

Next Generation Networks (NGN)

**Lecture at the Signalling Protocols Course
Helsinki University of Technology**

Miguel.An.Garcia@nokia.com
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Nokia Research Center

Outline

- Concept
- Standard bodies
- NGN overall architecture
- Architecture of each of the NGN subsystems

The concept

A NGN is a packet-based network able to provide Telecommunication services and able to make use of **multiple broadband, QoS-enabled transport** technologies and in which **service-related functions are independent from underlying transport-related technologies**.

It enables **unfettered access for users to networks and to competing service providers and/or services of their choice**.

It supports **generalized mobility** which will allow consistent and ubiquitous provision of services to users.

Source: ITU-T Rec. Y.2001

NGN characteristics

- A new telecommunications network for broadband fixed access
- NGN facilitates convergence of networks and services
- NGN enables different business models across access, core network and service domains
- NGN will be an IP based network
- SIP will be used for call & session control
- 3GPP release 6 IMS will be the base for NGN IP Multimedia Subsystem
- NGN enables any IP access to Operator IMS; from
 - Mobile domain
 - Home domain
 - Enterprise domain
- NGN enables service mobility
- NGN enables interworking towards circuit switched voice
- NGN maintains Service Operator control for IMS signaling & media traffic

The players

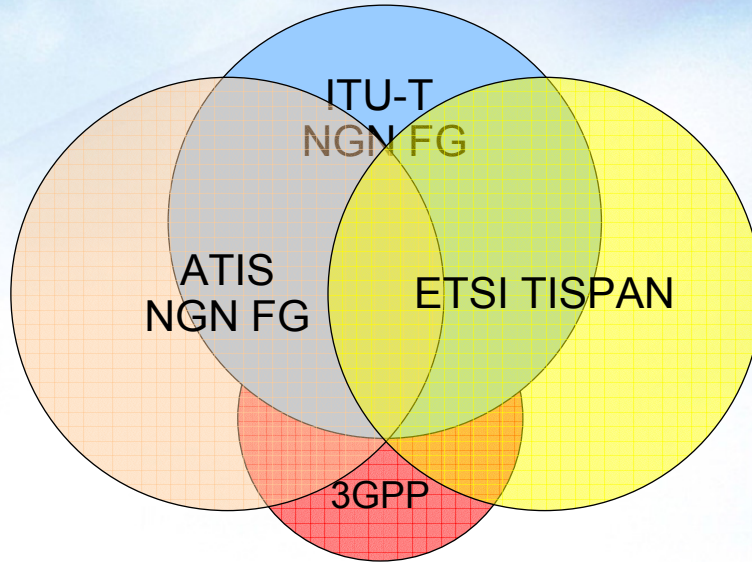
Legend

ATIS NGN FG: Alliance for Telecommunication Industry Solutions, Next Generation Networks Focus Group

ITU-T NGN FG: International Telecommunication Union (Telecom), Next Generation Networks Focus Group

ETSI TISPAN: European Telecommunications Standards Institute, Telecoms & Internet converged Services & Protocols for Advanced Networks

3GPP: Third Generation Partnership Project



ITU-T NGN-FG

- ITU-T created the NGN Focus Group (NGN-FG) in June 2004.
- Main topics:
 - Functional & Nomadicity Architecture (based on IMS & non-IMS)
 - QoS (include the xDSL Access)
 - Security Capability (inc. Authentication)
 - NGN Control and Signaling Capability
 - Evolution from the existing networks to NGN
- Service types:
 - PSTN/ISDN Emulation services
 - PSTN/ISDN Simulation services
 - Multimedia services
 - Internet access
 - Other services (data services etc.)
 - Public service aspects (LI, ETS/TDR, etc.)

ATIS NGN FG

- ATIS is a North American based body that is committed to rapidly developing and promoting **technical and operations standards** for the communications and related information technologies industry worldwide using a pragmatic, flexible and open approach.
- ATIS NGN FG is committed to:
 - Develop a North American set of **requirements for NGN** that includes multi-service architectures and an evolution path from currently deployed architectures.
 - Review and analyze **other international activities** underway to define NGN functional and structural architectures, and compare those architectures to the desired ATIS-requirements for NGN.
 - Coordinate with other standards bodies to arrive, to the extent possible, at a **consistent global view of the NGN**.
 - Guide the development of NGN standards from a **business perspective**.
 - The NGN-FG does not develop standards.
 - Technical & operational standards will be developed by appropriate standards developers to include ATIS' internal committees and other external developers; e.g., ITU-T, ETSI/TISPAN, 3GPP, etc..

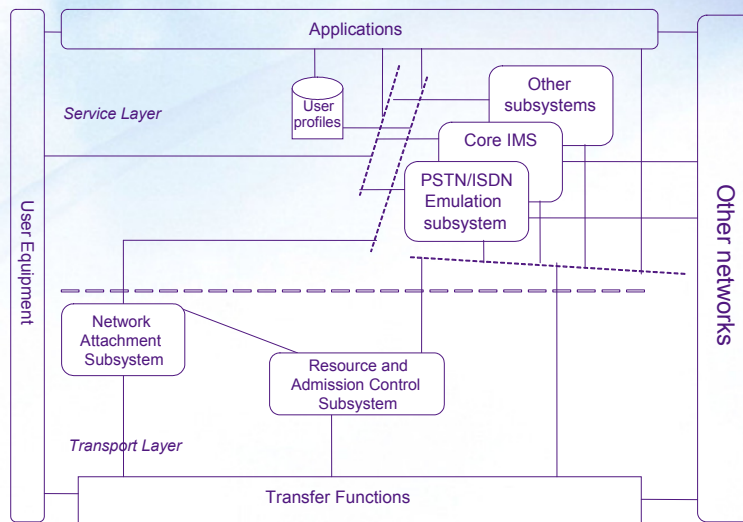
ETSI TISPAN

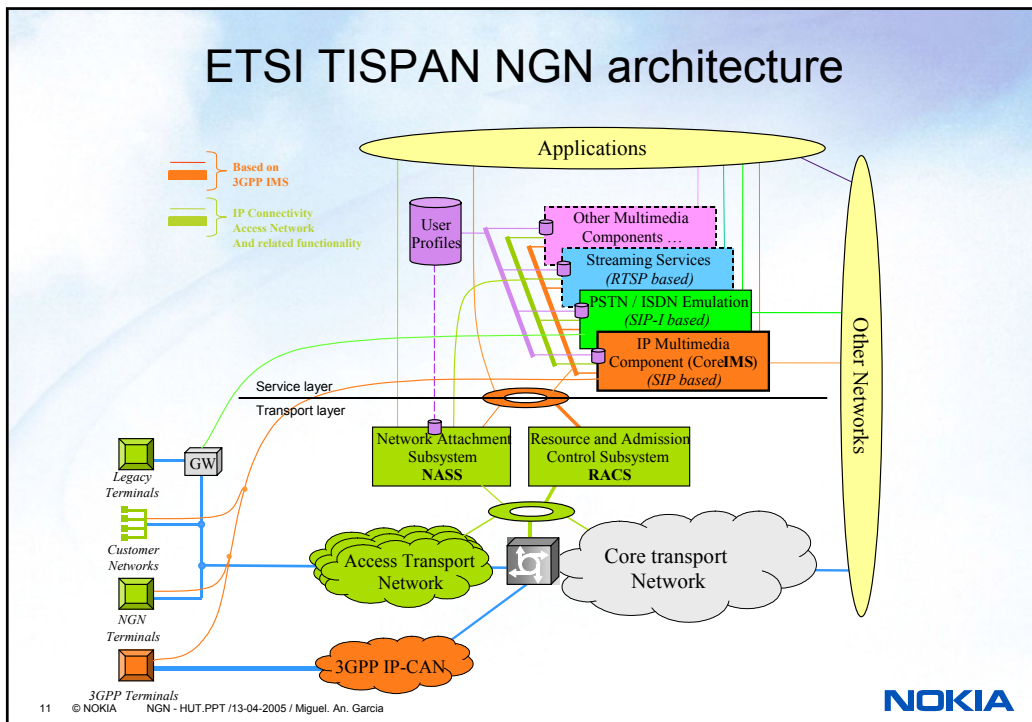
- The European Telecommunications Standards Institute (ETSI) is an independent, non-profit organization, whose mission is **to produce telecommunications standards** for today and for the future.
- The Next Generation Network will provide:
 - A multi-service, multi-protocol, multi-access, IP based network - secure, reliable and trusted
 - **Multi-services**: delivered by a common QoS enabled core network.
 - **Multi-access**: several access networks; fixed and mobile terminals.
 - **Not one network**, but different networks that interoperate seamlessly
 - An enabler for Service Providers to offer
 - **real-time and non real-time communication services**
 - between **peers** or in a **client-server** configuration.
 - **Nomadcity and Mobility**
 - of both users and devices
 - intra- and inter-Network Domains, eventually between Fixed and Mobile networks

3GPP

- The 3rd Generation Partnership Project (3GPP) is a **collaboration agreement** that was established in December 1998. The collaboration agreement brings together a number of telecommunications standards bodies which are known as **“Organizational Partners”**. The current Organizational Partners are ARIB, CCSA, ETSI, ATIS, TTA, and TTC.
- The original scope of 3GPP was to produce globally applicable **Technical Specifications and Technical Reports** for a 3rd Generation Mobile System based on evolved GSM core networks and the radio access technologies that they support (i.e., Universal Terrestrial Radio Access (UTRA) both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes).
- 3GPP created the **IP Multimedia Subsystem (IMS)**, which is part of 3GPP Release 5 and subsequent releases.
 - Next Generation Networks are largely based in IMS
 - Next Generation Networks are sometimes seen as IMS over fixed broadband access.
 - 3GPP remains as the solely “owner” of the IMS specifications.

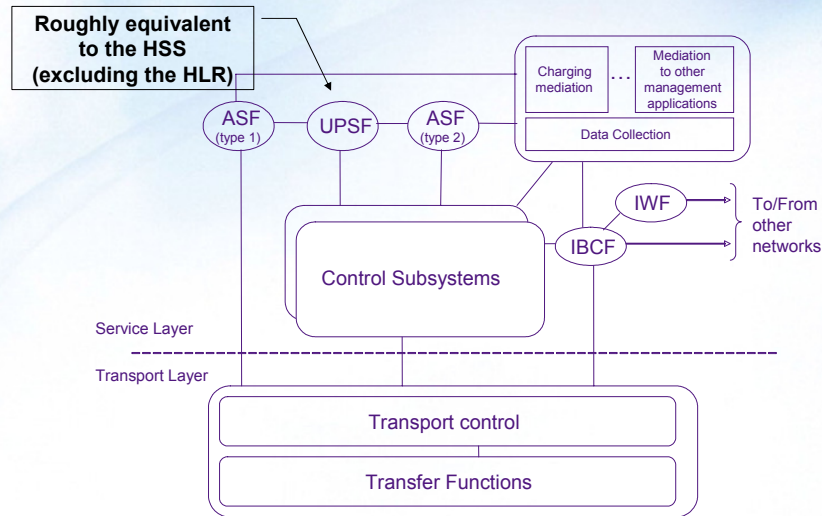
ETSI TISPAN overall NGN architecture





- ## NGN architecture principles
- A **layered approach**, including
 - A **transport layer**, including functional entities that do transport routing
 - A **service layer**, including functional entities that provide services
 - A **sub-system oriented approach**, enabling:
 - The addition of new subsystems over the time to cover new demands and service classes.
 - To import (and adapt) subsystems from other standardisation bodies.
 - Flexibility to adjust a subsystem architecture with no or limited impact on other subsystems.
 - **IP connectivity** is provided using **two subsystems**:
 - Network Attachment SubSystem (NASS)
 - Resource and Admission Control Subsystem (RACS)
 - **First service-oriented subsystems** include
 - the 3GPP IMS, a PSTN/ISDN Simulation Subsystem
 - a PSTN/ISDN Emulation Subsystem (PES)
 - **Future service-oriented subsystems** may include
 - A streaming subsystem
 - A TV Broadcasting subsystem
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TISPAN NGN common components



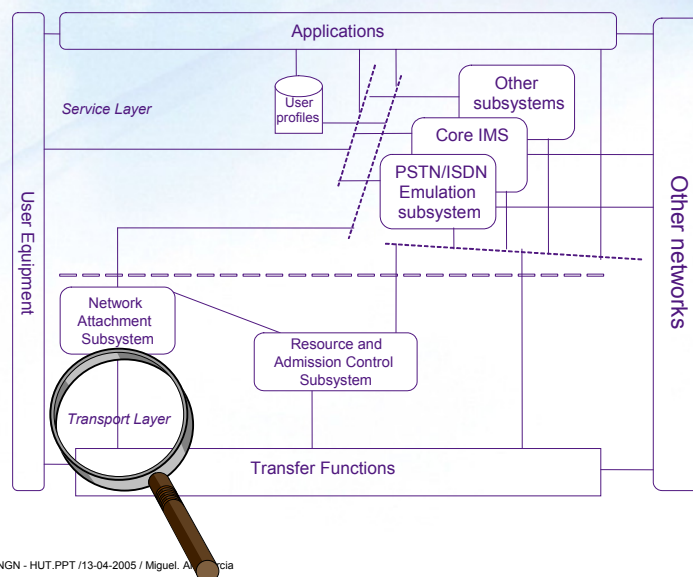
Common components (1)

- Common components are functions that are used by more than a subsystem
- **USPF: User Profile Server Function**
 - Service-level user identification, numbering, and addressing information
 - Service-level user security information
 - Service-level user location information
 - Service-level user profile storage
 - The IMS part of the USPF is similar to the 3GPP HSS without the HLR/AUC
- **SLF: Subscription Locator Function**
 - Helps locating the USPF of a given user
 - Like the SLF defined by 3GPP IMS
- **ASF: Application Server Function**
 - Offers services
 - Two types of ASFs:
 - Type 1: may interact with RACS for resource control purposes
 - Type 2: relay on the control subsystem.
 - Type 2 is equivalent to the Application Server defined by 3GPP IMS

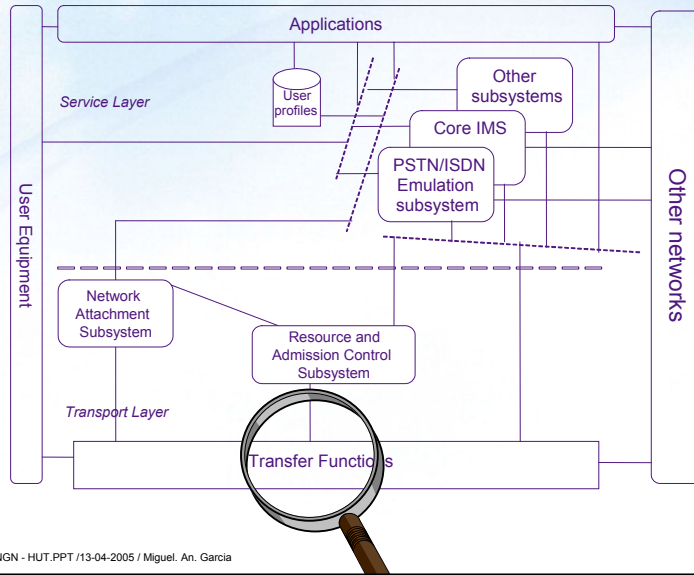
Common Components (2)

- **Charging Functions**
 - Data collection functions and mediation functions to the billing systems,
 - Both on-line and off-line charging.
- **IWF: Interworking Function**
 - Between different SIP profiles
 - Between SIP and H.323
- **IBCF: Interconnection Border Control Function**
 - Controls an operator's boundary
 - Interacts with RACS
 - Inserts IWF when appropriate
 - Screening of signalling based on source/destination addresses

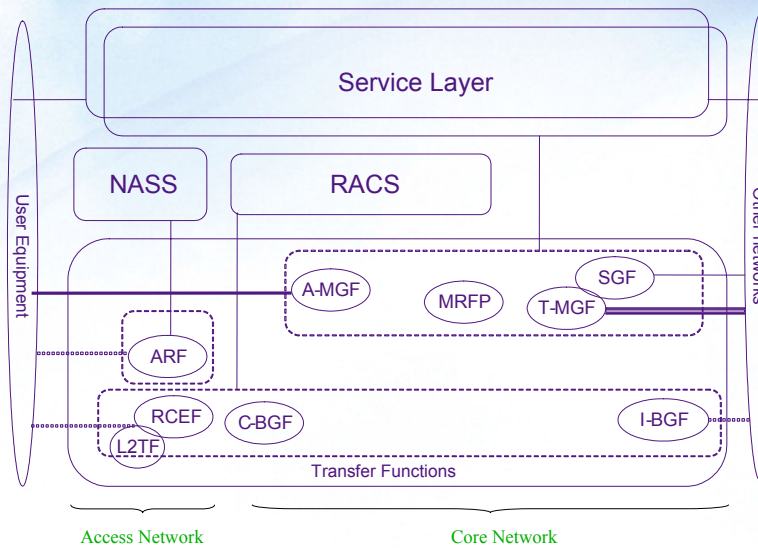
The Transport layer in NGN



Transfer Functions



Transfer functions



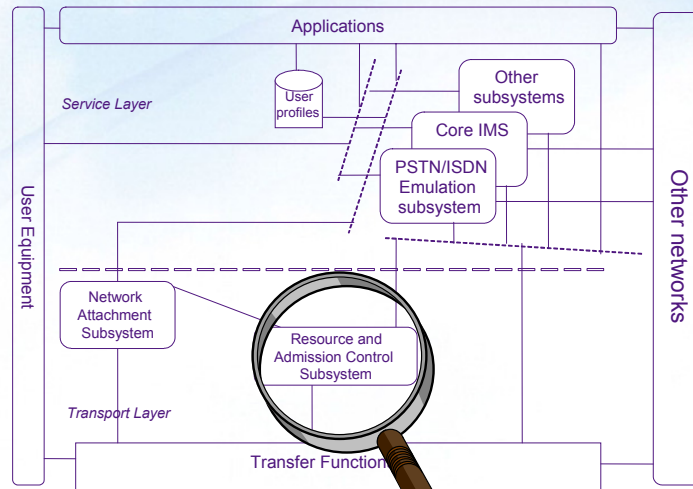
Transfer functions (2)

- **BGF: Border Gateway Function**
 - Interface between two IP transport domains
 - Open/close gates, packet marking, resource allocation, bandwidth reservation, NAT, NAT traversal, incoming traffic policing, usage metering, IPv4/IPv6 interworking, topology hiding
 - Three types of BGF:
 - **A-BGF (Access-BGF)**: located in between access and core network, at the access network side
 - **C-BGF (Core-BGF)**: located in between access and core network, at the core network side
 - **I-BGF (Interconnection-BGF)**: located in between two core networks
- **L2TF: Layer 2 Termination Function**
 - Terminates Layer 2, e.g., PPP or DSLAM
- **ARF: Access Relay Function**
 - Relay between the CPE and the NASS
 - Located in the access network
 - Resource reservation and admission control

Transfer functions (3)

- **MGF: Media Gateway Function**
 - Media mapping and transcoding between IP and CS networks
 - Three types of MGF:
 - **R-MGF Residential MGF**: located in the customer premises
 - **A-MGF Access MGF**: located in the access or core network
 - **T-MGF Trunking**: MGF located in the boundary of the core network and PSTN/ISDN network
- **MRFP: Media Resource Function Processor**
 - Multimedia conferences, media sourcing, IVR capabilities, media content analysis
- **SGF: Signalling Gateway Function**
 - Conversion of SS7 protocols to IP control protocols (e.g., SIP)
 - SS7 screening of MTP and SCCP parameters

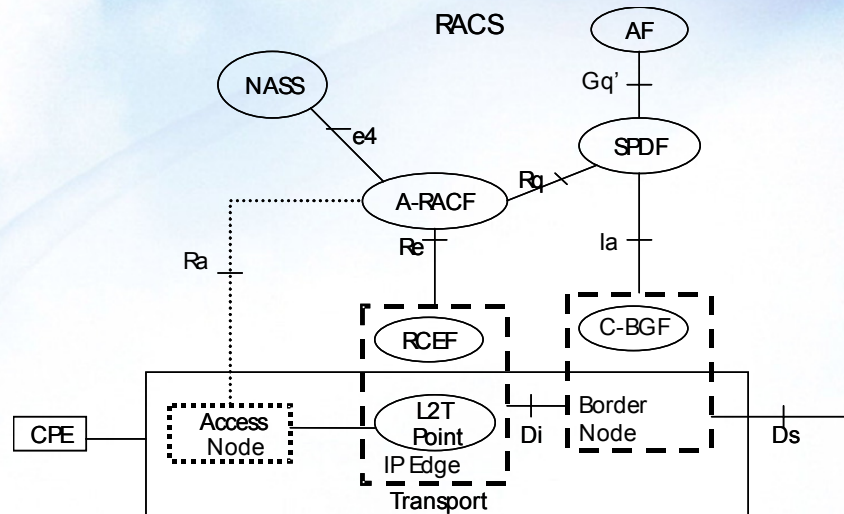
Resource and Admission Control Subsystem (RACS)



RASS functionality

- Support for **two types of QoS**:
 - Guaranteed QoS: resources are reserved
 - Support for Relative QoS: diffserv marking
- **Service Based Local Policy Control**: authorisation of QoS requests and definition of the polices to be enforced by the bearer service network elements.
- **Resource reservation**
 - Support for two mechanisms
 - Application Function (AF)-initiated
 - CPE-initiated (Authorization token a la 3GPP).
 - QoS support over multiple access networks (e.g. ADSL and GPRS) and CPE types.
- **Admission Control**: Apply admission control to resource reservation requests
 - Based on knowledge of transport resource availability over the “last-mile access” and aggregation segments of the access network
- **NAPT/ Gate Control**: controls near-end and far-end NAPT and FW functions, when required, between:
 - two core TISPAN NGN networks or,
 - at the border between core and access TISPAN NGN networks

RACS architecture



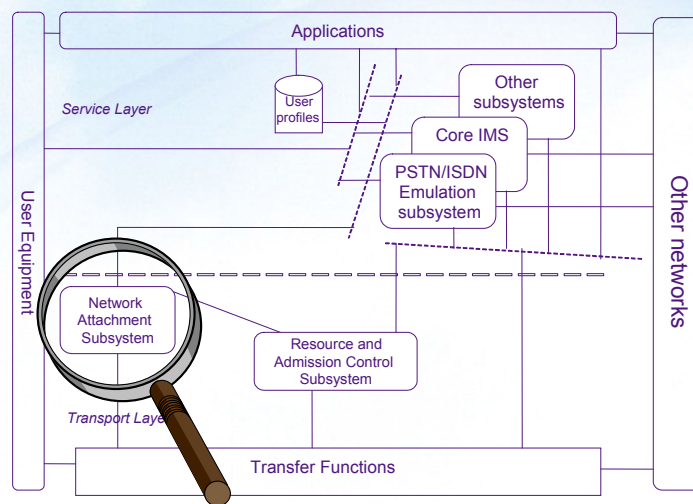
RACS architecture (2)

- **SPDF: Service-based Policy Decision Function**
 - Provides to AF a single point of contact
 - Authorization decision for QoS resource
- **A-RACF: Access Resource and Admission Control Function**
 - Located in the access network
 - Resource reservation and admission control
 - In Guaranteed QoS mode, it sets L2/L3 QoS policies in RCEF
 - In Relative QoS mode, it sets dynamically the diffserv QoS parameters in RCEF
- **C-BGF: Core Border Gateway Function**
 - Essentially, an edge router
 - Located at the border of networks (access/core – core/core)
 - NAT, Gate Control, packet marking, usage metering, policing enforcement function
 - SPDF controls the gates of the C-BGF based on a 5-tuple (source and destination IP addr., source and destination port numbers, protocol)

RACS architecture (2)

- **RCEF: Resource Control Enforcement Function**
 - Performs policy enforcement under the control of the A-RACF
 - Located in the access network
 - Gate control, packet marking, policing
 - A-RACF controls the gates of the RCEF based on a 5-tuple (source and destination IP addr., source and destination port numbers, protocol)
- **L2TF: Layer 2 Termination Functions**
 - Layer 2 (e.g., PPP, ATM) is terminated here
 - Authorization decision for QoS resource
- **AF: Application Function**
 - Officially, not part of RACS. Just a RACS user
 - Requests bearers resources, gets informed when resources are reserved and released
 - It is specific of the application. E.g., P-CSCF in IMS

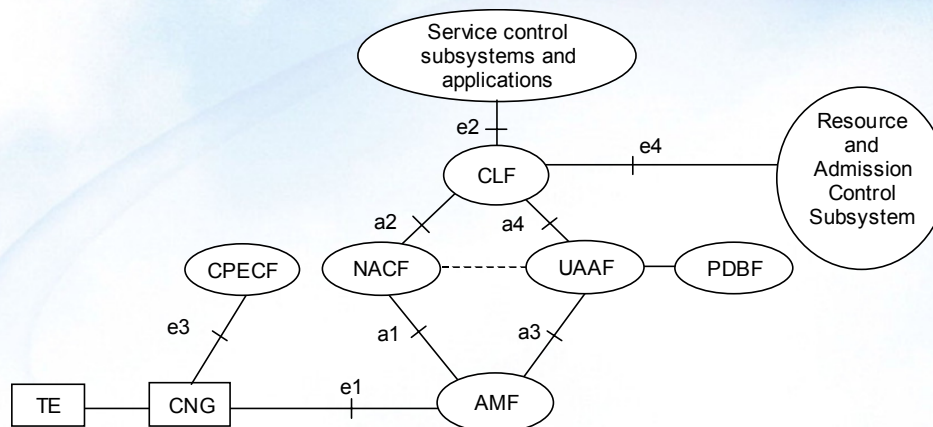
Network Attachment Subsystem (NASS)



NASS functionality

- Dynamic **provision of IP address** and other user equipment configuration parameters (e.g., using DHCP)
- **User authentication**, prior or during the IP address allocation procedure
- **User authentication** based on user network profile
 - Based on PPP, IEEE 802.11X or IETF PANA
- **Line authentication** based on Layer 2 line identification
- **Location management** (e.g. for emergency call, ...)
- **Customer Premises Equipment configuration**
- The NASS can be distributed between a visited and a home network
 - Allows nomadicity and roaming
- **P-CSCF announcement**

NASS architecture



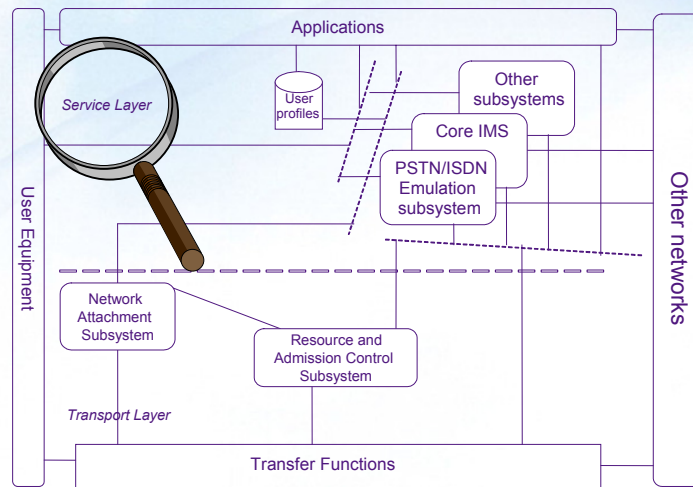
NASS architecture (2)

- **Network Address Configuration Function (NACF):**
 - IP address allocation to the CPE
 - Distribution of other network configuration parameters such as address of DNS server(s), address of signalling proxies for specific protocols (e.g., P-CSCF)
 - Typically implemented as RADIUS servers or DHCP servers
- **Access Management Function (AMF):**
 - Translates network access signalling between CPE and NACF/UAAF
 - Forwards requests to the UAAF to authenticate the user, authorize/deny network access, and retrieve user-specific access configuration parameters
 - Typically implemented as RADIUS client if the NACF is a RADIUS server.
- **Connectivity Session Location Repository Function (CLF):**
 - Registers association between the IP configuration of the CPE and access transport characteristics, line identifier, IP edge identity, geographical location, etc.
 - Provides user network profile information to the RACS.
 - Provides location information to TISPAN NGN core subsystems

NASS architecture (3)

- **User Access Authorization Function (UAAF):**
 - Performs user authentication and authorisation based on user profiles
 - Collects accounting data
- **Profile Database Function (PDBF):**
 - Stores the user network profile, containing
 - User identity
 - Supported authentication methods
 - Keys
 - Can be co-located with the UPSF
- **Customer Premises Equipment Configuration Function (CPECF):**
 - Provides the CPE with additional initial configuration information (firewall, diffserv packet marking, etc.)
- **Customer Network Gateway (CNG):**
 - Single point of entrance in the customer's network (e.g., ADSL router)
 - Participates in line and access authentication

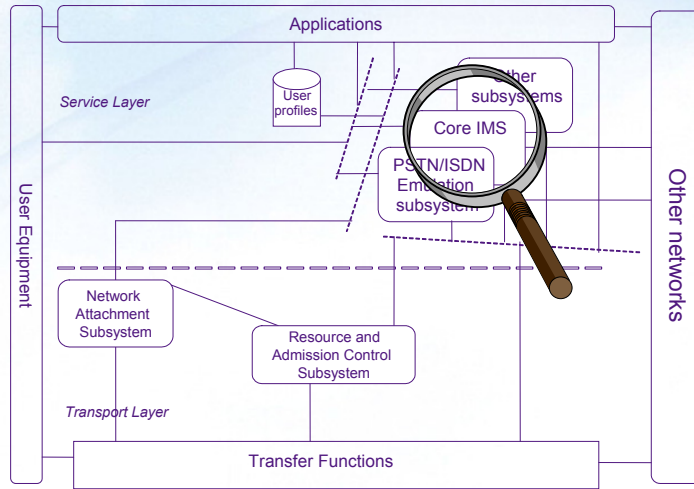
The Service layer in NGN



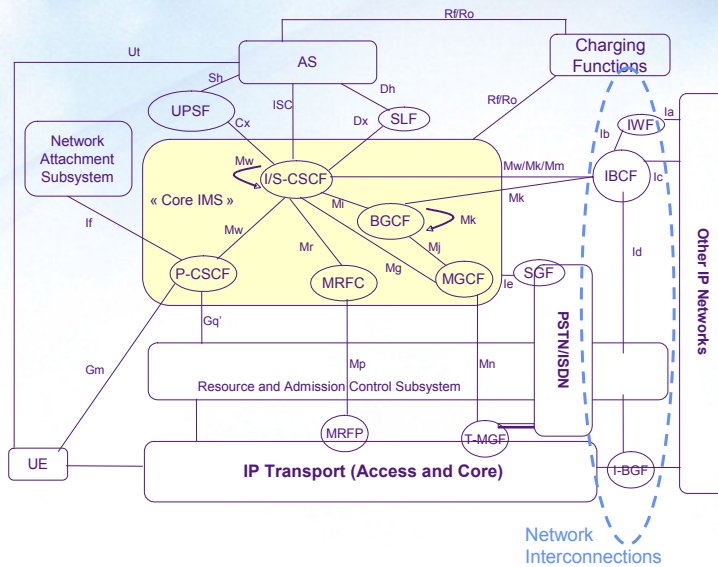
Service Layer

- Modular Subsystem design
- Two subsystem targeted in NGN Release 1:
 - **PSTN/ISDN Emulation Subsystem (PES)**
 - Emulates the PSTN/ISDN, users don't notice the change
 - Support for legacy equipment including black phones
 - **PSTN/ISDN Simulation Subsystem (a.k.a. IMS)**
 - Multimedia terminals, new services based on the IMS model.
 - Includes **PSTN/ISDN simulation services** (similar to the PSTN/ISDN Supplementary Services)
- Other subsystem may come in future NGN releases
 - **Streaming Subsystem**
 - **Content Broadcasting Subsystem**
 - Others as needed

The IMS in NGN



IMS architecture in NGN



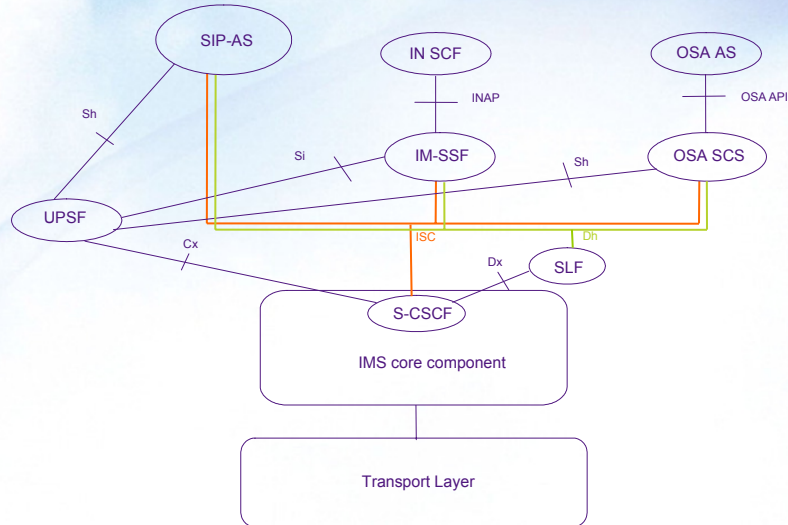
NGN impacts to IMS

- IMS can be mostly reused, as specified by 3GPP, due to its large access independence
- A few changes are required:
 - NAT traversal support in various points
 - Relaxation of IMS constraints:
 - SIP compression is no longer mandatory
 - SIP timers are not “wireless” specific
 - SIP preconditions (183, PRACK, UPDATE) are no longer mandatory
 - Support for ADSL access in P-Access-Network-Info header

IMS architecture (1)

- **Call Session Control Function (CSCF):**
 - Establishes, monitors, supports and releases multimedia functions
 - Three types of CSCFs: P-CSCF, I-CSCF, S-CSCF (same as in 3GPP IMS)
 - But P-CSCF contains also:
 - **Application Level Gateway (ALG)** to interface NAPT
 - Interfaces the NASS to retrieve user’s physical location
- **Media Gateway Control Function (MGCF):**
 - Controls a T-MGW
 - Converts ISUP to SIP
 - Functionality is equal to the 3GPP IMS MGCF
- **Multimedia Resource Function Controller (MRFC):**
 - Controls an MRFP
 - Together with the MRFP provides conference services, announcement playback, and media transcoding
 - Functionality is equal to the 3GPP IMS MRFC
- **Breakout Gateway Control Function (BGCF):**
 - Selects the network in which PSTN breakout is to occur
 - Or selects the MGCF
 - Equal to the 3GPP IMS BGCF

Architecture for IMS ASFs



Application Server Functions

- TISPAN NGN imports three types of ASFs from 3GPP IMS:
 - **SIP AS:**
 - Native application server for newly developed services
 - May act as a SIP User Agent, SIP proxy, SIP 3rd party call controller or SIP Back-to-back User Agent (B2BUA).
 - **IP Multimedia – Service Switching Function AS (IM-SSF AS):**
 - Gateway to legacy Intelligent Network services executed in a Service Control Point (SCP)
 - **Open Service Access Service Capability Server AS (OSA SCS AS):**
 - Gateway to legacy OSA services executed according to the OSA/Parlay framework

PSTN/ISDN Simulation Services

- ETSI TISPAN considers two types of IMS services:
 - **Basic PSTN/ISDN Simulation Services:**
 - Similar (but not equal) to PSTN/ISDN Supplementary Services
 - Unlike in the PSTN, not all these services require network support
 - Services must interwork with the similar PSTN/ISDN supplementary service and 3GPP supplementary service
 - **Multimedia services:**
 - New services, e.g., presence, multimedia instant messaging, SIP services that do not require extra standardization effort
- PSTN/ISDN Simulation Services defined in NGN Release 1 with three priorities:
 - Mandatory services
 - Strictly recommended services
 - Optional services

PSTN/ISDN Simulation Services (2)

Priority	Simulation Service	Equivalent Supplementary Service
Mandatory	Originating Identification Presentation (OIP)	Calling Line Identification Presentation (CLIP)
Mandatory	Originating Identification Restriction (OIR)	Calling Line Identification Restriction (CLIP)
Mandatory	Terminating Identification Presentation (TIP)	Connected Line Identification Presentation (COLP)
Mandatory	Terminating Identification Restriction (TIR)	Connected Line Identification Restriction (COLR)
Mandatory	Malicious Communication Identification (MCID)	Malicious Call Identification (MCID)
Mandatory	Anonymous Communication Rejection (ACR)	Anonymous Call Rejection (ACR)
Recommended	Communication Diversion (CDiv)	Call Diversion (CDiv)
Recommended	Communication Forwarding Unconditional (CFU)	Call Forwarding Unconditional (CFU)
Recommended	Communication Forwarding on Busy user (CFB)	Call Forwarding Busy (CFB)
Recommended	Communication Forwarding on no Reply (CFNR)	Call Forwarding No Reply (CFNR)

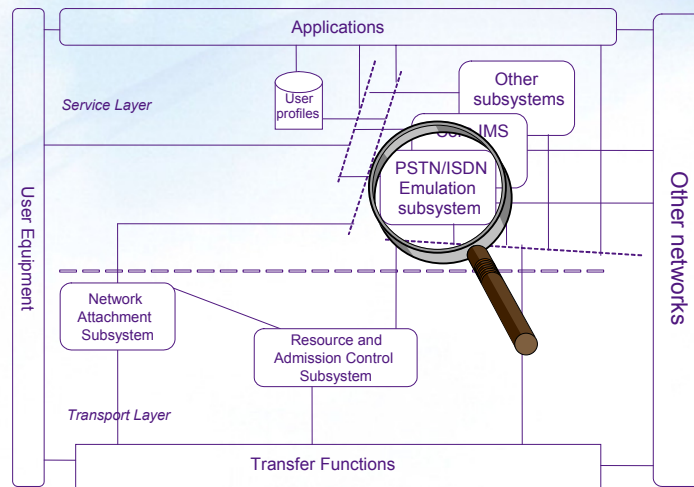
PSTN/ISDN Simulation Services (3)

Priority	Simulation Service	Equivalent Supplementary Service
Recommended	Communication Deflection (CD)	Call Deflection (CD)
Recommended	Communication Forwarding on Not-Logged In (CFNL)	Call Forwarding on Mobile Subscriber Not Reachable
Recommended	Communication Waiting (CW)	Call Waiting (CW)
Recommended	Communication Hold (HOLD)	Call Hold (HOLD)
Recommended	Communication Barring (CB) (Outgoing CB, Selective Outgoing CB, Incoming CB)	Outgoing Call Barring (OCB)
Recommended	Completion of Communications to Busy Subscriber (CCBS)	Completion of Calls to Busy Subscriber (CCBS)
Recommended	Follow Me (FM)	Follow Me (FM)
Recommended	Message Waiting Indicator (MWI)	Message Waiting Indicator (MWI)
Optional	Conferencing (CONF)	Conference Calling (CONF)
Optional	Advice of Charge (AoC)	Advice of Charge (AoC)

PSTN/ISDN Simulation Services (4)

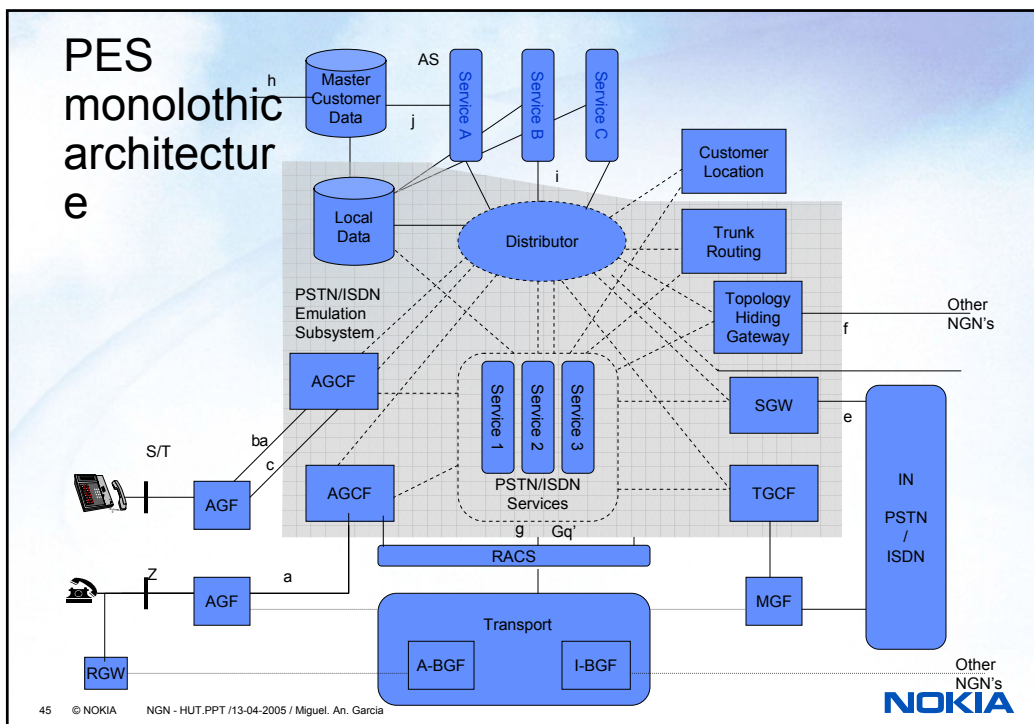
Priority	Simulation Service	Equivalent Supplementary Service
Optional	Closed User Group (CUG)	Closed User Group (CUG)
Optional	Fixed Destination Communication	
Optional	Inhibition of Incoming Forwarded Communications (IIFC)	
Optional	Direct Dial In (DDI)	Direct Dial In (DDI)
Optional	Explicit Communication Transfer (ECT)	Explicit Call Transfer (ECT)
Optional	Trunk Hunting (TH)	

The PSTN/ISDN Emulation Subsystem (PES)



PES principles

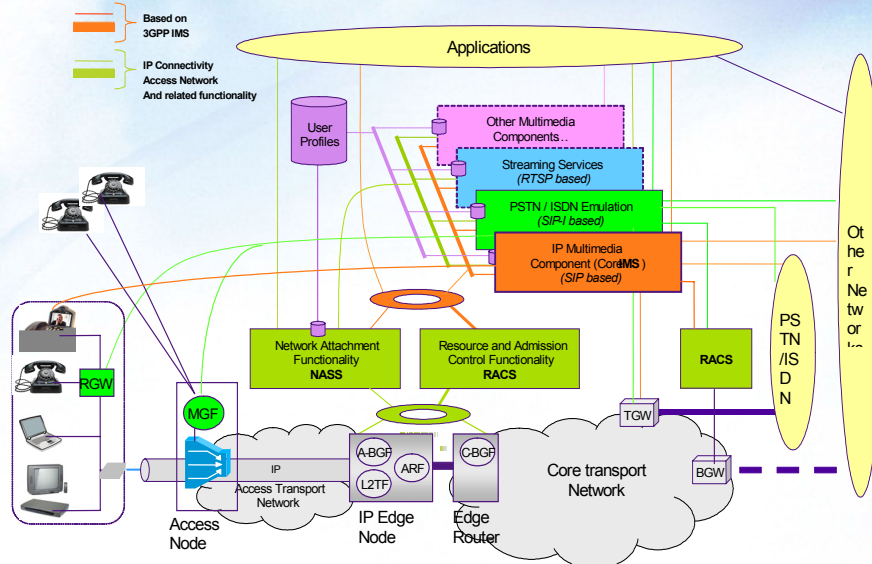
- The PSTN/ISDN Emulation Subsystem replaces the classic PSTN/ISDN without being noticed by end users
- Provides full support for legacy terminals and services
- Two PES implementations are possible:
 - Based on a monolithic Softswitch (scope TISPAN NGN R1)
 - Based on a distributed IMS (scope TISPAN NGN R2)
- In both cases, the call control protocol is SIP-I (SIP encapsulating ISUP bodies)



PES monolithic architecture (2)

- **Access Gateway Function (AGF):**
 - Provides a gateway functionality to:
 - Analog terminals connected to an analog interface
 - ISDN terminals connected to a Basic Rate Interface (BRI)
 - ISDN terminals connected to a Primary Rate Interface (PRI)
 - Residential Gateways
 - Typically located in the access network
- **Access Gateway Control Function (AGCF):**
 - First point of contact for AGF
 - Interacts with the RACS
 - Does ISUP (encapsulated in SIP) to H.248 conversion
- **Residential Gateway (RGW):**
 - Interface analog terminals and AGF

ETSI TISPAN NGN arch. for DSL access



Conclusion

- NGN networks will provide access to services over fixed broadband connections
- The architecture is layered: Service layer and Transport layer
- The architecture is modular: Different subsystem added on demand
- ETSI TISPAN NGN Release 1 will offer two subsystems:
 - PSTN/ISDN Emulation Subsystem (PSTN/ISDN replacement)
 - PSTN/ISDN Simulation Subsystem (Core native IMS)
- ETSI TISPAN NGN Release 1 standardization will be finished at the end of 2005