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Registration and Reservation / Signaling

Why a new Protocol Version for Registration, Reservation and Signaling

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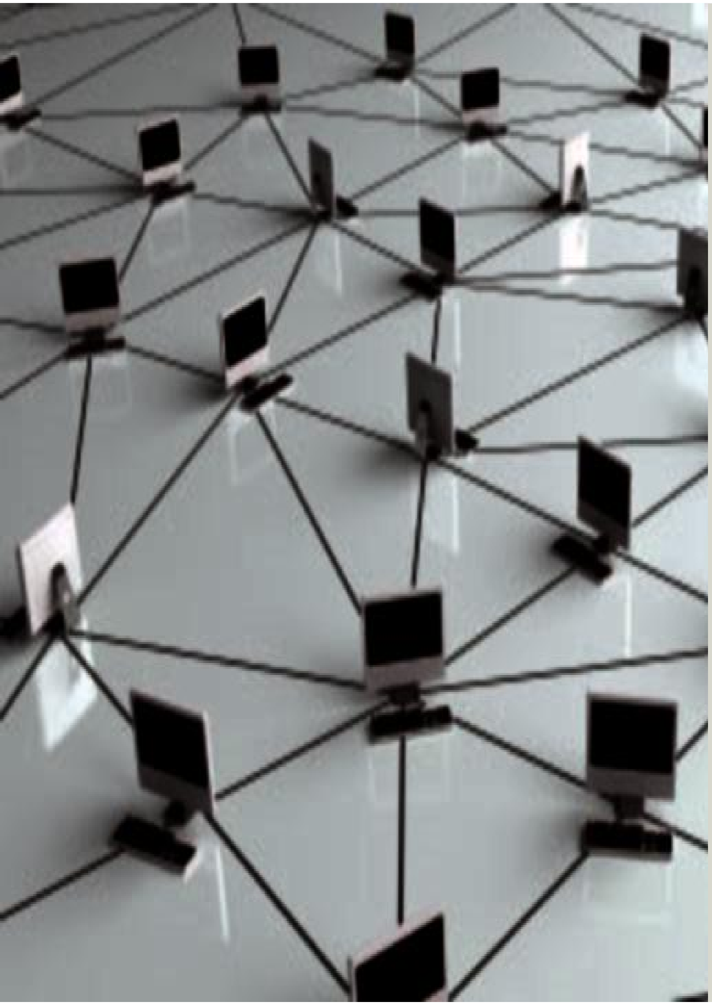

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Assumptions
TSN for Industrial Automation

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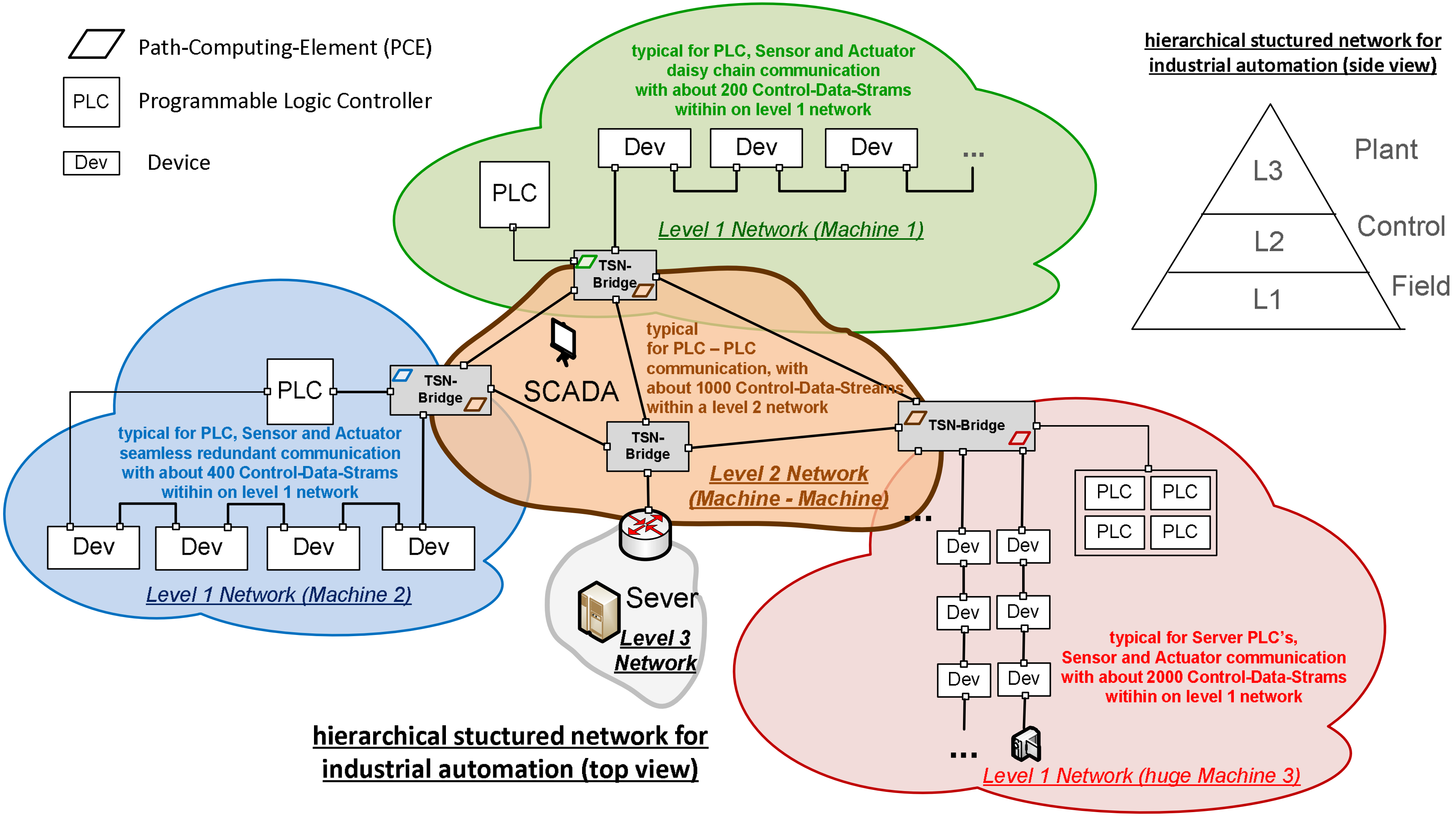
Required functionality for industrial TSN networks

- Industrial networks can be structured hierarchical networks
- Network segments should have the ability to work independent
- Separating and joining of network segments must be possible without losing connectivity within the segment
- After power up dynamically communication relation will be established
  - Control applications and services can go up and down at every time
    (such use cases are discussed within the TSN subgroup of OPC_UA foundation)
- The network must have the ability to add and remove network components and end stations add at every time
- Shared network between multiple control applications and other services must be possible
- The network must guarantee most possible independence between different control applications
- Today PLC's can handle more than 1000 sensors and actuators (up to ~4000 Control-Data-Streams)
- …

⇒ Static control applications mean not at all a static network configuration!

⇒ **For industrial automation networks there is a need for dynamic network configuration**

Example for a Structured Industrial Network



hierarchical stuctured network for industrial automation (top view)

Scalability of Streams in Structured Industrial Network

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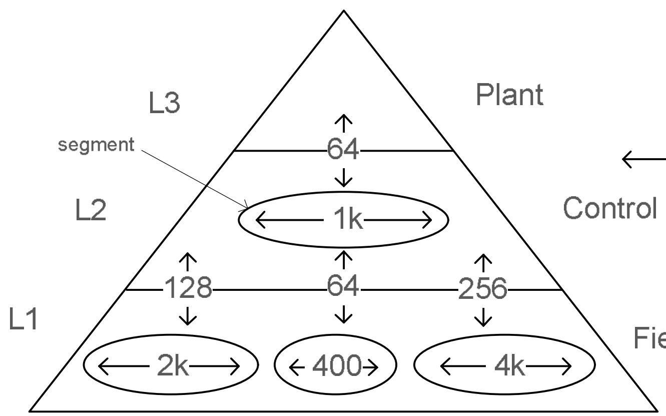
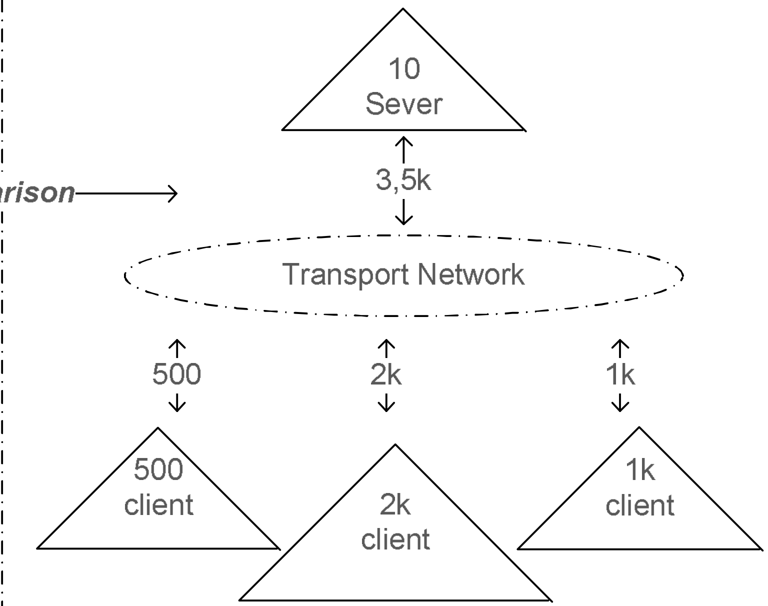
Number of streams in an
hierarchical structured network for
industrial automation (<u>highly de-centralized</u> approach)



Comparison

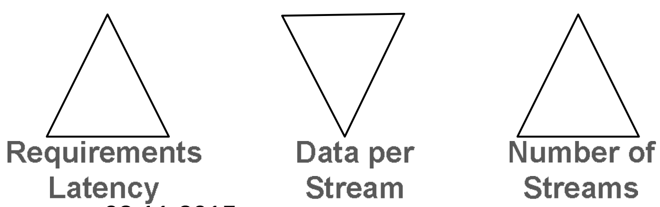
<u>Number of streams in</u>
<u>commercial AVB network (centralized approach)</u>



Example for communication relations in an industrial network:

- L1 : PLC <-> Actuator / Sensor (up to ~4000 Streams per segment)
- L2 : PLC <-> PLC (up to ~1000 Streams per segment)
- L1 -> L2 : e.g. PLC <-> SCADA (up to ~256 Streams between segments)
- L2 -> L3 : e.g. PLC <-> Server (up to ~64 Streams)

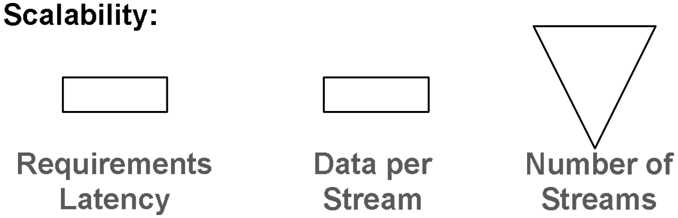
Scalability:



Example for a commercial AVB network:

- Streams are exchanged between server and client
- Flat network connects server and client

Scalability:



Industrial Requirements for Registration, Reservation and Signaling

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Industrial Requirements:

- **Improved protocol performance & deterministic** (more details see later slides)
  - Bridges with limited computing power are used especially in level 1 networks in industrial automation (field level)
  - Daisy chain is widely spread topology in industrial environments (especially in level 1 + 2 networks)

- **Higher scalability** (more details see later slides)
  - Registration, reservation and signaling of up to 4000 Streams (worst case over one port) must be possible

- **Support new TSN features**
  - like pre-established path by path computation, TAS, redundant path, seamless redundancy, manageable traffic classes, dynamic reservation for adding or removing network segments

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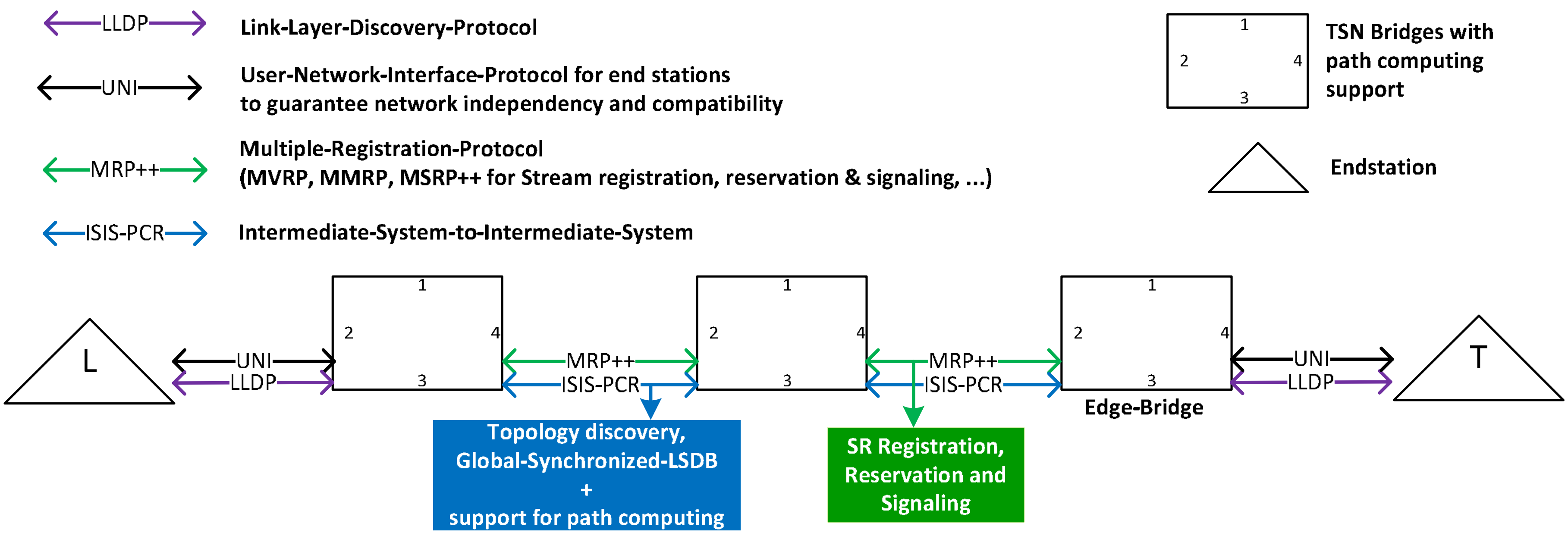
Example for Usage of MRP++/MSRP++

- **UNI is used in end-stations to request stream establishment in a network**

- **MRP++ is used within the network for MSRP++**
  - Stream *registration* (announce initiated by talker - downstream)
  - Stream *reservation* (bandwidth and resource reservation initiated by listener - upstream)
  - *Signaling* is used to distribute events (up- and downstream)
    (events: reservation confirmation [neg. / pos.], listener fails, talker fails, link change, …)



How to Achieve better Performance by a new Registration, Reservation and Signaling Protocol in Comparison to existing MSRP

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Feature	MSRP	New MRP++/MSRP++
Performance & Deterministic	Combines registration (3-packed-Events) and reservation / signaling (4-packed-Events) information.	**Splitting** registration, reservation and signaling information in separate attribute lists (TLV list coding).
	All attribute data are exchanged periodically. Attribute data can changed by events because they are coupled with events.	**Checksum mechanism** for static registration and reservation attribute list with a **slower update rate.** Events are dynamic and are transmitted independent.
	Only one speed for distribution of attribute and events.	**Events** are transmitted over a separate Signaling PDU to enable distribution (up-/downstream) and local processing of events in **parallel** (RSVP like architecture): • to support higher performance, more stringent determinism and • faster propagation of events independent of link-to-link synchronization.

How to Achieve better Scalability by a new Registration, Reservation and Signaling Protocol in Comparison to existing MSRP

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Feature	MSRP	New MRP++/MSRP++
Scalability	MSRP is limited to ~500 Streams	Support up to ~4000 Streams
	The registration, reservation and signaling information can be spread over max. 3 MSRP PDU's	Fragmentation mechanism is used to transmit reservation, registration and signaling attribute data

Background & Conclusion (1)

Background

- **MRP** was designed to register a small number and small size of network attributes
  - MVRP for VLAN registration (2 bytes per network attribute)
  - MMRP for MAC-Address registration (6 bytes per network attribute)
- **AVB** was focused on audio/video networks with a small number for streams
  - MSRP, based on MRP, was born to make about 500 Stream reservations because the size of network attributes increased (up to 34 bytes per network attribute)
  - MSRP was focused on typical server – client use cases (especially the packing mechanism)
- **TSN** is focused on professional audio/video and industrial networks
  - Now, the required number of Stream reservation within a L2 segments has increased up to ~4000 Streams
  - TSN has to support more features (e.g. redundancy, multiple shaper, different traffic classes, …), thus the size of network attribute is expected to increase
  - For n : m communication relations, vectoring mechanism is not practical

Background & Conclusion (2)

Conclusion

To meet the following requirements defined in the Qcc PAR

- *supporting for more streams, (The current worst case limit is less than 500 streams; there are use cases that require two order of magnitude greater than this.)*
- *and deterministic stream reservation convergence*

changes in the architecture of MRP / MSRP are necessary. But the current Qcc PAR does not include work on MRP.

Next Steps!

Industrial automation has a strong requirement for scalable and performance optimized registration, reservation and signaling protocols to support dynamic network configuration.

Our proposals:

- **Step 1:**
  - Detach the items that are not treated from the existing .1Qcc
- **Step 2:**
  - Create a new PAR for the items not covered in the existing .1Qcc PAR
  - Work on MRP++/MSRP++ to improve scalability and performance of the current MRP/MSRP

We ask for a decision to start the protocol work to fulfill the requirements from professional Audio/Video and from industrial!

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