

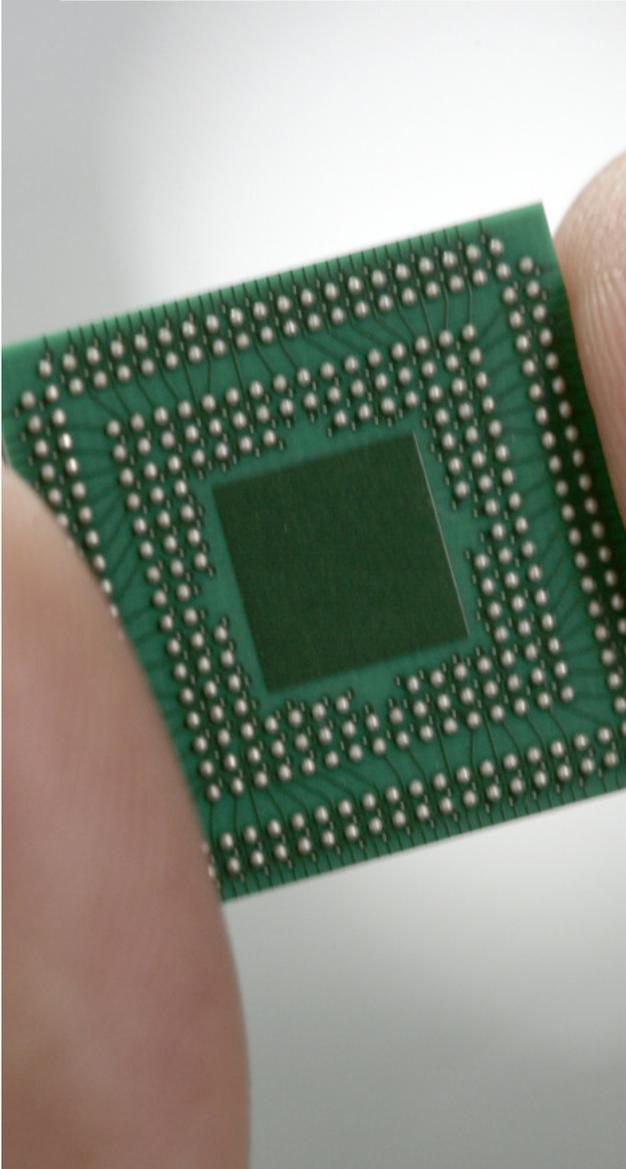
High Available Synchronization with IEEE 802.1AS bt

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Orlando / USA

Franz-Josef Goetz, Siemens AG



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

▪ 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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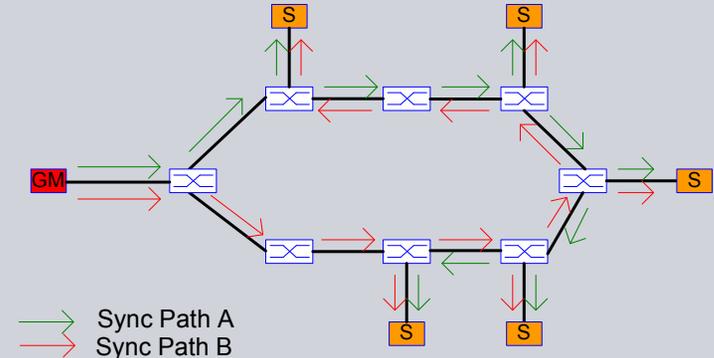
Further Requirements on Synchronization @ IEEE802.1 AS bt

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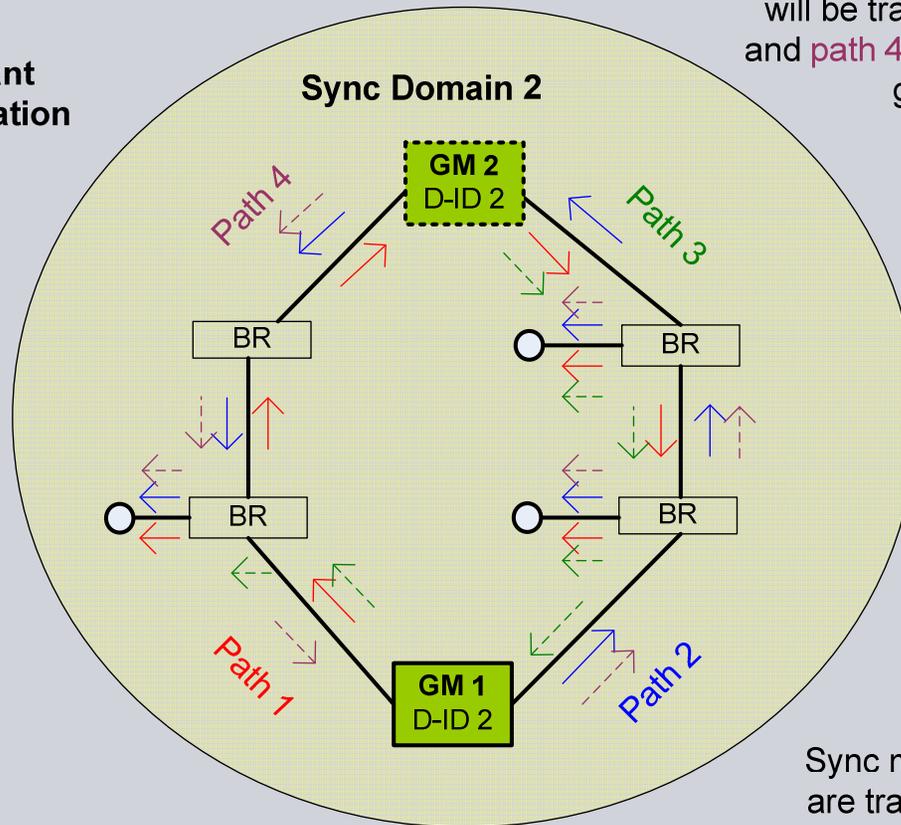
Methods to meet the requirements for high available and high accurate Synchronization

Use case 1:

Time aware domain with one active grandmaster but redundant sync messages transmitted over redundant path with or without auto-re-configuration of sync path

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

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



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

- BR bridge
- end station (slave only)
- GM
D-ID x end station (grandmaster)
- GM
D-ID x end station (slave, grandmaster capable)

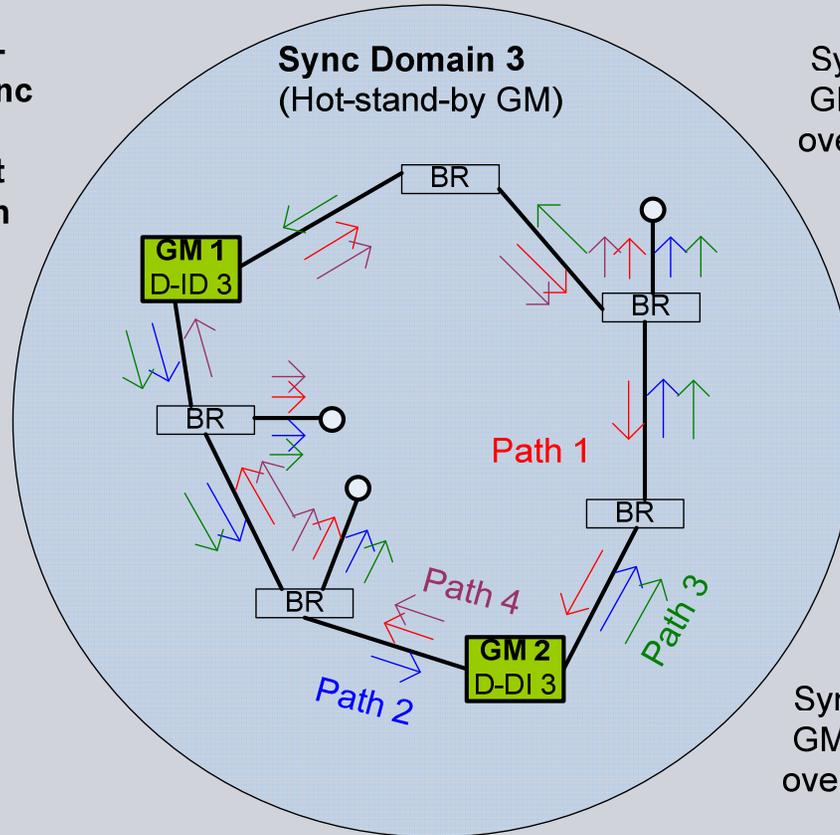
Methods to meet the requirements for high available and high accurate Synchronization

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

- BR bridge
- end station (slave only)
- GM
D-ID 1 end station (grandmaster)



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**

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

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

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	<ul style="list-style-type: none"> • Universal time (traceable time) • Working clock (free running, none traceable time)
Domain ID	<ul style="list-style-type: none"> • One time scale within one sync domain
Path ID	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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)?

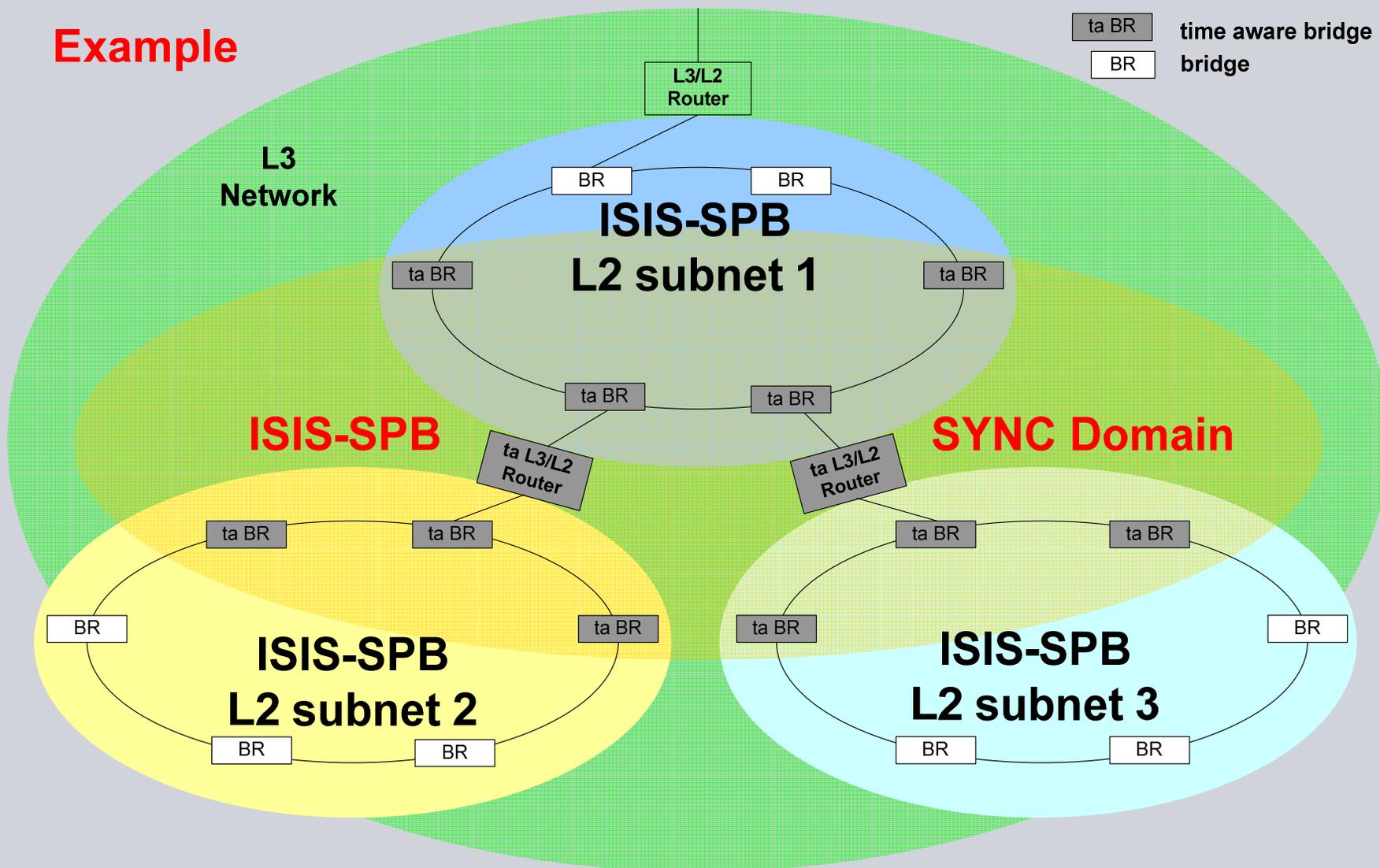
- **General Configuration**
 - Which time scale should be synchronized (universal time, working clock, ...)?
 - Which Domain ID is assigned to a time scale?
 - Is high availability required?
 - How many hot- or cold stand-by grandmaster?
 - How many redundant path for Sync messages?

- **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



Example



Proposal for Distributing Synchronization Information with ISIS-SPB for SYNC



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 (optional)
- 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**

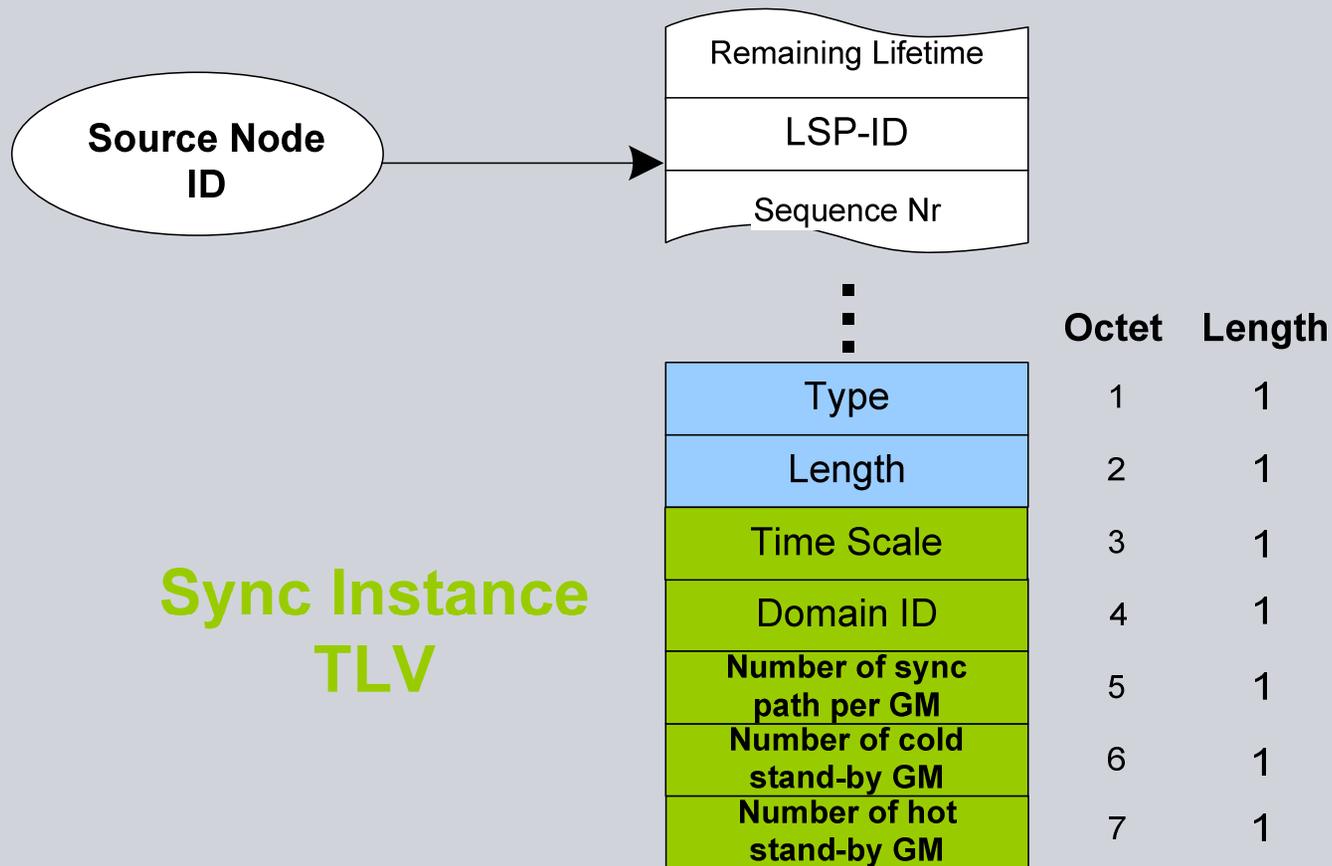
- ClockIdentity
- Priority
- ...

Proposal for ISIS-SPB for SYNC

New Sync Instance Sub-TLV in Link-State-PDU



IS-IS Link State PDU

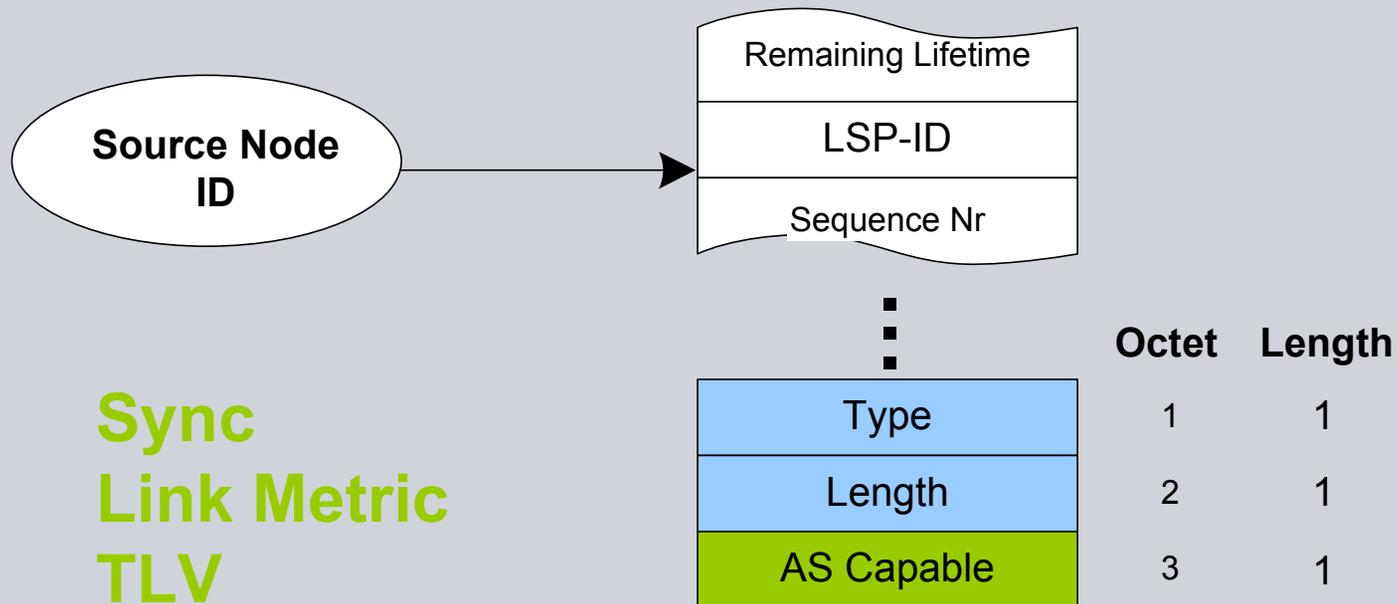


Proposal for ISIS-SPB for SYNC

New Sync Link Metric Sub-TLV in Link-State-PDU



IS-IS Link State PDU



Proposal for ISIS-SPB for SYNC

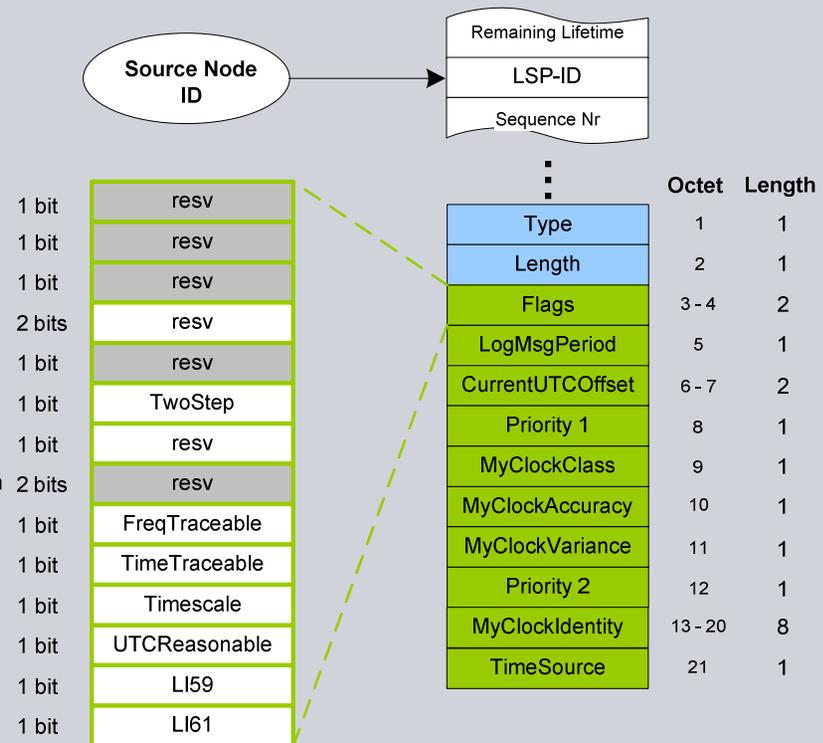
New Sync Announce Sub-TLV in Link-State-PDU



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

ISIS Link State PDU



Next Steps?

Thank you for your attention!

Questions?