SURPASS
Carrier Ethernet

- Speed, cost and flexibility of Ethernet for any infrastructure
- Broadband access to business and residential services on one network
- Fast and easy end-to-end operations and provisioning for quick time to market
- Carrier-grade solutions for guaranteed quality of service and network resiliency

Provider Ethernet VLAN Cross Connect

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COM FN A SB SE

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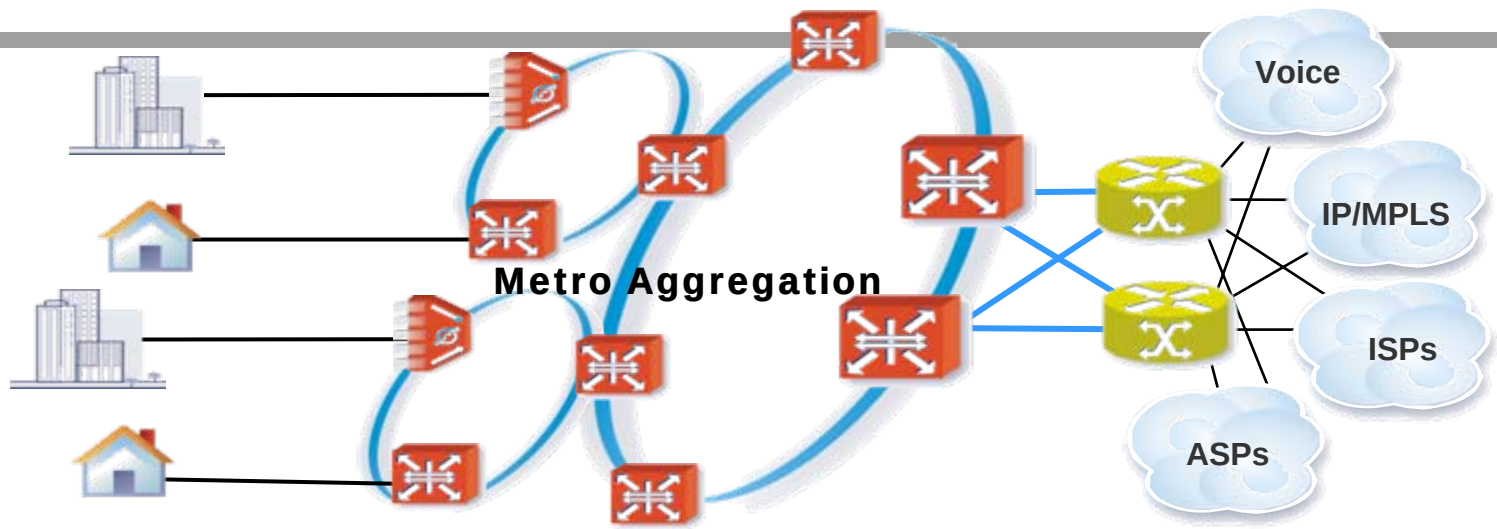
Provider Ethernet - Network Challenges

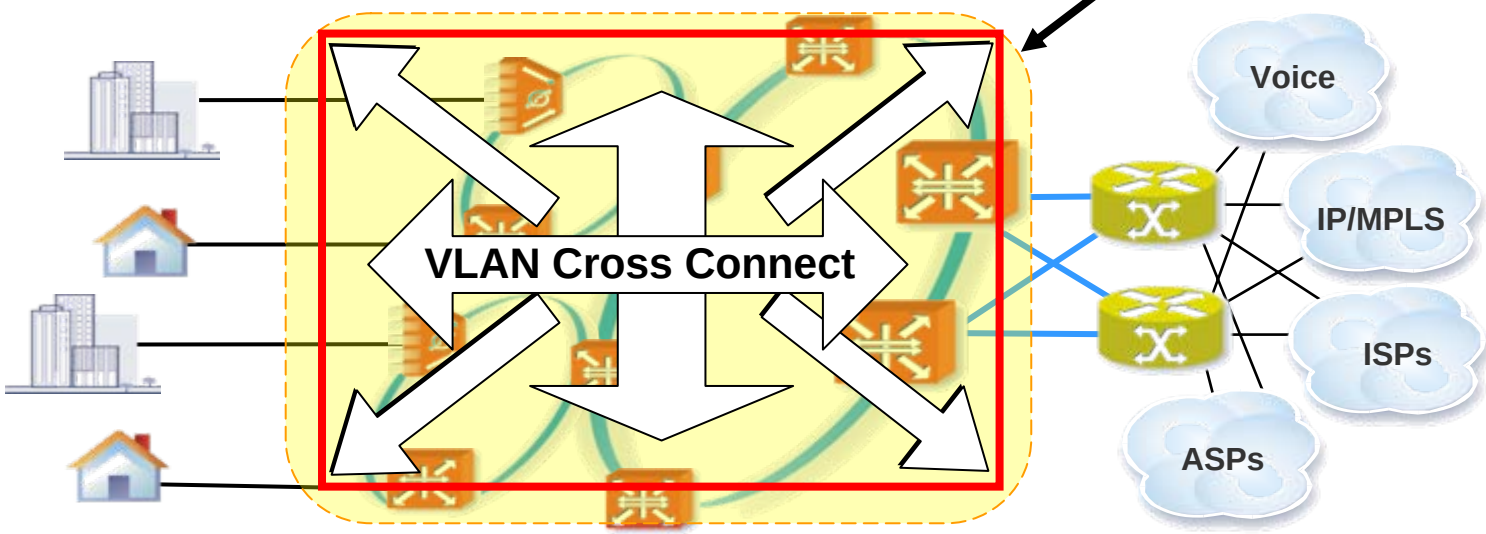
- Business and residential customers require an SLA with guaranteed bandwidth, jitter and delay (which cannot be provided end-to-end by legacy Ethernet bridging)
- Network resiliency with ~50ms recovery
- Huge number of MAC addresses in a single Ethernet domain
- Scalable VLAN networks to provide dedicated VLAN per customer in wholesale solutions
- Networks and services must be secured
- Networks should be kept simple to minimize CAPEX



VLAN Cross Connect – Taking Ethernet One Step Further

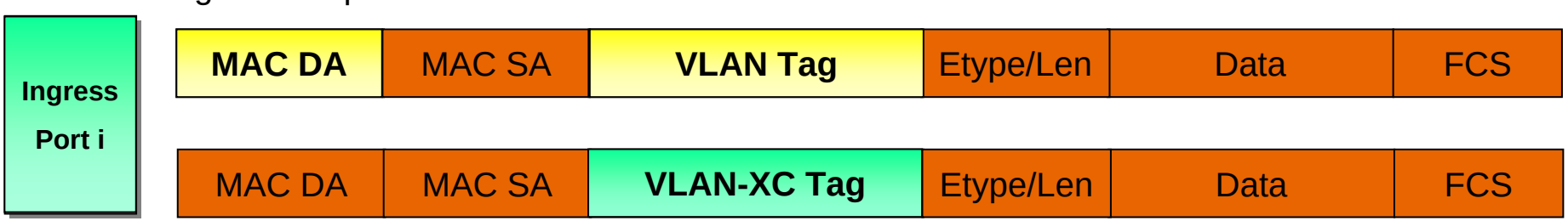
- Connection-oriented technique
- Enables traffic engineering & fast recovery
- Resolves MAC scalability
- Resolves VLAN scalability
- Inherent subscriber identification
- Resolves security issues
- Keeps the network simple

Can scale up to millions of subscribers per port based on standard Ethernet frame format



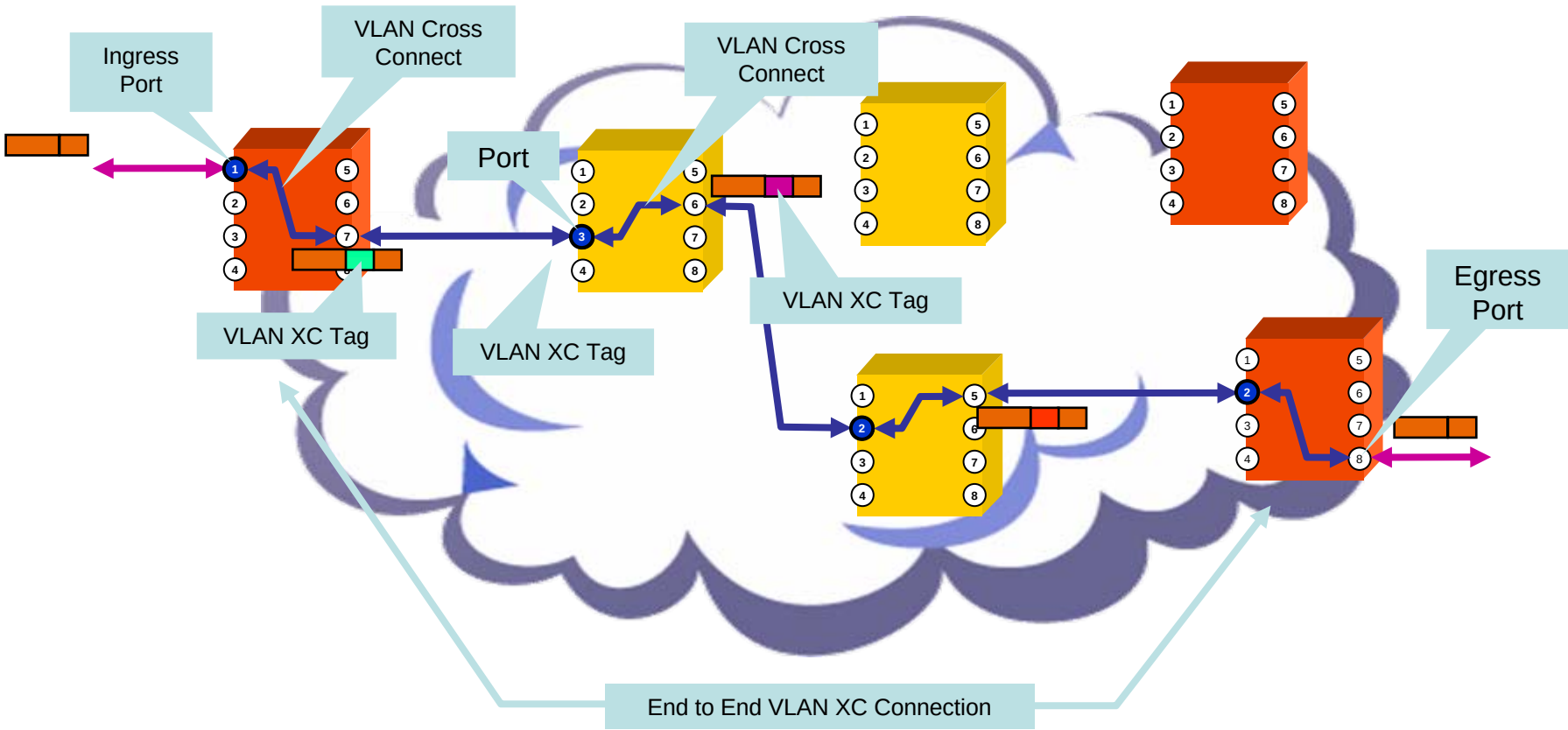
VLAN Cross Connect Concept

- **Standard VLAN Bridging**: Switching based on MAC addresses and VLANs
- **VLAN Cross Connect**: Cross Connect according to the **ingress port and** the **VLAN-XC Tag, regardless of the MAC addresses**

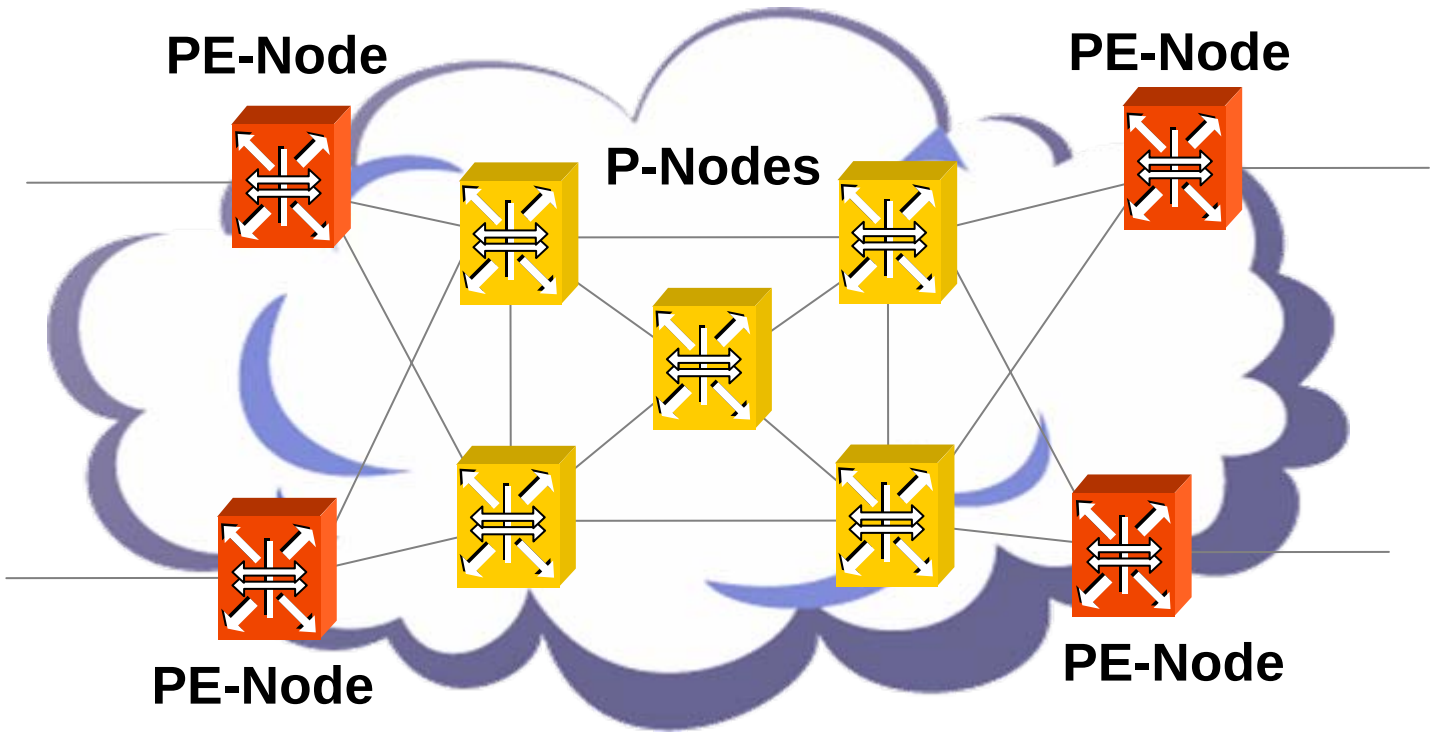


- VLAN Cross Connect **co-exists** with standard VLAN bridging, even on the same port
- VLAN Cross Connect **eliminates** MAC learning per VLAN
- VLAN Cross Connect **enables** up to 16M connections per port

The Concept of VLAN Cross Connect (cont.)

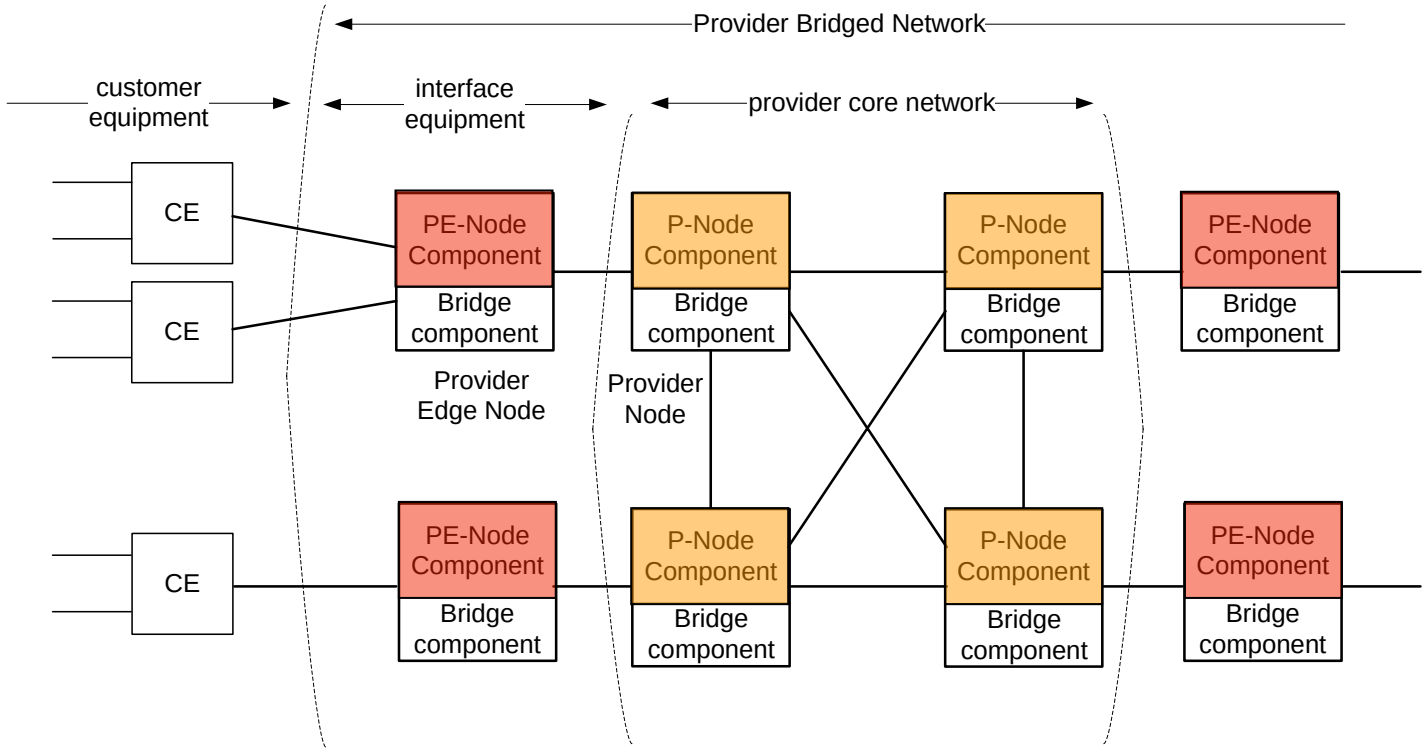


VLAN Cross Connect Network Reference Model



- Provider Edge Nodes (**PE-Nodes)** reside at the boundary of the provider network and create/terminate VLAN-XC connections
- Provider Internal Nodes (**P-Nodes**) perform VLAN Cross Connect switching

VLAN Cross Connect Network Topology



- Provider Edge Nodes (**PE-Nodes)** reside at the boundary of the provider network and create/terminate VLAN-XC connections
- Provider Internal Nodes (**P-Nodes**) perform VLAN Cross Connect switching

Hybrid VLAN Cross Connect & Bridging Network

Provider Ethernet network incorporating both bridging & VLAN Cross Connect methods to apply the optimum method per service:

- Bridging for residential multicast services & basic Ethernet transparent LAN services

Service	Method
IPTV	**Bridging**
Business VPN MPtMP (E-LAN)	**Bridging**
Network management	**Bridging**

- VLAN Cross Connect for business-critical services with associated SLAs

High Speed Internet Service	**VLAN-XC**
Business VPN PtP (E-Line)	**VLAN-XC**
Business & Residential Voice Services	**VLAN-XC**
Residential Video-on-Demand	**VLAN-XC**
Wholesale services	**VLAN-XC**

Hybrid Network Benefits

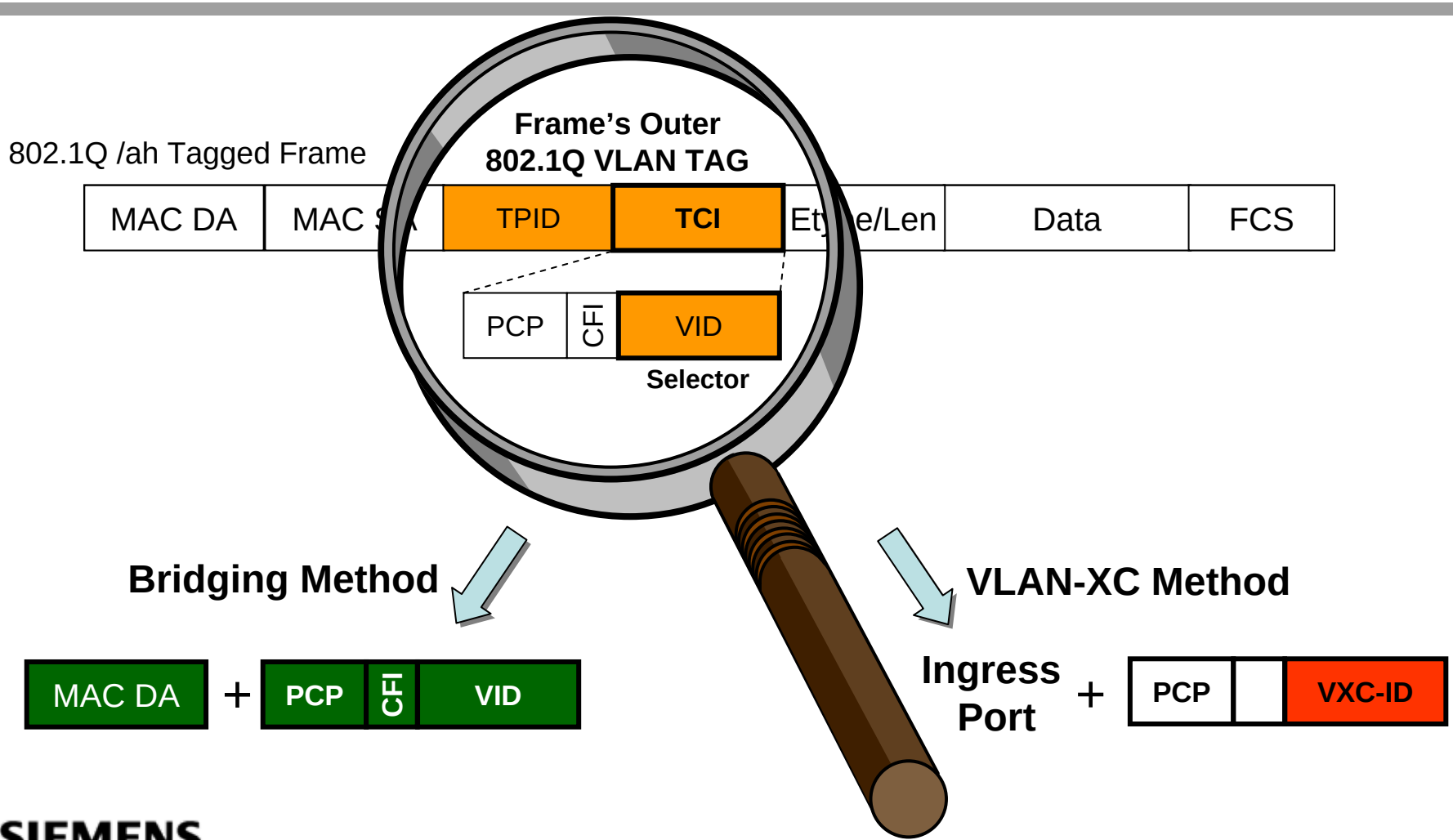
- **Traffic Engineering**
  - VLAN Cross Connect allows end-to-end TE for services with associated SLAs
- **Fast Recovery**
  - ~50ms recovery for VLAN Cross Connect services
  - Significantly reduces the recovery time for bridging services due to small FDB (yields from correct service partitioning between VLAN Cross Connect and bridging methods)
- **MAC Scalability Traffic Engineering**
  - VLAN Cross Connect allows end-to-end TE for services with associated SLAs
- **Fast Recovery**
  - ~50ms recovery for VLAN
  - VLAN Cross Connect for services that consume a large number of MAC addresses
  - Small FDB (used for bridging services) due to the insignificance of MAC addresses in the VLAN Cross Connect
- **VLAN Scalability**
  - VLAN Cross Connect identifiers have local port scope
    - *Up to 24-bit wide VLAN Cross Connect identifier*
  - Bridging VLAN identifiers have global scope

Hybrid Network Benefits (cont.)

- **User Isolation**
  - In the VLAN Cross Connect , users are inherently isolated by the end-to-end connection
  - In Bridging, user isolation requires additional methods such as PVLAN, Port Isolation, etc
- **User Identification**
  - In the VLAN Cross Connect , users are natively identified along the provisioned end-to-end connection
- **Protection against MAC spoofing and MAC attacks**
  - MAC Address insignificant in VLAN Cross Connect switching
  - MAC Learning inhibited for VLAN Cross Connect

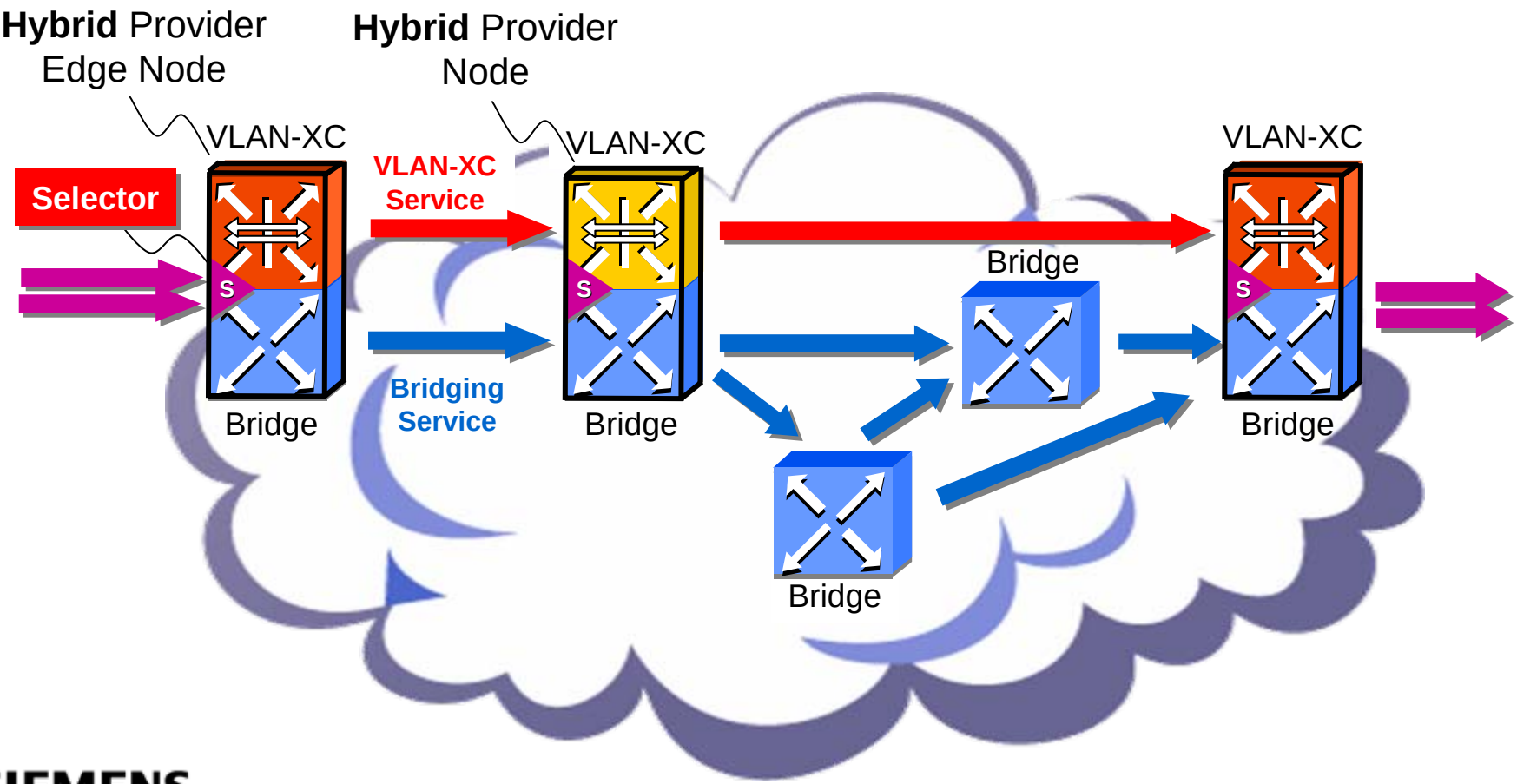
Bridging / VLAN Cross Connect Selector

VID of the frame's outer VLAN tag acts as method selector



VLAN Cross Connect & Bridging Hybrid Network

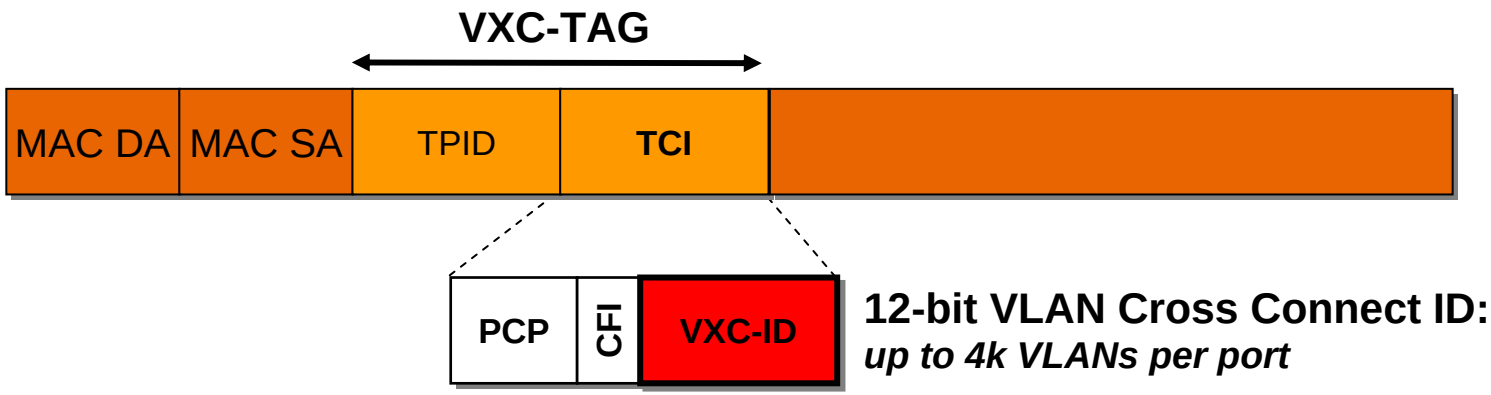
VLAN Cross Connect and bridging services coexist in the same provider network



VLAN Cross Connect Frame Semantic

- VLAN Cross Connect identifier has local port scope
  - Frame format as defined in IEEE 802.1Q
- VLAN Cross Connect tagged frame allows up to 4K VLANs per port

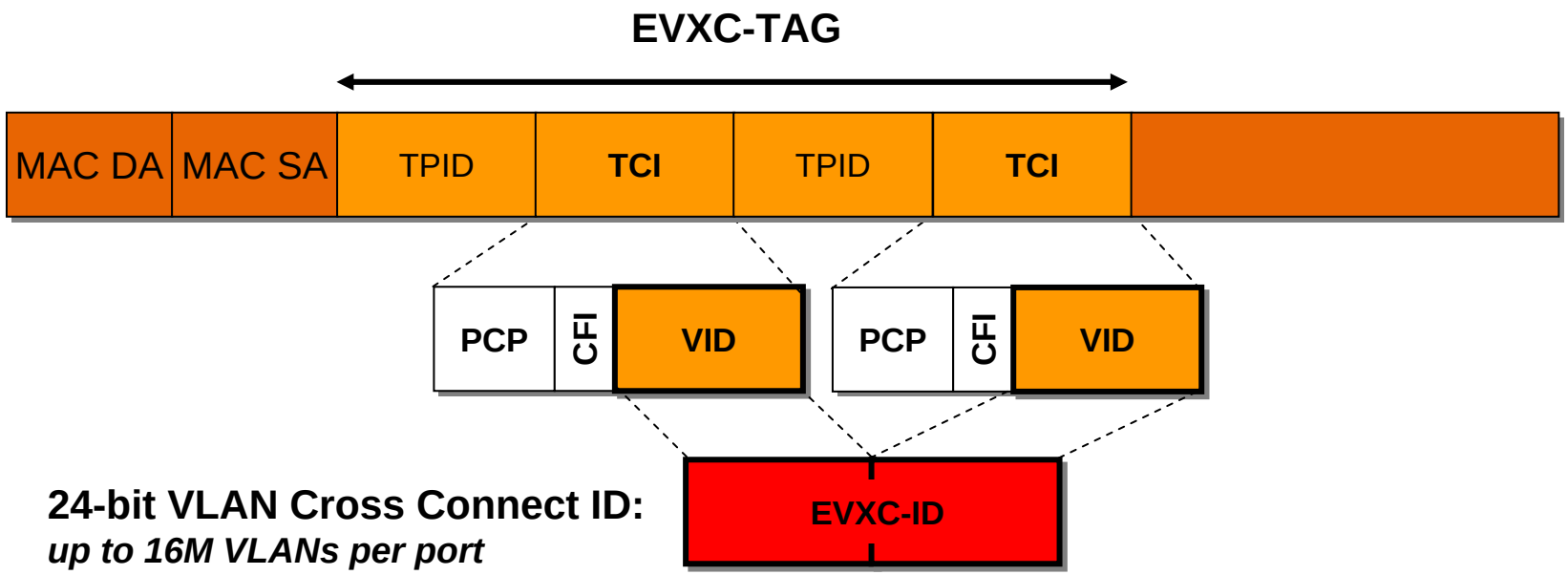
VLAN Cross Connect tagged frame



VLAN Cross Connect Frame Semantic (cont.)

- **Extended** VLAN Cross Connect
  - Frame format as defined in IEEE 802.1ad
  - VLAN Cross Connect tagged frame allows up to 16M VLANs per port

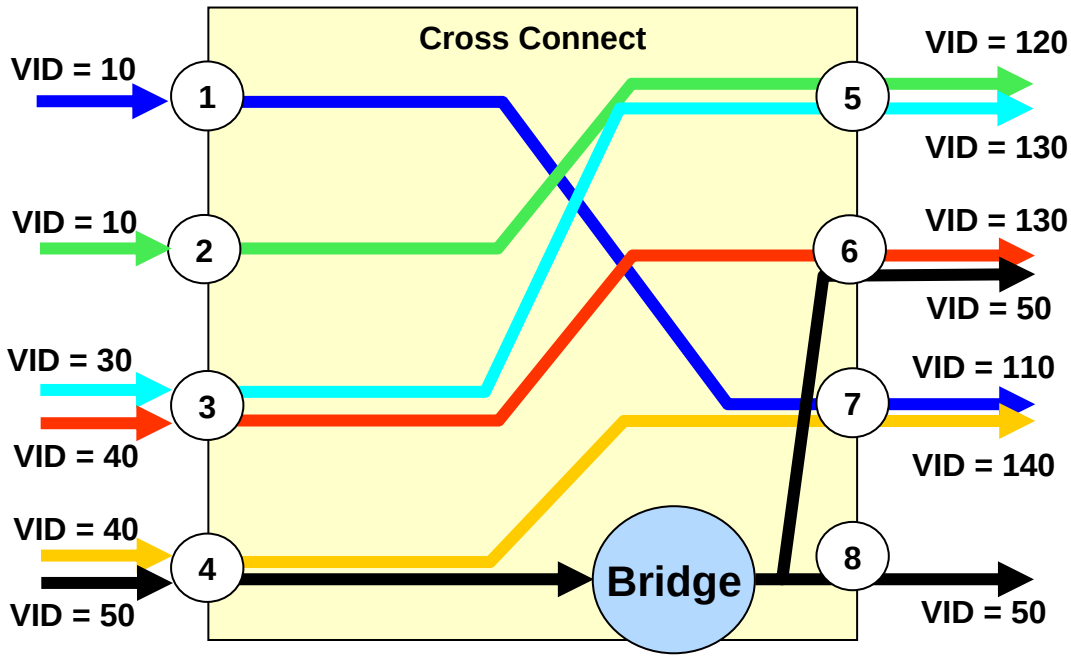
Extended VLAN Cross Connect tagged frame



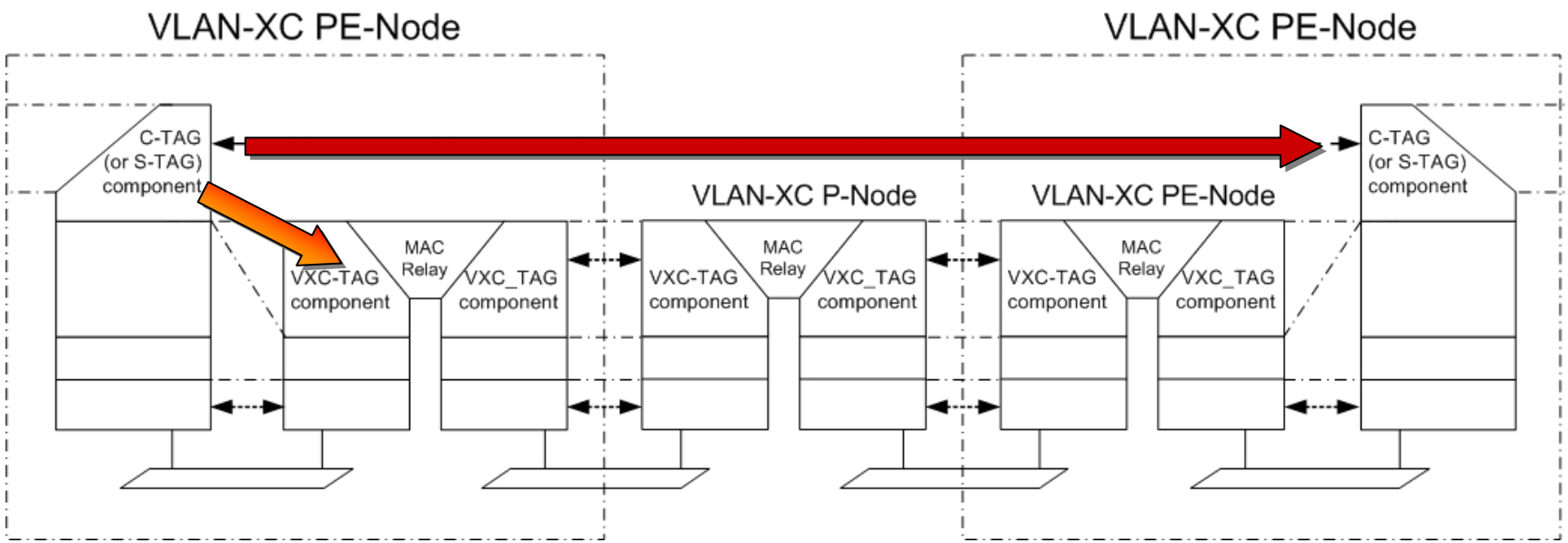
24-bit VLAN Cross Connect ID:
up to 16M VLANs per port

VLAN Cross Connect Process Example

In Port	Ingress VLAN	Out Port	Egress VLAN
1	10	7	110
2	10	5	120
3	30	5	130
3	40	6	130
4	40	7	140
4	50	Bridging according to MAC DA & VLAN ID	50

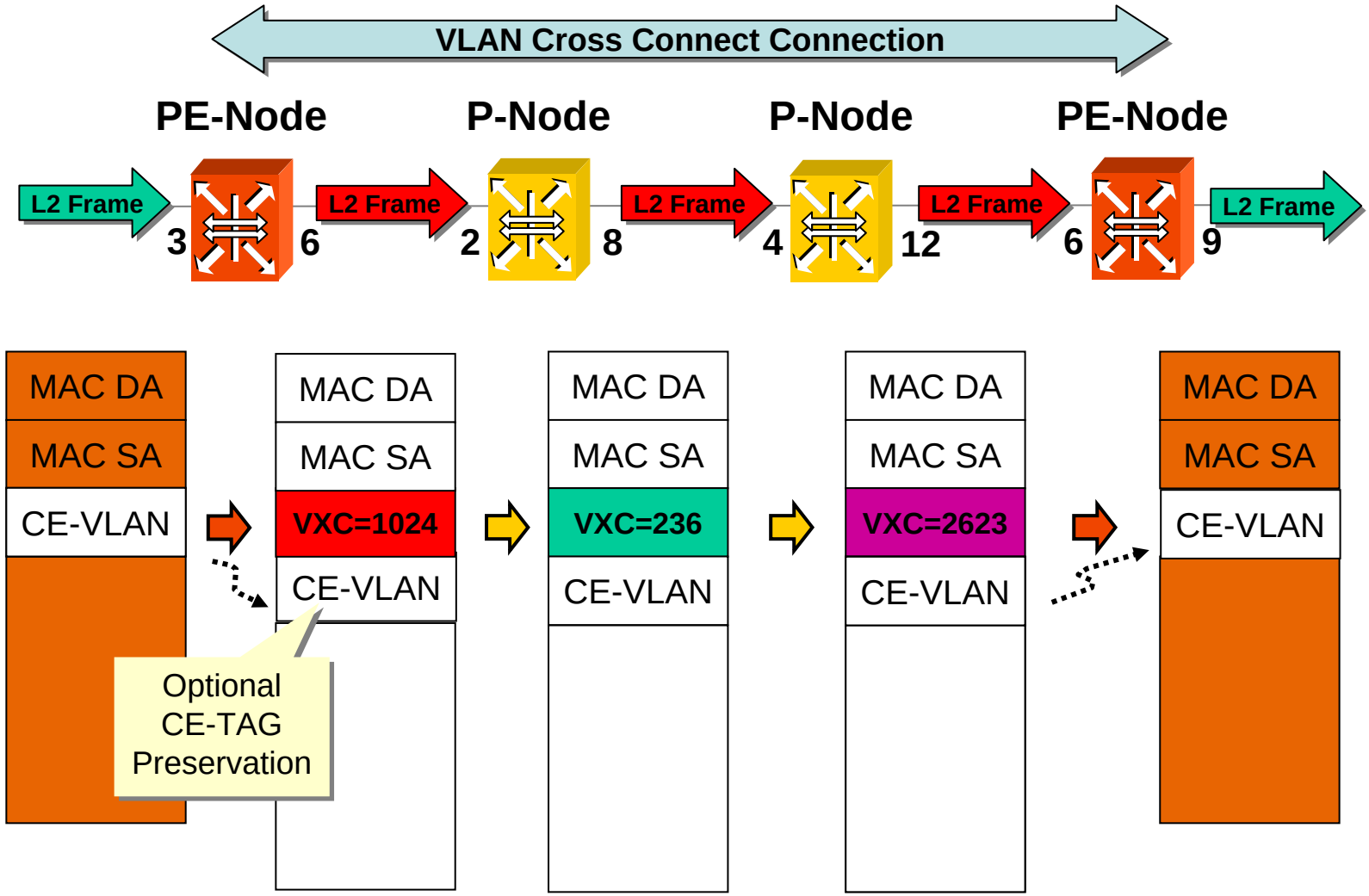


VLAN Cross Connect Service Model

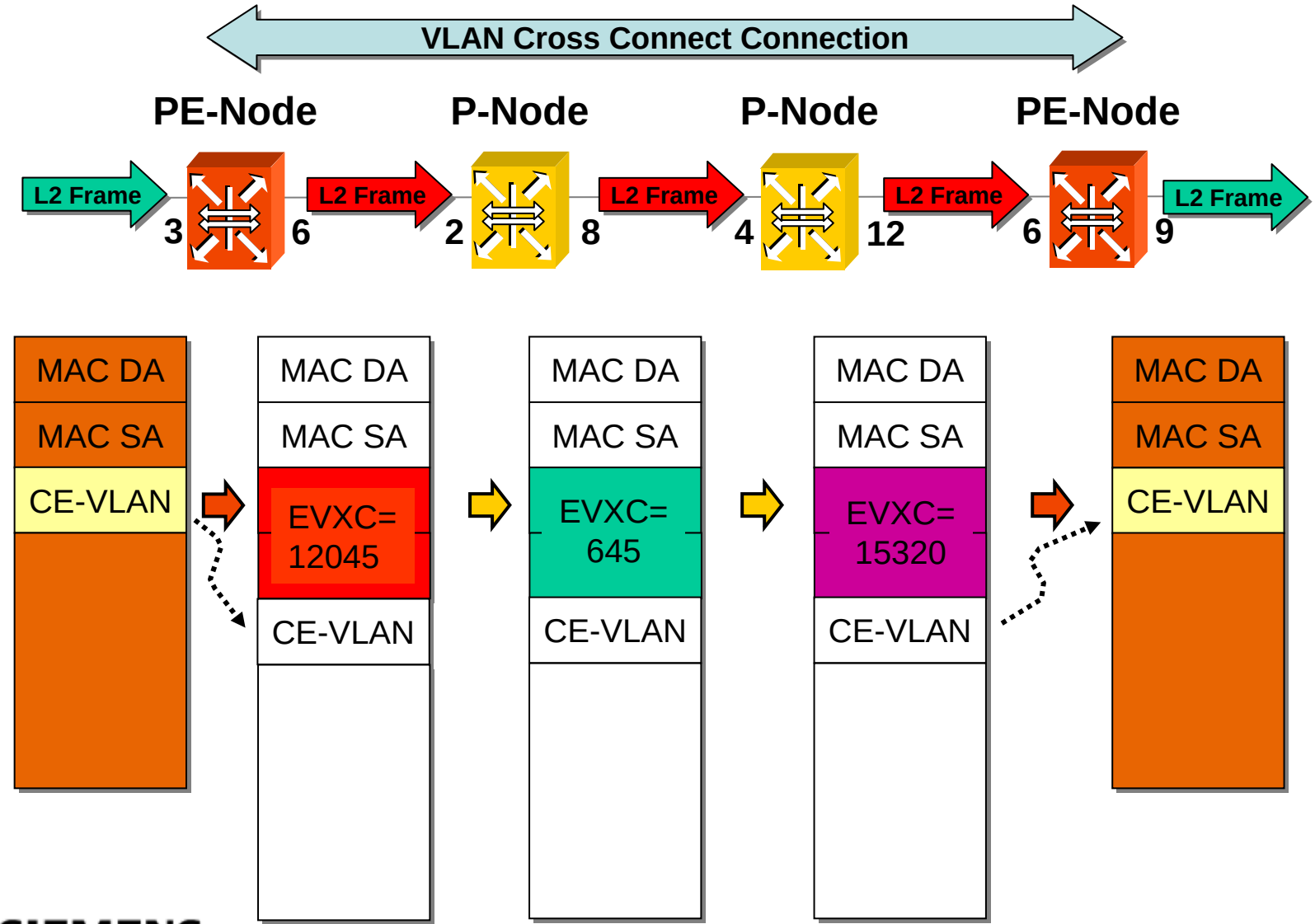


- At the boundary of the VLAN-XC domain, the VID of the outer tag (C-TAG or S-TAG) can be used to associate the frame with a particular VLAN-XC connection.
- If required, the outer tag (C-TAG or S-TAG) is preserved and transparently transported within the VLAN-XC domain.

VLAN Cross Connect Example (with CE-VLAN Preservation)



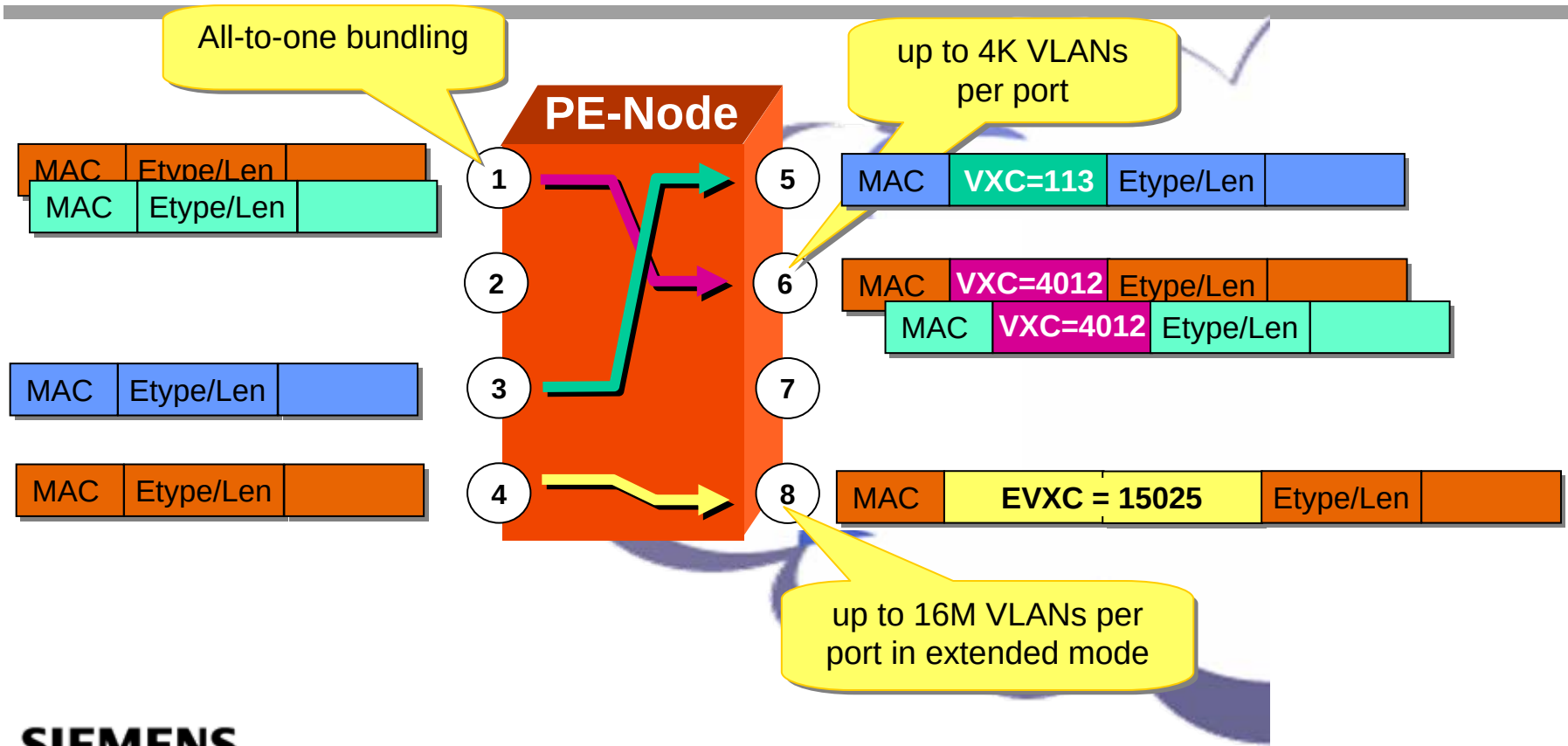
Extended VLAN Cross Connect Example



VLAN Cross Connect Services for Ingress Untagged Frames

All-to-one bundling for untagged frames:

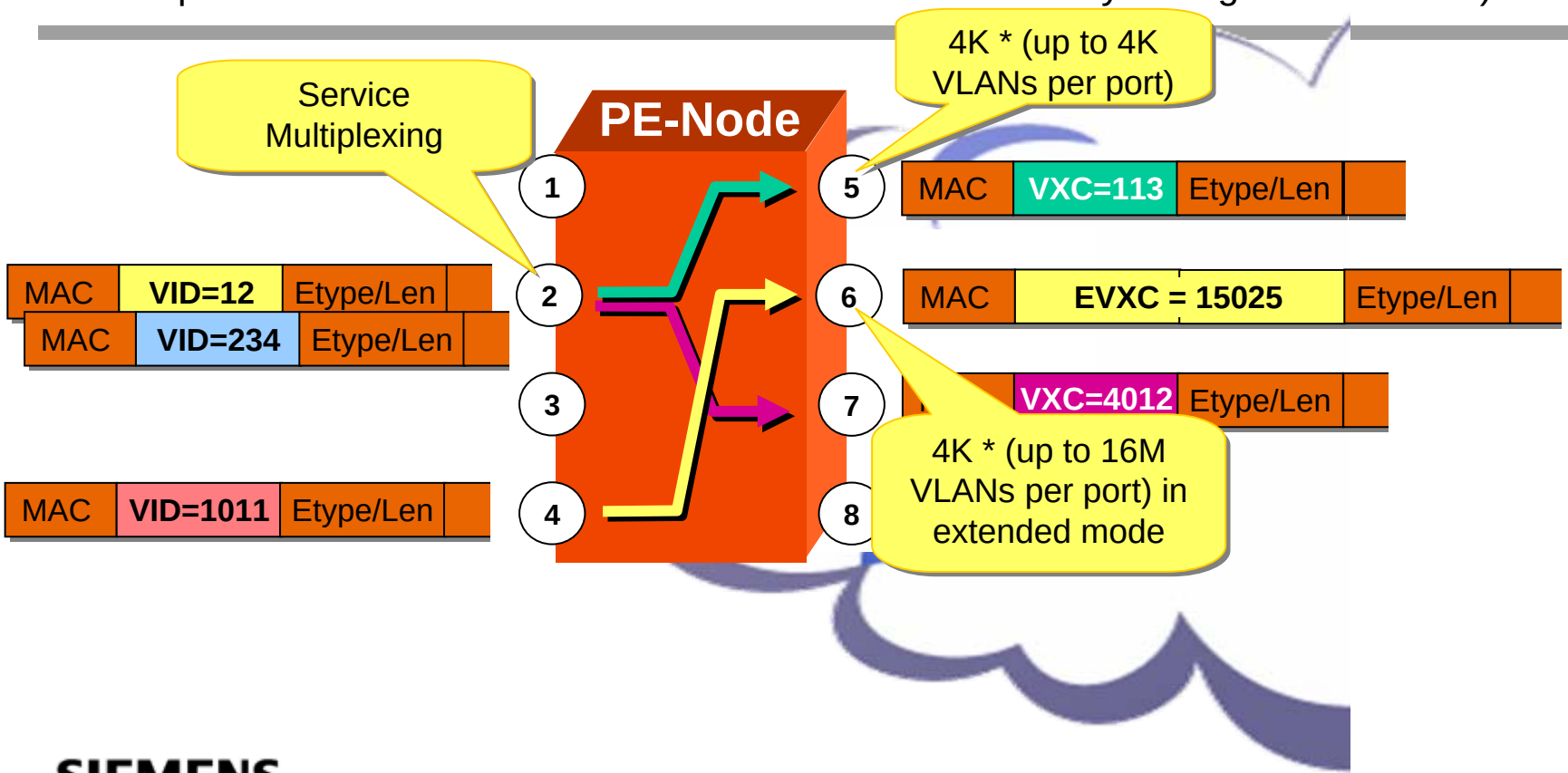
- All frames received on a particular ingress port are associated with a single connection over the provider network



VLAN Cross Connect Services for Ingress Tagged Frames

Service multiplexing with no ingress outer V-TAG preservation:

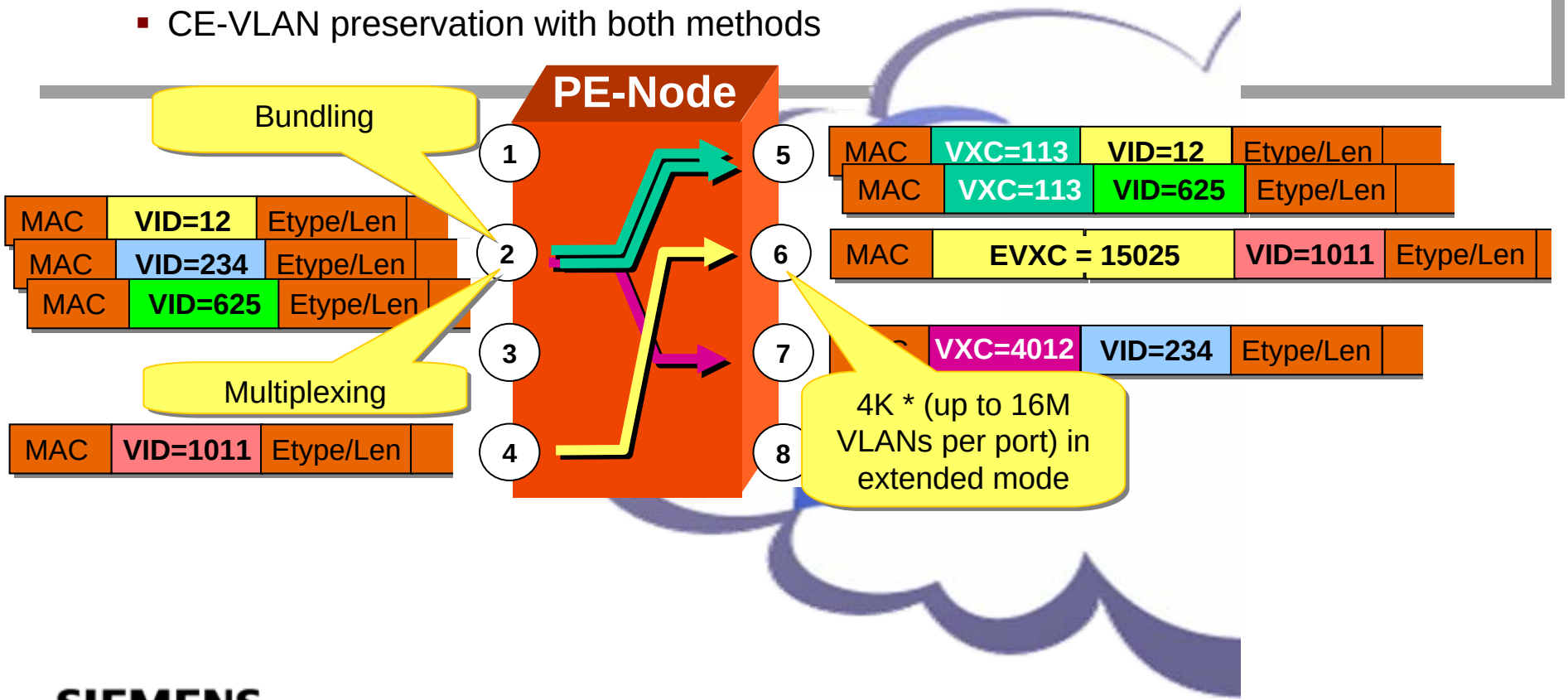
- Multiple outer VLANs received on a particular ingress port can be associated with multiple connections over the provider network.
- Outer VLAN tag is not preserved over the network (but may be retrieved from the penultimate VLAN Cross Connect identifier received by the egress PE-Node)



VLAN Cross Connect Services for Ingress Tagged Frames (cont.)

On the same ingress port:

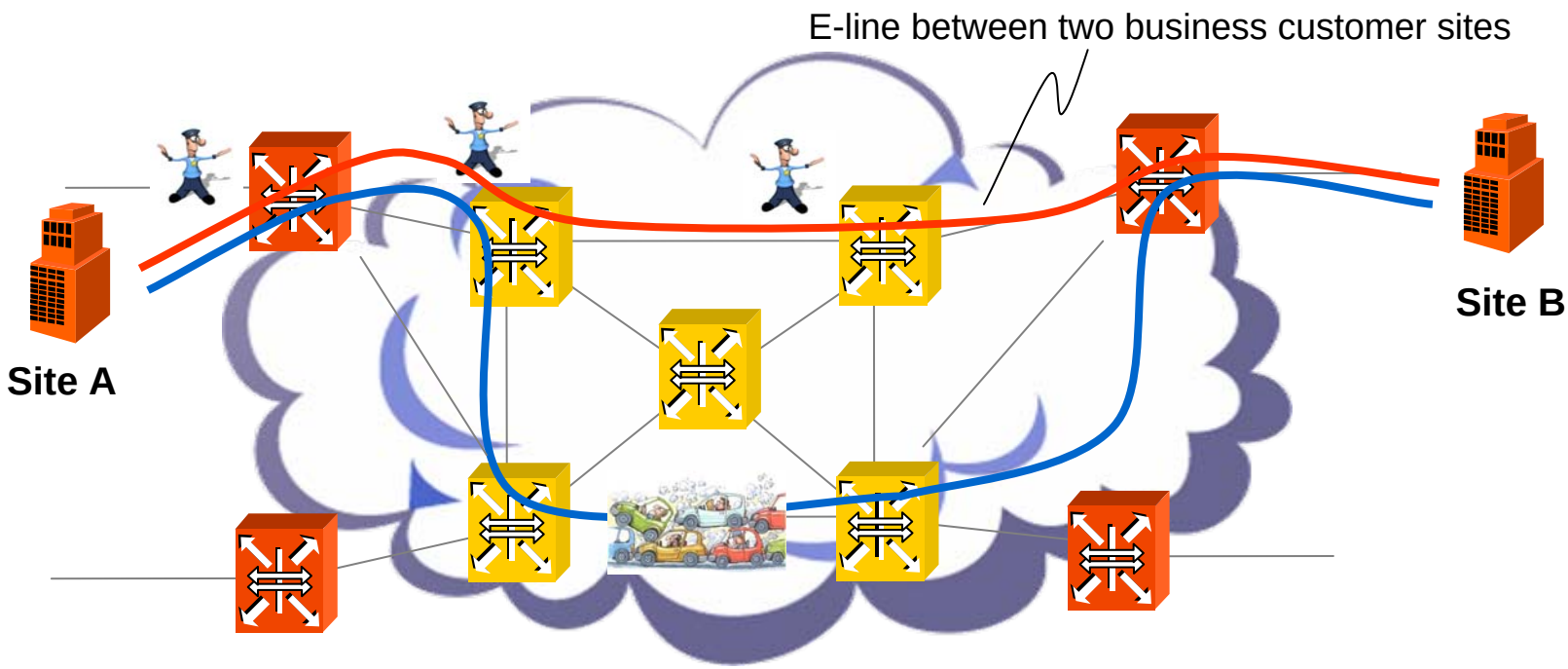
- Bundling: Multiple outer VLANs can be associated with a single connection over the provider network.
- Multiplexing: Multiple outer VLANs can be associated with multiple connections over the provider network.
- CE-VLAN preservation with both methods



VLAN Cross Connect Traffic Engineering

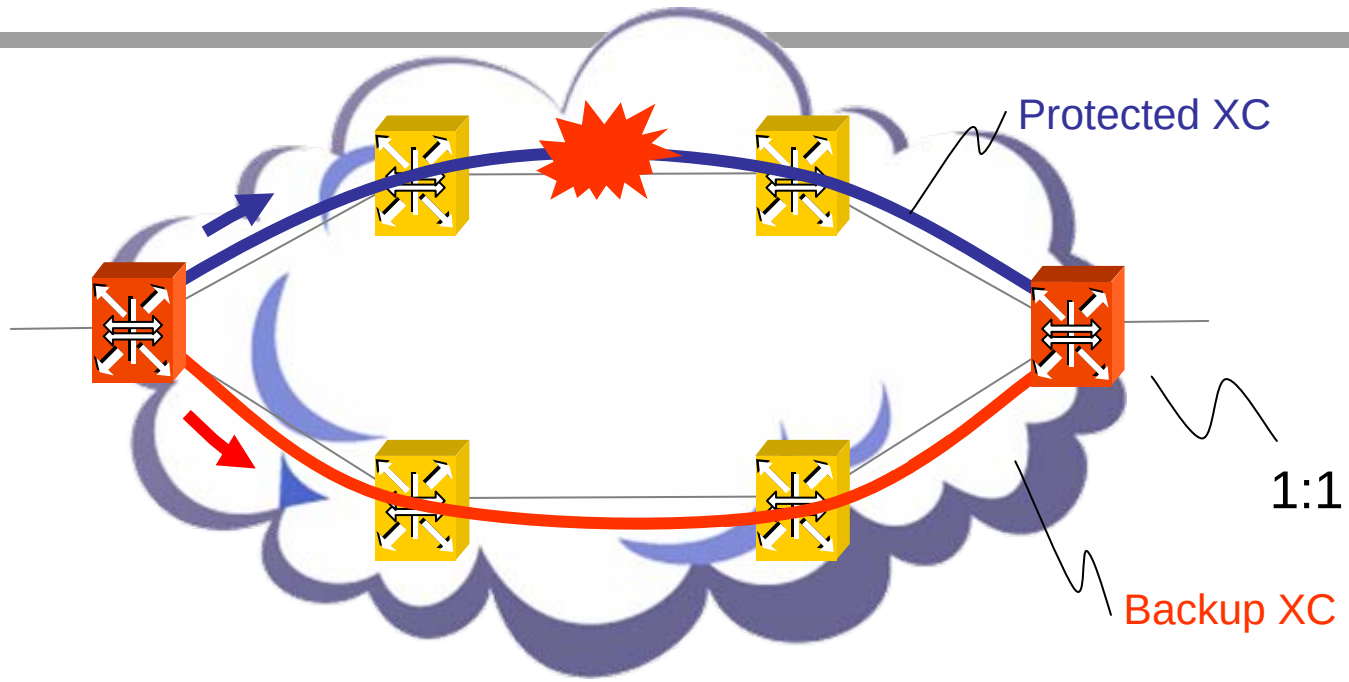
VLAN Cross Connect enables traffic engineering:

- Can be implemented using a domain-wide provisioning tool
- GMPLS control plane once standardized



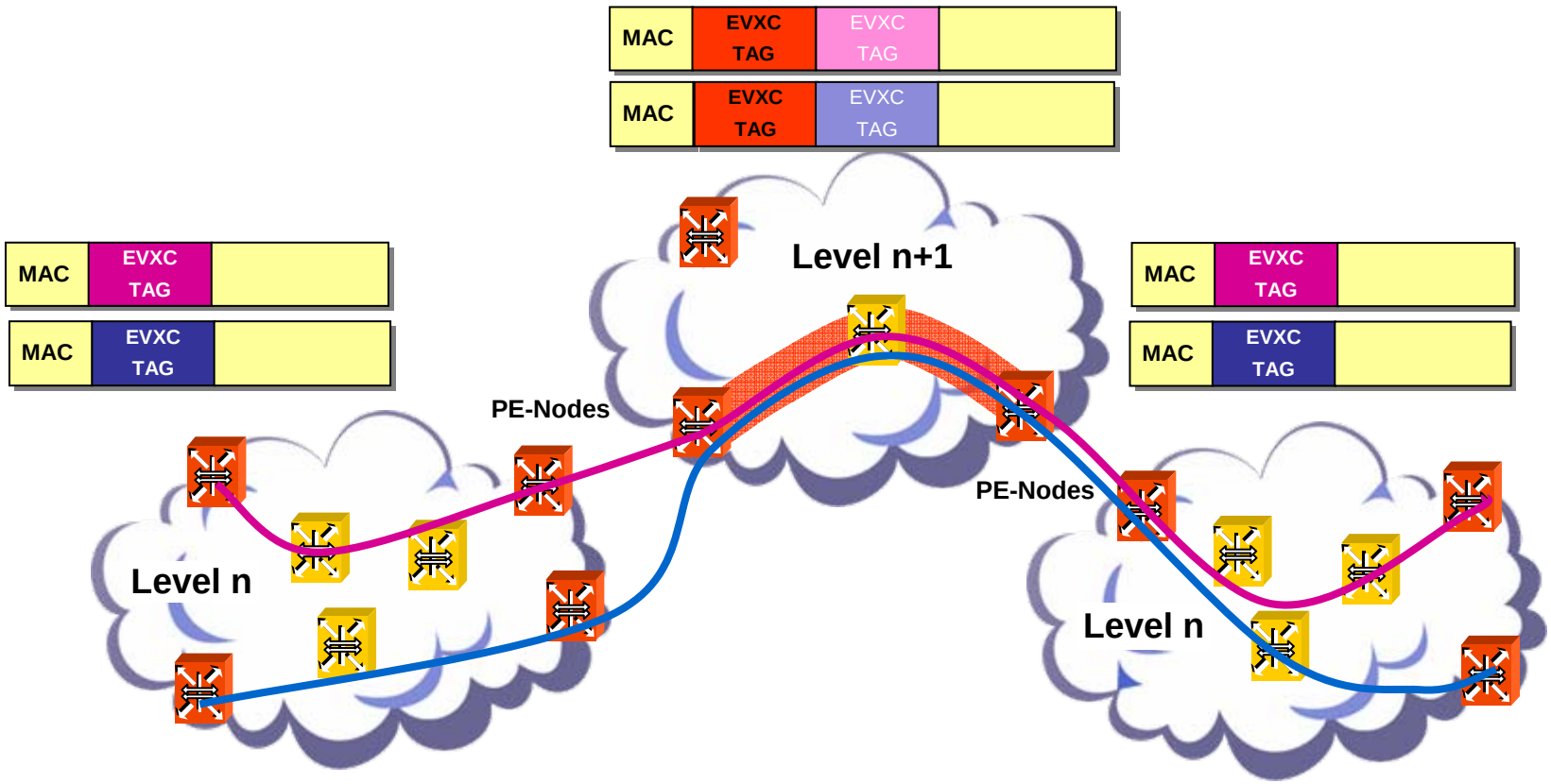
VLAN Cross Connect Network Resiliency

- 1:1 Global Protection with extra traffic
- Pre-provisioned backup paths using network-wide provisioning tools
- Sub-50ms recovery
- Revertive or non-revertive mode
- GMPLS resiliency mechanisms (including Fast Reroute) could be applied once GMPLS for Ethernet is standardized



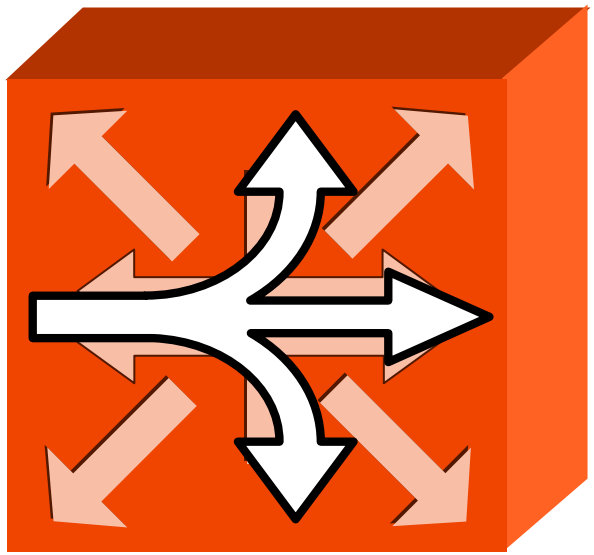
Scalability

- VLAN Cross Connect can be naturally extended to work with hierarchical domains using tunneling
- Uses standard VLAN stacking



Point-to-Multipoint Services

- VLAN Cross Connect can be naturally extended to provide point-to-multipoint services
- Subject to a forthcoming contribution



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Thank You!

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