Draft Standard

MEF 22.3.1 Draft (R1)

Transport for 5G Mobile Networks

Release 1

March 2019

This draft represents MEF work in progress and is subject to change.

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Rebuild ToC upon insertion/rollup of this amendment.

List of Figures

Rebuild LoF upon insertion/rollup of this amendment.

1. List of Contributing Members

The following members of MEF participated in the development of this amendment and have requested to be included in this list.

TBD

2. Abstract

This amendment specifies the requirements for Ethernet Services that can be used as transport for 5G mobile networks. The services and requirements in this Implementation Agreement (IA) are based on the services defined in MEF 6.2 [3], MEF 33[27] and MEF 51 [30] as well as the attributes in MEF 10.3 [7], MEF 26.2 [24] and this IA. The aim is to support a wide range of 5G mobile network deployments that use Ethernet Services for transport.

This amendment makes the following changes to MEF 22.3: incorporation of Fronthaul and describe Network Slicing applicability.

Note that the changes in this document are given as "editing instructions." To be clear, when inserting a new section (such as section 9) it is expected that the document editing software will aoutmatically renumber subsequent sections at the same level. Where this is expected to happen, in order to reduce ambiguity, subsequent changes refer to sections as they would be renumbered.

3. Terminology

Add to, or modify the corresponding entries to the Terminology Table as shown below:

Term	Definition	Reference
5GC	5G Core	3GPP TS 38.300 [94]
BBU	Base-Band Unit	3GPP TS 38.300 [94]
CPRI	Common Public Radio Interface	CPRI [112]
CU	Centralized Unit	3GPP TS 38.300 [94]
DU	Distributed Unit	3GPP TS 38.300 [94]
eCPRI	Enhanced/evolved CPRI	eCPRI [113]
eNB, eNodeB	Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Node B is the RAN Base Station in LTE. Also referred to as eNodeB or eNB. In this IA an eNodeB is one of the options for a RAN BS	3GPP TS 36.300 [88]
EPC	Evolved Packet Core	3GPP TS 38.300 [94]
F1	A 3GPP interface defined in 3GPP TS 38.401	3GPP TS 38.401 [95]
Fronthaul	A connection from the RAN BS site to a remote radio unit. Typically the connection is for transport of CPRI (or eCPRI)	This IA
gNB, gNodeB	Next Generation distributable NodeB	3GPP TS 38.300 [94]
HLS	High-Level Split	3GPP TS 38.300 [94]
LLS	Low-Level Split	3GPP TS 38.300 [94]
MFS	Mobile Fronthaul Service; also Fronthaul	This IA
NFV	Network Function Virtualisation	MEF 55
Network Function Virtualization	American English spelling of Network Function Virtualisation – or NFV – as defined by ETSI and included in MEF 55.	
NR	New Radio – the air interface defined for 5G by 3GPP	3GPP TS 38.300 [94]
RAN AN	RAN Access Node	3GPP TS 38.300 [94]
RAN BS	RAN Base Station	3GPP TS 38.300 [94]
RAN CU	RAN Centralized Unit	3GPP TS 38.300 [94]
RAN DU	RAN Distributed Unit	3GPP TS 38.300 [94]
RE	CPRI Radio Equipment	CPRI [112]
RRU	Remote Radio Unit	3GPP TS 38.300 [94]
eRE	eCPRI Radio Equipment	eCPRI [113]
REC	CPRI Radio Equipment Control	CPRI [112]
eREC	eCPRI Radio Equipment Control	eCPRI [113]
NB, NodeB	WCDMA RAN Base Station. In this IA a NodeB is one of the options for a RAN BS	3GPP TS 21.905 [70]
RBS	RAN Base Station defined in this IA and referred generally as Base Station in 3GPP TS 21.905	This IA

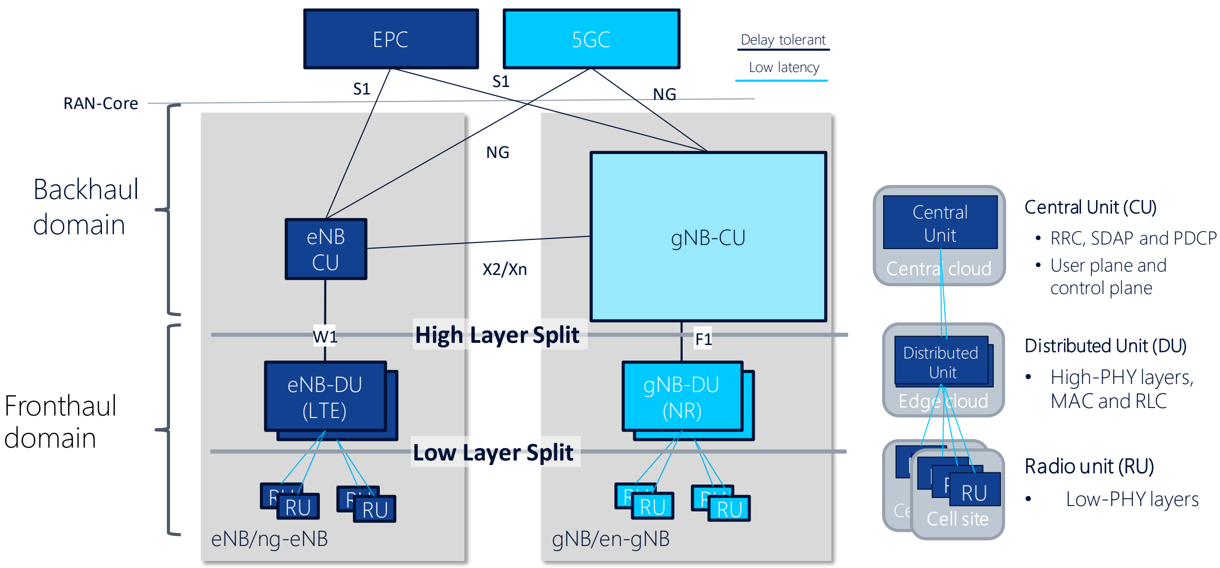
Table 1: Terminology

- In addition: Replace every occurrence of the phrase “Radio Base Station” in MEF 22.3 with “RAN Base Station” – preserving case in each instance.

4. Introduction

Add the following paragraph prior to Figure 1 – "Mobile Backhaul, Midhaul and Fronthaul" and replace Figure 1 with Amendment Figure 1.

5G [94] introduces several changes and new architectural alternatives for the evolution of the current mobile networks. The high level RAN Architecture (Amendment Figure 1) shows interworking options between LTE and 5G. Also the 5G Base Station (gNB) has new functional entities as the Base Band processing block has been devided to Centralized and Distributed Units (CU and DU) These can be placed in separate locations as well as the Radio Unit (RU). From transport point of view this introduces new optional connections commonly called as "Fronthaul", which can utilize Ethernet bridged networks.



Amendment Figure 1 – High-Level RAN Architecture

5. Mobile Network Topologies

Add the following text and figure(s) at the end of the text introducing this section:

5G has been designed [94] to support many new use cases and services beyond the earlier mobile broadband offering. It introduces a new air interface, new frequency bands and many options for physical deployments and network topology evolution. How an individual operator's network evolves depends on many factors like:

- Operator's migration strategy; Radio Access Technologies (RATs),
- Frequency bands (spectrum),
- Competition,
- Amount and cost of available transport resources (fiber, etc.),
- End user service strategy (not every user gets everything),

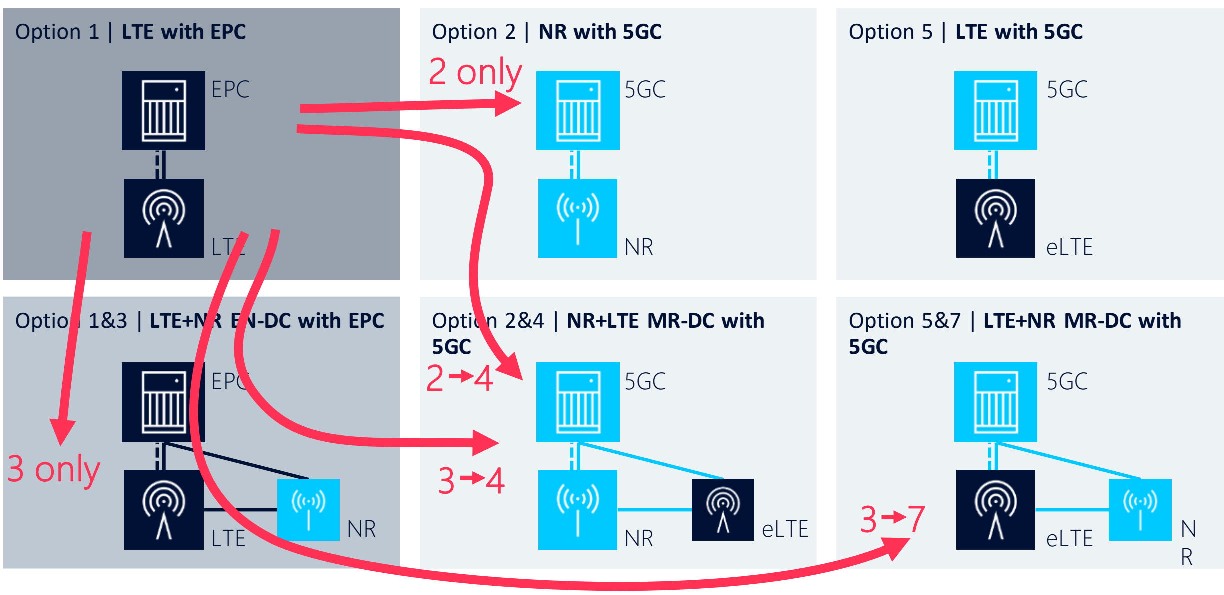
- Regulatory requirements.

Option	Core network	Master node	Secondary node	Generation
1	EPC	eNB (LTE)	-	4G
2	5GC	gNB (NR)	-	5G
3	EPC	eNB (LTE)	en-gNB (NR)	5G
4	5GC	gNB (NR)	ng-eNB (LTE)	5G
5	5GC	ng-eNB (LTE)	-	5G
7	5GC	ng-eNB (LTE)	gNB (NR)	5G

Table 2 – 5G Deployment/Migration Options (3GPP)

Migration options:

- Table 2 summarizes the deployment/migration options standardized by 3GPP for 5G.
- When planning the migration to 5G, an operator needs to consider not only the first step to 5G but also future evolution to support further use cases.



Amendment Figure 2 – Generic 5G Migration Strategies

Amendment Figure 2 summarizes common generic strategies.

Add the following section (5.4) "Network Slicing":

5.4 Network Slicing

Network slicing is a key RAN capability that enables flexibility, as it allows multiple logical networks to be created on top of a common shared physical infrastructure. The 5G transport network may be a shared physical infrastructure that may be used in many possible ways.

For the purposes of this IA, Network Slicing is a RAN construction defined by 3GPP, and possibly extended by NGMN. This IA considers that support for Network Slicing in a CEN service can be accomplished using CEN services already defined, combined with best fit CoS and other service parameters.

In order to support a Network Slice (as defined by RAN context) using a CEN service, it is necessary to provide a mapping from a RAN Network Slice Identifier to a corresponding EVC+CoS – i.e – RAN Network Slice data needs to presented at the CEN UNI using an appropriate C-TAG (VID+PCP) in an Ethernet Frame.

The precise CoS and other service parameter values associated with the CEN EVC+CoS will depend on specific customer applications and deployments and are as yet undetermined.

For information, an example is provided in an appendix.

6. Scope

6.1 In Scope

Amendment Editor's note: The list below is intended to literally replace the existing text listing what was "in scope" for MEF 22.3 – I have tried to underline the actual changes as compared to the list in 22.3

Modify the "In Scope" content to reflect the list below (remove underlining used to distinguish new or modified text):

The following work items are within the scope of this phase of Implementation Agreement:

- Mobile backhaul and midhaul, for macro and small cells, for mobile technologies referenced in standards: GSM, WCDMA, CDMA2000, WiMAX 802.16e, 4G/LTE/LTE-A, and 5G.
- Mobile fronthaul (e.g. CPRI/eCPRI) for mobile technologies referenced in standards: LTE/LTE-A and 5G.
- Support a single CEN with External Interfaces being only UNIs for Mobile Backhaul between RAN BSs and RAN NC or RAN CU.
- Support a single CEN with External Interfaces being only UNIs for Mobile Backhaul between RAN DUs and RAN CUs.
- Support a single CEN with External Interfaces being only UNIs for Mobile Fronthaul between eRE/RE and eREC/REC.
- Include Multiple CENs based on OVC Service Definitions
- Utilize existing MEF technical specifications with required extensions to interface and service attributes.
- Provide requirements for UNI-C and UNI-N beyond those in MEF 13 [12] and MEF 20 [17].
- Provide requirements for ENNI beyond those in MEF 51 [30].
- Define requirements for Mobile Backhaul and Mobile Fronthaul with Ethernet Services specified in MEF 6.2 [3], MEF 33 [27], and MEF 51[30].
- Provide requirements for Link OAM, Service OAM Fault Management.
- Provide requirements for Class of Service and recommend performance objectives consistent with MEF 23.2 [20], where possible.
- Provide requirements in support of network slicing for 5G
- Specify frequency synchronization requirements where possible for packet-based synchronization methods and Synchronous Ethernet.
- Specify time and phase synchronization methods and requirements.
- Define functional requirements applicable to Generic Inter-Working Function interfaces.
- Specify resiliency related performance requirements for Mobile Backhaul and Fronthaul.
- Specify support for all 5G transport requirements (i.e., multiple instances of mobile backhaul and/or fronthaul) over the same network or service (e.g., with traffic separation, QoS, etc.)

7. Compliance Levels

Modify the following paragraph as shown (adding BCP 14 and RFC 8174 references):

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 (IETF RFC 2119 [99] and RFC 8174 0) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

8. Mobile Backhaul Service Model

No changes to this section in this amendment.

Add the following text as Section 9 - "Mobile Fronthaul Service Model" (Apply - but do not include - Amendment editorial notes and renumber subsequent sections and subsections [this should happen automatically]):

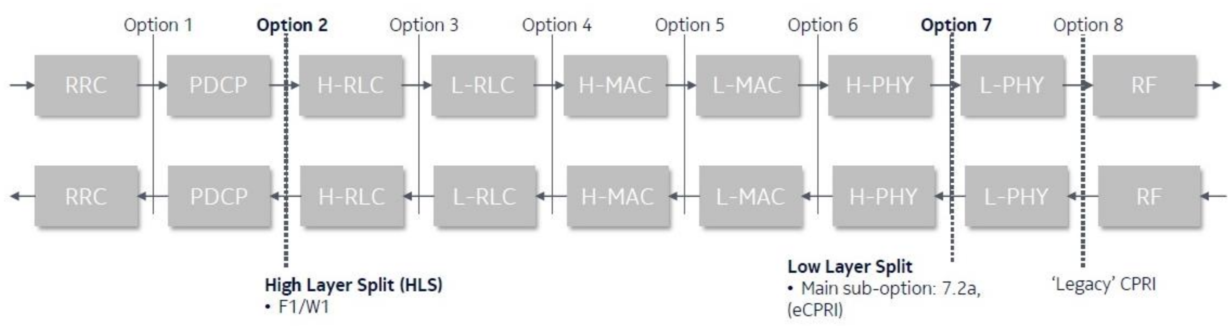
9. Mobile Fronthaul Service Model

This section includes: a description of a Mobile Fronthaul reference model; definitions of reference points and functional elements; and, use cases that reflect possible Mobile Fronthaul deployments.

A Mobile Fronthaul network can take on many forms depending on factors such as transport technology, mobile standard, operator preference, etc. This Section of the Implementation Agreement (IA) focuses on the Mobile Fronthaul network between RAN Base Station sites (baseband units – BBU) and Radio Antenna sites (remote radio unit – RRU). The Mobile Fronthaul Service (MFS) is between demarcations separating the responsibility of a Service Provider (SP) or CEN Operator's domain and the Mobile Operator's domain. This is the CEN supporting MEF 6.2 Services [3] between UNI reference points.

Functional blocks and internal interfaces of RAN Base Station

Until Release 15, 3GPP has treated the cellular Base Station as one functional block without any definitions of its internal architecture or interfaces. During development of Rel 15 a study was concluded to evaluate various options for a functional split and related interfaces to enable physical separation of the gNB functions. Amendment Figure 3 shows the 8 options covered in that study

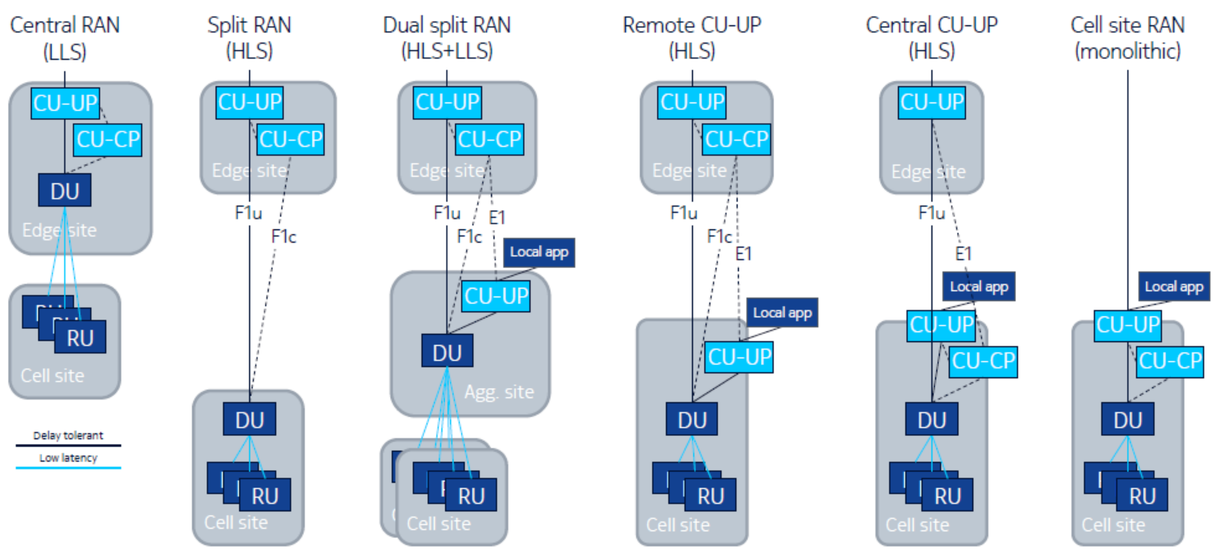


Amendment Figure 3 – 5G RAN Base Station Functional Blocks and Split Options

From these alternatives High Layer split option 2 was selected. The corresponding logical interface is F1 for NR and W1 for LTE. Amendment Figure 3 above shows also the new Low Layer interface eCPRI specified by CPRI cooperation with split option 7, and the legacy CPRI interface (in split 8), which has been in use in Remote Radio Head deployments.

The High and Low Layer interfaces differ mostly in two aspects; bandwidth requirement and latency tolerance. F1 and W1 require much less bandwidth and tolerate higher latency than the low layer options. At the same time, they bring much functionality (RLC, MAC, H-PHY) and related HW into the Radio Unit on the cell site.

The Low Layer interfaces like eCPRI offer possibilities for centralized aggregation and capacity integration together with lower complexity for the radios in the tower top.



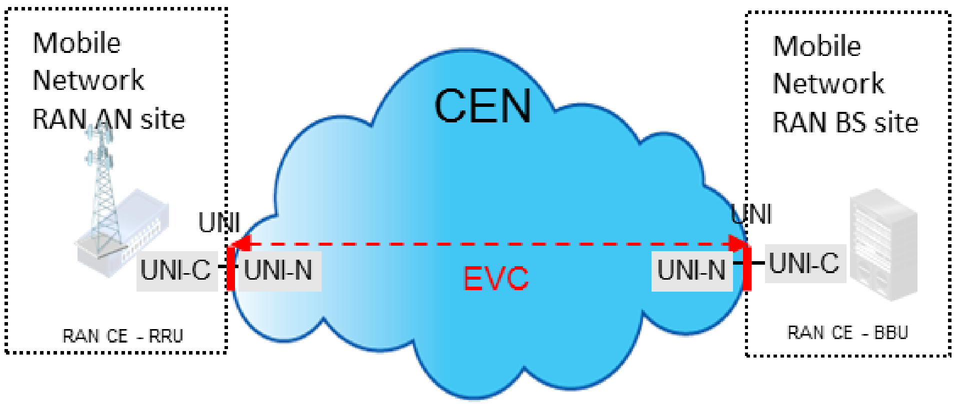
Amendment Figure 4 – Some Options For the gNB Functional Separation

Logical separation of the gNB functional entities and the corresponding fronthaul interface give operators new possibilitiestoplace the functions in separate physical locations according to their priorities. Amendment Figure 4 presents several options on placing the functions between cell site, aggregation site traditionally used for transport aggregation, and edge site, which is the most central site of the RAN. Selection between the options is dependent on several factors like transport network topology, availability of sites, latency and capacity limitations and computing resource availability.

9.1 Service Model Use Case

The functional split options in Amendment Figure imply a potential deployment scenario using MEF services.   Although the corresponding use cases are not necessarily representative of all possible deployment scenarios, they are the foundation of this IA for Mobile Fronthaul. The focus of this IA for Mobile Fronthaul is to recommend capabilities at the UNI and applicable MEF Services in support of Mobile Fronthaul; referencing MEF specifications, and specifying extensions when necessary.

Amendment Figure , shows a example where all traffic uses MEF 6.2 EPL service [3] across the CEN. How the Ethernet services are realized can vary depending on the mobile technology that is deployed, vendor equipment, operator requirements, and the type of services offered by the CEN.



Amendment Figure 5 – Mobile Fronthaul Example – All traffic with MEF 6.2 EPL Service across CEN

9.2 Applying MEF Service Definitions to Mobile Fronthaul

This section specifies the Mobile Fronthaul Ethernet services. This IA specifies requirements using:

- The baseline definition of MEF Services in MEF 6.2 [3],
- Service attributes defined in MEF 10.3 [7], MEF 23.2 [20],
- Additional attributes defined in this IA.

[Amendment R1] The CEN (or SP) **MUST** meet the mandatory requirements of MEF 6.2 that apply to a given Mobile Fronthaul Ethernet service

[Amendment R2] For MEF compliant UNIs, the Mobile Fronthaul Ethernet Service Provider MUST offer a service that complies with the following LAN based Ethernet service definition (in terms of service attributes for UNI and EVC, in addition to those specified in this IA – see MEF 6.2 [3], and Section 12.7.1 and Section 13.6.1):

Ethernet Private Line (EPL) Service

[Amendment O1] For MEF compliant UNIs, the Mobile Fronthaul Ethernet Service Provider MAY offer a service that complies with the following Virtual LAN (VLAN) based Ethernet service definition (in terms of the service attributes for UNI and EVC, in addition to those specified in this IA – see MEF 6.2 [3], and Section 12.7.1 and Section 13.6.1):

Ethernet Virtual Private Line Service (EVPL)

A Mobile Operator is more likely to use VLAN based services (EVPL) given the scalability of supporting many RAN Access Node (AN) sites with each UNI interface at a RAN BS site. Further, such VLAN based services also allow bandwidth profiles to be tailored to the needs of a RAN AN. For example, a smaller subset of RAN ANs might have higher user density with more traffic while most other RAN ANs might not. A Port based service, such as EPL for example, is constrained to applying one Ingress bandwidth profile per Class of Service Identifier at the UNI in the RAN BS site for traffic to all RAN ANs UNIs in the EVC. A Port based service also dedicates a RAN BS UNI resulting in inefficient use of the port. However, port based services could be applicable when a Mobile Operator uses each UNI port at RAN BS to be associated with UNIs at a limited number of RAN ANs so a failure of the UNI at RAN AN or in the CEN does not impact all RAN ANs.

Amendment Editor's note: **Sections 12.7 and 13.6 referred to below should be as correctly renumbered on applying this section addition; refer to section names for verification**.

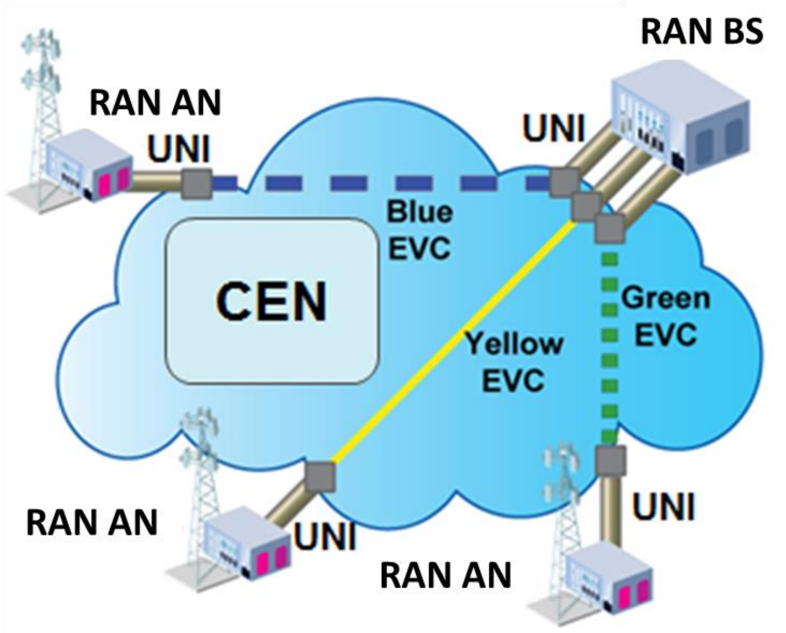
See Section 12.7 for the UNI Service Attributes and Section 13.6 for EVC Service Attributes from MEF 6.2 [3] as well as constraints, if any, as defined in this IA.

In LTE and 5G, E-Line is more likely to be used when MACsec mechanisms are used to transit through untrusted CEN domains with centralized Security Gateways. E-Line can be used to support both CPRI/eCPRI and F1 traffic.

The RAN BS itself can be viewed as an aggregation facility in that it can support service connectivity to large numbers of RAN AN sites. In some deployments, the RAN BS is in a centralized single location that gives mobile providers several options to connect RAN ANs with the RAN BS, including: a port-based implementation with one UNI per RAN AN, or a VLAN-based implementation with EVCs from different RAN ANs service multiplexed at one or more RAN BS UNIs. When several EVCs are multiplexed on a single UNI, there is a risk of a single point of failure, and therefore an appropriate EVC resiliency performance should be considered. Refer to Section 11 for resiliency performance attributes, Section 12.3 for UNI Resiliency, and Section 13.3.1 and 13.3.2 for Resiliency performance.

9.2.1 Ethernet Private Line Service

The Ethernet Private Line (EPL) service (MEF 6.2 [3]) is a port-based service with exactly 2 UNIs in an EVC. It is equivalent to the leased line service used for MFS between the RAN BS and RAN AN. All untagged, priority tagged and tagged Service Frames are mapped to 1 EVC at the UNI. The EPL service might be preferred in cases where there is a desire for a 1:1 port level correspondence between the RAN BS and each RAN AN UNI as shown in Amendment Figure 10 . Port based EPL services with dedicated UNI ports at RAN BS for every AN may not be a scalable model. VLAN based EVPL as described in Section 9.2.2 is preferred.

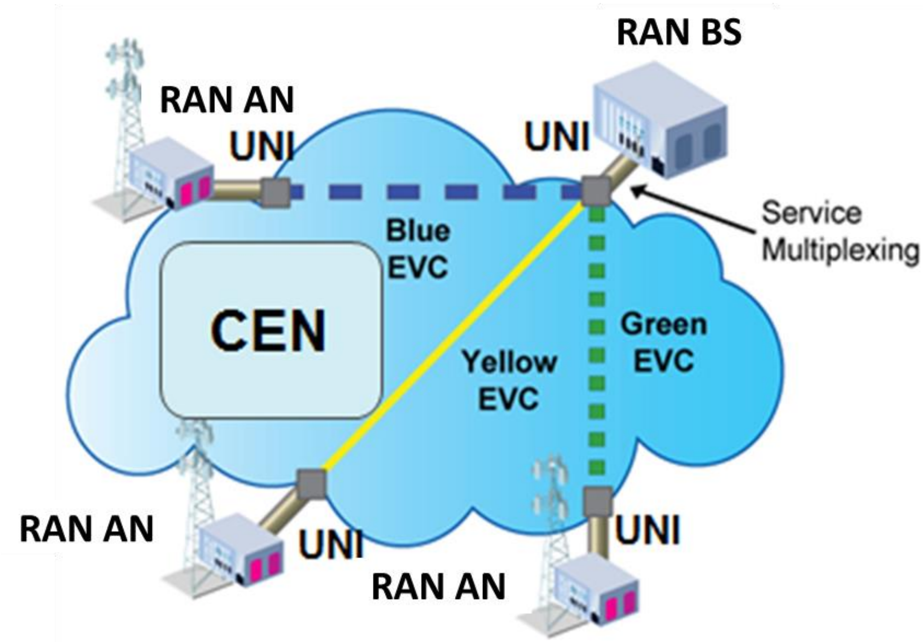


Amendment Figure 10 – Ethernet Private Line (EPL) Services

9.2.2 Ethernet Virtual Private Line Service

The Ethernet Virtual Private Line (EVPL) service (MEF 6.2 [3]) for Mobile Fronthaul is a VLAN based service with exactly 2 UNIs in an EVC and is used to access multiple RAN sites with Service Multiplexing (>1 EVC) at the RAN CU UNI. This allows efficient use of the RAN BS UNI, as illustrated in Amendment Figure 11 . The CE-VLAN ID to EVC map and Bundling service attributes (MEF 10.3 [7]) are used to identify the set of CE-VLANs, including untagged and priority tagged Service Frames, which map to specific EVCs at the UNI. At the RAN BS UNI, for example, if there is an EVC per RAN AN site then there is an upper bound of 4094[1] RAN ANs, assuming 1 CE-VLAN ID per RAN AN site.

[1] As mentioned in MEF 10.3 [7] section 9.9, note that the Customer VLAN Tag values 0 and 4095 in IEEE Std 802.1Q [32] are reserved for special purposes.



Amendment Figure 11 – Ethernet Virtual Private Line (EVPL) Service

Note: for additional requirements that may apply specifically to a MEF Fronthaul Service, see eCPRI Transport Network [114] - in particular to the “Requirements” section (section 4 of the current version). As a Caveat, this specification is a work in progress and may be amended in a future version.

10. Management Model for Mobile Backhaul Service

No changes to this section in this amendment

12. UNI Requirements

12.1 UNI Scalability

Add the following text and Requirements as section 12.1 "UNI Scalability"

[Amedment R3] The CEN operator **MUST** support at least 2 EVCs at a RAN BS UNI for VLAN based MBH Services.

[Amendment D1]The CEN operator **SHOULD** support at least 4 EVCs at a RAN BS UNI for VLAN based MBH Services.

[Amendment O1]The CEN operator **MAY** support minimum number of EVCs per MEF 13 [12] at a RAN BS UNI for VLAN based MBH Services.

[Amendment R4]The CEN operator **MUST** support minimum number of EVCs per MEF 13 [12] at a RAN CU UNI for VLAN based Services.

[Amendment R5] The CEN operator **MUST** support at least 1 EVC at a RAN AN UNI for VLAN-based Services

[Amendment R6] The CEN operator **MUST** support a minimum number of EVCs per MEF 13 [12] at a RAN BS UNI for VLAN-based MFH Services.

Add the following paragraph at the end of section 12.1 "UNI Scalability"

LTE can be enhanced to support 1Gbps over the air, this will drive an increase for backhaul bandwidth on its own. With 5G, 10Gbps over the air may be available.

13. EVC Requirements

No changes in this section for this amendment.

14. Synchronization

Add the following row at the end of Table 16 "Mobile Technology Synchronization Requirements

Technology	Frequency Accuracy (ppb)	Phase Error (µs)	Reference Document
NR	+/-50 (Wide area); +/-100 (Medium Range/Local Area)	3 µs (NR TDD)	3GPP TS 38.104 3GPP TS 38.133

Table 16: Mobile Technology Synchronization Requirements

15. References

Add the following at the end of the 3GPP references starting with reference [92] (renumber current 92 – 108 as 96 – 112)

[92] 3GPP TS 38.104 V15 (2018-03) "Technical Specification Group Radio Access Network; NR; Base Station (BS) radio transmission and reception (Release 15)"

[93] 3GPP TS 38.133 V15 (2018-03) "Technical Specification Group Radio Access Network; NR; Requirements for support of radio resource management (Release 15)"

[94] 3GPP TS 38.300 V15.3.0 (2018-09) "Technical Specification Group Radio Access Network; NR; NR and NG-RAN Overall Description (Release 15)"

[95] 3GPP TS 38.401 V15 (2018-03) "Technical Specification Group Radio Access Network; NG-RAN; Architecture description (Release 15)"

Add the following at the end of the IETF (RFC) references [107] (renumber then subsequent references 108 – 112 as 109 – 113):

[107] RFC 8174, "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words"

Revise the current CPRI reference (renumbered reference [112] – previously [107] – to read as follows:

[112] CPRI, "Common Public Radio Interface (CPRI); Interface Specification V7.0", October 2015

Add the following as additional CPRI references [113] and [114], and renumber remaining reference (renumbered as 113, previously 108) as [115]:

[113] eCPRI V1.2, "Common Public Radio Interface: eCPRI Interface Specification", June 2018

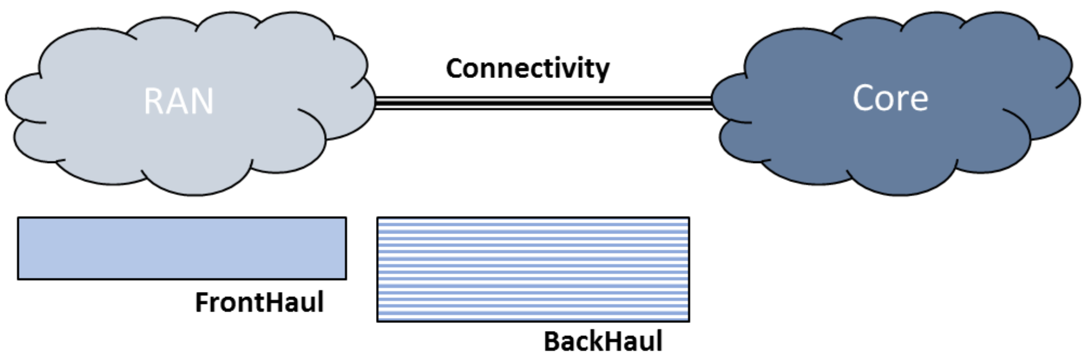
[114] eCPRI Transport Network V1.2, "Common Public Radio Interface: Requirements for the eCPRI Transport Network", June 2018

Update renumbering of references throughout MEF 22.3 as described above. References explicitly made in this amendment should be correct as made.

Add the following text and figure(s) as Appendix F (following last existing appendix).

Appendix F: Example CEN support for transport of RAN Network Slices

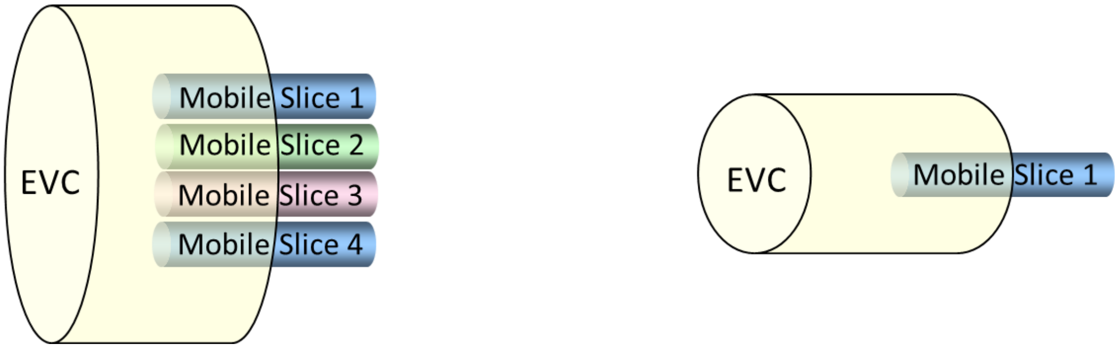
5G RAN slicing may use either shared or dedicated radio resources and so the corresponding "Lower Layer Split (LLS)" and "Higher Layer Split (HLS)" (see Amendment Figure 1) RAN functional split interfaces may be slice specific. On the other hand, the LLS eCPRI interface is likely to be common across multiple RAN slices and, if so, a single "transport slice" may be sufficient. 5G core slicing resources are slice specific Network Function Virtualization (NFV) functions – i.e. – core interfaces are slice specific. As a result, application specific slice/traffic may not be visible on fronthaul and (as a result) would require just a single "transport slice" as illustrated in **Error! Reference source not found.**. For backhaul, the application specific slices are visible as they use separate NFV functions and require "per slice connectivity". This could be offered bundled in one EVC or per EVC. In the core, though this is out of scope, since application specific slices may be visible, and use separate NFV functions, an application could require "per slice transport."



Amendment Figure 5 - Transport network slicing

With 5G, 3GPP [TS 23.501] defines a network slice as a logical network that provides specific network capabilities and network characteristics. In the MEF, this logical network separation is provided with an EVC + CoS combination. This means that there can be a 1:1 or a 1:N relationship between the EVC (transport network slice) and a 5G RAN slice (mobile network slice) as illustrated in **Error! Reference source not found.**. In either case the network slice instance will have some form of identifier (as specified by 3GPP), but only in the 1:1 relationship can that be mapped, along with its characteristics, to a single EVC. In many cases, the fronthaul network operator will not have visibility of the network slice traffic being offered by the 5G mobile operator. This would be the case if slices are aggregated on some basis. If it is not possible for the fronthaul operator to distinguish the network slice to which each offered frame belongs, the relation between the service and the network slices carried by the service, will then effectively be a 1:N relationship. This may be the case for fronthaul if there is no identification in this case.

Where the mapping of Network Slices to EVCs is on an N:1 basis, information used between the mobile operator and fronthaul provider (e.g. – C-VID + PCP) to map network slices to EVCs may need to be preserved by the fronthaul service.



Amendment Figure 6 – 1:N or 1:1 EVC to mobile network slice mapping