NGN requirements (for IPTV)

ASR 1000 Series overview

Cisco Expo Denmark
March 2008
per@cisco.com

Agenda

- **NGN (Carrier Ethernet) Requirements**
- **Cisco (Carrier Ethernet) Solution Architecture**
  - **Overview**
  - **IP / Optical Integration**
  - **Access / Aggregation UNI**
  - **Service Deployment Models**
  - **Video and IPTV Delivery, Admission Control**
  - **PPP sessions, IP sessions, No sessions**
  - **Quality of Service and SLAs**
  - **Network High Availability**
  - **Network Security**
  - **OAM&P**
- **Summary**
- **ASR 1000 Series overview**

Service Requirements in NGN infrastructures

Consumer	Business	Wholesale	Evolution of services
Internet **Voice / Video / data** **Voice** PSTN Multimedia **Video** Walled Garden Mobility Fixed / Mobile	TDM/ATM→Ethernet L1 services **L2 VPNs** **Pt2Pt** **Pt2MPt** **MPt2MPt** **L3 VPNs** **Connectionless** Value-add Services Based on L3 visibility	TDM/ATM→ Ethernet L1 services L2 VPNs Pt2Pt Pt2MPt MPt2MPt L3 VPNs L2TP Connectionless	PSTN Migrate Mobile RAN backhaul IP transition TDM Migrate and evolve to Ethernet ATM Migrate and evolve to Ethernet F/R Evolve to Ethernet

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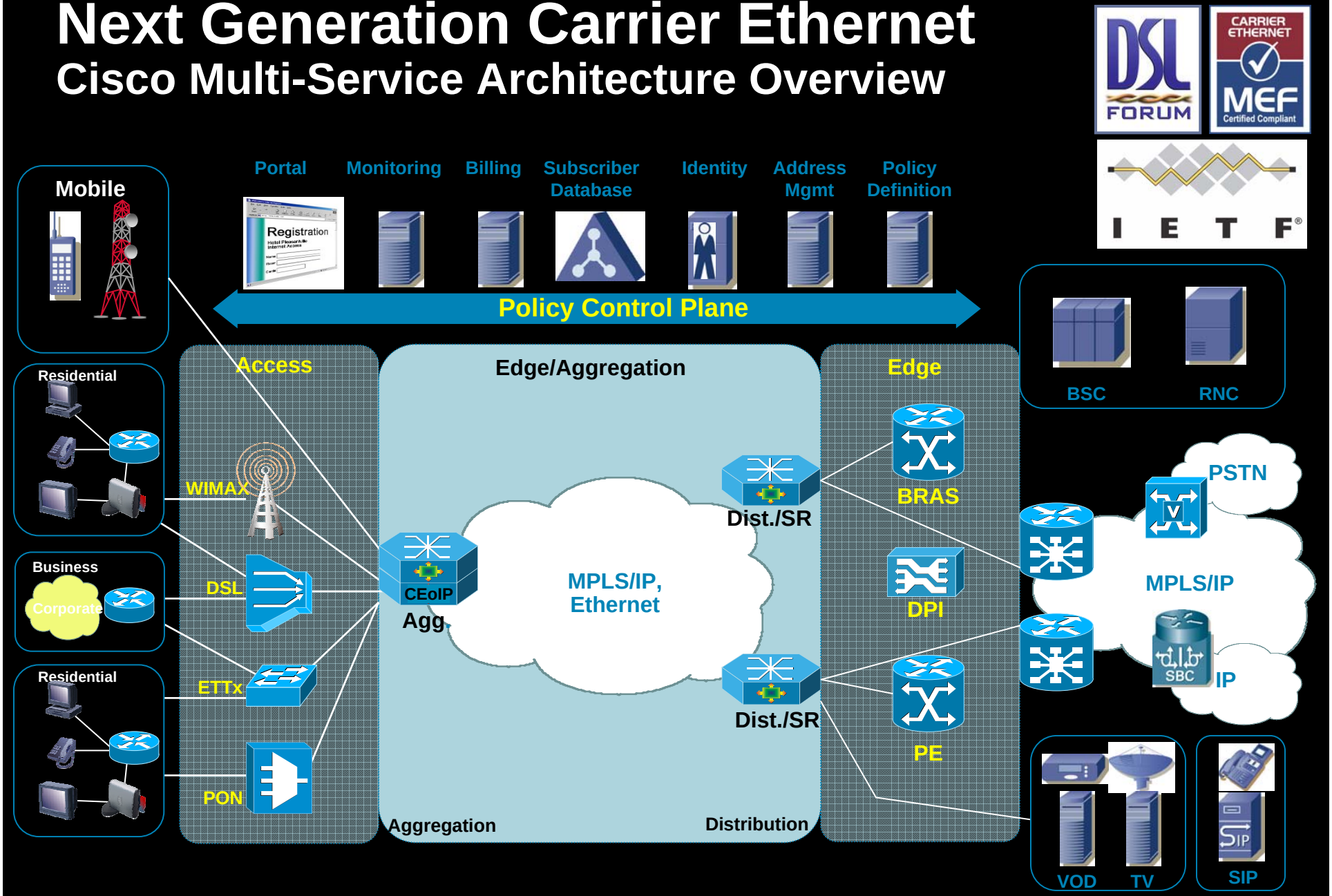
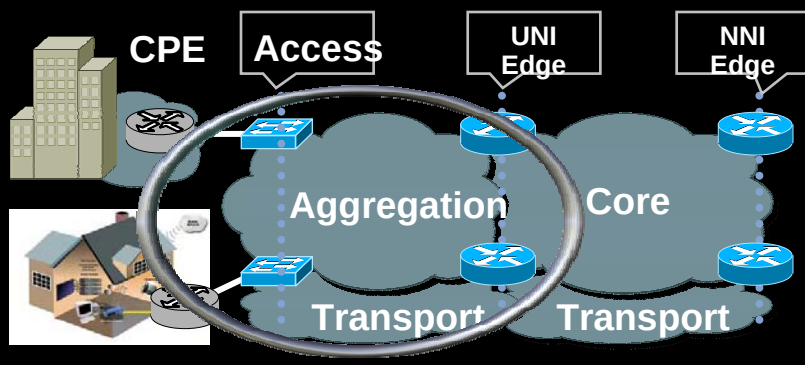
Next Generation Carrier Ethernet
Cisco Multi-Service Architecture Overview



Cisco Aggregation Architecture is aligned with major standardization efforts

- Ethernet technologies maturing for Carrier Aggregation Networks
- IEEE and IETF provide Ethernet and MPLS aggregation options
- DSL Forum defines architecture models for EtherDSL aggregation
- MEF defines Ethernet services and UNI options
- Cisco Systems has an active role in all these standards bodies



Focus on the User-Perspective: Ethernet Services, UNI, Traffic Engineering, E-LMI, ...

SP-Ethernet: Provider Bridges (802.1ad); EFM (802.3ah); Connectivity Management – OAM: 802.1ag; 802.1ah Provider Backbone Bridges, 802.1aq Shortest Path Bridging, etc.

L2VPN, PWE3 WG – Building the Network Core: VPWS, VPLS

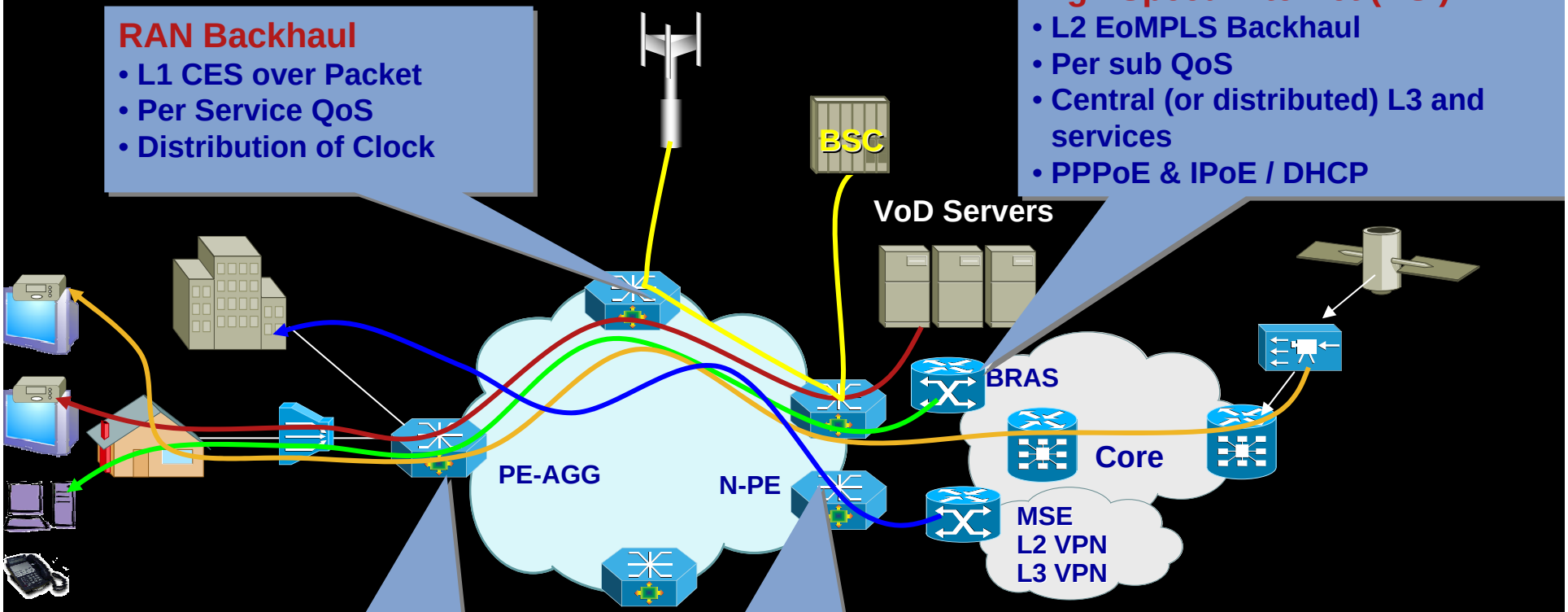
SG15/Q12, SG13/Q3; Architecture of Ethernet Layer Networks, Services etc. – from a Transport perspective. E2E OAM.

Ethernet to Frame-Relay/ATM Service Interworking

TR-101 alignment : BRAS-requirements, Ethernet Aggregation / TR-59 evolution, subscriber session handling; WT-146 IP sessions ...

From Design Principles to Implementation

One Carrier Ethernet Design



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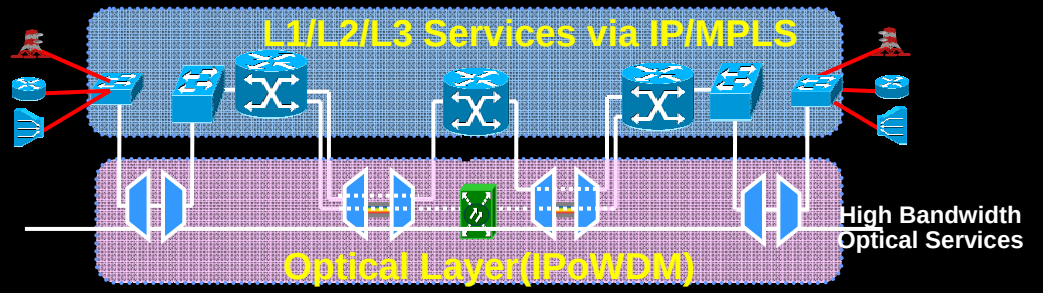
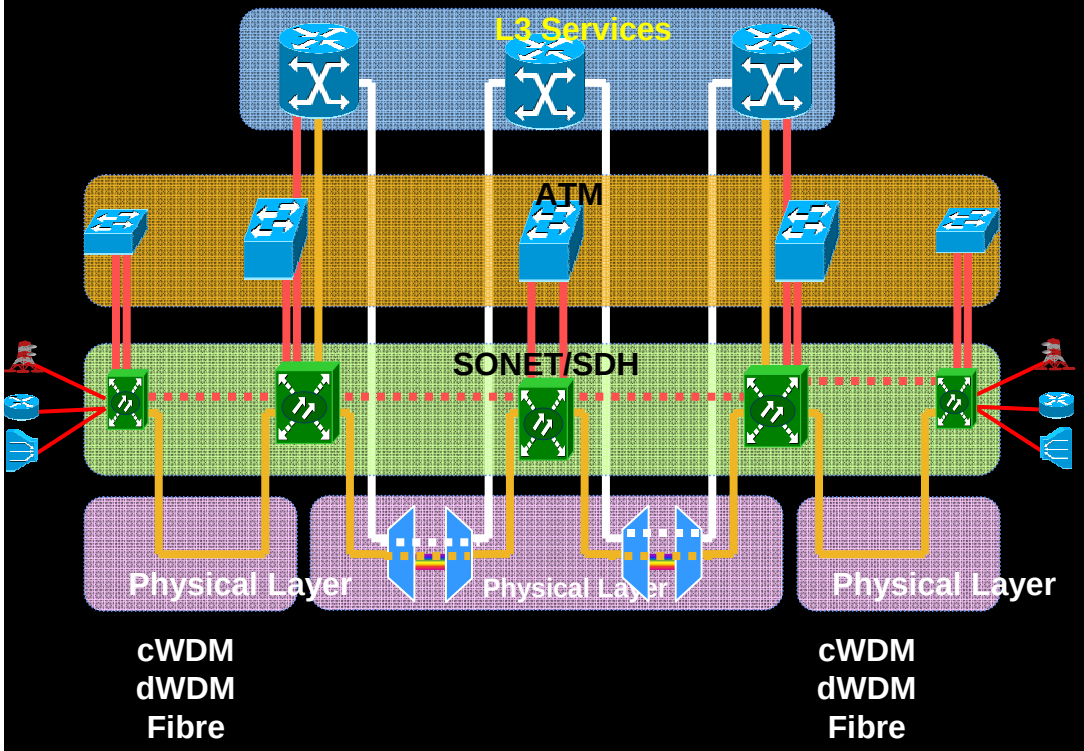
SP Network Evolution

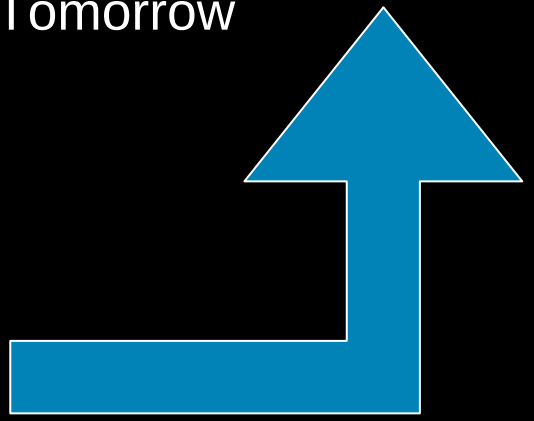
- Historic Growth
- Not built for packet initially
- Different Departments
- High OPEX due to layering



Today



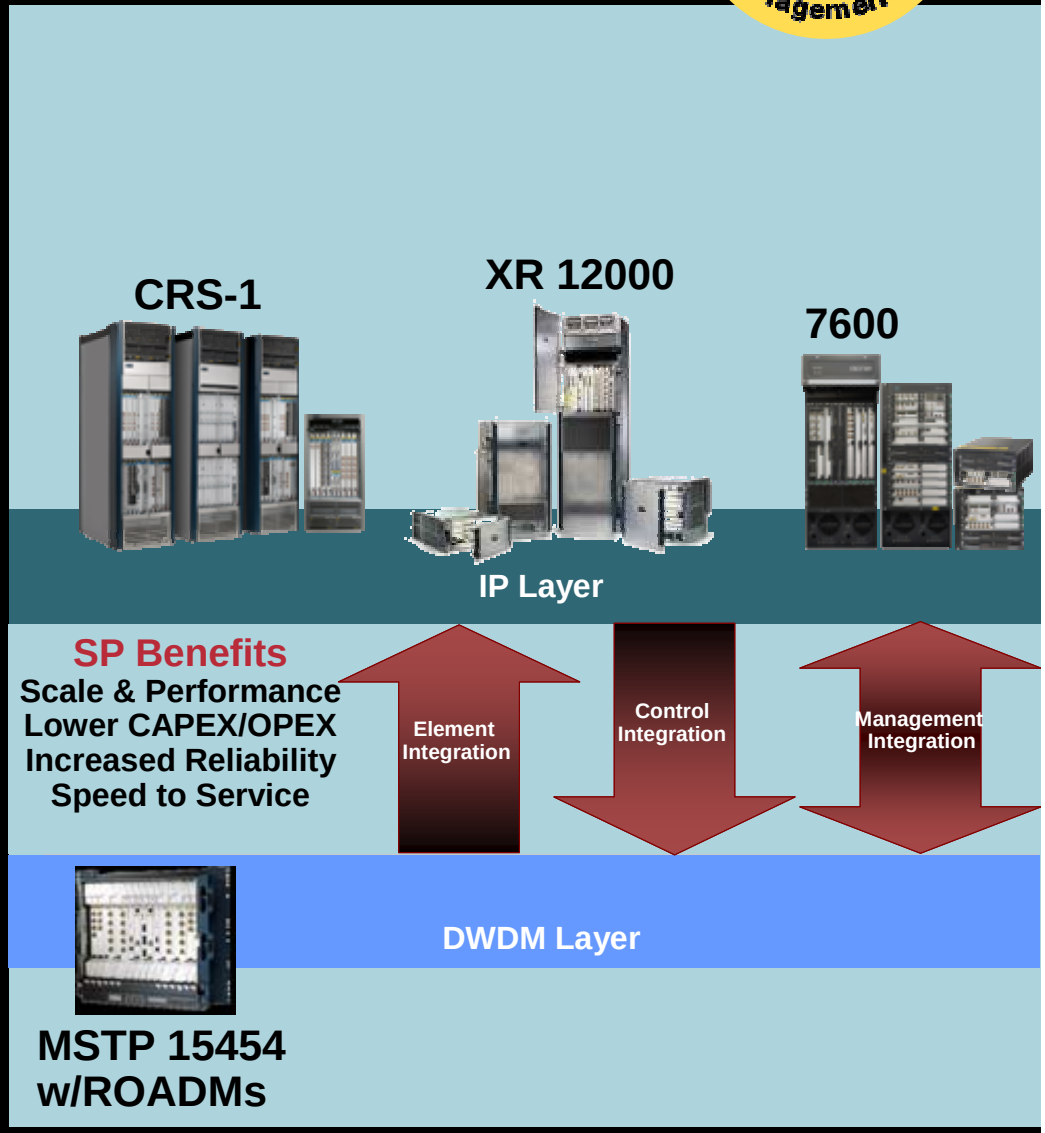
Tomorrow



- Evolution not revolution
- Minimal Layering
- Similar control plane in aggregation and core

Integration:
Cisco IPoDWDM Strategy

- Element Integration
  - Integrate transponder functionality onto routing platforms
  - Integrating photonic switching into DWDM optical platforms
- Control Integration
  - GMPLS for auto-provisioning of lambdas driven by IP control plane
- Management Integration
  - Separate or integrated management



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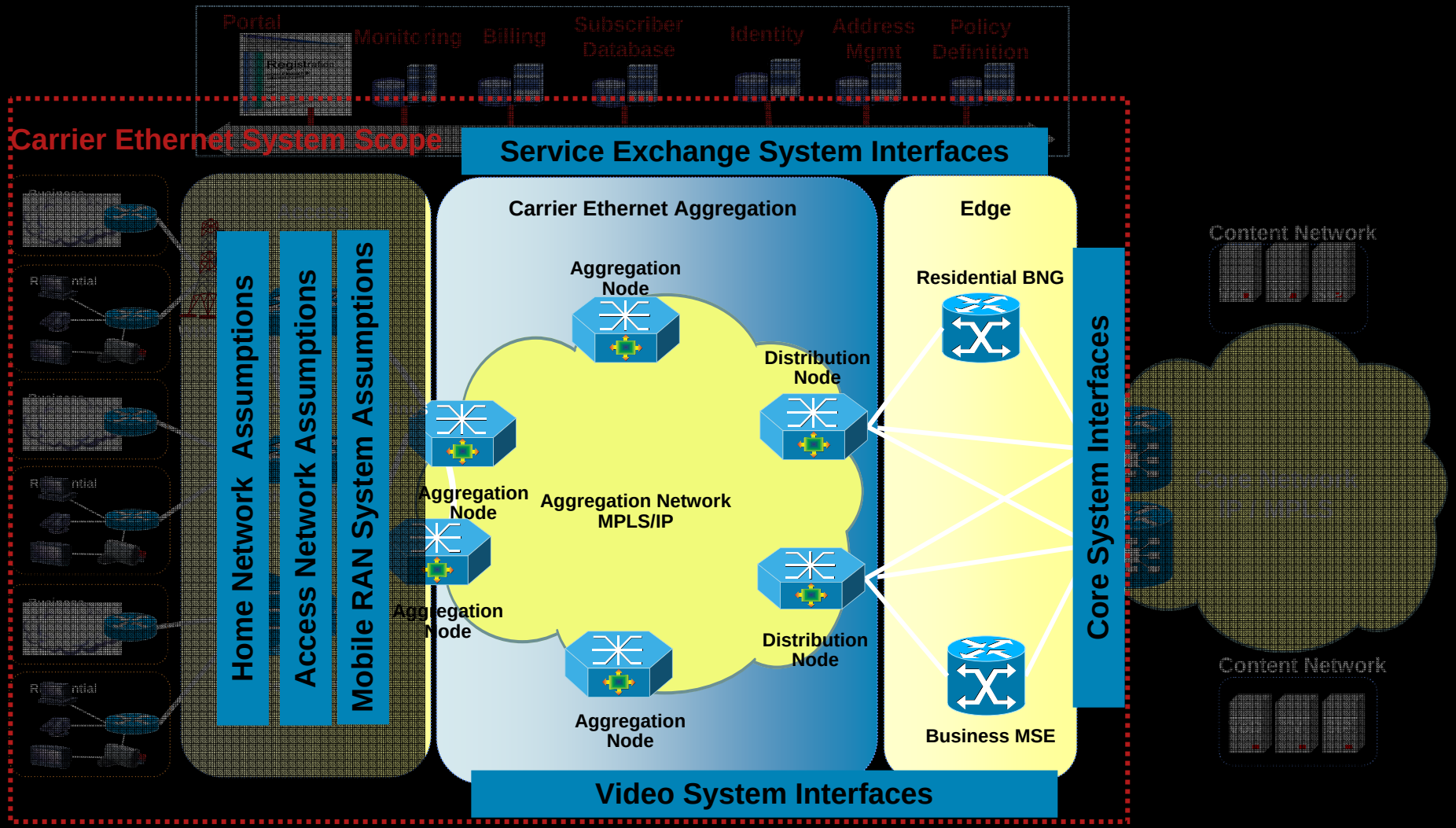
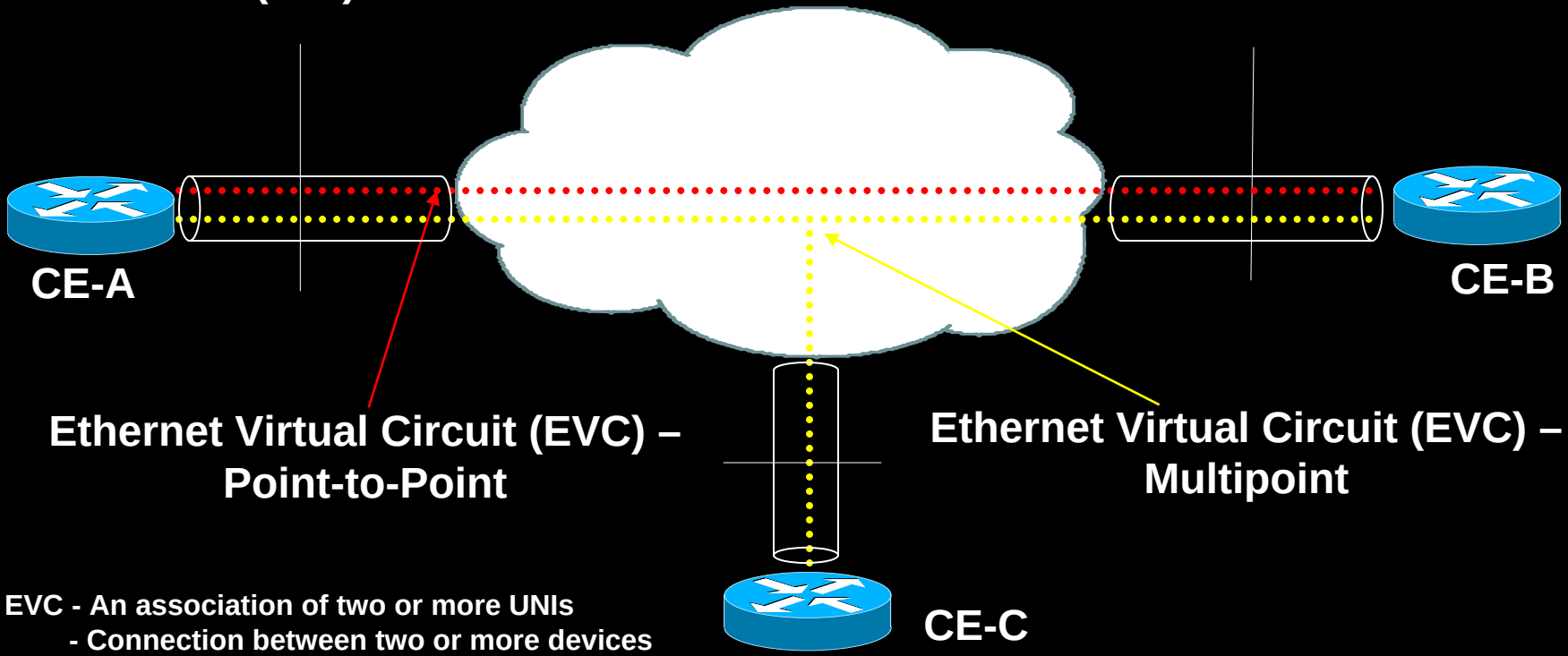
Cisco's Carrier Ethernet Aggregation System



MEF UNI and Services
Terminology

User Network Interface (UNI)

User Network Interface (UNI)



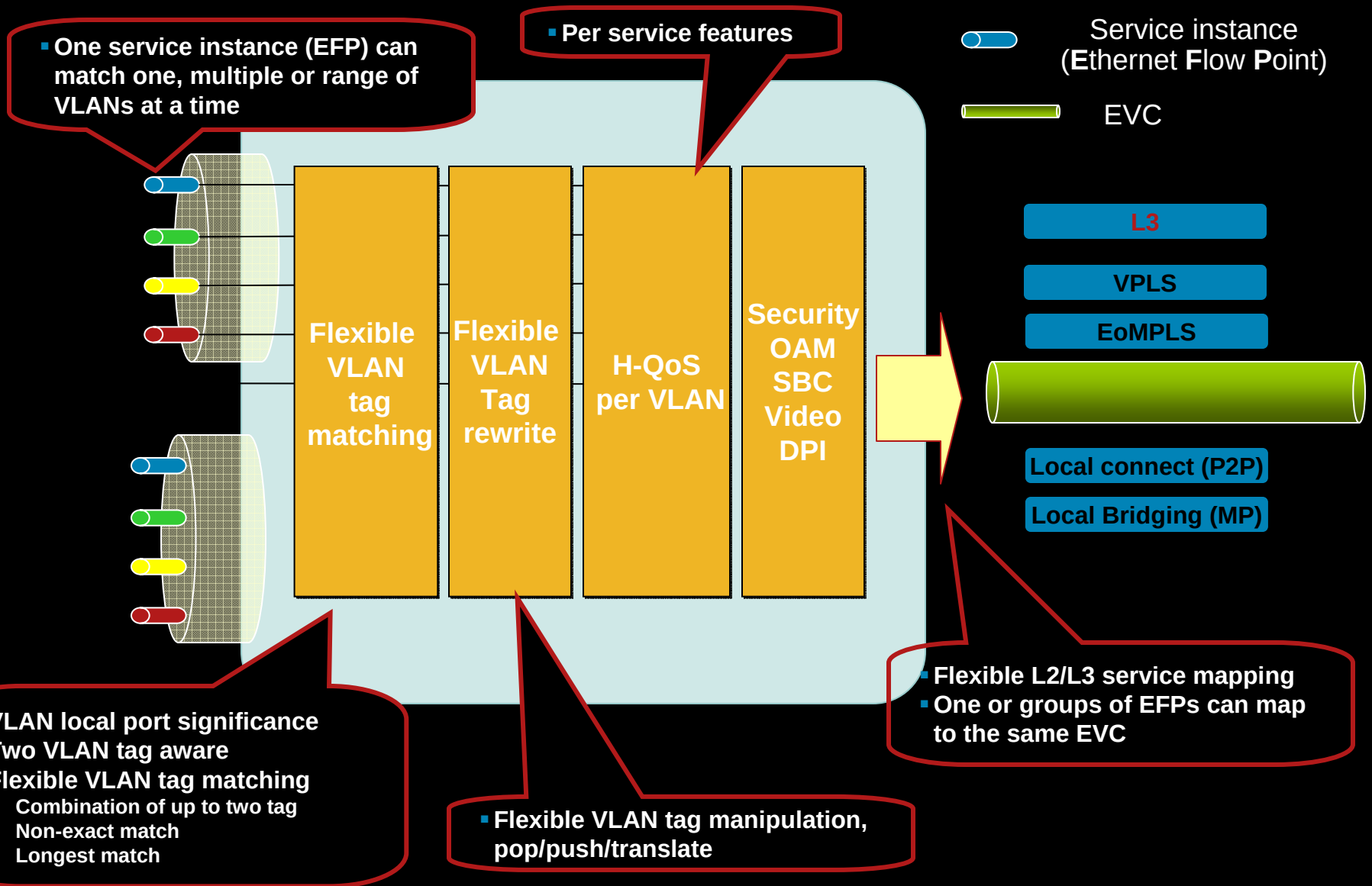
Ethernet Virtual Circuit (EVC) – Point-to-Point

Ethernet Virtual Circuit (EVC) – Multipoint

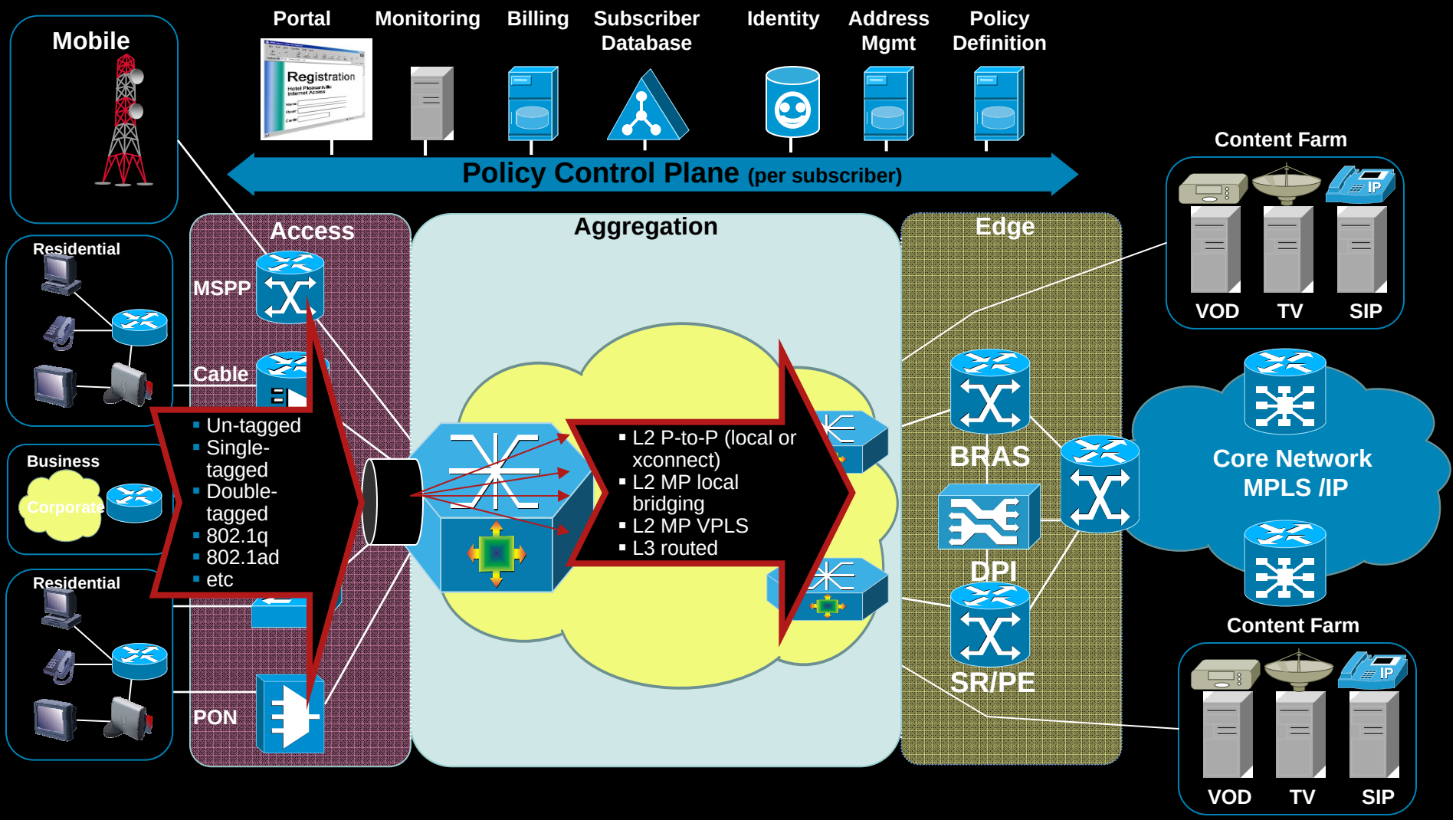
EVC - An association of two or more UNIs
- Connection between two or more devices

MEF defines services in terms of EVC,UNI attributes

Cisco's approach to the UNI
Ethernet Virtual Connection



Flexible Ethernet Edge Architecture



Cisco Carrier Ethernet System
Intelligent Transport - Functional Overview

Access Network Functions

DSL, Ethernet and Fixed WiMAX Access:

- DSL Forum TR-101 functions
- MEF Ethernet services models
- N:1 and 1:1 VLAN Multiplexing Models
- Multi VC, Trunk and Non Trunk UNI options
- Access agnostic: xDSL, ETTX, WiMAX
- Ring and H&S topologies

Residential, Business, Ethernet Bitstream services

Aggregation Network Functions

Transport between Access and Edge:

- Intelligent Access Multiplexing
- Optimal MPLS/IP L2 and L3 transport
  - ✓ EoMPLS and H-VPLS for virtualized Ethernet P2P and MP transport for **centralized service edge**
  - ✓ IP transport for 3Play services (IPTV, VoD, Voice) for **distributed service edge**

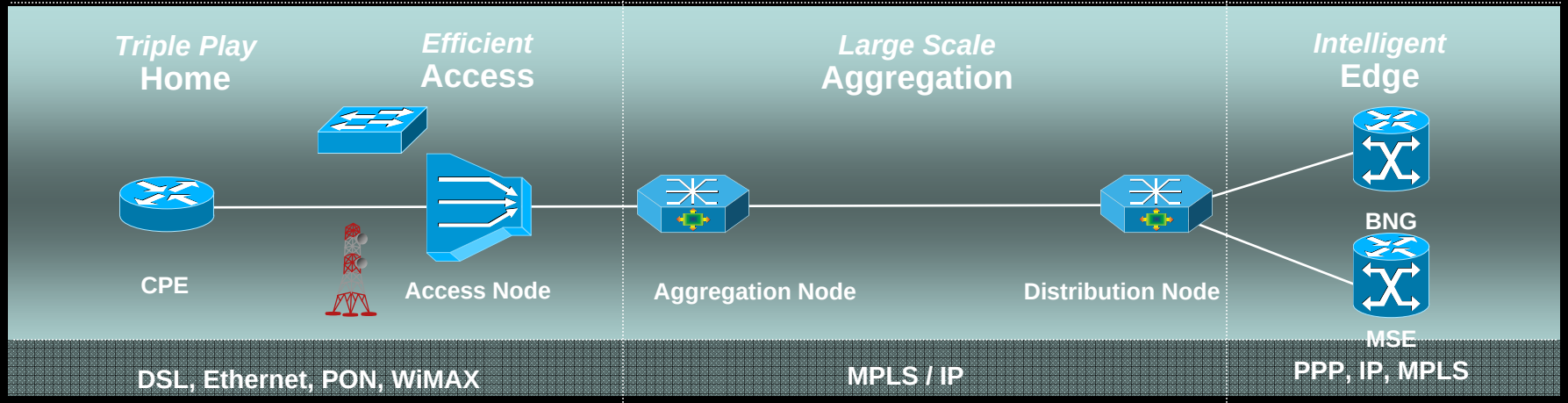
The Aggregation Network provides the option for implementing L2/L3 Business VPN Services

Edge Nodes Functions

Centralized Subscriber and Service Edge:

- Residential HSI in BNG
- Business L2/3VPNs in MSE

This network layer may be already present



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Video/IPTV Is Key but Hardest to Deliver

Video Challenges

Business Challenges
"Content Scope & Control"

- High Quality of Experience (QoE)
- Differentiated offer / content explosion
- Niche and local content
- Growth of "on-demand" TV
- Need to deploy new services
- Impact of "over the top" video

Technical Challenges
"Open, Balanced System"

- Stringent packet loss requirements
- Accurate CAC for VOD
- Efficient multicast for local insertion and to accommodate new services
- <1s recovery in any failure scenario
- Fast channel change
- Managing video in scope of larger Triple Play & Business Services portfolio

Traditional Web-Based Services

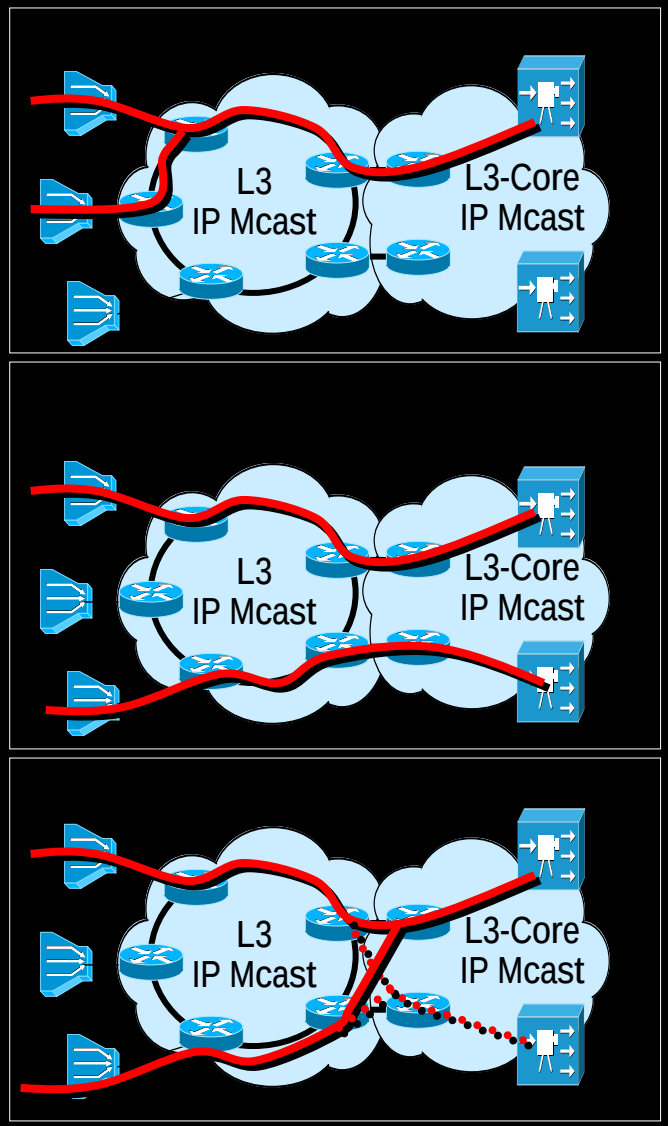
VoIP Services

Video-Based Services

Easiest → **Most Difficult**

IP for Video and IPTV Service Delivery
Key Characteristics and Benefits

- **Simplified Operations**
  - ✓ IGMP/PIM only required, no snooping necessary in aggregation network; snooping contained in DSLAM
  - ✓ Single Point of L3 termination for IPTV (no VRRP required)
- **Optimal and Scalable forwarding**
  - ✓ SSM multicast distribution model for optimal tree creation under all conditions
  - ✓ Dynamic Load Balancing on equal cost paths(!!)
  - ✓ Optimized ARP and IGMP tables through distribution
  - ✓ Flexible content injection, including localized content
  - ✓ Scales in terms of network nodes and subscribers in any topology due to distributed L3
  - ✓ Allows for on-path CAC
- **Resiliency**
  - ✓ Consistent Convergence in all failure cases: Source-, Node-, Link-Failure.
  - ✓ Anycast-Source model for enhanced redundancy
  - ✓ SSM Security & Address-Space Efficiency Proven architecture in many 3Play production networks today
- **Future Ready**
  - ✓ Possibility to add/distribute Video Monitoring and error concealment techniques easily

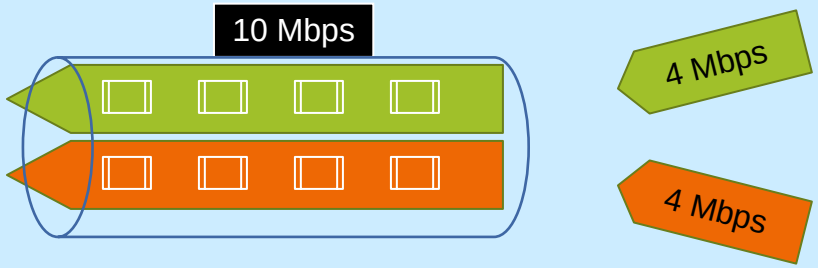


Why is Admission Control Essential for Video?

- Per-service QoS for broadcast video and VOD
  - Network must deliver 10^{-6} loss requirement to support video QoE
  - Per-sub QoS for video through BRAS function not optimal (not topology aware; does not take into account multicast replication)
  - Per service QoS optimizes quality & operational efficiency
- VOD Connection Admission Control
  - Every Link has queue dedicated to video, with a certain amount of planned capacity
  - CAC will make sure that this queue is NEVER oversubscribed by disallowing the VOD request that would oversubscribe the queue if allowed to flow over the network

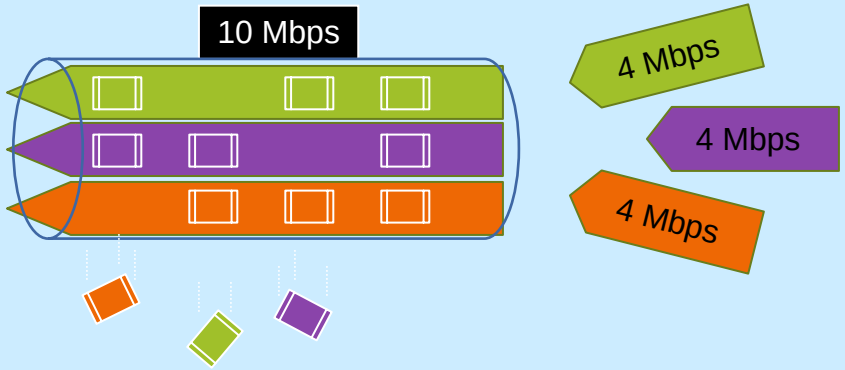
Video Quality Fantastic

2 VoD Streams – 4Mbps Each



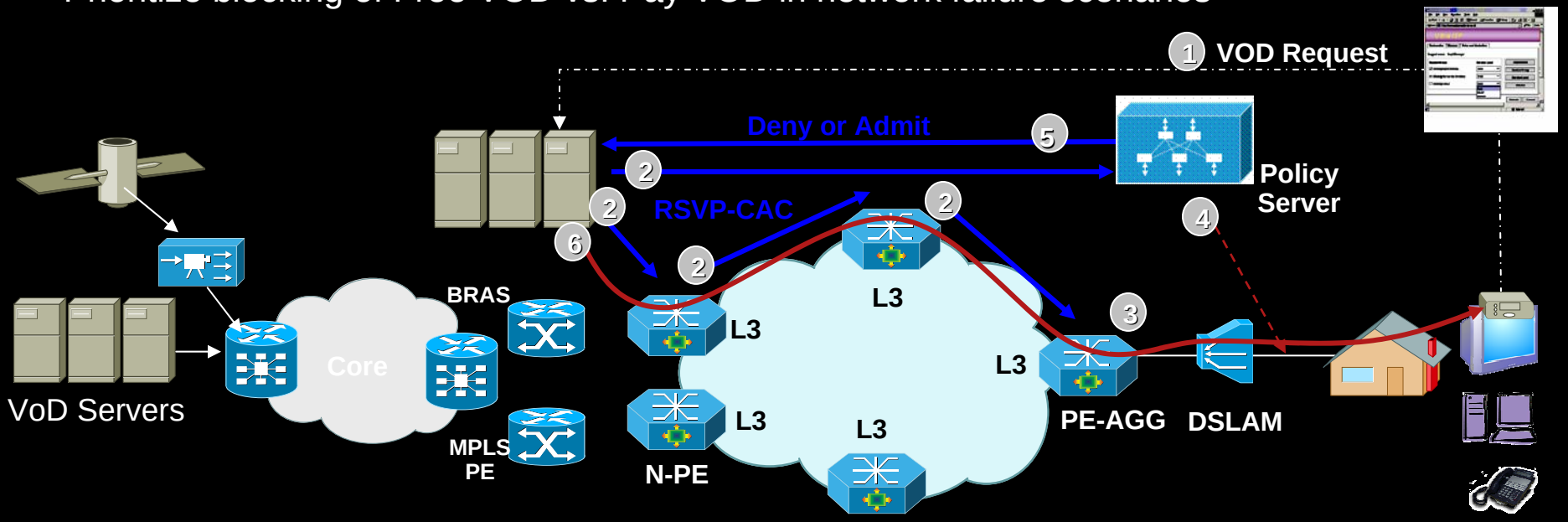
Video Quality Suffers (for all users)

3 VoD Streams – 4Mbps Each



Cisco's Integrated Video CAC

- Integrated Video CAC approach combines two methods
  - On-path RSVP-CAC
    - Topology aware, handles dynamic topology changes
    - DSCP based implementation eliminates scale challenges experienced with Intserv
    - Proven scale – tested to 50-100.000 sessions with 500 set ups per second
    - Layer 3 required at PE-AGG to implement path-based CAC
  - Off-path CAC based on Policy Server for DSL line congestion
- VOD stream will be denied if business rules of either fail
- Prioritize blocking of Free VOD vs. Pay VOD in network failure scenarios



Multicast Admission Control
Cost factor for per-interface Mroute State Limits

MCAC Use Case

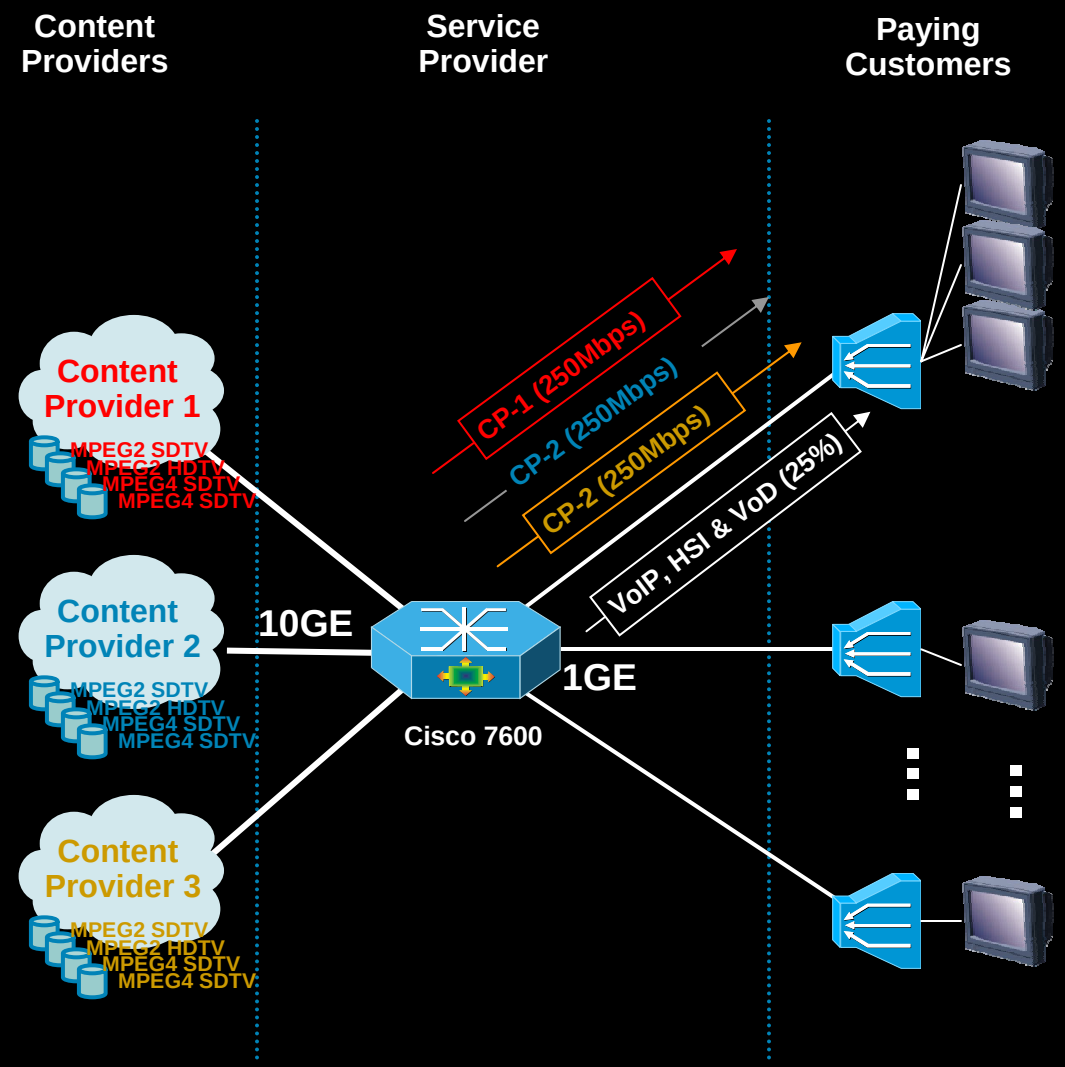
1. Consider the following. Three Content Providers (CPs) are providing multicast content.

2. Multiple CP will have TV programs w/ different BW:
   - MPEG2 SDTV: 4 Mbps
   - MPEG2 HDTV: 18 Mbps
   - MPEG4 SDTV: 1.6 Mbps
   - MPEG4 SDTV: 6 Mbps

3. Service Provider (SP) would like to provision fair sharing of bandwidth between these three content providers to its consumers across 1Gbps links.

4. 250Mbps for each CP, 250 Mbps for Voice/Internet/VoD.

5. Simple extension of multicast limits: global cost factor config.



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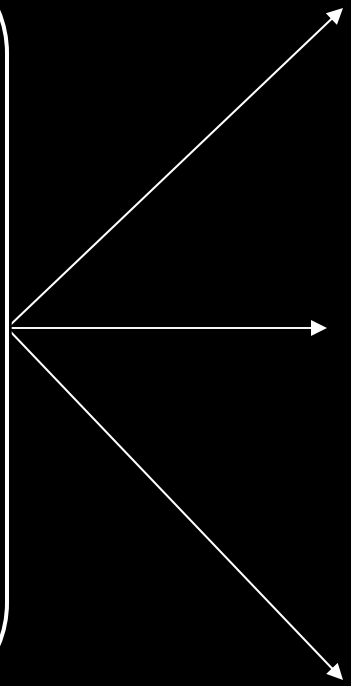
Why sessions & subscriber awareness in the first place?

- Dynamic provisioning / change in provisioning
- Per user granularity
  - Accounting/billing
    - time or volume
    - pre- or postpaid
  - (H-)QoS (for SLA) per session / subscriber
  - ACLs per session/subscriber
- Troubleshooting / OAM
  - Keepalives
  - Idle timers
  - Accounting
  - Per user debugging
- Advanced services
  - Layer 4 redirect
  - DPI integration (ISG-SCE ctrl bus)
  - Dynamic mapping wholesale services
    - VRF based
    - L2TP based
- Portal API
  - Services Selection
  - Self-provisioning/care

Note: Sometimes none of these feature/functions are required and operators choose a no-session-BNG deployment

Cisco ISG - Leading the way to "Sessionized" IP for PPP to IPoE Migration

- There is no such thing as an IP session ;-)
  - IPoE is connection-less
- IP Sessions need to be defined in respect of a session lifecycle
  - Start, Stop, Keepalive
- IP Sessions (may) need to be authenticated (CHAP like, as in PPPoX)



ISG Session instrumentation
Policy-plane for Session ID, AAA, QOS, Policy delegation, etc.

DHCP Authentication
PPP equivalent authentication of IP hosts

Keepalives

ARP, ICMP, BFD
(DSLF WT-146 aims at defining BFD as such a keep-alive mechanism ro be implemented on client and Server (BNG) in order to obtain PPP like behavior)

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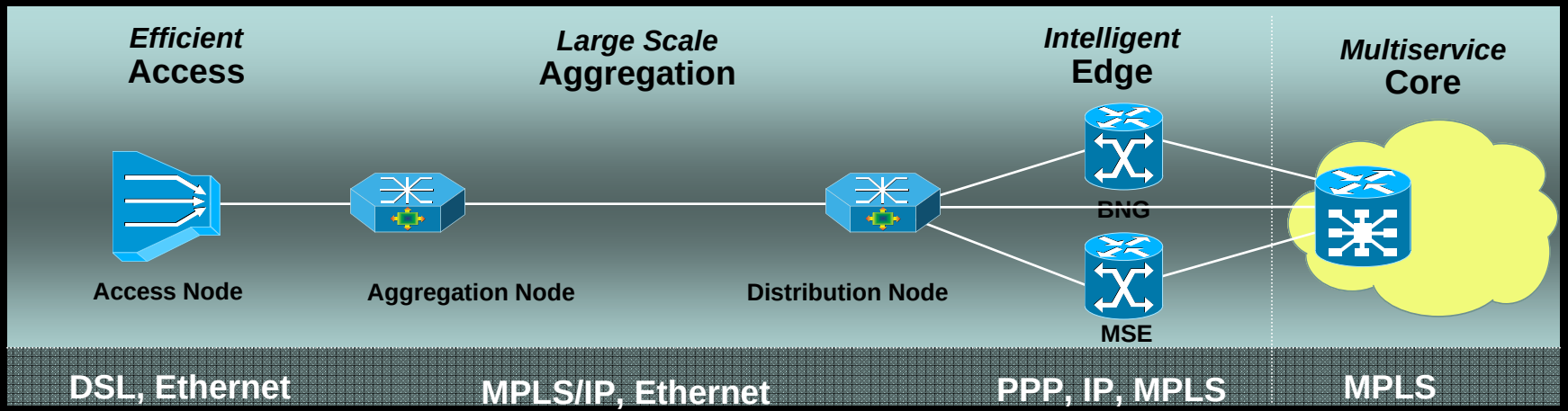
Cisco Carrier Ethernet Architecture
Network Availability Mechanisms

- IP Transport
  - Fast IGP/BFD convergence
  - Multicast Fast Convergence
- MPLS Transport
  - Pseudowire Redundancy
  - H-VPLS Redundancy
  - MPLS TE-FRR Link and Node protection with IP services, PW/VPLS PW tunnel selection
  - MPLS/IP Services use a combination of MPLS TE-FRR and fast IGP/PIM convergence
- Ethernet Transport
  - Rapid STP, MSTP
  - Fast Link Redundancy with Flexlink
  - LAG/LACP
  - REP (Resilient Ethernet Protocol)



Cisco Resilient Ethernet Protocol

Provides a solution for robust and predictable layer 2 convergence for Metro Ethernet ring networks

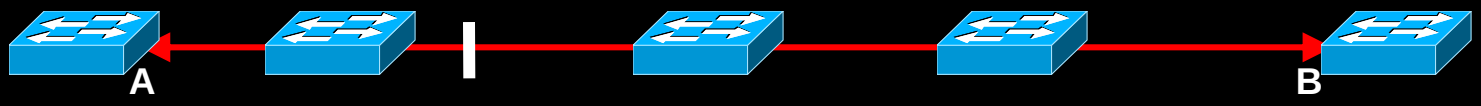
REP is designed to address:

- Fast re-convergence for simple ring networks **(<200ms)**
- No Spanning Tree (STP)
- VLAN load balancing
- Manual configuration for predicable failover behavior
- Support on existing hardware platforms

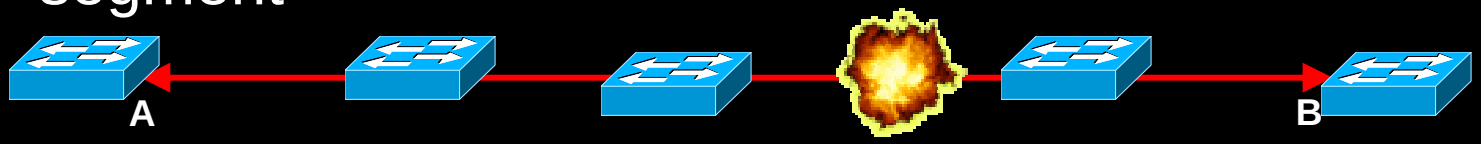
REP does NOT:

- Replace IEEE 802.17b RPR (no ring-based QoS / Fairness across the ring
- Replace Spanning Tree for complex layer 2 networks
- Protect against dual failure in the ring

REP in a Nutshell
REP is a Segment Protocol

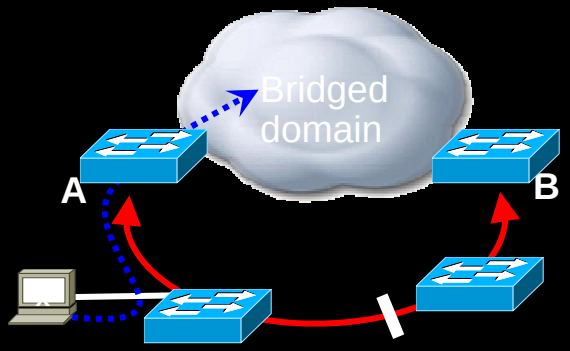


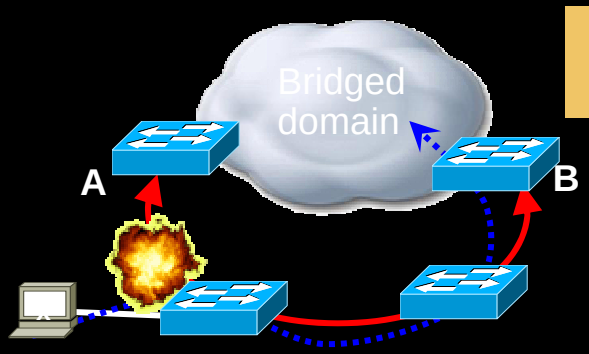
- Ports are explicitly configured to be part of a segment.
- When all the links in the segment are operational, a blocked port is determined so that there is no connectivity between the edges A,B through the segment



- If a failure occurs within the segment, the blocked port goes forwarding

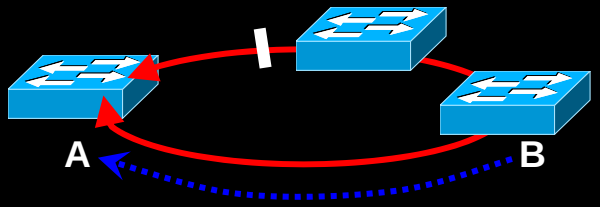
REP in a Nutshell
REP Redundancy Options

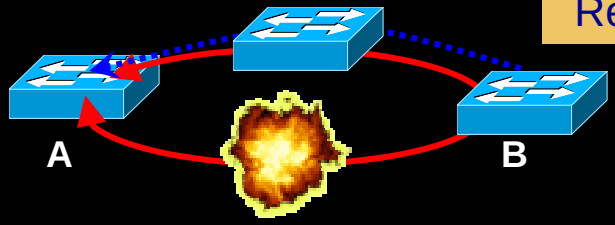




Host Redundancy

- The segment provides redundancy to the hosts within its boundaries: they can reach the rest of the network through either A or B.
- The segment will *not* unblock to cover a failure outside of its boundaries.





Link Redundancy

- When wrapped into a ring, the REP segment can also provide redundant connectivity between any two switches.

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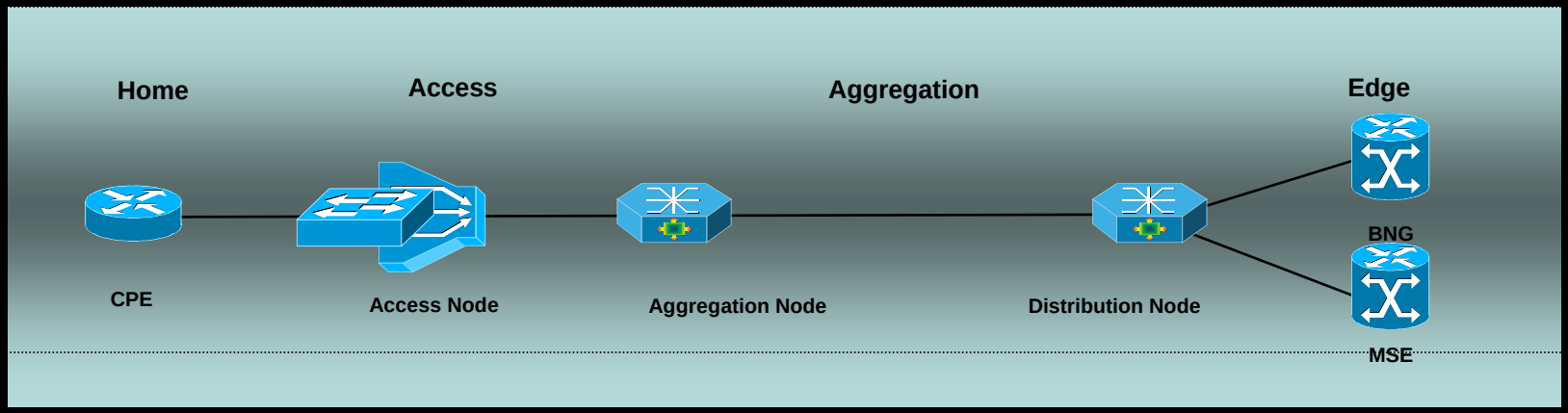
Carrier Ethernet Security: A Trust Model



- CPE – Not trusted, but should be utilized for trust
  - The CPE Provides invaluable security opportunities
  - Outbound service control, connection admission, QoS policy enforcement
- DSLAM/Switch – Trusted
- Aggregation and Distribution Nodes – Trusted
  - Aggregation and Distribution Nodes should have a set of features that “duplicate” the efforts on the CPE for common security mechanisms, but at a higher scale.
  - They should also provide strict separation between services including resource partitioning

Cisco Carrier Ethernet Solution
Attacks and Defence Tool-set

Service / Network Security Threats	Defensive Features
MAC Attacks (MAC Table Overflow, Overlapping MACs)	**Port Security, Per VLAN MAC Limiting**
ARP Attacks	Wire-Speed ACLs, Broadcast Storm Control, **Dynamic ARP Inspection**
VLAN Hopping, DTP Attacks	Disable Auto-trunking, Use Dedicated Native VLAN-ID for SP Trunk Ports, configure Native VLAN tagging, Avoid VLAN 1 traffic on UNI, Disable Unused Ports, Prune Unused VLANs
Spanning Tree Attacks	BPDU Loop Guard, Root Guard, Wire-Speed ACLs, BPDU Filter
Hijack Management Access	Encrypted communications (SSH), disable console access, encrypted configurations, disable password recovery
Customer-side L2 Loops, MAC Moves	**Storm-control with notification**, **MAC move notification & port shut**, STP BPDU Participation, Port Security
IP Spoofing Attacks	uRPF, **IPUnnumbered/IP Source Guard integrated with DHCP Snooping**

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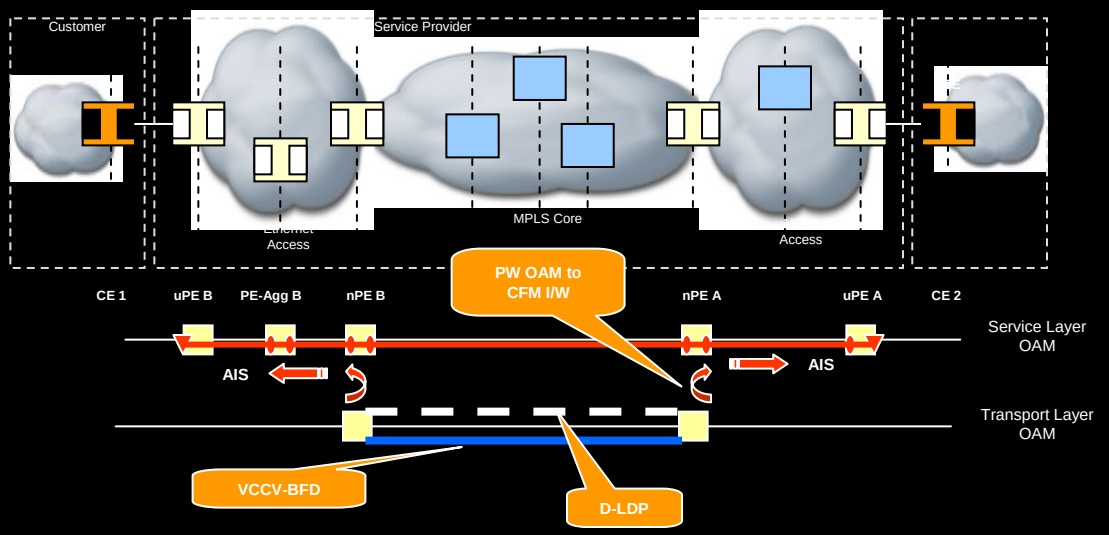
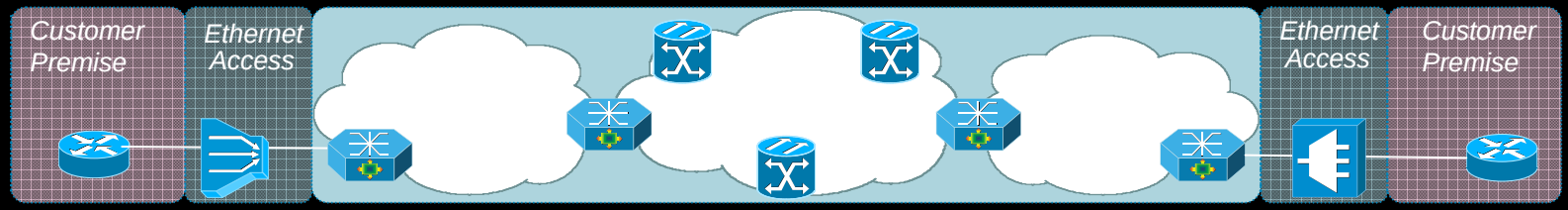
Cisco Carrier Ethernet IP/MPLS OAM Instrumentation

- Transport LSP
  - Ping, Traceroute,
  - Multi-path Traceroute
  - LSR Self-Test
- L1/L2 VPN
  - Virtual Connection Connectivity Verification (VCCV) – all types
- L3VPN
  - VRF-Aware Ping, Traceroute
- OAM automation with IP-SLA
  - Per CoS, QoS class SLA measurement and reporting
  - Packet time-stamping
  - Alarm integration
- MTU Discovery
- MPLS OAM inter-working with Ethernet OAM
- Complete set of Alarms & MIBs



Operating Carrier Ethernet IP/MPLS networks
Comprehensive OAM and Device instrumentation

Fault	Configuration	Accounting	Performance	Security



Cisco OAM & Device Instrumentation for superior Manageability

IP/MPLS OAM
- Ping/Traceroute
- VCCV
- BFD
- ISG per IP Session

802.3ah
- Remote fault indication
- Link Monitoring
- Loopback

802.1ag CFM
- Continuity Check
- L2 Ping, Traceroute
- AIS
- Post-Provisioning Cross-Check

EEM
Embedded Event Manager
Customizable event detection and recovery action

E-LMI
- Signals service parameters and status to a CPE

Config Change
- Logging and notification

Config Replace and Rollback

KRON
- Command scheduler

Diff
- Context diff utility

E-DI
Enhanced Device I/F
- CLI, Perl, IETF Netconf

ISG
- Per User accounting
- Per Service accounting

AAA
- RADIUS
- TACACS+

Flexible Netflow
- Per user accounting
- Per Service accounting

IP SLA
- Embedded Perf. Mgmt.
- Delay, jitter, packet-loss
- E-OAM Automation
- MPLS health monitoring
- Advanced object tracking

ERM
Embedded Resource Manager

GOLD
Generic Online Diagnosis

CBQoS MIB

RMON

Auto Secure
- One touch device instrumentation

uRPF
- IP Spoofing protection

Access Controls Lists
- L2 / L3 / L4
- Very high scale
- Line rate

AAA
- RADIUS
- TACACS+

Agenda

- NGN (Carrier Ethernet) Requirements
- Cisco Carrier Ethernet Solution Architecture
  - Overview
  - IP / Optical Integration
  - Access / Aggregation UNI
  - Service Deployment Models
  - Video and IPTV Delivery, Admission Control
  - PPP sessions, IP sessions, No sessions
  - Quality of Service and SLAs
  - Network High Availability
  - Network Security
  - OAM&P
- **Summary**
- ASR 1000 Series overview

Summary

- Next Generation Carrier Ethernet is driven by
  - New services
  - OPEX reduction of existing services
  - Optimization of CAPEX (simplification of the network infrastructure)
- Needs to support a wide range of varying applications
- Common network infrastructure is key
  - Minimal layering
  - IP/MPLS based providing L1, L2, L3 services
  - Flexible edge for optimal service delivery
- Cisco believe Carrier Ethernet IP/MPLS integrated with Optical technology offers the most cost effective and service rich solution for NGN aggregation

Agenda

- NGN (Carrier Ethernet) Requirements
- Cisco Carrier Ethernet Solution Architecture
  - Overview
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  - Access / Aggregation UNI
  - Service Deployment Models
  - Video and IPTV Delivery, Admission Control
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- ASR 1000 Series overview

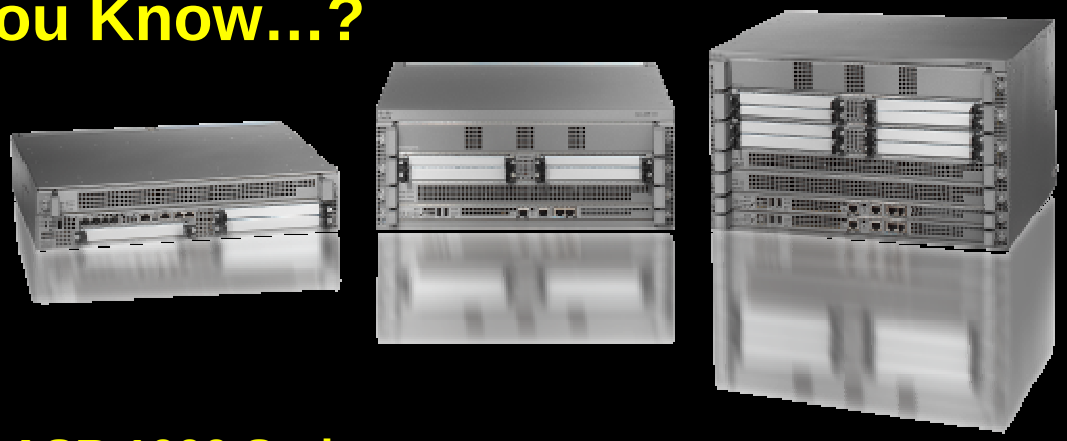
Introducing…

Industry's Most Powerful, Compact Aggregation Routers

Cisco ASR 1000 Series

Transforming and Extending the Network Edge

Cisco ASR 1000 Series Routers
Did You Know…?



- **A single ASR 1000 Series router can**:
  - ...switch between forwarding processors faster than a single flap of a hummingbird's wings
  - ...provide a fully encrypted T1/E1 VPN connection to every city in the world with a population larger than 150,000.
  - ...provide every person in a 60,000 employee company with their own individual multicast group
- **A standard telco rack of Cisco ASRs can**:
  - ... provide internet service with QoS and Firewall to every man, woman and child in Frankfurt, Germany
  - ... transmit the collected works of Shakespeare 5,250 times every second
- **The Cisco QuantumFlow Processor can**:
  - ...process 19,200,000,000 instructions in time it takes an average person to blink
  - ...provide equivalent processing power to 20 dual-core blade servers, using 10 times less space and 38,990 fewer KwH per year

Today's Drivers and Requirements at Edge

Video

Integral to nearly every major service experience

Web 2.0 Collaboration

Increasing dependency of services and applications

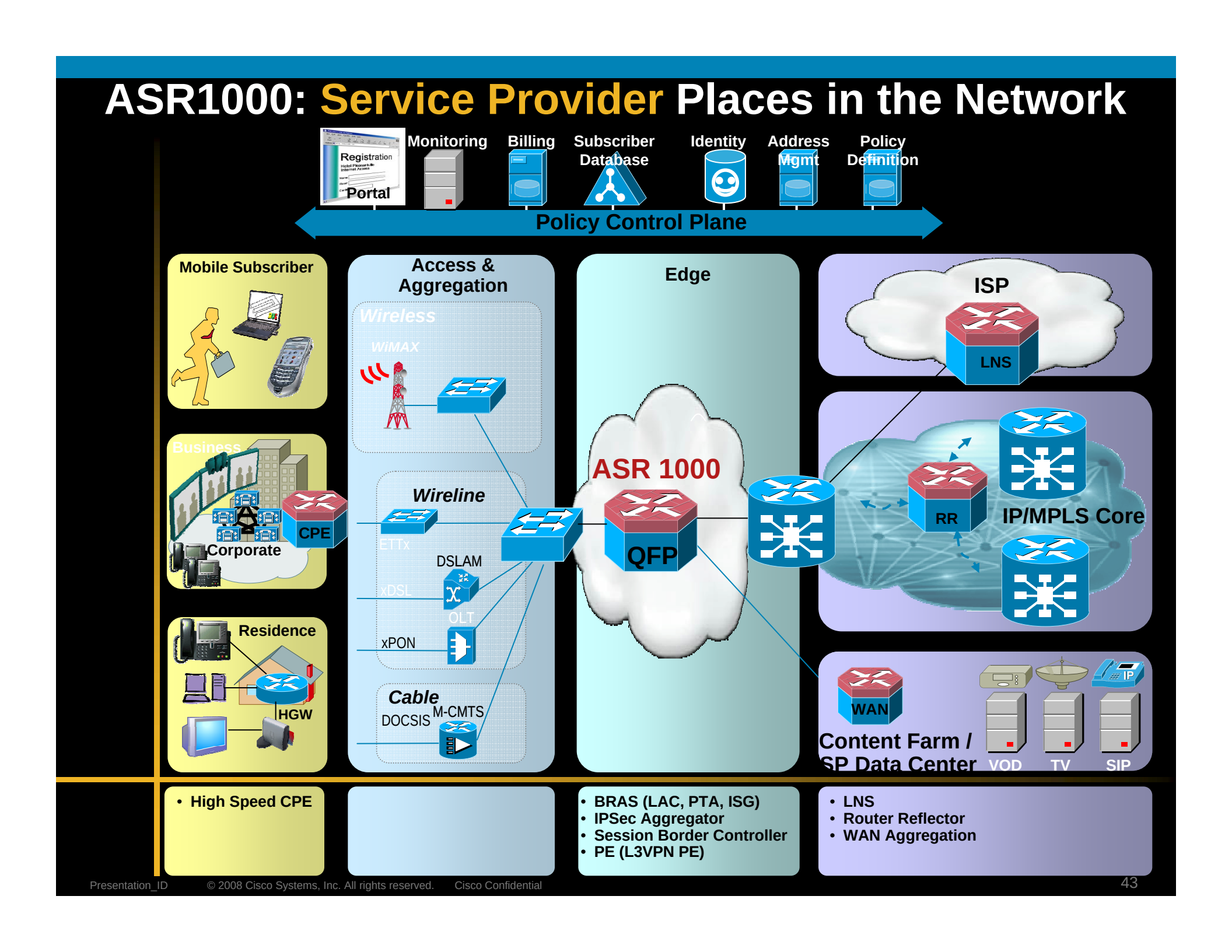
Emerging Services

Network Intelligence needed to seize market opportunities

Cost Efficiencies

CapEx and OpEx not growing as fast as change on networks, power not unlimited

ASR1000: Service Provider Places in the Network



- High Speed CPE

- BRAS (LAC, PTA, ISG)
- IPSec Aggregator
- Session Border Controller
- PE (L3VPN PE)

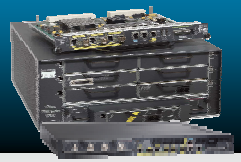
- LNS
- Router Reflector
- WAN Aggregation

Cisco (Enterprise) Routing Portfolio

Performance and Services Scalability

ISR Series

7200 Series



New

ASR 1000 Series

ASR 1000 with ESP-5G

New

ASR 1000 Series

ASR 1000 with ESP-10G

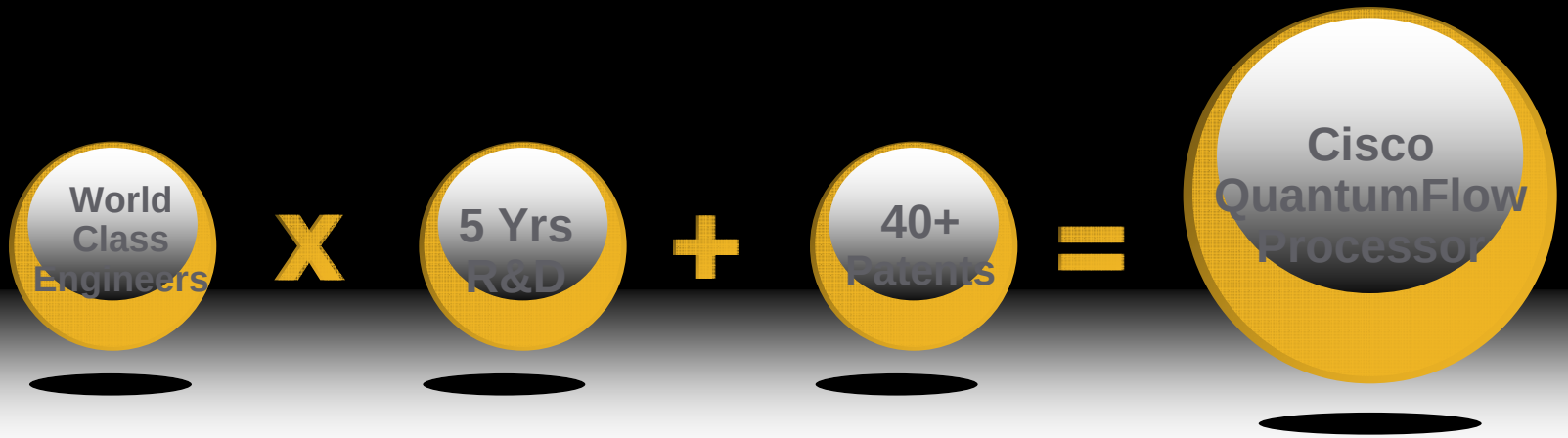
Catalyst 6500 Series

Cisco 7600 Series

Branch

Head Office / WAN Aggregation

ASR 1000 Series Innovations
Cisco QuantumFlow Processor (QFP)



World's Most Advanced Piece of Networking Silicon

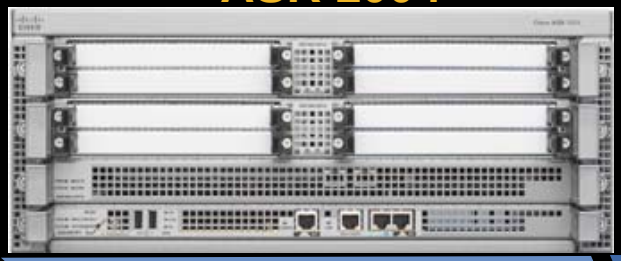
Performance	40Gbs Services
Scale	Over 1.3 Billion Transistors
Availability	Customized QoS
Services	Integrated and Programmab

- Instant-on Service Delivery
- Low Touch Deployment
- Faster Qualification
- Future Ready Technology

Cisco ASR 1000 Series- Overview

ASR 1002

ASR 1004



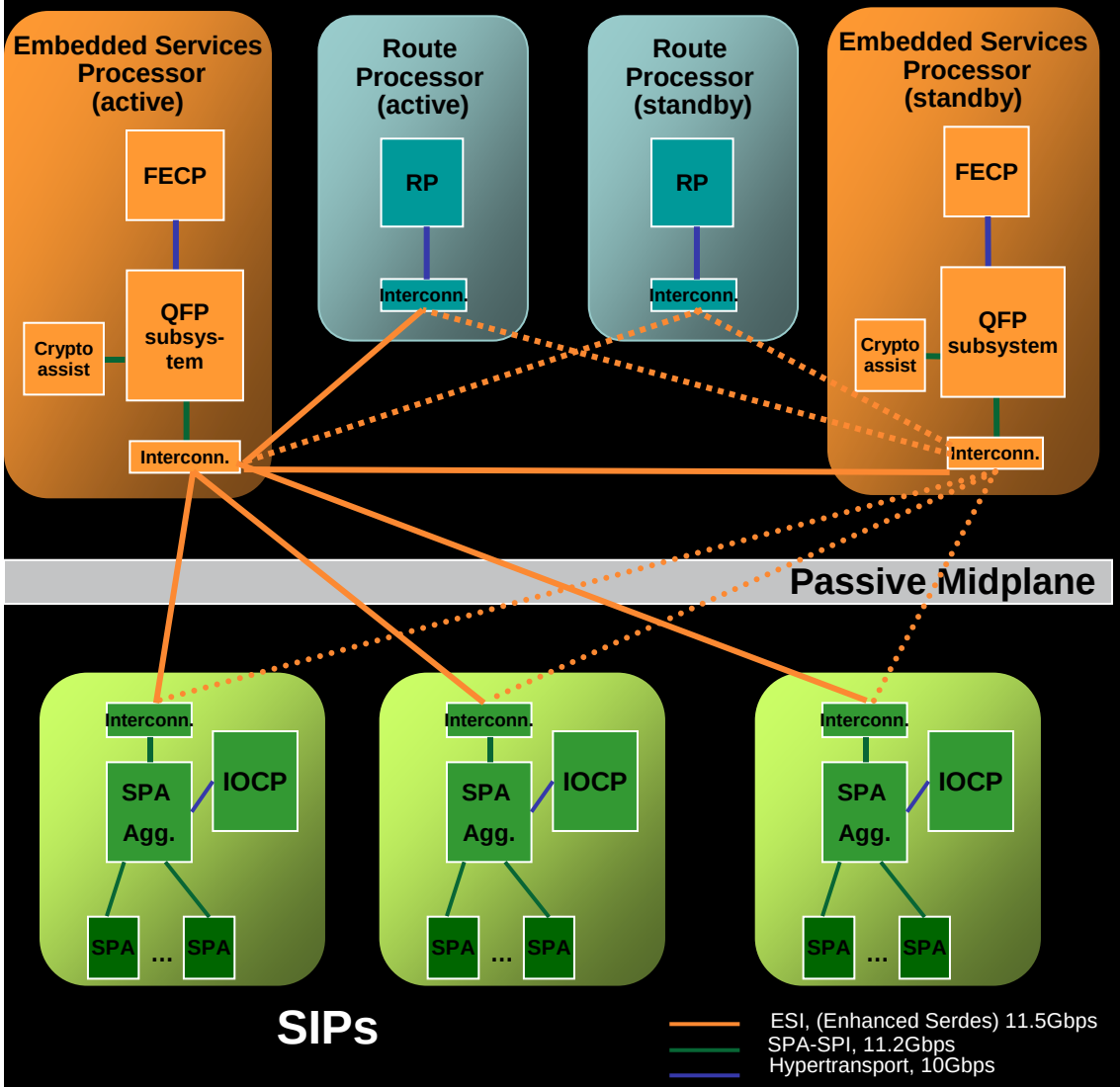
ASR 1006

SPA Slots	3-slot	8-slot	12-slot
# of ESP Slots	1	1	2
# of RP Slots	Integrated (RP1)	1	2
# of SIP Slots	Integrated (SIP-10G)	2	3
IOS Redundancy	S/W	S/W	H/W
Built in GigE	4	n/a	n/a
Height	3.5” (2RU)	7” (4RU)	10.5” (6RU)
Bandwidth	5-10 Gbps	10-40+ Gbps	10-40+ Gbps
Performance	15 Mpps	15 - 20 Mpps	15 – 20 Mpps
Air Flow	Front to Back	Front to Back	Front to Back
Power Supply (Watts)	470	765	1275

On Chassis Services: IPSec, FW, FPI, BB, SBC etc.

Aggregated Services & Scale

ASR 1000 Series Building Blocks

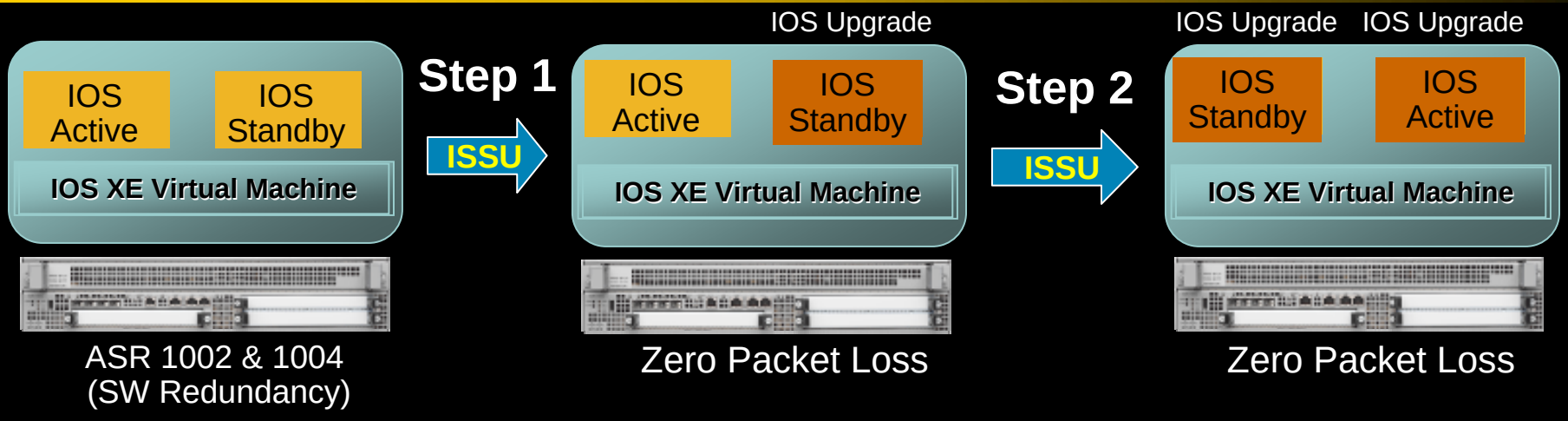


- **RP (Route Processor)**
  - Handles control plane traffic
  - Manages system
- **ESP**
  - Handles forwarding plane traffic
- **SPA Interface Processor**
  - Shared Port Adapters provide interface connectivity
- **Centralized Forwarding Architecture**
  - All traffic flows through the active ESP, standby is synchronized with all flow state with a dedicated 10Gbps link
- **Distributed Control Architecture**
  - All major system components have a powerful control processor dedicated for control and management planes (using dedicated GigE links running between all system components – not shown)

ASR 1000 Series Innovations

IOS XE: Modular IOS for Compact Edge Routers

Software Virtualization



Industry first, delivering hitless upgrades without costly hardware redundancy

Feature	Benefit
Combines rich edge feature set of IOS	Broad services: Enterprise & SP, hosted or managed
Common look and feel to IOS	Decreases OpEx, increases training ROI

ASR 1000 – First Release

Software Features – High level

- IPv4 Unicast & Multicast
- IPv6 Unicast and IPv6 Multicast
- High Availability – NSF/SSO & ISSU
- BB Aggregation - Phase I
- QOS/NBAR phase I
- Security ACLs
- SBC – Session Border Controller – DBE function
- IPSLA/EEM
- Netflow v5/v9
- cRTP/LFI
- Security Features
  - NAT, IOS FW – Phase I
  - IPSec/DMVPN
- MPLS VPN – Phase I
- GRE

Hardware Features

- 2/4/6 RU Systems
- ESP-5G, ESP-10G, CC-10G, RP-1
- SPAs
  - 8-port GE
  - 1-port 10GE
  - 2-port GE and 5-port GE, 10-port GE
  - 8-port FE
  - 8-port T1/E1
  - 2&4-port T3/E3
  - 2&4-port OC-3/STM1 POS
  - 1-port OC12/STM4 POS
  - 2 &4 –port Channelized T3
  - 4-port Serial (12-in-1)

ASR 1000 – Second Release

Planned

Software Features – High level

1. HA
   1. Multicast, L2TP, PPP, AAA
2. SBC
   1. DBE – Enhancements
3. QoS Features
   1. Phase II
4. BB Aggregation – Phase II
   1. Session level QoS
   2. ISG – Phase I
   3. Per-user FW
   4. DHCP Relay – Phase II
5. WCCPv2
6. IPV6 Features - Phase II
7. Security Features – Phase II
   1. NAT/FW ALG Phase II
   2. Control Plane Policing - Phase II
8. L3VPN - Phase II
   1. VRF aware features – Phase II
   2. MPLS over GRE
9. PBR

Hardware Features

- Hardware
  1. Forwarding Processor – ESP-20G
- SPAs
  1. 1-port Channelized STM1
  2. 2 & 4-port OC48 POS/RPR (POS mode)

Network Management

- Cisco Security Manager
- ASR 1000 Device Manager

Summary

Cisco transforms and extends the Enterprise WAN & SP Edge

Cisco ASR 1000 Series Routers deliver instant-on, secure, and reliable services

Cisco ASR 1000 Series simplifies operation and delivers increased return on investment

ASR 1000 Series Routers
Services .. without compromise or complexity