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OPC-UA @ TSN

User Network Interface & Protocols

Requirements for TSN in Industrial Networks

- **Multiple applications share the same network**
  - Guaranteed bandwidth for multiple applications (OPC_UA, Video, Condition Monitoring, etc.)
  - Guaranteed latency for streams
  - High availability
  - …
- **Different network organization models shall be supported (e.g. fully centralized, centralized, distributed)**
  - A traffic class organization shall be transparent to end stations
- **UNI shall be based on standardized functionality for stream classification and identification (e.g. IEEE 802.1Q DA, VLAN, Priority)**

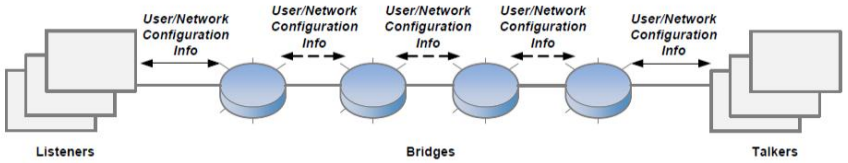

Figure 99-1 — Fully Distributed Model

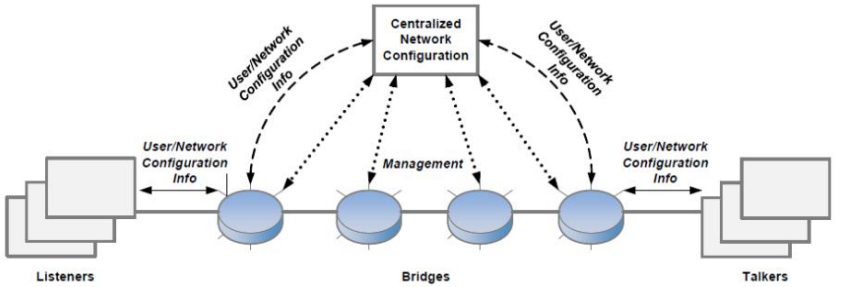

Figure 99-2 — Centralized Network / Distributed User Model

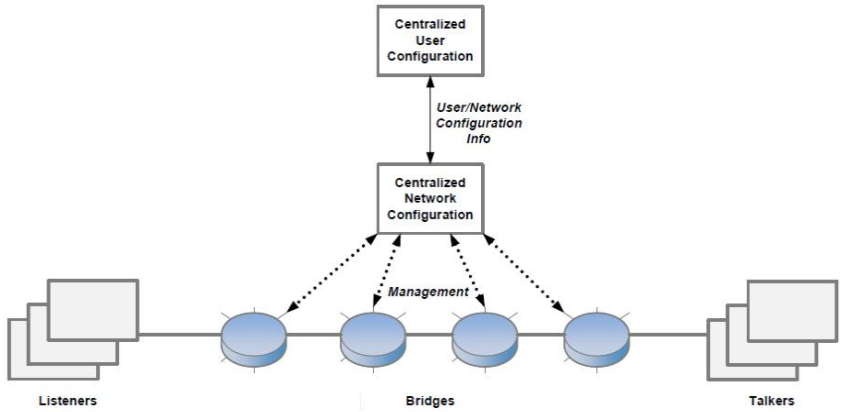

Figure 99-3 — Fully Centralized Model

Advantages of UNI

- One Stream-Service interface for session protocol (e.g. OPC_UA, ….)
- MAC Streams and IP Streams are supported (mostly transparent for session protocol)
- One stream configuration model for End Station
- All organization models (decentralized, centralized and fully centralized) are supported
- Within one network multiple organization models can coexists
  - **Example:**
    - Fully Centralized organization model for a closed system (“hard” real time, highly optimized)
    - Decentralized or centralized organization model for “soft” real time applications

L2 UNI Interface
to separate Applications from Network

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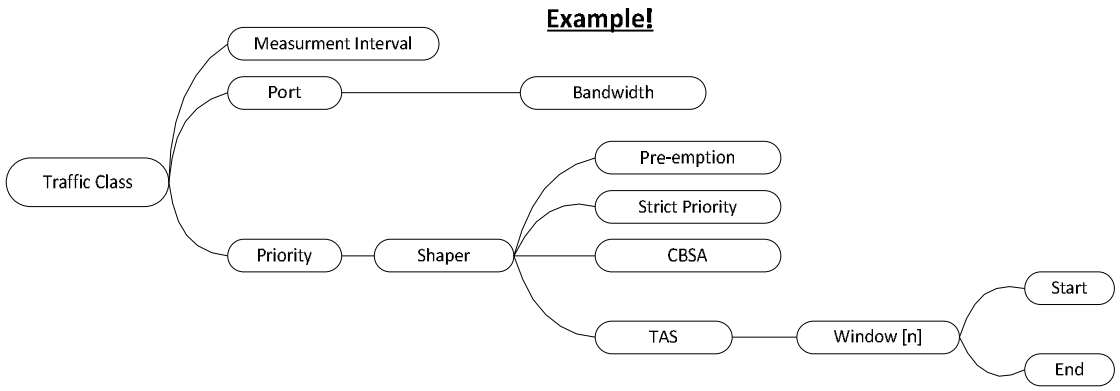
L2 UNI makes use of multiple protocols:

MUST:

- LLDP (network capabilities exchange between edge-port and end-station)
- Stream registration and reservation (MSRP/MSRP++)

OPTIONAL:

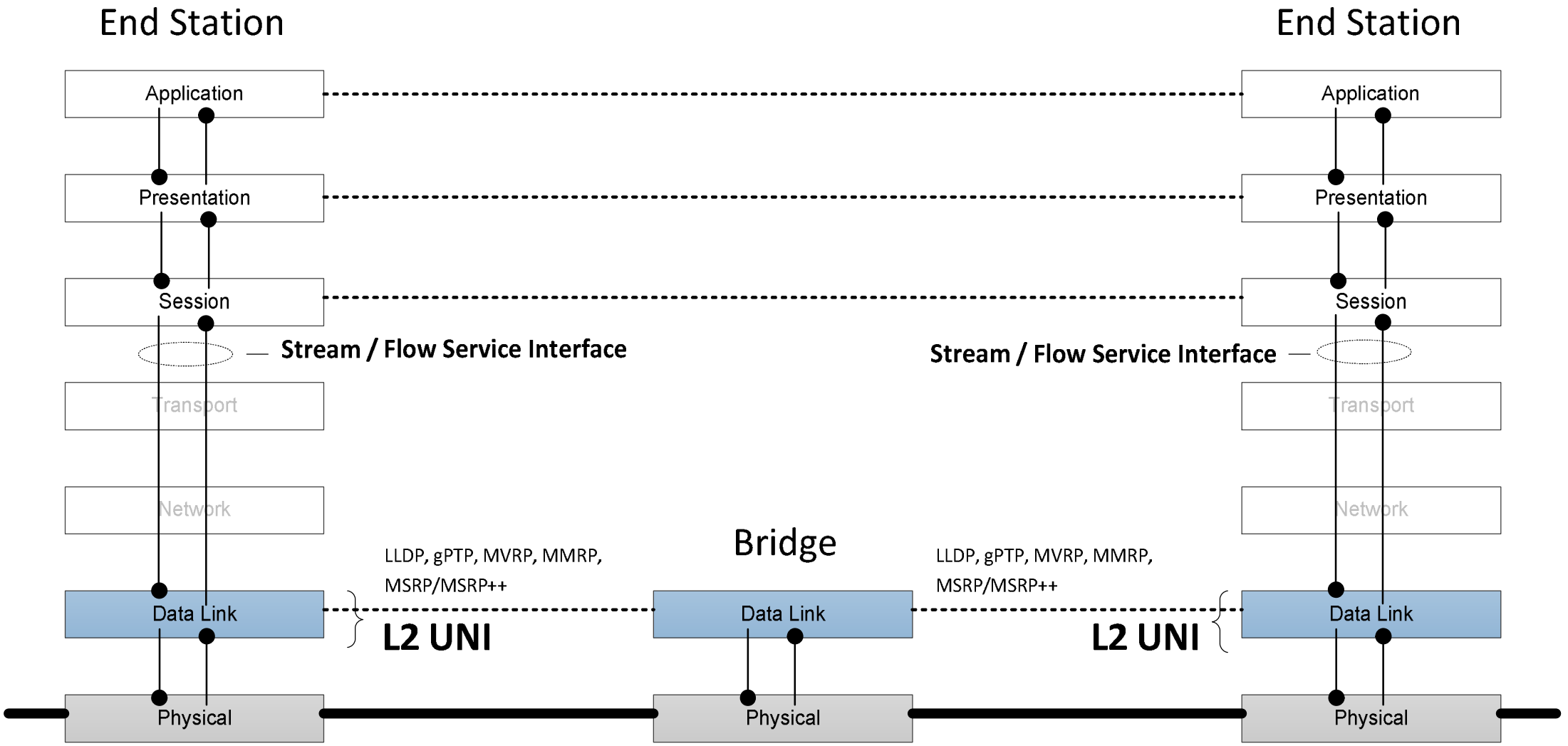
- Precision time sync (e.g. IEEE 802.1AS, IEEE 1588) to maintain a synchronized time
- Registration protocols (MMRP, MVRP) to register MAC addresses and VLANs
- Port security (IEEE 802.1X) to provide network access control
- …



Additional optional network services:

- Allocation of unique Stream ID
- Allocation of unique Stream DA (e.g. IEEE 1722 MAAP)
- Local Medium Access Control (MAC) Address Usage (802c)
- …

User Network Interface for MAC Streams based on OSI Reference Model



User Network Interface for IP Flows based on OSI Reference Model

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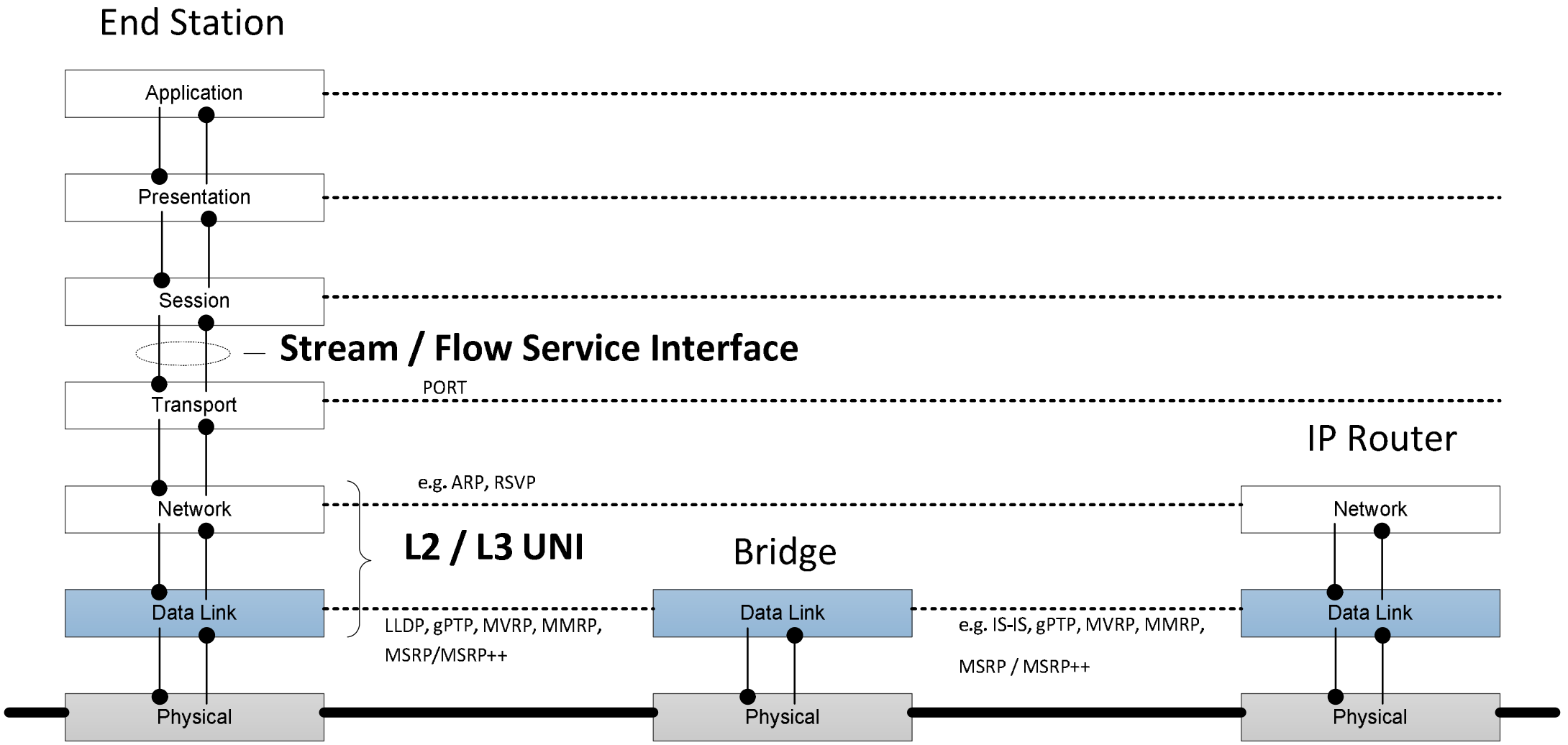
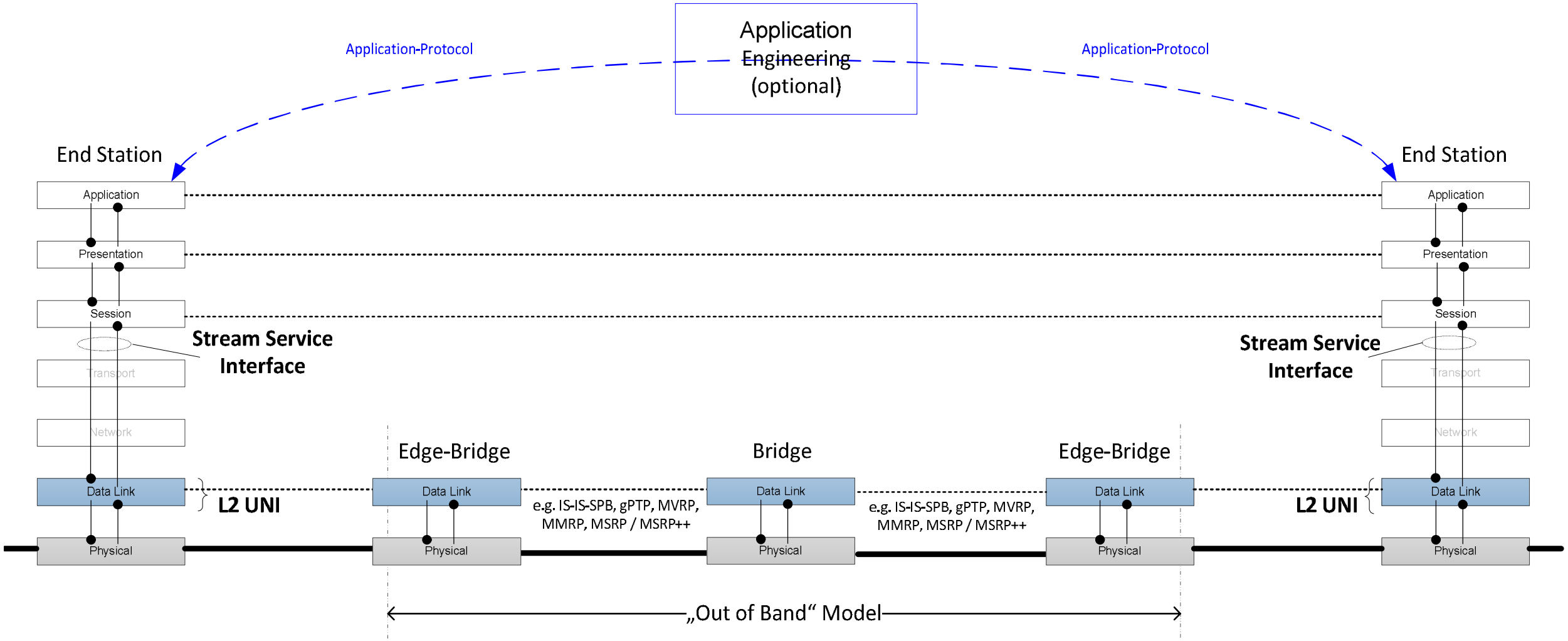
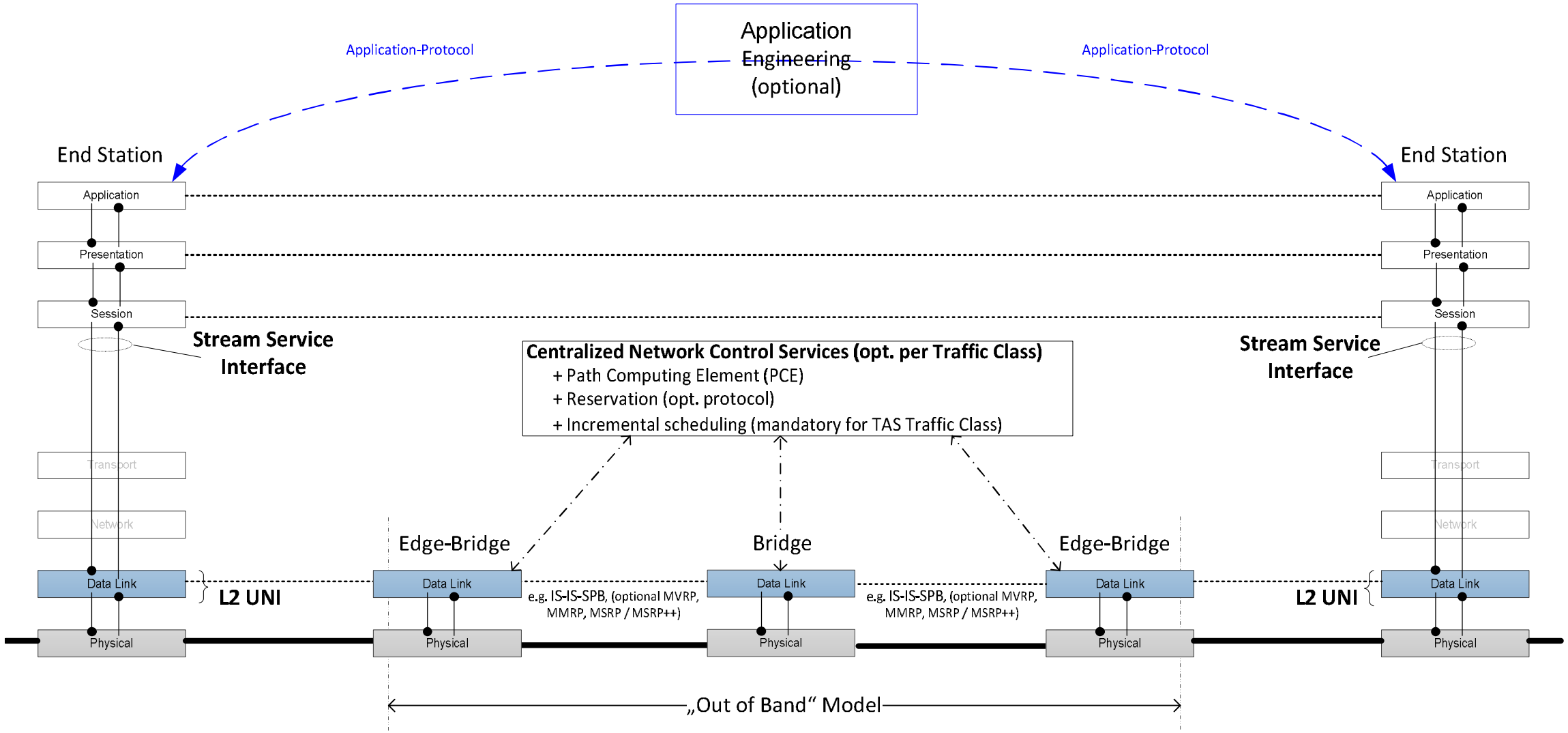


User Network Interface for MAC Streams in a distributed organized Traffic Class / Tree ("open systems")



User Network Interface for MAC Streams in a centralized organized Traffic Class / TE-Tree ("open systems")



User Network Interface for MAC Streams
in a fully centralized organized Traffic Class / TE-Tree ("within a closed system")

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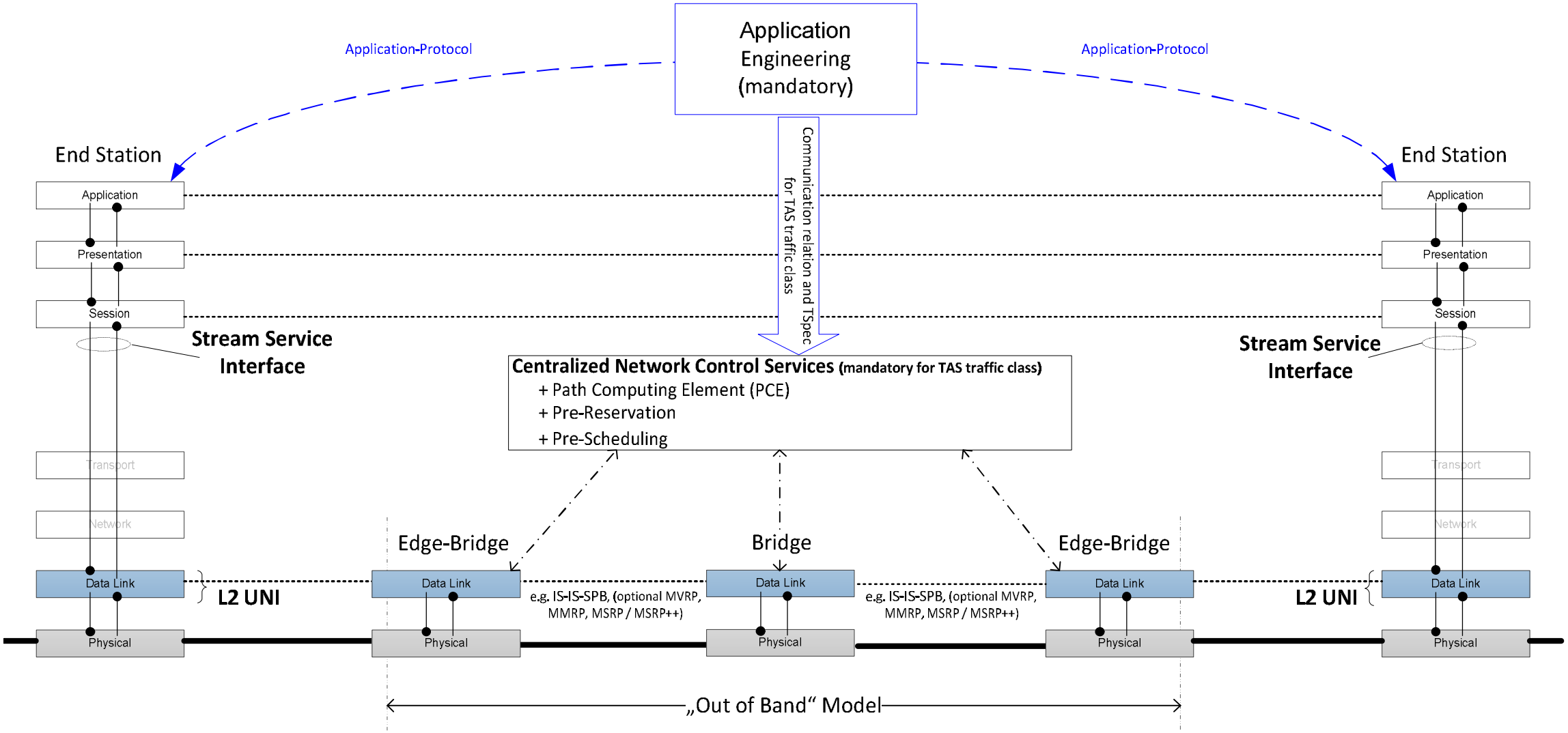

Stream / Flow Service Interface in Session Layer

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Stream / Flow service interface in session layer for

Source (for Streams called Talker)

- **Stream ID**
- **Service Class**
- **TSpec (SDU size, period, ..)**
- **Availability**
- **L2 / L3 Service**
- **…**

Sink (for Stream called Listener)

- **Stream ID**
- **Req. Latency**
- **…**

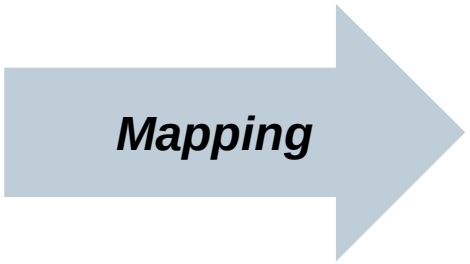
A specified Stream / Flow service interface is important for Session layer protocols like OPC_UA, …!

Example for Mapping Service Class to Traffic Class

Mapping example:

Service Classes *(RFC 4594)*

Telephony
Multimedia Conferencing
Real-Time Interactive
Multimedia Streaming
Broadcast Video
Network Control
Precision Time Sync
Telephony Signaling
Low-Latency Data
OAM
High-Throughput Data
Standard
Low-Priority Data



Ethernet

Priority / Class of Service

3	SR Class A
2	SR Class B
7	Network Control
6	BE High Priority
0	BE Standard
1	BE Low Priority

Thank you for your attention!

Franz-Josef Götz

PD TI AT 4

Gleiwitzer Str. 555

90475 Nürnberg

Phone: +49 (911) 895-3455

E-Mail: franz-josef.goetz@siemens.com