



IEEE 802.1Qca + .1Qcc+.. for Industrial Networks

TSN with Dynamic Registration & Stream Reservation on Bridge Local Computing Elements (BLCEs)

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Outline

- ❑ **Recap AVB: Dynamic Stream Reservation based on RSTP**
- ❑ **Why dynamic Registration & Reservation on Bridge Local Computing Elements?**
- ❑ **Proposal: Dynamic Stream Reservation based on ISIS-PCR**
- ❑ **Proposal: MRRP – Multiple Relation Registration Protocol**
- ❑ **Dynamic Registration & Reservation on calculated Redundant Trees**
- ❑ **Dynamic Registration & Reservation on redundant Trees combined with Seamless Failover**
- ❑ **Summary**

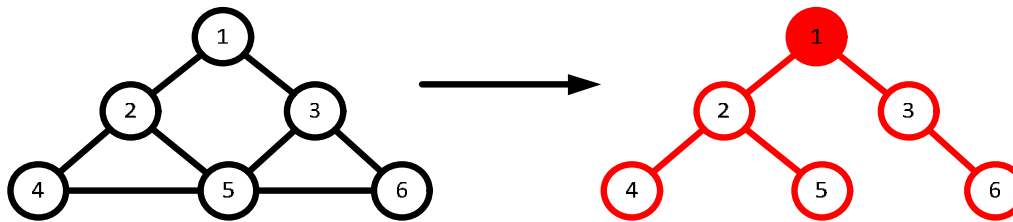
Recap – AVB

Dynamic Stream Reservation based on RSTP

AVB has specified guaranteed QoS for AV-Streams!

Used mechanism:

- RSTP – Rapid Spanning Tree Algorithm and Protocol (grantees a loop free data tree)



- MRP - Multiple Registration Protocol (template to register attributes like VID, MAC address, ...)
 - MVRP – Multiple VLAN Registration Protocol
(used to register and update their knowledge of set of VID's – e.g. VID used for Streams)
 - MMRP – Multiple MAC Registration Protocol
(used to register “Group Filtering Behavior” – e.g. for Streams with VID x filter unregistered groups)
 - MSRP – Multiple Stream Reservation Protocol
(used to register stream membership, resources, bandwidth,)

Why dynamic Registration & Reservation on Bridge Local Computing Elements?

PLC: Programmable Logic Controller for input/output data
 DEV: Device for input / output data (sensor / actuator)

— Ethernet

dynamic applications
 e.g. Client <-> Server

...
 => dynamic & flexibility
 relations

multiple static applications

Robot <-> PLC
 PLC <-> PLC

...
 => dynamic & flexibility
 relations

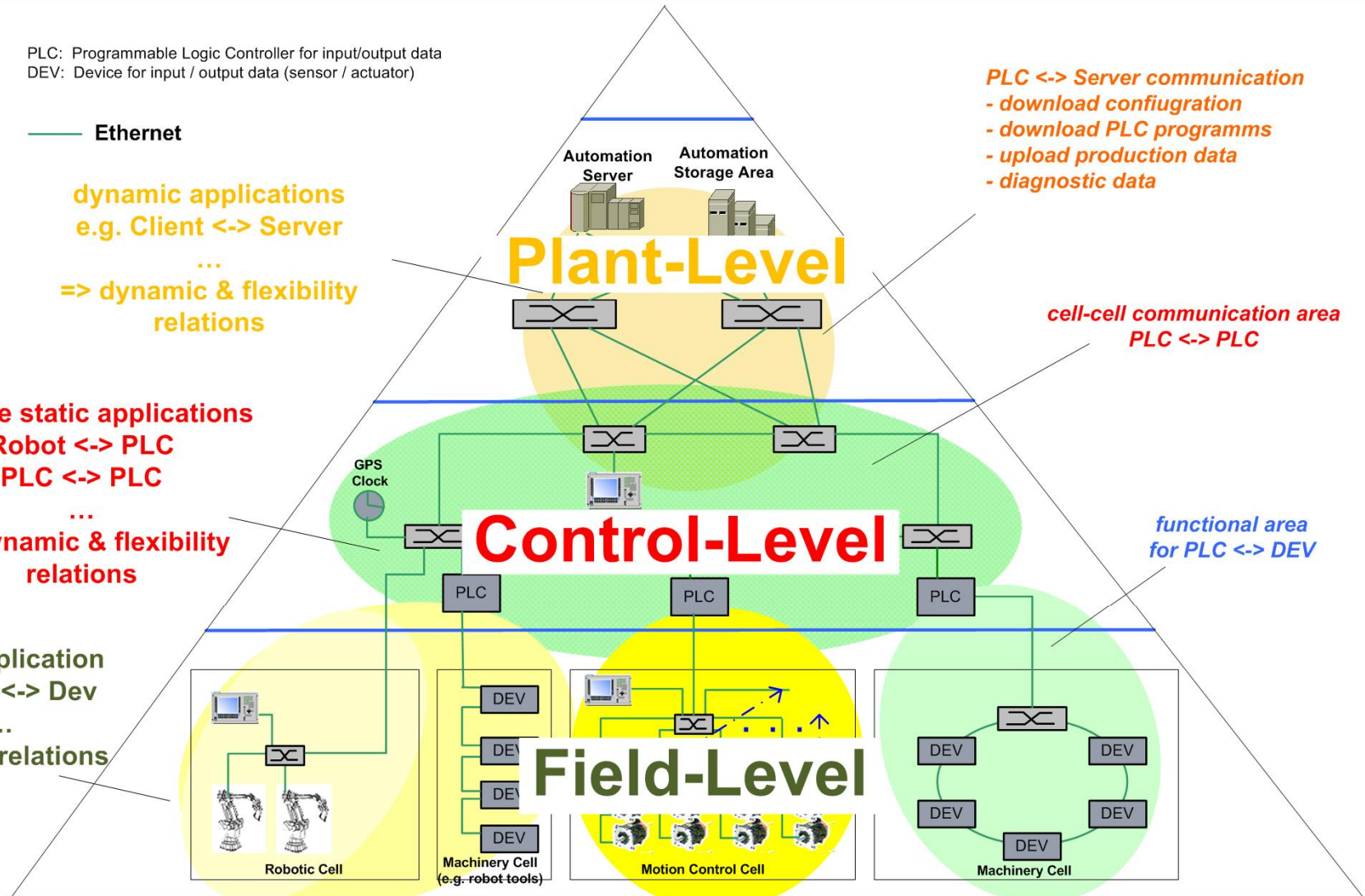
static application
 e.g. PLC <-> Dev

...
 => static relations

PLC <-> Server communication
 - download configuration
 - download PLC programs
 - upload production data
 - diagnostic data

*cell-cell communication area
 PLC <-> PLC*

*functional area
 for PLC <-> DEV*



Proposal for TSN

Dynamic Stream Reservation based on ISIS-PCR

TSN will specify guaranteed QoS for Streams (e.g. Control-Data-, AV-, Measurement-Streams, ...)!

Industrial application have higher requirements on Streams e.g. latency, robustness and availability!
=> Redundant path/trees are required to fulfill the availability requirements but still flexibility is desired!

IEEE 802.1Qca (ISIS-PCR) is working on a solution with centralized PCE's to establish "explicit path" and do reservations for streams.

This presentation is a proposal doing registration & reservation on decentralized BLCEs – Bridge Local Computing Element!

Proposal for dynamic Stream Reservation

MRRP – Multiple Relation Registration Protocol

TSN will specified guaranteed QoS for Streams!

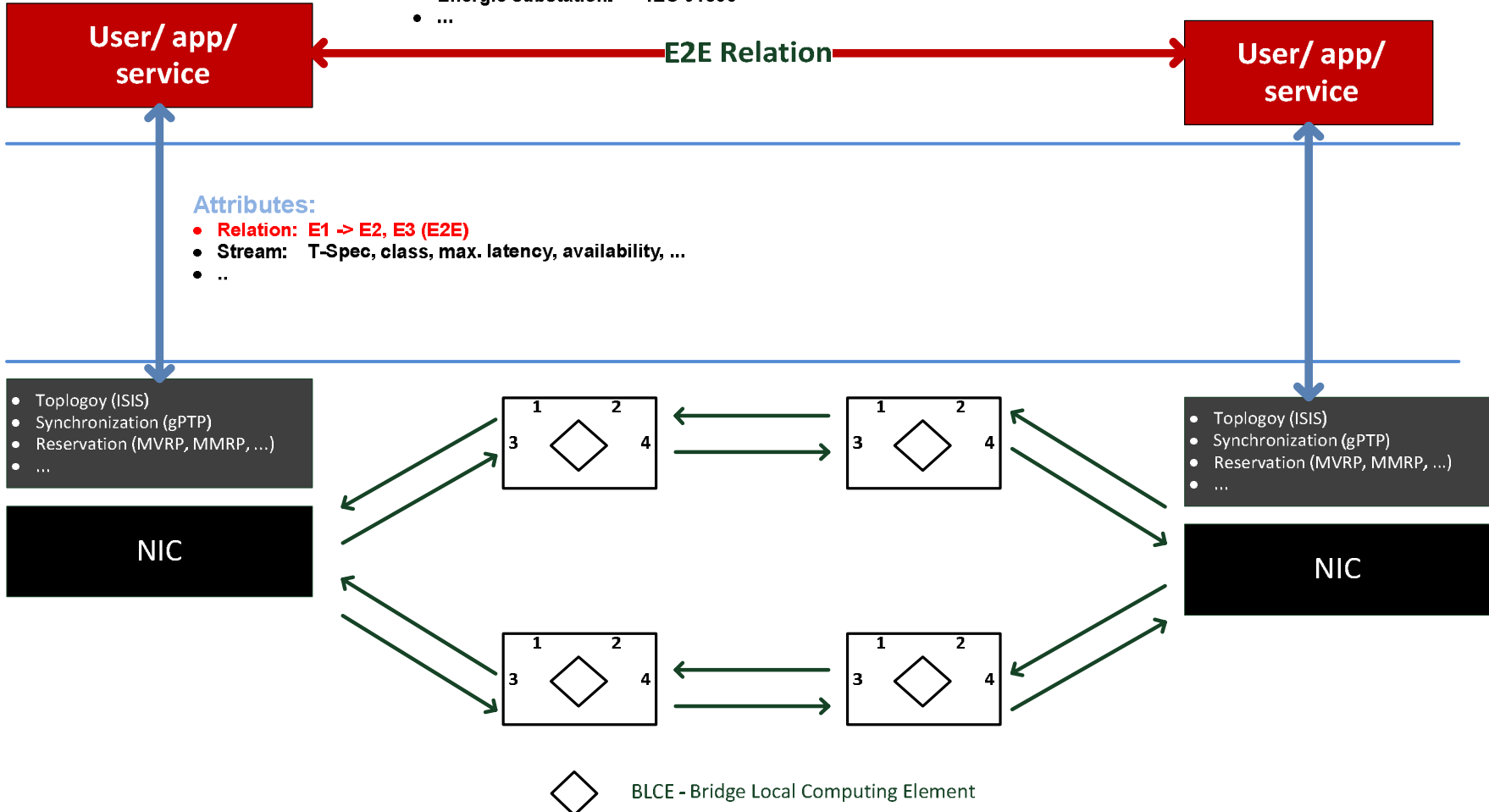
Proposed mechanism:

- MRP - Multiple Reservation Protocol (template to register attributes like VID, MAC address, ...)
- **MRRP – Multiple Relation Registration Protocol** **NEW!!!!**
(used to register relations for e.g. streams)
- MVRP – Multiple VLAN Registration Protocol
(used to register and update their knowledge of set of VID's – e.g. VID used for Streams)
- MMRP – Multiple MAC Registration Protocol
(used to register “Group Filtering Behavior” – e.g. for Streams with VID x filter unregistered groups)
- MSRP – Multiple Stream Reservation Protocol
(used to register resources, bandwidth, for streams)

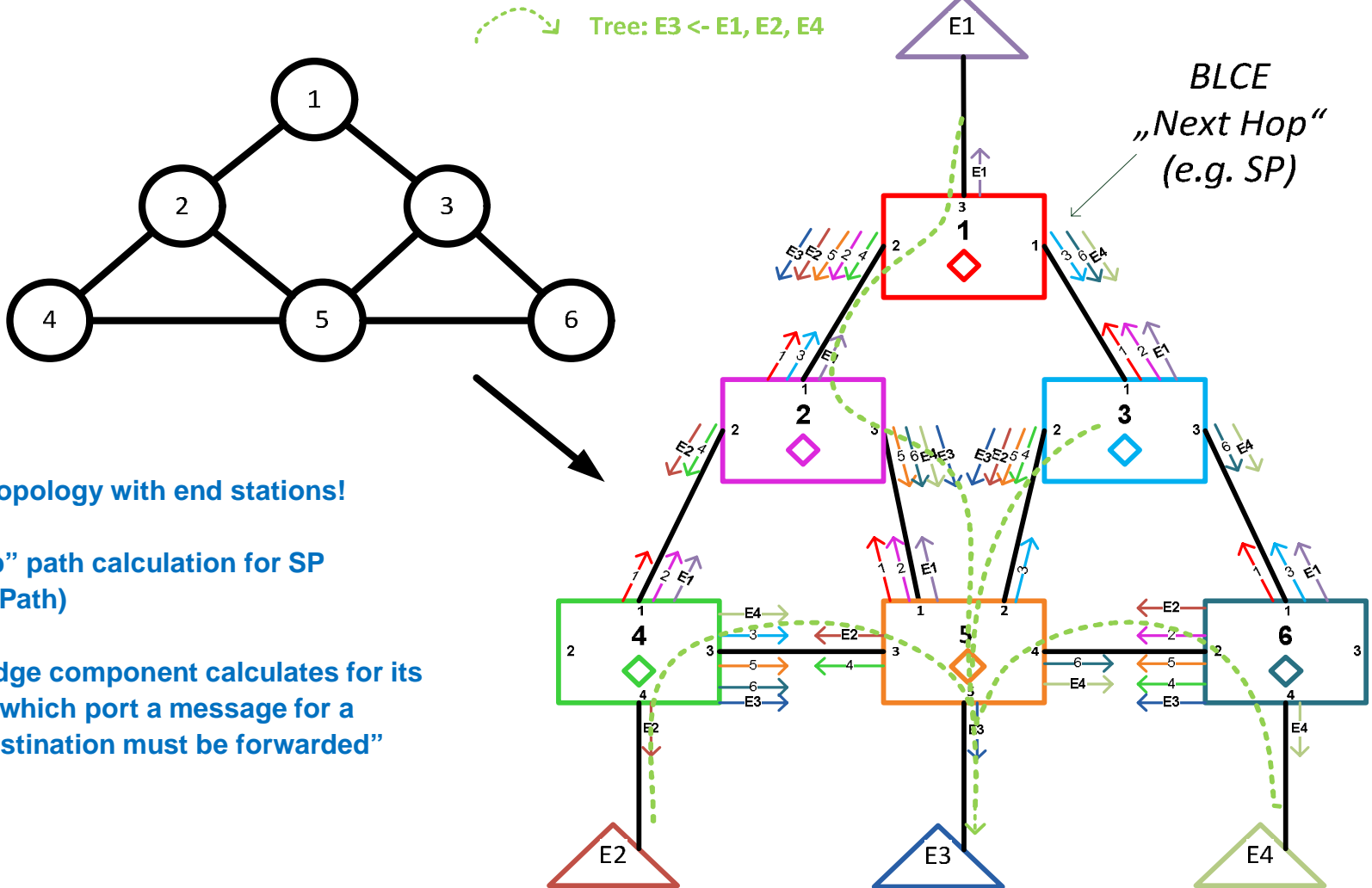
Assumption: Application Relations established by Higher Layer Protocols

Higher layer application protocols:

- AVB: IEEE1722
- Industrial automation: Ethernet IP, PROFINET, ...
- Energie substation: IEC 61850
- ...



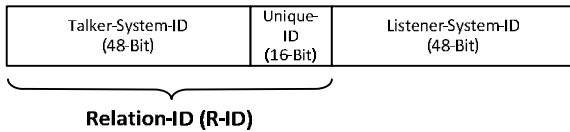
“Next Hop” Path Computing Result of decentralized BLCE for SP



- Network topology with end stations!
- “Next Hop” path calculation for SP (Shortest Path)
- “Each bridge component calculates for its own over which port a message for a certain destination must be forwarded”

Proposal MRRP – Multiple Relation Registration Protocol

New MPRP-Attribute:



Path Registration: Relation on Tree-ID „SP“

E1	1	E2
E1	1	E3

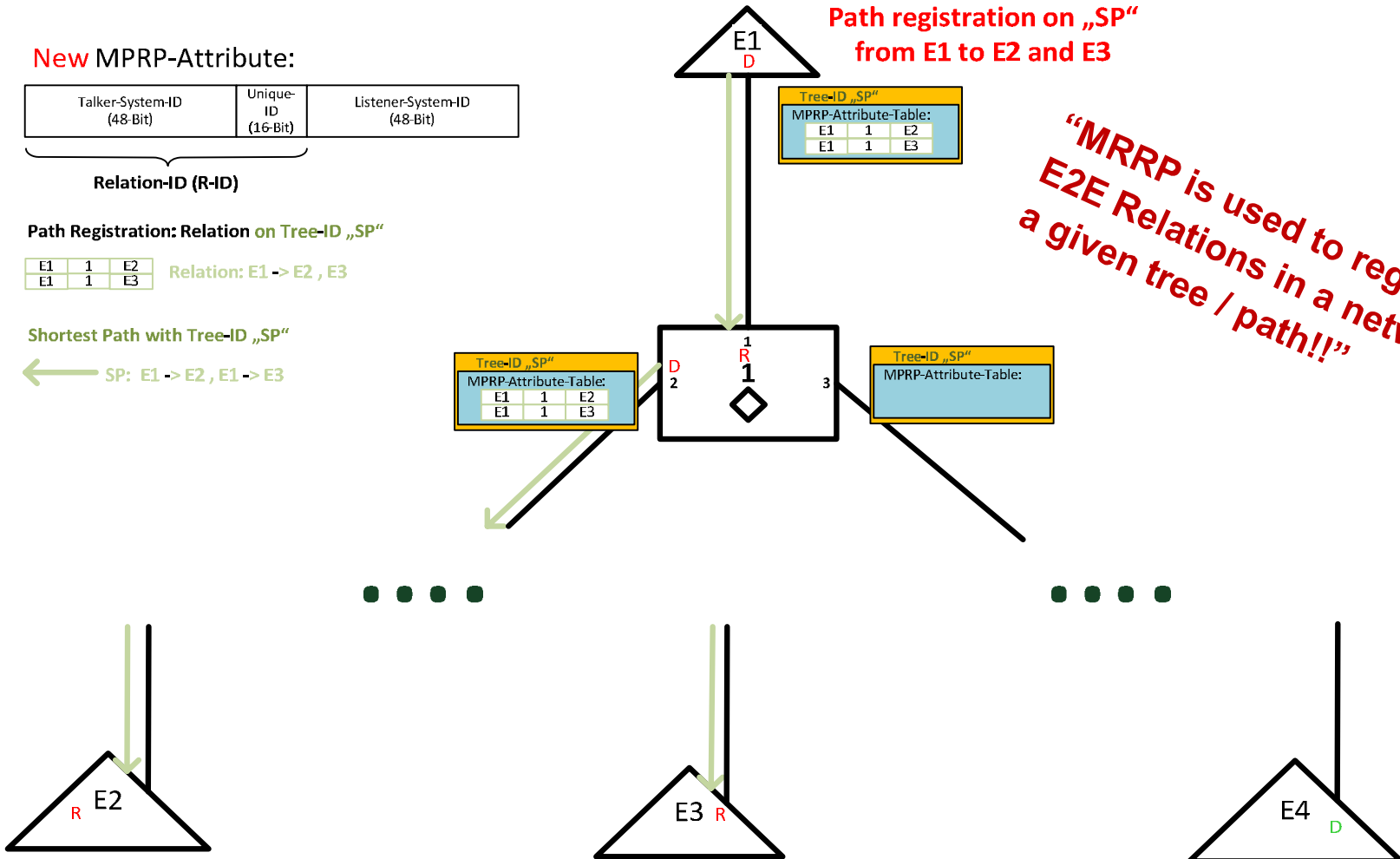
Relation: E1 -> E2, E3

Shortest Path with Tree-ID „SP“

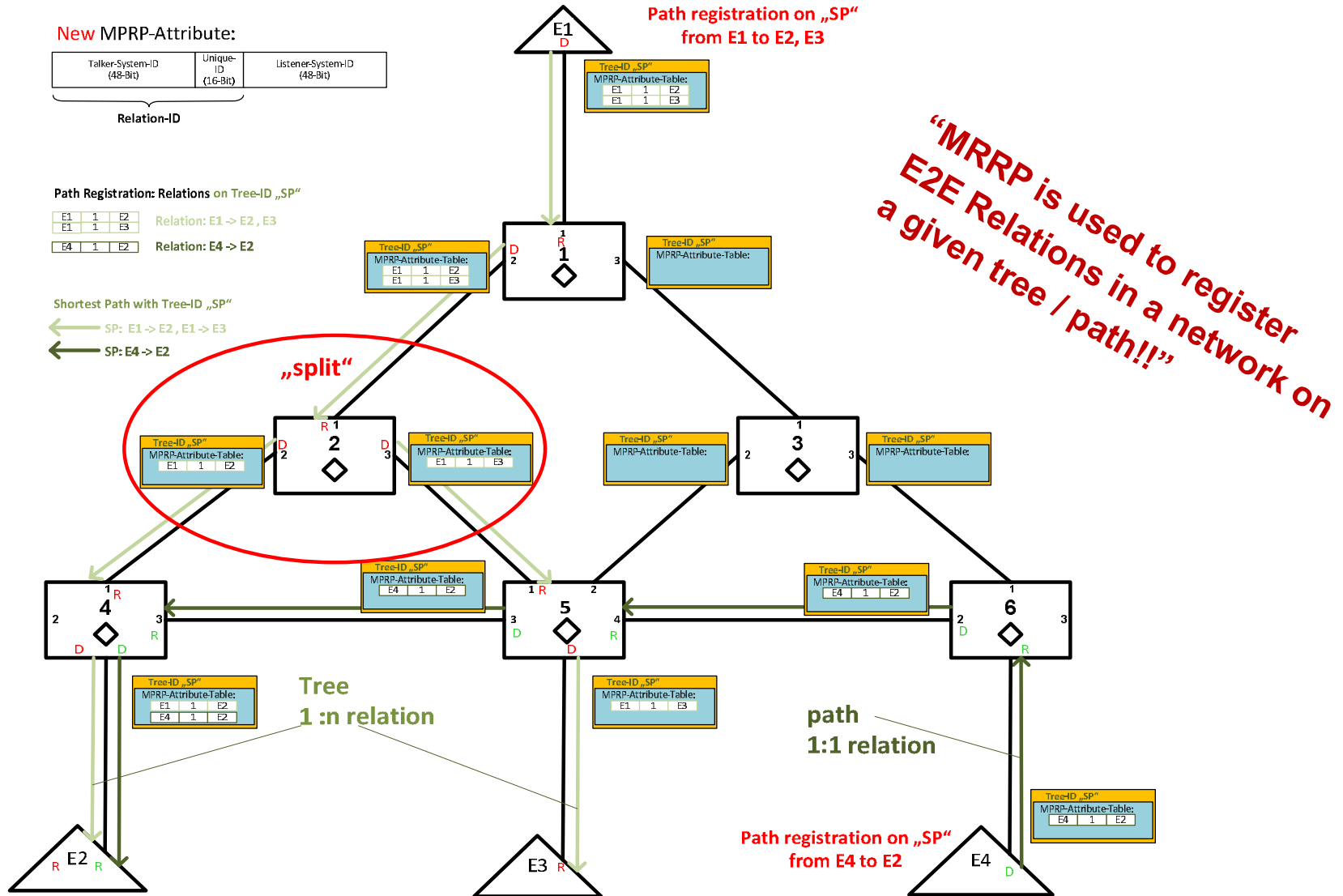
← SP: E1 -> E2, E1 -> E3

Path registration on „SP“
from E1 to E2 and E3

“MRRP is used to register
E2E Relations in a network on
a given tree / path!!”

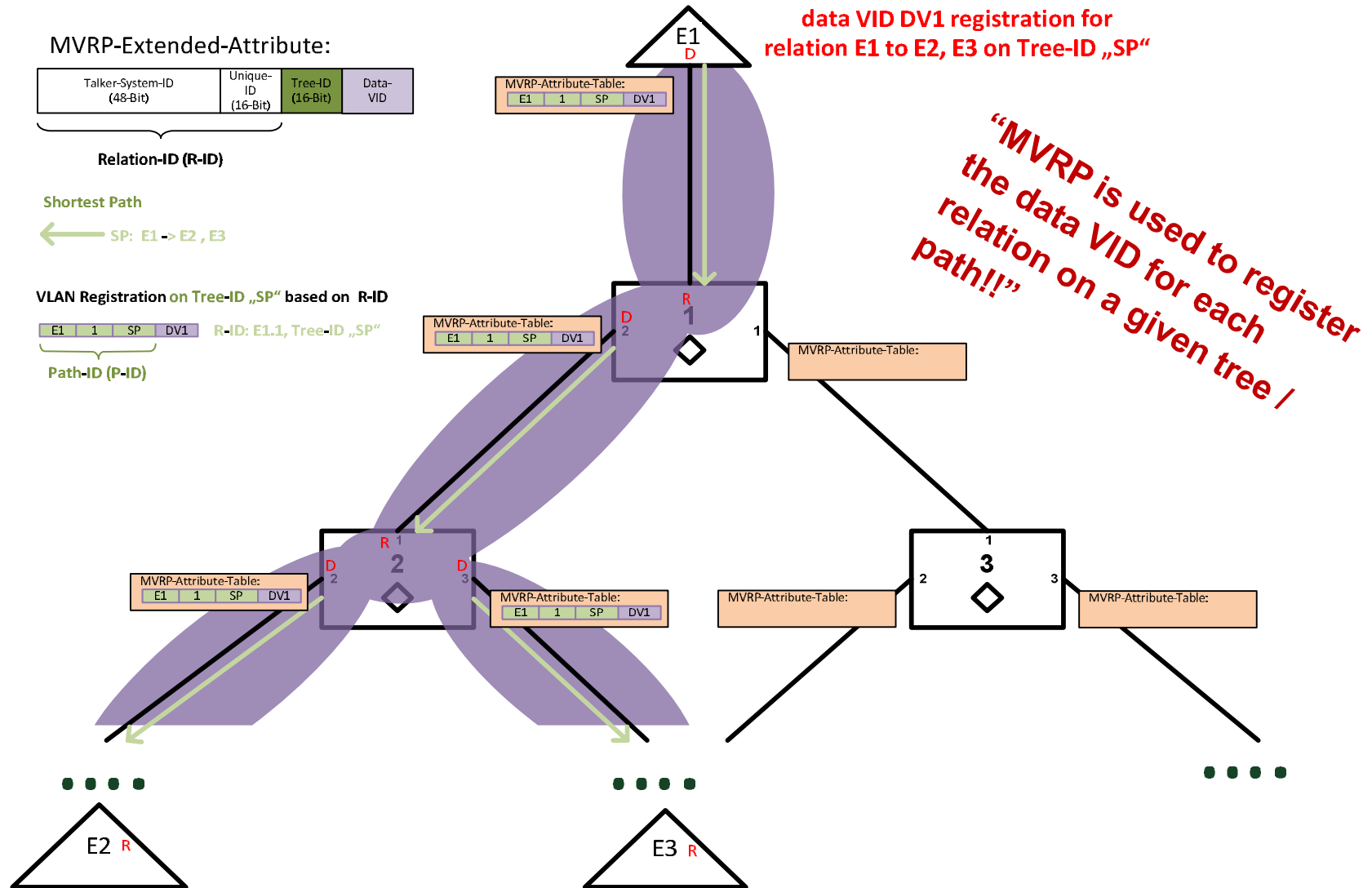


Proposal MRRP – Multiple Relation Registration Protocol



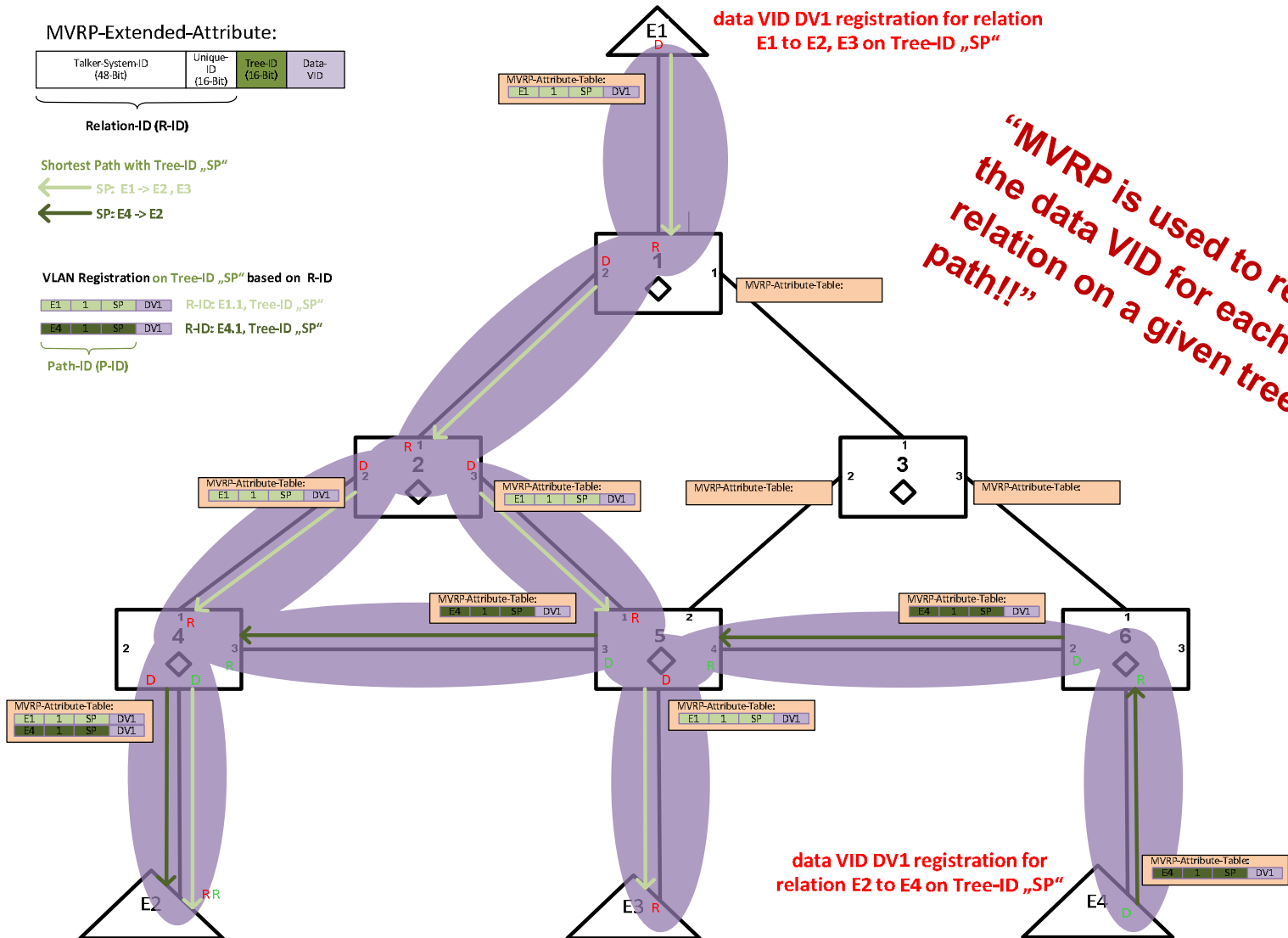
MVRP - Multiple VLAN Registration Protocol

Based on registered Relation and computed Tree



MVRP - Multiple VLAN Registration Protocol

Based on registered Relation and computed Tree



MMRP - Multiple MAC Registration Protocol

Based on registered Relation and registered VID (Data Plane)

MMRP-Extended-Attributes:

MAC-Vector-Attribute:

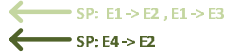
Talker-System-ID (48-Bit)	Unique-ID (16-Bit)	MC - MAC-Address
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Service-Requirement-Attribute:

Talker-System-ID (48-Bit)	Unique-ID (16-Bit)	BU - Block-Unregisterd
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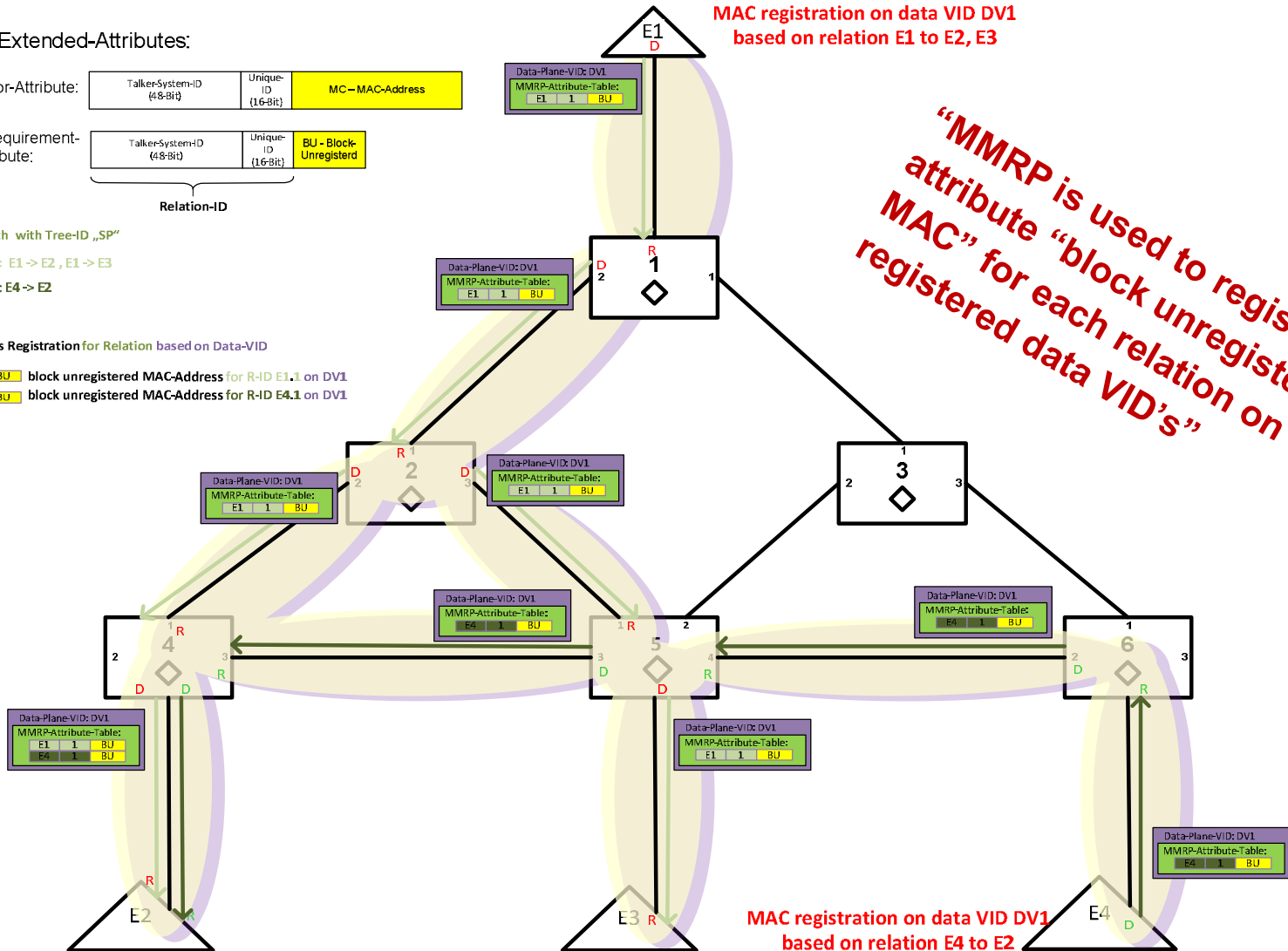
Relation-ID

Shortest Path with Tree-ID „SP“



MAC-Address Registration for Relation based on Data-VID

- E1 1 BU block unregistered MAC-Address for R-ID E1.1 on DV1
- E4 1 BU block unregistered MAC-Address for R-ID E4.1 on DV1

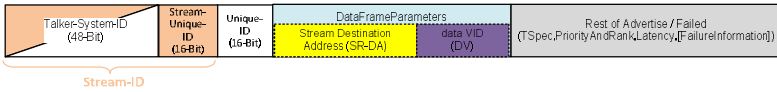


MSRP - Multiple Stream Reservation Protocol

Based on registered Relation and registered VID (Data Plane)

MSRP-Extended-Attributes:

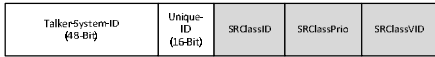
Talker Advertise/Talker Failed:



Listener:



MSRP-Domain-Discovery:

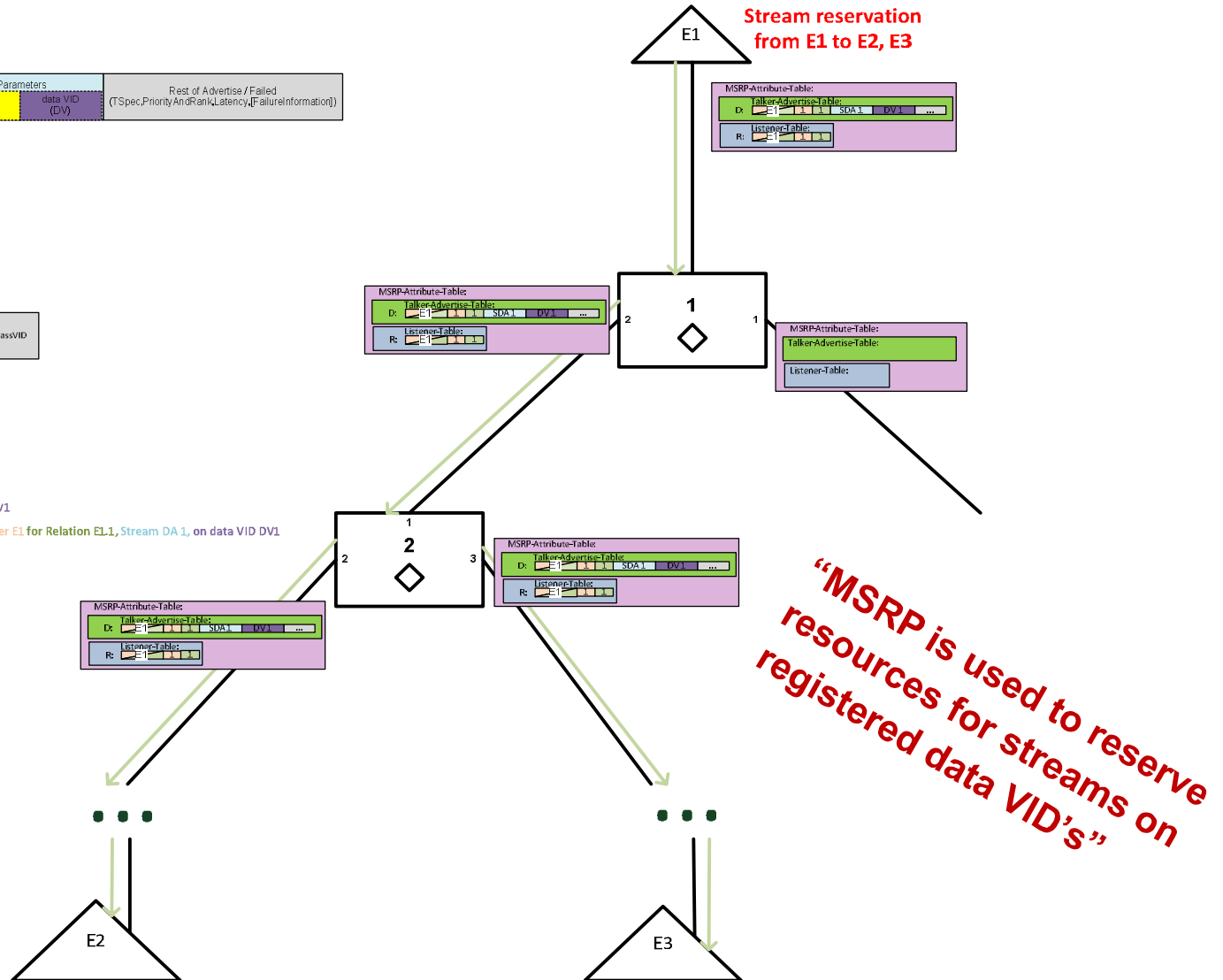


Shortest Path with Tree-ID „SP“

← SP: E1 -> E2, E3

Stream Reservation for Relation on Tree-ID „SP“ on data VID DV1

Stream E1.1 from Talker E1 for Relation E1.1, Stream DA 1, on data VID DV1



MSRP - Multiple Stream Reservation Protocol

Based on registered Relation and registered VID (Data Plane)

MSRP-Extended-Attributes:

Talker Advertise/Talker Failed:

Talker-System-ID (4B-B g)	Stream-Unique-ID (15-B g)	Unique-ID (5-B g)	DataFrameParameters Stream-Destination-Address (SR-D-A)	data-VID (V)	Rest of Advertise / Failed (TSpec,PriorityAndRank,Latency,FailureInformation)
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Relation-ID

Listener:

Talker-System-ID (4B-B g)	Stream-Unique-ID (15-B g)	Unique-ID (5-B g)
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MSRP-Domain-Discovery:

Talker-System-ID (4B-B g)	Unique-ID (5-B g)	SRClassID	SRClassPrio	SRClassVID
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Relation-ID

Shortest Path with Tree-ID „SP“

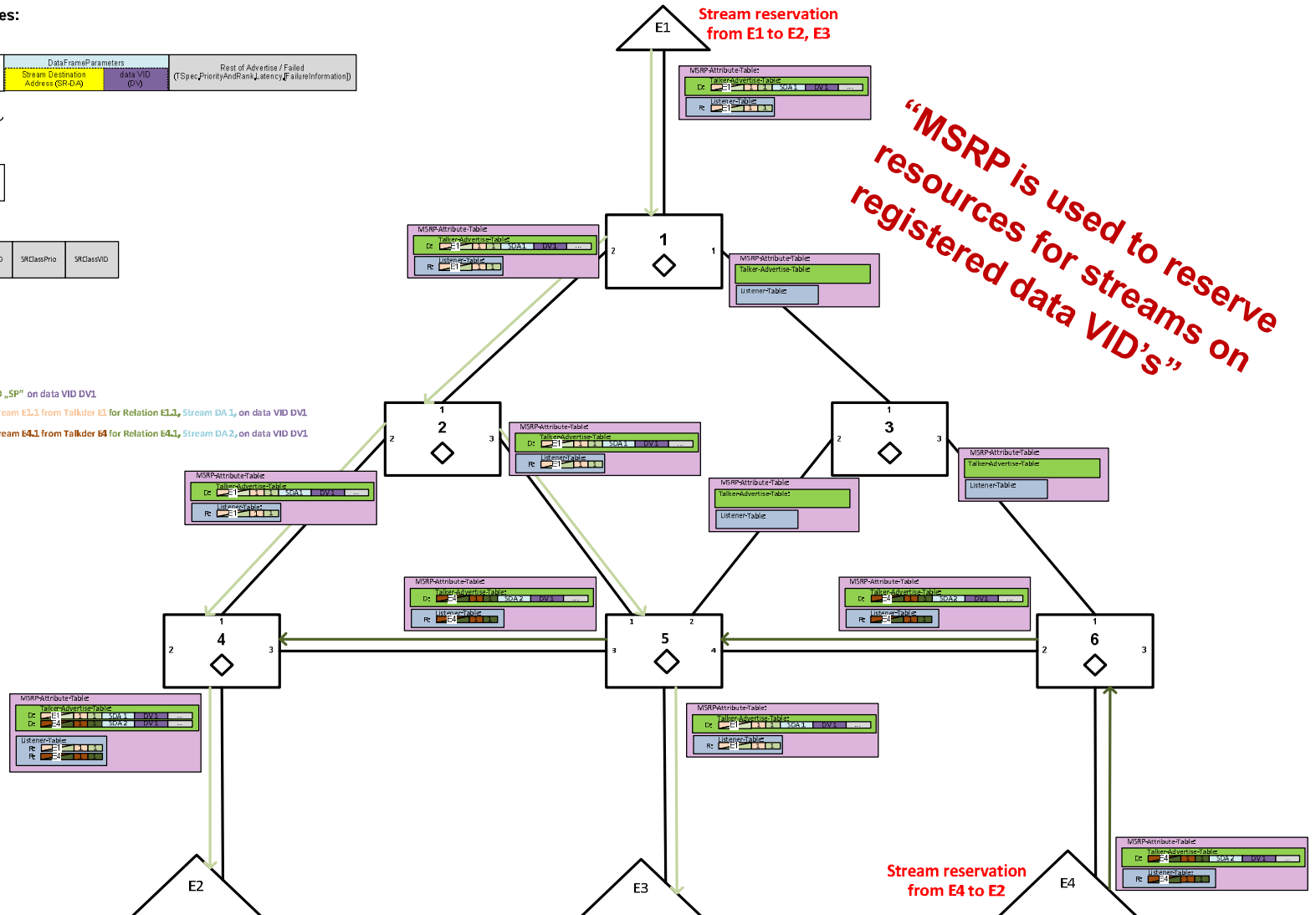
← SP: E1 -> E2, E3

← SP: E4 -> E2

Stream Reservation for Relation on Tree-ID „SP“ on data VID DV1

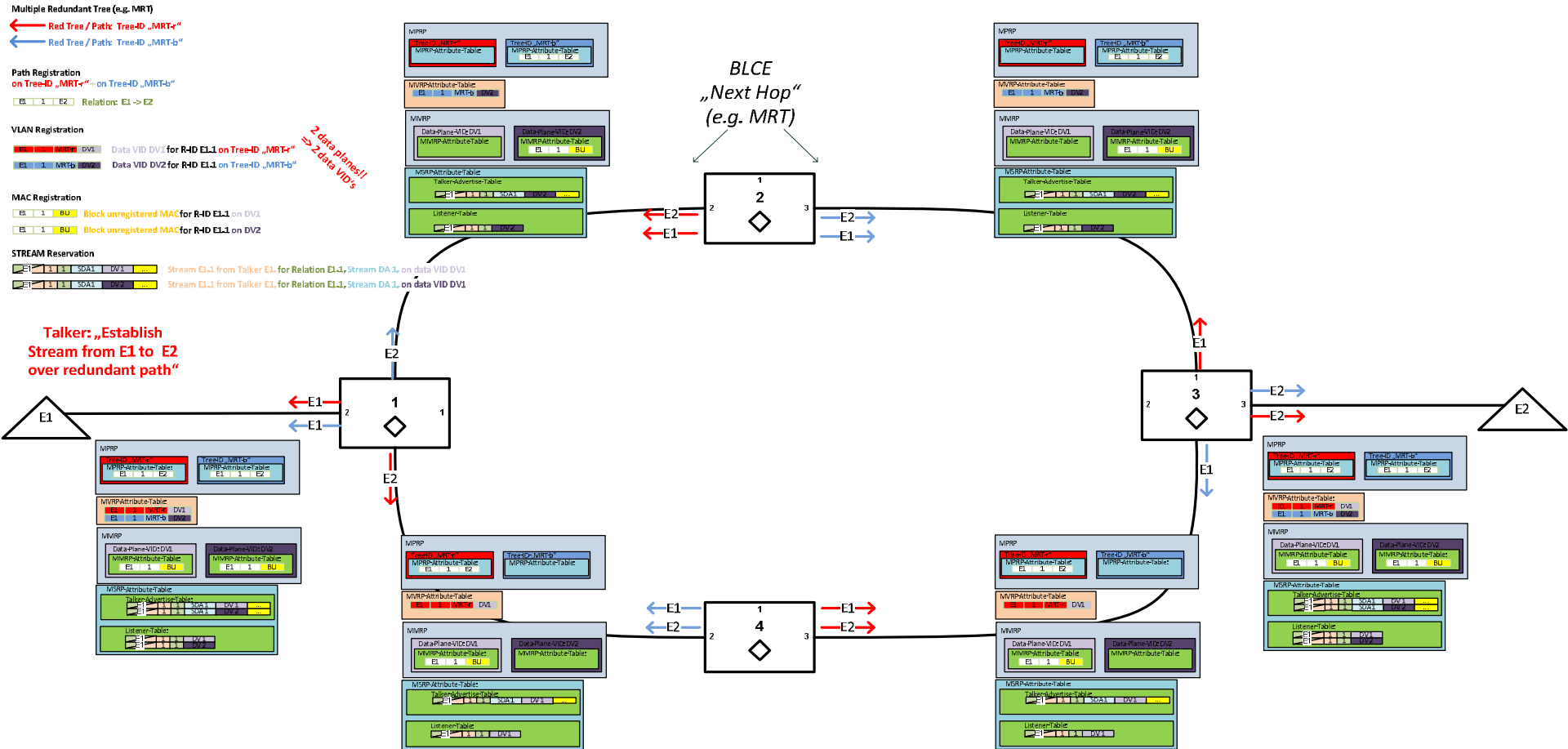
Stream E1.1 from Talker E1 for Relation E1.1, Stream DA 1, on data VID DV1

Stream E4.1 from Talker E4 for Relation E4.1, Stream DA 2, on data VID DV1



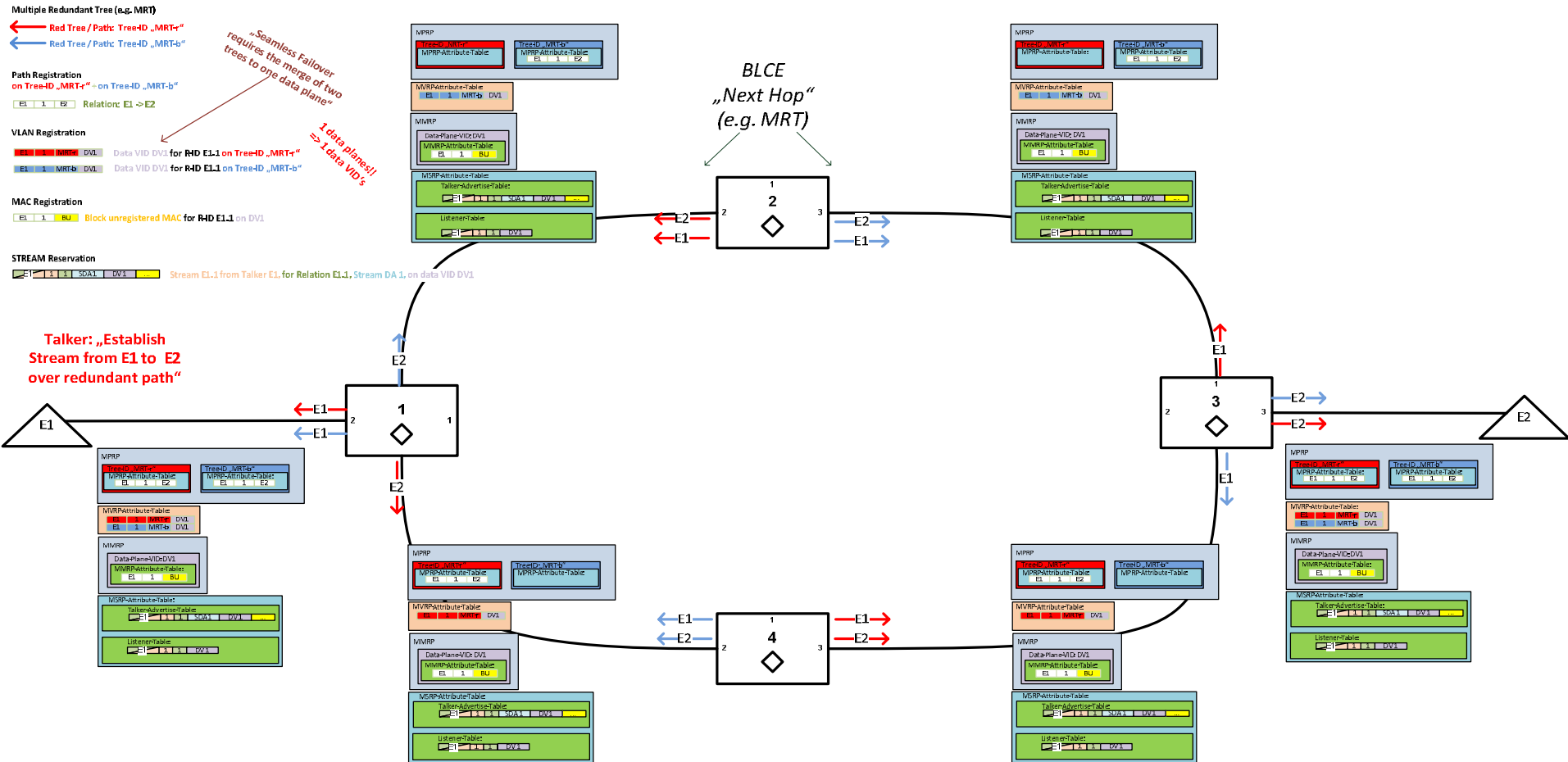
Dynamic Registration & Reservation on Calculated Redundant Trees

Establishing a Reservation for Redundant Stream



Dynamic Registration & Reservation on redundant Trees combined with Seamless Failover

Establishing a Reservation for redundant Streams based on „Seamless Failover“ IEEE 802.1CB

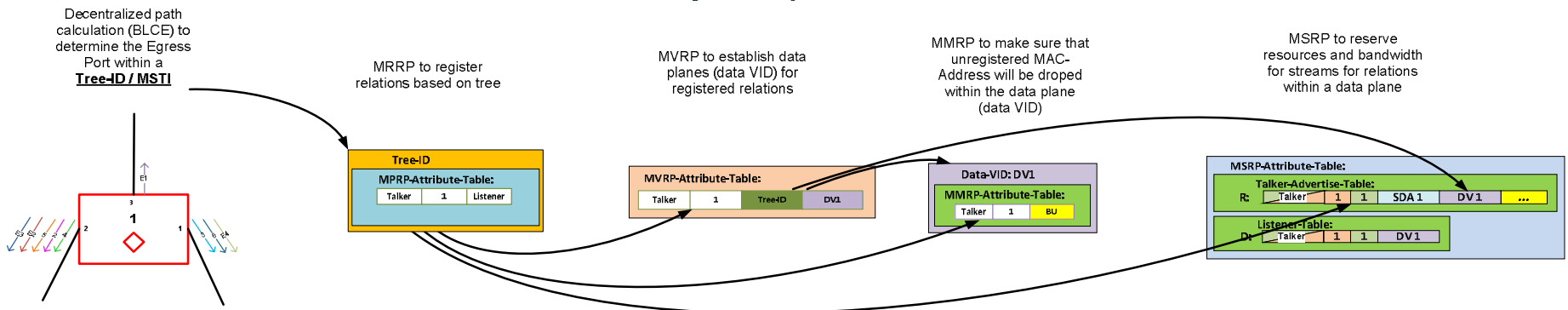


Summary

Registering the communication relations along the Tree to establish a **“Tree per Relation”** in a distributed organized network.

=> For dynamic registration and reservation the whole MRP-Protocol family can be used.
 Only MRRP and small extensions for the existing MRP-Protocol family are necessary!

Overview of the dependencies



Summary

“Plug & Play” was very essential feature for Ethernet and is one of the features which makes Ethernet so successful!!!

“Plug & Play” for robust QoS based on BLCE to support shortest path or redundancy is a valuable feature for a lot of industries (not only industrial automation).

- Is relation registration (MRRP) based on MRP for BLCE Ethernet networks acceptable?
- **Next Steps?**

Thank you for your attention!



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