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Towards a unified BH/FH data plane

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IEEE 1914.1
NGFI
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An unified transport protocol

- NGFI/Crosshaul's driving paradigms:
  - Packet switching-based transport
  - Flexible BS functional splits between BBUs and RRHs

Split #	Delay req. (ms)	DL BW req. (MB/s)	Others (PDCP/RRC)	RLC	MAC	PHY 2	PHY 1
Split 0 (BH)	30	150	RRH				
Split 1	30*	151	BBU	RRH			
Split 2	6	151	BBU		RRH		
Split 3	2	152	BBU			RRH	
Split 4	0.250	452	BBU				RRH
Split 5 (FH)	0.250	2457.6	BBU				

Table 1: Functional splits analyzed by the Small Cell Forum. LTE. 1 user/TTI, 20 MHz BW, IP MTU 1500B; DL: MCS 28, 2x2 MIMO, 100 RBs, 2 TBs of 75376 bits/subframe, CFI = 1; UP: MCS 23, 1x2 SIMO, 96 RBs, 1 TB of 48936 bits/subframe.

- This blurs BH/FH division: NGFI traffic should be transported across provider networks (Fronthaul+Backhaul=Crosshaul)

* Although Split 1 could run over BH requirements, additional delay due to RRC handing could affect some KPI

An unified transport protocol

The 5G-Crosshaul project aims at developing a 5G integrated backhaul and fronthaul transport network enabling a flexible and software-defined reconfiguration of all networking elements in a multi-tenant and service-oriented unified management environment

- XCF: Encapsulation (PBB-TE/MPLS-TP/…)
- XFE: XCF-enabled forwarding elements

What are its implications in NGFI design?

The 5G-Crosshaul project in a nutshell:

- *EC Contribution: 7.942.521€*
- *Duration: 30 Months (July 2015-Dec 2017)*
- *21 Partners from 6 countries*

XCF requirements

NGFI would presumably create (plain/VLAN-tagged) Ethernet frames

5G-Crosshaul transports NGFI through (circuit/packet-based) provider networks

- XCF provides encapsulation, XFEs are the forwarding gears

XCF (provider encapsulation) requirements have an impact on NGFI

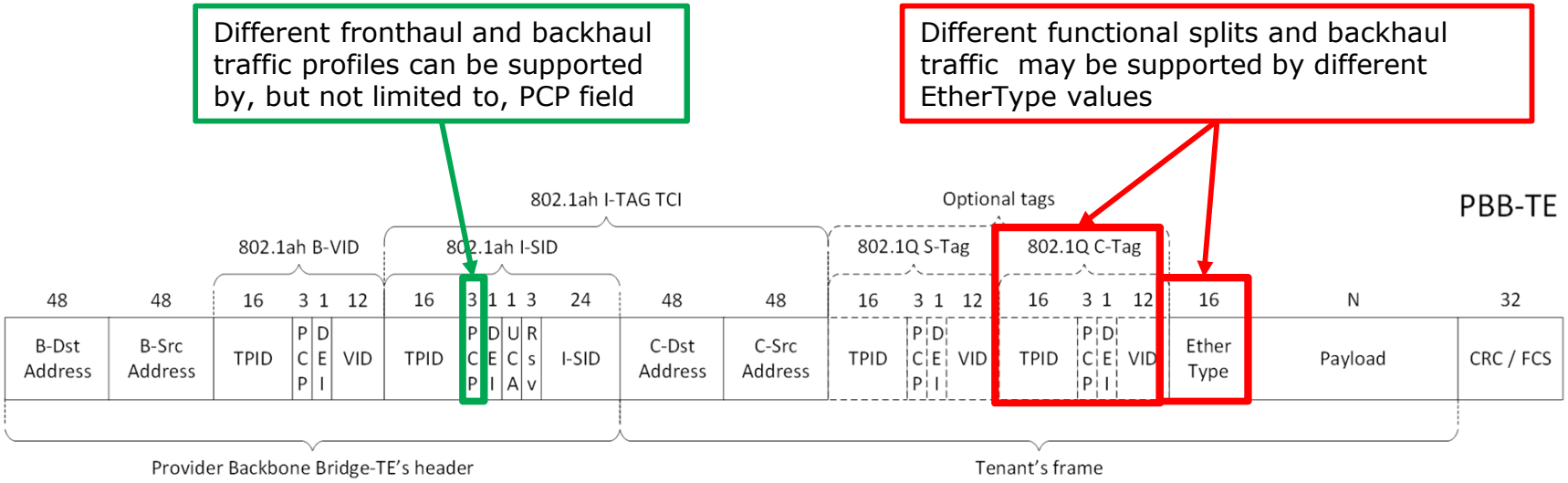
Req. #	Requirement
Functional splits	
R1	Support multiple functional splits
Multi-tenancy	
R2	Isolate traffic
R3	Separate traffic
R4	Differentiation in traffic forwarding
R5	Multiplexing gain
R6	Tenant ID

Req. #	Requirement
Coexistence	
R7	Ethernet-compatible
R8	Security support
R9	Compatible with IEEE 1588v2 or IEE 802.1AS
Transport Efficiency	
R10	Short overhead
R11	Multi-path
R12	Flow differentiation
R13	Class of Service differentiation

Req. #	Requirement
Management	
R14	In-band control traffic (OAM)
Support of multiple media	
R15	802.3
R16	802.11ad
R17	mmWave
Energy Efficiency	
R18	Energy usage proportional to traffic
Miscellaneous	
R20	No vendor lock in

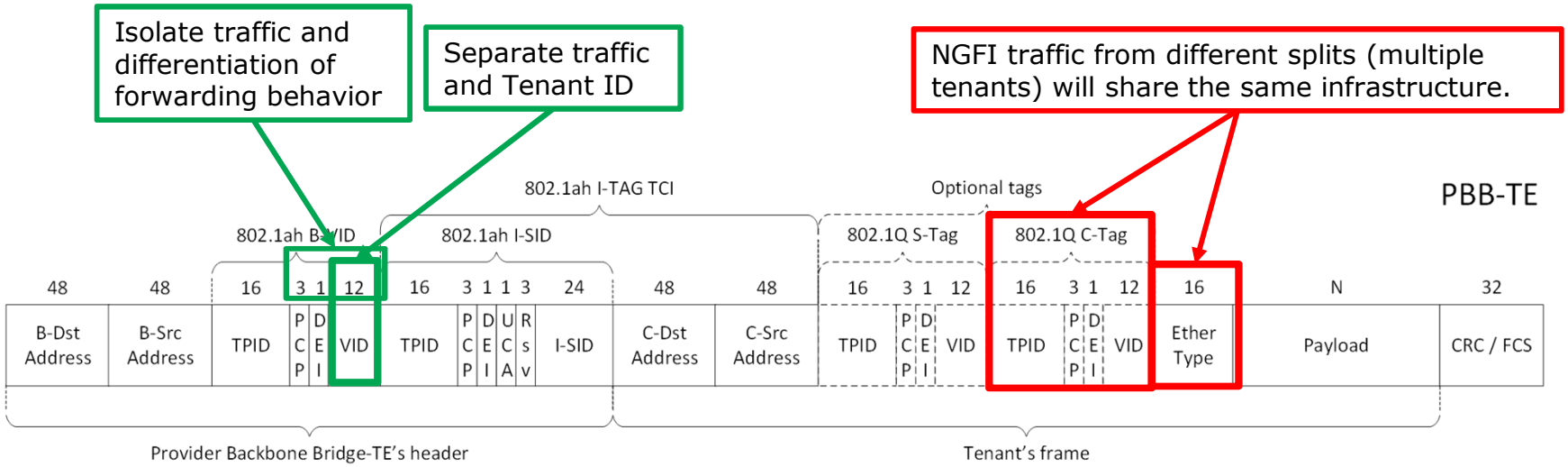
PBB-TE (1)

- **Multiple functional splits**



PBB-TE (2)

- Multiple functional splits
- **Multi-tenancy**

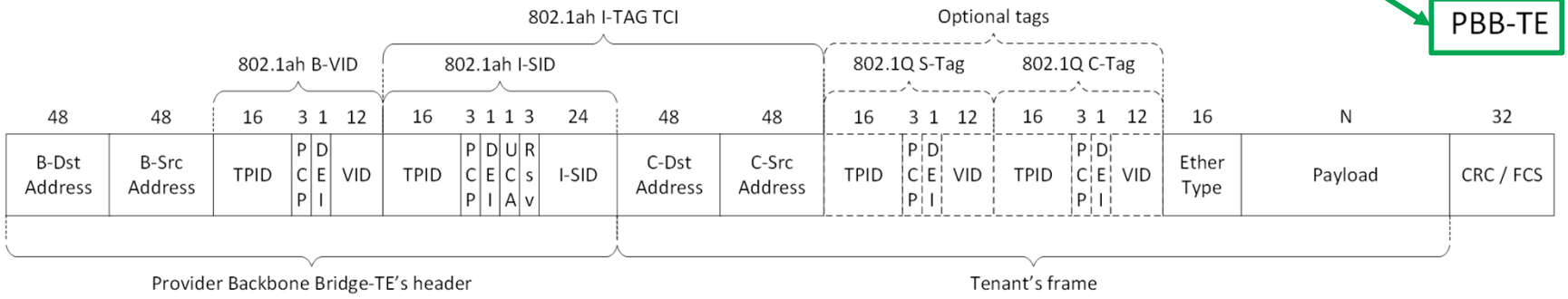


PBB-TE (3)

- Multiple functional splits
- Multi-tenancy
- **Coexistence**

802.1X and 802.1AE mechanisms can be applied to MAC-in-MAC: Authentication, Authorization, Accounting, Integrity, Confidentiality, etc.

PBB-TE



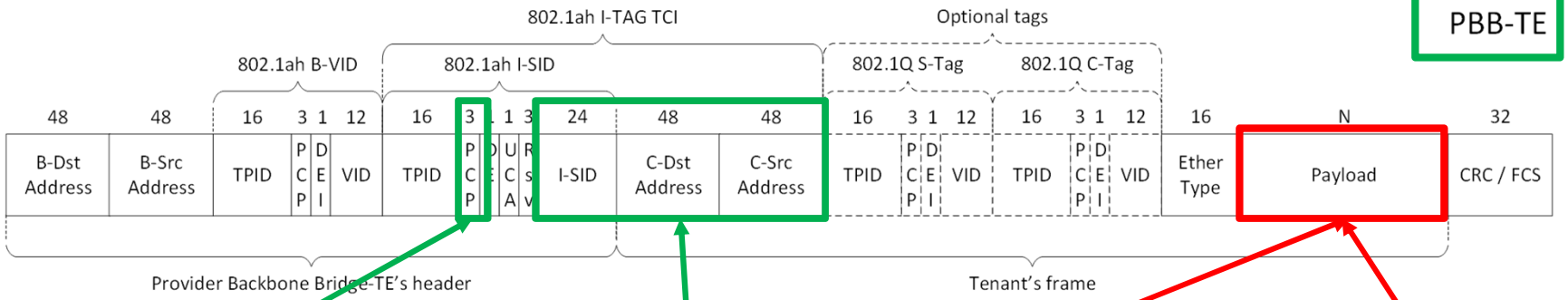
Payload encryption (802.1AE) may be unfeasible for NGFI delay-sensitive traffic

PBB-TE (3)

- Multiple functional splits
- Multi-tenancy
- Coexistence
- **Transport efficiency**

Flow Filtering Tag (F-TAG) might be considered as:
- Flow differentiation support #2,
- Equal Cost Multiple Path (ECMP) support

PBB-TE



Class of Service Differentiation can be supported by, but not limited to, PCP field

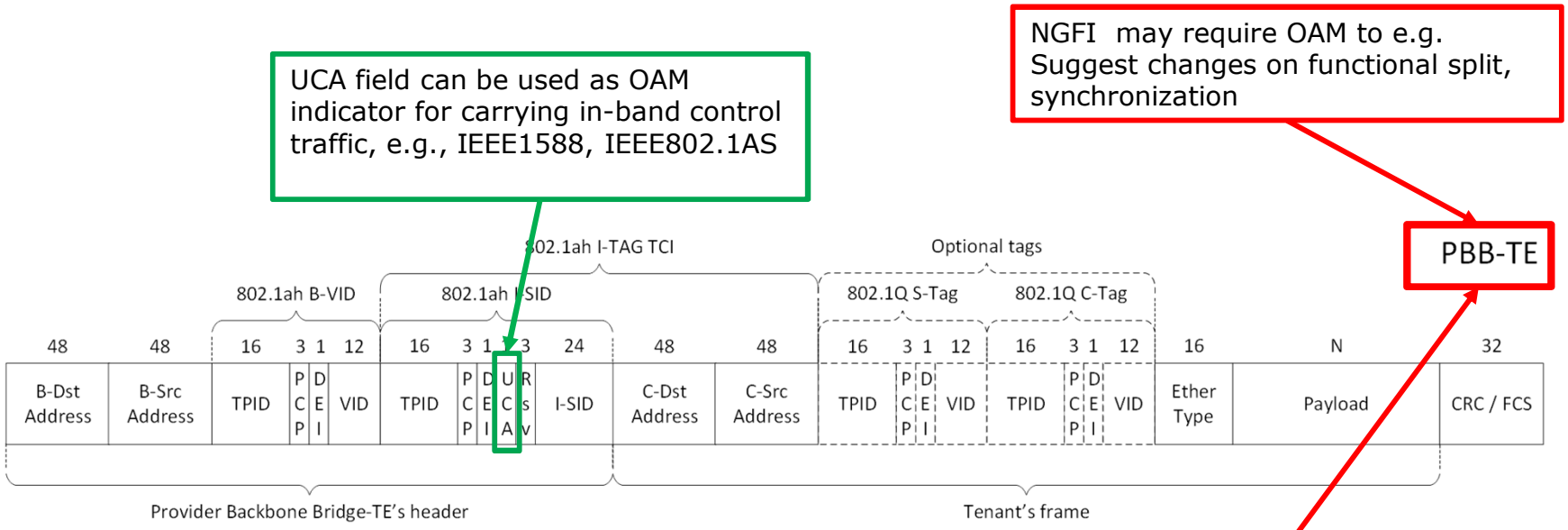
Flow differentiation support #1

Fragmentation may have to be avoided for delay-sensitive NGFI traffic

Relatively short NGFI overhead

PBB-TE (4)

- Multiple functional splits
- Multi-tenancy
- Coexistence
- Transport efficiency
- **Management**

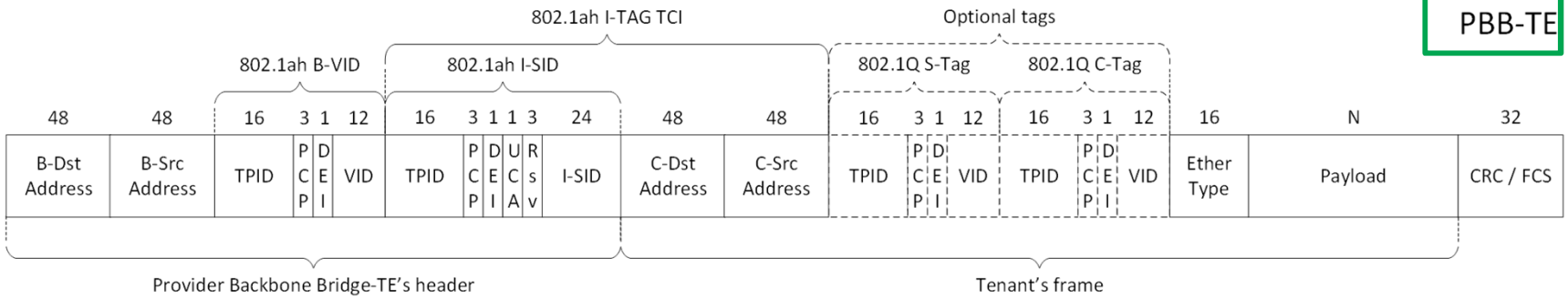


PBB-TE (5)

- Multiple functional splits
- Multi-tenancy
- Coexistence
- Transport efficiency
- Management
- **Energy efficiency**

- Energy-Efficient Ethernet (EEE) defined for 802.3 networks
- Power Save mode defined for 802.11 networks

PBB-TE



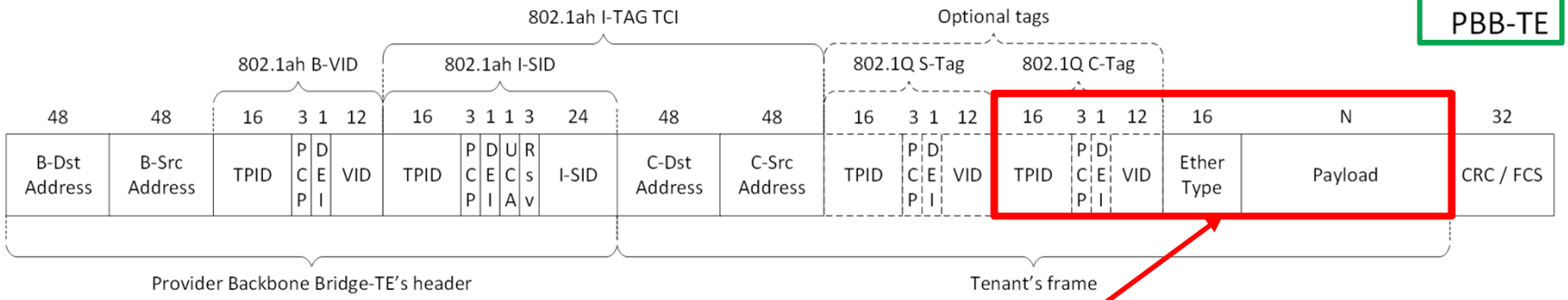
EEE or PS may have to be avoided to transport NGFI delay-sensitive traffic

PBB-TE (6)

- Multiple functional splits
- Multi-tenancy
- Coexistence
- Transport efficiency
- Management
- Energy efficiency
- **Multiple media technologies**

IEEE 802.11ak, 802.1Qbz, 802.1AC amendments extend IEEE 802.11 links from 802.1D to 802.1Q conformant networks (MAC-in-MAC is part of 802.1Q)

PBB-TE



Different splits have different requirements. Different media have different capacities, delays, etc.

Traffic flow characteristics of NGFI

Provider encapsulation (PBB/MPLS-TP) may have some requirements on NGFI

Identification

- Assumption: separate Ethertype

Required Bandwidth UL/DL

- Aligned with number of antenna or amount of user traffic (assuming the second)?

Packet types

- Are all packets equal or are there different types (with different priorities) (antenna data, control, …)?
- Only 3 bits for traffic classification (similar for PBB-TE and MPLS-TP)

Packet size

- Not too small: avoid too much overhead (PBB-TE header: 46B)
- Not too big: avoid head-of-line blocking
  500B serialization delay: 4us on 1G, 0.4us on 10G

Delay/jitter/packet loss tolerance?

- Relative priority compared to CPRI over Ethernet (1914.3), equal or lower?
- In case a link has been overbooked, what is the impact of congestion on the NGFI? I.e. how flexible is an NGFI traffic flow?

5G-Crosshaul consortium