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New Data Objects & New Protocols

How to continue with Qcc

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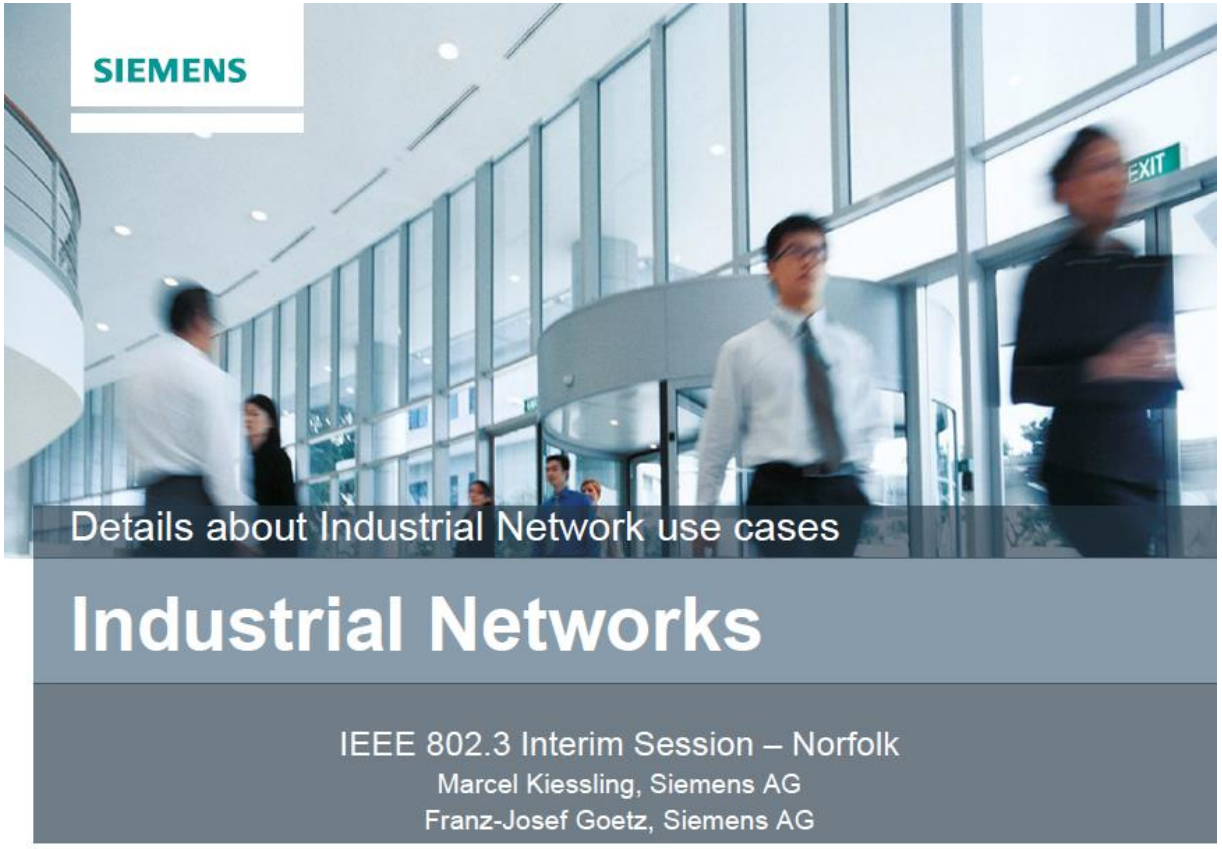
Requirements for Industrial networks



Protocols for a consistent network configuration & diagnostic information

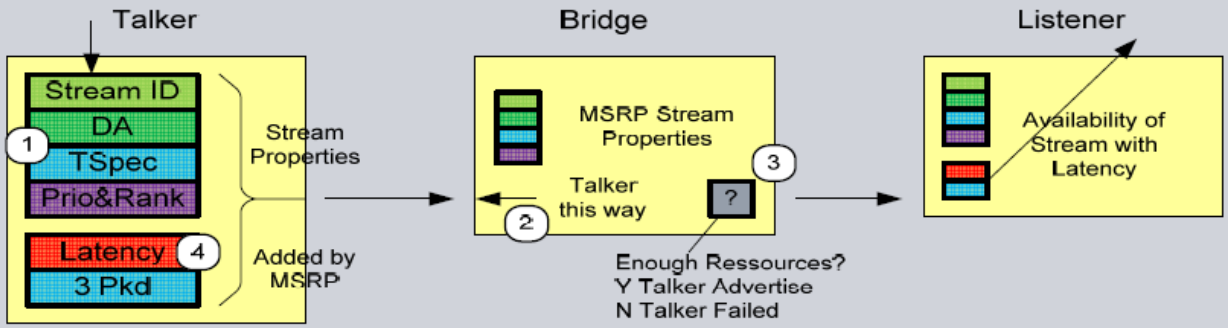
Applications are independent from the network – multiple share it

Recap: Task of MSRP in AVB networks

AVB Gen 1
Task of MSRP Talker Advertise

Talker advertise is used by MSRP for:

1. Announcement of stream properties (Talker -> Bridge -> Listener)
2. Find path to Talker in the RSTP network
3. Check availability of resources on the path from Talker to Listener (s)
4. Accumulate latency on the path from Talker (T) to Listener (L)



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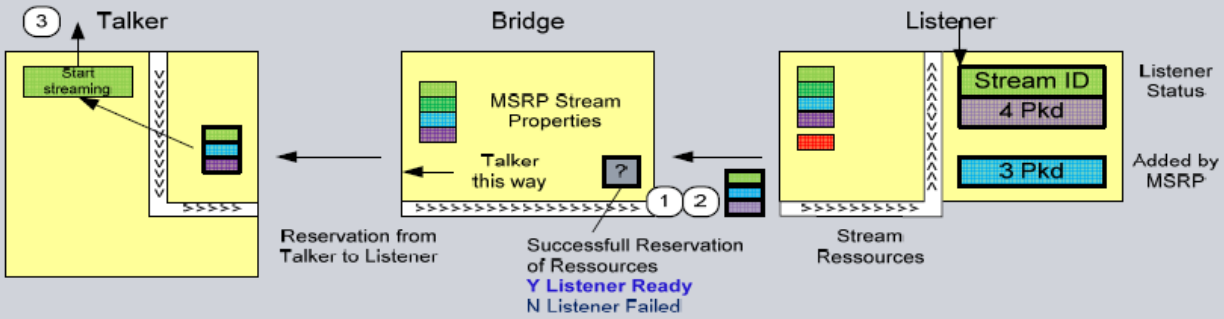
Recap: Task of MSRP in AVB networks

AVB Gen 1
Task of MSRP Listener Ready

The MSRP Listener Ready is used for:

1. Reservation of the resources
2. Control and set forwarding path (stop blocking)
3. Starting transmission of stream (after reservation of all resources)



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Changed tasks in a TSN network

Original design of Qca:

1) Announcement of stream properties
   *Registration of **more** Stream properties with improved MSRP*
2) Find path backwards to Talker in the RSTP network
   ***Qca** can be used to define forwarding paths*
3) Check availability of resources on the path from Talker to Listener(s)
   Resource Reservation and diagnostic information on the path
4) Accumulate latency on the path from Talker to Listerner
   *Min. and Max. Latency (for **CB**)*

Proposal for a new mixed Desgin (Qca + MRP** + MSP**):

1) Announcement of stream descriptions
   MSRP** for *registration of **more** Streams and more Streams properties (to support the new TSN mechanisms)*
2) Registration on
   - **RSTP**: MRP**
   - ***Pre-calculated Path (e.g. Qca):** MRP***
3) Check availability of resources on the path from Talker to Listener(s)
   MSP** *for reservation, state information and e2e **signaling** along the path*
4) Accumulate latency on the path from Talker to Listener(s)
   MSP** *provides Min. and Max. Latency (for **CB**)*

MRP++ and MSP
Reasons for splitting Registration and Reservation

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At the moment within the TSN group there is a discussion

- How to "support more streams. The current worst case limit is less than 500 streams; there are use cases that require two orders of magnitude greater than this."
- How to get "deterministic stream reservation convergence."
- …

(excerpt from the .1Qcc PAR)

The following slides

- explain **registration**
- explain **signaling** (reservation)

and show the difference also in the architecture between both

The current MSRP implementation expanded MRP to do both jobs

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Registration:

Properties:

- Attributes get synchronized between links *(ISIS-like on link)*

  Details on the following slides …
- Synchronized data is constant (no modification within a Bridge)

  -> called "static" information in the TSN Telco's
- No creation of new Attributes

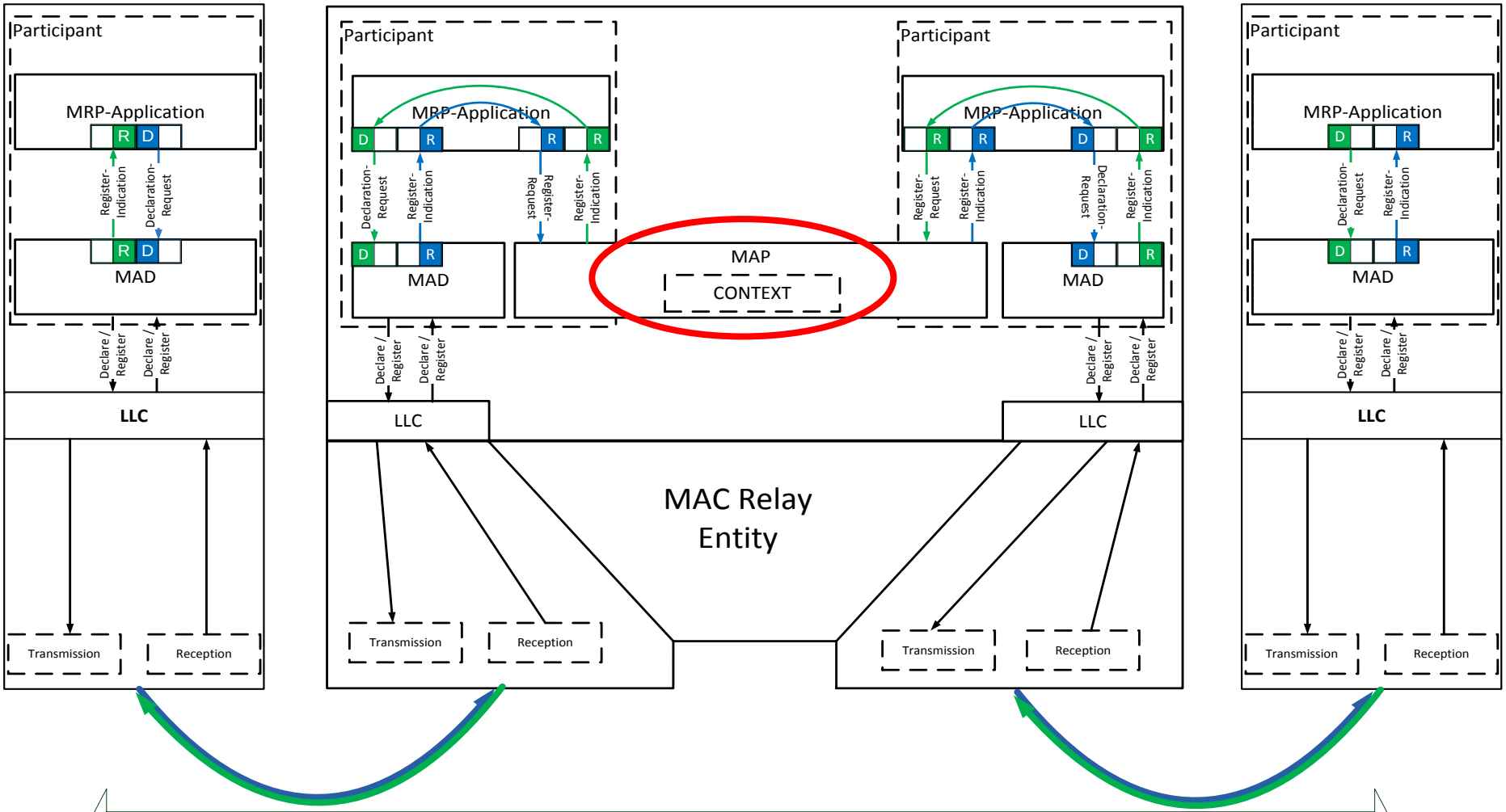
  -> propagation of the registered information in the network along the path
- Has to scale to larger amount of data

  Fragmentation of PDU is necessary!
- Synchronized attribute propagation is the main focus

Main focus:

- Reliable synchronization of network attributes within an active topology given by a context. (In contrast to ISIS where Attributes are flooded all over the network to everybody)

Registration: MRP++ Architecture



One Registration Application (out of others) is MSRP (Multiple Stream Registration Protocol)

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Used to propagate the **static properties** of a stream along the path.

Such properties are for example:

- VID
- Max. frame size
- Frame priority
- Rank
- Stream-ID
- Tree-ID (for path)
- Stream destination MAC
- …

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Reservation (Signaling)

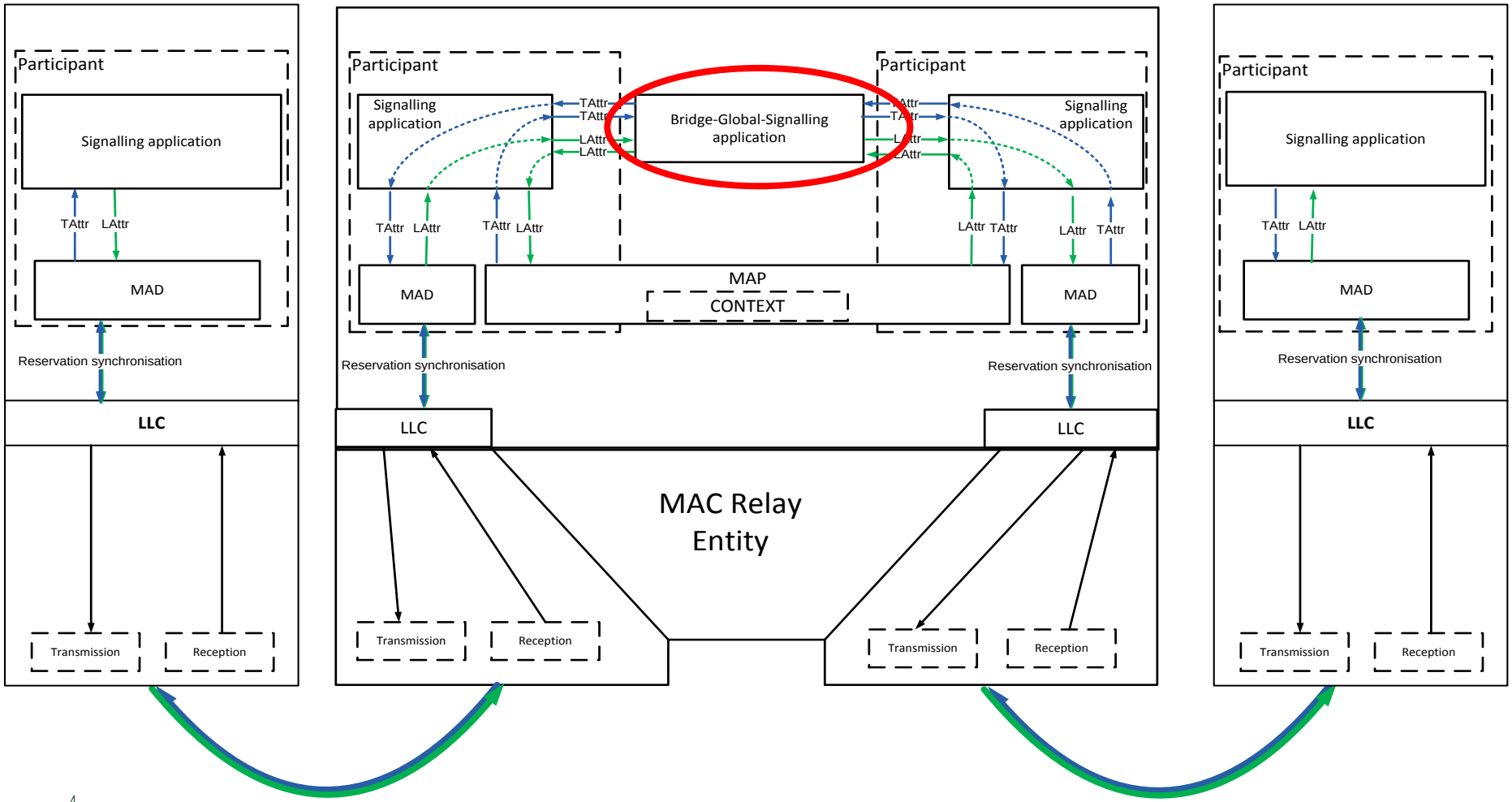
Properties:

- Directed from source to sink
- Attributes can get modified at every Hop
- Changes along the Path between source and sink has to be signaled very fast
- Attribute disappears if source withdraws or times-out
- Beside cyclic Link-To-Link synchronization, event based PDUs are necessary

Main focus:

- **End-to-End** signaling
- Monitoring the path between source and sink
- Fast signaling of changes along the path between source and sink
- Signal to source and sink what they get guaranteed along the path

Basic MSP Architecture



One Signaling Application (out of others) is MSSP (Multiple Stream Signaling Protocol)

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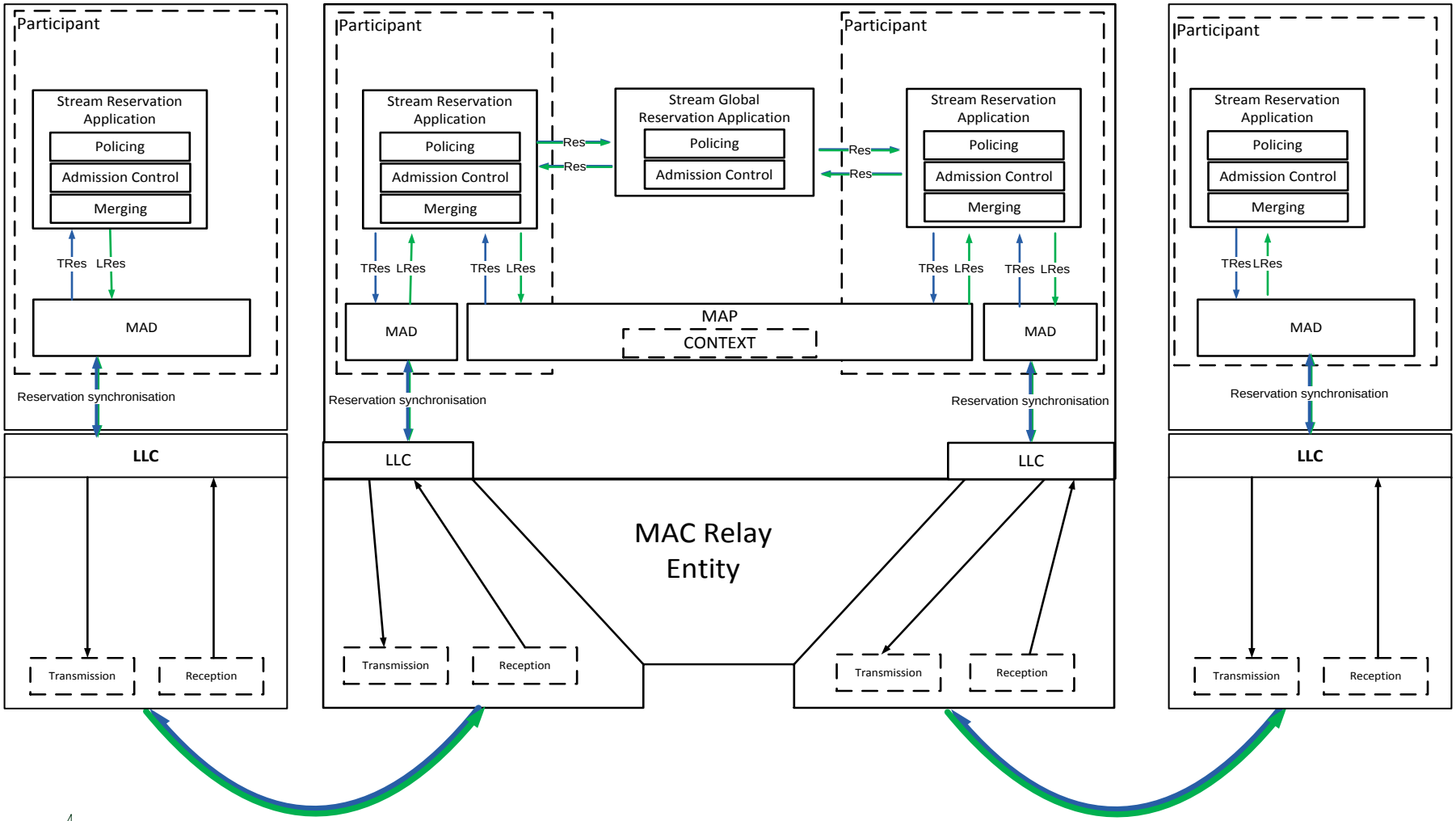
Used to:

- propagate the **dynamic properties** of a stream along the path (Upstream AND Downstream).
  E.g.:
  - Accumulated min. and max. Latency (Downstream)
  - Required Latency (Upstream)
  - Min. receive Interval (Upstream)
  - Effective receive Interval (Downstream)
  - Stream send state (Ready/Failed) (Downstream)
  - Stream receive state (Ready/Failed/ReadyFailed) (Upstream)

- Use the event based **messages** to by-pass the slow cyclic Link-To-Link synchronization to signal disruptive events on the path
  (e.g. Link-Down due to wire break)

MSSP Architecture
(Multiple Stream Signaling based on the MSP-Architecture)



Conclusion for decentralized and centralized Approaches

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Different proposals with general Requirements:

- *Common Interface (**UNI**) between Application and TSN Networks*
- *Applications with own (higher layer) protocol for application configuration should see no difference between centralized and decentralized organized networks!*
  - *Shapers (including time-based forwarding) in the same physical network*

Network control:

  - *Bridges can compute the paths (BLCEs) and do the local configuration (**decentralized**)*
  - *PCEs can compute path and scheduling and remotely configure bridges (PCEP – **centralized**)*
- *Connection to Layer 3 (IETF DetNet?)*

Both require a standardized network service for coordination

Registration and Reservation as network service

Diagnostic based on these available network information!

Tasks for Qcc:

  - *Adding new MRP data objects for control (TLV's) to support new TSN features like redundancy*
  - *Specifying new Managed Objects which are required to configure traffic classes*
- ***Suggested new work item:***
  - Splitting Registration and Signaling into M**R**P** for registration and M**S**P** for signaling (reservation)
    *MRP with M**S**RP => MRP** with M**S**RP** and MSP** with M**S**SP***

Requirements
TSN for Industrial Automation

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Required functionality for industrial TSN networks

- Industrial networks are typically structured hierarchically
- Network segments must have the ability to work independently
- Separating and joining of network segments must be possible without losing connectivity within the segment
- After power up dynamically communication relation will be establish
- The network must have the ability to add and remove network components and end stations at any time
- The network is shared between multiple control applications and other services
- Control applications and services can go up and down at any time
- The network must guarantee most possible independence between control applications

⇒ **Static control applications mean not only static network configuration.**

⇒ **Static centralized network configuration will not at all fulfill the automation requirements on industrial network!**

The following slide shows a possible Future of de-/centralized Industrial Networks based on the existing IEEE 802.1 Building Blocks

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Description of a hierarchical structured industrial network:

- **PLC 1 Usec Case in VLAN 4**
  - E2E higher layer protcol to establish communication between PLC 1 and its actuators and sensors
  - PLC 1 – Edge Bridge UNI interface
  - Edge Bridge contains a PCE (centralized path computing) and supports PCEP+
  - ISIS PCR for topology discovery / also the virtual topology of VLAN 4
  - MRP ++ for distributed registration of “explicit tree”, stream description, VID, … along the “explicit tree”
  - MSP for distributed reservation of resources, e2e signaling, .. along the “explicit tree”

- **PLC 2 Usec Case in VLAN 5**
  - E2E higher layer protcol to establish communication between PLC 2 and its actuators and sensors
  - PLC 2 – Edge Bridge UNI interface
  - Edge Bridge and all Bridges with the VLAN 5 contain a BLCE for decentralized path computing
  - ISIS PCR for topology discovery / also the virtual topology of VLAN 5
  - MRP ++ for distributed registration to nail down the path (MRRP), stream description, VID, … along the path
  - MSP for distributed reservation of resources, e2e signaling, .. along the path

- **PLC 3 Usec Case in VLAN 7**
  - E2E higher layer protcol to establish communication between PLC 3 and its actuators and sensors
  - PLC 3 – Edge Bridge UNI interface
  - Edge Bridge contains a PCE (centralized path computing) and supports PCEP+
  - ISIS PCR for topology discovery / also the virtual topology of VLAN 7
  - MRP ++ for distributed registration of “explicit tree”, stream description, centralized “schedule”, VID, … along the “explicit tree”
  - MSP for distributed reservation of resources, e2e signaling, .. along the “explicit tree”

Possible Future of de-/centralized Industrial Networks based on the existing IEEE 802.1 Building Blocks