Time-Sensitive Networking Proof of Concept Demo

It is high time …
Loss and Latency that really matters.

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Ericsson

Background

Telecommunication development

All industries are affected …

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In the #NetworkedSociety, everything that can benefit from being connected will be.

IEEE 802

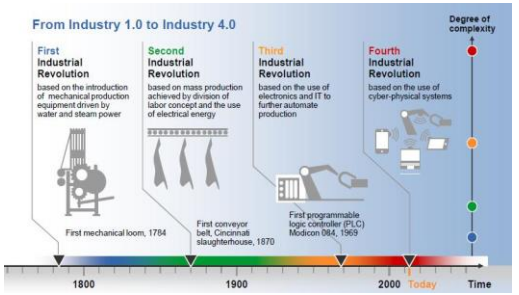
ITU

Deterministic Packet Transport

What is it …

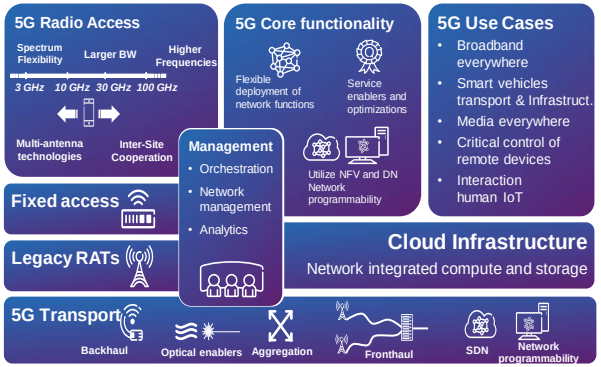
- Deterministic transport
  - provides guaranteed delivery with bounded low latency, low delay variation, and extremely low loss
  - operates over Layer 2 bridged and Layer 3 routed segments
  - often expected extreme values (µsec, lossless, …), but its main target is guaranteed upper bound on these parameters

- Many-many use cases
  - Telco systems
  - Industrial networks
  - Automotive networks
  - …



Industrial verticals

New opportunities …



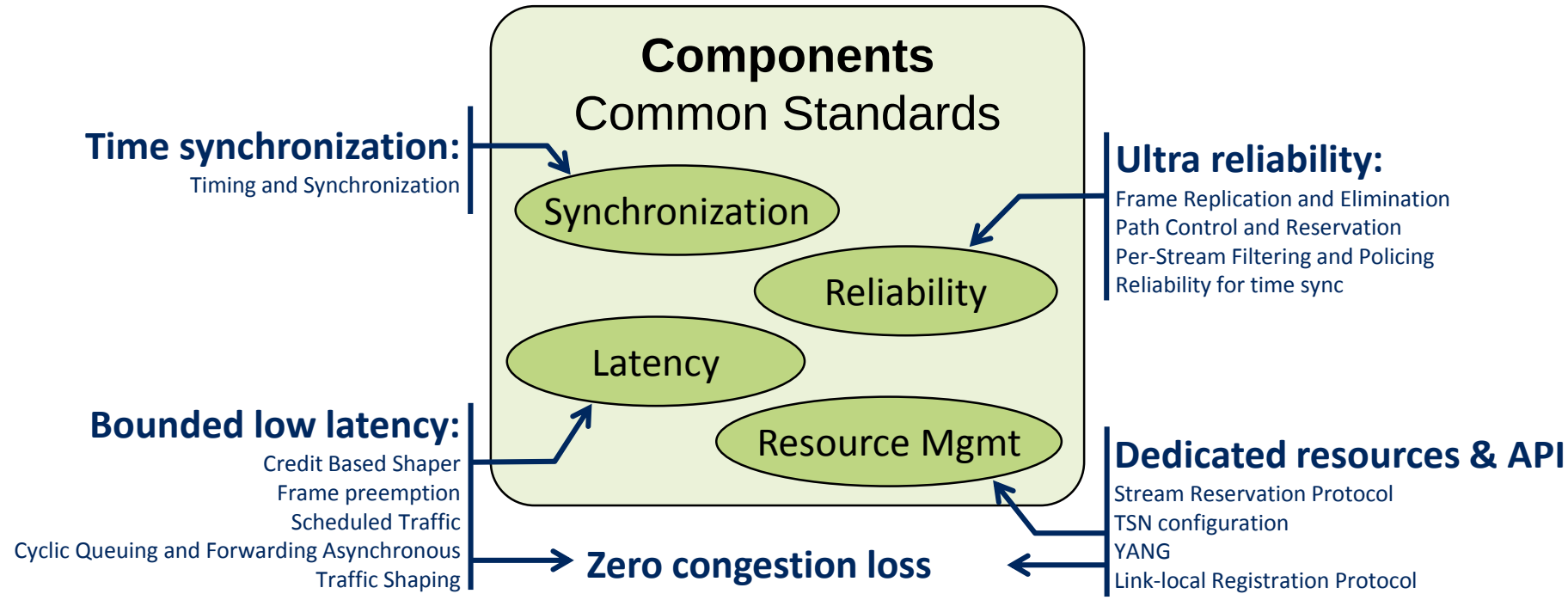
5G system end-2-end

Simply, it must work …

Note: many further deterministic packet transport scenarios exists …

Deterministic Transport

Add-ons to Regular Packet Transport

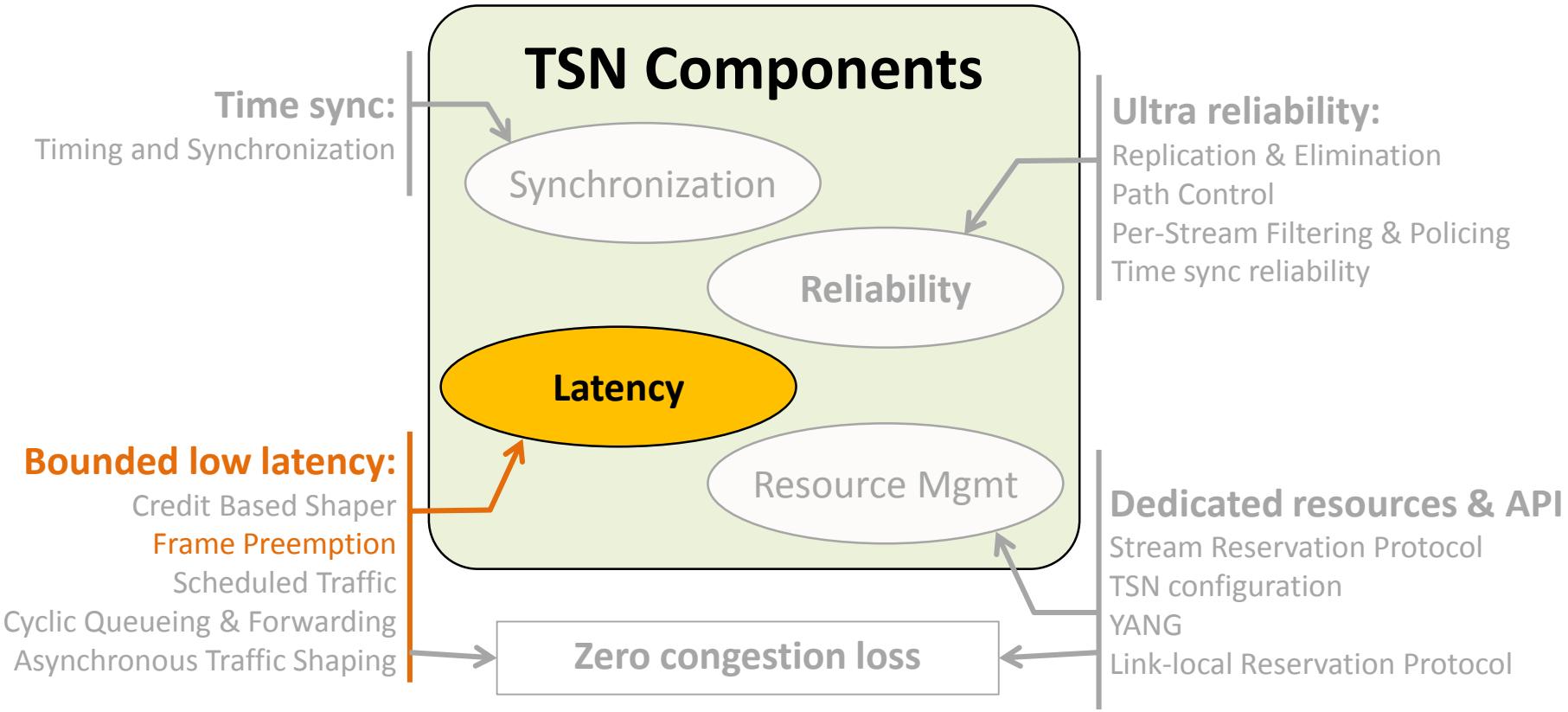


Guaranteed data transport with bounded low latency, low delay variation, and extremely low loss

API: Application Programming Interface; YANG: a data modeling language

Latency

Latency on the Spot

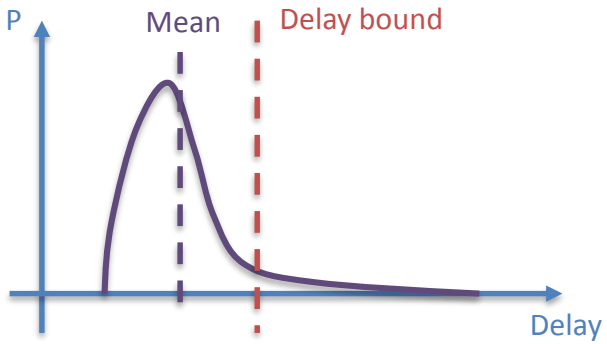


Guaranteed data transport with bounded low latency, **low delay variation**, and extremely low loss

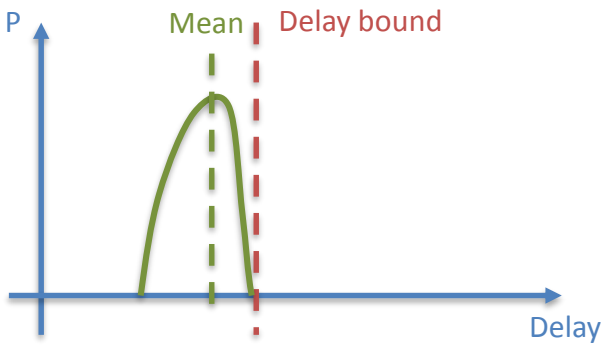
Traditional vs. Deterministic Service

Key differences

- Traditional Service
  - Target: Elastic traffic
  - Network centric:
    - Optimal network utilization
    - Maximize throughput (stat.mpx)
    - (Good average latency)
  - Delay probability curves with tail
  - **Bounding the latency** means **losing packets** (or overprovisioning)



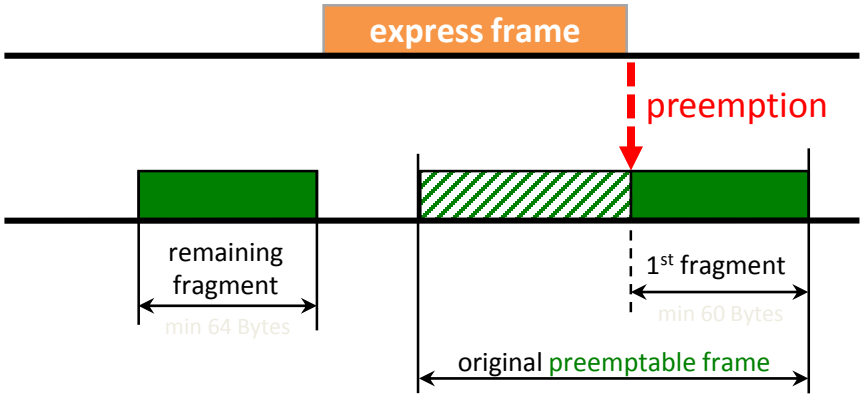
- Deterministic Service
  - Target: Delivery sensitive traffic
  - Service centric:
    - Optimal service parameters
    - Zero congestion loss
    - Bounded latency
  - Delay probability curves bounded
  - **In-time delivery** ensured by resource allocation

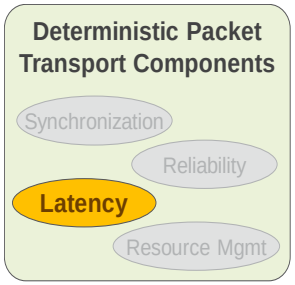


Frame Preemption

Minimize other flows impact

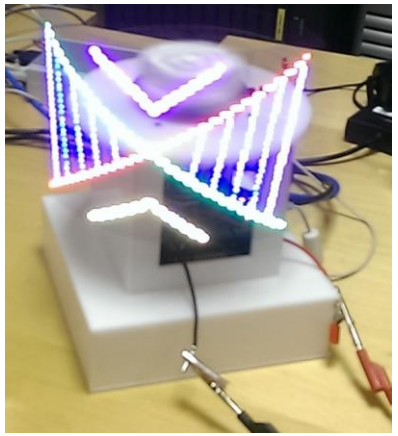
- Express frames suspend the transmission of preemptable frames
  - Decrease delay variation for express traffic
  - Increase bandwidth for preemptable traffic
  - It is link local per hop, it is not IP fragmentation
- Frame transmission example at a port:

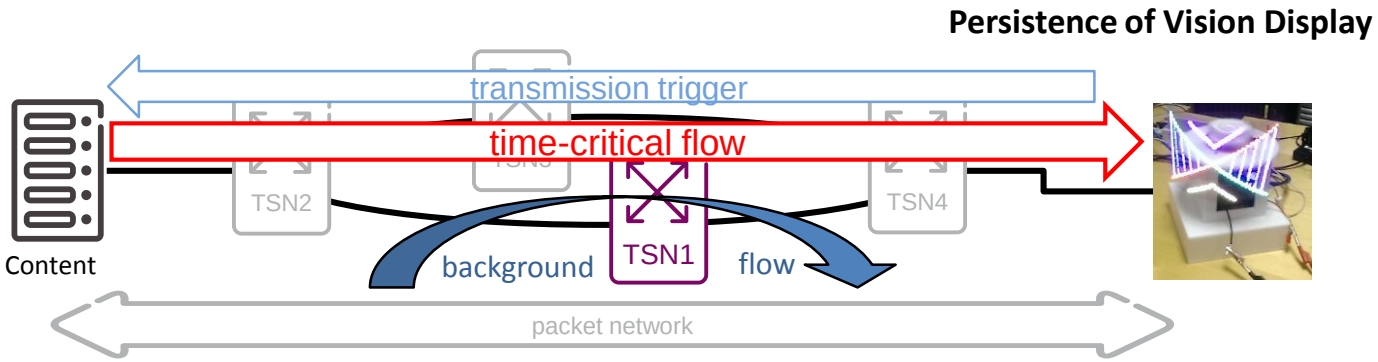




Latency Demo Setup

- Application
  - Remote, time-critical content on Persistence of Vision Display
  - Time-critical and background flows share the same packet network
- Network scenario
  - TSN switch implements frame preemption
  - Reference: simple strict priority queuing





Latency Demo Scenarios

1, No TSN: Single Queue

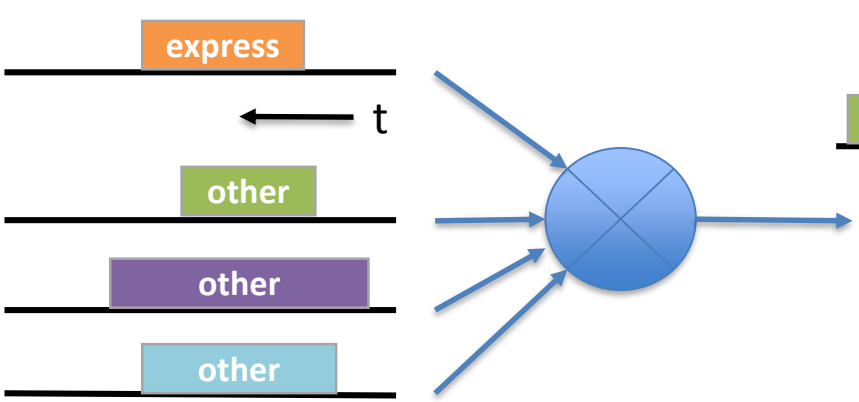
- Time-critical and background traffic are not distinguished
- Worst case delay variation depends on actual traffic mix

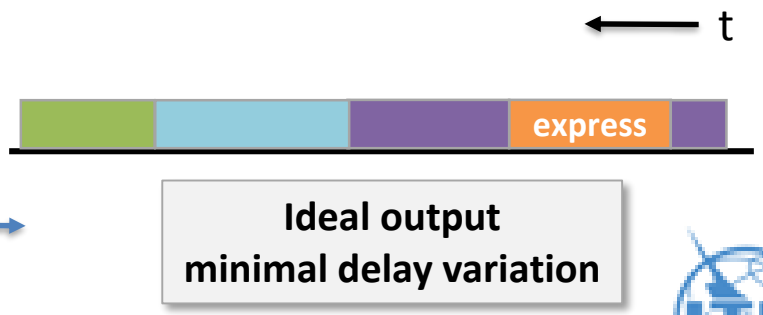
2, No TSN: Strict Priority

- Time-critical traffic has high prio
- Worst case delay variation corresponds to transmission of largest background packet

3, TSN: Frame preemption

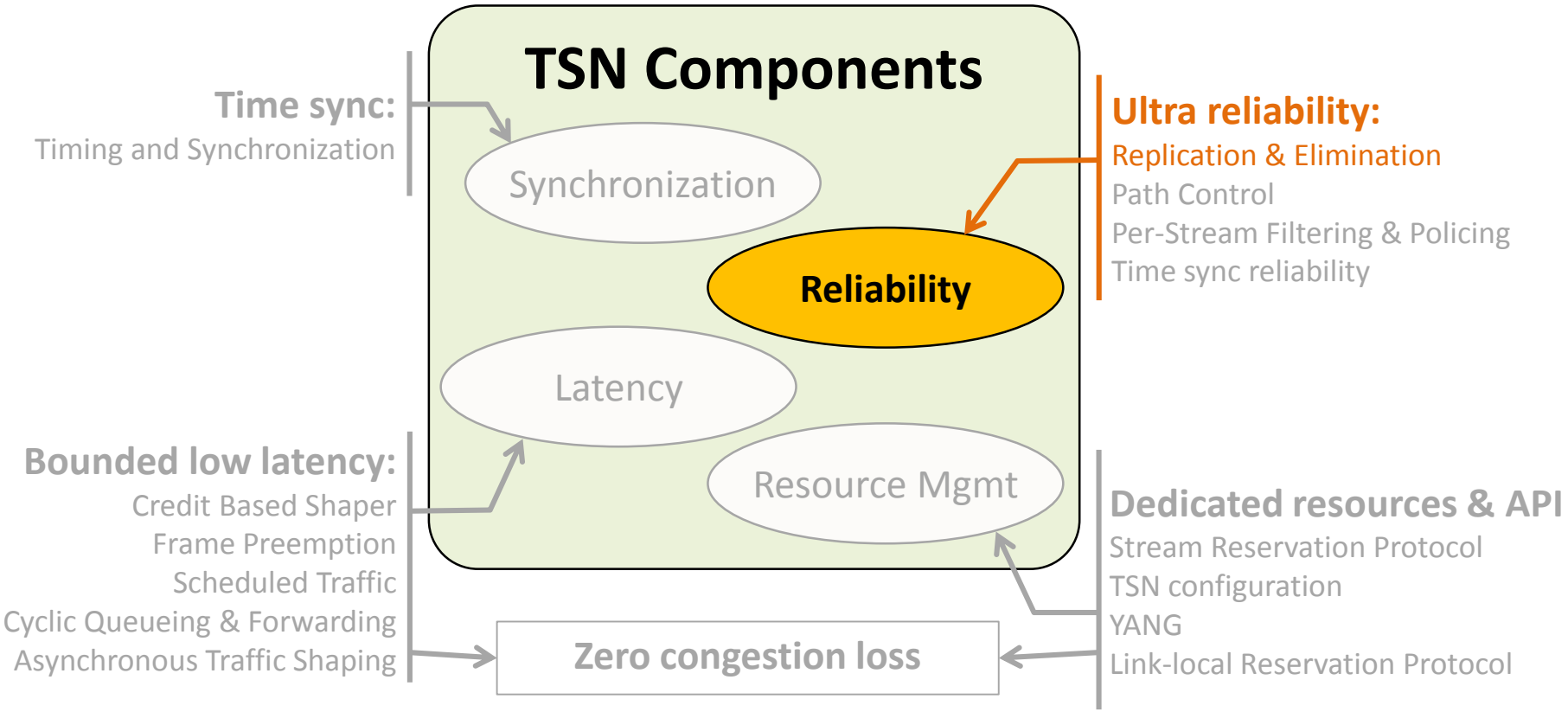
- Time-critical traffic: high priority express traffic
- Background traffic: low priority preemptable traffic
- Worst case delay variation corresponds to transmission of 123-Byte packet





Reliability

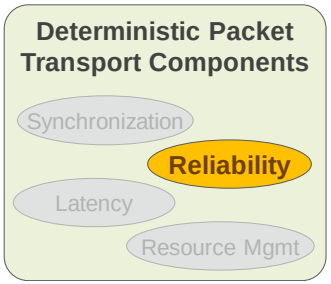
Reliability on the Spot



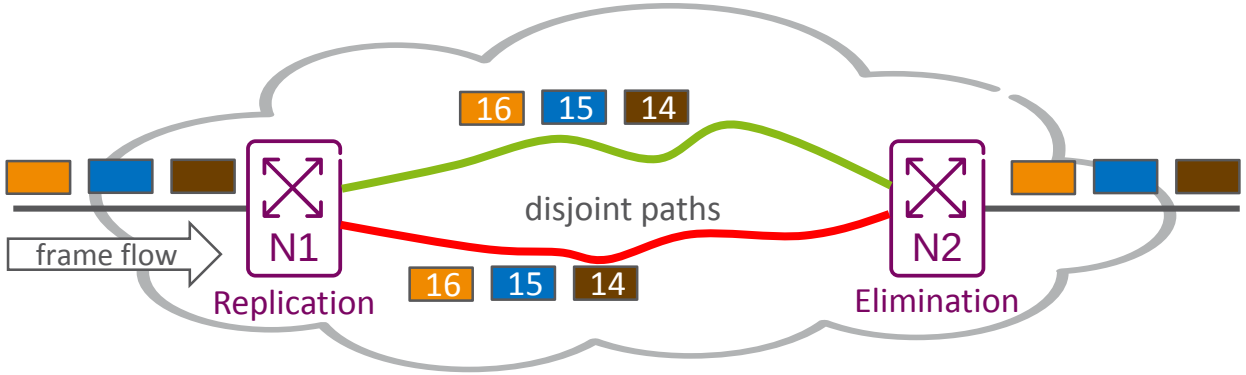
Guaranteed data transport with bounded low latency, low delay variation, and **extremely low loss**

Packet / Frame Replication

Ultra reliability

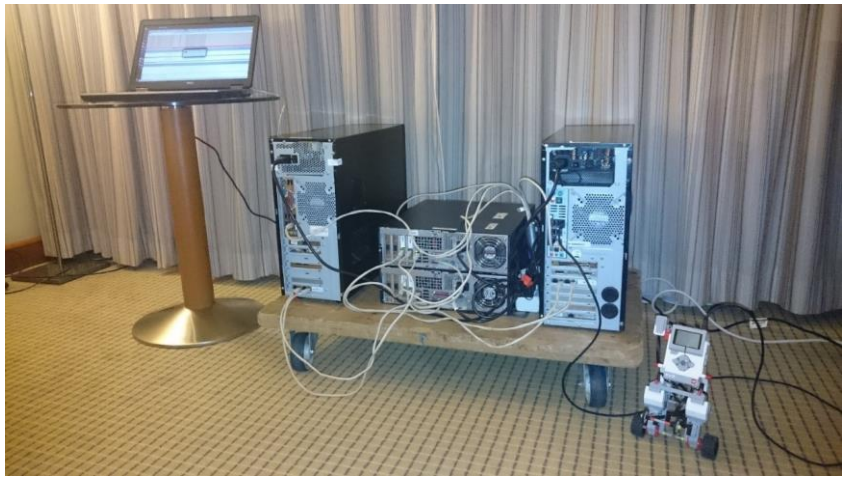


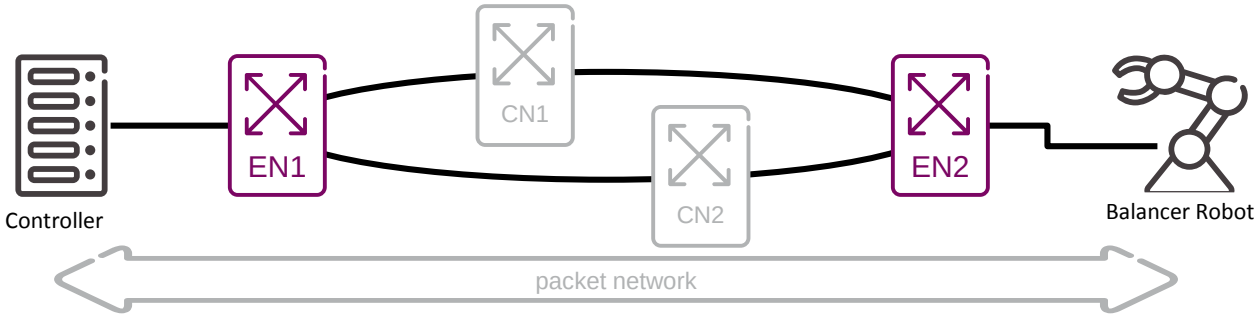
- FRER: Frame Replication and Elimination for Reliability
  - IEEE 802.1CB: mechanism, pseudo code, Layer 2 data plane
- PREF: Packet Replication and Elimination Function
  - IETF DetNet (draft-dt-detnet-dp-sol): Layer 3 data plane
- Method: Per-packet 1+1 (or 1+n) redundancy
  - Send packets on two (or more) disjoint paths, then combine and delete extras



Reliability Demo Setup

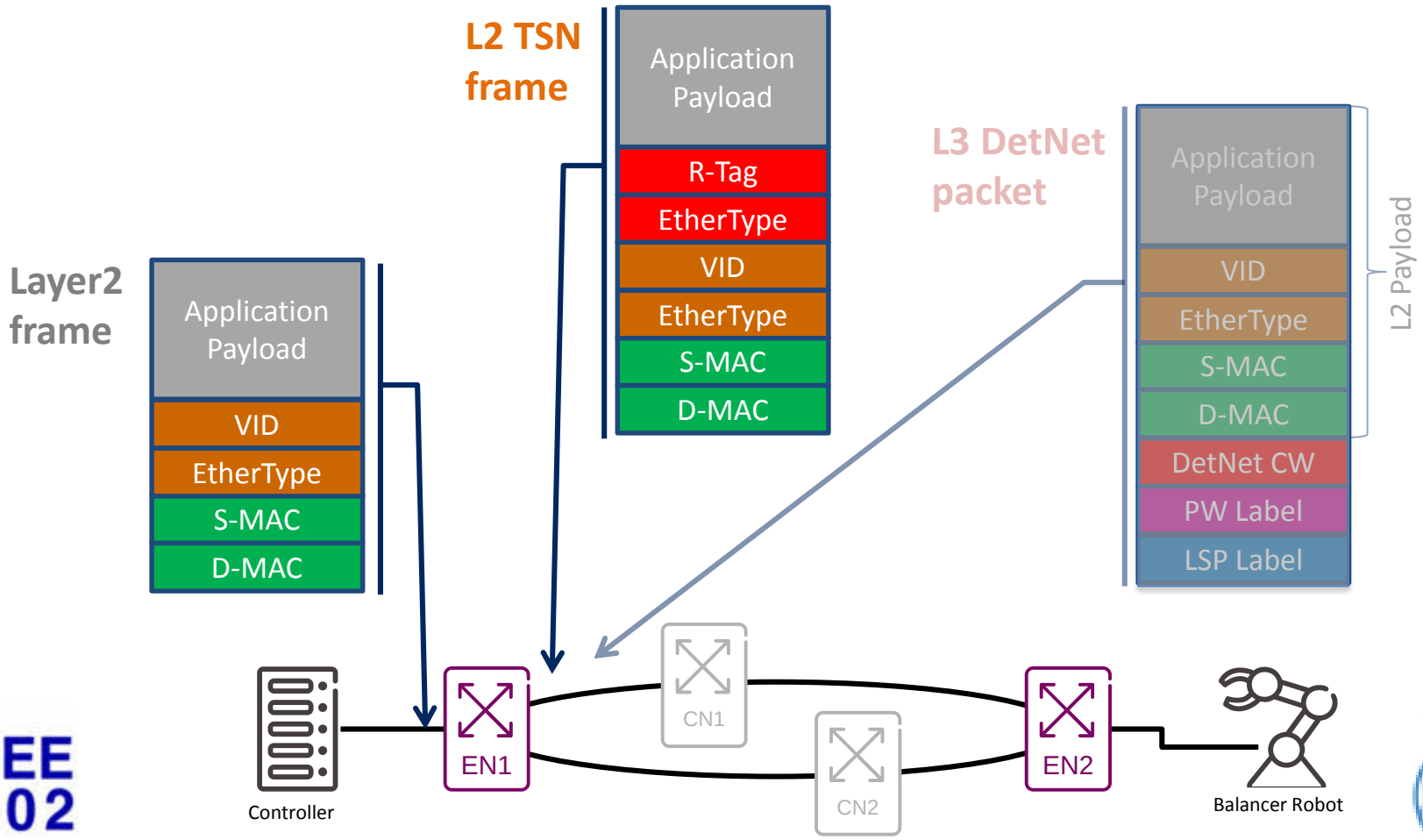
- Application
  - Remote control of a balancing robot
  - Control loop through a packet network
- Network scenario
  - FRER / PREF implemented in software switch running on PCs
  - Reference: 50ms protection switching





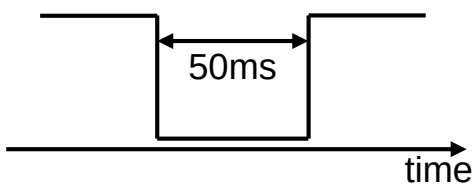
Data Plane examples

Ethernet, MPLS (preliminary)



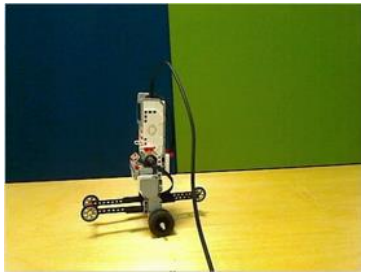
Demo Scenario 1: Link Failure

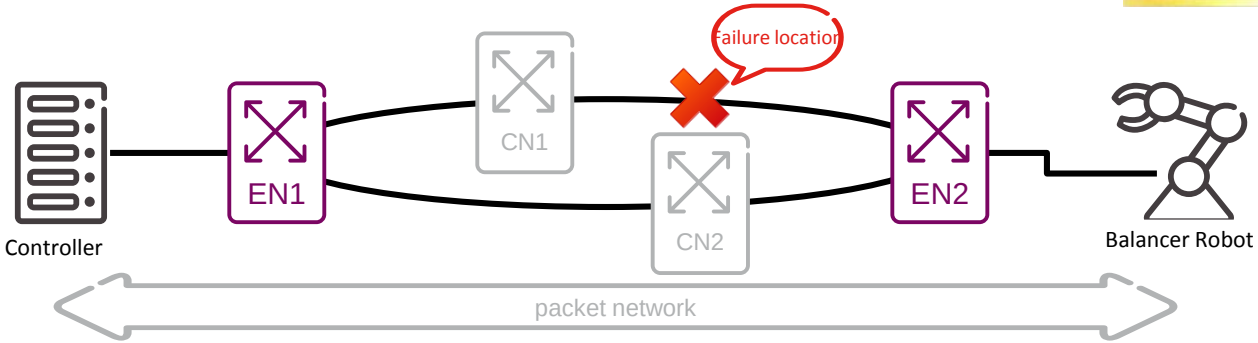
- Protection switching (a.k.a. linear protection)
  - Triggered by the failure
  - 50ms outage on working path (protection path is 2ms longer)
  - Impacts the application
- FRER / PREF eliminate packet loss caused by outage



No FRER/PREF

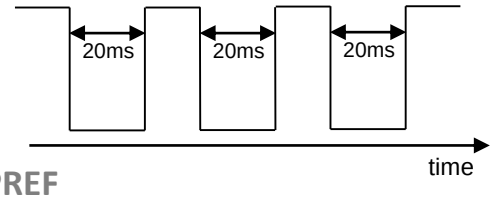
With FRER/PREF





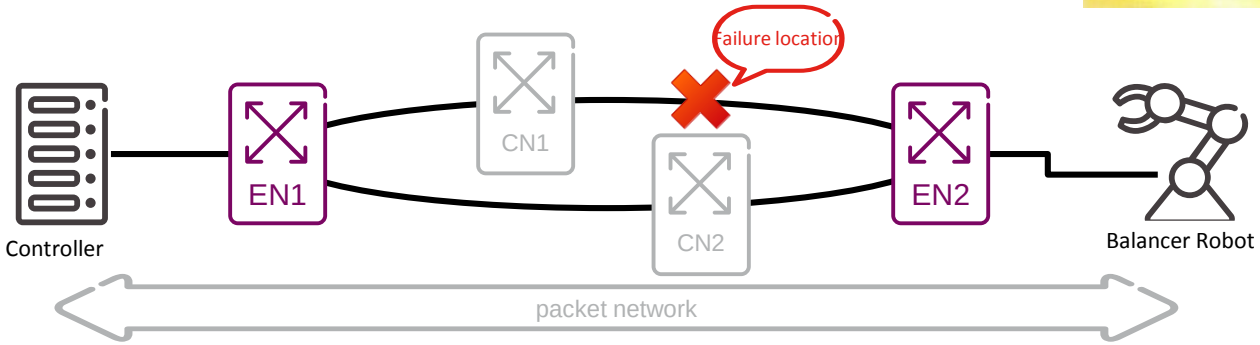
Demo Scenario 2: Link Flapping

- Link Flapping
  - Typical L1 problem caused by faulty cable or HW
- Protection switching does not react
  - Multiple 20ms loss periods impact the application
- FRER / PREF eliminate packet loss caused by outages

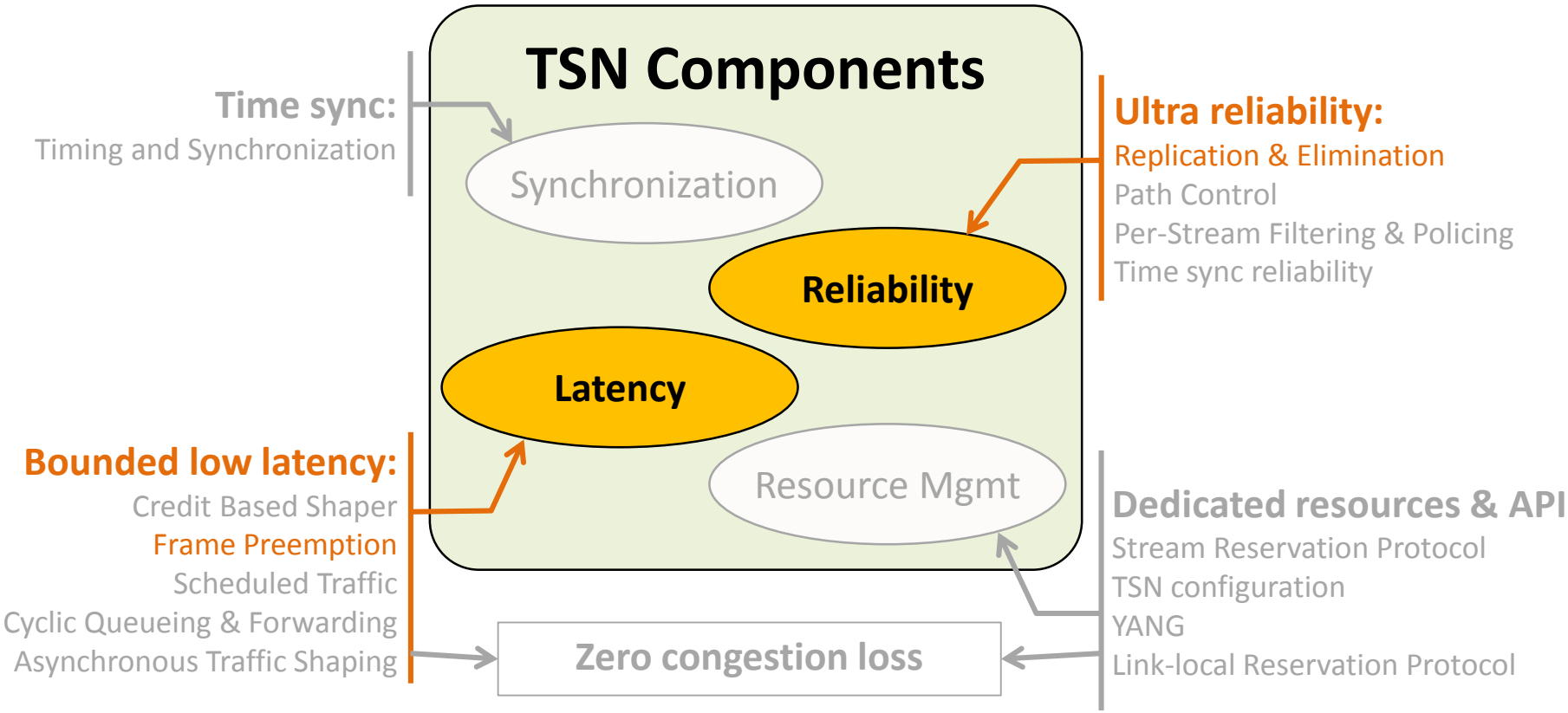


No FRER/PREF

With FRER/PREF



Summary
Delay and Reliability Demonstrated



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