Optical Communication in Access Network

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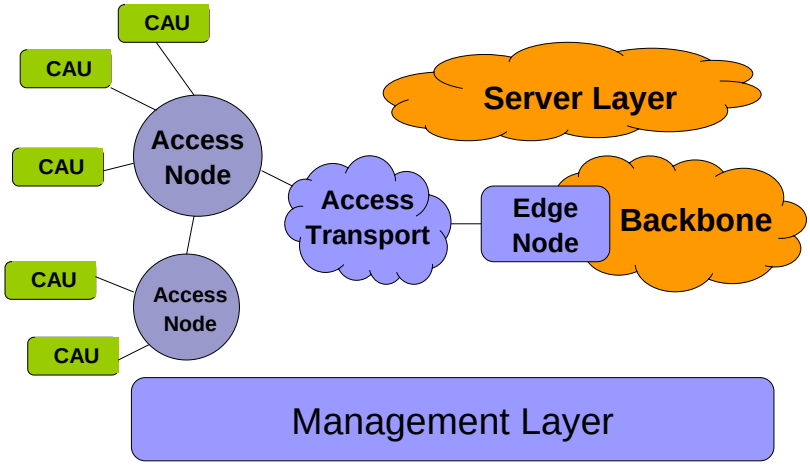
Outline

- Introduction
- Elements of Access Network
  - CAU, Access Node, Access Transport, Edge Node
- Access Transport
  - Optical Communication
- Next Generation Network
- Conclusions

Introduction
Drivers of the Access Network Evolution

- Unbundling of local loop
  - **CLEC can provide new access technologies**
- New Technologies
  - **xDSL**
  - **Radio Access**
  - **Fiber Access**
- IP-Based Network with QoS
  - **Rapid Growth in Data Services**
  - **VoIP Applications**
- Multi-Services Concept
  - **High Bandwidth Data Services**
  - **PSTN / ISDN**
- Cost Issue

Elements of Access Network

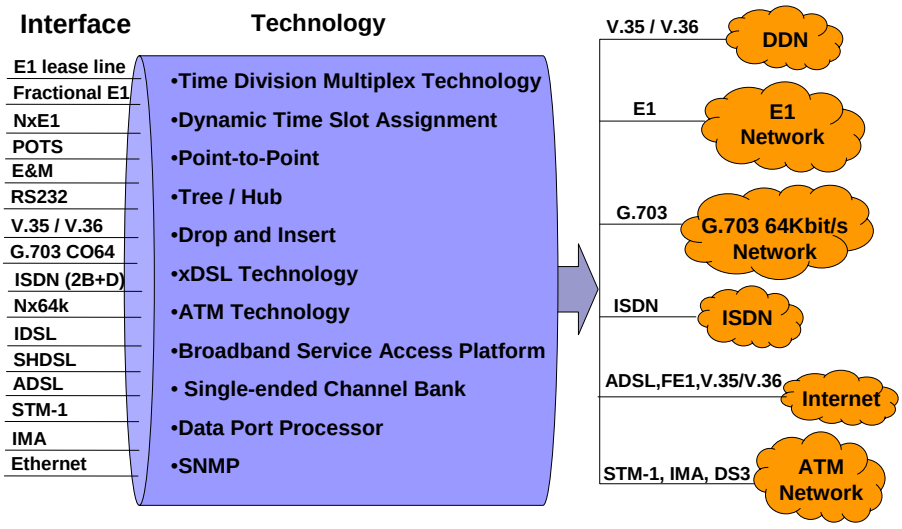


CAU: Customer Access Unit

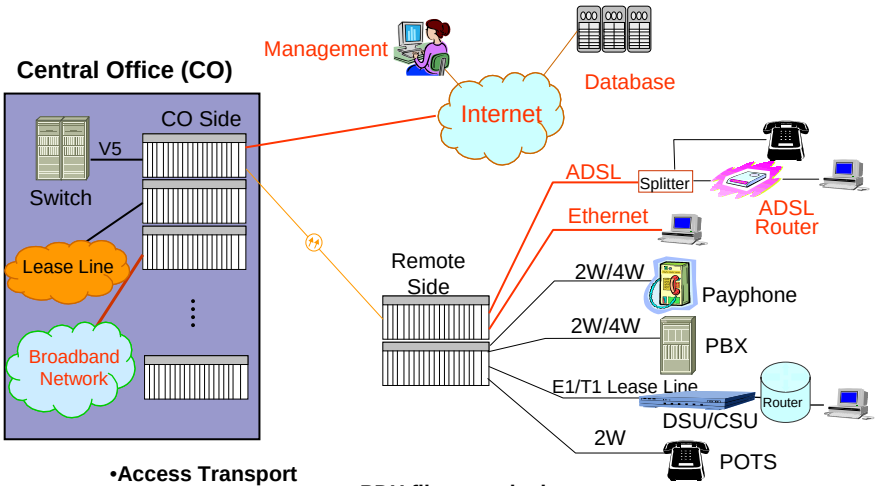
Technologies for Access Networks

	Interfaces / Technologies	Trend
CAU	POTS, ISDN, T1/E1 Lease Line, DSL, Ethernet	Narrow band → Broad band
Access Node	Legacy DLC, Multiservice Platform	Legacy →Multiservice
Access Transport	SDH, DWDM, PON, FTTx, Ethernet	
Edge Node	Local Exchange, V5, Access Server, Router	

Integrated Access Node



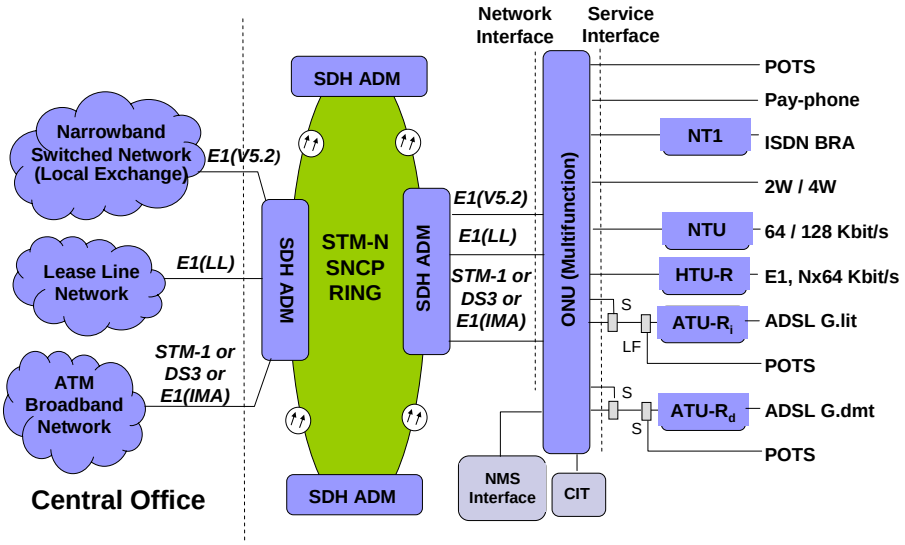
Broadband Digital Loop Carrier



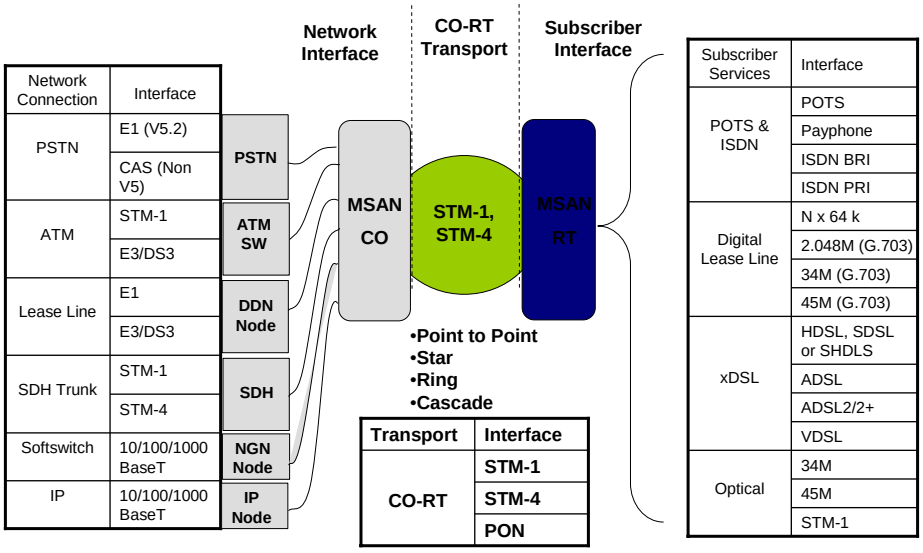
•Access Transport

T1 / E1 → Optical { PDH fiber terminal; SDH Interface

Multifunction Optical Network Unit



MSAN (Multi-Service Access Network)



Network Connection	Interface
PSTN	E1 (V5.2)
	CAS (Non V5)
ATM	STM-1
	E3/DS3
Lease Line	E1
	E3/DS3
SDH Trunk	STM-1
	STM-4
Softswitch	10/100/1000 BaseT
IP	10/100/1000 BaseT

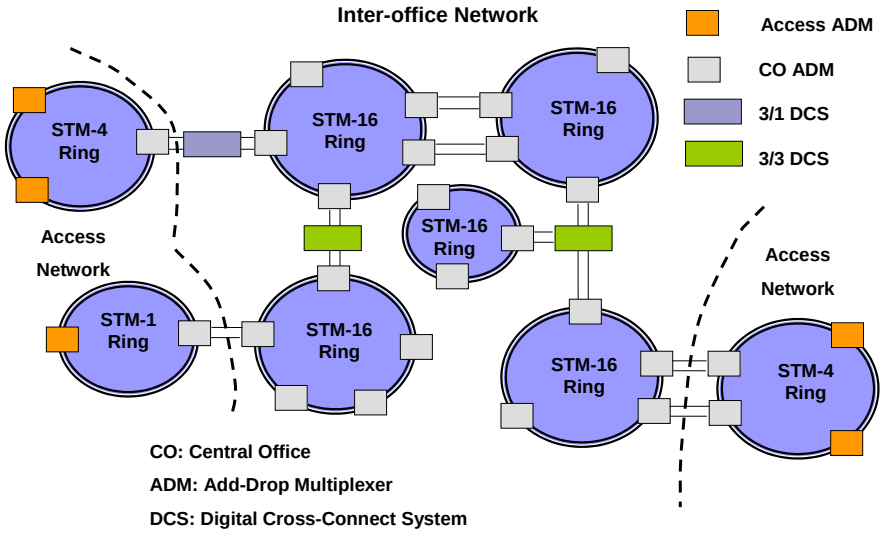
Transport	Interface
CO-RT	STM-1
	STM-4
	PON

Subscriber Services	Interface
POTS & ISDN	POTS
	Payphone
	ISDN BRI
	ISDN PRI
Digital Lease Line	N x 64 k
	2.048M (G.703)
	34M (G.703)
	45M (G.703)
xDSL	HDSL, SDSL or SHDLS
	ADSL
	ADSL2/2+
	VDSL
Optical	34M
	45M
	STM-1

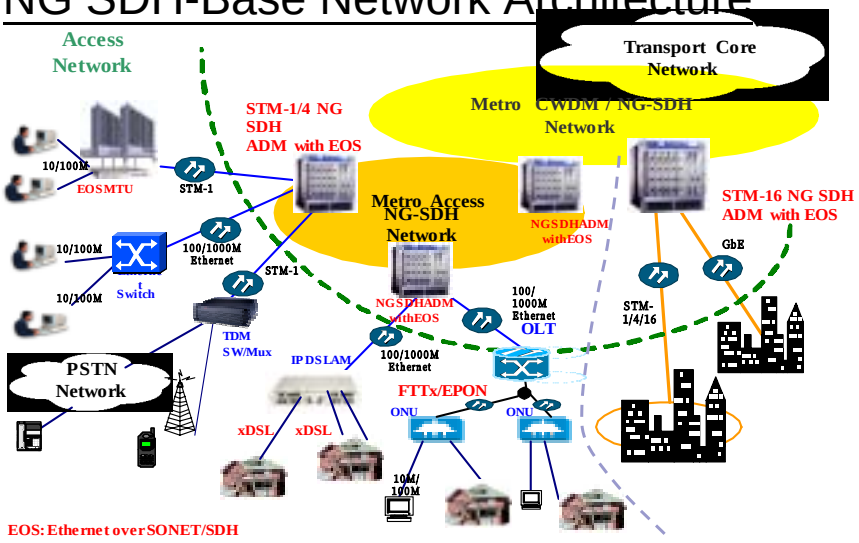
Access Transport

- SDH / SONET – Next Generation
- GbE / XGbE Network
- PON
- Others - RPR

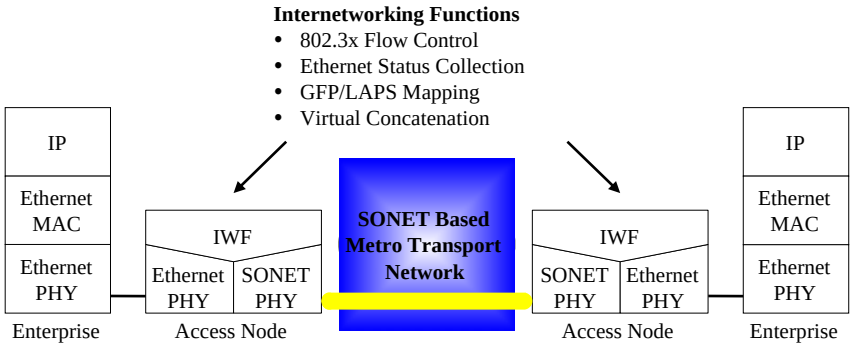
Typical Metro TDM Transport Network



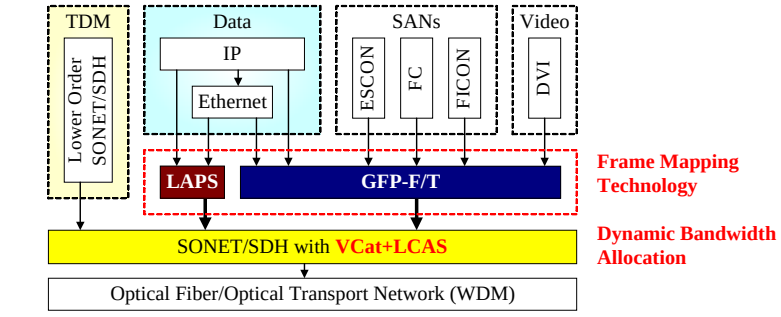
Access Transport
NG SDH-Base Network Architecture



EOS Transport Model



EOS Transport Technology

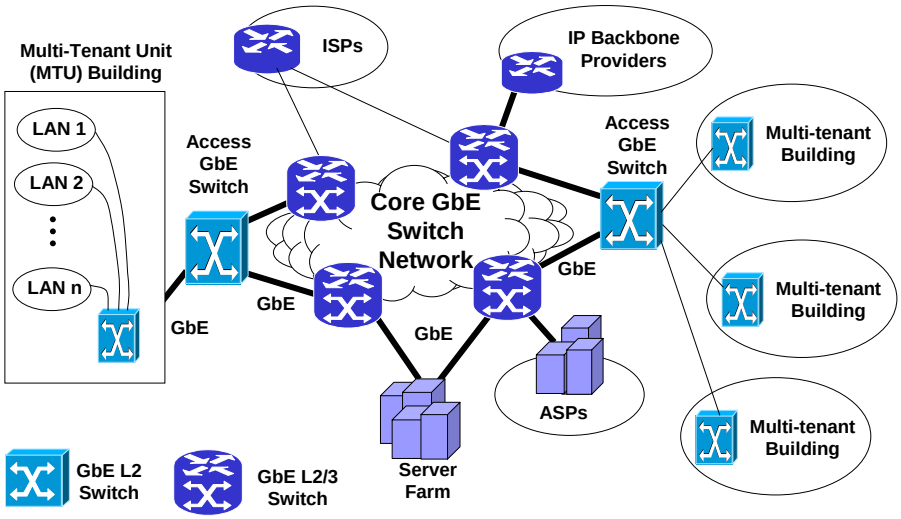


- **Frame Mapping Technology**
  - **Generic Framing Procedure (GFP-F/T)**
  - **Link Access Procedure – SDH (LAPS)**
- **Dynamic Bandwidth Allocation Technology**
  - **Virtual Concatenation (VCat)**
  - **Link Capacity Adjustment Scheme (LCAS)**

Link Capacity Adjustment Scheme (LCAS)

- A real time control mechanism to increase/decrease capacity of a virtually concatenated group without incurring hits to active traffic.
- Rerouting of traffic due to current network conditions, such as failures or maintenance procedures
- Defined for all high and low order SONET and SDH payloads

GbE Network Architecture



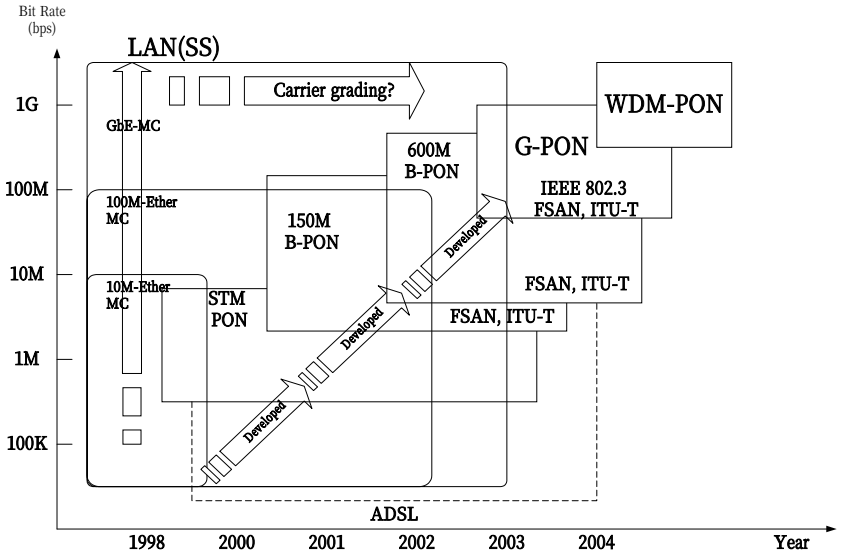
Gb/10Gb Ethernet Advantages

- Big cost advantage over SONET/SDH and ATM
- Uses standard Ethernet frame format (no protocol conversion)
- Full duplex point-to-point links with long reach to 40-70 km
- Layer 2/3 switches
  - **VLAN capacity (802.1Q)**
  - **Standard IP routing at layer 3 (e.g., OSPF, BGP)**
  - **Priority capability (aggregate flow QoS) provided by 802.1p at layer 2 and DiffServ at layer 3**
  - **Traffic policing, shaping and monitoring at edge**

Gb/10Gb Ethernet Deficiencies

- **Protection time ~ 1 sec >> 50 msec in SONET/SDH**
- **QoS**
  - **Over-provisioning needed to provide delay/jitter sensitive apps.**
  - **QoS provided for traffic aggregates, not individual flow**
  - **Providing QoS across network boundaries is difficult**
- **PM and Fault management worse than SONET/SDH**
  - **Ethernet provides no overhead for performance monitoring, alarms, protection signaling, etc.**
  - **Except for 10GbE WAN PHY, these functions must be performed at the management layer**
  - **Proprietary solutions (e.g., using the interframe gap) are being developed**
- **Accommodation of Legacy TDM Services → use TDMoIP technology**

PON Evolution



PON Standards

- PON Evolution Timeline -

BPON G.983 → **EPON** → **GPON G.984**

1995

- ATM-based PONs
- Early BPON products tested and installed in limited quantities by carriers
- Supports Voice and Data
- 622 Mbps bandwidth ~70% Efficiency
- Adopted as ITU standard in 1999

➢ EPON=Ethernet-based PONs
➢ Emerging market, especially for Metro Ethernet
➢ Efficiency (for Voice and data services) -~49%
➢ 1Gbps bandwidth
➢ IEEE acceptance expected only in 2004

Today

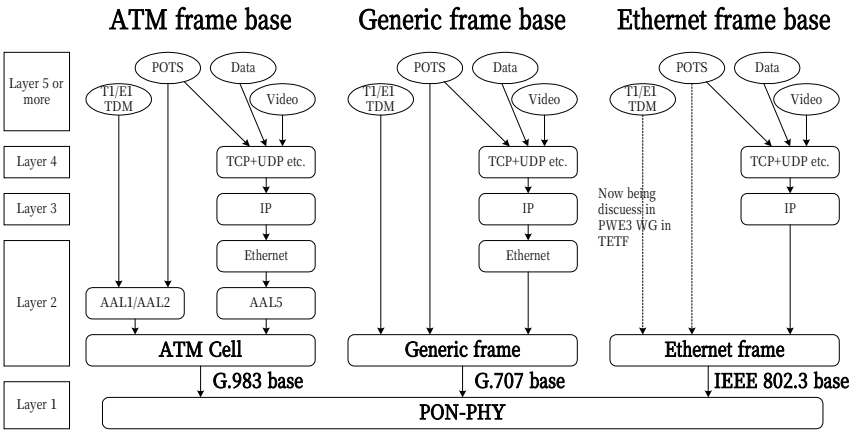
- GPON=Gigabit PON
- Evolution in FSAN Committee for Voice and Data in their native format
- Efficiency (for voice and data services) -~93%
- 2.5Gbps+ of bandwidth at 93% Efficiency
- ITU ratification in 2003

EPON vs. APON, GPON

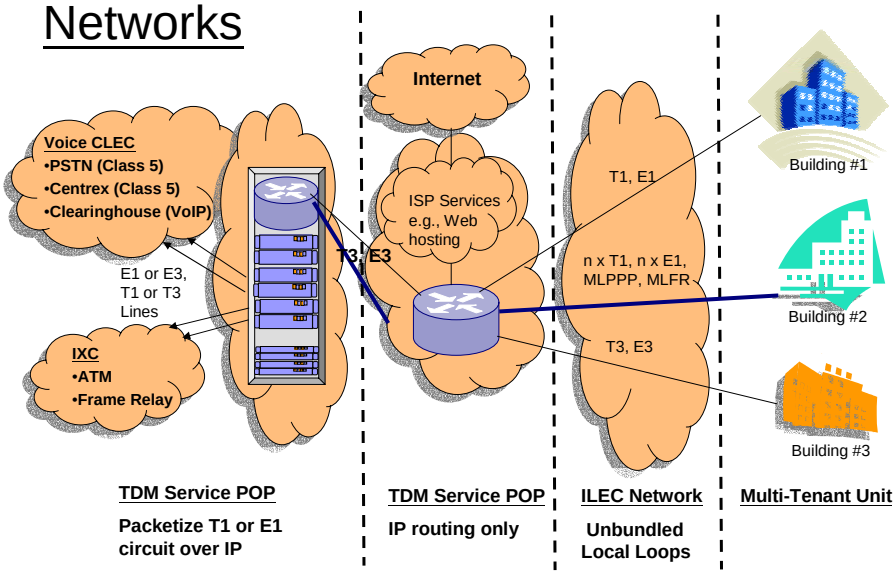
	EPON	APON	GPON
Standard body	IEEE	ITU-T (FSAN)	ITU-T SG15 (FSAN)
Standardization timeline	2004.07	1998	2003.11 (G.GPON.GTC)
Standard driven by	Vendors	SP	SP
Speed	1G	155/622 622/1244 Mbps (Amendment)	Up to 2.488 Gbps
Basic protocol	Ethernet	ATM	Ethernet/ATM/TDM
Protocol overhead for IP	Small	Large	Middle
US MAC scheme	TDMA	TDMA	TDMA
Line Coding	8B/10B	Scramble NRZ	Scramble NRZ
BER	10^{-12}	10^{-10}	10^{-12}
ODN Type	Type1, Type2	Class A, B	Class A, B, C
Max Reach	Type1 <= 10 km Type2 <= 20 km	20 km	20 km

GPON TC Layer Options

- Comparative analysis will be made by the FSAN members
- One of the best solutions will be proposed to ITU-T from the members in FSAN



Interworking between TDM and IP Networks



TDMoIP / CESoP

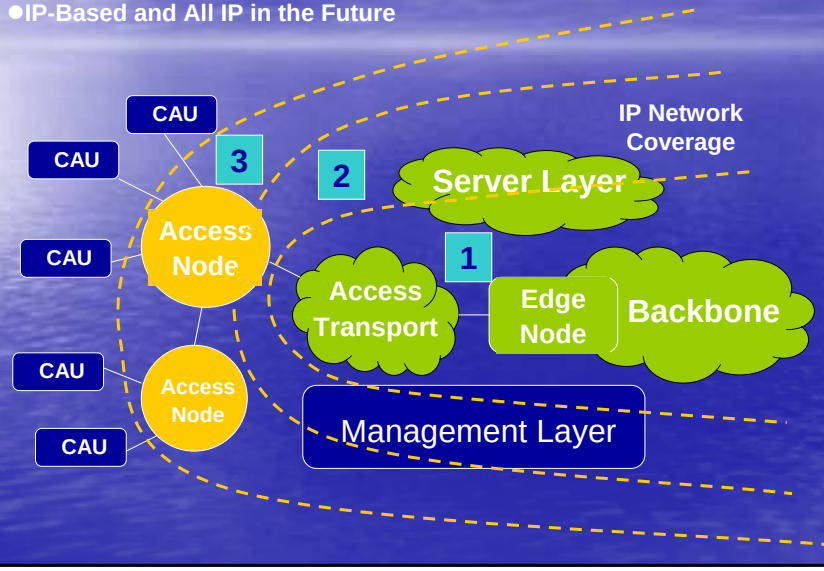
- Encapsulate TDM Signal (T1, E1, T3, E3) in IP packets
- Transparent service delivery
  - In Band Signaling id preserved and-to-end
- End-to-End Delay in minimized
  - Low latency
- Tributary clock recovery id difficult
  - Adaptive clock method
  - Differential clocking method (similar to SRTS in AAL1)

Edge Node and Local Exchange

- Local Exchange may be replaced by
  - Multiservice access nodes
  - Media gateway
  - Telephony server
- Access Servers
  - Narrowband Access Server
  - Broadband Access Server
- Voice Gateway
  - VoIP gateway, H.323 / SIP
  - VoDSL gateway, (AAL2)
- Routers

Next Generation Network

- IP-Based and All IP in the Future



Next Generation Network (NGN)

- Access Transport and Backbone Network → IP Network
- Server Layer and Edge Node → Sever, Controller, Internetwork Gateway
- Access Node → Gateway
- CAU → Intelligent Access Unit

Technologies for Access Networks

	Interfaces / Technologies	Trend	NGN
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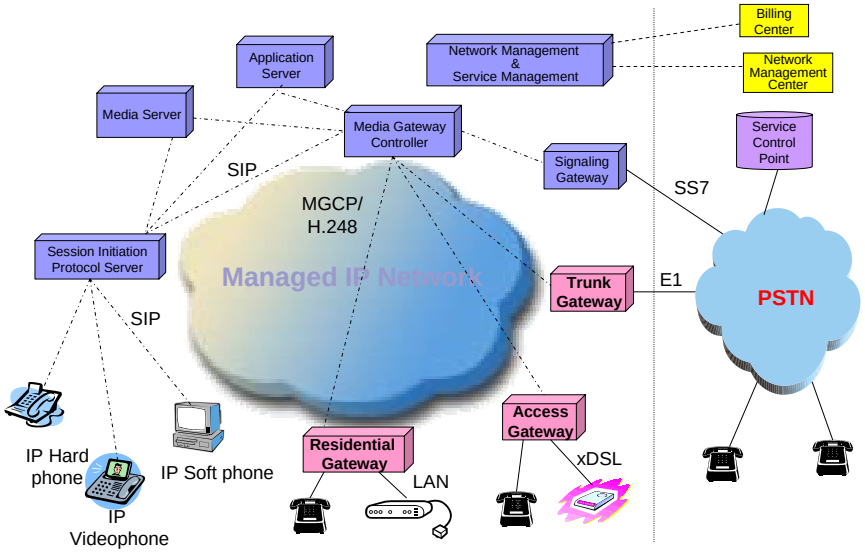
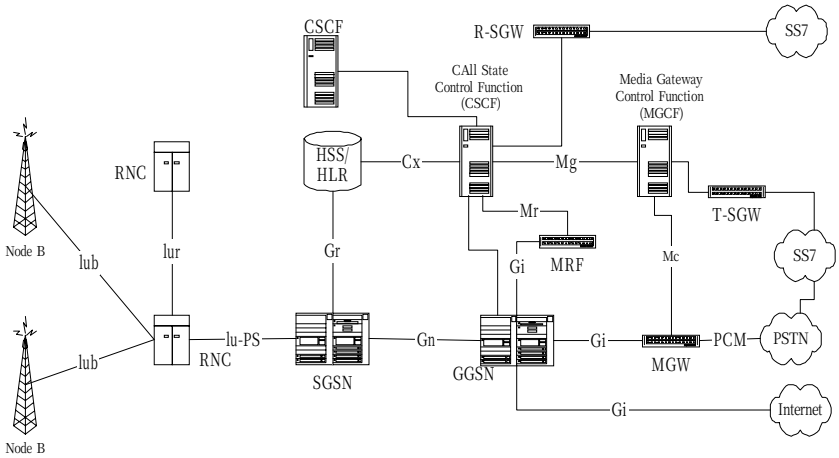
Access Transport	SDH, DWDM, PON, FTTx, Ethernet		→IP-Based Network
Edge Node	Local Exchange, V5, Access Server, Router		→Server, Controller, Internetwork Gateway

NGN Applications (VoIP-SIP Based)



3GPP Release 5 IP Multimedia Network



Conclusions

- Access Node Interfaces vary from NB to BB, to Multi services
- Access Transport can be SONET/SDH, Gb/XGb Ethernet, PON, RPR → Optical Communication Based
- An Evolution to NGN Driver is “IP”
  - Near tem convergence: TDMoIP
  - Long term convergence: All IP
- Telecom and Data Com become IP Com