



IP + Optical Big Bang Seminar
2001



Welcome ! Cisco MSPP Solution

Cisco.com

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Agenda

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- Today's Metro Optical Transport
- Multi-Service Markets
- How Does Cisco's MSPP(ONS15454/ 15327) Meet Customer Needs?
- Summary of Market Leadership
- Cisco ONS 15454 Release 3.x Launched
- System Description (ONS15454)
- Topologies (ONS15454)
- System Overview (ONS15327)
- Release 3.X Overview (ONS15327)
- Management (ONS 15454/ 15327)
- Applications (ONS 15454)
- Applications (ONS 15327)
- Q & A

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Today's Metro Optical Transport

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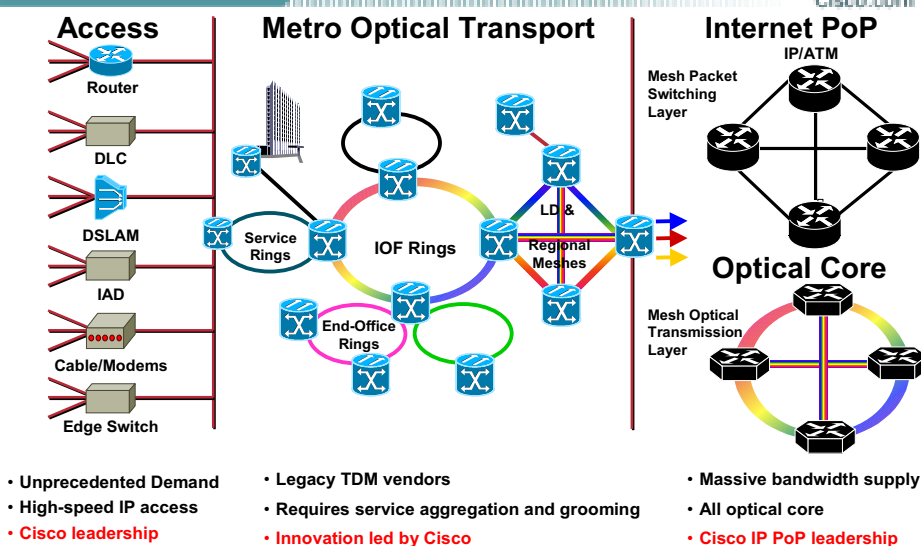
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Break the Transport Bottleneck!

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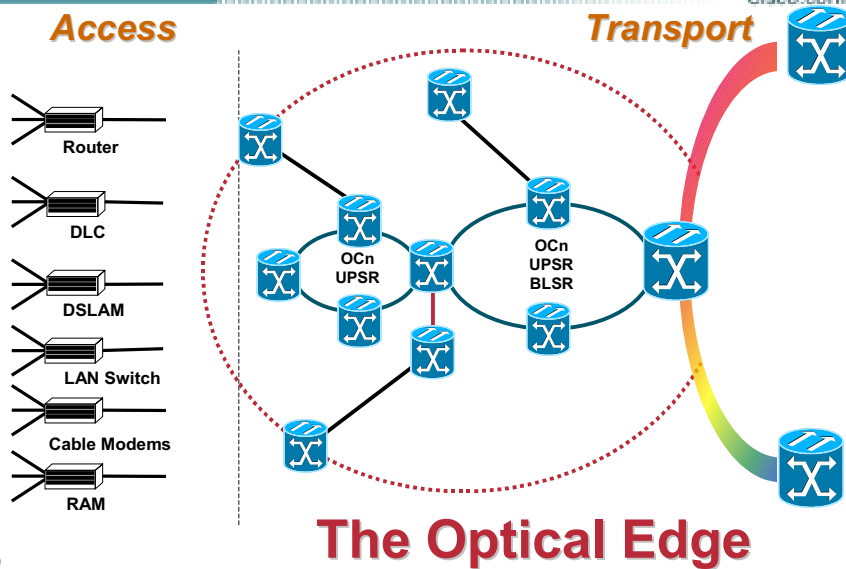


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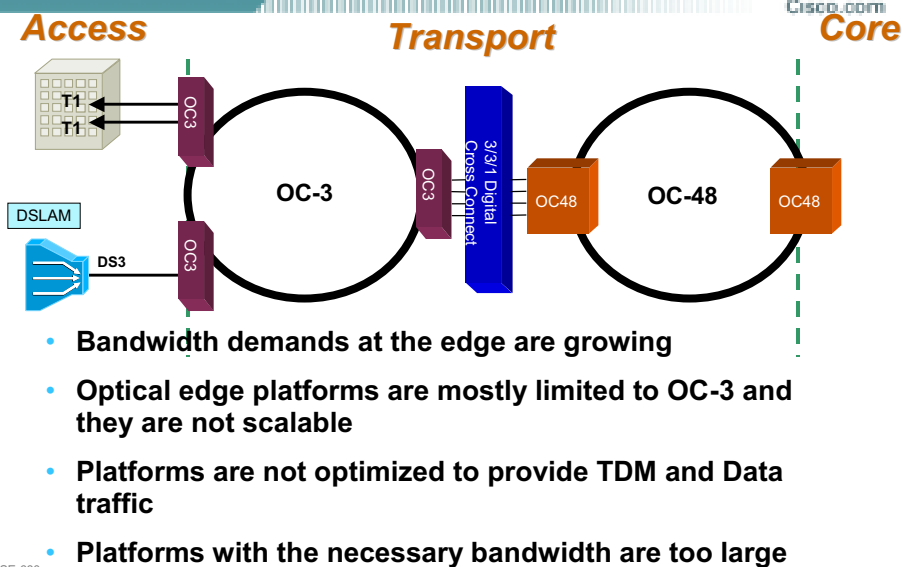
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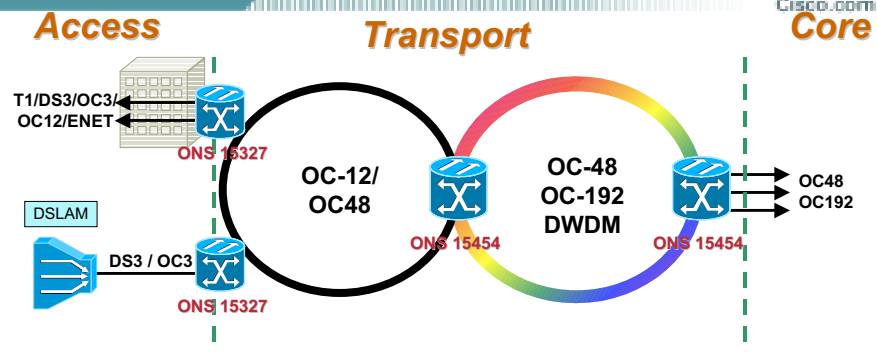
Defining the Optical Edge



Problems With Today's Optical Edge Networks



Solution: Expand the Optical Edge



- Upgrade the edge ring from OC3 to OC-12/OC-48
With a platform designed specifically for the optical edge
- Use a multi-service platform to maximize efficiency

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Multi-Service Markets



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Defining MSPP

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An MSPP is a new network element, designed to replace legacy SONET/SDH ADMs in metropolitan applications, that contains the functionality of a SONET/SDH ADM while adding non-TDM service interfaces, switching fabrics, and transport technology in a single chassis.



**Sterling Perrin,
IDC analyst**

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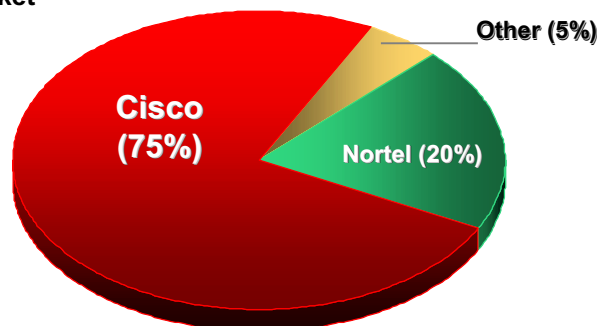
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Cisco Worldwide Leader in MSPP Market Share

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**2000 Worldwide
MSPP Market**



Total = \$1B

Source: IDC

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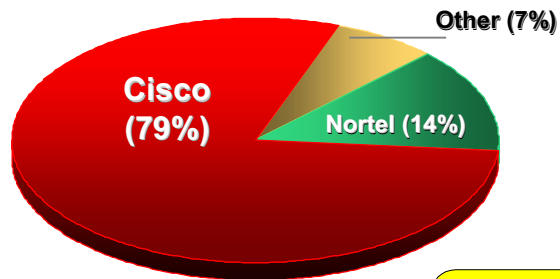
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Cisco #1 in N.A. MSPP Market Share

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2000 North American
MSPP Market (\$900M)
Source: IDC



Potential
Cisco Revenue in 2005?
\$4.8 Billion!!
(80% of \$6 Billion)

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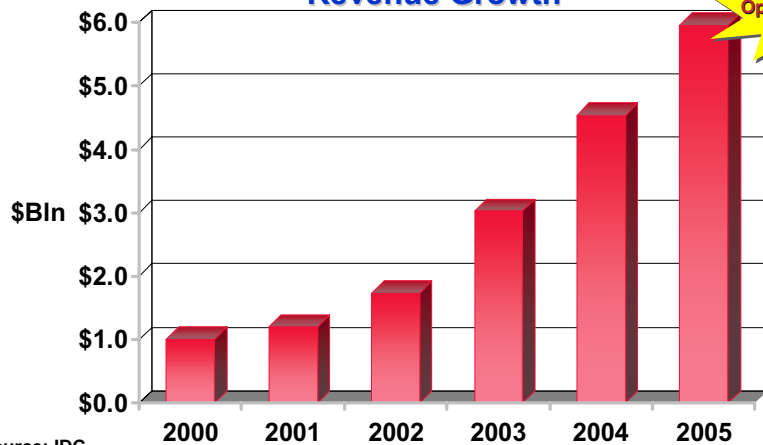
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Opportunity for Growth We Are in a Key Market!

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Worldwide MSPP
Revenue Growth



**\$6 Billion
Opportunity by
2005**

Source: IDC

MSPP = Multi-service Provisioning Platform

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Key MSPP Market Drivers

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- Increased metro capacity requirements
- Competitive metropolitan environment
- Increased data traffic in carrier networks
- Reduced infrastructure costs
- Continued need to balance both TDM voice and data traffic in networks
 - Multiple service types and speeds at the metro edge
 - Need for compatibility with legacy SONET/SDH infrastructure

Many of the N.A. drivers are also seen elsewhere in the world.

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MSPPs Headline Multiservice Networks in Today's Metro

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- MSPPs will enjoy a greater addressable market and generate more revenue than pure-play DWDM products.
- Non-SONET MSPP equipment will fill a niche role in the MSPP market as incumbent carriers migrate toward the technology with which they are most familiar — SONET.

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How Does Cisco's MSPP(ONS15454/ 15327) Meet Customer Needs?

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Customer Needs - Leverage Existing Fiber

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- **OC192 Quadruples System Capacity**
10Gbps per Fiber
- **ONS 15454 OC192**
Supported with deployed systems with simple card swaps
Cost effective bandwidth deployments
- **Capacity Upgrade Synonymous with:**
Moving from a water hose versus a fire hose
From twisted pair to coax
Roller skates to a Ferrari

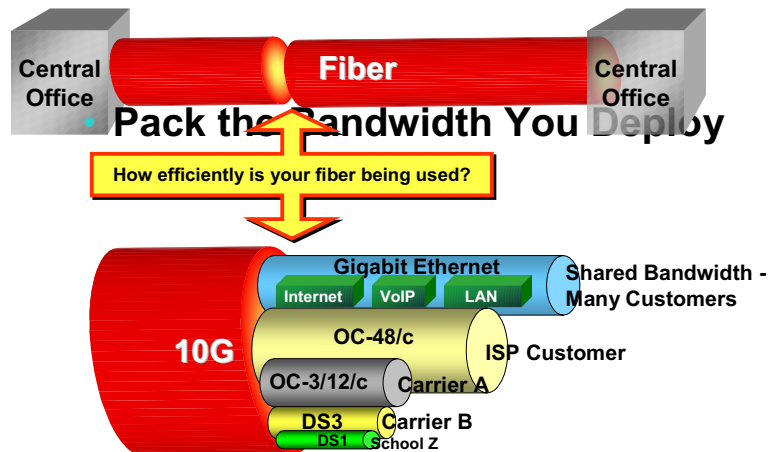
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Customer Needs - Efficient Bandwidth Utilization

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Customer Needs - Lower Transport Costs

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- **Radical Economics**
 - Designed for the Metro Network
 - Low first cost
 - Reduced footprint
 - Reduces long term facility costs
 - Simple engineering and installation
 - Lowers EF&I costs
 - Reduces training expenses and technician downtime

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Radical Economics - Low 1st Cost

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Legacy Vendors - OC192 Platforms

Cisco ONS 15454 - OC192 Platform



• Legacy OC192 Systems

Designed to long haul network's attributes

Limited interface selection or aggregation needed

Costs shared amongst a larger customer base



30 to 50% Savings

• Cisco ONS 15454

Designed for metro network's attributes

Maximum interface selection and aggregation required

Cost shared across smaller customer base

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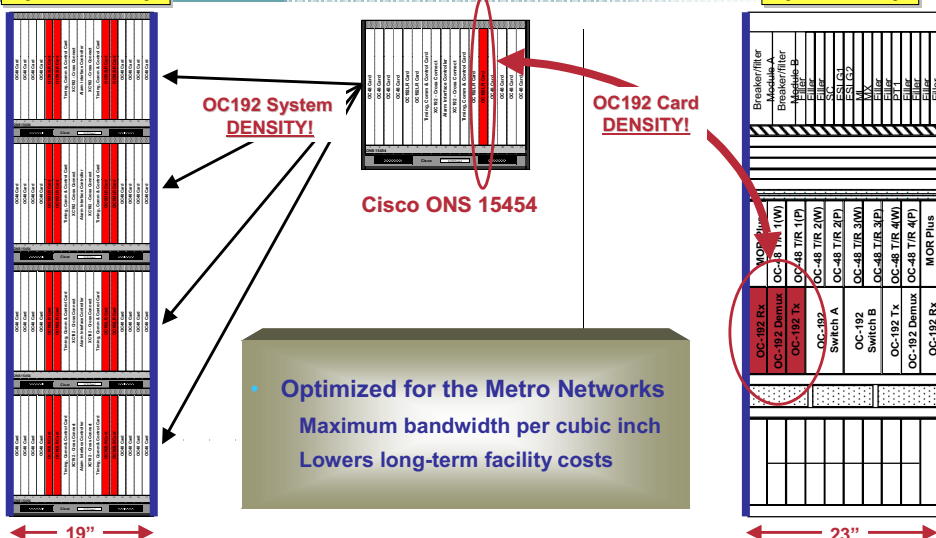
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Radical Economics - Increased Services Density

Cisco Four OC192 Systems / Bay!

Legacy ONE OC192 System / Bay!



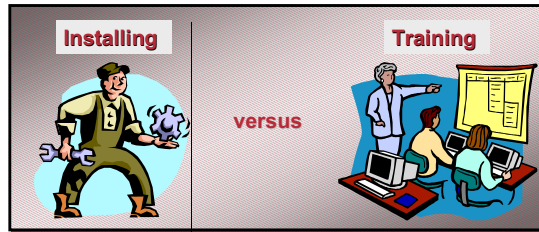
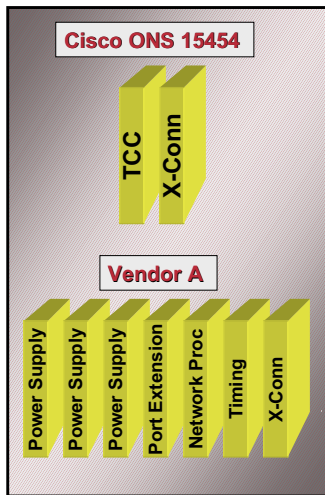
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Radical Economics - Simple to Engineer and Install

Common Equipment



- **Simple, Fast & Easy EF&I**
 - Reduced common equipment circuit packs
 - Simple to configure
 - Reduces spares inventory
- **Simplified training**
 - Improves employee productivity
 - Keeps employees installing equipment versus learning

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ONS 15454 Release 3.x Delivers

- **Scalability**
 - 60Gbps in a single system
 - Up to 10G per slot
 - Leverage deployed shelf assemblies or new installations
- **Improved Economics**
 - 10Gbps per fiber (versus 2.5G)
 - more bandwidth from existing fiber plant
 - Additional multi-service port densities
 - aggregate more customers onto existing infrastructure
 - Ethernet economics

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ONS 15454 Release 3.x Delivers

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- **Increase System Flexibility**
 - More bandwidth per slot
 - Added protection protocols
- **Maintains Radical Economics**
 - Lowering the cost to deploy bandwidth for exploding customer demands

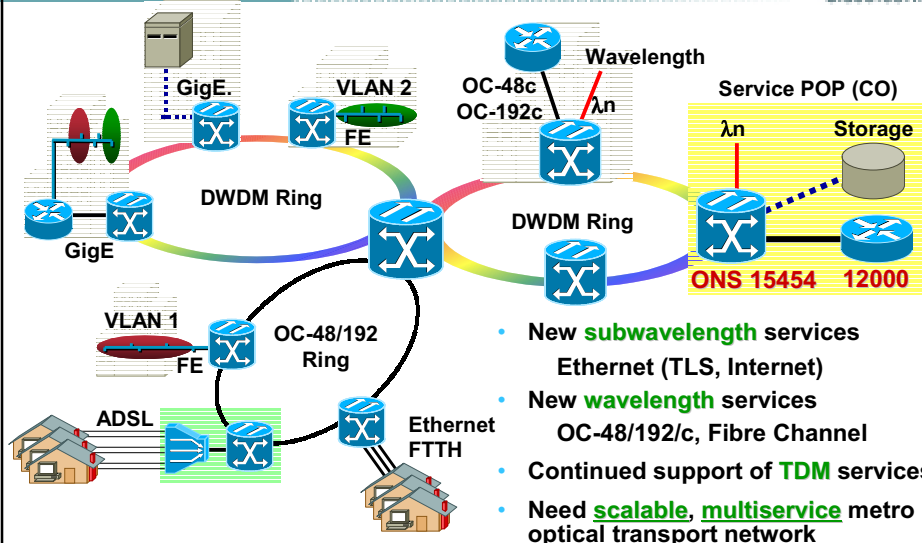
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Multiservice & Scalability Drivers

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Summary of Market Leadership

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Cisco's MSPP (ONS 15454/ 15327)



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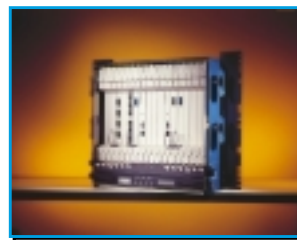
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Cisco ONS 15454 Deployment Update

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- **Customers: 600+ Across All Segments**
 - ✓ Independent LECs
 - ✓ Cable TV Carriers
 - ✓ Competitive Carriers
 - ✓ International
 - ✓ National Carriers
 - ✓ RBOCS
- **30,000+ Systems Shipped / In-Service**
 - No. 1 in OC48 shipments in CY2000 (RHK Jan 2001 report)
 - Projected to be No. 1 in Metro WDM Market in CY2001
 - 30,000 Ethernet and Fast Ethernet Ports Shipped/In-Service
 - 3,000 Gigabit Ethernet Ports Shipped/In-Service
- **All Network Topologies and Configurations Deployed**
- **First Cost and Life Cost Leader!**



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Optical Transport Family

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- The ONS 15327 extends the proven technology of the Cisco ONS 15454
- End-to-end integrated network management
- Scalability and flexibility
- Bandwidth on demand



Evolutionary, Radical Economics

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**Cisco ONS 15454
Release 3.x Launched
at**

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SUPERCOMM 2001



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Supercomm 2001 Details

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- What is it?: Largest service provider trade show in North America
- **Over 60,000 attendees!**
- Cisco OTBU demo:
 - Two ONS 15454 nodes in a 4F OC-192 BLSR ring
 - Displayed 4-port gig and OC-12 cards

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Supercomm Analyst Soundbites

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"When a company builds an over 600 customer base as quickly as Cisco has with the 15454, **it is obvious it is doing something right!**"
-- Current Analysis

The "ONS 15000 series includes the 15454, Cisco's **massively successful** SONET add-drop multiplexer."
-- Light Reading

"In the key metro optical arena, we believe **Cisco has now been successful in securing relationship's with at least 2 large incumbent carriers** in North America....We remain hopeful that Cisco could begin to see initial revenues from some of these new partners late in Calendar 3Q01."
-- Lehman Brothers

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Cisco ONS 15454

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System Description



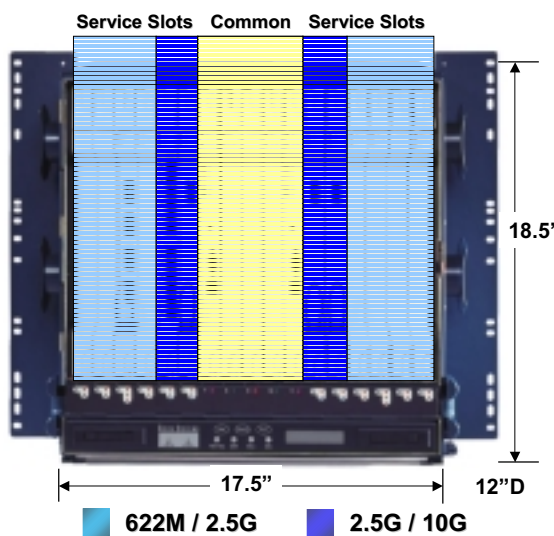
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Cisco ONS 15454 Chassis Design

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- **12 Universal Slots**
 - TDM electrical cards
 - OC-N optical cards
 - Ethernet/FE/GigE cards
 - Each provisionable for network and drop-side
- **5 Common Slots**
 - Redundant TCCs
 - Redundant XCs
 - Optional AIC
- **Compact Chassis**
 - Installs in 19" or 23" bay
 - Up to 4 chassis per 7' bay
 - (including 1.75" fuse and alarm panel)

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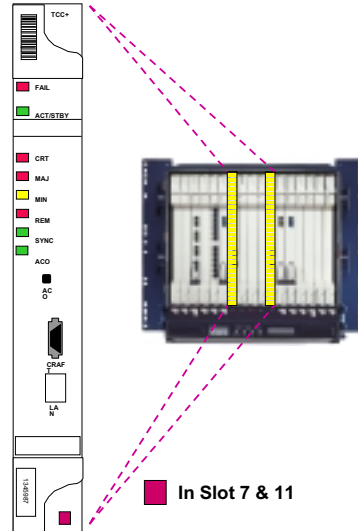
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System Common Equipment

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- **Timing Communications and Control (TCC+)**
 - System and Network Processor
 - OAM&P
 - TL-1, SNMP, and CORBA
 - 2 RS-232 and 3 10-Base-T ports
 - Synchronization
 - 2 T1 BITS inputs
 - 2 T1 BITS outputs
 - Line timing support
 - Synchronous Status Messaging
- In-Service Software Upgrades
- Fully Redundant - Hot / Standby



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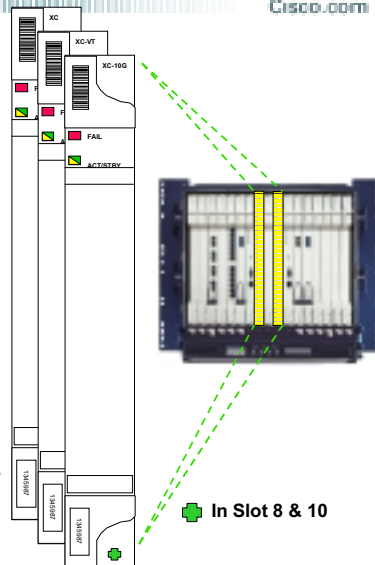
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System Common Equipment

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- **XC Cross Connect Card**
 - 288 STS-1 equivalent ports
 - Fully non-blocking at STS level
 - STS-1/3c/6c/12c/48c X-connects
- **XC-VT Cross Connect Card**
 - 288 STS-1 equivalent ports
 - Fully non-blocking at STS level
 - 672 VT1.5 ports via 24 STS logical ports
 - VT1.5 & STS-1/3c/6c/12c/48c X-connects
- **XC-10G Cross Connect Card**
 - 1152 STS-1 equivalent ports
 - Fully non-blocking at STS level
 - 672 VT1.5 ports via 24 STS logical ports
 - VT1.5 & STS-1/3c/6c/12c/48c/192C X-connects
- In-service Up-gradable
- Fully Redundant - Hot / Standby



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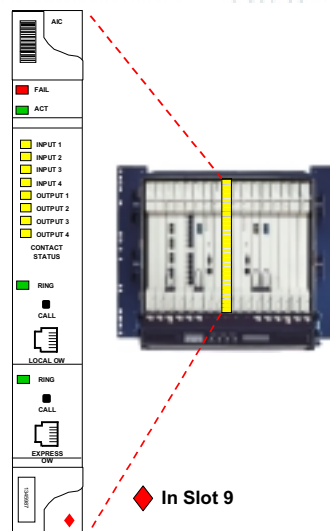
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Alarm Interface Controller

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- **Customer Defined Alarm Contacts**
 - 4 Inputs
 - Severity, 63 character description
 - 4 Additional Outputs
 - Triggered by definable alarm condition
 - 50V, 100mA, normally open/closed
 - Virtual Wire between sites
- **Orderwire**
 - 4 channels supporting, linear, single, dual and hub-n-spoke configurations
 - Use E1/E2 SONET overhead bytes
- **Optional**
 - Supplements the 4 standard severity-based alarm outputs



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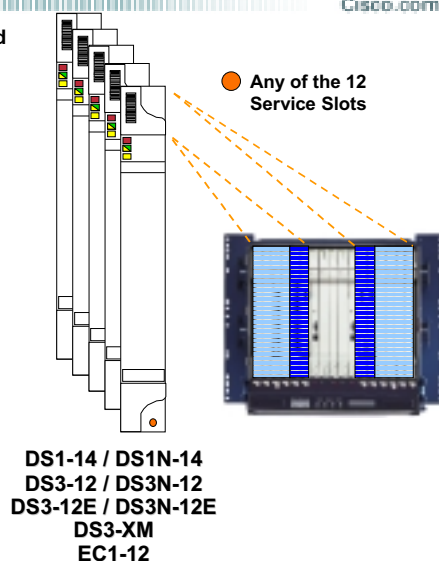
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Electrical TDM Interface Cards

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- **14 port DS1 Card**
 - Superframe, extended superframe and unframed
 - Async mapping into VT
 - 0:1, 1:1, 1:N<=5 protection
- **12 port DS3/E Cards**
 - Auto detection of M23, C-bit or unframed
 - Enhanced Perf. Mon. Option
 - SPE mapping into STS-1
 - 0:1, 1:1, 1:N<=5 protection
- **6 port DS3 Transmux Card**
 - M13 format
 - VT mapped into STS-1
 - 0:1, 1:1 protection
- **12 port EC-1 (STS-1E) Card**
 - SONET SPE or VT mapping
 - 0:1, 1:1 protection



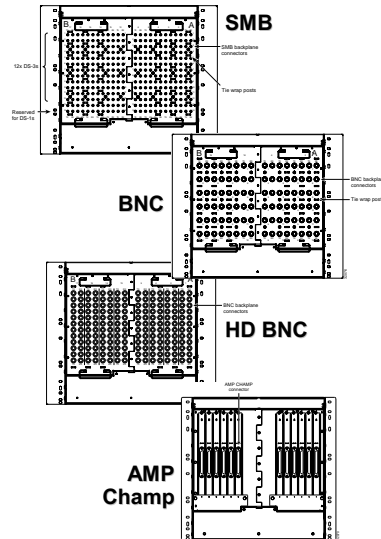
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Electrical Interface Adapter (EIA) Options

- A & B sides equipped independently
- SMB Backplanes (per side)
 - Support up to 72 DS3 or 84 DS1 (DS1 with balun) terminations
- BNC Backplanes (per side)
 - Standard - supports 24 DS3 terminations
 - High Density - supports 48 DS3 terminations
- AMP Champ Backplanes (per side)
 - Supports up to 84 DS1 connectorized terminations
- Blank Backplanes (per side)



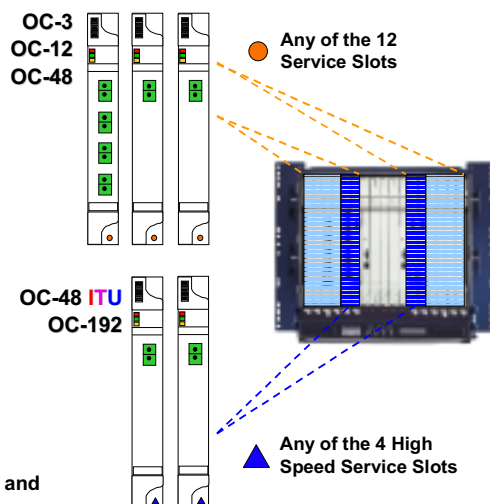
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Optical Interface Cards

- 4 port OC-3 / STM-1 Card
 - 1310nm IR SC (13dB)
- 1 port OC-12 Card
 - 1310nm IR SC (13dB)
 - 1310nm LR SC (25dB)
 - 1550nm LR SC (25dB)
- 1 port OC-48 Card
 - 1310nm IR SC (13dB)
 - 1550nm LR SC (26dB)
- 1 port OC-48 ITU ELR Card
 - 18I 15xx.xx nm ELR SC (26dB)
 - 37I 15xx.xx nm ELR SC (26dB)
- 1 port OC192 / STM64 Card
 - 1550nm LR SC (24dB)
- Cards Support
 - 1+1 APS or UPSR, 2F-/4F-BLSR and unprotected modes



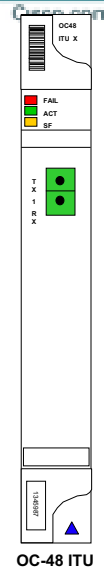
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OC48ELR 200GHz ITU DWDM Grid Optics

- **Designed for 16 λ DWDM Solutions**
 - 18 ITU wavelengths
 - Allows supports for third party vendor passive filters
- **Performance**
 - 200GHz laser stability
 - +/-0.25nm
 - Single channel link budget: 26db
 - Up to 80Km over un-amplified SMF28 links
 - Dispersion tolerance: **3600** ps/nm
 - Up to 200Km over amplified SMF28 links



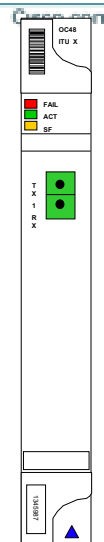
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OC48ELR 100GHz ITU DWDM Grid Optics

- **Designed for 32 λ DWDM Solutions**
 - 37 ITU wavelengths
 - Allows supports for third party vendor passive filters
- **Performance**
 - 100GHz laser stability
 - +/-0.12nm
 - Single channel link budget: 26db
 - Up to 80Km over un-amplified SMF28 links
 - Dispersion tolerance: **5400** ps/nm
 - Up to 300Km over amplified SMF28 links
 - Backwards compatible with deployed 200GHz filter solutions



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OC48ELR Wavelength Plans

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λ	200 GHz	100 GHz	λ	200 GHz	100 GHz
1528.77			1546.12		
1530.33			1546.92		
1531.12			1547.72		
1531.90			1548.51		
1532.68			1549.32		
1533.47			1550.12		
1534.25			1550.92		
1535.04			1551.72		
1535.82			1552.52		
1536.61			1553.33		
1537.40			1554.13		
1538.19			1554.94		
1538.98			1555.75		
1539.77			1556.55		
1540.56			1557.36		
1541.35			1558.17		
1542.14			1558.98		
1542.94			1559.79		
1543.73			1560.61		
1544.53			1563.00		
1545.32					

 Colored boxes represent supported wavelengths

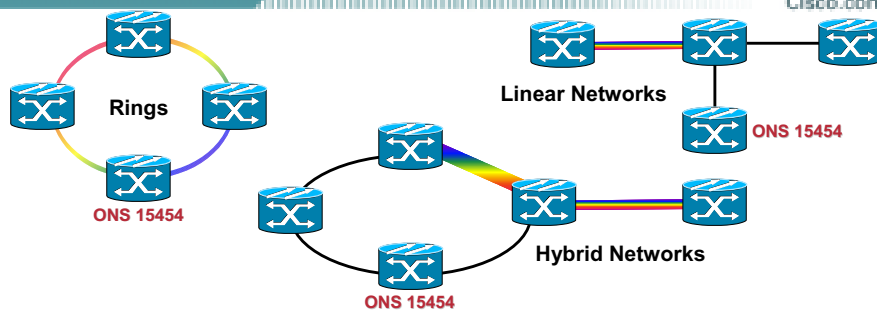
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Integrated DWDM Application

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- Combining ONS 15454 with ITU Optics and ONS 15216
1 λ , 2 λ , and full wavelength mux/demux
Optical amplification and performance monitoring
- Flexible to support all network topologies
- Deploy integrated DWDM solution on selected routes
Experiencing fiber exhaust or expecting high bandwidth growth

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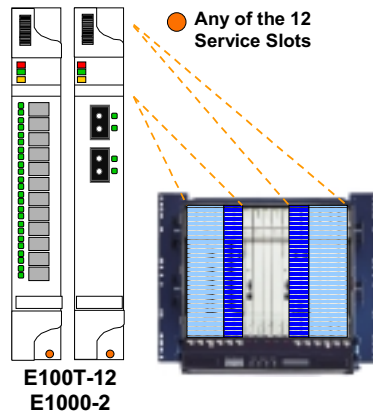
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Switched Ethernet Interfaces

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- 12 port Ethernet/Fast Ethernet Card
Auto-sensing 10BaseT or 100BaseT
- 2 port Gigabit Ethernet Card
1000Base-SX/LX GBIC for SM/MM fiber
- Per Ethernet broadcast domain
8000 MAC addresses
519 VLANs
- RFC 1619 encapsulation
- Ethernet switching with IEEE 802.1D
Spanning Tree Protection
- 2 level priority IEEE 802.1p
- Logical VLANs IEEE 802.1q
- Flow Control with IEEE 802.3X



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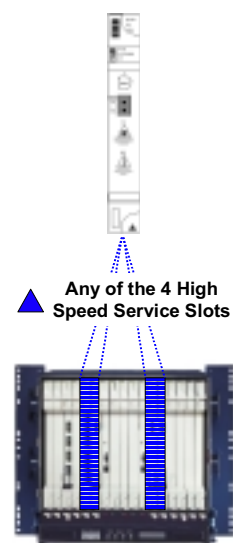
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Introducing the 10G Interface!

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- OC-192 / STM-64 Optical Interface Card
Single slot Tx/Rx card!
Long reach optics
24dB optical link budget
80Km reach over SMF fiber
1600 ps/nm dispersion tolerance
1550nm with angled SC connector
- Provisionable for SONET/SDH support
- Requires XC10G Cross Connect Card
- Operates in any high speed slots
Up to (4) OC-192 per shelf
- Unprecedented 10Gbps economics



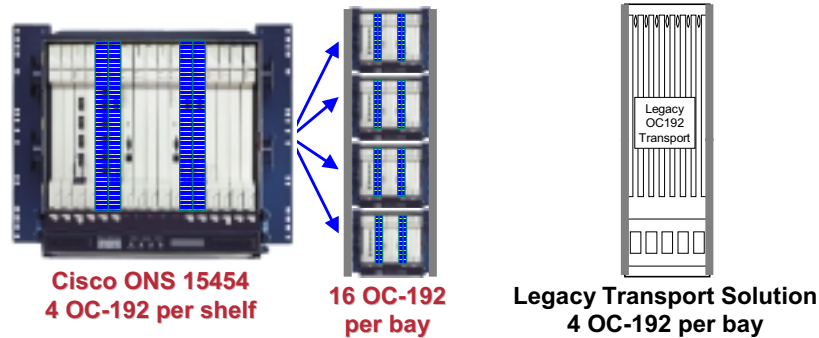
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Unprecedented OC-192 Density

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- **Multiply industry 10G density by 4x to 8x!**
Over existing legacy transport equipment
- **Enable economical, high bandwidth IDC collocations and FTTB deployments**

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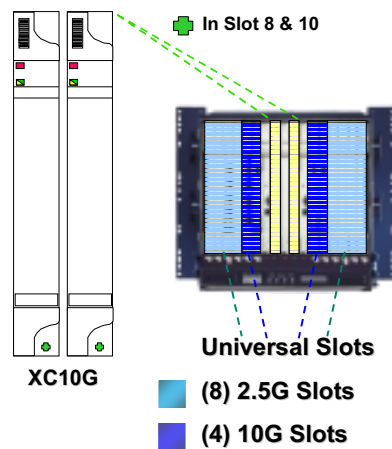
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Expanded Cross Connect

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- **XC10G Cross Connect Card**
 - 1152 STS-1 equivalent ports
 - Fully non-blocking at STS levels
 - 672 VT1.5 ports via 24 STS logical ports
 - VT1.5 & STS-1 / 3c / 6c / 9c / 12c / 48c / 192c cross-connects
 - Fully Redundant - Hot / Standby
- **Required for 10G transport**
- **In-service hitless shelf upgrade**
 - XC/XC-VT to XC10G
 - 4X capacity upgrade (15G to **60G**)
- **All existing cards are supported!**
 - Investment protection



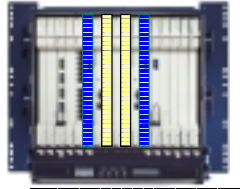
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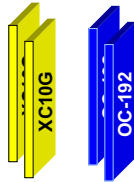
48

In-Service Upgrade to OC-192

Cisco **OC48**
ONS 15454

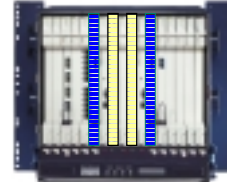


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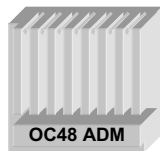


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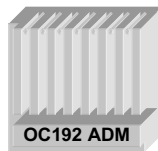
OC192
ONS 15454



Legacy Platforms



+



=



- Simple Card Upgrades vs. Forklift to Cascade Boxes!

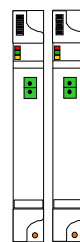
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Any Slot OC-48 Cards

- Any Slot OC-48 / STM-16 LR Optics
1550nm with 26dB optical link budget
Angled SC connector
- Any Slot OC-48/STM-16 IR Optics
1310nm with 13dB optical link budget
Angled SC connector
- Operate in any of the 12 multi-service slots
- Existing OC-48 "high speed" modules are supported in the high speed slots

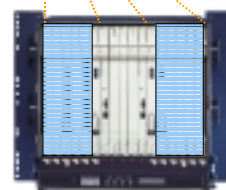


OC-48AS LR
OC-48AS IR

Shelf density:

- 6 OC-48 APS
- 5 OC-48 2F Rings
- Full, 4 protected OC-48 drops from a 2F or 4F OC-192 ring

Any of the 12 Service Slots



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50

4 Fiber BLSR

- **4F BLSR Support**

Convenience of one software load supporting all topologies and protection mechanisms

All Ring Types

UPSR

2 Fiber BLSR

4 Fiber BLSR

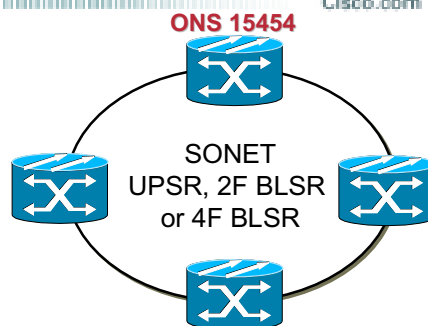
Linear - 1 + 1 APS

uni-directional

bi-directional

Mesh

Path Protected Mesh Networking (PPMN)



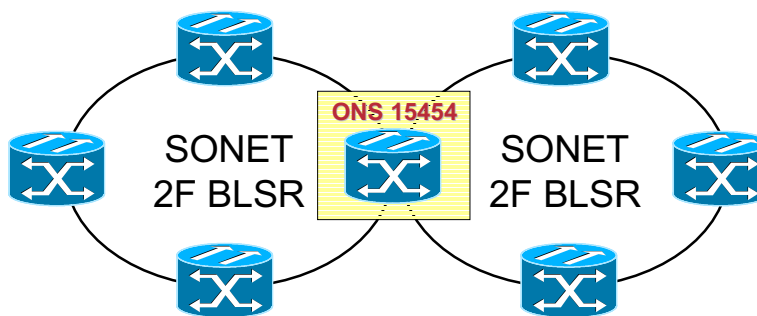
• **No Software Fees Per Feature!!**

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Further BLSR Capabilities



- **2 x 2F BLSR support on a single shelf**
Up to 3 additional UPSR can also be subtended
- **>16 nodes per BLSR ring**
Supports up to 24 nodes

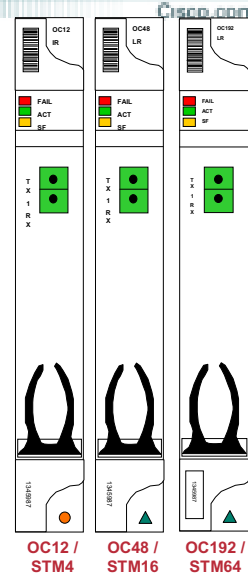
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SONET / SDH Optics

- SONET / SDH family of optic cards
 - OC3 / STM1 (mixed port support)
 - OC12 / STM4
 - OC48 / STM16
 - OC192 / STM64
- Software provisionable on **existing cards**
- SOH, LOH and pointer conversions
- SDH payload mapping to STS-Nc granularity
 - VC-4 to STS-3c
 - VC-4-4c to STS-12c
 - VC-4-16c to STS-48c
 - VC-4-64c to STS-192c
- Eliminate need for separate SDH network to transport STM services



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Provisionable Alarms

- Increased System Flexibility
 - Allows provisioning of:
 - Alarm severity (critical, major, minor)
 - Service affecting designation (not reported, not alarmed)
 - For alarm types LOS, LOF, LOP, AIS, RFI, SFBER, SD-BER and RAI
 - Multiple User Defined Alarm Profiles
 - Profile 0: Default (Telcordia GR-253)
 - Profile 6: Alarm Suppressed
 - Profiles 1 thru 5: User defined
- User can suppress alarms on a port by port basis

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Simple Bandwidth Upgrades

CISCO.COM

- **Span upgrade wizard**
Simple, fast and easy!
- **Allows network to scale with increasing customer demands**
- **Supported span upgrades**
 - OC12 to OC48
 - OC12 to OC192
 - OC48 to OC192
- Over Protection types**
 - UPSR
 - BLSR
 - APS



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High Density Optics

Available Soon

- **High Density OC12 / STM4IR Optics Card**

Enables:

Increase revenue generating interfaces per shelf

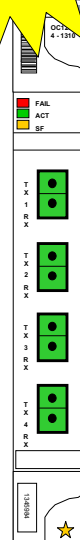
Decreases network cost - fewer cards and shelves

Four ports per card

Provisionable by port for SONET or STM

Cost effective 1310nm optics

Identical 12dB optical link budget as current OC12IR card



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Gigabit Ethernet Transport

Available Soon

- **Four Port Gig-E Card**

Provides Layer 1 Gigabit Ethernet Transport

Point-to-point circuits

Configurable transport bandwidths

Up to STS-48 per card

Enables scaled transport bandwidth

STS1/3c/6c/12c/24c & 48c per port selectable

Simple circuit provisioning leveraging CTC's A-to-Z provisioning

GBIC Interface Slots Support:

SX short reach, 500m

LX long reach, 10km

ZX very long reach, 40km

802.3z Flow Control

Ultra Low Latency Ethernet Transport



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Cisco ONS 15454

Cisco.com

Topologies



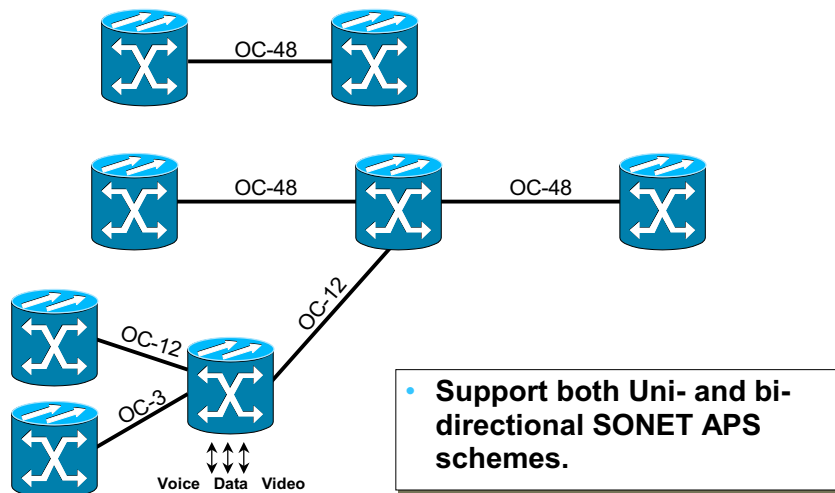
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Terminal, Linear Pt-to-Pt & Add/Drop Topologies

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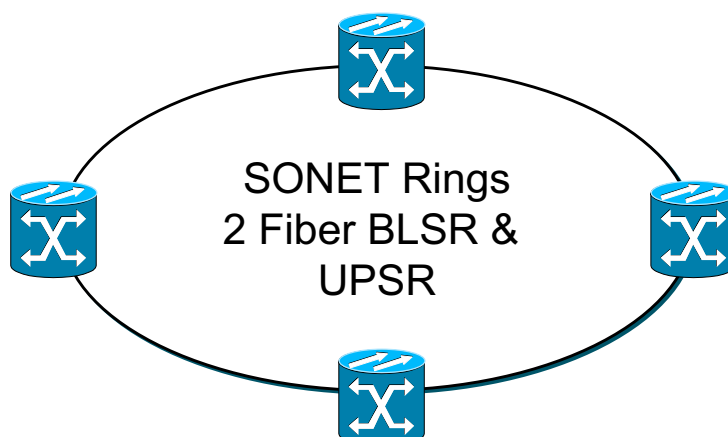
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SONET Ring Topologies

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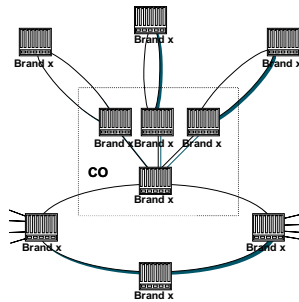
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Multiple Subtending Rings

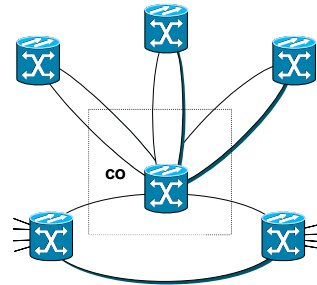
Cisco.com

Traditional Multi-Ring Implementation



- Expensive, many shelf solution
- Cumbersome shelf to shelf interconnections
- No ring to ring provisioning

15454 Multi-Ring Implementation



- Shares cost of shelf and common equipment for lower network cost
- Supports electronic cross connect capabilities vs manual shelf interconnects
- A to Z, ring to ring provisioning

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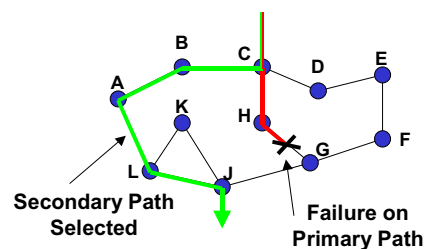
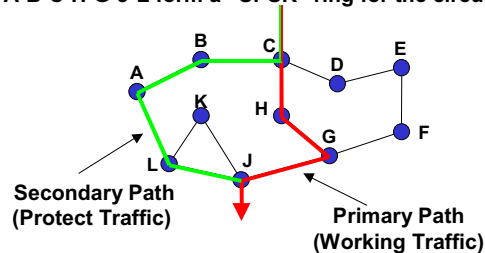
61

Path Protected Mesh Networking (PPMN)

Cisco.com

- Optical path protection over meshed topology
 - Similar to UPSR protection
- Redundant circuit paths diversely routed upon initial connection request
 - Based on open shortest path algorithm
- Less than 50ms switch over

A-B-C-H-G-J-L form a "UPSR" ring for the circuit.



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Cisco ONS 15327

Cisco.com

System Overview



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ONS 15327 Today

Cisco.com

- **SONET cross-connect / processor**

XTC-14

14 DS-1s

XTC-28-3

28 DS-1s

3 DS-3s

- **Optical interfaces**

OC3 IR, 4 port

OC12 IR, + OC12 LR

OC48 IR, + OC48 LR

- **Data interfaces**

10/100BaseT, 4 ports



Additional Enhancements

- + **2-fiber BLSR**
- + **Industrial temperature**
- + **CTC enhancements**
- + **IPPM**
- + **In-service Upgrades XTC-14 to XTC-28-3**

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OC3/STM-1 Intermediate Reach Hi-Density Optical Card

Cisco.com

- Four Intermediate Reach (IR) Tx/Rx optical interfaces
- Provisionable for SONET OC-3 or SDH STM-1 (tunneling)
- 1310 nm optics
- LC connectors (small form factor)
- Flexible protection options
 - 1+1, UPSR or PPMN (BLSR not supported)
- Link budget: 13 dB
 - Tx: -8 to -15 dB
 - Rx: -8 to -28 dB
- Industrial temperature rated (-40 to +65 deg C)



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OC12/STM4 Long Reach Optical Card

Cisco.com

- One Long Reach (LR) Tx/Rx optical interfaces
- Provisionable for SONET OC-12 or SDH STM-4 (tunneling)
- 1550 nm optics
- SC connectors
- Flexible protection options
 - 1+1, UPSR, BLSR, or PPMN
- Optical characteristics
 - Link budget: 26 dB
 - Tx: +3 to -2 dB
 - Rx: -8 to -28 dB
- Industrial temperature rated (-40 to +65 deg C)



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OC48/STM16 Long Reach Optical Card

Cisco.com

One Long Reach (LR) Tx/Rx optical interfaces

Provisionable for SONET OC-48 or SDH STM-16 (tunneling)

1550 nm optics

SC connectors

Flexible protection options

1+1, UPSR, BLSR, or PPMN

Optical characteristics

Link budget: 26 dB

Tx: +3 to -2 dB

Rx: -8 to -28 dB

Industrial temperature rated (-40 to +65 deg C)



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BLSR Networking

Cisco.com

- **Additional system flexibility**

Supports

2F-BLSR in addition to UPSR and 1+1

Two, 2F-BLSR per node

OC-48 line rate

OC-12 line rate

Up to 25 nodes per BLSR

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Cisco ONS 15454/ 15327

Cisco.com

Management



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Cisco Transport Controller *Revolutionary Craft System*

Cisco.com

- Integrated GUI craft system
- 100% free JAVA application
- Auto-discover systems & networks
- Breaks the mold of legacy CLI craft interface
 - Full GUI; no commands to remember
 - Subnetwork scope for ~50 nodes
 - Auto-routed A-Z circuit provisioning
- Task-oriented tool targeted at
 - Installation & turn-up
 - Maintenance & troubleshooting
 - Provisioning & control of a subnetwork
 - Handle transport and data functions



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Cisco Transport Manager

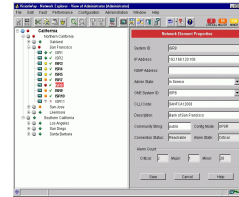
CISCO.COM

- **Client/server-based EMS for Cisco Optical Transport Solution**

Follow open TMN framework

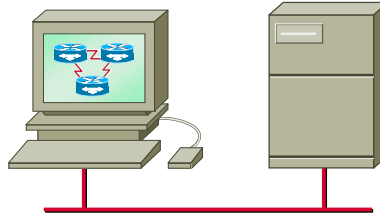
FCAPS and Circuit Management

Scalable (Target 1000 nodes / 100 users)



CTM Client

Java application
Solaris 2.6
Windows NT / 95



CTM Server

Sun UltraSparc 60
Solaris 2.6

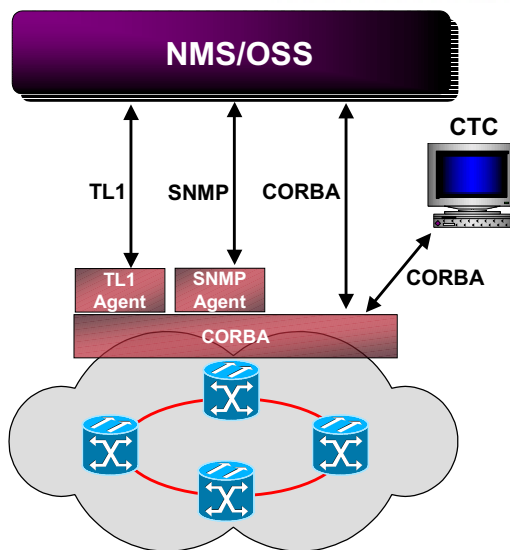
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Cisco ONS 15454 NMS/OSS Interface Options

CISCO.COM



- **TL1**

Alarm and event reporting
Configuration and PM
Telcordia OSS certified (R3.0)

- **SNMP**

Trap and Gets support
IETF standard MIBs
SNMP v1 or v2c
Tested with HP Openview

- **CORBA**

Alarm and event notifications
Performance management
Connection management
Equipment Inventory
CORBA 2.1

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Cisco ONS 15454

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Applications



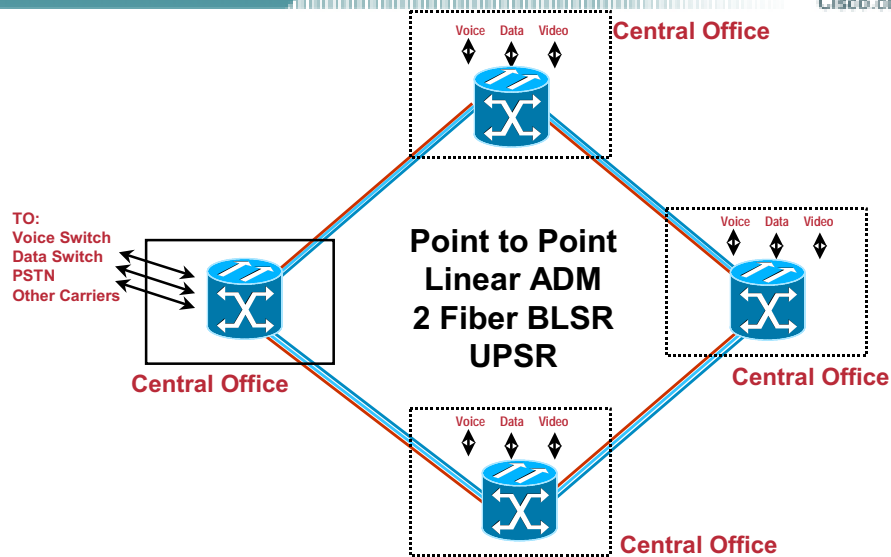
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Traditional Interoffice Transport

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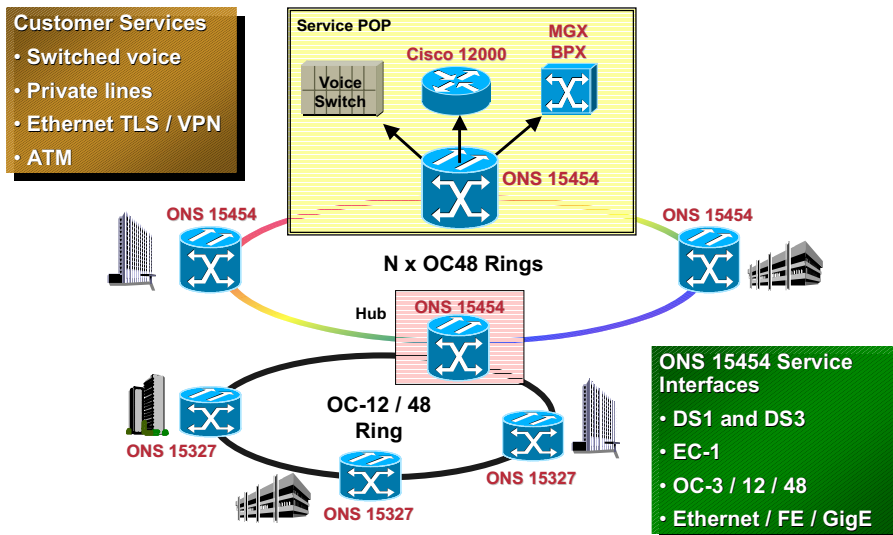
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Metro Transport Services

CISCO.COM



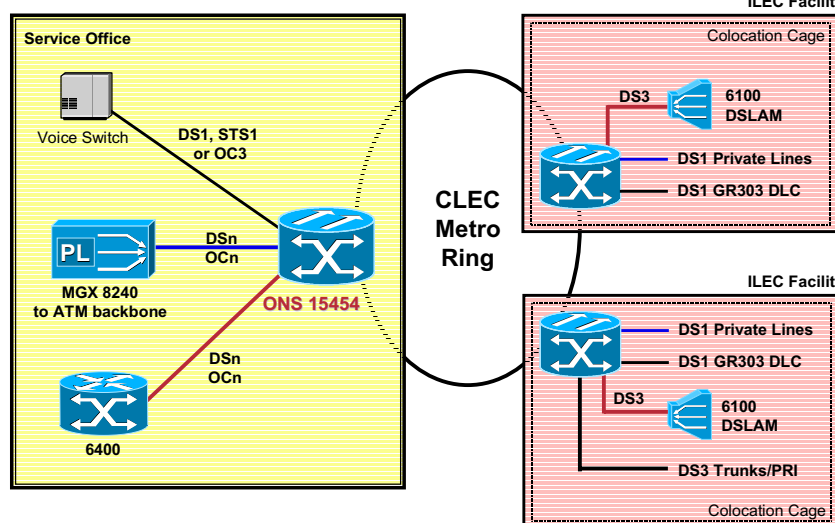
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Intra-City CLEC to ILEC Colocations

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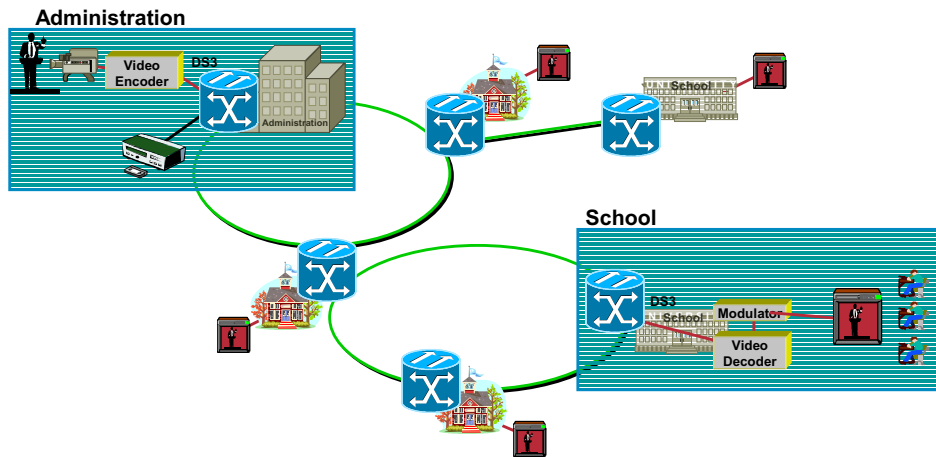
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Video Distribution Network

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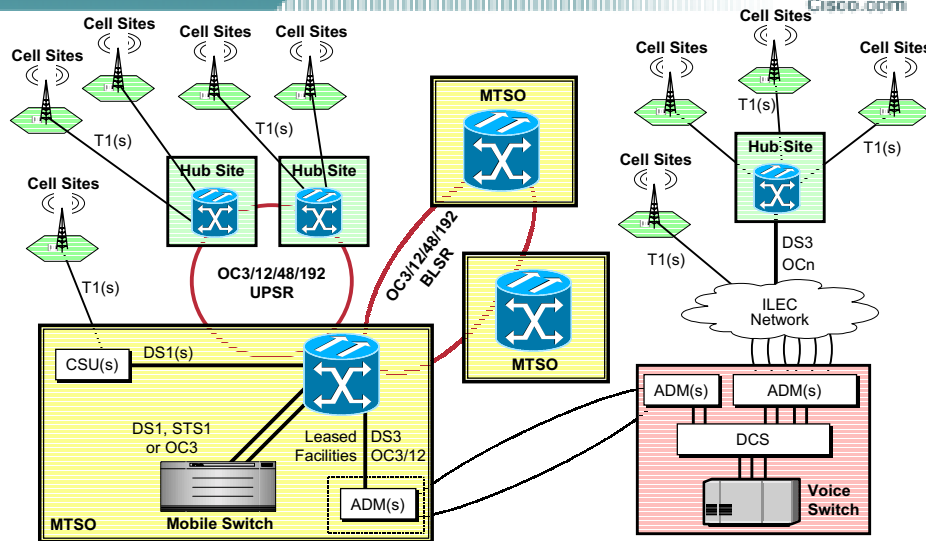
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Wireless Networking - Optical Transport Bandwidth Mgmt.

CISCO.COM



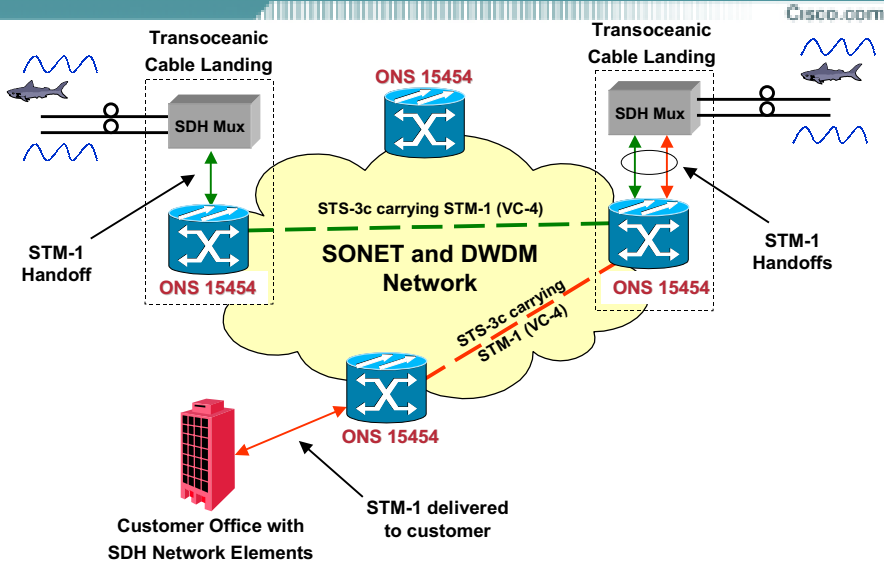
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MTSO = Mobile Telephone Switching Office

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Carrier End-to-End STM-1/4/16 Circuit Support

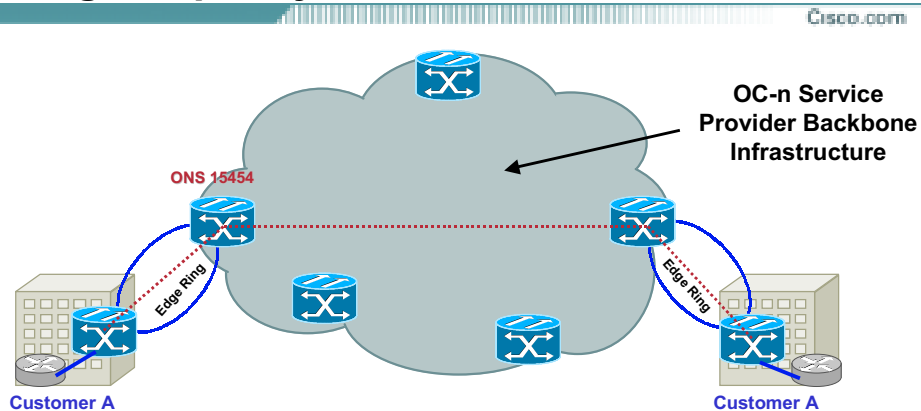


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High Capacity Ethernet Service



- **High Bandwidth Interface**
Customer can grow into bandwidth
No truck roll to customer sites for bandwidth increases

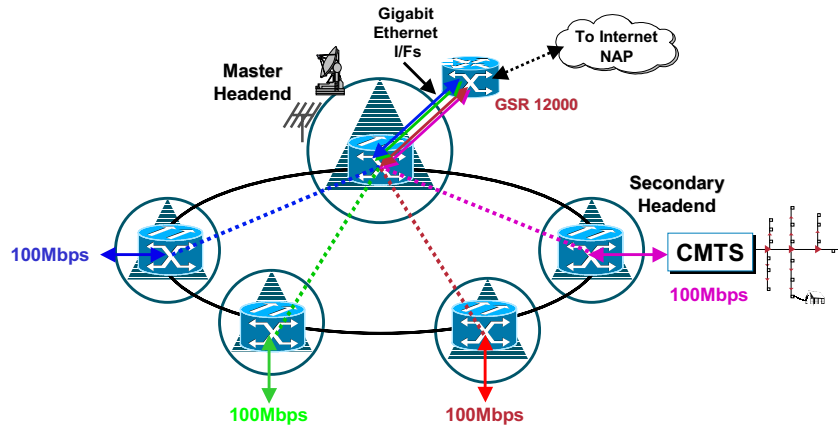
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Cable Modem Aggregation

CISCO.COM



- Scales to Meet Cable Modem Growth
50Mbps to 150Mbps to 300Mbps to 622Mbps via Gigabit Interface

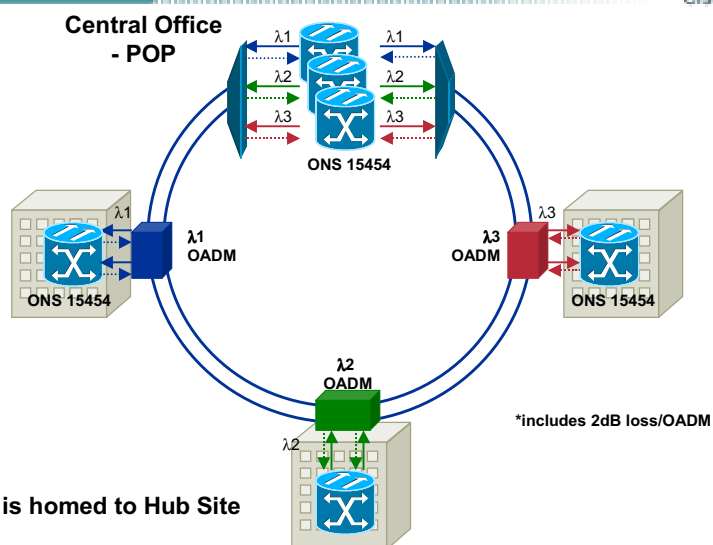
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High Bandwidth Metro Optical Network

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Cisco.com

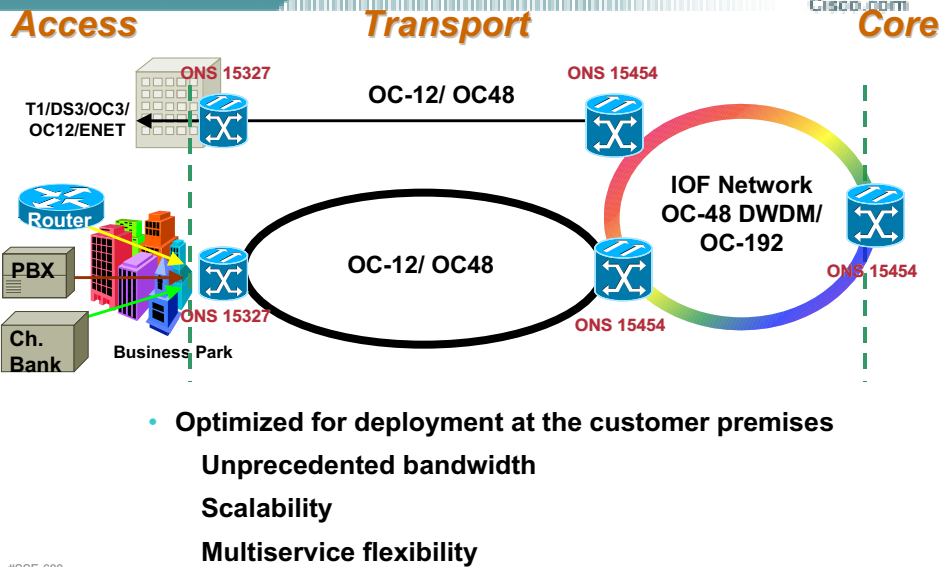
83

[Cisco.com](http://www.cisco.com)

-
- The diagram illustrates a Metro Ethernet Network Architecture. On the left, a 'METRO' label is positioned above a city skyline. Below the skyline is a 'Router' icon. To the right of the router is a 'PBX Channel Bank' represented by three brown boxes. Further right is a 'DLC' (Data Link Control) box, which is connected to two small house icons. The network is divided into three main sections: 'Edge', 'Core', and 'Network'. The 'Edge' section is highlighted in green and contains a 'Router' icon. The 'Core' section is highlighted in red and contains a 'Core' label with a red arrow pointing towards the right. The 'Network' section is highlighted in purple and contains a 'Network' label with a purple circle. The network is composed of several nodes, including 'ONS 15454', 'ONS 15327', and 'OC-1248'. The nodes are interconnected by lines, with labels such as 'OC-1248' and 'ONS 15454' indicating the specific connections and equipment used.

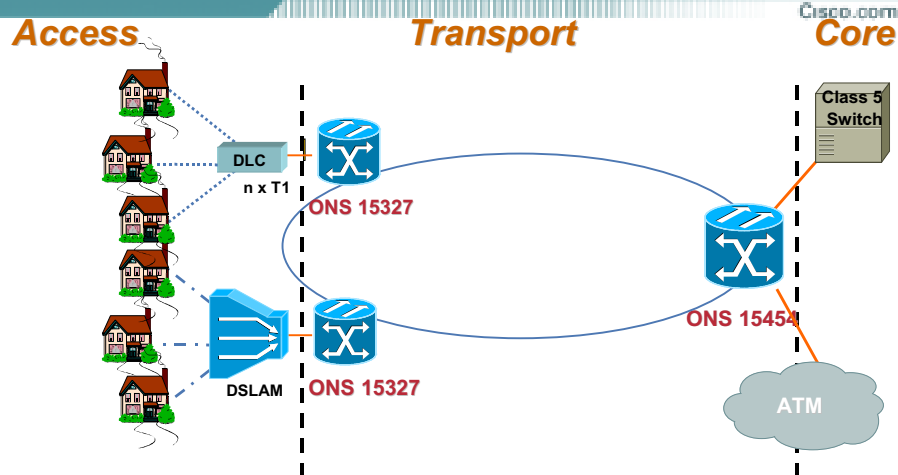
84

Fiber to the Building Applications



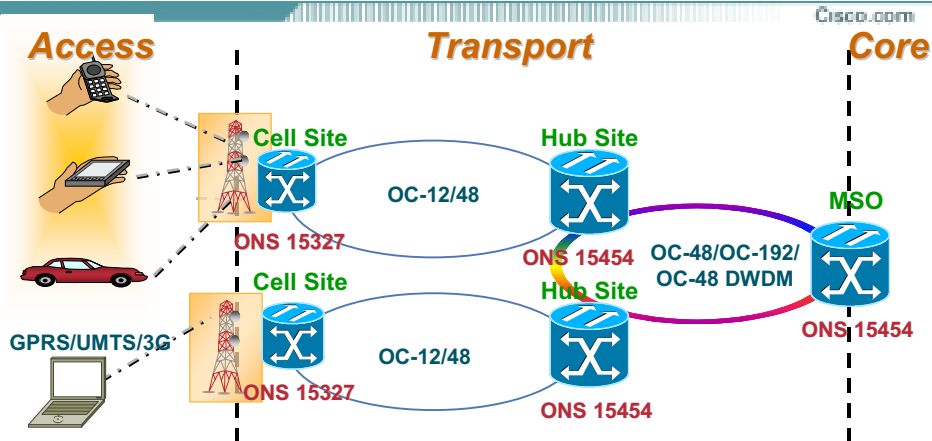
85

DSL & DLC Aggregation



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Wireless Applications



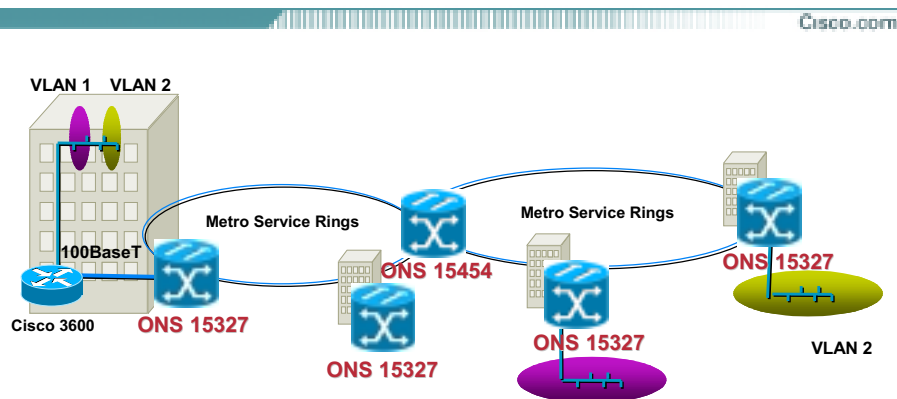
- Build a “future proof” transport network supporting today's TDMA/CDMA **TDM** based services and tomorrow's wireless 3G **data** based services!

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Data Services - VLAN Support for Remote Office Connections



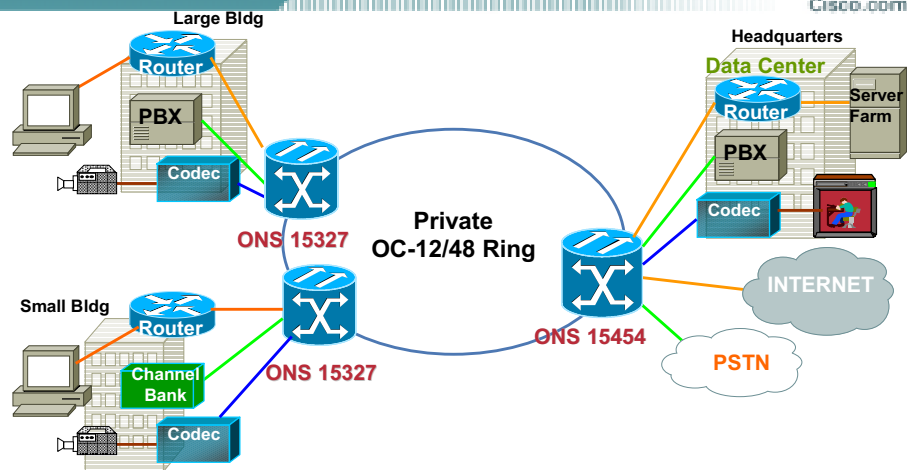
- Transparent LAN and Layer-2 VPN services!

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Campus Backbone Application



- **PBX Extension, Server-less Office, and Video Applications!**

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