eCPRI Transport Network D0.1 (2017-08-30)

Requirements Specification

Common Public Radio Interface:
Requirements for the eCPRI Transport Network

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1. Introduction

The Common Public Radio Interface (CPRI) is an industry cooperation aimed at defining publicly available specifications for the key internal interface of radio base stations, such as eCPRI connecting the eCPRI Radio Equipment Control (eREC) and the eCPRI Radio Equipment (eRE) via a so-called fronthaul transport network. The parties cooperating to define the specification are Ericsson AB, Huawei Technologies Co. Ltd, NEC Corporation and Nokia Networks.

The eCPRI Interface Specification [1] can be supported by Ethernet-switched or IP-routed fronthaul networks, or similar types of transport networks. This specification version describes the requirements of eCPRI services towards the packet switched transport network.

<u>Scope of Specification:</u>

This specification defines the details necessary to qualify and quantify the requirements on the underlying transport network needed by the eCPRI layers to provide its services to the application.

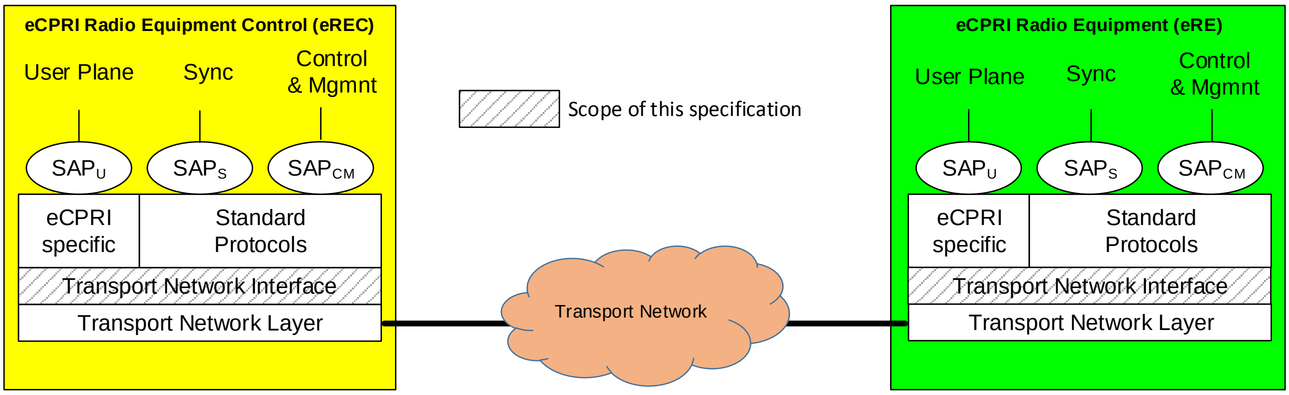

Figure 1 Scope definition

Equipment of independent vendors can share a common network. Thus, there must be no dependencies (explicit or implied) between equipment of different vendors that use the same transport network. The details of the network implementation shall be separated from the details of its users, i.e., the eCPRI equipment, by means of a Transport Network Interface. This specification provides the eCPRI requirements to enable such separation.

The eCPRI requirements towards the packet switched transport network are independent of the technology used by a given packet transport network supporting eCPRI, i.e., the same requirements apply to Ethernet or IP transport networks. This document refers to the Carrier Ethernet services specified by the MEF Forum, especially on the Ethernet Service Attributes defined by the MEF 10.3 Technical Specification [2]. However, Ethernet transport services are only used as an example, which are applicable, e.g., to Ethernet-based transport networks. The requirements (and corresponding definitions) described in this document are equally applicable to other packet transport networks based on different transport technologies (e.g., MPLS or IP) that can provide transport services similar to the MEF transport services.

In MEF terminology, the Service Provider is the organization providing Ethernet Service(s) and the Transport Network illustrated in Figure 1 is a network from a Service Provider or network Operator supporting the MEF service and architecture models. The Subscriber is the organization purchasing and/or using Ethernet Services, i.e., the eRE and eREC illustrated in Figure 1 belong to a Subscriber of transport service(s). The technical specification of the service level being offered by the Service Provider to the Subscriber is referred to as Service Level Specification (SLS).

2. Transport Network Terminology and Services

This section describes terminology, services, service attributes, etc. that are widely used for transport networks. Although, this section largely refers to the terminology used by the MEF Forum, neither the transport network nor the service provided is limited to Ethernet, other technologies and services, e.g., IP can also be used.[1]

2.1. User Network Interface

The User Network Interface (UNI) is the physical demarcation point between the responsibility of the Service Provider and the responsibility of the subscriber (section 7 in MEF 10.3 [2]). Figure 2 illustrates UNIs between eCPRI equipment (eRE/eREC) and a transport network. It may contain one or more physical termination points (e.g., Ethernet physical interfaces, see section 9.4 in MEF 10.3 [2]). Usually all physical termination points of an eCPRI unit are part of the same UNI.

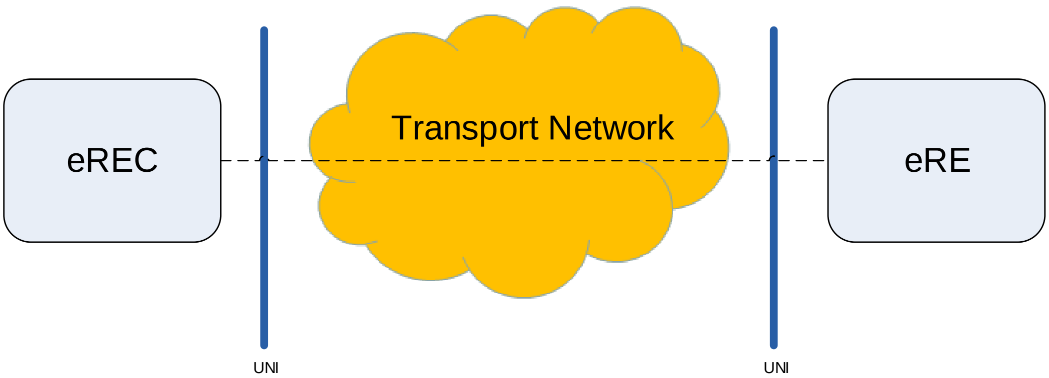

Figure 2 UNI between a eRE/eREC and a transport network

Note that the equipment on the Subscriber side of the UNI, i.e., eRE and eREC are referred to as Customer Edge (CE) in MEF 10.3 [2].

2.2. Transport Connection

The connection is the key component of the service(s) provided by a transport network.

A fundamental aspect of Ethernet Services is the Ethernet Virtual Connection (EVC). An EVC is an association of two or more UNIs. The UNIs associated by an EVC are said to be “in the EVC.” A given UNI can support more than one EVC. (See section 8 in MEF 10.3 [2]). Service Frames are transmitted via a MEF UNI, where, a Service Frame is from the first bit of the Destination MAC Address through the last bit of the Frame Check Sequence of an IEEE 802.3 Packet (MEF 10.3 [2]).

[1] The definition of IP Services is an ongoing work at MEF

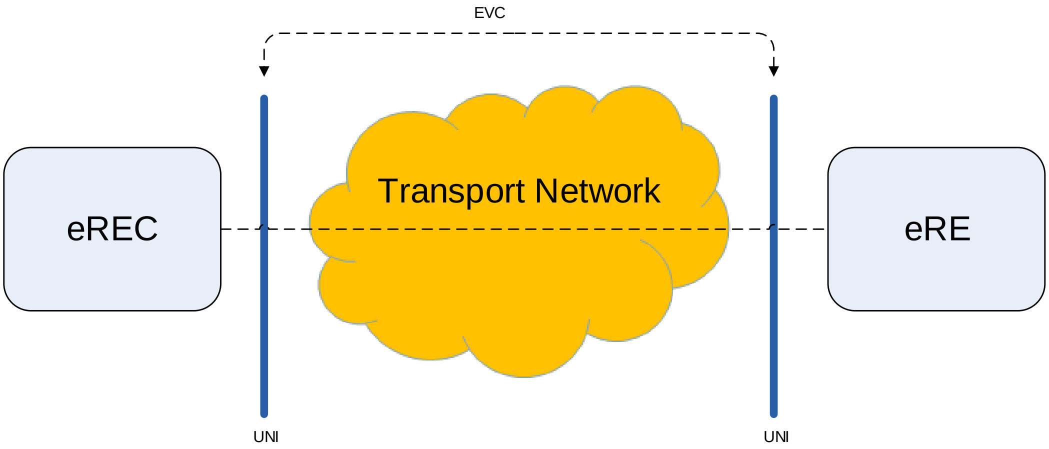

Figure 3 Example of EVC and its relation to the UNI

Note that the same packet format is used at each UNI belonging to a particular service provided by a transport network. For instance, Ethernet Service Frame on each UNI in the case of an Ethernet service. Alternatively, it can be e.g., IP packet at each UNI.

UNI Service Attributes are described in section 9 in MEF 10.3 [2].

2.3. EVC Service Attributes

A transport service is specified using service attributes. Each of these attributes defines specific information about the service that is agreed between a subscriber and a provider of the transport service. It is outside the scope of this document how an agreement is being established between a subscriber and a provider. See chapter 5 for examples of how an agreement can be established.

EVC Service Attributes are described in section 8 in MEF 10.3 [2] and EVC per UNI Service Attributes are described in section 10 in MEF 10.3 [2].

Two EVC Performance Service Attributes are of special interest of the current release of this document.

2.3.1. One-way Frame Delay Performance

The One-way Frame Delay for an egress Service Frame in the EVC is defined as the time elapsed from the transmission at the ingress UNI of the first bit of the corresponding Service Frame until the reception of the last bit of the Service Frame at the given UNI (section 8.8.1 in MEF 10.3 [2]).

Note that this definition of Frame Delay for a Service Frame is the one-way delay that includes the delays encountered as a result of transmission of the Service Frame across the ingress and egress UNIs as well as those introduced by the transport network.

The One-way Frame Delay Performance is described in section 8.8.1 of MEF 10.3 [2].

- Only the maximum value of the One-way Frame Delay Performance is of special interest of the current release of this document.

2.3.2. One-way Frame Loss Ratio Performance

The One-way Frame Loss Ratio Performance is described in section 8.8.3 of MEF 10.3 [2].

2.4. EVC per UNI Service Attributes

The Class of Service Identifier for Data Service Frames is an EVC per UNI Service Attribute that is of special interest of the current release of this document.

2.4.1. Class of Service Identifier for Data Service Frames

Each service Frame mapped to a given EVC has a single Class of Service Identifier. The Class of Service Identifier can be determined from inspection of the content of the ingress Service Frame (see section 10.2 of MEF 10.3 [2]).

2.4.1.1. Class of Service Identifier based on the EVC

When Class of Service Identifier is based on EVC, all ingress Data Service Frames mapped to the EVC must map to the same Class of Service at the given UNI (see section 10.2.1.1 of MEF 10.3 [2]).

2.4.1.2. Class of Service Identifier based on the Priority Code Point Field

Throughout this chapter, CE-VLAN CoS refers to the Priority Code Point Field in the Customer VLAN Tag in a Tagged Service Frame. When the Class of Service Identifier is based on the Priority Code Point Field, the CE-VLAN CoS must determine the Class of Service and each possible CE-VLAN CoS value must map to exactly one Class of Service (see section 10.2.1.2 of MEF 10.3 [2]).

2.4.1.3. Class of Service Identifier based on Internet Protocol

When the Class of Service Identifier is based on Internet Protocol, the Class of Service Identifier is determined from the DSCP for a Data Service Frame carrying an IPv4 or an IPv6 packet (see section 10.2.1.3 of MEF 10.3 [2]).

When the Class of Service Identifier is based on Internet Protocol, each possible DSCP value must map to exactly one Class of Service for ingress Data Service Frames carrying an IPv4 packet.

When the Class of Service Identifier is based on Internet Protocol, each possible DSCP value must map to exactly one Class of Service for ingress Data Service Frames carrying an IPv6 packet.

When the Class of Service Identifier is based on Internet Protocol, all ingress Data Service Frames mapped to the given EVC that do not contain either an IPv4 or an IPv6 packet must have the Class of Service that is agreed upon by the Subscriber and the Service Provider.

3. Traffic Characterization

3.1. CBR Traffic

TBD

3.2. ON/OFF Traffic

TBD

3.3. Generic Traffic

TBD

4. Requirements

Please note that in this document **all quantitative figures are preliminary**.

4.1. Per flow requirements

4.1.1. Split E and splits ID, IID, IU when running E-UTRA

Table 1 is applicable for the functional decompositions splits E and I_D, II_D, I_U as defined in [1].

Table 1 Split E and splits I_D, II_D, I_U requirements

CoS Name	Example use	One way maximum packet delay	One-way Packet Loss Ratio
High	User Plane	100 µs	10^{-7}
Medium	User Plane (slow), C&M Plane (fast)	1 ms	10^{-7}
Low	C&M Plane	100 ms	10^{-6}

4.1.2. Placeholder for future flow requirements

TBD.

4.2. Timing accuracy requirements

In the case where the transport network is used for synchronization, it shall provide adequate timing accuracy. Four timing accuracy categories are defined for different use cases depending on which 3GPP features that are to be supported by a specific eCPRI node. The transport network shall provide required timing accuracy |TE| at the edge of the transport network (i.e. at the UNI) relative to a reference clock, which can be located inside or outside the network, depending on the synchronization method. This is illustrated in Figure 4. Depending on the use case the accuracy requirements for |TE| apply relative to a global reference for the whole network (e. g. GNSS) or a local reference for only few co-located eREs (e. g. last common T-BC).

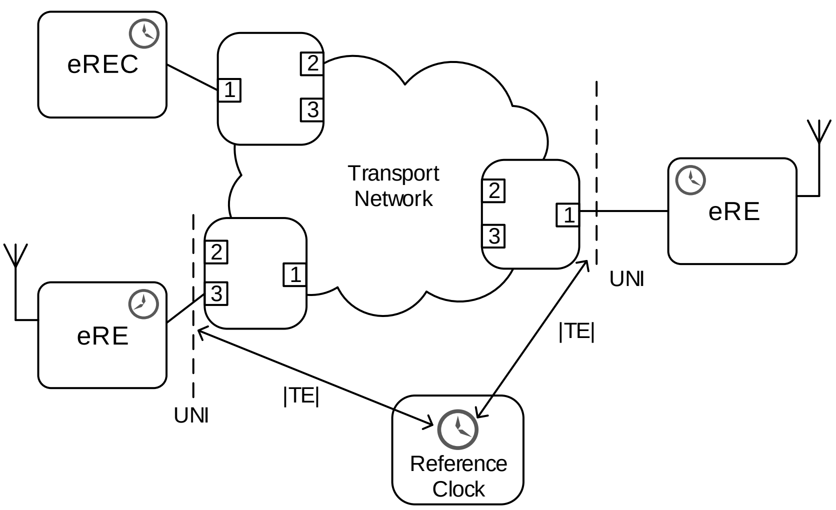

Figure 4 Timing accuracy definitions

Transport network synchronization may be implemented via standard mechanisms e.g. IEEE1588 with or without SyncE, such that the timing accuracy at the UNI is fulfilled. The maximum timing errors at the UNI for different categories are shown in Table 2.

The figures for |TE| in Table 2 are the maximum timing error provided by the transport network relative to an absolute time reference (e.g. GNSS engine). For categories A+, A and B the underlying 3GPP requirements are defined as timing error between transmitter antenna ports (relative).

Table 2 Timing accuracy requirement

Category (note 3)	**Time error requirements at UNI, |TE|**		**Typical applications and time alignment error (TAE) requirements at antenna ports of eREs (for information)**	
	Case 1 (note 1)	**Case 2 (note 2)**	**Typical applications**	**TAE**
A+	TBD ns (relative)	TBD ns (relative)	MIMO or TX diversity transmissions, at each carrier frequency	65 ns (note 4)
A	TBD ns (relative)	TBD ns (relative)	Intra-band contiguous carrier aggregation, with or without MIMO or TX diversity	130 ns (note 4)
B	TBD ns (relative)	TBD ns (relative)	Intra-band non-contiguous carrier aggregation, with or without MIMO or TX diversity, and Inter-band carrier aggregation, with or without MIMO or TX diversity	260 ns (note 4)
C (note 5)	1100 ns (absolute) (note 6)	1100 ns (absolute) (note 6)	3GPP LTE TDD	3 us (note 7)

Note 1) Interface conditions for Case 1

- T-TSC is integrated in eRE, i.e. PTP termination is in eREs
- Refer to “deployment case 1” in Figure 7-1 of [10]

Note 2) Interface conditions for Case 2

- T-TSC is not integrated in eREs, i.e. PTP termination is in T-TSC/T-BC at the edge of transport network
- The phase/time reference is delivered from the T-TSC/T-BC to the co-located eREs via a phase/time synchronization distribution interface (e.g. 1PPS and ToD)
- Refer to “deployment case 2” in Figure 7-1 of [10]

Note 3) In most cases, the absolute time error requirements (Category C) is necessary in addition to the relative time error requirements (Category A+, A and B)

Note 4) TAE, section 6.5.3.1 [7], |TE| at the antenna ports shall be less than TAE/2

Note 5) The same requirements as “class 4” listed in Table 1 of [9]

Note 6) The same value as the network limits at the reference point C described in chapter 7.3 of [10]

Note 7) Cell phase synchronization requirement for wide area BS (TDD), Table 7.4.2-1, section 7.4.2 of [8], |TE| at the antenna ports shall be less than TAE/2

4.3. In-order delivery

During normal operation, the transport network shall provide guarantee of in-order delivery of the UNI service frames within the same EVC, with the same requested priority (or Class of service identifier) and for the same combination of VLAN classification, destination address, source address, and flow hash, if present (see clause 6.5.3, 8.6.6 in [6]). Only a negligible rate of reordering is permitted under exceptional circumstances, such as network reconfiguration (see Annex P in [6]).

5. Annex A: Service Agreement considerations

This is a non- exhaustive list of how an agreement between a subscriber and a provider on the attributes of a network service can be established:

- The provider mandates a value for each attribute
- The subscriber selects from a set of options specified by the provider
- The subscriber requests a value for each attribute, and the provider indicates whether they can provide the service based on these attributes
- The user and the provider negotiate to reach a mutually acceptable value for all parameters

An agreement can be established manually (e.g. on a piece of paper) or automatically, i.e. through API provided by the network provider.

6. List of Abbreviations

1PPS	Pulse Per Second
3GPP	3rd Generation Partnership Project
CBR	Constant Bit Rate
CE	Customer Edge
CE-VLAN	Customer Edge Virtual LAN
CoS	Class of Service
CPRI	Common Public Radio Interface
DiffServ	Differentiated services
DSCP	Differentiated services code point
eRE	eCPRI Radio Equipment
eREC	eCPRI Radio Equipment Control
EVC	Ethernet Virtual Connection
GNSS	Global Navigation Satellite System
HW	Hardware
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
L2	Layer 2
L3	Layer 3
LTE	Long Term Evolution
MAC	Media Access Control
MEF	Metro Ethernet Forum
MIMO	Multiple Input Multiple Output
N/A	Not Applicable
PCP	Priority code point
PDU	Protocol Data Unit
PHY	Physical Layer
QoS	Quality of Service
SLA	Service Level Agreement
SLS	Service Level Specification
SW	Software
SyncE	Synchronous Ethernet
T-BC	Telecom Boundary Clock
TDD	Time Division Duplex
ToD	Time of Day
T-TSC	Telecom Time Slave clock
UNI	User Network Interface
VID	VLAN Identifier
VLAN	Virtual LAN

7. References

[1] eCPRI Specification V1.0, Tech. Rep. Aug. 2017, http://www.cpri.info/
[2] Technical Specification MEF 10.3 Ethernet Services Attributes Phase 3 October 2013
[3] IEEE Std 802.3™-2015 IEEE, New York, USA, 3 December 2015
[4] RFC 791- INTERNET PROTOCOL, September 1981
[5] RFC 2460 - Internet Protocol, Version 6 (IPv6) Specification, December 1998
[6] IEEE Std. 802.1Q™-2014 IEEE, New York, USA, 3 November 2014
[7] 3GPP TS36.104," E-UTRA; Base Station (BS) radio transmission and reception"
[8] 3GPP TS36.133, "E-UTRA; Requirements for support of radio resource management"
[9] ITU-T G.8271, "Time and phase synchronization aspects of packet networks"
[10] ITU-T G.8271.1, "Network limits for time synchronization in packet networks"

8. History

Version	Date	Description
D 0.1	2017-08-30	First Draft