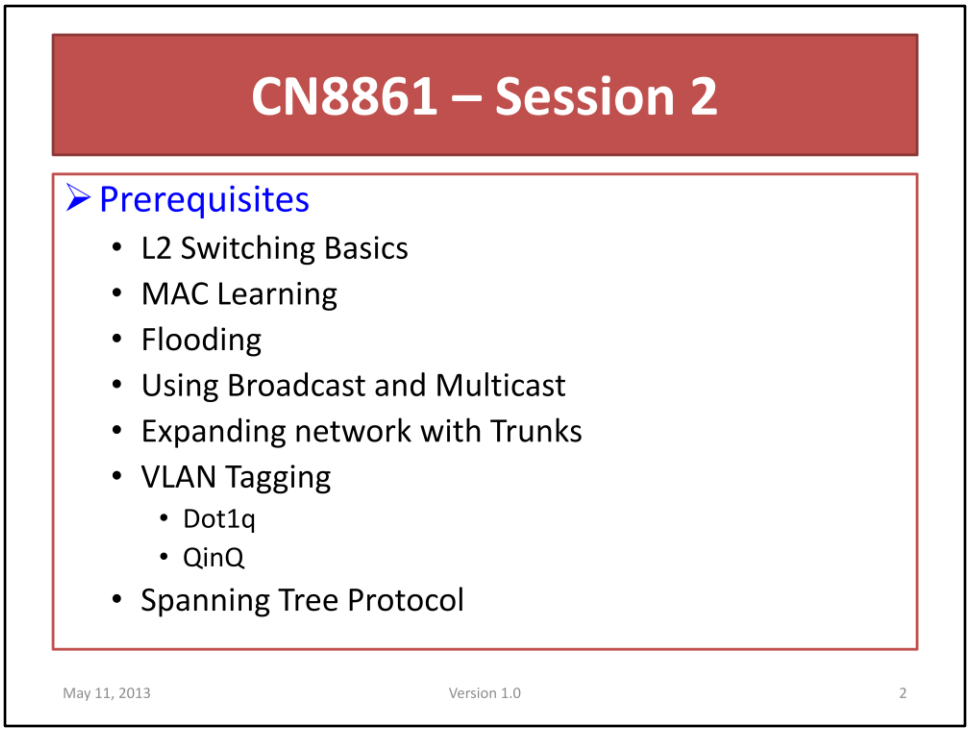
CN8861 – Session 2

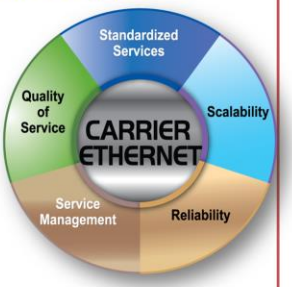


- L2 Switching Basics
  - MAC Forwarding Table
- MAC Learning
  - Source MAC learning
- Flooding
  - Unicast Flooding
- Using Broadcast and Multicast
  - Broadcast: Forward frame to all ports, other than it received
  - Multicast: Forward frame to only member ports (IGMP)
- Expanding network with Trunks
  - Dot1q (widely adopted)
  - ISL (Cisco Proprietary, Cisco suggest to use dot1q)
- VLAN Tagging
  - Dot1q
  - QinQ
- Spanning Tree Protocol
  - RSTP
  - MST
  - Switch flush the MAC forwarding table, when receive Topology Change Notification

Metro Ethernet Services Concepts

Metro Ethernet

- What is Metro Ethernet (Carrier Ethernet)?
  - Universal, Standardized, Carrier-class Service and Network
- Is it a Service, a network, or a Technology?
  - For End-User
    - It's a Service defined by 5 attributes
  - For Service Provider
    - Set of certified network elements that connect to transport the services offered to the customer
    - Platform for value added services
    - Standardized service for all users



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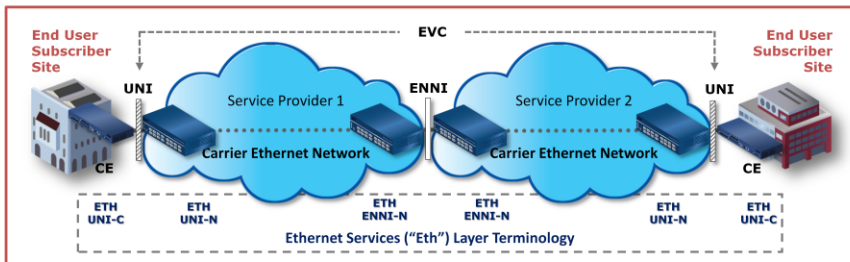
•What is Metro Ethernet (Carrier Ethernet)?

•For End-User

It's a Service defined by 5 attributes:

1. Standardized Service
2. Quality of Service
3. Service Management
4. Reliability
5. Scalability

Metro Ethernet Architecture



EVC:	Ethernet Virtual Connection
UNI:	User Network Interface. the physical demarcation point between the responsibility of the Service Provider and the responsibility of the Subscriber
UNI-C:	UNI customer-side processes
UNI-N	UNI network-side processes
ENNI:	External Network to Network Interface; the physical demarcation point between the responsibility of the two Service Providers
ENNI-N:	ENNI Processes

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The User Network Interface (UNI)

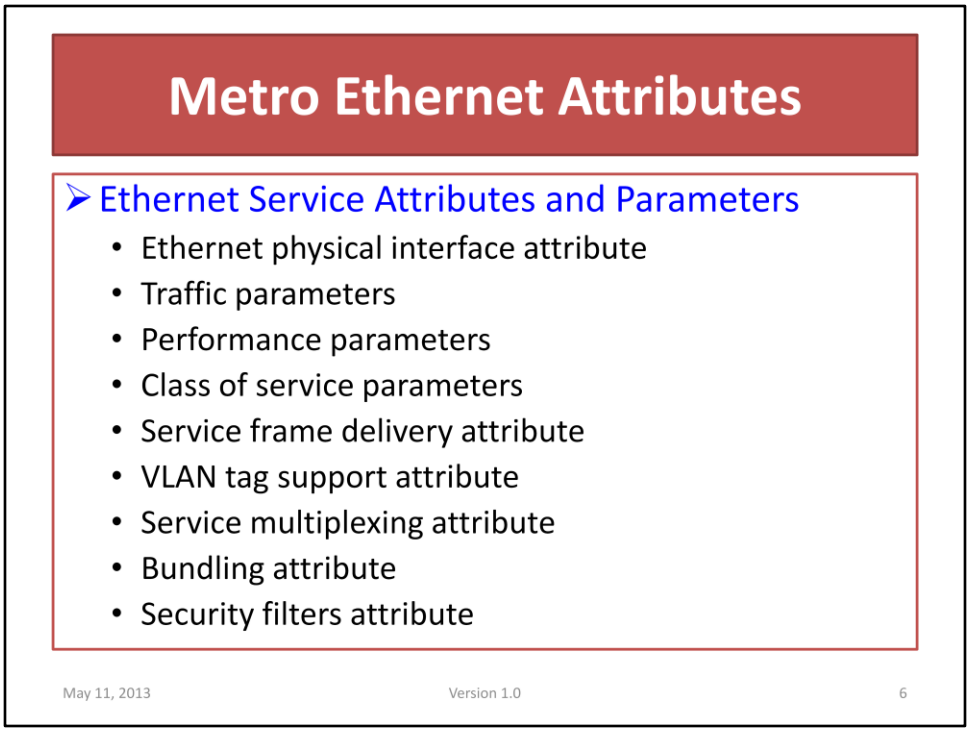
- The UNI is always provided by the Service Provider
- The UNI in a Carrier Ethernet Network is a physical Ethernet Interface at operating speeds 10Mbs, 100Mbps, 1Gbps or 10Gbps

Ethernet Virtual Connection (EVC)

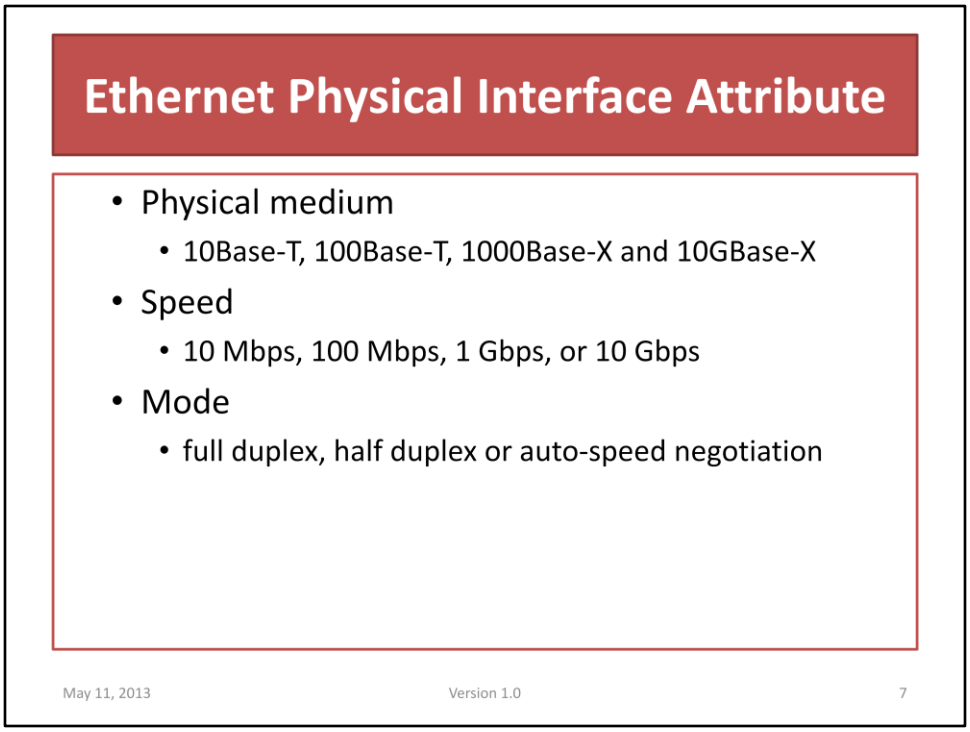
- Service container
- Connects two or more subscriber sites (UNI's)
- An association of two or more UNIs
- Prevents data transfer between sites that are not part of the same EVC
- Three types of EVCs
  - Point-to-Point
  - Multipoint-to-Multipoint
  - Rooted Multipoint
- Can be bundled or multiplexed on the same UNI

Network to Network Interface (NNI)

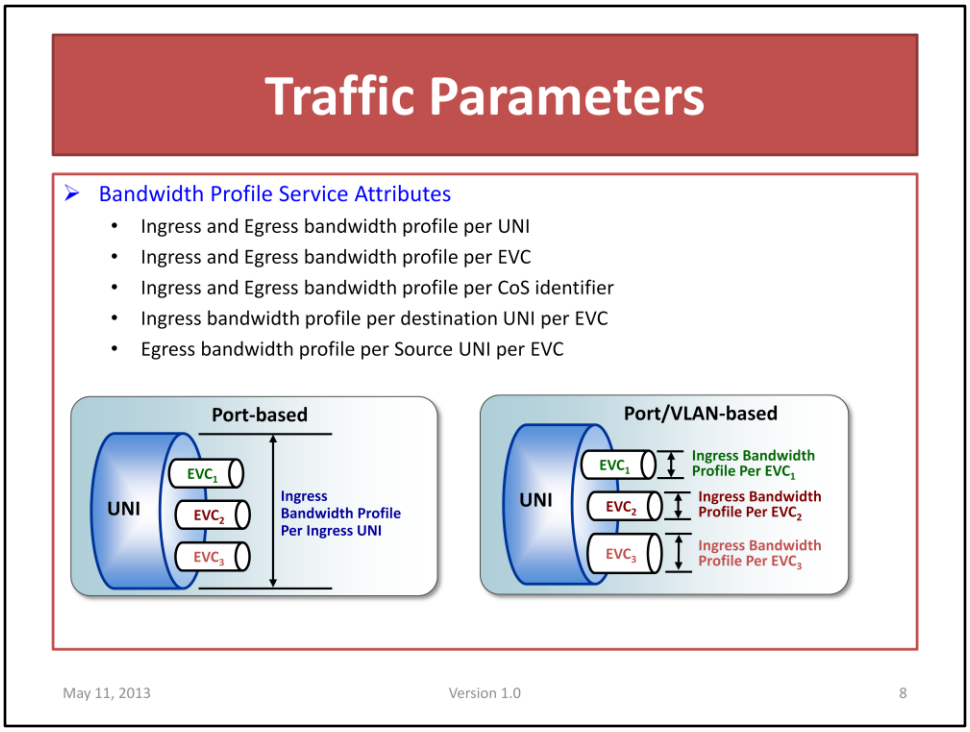
- Network to Network Interface between distinct MEN operated by one or more carriers
- An active project of the MEF



The MEF has developed an Ethernet services framework to help subscribers and service providers have a common nomenclature when talking about the different service types and their attributes.



The Ethernet **Physical Interface Attribute** has the following parameters:
Physical medium— Defines the physical medium per the IEEE 802.3 standard. Examples are 10BASE-T, 100BASE-T, 1000BASE-X and 10GBASE-X.
Speed— Defines the Ethernet speed: 10 Mbps, 100 Mbps, 1 Gbps, or 10 Gbps.
Mode— Indicates support for full duplex or half duplex and support for auto-speed negotiation between Ethernet ports.

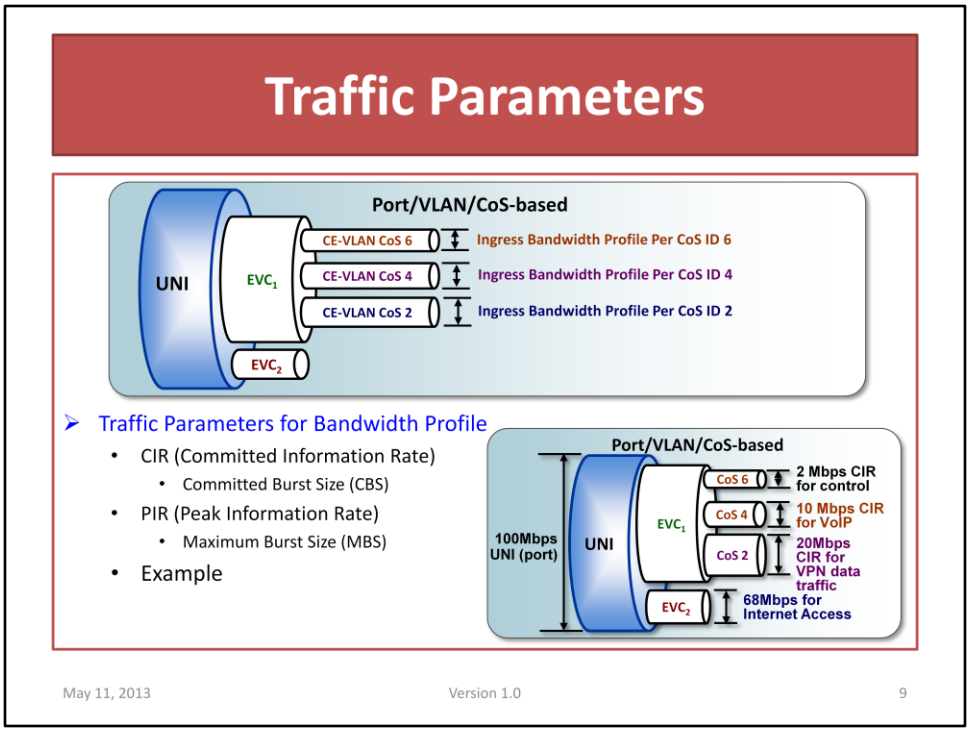


Traffic Parameters

The MEF has defined a set of bandwidth profiles that can be applied at the UNI or to an EVC. A bandwidth profile is a limit on the rate at which Ethernet frames can traverse the UNI or the EVC.

Bandwidth Profile service attributes

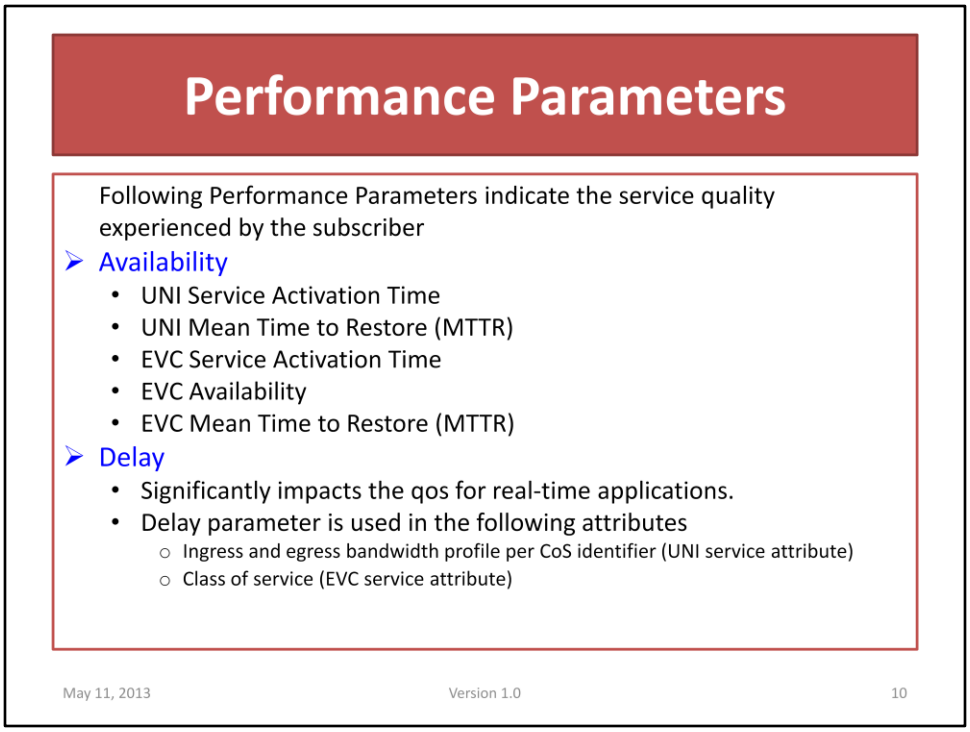
- Ingress and Egress bandwidth profile per UNI
- Ingress and Egress bandwidth profile per EVC
- Ingress and Egress bandwidth profile per CoS identifier
- Ingress bandwidth profile per destination UNI per EVC
- Egress bandwidth profile per Source UNI per EVC



Traffic Parameters

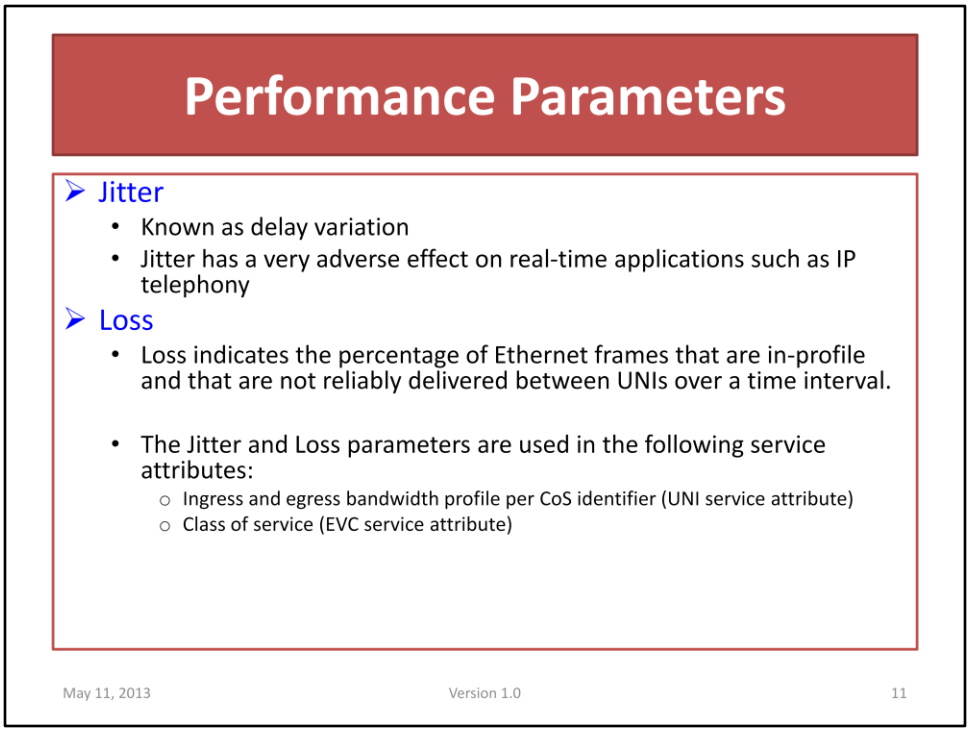
Traffic Parameters for Bandwidth Profile

- CIR (Committed Information Rate)
  - This is the minimum guaranteed throughput that the network must deliver for the service under normal operating conditions.
  - The Committed Burst Size (CBS) is the size up to which subscriber traffic is allowed to burst in profile and not be discarded or shaped. The in-profile frames are those that meet the CIR and CBS parameters.
- PIR (Peak Information Rate)
  - The PIR specifies the rate above the CIR at which traffic is allowed into the network and that may get delivered if the network is not congested.
  - The Maximum Burst Size (MBS) is the size up to which the traffic is allowed to burst without being discarded.
- Example: A sample service may provide a 3-Mbps CIR, 500-KB CBS, 10-Mbps PIR, and 1-MB MBS.
  - Traffic is less than or equal to CIR (3 Mbps)— Traffic is “in profile” with a guaranteed delivery. Traffic is also “in profile” if it bursts to CBS (500 KB). Exceed traffic may be dropped or delayed.
  - Traffic is more than CIR (3 Mbps) and less than PIR (10 Mbps)— Traffic is “out of profile”. It may get delivered if the network is not congested and the burst size is less than MBS (1 MB)
  - Traffic is more than PIR (10 Mbps)— Traffic is discarded

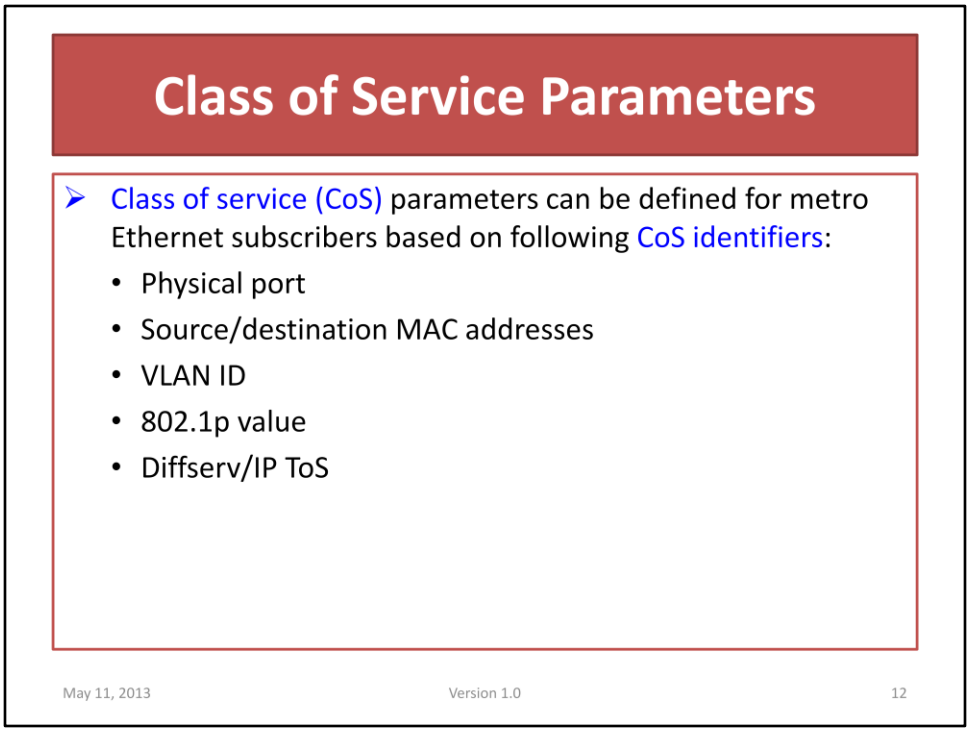


The **Performance Parameters** indicate the service quality experienced by the subscriber. They consist of the following:

- Availability
    - UNI Service Activation Time— Specifies the time from when the new or modified service order is placed to the time service is activated and usable. Remember that the main value proposition that an Ethernet service claims is the ability to cut down the service activation time to hours versus months with respect to the traditional telco model.
    - UNI Mean Time to Restore (MTTR)— Specifies the time it takes from when the UNI is unavailable to when it is restored. Unavailability can be caused by a failure such as a fiber cut.
    - EVC Service Activation Time— Specifies the time from when a new or modified service order is placed to when the service is activated and usable. The EVC service activation time begins when all UNIs are activated. For a multipoint EVC, for example, the service is considered active when all UNIs are active and operational.
    - EVC Availability— Specifies how often the subscriber's EVC meets or exceeds the delay, loss, and jitter service performance over the same measurement interval. If an EVC does not meet the performance criteria, it is considered unavailable.
    - EVC (MTTR)— Specifies the time from when the EVC is unavailable to when it becomes available again. Many restoration mechanisms can be used on the physical layer (L1), the MAC layer (L2), or the network layer (L3).
- Delay
    - Delay is a critical parameter that significantly impacts the quality of service (QoS) for real-time applications.
    - The delay parameter is used in the following attributes:
        - Ingress and egress bandwidth profile per CoS identifier (UNI service attribute)
        - Class of service (EVC service attribute)

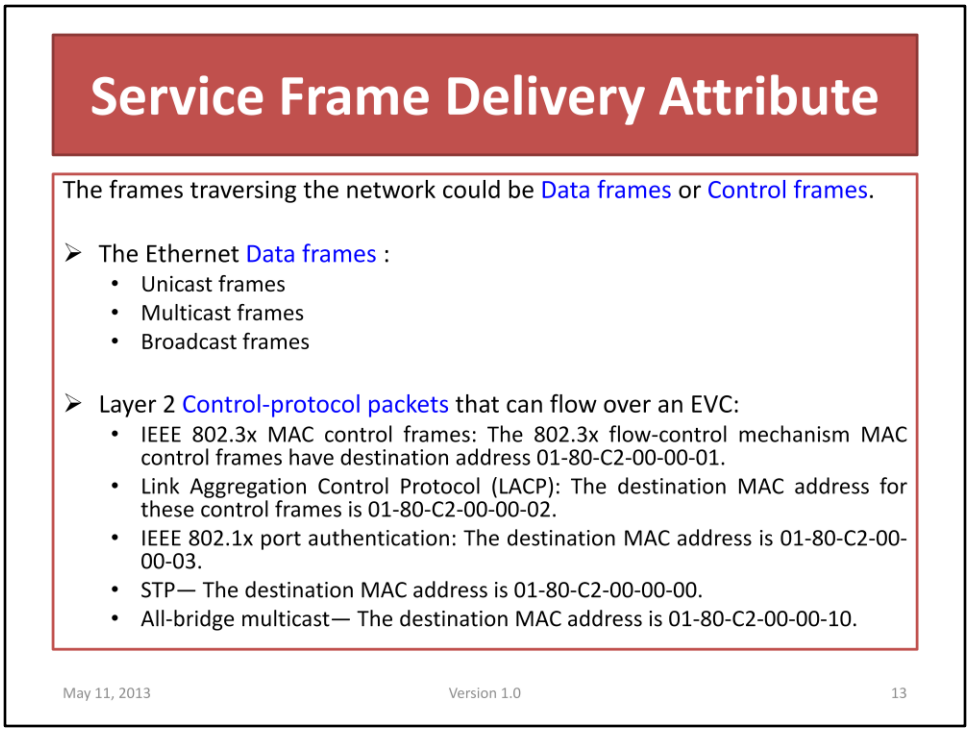


- Jitter
  - Jitter is also known as delay variation. Jitter has a very adverse effect on real-time applications such as IP telephony.
  - The jitter parameter is used in the following service attributes:
    - Ingress and egress bandwidth profile per CoS identifier (UNI service attribute)
    - Class of service (EVC service attribute)
- Loss
  - Loss indicates the percentage of Ethernet frames that are in-profile and that are not reliably delivered between UNIs over a time interval. Applications such as e-mail and HTTP web browser requests can tolerate more loss than VoIP.
  - The jitter parameter is used in the following service attributes:
    - Ingress and egress bandwidth profile per CoS identifier (UNI service attribute)
    - Class of service (EVC service attribute)



Class of service (CoS) parameters can be defined for metro Ethernet subscribers based on various CoS identifiers, such as the following:

- Physical port: All traffic enters and exits the port receives the same CoS
- Source/destination MAC addresses: This type of classification is used to give different types of service based on combinations of source and destination MAC addresses.
- VLAN ID: This is a very practical way of assigning CoS if the subscriber has different services on the physical port where a service is defined by a VLAN ID
- 802.1p value: The 802.1p field allows the carrier to assign up to eight different levels of priorities to the customer traffic
- Diffserv/IP ToS: The IP ToS field is a 3-bit field inside the IP packet that is used to provide eight different classes of service known as IP Precedence. Diffserv allows for 64 different CoS values, called Diffserv codepoints (DSCPs).



Service Frame Delivery Attribute

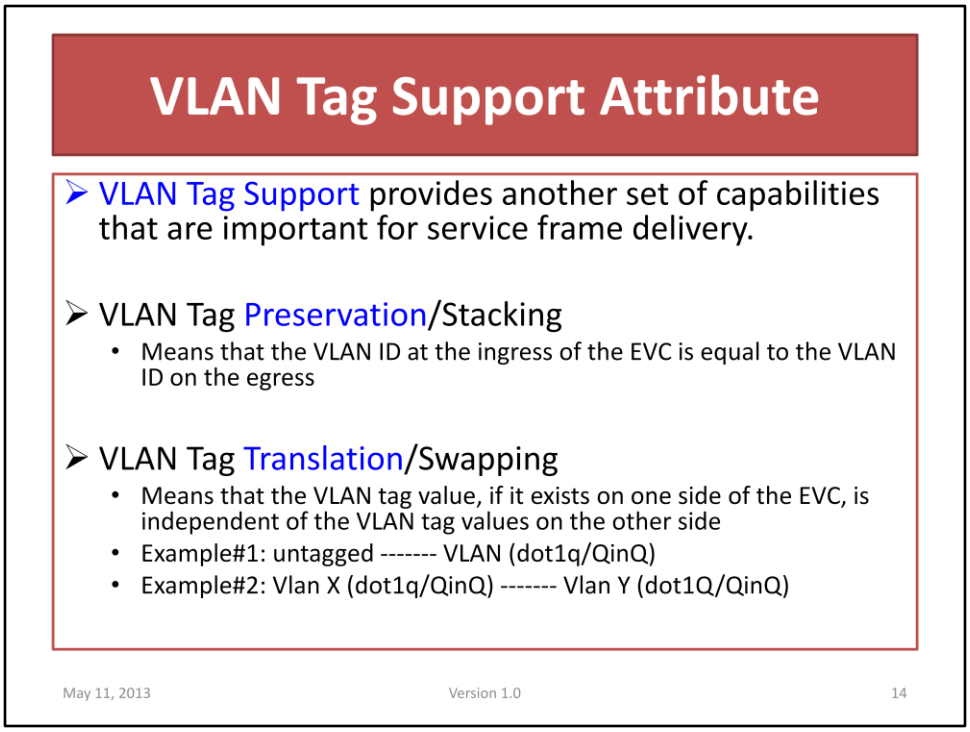
On a typical LAN, the frames traversing the network could be data frames or control frames.

The different possibilities of the Ethernet data frames are as follows:

- Unicast frames
- Multicast frames
- Broadcast frames

The different Layer 2 Control-Protocol packets that can flow over an EVC:

- IEEE 802.3x MAC control frames: 802.3.x is an XON/XOFF flow-control mechanism that lets an Ethernet interface send a PAUSE frame in case of traffic congestion on the egress of the Ethernet switch. The 802.3x MAC control frames have destination address 01-80-C2-00-00-01.
- Link Aggregation Control Protocol (LACP): This protocol allows the dynamic bundling of multiple Ethernet interfaces between two switches to form an aggregate bigger pipe. The destination MAC address for these control frames is 01-80-C2-00-00-02.
- IEEE 802.1x port authentication— This protocol allows a user (an Ethernet port) to be authenticated into the network via a back-end server, such as a RADIUS server. The destination MAC address is 01-80-C2-00-00-03.
- STP— The destination MAC address is 01-80-C2-00-00-00.
- All-bridge multicast— The destination MAC address is 01-80-C2-00-00-10.



VLAN Tag Support Attribute

VLAN tag support provides another set of capabilities that are important for service frame delivery.

VLAN Tag Preservation/Stacking:

With VLAN Tag Preservation, all Ethernet frames received from the subscriber need to be carried untouched within the provider's network across the EVC. This means that the VLAN ID at the ingress of the EVC is equal to the VLAN ID on the egress.

VLAN Tag Translation/Swapping:

VLAN Tag Translation or Swapping occurs when the VLAN tags are local to the UNI, meaning that the VLAN tag value, if it exists on one side of the EVC, is independent of the VLAN tag values on the other side.

Example#1

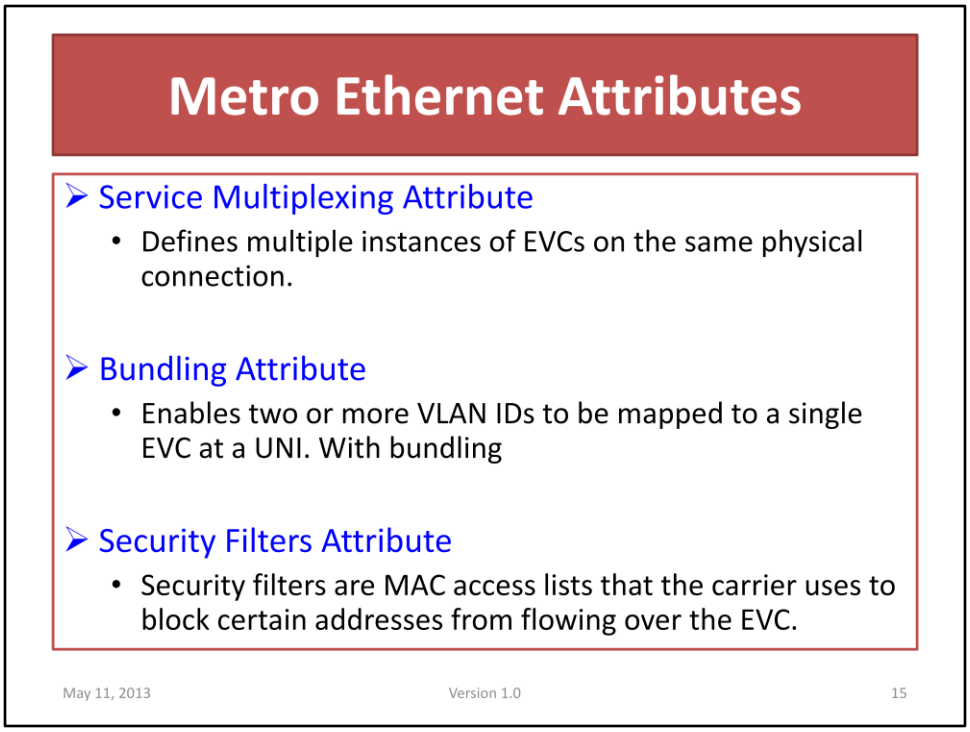
In the case where one side of the EVC supports VLAN tagging and the other side doesn't, the carrier removes the VLAN tag from the Ethernet frames before they are delivered to the destination.

Example#2

Another example of tag translation is a scenario where different customers are given Internet connectivity to an ISP. The carrier gives each customer a separate EVC. The carrier assigns its own VLAN-ID to the EVC and strips the VLAN tag before handing off the traffic to the ISP.

Example#3

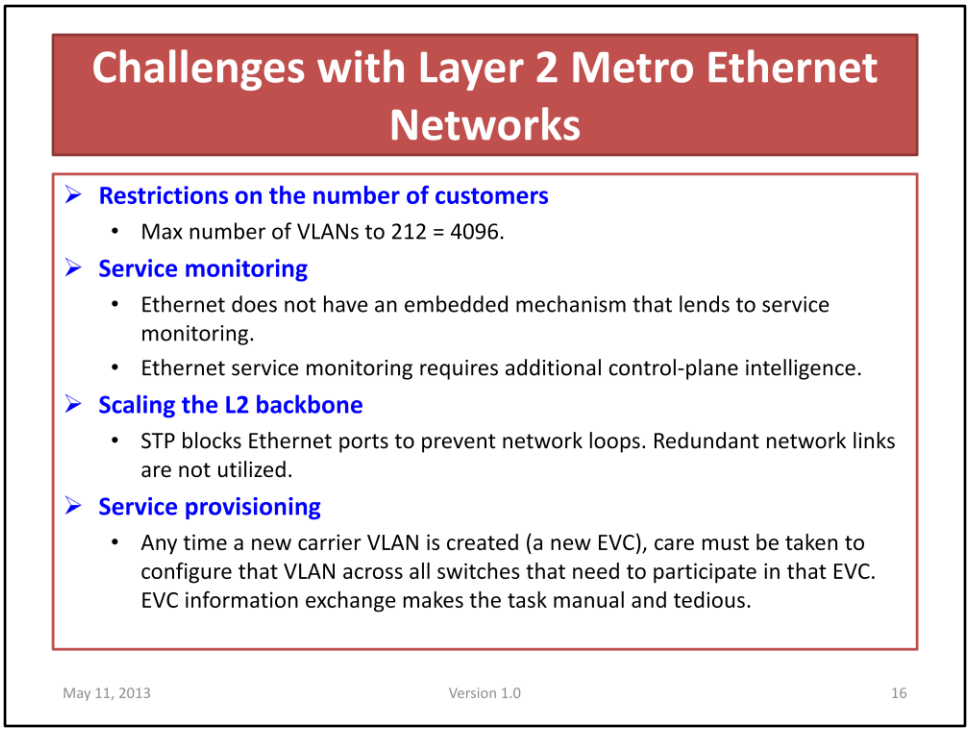
Another example of tag translation is a scenario where different customers are given Internet connectivity to an ISP. The carrier gives each customer a separate EVC. The carrier assigns its own VLAN-ID to the EVC and strips the VLAN tag before handing off the traffic to the ISP.



Service Multiplexing Attribute
Service multiplexing is used to support multiple instances of EVCs on the same physical connection. This allows the same customer to have different services with the same Ethernet Wire.

Bundling Attribute
The Bundling service attribute enables two or more VLAN IDs to be mapped to a single EVC at a UNI. With bundling, the provider and subscriber must agree on the VLAN IDs used at the UNI and the mapping between each VLAN ID and a specific EVC. A special case of bundling is where every VLAN ID at the UNI interface maps to a single EVC. This service attribute is called all-to-one bundling.

Security Filters Attribute
Security filters are MAC access lists that the carrier uses to block certain addresses from flowing over the EVC. This could be an additional service the carrier can offer at the request of the subscriber who would like a level of protection against certain MAC addresses. MAC addresses that match a certain access list could be dropped or allowed.



All-Ethernet L2 metro networks pose many scalability and reliability challenges. The following are some of the issues that arise with an all-Ethernet control plane:

Restrictions on the number of customers

The Ethernet control plane restricts the carrier to 4096 customers, because the 802.1Q defines 12 bits that can be used as a VLAN ID, which restricts the number of VLANs to 2^{12} = 4096.

Service monitoring

Ethernet does not have an embedded mechanism that lends to service monitoring. Ethernet service monitoring requires additional control-plane intelligence.

Scaling the L2 backbone

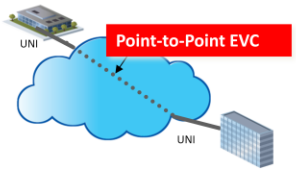
A Metro Carrier that is building L2 Ethernet backbone. STP blocks Ethernet ports to prevent network loops.

Service provisioning

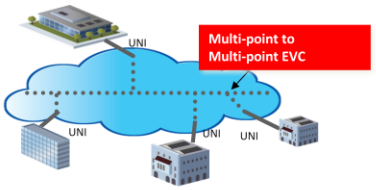
Any time a new carrier VLAN is created (a new EVC), care must be taken to configure that VLAN across all switches that need to participate in that EVC. The lack of any signaling protocols that allow EVC information to be exchanged makes the task manual and tedious.

Metro Ethernet Service Types

E-Line Service Type for
- Virtual Private Lines (EVPL)
- Ethernet Private Lines (EPL)
- Ethernet Internet Access



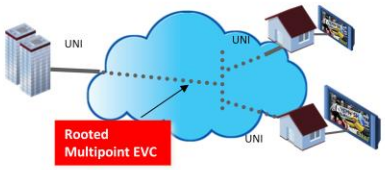
E-LAN Service Type for
- Multipoint L2 VPNs
- Transparent LAN Service
- Multicast networks



Metro Ethernet Service Types

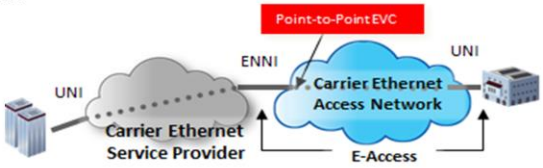
E-Tree Service Type for

- Rooted multi-point L2 VPNs
- Broadcast networks
- Telemetry networks



E- Access Service Type for

- Wholesale Access Services
- Access EPL
- Access EVPL



Q & A