# TSN Profile for Network Slicing

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Background

- 5G transport network is generally a multi-service network, which will be shared by 5G services and other traffics. Multiple 5G transport standards are under developing, to support network slicing.

- "Network Slicing" is defined as "providing dedicated virtual networks with functionality specific to the service or customer over a common network infrastructure." – 3GPP

- uRLLC/eMBB/mMTC will possibly be on different slices.
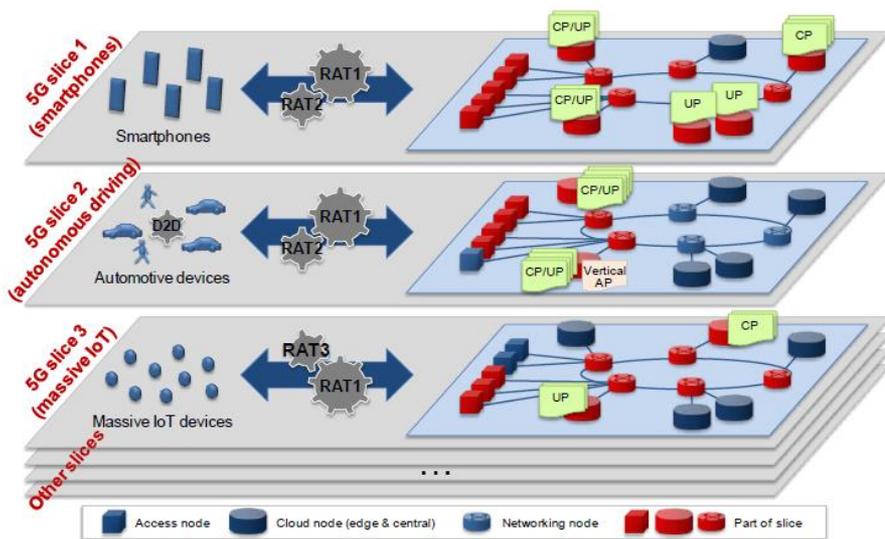
From NGMN 5G white paper

Degree of Interference

- There is desire for bounded latency and no interference in 5G transport network slicing.
  - Customers of an infrastructure are competing for carriers resources.
  - Interference with one customer's bandwidth caused by variations in other customers' loads is undesirable.
  - Classical Best-Effort-based methods of traffic separation and bandwidth allocation among customers are approximate.

- Degree of interference will be the key difference between hard partitioning network and soft partitioning network, and TSN techniques can be used for both schemes.
  - Same as "Soft isolation" and "hard isolation" defined in ITU-T "Transport network support of IMT-2020/5G" to support 5G network slicing.
  - TSN Ethernet is an option to fulfill network slicing requirement from ITU-T/IETF/3GPP.

- There are two well-known technologies for eliminate interference, so that customers' SLA on bounded latency are met:
  - Switching Time-Division Multiplexed (TDM) circuits (e.g. ATM).
  - Time-Sensitive Networking (TSN),including QoS methods.

TSN Profile for Network Slicing

- TDM has advantages and disadvantages
  - Lowest possible latency – words, not packets, are buffered and switched.
  - Bandwidth partitions are hard, and variations in one customers' load have no effect whatsoever on other customers.
- TSN has advantages and disadvantages
  - Smaller fraction of hard-partitioned traffic = lower cost.
  - Best-effort traffic can use partitioned but unused bandwidth.
- Neither is viable without supporting standards.
  - A TSN Network Slicing profile is only one of many standards to define a viable network, but an essential one.

Provide strict SLA and BE in same physical network infrastructure

- By network slicing, it may have different latency and packet loss performance on slices;

- Essentially, this is calling for mixed traffic transportation.

- This profile will provide TSN as a candidate for 5G network slicing, with hard isolation and soft isolation capability.

SLA: Service Level Agreement; BE: Best Effort

Soft Isolation

- Supported by packet encapsulation, such as VPN/VlanID, mainly for user data separation.

- Latency, jitter and packet loss performance differ with data plane mechanisms, affected by scheduling and queueing methods. Traffic interference exists between slices.

- Provide bounded latency with limitations.
    - CBS
    - QoS
    - ATS

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Hard Isolation

- Supported by time-based data plane mechanisms, like Std 802.1Qbv.

- No interference from other slices.

- Provide bounded latency, at heavy network load, at expense of time sync and non-trivial static configurations.
  - 802.1Qbv
  - Other time based scheduling

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Proposal

- Develop a standard profile for network slicing, based on current TSN "tools" that provides bounded E2E latency. TSN profile for network slicing can be applied in wide range of network, e.g. backhaul network.(network slicing is **NOT** for fronthaul network)

- Similar to other TSN profile projects.

- The profile

  - Analyze requirement on network slicing

  - Select features, protocols to build networks capable of slicing,

  - Provide guidance on how to meet requirement.

- The project may identify additional functions that are needed.

- Possible TSN tools for this profile

  - 802.1Q-2018 (including 802.1Qbv and 802.1Qbu)

  - 802.3br

  - 802.1Qbu

  - 802.1Qbv

  - P802.1Qcr

  - Time Synchronization

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Goals

- Develop standard TSN profiles for 5G transport network in order to provides network slicing services.

- This profile will specify

  - Hard partitioning network
  - Soft partitioning network

- Discuss whether any technologies will be selected for identifying the different customers' traffic.

  - uRLLC traffic
  - eMBB traffic
  - mMTC traffic

Thank you

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TSN Solutions for E2E Bounded Latency

- E2E Latency calculation can be estimated for different network slicing approaches.

    - Worst case latency can be estimated based on simple QoS scheduling methods (SP/WRR) with E2E network planning. Note that latency performance degrades with increasing number of flows/users/applications. This is a valid solution within a light loaded network.

    - Worst case latency can be estimated based on packet switch time based scheduling, with E2E network planning.