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CONCEPTION OF NEXT GENERATION NETWORKS

ABSTRACT

This article presents a review of the existing networks and the NGN concept. By analysing the condition of the existing telecommunication networks and services it is obvious that they are different single-service networks that cannot meet the requirements of the users for various services. The increased demands of the users for telecommunication services have induced the introduction of liberalization in the telecommunication market. That opened the door for competition and great investments in the development of telecommunication networks.

The existing telecommunication networks orientated to the transmission of voice and the existing data network could not be adapted to new requirements without difficulties. That is the reason why the search for a solution for convergence and union of a great number of different single-service networks started. The basic requirement was reduced in the end to the conception of the universal wideband data network that can meet all the demands of the users by dividing the resources. As a consequence of that it was necessary to find the solution for the transmission of voice by a data network. The solution was seen in the erection of softswitch architecture for VoIP. Thus, the voice would be transmitted by packets as one of the components in data transmission. It was necessary to define protocols for enabling the operation in the NGN conception, as well as to thoroughly observe the problems of the IP telephony operation in regard to the real-time voice component. Apart from these tasks it was necessary to see how to adapt the existing networks into the NGN conception and to provide interaction between different networks and different layers of networks by applying certain standards and protocols. The awareness of the necessity of gradual introduction and realization of NGN conception has become obvious, always in the relation to the existing condition of PSTN and the users' demands. Special attention should be given to the introduction of IN as a tool for the realization of additional services and for enabling the control in NGN. The problem of IP routers for NGN has also been mentioned, as well as the importance of the new core generation of optical networks.

The conceptual framework of NGN is based today on IP/ATM transport technology, which is at this level of development generally accepted as the optimal transport solution. The problem of addressing caused by the insufficient address space of Ipv4 has been stressed and the solution of that problem has been anticipated with the introduction of Ipv6 technology, which, due to its complexity and high costs, would be gradually introduced by a dual approach into the system.

The differentiating elements of NGN in relation to the existing networks have been specially pointed out. The modular, that is, plane nature of the NGN conception in relation to the vertical and hierarchical conception of PSTN has been stressed, as well as the privileges that this open conception offers when choosing the equipment of the highest quality by different manufacturers. Both existing, voice (TDM) and data (NGN) (ATM/IP), networks will act parallel in the next years until new solutions to NGN will have been introduced.

KEY WORDS

PSTN, NGN, convergence, softswitch, VoIP, MGC, MG, intelligent network (IN), Internet protocol (IP), ATM, MPLS

1. INTRODUCTION

The agreement of the World trade organization (WTO) from the year of 1997 defined the introduction of liberalization and deregulation to the world telecommunication market. This has enabled the introduction of competition and great investments in the development of telecommunication networks. A massive turnover has taken place in the developmental trend of telecommunication networks and has enabled them to meet the growing requests of users. The constant technological evolution has directed the world towards information society. The telecommunication branch has had the leading role there, paving the way for the introduction of new services and applications, which will make the base of the information society. The change in the technological development has been conducted by the following strategic goals:

- the development of voice and data networks,
- the development of mobile networks,
- the development of integration and services.

The liberalization and deregulation of the telecommunication market and the expansion of data networks and services, above all the Internet, have forced the operators to change the approach to providing voice and data services. Their infrastructures migrate from the networks oriented to voice transmission, and data that they transmit, towards data transmission oriented networks that will transmit voice as only one of the multimedia traffic components. Voice transfer (Voice over IP, Voice over ATM, Voice over Frame Relay, Voice over DSL), as well as voice services in 3 Generation mobile telephone network (3 Generation/Universal Mobile Telecommunications Systems-3G/UMTS), will be realized by packet transmission. A possible solution could be convergence between packet oriented networks and telephone networks, as well as the creation of a universal packet service network: **Next Generation Networks - NGN.**

NGN is a new network architecture in telecommunications. That is a network that is being developed as a new grade in the constant evolution of telecommunication networks. It is the result of convergence, Public Switched Telephone Network (PSTN) and Packet Switched Public Data Network (PSPDN).

Recommendation #1: *The ETSI (European Telecommunications Standard Institute) GA is invited to note the following definition of NGN:*

NGN is a concept for defining and deploying, which, due to their formal separation into different layers and planes and use of open interfaces, offers service providers and users a platform which can evolve in a step-by-step manner to create, deploy and manage innovative services [1].

2. EXISTING TELECOMMUNICATION NETWORKS

The existing telephone network (Figure 1) is based on the switching systems network, which contains traditional TDM (Time Division Multiplex) telephone switches, hierarchically divided into several levels. That is usually international exchange, transit exchange (TEX) and local exchange (LE). Generally, those are huge supraordinated switching nodes with belonging remote switching stages. They are connected with digital transmission systems. The connection is mostly based on TDM principle for the uncompressed voice transmission.

It is based on SS7 (Signalling System number 7) of the signalling infrastructure. Switching and data transport (DT) are vertically integrated and the networks are designed for personal services. The access network, observed as a local loop from customers to switching nodes, has a limited transmission capacity. Transport streams between switching nodes are based

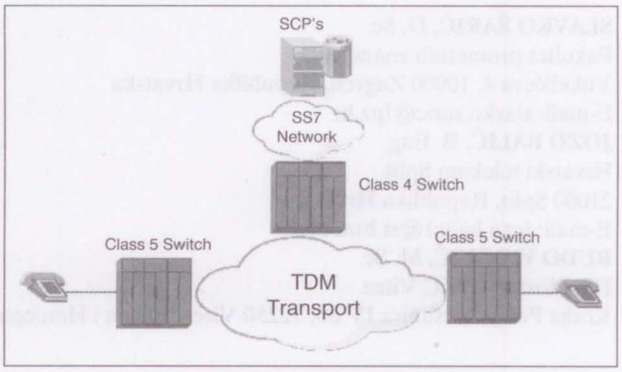

Figure 1 - Organization of the existing telephone network [16]

on multiplexing. Each realized connection is assigned an already defined path through the network. The network structure is oriented to voice transfer and switching nodes actually represent the breaking point for data transmission.

Along with the PSTN network data the PSPDN network has also been developed. This conception is such that at each request for data transmission the transmission path does not have to be determined in advance, but it enables the packets of the same data messages to go through different paths through the network to the common destination, before being reconnected.

Present day voice and data networks (Figure 2) are manifold and act as independent networks. Their control and management architecture are different, and their capacity and performance are a bottleneck. Each network has its own control plane, management plane and its own services.

According to the functionality in the system, telecommunication networks can be grouped into:

- switching networks,
- transmission networks,
- access networks,
- signalling networks,
- intelligent networks,
- management and control networks,
- business subscriber networks,
- mobile networks [10].

Due to different technologies, the operators have become aware of the necessity of the concentration on the development of the network architecture, adapted to data transmission. Due to huge requests in the telecommunication and information sphere, different network technologies and data transfer technologies have been developed, and thus are in use today (Figure 3).

In access networks, which should enable broadband services, ASDL, video-on-demand, etc., certain reduction of customer loops to the length of up to one

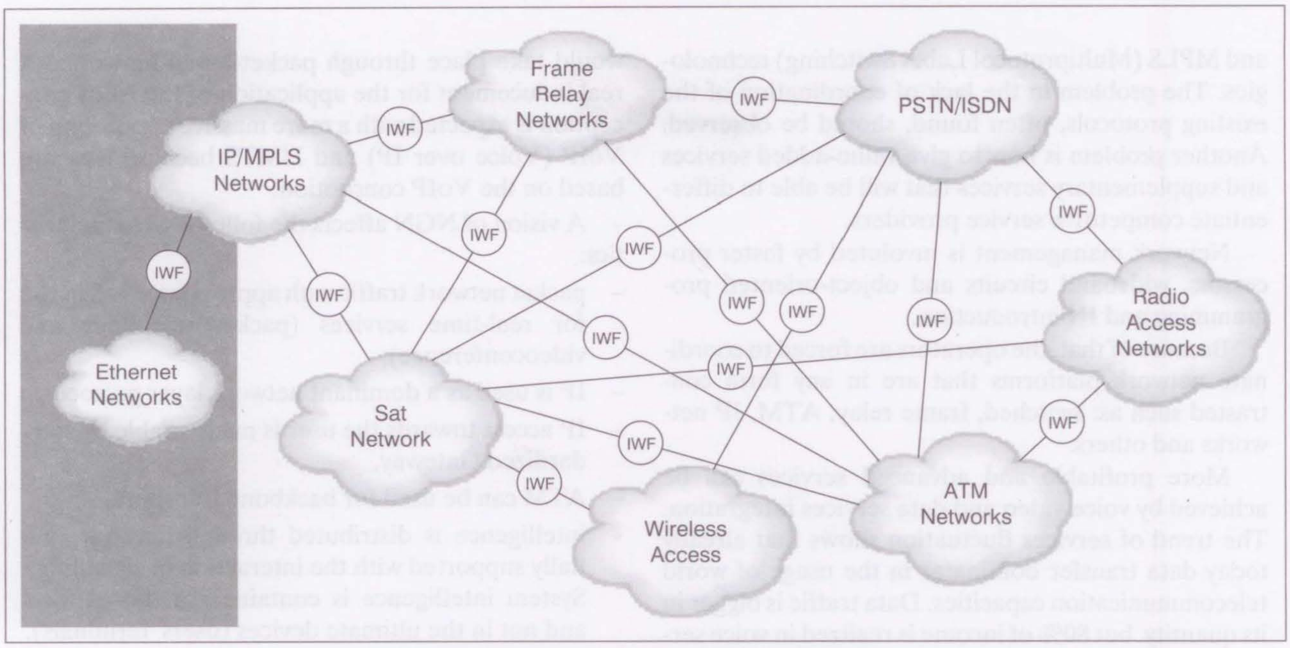

Figure 2 - Present-day network situation [7]

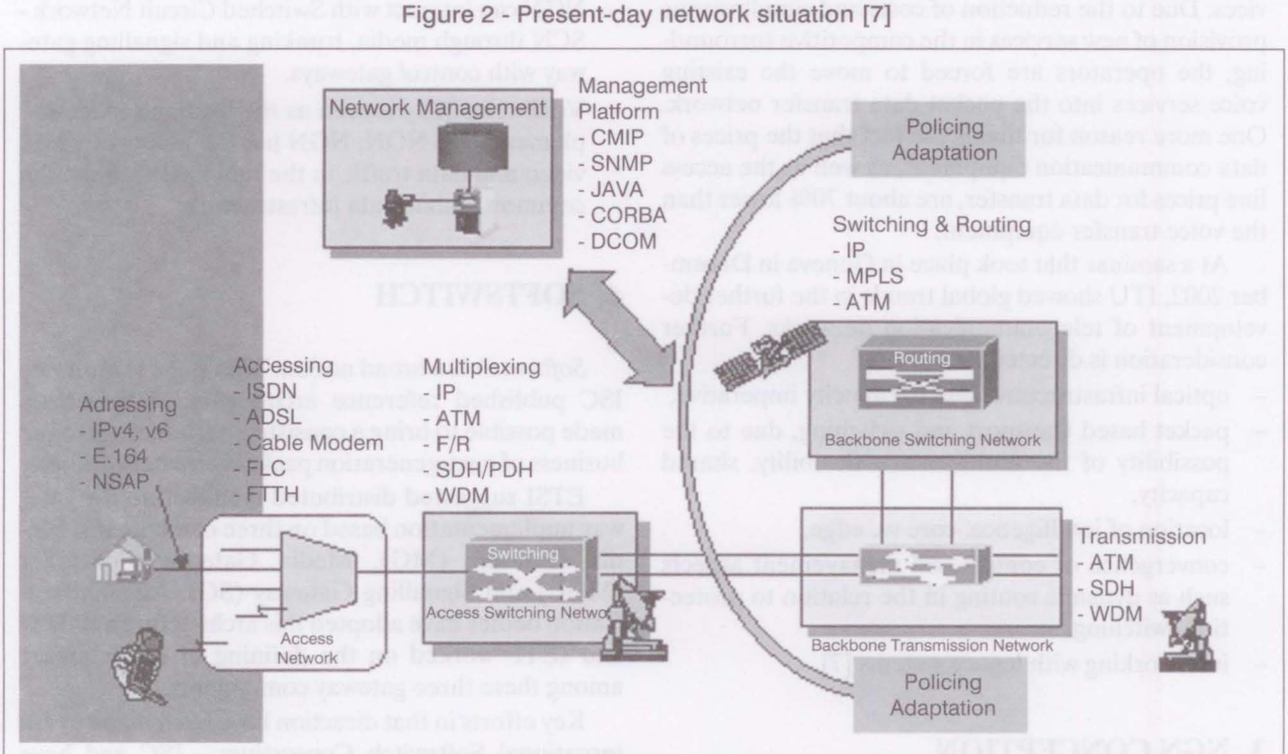

Figure 3 - Network evolutional trends - a diversity of technologies [7]

and a half kilometres is introduced. Interesting here is the last mile access options that have been solved as:

- copper pair with xDSL (x- Digital Subscriber Line) technology,
- optical cable (Fiber) in the combination with the coaxial cable (Coax),
- wireless Celullar radio, Broadband Wireless and others.

ASDL will be one of the most important xDSL technologies and it is estimated that it will be used as the solution for the next forty years [6]. CATV can converge television and the Internet but it cannot replace twisted pair for local telephone services [6]. The ultimate goal is a favourable local loop.

Different transport technologies are used in data transport (DT) in the network: IP (Internet Protocol), ATM (Asynchronous Transfer Mode), FR (Frame Relay), SDH/PDH (Synchronous Digital Hierarchy/ Plesiochronous Digital Hierarchy), WDM (Wavelength Division Multiplexing). On the backbone transport network the aim is to use SDH, WDM, IP, ATM and MPLS (Multiprotocol Label Switching) technologies. The problem in the lack of coordination of the existing protocols, often found, should be observed. Another problem is how to give value-added services and supplementary services that will be able to differentiate competitive service providers.

Network management is involuted by faster processors, wideband circuits and object-oriented programming and IN introduction.

Because of that, the operators are forced to coordinate network platforms that are in any form contrasted such as: switched, frame relay, ATM, IP networks and others.

More profitable and advanced services can be achieved by voice video and data services integration. The trend of services fluctuation shows that already today data transfer dominates in the usage of world telecommunication capacities. Data traffic is bigger in its quantity, but 80% of income is realized in voice services. Due to the reduction of costs and simultaneous provision of new services in the competitive surrounding, the operators are forced to move the existing voice services into the packet data transfer network. One more reason for that is the fact that the prices of data communication equipment, as well as the access line prices for data transfer, are about 70% lower than the voice transfer equipment.

At a seminar that took place in Geneva in December 2002, ITU showed global trends in the further development of telecommunication networks. Further consideration is directed to:

- optical infrastructure, due to capacity imperative,
- packet based transport and switching, due to the possibility of the multi-service flexibility, shared capacity,
- location of intelligence, core vs. edge,
- convergence of control and management aspects such as dynamic routing in the relation to protection switching,
- interworking with legacy systems [7].

3. NGN CONCEPTION

The NGN conception represents an open network architecture with horizontally integrated layers through the common transport layer. It is founded on packet technology. The difference between the present-day PSTN and NGN is in the fact that the two highest layers of NGN, application layer and medium management layer, are separated in computing environment with open standards. That enables them to offer application services that are in heavy demand on the market. NGN is a conception of the transformation of the existing PSTN network, where in the end the circuit switched network is eliminated. All traffic would take place through packet-based networks. A real inducement for the application of the NGN conception is expected with a more massive application of VoIP (Voice over IP) and UMTS because they are based on the VoIP conception.

A vision of NGN affects the following characteristics:

- packet network traffic with appropriate QoS in use for real-time services (packet telephony and videoconference),
- IP is used as a dominant network layer protocol,
- IP access towards the user is made usable by standardized Gateway,
- ATM can be used for backbone transport,
- intelligence is distributed through network (initially supported with the interaction of signalling). System intelligence is contained in the network and not in the ultimate devices (users' terminals),
- NGN can interact with Switched Circuit Network - SCN through media, trunking and signalling gateway with control gateways,
- VoIP telephony is seen as the leading service implemented in NGN; NGN has the ability of voice, video and data traffic in the real time through the common, public data infrastructure.

4. SOFTSWITCH

Softswitch is a broad notion. That is the reason why ISC published reference architecture. It has been made possible to bring a consistent terminology to the business of next-generation packet voice networks [2].

ETSI suggested distributed architecture for gateway implementation based on three components: Media Gateway (MG), Media Gateway Controller (MGC) and Signalling Gateway (SG). All standardization bodies have adopted this architecture and ITU and IETF worked on the defining of the interface among these three gateway components.

Key efforts in that direction have been made by International Softswitch Consortium - ISC and have been published as the reference architecture for VoIP [2].

It was important to unify the terminology in the business of the next-generation packet voice networks - VoIP. Functional elements that make the softswitch have been defined. That enabled the promotion of the interaction and the clearance of ambiguities that exist among the providers and users of VoIP products and services [2]. This has been stressed because, by far the most important component in this set, is the 'softswitch' technology, which makes the base of MGC and with it of NGN. The decision about the implementation has been given to vendors and operators [2].

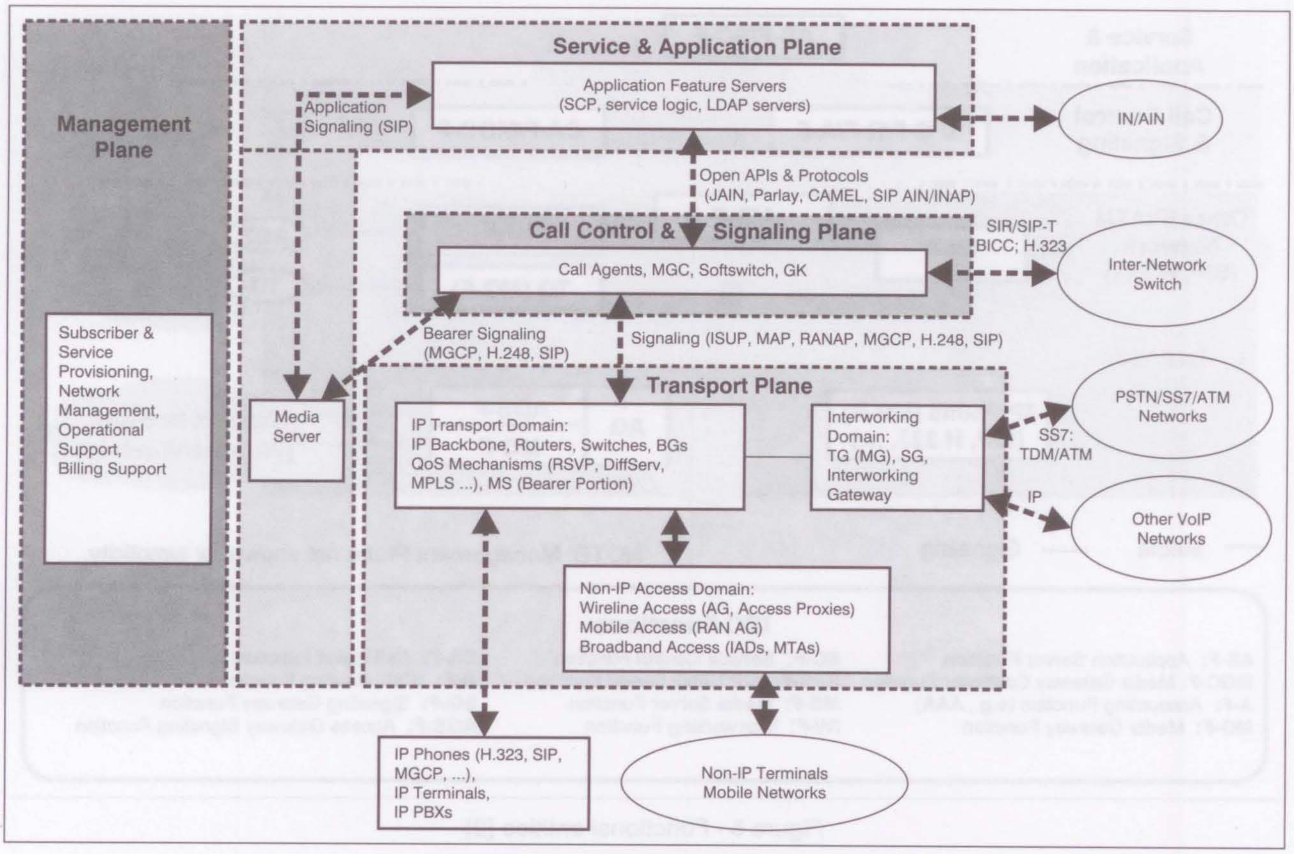

Figure 4 - Functional plan [2]

a) Functional plan

Functional plan (Figure 4) represents the widest level of separation among functional entities in VoIP network. There are four separated functional planes applied in the ISC description of the functioning of end-to-end VoIP networks: transport, call control and signalling, service and application and management plane [2].

b) Functional entities

Functional entities (Figure 5) are logical entities of the VoIP network. Functional components have been quoted and shown here. Different functions can exist physically in an autonomous device or in various combinations on multi-function platforms. The comprehension of the importance of the autonomy of each single function is important for the insight in the characteristics of ISC Reference Architecture [2].

c) Media Gateway Controller Building Blocks

Media Gateway Controller - MGC (Figure 6) is one of the key physical elements of the VoIP network. There are numerous different implementations of MGC and it is known under different names: including Softswitch, Call Agent, Call Controller and others [2].

Most of the Media Gateway Controller MGC systems perform today other functions in addition to MGC functions. Other functions shown on picture (CA-G, IW-F, R-F and A-F) can be conditionally connected on the same physical platform or distributed through various systems that together make a complete solution [2].

Based on these postulations we have today a new approach under the generic name of **softswitch** after telephone commuting that has the possibilities of the removal of all the shortcomings of traditional commuting of local switchboards. The common elements of softswitch solutions comprise:

Media Gateway Controller - MGC or softswitch, Media Gateway - MG application database, SS7/IP gateway, billing module.

5. PROBLEMS OF IPV4 AND IPV6 ADDRESSING

Already today certain thoughts have been given on the market to the problem of limitation caused by the regulations of address assignment. The question is raised regarding the size of the total of routing, which is growing constantly, as well as the greater level of security and flexibility. The address size and structure define the basic nature of the network that is using them, because the implementation of the Ipv6 protocol demands above all hardware and software upgrading, and thus they influence the development path of the network. Ipv6 is actually an expanded Ipv4 protocol. Address fields in Ipv6 titles are determined with

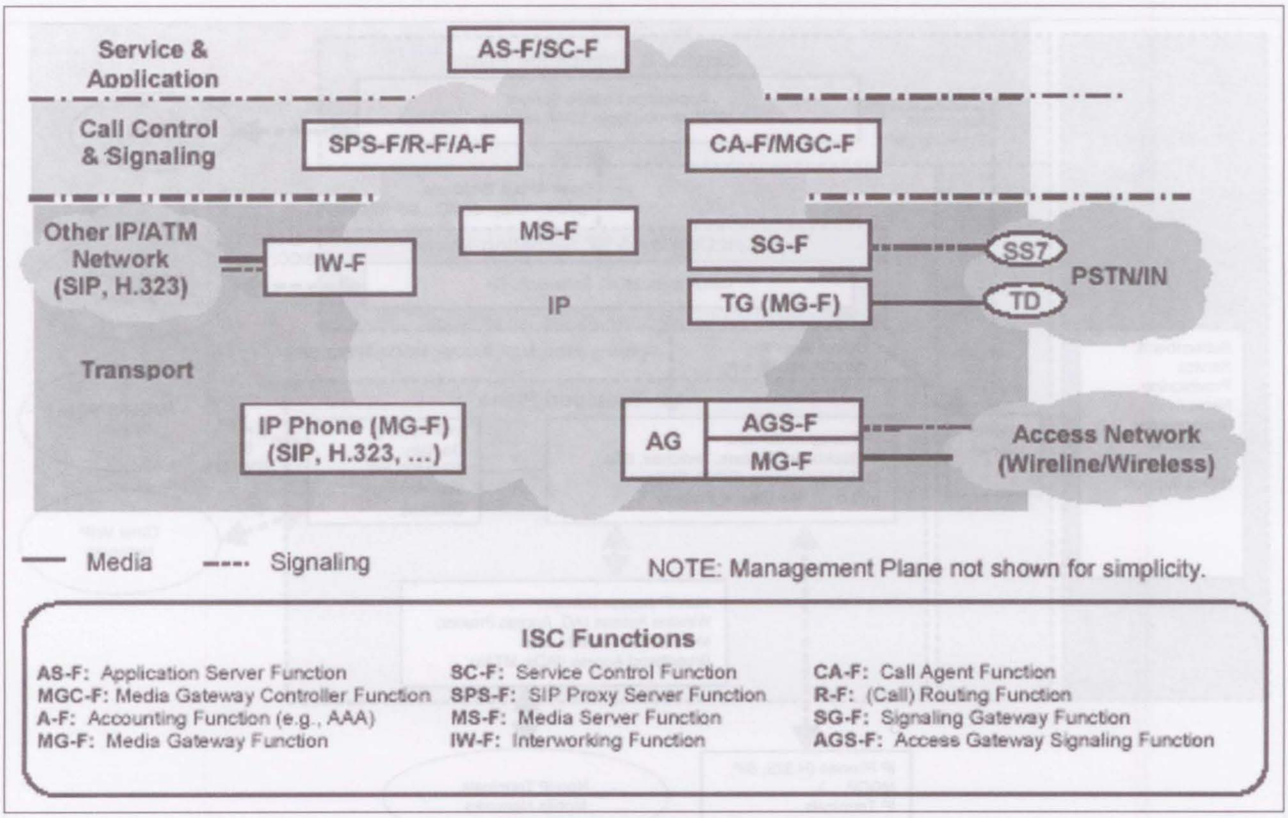

Figure 5 - Functional entities [2]

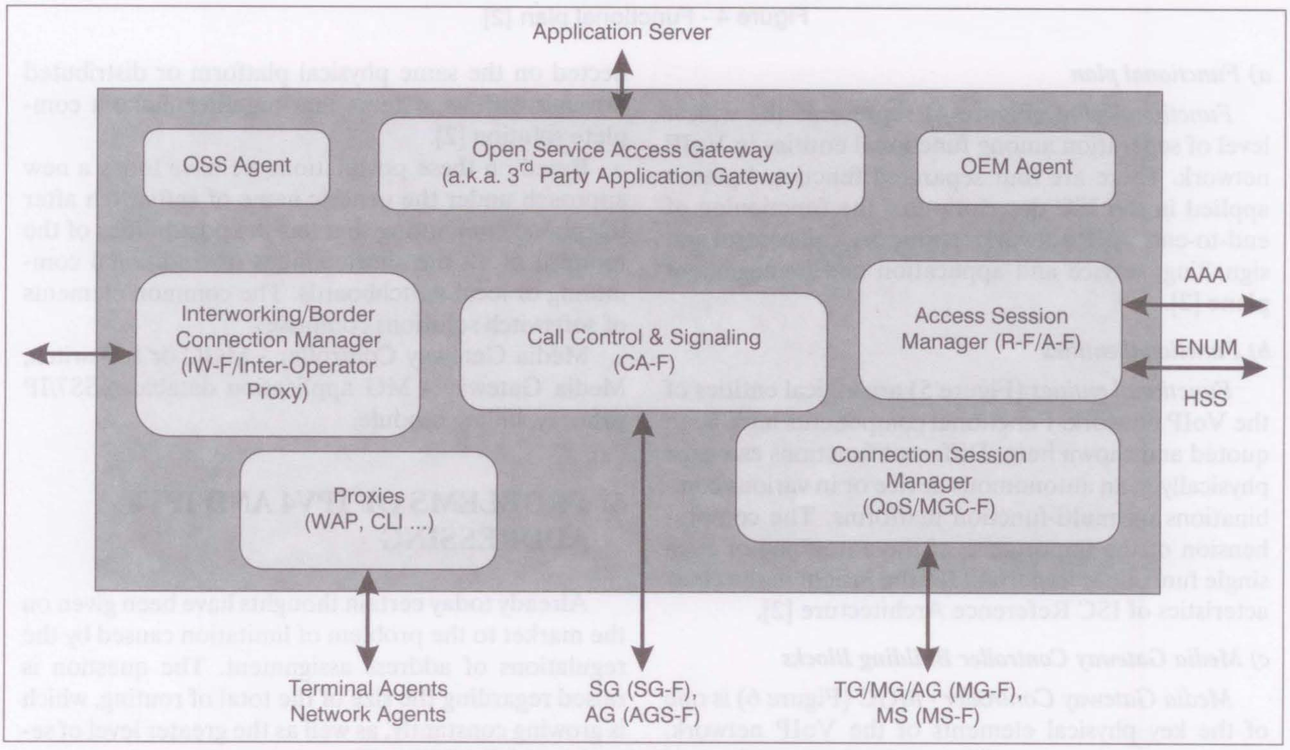

Figure 6 - Media Gateway Controller Building Blocks [2]

128 bytes in the relation to 32 bytes in Ipv4 addresses. In the title of Ipv6 protocol there are fields that define the quality of the service: Traffic Class and Flow Label. Apart from that, Ipv6 can improve the roaming so that, together with the enlargement of the address space it is a big gain for mobile operators. Since a longer period for its full introduction is foreseen, there are greater costs of the introduction of Ipv6 to the existing Ipv4 network. This means a long-term dual scenario (Figure 7) that is based on the principle that sin-

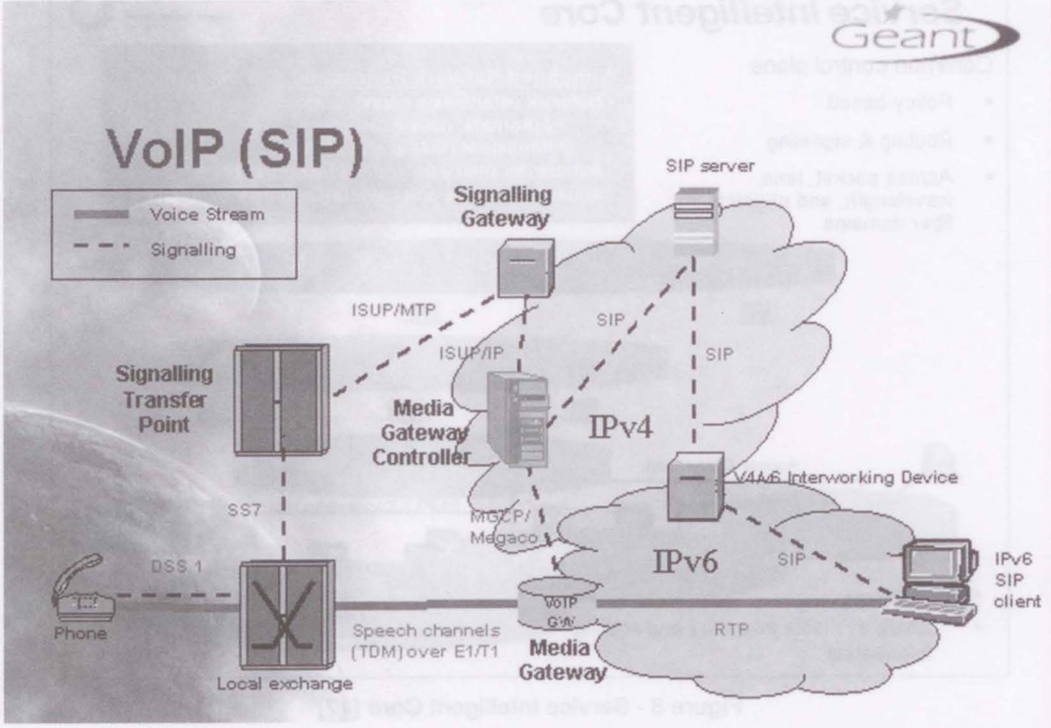

Figure 7 - Dual scenario of the IP protocol [19]

gle parts of the equipment (terminals) can exist both with one and the other protocol. As we can see, the introduction of Ipv6 is predicted to be introduced over a longer period of time, and, with a much better usage of 128 byte address space, it will enable a full solution for the problems of addressing. It enables the creation of one's own address when linking to the network. Ipv6 is not a separate technology. It penetrates all the segments of the technologies, applications, control and by doing so demands the participation of government departments in its realization, as well as research institutes, network operators, equipment manufacturers and service providers.

6. IP ROUTERS FOR NGN AND OPTICAL CORE NETWORK

IP routers are important NGN elements. In the network topology core routers are connected through edge routers towards PSTN network with gateways. Key technologies for NGN IP routers are the packet processing engine and a scalable switch architecture [13]. The network gateway layer enables the access of users of inherited telephone and mobile networks towards the existing IP network.

The optical core network enables an extremely fast transmission of a huge extent of traffic. With the development of the new generation of optical networks many solutions in the network structure will be changed.

7. NETWORK INTELLIGENCE AND NGN NETWORKS

Basic research in the area of telecommunications and informatics are directed towards the development of an intelligent network IN. An intelligent network (IN) is an architecture characterized by the centralized service control and service logic, distributed switching functions and specialized resources [4]. The network functions required to provide services are modular, reusable and portable among the physical entities [4]. The IN architecture realized in PSTN has enabled the introduction of computers in the telephone network and, as a consequence of that, it has enhanced additional services. As the demands for new applications grow extremely fast, there is an increase for the demands for intelligence. Faster processors, wideband switches and object-directed programming contribute to the advancement made in IN. Intelligent network is pictured as a helping tool to the providers of services so that they can offer more additional services such as prepaid, freephone and VPN (Virtual Private Network), televoting, universal number, personal communication systems and the like.

IN uses the SS7 technology and by adding its functionalities in the applications layer achieves these key goals:

- provide timely creation of new services for the customer,
- support a wide range of services,

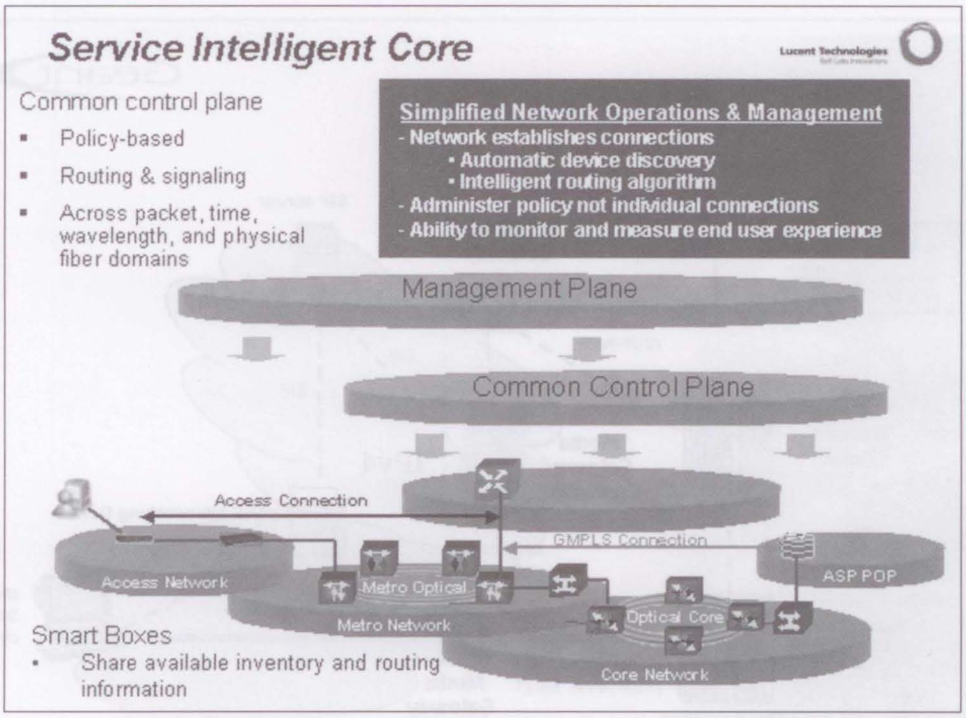

Figure 8 - Service Intelligent Core [17]

- support maintenance of the IN system,
- require a seamless environment between vendor's systems,
- automate services that entail operator intervention [5].

Network intelligence (Figure 8) is defined as the ability of accepting new knowledge through different interfaces, contents, traffic classification, and application level of classification [21]. NGN elements must support the necessary network intelligence. 'The knowledge' of the network is integrated in the assistance of OSS (Operations Support System) architecture, that stretches through the process of switching on from the beginning to the end of the network [21]. It contains complete businesses, services, network control and network elements. An especially complex issue is OSS interconnection among competition, above all due to the adjustment of international and industrial standards. Goal architecture and the functionality of the telecommunication network (Figure 9), which is the base of the control from the beginning to the end, is the base of all NGN conceptions [20].

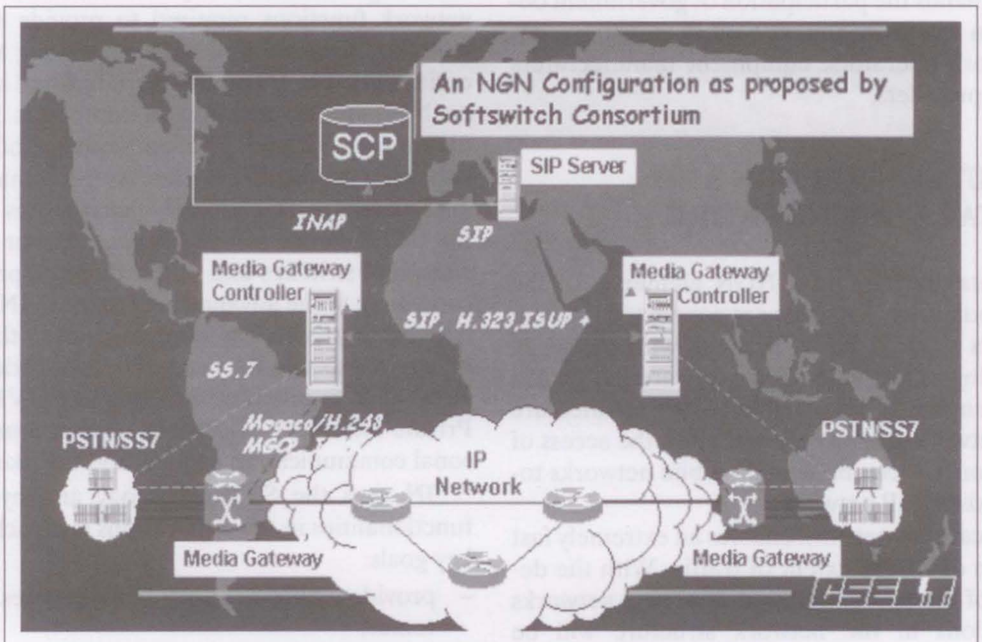

Figure 9 - Control architecture in NGN network [20]

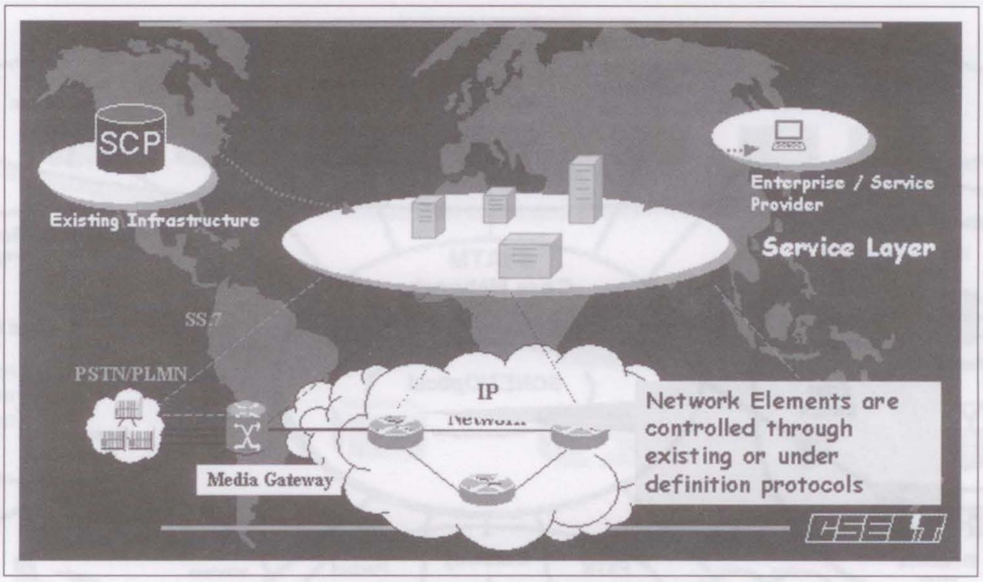

Figure 10 - Network elements control [20]

The defining and development of intelligence of the control layer for data network and its interaction with SS7 and IN from PSTN are a matter of the most thorough analysis in NGN networks.

One of the most challenging parts of IN is the ability to *dispose with mobility* in mobile networks and a similar challenge is the capability of the IN system to assist in the *portability of numbers*. Operators, equipment manufacturers and standardization groups have directed their action towards the idea of Telecommunications Information Network Architecture - TINA. In this conception the control of elements is realized by the interaction through DPE and API. The existing services are integrated in the architecture. Service characteristics are exposed in external applications through reliable API. Network elements (Figure 10) can be controlled through the existing or underdefined protocols [22].

The idea of TINE is to integrate Telecommunication Management Network TMN, Open Distributed Platform ODP, Common Object Request Broker Architecture CORBA and Universal Mobile Telecommunications System UMTS in the *united support architecture IN* [5].

8. NGN ARCHITECTURE

The NGN network will be comprised of differently structured networks and elements (Figure 11) and its key characteriastics are:

- network topology will consist of the optical core integrated with different access technologies such as optical, DSL, wireless and copper pairs on its edge,
- services will be provided on key server elements in the network, based on open systems, built on open industrial standards, for example Java technology. It will enable the services to spread through heterogeneous elements of the network.

In order to deal with the convergence of voice, data, facsimile and video in the next-generation networks new solutions are required. New network should form a highly capable and high-quality backbone in order to enable IT services. The migration of more one-service networks towards one, wideband technology imposes itself as a solution. For the adjustment of different types of traffic and protocols from access networks to the basic network, media gateways are used. For traffic towards a higher level and other MG common signalling and management protocols are used. The NGN architecture (Figure 12) that includes the existing condition of the network and introduces Softswitch conception can be presented by a number of functional planes and the management plane, which realizes interaction with all the layers.

Functional planes are access, transport, control and intelligence, and service planes. Layers are independent in the sense of modification or supplement to other functional layers [12].

The access plane is responsible for the transformation of the signalling and generally for the acceptance of external networks media in the form that can be sent along different entities inside the NGN network and vice versa. Devices in this plane are: Signalling Gateway, Media Gateway and Interworking Gateways [12].

The transport plane is responsible for the transport of all the data through network. It enables transport backbone and routing/switching organization for the transport of packets through network. Router and switches as well as QoS provision devices and control devices belong to this sphere of work [12].

The control plane controls the main network elements, especially the transport plan. The control is

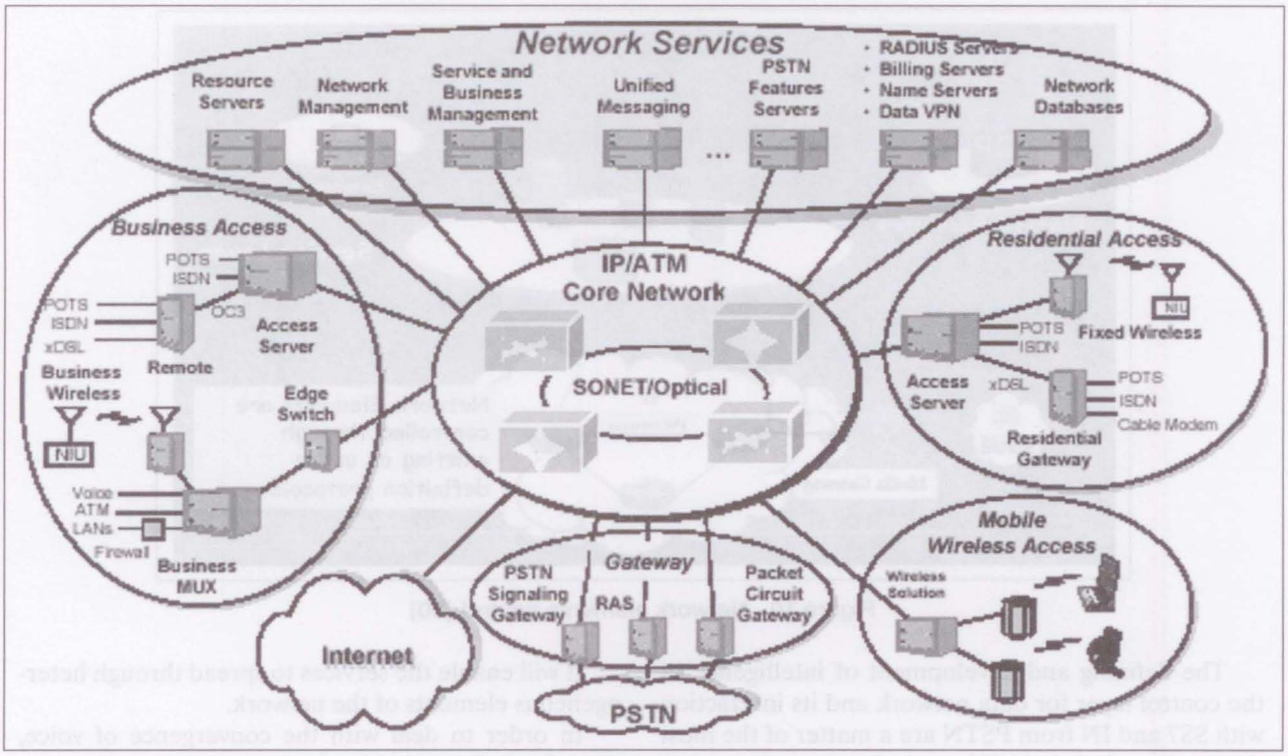

Figure 11 - General NGN conception [11]

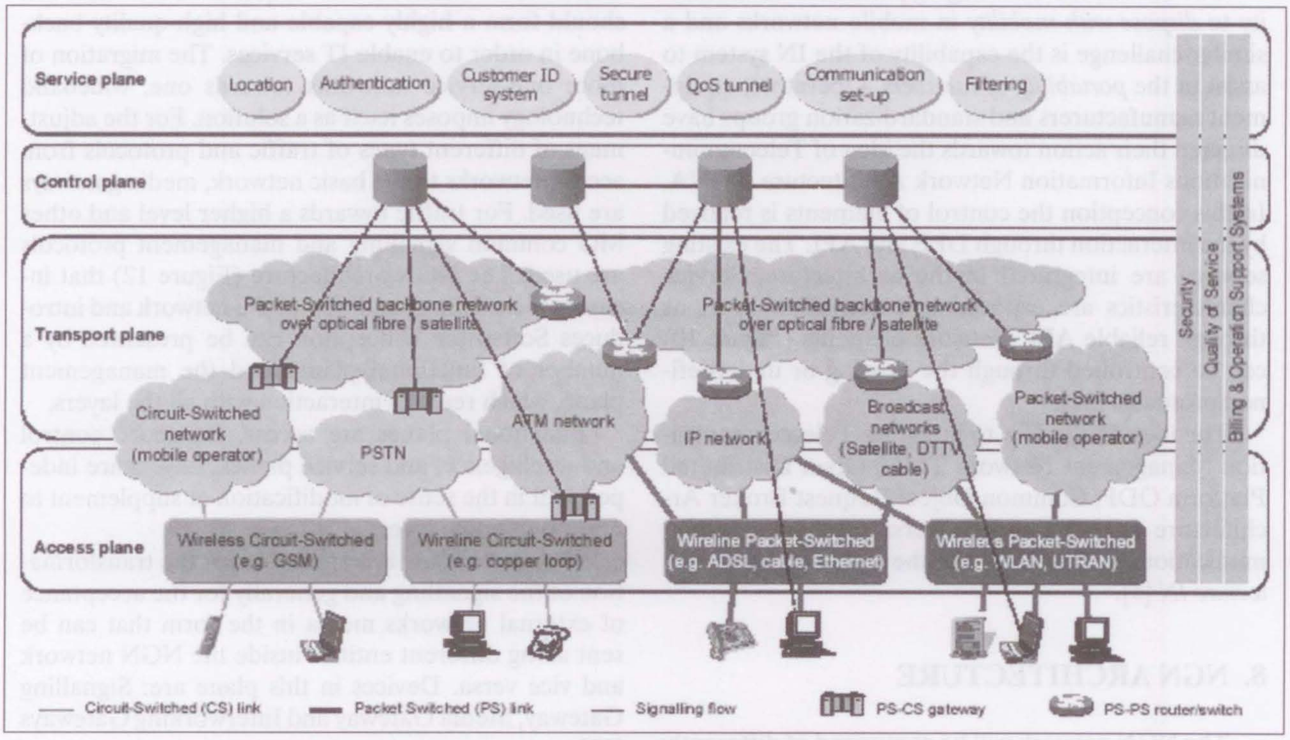

Figure 12 - Anticipated NGN architecture and layers [12]

made on the base of signalling messages received from the transport plane. The main devices of this plane are MGC and Gatekeepers.

The service plane enables control, logic and performance of services or applications in the network. The devices in this plane control the course of the call based on the logics of service performance. Devices of this plane are applications servers and feature servers [12].

The management plane enables functions of operative support, billing and other management tasks. It can be interactive with some or all the other planes through standards and own protocols or API (Application Programming Interface) [12].

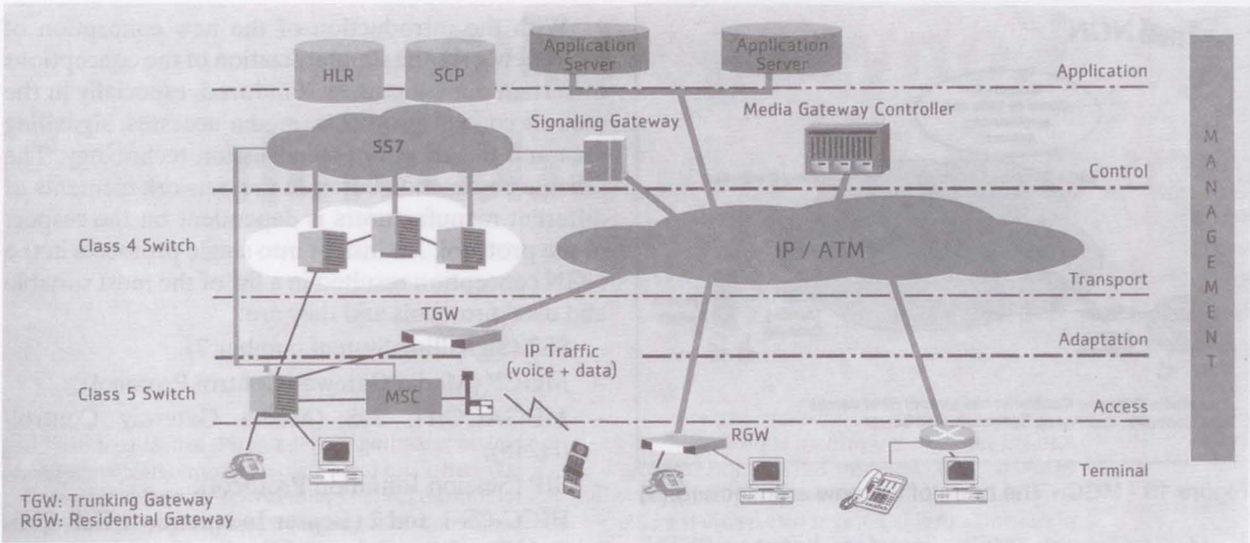

Figure 13 - Present-day conception of the NGN network evolution [8]

In the present-day IP/ATM accepted conception of NGN the optimal solution is shown in Figure 13, showing the network layers and the way of functioning of the inherited PSTN networks incorporated in the new NGN conception.

The roles of single network layers are shown briefly:

- Terminal Layer- includes all kinds of terminal devices,
- Access Layer- based on different transmission media for access and linking of customers into the network,
- Transport Layer- performs the transmission of adapted traffic through network,
- Adaptation Layer- adapts the traffic to its transmission through network,
- Control Layer- determines the connection parameter, manages the connection and services, manages the users and other lower network layers,
- Application layer- enables supplementary services and value-added services,
- Management - present in all the layers.

In this NGN conception the classical monolite telephone switch is divided into:

Media Gateways, Media Gateway Controller, Broadband Network and transformed into 'Next Generation Local Switch' and later into 'Multimedia Softswitch' [3].

The basic distinguishing elements of the NGN architecture that do not exist in the classical PSTN architecture are:

- Media Gateway Controller (MGC),
- Media Gateway (MG) (Figure 14).

Media Gateway Controller (MGC) (Figure 15) - determines the condition of the call engine towards end points. As the brain of the new architecture it enables both the calls and the call signalling control. It manages the calls and services in packet network, operates with all the existing types of signalling and establishes control over Media Gateways. MGC is an open standard software. It can perform distributed communication functions on an open computer platform. It has the functionality of the traditional TDM commutation. It can integrate voice, data and video.

It can also perform the translation of the protocol between open networks. It enables cheap introduction of the VoIP solution. Operators can easily add values to their network and at the same time retain their existing protocols like SS7. It enables the functionality union of transit and local PSTN switchboards with VoIP accesses by working on standard open computer platforms. It is also called Softswitch, Call Manager, Telephony Server, Call Agent, Call Server, it supports IN (SCP) and Network Management functionality.

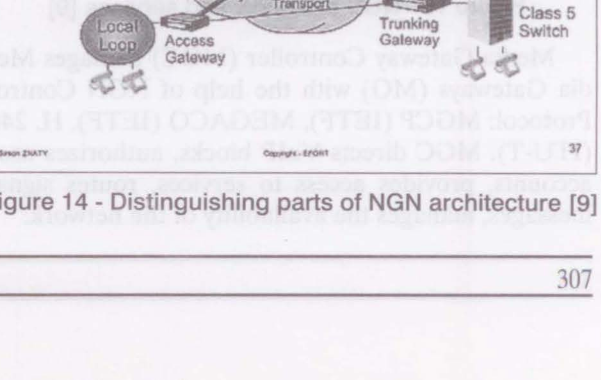

Figure 14 - Distinguishing parts of NGN architecture [9]

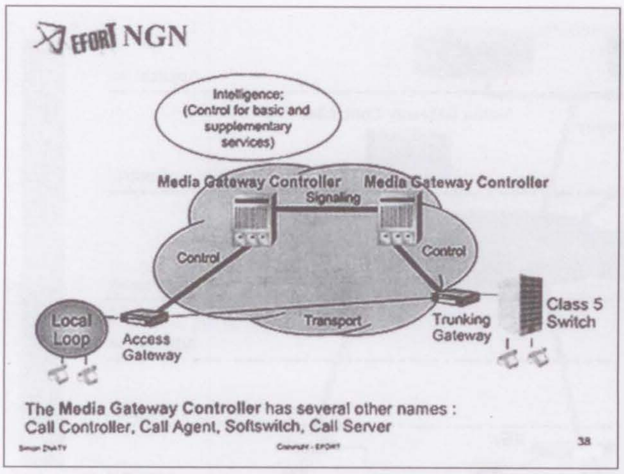

Figure 15 - MGC - The brain of the new architecture [9]

Media Gateway (MG) - interface between PSTN and IP/ATM network. MGW communicates between networks with different protocols, for example: PSTN voice and IP data networks. According to the functionality it is divided into Access, Signalling, Trunking, Residential Gateway. Signalling gateway adapts telephone signal messages for the transmission through packet data networks. Other gateways enable adequate interface of analogue PSTN towards packet networks.

The network management platform supports management services for users' databases, e-trade, billing and the introduction of the distributed intelligent data network.

The new architecture and hierarchy realize functionality by defining signalling and control protocols (Figure 16).

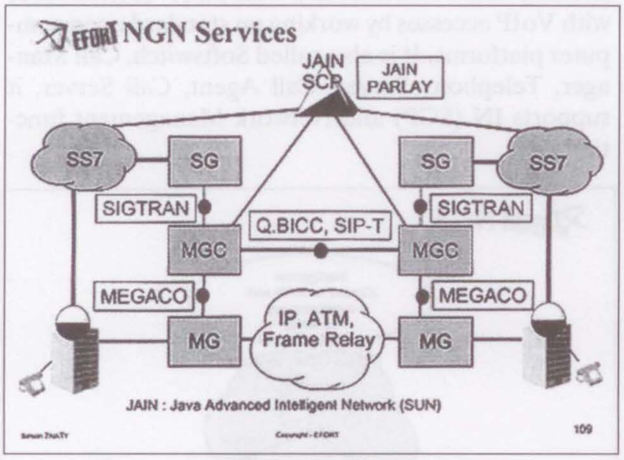

Figure 16 - NGN protocols and services [9]

Media Gateway Controller (MGC) manages Media Gateways (MG) with the help of NGN Control Protocol: MGCP (IETF), MEGACO (IETF), H. 248 (ITU-T). MGC directs VoIP blocks, authorizes user accounts, provides access to services, routes signal messages, manages the availability of the network.

With the introduction of the new conception of NGN networks the standardization of the conceptions of certain manufacturers is induced, especially in the area of control protocols, media accesses, signalling area and the choice of transmission technology. The reliable co-function between the network elements of different manufacturers is dependent on the respect of the protocol. An insight into single protocols in the NGN conception resulted in a list of the most suitable and used protocols and they are:

- SS7 (Signalling System number 7),
- MGCP (Media Gateway Control Protocol),
- MEGACO/H. 248 (Media Gateway Control/ /H248),
- SIP (Session Initiation Protocol),
- BICC-CS-1 and 2 (Bearer Independent Call Control- Capability set-1 and 2),
- SIGTRAN (SIGnalling TRANsport),
- ISUP (ISDN User Part), RTP (Real –Time Protocol).

Since NGN conception is connected with the conception of IP telephony it is necessary to quote the basic protocols that enable the realization of that conception. Those are H. 323 as umbrella protocol for IP, real-time/control RTP/RTC and session SIP-T. The role of SIP protocol should be singled out and its role in the NGN conception defined, due to its good characteristics, as compared to the leading IP protocol H. 323 (much more flexible and expandable because of its flexibility for service provider differentiation) and with NGN protocol H. 248 (because SIP is a client-server protocol that establishes session between user agents and H. 248 (Megaco) is a master-slave peripheral protocol) [22].

9. MIGRATION PATH

The existing PSTN is one of the most developed technological systems today. It is limited in its development capability because interaction and connection between single segments can be established only in the network layer. Still, PSTN network structure has served as framework for the realization of the idea of a universal network, that is, according to the NGN conception.

Inter-working and interoperability in the new network conceptions relate to the transport layer, intelligence, application layer, management layer of networks and services. Inter-working and interoperability will become an important task for different participants that will act in the coming InfoCom era [18].

Modelling and planning of migrations for NGN from the existing networks is definitely a complex process. In order to reduce technological obstacles, the European telecommunication operators and the manufacturers of the telecommunication equipment have united and acted through CONVAIR project as part of the ACTS programme of the European Committee. As main driving forces that influence the strategic planning of high technology, including telecommunication and information technologies, applications have been denoted as the 'pulling force' and technology as the 'pushing force'. The CONVAIR project generates research and visions of the Infocom infrastructure evolution in Europe in the years to come. Since 1996 it has been involved in predicting the evolution of the sectors of information and communication technology (ICT) in Europe. Predictions have been made for each important area and they have been based on the observed trends, and the visions of development have also been made. The CONVAIR project has developed the vision of the evolution of communication networks for the period of 10 and more years. Important supporting issues, inducements and regulators effecting that evolution have been calculated into the project. Due to the study and modelling of the relevant infocom network aspects, CONVAIR developed the Infocom conception framework [14].

An important factor in the development and application of new technologies are also various research networks. Still, the migration path is not completely clear and predictable and depends on many factors.

In the areas of transmission technologies NGN will integrate the current circuit switched networks and packet switched technology networks through the so called overlay strategy. The most widely accepted protocol for computer networks and communications is TCP/IP protocol because of its characteristics, as well as ATM protocol. IP network will be developed in a complementary way with ATM core.

IP is a connectionless based protocol of the third OSI layer and the physical transmission of data is possible with the protocols of the second OSI layer. The most suitable protocol of the second layer is the connection based ATM protocol. Due to different connection natures of IP and ATM protocol, the development of MPLS protocol has been induced, as an attempt of adjustment of IP to ATM. The advantage of the fast commutation on the second layer has enlarged the possibility of the integration of IP protocols with other transmission technologies. The evolution of core nodes towards ATM/IP hybrids will enable the usage of MPLS (Multi-Protocol Label Switching) (Figure 17) for IP [7] [15]. The core will be a *hybrid* between the ATM and IP network. This technology adds a mark in the IP title for a simpler routing. It enables good method of the transmission of IP traffic through ATM and a specific way of QoS support in IP. IP and ATM therefore have the characteristics that make them the technology of choice for telecom operators in this period of migratory processes. The introduction of NGN networks will be a long-lasting process. In regard to the existing condition of telecommunication networks and the conception of NGN networks a

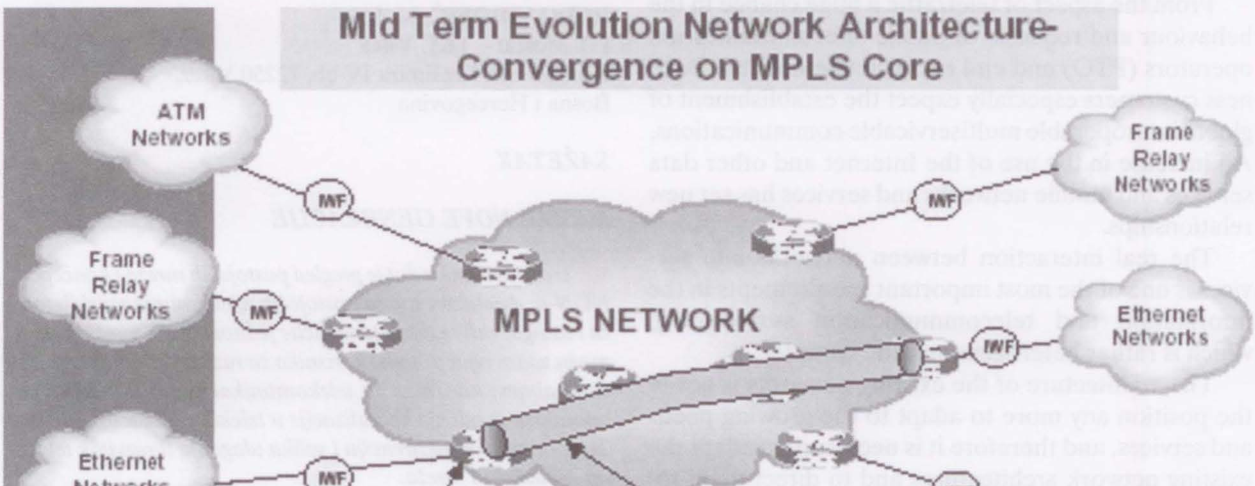

Figure 17 - Interworking with MPLS [7]

gradual transition from the existing condition to the new conception will be needed. The NGN conception is based on the conversion of PSTN/ISDN network with IP/ATM platforms.

In order for the NGN concept to replace the existing PSTN/ISDN network in a successful way it must support all the existing services and their quality, including also the IN service. This is achieved by implementing the quoted functionalities in MGC. All this changes the approach in planning. Before it was a planning of great capacities, switches nodes and the transmission equipment. Now, the planning is reduced to the planning of platforms that enable special services and respond to users' requests. The platform can be organized as a functional unity that enables the nodes to have all the functions of the required SW, the charge and account settlement functions. It can contain one or more network applications. By using open interfaces between the elements of NGN the operators can choose the best network components, from different manufacturers for each part of the new network, which is also a great convenience for operators.

Today, lots of solutions for NGN are offered. All the leading European and world manufacturers of telecommunication equipment (ERICSSON, CISCO, SIEMENS, LUCENT, SONUS, NORTEL, ALCATEL...) offer their solutions.

10. CONCLUSION

From the aspect of teletraffic a huge change in the behaviour and requests of public telecommunication operators (PTO) and end users can be noticed. Business customers especially expect the establishment of global interoperable multiservicable communications. An increase in the use of the Internet and other data services and mobile networks and services has set new relationships.

The real interaction between networks and services is one of the most important requirements in the information and telecommunication surrounding, which is rather heterogeneous and complex.

The architecture of the existing networks is not in the position any more to adapt to the growing needs and services, and therefore it is necessary to adapt the existing network architectures and to direct them towards a unified approach.

Since present-day networks are as a rule single-servicable, it has become necessary to induce a migration process towards one multi-servicable network. By means of stepwise transition it is necessary to create the new generation of NGN networks where fix and mobile networks, as well as voice and data services, can be united.

Present-day processes of deregulation and liberalization of the telecommunication market give a broader approach and enable more solutions towards the new conception which has been called the next generation network NGN.

At the present-day level of development it can be said that there is a consensus in the telecommunication surrounding that NGN will be made of IP multi-service networks with ATM support. The basic demand of the NGN is to build a new network architecture with software solved nodes to achieve the same quality and reliability of service as at PSTN, but realized through a packet-based, software-controlled network. That should create a surrounding and possibility for the differentiation of new intelligent services. That is the reason why it is necessary to develop intelligent capabilities of the networks. It is also necessary to develop OSS interconnection.

Since the existing PSTN networks will function for many more years, it is important to pay attention to the interaction of these two systems.

The competition that has been imposed by the liberalized market will be mostly applied on the application level, because it is most open to free market since it offers new services.

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SAŽETAK

MREŽE NOVE GENERACIJE

U ovom članku dat je pregled postojećih mreža i koncepcije NGN-a. Analizom stanja postojećih telekomunikacijskih mreža i usluga, vidi se da su to različite jednouslužne mreže, koje ne mogu zadovoljiti potrebe korisnika za različitim uslugama. Sve veći zahtjevi korisnika za telekomunikacijskim uslugama potaknuli su uvođenje liberalizacije u telekomunikacijsko tržište. To je otvorilo konkurenciju i velika ulaganja u razvitak telekomunikacijskih mreža.

Postojeće telekomunikacijske mreže orijentirane na prijenos govora i postojeće podatkovne mreže, nisu mogle biti lako prilagođene novim zahtjevima. Zbog toga se počelo tražiti rješenje za konvergenciju i objedinjavanje velikog broja različitih jednouslužnih mreža. Temeljni zahtjev se na kraju sveo na koncepciju univerzalne širokopojasne podatkovne mreže koja može opsluživati sve korisničke zahtjeve dijeljenjem resursa. Zbog toga je bilo potrebno naći rješenje za prijenos govora podatkovnom mrežom. Rješenje je bilo u izgradnji softswitch arhitekture za VoIP. Tako bi govor bio prenošen paketskim putem, kao jedna od komponenti u prijenosu podataka. Bilo je

potrebno definirati protokole za omogućiti rad u NGN koncepciji, kao i temeljito sagledati probleme režima rada u IP telefoniji s obzirim na realno-vremensku komponentu govora. Osim ovih zadataka potrebno je bilo vidjeti kako prilagoditi postojeće mreže u koncepciju NGN i osigurati međudjelovanje između različitih mreža i različitih slojeva mreža, primjenom određenih standarda i protokola. Došlo se do spoznaje o nužnosti postupnog uvođenje i realiziranja NGN koncepcije, uvijek u odnosu na postojeće stanje PSTN-a i zahtjeve korisnika. Naročitu pozornost treba posvetiti uvođenju IN-a kao alatu za realizaciju dodatnih usluga i omogućavanju nadzora u NGN-u. Također je dotaknut problem IP rutera za NGN, kao i važnosti nove jezgrene generacije optičkih mreža.

Koncepcijski okvir NGN danas je zasnovan je na IP/ATM transportnoj tehnologiji, koja je na ovom stupnju razvoja općeprihvaćena kao optimalno transportno rješenje. Sigurno je da će uvođenje novih generacija optičkih jezgri u prijenosu tražiti nova transportna rješenja. Također je naglašen problem adresiranja uzrokovan nedovoljnim adresnim prostorom IPv4 i predviđeno rješavanje tog problema uvođenjem IPv6 tehnologije, koja bi se zbog kompleksnosti i skupoće uvodila postupno i dualnim pristupom u sustav.

Posebno su istaknuti razlikovni elementi NGN-a u odnosu na postojeće mreže.

Naglašena je modularna tj. ravninska priroda NGN koncepcije u odnosu na vertikalnu, hijerarhijsku PSTN-a i prednosti koje omogućuje ova otvorena koncepcija pri izboru najkvalitetnije opreme različitih proizvođača.

Obje postojeće: govorna (TDM), i podatkovna NGN (ATM/IP) mreža će djelovati paralelno u sljedećim godinama do uvođenja novih rješenja u NGN.

KLJUČNE RIJEČI

PSTN, NGN, konvergencija, softswitch, VoIP, MGC, MG, intelligent network (IN), internet protokol (IP), ATM, MPLS

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