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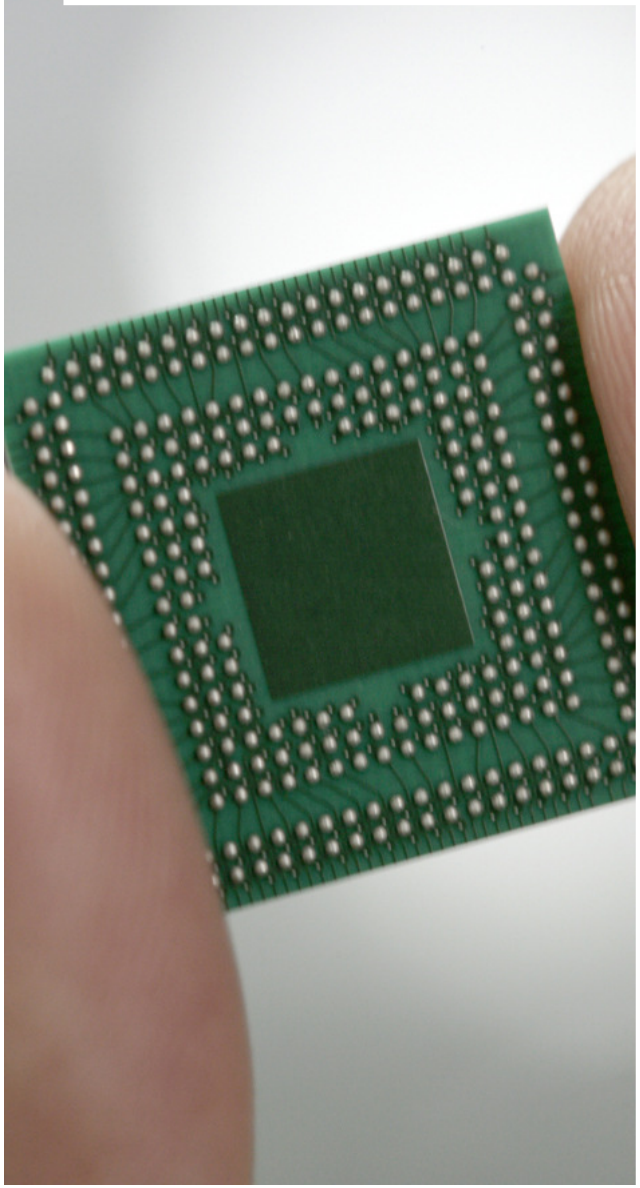

High Available Synchronization with IEEE 802.1AS bt

2013-03-19

IEEE 802 Meeting - TSN-TG

Orlando / USA

Franz-Josef Goetz, Siemens AG

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Structure of this Presentation

1. Methods in IEEE 1588 v2 and IEEE 802.1AS to establish the Sync Path
2. Further Requirements on Synchronization @ IEEE802.1AS – Gen 2
3. Methods to meet the Requirements for High Available and High Accurate Synchronization
4. Proposals how a Sync-Relay of a Time Aware System can distinguish multiple Sync Path
5. Proposal for Distributing Synchronization Information with ISIS-SPB

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Method how IEEE 1588 v2 establish the Sync Path

Today: Two Methods already used to established a sync path

- **IEEE 1588v2: (PTPv2 – Transparent Clocks, TC)**
  - **Announce, Sync and FollowUp messages are multicast frames**
    => Announce, Sync and FollowUp messages are forwarded by the MAC-Relay of a TC in typical implementations
  - **When network consist of ordinary clocks (OC) and transparent clock (TC)**
    Today: *typical usage in industrial networks*
    – Port roles for TC are established by RSTP this means that when receiving a Sync message, the ingress port is the slave-port and the egress port is the master-port
    – No guaranteed path for sync message by network reconfiguration
  - **Announce, Sync and FollowUp are forwarded by MAC-Relay entity**
    – In typical implementation of TC 1588v2

⇒ **Network must provide a mechanism to prevent loops e.g. RSTP**

⇒ **Redundant disjoint path for redundant sync messages are not supported**

Methods in IEEE 1588 v2 and IEEE 802.1AS to establish the Sync Path

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- **IEEE 802.1AS – Gen 1 (gPTP)**
  - **Announce, Sync and FollowUp messages are peer-2-peer frames**
    => no flooding of announce messages and overload situations
    => exchange of source address to be standard conform
    – manipulate correction field in payload of sync message at each hop
    => Sync- and FollowUp messages are forwarded by Sync-Relay (higher layer entity)
  - **Network consists of time aware systems which has to support the BMC**
    – end stations, bridges and routers
  - **Sync tree is established by BMCA (like boundary clocks BC) which assigns fix port roles**
    – slave port or master port
  - **But:**
    - Forwarding of sync and FollowUp frames is based on a **Sync-Relay**
      – independent of bridge MAC relay
    - The methods for correction residence time of sync message within a time aware system are the same as specified for transparent clock (TC)

  ⇒ **By using BMCA gPTP has specified it's own network independent loop prevention mechanism**
  ⇒ **Redundant disjoint path for redundant sync messages are not supported**

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Further Requirements on Synchronization @ IEEE802.1 AS bt

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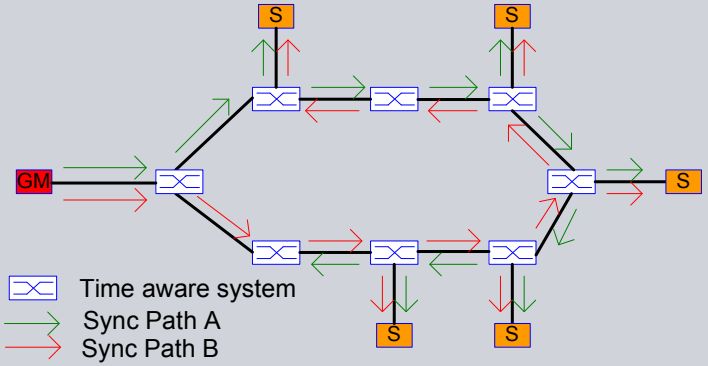
- Two Time Scales (Universal Time & Working Clock) for industrial application
- …
- High accuracy and availability
  - Redundant disjoint sync path
    - Simultaneously transmission redundant sync messages over redundant path (e.g. path A and path B)

    =>Receiving redundant sync messages
      - Better sync quality – using redundant sync message (e.g. from path A and path B)
      - Zero switchover time by single point of failure to guarantee accuracy (using low quality oscillators in rough environment)
      - Maintenance and surveillance

    - Cold- or hot-stand-by grandmaster

Grandmaster (GM) distributes redundant sync messages over redundant path to synchronize end stations (S)



Proposed method to fulfill these further requirements:

⇒ **Knowledge about physical topology, link state information and a appropriate routing algorithm is required to establish sync path**

⇒ **IEEE 802.1 has introduced ISIS-SPB (intermediate to intermediate system shortest path bridging) as link state protocol**

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Methods to meet the requirements for high available and high accurate Synchronization

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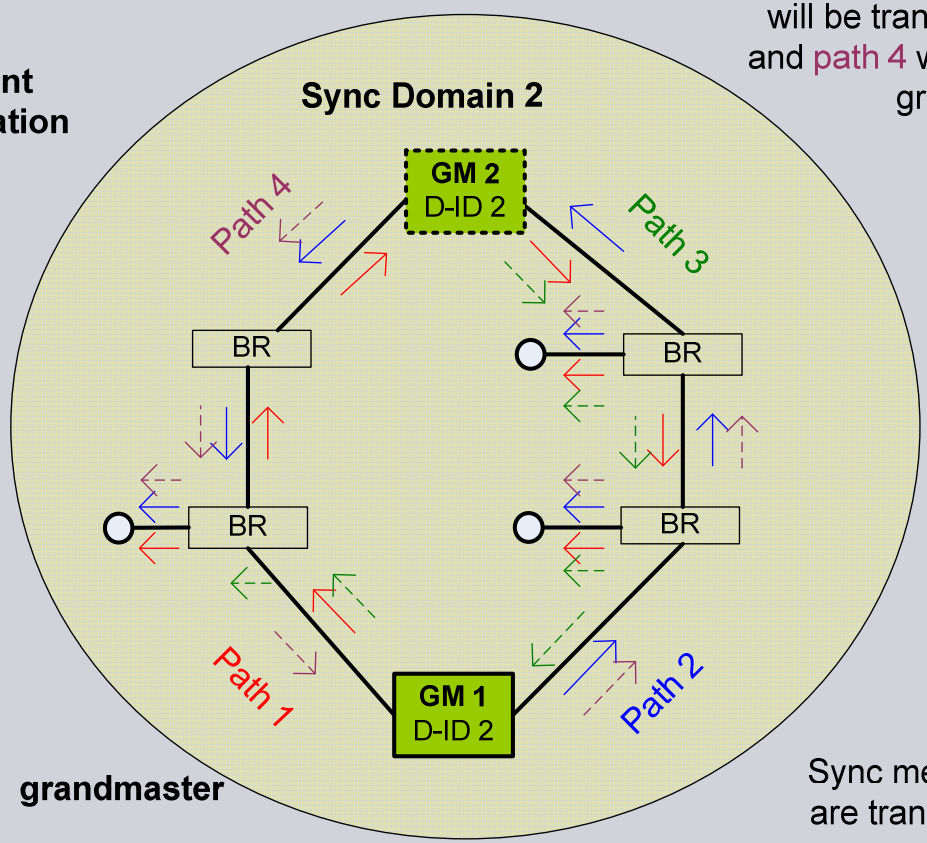
Use case 1:
Time aware domain with one active grandmaster but redundant sync messages transmitted over redundant path with or without auto-re-configuation of sync path

The sync paths for sync messages from GM 1 and GM 2 are determined from information distributed by ISIS



The Sync messages from GM 2 will be transmitted over path 3 and path 4 when GM 2 becomes grandmaster

Sync messages form GM 1 are transmitted over path 1 and path 2

BR **Time aware bridge**

End station (slave only)

GM D-ID x **Time aware bridge which is grandmaster**

GM D-ID x **Time aware bridge which is grandmaster capable but passive**

Methods to meet the requirements for high available and high accurate Synchronization

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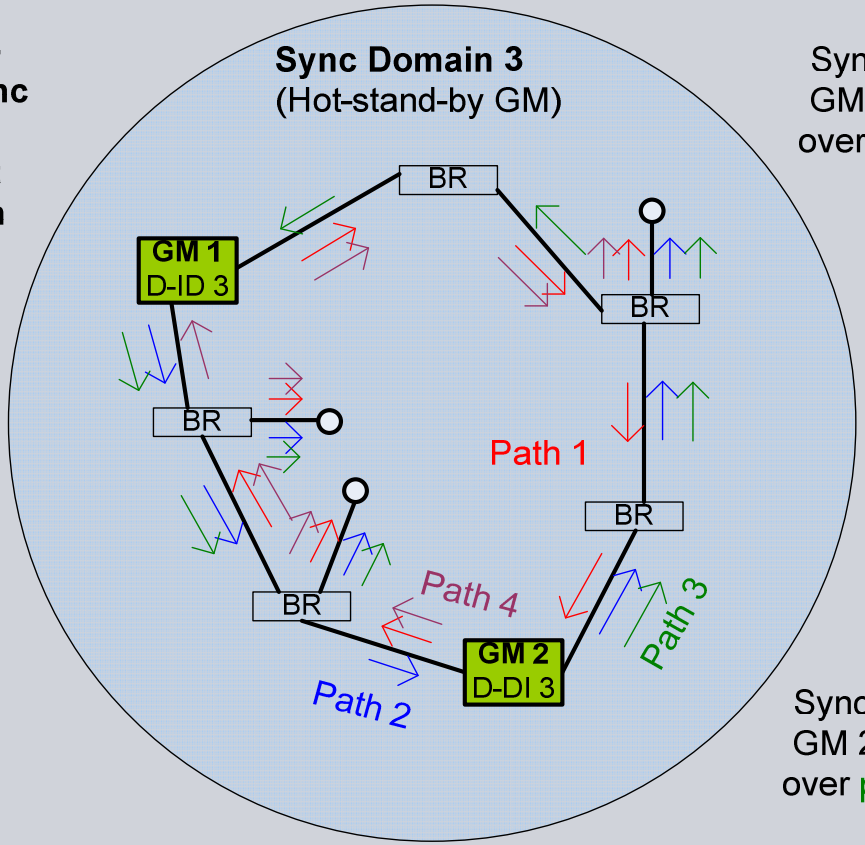
Use case 2:
Time aware domain with hot-stand-by grandmaster and redundant sync messages transmitted over redundant path and with or without auto-re-configuration of synch path

The sync paths for sync messages from GM 1 and GM 2 are determined from information distributed by ISIS



Sync messages from GM 1 are transmitted over path 1 and path 2

Sync messages from GM 2 are transmitted over path 3 and path 4

BR **Bridge**

End station (slave only)

GM D-ID 1 **Time aware bridge which is grandmaster**

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Proposals how a Sync-Relay of a Time Aware System can distinguish multiple Sync Path

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1. For each sync path a unique destination MAC address

   Problem: A list of multicast MAC address are required

2. Tagged sync messages (VLAN ID per sync path)

   Problem: Peer-To-Peer messages are not be tagged

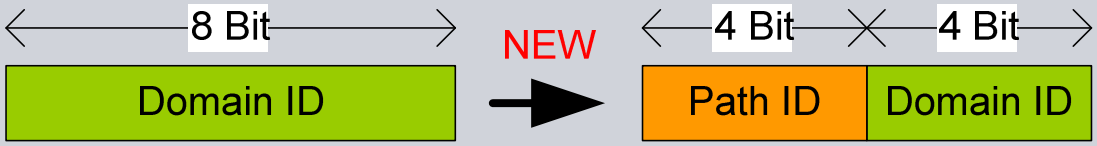
3. Introduce Path ID

   Problem: Not in the IEEE 1588 & IEEE 802.1 AS standard

   Proposal:

Sync Message Header

	Octet	Length
DA		
SA		
ET		
TransporSpecific	1	4 bits
MsgID	1	4 bits
PTPVersion	2	1
MsgLength	3 - 4	2
DomainID	5	1
Flags	6 - 7	2
	....	



Proposals how a Sync-Relay of a Time Aware System can distinguish multiple Sync Path

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The table gives a high level overview about the information we propose to use for the purpose of forwarding sync messages over redundant path:

Information	Purpose
Time Scale	• Universal time (traceable time) • Working clock (free running, none traceable time)
Domain ID	• One time scale within one sync domain
Path ID	• Sync and Sync' frames shall be transmitted on independent paths • Path ID's are used to mark redundant path (Path A, Path B, …) • Path ID's are used to mark grandmaster / time source (e.g. GM1 / Path A, GM1 / Path B, GM2 / Path A, GM2 / Path B, …)
MAC Address	• All Sync frames have the same destination MAC Address.

⇒ **Forwarding decision in Sync-Relay for the Sync & FollowUp message is based on**

- **Destination MAC Address, Domains ID & Path ID**

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How can ISIS-SPB & gPTP work together?

Proposal: The communication path for sync messages shall be established by ISIS-SPB

Which information are needed from ISIS-SPB to pre-configure sync path?

- **Topology for Synchronization**
  - Which end stations and bridges support gPTP (are time aware system)?
- **General Configuration**
  - Which time scale should be synchronized (universal time, working clock, …)?
  - Which Domain ID is assigned to a time scale?
  - Is high availability required?
    - How many hot- or cold stand-by grandmaster?
    - How many redundant path for Sync messages?
- **Synchronization end-to-end connectivity for ISIS-SPB**
  - Which end stations and bridges supports gPTP?
    - Which time aware systems are grandmaster capable?
    - Which priority has a grandmaster capable time aware systems?
    - Which time quality has a grandmaster capable time aware systems?
    - Which time aware systems shall be synchronized?
    - …

ISIS-SPB for SYNC based on gPTP can cross L3 Router because all messages are peer-to-peer messages

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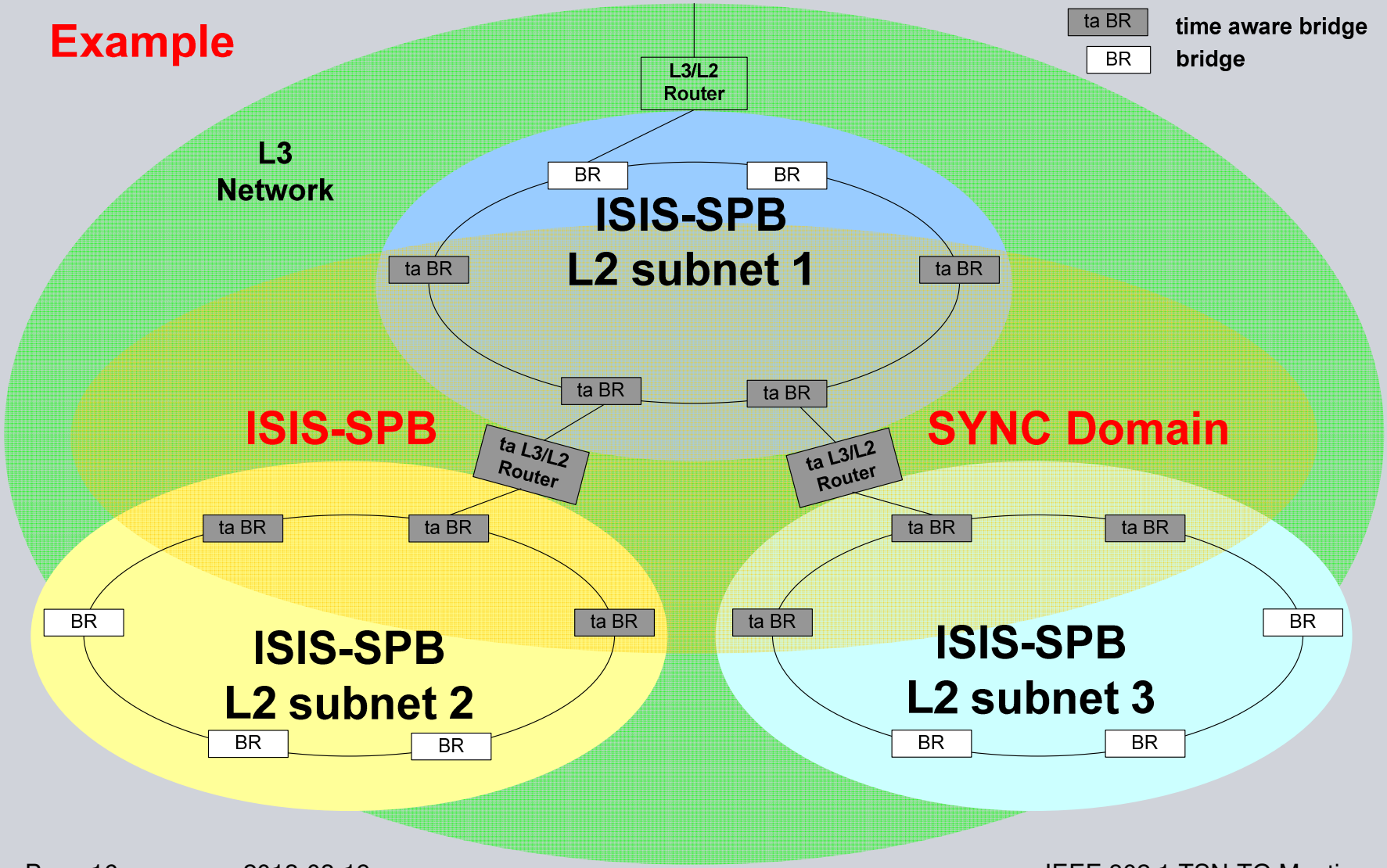

Proposal for Distributing Synchronization Information with ISIS-SPB for SYNC

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New **"Sync Instance Sub-TLV"** in ISIS Link-State-PDU

- **Information for layer 2 sync routing**
  - Time Scale (e.g. universal time, working clock)
  - Sync Domain ID (for one time scale)
    - Path ID: path A, path B (optinal)
  - Number of Hot-stand-by or cold-stand-by GM *(typical one)*

New **"Sync Metric Sub-TLV"** in ISIS Link-State-PDU

- **gPTP port information**
  - .1AS or PTP Version x capable

New **"Sync Announce Sub-TLV"** in Link-State-PDU

- **Information for BMCA to elect primary GM, cold- or hot-stand-by GM, slaves**
  - ClockIdentity
  - Priority
  - …

Proposal for ISIS-SPB for SYNC
New Sync Instance Sub-TLV in Link-State-PDU

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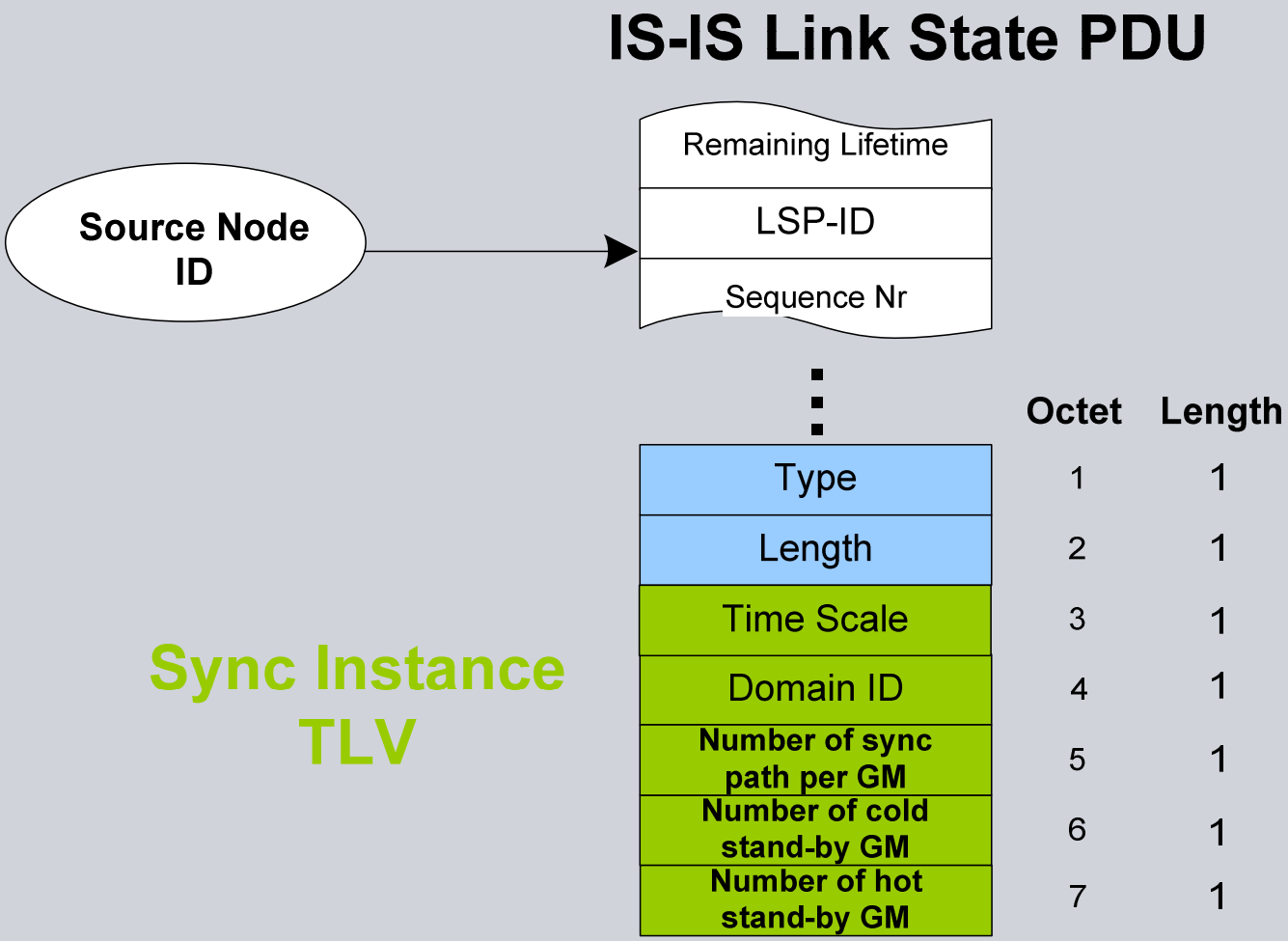

Proposal for ISIS-SPB for SYNC
New Sync Link Metric Sub-TLV in Link-State-PDU

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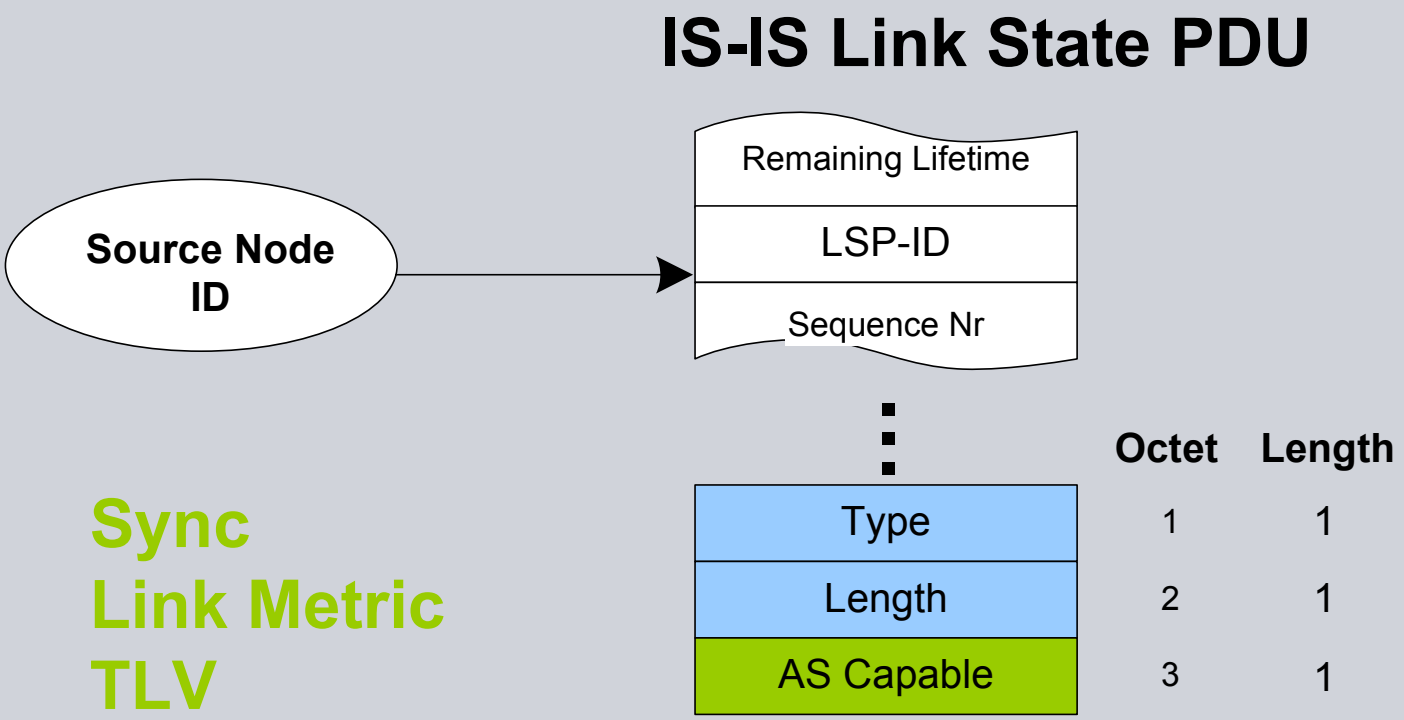

Proposal for ISIS-SPB for SYNC
New Sync Announce Sub-TLV in Link-State-PDU

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PTP Announce PDU

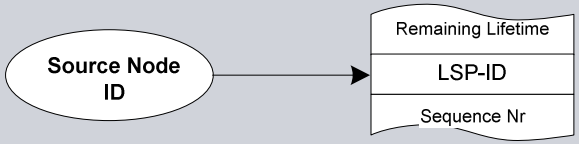
	Octet	Length
TransportSpecific	1	4 bits
MessageID	1	4 bits
PTPVersion	2	1
MsgLength	3 - 4	2
DomainNumber	5	1
Flags	6 - 7	2
Correction	08 - 15	8
Resv #1	16 - 19	4
ClockIdentity	20 - 27	8
SourcePortID	28 - 29	2
SequenceID	30 - 31	2
ControlField	32	1
LogMsgPeriod	33	1
Resv #2	34 - 43	10
CurrentUTCOffset	44 - 45	2
Resv #3	46	1
Priority 1	47	1
GMClockClass	48	1
GMClockAccuracy	49	1
GMClockVariance	50	1
Priority 2	51	1
GMClockIdentity	52 - 59	8
StepsRemoved	60 - 61	2
TimeSource	62	1

Sync Announce TLV

(not all information from the PTP Announce PDU are required)

1 bit	resv
1 bit	resv
1 bit	resv
2 bits	resv
1 bit	resv
1 bit	TwoStep
1 bit	resv
2 bits	resv
1 bit	FreqTraceable
1 bit	TimeTraceable
1 bit	Timescale
1 bit	UTCReasonable
1 bit	LI59
1 bit	LI61

IS-IS Link State PDU



	Octet	Length
Type	1	1
Length	2	1
Flags	3 - 4	2
LogMsgPeriod	5	1
CurrentUTCOffset	6 - 7	2
Priority 1	8	1
MyClockClass	9	1
MyClockAccuracy	10	1
MyClockVariance	11	1
Priority 2	12	1
MyClockIdentity	13 - 20	8
TimeSource	21	1

Next Steps?

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Thank you for your attention!

Questions?