

IP Transport over SONET

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Ethernet &
DS1/DS3 IP
Transport over
SONET

Media Mix

- In order of development
 - Copper
 - Atmospheric
 - Fiber Optic

Copper + Microwave Based Media

- DS-X speed data communication
 - DS0 64 kbps
 - DS1 1.544 kbps
 - DS3 44.736 Mbps
 - DS4 274.176 Mbps
- Based on needs of a PCM encoded voice data telephone system

New Media / New Techniques

- Data based system
- High bandwidth availability
- Fast switching capabilities

SONET (Synchronous Optical Network)

- An ANSI Standard for synchronous data transmission on optical media.
- U.S. analog of international standard SDH, Synchronous Digital Hierarchy.
- Operates digital transmissions at base rate, and base rate multiples.

Optical Carrier Levels

- Begins at a base rate of 51.84 Mbps: OC-1.
- Operates digital transmissions at base rate, and base rate multiples. E.g.
 - OC-2 at 103.68 Mbps
 - OC-3 at 155.52 Mbps
 - OC-192 at 9.95 Gbps

SONET contents

- SONET may “provision” a variety of traffic contents including
 - Asynchronous transfer mode (ATM) packets.
 - IP packets (Packets over Sonet: POS).
 - Time Division Multiplexing (TDM)
 - Video
 - Frame relay

ATM and SONET

Pure ATM SONET Rings

- All services share statistically mux'd bandwidth via fixed sized cells
- ATM QoS controls allocation & usage
- Protection via ATM protocols



Voice Data Video

TDM SONET

Pure TDM SONET Rings

- Every subscriber gets dedicated circuit, stranding bandwidth
- Protection via SONET APS (50ms recovery)

Voice

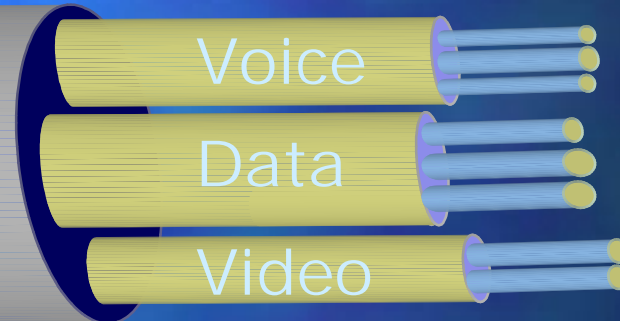
DS1
OCn
DS3

Data

Leased line
ATM VPs
IP Router links

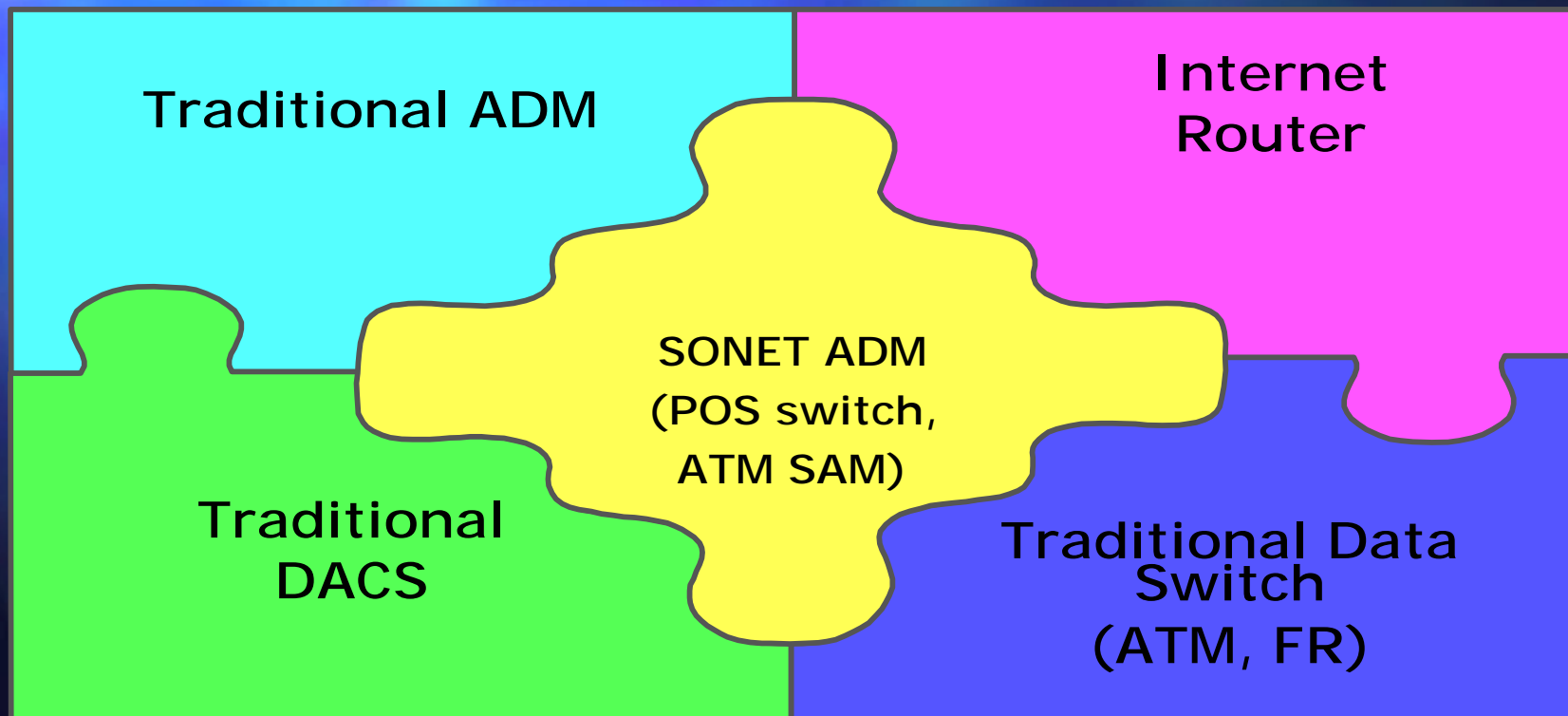
Video

DS3
DS3



New Class of SONET Device

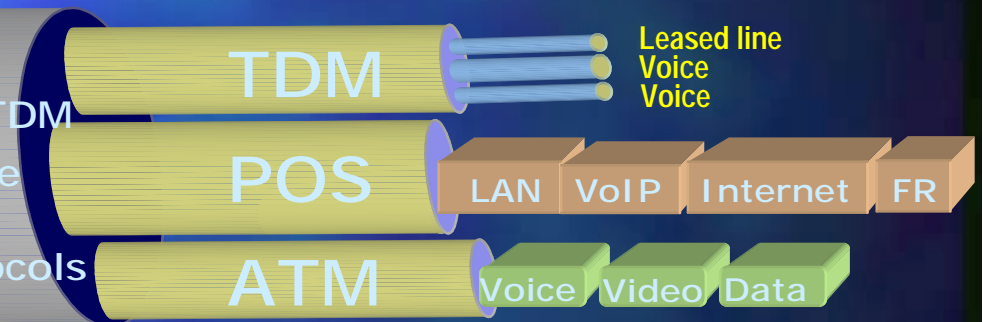
A highly integrated, Multi-function Transport Platform

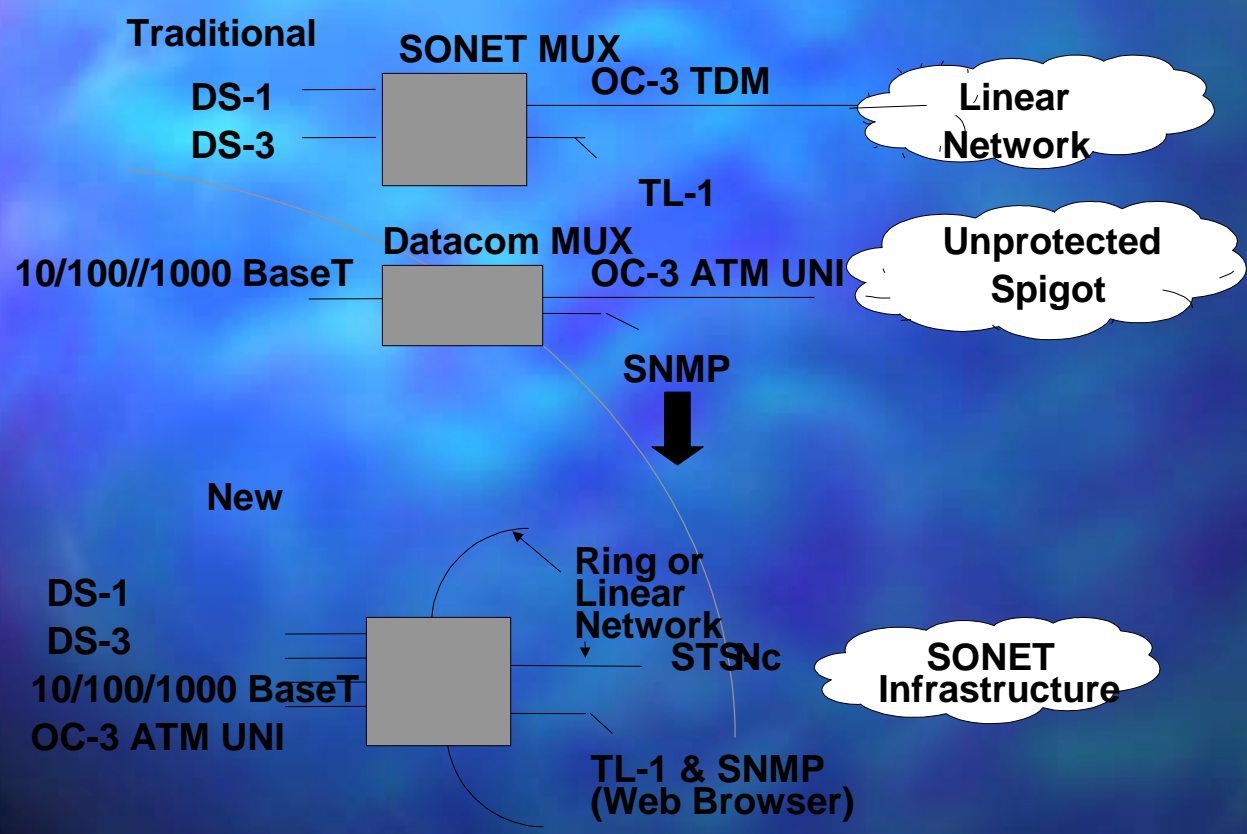


New Methods of Voice & Data over SONET - Hybrid

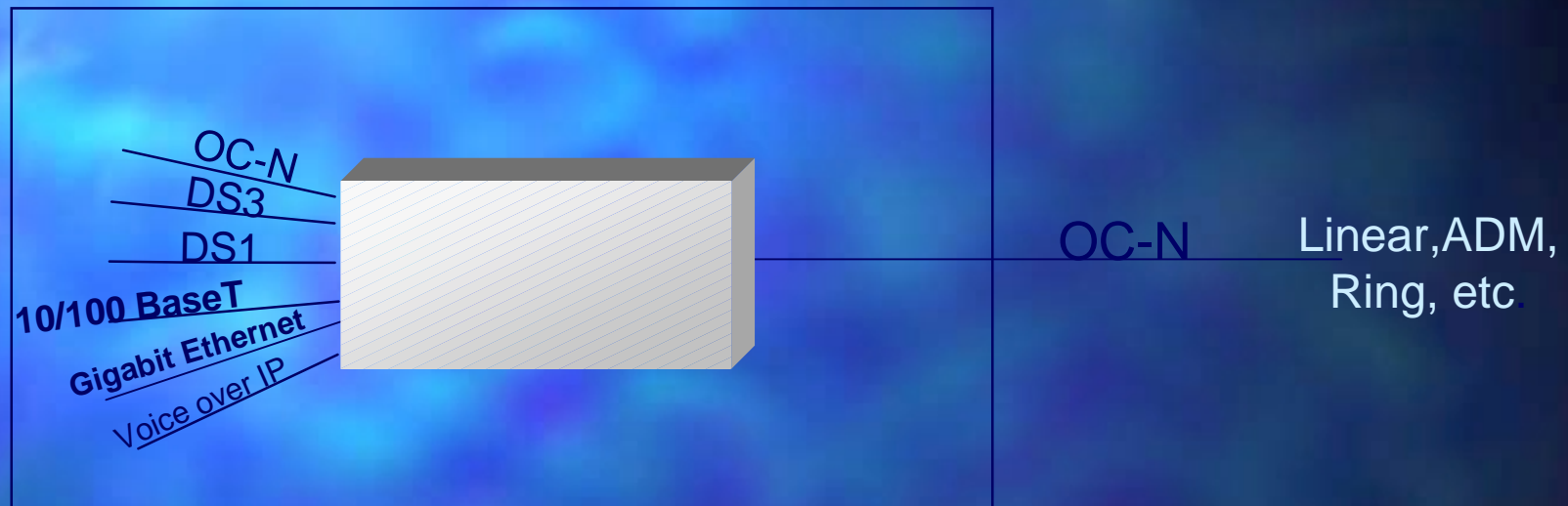
Hybrid SONET Rings

- Services get dedicated bandwidth via TDM
- Statistically muxing used within service bandwidth for efficiency
- Protection - SONET APS and data protocols



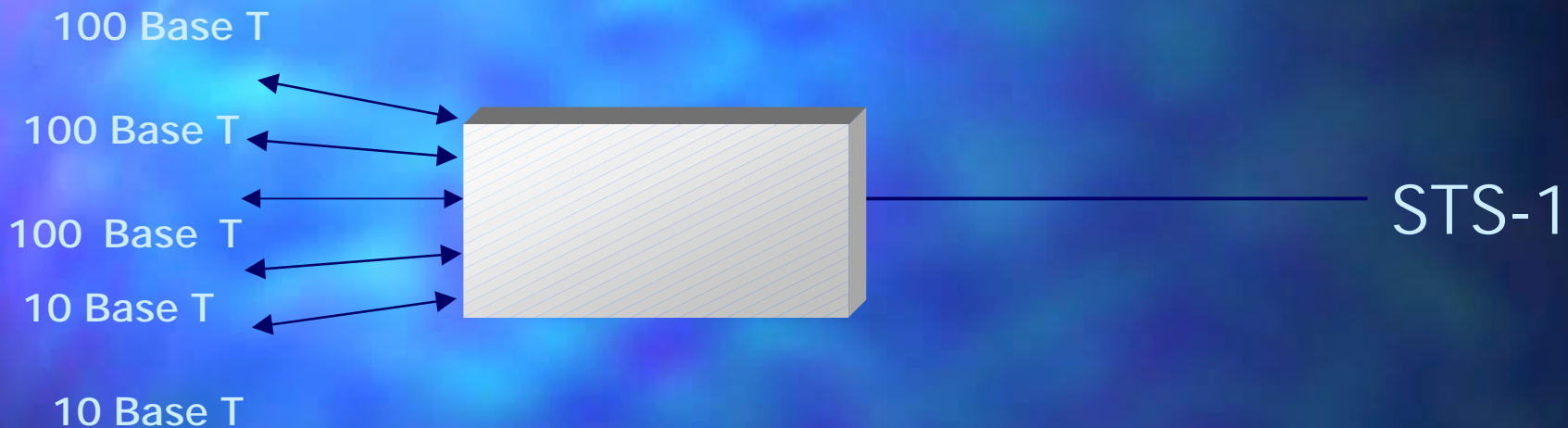


Access Multiplexer Application



- Deliver private lines, LAN, video and switched services
- Consolidate traffic into SONET pipe
- Use linear, add/drop, and ring configurations to connect nodes

Concentration - Transmission Perspective



- Flows are aggregated into one or more STS-1
- Example shows 320 Mb/s concentrated to 50Mb/s
- Concentration of IP, ATM, and Frame Relay

Use of Hybrid SONENT

- Reduces ancillary equipment costs
- Gathers diverse data elements into SONENT's fault tolerant environment

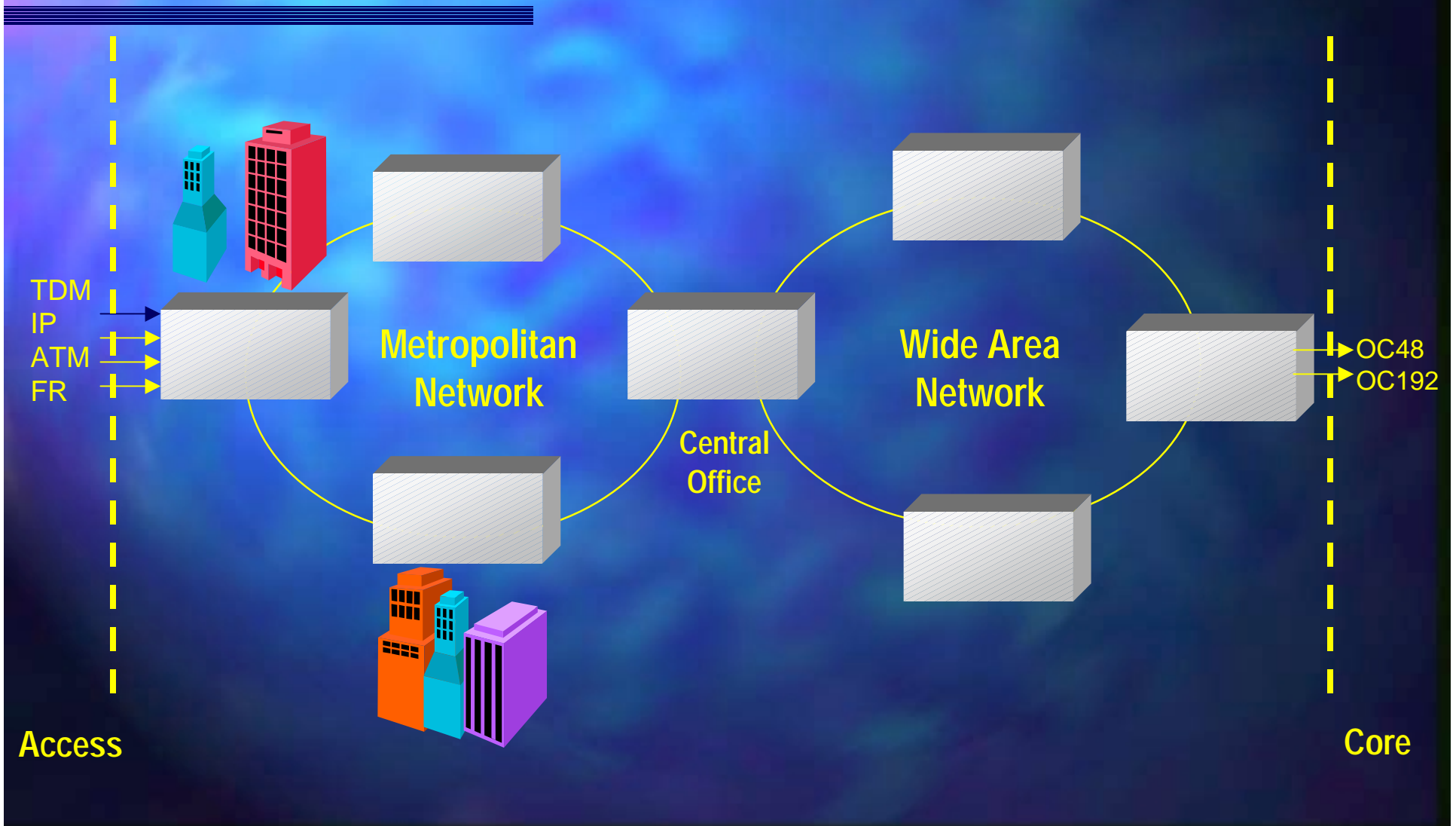
SONET Fault Tolerant

- Topology
- Multiple pairs of transmit and receive fibers
- Self healing feature

Markets

- ✓ ■ Competitive Carriers
 - ✓ – CLEC / ICP
 - ✓ – Regional IXC
 - ✓ – Cable TV
 - ✓ – Utilities
- Incumbent LECs
- National Carriers
- RBOCs
- International

SONET Transport



System Capabilities

- SONET/SDH Transport
- Digital Cross-Connect (VT and STS)
- High Speed Data Access, Concentration and Switching.

Features of Hybrid SONET TDM Interfaces

- Optical Interfaces
 - OC-192, OC-48, OC-12, OC-3
- Electrical Interfaces
 - DS1, DS3, STS-1, E1

Hybrid SONET features

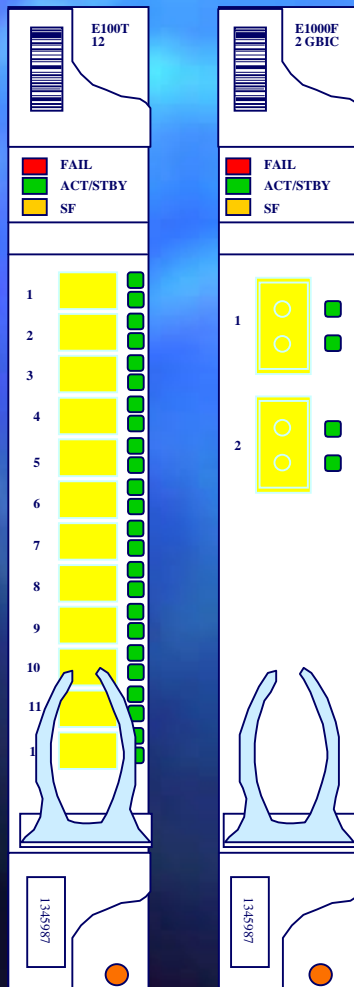
High Speed Data Interfaces

- Data Interfaces
 - 10/100/1000 Ethernet
 - OC3, OC12, OC48 Packet Over SONET
 - DS1, DS3, OC3, OC12 ATM UNI
 - DS1, DS3 Frame Relay

Packet over SONET

- Supports native transmission of IP traffic
- Eliminates interim ATM steps of IP encapsulation (incl.. ATM "cell tax")
- Eliminates ATM switches and ADMs

Sample SONET Interface Card Capability



- 12 port 10/100 Ethernet
 - Auto-sensing 10/100Mb
 - 10BaseT/100BaseT copper
- 2 port Gigabit Ethernet
 - 1000Base-SX, 1000Base-CX
- Full Ethernet switching via IEEE802.1D

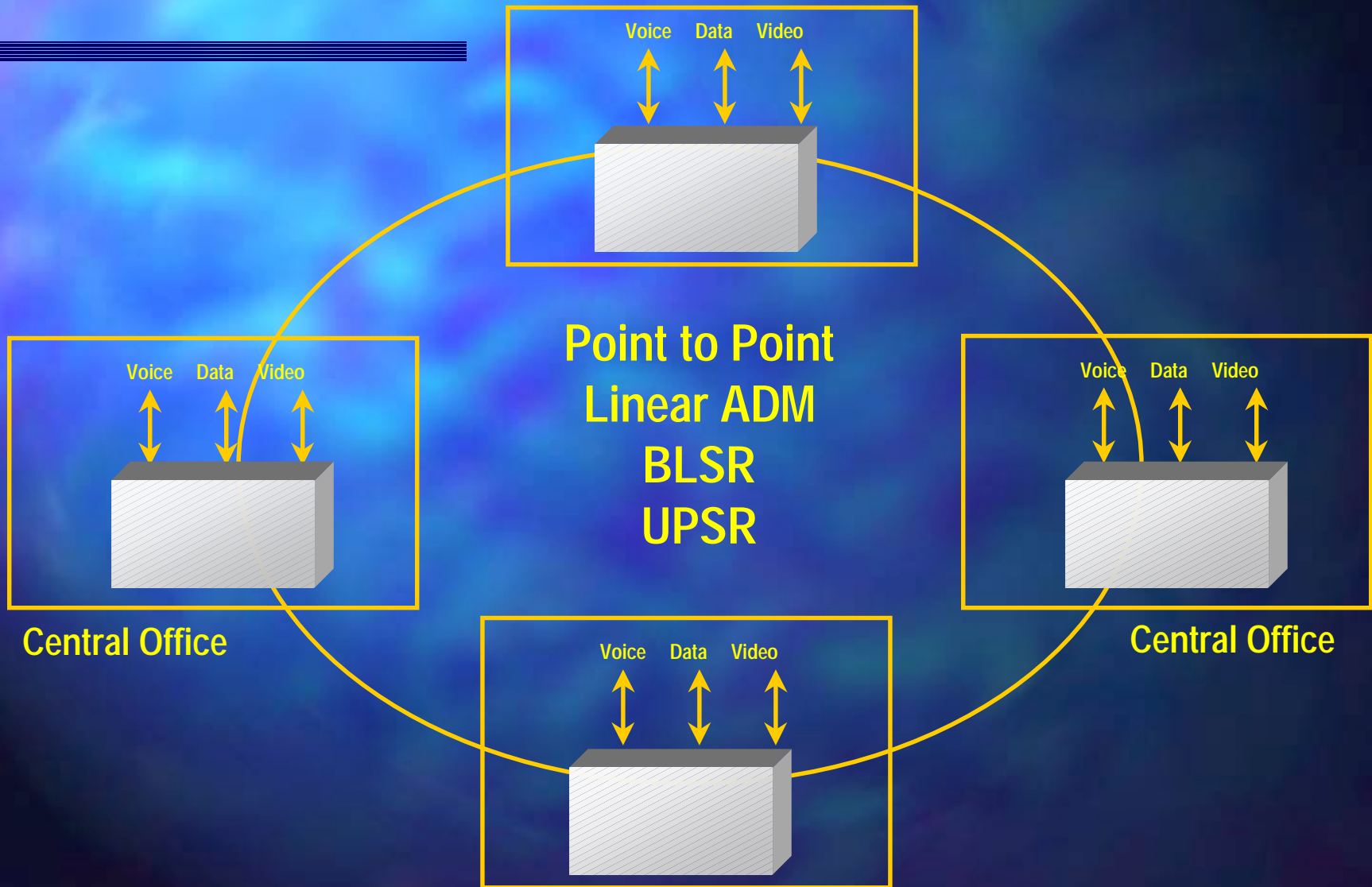
Ethernet Over SONET Value Set

- Cards enable Operators to provide multiple 10/100/1000 Mb/s access
 - Customer LAN Interconnects (TLS)
 - Internet traffic
 - Cable modem traffic
- Mitigates need for external aggregation equipment (e.g. Routers, Ethernet switches, etc.)
- Coexists with traditional TDM traffic (e.g. DS-1)
- Supports Copper and Fiber interface options
- Maximizes use of fiber plant and available STS bandwidth

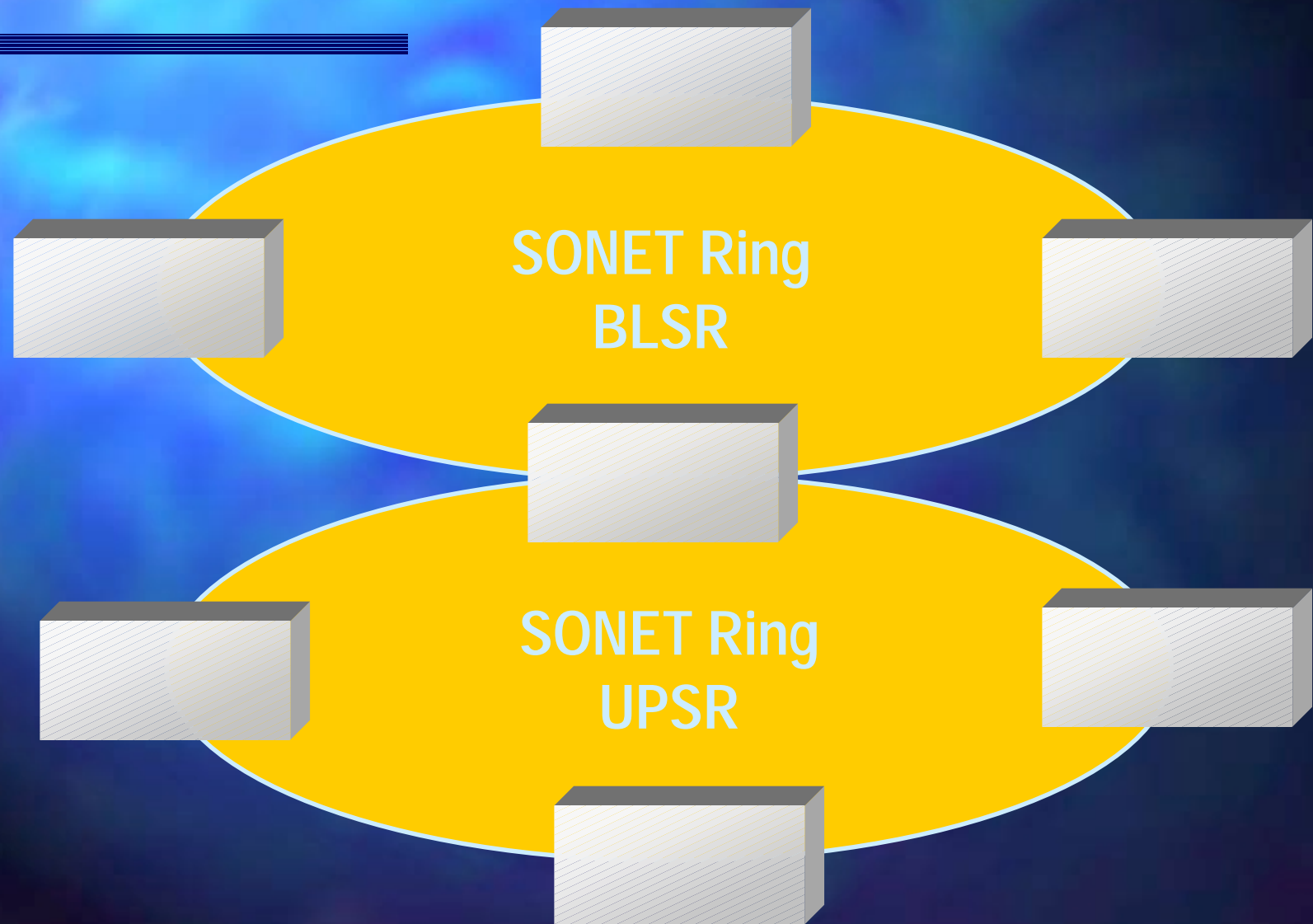


Applications

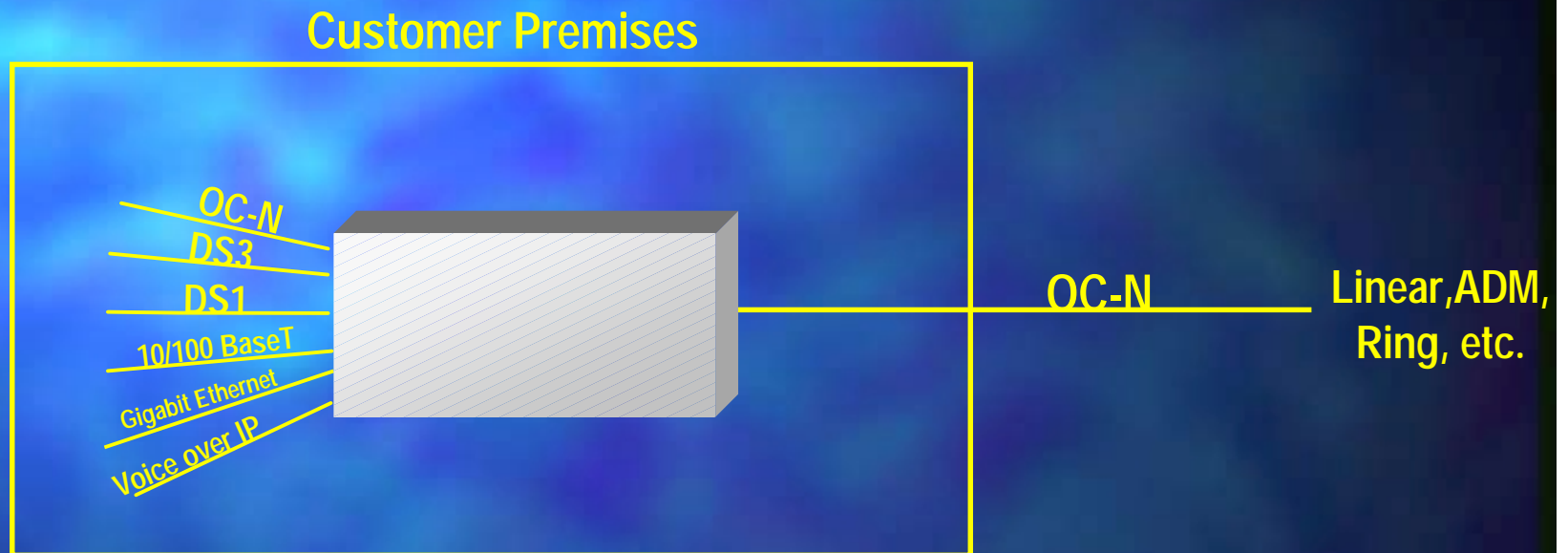
Backbone Transport



Sub-Network Interconnection

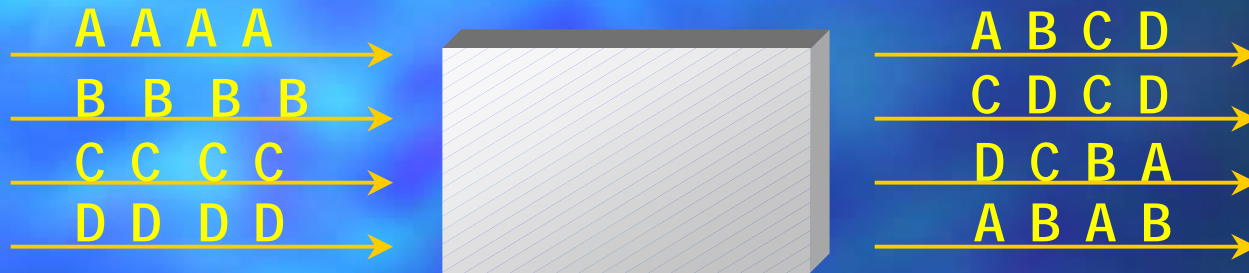


Scalable Access Multiplexer



- Deliver private lines, LAN, video and switched services
- Consolidate traffic into SONET pipe
- High speed data aggregation to maximize revenue of Sonet ring

Digital Cross-Connect



- **STS Cross-connect Matrix**

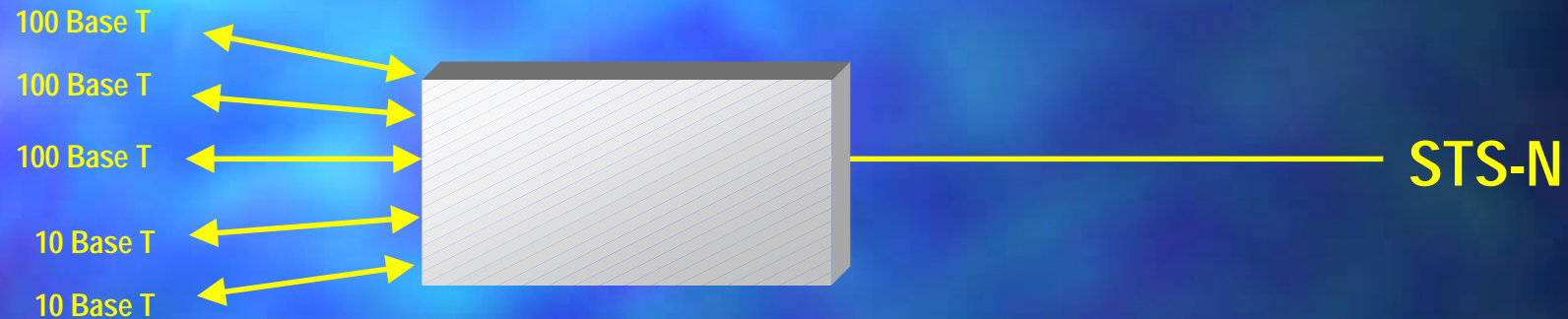
 - 288 STS1 Capacity

- **VT1.5 Cross-connect**

 - 336 VT1.5 Capacity

- **Grooming and consolidation of traffic**

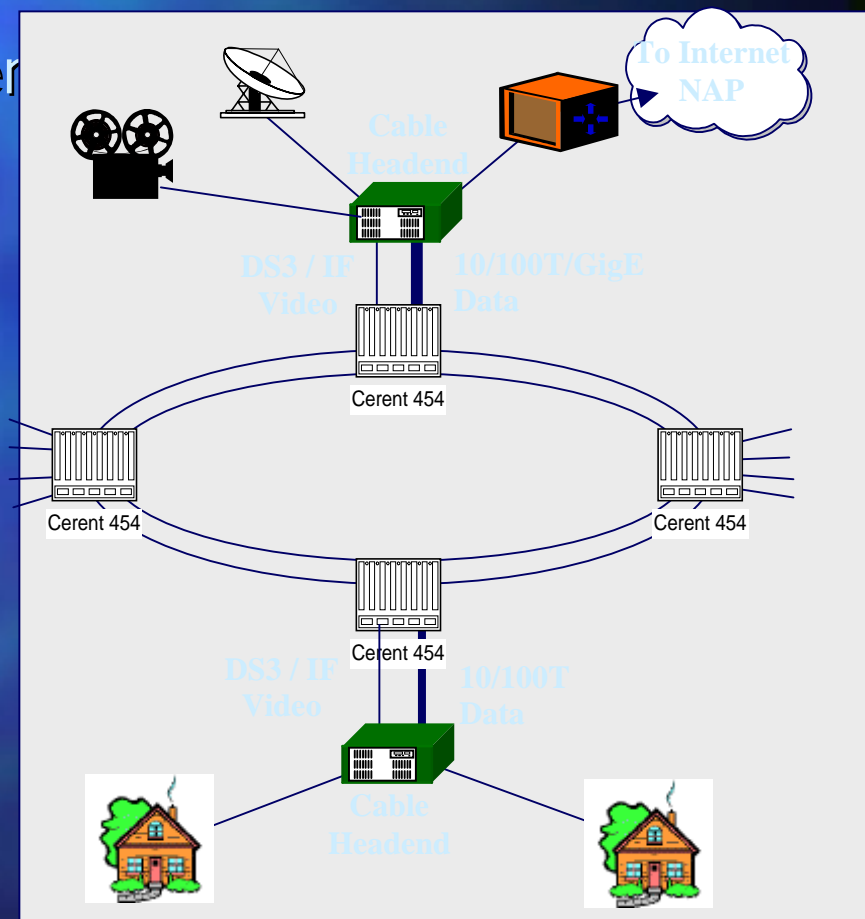
Ethernet Aggregation



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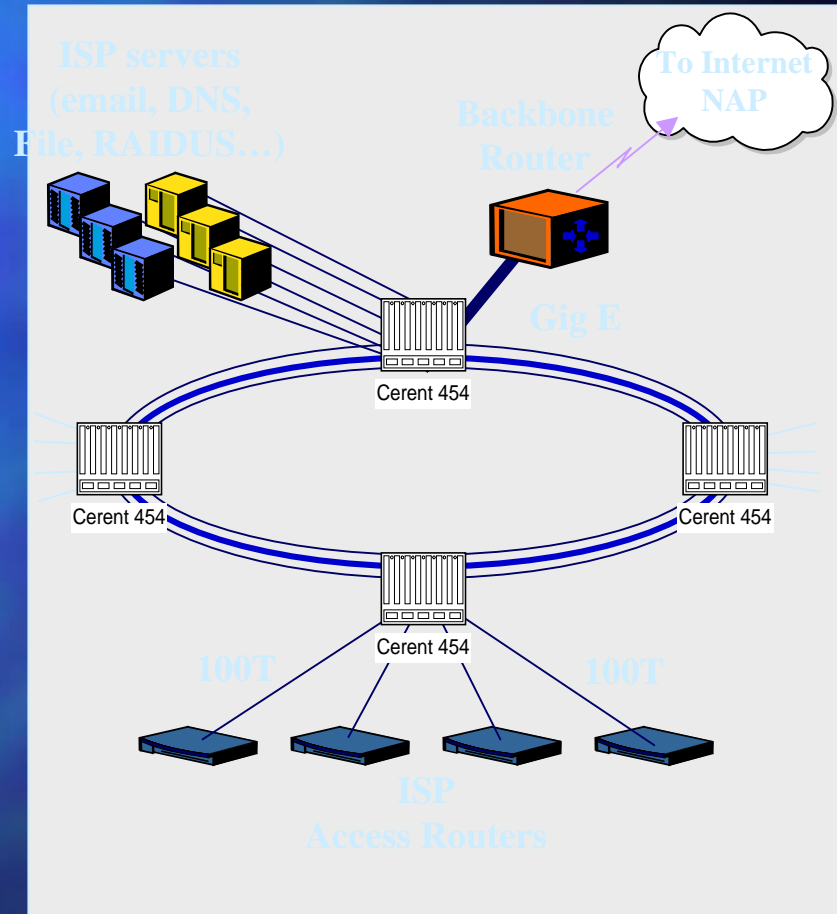
Cable Modem Backbone

- Traffic Characteristics
 - Shared 10Mbps per subscriber
 - Shared Ring is ideal data topology
 - Hairpinning is common
- Features/Benefits
 - Bandwidth per loop can be engineered/guaranteed
 - No need for remote routers



Internet Backbone

- Traffic characteristics
 - Mostly homing pattern
 - Some local & hairpinning
 - Local server attachment at CO
- Benefits
 - Efficient bandwidth use
 - Reduces need for backbone routers in POPs
 - Eliminates need for separate data center Ethernet switch in CO



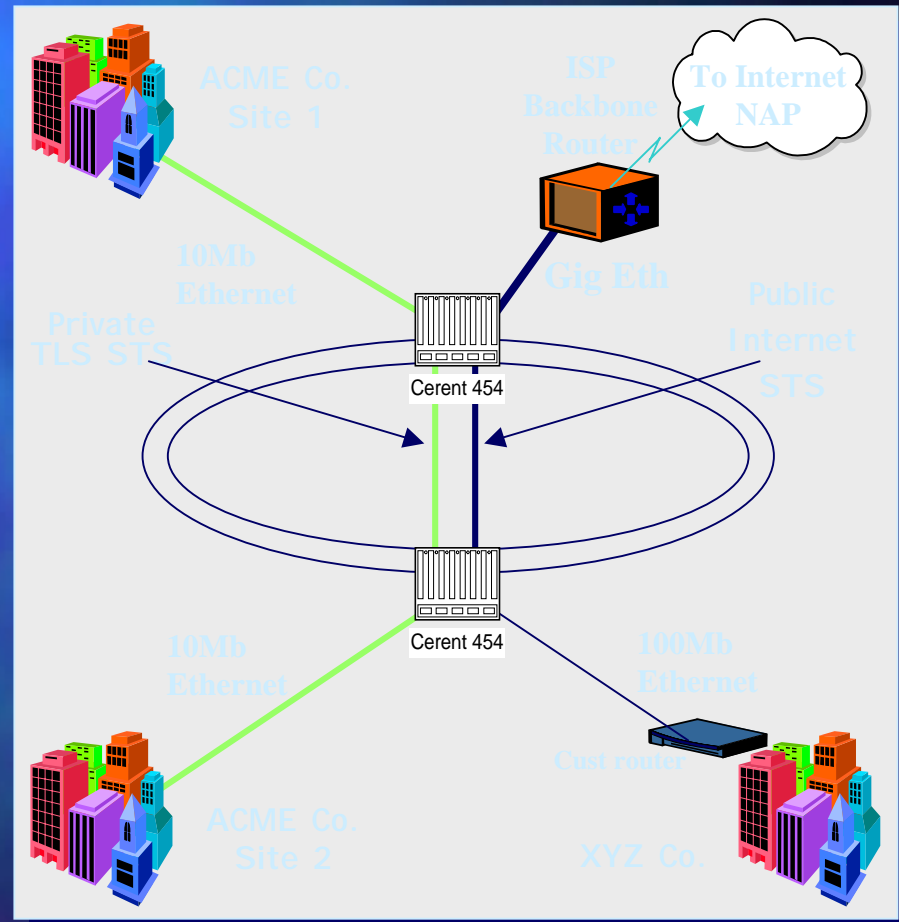
Transparent LAN Service Backbone

■ TLS Features

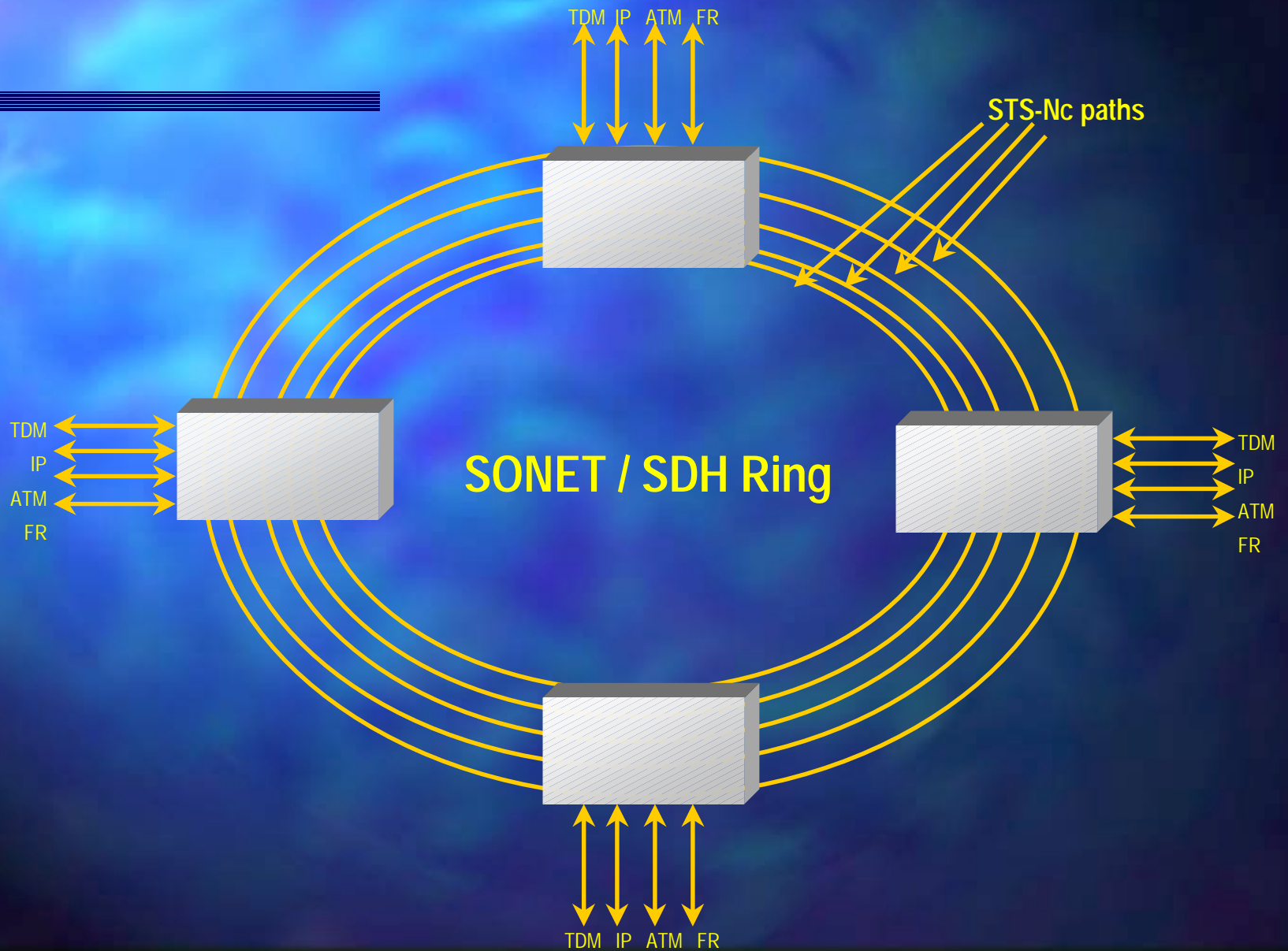
- Supports private networks and Internet Access.
- Provides CIR-style bandwidth guarantees.
- Use shared STS for subscribers
- Priority can be applied to separate STS for premium service

■ Benefits

- Efficient use of bandwidth
- Shared bandwidth with SLA capability



Signal Management



The background is a dark, abstract gradient of blue and purple. A horizontal line consisting of several thin, parallel lines is positioned in the upper left quadrant. The word "Economics" is centered in the lower half of the image.

Economics

Economics of Hybrid SONET

- Low First Cost
- Efficient Bandwidth Utilization
- Life Cost Savings
 - Plug and play architecture
 - Scalable transport
 - High density interfaces

Summary

- Scalable Transport Interfaces
 - OC3 to OC192
- High Speed Data Access and Switching
 - IP, ATM, and Frame Relay
- Efficient Use of Bandwidth
 - Statistical Multiplexing