ITU Centres of Excellence for Europe

Next Generation Networks - NGN

Module 1:

ITU NGN standards and architectures

Main drivers to Next Generation Networks – NGN, All-IP concept and ITU NGN standards,

NGN control architectures and protocols (TISPAN),

Numbering, naming and addressing in NGN

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1. Introduction

The market for information and communications technology is currently undergoing a structural change. The classic telecommunication networks were planned and implemented for the transfer of specific data such as telephone calls or pure data packages. The recent growth in competition, new requirements for the market and technological developments have fundamentally changed the traditional attitudes of the telecommunications industry. The present industry is characterized by the rapid growth of broadband connections, the convergence processes of various network technologies and the emergence of a uniform IP standard for individual and mass communications.

Traditional telecommunications operators find themselves confronted with a host of new challenges. In particular, their previously successful fixed-network business is coming increasingly under pressure. New communication possibilities, such as telephoning via the Internet, and also growing market shares in mobile telephony are causing a great deal of concern.

To counteract these losses, the network operators are investing more strongly in the growth driver, broadband. The bundling of phone, Internet and television – known in the telecommunications industry as Triple Play Services – has moved into the limelight of these new business models. The traditionally familiar market boundaries between fixed networks, mobile telephony and data networks are disappearing more and more quickly. This gives the customer the advantage that he can call on an extremely wide range of services, regardless of his access technology. This development requires a meta-infrastructure beyond the existing, subordinated networks – a core network for all the access networks. This new network is called the Next Generation Network. The Internet Protocol is the most significant integration factor because it is available globally and, at least in principle, it can use almost all the services and applications in all the networks.

2. Main drivers to Next Generation Networks

The heterogeneity of the infrastructure, the growing competition and the falling call sales can be regarded at present as the primary threats to the telecommunications industry. Established network operators are finding themselves forced to rethink their business models and to convert their infrastructure to a fully IP-based platform – the Next Generation Network. The overall aim is to reduce costs and to create new sources of income, as shown in Figure 1.1.

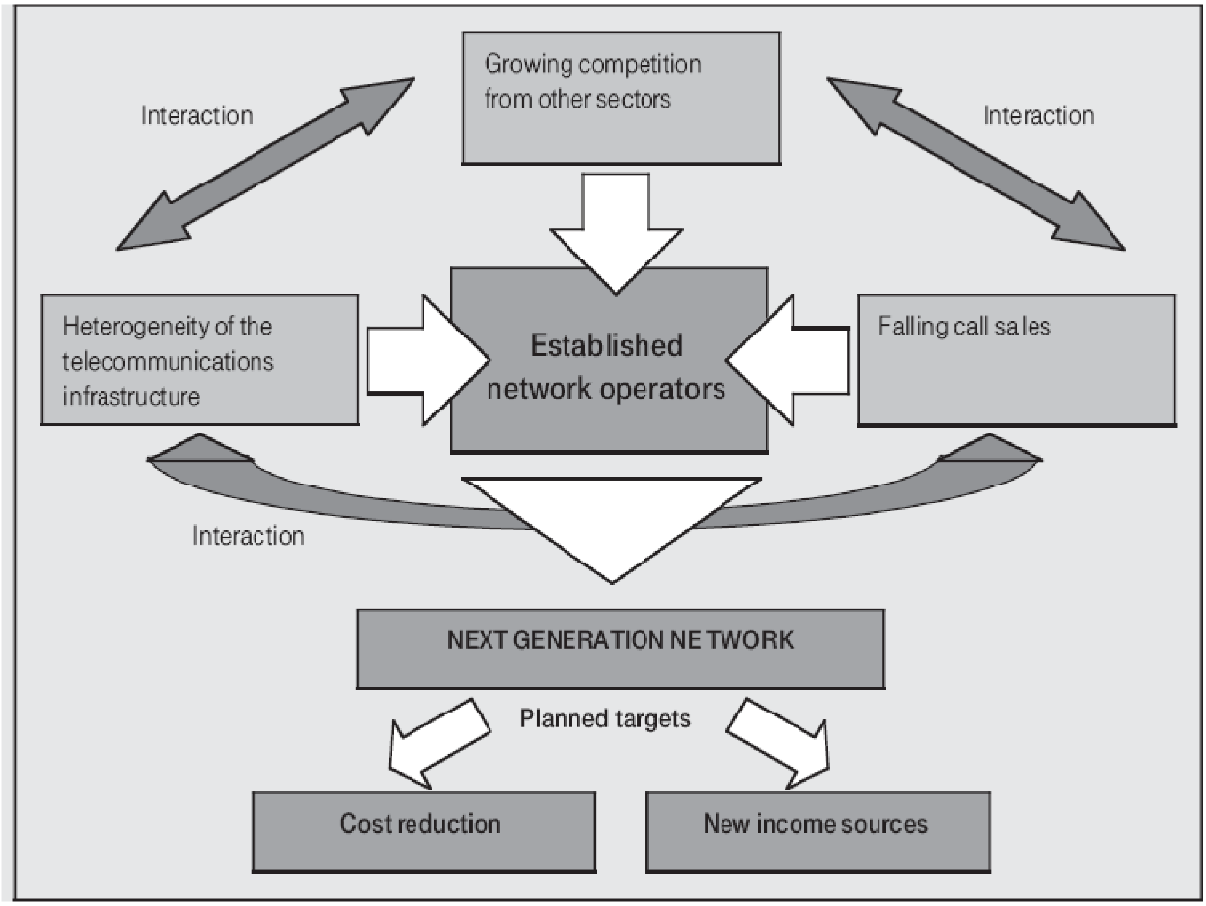

Figure 1.1 Reasons for the migration to the Next Generation Networks

2.1. Heterogeneity of the Telecommunications Infrastructure.

The modern telecommunications networks consist of various wired and wireless technologies: satellite and mobile phone networks such as GSM/UMTS, public phone networks, wireless local networks such as wireless LAN and Bluetooth networks, fixed networks such as Ethernet and fiber-optic networks.

In the traditional network infrastructure, the introduction of new services and applications can be an arduous and expensive process. For instance, a concept for launching innovative services can take between 6 and 18 months. The process requires high staffing costs. Many functionalities in the network have to be configured manually in order to implement new features. Moreover, the variety of networks and the heterogeneous subscriber end devices make the provision of infrastructure-independent services more difficult. As a result, the services can only be used via specific networks and appropriately adjusted end devices such as fixed-network phones, cellphones, televisions, etc.

The growing number of services has led to an increase in the platforms needed to provide them, which in turn has increased the complexity of the overall infrastructure. The problems of interoperability between the various systems are becoming more serious, and this growing complexity is also placing greater demands on staff. Maintaining these platforms involves high annual operating costs for the network operators. Established network operators often maintain 15 to 20 different platforms with hundreds of central switches, which inevitably leads to extremely high staffing costs.

2.2. Growing Competition from Other Sectors.

As a rule, networks such as mobile telephony, data networks and fixed networks are dominated by different suppliers. Providing services and products in these networks requires an interaction of various, complementary elements. In this sense, it is necessary to differentiate between value-added levels such as hardware, network access, applications and content. The increased use of IP-based networks for the provision of applications and services is allowing the development of new, digital value-added chains.

Visions of the gradual convergence of fixed networks, mobile telephony and the Internet are having a crucial influence on the development of this sector. In the future market, the widest possible range of roles will be available for different players. This will particularly threaten the leading position of the established network operators on the telecommunications market. Apart from the fixed-network and cellphone operators, companies from other sectors will also establish themselves in future on this convergent market. Portal suppliers with strong brand names and powerful financial backing – including Google, MSN, eBay and Yahoo – are planning to penetrate the voice and infrastructure business. They will also be joined by cable network operators and companies that provide media content, such as Microsoft (see Figure 2.1).

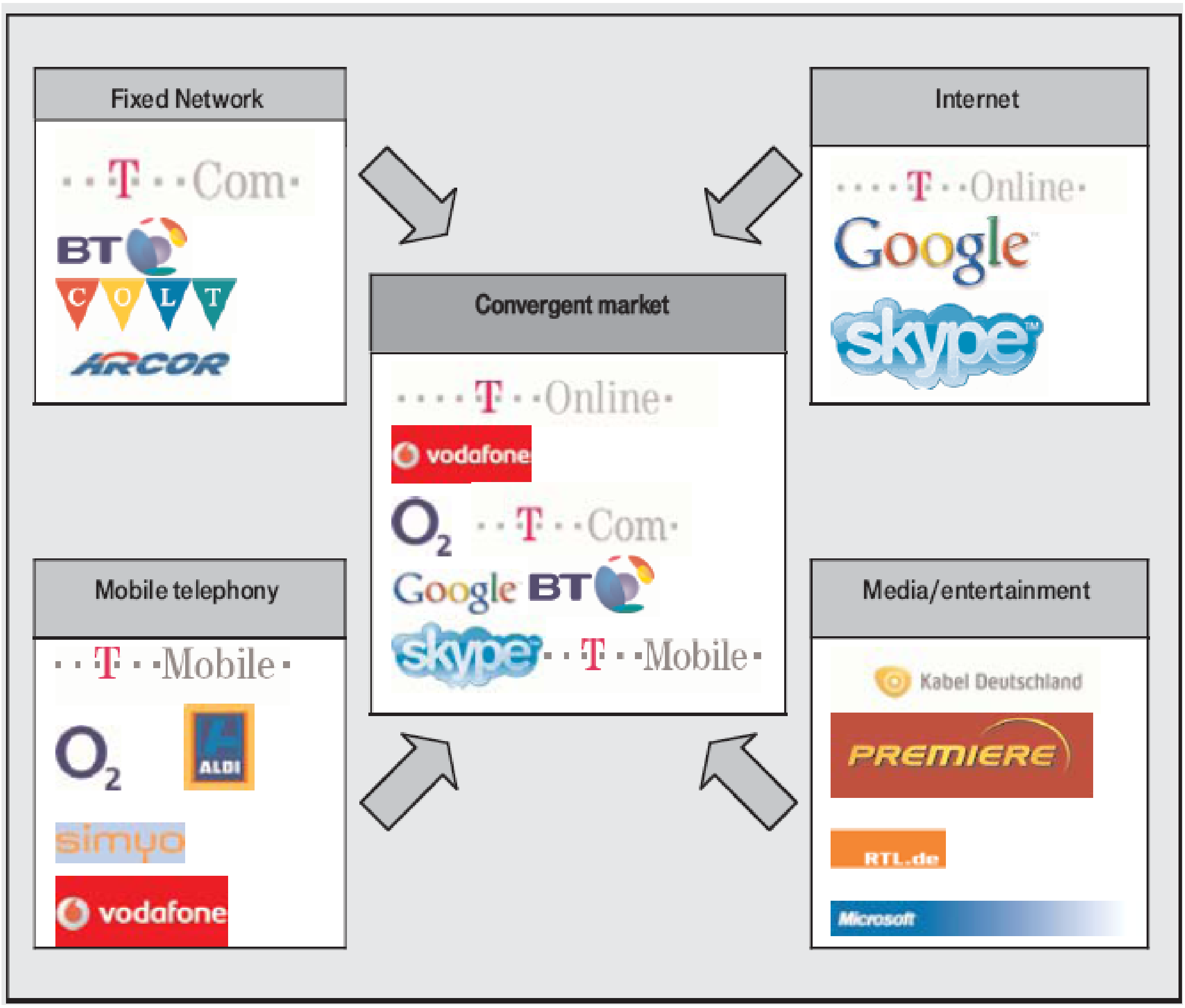

Figure 2.1 Possible convergence of the markets

This convergence is therefore producing virtually inevitable conflicts and incompatibilities. Technologies and market forces are colliding with each other. The market participants are crowding each other out and defending their positions strongly.

In the course of this convergence, the value of the network business will gradually decrease and the service range will make a much larger contribution to end-customer sales. Traditional network operators will have to rethink their business model and also position themselves much more strongly on the upper levels of the value-added chain.

2.3. Falling Call Sales.

The increasing competition due to the liberalization of the markets and the arrival of market participants from other sectors are causing great concern to the operators of former state monopolies. The classic telephone business, known as a Public Switched Telephone Network (PSTN), is particularly unsatisfactory. The golden age of the high-margin business with revenue in the billions based on classical phone calls is clearly over. Figure 2.2 shows the estimated development of the global number of telephone minutes since 1990 end some predictions for market trends till 2015. In spite of the current fall in fixed-network minutes, a strong growth in the total of telephone minutes is to be expected. Experts see particularly strong potential in the use of the Internet Protocol for phone calls. This so-called Voice over IP (VoIP) is possible with all IP-based networks.

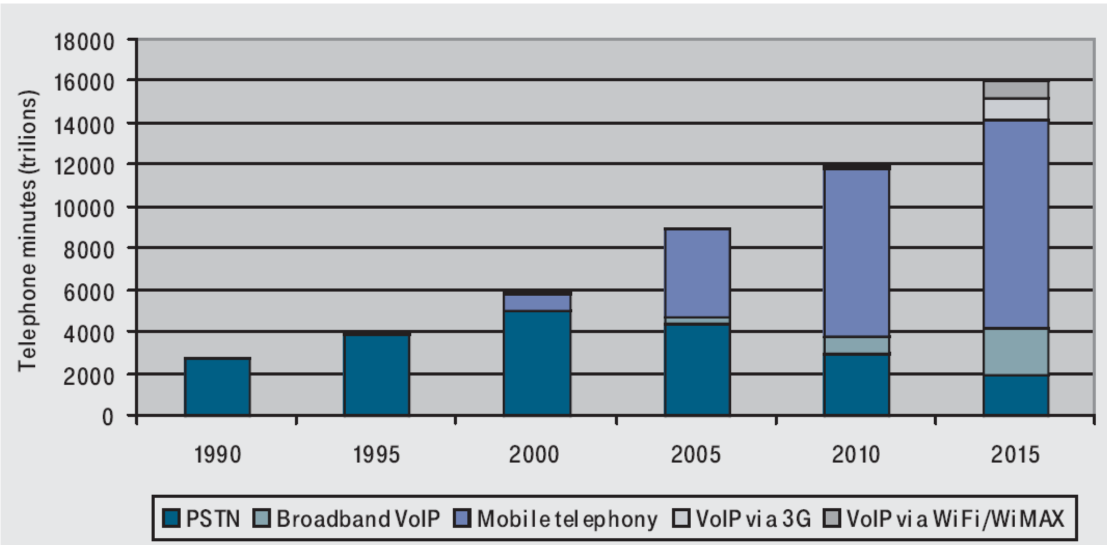

Figure 2.2 Development of global telephone minutes

While fixed-network calls are stagnating, mobile telephony is enjoying strong growth. Fixed-network operators are afraid of widespread cancellations of fixed-network connections.

Increasing losses on the domestic fixed-network market are therefore forcing the operators to develop new strategies to secure their future and to boost their profitability. No further growth can be expected through call sales alone.

2.4. Planned Targets – Cost Reductions and New Sources of Income.

Established network operators are pursuing two basic goals with NGN. On the one hand, the optimization of the networks and technology should open up excellent potential for cost savings. On the other hand, they intend to exploit new income sources with the future network. The plan is to create an entirely new form of communication for the customers.

2.4.1. Cost reduction.

With NGN, the established network operators plan to develop a sustainable infrastructure that will remain competitive in a convergent environment. The primary focus will be on the potential for cost savings. These savings will be produced by focusing on a single technology system and through the related reduction in technology sites and technical equipment areas. A single infrastructure is easier to maintain. The simplification of the technology system will therefore promote a reduction in the staffing costs. Moreover, spare parts will only be necessary for a single form of network technology.

Furthermore, the modular structure of the NGN will provide the foundation for the simple and cost-effective development of future services. It will no longer be necessary to carry out the new development and installation of networks for specific services. The open platform will also allow the rapid implementation of customer-specific solutions. For instance, applications from the network operators and other specialists can be inserted more easily in the standardized NGN architecture using Service Creation Environments. Predefined library functions will be used via an Application Programming Interface (API) to activate a Gateway and so ultimately to carry out actions in the network.

According to some predictions the migration to a homogeneous IP platform that supports all services will permit annual cost savings of up to 30 percent. It is expected that it will take some time before the cost-reduction potential becomes noticeable due to more efficient network management. The procedure will take several years. Apart from anything else, the technical equipment will have to be replaced at all the exchanges in the entire national network. As well as that, the employees will have to be retrained to work on the new network environment. A relatively long period of parallel operation with the already existing, mostly PSTN-based networks will be necessary before they can gradually be replaced by IP. The services provided via traditional networks will have to be provided for a certain period of time through emulation or simulation. Users will be able to continue using their present end devices. Even so, appropriate end devices will have to be developed to use all the functionalities of the forthcoming new services.

2.4.2. New Sources of Income.

Established network operators see the possibility of new income as another motivation for promoting NGN. More and more innovations with new sales opportunities are expected in the field of value-added services. The market development features a range of telecommunications services that have been tried and tested or are still evolving. For instance, these include television, information services, tele-learning and teaching, online games, virtual reality, business-to-business services, business TV, videoconferencing, etc.

However, opinions vary on the level of this income. The emerging price models will have a considerable influence on the generation of new sales. In an all-IP world, there is little correlation between the volumes on offer and the price. This can be seen in the familiar flat-rate tariffs in the broadband sector. In spite of the unlimited transmission volumes, the prices remain relatively stable. There is an opinion that only introduction of innovative services will allow established network operators to increase their profitability. Established network operators will be able to double their average revenue per user (ARPU) and to reduce customer migrations, among other things. As a result, the additional investments in this future technology will pay for themselves in less than five years. In this context, however, we must refer back to the flop with UMTS. Established network operators invested billions to acquire the licenses alone, which are not remotely profitable even today.

2.5. Benefits for the customers

The interaction of man and technology plays a crucial role in the introduction of previously unknown technologies on the market. The essential prerequisite for the success of innovative information and communications systems is their acceptance by the customers. Characteristics such as the perceived system benefit and the user-friendliness of the technology are extremely important.

One of the desired goals of NGN is the possibility of adapting the services better to the needs of the customer. Due to the future restriction to a single end device – equipped with a wide range of applications and services – the customer will in many ways enjoy improvements on the current situation. At present, customers expect applications for telephony and conferences. This sort of application should be independent of the network type. Customers also want to have more control over their services. That includes the ability to easily change or add services, regardless of location. Above all, though, the primary focus is on the wish to reduce costs and so there is great interest in package prices.

In the past, network operators sold specific end devices and services for every type of telecommunications network, e.g. text messaging (SMS) via mobile telephony or e-mail via the Internet. Due to the integration of telephony, messaging, video communications and other multimedia information services both in fixed and mobile networks, it will probably be possible to offer the customer greater convenience in future. It should be expected that the greater control of the customer over his own services, the omnipresence of the network and flexible billing methods will prove to be extremely advantageous.

- Control: Current processes require a personal communication with the customer for the activation or deactivation of services. NGNs should give the customer more control over his own service portfolio through online interfaces, such as webpages, for instance. In this way, network operators and service providers will save processing costs and the services will be provided for the customer in real time.
- Omnipresent: The term “presence” is frequently used in the mobile world and describes the personalization of services. Personalization characterizes the individual customizing of services to a specific user, in contrast to uniform standard services (e.g. the analog telephone service). Moreover, the services should be provided regardless of the location. The network must detect with which end device the user is currently connected to the net and where he is currently located. His subscribed services are then provided to him regardless of his location.
- Flexible billing methods: It will be possible for network operators to charge for scaled services via the NGN. For instance, the customer could be provided with only “best-effort” broadband services for surfing on the Web, but he could also use a much higher bandwidth with QoS parameters on request, to guarantee the required quality. Additional

costs may be incurred when downloading a movie, which are automatically integrated in the customer's bill.

It is therefore to be expected that the perceived benefits – especially because of increasing flexibility, mobility and convenience – will grow as convergent services become more widespread. The increasing personalization of the services will also significantly influence the perceived benefits. The information and services provided will be customized to suit each customer's personal context. However, it remains to be seen to what extent applications and services can be used with a single end device without any particular technical knowledge. Real growth spurts can be expected especially once a clear, tangible added value is perceptible without any particular complexities and also the majority of the market segments are being addressed. The user-friendliness is a decisive factor particularly for older people. The variety of services must not be too heavily technical, complex or unclear. In the end, the successful interaction between man and technology often proves to be much more difficult than anticipated.

3. ITU NGN standards

The NGN standardization work started in 2003 within ITU-T, and is worldwide today in various major telecom standardization bodies. The most active NGN relevant standardization bodies are ITU, ETSI, ATIS, CJK and TMF. The Next Generation Mobile Networks (NGMN) initiative is a major body for mobile-specific NGN activities, which are important contributors to the 3GPP specification for NGMN.

For those who maybe don't know the ITU (International Telecommunication Union) is an international organization within the United Nations in which governments and the private sector coordinate global telecom networks and services. ITU-T is the telecommunications sector of ITU. Its mission is to produce high-quality recommendations covering all the fields of telecommunications.

In 2003, under the name JRG-NGN (Joint Rapporteur Group on NGN), the NGN pioneer work was initiated. The key study topics are:

- NGN requirements;
- the general reference model;
- functional requirements and architecture of the NGN;
- evolution to NGN.

Two fundamental recommendations on NGN are:

- Y.2001: 'General overview of NGN'.
- Y.2011: 'General principles and general reference model for next-generation networks'.

These two documents comprise the basic concept and definition of NGN.

In May 2004, the FG-NGN (Focus Group on Next Generation Networks) was established in order to continue and accelerate NGN activities initiated by the JRG-NGN. FG-NGN addressed the urgent need for an initial suite of global standards for NGN. The NGN standardization work was launched and mandated to FG-NGN.

On 18 November 2005, the ITU-T published its NGN specification Release 1, which is the first global standard of NGN and marked a milestone in ITU's work on NGN. The NGN specification Release 1, with 30 documents, specified the NGN Framework, including the key features, functional architecture, component view, network evolution, etc. Lacking protocol specifications, the ITU NGN Release 1 is not at an implementable stage; however, it is clear enough to guide the evolution of today's telecom networks. With the release of NGN Release 1, the FG-NGN has fulfilled its mission and closed.

Following FG-NGN, the ITU-T NGN standardization work continues under the name GSI-NGN (NGN Global Standards Initiative) in order to maintain and develop the FG-NGN momentum. In parallel with the FG-NGN, there are two other groups working on the NGN relevant issues. They are the NGN-MFG (NGN Management Focus Group) and the OCAF-FG (Open Communication Architecture Forum Focus Group), directly contributing to the GSI-NGN.

3.1. GSI-NGN Concept

The ITU has defined the NGN as:

"A packet-based network able to provide telecommunications services and able to make use of multi broadband, QoS enabled transport technologies and in which service related functions are independent from underlying transport-related technologies. It offers unfettered access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users".

The ITU's NGN possesses the following key features:

- packet-based transfer;
- separation of control functions among bearer capabilities, call/sessions and applications/services;
- decoupling of service provision from transport, and provision of open interfaces;
- support for a wide range of services, applications and mechanisms based on service building blocks (including real time/streaming/noon-real time services and multimedia);
- broadband capabilities with end-to-end QoS;
- interworking with legacy networks via open interfaces;
- generalized mobility;
- unfettered access by users to different service providers;
- a variety of identification schemes;
- unified service characteristics for the same service as perceived by the user;
- converged services between fixed/mobile;
- independence of service-related functions from underlying transport technologies;
- support of multiple last mile technologies;
- compliance with all regulatory requirements, e.g. concerning emergency communications, security and privacy.

3.2. Functional Architecture

Figure 3.1 presents current functional architecture of ITU NGN, designed to support so-called Release 1 services and Release 1 requirements. This functional architecture is composed of functional groups separated by well defined interfaces. Each functional group contains a set of functional entities.

The main functional groups are:

- the transport stratum,
- the service stratum,
- the end-user functions,
- the third-party applications,
- the management functions and
- the other networks.

The main interfaces are the UNI between the user and network interfaces, the ANI between the application and network interfaces and the NNI between the network and network interface.

The solid lines indicate the user traffic; the dashed lines indicate the signalling paths; the thick dashed lines indicate the management data flows.

3.2.1. Transport Stratum Functions

The transport stratum functions include:

- transport functions,
- transport control functions and
- transport user profiles.

Transport functions provide the connectivity for all components and physically separated functions within the NGN. These functions provide support for the transfer of media information, as well as the transfer of control and management information. Transport functions include:

- access transport functions,
- edge functions,
- core transport functions and
- gateway functions.

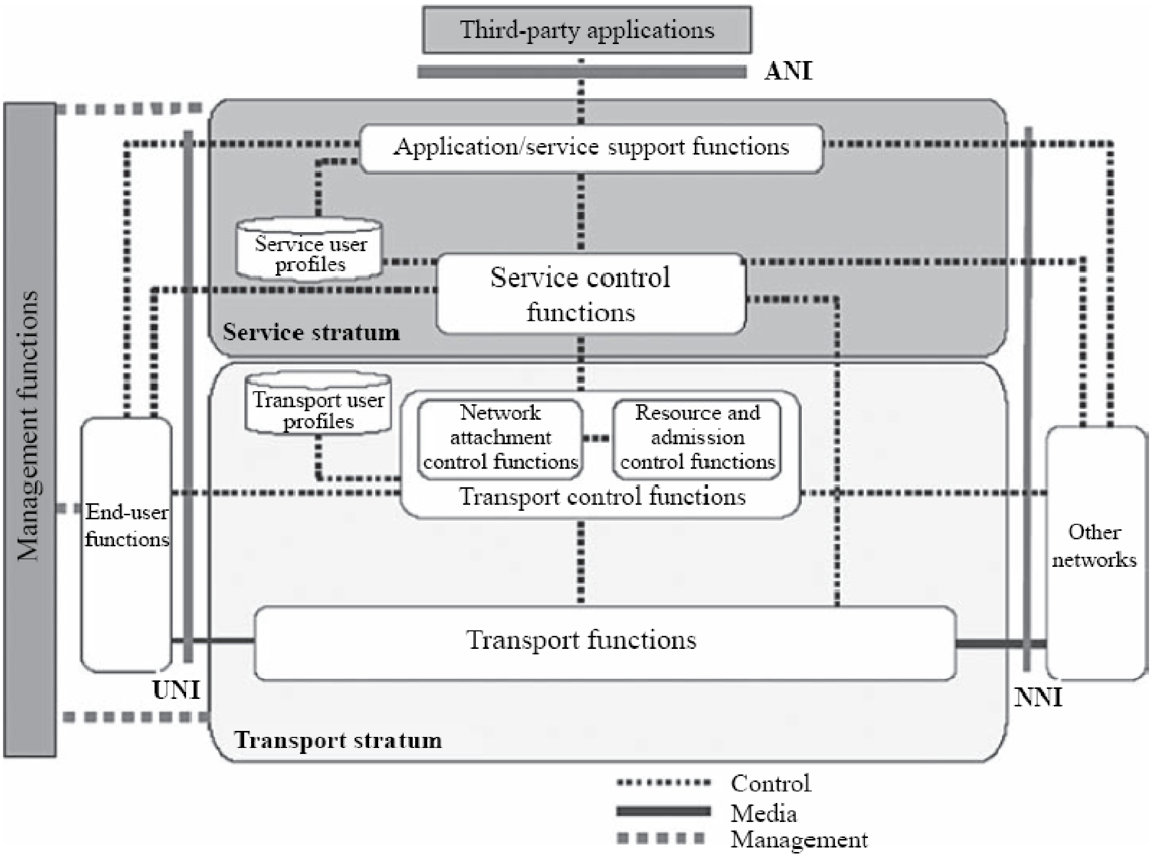

Figure 3.1. GSI-NGN functional architecture

The ***access transport*** *functions* take care of end-users' access to the network as well as collecting and aggregating the traffic coming from these accesses towards the core network. These functions also perform QoS control mechanisms dealing directly with user traffic, including buffer management, queuing and scheduling, packet filtering, traffic classification, marking, policing and shaping. These functions also include access-technology dependent functions, e.g. the WCDMA mobile access and the xDSL fixed access. Depending on the technology used for accessing NGN services, the access network includes functions related to optical access, cable access, xDSL access, wireless access, e.g. IEEE 802.11 and 802.16 access technologies, and IMT2000 radio access technologies.

The following is a non-exhaustive list of candidate technologies to implement access transport functions for NGN Release 1.

- Wireline access:
    - xDSL – this includes ADSL, SHDSL and VDSL transport systems and supporting connection/multiplexing technologies;

    - SDH dedicated bandwidth access;
    - optical access – this covers point-to-point and xPON transport systems such as BPON, GPON and EPON (Gigabit EPON is sometimes called GEPON).
    - cable networks – this covers cable networks based on packet cable multimedia specifications.
    - LANs – this covers LANs using either coaxial or twisted pair cable, including 10Base-T ethernet, fast ethernet, gigabit Ethernet and 10 gigabit ethernet;
    - PLC networks – the PLC network transmits and receives data over the power line.
- Wireless access:
    - IEEE 802.11x WLAN;
    - IEEE 802.16x WiMAX;
    - any 3GPP or 3GPP2 IP-CAN (NGN does not support the CS domain as an access transport technology);
    - broadcast networks – this covers 3GPP/3GPP2 Internet broadcast/multicast, DVB, and ISDB-T.

The ***edge functions*** are used for media and traffic processing when aggregated traffic coming from different access networks is merged into the core transport network; they include functions related to support for QoS and traffic control. These functions are also used between core transport networks.

The ***core transport functions*** are responsible for ensuring information transport throughout the core network. These functions provide IP connectivity, at the transport stratum and across the core network, and provide the means to differentiate the quality of transport in the core network. They also provide QoS mechanisms dealing directly with user traffic, including buffer management, queuing and scheduling, packet filtering, traffic classification, marking, policing, shaping, gate control, and firewall capability.

The ***gateway functions*** provide capabilities to interwork with end-user functions and other networks, including other types of NGN and many existing networks, such as the PSTN/ISDN and the public Internet. These functions can be controlled either directly from the service control functions or through the transport control functions.

The ***media handling functions*** provide media resource processing for service provision, such as the generation of tone signals and trans-coding. These functions are specific to media resource handling in the transport stratum.

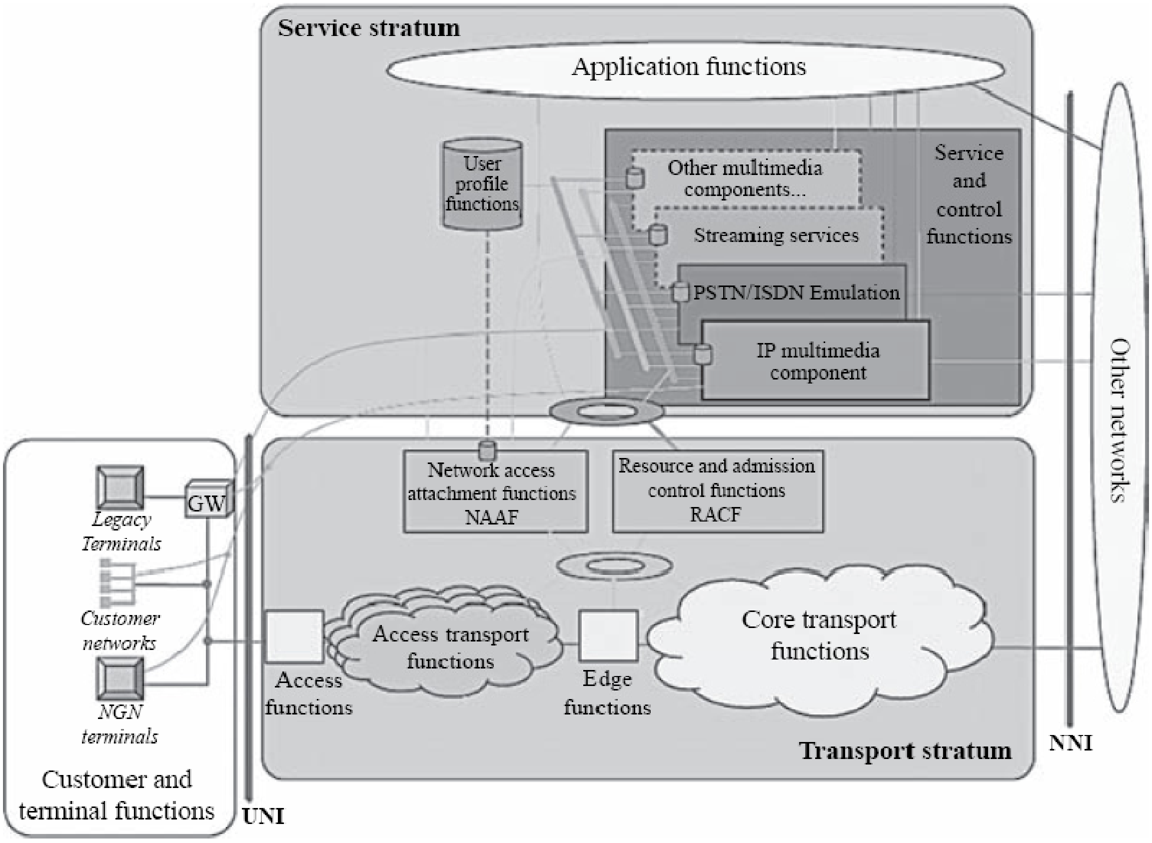

Figure 3.2 Component view of a possible realization of GSI-NGN functional architecture.

The *transport control functions* include resource and admission control functions (RACF) and network attachment control functions (NACF). The RACF provides QoS control (including resource reservation, admission control and gate control), NAPT and/or FW traversal control functions over access and core transport networks. The Admission control involves checking authorization based on user profiles, SLAs, operator-specific policy rules, service priority and resource availability within access and core transport.

The RACF acts as the arbitrator for resource negotiation and allocation between service control functions and transport functions. The RACF interacts with service control functions and transport functions for session-based applications (e.g. SIP call) and non-session-based applications (e.g. video streaming) that require the control of NGN transport resource, including QoS control and NAPT/FW control and NAT traversal. The RACF interacts with transport functions for the purpose of controlling one or more the following functions in the transport layer: packet filtering; traffic classification, marking, policing and priority handling; bandwidth reservation and allocation; network address and port translation; and firewall. The RACF interacts with NACF, including network access registration, authentication and authorization, and parameter configuration for checking user profiles and SLAs held by them. For those services across multiple providers or operators, service control functions, the RACF and transport functions may interact with the corresponding functions in other packet networks.

The NACF provides registration at the access level and initialization of end user unctions for accessing NGN services. These functions provide network-level identification/authentication, manage the IP address space of the access network and authenticate access sessions. These functions also announce the contact point of NGN service/application support functions to the end user. The NACF provides further the functionality of:

- dynamic provision of IP addresses and other user equipment configuration parameters;
- authentication at the IP layer (and possibly other layers);
- authorization of network access, based on user profiles;
- access network configuration, based on user profiles;
- location management at the IP layer.

The transport user profile functions take the form of a functional database representing the combination of a user's information and other control data into a single 'user profile' function in the transport stratum. This functional database may be specified and implemented as a set of cooperating databases with functionalities residing in any part of the NGN.

3.2.2. Service stratum functions

The service stratum functions include:

- service control functions,
- application/service support functions, and
- service user profile functions.

The ***service control functions*** include both session and non-session control, registration and authentication and authorization functions at the service level.

They can also include functions for controlling media resources, i.e. specialized resources and gateways at the service-signaling level.

Within the service control functions, the possible components included are:

- the IP multimedia component,

- the PSTN/ISDN emulation component,
- the streaming services component and
- other multimedia components.

*The **IP multimedia service component*** is a service component based on the capabilities of the 3GPP IP Multimedia Subsystem (IMS). It has been a starting point for the definition of Release 1 to leverage the capabilities of the 3GPP IMS. The IMS functionality for NGN Release 1 employs SIP-based service control. To support the heterogeneous access transport environment of Release 1 the capabilities of the 3GPP IMS need to be extended. NGN Release 1 will maintain full compatibility with 3GPP/3GPP2 IP connectivity access transport functions (e.g. IP-CAN) and terminals.

The ***PSTN/ISDN emulation service component*** is a service component defined to support PSTN/ISDN replacement scenarios, with full interoperability with existing (legacy) PSTN/ISDN networks. This component fully supports legacy (PSTN/ISDN) interfaces to customer equipment and provides the user with identical services and experience to that of the existing PSTN/ISDN.

The ***application/service support functions*** include functions such as the gateway, registration, authentication and authorization functions at the application level. These functions are available to the 'third-party applications' and 'end-user' functional groups. The application/service support functions work in conjunction with the service control functions to provide end-users and third-party application providers with the value-added services they request. Through the UNI, the application/service support functions provide a reference point to the end-user functions, e.g. in the case of third-party call control for click to call service. The third-party applications' interactions with the application/service support functions are handled through the ANI reference point.

NGN will help in the creation and offering of new services. As the number, sophistication and degree of interworking between services increase, there will be a need to provide more efficiency and scalability for network services.

Therefore, NGN applications and user services should be able to use a flexible service and application-provisioning framework. Such a framework should enable application providers, both NGN internal and third-party, to implement value-added services that make use of network capabilities in an agnostic fashion. Network capabilities and resources that are offered to applications are defined in terms of a set of capabilities inside this framework and are offered to third-party applications through the use of a standard application network interface. This provides a consistent method of gaining access to network capabilities and resources, and application developers can rely on this consistency when designing new applications. The internal NGN application providers can make use of the same network capabilities and resources that are used by third-party application providers.

NGN Release 1 should support the following three classes of value-added service environments:

• IN-based service environment – support for intelligent network (IN) services. Examples of ANI-specific protocols for this environment include IN Application Protocol, Customised Application for Mobile network Enhanced Logic (CAMEL) and Wireless Intelligent Network (WIN).

• IMS-based service environment – support for IMS-based service environment. Examples of ANI-specific interfaces include ISC, Sh, Dh, Ut, Ro, Rf, Gm and Mb.

• Open service environment – support for open service environments. Examples of this environment using ANI include OSA/Parlay, Parlay X and OMA.

The ***service user profile functions*** represent the combination of user information and other control data into a single user profile function in the service stratum, in the form of a functional database. This functional database may be specified and implemented as a set of cooperating databases with functionalities residing in any part of the NGN.

Release 1 defines the user profile functions, which provide capabilities for managing user profiles and making the user profile information available to other NGN functions. A user profile is a set of attribute information related to a user. The user profile functions provide the flexibility to handle a wide variety of user information. Some of the user profile models that may inform the design of the user profile functions include:

- 3GPP Generic User Profile (GUP);
- 3GPP2 User Profile;
- W3C Composite Capabilities/Preference Profile (CC/PP);
- OMA User Agent Profile;
- 3GPP/ETSI Virtual Home Environment;
- Parlay Group – user profile data.

As shown in Figure 3.2, the user profile functions support the identified service and control functions in the service stratum, as well as the network access attachment functions in the transport stratum. This central role for the user profile functions is natural, since users and their service requirements are the driving forces behind the existence of the network itself.

3.2.3. End-user Functions

No assumptions are made about the diverse end-user interfaces and end-user networks that may be connected to the NGN access network. Different categories of end-user equipment are supported in the NGN, from single-line legacy telephones to complex corporate networks. End-user equipment may be either mobile or fixed.

Customers may deploy a variety of network configurations, both wired and wireless, inside their customer network. This implies, for example, that Release 1 will support simultaneous access to NGN through a single network termination from multiple terminals connected via a customer network. It is recognized that many customers deploy firewalls and private IP addresses in combination with NAPT. NGN support for user functions is limited to control of (part of) the gateway functions between the end user functions and the access transport functions. The device implementing these gateway functions may be customer or access transport provider-managed. Management of customer networks is, however, outside the scope of Release 1. As a result, customer networks may have a negative impact on the QoS of an NGN service as delivered to user equipment.

Implications of specific architectures of customer networks on the NGN are beyond the scope of Release 1. Customer network internal communications do not necessarily require the involvement of the NGN transport functions (e.g. IP PBX for corporate network).

User Equipment

The NGN should support a variety of user equipment. This includes gateway and legacy terminals (e.g. voice telephones, facsimile, PSTN textphones etc.), SIP phones, soft-phones (PC programmes), IP phones with text capabilities, set-top boxes, multimedia terminals, PCs, user equipment with an intrinsic capability to support a simple service set and user equipment that can support a programmable service set.

It is not intended to specify or mandate a particular NGN user equipment type or capability, beyond compatibility with NGN authentication, control and transport protocol stacks.

NGN supports a mobile terminal that is fully compliant with 3GPP specifications only when directly connected through a 3GPP IP-CAN. Release 1 may not support 3GPP mobile terminals when they are not directly connected through a 3GPP IP-CAN.

NGN should allow the simultaneous use of multiple types of access transport functions by a single terminal; however there is no requirement to coordinate the communication. Such

terminals may therefore appear to be two or more distinct terminals from the network point of view.
The user equipment should enable interface adaptation to varying user requirements, including the needs of people with disabilities, for connection with commonly provided user interface devices.

3.2.4. Management Functions

Support for management is fundamental to the operation of the NGN. These functions provide the ability to manage the NGN in order to provide NGN services with the expected quality, security and reliability. These functions are allocated in a distributed manner to each functional entity (FE), and they interact with network element (NE) management, network management and service management FEs. Further details of the management functions, including their division into administrative domains, can be found in ITU-T M.3060.
The management functions apply to the NGN service and transport strata.
For each of these strata, they cover the following areas:

- fault management;
- configuration management;
- accounting management (includes charging and billing functions);
- performance management;
- security management.

3.2.5. Network Node Interfaces

Interconnection and network node interfaces (NNIs) – as well as interconnection between multiple NGN administrative domains, the NGN is also required to support access to and from other networks that provide communications, services and content, including the secure and safe interconnection to the Internet.
NGN provides support for services across multiple NGN administrative domains. Interoperability between NGN administrative domains shall be based on defined interconnection specifications.

Table 3.1 Release 1 (P-)NNIs for interconnection to other types of networks.

Type of networks	Signaling interface	Bearer interface
Circuit-based networks	ISUP	TDM
IP-based networks	SIP (session control)	IPv4
	IPv4	IPv6
	IPv6	MIPv4
	MIPv4	MIPv6
	MIPv6	RTP
	BGP	RTCP
	HTTP	

NNIs to non-NGNs – Release 1 supports interconnection to other IP networks and by implication to any IP-based network that complies with the NGN interconnection protocol suite. It supports direct interconnection with the PSTN/ISDN by means of interworking functions that are implemented within the NGN. Interoperability between NGN and non-NGN will be based on defined interconnect specifications.

Table 3.1 lists the candidate interconnection interfaces, including a nonexhaustive list of protocols that may be supported in Release 1 and may be applied as P-NNIs to Enterprise networks. The following is the list of candidate networks that will interconnect using NNIs to the NGN:

- Internet;
- cable networks;
- enterprise networks;
- broadcast networks;
- PLMN networks;
- PSTN/ISDN networks.

NNIs between NGNs – NGN release 1 allows for the partition of the NGN into separate administrative domains. Interfaces on a trust boundary between domains need to support various functionalities to enable robust, secure, scaleable, billable, QoS-enabled and service-transparent interconnection arrangements between network providers. Some of the trusted domain’s internal information may be removed across a trust boundary, for instance to hide the user’s private identity or network topology information.

3.3. GSI-NGN Release 2

Even there is no official Release 2 of GSI-NGN, a lot of work is done in this area resulting in grate number of recommendations. For example they address ID management, IPTV, mobility, security-related issues end much more.

ITU groups working in the field of NGN are:

- Study Group 2 - Operational aspects of service provision and telecommunications management
- Study Group 9 - Television and sound transmission and integrated broadband cable networks
- Study Group 11 - Signalling requirements, protocols and test specifications
- Study Group 12 - Performance, QoS and QoE
- Study Group 13 - Future networks including mobile and NGN
- Study Group 15 - Optical transport networks and access network infrastructures
- Study Group 16 - Multimedia coding, systems and applications
- Study Group 17 - Security
- IPTV-GSI - IPTV Global Standards Initiative

3.4. NGN related recommendations

NGN related recommendations are listed in Table 3.2.

Table 3.2 NGN related ITU recommendations

Recommendation	Short title
Y.2001	General overview of NGN
Y.2002	Overview of ubiquitous networking and of its support in NGN
Y.2006	Description of capability set 1 of NGN release 1
Y.2007	NGN capability set 2
Y.2011	General principles and general reference model for Next Generation Networks
Y.2012	Functional requirements and architecture of the NGN
Y.2013	Converged services framework functional requirements and architecture
Y.2014	Network attachment control functions in next generation networks
Y.2015	General requirements for ID/locator separation in NGN
Y.2016	Functional requirements and architecture of the NGN for applications and services using tag-based identification
Y.2017	Multicast functions in next generation networks
Y.2018	Mobility management and control framework and architecture within the NGN transport stratum
Y.2019	Content delivery functional architecture in NGN
Y.2021	IMS for Next Generation Networks
Y.2031	PSTN/ISDN emulation architecture
Y.2051	General overview of IPv6-based NGN
Y.2052	Framework of multi-homing in IPv6-based NGN
Y.2053	Functional requirements for IPv6 migration in NGN
Y.2054	Framework to support signalling for IPv6-based NGN
Y.2091	Terms and definitions for Next Generation Networks
Y.2111	Resource and admission control functions in Next Generation Networks
Y.2112	A QoS control architecture for Ethernet-based IP access network
Y.2113	Ethernet QoS control for next generation networks
Y.2121	Requirements for the support of flow state aware transport technology in an NGN
Y.2122	low aggregate information exchange functions in NGN

Y.2171	Admission control priority levels in Next Generation Networks
Y.2172	Service restoration priority levels in Next Generation Networks
Y.2173	Management of performance measurement for NGN
Y.2174	Distributed RACF architecture for MPLS networks
Y.2175	Centralized RACF architecture for MPLS core networks
Y.2201	NGN release 1 requirements
Y.2205	Next Generation Networks - Emergency telecommunications - Technical considerations
Y.2206	Requirements for distributed service network (DSN)
Y.2211	IMS-based real time conversational multimedia services over NGN
Y.2212	Requirements of managed delivery services
Y.2213	NGN service requirements and capabilities for network aspects of applications and services using tag-based identification
Y.2214	Functional model for customized multimedia ring service
Y.2215	Requirements and framework for the support of VPN services in NGN including mobile environment
Y.2216	NGN capability requirements to support multimedia communication centre (MCC) service
Y.2221	Requirements for support of ubiquitous sensor network (USN) applications and services in the NGN environment
Y.2232	NGN convergence service model and scenario using Web Services
Y.2233	Requirements and framework allowing accounting and charging capabilities in NGN
Y.2234	Open service environment capabilities for NGN
Y.2235	Converged web-browsing service scenarios in NGN
Y.2236	Framework for NGN support of multicast-based services
Y.2237	Functional model, service scenarios and use cases for QoS enabled mobile VoIP service
Y.2261	PSTN/ISDN evolution to NGN
Y.2262	PSTN/ISDN emulation and simulation
Y.2271	Call server based PSTN/ISDN emulation
Y.2401	Principles for the Management of the Next Generation Networks
Y.2601	Fundamental characteristics and requirements of future packet based networks
Y.2611	High level architecture of future packet based networks
Y.2612	Generic requirements and framework of FPBN addressing, routing and

	forwarding
Y.2613	The general technical architecture for public packet telecommunication data network (PTDN)
Y.2701	Security requirements for NGN release 1
Y.2702	Authentication and authorization requirements for NGN release 1
Y.2703	The application of AAA service in NGN
Y.2704	Security mechanisms and procedures for NGN
Y.2720	NGN identity management framework
Y.2721	NGN identity management requirements and use cases
Y.2801	Mobility management requirements for NGN
Y.2802	Fixed-mobile convergence general requirements
Y.2803	FMC service using legacy PSTN or ISDN as the fixed access network for mobile network users
Y.2804	Generic framework of mobility management for next generation networks
Y.2805	Framework of location management for NGN
Y.2806	Framework of handover control for NGN
Y.2807	MPLS-based mobility capabilities in NGN
Y.2808	Fixed mobile convergence with a common IMS session control domain
Y.2901	The carrier grade open environment reference model
Y.2902	Carrier grade open environment components

4. TISPAN NGN

ETSI (European Telecommunications Standards Institute) is a standard organization active in all areas of telecommunications (radio communications, broadcasting and information technologies). Its mission is to produce telecommunications standards for today and for the future. ETSI also contributes to the ITU standardization. In May 2003, ETSI formed the TISPAN (Telecommunications and Internet-converged Services and Protocols for Advanced Networking) project targeted at specifying NGN.
Since its creation in 2003, ETSI TISPAN has been the key standardization body in creating the Next Generation Networks (NGN) specifications.
TISPAN NGN Release 1 was finalized in December 2005, provided the robust and open standards that industry required for the development, testing and implementation of the first generation of NGN systems. NGN Release 1 specifications adopt the 3GPP IMS (IP Multimedia Subsystem) standard for SIP-based applications, but also add further functional blocks and subsystems to handle non-SIP applications. Initially TISPAN worked on harmonizing the IMS core for both wireless and wireline networks. However in early 2008, the common IMS specifications were transferred back to 3GPP so that one unique standards organization be responsible for providing a Common IMS fitting any network (fixed, 3GPP, CDMA2000, etc.).

TISPAN NGN Release 2 was finalized early 2008, and added key element to the NGN such as IMS and non IMS based IPTV, Home Networks and devices, as well as NGN interconnect with Corporate Networks. TISPAN IPTV specifications answer the emerging market needs such as triple-play and quadruple-play service offers: access independent solutions, integration in a multi-service environment, availability of enhanced services combining features from every component of the triple/quadruple-play offers.

TISPAN is currently working on the third release of specifications with focus on:

- IPTV: New IPTV services have been defined including advertising, IMS enabled IPTV Roaming/Mobility, User Generated Content (UGC), and Personalised Channel (PCh)/User oriented content. The Content Delivery Network (CDN) is also being defined. Peer-to- peer technologies for delivering IPTV services have been analysed. Definition of the IPTV service protection is also on its way
- Enterprise networks with a NGCN-NGN Interface Implementation Guide
- Network interconnection

- QoS with an analysis is performed on the interaction of the TISPAN Resource and Admission Control Sub-System (RACS) with the Customer Premises Network (CPN) in order to manage the resources inside the home network
- Radio Frequency Identification (RFID) security
- NGN security enhancements
- Energy monitoring in the customer premises network
- Regulatory issues

4.1. TISPAN NGN Concept

The TISPAN-NGN is targeted at:

- Providing NGN services
    - conversation (voice call, video call, chat, multimedia sessions);
    - messaging (email, SMS, EMS, MMS, instant messaging and presence);
    - content-on-demand (browsing, download, streaming, push, broadcast).

- Supporting access technologies
    - 3GPP standardized mobile GSM/GPRS/EDGE/UMTS/HSPA/LTE;
    - fixed DSL;
    - wired LAN;
    - wireless LAN;
    - cable

The TISPAN NGN specification covers NGN services, architectures, protocols, QoS, security and mobility aspects within fixed networks. TISPAN and 3GPP was working together to define a harmonized IMS-centred core for both wireless and wireline networks. This harmonized all-IP network has the potential to provide a completely new telecom business model for both fixed and mobile network operators. Access-independent IMS is a key enabler for fixed/mobile convergence, reducing network installation and maintenance costs, and allowing new services to be rapidly developed and deployed to satisfy new market demands.

Figures 5.1–5.3 provides an overview of the TISPAN NGN architecture. This NGN functional architecture described complies with the ITU-T general reference model for next-generation networks and is structured according to a service layer and an IP-based transport layer.

4.1.1. Service Layer

The service layer comprises the following components:

- core IP multimedia subsystem (IMS) – this component supports the provision of SIP-based multimedia services to NGN terminals and also supports the provision of PSTN/ISDN simulation services;

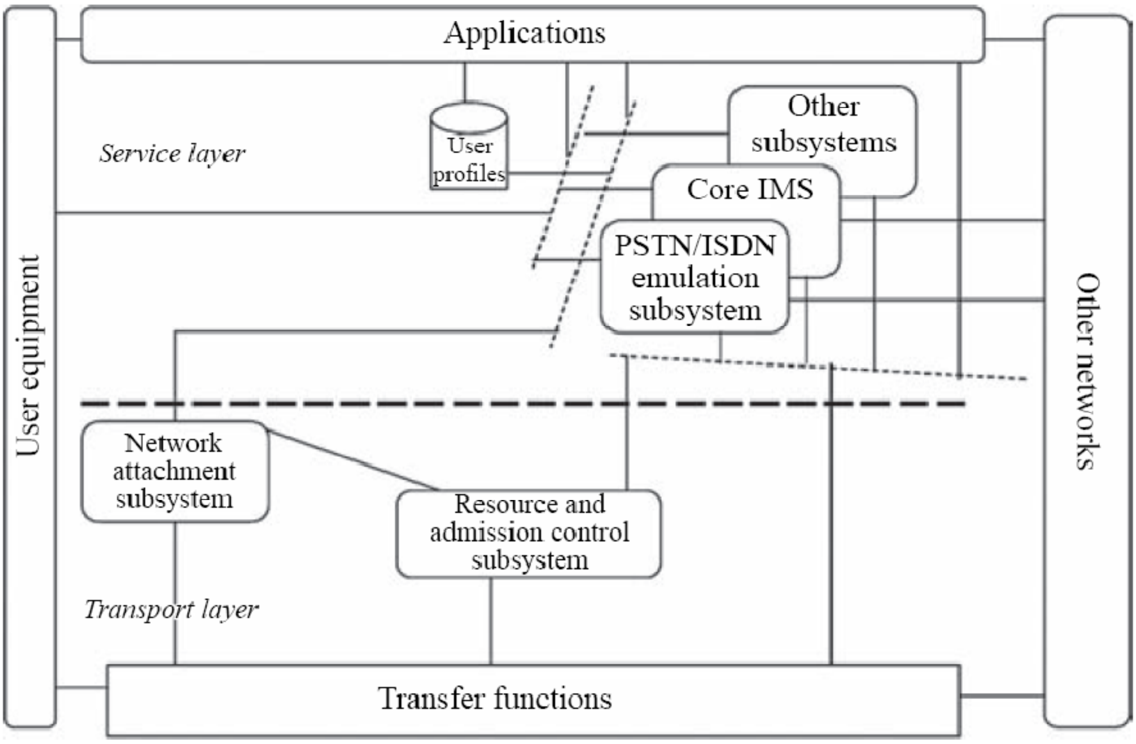

Figure 5.1 TISPAN-NGN overall architecture

- PSTN/ISDN emulation subsystem (PES) – this component supports the emulation of PSTN/ISDN services for legacy terminals connected to the NGN, through residential gateways or access gateways;
- streaming subsystem – this component supports the provision of RTSP-based streaming services to NGN terminals;
- content broadcasting subsystem – this component supports the broadcasting of multimedia content (e.g. movies, television channels etc.) to groups of NGN terminals;
- common components – the NGN architecture includes a number of functional entities that can be accessed by more than one subsystem. As shown in Figure 8.6, these are:

- the user profile server functions (UPSF);
- the subscription locator function (SLF);
- the application server function (ASF);
- the interworking function (IWF);
- the interconnection border control function (IBCF);
- the charging and data collection functions.

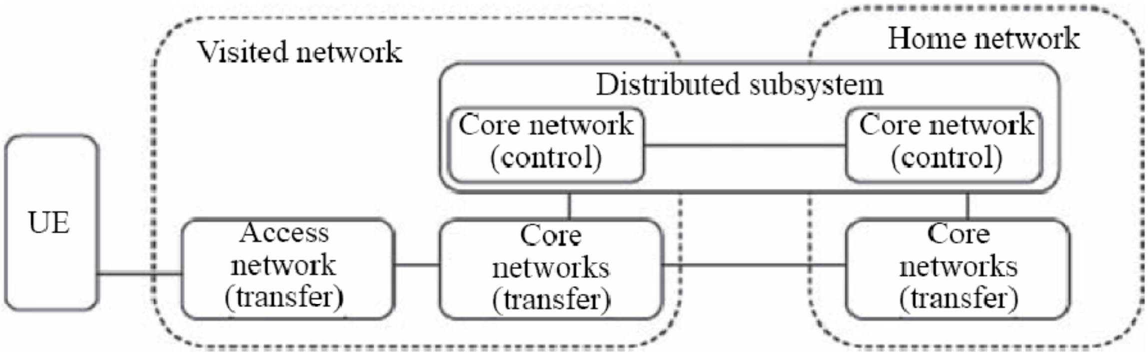

Figure 5.2 Distributed subsystem between a visited and a home network

4.1.2. Transport Layer

The transport layer comprises a transport control sub-layer on top of transfer functions. The *transport control sub-layer* is further divided in two subsystems, i.e. the network attachment subsystem (NASS) and the resource and admission control subsystem (RACS).

NASS provides the following functionalities:

- dynamic provision of IP addresses and other terminal configuration parameters;
- authentication taking place at the IP layer, prior to or during the address allocation procedure;
- authorization of network access based on user profiles;
- access network configuration based on user profiles;
- location management taking place at the IP layer.

RACS provides admission control and gate control functionalities including the control of NAPT and priority making. Admission control involves checking authorization based on user profiles held in the access network attachment subsystem, on operator-specific policy rules and on resource availability. Checking resource availability implies that the admission control function verifies whether the requested bandwidth is compatible with both the subscribed bandwidth and the amount of bandwidth already used by the same user on the same access, and possibly other users sharing the same resources.

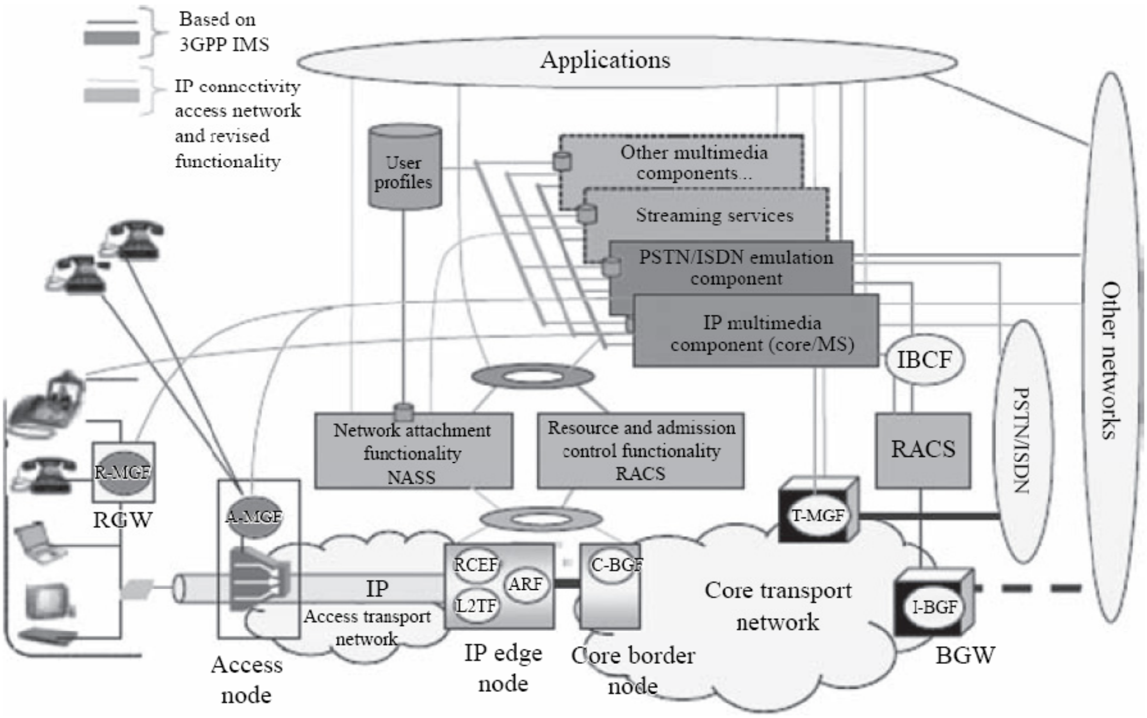

Figure 5.3 ETSI TISPAN-NGN example architecture with xDSL access

Figure 5.4 provides an overview of the *transfer functions* and their relationship with the other components of the architecture. Modelling of transfer functions here is limited to aspects that are visible to other components of the architecture. Only the functional entities that may interact with the transport control sub-layer or the service layer are visible in the transfer sub layer.
These are:

- The media gateway function (MGF). The MGF provides the media mapping and/or transcoding functions between an IP-transport domain and switched circuit network facilities (trunks, loops). It may also perform media conferencing and send tones and announcements;.
- The border gateway function (BGF) provides the interface between two IP transport domains. It may reside at the boundary between an access network and the customer

terminal equipment, between an access network and a core network or between two core networks.

- The access relay function (ARF) acts as a relay between the user equipment and the NASS. It receives network access requests from the user equipment and forwards them to the NASS. Before forwarding a request, the ARF may also insert local configuration information and apply protocol conversion procedures.
- The signalling gateway function (SGF) performs signalling conversion (both ways) at the transport level between the SS7-based transport of signaling and IP-based signalling transport.
- The media resource function processor (MRFP) provides specialized resource processing functions beyond those available in media gateway functions. This includes resources for supporting multimedia conferences, sourcing multimedia announcements, implementing IVR (interactive voice response) capabilities and media content analysis.
- layer 2 termination function (L2TF).

An example of realization of this functional architecture, with an xDSLbased access network, is given in Figure 5.3. The configuration assumes the following:

- A border gateway function (C-BGF) is implemented in a core border node sitting at the boundary between the access network and a core network, at the core network side.
- A resource control and enforcement function (RCEF) is implemented in an IP edge node sitting at the boundary between core networks, at the access network side. In this example, this node also implements the L2TF and ARF functional entities.
- A border gateway function (I-BGF) is implemented in a border gateway (BGW) sitting at the boundary with other IP networks.
- A media gateway function (T-MGF) is implemented in a trunking media gateway (TGW) at the boundary between the core network and the PSTN/ISDN.
- A media gateway function (A-MGF) is implemented in an access node (AN), which also implements a DSLAM.
- A media gateway function (R-MGF) is implemented in a residential media gateway (RGW) located in the customer premises.

4.1.3. User Equipment

The user equipment (UE) consists of one or more user-controlled devices allowing a user to access services delivered by NGN networks. Different components of the customer equipment may be involved depending on the subsystem they interact with.

The UE functionalities are:

- Authentication – as shown in Figure 5.5, two levels of network identification/ authentication are available in the NGN architecture, namely at the level of the network attachment between UE and NASS and at the service layer level between NGN service control subsystems and applications.
- Interfaces:
    - Interfaces to the core IMS – access to the services of the IMS is provided to SIP-based terminals;.
    - Interfaces to the PSTN/ISDN emulation subsystem – access to the services of the PSTN/ISDN emulation subsystem is provided by legacy terminals through a gateway function, which may reside in customer premises or in the operator's domain.
    - Interfaces with applications – interactions with SIP application servers take place through the Ut interface. This interface enables the user to manage information related to his or her services, such as creation and assignment of public service identities, management of authorization policies that are used, for example, by presence services or conference policy management.
    - Interfaces with the NASS – these interfaces enable the user equipment to attach to the network and receive configuration information. Signalling between the UE and the NASS may be relayed via the ARF in the transfer sub-layer.
    - Interface with RACS.

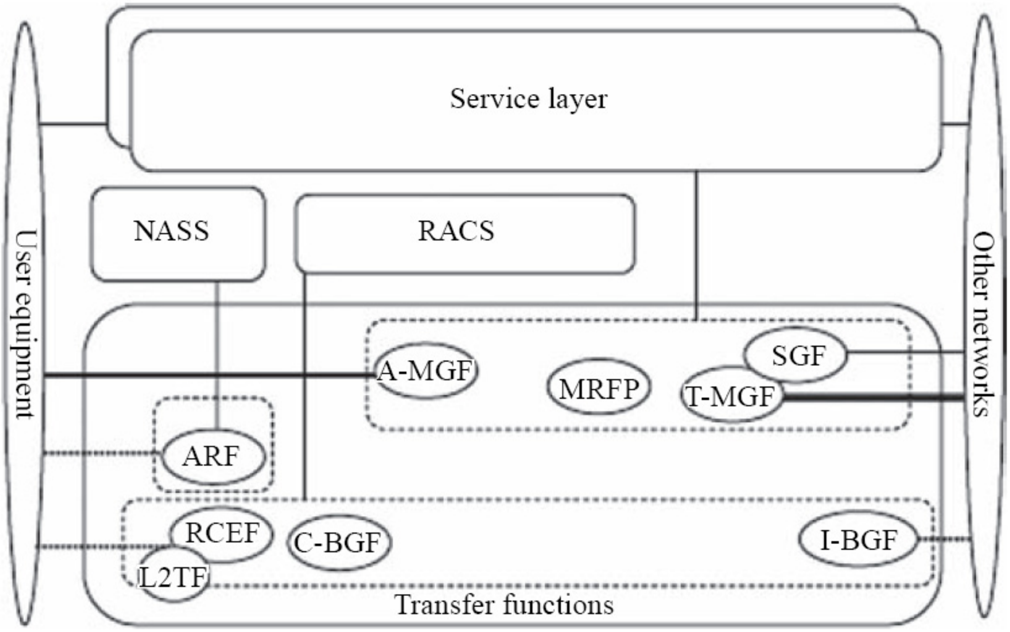

Figure 5.4 Transfer functions overview

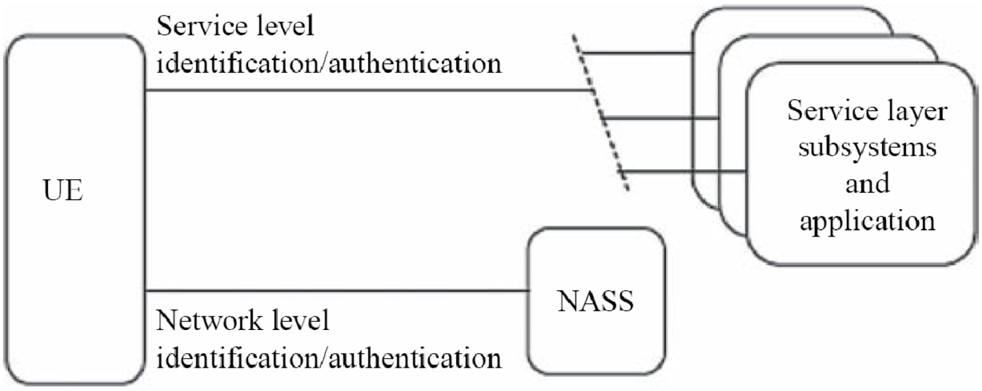

Figure 5.5 NGN authentication levels

- Interconnection with other networks/domains – the interconnection can happen at the transport layer or at the service layer:
    - interconnection at the transport layer;
        - at the transfer layer – interconnection at the transfer level takes place either with TDM-based networks through T-MGF and SGF entities or with IP-based networks, at the Iz reference point, through an I-BGF entity (see Figure 5.6). Interconnection with SS7-based networks only applies to the IMS and PSTN/ISDN emulation subsystems. In such cases, the service

layer controls the T-MGF entity behaviour. Interconnection with IP-based networks depends on the subsystems involved. The I-BGF may behave autonomously or under the control of the service layer, through the RACS, for services that involve the IMS core component or the PSTN/ISDN emulation subsystem. Future releases of the TISPAN specifications will address the control of the I-BGF in other configurations.

  - at NASS;
  - at RACS.

- Interconnection at the service layer – interconnection at the service layercan take place either with SS7-based networks or with IP-based networks. Interconnection with SS7-based networks only applies to the IMS and PSTN/ISDN emulation subsystems, both of which include appropriate functionality to interact with the T-MGF and the SGF. Interconnection with IP-based networks depends on the subsystems involved. IP-based interconnection to/from the IMS core component or the PSTN/ISDN emulation subsystem is performed using the IBCF entity and possibly the IWF entity (see Figure 5.7). Direct interconnection between other types of subsystems or applications is outside the scope of TISPAN R1. IP-based interconnection with external networks supporting a TISPAN compatible version of SIP is performed at the Ic reference point, via the IBCF. Interconnection with external networks supporting H.323 or a non-compatible version of SIP is performed at the Iw reference point, via the IWF. The IBCF and the IWF communicate via the Ib reference point.

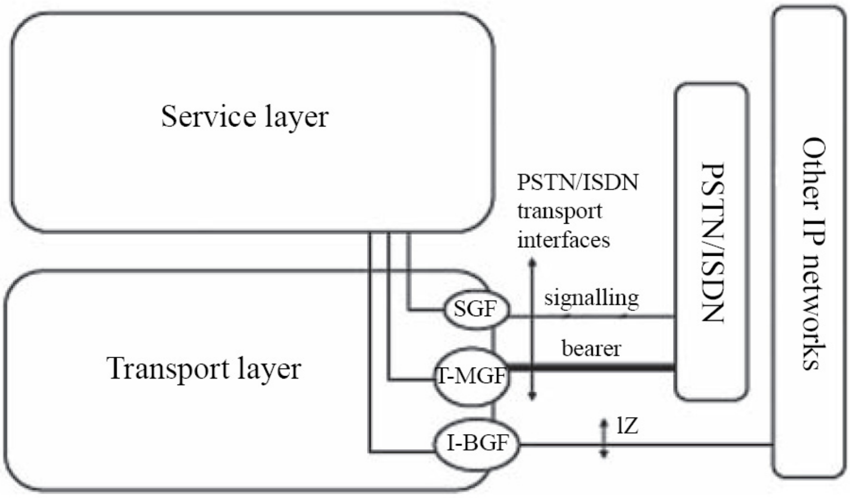

Figure 5.6 Network interconnection at transfer level

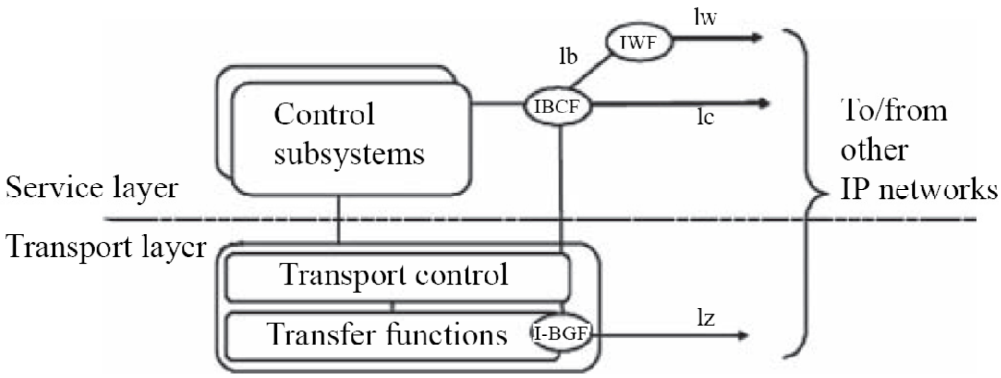

Figure 5.7 IP interconnection

For more details about TISPAN deliverables please visit ETSI standard download page (http://pda.etsi.org/pda/queryform.asp).

5. Numbering, naming and addressing in NGN

NGN must be able to support the existing Naming, Numbering and Addressing plans for fixed and mobile networks.

For networks like PSTN/ISDN, GSM-based PLMNs and the Internet there is a common terminology defined in ITU-T E.191 Recommendation, used concerning the present identifiers (IDs) used in these networks:

- Name,
- Number and
- Address.

In the PSTN the ID is the E.164 number and that number is used for identifying and routing the call to the subscriber/user or services. With the introduction of services based on non-geographic numbers and number portability the function of the number has been split between a name role for identifying the user or service and an address role to indicate how to route the call to the subscriber's network termination point.

In the UMTS based mobile networks several additional identifiers are used to identify the user: Public ID(s), Private ID and Home Domain ID, described in TS 123 003. Additional applications like UMTS Subscribers Identity Module (USIM), and the IM Services Identity Module (ISIM) are used for user access in the network.

Furthermore, in circuit switched networks there are also some IDs used for different network functions, like for example Signaling Point Codes for the ITU-T Signaling System No. 7 (SS7).

In GSM-based PLMNs the E.164 number is often called an MSISDN to indicate that the E.164 number is used for mobile services. Another ID used in GSM networks is the IMSI, based on ITU-T Recommendation E.212, providing a unique identifier of the mobile subscription for registration purposes. Most of the present SIM cards used in GSM networks are marked with another ID called the Issuer Identifier Number (IIN) according to ITU-T Recommendation E.118.

For Internet and other IP based networks, at the beginning only IP address was major ID. Later, names in the form of Domain Names according to RFC 1035 are used.

The Domain Name is used to identify the user/host and the IP address used for routeing to the interface to which the host is connected.

In the context of an NGN, E.164 numbers need to be translated into other kind of IDs (e.g. IP addresses) usable within the NGN.

Many network operators across the world are in the process of migrating their core network from the traditional circuit-switched network to IP-based NGN. With the emergence of NGN, new numbering, naming and addressing schemes may be introduced for new service applications.
In recent years, fixed and mobile network operators have started migrating their networks to IP-based NGN which can offer a number of advantages over the circuit-switched network. Such migration is expected to continue for some years. Being the dominant scheme within voice communications to identify and connect users, the E.164 numbering scheme is expected to continue, at least in the short to medium term, under the NGN environment.
However, some new numbering and addressing schemes such as Electronic Number Mapping (ENUM) and domain name may become the new schemes for service applications in NGN.
ENUM is a protocol developed by the Internet Engineering Task Force (IETF) for mapping an E.164 number into a collection of service specific Uniform Resource Identifiers (URI) that are based on the Domain Name Server (DNS) architecture in the IP environment. Under the public ENUM, an E.164 number e.g. (852) 2961 6333 is converted into "3.3.3.6.1.6.9.2.2.5.8.e164.arpa" where "e164.arpa" is the public ENUM top level domain. The advantage of public ENUM is that users may use a single number to access a wide range of terminals and services, such as phone, fax, email, web or any other services available through an Internet addressing scheme in the NGN world.
With the migration of the existing circuit-switched PSTN to IP-based NGN, public ENUM may be one of the possible schemes to facilitate interoperability for a wide range of applications such as voice, video and instant messaging by using E.164 numbers.

Table 6.1 Overview of Identifiers

	Public ID (User aware)	**Format of the Public ID within the network**	**Private ID (Network Aware)**	**NGN Layer**
User/Service Identifier	Name(s)	SIP URI	ID stored in ISIM	Service
	Number(s)	tel URI SIP URI with domain operator-provided	ID stored in ISIM or derived from USIM	
Network Identifier	Address	Number, and Routeing Number IP Address	Network ID Line ID	Transport

5.1. IDs used in TISPAN NGN

To enable access to NGN using the existing mobile subscriptions (that are based only on USIM) also a mechanism to derive these values from USIM could be evaluated. This results in the requirement to support Home Domain Names in the 3GPP format.

5.1.1. IDs for Users

An NGN operator can store User IDs in ISIMs provided to its subscribers or directly inside the terminals, if necessary. 3GPP specify that the ISIM itself is made up of various attributes. The main 3GPP attributes used for registration and authentication are

- the Home Domain Name,
- the Public and
- the Private Identifier.

5.1.1.1. Home Domain Name

The Home Domain Name is used to identify the home domain of the user. This is used during authentication and registration. The format of the Home Domain Name is based on the Domain Name e.g. *'operator.com'* as specified in RFC 1035.

The Home Network Domain Name is the parameter which is used to route the initial SIP registration requests to the home operator's IMS network. The Home Network Domain Name is stored in the ISIM. If there is no ISIM application (i.e. when there is no IMS-specific module), the Home Domain Name must be derived from the data available "locally" to the UE.

5.1.1.2. Private User Identifiers

Every NGN user has at least one private identifier. Private user identifiers are assigned by the home operator and are used to identify the IMS user's subscription. Its main role is to support the authentication procedure during registration/re-registration/de-registration, authorization, administration and accounting purposes at the home IMS. It is also used as the primary means of identifying the user within a dialog between network entities. A private user identifier is "permanent" and stored locally in the ISIM. The private user identifier shall take the form of an NAI, and shall have the form username@realm as specified in RFC 4282 in accordance with TS 123 003 and TS 123 228. In case there is no ISIM on the UICC, the private user ID is derived from the IMSI. The username is replaced with the complete IMSI value.

5.1.1.3. Public User Identifiers

Every IMS user has one or more public identifiers, which are primarily used for user-to-user communication. The public identifier serves as a basis for message routing, possibly after a translation mechanism when appropriate, both for IMS session-based SIP messages (e.g. INVITE) or off-session SIP messages (e.g. NOTIFY). There is at least one public identifier stored in the ISIM, but like the private identifier, in some cases, it may also be instantiated with default values when no such ISIM is available.

For its syntax, the public identifier shall take the form of either a SIP URI or a tel URI.

A SIP URI shall take the form "sip:user@domain" (TS 23.003 or TS 23.228). Note that tel URIs public user identifiers (whether they are based on E.164 (i.e. public) or private number) cannot be used for SIP call routing in IMS and must be translated in SIP URI using ENUM.

Correct operation of a 3GPP IMS based network requires a number of different identifiers to be present in the IMS. The key identifiers, together with the role they fulfill in NGNs and how they come to be present in the system, are shown in table 6.2.

Table 2: Overview showing the role of different identifiers and associated handling

Identifier	Role within 3GPP	Method of provisioning 3GPP	Method of provision for fixed line access
IP address	Used to support media and signaling stream	Downloaded into terminal from DHCP in access network and uploaded to S-CSCF as part of registration process	Associated with line card as part of service provision process
Private identifier	To identify terminal to system as part of registration / authentication process. Also used for billing	Held in ISIM explicitly or derived from USIM, then loaded into S-CSCF via registration process.	'Pseudo IMSI' provided and held in UPSF as part of service provision process
Public identifier	Used to identify required terminal on incoming calls. Also used as CLI on outgoing calls	Programmed into ISIM and loaded into HSS as part of service provision process.	Programmed into UPSF as part of service provision process.

5.1.2. Identification of Network Nodes

The CSCF, BGCF and MGCF nodes (functionalities I-BCF and IBGF) shall be identifiable using a valid SIP URI (Host Domain Name or Network Address) on those interfaces supporting the SIP protocol, (e.g. Gm, Mw, Mm, and Mg).

These SIP URIs would be used when identifying these nodes in header fields of SIP messages. The names should be allocated in the public DNS system, however, this does not require that the nodes be reachable from the global Internet. These URIs will not be resolvable via the public DNS, they will only resolve from within the operators' network.

Globally unique identifiers for certain network elements (e.g. x-CSCFs) will be required so that a shared interconnect model, e.g. a GRX/IPX type interconnect model can be supported. Element identifier can be left to the choice of the service provider since the operator identifier and root domain uniquely identify the service provider. However the element name should be compliant with RFC 1093 and it is possible that further constraints, yet to be identified, may be required.

5.1.3. IDs for Services

Public Service Identifiers shall take the form as defined in TS 123 003.

All public service identifiers need to meet the specific requirements of services such as:

- Voice.
- Instant Messaging Service.
- Presence Service.
- Location Service.

The public service identifier shall take the form of either a SIP URI (RFC 3261) or a tel URI (RFC 3966).

A public service identifier defines a service, or a specific resource created for a service.

The domain part is pre-defined by the NGN operators and the IMS system provides the flexibility to dynamically create the user part of the PSIs.

The SIP URI shall take the form of a distinct PSI "SIP:service@domain", where 'service' identifies a service.

EXAMPLE: sip:conference@examplenetwork.com.

Generally for SIP URIs three different contexts have to be differentiated:

- international E.164 number;
- private number which must include a context;
- short codes.

5.1.4. IDs for NGN operators

Proposals have been made for a naming scheme for NGN network elements. This takes the format <element id>.<service provider>.<root domain>. The nature of the root domain needs further consideration in the light of recent initiatives outside ETSI (e.g. GSMA). However there is general agreement that this needs to be allocated from within the public DNS name space. A name per operator/service provider will need to allocated, and this must be unique within the root domain if misrouteing is to be avoided. To ensure that uniqueness is achieved, the entity responsible for governance of the route domain will need to be responsible for allocation of SP identifiers. A user friendly name for the root domain is favourable.

Additional requirements may occur in the situation, where same services are supplied to the user from different service providers. In such circumstances separate public service provider identifiers would be required and must be supported by the NGN.

5.2. Administration of NGN IDs

Identifiers fall into 3 classes (not mutually exclusive):

- Those generated automatically by network elements (e.g. call identifiers). For these, no human intervention is required (or possible).
- Those that may be allocated by operators without reference to external bodies (e.g. customer account number).
- Those for which operators must go to external bodies (e.g. NRA and others) to receive allocations (e.g. E.164 numbers, public IP addresses).

According to Framework Directive, Article 10.1 National regulatory authorities have to control the assignment of all national numbering resources and the management of the national numbering plans. Adequate numbers and numbering ranges shall be provided for all publicly available electronic communications services.

Furthermore, according to Framework Directive, Article 10.1, National regulatory authorities is obligated to establish objective, transparent and non-discriminatory assigning procedures for national numbering resources.

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5.2.1. Administration of E.164 Numbers

According to the WTSA, ITU-T Study Group 2 ('SG2') is the lead ITU-T Study Group with regard to the Administration of International Numbering Resources. SG2's responsibilities, under this mandate, include overseeing the administration of all such resources in order to ensure uniformity and equity in their assignment, despite the fact that technical responsibilities for these resources are dispersed across multiple ITU-T Study Groups.

5.2.2. IP Addresses

Currently there are two types of Internet Protocol (IP) addresses in active use:

- IP version 4 (IPv4) - older version, running since January 1983, with 32-bit long addresses and
- IP version 6 (IPv6) – deployment started in 1999, with 128-bit long addresses.

Both IPv4 and IPv6 addresses are assigned in a delegated manner. Users are assigned IP addresses by Internet service providers (ISPs). ISPs obtain allocations of IP addresses from a local Internet registry (LIR) or national Internet registry (NIR), or from their appropriate Regional Internet Registry (RIR):

- AfriNIC (African Network Information Centre) - Africa Region
- APNIC (Asia Pacific Network Information Centre) - Asia/Pacific Region
- ARIN (American Registry for Internet Numbers) - North America Region
- LACNIC (Regional Latin-American and Caribbean IP Address Registry) - Latin America and some Caribbean
- Islands
- RIPE NCC (Réseaux IP Européens) - Europe, the Middle East, and Central Asia

The IANA's role is to allocate IP addresses from the pools of unallocated addresses to the RIRs according to their established needs. When an RIR requires more IP addresses for allocation or assignment within its region, the IANA makes an additional allocation to the RIR.

5.2.3. Domain Names

Every computer on the Internet has a unique IP address - just like a telephone number - which is a rather complicated string of numbers. IP addresses are hard to remember. The Domain

Name System (DNS) makes using the Internet easier by allowing a familiar string of letters (the "Domain Name") to be used instead of the arcane IP address.
The Internet Corporation for Assigned Names and Numbers (ICANN) is an internationally organized, non-profit corporation that has responsibility for gTLD and ccTLD name system management.
The responsibility for operating each TLD (including maintaining a registry of the Domain Names within the TLD) is delegated by ICANN to a particular organization. These organizations are referred to as 'registry operators'. Currently, the gTLD of .aero, .biz, .com, .coop, .info, .museum, .name, .net, .org and .pro are in use, and the corresponding registries are under contract with ICANN. Separate arrangements apply to .edu, .mil, .gov, under United States Government responsibility, and .int which is directly under ICANN's responsibility.
Domain Names can be registered through many companies known as "registrars". The registrar collects various contact and technical information that makes up the user's registration. The registrar keeps then records of the contact information and submit the technical information to the registry operator. The latter provides other computers on the Internet the information necessary to resolve the Domain Name in the correct IP address.
SIP addresses used as public user ID in NGN are based on Domain Names. A SIP address (or a SIP URI) is a type of Uniform Resource Identifier that identifies a communication resource in SIP. A SIP URI usually contains a user name and a host name and is similar in format to an email address (example: user@domain.foo).

5.2.4. International Mobile Subscriber Identity - IMSI

The IMSI is a string of decimal digits, up to a maximum of 15 digits, that identifies a unique mobile terminal or mobile subscriber internationally. IMSIs may also be used for terminal or subscriber identification within fixed or wireline networks that offer mobility services, or to achieve compatibility with networks that have mobility services. The IMSI consists of three fields: the MCC, the MNC, and the MSIN. The IMSI conforms to the ITU-T Recommendation for E.212 numbering. MCCs are assigned by the ITU in response to formal requests from national administrators of ITU Member States.
Additional MCCs will be assigned only in anticipation of exhaust of assigned code(s). MNCs are administered by the designated administrator within each country or by the TSB in the case of shared MCCs. Additional MNCs are assigned to MNC assignees within a shared MCC only for exhaust of the assigned code(s). MSINs are administered by the MNC assignee.

In principle, only one IMSI shall be assigned to each mobile terminal or mobile user. In case of multiple subscriptions (subscriptions to more than one mobility service from one or more service providers), a mobile terminal or mobile user may be assigned a different IMSI for each subscription.

Abbreviations

2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Project
3GPP2	Third Generation Partnership Project 2
4G	Fourth Generation
AAA	Authentication, Authorization and Accounting
ADSL	Asymmetric Digital Subscriber Line
aGW	access Gateway
AIPN	All IP Network
ANI	Application Network Interface
API	Application Programming Interface
ARF	Access Relay Function
ARIB	Association of Radio Industries and Businesses (Japan)
ASF	Application Server Function
ATIS	Alliance for Telecommunications Industry Solutions
ATM	Asynchronous Transfer Mode
BGF	Border Gateway Function
BGP	Border Gateway Protocol
BPON	Broadband Passive Optical Networks
BRAN	Broadband Radio Access Networks
CAMEL	Customized Application for Mobile Network Enhanced Logic
CAN	Car Area Network
CCSA	China Communications Standard Association (China)
CDMA	Code Division Multiple Access
CEPAA	Council on Economic Priorities Accreditation Agency
CI	Contract Interface
CN	Core Network
CTE	Customer Terminal Equipment
CRM	Customer Relationship Management
CSR	Corporate Social Responsibility
CT	Communication Technology
DAB	Digital Audio Broadcasting

DAN	Device Area Network
DECT	Digital Enhanced Cordless Telecommunications (former for Digital European Cordless Telephony)
DfE	Design for Environment
DiffServ	Differentiated Services
DMB	Digital Multimedia Broadcasting
DMB-T	Terrestrial Digital Multimedia Broadcasting
DSCP	DiffServ Code Point
DVB	Digital Video Broadcasting
DVB-C	DVB Cable
DVB-H	Handheld Digital Video Broadcasting
DVB-HS	DVB Handheld and Satellite
DVB-S	DVB Satellite
DVB-T	Terrestrial Digital Video Broadcasting
DVD	Digital Video Disk
EDGE	Enhanced Data Rates for Global/GSM Evolution
EF	Expedited Forwarding
EGPRS	Enhancd GPRS
EITO	European Information Technology Observatory
EMS	Enhanced Messaging Service
eNB	evolved Node B
EPC	Evolved Packet Core
EPE	Environmental Performance Evaluation
ePDG	enhanced Packet Data Gateway
EPON	Ethernet Passive Optical Networks
eRAN	evolved Radio Access Network
ETNO	European Telecommunication Networks Operation Association
eTOM	enhanced TOM
ETSI	European Telecommunications Standards Institute
EU	European Union
eUTRAN	evolved Universal Terrestrial Radio Access Network
EVDO	Evolution Data Optimized
FFS	For Further Study
FG-NGN	Focus Group-NGN

FMC	Fixed Mobile Convergence
FTP	File Transfer Protocol
FTTH	Fibre To The Home
FTTx	Fiber To The *x* (*x* = home, building, curb)
FW	Framework
GEO	Geostationary Earth Orbit
GERAN	GSM/EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GMPLS	Generalized MPLS
GOCAP	Generic Overload Control Activation Protocol
GPON	Gigabit Passive Optical Networks
GPRS	General Packet Radio Service
GPS	Global Positioning System
GRI	Global Reporting Initiative
GSI-NGN	Global Standards Initiative-NGN
GSM	Global System for Mobile Communication
GTP	GPRS Tunnelling Protocol
GUP	Generic User Profile
GW	Gateway
HAN	Home Area Network
HDTV	High-Definition Television
HEF	Human Ecological Footprint
HSDPA	High-Speed Downlink Packet Access
HSPA	High-Speed Packet Access
HSS	Home Subscriber Server
HSUPA	High-Speed Uplink Packet Access
IBCF	Interconnection Border Control Function
ICT	Information and Communication Technology
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IM	Issue Management
IMS	IP Multimedia Subsystem
IN	Intelligent Network

InRD	Infrared
IntServ	Integrated Services
IP	Internet Protocol
IP CN	IP Core Network
IP-CAN	IP-Connectivity Access Network
IPR	Intellectual Property Rights
IPsec	secured IP
IPTV	Internet Protocol Television
IPv4	IP version 4
IPv6	IP version 6
ISDB-T	Integrated Services Digital Broadcasting-Terrestrial
ISDN	Integrated Services Digital Network
ISO	International Standardization Organization
ISP	Internet Service Provider
ISUP	ISDN User Part
IT	Information Technology
ITIL	IT Information Library
ITU	International Telecommunication Union
IUCN	International Union for the Conservation of Nature
IWF	Interworking Function
JRG-NGN	Joint Rapporteur Group on NGN
KPI	Key Performance Indicator
KQI	Key Quality Indicator
L2TF	Layer 2 Termination Function
LAN	Local Area Network
LCA	Life Cycle Analysis
LEO	Low Earth Orbit
LMDS	Local Multipoint Distribution System
LSDI	Large Screen Digital Imagery
LSP	Label Switched Path
LTE	Long-Term Evolution
MAC	Media Access Control
MBMS	Multiple Broadcast Multimedia Services
MediaFLO	Media Forward Link Only

MEO	Medium Earth Orbit
MGF	Media Gateway Function
MIMO	Multiple Input Multiple Output
MIPS	Material Intensity Per unit of Service
MIPv4	Mobile IP version 4
MIPv6	Mobile IP version 6
MMDS	Multichannel Multipoint Distribution Systems
MME	Mobility Management Entity
MMoIP	Multimedia over IP
MMS	Multimedia Message Service
MOS	Mean Opinion Score
MoU	Memorandum of Understanding
MPLS	Multi-Protocol Label Switching
MPLS-T	MPLS Transport
MPtMP	Multipoint to Multipoint
MRFP	Media Resource Function Processor
MVDS	Multichannel Video Distribution System
NACF	Network Attachment Control Functions
NAPT	Network Address Port Translation
NASS	Network Attachment Subsysem
NAT	Network Address Translation
NE	Network Element
NFC	Near-Field Communication
NGMN	Next Generation Mobile Network
NGN	Next Generation Networks
NGN-GSI	NGN Global Standards Initiative
NGN-MFG	NGN Management Focus Group
NGOSS	New Generation Operation System and Software
NIR	Non-Ionizing Radiation
NNI	Network Node Interface
OAM	Operation And Maintenance
OCAF-FG	Open Communication Architecture Forum–Focus Group

OFDM	Orthogonal Frequency Division Multiplex
OFDMA	Orthogonal Frequency Division Multiple Access
OMA	Open Mobile Aliance
OS	Operating System
OSA	Open Service Access
OSS	Operation Supporting System
OTA	Over The Air
PAM	Presence and Availability Management
PAN	Personal Area Network
PBX	Private Branch Exchange
PC	Personal Computer
PCEP	Policy and Charging Enforcement Point
PCRF	Policy and Charging Rules Function
PDA	Personal Digital Assistant
PES	PSTN/ISDN Emulation Subsystem
PLC	Power Line Communication
PLMN	Public Land Mobile Network
PON	Passive Optical Network
POTS	Plane Old Telephony Service
PSTN	Public Switched Telephone Network
PtMP	Point to Multipoint
PtP	Point-to-point
QoS	Quality of Service
RA	Risk Analysis
RACF	Resource and Admission Control Functions
RACS	Resource and Admission Control Subsystem
RAN	Radio Access Network
RAT	Radio Access Technology
RB	Reserve Bandwidth
RF	Radio Frequency
RFID	Radio Frequency Identity
RLC	Radio Link Control
RRC	Radio Resource Control
RRM	Radio Resource Management

RSVP	Resource Reservation Protocol
RTCP	Real-Time Control Protocol
RTP	Real-Time Protocol
RTSP	Real-Time Streaming Protocol
SA	Social Accounting
SAE	System Architecture Evolution
SC	Score Card
SCF	Service Capability Function
SC-FDMA	Single Carrier-Frequency Division Multiple Access
SCS	Service Capability Server
SDTV	Standard Definition Television
SEAAR	Social and Ethical Accounting, Auditing and Reporting
SGF	Signaling Gateway Function
SGSN	Serving GPRS Service Node
SID	Shared Information and Data model
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SL	Service Level
SLA	Service Level Agreement
SLF	Subscription Locator Function
SM	Stakeholder Management
SMS	Short Message Service
SOA	Service-Oriented Architecture
SON	Self-Organizing Networks
SW	Software
TA	Technology Assessment
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TETRA	Terrestrial Trunked Radio
TIA	Telecommunication Industry Association (NAFTA countries: USA, Canada, Mexico)
TISPAN-NGN	Telecommunication and Internet converged Services and Protocols for Advanced Networking-NGN
TMF	Telecom Management Forum

TNA	Technology Neutral Architecture
TOM	Telecommunication Operation Map
TOS	Type Of Service
TTA	Telecommunications Technology Association (Korea)
TTC	Telecommunication Technology Committee (Japan)
TTI	Transmission Time Interval
UDP	User Datagram Protocol
UE	User Equipment
UMB	Ultra Mobile Broadband
UML	Unified Modelling Language
UMTS	Universal Mobile Telecommunucation System
UMTS-S	UMTS Satellite component
UNI	User Network Interface
UPE	User Plane Entity
UPSF	User Profile Server Functions
URL	Uniform Resource Locator
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial adio Access Network
UWB	Ultra Wide Band
VAN	Vehicle Area Network
VAS	Value-Added Service
VoIP	Voice over IP
WBCSD	World Business Council on Sustainable Development
WCDMA	Wideband CDMA
WiMAX	Worldwide interoperability for Microwave Access
WIN	Wireless Intelligent Network
WLAN	Wireless LAN
WWF	World Wildlife Fund
xDSL	*x* Digital Subscriber Line (*x* = A, V, H, etc.)

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