



Technical Specification

MEF 11

User Network Interface (UNI) Requirements and Framework

November 2004

MEF 11

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Abstract

This document describes the User to Network Interface (UNI) Requirements and Framework. It provides requirements, framework and functional model on how the UNI reference point will operate in a Metro Ethernet Network (MEN).

1. Terminology (Normative)

Term	Definition
All to One Bundling	A UNI attribute in which all CE-VLAN IDs are associated with a single EVC.
Bandwidth Profile	A method of classifying a particular set of Service Frames based on the bandwidth used by the frames at the UNI.
Broadcast Service Frame	A Service Frame that has a broadcast destination MAC address.
Bundling	A UNI attribute in which more than one CE-VLAN ID is associated with an EVC.
CBS	Committed Burst Size
CE	Customer Edge
CE-VLAN CoS	Customer Edge VLAN CoS
CE-VLAN ID	Customer Edge VLAN ID
CE-VLAN ID Preservation	An EVC attribute in which the CE-VLAN ID of an egress Service Frame is identical in value to the CE-VLAN ID of the corresponding ingress Service Frame.
CE-VLAN ID/EVC Map	An association of CE-VLAN IDs and EVCs at a UNI.
CE-VLAN Tag	Customer Edge VLAN Tag
CIR	Committed Information Rate
Class of Service	A set of Service Frames that have a commitment from the Service Provider to receive a particular level of performance.
Committed Burst Size	A measure of the amount of bytes sent in back-to-back Service Frames at the UNI.
Committed Information Rate	A measure of long term average bit rate for a set of Service Frames with at the UNI.
Customer Edge	Equipment on the Subscriber side of the UNI.
Customer Edge VLAN CoS	The Subscriber_priority bits in the IEEE 802.1Q Tag in a tagged Service Frame.
Customer Edge VLAN ID	The identity of the VLANs on the Ethernet port of the customer equipment that is attached to the UNI.
Customer Edge	The IEEE 802.1Q Tag in a tagged Service Frame. When present it

Term	Definition
VLAN Tag	contains the Customer Edge VLAN ID.
Egress Frame	A frame sent from the Service Provider network to the CE.
Ethernet Virtual Connection	An association of two or more UNIs that limits the exchange of frames to UNIs in the Ethernet Virtual Connection
EVC	Ethernet Virtual Connection
Frame	Short for Ethernet frame.
Frame Delay	A performance attribute of an EVC.
Frame Jitter	A performance attribute of an EVC.
Frame Loss	A performance attribute of an EVC.
Ingress Frame	A frame sent from the CE into the Service Provider network.
Layer 2 Control Protocol Service Frame	A Service Frame that is used for Layer 2 control, e.g., Spanning Tree Protocol.
Layer 2 Control Protocol Tunneling	The process by which a Layer 2 Control Protocol Service Frame is passed through the Service Provider network switches without being processed by those switches and delivered to the proper UNI(s).
Multicast Service Frame	A Service Frame that has a multicast destination MAC address.
Multipoint-to-Multipoint EVC	An EVC with two or more UNIs.
EBS	Excess Burst Size
Excess Burst Size	A measure of the amount of bytes sent in back-to-back Service Frames at the UNI.
Excess Information Rate	A measure of long term average bit rate for a set of Service Frames at the UNI.
EIR	Excess Information Rate
Point-to-Point EVC	An EVC with exactly 2 UNIs.
Service Frame	An Ethernet frame transmitted across the UNI toward the Service Provider or an Ethernet frame transmitted across the UNI toward the Subscriber.
Service Multiplexing	A UNI attribute in which the UNI can be in more than one EVC instance.
Service Provider	The organization providing Ethernet Service(s).
Subscriber	The organization purchasing and/or using Ethernet Services.
UNI	User Network Interface
UNI-EVC	The part of the EVC between the UNI-N and UNI-C
UNI-EVCID	The ID that identifies the part of the EVC between the UNI-N and UNI-C. This can be derived from CE-VLAN ID, Physical Port, TRANS Tag or combination of these.
Unicast Service	A Service Frame that has a Unicast destination MAC address.

Term	Definition
Frame	
User Network Interface	The physical demarcation point between the responsibility of the Service Provider and the responsibility of the Subscriber

2. Scope

This document provides a framework and requirements for the MEF ETH-layer UNI. The UNI is a demarcation point between the responsibility of the Service Provider and the responsibility of the Subscriber. The MEF UNI is a reference point for all interactions between Subscribers of MEF defined services and the MEN Service Provider.

The UNI is physically implemented over a bi-directional ETH link that provides the various data, control and management plane capabilities required by the MEN Service Provider to clearly demarcate the two different network domains involved in the operational, administrative, maintenance and provisioning aspects of the service.

This document describes the different functional components that are used to implement these control, data and management plane aspects related to MEF UNI. These functional components can be specified in subsequent UNI Implementation Agreements(s). The actual implementations and protocols used to implement UNI functional components are out of scope for this document.

MEF UNI references the Basic Network Reference Model of MEF 4 [8]. The model depicted below identifies the UNI Reference Points.

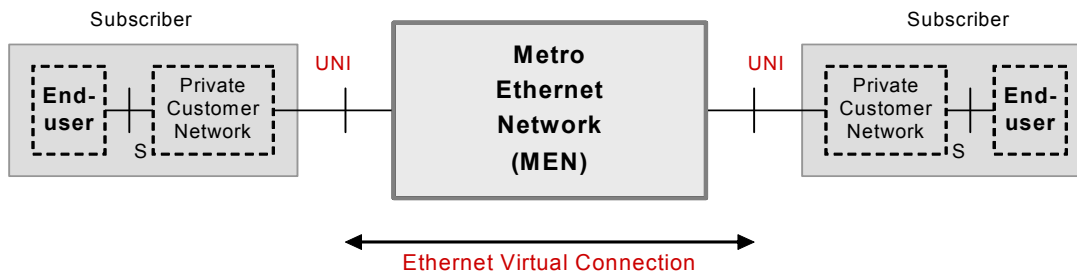


Figure 1: Basic Network Reference Model and UNI Reference Points

3. Compliance Levels

The key words “**MUST**”, “**MUST NOT**”, “**REQUIRED**”, “**SHALL**”, “**SHALL NOT**”, “**SHOULD**”, “**SHOULD NOT**”, “**RECOMMENDED**”, “**MAY**”, and “**OPTIONAL**” in this

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document are to be interpreted as described in RFC 2119 [1]. All key words use upper case, bold text.

4. UNI Reference Point

The UNI describes different aspects of the interface between the Subscriber and Service Provider. The UNI is physically implemented over a bi-directional ETH link that provides the various data, control and management plane capabilities required by the MEN Service Provider to clearly demarcate the two different network domains involved in the operational, administrative, maintenance and provisioning aspects of the service. The control, data and management plane aspects that relate to this interface are implemented via various functional components. As illustrated in Figure 2, the UNI Reference Point provides the demarcation between a Subscriber and the MEN boundaries. The UNI Reference Point is typically located at the Subscriber premises and is always at connector where the Subscriber network connects the Service Provider network.

The UNI functionality is split between the Subscriber's functions, called UNI-C, and the MEN functions, called UNI-N. Because of the distributed nature of the UNI, UNI-C and UNI-N maintenance is necessarily performed by different autonomies. The MEN Service Provider is responsible for UNI-N, i.e. all aspects of the UNI from the Provider Edge to the UNI Reference Point. The UNI-N is used to refer to a set of one or more functional elements that supports the MEN Service Provider's technical capabilities and compliance to the UNI specification. The MEN Subscriber is responsible for UNI-C, i.e. all aspects of the UNI from the Customer Edge (CE) device to the UNI Reference Point. The UNI-C refers to the functional elements within the CE that supports the MEN Subscriber's technical capabilities and compliance to the UNI specification.

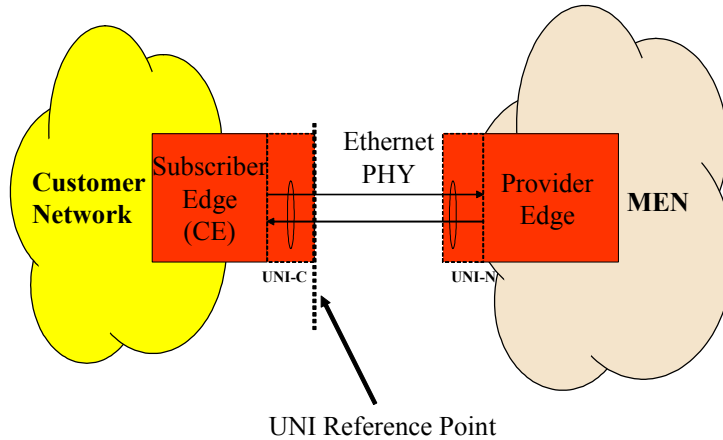


Figure 2: UNI Reference Point

The UNI-C is always connected to the UNI Reference Point by an IEEE 802.3 PHY. The UNI-N functional components which implement the Service Provider side of the UNI functions may be distributed over an access network. The reference point between the access network and the Provider Edge (PE) equipment is called Service Node Interface (SNI). In the simplest case where the access network is an Ethernet 802.3 PHY and UNI-C and UNI-N are connected to the UNI Reference Point by an IEEE 802.3 PHY, the UNI and SNI Reference Points are coincident. The UNI and SNI Reference Points are analogous to the T(TB) and V(VB) reference points used in ISDN and B-ISDN terminology. The SNI Reference Point is beyond the scope of this framework.

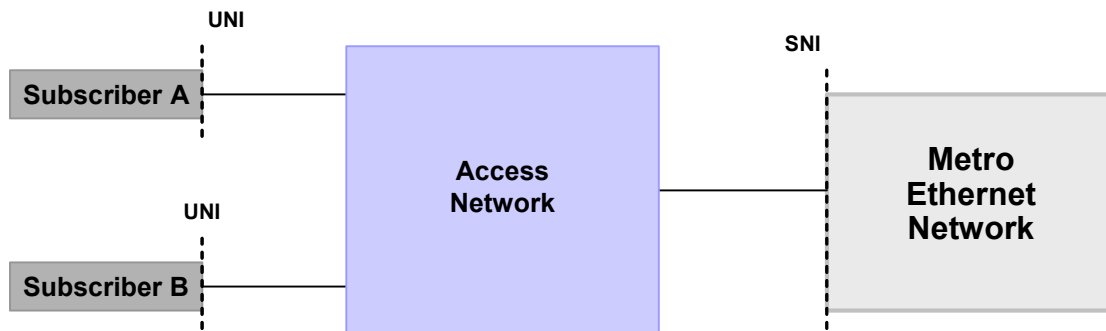


Figure 3: UNI and SNI Reference Points

5. UNI Reference Model

This section gives an overview of the different building blocks that constitute the UNI functions, and describes the various layers, capabilities and processes that are part of each building block. UNI Reference Model is shown in Figure 4.



Figure 4: UNI Reference Model

The UNI Reference Model consists of three planes:

The **UNI data plane**, which defines the means of transporting information across the UNI reference point;

The **UNI control plane**, which defines the means for the Subscriber and the MEN Service Provider to communicate to make use of the UNI data plane;

The **UNI management plane**, which configures and monitors the operation of the UNI data and control plane.

Figure 4 also shows a number of specific functional capabilities and the planes to which they typically belong. Note that several of these functional capabilities are closely related with functional capabilities in other planes of the UNI Reference Model.

Each of these planes and their associated functionality will now be discussed in more detail.

5.1 UNI DATA PLANE

The UNI data plane consists of the mechanisms used to transport various Subscriber Service Frame flows, including Subscribe data, control and management frames, across the UNI reference point. For the purposes of the Ethernet UNI, all Service Frame flows are associated with on IEEE 802.3/Ethernet frames.

The UNI data plane includes the definition of the physical and data link layer. The physical layer is based on an IEEE 802.3 PHY. Other physical layers may be considered, provided that they can transport Ethernet frames over the UNI reference point in a transparent manner.

5.1.1 Ethernet Frames at the UNI

The physical and data link layers across the UNI will be based on the IEEE 802.3/Ethernet PHY & MAC. The Subscriber and Service Provider are expected to send only Ethernet frames across the UNI.

5.1.2 Tagging

Ethernet frames may be tagged by the subscriber using IEEE 802.1Q [5] VLAN tags (CE-VLAN ID) before entering the MEN. The MEN Service Provider could use tagging for traffic management and Subscriber traffic segregation purposes. Tagging of ingress frames by the Service Provider is based on the CE VLAN ID [7].

When a Service Provider tagged Ethernet frame is sent from inside the MEN to the Subscriber, the UNI-N ensures that the egress frame has the correct CE-VLAN ID. The specific format of the frame at the UNI depends on the Service Provider policies that are under control of the management plane.

The Ethernet UNI is typically not concerned with any other higher layer protocol data units (PDUs) contained in the Ethernet frame. Unless otherwise specified (as part of a client-specific Ethernet UNI-C function) this higher-layer information may be handled by other higher-layer UNIs.

5.1.3 Traffic Management

The Subscriber may be provided with one or more classes of service determined by the CE-VLAN CoS [7] values for a given service. Different traffic management functions may be applied to the different classes of service determined by the CE-VLAN CoS value. For more details on traffic management parameters, refer to [9].

5.2 UNI CONTROL PLANE

In order for a Subscriber to make use of one or more Ethernet services, a communication mechanism may be required between the Subscriber and the MEN Service Provider. This communication mechanism may be either in-band or out-of-band. The communications mechanism is defined as part of the UNI control plane.

The UNI control plane defines the means for the Subscriber and the MEN Service Provider to agree on which Ethernet service(s) will be offered and on the characteristics of this service. More specifically, it defines the means to agree on how the Subscriber and the MEN Service Provider will make use of the UNI data plane. Both will be subject to a bilateral contract: the Subscriber should comply with the Ethernet service specification, and the MEN Service Provider must satisfy the commitments in the offered Ethernet service.

The UNI control plane functionality may include a dynamic connection setup function that allows dynamic establishment of Ethernet services. Unlike the static service discovery model (see section 5.3.1), the Service Provider can provision the network at the time the service request is received from the Subscriber. This obviously increases the complexity of the service activation process, but increases configuration flexibility and manageability to the Subscriber. This mechanism could also be used to change the characteristics of an established Ethernet service.

5.3 UNI MANAGEMENT PLANE

The UNI management plane configures and monitors the operation of both the UNI data and control plane. It includes the provisioning and management steps that need to be taken in order for the UNI data plane to support the Ethernet service. The management plane also controls how the control plane may operate, i.e., it controls when static service discovery and/or dynamic connection setup are allowed. Static service discovery function allows auto-configuration of the CE.

5.3.1 Provisioning and Static Service Discovery

In order for the Subscriber to make use of an Ethernet service, the MEN Service Provider needs to make sure that his network is correctly provisioned to satisfy the service needs. This process includes configuration of involved MEN network elements and associated CEs based on the service attributes. The management plane performs this task.

The management plane may interact with a network management system in the MEN domain that determines which configuration should be used for a particular Subscriber. Static configuration of the UNI makes use of management interfaces, such as the one defined in the MEF 7 [11]. The Subscriber's equipment can be provisioned with the service-specific parameters either manually or automatically via a static service discovery function. The static service discovery function allows the UNI-C to statically retrieve the needed configuration information from the UNI-N. In this manner, the Ethernet services may be activated without manual configuration intervention by the Subscriber. The process is static in the sense that the service is already provisioned by the MEN Service Provider, and does not require further provisioning information from the Subscriber at the time the Subscriber retrieves the configuration parameters from the UNI-N.

QoS management is a subset of the service provisioning functions. It specifically includes the provisioning of service attributes and characteristics of traffic policer, shapers, etc. This process enables the correct behavior in the UNI data plane and the Ethernet service activation.

5.3.2 Protection and Restoration

Although more important inside the MEN domain, protection and restoration could also play a role between the UNI-C and the UNI-N. For example, a Subscriber may have two physical links activated towards the MEN as part of the same Ethernet service. Depending on the service characteristics, interaction between the management planes of both links may be required. For instance, if one link fails, the other link could take over. If load balancing is performed over both links under normal operation (e.g. 50% traffic in each link), upon failure of one link the failed link's traffic can be carried across the remaining active link.

This function is closely related to the OAM function described below.

5.3.3 Operation, Administration and Maintenance (OAM)

OAM is the process that is primarily concerned with fault and performance management. This process includes:

connectivity verification, to make sure Ethernet traffic can be sent over the UNI;

performance monitoring, to assert the extent to which errors have occurred across the UNI;

statistics gathering of the number of frames successfully sent, as well as lost or corrupted frames for SLS verification purposes.

fault indication, informing the far end that a fault condition is present on the UNI.

In order to achieve these functions, an OAM management plane is required between the UNI-C and the UNI-N. This plane is provided over the Ethernet link as illustrated in Figure 2.

6. Relationship to Functional Elements in the MEN Architecture

The relationship between the UNI Reference Model and the MEN Functional Elements is depicted in Figure 5. The UNI Reference Model specifies the sub-set of functional capabilities supported by the UNI-C and the UNI-N to operate, administer, manage and provision the service across Subscriber to MEN boundaries. In this model, the UNI-C and UNI-N are specified as a set of one or more functional elements that support the necessary functions of the UNI. The relationship between the physical connectivity between the UNI-C and the UNI-N and TRAN

Layer is described in Section 6.1. Subscriber to Subscriber service frames (including Subscriber’s data, control and management frames) are handled by UNI-C and UNI-N data plane functional elements. Control frames between Subscriber and Service Provider are handled by UNI-C and UNI-N control plane functional elements. Management frames between Subscriber and Service Provider are handled by UNI-C and UNI-N management plane functional elements.

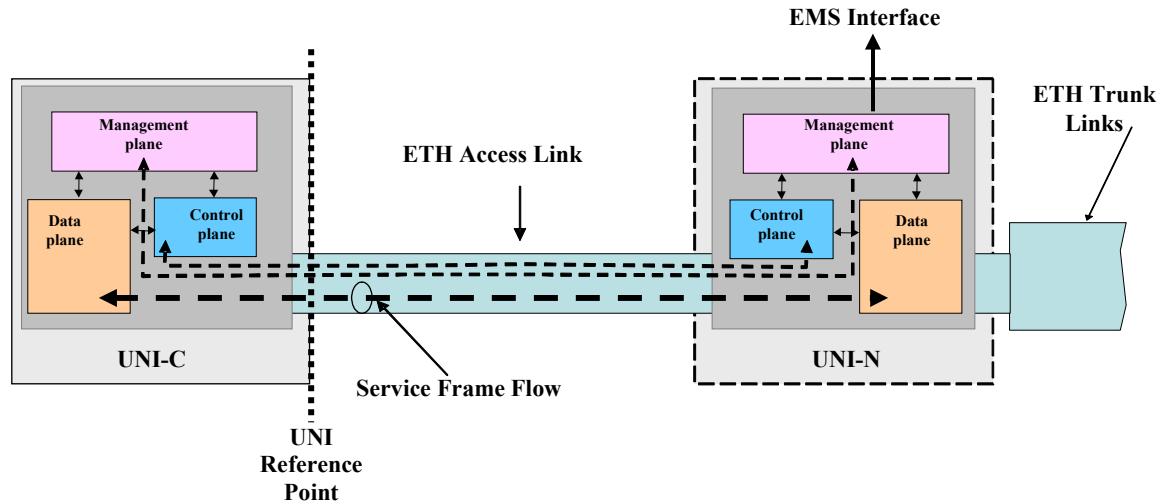


Figure 5: Relationship between the UNI Reference Model and the MEN Functional Components

6.1 RELATIONSHIP TO TRAN LAYER(S)

The physical layer at UNI Reference Point is defined to be an IEEE 802.3 PHY, as mentioned in Appendix B. The types of TRAN components are defined here that can be used to provide transport connectivity between the UNI-C and UNI-N which comprises the ETH Access Link [8]. The section below defines the various types of UNI configurations that are permissible.

6.1.1 Ethernet PHY as a TRAN component in the ETH Access Link

Figure 6 illustrates the relationship between the UNI Reference Model and other Functional Elements in the MEN Architecture when the UNI-C is directly attached to the UNI-N via a point-to-point Ethernet PHY TRAN link. The ETH Access Link is an abstract link which is composed of TRAN Layer components (in this case Ethernet PHYs) and ETH Layer components. There may be one or more EVCs handled by UNI-N. The EVC for each Ethernet Service Frame is identified by the CE-VLAN ID of the service frame and the CE-VLAN ID/EVC Map [7]. The UNI-N and the UNI-C need to be configured with the same CE-VLAN ID/EVC Map values.

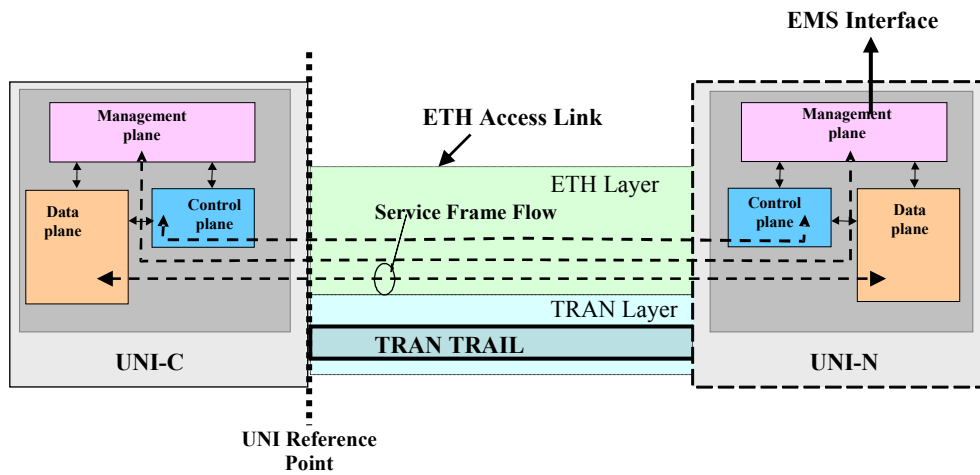


Figure 6: Relationship between UNI Reference Model and MEN Functional Elements – Direct Attachment

6.1.2 TMF as a TRAN component in the ETH Access Link

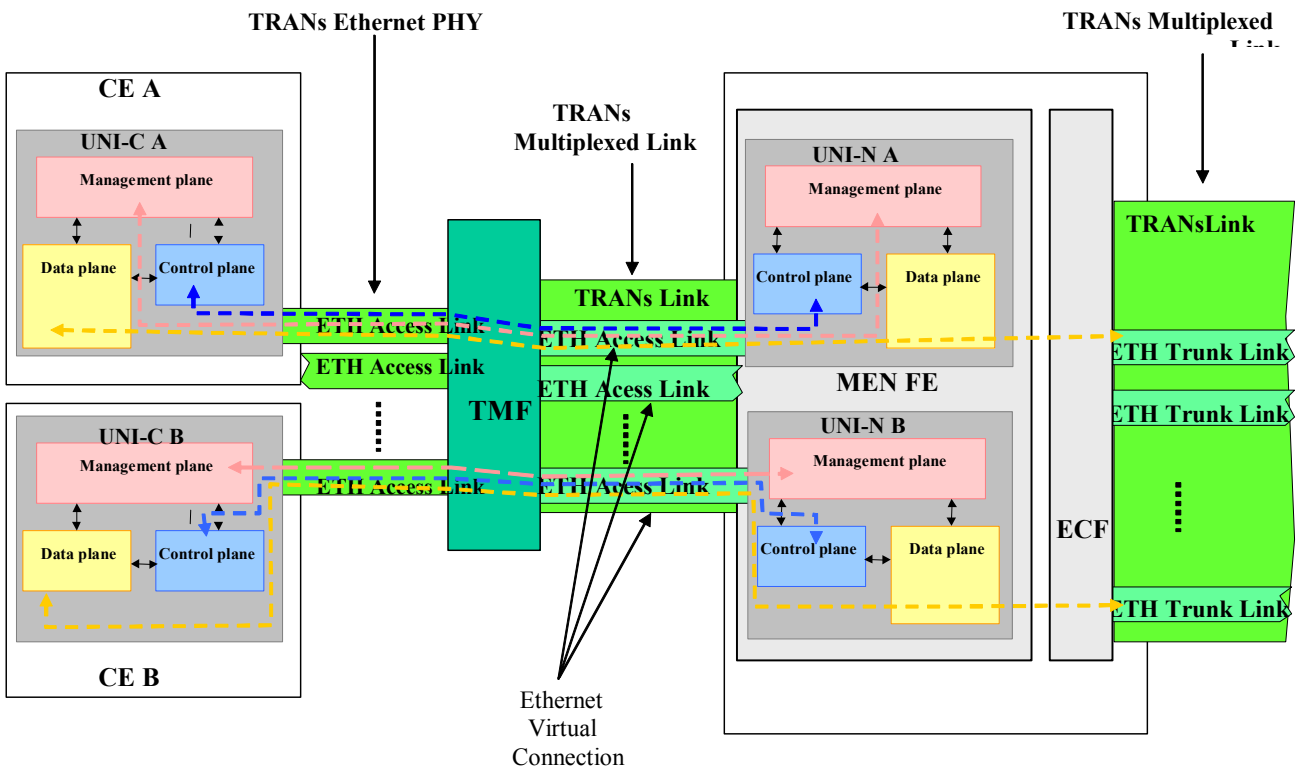


Figure 7 illustrates the relationship between the UNI Reference Model and MEN Functional Elements when the UNI-C is attached to the UNI-N via a TRAN Multiplexed Link provided by a TMF (Transport Multiplexing Function).

The TMF provides the multiplexing of several ETH Access Links over a single TRAN Multiplexed Link that terminates at the PE. Since each UNI-C instance is related to a specific CE, it is necessary to relate each UNI-C to a specific ETH Access Link at the UNI-N via a TRAN tag that defines the relationship of the ETH Access Link and the location within the TRAN Multiplexed Link. This is done by using a TMF tag at the TRAN Multiplexed Link (between the TMF and UNI-N) as a logical identifier that defines the ETH Access Link and therefore the respective UNI-C. As indicated in

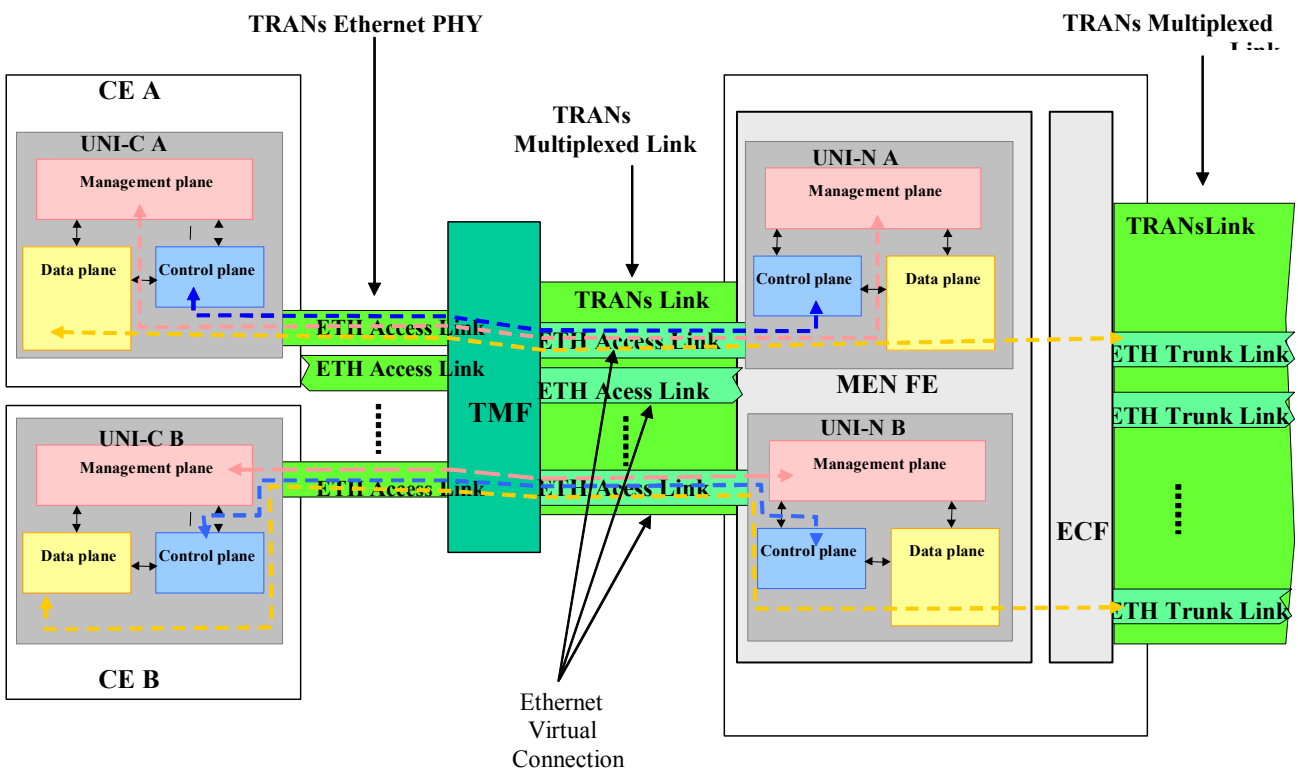


Figure 7, one to one correspondence between UNI-C and UNI-N is still maintained.

The details of TMF are for further study and will be covered in a future document.

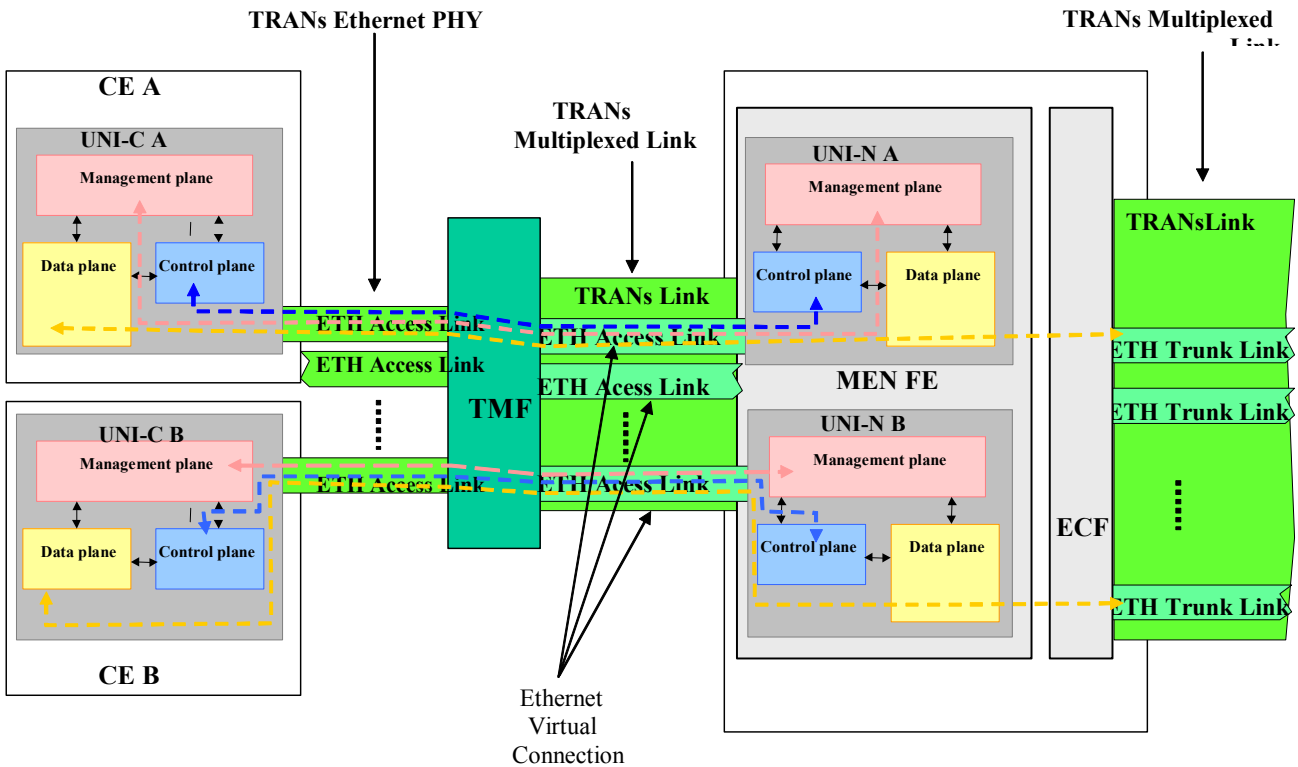


Figure 7: Relationship between UNI Reference Functional Model and MEN Network Reference Model – Attachment via TMF

7. UNI Types

This document introduces 3 types of UNIs: UNI Type 1, UNI Type 2, and UNI Type 3. These three types of UNIs determine the CE’s ability to negotiate services connections and attributes. The following section describes the operational aspects of three types:

7.1 UNI TYPE 1

The MEF UNI Type 1 will operate in manual configuration operation in which the Service Provider and Subscriber will have to manually configure the UNI-N and UNI-C for services.

7.2 UNI TYPE 2

The UNI TYPE 2 mode of operation allows the UNI-N to provision, configure, and distribute EVC information and the associated service attributes to the CE. In a manner akin to Frame Relay LMI and ATM ILMI, the CE in UNI Type 2 mode can retrieve certain information from the network through an automated link management interface. The customer equipment (CE) is

able to communicate with Service Provider equipment to ascertain the properties of a given EVC, such as the availability and status of the EVC that exist at the UNI.

Upon initialization, the CE uses the link management interface to learn about the EVCs at a given UNI and configures itself appropriately for those EVCs.

It is worth noting that the link management interface in UNI Type 2 mode is valuable both to Service Providers and to Subscribers. The automated capability significantly reduces turn-up time, turn-up cost, and turn-up errors, providing a much preferable alternative to the often-inefficient manual provision process.

7.3 UNI TYPE 3

The UNI Type 3 Mode of operation allows the CE to request, signal and negotiate EVCs and its associated Service Attributes to the UNI-N. This section will be completed in future versions of this document.

8. UNI Service Attributes

A UNI can have a number of characteristics as seen by the CE that will be important to the way that the CE sees services. These characteristics are called UNI service attributes. UNI service attributes include:

UNI Identifier,

Physical Layer (speed, mode, and physical medium),

MAC Layer,

Service Multiplexing,

UNI EVC ID,

CE-VLAN ID/EVC Map,

Maximum number of EVCs,

Bundling,

All to One Bundling,

Bandwidth Profiles, and

UNI Layer 2 Control Protocol Processing.

The complete list of UNI Service Attributes along with normative definitions is contained in MEF 1 [7] and MEF 5 [9].

9. EVC Service Attributes

The EVC Service Attribute provides for the ability to describe the characteristics of the EVC at each UNI reference point. The EVC Service Attributes include:

EVC Type (Point-to-Point or Multipoint-to-Multipoint),

UNI List,

Service Frame Delivery,

CE-VLAN ID Preservation,

CE-VLAN CoS Preservation

Layer 2 Control Protocol Processing, and

EVC related Performance

The complete list of EVC Service Attributes along with normative definitions is contained in MEF 1 [7] and MEF 5 [9].

10. UNI Requirements

This section specifies requirements for the UNI and considers three phases of its deployment. UNI Type 1 focuses on Ethernet deployment with existing customer equipments such that UNI-Cs require no changes and use existing IEEE Ethernet PHY and MAC functionality. UNI Type 2 provides the UNI with a service discovery function that supports automatic service discovery and OAM, where automatic service discovery allows UNI-Cs to be provisioned automatically by discovering service attributes across the UNI, while OAM provides mechanisms to manage and troubleshoot the UNI. UNI Type 3 provides UNI with a dynamic EVC setup function that allows EVC setup and/or modification capabilities from the UNI-C. A UNI compliant implementation can choose to comply with any UNI Type. However, subsequent UNI Types must be backward compatible.

The requirements for each UNI Type are specified across the physical layer and 3 planes of UNI Reference Model introduced in section 5. The physical layer specifies UNI PHYs that will

connect the UNI-C to the MEN. Functional aspects of each UNI Type will be covered in separate implementation agreement documents, and are outside the scope of this document.

Unless indicated specifically, these requirements are applicable to UNI-Ns.

10.1 UNI TYPE 1 REQUIREMENTS

10.1.1 General UNI Type 1 Requirements

[R1] UNI Type 1 **MUST** allow UNI-C of Subscriber equipments to connect to a UNI-N of MEN using an IEEE 802.3 2002 conforming interface.

[R2] UNI Type I **MUST** allow UNI-C of Subscriber equipments, conforming to IEEE 802.1Q [5] and IEEE 802.1D [6], to connect to a UNI-N of MEN.

[R3] UNI Type I **MUST** allow UNI-C of Subscriber equipments, implementing IEEE 802.3 end stations e.g. routers, to connect to a UNI-N of MEN.

[R4] UNI Type 1 **SHOULD** allow a connecting UNI-C of Subscriber to be authorized by a UNI-N of MEN such that unauthorized Subscribers are not allowed to access MEN services.

Note: IEEE 802.1X may be used by MEN to meet this requirement.

[R5] UNI Type 1 **SHOULD** support multiple (more than one) EVCs within the MEN.

[R6] UNI Type 1 UNI-Cs **SHOULD** support the full range of CE-VLAN Ids, in accordance with IEEE 802.1Q [5] tag.

[R7] UNI Type 1 UNI-Ns **MUST** support the full range of CE-VLAN Ids, in accordance with IEEE 802.1Q [5] tag.

10.1.2 UNI Type 1 Physical layer Requirements

In the following requirements, the physical layer is assumed to be part of UNI data plane. The physical layer for control and management planes may be different if control and management planes are out of band with the data plane.

[R8] UNI Type 1 **MUST** support at least one of the following IEEE 802.3 Ethernet PHYs:

10BASE-T in Full-duplex mode [2].

100BASE-T including 100BASE-TX and 100BASE-FX in Full-duplex mode [2].

1000BASE-X including 1000BASE-SX, 1000BASE-LX, and 1000BASE-T in Full-duplex mode [2].

10GBASE-SR, 10GBASE-LX4, 10GBASE-LR, 10GBASE-ER, 10GBASE-SW, 10GBASE-LW, and 10GBASE-EW in Full-duplex mode [3].

10.1.3 UNI Type 1 Data Plane Requirements

[R9] UNI Type 1 **MUST** allow sending Subscriber's IEEE 802.3-2002 compliant service frames across the UNI.

[R10] When multiple EVCs are supported by UNI-N, UNI Type 1 **MUST** allow mapping of Service Frames to corresponding EVCs.

[R11] UNI Type 1 **MUST** allow the mapping of Service Frames to the following types of EVCs:

Point-to-Point EVC

Multipoint-to-Multipoint EVC

[R12] UNI Type 1 **MUST** support an option for ingress bandwidth profile across the UNI based on mechanisms specified in MEF 5 [9].

[R13] UNI Type 1 **MAY** support an option to have different bandwidth profiles across the UNI for each direction of Service Frames.

[R14] UNI Type 1 **MUST** be transparent to higher layer protocols.

[R15] UNI Type 1 **MUST** allow manual configuration to set-up or tear-down EVCs across the UNI within the bounds of [R6].

[R16] UNI Type 1 **MUST** allow manual configuration to modify the service attributes associated with the EVCs across the UNI.

[R17] UNI Type 1 **MUST** allow manual configuration to modify the ingress bandwidth profile across the UNI, where the modification may result in increment or decrement of bandwidth.

[R18a] If Bandwidth Profile Parameter CIR as per MEF 5 [9] is supported, UNI Type 1 **MUST** allow manual configuration to modify CIR in the following granularities:

1Mbps steps up to 10Mbps

5 Mbps steps beyond 10Mbps and up to 100Mbps

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50 Mbps steps beyond 100Mbps and up to 1Gbps

500 Mbps steps beyond 1Gbps

[R18b] If Bandwidth Profile Parameter CIR as per MEF 5 [9] is supported, UNI Type 1 **SHOULD** allow manual configuration to modify CIR in the following granularities:

100 Kbps steps up to 2 Mbps

2 Mbps steps beyond 2 Mbps and up to 50 Mbps

50 Mbps steps beyond 50 Mbps and up to 150 Mbps

150 Mbps steps beyond 150 Mbps

Note: 100Kbps corresponds to DS0, 2 Mbps correspond to VT, 50 Mbps correspond to STS-1 and 150Mbps correspond to STS-3.

[R18c] If Bandwidth Profile Parameter CIR as per MEF 5 [9] is supported, UNI Type 1 **MAY** allow manual configuration to modify CIR in granularities, other than those covered in R18a and R18b.

[R18d] If Bandwidth Profile Parameter EIR as per MEF 5 [9] is supported, UNI Type 1 **MUST** allow manual configuration to modify EIR in the following granularities:

1Mbps steps up to 10Mbps

5 Mbps steps beyond 10Mbps and up to 100Mbps

50 Mbps steps beyond 100Mbps and up to 1Gbps

500 Mbps steps beyond 1Gbps

[R18e] If Bandwidth Profile Parameter EIR as per MEF 5 [9] is supported, UNI Type 1 **SHOULD** allow manual configuration to modify EIR in the following granularities:

100 Kbps steps up to 2 Mbps

2 Mbps steps beyond 2 Mbps and up to 50 Mbps

50 Mbps steps beyond 50 Mbps and up to 150 Mbps

150 Mbps steps beyond 150 Mbps

Note: 100Kbps corresponds to DS0, 2 Mbps correspond to VT, 50 Mbps correspond to STS-1 and 150Mbps correspond to STS-3.

[R18f] If Bandwidth Profile Parameter EIR as per MEF 5 [9] is supported, UNI Type 1 **MAY** allow manual configuration to modify EIR in granularities, other than those covered in R18d and R18e.

10.1.4 UNI Type 1 Management Plane Requirements

[R19] UNI Type 1 **MUST** support manual configuration of following service parameters at UNI-C and UNI-N.

- a) CE-VLAN ID/EVC Map allowing mapping each Subscriber service frame into an EVC.
- b) Parameters of Ingress bandwidth profile per UNI defined in MEF 5 [9]
- c) Parameters of Ingress bandwidth profile per EVC defined in MEF 5 [9]
- d) Parameters of Ingress bandwidth profile per CoS defined in MEF 5 [9]
- e) CoS Identifiers
- f) Handling of UNI Layer 2 control protocols, where the handling may include:

Tunneled through EVC

Discarded, or

Processed

[R20] UNI Type 1 **MUST** support failure detection based on failure detection mechanisms of IEEE 802.3ah [4].

10.2 UNI TYPE 2 REQUIREMENTS

10.2.1 General 2.0 UNI Requirements

[R21] UNI Type 2 UNI-C and UNI-N **MUST** be backward compatible with UNI Type 1. Backward compatibility means that UNI Type 2 **MUST** continue to support all UNI Type 1 requirements. New UNI Type 2 requirements **MUST** be added over and above UNI Type 1

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requirements. Type 1 UNI-C **MUST** be able to work with Type 2 UNI-N and Type 2 UNI-C **MUST** be able to work with Type 1 UNI-N.

Note: A Type 2 UNI-N must automatically detect a Type 1 UNI-C and fall back to UNI Type 1. Similarly a Type 2 UNI-C must automatically detect a Type 1 UNI-N and fall back to UNI Type 1.

[R22] UNI Type 2 UNI-C and UNI-N **SHOULD** be extensible such that new features and parameters, besides those identified in these requirements, can be added.

10.2.2 UNI Type 2 Physical layer Requirements

[R23] UNI Type 2 UNI-C and UNI-N **MAY** support Auto-negotiation mechanism. Auto-negotiation, when used, allows UNI-C and UNI-N to advertise and arbitrate operational modes and capabilities e.g. speed, duplex modes, PAUSE capabilities etc.

10.2.3 UNI Type 2 Data Plane Requirements

[R24] UNI Type 2 UNI-C and UNI-N **MUST** support sending Ethernet OAM frames, as required by UNI Type 2 management plane, across the UNI.

10.2.4 UNI Type 2 Management Plane Requirements

[R25] UNI Type 2 UNI-C and UNI-N **MUST** support the service parameters to be communicated from UNI-N to UNI-C, as identified in [R21].

[R26] UNI Type 2 UNI-C and UNI-N **MUST** support the following Ethernet OAM mechanisms between UNI-C and UNI-N such that UNI can be managed:

- a) Connectivity verification which helps in establishing connectivity status between UNI-C and UNI-N.
- b) Communicate the EVC availability status to the UNI-C.

[R27] UNI Type 2 UNI-C and UNI-N **SHOULD** support the following Ethernet OAM mechanisms between UNI-C and UNI-N such that UNI can be managed:

- a) Performance monitoring by exchanging performance statistics from either side of the UNI. These statistics can be used for SLA monitoring/verification.

10.3 UNI TYPE 3 REQUIREMENTS

10.3.1 General 3.0 UNI Requirements

[R28] UNI Type 3 UNI-C and UNI-N **MUST** be backward compatible with UNI Type 2 and UNI Type 1. Backward compatibility means that UNI Type 3 **MUST** continue to support all UNI Type 1 and UNI Type 2 requirements. New UNI Type 3 requirements **MUST** be added over and above UNI Type 1 and UNI Type 2 requirements. Type 1 and Type 2 UNI-Cs **MUST** be able to work with Type 3 UNI-N and Type 1 and Type 2 UNI-Ns **MUST** be able to work with Type 3 UNI-C.

Note: A Type 3 UNI-N must automatically detect a Type 1 or Type 2 UNI-C and fall back to UNI Type 1 or UNI Type 2 respectively. Similarly a Type 3 UNI-C must automatically detect a Type 1 or Type 2 UNI-N and fall back to UNI Type 1 or UNI Type 2 respectively.

10.3.2 UNI Type 3 Control Plane Requirements

[R29] UNI Type 3 UNI-C and UNI-N **SHOULD** allow signaling mechanisms across the UNI to allow UNI-C to request the following actions at UNI-N:

Set-up or tear-down EVCs within the bounds of [R6].

Modification of service attributes associated with the EVC across the UNI.

Bandwidth profile modifications including bandwidth increment or decrement requests.

[R30] UNI Type 3 UNI-C and UNI-N **SHOULD** allow signaling mechanisms across the UNI to allow UNI-C to request modification to the UNI speed associated with EVPL service, as defined in MEF 6 [10].

11. References

- [1] RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, March 1997
- [2] IEEE 802.3–2002, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*, March 2002 (Normative)
- [3] IEEE 802.3ae–2002, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method*

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and physical layer specifications - Amendment: Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation, August 2002 (Normative)

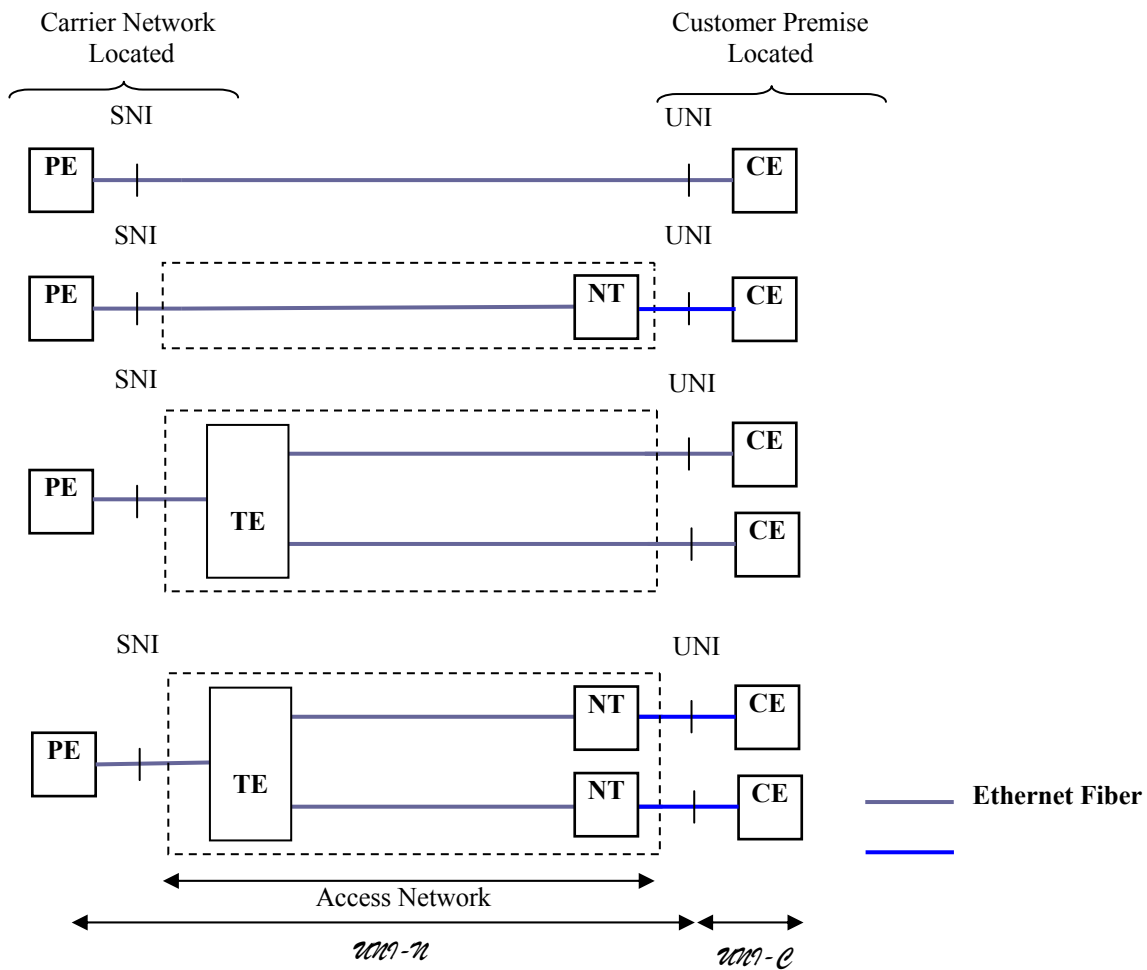
- [4] IEEE 802.3ah-2004, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications - Amendment: Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for Subscriber Access Networks, September 2004 (Normative)*
- [5] IEEE 802.1Q-2003, *IEEE Standards for Local and metropolitan area networks—Virtual Bridged Local Area Networks, May 2003 (Normative)*
- [6] IEEE 802.1D-2004, *IEEE Standards for Local and metropolitan area networks—Media Access Control (MAC) Bridges, June 2004 (Normative)*
- [7] MEF 1, *MEF Ethernet Service Model – Phase 1, November 2003 (Normative)*
- [8] MEF 4, *Metro Ethernet Network Architecture Framework – Part 1: Generic Framework, May 2004 (Normative)*
- [9] MEF 5, *Traffic Management Specification – Phase 1, May 2004 (Normative)*
- [10] MEF 6, *Ethernet Services Definitions – Phase 1, October 2004 (Normative)*
- [11] MEF 7, *EMS-NMS Information Model, October 2004 (Normative)*

Appendix A: UNI Examples

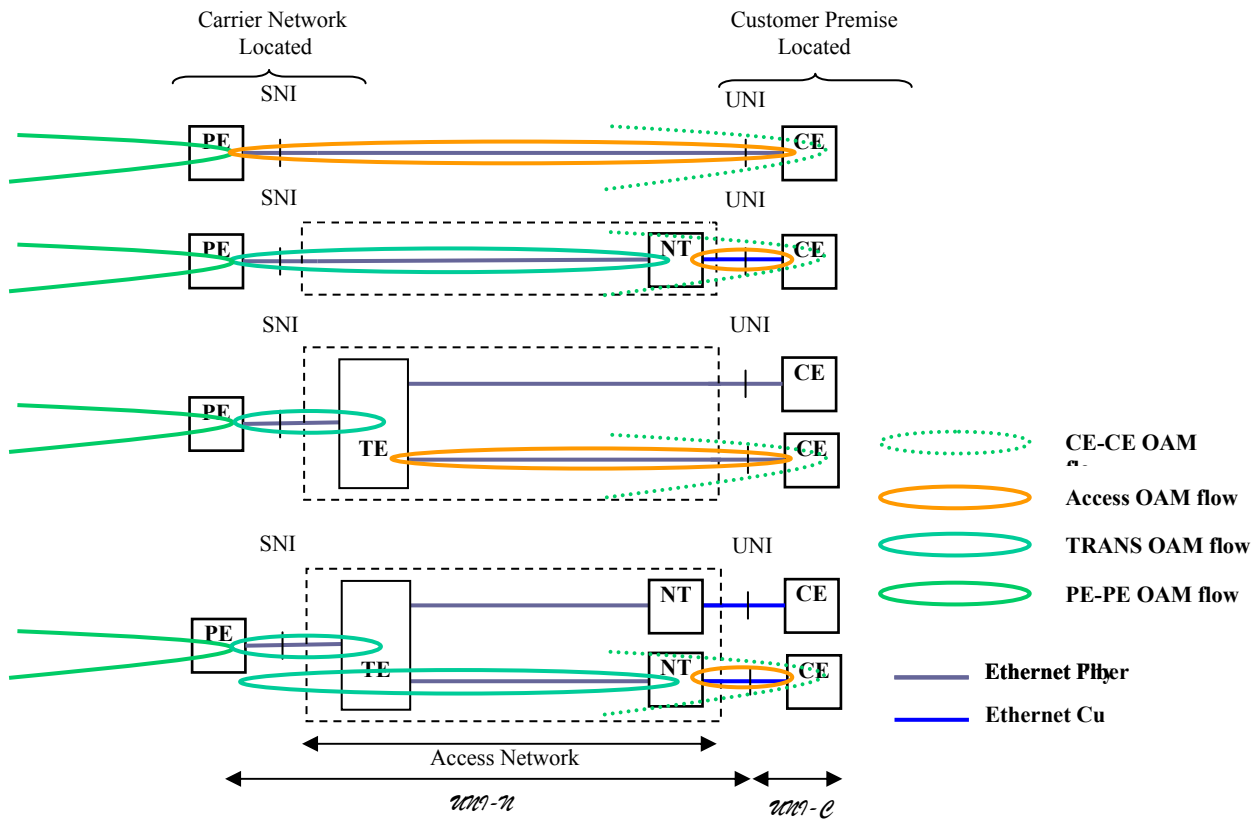
The UNI-N is a compound functional element whose components may be implemented in various places in the Access Network and PE. The UNI-N includes a Transport Connector Function which is a connector and is the demark between the Service Provider network and the Subscriber network, a TDF which is the transport demark function that provides monitoring of the final transport link to the Subscriber, and the ESCF which provides service aware conditioning.

Implementations distribute the UNI-N functional components over various equipments. Three generic equipment types are used to describe various implementations. These equipment types are Network Termination Equipment (NT), Transport Edge Equipment (TE), and Provider Edge Equipment (PE). The exact functional composition of these generic equipment varies from implementation to implementation, however the PE always contains a ESCF function and the NT always contains a TCF.

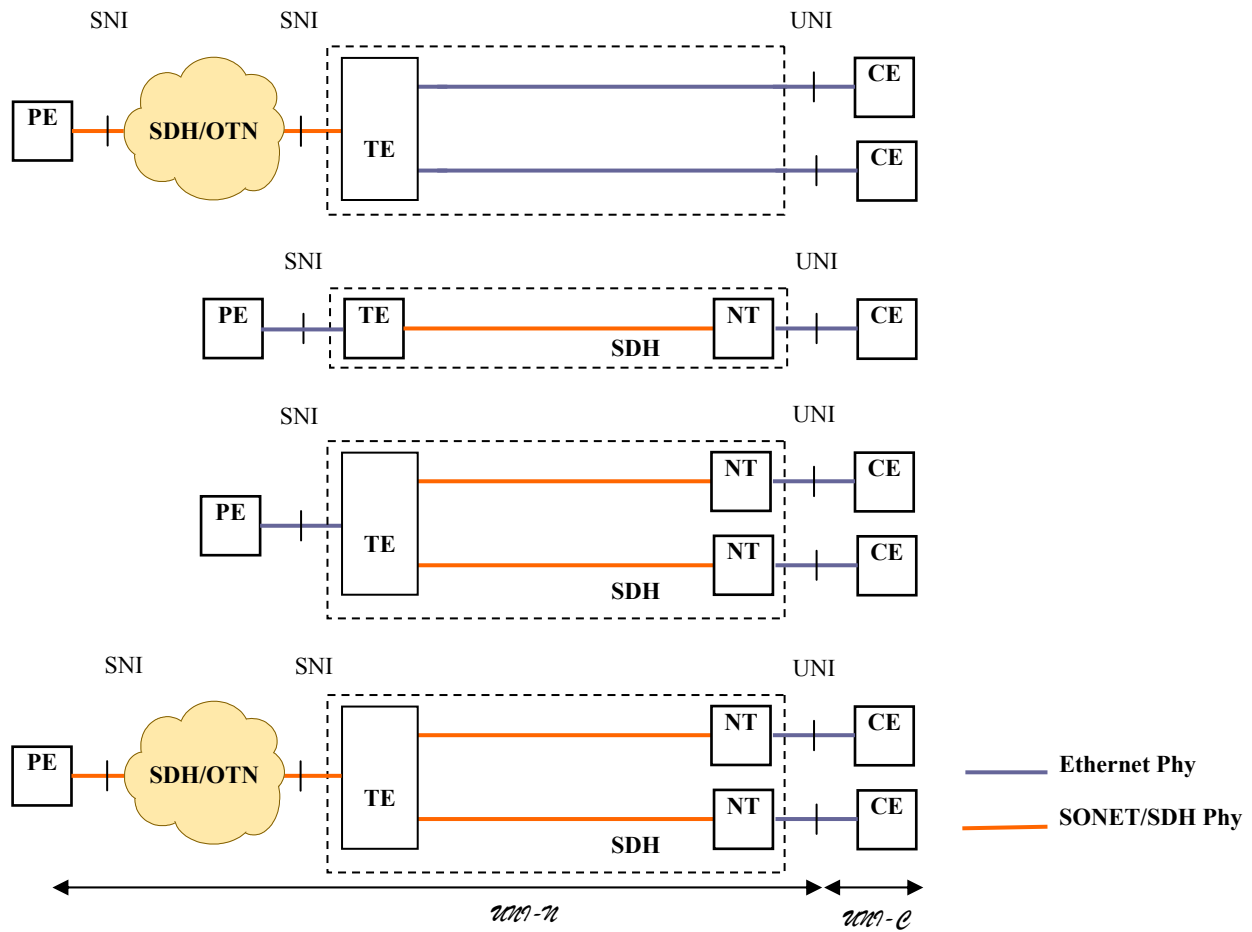
The UNI functions may be distributed over the Access Network and PE device. The following diagrams provide examples of different Access Networks. The components of these access networks are described generically as the Transport Edge Equipment (TE) and the Network Termination Equipment (NT).



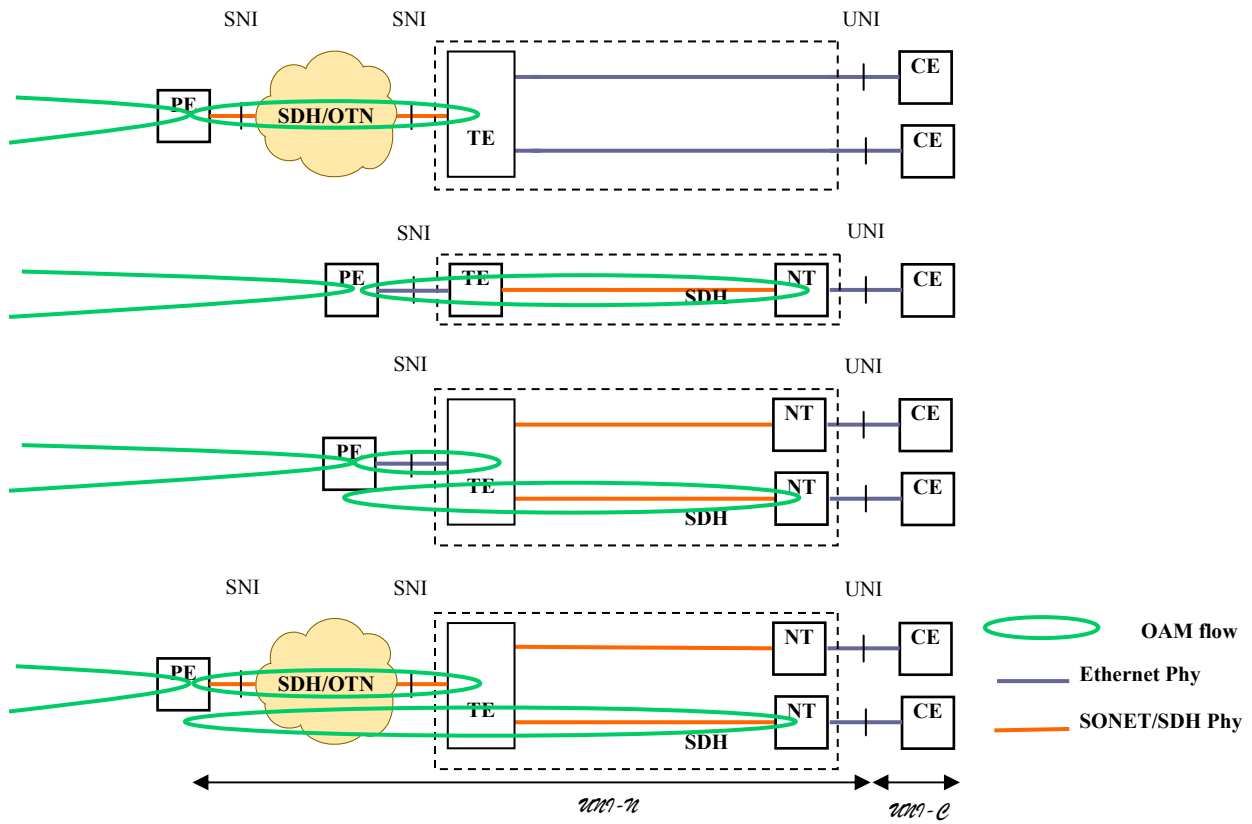
Example: Tenants Serviced by an Ethernet



Example: OAM Flows for Tenant Serviced by an Ethernet



Example: SONET/SDH Extensions



Example: OAM Flows for SONET/SDH Extensions

Appendix B: Physical Layer

The physical layer, or PHY, defines the electrical signaling, symbols, line states, clocking requirements, encoding of data, and connectors for data transmission. The Ethernet MAC can be combined with different PHYs. The UNI supports several of the IEEE 802.3 PHYs.

Ethernet standards provide options for both duplex and half duplex operation modes.

This section provides a short overview of the different PHY implementations, as specified by IEEE 802.3 that may be supported by UNI

B.1 10Base-T

10BASE-T specifies Ethernet over unshielded twisted-pair. The IEEE 802.3-2002 specification addresses the Medium Attachment Unit (MAU), the Repeater Unit, and the Twisted-Pair media for 10Mbps CSMA/CD LAN.

It utilizes two pairs of unshielded twisted-pair cable: one pair of wiring to transmit data, and a second pair to receive data. Eight-pin modular plugs, type RJ-45, are used as connectors. The signaling frequency is 20MHz, and UTP cable (Category 3 or better) must be used.

The maximum segment length is 100 meters, which is in accordance with EIA/TIA 568-A wiring standard. Repeater-repeater links are also limited to a maximum of 100 meters. Maximum of 4 repeaters and 5 segments are allowed, therefore 10BASE-T LAN can have a maximum diameter of 500 meters.

It requires a star-wired configuration with a central hub. External MAUs are allowed, but most 10BASE-T equipment integrated the functions of the MAU in the UNI-C or the hub itself.

B.2 100Base-T/Fast Ethernet

100BASE-T is the 100Mbps version of the classic Ethernet standard. The IEEE 802.3-2002 specification couples the IEEE 802.3 CSMA/CD MAC with a family of new physical layers for 100Mbps Ethernet, including:

100BASE-TX, which requires two pairs of Category 5 UTP or Type 1 STP cabling

100BASE-FX, which uses two strands of multimode fiber

Like 10BASE-T, all 100BASE-T PHY specifications require a star configuration with a central hub. All 100BASE-T UTP PHYs use RJ-45 connector and specify a maximum 100-meter cable distance. The signaling frequency is 125MHz.

100BASE-FX utilizes two strands of the multimode (62.5/125 m) fiber cabling. The maximum segment length for fiber-optics connections varies. For multimode fiber, it can be 412 meters while repeater diameters can be up to 320 meters.

The ratio of packet duration to network propagation delay for 100BASE-T is the same as for 10BASE-T. This is since the bit rate is faster, bit times are shorter, packet transmission times are reduced, and cable delay budgets are smaller, all in proportion to the change in bandwidth.

B.3 1000Base-X/Gigabit Ethernet

1000BASE-X refers to the 1000Mbps MAC and the LX/SX/CX transceiver technology. The IEEE 802.3z specification couples an extended version of the ISO/IEC 8802-3 (CSMA/CD MAC) to a family of 1000 Mb/s PHY connected through a Gigabit Media Independent Interface (MII) layer to physical layer entities such as:

- 1000BASE-SX and 1000BASE-LX to support fiber-optics cable
- 1000BASE-T PHY for four pairs of Category 5 balanced copper cabling.

1000BASE-SX is targeted at cost-sensitive, shorter backbone, or horizontal connections. It uses the same physical layer as LX and uses affordable 850nm short-wavelength optical diodes. It uses only multimode fiber. Distance supported is 200m to 550m, depending on the type of fiber cable used.

1000BASE-LX is targeted at longer backbone and vertical connections. It uses single mode or multimode fiber. It requires 1300nm lasers. Distance supported is 5000m for single mode fiber while it is 550m for multimode fiber.

1000BASE-T provides a cable length of 100m.

Gigabit Ethernet extends the ISO/IEC 8802-3 MAC beyond 100 Mb/s to 1000 Mb/s. The bit rate is faster, and the bit times are shorter, both in proportion to the change in bandwidth. In full duplex mode, the minimum packet transmission time has been reduced by a factor of ten. Achievable topologies for 1000 Mb/s full duplex operation are comparable to those found in 100BASE-T full duplex mode:

B.4 10GBase-xx/10 Gigabit Ethernet

The newly ratified IEEE 802.3ae standard specifies 10 Gigabit Ethernet that uses the IEEE 802.3 MAC sub layer connected through a 10 Gigabit Media Independent Interface (XGMII) to Physical layer entities such as 10GBASE-SR, 10GBASE-LX4, 10GBASE-LR, 10GBASE-ER, 10GBASE-SW, 10GBASE-LW, and 10GBASE-EW. Achievable topologies for 10Gbps operation are comparable to those found in 1000BASE-X full duplex mode and equivalent to those found in WAN applications.

10 Gigabit Ethernet is defined for full duplex mode of operation only.