SIEMENS

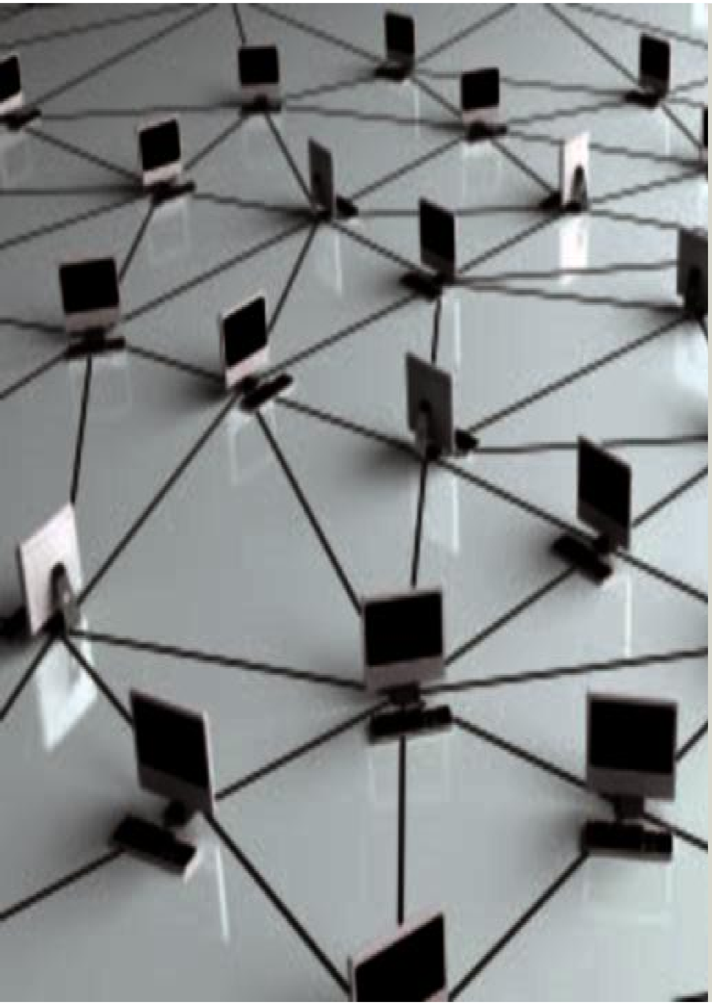
Registration and Reservation / Signaling

Why a new Protocol Version for Registration, Reservation and Signaling

Franz-Josef Goetz – Siemens AG
Juergen Schmitt – Siemens AG
Feng Chen (Presenter) – Siemens AG

IEEE Meeting in Dallas, November 2015

Contents



- Assumptions
- Example for a Structured Industrial Network
- Scalability of Streams in Structured Industrial Networks
- Industrial Requirements
- Example for Usage of MRP++ for MSRP++
- Performance and Scalability of MRP++ / MSRP++
- Next Steps!

Assumptions
TSN for Industrial Automation

SIEMENS

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 (~2000 Control-Data-Streams)
- …

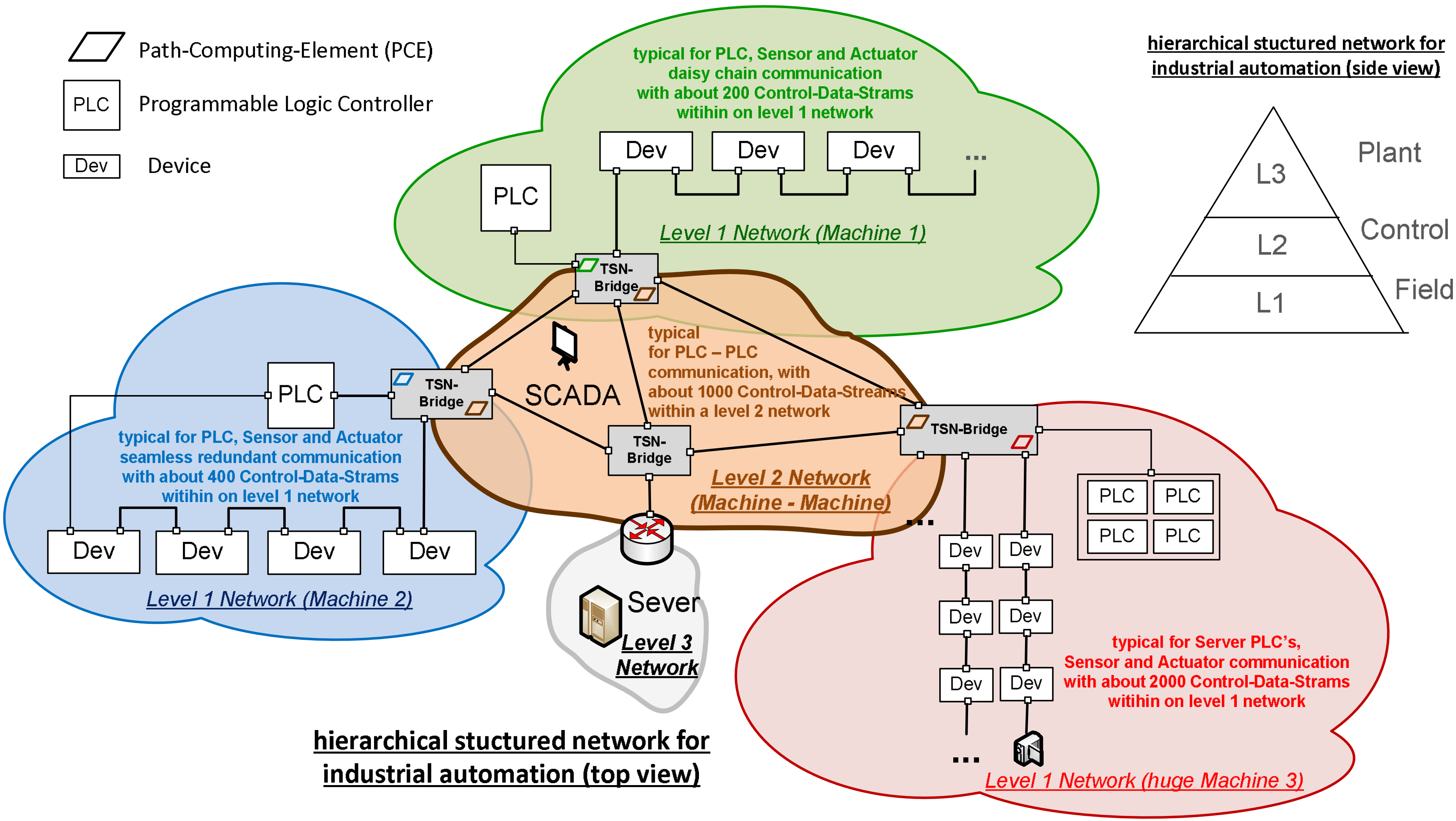
⇒ Static control applications mean not at all a static network configuration!

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

Example for a Structured Industrial Network

SIEMENS

- Path-Computing-Element (PCE)
- PLC — Programmable Logic Controller
- Dev — Device



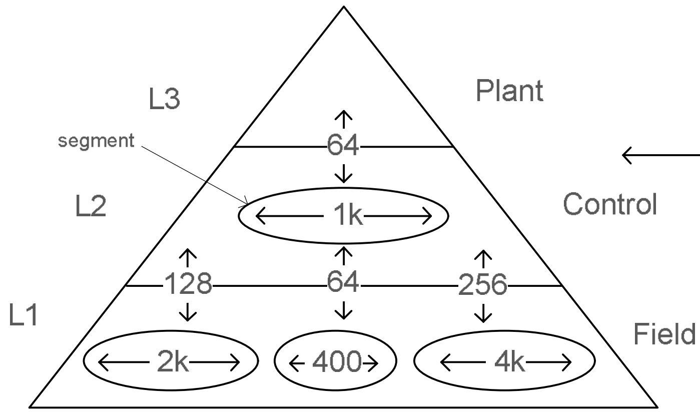
hierarchical stuctured network for industrial automation (top view)

hierarchical stuctured network for industrial automation (side view)

SIEMENS

Scalability of Streams in Structured Industrial Network

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

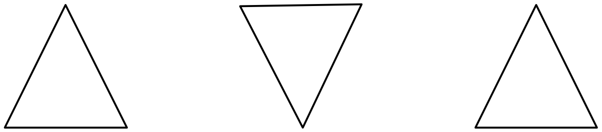


Comparison

Example for communication relations in an industrial network:

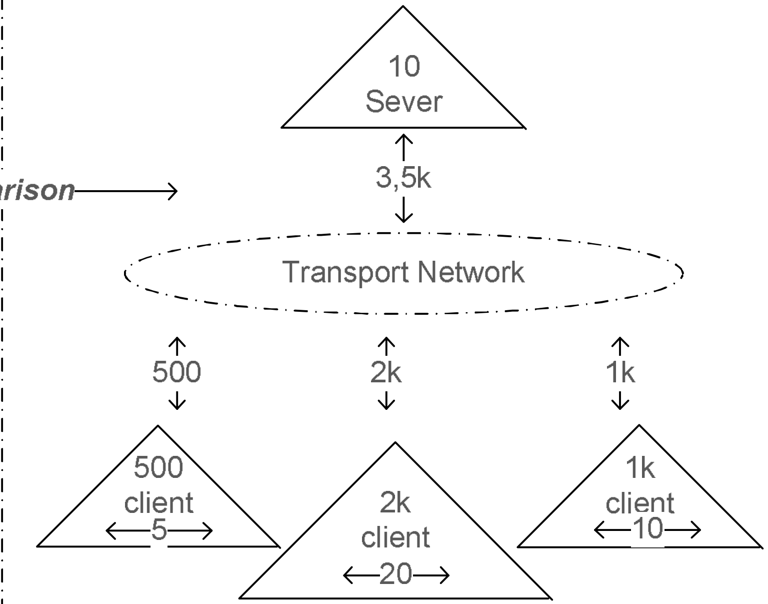
- L1 : PLC <-> Actuator / Sensor (up to ~4000 Streams per segment)
- L2 : PLC <-> PLC (up to ~1000 Streams per segment)
- L1 -> L2 : e.g. PLC <-> SCADA (up to ~256 Streams between segments)
- L2 -> L3 : e.g. PLC <-> Server (up to ~64 Streams)

Scalability:



Requirements Latency | Data per Stream | Number of Streams

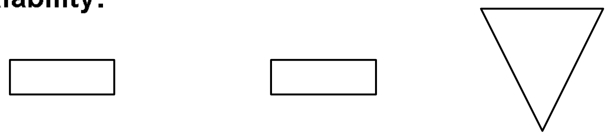
Number of streams in
commercial AVB network (centralized approach)



Example for a commercial AVB network:

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

Scalability:



Requirements Latency | Data per Stream | Number of Streams

Industrial Requirements for Registration, Reservation and Signaling

SIEMENS

Industrial Requirements:

- Bridges with limited computing power are used especially in level 1 networks in industrial automation (field level)
- Daisy chain is wide spread topology in industrial environments (especially in level 1 + 2 networks)
- Registration, reservation and signaling of more than 5000 Streams (worst case over one port) must be possible
- Supporting new TSN features like pre-established path by path computation, TAS, redundant path, seamless redundancy, manageable traffic classes, … is part of .1Qcc.
- Supporting new industrial requirements like structured networks, tool changing, …

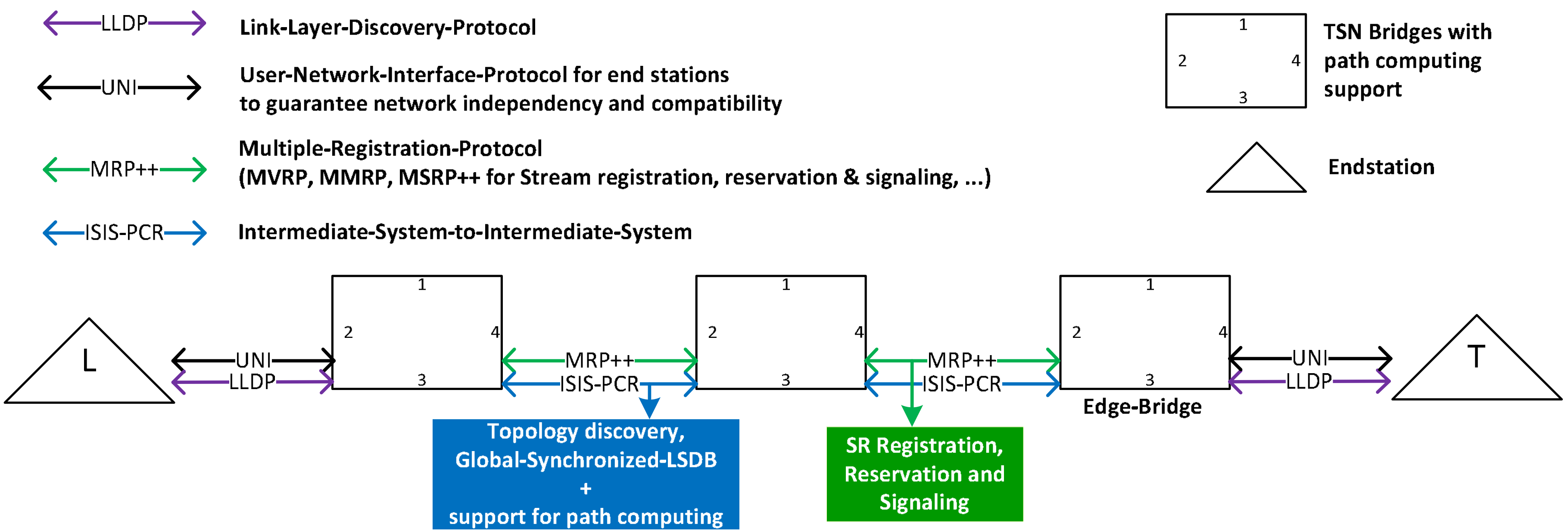
⇒ *Major goals for a new registration, reservation and signaling protocol:*

- **Improved protocol performance & deterministic** (more details see later slides)
- **Higher scalability** (more details see later slides)
- **Supporting new TSN features**
  - Pre-established path, TAS, redundant path, …
- **Supporting new industrial requirements**
  - Mapping for different stream classes on crossover, pending reservations, rate constrained services, …

Example for Usage of MRP++ for 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

SIEMENS

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

SIEMENS

Feature	MSRP	New MRP++/MSRP++
Scalability	MSRP is limited to ~500 Streams	Up to 5000 Streams are supported
	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 5000 Streams
  - TSN has to support more features (e.g. redundancy, multiple shaper, different traffic classes, …)
  - n : m communication relations (not only centralized server)

Background & Conclusion (2)

Conclusion

While working on the .1Qcc project it turns out, to fulfill the expectation on

- 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

the architecture of MRP / MSRP must be changed. This is *not in scope* of the .1Qcc project.

Stream reservation is an essential function for a dynamic TSN system. There is a need for a quick solution!

SIEMENS

Next Steps!

Industrial automation has a strong requirement for a scalable and performance optimized registration, reservation and signaling protocol supporting dynamic network configuration.

We see two steps for a quick solution:

- **Step 1:**
  - Revise the existing .1Qcc PAR to detach items for the existing .1Qcc which can not be treated
- **Step 2:**
  - Create a new PAR for the detached items
  - Work on MRP++/MSRP++ to improve scalability and performance of the current MRP/MSRP

➢ **There is a need for a decision to start the protocol work as soon as possible to fulfill the requirements from professional Audio/Video and from industrial!!!!**

SIEMENS

Authors

Franz-Josef Goetz
Senior Key Expert „System Communication“
Siemens AG
PD TI AT TM 4 2
Gleiwitzer-Str. 555
90475 Nürnberg
Phone: +49 (911) 895-3455
E-Mail: franz-josef.goetz@siemens.com

Jürgen Schmitt
Architect
Siemens AG
PD TI AT TM 4 2
Gleiwitzer-Str. 555
90475 Nürnberg
Phone: +49 (911) 895-5338
E-Mail: juergen.jues.schmitt@siemens.com