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Time Sensitive Network Applied in 5G Edge Computing

IEEE 802.1

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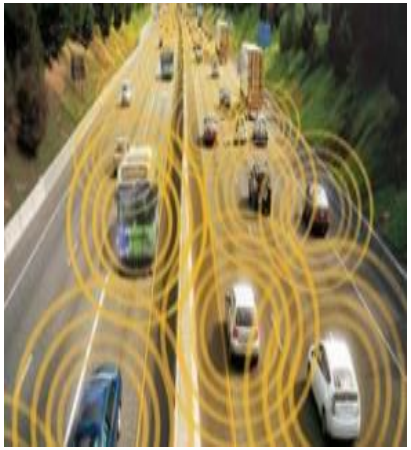
2019.11

www.10086.cn

5G Edge Computing interactive with Time Sensitive Networking

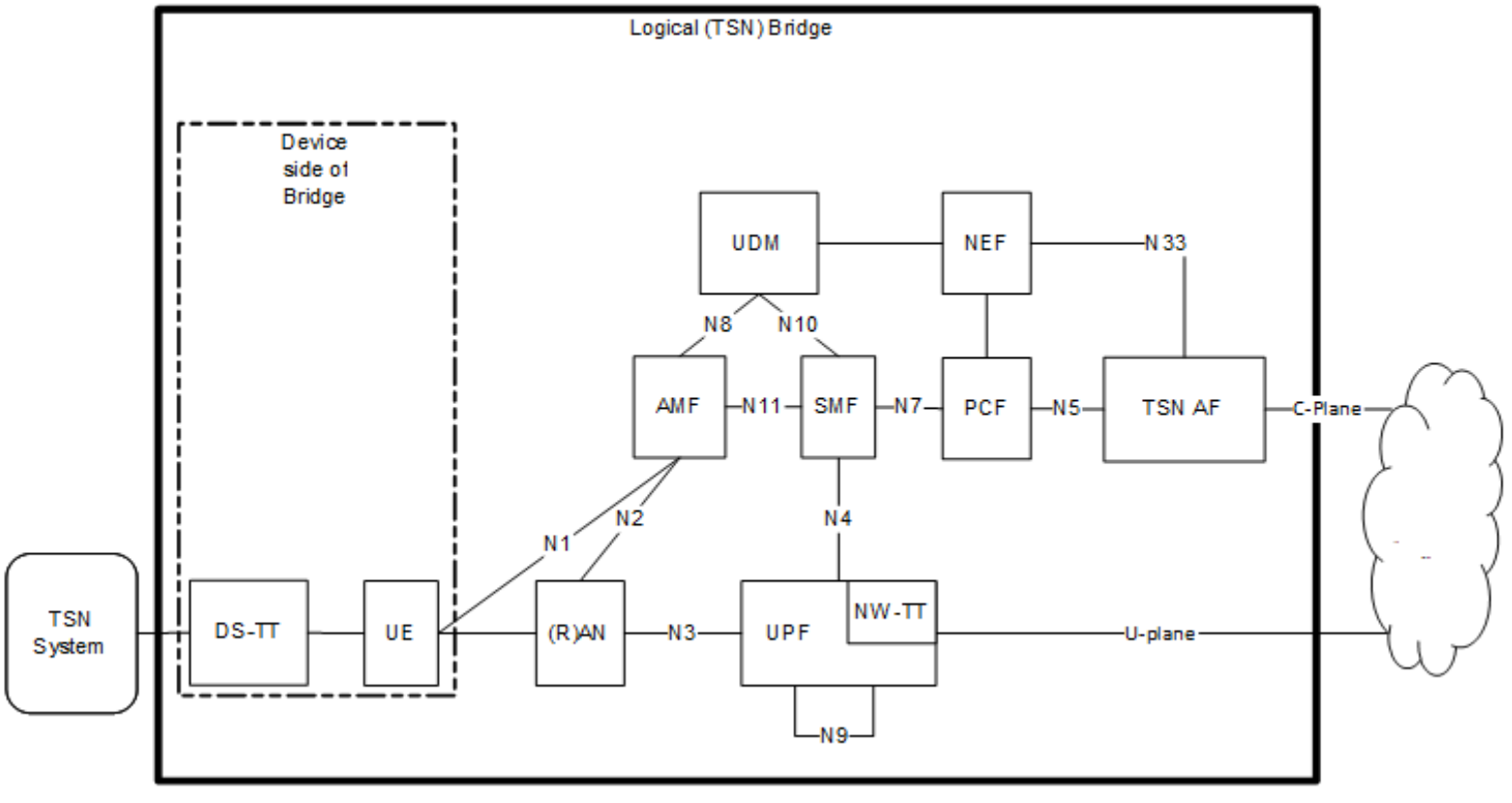
- Connectivity will play an important role in factory automation and Industry 4.0. Secure transport of data in a timely manner is one of the key requirements on industrial communication technology. Time sensitive networking (TSN), an IEEE Ethernet standard, is a promising enabler for satisfying that requirement, as is the 5G mobile technology, standardized by 3GPP.
- Edge Computing places the 5G network and computing resource at the near site to the users, which facilitates URLLC applications.



Interworking the 5G and TSN

- Interworking of 5G and TSN will enable holistic communications for industrial automation



System architecture view with 5GS appearing as TSN bridge

5G makes an important sense in an industrial environment

- 5G technology can reduce costs relating to cabling infrastructure, support mobile applications like autonomous carts or moving AGVs, and increasing flexibility in industrial applications.
- In manufacturing, there is an increasing demand for custom made products, which drives a trend towards more flexible production sites.
- With edging computing architecture, 5G network is on the field of factory.

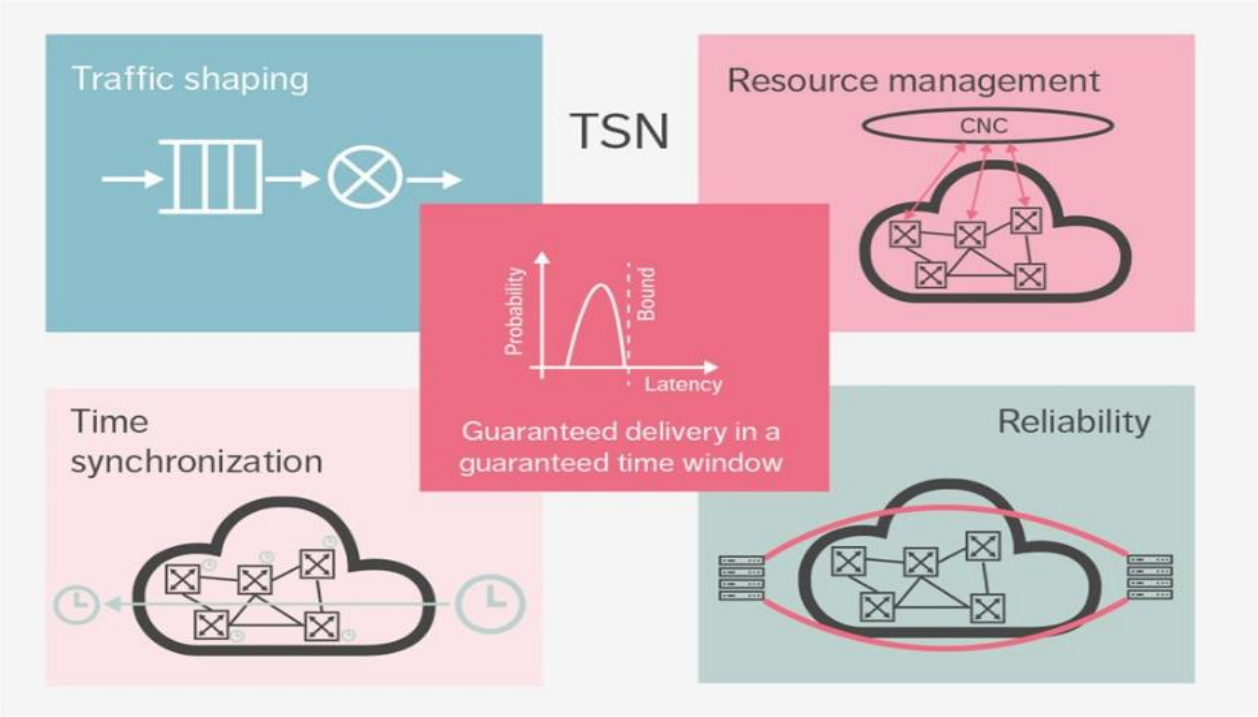
Table 7.1-1 Performance requirements for high data rate and traffic density scenarios.

	Scenario	Experienced data rate (DL)	Experienced data rate (UL)	Area traffic capacity (DL)	Area traffic capacity (UL)	Overall user density	Activity factor	UE speed	Coverage
1	Urban macro	50 Mbps	25 Mbps	100 Gbps/km^2 (note 4)	50 Gbps/km^2 (note 4)	10 000/km^2	20%	Pedestrians and users in vehicles (up to 120 km/h	Full network (note 1)
2	Rural macro	50 Mbps	25 Mbps	1 Gbps/km^2 (note 4)	500 Mbps/km^2 (note 4)	100/km^2	20%	Pedestrians and users in vehicles (up to 120 km/h	Full network (note 1)
3	Indoor hotspot	1 Gbps	500 Mbps	15 Tbps/km^2	2 Tbps/km^2	250 000/km^2	note 2	Pedestrians	Office and residential (note 2) (note 3)
4	Broadband access in a crowd	25 Mbps	50 Mbps	[3,75] Tbps/km^2	[7,5] Tbps/km^2	[500 000]/km^2	30%	Pedestrians	Confined area
5	Dense urban	300 Mbps	50 Mbps	750 Gbps/km^2 (note 4)	125 Gbps/km^2 (note 4)	25 000/km^2	10%	Pedestrians and users in vehicles (up to 60 km/h)	Downtown (note 1)
6	Broadcast-like services	Maximum 200 Mbps (per TV channel)	N/A or modest (e.g., 500 kbps per user)	N/A	N/A	[15] TV channels of [20 Mbps] on one carrier	N/A	Stationary users, pedestrians and users in vehicles (up to 500 km/h)	Full network (note 1)
7	High-speed train	50 Mbps	25 Mbps	15 Gbps/train	7,5 Gbps/train	1 000/train	30%	Users in trains (up to 500 km/h)	Along railways (note 1)
8	High-speed vehicle	50 Mbps	25 Mbps	[100] Gbps/km^2	[50] Gbps/km^2	4 000/km^2	50%	Users in vehicles (up to 250 km/h)	Along roads (note 1)
9	Airplanes connectivity	15 Mbps	7,5 Mbps	1,2 Gbps/plane	600 Mbps/plane	400/plane	20%	Users in airplanes (up to 1 000 km/h)	(note 1)

NOTE 1: For users in vehicles, the UE can be connected to the network directly, or via an on-board moving base station.
NOTE 2: A certain traffic mix is assumed; only some users use services that require the highest data rates [2].
NOTE 3: For interactive audio and video services, for example, virtual meetings, the required two-way end-to-end latency (UL and DL) is 2-4 ms while the corresponding experienced data rate needs to be up to 8K 3D video [300 Mbps] in uplink and downlink.
NOTE 4: These values are derived based on overall user density. Detailed information can be found in [10].
NOTE 5: All the values in this table are targeted values and not strict requirements.

About the world of TSN

- The main goal of a Time Sensitive Network is to provide deterministic services over IEEE 802 (Ethernet) wired networks. This means guaranteed packet transport with bounded latency, low packet delay variation, and low packet loss.
- TSN standards can be applied in many verticals, for example industrial and automotive networks.

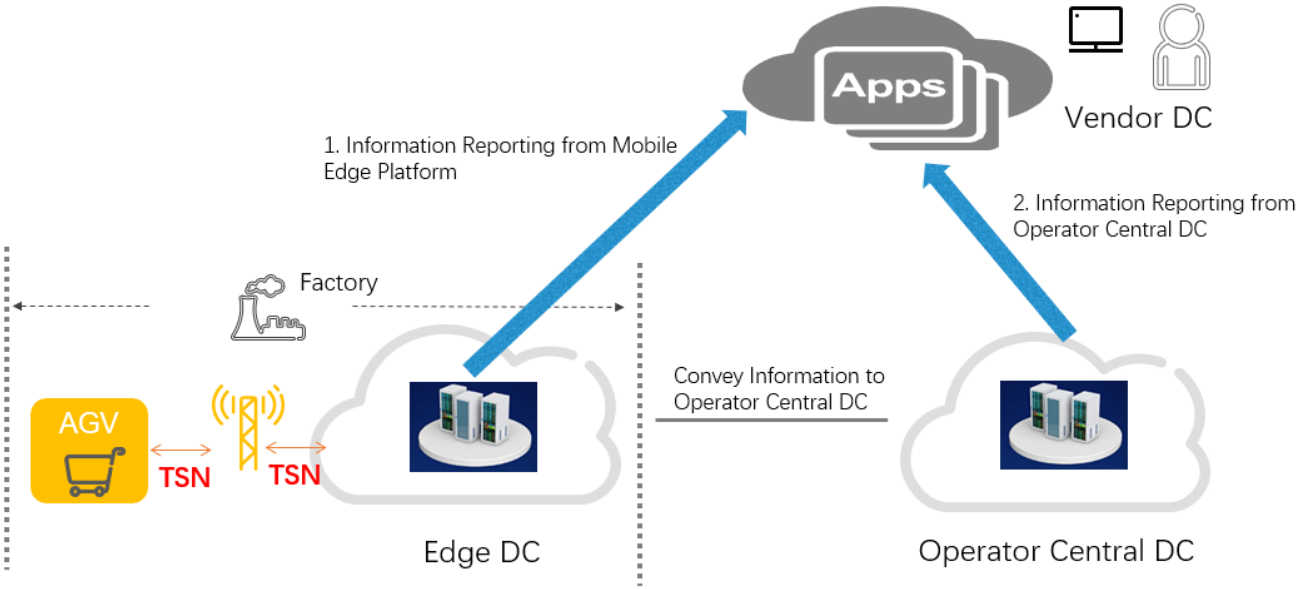


Refer to 5G-TSN integration meets networking requirements for industrial automation, from Ericsson web site

Valuable tools within the TSN toolbox that enable deployments in industrial automation

5G Integration with TSN

- To connect devices (industrial sensor/actuators) wirelessly to a TSN network, 5G is the right solution. The new features of 5G, especially in the Radio Access Network (RAN), provide even better reliability and transmit latencies compared to 4G, and the new 5G system architecture allows flexible deployments. As a result, 5G can enable TSN networks that are not limited by cable installations.
- To support TSN services over 5G systems, further enhancement in radio access network and core network is needed. The main challenges is to enable interworking of the TSN and 5G network. The below figure shows an example: how the 5G network expands a TSN wired network.



TSN+5G applied in Industry Scenario

3GPP enablers for TSN over 5G

- 3GPP features to support provide time reference information to UE.
- 3GPP features to support latency by enhancing physical and medium access layer.
- 3GPP features like enhance scheduling to support cyclic traffic.
- 3GPP features like edge computing to support TSN transport.
- 3GPP features like policy control for TSN traffic.
- 3GPP feature to support TSN service subscribe and TSN data storage.

Summary

- URLLC is one significant requirement in 5G Networks, which can help deploying multiple use scenarios, especially industry cases.
- Prefer to have 5G edge computing network providing multiple solutions with differentiated SLA, especially TSN/DetNet Connections.
- Prefer the policy control enhancement for TSN traffic and user data management for TSN service.

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Thank you!