

Converged Architecture for Broadband Services

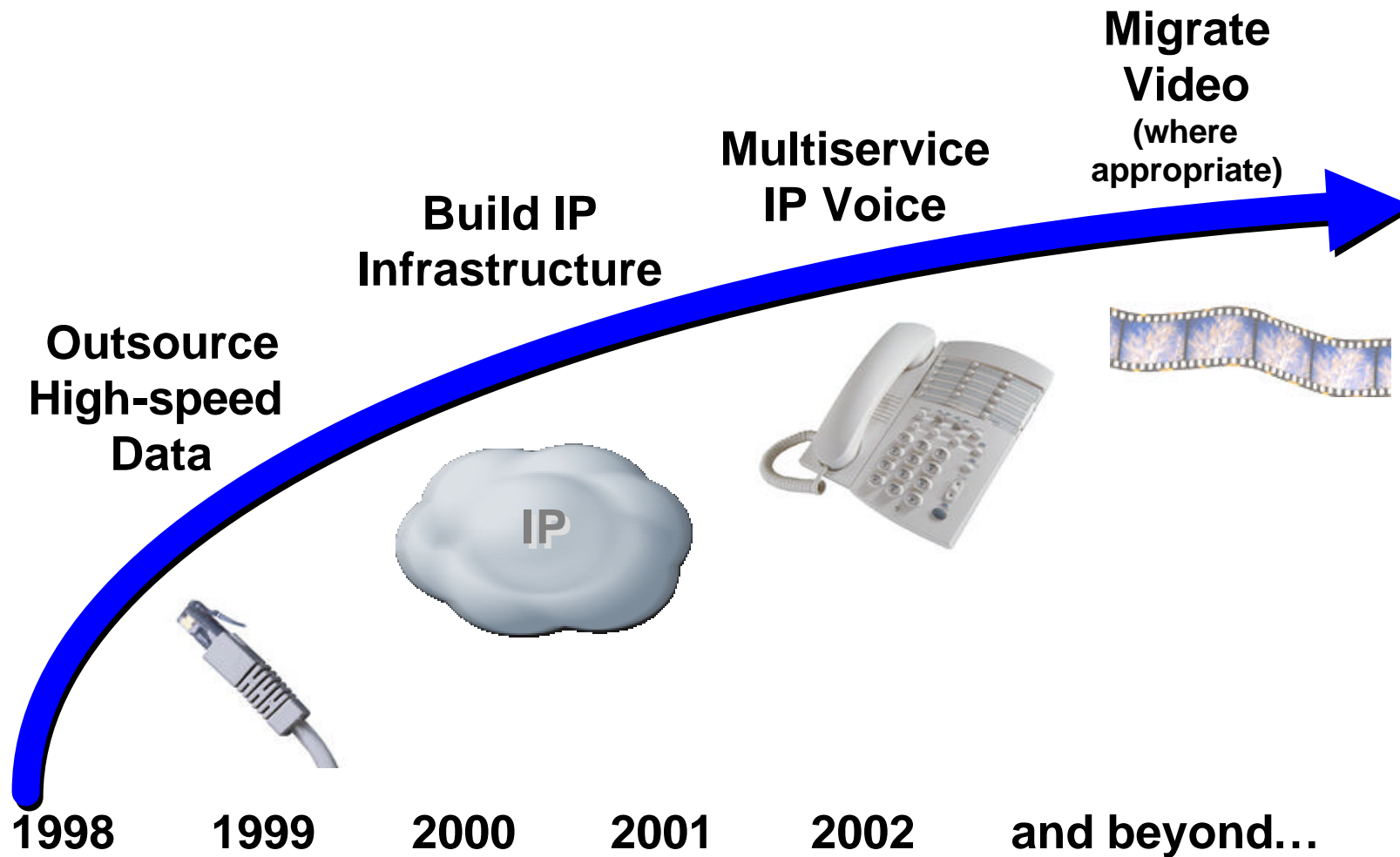
Steve Lee
Manager – Broadband Network Engineering

Cable Multiservice Architecture
Cisco Systems, Inc.
April 2002

Evolution of Broadband IP Services

IP/Packet Services Increasingly Key in Cable's Future

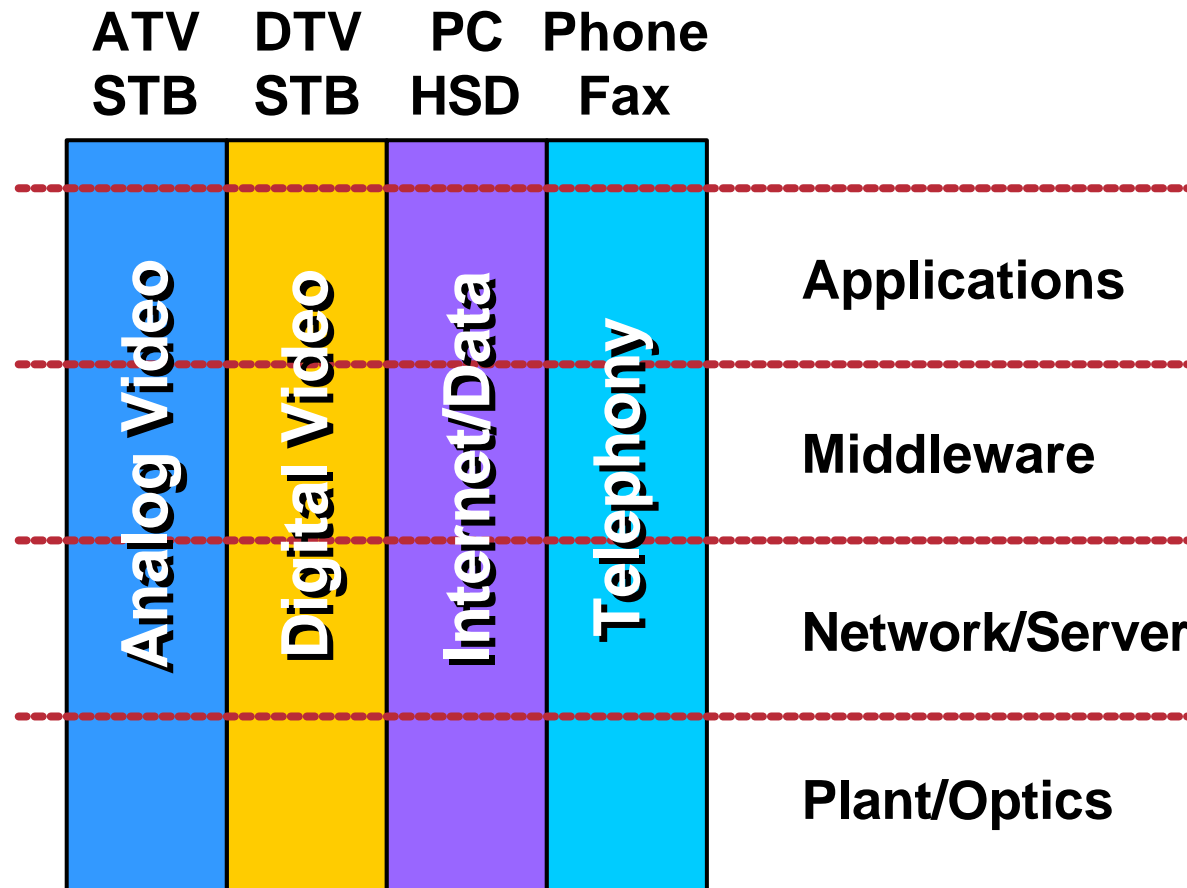
Cisco.com



Today's Broadband Architectural Challenge

Building Four Parallel Networks for Four Services

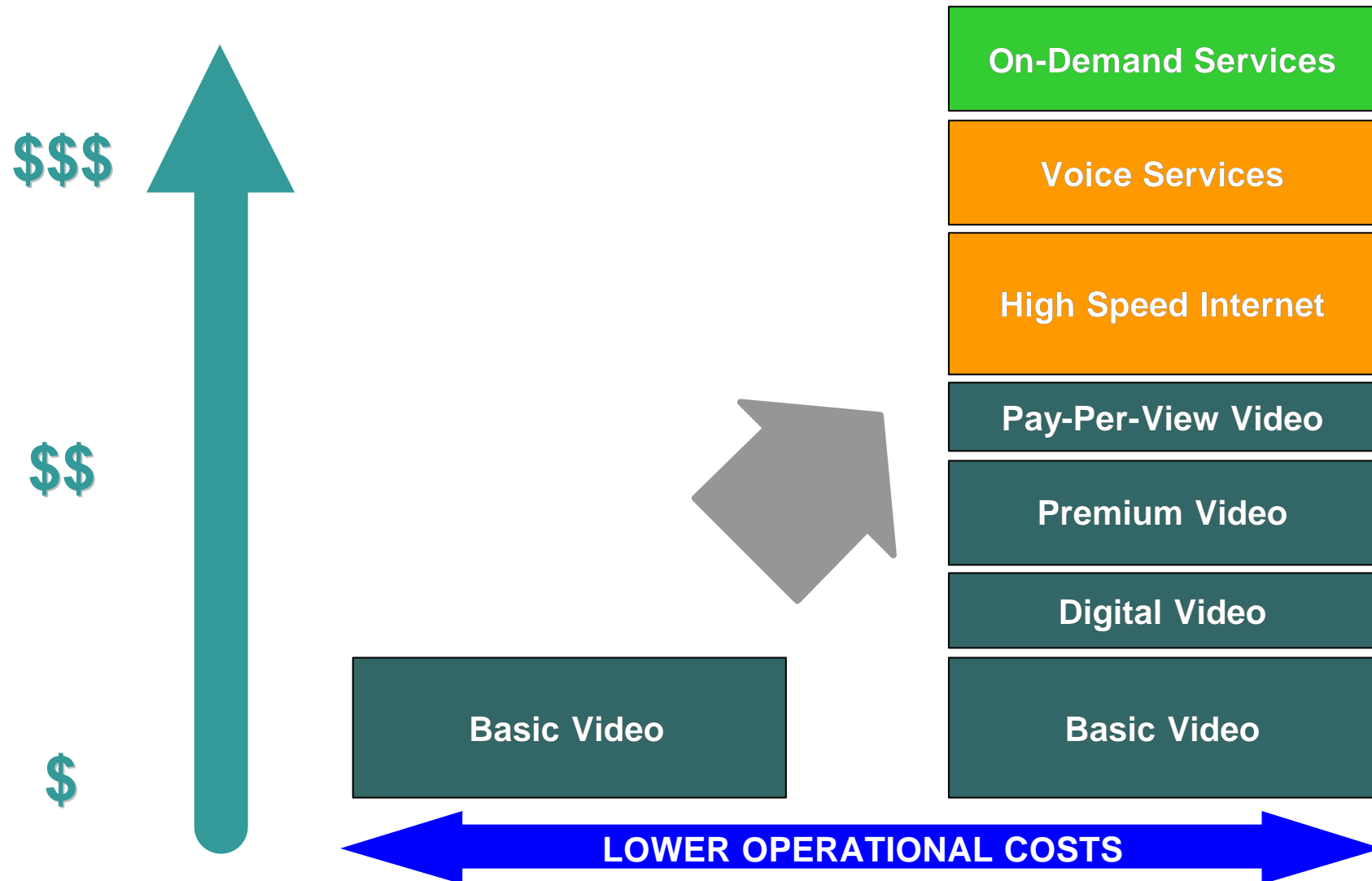
Cisco.com



New Services Increase Revenue/Subscriber

Industry Drivers: Acquisition, Retention, Core Financials

Cisco.com



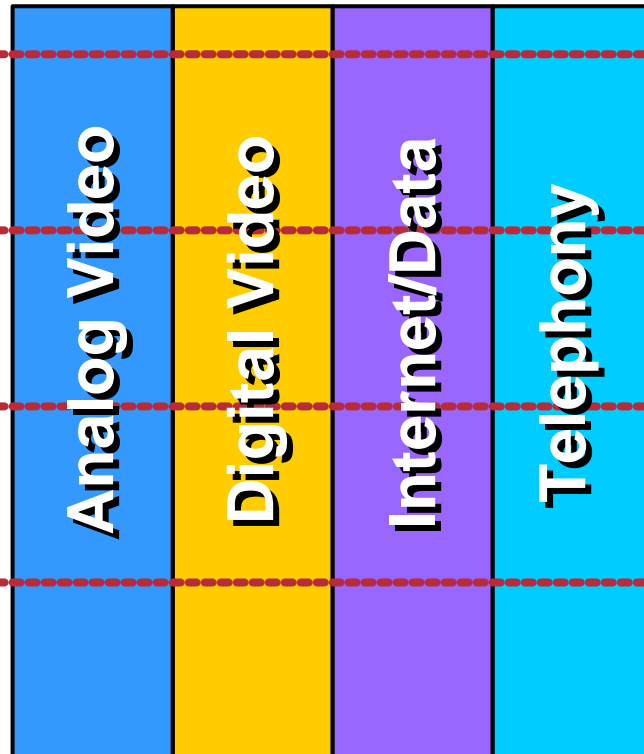
Migrating to a Converged Network

Single Network for All Services

Cisco.com

Parallel Networks

ATV DTV PC Phone
STB STB HSD Fax



Applications

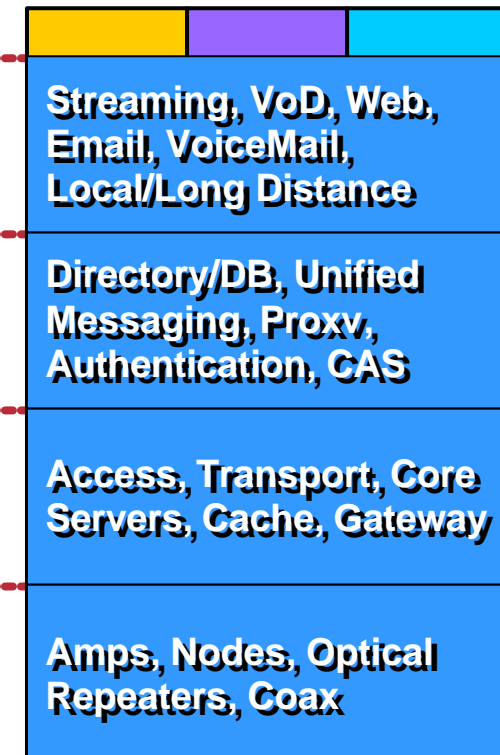
Middleware

Network/Server

Plant/Optics

Converged Network

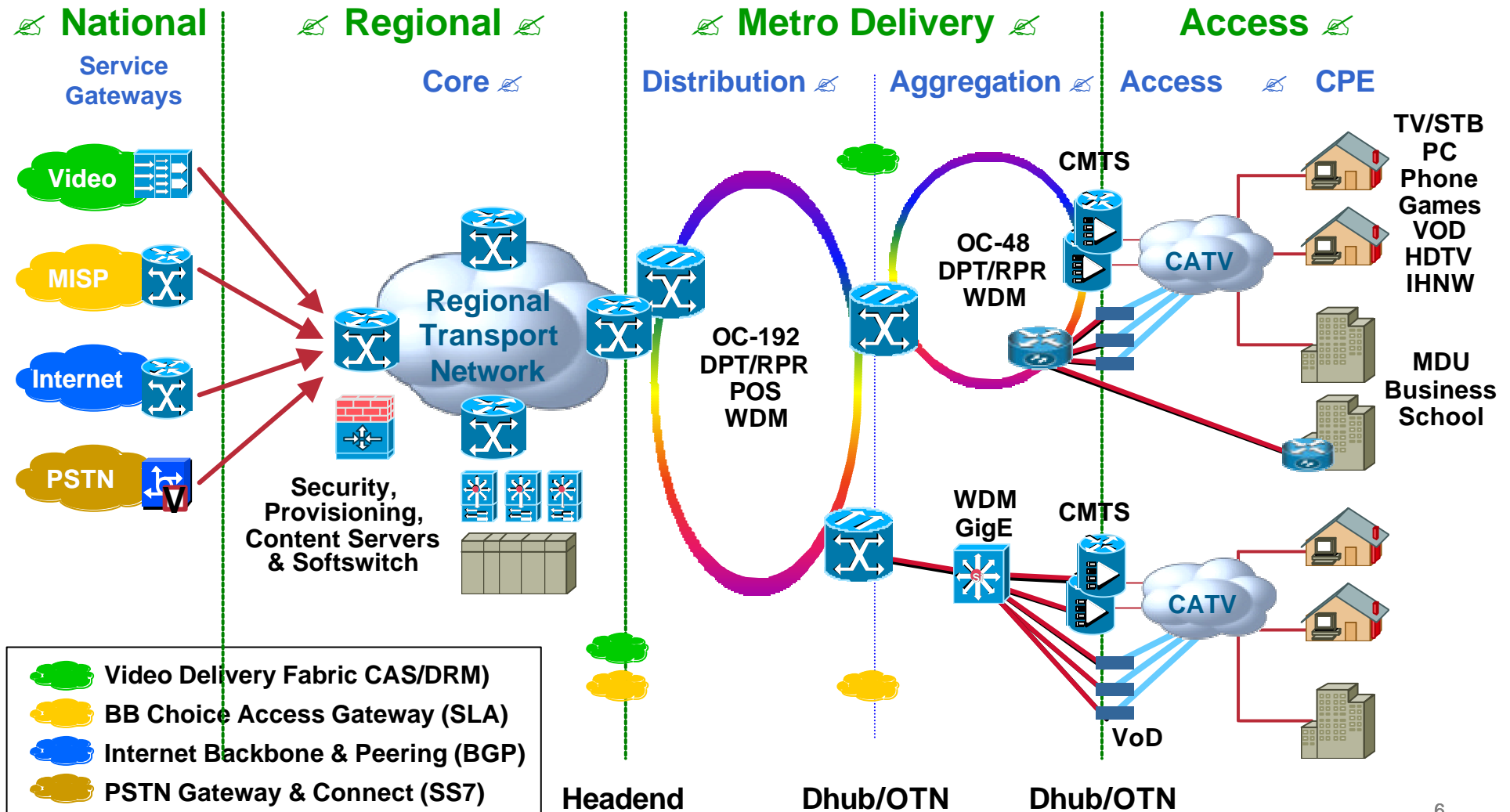
TV PC Phone
STB HSD Fax



High Level Network View

Cisco.com

Cable Services Network



Technology for Converged Broadband Networks

Technology Choices: Media

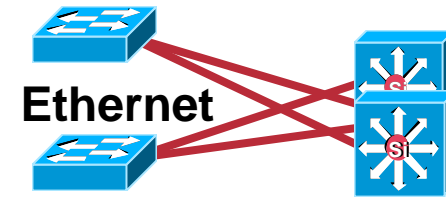
Driven by Customer Requirements

Cisco.com

- **Ethernet**

Ethernet Aggregation

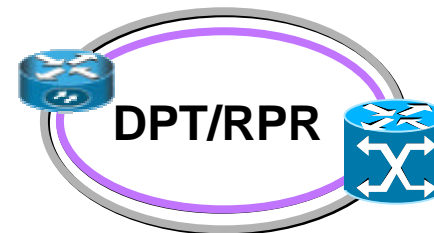
10/100/1GE/10GE



- **DPT/RPR**

Reliable Packet Rings

OC-12/OC-48/OC-192



- **SONET/SDH**

TDM services for legacy
Voice

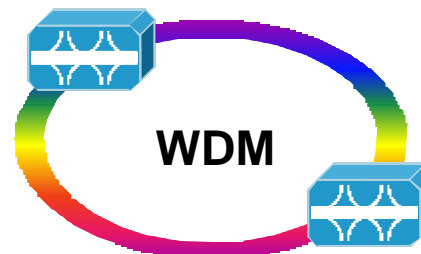
DS1 to OC-192



- **WDM**

CWDM: 8 wavelengths

DWDM: 32+ wavelengths



Converged Broadband Infrastructure

Building an Architecture that Scales for the Future

Cisco.com

- **Develop and Deploy a Network Architecture that Lasts:**
 - Scalable to Handle Growth (devices, ports, bandwidth capacity)**
 - Flexible to Accommodate Today's Services and Future Innovative Services**
- **Easy to Operate and Manage**
 - Simplicity is Key**
 - Operational expense is by far the Largest Recurring Expense (50-70%)**
 - Capital efficiency also improved**
 - Resource Constraint – People/Skills (esp. Regional Level) Remain Constrained**

Services

Architectures

Products

Technology Choices: Platforms

Driven by Customer Requirements

Cisco.com

- **Home Networking Switches**

Linksys

\$



- **Wiring Closet Switches**

Catalyst 3500



\$\$



- **Campus Switches**

Catalyst 4000, 6500



\$\$\$



- **Backbone-Class Routers**

Cisco 12000, Cisco 10720,
uBR-7xxx, uBR-10000



\$\$\$\$



Network Platforms Optimized for Network Application

Backbone-Class Networks

What Makes the Internet Work?

Cisco.com



Control Plane Scale

Large Routing Tables

Generous buffering



High Availability

99.999% Uptime

Element and Network Redundancy



Bandwidth/Services Management

QoS: CAR, WRED, etc.



Security

RPF check, ACLs, SSH, etc.



Transport Technologies

DPT/RPR, Ethernet

WDM, SONET/SDH

Control Plane Scale

Cisco.com

- **Routing Table Size**

Ability to run BGP and take full routes can reduce transit costs (big cost savings)

- **Buffering**

Subs offered ~1Mbps service; backbone provisioned ~15kbps/sub

60-1 Over-subscription is very economical, but bursts require generous buffering

- **Routing/Forwarding Flexibility**

Open Access/Broadband Access requires some of:
PBR, IP GRE, MPLS, UTI/L2TPv3

- **Withstand Network Vandalism**

Network Vandalism is a fact of life; be ready for it
Withstand, Detect, and Counter Denial of Service

High Availability Networks and Systems

Achieving 99.999% Uptime

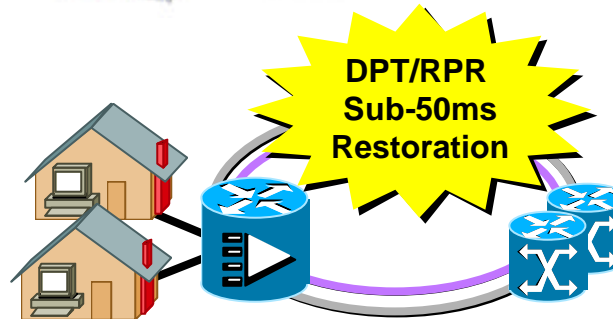
Cisco.com

Element Reliability



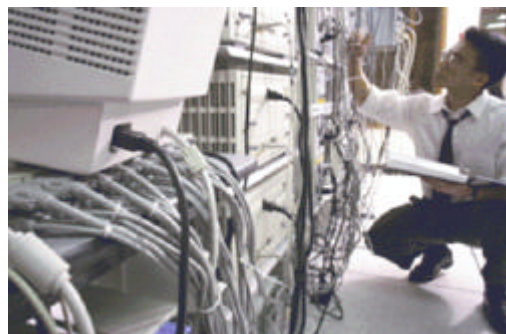
1. Physical redundancy
2. Logical redundancy
3. Graceful router reload
4. Stateful switch-over
5. Online software upgrade

Network Availability



1. uBR 1-N RF Switch
2. HSRP
3. Sub 50-ms ring restoration
4. Fast Route Convergence
5. MPLS Fast Re-Route

Best Practices



1. Element management
2. Programmable networks
3. Training
4. Certification

Bandwidth Service Management

Cisco.com

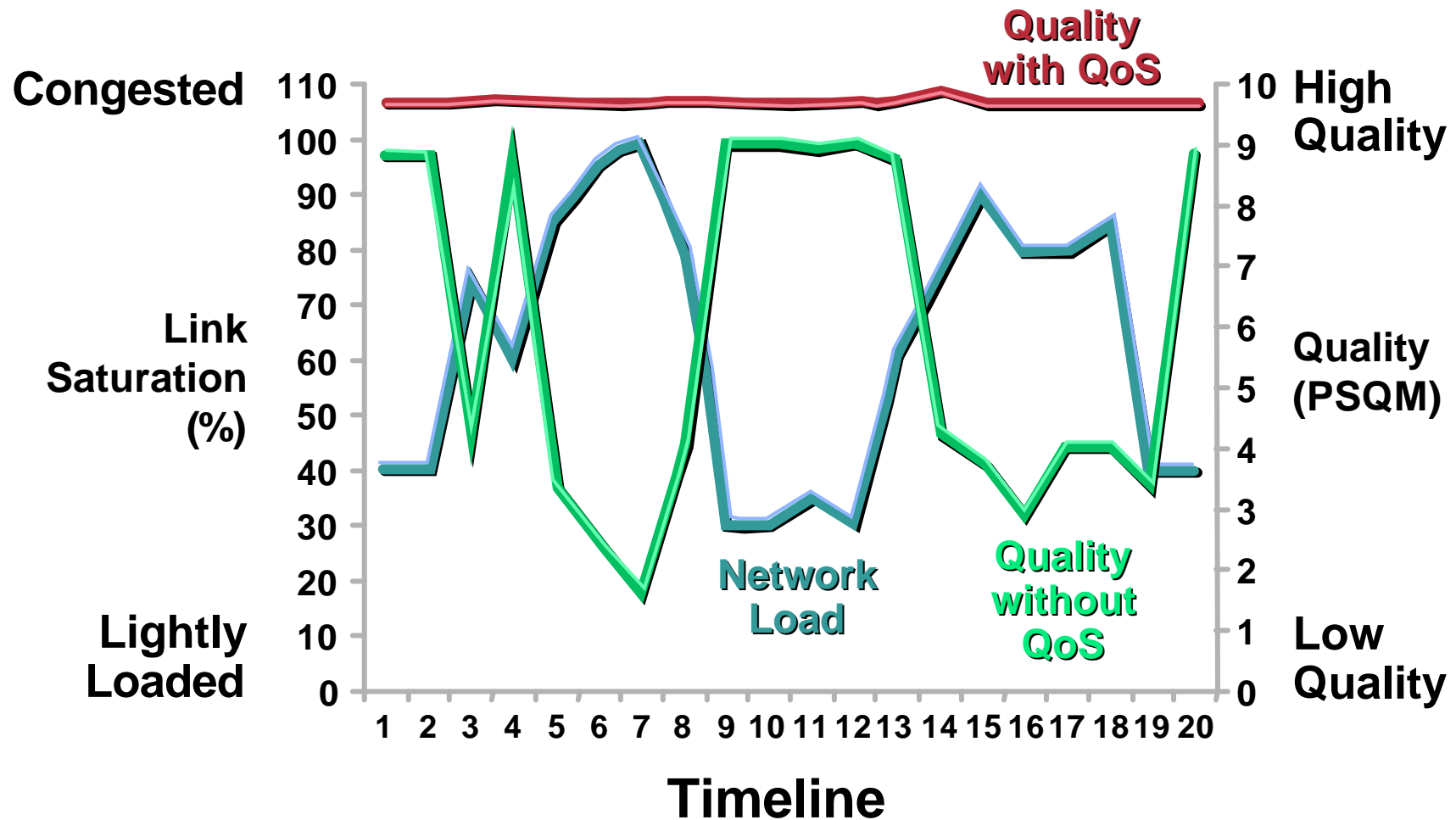
- **QoS Robustness: Priority Queuing, Assured Bandwidth, Packet Marking, Policing, and Shaping**
- **CAR (Committed Access Rate) to Police the Edges**
Manage some NAPSTER/Morpheus usage
- **DiffServ Code Points (DSCP) to indicate service throughout the net**
- **RSVP to Signal Usage of High-Value Traffic (Voice)**
Allows Admission Control
Support large number of flows; RSVP Aggregation used on the backbone
- **Packet Cable DQOS for CMTS Control of DOCSIS Bandwidth**

Cisco uBR, 10720, and 12000 Series ISE (IP Service Engine) cards have robust QoS support

Delivering Voice Service Quality

Quality of Service (QoS) Across the Network

Cisco.com



Source: Cisco Labs

Traffic Management for the Real World Use

CAR to Reign In Network Abuse

Cisco.com

- Committed Access Rate (CAR) used to rate limit bandwidth on a per user basis
- Prevent your network from being overwhelmed by external traffic



One operator was able to isolate and throttle back bandwidth usage for Morpheus and other peer-to-peer applications

The same tools that manage planned services can manage unplanned usage and prevent attacks!

Securing Networks from Attacks

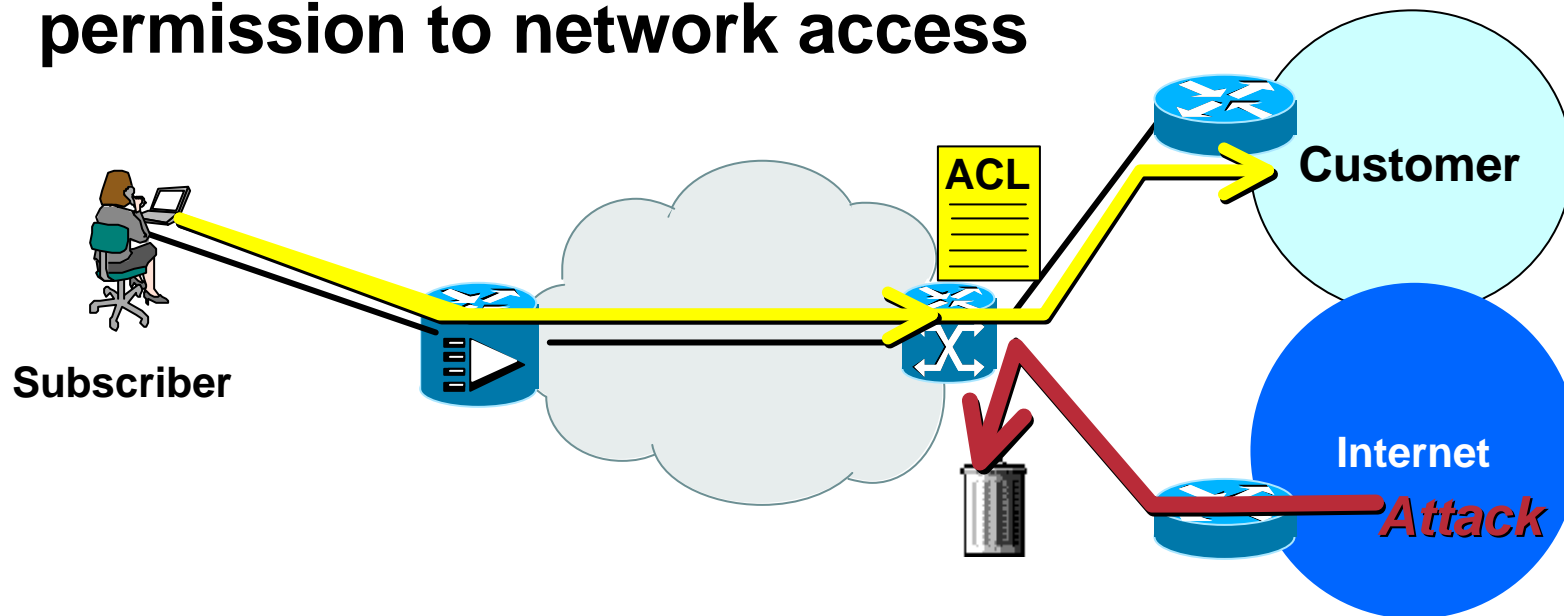
RPF Check and ACLs to Prevent Hacking

Cisco.com

- **Reverse Path Forwarding (RPF) Check to identify and prevent Denial of Service attacks**

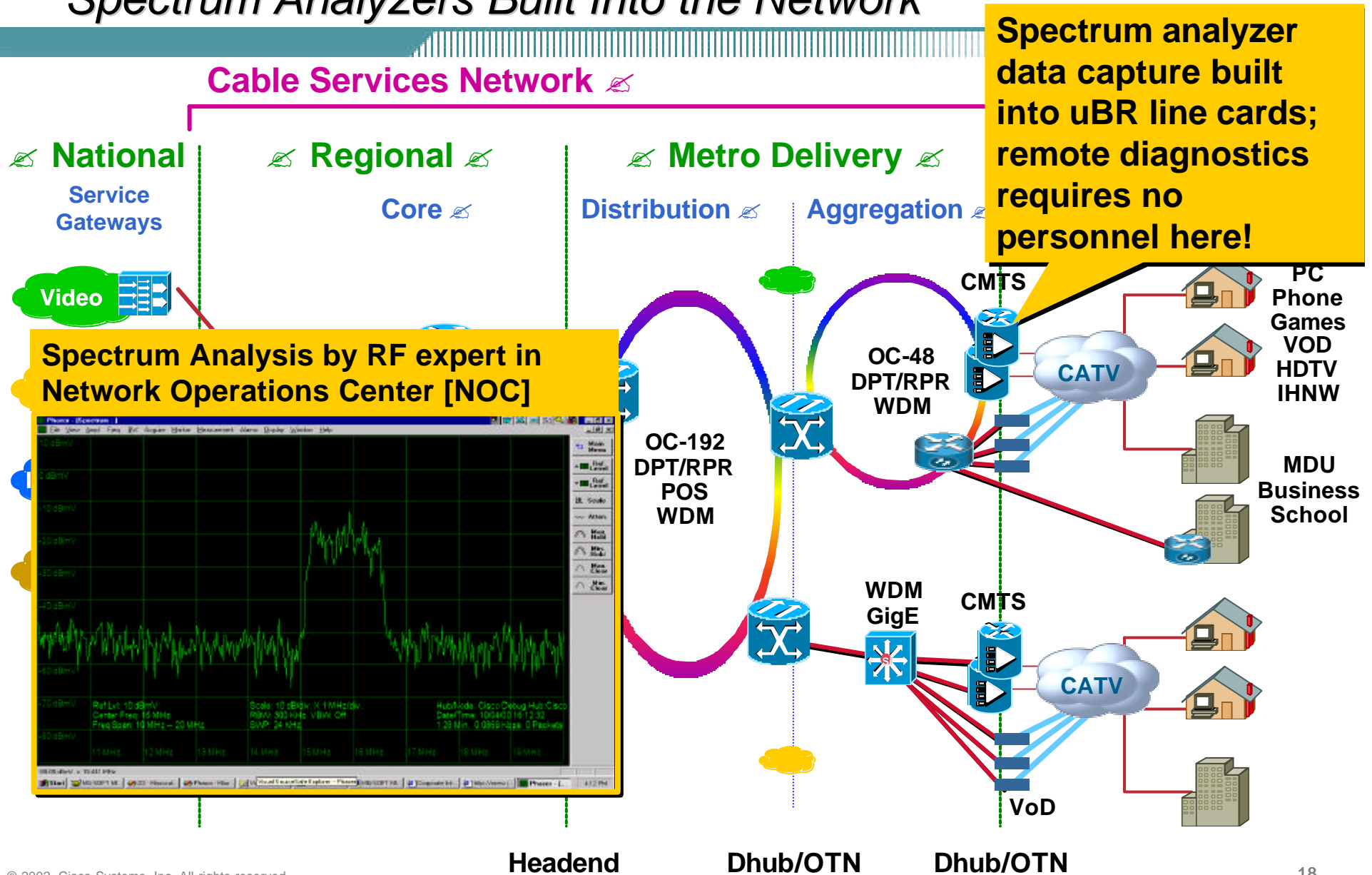
RPF Check built deeply into Cisco uBR and Cisco Internet Routers

- **Access Control Lists (ACLs) to control user permission to network access**



Improving Operational Efficiency

Spectrum Analyzers Built Into the Network

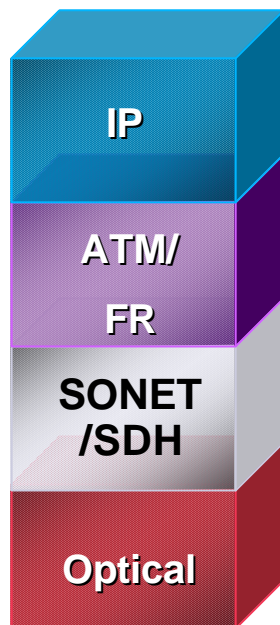


Optimizing Infrastructure for Services

Lower CAPEX and OPEX for Increased Profits

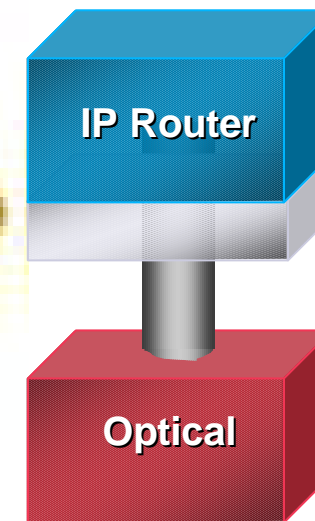
Cisco.com

Traditional Model



- Reduced OPEX
- Reduced CAPEX
- Simplified Architecture
- Scalable Network

Optical Internetworking (IP/MPLS Operator)



IP Services

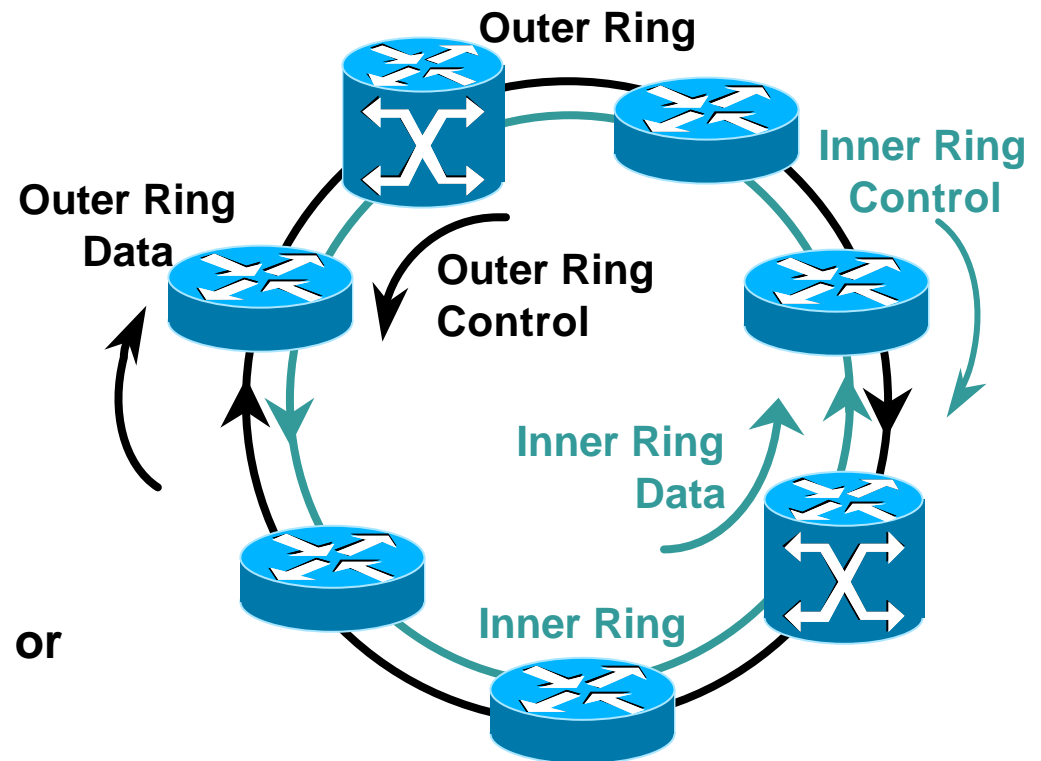
Big Optical Pipe

Cisco DPT/RPR Overview

Customer Benefits

Cisco.com

- **Eliminates SONET/SDH equipment for IP transport while retaining resilience benefits**
 - Sub-50ms restoration
- **Simplest and most scalable solution for IP in the metro**
- **Lowers operating costs by minimizing provisioning, configuration and maintenance requirements**
- **Doubles bandwidth over traditional SONET/SDH rings**
- **Operates over dark fiber, WDM, or SONET/SDH**
- **IEEE 802.17 RPR Standard underway**

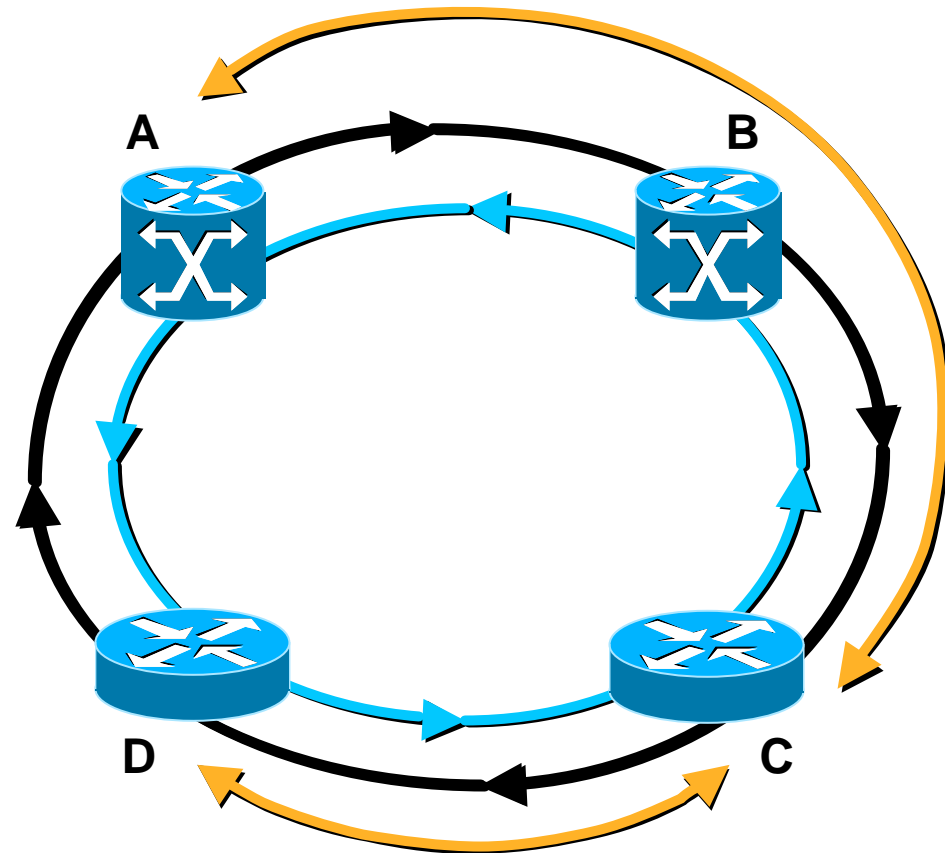


Cisco DPT/RPR

Technology Overview

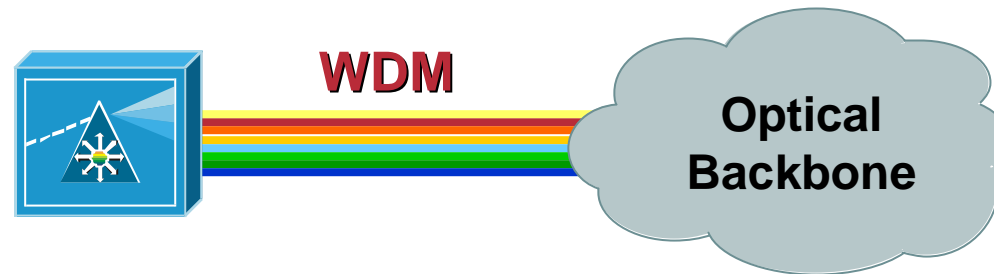
Cisco.com

- **Dynamic Packet Transport / Resilient Packet Rings – Counter-Rotating Rings**
- **Bandwidth consumed only on traversed segment**
- **Protection bandwidth available for low priority traffic**
- **Ring healing in 50msec.(Self-Restoration/Fail-Over)**
- **Very low delay (~3 usec max at OC-48) per node**
- **Multicast traffic goes to all nodes with one packet**



Overview of Wave Division Multiplexing

Cisco.com

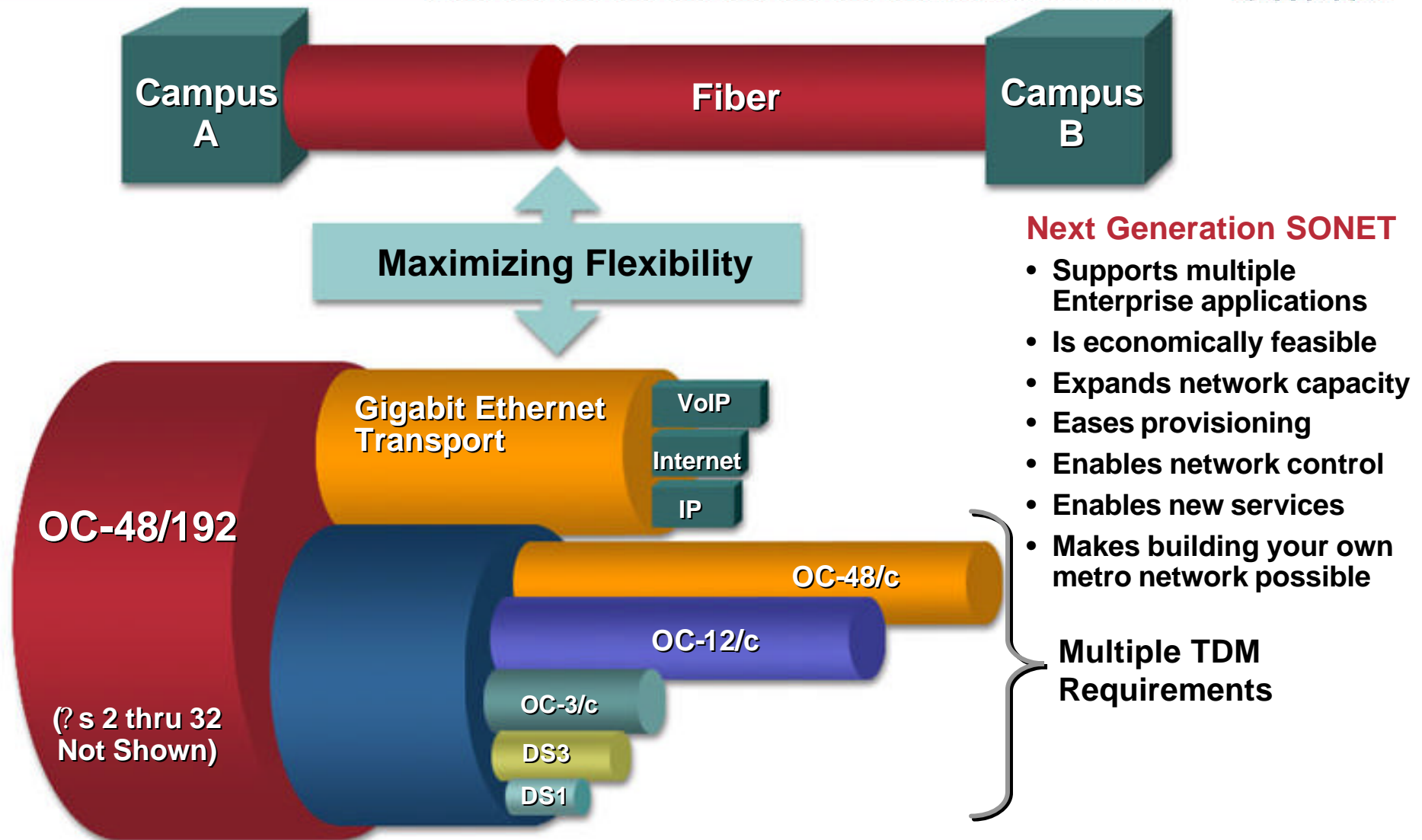


- **WDM multiplexes multiple services into different wavelengths on a single fiber**
- **More wavelengths = More bandwidth per fiber**
- **Dramatic increase in capacity and throughput**
- **Minimized latency for business continuance**
- **Reduced fiber requirements within networks**
- **Storage (SAN/NAS) consolidation and sharing independent of location**
- **Fast recovery (sub 50ms)**

Overview

Next Generation SONET

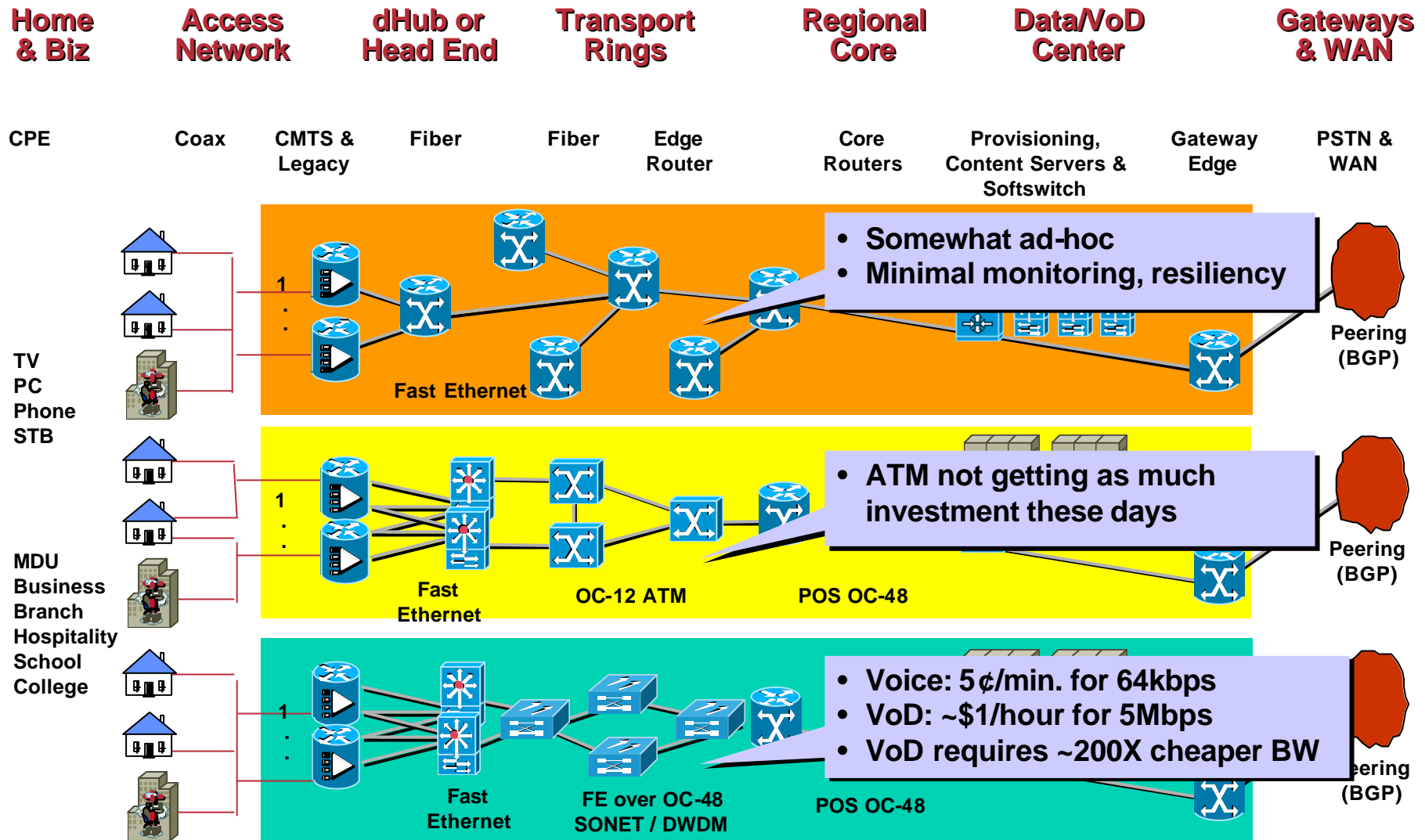
Cisco.com



Architecture for Converged Broadband Networks

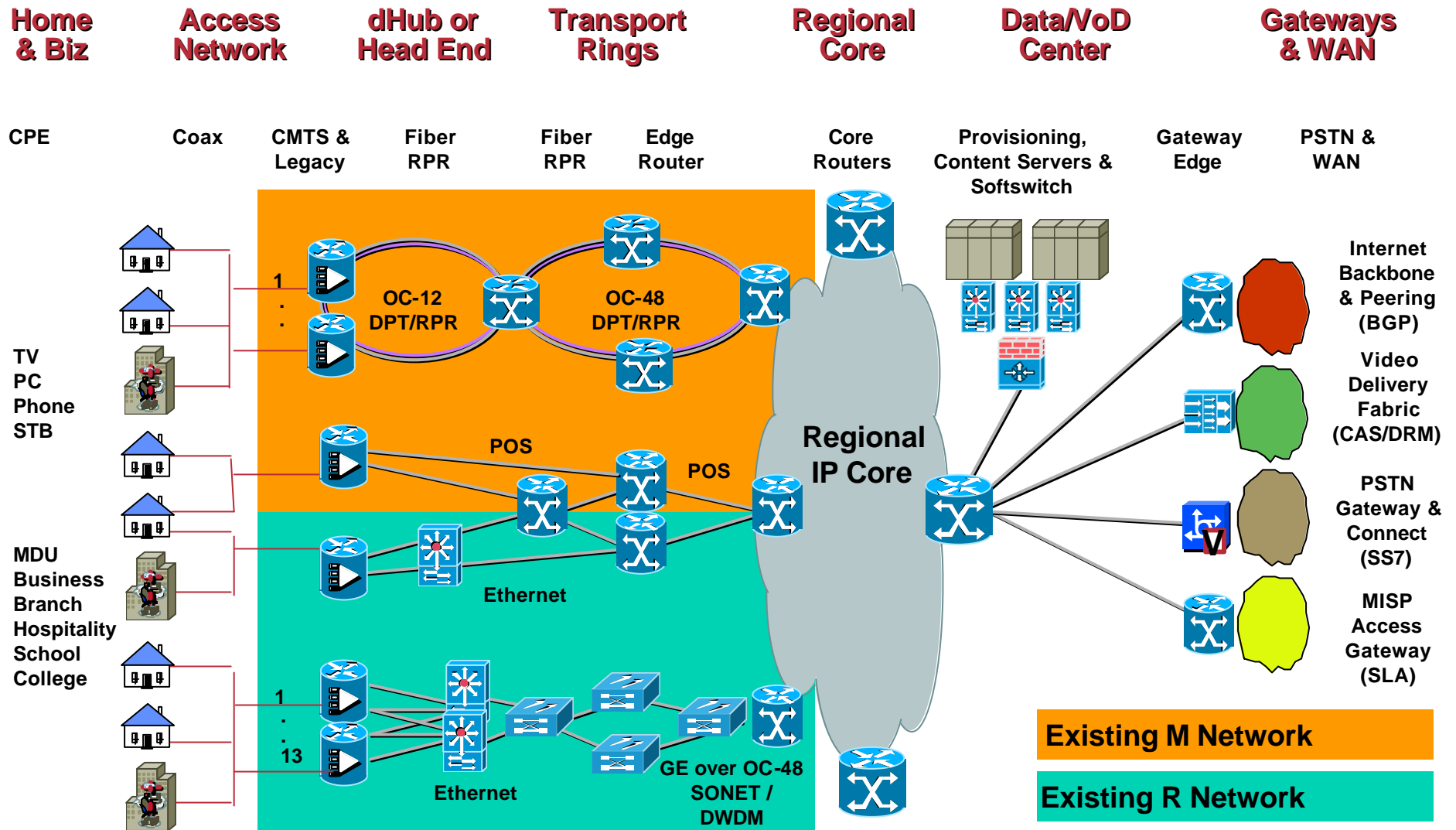
Existing Network Infrastructure #1

Cisco.com



Existing Network Infrastructure #2

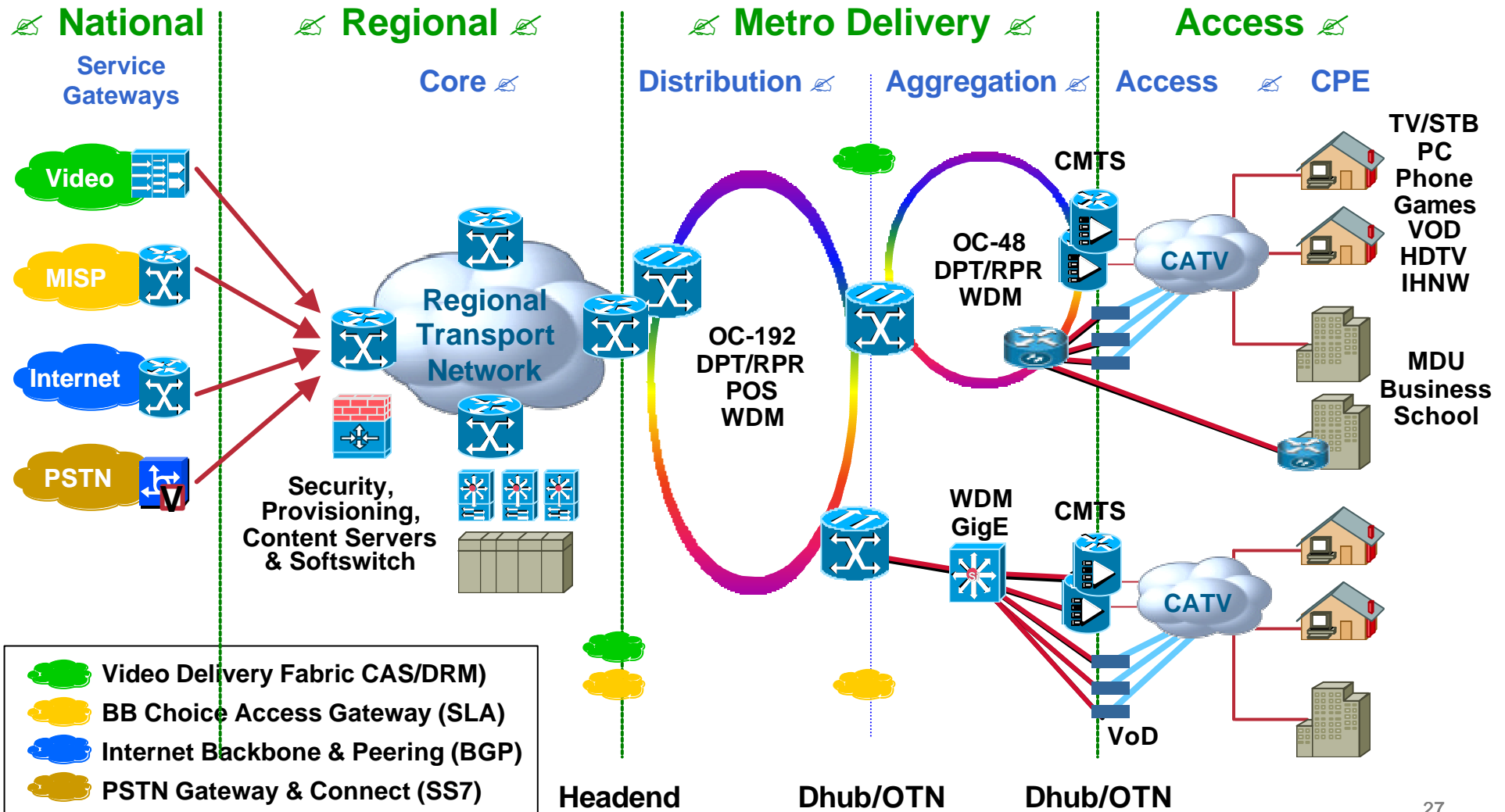
Cisco.com



Cisco Converged Network Architecture for Broadband Networks

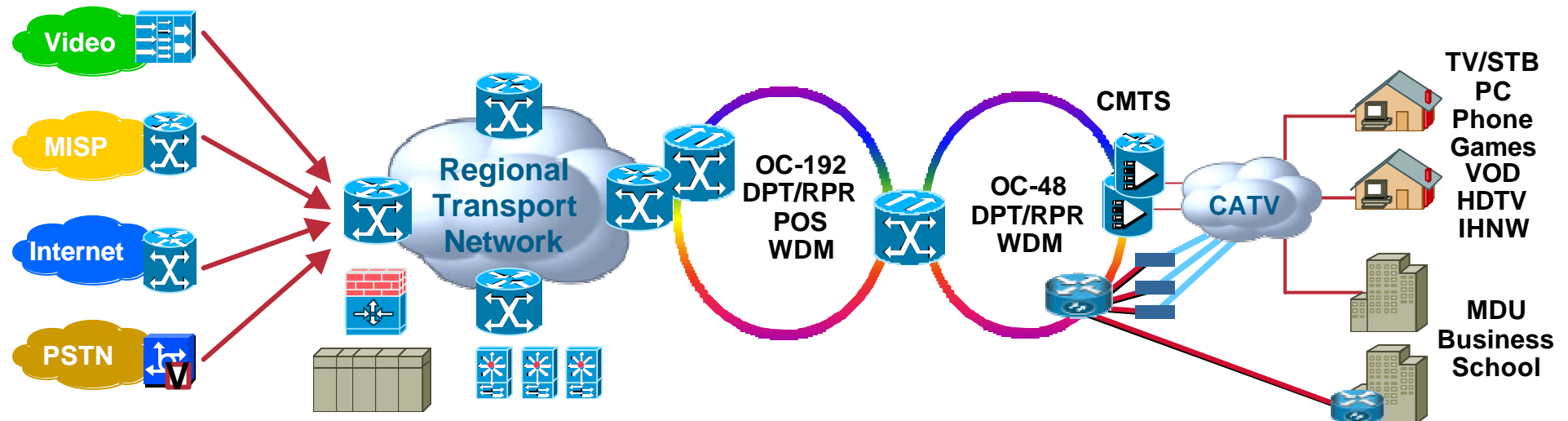
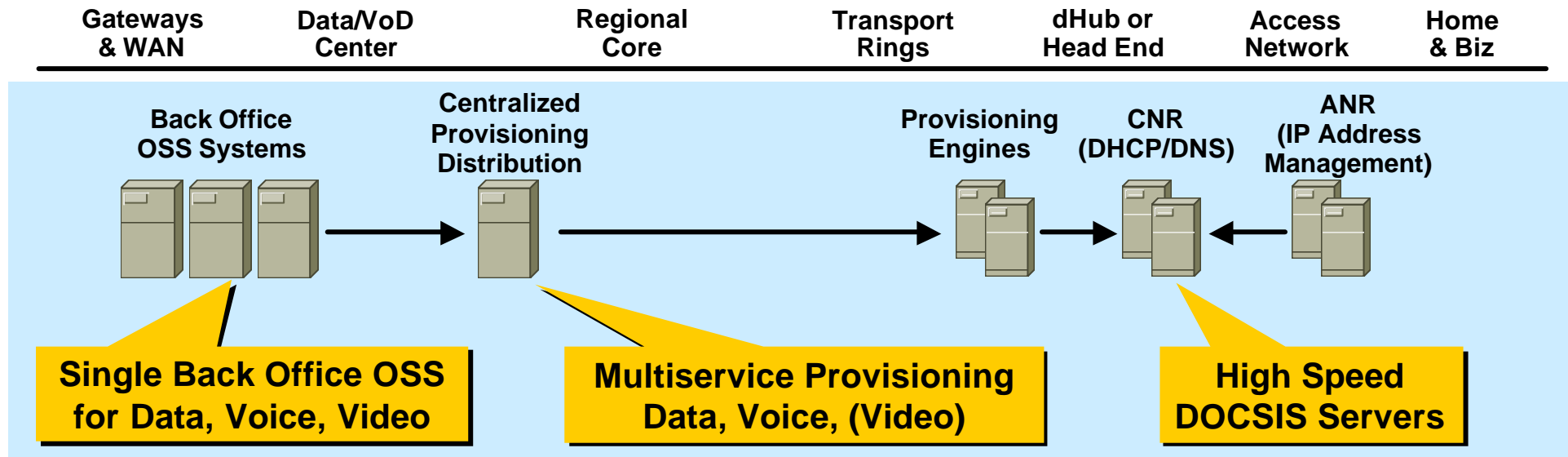
Cisco.com

Cable Services Network



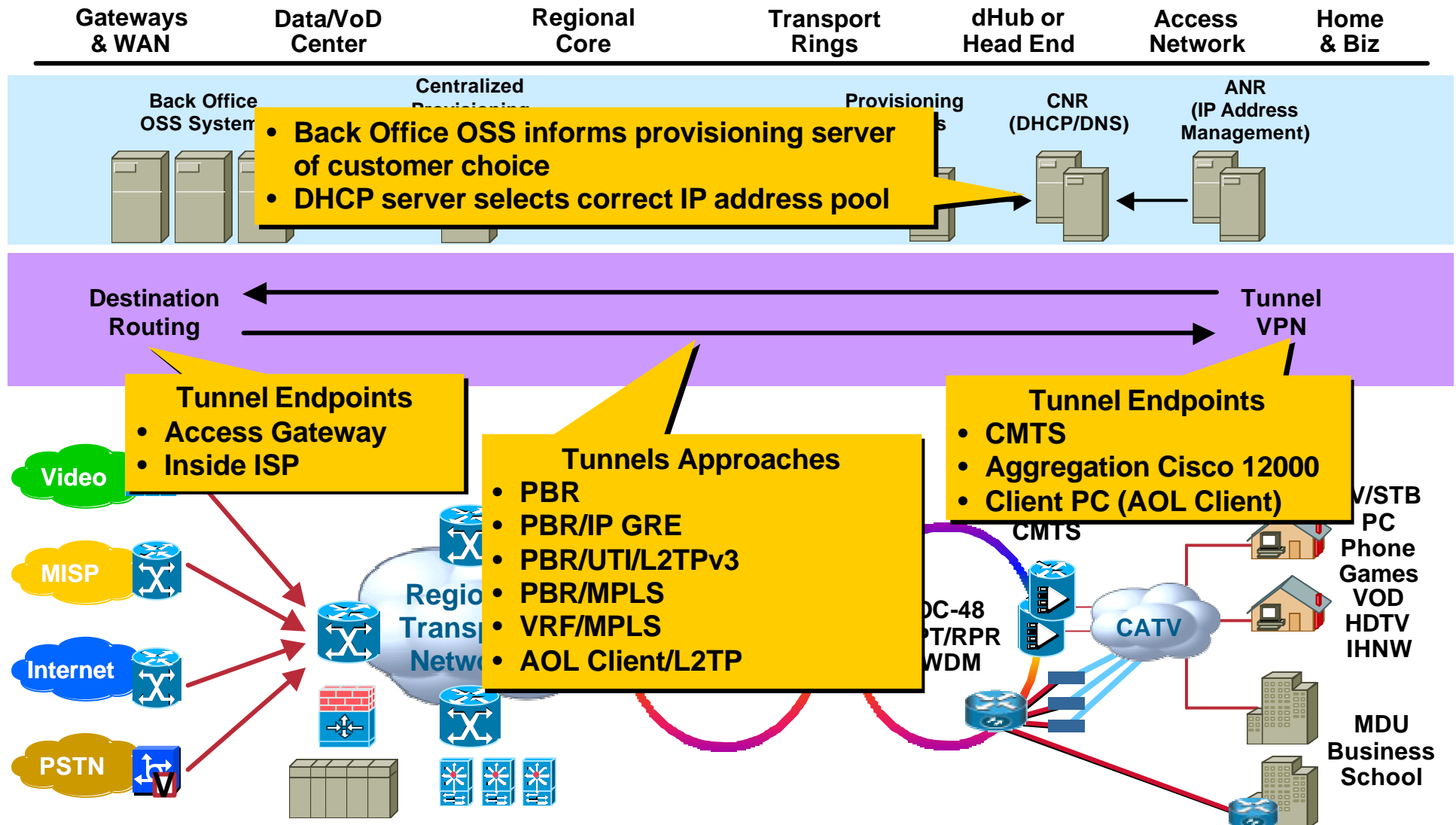
Cable Multiservice Architecture: Services Provisioning Overlay

Cisco.com



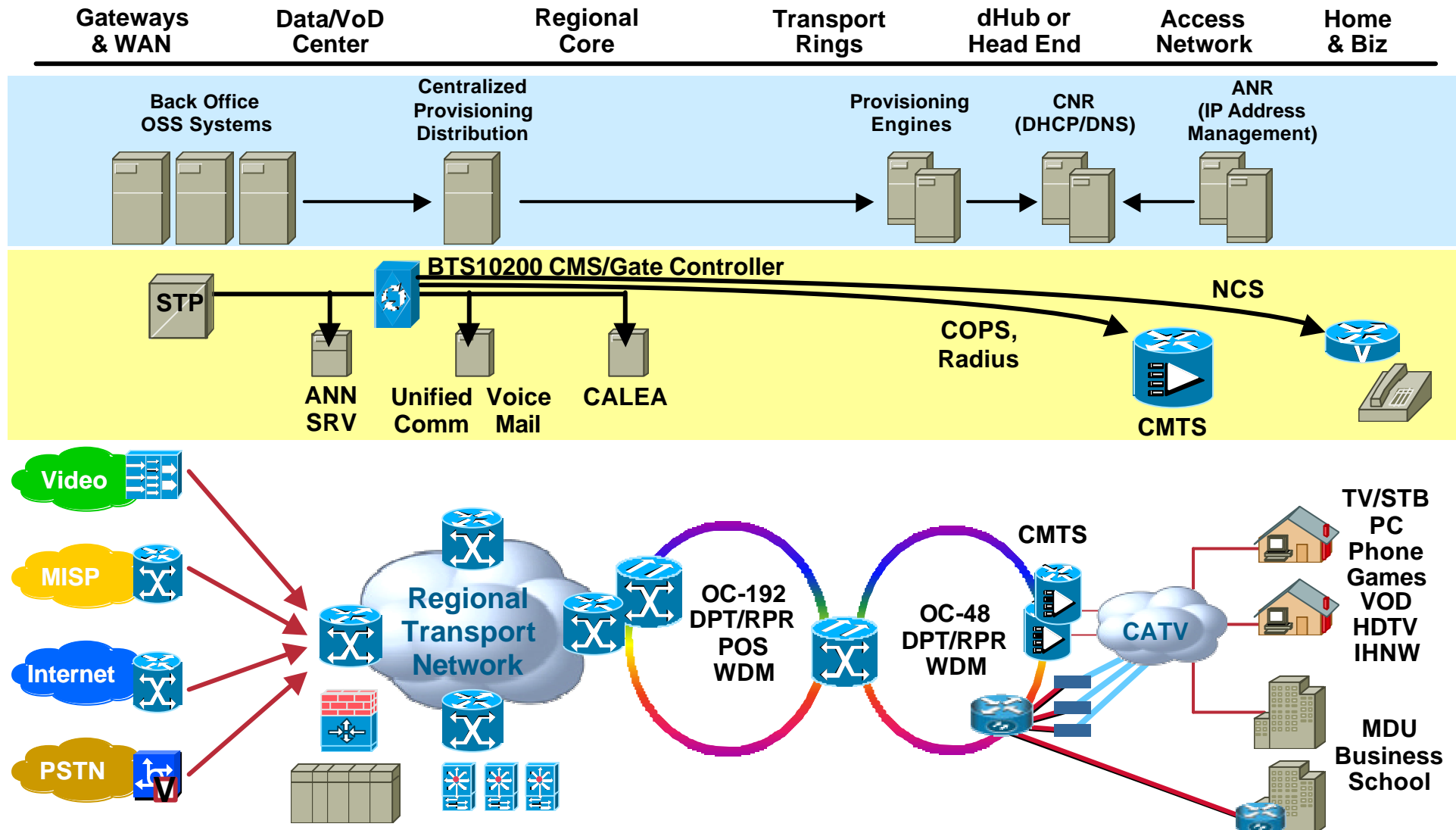
Cable Multiservice Architecture: Multiple ISP Overlay

Cisco.com



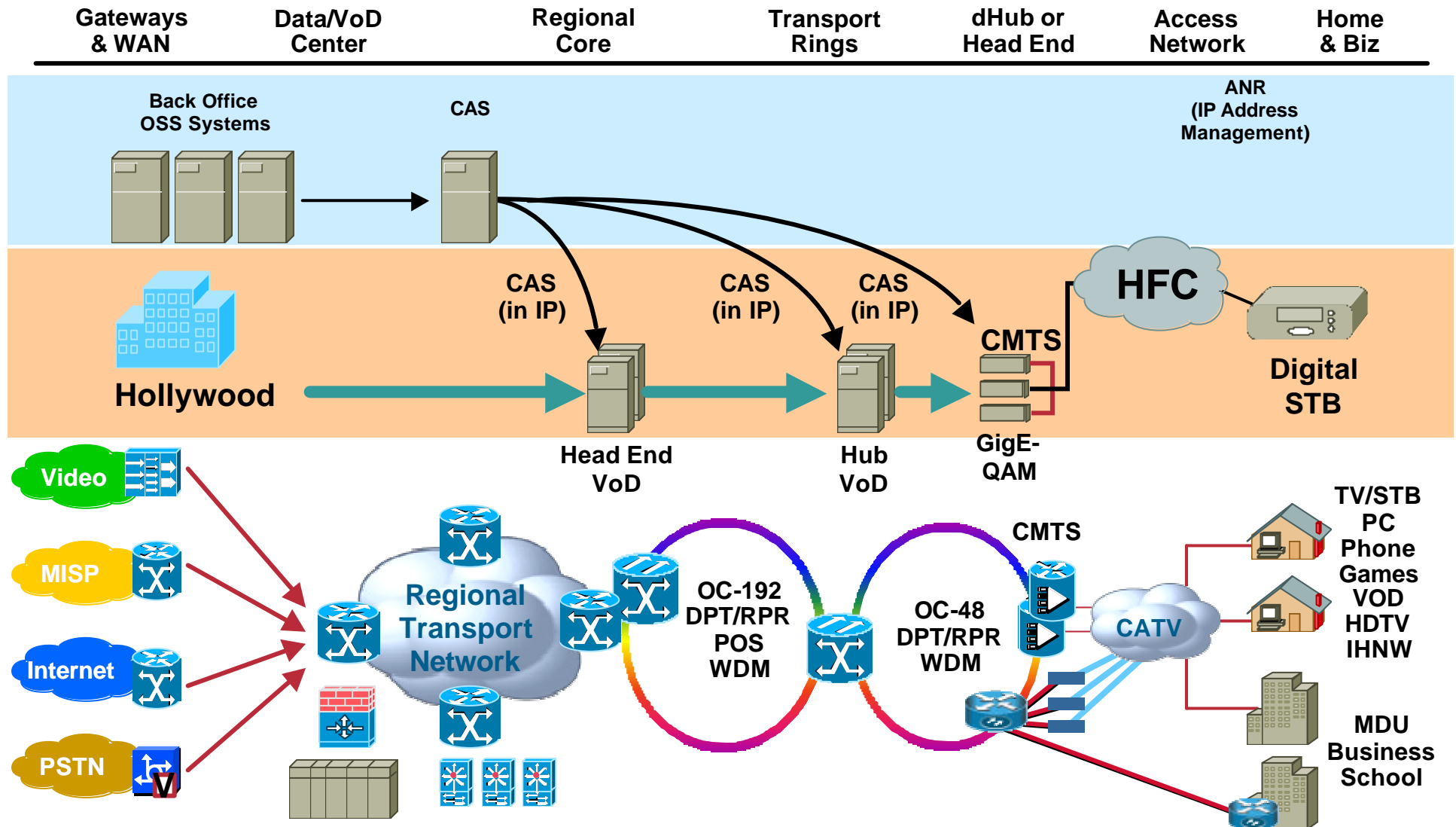
Cable Multiservice Architecture: Voice Services Overlay

Cisco.com



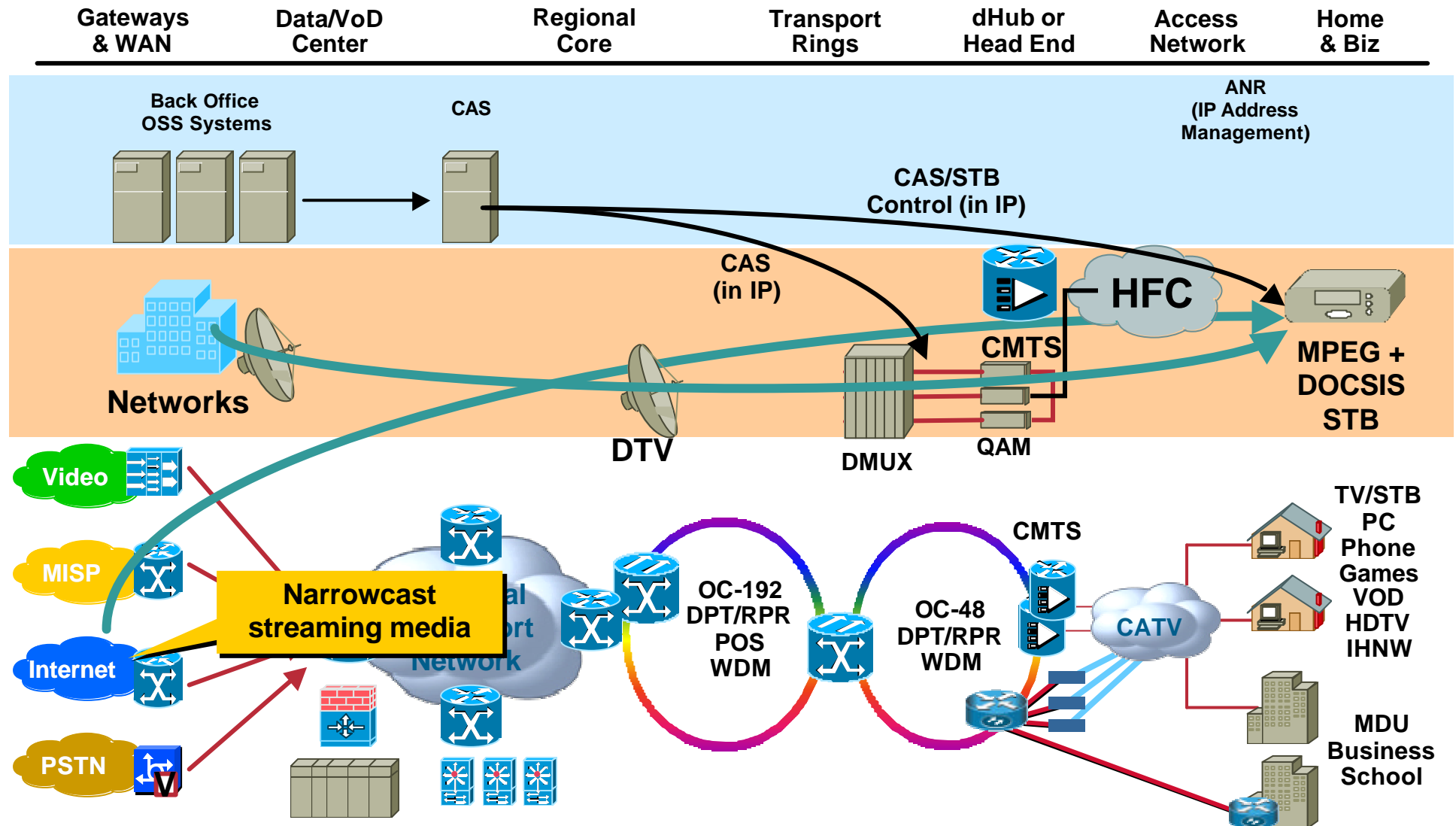
Unified Network Architecture: Video on Demand

Cisco.com



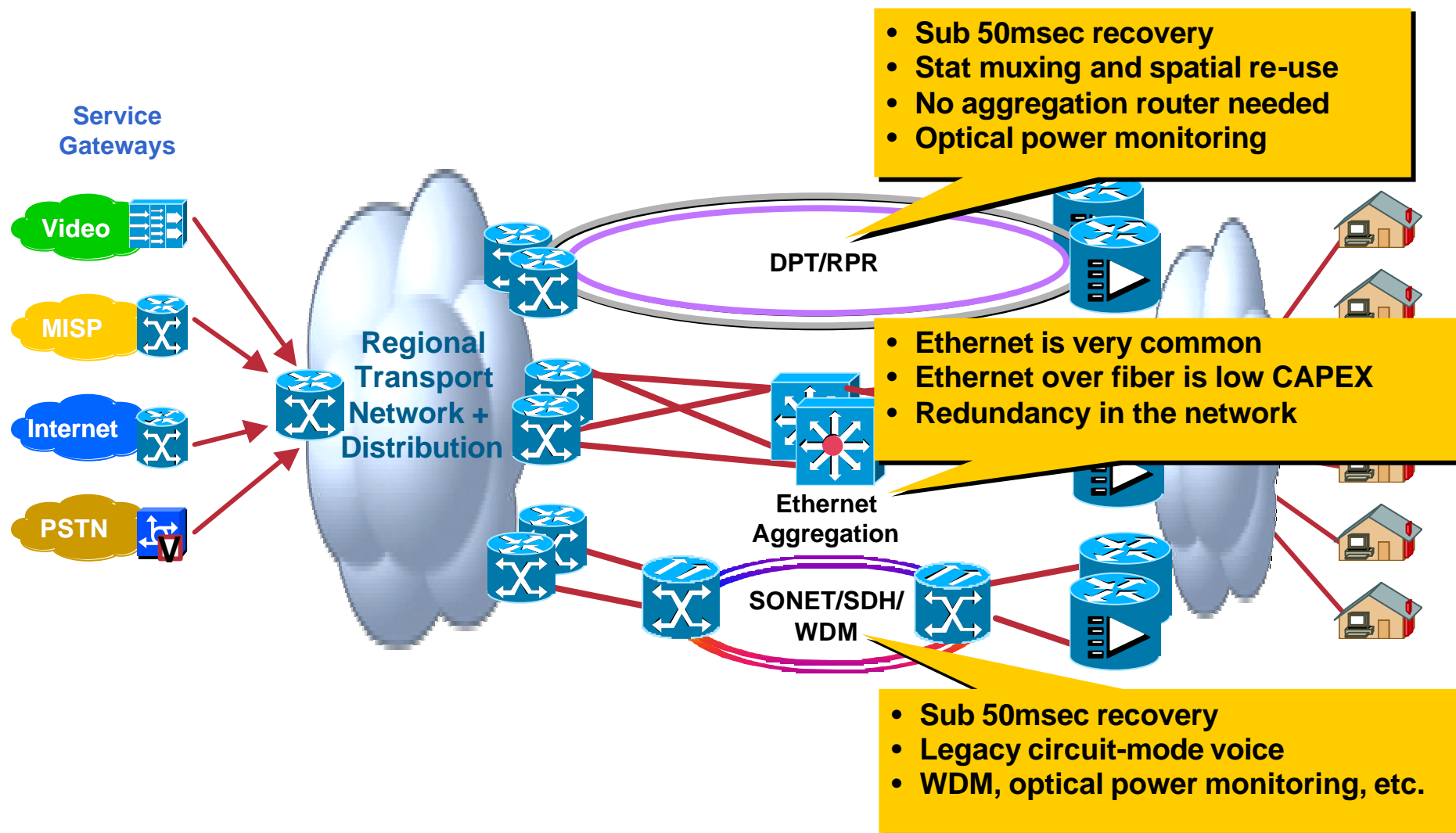
Unified Network Architecture: Broadcast Video

Cisco.com



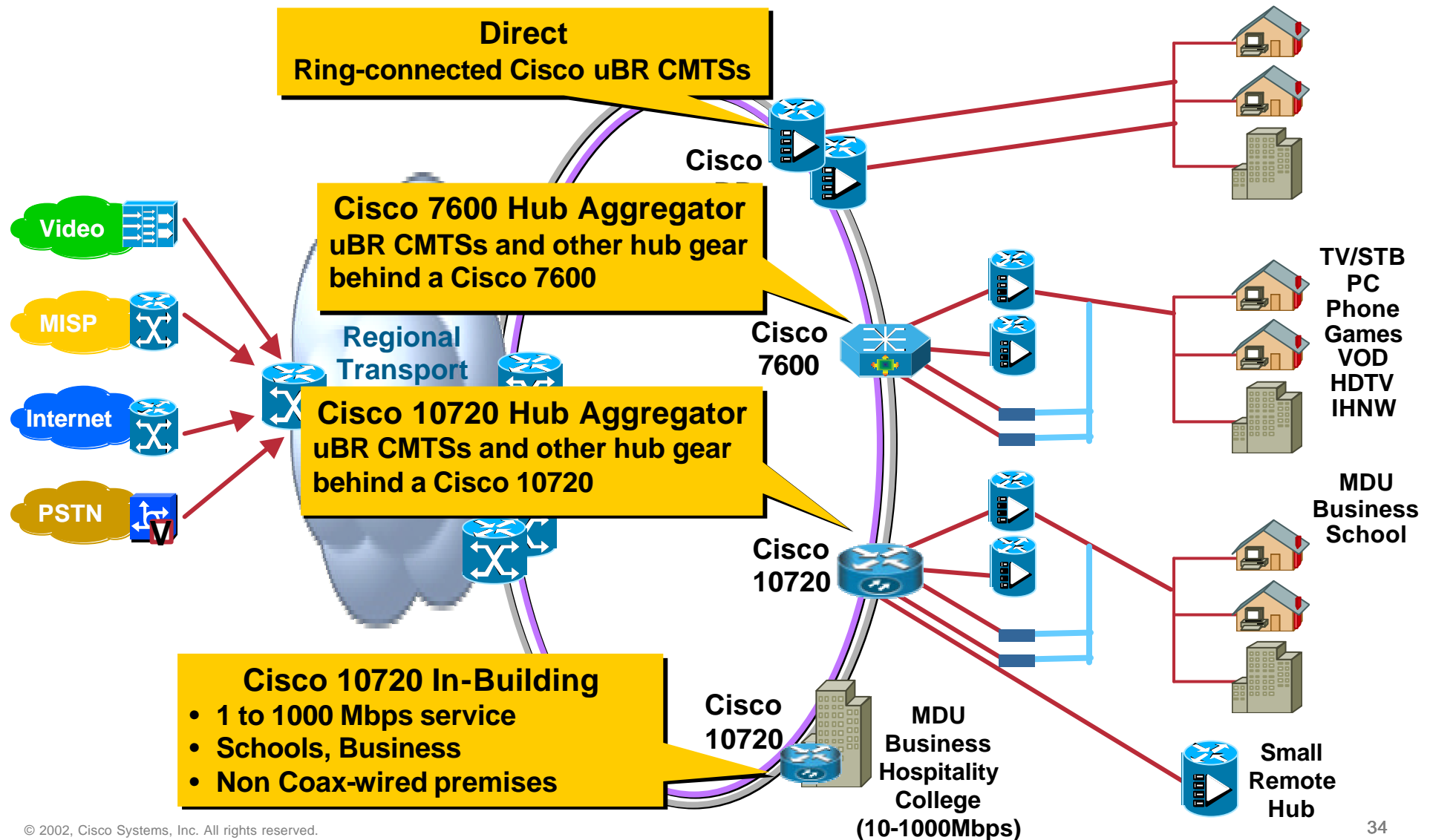
Cable Architecture: Aggregation Alternatives

Cisco.com



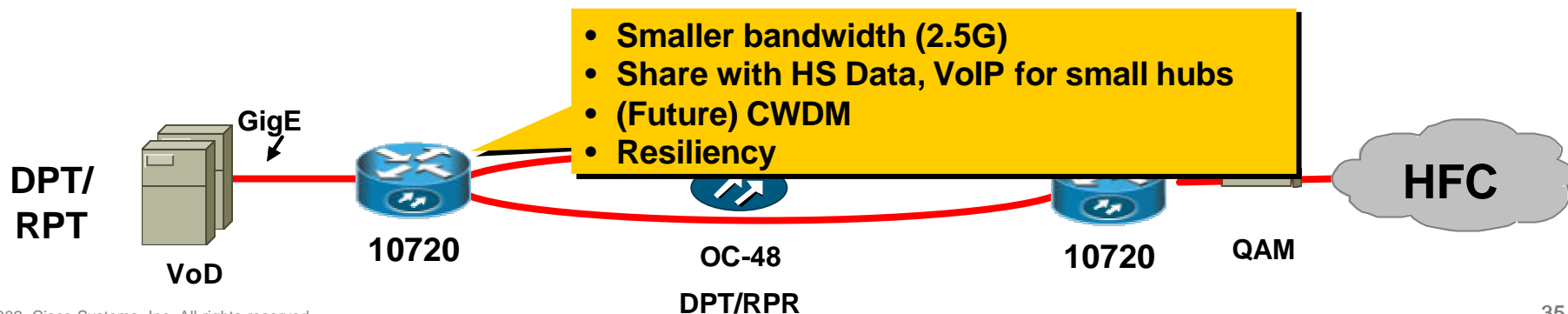
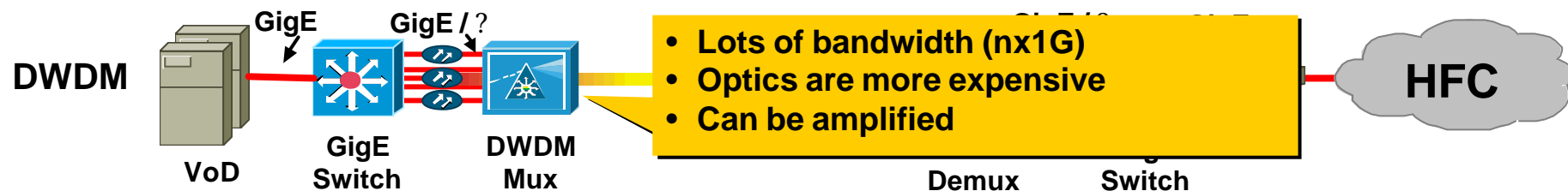
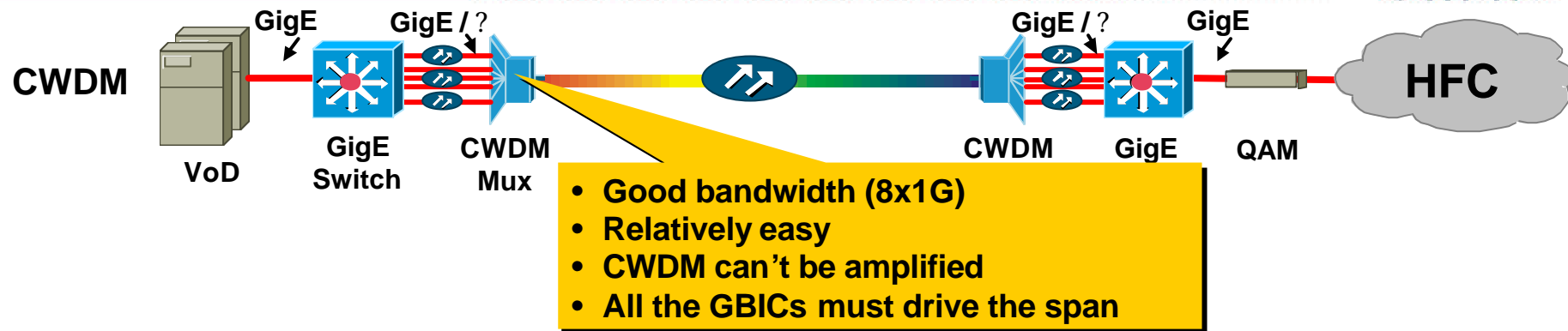
Cable Architecture: Hub Details

Cisco.com



Cable Architecture: VoD Transport Solutions

Cisco.com



Products for Converged Broadband Networks

Cisco Portfolio for Converged Broadband Architecture

Cisco.com



Ethernet Switching



CMTS Platforms



IP Infrastructure



SONET/SDH Transport



WDM Transport

Cisco COMET Optical Platforms

Cisco.com

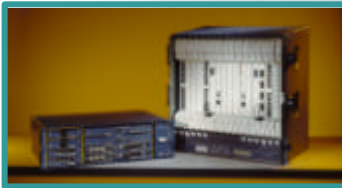
ONS 15201 + 15252

- Lowest first cost ? to building solution
- OC/STM-n, GE, bit-rate independent

λ
To The Building



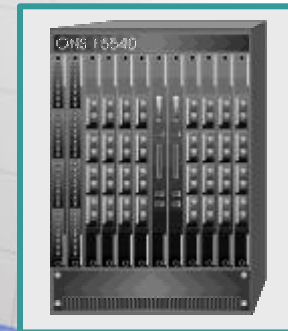
ONS 15327 + 15454/15216



- 500+ customers
- #1 Ethernet over SONET/SDH (CIR)
- #1 OC-48/STM-16 (RHK)

ONS 15540

- Dense ESCON, FC, GE
- EMC, IBM, Compaq,
- Brocade, MFN certified
- Transparent, bit-rate independent interfaces



Supercharged
SONET

High-Density,
Extended-Services

Cisco 12000 Series: Industry's Premier Platform for High End Networking Solutions

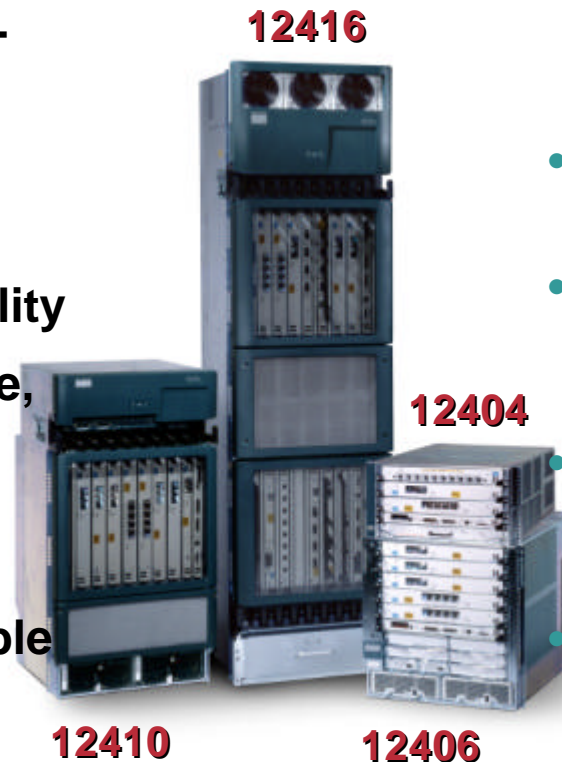
Cisco.com

Only 10G router portfolio

- Complete range of form factors with 10Gbps (OC-192) per slot: 1/8 to full rack
- Only distributed architecture for highest performance and scalability
- Same line cards, software, management
- Proven investment protection
- Only modular, upgradeable switch fabric

Only High End Services Edge

- Only adaptive network processing with line rate performance
- Edge-optimized line card technology (ISE)
- Only small form factor 10G chassis for edge applications
- Only distributed system architecture scales the edge
- First VSR for low cost OC-192 POP connectivity

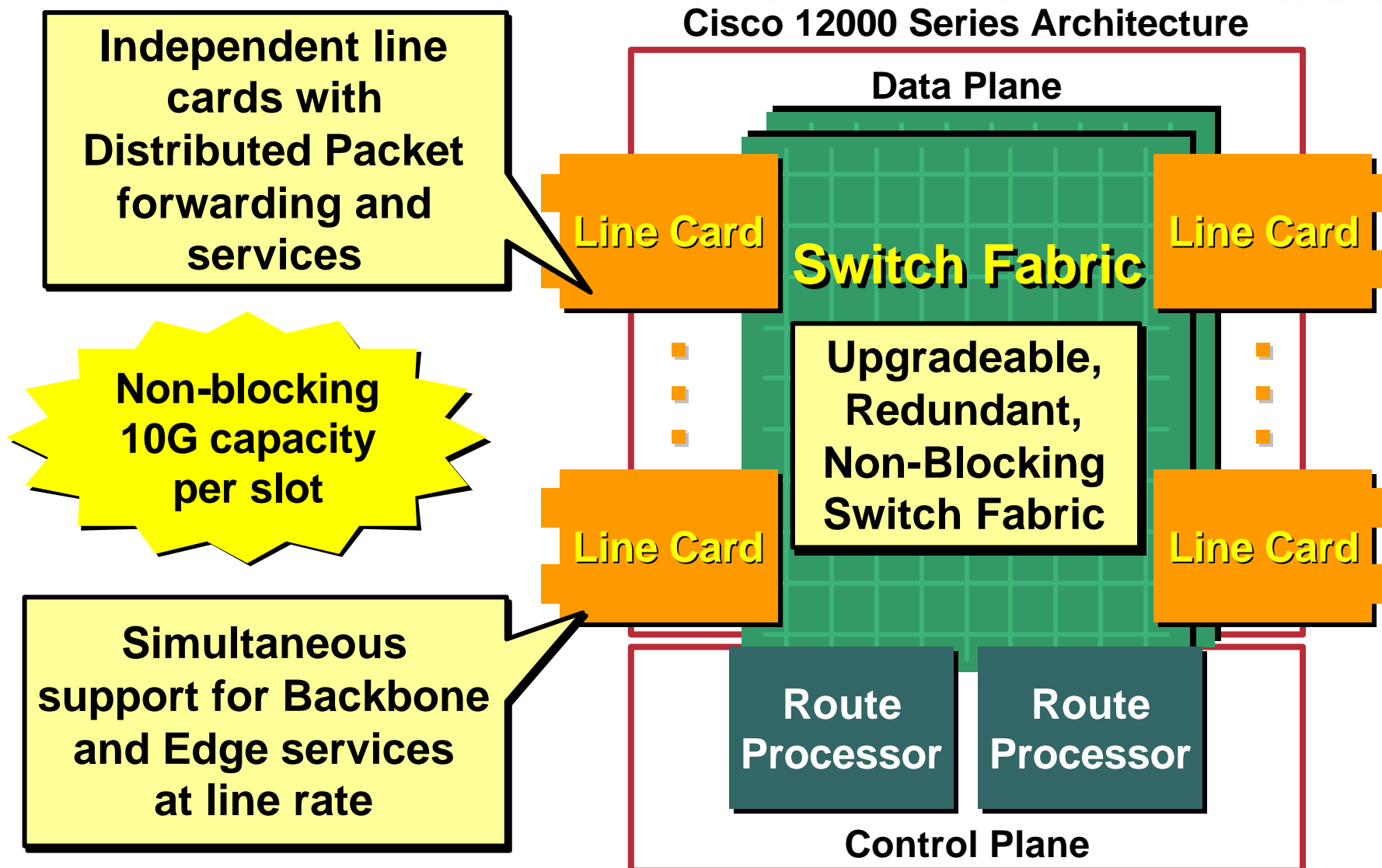


**10Gbps is
about 2,000
Digital TV
Channels!**

***The Highest Backbone and
Edge Performance (up to 375 Mpps)***

Internet Service Provider Optimized *Cisco 12000 Series Distributed Architecture*

Cisco.com



12000 Series IP Services Engine (ISE)

Optimized for the High-Speed Provider Edge

Cisco.com

- All features, line-rate performance
- Programmable support for new services

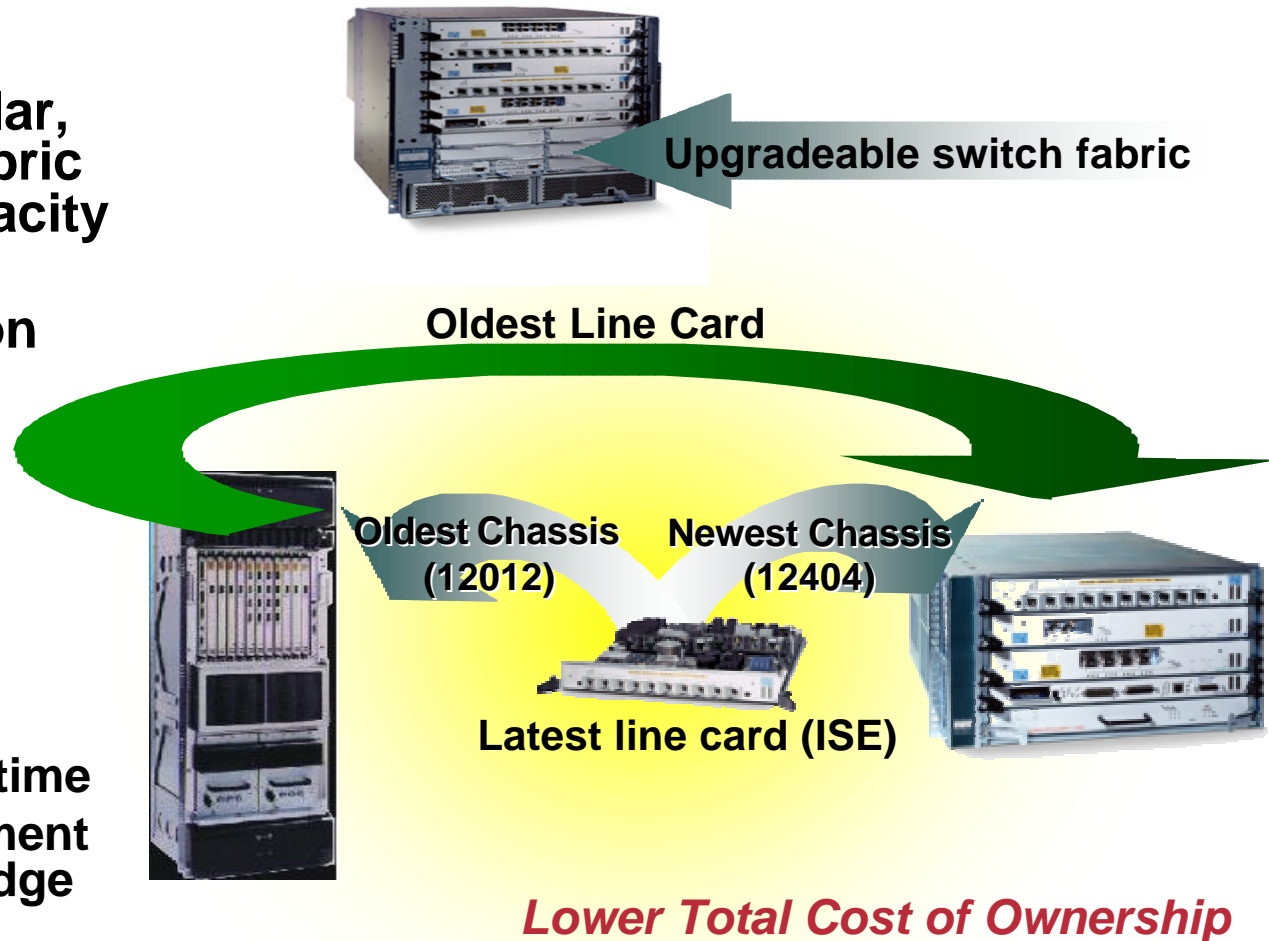
Service	Enabling Features
Voice/Video	QoS, LLQ, IP Multicast
VPN	L2TP V3 / MPLS VPN
Security	ACLs, Packet Filtering, uRPF
Billing	Netflow Accounting
Tiered Levels of Service	Congestion Avoidance, Queuing, Prioritization, Rate Limiting, Shaping

Cisco 12000 Series

The Only Proven Investment Protection

Cisco.com

- The only high end systems with a modular, replaceable switch fabric for field-installed capacity upgrades
- Full upwards migration for *all* line cards
- Latest ISE line cards run in *any* 12000 Series chassis
- Benefits:
 - Lowest total cost of ownership
 - Longer equipment lifetime
 - Greater system placement flexibility (core to edge migration)



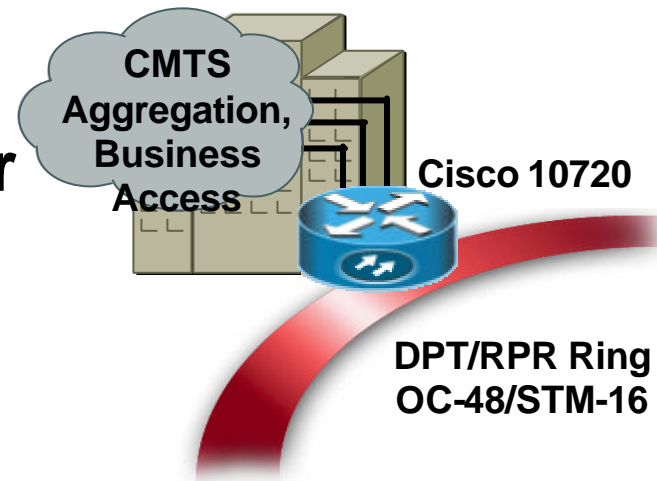
Cisco 10720 Internet Router

Cisco.com

- Internet-class IP routing, QoS, security, content, VPN, TLS, voice/video services
- OC48/STM16 DPT uplink module
- (24) 10/100 Ethernet or 4GigE+8FE access modules
- 2 Rack Units (3.5"); Dual AC or DC power
- CMTS aggregation
- High speed business access



Cisco 10720 Internet Router



Cisco Catalyst Family: Ethernet Switching

Cisco.com

Catalyst 3550 / 2950



Catalyst 4000



Catalyst 6500 / Cisco 7600



- Scalable wire speed IOS switching
- 10/100/GE/10GE Ethernet and WAN
- Highest density 10/100 Ethernet and GE systems
- Flexible interfaces for content networking and WAN routing
- Hub and spoke architectures
- Traffic shaping and queuing

Cisco Universal Broadband Router

Premier Platform for Cable IP Networks

Cisco.com

- **Highest Scalability**
 - Open-system, passive midplane
 - Fully upgradeable processors, linecards & software, most WAN interfaces
- **Highest Performance**
 - Highest port density, today & future
 - Highest effective throughput
- **Highest Reliability**
 - Carrier class VoIP implementation
 - Proven, stable hardware & software
 - Over 225,000 upstream ports deployed
- **Best Investment Protection**
 - All line cards forward-compatible
 - All components upgradeable

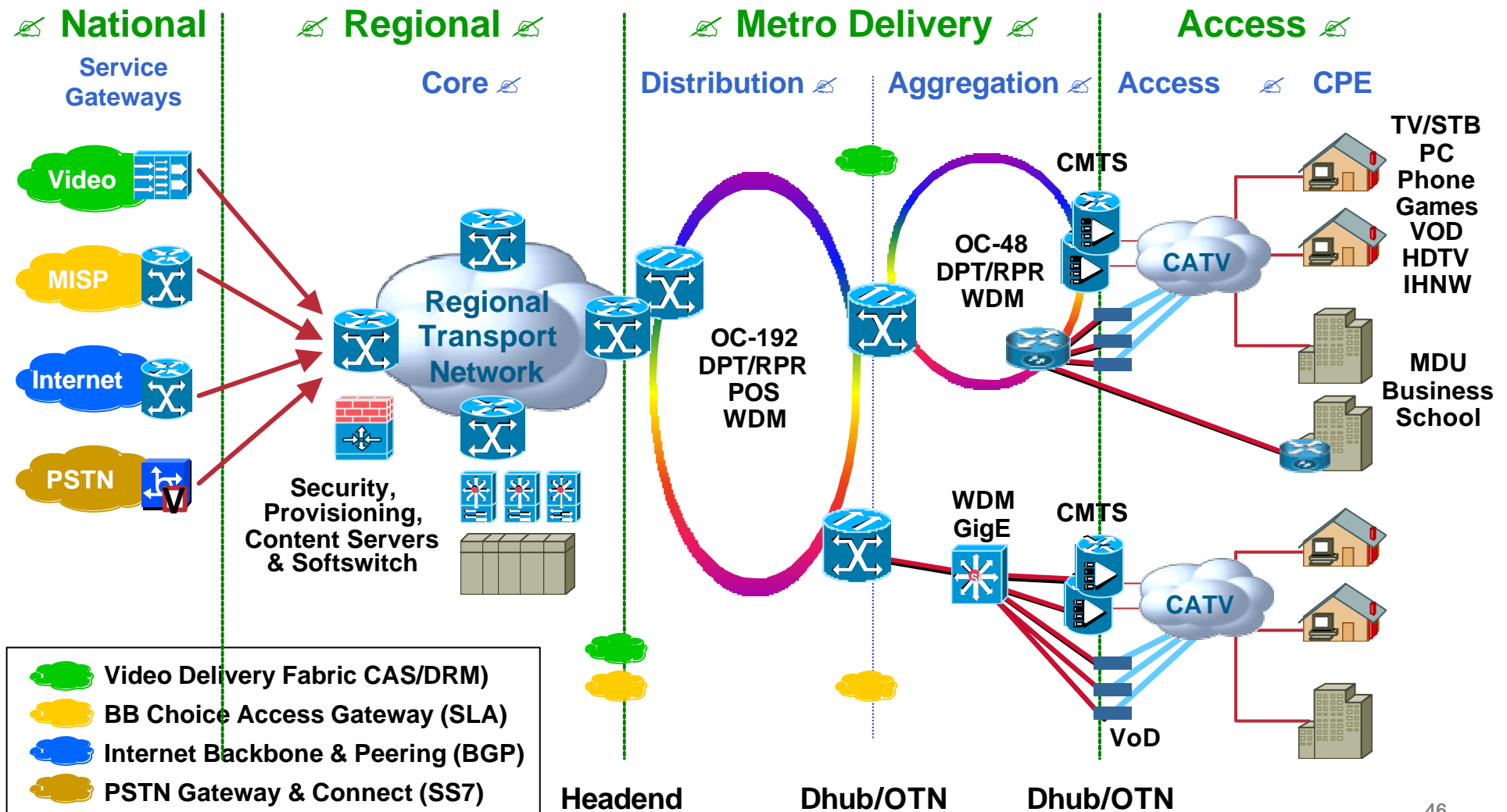
Broadest CMTS Product Line
Market & Technology Leadership
1st DOCSIS 1.1 Qualified L3 CMTS



Cisco Converged Network Architecture for Broadband Networks

Cisco.com

Cable Services Network



CISCO SYSTEMS



EMPOWERING THE
INTERNET GENERATION