Evolution of services

- The technological migration to the NGAN requires an adaptation of current services provided through the copper infrastructure
- Services may be:
  - emulated/simulated
  - replaced
- In order to analyze the evolution of services, we will classify services as
  - Intermediate services (services internally used by one Operator or services among two operators)
  - Wholesale services for other operators (including unbundling and colocation)
  - Retail services

Intermediate services

- A typical example of this class of services is the connection of mobile network antennas to the core network (UMTS, HSPA, LTE)
- This connection is called “backhauling” and potentially a “fiber deep” access could help building a more cost-efficient backhauling
- However, currently a widely adopted technical solution is using groups of E1 lines for backhauling
- This makes it difficult to distribute the synchronism needed by mobile radio stations
- Pseudowire could be used as a possible technical solution. Another possibility is to use Synchronous Ethernet, synchronization over packet network …

Intermediate services

- However, the E1 legacy in backhauilng places a significant constraint and operators are still using hybrid solutions where dedicated E1 lines are used to distribute synchronim
- GPS receivers could be used as well, but the GPS system is under the administration of the Defense Department of the USA, who can decide to turn it down without any notice
- This calls for alternative solutions such as hybrid, pseudowire, syncronism over packet networks

Wholesale services

- Wholesale services can be classified as:
  - Bitstream access
  - Wholesale Line Rental
  - Individual Line Rental

Wholesale services: bitstream

- From a technical standpoint bitstream services do not place issues: the NGAN can offer customizable high speed access, usually to business users (see the Openreach GEA (Generic Ethernet Access) offer in Great Britain, over FTTC/FTTH)
- Quality of service (QoS), can be differentiated, at least two priority levels can be provided, for example with IEEE 802.1p
- Offering different classes of service through the NGAN allows an effective sharing of the infrastructure among different applications

Wholesale services: Line rental

- The standard line rental service could be substituted with a packet-base service through the NGAN
- The problem of the distribution of line synchronism applies also in this case

Unbundling and colocation

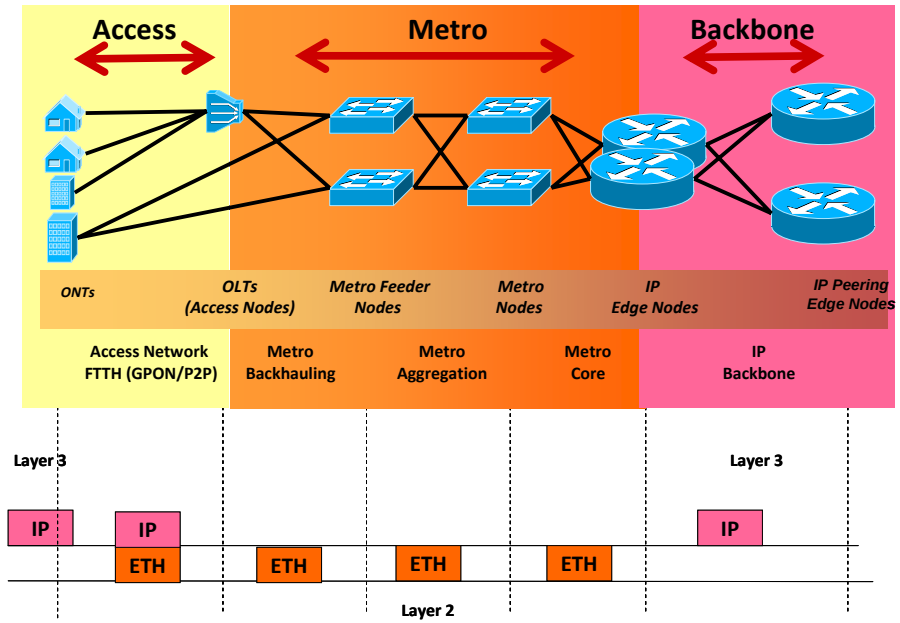
- Only large operators can sustain the investment costs for the deployment of a NGAN infrastructure
- Allowing small operators into competition is thuis a significant issue
- For the incumbent operator, the migration to the NGAN leads to the removal of local exchange offices
- The issue is that in local exchange offices usually other operators locate equipment (colocation) to implement Unbundling of the Local Loop (ULL)
- In Holland and Spain (for example) the devised solution is to allow enough time to colocated operator to implement alternative solutions
- Five years of time is generally agreed as a reasonable time span

Unbundling and colocation

- A colocated operator could:
  - Transfer unbundling to alternative locations
  - Sub-Loop Unbundle in street cabinets only in FTTC case

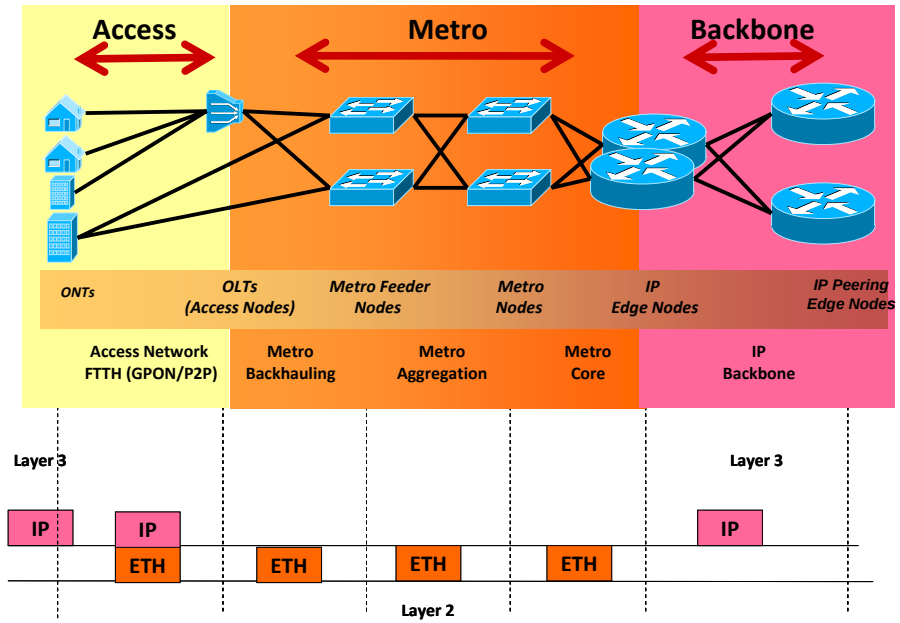
Access, metropolitan and backbone networks

- NGAN is the peripheral system component of the NGN network, which in turn is constututed by Access, Metro and Backbone networks
- A possible (not the unique) architectural solution is to operate at the IP layer in the Access and Backbone network, and at the Ethernet layer in the Metro network, as shown in the Figure



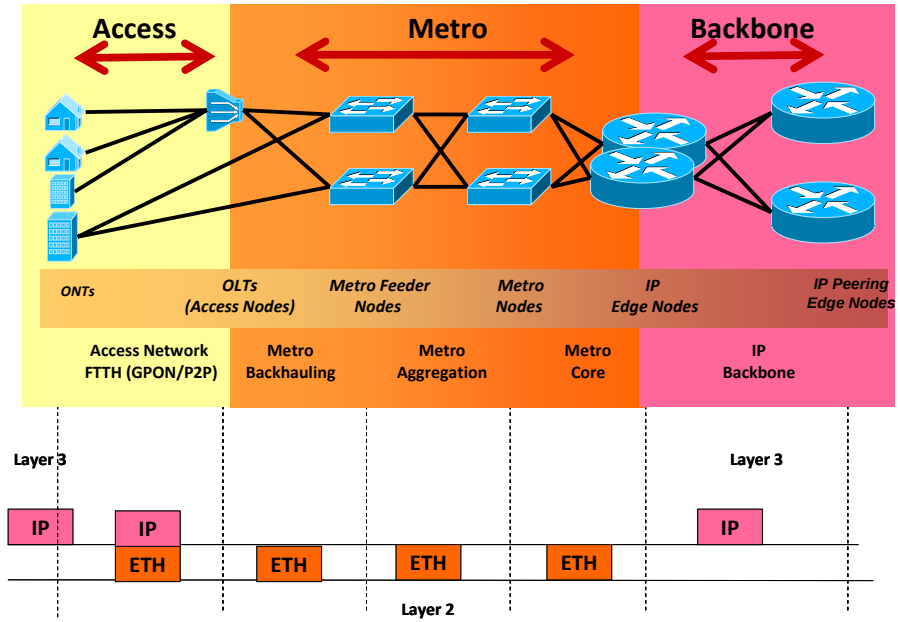
Access, metropolitan and backbone networks

- The differentiation of Quality of Service is a critical issue
- In the Metro network, it can be done thorough virtual LANS, by means of IEEE 802.1Q or IEEE 802.1ad
- IEEE 802.1Q differentiates VLANs by means of a priority indication in the Ethernet frame (IEEE 802.1p)
- In this way, 4.096 VLAN can be identified and managed
- IEEE 802.1ad with VLAN stacking enables 16.777.216 VLANs
- The VLAN space usually is not flat: Service VLANs (S-VLAN) and Customer VLANs (C-VLAN) can be distinguished
- S-VLANs can be associated to operators and/or services, while C-VLANs are associated to individual users



Access, metropolitan and backbone networks

- In the metro network also MPLS can be employed
- MPLS partially overlaps with Ethernet VLANS
- An interesting feature of MPLS is the efficient multicasting it can provide which, in turn, is useful for the distribution of audio/video content in a push model of distribution



IP multimedia services in the NGN

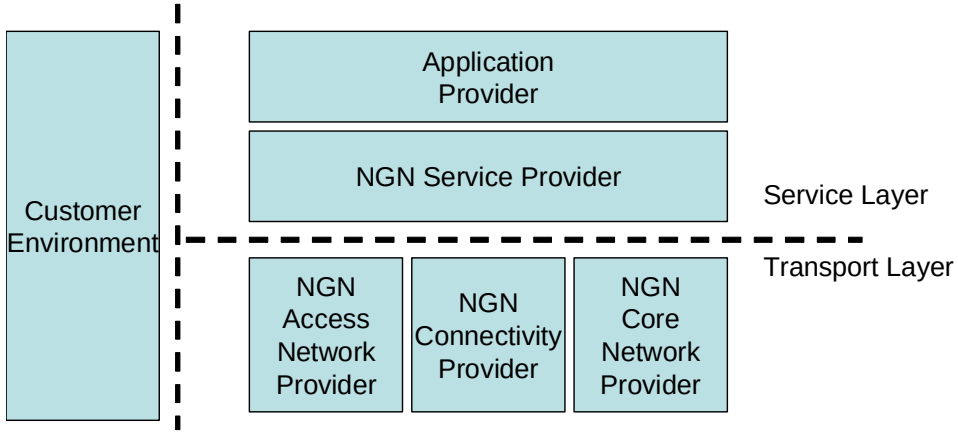
- In the ETSI the working group TISPAN (Telecommunications and Internet converged Services and Protocols for Advanced Networking) has already defined many NGN standards
- A relevant part of these standards covers the interconnection of multiple NGN network, of different operators

IP multimedia services in the NGN

- High-level requirements :
  - QoS must be negotiated both at the connection setup and when the connection is already established
  - QoS negotiation must be enabled also in case of roaming between different operators
  - IP multimedia session must support a wide set of audio/video codecs
  - IP multimedia services must, as much as possible, be provided to a variety of access technologies available to the user UTRAN, WiMAX, ...

Service layer e transport layer

- The Figure shows the logical division among the service layer and the trasnport layer in the NGN:
- **NGN Access Network Provider (NANP)**: concentrates traffic from multiple access lines towards one ore more NGN Connectivity Providers
- **NGN Connectivity Provider (NCP):** provides connectivity to NGN Core Network Provider
- **NGN Core Network Provider (NCNP):** aggregates trafic from edge nodes of multiple access networks towards external networks
- **NGN Service Provider (NSP):** provides services requiring transport onto the NGN. Performs authentication, service control & management, billing. In case of IPTV services performs content ingestion & Digital Rights Management (DRM)



Service requirements

- Two interconnected NGN operators offer end-to-end services
- Quality of Service must be guaranteed in end-to-end fashion through coordination among operators
- Example: carrier-grade VoIP services

VoIP Service requirements

- ETSI TISPAN identifies the emulation/replacement of PSTN/ISDN services as a key issue of the
- With service emulation, a new service is provided through the NGN with identical features of the old service
- Replacement means that some features of the new service may be slightly different

VoIP Service requirements

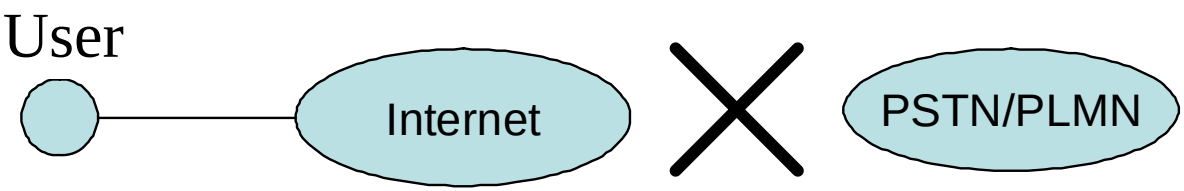
- Basic requirements of the classic PSTN/ISDN service:
  - Numvering plan must be preserved
  - Lawful Interception (LI) must be guaranteed
  - Emergency services must be guaranteed
  - Malicious Call Identification (MCID) service must be guaranteed
  - Anonymous Call Rejection (ACR) service (LI) must be guaranteed
  - Interoperability with the old PSTN/ISDN service must be guaranteed
- Two basic categories of telephone services are devised:
  - **Publicly Available Telephone Service** (PATS);
  - ECS (**Electronic Communication Service**).
- PATS is the service mapping for the classic PSTN/ISDN service and has more tight requirements than ECS

VoIP Service requirements

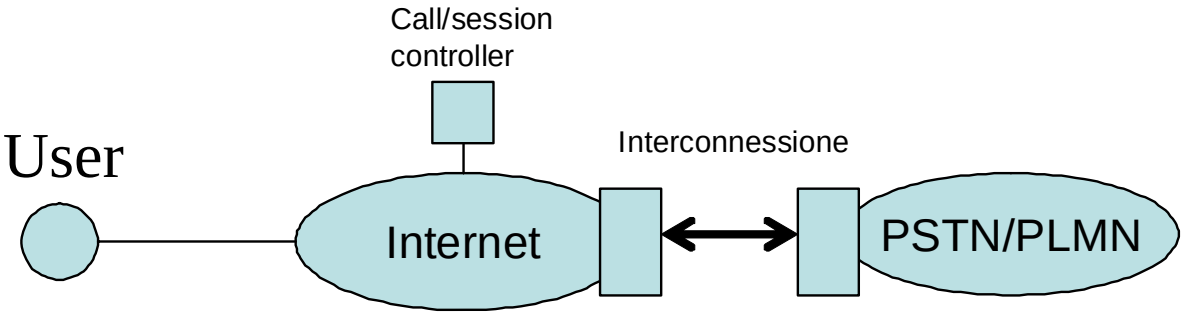
- The emulation of the classic PSTN/ISDN service is usually referred to as ToIP (Telephony over IP), to distinguish it from ECS services, such as VoIN (Voice over Internet)
- In the VoIN service network operatori usually do not control the service and do not guarantee qos
- Typical VoIN services are p2p telephony such as Skype, among others
- The VoIN In&Out service allows users to interconnect through external networks such as PSTN/PLMN

VoIP Service requirements

a) VoIN Peer-to-Peer



b) VoIN In&Out

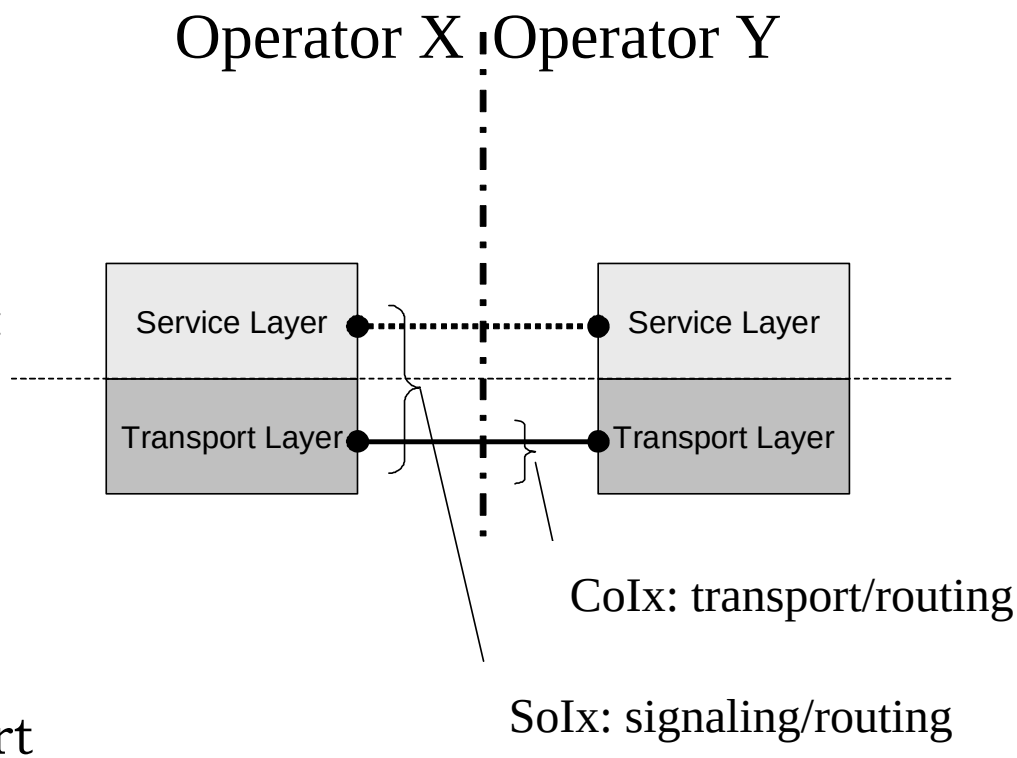


VoIP Service requirements

	Calls to PSTN & PLMN	**Additional services (emergency calls, number portability, telepowering, special number, connection through other networks)**		
VoIN Peer-to-Peer	NO	**NO**		
VoIN IN&OUT	YES	YES (no emergency calls, number portability, telepowering, special number)		
ToIP	YES	YS (no telepowering)		

NGN Interconnection

- NGN interconenction is standardized by ETSI/TISPAN
- In ETSI standards, interconnection can be performed in two ways::
  - Service-oriented Interconnection (SoIx);
  - Connectivity-oriented Interconnection (CoIx).
- SoIx operates at the service layer, CoIx operates at the transport layer

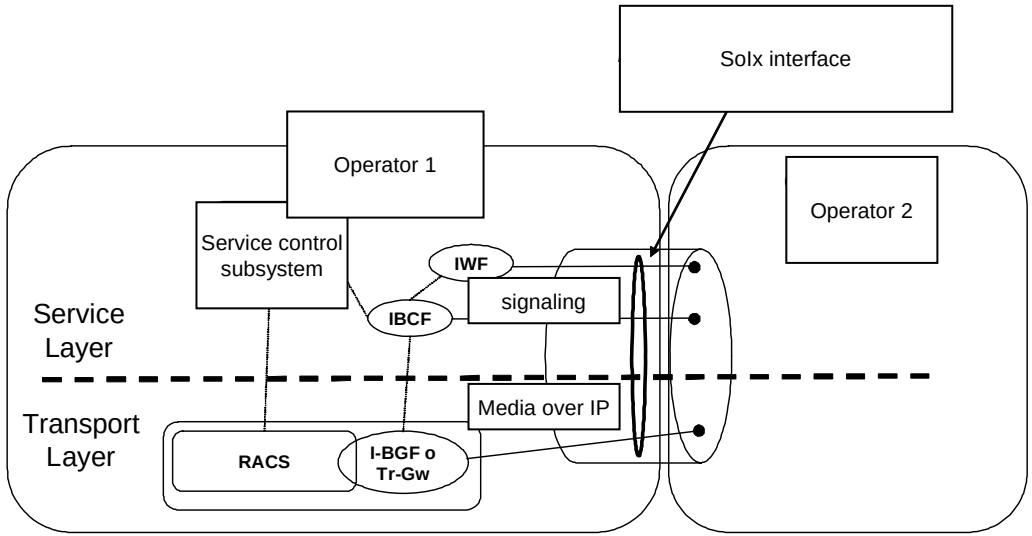


NGN Interconnection

- SoIx interconnection is the physical and logical interconnection between two administrative domains of different NGN operators. It allows operators to offers a complete service with QoS requirement in end-to-end fashion
- The CoIx interconnection operates basically at the IP layer, without considering service-level QoS requirements
- The CoIx interconnection may operate guaranteeing IP-layer service requirements

NGN Interconnection

- With reference to the interconnection for the delivery of ToIP services, the InterWorking Function (IWF) enables interworking of different signaling protocolssuch as SIP (Session Initiation Protocol) and ISUP (Integrated Services User Part)
- The Border Gateway Function (BGF) separates the two interconnected administrative domains, supporting security, QoS, call tracing, traffic logs
- The RACS (Resource and Admission Control Subsystem) function controls the usage of resources at the IP layer and it is responsible of QoS at the IP layer



Legenda
IBCF: Interconnection Border Control Function
I-BGF: Interconnection Border Gateway Function
Tr-GW: Transition GateWay in 3GPP
IWF: Interworking Function
RACS: Resource and Admission Control Subsystem

NGN Interconnection

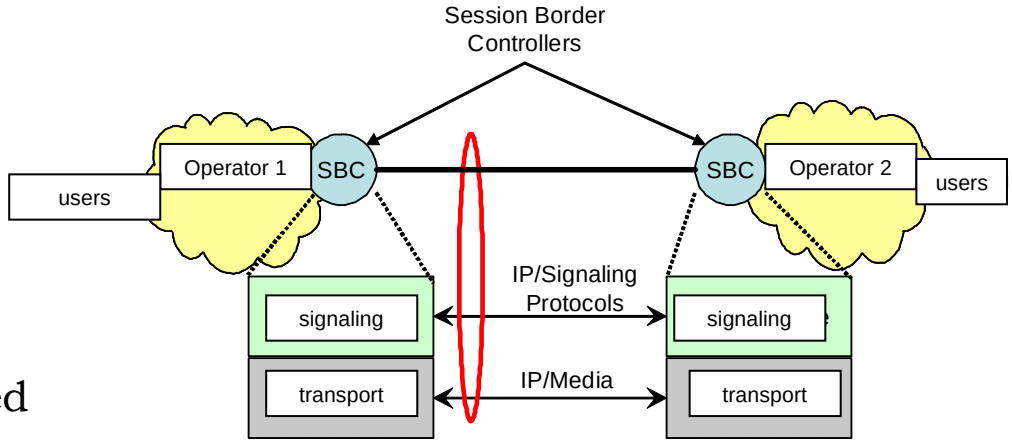
- The CoIx interconnection provides the connectivity allowing operators to let their customers reach external networks
- A typical example of CoIx interconnection is the peering IP service

NGN Interconnection

Interconnection service	Definizione	Esempi di applicazione	
		SoIx	CoIx
termination	Service requests are originated at the OLO/SP side and terminated onto customers of the interconnected operator	Telephone termination e videotelephony Termination of video-streaming session based Messaging (SMS, MMS...)	N.A.
collection	Service requestsof customers are forwarded to OLO/SP	Communication to non-geographic numbers Carrier Selection & Carrier Pre-selection Internet Dial-up	N.A.
transit	Service requests of OLO/SP transit through the interconnected operator	Transit of telephony & video telephony	N.A.
IP transit	IP traffic of OLO/SP transit through the interconnected operator	N.A.	IP transit to Peering domains
access	IP traffic of customers are forwarded to OLO/SP	N.A.	Bitstream Leased Lines (Terminating)
IP transport	IP traffic of OLO/SP between two remote points transits through the interconnected operator	N.A.	Leased Lines (trunk) VPN interconnection

SoIx requirements

- Signaling requirements:
  - Interoperability of signaling and service identification
- Requirements on codecs:
  - A set of codecs must be supported: at least G.711 bur are recommended Adaptive Multirate (AMR), G.729A and Enhanced Variable Rate Code (EVCR)
- Authomatic selection of codecs must be supported, the system must be able to scale down to the lowest quality codec involved in the session. Audio transcoding must be supported.
- Video codecs: at least H.263 and H.264



SoIx requirements

- routing:
  - Service-based routing must be supported
- security
  - Lawful interception, authorization, authentication, access control, data integrity, privacy
- Billing and accounting
  - Logs, traffic reports, billing generation, Charging Data Record (CDR).
- QoS & SLA
  - Resource reservation for QoS-aware sessions
- Connection Admission Control