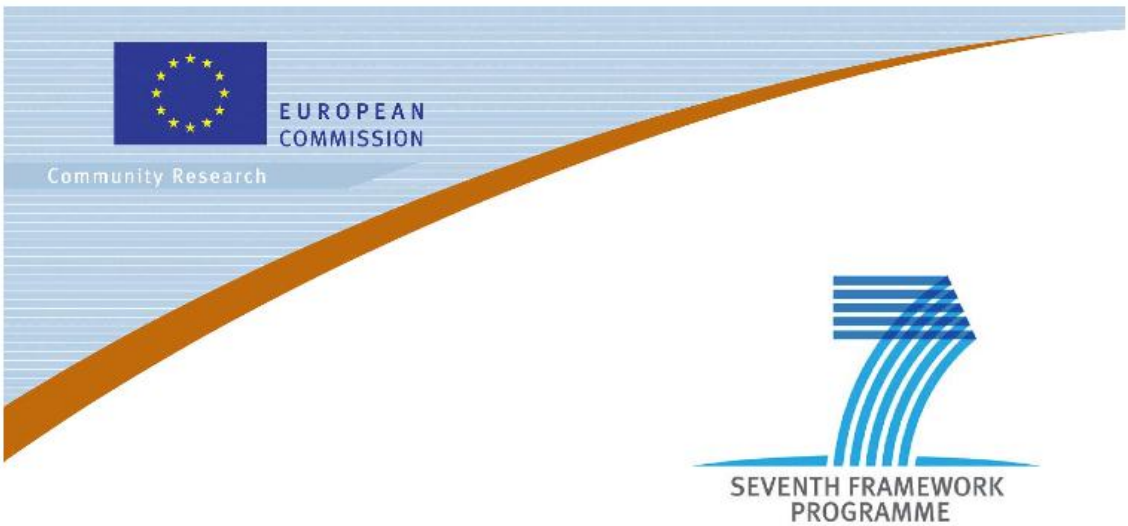

Private Public Partnership Project (PPP)

Large-scale Integrated Project (IP)

D.11.1.1b: FI-WARE Market and Competition Analysis

Project acronym: FI-WARE

Project full title: Future Internet Core Platform

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1.1 Executive Summary

This document presents a preliminary indication of the market situation that justify the introduction of the FI-WARE concept; the strengths and opportunities of the concept as a whole and of the different parts and some initial indications on the best strategy to fully develop a successful commercial offering.

Initially, a general outline of the economic situation together with the fact that platforms have deeply restructured how hi-tech industries operate and the reason why platforms have taken on such a key economic role is that platforms, where convergence between IT, internet, telecommunications and media services and technologies occurs, are engines of innovation. The new proposal, being put forward in the context of European collaboration has some advantages in terms of Standardization and critical mass, as compared to a possible independent approach.

Platforms require a non-traditional business model and a different way of working. These are not one-off products but are rather ecosystems with many cross-dependencies. As a result, the design, governance and execution need to be done with a more holistic approach such that the interests of ecosystem partners are balanced. Consequently, decisions regarding open versus closed, free versus charged, and cooperation versus competition will influence the success of the platform in both size and longevity:

- Market creation
- The size and sustainability of the ecosystem
- The ability of the platform to encourage and capture network effects

In this context, FI-WARE appears as a very attractive proposal: an open standardized platform that can be used by external companies to develop their own business models relying on already existing the facilities and infrastructures and complemented with new elements that should facilitate the use of internet of things, the cloud and simplify the management of data. All this with the adequate security tools offered in a flexible manner. The different elements are connected to the network and use it as an extra element in the complete FI-WARE offering. The technologies, that FI-WARE project will provide, carry the potential for enabling new business opportunities for established and emerging application and service providers in areas such as energy, telecommunications, healthcare, media and e-government.

The document performs a SWOT analysis of the platform concept. Perhaps the most relevant conclusion is that FI-WARE can become a good solution, particularly if it makes use of the latest developments, including HTML5 and is developed with adequate agility to avoid mew entrants attacking the most profitable elements of the solution. Another key success factor will be the implication of early users. Next, a relatively detailed analysis of the market and main competitors of the different building blocks of FI-WARE is performed. The situation is very different depending on the case. Cloud solutions are already very well developed, whereas the situation in Internet of things and data management is not so mature.

The main conclusion of the document is that the success of the FI-WARE concept will depend very much on the use of the adequate technological solutions and its ability to engage small and medium developers to use the different tools FI-WARE is going to provide. In the end, FI-WARE success will depend on the success of the applications that are going to be developed on top. FI-WARE will succeed if the developers using FI-WARE succeed.

The classic difficulty for building a platform is the chicken-and-egg launch problem. Users of a platform want content and applications before they will use it; developers for a platform want users before they will provide content and applications. Each side wants the other side to commit before it will spend resources to adopt the platform. This is a "critical mass" problem**.** An important drive to that final success will be the ability of FI-WARE partners and the EC to convince user communities to consider FI-WARE as a good platform to develop applications on top. The experiments and use trials, and the involvement of European cities –and other communities- in the experiments will be crucial. Time is of essence. Competition is also moving and it may be necessary to start making experiments and involving the developers community

soon. One possibility is to start implementing the concept even with pieces taken from outside, in order to build a useful solution, even it will be changed as we go along

1.2 About this Document

This document has two parts: first it provides an analysis, relatively general, of the emergence and peculiarities of platforms in the ICT industry which have developed rapidly over the past years. In this study we analyze the concept of the platform; 'platform definition', 'platform ecosystem', and 'platform strategy', in this section we explore also the peculiarities of the platform leadership strategies, two-sided platform businesses and indirect network externalities that are relevant to managing open innovation within this context, and we conclude with potential regulatory concerns for specific platform types and the economic implications derived and the resulting research questions that guide the potential business models. Second, a more detailed analysis of the different elements constituting FI-WARE platform is performed together with FI WARE Platform Value Proposition definition, SWOT analysis and impact.

1.3 Intended Audience

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

1.4 Context of Chapter WP11 Exploitation

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

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

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

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

- Definition and implementation of a standardization strategy that will enable adoption and achievement of the project goals and ambitions
- Definition of impact indicators and management of those along the project duration

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

1.5 Structure of this Document

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

D.11.1.1b FI-WARE 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

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

1.8 Changes History

Release	Major changes description	Date	Editor
0.1	Table of Contents	01/06/2011	Carmen Perea (Atos)
0.2	Content	30/03/2012	Juan Bareño (Atos)
0.3	Content	15/04/2012	Juan Bareño (Atos)
0.4	Content	30/04/2012	Juan Bareño (Atos)
0.5	IoT Chapter	20/05/2012	Thierry Nagellen (Orange)
0.6	Security Chapter	21/05/2012	Daniel Gidoin (Thales)
0.7	Data Context definition in FI WARE Definition	22/05/2012	Carlos Ralli (TID)
0.8	Apps Chapter minor changes	23/05/2012	Uwe Riss (SAP)
0.9	Introduction and summary. Changes in market analysis	27/05/2012	Jose Jimenez (TID)

0.10	Interfaces to the Network Chapter	29/05/2012	Pierangelo Garino (TI)
0.11	Final Review	31/05/2012	Juan Bareño/Carmen Perea (Atos)
0.12	Introduce recommendations form the June Review: 3 Why Platforms? ICT markets as particular platform markets 4 FI WARE vision 5 FI WARE offering, actualize the Apps chapter 6 FI WARE Platform value proposition, SWOT and Impact	25/10/2012	Juan Bareño (Atos)
0.13	Final review	12/11/2012	Juan Bareño (Atos)

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2 General analysis

Today, there are more than 2 billion Internet users. The Internet has not only fundamentally changed the way we stay in touch with our friends and relatives, purchase products and services, or entertain ourselves, it has also transformed the way we do business. The Internet has become a fundamental enabler of economic development and growth.

Europeans firms only dominate the more mature segments of the Internet industry. Europe's activity portfolio is concentrating to a large extent on the manufacturing of terminal and network equipment, and on the operation of networks. Europe only has a limited presence regarding "software and IT services" and the web ecosystem. In particular, "advertising" based business models – characteristic for many successful players in the web ecosystem– only play a minor role for the vast majority of players within the European Internet industry.

Additionally, the EU has been a follower, rather than a leader in the global Internet industry. Up until now, Europe has been slower than the US or Japan to capture the full benefits of Internet-based innovation.

Specifically, US productivity growth accelerated from an average rate of 2.08% in the 1973-1995 periods to a rate of 4.77% in 1995-2000. ICT played a major role in this acceleration in terms of capital deepening (ie: increased investment in ICT capital) and total factor productivity (TFP) growth. TFP growth in the ICT production sector increased from 0.25% to 0.58% when comparing 1973-1995 and 1995-2000. Similarly, the rate of ICT capital deepening more than doubled from 0.40% to 1.01% between these two periods (Jorgenson et al 2008). By contrast, the EU did not enjoy the same productivity acceleration after 1995 and the convergence of EU-US productivity levels that had been happening for 50 years swung into reverse. While there was only a 1.8% gap in the level of output per hour worked between the US and the EU in 1995 this increased to a 9.7% gap by 2004. Since productivity is the key measure of economic wellbeing in the long run, this is a source for concern for European policy-makers. The US-EU gap increased most in the ICT production sector (where US labour productivity growth was almost double that of the EU over 1995-2004) and the market services sector (where US growth was more than three times greater than the EU).

Building this new business models, related to Future Internet, will rest into the following technological drivers:

- **Cloud computing**, already mentioned as one of the new elements of network operators offering. Cloud computing offers the possibility to deploy new services and applications without making very high investment in Network elements, paving the way for new market entrants and, more importantly, for the development of new business models at a low risk.
- **New wireless networking technologies such as LTE (4G) and the deployment of Fibre to The Home (FTTH).** These elements should allow a significant increase of the connection possibilities as well a significant price reduction.
- **The Internet of Things,** with the vision of ubiquitously connecting intelligent devices and sensors and offering new possibilities for contextual and environmental information sensing, processing and analysis, thereby opening the door to new automation and control applications and services in various sectors.
- **The Internet of Services** which is accelerating the creation of complex value networks of service providers, consumers, and intermediaries bringing businesses and end customers innovative applications better tailored to their needs.

This analysis needs to address the different technologies, which affect the user/customer to provider relation for the e-services market, as well as the physical environment of e-services in terms of availability and dependability for commercial services. This will enable to determine the economic growth, providers' revenue maximization, and customers' benefits for the different elements and for the concept as a whole.

The consideration of socio-economic aspects in the Future Internet is of key importance. The research challenges faced in this context are manifold. Suitable pricing and business models need to be designed which will provide appropriate incentives for network operators, service providers, and end-users.

In the first place, from an **economic perspective** it can be observed that many companies in **the traditional ICT sector face difficulties concerning the transformation of their own business models into new areas**, tackling commoditization and marginalization threats. To address this difficulty, a framework is needed where new business models can be explored and validated effectively. Such a framework could help to cultivate an ecosystem comprised of agile and innovative service providers, which in turn consume services provided by the traditional ICT players.

ICT industry is still split between IT suppliers and Telecom suppliers. Both have a different history and culture, the former dominated by the US, the latter by Europe. Europeans firms however, tend to dominate the more mature segments of the Internet industry: approximately 60% of their current revenues come from telecom services, particularly subscriptions to access and use the Internet. Communications network operators are therefore not surprisingly the key Internet players with headquarters in Europe. There is only one European software "world player" (SAP) and there are only two European equipment manufacturers on a world scale (Ericsson and Nokia).

Recently, new market players with new business models have entered the European Internet industry and will continue to do so in the future as the legal and economic entry barriers for the fastest growing and most profitable parts of the value chain are relatively low.

Two aspects are contributing to accelerate this change.

- The first, of course, is **the global economic downturn** that continues to adversely affect the performance of operators in markets around the world. Growth naturally slowed, abetted by constrained credit markets, and thus accelerated the commoditization of traditional telecom services, while reducing the valuations of operators large and small. As a result, operators focused on cutting costs and increasing operational efficiency to protect profitability.
- **The second, and more specific, is the fact that most hi-tech industries have become platform battlegrounds**, for example, digital media players for music and video (Apple versus Microsoft and Real), mobile smart phones and other handheld devices (Nokia-Symbian versus Palm, Microsoft, and Linux), video game consoles (Sony versus Microsoft and Nintendo), enterprise software (SAP versus IBM, Oracle, and Microsoft), online payment services (PayPal/eBay versus Sony, Microsoft, credit card companies, and others), and even "Web 2.0" social networking sites (Facebook vs. MySpace and others). **Platforms have deeply restructured how hi-tech industries operate** and the reason why platforms have taken on such a key economic role is that **platforms,** where convergence between IT, internet, telecommunications and media services and technologies occurs, **are engines of innovation**. Instead of narrowly limited products or services with predetermined uses, they become alive, fuelled by continuous innovation brought about by third-parties. **Accordingly, several services bundled with different service platforms are emerging in the market,** aiming at providing elderly-care, energy management, security or entertainment services

Consequently, many of today's "incumbent" players in the Internet industry face the necessity to adapt or renew their business models. We are now witnessing the **emergence of business model ecosystems that connect a set of people, devices (with embedded intelligence), and businesses** on a digital platform for value creation. These business ecosystems are supported by contracts and collaboration practices for mutual benefits. Such ecosystems are emerging as a critical asset in the success of business models in industries ranging from healthcare and education to entertainment services. **Economies of scale for the physical operation of platforms depend on the specific purpose of the platform**. Thus, scale advantages are lower for mere housing or hosting activities compared to activities related to supra-national content delivery networks.

From a broad perspective the operation of platforms in a given country usually is a competitive market in which a considerable number of market players are active. Apart from local or regional housing and

hosting activities, **the platform business is typically multi-national, if not global**. In such an environment geo-political borders do not exist as long as the different locations of the platform are connected via transmission networks (such as Apple's iTunes Store)

The previously separate value chains of the sector (telecom services, software, IT services, etc.) are converging into a complex Internet and Web ecosystem with strong interrelations. This trend in business models more pronounced now with the expansion of online cloud-based platforms from the likes of Apple, Google, Amazon, Facebook, and Microsoft. These platforms enable businesses to build ecosystems to connect with their customer communities, employees, suppliers, and partners

Considering this scenario, the **FI-WARE project will introduce a generic and extendible ICT platform for Future Internet services.** The platform – also referred to as the "Future Internet Core Platform" or "FI-WARE" – aims to meet the demands of key market stakeholders across many different sectors, strengthen the innovation-enabling capabilities in Europe and overall ensure the long-term success of European companies in a highly dynamic market environment.

As most revenues in the ICT sector in 2020 will be generated by products and services which have not yet been developed, it is essential that new developments offer evolutive technical solutions that will be able to adapt themselves to the changing situation.

In order to perform a general analysis of FI-WARE offering, a general consideration to the present economic situation, in the ICT world and the reasoning for the FI-WARE project and its major objectives, needs to be made

3 Why Platforms? ICT markets as particular platform markets

Despite such valuable attempts to contextualize platforms and platform markets, the notion of a platform is still mostly considered as a given, as an abstraction that allows generally valid analysis and comparison. In opposition to this, and particularly in relation to studying the ICT industry, a number of authors (Parker & Van Alstyne, 2008; Ballon, 2007b; Boudreau, 2005) argue that r**eal-life platforms exhibit strong heterogeneity in terms of the configuration** of components and boundaries, in terms of integration and compatibility strategies, of revenue (sharing) models **and even in terms of the associated regulatory concerns** - to the point that the terms 'platform' and 'platform strategy' to capture all these initiatives lose most of their explanatory power. Consequently, they argue that **research needs to abandon abstract and static conceptions of a "platform"**, and instead should concern itself with changing boundaries of platforms, **different types of platform business models, and various levels of integration and control.**

Whether we talk about Microsoft, Apple, Google, Intel, Cisco, ARM, Qualcomm, EMC, or Facebook, platforms seem to have taken our business landscape by storm. Firms that provide these platforms, building hardware and software products as well as applications, and provide a variety of services ,are able to orchestrate and take advantage of innovation coming from myriads of other firms that operate in coalitions sometimes called innovative business ecosystems. This study aims to present succinctly the essential ideas that managers need to understand about platform strategy.

All these firms and their partners participate in what we can call platform-based "ecosystem" innovation (Moore, 1996; Iansiti and Levien, 2004). Platforms are also often associated with "network effects": that is, the more users who adopt the platform, the more valuable the platform becomes to the owner and to the users because of growing access to the network of users and often a set of complementary innovations. As we will discuss later, moreover, there are increasing incentives for more firms and users to adopt the platform and join the ecosystem as more users and complementors join. **Correspondingly, an increasing number of companies strive for 'platform leadership'**. Platform leadership represents a company's strategic intentions to make its products or services,the foundation on which other companies build their products or offer their services' (Gawer & Cusumano, 2002). **This allows them to complement the platform's core value proposition and benefit from external innovation**. The emerging platform ecosystem consisting of customers and autonomous partners complementing the core platform offer represents a collaborative arrangement that is actively shaped and controlled by the platform owner in a manner to co-create the platform's overall value proposition, extend its market reach and support its market adoption (Hagel & Brown 2008). Leading examples refer to the platform ecosystems of Intel, Apple, SAP, eBay, Facebook or Salesforce that license their platform technologies to independent software vendors and application developers, while motivating them to complement the core platform value proposition.

In the ICT industry, controlling a platform in the economic sense is commonly (yet not necessarily) **associated with controlling a platform in the technological sense**, i.e. a hardware configuration, an operating system, a software framework or any other common entity on which a number of associated components or services run. **Issues of interoperability, of open and proprietary interfaces and standards,** are more relevant in ICT industry than in most other industries (see e.g. Evans et al, 2005).

All companies face limits; not even Google has infinite resources. But you can dramatically expand those limits. Building a powerful platform lets you cultivate an ecosystem of developers, partners, users, and other collaborators who contribute to—and may drive—innovation at your company. Think of Apple's app tsunami. By inviting thousands of users to develop apps for its iPhone and iPad, the company generated billions in new revenue. It has tapped into an endless stream of inventors and innovation. **Offering tools such as application programming interfaces (APIs) and software development kits**

(SDKs) only gets you halfway there. You have to create incentives for prospective partners to extend your platform and build different planks for your mutual benefit

The overwhelming number of service platforms (mostly with proprietary standards and technologies) has made this domain even more complex and doubtful for users. The growing popularity of mobile and internet-based services is increasingly changing the vision of smart homes from simple home automation to advanced ICT services which are accessible everywhere. Many small and large vendors and service providers across different industries are becoming more aware of the remarkable prospects in the smart living domain. **Today's smart home concepts are no longer limited to home automation,** but increasingly involve smart health, energy, security and entertainment services. Such smart living services are typically offered through sector-specific service platforms that are rarely interoperable and not fully standardized. **As a result, the lack of openness and cross-sectorial interoperability of the service platforms**, combined with large differences in the technological architecture, explains why smart living services still struggle to make their way to the market. Based on these findings, we argue that collective action for developing common service platforms that cross traditional industries is needed to break the deadlock of smart living service innovation.

Accordingly, several services bundled with different service platforms are emerging in the market, aiming at providing elderly-care, energy management, security or entertainment services. These industries / contexts share **common features:**

- Complex technological systems
- Fast evolution of technology
- Importance of interoperability and integration
- Require collaboration among several firms

3.1 Platform Definition: What Constitutes a Platform?

Corresponding to its wide application, **the term 'platform' connotes different meanings.** For example, Baldwin & Woodard (2009) have identified three distinct, but related fields throughout academic literature, wherein the term 'platform' has been used: **Product and service development**, **technology strategy**, and **industrial economics**. Throughout the **first field**, the term is applied to describe the platform-based development concept that **enables companies to create new product and service generations or families.** Within this research stream, a product platform is most commonly defined as a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced' (Meyer & Lehnerd, 1997: 39). **The second research stream considers platforms as valuable points of control and rent extraction in an industry** (Baldwin & Woodard, 2009). Explicitly, Gawer (2009: 3-4) defines a platform as a building block which can be a product, a technology, or a service that acts as a foundation upon which other firms can develop complementary products, technologies or services'. Finally, **industrial economics** examines focal platforms in their **ability to connect, mediate and coordinate between two or multiple groups of platform users**, also referred to as platform sides. Within the economic **context of two-sided platforms**, a platform is understood as a means of providing the ‚infrastructure and rules that facilitate the (multiple) groups' transactions. In other cases, they are places providing services, like shopping malls or Web sites such as Monster and eBay' (Eisenmann et al., 2006: 94). Platforms as conceived of by Boudreau (2008) and Parker & Van Alstyne (2008) are ‚components used in common across a product family, whose functionality can be extended by applications and which is characterized by network effects.

In the ICT industries, many platforms **at the same time provide active matching services** (e.g. through offering personalization or features) **as passive mediation** (e.g. through offering a Service Development Kit). **Eisenmann (2007) identifies proprietary platforms**, which have a single provider that individually

controls its technology, **and shared platforms**, in which multiple firms collaborate in developing the platform's technology, and then compete by offering users different but compatible versions of the platform. **However, many, if not most, ICT platforms can be characterized as hybrids,** externalizing mostly proprietary technologies, but at the same time incorporating open, standardized and/or shared functionalities.

Industry platforms are products, services or technologies that are developed by one or several firms**, and serve as foundations** upon which other firms can build complementary products, services or technologies. Building on these platforms, a large number of firms, loosely assembled in what are sometimes called innovative business ecosystems, develop complementary technologies, products, or services. Microsoft Windows operating system, Linux operating system, Intel microprocessors, Apple's iPod, iPhone and iPad together with iTunes, Google the Internet search engine, the Internet itself, social networking sites such as Facebook, operating systems in cellular telephony, video games consoles, but also payment cards, fuel cell automotive technologies, and some genomic technologies are all industry platforms.

Examples:

1. Desktop OS: *Unix, Mac, Windows*
2. PDAs: *Palm, Psion, Newton*
3. Game Consoles: Wii, Xbox, Playstation
4. Network Switches: Cisco, IBM, HP
5. Multimedia: Adobe/Flash, MS/Silverlight, Google-Apple/HTML5
6. Payment Systems: Paypal, Google Checkout, Visa, Apple, Mobile Felica
7. Mobile Devices: iPhone, Android, Symbian, Blackberry
8. Enterprise Systems: Salesforce, Oracle, i2, IBM, SAP
9. Social Networks: Facebook, MySpace, LinkedIn, Monster, Twitter
10. Voice over Internet Protocol (VOIP): Skype, Nextiva, Yahoo!
11. Web Search: Google, Bing+Yahoo!,Baidu
12. Ebooks: Kindle, iPad, Nook, Sony

Summarizing, the most powerful platforms today have **two things in common**:

- **They are rooted in equally powerful technologies—and their intelligent usage**. In other words, they differ from traditional platforms in that they are not predicated on physical assets, land, and natural resources.
- **They benefit tremendously from vibrant ecosystems** (read: partners, developers, users, customers, and communities).

3.2 What is different about platform competition?

Platform competition is different from competition as we know it, because instead of firms competing directly with each other, **there are coalitions of firms competing between each other**. These coalitions comprise a loosely grouped range of firms that develop products, technologies or services that are

complementary to the platform. They may not be part of the same company, nor even the same supply chain, **but their destinies are linked together.**

In recent years, most hi-tech industries have become platform battlegrounds. Take, for example, digital media players for music and video (Apple versus Microsoft and Real), mobile smart phones and other handheld devices (Nokia-Symbian versus Palm, Microsoft, and Linux), video game consoles (Sony versus Microsoft and Nintendo), enterprise software (SAP versus IBM, Oracle, and Microsoft), online payment services (PayPal/eBay versus Sony, Microsoft, credit card companies, and others), and even "Web 2.0" social networking sites (Facebook vs. MySpace and others). Platforms are systems of technologies that combine core components with complementary products and services usually made by a variety of firms. **Together, the platform leader and its complements form an "ecosystem" for innovation** that can greatly increase the value of the platform and its complements as more users adopt the platform.

The reason why platforms have taken on such a key economic role is that platforms are engines of innovation. Platforms make us think very differently about the nature of products and services. Instead of narrowly limited products or services with predetermined uses, they become alive, fuelled by continuous innovation brought about by third-parties. **Platforms have deeply restructured how industries operate**. They have raised high expectations for firms attempting to achieve platform leadership as well as serious concerns for survival among firms being attacked by platform leader wannabes. Not surprisingly, there is now a growing body of research on how platform markets work.

A particular danger of platform competition is that your **complement of yesterday could become a substitute** and even dislodge you as a competing platform tomorrow. Firms are quite savvy about this possibility: they are aware of it, whether as an offensive or a defensive move. For example, Netscape started as a complement to Windows, but Microsoft saw it later as a possible substitute and 'gateway to the internet' and fought it by absorbing similar features and bundling them as Internet Explorer. Similarly, Sun Micro Systems' Java started off as a complement to Windows as well, only to later position itself as a layer that would make Windows substitutable to other Operating Systems. Google also started off as a complement to Explorer (as well as others) and gradually became a platform of its own. More recently, Facebook entered into the email market – starting as a complement to Outlook (using interoperability information disclosed by Microsoft) – but with the intention of offering a 'filter' that works inside Outlook (selecting mail from 'Friends' that would appear on top of the list) – demonstrating an avowed objective to transform Facebook into a platform on top of which other applications will run

3.3 Degrees of Platform Openness - Disclosure and Governance

One of the important characteristic of a service platform is platform openness; the degree in which a platform **is open to third-party complementary providers**. The platform openness can be seen from two perspectives:

- From a technical perspective, a platform could be open in terms of **accessing to technical specifications and standards of the core components through an API (Application Programming Interface) or a SDK (Software Developers Kits).** Note that accessing to **APIs or SDKs might require paying licensing fees or it could be free of charge.**
- From an **ecosystem perspective, platform openness determines which roles (i.e. platform providers, service providers, application developers, and end-users) can participate on development, commercialization and usage of a platform** (Eisenmann, Parker, & Van Alstyne,

2008a). Similar to technical openness, participation in the ecosystem might need membership fees or it can be free.

Decision to open or close a service platform is critical and depending on the market situations or potential parties, platform providers would apply different strategies.

- Although opening a platform may stimulate adoption of the platform, it intensifies the **competitive pressure and may reduce the incentives of complementary providers for investment on the platform**.
- Boudreau argues that while *granting access to platform for complementary products and services significantly foster innovation and increase the incentives to invest on the platform,* giving up control of the platform and **opening it to outside contributors for development, commercialization and ownership has less positive impact on innovation**.

Whether a technology is "open" and "closed" is the result of two distinct behaviors: disclosure of intellectual property (IP), and governance of how the technology evolves. Firms who opt for open technologies tend to disclose at least some of their IP to other firms (usually IP for interfaces or connectors, i.e., of what it takes to interface with their technology), sometimes for a fee. Some organizations such as Open Source, at the most "open" end of the spectrum, design technology in an open governance format and fully disclose not only interfaces but also the innards of their technology, -- and for free. **At the "closed" end of the spectrum, some firms don't disclose anything and evolve their technology all by themselves**. Somewhere in the middle of the open-closed spectrum, firms such as Apple keep full ownership of the process of design of their technology, but will disclose interface information to allow other firms to develop complements to interface with their technology.

In addition, unlike with standards, where aggressive licensing and control over intellectual property is essential, platform leaders have a wider array of options with respect to openness, which encourages the supply of complements. **Some platforms, such as Linux, have opted for complete openness**. But other platforms, such as **Apple's Macintosh or iPod, remained more proprietary** and appear to us more like great products than industry-wide platforms. As we explained earlier firms can choose **to open or close their technology along two dimensions: disclosure and governance**. The general rule is that firms that keep a closed governance format, i.e., full ownership of the process of design of their technology, tend to guarantee better system integration and performance, but will obviously benefit much less from contribution from external firms.

	Linux	Windows	Macintosh	iPhone
Demand-side user (End user)	Open	Open	Open	Open
Supply-side user (Application developer)	Open	Open	Open	Closed
Platform provider (Hardware/OS bundle)	Open	Open	Closed	Closed
Platform Sponsor (Design and IP rights owner)	Open	Closed	Closed	Closed

Figure 1 Comparison of openness by role in platform-mediated networks

What level of openness is the adequate for a creator of a platform?

- **Too open** – such as Linux means no one is leading, which does not optimize the value of the platform, and therefore builds a smaller network.
- **Too much control means not enough innovation**, not enough meaningful and relevant content, and therefore not a big enough ecosystem to create a meaningful match – Apple in the 1990s.

Openness is a balance of access, providing value to the ecosystem partners and value to the platform. While closed platform do create value – they tend to be limited in both scope and market penetration. When Facebook opened itself to developers**,** they experienced massive growth relative to MySpace which had entered the market earlier. Openness in the right place works because developers then push out the demand curve themselves by innovating and creating more value. It happens over and over again. **Openness at the demand and supply side are critical to building out the ecosystem**, creating volume and thus value.

3.4 Platform Typologies

Referring to our **focus on control and value configurations** and according to Balloon's classification, what does appear to distinguish various types of platforms is the question whether **control over assets is linked to control over customers**:

- **Control over Assets:**
  - Tangible and intangible elements that construct the value proposition
- **Control over Customers:**
  - Elements related to the customer relationship (e.g. charging and billing, profile and identity, branding, etc.)

Reinterpreting the business models currently employed in the ICT industry in this light, **four basic platform types can be distinguished.**

	No Control over Customers	**Control over Customers**
No Control over Assets	Neutral Platform	Broker Platform
	The platform owner is strongly reliant on the assets of other actors to create the value proposition, and does not control the customer relationship	The platform owner is strongly reliant on the assets of other actors to create the value proposition, but does control the customer relationship
	Examples: Google search, PayPal	*Examples: Facebook, eBay*
Control over Assets	Enabler Platform	System Integrator Platform
	The platform owner controls many of the necessary assets to ensure the value proposition, but does not control the customer relationship	The platform owner controls many of the assets to ensure the value proposition, and establishes a relationship with end-users. Entry of 'third-party' service providers is actively encouraged
	Examples: Intel, IMS	*Examples: Apple iPhone, Microsoft OS*

Figure 2 Professor Balloon´s Platform Typologies

3.5 Platform Strategy

Gawer and Cusumano (2008) argue **that not all products, services or technologies can become industry platforms.** To perform this industry-wide role and convince other firms to adopt the platform as their own, the platform must satisfy all the following three criteria:

- (1) **It performs a function that is essential to a broader technological system, or solves a business problem for many firms and users in the industry**. Thereby encourages many other firms & users to adopt it- As the Internet was this unchartered universe of information, Google brilliantly solved an essential technical problem that of how to find anything in the maze of the Internet, with millions of web sites and documents online. **Google's search function provided therefore an essential function to use the Internet**
- (2) It is **easy to connect to or to build-upon**, to expand the system of use as well as allow new, even unintended end-uses- **Google distributed its technology to web site developers and users as an embedded toolba**r, making it easy to connect to and to develop upon. It also allowed different uses (such as combining search with different kinds of information or graphics) due to the inherently versatile nature of Internet search
- (3) **It is difficult to substitute for**- Third, Google quickly proved to be the best search tool, which has kept substitutes at bay

For the first criterion, they recommend to test whether the overall system could function without the particular product, technology, or service. If the system cannot operate, then the product does indeed perform an essential function. For example, the Intel microprocessor and the Windows operating system are both platform components of the personal computer, which is itself a system that could not function without these essential components. **For the second criterion, the challenge is to test whether a product or a technology is easy to connect to or to build-upon**. A way to do this is to see whether external firms have indeed succeeded in developing complementary and interoperable products, or have at least started to do so. **Finally, to test the third criterion, firms have to establish whether there exists a product, technology, or service that could fully replace the existing platform candidate**

In a recent article, Gawer and Cusumano (2008), conclude that **successful platform strategies must simultaneously combine specific insights on platform desi**gn with **specific methods on how to conduct a platform business**. In this article, they argue that there were two fundamental strategies to win in platform battlegrounds:

- One strategy, which we call "**coring," tackles the problem of how to create or establish a new platform where one has not existed before**. Coring sets out to identify or design **an element (which can be a technology, a product or a service)** and **make it "core"** to a technological system as well as a market. The goal of coring is thereby to re-architect technological and business relationships to create a functional hierarchy in the power structure among firms.
- **The second strategy, which we call "tipping," helps managers build market momentum to win a platform battle**. Tipping sets out to influence platform dynamics and needs to be deployed in the context of platforms competing between themselves.

Strategic Option	Technology Actions to Consider	Business Actions to Consider
Coring How to create a new platform where none existed before	• Solve an essential "system" problem • Facilitate external companies' provision of add-ons • Keep intellectual property closed on the innards of your technology • Maintain strong interdependencies between platform and complements	• Solve an essential business problem for many industry players • Create and preserve complementors' incentives to contribute and innovate • Protect your main source of revenue and profit • Maintain high switching costs to competing platforms
Tipping How to win platform wars by building market momentum	• Try to develop unique, compelling features that are hard to imitate and that attract users • Tip across markets: absorb and bundle technical features from an adjacent market	• Provide more incentives for complementors than your competitors do • Rally competitors to form a coalition • Consider pricing or subsidy mechanisms that attract users to the platform

Gawer, A and Cusumano, M. (2008). How Firms Become Platform Leaders.

Figure 3 Strategies to become a platform leader: Coring and Tipping

We found that **both technical and business re-architecting have to be performed**, otherwise coring will fail. **An effort at coalition-building without a proper technological platform design will run out of steam**. Likewise, a good platform design **without appropriate business incentives for complementors will fail,** as we shall detail in the **EMC data storage example**

To provide more detail on **how firms can successfully create a new platform where none existed before,** Gawer (2008) suggest a 7-step process summarized as a checklist.

- (1) Have a vision of **how an alternative, platform-based architecture could supplant the current industry architecture**
- (2) Design (or, if necessary, extract and "un-hide") **an element with platform potential** (i.e., performing an essential function, easy to connect to, difficult to substitute)
- (3) **Add connectors or interfaces so that other companies can build on the platform** and share the intellectual property of these connectors
- (4) **Identify third-party firms that could complete the platform for different types of finished, integrated products** (possibly in different markets and for different uses)
- (5) **Build a coalition**: share the vision by evangelizing the technical architecture, but also by **articulating a business model for different actors in the ecosystem**, rally complementors, **share risk**s, and facilitate complementary innovation
- (6) **Keep innovating on the core, ensuring that it continues to provide an essential (and difficult to replace) function** to the overall system
- (7) Gradually **build up one's reputation as a neutral industry broker**, alongside with making long-term investments in industry coordination activities (whose fruits will create value for the whole ecosystem, including end users

A novel tipping behavior which we have observed is to see competitors banding up together in a coalition, as a defense mechanism, to fight entry by a platform leader wannabe. This can be seen not only in the storage example set out above, but also in cellular telephony with **Nokia ganging up with competitors to back up the Symbian operating system to build a viable alternative to Microsoft's mobile operating system**. Japanese, European, and Chinese telecommunications equipment producers and service providers have also banded together to oppose Qualcomm's monopoly in CDMA technology.

In addition to the assets noted above, we would add a series of other assets, which successful market tippers have used. These broadly fall into two strategic categories:

(1) Influencing the demand side, such as through pricing; and

(2) Influencing the supply side, through as through product design and production, or bundling of complementary features.

Gawer and Cusumano (2008) describe some successful, failed an ongoing coring and tipping strategies cases that we summarize in the following table.

Type of Strategy	Player		Strategy
Coring	Google (Success)	Business	How to make money on the Internet. Google solved that essential business problem by linking focused advertising to user searches
		Tech	Google had competition, Altavista and Yahoo, and was not the first one to solve the technical aspect of coring (even if its technical solution was better). they failed to create as much business for advertisers as Google had
	Qualcomm (Success)	Business	To lessen conflicts with Nokia, Ericsson, Motorola, and other customers, and to encourage them to adopt its platform technology, during 1999-2000 Qualcomm sold its cell phone handset and equipment businesses as well as its chip manufacturing operations, and decided to focus on licensing its technology to users of CDMA/CDMA2000 and WCDMA. Qualcomm was perhaps not as successful as it could have been in the business side of coring – it might have shared more of the profits with its ecosystem partners
		Tech	Qualcomm commercialized its CDMA (Code Division Multiple Access) technology. Various technologies were incompatible, made inefficient use of the wireless spectrum, and offered poorer quality than CDMA, which breaks calls into small bits and then reassembles them much like the Internet does with data packets
	EMC (Failed)	Business	The Wide Sky effort never gained industry support. EMC was unable to convince its competitors -- principally IBM, Hewlett-Packard, Hitachi, and Sun Microsystems – to adopt the EMC proprietary technology. Non-EMC customers were also reluctant to adopt a proprietary standard. As an alternative, EMC's competitors established a new open standards platform controlled by their own organization, the SNIA (Storage Networking Industry Association). The number of firms and users supporting this open technology eventually forced EMC to abandon its platform-leadership effort and adopt the SNIA standards.
		Tech	EMC, a market leader in data storage technology, launched a strategy in the early 2000s that aimed to establish its hardware and software technology, known as Wide Sky, as the industry-wide platform. This coalition of firms, the SNIA (Storage Networking Industry Association), has therefore succeeded at the business aspect of coring, but failed at reaching a technical solution that would really solve the industry's main technological problem
	Facebook (On-Going)	Business	Zuckerberg announced that independent developers can sell advertisements or incorporate tools for conducting online transactions and keep all the resulting revenue. By doing so, Facebook appears to be proactively trying to provide or at least protect business incentives for potential complementors.
		Tech	Facebook is offering a very good product. It also has facilitated development of complementary applications by sharing with developers a special language based on HTML
Tipping	Linux (Success)	Supply	Linux, supported by the open-source movement as well as companies such as Red Hat and IBM, has managed to become the fastest growing operating system used on servers. The Apache web server, became the "killer application" for IT departments that helped establish Linux as a server operating system.
	Netscape (Failed)	Demand	The Navigator browser initially was really a complementary product because it worked along with Windows. But Netscape designed its browser to work on all desktop operating systems, including the Unix and the Macintosh, and later Linux. Microsoft responded by designing its own browser technology, Internet Explorer, and bundling this "for free" with Windows from 1995. This was an explicit tipping strategy. As hundreds of millions of new PCs shipped with Internet Explorer over the next several years, and as Microsoft steadily improved its browser technology. Netscape's greatest mistake was to challenge Microsoft too directly and present the browser as an alternative computing platform before it had enough of a user base and ecosystem of complementors (web site designers and web application developers as well as Internet service providers and PC assemblers who were licensing Navigator) to sustain its position
	Palm (Failed)	Supply	After a resounding success in 1996-1999 as the pioneer of personal digital assistants (PDAs) with its Palm Pilot, Palm tried to do two things at once: succeed both as a product and as a platform. Not only did it try to establish its Palm device as the preeminent PDA, but it also promoted the Palm OS as an industry platform and tried to license it to PDA competitors.Palm is optimized around PDA functions, whereas smart phones that use other operating systems and devices are designed to serve more like handheld computers or telephones or both. Consequently, Palm had great difficulty competing with the Nokia-backed Symbian operating system for smart phones and also Microsoft's Windows CE and Mobile OS

Figure 4 Examples of successful, failed an on-going coring and tipping strategies

Gawer and Cusumano (2008) think that the social networking platforms that best manage this delicate balance of openness – both to stimulate the development of compelling complementary applications as well as to provide ways to generate money – **with some control over content will prove to be the most lasting and valuable**. In particular, it appears to us that **Facebook is doing coring exactly right by tackling both the technological and the business sides simultaneously**.

- First, **Facebook is offering a very good product**. It also has facilitated development of complementary applications **by sharing with developers a special language based on HTML.**
- Moreover, **Facebook understands the business aspect of coring, as it explicitly wants to encourage companies to build businesses catering to its user base**. For example, Zuckerberg announced that **independent developers can sell advertisements or incorporate tools for conducting online transactions and keep all the resulting revenue**. By doing so, Facebook appears to be proactively trying to provide or at least protect business incentives for potential complementors.

Nonetheless, **many firms face strategic questions** that existing research has failed to answer. In particular, many managers – in both high technology and non-technology businesses – are asking the following four questions:

- (1) What concrete steps do I need to follow to become a platform leader?
- (2) What strategy should I follow if I want to dislodge an existing platform leader?
- (3) What strategy should I follow if I want to protect my position from platform competition?

There are common misunderstandings on what it takes to establish a successful platform.

- Many managers assume that **identifying a core component should be enough**.
- Others have thought it sufficient **to manage relationships with complements** or **to find the right pricing strategy** to set off the dynamics of a platform market. There have been a few well-known examples, such as **Intel and Microsoft, which have reinforced overly simplistic notions about what it takes to be a platform leader**

Gawer and Cusumano (2008) now summarize their insights/recommendations and construct a toolkit for platform-leader wannabes.

- **First,** they recommend that in all cases firms should first assess whether their **product, service, or technology has platform potential**.
- Then, what to do next **depends on the nature of end-user demand** (would end-users prefer **specialized products or a variety of applications**) as well as on the extent of the **firm's capabilities (specialist or system integrator).**
- Also relevant are **competition or threat of entry** (i.e., whether there is a credible threat of entry by platform wannabes) as well as the **availability of external firms' capabilities for complementary innovation**.

All these factors constitute **different conditions under which wannabes might apply a combination of coring and tipping**.

		Target industry	
		Has no dominant platform	Has a dominant platform
Entrant's capability	Specialist component-maker	**Coring** Attack system-based competition with platform • Microsoft • Intel • Qualcomm	**Coring + Tipping** Build an alternative coalition and articulate business models for alternative ecosystem followers to rally opponents to existing platform, and/or firms that were left out in the previous platform ecosystem business model • Linux • Google
	System assembler or integrator	**Do Not Try a Platform Strategy** Stay with a product strategy and remain a closed system	**Product Strategy + Tipping.** Start with a proprietary system/device, then bring on complements • Apple iPod, iTV, iPhone • Video Games, with, Sony and Nintendo fighting Microsoft

Figure 5 Strategic toolkit for Platform Wanabees

		If attacked by external platforms
Firm's capability	Component-maker	**Ally with Competitors** But it will be very hard to resist envelopment if you are attacked by a monopolist from an adjacent market
	System integrator	**Dual Strategies: Product and Platform** • SAP/NetWeaver • Nokia/ Symbian

Figure 6 How to protect one´s Position from Platform Entrants

3.6 Platforms at the core of innovative business ecosystems

Platform ecosystems represent a prime example of 'open innovation', enabling a single company to benefit from value creation outside the company's borders. Within the context of **a platform leadership strategy opening up dedicated interfaces to external complementary resources,** however, changes the company's business model from formerly **being 'single-sided' to then being 'two-sided', indicating the**

number of markets the company now has to serve. Per definition, '**two-sided platform businesses'** are perceived as platform operating companies that have opened up their business model and dedicated platform interfaces to external complementary resources (Evans, 2004; Gawer & Cusumano, 2002; 2008). These organizations are targeted at **motivating autonomous third party companies to complement the core platform value proposition to the customer**. Correspondingly, the characteristic of two-sided platform businesses is the mediating role between two or more types of customers who are mutually dependent, and whose joint participation makes the platform valuable to each other (Evans et al., 2004).

Notably, **two-sided platform businesses** differ significantly in their economic rational and strategic behavior from non-platform businesses. Explicitly in platform competition, **indirect network externalities become crucial** to these businesses' success: They imply that **the more buyers (customers) are attracted to a platform, the more valuable the platform becomes to sellers (complementing third party companies)** and, consequently, the more sellers are attracted to it. In turn, the more sellers are offering innovative complementary products and services on top of the platform, the higher the variety and likelihood to match individual customer requirements (Rochet & Tirole, 2003). **As a result, the broader the customer choice of complementary offerings** on top of the platform is, **the greater is the utility customers** are able to derive from the platform **and the greater the platform's profitability** for the platform owner and its complementors (Caillaud & Jullien, 2003; Cusumano, 2008). In this context, **empirical investigations, e.g. on the organization of platform leadership** (Gawer & Cusumano, 2002; 2008; Boudreau, 2006) have come to the conclusion that **innovation outcomes are noticeably shaped by the opening of the platform to external development resources**. In particular, the observation those platform owners such as Apple, Inc., Salesforce, Inc. or eBay, Inc. succeeded in mobilizing thousands of independent software vendors and application developers to build and innovate complementary applications on top of their platforms centers focusing attention on the platform owner's managerial capabilities. **Gawer & Cusumano (2002**) conclude that **stimulating and channeling external complementary innovations** in order **to exploit the dynamics of platform markets becomes a key to a platform's market success**. Platform leaders usually need to perform a delicate **balancing act between competing and collaborating with complements producers**, whose products [and services] are necessary to create demand for the platform' (Gawer & Cusumano, 2002).

3.6.1 Two-sided markets characteristics and Network effects leverage

The economics of platform markets represent dedicated challenges to the establishment of a successful two-sided platform business. The platform owner's primary challenge, thereby, lies in exploiting indirect network externalities. This requires platform owners to manage and sustain a continuous supply of external innovative complementary products and services (Gawer & Cusumano, 2002) to secure the profitability of their investments into an open modular platform concept. Thus, the platform owner's behavior is characterized by its intention to:

- **Convince users on both platform sides** to use the platform and
- **Carefully balance their two demands as demand on each side** vanishes if there is no demand on the other side (Evans, 2002).

Network effects can also be observed across "two-sided" markets where an increase in the number of consumers increases the attractiveness of the platform for developers, while more development increases the attractiveness of the platform to consumers (Parker & Van Alstyne 2000, 2005). But perhaps the most critical distinguishing feature of an industry platform compared to an internal company platform or supply chain is **the potential creation of network effects.** As mentioned earlier, these are positive feedback loops that can grow at exponentially increasing rates as adoption of the platform and the complements rise. **The network effects can be very powerful, especially when they are "direct"**

(sometimes called "same-side") between the platform and the user of the complementary innovation and reinforced by a technical compatibility or interface standard that makes using multiple platforms ("multi-homing") difficult or costly. For example, Windows applications or Apple iPhone applications only work on compatible devices. Or Facebook users can only view profiles of friends and family within their groups. **The network effects can also be "indirect" or "cross-side," and sometimes these are very powerful as well.** These occur when, for example, advertisers become attracted to the Google search engine because of the large number of users. **Companies can also innovate in business models and find ways of charging different sides of the market to make money from their platform** or from complements and different kinds of transactions or advertising (Eisenmann, Parker and Van Alstyne, 2006).

Strategies that leverage on network effects

- Move early (cfr. Sony Playstation)
- Subsidize product adoption (penetration pricing; value is less for initial customers) (cfr. PayPal)
- Leverage viral promotion (cfr. Skype)
- Expand by redefining the market to bring in new categories of users (cfr. Nintendo Wii) or through convergence (cfr. iPhone)
- Alliances and partnerships (cfr. Android)
- Distribution channels (cfr. Microsoft Media Player)
- Seed the market (cfr. Adobe Acrobat)
- Encourage the development of complementary goods – this can include offering resources, subsidies, reduced fees, market research, development kits, venture capital (cfr. Facebook fbFund)
- Maintain backward compatibility (cfr. Apple's Mac OS X)
- Rivals: be compatible with larger networks (cfr. Apple's move to Intel)
- Incumbents: constantly innovate to create a moving target and block rival efforts to access your network (cfr. Apple's efforts to block access to its own systems)

In summary, **a platform's market success and profitability critically depends on the platform owner's ability to strategically orchestrate a value net of complementary innovation resources and capabilities** (Scholten & Scholten, 2010). These insights reveal the following research questions:

- How shall a pl**atform owner holistically manage internal and external innovational efforts** within the context of its platform leadership strategy?
- How **shall a platform owner decide, which innovational efforts to pursue internally** and which to steer within the platform ecosystem?
- How **shall a platform owner stimulate and control the supply of external complementary innovational efforts** in a platform ecosystem of autonomous, however, mutually interdependent partners, striving for own profitability?
- **How shall a platform owner model the open innovation** process in order to coherently evolve the core platform and platform ecosystem to provide the customer with an adequate variety of high-quality complements

3.6.2 Competition in two-sided Platform Business

Platforms are systems of technologies that combine core components **with complementary products and services** usually made by a variety of firms. Together, the platform leader and its complements form **an "ecosystem" for innovation** that can greatly **increase the value of the platform** and its complements

as more users adopt the platform. A key rule of platform design is that you must **design for the good of the ecosystem to ensure that the ecosystem survives.**

An important insight from the economists literature is that pricing can play a key role in attracting either consumers to adopt a platform or developers to invest in developing complementary applications specific to a platform. In particular, economists indicate that platforms can be understood as **double-side markets**, and that it may be necessary for platform owners **to subsidize one side of the market in order to bring on the other, paying, side.**

The platform creator needs to understand what is of primary value to the system, and *subsidize* that side of the ecosystem. This could mean a combination of factors:

- Identify **the marquee developers (supply side) and attract them** through pricing incentives
- Ensure that **governance rules attract third parties who will add value**. Participants need a reason to be part of the ecosystem
- Identify **influential consumers (demand side) who will talk up the virtues of the platform and attract other users** – through incentives
- **Pricing should adjust** to the opportunity cost of the recipient and to the market dynamics

The classic difficulty for building a platform is the chicken-and-egg launch problem. Users of a platform want content and applications before they will use it; **developers for a platform want users before they will provide content and applications**. Each side wants the other side to commit before it will spend resources to adopt the platform. **This is a "critical mass" problem. There are several strategies to promote successful launch.**

- **Seeding Strategies** – Portable Document Format (PDF) has become such a ubiquitous standard that most people do not recall the difficulty Adobe had building its ecosystem. Originally, consumers had no reason to bother acquiring PDF readers because there was no content. Document publishers had no reason to buy the PDF writer because no one had the reader (Parker and Van Alstyne, 2005). Adobe adopted one brilliant strategy and offered the government massive discounts to place all tax forms online for free.

- **Marquee Strategies –** Another common launch strategy is to identify key user groups or key developers and offer them attractive reasons to participate. Microsoft, for example, convinced Electronic Arts to offer popular sports games on the Xbox in order to give users a reason to buy Xbox.

- **Platform Envelopment –** If a platform sponsor has an existing platform, the user base is a remarkable asset that can be used to expand into adjacent platform markets (Eisenmann et al., 2011). Consider that the iPhone emerged into an eBook space that was already crowded with eReaders from Sony, Amazon, Samsung, and numerous others. When Apple then introduced the iPad 1, the firms simply bolted eReader applications onto an iPhone with a larger screen (while cutting the phone and camera capabilities) thereby tapping its large iPhone user base. It expanded into eBooks, displacing existing players, without any true upgrades to its core feature set.

- **Converters & Interoperability** –In the early 2000s, when Apple had a much smaller PC network than Microsoft, its personal computers could read and write disks formatted in the MS-DOS format. This ensured that it could piggyback on the larger network. In cases where Posts have fallen behind other communications networks, they can choose to interoperate with an existing platform to reduce consumer switching costs and grow their own platforms.

- **Articulate Whitespaces** – To show its ecosystem partners where to invest, SAP provides its developers with a 12-24 month roadmap of where its own new developments are occurring. This gives developers at least two valuable pieces of information. First, it indicates what new features are coming so developers know the functions upon which they can build. Second, it indicates where SAP is not going to compete so developers feel safe investing

3.6.3 Platform leadership

Annabelle Gawer and Michael A. Cusumano have focused on the strategic aspect of platforms, and **developed the concept of platform leadership**. Platform leaders are organizations that manage to successfully establish their product, service or technology, as an industry platform. As such, they reach a position that enables them **to drive the technological trajectory of the overall technological and business system of which the platform is a core element,** as well as derive an **architectural advantage from their position in the industry.** Industry platform leaders orchestrate firms that do not necessarily buy or sell from each other, but **whose combined products, technologies or services add value to the ecosystem as well as to end-users**. Platform leaders are **highly dependent on innovations developed by the other firms**, but, at the same time, take it upon themselves to ensure the **overall long-term technical integrity of its evolving technology platform.**

Platform leaders aim to create innovation in complementary products and services, which in turn **increase the value of their own product or service**. Simultaneously they wish to **maintain or increase competition among complementors, thereby maintaining their bargaining power over complementors**. Platform leadership is therefore always **accompanied by some degree of architectural control**. Furthermore, the momentum created by the **network effects between the platform and its complementary products or services** can often erect **a barrier to entry from potential platform competitors.**

Establishing an industry platform requires not only technical efforts from the platform leader to increase value creation opportunities for the ecosystem participants. It **also requires the platform leader to attempt to establish a set of business relationships that are mutually beneficial for ecosystem participants.** Therefore, an important idea that managers must remember is that **technological design and business relationships are to be dealt with together when attempting to create or sustain a platform**

3.6.3.1 *Platform Leadership Strategies*

Platform leadership is understood as ,the ability of a company to drive innovation around a particular platform technology at the broad industry level, (Cusumano & Gawer, 2003). Within this strategic context, platform leaders are facing three particular challenges:

- **First platform leaders have to maintain the integrity of the platform**, i.e. the compatibility with complementary products and services in the face of future technological innovation and the independent strategies of other companies
- **Secondly, platform owners have to evolve platforms**, while maintaining compatibility with past complements.
- **Third, platform leaders are challenged to ensure market leadership** in platform environments in order to **benefit from network externalities**.

Platform leaders find themselves in both a laudable and difficult strategic situation: They are central players in an ecosystem but **highly dependent on innovations and investments from other firms**. Far from remaining passively impacted by the decisions of others, however, the evidence suggests that **platform leaders have a variety of strategic alternatives they can use to influence the direction of innovation in complementary products by third parties**. Platform leaders, therefore, are organizations that manage to successfully establish their product, service, or technology, as an industry platform and **rise to a position where they can influence the trajectory of the overall technological and business system of which the platform is a core element**. When done properly, these firms can also derive an architectural advantage from their relatively central positions.

Gawer and Cusumano (2002, 2008) have studied several examples of industry platforms and the behavior of leading companies in those markets. In particular, based on their **study of Intel**, with comparisons to Microsoft, Cisco, Palm, and NTT DoCoMo, they developed the concept **of "platform leadership," along with its associated strategic activities and practices.** Their 2002 study in particular describes in detail the key actions **Intel took to rise from a simple component maker to supplier within a system architecture** that it had not designed, and then to transform itself into **a major source of influence over the evolution of the personal computer**.

3.6.3.2 *Effective Practices for Platform Leadership*

Platforms supported by a global ecosystem of complementors and strong network effects should be more difficult for competitors to dislodge than standalone products that are more subject to competition based on fashion or price. This makes it difficult for a firm to change its products or its platform, even though these probably need to evolve before they become obsolete. **A number of well-known platform leaders have experienced this type of innovator's dilemma**. Please find here described a set of guidelines to follow an effective Platform Leadership Strategy:

- **First, develop a vision of how a product, technology or service could become an essential part of a larger business ecosystem**
  - Identify or **design an element with platform potential** (that is, performing an essential function, and easy for others to connect to).
  - Identify **third-party firms that could become complementors** to your platform (think broadly, possibly in different markets and for different uses)

- **Second, build the right technical architecture and 'connectors'**
  - Adopt a **modular technical architecture, and in particular add connectors** or interfaces so that other companies can build on the platform
  - **Share the intellectual property of these connectors** to reduce complementors' costs to connect to the platform. This should incentivize and facilitate complementary innovation.

- **Third, build a coalition around the platform:** Share the vision and rally complementors into **co-creating a vibrant ecosystem together**
  - Articulate a set of mutually **enhancing business models** for different actors in the ecosystem
  - Evangelize **the merits and potentialities of the technical architecture**
  - **Share risks with complementors**
  - Work (and keep working) on firm's legitimacy within the ecosystem. Gradually **build up one's reputation as a neutral industry broker**

  - Work to **develop a collective identity for ecosystem members**

- **Finally, evolve the platform while maintaining a central position** and improving the ecosystem's vibrancy
  - **Keep innovating on the core**, ensuring that it continues to provide an essential (and difficult to replace) function to the overall system, making it worthwhile for others to keep connecting to your platform
  - **Make long-term investments in industry coordination activities**, whose fruits will create value for the whole ecosystem.

3.7 Implications for Regulation

The emergence of these ICT multi-sided platforms implies that **policy makers and regulators should not take for granted that simply allowing and facilitating the convergence** between IT, internet, telecommunications and media services and technologies **will result in an unbundled, open marketplace in which competition will flourish** (Ballon, 2009a). The final objective of this study is to **explore how such aspects could be taken on board by the regulation** of electronic communications and ICT markets in Europe.

3.7.1 Platforms and Regulatory concerns

The recent Digital Agenda for Europa appears to acknowledge the need to adapt the regulatory framework to the reality of platform markets. It was launched by EU commissioner Kroes on 19 May 2010 as a comprehensive action plan, to be implemented through a range of follow-up actions including legislative proposals. It **identifies seven priority areas for action**, i.e. creating a digital Single Market, greater interoperability, boosting internet trust and security, much faster internet access, more investment in research and development, enhancing digital literacy skills and inclusion and applying information and communications technologies to address challenges facing society like climate change and the ageing population. **One striking aspect of the Digital Agenda** is that it foresees new European **interoperability rules** for the electronic communications industry, **based on antitrust rules related to the abuse of market position**, referring in this case to a significant, instead of dominant, position. In this case, **obligations will be imposed related to license interoperability information, to ensure consumer choice in software as well as hardware**. Commissioner Kroes has recently expressed **concern over the market position and conduct of Apple**, in particular in relation to the interoperability between various smartphone platforms. Observers disagree about the extent to which a similar case can be built by the Commission as was done related to **the openness of the Microsoft platform**. Some also call for a further European **continuation of the US-originated net neutrality debate, on the merits of ex ante regulation of telecom operators' involvement** in, and treatment of, internet content and services. In any case, it is clear that there is a growing awareness of and **concern over the position and potential abuse of market power by platform owners in the electronic communications industry**.

However, the characteristics of platforms provide also a number of reasons to mitigate concerns and/or intervention. A platform coordinates interactions between two or more distinct groups of stakeholders and is able to internalize the externalities created by one group for the other group. **Business models in multi-sided platform markets, rather than to focus on profit maximization** in a single market, primarily deal with **getting the various stakeholder groups on board, balancing interests between these groups and with single- or multi-homing of customers** (i.e. whether customers are tied to one or more platforms) (Evans, 2003). This means that, in a multi-sided market, **a viable pricing strategy could consist of subsidizing one side to attract customers on the other**. This implies that **competition**

policy analysis cannot consider prices separately, and should not regard a strategy based on cross subsidies as predatory in many instances (Cortade, 2006; Wright, 2004).

It has also been argued that **regulators, who impose price regulations and other restrictions on one specific** (type of) actor, seldom take into account **the impact of such regulation on the entire value network, which is especially relevant in the case of multi-sided platforms.** Policy makers and regulators ought to use a more holistic framework, which may shift the emphasis from traditional policy analysis based on **specific policy domains or isolated 'relevant markets'**, towards the relevant determinants **for successful platform models** (Poel et al, 2007

In electronic communications, **access operators are regulated in an ex ante fashion because they control essential facilities and because the prospects for competition are regarded as limited**. In other parts of the ICT industry, **dominant players are regulated ex post under competition law**. Under the **new Digital Agenda, Europe appears to move further towards regulating platforms in general,** i.e. the access to platforms, the interoperability between platforms, and so on.

3.7.2 Platform types and Regulatory concerns

The **platform typology highlights different control and value configurations that platforms employ**. It spans the whole value network and therefore may be fairly robust to technological and economic evolutions. As the emphasis of current European legislation and regulation of electronic communications currently **lies with competition issues in the access market, upstream market developments are largely ignored**. However, not only businesses with significant market power in access markets may abuse their position at the expense of their competitors and of end users, but increasingly, **these access providers are dependent upon service providers, content providers, software and hardware manufacturers that are also in the position to abuse their power.**

The platform typology introduced in this study **describes all actors involved in ICT service provision and consumption in a more abstract** manner, and attempts to position them within a simple framework that enables an evaluation of their relative position within the struggle for platform leadership. This relates to questions such as **who has dominance within a complex ecosystem of actors, who possesses the strongest bargaining position, who may function as a competitive bottleneck, and who may lock-in users.** Given the fact that recognition of the specific nature of platforms and the associated regulatory concerns came only recently, it is unavoidable that European policy makers and regulators are uncertain about the necessity for intervention (i.e. ex ante or ex post), and a fortiori about the basis and methodology for potential intervention. This is partly a consequence of the fact that platform markets do not fit the relevant market scheme as defined in the European system, and partly the **consequence of the fact that very diverse types of companies may be involved**. Many, if not most of these companies do not have to comply so far to any sector-specific regulation. This also poses the question of **regulated access providers being confronted with non-regulated competitors**. In addition, platform companies operating in multi-sided markets may offer product and service bundles, with prices set at each side that are often not cost-oriented, without this necessarily leading to a decrease in consumer surplus. **Both lawmakers and regulators therefore will have to display a high level of inventiveness in order to deal with these issues in the short term**. How to make the link between platform regulation and specific business models?

Table 2: Platform Types and Regulatory concerns

	No Control over Customers	Control over Customers
No Control over Assets	Neutral Platform	Broker Platform
	The platform owner is strongly reliant on the assets of other actors to create the value proposition, and does not control the customer relationship	The platform owner is strongly reliant on the assets of other actors to create the value proposition, but does control the customer relationship
	Regulatory concerns: - *no specific concerns*	*Regulatory concerns:* - *Customer lock-in (raising switching costs)* - *Price squeeze of service / content providers*
Control over Assets	Enabler Platform	System Integrator Platform
	The platform owner controls many of the necessary assets to ensure the value proposition, but does not control the customer relationship	The platform owner controls many of the assets to ensure the value proposition, and establishes a relationship with end-users. Entry of 'third-party' service providers is actively encouraged
	Regulatory concerns: - *Refusal to deal* - *Strategic design of products (interoperability)* - *Lock-in of service/content providers*	*Regulatory concerns:* - *Customer lock-in (raising switching costs)* - *Price squeeze of service / content providers* - *Refusal to deal* - *Strategic design of products (interoperability)* - *Lock-in of service/content providers* - *Cross-subsidisation*

Figure 7 Platform Types and Regulatory concerns

3.7.3 Tools for regulatory intervention

After identifying the specific concerns raised by the four platform types that Ballon and Van Heesvelde distinguished, the question is in which way regulators may intervene, if necessary**, to ensure the development of the market and citizens' rights to pluriformity, choice, affordable tariffs, quality and innovation.** Moreover, it should be asked whether **such intervention ought to be ex ante,** i.e. by specifying up front a corpus of regulatory goals and measures with the aim of fixing a number of rights and obligations in an anticipative manner, as is the **typical approach for electronic communication**; **or whether ex post interventions,** essentially based upon classic competition rules, suffice.

Any typology used to characterize platform markets should be based on an analysis of the market situation, and provides an indication of competition issues that may be expected, or may not be ruled out. As with the market definitions of the European Recommendation, NRAs may then, using the principles of competition law, assess whether a company is able to behave independently of competitors, suppliers, and users. Furthermore, they may assess **whether a company is able to price goods or services above the competitive level**. Finally, they may analyze whether **a company can raise 'bottlenecks' against its competitors**. The level of competition is assessed by **analyzing substitutability on the demand as well as**

the supply side, using the hypothetical monopolist test for groups of services that are used by consumers for the same purpose. **Article 14 (2) of the Framework Directive** states in this respect: "An undertaking shall be deemed to have significant market power if, **either individually or jointly with others, it enjoys a position equivalent to dominance**, that is to say a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers and ultimately consumers". Market definitions necessarily also entail an investigation into the position of users. Instead of being involved merely as passive consumers, they determine, through their choices, **the market shares of the specific platforms**. Those choices are influenced by **several factors, including tariffs, technologies, service offerings, expectations about the success and durability of a specific platform**, usability, and so on. Also, there is the question of the extent to **which consumers themselves may develop** (e.g. content creation and/or distribution) platforms, or at least strongly influence them.

The second step in present regulation is that of market analysis. It is analyzed what the **relative weight (i.e. the market share) is of various businesses operating within a defined market**, and whether there **are sufficient opportunities for other companies to enter the market with chances of success, or to further develop themselves.** If this is not the case, **remedies are imposed** on businesses with significant Market Power. **This is the third step.** It can already be remarked that these remedies will probably have a different form in multisided markets, as they are not, or at **least not almost exclusively, targeted at access problems**, and do not strive towards the ladder of investment principle – even though they cannot be in contradiction with these principles. The assessment of whether a market functions well or not is again based on competition rules. **Three criteria are important in this respect**:

- High and non-temporary barriers to entry in a market;
- The dynamic state of competition behind these barriers to entry ;
- The question of whether existing competition law is sufficient or not. The recommendation on Relevant Markets (para 16) states: " ... **justifying ex ante regulation would depend on the persistence of high entry barriers**, ... the dynamic state of competitiveness and thirdly on the sufficiency of competition law (absent ex ante regulation) to address persistent market failures."

The European framework foresees a number of measures that can be taken ex ante. They are principally aimed at the wholesale market, and derive from the Access Directive and the Universal Service Directive. As they essentially pertain to the regulation of networks, they cannot be applied as such for regulating the platforms reviewed here. The most important remedies in the Access Directive in this context are: transparency, nondiscrimination, accounting separation, co-location and facility sharing, technical standards, price control, cost orientation, and publication and access to information (in the context of potential obligations to grant access to networks/platforms). NRAs can choose to enforce these remedies separately or in combination. An additional remark in this regard is that there is a package of remedies aimed at the protection of the consumer (i.e. the Universal Service Directive), that may also have positive effects on competition. One important element is included in article 3 of the Services Directive: "...that vertical integrated public undertakings which provide electronic Communications networks and which are in a dominant position do not discriminate in favor of their own activities." Reference is naturally alo made in the Framework Directive (art. 14 (3)): "Where an undertaking has significant market power on a specific market, it may also be deemed to have significant market power on a closely related market, where the links between the two markets are such as to allow the market power held in one market to be leveraged into the other market, thereby strengthening the market power of the undertaking."

While the competition issues can constitute an effective method for a theoretical and anticipatory analysis with regard to the types of platforms that pose most risks, it is far less evident that all the current remedies are useful in this new context (in this regard, see also the discussion in the section on policy concerns related to platforms in general). **In addition, the underlying markets are far more complex than mere access markets.** The bundling of services, the employment of cross subsidies, and **temporary selling below cost at one side of the market may all be acceptable**, as they may lead to

consumer surplus in the longer term. Still, measures such as transparency, non-discrimination and the obligation to negotiate (if necessary under supervision), may be relevant in various cases. **And the more classical instruments of competition law, as translated into the measures of the Universal Access Directive**, will be appropriate in a number of instances. Yet it is **far from evident that these ought to be applied ex ante**

Therefore, **a thorough investigation can be recommended of potential risks as a consequence of multisidedness of markets**, inspired by the current regulation of access markets. Such investigation must lead to a framework to guide NCAs, NRAs, and the EC. It may also yield two positive and important results, i.e. a harmonized approach among the member states and substantial gains in time. It is up to the EC, and in first instance the European Regulatory Group (ERG)- **presently called BEREC, to conduct this investigation and assess whether ex ante regulation is required, or whether ex post intervention, if necessary at all, suffices.**

3.8 The nature of the Platform Business Models

Opening up dedicated platform interfaces to external development resources transforms the former product into a platform consequently, t**he nature of the respective business model determines the platform owner's** revenue generation from the platform. Fundamentally, platform business models are differentiated into three categories:

- The integrated,
- The product and
- The two-sided platform business model

In the integrator platform model, the company **integrates external innovations** and sells the final product to customers. In the product platform model, **external innovators build on the platform and sell the resulting products to customers.** Finally, in the **two-sided platform model, external innovators and customers are enabled to transact,** while transactions are facilitated, governed and mediated by the platform owner. **Two-sided markets characteristics:**

- Two distinct groups of customers with distinct characteristics and preferences
- They *have to* participate both in order for a market to exist
- The extent of participation of one group determines the extent of participation of the other group
- They need a 'platform' to find each other
- Positive externalities arise by finding each other
- The platform internalizes (part of) the externalities created at both sides of the platform

3.8.1 Platform Economics: So how do platforms make money?

Numerous sophisticated organizations **have made *pricing errors determining how to make money in platform markets.*** Even the best platform firms have made serious mistakes because prices on one side of a market are connected to purchases on the other side. Adobe originally tried to charge for the PDF Reader at a time when there was not yet PDF content for consumers to view, causing their business model to fail. In the 1980s, Apple charged $10,000 for its system developer toolkits, which drove developers to Microsoft (Eisenmann et al., 2011). Surprisingly, Salesforce.com repeated this mistake in the 2000s. Or eBay's own failure to capture auction markets in Japan and China when it imported its U.S. pricing model into those markets, where its rivals initially offered free transactions

However, because platforms couple developers and consumers, there exist reasons to subsidize one side of the market in order to increase revenues on the other side of the market. Google paid $5.5M in prizes for the best new Android applications in order to promote Android adoption. It has now overtaken Apple's iPhone in the total stock of mobile phones supporting Android. In the digital mail context, Zumbox is covering all costs on behalf of consumers to support scanning, bill collection, presentment, payment, archiving, and single sign-on across users' various accounts. This is a subsidy. Having a captive set of consumers allows Zumbox to charge merchants and mailers more than if they had no such pool of users. Additional revenues will later come from providing advertising access to these consumers on a consumer permission basis.

In an important new development, some operators are also participating directly in platform models. Case in point: Sprint, which has maintained a developer network for years, and which **offers its developer community access to platform services like billing, location, and data services**

In a one-sided model, the wholesale supplier does not have a direct relationship with the customer, and is only paid by the vendor. **In the two-sided model, the vendor—now called a "platform company"—receives money from two sources**: the traditional customers but also a developer community that builds new services or applications on top of the platform, and which can be more aware of customer needs.

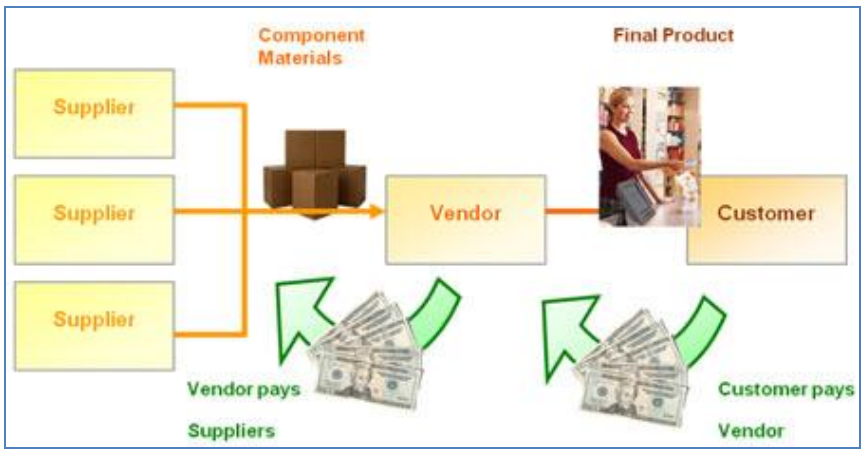

Figure 8 A traditional one-sided supply chain

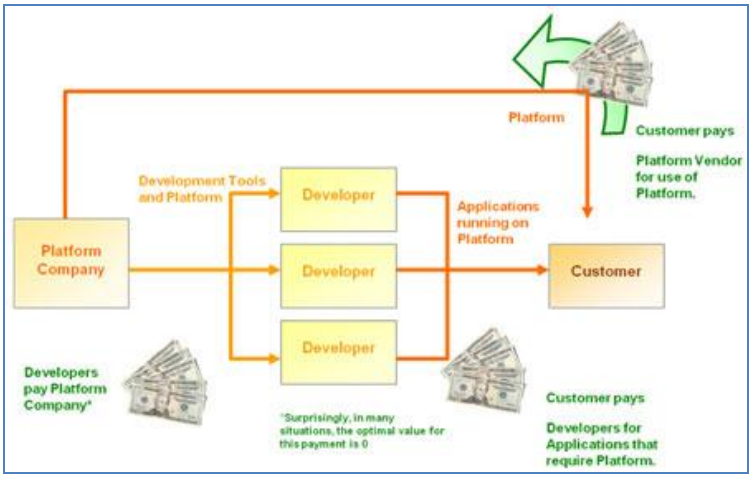

Figure 9 In a two-sided business model, the platform company draws revenues from both the traditional customer but also potentially a developer community

A key rule of platform design is that **you must design for the good of the ecosystem to ensure that the ecosystem survives**. The platform creator needs to understand what is of primary value to the system, **and *subsidize* that side of the ecosystem.** This could mean a combination of factors:

- Identify **the marquee developers (supply side) and attract them** through pricing incentives
- Ensure that **governance rules attract third parties who will add value**. Participants need a reason to be part of the ecosystem
- Identify **influential consumers (demand side) who will talk up the virtues of the platform and attract other users** – through incentives for tweets, posts etc.
- **Understand the market dynamics** so that charges apply to the price *inelastic* side of the market while subsidizing where there is low marginal cost
- **Pricing should adjust** to the opportunity cost of the recipient

3.8.2 Platforms and Network Effects/Pricing Leverage

Platforms should *not* price to marginal cost or price to extract the most revenue from a given user group. Instead, they must price to drive *adoption*, maximizing revenues across *both* sides of the platform. A full set of six implementation rules for pricing was provided on platform principles

1. ***Capture the cross-side network effects*.** In consummating the match, **the platform must ensure it takes a fee**, either to participate or to transact, to run the platform. **This fee should not create undue resistance to participation.** Netscape gave away free Internet browsers but the complement, Internet servers, were not proprietary complements so Netscape made no money.
2. ***Subsidize the price elastic side and charge the price inelastic side***. Platforms need critical mass so to launch they bring one side on board by giving that side value. They make up this value **by charging the other side**. To get digital documents into the PDF standard, **Adobe gave away the reader and charged for the writer.**
3. ***Subsidize the creators of value*.** The consumer demand curve shifts out when there is more value added to a platform. **All major operating and gaming companies subsidize developers with free access to** Application Programming Interfaces **(APIs)** and heavily discounted System Development Toolkits (SDKs).

4. ***Platform subsidies should involve negligible marginal costs*.** Information goods and hosted services make good giveaways. Free PCs make poor giveaways. **Platforms must understand what the costs of what they give away.**
5. ***Avoid interfering same-side network effects***. If a platform forces one side of its market e.g. suppliers/developers, into fierce competition, then they might choose to avoid the platform entirely.
6. ***Cater to marquee users*.** Certain large consumer groups or individual developers can get better deals because they bring with them other large user groups, they add critical value, or the platform needs them to stay away from competitors.

3.8.3 A typology of platform business models

Referring to our **focus on control and value configurations** and according to Ballon´s classification, what does appear to distinguish various types of platforms is the question whether **control over assets is linked to control over customers**:

- **Control over Assets:**
  - Tangible and intangible elements that construct the value proposition
- **Control over Customers:**
  - Elements related to the customer relationship (e.g. charging and billing, profile and identity, branding, etc.)

	No Control over Customers	**Control over Customers**
Control over Assets	***Enabler Platform***	***System Integrator Platform***
	The platform owner controls many of the necessary assets to ensure the value proposition, but does not control the customer relationship	The platform owner controls many of the assets to ensure the value proposition, and establishes a relationship with end-users. Entry of 'third-party' service providers is actively encouraged
	Examples: IMS, Intel, Windows Mobile, Android	Examples: Microsoft Windows ecosystem, iPhone, Ovi
No Control over Assets	***Neutral Platform***	***Broker Platform***
	The platform owner is strongly reliant on the assets of other actors to create the value proposition, and does not control the customer relationship	The platform owner is strongly reliant on the assets of other actors to create the value proposition, but does control the customer relationship
	Examples: PayPal, LiMo, Bondi	*Examples: eBay, GetJar, Handango*

Figure 10 Ballon´s Platform Typologies

- **Enabler:** (Windows Mobile, Android (2008))
  - Significant contribution to value proposition; no customer relationship
  - Mainly license model, but advertiser model also possible
  - Success factors and constraints
    - Price/revenue share to access the platform
    - Diversity of available APIs and access to network capabilities

        - Available documentation and support
        - Value proposition to the end user (no customer relationship)
    - Core competences
        - Building and maintaining an IT infrastructure to support the services offered in the platform
        - Supporting developers in creating and submitting their software
        - Developing attractive pricing for developers
        - Developing skills in a different type of customer support (towards developers and thus, on a technical level)
        - Involvement in standardization activities
        - Induce innovation by incentivizing developers
    - Example: Telefonica's Open Movilforum
        - Provide to independent developers open APIs to integrate
        - Applications/mashups with mobile services' features such as SMS or MMS.
        - Open Movilforum also offers SDKs, tutorials and a blog to facilitate developers' engagement.
        - Registration is open to everyone and free.

- **System Integrator Platforms (Apple iPhone, Nokia Ovi)**
    - Strong contribution to value proposition; strong customer relationship
    - Service purchase through platform owner (or operator)
    - Revenue share model determined by platform, revenue share with operators may exist; also typical cross-subsidy model
    - Most revenue sources, but need to be able to create real scarcity
    - Success factors and constraints
        - Same factors as for Enabler Platforms
        - Plus attracting end users
        - Charging and billing
        - Management of developer community
        - Competition from existing successful (manufacturers') system integrator platforms
    - Core competences
        - Enabler platform competences also apply here
        - Successfully attracting both developers and end users
        - Towards developers: setting up an attractive revenue share rate and a good development platform with possibility for feedback
        - Towards users: setting up competitive pricing and billing schemes
    - Example: Orange Partner
        - Provides developers with free access to device specifications, APIs, tools and a developer's community, as well as technical support during development and testing of the final application.
        - A premium subscription is needed to access advanced APIs and publish the mobile software in the marketplace. This marketplace was made available by the end of 2008 and consists of a Web Portal and a mobile
        - WAP portal. It was extended to a mobile client, enabling end-users to browse, download and purchase applications at the end of 2009.

        - Orange Partner manages sales, marketing and distribution of the mobile applications via the different sales channels and splits the revenues with the application developer

- **Neutral Platforms (LiMo, Bondi)**
    - Basic set of tools, but weak contribution to value proposition; no customer relationship
    - Acceptance as most important strategic objective; Open source and/or consortium approach
    - Funded by indirect revenues (through consortium agreements, or advertising)
    - Success factors and constraints
        - Managing relations between existing organizations
        - Founding group
        - Attractive proposition to potential consortium partners
        - Threshold to join
        - Balancing potentially diverging interests of partners
        - Cooperating (legal, IPR, technology…)
    - Core competences
        - Being organized and structured to facilitate efficient collaboration
        - Managing relationships and balancing the internal and external interests of partners
        - 'Standardization' mindset and approach
        - Setting up business-to-business public relations to create awareness of the platform
    - Example: Linux Mobile Foundation
        - Offers tools, documentation and –in the near future– SDKs to developers and manufacturers, all based on the Linux kernel.
        - The Foundation wants to offer a complete middleware package (kernel and application layer) on which the mobile OS can be built. Members include Orange, NTT Docomo, Vodafone, Telefonica, Verizon Wireless, SK Telecom, Telecom Italia and SFR

- **Broker Platforms (GetJar, Handango)**
    - Weak contribution to eventual value proposition of the services offered; but customer relationship exists
    - Funded by service fees; revenue share with service providers; relationship with service developers is key
    - Can also be offered in white brand / licensing mode
    - Success factors and constraints
        - Attracting developers (revenue share, Time to market, support systems...)
        - Usability and discovery towards end users
        - Fragmentation of the market and of market places
        - Managing different devices and OSs
    - Core competences
        - Again related to attracting both developers and end-users
        - Providing developers incentives to publish on the platform (e.g. an attractive revenue sharing scheme)
        - Providing developers with tools to track statistical information on their products
        - Focus on user experience and provide a user friendly environment with competitive prices

- Example: Vodafone's "App" and "Extras" storefronts
  - The store is accessible via Vodafone's webpage and allows users to download software for their specific device, as the store supports different types of hardware.
  - Some of the software is available for free, others require a fixed monthly fee or a per-use fee.
  - This operator branded application store is an example of an MNO broker platform as it offers third-party developed applications to Vodafone customers in a single environment

3.9 Lessons Learned from Platform Market Analysis

Platforms require a non-traditional business model and a different way of working. These are not one-off products but are rather ecosystems with many cross-dependencies**.** As a result, the design, governance and execution need to be done with a more holistic approach such that the interests of ecosystem partners are balanced. Consequently, decisions regarding **open versus closed, free versus charged, and cooperation versus competition** will influence the success of the platform in both size and longevity:

- Market creation
- The size and sustainability of the ecosystem
- The ability of the platform to encourage and capture network effects

In addition, the rise of industry platforms raises complex social welfare questions regarding the **trade-offs** between the social **benefits of platform-compatible innovation**, versus the potentially negative effects of **preventing competition on overall systems.** The analysis simultaneously evokes the fundamental question of **how incentives (for third-parties) to innovate can be embedded in the design of the platform**. This leads to another design rule for platforms:

- **The interfaces around the platform must be sufficiently "open" to allow outside firms to "plug in" complements** as well as innovate on these complements and make money from their investments. This resonates well with research by Chesbrough (2003) and others (von Hippel, 2005) on open innovation.
- **However, recent research on platforms, by highlighting the complex trade-offs between "open" and "closed**" (Eisenmann, Parker and Van Alstyne, 2009; Greenstein, 2009; Schilling, 2009; Gawer and Cusumano, 2008), suggest that while **opening up interfaces will increase complementors' incentives** to **innovate**, it is **important to preserve as proprietary some source of revenue and profit**. It therefore adds a more subtle take on the literature on open innovation that had extolled the benefits of opening interfaces.

Another key objective of new platform-based product development seems to be the **ability to increase product variety and meet diverse customer requirements, business needs, and technical advancements** while **maintaining economies of scale** and scope within manufacturing processes – an approach also associated with "mass customization". For all these abovementioned purposes, we summarize the **key themes identified in platform design:**

- Absolute need to distinguish clearly between (only) **technical and (technical as well as) business platforms**
  - **Great platforms beat great products.** Apple became valuable by developing a great platform. It offered an inferior gaming device relative to the dedicated Sony PSP and an

inferior camera relative to the dedicated Canon Powershot yet iPhone outsells both of them.

- **The overall ecosystem that is built around the platform is what makes the platform work;** therefore an understanding of the components of the ecosystem is required to develop the required platform.
    - This implies **focus on business ecosystem management in two-sided or multi-sided markets**
    - It implies also a very detailed analysis of multihoming tradeoffs at various levels
    - Wannabe platforms should either focus on **huge functionality leap or openness and interoperability**
- **The platform must have rules that define how various parties interact**. The rules of participation make the ecosystem work for the benefit of *all* parties in the ecosystem.
    - **Governance must establish responsibility and accountability**. This includes commitments on what the platform will promise developers. It also ensures participants are rewarded for the value they add to the network overall. Platforms can fail when the owner thinks only of what to take from the ecosystem and not what to give back.
- **Network effects result from both a volume of users and a volume of content creating a virtuous circle.** The more users you have the more valuable the network becomes to existing users
    - A proper functioning network rewards participants for the value they bring and fosters creativity and innovation across the ecosystem. The creativity and innovation ensure that the platform remains relevant over the long-term
- **Different types of platforms can be distinguished,** according to different control and value configurations
- The platform must have standards to provide **clarity for how components interact.**
- **In the open vs. closed choice**, a closed architecture is more profitable for short term gains, but will limit the size in the long-term. Being too closed can even cause the platform to collapse as Apple learned in the 1990s. The more commoditized the service/solution the more open the platform must be.
- **Regulatory drive towards** (some) platform neutrality: **interoperability and standards**

Regarding policy and regulation side, **the rise of platforms in ICT markets invites a reappraisal of regulatory frameworks and practices.** Besides inter-organizational collective action, formal law regulations and policies from government and/or regulatory authorities play an important role in enabling the vision of common service platforms

- One relevant issue in this domain is that **sharing distributed service resources** (i.e. network infrastructure, service platform and devices) may not be in the interest of all involved actors only if there is strong added value or perhaps enforcement from market competition or regulations.
- Moreover, there is **a lack of interest from actors to solve the problem of interoperability** mainly because of related costs, complexity, and reliability or competition concerns.
- As such, **policy and regulation coordination** (i.e. horizontal policies like macro-economic, competition and IPR policies) can be part of solution for collective action to emerge in this domain and thus solve the issues in this complex situation.

A final key challenge for platform sustainability is that, as technology is constantly evolving, the business decisions and the **technology or design decisions have to be taken in a coherent manner**. This is difficult to achieve since these decisions are often made by different teams within the organization. Hence, to make the whole greater than the sum of the parts, as in Gawer and Cusumano (2002), we can see the need in many complex systems industries for one firm or a small group of firms to **act as a "platform leader**.

4 FI-WARE Vision

The high-level goal of the FI-WARE project is to build the Core Platform of the Future Internet. This Core Platform, also referred to as the "FI-WARE Platform" or simply "FI-WARE" , will dramatically increase the global competitiveness of the European ICT economy by introducing an **innovative infrastructure for cost-effective creation and delivery of versatile digital services, providing high QoS and security guarantees.** As such, it will provide a powerful foundation for the Future Internet, stimulating and **cultivating a sustainable ecosystem for** (a) **innovative service providers delivering new applications** and solutions meeting the requirements of established and emerging Usage Areas; and (b) **end users and consumers actively participating in content and service consumption and creation**. Creation of this ecosystem will strongly influence the deployment of new wireless and wired infrastructures and will promote innovative business models and their acceptance by final users.

4.1 FI-WARE Objectives and Building Blocks definition

The major goal of the FI-WARE project is to build the Core Platform of the Future Internet. This Core Platform will deliver a novel service infrastructure, building upon elements (called Generic Enablers - GEs) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors

- **FI-WARE's principal objective is to become a facilitator between application providers and final customers** bringing a new service experience to end users, smoothly integrating tailored and dependable services into their daily life
- **The unique and entirely novel harmonization, consolidation, and convergence across technologies and business frontiers proposed and implemented by the FI-WARE platform,** in close alignment with the different Usage Areas, will reinforce and extend European strength, capability, and productivity by providing a framework in which participation of stakeholders is taken to an entirely new level.

FI-WARE addresses the requirements of Future Internet networked applications by an evolutionary architecture that allows composition of standard and existing elements (generic enablers) in an on demand fashion via open, flexible, and harmonized interfaces. The flexibility and compatibility implemented by the FI-WARE architecture and business vision will in turn support unprecedented orchestrations of infrastructure and services tailored to specific needs without heavy spending on customization, on-premise infrastructure, and other CAPEX bound to silo-solutions.

- **The architecture of FI-WARE is**, by no means, limited to the requirements of a limited set of selected Usage Areas but universal in ambition and by that able to cater to any potential application and cross-application domain
- **The proposed FI-WARE architecture is being developed with a view to connect and give value to Smart Infrastructures**, including the Internet of Things, Personalization of services and flexible infrastructures. Those developments should facilitate the value of existing infrastructures and new developments built on top of them, in an open and interoperable way.
- **FI-WARE fully endorses the concept of IaaS and PaaS in order to enable rapid infrastructure creation or service creation through application blueprints**. It will be complemented by NaaS by network virtualisation. All together IaaS/PaaS Cloud hosting GEs in FIWARE will provide a unique opportunity to take the lead of the Future Internet by providing a platform for execution that will be able to serve and scale to unforeseen levels and purposes, while minimizing risks in ―a priori‖ investment on infrastructures.

- **FI-WARE's full support of XaaS (Everything as a Service)** through the Apps/Service Ecosystem and Delivery GEs will in particular allow for customer-centric innovation and the uptake by smaller sized companies. These users can innovate on top of FI-WARE.

The promotion of seamless cross-domain inter-operability provided by the FI-WARE will lead to the creation of entirely new markets for applications. FI-WARE envisages the creation of new emerging markets that do not yet exist or niche market exploiting partial elements of the multiple components that the platform will require.

As the construction of the applications on top of a platform will necessarily require the setting of common standards, a European or even international level will provider wider facilities to reach the goal. The complete and international representation and involvement in FI-WARE provides an ideal platform for setting international standards across technology and business. The shift from stove-pipe on-premise applications towards service oriented architectures and the trend towards **collaborative application and software development with a mix of Proprietary and Open Source solutions puts far-reaching demands on application providers.**

The Core Platform to be provided by the FI-WARE project is based on GEs linked to the following main **FI-WARE Technical Chapters**:

4.1.1 Application and services ecosystem and delivery framework

The Application and Services Ecosystem and Delivery Framework in FI-WARE comprise a set of generic enablers for creation, composition, delivery, monetization, and usage of applications and services on the Future Internet.

It supports the necessary lifecycle management of services and applications from a technical and business perspective, the latter including business aspects such as the management of the terms and conditions associated to the offering, accounting, billing and SLAs.

4.1.2 Cloud hosting

FI-WARE will comprise the Generic Enablers are able to serve the needs of companies that may need IaaS Cloud hosting capabilities, PaaS Cloud hosting capabilities or both, meeting the requirements for the provision of a cost-efficient, fast, reliable, and secure computing infrastructure "as a Service".

Building upon existing virtualization technologies, FI-WARE will deliver a next generation Cloud Stack that will be open, scalable, resilient, standardized, and secure, and will enable Future Internet applications and extend the reach of the cloud infrastructure to the edge of the networks, much closer to end users.

4.1.3 Internet of the things

The FI WARE IoT Services comprise those Generic Enablers allowing a large number of distributed and heterogeneous things and associated IoT resources to become available, searchable, accessible and usable by Future Internet Applications and Services.

IoT Services Enablement in FI-WARE will provide a set of IoT-oriented Generic Enablers dealing with: IoT communications, heterogeneous resource management, data handling and process automation.

This substrate of IoT-oriented Generic Enablers will provide important efficiency gains in many industries and usage areas, particularly when combined with other FI-WARE Generic Enablers.

4.1.4 Data context management services

FI-WARE will provide the methods and components for effective gathering, accessing, processing and analyzing large amounts of stored or live data providing native facilities for multimedia and semantic classification.

FI-WARE added-value on this regard relies on the following enablers and services:

- Facilities to massively collect incoming data from the Internet of Things world, aligned with an improved release of the OMA NGSI standard.
- Publication & Subscription of notifications, decoupling events consumers and producers.
- Definition of new events triggered as complex combinations of primary events occur.
- Smart storage and map-reduce analysis of large amounts of data or massive data streams.
- Analysis of Multimedia streams or stored files, detecting specific patterns appearance.
- Location information retrieving for mobile objects.
- Enrichment of data objects with metadata, semantic annotation and ontologies management

4.1.5 Interfaces to the network and Devices

FI-WARE will provide the open interfaces to networks and devices, providing the connectivity needs of services delivered across the platform.

The Generic Enablers provided to implement a standardized Interface to Networks and Devices (I2ND), can be used by other FI-WARE elements, such as Cloud Hosting, Internet of Things, etc. They can also be directly used by the applications in multiple Usage Areas.

4.1.6 Security, Privacy, Trust

FI WARE will provide the mechanisms which ensure that the delivery and usage of services is trustworthy and meets security and privacy requirements:

- A set of GEs for a number of shared security concerns (i.e. identity and access management as well as privacy and auditing)
- A set of optional Security GEs to address current and future requests from concrete Usage Areas.
- An advanced security monitoring system that covers the whole spectrum from acquisition of events up to display, going through analysis but also going beyond thanks to a digital forensic tool and assisted decision support in case of cyber attacks

4.2 FI-WARE Business Ecosystem

The FI-WARE project intends to support the development of innovation-driven value chains around Applications and Services. These value chains are materialized by a **number of actors playing various roles supported by FI-WARE technologies**. The following table describes the different roles envisioned for the FI-WARE-enabled value chains.

Role	Description
Application Developer	Future Internet Application Developers are encouraged to develop smart applications targeting either mass markets or individual enterprises and organizations (which in turn may have a limited number of users or, again, the mass market as end users). These Applications should offer flexible means for deployment, provisioning and runtime operation "on the Cloud". Future Internet Applications are intended to be meaningful and stand-alone, implementing a number of functions they export "as a Service" to End Users through a number of User Interfaces but also to third Applications in some cases, through well-defined Service APIs (Application Programming Interfaces). They typically rely on functions provided by a number of Enablers, which can be specific to the Application Domain or Generic (meaning they are general purpose).
Enabler Developer	Enabler Developers are encouraged to develop software components or more complex systems that can be instantiated to provide functions easing the development, provisioning and/or runtime operation of Future Internet Applications. Enablers are intended to be universal, that is, they refer to multiple Applications that rely on the functions they implement. Those functions are exported "as a Service" to third Applications through well-defined Service APIs and also to End Users in some cases, through a number of User Interfaces. Enabler Developer may integrate several lower-level Enablers to realize new and more powerful Enablers.. Note that Applications and Enablers resemble each other in their architecture since both implement functions that they export as services. The central differentiator between them is the primary users to be addressed (End Users in the case of Applications, other Applications in the case of Enablers). Note, however, that some products may qualify equally as Applications or Enablers.
(Application / Enabler) Service Provider & value added service	**Service Providers** are in charge of deploying, provisioning and operating either Applications or Enablers. Stakeholders playing the Application/Enabler Developer role may also play this

providers	role. However, this is not always the case (e.g., a Public Administrator may be playing the Service Provider role with respect to applications developed by third parties and that the city offers to its citizens) Application and Service Providers mainly participates in an ecosystem enabled with FI-WARE technology through provisioning, consuming or discovering of services in relation to their business. A service provider is in general active in one business domain where his main business model is residing, but potentially is enable to be active in other business domains, enabled through FI-WARE technology. As a sub-role the **value-added service provider** will be enabled to build innovative services and apps on top of the offerings other providers within and crossing the ecosystem.
(Application / Enabler) Service Hosting Provider	**Service Hosting Providers** provide and operate the hosting infrastructure on top of which Applications or Enablers are deployed. They entwine themselves with the Service Providers to reduce the costs for service provision. Service Hosting Providers may provide Cloud Services for hosting Applications and Enablers. Note that, in that case, they can indeed be considered a concrete case of Enabler Service Provider (here, the Enabler is the Cloud providing hosting services) so they may be also referred as "Cloud Hosting Provider". In many cases, an entity playing the Enabler Service Provider role also hosts the Enablers it provides, therefore also playing the Enabler Service Hosting Provider role. However, note that this is not strictly required (one may think about a Enabler Service Provider that provides a number of enablers, all of them being deployed on Amazon hosting services).
(Application / Enabler) Service Aggregators	Service Aggregators select Services from a broad variety of Service Providers and compose them to build new service offerings that address the specific requirements of niche End Users.
(Application / Enabler) Service Brokers	Service Brokers bring together a multitude of Services from diverse Providers and publish them on marketplaces where end users can compare them, matching their requirements with capabilities of published Services. they should exploit economies of scale and protect investments in the long run. Finally, the ability to combine applications from different sources necessitates innovative revenue sharing models across partners and potentially also customers (e.g. crowd-sourcing) which have to be adapted dynamically as market conditions change.
(Application / Enabler) Service Channel Makers	Often specialized services must be adapted to the specific environment in which they are used. Without such adaptation it can be difficult to make profitable use of some service, e.g., in hospitals. Service Channel Makers are in charge of such

	adaptation.
FI-WARE Instance Providers	An instance provider operates and provides one particular FI-WARE instance to a given ecosystem or business domain or to a use case project. He assembles a given set of Generic Enablers and defines a scenario and usage domain for the particular FI-WARE Instance. Finally he provisions information about how to use the instance, defines his terms and conditions and enables others to work and collaborate on top of the given FI-WARE instance.
Roles in relation to the Open Innovation Lab	There are a number of upcoming roles, which will play a leading role in the "Open Innovation Lab", yet to be defined (Hosting provider, SME/3rd party integrator..)

While there are clear boundaries among these roles, a company/organization may take one or more of the roles defined above. Indeed, we foreseen it will be very common that some companies/organizations play one of these roles as its core role but will try to gain differentiation in the market or try to capture additional revenue streams by playing any of the other complementary roles.

Additionally, we may distinguish between a numbers of different types of **End Users**: End Consumers (individuals in the mass market) and enterprises and other organizations:

- **FI-PPP Use Case projects** will adopt FI-WARE technology in their given domain and allow others to collaborate and work on top of joint scenarios in a defined setting.

- **End Consumers** want to gain access and easily consume applications that can effectively **assist them in daily life situations** (e.g., purchasing goods, managing bank accounts, or planning travels). Some of the underlying problems involved are the **management of the ever-growing data and information** (e.g. from their sensor-enabled environments) and the **seamless access anywhere, anytime and from any device.** They also ask for improved means for communication and **collaboration within their social networks, families, neighborhoods in real-time** and while being mobile, meeting security and privacy requirements. Overall, these capabilities would **transform communities, homes and cities into safer and better places to live** and leverage the Internet as an additional societal utility. The Future Internet that aims at more fine-grained and individualized services has to respond to their requirements as a **central issue of innovation**. Even though these end consumers do not bring about innovation they nevertheless indirectly **become the drivers of innovation because they ultimately decide about the success or failure of innovation.**

- **Enterprises and other organizations** on the other hand, wish to get closer to their customers in order to deliver an **even more compelling user experience and better service**. For this reason, they would like to **exploit contextual user data which may lead to a more personalized interaction experience and service offering**, and would like to realize a **stronger participation of users in all phases of product and service lifecycles,** thereby bringing the lessons of the Web 2.0 phenomena into the services space. In order to develop and operate their services, new methods, technologies and tools are **needed to speed up the time to market, to establish value added services which may be better configured in partnership with others and to simplify access to relevant resources and capabilities,** e.g., from the Internet of Things. Additional requirements on business services include reduced complexity of ICT provisioning, scaling, global availability and meeting security requirements from customers and legal authorities. **An appropriate Future Internet platform would greatly contribute to meeting these demands from business customers**. Enterprises and organizations possess the capacity to investigate

consumer behavior and drive development of innovative services and applications based on these investigations. Despite we are referring here to enterprise and organizations playing the End User role, they can partake in the Future Internet in different ways so that we will individually consider these roles in the following. **They can appear as End Users as well as in any of the previously described roles**. Relations between enterprises and organizations are often governed by long-term contract, which **provides another area of possible innovation.**

Many different business stakeholders will be part of the ecosystems creating Future Internet based applications and services. They are likely to have different business objectives and offerings. The following categorization summarizes the relevant stakeholders, the roles they are expected to play and, consequently, the impact FI-WARE may induce:

Established Telecom Industry

- Telecom Service Providers: They will typically play the role of FI-WARE Instance Providers as their core role, relying on FI-WARE technologies to develop new open and innovative business models leveraging the assets they already have, i.e. exploring possibilities to "open up" their existing networks or the data they manage or connecting third Application/Services Providers with their large customer base. In general, trying to create a compelling ecosystem for Application/Services Providers that leverages on revenue share models. They, of course, will need to understand the technical hurdles, which need to be overcome. They can also play a relevant role as FI-WARE GE Provider and accelerating the development of standards based on FI-WARE results. They also may play the role of FI-WARE Application/Service Providers, developing new services and applications for large Usage Areas where telecom-based communication, security and availability levels as well as support to roaming users are required. Also to leverage their position as FI-WARE Instance Provider or simply extend its portfolio, thus being able to keep growing in the Digital world.
- Network equipment manufacturers (core and access networks): Develop and provide technical solutions to support Telecom Service Providers in their role as FI-WARE Instance Providers. They may generate product/platforms covering a number of FI-WARE GEs and provide services on which Telecom Service Providers may rely to implement their role as FI-WARE Instance Providers or FI-WARE Application/Service Prroviders. They can also play the role of FI-WARE Application/Service Providers, commercializing compelling ICT-based services based on FI-WARE which can be bundled together with other Application/Services in their portfolio to bring solutions to different Usage Areas or to enrich the Applications/Services ecosystem a given Telecom Service Provider wishes to build around the FI-WARE Instance it operates.
- Mobile terminal manufacturers: Develop and provide appropriate terminal devices with new features, M2M communication equipment and sensors for new application domains, which can interface easily with FI-WARE Applications and Services. Some of these new capabilities may require they implement some FI-WARE GEs, so that they are more suitable to run on their devices. Based on open standardized interfaces, economies of scale and affordable/interchangeable solutions for customers can be achieved.

IT Industry

- Software vendors: They will typically play the role of FI-WARE GE Provider. Therefore, they will explore, develop and provide new software components, services, middleware, business services (delivery) platforms and cloud-based infrastructure components needed for emerging Future Internet applications and services in a converging IoT, IoS, and IoC environment.
- IT Providers: Many of them are evolving in a line similar to Telco Service Providers, therefore playing any of the three defined roles.
- IT Solution integrators: They will typically play the role of FI-WARE Application/Service Providers, adapting to the new challenges of developing and integrating new converged

Telecom/IT solutions. They sometimes may decide to play the role of FI-WARE Instance Providers, offering the outsourcing of all ingredients that are part of the solution.

FI-PPP Use Case projects

FI-PPP Use Case projects will adopt FI-WARE technology in their given domain and allow others to collaborate and work on top of joint scenarios in a defined setting.The various stakeholders in the Usage Areas are expected to have very different objectives. Many of them suggest basic improvements of their business processes and the more efficient use of resources of any kind. Others request solutions to support them in the development of new cross-sector solutions currently considered as complex to implement and operate. Both of them are in charge of supporting societal challenges either based on financial incentives or based on regulatory requirements. FI-WARE is a key element to support the different sectors in their approach.

Emerging Future Internet solution aggregators for converged services

In a converged Future Internet ICT industry new challenges for developing / composing / deploying of (domain- or sector-specific) solutions emerge. Established or new players especially from the SME sector will increasingly have to develop solutions in a world of complex service networks crossing telecom services. Therefore, they will play the role of FI-WARE Application and Service Providers, thereby adapting their business models and technology know-how appropriately.

Note that convergence equally well applies to cross-sector innovation concerning domain-specific service providers, e.g. from the areas of logistics, healthcare, energy, services, where new services are composed by linking and services from different sectors and developing new business models around them.

End users

Further end users affected by the FI-PPP and contributions of FI-WARE are citizens, (non-governmental) organizations, individuals, employees, and the generation of prosumers (possibly also aiming at generating their personal income). Solutions that have direct impact on this group of stakeholders are highly desirable.

4.3 Enabling 3rd party innovation in FI-WARE

Two major concepts have emerged, see "Third Party Innovation Enablement in FI-WARE" document, while we tried to come up with design decisions that enable innovation by 3rd parties (potential actors). The first was that technologies in FI-WARE must rather work as a **backbone** for Future Internet Applications. Equally important, they must be **open in order to give enough freedom to innovative ideas.**

To realize this backbone, FI-WARE will provide the following assets:

- **A single set of APIs, each of which brings about concrete built-in innovation-enabling capacity** and altogether allow Application Developers to focus on domain-specific innovation.
- **An approach of comprehensive service description and annotation, optionally externalized through languages like the Unified Service Description Language (USDL), that enables FI-WARE GEs to describe relevant data of technical, operational and business aspects in a unified way,** easing the integration of different applications and services beyond a mere interoperability perspective.

At the same time openness is supported by the following aspects of the FI-WARE approach:

- **The public and royalty-free nature of FI-WARE Open Specifications** allows replacement of products instantiated to build FI-WARE Instances, or used from Applications. This way, both FI-WARE Instance Providers and Application Providers **avoid to get locked in a concrete product vendor**.
- **FI-WARE Open Specifications do not prescribe more than what is strictly required to ensure the ability to replace compliant products** without compromising functionality. This **opens up opportunities for FI-WARE GE developers to drive innovation.**
- **FI-WARE Instance Providers can go for developing sustainable business models around FI-WARE Instance**s, which do not necessarily comprise the whole set of FI-WARE GEs. This fosters the appearance of FI-WARE Instance Providers who are specialized in concrete FI-WARE Chapters where they feel capable to bring innovative ideas that differentiate them from potential competitors. Application Providers, on the other hand, are able to decide which concrete FIWARE GE Instances they will use out of the variety of available FI-WARE Instances. They might even be able to change their selection dynamically.
- **FI-WARE Instance Providers can complement the FI-WARE GE Instances they build with other Enablers** (e.g., Enablers providing access via API to services offered by a popular Social Web service or some mobile advertising platform they own) that may bring a differential value to target Application users.
- The **value-added service provider** will be enabled to build innovative services and apps on top of the offerings from other providers within and crossing the ecosystem.
- **Application Developer** will benefit from the existence of alternative FI-WARE GE compliant products offering the same set of APIs, avoiding to get locked in any specific vendor, therefore protecting their investment.

This **technical infrastructure composes the basis on which FI-WARE Application Developers as well as FIWARE Instance Providers can develop those innovative offerings** that bring about completely new business opportunities and stimulate the service economy of the future

4.3.1 The FI-WARE Testbed and Open Innovation Lab

The FI-WARE project will generate a FI-WARE Instance, hereunder referred to as **FI-WARE Testbed**, which will allow partner Use Case projects (including a number of Use Case projects that are part of the European FI PPP initiative) to run and test Future Internet Applications based on FI-WARE Generic Enablers. This FI-WARE Testbed will be available shortly after delivery of the first FI-WARE major release. FI-WARE Instances linked to trials or commercial services (exploitation phase) are, in turn, referred to as "**FI-WARE Instances in production**".

The FI-WARE Testbed is aimed to be complete, in the sense that it will comprise reference implementations of all Generic Enablers defined in the FI-WARE Architecture. The Testbed will not necessarily be centralised, but will be under central control and be accessible from a dedicated website. The FI-WARE partners will provide support to Use Case projects for the deployment of applications (e.g., the conceptual prototypes) on top of the FI-WARE Testbed. Tests run by the partner Use Case projects, coordinated with tests defined by the FI-WARE project, will help to validate Generic Enabler Open Specifications, the reference implementations of FI-WARE Generic Enablers developed within the FI-WARE project, as well as the conceptual prototypes developed by Use Case projects.

In order to pave the way for a successful exploitation and sustainability, the FI-WARE project will work on setting up an **Open Innovation Lab** around the FI-WARE Testbed **after the second release of FI-WARE**.

This Open Innovation Lab will support community involvement beyond the initial partner Use Case projects, offering a space where future innovations on top of the generic enablers provided by FI-WARE can be nurtured. Availability of the FI-WARE Testbed per se does not guarantee innovation as such, therefore the FI-WARE Open Innovation Lab will comprise all what is needed to stimulate awareness among target application providers and users so that they feel attracted to participate and build a community. **In order to support this, it will also bring tools helping members of the community to share their experiences, needs, etc**. Combined with FI-WARE Instances that will be setup to support trials in phase 2 of the FI-PPP, it will **help potential FI-WARE Instance Providers to realize about the business opportunities that participation in FI-WARE** –enabled value chains will bring for them.

5 FI-WARE Market Positioning

The overwhelming number of service platforms (mostly with proprietary standards and technologies) has made this domain even more complex and doubtful for users. The growing popularity of mobile and internet-based services, as **Google Android and Apple platforms,** is increasingly changing the ICT Vision from simple home automation services to advanced ICT services which are accessible everywhere. Additionally, **many small and large vendors and service providers across different industries** are becoming more **aware of the remarkable prospects in the smart living domain.** Accordingly, several services bundled with different service platforms are emerging in the market**,** aiming at providing elderly-care, energy management, security or entertainment services. All **these industries / contexts share common features:**

- Complex technological systems
- Fast evolution of technology
- Importance of interoperability and integration
- Require collaboration among several firms

FI-WARE will address the requirements of Future Internet networked applications by an evolutionary architecture that allows **composition of standard and existing elements** (generic enablers) in an on demand fashion **via open, flexible, and harmonized interfaces**. The main pillars over this architecture will be build up will be the following:

- **Cloud hosting companies, which can be considered as a particular type of FI-WARE Instance Providers,** are already delivering on the promise of the Cloud paradigm. They own and manage large IT infrastructures and offer their use as a service on a pay-as-you-go model. Cloud hosting is particularly appealing to SMEs and start-ups wanting to offer some new and innovative service over the Internet.
- **The IoT Communication function in FI-WARE will allow unified communications** regardless of the different network standards and will enable data transfer services agnostic to the underlying connection protocol
- **An appropriate Interface to the Network and to the Devices as envisaged by FI-WARE will comprise a number of layered interfaces specializing** in serving significantly different connectivity purposes and **providing the enablers which offer the expected functionalities**: the network infrastructure, the network services and the broad range of connected devices used to access the services/applications in every condition and location (e.g. in mobility, in indoor environments).
- **FI-WARE is going to define and standardize a common service level interface (or API)** that will define how to **access information in a safe way,** preserving confidentiality of data and privacy of the user.

The flexibility and compatibility implemented by the FI-WARE architecture and business vision will in turn support unprecedented orchestrations of infrastructure and services tailored to specific needs without heavy spending on customization, on-premise infrastructure, and other CAPEX bound to silo-solutions. **By this, FI-WARE directly addresses one of the fundamental strategic concerns** in the infrastructure, application and service provider domains, **namely operational expenses**.

On the whole, FI-WARE will change the way that different players across the sectors (technology, business) talk and act about discovering, managing and using networked applications and services, with increased dependability, agility and a much reduced time from idea to realization at scale.

5.1 Application and Services Ecosystem and Delivery Framework

The Application and Services Ecosystem and Delivery Framework comprise a set of generic enablers for creation, composition, delivery, monetization, and usage of applications and services on the Future Internet.

It supports the necessary lifecycle management of services and applications from a technical and business perspective.

5.1.1 Market Overview

In a growing market, $3,8Billion apps sale by 2011, vs $206 Million in 2008 and over $8 billion per year expected by 2014, there will be lots of competition from Internet players (Google, Facebook, Apple), from other industries (banks etc.), and to capitalize on the opportunity requires new skills and relationships - latent assets, new revenue model, new distribution channels etc.

- **Apple has demonstrated the value of integrated content/software/delivery systems** and Google has rightly perceived the combination of iTunes, iAds, and the iOS devices as a major competitive threat. Moreover, **Apple's focus on apps, rather than web browsing,** threatens to weaken the strategic position of Google's search engine.
- **Google clearly wants to extend its dominance of search-related advertising into the mobile market** and Android, no license fees, customizable and user friendly strategy, is becoming a potent weapon.
- **Facebook has facilitated development of complementary applications** by sharing with developers a special language based on HTML. Additionally, Zuckerberg announced that independent developers can sell advertisements or incorporate tools for conducting online transactions and keep all the resulting revenue. By doing so, Facebook appears to be proactively trying to provide or at least protect business incentives for potential complementors.
- **Telco Companies have failed to realize revenue growth from the app economy** in their other core services (voice and messaging) or **in their enabling services** (advertising, payments, location, etc.) they will have to demonstrate at least some of the technical and commercial skills displayed by Apple.
- **Regarding business applications domain, SAP has established a business process platform (BPP), attracting a large platform ecosystem of partners to build solutions on top of its technology platform.** In 2010, SAP ,continues to **invest in its partner ecosystem to support the development of solutions built on the SAP Net Weaver technology platform** and leverage partner sales forces to address the various market and customer segments' (SAP AG, 2010b). Globally, **more than 9.000 companies participated in SAP's various partner networks**, and 1.2 million individuals in SAP's online communities

Supported by hundreds of thousands of software developers, Apple, Google and Facebook's platforms are fuelling innovation in consumer and, increasingly, business services on both the fixed and mobile Internet**. Apple, Google and Facebook are making their way to the top of that order, pushing aside some of the world's biggest Telco, equipment makers and media companies.** This trio, together with Amazon and Skype (soon to be a unit of Microsoft), are fundamentally changing consumers' behaviour and dismantling longstanding TMT value chains, while opening up new markets and building new ecosystems

In the 'app economy', the provision of applications and content to mobile devices, is a key reason for this growth. The app economy has itself benefited from the confluence of three key drivers

- the development of more powerful devices with greater functionality, and
- the creation of appstores
- the (probably temporary) shift to flat rate data plans,

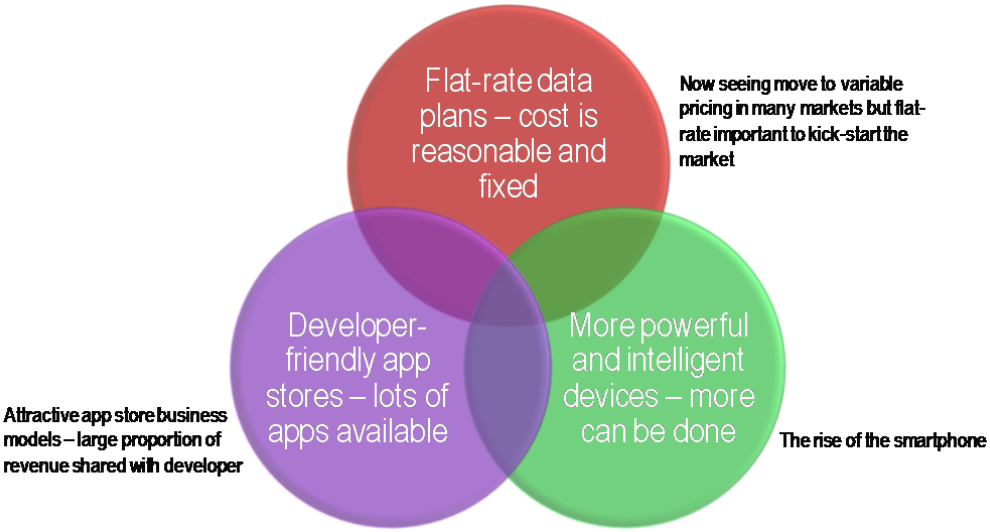

Figure 11 The $125Bn 'Two-Sided' Telecoms Market Opportunity, Source: Telco 2.0

On their current trajectory, **Apple, Google and Facebook have become major conduits for software applications**, games, music and other digital content, rewriting the rules of engagement for the media industry. **These companies are set to suck much of the value out of the telecoms services market**, substituting relatively expensive and traditional voice and messaging services with low-cost, feature-rich alternatives and leaving Telco simply providing data connectivity

The Google Play Store now, October 2012, accounts for 700,000 Android apps, according to Google company release, finally **catching up to roughly the same number of programs in Apple's App Store**. As for other platforms, Windows Phone has more than 120,000 apps, and research in Motion is currently trying to convince developers to build for its BlackBerry 10 platform. In two years' time, the number of Android apps has grown from 100,000 to current 700,000, closing the gap with Apple, which grew from 285,000 to current 700,000.

Regarding the most fast growing mobile devices, smart phones and tablets **Android and Apple devices dominate, with 85 percent of the worldwide market** combined, according to research firm IDC in the second quarter of 2012. Other OS, Symbian, Blackberry, Microsoft have decreased in the market share of smart phones but they are still challenging Apple and Android and may play different strategies on new devices. Microsoft, for instance, proposes a consistent set of solutions for convergence between connected devices, fixed and mobile, and cloud services.

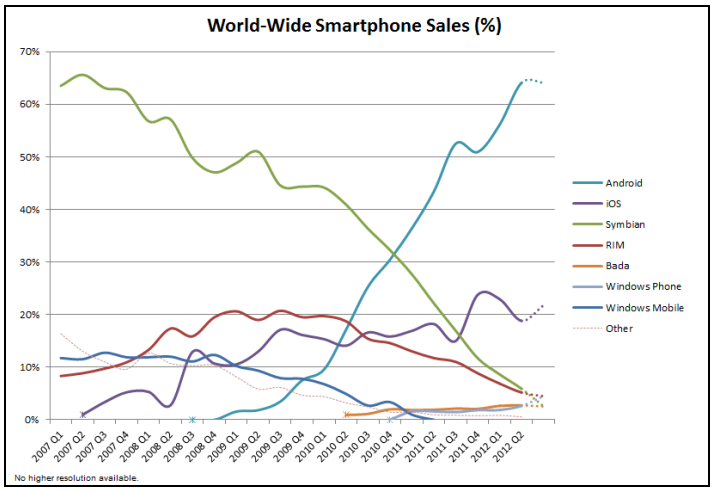

Figure 12 IDC's figures for worldwide smartphone unit sales and market share in the second quarter of 2012, by operating system.

The diversity and fragmentation in the offer of connected devices, both in terms of hardware capabilities and software platform, **is one of the reasons of the overall increasing of their market share** and one of the reasons that **makes the Future Internet a real technology foundation for all the other future innovation**. **In fact, 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. Starting from the past year, a new solution for bridging different OS has been offered by HTML5.** Adopted by W3C as a standard in progress, but de facto mainly driven by Google and few other OTT companies, **HTML5 (together with JavaScript) offers a way to access to device and network capabilities using common Web languages**.

Although Android and Apple based platform actually have the largest market share and thus have a greater priority and **attention from developers**, nevertheless it's not so obvious which winner strategy should be adopted to fit the widest set of users and devices and their different habits, that sometimes imply the usage of different devices for different activities. Vendor strategies are still in progress and **Windows 8 could play a significant role in the future and some forecasting assign up to 20% to Microsoft for the future global share.**

The **uncertainty about the future trends is still splitting the interest and the effort of application developers** towards **multiple different platforms**, as shown in the Figure 13.

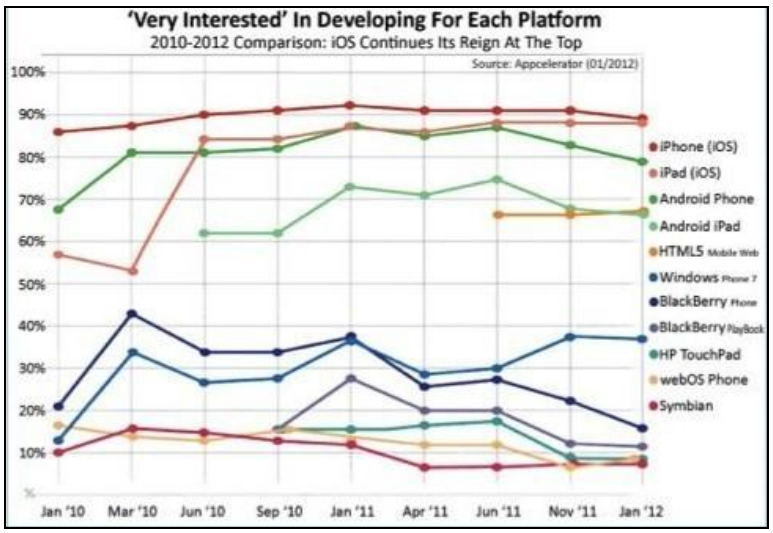

Figure 13 Relative Interest of Developers for different SW Platform / OS, Source: Appcelerator

On the whole, the operative systems that are attracting most developers are iOS and Android, but we identify the following opportunities within the application market to work on them:

- **HTML5 web apps, present new distribution opportunities** for app developers to include Telco services as; voice, messaging, and payments, in a uniformed way
- Additionally **the business application domain,** where these OTT companies are not yet positioned, offers a new opportunity than main European ICT players should explore.
- The possibility to address the **upcoming challenges from IoT heterogeneity and data context management**
- While a store **Apple, Google, and Amazon is owned by a store owner** who has full control over the specific (limited) service portfolio, **the option of a marketplace** as a platform for many stores to place their offerings to a broader audience and consumers to search and compare services and find the store, where to buy, seems a fruitful option to avoid to get locked in any specific vendor, and therefore protecting their investment.

5.1.2 Vendors

A platform approach is typically enabled by opening application programming interfaces (APIs) to facilitate an environment for low-risk experimentation and makes it possible to develop applications on top of existing infrastructure. Currently there are many players in the worldwide market including software vendors that developed a platform to build applications on top of. The main are:

1. The **Apple App Store** is a digital application distribution platform for iOS developed and maintained by Apple Inc. The service allows users to browse and download applications from the iTunes Store that were developed with the iOS SDK or Mac SDK and published through Apple Inc. Apple has benefited from iPhone sales significantly more than its competitors because it has built an end-to-end user experience. Apple has deployed its skills, partnerships and integration capabilities across the value chain - content owner, developer, app store, billing and payments and hardware all have to work in concert technically and commercially
2. **Google app Engine**- low cost web apps (https://developers.google.com/chrome-developer-tools/docs/overview) The Developer Tools, bundled and available in Chrome, allows web developers and programmers deep access into the internals of the browser and their web application. The Developer Tools are heavily based on the WebKit Web Inspector, a part of the open source WebKit project. This overview of the Developer Tools points out its most popular and useful features.
3. **Amazon web services** (AWS- http://aws.amazon.com/what-is-aws/) provides a highly reliable, scalable, low-cost infrastructure platform in the cloud that powers hundreds of thousands of businesses in 190 countries around the world.
4. **Facebook,** or the over over one billion people that use Facebook and more than half of them using Facebook on a mobile device,the App Center is the central place to find great social apps. Everything has an app detail page, which helps people see what makes an app unique and lets them install it before going to an app. Possibility of reach millions of people on mobile each month by integrating your app with our tools and SDK**s.**
5. **SAP has grown to become the world‘s leading provider of e-business software solutions.** With 194,000 customers, an external software ecosystem of 3,000,000 developers, and more than 11,500 partners, SAP is the world‘s largest inter-enterprise software company and the world‘s third-largest independent software supplier, overall. **SAP has attracted a large platform ecosystem of partners to build solutions on top of its Business Process Platform**. In 2010, SAP ,continues to invest in its partner ecosystem to support the **development of solutions built on the SAP Net Weaver technology platform** and leverage partner sales forces to address the various market and customer segments.
6. **Pachube,** Pachube is a real time data infrastructure platform for the Internet of Things, managing millions of data points per day from thousands of individuals, organizations & companies around the world. Pachube's powerful and scalable infrastructure enables you to build 'Internet of Things' products and services, and store, share & discover real-time sensor, energy and environment data from objects, devices & buildings around the world. Pachube was acquired by LogMeIn.

Apple

Apple’s strategy was justified on several accounts. First, contrary to Microsoft, which focused on software, **Apple has always designed and commercialized hardware combined with software.** Apple’s **business model was (and remains) to make money from hardware that is unique both because of its design and its software**. Apple, therefore, showed **little interested in licensing its software**. Further, another justification for keeping software and hardware integrated was to **make the best possible computer and to improve the system’s capabilities** without having to ensure that it would work on a variety of hardware configurations. **A superior integrated experience has always been what Apple was striving for**. As a result, **Apple did not benefit from the kind of ecosystem dynamics that Microsoft did**. There was no

competition to drive down hardware (and software) prices and much **less incentive for software companies to produce applications for the smaller Macintosh market.**

Apple has learnt from its early mistakes and from the success of Microsoft. Apple understands now how to **harness the power of platforms, and in particular the importance of complementary products and positive feedback loops**. With its **iTunes store, Apple has lined up the best content and has signed the most deals with music content providers**. It also recently signed a deal to **display videos from Google's YouTube service**. Building on iPod's tremendous success, Apple has also entered the mobile **telecom space with iPhone, which adds e-mail, web browsing, and phone capabilities**. Apple's platform ambitions can in fact be traced back to 2000, when it began to develop service software such as iTunes, but also launched a series of hardware machines, with new Macintoshes, the iPod, and the Apple TV -- a wireless set-top box that wirelessly shares and accesses content, and is integrated with iTunes -- and soon the iPhone. The combination of hardware and software is an ambitious effort by Apple to establish a platform in the digital space.

Apple has benefited from iPhone sales significantly more than its competitors because it has built an end-to-end user experience. Apple has deployed its skills, partnerships and integration capabilities across the value chain - content owner, developer, app store, billing and payments and hardware all have to work in concert technically and commercially

Apple's App Store, an update to iTunes and known as the "walled garden," because Apple reviews every app submitted to its app store and requires developers to follow a seven-page list of strict guidelines to get an app approved. Once enrolled in Apple's standard program, individual developers can upload their application to Apple and wait for at least a week to have the feedbacks. Apple will issue the developer the certification to offer the application in the app store to download.

It also means higher quality apps for consumers who like the fact that **Apple now has more than 700,000 approved apps for the platform**. Regarding the revenue sharing model adopted, **the 70% of the revenue will be given to the developer every month.** Even if the application is for free to download, the individual developer has to pay $99 one-time fee to be enrolled into the standard program to have the right to upload their application on the app store.

But what should Apple worry about now? While a **proprietary platform approach seems fine for creating new markets and product categories**, it may become vulnerable once a market takes off – **if new uses become available or attractive to customers** and the company is unable to provide those new capabilities. **Another danger is imitation and commoditization** – if other firms succeed in copying the essential features of the unique product and drive down prices. Therefore, Apple must remain on the frontier of product design and the user experience

Favourable aspects

- It shortens the product development cycle.
- The developer is able to develop their applications to the entire world, the multi-language support gains more opportunity: it helps sales and is valued by customers.
- Apple provides a single distribution channel which makes the distribution relatively cost -saving.
- Protect applications developers investment

Shortcomings

- A closed store, limitation to the innovation
- Linked to a device
- High barriers to entry
- Too much Paperwork
- The developers have no knowledge about the application approval procedure and the rejection report is sometimes unclear

Google

Google continues to core its market by appealing aggressively to developers to innovate on and extend the Google platform through:

- Google's Application Programming Interfaces (APIs) to enable developers to embed Google applications such as search, maps, calendars on websites, or to develop custom search engines.
- Google also presented APIs for the W2.0 social networking site YouTube, which it purchased in 2006.
- **Google App Engine is a unique hosting platform that lets you build applications and run them in Google's data centers** using the massive global infrastructure built to run the Internet's most powerful company. **App Engine offers a development environment that uses familiar technologies** (Java and Python) and provides a powerful and robust set of APIs to users while maintaining security and independence from other apps running in the cloud
- **Google Play is a digital-distribution multimedia-content service from Google** which includes an online store for music, movies, books, and Android applications and games, as well as a cloud media player.

Google has also increased the amount of free online software it provides and is expanding its ambitions, and even though Apple has a 10-year advantage, **Google has closed the gap and now has 700,000 apps catching up to roughly the same number of programs in Apple's App Store** and supposedly 1,300,000 new device activations every day, according to Google company release. Unlike Apple, there's no vetting process for developers who want to submit apps and those apps can be available almost immediately.

Favourable aspects

- Fast and easy to develop for
- No maintenance effort needed
- Android is a Linux distribution - It also benefits from an enormous pool of Unix/Linux talent at every level from hardware to applications development.

Shortcomings

- Although opening a platform may stimulate adoption of the platform, it intensifies the competitive pressure and may reduce the incentives of complementary providers for investment on the platform.
- Google App Engine supports only a limited set of Java libraries due to restrictions on the platform. It may also be more difficult to move your applications out of GAE
- Certain applications will be impossible to implement

Facebook

"Web 2.0" platforms encourage their users to contribute either with content or with complementary applications (called "widgets" in this context), platforms do differ in their approach to the degree of openness they encourage or tolerate. For example, MySpace strictly controls the features embedded in its site. In the spring of 2007, it blocked some third-party makers who sold ads on their small program, such as a popular photo sharing widget maker called Photobucket. This approach contrasts with Facebook, whose co-founder Mark Zuckerberg announced in May 2007 before 750 developers that he aimed to make of Facebook "the first open social network platform." Zuckerberg promised that **Facebook would remain available for any company or developer that wishes to develop for it and claimed that until then, social network platforms were "closed"**. He also announced that the company had signed 65 partners, including Microsoft and Amazon, to build and embed embedding customized features into Facebook. These features include Amazon's "Book Review" application, which allows Facebook members to share their book reviews with people in their private network

While closed platform do create value – they tend to be limited in both scope and market penetration. When **Facebook opened itself to developers, they experienced massive growth relative to MySpace**

which had entered the market earlier. Openness in the right place works because developers then push out the demand curve themselves by innovating and creating more value.

In particular, it appears that **Facebook is doing exactly right by tackling both the technological and the business sides simultaneously**.

Favourable aspects

- **Openness at the demand and supply side are critical to building out the ecosystem**, creating volume and thus value
- **Facebook is offering a very good product**. It also has facilitated development of complementary applications by sharing with **developers a special language based on HTML**.
- Moreover, **Facebook understands the business aspect**, as it explicitly wants to encourage companies to build businesses catering to its user base. For example, Zuckerberg announced that **independent developers can sell advertisements** or incorporate tools for conducting online transactions and keep all the resulting revenue.
- Facebook would keep a cut of the revenue generated by developers who sell software in the store, helping it diversify away from traditional advertising.

Shortcomings

- Growth in use of Facebook through their mobile products, where their ability to monetize is unproven, as a substitute for use on personal computers may negatively affect their revenue and financial results
- Facebook's mobile ads are ineffective is because they haven't adapted the graphics to mobile devices, so ads are difficult to read

Amazon

Apart from selling books and a significant business selling both physical electronic games and consoles within the Amazon AppStore, Amazon has entered into the IT market and it will be a serious player for years to come.

Amazon web services (AWS- http://aws.amazon.com/what-is-aws/) provides a highly reliable, scalable, low-cost infrastructure platform in the cloud that powers hundreds of thousands of businesses in 190 countries around the world.

- Amazon Web Services (AWS) takes what is essentially unused infrastructure capacity on Amazon.com's network and turns it into a very profitable business.
- Amazon Web Services represents only a small fraction of Amazon's overall business sales at the moment, but it is a rapidly growing component. Amazon Web Services is a $500 million business.

Favourable aspects

- Largest online retailer, free daily promotions of leading applications
- The scalability of cloud computing with AWS allows to ramp up bandwidth to accommodate future growth and expansion
- Very flexible, create anything you want
- Have complete control of the machine and can run any database you want, on any server outside of AWS if you wish.

Shortcomings.

- Amazon AppStore is impossible to install on some "locked-down" Android handsets

- The learning curve of AWS is definitely much higher and will take a significant investment in time to get everything working
- Will take much longer to create simple web applications

SAP's Platform Leadership Strategy

SAP is ranked as the world's largest provider of business software. Today, customers in more than 120 countries run SAP applications, from distinct solutions addressing the needs of small businesses and midsize companies to suite offerings for global organizations. **SAP has grown to become the world's leading provider of e-business software solutions**. With 194,000 customers, an external software ecosystem of 3,000,000 developers, and more than 11,500 partners, SAP is the world's largest inter-enterprise software company and the world's third-largest independent software supplier, overall. SAP solutions help enterprises of all sizes around the world to make them a best-run business. E.g. by improving customer relationships, enhancing partner collaboration and creating efficiencies across their supply chains and business operations

The SAP Enterprise Services Architecture was developed with the goal to create software applications targeted at individual customer needs; extend or change existing applications; and integrate SAP and non-SAP applications and services. By defining interface standards and allowing independent software vendors (ISVs) to develop new, highly specialized business applications,

- **SAP has attracted a large platform ecosystem of partners to build solutions on top of its technology platform.** Within this context, **the Business Process Platform** represents a Web-services-based platform, consisting of a collection of software technologies, tools and content, allowing customers to integrate composite applications developed by third parties (Frederico & Burgelmann, 2006). **Correspondingly, a close collaboration with customers and partners, referred to as co innovation, plays a key role in SAP's growth strategy.**
- In 2010, SAP ,continues to **invest in its partner ecosystem to support the development of solutions built on the SAP Net Weaver technology platform** and leverage partner sales forces to address the various market and customer segments.

Considering these company insights, **the importance of external complementary innovations on top of the Business Process Platform becomes apparent**. From the perspective of **SAP in its role of a platform owner**, it is particularly the ecosystem's **effectiveness, flexibility and cost-efficiency to deliver whole solutions that determines success**. SAP in its role of a platform owner fundamentally depends on continuous **external innovational efforts in parallel to the core platform evolution**. In particular, it became obvious that the company is required to:

- **Maximize its profits and market share**, while at the same time enabling and motivating the platform ecosystem to innovate and evolve in ever-better ways around the platform;
- **Create win-win situations with autonomous partners,** participating in the ecosystem**;**
- **Continuously evolve the platform and ensure that complementary capabilities** evolve simultaneously;
- **Maintain integrity and coherence** of the overall platform value proposition;
- **Sustain market and platform leadership** in platform competition**.**

Against this background, SAP has to find new ways to tackle innovation in order to:

- **Foster the ecosystem's productivity and, in particular, its ability to consistently transform inventions** into lowered costs, new services, and functions; and
- **To create new, valuable functions** and diversity on top of BPP.

Offering from the Telco

The Wholesale Applications Community (WAC)

WAC's goal is to **create a platform developers can use to create apps that will run across different device operating systems,** while tapping the capabilities of Telco's networks and messaging and billing systems.

At the Mobile World Congress in February 2011, **WAC said that China Mobile, MTS, Orange, Smart, Telefónica, Telenor, Verizon and Vodafone are "connected to the WAC platform**", while adding that Samsung and LG will ensure "that all devices produced by the two companies that are capable of supporting the WAC runtime will do so." **It also announced the availability of the WAC 2.0 specification, which supports HTML5 web applications**, while WAC 3.0, which is designed to enable developers to tap network assets, such as in-app billing and user authentication, is scheduled to be available in September 2011**. Ericsson, the leading supplier of mobile networks, is a particularly active supporter of WAC**, which also counts leading Alcatel-Lucent, Huawei, LG Electronics, Qualcomm, Research in Motion, Samsung and ZTE, among its members.

WAC's solution for "write once, run anywhere" applications is HTML5, the emerging Web standard that can be understood by the browser on any device, regardless of its operating system. WAC apps can't take advantage of a phone's hardware specifications, because they need to be written for all devices, so **the ultimate success or failure of WAC will likely depend on how enthusiastically Apple and Google, in particular, embrace HTML5** and actively support it in their respective smartphone platforms.

Telco companies´ API developer programmes

To date, most operators' API developer programmes have enjoyed little success. Most have a suite of APIs available to developers – such as the 18 mobile APIs listed on Orange's website in both English and French.

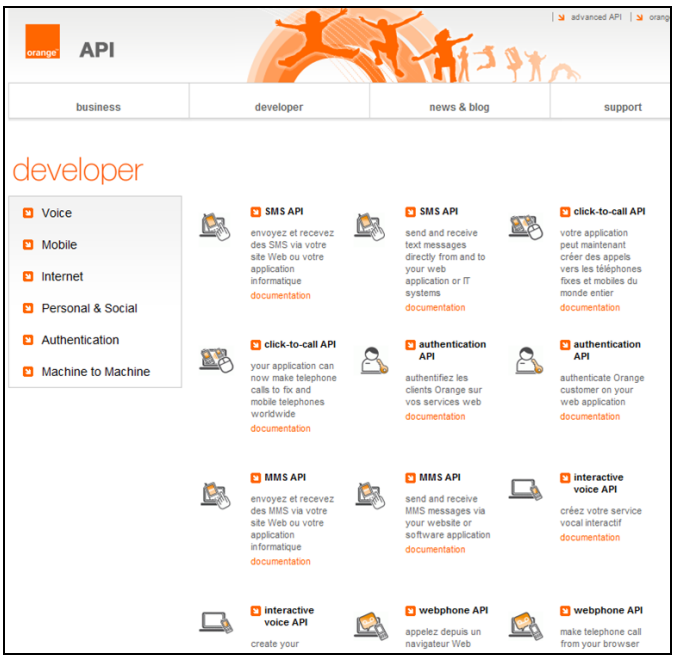

Figure 14 APIs listed on Orange's website, Source:Orange

But usage of operator network APIs by developers has been almost universally low. There are three possible reasons:

- **Limited technical integration**: it has not been easy enough for developers to use network APIs and they have not been standardised across networks and app stores. GSMA, with its OneAPI programme which has defined a common set of basic APIs across the operator community, and the

Wholesale Application Community (WAC), which aims to make creating applications that can be deployed across all mobile app stores are seeking to address this.

- **Lack of commercial models and incentives:** operators have not yet made it sufficiently attractive for developers and content owners to build solutions that incorporate network APIs. AppStores and apps themselves represent a significant network-API distribution opportunity for operators, and ultimately a critical one if Telco want to participate fully in the future communications market.
- **Finding and growing the markets of developers (and ultimately end-users).** To make business models based on wholesale use of APIs to work, it is necessary that a developer community wishes to use them. On this front, we think the WAC is on the right track in supporting the in-app billing API first, as is Blue Via, who have just announced their in-app billing API, as this has the clearest use-case for developers.

5.1.3 FI-WARE offering

FI-WARE directly addresses a number of the fundamental strategic concerns in the application and service provider domain. FI-WARE will have a strong impact on this domain as it focuses on those domain inhibitors that today make this difficult and expensive, by:

- **Providing lifecycle support for applications and services across the involved stakeholders.**
- **Providing machine-readable models for discovery, security and performance engineering**.
- Furthermore, **FI-WARE is envisioned to mitigate the huge obstacles composed applications face today**. Today, for every Euro spent on software and hardware for more complex business applications, seven Euros (and months of additional time to market) flow into consulting and integration tasks. This is a considerable concern that prevents the uptake of Internet-enabled applications.
- **Dismantling artificial barriers that could provide scale to have better performance as well. The applications developed under the umbrella of FI-WARE will have common baselines**, and will be applicable to a single, extended market, even though, in some cases, adaptations will be required to cope with niche market specificities. However, the fact all of them share interoperable components will simplify both the universality and the flexibility for customization.
- Finally the FI-WARE project seeks to coin an ecosystem around its technology and concept in order to foster innovation in the application and service provider domain. The means for this are the “Testbed” and the “Open Innovation Lab” initiative, which can be taken as a blueprint for later more productive settings.

FI-WARE will provide technical infrastructure as the basis on which **Application Developers as well as Instance Providers can develop innovative offerings** that bring about completely new business opportunities and stimulate the service economy of the future **leveraging on the following assets**:

- **A single set of APIs**, each of which brings about concrete built-in innovation-enabling capacities and altogether allow Application Developers to focus on domain-specific innovation.
- **An approach of comprehensive service description and annotation, optionally externalized through languages like the Unified Service Description Language (USDL)**, that enables FI-WARE GEs to describe all relevant data of technical, operational and business aspects in a uniform way, easing the integration of different applications and services beyond a mere interoperability perspective

The idea is to offer a "Catalogue" for making it easy for developers to find, navigate and understand what is offered by FI-WARE project in terms of Generic Enablers. In fact, the FI-WARE Catalogue will contain information about:

- Generic Enablers Open Specifications,
- Generic Enablers reference implementations (API, interfaces, source code, executable, etc.),
- Generic Enablers reference implementations clients (if any),
- Generic Enablers reference implementations tutorial and any other information that may be useful for a developer that wants to use these.
- The reference to the FI-WARE Instances (e.g. FI-WARE Testbed at least) where the Generic Enablers implementations have been deployed.

5.1.4 FI WARE SWOT Analysis

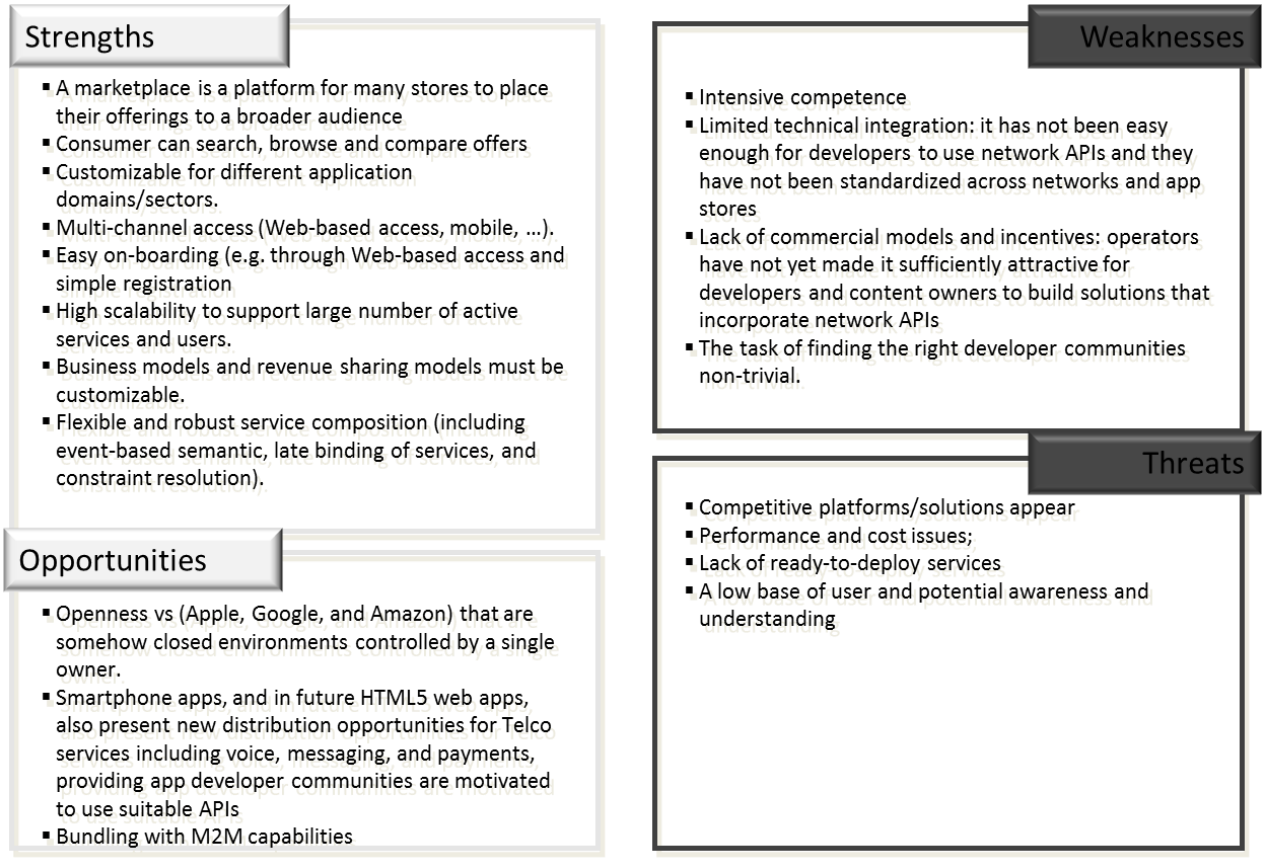

Figure 15 Applications SWOT Analysis

Generally we can say that the **Apps Chapter diminishes the following barriers for 3rd party innovation:**

- lack of guaranteed SLAs for compositions of service
- complexity in handling service compositions, taking into account compliance with business terms and conditions
- complexity during the integration of specialized services

- proprietary environments for services that are to be composed
- complexity of frameworks supporting monetization of services and service compositions

5.2 Analysis of the different FI WARE components

5.2.1 Cloud

5.2.1.1 *Cloud hosting market analysis*

Cloud computing is an evolving model that is best described in terms of business and IT functionality. Today, most business and IT system functions are delivered or supported by on-premises, functionally (or business unit) aligned IT systems. These systems are comprised of servers, networking equipment, and storage hardware, and are generally housed in a computer room, data centre, or other facility that is managed, controlled, or contractually bound to the organisation in question.

If we replace the word 'cloud' with the word 'Internet', then things starts to become easier to understand. **'Cloud computing' is, in effect, 'Internet computing',** i.e. a computing model that uses Internet-based technologies to deliver a range of services.

Cloud computing is nowadays a reality. **Cloud hosting companies, own and manage large IT infrastructures and offer their use as a service on a pay-as-you-go model.** Cloud hosting is particularly appealing to **SMEs and start-ups wanting to offer some new and innovative service over the Internet**.

An on-going **industrialization of IT in the form of cloud computing and open service delivery platforms** (as a service, pay per use). The on-demand, pay-per-use nature of these provisioning models is expected to fundamentally change how IT infrastructures are provisioned, essentially enabling them to be delivered as a service.

XaaS characterizes several cloud services concepts, including "X as a Service" or "Anything as a Service " or "Everything as a Service. " XaaS encompasses: SaaS (Software as a Service), PaaS (Platform as a Service), IaaS (Infrastructure as a Service).

- **Cloud Infrastructure as a Service (IaaS).** The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems; storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).
- **Cloud Platform as a Service (PaaS).** The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations

Additionally, there are different modalities depending on the ownership of the cloud where this service is delivered:

- **Public clouds (Internet).** Third parties operate and are the owners of Public Cloud. The cloud is located in data centres that are outside of companies that use it. Customer companies share the resources of these public clouds; they are each assigned their own virtual resources based on a common set of physical resources. Companies that provide Public clouds are: Amazon, Hewlett-Packard, IBM, Google, Rack space, Salesforce.com and Windows Azure.
- **Private clouds (On Premises)** are used by a single customer. They could be owned and operated by a company or a cloud computing provider. The technology used by public and privates clouds is

identical, and they are often built to enable an individual company to maximize the use of its computing resources and be more responsive to company needs than was possible under the traditional IT operating model. Example: eBay.

- **Hybrid Clouds** use both public and private cloud infrastructures. The hybrid cloud users try to keep the control over some essential resources while trying to reducing costs using public cloud. Sometimes, the hybrid cloud uses the services provided by a cloud aggregator.

Market Overview

Cloud computing as a delivered service is essentially the next generation of utility computing, which has been providing processing and storage on an 'on demand' basis for many years. The scale, combined with standardization of hardware, software and of operational processes, gives them, the big players, the economies of scale that they need to be able to offer the flexible use of low cost shared services provided over the Internet.

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

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

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

However, as the IT infrastructure moves from being owned and managed by the service providers to being hosted on the cloud, **the cloud hosting companies become a critical part of their customers' businesses.** This creates a **dependency relationship** that could even lead to unhealthy and undesirable situations such as **vendor lock-in,** if the necessary safeguards in terms of technology, market offerings and warranties are not in place.

Typical benefits for adopting Cloud are considered to be:

- **Increasing efficiency, improving the scalability**, CAPEX and OPEX reduction, simplifying provisioning, are considered typical IaaS benefit.
- On the other hand, are considered benefits to Pass the following: Increasing the responsiveness to the changing market, allowing growth according to the demand, speeding time to market, avoiding big hardware purchases simplifying provisioning , paying per use flexible models

While cost-cutting is the main argument put forward for many cloud deployments to adopt Cloud, **the main points of concern,** shown by the potential adopters companies**, are data security, performance and compliance issues.**

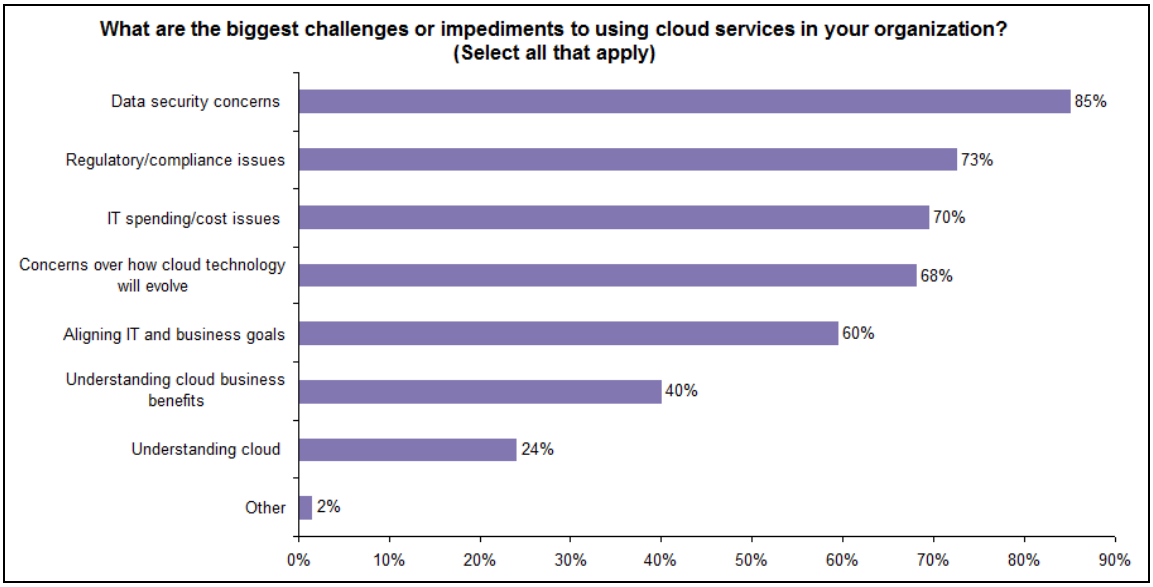

Figure 16 Biggest challenges or impediments to using cloud services, Source: Cloud Services Business Trends Survey: Summary Results Ovum

Moreover, the cloud **hosting market is still limited to a few, very dominant, large companies with proprietary solutions.** The lack of a competitive and open market for cloud hosting providers, in turn, slows down the adoption of the cloud paradigm and the economic benefits embodied in it. **For the success of the Internet-based service economy it is crucial that cloud hosting does not become a market limited to a few strong players,** and that future cloud hosting is based on open standards and support interoperability and portability.

Large companies are considering Cloud as a viable option for obtaining services. The organizations are planning to invest in Cloud in the coming years. They continue showing more interest in private cloud than in public cloud.

With technology developing fast and customer case studies of cloud usage becoming compelling**, IBM forecasts a public cloud market of $85bn by 2015, growing at around 25% CAGR**.

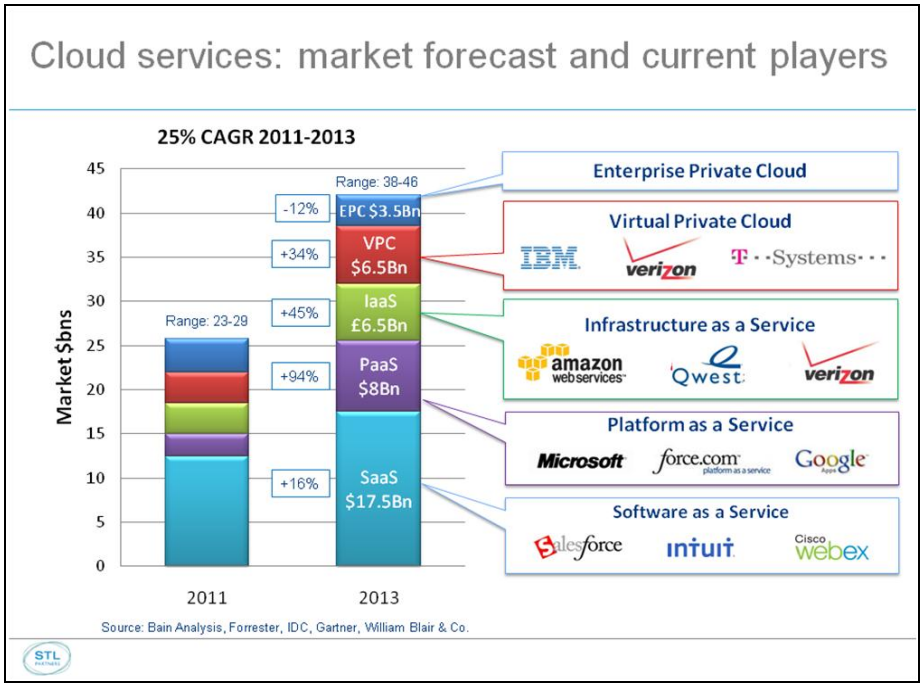

Figure 17 Cloud Services: market forecast and current players, Source: Bain Analysis, Forrester, IDC, Gartner, William Blair & Co

Additionally, conservative estimates see over 40% of all business technology spending happening in the cloud by 2020.

Telcos will adopt the Cloud business as a market expansion priority. Telco having the opportunity to take anywhere between 30-70% of it. 'network-as-service' (public IT cloud but including key Telco network capabilities) offered the greatest opportunity for Telco to add value and differentiate

- Big market players like AT&T, NTT Communications, Deutsche Telekom, BT and France Telecom-Orange, along with smaller enterprise solutions providers, have built up a critical mass of IT related business over the last decade.
- The convergence of mobile, fixed and internet provider's operations and the ever growing 'IT-zation' of telecom technologies as a whole, strengthen the case for Telco's strategic expansion into IT related business.

At present, Telco offer a portfolio of enterprise and corporate services ranging from desktop services to managed storage and data centres operations.

- For the next step **they will need to respond to the fast march of Google, Amazon, Drop box** and the like, who are conquering the consumer customer base with sticky cloud based services that are easy to use, globally accessible, highly available and beyond all -- inexpensive. This is why we expect to witness some acquisitions of mid-sized IT players by telecom companies in the near future.

<u>Platform as a service (PaaS)</u>

Includes users and vendors in enterprise software markets. **Although PaaS adoption is behind IaaS and it is at an early stage of development Industry experts already forecast a significant growth of the market** and this is a good moment to invest and to position to obtain a strategic position. According to Morgan Stanley report the estimated growth of PAAS is slow but sustain.

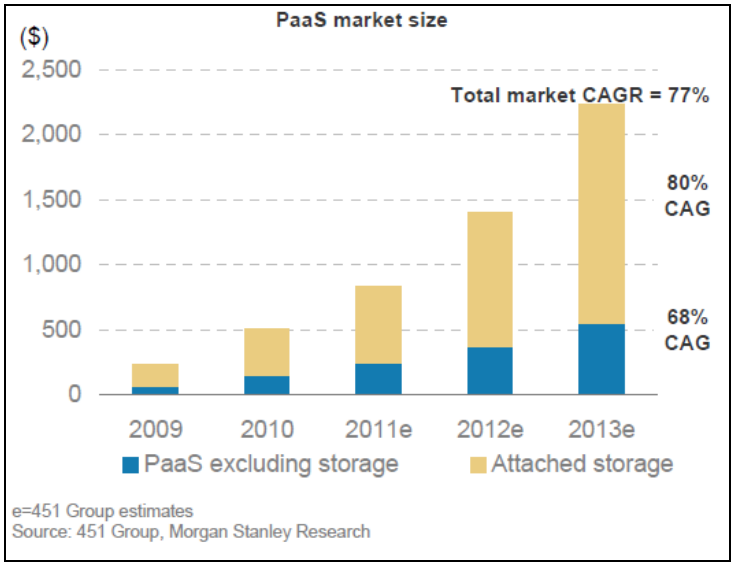

Figure 18 PaaS market Size, Source: Morgan Stanley[1]

Infrastructure as a service (IaaS)

As Morgan Stanley forecast in the following chart **the growth estimate for Iaas continues upwards**

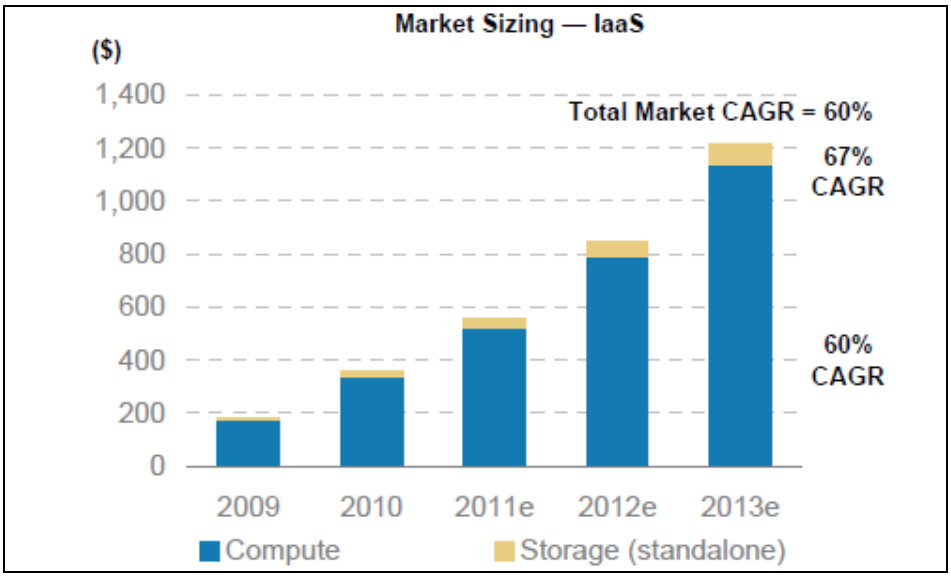

Figure 19 Market Sizing, Source: Morgan Stanley[2]

[1] Morgan Stanley Blue Paper Cloud Computing Takes Off

[2] Morgan Stanley Blue Paper Cloud Computing Takes Off

Lately, there has been an increase in the number of Cloud service providers. These services are offered under different architectures, developed under multiple techniques and delivered under a wide range of business models.

5.2.1.2 *Vendors*

Paas Vendors

Platform as a service (PaaS) includes users and vendors in enterprise software markets. Although PaaS adoption is behind IaaS and it is in an early stage of development Industry experts already forecast a significant growth of the market and this is a good moment to invest and to position for several years of expansion

Vendors	Products
Adobe	LiveCycle ES2
Engine Yard	Cloud Services Platform
Google	App Engine
IBM	Rational Application Developer
Intuit	Partner Platform
Joyent	SmartPlatform
SalesForce	Force, VMForce, Heroku
Microsoft	Azure Platform
Netsuite	SuiteCloud
Pegasystems	BPM PaaS
RedHat	Cloud Application Platform
Software AG	ARIalign
Appistry	Appristry Cloud IQ
Gogrid	CloudCenter
VMware	Cloud Foundry, SpringSource

Table 1 More Relevant Paas Vendors

Google App Engine is a unique hosting platform that lets you build applications and run them in Google's data centers using the massive global infrastructure built to run the Internet's most powerful company. **App Engine offers a development environment that uses familiar technologies** (Java and Python) and provides a powerful and robust set of APIs to users while maintaining security and independence from other apps running in the cloud

Engine Yard is the leading Platform as a Service (http://www.engineyard.com), empowering software application innovation more rapidly, easily and cost effectively. With deep technical expertise, powerful

infrastructure orchestration, strong support of the open source community, and world-class service, Engine Yard provides a complete commercial grade solution that enables developers to focus on creating great applications, instead of managing their platform

Sales force Paas: Sales force offer in Paas is based on three products:

- Force.com "Build apps for the Social Enterprise". The platform allows the users to build and deploy enterprise applications. The basis of the process of innovation lies in the easy-to-use development model. The tool assembles applications with clicks, components and code and deploy them to the salesforce.com infrastructure. The developed applications run on smart devices. The tool provides real-time reports and is able to design and automate virtually any business process. SOAP and REST-based APIs can be called from a wide variety of applications-
- Heroku is a Ruby on Rails platform; it has added support for Java, Node.js, Scala, Clojure and Python (multi-language cloud). Heroku allows developers to deploy, scale, and manage their apps without needing to think about servers or systems administration.
- VMforce: The platform provides the tools to build and run enterprise Java apps without worrying about provisioning, maintaining, or scaling hardware, app servers, or databases. VMforce makes make easier the development.

Windows Azure platform

The Windows Azure platform provides an environment for developers to create cloud applications and services in a flexible way. Windows Azure reduces the time to market and provides flexibility for adaptation to demand. Applications can be built using any language(.net, java, node.js, php and others)

Windows Azure offers:

- Windows Azure: operating system as a service
- Microsoft SQL Azure: fully relational database in the cloud
- Windows Azure platform AppFabric: makes it simpler to connect cloud and on-premises applications

IasS vendors

IaaS Cloud computing is being mainly implemented in the hosting and outsourcing markets.

Figure 20 Magic Quadrant for Public Cloud Infrastructure as a Service, Source: Gartner

Vendors	Products
Amazon	Enterprise Compute Cloud (EC2), Simple Storage, Service
AT&T	Synaptic Compute Cloud, Synaptic Storage
British Telecom	Virtual Data Service
CSC	Trusted Cloud
EMC	Mozy
Google	AppEngine & Big Table
HP(eds)	EDS
Eucalyptus	Eucalyptus
IBM	SmartCloud Enterprise, Blue Cloud, Smart Business Storage Cloud
Joyent	SmartMachines & SmartDataCenter
Microsoft	Azure & SSDS
NTT	NTT America Cloud , Cloud Files
Oracle	Cloud Compute

RackSpace	Cloud Servers & Cloud Sites CloudFiles
Salesforce.com	Force.com / Database.com
Savvis	Savvis Cloud Compute Project Spirit
SunGard	Hosting365
Terremark	vCloud Express
Verizon Business	Cloud Compute Cloud Storage
Wipro	The Wipro Cloud Cloud Storage

Table 2 Iaas Key Providers, Source: Morgan & Stanley Research

Amazon elastic compute cloud is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers. (source: http://aws.amazon.com/ec2/)

Amazon Simple Storage System: Amazon S3 is storage for the Internet. It is designed to make web-scale computing easier for developers (source: http://aws.amazon.com/s3/)

Amazon Elastic Block Store (EBS) provides block level storage volumes for use with Amazon EC2 instances. (source: http://aws.amazon.com/ebs/)

5.2.1.3 *Services*

According to Gartner [3]these are the common business models for Infrastructure as a Service.

- The difference between the models is basically the distribution of responsibilities between the customer and the provider. These models are not unique and a wide range of combinations are possible.

Self-Managed Iaas

Provider Responsibilities	Customer Responsibilities
• Network • Hardware	• The guest OS • The applications running

[3] Evaluating Cloud Infrastructure as a Service Garnet Report. Gartner RAS Core Research Note G00210090, Lydia Leong, 3 March 2011, RA14 08132011

• virtualization layer and related tools (monitoring the orchestration engine and customer portal)	on the virtual machine(middleware and customers ' applications

Managed Hosting

Provider Responsibilities	Customer Responsibilities
• Network • Hardware • virtualization layer and related tools (monitoring the orchestration engine and customer portal) • Provide additional services • May also managed the middleware	• Their applications

IU for a specific application

Provider Responsibilities	Customer Responsibilities
• All the infrastructure related to a specific application	• Their applications

Foundation for data centre outsourcing (DC):

Provider Responsibilities	Customer Responsibilities
• Network • Hardware • virtualization layer and related tools (monitoring the orchestration engine and customer portal) • DCO services	• The guest OS • The applications running on the virtual machine(middleware and customers ' applications)

PaaS models comprise a wide range of services:

- **Application development**: A PaaS platform that provides the tools needed to construct different types of applications
- **Collaboration**: The PaaS systems allow multiple stakeholders to work together on the same projects. This cooperation can foster better process improvement.
- **Data management**: The platform enables the user to access and use the data in a data store.

- **Instrumentation, performance, and testing**: Tools for measuring the performance of applications and providing the possibility of improve them.
- **Storage**: The tools Data can be stored in either the PaaS vendor's service or accessed from a third-party storage service.
- **Transaction management**: Services that provide transaction managers or brokerage service for maintaining transaction integrity.

A more **simple classification can be found in the PaaS vendor Salesforce web page:**

- **Social Application Platforms:** Social network platforms provide APIs to third parties. They use these tools to write new applications. The applications that is made available to all users. E.g. Facebook.
- **Raw Compute Platforms:** Platforms that provide storage, processor, and bandwidth as a service. Developers can upload their traditional software stack and run their applications. For example Amazon Web services
- **Web Application Platforms**: Platforms that provide APIs and functionality for developers to build Web. For example Google App Engine
- **Business Application Platforms**: Platforms provide application infrastructure specifically geared towards transactional business applications such as database, integration, workflow, and user interface services. E.g. Force

Paas Price models

Vendors offer PaaS with different pricing models. **Since Pay as you go to licensing**. For example: Amazon charges per instances, Google per hour per GB, Force per user-month and Windows offers a wide range of pricing, such as licensing, pay-as-you-go, and subscription-based.

Iaas Price models

Vendors offer IaaS, among others, with these pricing models. **Pay-for-consumption business model** Providers charge an hourly rate depending on the CPU size and memory required. In addition a bandwidth fee for data transfer could be applied.

5.2.1.4 *Value Chain*

The following classification of **individual roles in Cloud** is extracted from the report THE FUTURE OF CLOUD COMPUTING report. These individual roles are closely linked with the business models.

- **Cloud Providers** are providers that offer clouds services to the customer e.g.: dedicated APIs (PaaS), virtual machines and / or direct access to the resources (IaaS).
- **Cloud Resellers or Aggregators** aggregate cloud platforms from cloud providers to either provide a larger resource infrastructure to their customers or to provide enhanced features. An aggregator pulls together different services and systems to create a package of offerings for clients. It is also known as “Cloud Broker.”
- **Cloud Adopters or (Software / Services) Vendors** improve their own services and capabilities by exploiting cloud platforms from cloud providers or cloud resellers. This enables them to e.g. provide services that scale to dynamic demands – in particular new business entries who cannot estimate the uptake / demand of their services as yet. The cloud enhanced services thus effectively become software as a service.
- **Cloud Consumers or Users** make direct use of the cloud capabilities. They do not improve the services and capabilities they offer, but they make use of the direct results, i.e. either to execute complex computations or to host a flexible data set.

- **Cloud Tool Providers** do not provide cloud capabilities per se, but they provide cloud supporting tools that lets other use cloud resources

5.2.1.5 *FI-WARE offering*

FI-WARE will comprise the Generic Enablers are able to serve the needs of companies that may need IaaS Cloud hosting capabilities, PaaS Cloud hosting capabilities or both, meeting the requirements for the provision of a cost-efficient, fast, reliable, and secure computing infrastructure "as a Service".

Building upon existing virtualization technologies, **FI-WARE will deliver a next generation Cloud Stack that will be open, scalable, resilient, standardized, and secure**, and will enable Future Internet applications and extend the reach of the cloud infrastructure to the edge of the networks, much closer to end users.

Cloud hosting companies, which can be considered as a particular type of FI-WARE Instance Providers, are already delivering on the promise of the Cloud paradigm. They own and manage large IT infrastructures and offer their use as a service on a pay-as-you-go model. Cloud hosting is particularly appealing to SMEs and start ups

Generally we can say that the **FI-WARE Cloud Services reduce the following barriers for 3rd parties**:

- The entrance **threshold for new players on the market, especially if they provide applications and services for smaller consumer groups** is reduced since the support of the cloud enablement supersedes the investment into expensive infrastructure.
- On the other hand, **a dynamic market for cloud services can provide a competitive environment that encourages the development of new kinds of hosting services** for smaller groups of services providers with more specific needs.

5.2.1.6 *FI WARE SWOT Analysis*

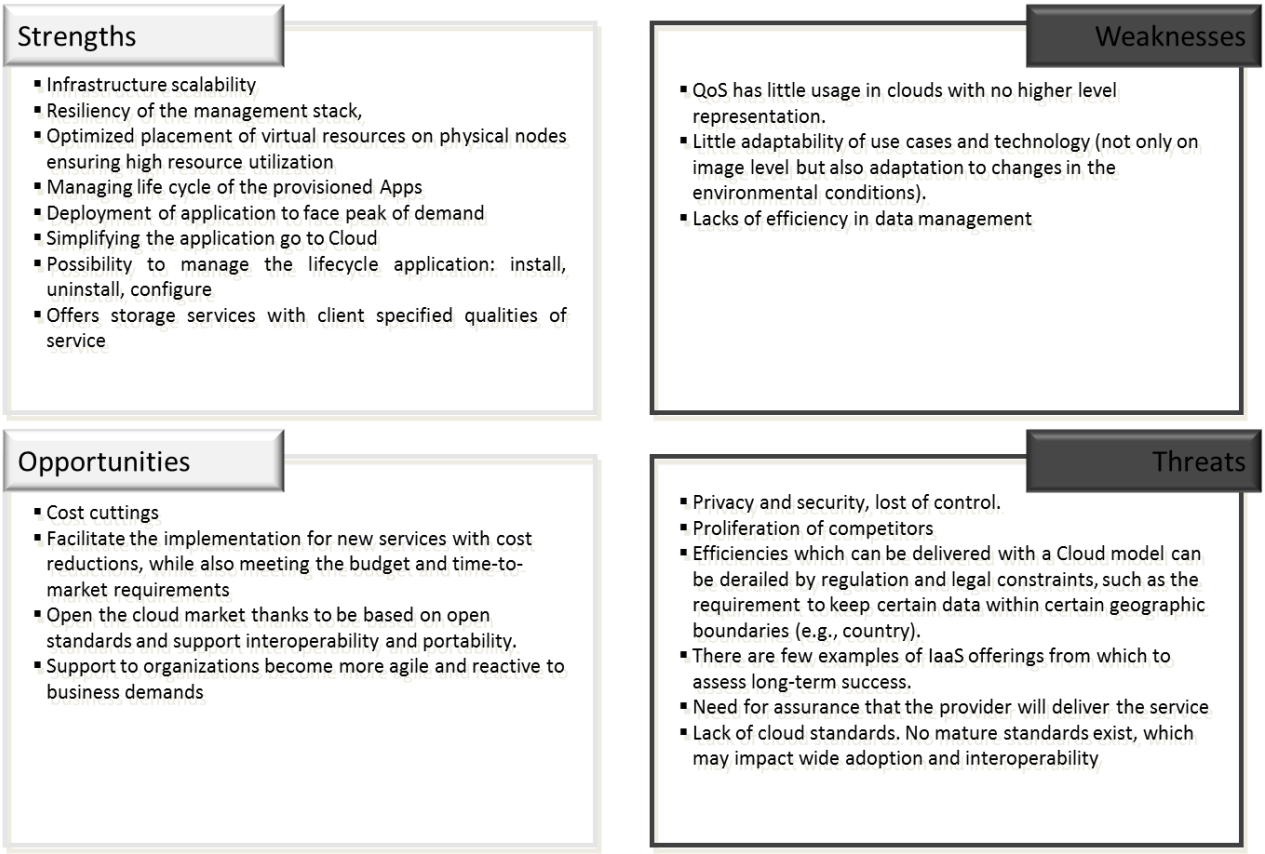

Figure 21 Cloud SWOTs Analysis

5.2.2 Internet of Things

The term **IoT resource refers to the computational elements** (i.e. software running on devices), enabling to gather information about things and act upon them.

A global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities.

- This infrastructure includes existing and evolving Internet and network developments.
- It will offer specific object-identification, sensor/actuator and connection capability as the basis for the development of independent federated services and applications.
- The related physical infrastructure includes 3 different layers: devices, gateways and backend.
- These will be characterised by a high degree of autonomous data capture, event transfer, network connectivity and interoperability.

This concept is not just about people/business communicating with people/business or devices/machines communicating with devices/machines; **it also includes people/business communicating with devices/machines, and devices/machines communicating with people/business,** bearing in mind the anytime-anyplace dimensions.

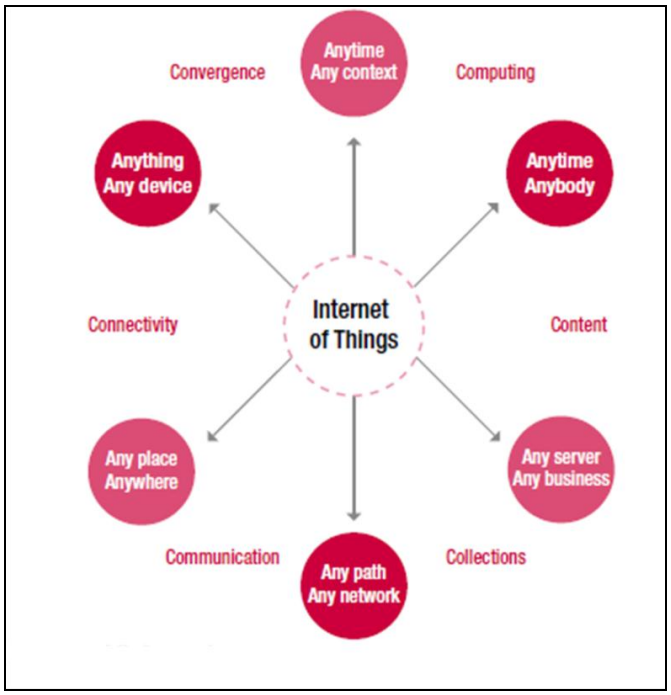

Figure 22 Internet of Things Vision, Source: Atos Scientific Community

The vision of the IoT is to join the physical and digital worlds. The objective is to create a seamless network of billions of identifiable connected objects that are able to exchange with one another and are reachable by any kind of application:

- **The number of devices is expected to outnumber the human population by orders of magnitude**, thus the development of efficient means for communication, management and interaction with them will be a necessity, coping with the need to support the co-existence of a variety of existing and emerging communication technologies.

Actually, the IoT application environment is extremely heterogeneous, leading to different interaction patterns (push, pull, converge-cast, multicast, periodic, event-based, etc.) **and different interaction constraints compared to the current Internet** (in terms of reliability, timing, capabilities of devices, etc.) This heterogeneous application environment will thus also entail a pronounced heterogeneity of the underlying communication layers.

5.2.2.1 *Market Overview*

Machine-to-Machine (M2M) technologies link machines to an information system, generally to automate existing humanly performed operations, such as meter reading, or to enable new services based on remote connected devices, such as e-health.

In 2016, Forrester forecasts there will be about 450 million connected M2M devices globally. These will generate nearly $17 billion in connectivity revenues, growing at a 34% compound annual growth rate (CAGR) between 2010 and 2016.

According to GSMA, by 2020 the number of mobile connected devices is expected to increase by 100 percent to nearly 12 Billion. They said that in the 2012 International CES [4]more than 50% of the devices showed there were connected. GSMA estimated: 90% of TVs, 70% of automotive devices, 44% of healthcare devices and 30%. They declare that cross-industrial collaboration is needed in order to achieve ta successful Internet of the Things.

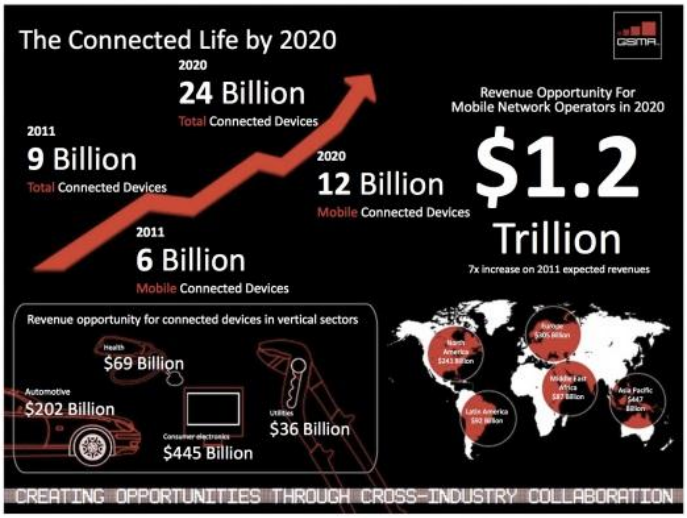

Figure 23 8GSMA's data on connected devices, Source: GSMA

M2M represents a huge business opportunity for the telecoms industry in application areas such as automotive, asset management, energy management, home and business security and telehealth since they own the communication infrastructure which connects the dots.

Sensor Networks are also impacting new services in the telecom space. Sensor networks are a generalized term for spatially distributed devices, with at least one sensor, that are able to detect and monitor events. Each has a transceiver, controller and power source. It can also include mobile devices with sensors, such as smartphones or vehicle on-board units. **The underlying concepts are the foundation of the internet of things (IoT), which is an evolution of M2M technologies**.

Business opportunities for Telco can be found in various scenarios: detection of environmental changes (for instance pressure/ temperature), warning of impending disasters, vehicle traffic monitoring, surveillance and security, to name but a few.

To address the need for information visibility and understanding of real-time traffic, Network Intelligence is an emerging category of technology that **can be leveraged by Telco's to offer and**

[4] the International Consumer Electronics Show (CES) reaches across global markets, connects the industry and enables CE innovations to grow and thrive

enhance new and existing services. Being able to analyse data flows in real-time will enable telecom operators to act.

The classical approach to M2M may fail to deliver the full value of the Internet of Things

- Closed and standalone solutions
  - Does not support interaction between loosely coupled participants
- High barriers for innovation
  - Inefficient
  - Complex
  - Hard to reuse
  - Energy consumption: main efforts are dedicated to limit energy consumption with good innovation but this approach is again large amounts of data which are a key point to improve information in a near future
- Limited freedom of choice and reusability for the end user
- Sharing objects and information is difficult
  - No common standards for different sectors
  - Lack of regulation regarding property of data from sensors
  - Lack of interoperability or compliance especially between wireless low-level technologies,
- Not the Internet of Things
  - Sensors send only raw data
  - Few actuators are available to really act on their environments
  - Intelligence at device level requires energy and new chipsets

The expected Internet of the Things adoption in the next 5 years, between 5 and 8 years and in the space of 8 years. In some of the verticals sectors IoT is gaining popularity and is in early deployment stages. On the basis of the findings of Foundation Bankinter's survey the Future Trends Forum consulted experts revealed that:

- **69% of respondents think the Internet of Things will be adopted in less than five years in retail and logistics sectors.**
- **Experts also argue that the aerospace, aviation and automotive industry will need more than** eight years to adopt the technology.

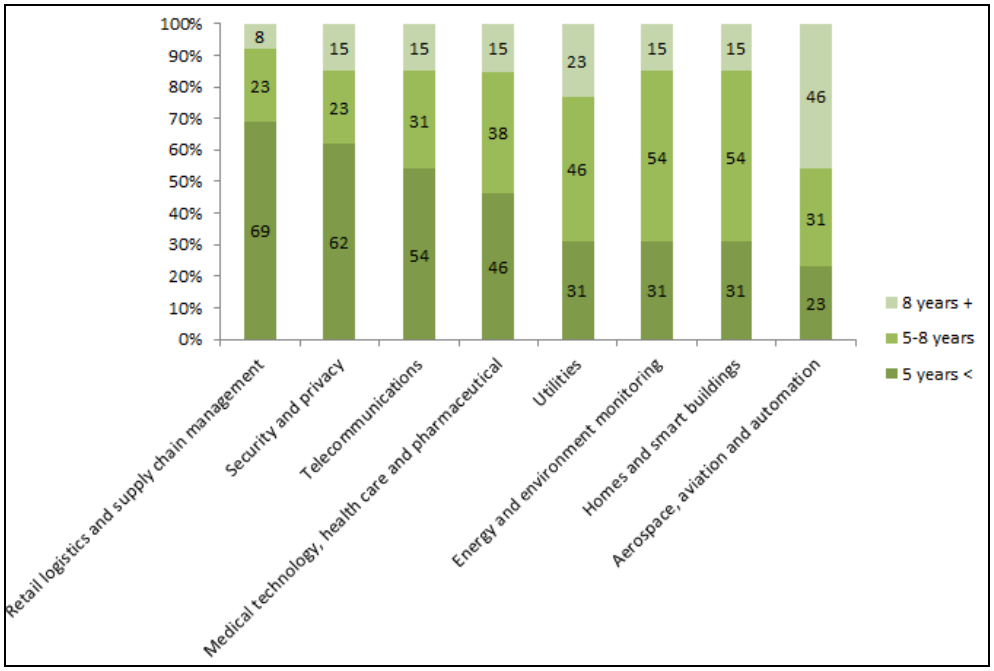

Figure 24 IoT adoption, Source: Foundation Bankinter

The following pictures show the **main reason express by the experts regarding Internet of things adoption.**

- It can be seen that one of the biggest **concern is security and privacy**.
- **Lack of global standards is holding back the adoption too**, therefore the lack of clear business models addressed to small volumes of traffic for M2M tools

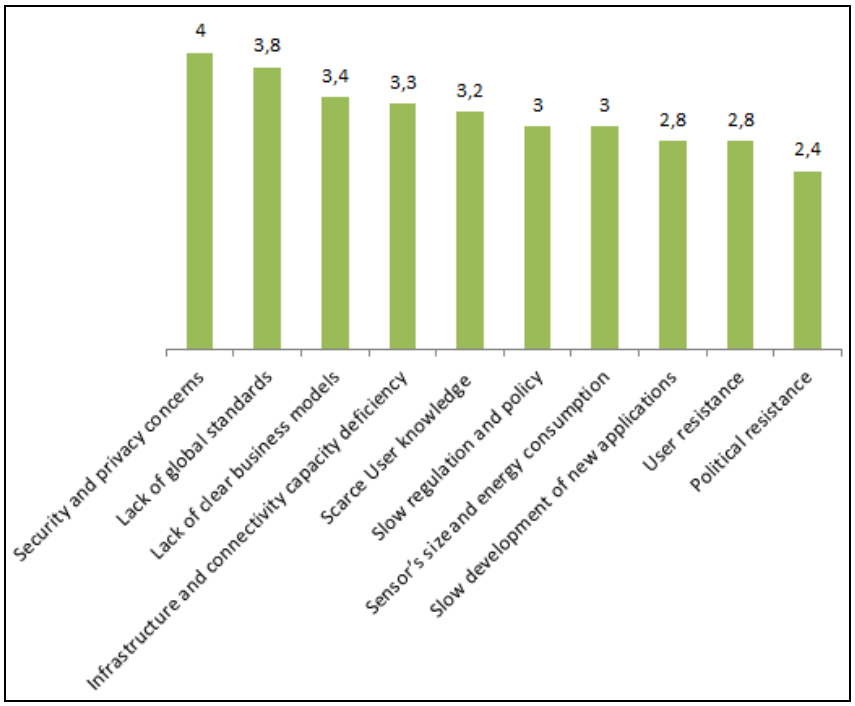

Figure 25 Main concerns regarding IoT adoption, Source: Foundation Bankinter

Over the next five years we will see a dramatic breakthrough in M2M applications as organizations recognize the potential it represents for:

- Reducing operating and maintenance costs
- Revenue generation and for improved customer satisfaction.
- Improving the citizens' quality of life.

Different internet applications in the different sector are shown in the figure as can be seen is a very **wide range of applications which are going to provide ample social benefits.**

Figure 26 Vision IERC - EUROPEAN RESEARCH, Source: Internet of Things Pan European Research and Innovation

The "growth opportunity" will be in Software Enabling Services (SES) and resources connectivity management. Operators can add value by creating and participating in **the service enablers market for developers/application providers to easily identify, authenticate, provision, and maintain their device fleet**; to update and rollback software on the devices and enable them to deploy processing logic into the "Internet of things" in order to render the system more robust, distributed, and autonomous

Machine-To-Machine (M2M) appears to be finally coming of age and 'horizontal' / 'two-sided' business models look to be a key part of an effective growth strategy for operators. However, there was also a strong belief that M2M's time is finally coming and a determination to learn the lessons from the past and from elsewhere, more specifically, from the Internet.

- **Is there a danger of Telco repeating bad old habits**? Telco will play a profitable role in the opportunity depends on whether they can deliver a combination of low-cost economics connectivity, added-value enabling solutions, and horizontal platforms that enable developers and ultimately end-users to connect and manage devices easily and innovate on top of.
- **Are Application Service Providers ready to adopt some standards?** IT companies would adopt new standards to enhance cross-sectors applications and services and to show an acceptable Rerun On Investment not only for big companies but also for all SMEs to invest in this area.
- **Identify the common elements in the set of interactions associated with each industry vertical**, you should be able to horizontals them - to create a set of building blocks that apply to all the M2M verticals. If you then do this in an open, inter-operable manner, you start to create the infrastructure for the Internet of Things

M2M customers (primarily application providers and developers) **have had to work with different operators in each territory and been presented with various levels of support infrastructure and interfaces**. This has made it extremely complex and expensive to roll-out M2M applications across a region such as Europe.

- For example, when **Amazon sought to introduce its Kindle across Europe, it was frustrated by the absence of a single commercial or commercial platform**. Amazon eventually contracted AT&T (an operator with no network presence of its own in Europe, only roaming agreements) to provide the service that European operators could not

M2M is being applied to several vertical markets, also it is spreading to some horizontal areas, even to consumers in fields as monitoring health, home security and automation and security. **The M2M opportunity presents multiple challenges for network operators.** From the business model, to the supply chain, to vertical applications, to ongoing support challenges, M2M market development represents a very complex set of inter-related elements.

Key success requirements for cellular network operators' wireless building M2M businesses will include:

- **M2M Requires New Innovations**: It's very hard to foster technology innovation and create new businesses at the same time. Focusing on new values - such as extended communications infrastructure for M2M, new user experiences and connected device component developments (such as new SIM cards formats for M2M) are all examples of innovation that will help the market develop faster.
- **M2M Requires "Catalytic" Alliances**: Focus on the ecosystem, not simply on technologies or products. The slow evolution of the M2M market has largely been because it is complex and requires several players to perform different roles within it. There are many categories of partners to work with, but determining which potential partners will be key to success
- **Interoperability and Network management**: some of the radio technologies are managed with few regulation sets and lots of local initiatives happen based on very heterogeneous technical environments. An innovative but costly competition to save local investments is a main challenge and new network management tools should appear to provide a common and cross-technologies management layer.

5.2.2.2 *Vendors*

The IoT offer is mainly composed of vertical solutions; due to this fact we are going to show some examples in the table below extracted from the FORRESTER report M2M Connectivity Helps Telcos Offset Declining Traditional Services

Vendors	Products
VeriFone Systems	Retail and Finance/Kiosk Apps
Diebold	
Hypercom	
USA Technologies	
NexTraq	Transportation/Fleet Management
TeleNav	
TomTom	

Garmin	
OnStar	
BMW	
Mercedes Benz	
On Asset Intelligence	Manufacturing/Asset Management
Omnilink Systems	
ILS Technology	
General Electric	Utilities/Energy Demand management
Echelon	
Elster	
Silver springs Network	
Landis+Gyr	
Cardionet	Healthcare/Health monitoring
Vitality	
Ideal Life	
Reflection Solutions	
Alarm.com	Security
Securitas Direct	
Johnson control	
ADT Security services	Consumer services/ appliance control
Lok8u	
Electrolux	
Samsung	
LG Electronics	

Table 3 M2M Solutions Focus On Seven Specific Categories, Source: Forrester

Additionally, Telco are recognising the potential value and they know that they cannot forego the opportunity. But they should change their structure, business models, and billing procedures and look for partners associations. Some of them are already carrying out these changes.

- **AT&T announced the opening of the AT&T Control Center through an agreement with Jasper Wireless** that aims to speed time to market for connected devices, thus addressing a traditional area of concern for customers/ developers.
- **Verizon continued to hone its Open Development Initiative (ODI) and also announced nPhase,** which is a joint venture with Qualcomm aimed at enabling M2M across a variety of markets. Additionally, nPhase reached an agreement with Verizon Wireless and Vodafone that allows the company to offer global connectivity, certification, and pricing for M2M solutions.
- **Sprint reorganized its legacy M2M business into the Emerging Solutions Group (ESG)** to focus on both B2B and B2C opportunities and leverage its 4G services. International network operators were not quiet either. Vodafone expanded the breath of its M2M service programs, Telefonica established a multinational M2M global unit and Orange established an International M2M Center. Asian carriers China Mobile and China Telecom ramped up service offerings and capabilities for M2M as the country continued heavy investments in IT Infrastructure
- **Telenor presented an impressive new venture launched under a year ago** - Telenor Objects - an M2M platform implemented as open-source software. What we saw was not so much the Industry rethinking M2M, as the industry getting on with redoing M2M

5.2.2.3 *Services*

Nowadays, the services provide by Internet of the things are clearly in these categories

- Custom developed: Applications specially develop for an organisation, highly-customized and with difficulty applicable to other environments
- Vertically focused: The majority of applications are developed focused on a vertical sector and it cannot be extrapolated to other sectors.

The current solutions are firmly integrated into core business processes.

Service	Description
M2M connectivity	Allow the communications between IoT stakeholders
Integration Services	Provide system integration services to integrate M2M services for the applications
M2M management Services	Provide the tools to manage the devices
Provide hosting services	Provide hosting services
Information Analysis	Tools to gain insight into the huge amount obtained
Vertical services	Provide services on the vertical sectors

5.2.2.4 *Value chain*

The following classification of **individual roles in Internet of Things,** based on M2M value chain, but also including the master dimension which will appear in the following years:

- **Chipsets manufacturers** are the first actors who provide the right component with the best level of miniaturization and using several communication technologies. They are also with Devices Manufacturers in best place to improve energy consumption.
- **Devices manufacturers** will provide smarter devices including several chipsets in the same device to host multi M2M functionalities. They are also key actors to improve additional computational resources in association with some robotics improvements to go from data collection devices to information-based actuators. A smartphone includes typically several features and chipset but has no robotics functionalities when small actuators in industrial environments do not have the same connectivity capacities.
- **Software companies** will provide the middleware to manage in a consistent way all chipsets, devices and networks capabilities. They are key actors to improve interoperability between the different vertical standards and devices, as well as to provide common interfaces for Applications.
- **Telecommunication operators** will have in charge the connectivity for all family of things. Based on the diversity of technologies, a seamless connectivity including nomadic smart things is one of the main challenges these actors have to target, as well as the management of large amount of data and information which could push to networks collapses.
- **Integrators** make direct use of connected things capabilities based on their dedicated vertical sectors knowledge. They have to manage the automatic part of a process using smart things as well as human interactions which will be more and more required based on cross-sector applications.
- **Application Service Providers** have two different roles: as key players for vertical applications, they will use more and more smart things interfaces to optimize processes and use as much as possible some robotics innovation to interact with professional environments, and for generic applications will provide new innovative way to merge information from many vertical sectors to provide a pervasive world and create the new Digital World
- **Cities** have a key role to play in a near future as facilitator to build quickly smart environments using public and private connected things, to support physical implementation in our daily environment and to propose new networks capabilities in urban areas.

5.2.2.5 *FI-WARE offering*

The IoT Communication function in FI-WARE will allow unified communications regardless of the different network standards and will enable data transfer services agnostic to the underlying connection protocol

- **The FI WARE IoT Services comprise those Generic Enablers** allowing a large number of distributed and heterogeneous things and associated IoT resources to become available, searchable, accessible and usable by Future Internet Applications and Services.
- **IoT Services Enablement in FI-WARE will provide a set of IoT-oriented Generic Enablers** dealing with: IoT communications, heterogeneous resource management, data handling and process automation.
- This substrate of IoT-oriented Generic Enablers will provide important efficiency gains in many

5.2.2.6 *FI WARE SWOT Analysis*

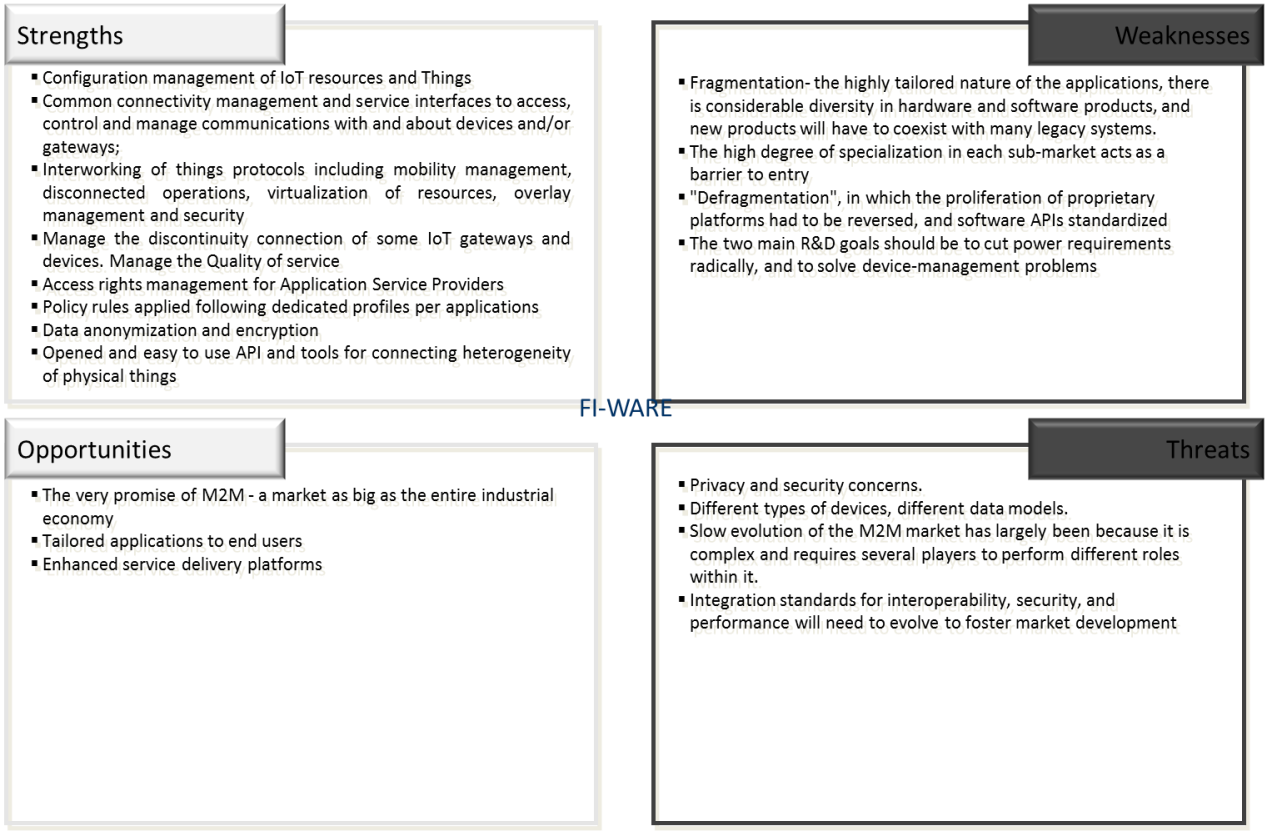

Figure 27: Internet of Things SWOT Analysis

5.2.3 Data context management services

Future Internet services require access to large volumes of dynamically changing data records that are spread across different locations. With thousands or millions of distributed nodes storing the data, node crashes or temporary network failures are normal rather than exceptions and it is therefore important to hide failures from the application.

- **Web 2.0, that is, the Internet as an information society platform supporting business, recreation and knowledge exchange, initiated a business revolution**. Service providers offer Internet services for shopping (Amazon, eBay), online banking, information (Google, Flickr, Wikipedia), social networking (MySpace, Facebook), and recreation (Second Life, online games). In our information society, Web 2.0 services are no longer just nice to have, but customers depend on their continuous availability, regardless of time and space. A typical trend is illustrated by Wikipedia where users are also providers of information. This implies that its underlying data store is updated continuously from multiple sources.

Big Data are very large data sets, terabytes or petabytes, such as weblogs, machine and sensor data and social media data, purchasing data, business transactions, video etc.

- **Nowadays a vast amount of data is available** —doubling every 18 months— the access to this information provides organization with a better knowledge of customer behaviour and needs. This acquired knowledge favours experimentation, supporting best make informed decisions as well as, to test new products, business models, and improve customer experience.

The first companies **interested in big data were the Internet companies, but now the adoption is not limited to big organizations and Internet companies.** Organizations want to obtain the **most detail information available about customer transaction, opinions, etc.** This information is a powerful tool to

improve marketing decisions, improve products, to carry out forecast demands **and innovations in customer experience.**

On the other hand, users have available **a huge amount of data from different sources that processed with technologies can be aggregated and analysed providing the users with more valuable** online experiences.

5.2.3.1 *Market Overview*

We are witnessing an explosive growth of the information that all facets of humanity (business, government, social, personal) are creating and processing. This increasing demand for processing and storage has a profound impact for ICT, both technologically and commercially: as the world gets more connected with more online services and more sensors, even more data will be produced and collected. Traditional infrastructures and software architectures are being superseded.

The Internet has given rise to global companies such as Amazon, Facebook, Google or Twitter. They need to manage data on a massive scale and to find ways to use it beyond its original means. Strong open source foundations have enabled them to instigate solutions, such as NoSQL, to manage and process 'big data'.

Reams of data still flow from financial transactions and customer interactions but also cascade in at unparalleled rates from new devices and multiple points along the value chain. Just think about what could be happening at your own company right now: sensors embedded in process machinery may be collecting operations data, while marketers scan social media or use location data from smartphones to understand teens' buying quirks. Data exchanges may be networking your supply chain partners, and employees could be swapping best practices on corporate wikis.

- **Big data permits a major step beyond what until recently was considered state of the art, by making real-time personalization possible.** A next-generation retailer will be able to track the behaviour of individual customers from Internet click streams, update their preferences, and model their likely behaviour in real time. They will then be able to recognize when customers are nearing a purchase decision and nudge the transaction to completion by bundling preferred products, offered with reward program savings. This real-time targeting, which would also leverage data from the retailer's multitier membership rewards program, will increase purchases of higher-margin products by its most valuable customers.
- **Smart mobility services enabled by Context- Aware Computing** will anticipate and react to the needs of users, providing relevant, useful information to allow them to make better-informed decisions. These services will supersede the existing smartphone applications and revolutionize how providers interact with consumers, organizations with employees, governments with employees and people with their social networks.

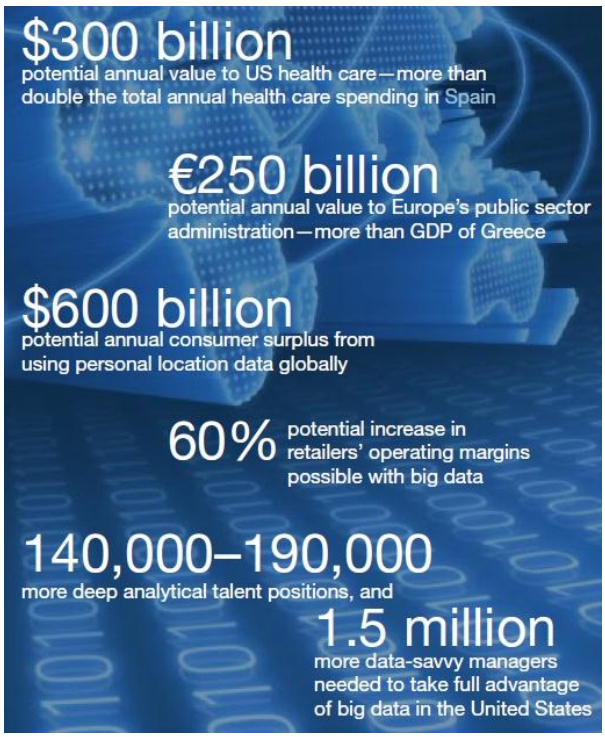

Figure 28 Big DATA, Source: McKinsey Global Institute

As a larger amount of data on the buying preferences, health, and finances of individuals is collected, however, **privacy concerns will grow**. That's true for data security as well.

The trends we've described often go hand in hand with more open access to information, new devices for gathering it, and cloud computing to support big data's weighty storage and analytical needs. The implication is **that IT architectures will become more integrated and outward facing and will pose greater risks to data security and intellectual property**.

As the following picture shows **one of the biggest challenges in adopting analytics is lack of understanding how to use analytics,** followed by **the lack of management bandwidth**, but many challenges are named and none can be taken lightly.

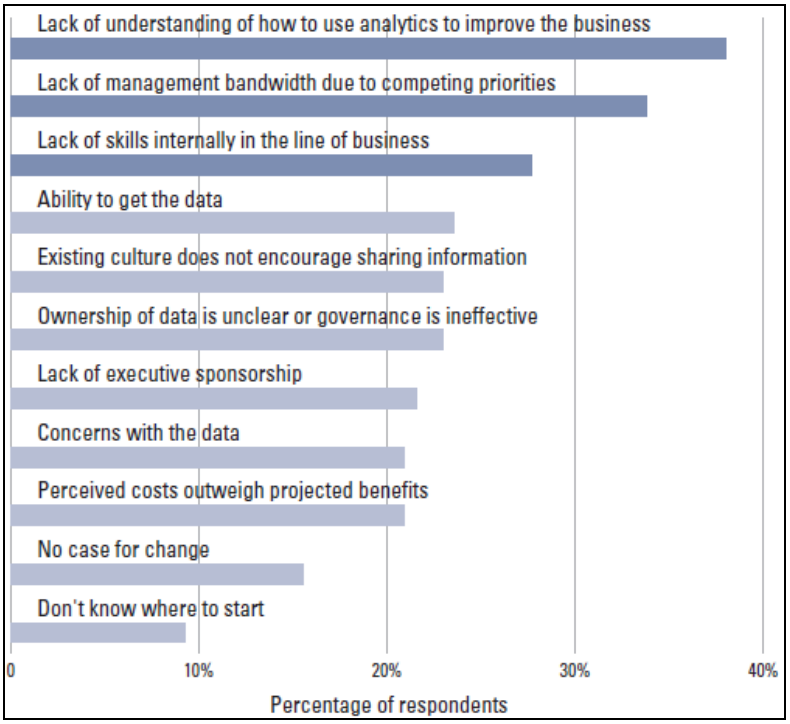

Figure 29 The impediments to becoming more data driven, Source: MIT Sloan Management review

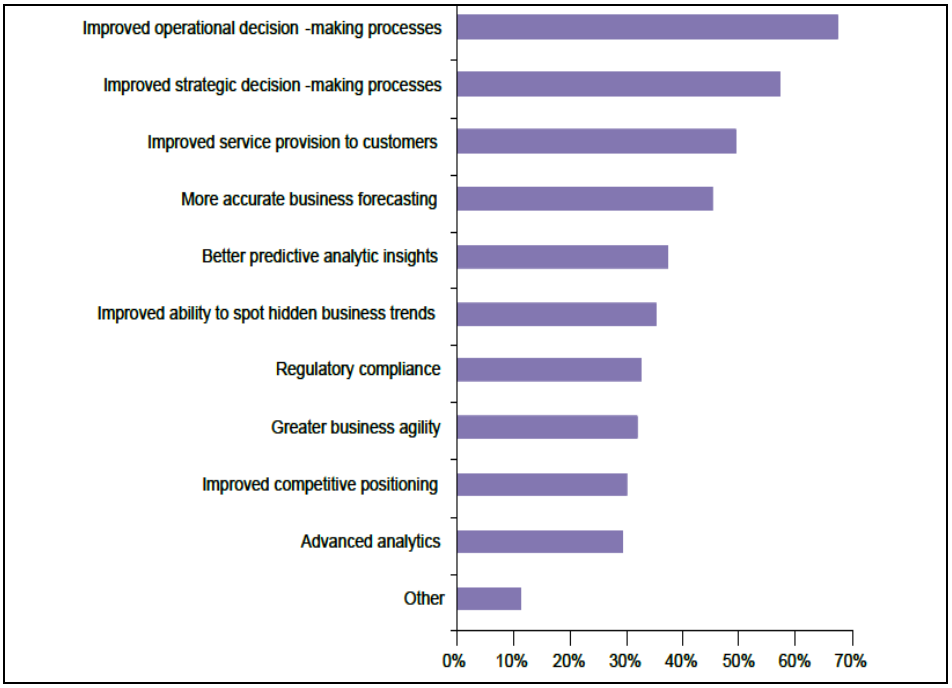

Figure 30 Business objectives for Big Data Analytics, Source: Ovum

5.2.3.2 *Vendors*

According to Gartner report "Cool Vendors in Data Management and Integration, 2011"

There are many innovative new vendors in the field of data management and integration. We profile four that can help organizations meet the challenges presented by rising volumes of data, increasing variety of data, and the need to make that data available for use more quickly.

Vendors	Products
Aster Data	nCluster is a massively parallel (MPP) analytic platform, a software solution that embeds MapReduce analytic processing with data stores for deeper insights on new data sources and types to deliver new analytic capabilities with breakthrough performance and scalability.
GreenPlum(acquired by EMC in July 2010)	GreenPlum solutions for large-scale data warehousing and analytics, providing customers with flexible access to all their structured and unstructured data for business intelligence and advanced analytics
Box	Box is leading the consumerization of content management's move to the cloud with a set of Web-based services for content management and secure collaboration that appeal to the business buyer in enterprises and organizations Box makes it simple for businesses to share, manage and access all their content online. It's a single, flexible solution that can serve and adapt to all your business sharing needs.
CLM Matrix	Matrix Software is a wizard-driven, policy-based contract creation and workflow approval system designed to dynamically build both standard and custom configured contracts based upon pre-defined business rules. The product is fully configurable without programming which allows organizations to work the way they want to work using Microsoft's ubiquitous Office productivity tools.
Dexrex	The product captures social content, including instant messaging, social media and Short Message Service communication, which are normalized and archived into a database for a conversation view for e-discovery and compliance. Dexrex ChatSync supports social media

	services such as Facebook, Twitter and LinkedIn and enterprise unified communication and collaboration systems, such as Microsoft OCS and IBM Lotus Sametime,
MyCube	MyCube is the world's first "social exchange", where you can share your information, ideas and content with others while maintaining full ownership and control of what you share, with whom, and on what termsits solution platform, where users own, control and monetize their digital assets (that reside on a myriad of subscribed social sites), to Sweden, the U.K. and Australia. Privacy and security relating to digital identity is secured in a personal MyCube Vault — a personal desktop container that provides a dashboard view of all digital assets (for example, profiles, contacts, albums of photos, blog posts, events, links, notes and interaction history), which are permission links back to the owner, rather than the assets themselves
ReputationDefender Inc.	My Privacy allows consumers to find and remove their personal information, such as name, address, phone number, credit score and transaction history from data aggregation sites

Table 4 Cool Vendors in Data Management and Integration, Source: Gartner

5.2.3.3 *Services*

Big data applications could be deployed on the cloud, and thus facilitate the SMEs adoption avoiding large inversions. Radical customization, constant experimentation, and novel business models will be new hallmarks of competition as companies capture and analyse huge volumes of data.

Big data may well become a new type of corporate asset that will cut across business units and function much as a powerful brand does, representing a key basis for competition. If that's right, companies need to start thinking in earnest about whether they are organized to exploit big data's potential and to manage the threats it can pose. Success will demand not only new skills but also new perspectives on how the era of big data could evolve—the widening circle of management practices it may affect and the foundation it represents for new, potentially disruptive business models.

At the outset, we'll acknowledge that these are still **early days for big data, which is evolving as a business concept in tandem with the underlying technologies**. Nonetheless, we can identify big data's key elements.

- First, **companies can now collect data across business units and, increasingly, even from partners and customers** (some of this is truly big, some more granular and complex).
- Second, **a flexible infrastructure can integrate information** and scale up effectively to meet the surge.
- Finally, experiments, **algorithms**, and analytics can make sense of all this information.

Big data also is turbocharging the ranks of data aggregators, which combine and analyze information from multiple sources to generate insights for clients. In health care, for example, a number of new entrants are integrating clinical, payment, public-health, and behavioural data to develop more robust illness profiles that help clients manage costs and improve treatments.

And with pricing data proliferating on the Web and elsewhere, **entrepreneurs are offering price comparison services that automatically compile information across millions of products**. Such comparisons can be a disruptive force from a retailer's perspective but have created substantial value for consumers. Studies show that those who use the services save an average of 10 percent—a sizable shift in value.

5.2.3.4 *FI-WARE offering*

FI-WARE will provide the facilities for effective accessing, processing, and analysing massive streams of data, and semantically classifying them into valuable knowledge.

FI WARE will offer added value services enabling:

- Publication & Subscription to relevant context data
- Complex Event Processing
- Analysis of large amounts of data (Big Data platform)
- Multimedia Processing/Analysis
- Location of mobile objects

5.2.3.5 *Value chain*

The Complete Big Data Value Chain includes:

- **Collection** -- collecting structured, unstructured and semi-structured data
- **Ingestion** -- consuming vast amounts of data efficiently
- **Data Discovery and Data Cleansing** -- clean up, formatting and statistical analysis of the data
- **Integration** -- linking, indexing and data fusion
- **Analysis** -- extraction of information, non-obvious relationships and machine learning
- **Delivery** -- including querying, visualization, and redundancy, enterprise-class availability

5.2.3.6 *FI WARE SWOT Analysis*

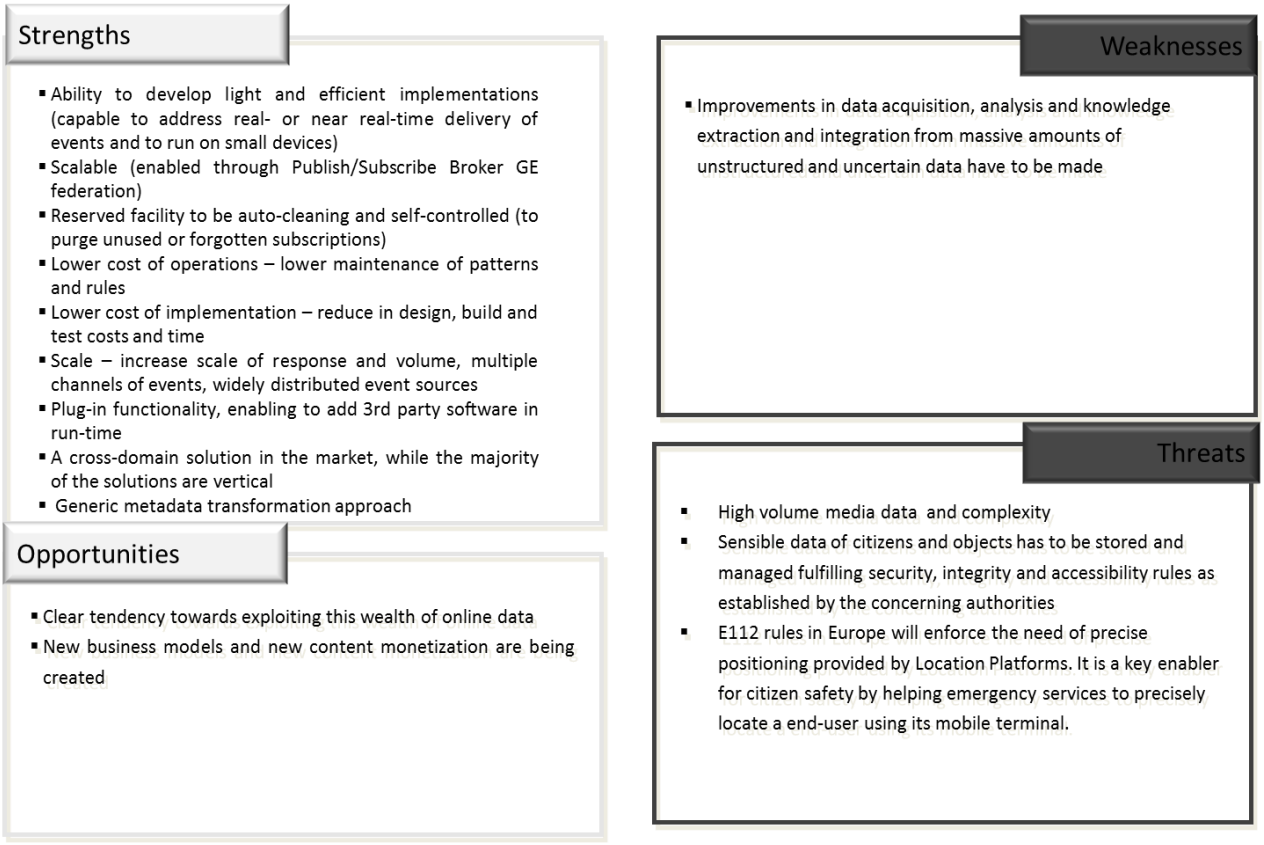

Figure 31 Data SWOT Analysis

5.2.4 Interfaces to the network and Devices

Interfaces to the Network and Devices: 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. The results will contribute to standardisation bodies such as IETF and ETSI.

5.2.4.1 *Market Overview*

Studies have shown that the bandwidth requests especially in the mobile and wireless access will grow enormously. In the same time the number of devices will grow in the same way. The complexity of connecting these devices will grow exponentially

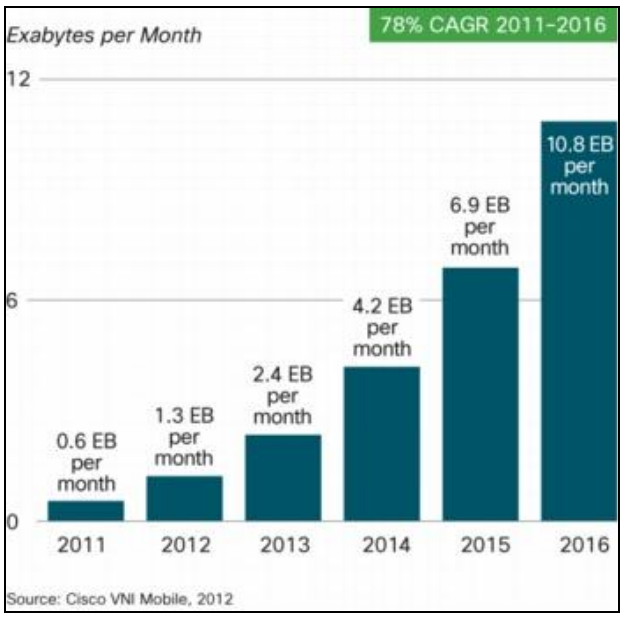

Figure 32 Cisco Forecasts 10.8 Exabyte per Month of Mobile Data Traffic by 2016, Source: Cisco

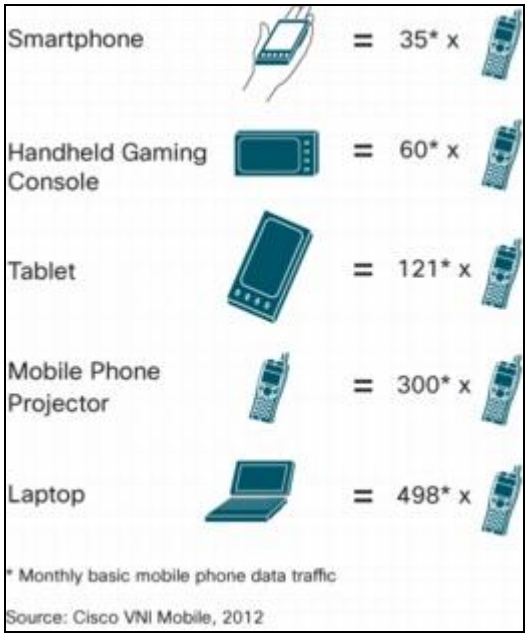

Figure 33 High-End Devices Significantly Multiply Traffic Source Cisco

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

This in turn will lead to more content, either provided by content providers and broadcasters, or content users and owners themselves. And this in turn means not just more content, but more complex content. In particular the rise of 3D content and video content will accelerate the growth of Internet content and results in the web requiring 60 Exabytes (a billion billion)/per second data stored, 800 Exabytes/sec of peak IP traffic and 20x the compute capacity we have today (Source INTEL).

Considering traffic and sales of the actual internet, the forecast shows a general trend of diversification considering both the sales and the generated traffic of the connected device (Figure 34, Figure 35, Figure 36): a multiplicity of device categories and of traffic types will lead the evolution to the Future Internet, and it will be strictly connected by the user habits, meaning that there will be a reciprocal influence between application/services and time spent (even more than traffic generated) by people for different activities in the Future Internet (Figure 37).

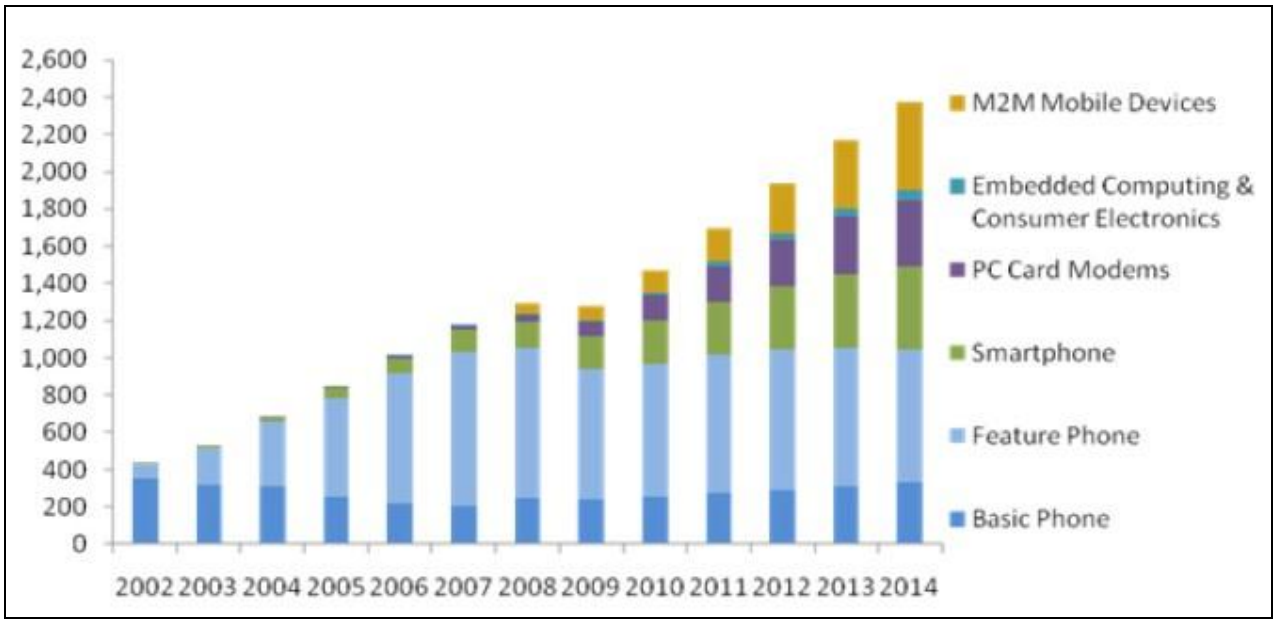

Figure 34 Global sales of Device by Type

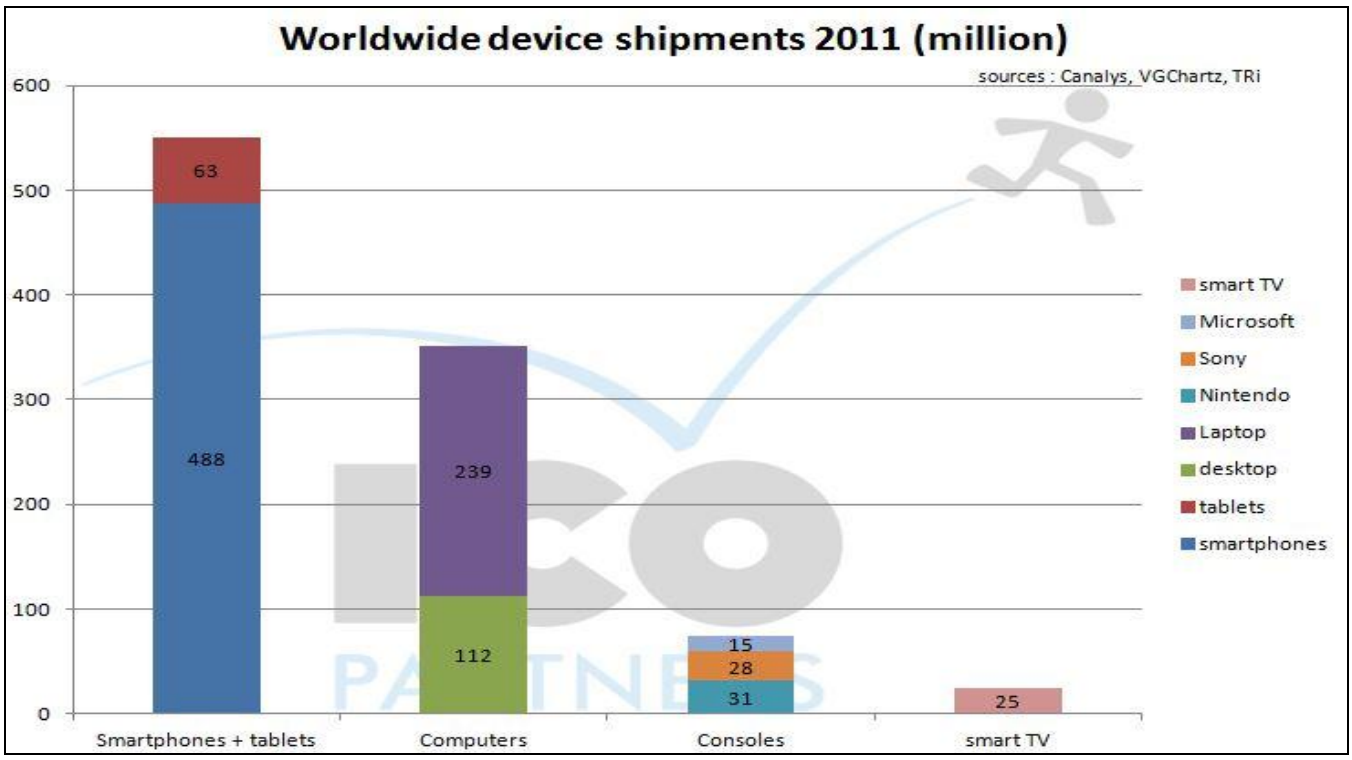

Figure 35 Global sales of Device by Type (in Millions), Source: Strategy Analytics & ABI research, Canalys, VGChart

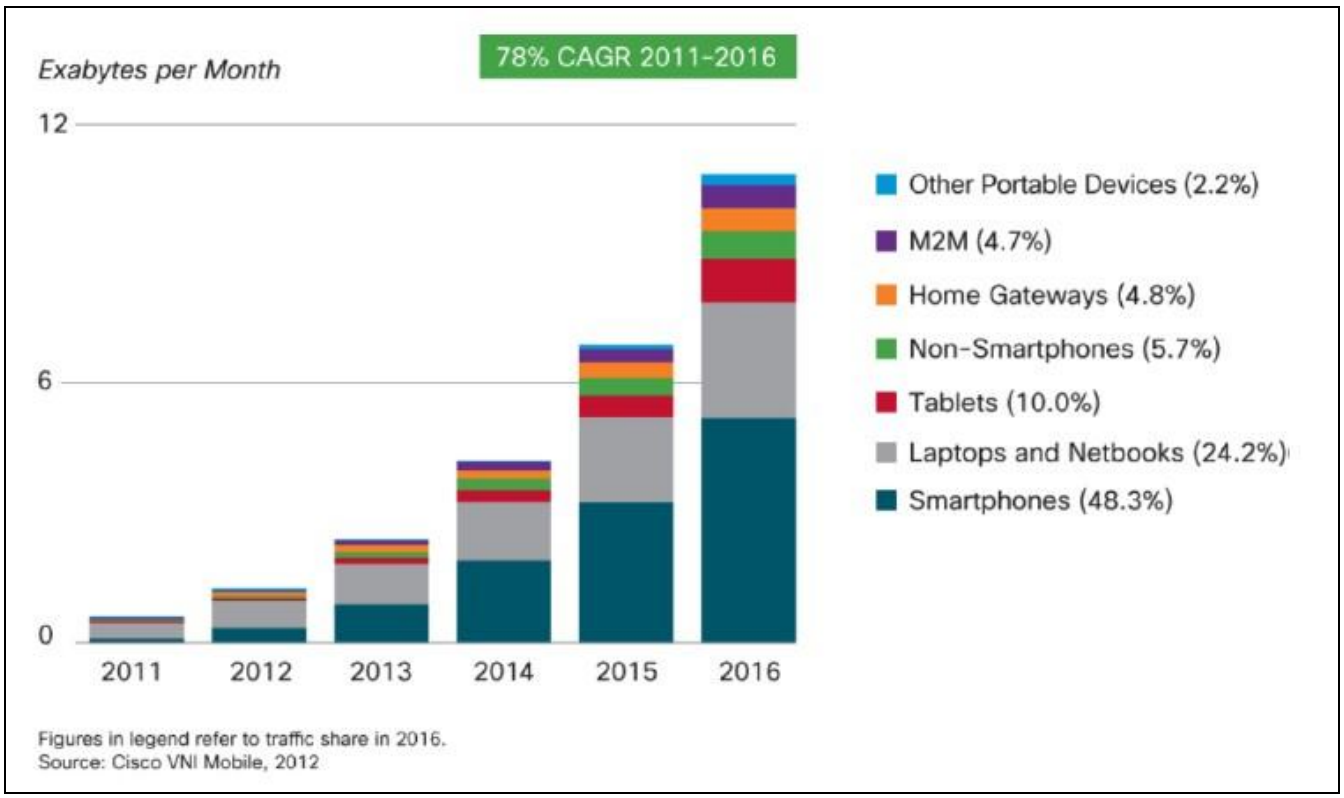

Figure 36 Cisco Data Volumes Forecast by device type, Source: Cisco

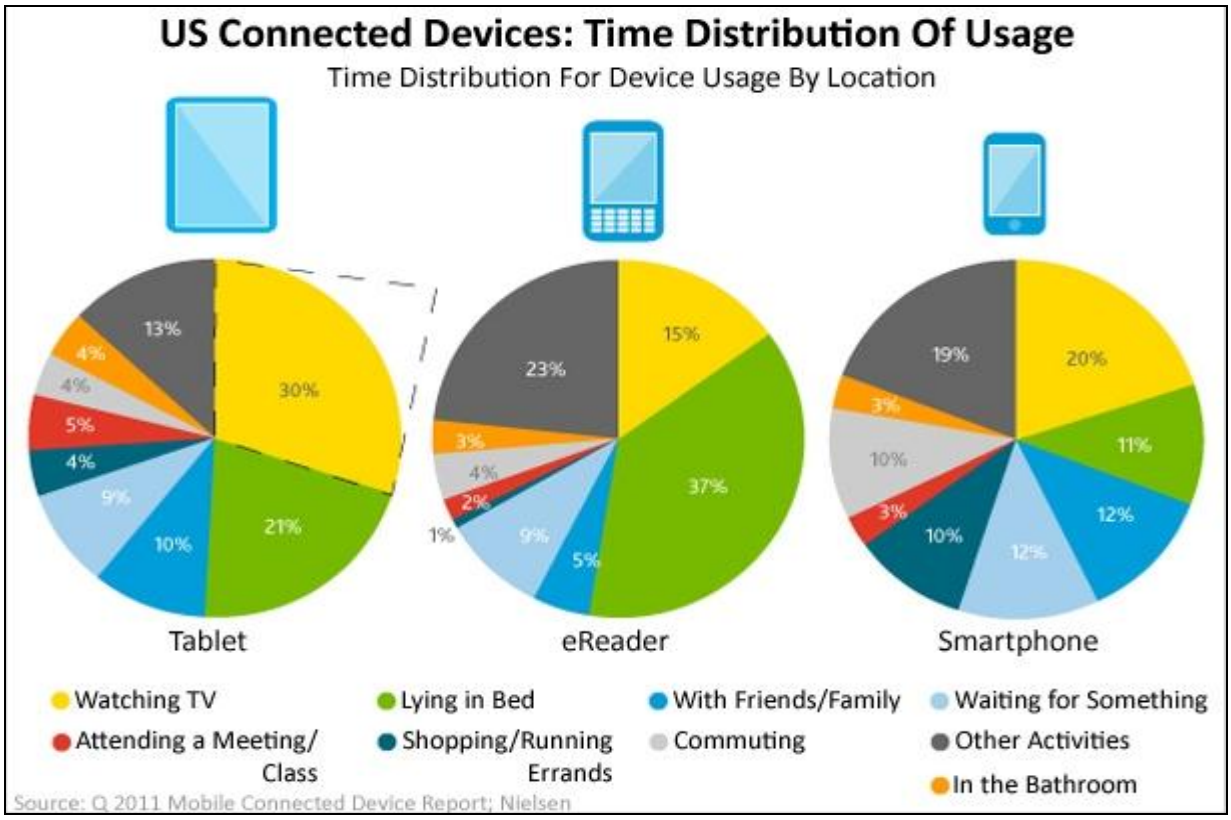

Figure 37 Distribution of time by activity and device type, in US, 2011

Differentiations in time, traffic and devices will offer a general opportunity for different B2B2C scenarios; however they also strongly rely on a great diversity in devices capability and Operative Systems, as well as in the type of available access networks and mode of connections.

Despite the apparently well-defined set of communication protocols affirmed in the current and Future Internet, a large and heterogeneous set of functions and capabilities are available in the connected devices and in the network.

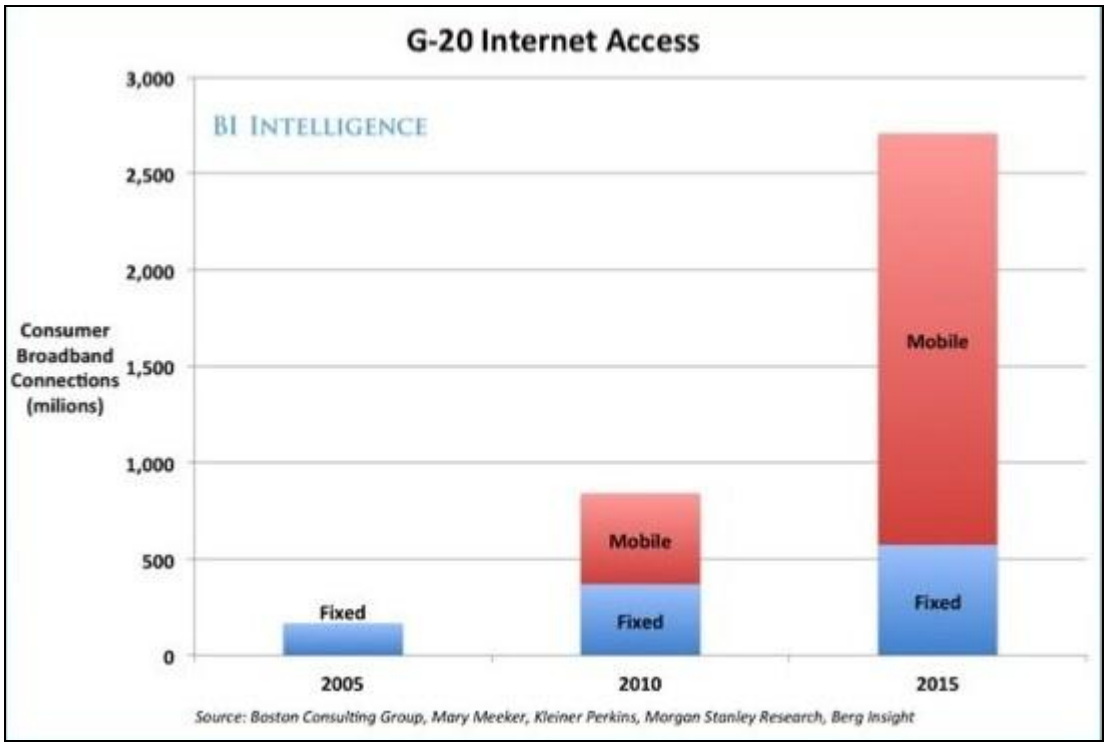

Figure 38 : Consumer Broadband Connection for Fixed and Mobile devices, Source Boston Consulting Group, Mary Meeker, Kleiner Perkins, Morgan Stanley Research , Berg insight

A first general consideration is a well-known trend of bandwidth increase from mobile devices (Figure 38); notebook and tablet have already bypass in number the personal computer (Figure 39) thanks to significant technological improvements that allows to have new screens with high contrast and high resolution, performing low power CPU and chipset, and batteries with longer lifetime. The connected TV set have already been a reality but such devices lack of user-friendly interfaces (navigation is typically achieved with a remote control) with poor usability and as a consequence they do not generate significant traffic; the only exception to this consideration is on-demand video streaming services, but these are only significant in the US and not in the UE, that have a wide digital TV broadcasting coverage and offer. Even for video streaming, however, the tablets are competitive with TV, because they offer same o greater resolution, touch interaction and the comfort to watch video in any place (in bed, on a armchair, in a public place).

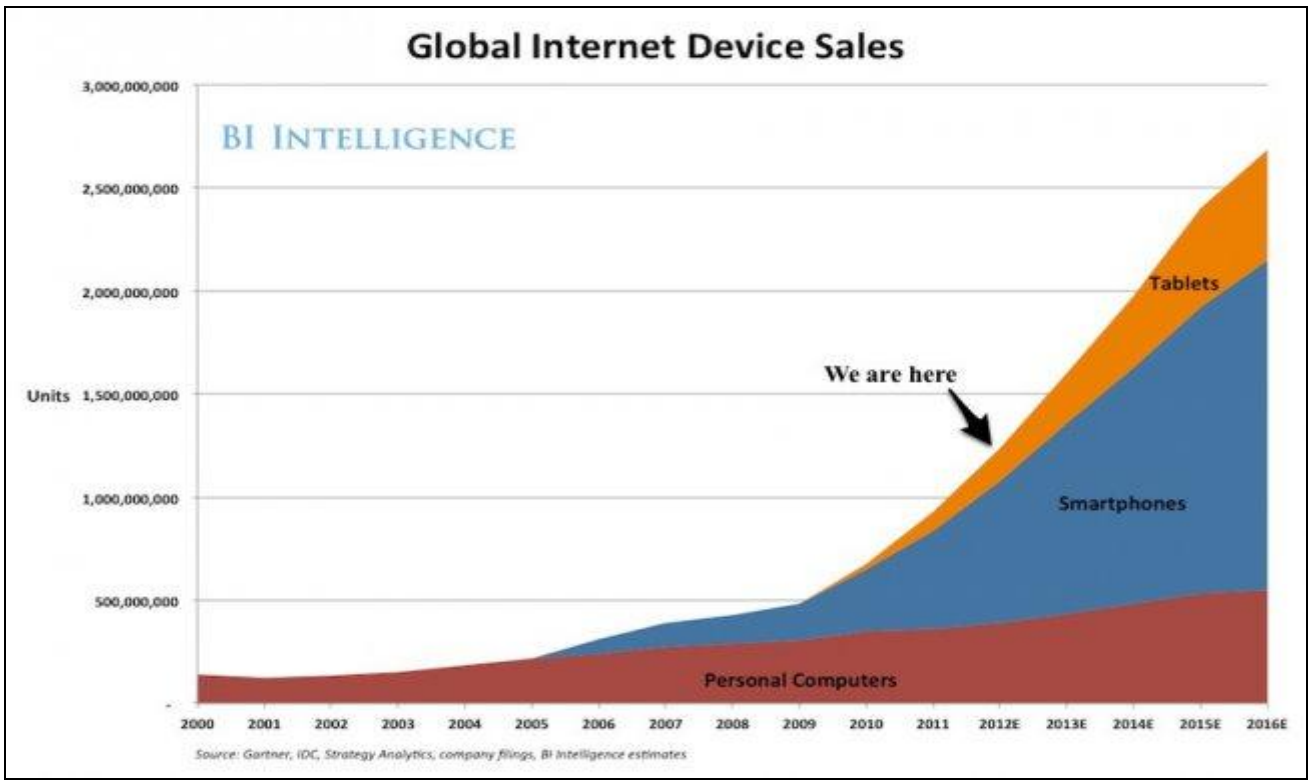

Figure 39 Global Sales Connected Internet Device Devices, Source:Gartner, IDC, Strategy Analytics and others

Focusing on the most fast growing mobile devices, smart phones and tablets (Figure 39), the market share by OS (Figure 40) shows that Apple and Android are quickly expanding against their competitor; this trend may be even more relevant if we consider that both Android and Apple iOS are also adopted as operative system of an increasing number of connected TV set. Other OS, Symbian, Blackberry, Microsoft have decreased in the market share of smart phones but they are still challenging Apple and Android and may play different strategies on new devices. Microsoft, for instance, propose a consistent set of solutions for convergence between connected devices, fixed and mobile, and cloud services.

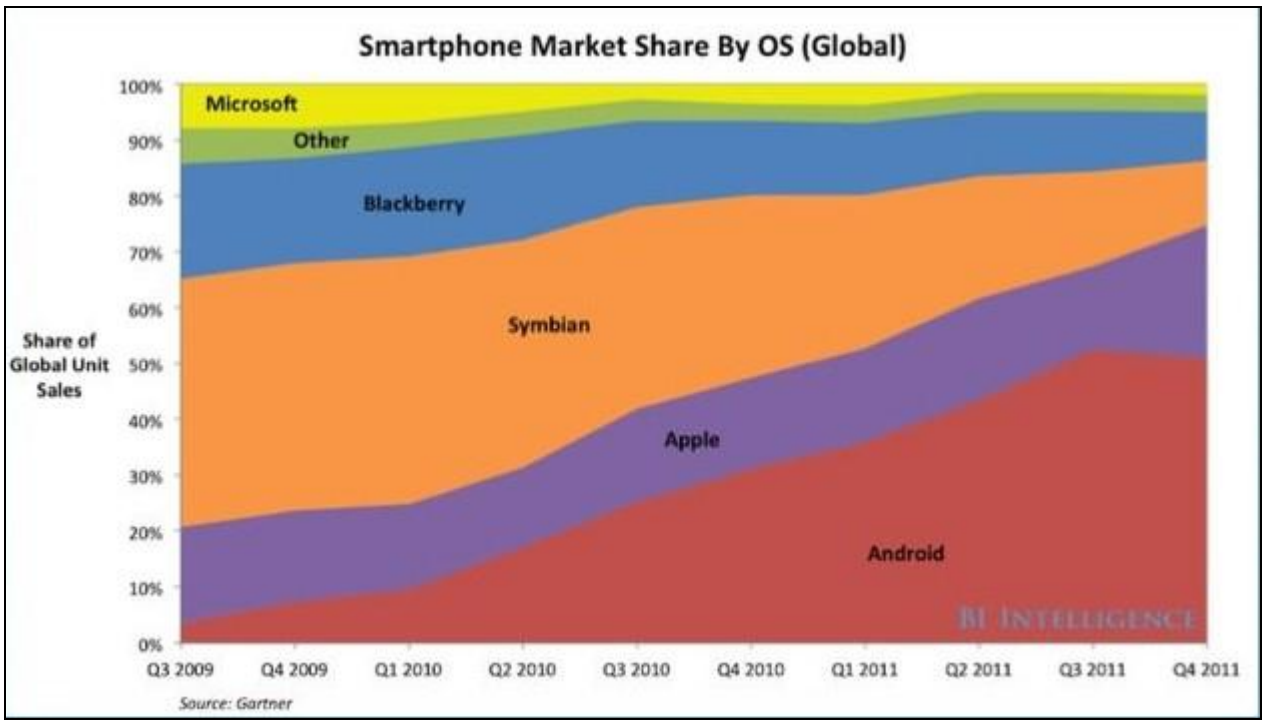

Figure 40 Smartphone Market Share by OS, Source Gartner

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

A further step in creating a common developing platform has emerged, by offering libraries specifically designed to overcome the limitation of **using pure HTML5/JavaScript**; these new libraries offer a wide set of functions written and optimized in the native language for all main OS, to guarantee good performance and the most uniform and predictable appearance of graphical elements and interactions used in the applications**. The set of API provided are typically accessed using JavaScript**, and the library are maintained and updated to support the changes in the device technologies and software. These type of solutions have already been analysed in chapter 4.1, about Application and Service and Delivery Framework; most of them come from private group or consortium and their specification is generally close even if some of the code may be released under open licenses. Considering these solutions from the aspect of Interfaces to network and devices, their greater limit is the absence of uniformity, as well as the ability to consider also the network evolution, instead of focusing mainly on the emerging technologies on devices and on the application market opportunities. One of the aspects not clearly considered is the ability to measure a real Quality of Experience from a user feedback, as well as the ability to efficiently change the connectivity, exploiting information from the access network and user preferences. Users feedback are up to now submitted using an application ranking score shared in the application market; such mechanism is very simple and do not consider the effective and variable network conditions, neither it allows to adapt the network selection to agree a QoS with the available access networks, nor to dynamically signals variable QoE conditions.

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

Cloud Edge/Proxy

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

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

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

5.2.4.2 *Vendors*

Terminals

The definition of a common set of functions requires the definition of software interfaces using the most pervasive and compatible language. Since there's no unique choice for native languages in the different OS (e.g. Objective C for iOS, Java for Android, etc), the choice is naturally demanded to Web languages and specifically to JavaScript: nowadays any device able to connect to Internet supports such language (by means of a JavaScript interpreter), even for the simplest connected devices where a graphical Web browser may not directly be accessible to the user (a JavaScript interpreter may exist even in absence of a Web Browser engine).

The choice of JavaScript is widely adopted to enrich Web pages with functions and allows interactions with Web Applications; this trend is not changed even after the advent of HTML5, because even though HTML5 defines graphical functions and new way of remote communication, it is not supposed to replace JavaScript. The wide usage of JavaScript is made evident by analysing the average size of code for the different Web languages in the past year: as shown in Figure 41, not only largest code of many Web pages is still due to JavaScript, but this language also had the highest growth in the past year.

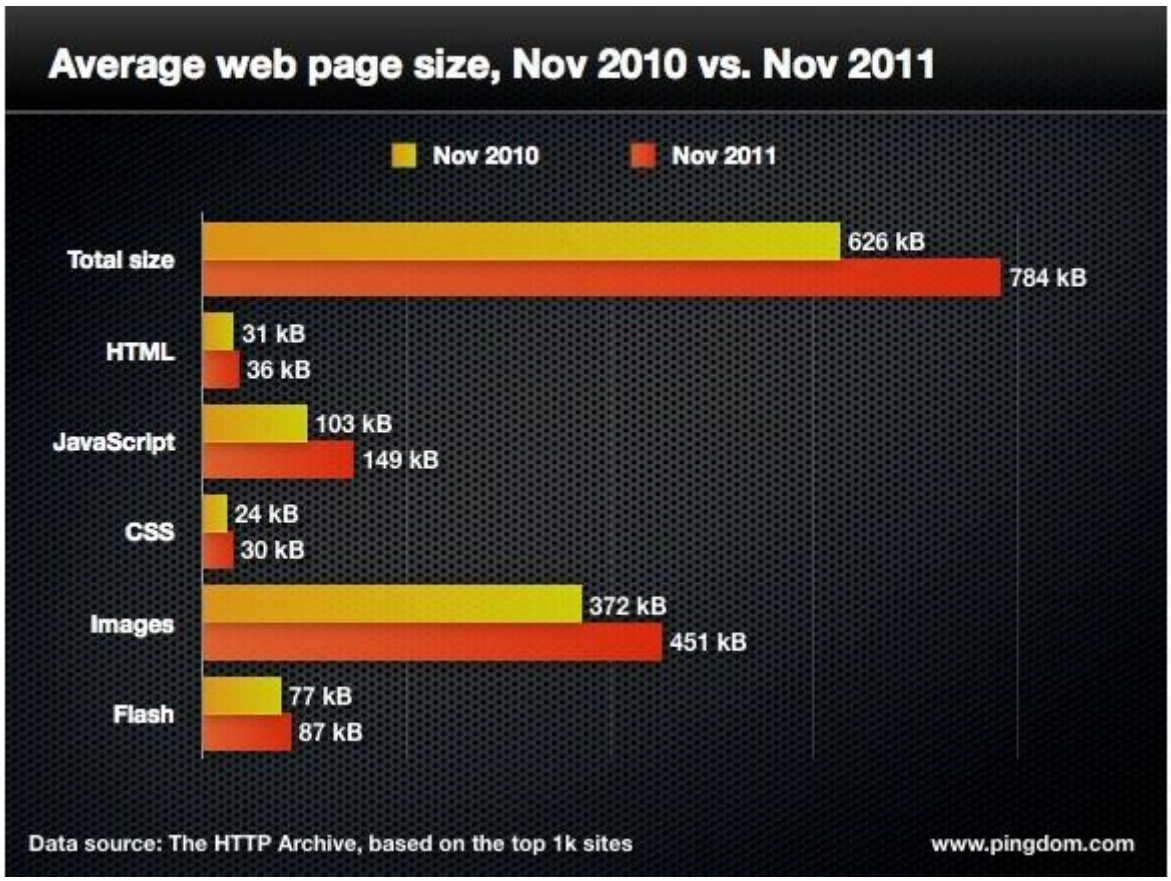

Figure 41 Average size of popular Web pages in 2010 and 2011, Source

The undeniable importance of JavaScript in the definition of the interfaces to access functions is balanced by the necessity to implement the most critical and highly performing functions in native code. Android, for instance, allows the definition of routines in native C code by means of an NDK tool, to further improve the efficiency of the Dalvik Java ByteCode virtual machine. An efficient implementation of the CDI GE may require use of native code, at least for the most critical functions, while the API should be accessible in JavaScript language.

More generally, the operative system of any connected device has a straightforward impact on how the applications interact with the device and on the efficiency it communicates with the network. As briefly introduced in the previous sections, most connected devices in the actual market use one of the following OS: Google Android, Apple iOS, Microsoft Windows, RIM Blackberry, HP Web OS, Nokia Symbian. Even though the first two OSes have gained the greatest popularity and have a collective market share of 85% the situation is still quickly evolving. Nokia for instance is pushing also on devices equipped with Windows 7 Mobile, that some analysts predict to grow up to market shares of 20% in 2015. A new promising OS is Tizen, based on Linux, like Android, but defined by an alliance of companies (the Tizen Association, Linux and Limo foundations) and designed as an evolution of many previous mobile OS from different sources, mainly Meego, but also Moblin by Intel, Meemo by Nokia.

The OSes currently used by most devices can be classified according to their different features to support an efficient network interaction; these features are briefly summarized in the table below.

Vendor	Detection of Network type	Data Caching	Data Compression	Support Efficient Data format JSON / XML	Push Notifications
Apple iOS	Yes, with Reachability	Supported by default	Enabled by default	Yes (from iOS 5)	Yes(from 4.0)
Google Android	Yes, with Connectivity manager	Not Supported by default	Not Supported by default	Yes	Yes (from 2.2)
Microsoft Windows Phone	Yes, via Network Interface	Not Supported by default	Not Supported by default	Yes	Yes
RIM Blackberry	Yes, via Network manager	Supported by default	Enabled by default	Yes	Yes

Table 5 OSes currently used by most devices

The table shows that any OS supports a Detection of Network Type using proprietary strategies; a common method to allow access selection and detection would be desirable both for the application/service Developer and providers than for the Network and Telco Operators.

The importance of a common set of interfaces for network and devices is also demanded by the continuously growing data traffic generated by the connected devices. Data traffic is mostly due to the access to video and audio content but the proportions between application types also depend on the users' data plan, as shown in the Figure 42 and Figure 43.

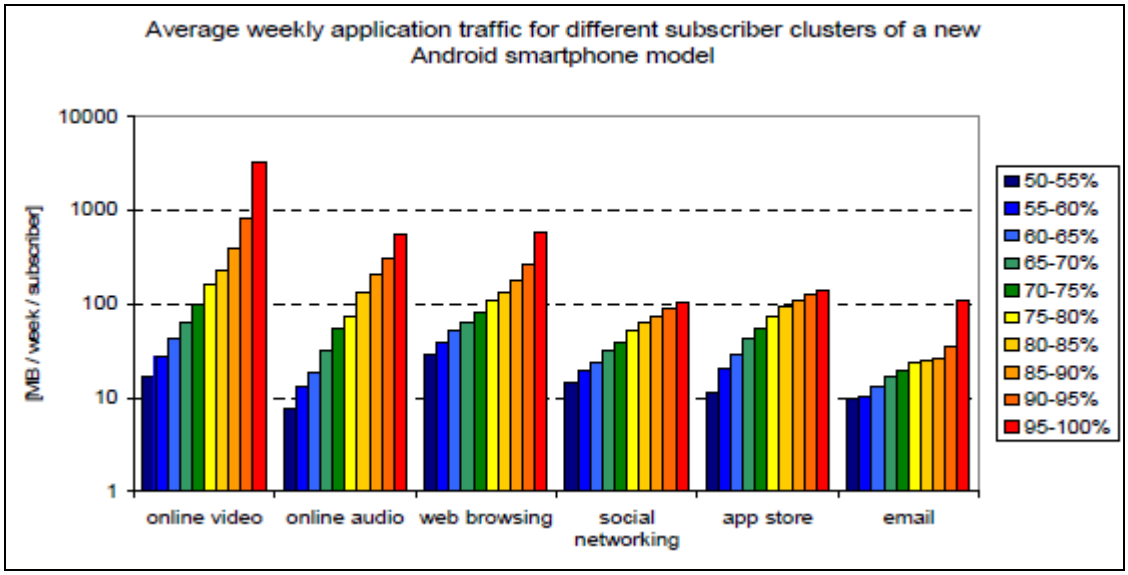

Figure 42 Typical weekly traffic for Android Smartphone users, Source: Ericsson Traffic and Market data report, 2011

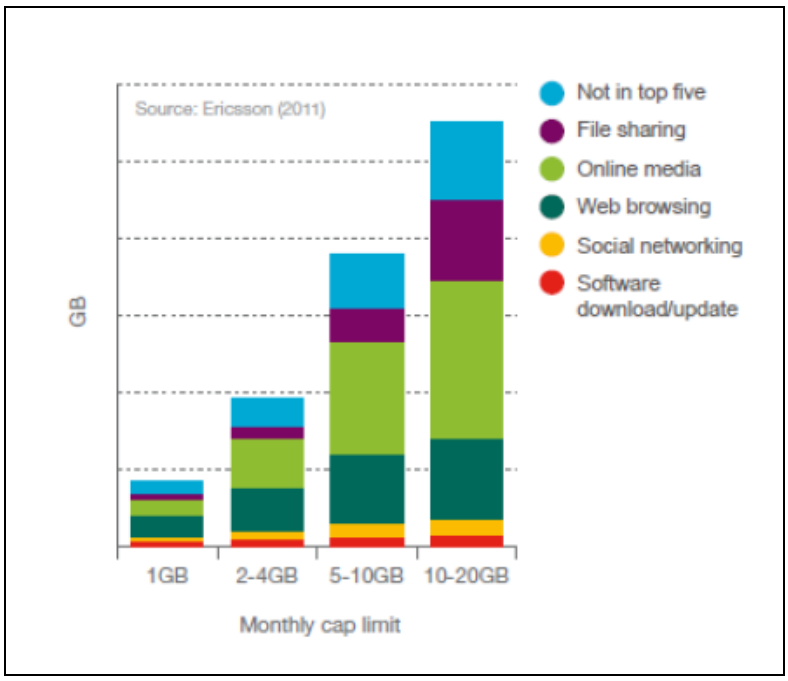

Figure 43 Traffic mix for different data plans, source Ericsson Traffic and Market data report, 2011

Beyond specific considerations about technical aspects concerning data offloading, or the asymmetric downlink and uplink traffic, the Indoor/outdoor usage, it's clear that different applications have different requirements not only in terms of delay, max and average throughput, connection stability and continuity, and these requirements need to be balanced between the users, the network, and the applications. To exploit both the network and the device capabilities, and to balance them with the applications requirements and the user needs and expectations, it is of primary importance defining a set of common functions to express the perceived Quality of Experience and to change it according to the network policies, the user preferences (also driven by data plans) and the availability of different network access with different QoS. Such approach should be beneficial for all the actors involved: users, application developers, service providers, Network operators, at the condition that such interfaces are uniquely defined and at the same time will allow the best flexibility and total independence from the device and OS type.

Cloud Proxy

As explained earlier in this section, the Cloud Edge market is not yet well defined. We consider that the players from the Internet access market, providing solutions to Network/telecommunication operators and Internet services providers will enter this market by supplying advanced Internet gateways. We believe that the actors from the consumer electronics market are also in a good position to design new Cloud Edge products or to include Cloud Edge functionalities in existing products. Below list gives an overview of the main players of each of these markets.

Top Vendors
Telecommunication suppliers
Huawei
Pace
Motorola

ZTE
Technicolor
Consumer electronics suppliers.
Apple
Samsung
Logitec

Network Management Systems

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

Table 6 Network Management Systems Vendors

Open Networking Components for Software Driven Networking (SDN)

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

Top Vendors	Description
Juniper Networks	promotes QFabric as a solution for SDN, Codonis (large DC provider) uses that (but they are also looking for OpenFlow-based

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

Table 7 Open Networking Components for Software Driven Networking Providers

Evolved Packet Core – Implementations

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

Top Vendors	Description
Ericsson	SRC:http://www.ericsson.com/campaign/evolved_packet_core/epc/index.html • Smooth integration while legacy systems will not be touched • First time brought out in 2009 with the help of TeliaSonera • Ericsson has a market share of 40% in GSM&WCDMA
Huawei	SRC:http://www.huawei.com/en/solutions/broader-smarter/hw-094052.htm • Fast deploy via SingleRAN, SingleEPC and SingleOSS • CS Fallback • E2E Tracing/Tracking for diagnosis • Intelligent Coverage Map • Policy Control + Service Profile Identities (for users)

Nokia Siemens Networks	SRC: http://www.nokiasiemensnetworks.com/portfolio/products/evolved-packet-core • Liquid Radio Access Network (Active Antennas, Baseband Pooling) • Products: • Flexi Network Gateway for diff. kinds of Access Technologies + Session Management • Flexi Network Server: SGSN/MME Server • PCS-5000: Policiy Control Service + QoS
Alcatel Lucent	SRC: http://www.alcatel-lucent.com/wps/portal/Solutions/detail?LMSG_CABINET=Solution_Product_Catalog&LMSG_CONTENT_FILE=Solutions/Solution2_Detail_000190.xml • Support 2G/3G + LTE Access (BTS,NodeB, eNodeB) • EPC is here called Ultimate Wireless Packet Core (incl. SGW,MME/SGSN, PCRF, PGW/GGSN) Additional IMS for converged IP NetworkProducts: • 7750 SR: GPRS/WCDMA, GGSN and LTE EPC Gateway, user plane functions, 10GigE line + Packet Inspection • 9471 WMM: Wireless mobility management functions of 2.5G/3G SGSN + LTE MME • 5780 DSC: Subscriber / Policy Control • 5620 SAM: OAM and Management Planes, E2E wireless management solution
Fraunhofer Gesellschaft (Open Source project)	SRC: http://www.openepc.net/project_info/features/index.html • Use of Open Standards, Open Interfaces, Open Protocols and Flexible Configuration • Different License models like binary,

	open source and prototypes • Features: Core Network Mobility Management, Core Network Support for LTE Access, • Core Network Support for Other 3GPP Accesses, AAA for non-3GPP Accesses, Policy and Charging Control, Offline Charging System, Subscription Management, AAA Signaling Routing, Client Mobility Support, Additional EPC Demonstration Enablers and Protocol Stacks • Long term development with increasing functionalities per release • Rel. 3 Features: 2G/3G access emulation, Charging Control System, Non-3GPP AAA Functionality, eNodeB emulation for LTE access, truly seamless handovers, IP flow view for diagnosis

Table 8 Evolved Packet Core Vendors

5.2.4.3 *Services*

The main services offered by the I2ND chapter outcomes can be summarised at high level in the following list:

- **Deployment:** Interfaces for the installation of new Internet architectures, where ICT technologies will meet network service provider technologies (OSGi)
- **Openness**: Open APIs and interfaces for not highly critical nodes to offer the possibility of secure access by developers and their communities. Critical nodes – for example lawful interception-capable nodes – will be closed and only infrastructure provider and government institutions will have access.
- **End-to-end connectivity:** Interfaces for network service providers enabling them to set up interconnections between several network domains to provide **the necessary Quality /Experience to the customers and end-users**. These interfaces will enable service providers, content providers, and developers to signal and to request their needs, from the infrastructure of the network service provider. Of course, the network service provider will decide on the requests on contractual bases and the final control of the infrastructure will stay in the hands of the network service providers (thus extending concepts of projects such as FP7-project ETICS, and contributing to projects such as IPsphere/Telemanagement Forum).

5.2.4.4 *FI-WARE offering*

An appropriate Interface to the Network and to the Devices as envisaged by FI-WARE will comprise a number of layered interfaces specialising in serving significantly different connectivity purposes and providing the enablers which offer the expected functionalities: the network infrastructure, the network

services and the broad range of connected devices used to access the services/applications in every condition and location (e.g. in mobility, in indoor environments).

From a technical point of view, the programmer communities, such as the **Linux Foundation community, will take benefit of the openness approach adopted by FI-WARE**.

Cloud proxy as evolution of the home hub, able to federate the connected devices and expose functionalities to support a large variety of service bundles. The API layer provided by the Cloud proxy allow the cloud-based applications to interface properly and easily with devices connected to the home network (home automation/storage devices/renderers/tablets/....) and with other services hosted on other Cloud Proxies (for instance for implementing P2P services or remote surveillance applications).

In summary, **the I2ND GEs address the needs of several 3rd party innovators targeted by the FI-WARE platform,** Application Developers and Service Providers being the prevailing ones. New or enhanced services can benefit of the additional functionality from the network side to improve their existing services or even create completely new ones. On the Application Developer side, it is possible connecting via the CDI GE to a homogeneous Interface and obtain and set settings of the end user's device while interacting to a service which is simultaneously able to obtain the network status, request flow/application based QoS parameters, receive additional information from the network side and will therefore be capable to adapt the flow settings and content specifications of its application.

5.2.4.5 *Value chain*

Terminal issues have a considerable impact to the value chain of an App developer. The primary activities an App developer undertakes within their value chain are:

- Research and Development
- Design of Products (Applications)
- Production of Applications (Development)
- Marketing & Sales
- Distribution
- Support (service)

CDI impacts the Research and Development, Design, Production, and Support actives:

Research and Development: CDI provides a common platform for application development and as a toolset provides developers with a focus point for their product research and development.

Design of Products: Developers can use CDI as a tools to aid the design of new products, reducing the amount of time expended to design new applications and reducing the overhead of the activity in this area.

Production of Applications (Development): This activity benefits from a reduced overhead cost, by using the CDI Generic Enabler developers can develop applications which can run with a wide range of HTML5 frameworks in a cost effective way. The wide range of platforms which can be supported provides an additional value to this activity as it increases the potential reach of the resulting application, by allowing it to run on a wide range of platforms.

Support (service): The remote management functionality, and the cross device nature of the CDI GE reduce the overhead of this activity. The remote management functionality allow developers to monitor and control their application (if required / desired) on a wide range of platforms in a simple unified way. This allows the developer to invest less in platform specific support activities. Additionally any changes or updates to applications can be implemented on multiple platforms for a reduced overhead.

Network Service Provider: A value chain model is defined around the network service provider. The end-to-end value chain is not considered in the FI-WARE project. In such a model, the following roles can be identified:

- Customer (will be connected through the access network, has a contract with the access network provider, consumes a service, and in certain cases has a contract with the content provider)
- Access network provider (connects the customer to a core network provider, or connects a content provider to a core network provider)
- Core network provider (connects an access provider to intermediate core network provider)
- Intermediate core network provider (connects other intermediate core network providers or intermediate core network provider with a core network provider)
- Content provider (will be connected through the access network, has a contract with the access network provider, and in certain cases has a contract with the customer)

In some cases, the access network provider can be combined with a core network provider. In principle the value chain is defined as follows:

Content provider – Access network provider (– Core Network provider) – Intermediate core network provider (– Core Network provider) – Access network provider – Customer

In the framework of the I2ND-Network service provider issues, the focus is on the Core network provider and Access network provider. The planned developments will help reducing CAPEX and OPEX and to provide better services to the end customer. From a business point of view the value contribution cannot been provided so far.

End-to-end service delivery is not considered by FI-WARE directly; this can be taken into account by referring to the FP7-projects ETICS (https://www.ict-etics.eu/).

5.2.4.6 *FI WARE SWOT Analysis*

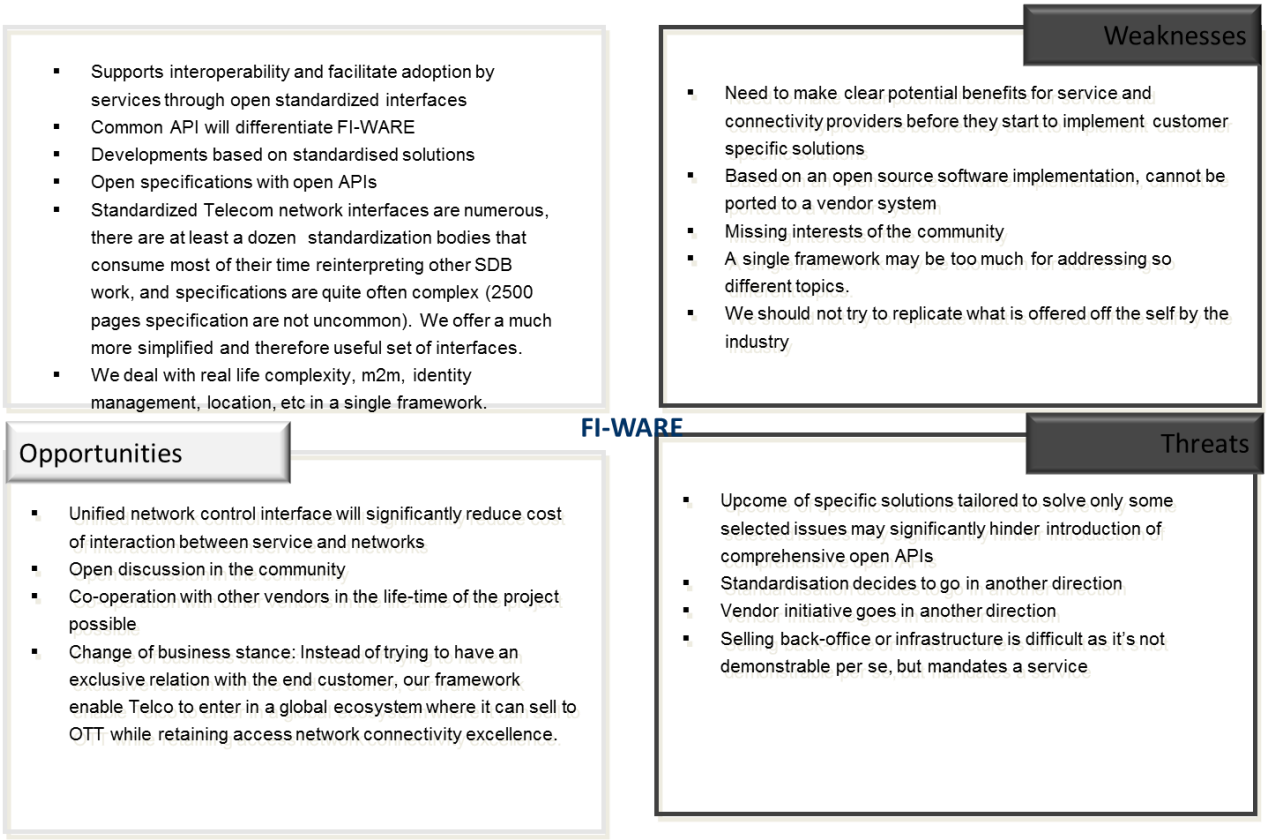

Figure 44 I2ND SWOT Analysis

5.2.5 Security, Privacy, Trust

While lots of security technologies for the Internet are available, the Future Internet imposes additional challenges on security and trust, mainly due to its pervasiveness, its scale, and the lifelong involvement of its users. The challenges include, for instance:

- the design of identity management systems capable of dealing with billions of entities and their different roles in the Future Internet,
- the trustworthiness and control of distributed applications based on services offered through open service delivery platforms, and
- the secure and trusted interaction with real-world objects and entities through sensor and actuator network infrastructures.

Nowadays, in the future internet environment, what the user **seen as a single operation could be composed by several services provided by different suppliers.** Moving from today's static services, we will see service consumers that transparently mix and match service components depending on service availability, quality, price and security attributes. Thus, the applications end users see may be composed of multiple services from many different providers, and **the end user may have little in the way of guarantee that a particular service or service supplier will actually offer the security claimed**

Additionally companies are facing challenges such as:

- **Data protection**, the large number of diverse types of devices (laptops, mobile phone, tablets, USB memories, etc), Web security and son on, require the capacity to **guarantee that this personal information provided by users will be processed according with the user rights and requirements.**
- **The rising number of cyber-attacks,** creating safe and trusted services without sacrificing much of the desired functionality, usability, performance and cost efficiency is a great challenge, especially in a dynamic environment where new threats and attack methods emerge on a daily basis.

Consequently, the final ambition is to demonstrate that the **vision of a Future Internet that is "secure by design" is becoming a reality**

5.2.5.1 *Market Overview*

Cyber-security threats are a significant and growing concern. The Privacy Rights Clearinghouse reports that over 345 million records containing sensitive personal information were involved in security breaches in the U.S. since January 2005 (Source Intel), while a recent PwC study quantified cyber-crime as having doubled from 2008 to 2010 to £10B in the UK alone.

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

According to Gartner, **during 2010 the Security Information and Event Management market grew from $858 million to $987, achieving a growth rate of 15%.** There is a strong growing in Europe due to compliance and threats requirements.

The SIEM market is mature and is looking for expanding in:

- Integrity monitoring,
- Vulnerability assessment,
- Security configuration assessment and
- Data access monitoring

IT security products: market forecasts

$ million	2009	2010	2011	2012	2013	2014	2015	CAGR%
Total	**16,633**	**17,735**	**19,145**	**20,399**	**21,536**	**22,851**	**24,303**	**8**
DLP	458	493	553	639	729	764	832	12
Cont. & web.	1,693	1,841	2,028	2,192	2,342	2,513	2,699	8
Endpoint	2,884	3,059	3,255	3,426	3,568	3,767	3,977	5
IAM	3,970	4,221	4,517	4,772	5,004	5,305	5,624	6
Network security	4,829	5,082	5,396	5,650	5,886	6,177	6,497	5
Security mgmnt	2,799	3,039	3,396	3,720	4,007	4,325	4,674	9

Note: includes new licenses, associated maintenance, and services

Source: Ovum

OVUM

Figure 45 IT security product market forecast, Source: Ovum

5.2.5.2 *Vendors*

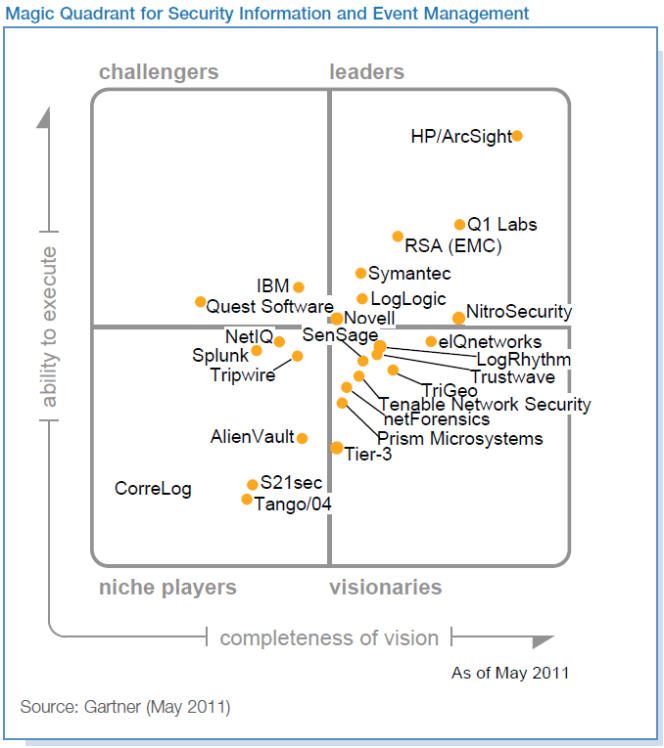

Figure 46 Magic Quadrant for Security Information and Event Management Source Gartner

Vendors	Products
RSA Archer SourceFire Bivio Networks HandySoft SCITLabs	Automated actions.
HP/ArcSight Q1 Labs Damballa Invincea Securonix ENC/Netwitness Mapreduce-based applications Amazon Web services Symantec Deepsight Verizon/Terramark	Analytics Driven Security

Masking Networks	
Akamai Mandiant Verizon FireEye Amazon web services	Just in time resources.

Table 9 Sample solution vendors, Source: Accenture

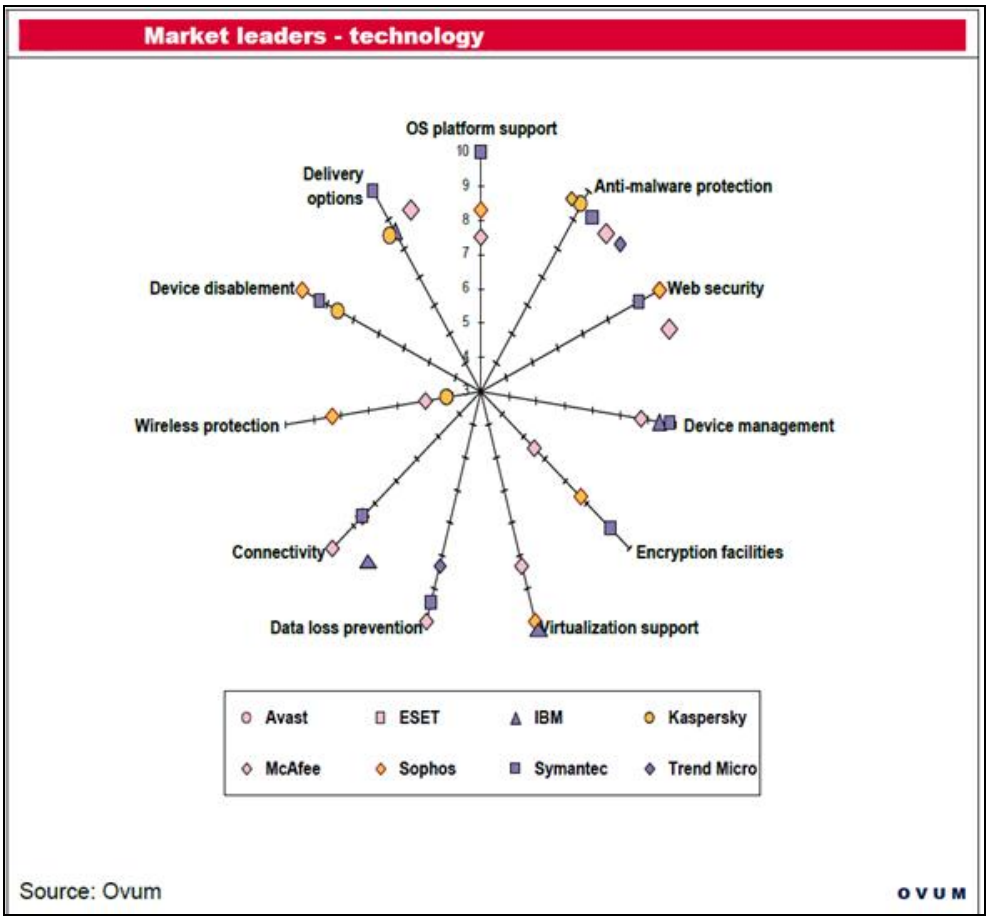

Figure 47 Market leaders technology, Source OVUM

The OVUM Market leaders are shown in eleven dimensions. The anti-malware market is mature as is shown with the population of the end of the axe.

5.2.5.3 *Services*

Security monitoring is the first step towards understanding the real security state of a future internet environment and, hence, towards realizing the execution of services with desired security behaviour and detection of potential attacks or non-authorized usage.

Through a set of modular services:

- the correlation of security events, the risk analysis service, the decision making support, the security visualization and reporting, the digital technical forensics for evidence service, it will

provide the information needed for the security stakeholders to take appropriate actions to prevent and mitigate the impact of abnormal behaviour. Additionally it will provide digital forensic information.

Identity management delivers the authentication/access control and identity/attribute assertion as a service to relying parties (IdMaaS). The relying parties are typically service providers that provide easy and secure access to their services to users/IoT/other services for instance by means of SSO and that rely on (personal user) attributes (e.g. preferences, location, home address, etc).

The functionalities available are:

- the user management managing a user's identity in the system, the user authentication providing a set of functionalities that a service can use to authenticate a user, an identity federation interface which allows a single sign on to be provided, a credential management used to convey a user's right to access a resource, an access policy specifying the conditions a user/service has to satisfy in order to obtain access to a resource, and external Directory Services as an external directory service is an alternative for verifying user's credentials.

Privacy Generic Enabler provides a set of functionality similar in scope to the Identity management generic enabler but enhanced using special privacy enhancing technologies. These privacy-enhancing technologies are primarily centered on special credentials that contain attributes about the user which can be disclosed for authentication purposes selectively on a need-to-know basis. That is how the Privacy Enhanced Credential Management provides private credential systems and minimal disclosure tokens for enhanced privacy protection mechanisms, End-users having the option to disclose selectively their asserted private attributes or even just to prove predicates over their attributes in an unlikable manner.

Data Handling Generic Enabler is a privacy-friendly attribute-based access control system to (sensitive) data. It mainly focuses on revealing certain attributes according to specific prove conditions. It ensures, for instance, that the data usage purpose must always be declared, so to be verified against the user privacy policy. It can also regulate, for instance, downstream usage, i.e., whether one can disclose collected data with third parties. The Data Handling Generic Enabler supports the enforcement of a number of obligations that are bound tightly to data. For instance, one can impose a specific retention period, as well as the production of user's notifications and/or logging under certain conditions.

Context-based security and compliance Generic Enabler supports additional security requirements requested by applications (e.g.. Instant Mobility, Safe city..) as a result of the application of very specific regulatory constraints. Also, if a security policy non-conformance is detected, the Generic Enabler is capable of performing run-time and context-based reconfiguration of deployed security enablers, such that the client application will be provided with a new configuration for the security enabler it is utilizing, or it can receive instructions to stop using that security enabler and use a newly provided one.

The generic enabler includes a new business service oriented language that is able to describe and register security services, capabilities and compliance rules. **The USDL-SEC language** provides mechanisms to cover both high level description of the service and detail functionalities & implementations, describes functional security services provided by the platform, provides means to compare and select services according to consumer needs and offers event management capabilities to allow monitors get the context event information from the security enablers they overseen.

Data Base Risk and Anonymization (Optional Generic Enabler) can be used to check if a shared database is not vulnerable to the re-identification of the non-shared part of the database. This service provides a feedback on the re-identification risk when disclosing certain information and proposing safe combinations in order to help him during the information disclosure.

A **Secure Storage Service** (Optional Generic Enabler) offers the possibility to safely backup data and delegates the access to parts of data to third party, providing a secure storage service, manipulating self-protected metadata only.

A **Malware Detection Service** (Optional Generic Enabler) allows exploring a data structure in order to check whether this dataset contains malware applications. Morphus is a generic malware detector based on graph signatures.

5.2.5.4 *FI-WARE offering*

Security, Privacy and Trust in FI-WARE will be mainly focusing on delivering tools and techniques to have the above-mentioned security needs properly met. This will be performed by design and some semi-automation and assistive technology to alleviate the workload of users and administrators while raising their security awareness to make informed decision.

- **Security Monitoring** Generic Enabler provides a comprehensive and pro-active monitoring ranging from acquisition of events to role-oriented display, providing "intelligibility" of the visualization according to each of the stakeholders' perspective, a role-based decision making support, a digital forensics tool targeting at Services and promotes a collaborative Security.
- **Identity management** Generic Enabler offers an authentication and attribute assertions about users and things as a service to relying parties via open protocols, a Single sign-on (SSO) for end-users, the enforcement of end-users' privacy policies in attribute assertions and real extensibility with external identity stores and authentication support functions, and also a graphical user interface (GUI) for end-users to manage the rules to reveal their attributes via policies.
- **Privacy** does not allow different tokens created by the same user to be linked unless the token was explicitly created in a linkable way, and the user who created a token cannot be identified unless the token was explicitly defined to be traceable by a trusted authority.
- **Data Handling** permits a fine-grained control over a user's personal information on the Internet with respect to an arbitrary number of actors, enforcing privacy policies that are explicitly approved by owners, with the possibility to set obligations associated to private data. It provides an usage control in multi-tenant contexts.
- **Context-based security and compliance** allows managing dynamically the compliance of software services to business regulations and user requirements and offers tools for modelling business relations and agreements into an abstract set of rules, a new business service oriented language describes and registers security services or capabilities, this language providing mechanism to cover from high level description of the service to detail functionalities and implementations.
- **Optional Generic Enablers** are planned to be used either in isolation or in conjunction with other Security GEs when relevant or needed (Security Monitoring can trigger Malware detection service in case of ...)

5.2.5.5 *FI WARE SWOT Analysis*

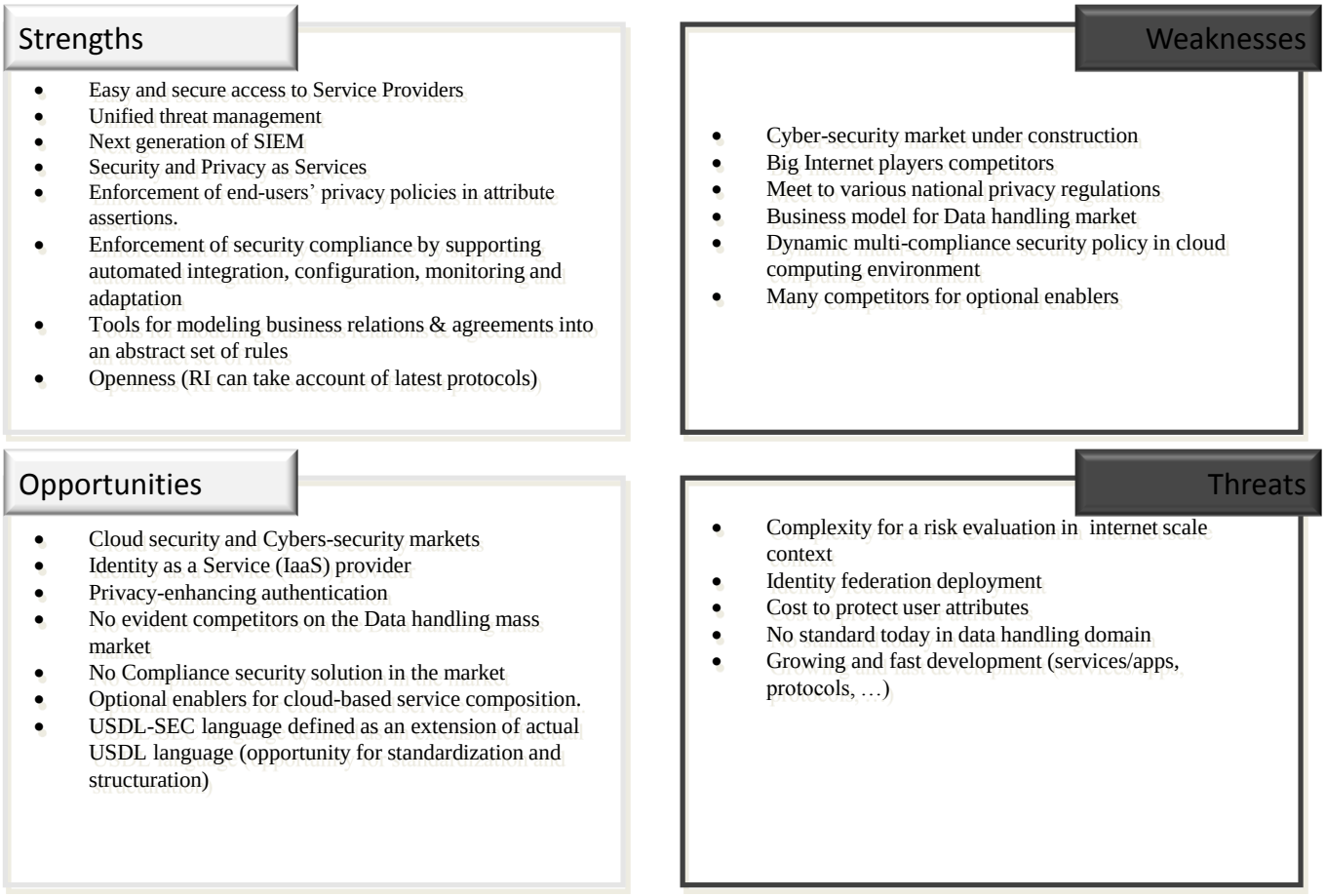

Figure 48 Security SWOT Analysis

6 FI-WARE Value Proposition

The high-level goal of the FI-WARE project is to build the Core Platform of the Future Internet. This Core Platform, also referred to as the "FI-WARE Platform" or simply "FI-WARE" , will dramatically increase the global competitiveness of the European ICT economy by introducing an **innovative infrastructure for cost-effective creation and delivery of versatile digital services, providing high QoS and security guarantees.** As such, it will provide a powerful foundation for the Future Internet, stimulating and **cultivating a sustainable ecosystem for** (a) **innovative service providers delivering new applications** and solutions meeting the requirements of established and emerging Usage Areas; and (b) **end users and consumers actively participating in content and service consumption and creation**. Creation of this ecosystem will strongly influence the deployment of new wireless and wired infrastructures and will promote innovative business models and their acceptance by final users.

6.1 What is the FI-WARE platform concept?

The FI-WARE project provides a concept and concrete implementations of a generic and extendible ICT platform for Future Internet services that aims to meet the demands of key market stakeholders across many different sectors **strengthen the innovation-enabling capabilities in Europe** and overall ensure the long-term success of European companies in a highly dynamic market environment.

The FI-WARE project addresses the requirements of Future Internet networked applications by an evolutionary architecture that allows composition of standard and existing elements (generic enablers) in an on demand fashion via open, flexible, and harmonized interfaces.

The project will result in an ecosystem where infrastructure providers can tap into **novel revenue streams by providing their assets to novel business domains** while at the same time application and service providers can offer novel and smarter applications on top of a more flexible ―smart infrastructure. Rather than a focus on best in breed functionality of isolated applications, the winning combination becomes sufficient functionality together with ease of adaptation, interoperability and operations at scale.

6.2 What does FI WARE offer?

FI-WARE will provide technical infrastructure as the basis on which **Application Developers as well as Instance Providers can develop innovative offerings** that bring about completely new business opportunities and stimulate the service economy of the future **leveraging on the following assets**:

- **A single set of APIs, each of which brings about concrete built-in innovation-enabling capacities** and altogether allow Application Developers to focus on domain-specific innovation.
- **A common language, USDL,** that enables FI-WARE GEs to describe all relevant data of technical, operational and business aspects in a uniform way**,** easing the integration of different applications and services beyond a mere interoperability perspective.

6.3 What are the Benefits of FI WARE?

- **FI-WARE gives Application Developers opportunities that current platform technologies do not supply because** they are usually based on different technologies, different standards, missing an overall usage model that describes how they can be used together:
    - **The possibility to easily aggregate services and applications**, saving efforts and costs; the adoption of a common aggregation model by the backbone reduces the complexity of this task;
    - **The response to obvious market requirements regarding secure, stable and cost-efficient products**; the definition of a common standard backbone covering most of the Generic

Enablers, which are needed to develop Future Internet applications, 3rd parties are encouraged to integrate available FI-WARE services that disburden them from developing essential but expensive services on their own; this removes a significant barrier for new 3rd parties with limited financial resources;

- **The opportunity for Application Developers to focus their efforts on the actual differentiation of their products** from those of their competitors; this means a particular chance for small and medium sized service providers to concentrate on what is crucial for their for business success.

- **FI-WARE addresses the specific currently existing requirements and business constraints** in order to realize these business enabling factors:
  - **FI-WARE offers royalty-free, open and standardized access points to essential services and technologies**, developed in the different FI-WARE chapters, thus protecting the investment of Application Developers;
  - **The architecture of FI-WARE ensures the general interoperability** (interplay) between the different applications and services and, overall, the ability to combine offerings from different FI-WARE Instance Providers;
  - **3rd parties become part of the FI-WARE ecosystem as long as they follow the FIWARE standards** but without being forced to use all defined FI-WARE GEs.

Figure 49 FI-WARE Targeting Developers Needs

6.4 What added value provides FI-WARE Project to ICT world?

FI-WARE directly addresses a number of the fundamental strategic concerns in the application and service provider domain. FI-WARE will have a strong impact on this domain as it focuses on those domain inhibitors that today make this difficult and expensive, by:

- **Providing lifecycle support for applications and services across the involved stakeholders.**
- **Providing machine-readable models for discovery, security and performance engineering**.

- Furthermore, **FI-WARE is envisioned to mitigate the huge obstacles composed applications face today**. Today, for every Euro spent on software and hardware for more complex business applications, seven Euros (and months of additional time to market) flow into consulting and integration tasks. This is a considerable concern that prevents the uptake of Internet-enabled applications.
- **Dismantling artificial barriers that could provide scale to have better performance as well. The applications developed under the umbrella of FI-WARE will have common baselines**, and will be applicable to a single, extended market, even though, in some cases, adaptations will be required to cope with niche market specificities. However, the fact all of them share interoperable components will simplify both the universality and the flexibility for customization.
- **Finally the FI-WARE project seeks to coin an ecosystem around its technology** and concept in order to foster innovation in the application and service provider domain. The means for this are the "Testbed" and the "Open Innovation Lab" initiative, which can be taken as a blueprint for later more productive settings

6.5 FI- WARE Platform SWOT Analysis

Analysis of the competitive advantages of the FI-WARE platform as well as its environment.

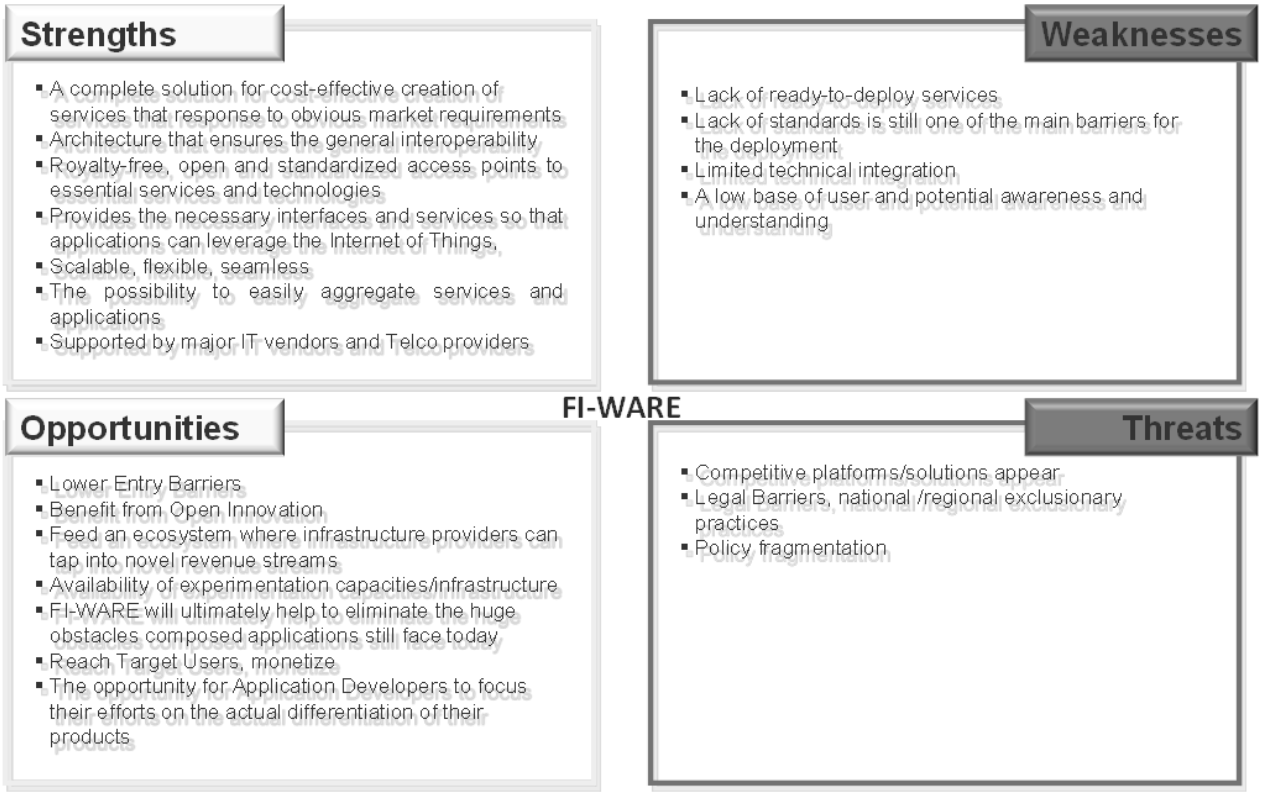

Figure 50 FI-WARE Platform SWOT

6.6 FI WARE Impact

FI-WARE will have significant impact in three distinct dimensions: technological-industrial, economic and social:

- **Reinforce industrial capability and competitiveness**: The platform, together with the Usage Areas projects tends to increase European productivity providing standard elements which can be re-used in different industrial areas. This is achieved using the concepts of a PaaS, enabling rapid service creation through application blueprints, and NaaS, implementing network virtualization for the Cloud, which

together will contribute to the implementation of the Future Internet by providing a service platform that will be able to scale to the unforeseen level envisaged.

- **Create new opportunities for novel business models and its derived economic benefits:** FI-WARE project could help to cultivate an ecosystem comprised of agile and innovative service providers, which in turn consume services provided by the traditional ICT players. the availability of a platform whereby stake holders across different sectors (e.g., healthcare, logistics, energy management, sustainability, transport etc.) can cooperate will accelerate the development of new innovative services for the European society within and across various sectors.
- **Contribute to the people welfare and job creation.** FI-WARE results are expected to make a significant contribution to social welfare through the enabled applications. It is envisaged that this ample set of services/applications/products will provide the European a better quality of life. FI-WARE will be good example of those next generations of systems that will transform our economy and society in the face of the major challenges of globalization, ageing, climate change and sustainability etc.

The concepts developed in the FI-WARE project are targeting cost-effective lifecycle management support for infrastructure, applications, and services across the relevant actors and domains. By this, FI-WARE directly addresses one of the fundamental strategic concerns in the infrastructure, application and service provider domains, namely operational expenses**:**

- The economic benefits of achieving the technological objectives of the FI-WARE can be partly quantified, in particular in terms of **reductions in system operation due to the inherent benefit of creating a unified, holistic, interoperable architecture** that allows collaborations and innovation formerly **inaccessible by domain incompatibilities**.

Consequently, the abovementioned **FI-WARE concepts intent to change the way that different players across the sectors (technology, business) talk and act** about discovering, managing and using networked applications and services, with increased dependability, agility and a much reduced time from idea to realization at scale.

- For this purpose, **through "Testbed" and "Open Innovation Lab**, FI-WARE project is set to enable existing stakeholders as well as newcomers (including SMEs) to design and deploy services for non-commercial use, opening the way to explore new business models and new content monetization possibilities

In addition, the technologies, that FI-WARE project will provide, carry the potential for enabling new business opportunities for established and emerging application and service providers in areas such as energy, telecommunications, healthcare, media and e-government. Typically, **smart living services are delivered to households through service platforms**. Service platforms can be seen as hardware, software, network infrastructure or even a combination of them that host a set of core functions (e.g. data storage, processing power, intelligent decision-making component) deployed by service providers to build, run and deliver value-added services to customers. **The vision of smart living is to facilitate comfort living for consumers by providing several ICT-enabled services** that combine value drivers of health, energy, security and entertainment services.

- **Looking at energy sector**, for instance, considerable attentions especially from governments are given to **smart metering** and energy management services in an attempt to enable consumers to proactively control and manage their energy consumption, reduce their electricity bills and benefit the environment. The smart meter is the most well-known service platform in the energy sector that is intended to raise awareness of electricity consumption of consumers and stimulate energy saving behavior
- **In the health sector, increasing costs of healthcare and elderly care services** has triggered many service providers to explore new ways of service offering. Healthcare service platforms are responsible for exchanging data between household and service providers. The data is collected from connected devices and sensors (e.g., camera, portable wireless devices, motion, Infrared and/or wearable sensors, and blood sugar or heart rate readings) at home. The core functions on the service platform are used to

send real-time information from home to health-care service providers. Then, depending on the status, service providers can deliver specific e- health services to a household through a device at home, internet, or mobile phone.

- **Entertainment and Communication Service Platforms:** ICT advancement and increasing broadband connection to houses have motivated many content providers to provide online and on-demand audio and video services, like Amazon Instant Video, Blockbuster on Demand. The growing demands for the Internet TVs and increasing amount of online contents have also triggered many leading electronic manufacturer to deploy internet-enabled service platforms (e.g. Google TV, Yahoo TV) on their TVs to make them smarter. Such TVs acts as service platforms and eliminate the need for set-up boxes or any other devices
- In the same way, **security service providers** are also trying to utilize new communication technology and devices for more advanced security services

On the whole, what most of smart living service platforms have in common with FI-WARE is that:

- They all need **a communication infrastructure to communicate data and information** between service providers and households.
- They also need **to be interconnected to a set of controlling devices and sensors for end-user service delivery at home** (e.g. energy, health or security services).
- As such, there are **possibilities for service providers to share such common functions and requirements for serve delivery on common service platforms**. While, advancing technologies, like the 'Internet of Things', cloud computing and 'Platform as a Service', could enable the common service platforms of future for smart living services.

Following with the above mentioned need for "smarter" infrastructures", **cities offer an ideal platform for ICT and other Industries to integrate and test concepts to serve Europe's future sustainability**:

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

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

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

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

7 Conclusions

It has been performed a general analysis of the market situation leading to the proposal of service platforms, together with a more detailed description of the specific situation for the different areas constituting FI-WARE.

Regarding the general situation analysis, the main conclusion is that platforms have deeply restructured how hi-tech industries operate and the reason why platforms have taken on such a key economic role is that platforms, where convergence between IT, internet, telecommunications and media services and technologies occurs, are engines of innovation and that although a generalized service platform can be very useful and may offer interesting market possibilities, it is very difficult to predict the success of a standardized approach. Existing offerings address different business niches and are very dynamic in its inception. It is relatively simple to new entrants to develop a new business model even if they are not likely to cover the complete FI-WARE value chain.

Platforms require a non-traditional business model and a different way of working. These are not one-off products but are rather ecosystems with many cross-dependencies. As a result, the design, governance and execution need to be done with a more holistic approach such that the interests of ecosystem partners are balanced. Consequently, decisions regarding open versus closed, free versus charged, and cooperation versus competition will influence the success of the platform in both size and longevity:

- Market creation
- The size and sustainability of the ecosystem
- The ability of the platform to encourage and capture network effects

The different FI-WARE building blocks face a varied competition scenario. The situation in cloud is perhaps the most difficult, with very interesting and significantly well-developed proposals, coming from Amazon and other companies. In IoT and data management, the competition is not so significant and there is still room for new innovative solutions. In addition, the technologies, that FI-WARE project will provide, carry the potential for enabling new business opportunities for established and emerging application and service providers in areas such as energy, telecommunications, healthcare, media and e-government.

Regarding policy and regulation side, the rise of platforms in ICT markets invites a reappraisal of regulatory frameworks and practices. Besides inter-organizational collective action, formal law regulations and policies from government and/or regulatory authorities play an important role in enabling the vision of common service platforms.

The final success of the FI-WARE concept will significantly rest on the success of the different building blocks and, more importantly, on the capacity of FI-WARE partners to incorporate SME that would endorse the model and use it to develop their specific applications. Additionally, as technology is constantly evolving, the business decisions and the technology or design decisions have to be taken in a coherent manner. We can see the need in many complex systems industries for one firm or a small group of firms to act as a “platform leader”.

The classic difficulty for building a platform is the chicken-and-egg launch problem. Users of a platform want content and applications before they will use it; developers for a platform want users before they will provide content and applications. Each side wants the other side to commit before it will spend resources to adopt the platform. This is a "critical mass" problem**.** The results of the following phases of the PPP and the capacity to integrate the business models of the different usage areas, as well as the ability to integrate the business models of agile European SMEs, together with the support of European communities and administrations will play a key role in the final success of the concept.

8 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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