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Introduction

Today, traditional telecom operators are facing two life-and-death challenges brought about by competition and technology:

- Challenge 1: Internet Service Providers (ISP) providing communication services based on the Internet Protocol (IP) are replacing traditional telecom services, not only at lower costs but also with enhanced features and almost unlimited potential.
- Challenge 2: overwhelming technology development on the one hand complicates the infrastructure investment decision but on the other hand enables competition as more players enter the telecom market.

However, nothing will happen overnight. There are ways for operators to survive these challenges: challenge 1 – the telecom operator should *become more than an ISP*; and challenge 2 – the telecom operator should *apply a model of operation driven by the needs of customers*.

1.1 CHALLENGE 1: TO BECOME MORE THAN AN ISP

ISP provide various IP-based communication services that are software-enabled and which they can therefore deploy rapidly and widely in various ways. However, as ISP services are delivered to customers over the physical networks of incumbent telecom operators, the quality of service delivered or the service

Next Generation Networks: Perspectives and Potentials Jingming Li Salina and Pascal Salina

experience perceived by the customer relies heavily on the performance of the underlying transport network. Therefore, ISP cannot fully guarantee the service quality delivered to customers.

In contrast, a telecom operator has the control of service quality in its hands and can seize this advantage to become more than an ISP. For some time traditional telecom operators have tried to provide ISP services; however, in spite of following the mainstream ISPs, the innovative spirit of the latter has not yet been incorporated by operators. Subject to willpower and effort, it will be only a question of time before telecom operators catch up with ISP in terms of IP-based services.

The way for a telecom operator to outrun an ISP is:

- to master the performance control of its underlying network, which goes beyond keeping the network working, as happens today;
- to be more innovative and aggressive than the ISP in creating and delivering IP-based services.

1.2 CHALLENGE 2: TO APPLY A MODEL OF OPERATION DRIVEN BY CUSTOMER NEEDS

The telecommunications industry has entered a new era. The level of technology development exceeds the level of customer desire, as represented on Figure 1.1, and the difference between the two is increasing rapidly.

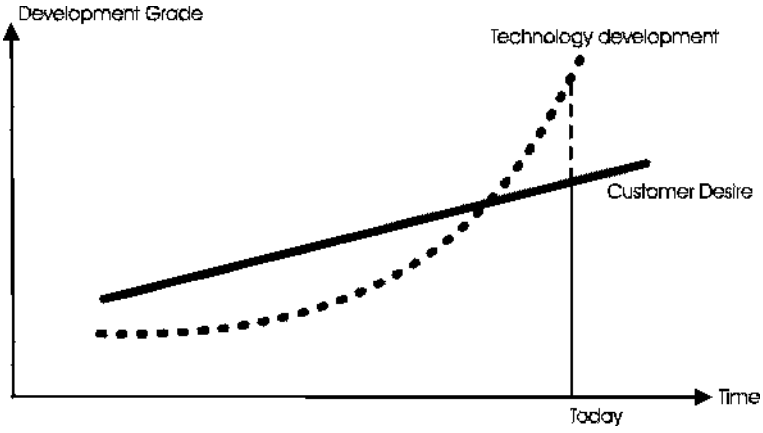

Figure 1.1 Technology development vs customer desire

The current boom in technology development expands the playground of telecom operators, but also makes its investment in infrastructure more complex. Furthermore, it empowers new players.

How to retain customers with adequate investment has become the central question an operator must answer, in order to stay at the front of this increasingly competitive market. This leads to a change in the operation model from a technology-driven to a customer-need-driven model.

1.2.1 The Technology-driven Operation Model

The technology-driven model is well suited in a period when the technical development lags behind customer needs, as indicated in Figure 1.1, before the crossing point. In this situation, a newly developed technology fulfils the customer's practical needs and can therefore be adopted immediately, even without marketing stimulation. A typical example is mobile telephony, where the feature 'mobility' serves the practical need of the general customer if not of every customer.

Under the technology-driven model, the focus is on the technology. The infrastructure vendors control the telecom industry in the following ways:

- Vendors guide and master the technology development and build the infrastructure with services for operators.
- Operators follow the development, introduce the technology when it is mature and keep it working.
- Customers subscribe to an operator and are served with services coming with the infrastructure; technically all customers are treated equally on a first-come, first-served basis.

In short, the technology-driven model puts the vendor in the driver's seat. The control chain Vendor $\rightarrow$ Operator $\rightarrow$ Customer describes the model.

The role of operator is rather simple and passive: buy an infrastructure and keep it working. The operator's strategy reduces to when and how fast to introduce a new technology. Owning the latest technology and setting prices as low as possible for the same technology drives the competition among operators.

1.2.2 The Operation Model Driven by Customer Needs

Thanks to a rapid and constant development of technology, the world of telecom has entered a new era, graphically located after the crossing point in Figure 1.1.

In this domain, the newly developed technologies are beyond the practical need of most customers and their adoption is very selective. A typical example is the overwhelming emergence of mobile and wireless access technologies such as UMTS, HSPA, LTE, WiMAX, Flash-OFDM and Wireless MeshNetwork.

Under these circumstances, continuing with the technology-driven model would mean unaffordable investments and nevertheless unavoidable customer losses. It is therefore advisable to switch to an operation model centred on the needs of customers, which we will call the customer-needs-driven model.

The customer-needs-driven model suggests that operators focus on the service value brought to the customers; for instance services which improve the quality of life or which bring a new life experience. Under the customer-needs-driven model, the operator is the driver of the telecom industry. The relationship Customer → Operator → Vendor describes this model.

This change of paradigm requires:

- a vendor to focus more on the product and solution development in an innovative, fast-to-market and cost-effective way, besides understanding the needs and requirements of the operator.
- an operator to make tremendous efforts to
  - constantly study the *practical and potential needs of its customers* in order to build up a clear business vision and strategy;
  - thoroughly understand *the essence of existing and emerging technologies* in order to make the right choice for the development of infrastructure;
  - satisfy customers in a differentiated way – this requires
    (a) a flexibility to add and remove services according to the actual needs of customers;
    (b) a real-time manageability to guarantee the service according to a service level agreement (SLA);
    (c) a customer self-care including on-line subscription, service provisioning, account checking, etc.
  - behave in a responsible way towards the society and the environment, taking its corporate responsibility seriously and thus building up trust and winning the heart of the customer;
  - set requirements for new products and new solutions for vendors.

In summary, under the technology-driven model, the fundamental questions to answer are what can be sold to customers based on installed or upcoming technology and how and when to sell.

Under the customer-needs-driven model, the fundamental questions for an operator are what the current and the potential needs of the customers are

and which technology can or will enable an operator to satisfy the identified customer needs.

1.3 NGN – THE HOLY GRAIL FOR A TELECOM OPERATOR?

How can a traditional operator become more than an ISP and how can it operate with the customer-needs-driven model?

The concept of NGN (Next Generation Networks) has been initiated and designed for traditional telecom operators to become more than ISP and to operate with the customer-needs-driven model in order to survive the challenges mentioned in the first paragraph. It brings fundamental changes to service network architecture and service network management. Figure 1.2 illustrates the architecture of NGN.

Service Network Architecture

The NGN service network architecture is based on information and communication technology (ICT), where the information technology part (IT) is mainly devoted to creating and delivering service and the communication technology part (CT) is for transporting data.

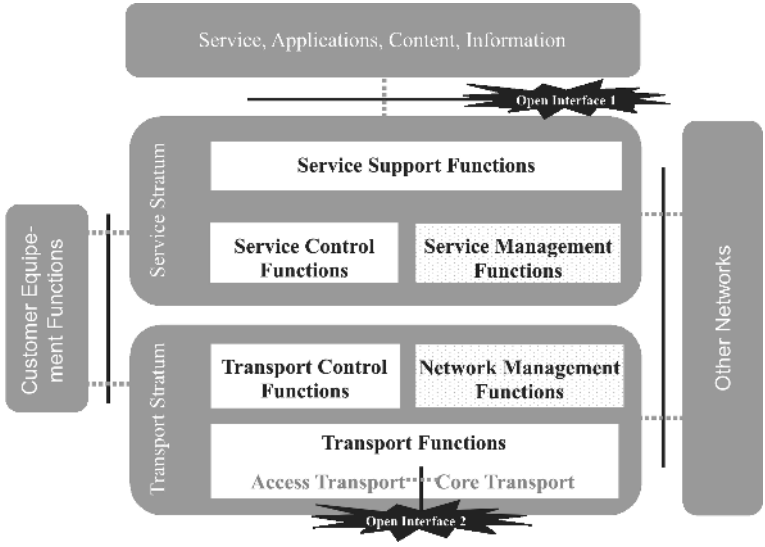

Figure 1.2 NGN service network architecture and management. Reproduced with the kind permission of ITU

The distinguishing characteristics of this service network architecture are:

- the separation of service layer and transport layer, thus enabling operators to add, upgrade and remove services without touching the transport network, and setting the conditions for an unlimited potential for IP-based services;
- the open interface between service creation and service delivery (indicated as open interface 1 in Figure 1.2) that enables a standardized way of creating services – this feature opens the door to many new providers, including consumers for advanced service, application, content and information;
- the open interface between the core and access network (indicated as open interface 2 in Figure 1.2) furthermore enables
    - the addition or the removal of an access network without changing the core network;
    - the provision of the same service through all kinds of access networks, although with a service quality that can be different.
- The customer equipment can be an end-user device, a home or vehicle LAN gateway, a corporate network gateway, a sensor or a machine.

Service Network Management

The NGN service network management is end-to-end, from customer management → service management → terminal management → network management → server farm management. The end-to-end management can be grouped into two parts, located on the service and the transport strata. The two parts communicate with each other in real time to fulfil real-time and customer-oriented management.

- The management on the service stratum is responsible for delivering services with a sufficient quality to end users by first setting up the performance requirements for the transport stratum and second monitoring the service quality received at the customer end. The performance requirements are set according to service priority, service quality requirements, customer subscription, actual customer SLA satisfaction level and the business relationship with the service provider.
- The management on the transport stratum is in charge of assigning adequate network resources for end-to-end transportation and guaranteeing the performance thereof. The network resource is allocated in an optimized manner according to the performance requirements from the service stratum, the network resource availability, the terminal capability, etc.
- A proactive management of the network performance is provided, where the performance data are measured along the end-to-end transport chain and analysed in real time, and action is generated when necessary as follows:

- When a problem is detected, the relevant information is generated and delivered to the relevant teams, which are:
  (a) a management team, supplied with information on service impact and financial consequences;
  (b) a customer care team, requiring explanation and description of the problem, delay, repair time, etc.;
  (c) an operation team, that needs information on the cause of problem and the level of emergency to be resolved.
- When a problem is predicted, a preventive measure should be activated to prevent the problem occurring.
- When a customer has difficulty in running the requested service, adequate software is sent to the terminal.

- Terminal management is provided to enable the requested service using the correct configuration and adequate software.
- Third-party service management includes discovery, registration and use of the network services provided by an operator.

The NGN thus enables virtually unlimited IP-based services, far beyond an imagination that is certainly shaped and bound by today's available telecommunications, broadcasting and Internet services. Therefore, operators should not consider NGN simply as an upgrade or another novel network technology to follow. NGN represents a tremendous step ahead of today's networks and many new developments are still needed. However, the NGN concept and philosophy should be clear enough today for operators to orient their efforts and shape their network's evolution.

Today, several standards bodies, including ITU-T, ETSI, ATIS and CJK, actively standardize and specify the technical features of NGN. However, these on-going works address only the early features of NGN, which represent more an improvement of today's network than the fundamental changes that potentially can be included in the concept of NGN.

1.4 NGN AIMS AT IMPROVING LIFE QUALITY AND BRINGING NEW LIFE EXPERIENCE

NGN was designed as a solution for operators to take up the challenges of competition and technology – and ends up with the potential to bring much more to human beings than we can imagine today. By networking everybody and everything on the earth, below the surface of the seas and in space, NGN offers the possibility to improve quality of life and bring new experiences to people.

Sometimes known as 'pervasive computing' or 'ambient intelligence' when it focuses on the computing part of NGN, the vision of future applications of

ICT describes the network of sensors, processors and terminals that will become part of our daily life: 'A billion people interacting with a million e-businesses through a trillion interconnected intelligent devices' (Gerstner, IBM, 2000, on pervasive computing).

NGN will also network computing power, thereby empowering scientific research to advance technologies such as biologics, thus bringing further improvements in human life. Regarding human-to-human communication, NGN will provide virtual face-to-face communication, all-media and context-aware. Distance-independent and rich in resources (if properly designed), NGN will palliate diverse shortcomings such as the language barrier and perhaps more serious physical handicaps whenever and wherever necessary.

For human-to-machine communication, the user interface will be similar to human-to-human communication, including the use of speech, touch and sign language. For machine-to-machine communication, the connection is real-time, on-demand (ad-hoc) and autonomous. For sensor-to-server communication, situation-dependent instant communication takes place towards data centres for processing information and generating alarms and reactions. An example could be early warning systems for natural disasters such as earthquakes, hurricanes and tsunami. The NGN access will be ubiquitous and quality (bandwidth) available on demand.

Considering the stage of today's networks, NGN will need to take time to evolve. It is a long-term process that will take place stepwise.

1.5 THE NETWORK EVOLUTION TOWARDS NGN

Thanks to the pioneer work of ITU and other standardization bodies, the NGN functional architecture is today mature and clear enough to guide network evolution. Early steps to make would be:

- To open the interface between application creation and delivery. Until now, most operators have controlled the service creation and delivery interface in order to protect their revenue. However, the future demands on IP services, collectively known as 'electronic applications' or 'e-applications' and including e-government, e-learning, e-health, e-banking and e-tourism, are beyond most current operators' capabilities. The open interface will enable third parties to develop and delivery such applications.
- To decouple the service layer from the network layer. Until now, networks have been built for a specific service or a specific service was fitted onto the network. Typical examples are voice and short messages services (SMS), the preliminary services built in the GSM network. The future ICT enabled by NGN will rely on IT for the IP-based services and on CT for the data transportation.

- To separate the access network and the core network (a common core, access agnostic). Until today, a core network has supported its own access network; the simplest example is the GSM access network supported by its own core network. Recently, UMTS core networks have also started to support GSM access. This concept will be extended within NGN. In NGN, a single core network may have multiple access networks and access networks can be added, upgraded and removed without impacting on the core network.
- To manage an end-to-end system driven by customers needs. Until now, the management system has comprised a business supporting system (BSS) and an operation supporting system (OSS), where:
  - the BSS is responsible for everything related to customers – billing, customer care, customer relationship management (CRM);
  - the OSS is responsible for everything related to technology, such as network operation, fault management.

Operations centred on customers will require a communication between the BSS and the OSS in order to have the BSS direct the OSS action.

1.6 THE TELECOM ENVIRONMENT AND CORPORATE RESPONSIBILITY

The NGN brings hopes of a better future but has undesirable side effects that need to be considered when planning or implementing NGN features. Assessments of the technology, using tools such as life cycle analysis (LCA) or risk analysis, have identified the negative as well as the positive effects of NGN.

Direct impacts on the environment such as energy and material consumption, waste management or non-ionizing radiations (NIR) are associated with NGN. Social and societal aspects can also be critical: digital illiteracy and poverty can divide people, and lack of access to information, personal data collection and social surveillance could, if not properly handled, lead to a rejection of NGN.

The positive aspects of NGN are numerous and could offset the negative impacts. A few of them were presented in Section 1.4 and the rest of the book will provide more information on the positive aspects. Dematerialization, distance independence and process efficiency are the key words in summarizing the positive environmental aspects.

Telecom operators and manufacturers will have to determine their attitude toward such issues and set straight their corporate governance and operating standards. Dealing with customers and other stakeholders in a responsible manner will bring trust and confidence in corporations, thus allowing for a sustained development of NGN.

As the customer is the centre of attention in the operation model driven by customer needs, boundaries of activities should also be set through open dialogue with the stakeholders.

1.7 THE ORGANIZATION OF THE BOOK

This book introduces the world of NGN, starting from a distant perspective and narrowing to the core of the subject as the chapters progress. It is similar to discovering a new land: first it is observed from far as an overview, then in greater detail, revealing hills, valleys and forests.

This book is organized in the following 10 chapters:

1. Introduction
2. NGN Vision, Scenarios and Advances
3. NGN Requirements on Technology and Management
4. NGN Functional Architecture
5. NGN Operator, Provider, Customer and CTE
6. NGN Network and Service Evolution towards NGN
7. NGN Key Development Areas
8. NGN Standardizations
9. NGN Corporate Responsibility
10. Summary

In Chapter 1, the background to the birth of NGN is described, with the challenges traditional operators are facing and the transformation of operation model that they are undertaking. The objective of NGN is to improve the quality of life and to bring new life experiences.

In Chapter 2, a vision of NGN is proposed, which puts the end user (human) in the centre and mobilizes the NGN service capability for his or her benefit. Typical scenarios that could be realized thanks to the NGN are provided to inspire the imagination of reader. Compared with today's network, the advances brought by NGN are also mentioned.

In Chapter 3, derived from the NGN vision proposed in the previous chapter, the technology and management requirements for NGN are analysed and deduced. In an NGN environment, the customer-need-driven operation model sets very high requirements on management functions; fulfilling them will make the NGN come to life.

Chapter 4 covers the NGN functional architecture. Starting from the ITU-T NGN functional architecture, an NGN functional architecture with integrated management functions is proposed. Each functional component and the interfaces between functional components are explained.

Chapter 5 concerns the NGN operator, provider, customer and terminal equipment. It explains the NGN open interfaces (between functional

components) that will create an extended landscape for operators, providers, customers and customer terminal equipment. Possible NGN operator, provider, customer and terminal equipment are speculated upon.

In Chapter 6, the major evolution steps to move from today's network toward NGN are highlighted – a roadmap for operators and other actors in this field.

Chapter 7 explains the key areas and key technologies to be developed in order to realize or implement NGN, considering today's situation.

Chapter 8 provides an overview of the current NGN-related standardization bodies, their activities, their achievements and their further plans.

Chapter 9 is on corporate responsibility, the attitude corporations may well be advised to follow in the face of the less positive aspects of NGN, such as energy consumption, resources depletion, waste management and social control. Depending on this attitude, trust could result and NGN may be well received and accepted.

Chapter 10 summarizes the whole book, highlighting the main issues of NGN that have been discussed and the contributions of this book.