Multi-traffic transmission in industrial backbone network

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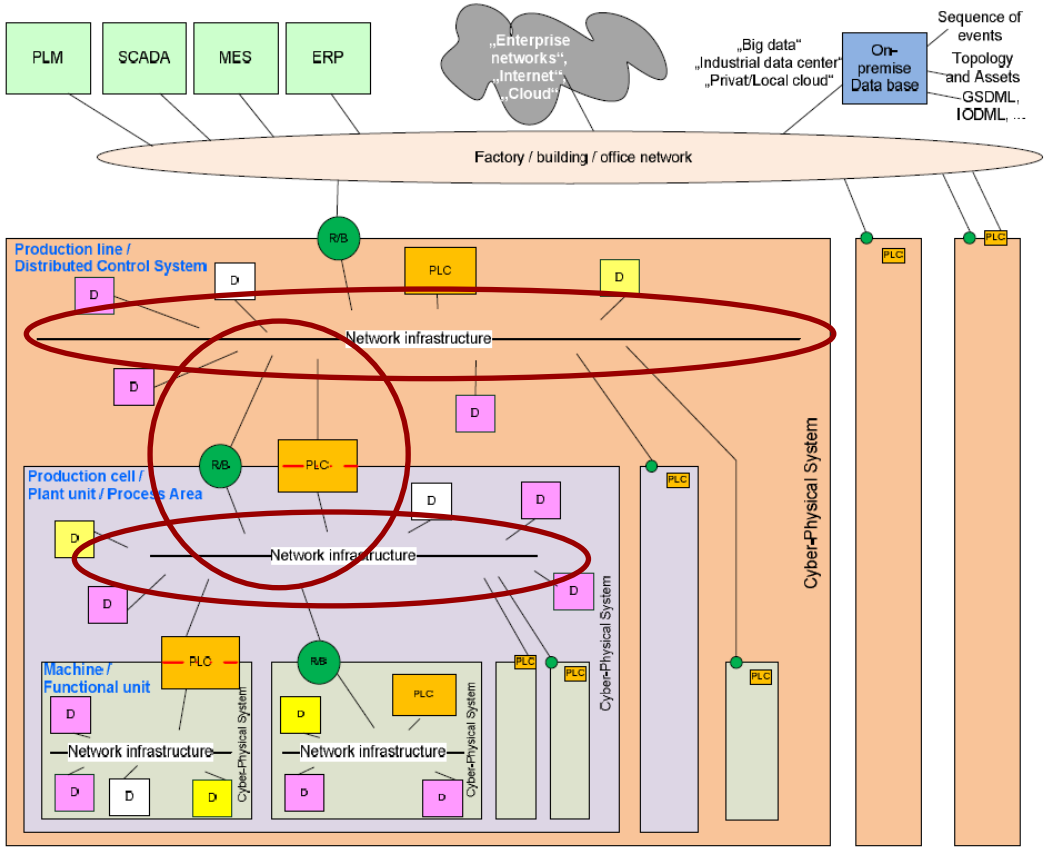
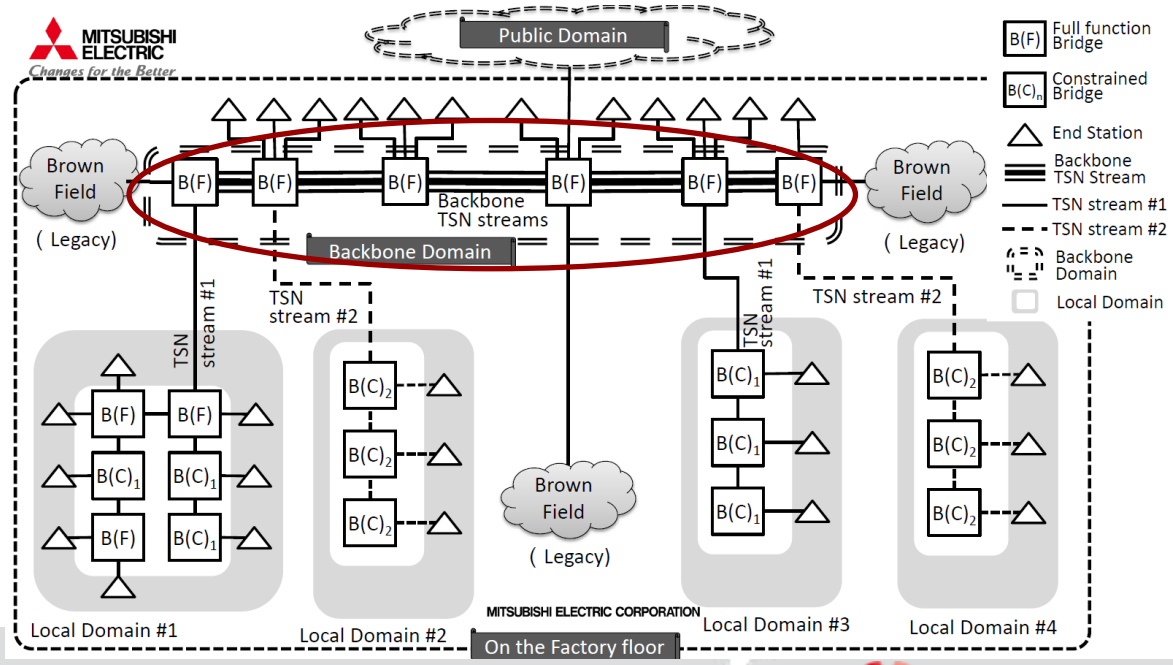
Background

- **Industry backbone network connects subnets and/or public network.**
  - Hierarchical structure of industrial automation – use case
    - Network infrastructure from Production line to Production cell
  - Hierarchical domain based network system – MITSUBISHI ELECTRIC
    - Network infrastructure inside Backbone domain





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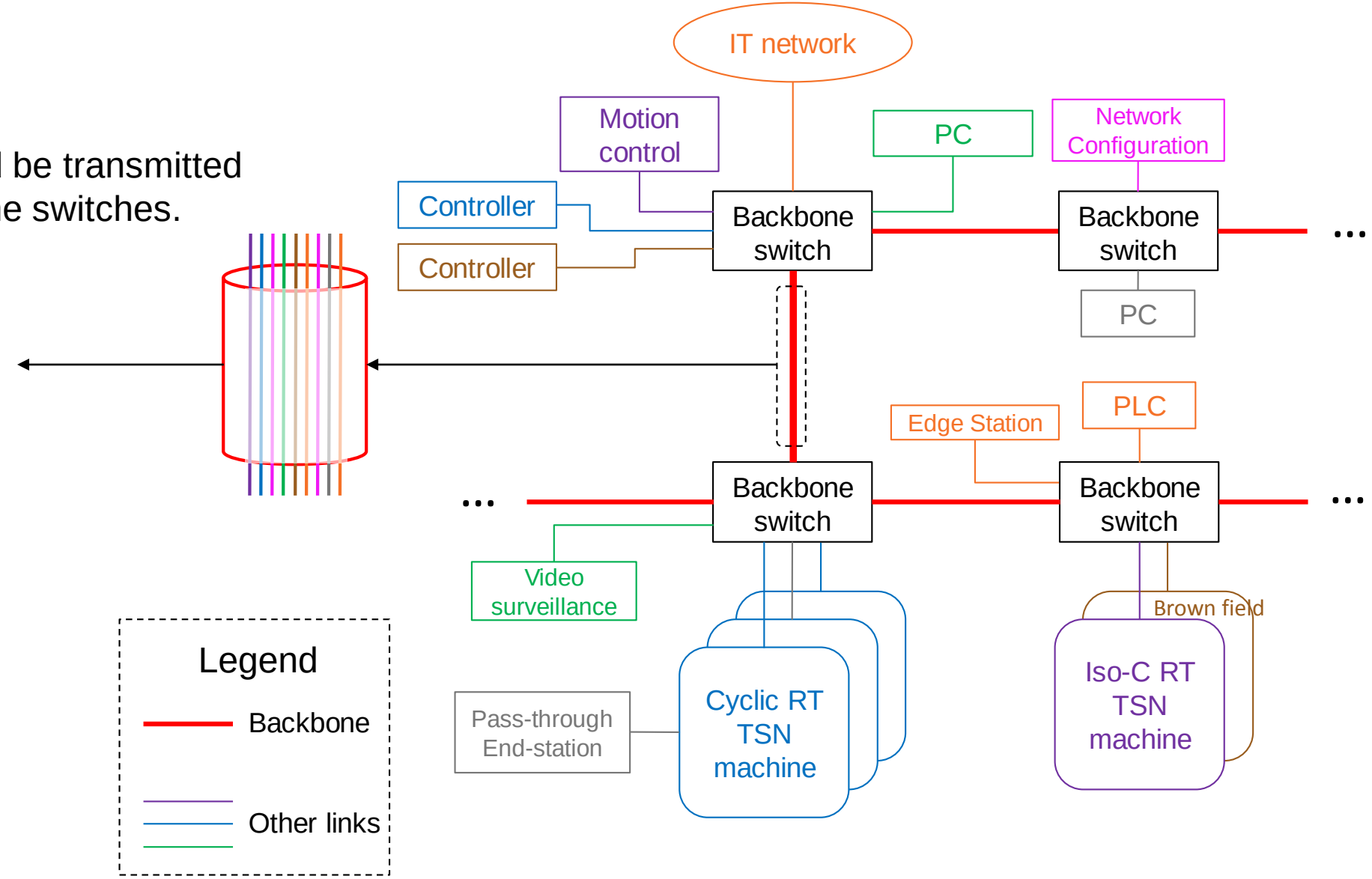
Example

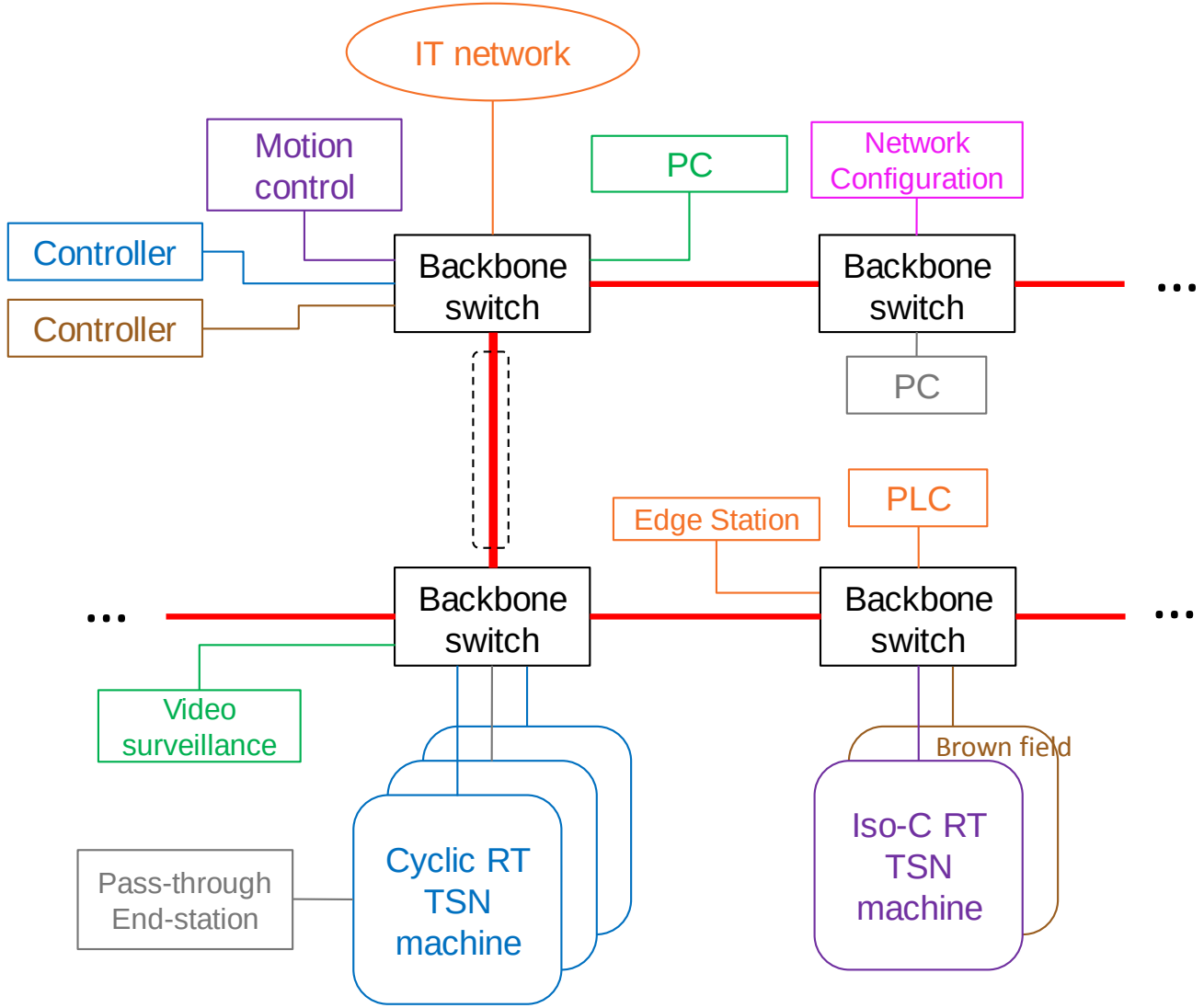
Different traffic types could be transmitted together between backbone switches.

Traffic type
Isochronous cyclic real-time
cyclic real-time
network control
audio/video
brownfield
alarms/events
configuration / diagnostics
internal / pass-through
best effort



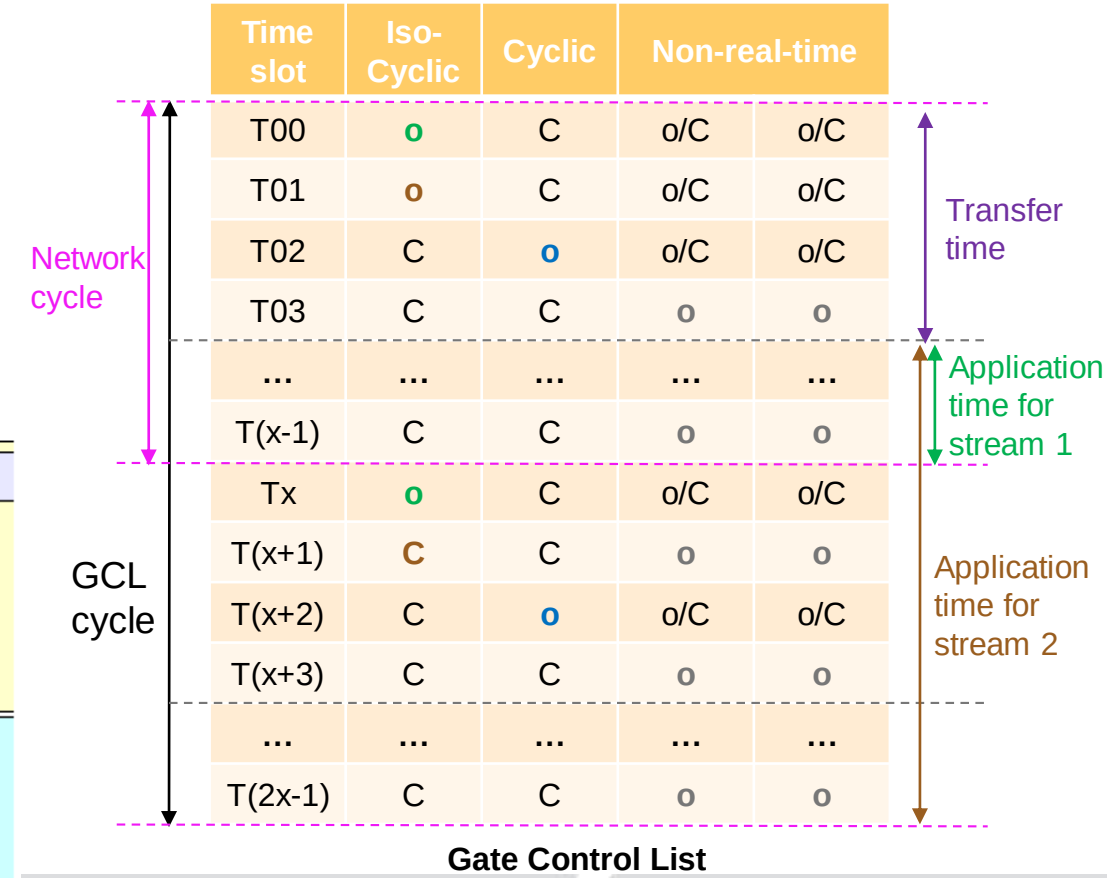
Features

- Efficiency
  - Multi-communication shares one network.
  - Easier network OAM & Redundancy.
- Flexibility
  - Facilitate remote/centralized control architecture.
  - Reduce end-station positioning constraint.
  - Support flexible manufacturing for the future.
- Requirements:
  - Guarantees (deadline, bounded latency, bandwidth) of each different traffic type has to be fulfilled.
  - Change of one stream will not cause disturbances to others.



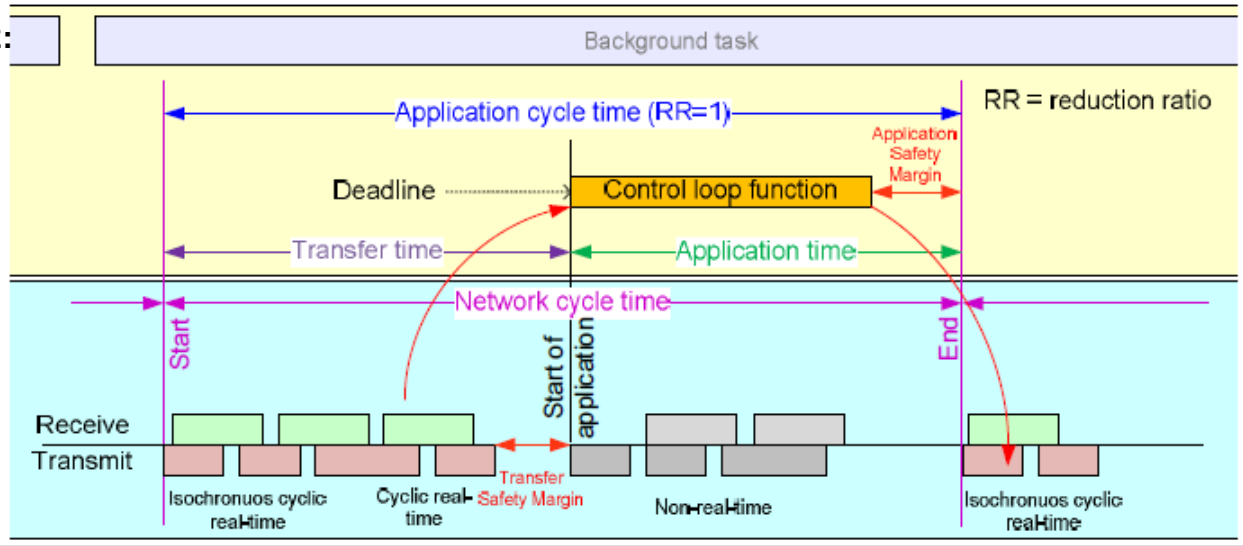
Network Approach 1: Backbone Switch with TAS

- Support both stream and class based scheduling.
  - The cycle of Gate Control List (GCL) could be multiple of network cycle, to integrate multiple flows with different cyclic period.
- Multiple traffic configuration example:
  - Step 1: Schedule periodic traffic
    - Iso-Cyclic stream/class 1: app cycle = network cycle (RR=1)
    - Iso-Cyclic stream/class 2: app cycle = 2 network cycle (RR=2)
    - Thus, choose GCL cycle = 2 network cycle
  - Step 2: Schedule sporadic traffic
    - Non-real-time traffic: “fill in the blank”



Gate Control List

Use case 02:



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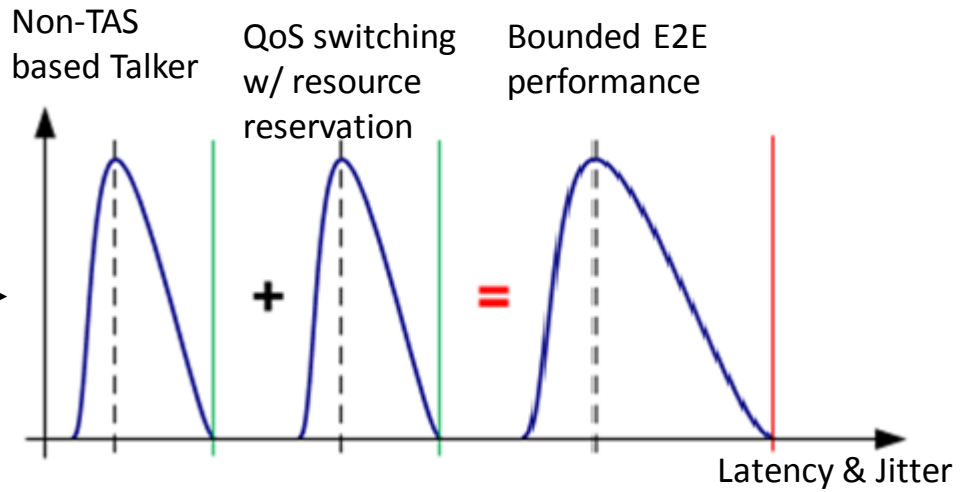
Network Approach 1: Backbone Switch with TAS

- Advantages:
  - Fulfill the requirement of all traffic types (even with different application cycle).
  - Path planning and scheduling for more deterministic performance.
- Challenge:
  - Scheduling complexity when the number of station/stream is large.
- TSN Mechanisms needed in switches include,
  - Required: TAS (Qbv), Time sync (AS-Rev).
  - Optional: Preemption (Qbu), CQF (Qch), PSFP (Qci), etc.
  - Control plane mechanisms like SRP/RAP, NETCONF/YANG with CNC.

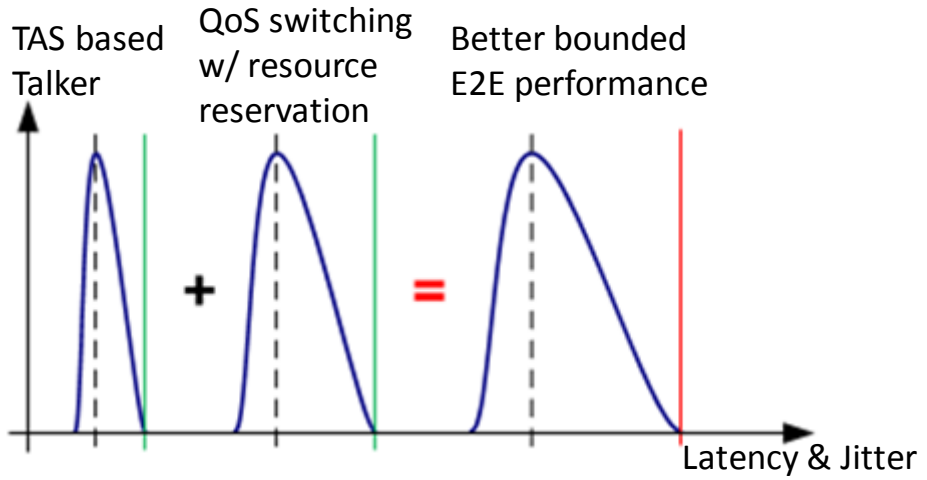
Network Approach 2: Backbone switch with QoS/Shapers

- Description:
  - Streams with same traffic type could be aggregated as a same class.
  - Using Strict Priority and Credit-based Shaper with resource reservation.
  - Similar as 802.1BA TSN profile for AVB, bounded end-to-end latency can be achieved.
  - Better end-to-end performance if scheduled traffic is enabled on Talkers, while switches use only QoS/shapers.



- Multiple traffic configuration example:
  - 3 traffic class with 2 SR class.

Traffic type	Algorithm	SR class	Priority
Iso-Cyclic	CBS	A	2
Cyclic	CBS	B	1
Best effort	SP	--	0



Network Approach 2: Backbone switch with QoS/Shapers

- Advantages:
  - No need for time synchronization and centralized configuration.
  - Relative simple approach which could fit in many use cases.
- Challenges:
  - More chance for bursting and larger variation in latency.
- TSN Mechanisms needed in switches include,
  - Required: CBS (Qav).
  - Alternative: Preemption (Qbu), ATS (Qcr), PSFP (Qci), etc.
  - Control plane mechanisms like SRP-MRP, RAP-LRP.

Proposal

- Add an explicit use case for mixed traffic transmission to the use case draft.
  - Use case XX: Transmission of mixed traffic types. (text uploaded)
  - Under Clause 2.4 Industrial automation mode of operation (or Clause 2.5 Industrial automation networks)
- Add requirements to the requirement draft accordingly.
- Questions?

Thank you

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