ITU/ BDT «Training and Trials on Network Planning Tools for Evolving Network Architectures»

June 4-8 2007
Moscow, Russian Federation

Network Architectures for Planning and Technological alternatives. NGN: What and How

Oscar González Soto
ITU Consultant Expert
Strategic Planning and Assessment

Network Architectures and NGN Content

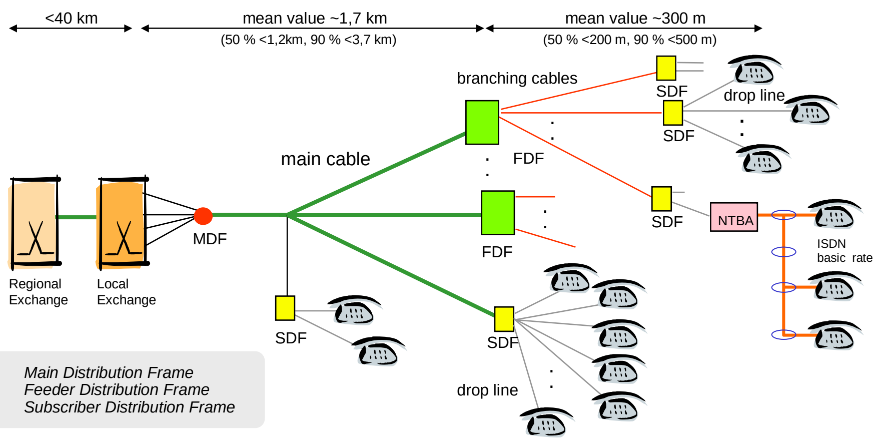
- Modeling of the network by layers and segments for planning purposes
- Technology solutions for Access and Core architectures
- NGN: What and how

Network Architectures and NGN
Network Modeling

- **High complexity of the whole Network requires a modeling and splitting in subnetworks to facilitate analysis and design.**
  - By Layers in a vertical dimension following the client-server relation (one layer is supported in the layer below and provides resources for the layer up). Physical, Transmission, Switching, etc.
  - By Segments or splitting of the end to end communication into subareas as customer premises, access, core national, core international
  - By Technologies or underlying technique as PDH, SDH, PSTN, ATM, IP, NGN, GSM, 3G, WiMAX, etc.....
- **Network Planning follows the same splitting or partitioning to allow treatment of the problems and adaptation to associated**

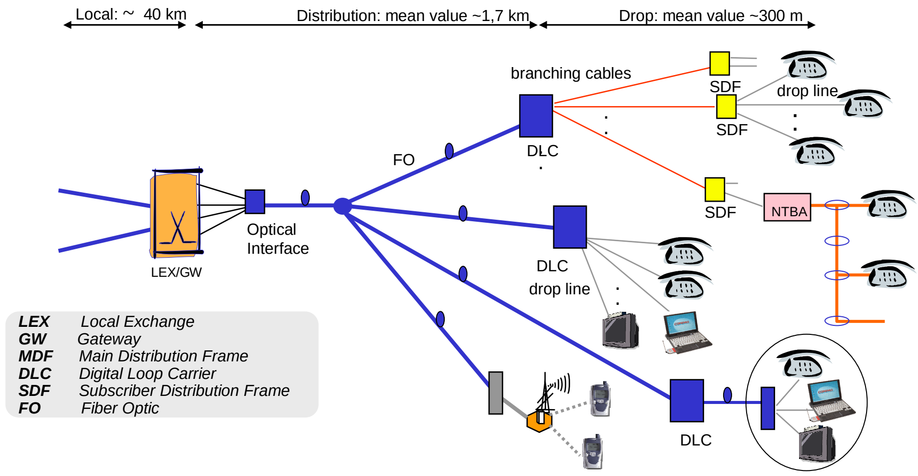
Network Architectures and NGN
Access Network: Wireline

Typical Access Network structure: (classical)

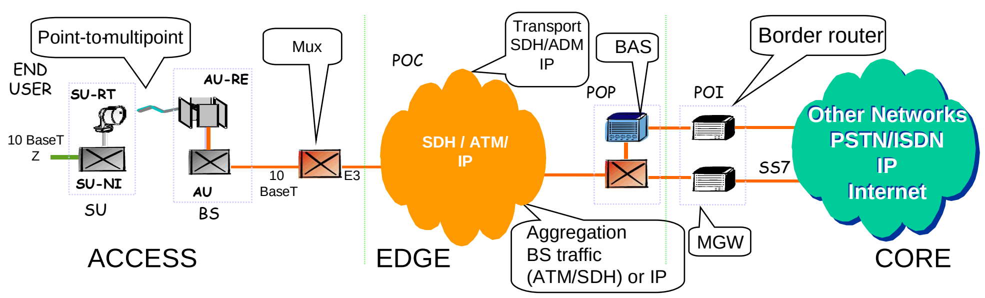


Network Architectures and NGN
Access Network: Wireline Evolution: FTTx

Typical Access Network evolution towards BB and Convergence



Network Architectures and NGN
Access Network: x.WIP



SU: Subscriber Unit
SU-RT: Subscriber Unit Outdoor Unit
SU-NI: Subscriber Unit Indoor Unit

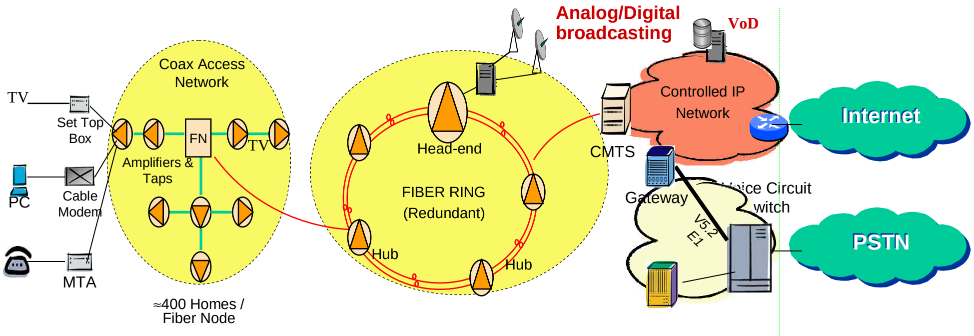
BS: Base Station
AU: Access Unit
AU-RE: Radio Front-end
MGW: Media Gateway

POC: Point of Concentration
POP: Point of presence
POI: Point of Interconnection
BAS: Broadband Access Server

Note: The current Network description shows the ATM approach (BAS is needed). A fully IP scenario is also feasible (BAS is not needed)

Network Architectures and NGN

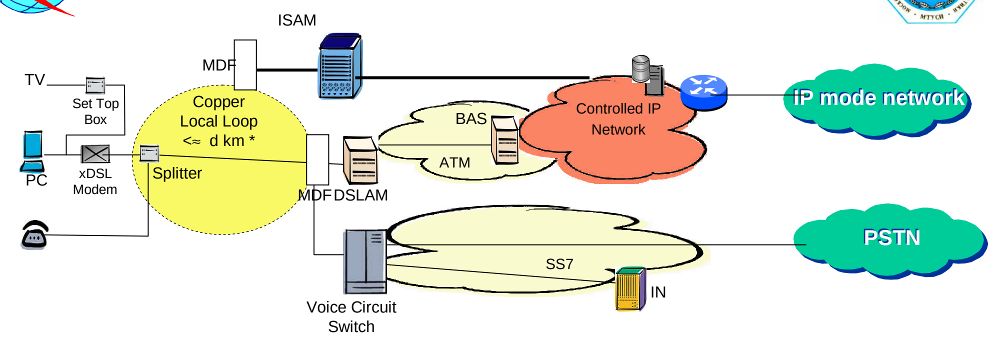
Access Network: HFC



MTA: Multimedia Terminal Adapter
FN: Fiber Node
CMTS: Cable Modem Termination System
VoD: Video on Demand
IN: Intelligent Network

Network Architectures and NGN

Access Network: xDSL

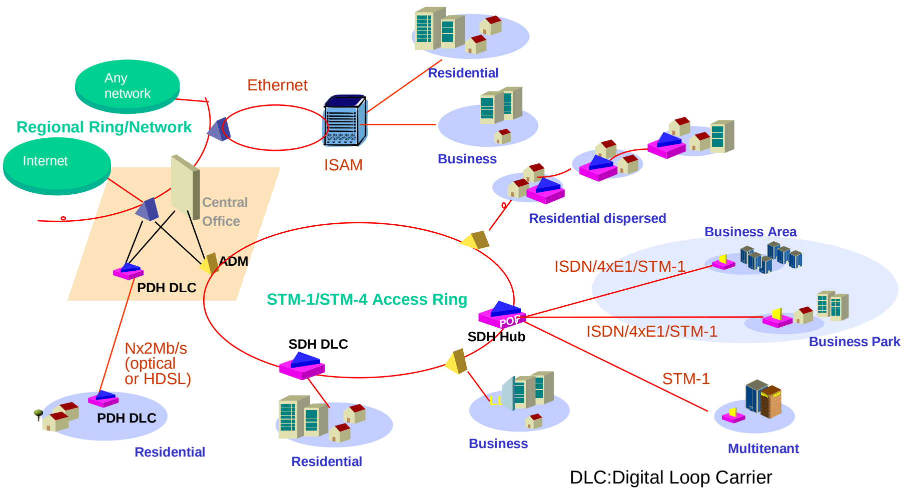


* Bandwidth/distances per solution
ADSL: up to 4/8 Mbps/800 kbps d <= 3/1,5 km
ADSL plus: up to4/ 8 Mbps/800 kbps d <= 4.5/2,1 km
SHDSL: up to 2.3 Mbps symmetric d <= 1.8 km
VDSL: up to 52 Mbps Assym/ 26 Mbps Sym d <= 300m
(In all cases, higher distances imply less bitrate following bandwidth shape curve)

MDF: Main Distribution Frame
DSLAM: Digital Subscriber Line Access Multiplexer
IN: Intelligent Network
BAS: Broadband Access Server

Network Architectures and NGN

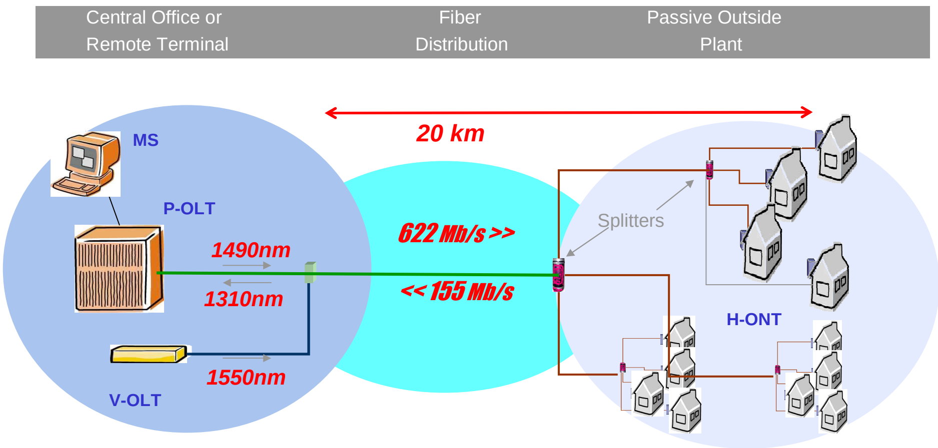
Access Network : Multiservice Nodes



DLC:Digital Loop Carrier

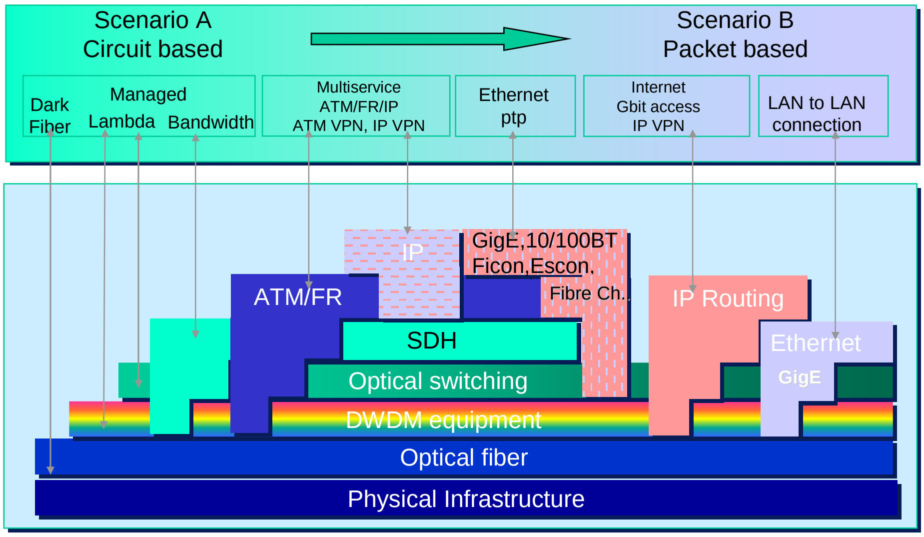
Network Architectures and NGN

Access Network : FTTU



FTTU:Fiber to the User
ONT: Optical Network Termination
OLT: Optical Line Termination

Network Architectures and NGN:
Technological alternatives at core



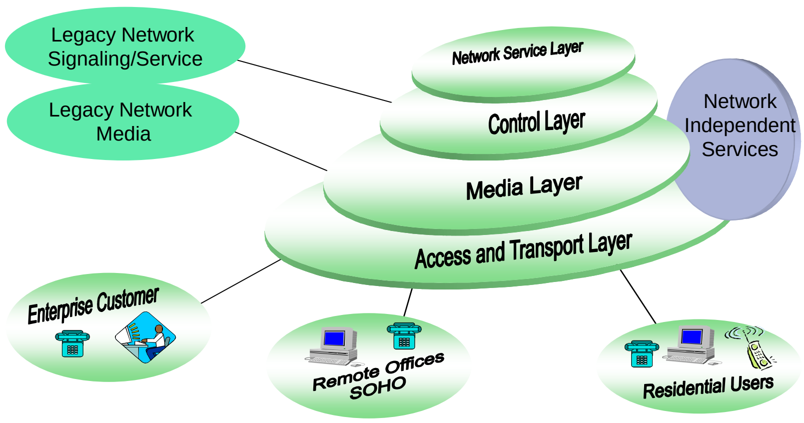
Network Architectures and NGN:
Evolution towards NGN

NGN concept

- •A **multi-service network** able to support voice, data and video
- •A network with a control plane (signaling, control) **separated** from the transport/switching plane
- •A network with **open interfaces** between transport, control and applications
- •A network using **packet technology** (IP) to transport of all kind of information
- •A network with **guaranteed QoS** for different traffic types and SLAs

Network Architectures and NGN:
Evolution towards NGN

NGN layers



Network Architectures and NGN:
Evolution towards NGN

NGN : Why

- **Flexibility** for service building and offering
- Expectation of **cost reductions** by sharing infrastructure and systems
- **Simplification of O&M**, thus lowering OPEX.
- Use of **open interfaces** leads for:
  - quick deployment of services and applications
  - new services (third parties)

Network Architectures and NGN
Modeling issues for NGN and 3G

- New models to represent multiservice flows
- New dimensioning methods for resources handling multimedia services with QoS
- New measurement procedures for aggregated multiservice traffics
- New multicriteria dimensioning for 3G and xG combining coverage by frequency, service speed and data traffic capacity
- Which procedures to ensure interoperability and end-to-end performance across multiple domains?
- Which units to define dimensioning and costing units for interconnection?

Network Architectures and NGN
QoS and Performance Issues

• Quality of Service (QoS) domains to be modeled, defined and/or extended for NGN and 3G. Measured in waiting time and/or loss probabilities

• Domains for QoS evaluation:

- Service accessibility: capability to access a service
- Connection establishment: Capability to get connection
- Information transfer: Quality of information delivery
- Reliability: Failure probability
- Availability: Probability of system being active
- Survivability: Capability to provide service in abnormal conditions
- Security: Information and systems protection level
- Qualitative: Intelligibility, audibility, visualization ... of information content as derived from user perception (MOS)

Network Architectures and NGN
Traffic flow types for QoS based dimensioning

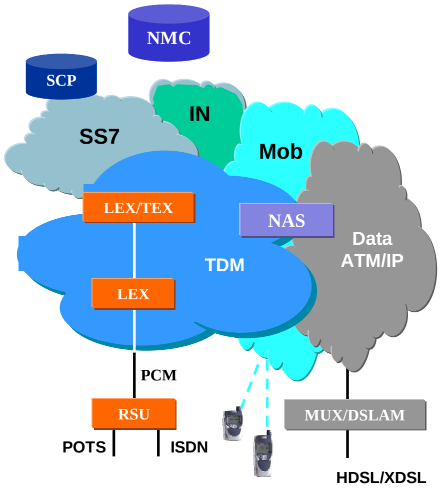
- **T1) QoS constant stream**: bandwidth transmission at a constant speed with a specified delivery and jitter (ie: video distribution)
- **T2) QoS variable stream** : bandwidth transmission at a variable speed derived from a user information and coding algorithm which requires guaranteed quality and specified jitter (ie: VoIP, Video streaming, audio streaming, etc.)
- **T3) QoS elastic:** bandwidth transmission at a variable speed without jitter restrictions and asynchronous delivery (ie: browsing, file transfer, mail, UMS, etc.)

Network Architectures and NGN
Traffic units for aggregated flows

Proposal of NGN units in multiservice networks/interfaces for demand/dimensioning/costing :

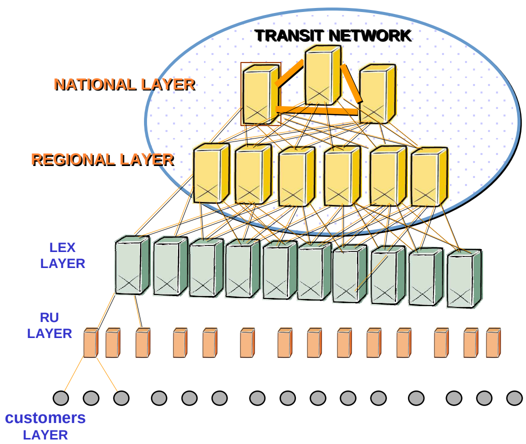
- Equivalent Sustained Bit Rate (ESBR) or aggregated equivalent rates for same QoS category flows efficiently carried in a common reference busy period (ie. 5 minutes)
- Computed as weighted average for the services at QoS category (i) and customer classes (j) at each network element: $\sum_i \sum_j \text{ESBR}_{ij}$

Network Architectures and NGN
Existing networks and architecture



- 5 different network types to handle telecom services
- TDM for fixed and mobile networks working in circuit mode with end to end reserved paths
- SS7 and IN network working with message switching mode
- Data network working with leased lines and packet mode with different and conventional IP protocols

Network Architectures and NGN
Existing networks and architecture

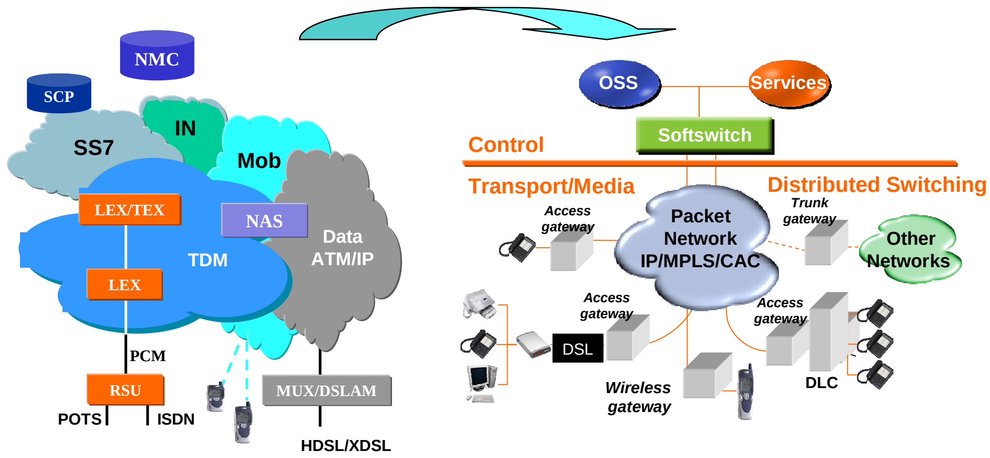


- Hierarchical topology with 4 to 5 layers, connectivity to the upper next layer and within each layer as a function of economical optimization
- Number of nodes as a function of O/D traffic and nodes capacity
- Service handling for media, signaling and control at all exchange nodes
- Carrier grade quality with well defined QoS criteria and standardized engineering rules

Network Architectures and NGN

Architecture migration: Topology

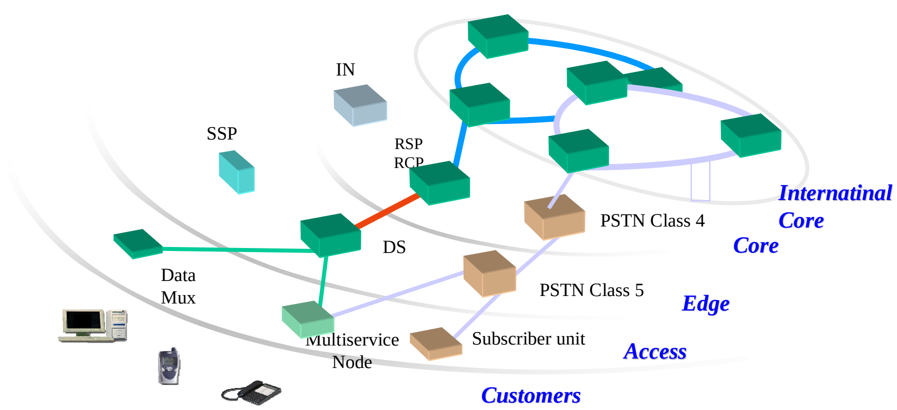
What changes from current scenario towards target network ?



Network Architectures and NGN

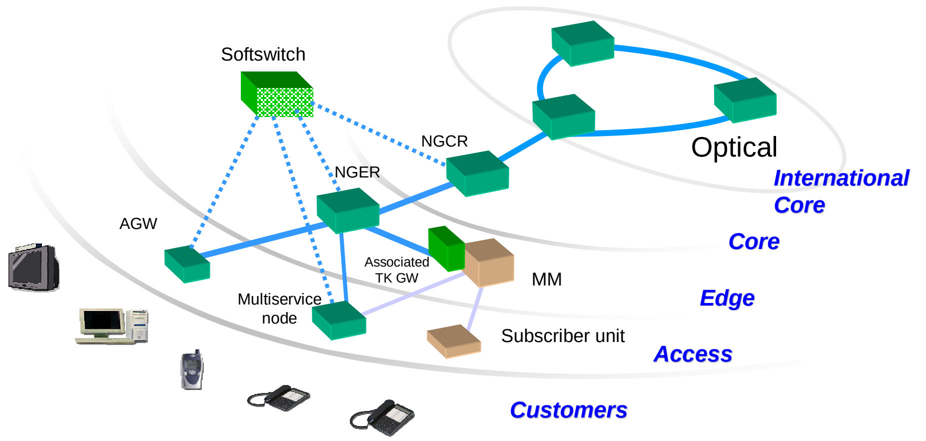
Evolution towards NGN

Current end to end architecture



Network Architectures and NGN:
Evolution towards NGN

Target end to end architecture for NGN



Network Architecture towards NGN
Architecture Evolution: Topology

Topological changes impact on infrastructure and are slower to implement than technology substitution

- **Less network nodes and links** due to the higher capacity of systems (one order of magnitude).
- **Same capillarity** at access level due to identical customer location
- Topological **connectivity higher** for high capacity nodes and paths for security
- **High protection** level and diversity paths/sources in all high capacity systems, both at functional and physical levels

Network Architectures and NGN:
Cost drivers and trends

- Network physical infrastructure as a function of location and density (costs proportion around 70% in the access segment)
- Volume of customers per category
- Bandwidth demand per origin/destination
- Packet processing rates for control related functions
- Variety of applications/services and related platforms
- Content storage and location within the network
- Leasing of physical or communication resources

Fundamental importance of economies of scale by volume and convergence at network resources, service platforms and OSS

Network Architectures and NGN:
Cost drivers and trends

Cost trends for NGN

- Cost reduction in CAPEX due to technological economy of scale by larger capacities
- Similar values for costs in the physical civil infrastructure
- OPEX in NGN trends to be lower due to the integrated operation and maintenance
- Plan higher investments in security/survivability with diversity paths and protection for large capacity systems

Check and validate correct cost modelling with fixed and variable components as a function of economy of scale

Network Architectures and NGN

Unified IMS Model for Mobile and Fixed Convergence

What is IMS?

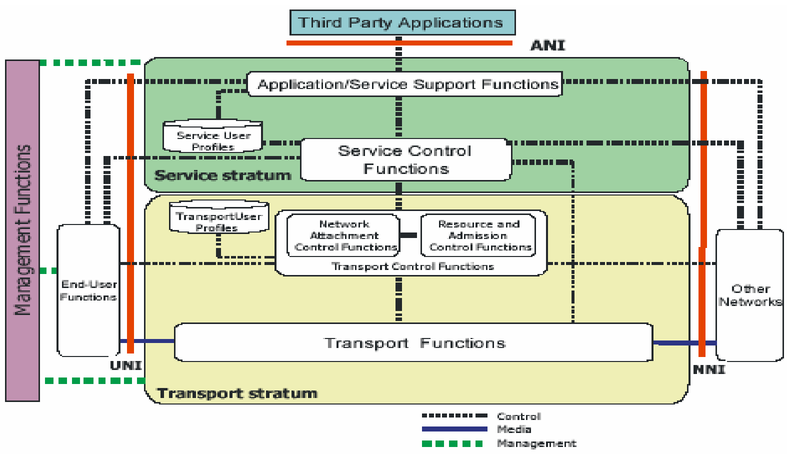
- **Concept:**
  - **Application of 3GPP's IMS architecture and protocol extensions for fixed and converged networks**
- **Key actors:**
  - **Operators**
  - **ETSI, TISPAN, VASA, ITU-T**
  - **Equipment vendors**

Why IMS ?

- **Deliver person-to-person real-time IP-based multimedia communications**
  - **Person-to-person, person-to-machine**
- **Fully integrate real-time with non-real-time multimedia communications.**
  - **i.e., live streaming and chat**
- **Easy user setup of multiple services in a single session, or multiple synchronized sessions**
- **Operators have better control of service value chain**
  - **End-to-end QoS**

Network Architectures and NGN

IMS Architecture



Network Architectures and NGN
Evolution to IMS: Benefits

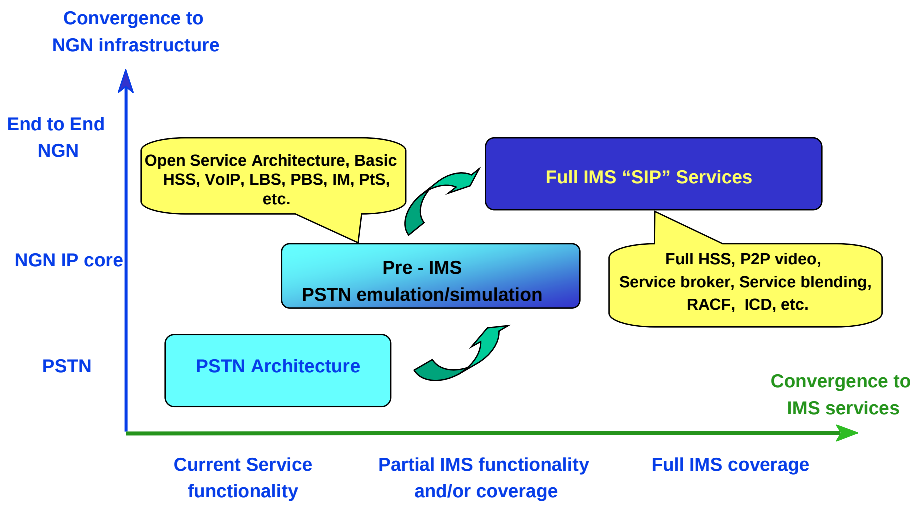
- **First advantage is the higher flexibility of the IMS functionality to adapt to the customer services**, irrespective of the technology they use and the access method to reach the network.

- **Saving in effort and time for the development and deployment** of a new service is considerably reduced once the architecture is ready at the network, implying economic savings and better Time to Market for a given service provider in a competitive market.

- **Efficient introduction on new services at a lower cost** will increase the service provider revenues and ARPU which is the major business driver for the healthy operation, market grow and financial results.

- **Higher utilization of services and better personalization** of functions to specific requirements from the end customers' point of view, a common use and feel for all services and applications

Network Architectures and NGN
Evolution to IMS: Phases



Network Architectures and NGN
Summary Remarks

- **Multiservice flows** impose a set of requirements on models and tools for NGN and 3G.
- **Interoperability and interconnection** require special effort to players and planners to ensure end-to-end performance
- Migration of existing architectures to the new generation ones **require techno-economic planning** for each country scenario
- Complexity of converged networks require the use of **high quality support tools**