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QoE-based service differentiation: Business models analysis for the mobile market

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Abstract submitted to
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Title:
QoE-based service differentiation: Business models analysis for
the mobile market

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1. Introduction

New paradigms in both the wholesale and retail service markets are being formed and accelerated by technological advances (e.g., in networking, virtualization), content delivery, and regulatory changes on access and competition rules (ITU, 2012). This scenario poses ever-increasing demands to mobile infrastructures but also enriches the roles of service providers, differentiates traditional pricing schemes, and enables new business models. To succeed in this competitive landscape, operators are required to choose a more rigorous approach, increase operational efficiency, and roll out new services in a cost effective manner. Current market evolution presents mobile operators with a challenge and an opportunity: operators that can deliver the best user experience in terms of service choice, availability, speed and quality will gain brand loyalty (Boohene & Agyapong, 2011), (Yung-Lung & Shih-Chieh, 2013), (Petrovic, 2014).

New multimedia services have acquired personalization and customization features which are enclosed under the concept Quality of Experience (QoE). Therefore, telecommunications actors have the opportunity to lead the market on service differentiation by delivering the appropriate user's QoE with the speed, capacity, coverage and availability demanded by users of laptops, smartphones and other devices. QoE is seen as a measure of the overall level of customer satisfaction with a vendor, both objectively and subjectively. The QoE paradigm can be applied to any consumer-related business or service.

The overall QoE demand involves the identification of technological, social and economical requirements within a regulatory framework. In terms of technology, equipment providers, content and service providers and network providers are expected to handle much higher traffic levels, offering improved quality. The social context also matters, since application/service/network usage will not be only influenced by the perceived QoE but also by the user's context and its relation with the other actors in the business chain. From an economical perspective, the main difficulty hereby for providers is the definition of service/price offers based on QoE differentiation and the potential acceptance by the subscribers. Also the uncertain attitude of regulation authorities on QoE differentiation and how this approach might impact the net neutrality principles may require special attention at the moment of defining a regulation framework.

An answer to these new challenges must follow a holistic approach, taking into consideration a number of key aspects, from technical requirements to business models. At the same time the different providers (i.e., equipment, content, and network) have to understand the technical requirements and implications associated to offering QoE-based differentiated services on their infrastructure, they have to identify the economic impact of the differentiation in the service provision. This means a deep analysis and definition

of business, pricing and compensation models that can/should be used in order to incorporate QoE-based types of services to be commercially available in the mobile market. **The proposed paper focus its results on the techno-economic aspects linked to the implementation of QoE-based differentiation approach in the mobile services provision, by analysing the implications on the mobile operator's business models.**

Here goes the chapter organization. First the evolution of the QoE concept, then the presentation of a QoE based system to provide services, later the QoE ecosystem and the initial QoE business model analysis based on Osterwalder's framework, considering the mobile operator and content provider approaches. Finally the conclusions section is presented.

2. From Quality of Service to Quality of Experience

From providers' perspectives, the interpretations of QoE go hand-in-hand with the assumption that by optimizing the Quality of Service (QoS), the end user's QoE will also increase. However, this is not always the case. Even though, QoS implementation enables network operators to isolate traffic into flows based on attributes, such as traffic type (voice, video or control) or application needs (throughput, latency and/or jitter), this focus does not consider all the content delivered features or the use of information provided by terminals and users regarding the content processing.

The concept of QoS continues to be important in the service provider environment, but QoE is rapidly gaining mindshare. The QoE concept differs from QoS in that it considers much more than the network performance. According to the Qualinet definition "*Quality of Experience (QoE) is the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and / or enjoyment of the application or service in the light of the user's personality and current state*" (Le Callet et. al., 2012). QoE is concerned with the overall experience consumers have when accessing and using provided applications/services. Thus, it is important for operators and content providers to incorporate a high degree of intelligence to transport different types of traffic in a way that provides a satisfactory and competitive end-user experience, while also maximizing revenue per user.

With the development of mobile networks, customer needs and behaviours have changed. Mobile communications means so much more than simple voice communication; there is now mobile Internet with web surfing, videophone, streaming media, and microblogging. Traditional KPIs are no longer adequate for measuring the quality of mobile services. The objective of network optimization has gradually shifted from enhancing network performance to improving QoE. This makes QoE a new fundamental component of the mobile networks framework for satisfactory delivery of applications and services with effective end-to-end management of network resources.

The main challenge that operators face nowadays is to find a solution to manage the traffic growth while meeting the users' expectations in a cost effective manner. A common approach to reach the goal of high quality information delivery has been the implementation of resource management schemes and scheduling algorithms to optimize resource allocation and traffic distribution as function of network parameters (Yin, 2000) (Piamrat, 2009) (Thakolsri, 2009) (Aristomenopoulos, 2010) (Shehada, 2011) (Chuah, 2012) (Dutta, 2012). By maximizing performance through infrastructure improvements mostly oriented to increase QoS, network providers want to meet the growing end-user demand for more quality and faster connectivity on the move.

Solutions have been gradually evolved from a perspective mainly centred on the evaluation of network based constraints (e.g. signal-to-noise ratio (SNR) or instant data rates) deprived of knowledge about the transferred content (Yin 2000), to a perspective where inherent characteristics of the content are considered to improve network performance. In this regard, solutions oriented to improve video transmission are a clear example. Although proposed solutions offer a path towards the solution of the traffic growth and the demanding user expectation issue, this approach does not consider the type of content delivered by the network or the use of information provided by terminals to manage the resource allocation.

In that sense, it is also important to consider what is happening during the content processing at user's side in order to get a better picture of the traffic management. Mobile networks can utilize this information to impact in a positive way the use of limited resources inside the infrastructure. It is possible to incorporate and provide awareness to the wireless infrastructures in the context of cross-layer systems to manage the resource allocation according to expected QoE levels. From a user's perspective, this QoE-awareness will represent the probability that the network delivers sufficient performance to run a particular application/service at an acceptable quality level. From the network side, the use of this concept would ensure a high probability that the most widely used application/services will deliver exactly what the user expects, improving the utilization of the network infrastructure resources

3. QoE-aware mobile architecture

The telecom industry is facing new challenges represented by factors such as new technologies, new opportunities from the Internet, increased competitiveness in the market, regulatory changes and alliances between companies to offer more elaborated services. As a consequence of the changes represented by these challenges, network, content and service providers need a readjustment of business models where there are opportunities for new revenues in business like e-health, smart cities and gaming. These are examples of value-added services that can be offered both to the consumer and

enterprise markets. Many of these services will have to deal either with data growing at a fast pace that puts heavy load on the network (including access networks) or with users interested on sophisticated users with special/specific demands.

One of the goals for mobile operators today is to enable the best experience for as many users as possible, given the available content, apps and devices (Ericsson, 2014) (Citrix, 2013) (De Pessemier, 2013). In addition to monitoring network performance, operators must increasingly be aware of the usage of both devices and content/apps in their networks. They then need to measure how fast the demands on the network are increasing but also what the user's perception is regarding the content delivered by the network infrastructure in order to build this knowledge into their network investment.

Traditionally, QoE has been evaluated through subjective tests carried out on the users in order to assess their satisfaction degree with a MOS value. This method cannot be used for making decisions (including resource allocation ones) to improve the QoE on the move. A possible solution to evaluate the QoE and the content processing status instantaneously is to integrate reporting tools in the mobile terminal, providing QoE-awareness to the wireless infrastructure. In this regard, QoE-awareness might represent a way to optimize wireless communication based on a model of the mobile service requirements for wireless communication in the context of a desired QoE. In order to incorporate this capacity in the context of a mobile infrastructure, we propose an architecture that can be used to implement a QoE-aware resource management for delivery of multimedia content. The key idea of the QoE-aware architecture is to collect information about content processing and buffer status in the mobile terminal at a central entity, the QoE-aware communication engine. It is able to evaluate information sent by mobile terminals and make resource allocation decisions considering the impact of the interruptions in the QoE perceived by mobile users. This architecture was introduced in paper (Martinez&Segall, 2012) and detailed more in (Martinez, 2014).

Towards QoE-aware mobile infrastructures, one important element is the definition of the network architecture that will allow the incorporation of QoE-awareness concept within the wireless infrastructure. We present an architecture proposal that takes advantage of the current features of mobile terminals and applications to provide awareness to the wireless networks about the content processing and user's QoE. Figure 1 shows the different components of the proposed architecture.

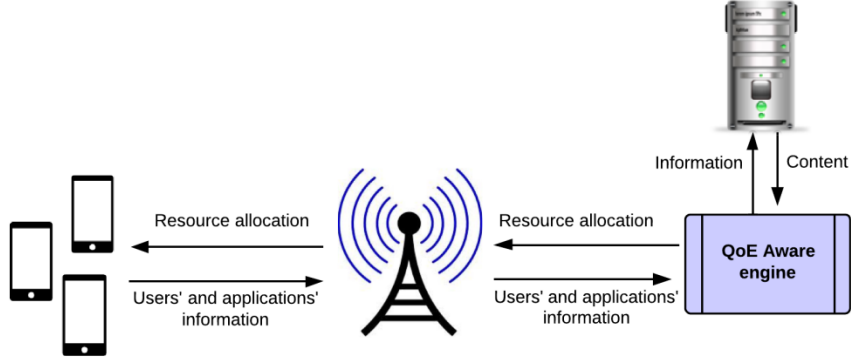


Figure 1. QoE-aware proposed architecture.

The first element to consider in the proposed architecture is the QoE-aware communication engine that receives information from the application and the mobile terminal. It is additionally connected to the devices in the network that actually enforce resource management decisions (radio interface/content servers). When notified by an application monitor about a critical state of an application, the QoE-aware communication engine evaluates information provided by terminal and decides about the resource allocation. This means that based on the information on application, it determines how to allocate resources in a way that can avoid a situation that impacts negatively the end user's QoE.

Another key component is the application monitor that is running on the client. The task of the monitor is to keep track of the status of the applications that are subject to the resource management decisions and inform the QoE-aware communication engine about the application/service situation. The status of an application is a collection of key performance indicators that the customer will directly perceive as quality parameters. These key performance indicators are specific for each application and describe whether the current performance offered by the network leads or not to QoE degradation. Evaluating these key performance indicators, the architecture is able to indirectly consider the QoE of applications within the resource management and avoid degradations.

Two approaches are introduced in this chapter to address the challenge to develop a QoE-aware resource management in a mobile infrastructure: Fully integrated within the operator network (FION) and over the top (OTT). FION proposes a system where the base station (BS) and the network is aware about both the content processing and the status in the mobile terminal and uses this information to make resource allocation decisions. For OTT approach, it is the content provider server who allocates resources after evaluating the content processing in the mobile terminal.

3.1. FION approach

In this approach the QoE-aware communication engine capability is placed in the BS. Thus, the BS is aware about both the content processing and the buffer status in the mobile terminal making resource allocation decisions by evaluating information provided by application monitors. Content provider server is agnostic about the content status in the terminal. Figure 2 shows the scenario considered in this study.

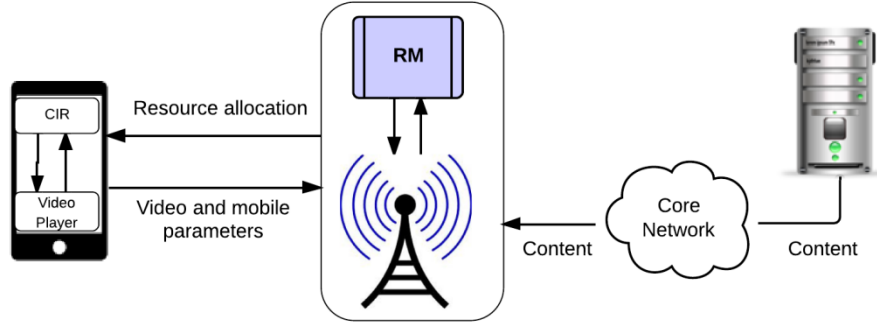


Figure 2. FION architecture.

In the proposed infrastructure we can identify two entities, fully integrated within the operator network. These entities are:

- An entity dedicated to the resource allocation based on the information received from terminals about current status of the application/service.
- An entity dedicated to report the information about the current status of application/service from the mobile device to the wireless infrastructure.

The first entity or resource manager (RM) plays the role of the QoE-aware communication engine proposed in our architecture. It is centrally located in the BS and collects the reports provided by the user's terminals. It takes care of profiling user requests, as well as keeping track of the terminals and content's processing current status. A proper dynamic linkage between the RM and the base station is recommended with the aim of achieving a dynamic control of the resource allocation based on user perception.

Second entity or application monitor is a client application in the mobile terminal, called client information reporter (CIR). CIR reports to the resource manager information regarding the application status at the terminal, the type of content, the user profile, etc. The CIR is represented by software applications with collecting and sensing functionalities installed in the mobile terminals. The application monitor will require the establishment of a radio bearer between the terminal and the base station in order to send the QoE/buffer-based associated information.

To facilitate this, the terminal has to initiate an attach procedure when the user's application starts. Once the attach procedure succeeds, an initial context is established for the mobile terminal in the base station controller, and a default bearer is established between the terminal and the core network. Once the mobile terminal and the CIR have connectivity, the terminal can start sending information to the infrastructure. Reported information will be passed to the base station and the resource manager. Once the gathered data is passed to the resource manager, this selects the more appropriate moment for allocating resources and delivering content to individual users by applying a scheduling policy based on the identified QoE requirements.

3.2. OTT approach

In this approach, it is the content provider who is aware about the content processing in the mobile terminal, without involving the network operator, so base station and radio access network (RAN) are not aware about what happens in each terminal. The QoE-aware engine is placed in the content server and helps the provider to allocate resources according to the content processing status. Figure 3 shows the OTT architecture.

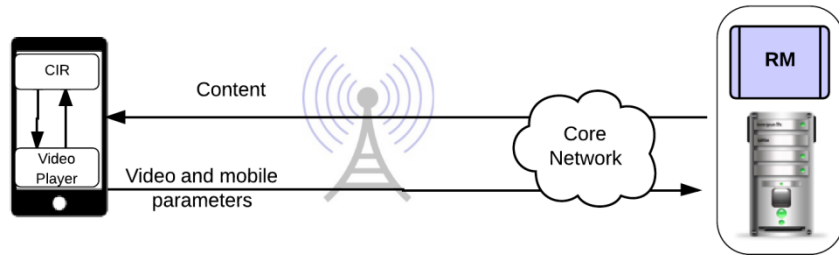


Figure 3. OTT architecture.

In the proposed infrastructure we can identify two entities working for the content provider and leaving the network operator responsible only for transporting IP packets. The RM in the server has access to enough information to decide about the resource allocation in a way that would impact positively the throughput of the network and the individual user's experience. Information reported by users' devices includes, for all instants of time, detailed data about the mobile terminal's content and user profile.

From the two proposed architectures we can envision user's QoE can be improved by incorporating a more user-centric approach in the resource allocation. In our case, an initial step towards this goal is represented by a mobile network capable of identifying

users' expectations and using this information to dynamically adjust network parameters according to a QoE model while the content is being processed in the user terminal.

4. QoE end-to-end Ecosystem and Business Models

4.1. Ecosystem

QoE is an assessment of the human experience when interacting with technology and business entities in a particular context (Laghari & Connelly, 2012). In that sense, an analysis of the QoE ecosystem should consider different players interacting with each other at different levels (technical, social, business) and with different approaches. For understanding the structure of the QoE ecosystem it is important to define/identify a framework that describes the main interactions between users, business, and technology in a communication service provision. This is illustrated in Figure 4,

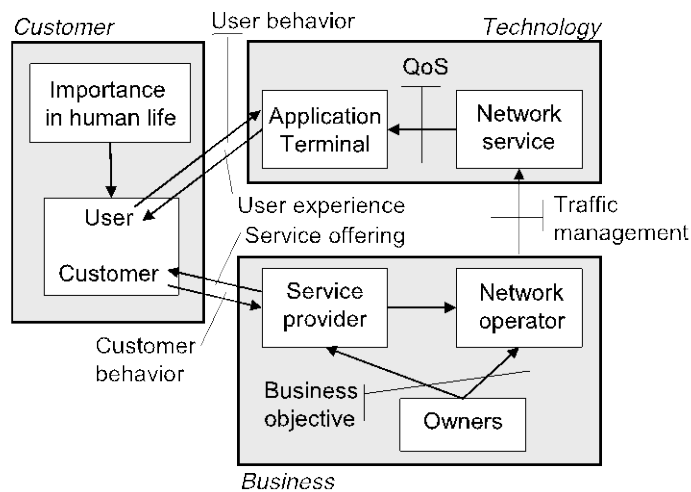


Figure 4. Mobile business ecosystem.

The framework includes two actors that have independent aims: customers who want to maximize their happiness, and content and network providers who want to maximize their income. Services are offered and networks are built only if service providers have opportunity for profitable business and customers have possibility to obtain real benefits. On the other hand, any commercial company shall make their operational decisions based on clear business objectives. A typical objective is to maximize Return of Investment (ROI).

In the proposed framework it is also possible to identify different interactions. For instance, content, services and network providers try to provide a better user experience by ensuring network and service performance based on QoS models. From a business side, these actors need to develop economic models and business models for their technological infrastructure. This business interaction also implies an identification of how effectively the operators can utilize their resources to increase their profit by

retaining customer as well as attracting new ones. The interaction between user and providers develops customer experience models to understand customer requirements with respect to business aspects. Customer care, cost, promotion and brand image may influence customers to develop positive or negative feelings about a service. Therefore, QoE is a convergent concept that combines the influences of all these aspects to produce QoE requirements. The question here is how changes in the user experience of the offered service or application impact the value that the user perceives from the service. By offered service we mean here the part of service provider's offering that is able to satisfy one type of need.

4.2. Business Model Structure

A business model describes the rationale of how an organization creates, delivers and captures value. In that sense, the business model is like a blueprint for a strategy to be implemented through organizational structures, processes and systems. Following this, we decided to describe a generic business model through the nine basic blocks proposed by Osterwalder in its framework (Osterwalder, 2010), considering its extended use in different industries. The nine building blocks cover the four main areas of a business: customers, offer, infrastructure and finance. A description of the mentioned areas as follow:

Customer block: This block defines the different groups of people or organizations an enterprise aims to reach and serve. It also describes how a company communicates with and reaches its customer segments to deliver a value proposition. Moreover, this describes the types of relationships a company establishes with specific customer segments. The customer relationships called for by a company's business model deeply influence the overall customer experience. This is a relevant aspect to consider when the idea is to work with QoE elements. Nowadays, the user/customer experience is an important factor at the moment of creating customer retention and increasing average revenue per customer.

Offer: This block describes the bundle of products and services that create value for a specific customer segment. The relevant issue to address here is the description of the value proposition. Each value proposition consists of products and/or services that cater to the requirements of a specific customer segment. In this sense, the value proposition is an aggregation of benefits that a company offers customers.

Infrastructure: This area identifies the key parameters, activities and resources to create the product or service the company offers. With regard to the key resources, it is necessary to describe the most important assets required to make a business model work. These resources allow an enterprise to create and offer a value proposition, reach

markets, maintain relationships with customer segments and earn revenues. The key activities block describes the most important actions a company must do to make the business model work and operate successfully. Finally, within this area (the infrastructure) is important to identify the key partnerships. In that sense, this block should describe the network of suppliers and partners that make the business model work.

Finance: Creating and delivering value, maintaining customer relationship and generating revenue all incur costs. Such costs can be calculated after defining key resources, key activities, and key partnerships. In that sense, this area identifies the cost structure describing all costs incurred to operate a business model. Moreover, the finance also identifies the revenue streams. The revenue block also addresses the flows received from partners co-commercializing the products. This block represents the cash a company generates from each customer segment. A business model can involve two different types of revenue stream: transaction revenues resulting from one-time customer payments or recurring revenues resulting from on-going payments to either deliver a value proposition to customer or provide post-purchase customer support. Finally, the profit should be addressed, i.e., to what degree does the revenue exceed the costs. This later will be based on the pricing models applied (usage, subscription or licensing based fees or combination of these). Estimating the profit potential, sales volume, and the time it will take for the idea to produce a positive return is also addressed here.

4.3. Business Model mapping to Osterwalder's framework

QoE-awareness in mobile networks might be the solution and a new way to improve the service provision, resource management and generate new revenue streams for content and network providers. However, the business opportunities for actors generated by this new approach are still unexplored.

A tentative illustration of Osterwalder's business model framework applied on QoE differentiation is shown in Figures 2 and 3 and described as follows.

<u>Key Partners</u> <ul style="list-style-type: none">• Content providers• Users' generated content	<u>Key Activities</u> <ul style="list-style-type: none">• Platform management• Development & maintenance• Service provisioning• Service promotion• Software development• Billing <u>Key Resources</u> <ul style="list-style-type: none">• Network brand• Customer base• Content agreements• IT staff• Billing system	<u>Value Proposition</u> <ul style="list-style-type: none">• Improved user experience• QoE differentiated services• Customized content (QoE levels according to expectations: Basic and Premium QoE plans)	<u>Customer relationships</u> <ul style="list-style-type: none">• Automated services• Personal assistance• Communities• Retention• Acquisition• Membership <u>Channels</u> <ul style="list-style-type: none">• Retail network• Mobile operator web• Partners ecosystem	<u>Customer segments</u> <ul style="list-style-type: none">• Consumers interested in a specific type of content service• SME• Enterprises (In SME and enterprise cases they are interested on priority to type of content of their interest)
<u>Cost structure</u> <ul style="list-style-type: none">• Marketing• Network• Platform development• Personnel costs		<u>Revenue streams</u> <ul style="list-style-type: none">• Service revenue attached to a subscription fee• Basic subscription for a basic profile service• Customized subscription based on profiles• Fees for ads in content• Revenue share with partners		

Figure 2. Business Model from Mobile Operator perspective

<u>Key Partners</u> <ul style="list-style-type: none">• Payment providers• Distribution partners• Mobile operators	<u>Key Activities</u> <ul style="list-style-type: none">• Service provisioning• Service promotion• Software development• Billing <u>Key Resources</u> <ul style="list-style-type: none">• Software developers• Software• Billing system	<u>Value Proposition</u> <ul style="list-style-type: none">• Improved user experience• QoE differentiated services• Customized content (QoE levels according to expectations: Basic and Premium QoE plans)	<u>Customer relationships</u> <ul style="list-style-type: none">• Automated services• Communities• Membership	<u>Customer segments</u> <ul style="list-style-type: none">• Consumers interested in a specific type of content service• SME• Enterprises (In SME and enterprise cases they are interested on priority to type of content of their interest)
			<u>Channels</u> <ul style="list-style-type: none">• Content provider web• Partners ecosystem	
<u>Cost structure</u> <ul style="list-style-type: none">• Software development• Complaint management			<u>Revenue streams</u> <ul style="list-style-type: none">• Service revenue attached to a subscription fee• Free• Fees for ads in the content	

Figure 3. Business Model from Content provider perspective

Offer: QoE differentiation will offer several specific value propositions for mobile operators and content provider's customers. First, customized content oriented to guarantee/provide QoE levels according to user expectations. The fulfilment of customer

demands and user experiences are becoming more the main differentiators for the effectiveness of mobile operators and service providers. In this era of competition, poor customer experience leads to a chain reaction of negative word of mouth, pushing customers into the arms of waiting competitors. For instance, a customer who pays for online video on demand service may have stricter video quality requirements than a user who uses free video on demand service.

Mobile operators and content providers may learn if a particular demographic is more interested in pricing and off-peak promotional rates. They can use this to inform decisions on pricing plans and investments in technology/service they should make for the future. If they determine that off-peak pricing has only a limited impact on QoE for their main demographic, they may choose to market aggressively to another demographic, investigate alternative pricing mechanisms, and/or upgrade their delivery infrastructure to improve QoS.

Additional could be added to the product offered to enterprise customers segment by including more advance type of content. QoE differentiation will allow customers to enjoy more flexible and rich services improving the user experience adjusted to their expectations.

Customer: The QoE differentiation value proposition could be directed to different segments-consumers and businesses. The former would include youths and adults consuming mobile data traffic on video, VoIP, gaming, etc. According to Ericsson, mobile data traffic is expected to grow at a compound annual growth rate (CAGR) of around 45% over the next 5 years. In this segment, music, movies, games and online TV based services might be the key type of content. For the business market, QoE might start with communication related services followed by collaboration and videoconferencing based services.

With regard how the mobile operator communicate the value proposition to the customers, this would happen through mobile operators' retail network, mobile operator web platform and through partners' channels. On the other hand, content providers can reach their customers using their web channels as well as using partners' ecosystem.

Infrastructure: From mobile operator perspective, the network asset is important for offering end-to-end services. To deliver QoE differentiated services, it will be necessary to develop/implement prioritization systems. Together with the infrastructure, mobile operators already have an important customer base and a network brand build after years of experience in the market. They also have billing solutions and marketing competences that will be important at the moment of launching QoE differentiated services.

From the content provider perspective, strategic partnerships with leading mobile operators are necessary to establish in order to develop and operate competitive QoE

differentiated services. Partnership with 3rd party developers is then an important asset. For this role, partnerships with marketing and sales are also needed. The billings systems and competence along with network assets are important key resources.

Finance: Major cost categories are related to start-up investments connected to establishing the new business unit and running personnel cost. A mobile operator will typically have costs related to running the QoE differentiation, billing systems and for IT personnel. The latter two are relevant also for the content provider. Other relevant cost would be related to administrating the customer base, support and marketing of product offerings. The revenue streams for network and content provider are service revenue attached to a subscription fee or alternatively from subscription. It might be possible to generate revenues by charging fees for ads in content. For the content provider, and due to required services provided for by 3rd party developers and other partnering vendors, revenue split with these partners is necessary.

5. Conclusions

In this paper we have introduced some QoE differentiation features that need to be considered at the moment of implementing QoE-based differentiation in mobile networks. Together with the presentation of the features, we present the initial framework for implementing QoE differentiation.

In our analysis we focus on the potential business opportunities for QoE based wireless networks deployment and a description of the technical challenges this solution will face. Then, we identify the QoE end-to-end ecosystem, in order to settle the core and periphery actors. In this scenario is important to consider that the primary drivers of the market are global growth in content consumption - anytime and on any screen; growing adoption of higher-end devices in emerging economies; and continued innovation in terms of new form factors, new device classes and transformative user experiences.

Finally, considering the ecosystem actors identified, we will propose/analyse business and pricing models that taking advantage of the service provision based on QoE-differentiation can have an impact on the mobile operators' strategies.

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