# Next Generation Network (NGN) and Reliability

Pertti Raatikainen
VTT





## Outline

- Overview of NGN
  - Architecture
  - Functionality
  - IMS
- About reliability

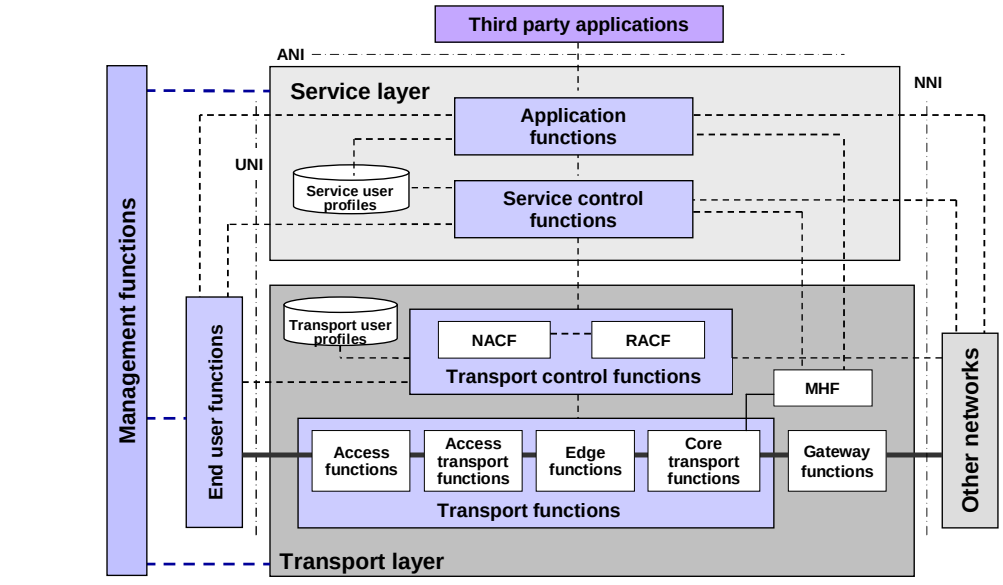
# What is NGN ?

- ITU-T defined telecommunications network architectures and technologies
- Covers conventional PSTN services as well as packet based services
- All information is carried in packet (switched) form as in the Internet
- Packets are labelled based on their type (e.g. data, voice and video) and forwarded based on their QoS and security parameters
- Clear distinction between the transport and services
  => allows smooth introduction of new services
  => services defined directly at the service layer (transport not considered)





# Overview of NGN architecture




ANI - Application-to-Network Interface
NNI - Network-to-Network interface
UNI - User-to-Network interface

Media
Control
Management

## NGN functionality

- NGN functions are divided into service and transport layers
- End-user functions are connected to NGN by UNI
- Networks are interconnected by NNI
- Third party applications utilize ANI





## Transport functions

- Transport layer functions provide connectivity for all components and physically separated functions within an NGN
- Internet Protocol (IP) is the most obvious NGN transport technology => transport layer will provide IP connectivity for
  - end-user equipment (residing outside an NGN)
  - various controllers and enablers that are usually located in servers within the area of an NGN
- Transport layer is further divided into access and core network

## Access network functions

- **Access functions**
  - access technology dependent
  - manage end-user access to an NGN network
  - examples of supported technologies: cable access, DSL, wireless technology, Ethernet technology and optical access
- **Access transport functions**
  - responsible for carrying information across the access network
  - support of QoS (packet filtering, buffer management, traffic classification, policing, traffic shaping, etc.)
- **Edge functions**
  - for traffic processing when access traffic is merged into the core network





## Core network functions

- **Core transport functions**
  - ensure information transport through the core network
  - provide means to differentiate the quality of transport by interacting with the transport control functions
  - support of QoS (buffer management, packet filtering, traffic classification, marking, policing and shaping, firewalls, etc.)
- **Network attachment control functions** (NACF)
  - provide registration at the access level and initialisation of end-user functions to allow access to NGN services
  - support network-level identification and authentication, manage IP address space of the access network, authenticate access sessions, etc.

## Core network functions (cont.)

- **Resource and admission control functions** (RACFs)
  - offer admission control and gate control functionality, such as control of network address and port translation (NAPT) and management of differentiated services field code points (DSCPs)
- **Transport user profile functions**
  - comprise user and control information to form a single “user profile” function in the transport layer
- **Gateway functions**
  - support capabilities to interwork with other networks, e.g. PSTN/ ISDN-based networks and the Internet
- **Media handling functions** (MHF)
  - supply services, such as tone signal generation, transcoding and conference-call bridging





## Service functions

- NGN supports
  - session-based services, e.g. IP telephony and video conferencing
  - non-session-based services, e.g. video streaming and broadcasting
- NGN supports also network functionality associated with
  - existing PSTN/ISDN services and capabilities
  - interfaces to legacy customer equipment

## Service functions (cont.)

- **Service and control functions**
  - session control functions, registration function and authentication & authorization functions (at the service level)
- **Service user profile functions**
  - cover user and other control information that form a single user profile function in the service layer
- **Application functions**
  - trusted and/or untrusted
  - used by third-party service providers to access NGN service layer capabilities and resources through servers or gateways in the service layer





## Management functions

- Enable an NGN operator to
  - manage the network
  - provide NGN services with required quality, security and reliability
- Distributed to each functional entity
- Interact with the network element management, network management and service management functional entities
- Include charging and billing functions, which interact with each other to collect resource utilisation information

## End-user functions

- End-users interfaces are
  - physical
  - functional (control) interfaces
- ITU-T specifications do not limit the types of customer interface that can be connected to an NGN network
- NGN supports all kinds of customer equipment categories
  - from single-line legacy telephones to complex corporate networks
  - mobile and fixed





## IP multimedia subsystem (IMS)

- IMS has a central role in providing session based services for NGN
- IMS is based on IETF defined IP protocols
- 3GPP (3rd Generation Partnership Project) has defined IMS for mobile networks - later introduced for NGN.
- IMS is mostly independent of the access network technology, although there are some transport specific aspects
- Basic signaling protocol is SIP (Session Initiation Protocol)
  - used to create, modify and terminate sessions

## IMS architecture

- IMS makes separation between the core and access network
- Separation comes from 3GPP's original IMS definitions, i.e. from the wireless network model (in which one or more radio access networks are connected to a common core network)
- Radio access networks provide connections between terminals and services available in the core
- Access network is a collection of entities providing IP transport connectivity between a user domain and a core transport network
  - different sorts of access networks are distinguished based on the underlying technology, ownership or administrative partitioning

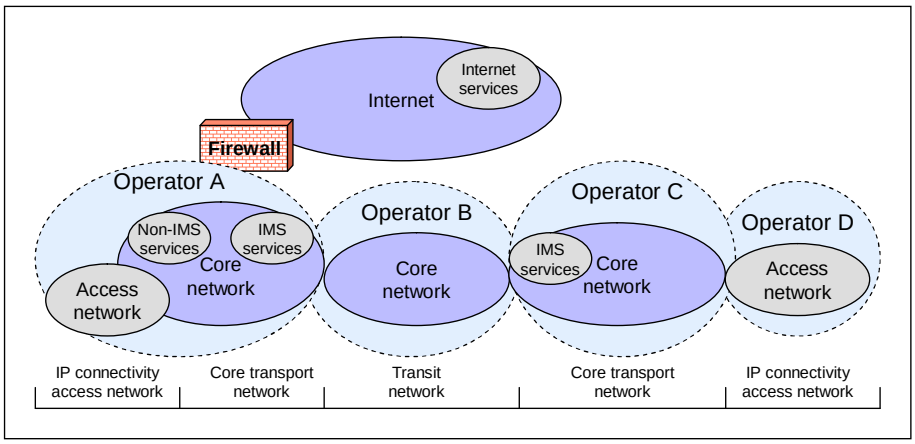




## IMS architecture (cont.)

- IMS defines a collection of core network functional entities that the core uses in offering IP transport connectivity
  - between an access network and a core transport network
  - between two access networks
  - between two core networks
- Core network also offers connectivity to service layer entities
- Core networks can differ from one another according to the underlying technology, ownership or administrative partitioning
- A fundamental characteristic of an IMS is the support of user mobility
  - the distinction between the core and access networks has significance, especially when dividing the functions necessary to support an IMS

# Network partitioning in respect of IMS








# IMS functional entities

- **Application server** (AS) - provides service control for the IMS
- **Gateway control function** (BGCF) - receives session requests forwarded by an S-CSCF (or another BGCF) and selects the network in which a PSTN attachment point is located
- **Call Session Control Functions** (CSCF) - are responsible for the control of session features, routing and resource allocation in cooperation with other network elements
- **Home Subscriber Server** (HSS) - contains a subscription database for IMS
- **Media Gateway Control Function** (MGCF) - supports interworking between IMS and PSTN

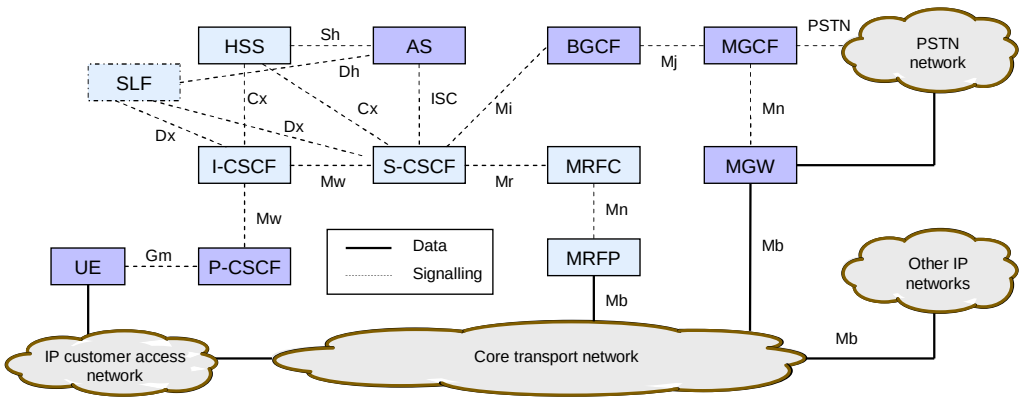
# IMS functional entities (cont.)

- **Media Gateway** (MGW) - terminates bearer channels from circuit-switched networks and media streams from packet switched networks and performs media conversion functions such as transcoding
- **Media Resource Function Controller** (MRFC) - controls MRFP's media stream resources
- **Media Resource Function Processor** (MRFP) - supports functions such as media stream mixing, tone and announcement generation, transcoding and media analysis
- **Subscription Locator Function** (SLF) - acts as a front-end for distributed HSS systems
- **User Equipment** (UE) - represents the functionality of user terminals





# IMS functional entities and reference points



## NGN and reliability

- NGNs are going to be a mixture of circuit and packet switched networks and technologies
  => not easy to say whether reliability of an NGN network is closer to that of a conventional PSTN network or the Internet





## Performance concerns

- Open and distributed nature
- Lack of inherent security mechanisms
- Increasingly complicated network concept
- Running of mission-critical applications
- Deployed before fully matured
- Few expert solutions for effective management
- Require time- and cost-consuming integration and configuration

## Open and distributed nature

- Any company or any person can develop applications and run them on an NGN network
- Difficult to prepare for possible malicious applications, either end-user or control applications
- Distributed nature means that it is difficult to locate and eliminate observed disturbances, especially in cases when the disturbance is able to move in the network and/or make copies of itself to various locations of the network





## Lack of inherent security mechanisms

- Secure PSTN functions are modified to adapt to the packet switching paradigm
  => security of communication often degraded
- An example is the numbering scheme (E.164) that needs to be modified to allow the internet type of addressing mechanism
  - new telephone number mapping (ENUM) scheme builds on the Internet's domain name server system (DNS)
  - introduces similar performance problems as present in the DNS system (examples are the distributed denial of service (DDOS) and DNS pollution problems)

## Running of mission-critical applications

- Mission-critical applications, such as banking, medical systems and power station control, require error-free transport, short response times and absolute security
- Pure Internet type of data transport does not guarantee delivery of IP packets to their intended destinations
  - packets may be dropped, delayed or directed to false destinations
  - increase of network load increases delay and number of dropped packets
- Spoofing is a known problem in conventional IP networks and NGN's open architecture preserves that problem
  - spoofing stands for the various techniques that enable unauthorised access to computers and user information
  - examples of spoofing techniques are the man-in-the-middle, source routing and flooding





## Deployed before fully matured

- Increasingly complicated network concept
  - integration of conventional network technology with the all-IP technology no doubt increases complexity
- Few expert solutions for effective management
- Require time- and cost-consuming integration and configuration
  - implementation of new solutions to run smoothly with the conventional technology is going to be time-consuming and costly
  - there is a lack of trained professionals to deal with the new technology and its problems

## Enhanced internet quality

- Main difference between the Internet and NGN is the IMS, which
  - builds on IETF protocols
  - but implements specific profiles and enhancements to provide a robust multimedia system
- Enhancements and operational profiles offer support for operator control, billing and security





## Enhanced internet quality

- IMS provides:
  - common interfaces to application servers for accounting, security, subscription data, service control and service building blocks
  - coordinated and enforced QoS
  - session-based media gating under operator control
  - accounting and charging among the service, session and transport layers

=> IMS and thus NGN is different from the Internet on session control point of view

=> Network operator controls access to the network and a service provider controls access to the services

- This is contradictory to the usual Internet model in which the network is transparent and all services are provided by endpoints

# Conclusions

- **NGN is more controllable and therefore more reliable than the usual Internet, but**
- **it is difficult to see how NGN will provide the same level of performance reliability as the old established PSTN used to have**

**=> NGN does not offer perfect performance (reliability), but the level that the users accept**