Time Sensitive Networking for 5G

Kasu Venkat Reddy (kvreaddy@cisco.com), IETF 103 Bankok
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

### 5G Ultra Low Latency

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

![Diagram of 5G Use Cases](Image)

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

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</thead>
<tbody>
<tr>
<td>Discrete automation – motion control</td>
<td>1 ms</td>
<td>1 μs</td>
<td>0 ms</td>
<td>99.999%</td>
<td>99.999%</td>
<td>1 Mbps up to 10 Mbps</td>
<td>Small</td>
<td>1 Tbps/km²</td>
<td>100 000/km²</td>
<td>100 x 100 x 30 m</td>
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<tr>
<td>Discrete automation</td>
<td>10 ms</td>
<td>100 μs</td>
<td>0 ms</td>
<td>99.96%</td>
<td>99.99%</td>
<td>10 Mbps</td>
<td>Small to big</td>
<td>1 Tbps/km²</td>
<td>100 000/km²</td>
<td>1000 x 1000 x 30 m</td>
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<tr>
<td>Process automation – remote control</td>
<td>50 ms</td>
<td>20 ms</td>
<td>100 ms</td>
<td>99.999%</td>
<td>99.99%</td>
<td>1 Mbps up to 10 Mbps</td>
<td>Small</td>
<td>100 Gbps/km²</td>
<td>1 000 Gbps/km²</td>
<td>300 x 300 x 50 m</td>
</tr>
<tr>
<td>Process automation – monitoring</td>
<td>50 ms</td>
<td>20 ms</td>
<td>100 ms</td>
<td>99.9%</td>
<td>99.9%</td>
<td>1 Mbps</td>
<td>Small</td>
<td>10 Gbps/km²</td>
<td>10 000 Gbps/km²</td>
<td>300 x 300 x 50 m</td>
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<tr>
<td>Electricity distribution – medium voltage</td>
<td>25 ms</td>
<td>25 ms</td>
<td>25 ms</td>
<td>99.9%</td>
<td>99.9%</td>
<td>10 Mbps</td>
<td>Small to big</td>
<td>10 Gbps/km²</td>
<td>1 000 Gbps/km²</td>
<td>100 km along power line</td>
</tr>
<tr>
<td>Electricity distribution – high voltage</td>
<td>5 ms</td>
<td>1 ms</td>
<td>10 ms</td>
<td>99.999%</td>
<td>99.99%</td>
<td>10 Mbps</td>
<td>Small</td>
<td>100 Gbps/km²</td>
<td>1 000 Gbps/km²</td>
<td>200 km along power line</td>
</tr>
<tr>
<td>Intelligents transport systems – infrastructure backhaul</td>
<td>10 ms</td>
<td>20 ms</td>
<td>100 ms</td>
<td>99.999%</td>
<td>99.99%</td>
<td>10 Mbps</td>
<td>Small to big</td>
<td>10 Gbps/km²</td>
<td>1 000 Gbps/km²</td>
<td>2 km along a road</td>
</tr>
<tr>
<td>Tactile interaction (note 1)</td>
<td>0.5 ms</td>
<td>TBC</td>
<td>TBC</td>
<td>[99,999%]</td>
<td>[Low]</td>
<td>[Small]</td>
<td>[Low]</td>
<td>[Low]</td>
<td>TBC</td>
<td></td>
</tr>
<tr>
<td>Remote control</td>
<td>[5 ms]</td>
<td>TBC</td>
<td>TBC</td>
<td>[99,999%]</td>
<td>[99,999%]</td>
<td>[From low to 10 Mbps]</td>
<td>Small to big</td>
<td>[Low]</td>
<td>[Low]</td>
<td>TBC</td>
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</table>

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

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