Consideration on TSN for Service Provider Networks

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Background

- In IEEE 802 Plenary meeting at San Diego, motion to start “TSN profiles for service provider networks” project was passed.

Motion

- 802.1 authorizes the September 2018 Interim to generate PAR and CSD for a standard specifying TSN profiles for service provider networks.

- Proposed: Tongtong Wang
- Second: Johannes Specht

- In the WG (y/n/a): 32, 0, 3

5.2 Scope: This standard defines profiles that select features, options, configurations, defaults, protocols and procedures of bridges, stations and LANs that are necessary to build networks provide Time-Sensitive Network quality of service features for shared service provider networks.

5.4 Purpose: This standard provides guidance for designers and implementers of service provider networks, to be shared by some number of applications, who need the Quality of Service features offered by IEEE Std802.1Q bridges, including dependable bandwidth and latency promise.

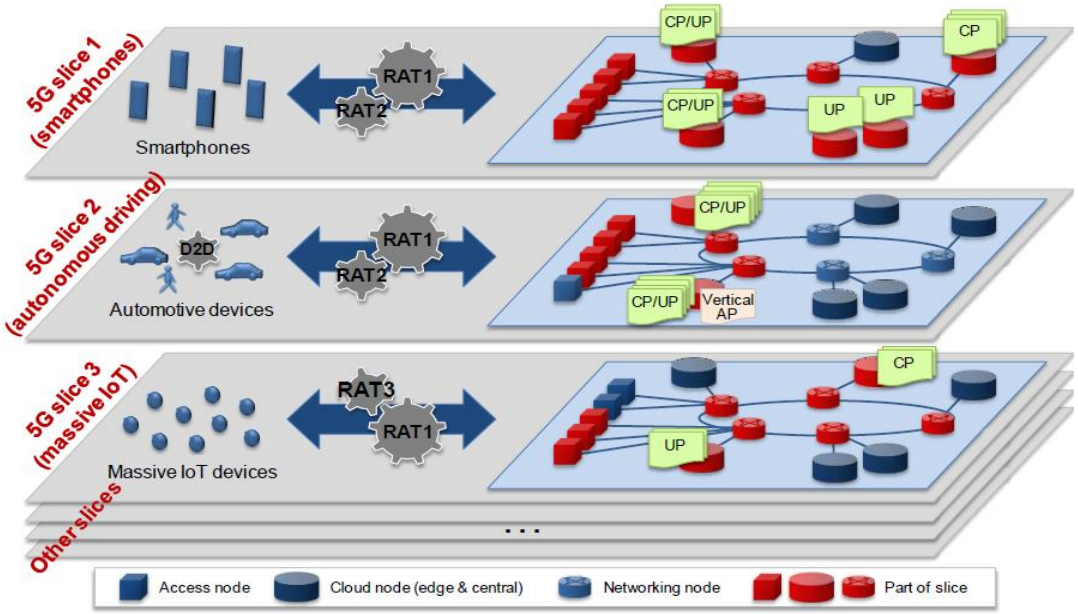
5.5 Need for the Project: 5G transport networks will have an order of magnitude more cells than present networks, making it essential for multiple carriers(applications/users) to share a physical infrastructure. This sharing is sometimes called “network slicing”. QoS partitioning between applications or customers will enable high-value services that have stringent bandwidth and latency requirements, to efficiently share the network with best-effort services.

- This contribution shares some consideration for deploying TSN technologies to enable mixed traffic transporting in service provider networks, especially for next generation transport network.

Refer to: http://www.ieee802.org/1/files/public/minutes/2018-07-closing-plenary-slides.pdf

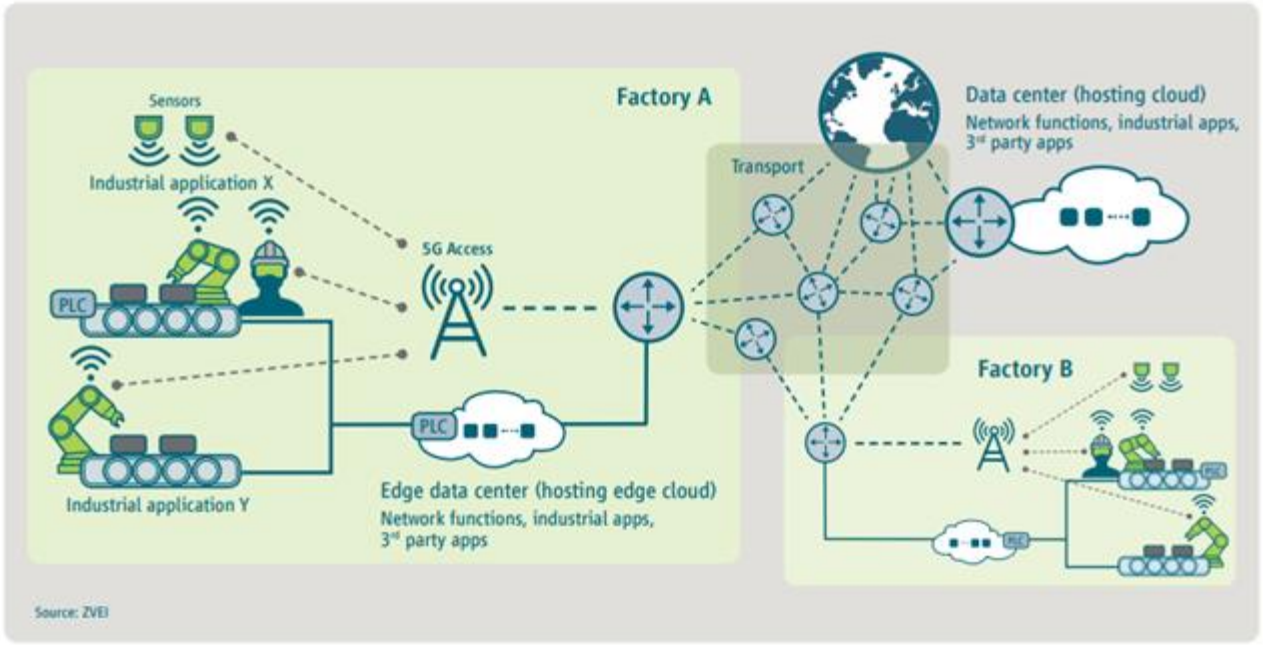
Multiple Users/Applications Over Service Provider Networks

- From customer perspective, numerous applications with different latency/jitter/reliability requirement shall be provided in transport network.
- From carrier perspective, multiple logical network slices, with ensured quality of service, overlap in a physical infrastructure with minimal CAPEX & OPEX.



From NGMN white paper

Transport Network for Connected Industries and Automation



refer to [5G-for-Connected-Industries-and-Automation-White-Paper]

- Transport network provides connectivity between remote Industrial sites and equipment/devices.
- Most of the data is stored at data center, and industrial process can be managed by edge cloud and/or center cloud.
- **Bounded latency service is critical in closed loop control process.**

Other vertical applications can also be supported in TSN based service provider networks.

Challenges on Service Provider Networks

- Diverse latency requirements for different services
  - Service provider networks need to be adaptable, dynamic, and programmable by implementing network slices for each supported use case with tailored performance.
- Reliability
  - Critical application traffic must be successfully transmitted and received with in predefined deadline. Multiple critical traffic with different deadline shall be planed and scheduled in coordination.
  - Packet replication and elimination method prevent data loss during link failure time.

Challenges on Service Provider Networks

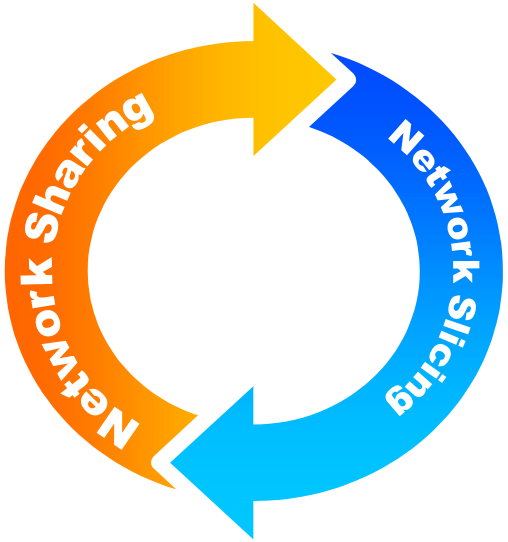
- Security/Isolation
  - Various services in a shared network infrastructure, need to be isolated one from another. Each virtual network belonging to different customers are protected, preventing their resources and data from being accessed by others. This is necessary to ensure a reliable and warranted service assurance, together with data and communication integrity and confidentiality

- Scalability
  - Service or user traffic may change during operation, network shall be able to create, remove or resize a logical slice.

**https://www.huawei.com/minisite/5g/img/5g-network-slicing-for-vertical-industries-en.pdf*

Resource Sharing and Slicing is a Key

- Provide soft and hard traffic isolation between different slices.
- Sharing physical infrastructure for better bandwidth efficiency and lower CAPEX&OPEX



- Partition physical network resources into logical slices for multiple uses.
- Guarantee bounded latency and low packet loss ratio, be measureable.

- To meet SLA for network slicing and multiple services in next generation transport network, both soft isolation and hard isolation capabilities are required*.
- TSN mechanisms enable high-value services that have stringent bandwidth and latency requirements, to efficiently share the network with best-effort services.

**https://www.itu.int/en/ITU-T/Workshops-and-Seminars/20180127/Documents/1.%20Steve%20Gorshe.pdf*

Expectation on Transport Networks

Many discussion happened in ITU-T/3GPP/IETF on network slicing in service provider networks, calling for hard/soft isolation capabilities and bounded latency forwarding.

10 Support of 5G Slicing in the transport network

The transport network is, in general, a multi-service network and we can expect that, in some cases, the common transport network infrastructure will be shared between 5G services and other services. It is necessary to provide isolation between each of these services. Further it is necessary to provide isolation between the different 5G transport network slice instances. From a management perspective the services are placed in virtual networks (VNs) that are established as described in section 8. The forwarding plane must ensure that the traffic from one VN is not (accidentally) delivered to a different VN. It is also necessary for the forwarding plane to provide isolation that limits the interaction between the traffic in different VNs. The transport network provides two types of traffic isolation as described below:

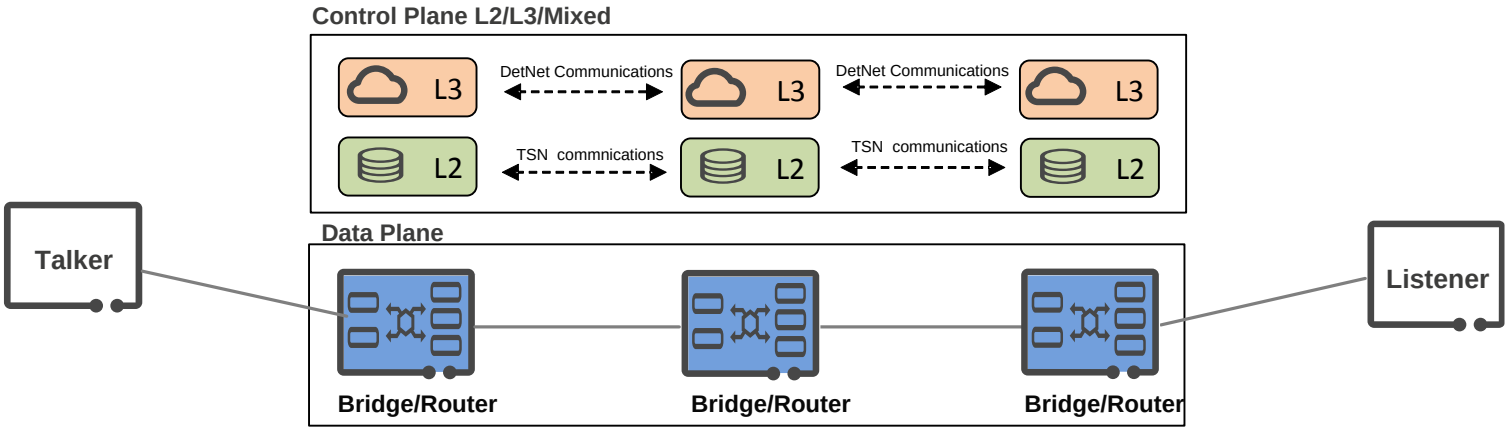
- **Hard isolation**: The traffic loading one VN has no impact on the traffic in any other VN, including QoS effects.
  Hard isolation is implemented by providing independent circuit switched connections for the exclusive use of one VN. A circuit switched connection is provided by, for example, a dedicated wavelength or a dedicated TDM time slot.
- **Soft isolation**: The traffic loading of one VN may have an impact on the QoS provided to the traffic in other VNs.
  Soft isolation is implemented by statistically multiplexing the traffic from two or more VNs onto a common circuit switched connection using a packet technology (e.g., Ethernet VLAN, MPLS tunnel). The impact on the QoS provided by one VN caused by the traffic on other VNs may be constrained by traffic engineering including, for example, limiting the statistical multiplexing ratio, traffic policing on each VN.

ITU-T Technical Report GSTR-TN5G: Transport network support of IMT-2020/5G

You may be interested in the work of the DetNet working group [1] which is collaborating with the IEEE802.1 TSN task group to develop mechanisms to provide deterministic data paths that operate over Layer 2 bridged and Layer 3 routed segments, where such paths can provide bounds on latency, loss, and packet delay variation (jitter), and high reliability. These features may prove to be particularly useful in supporting connectivity (or slices) for 5G services. The DetNet Architecture is largely complete and is described in [2]. DetNet's use of the IP [3] and MPLS [4] date planes is still being defined in the working group. You may also be interested in early work on configuration control in [5].

Liaison letter between 3GPP and IETF for Network Slicing relevant work

TSN/DetNet Interworking for Service Provider Networks



A Framework for TSN/DetNet Network

- Both L2/L3 Network control plane are viable, peering with end stations(talker/listener)
- TSN Standard behaviors in data plane provide bounded latency forwarding and management capability. Multiple queueing and forwarding methods can be deployed, with different cost and performance(latency/jitter).
- TSN techniques provide soft partitioning and hard partitioning capabilities over Ethernet*.

*new-tsn-wangtt-applicability-of-TSN-for-5G-services-0318-01.pdf

Performance Isolation

- Essentially, guarantee the service quality at each network slice is similar as guarantee the service quality at each flow/stream in TSN Ethernet;
  - Time window based scheduling has hard isolation capability
  - Shaper based scheduling has soft isolation capability

- In this profile, we like to discuss and clarify how TSN provide isolation among network partitions and thus enable isolation in network slicing architecture.

TSN Data Plane for Network Partitioning

- Legacy Qos for network partitioning → soft isolation
  - Provide average bandwidth, resource contention happens at times
  - Bounded latency can be expected with conditions
  - Limitation on traffic load. Latency performance degrades with increasing number of streams.
    - Examples: AVB, 802.1CM
  - Leverage current resource reservation and improved Qos mechanisms, fast to market.

- Time based network partitioning → hard isolation
  - Provide fixed bandwidth, no resource contention at any time
  - Unconditional bounded latency
    - Examples: 802.1 Qbv
  - Limitation on application and network scale, due to complexity on time based planning and scheduling
  - Develop new hardware and network planning algorithms, Need time to market.

Thank you