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Development of Business Models and Strategies for Adaptation and Change Management

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Executive Summary

This report on “Development of Business Models and Strategies for Adaptation and Change Management” is a public deliverable of the Mobile Cloud Networking (MCN) EU-FP7 Project and provides the results of the Business Model research of the second year of the MCN Project. The goal of this research phase is investigating potential business scenarios for the technologies developed in the project accompanied by the investigation of collaboration between existing and envisioned market participants. The performed research work has made progress towards a methodology for business model ideation that supports the generation of scenarios based on the analysis of the specific case of technological innovation. Since this is one goal of the MCN project we applied the methodology to the developed technology to produce suitable business scenarios.

The report is structured in an introduction and 5 chapters:

- The *Methodology* chapter outlines the approach developed to transfer so-called Value Characteristics of novel technologies into business opportunities. The details of the application of this approach are provided in the Appendices A and B;
- The *Services* chapter contains an analysis the MCN services with respect to their Value Characteristics, involved stakeholders and potential customer groups. It also encompasses discussion limitations of the services with respect to their economic exploitability;
- The *MCN Scenario* chapter provides scenarios that illuminate various value creation processes for these most prominent MCN services, providing detailed user stories, relevant value flows and illustrate the critical points in the respective Business Models before each scenario is concluded by a discussion;
- The *Discussion* chapter consists of a detailed analysis of the findings from the scenario development and points at different constellation how MNOs, Cloud Providers and the new role of the Mobile Cloud Network Service Provider (MCNSP) can work together. The chapter ends with a discussion, how existing regulation interfere with the provided scenarios;
- The *Outlook* chapter points at the research that is planned for the final year of the project.

This report presents the first phase of the proper business model analysis. Instead of fully elaborating business models it is intended to explain the principle features behind the potential business. It describes the collaboration between different service providers and illustrates this by concrete scenarios that serve as mediators between technology and business view. These scenarios demonstrate the added value for the potential customer. The mediation process is conducted by the aids of the newly developed methodology for this non-trivial mediation process. The final goal of this phase has been to provide a broad variety of scenarios that allow us to explore as many business aspects of the MCN services as possible while the consolidation to the most relevant scenarios as well as a more detailed description is planned for the final year.

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List of Acronyms

4G	4th Generation of Mobile Telecommunications Technology
3GPP	3rd Generation Partnership Project
ABC	Always Best Connected
AAA	Authentication, Authorisation, and Accounting
B2B	Business-to-Business
B2C	Business-to-Customer
BMI	Business Model Innovation
BS	Base Station
CAPEX	Capital Expenditure
CDN	Content Delivery Network
CSP	Cloud Service Provider
DoW	Description of Work
DNS	Domain Name System
DS	Digital Signage
DSS	Digital Signage System
E2E	End-to-End
EEU	Enterprise End User
EPC	Evolved Packet Core
EPCaaS	EPC-as-a-Service
EPS	Evolved Packet System
EU	End User
FP7	Framework Programme 7
GSM	Global System for Mobile Communications
HW	Hardware
IaaS	Infrastructure-as-a-Service
ICN	Information Centric Networking
IEU	Individual End User
IMS	IP Multimedia Subsystem
IMSaaS	IMS-as-a-Service
IP	Internet Protocol
LAN	Local Area Network
LB	Load Balancing
LCD	Liquid Crystal Display
LTE	Long Term Evolution
M2M	Machine to Machine
MCN	Mobile Core Network
MCNSP	Mobile Cloud Networking Service Provider
QoE	Quality of Experience
QoS	Quality of Service
OPEX	Operational Expenditure
RAN	Radio Access Network
RANaaS	Radio Access Network-as-a-Service
RCB	Rating, Charging and Billing
SLA	Service Level Agreement
SMS	Short Message Service
SW	Software
SWOT Analysis	Strength Weakness Opportunity Threat - Analysis

1 Introduction

1.1 Overview and Roadmap

The task T2.2 of the MCN project aims at exploring the potential implications of the new cloud computing concepts and technologies on the telecommunications industry from the multi-stakeholder point of view. The focus is to analyse the changes in value networks, generation of potential business scenarios and related business models to exploit emerging trends and developed technology. Figure 1 depicts the stages of the T2.2 activities, which have been explained in detail in Deliverable D2.3 [MCN-D2.3]. This deliverable reports the results of step 3 activities, which focus on Business Scenario Development and Evaluation. It also includes a detailed description of the applied methodology since the development related to step 3 require a systematic support in transferring technical innovation into business ideas, which had not been available. This methodology is a significant research result which is included in this report.

In brief, in step 1 structures and modelling elements were defined and basic facts as the elements on which we build the business model design were compiled (reported in D2.1 [MCN-D2.1]); in step 2 the existing value network, the business models and ecosystem in the telecommunications industry were analysed (reported in D2.3 [MCN-D2.3]). In step 3 business scenarios were developed, based on derived extensions and modifications due to the developed technology, which results are described in this deliverable; finally, stage 4 will follow a more detailed analysis of the most promising designs consisting of a deeper analysis of possible business models (to be reported in D2.6).

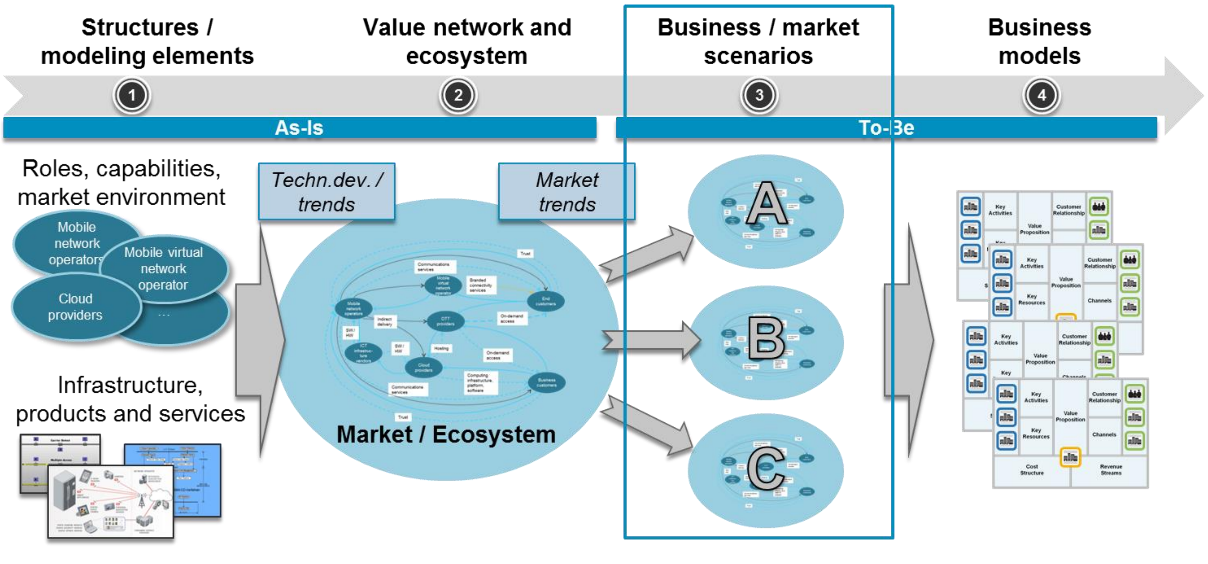


Figure 1. T2.2 Roadmap (D2.3. pg. 14)

1.2 MCN Business Research Scope

The Mobile Cloud Networking Project brings together various concepts, both technological and economical, of mobile networking and cloud computing, where the primary focus is on the technological side. However, technological changes usually come along with changes in business models, which help to better exploit the opportunities of new technologies. Therefore, the MCN business model investigation is focussing on the Mobile Cloud Networking Service Provider (MCNSP), which we introduced in D2.1 [MCN-D2.1], and the role it could play to foster the developed technology. The main structure of the services that might be relevant for a MCNSP is depicted in Figure 2. The MCNSP is supposed to manage the End User (either IEU or EEU) subscription and provides the general connectivity where they depend on other MCN service providers that offer services such as RANaaS, EPCaaS/IMSaaS and DSSaaS. In addition, the MCNSP integrates the service components required to build Mobile Cloud Network services to the EU (D2.1 [MCN-D2.1]). The MCNSP services fall into the spectrum of two categories of services, as afore-mentioned: the MCN services and the support services. There are various collaborations and joined value-creation opportunities for MCNSPs, which might not only work together with MNOs but also with Cloud Providers, RAN Providers or any type of provider, able of offering at least one of the MCN services. The introduction of the MCNSP role into the value network fractionates the responsibilities of the MNO, the Cloud Provider and the MCNSP in the offering of the services. The possible combinations in the distribution of the services between the three stakeholders is shown in a diagram that describes the "Triangular Relationship" between MCNSPs**,** specific Providers (e.g. for RAN, EPC or MNOs) and Cloud Providers (see Chapter 5).

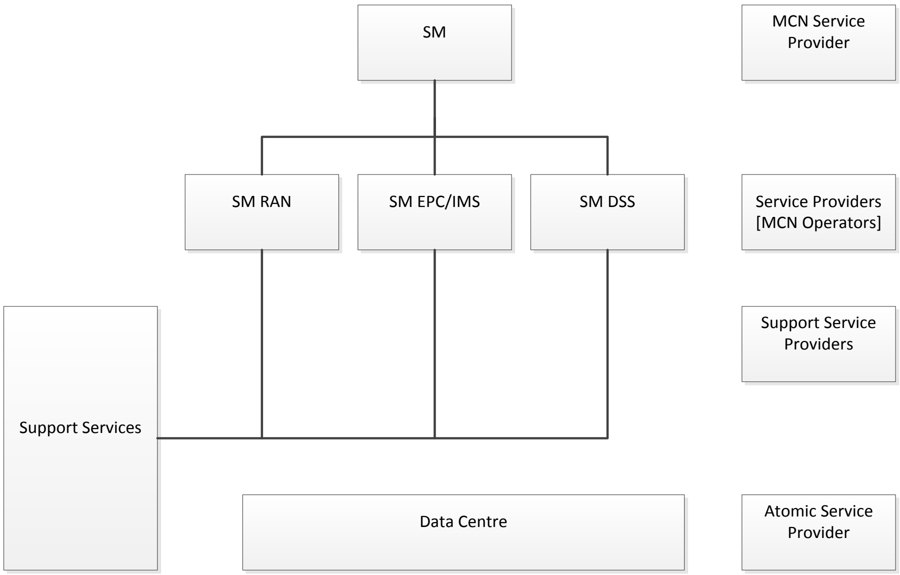


Figure 2. Structure of MCNSP services

1.3 Adjustments in regard to the past deliverables

Methodological frame

Use Case Maps, as suggested in D2.3 [MCN-D2.3], focus on "the evaluation of architectural alternatives at a very early stage in the software development process" (Mussbacher, Amyot & Weiss, 2007, pg. 106). After further analysis, we realized that they were not appropriate for the creation of business scenarios that identify new ways of value creation enabled by the developed technology. Thus, the approach was discarded and research was pursued towards a new methodology. The newly developed methodology focuses on the creation of value-centred scenarios. The Value Flow Analysis (VFA) developed by SAP and described in D2.3 [MCN-D2.1] was used to complement the methodology explained in detail in Chapter 2. The VFA – the complementing analysis tool – was used to refine the investigation of the value creation in networks. Its consideration in each scenario facilitates a better understanding of the impact of each service in the value network. More explicitly, the VFA is applied to each scenario, in order to understand the value creation mechanisms of the various combinations of the services provided by the MCN Technology and the interactions between the new MCNSP role, the MNOs, the Cloud Providers and the customers. All combinations created by the MCN scenarios are represented in the MCN Business Research Scope, which show how the new MCNSP role will be added into the Value Network as described in D2.3 [MCN-D2.3], Chapter 4.

1.4 Collaborative process

The methodology that we mentioned in the previous chapter and that has been applied to the MCN Technology required a continuous collaboration between technical and business experts. Thus, the business related aspects, such as the methodology, have been developed by SAP as the leading partner of task T2.2, while the application of this methodology was conducted in collaboration with technical partners of task T2.2. This collaboration mainly concerned partners that are closely involved in the major services considered for this deliverable: Orange for RANaaS and Fraunhofer for the EPCaaS. Other partners in the task provided general support as they were able to do.

According to the methodology the main interaction addressed the following goals:

1. Provide the business team with the required understanding on the technology and the technical potential beyond state of the art as collaboration of business and technology experts.
2. Elaborate the value of the focus technologies on the basis of certain categories (see Value Characteristics in Chapter 2.2), mainly conducted by the business experts.
3. Propose scenarios that show the value for potential customers in evident scenarios, suggested by the business experts.
4. Discuss the suitability of these scenarios as collaboration between technical and business experts.

The details of the methodology will be explained later. It is important to mention that the outcome resulted from a joint effort of both types of experts through various conference calls and discussions during the consortium meetings.

1.5 Structure of the document

Chapter 1 [Introduction] outlines the overall roadmap and objectives of T2.2 with a focus on the current D2.4 aims. Also, MCN scope of research is clarified by putting emphasis on the fact that the MCNSP role and services are at the core of the value networks.

Chapter 2 [Methodology] evaluates a suitable methodology to generate scenarios that highlight and translate the potential value of the MCN Technology to business scenarios. The basis for the methodology lies in researching the methods for scenario creation, as well as value characteristics to be translated accordingly. Furthermore, it discusses how this methodology, developed for the project, is applied for the ideation of MCN business scenarios.

Chapter 3 [MCN Services] summarises MCN and support services in a set of general descriptions for the reader to gain insight into the different technologies that services can offer. In response to such need, the service descriptions are divided into four parts, covering different aspects such as general service introduction, related value characteristics, potential customers and limitations.

Chapter 4 [MCN Scenarios] illustrates a variety of MCN scenarios that utilise a combination of both MCN and support services to underpin the integration of cloud computing into mobile networking industry. In addition, it details the scope and framework of MCN scenarios through explicit description of the involved stakeholders and services along with elucidating the relations formed among them.

Chapter 5 [Discussion]: This chapter focuses on discussing the relationships between the main roles (namely: MCNSP, MNO and Cloud Provider) in the new telecommunication paradigm generated, by the flexibility of the new technology and their potential interactions discovered in the scenarios. In addition, the compatibility of the MCN Technology with the current legal regulations is discussed, as well as the limitations and assumptions of the research performed in this deliverable.

Chapter 6 [Outlook]: It concludes the report by outlining further research to be done in year 3, in relation to the next step of the roadmap (step 4).

2 Methodology

2.1 Introduction

One central part of the work in Task T2.2 consisted in the creation of application scenarios for mobile cloud services. The purpose of these scenarios was to get input for the design and evaluation of the technology, analyse value-adding or disruptive elements related to the MCN technology, investigate the impact of the technology in existing Business Models, and develop a strategy for a successful adaptation of the technology in the existing markets to project potential future Business Models.

One of the goals of the MCN Project (regarding the business context) consists in the exploration of the potential value that results from the cloudification of services in the telecommunication's domain, as well as the interactions and synergies obtained through the combination of them. The creation of scenarios is an eminent means to approach this task.

There is some research on approaches to create suitable scenarios that refer to the value of technologies; however, they do not explain how this value can be translated into business opportunities. Pateli & Giaglis (2005) emphasize the importance of scenarios for the successful implementation of disruptive Business Models and demonstrate that scenarios are a powerful tool for exploring promising business changes, as it is an efficient way to deal with uncertain and complex environments. Nevertheless, they do not provide a detailed description about how one can assess the available technology with respect to their business potential. Chanal & Caron-Fasan (2007) consider more aspects than Pateli's methodology; they design scenarios to support the construction of Business Models; nonetheless, they also lack in answering the central question of how to grasp the value of the technology.

Therefore we developed a methodology in Task 2.2 to support the scenario creation and facilitate the translation of the MCN Technology features into Business Value, overcoming the problems found in the current research. Additionally, we found that the methodology improved the communication between Technology and Business Stakeholders in the project, as both have different mind-sets and use different languages to express ideas.

This chapter is structured as follows:

In Chapter 2.2, we introduce Value Characteristics as a medium to better understand the value of innovative technologies. The research is based on the analysis of successful technological innovations in the past, describing the effect of these technologies in terms of business innovation. The second part of the chapter outlines specific relationships between different Value Characteristics. In particular it is described how these relationships affect a potential disruption of Business Models.

Chapter 2.3 depicts the proposed methodology by using the list of Value Characteristics researched in Chapter 2.2.

Chapter 2.4 depicts a short overview of how the methodology was applied for the ideation of scenarios that exploit the value of the MCN Technology.

2.2 Value Characteristics Research

In the following, we explain how we enhanced the approach of Pateli and Chanal to fit the specific requirements of the MCN project by further researching the origins of value creation with respect to exploitation of innovative technologies. To this end, we investigated how previous technological innovations led to disruption in Business Models. The selection of the investigated technologies was carried out following the criteria of Christensen (1997) for disruptive innovations, given the assumption that disruptive innovation is the main factor for the evolution of disruptive Business Models. To further support this assumption, Christensen & Raynor (2003) have argued that disruptive innovations usually simplify the purchase and use of a product or supersede the need for customer training. It was discovered that technological innovations possess specific attributes at the moment of market entrance, which caused disruption in their Business Models.

Analysing the past technological disruptions, we discovered that the associated innovations follow certain patterns, which are independent of the field in which the technology was developed regarding the basic features of their value creation. We call these patterns “Value Characteristics”; they determine “the effect of a piece of technology via its implementation in a product producing additional value”.

The central question that we wanted to answer during the research in year 2 of the project has been how to determine the business value of a new technology by means of the technology’s Value Characteristics. The target has been to develop a methodology that helps to identify the most prominent features of such technology and transfer promising market opportunities from existing examples, which serve a business blueprints for the case under investigation. The main purpose of this approach has been to come up with reasonable ideas for business models that can be evaluated later on.

The identification of abstract Value Characteristics is usually not sufficient to clarify the implication regarding the business opportunities. These often depend of particular settings. Therefore we referred to technological innovation examples to develop scenarios for the MCN technology under investigation. This is explained in Chapter 2.3.

The Value Characteristics were structured in a similar manner as the Business Model Innovation patterns developed by the University of St. Gallen (Gassmann, Frankenberger, & Csik, 2013), which have been successfully used for the ideation of new business models, however, without specific reference to technological innovation. Before we go into details, we first explain what a Value Characteristic means, showing their role in assessing the value of a new technology in an example. The particular purpose of the example was to illuminate the market effect induced by a technology and how this effect determined the respective Business Model. The list is shown in the next chapter.

2.2.1 List of Value Characteristics

The following compilation of Value Characteristics was derived from a systematic inspection of disruptive technology changes in the past. This list describes the most basic Value Characteristics and is planned to be extended in the future. However, for the current purpose, the compiled Value Characteristics were sufficient to determine the central disruptive features of the MCN technology.

Cost Reduction: This characteristic is related to the technology incorporated in products provided to customers at a lower price than existing products in the market that accomplish the same function. Cost reduction is a gradual effect that does not automatically lead to new Business Models; only if the reduction of the price goes beyond a certain limit, it has the potential to convince new buyers to purchase the product and consequently the technology opens new customer segments, affecting the Business Model decisively. Another possibility transpires when the price is reduced close to zero, since the revenue comes then from a different source, triggering changes in the different building blocks of the Business Model Canvas. Business Models that obtain revenues from other sources exist already and are used by non-profit organizations (e.g. Greenpeace, Human Rights Watch).

Examples:

Mobile Phone: The first portable cell phone, the Dyna Tac 8000, entered the market in 1984, and at that time it cost about 4000 dollars in the U.S. (10.000 dollars in today's currency). Even if it had a big demand for being an innovative technology at the time, it was too expensive to become conventional. The actual break-through has taken place in the course of consecutive reductions of the price through the years, when a threshold was passed, opening up the private end consumer market for this technology.

Wikipedia: The free encyclopaedia disrupted the physical encyclopaedia market by offering free access to its contents based on a disrupted change in the Business Model (if the cost of connecting to the Internet to access the material is not considered). The first disruption in this market occurred when digital encyclopaedias appeared with CD-ROM technology, winning market share from the book market, followed by a transition to an online product sustained by advertisements in the case of Encarta, or by donations, as Wikipedia operates currently with its Crowd-Funding revenue model. Wikipedia is also successful for other attributes as others contribute to the creation of the product, and are able to use it for free as a sole user, according to the Open Source Business Model (Gassmann, Frankenberger, & Csik, 2013), but is its free access what made it so widely known.

iTunes: One of the advantages of the iTunes platform is the possibility to purchase single songs digitally, which represents a cost reduction as the company does not have to produce a physical device to contain the music, thus lowering the cost of the song.

Complexity Reduction: this Value Characteristic becomes relevant when new technology is easier to use than previous ones, for example, enabling customers to handle it without specific education or training. This creates a different value proposition for the user, leading to new Business Models.

Examples:

Personal Computer: The mainframes functioned with punched cards (a piece of hard paper drilled in specific areas of its surface) as the main medium to input data into the machine, which created a limitation in the interaction between the user and the computer; therefore, it could only be operated by technically specialized users. The home computer was designed for non-technical users, thus allowing a wider range of customers to control it.

Telephone: The telephones disrupted the telegraph due to their simplicity. The user only needs to speak through the handle for the receiver to hear the message; in comparison to the telegraph, which was more difficult to use as the user had to learn the Morse alphabet in order to redact or understand a message.

iTunes: The iTunes platform reduces the complexity of buying music because this can be done online whenever the customer wants it, without the need to go to a record store to buy an album.

Gain of Adaptability: The online dictionary oxforddictionaries.com defines *adaptable* as "Able to be modified for a new use or purpose" (adaptable, 2014). In this sense, this characteristic appears when a particular innovation holds more uses than the technology it replaced. When a technology possesses this characteristic, it usually leads to new Business Models because it creates significant change in previous value propositions. Hereinafter, this characteristic will be referred to simply as "Adaptability"

Examples:

Personal Computer: The technology was not as powerful as its predecessor in terms of memory and computation, yet its adaptability allowed the usage of the PC for word processing, database organization, leisure time (in the form of videogames), etc., which was appealing for the non-technical user.

Plastic: It is a material made of synthetic organic solids that can be moulded in a variety of forms and shapes. In addition to that, plastics can be produced in different degrees of stiffness, allowing a larger set of products to be created from it. The adaptability of plastic diminished the usage of other materials for storage, e.g. wood or metal.

Steam Engine: The steam engine is a machine that delivers mechanical work with steam as its working fluid, replacing the use of animals to generate a force e.g. horses. This mechanism improved transportation in general by powering for example locomotives, ships, cars, tanks, etc., as well as it was used in stationary applications, like pumps, mills and factories.

Gain of Independence: It refers to technology innovations that accomplish the same function as its predecessor without certain constrains existing in the former product. The new product is more valuable because such constrains were an impediment to expand the uses of the former product in creative ways. Hereinafter, this characteristic will be referred to simply as “Independence”.

Examples:

Electric Refrigerator: A technology that lowers the temperature of a cabin to storage perishable food. It replaced the ice box, which was dependent on ice to maintain the food at a low temperature, whereas the electric refrigerator generates the ice on its own. This fact signified a change in the value proposition of the refrigerator.

Transistor Radio: These radios allowed the user to hear music anywhere as they were smaller and lighter using the technology of the transistor, in contrast with the vacuum tube radios which limited the user to utilize them only at home or the office, the new value proposition affected the Business Model of radios as it could address different customer segments e.g. young individuals.

LCD Screen: The Liquid Crystal Display (LCD) screens were not ready to replace the cathode ray tube screens in the market. However, a high performance was not indispensable for small size applications e.g. watches and pocket calculators, which allowed portability of the screens and hence independence.

Pocket Camera: Pocket cameras (the first cameras that were small in size, not to be confused with Digital Cameras) created the possibility to undertake the photo-making process without the need of a professional, thus a user is now capable of controlling what and when to make a picture. This fact creates independence from the photography service, generating a sense of ownership of it.

Cloud Computing: Cloud Computing generated the possibility to be independent of the computing infrastructure and obtain the same value in a service-based way.

Automobile: The automobile allowed people to decide where and when to go, in comparison to transportation by train, which is fixed to schedules and locations (tracks).

Business Network Change: A change in the business network of a company means forming new partnerships or eliminating them as a result of the new value proposition brought by the technology.

This characteristic is partially related to Independence, when the latter is understood as the achievement of autonomy from a role in the business network.

Examples:

Digital Camera: The possibility for cameras to storage pictures digitally without the need of film changed the network of the photography industry since there is no need to go to a photo store to obtain the pictures, as is it possible to look at them through a screen or print them at home with the help of a personal computer and a printer. This is an example of how Independence and Business Network Change can be interrelated.

iTunes: The platform substitutes the need of a physical device (e.g. Compact Discs) to store music, thus record stores lose importance in the business network.

Automobile: The continuous use of the automobile required the development of new roles in the industry, e.g. repair shops and gas stations.

Enablement: A new technology allows the development of new products and services that could not be envisioned before the existence of the innovation. Often the enabling technologies do not cause fundamental change in the Business Model prior to its existence (if there was ever one), but to the Business Models that it enables as a result of its usage.

Examples:

Internet: The Internet is a system that interconnects several billions of computers across the globe. Such linkage allows the development of numerous services and possibilities, being perhaps the most prominent the World Wide Web (WWW), along with other services such as e-commerce, voice over IP (VoIP), e-mail, etc. The Internet allowed the incorporation of new products and services, ranging from the e-mail to e-commerce, disrupting normal mail and brick and mortar stores. Entrepreneurs can promote themselves and do business using the Internet. Communications between individuals are easier and cheaper with VoIP. Information is available faster and in abundance due to all the content available on Internet, (caveat: at the risk of obtaining false information since everyone can access and edit content).

Transistor: This technology disrupted vacuum tube technology, as it allowed a smaller and inexpensive way to amplify and switch electronic signals revolutionizing the field of electronics. All modern electronic devices such as computers, watches, mobile phones, radios and calculators operate based on transistors as the basic fundamental block of them. The fact that it was cheaper and smaller than the vacuum tube allowed the fast development of the technology seen in the last century. The producers of the enabled technologies were able to develop new products (see above transistor radio) at lower costs.

Steam Engine: This technology enabled the existence of new machines, such as locomotives, ships, cars, tanks, pumps and mills (see example in Gain of Adaptability for more information). But it also enabled the development of railways, which were not suitable at the moment for locomotives powered by steam engines.

A special case of enablement occurs when the development of a technology interferes with the development of a second one, creating a synergy between them. *Synergy* is defined in the online dictionary oxforddictionaries.com as “Interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects” (synergy, 2014). Three examples of this special case are shown next.

Trains and Railways: As explained in the example above, the development of the steam engine for transportation purposes resulted in the steam locomotive. This breakthrough demanded better railways. The proliferation of railways across the land created a network that required better and faster locomotives, which translated in the design of better steam engines for the trains.

Automobiles and Gas Stations: The supply of oil for the automobile required the creation of specialized gas stations for them. The technology incorporated in gas stations was designed specifically to meet the demand of automobiles. On the other hand, the intake of oil system in automobiles, as well as the type of oil it receives was standardized to increase the efficiency at the moment of filling the car tank.

Printing and Paper Production: The mass production of written media fostered the specialization of the printing industry. The development of low cost paper was fostered by the need to generate newspapers at a lower cost. In this case, the quality is unimportant. On the other hand, for more specialized products e.g. collection books, the quality needed for the paper and the printer requires to be improved. The connection between both technologies is formed by the level of quality required.

2.2.2 Relationships between Value Characteristics

As it can be noticed through the examples, a single Value Characteristic rarely causes business disruption, being a combination of them what usually triggers this. Some combinations hold stronger relationships than others; a good example are the interactions between Information Technology and the Internet, which leads to Business Models with different revenue streams, such as the Wikipedia example. The creation of a synergy of any innovation with the Internet could create the reduction of price close to zero.

Another type of relationship can be found between Enablement and Gain of Adaptability; they relate to each other by definition because the fact that a technology supports others to come into existence means that such technology is used in other ways.

The interrelations found between the characteristics are not always 100% applicable, i.e. the fact that a relationship applies for one example does not necessarily means that it also works for the next, thus, the boundaries between the Value Characteristics are not always clear. However, the differentiation is made in Chapter 2.2.1 to better understand the value concepts of innovative technologies, and they serve as a starting point to attempt the creation of scenarios, an important part of the methodology explained in Chapter 2.3.

Insights about the creation of value can be drawn out by understanding that some Value Characteristics can lead to other ones. For example, the creation of independence from a player by means of the innovation changes the Business Network, as in the iTunes example, the user of the technology no longer needs to go to the record store since it can now download the music at home, representing also Complexity Reduction, and by owning the product digitally (no physical device in where it is stored) it also represents Cost Reduction. In other example, the transistor is an innovation that enables other technologies, since it is used to produce all modern electronic devices, lowering the costs of such products and decreasing its size, hence making them easier to use.

Using this line of argumentations, the first insight in the creation of value is that all the Value Characteristics seem to lead to Cost Reduction and Complexity Reduction. However, it does not diminish the importance of the other Value Characteristics since the cause of disruption is not always centred on the price and the simplicity of use of a product.

Cost Reduction is straightforward as the price undoubtedly drives the buying behaviour. Money is a tangible asset easy to see and measure, thus it is related to the obvious concept of value. On the other hand, Complexity Reduction is related to the intangible assets, answering always the question "How do the end users solve their needs with less effort?" In this case the value cannot be quantified, according to Allee (2008), due to its intangible connotation. She states that the majority of intangible transactions should never be converted into units of measure and must be acknowledged as such.

A second insight relates to the disruption of Business Models and its relationship to technology innovation. Most innovations may possess one or two of the Value Characteristics aforementioned, but that fact alone would not change the Business Models disruptively. Nevertheless, if a technology owns several of these characteristics, the chance to change the Business Model fundamentally increases. This phenomenon could be analogous to the diminution of price explained in the mobile phone example for the Cost Reduction Value Characteristic. If the value proposition of a technology is appealing enough by acquiring several of these attributes, and surpasses a certain threshold in terms of value for the customer, a fundamental change in the Business Model is prone to occur.

Secondary Value Characteristics

Certain combinations of Value Characteristics are easy to interpret and identify when analysing an innovative technology, reflecting the fact that the Value Characteristics are interwoven. We call the results of these combinations Secondary Value Characteristics. They serve as a starting point to grasp the value of the technology, and are valid as Value Characteristics per se, if some reasoning about them is given. The Secondary Value Characteristics are explained next:

Private use: Technologies operated directly by the end user (the individual who benefits from the technology). Sometimes this can be a valuable characteristic as it opens new customer segments (see example of the Personal Computer). Private use is the result of the combination of Complexity Reduction, Cost Reduction and Independence.

Self-service: Technologies that enables the user to generate products or services that were otherwise not accessible for the user, or the latter had to make an additional effort to obtain it separately (e.g. production of ice with the refrigerator, coffee machines). Self-service creates independence from the provider of such product and therefore, it could potentially change the business network.

Portability: Technologies that can be carried easily by the user and can be used everywhere are portable. Portability creates a sense of independence from position, and generates adaptability.

Increase of Speed: Related to technology that solves a need for the user faster than other technologies, for example, high-velocity trains which became competitors to plane transportation. Increase of speed could generate Adaptability.

Sizing: The sizing of an innovation is a tangible characteristic that affects how it is used. The tendency in the electronics field for the last years is to create smaller devices which contain more capacity, supported by transistors and microchip technologies as stated by Moore (1965). The diminution of the physical size allows an easier portability of it (e.g. smaller cell phones, cameras, watches), whereas the increase of digital size (e.g. hard drives with bigger storage sizes, cameras with more storage potential), given that the price of the product remains the same, leads to cost reduction because the cost/benefit ratio is reduced.

Customisation: If the user is able to tailor the product to its particular needs, a product is customizable. Depending on the degree of such customization, it can lead to Adaptability, as it opens possibilities to use a single product in different ways, which leads ultimately to a stronger value proposition and hence to new Business Models.

The study of these characteristics in more depth is out of the scope of the project, but it holds potential for further research in the area. However, the knowledge found at this point is sufficient to create a new methodology.

2.3 Methodology Details

The insights explained in the above Chapter are helpful for the creation of new Business Models that derive from technological innovation. Nevertheless, the process of ideating Business Models is not straightforward, as it depends also on external factors and special considerations that need to be recognized.

A series of steps were developed in order to accommodate the new technology into useful scenarios for the development of Business Models. The construction of scenarios is important for the successful implementation of disruptive Business Models as they are a powerful tool for business change that deals efficiently with uncertain and complex environments (Pateli & Giaglis, 2005).

The developed methodology comprises five steps, depicted in Figure 3. A further explanation of each step is described below.

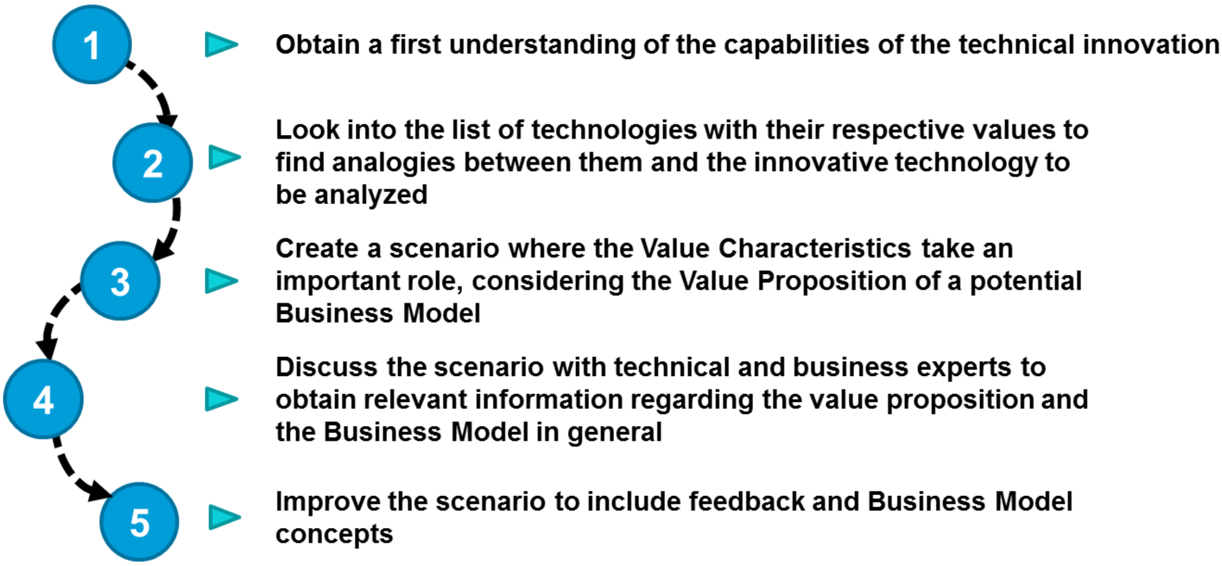


Figure 3. Methodology

1. **Obtain a first understanding of the capabilities of the technical innovation.**

A first approach with technical partners is necessary to grasp what the innovation is about. Some initial questions could be:

- What does the innovation do?
- Who is the addressee or target group of the innovation?
- What is necessary for the innovation to happen?

The first step might seem obvious and straightforward, but an initial understanding of the capabilities of the technology innovation is necessary in order to link the innovation to the list of technologies. (It is not essential to grasp complex issues and technicalities).

2. **Look into the list of technologies with their respective values to find analogies between them and the innovative technology to be analysed.**

The business stakeholder must utilize the knowledge obtained through the initial contact with the technical stakeholder to assess what Value Characteristics belong to the innovative technology. The explanation of the value generated by the technology through the Value Characteristic alone is not enough to practically understand the real value of the innovation, hence the importance of the examples researched in Appendix A, which highlights the Value Characteristic in scenarios to be developed in step 3, and serves as an example to implement the same attribute in the technology under investigation.

This particular step is crucial for the development of scenarios and the whole methodology because the ideation process starts here; therefore, this step is broken down into small indications to ensure that it is followed correctly.

1. Look into the list of technology examples and select at least one of each kind that could be similar to the innovation under investigation.

2. Determine how the Value Characteristics shown in each example are relevant in that case and how it determined the success of the innovation; this activity aids greatly in the understanding of the value in the given technology example.

3. Correlate the value obtained in the example with the technology under investigation. At this point, three important questions should be inquired:

- Does this technological innovation possess this Value Characteristic?
- Could it possess it?
- Could the situation in a particular example be applied similarly with this innovation?

The last two questions are meant to give constraints to the creativity process that fosters the value creation of the technology, since the strategic use of such constraints can raise the creativity to encounter a plausible solution (Stokes, 2005). It could occur that the values are not compatible with the innovation, in which case the argument is also useful to understand what is possible and what not in the innovation context. In this regard, the possible value obtained for the innovation could be rated with a plus (+), when the value is relevant, a minus (-) when the value cannot be applied, or a plus-minus (+/-) when it does not make a difference. Additionally, if it is not clear when a value is applicable, a question mark can be added (?).

4. Once all the examples related to the Value Characteristic are analysed, repeat the process with other selected example.

The results of this exercise will show initial ideas that contain the potential to be converted into Value Propositions for the innovative technology, which is the starting point in the generation of new Business Models. Furthermore, the amount of values found at this stage, if proven feasible later by Technical and Business Stakeholders, can help to predict how disruptive the innovation in study could be. A brainstorming session could be useful to increase the amount of values generated at this point.

This step of the methodology closes a gap in previous research where the identification of the value in the usage of technologies is not clear. The application of the Value Characteristics and the technology examples initiate an ideation process to grasp the value in the usage of a given technology. It also reinforces the second step in the work of Pateli & Giaglis (2005), related to the assessment of the technology innovation, as it was previously discussed.

3. **Create a scenario where the Value Characteristics take an important role, considering the Value Proposition of a potential Business Model.**

The construction of the scenario is critical to build the bridge that joins the business mind set with the technical mind-set. The advantage of creating the scenario with the Value Characteristics as the central point consists in the contemplation of valuable features for the end user, ensuring that it covers actual needs, instead of being only a “nice to have” feature. The capabilities of the technology might be challenged in the scenario, but at this point no restrictions in that regard have to be considered as that should be judged by the technical stakeholder.

Examine other building blocks of the Business Model if possible, i.e. provided that enough information exists in order to do so. The Business Model Innovation process should start at this point because it forces the technical party to consider possible adaptations of the innovation to fit the market, instead of being constrained by technical restrictions they could have in mind, not allowing the exploration of further possibilities. Nevertheless, the scenarios should not be too long and must focus mainly on the specific values drawn from the comparisons in step 2.

Potential questions in this step could be:

- What is the main value proposition in the scenario? (taking the Value Characteristic into account)
- How does the end user benefit in this scenario?
- Is the Value Characteristic correctly transferred into the scenario?

4. **Discuss the scenario with technical and business experts to obtain relevant information regarding the value proposition and the Business Model in general.**

Once the scenario is built, a second discussion with technical and business experts should take place. In this meeting, it should be discussed whether the scenarios make sense in both the business and the technical point of view. As argued in the third step, the scenario could challenge the technical features of the innovation to fit the market, and at this point, the technical stakeholder should analyse whether it is possible to add these features or not, and if it is in the scope of innovation research. The business stakeholder must confirm if a potential business can be drawn from the scenario, to reinforce the Business Model construction in the next steps.

If the scenario is relevant to the technical partners, then the scenario can move to step 5, some questions to ask in these case are:

- Is the scenario technically feasible and within the scope of the research?
- What results would you expect after implementing the scenario?
- How would you improve the scenario?
- Do you a see a business opportunity resulting from the implementation of the scenario?

- Does it affect other business areas? If so, how?

The discussion might show that the scenario is not relevant for the technology in research; the feedback obtained must be acknowledged and the scenario is discarded, however, the reasons behind the elimination of these scenarios must be well discussed.

In this case, some questions to be asked are:

- What changes are required to make the scenario feasible?
- Will it have business potential after these changes are made?

5. **Improve the scenario to include feedback and Business Model concepts.**

The feedback obtained will serve to strengthen the scenarios into more realistic ones that describe how the value of the technology can be created, captured and delivered, thus recreating a Business Model (Osterwalder & Pigneur, 2010). At this point the scenarios should take into consideration the other building blocks of the Business Model apart from the Value Proposition, including how will the Business Network look like (Customer and Partners) and the infrastructure needed to deliver the value proposition (Channels and Key resources). It could be complex to analyse the financial viability of the technology, as it is still in a development stage, however, some initial ideas about the revenue models should be drafted. The scenarios should be reviewed by both technical and business partners to ensure that it is a potential use for the technology, and include new ideas that enhance the value in the usage of the technology.

Final question to be ask once the scenarios are finished:

- Are the Business Model elements addressed in the finalized scenario?

The information created through the presented methodology should ease further investigation to prepare the technology to enter the market with an innovative Business Model.

The methodology presented in this chapter does not intend by any means to replace past studies in the subject of Business Model Innovation and scenario ideation, but rather closes an existing gap in them and thus serves as a tool to facilitate the creation of valuable scenarios.

2.4 Application of the methodology to the MCN Technology

In this chapter we present a short summary of the application of the methodology for the MCN Technology. Detailed information about application and results is compiled in **Appendix** B.

In a first instance, we conducted interviews with Orange and Fraunhofer (see Chapter 1.4) in relation to the functionalities and advantages of RANaaS and EPCaaS. With the information provided, along with data collected from previous deliverables (D3.1 [MCN-D3.1], D4.1 [MCN-D4.1] & D5.1 [MCN-D5.1]), we learned about the exclusive features of the MCN Technology.

Next, we applied the second step of the methodology by comparing the values that derive from the technology examples with what we knew about the MCN Project, resulting in the understanding of the value in the usage of the MCN technology.

A first set of scenarios were drafted focusing on the information we had at hand (see pg. 89ff). The scenarios created in this step were only a short overview, focusing on the Value Proposition in the offering of the MCN services.

We discussed the drafted scenarios with the partners, and incorporated their suggestions into the scenarios to finally draft more completed scenarios, considering the value flows between the stakeholders for each scenario and acknowledging possible strengths and weaknesses in them. The resulting scenarios are described in Chapter 4.

3 Services

This chapter delves into the description of services whose existence is essential to the creation of MCN scenarios. Services constitute a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description." A service can be uniquely identified by its interface. Its identity is known as its type [MCN-D2.2]. A combination of more than two types of services results into the creation of “composed” services.

3.1 RANaaS

3.1.1 Introduction

Radio Access Network as a Service (RANaaS) allows any type of Radio Access Network to be provided on demand to enterprise end users (EEU) (D2.3 [MCN-D2.3], pg. 71).

In other words, RANaaS enables MNOs and MVNOs to enhance their radio access capabilities for certain areas in periods when usage reaches its peak. This means a decline in CAPEX and OPEX related to the transmission towards core services, since its maintenance will not be part of the MNO expenses, but of the RAN provider instead. Theoretically, the decrease in redundancy, and the utilisation of “economies of scope” would decrease the costs of maintenance for the MNO.

In addition to the clear benefits to MNOs, there are further opportunities to explore potential service demands, for example when the public safety department decides to have its dedicated RAN network in case of an emergency situation, such as a natural calamity. Some companies may also request for a dedicated RAN in combination with an exclusive EPC rather than sharing one with other users. A typical example of this approach includes a company like Amazon to opt for connecting Kindle users abroad, instead of relying on sponsored connectivity services and individual local contracts. This ensures their service reliability to request more or less resources depending on the latest business intelligence results as well as to have some level of control on the RRM (unmanaged mode). The new setting is more dynamic than the previous one, since the customer can adjust its offer to accommodate more or less subscribers in case forecasts change. The current setup is less dynamic, since it requires meetings with people in charge of the RAN dimensioning.

3.1.2 Stakeholders

RAN Provider: This is the most essential role for this service as it provides Radio Access to the End User.

MNO and MVNO: They provide connectivity to the End User supported by the RAN Provider.

End User: They are the receivers of the final service and comprise the main source of revenue.

More detailed information about the stakeholders’ capabilities can be found in D2.1 [MCN-D2.1], Chapter 4.

3.1.3 Value characteristics

Stand-alone potential

RANaaS is vital for the MCN concept. Its detachment from MNOs, as a stand-alone service, has the potential of individual commercialisation, yielding new relationships and new business models (D2.3, pg. 73).

Flexible Service Delivery

The term quality – as comprehended at this point – involves: Capacity, Availability, Range, QoS, and Stability. The QoS is prone to be affected negatively as the infrastructure becomes more complex. However, RANaaS offers the opportunity to deploy additional capacity where needed, thus it has the potential to increase or at least maintain the standards prior to the application of this concept. Other aspects related to quality in general are improved, as well, such as the quality of the delivered service, as more flexibility in this regard is expected, decreasing also "time to market". In this particular case, the question arises if a RAN is considered to be a crucial part of an MNO. In comparison with other industries, there are similar outsourcing concepts, which are already established. In fact IaaS providers deliver crucial platforms for all kinds of services, e.g. cloud services. Cloud service providers, on the other hand, do not necessarily provide the infrastructure themselves, even though it is considered to be a key part of their products. The industry has addressed that issue by establishing SLAs, a method which ensures the necessary quality of the service. The same concept seems to be essential in the RAN scenario, as MNOs or MVNOs would have the need to be protected against quality issues of a rented RAN access.

On demand coverage

Another interesting option to MNOs or MVNOs focuses on areas with a low density of population, or isolated areas (roads between cities, mountains, etc.), where the relation between actual transmission and cost of maintenance and operability is moderate. Ergo, if these areas are outsourced to a RAN Provider, an MNO would pay only when signal is transmitted as a medium to optimise the use of their own resources. The on-demand concept of RANaaS could be further enhanced with the usage of small cell technologies, which foster other transmission options in such situations. This solution is further discussed in the small cell scenario (D2.4, pg. 61).

Customisation

RANaaS can be offered in a managed or unmanaged mode. In the managed mode, the client is not able to control and configure certain parameters of the network, leaving the work to the RAN Provider. This kind of service might be beneficial to users such as the public safety service provider that has no particular interest in configuring these parameters. In the unmanaged mode, the client would be able to customise certain parameters such as the number of users or the usage of data in a designated area. The customisation of the RAN can be easily accomplished by the client if parameters are not complex, (i.e. estimation of users and traffic), but it can probably be more difficult if further technical parameters are taken into consideration. These parameters have not yet been fully defined by the current technical work packages as more pieces of information and exploitation of this characteristic are meant to be rendered in D2.6.

3.1.4 Potential customers

MNOs/MVNOs: The (virtual) mobile network operators would work closely with the RAN Providers to ensure the procurement of additional Radio Access resources when needed.

Commodity Companies: Electricity/Water providers (to collect consumptions in M2M paradigm)

Big companies: This type of companies is interested in renting the Radio Infrastructure in case they have to run their own EPC for telecommunication purposes.

End Customers: End customers are not falling into the category of direct customers for RAN solutions, but they benefit from the results of the alliances formed by the operators/companies and the RAN Provider.

3.1.5 Limitations

Viability of Outsourcing

Outsourcing RANs ought to be considered carefully as outsourcing parts of a value added process can be beneficial when costs can be reduced to a certain extent. However, one has to be aware of a company's core competencies: If a value added process is crucial to the quality of its own service, lower costs might not be the only reason for something to be outsourced in the future.

Interdependency with EPC

It was widely discussed with technical partners, whether the RAN service can be provided independently from any kind of EPC(aaS) or not and if that would be based on a concrete assumption. It is technically possible to develop a RAN which is independent from the EPC architecture, but that does not follow 3GPP standards and therefore the EPC should always be taken into account for RAN services. Nevertheless, the last fact does not mean that a particular RAN must be attached to a particular EPC as RAN and EPC can be easily decoupled and coupled again in a new configuration of different settings. All in all, the interdependency with EPC can be translated into a future opportunity and not only be seen as a barrier as further business cases might take advantage of it resulting in the development of ensuing scenarios incorporating combinations of MCN services.

3.2 EPCaaS

3.2.1 Introduction

The Evolved Packet Core (EPC) is a set of network elements that allows the transmission of data packets on mobile networks in the form of Internet Protocol (IP), supporting the latest technologies. EPC is the core network for 4G, 3GPP access networks (LTE, 3G, 2G) and supports connectivity through other trusted and untrusted non-3GPP access networks such as Wi-Fi, 3GPP2, WiMAX, Femto-cells, etc.

The EPCaaS represents a "cloudified" implementation of 3GPP EPC architecture, which can be provided on demand to enterprise end users (EEUs) in accordance with the MCN architectural framework (D2.3, pp 71). Compared to existing EPCs, this represents an optimisation that increases the core efficiency, scalability, capacity for subscribers, adaptability, etc., and results eventually in the reduction of the running and maintenance costs of an EPC, which eventually can lead to reduced prices for the end consumer. Additionally, this technology breaks the vendor lock-in, as the customer does not need a particular hardware to run it.

Functionally, EPCaaS can be defined as a single service that provides customised mobile connectivity. Among the customisable functions of EPCaaS there are: authentication and authorisation, security, lawful interception, mobility support, quality of service, charging and others. The customised connectivity provides a major degree of flexibility for potential customers.

This new type of customisable connectivity sets the foundation for a new market for telecommunication infrastructure as a service, with the possibility to create time-based markets that provide connectivity for a limited period of time.

EPCaaS can be offered as a standalone service by operators and cloud providers as well as possible vendors. For cloud providers this is a new market opportunity to offer a service that was until now available only through the deployment of costly hardware infrastructure at the customer's premises. Lastly, mobile operators have a tremendous advantage when offering EPCaaS as they can guarantee quality of service along with wireless transmission.

3.2.2 Stakeholders

Business Customer: It renders services to the end customer, using the connectivity provided by the MCNSP.

End Customer: The receiver of the final service; they are the source of the revenue to the Business Customer.

MCNSP: It offers customised connectivity to the Business Customer either in the form on demand; the MCNSP can be the owner of data centres to run the software, or make partnerships with Cloud Providers to run it.

MNO and MVNO: They provide connectivity to the end user.

Cloud Provider: This role is in charge of running the EPCaaS software in their data centres. However, the EPC Providers could also run the software on their own infrastructure. In this case the EPC Provider would also act as a Cloud Provider.

More detailed information about the stakeholders' capabilities can be found in D2.1 [MCN-D2.1], Chapter 4.

3.2.3 Value Characteristics of EPCaaS

Enhanced Flexibility in Infrastructure Management

EPCaaS allows software and hardware to be externalised to partners, resulting in a faster and more economical allocation of the infrastructure sources. Companies are concerned over the security issues the new setup might bring, as the infrastructure will be run by a third party (EPCaaS is offered as SaaS, or even as PaaS), which can be integrated into virtual machines to run applications. The cloudification of the connectivity infrastructure will ultimately lead to diminished switching costs for companies, higher degree of competition, lower reliance on suppliers and independence form hardware vendors.

Region-Free Connectivity

The current model is limited due to regional restrictions posed by local networks and regulations, making the connection among different providers rather expensive. EPCaaS offers the possibility to create instances of EPC software through cloud technologies in different countries. In this way they bypass regular roaming contracts, allow companies to build their own customised networks and run their applications locally (i.e. without the intervention of a third party for the connection). RAN connection would still be needed for mobile support.

Adaptable Security Mechanisms

EPCaaS enables security mechanisms, which helps a company control which devices connect to the network. In particular they may have different levels of authorisation for different applications. The advantage of EPCaaS relies in that the business customer possesses a higher level of control over the network, in comparison with normal EPC, in which the security mechanisms were previously defined for entire mobility networks and were not configurable to individual or business customers. While normal GPRS voice communication from current MNOs offers moderate encryption to everyone, the EPCaaS would allow a customer to decide on security mechanisms as long as these are compliant with 3GPP. The service enabler would be able to decide which devices are allowed to connect (authentication), and what permissions these devices have (authorisation). Additionally, the signals between the end user devices and the EPC could be encrypted in a particular manner (if supported by the device) to ensure that communication over RAN networks cannot be intercepted and read easily by third parties through special hardware.

Control of Quality of Service

Quality of service (QoS) is the process function of giving priority to certain data packets over others, which is provided by EPCaaS. Ergo, a potential customer of EPCaaS would be able to assign different levels of QoS to specific applications/services and users individually. However, because of the nature of the network, QoS depends on the limitations of the physical network that lies underneath.

Flexible Integration with Other Services

EPCaaS can increase its value when provided in combination with applications, voice, video, documentation management services, etc. This enhancement is in line with the current needs of enterprises, because it integrates and controls the needed infrastructure accordingly. In addition, each service can define their particular authentication, security and QoS settings, granting enterprise customers the possibility to set their own requirements for their services. The combination of EPCaaS with IMSaaS on top of the afore-mentioned infrastructure configuration is more realistic, as it provides the interfaces with the application layer, (see IMSaaS chapter).

The role of RAN in the value proposition of EPCaaS

RAN and mobility

RAN sharing between multiple EPCs is already an established practice. Currently the EPCs are available only to operators of one country (due to each country’s spectrum licensing) as RAN is not a continuous system. RAN consists of multiple sets of antennas which are loosely coupled to each other. An EPC can connect to multiple antennas either owned by the same operator or by different operators. Both procedures can be established via standard 3GPP procedures.

RAN and security

RAN is partially associated with the authentication and authorisation procedures of the device as it conveys authentication messages. The information in transit is encrypted by the EPC. For the data path only the chapter between the mobile device and the RAN is encrypted. However, applications encrypt important information end-to-end independent of EPC or RAN, thus, interception would be ineffective as it is not unveiled which devices are connected with each other.

RAN and QoS

RAN supports the QoS over the radio link. The Radio Resource Controller (RRC) shares the resources between several EPCs. However, to ensure the levels of QoS the RRC has to be slightly extended when a high number of EPCs are connected.

3.2.4 Potential customers

EPCaaS is envisioned for business customers; nevertheless, the offer might change depending on the nature of business. As each type of customer has different needs, we separate them by size and identify what could be interesting to a particular group.

Small companies: They will be able to externalize their software, acquiring it as a service on demand. The technology is more appealing to these companies if they can have the software bundled with applications such as data management, voice, video, etc., because it would lower the costs in comparison to the acquisition of each application separately. Maintenance efforts are also lowered.

Medium companies: These companies can be found in more than one location worldwide. Additional to the advantage of saving the costs of purchasing the infrastructure they need as a service, these companies can also benefit by signing a single contract with the MCNSP for all the countries they are in.

Big companies: EPCaaS automates the infrastructure management. Currently, there are high labour costs that can be eliminated to a certain extent with the introduction of automation. An alternative option exists for them to run the automation themselves; nevertheless other costs might appear in the form of highly-specialized personnel. The MCN technology is flexible enough to allow the combination of the services that the company uses with the cloud infrastructure provided by the MCNSP.

Public administration: The public administration would utilize the service to transfer documents from one location to another, in a secure way, and for emergency services, which require a guaranteed Quality of Service (QoS), ensuring the transmission of information at all times.

3.2.5 Limitations

Quality issues

It is not known yet how EPCaaS will affect the quality in the current connectivity services. A possible drawback of EPCaaS might transpire if a very large delay is caused by passing all the data traffic of the mobile device through an additional set of non-customized servers running on top an additional virtualisation layer, which would lose all the major achievements in the radio technologies of the last years. E.g. LTE has a transmission window of 1ms (vs. 10 ms in 3G) while processing in a VM may be 10ms.

Interdependency with RANs

To fully take advantage of the capabilities of EPCaaS, a RAN is needed; therefore, it plays an important role in providing mobile connectivity. Additionally, the RAN has to be adapted in order to comply with properties intended for the EPCaaS, e.g. to fully provide the QoS capabilities.

3.3 IMSaaS

3.3.1 Introduction

The IP-Multimedia-Subsystem (IMS) is a telecommunication infrastructure standardised by the 3GPP standardization bodies (3GPP, 2013). It provides an application-layer approach for session control on all-IP NGNs. In general, it furnishes procedures for registration and discovery of subscribers, offering them VoIP services, conferencing and messaging. It mainly uses protocols like SIP (Rosenberg, et al., 2002) and Diameter (Calhoun, Loughney, Guttman, Zorn, & Arkko, 2003) for session control functionalities. The IMS as a Service aims at developing a platform for offering IMS infrastructures to the EEU on demand, applying the cloud principles. Its innovation is mainly represented by the cloudification and virtualisation of the main network entities without changing the related standard. IP Multimedia Subsystem (IMS) is an architectural framework standardized by 3GPP for delivering multimedia services over IP. IMS as a Service (IMSaaS) defines an architecture for delivering IMS infrastructure using the pay-as-you-go model introduced by the cloud model.

3.3.2 Stakeholders

MNOs/MVNOs: The mobile network operators would collaborate with the MCN Providers as access and connection to EPC is a prerequisite to the functionality of IMSaaS.

MCNSP: It could offer IMSaaS on demand to other parties.

IMSaaS Provider: Alternatively IMSaaS could also be offered by a dedicated partner.

Cloud Provider: This role is in charge of running the IMSaaS software in their data centres.

EEU: The customer benefiting from the delivery of IMSaaS.

3.3.3 Value Characteristics

On-demand elasticity

The deployment of the IMSaaS is expected to reduce the overall deployment and management costs through the acquisition of software components running on top of common hardware architecture and through elastic deployments. The system might become less stable and highly distributed, requiring novel paradigms of management and orchestration. By running the IMS as software on top of common hardware architecture, a MCNSP is able to highly reduce the costs of deployment.

Additionally, through the on-demand characteristic of cloud-based infrastructures, an MNO could also reduce its operational costs through deploying only the IMS components required at a specific moment of time. The biggest advantage the IMSaaS can offer when compared to any other platform at this moment, accounts the standardised interfaces used in the application servers. Instead of purchasing a tool from a software company provided through a file server, the MCNSP can buy an application server for an IMS at a reduced cost.

3.3.4 Potential customers

Big companies: This type of companies such as (MNOs and MVNOs) is interested in purchasing IMS services to reduce the operational and management cost of their applications.

3.3.5 Limitations

Service architecture

To profit from cloud computing environments, IMS has to be deployed “as a Service”, based on the underlying server architecture, as the common hardware architecture currently addresses mainly applications. Nonetheless IMS components mostly run on service control platforms with a few exceptions falling into the category of hardware specific.

3.4 DSSaaS

3.4.1 Introduction

Digital Signage (DS) encompasses the use of digital displays exploiting technologies such as LCD, LED, plasma displays, or projection to exhibit multimedia content. Digital Signs are used in navigation, place making, exhibitions, public spaces, marketing and outdoor advertising.

DSSaaS is a service offered through the deployment of Digital Signage (DS) system, a network of customisable displays that can be electronically administered and controlled using a computer. This allows content to be modified remotely, aiming to convey messages efficiently and in a well-targeted fashion.

Digital Signage architecture encompasses two main components:

- DS Central Server: a server where multimedia content is uploaded. In addition, it is capable of hosting an application frontend to schedule and set up playlists and monitor the network to ensure that everything works well (D2.1, pg. 44).
- DS Player: A player is usually composed by a PC and a screen (LCD TV, video wall, video projector, etc.) forming a system able of receiving real time events from different sources (camera, sensors, etc.) that can dynamically contribute to creating content in real time.

The DS central server collects data reports comprising of content that has been displayed in past broadcast sessions along with data harvested from human interaction with DS or installed sensors. Both types of data can be processed offline and online, producing customised content on demand and in real time respectively.

Existing connectivity and infrastructure, telecommunication companies and cloud providers possess, is a vital key to connectivity for a DS network with no location restrictions. Given the vast use and significance of digital signage in present days, the DSSaaS could prove an ideal opportunity of MCNSPs to utilise the cloud concept for their own benefit expanding their business to a new territory.

3.4.2 Stakeholders

End Customer: The receiver of the targeted and customised content.

MCNSP: It provides DSSaaS on demand offering the required infrastructure as well.

Content Creator: Any kind of small and big company capable of supplying the MCNSP with tailored made content.

MNO and MVNO: They provide with connectivity the End User.

3.4.3 Value Characteristics

Flexibility

The software enables the scheduling of different content to be displayed automatically at different times of the day and the week, as well as on different screens so that the message is rendered in a timely and relevant manner. If several persons are managing the system, different degrees of authority according to their role within the company could be assigned (i.e. full access granted to staff based at headquarters, while regional department employees have limited access). The cloudification of the Digital Signage Service Architecture would enable a DS provider to instantiate a Digital Signage infrastructure on-demand for each customer, attending his requirements, and he would only be charged for the real resources usage. In spite of the latter method to account real costs, the DS network set-up proves to be rather expensive given the current technological trends and market prices. In addition, DS services can be provided wherever needed through virtualisation of service's physical infrastructure. On occasions in which specific parameters ought to be taken into account the DS system is capable of offering the flexibility needed. A good example describes the provision of high definition quality through the placement of the DS datacentre close to the players to ensure a high bandwidth data pathway.

Remote control

The system is accessible at any moment from any location via an Internet connection taking full advantage of the cloud- based feature. The remote control functions are limited to accessing the browser, connecting to the portal and scheduling and modifying the content.

Scalability

Modern digital signage software can support full HD quality video and image as well as live news feed formats. It also allows the partitioning of screen enabling to display complementary information simultaneously (or in other words different type of files at the same time: a photo, a video and Twitter feeds) on a large scale operation along with making the screen content more appealing and informative.

Customised advertisement

With the help of Big Data Analytics, the customised ads shown on the screens match the interests of the target audience resulting in an incremental increase of the level of customer's attention. The data collection renders possible through a variety of mechanisms such as the deployment of sensors able to identify the gender of the target audience or interactive applications available on touch screens to extract raw data on demand. Moreover different customers have different requirements and desires. The ideal situation would be when the Digital Signage provider could provide each customer with an infrastructure that matches perfectly customer's demands. This challenge fits pretty well in the cloud computing paradigm.

3.4.4 Potential customers

Customers interested in DSSaaS include advertising agencies, event organisers, content providers or any type of enterprise who is involved in the industry related to wayfinding, placemaking, exhibitions, public installations, marketing and outdoor advertising.

3.4.5 Limitations

Infrastructure

As in many services, and Digital Signage (DS) (2008) is not an exception, flexibility is a key feature to curb a path of business innovation and improved services. DSS engulfs flexibility by automated broadcast processes and tailored configuration of the DS system. If a customer wants to have a Digital Signage service, he will have to confront the decision of building himself the infrastructure or contracting the DS Infrastructure as a Service. Obviously, the Digital Signage as a Service option is the most flexible solution and has no investment cost on building the infrastructure, buying the servers, providing the connectivity to the servers, etc.

Service architecture

Cloudifying the Digital Signage Service requires a modification of the service architecture to make it compliant with the cloud computing principles. The service components must be designed to scale horizontally and vertically, that is, the components must be prepared to interact with multiple instances of the same component. Thus all the protocols between the components must also be revised. Each service component must be as much decoupled as possible from the rest of the architecture. In addition, as many service component instances are going to be created, an orchestration layer must be added to the architecture to manage the creation and disposal of the service instances attending to the monitoring information or the customer direct interaction.

The re-designed Digital Signage Service will be part of an overall architecture where other services will be present. In order to enhance and enrich the Digital Signage Service, the architecture will have to be designed to interact with other services. These services could be supporting services like monitoring, rating, charging, billing, etc., or other complementary services like a Content Delivery Network as a technology that improves content delivery for the DS players or an EPC instance for providing the connectivity to the DS players and managing the network QoS.

Privacy Issues

Utilising customer information can bring privacy problems, which must be taken care of by evaluating what information can be used without issues, and what data is considered to be of personal information to consumers and cannot be gathered. One possibility is the application of anonymisation or aggregation mechanisms. These kinds of analytics modules will be only useful in large traffic areas, where an appropriate level of anonymisation is possible. Privacy issues are highly dependent on regional limitations and laws.

3.5 Support Services

3.5.1 Support services Authentication, Authorisation, Accounting as a Service (AAAaaS)

Authentication, authorization, and accounting (AAA) refers to the term of forming a framework to intelligently control the access to resources and providing the information necessary to charge services. Authentication aims to identifying a user by utilising a unique set of criteria for gaining access. Following authentication, a user must be granted authorisation to perform tasks and issue commands. Authorisation is the process of enforcing policies and determining what types or qualities of activities, resources, or services a user is permitted to access. Usually, authorisation occurs within the context of authentication. Once a user is authenticated, they may be authorised for different types of access or activity. The final part of the AAA framework is accounting, which measures the resources a user consumes during access. This can include the amount of system time or the amount of data a user has sent and/or received during a session. Accounting is rendered possible by logging of session statistics and usage information and is used for authorisation control, billing, trend analysis, resource utilisation, and capacity planning activities.

The AAAaaS signifies an opportunity for the MCN Service Provider to integrate AAA procedures for the many mobile service blocks composing the end-to-end MCN service. This means that the MCN Service Provider is able to opt to use the integrated AAA service whenever it is useful. The role of the AAAaaS is to allow the different MCN services and the different service providers to use a simple, flexible and on-demand AAA functionality. **[**MCN-D5.1**]** The value of this service lies in the fundamental functionalities it provides to each MCN component that requests it. Having one service saves setup and maintenance costs for user, account and rights management, by reducing complexity of this fundamental task.

Requires the following services MaaS [MCN-D5.1, pg. 156]
Required by the following services EPCaaS [MCN-D4.1]

3.5.2 Domain Name System as a Service (DNSaaS)

The Domain Name System (DNS) is an extensible, hierarchical distributed naming system for resources connected to the Internet or a private network. DNS is responsible for linking human readable and static host names, such as http://mobile-cloud-networking.eu, to a specific computation compatible IP address, such as 192.168.124.1, which might change, as networks or infrastructures evolve.

Providing DNS as a Service (DNSaaS) allows the creation of on-demand configurable DNS servers. DNSaaS is a supporting service that can be seen as part of the infrastructure (IaaS) as a whole. Even though service-specific requirements may exist, the interfaces provided by DNSaaS are generic enough to support all MCN-services through a unified application programming interface (API). In upcoming developments of the DNSaaS, a detailed analysis of the service's life cycle, as well as a thorough validation of the defined interfaces, will be performed, adjusting the service accordingly and supporting the prototype implementation phase [MCN-D3.1]. The value lies in a standardised domain name management system, which can be deployed quickly on demand. It is used for almost all IP based services and, thus, plays a fundamental role for all other components.

Requires the following services IaaS, CC/PaaS, AAAaaS, MaaS
Required by the following services EPCaaS (D4.1), IMSaaS, ICN/CDNaaS, DSSaaS [MCN-D5.1]

3.5.3 Service Level Agreement as a Service (SLAaaS)

The SLA denotes a formal negotiated agreement between two parties. It is based on a contract that exists between the Service Provider (SP) and the Service Customer (SC). It is designed to craft a common understanding about Quality of Service (QoS), priorities, responsibilities, etc. SLAs can cover many aspects of the relationship between the SC and the SP, such as performance of services, customer care, billing, service provisioning, etc.

Some metrics that SLAs may specify include:

- Percentage of the time that services will be available
- The number of users that can be served simultaneously

- The schedule for notification in advance of network changes that may affect users
- Dial-in access availability
- Usage statistics that will be provided.

SLA management is provided through a dedicated support service handled by an MCN Service Provider, in order to guarantee and validate the compliance of the service instances provided to its own customers with the agreements defined during the business negotiation of a given service. In this sense, it can be noted that the SLA management service is deployed by an MCN Service Provider to manage SLAs for multiple customers, and it is not instantiated with a per-tenant scope as for the other X-aaS services in MCN. However, for consistency with the other services, we use the SLAaaS name and acronym to indicate the overall SLA management performed by an MCN provider for the whole set of services delivered to its customers. The value of this service lies in establishing a standardized integrated management system for SLAs, which integrates SLA claims and control mechanisms (monitoring) into one quickly deployable system. Constraints and rules can be applied to the services directly.

Requires the following services: RCBaaS (D5.1), MaaS (D3.1)

3.5.4 Rating, Charging and Billing as a Service (RCBaaS)

The Rating, Charging and Billing (RCB) service supports the charging and billing process of both the end user and the service provider itself that operates the service. Accounting, charging, and billing are the most sensitive services in the telecom arena because they give to the operators a way to measure the usage and the efficiency of the services provided by their network.

RCB also refers to the set of processes and algorithms that takes as input the service consumption metrics, processes them, calculates the price to be charged to the user, and generates the bill or the invoice for payment. In the MCN project RCB is considered a support service provided as a Service (RCBaaS) with the aim of supporting the charging and billing process of end-to-end services in a common way, including all partners apart from customers. It allows charging both the end user (EU) and the enterprise end-user (EEU) or service operator itself that operates a service in a cloud, as a service. Since many MCN components are used for value creation towards an EU, all of these components need to be included in the billing process. The RCBaaS, therefore, does relate to many, if not all of the MCN services.

Requires the following services: MaaS [MCN-D3.1]

3.5.5 Monitoring as a Service (MaaS)

MaaS is a support service defined within the MCN framework that gathers the different monitoring information relevant for a specific MCN service and procures them to the single components (functional entities or other support services) of the end-to-end service.

The goal of the monitoring system is to extract different monitoring data out of several services of the MCN architecture and subsequently procure them A centralised monitoring instance creates advantages in management, maintenance and analysis processes of the data, as changes can be applied more quickly, which saves time and reduces costs.

Requires the following services: None
Required by the following services: SLAaaS, AaaS, RCBaaS

3.5.6 Mobility and Bandwidth Availability Prediction as a Service (MOBaaS)

MOBaaS is a MCN support service that generates prediction information to be used by any MCN service in order to generate triggers needed for self-adaptation procedures e.g. optimal run-time configuration, scale-up and scale-in of service instance components, or optimal network function placement.

MOBaaS (Mobility and Bandwidth Availability Prediction as a Service) is a MCN support service that assists in predicting information regarding (1) the movement of individual end-users (estimated location of an individual end-user in a future moment in time); (2) the traffic that these individual end users will be generating at a certain location in a future moment in time; (3) bandwidth available at a certain location in a future moment in time (D4.1).

Requires the following services: MaaS [MCN-D3.1], AaaS [MCN-D3.1]

3.5.7 Load Balancer as a Service (LBaaS)

Load balancing is done to distribute traffic between several servers. Mainly to get optimal service consumption rates but also to enable high availability. It also aims to optimise resource usage, maximize throughput, minimize response time, and avoid the overload of any one of the resources.

In MCN, LBaaS is needed to support MCN functions both for scaling purposes and for generic service availability. Nevertheless, load balancing is very specific to the service to be balanced as, e.g. not all sessions might be equally consuming compute resources and should be though distributed to the servers after considering the impacts. Possible application specific balancing logic might be eventually needed and its development will be taken into account on the need. A centralized support service for load balancing not only reduces maintenance cost but also allows for more complex optimization scenarios. It lifts the load balancing controls from particular individual components to entire networks and centralizes the efforts for load distribution.

Requires the following services: AAAaaS [MCN-D5.1]
Required by the following services: ICN/CDNaaS [MCN-D5.1], DSSaaS [MCN-5.1]

3.5.8 Database as a Service (DBaaS)

A database is a collection of information that is organized so that it can be easily accessed, managed, and updated. In one view, databases can be classified according to types of content: bibliographic, full-text, numeric, and images.

Database as a Service (DBaaS) is a service that is managed by a cloud operator (public or private) that supports applications, without the application team assuming responsibility for traditional database administration functions. The primary objective of the Database as a Service (DBaaS) is to provide storage of data objects using an on-demand, self-service model. It takes the operational burden of provisioning, management and maintenance, and scaling away from the users of the Database. DBaaS also supports traditional database service architectures in relation to elasticity, secure multi-tenancy, automated resource management, and integrated capacity planning.

Requires the following services: MaaS [MCN-D3.1]

3.5.9 Analytics as a Service (AaaS)

Analytics is part the field of data analysis and is often affiliated with probing past historical data to research potential trends, to analyse the outcome of certain decisions or events, or to evaluate the performance of a given tool or scenario. Analytics as a Service (AaaS) enables service consumers to leverage the power of measured data to improve the quality of the service they offer to individual end users. More specifically, service consumers are able of analysing the measured data to reach to taking appropriate actions to maintain the performance levels of their service. However, AaaS has been seen as a valuable addition to the project. This is mainly based on the number of use cases defined earlier. It has been stated that AaaS can support many tasks in the project to perform their objectives. Therefore, it will be enhanced in the next project phase. The potential for analytics processes is increased with a centralised analytics approach. Interrelation can reach from analytics needed for load balancing services, up to planning and prediction of needed resources, or even the generation of completely new insights into processes, trends, or even customers, which might prove to be valuable to entities outside of the MCN service architecture.

Requires the following services: MaaS [MCN-D3.1]

4 MCN Scenarios

4.1 Introduction

The scenarios, which we describe in the following, are mainly based on those scenarios that have been presented in D2.1 (Chapter 5). However, while the scenarios in this precedent deliverable had a rather technical focus due to the fact they were used to derive technical requirements the following scenario primarily focus on business aspects. Nevertheless there is still a correspondence:

- Scenario 5.1 (“Cloud-Enabled MVNO”), 5.2 (“Cloud-optimized MNO Operations”) and 5.5 (“End-to-End Mobile Cloud”) of D2.1 are mainly covered by the scenarios in Chapters 4.3 – 4.4 with emphasis on the core network functionality and its business value;
- Scenario 5.3 (“Machine-to-Machine / Machine-type Communication Mobile Cloud”) of D2.1 is pursued in Chapter 4.6
- Scenario 5.4 (“MCN-enabled Digital Signage”) is pursued in Chapter 4.7.

In addition, to these scenarios other scenarios have been derived to extend the spectrum of possible application of MCN technology.

Each scenario in this chapter has been initially conceived with the aid of the scenario ideation method, which has been explained in Chapter 2 and focuses on the successful identification and understanding of the value created by the new MCN technology. The initial idea is further developed adhering to a specific structure, culminating into each scenario to comprise of the following chapters: General Background, User Story, Specific Stakeholders to the Scenario, Value Creation and Flows, Challenges, and Conclusions. Subsequently, each chapter succeeds in providing the right pieces of information to formulate a spherical approach to the description of the respective MCN business scenario.

The General Background aims to provide a summary description of the scenario’s value proposition putting emphasis on the business side. The Stakeholders’ chapter, as the name suggests, encompasses the potential types of stakeholders found within the scenario.

The User Story outlines the business opportunity in a potential case that aids in the exemplification of the value creation, together with a mention to exemplary stakeholders from the perspective of the party who desires the new business capabilities.

The next part revolves around the specific value creation and flows that engulf the scenario. More importantly, the latter is deemed as a piece of core interest complemented with a value flow diagram for the reader to utterly comprehend how encapsulated value is captured.

The last two remaining chapters present the challenges that appear with the inauguration of each scenario and conclusions which offer an overall evaluation, suggestions, ideas and final comments on the scenario’s potential realisation. In each MCN scenario the respective services deployed are mentioned within the introduction part concluded by a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis from the angle of the MCNSP, found in the last part. The latter analysis is depicted through the prism of the MCNSP illustrating potential opportunities for the respective stakeholders of the scenario underlining the business potential.

4.2 EPC Scenarios

4.2.1 General background

In order to understand the present situation regarding the delivery of digital services, and how EPCaaS enhances this condition, the value flow of the current service delivery is explained and depicted in Figure 4. The Service Enabler delivers its service with the support of the MNO, who supplies with radio access the end user. The latter has to pay both parties independently in return. The main drawback of the afore-mentioned case lies in the fact that the Service Enabler has no control over the connectivity the MNO provides; hence the Service Enabler must abide to their standards regarding quality of service, speed of connection, security, etc.

With the EPC solution, the service enabler will be able to provide their services along with the connectivity through their own independent mobile network. The following three scenarios demonstrate this gain in value, yet they differ in terms of who offers the service and how it is delivered. To stress these differences, an initial business model for each scenario has been developed, as a method to differentiate further the scenarios and comprehend the advantages and disadvantages of each one, as the interactions between stakeholders are complex in those cases.

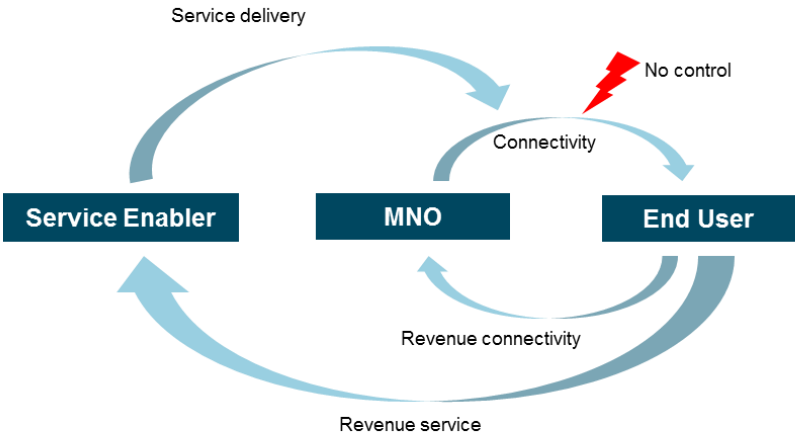


Figure 4. Value Flow of the current EPC

Type of MCN service(s) deployed for these scenarios:

RANaaS
EPCaaS

All support service(s) are deployed for these scenarios.

4.3 Core Network Infrastructure on Premise

4.3.1 User story

An ERP company has developed a new application for mobile devices that allows their customers to monitor all industry parameters in real time as similar type of information is susceptible to change every second prompting an MNO not to be able to provide the required QoS. Unfortunately, the ERP Company does not possess the virtualised mobile network infrastructure required to run the application; hence is not able to provide the QoS to their customers in real time. In order to resolve this issue, an EPC software license is purchased from an MCN software provider to deploy their own mobile network. Additionally, this solution enables the ERP Company to control connectivity conditions and monitor the state of the communications of their clients countrywide. Due to the fact that the ERP Company possesses the infrastructure to run the software on their premises, additional efforts in this regard are not needed. The ERP Company possesses the infrastructure for a private cloud to run the software on their premises. In addition to EPC's customisable feature, the MCN Software Provider can also offer a special version of the program to the ERP Company to enhance the value of the mobile network. To further support their clients, the same MCNSP or a new one that offers RAN services has to be commissioned in order to establish the connection between the end user and the ERP Company. This grants the end users with access to the application wherever is needed.

4.3.2 Value flows

The value flow for the Core Network Infrastructure on Premise scenario is depicted in

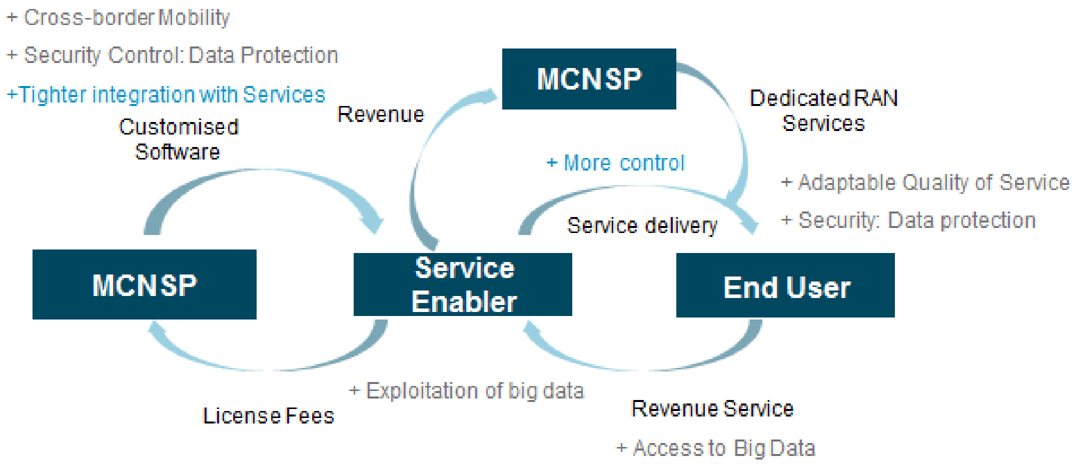


Figure 5. Value Flow of the Core Network Infrastructure on Premise Scenario

. The Service Enabler provides their services to the end user without the intervention of the MNO. The offer of connectivity rendered by the MNO is replaced with the assistance of two new roles. For the connectivity the Service Enabler acquires the software from the MCNSP that offers EPCaaS and pays license fees in return. The second MCNSP role offers the radio access services to enable mobility.

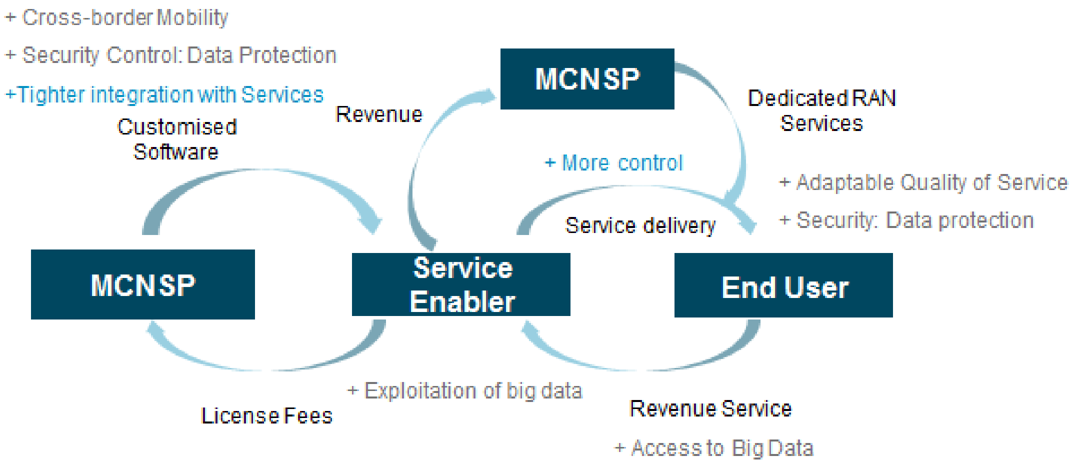


Figure 5. Value Flow of the Core Network Infrastructure on Premise Scenario

4.3.3 Business model

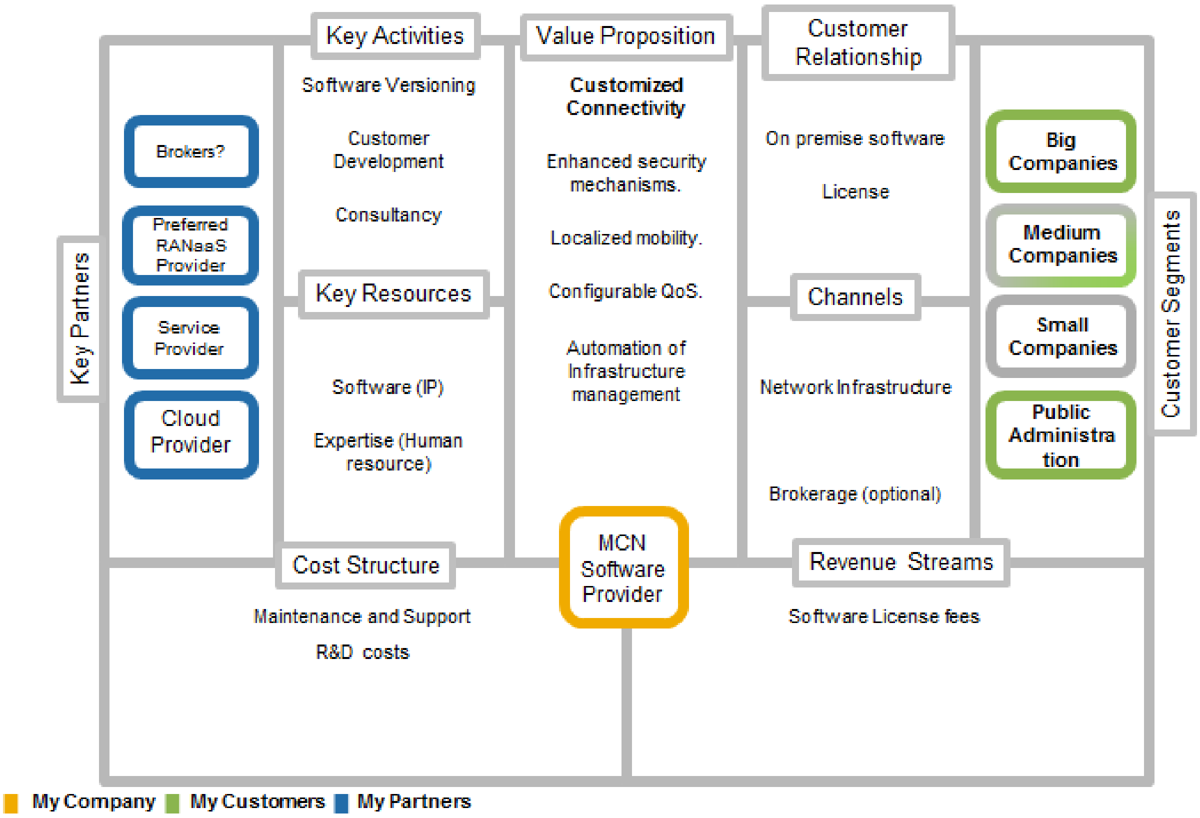


Figure 6. Business Model of the MCN Software Provider

The main idea behind this business model consists of selling EPC services through licensing instead of using cloud-based services from an EPC Service Provider. Thus, the software is offered on premise and not in the cloud. In that case, there is no need for a particular EPC Service Provider, as the MCN Software Provider is the one who procures the product in this case. One of the advantages for the customer in this scenario is the direct relationship formed with the MCN Software Provider. In case particular extensions of the EPC service are required, the MCN Software Provider can develop a specific version of the software tailored up to the needs of the potential customer. In order to conduct these activities, the MCN Software Provider ought to demonstrate sufficient expertise and pose a well-trained human resource. Additionally, to prevent similar solutions to conquer this new market, the MCN Software Provider must secure their intellectual property rights.

The MCN software provider must have a partner pool to effectively deliver their service and provide support on a global scale. As previously discussed, a network infrastructure is needed to deliver the EPC service. Therefore, the RAN service complements the EPC offer with the network infrastructure.

Financially, the majority of revenue streams derives exclusively from the fees attached to the license, training and support. As the customer would have at its disposal the software along with a high customisability of it, the license might be too expensive and the costs for operating the software too high, especially for small and medium companies. In return, the MCN Software Provider must pay for the maintenance of the software and the support infrastructure. They also have to invest in R&D for future updates.

In the case that different MCN Software Providers exist in the market, a broker can be useful for the customer to select which one adapts best to their needs.

4.3.4 Conclusions

In the Core Network Infrastructure on Premise scenario, the MCN Software Provider focuses on client relationship management in order to familiarise with the user requirements regarding the software and provide a tight integration with the services the client already offers. This line of action offers complete control over quality and security, and complete access to the collected data, which might be useful for future Big Data solutions. Cons for this scenario include high costs burdening the customer due to the service support and integration of external RAN services.

Core Network Infrastructure on Premise

Strengths

- Tight integration with own services
- Complete control over quality and security
- Complete access to data collected

Weaknesses

- Operational and maitenance costs run on the customer side.
- RAN services are additionally needed for wireless connectivity.

Opportunities

- Growth of data consumption.
- Big Data Analytics exploitation.

Threats

- Competition with other scenarios (EPC and MCN Service provider).

Table 1. SWOT Analysis for the Core Network Infrastructure on Premise Scenario from the angle of the MCNSP

4.4 Core Network Infrastructure on demand

4.4.1 User story

A market research company is seeking on frequent basis to deliver a report that encapsulates the performance of the market in the last month, as well as its correspondent analysis and implications to their clients in a secure and timely manner. The company has already developed a mobile application which displays these results on the go. However, they failed to tackle the connectivity issues the client might experience, a situation that has caused a great deal of misunderstanding in the past. In order to solve this problem, an EPC on demand through an MCSNP Provider was rented, in order to possess a private mobile network. It deemed to be the best suitable solution since the market research company does not possess a large enough infrastructure to operate the software. The MCN service provider can also design the Core Network according to the needs of the market researcher.

To further support its clients, a MCN service provider that offers RAN services was contracted, permitting the end user to have access to the application wherever needed.

4.4.2 Value flows

In the Core Network Infrastructure on Demand scenario, the value flows change in a way that the EPC is not provided as a software to the service enabler, but as a service. The MCN service provider maintains the same responsibilities for this scenario by offering RAN services.

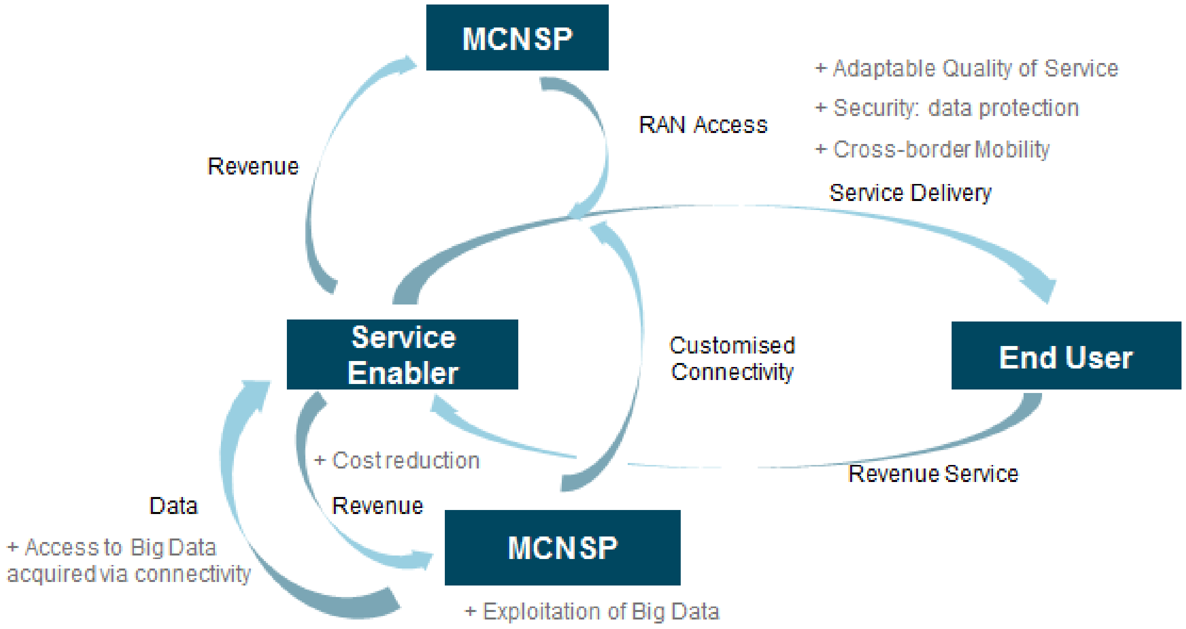


Figure 7. Value Flows of the Core Network Infrastructure on Demand Scenario

4.4.3 Business model

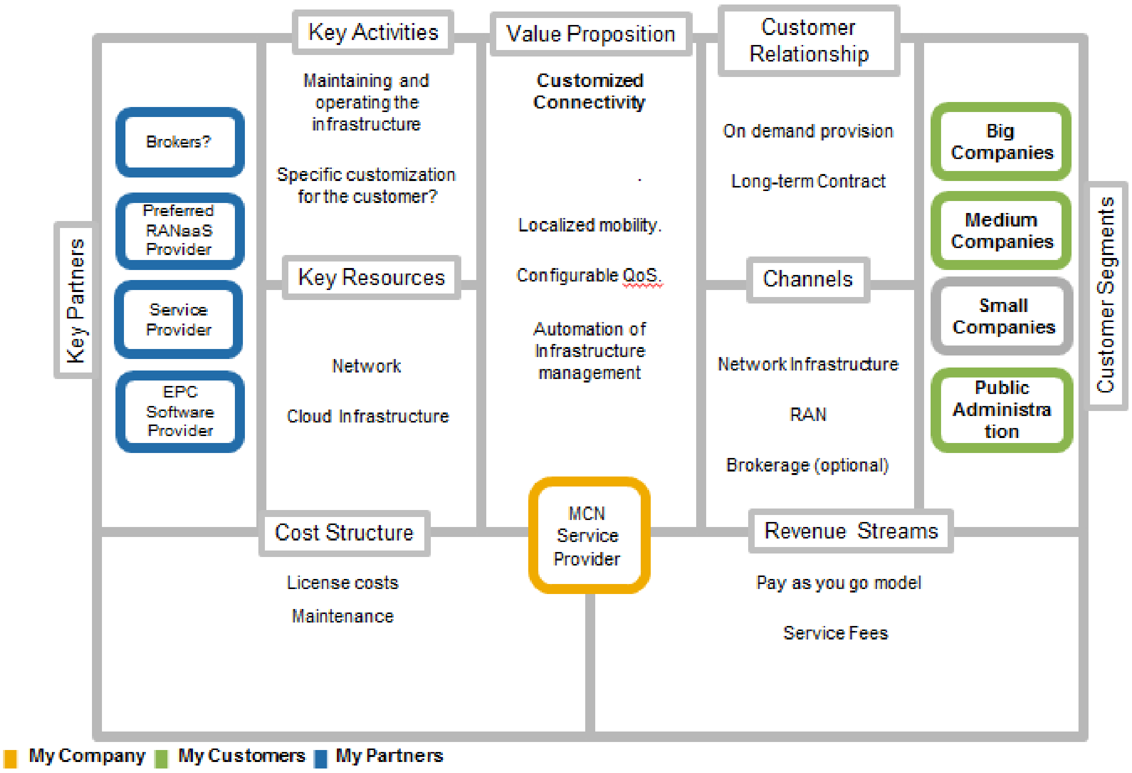


Figure 8. Business Model of the MCN Service Provider

The value proposition is very similar to the one in the previous scenario, but in this occasion, the service is supplied through the cloud. The advantage of this solution for the customer consists of eliminating costly infrastructure in their premises and run them on the cloud instead. This transforms the customer relationship into an on demand provision of the service instead of a license, and it has to be subjected to a long term contract to guarantee a steady income. The channels remain the same for this option, as the network infrastructure is still necessary. The maintenance of the cloud infrastructure becomes a key responsibility for the owner, to guarantee the service at all times.

The MCN Service Providers ought to own the software in order to provide it to the customers and for that reason, the EPC Software Provider becomes a key partner responsible for software licensing. The MCN Provider is still essential to supply the mobile network with RAN services in this scenario.

The financial blocks have been reshaped for this scenario, as the revenue streams source from the customers through a pay as you go model and service fees. It is expected that in this business model, the customers would not pay as much as in the previous scenario. However, it is speculated that it might be unaffordable for small customers. As for the costs, the license must be paid to the software provider, and the maintenance of the infrastructure must be taken care of as well.

The brokerage option remains the same for this scenario.

4.4.4 Conclusions

The Core Network Infrastructure on Demand scenario includes the management of the EPC Service, as the customer pays for the service with the provision that the provider will cover all operational and maintenance costs of the cloud infrastructure. Nevertheless, this scenario does not grant a tight integration with the services of the client. RAN services cannot be offered as part of this solution due to their high cost of merging with an EPC.

Core Network Infrastructure on Demand

Strengths • Operational and Maintenance costs run on the provider. • Cloud infrastructrure available and paid as needed.	**Weaknesses** • Integration with own services limited. • No access to data. • RAN services are additionally needed for wireless connectivity.
Opportunities • Growth of data consumption.	**Threats** • Competition with other scenarios (EPC Software Provider and MCN service provider).

Table 2. SWOT Analysis for the Core Network Infrastructure on Demand scenario from the angle of the MCNSP

4.5 MCN Service Provider for Business Customers

4.5.1 User story

A manufacturing company has completely automated their factory in order to mitigate the production costs. An application has been created to manipulate the machines remotely, so that the employees are no longer needed on site with the only exception of maintenance routine operations. To utilise this application, connectivity is essential between the headquarters and the factory located several miles away from their headquarters.

Signing a contract with an operator is not suitable since control over the communication process is necessary together with ability to edit certain parameters of it. Thus, it was decided to contact an MCN Service Provider (MCNSP) to offer a complete end-to-end connectivity to the company. It deemed to be the best suitable solution since only one partner was able to provide with complete connectivity.

The EPC is designed to focus exclusive on the cells (antennas) where the factory and the headquarters are, enduring QoS along the way. In this manner, the solution meets the needs of the manufacturing company.

4.5.2 Value flow

With EPCaaS, as part of an MCNSP mentioned in the user story, the Service Enabler offers the service directly to the end user without the MNO acting as an intermediary third party. The MCNSP provides connectivity as the enabler of the service, and the End User pays directly the Service Enabler; the new value flow is depicted in

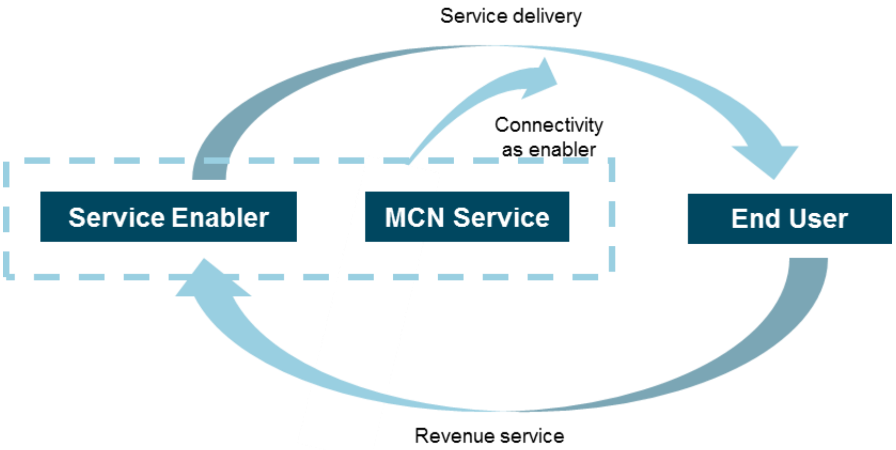


Figure 9.

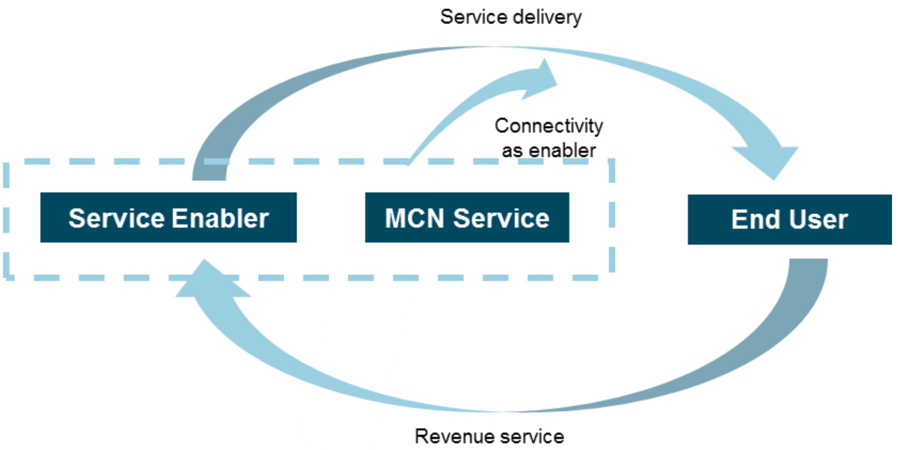


Figure 9. Value Flows of the MCN Service Provider for Business Customers Scenario

4.5.3 Business model

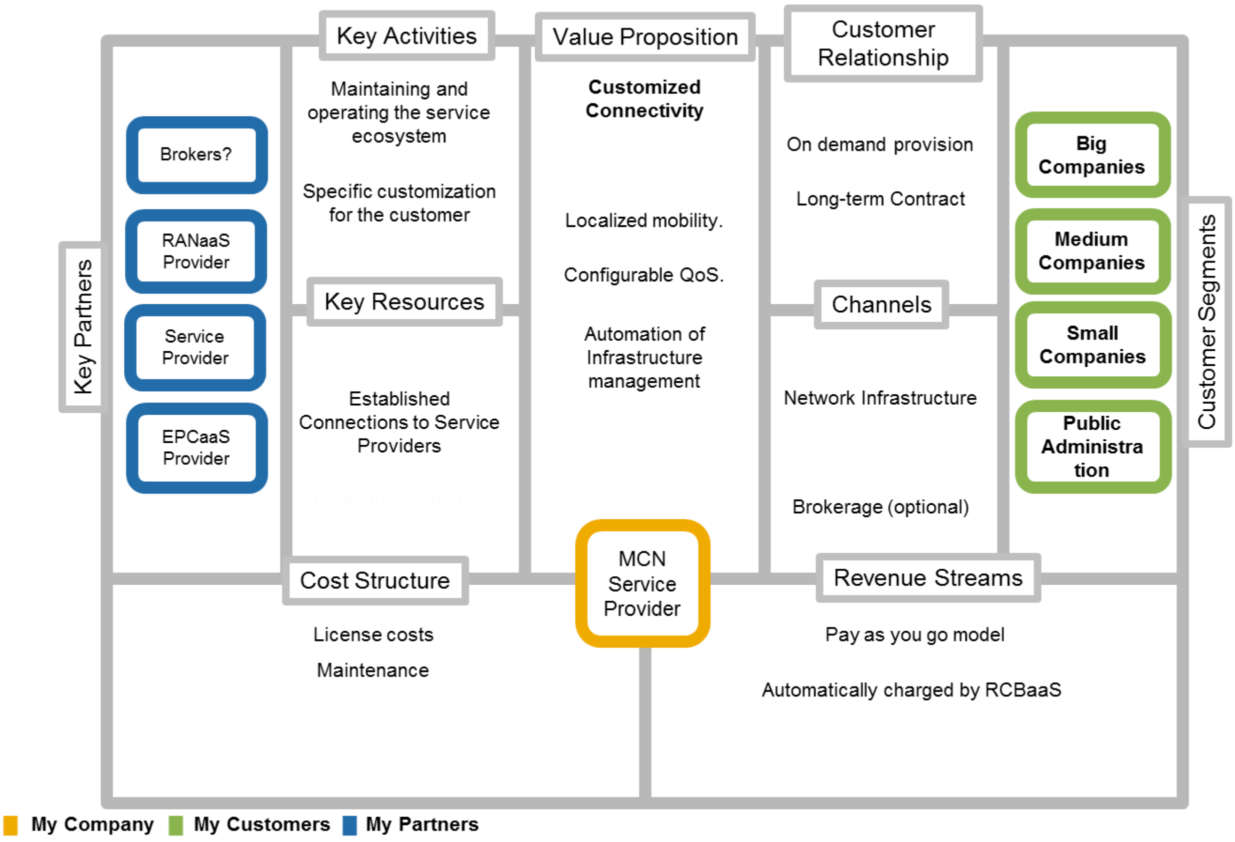
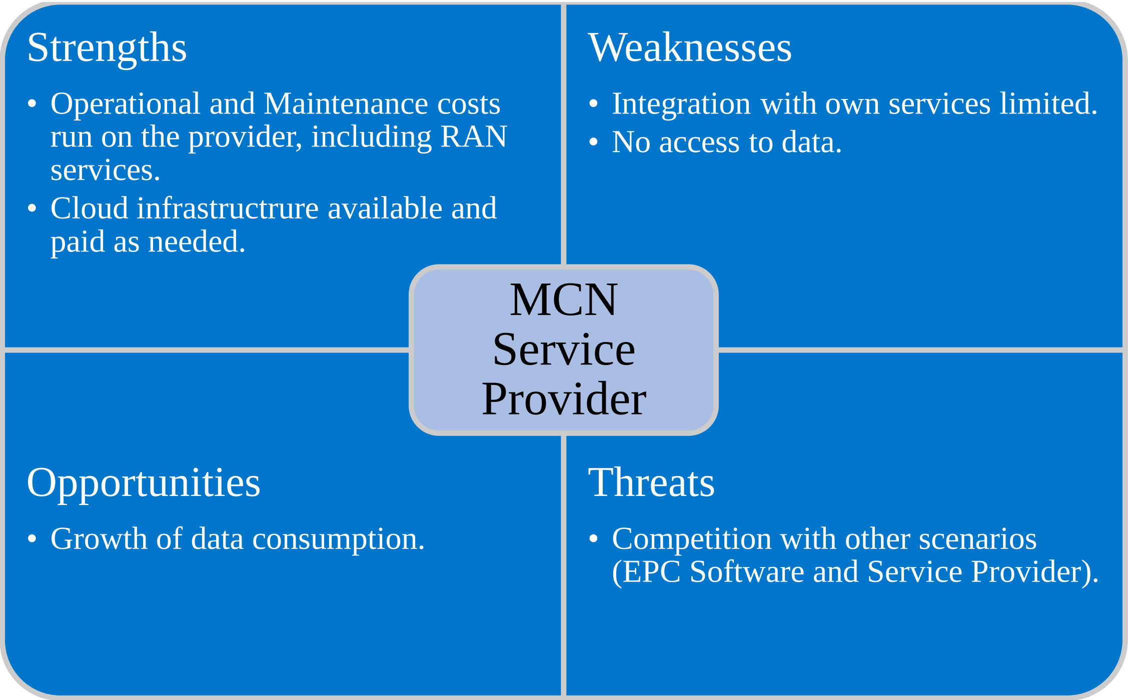


Figure 10. Business Model of the MCNSP

The MCN Service Provider plays a very important role to the MCN Project, due to its capability of administrating all the services within the project. The business model created for the MCNSP is similar to the one created for the MCN Service Provider offering EPCaaS, though in this case, it acts as the median link between the specific providers and the customers. The right side of the business model maintains the same structure found in the previous scenario. However, the left side has undergone moderate changes. The MCNSP has established connections with service providers, forming an ecosystem comprised of RAN and the EPC providers. The customer is given the option to acquire a full mobile service due to the ability of the MCNSP to procure both the core and the radio access in a single offer.

4.5.4 Conclusions

The scenario takes advantage of both RANaaS and EPCaaS technologies to offer an appealing solution for business customers. Pros of the scenario comprise the coverage of all operations and maintenance costs of core and radio access technologies, thus the customer ought to pay for those services only when used. Nonetheless, the integration of the solution is partial as a result the opportunity to collect data of Big Data for the purpose of further analysis is annulled.



Strengths

- Operational and Maintenance costs run on the provider, including RAN services.
- Cloud infrastructrue available and paid as needed.

Weaknesses

- Integration with own services limited.
- No access to data.

MCN Service Provider

Opportunities

- Growth of data consumption.

Threats

- Competition with other scenarios (EPC Software and Service Provider).

Table 3. SWOT Analysis for the MCN Service Provider for Business Customers scenario from the angle of the MCNSP

4.6 M2M Utility Scenarios

4.6.1 General background

This set of scenarios entails the deployment of a RANaaS by an MCNSP to enable the transmission of quantitative and qualitative measurement data from smart meters or other devices to data centres by exploiting the M2M technology (D2.3, pg. 42). This includes an antenna or group of antennas covering a particular area (towns or cities mostly) connected to a number of smart devices that gather information regarding the utility consumption in behalf of the utility provider.

Type of MCN service(s) deployed for this scenario:

RANaaS
EPCaaS

All Support service(s) are deployed for this scenario.

4.6.2 User story

Scenario I: RANaaS in a M2M scenario, gathering information regarding the consumption of water/gas/electricity in households

An antenna or group of antennas is placed in a particular area of a city where a cluster of small devices that gather certain data is connected to them. The transmission would transpire within a small time frame, e.g. once a week, or once a month (or in a convenient periodicity for the utility provider), being suitable to take advantage of the cloud concept meant for RANaaS. These small amounts of data do not require bandwidth in abundance for transmission to base station.

The information is collected through the use of the radio access offered by the MCN Service Provider transmitting the signal from the domestic device to the antenna. The pieces of information will be transmitted to a central base station that has embedded a processor to assist with the aggregation of data in an appropriate manner. Since the form and route of the data is pre-defined (ideally in the range of a single cell) an EPC may not be required for the service. Transmissions only ensue from one place, within the cell tower range, to another central receiving station.

Scenario II: RANaaS in a M2M scenario, controlling household devices from a datacentre

This scenario is an extension of the previous incorporating the idea of meter reading on a more frequent basis, with the intention of analysing the information data and taking further action case values are offset, or utility sources are aimlessly wasted resulting in cost saving. In the past, most of the analysis was conducted collectively through manual selection of data found solely on domestic ground. A fair example of that includes energy saving through a heating device that can be turned off in case the house remains unoccupied. The signal of presence is forwarded to the central station using the RAN service, and the datacentre subsequently processes this signal and sends it back deactivating the utility device. When presence is read again, the processor indicates the heater to turn itself on again. The same can apply for electricity and water consumption. The system has to be competitive in comparison to a local control for the case to be viable. The latter is rendered possible via the route of deploying only one processor to regulate the households found in a region, instead of utilising a single small processor per estate. The previously described service is quite similar to a cloud provider one with the difference of utilising mobile infrastructure in addition.

4.6.3 Specific stakeholders of the scenario

There is a mixture of stakeholders that involve RANaaS and EPCaaS Providers, MCN Service Providers and MNOs on side, and Utility companies, domestic households and analytics enterprises on the other.

The MCN Service Provider relies on RANaaS and EPCaaS Providers to be able to create such a specific offering. Both of the latter need an overarching MCN Service Provider, which orchestrates and combines the necessary functions of this service, as a customer. The value of the entire service stems from the business between domestic households and utility suppliers, as the latter strive to ease and automate their processes, and the former can benefit from a simplified product.

4.6.4 Value creation and flows

The specific value of the service provides dedicated RAN connectivity to smart meters and enables the collection of information from a covered region (e.g., about consumption) in a remote operation. In addition, the central collection of data opens up opportunities for aggregating mass data into relevant pieces of information of utilities consumption on a greater scale (Analytics, Big Data), which would provide supplementary value. Utility providers are the main potential customers with MNOs and Analytics companies to follow as potential partners to this conjoint. The data collection uses the radio access supplied by the RAN Provider (functioning on higher transmission range when compared to other technologies such as Wi-Fi, Zigbee, or proprietary standards). The data are transmitted from the domestic device to the RAN that forwards the information to a central base station; this base station is most likely to be located in the same cell, or at least close to a RAN cell. It is operated by the utility provider and connected to a processor that gathers information in an efficient manner. Due to the form of data (IP packets) an EPC is required for this service.

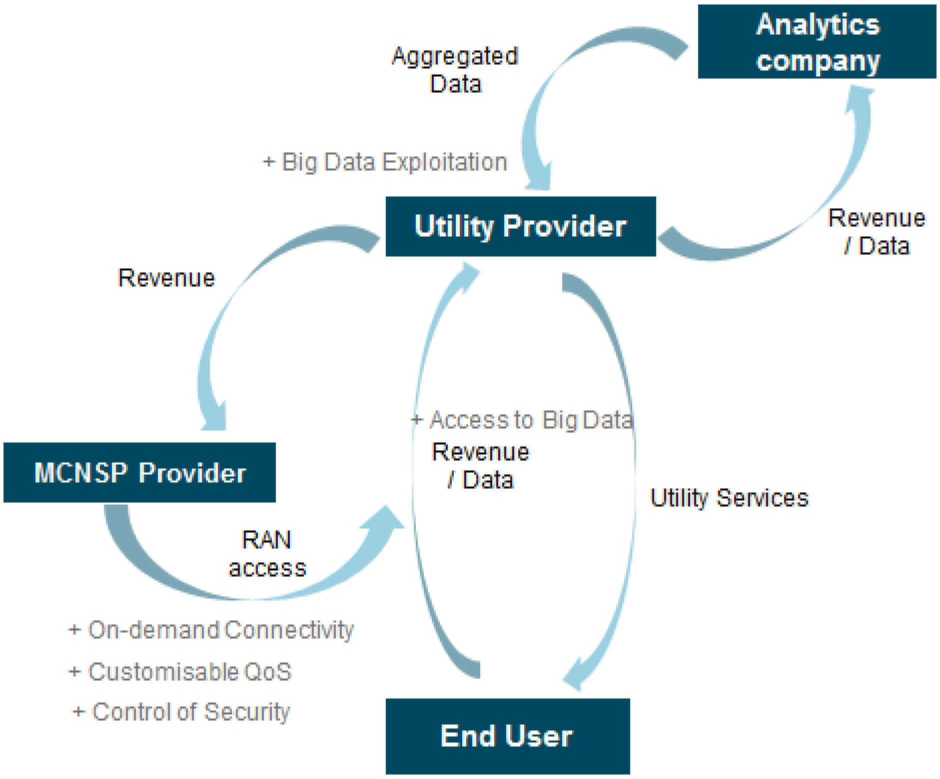


Figure 11. Value Flow for the M2M Utility Scenarios

4.6.5 Challenges

Current barriers of the described scenarios include the imperative presence of LTE systems that require connection to core network prompting the need of EPC. The latter poses very crucial as otherwise the implementation of modifications to the current 3GPP standards to provide specific autonomous functions to the base station would be unavoidable. Another hurdle to overcome is the cost as the solution has to be competitive enough for the utility providers in order to adapt to the new method. Many smart meter scenarios rely on short range transmission standards, limiting the data collection through a mobile receiver station (a car driving around). If the cost of the previously mentioned receiving process could be contracted then this set of scenarios could theoretically considered as a high potential case for extended application of M2M technology.

4.6.6 Conclusions

In both scenarios, the solution has to be a competitive one in terms of price for utility providers to adopt the new method. Decreasing the costs through deployment of long range transmission infrastructure is one part of the solution, while the second part lies in the efficient extraction of data to be procured to enterprises active in the field of analytics. Nonetheless, M2M scenarios are capable of embracing a plethora of other devices whose data could be harnessed for the purpose being further analysed encapsulating value capture. Seemingly similar scenarios could be the main focus of the "Internet of Thing" era as every device could be remotely controlled a fact which results in the creation of a market of exquisitely high interest for any MCNSP. The required connection to EPC could be an advantageous trait for the MCN providers instead of being a mere weakness as they already possess established EPC networks. Conclusively, the M2M scenario is characterised predominantly by strengths and opportunities as weakness and threats could turn in favour for the MCNSP.

M2M Scenarios

Strengths	Weaknesses
• Cost saving method offered to any kind of utility company	• Connection to EPC is required by current standards.
Opportunities	**Threats**
• MCNSP to collect data providing market with Analytics and Big Data	• MNOs and VMNOs might offer similar services • Existing data gathering technologies rendered possible via the route of sensor devices operating in low range networks.

Table 4. SWOT analysis for the M2M Scenarios from the angle of the MCNSP

4.7 Broadcast Mobility Advertisement Solution

4.7.1 General background

The following scenario sets Digital Signage Systems (DSS) into motion to serve the needs of institutions which seek to promote their products or services through a customised and flexible solution. The DSS consists of a single or a set of electronic displays that form a network of displays managed by a central server (D2.3). The key parts of DSS are on the one side the content and on the other the technology that supports the entire service. Both are provided as a service on demand within the DSSaaS concept.

The value proposition of this scenario focuses on offering DSSaaS to business customers for the sole purpose of providing commercial advertisement services through a suite of mobile connectivity with portable devices found in various premises such as: public spaces, transportation hubs, museums, stadiums, retail stores, hotels, restaurants and corporate buildings. The service can also be enhanced by an analytic tool that processes extracted raw data selectively collected from sensors installed in the vicinity of DS displays. The aggregated information is classified based on characteristics such as age or gender of the specimen audience. Consequently, the processed data result in the creation of well-targeted commercial spots or advertisements tailored up to the preferences of the target audience or targeted location.

MCN Services deployed for this scenario:

DSSaaS

All Support service(s) are deployed for this scenario

4.7.2 User story

Phi-Zeta Sports is a company that manufactures sports equipment for young people and seeks to expand its business market into a country where it had never been present before. The financial and marketing analysts of the company believe that the key element to establish their business and fully exploit any given opportunities lies within their marketing strategy. Thus, they solicit the consultation of a technology partner who advises them among other propositions to turn to Digital Signage as a proven method to advertise their products to general public effectively and efficiently. A DSS provider enters an agreement with the sports company to offer a customisable advertisement solution aligned with the company's strategic targets. In return the DSS provider outsources its services to portable canteen owners found within the urban setting of a megalopolis such as New York City. More specifically, food carts are mounted with an LCD screen comprised of an embedded mobile device that is connected to servers of the DSS provider to display in real time on-screen commercial advertisement.

4.7.3 Specific stakeholders of the scenario

Potential customers entail any kind of business companies ranging from small to big as well as RAN, EPC, Cloud and Service Providers. Rest of stakeholders include the receivers of the advertised message, described as Target Audience in the value flow chart below, while End Users entail all kind of companies that offer mobile mediums through which DSSaaS can be offered.

The main DSSaaS offering in an MCN Scope would come from a specific MCN Service Provider for DSS services. Each necessary component, in form of a service provider, in creating this service (RANaaS, EPCaaS, DSSaaS, possibly IMSaaS) might have an interest in this business, as it provides means to sell mobile capacities and resources (RAN, EPC, IMS), as well as specific capabilities (DSS) for this particular offering. End customers, such as advertising agencies and target audiences benefit from more efficient advertising efforts.

4.7.4 Value creation and flows

The values of this scenario derive from the combination of the features of content customisation and broadcast mobility. More specifically, the DSS can be mounted and installed on any type of mobile medium or vehicle emanating customised advertising content tailored according to various factors such as location and target audience group found within the range of the broadcast. The mobility trait encapsulates flexibility and eventually magnifies the broadcast scope leveraging the value capture that pre-existed but could not be exploited before.

The following

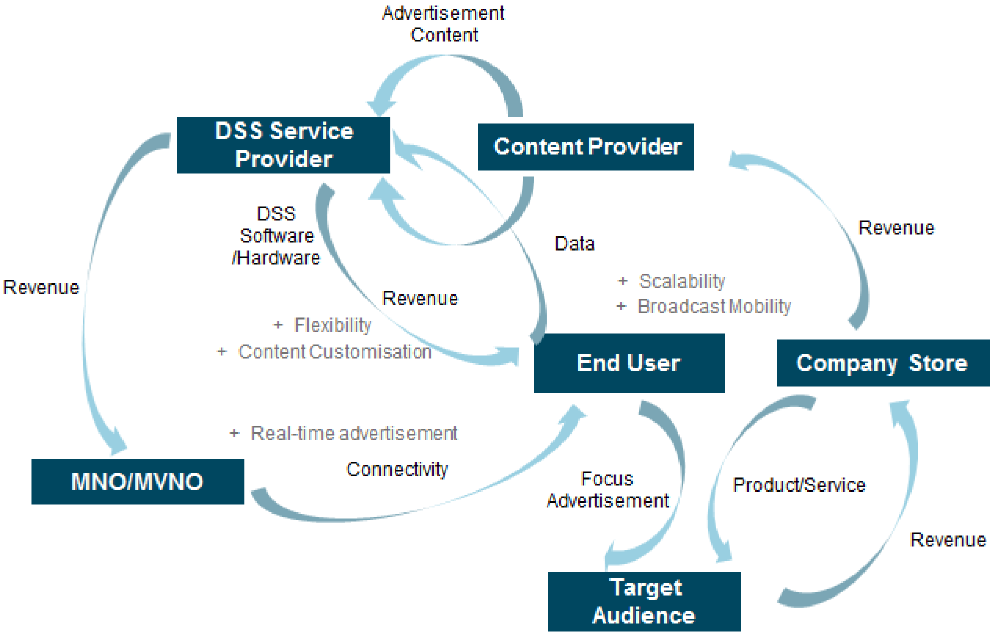


Figure 12 depicts the relationships among the aforementioned stakeholders. The content provider along with the company store could be any kind of size Business Company falling into a spectrum ranging from small to large enterprises. The content provider acts in behalf of the company store creating promotion material that would be later used to lure the target audience in purchasing the final service or product. The role of the DSS Service Provider is a very distinctive and central one as it ensures the procurement of services together with software and hardware to the end user. The latter one enacts as the medium of the advertising campaign as described in the user story above. In particular the food-cart seller could be any company that has an armada of vehicles or mobile stations (ice cream van, ticket sales, raffle, information services truck, taxis etc.) in their ranks to offer services or purchasing of goods.

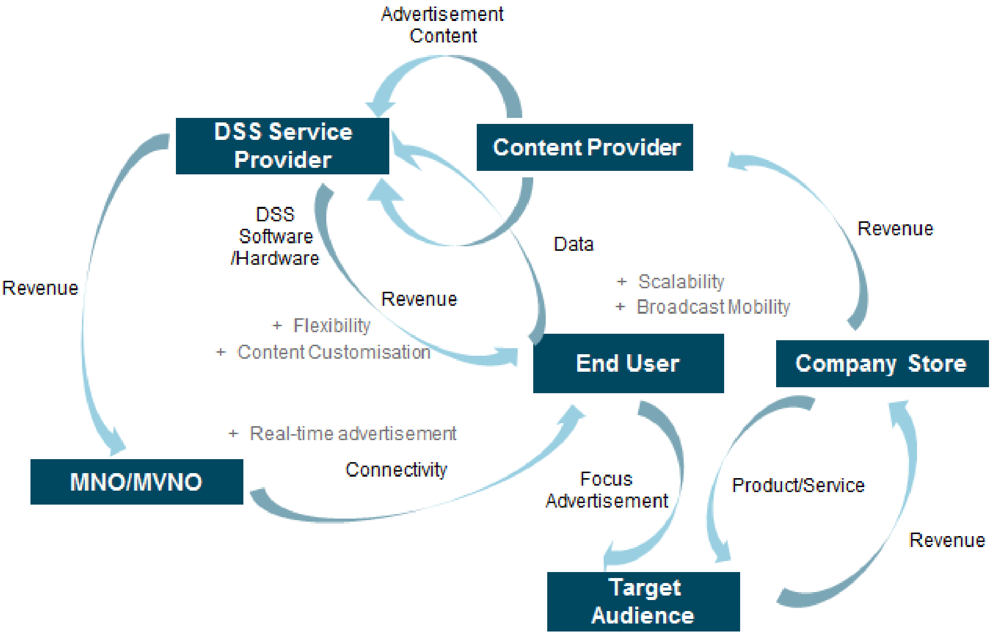


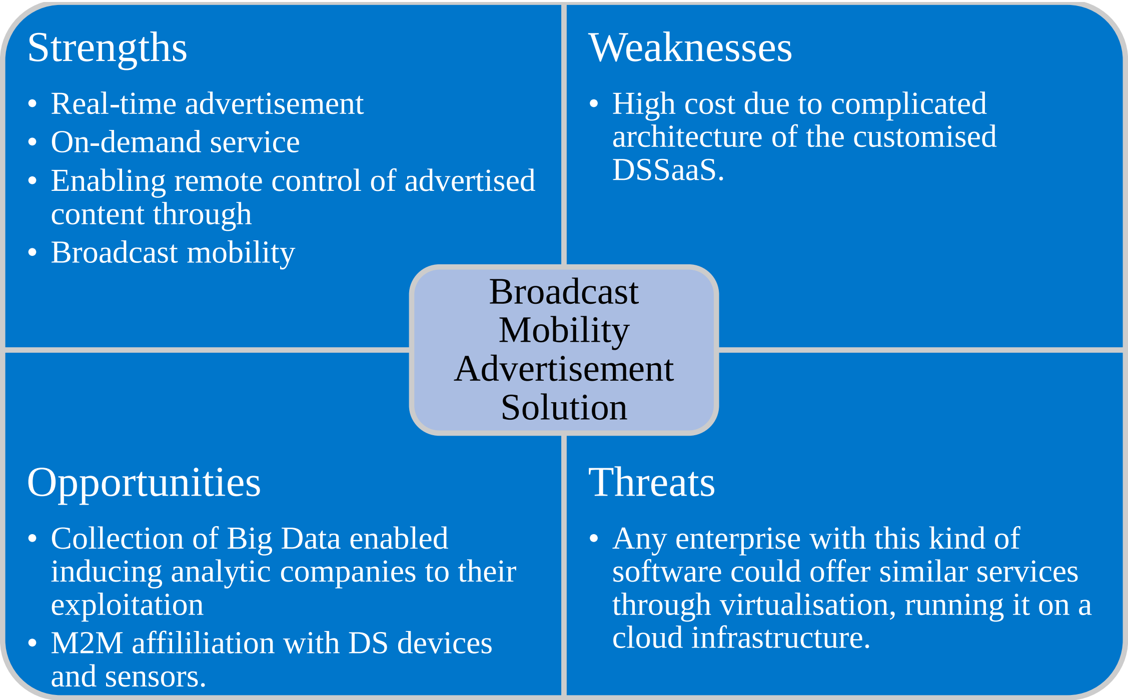
Figure 12. Value Flow for the Broadcast Mobility Advertisement Solution Scenario

4.7.5 Challenges

MNOs/MVNOs are new to this business scenario, thus they have to overcome the hurdles breaking paradigms in order to embrace new business solutions.

4.7.6 Conclusions

Ultimately, DSS could play a significant role in reintroducing business innovation into the MCN scheme as they offer a new set of novel business scenarios that bring together a variety of different stakeholders. The Mobile Broadcast Advertisement Solution is one of them, inaugurating a new set of exclusive to the scenario values. The strengths, as part of the SWOT analysis depicted below, engulf values such as real-time and on-demand advertisement with the option of enabling a remote control mechanism of the media content. Broadcast mobility is the main principle feature that unleashes the uncaptured value found hidden within previously unreachable target audience benefitting both advertisement companies and mobile networking industry by taking full advantage of the connectivity prerequisite to devise advertisement services. Generic values encompass enhanced DSS solutions which address the existing demand for personalised or well-targeted advertisement and place the knowledge that exists from virtual targeted advertisement services back into a real world setting. Conclusively, DSSaaS offers a plethora of business opportunities, such as the introduction of an analytics tool resulting in the possible creation of future multisided business models with the horizon of involving even more stakeholders into a win-win situation.



Strengths

- Real-time advertisement
- On-demand service
- Enabling remote control of advertised content through
- Broadcast mobility

Weaknesses

- High cost due to complicated architecture of the customised DSSaaS.

Broadcast Mobility Advertisement Solution

Opportunities

- Collection of Big Data enabled inducing analytic companies to their exploitation
- M2M affililiation with DS devices and sensors.

Threats

- Any enterprise with this kind of software could offer similar services through virtualisation, running it on a cloud infrastructure.

Table 5. SWOT analysis for the Mobile Broadcast Advertisement Solution scenario from the angle of the DSSaaS provider

4.8 Emergency Communication Scenario

4.8.1 General background

The current scenario describes the embodiment of integrating RANaaS to communication systems of emergency services. The scenario succeeds in providing an emergency communication service, in case an imminent natural disaster strikes a region or town, through the utilisation of a RAN of single cells or a combination of them in conjunction with EPCaaS. The scenario also incorporates a speculation on theoretical level when the connection to the EPC is out of service.

Type of MCN service(s) deployed for this scenario:

RANaaS
EPCaaS

Support service(s) not deployed for this scenario:

AaaS

4.8.2 User story

The following example aims to elucidate the situation of a hypothetic adverse event in which RANaaS could be implemented to enhance the communication system of emergency services offering increased reliability during transmission. A natural calamity lashes a city, some of the buildings become heavily damaged and fireguard, police and hospitals must communicate with each other to ensure the safety of civilians. The cell towers are assumingly damaged and disconnected from the core network due to the disaster; however with the deployment of a dedicated RAN, a stable connection could be established so that the urgent situation can be handled in an efficient way.

4.8.3 Specific stakeholders of the scenario

Stakeholders of the afore-mentioned scenario include local governments, small or medium companies acting as brokers, emergency services, ICT vendors, and, of course, the RANaaS providers or MNOs in charge of the RAN infrastructure.

Stemming from the MCN Scope the MCN Service provider is seeking to combine RANaaS and possibly other needed services to create the afore-mentioned emergency service. ICT vendors/standardization members need to take part in creating the technological framework and specifics of such a service, and the emergency services benefit from another more reliable or even extended communication channel in emergency cases.

4.8.4 Value creation and flows

The value of the Emergency Communication Scenario is based on three main pillars: reliability, resilience and high priority.

Reliability is ensured through the inauguration of a novel RANaaS to demonstrate a back-up option to the current established RAN. In times during the disastrous occurrence when the increased capacity of information generated cannot be handled in efficient manner, the new RANaaS is capable of facilitating the extra communication load.

The second pillar of the scenario is devised through the introduction of a high quality customised type of infrastructure that is able to withstand various weather conditions mitigating the risk of a communication system failure.

Emergency services have to quickly respond to address specific disaster events calling for higher priority. Communication in those situations can become rapidly complex as many different units have to exchange pieces of information. RANaaS is able to provide this type of communication within the range of a certain cell or several cells. The MCN Service provider could operate as an emergency communication channel, which would allow emergency respond services to engage in swapping information. In addition to particular voice services, as provided by CB radio, data services could be offered as well and delivered in a priority mode. Direct communication, throughout the reach of a cell is ought to be ensured by standardised protocols and mechanisms.

On the assumption that no EPC is involved, authorisation mechanisms need to be implemented. In locations where a natural disaster occurs, this type of contribution could provide connectivity, even when a cell tower gets disconnected from the EPC. The RANaaS could be switched into some kind of autonomous mode, where connections within the cell tower range would be allowed for emergency services. The value added of this service in comparison to current emergency calls or CB Radio, is identified in the dedicated access with privilege, such as higher priority.

The value flows form a rather complex network of relationships revolving around the emergency services with brokers being the third party responsible for facilitating the transaction bargain between the MCN Service Providers and the responsible Government department.

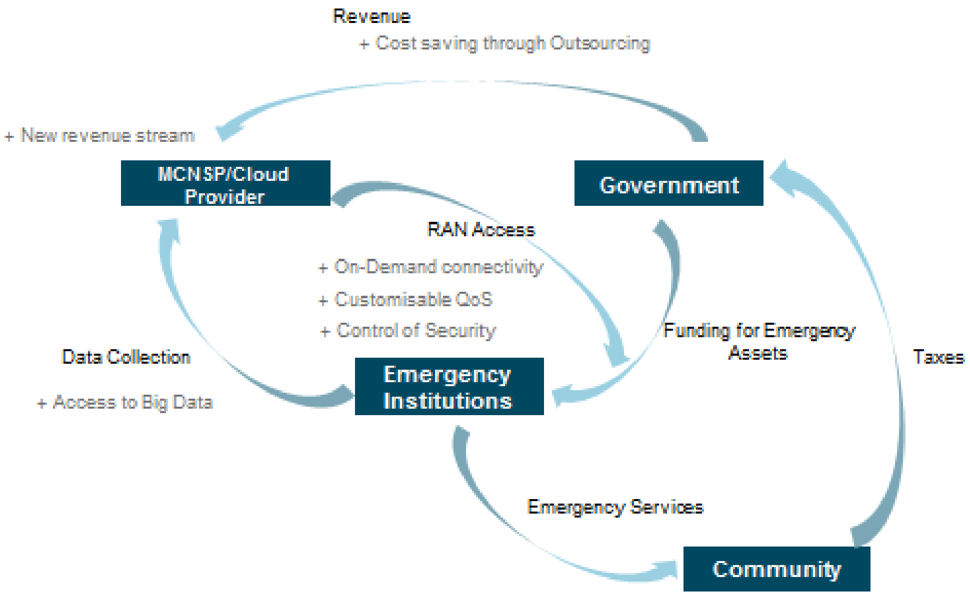


Figure 13. Value Flow for the Emergency Communication Scenario

4.8.5 Challenges

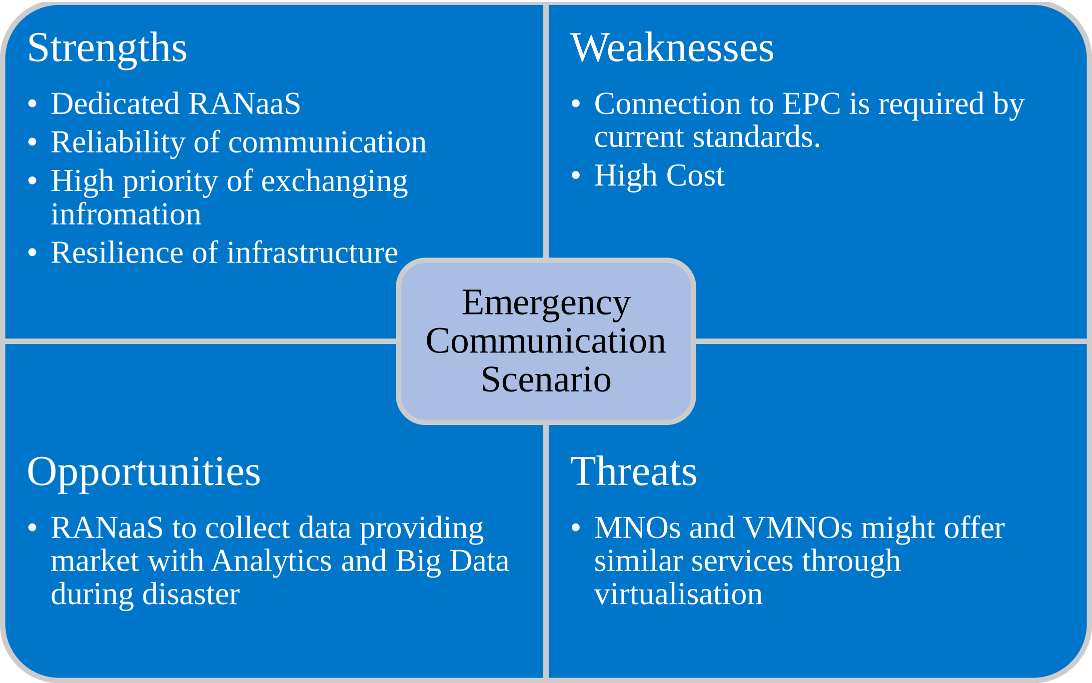
Currently, connection to the EPC is a prerequisite for the UEs to connect. The main reason behind this barrier lies within the connectivity protocols as current 3GPP base stations according to latest standards do not grant access to the mobile network if the base station is not connected to the core network, since access to LTE is granted by MME at attachment.

Another challenge accounts the special infrastructure that must be deployed in order to withstand natural phenomena and calamities. An issue that is ought to be addressed to ICT vendors to manufacture devices offering high resilience and invulnerability to natural damage caused by an earthquake, fire and other catastrophic sources.

4.8.6 Conclusions

On the hypothesis that cell towers work independently from EPC, the UEs would be recognised by the towers that act as a medium to provide a certain independency from the core network. Despite this assumption, connection to EPC is essential at present therefore the system cannot run in an autonomous stand-alone mode independent from other services.

Lastly, similar deployment and development of independent networks are currently out of the scope of MCN, however some UEs may be modified to access legacy mobile networks (old generation networks rarely used today based on outdated protocols) as the virtualisation allows rapid retuning of the mobile network, enabling resources in a cell where an accident occurred to be redistributed according to the importance of the occasion. On the other hand, the dependency to the EPC poses a great opportunity for MVNOs and MNOs to elaborate further or cooperate closely with uprising MCN service providers.



Strengths
- Dedicated RANaaS
- Reliability of communication
- High priority of exchanging infromation
- Resilience of infrastructure

Weaknesses
- Connection to EPC is required by current standards.
- High Cost

Emergency Communication Scenario

Opportunities
- RANaaS to collect data providing market with Analytics and Big Data during disaster

Threats
- MNOs and VMNOs might offer similar services through virtualisation

Table 6. SWOT analysis for the Emergency Communication Scenario from the angle of the MCNSP

4.9 Spectrum Brokerage Scenario

4.9.1 General background

This scenario addresses the possibility for MNOs and MVNOs to expand their frequency resources on demand, exploiting business opportunities for the role of the MCN Service Provider by providing RANaaS. It does not address a specific trend as identified on D2.3; but it can be seen as an extension to the trend of RAN Sharing, which is a common practice within the telecommunications industry.

RAN Sharing can be found in many forms ranging from passive sharing of infrastructure to actual Radio Access Networks (RAN). Passive sharing refers to the common utilisation of passive elements in the network infrastructure, like the mast, sites, power, etc. This kind of sharing is also known as site sharing. Active sharing includes the common exploitation of components like the antenna, the node, and the radio network controller elements. A third kind of sharing, called spectrum sharing, includes common utilisation of frequencies among different operators. (BEREC & RSPG, 2011).

According to the European Commission, the total volume of services depending on radio spectrum availability is estimated to be worth at least €200 billion annually in Europe (European Commission, 2014a). In a market of those dimensions, running out of frequencies to deliver services can be very costly.

MCN service(s) deployed for this scenario:

RANaaS
EPCaaS

All Support service(s) are deployed for this scenario.

4.9.2 User story

The streets of London are crowded as usual and on today's world almost every individual walking on the streets is using a mobile device to connect to the internet through a mobile network. "Telco Prime" is monitoring the amount of data traffic in the city and observes a peak close to the maximum data capacity in Piccadilly Circus. In order to avoid a shortage in their services, Vodafone contacts a MCN Service Provider to increase their capacity in the area. Subsequently, the MCN Service Provider checks which frequencies Vodafone already uses in Piccadilly Circus, and offers an additional block of frequencies to extend the capacity in the area for that day. The transaction is completed smoothly and the users avoid decrease in the signal quality.

4.9.3 Specific stakeholders of the scenario

Government: In most countries, the state is the owner of the radio frequency bands and also responsible for regulating the telecommunication scheme. This regulation stems from the intentions to efficiently and fairly distribute the scarce frequency 'resource' among different providers, and to keep a competitive market. Another main stakeholder in the MCN Scope is the MCN Service provider who does not directly care about the frequencies themselves, but rather wishes to see a communication channel of a particular quality offered to create his service. Lastly, the RANaaS providers obviously are directly affected, as this scenario directly affects their main business model (in terms of how they provide the communication channel technically and concept wise).

As these technical channels (frequencies) are the point of change, compared to other scenarios, no end users should be affected, as they usually do not care about the particular frequencies they use to ensure the communication services.

4.9.4 Value creation and flows

The main value of this service is created by the increased flexibility in the use of the radio spectrum; as frequencies are only paid for the amount of time they are used, and are available whenever needed. The MCNSP acts as a Spectrum Broker for this setting, as it is responsible of handling the frequencies. The value flow for the Spectrum Brokerage Scenario is depicted in the next Figure.

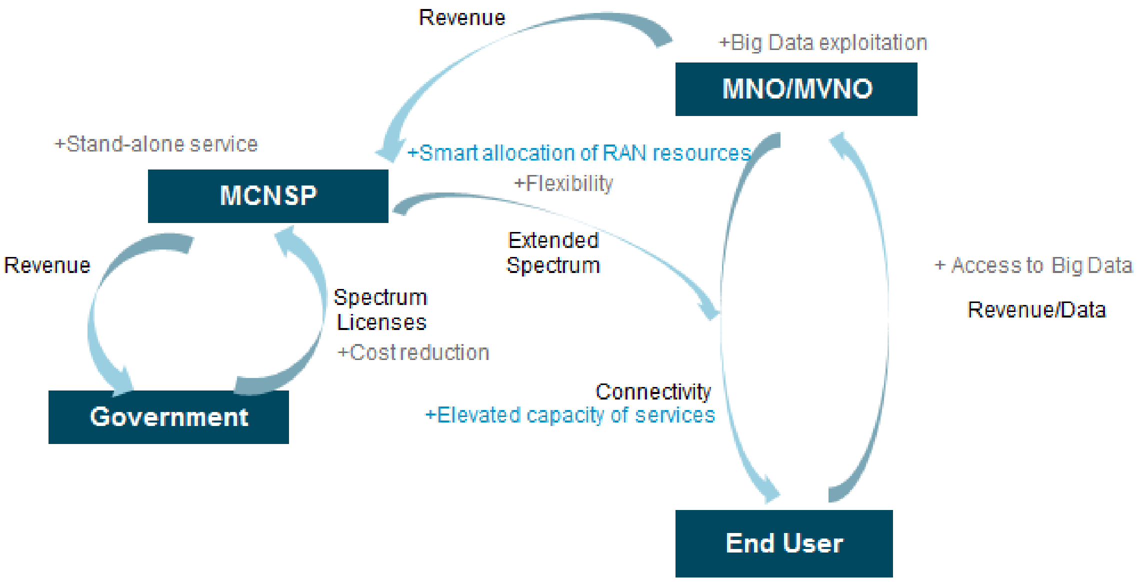


Figure 14. Value Flow for the Spectrum Brokerage Scenario

This service would be directly beneficial to MNOs and MVNOs because in that way they could potentially expand their capabilities by obtaining a wider range of frequencies on demand. In order to achieve this goal, the MCNSP must offer to an MNO additional frequency blocks with the purpose of increasing the bandwidth available for the end user, a fact which ultimately leads to a stable and continuous connectivity regardless of the number of users in a single cell, which formerly could only be dimensioned statically. The MNO shall measure the amount of activity in specific cells and deploy predictive methods to estimate when a specific cell should be loaded, in order to request additional frequency blocks in the area. This process would be completely transparent to the end user. The MCNSP must work closely with the government to elucidate the method of how the spectrum will be handled and what licenses could be shared.

4.9.5 Challenges

Frequency Regulations

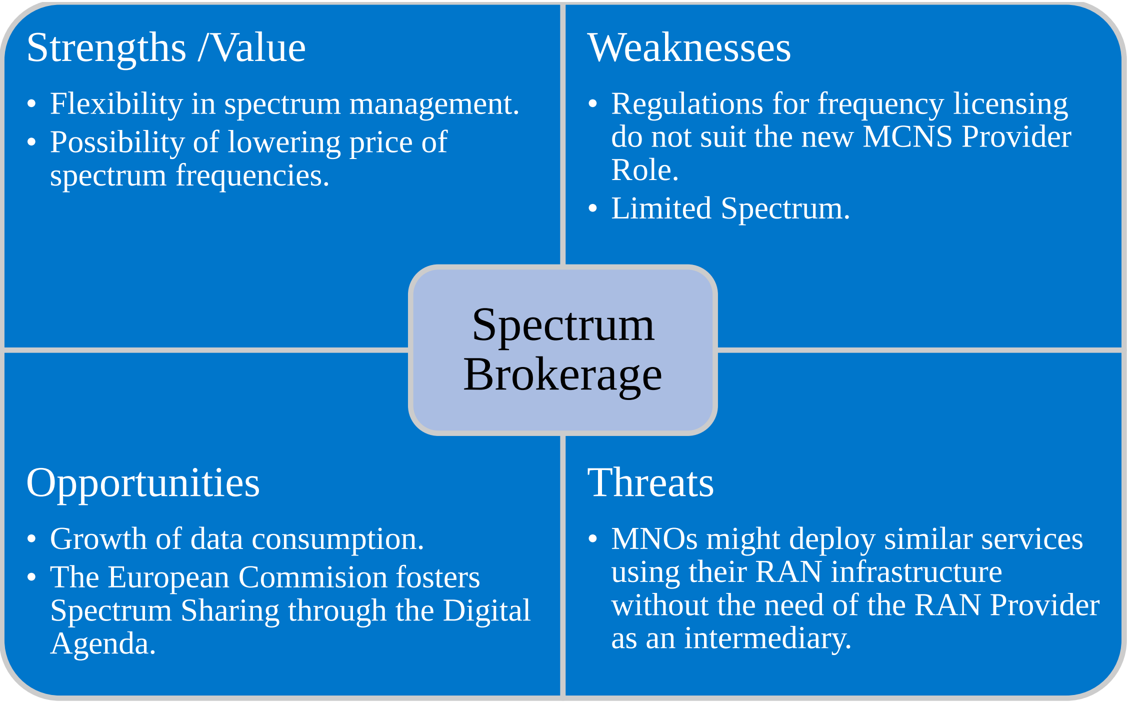
The proposed scenario requires the implementation of a critical amendment on how radio frequencies are handled today. Currently, they are licensed in auctions directly to the operators, who pay large amounts of money to the government for the rights of allocating specific frequency blocks. The regulations may change slightly from country to country, but all follow the same license obtaining process. Ergo, MNOs might be unwilling to share their spectrum licenses with other parties. In addition, the Digital Agenda for Europe aims at allowing tradability of the Radio Spectrum and adds flexibility to its management (by allowing MNOs to share the spectrum under certain conditions) (European Commission, 2014b). Despite the aforementioned; this does not envision the handling by only a single RAN Provider.

Limited Spectrum

The amount of frequencies to be granted to MNOs is not limitless; therefore the spectrum emerges scarce in terms of frequency allocation. Furthermore a MCNSP could not provide more frequency slots without comprising the allocation for other MNOs or parties, hence limiting the service would not be possible to provide always on demand if the maximum capacity is reached.

4.9.6 Conclusions

In conclusion, the scenario proposes an increased flexibility in spectrum management as it is part of the Digital Agenda of the European Commission because it provides frequency allocation on demand without previous agreements. The fact that the MCN Service Provider has at its disposal a large frequency pool, may lower the costs of maintenance and operation due to economies of scale. Arguments against the scenario are the existing regulations as they are not suitable for the MCN Service Provider role, and the available limited spectrum. The growth in data consumption and the openness of the European Commission towards RAN Sharing and flexibility might open space for the new role, but it could be difficult for MNOs to accept the change in the network, unless they deploy similar services to collaborate with each other without the intervention of a MCNSP.



Spectrum Brokerage

Strengths /Value	Weaknesses
• Flexibility in spectrum management. • Possibility of lowering price of spectrum frequencies.	• Regulations for frequency licensing do not suit the new MCNS Provider Role. • Limited Spectrum.
Opportunities	**Threats**
• Growth of data consumption. • The European Commision fosters Spectrum Sharing through the Digital Agenda.	• MNOs might deploy similar services using their RAN infrastructure without the need of the RAN Provider as an intermediary.

Table 7. SWOT analysis for the Spectrum Brokerage scenario from the angle of the MCNSP

4.10 Small Cells Scenario

4.10.1 General background

This scenario offers a **flexible on demand** extension of existing cell structures in terms of bandwidth for unique or recurring events, e.g. soccer games, folk fests (e.g. Oktoberfest) or rock festivals, as these kinds of events lure a large amount of people to a particular location at the same time. Increasing the bandwidth available to each device can be achieved by increasing the overall bandwidth of the cell. However, within current setups the bandwidth limits can be reached fairly easily when the number of connected devices is unusually high because resources are shared among all end user devices that are connected to a single radio cell. Thus, the increasing demand of mobile connectivity and particularly of internet services on the go radically contribute to the utilisation of alternative base station structures, in particular **small cell technology**. This kind of situation leverages the exploitation of **Big Data analytics** (D2.3), as the concentration of users in a smaller cell structure allows for more fine grained data analytics, especially concerning location based data, in order to create advertisements which **enables DSS solutions**, described in chapter 3.4. Moreover, the high concentration of devices in a relatively small area eases the data aggregation process to protect the **privacy** of the users.

Small cells have the potential to range from ten to several hundred meters of unlicensed and licensed spectrum. Femtocells are a type of cells, which provide access to residential homes, enterprises or rural/metropolitan areas within a short range. Picocells cover indoor or occasionally smaller outdoor areas for enterprises or the public just at higher capacities. Microcells are base stations used to extend capacity in areas where macro cells cannot provide reception indoors or outdoors in certain rural areas, but the reach is supposed to be higher than in Pico- or Femtocells. Metrocells is an overarching term for all the cell types above, that are used to increase coverage and capacity in metropolitan areas. These base stations are mounted on buildings or designated infrastructure. This technology can increase the wireless capacity exponentially as it reuses frequency in smaller areas. (Small Cell Forum, 2012)

Informa Telecoms & Media's estimates revenue of US$22 billion dollars for the small cell market by 2016. Therefore, this is a trend that should not be ignored and could be integrated with RANaaS capabilities. (Informa Telecoms & Media, 2013)

Type of MCN service(s) deployed for this scenario:

RANaaS
EPCaaS

All Support service(s) are deployed for this scenario.

4.10.2 User story

The FIFA World Cup in Brazil is about to kick off and the stadium where the opening ceremony is taking place, the Arena Corinthians, is at its maximum capacity of 65.000 people. A large portion of the crowd is using their mobile devices to shoot and upload pictures on Facebook and other social networks to gravitate their excitement. The stadium organisers were able to offer free and available connectivity inside the premises for an additional fee to the ticket, as they had an agreement with TIM Brazil to ensure access to the network at all times regardless of the amount of users present. The MNO in conjunction with "Fokia", a small cell provider, analysed the dimensions of the stadium and deployed cells accordingly to elevate the capacity available in the particular zone.

4.10.3 Specific stakeholders of the scenario

The Event Organiser, for this particular scenario, stages events for the general population, which usually leads to luring large crowds into small areas. Small Cell Providers play an important role in the scenario as it procures the technology to enable the whole scenario. ICT vendors provide hardware and technology to improve small cell technology.

4.10.4 Value creation and flows

The value flow analysis illustrates the interactions between the different roles involved in the scenario. To retain simplicity in the Value Flow Analysis, the EPC provider has been excluded from the analysis as the MNO/MVNO is capable of ensuring the connection to the core.

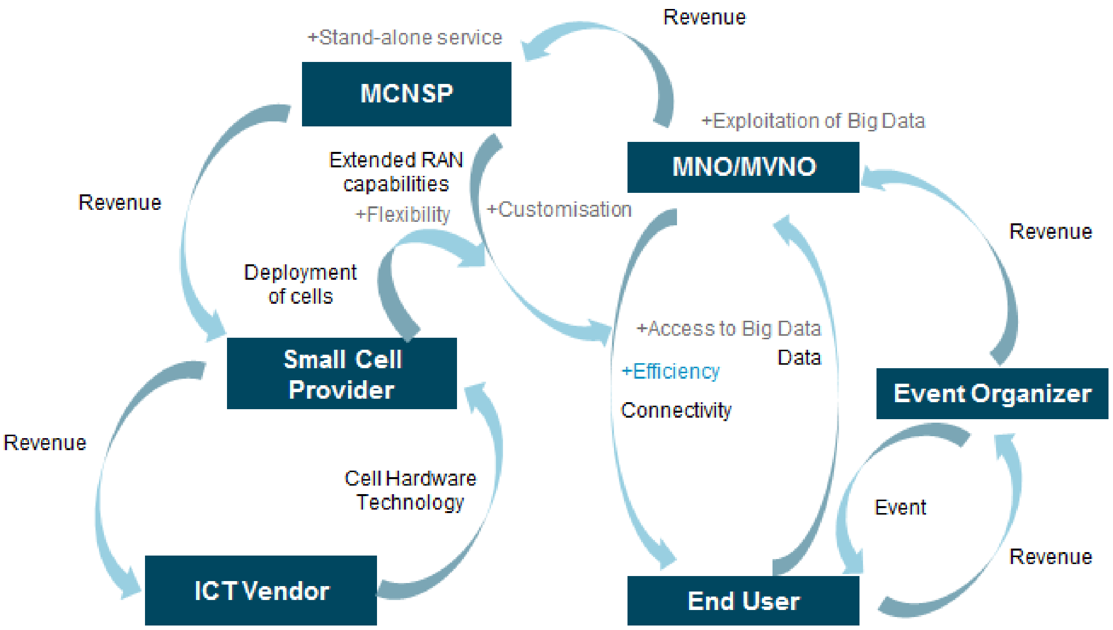


Figure 15. Value Flow for the Small Cell Scenario

End users would not lose connectivity regardless of the high traffic occurred during the event, and additionally, they could use their equipment as they usually do without being prompted to an authentication process, as it is present currently in WIFI solutions, which represent a setup effort for the end user. In return, the generated data is collected by the MNO in order to be used for further analytics. Lastly, revenue flows from the end user to the different stakeholders in the scenario.

Event Organisers benefit from charging customers for the enhanced connectivity capabilities, and potentially integrating additional services of the event like mobile payment, DSS, etc.

MNOs will provide the end user with connectivity at all times with the support of the RAN Provider and the Small cell provider while deploying cells in the event site to ensure a higher bandwidth availability.

4.10.5 Challenges

EPC connection: Providing the connection between the antenna and the core might be complicated in non-stationary settings (e.g. open air festivals), as this would require moving the antenna for every event, therefore disconnecting it every time manually from the core. The last one would require additional operational resources.

4.10.6 Conclusions

To sum up, this scenario inaugurates the increase of wireless capacities through the deployment of small cells in setups where the traffic can be unusually high like festivals or stadiums. In comparison with current WIFI solutions, the small cells would allow a device to use voice and messaging in the network, bypassing the authorisation steps currently needed when using WIFI and internet protocols, either by leveraging the connectivity contracts a user already possesses with his mobile phone, or by offering the connectivity to users who require it. The solution could work for stationary settings as well for events in open spaces, where the location is not fixed, however, the connection to the core for the latter can be challenging. The scenario takes advantage of the small cell trend, which is already being tested in different settings, and the possibility to exploit Big Data solutions as privacy issues are solved by an easy aggregation of data.

Small Cells Scenario

Strengths	Weaknesses
• Increases wireless capacity. • No further authentication needed in comparison to WIFI.	• Connection to EPC might be difficult for non-stationary settings, e.g events that occur in open spaces.
Opportunities	**Threats**
• Small cell technologies are improving as a way to provide connectivity to crowded areas. • Big Data Analytics	• N/A

Table 8. SWOT analysis for the Small Cells Scenario from the angle of the MCNSP

4.11 Weather Prediction Scenario

4.11.1 General background

Apart from the usual telecommunications services, there are other possibilities to exploit the assets a MCN Service Provider possesses. Recent studies explored the possibility of measuring weather conditions and predicting them by measuring the strength of radio signals coming in and out of cell towers, as they are related to the humidity in the air (Covert A.,2009), offering a better resolution than traditional measure techniques. As the amount of antennas throughout the world is extensive, and data is collected at all times, this becomes an ideal scenario for the exploitation of the Big Data trend (D2.3).

Weather data provided by weather institutions relies on a fixed set of weather stations scattered throughout a certain area. In order to increase the quality of the measurement, the number of those gathering stations must increase accordingly, incurring in high costs. The advantages of the method exposed here is that radio antennas are already installed, even in remote places where no weather stations are located, and that the signal strength is already measured by MNOs. The measured information could also be provided in a better quality and it could be more precise due to the number of cell towers available. This scenario could be independent from an EPC since no authentication is needed, as the only measured parameter is the signal strength.

It is important to notice that in this scenario, the main value is the generation of weather data; for this reason, the revenue source will not come from the end user (understood as the person holding a mobile device) but from climate institutions, therefore, the solution here proposed shall attend the needs of the latter.

Type of MCN service(s) deployed for this scenario:

RANaaS

All Support service(s) are deployed for this scenario.

4.11.2 User story

Pezofone does measurements of their radio signals to monitor and maintain their antennas, they find out that some weather institutions might be interested in the data they collect to improve their predictions, and it is a practice that has been successful for some time now. The data can be sold without causing any major additional cost to the operator since it does not pose an extra effort for them, apart from transforming the radio signal into usable weather information. They plan to launch a first transaction in Germany to perform an initial test. To keep operations simple, Telefonica cooperates with an analytics company to process the information and sell it accordingly to a weather institution.

4.11.3 Specific stakeholders of the scenario

Analytics Companies have the capability to convert and analyse information. Climate institutes gather weather data, derive weather models and predictions, and offer the weather information and forecasts to the public.

4.11.4 Value creation and flows

The value flow for the Weather Prediction scenario is depicted in the next Figure. End users by utilising their mobile devices create data about signal strength, which correlates to the weather condition at their location at the time. The MCNSP would collect and sell this raw data to an Analytics company. The latter would then analyse and transform it into valuable weather prediction data to be resold to the Climate Institute. In a second business setting, the MCNSP could enhance the value of the raw data by analysing it themselves to turn it into statistical weather information, however, at this point it is not clear if it is feasible for the MCNSP to acquire this competency. Hence, outsourcing of such activity could be more profitable.

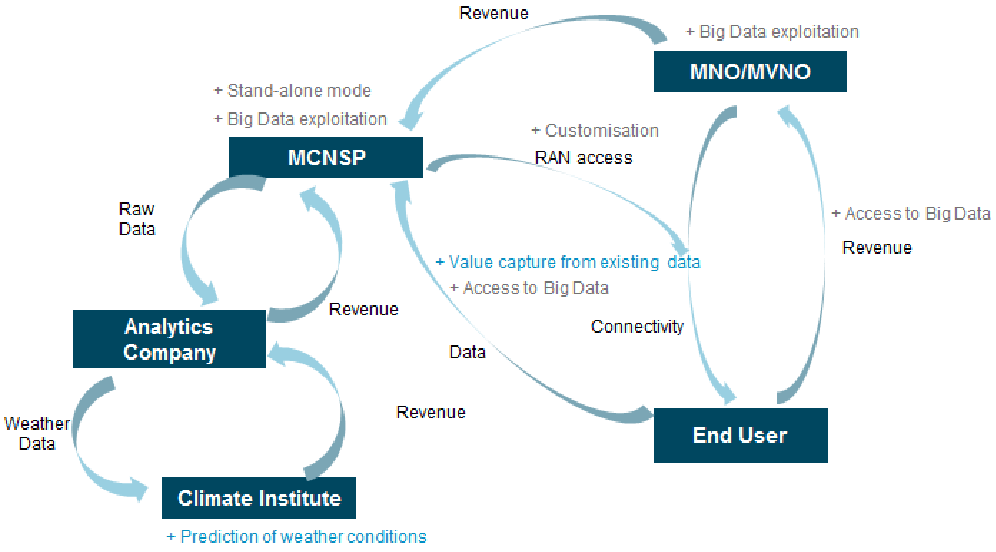


Figure 16. Value flow for the Weather Prediction Scenario

4.11.5 Conclusions

The scenario poses a good opportunity for Mobile Operators to monetise their assets without putting much effort and sell pieces of information they already possess without comprising any part of their business. This method to predict weather conditions has been proven to be more reliable than existing methods in remote areas (Tel Aviv University, 2009). The amount of data to be processed is substantial, therefore, it falls into the field of Big Data analysis. Possible threats to this scenario may be other weather prediction technologies, especially if they were to further advance in their current solutions as well as Big Data analytics. For example, Vaisala is selling compact weather stations, easy to install, and Lufft in Germany offers a rain sensor based on Doppler radar technology (Meteo Technology, 2014).

Weather Prediction

Strengths / Value	Weaknesses
• More reliable weather information in distant areas.	• (No weaknesses were identified)
Opportunities	**Threats**
• MNO to comercialise their current information assets • Big Data trend	• Advancements in other weather measurement technologies.

Table 9. SWOT analysis for the Weather Prediction scenario from the angle of the MCNSP

5 Discussion

The discussion takes a more high-level standpoint than the presentation of the scenarios. In the scenarios we have only discussed the general principles of value generation. However, the scenarios still leave some open space for differentiation. In particular this concerns the questions which market participant (according to the respective role) is operating which service. Here several options are possible to create the same value. Nevertheless, there are differences in the suitability of services to be operated by the different parties.

In Chapter 5.1 we explain the general opportunities of the MCNSP that had been introduced already in D2.1 [MCN-D2.1]. Here we explain which alternative kinds of MCNSPs are imaginable and how they would work together with other roles. In Chapter 5.2 we will then describe which consequences these different approaches would have for the individual scenarios or which scenario would be most suitable for which distribution of services among the partners. Finally in Chapter 5.3 we look at the role of regulations and investigate the constraints that they may impose on the development of the analysed scenarios.

5.1 Business opportunities for MCNSP

In the following we will discuss the business opportunities that come along with the MCN services, as we have described them in the scenarios. We will take a more general perspective and investigate possible distributions of services among the main market players. We have used the work of Copeland and Crespi (2011) on the different roles of MNOs and MVNOs as a blueprint for the following discussion. However, it is important to notice that the situation becomes more complex since the Cloud Provider comes into play as an additional partner in a potentially multi-sided business setting.

In analogy to the categorisation of Copeland and Crespi, we can distinguish three categories of MCNSPs with respect to the variety of services that they provide.

- Full MNO – where the MNO takes the roles of the MCNSP
- Light MCNSP – as a very restricted role regarding the provided services
- Hybrid MCNSP – with various distributions of services between MCNSP, MNO and Cloud Providers
- Full MCNSP – where the MCNSP controls as many services as possible

While these distributions of services are mainly analogous to those between MVNOs and MNOs, additional complexity comes into play due to the additional role that the Cloud Provider plays in the scenarios. Regarding the Cloud strategy, we can as well distinguish three categories mainly with respect to the MCNSP:

- Private Cloud Strategy
- Hybrid Cloud Strategy
- Public Cloud Strategy

In the following we will discuss the consequences of the different distributions in regard of the control of the included services. Subsequently we will discuss the consequences of the different Cloud strategies (private versus public Cloud). Although the latter question is rather technical it has certain implication on business questions.

It is to be remarked that we do not explicitly distinguish between MNOs and RAN Providers although there is a clear difference between the two roles. However, it seems to be unlikely to base the analysis on the assumption that we will have a large variety of independent RAN providers in the future due to the high infrastructure costs. Moreover, the distinction does not seem to be particularly relevant for the discussion since it mainly deals with the distribution of services, where the MNO can run the same services as the MCNSP.

5.1.1 Full MNO

In this case the MNO assumes the role of the MCNSP and only collaborates with a Cloud Provider to run the services in a more flexible way. However, as in the MVNO case the MNO is less flexible than an independent MCNSP so that opportunities are left out.

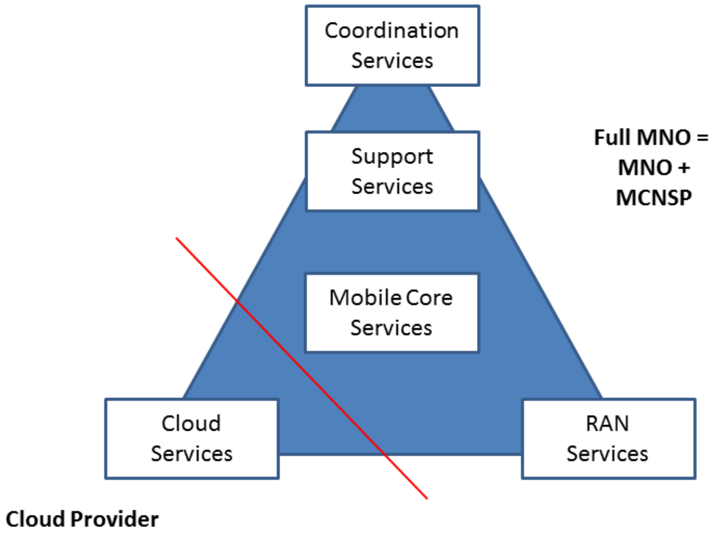


Figure 17. Full MNO

The case reduces to an ordinary cloud outsourcing scenario with two roles, MNO and Cloud Provider.

5.1.2 Light MCNSP

In this case the MCNSP mainly takes care of the **customer management** and partially the overall service orchestration. Their tasks would not include running an EPC / IMS of their own or any Support Services.

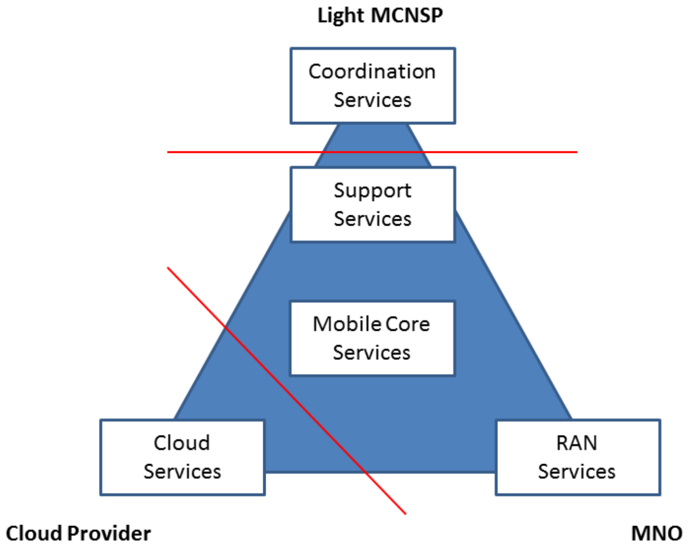


Figure 18. Light MCNSP with major MNO role

The advantage of the MCNSP in this scenario is that the set-up can be realized quite quickly and is interesting for players without expertise in telecommunication technologies but with a broad existing customer base. This could be an option for companies such as supermarkets or Application Providers, which want to sell (mobile) services to their already existing customer base.

An advantage that the MCNSP inherits from the MVNO role is the ability to contract various MNOs in order to optimise the conditions. This gives them more independence regarding locations and regional restrictions.

The disadvantages of this scenario are the same as in the Light MVNO case. It is the loss of control (e.g., with respect to the quality of service) and of exploiting business opportunities, for example, with respect to Big Data usage.

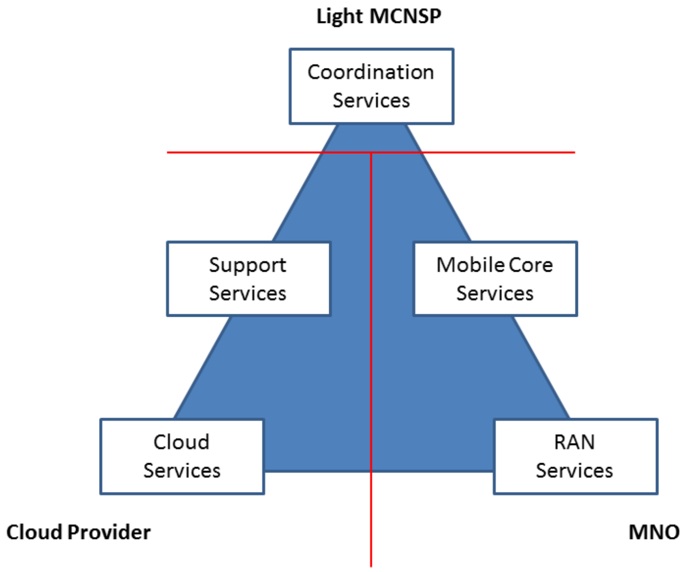


Figure 19. Light MCNSP with major Cloud Provider role

Although the MNO could provide both Core Services and Support Services, there is still the alternative that the MCNSP autonomously works together with a Cloud Provider that offers suitable Support Services. This would decrease the dependence on the MNO but could also make the setting rather complicated, technically as well as economically, so that it is not clear whether it would be feasible at all.

5.1.3 Hybrid MCNSP

In this case, the MCNSP would run the high-level service orchestration and the Core Services (EPC / IMS etc.) while the remaining services would be run by the Cloud Provider or the MNO, respectively. It might also be an option for the hybrid model that the MCNSP only runs the Support Services whereas the Core Services (EPC / IMS etc.) are run by the MNO. The suitability of this distribution might be of a technical as well as a strategic nature, due to the question who can run these services most efficiently and which consequences with respect to business opportunities this might bring along.

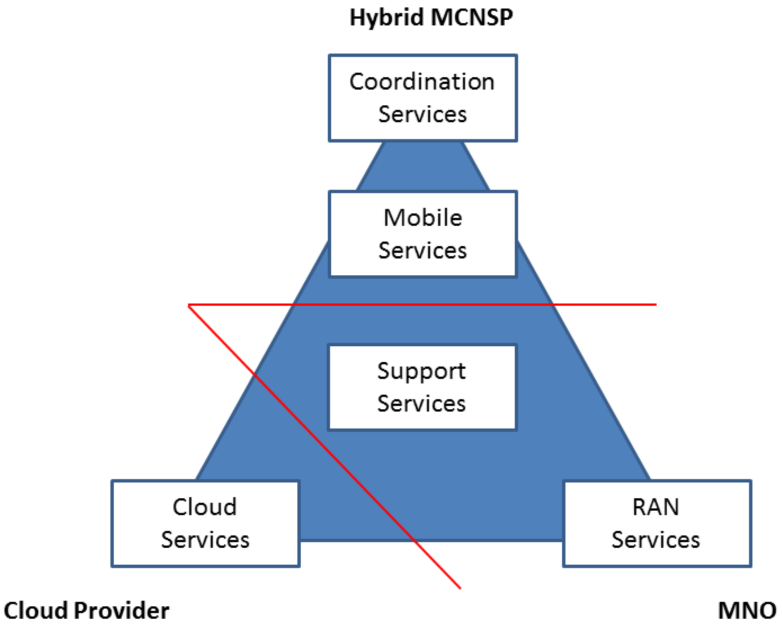


Figure 20. Hybrid MCNSP with major MNO role

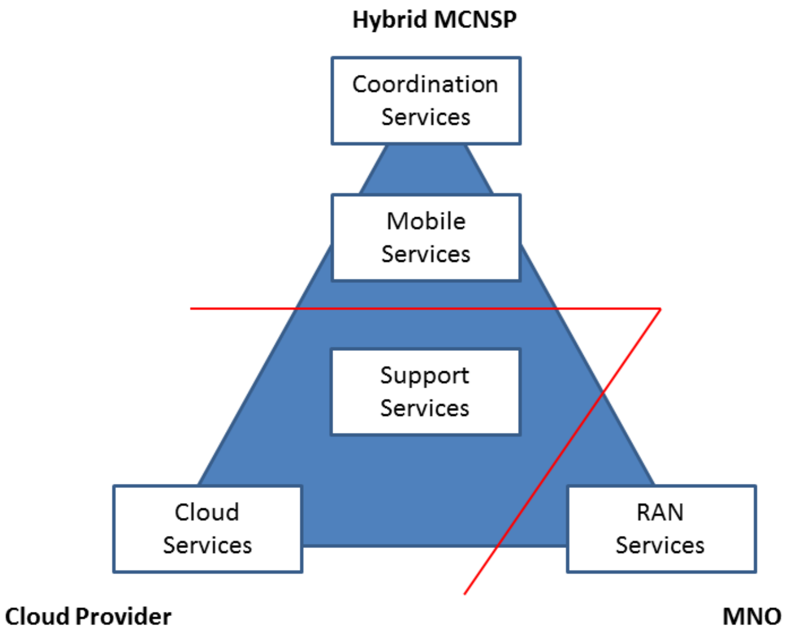


Figure 21. Hybrid MCNSP with major Cloud Provider role

The main question would be whether the MCNSP can efficiently access data and control the quality of service in such a split scenario since these appear to be the main advantage of an independent MCNSP role.

5.1.4 Full MCNSP

In this case, the MCNSP runs the Core Services as well as the Support Services. Thus, they are able to control the Quality of Service and also have access to communication data. This also means that they can tailor well-defined services for Application Providers and address niche markets that a MNO could not deal with. They only require the RAN services to be run by the MNO. As in the previous case the MCNSP could make contracts as it needs them (with respect to local coverage and quality).

Their main competence consists in the optimization of service offering in terms of specific requirements of their customers. In this respect, they can collaborate with Cloud Providers and MNO as RAN Providers in a flexible way. Since they run their own services they only need a basic cloud solution and can work together with a large variety of Cloud Providers, which they also contract to cover locally and temporally restricted events.

Alternatively, they could let the Cloud Providers run the Support Services or part of them. In this case, they would not have to deal with this infrastructure. The advantage for the Cloud Providers could be that they could exploit the *Support Services*, for example, with respect to data. However, the MCNSP could only work together with those *Cloud Providers* which offer the respective services; this would be a considerable restriction and diminish the advantages that servitisation and cloudification bring along.

The *contracting* with suitable MNOs and Cloud Providers and the orchestration of the various services in an optimised way could become one of the **core competencies** of a future MCNSP. They would have to ensure that relevant areas are sufficiently covered by Radio Access and that adequate Cloud Providers would be available to provide the required Quality of Service, which they could adapt to the demands of their customers.

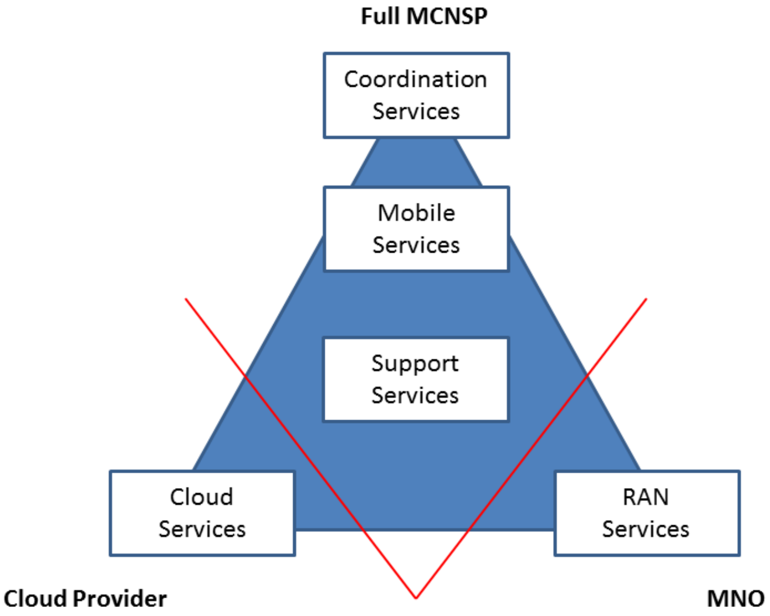


Figure 22. Full MCNSP

Generally, we can say that the Full MCNSP would profit from the set of business advantages that also exist for the MVNO since they would play a similar role (Copeland & Crepsi, 2011).

5.1.5 Cloud dimensions

In addition to the different ways to distribute the services, there are also different possibilities to run these services in the Cloud. Here we can refer to the concepts of **Private Cloud** versus **Public Cloud** as well as the intermediate setting of the **Hybrid Cloud**. Moreover, regarding the collaboration with the *Cloud Provider*, there are the different option of IaaS, PaaS and SaaS. In the first case the Cloud Provider would only provide the data centre, where the MCNSP would deploy the Core and/or Support Services. In the PaaS case, the Cloud Provider would provide a framework such as Openstack. The main question in this respect is to which degree such offering of Cloud Providers actually add value to MCNSPs and MNOs or whether they only restrict the opportunities of both parties to collaborate with different partners.

One interesting point in this discussion is the differentiation between **operation** and **control**. It is possible that a Cloud Provider runs the services but, at the same time, the MCNSP has full control of data and the quality of service. Here we have to distinguish two cases how a Cloud Provider can run the services:

- Offering the full service in a SaaS manner so that the Cloud Provider controls the service. In this case the MCNSP (or MNO) has to ensure the adequate setting by contracts with the Cloud Provider using SLAs.

- Running the service in the cloud in an IaaS/PaaS manner. Here, the Cloud Provider only provides resources at a basic level while the MCNSP (or MNO) has to take care of the actual service performance.
- Considering the role on the MCNSP as a dedicated service provider for mobile connectivity the second option seems to be preferable since it ensures the MCNSP's control of the operational parameters so that they are better suited to offer carefully tailored services.

Coming back to the use of **Private** and **Public Cloud** there are similar aspects that have to be taken into consideration (Aerohive Networks, 2013):

- **Local flexibility:** Are the cloud resources where they are (locally) needed;
- **Costs:** A large *Private Cloud* that is completely used is likely to be more cost efficient than *Public Cloud* where the administrative overhead of the *Cloud Provider* has to be paid. However, a small or insufficiently used *Private Cloud* is more expensive since the MCNSP has to cover the maintenance costs.
- **Reliability:** working together with different partners may lead to the question of protection against the loss of data and their security. In a *Private Cloud* the MCNSPs have responsibility and control themselves.
- **Investment and taxes:** A *Private Cloud* can be advantageous for tax reasons since a data centre appears as an investment supported by the tax scheme. Moreover, the data centre is a tangible asset with a certain value that might count as security.

Against this background two principle approaches seem to be viable:

1. The MCNSP runs a large Cloud based on their own data centres and serves as a Cloud Provider for other customers. In this way, the MCNSP can avoid overcapacities. A difficulty arises from the regional coverage since the data centres are likely to be centralised to be efficient.
2. The MCNSP runs a small Cloud that only covers the major load and work together with other Cloud Providers to cover the remaining demands according to the respective requirements. This allows the MCNSP to localize the cloud resources where they are required while coverage the major workload themselves.

The first case represents a Private Cloud approach while the latter case makes use of a Hybrid Cloud. Which of the two approaches provides better opportunities depends on additional data and the particular setting of a MCNSP.

5.2 Application of the MCNSP categories on MCN scenarios

To put the newly created MCNSP categorisation into practice we apply it to the MCN scenarios that we drew in Chapter 4. The premise for this application is the evolvement of the market into a constellation similar to what is sketched in the MCN Scope (Chapter 1.2). Because of the existence of particular players and certain restrictions that exist, which are outlined in chapter (regulations chapter) the categorization works around the three main roles of a newly created MCNSP, existing Cloud providers which offer computer infrastructure and cloud platforms, as well as existing MNOs.

5.2.1 Core Network Provider for Business Customers

Providing the core network to business customers can be done in several different ways. As an on premise solution, the MCNSP only acts as a legacy software provider. A solution is sold to a business customer, who does need expertise and capacity for deploying the system on his own. Logically, the involvement of an MCNSP is rather limited, even though, complementary services, like support, could be offered. At maximum, a role as a light MCNSP could be defined for this scenario.

As soon, as the involvement increases, the role of an MCNSP would shift towards a **hybrid setup**. The MCNSP in ‘on demand’ (aaS) scenarios will have to maintain closer relationships to customers as not the software itself is the business, but the service that come from it. The MCNSP acts as a coordinator between RANaaS providers, installs, maintains and generally runs the EPCaaS, or even IMSaaS, solutions itself or by a contractor (e.g. a cloud provider). Since the SLAs are done with the MCNSP, it is directly responsible for the quality and reliability of this service. Thus, running the EPC becomes a core competency and a key value of the offering, which needs to be closely controlled or directly operated by the MCNSP. It is not directly obvious, who could or would offer the needed support services as they are necessary, but not essential to the core value of the product. Depending on the actual realization of the business contracting could exclude cloud providers totally, or include them to a large extent by renting infrastructure and partially support services.

5.2.2 M2M

To offer an M2M mobile network solution an MCNSP needs to control a major part of the network in order to adjust it to the special needs of this scenario. A high number of devices, each with a low bandwidth demand. Mainly data connections are needed, and it is even possible to think of real time communication scenarios, where the time the data needs to travel is mainly important. All these properties are defined by the infrastructure, including RAN, EPC and other services needed, and need to be carefully set up and maintained. These properties mark the core value of this offering and, thus, lie within the responsibility of the MCNSP itself.

The conclusion of this is that a Full MCNSP or even a Full MNO structure is probably the best choice. Depending on the particular dependency on the RAN component the MCNSP either holds all the other necessary parts to be able to provide this very specific communication infrastructure, or an MNO itself becomes such an MCNSP and would even control the RAN itself. The specific requirements and properties of such an M2M communication network makes it reasonable to control all defining components of the infrastructure simply to have the flexibility and control to meet all the customer needs in this industry sector.

5.2.3 Emergency services

The emergency services scenario marks a very specific use case, which revolves around the RAN/RANaaS component of a mobile network. The main value comes from specialized implementations of cell towers and base stations to run autonomously and provide special communication channels for emergency forces and emergency communication. Consequently, it does pose a special case to be considered by future RANaaS providers, or Full MNOs, as they have control over the RAN infrastructure.

It is imaginable that a special light MCNSP emerges as an independent role to coordinate all the efforts related to this scenario. It could coordinate communication with emergency forces and local authorities, or even act as a driving force to define requirements and standards for this type of service.

Yet, it is questionable if such an independent entity is really necessary. RANaaS providers (MNOs) could realize such services themselves, as they do and did already with related products.

5.2.4 Small cells scenario

Offering small cells and smaller on demand mobile communication networks is a task, which can involve many components of a mobile communication infrastructure. The main element in fact is the RAN itself, which is of a special type. The MCN project works on realizing the necessary flexibility and interoperability of these components. From a process standpoint, this flexibility is a key value in this kind of service.

While it is possible to see this service in the hands of a RANaaS provider only, it seems also realistic that Full MNOs - many of which already work with small cell technology - create a more complete and more dedicated service around this (on demand) small cell business. Having EPC/IMS and even complementing services at hand and under own control can ensure the flexibility and reliability of this concept, which are the two most important values.

5.2.5 Broadcast mobility advertisement

Mobile advertisement and Digital Signage Services are concepts, which are somewhat similar to other communication services, but also different. A similarity is, to provide a particular communication channel with special properties. The difference is, that mobile communication networks here are merely one technology providing a physical communication means for this idea, while the main communication channel provided here is represented by digital signs or displays spread throughout the world, which potentially address the entire population. Mobile communication networks are simply a flexible way of providing data to and control over any display device wirelessly.

In many cases there are no special properties that the mobile communication channel has to meet. Therefore, it does not pose as a main value creating component here. A light or hybrid setup should be sufficient, where the MCNSP focuses on interfaces, concrete service bundles, and product development for potential DSS customers. Deploying a DSSaaS instance and providing appropriate interfaces, or even complementary hardware (e.g. remote displays or information terminals), should become the main concern as it holds the characteristic value behind this business.

5.2.6 Spectrum brokerage

The idea of a spectrum broker is an extension to what companies in the telecommunications industry already do. Sharing frequencies is done by allowing MVNOs, sharing tower infrastructure, and even by selling parts of frequency licenses, which are not needed to other providers. While these examples cannot compete with the flexibility of what is imagined in this scenario, they provide hints about how this might evolve into in the future.

A straight forward way of creating such brokerage services would be for an existing MNO, which would act as a RANaaS provider at the same time, to take that role directly. As a RAN operator this service would integrate directly with the service offering. An MNO does have the according capabilities and knowledge to run a RAN and in many cases does already hold the competency to manage frequencies in such a flexible manner, both technically and administratively. However, these competencies are a necessity and are not to be seen as a core competency to MNOs. Thus, a second way is imaginable, where MNOs focus on the technical aspect of providing RANaaS, and a new light MCNSP emerges, which handles the necessary administrative tasks and coordination needed to manage and assign frequencies in the desired flexible way. This new player acts as either a service bought by RANaaS providers or acts as a customer of these, to further sell frequency capacities to other MCNSPs offering end user services.

5.2.7 Weather prediction

The weather prediction scenario does not directly fit into the sketched schemas right away. It can be seen as a complementary but distinct extension to the existing RANaaS offerings. The core competency here is the proper gathering and processing of information coming from RAN infrastructure and providing it to interested customers, e.g. weather institutions.

Nonetheless, it is not impossible to also construct a setting in which this service is incorporated into either a light MCNSP. This provider’s core competency lies in the gathering and analytical processing of data stemming from mobile communication services. In any case, wherever it is legally possible for telco institutions to provide (anonymized) data to third party companies, such analytical services could be imagined. In the U.S. such services are already offered, with anonymized user data, which does show that such a scenario is not only fiction. Furthermore, The MCN project does conceptually consider analytics and data gathering support services, e.g. AaaS, MaaS, DBaaS, etc. The integration of a specific weather prediction analysis service, as described in this scenario, merely relies on the possibility of integrating enough with RANaaS providers or MNOs, respectively, to gain access to the needed RAN data, which is of very specific type. In this setup, the MCNSP does merely pose as a customer to the RAN operators, which simply sell accrued data, which was formerly considered to be of no value.

5.3 Regulatory issues

The concept of the MCN Scope goes along with the idea of creating new market participants, roles, or constellations of setups in the telecommunication sector. This addresses several of the principal ideas behind the Regulatory Framework of the European Commission and corresponds to the Proposals for the Reform of this framework in the EU that is bolstering competition and improving digitalisation. Supporting a free market and competition is expected to boost Europe’s economy as ICT has become a basic need for any modern industrial country.

5.3.1 New roles

The MCN idea supports this agenda of free and improved competition as it envisions new market players for each component in a mobile communication network. Formerly, close intertwined elements like RAN, EPC, or IMS would become more loosely coupled, and could be operated by different dedicated providers. Operators of cloud infrastructures and platforms are encouraged to position themselves in a future telecommunication market by supporting entirely new MCN scenarios through the provision of on-demand support services. In Chapter 5.1 we discuss the options of distributing the newly envisioned MCN services among existing (cloud providers, MNOs), but also among new players (MCNSP, SP, Support Service Providers). The concept is based upon the immense separation of services from particular infrastructure and even further divides the mobile communication infrastructure into smaller modules that can be combined and reused for different purposes. New markets are created, as well as new technological solutions, which support current technology trends (IoT, Big Data, M2M communication, virtualization) and again yield growth in economy through new services and products.

Along the lines of the EUs digitalization plans, the MCN project fostering virtualisation and cloudification supports the digital age and underpins the next generation of mobile communication ideas that consequently progress the digitalisation agenda. Here, we do not only find mobile communication services, but also digital media services running on top benefit from the new technologies responsible for improving the new channel for mobile media and television services.

For the MCN scope and derivative concepts to be put into practice, the regulations or laws do not appear as the main problem, but the established market situation that must be challenged and changed to be ready for a new and more dynamic approach. Yet, there are issues that have to be addressed by each country or by the EU as a whole. In the MCN scope, services like the RANaaS are separated from the greater picture of the mobile communication infrastructure. Whoever decides to provide such a mobile communication channel has to cope with current regulations and laws connected to radio wave frequencies. For a new participant, there are no frequencies available at all at this point. In most countries frequencies were auctioned off to major mobile communication companies and are therefore bound to these. The respective companies already invested in appropriate technologies and provide according products to customers in order to generate revenue from these large investments. Even if there were available frequencies, new market players would have to overcome very high costs in order to buy the appropriate licenses. Accordingly, only MNOs have the means and rights to appear as RAN providers at the current time. Since we cannot expect a natural evolvement of this setting due to the explained reasons there might be good reasons to support the transformation process towards a more open market as it is envisioned in the MCN project.

With the reform proposal from 2007, the EU Commission granted the governments of member states the right to split services divisions on a functional level, if necessary. This should only be the last resort and other means ought to be considered first to guide the market towards more competition, located in a free industry setting.

5.3.2 Authorisation

The MCN project and the newly created roles we envision need to be reflected in the authorization processes of each country, as each member state has to create rules and regulations for authorization and registration individually. It has to be evaluated, if and how parts of the MCN service collection need authorisation. For example, depending on the detailed conceptualisation of the future RANaaS providers, which would provide connectivity and capacity partially independent of certain frequencies (if the transmission technology allows it), frequency authorisation and allocation by officials, might be revised. If RANaaS providers solely offer cell towers and technology, but do not control the proper radio transmission, they might not need special frequency licensing for their operation. On the other hand, if they are involved in controlling the radio transmission technology and provide connectivity through standardized interfaces to MCNSPs, they will probably need proper rights to utilize certain mobile frequencies. Thus, depending on the realized concept, the responsibility for the frequency licenses can shift between RANaaS providers and MCNSP.

Additionally, we have to consider splitting up the mobile communication components and assigning these to different roles. Decisions need to be taken in regard to the parties, which are going to be authorised and register their participation in providing parts of mobile communication services.

5.3.3 Frequencies

While it is the intention of the EU to fairly grant access to needed frequencies, the current licensing model seems to actually prevent the frequencies from being used and shared equitably. It is not unusual for MNOs to share frequencies, or even entire RANs, but they established such relationships on their own, which results in a somewhat static sharing environment between only a few providers. Since access to the mobile channel is made available with ease to other partners, e.g. MVNOs, it seems logical to further improve these sharing strategies.

Positive impact on services and especially prices, as it is curbed by the EU regulatory framework, has been seen by the sharing of mobile infrastructure with MVNOs. Yet the actual frequencies and RAN access are still in the possession of only a few MNOs, that still curb the services and offerings that can be made to End Users or Business Users.

5.3.4 Data protection regulation

Every communication provider that offers services within the MCN scope must also obey the country-specific laws on data protection. Changes in the current market situation, as envisioned in the MCN project, lead to new roles in the communication sector. The latter might raise the necessity to draft privacy regulations in more detail because access to individual communication information is split among various parties while a set of individual service providers is involved in this process. Data pass from RAN providers, through EPC and IMS providers and even other instances throughout the MCN setup. Due to the virtualisation attempts of the MCN project, mobile communication data now could also flow through infrastructure and platforms operated by third party Cloud providers. Regulators and responsible local control departments need to take this new setting into account and, if necessary, adjust the regulations to it.

5.3.5 Data retention

The EU provided a directive on data retention, which lays the foundation for supporting crime prosecution by providing access to communication meta-data to authorities. According communication data, like call duration, time of communication, location, and equal meta-data on email and text messages are to be stored for at least 6 months, but no more than 24 months. Access to this data is only given to appropriate authorities and only with court authorisation. The current setup mainly holds the MNOs responsible for data retention, as they control all components of the mobile communication infrastructure, RAN, EPC, IMS and the network in between.

The setting envisioned by MCN has to respect the lawful data retention regulations, but might bear a more complex setting of participants in the provision system of modern mobile communication. In particular scenarios or business models the entities responsible for data retention have to be identified. In most cases it would be the EPCaaS provider to take this responsibility. Nonetheless, other supporting providers for RAN or IMS (if provided as a stand-alone service) also store necessary information, e.g. on location of mobile devices, the type of mobile device, or the used communication services (VoIP, email, text messages, etc.). In more complicated service provision constellations standardised data retention processes ought to be considered to limit the amount of complexity in case authorised governmental bodies need to access the communication information retained.

5.4 Limitations and assumptions

One of the goals of T2.2 was to focus on roles instead of players as it is essential for analysing value networks and also to manage the actual complexity of the market (D2.3, pp 13). The usage of roles eased the analysis of the telecommunication's market and its value network, which demonstrated the current problems of the MNOs in the market. However, the strategies of some telecommunication's companies might not be represented in this analysis and therefore, the continuation of the investigation in D2.4 might also not be relevant for the strategies of specific players. The usage of roles instead of players involves the risk of overlooking details in the telecommunication's industry, as it is expected in any simplification of reality.

Another task for D2.4 was the consideration of new roles in the market appearing as a consequence of the development of the new MCN Technology. The MCNSP was conceived as an organisational entity with the possibility to undertake also other technical capabilities, (handling of the Core Network and/or support services). But it is not really known how realistic this setup might be. Furthermore, other roles, which might emerge with the utilisation of the MCN Technology, are impossible to conceive at this point, hence, they are not considered in this analysis.

The research in D2.4 does not take into consideration costs and pricing figures due to the complexity of the environment and network of the telecommunication's industry. In addition, the information needed to produce such numbers relies on too many factors to generate an accurate prediction. Hence, this activity was not considered in this deliverable but planned for D2.6 instead. In the current deliverables we produced a qualitative analysis that focus on the potential value of the MCN technology in order to better comprehend the business opportunities that derive from it.

The scenarios are a renowned tool to predict the future. They demonstrate the potential future of the telecommunication's market and value network once the MCN technology finally arrives to the market. Nevertheless, it is very difficult to predict the evolution of the telecommunication's market due to its complexity as previously stated. Moreover, the scenarios were created based on the own assumptions of the MCN consortium, which have insights about the needs of the market but without a strong research regarding consumer interest.

Furthermore, the scenarios were ideated based on the goals from the technological work packages, with no guarantee that all of the assumptions made in the scenarios are realistic enough because it is not known if the offered services are utilising the complete potential of the technology. This limitation is a consequence of the way the project structure was conceived, since the Business Model development and the technology development are executed in parallel, when ideally, the Business Model development should be performed first in order to exploit all possible trends and market needs in the technology development, which should be performed at a later stage. In this regard, the ideation of scenarios was somehow limited by the capacities already developed for the technology.

Finally, the methodology developed for the ideation of scenarios in this deliverable uses examples of past innovation technologies from other fields to generate ideas of value for the MCN Technology. This aids in the conception of new value ideas that can be thought by looking "outside of the box", however, it is possible that some specific value details related to the telecommunication's field are also overlooked.

6 Outlook

6.1 Further research

In this report we continued the work presented in D2.3 regarding the development of scenarios for the MCN technology, which represents the step 3 of the business modelling roadmap (see Figure 1). It has been the aim to bring together the technical concepts of D2.1 and the market research in D2.3 to further evaluate the potential evolution of the telecommunication's industry by means of the scenarios developed in this work.

According to the proposed Roadmap (Chapter 1.1) we have developed scenarios that demonstrate the business value of the newly defined methodology. The following step consists in an elaborative description of the respective business models and their elements. However, the scenarios have already shown that there is a high degree of complexity in the settings due to the involvement of several partners. This is also a challenge for Business Model research. Ergo, as a response to this challenge we will devise a set of approaches to a systematic description of the developed setting.

The course of action we will take in this respect entails the application of a semantic wiki approach, which, on the one hand, allows for collaborative proceeding among the partners but also provides a structural framework that enables us to the define with precision the relationships between business model elements and the value exchange between partners. In the context of technological basis we will use the same infrastructure as we have used it previously for the internal collaboration platform: the Semantic Mediawiki (see Deliverable D1.2). We hereby hope to leverage the communication among partners for developing joint results.

This approach will not only support the collaboration but will also allow us to document the results of the Business Model research in a systematic way. Further development of the scenarios could help us to observe that some parts in the description were redundant among the different scenarios. The wiki approach will contribute to avoiding double work since it enables the reuse of reoccurring structures while at the same time it yields the same full level of detail to each scenario and the related Business Model.

The wiki framework is scheduled to be developed in a way that illustrates different views of the developed scenarios, for example, regarding the value flows among providers or the synergies between scenarios, which help us to better understand the business opportunities. This is particularly important since the scenarios are fictitious, meaning that there are no comparable business settings today that could provide data on which more detailed research could be built. Therefore, it is important to enable different views of the developed scenarios through means of clear semantic structures in order to keep the consistency of business model description between the different scenarios.

It is important to implement this framework at this point, given the fact we are about to enter an advanced and more complex phase of the project. The wiki environment corresponds to this demand as it encompasses a rapid development of structures, we confirmed in preliminary studies. Finally, we can adopt the wiki as a learning platform for Business Model development with respect to the servitisation and cloudification of the mobile core that can exist beyond the actual timespan of the project.

A particular target in this respect accounts the investigation of possible implementation strategies for the designed business model. Here we have to remark that even a valid business model design might not be implemented due to the market power of existing players. This might also include considering how the existing telecommunication companies approach a strategic change in their business models. In this respect a framework that allows the reflection on different alternatives would be very useful. With the existing Business Model Innovation this is not really to achieve.

6.2 Progress regarding the Roadmap

The aim of the described research is to proceed to step 4 of the proposed Roadmap (Figure 1), which consists in the further development of elaborated business model elements for the most promising MCN scenarios. As described above, this will be supported by additional tooling to reduce the effort for the detailed analysis.

The planned analysis will rather be qualitative than quantitative since the latter would require reliable data, which are hard to obtain, and result in more or less arbitrary results regarding costs and potential revenues due to the high number of inaccessible influence factors. In contrast, the qualitative approach aims at the better understanding of the relevant value generation mechanisms that result from the novel technology and have been demonstrated in the provided scenarios. It is this knowledge of the mechanisms that allows us to understand, in which setting the MCN services lead to new business opportunities.

After we have defined the feasible value network scenarios in step 3 of the Roadmap we will concentrate on the most feasible and relevant network scenarios. For the most promising scenarios we will design more specific business models supported by the additional tools. There are two dimensions that will guide the selection of scenarios:

1. Ease of Implementation
2. Possible Business Value

We will make further use of SAP’s BMDI methodology as an established approach. The methodology is provided to the project as-is and is not part of the work; however, it will be adapted to the particular needs of the project and the telecommunications domain. The final phase of the roadmap step 4 also aims at the verification of results, which will be conducted in collaboration with the partners in T2.2.

A particular focus of the final phase will be the interaction between the different roles, especially between MCNSP, MNO and Cloud Provider. We have seen that there is a variety of different options how the services can be distributed among these players. And it seems to be important to better understand the market participants’ advantages and disadvantages behind the various options in order to determine whether these are likely to be realised. This investigation will also provide ways how new business models might be implemented and how current markets can be changed.

A Appendix: The list of Technology Examples

In this appendix the complete list of technologies that were analysed to identify the Value Characteristics is presented. The technologies were tagged for an easier identification, acknowledging the most important characteristic for each technology, classifying them somehow at the same time. However, it is important to notice that the technologies shown next caused disruption in Business Models because of the sum of its individual values and not due to a single one.

The tag system is shown in Table 10. The tags on the technologies will be useful at the moment of applying the methodology, as explained in Chapter 3.3.

C	Cost Reduction
S	Complexity Reduction (Simplicity)
A	Adaptability
I	Independence
B	Business Network Change
E	Enablement

Table 10. Tag System for the Analysed Technologies

The final results of the investigation to find the Value Characteristics are shown in Table 11. As explained before, the technologies do not rely on a single value but on a combination of them, and this is noticeable in Table 11. The specific Value Characteristic related to the value of the technology is written in brackets after its description.

Tag	Examples:	Value
C1	Cell phones:	Gradual cost reduction made it accessible to other customer segments. (Cost Reduction)
		Independent from position. (Independence)
		Integration with other functions (camera, Internet, etc.). (Adaptability)
		Smaller size allowed portability (Adaptability)
C2	Cloud Computing:	Pay per use, lower cost compared to acquiring infrastructure (same functionality provided). (Cost Reduction)
		Complexity Reduction as IT is virtualized and maintenance is done by the provider. (Complexity Reduction)
		Adaptable, meet different service models (SaaS, PaaS, and IaaS). (Adaptability)
		Cloud Providers are new players that changed the business network by allowing companies to outsource their infrastructure with their on-demand service. Synergies with other roles like applications providers and mobile operators enhanced the Cloud Provider offer. (Business Network Change)
C3	Wikipedia:	Price reduction close to zero (Cost Reduction)
		Production cost reduced as customers fill the Wikipedia entries. (Cost Reduction)
		Immediate information accessible, updated in real time.

		(Complexity Reduction)
		Expandable, amount of information seems limitless. (Sizing)
C4	Paper	Cheaper than parchment. (Cost Reduction)
		Private use due to disposability, allowing use for smaller problems, e.g. writing small notes, reminders, memos. (Adaptability)
		Synergies with Printing business. (Synergies with other Technologies)
S1	Personal Computer:	Easier to use than previous technology e.g. Minicomputers, no specialized user is needed. (Complexity Reduction)
		Gradual cost reduction made it accessible to other customer segments later on. (Cost Reduction)
		Integration with other services, e.g. word processing, Internet. (Adaptability)
		It can be used for other purposes, solving smaller problems, (word processing, small computations, leisure time) (Adaptability)
S2	Fixed telephony	Easier to use in comparison with Telegraph, no need to learn Morse code. (Complexity Reduction)
		Immediate communication. (Increase of speed)
S3	Automobiles:	Control of location, independent from trains. (Independence)
		Synergies with gas stations fostered better automobiles (Synergies with other Technologies)
S4	E-Mail:	Faster than sending a normal letter, it is almost immediate. (Complexity Reduction, Increase of Speed)
		Cost reduction close to zero due to its bundling with advertisements. (Cost Reduction)
		Different types of information can be sent e.g. digital media (Adaptability)
		Independent from the post office.(Independence)
A1	Smart Cards:	Stores different types of data (Adaptability)
		Smaller size, portable. (Sizing)
		Easier identification of users. (Complexity Reduction)
A2	Plastic:	Can be molded into different products, bags, small containers, pipes, etc. (Adaptability)
		Gradual cost reduction, eventually it was more economical than other materials. (Cost Reduction)
I1	Transistors Radios:	Portable, smaller size due to transistor technology, independent of location. (Independence)
		New customer segments to which quality is not relevant. (Business Network Change)
I2	Refrigerator:	Generates Ice (product) easily, independent from the ice vendors. (Independence)
		Different sizes for different types of use. (Adaptability)
I3	Digital Cameras	Less partners, no photographer, no stores to reveal film (Independence)
		Easier to handle than previous cameras, generates photos immediately. (Complexity Reduction)
I4	LCD Screens	Smaller screens allows portability which generates independence from location (Independence)

		Adaptable to use for different uses, calculators, watches, etc. (Adaptability)
B1	ERP Systems:	Change in the Business Network (Business Network Change)
		Easier to organize information (Complexity Reduction)
		Enables faster reaction to market (Increase of speed)
B2	iTunes	New role in the business network (platform of ITunes), substituting record stores. (Business Network Change)
		Buying behavior changed, cost reduction due to virtualization. (Cost Reduction)
		Downloadable at any time (Independence)
E1	Steam engine	Enables new technologies to power machines. (Enablement)
		Used in different kind of transportation and stationary applications. (Adaptability)
E2	Internet	Enables new applications (e-mail, e-commerce, VoIP, WWW). (Enablement)
		Easy access to information at any time. (Independence)
		Abundant amount of information and content. (Adaptability)
		Entrepreneurs can promote themselves more with advertisement. (Cost Reduction)
E3	Transistors	Enables the creation of smaller technologies (Mobile phones, PCs, Radios, etc.). (Enablement)
		Lower cost than vacuum tubes, that continues to reduce in time. (Cost Reduction)
		Size of the transistor continues to decrease enabling more powerful capacities in time. (Sizing)

Table 11. List of Technologies and their Values

B Appendix: Application of the Methodology

Appendix B contains the application of the methodology, step by step, explaining how it has been carried out to create three of the scenarios in the deliverable.

1. **Obtain a first understanding of the capabilities of the technical innovation.**

The services developed in the MCN project are designed to offer mobile infrastructure networks, (radio access, core network and applications) on-demand, according to cloud principles. The Mobile Cloud Network Service Provider (MCNSP) represents a new business role that is envisioned to offer and integrate these services and will work closely with other players (typically MNOs and Cloud Providers) to obtain the necessary capabilities to achieve this objective. The relationships between these roles and how they will unfold are still under investigation.

Each individual service, which the MCNSP is going to offer, needs to be explained precisely in order to generate scenarios that exploit their potential values. Therefore, conversations with experts who work specifically in the cloudification of the aforementioned services were carried out to grasp the necessary concepts to be used in the step 2 of the methodology. Some of the services that are being developed in the MCN Project are: Evolved Packet Core as a Service (EPCaaS), Radio Access Network as a Service (RANaaS), and Digital Signage System as a Service (DSSaaS).

In the following paragraphs each of these services is described based on the inputs obtained from the technical experts, taking special consideration in what is considered to be valuable information for the development of scenarios in step 3.

EPCaaS: The main feature provided by EPCaaS consists in the provision of **"customized connectivity"**, i.e. a customer who contracts this service has now the possibility to adapt the speed of connection, the number of users in a network, the prioritization of applications and users and the level of security, among other characteristics. In other words, the customer can now possess their own mobile network tailored to its needs. The fundamental advantage of EPCaaS compared to EPC is the speed of setting it up and its independence from certain resources, as the service can run anywhere in the cloud and it is not limited to a particular infrastructure.

The EPCaaS can also be offered as a stand-alone service provided that the customer has the means to connect their devices to the infrastructure where the EPC operates. The customer can whether connect through cables or wireless via the RAN.

RANaaS: RANaaS comprises the offering of RAN services on demand according to cloud principles. In this regard, RANaaS enables an MNO to enhance their radio access capabilities for certain areas in times when usage reaches its peak. This signifies a decline in Capital Expenditures (CAPEX) and Operational Expenditures (OPEX) related to the transmission to core services. Theoretically, the decrease in redundancy and the utilization of economies of scope would decrease the costs of maintenance for the provider of this service.

RANaaS can be customizable to a certain extent. The user can choose how many users can be connected or limit the amount of data to be transferred in a certain area. Nevertheless, the parameters that can be managed by the users are still under research at the moment.

DSSaaS: The DSS consists of a single or a set of electronic displays which are managed by a central server for informational or advertisement purposes.

DSSaaS is a service offered through the deployment of DSS in a cloud-based approach, consisting in a network of customizable displays that can be electronically administered and controlled using a computer. This customization allows content to be modified remotely aiming to convey messages efficiently and in a well-targeted fashion. The DSSaaS represents an example of an application that can be deployed using the RAN and EPC services.

The information acquired in step 1 serves as an input to compare the MCN technology with a list of technologies in step 2.

2. **Look into the list of Technologies with their respective values to find analogies between them and the innovative technology to be analyzed.**

The second step comprises the use of the list of innovations portrayed in Appendix: The list of Technology Examples. The values that derive from the technology examples are compared with what is known about the MCN Project, resulting in the generation of potential values for the technology under investigation. The outcomes of this comparison are shown in tables Table 12 to Table 17. The left side of each table comprises the values for the chosen technology example, whereas the right side shows the analogous value in the MCN Technology.

The numbers in squared brackets found on the right side of the table next to each value relate to the scenario of step 3 in which it was used, therefore it is not part of this step of the methodology. More details about how to generate the comparisons can be found in Chapter 2.

Example C2: Cloud Computing:

Values of Cloud Computing	**Potential Values of the MCN technology**
Pay per use, low cost compared with acquiring infrastructure (same functionality provided)	The cloudification of the services involves pay per use. (+) [1]
Complexity Reduction as IT is virtualized and maintenance is done by the provider.	Same concept for the MCN technology, the cloudification allows virtualization of hardware.(+) [1]
Adaptable, meet different service models (SaaS, PaaS, IaaS)	The MCN would offer only SaaS, as customers may not want to get involved in programming or handling infrastructure. (-), however, the offering can be adapted for different types of customers, e.g. individuals, applications providers, business customers, which require different types of mobile networks (+) [6]
Cloud Providers are new players that changed the business network allowing companies to outsource their infrastructure with their on-demand service. Synergies with other roles like applications providers and mobile operators enhanced the Cloud Provider offer.	The MCNSP becomes a new player. That will allow the outsourcing of mobile network infrastructure, thus creating change in the Business Network, creating interactions with Cloud Providers. (+) [2]

Table 12. Comparison of values between Cloud Computing and the MCN technology

Example S4: E-mail:

Values of the e-mail	Potential Values of the MCN technology
Faster than sending a normal letter, it is almost immediate.	How is the service instantiated? To whom is one to go? (?)The deployment of the service is definitely faster. [4]
Cost reduction close to zero due to its bundling with advertisements.	Can the cost be reduced to zero? Is it possible to have other revenue streams? (?) Some applications could be offered in a bundle together with the connectivity service [3, 10]
Different types of information can be sent e.g. sending digital media	Applications on top of the cloudified infrastructure could be envisioned (+), other applications for RANaaS? (?)
Independent from post office.	Independent from the infrastructure to run the core network. But now dependent from the MCNSP (+/-) [5]

Table 13. Comparison of values between E-mail and the MCN technology

Example A2: Plastic

Values of Plastic	Potential Values of the MCN technology
Can be molded into different products, bags, small containers, pipes, etc.	The configurations between services allow for different uses, flexibility can be offered as the RAN and EPC services can be combined in many ways, and with the services already possessed by a Business Customer. (+) [6]
Gradual cost reduction, eventually it was more economical than other materials	In this case the cost reduction is not gradual. Perhaps the price can decrease the more the technology is used. (+/-)

Table 14. Comparison of values between Plastics and the MCN technology

Example I1: Transistor Radios:

Values of Transistor Radios	Potential Values of the MCN technology
Portable, smaller size due to transistor technologies, independent of location.	The portability as such is not applicable, But the independence from location might be possible (immediate service wherever needed) (+) [7]
New customer segments, to which quality is not relevant.	Applications for which lower quality is sufficient can be envisioned that do not need speed for example. Perhaps some applications do not need high quality. New customer segment for the MCN Technology (Enterprises) (+) [8, 9]

Table 15. Comparison of values between Transistor Radios and the MCN technology

Example B2: iTunes

Values of iTunes	**Potential Values of the MCN technology**
New role in the business network (platform of ITunes), substituting record stores	New role in the business network (the MCNSP) (+/-)
Buying behavior changed (singles instead of albums)	Buying behavior also changes, the customer only buys what it needs instead of a predesigned package. Customization of the service. (+) [6]
Downloadable at any time.	Usable anytime. (+) [1]

Table 16. Comparison of values between iTunes and the MCN technology

Example E1: Internet:

Values of Internet	**Potential Values of the MCN technology**
Enables new applications (e-mail, e-commerce, VoIP, WWW)	It should enable new ways to deliver applications. (+) [9]
Easy access to information at any time.	MCN technology can be provided on demand (+) [1]
Abundant amount of information and content.	Abundant information could be collected to generate other revenue streams. (Big Data) (+) [11]
Entrepreneurs have more presence, easier advertisement	Dedicated advertisement. (+) [12]

Table 17. Comparison of values between Internet and the MCN technology

Each comparison produced in these tables could be analyzed separately, nevertheless, in order to avoid repetition as every example possesses a combination of Value Characteristics, the analysis is perform per Value Characteristic in order to highlight the most prominent values of the new technology.

Cost Reduction: The characteristic gains significance depending on how much the price of the service provided by the MCNSP can be reduced in comparison with normal connectivity, and whether the price/benefit relationship is acceptable for the end user. At this stage of the development, it is difficult to predict actual market prices to create a valid comparison, however, the on demand service, due to the pay per use revenue model of the C2 example (Cloud Computing), may represent savings for the customer. Example S4 (e-mail) helped to generate an idea about offering the product in a close to zero approach, provided that revenues are obtained from other sources.

Complexity Reduction: The process of creating a dedicated network for a customer is definitely faster with this technology; nonetheless, it is not instant as in the S4 example (e-mail). However, once the network is installed, the service can be used at any time. Another argument for Complexity Reduction is the virtualization of the infrastructure to create the mobile network as in the C2 example (Cloud Computing). The virtualization represents an optimal use of the assets of a business customer, outsourcing specialized resources to manage the network.

Adaptability: The context of the MCN Project allows for a great customization of variables that generates a great amount of applications. The degree of customization can be observed by the number of different scenarios in which the technology can be used; therefore, adaptability plays a central role for the MCN technology. This customizability is only possible because the different services offered by the MCN Project can be combined with one another, as polymers can be combined in different ways to create different kinds of plastics, an abstract comparison but still a valid one, in the A2 example (Plastics). Moreover, the fact that the business user is capable of adapt the network to its own needs grants an additional level of adaptability.

Furthermore, each service can be offered as a stand-alone service, which also generates adaptability since each service addresses a different problem.

Independence and Business Network Change: A change in the business network occurs due to the new MCNSP role. The buying behavior of the customer also changes since the purchase is based on the amount of resources used, in comparison with the B2 example (iTunes), where the customers only buy the songs they like, avoiding the purchase of a whole album. The quality of the data transmission does not need to be of high quality, as some applications and uses do not require that , in analogy to example I1 (transistor radios). Another branch of the independence characteristic can be perceived in the externalization of the infrastructure to create the mobile network from example C2 (Cloud Computing). In this case, the customer obtains independence from the device (infrastructure) and obtains it as a service, in concordance with the cloud principles present in the project. Paradoxically, this also creates a sense of dependency on the role of the MCNSP. It could be possible to eliminate this connection if the company operates the software for the EPC and run it on their own infrastructure.

Enablement: Control of information is another potential aspect of the MCNSP. It might be possible for business to collect information that can be monetized later, using Big Data. This possibility can be a revenue source that can reduce the price of the product as seen in example E1 (Internet). The combination of connectivity with applications could be further adapted to enable new technologies regarding the collection of Big Data. Furthermore, Big Data could also enable new tools to manage technology. New applications, collection of information and advertisement are all found in example E1 (Internet).

The values obtained in step 2 are necessary for the application of step 3 in the methodology, explained next.

3. **Create a scenario where the Value Characteristics takes an important role, considering the Value Proposition of a potential Business Model.**

The scenarios that are generated in this step are based on the Value Characteristics found during the comparisons of step 2. Twelve scenarios were created focusing on each particular value discussed in the last step, underlining key words in each scenario to ensure the value in them. To see from which value each scenario is derived, refer to tables Table 12 to Table 17, where a number in squared brackets addresses the scenario in which it was used. The scenarios created in this step are only a short overview that focuses on the Value Proposition in the ideation process for Business Models. More refined scenarios that take into consideration other Business Model elements are presented later in step 5.

Scenario 1: MCN on Demand

MCN on Demand consists in the provision of the MCN services on demand to any party interested, i.e. to obtain their own mobile network and configure it. The main value of the technology in this scenario is that the customer only pays for the resources they use.

Main Value Characteristic(s): Cost Reduction, Adaptability.

Scenario 2: MCNSP interacts with Cloud Providers to outsource infrastructure:

The MCNSP needs to work closely with other players to offer their services, the cooperation with Cloud Providers is very important to ensure that enough resources are available for the delivery of services as well as with support regarding cloud applications. The value for companies in this scenario is the possibility to outsource the mobile network infrastructure. The synergy obtained from the interaction between the MCNSP and the Cloud Providers enhances the value of the MCN services.

Main Value Characteristic(s): Business Network Change, Cost Reduction, Complexity Reduction, Independence.

Scenario 3: MCN for free:

MCN for free consists in the provision of the MCN services for free to any party interested. The main value proposition of this scenario is that the customer obtains the technology for free. However, the costs should be covered by other forms of revenue, either in the form of advertisements or data.

Main Value Characteristic(s): Cost Reduction.

Scenario 4: Immediate MCN Services:

Immediate MCN Services consists in the creation of the service at any moment requested within a small time frame. The value of the scenario relies in the possibility to use the service whenever required, as the MCNSP can react almost instantly to provide them.

Main Value Characteristic(s): Adaptability.

Scenario 5: MCN Software on Premise:

The scenario eliminates the connection between the MCNSP and the user by running the software on the premises of the client. The "cloud" would not be utilized as the user possesses all the tools to run the network themselves. The technology is more valuable to the customer in this scenario as it grants the customer even more freedom to adapt the network to its needs, at the expense of possessing the costly infrastructure to do so. The MCNSP would now support the customer with know-how for a better use of the software.

Main Value Characteristic(s): Adaptability, Independence.

Scenario 6: MCN Customized:

The adaptability value of the MCN technology takes a larger significance in this scenario. The MCN services can be offered in a flexible manner, so that the customer can customize their network by controlling the area in which the network will work, the number of users allowed, levels of security and authentication among other settings, the user can combine how much RAN they want to use, and the size of their core network. The MCN services can be combined in any configuration desired by the customer even to extreme cases where the EPCaaS or the RANaaS are offered as stand-alone services (i.e. the MCNSP offers only the EPC or the RAN)

Main Value Characteristic(s): Adaptability.

Scenario 7: MCN everywhere:

MCN everywhere deals with the opportunity to generate the MCN services in any location. The value of the technology in this scenario relies in that the mobile network can be provided anywhere as long as radio antennas are located in the desired area.

Main Value Characteristic(s): Adaptability.

Scenarios 8: M2M Application for Utility Providers

The M2M (Machine to Machine) Application for utility providers consists in the collection of information about the services they provide (water, electricity, gas, etc.) without the effort of going to each place and read a meter, saving resources for that activity. The value of the technology in this scenario lies in the wireless transmission itself, since the information was transmitted before in a more complicated way.

Main Value Characteristic(s): Complexity Reduction, Cost Reduction.

Scenario 9: M2M Application for households

In the M2M Application for households scenario, information about the status of certain appliances (lights in the living room, heating devices, etc.) is transmitted wireless to a central station. The devices can switch off automatically when no presence is sensed in the house, generating savings for the customer. The MCNSP also saves costs by managing many households at the same time (economies of scope).

Main Value Characteristic(s): Complexity Reduction, Cost Reduction.

Scenario 10: MCN delivers connectivity with apps in a bundle:

The MCNSP does not only provide connectivity to customers, as a normal MNO does, but it also creates generic applications for their customers, this generates value as the bonding of both offers reduces costs for the MCNSP (it is all offered as a bundle) but also for the customer who does not need to procure the applications separately.

Main Value Characteristic(s): Cost Reduction, Complexity Reduction.

Scenario 11: MCN generates Big Data

The MCNSP utilizes the data concerning location of the user, websites visited or time of connection can be used to create more user-oriented advertisements, or even to increase the efficiency in the usage of resources. The value of the technology in this scenario relies in the monetization of this information using Big Data tools.

Main Value Characteristic(s): Enablement, Cost Reduction.

Scenario 12: MCN offering an advertisement solution:

The MCNSP can offer its service for companies to advertise themselves using the mobile networks. The main value proposition of this scenario is related to the provision of an advertisement medium which has the possibility to change what is being displayed at will.

Main Value Characteristic(s): Cost Reduction.

An important remark in the creation of the scenarios is that they take the initial idea of the value from the technology example, and then evolve into their own argument, with the Value Characteristic embedded within them. Henceforth the initial value idea from the example scenarios are taken into a second plane and the scenarios will be used as the initial point of discussion with the other stakeholders. To achieve this level of comprehension, it was necessary to perform the first 2 steps to really grasp the value in the usage of the MCN Technology. The importance of proceeding in the creation of scenarios in this particular manner is that scenarios that do not rely on the technology capabilities, or that possess only “nice to have” features are avoided.

However, it is also important to comment that due to the complexity of this project, it is difficult to conceive a scenario which would take place in the future exactly as it was envisioned. In that regard, the scenarios that were created for the project serve more as a direction in which the technology could be developed. The scenarios still need some validation from Business and Technical Stakeholders, which was carried out in step 4 of the scenario, shown below.

4. **Discuss the scenario with technical and business experts to obtain relevant information regarding the value proposition and the Business Model in general.**

The discussion with the experts revealed that the majority of the scenarios are grounded in the capabilities of the MCN Technology, as expected. There are some remarks considering the viability of combining the scenarios to create stronger and more appealing ones, and some scenarios are not realistic enough, hence they are discarded. The scenarios that are not plausible are described first, explaining reasons behind it. Then, the scenarios that can be combined together to form a solid scenario are shown, and finally, the scenarios that would still need more elaboration to cover more aspects and can be considered as a plausible scenario for the MCN technology are presented.

Eliminated Scenarios:

Scenario 3: MCN for free: This scenario is very risky because even if there is a Business Model based about it, it is not guaranteed to be successful.

Scenario 5: MCN Software on Premise: This is not a valid model due to the complexity of the software, which is not a core activity of the customer. Therefore, they would outsource it.

Scenario 10: MCN delivers connectivity with apps in a bundle: In theory it looks like a good scenario where the bundling of connectivity with applications can in fact generate new products, but no practical examples of this scenario could be conceived, nevertheless, the bundle as such can still be offered.

Scenario 11: Big Data Scenario: The concept in the scenario has a great potential because Big Data is a trend gaining significance in the last years. There are no current developments of the MCNSP incorporating Big Data solutions but it has to be acknowledged because of their potential to become an important revenue source in the future, especially in the mobile network scenery. However, the scenario as such needs context, what type of data is going to be analyzed and how is it going to be monetized? Is there a concrete example? These questions are answered by applying Big Data in the other scenarios, where specific information can be collected and monetized effectively, Big Data will be treated as an add-on for the rest of the scenarios.

Combined Scenarios:

MCN on demand (Scenarios 1, 2, 4, 6 and 7): A strong case can be generated when these 5 scenarios are combined together, using the MCNSP potential. This business scenario can be a solid one to demonstrate the possibilities drawn from the combination of cloud computing with mobile networks. It will serve as a standard scenario that explains the capabilities of the MCN Technology.

M2M Scenario (Scenarios 8 and 9): This set of scenarios can also be combined into a single one that focus on the M2M services, where quality in the transmission of data is not that relevant, but other aspects can be adapted depending on the requirements of the customer. The M2M scenarios could be seen as a different configuration of the on demand attribute of the MCNSP since it requires its usage on a very short frame of time, exploiting the flexibility of the service. The scenario can be further enhanced by offering data transmission services to other potential customers, and not only Utility Providers.

Scenarios to be further developed:

Scenario 12: Advertisement solution through MCN: This application of the MCN technology for advertisement is a great solution for companies that want to have more presence in the market with the possibility to change the advertisements at will. It could be possible to take advantage of DSS technology to further elaborate this idea.

From 12 scenarios that were envisioned in step 3, it was narrowed down to 3 during the revision; however, the 3 scenarios that result from the feedback in this step will be more realistic. The improvement of the scenarios is written down in step 5.

5. Improve the scenario to include feedback and Business Model concepts.

The scenarios shown in this step are more thoroughly thought, enhancing the Value Proposition, understanding the changes that these scenarios create in the network, and visualizing how the value generated by the MCNSP is transferred to the customer, thus considering the main aspects of a Business Model. In that regard, the scenarios will contain five subsections, namely: value proposition, potential customers, infrastructure needed, revenue models and Big Data influence (as explained in step 4). The scenarios were elaborated together with technical partners in order to incorporate their ideas into it. To differentiate these scenarios from the previous ones, they will now be numbered with roman numerals.

Scenario I: MCN for Business Customers (Previous MCN on Demand)

Value Proposition:

The MCNSP solution allows a customer to be able to provide their services along with the connectivity through their own independent mobile network.

The technology leverages the values of Cloud Computing in these three aspects:

The customer only pays for the resources they use.

The provision of the network is almost immediate.

The network can be activated at any time required.

Additionally, the MCN technology allows the user to customize their networks, controlling the area in which the network will operate the number of users allowed, levels of security and authentication among other settings. The user can combine how much RAN they want to use, and the size of their core network.

To whom can it be addressed?

The advantages offered by the MCN technology will open a new market regarding the delivery of connectivity, enabling a customer to operate their own mobile network, which is very interesting for business customers; nevertheless, the offer might change depending on the nature of the business. Each size of company has their own needs and these are addressed next:

Small companies: They will be able to externalize their software, acquiring it as a service on demand. The technology is more appealing to these companies if they can have the software bundled with applications such as data management, voice, video, etc., because it would lower the costs in comparison to the acquisition of each application separately.

Medium companies: These companies can be found in more than one location worldwide. Additional to the advantage of saving the costs of purchasing the infrastructure they need as a service, these companies can also benefit by signing a single contract with the MCNSP for all the countries they are in.

Big companies: The MCN technology automates the infrastructure management. Currently there are high labor costs that can be eliminated to a certain extent with the introduction of automation. An alternative option exists for them to run the automation themselves; nevertheless other costs might appear in the form of highly-specialized personnel. The MCN technology is flexible enough to allow the combination of the services that the company uses with the cloud infrastructure provided by the MCNSP on demand.

Public administration: The public administration would utilize the service to transfer documents from one location to another, in a secure way, and for emergency services, which require a guaranteed Quality of Service (QoS), ensuring the transmission of information at all times.

What infrastructure is necessary to provide this service?

The MCNSP needs to provide RAN and EPC services to the customer to ensure basic mobile connectivity, along with cloud computing infrastructure to operate the mobile network.

What could be possible revenue models?

The service is intended to be offered under cloud principles, so the revenue model proposed for this scenario would be pay as you go, i.e. the customer only pays for the resources used, instead of for the maximum capacity rented. This revenue model is very typical in the cloud computing business.

Big Data Influence:

Big Data will allow the analysis of different parameters such as time of connection and usage of the services using the mobile devices to generate valuable information for the company. In this case, the data collected is related in how the service provided by the customer is used, detecting for example if there are some problems in the connection of a device acting accordingly. Other ways to use Big Data in this scenario are related to the offering of a better service by analyzing the behavior of the customer in the web. The application of Big Data has to consider the privacy of the users by aggregating pieces of data and eliminating any personal information in it. Therefore, high computational power is needed to generate these analyses.

Scenario II: M2M applications

Value Proposition:

This scenario entails the deployment of the MCN technology to enable the transmission of data from smart devices to data centers exploiting in this way the capabilities of the MCN technology, eliminating the need to collect the information manually. As the amount of data transmitted from a single device is not that large in comparison with other applications, the quality of the technology does not have to support a large bandwidth for that specific purpose and can be adapted so that the customer can decide in other types of solutions based on Big Data.

To whom can it be addressed?

The MCN technology can be used by any party interested in transmitting data automatically from one device to a data centre. Potential customers for this service are:

Utility Providers: The scenario is very interesting for them, as they need to measure the utilities they deliver to charge for them accordingly. In this case, the technology can be very valuable since the data is transmitted once or twice a month from a smart meter to a data centre where they could collect the data. The transmission of information in this regard is also useful to control appliances in households and in this way save resources. Information about the status of certain appliances (lights in the living room, heating devices, etc.) is transmitted so that the devices can switch off automatically when no presence is sensed in the house, generating savings for the customer. The MCNSP also saves costs by managing many households at the same time (economies of scope).

Climate Institutes: These customers could have remote access to their measurement equipment scatteredly located through an area to configure them remotely and retrieve information from them whenever needed.

Manufacturing companies: It can be an interesting service for them if they want to change the parameters of an automated line of production remotely, so that no personnel would be needed on site.

What infrastructure is necessary to provide this service?

The wireless transmission of data requires the utilization of the RAN services, however, depending on the requirements of the customer, not all the RAN infrastructure needs to be available for its usage in a particular moment, because the M2M devices are unlikely to move from location, therefore, the number of antennas and its location is known beforehand by the MCNSP, probably lowering operational costs. Core Network Infrastructure is also needed for this scenario, in order to organize the transmission of information and it can be designed to fit the requirements of the M2M scenario.

What could be possible revenue models?

The pay as you go model is very likely to fit in this scenario, because the amount of data transmitted is not that large, thus representing an appealing solution for the customer.

Big Data Influence:

The number of devices used in the M2M scenario can be very large, considering the area that it has to cover, in this regard, Big Data analytics can support in the following ways.

Maintenance measures: Big Data can aid in the management of the status of every device to apply corrective measures on time in case of failure.

Consumption trends: The analysis of the consumption of utilities in every household can help to predict when more resources are needed and act accordingly.

Scenario III: Broadcast Mobility Advertisement Solution (Previously Advertisement solution through MCN)

Value Proposition

The value proposition of the technology in this scenario focuses in offering DSSaaS to business customers for the purpose of providing commercial advertisement services through a suite of mobile connectivity with portable devices found in various premises such as: public spaces, transportation hubs, museums, stadiums, retail stores, hotels, restaurants and corporate buildings. The advertisements broadcasted in the electronic can be changed in every screen separately at any time.

To whom can it be addressed?

The advertisement solution is mainly addressed to business customers that want to promote their products and have control at all times of what is being broadcasted. This scenario offers its value to the same customers from scenario I, because the advertisement solution can be seen as a special application for the MCN on Demand.

What infrastructure is necessary to provide this service?

The MCNSP needs to provide RAN and EPC services to the customer to ensure basic mobile connectivity, along with cloud computing infrastructure to operate the mobile network. DSS infrastructure is also needed, the display screens and the central server.

What could be possible revenue models?

As a special application of the first scenario, it follows the same pay as you go revenue model.

Big Data Influence

The advertisement broadcasted on the electronic displays is controlled by the customer at will; however, the ad does not necessarily reflect what the viewer wants to see. With the use of small camera embedded in the screen, a computer can identify if the viewer is male or female and some other details like clothing to show specific advertisement that matches the target group of the viewer. The advertisement can also be interactive with touch screen technology. The viewer will have the choice to request more information about a product by just touching the screen.

References

adaptable. (2014). In oxforddictionaries.com. Retrieved March 3, 2014, from http://www.oxforddictionaries.com/definition/english/adaptable

Aerohive Networks. (2013). Public or Private Cloud: the choice is yours. Aerohive Networks, Inc.

Aktinson, C., et al., et al. (2000). Component-based software engineering: the KobrA approach. 3rd International Workshop on Component-based Software Engineering.

Allee, V. (2008). Value Network Analysis and Value Conversion of Tangible and Intangible Assets. Journal of Intellectual Caputal, 9(1), 5-24.

Body of European Regulators for Electronic Communications, Radio Espectrum Policy Group. (2011). BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks. BEREC/RSPG.

Bontemps, Y., et al., et al. [ed.] T. Männistö and T. Bosch. (2004). Semantics of FODA feature diagrams. ‘Proceedings SPLC 2004 Workshop on Software Variability Management for Product Derivation – Towards Tool Support. pp. 48-58.

Chanal, V., & Caron-Fasan, M.-L. (2007). How to explore new business models for technological innovation. Conférence de l'Association Internationale de Management Stratégique. Montreal.

Christensen, C. M. (1997). The Innovators Dilemma: When New Technologies Cause Great Firms to Fail. Boston: Harvard Business School Press.

Christensen, C. M., & Raynor, M. E. (2003). The Innovator's Solution: Creating and Sustaining Successful Growth. Boston, Massachusetts: Harvard Business Review Press.

Copeland, R., & Crespi, N (2011). Modelling multi-MNO business for MVNOs in their evolution to LTE, VoLTE & advanced policy. Berlin. Intelligence in Next Generation Networks (ICIN), 2011 15th International Conference on.

Covert, A (2009) Researchers Predict the Weather Using Cell Towers from Popular Science http://www.popsci.com/scitech/article/2009-07/researchers-find-way-predict-floods-using-cell-towers visited on 12.05.2014

Czarnecki and Eisenecker (2005) Generative Programming - Methods, Tools, and Applications. s.l. : Addison-Wesley

European Commission (2014a) How to get involved in EU Radio Spectrum Policy, retrieved May 12, 2014, from Digital Agenda from Europe, a Europe 2020 Initiative: http://ec.europa.eu/digital-agenda/en/how-get-involved-eu-radio-spectrum-policy (visited on 12.05.14)

European Commission (2014b) Promoting the shared use of Europe's radio spectrum, retrieved May 12, 2014, from Digital Agenda from Europe, a Europe 2020 Initiative https://ec.europa.eu/digital-agenda/en/promoting-shared-use-europes-radio-spectrum visited on 12.05.14)

Gassmann, O., Frankenberger, K., & Csik, M. (2013). The St. Gallen Business Model Navigator. St. Gallen: Institute of Technology Management, University of St. Gallen.

Informa Telecoms & Media. (2013). Small Cell Market Status. Dursley: Small Cell Forum Ltd.

Kang, et al., Feature-Orineted Domain Analysis (FODA) Feasibility Study. s.l. : Software Engineering Institute, 1990

Meteo Technology (2014). “Company Database” from Meteo – Technology.com http://www.meteo-technology.com/company_address.htm Visited on 16.05.14

Moore, G. E. (1965). Cramming More Components onto Integrated Circuits. Electronics, 114-117.

Mussbacher, G., Amyot, D., & Weiss, M. (2007). Visualizing Early Aspects with Use Case Maps (pp. 105–143). Springer US.

Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaires, Game Changers and Challengers. New Jersey: John Wiley & Sons, Inc., Hoboken.

Pateli, A. G., & Giaglis, G. M. (2005). Technology innovation-induced business model change: a contingency approach. Journal of Organizational Change Management, 167-183.

Pohl, Boeckle and Linden. (2005) Software Product Line Engineering. Foundations, Principles, and Techniques. Berlin: Springer.

Small Cell Forum. (2012) Small cells, what's the big idea? Femtocells are expanding beyond the home. Dursley : Small Cell Forum Ltd.

Stokes, P. D. (2005). Creativity from Constraints: The Psychology of Breakthrough. New York: Springer Publishing Company.

synergy. (2014). In Oxforddictionaries.com. Retrieved May 15, 2014, from http://www.oxforddictionaries.com/definition/english/synergy

Tel Aviv University (2009). "Cell Phone Towers Can Help Predict Big Floods." ScienceDaily. ScienceDaily, 14 July 2009. <www.sciencedaily.com/releases/2009/07/090706161304.htm>. Visited 16.05.2014

Weiss, David M. and Lai, Chi Tau Robert. (1999). Software Product-Line Engineering: A Family-Based Software Development Process. s.l. : Addison-Wesley.