OVH, United Stack, VEXXHOST and VMUnify.
- **The Open Stack distributors** are the next largest sector in terms of overall revenue $119m by 2015. As they did with Linux throughout the last decade, enterprises are increasingly engaging vendors with a supported version of Open Stack rather than opting to consume the source code directly. The largest Linux distributors have all announced supported Open Stack distributions. Among this group are Red Hat, SUSE and Canonical, as well as Spanish startup Stack Ops.

Given that it is viewed as a viable platform for continuous integration, **continuous deployment and devops, Open Stack is also leveraged as the IaaS for PaaS.**The pressure on enterprise organizations to iterate and deploy software and services faster forces a dramatic change in approach in both process and technology **opening the door for Open Stack**. Organizations seeking continuous integration and continuous deployment processes, widely known as devops, view Open Stack as an ideal technology and ecosystem to support it.

7.2 Building a Community

Basics of Community Building

It is a challenge to establish a project community. All communities start with users, attracted by the software's packaging and branding, or word–of–mouth recommendations. A real community building can happen and take place from the moment the platform/system is ready, presentable, and usable. **The first step must be the identification of target groups**. At this stage, two possible communities are foreseen:

- **A community interested in using the platform**. A concrete example here is an institution interested in open source software development by reuse of existing components and therefor to solve the compatibility problem of different license usage.
- **A community interested in providing a platform service to the public** and further developing the operating system or building some added value services on top of it. This category includes consulting and support enterprises, software forge providers, as well as Research and Development institutions willing to use the platform for their own business, research, and development activities.

The task is tightly related to other activities including dissemination, exploitation and validation workshops. Depending on which of those communities come into closer consideration for the final community building, or in which direction the project wants to go, the strategies of community building will differ, as is shown in the following chapters.

Supporting Tools

By using software forge coordinated designing, programming, testing, documenting, commenting and reviewing of platform open source software is supported on different platform communities. Typically, software forges provide the following features which foster the building of platform communities:

- **Issue tracker support the reporting of bugs and the tracking of following error correction process**. Furthermore, requests for support and for implementation of additional missing features are possible, as well as software patches to correct bugs, or change or improve functions can be proposed
- **Software repositories with version control capabilities**. This software control management tools allow simultaneous programming and the releasing of conflicts that occur when the same source files to be processed. Furthermore, SCM tools allow to get the current state of platform development, as well as to restore older software versions which are needed to reproduce and understand reported bugs.
    - A document management system for collaborative, distributed creation of documents on software design and architecture, manuals about software installation and usage, and scientific papers for conferences and workshops.
    - Provision of screenshots and demonstration material to convey the look and feel of the platform/ software system
    - Management and deployment of software releases to show the respective progress of platform software development and to provide an executable version available to potential users.
    - Mailing lists to support asynchronous communication within the distributed community of developers, but also between developers and early involved users (like testers and reviewers) or subsequent service providers of the platform software system to be developed.
    - Forums to support and structure themed discussions within the developer community, but also between developers and early involved users (like testers and reviewers) or subsequent service provider of the platform software system to be developed.
    - Task management allows the planning and arranging of development tasks, as well as the tracking of the current state of platform development.

It should be noted that the **use of a software forge is a precondition** for the formation of different platform communities.

- On the one hand, the cooperative software design, development, distribution and documentation is supported in the distributed platform developer community.

- On the other hand, potential users as well as service providers are involved in the process at every stage of platform project development, which the community-building process significantly drives.

Additionally, **in the software world, developers are considered vital to the health of platforms, of which they have several to choose from**. Platform owners have to work very hard to make sure their SDKs and tools are easy to use. **Too much friction, too little documentation or too steep a learning curve can drive developers away**.

Use of Social Networking to foster Community Building

An essential part of fostering a community building process is to generate attention for the new platform/ system with its main functions. The channels to attract users for platform/ system and services are social networks, such as Facebook, Google+, Twitter, LinkedIn, etc. Therefore appropriate sites and groups for the platform/ system and services in the relevant social networks should be established.

The purpose of this task is to define a strategy for a community building process of users of the publicly offered Platform/System services. A typical Platform/System service user is an institution interested in open source software development by reuse of existing components and therefor to solve the compatibility problem of different license usage.

- **Platform/System target users, use purposes and usage scenarios :** The section identifies the target categories of users for the Platform/System system, purposes for which it can be used and proposes corresponding usage scenarios.

- **Identification of potential Platform/System service providers:** Identify potential institutions or enterprises who are interested in exploitation of FI WARE results. Examples of these institutions and enterprises are:
  - Consulting & Support: Black Duck Software, Bull, O'Reilly, OpenLogic, etc.
  - Open Source Distributors: Red Hat, SUSE, Ubuntu, Debian, etc.
  - Software Forges: Sourceforge, GitHub, Google Code, CodePlex, LaunchPad, OW2, etc.
  - Research & Development: ATOS, Engineering

Since the project is still on an early stage it can significantly benefit from collecting user feedback and requirements. Usability workshops should be organized where the functionality of the Platform/System is presented and suggestions for improvements from potential service users are collected. Besides workshops further presentations should be performed in online tutorials as well as feedback should be collected by online surveys.

7.3 Incorporate Open Data for fostering Innovation and promote Network Effect

Open data provides an unprecedented opportunity for innovation around transparent, evidence-based decision making, public engagement and trust. Just as importantly, it also facilitates more efficient government with each department or agency better able to reuse data collected and managed by their colleagues. Public sector information (PSI) may be offered as "open data" in many forms and through different media: from simple datasets describing traffic or unemployment, to Web services linking and mashing information from different sources, to interactive visualisation of complex phenomena, to citizen-based data gathering and transmission. Through these different channels, **new information is made available across the public and private sectors, to scientists, citizens and enterprises, all of whom are then able to benefit from each other's activities in a growing network effect:**

- Uses of open data within government for innovation and efficiency proving the value of open data within the public sector;
- Improvement in public service delivery;
- Examples of open data utilization for policy making purposes;
- New approaches for public sector information processing and visualization;
- Open data and citizen participation in information gathering / crowdsourcing;

Open innovation is also an important aspect in the Future Internet evolution. It is becoming apparent that open relationships between customers, partners and even competitors can stimulate innovation that would otherwise be constrained by the organizational boundaries. **Open Data is core to establishing this Trust ecosystem for innovation.**

According to Mckinsey report, when the **government and other stakeholders release data**, they help companies, agencies, and individuals to develop innovative apps, products, and services or improve existing offerings. Consider a **few examples of companies that rely on open data** for their success:

- The Climate Corporation employs open data to create various tools, including weather monitoring and yield-forecasting products, which farmers use to make decisions such as where and when to plant crops.
- Propeller Health, a private company, has benefited from access to data from the US Centers for Disease Control and Prevention (CDC). It created a GPS-enabled tracker that monitors inhaler usage by asthmatics.
- The UK-based website findthebest.com used open data from the government to create the UK Car Fuel Economy and Emission App, which helps car buyers compare features such as fuel economy based on their type of commute.
- Emergency-room physicians created iTriage, a mobile app that helps patients understand their symptoms, locate nearby health facilities or physicians, and book appointments.
-

Many businesses are now creating innovative products and services based on Open Data. Other companies may be more inclined to use Open Data if they see the economic potential.

8 THE EUROPEAN POLICY OPPORTUNITY

The speed of growth from the App Economy and the breadth and depth of wider economic and social benefits in Europe, as well as European competitiveness, **will depend on the policy environment in Europe**. Europe has **a strong base to build on in terms of an established ecosystem of apps developers**, comparatively high levels of smart device take-up, high household penetration of Wi-Fi and an accelerating transition to LTE. However, to realize the full benefits, and to become global leaders in the App Economy, **Europe will need to get the right and common regulatory framework in fast moving industry sectors**

In this chapter we discuss, the **five policy pillars** to maximize the economic and social benefits of the current fragmented European apps ecosystem that have been identified by Vision Mobile Research.

8.1 Developer Access to European Government data sets

Data held by European governments can support the development of innovative apps that increase the value of such data for citizens and potentially reduce the cost of government service provision. Examples include **mapping, meteorological and real time public transport data, as well as information on schools, education and other community-level services**

Making data available in Europe has a number of benefits:

- App developers have technical expertise and are better placed than governments or public agencies to provide innovative services based on government data.
- Apps extend the ways in which data can be used, and ensure it is available in an appropriate form on mobile devices.
- By making data available rather than putting resources into developing information services, governments may reduce costs while also enhancing service.

To deliver on this vision the following are required:

- Access to government data in a machine readable format with appropriate application programming interfaces (APIs)
- Free non-exclusive access to encourage innovation and competition

Several initiatives to make government information available have been established, notably in the US and some European countries. These initiatives need to be accelerated and extended throughout Europe.

8.2 Completing the European Single Market

Europe has always excelled at innovation. Radio, television, and the standard for second-generation mobile communications, GSM, all are originated in Europe. But past success won't ensure Europe's long tradition of innovation continues. New technologies require more risk-taking and the ability to launch new products with speed and scale. There is no doubt that Europe is poised to embrace the new, digital world but at the same time, **Europe needs to reform and forge a true digital single market** for pan-European Big Data Value services and Applications, based on the following:

- Apps work across borders, networks and devices and thus contribute to a single market.
- Apps open up new markets, compete with existing services, drive innovation and widen choice for consumers and enterprises.

- European and national regulations will have been adapted to the needs of the data-driven economy and society.
    - A modern, **robust and flexible intellectual property rights framework** for handling complex issues related to ownership and licensing in combination with standards and knowledge based approaches will have **facilitated the interoperability and the exchange of data across Europe.**
    - A truly modernized legal framework will have been provided for a **high level of data protection** while leaving sufficient flexibility to business and innovation.

This will give European entrepreneurs, who have all the right building blocks, **the incentive to invest and the ability to achieve global scale at greater speed**. Significant political will needs to be mustered to support these changes and **ensure Europe's startups succeed.**

If Europe's single market becomes truly and thoroughly digital, the macroeconomic benefits would be enormous. **Europe's digital businesses no longer would have to get individual licenses to operate in 28 different countries**. If regulatory barriers are removed, startups could directly access half a billion European consumers, a market that's larger than the US, where technology companies have the ability to achieve scale before they expand internationally.

Imagine if the **vibrant European entrepreneurial scene could benefit from a digital single market**, which would end the need for obtaining different national licenses and reduce regulatory red tape. High-growth firms and technology-intensive startups suddenly could scale-up and compete more vigorously in the global marketplace.

8.3 Embracing Innovation throughout the EU Economy

Regulation should be appropriate, thoughtful and, above all, **supportive of app-enabled innovation**. Regulations should be reappraised and adapted, sector by sector, to ensure that individuals, firms and **society can benefit from app-driven innovation in every sector and industry**.

Europe has an opportunity in these and other areas to adopt appropriate frameworks that jump start the App Economy. Where regulations may be required (e.g. for health and safety reasons), a multi stakeholder co-regulatory approach should be preferred to ensure that the development of new innovative uses is not hindered.

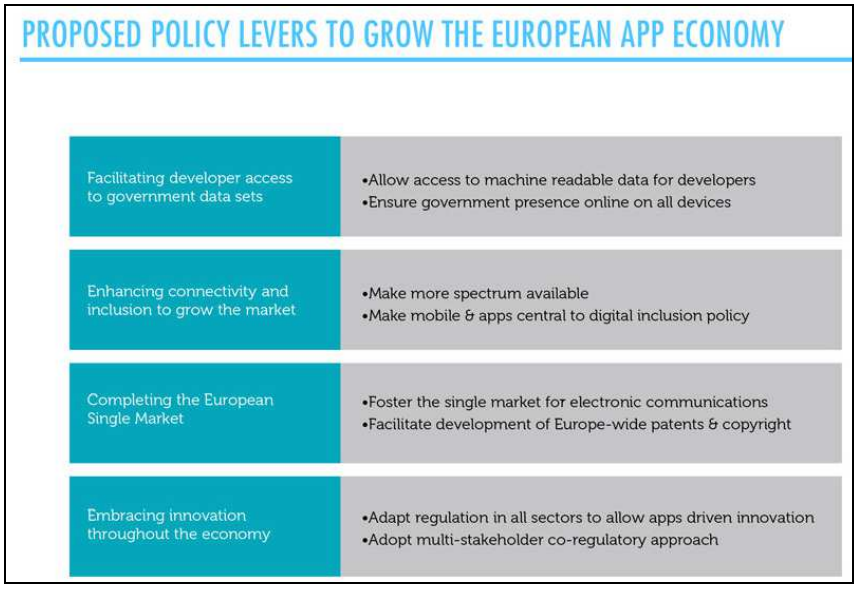
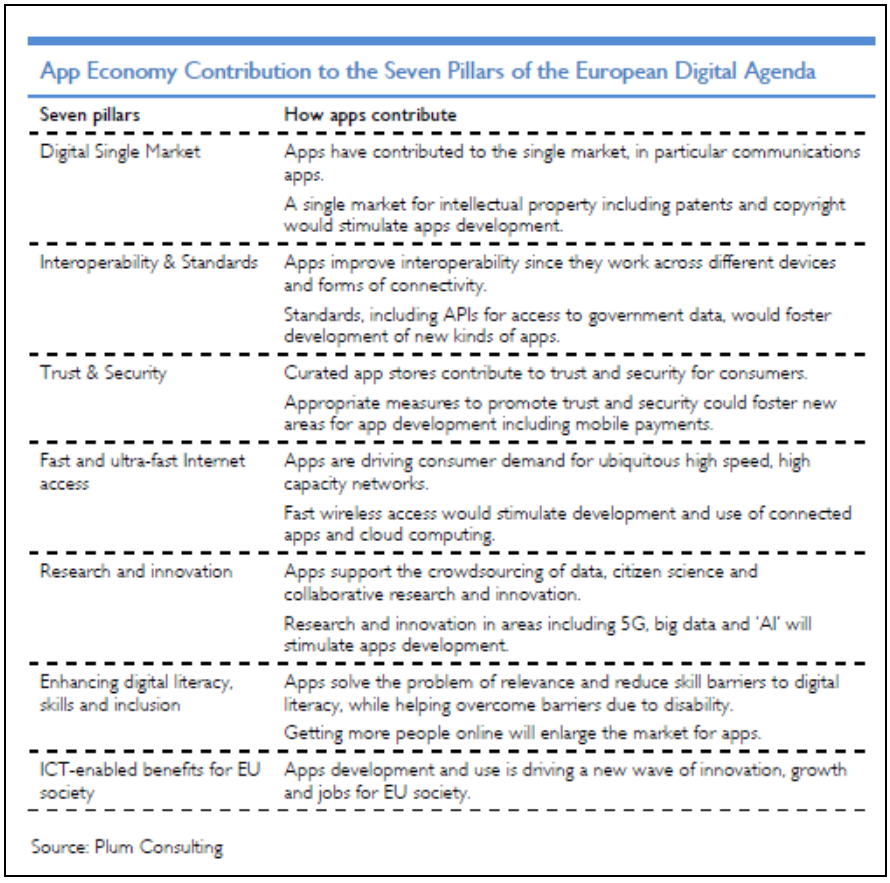


Figure 27: Proposed Policy levers to grow the European App Economy. Plum Consulting

8.4 Contributing to the European Digital agenda

The Digital Agenda for Europe includes seven policy pillars aimed at enhancing the role of the digital economy in Europe and helping achieve the Lisbon agenda for growth and jobs. Below we illustrate ways in **which the apps ecosystem is contributing to the seven pillars**, and the ways in which delivering the seven pillars can stimulate the apps ecosystem



App Economy Contribution to the Seven Pillars of the European Digital Agenda

Seven pillars	How apps contribute
Digital Single Market	Apps have contributed to the single market, in particular communications apps. A single market for intellectual property including patents and copyright would stimulate apps development.
Interoperability & Standards	Apps improve interoperability since they work across different devices and forms of connectivity. Standards, including APIs for access to government data, would foster development of new kinds of apps.
Trust & Security	Curated app stores contribute to trust and security for consumers. Appropriate measures to promote trust and security could foster new areas for app development including mobile payments.
Fast and ultra-fast Internet access	Apps are driving consumer demand for ubiquitous high speed, high capacity networks. Fast wireless access would stimulate development and use of connected apps and cloud computing.
Research and innovation	Apps support the crowdsourcing of data, citizen science and collaborative research and innovation. Research and innovation in areas including 5G, big data and 'AI' will stimulate apps development.
Enhancing digital literacy, skills and inclusion	Apps solve the problem of relevance and reduce skill barriers to digital literacy, while helping overcome barriers due to disability. Getting more people online will enlarge the market for apps.
ICT-enabled benefits for EU society	Apps development and use is driving a new wave of innovation, growth and jobs for EU society.

Source: Plum Consulting

Figure 28: App Economy Contribution to the Seven Pillars of the European Digital Agenda. Visio Mobile.

8.5 Policy and Regulation Priorities for the development of Future Internet

The Future Internet gives rise to a wide range of new challenges regarding policy, regulation and governance. Making 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.

Based on these envisaged Future Internet impacts the following **priorities have to be worked in the domain of policy and regulation.**

- **Policy and regulatory issues**: Emerging frameworks for policy and regulatory conditions such as interoperability, openness, standards, security and privacy
    - **Europe is, however, lagging behind other regions in the take-up of cloud computing**. Moreover, due to a lack of regulatory consistency and due to policies which are technologically conservative, cloud computing in Europe remains fragmented, at times making it difficult for European citizens and businesses to reap the full benefits that the cloud undeniably offers
    - In this **context, data ownership is a major concern that could provide serious gaps across European countries** depending how national regulation processes are supporting the deployment of new technologies. Additionally, data is stored, distributed and analyzed globally rather than locally, with no clear jurisdiction or established regulatory framework to deal with any disputes
    - Data stored in cloud-based systems are vulnerable for **privacy breach** e.g. tracking down individuals. **Establish rules that balance respect for data privacy** with flexibility to support innovation
    - While there are already many public administrations offering Open Data, there are several obstacles that prevent a wide use of Open Data, such as poor data quality, privacy risks and deployment limitations. **Increase access to data held by public authorities and the private sector**
    - **Ensure global data flows** : Creating a 'Fortress Europe' for data will limit the potential for growth and innovation. The European Union and the United States must redouble efforts to work out common standards for the handling of personal data that allow for the free exchange of data. These standards should cover open data and anonymisation, among other issues. **Step up efforts to agree common EU-US standards** for the handling of personal data.
    - **Platform Neutrality**: issues of cross-platform interoperability, data portability, lock-in/lock-out for users, suppliers, competitors are quite parallel
- **Ensuring the impact of Future Internet and create the appropriate Ecosystem**: shaping SME involvement, entrepreneurship and incubation activities.
    - Develop approaches and **policies to stimulate web-entrepreneurs,** working with the web-entrepreneurship initiative

- Regarding the intellectual property there **are two European policy requirements** to address:
  - **Protection of the intellectual property of app developers** to ensure that they are prepared to invest in risky new ventures, and to foster an environment conducive to innovation, creativity and consumer trust.
  - **Copyright, trademarks and patents ought to apply throughout Europe on a common basis**. Application developers need ways of utilizing and paying for content rights throughout Europe without having to incur costs in agreeing rights on a country-by-country basis
- **Additionally, a thriving startup ecosystem relies on easy access to capital**. Europe needs tax incentives and other proactive measures that make it easier for startups to get funding. Governments should think carefully about the balance between driving growth and taxing capital.

8.5.1 Cloud Computing: A Trusted European Cloud

Europe is, however, lagging behind other regions in the take-up of cloud computing. Recent revelations about intelligence services surveillance of **data have the potential to harm trust in cloud-based solutions**. Moreover, due to a lack of regulatory consistency and due to policies which are technologically conservative, cloud computing in Europe remains fragmented, at times making it difficult for European citizens and businesses to reap the full benefits that the cloud undeniably offers

Existing cross-border 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**. A more robust regulatory regime delineating how data is handled and released is needed. European cloud strategy should come with common data privacy and management regulation. **In addition to the debate regarding digital privacy legislation, the European Commission created the European Cloud Partnership** last year as part of a broader strategy to promote cloud computing. It is important that privacy and data protection issues are part of it.

The need to support an efficient EU wide single market for cloud services, based on best practices, a common understanding of regulatory requirements and the most effective way of meeting the needs of specific cloud use cases. Achieving this goal requires actions from a variety of stakeholders, including the elimination of regulatory and market access barriers at both national and EU level, but also the identification and promotion of best practices by industry in respect of applicable laws, technical standardization and operational assurances. In this way, a single market for cloud services will be supported, generating benefits for all European stakeholders:

- **On the demand side, European cloud users** (citizens, businesses including SMEs and public administrations) will be able to choose and use cloud services with confidence, knowing that they adhere to European legal norms and international standards, and that data in such clouds is secure.
- **On the supply side, cloud providers** will be able provide their cloud services to European customers, without hindrance from national regulatory barriers

The European cloud market is currently confronted with a significant number of regulatory and market access barriers that impede both development and commercial exploitation by cloud providers and adoption by cloud users, especially for cross border use cases. Some of these regulatory and market access barriers are linked to legal issues, whereas others are principally tied to trust concerns, technical control, or operational requirements.

- Privileged information can be protected by legal frameworks that stop cloud adoption or limit use cases. Significant benefits could be realized through **trusted cloud solutions**.
- The **lack of full EU harmonization of data protection** rules is a recurring legal barrier.
- Even outside of formal laws, norms may exist (issued by supervisors, regulators, sector organizations etc.) which stop or **discourage the use of cloud services outside national borders**.
- **Cloud adoption barriers can vary from sector to sector**. Legacy legal frameworks that are not adapted to the global market can cause legal challenges, and operational/business concerns may lead to a strong preference for private clouds

From a European perspective, there is the dual risk that excessively restrictive regulations can place European cloud service providers at a clear competitive disadvantage in relation to their non-European counterparts, and inversely that overly flexible rules could result in serious harm to end users. Ambiguities in the law should at any rate be identified and addressed to ensure that the legal status of cloud computing services and the rights and obligations of each of the stakeholders is clear, especially when **dealing with security and privacy concerns**.

Existing cross-border 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.** A more robust regulatory regime delineating how data is handled and released is needed. **European cloud strategy should come with common data privacy and management regulation**.

Additionally, **Trust and consequentially security concerns** are one of the top obstacles that hinder Cloud Computing adoption today. **Cyber-security, data sovereignty and consistent procurement processes** are among the issues holding back wider adoption of cloud computing and services, according to a survey on the Trusted Cloud Europe. This is linked to implementation of the **European Cybersecurity Strategy and issues such as identity and access management,** certification, research and innovation, and SME needs.

The **Trusted Cloud Europe framework aims to support a single market for cloud computing in Europe based** on a common understanding of best practices which will enable Europe to become a trusted leader in cloud computing, as both a provider and user of cloud services. **Specific recommendations** directed by the Board towards different stakeholders (i.e. Member States, industry, the Commission) include:

- Creation of **a common framework of legal, operational and technical best practices**
- Review of **formal data location requirements** (that currently still divide cloud architectures up by national jurisdiction) with the aim of replacing them by functional requirements to ensure the same data accessibility and security
- **Encouraging public bodies to consider cloud computing** when procuring IT systems.

8.5.2 Big Data: One step closer to Europe's future privacy rules let it be a win-win for citizens and businesses

Nowadays a huge amount of data is collected, sometimes without a defined outcome of quantifiable value for either consumers or businesses. **The Internet of Things concept, leveraging data gathered by sensors** embedded in countless devices, potentially enhances the richness of information that can be generated from transactional platforms. These different sources of data are being processed more easily 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.

The abundance, pervasiveness and reproducibility of data will intensify the **debate on data ownership and usage, data protection and privacy, security, liability, cybercrime, Intellectual Property Rights (IPR) and the impact of insolvencies on data rights**. Legal regimes are challenged by these developments on

many levels with an effect on civil and criminal as well as European and international laws. In order to keep pace with these cutting-edge changes, **legislators have to become active and adapt the respective laws and legal practices to a new data-driven global environment**.

In the next years, the collection, storage, analysis and usage of personal data will increase. This development will have an effect on all levels of society and influence many parts of our everyday life. However, **without trust in privacy policies of businesses and administrations as well as appropriate data protection rules in place**, benefits from using Big Data will be more difficult to materialize. **A legal framework is needed that provides for a high level of data protection** for data suppliers and users while leaving sufficient flexibility to researchers and companies.

An increasing number of companies, established global players, SME's and start-ups build their **business models on using and selling data** in raw or augmented form, or even data analysis algorithms. New legal models need to be developed to identify, evaluate and protect ownership of the data itself and the intellectual property associated with it.

In this context, **data ownership is a major concern** that could provide serious **gaps across European countries depending how national regulation processes** are supporting the deployment of new technologies. Additionally, **data is stored, distributed and analyzed globally rather than locally,** with no clear jurisdiction or established regulatory framework to deal with any disputes. Some of the concerns in relation to use of data are the following:

- 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.
- Access to Open Data. There are many risks involved around Open Data and their potential use, and this may form a specific policy and regulation issue for both national policy actors and the European Commission providing European guidelines and common understanding on what are the opportunities and potential negative implications are, and to stimulate best practices regarding the use of Open Data including handling of privacy aspects.
- Data and privacy breach. Data stored in cloud-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.

Work is to be done on developing changes in regulatory **frameworks regarding Data Protection ensuring a single set of rules applicable across the EU** and clear rules on when EU law applies to data controllers outside the EU. Here we see two main aspects.

- The first is the review of the EU data protection regulatory framework. The Data Protection Directive[4] is a European Union directive which regulates the processing of personal data within the European Union, with a view to enhancing individuals' confidence and strengthening their rights and the aim of harmonizing the current data protection laws in place across the EU member states. The fact that it is a "regulation" instead of a "directive" means it should be directly applicable to all EU member states without a need for national implementing legislation. Some of the aspects to take into account are:
    - A **clear definition of personal data** is imperative in order to distinguish personal and non-personal data.

[4] Officially Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data.

- Moreover, the inference of identity out of **aggregated data coming from different sources** has to be considered as well in the regulation (currently it is not).
- The **international dimension** is also a very important one since users share data without taking into account national boundaries.
- Additionally, this **directive must be used or revised to include Internet of Things subject. 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. European Union should be flexible to avoid any breakthrough with regulation on this topic in Europe and in other areas around the world.
- The regulatory **framework should cope with the evolving market structure moving from a traditional regulatory framework to a more global one encompassing all ICT related players and services**

- The second addresses the review and update of the 2003 Directive on Re-Use of Public Sector Information (PSI). The update of the PSI Directive has the objective to achieve a Europe-wide consensus in making PSI readily available, which would help bridge the current gap between member states' levels of openness regarding non-personal data that is produced, stored, or harvested by the public sector.
  - **The envisaged PSI update requires European national governments to provide access to all PSI data** ranging from digital maps to weather data to traffic statistics at zero or marginal cost. Also new is the explicit inclusion of cultural institutions, such as museums, libraries, and archives. The expected effect of this new set of guidelines is also to stimulate economic development (EPSI platform, 2013).

In this respect, **it is critical to design a European Data Environment,** capable of amplifying positive externalities and to minimize negative externalities. For this purpose, **individual privacy and public security concerns** must be addressed in order to **convince governments and societal actors to share data more openly,** not only in the public domain but sharing in a restricted manner with other governments or international entities.

So the European Union is soon to implement the **General Data Protection Regulation (GDPR),** which will bring **all 28 countries under a single regime of rules, and penalties for breach**. This is perhaps the greatest opportunity that cloud providers will have seen a chance **to deliver EU wide services under one single operations model.** The purpose of the GDPR is to provide a single law for data protection to cover the whole of the EU. As a Regulation, rather than a Directive, there will be one single set of rules regarding data protection and individual countries will not have the freedom to make choices. As soon as the regulation is passed, each of its provisions will become part of the national legal system of each EU Member State, "as is".

The GDPR will thus make it easier for both European and non-European companies to comply with data protection requirements. In addition to giving a common approach to privacy, unlike the existing Directive, the new Regulation covers both cloud computing and social media, and provides common levels of fines for breaches. It also covers all organisations operating in Europe irrespective of where the data is stored.

8.5.3 Open Data: Government can serve as a catalyst for the use of Open data

The use of open data is a relatively recent phenomenon but, as with many technological advances, it is growing in relevance and prevalence in other words, it is becoming the “new normal.” Yet while the

benefits of open data are significant, the success of open-data programs is not guaranteed. For government to serve as an open-data provider, catalyst, user, and policy maker in an effective and sustainable way, it needs to have the right people, tools, and systems in place. **The importance of open data is evident in terms of revenue growth (for both private and public sector) as well as achieving cost savings while increasing transparency (mostly for public sector).**

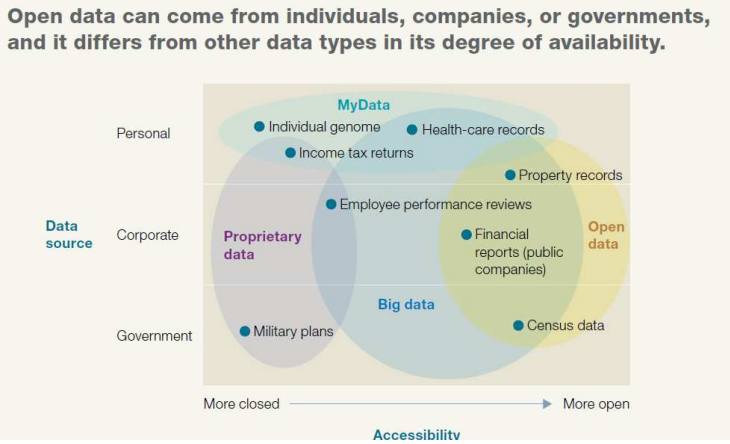


Figure 29: Open Data Sources. Source: Mckinsey

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, and 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).

There are many risks involved around Open Data and their potential use, and this may form a specific policy and regulation issue for both national policy actors and the European Commission providing European guidelines and common understanding on what are the opportunities and potential negative implications are, and to stimulate best practices regarding the use of Open Data including handling of privacy aspects. While there are already many public administrations offering Open Data, there are several obstacles that prevent a wide use of Open Data, such as poor data quality, privacy risks and deployment limitations.

- **Open data:** Governments should take steps to ensure that data held by public authorities is made available as freely as possible and at minimum cost to users while ensuring that data privacy rules are respected. Companies should share the data they hold that can be used to develop new services for consumers.
    - Action point: Increase access to data held by public authorities and the private sector.
- **Trust and security:** Consumers' and citizens' confidence in how individuals' information is used and protected in the era of big data is essential if the digital economy is to grow. Governments must ensure that fundamental principles of data privacy are respected while ensuring that rules are flexible enough to allow for innovation. Individuals will never understand the full complexity of the data ecosphere, so giving they control over their data through data vaults or privacy seals could play an important role in contributing to trust.
    - Action point: Establish rules that balance respect for data privacy with flexibility to support innovation
- **Ensure global data flows**: Creating a 'Fortress Europe' for data will limit the potential for growth and innovation. The European Union and the United States must redouble efforts to

work out common standards for the handling of personal data that allow for the free exchange of data. These standards should cover open data and anonymisation, among other issues.

- Action point: Step up efforts to agree common EU-US standards for the handling of personal data.

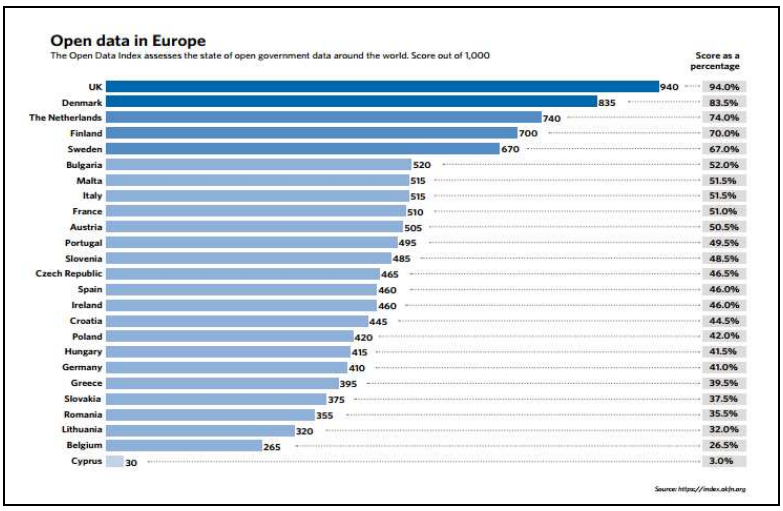


Figure 30: Open Data in Europe

Nowadays, Open Data websites are emerging everywhere around the world:

Figure 31: 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
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 6: European Open Data websites

Government can serve as an open-data provider, catalyst, user, and policy maker to create value and mitigate risks.

- **Provider.** Across all levels of government in all regions of the world, millions of individual data records are collected, stored, and analyzed. From tax returns and unemployment claims to hospital reimbursements and energy use, much of this information can be made available electronically and readily shared, enabling third parties to create innovative products and services. By making these data available to enterprising companies and individuals, government is spurring private-sector innovation and increasing transparency two of the most important goals of any open-data initiative. The 2013 G8 Open Data Charter establishes an expectation that all government data be published openly by default, while recognizing that there are legitimate reasons why some data cannot be released.
- **Catalyst.** Government can serve as a catalyst for the use of open data by creating a thriving ecosystem of data users, coders, and application developers. To attract an ecosystem of developers, it can advertise open-data availability through press releases or other marketing materials, or even engage in individual outreach efforts.
- **User.** There are two key actions that government agencies can take to use open data. First, to optimize the use of public data within their own agencies. Second, governments can apply advanced analytics to improve internal decision making, promote the creation of new services, and increase accountability.. Governments around the world are taking similar steps to integrate data as the new standard for how their agencies operate.
- **Policy maker.** Public-sector leaders are often called on to protect individuals and organizations from the risks of open data while also advancing open data's potential value. Risks include those that fall largely on individuals, such as privacy, security, and personal safety, and those related primarily to organizations, such as confidentiality, liability, and intellectual property. Leaders can draw on their legislative authority and enforcement powers to enhance safety, security, equity, and justice for all members of society. They can also participate in setting technical standards that can significantly increase and scale the benefits of open data.

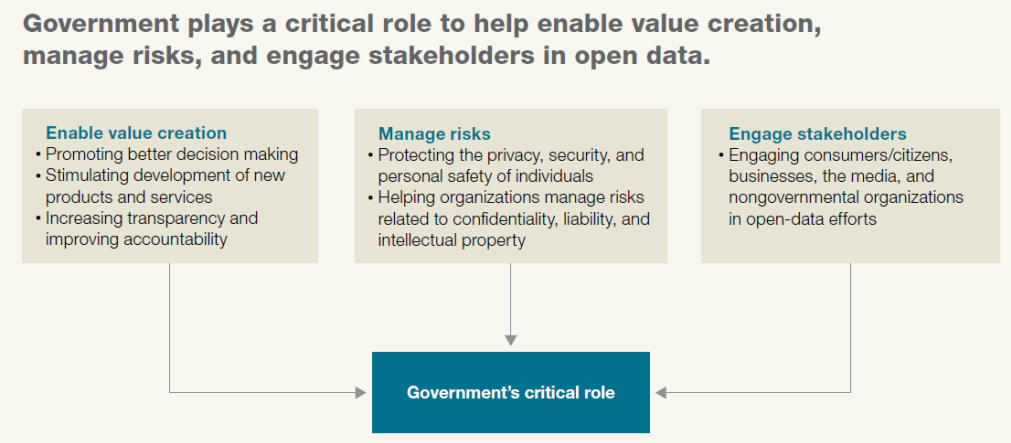


Figure 32: Government Critical Role in Open Data. Source: Mckinsey

8.5.4 Security: European Cybersecurity Strategy

At an unprecedented pace, cloud computing has simultaneously transformed business and government, and created new security challenges. The development of the cloud service model delivers business-supporting technology more efficiently than ever before. The shift from server to service-based thinking is transforming the way technology departments think about, design, and deliver computing technology and applications. Yet these advances have created new security vulnerabilities, including security issues whose full impact is still emerging. Among the most significant security risks associated with cloud computing is the tendency to bypass information technology (IT) departments and information officers. Although shifting to cloud technologies exclusively is affordable and fast, doing so undermines important business-level security policies, processes, and best practices. **In the absence of these standards, businesses are vulnerable to security breaches** that can quickly erase any gains made by the switch to SaaS. Recognizing both the promise of cloud computing, and the risks associated with it**, the Cloud Security Alliance (CSA)** has pioneered the **creation of industry-wide standards for effective cloud security**. Already, many businesses, organizations, and governments have incorporated this guidance into their cloud strategies. However, CSA recognizes that a central component of managing risks in cloud computing is **to understand the nature of security threats**.

- **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).

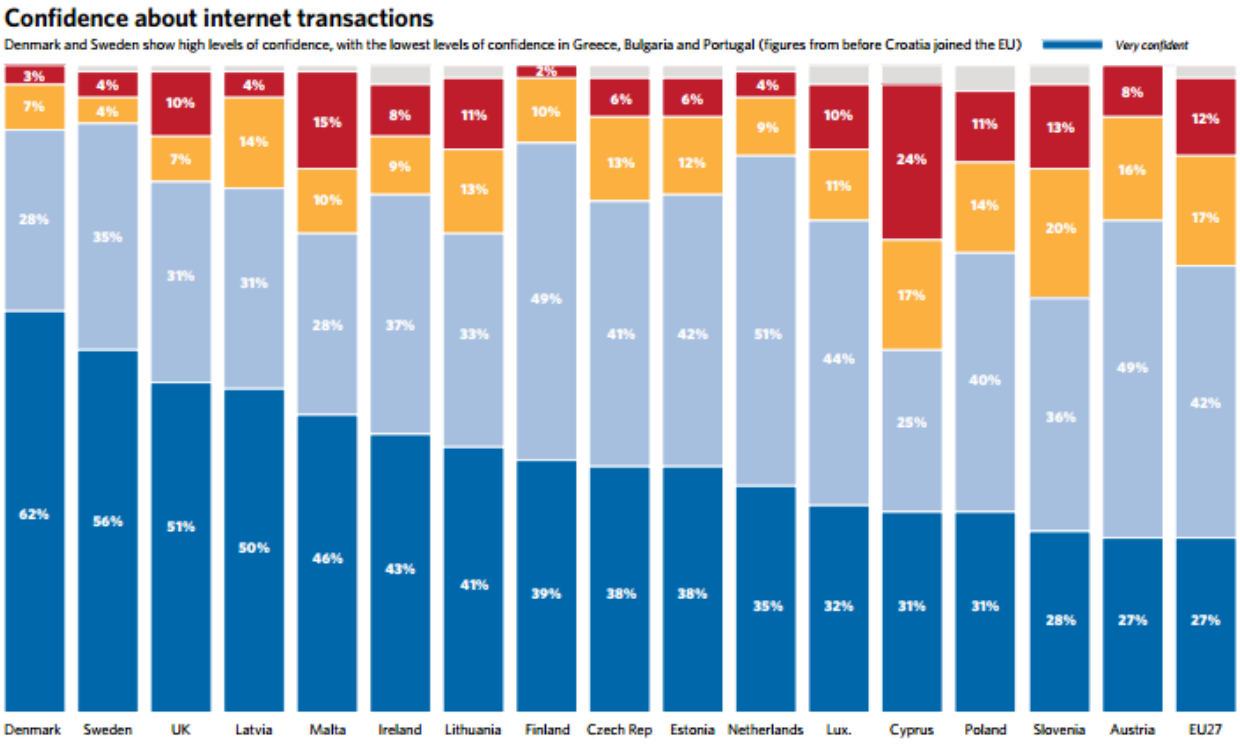


Figure 33: Confidence about Internet Transactions

The situation on EU Cyber Security Strategy is more developed[5]. ENISA and the European Cybercrime Centre (EC3) play key roles.

- **Cisco and Google are seeking to be excluded from a new EU cybersecurity law** that would force them to adopt tough security measures and report serious security breaches to national authorities. The so-called Network and Information Security directive is due to be **finalized in talks between the European Parliament, the European Commission and member states over the coming weeks.**
- **EU lawmakers want the law to cover only sectors that they consider critical**, such as energy, transport and finance. But the Commission and some countries, such as Germany and France, are pushing to **include cloud providers, social networks, search engines and e-commerce platforms because of their widespread use by people and businesses**.

8.5.5 Third Platform Marketplace: Neutrality, Intellectual Property and Business Models.

In relation to Future Internet, 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. **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?

[5] http://eeas.europa.eu/policies/eu-cyber-security/cybsec_comm_en.pdf

What they term “Platform Neutrality”, an interesting adaptation of a term usually used in software circles to point to (or away from) lock-in to one or another software “platform” (think Microsoft or SAP). The use of the terminology in fact is similar the Internet (and now mobile) based platforms — Google, Facebook, Twitter, Amazon where similar **issues of cross-platform interoperability, data portability, lock-in/lock-out for users, suppliers, competitors are quite parallel**. Net neutrality enforcement for platforms must do more than just protect consumers’ well-being. It must also protect the well-being of citizens by ensuring that the **Internet’s role as a catalyst for innovation, creation, expression and exchange is not undermined by development strategies that close it off.**

The creation of a third platform marketplace, where several stakeholders need to successfully cooperate while preserving their specificities (in 28 countries), raises potentially critical legal issues at different levels. One crucial aspect regards **intellectual property**. As stated by the European Commission, in our growing knowledge-based economies the protection of intellectual property is important not only for promoting innovation and creativity, but also for developing employment and improving competitiveness (http://ec.europa.eu/internal_market/intellectual-property/). Intellectual property covers two areas: industrial property and copyright.

- **Copyright.** It is important to exercise considerable caution where material is taken from a third party source without permission, as their activities are likely to amount to an infringement of copyright and/or database rights. Copyright infringement will occur if the whole or a substantial part of a copyright work is copied or adapted without the copyright owner's consent. This concept may also vary across European countries since there may be more and less restrictive definitions of what can be considered “substantial”.
- **Usage of data.** Data may also be protected by copyright and, additionally or in the alternative, by database rights. Again, this may vary across countries. These aspects should be taken into account when building composite applications.
- **Industrial Property/Patents.** The EU approach is that “a strong industrial property rights system is a driving force for innovation, stimulating R&D investment and facilitating the transfer of knowledge from the laboratory to the marketplace”, (http://ec.europa.eu/internal_market/indprop/rights/index_en.htm). The marketplace and application composition platform should not facilitate IP infringements, quite the opposite. It is therefore important to find a tradeoff between the protection of intellectual property and consumer privacy versus fair-use and the free flow of information through applications.

Another important legal implication comes **from the combination of GEs that follow different business models.**

- **Business models.** As discussed in previous sections, pay-per-use business models have been growing in popularity. When a consumer buys/contracts an application or service; he pays for its usage. Both composite and atomic services must be accounted, rated and charged according to their business model, and each of the service providers must receive their corresponding payment. In other segments, more traditional license-based business models are currently enforced. It may happen that **different types of business models, pay-per-use and license-based, are enforced in the same composite application** because single applications enforce different business models. Therefore, a demanding challenge for enabling the ecosystem of applications is the harmonization of business models, especially within the same composite application**.**

From the above considerations, we can advocate **the need for an EU regulatory framework, which is able to mediate and find suitable legal collaboration patterns between different stakeholders (and their countries**), while avoiding imposing too strict limitations to the characterizing modus operandi of the marketplace. In fact, it is likely that several issues that are typical of any marketplace (be it digital or in the physical world) would be subject to debate within the EU, in order to find a **viable policy that protects individual rights while encouraging the development of applications in the marketplace**.

Reform of the **current EU framework is urgently needed in order to take account of the new digital context and to introduce more harmonisation across the EU and legal certainty for business**

A first step was, 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.

The new European Commission president Jean-Claude Juncker understands these priorities. In the Wall Street Journal, he recently called for the completion of Europe's digital single market, called for tearing "*down our regulatory walls and finally move from 28 national markets to a single digital market. For this to happen, we have to get serious:* ***We have to end the regulatory silos in telecoms and copyright regulation, in data protection and in the application of European competition rules****. This requires political determination. Europe would miss a historic opportunity if we fail to tackle this challenge head-on."*

If the new **European Commission manages to introduce effective reform, Europe will play a leading role in the global digital economy and be a better place to work and live**.

9 Consolidation

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. The following factors are crucial:

- **Stakeholders' (Entrepreneurs, SMEs, Start-ups…) 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** (Testing Environment): it is important to have and show them to possible customers, both internally and oversees.
- For Europe, the extent and pace of these changes will depend not just on the market but also the **European policy environment**. The right policy environment in Europe can strengthen each element of the virtuous circle and enhance the complementarities between them. Actions needed:
    - Access to government Data
    - Enhancing connectivity
    - App-driven innovation across all sectors
    - European single market for intellectual property
    - Ensuring a flexible and supportive business environment for start ups

9.1 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		
Open Stack, the leading open source framework for building hybrid IaaS clouds.	**Open Stack is an exciting new development in the cloud system software market,** offering an open alternative to proprietary systems. **Open Stack is a concerted effort by many industry participants to provide an interoperable and open cloud platform** that will help address the problem of workload migration in a hybrid scenario, from cloud	**Open Stack is well poised** to deliver massive portability and interoperability for IaaS apps, (i.e. interface with AWS) Given that scenario, we believe **Open Stack adoption in Europe will continue to accelerate**

	to cloud.	
The **slower rate of cloud adoption in Europe**	Largely because of **data sovereignty issues** that have kept some European companies out of the public cloud.	**The European market is quite different from the US cloud market** in that customers prefer to go with **someone local to ensure data privacy regulations** are met.
Big Data		
Hadoop is the leading open source platform for storing, processing and accessing large data sets across clusters of computers,	Together with **Open Stack, the leading open source framework for building and** managing private, public and hybrid Infrastructure-as-a-Service **(IaaS) clouds**, provides the perfect "greenfield" use case for those looking **to start a new on a platform that makes sense** and **that can be cost effectively deployed.**	Providing advanced tools for management or complementary functions Provides a full set of innovative features
A favourable Regulatory Environment will be paramount to foster take up of Big Data Value technologies and solutions.	Standardisation is essential to the **creation of a Data Economy**, de-facto standards for technologies and for data, notably **for interoperability**. **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**	European Legal Framework guaranteeing **privacy harmonized across Europe** Data protection regulations may help restrict the **delivery of personal data to M2M**
Facilitating access to government data for developers.	**The use of Open Data is a relatively recent phenomenon but, as with many technological advances**, it is growing in relevance and prevalence.	Governments around the world should take **steps to develop responsible and robust open-data programs**. Promote Open Data in a way that helps **unlock economic and societal benefits**.
Internet of Things		

Deploying end-to-end M2M/IoT solutions and being able to manage an increasing range of applications becomes the next challenge for enterprises.	Providing **a dedicated enterprise platform and toolset**, and enabling the re-use of components by the enterprise, enhances the ability of enterprises to manage the growing range of applications. **Rapid Enablement, Shorten lifecycle.** There is clear opportunity for consolidation going forward, as more suppliers are augmenting their capabilities to **offer nearly one-stop shop services,** and we expect that as the **M2M market becomes ever more main stream.**	The most important force driving the growth of these application enablement platforms (AEP)**, is evolution of the supplier ecosystem**
Open Standards in the Internet of Things are challenging closed platform approaches	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	**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.
Apps		
A demanding challenge for enabling the ecosystem of applications is the **harmonization of business models**.	**Application/service developers and providers** are faced with the challenge to have the ability to combine applications from different sources needs **innovative revenue sharing**	In the years to come the different stakeholders of **business ecosystems need to be able to develop a good competence skill** in these relevant areas of business frameworks for service-based or

	models across partners and potentially also customers (e.g. crowd-sourcing) which have to be adapted dynamically as market conditions change.	application-based ecosystem platforms in the Future Internet.
The creation of **a third platform marketplace** raises potentially critical legal issues at different levels.	In fact, it is likely that several issues that are typical of any marketplace (be it digital or in the physical world) would be subject to debate within the EU, in order to find a **viable policy that protects individual rights while encouraging the development of applications in the marketplace.** The marketplace and application composition platform should **not facilitate IP infringements,** quite the opposite. It is therefore important to find a **tradeoff between the protection of intellectual property** and **consumer privacy versus fair-use and the free flow of information through applications**	**The need for an EU regulatory framework, which is able to mediate and find suitable legal collaboration patterns between different stakeholders** (and their countries), while avoiding imposing too strict limitations to the characterizing modus operandi of the marketplace
Interface to the Network and Devices		
There is a **strong need for common APIs** for interaction between the different functional levels providing an open basis for interoperability in order to be able to provide **an open ecosystem** in which all the market stakeholders can benefit.	**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	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.

Security		
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.	**Lack of national coordination can lead to redundant policy and legislation,** thereby hindering economic growth and development**.** **Each nation connected to the Internet should have a comprehensive and transparent national cyber strategy** that is integrated and harmonized with the strategies and procedures across all domestic and international policy.
Smart Cities		
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**.	Define the **Facto Standard for Smart Cities.**
Open Data form the Cities	In **Smart Cities companies** are combining and **integrating data from different sources** to make easier for **developers to build exciting applications** **Cities, to address their challenges, are opening their data and deploying open source methodologies which let people**, community, and their organizations to develop contents and applications that result in social and technological innovation and economic growth.	**Open data refers not only to the opening of public sector data which would be available to society on public platforms**, but would also extend to the data produced by citizenship and private companies who share their data with the authorities, whom share their public data with the city.
Smart Industry		
Combinations of 3rd	The 3rd Platform is being	This threat and opportunity

Platform technologies will transform and already are transforming industries such as retail, financial services, telecommunications, healthcare, and government.	used to **digitally transform entire industries** and develop major new sources of competitive advantage. Hundreds of thousands, if not millions, of industry-specific **cloud service platforms and marketplaces will emerge**, and the highest-value technologies and solutions will be found in these locations.	makes it imperative that **senior management become much better versed about the 3r Platform and its possibilities in their own business and industry** **Some of the most important Smart City Platforms are European**. To achieve these objectives some of these projects are using **open source technologies** and methodologies and releasing their solutions, fully or partially, as open source. **The same approach will be required in the Smart Industry** with upcoming of the **IoT growing market**

Table 7: FIWARE Research and Market Analysis conclusions

The **following table summarises barriers** found and propositions for its management from the analysis done in the exploitation task of FIWARE.

Objective	Barrier/competition	Recommendation/Workaround
User adoption	Make sure that the **proposed platform architecture evolves** by integrating new components, also making the integration among existing components much stronger, **and overall bringing more added values.** A lot of focus has to be made on **simplicity and documentation and on Open Source Communities contribution.**	• Provide to developers the **necessary training, coaching and support.** • **Enabling contribution by third parties**. Success will only be achieved thanks to the active contribution of **all partners in this transformation.**
Privacy and Security in IoT	The complexity of IoT solutions will require a fresh way of thinking about security. **Security will need to be considered on an end-to-end basis**. Furthermore M2M and, particularly, IoT involve **the widespread sharing of data.** Understanding the dynamic and implications of all of that data sharing	• Rethinking is needed about where strategies should support a portfolio that focuses on services that **put the privacy needs of the client at its core**. • To determinate how to **secure rights to the data and**

	will be critical.	**manage data access.**
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.**	• To **prevent data flooding** as a result of the unstructured communication between billions of devices • **To prevent the grow of large but encapsulated sensor networks (**walled gardens), where only specific and predefined devices can interact. • To **push the creation of virtual sensors forward** as they are providing the possibility to derive, generate and finally correlate information from sensors, as a direct result of the integration of numerous devices
Standardization	IoT needs **a common framework** on which all services and devices can interoperate and scale, and be efficient and widely available	• Approach to EIRC (European Research Cluster on Internet of Things) community.
Access to Capital	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	• Ensuring a **flexible and supportive business environment** for start-ups and entrepreneurs
Lack of national coordination can lead to **redundant policy and legislation**, thereby hindering economic growth and development.	Each nation connected to the Internet should have a comprehensive and **transparent national cyber strategy** that is integrated and harmonized with the strategies and procedures across all domestic and international policy. **A competent institution is needed to be responsible** for the successful implementation and rollout of the national strategy.	• To **drive the adoption of initiatives**. The **focus on incentives** driven by the government and independent providers should be enhanced.

Table 8: FIWARE barriers and recommendations

There are a number of areas where we believe governments in Europe can make a difference and support the App Economy:

- Facilitating access to government data for developers, e.g. mapping, meteorological and real time public transport data as well as information on community level services.
- Enhancing connectivity by making more spectrums available for wireless services.
- Advancing the European single market in intellectual property and communications.
- Embracing app-driven innovation across all sectors, e.g. health, education, enterprise, lifestyle.
- Ensuring a flexible and supportive business environment for start-ups and entrepreneurs

10 Conclusions

Almost every company is becoming a software company. By considering business and operating models pioneered by the software industry and tailoring them to their own needs, organizations can lower their costs, boost performance, and turn software into a competitive advantage. Software is becoming critical for almost every company's performance.

As Harvard Business Review mentions, IT is becoming an integral part of the product itself. Embedded sensors, processors, software, and connectivity in products (in effect, computers are being put inside products), coupled with a product cloud in which product data is stored and analyzed and some applications are run, are driving dramatic improvements in product functionality and performance. **Massive amounts of new product-usage data enable many of those improvements.**

Collaborative development and open source software are defining the next generation of the enterprise and are offering developers and users unprecedented opportunity to innovate. 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.

More and more partners are involved in the end-to-end service delivery chain, therefore to operate both elements successfully**.** Operators need a flexible and open environment. Cloud technology will enable you to cost-effectively use of Big Data analytics, Social media thrive on the ubiquitous smartphone**. The 3rd Platform, where cloud, social business, mobile, and big data/analytics come together, has the potential to create the underpinning of business process transformation and business model transformation.** As businesses operate on the 3rd Platform, they will be able to transform how they engage with customers, the speed at which they deliver products and services, how they innovate, the reliability of their operations, and their resilience to market changes. The power of connectedness and intelligence brought about by the 3rd Platform not only provides excellent business opportunities for growth but also highlights the need for change.

A new digital revolution will take place as a result of applying a number of technologies that have emerged recently, mainly Cloud, Big Data and Internet of Things technologies. **The advent of Big Data magnifies this trend**. Business users are struggling to make sense of the data and try to find the patterns that enable them to create new products and services for their customers.

Application/service developers and providers are faced with the challenge to build smart applications that cover consumer's needs. From a development perspective, such applications and services should be built on top of **powerful but easy to use APIs, be based on standards and offer flexible deployment and provisioning means** (e.g., many devices, multi-tenant architectures, global scalability, and on-demand provisioning) and management frameworks (e.g. in the Internet of Things). Additionally, **they should exploit economies of scale and protect investments in the long run.** Finally, the ability to combine applications from different sources needs innovative revenue sharing models across partners and potentially also customers (e.g. crowd-sourcing) which have to be adapted dynamically as market conditions change.

Amazon, Google and other Internet players have already demonstrated how an innovative combination of business models, Internet-based platforms, and marketplaces can lead to a successful monetization of offerings. However, while **marketplaces and business models** have experienced a relevant development on certain proprietary domain-specific platforms operated by a single provider, the **open innovation in the apps/services space is still in its infancy**, thus maintaining high entry barriers for smaller players to the Internet business ecosystem

Delivering a platform with rapid application development, a ready-made **ecosystem of partners**, and a **marketplace of application** components creates a new and disruptive approach to more time-consuming and increasingly costly application development and deployment approaches and opens many doors and market opportunities. Moreover, **organizations must find ways to broaden their ecosystems** to include start-ups may offer forward-thinking companies an opportunity to position themselves at the leading edge of innovation in their

- **Opening the Applications market to the small and medium sized business (SMB) space**. Significantly reduced application development times, available application components and toolkits, lower costs and the underlying more pervasive base of connected devices in an IoT world will shift and introduce the market towards the small and medium businesses, both as innovators (start-ups) and adopters of IoT solutions.
- **Creating application development communities.** As in the mobile space, the opening of programmer toolkits enables a new group of application developers to grow the market. Where before, application development will have been for a very specific and limited scale purpose, the advent of IoT application platforms opens huge opportunities for application development communities to develop comprehensive solutions that not only address the immediate application requirements of an enterprise or market segment but also allows for a wider and more innovative market space to evolve.
- **Exploring revenue sharing models.** Where collaborative service models emerge, there is also the opportunity and perhaps need for new business models to develop, and enabling end-to-end IoT solutions opens the opportunity for revenue sharing models

Additionally, the speed of growth from the App Economy and the breadth and depth of wider economic and social benefits in Europe, as well as European competitiveness, **will depend on the policy environment in Europe**. Europe has **a strong base to build on in terms of an established ecosystem of apps developers**, comparatively high levels of smart device take-up, high household penetration of Wi-Fi and an accelerating transition to LTE. However, to realize the full benefits, and to become global leaders in the App Economy, **Europe will need to get the right and common regulatory framework in fast moving industry sectors.**

11 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

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