DPoE in MSO Network

SCTE Piedmont Chapter

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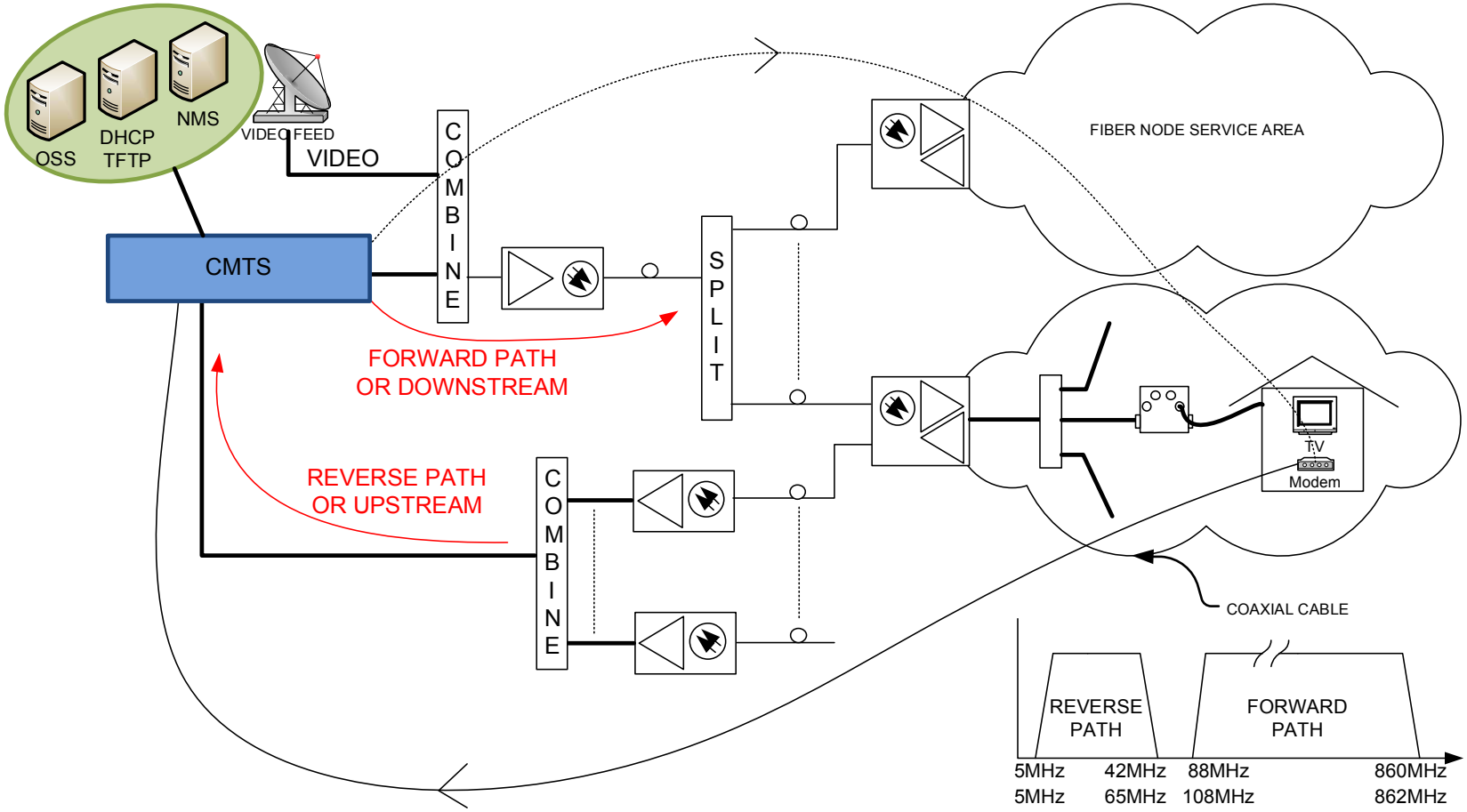
- **Introduction to DPoE**
- DPoE Defined Services
- Future Enhancements

What is DPoE

- DOCSIS Provisioning of EPON (DPoE™) is a joint effort of operators, vendors, and suppliers to support EPON technology using existing DOCSIS-based back office systems and processes.

A Brief Review of the DOCSIS Architecture



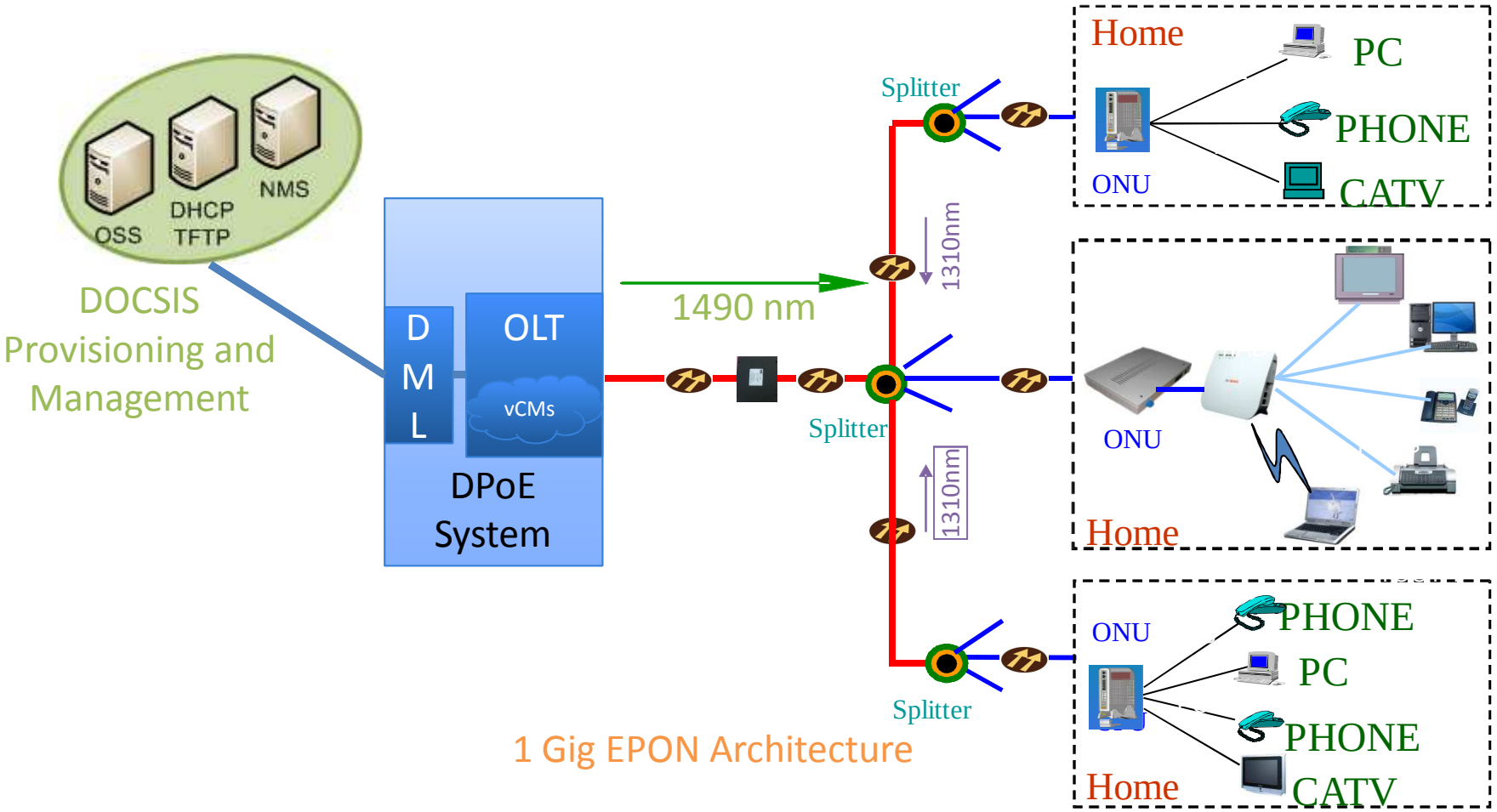
Cable Modem Initialization Process Summary

- CM scans for a downstream channel
- CM synchronizes to the downstream channel and locks on the time-base clock
- CM receives upstream parameters (UCD) from downstream messages
- CM receives upstream bandwidth allocation MAP
- CM performs upstream ranging
- CM establishes IP connection (DHCP)
- CM establishes Time of Day
- CM acquires configuration file (TFTP)
- CM registers with the CMTS
- CM is operational
- Optional Baseline Privacy Negotiation

A Comparison of EPON and DOCSIS

- Both EPON and DOCSIS are Point-to-Multipoint access networks
  - They both allow two or more network elements to transmit on the same media using TDMA
  - EPON uses fiber exclusively
  - DOCSIS uses coax
- However, neither 1G-EPON nor 10G-EPON as specified in IEEE Std 802.3 define any OAMP that allows forwarding of traffic between an ONU Interface (UNI) and the PON.
- One of the primary goals of the DPoE specifications is to provide an interoperable method of reaching the controller for the ONU, identifying the ONU capabilities, and providing that information to the OLT so that it can configure service on an ONU.
- The other is to adapt DOCSIS-based back office provisioning and operations models to EPON. This is the core objective of the DPoE specifications.

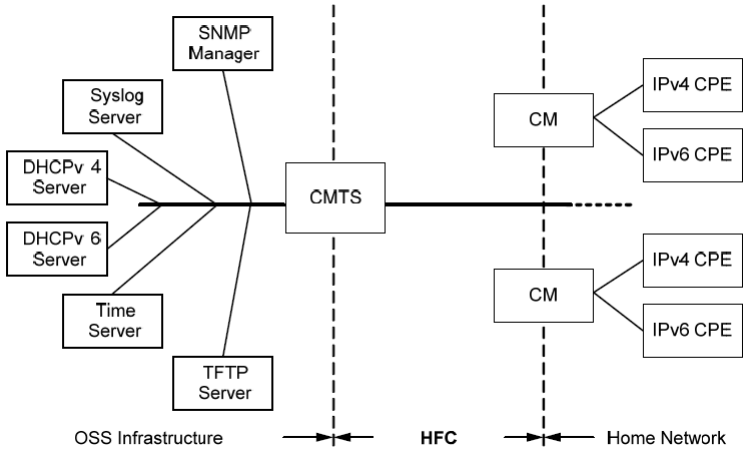
DPoE Architecture



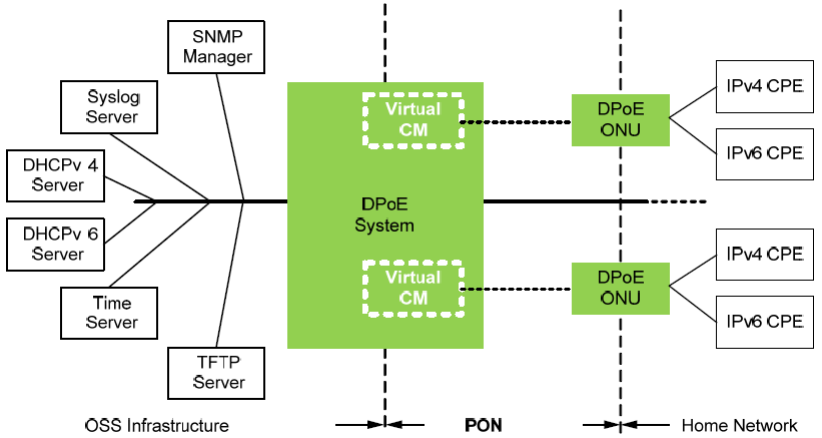
1 Gig EPON Architecture

Operations Support Systems Comparison

DOCSIS



DPoE



The DOCSIS Mediation Layer

- The DOCSIS Mediation Layer (DML) is the entity or process on the DPoE system that translates all DOCSIS specific management tools into EPON, some of its tasks are:
  - Interprets the DOCSIS MIBs
  - Creates virtual Cable Modems (vCMs) for every ONU and requests IP addresses and configuration files for them.
  - Translates the parameters received in the configuration file for each vCM to EPON OAM messages for the ONU.
  - Keeping ONU software load up to date using the DOCSIS secure software download mechanism with digitally signed software images
  - Provides a CLI that “looks and feels” like a CMTS

DPoE ONU Initialization Process

- DPoE ONU ranges and registers with OLT first, as mandated in the 802.3ah and 802.3av specifications
- DPoE system creates vCM for each newly discovered ONU
- vCM obtains IP parameters from the DHCP server, including configuration file name and TFPT server address
- Time of Day does not need to get established since vCMs will synchronize to the DPoE system clock
- vCM obtains configuration file via TFTP
- ONU is then configured through OAM messages
- ONU is now successfully registered and vCM goes into “Operational” state

DPoE Service Flow Parameters

- The table details which parameters are applicable for an Upstream Service Flow, according to its configured Upstream Scheduling Service Type
  - Best Effort (BE) column applies to IP HSD services
  - Real Time Polling (RTP) column covers the business MEF services
- Other scheduling types (i.e. UGS) although currently not required in DPoE are also permitted.

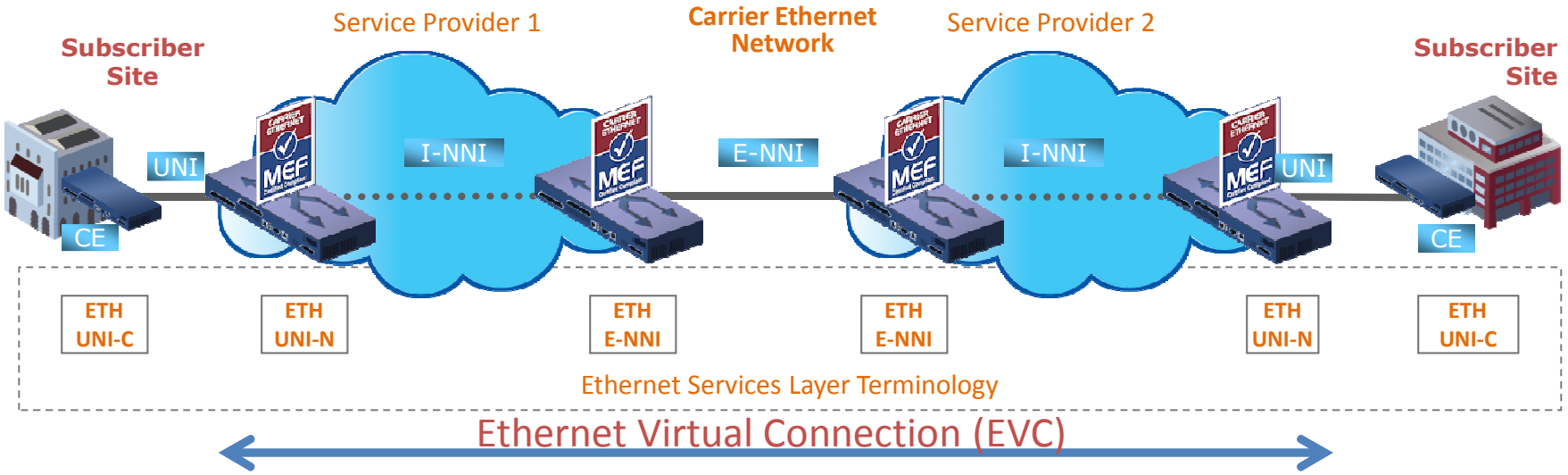
Service Flow Parameter as defined in DOCSIS MULPI	Best Effort	Real-Time Polling
Miscellaneous		
Traffic Priority	Optional Default = 0	N/A[1]
Upstream Scheduling Service Type	Optional Default = 2	Mandatory
Request/Transmission Policy	Optional Default = 0	Optional Default = 0
Maximum Rate		
Max Sustained Traffic Rate	Optional Default = 0	Optional Default = 0
Max Traffic Burst	Optional Default = 12800	Optional Default = 12800
Minimum Rate		
Min Reserved Traffic Rate	Optional Default = 0	Optional Default = 0
Polls		
Nominal Polling Interval	N/A[1]	Mandatory

- Introduction to DPoE
- **DPoE Defined Services**
- Future Enhancements

DPoE Services and MEF

- Initial focus of DPoE is on business services.
- The majority of business services can be delivered using Ethernet.
- The foundation for all DPoE services is an Ethernet and 802.1 VLAN-based forwarding model as described by MEF
- Ethernet is the least common denominator of all modern telecommunications services.
- In the access network, Ethernet can be used to deliver:
  - Native Ethernet services (as defined by the Metro Ethernet Forum or MEF), or
  - IP services transported over Ethernet. IP can, in turn, be used to deliver private IP (IP-VPN) services or public IP (Internet) services.

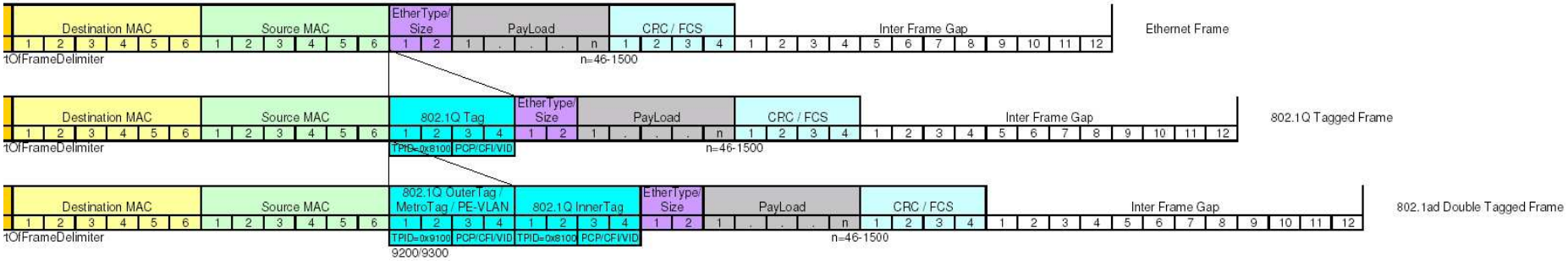
MEF Reference Architecture



- **UNI: Interface between Public Service Provider Network and Customer Network**
- **E-NNI: Open Interface between Service Provider Networks [MEF-26]**
- **I-NNI: Open Interface between two network elements in the same Service Provider Network.**
- **EVC: The architecture construct that supports the association of UNI reference points for the purpose of delivering an Ethernet flow between subscriber sites across Carrier Ethernet Network.**
  - **EVC carry traffic that belongs to MEF Carrier Ethernet Service instance**
  - **Tagging/Encapsulation is used to isolate traffic that belong to different EVCs**
- **DPoE MEF Supports IEEE 802.1ad tagging and IEEE 802.1ah Encapsulation**

IEEE 802.1ad Tagging

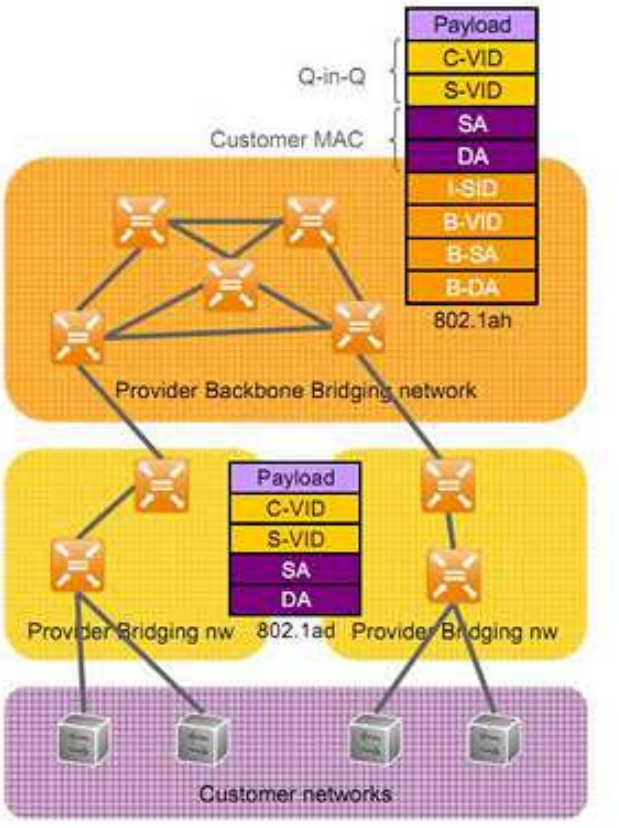
- Also known as
  - Provider Bridging (PB)
  - Stacked VLANs
- 802.1ad allows multiple VLAN headers to be inserted into a single frame



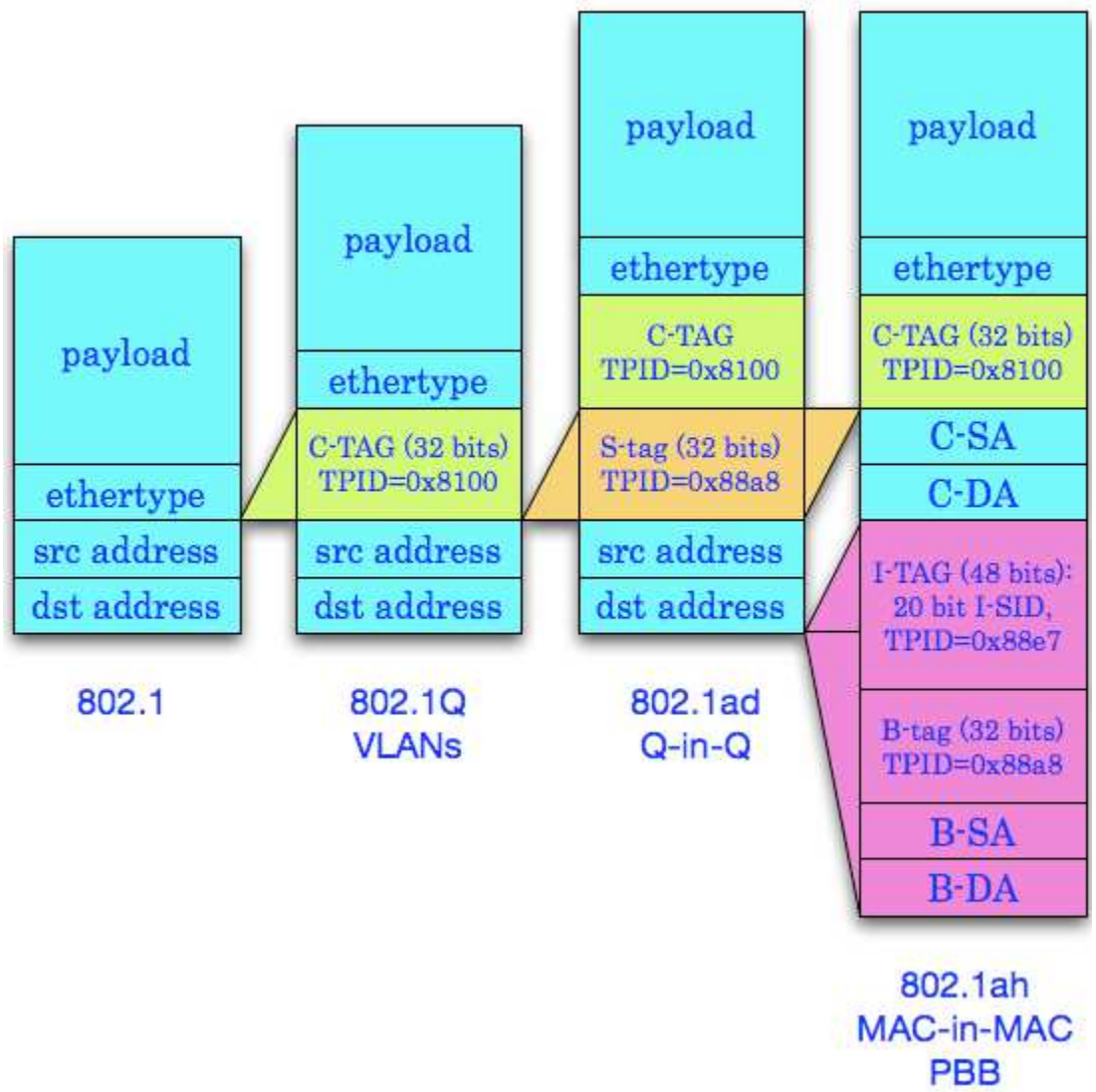
- Inner tag is called C-Tag (Customer tag), Ethertype (TPID) 0x8100 (802.1Q)
- Outer tag is called S-Tag (Service tag), Ethertype (TPID) 0x88a8 (802.1ad)
  - Other non-standard TPID values can be found in older equipment
- VLAN ID is 12 bits long (0-4095), remaining 4 bits are for QoS

IEEE 802.1ah Encapsulation

- Also known as:
  - Provider Backbone Bridges (PBB)
  - Mac-in-Mac
- Allows interconnection of multiple Provider Bridge Networks without losing each customer's individually defined VLANs
- PBB offers complete separation of customer and provider domains.



PBB Frame Structure



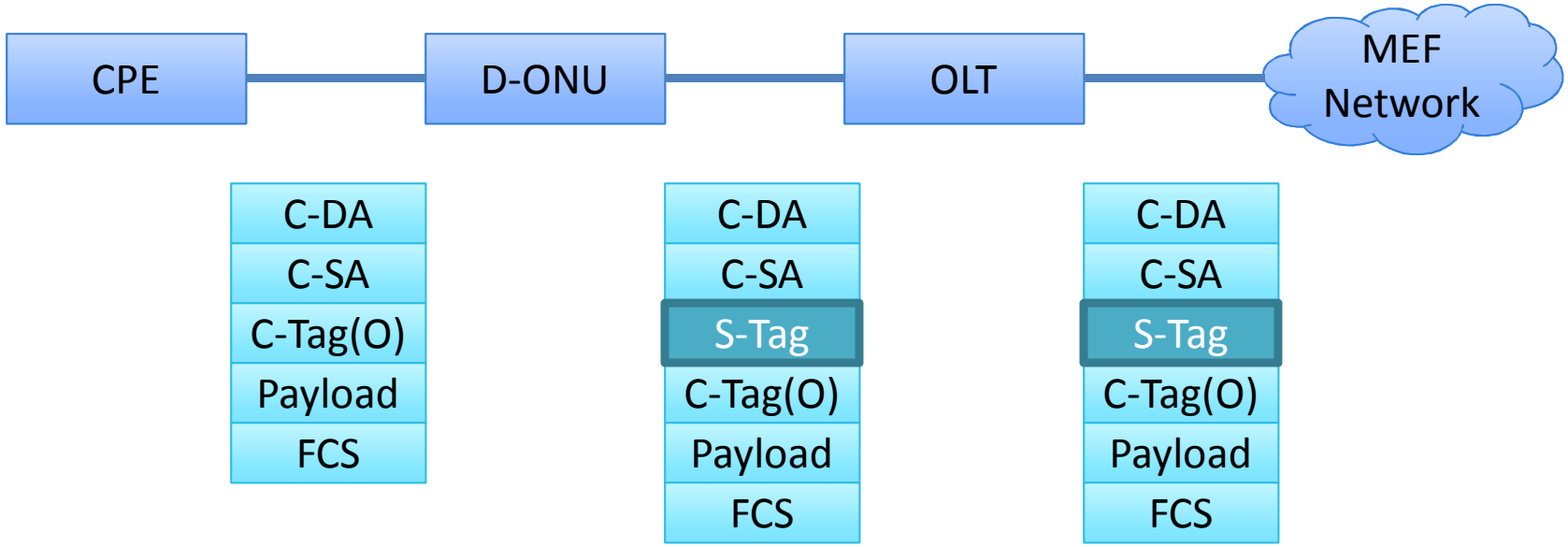
- B-Tag is the Backbone VLAN tag
- I-TAG contains:
  - Ethertype 0x88e7
  - A 20 bit I-SID (Backbone Service Identifier)
  - Other bits reserved, used for OAM,or QoS
- From a Provider Backbone Bridge perspective, everything after the I-TAG is just payload

Services Defined by DPoE v1.0

- MEF services
  - PB
    - Encapsulation mode
    - Transport mode
    - TPID translation (Optional)
  - PBB
    - Encapsulation mode
    - Transport mode
- IP (HSD) service

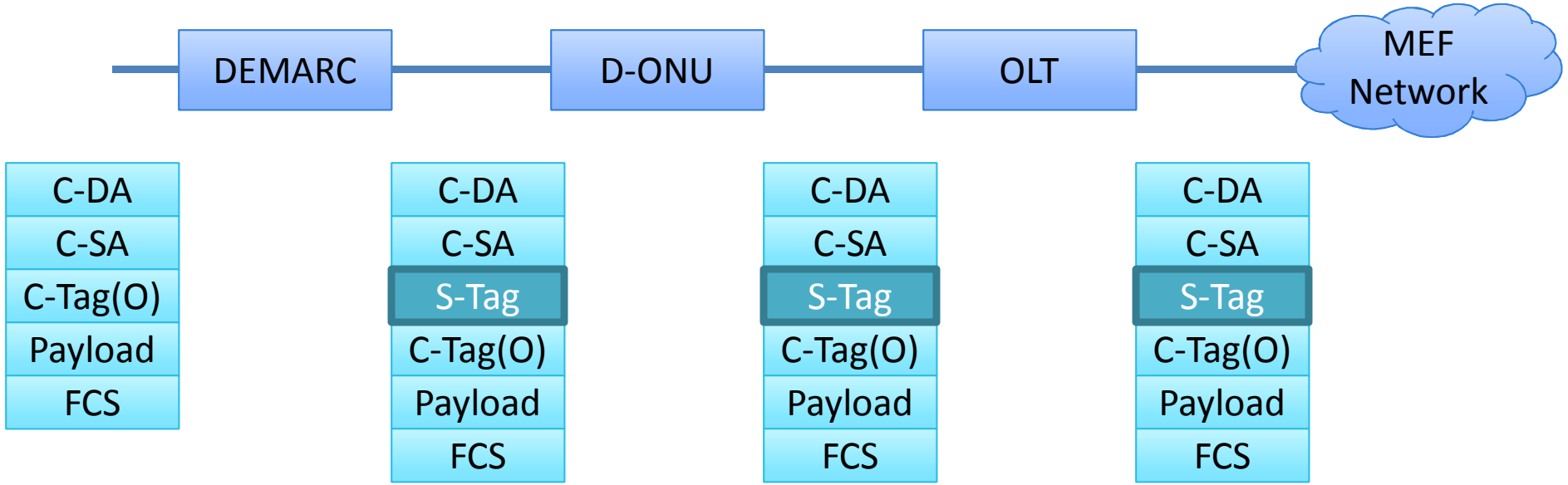
PB on DPoE - Encapsulation

- In this mode the ONU adds a Service Tag (S-Tag) to any incoming traffic from the customer (tagged or untagged):



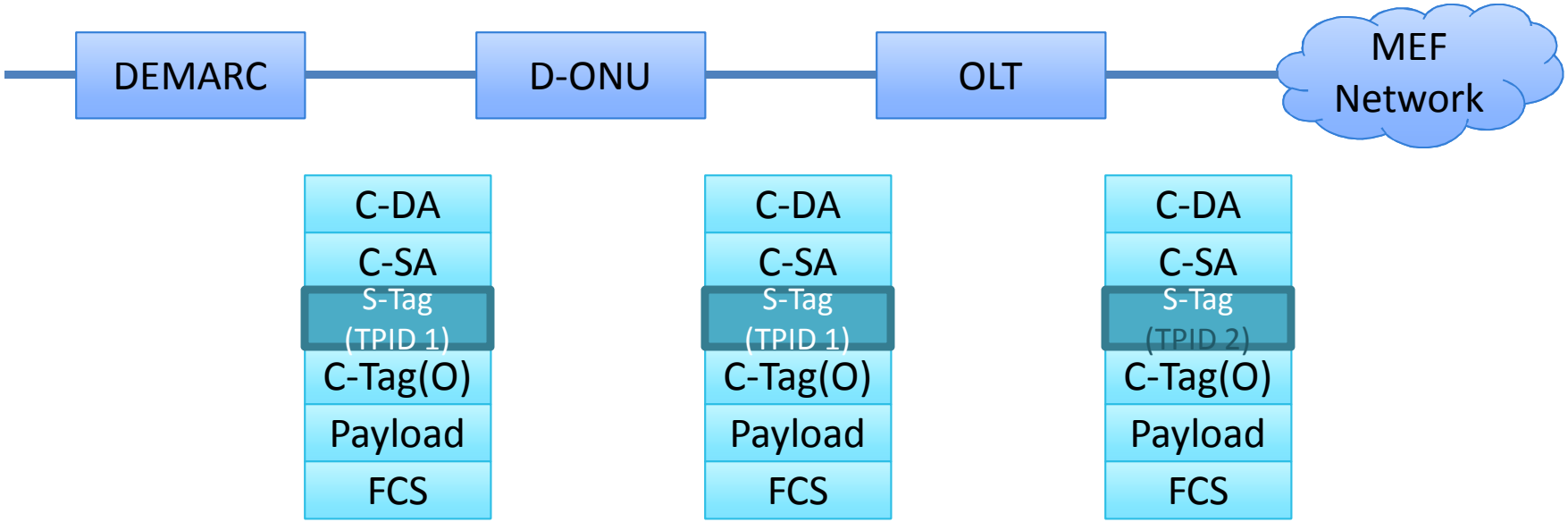
PB on DPoE - Transport

- In this mode a DEMARC device before the ONU adds a Service Tag (S-Tag) to any incoming traffic from the customer (tagged or untagged).
- Alternatively, customer generates frames with two tags:



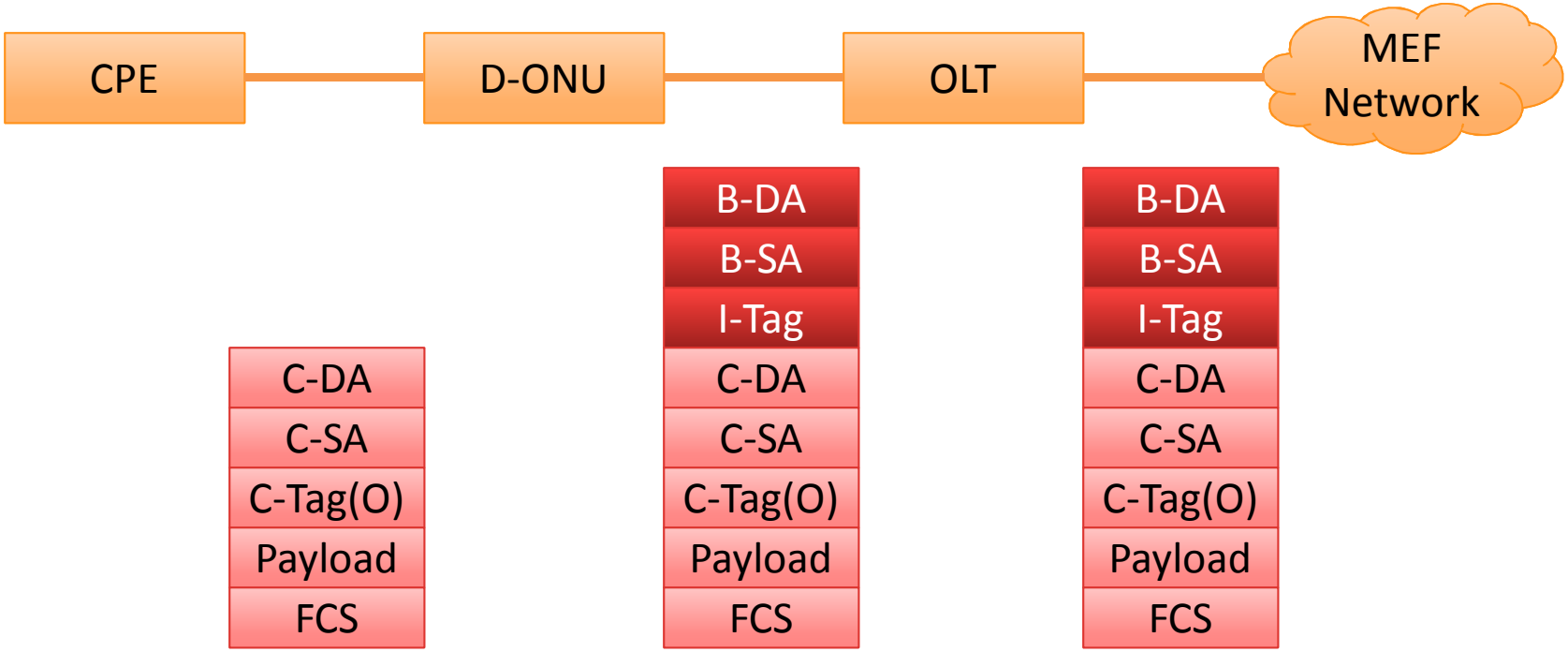
PB on DPoE – TPID Translation

- TPID Translation allows the OLT to modify the incoming TPID provided by the DEMARC or ONU and change it to another value (i.e. from 0x8100 to 0x88a8)
- Can be used in Transport or Encapsulation Mode



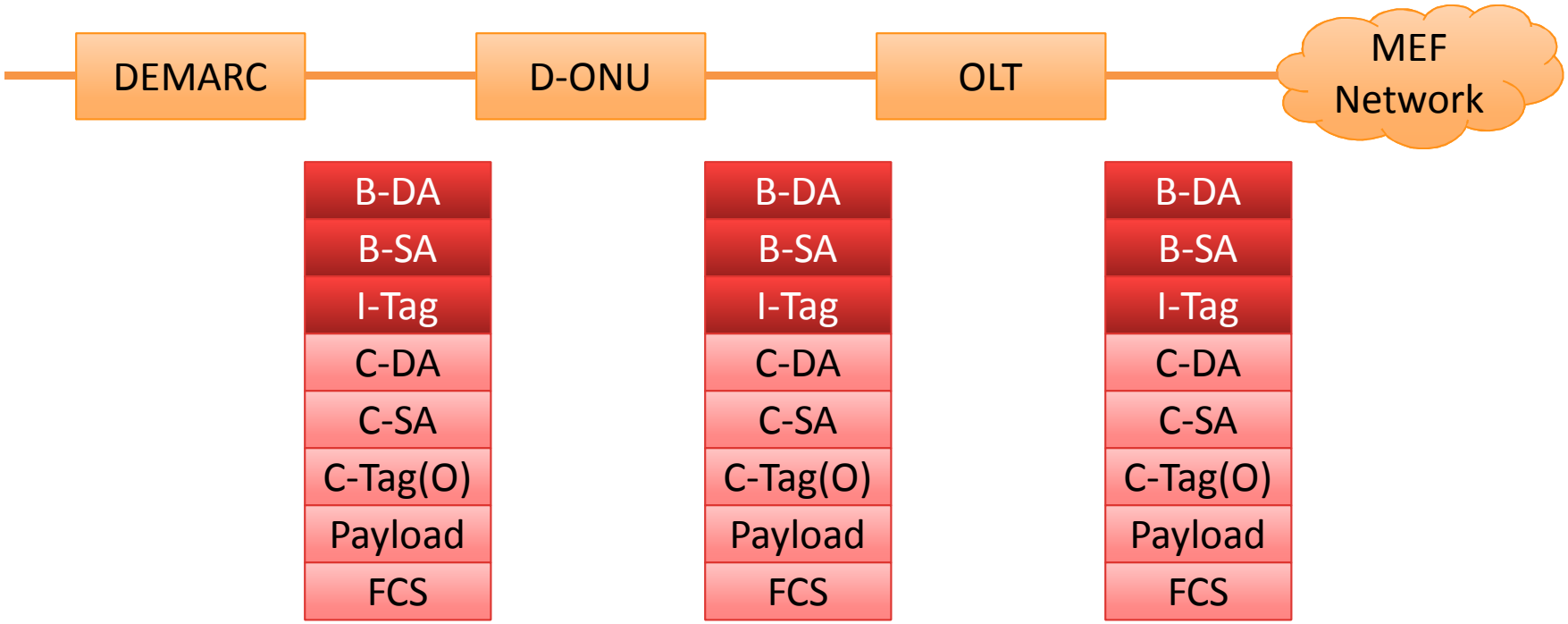
PBB on DPoE - Encapsulation

- In this mode the ONU adds the Bridge Source MAC, Bridge Destination MAC, and I-TAG to the beginning of the frame



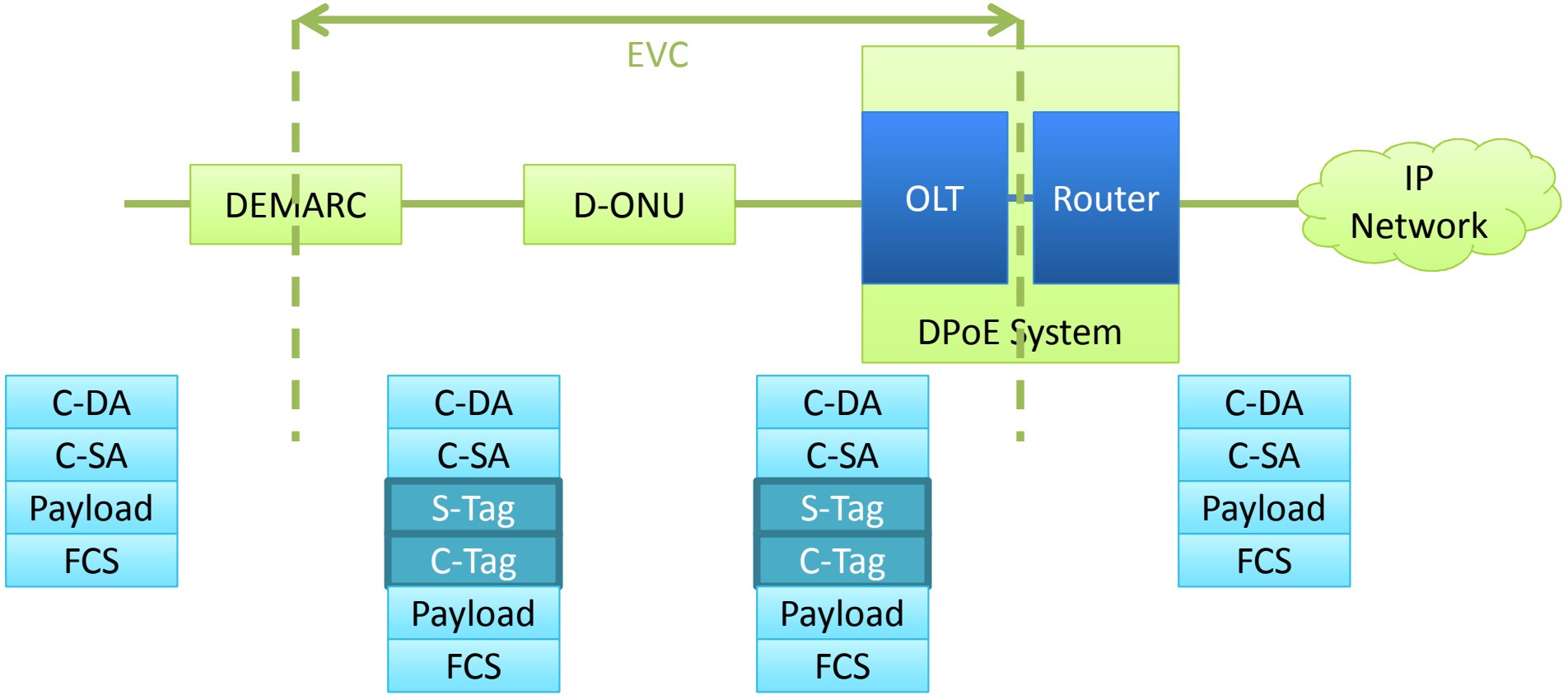
PBB on DPoE - Transport

- The DEMARC device adds the Bridge Source MAC, Bridge Destination MAC, and I-TAG to the beginning of the frame.
- The ONU and OLT simply pass this traffic transparently



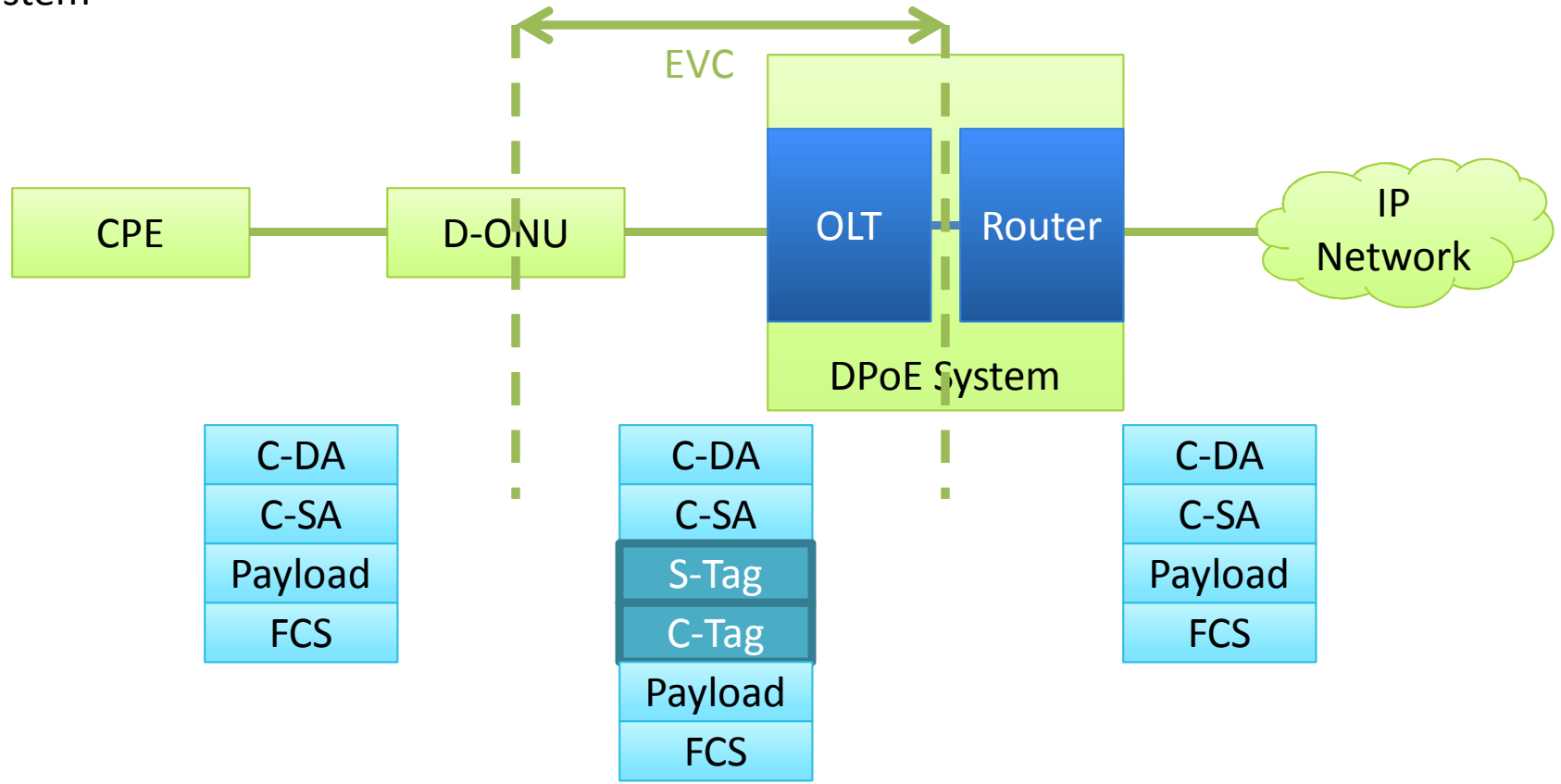
IP HSD Service Through a DEMARC device

- An EVC is created between the DEMARC device and the OLT. Tags are removed by the OLT before entering the router in the DPoE System.



IP HSD Service Through the ONU CMCI Interface

- The ONU encapsulates incoming untagged traffic using a dynamically assigned C-Tag/S-Tag pair. OLT then removes tags before entering the router in the DPoE System

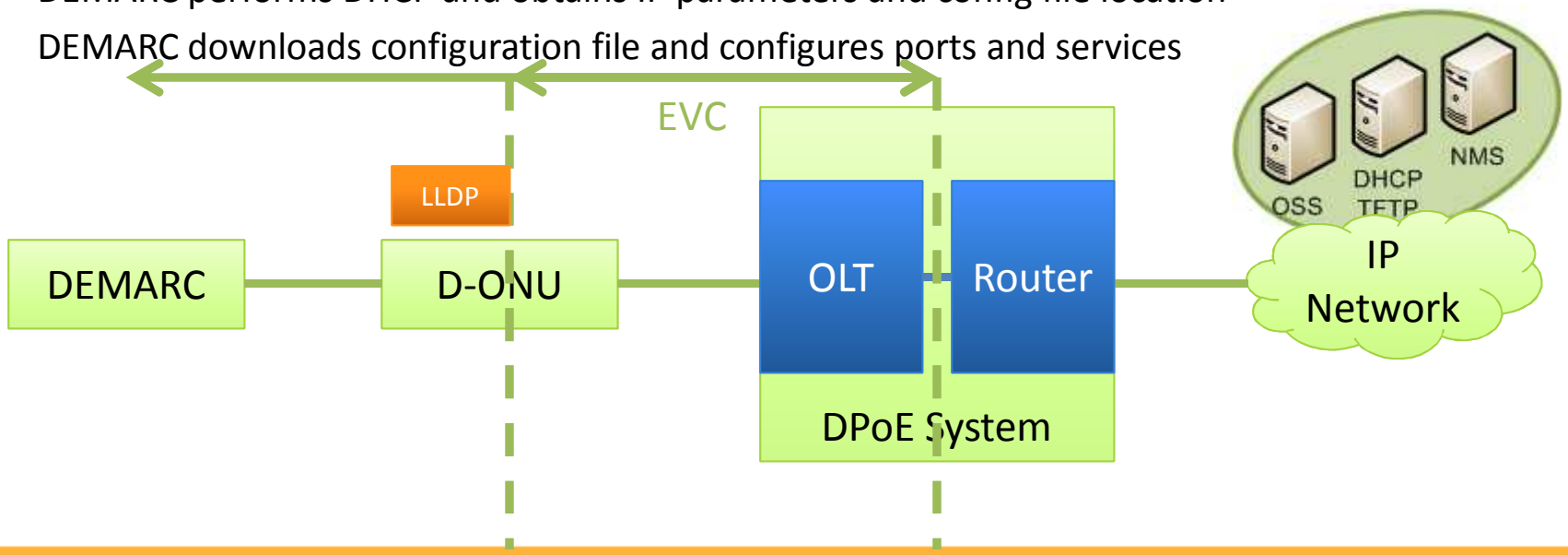


DEMARC Auto Configuration

- DEMARC devices are used to provision business services in existing MSO networks, typically connected to dedicated CWDM link
- There is strong drive to retrofit such devices with DPoE uplink (SFP ONU) for lower cost transport solution.
- The process of DEMARC service provisioning is currently fully manual and requires a truck roll every time service changes are needed (configuration is done manually on the DEMARC device at customer site)
- There is a strong drive for service configuration automation to allow operators to change provisioning on demand.
- The DEMARC Auto Configuration mechanism (DAC) process provides means for the automatic discovery, configuration of an in-band IP management service, and the discovery and transfer of a configuration file specific to the particular DEMARC that is discovered and connected

DAC Overview

1. DPoE ONU registers with DPoE System, EVC is established. This is the DEMARC Management EVC.
2. D-ONU sends LLDP (802.1AB) messages to DEMARC on UNI port. Parameters sent include:
   - Bridge Type (PB, PBB)
   - S-Tags and C-Tags if any (PB)
   - I-Tags and B-Tag if any (PBB)
3. EVC now extends to DEMARC
4. DEMARC performs DHCP and obtains IP parameters and config file location
5. DEMARC downloads configuration file and configures ports and services



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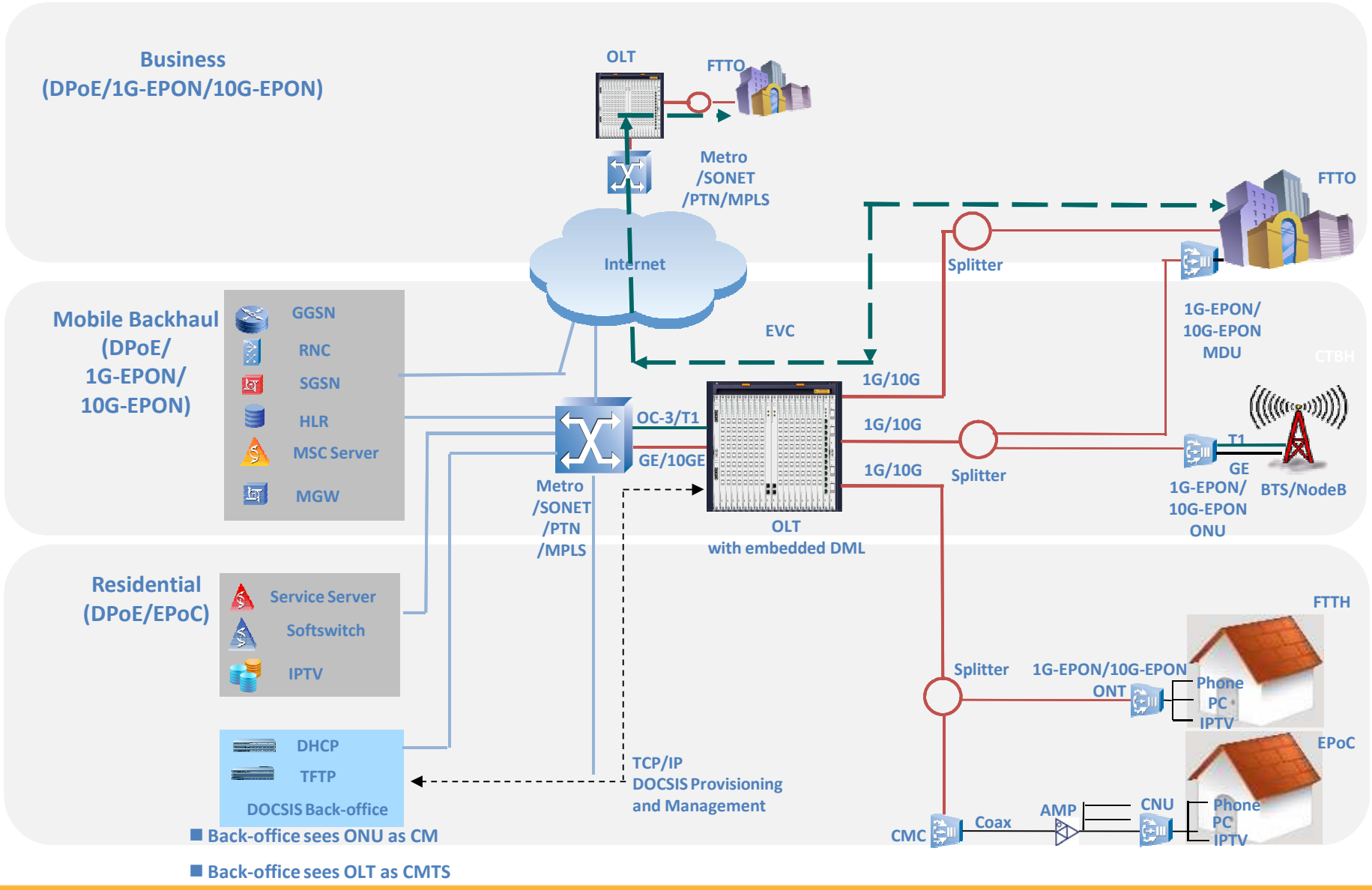
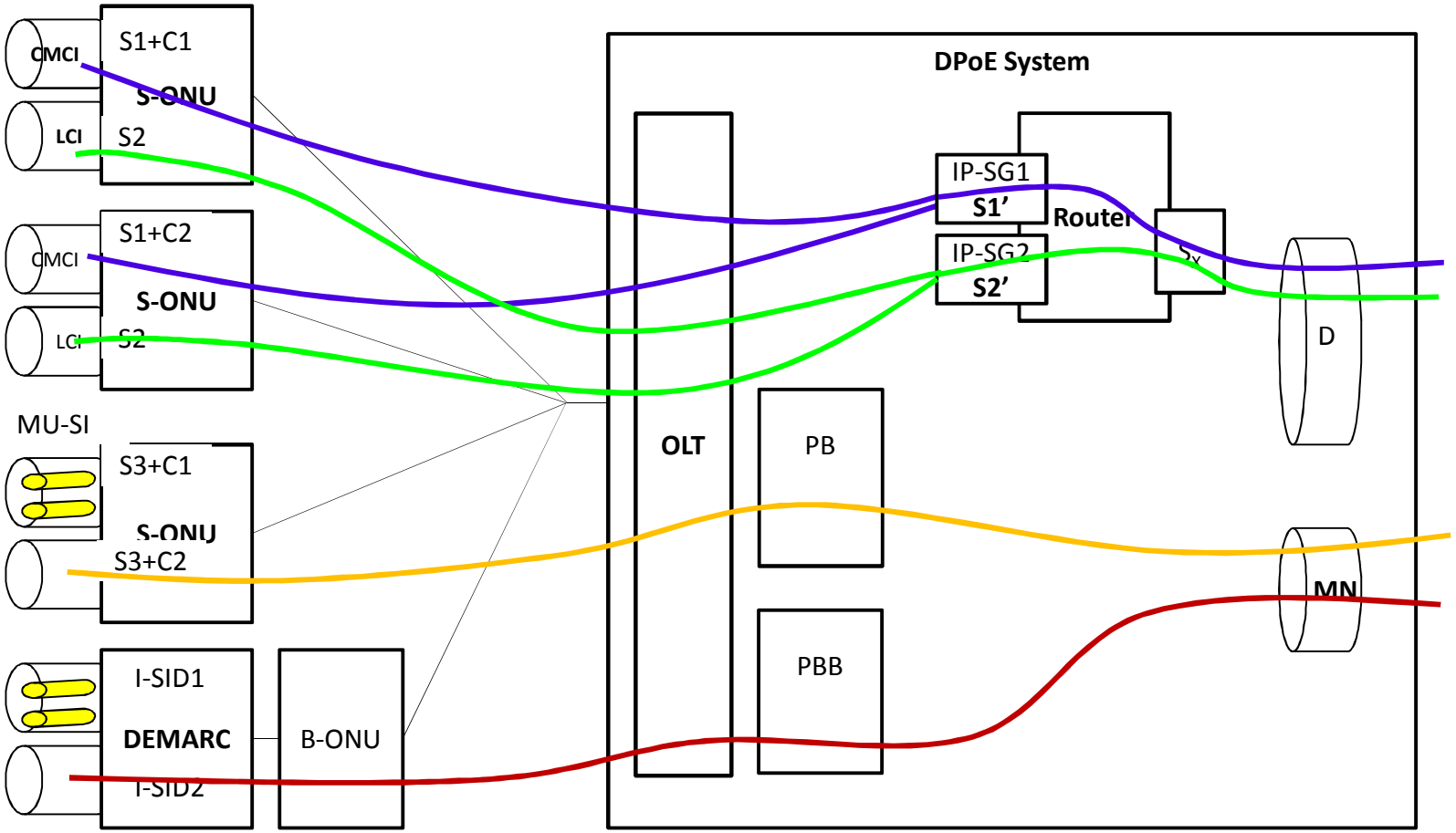
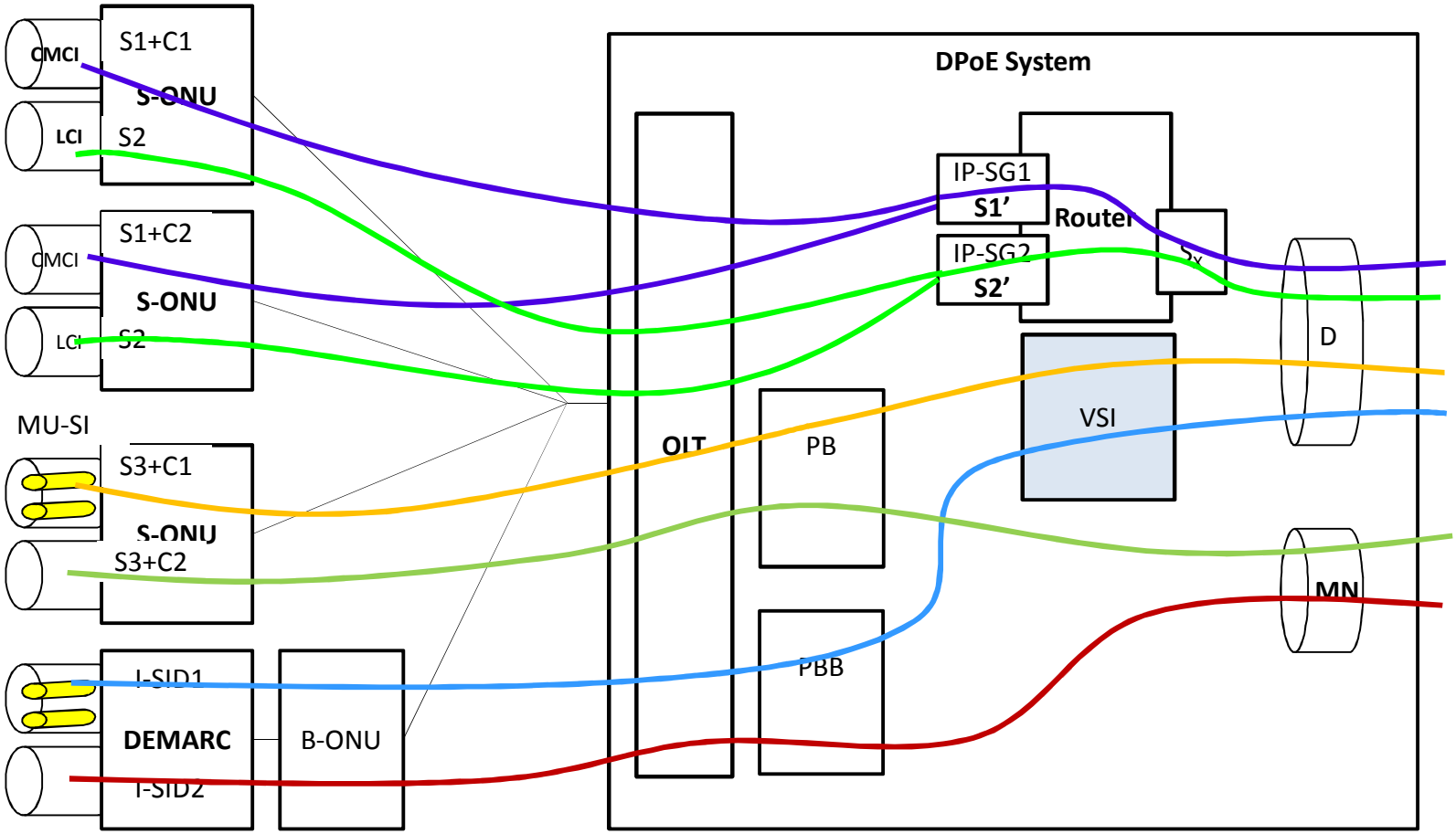
DPoE/EPoC Complete Solution



PB/PBB/IP HSD Service Model



DPoE 2.0 Service Model



IP Data Service

IP Voice Service

MEF Ethernet Service(PB)

MEF Ethernet Service(PBB)

MEF Ethernet Service(PB+EoMPLS)

MEF Ethernet Service(PBB+EoMPLS)

Features for Future DPoE versions (Tentative)

FEATURES
MPLS PE/VPLS
IP-SG Auto-configuration
ASP & MESP
PacketCable Provisioning for Voice Services
Multicast
1588v2 – Precision Time Protocol for Ethernet Mobile Backhaul
IPv6
IPDR
Service OAM

Bringing you Closer

Thanks!