Final users perceived QoS on mobile convergent multimedia services

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Abstract: The continuity of organizations depends directly on its ability to competitively meet customers' expectations, according to their perception, on the supply of goods or services. To meet customer expectations is a task that is greatly expanded when we refer to mobile convergent multimedia services, where a big bunch of heterogeneous technologies must interoperate in a transparent way to final users. This paper describes how to assure the QoS continuity, in order to attend users expectations and, also, how Future Internet and Living Labs can contribute to reach this goal. The adoption of these concepts cannot be supported by current business models since they are strongly linked to a vast systems legacy. The implementation of novel concepts requires the adoption of a new business model, as proposed in this paper.

Keywords: Assured QoS; Handover; Living lab; User perception; Future internet; Cloud computing; Mobile services

1. Introduction

Why a new vision about Internet is necessary? One consistent answer is: to improve the services quality desired, and perceived, by final users.

The innovation discussion about the Future Internet, traditionally, considers the industry, the academia and the government as stakeholders.

The Internet communities must be considered in this discussion, and they are, indeed, stakeholders too. The final users, as a class of Internet communities, are the customers, because Internet, and services available through it, are consumed by them, and they are whose push the services/products providers' development efforts, the business models and, consequently, the marketing action. Final users, inside or outside of an Internet community, are stakeholders as well, because the Future Internet must attend their perception about what is a good service in their own opinion.

This vision about the fundamental importance of final users (inside or outside of the Internet communities) in the development and implementation of Future Internet requires the inclusion of them in the innovation process.

Future Internet, however, implies in an assured QoS continuity perception by final users, even more when it comes to mobile convergent multimedia services. To ensure such quality, it is proposed here a set of technologies and concepts such as vertical handover, cloud computing, living labs and a new business model that considers the creation of a service provider.

People are, then, the reason why all the Internet resources exist, and the reason why the Future Internet course has been discussed.

2. Business Model

"The main focus of our society is information, available under format of audio, data, images and video; and increasingly, the users want to obtain, to supply, to share and to interact with information using interactive mobile services with multimedia content in any place, any time, using any device, and on move. This scenario has created new opportunities to offer new services by providers that compose the segment of telecommunications businesses" [1].

To support these final users' demands, the mentioned paper proposes a new business model to be adopted, as depicted on Figure 1. This figure 1 shows that the base of the whole process is the final user, and the Service Provider is the entity responsible to understanding and meeting the needs of each particular user, ensuring the quality of services engaged, offering the cost-benefit expected by final user.

The final user requirements will compose the USLA – User Service Level Agreement. This document will register the final user wishes for each one of the services agreed upon. The same user can hire the same

services from different Service Providers or, yet, different services from different Service Providers.

The Service Provider, by your turn, will come to agreements with the Content Providers, the Infrastructure Providers and the Access Providers through PSLA – Provider Service Level Agreement, which contain all the requirements stated in the USLAs and all those specific between providers.

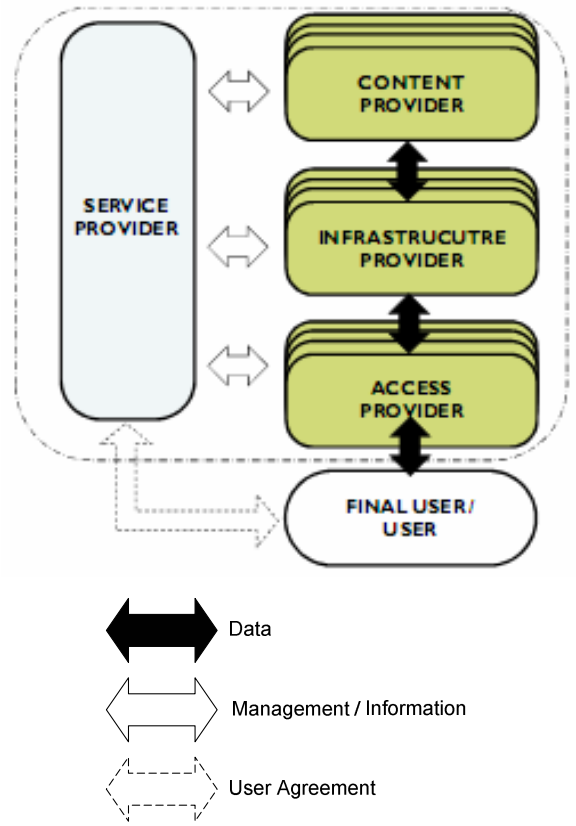

Fig. 1: Proposed business model [1]

But how to capture and correctly interpret the final users expectations and, then, transform them in a business model? Figure 2 shows a general model for this purpose, focused on final user. The living lab, mentioned ahead, is a useful tool to perform the first step that is the preliminary definition of the desired services.

3. Final Users Perceived QoS (Quality of Service)

Ensuring continuity of telecommunications services depends on algorithms to guarantee a perfect operation of the vertical handover (or handoff), through mechanisms to predict QoS and timing between data streams, since delays in the flow can deteriorate connection, or pause it, due to the occurrence, for example, of the phenomenon of Dead Lock in switching between streams.

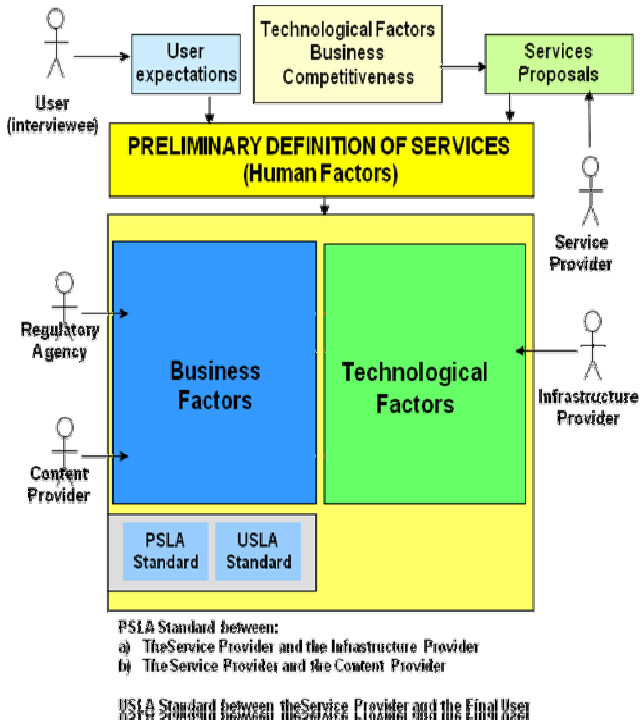

Fig. 2: General business model focused on final user

In a horizontal handover process the data stream switches from one Access Provider to another, but inside the same technology. For instance, from a GSM provider to another GSM one.

In a vertical handover process the data stream switches among a lot of different Content, Infrastructure and Access providers, walking through many different technologies.

Vertical handover can occur due to many reasons, such as external electromagnetic interferences, saturation of the bandwidth, a provider breakdown, delay, fluctuation, jitter, losses and others.

In mobile multimedia applications is quite important to keep the synchronism between data sound and image. Both data flows must reach the user device simultaneously, regardless of the route followed.

For an assured QoS, there is a need that the handover mechanisms must occur in order to not impact the service in progress, this is, the user should not perceive the occurrence of a switch in data stream.

Figure 3 shows, as an example, a connection supporting a video conferencing in progress. The final user, however, is moving. Suppose that the connection does not sustain itself, either by displacement, as by some abnormality in the Infrastructure Provider. A vertical handover will occur, then. Figure 4 represents the new connections map. The ongoing service from the Content Provider must be switched to another Infrastructure Provider and to another Access Provider.

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In the handover process the final user device must detect when the signal from an Access Provider is fading and, then, it must look for another stronger signal in the region. If there is not another signal, the connection will breakdown.

One of the major resources to keep the correct data flow route is the QoS prediction algorithms.

The everyday uprising of new applications and QoS increasing requirements by final users has been driving a strong need for tools that can aid in the global management of mobile networks, as the growing demand for bandwidth management. The highly unpredictable behavior of network traffic can be mainly attributed to the combination of different factors: the number of users, the capacity of the access links/points, traffic matrices, users' mobility, background traffic and the diversity of applications, services and user behaviors [2].

Considering these facts, the algorithms of prediction about the communication system performance, to assure QoS, must consider multiple factors that are not under the providers control.

Only as an example, QoS parameters could be predicted: 1) based on the historical behavior (segmented temporally) of the wireless network on analysis, 2) based on traffic simulations and the final users historical profile, 3) a combination of the two previous algorithms, or any other prediction model.

4. Future Internet for mobile convergent multimedia services

How assured QoS continuity can be implemented to improve the services quality desired, and perceived, by final users? Future Internet can be one of the possible answers.

The concept of Future Internet, according to Future Internet X-ETP Group Report – January 2010 (represented in Figure 5), has four main pillars: a) People, b) Contents/Knowledge, c) Internet of Things and d) Internet of Services. The Technology Base shown in Figure 5 must attend a bunch of requirements, such as: scalable and dynamic routing and addressing, security, privacy, efficient data and traffic management, energetic and economic sustainability. All these requirements can be supported by the Cloud Computing concept.

The Cloud Computing structure supplies not only hardware and telecommunication resources but, also, it allows that softwares can be treated as services. The major advantage of this concept is to segment different kind of Cloud users, offering them the specific service they desire.

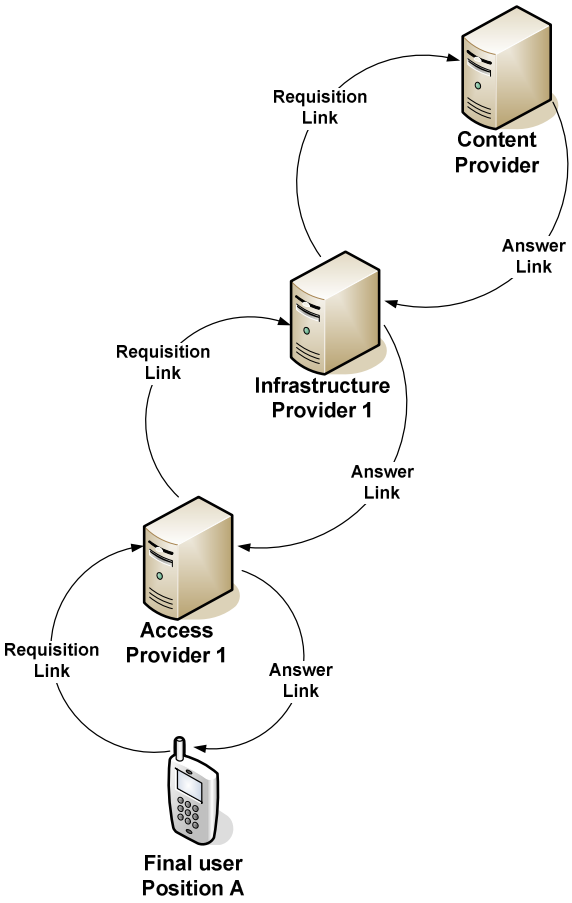

Fig. 3: A final user connection at a fixed position

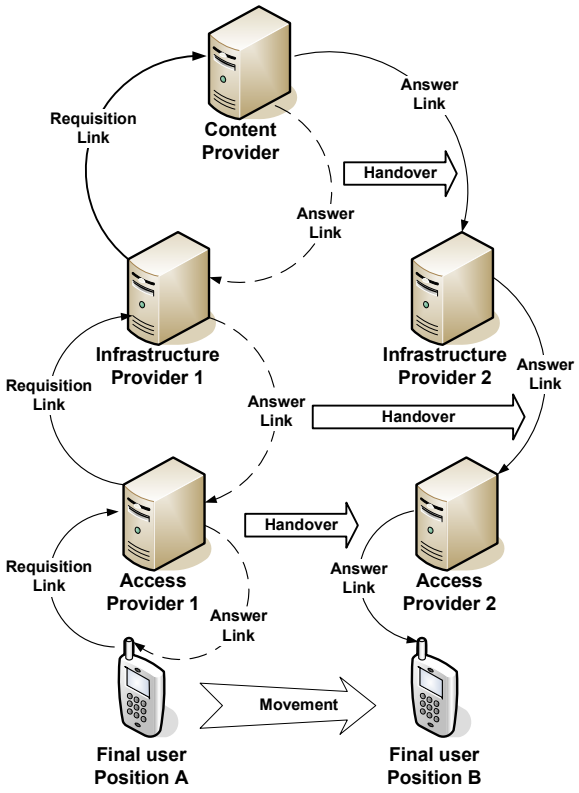

Fig. 4: The vertical handover process

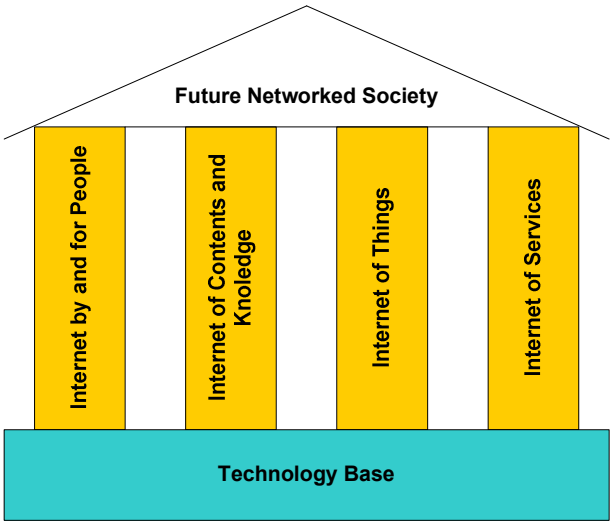

Fig. 5: Future Internet concept [4]

"The benefits of SaaS (Software as a Service), to both SaaS users and SaaS providers are well documented, so we focus on Cloud Computing's effects on Cloud Providers and SaaS Providers/Cloud users. The top level can be recursive, in that SaaS providers can also be a SaaS users. For example, a mashup provider of rental maps might be a user of the Craigslist and Google maps services" [3]. The SaaS process is depicted in Figure 6.

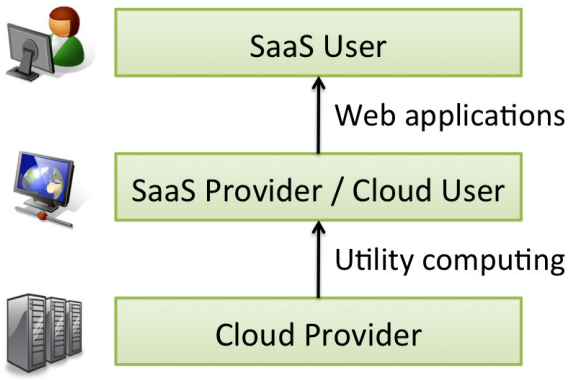

Figure 6: Users and Providers of Cloud Computing [3]

On the other hand, each one of the columns shown in Figure 5, must support [4]:

- People – Accommodation of all user ideas and requirements.
- Contents/Knowledge – Interactive multimedia content everywhere and easy to search.
- Internet of Things – Communications of context-aware autonomic objects.
- Internet of Services – Consumers enjoying permanent, seamless and confident services.

The roof sustained by the columns, representing the Future Networked Society, can be implemented through the concept of Living Labs, as a way to bring, and to include, all the communities in the construction of this new information society.

4.1. People

According to [5]. "The Future Internet should be able to interconnect growing population over time. It shall be capable to meet new and common people (Internet users) expectations and needs while promoting their continuous empowerment, preserving their self arbitration (control over their online activities) and sustaining free exchanges of ideas. The Future Internet shall also provide the means to i) facilitate everyday life of people, communities and organizations, ii) allow the creation of any type of business regardless of their size, domain and technology, and iii) break the barriers/boundaries between information producer and information consumer".

The Swedish minister for communications Åsa Torstensson, in the closing session of FIREweek 2009, said: "It is not the technologies that will make a difference to society, it is the users that will make a difference" [6].

The Networked Society means that everybody will share all the information and, more than that, everybody will participate to build this new society, and that's why users will make a difference.

4.2. Internet of Contents and Knowledge

The digital communication allows that society goes beyond information and content accumulation only. The content and the knowledge can be crossed, analyzed and rearranged to generate new knowledge and support to research and innovation [5].

To achieve these goals, the future Internet must offer mechanisms for dissemination of the knowledge with friendly and fast access.

4.3. Internet of Things

Everybody connected to everybody, everything connected to everything and everybody connected to everything: that is the Internet of Things goal.

The way to do it encompasses a great variety of technologies, such as: RFid, NFC (Near Field Communication), 2D Bar Codes, IPv6, 3G or 4G, sensors and actuators wireless, and so on.

Internet of Things, thus, provides the actors (people or things) interoperability.

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4.4. Internet of Services

The Internet of Services advocates that in future Internet organizations and individuals can find software as services, combine them, and easily adapt them to their specific context. Users should be able to use software services that do exactly what they need. The Internet of Services will consist of virtualization technology that will make network, storage and computing resources available [7].

The Cloud Computing technology is clearly the resource that will allow the Internet of Services to flourish, offering services on demand.

5. Living Labs contribution to map the final user desires

According to [10], "Living Lab is as a research methodology to evaluate, validate and test prototypes, as well as to improve complex solutions in a real multifaceted emergent context".

Living Lab proposes to identify the requirements with the users, enterprises and government involvement to create scenarios about some service, to validate it and to test it. A service involves not only new electronic systems but, also, new processes and, consequently, new ways to do something.

In a Living Lab environment final users can test services on a real world basis. This characteristic is why a Living Lab can help to detect and understand the users expectations about what QoS means for them concerning mobile services.

The Living Lab is a concept, then, that refers to methodologies where services, products and applications improvements through innovations are created and evaluated based on a human approach in the real world context. This concept is depicted in Figure 7.

The Living Lab basic intention is to open access to ideas, experiences and knowledge that final users hold, based on their daily necessities for support from products, services or applications. The Living Lab approach is centered on the users, on the citizens and on the civil society as a source of innovative ideas [6]. Its main objective is to involve users in the product/service development and prototyping stages before their release in the market [8][9].

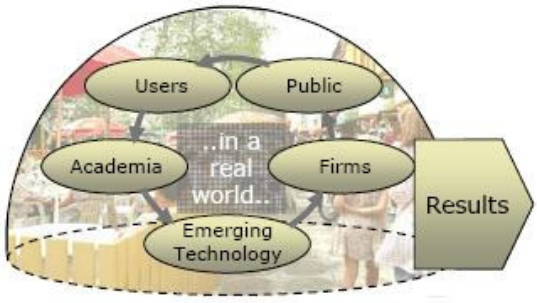

Fig. 7: Basic concept of Living Lab [10]

So, the Living Lab can be seen as an instrument to sustain an efficient and dynamic innovation process, where it furnishes an environment to companies test their innovations in different stages of development. Moreover, it is an environment that allows potential users to influence in the products final stage through a close cooperation with the company [7]. The Living Labs kernel is the users involvement, so the innovation process becomes *human-centric* instead of *technology-centric* [10].

The participation is not restricted to potential users, but it is also open to all other stakeholders along the value chain. They can be considered as the main element necessary to a good functioning of a Living Lab. According to [11], a Living Lab does not need to bring access to the technology state of the art of only one kind, but from various technologies available from different business models. The Living Lab concept main advantage over the traditional methodologies, as the user-centric, is its multi-contextual vision where products and services development distinguishes the Living Lab as an approach of other partnerships between supplier and customer. In other words, a cross-disciplinary approach. The evaluation is done based on the daily life context, and the users are involved in all stages of R&D, not only in the final stages.

The Living Lab concept is characterized for the approach "users as innovators". It means that the basic idea is not use them as guinea pigs, but to obtain access to their ideas and knowledge [8].

The Living Lab brings benefits for different sort of stakeholders, and they can be summarized as [12]:

- For users in your role as citizens and communities: it allows their influence in products and services development so that suit their real needs, and jointly contribute to the economy and the improvement process through active participation of R&D, as well as the life cycle innovation.

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- For SMEs as suppliers: development, validation and integration of new ideas and quick supply enlargement of their local services and products to other markets.

- For large companies: making effective the process of innovation through partnerships with other enterprises and considering the users experience.

- For researchers, the economy and the society: Encourages business partnerships with citizens and government to a flexible service and technology innovation ecosystem, integrating technological innovation and social development in an innovative culture ("Beta Culture"), increasing return of investments in ICT, R&D and innovation.

Concerning the Living Lab, and according to [13], "In Europe it has been mentioned in four different contexts":

1. Bring to real life the technology developed in laboratories and that applies in urban environments, according to a user centric-approach.

2. Developing mobility services for citizens in nearby communities with market technologies. Focus on user-centered processes, activities co-design and co-creation, the public-private partnerships, and interaction between producers and users.

3. Virtualizing Living Lab as a context-sensitive methodology for R&D to multi-site and multi-stakeholder, for the purpose of creating new work environments.

4. Developing industrial initiatives to validate new mobility services, a model based on real user.

6. Conclusion

As much as technology advances, if companies want to attract your users they must involve them in the process of requirements definition, development and testing of the products and services to be offered. This will cause a positive perception about them leading to a loyalty to the products/services.

From this perspective, it is necessary the joint use of technologies and concepts mentioned in this article to achieve the objective of implementing mobile converged multimedia services with assured QoS, with users participation throughout the development chain of products/services.

So the commercial implementation of the conjunction of these resources can not be supported by existing business models, which require the development of a new business model which will result in new market rules and will require a new vision about the regulatory processes.

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