NGN - ПРИНЦИПИ, ДЕФИНИЦИИ, АРХИТЕКТУРА

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Докладът е въвеждащ в мрежите от следващо поколение (Next Generation Networks) и е посветен на основните принципи и дефиниции за NGN. Разгледана е общата архитектура на мрежата и са систематизирани основните характеристики на отделните елементи (равнини) в нея.

NGN се базира на следните принципи:

- *Обединява всички видове съществуващи телекомуникационни мрежи в единна структура*
- *Структирирана е във функционални равнини на достъп, транспорт, управление, интелигентност, приложения и услуги*
- *Равнините са независими по отношение на тяхното усъвършенстване и технологична реализация*
- *Използвани са отворени интерфейси, улесняващи взаимното свързване на различни мрежи*
- *Обединява всички видове съществуващи телекомуникационни мрежи в единна структура*
- *Позволява бързо и ефективно създаване и въвеждане на широк спектър от теснолентови, широколентови и мултимедийни услуги във фиксираните и мобилните мрежи, адаптирани към конкретните изисвания на всеки един клиент.*
- *Осигурява конвергенция на услугите, т.е. използване на услугите независимо от типа мрежи на двамата кореспонденти.*

Посочени са основните функционални характеристики на отделните функционални равнини: Равнина на достъп (Access plane), Транспортно-комутационна равнина (Transport & switching plane), Равнина на управлението (Control plane), Равнина на услугите и приложенията (Service and application plane).

Key words: NGN, Next Generation Networks

1. NGN principles

Next Generation Networks rely on the following main principles:

- NGNs are structured in such a way that the functions performed by the
- network are separated into functional planes.
- The functional planes include access, transport, control & intelligence, and service.

- Layers are independent - they can be modified or upgraded regardless of other functional layers.
- The functional planes are separated by open interfaces in order to facilitate the
- interconnection to other operators' networks and to provide the integration of third-parties' services and applications.
- This can widen the operator's coverage and service scope and can also provide end-users with an access to a greater number of services.
- This architecture provides a flexible, effective and scalable network, reducing time to market for the implementation of new services.
- NGNs are multi-service networks, meaning that an NGN can be used to provide multiple types of services, in contrast to old (legacy) networks that are only used for specific services.
- This multi-service network enables operators to implement converged and new services.
- From the users' point of view the convergence of the services will make possible for them to access their "home" services from any type of access network.

2. NGN Architectural concepts

The NGN architecture can be illustrated as shown in the figure 1 below.

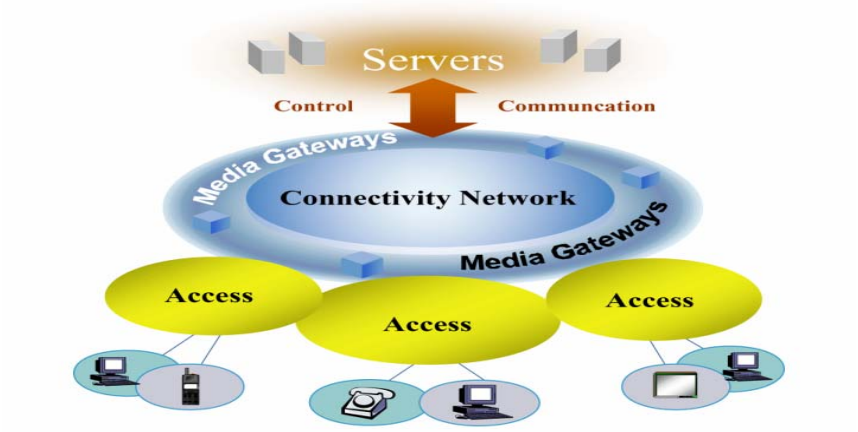


Figure 1. NGN Architecture

The NGN architecture is composed of functional planes that perform tasks at different levels:

- ✓ **Access plane**
- ✓ **Transport & switching plane**
- ✓ **Control plane**
- ✓ **Service (application) plane**

Other technologies not shown on the figure will also be part of the NGN architecture and are used in all of the four planes described:

- Operations Support Systems (OSS)
- Billing systems
- Quality of Service (QoS) and
- Security systems

In the horizontal network architecture the call and connection control are separated from each other. This fundamental characteristic allows migration of technologies and services as the need arises.

Communication and control servers comprise the next layer, controlling service provisioning and usage as well as network infrastructure resources.

The connectivity layer including the backbone network takes care of the packet transport.

Access layer is connecting the end-users to the multi-service network.

3. Definition of NGN

A Next Generation Network, in its purest definition, is an open, standards-based, packetized infrastructure capable of efficiently supporting a wide range of applications and services, while providing the scalability needed to meet the demands of tomorrow's IP traffic and the flexibility to rapidly address the demands of the marketplace.

Further should be mentioned Convergence in all aspects (application convergence - voice and data and infrastructure convergence - optics and IP), quality, security and mobility.

Networks themselves are not the central focal point of the Next Generation of telecommunications — they are only the enabler, the basis for profitable service delivery.[1], [2], [3], [4].

The Access plane

- Provides different infrastructures (analogue, ADSL, cable modem, base station, LANs, MANs, PABXs, ATM users etc.) in the access network between the end-user and the transport network.
- It may be wireless and/or wire-line.
- It can be based on different transmission media (copper cables and fiber optic).
- Technologies in the access plane can be based on circuit-switching or packet-switching (ATM or TCP/IP).
- The access network is connected to network transport/switching nodes at the edge of the backbone network.

The Transport plane

- Provides transport between network nodes to which the access
- networks are connected.
- It consists of one or several backbone networks based on packet or cell switched network nodes (ATM or TCP/IP).
- Links are mainly based on optical fiber links but can also be wireless links (satellite or terrestrial radio links).
- The transport plane is capable of handling different kinds of traffic, e.g. voice, data, multimedia, interactive data etc.
- Gateways at the edge of the transport network converts traffic to and from legacy networks, e.g. telephony, Internet and real-time data applications.

The Control plane

- Includes ***service control*** and ***network control*** elements.
- Controls all other planes: access, transport and services.
- The control plane, depending on the service requested, is responsible for the control of:
    - communication sessions (e.g. establishing and disconnecting voice calls)
    - multimedia sessions
    - intelligent service provisioning
    - resources provisioning.
- A core principle of the NGN architecture is to separate the control logic from the underlying switching/transport hardware.
- The network elements in the control plane are application-specific soft-switches (servers) in order to manage traffic coming from the different access networks.

The Service plane

- It is an applications layer similar to today's intelligent networks.
- Offers elementary service functions that can be used by service providers to build more complex or comprehensive services (see examples of such functions in the table below)
- The service plane also provides interfaces towards service providers who want to use these elementary service functions to access the underlying infrastructure.
- Such access will depend on commercial agreements between service providers/third parties and network operators

- The interfaces may be implemented in different ways, e.g.
    - in the form of Application Programming Interfaces (APIs) for service specific software which has to be run on servers within the network or
    - in the form of open standardized interfaces between the network and application servers.
- The main goal of such interfaces is to make possible the unbundling of services and underlying technologies.

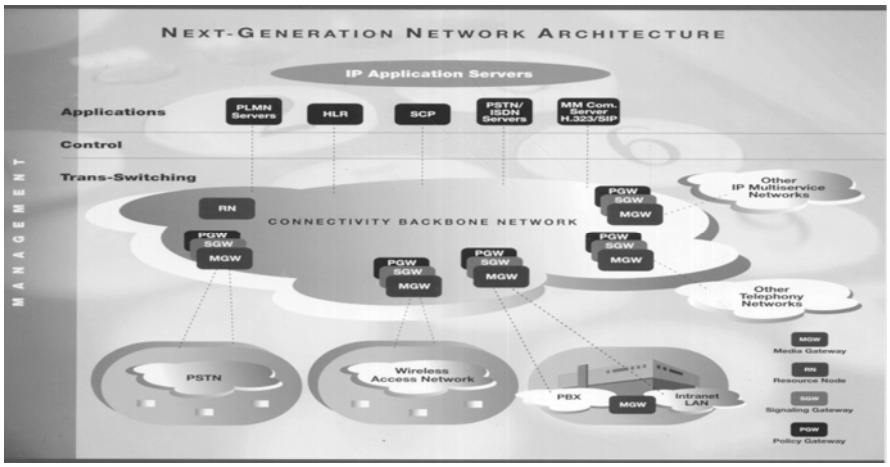
4. Access layer

- Access layer comprises of different types of access infrastructure specific for the particular existing and newly evolved types of network – fixed public voice and data networks, public and private mobile networks, Local and Metropolitan networks, Multimedia networks etc.
- The main goal in the development of the access layer is to extend rapidly the bandwidth providing not only narrowband but broadband services.
- The access infrastructure uses existing copper cables and optical fibre cables.
- A wireless access is widely deployed too.
- The access layer contains the traffic concentrating switching and transmission facilities with its own management,
- Trends in access technologies show that:
- Access networks will increasingly be based on broadband, packet-based and "always-on" technologies.
- Mobility and wireless connectivity is becoming increasingly important and is supported by Wireless Ethernet (WLAN), 3G networks, Bluetooth, etc.
- Technologies are developed to enhance the capabilities of existing wire-line infrastructures and optimize the usage of existing assets providing wide or even ubiquitous coverage – e.g. DSL technologies, Cable TV technologies, etc.
- Previously dedicated networks such as electricity networks or broadcasting networks are perceived as potentially suitable means for providing data and/or voice services.

The positioning of the access technologies is shown on the figure below and will be described further.

5. Transport layer

To look a little bit more in details to the transport layer of an NGN architecture



Source: Ericsson

IP Application Servers PLMN Servers HLR – Home Location Register, **SCP** – Service Control Point in Intelligent Networks, **PSTN/ISDN Servers, MM Com. Server H.323/SIP** – Servers for IP communications, **Trans-Switching** – Transport and switching **RN** - Resource Node, **PGW** - Policy Gateway **SGW** - Signaling gateway **MGW** - Media Gateway .

One of the main elements in this plane is the "Gateway".

From the functional point of view gateways could be defined as:

- Media gateways – converting the user's information from the form specific to the particular type of the access network to the form specific to the particular type of the transport network (ATM or IP)
- Signalling gateways – converting the signalling type for a call coming from particular access network in to the signalling type specific to the transport layer or transferring it to the respective server in the Control plane

Technically all the functions could be implemented in a common hardware units.

Transport Backbone network

As it was mentioned already the phisical transport will be based on the fiber optic cables multiplexed with SDH systems and WDM, resp. DWDM systems providing extremely high capacities and speeds.

For the switching part of the Transport layer there are two alternatives:

- ATM network
- TCP/IP network

Note: TCP/IP network is not the Global Internet (Global Public Computer Network) formed by interconnection of thausands of subnetworks that use TCP/IP protocols and a common address structure. In NGN It is a separate carrier class (high quality) switching/transport network based on TCP/IP protocols.

6. Control and Application layers

6.1. Control layer

- Within the control layer, the session coordinator is in charge of:
    - controlling calls and service sessions
    - routing calls and connections and
    - handling the application layers signaling protocols (for example, the SS7 user parts).
- To carry out these tasks the session coordinator must control the elements in the transport layer, specifically gateways and enhanced access elements.
- The registration/authentication functional entity belonging usually to this layer provides the registration and authentication of users and terminals.
- The main elements of the Control layer (the session coordinators) are the servers called often "soft-switches" as they contain only the call handling logic without any traffic trunks. Линк към зеленото
- The use of a "soft-switch" in a NGN architecture permits the separation of the "service management" function from the access and switching functions.
- The Soft-switch controls the gateways between the packet network and PSTN; it is not involved for packet-to-packet calls and sessions.

6.2. Application (Service) layer

- The service/application layer contains the logics that allow the execution of all services, making use of the functions of the control layer. Some examples of service logic may be Class 5 services, data services, VPN services, and so on.
- The application layer is where the end-user applications reside. In modern networks, applications are implemented in mobile terminals and in dedicated application servers in the network.
- The application servers are often complemented with content servers, which host service-related databases or libraries (such as video-clip libraries or news history databases).
- The application layer interfaces with the network control layer via a defined set of open application program interfaces (API). By using open APIs, application developers can make use of the features of standardized service capabilities, to design new services and applications (see figure below)
- The separation of information from the service logic and from the management functions is very important in order to allow a flexible service provisioning and configuration.
- As sub-layers to this layer could be defined the Data *and profile sub-layers*
- *The Data sub-layer contains:*
    - The call detail records – contain the database of the information

related to calls and sessions

- IP addresses – contain the list of the available IP addresses that can be used by the control layer
- The routing database - keeps information about the paths to reach a certain address or location.

- The *Profile sub-layer contains:*
  - The user profile - keeps track of the end-user identity and preferences
  - .The terminal profile - describes the features of the relevant terminals and maintains the state of the active terminals.
  - The service profile enables the mapping of relevant service information into calls and sessions.

7. Management layer

General purpose of the Management layer [5}:

- Management layer is called very often Operation Support System (OSS).
- It takes care for the operational support and management of the elements in all NGN layers related to all services.
- It includes technologically advanced support tools that efficiently manage the network infrastructure of NGN Network and Circuit Switched Networks, ATM and IP backbone as well as open single-point interfaces with higher-level management

Benefits of the management level:

- Reduces operation and maintenance costs
- Using a centralized management system, the operator can have total control over the entire network.
- The network can be managed from a single point or through dedicated work centres, such as a Subscriber Service Centre, Transmission Centre etc. This means that fewer resources are required in this area with resource concentration on other more valuable areas.
- Protects existing investments in management infrastructure by enabling integration with existing management systems, while supporting modernization to enhanced solutions.
- Takes care to provide carrier-class performance.
- Provides automation and procedure support enabling more efficient handling of frequent tasks.

Basic functionality in the Management Layer

The OSS offers the following functions:

- Fault Management for detecting and predicting faults or potential problems in the network

- Configuration Management for configuration of network resources (e.g. equipment, service connections etc.)
- Accounting Management for gathering of data for billing purposes
- Performance Management for gathering of data on network performance, utilization, for Service Level Agreements, etc.
- Security Management to prevent unauthorized access or modifying of the network configuration
- Network configuration from the service, equipment and traffic point of view. It handles bulk configuration and software management of many nodes as well as the detailed configuration of individual network elements
- Controlling and provision of a high quality service to the customer
- .Life-cycling handling of the Backbone signalling links
- Handling B-numbers (as Number Analysis Manager application)
- .Basic and extended execution of command files.
- .Transferring of files between the MN-OSS and external systems, including network elements or other OSS systems.
- ATM Connection Management
- Viewing the status of the Telephony and Packet service
- Understanding a fault situation problem reducing the network downtime.
- Resolving the fault situation including fault localization, testing, trouble-shooting, call path tracing and multiple loop-backs, which allows the operator to get an overview of all connections in the network and indications of possible faults.
- Viewing Performance data

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