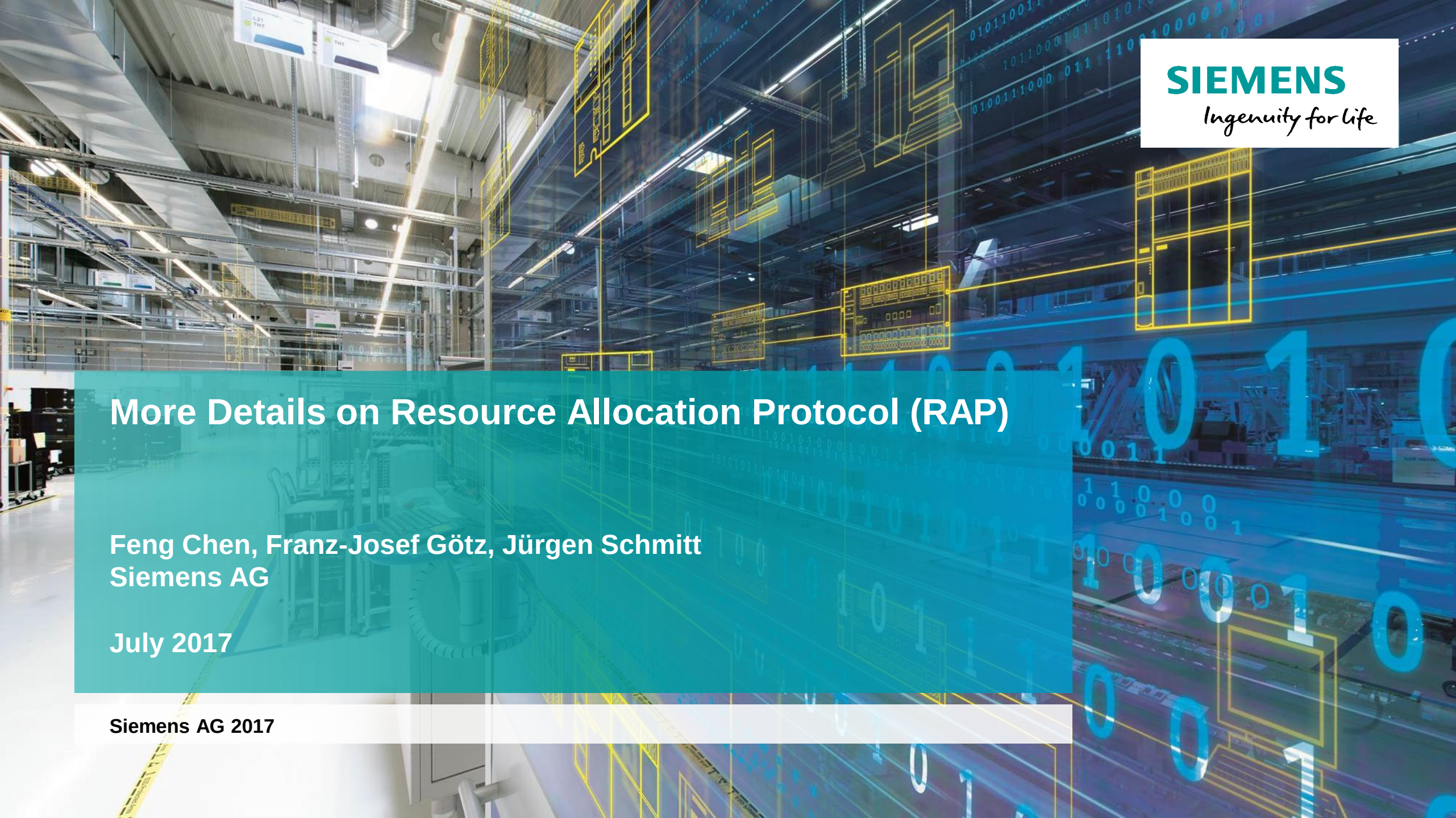

More Details on Resource Allocation Protocol (RAP)

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Recap

Motivations for a new Resource Allocation Protocol (RAP):

(see presentation: http://www.ieee802.org/1/files/public/docs2017/new-chen-RAP-proposal-and-requirements-0517-v02.pdf)

- driven by the need of many industrial applications for bounded latency and zero congestion loss, which are achievable by shaper plus distributed stream reservation without the necessity of applying scheduled traffic with centralized scheduling
- further development of the distributed configuration model for TSN to support more features
- leverage the benefits of LRP – better efficiency and support for larger registration database than MRP

Proposed features of RAP:

(see presentation: http://www.ieee802.org/1/files/public/docs2017/new-kiessling-RAP-poposal-and-features-0517-v01.pdf)

- distributed stream reservation based on configurable SR Class associated with TSN transmission mechanisms
- stream configuration for seamless redundancy
- improved attribute propagation
- collaboration with upper layer reservation

Outline

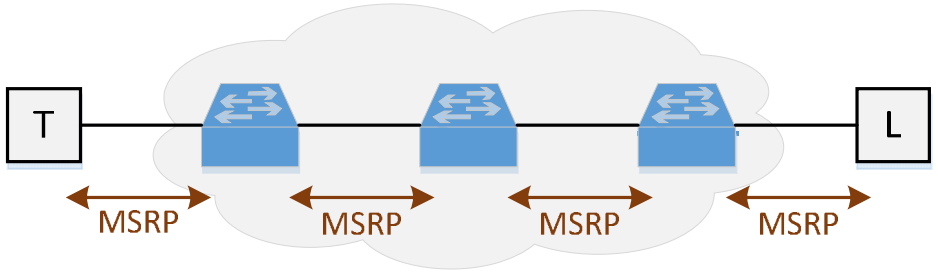
This presentation discusses the following issues

1. Information model for RAP
2. Improved attributes propagation
3. Domain detection for RAP
4. Stream reservation for seamless redundancy
5. Collaboration with upper layer reservation

1. Information Model

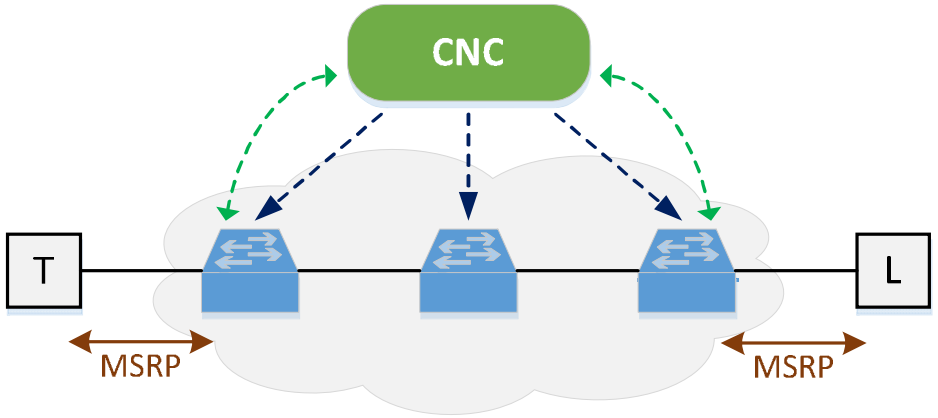
for Distributed Stream Configuration in RAP

Information Flow of Distributed and Centralized Configuration Models based on Qcc



Distributed Configuration (SR class based)

- Network service is described and provided for user **on a per SR Class base**
- SR classes exist on the network as default (AVB Class A/B) or can be preconfigured by management (already enabled by Qcc)
- End-stations have knowledges of SR class settings on the network and decide which SR class to use for their streams before sending their requests
- A peer-to-peer protocol performs stream reservation hop-by-hop using both stream-specific information (like T-Spec) and SR class parameters (e.g. measurement interval, shaper, etc)

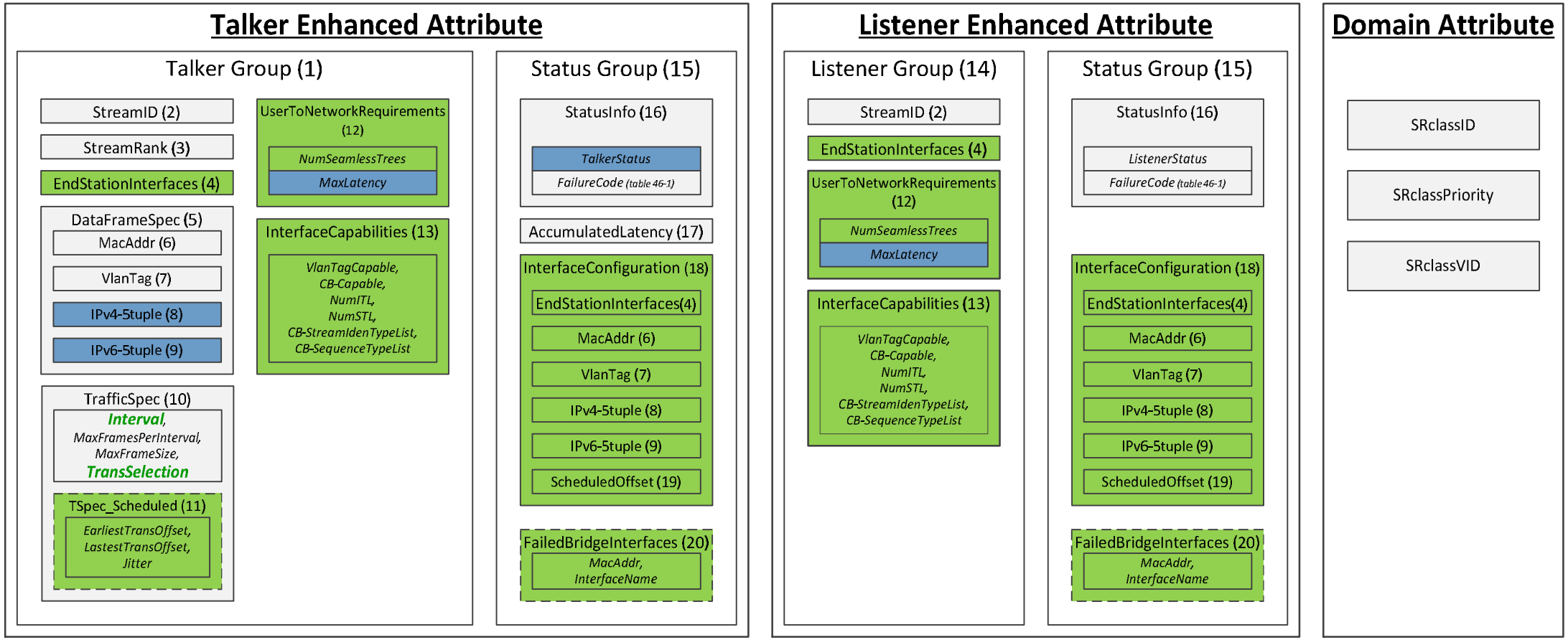


Centralized configuration

- A per-stream request-response model, where **SR class is not explicitly used**
- End-stations can send request for a specific stream (via edge port) to CNC without knowledge of the network configuration
- CNC processes each stream request and perform steam reservation centrally
- MSRP runs only on the link to end-stations, as “information carrier“ between end-stations and CNC (not really used for stream reservation in the network)

Different configuration models require different configuration information.

MSRPv1 Attributes
based on Information Model in Qcc Clause 46



XXX *defined by MSRPv0*

XXX *defined by MSRPv1, applicable for both distributed and centralized models*

XXX ***defined by MSRPv1 exclusively for centralized configuration** (with a CNC and „MRP External Control" enabled in the nearest **bridge**)*

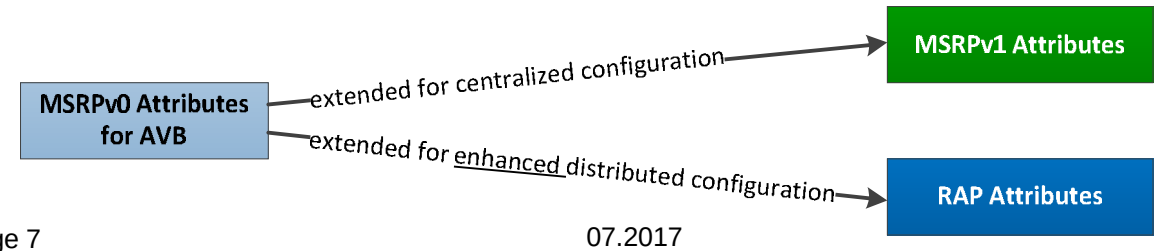
(These MSRPv1 items suits not for the distributed Stream configuration model because path control and scheduling is not part of it.
For path control the IEEE 802.1Q standard has already defined different managed objects and procedures.)

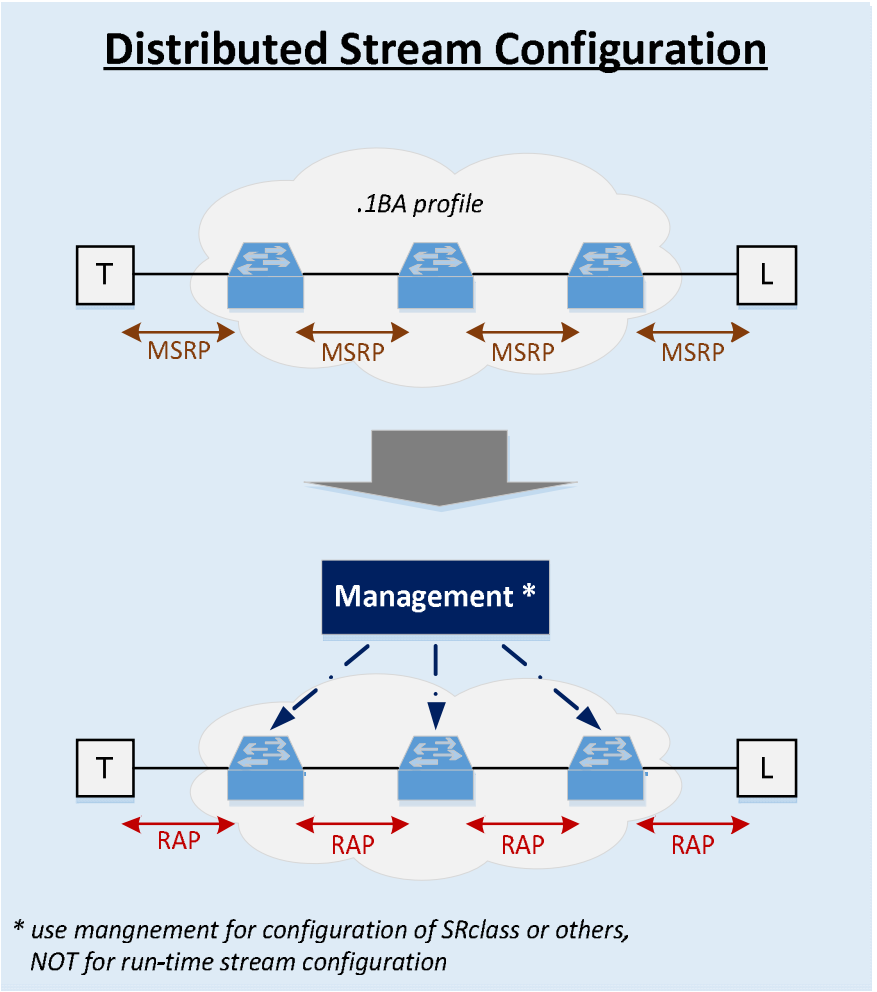
Proposal for RAP Information Model

- The **MSRPv1** attributes contains many items that are exclusively designed for **centralized configuration** and only used by CNC to conduct the following operations:
  - **centralized path computing**
  - **centralized scheduling and reservation for streams**
  - **centralized configuration for seamless redundancy**

- The main focus of **RAP** is **distributed stream reservation**
  - **path computation is not part of RAP and will be provided by other mechanisms** (e.g. SPB-PCR, MST-TE, …)
  - **seamless redundancy can be supported, e.g. based on MRT established** by ISIS-PCR
  - **scheduling is not directly supported**

Proposal: **The information model for RAP should be defined based on the MSRPv0 attributes, as extensions for distributed configuration**





Proposal for RAP Attributes

Talker Advertise Attribute

StreamID

SRclassID

TrafficSpec

MaxFramesPerInterval, MaxFrameSize,

StreamRank

AccumulatedLatency

MaxLatency

TalkerStatus

FailureCode

DataFrameSpec

MacAddr

VLAN Tag

PCP, VID

Encapsulation for IP?

SRclassID: SRclass associated with this stream

Listener Attribute

StreamID

MaxLatency

ListenerStatus

FailureCode

Domain Attribute

SRclassID

SRclassPriority

Transmission Selection

ClassMeasurementInterval

SRclassMaxFrameSize

SRclassTargetMaxLatency

Note: The original Domain Attribute in needs to be extended to support detection of RAP domains for configurable SRclass. *(more info on the 2nd part of this presentation)*

xxx *defined by MSRPv0*

xxx *defined by MSRPv1*

xxx *defined by RAP*

2. Improved RAP Attribute Propagation

Separation of Stream Reservation Information for LRP

Goal: to minimize the amount of data exchanged over the link by LRP in the operation mode and to leverage the checksum mechanism (e.g. checksum per Sub-TLV)

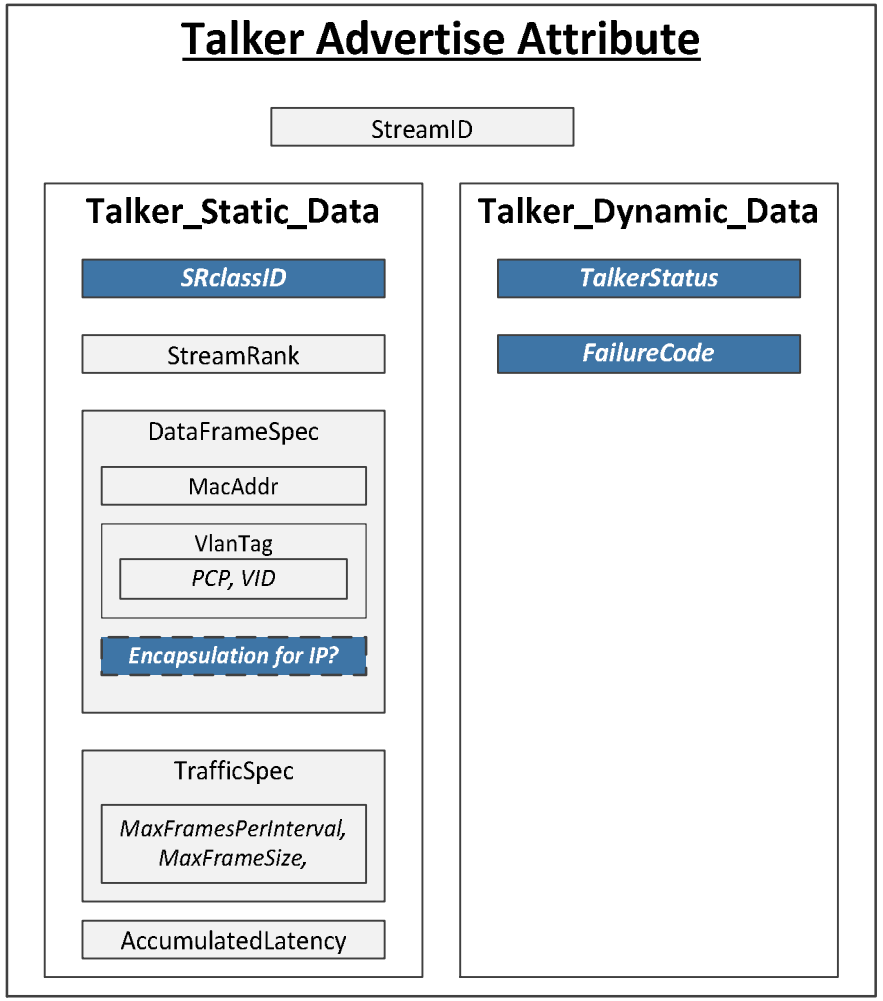
Proposal: split **Talker Advertise Attribute** into two Sub-TLV's

§ **StreamID**

§ **one Sub-TLV for static data (relatively stable on link)**

- SRclassID, Stream Rank
- DataFrameSpec (MacAddr, PCP, VID)
- Tspec (MaxFramesPerInterval, MaxFrameSize)
- Accumulated Latency

- **one Sub-TLV for dynamic data (relatively variable on link)**
  - Talker Status
  - FailureCode



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3. Domain Detection for RAP

Domain Attributes for RAP

Purpose:

- In network to establish domain boundaries the information which characterize a SR class must be exchanged on each link
- For Talkers to select the proper SR class for Streams

SR class Domain Attributes

Domain Attributes	Description
srClassID	All stations (bridges and end stations) those transmit streams associate the same unique srClassID value for a certain SR class
Priority	All stations those transmit streams associate the same priority value for a certain SR class
Transmission Selection	All stations those transmit streams at a certain SR class should support the same shaper / transmission mechanism (e.g. CBSA, CQF, ATS) to a given outbound queue
ClassMeasurmentInterval	All stations those transmit streams associate the same interval for a certain SR class
srClassMaxFrameSize	Maximum frame size of streams for a given SR class for calculation of maximum interference for SR class with higher priority
srClassTargetMaxLatency	Maximum latency for Streams of a given SR class (comparable to TargetLatency of .1BA, e.g. 2ms for SRClass A over 7 hops). Calculated by management upfront based on the network diameter (max hop count), ClassMeasurementInterval, used transmission mechanism… to assist the talker to choose the desired SRClass for a given stream.

4. Stream Reservation with RAP for Seamless Redundancy

.1CB Use Case 1: End-To-End FRER

Assumptions:

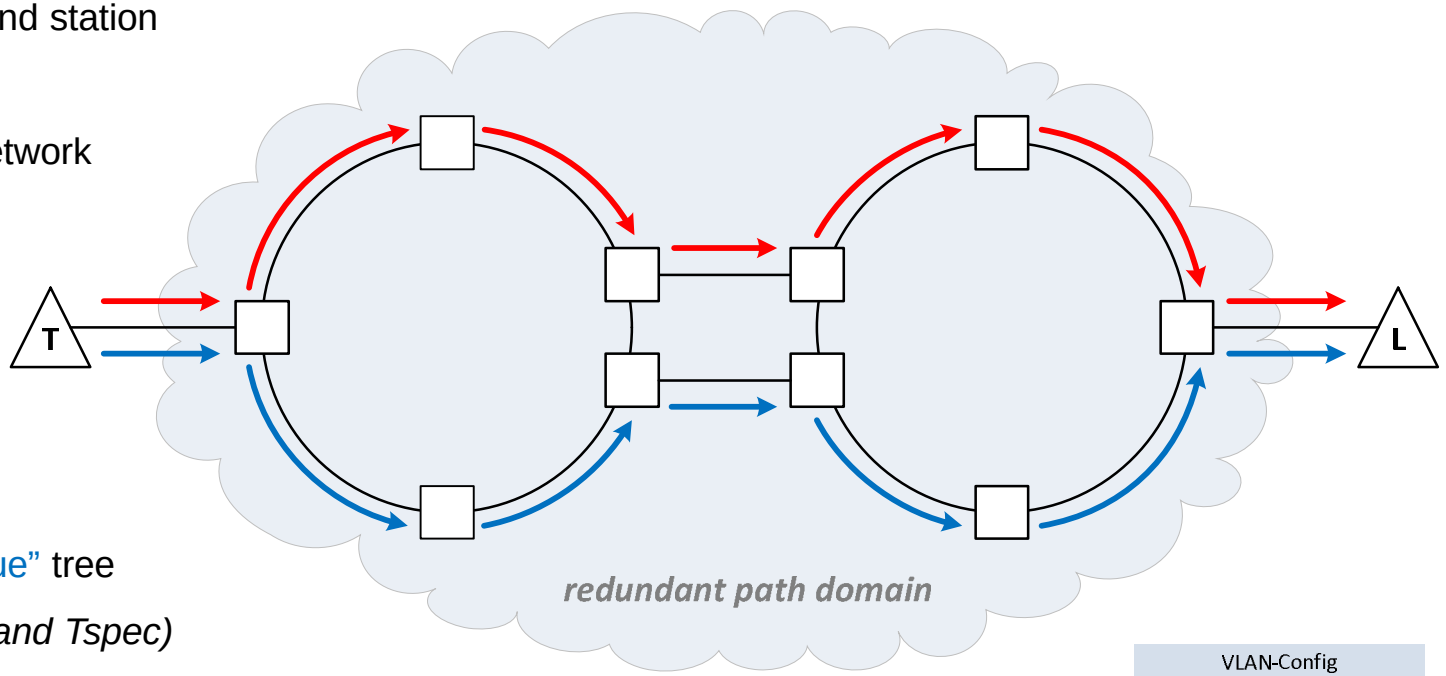
§ End stations send and receive redundant frames (one compound stream with two member streams)

§ Duplicate generation and eliminations done within the end station

§ End stations recognize if one path fails

§ Redundant spanning trees are pre-established in the network

§ Each tree uses a different VID



Proposals for RAP:

§ The Talker transmits two **TalkerAdvertises**

- one over the "red" tree and the other over the "blue" tree
- using the same values in *(StreamID, DA, Priority and Tspec)*
- but with different *VIDs*

=> RAP needs to accept two **TalkerAdvertises** with the same values of (StreamID, DA, Priority, Tspec) but with different **VIDs**

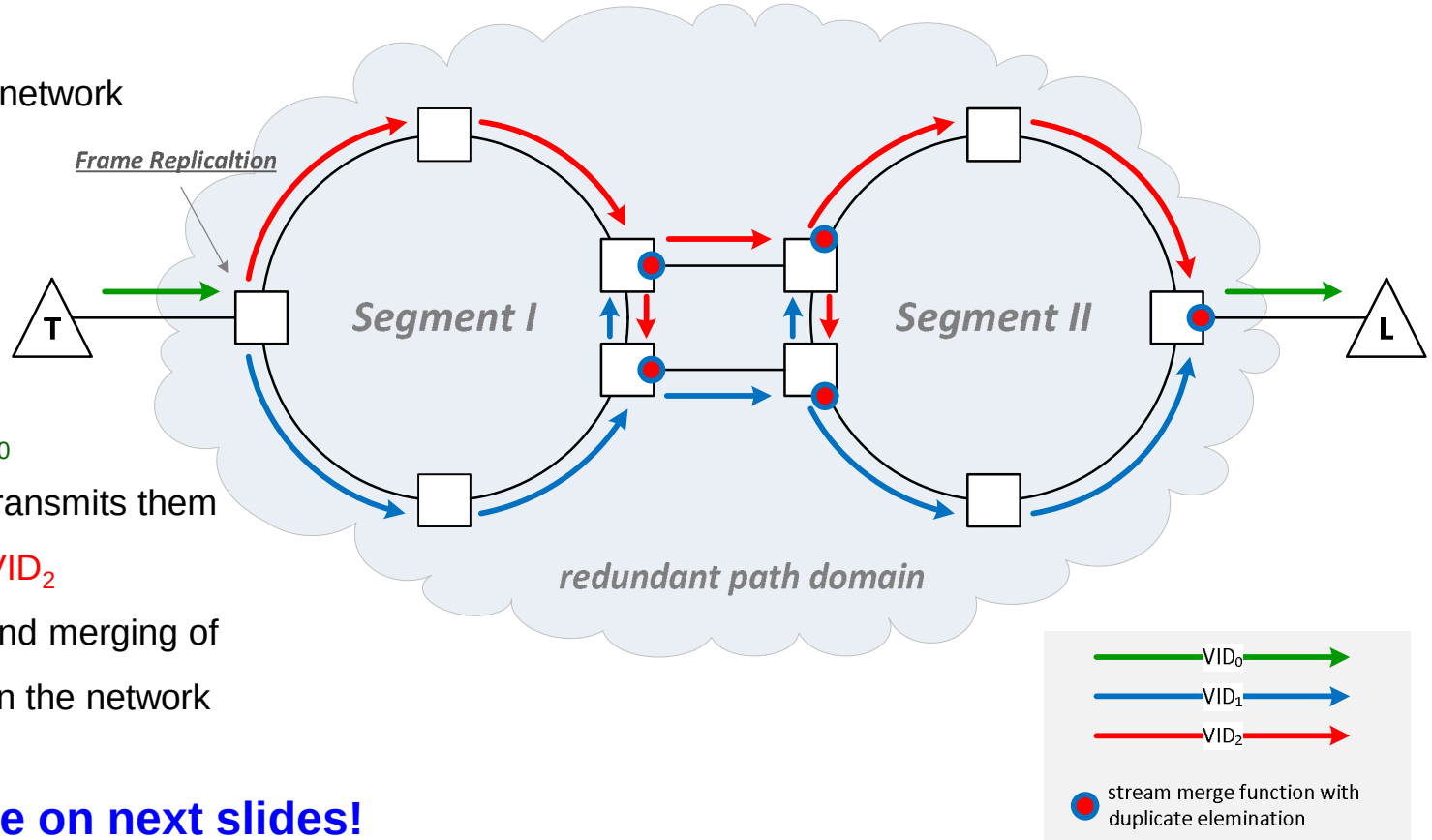
.1CB Use Case 2: Seamless Redundancy with Segment Protection

Assumptions:

- End stations send and receive one frame
- FRER is done by Bridges according to 802.1CB
- Redundant spanning trees are pre-established in the network
- Each tree uses a different VID

Proposals for RAP:

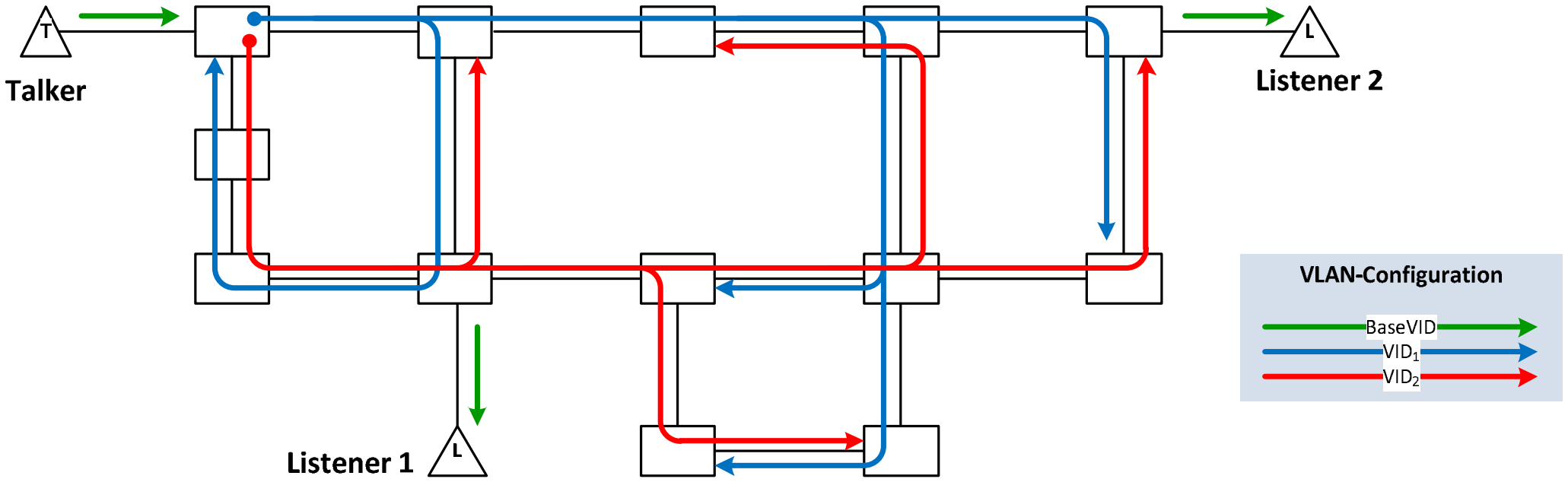
- The Talker transmits one **TalkerAdvertise** using VID_0
- The first bridge replicates the **TalkerAdvertise** and transmits them over the "blue" tree with VID_1 and the "red" tree with VID_2
- RAP needs to define some rules to support splitting and merging of the attributes over redundant trees at certain points on the network



=> We show more details for this use case on next slides!

.1CB Use Case 2: Seamless Redundancy with Segment Protection
Example: Ladder Redundancy with MRT

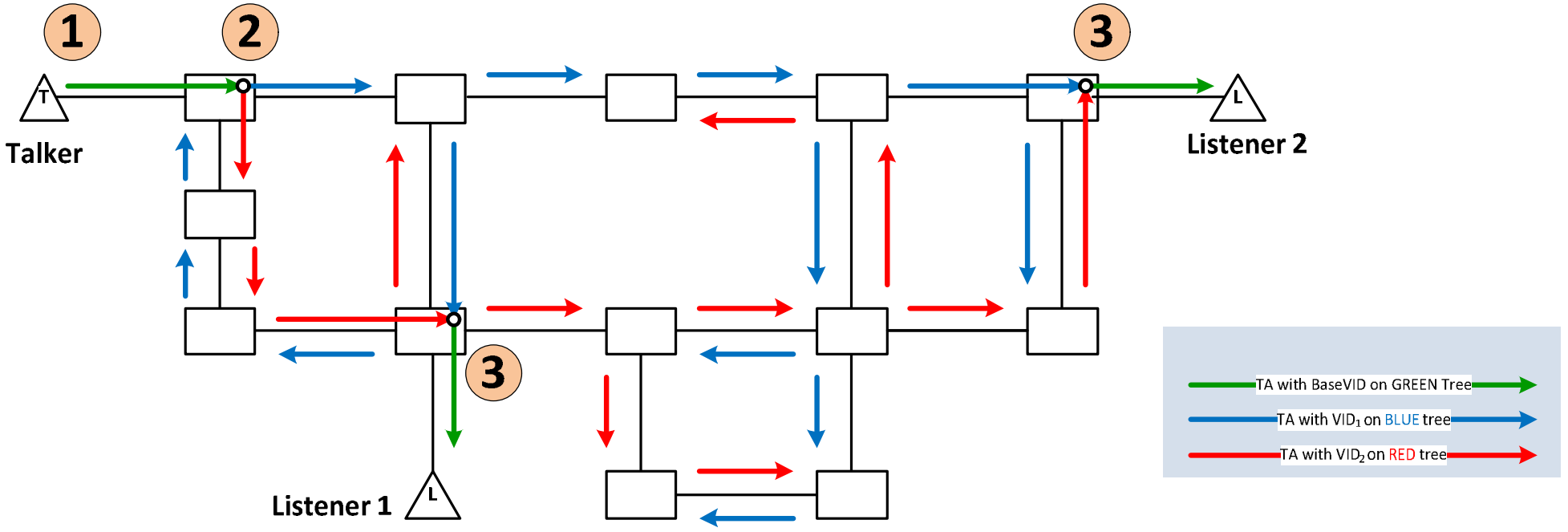
Assumption: pre-installed Maximal Redundant Trees (MRT)



1. One VLAN with a BaseVID (“green”) and **two** associated VIDs for the maximal redundant trees (“red” and “blue”), e.g. installed by ISIS-PCR (è MRT)
2. RAP can learn about the **VLAN configuration** from e.g. the MST configuration table

.1CB Use Case 2: Seamless Redundancy with Segment Protection
Propagation of Talker Attribute

Proposal for RAP's rules of propagating the **TalkerAdvertises** along the pre-installed MRT



1. The Talker sends one **TalkerAdvertise** using BaseVID
2. The bridge with the Talker edge-port replicates the "green" **TalkerAdvertise** into a "red" and a "blue" one
   - è The "blue" **TalkerAdvertises** follows the "blue" tree using VID_1
   - è The "red" **TalkerAdvertises** follows the "red" tree using VID_2
3. The edge-port to the Listener merges the "red" and "blue" **TalkerAdvertises** to a "green" **TalkerAdvertise** for the Listener
   - è hence the "red" and "blue" maximal redundant tree are transparent for the Listener

.1CB Use Case 2: Seamless Redundancy with Segment Protection
Propagation of Listener Attribute

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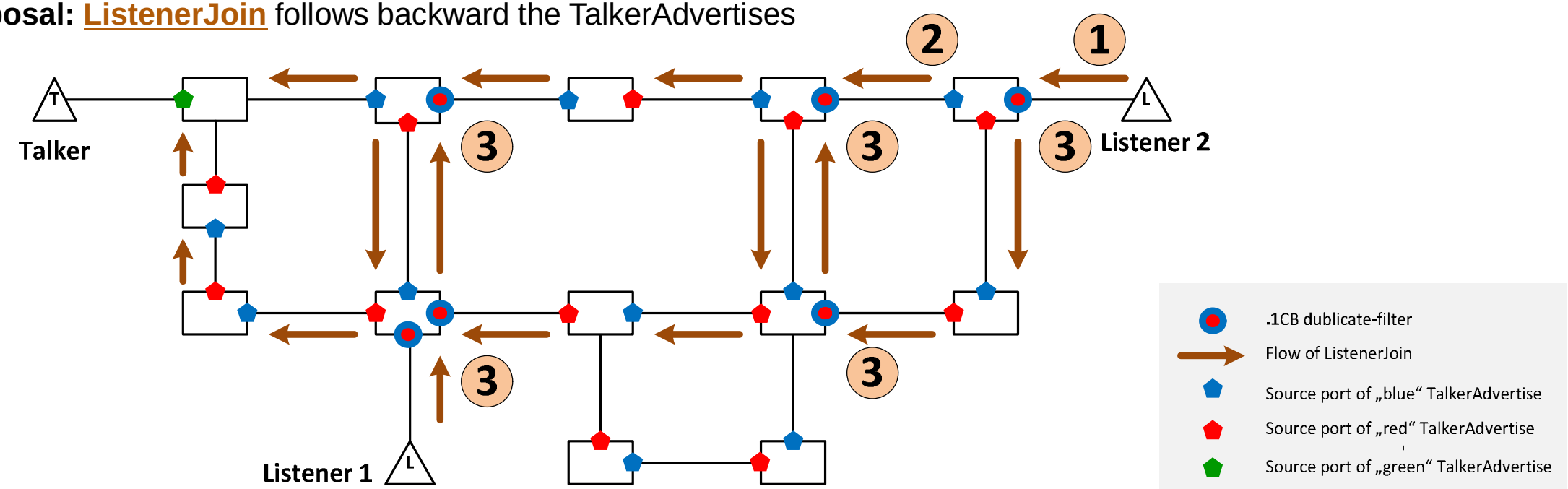
Proposal: ListenerJoin follows backward the TalkerAdvertises



1 Listeners initiate **ListenerJoin**

2 The **ListenerJoin** follows the TalkerAdvertises backwards according to the following rules:

- è Forward the **ListenerJoin** only to source ports of all received TalkerAdvertises (on ”blue” and ”red” trees)
- è but do not mirror the **ListenerJoin** backwards (no loop back)

3 Activate .1CB filter according to the following rule:

- è Activate the .1CB duplicate-filter on the source port of a **ListenerJoin** when a **ListenerJoin** must be forwarded to more then one source ports (e.g. ”blue” and ”red”) of TalkerAdvertices - *(set the .1CB duplicate-filter on an egress port of a bridge where duplicates from different ingress ports are received)*

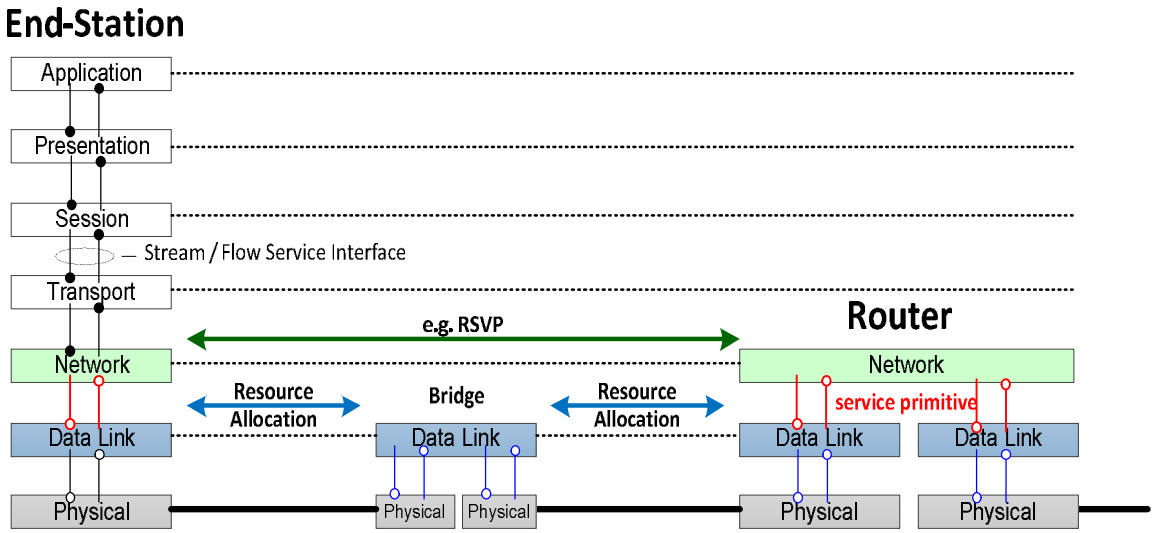
5. Collaboration with upper layer reservation

Collaboration with Upper Layer Reservation

Proposal: Supporting **two** options for collaboration with upper layer reservations

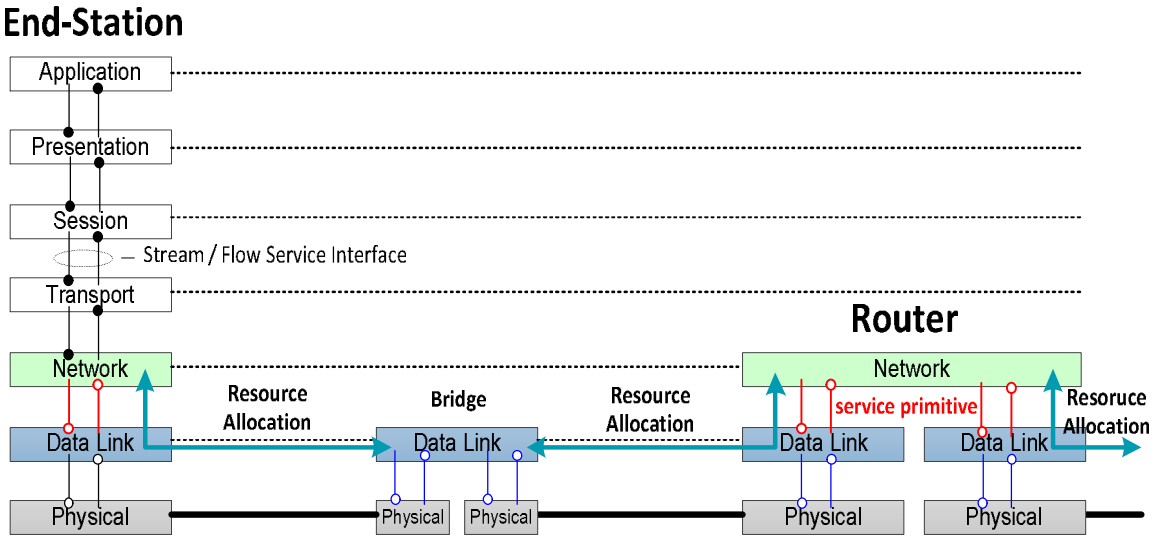
1st Option: Parallel Mode

Layered through service primitives with Layer 3 reservation protocols (e.g. RSVP**)**



2nd Option: Serialized Mode

Encapsulated Layer 3 information within RAP (additional optional TLVs are required)



è Question: Who specifies the service primitives and the additional TLV‘s?

Summary

Why Distributed Stream Configuration for Industrial?

Ø The distributed Stream configuration based on RAP with

- § decentralized and centralized path computing (not part of RAP)
- § **SRclass based Streams** (with its associated shaper / transmission mechanism like CQF, CBSA and in future ATS) are able to guarantee a bounded max. latency and zero congestion loss
- § redundancy and seamless redundancy (e.g. based on MRT established by ISIS-PCR) can be supported
- § distributed Stream reservation

Ø The (fully) centralized Stream configuration model with

- § centralized path computing
- § centralized scheduling for **none-SRclass based Streams** (with its associated shaper / transmission mechanism like CT and TAS)
- § centralized configuration to support (seamless) redundancy
- § centralized Stream reservation

Thank You!

Questions?

RAP + ISIS-PCR for Redundancy
General ISIS-PCR Principles supporting Redundancy

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Basics:

- **MSTID**
  - **SPBM-MSTID** with none source address learning
    - Forwarding
      - determined by unicast destination address
      - for multicast destination addresses based on source address
  - **SPBV-MSTID** with source address learning
    - Forwarding
      - Flooding on all port
      - Blocked ports prevent loops (tree dependent)
- **ECT Algorithm**
  - Shortest path
  - Support for redundancy (e.g. MRT, MRTG)
- …

VLAN configuration
for SPBM-MSTID and SPBV-MSTID by managed objects:

The PCR static configuration Table defines the MRT VIDs for the Base VID if MRT is used

Ieee8021MstpVlanEntry ::= SEQUENCE {
ieee8021MstpVlanComponentId
ieee8021PbbComponentIdentifier,
ieee8021MstpVlanId IEEE8021VlanIndex,
ieee8021MstpVlanMstId IEEE8021MstIdentifier
}

Ieee8021PcrEctStaticTableEntry {
ieee8021PcrEctStaticEntryTopIx IEEE8021SpbMTID,
ieee8021PcrEctStaticEntryBaseVid VlanIdOrAny,
ieee8021PcrEctStaticEntryMrtBlueVid VlanIdOrNone,
ieee8021PcrEctStaticEntryMrtRedVid VlanIdOrNone,
ieee8021PcrEctStaticEntryRowStatus RowStatus
}

è The VLAN configuration from ISIS-PCR can be used by RAP supporting redundancy!

RAP + ISIS-PCR for Redundancy
Attribute Propagation (AP) Context for RAP

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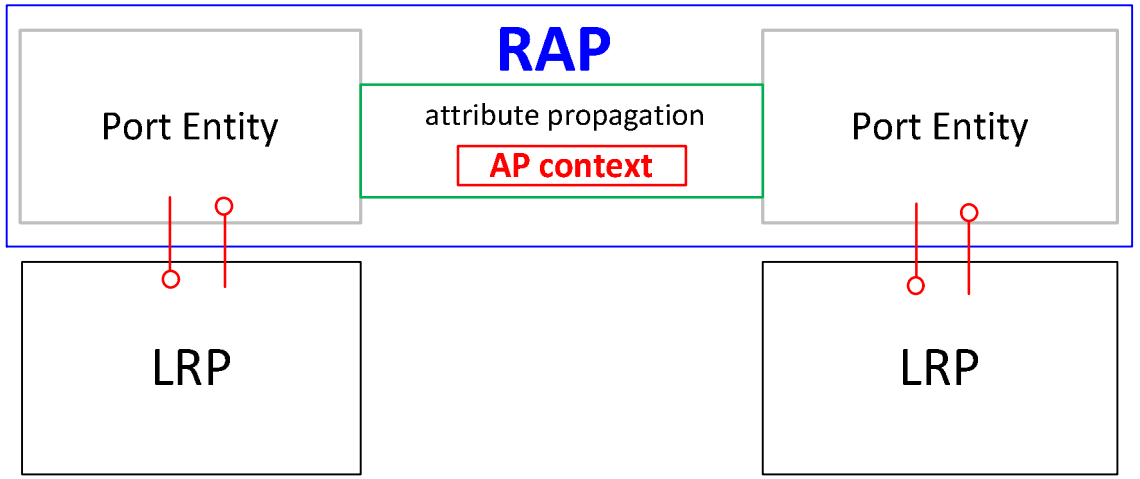
AP Context

- The AP context to controls the attribute propagation from one port entity to other port entities
- The AP context in RAP is dependent on the VLAN topology.



Proposal:

Using the forwarding rules on data plane defined for SPBV and SPBM for propagation of RAP attributes on the control plane!

To support SPBV/SPBM additional information within the TalkerAdvertise is required.

AP Context based on SPBV-MSTID

- Attribute propagation on topology identified by VID for TalkerAdvertise
  - Propagate to all non-blocked ports

(This behavior is similar to the „MRP context“ of e.g. MSRP)

AP Context based on SPBM-MSTID

- Attribute propagation for TalkerAdvertise
  - based on topology identified by {**SystemID** of the nearest bridge to Talker **, VID, I-SID}**