5 Requirements for NG-EPON

5.12 Service ~~Profiles~~Types

NG-EPON ~~should~~ is expected to support all the mechanisms necessary to implement differentiated QoS that is necessary to support residential and business service types. It is highly desirable that NG-EPON be able to support both residential and business customers on the same OLT through properly defined QoS enforcement mechanisms that can be configured to support target SLAs for each customer type.

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Today operators provide best-effort (BE) services for residential applications. Each customer account is associated with a service profile that is described in terms of peak bandwidth and a number of other SLA parameters, such as average service down time allowed during a year, average response time to technical anomalies, etc.

For business applications, two types of service are provided today, depending on the presence (or absence) of BE bandwidth component. In both cases, each customer account is associated with a service profile described in terms of minimum guaranteed and peak bandwidth, and a number of other SLA parameters, such as average service down time allowed during a year, average response time to technical anomalies, etc.

A typical business service is provided with guaranteed bandwidth, where the minimum guaranteed and peak bandwidth parameters in the associated SLA profile are set to the same value. Customers with such service profiles are therefore guaranteed access to the medium, and careful network engineering prevents oversubscription of OLT ports that such users are connected to. Such services are typically provided for cell tower backhaul, larger enterprise business customers, dedicated Internet access (DIA) circuits for educational institutions, etc.

Smaller business customers or business customers with less stringent SLA requirements are offered a medium-effort service type, where the SLA profile provides the customer with both guaranteed and best-effort bandwidth components. However, in the case of medium-effort services, the guaranteed bandwidth component is set to a value smaller than peak bandwidth, still providing guaranteed bandwidth but in the amount necessary to maintain basic network connectivity.

Examples of service types are included in the following sections.

5.12.1 Residential services

The OLT system is often configured to operate as an IP router to support residential services. In this mode, IP connections from customer CPEs connected to the ONU are carried across the PON and then routed to the public Internet across the converged transport network.

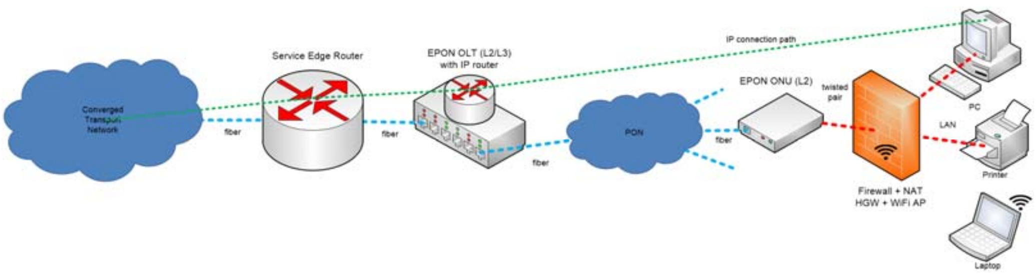

Figure 1~~20~~: Architecture of a residential FTTH services

In many MSO-specific access networks providing residential services, the provisioning processes are derived from their DOCSIS counterparts, following the DPoE service and provisioning models. This means that all the existing tools and backoffice procedures developed over the years to deploy, manage, and bill DOCSIS-based residential customers are directly applicable to residential customers served over EPON. The obvious differences are the physical media (fiber rather than coax) and the possible bandwidth tiers - providing up to ~~1~~ 1 ~~Gbps~~ Gb/s symmetric services today (over 1G-EPON) and soon to exceed this value once 10G-EPON is deployed commercially.

5.12.2 Direct Internet Access

Direct Internet Access (DIA) is a type of commercial service in which the customer receives a connection to the public Internet. Often, when implementing DIA, the OLT does not operate in the routed mode. Instead all Internet data between the customer CPE and the ~~the~~ Internet is carried within a L2 tunnel based on a pre-configured combination of [802.1Q] VLAN tags to an IP router. Figure 2~~Figure 21~~ presents an example of a typical DIA service implementation over EPON.

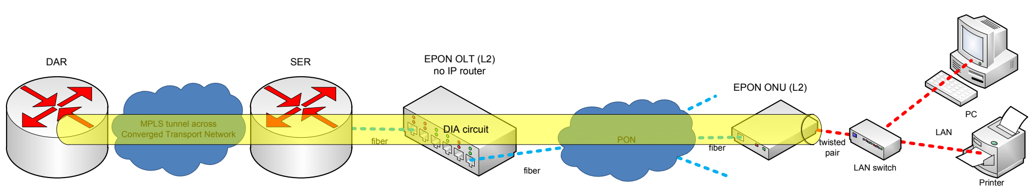

Figure 2~~21~~: Architecture of DIA service

5.12.3 MEF services

MEF services are used to interconnect two or more customer locations across the service provider's network. Similar to DIA the OLT does not operate as an IP router, and data generated by the customer at one site is transported to the other location in a dedicated L2 tunnel, less locally significant L2CP traffic. This L2 tunnel is designed based on a pre-configured combination of [802.1Q] VLAN tags.

There are several types of MEF services that can be supported over the EPON, namely: E-LINE, E-TREE, and E-LAN. These individual MEF service types can be demonstrated using Figure 3~~Figure 22~~ as the reference access network architecture.

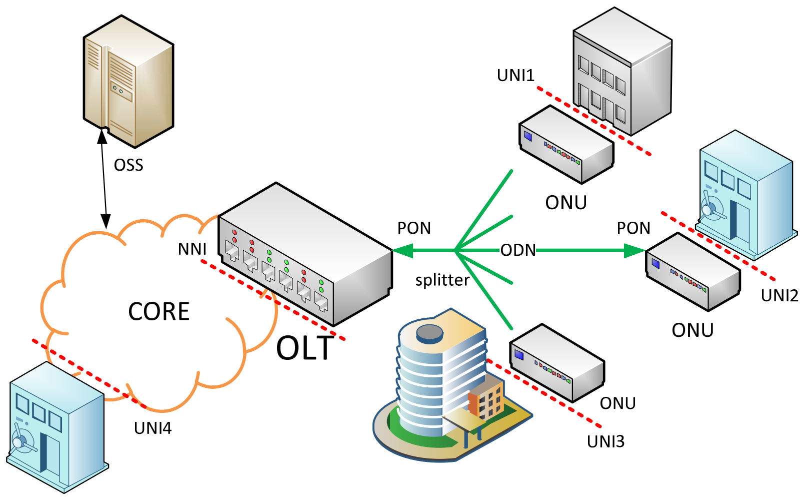

Figure 3~~22~~: Reference scenario for description of MEF service types

An E-LINE service spans between a UNI (UNI1, UNI2, or UNI3) on any of the ONUs connected to the OLT, and a single remote UNI. Effectively, each E-LINE creates a simple point-to-point tunnel between the selected MEF UNIs.

An E-TREE service creates a rooted multipoint service that connects a number of UNIs providing sites with hub and spoke multipoint connectivity. Each UNI is designated as either 'root' or 'leaf'. A root UNI can communicate with any leaf UNI, while a leaf UNI can communicate only with a root UNI. An E-TREE root could be located at the OLT, and individual leaf sites at UNI1, UNI2, or UNI3. Alternatively, the root could be located at the remote UNI4, and individual leaf sites at UNI1, UNI2, or UNI3.

An E-LAN service creates a multipoint-to-multipoint service that connects a number of UNIs (2 or more) providing full mesh connectivity for those sites. Each UNI can communicate with any other UNI that is connected to that Ethernet service. In the architecture shown an E-LAN could be created among UNI1, UNI2, and remote UNI4.

Each MEF service type can be further sub-divided into Private and Virtual service. We have therefore:

- EP-LINE: Ethernet Private Line
- EV-LINE: Ethernet Virtual Line
- EP-LAN: Ethernet Private LAN
- EV-LAN: Ethernet Virtual LAN
- EP-TREE: Ethernet Private Tree
- EV-TREE: Ethernet Virtual Tree

In a Private service type, each UNI is associated with one and only one service delimitating VLAN tag. All users connected to such a MEF UNI share a single MEF service instance.

In a Virtual service type, each UNI is associated with at least two service delimiting VLAN tags, effectively creating multiple MEF Ethernet Virtual Circuits (EVC) on a single physical UNI. In such an arrangement, each MEF service is connected to at least one other UNI.

From a provisioning perspective, the difference between private and virtual MEF services lies only in association of individual services (service flows) to individual UNIs on the ONU:

- multiple instances of virtual services are assigned to one and the same physical UNI, sharing its bandwidth;
- a single private service instance is always assigned to one dedicated physical UNI; no other service instances share this particular UNI

Figure 4~~Figure 23~~ shows an example of a simple MEF service, with an L2 tunnel interconnecting two customer sites: SITE1 and SITE2. Dedicated MEF tunnels are built at both sites across ONU and OLT operating in L2 mode only. There is no routing involved within deployed MEF circuits.

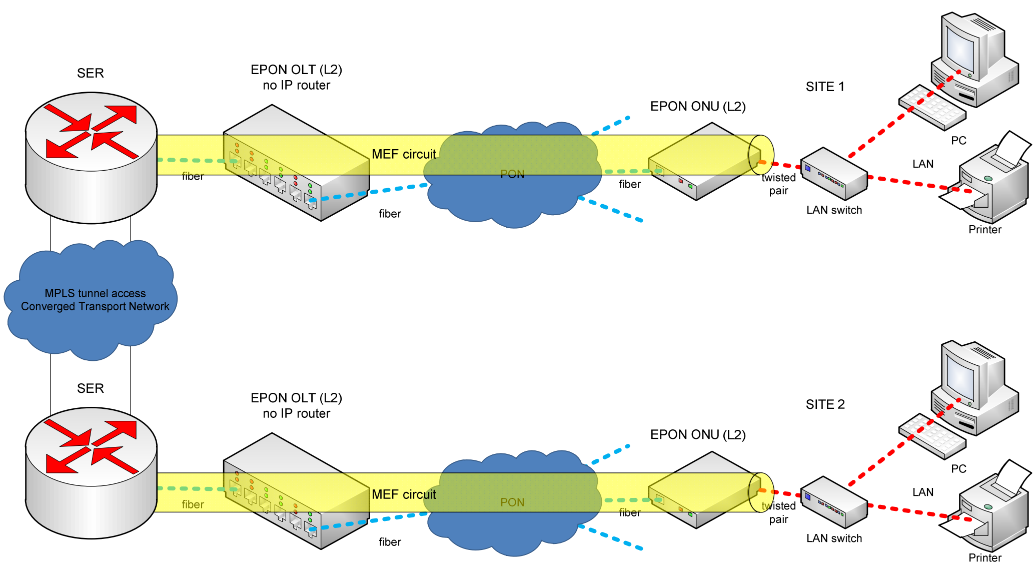

Figure 4~~23~~: Architecture of MEF service

5.12.4 Public WiFi backhaul

The public WiFi backhaul service is very similar to the residential service (see Figure 5~~Figure 24~~), in that a WiFi AP is treated as a CPE device connected to an EPON ONU. In one arrangement, a stand-alone EPON ONU is used, and the WiFi AP is then connected using standard twisted pair (at least CAT5e-class) cable. Alternatively, an SFP-ONU can be plugged directly into the WiFi AP. The second configuration is preferred for all new deployments, lowering the resulting power consumption.

During the initialization phase, the WiFi AP either retrieves an IP address from the default DHCP server or has its IP parameter preconfigured, and then establishes a communication path with the WiFi core controller. The said controller configures the WiFi AP with specific service parameters, including SSID, bandwidth profiles, and other parameters required for its proper operation. All the control and customer data is transmitted in-band across the public Internet.

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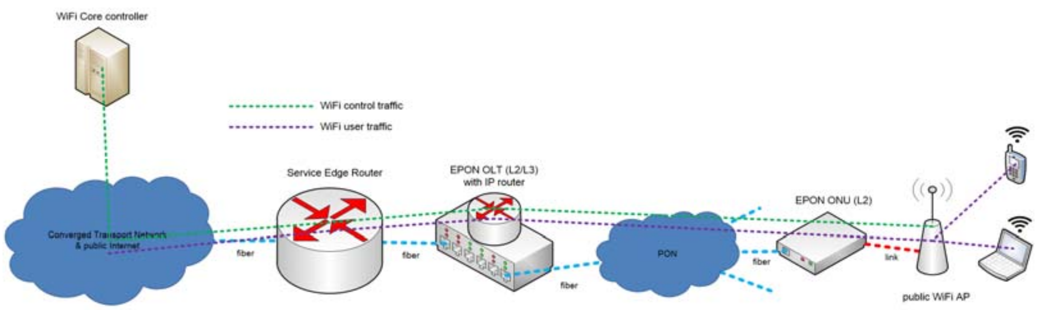

Figure 5~~24~~: Architecture of public WiFi backhaul service

5.12.5 Cellular backhaul

Cellular backhaul is a very specific type of commercial service in which digital data generated by the radio interfaces on a cellular base station is then backhauled into a dedicated DWDM transport network within the operator's footprint, as shown in Figure 6~~Figure 25~~. Apart from this one distinction, the service model is very similar to a P2P EVPL MEF circuit.

For redundancy purposes, a NID located between the EPON ONU and the cellular tower (NID_A) creates two independent VLANs transported by the ONU and the OLT. One of the VLANs is injected into the primary DWDM transport ring, while the other VLAN is injected into the secondary DWDM transport ring. This arrangement provides redundancy north of the OLT.

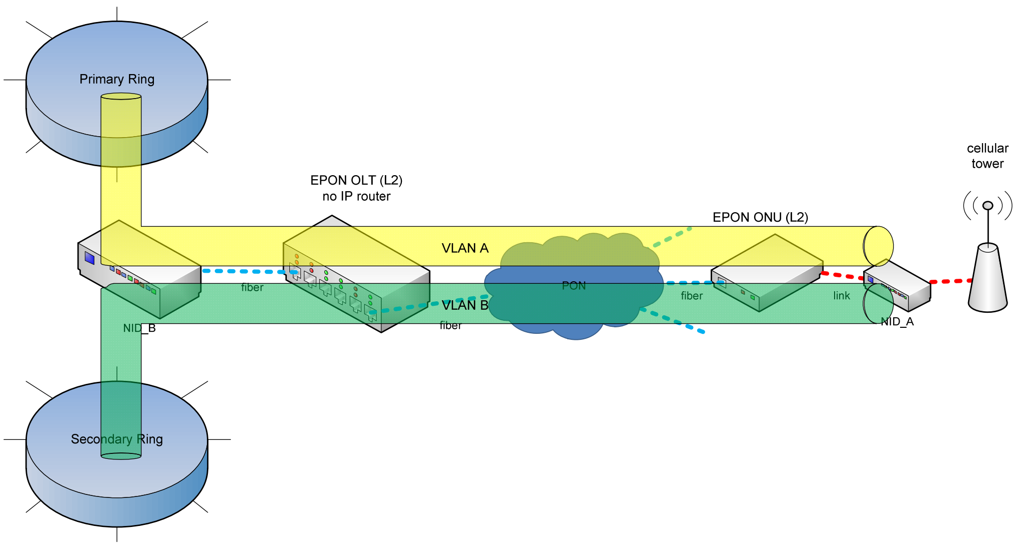

Figure 6~~25~~: Architecture of cellular backhaul service

~~5.13~~5.12.6 ~~Application Types~~Requirements for NG-EPON

NG-EPON ~~should~~ is expected to support all application types supported today on 1G-EPON and 10G-EPON platforms, while allowing at least the same SLA levels to be implemented. Improved jitter and delay characteristics are important for time-sensitive applications, such as cellular backhaul. Support for cellular fronthaul is highly desired, though a technical feasibility study might be required before specific requirements for aggregate bandwidth, timing, and jitter are narrowed down.

Native support for improved time distribution at the physical layer is highly desired, to eliminate the need for operation of higher layer protocols such as [802.1as] or [1588v2].

~~5.14~~5.13 Maximum Transmission Unit (MTU)

There is a demonstrated operator demand to carry frames with sizes exceeding 2 kB. To address this demand, NG-EPON ~~should~~ is expected to support the ability to transfer frames of at least 9 kB (often referred to as *Jumbo Frames)*, either natively (through increased MAC frame size), or through a fragmentation mechanism at the ONU and the OLT.

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