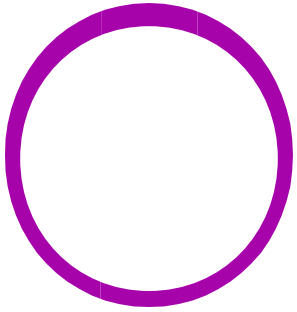


Optical Networks Infrastructure

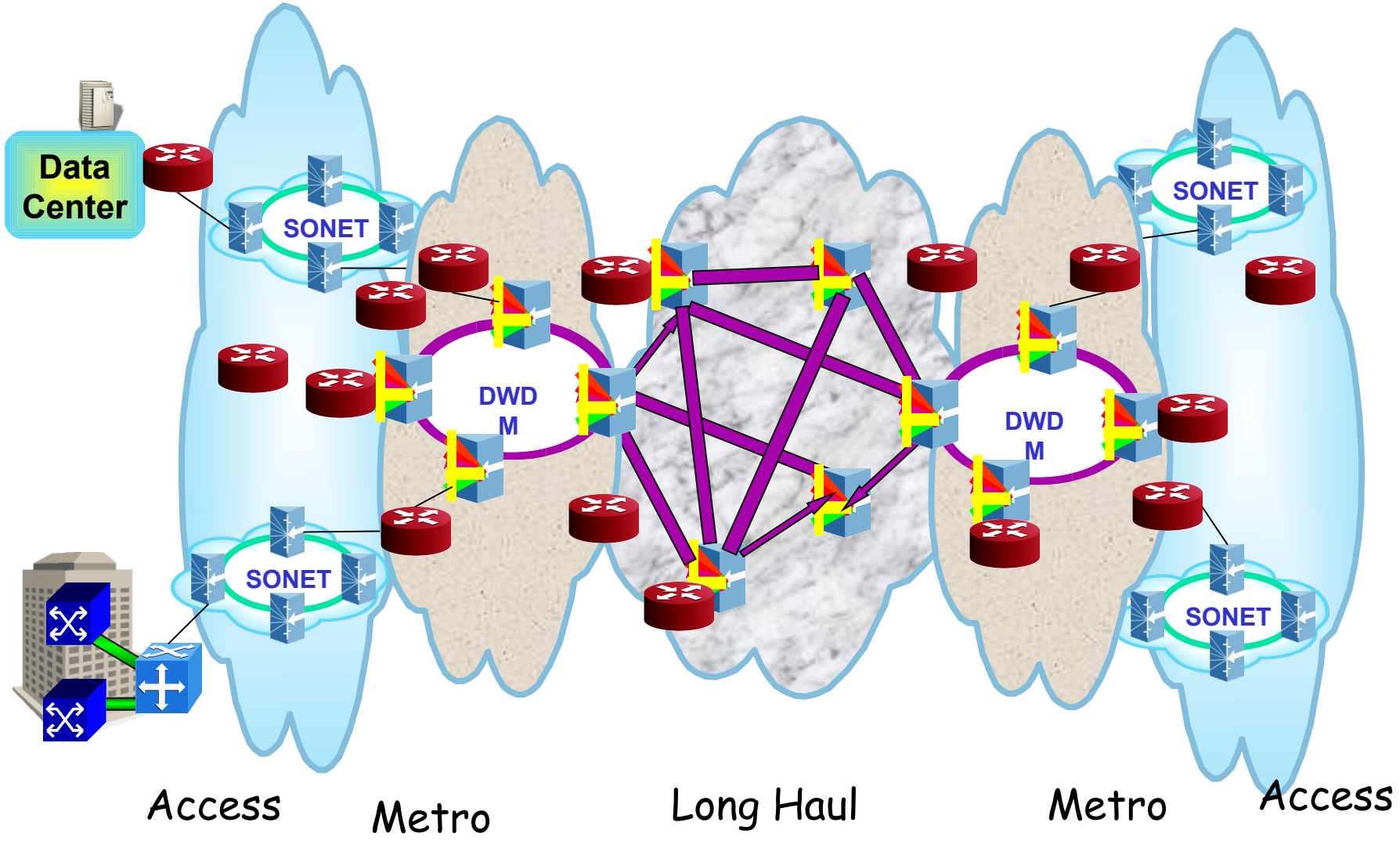
Tal Lavian

Area of interest

- Need for building new services utilizing agile optical
- What are the new services?
- Impendence mismatch
- Static Provisioning
- Carrier Hotels
- Optical Ethernet - 802.17 RPR – Resilient Packet Ring
- ASON – Automatically Switched Optical Networks
- EFM - Ethernet First Mile
- Where are the bottlenecks - it is changing
- OXC – Optical Cross Connects – long hope – move intelligence to the edge

Need for new services

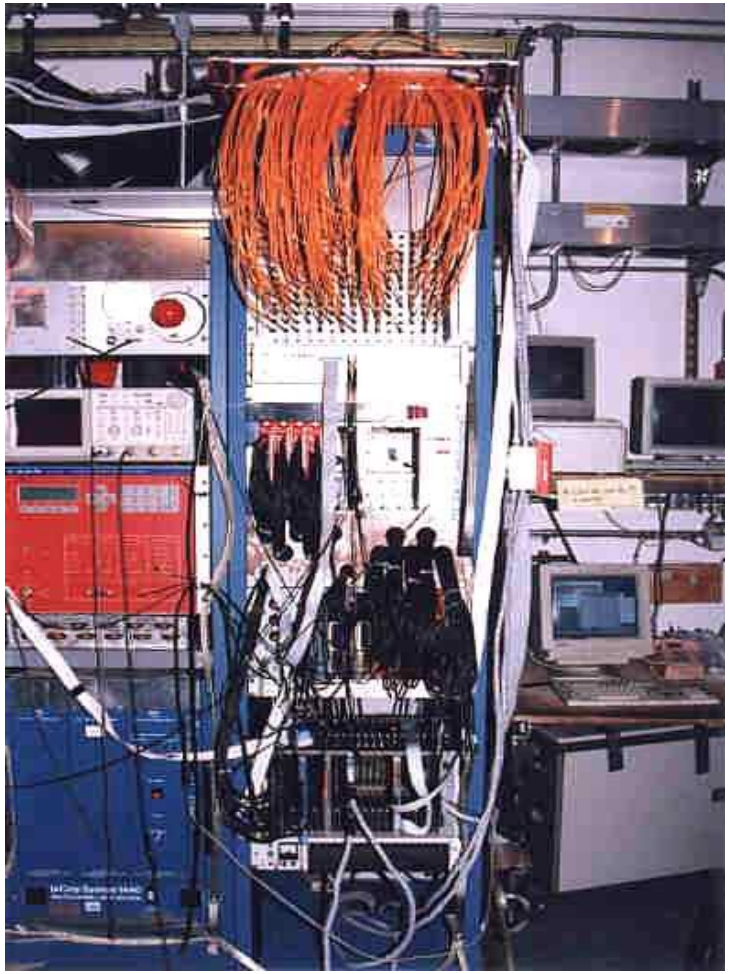
Internet Reality



Patch Panel- Manually provisioning

New services takes too long

- Manually cable connections
- It takes 4-6 months to provision a new optical connection
- Cross bounders
- Tier 1, Tier 2, Tier 3
  - Why not Tier 3 talk directly with another Tier 3?
  - Small Metro providers in LA and NY want to connect via small LH provider.
  - Why we need the big players?



Service Composition

- Service composition of light path across service provider
- Many AS each of them does not have access to the rest
- Build a light path among service providers
- Many different networks, no one can have full coverage,
- Network infrastructure is extremely expansive (Billions of Dollars), service composition save resources (I'll use your infrastructure, you'll use mine)
- Service composition to set light path between technologies (Access, Metro and Long Haul)
- Grid computing, SAN

Cooperation and Brokering_

- Service composition

Impedance Mismatch_

- Cross boundaries (Control, Management, security)
- Cross Technologies (Sonet, DWDM, ATM)
- Dross topologies (P2P, Rings all types, mesh,)
- Circlet , packets
- Speeds (1.5, 10, 51, 100, 155, 622, 1G, 2.4G, 10G…)
- Fiber, copper, wireless
- Level of media security

Business Case for Direct Peering

- Typical Internet transit costs - $1000/Mbps per month
  - For 100 Mbps Internet transit then $100,000/mo
- But coast to coast 100 Mbps channel is $1000/mo (e.g. www.Cogent.com)
  - New optical technology will reduce that cost further
- Compelling business case to do as much no-cost direct peering as possible
  - See http://www.nanog.org/mtg-0010/tree.doc
- OBGP is a proposed protocol that will allow massive direct peerings
  - Each optical switch is in effect a mini-IX to allow direct no cost peering
  - OBGP will also automate peering relationships
- Significant business opportunity for carriers who want to partner with CANARIE in building next generation optical Internet
- For example Telia claims that they save 75% in Internet transit fees with massive direct peering
- Speeds up convergence time on BGP routing
-

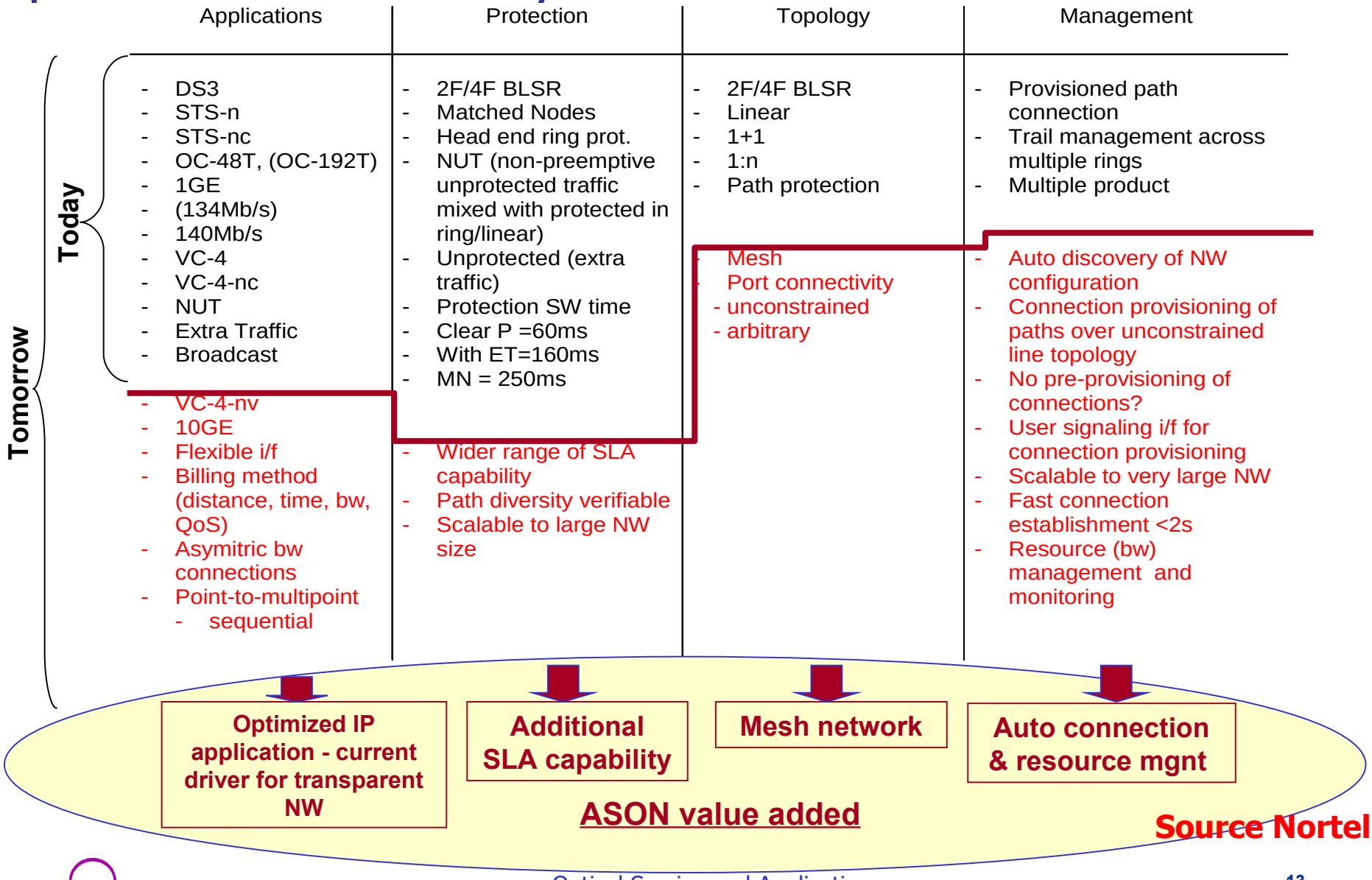
ASON – Automatically Switched Optical Networks

- Dynamically switch the light path
- Enabler for many applications
- Controlled by UNI and NNI – Allow applications to set the light path
- Allow to add the intelligence into the optical core

What is ASON?

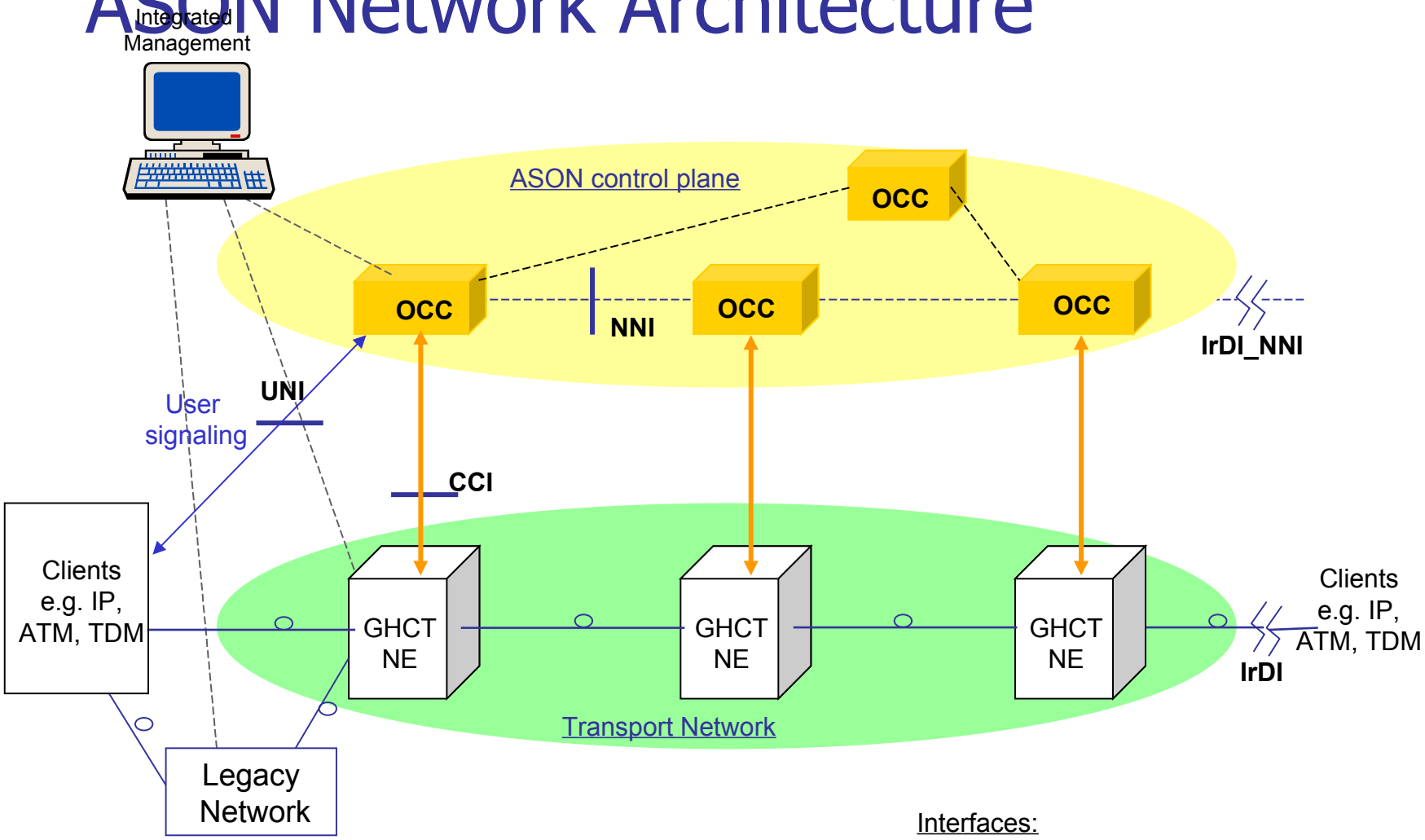
- The Automatic Switched Optical Network (ASON) is both a framework and a technology capability.
- As a framework that describes a control and management architecture for an automatic switched optical transport network.
- As a technology, it refers to routing and signalling protocols applied to an optical network which enable dynamic path setup.
- Recently changed names to Automatic Switched Transport Network (G.ASTN)

Optical Network: Today vs. Tomorrow



Source Nortel

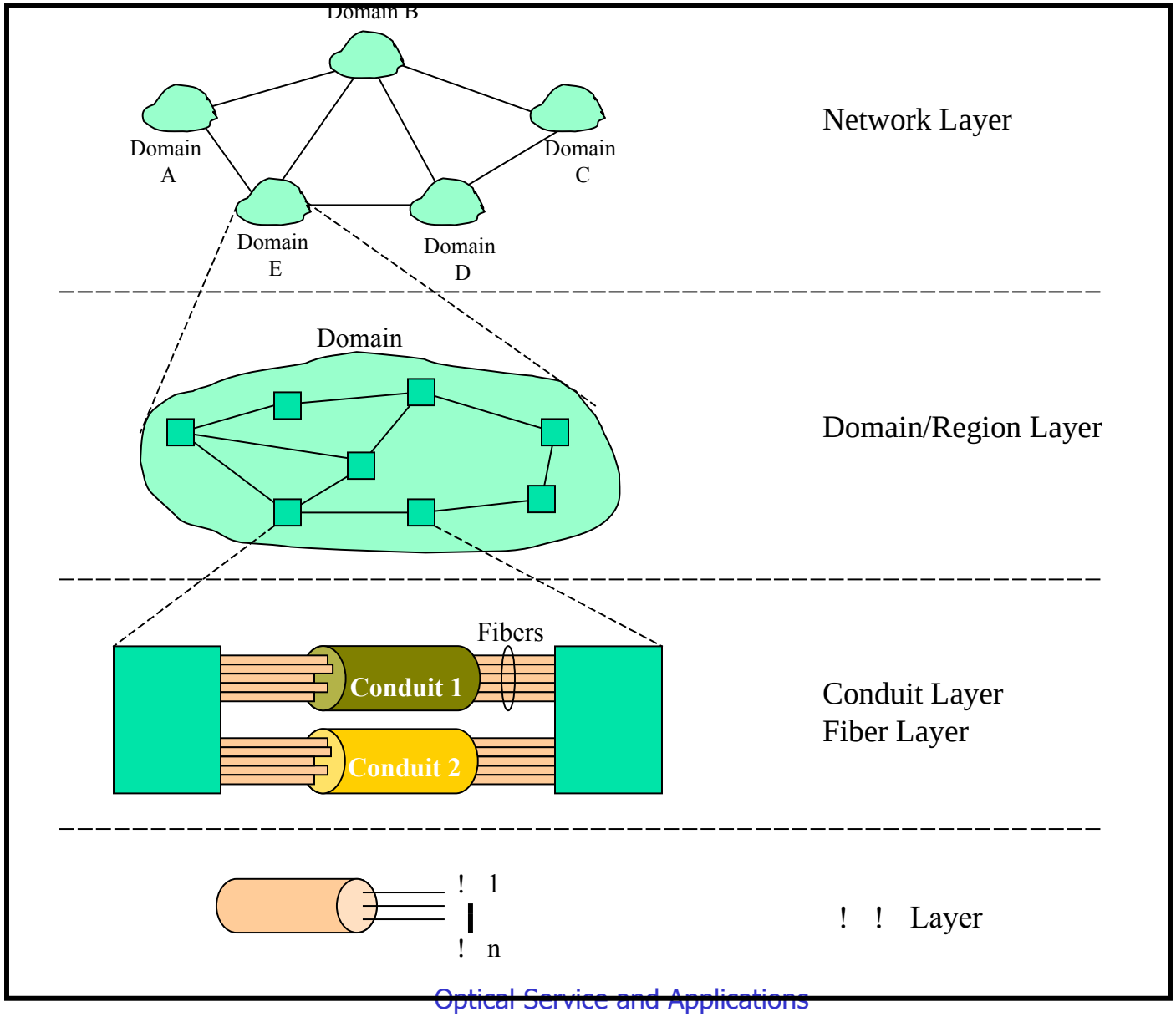
ASON Network Architecture



GHAT NE: Global High Capacity transport NE
ASON: Automatic Switched Optical Network
OCC: Optical Connection Controller
IrDI: Inter Domain Interface

Interfaces:
UNI: User Network Interface
CCI: Connection Control Interface
NNI: ASON control Node Node Interface

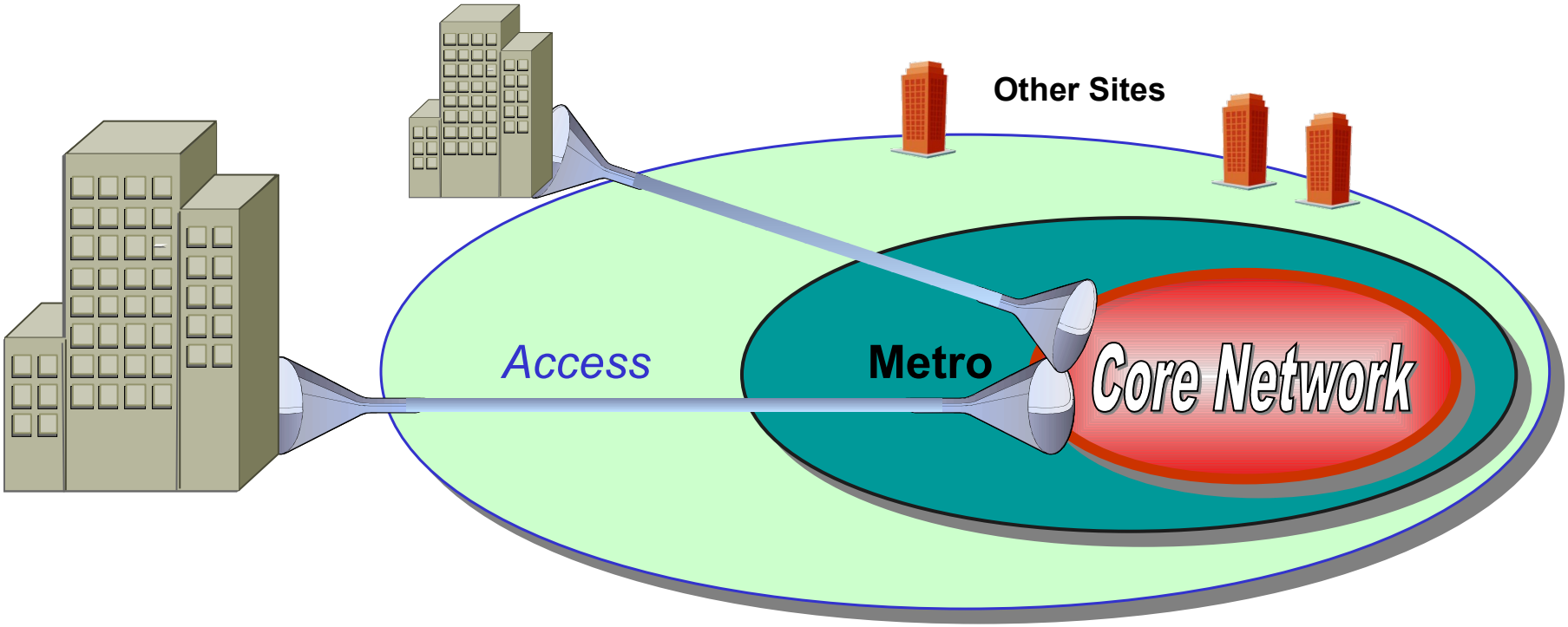
ASON Service Composition



Optical Ethernet – RPR

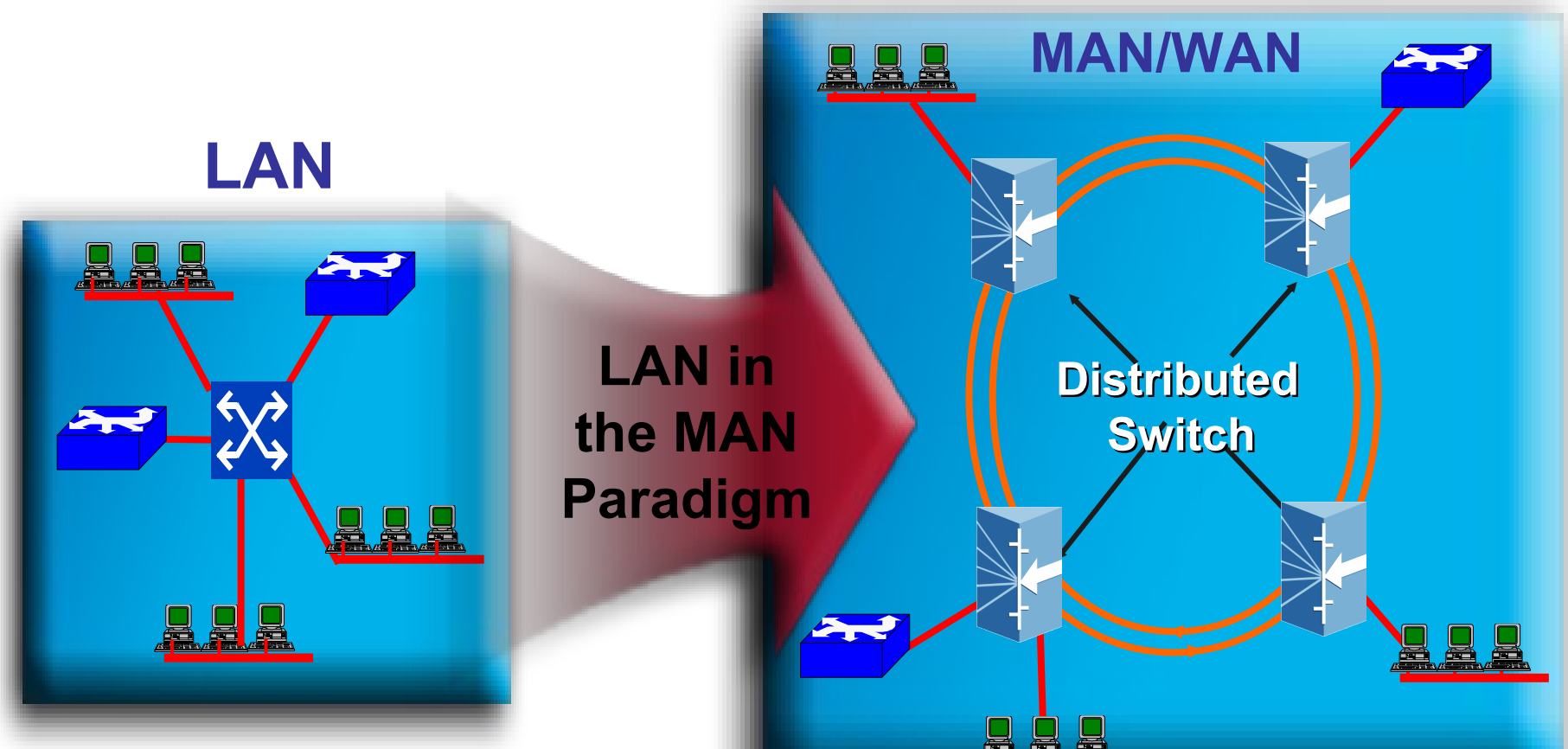
- RPR – Resilient Packet Ring – IEEE 802.17
- Ethernet over MAN (Ethernet is winning all time)
- Distributed L2 switch over MAN
  - Can have one part of the same subnet at SF, another part in SJ and SC
  - Virtual organization over MAN with NO routing.
  - Started to be deployed in the field
- Cost – much cheaper than WAN

The Metro Bottleneck



End User	Access	Metro	Core
Ethernet LAN	T1 DS1 DS3	OC-12 OC-48	OC-192 DWDM n x !
IP/DATA 1GigE	LL/FR/ATM 1-40Meg	1Gig+	10GigE+

RPR - Expanding the LAN to the MAN/WAN



- Low Cost
- Simplicity
- Universality

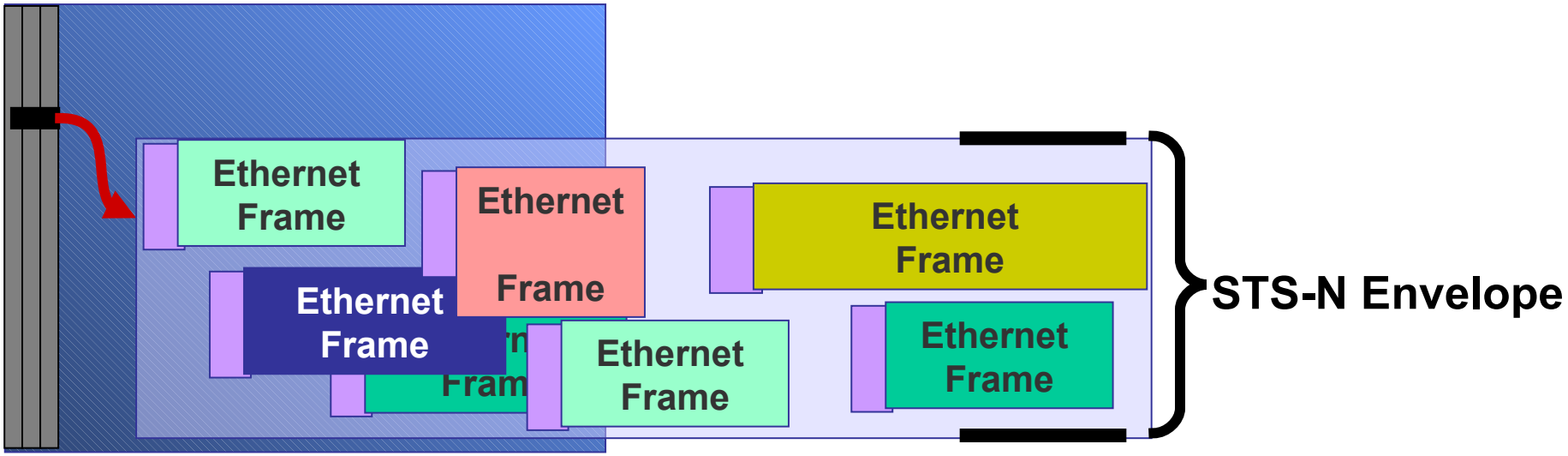
- Low Cost
- Simplicity
- Universality

+

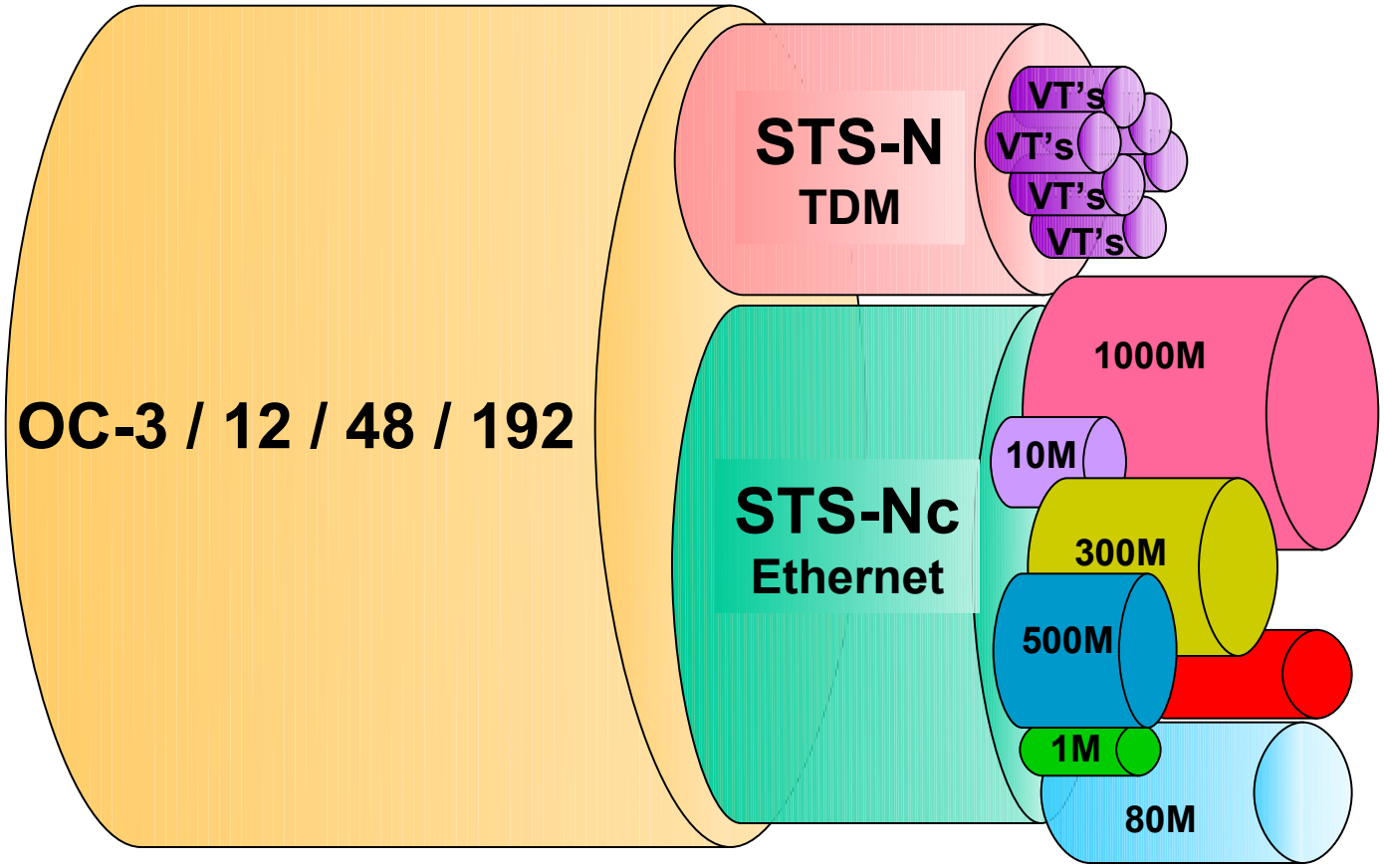
- Scalability
- Reach
- Robustness

What is RPR?

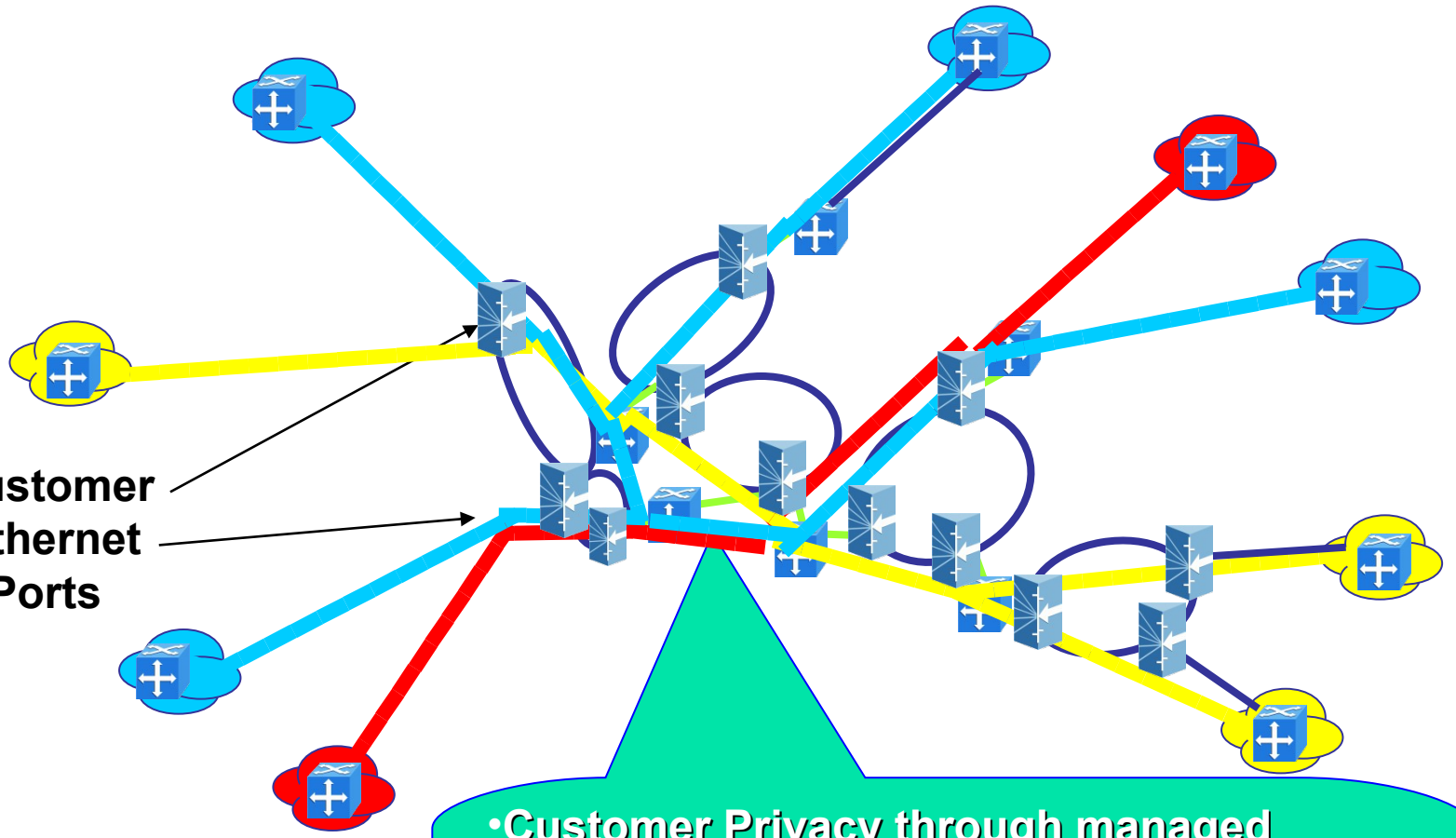
Ethernet networking on Optics (STS-Nc)



Scalable Bandwidth and Services



Network & Customer Management



- Customer Privacy through managed Virtual LANs (802.1Q tags)
- Customer Agreements through flow attributes (802.1p prioritized queues and traffic policing)

Streaming media as bandwidth driver_

- Streaming needs big pipes – 2-3 orders or magnitudes more than web surfing.
  - Speed of 3Mbs is about 1GB per hour
- Constant traffic (can be turn on for hours with no one watching)
- Web looks like a big traffic driver on the edge – but it is small traffic on the core.
  - One hour web, 10 second a page, 360 pages, 10KB page → 3.6MB

EFM –Ethernet First Mile

- Ethernet at the first mile start to be attractive.
- Drive more bandwidth to the end users
- Three proposals :
  - 22Mbs on the current phone line
  - PON –Passive Optical Network – split the optical link to 4 and additional 8 total 32 customers (60Mbs per residence)
  - Point-to-point optical – more expansive
- SBC and alike are interested.

- The tight of way is the main issue. Optical fibers work fine in harsh environment
  - Sewer net, Power line, Gas line, water line.

Where are the bottlenecks

- Optical networking is evolving
  - Much more bandwidth
  - Agile reconfiguring of light path
- As soon as one problem is solved, the bottleneck is moving to a new place
- Currently it looks like the bottleneck is at the first mile
- Streaming media - bottleneck push on routers
- Much more bandwidth in the MAN move the bottlenecks away from the access and the edge
- Peering points between service provides

OXC – Optical Cross Connect

- Optical cross connects – less need for core routing
  - Fat pipes replace core routers with NO delay
- It looks more like circuit switching instead of packet switching (ouhh)
- MPLS, MP! S, LDP – Label Distribution Protocol – room for binding it to services on the edge.

- UNI - User Network Interface , - allow the end machines and edge to send service request to the core
- NNI – Network Network Interface, - control of the core (if the core agree to provide the service, might say no)

Backup Slides

Major Data Transport Solutions

Packet Switch

- data-optimized
  - Ethernet
  - TCP/IP
- Network use
  - LAN
- Advantages
  - Simple
  - Low cost
- Disadvantages
  - unreliable

Circuit Switch

- Voice-oriented
  - SONET
  - ATM
- Network uses
  - Metro and Core
- Advantages
  - Reliable
- Disadvantages
  - Complicate
  - High cost

Optical BGP Networks

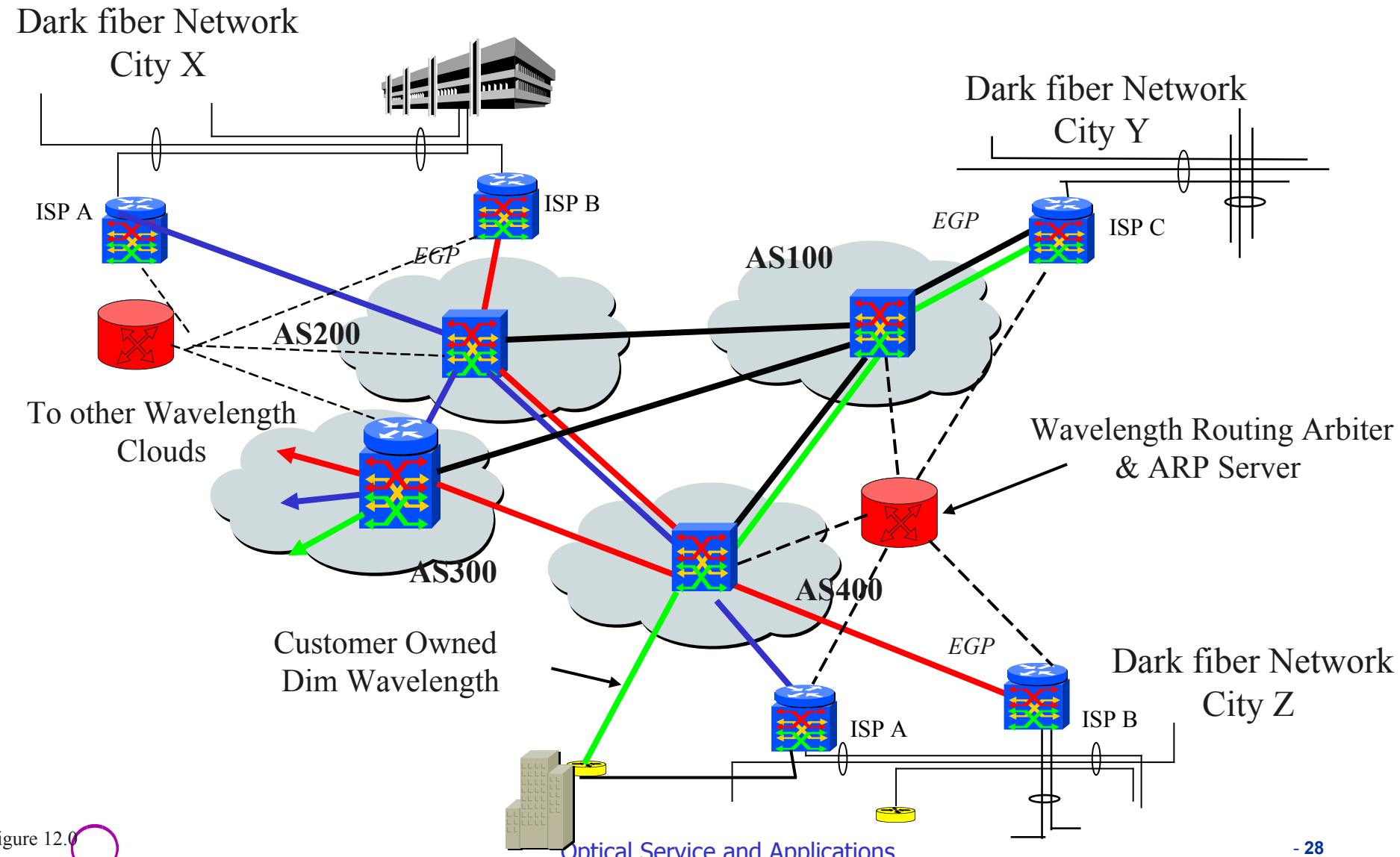


Figure 12.0