Solution Consideration about Differentiated DetNet QoS and TE

Quan Xiong(ZTE)

IETF 118 Side meeting, November 2023

Agenda

- Enhanced use cases, gaps, requirements of scaling deterministic networks
- Enhanced DetNet QoS defination
- TE requirements for enhanced DetNet
- QoS and TE solutions considerations
- Differentiated DetNet-aware TE (DD-TE)

Use cases, Gaps, Requirements of Enhanced DetNet

- Enhanced use cases in scaling deterministic networks
  - Industrial Internet
  - High Experience Video
  - Computing-aware Applications
- The new goals and gaps for enhanced DetNet
  - Provide various deterministic services with differentiated SLAs in scaling networks
  - Support high utilization of network resources
- The requirements of scaling deterministic networks
  - Support enhancement of queuing-based mechanisms and the related DetNet-Specific metadata (The candidate queuing solutions are being discussed in DetNet DT)
  - Support different levels of applications with different SLAs requirements and DetNet technologies

How to define enhanced DetNet QoS?

- The DetNet QoS MAY be classified and divided into several traffic classes based on the applications and differentiated SLAs requirements in scaling determnistic networks.

- Applications co-existed with different SLAs

Applications	Bandwidth	Bounded Latency	Reliability
AR/VR Video	High 10Gbps	Medium delay<10ms jitter<5ms	Medium
Smart grid	N/A	High delay<15ms jitter<50us	High 99.9999%
Industrial control	Low	High MaxDelay 500us~50ms	High 99.9999%
Internet of Vehicles	Low	Medium Delay 2ms -> 20ms	Medium 99.999%
Remote control	Medium 25Mbps~6Gbps	Medium Delay 5ms -> 20ms	High 99.9999%

- Differentiated DetNet QoS (DD-QoS)

DD-QoS Traffic class	Class-1	Class-2	Class-3	Class-4
Deterministic Forwarding and Behaviors	Jitter Guarantee	Delay Guarantee	Low Delay and Jitter Guarantee	Ultra-low Delay and Jitter Guarantee
SLAs	Delay <300ms, jitter<50ms, 99.9%	Delay <50ms, jitter<50ms, 99.99%	Delay<20ms, jitter<5ms, 99.999%	Delay<10ms, jitter<100us, 99.9999%
Applications Examples	Synchronous voice services	Video, production monitoring, and communication services	AR/VR, holographic communication, cloud video and cloud games services	Industrial services such as power protection and remote control

What is TE Requirements for enhanced DetNet?

DetNet QoS of Scaling Deterministic Networks

- DetNet QoS can be classified based on the applications with different SLAs requirements
- It demands differentiated QoS behaviors in scaling deterministic networks

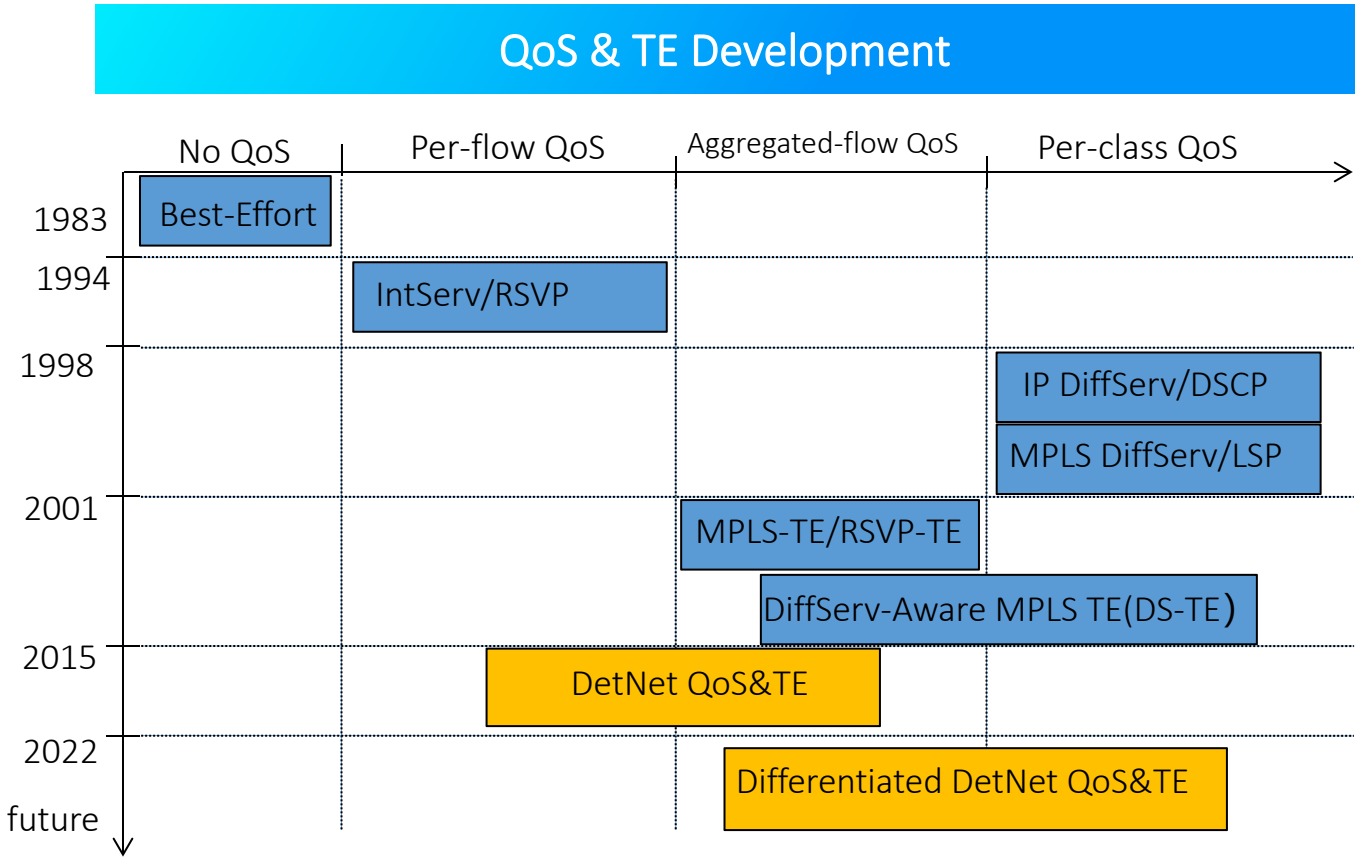
Characteristics of Scaling Deterministic Networks

- Scaling Flows
  - Massive traffic flows
  - Different levels/types services
  - Flows with Different T-Spec/SLAs
- Scaling Networks
  - Large number of nodes and links
  - High speed, long-distance transmission
  - Multiple domains
  - Interconnected with Heterogeneous sub-network technologies

TE Requirements for enhanced DetNet

- Provide path steering to forward packet and provide determinstic behaviors for data plane to achieve differentiated DetNet QoS
- Resolve the scalability issues to reduce the amount of control signaling and network operations
- Resource management should be considered
  - guanrantee the time-based SLAs requirements
  - make reasonable use of resources
- End-to-end deterministic routes establishment and control in scaling networks
  - Distributed routes and inter-domain routes
  - Path computation with multiple network metrics and frequent topology changes
  - Path planning with resource reservation

QoS and TE Solutions Considerations



QoS & TE Solutions

- Best effort service without QoS guarantee
- End-to-end per-flow QoS with scalability issues
- Traffic class scheduling without end-to-end QoS guarantee
- TE guarantee end-to-end QoS, can not identify traffic
- Per-class resource scheduling based on bandwidth without deterministic QoS, relying on RSVP
- Per-flow and aggregates flows scheduling based on bandwidth
- Per-class traffic scheduling based on time-based resource

Differentiated DetNet-aware TE (DD-TE)

- Consideration from TE Elements:
- Policy
  - The routing policy including bounded latency constraint-based routing can be considered when selecting and distributing the candidate paths.

- Path Steering
  - Per-class traffic scheduling should be considered for differentiated DetNet QoS.
  - The deterministic latency information may be provided to forward packets for path steering in IPv6/SRv6/MPLS.

- Resource management
  - Time-based resource-aware control and forwarding should be considered based on the queuing mechanisms and different traffic classes.

Per-class TE Vs Per-flow/aggregates TE

- DiffServ-aware MPLS TE (DS-TE) Vs MPLS-TE
  - MPLS-TE
    - per-flow/ Flow-aggregates based QoS + per-aggregates TE (Routing policy+Resource management)
  - DS-TE
    - traffic-aggregates based QoS+ per-class TE (Routing policy+Resource management)
  - Benifits
    - achieve scalable network designs supporting multiple classes of services
    - achieve fine-grained optimization of transmission resources and further enhanced network performance and efficiency

- Differentiated DetNet-aware Traffic Engineering (DD-TE) Vs DetNet
  - DetNet
    - per-flow/ Flow-aggregates based DetNet QoS + per-flow/aggregates TE (explicit path+resources allocation)
  - DD-TE
    - traffic-aggregates based Differentiated DetNet QoS + per-class TE (QoS-aware Routing policy+Time-based Resources management)
  - Benifits
    - achieve scalable network supporting different levels of deterministic applications
    - achieve fine-grained time-based resource scheduling and management to meet the bounded latency requirements, rational utilization of resources, improvement of network performance

Time-based Resources Vs Existing Resources

- TE existing resources management
  - Provides resource-aware control and forwarding (e.g. bandwidth, buffers, and queues, all of which can be managed to control loss and latency), such as
    - resoures reservation and allocation based on the bandwidth constraints by carrying average bits within 1 second
    - bandwidth availability control of the BE (Best Effort) flow to meet the peak information rate (PIR) of the flow at the macro level

- Time-based resources management
  - Provides time-based resource-aware control and forwarding, such as
    - resoures reservation and allocation based on the time-based constraints by carrying maximum bits within a time unit which is much shorter then 1 second (e.g. 1ms,2ms,10us, 20us...)
    - guanrantee bounded latency by providing time-based queuing mechanisms (e.g. CSQF, TQF, Deadline,g-LBF, C-SCORE...)
    - simplify the resource scheduling by providing one-dimensional resource object instead of multiple dimensionals of resource such as bandwidth, buffers, and queues

End-to-end Deterministic Routes Establishment

- Deterministic Links
  - indicates the deterministic forwarding capabilities at different levels
  - provide one-dimensional deterministic metric for selecting path as per draft-xiong-lsr-detnet-deterministic-links
- Distributed Routes
  - compute deterministic paths with a deterministic delay metric within a distributed networks such as a Flexible-Algorithm topology as per draft-peng-lsr-flex-algo-deterministic-routing
- Inter-domain Routes
  - advertised with BGP intent routes carrying the deterministic metric credit information to provide an optional metric related BGP path attribute as per draft-peng-idr-bgp-metric-credit
- Multi-domain Routes
  - PSE extensions other than inter-PCE, hierarchical PCE as per draft-bernardos-detnet-multidomain

Related Drafts links for your reference

- https://datatracker.ietf.org/doc/draft-xiong-detnet-enhanced-detnet-gap-analysis/
- https://datatracker.ietf.org/doc/draft-ietf-detnet-scaling-requirements/
- https://datatracker.ietf.org/doc/draft-xiong-detnet-large-scale-enhancements/
- https://datatracker.ietf.org/doc/draft-zhao-detnet-enhanced-use-cases/
- https://datatracker.ietf.org/doc/draft-xiong-detnet-differentiated-detnet-qos/
- https://datatracker.ietf.org/doc/draft-xiong-detnet-teas-te-extensions/

Thank you!