Time Sensitive Networking for 5G

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Background

Joint IEEE 802 and ITU-T Study Group 15 workshop “Building Tomorrow’s Networks” concluded further study required for TSN applicability to 5G

Session 3: Mobile fronthaul, 5G mobile transport

Takeaways and Conclusions

1. IEEE 802.1 TSN is applicable to 5G transport, e.g., 802.1CM TSN for Fronthaul
2. ITU-T Q13/15 is enhancing Synchronous Ethernet and the Telecom Profiles of the Precision Time Protocol to address 5G requirements

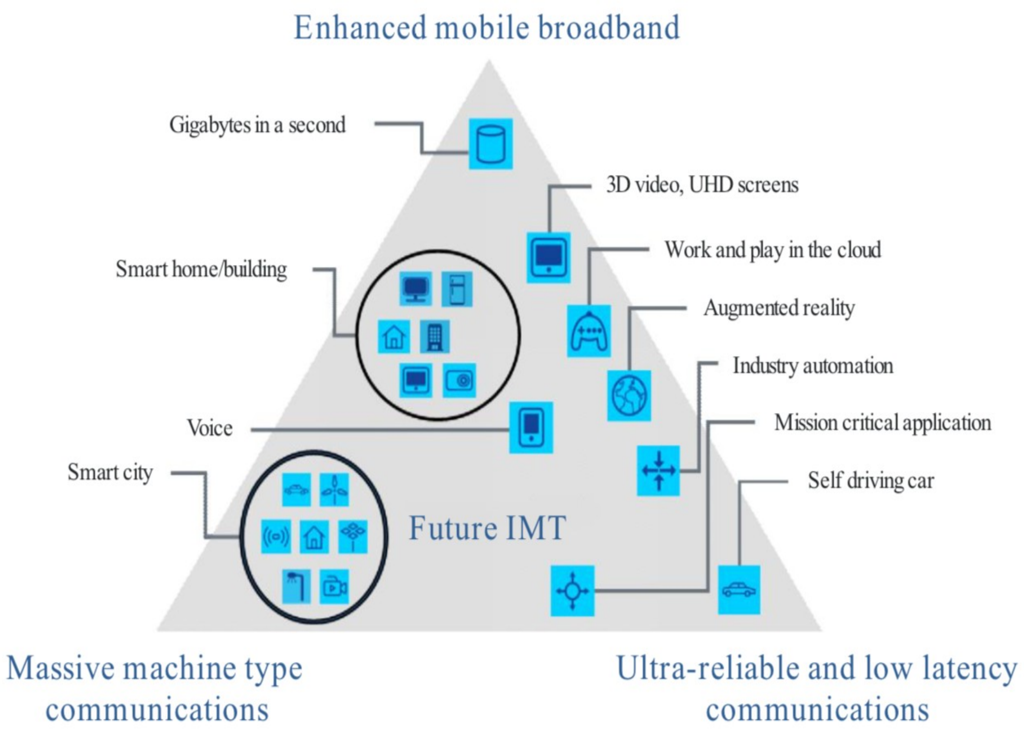
Suggestions

- ITU-T SG 15 should continue to collect 5G/IMT2020 requirements
- ITU-T Q13/15 in cooperation with 3GPP and CPRI should continue to collect synchronization requirements for 5G
- Applicability of SG15 technologies to 5G transport should be considered
- Applicability of TSN to 5G applications beyond fronthaul should be studied

https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20180127/Documents/Outcomes%20-%20Building%20Tomorrow%20Networks-Final.pdf

5G Ultra Low Latency

5G Use Cases Source: ITU-R M.2083-0



Performance requirements for low-latency and high-reliability Use Cases Source: 3GPP TS 22.261

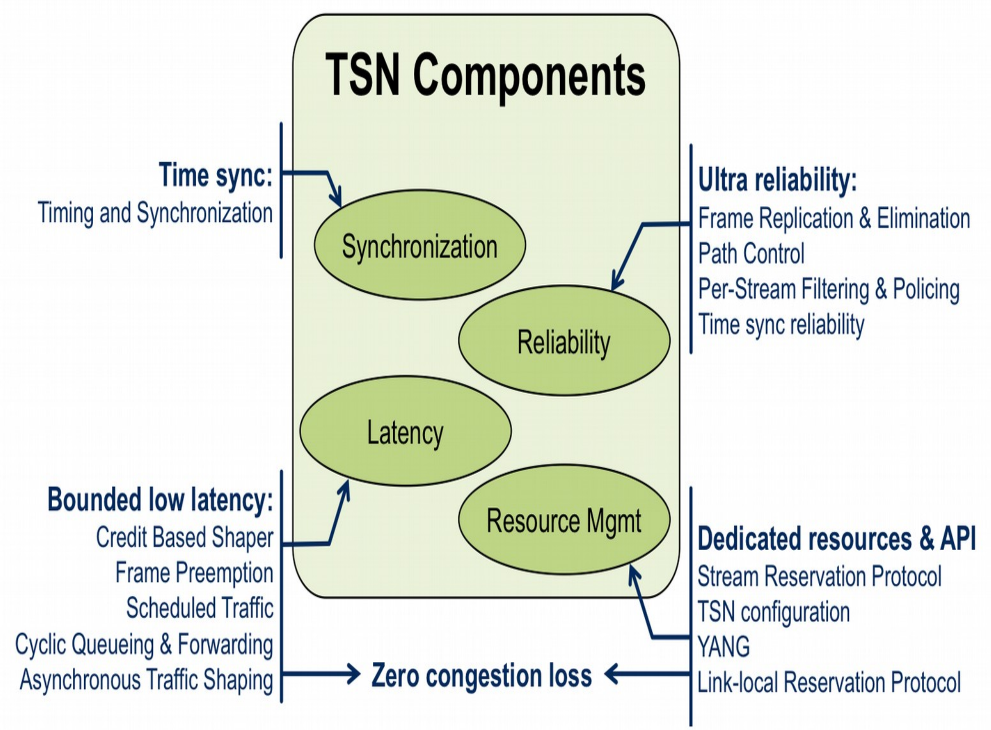
Scenario	End-to-end latency (note 3)	Jitter	Survival time	Communication service availability (note 4)	Reliability (note 4)	User experienced data rate	Payload size (note 5)	Traffic density (note 6)	Connection density (note 7)	Service area dimension (note 8)
Discrete automation – motion control (note 1)	1 ms	1 µs	0 ms	99,9999%	**99,9999%**	**1 Mbps up to 10 Mbps**	Small	1 Tbps/km^2	100 000/km^2	**100 x 100 x 30 m**
Discrete automation	10 ms	100 µs	0 ms	99,99%	**99,99%**	**10 Mbps**	Small to big	1 Tbps/km^2	100 000/km^2	1000 x 1000 x 30 m
Process automation – remote control	50 ms	20 ms	100 ms	99,9999%	**99,9999%**	**1 Mbps up to 100 Mbps**	Small to big	100 Gbps/km^2	1 000/km^2	300 x 300 x 50 m
Process automation – monitoring	50 ms	20 ms	100 ms	99,9%	**99,9%**	**1 Mbps**	Small	10 Gbps/km^2	10 000/km^2	300 x 300 x 50
Electricity distribution – medium voltage	25 ms	25 ms	25 ms	99,9%	**99,9%**	**10 Mbps**	Small to big	10 Gbps/km^2	1 000/km^2	100 km along power line
Electricity distribution – high voltage (note 2)	5 ms	1 ms	10 ms	99,9999%	**99,9999%**	**10 Mbps**	Small	100 Gbps/km^2	1 000/km^2 (note 9)	200 km along power line
Intelligent transport systems – infrastructure backhaul	10 ms	20 ms	100 ms	99,9999%	**99,9999%**	**10 Mbps**	Small to big	10 Gbps/km^2	1 000/km^2	2 km along a road
Tactile interaction (note 1)	0,5 ms	TBC	TBC	[99,999%]	**[99,999%]**	**[Low]**	[Small]	[Low]	[Low]	**TBC**
Remote control	[5 ms]	TBC	TBC	[99,999%]	**[99,999%]**	**[From low to 10 Mbps]**	[Small to big]	[Low]	[Low]	**TBC**

NOTE 1: Traffic prioritization and hosting services close to the end-user may be helpful in reaching the lowest latency values.
NOTE 2: Currently realised via wired communication lines.
NOTE 3: This is the end-to-end latency the service requires. The end-to-end latency is not completely allocated to the 5G system in case other networks are in the communication path.
NOTE 4: Communication service availability relates to the service interfaces, reliability relates to a given node. Reliability should be equal or higher than communication service availability.
NOTE 5: Small: payload typically ≤ 256 bytes
NOTE 6: Based on the assumption that all connected applications within the service volume require the user experienced data rate.
NOTE 7: Under the assumption of 100% 5G penetration.
NOTE 8 Estimates of maximum dimensions; the last figure is the vertical dimension.
NOTE 9: In dense urban areas.
NOTE 10: All the values in this table are targeted values and not strict requirements.

- Latency & Jitter are 2 key metrics for Ultra Low Latency applications
- ULL applications often require deterministic latency, i.e., all frames of a given application traffic flow must not exceed a prescribed boundary

Time Sensitive Networking

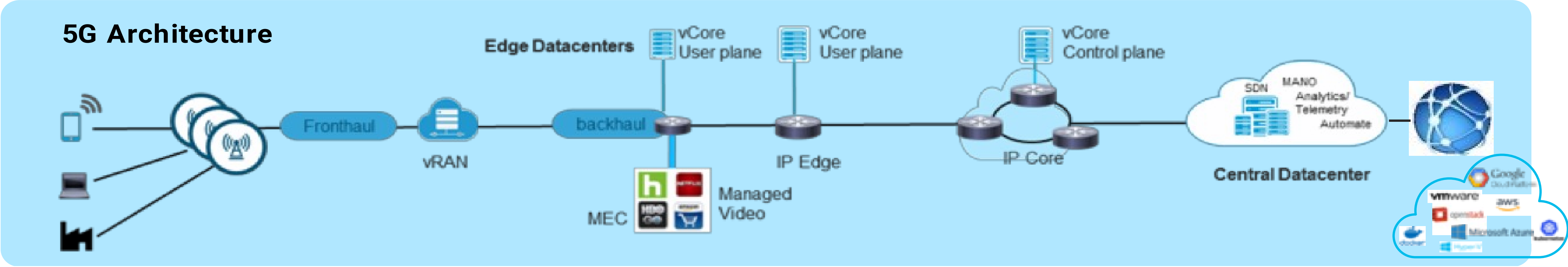
Background
Ethernet has been widely adopted as a common mode of networking connectivity due to very simple connection mechanisms and protocol operations
Ethernet fundamentally lack deterministic latency properties of end-to-end flows



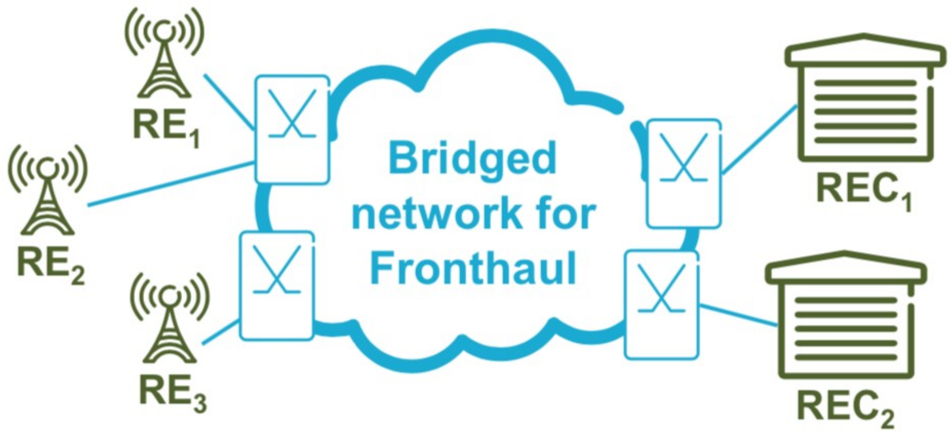
Time Sensitive Networking is an enhancement to IEEE 802 networks enabling the convergence of real-time control with time-critical streaming and and bulk data into a single communication network.
•It provides guaranteed latency, low-jitter and zero congestion loss for all critical control data of various data rates.
•It reduces complexity and costs through convergence of multiple kind of applications into a single network.
•It protects critical traffic to effects of converged, non-critical bulk traffic
It simplifies overall networking through common design, provisioning, and maintenance of a single infrastructure

Maintain 100% of the compatibility, scalability, robustness, speed, and reliability that make Ethernet attractive.

TSN Applicability to 5G



IEEE Std 802.1CM Time-Sensitive Networking for FH



Standard TSN Profiles for fronthaul

Enable the transport of fronthaul streams in a bridged network

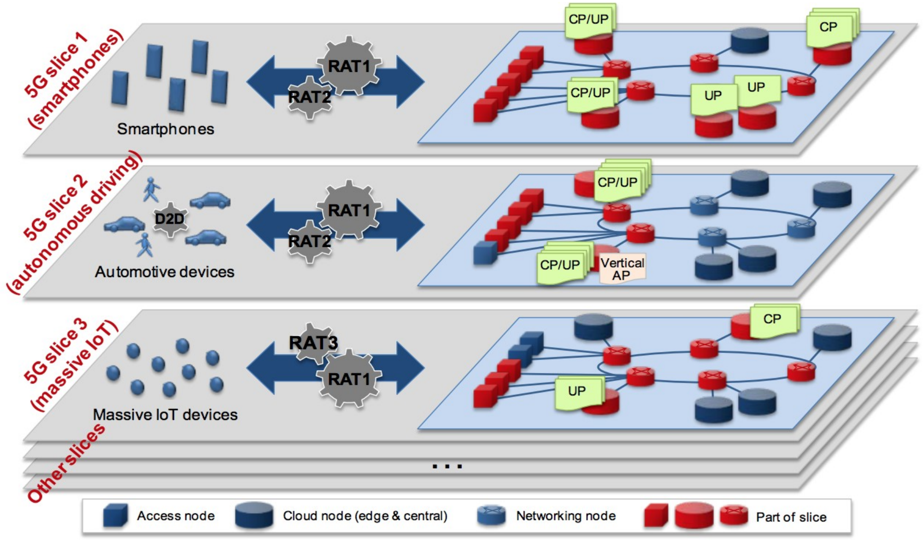
TSN Profile

Specifies aspects of bridge operation

Set of feature and option selections

Configuration guideline

E2E Network Slicing



TSN offers deterministic latency for Network Slices at Layer 2 & DetNet at Layer 3

Topics to Explore

Centralized SDN / Orchestration framework for TSN flow management

TSN interworking with Deterministic Networking to achieve E2E deterministic latency

TSN performance for various fronthaul splits

Mechanism to ensure a bounded worst-case delay for low priority traffic in TSN networks