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IDENTIFYING AND RANKING NEXT GENERATION NETWORK SERVICES

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THE ECONOMICS OF MEDIA AND TELECOMMUNICATIONS

PREFACE

This report presents the results of a study of future services on next generation telecommunication networks using a ranking-type Delphi method with two panels of experts from service provider and consulting firms respectively. The purpose of this study is to identify and rank services for next generation networks and provide a basis for further analysis of business models for these services.

The report is written as a deliverable of the SNF-project 6255, Debussy – "Designing Business Models for Customer Value in Heterogeneous Network Services". The report is a joint effort of the authors. Valuable inputs have been provided by all the experts in the data collection process of this study.

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ABSTRACT

As telecommunication networks are being transformed into next generation networks the communication and media landscapes are being reshaped, and a wider range of network services is expected to emerge. Technological development, deregulation and competition will probably introduce many more service suppliers than in the past, but little is known about what the service market will look like. By deploying a Delphi study using two panels of experts from the Nordic region - service providers and analysts - this paper develops a comprehensive list of 67 services organized into ten groups that are expected to be offered on the next generation networks over a time span of five to ten years. Each panel produced a rank-order list of services through an iterative feedback process. The two panels perceive, as anticipated, the future telecommunication services market differently. Among the identified services, the analysts agree that *Web-based computing* will be the most important service, while the service providers rank *Mobile broadband* as most important.

Keywords: Telecommunication, next generation networks, network services, the Delphi method.

1. Introduction

This paper investigates services to be offered on next generation networks in a time span of five to ten years. As we are moving from a telecommunication world characterized by single-service networks towards an information service world characterized by multiservice networks, it is expected that the converging technology will drive all information services towards a common infrastructure - the next generation network (NGN). The NGN is anticipated to utilize a wide range of current and future heterogeneous access networks and provide end-users with seamless services across these networks (e.g., Tachikawa, 2003; Hui & Young, 2003). The key principle of the NGN is the decoupling of services and networks, allowing them to be offered separately. Other characteristics are packet-based transfer, end-to-end quality of service, open interfaces and the provision of improved end-user mobility (Li & Sandrasegaran, 2005).

The scope, scale and importance of NGNs can best be understood by an analogy described by British Telecom (BT): "Imagine a single, integrated transportation infrastructure that allows passengers to travel from anywhere to any destination - regardless of whether they want to travel all or part of the journey by car, by train, on foot, by bus or airplane. The customers will have the power to make their own choices". This is what BT's 21CN program is setting out to achieve in communication.

A major driver for this change is the technical possibilities enabled by broadband access and the host of new services demanding Internet access. Other pressures arise from deregulation and competition (Huigen & Cave, 2008). Technological research conducted to fulfill the vision of NGN has been intense, and is expected to continue growing for the next years (Houssos, Gazis & Alonistioti, 2004).

The emergence of the new infrastructures that NGN brings will reshape the telecommunication as well as the media landscape. Deregulation is expected to introduce many more suppliers than in the past, and the NGN represents a real opportunity to service providers for growth and revenue creation. It is also expected that the future NGN will support a greater number and variety of services and applications than those supported by

legacy networks. These services and applications will have different characteristics and traverse unique sets of functions, databases and servers through the network (Richman & Pant, 2008). Service creation is fundamental to the promises of NGN, but there is still significant uncertainty as to what the service market of NGN will look like in the future. The purpose of this paper is to reduce this uncertainty. Our goal is to develop an authoritative list of services that will be offered on the future NGN. More precisely, our research questions are:

1. Which services will be offered on the next generation networks in a time span of five to ten years?
2. Which services are considered most important?

In order to approach these questions, and to identify, select and rank future network services, a ranking-type Delphi method (Schmidt, 1997) was chosen as the research method. Twenty-four experts, grouped into two panels - service providers and analysts - participated in this study. Based on the suggestions of the experts, a comprehensive list of 67 services, organized into 11 groups, has been compiled. Through a selection and ranking procedure, two independent ranked lists, one from each panel, were derived. From their list of 17 ranked services, the analysts agreed that *Web-based computing* will be the most important service on the new network. The service providers, on the other hand, ranked from a list of 21 services *mobile broadband* as most important.

The results from this study are relevant for many - networks operators, service developers and providers, investors, standards bodies and regulatory authorities - and may be used to understand the technical, market and business requirements for successful adoption of future services provided over heterogeneous networks. This paper will give the reader a reasonably good feel for what the future market of NGNs will bring. This paper proceeds as follows. First, it presents and discusses basic concepts based on a literature review. Next, it discusses the research methodology used, followed by a presentation and discussion of the complete list of services identified, as well as the results from the selection and ranking processes. The paper concludes by discussing results, possible explanations and limitations, and suggests implications for practice and future research.

2. Background: The Context

2.1 The next generation network

The past advances of telecommunications have brought us several autonomous networks, each with their unique services. In many countries, telecommunications have been traditionally provided by government controlled organizations. The dominating business model has been that almost all services on a network were provided from a single operator, vertically organized to perform almost all functions. Services were created in a proprietary manner (Kocan et al., 2002). Several major networks based on this approach exist today: the switched telephone network, the mobile phone network, the Internet and the television broadcast network. These networks constitute a critical infrastructure and are central to the national and global economy and daily life; their services and reliability affect us all. Telecommunication networks are a base for economic interaction and growth.

There is a strong push by service providers, network equipment vendors and industry consortia towards open distributed networks that can be utilized by all types of service providers and for a broad range of services. In addition, growing telecommunications privatization has encouraged competition, new services, new business models and lower prices (Richman & Pant, 2008). At present, there is a migration from these separate network architectures to common distributed layered network architectures.

The next generation network (NGN) is a conceptualization of this emerging technological and market development. The vision behind NGN is to move from a vertical approach, where access, control and services are closely tied, to a horizontal approach, where each network layer provides reusable elements to other layers (Bertin et al., 2007). The development of NGNs involves a transformation from a telecommunication world towards an information service world. The key cornerstone of the NGN is the decoupling of services and networks, allowing them to be offered separately. Other characteristics are packet-based transfer, end-to-end quality of service, open interfaces and the provision of improved end-user mobility (Li & Sandrasegaran, 2005). In addition, future networks will be more software driven than those at present. There will be a need to ensure that these software components will work together, and to have a controlled deployment, coordinated across all of the vendors.

ITU-T defines a next generation network (NGN) as:

> "*A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users*". (ITU-T, 2004)

The NGN concept can be seen as a broad concept encompassing development of new network technologies, new access infrastructures and new services, or as a more focused concept of specific network architecture, with one common IP core network deployed for current and future networks.

The major drivers for the development of NGNs are the technical possibilities enabled by broadband access and the host of new services demanding Internet access. NGAs arrive at a time when basic popular services, such as voice telephony, radio and television broadcasting, are extended to the Internet and new digital devices are making it possible for the consumers to use web-based services without any interaction with a PC. In this next phase of online life, access to the Internet will be embedded in new, broadband-enabled versions of familiar devices. "These devices - such as radio, TV sets and mobile handsets - will be user-friendly and central to everyday life of most households. Their functionality is also likely to evolve to support the delivery of a broader set of services" (Gaio, 2008).

As broadband access is becoming widely available, more attention is devoted to content and new network development is being driven by a range of different services, like VoIP, IPTV, VoD and smart home services (Editorial, 2007). NGNs are commonly built around the Internet protocol, and sometimes the term "all IP" is used for NGNs. The evolution of the NGN can be split into three areas: the access network (NGA), which refers to the implementation of new technologies (VDSL, fiber, etc.) in the access network; the core network, with nearly unlimited bandwidth in the backbone; and the service control platform. The NGN enables ubiquitous, real time, multimedia communications. The emergence of these

new infrastructures that NGNs bring reshapes the telecommunication as well as the media landscape. Future networks are expected to include many more vendors than in the past. Hence, more issues regarding software and hardware interoperability and consistency will exist (Richman & Pant, 2008). It is expected that the NGN's service market will be quite different from what exists today.

Other drivers are deregulation, competition and the ability to deploy new services. This development together with the fresh vision of the NGN will generate significant challenges in terms of operation, administration and maintenance of network and services (Li & Sandrasegaran, 2005).

The migration to NGNs will take years, and during this transition, applications and services will continue to originate and terminate on the existing separate networks that interface with the future networks (Richman & Pant, 2008). In this paper we talk about the NGN as a conceptualization of the new integrated network, but in practice, there will be a multitude of NGN implementations within and across nations with different attributes, characteristics and qualities.

2.2 Services on NGNs

In order to discuss and forecast future network services, the notion of service must be clarified. The term is used in a variety of ways, and a wide range of definitions exists. According to Cook et al. (1999), no single definition of service is capable of encompassing the full diversity of the fact. Services represent a large range of highly heterogeneous nonmanufacturing activities. In the words of Dowden et al. (2000), "*basically, anything a service provider can sell that is not equipment is a service*". However, services have some distinguishing characteristics: They are intangible, simultaneously produced and consumed, and often customized to a client's needs (de Jong et al., 2003). In our context we find the perspective of Grönroos (1990) constructive as he defines a service as "*an activity or a series of activities which are provided as solutions for customer problems*". When we are identifying future services provided by NGNs, they must be anchored in specific problems or needs that the users are facing.

An additional perspective that we find relevant for our research on future NGN services is presented by Kocan and colleagues (Kocan et al., 2002). They define service as "*a network capability or capabilities made available to end users, providers of the service, or other network elements*". In their expression, a service can be a capability provided by one network element and then used by other elements in the context of an end-user service or application. Their broad definition includes network capabilities that may never be seen by an end-user, but are used to create an end-user service. In this way a network service may be provided by an individual network element or a combination of network elements. In the future NGN, services will exist at all layers of the network. Some groups of services reside in a particular layer of the network, while other services span two or more layers. It is thus essential to create defined interfaces and use open standard APIs and protocols between layers to allow services to be utilized by other layers (Kocan et al., 2002).

The ability to more easily create and deploy new services is a major driver for movement towards the NGN (Kocan et al., 2002). It is expected that the NGN will support a greater number and variety of services and applications than those supported by legacy networks. We are beginning to see the development of new services based on new digital devices, making it possible for consumers to use a growing range of web-based services without any interaction with a PC. The future network endpoints will include intelligent devices such as personal digital assistants, smart phones that run commercial off-the-shelf operating systems, and web browsers (Richman & Pant, 2008). NGNs offer the user more bandwidth, more services and more intelligence at the terminal. Endpoint intelligence and the Internet represent the greatest opportunities for growth in future services. An essential feature of NGNs is that they are substantially better at two-way services, with significant uploading capabilities as well as downloading speeds (Digital Britain, 2009). Service creation is a fundamental aspect of the promise of the NGN, and specialized tools for developing and deploying new NGN services are emerging (Burns, 2008). These services and applications will have very different characteristics and traverse unique sets of functions, databases and servers through the network (Richman & Pant, 2008).

One of the first efforts to identify the services to be expected on NGN was made by ITU (ITU-T, 2003). Here, 16 service groups are listed: voice telephony, data services, multimedia

services, virtual private networks, public network computing, unified messaging, information brokering, electronic commerce, call center services, interactive gaming, distributed virtual reality and home managers. Ofcom presents a report on broadband developments based on new-generation access technologies, and claims that broadband has fundamentally changed how people work, communicate, access information and consume media services. According to Ofcom, examples of new services that NGAs or super-fast broadband might include are: "reliable high definition video; two-way video communications; simultaneous usage of broadband services by different householders; social inclusion for disabled people through new ways of communicating; new ways to access public service content and information, including health and education information" (Ofcom, 2008, pp. 1).

The literature surveys on the services presented above bear evidence more of the technological possibilities in NGNs than market applications and services. Also, the benefits are viewed from the supply side. Multiservice suppliers in the telecom sector are today facing a complex operating environment, with a multitude of networks to support the services they deliver in the market. To deploy, operate and manage these networks require large resources. At the same time revenues from their most traditional services, such as fixed telephone services, are shrinking. The imperatives to move towards NGNs are therefore strong.

Summing up, for this research we acknowledge the prevailing view of services as conceptual distinguished from products, but we allow for tangible characteristics to occur. We allow for services to reside at all networks layers, for some to span several layers, and understand that some services are consumed by other services thus making them invisible for the end-user. Additionally, when asking the experts about their view about future NGN services, we will expect them to focus on user problems and needs that are to be solved.

Despite the predictions given above, there is still a lot of uncertainty as to what the service market of NGNs will look like in the future. We need to know what kind of services we can expect in the future NGNs and which services will be important for the service providers to offer. Rather than search the literature and compose yet another list of example services, it was decided to do a scenario study using a disciplined approach.

3. Research method: The Delphi method

The aim of this study is to develop an authoritative list of services that will be offered on the next generation network in a time span of five to ten years. In order to identify, select and rank alternative future network services, a ranking-type Delphi method was chosen (Schmidt, 1997). The Delphi method is a widely employed and accepted method of establishing forecasts of future issues when experts are geographically dispersed (Story et al., 2001). The primary purpose of the Delphi method is to obtain the most reliable consensus of opinion of a group of experts, but not necessarily to elicit a single answer to a problem (Gupta & Clarke, 1996).

The Delphi method is a highly formalized method of communication between researchers and a panel of experts, and is designed to extract the maximum of unbiased information from the experts. The data collection process is anonymous and involves a number of rounds of data collection. The Delphi method is being increasingly used in many complex areas in which a consensus is to be reached. Since most readers of this journal are likely to be familiar with the Delphi method and its variations, a detailed description of this method is not given here. Readers interested in detailed descriptions and discussions of the Delphi method are referred to (Okoli & Pawlowski, 2004; Story et al., 2001; Schmidt, 1997; Rowe et al., 1991).

3.1 Composition of the panels (the expert panels)

The success of a study based on the Delphi method depends in particular on the selection of the expert panel. A Delphi study does not, however, depend on a statistical sample that attempts to be representative for a certain population. Delphi is a group decision method and requires highly qualified experts with thorough understanding and knowledge of the topic in question. Where do we find the experts of next generation network services and their drivers? The most experienced and knowledgeable persons in this field could be found either among people serving the market with advanced telecommunication and media services, or professional people following the market either as researchers or consultants. We anticipate that these two groups of experts have different views of the future NGN markets. To be able to poll the difference in opinion between them, two panels were established, one is called the service provider panel and the other is called the analyst panel. The selection of experts

followed the selection process presented in Okoli & Pawlokowski (2004). The following main criteria were used to establish the panels:

1. The service provider panel was recruited from experienced, high-level managers in Norwegian telecommunication companies and regulation authorities. The companies range from large incumbent operators to smaller broadband Internet services.

2. The analyst panel was recruited from well-known analysts, researchers and consultants in Denmark, Norway and Sweden.

We contacted experts by e-mail and by phone, and invited them to participate. In addition, we asked each addressee to nominate one other person well known of the field. Twenty-five analysts were invited to participate in the analyst panel, of which 11 accomplished the brainstorming phase. The service provider panel included 30 invited persons, of whom 13 remained after the brainstorming phase.

3.2 Data collection and analysis method

Data collection and analysis were based on the method provided by Schmidt (1997) and Schmidt et al. (2001), and were divided into three distinct phases as shown in Figure 1.
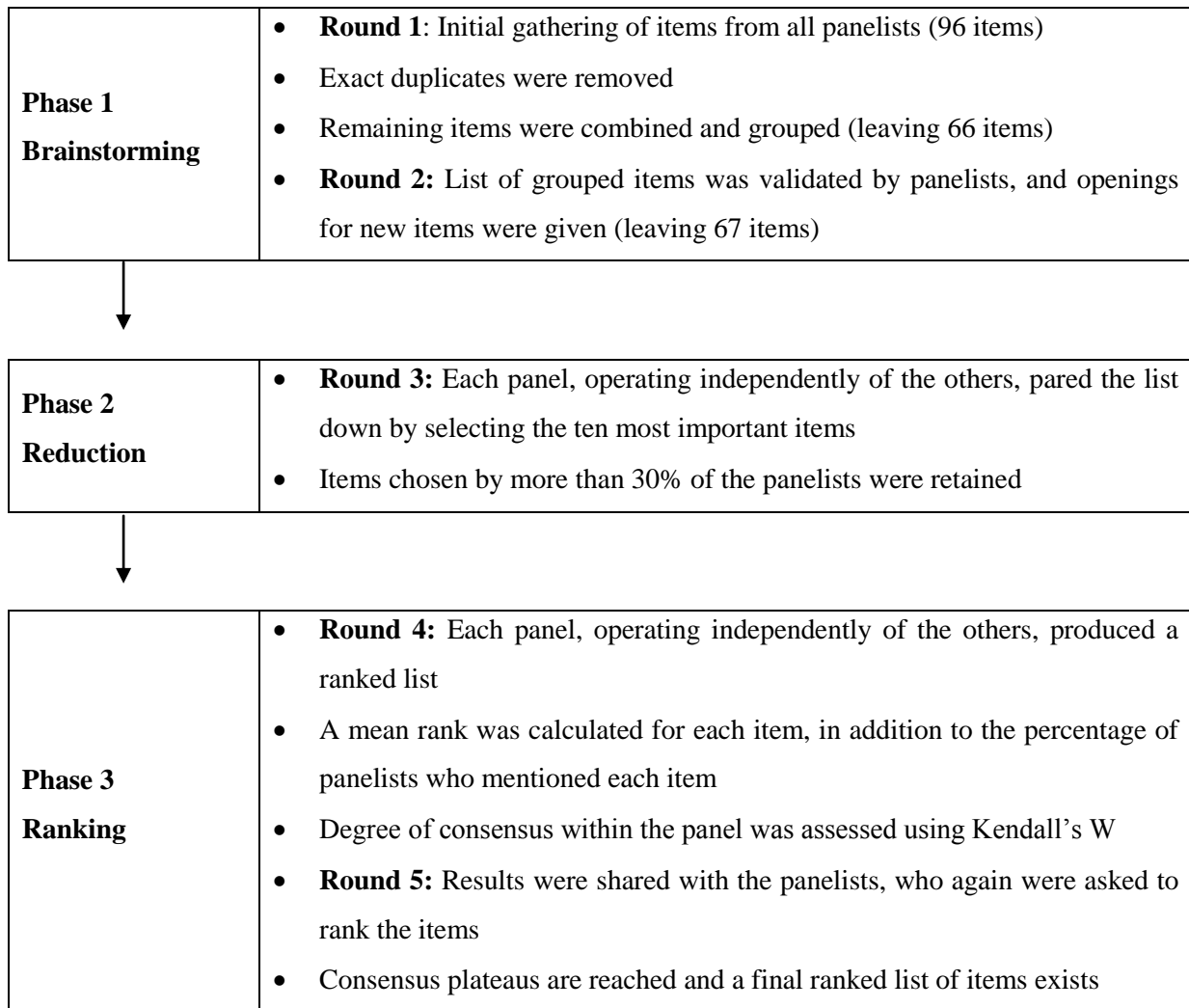
Phase 1 Brainstorming	• **Round 1**: Initial gathering of items from all panelists (96 items) • Exact duplicates were removed • Remaining items were combined and grouped (leaving 66 items) • **Round 2:** List of grouped items was validated by panelists, and openings for new items were given (leaving 67 items)

Phase 2 Reduction	• **Round 3:** Each panel, operating independently of the others, pared the list down by selecting the ten most important items • Items chosen by more than 30% of the panelists were retained

Phase 3 Ranking	• **Round 4:** Each panel, operating independently of the others, produced a ranked list • A mean rank was calculated for each item, in addition to the percentage of panelists who mentioned each item • Degree of consensus within the panel was assessed using Kendall's W • **Round 5:** Results were shared with the panelists, who again were asked to rank the items • Consensus plateaus are reached and a final ranked list of items exists

Figure 1: The data collection process used in this study. (Adapted from Schmidt, 1997, and Schmidt et al., 2001)

Phase 1: Brainstorming - identifying services

An invitation letter was first sent to a group of people knowledgeable in the field of tele-/media services either by working at providers of such services or as analysts, consultants or researchers, hereafter denoted as experts. The letter explained the research area of interest, the purpose of the research and the research method to be used, and the experts were asked to respond by e-mail to confirm their participation. Of the initial 55 candidates, 24 agreed to participate.

Then, a welcome letter was sent to each expert by e-mail, where they were asked to 1) identify at minimum six services that they expect will be offered on next generation networks within the next five to ten years. A plain document template was attached for the experts to fill in services. The purpose was to allow the individual experts freedom to identify the important issues from their point of view.

Two researchers worked independently to collate the responses from the panelists. Then the two independently constructed lists were compared and reconciled by the researchers working together. Duplicates were removed, reducing the total number of items proposed to a compiled list of 66 services. The compiled list was circulated to all panelists for corrections, additions and validation. For this purpose, each panelist received a special version of the list where his initial proposals were highlighted. Three new services were proposed, which, after a consolidation, resulted in a final list of 67 services.

Phase 2: Reduction - preparing for ranking

In the second phase, the experts were divided into two panels, service providers and analysts, allowing each panel to independently pare down the number of services. The purpose was to narrow the list to a manageable number of items, so that they, in the next phase, could be meaningfully ranked by the panelists. Each panelist received an e-mail with an attached randomized list of services and was requested to select (check off) at least ten services that he or she expected to be most important for next generation networks on a five-to-ten-year scale.

In order to narrow the list for ranking, services that were chosen as important by more than 30 percent of the panelists were retained. Through this procedure, the panels effectively reduced the initial list of 67 to a manageable size that reflected the opinion of importance within each panel. The analysts reduced the list to 17 services and the service providers reduced their list to 21 services.

Phase 3: Ranking

The ranking of the selected services was done in the third phase. Here, panels ranked the services in order of priority, that is, the top-ranked services would be the most important services offered in the next generation networks. The panelists were asked to select ten

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services from the list given to them; that is, the provider panel had 21 services on its list, and the analyst panel had 17 services. The ten selected services were then ranked from 1 to 10, where 1 is of highest importance and 10 is of lowest importance.

Three ranking rounds were conducted. Basically, the number of ranking rounds should be determined by each panel reaching an acceptable level of consensus. To measure the degree of consensus among the panelists, Kendall's coefficient of concordance (W) was used. Using Kendall's W, one can measure the relative strength of the consensus, make a realistic determination of whether any consensus has been reached and whether the consensus is increasing as the panelists receive information about the mean rank of each service as data are collected from the panelists round by round. Since the panelists rank 10 out of 21 services in one panel and 10 of 17 in the other, each panelist leaves some of the items unranked. We therefore use a modified formula for calculating Kendall's W proposed by Schmidt (1997). In his paper, Schmidt (1997) gives an interpretation of Kendall's W. According to this interpretation, W needs to be at least 0.5 for the panel to collectively have a "moderate agreement" on the ranking. In this study we almost reached this level after three rounds. Due to the marginal improvement in W reached by round three, we decided to stop the ranking after three rounds. To minimize bias ranking for the first round, the services to be ranked were provided in a different random order for each expert. Subsequently, the services were listed in the order of their adjusted mean value. For each service, mean value was adjusted for the number of panelists selecting the service for ranking. As consensus increased through the iterations, services that were not ranked by any of the panelists were treated as "missing cases" and deleted from the list.

4. Results

4.1 The NGN service list

The first objective of this research was to identify the services that will be offered on the next generation networks in a time span of five to ten years. Since NGNs are still is in an early phase of development, and since there is a lot of uncertainty about what the market situation of NGNs will look like, such an authoritative list of services may be of great value. The

complete list of important NGN services identified in phase 1 is presented in Table 1. The list of 67 services is organized into ten groups based on theme.

As may be expected, the list contains a blended mix of services: services which are well established in today's networks, services which are in an early phase of development and services which are futuristic. Those already established represent as anticipated the largest number. Within the consumer applications group, for example, services like *"Online ordering and payment of groceries and goods", "Online banking services"* and *"Online form-filling for public services"* are well institutionalized. In the multimedia services and entertainment group, we find, on the other hand, a number of services which are technical achievable, but where the market penetration for various reasons is low, like *"Interactive TV with personal video recorder (PVR)"*, *"Multiplay"*, *"Flat-rate pricing models"*, *"TV on mobile"*, *"Internet on TV sets"* and *" TV channels á la carte".* In the company services group, service proposals like *"Web-based computing"*, and *"Meta-information management"* are still under conceptual and technological development, and may sound futuristic to many. As far as we interpret the suggestions from the panelists, no services are entirely new.

The largest number of services relate to *multimedia services and entertainment*, with 17 identified services. Many of these relate to innovations in television, like *"Real-time distribution of events in high-definition 3-dimension"*, *"Interactive TV with personal video recorder"*, *"High-definition TV"*, *"Internet on TV sets"* and *"Hologram on TV"*. While others relate to suppliers' pricing models and governmental policies, like *"Flat pricing models"*, *"Channel-independent access to content"*, *"TV channels à la carte"* and *"Global 'broadcasters'"*.

The second largest number of services relate to what we have termed *consumer applications*. In this group we find 13 services, which include *"Online ordering and payment of groceries and goods", "Online banking services"*, *"Online form-filling for public services", etc.,* services which are already available to most end-users, especially in industrialized countries, and are labeled e-commerce, e-government and online banking.

The third major group, with seven services, is *communication and networks services*. In this group panelists proposed *"Unified communication"*, *"Mobile broadband"*, *"Internet by satellites"*, *"Voice over IP",* among others. Many of the services here have a technical flavor, and are less oriented towards a specific application.

Table 1: Full list of NGN services

1. *Company services*

1.1. **Web-based computing**. Scalable and virtualized computer resources provided as a service over the Internet. Also called cloud computing and Internet computing.

1.2. **Meta-information management**. Representing and providing unambiguous information about data. For exchange of data in an open and heterogeneous computing environment.

1.3. **Mobile video and game platforms for business services**.

1.4. **Multimedia cross-platform meeting systems**. Enable employees on different platforms to meet and share multimedia content.

1.5. **Collaboration tools based on social networking and Web 2.0.**

1.6. **Anywhere-playback of media files**. Access to convert and play media files on a portable device of choice over the Internet from anywhere.

1.7. **Field mobile computing**. Applications and solutions enabling mobile phones and specialized handhelds to be used as work tools in the field (out of office).

2. *Logistics*

2.1. **Real-time tracking of goods**. The use of RFID and sensors for logistics.

2.2. **Real-time quality control**. Tracking the origin of resources and of processes in a value chain; for example, for ensuring food safety.

3. *Quality of service*

3.1. **Secure communication over open networks**. To guarantee secure transmission of commercial communication and transactions over open networks.

3.2. **Prioritized communication in open networks**. To guarantee a certain bit rate level or response time for commercial communication and transactions over open networks.

3.3. **Online reporting of security management**. Customers get online access to information about managed security in order to verify agreed security standards.

3.4. **Online reporting of service quality**. Customers get online access to information about delivered service level in order to verify agreed service levels.

4. *Communication and network services*

4.1. **Unified communication**. Integrated solutions for use of multiple communication channels and collaborative modes.

4.2. **Mobile broadband**. Providing wireless high-speed Internet access through portable devices.

4.3. **Internet by satellites**. Use of a satellite dish for two-way data communication and IP multicasting.

4.4. **Voice over IP**. VoIP over several channels, including mobile VoIP.

4.5. **Communication based on Internet Packet Exchange (IPX).** The OSI-model network layer protocol providing network interconnection.

4.6. **Open operator-neutral fiber networks**. A network access model based on fiber where the infrastructure (platform) is owned by a network access company and services are provided by separate companies.

4.7. **Fixed-mobile telephony convergence**. Providing fixed and mobile telephone services using a single phone ad hoc switching between networks.

5. *Smart homes - Internet of things*

5.1. **Remote control of home functions and properties**. Relevant for air conditioning, alarms, VCRs, white goods and robots, as well as for commercial things like vending machines and feeding machines.

5.2. **Intelligent buyer agent**. A software agent participating in electronic markets, both in business and private domains. In the private domain this agent can be connected to refrigerator, freezer and a recipe database.

5.3. **Remote meter readings**. Meters in private homes are read remotely and automatically.

5.4. **Environmental surveillance over the Internet**. Web-based remote surveillance of environmental conditions like temperature, humidity and pollution.

6. *Consumer applications*

6.1. **Online ordering and payment of groceries and goods.**

6.2. **Online banking services**. The ability to perform balance checks, account transactions and payments over the Internet from a PC or a mobile device.

6.3. **Online form-filling for public services**. Internet portals where citizens can apply for public services and complete public reporting.

6.4. **Online access to advanced public services**. Economic crises, increasing unemployment and more demanding citizens will initiate large-scale public services development programs.

6.5. **Online ordering of additional output to existing products**. "Chip-tuned over the air." Requires flexible service levels and pricing models.

6.6. **24/7 self-service**. Firms are providing portals for customer self-service. Examples may be: ordering, changing subscriptions, controlling consumption and expenditures, etc.

6.7. **Near field communication services I**. Ticketing and payment from mobile devices.

6.8. **Near field communication services II**. Advertising and information services to mobile devices.

6.9. **3D virtual trial booths**. Web site for virtually trying out products, e.g., clothes.

6.10. **Home care services for elderly people via a mobile device**. For example, various alarm functions, telemedicine and other support services that make it easier for elderly people to live at home as long as they can.

6.11. **Virtual private networks for sharing of media content within defined groups of users**. May include a server for storing and managing media content.

6.12. **E-learning**. Education and learning supported by combining digital technologies like blogs, collaborative software and learning management systems.

6.13. **Electronic paper**. A technology for the display and transmission of content over a network. Example applications are e-books, e-magazines, electronic pricing labels, timetables at transport stations and billboards.

7. *Location- and context-based services and advertisements*

7.1. **Information about individual's presence and activity on the Internet**.

7.2. **Position-based services**. Two categories of applications relate to location: push of information and advertisements, and control with objects and people.

7.3. **Context-dependent services**. Applications that are context aware and that provide services related to specific situations and needs. Customer lock-in.

7.4. **Personalized services**. Services that collect and manage information related to a person and personal characteristics such as personification, health and behavior. May include sensitive data and affect privacy.

8. *Home-based private services*

8.1. **Family media center**. Centrally located media server reachable by the household's PCs, mobile devices, media streamers, etc., irrespective of location.

8.2. **Advanced setup box**. Setup box for recording, video on demand, video conferences and other time-shifting-based services.

8.3. **Remote control of set-top box via mobile and Internet**. A service that enables remote handling of set-top box.

8.4. **Thin client solutions for personal use**. Solutions that shift the load of processing, storage, management and security to a server.

8.5. **Entertainment machines with sense and feel attributes**. Increases the user's adventure in the game.

9. *Social computing*

9.1. **User-generated content**. Production and distribution of user-generated content across all types of terminal devices (PC, mobile, video, GPS) and across all types of media (video, film, text).

9.2. **Life log**. The logging of all personal media activities.

9.3. **Net-based socialization**. Using services such as Facebook, MySpace, Yahoo, etc., for creating, recreating and maintaining social conventions online.

9.4. **Adventures in virtual worlds**. A virtual world where users socialize in the forms of animated characters (e.g., Second life).

10. *Multimedia services and entertainment*

10.1. **Online ordering and renting of games, music and video**. Games, music and video are offered over a network, notably the Internet, to individuals or communities.

10.2. **Real-time distribution of events in high-definition 3-dimension**. The video format resolution is at least 720 vertical lines or more, presenting three-dimensional objects on the device.

10.3. **Online gaming**.

10.4. **Interactive TV with personal video recorder (PVR)**.

10.5. **Triple play**. Providing a bundle of voice, Internet and video over a single broadband connection.

10.6. **Multiplay**. Providing triple-play services added with mobile and a sensor-based network services (smart home surveillance services, etc.).

10.7. **Peer-to-peer network services**. A distributed system that provides file sharing without any centralized control or hierarchical organization, and where the software running at each node is equivalent in functionality.

10.8. **Flat-rate pricing models**. Unlimited use within a fixed time period to a fixed price.

10.9. **High-definition TV, 3-D TV, streaming of video in HD**. High-definition, 3-D video constantly received while delivered by the streaming provider.

10.10. **TV on mobile**. Television services delivered to subscribers on mobile devices.

10.11. **Internet on handheld devices**. Provide Internet browser on the mobile phone, which enables Internet access (Internet in the pocket).

10.12. **Internet on TV sets**. Using TV sets as terminals with access to Internet.

10.13. **TV on the Internet, Web TV**. Streaming video continuously downloaded from the Internet while it is being delivered by the streaming provider.

10.14. **Channel-independent access to content**. Users can access their files by any channel (fixed line, wireless, satellite, etc.).

10.15. **Hologram on TV.** Hologram technology enables images to change as the position and orientation of the viewing system changes in exactly the same way as if the object was still present, thus making the recorded image appear three-dimensional.

10.16. **TV channels à la carte**. Buying one TV channel at a time, rather than dealing in preset bundles.

10.17. **Global "broadcasters".** Streaming TV or on-demand TV distributed by peer-to-peer (P2P) networks.

4.2 Ranking of NGN services

Table 2 and Table 3 present the selections and the rankings round by round by each panel respectively.

Table 2: Ranking results, round by round: analysts

			Adjusted Mean Ranks		
Services					
Rank	**Label**	**Group**	**Round 1**	**Round 2**	**Round 3**
1	Web-based computing	1	2.90	1.70	1.30
2	Multimedia cross-platform meeting systems	1	4.40	3.80	3.60
3	Collaboration tools based on social networking & Web 2.0	1	4.90	4.10	3.80
4	Secure communication over open networks	3	5.10	3.80	4.00
5	Field mobile computing	1	7.80	6.10	5.60
6	Real-time tracking of goods	2	7.00	8.80	6.80
7	Mobile video and game platforms for business services	1	6.80	8.00	7.20
8	Family media center	8	7.60	7.00	7.50
9	Remote control of home functions and properties	5	8.60	10.80	9.40
10	Meta-information management	1	15.20	16.80	14.40
11	Environmental surveillance over the Internet	5	11.20	16.40	17.80
12	Remote meter readings	5	14.00	24.40	37.50
13	Electronic paper	6	17.80	16.90	40.00
14	Prioritized communication in open networks	3	27.80	47.50	50.00
15	Intelligent buyer agent	5	60.00	70.00	70.00
16	Online reporting of service quality	3	90.00	90.00	100.00
17	Online reporting of security management	3	26.70	32.50	m.c.
Kendall's W			0.162	0.261	0.293

Table 3: Ranking results, round by round: service providers

Services			Adjusted Mean Ranks		
Rank	**Label**	**Group**	**Round 1**	**Round 2**	**Round 3**
1	Mobile broadband	4	5.30	3.55	1.92
2	Channel-independent access to content	10	4.65	4.03	3.76
3	Internet on handheld devices	10	8.22	5.85	4.40
4	Open operator-neutral fiber networks	4	5.72	4.51	4.67
5	Secure communication over open networks	3	9.82	6.58	6.42
6	Voice over IP	4	8.94	7.38	7.28
7	Interactive TV with personal video recorder (PVR)	10	11.96	7.54	8.32
8	Real-time tracking of goods	2	15.44	8.49	10.14
9	Online ordering and payment of groceries and goods	6	10.35	11.14	12.59
10	TV on the Internet; Web TV	10	9.95	17.16	13.36
11	Remote control of home functions and properties	5	9.55	19.76	16.61
12	Remote meter readings	5	14.44	15.17	18.20
13	Online banking services	6	10.88	18.69	20.31
14	Near field communication services I. Ticketing and payment from mobile devices	6	23.11	14.81	20.80
15	User-generated content	9	13.72	20.31	26.81
16	Near field communication services II. Advertising and information services to mobile devices	6	14.56	24.38	28.89
17	Multimedia cross-platform meeting systems	1	13.53	21.84	33.22
18	Global "broadcasters"	10	12.64	27.63	52.00
19	Field mobile computing	1	34.67	104.00	58.50
20	Position-based services	7	21.13	52.00	130.00
21	Family media center	8	21.32	26.00	m.c.*
Kendall's W			0.206	0.375	0.404

*m.c.: missing case (not ranked by any panelist)

As the two tables demonstrate, the majority of services selected by one panel for ranking were not selected by the other. For example, the service providers ranked "*Mobile broadband*" and "*Channel-independent access to content*" as their top two services, but these services were not selected by the analysts. Conversely, the analysts ranked "*Web-based computing*" as their

most important service, a service which was not included in the providers' selection. This supports our initial supposition that different actors evaluate the future service market for NGNs differently. By analyzing the two lists, we find that only seven services are common to both lists, and they are ranked quite differently.

By studying those 17 services ranked only by the analysts, we see that these experts have primarily selected and prioritized services which are firm- and business-oriented: *Company services* (6), *Quality of service* (4), *Logistics* (1). Eleven of the 17 services have this orientation. The analysts also believe that applications for homes and machine-to-machine solutions are highly relevant. Five services within the *Smart homes - Internet of things* group are selected. The more technical oriented services found in the *Communication and networks services* and *Multimedia services and entertainment* groups are not emphasized by this panel. If we are doing the same analysis for those services ranked by the providers, we find that they prioritize quite differently. These experts have primarily selected and prioritized consumer-oriented services: *Multimedia services and entertainment* (5), *Consumer applications* (4), *Communication and network services* (3) and *Smart homes - Internet of things* (2).

Interestingly, services within the *Social computing*, *Home-based private services* and *Location- and context-based services and advertisement* groups are not emphasized in either panel.

To understand more deeply to what extent the experts agreed on the relative importance of the various services, we compared their rankings within each panel statistically. The final level of consensus for the analysts is low (W=0.293), while that for the service providers is somewhat stronger (W=0.404), both, however, indicating rather weak agreements on the rankings within each panel.

In Table 4, the seven common services are summerized in ranked order. This ranking is based on merging the two panels' rankings of these services. Thus we have the seven services judged by 23 panelists. The ranking is based on adjusted mean rank, similar to the ranking of each panel above. To be able to calculate the degree of concordance using Kendall's W coefficient, the ranking has been adjusted to a 7-point scale and not the 10-point scale used

earlier since we have only seven services. Kendall's W is here calculated to 0.300, which again indicates weak agreement among the panelists.

To evaluate the degree of similarity between the provider panel and the analyst panel in ranking the seven common services, we use Kendall's rank correlation coefficient (T). The rank correlation coefficient for the two panels is calculated to T=0.143, indicating that the two panels weakly agree on their ranking of these seven services. This is confirmed by visually inspecting the ranking of the two panels in Table 4. Only two of the seven common services are ranked among the top ten services by the providers (rank 5 and 8), while six of the seven services are ranked among the top ten by the analysts.

Another interesting feature observed is that these seven services are distributed almost evenly on five of the 11 major service groups: *Company services* (2), *Smart homes - Internet of things* (2), *Quality of service (1)*, *Logistics* (1) and *Home-based private services (1)*. Interestingly, the first four services are business oriented, while the last three are consumer oriented.

Table 4: Ranking results, seven round by round: service providers

Ranking	Services	Group	Analysts' rank	Providers' rank
1	Secure communication over open networks	3	4	5
2	Multimedia cross-platform meeting systems	1	2	17
3	Real-time tracking of goods	2	6	8
4	Field mobile computing	1	5	19
5	Remote control of home functions and properties	5	9	11
6	Family media center	8	8	21
7	Remote meter readings	5	12	12

5. Discussion and implications

As anticipated, the two panels perceive the future telecommunication services market differently. From the list of services generated in the brainstorming phase by all experts (Table 1), the two panels select and rank services (Table 2 and Table 3) from very different service groups. While the service provider representatives have chosen their services from more consumer-oriented groups like *Smart homes* and *Multimedia services and entertainment*, the analysts have selected their services primarily from business-oriented groups. If we narrow our view to the ten highest-ranked services in the two ranking lists, we find that the provider panel has chosen six services from group 1, C*ompany services*, of which three are the top three ranked, while the analyst panel has selected four services from the *Multimedia services and entertainment* group and three services from the *Communication and network services* group. To further underscore the difference between the two panels we can look at Table 4, the ranking list of the seven services common to the two panels. Here, only one service is ranked among the ten highest by the providers, while six of these services are among the ten highest-ranked services by the analysts. It looks like the providers are more focused on the consumer market, while the analysts see the business market as most important for future NGN services. Our statistical analysis of the degree of similarity (Kendall's T) of the ranks given by the two panels of the seven common services confirms rather low correspondence between the two panels. It should also be noted that the consensus among the panelists within both panels is weak (Kendall's W).

There are several explanations to these variations.

Let us recall the questions presented to the panelists: Which services will be offered on next generation networks in a time span of five to ten years, and which services will be considered most important?

Firstly, NGN is a broad term describing some key architectural evolutions in tele-communication core and access networks that will be deployed over the next five to ten years. There is no universally agreed definition of NGN, and its evolutionary features are open for both existing services as well as unknown future services to be carried on these networks.

Furthermore, service is likewise a broad term, and, as noted above, no single definition of a service is capable of encompassing the full diversity of services. In practice, we find a wide range of definitions. Although we initially provided our experts with a description of NGNs, the experts' identification, selection and ranking of services offered on NGNs are affected by their own interpretations of the two terms NGN and service. These aspects may explain some of the variations found within each panel and between the two panels.

Secondly, we are asking for events occurring within a time span of five to ten years. The minds of the panelists will be influenced by their daily working contexts, educational backgrounds and working experiences. It seems that the service providers tend to prioritize services closely related to their current business operations. Conversely, the analysts are more focused on company services, which may be explained by the fact that analysts earn their income by giving advice to businesses. Furthermore, it is not inconceivable that the service providers may have a shorter time horizon than the analysts. These contextual factors may influence their choice of services and ranking, and explain variations between the two panels.

Thirdly, the long time span imposes great uncertainty on the panelists in both panels. Future services on NGNs in this perspective are dependent on many unknown variables, such as future sociological and economical factors, as well as new technological developments, applications and business models not easily and equally known by the panelists. This may explain both intra-panel and inter-panel variations.

In sum, NGN and services are fuzzy concepts, the panelists have various working contexts and the domain is complex in terms of rapid technological developments. These factors may explain the variations found. On the other hand, our experts are among those who will bring the future NGN with its infrastructure and services to the market. The variations in background and interpretations have enriched our results by widening the scope of services under consideration.

5.1 Implications for practice

This study reveals information about services in the next generation networks that has several implications for practitioners. The list of 67 services identified by our panelists provides a

good checklist for service providers in their choice of market positioning and strategies in next generation networks. Also, the different profiles of the two panels, analysts versus service providers, and their different selection and ranking of services should be thought provoking. Are the service providers too narrow-minded in terms of scope and time horizon? Perhaps the two ranking lists can be seen along the time dimension where the service provider list represents the near-term services, while the analyst list represents the longer-term services. It is also worth noticing the two highest-ranked services by the analysts and service providers respectively, viz. *Web-based computing* and *Mobile broadband*. Web-based computing implies that resources are scattered around and can be accessed by the Internet, and is seen as a new paradigm of computing with implications not only for service providers of tele-/media services. Mobile broadband includes various types of wireless high-speed internet access. The rapid expansion of WiMAX and the developments in 4G technologies such as LTE create new opportunities for service providers. These developments will change the working environment of end-users in companies and in private. Regulatory agencies will have to address the new challenges of competition, privacy and security in the service provider markets. Furthermore, issues such as interconnection, licensing, QoS and infrastructure versus service competition are some other regulatory issues to be dealt with. Finally, web-based computing constitutes a new computing paradigm and will have effects on the education of information system specialists and application developers.

5.2 Implications for research

The panels used in this Delphi study were recruited from the telecom and media businesses, primarily in Norway. The panelists were experienced persons either employed by service providers or as researchers and consultants, thus recognized as experts in the domain. There are two limitations regarding the sampling of experts: 1) their geographical location, and 2) their age. To gain more general knowledge about future services in NGNs, a similar study should be carried out in other parts of the world, preferably in the United States and in Asia. Furthermore, there are age variations with respect to mastering the new computer facilities. Therefore, it would be interesting to carry out a similar study with a panel of youths to see what services they see on the NGN.

Methlie & Pedersen (2008) studied the relationships between structural market conditions, business model choices and customer values of mobile data services, and explored the chain of causality empirically of these relationships. The drivers of NGN services can be found in the structural conditions where technological developments, regulatory regimes and socioeconomic factors will all influence the future markets of these services. For the business models of NGN services, providers will have to develop new platforms serving applications that are driven not just by the characteristics of the service itself, but also by network effects that are either user- or service-complement-driven. Thus, for new services such as Web-based computing on NGNs, we need research on what the new business models will look like and what the new rules of competitive advantage will be. Furthermore, a number of regulatory issues arise from the technological changes in the NGN that will require research on new regulatory regimes (de Streel, 2008; Dodd et al., 2009).

6. Conclusions

The aim of this study has been to develop an authoritative list of services that will be offered on the next generation networks in a time span of five to ten years. First, we used a systematic procedure to elicit and define a list of 67 NGN services organized into ten groups. Since the list is based on input from 23 experts engaged in telecommunication and media services, we are fairly confident that the list is comprehensive and well grounded. The list constitutes a valuable reference for the future NGN service market. Two panels, one consisting of ten telecommunication analysts, and the other consisting of 13 service provider representatives, were selected, and they ranked services by a rigorous data collection method known as a ranking-type Delphi survey (Schmidt, 1997). Two independent rank-order lists, one from each panel, were produced.

As the two groups of panelists represent two distinctively different roles in the telecommunication market, we were right when we first anticipated that their predictions would be different. Of the initial 67 services, only seven services selected were common to both panels, and they disagreed on their ranking. It is therefore not possible, combining the views of the two panels, to nominate the future "killer applications". If we study each list

separately, however, we find that each panel has nominated one service with a mean rank far better than the others. The analysts agree that *Web-based computing* will be the most important service on the new network. These experts consider the new style of computing, where scalable and virtualized resources are provided over the Internet, to be the most important network service for the future. The service providers, on the other hand, agree that *Mobile broadband* will be the most important. These experts believe that this already popular technology for getting access to the Internet, both by companies and households will become the most important network service for the near future.

Limitations of the study

This study is based on a Delphi method with a limited number of experts. Subjects were chosen for their knowledge and experience in telecommunication and telecommunication services, and we do not claim that they constitute a representative sample. The Delphi method is one of the most popular forecasting techniques available and has been applied in various disciplines, including technology, healthcare and marketing (Gupta & Clarke, 1996). The method, however, is not without limitations and has also been criticized for its methodological inadequacies (Story et al., 2001). One problem is how to measure expertise. Although we have been careful to establish panels with persons who have thorough understanding and knowledge of the topic in question, there are no procedures for ranking and measuring their expertise level. Another debated question is whether group opinion is superior to individual opinion, and how to combine individual opinions. We find, however, the Delphi method a suitable method for this study. Our purpose is to compose a rank-order list of services based on group opinion. Another methodological issue is the mode of communication between the experts and the researchers. E-mail, as applied in this study, is a resource and time-effective communication channel, but also a narrow channel. Since our experts are geographically dispersed and difficult to reach with synchronous communication means because of job characteristics, we see no other way of communicating with them.

The study has been conducted within a Nordic context - the experts reside in this region and their knowledge and perception of telecommunication, networks, services, as well as economic, political, social and regulatory factors are based on this relation. An aspect of this is that the Scandinavian countries score high on most indexes related to technology

expenditures and penetration; for example, when it comes to households with broadband access (OECD, 2004). This is likely to influence the experts' perceptions and suggestions.

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Vitae

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