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IEEE 802.1AS-Rev

Runtime Control for Redundant Synchronization

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Outline

- Overview of redundancy support in 1588-Rev
- Redundancy with run-time control for industrial automation
  - BMCA for run-time selection of GM
  - Path computation and reservation for Sync path redundancy
- Suggested work for .1AS-Rev and conclusion

1588's Proposals for Redundancy

- Bases for support of sync redundancy in 1588
  - Redundant GMs/Sync spanning trees are separated in different PTP domains, which are independent of each other
  - Timing transfer between domains (e.g. merging of multiple redundant synchronized time) occurs only at end-stations
- In the 1588 Upkeep proposal 94 (approved on May 25, 2015)
  - A new attribute ***optionalDefaultDS.externalPortConfiguration*** enables the PTP ports to be directly configured from external
    - allowing creation of different spanning trees for redundancy through external configuration of domain-specific port roles (one tree per domain)
  - In case of external configuration, the default BMCA will be disabled
    - implying that GM is not determined by the default BMCA
    - but OC/BCs keep sending Announce msgs on their Master Ports w/o BMCA
    - both Announce and Sync msgs will be forwarded over the master ports on the same tree established by external

Redundancy with Run-time Control for Industrial Automation

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- It seems that 1588 proposes a fully centralized configuration method via management for setting up redundancy.

- But it is also mentioned in the <<*1588 Upkeep proposal 94*>> that *"the presence of such an interface would allow the creation of alternate BMCAs by external protocols outside the scope of 1588"*
  - meaning that using control protocols for run-time configuration of sync redundancy is also permitted by 1588

- In addition to centralized management, industrial automation also requires run-time control with protocols to realize auto-configuration in the following sync functions

  - **Selection of GMs incl. primary GM and hot-standby GM for redundant GM**

  - **Establishment of redundant Sync spanning trees with external path computation entities**

Run-Time GM Selection with BMCA for GM Redundancy in .1AS-Rev

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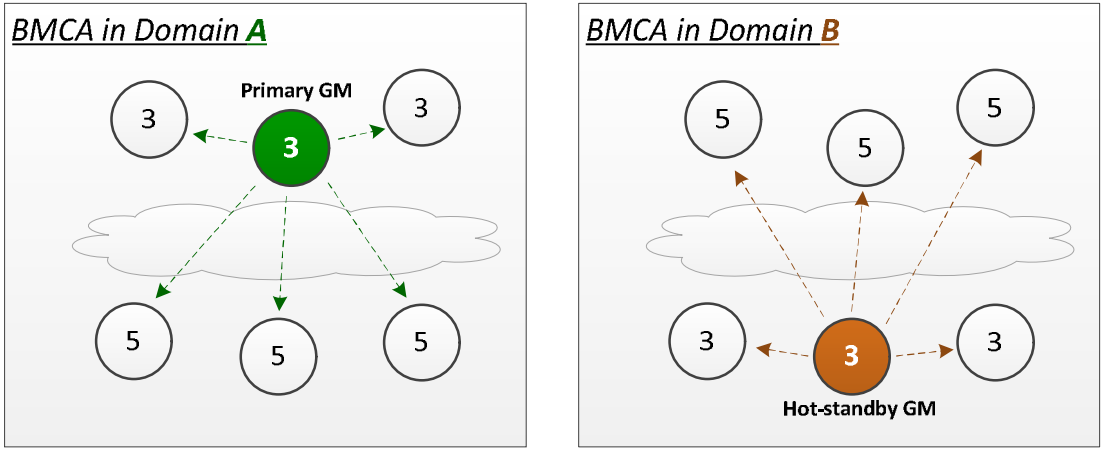
- The BMCA in .1AS is a distributed protocol for automatic run-time GM selection.
- **The .1AS BMCA can be directly applied for selection of redundant GM in .1AS-Rev**
  - The primary GM and the hot-standby GM will be selected separately in two domains, because BMCA is domain-specific.
  - To avoid the selected primary and hot-standby GMs to be the same clock, ***priority1*** attributes of GM-capable stations need to be configured differently in two domains.
    *(see option 2 presented in *)*



In different domain, a different set of clocks are configured with the same lowest priority1 value as the preferred GM-candidates, among which the GM is selected by BMCA through comparing other attributes like clockClass and colckAccuracy.

Example of GM redundancy: use BMCA for selection of redundant GMs

** http://www.ieee802.org/1/files/public/docs2015/as-chen-goetz-configuration-bmca-0715-v01.pdf*

Separation of Announce Tree and Sync Tree For Sync Path Redundancy in .1AS-Rev

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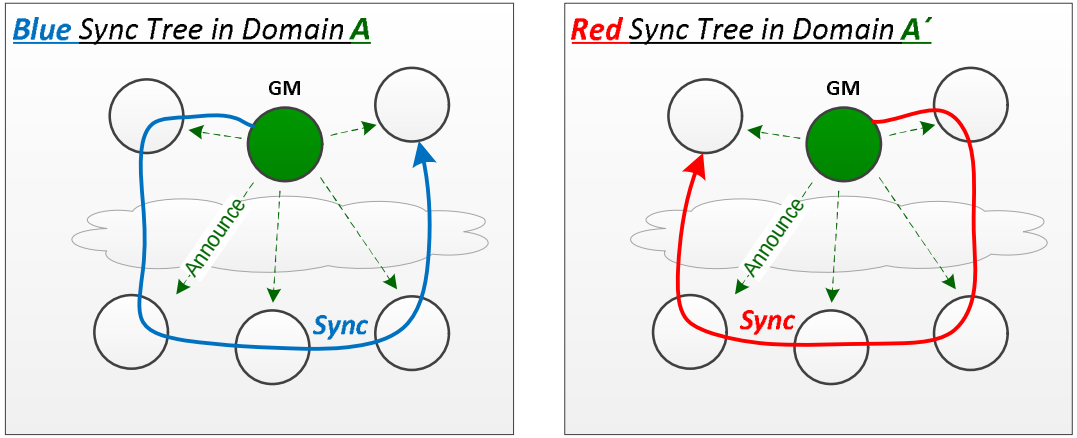
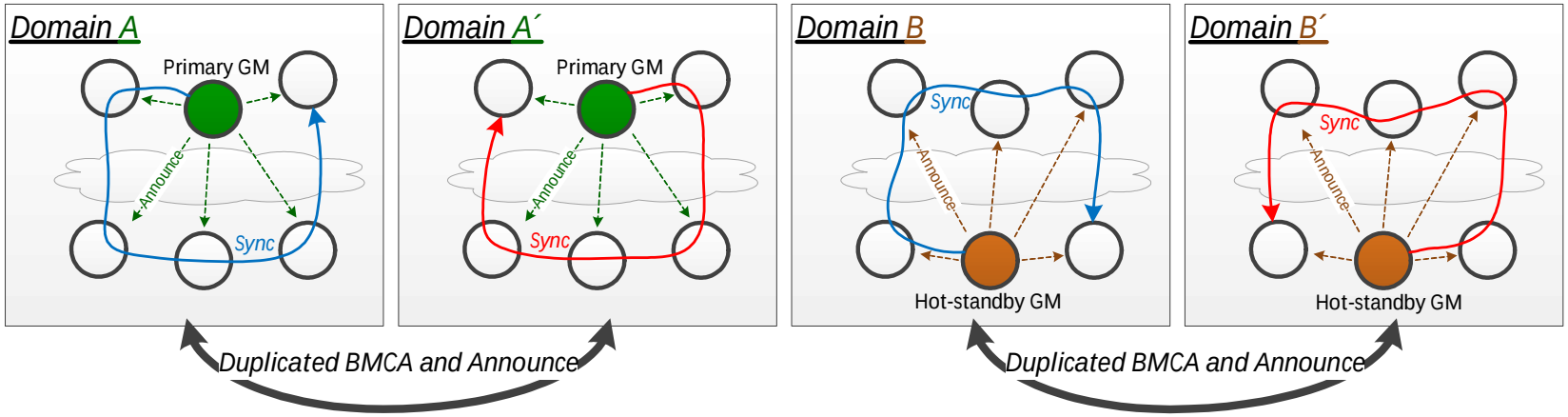
- **In .1AS:** BMCA selects a single GM per domain and meanwhile creates a spanning tree, based on which both Announce and Sync msgs are transmitted throughout the domain.
- **Problem:** the RSTP-based BMCA is not capable of creation of redundant trees, e.g. MRT, which is needed for support of Sync path redundancy in .1AS-Rev.
- **Proposals for .1AS-Rev in support of Sync path redundancy**
  - ***Announce Tree:*** the spanning tree established by BMCA and described by the existing *portRole* attributes is used to transmit only Announce msgs.
  - ***Sync Trees:*** redundant trees computed by external components and configured via the interfaces are used for redundant transmission of Sync msgs

  ⇒ **need an additional *portRole* attribute per port for external configuration of sync trees**



Example of Sync path redundancy: use different trees for transmission of Announce and Sync msgs

Issues of Duplicated BMCA and Announce

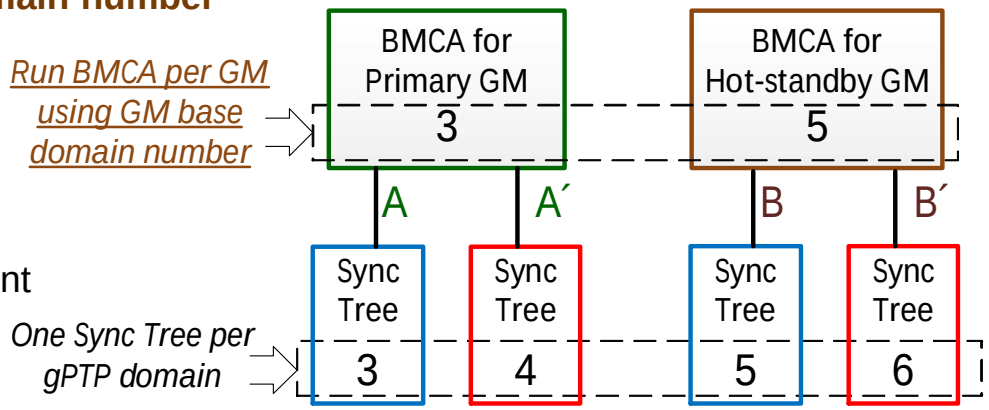


Example of GM + Sync Path redundancy in four gPTP domains (A, A´, B, B´)

Issues: if running BMCA in each domain, there will be duplicated BMCA and Announce transmission in the domains with the same GM, causing a waste of resource and bandwidth.

Solution: run BMCA per GM with GM base domain number

- similar to configuration of *VLAN, base VID, SPVIDs and FIDs* specified for SPB in 802.1Q
- only one BMCA per GM, while Announce msgs use GM base domain number
  - domain number allocation via management
  - no changes to hardware because BMCA and Announce are handled by software



Path Computation and Reservation for Redundant Synchronization (PCR4Sync)

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- Support run-time computation and reservation of sync trees for support of sync path redundancy in .1AS-Rev – **a new PAR (PCR4Sync) is needed**
- Some basic mechanisms like ISIS-based topology discovery, mechanisms and algorithms using PCE or/and BLCEs for computation of explicit trees like MRTs etc. have been specified in .1Qca
- But there are some specifics related to synchronization not yet covered by .1Qca
  - Each sync tree has to be identified by gPTP domain number, not VID
  - Interaction between gPTP (.1AS-Rev) and PCR4Sync
    - PCR4Sync needs to know about the range of each domain-specific active topology in the context of gPTP.
    - The root of each tree is always the GM selected by the BMCA in each domain, based on which PCR4Sync computes the trees of required type.
    - The computed trees will be installed by PCR4Sync in the form of port-role configuration through the external interfaces provided by .1AS-Rev.

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A Summary of Proposals for Sync Redundancy

Redundancy Functions	**IEEE 1588**	**Proposals for 802.1AS-Rev** (to support industrial requirements)
GM selection (incl. redundant GM)	disable default BMCA thus GM is appointed by management or selected by an alternate BMCA	**use .1AS BMCA with domain-specific *priority1* values to support run-time GM selection**
Transmission of Announce and Sync msgs	on the same externally specified tree	**Announce on the (internal) BMCA tree and Sync on the externally specified tree with an extra portRole attribute**
Establishment of redundant sync trees via external interfaces	management	**Path computation and reservation for Sync with run-time control**

- Suggested work related to .1AS-Rev includes (likely not complete)
  - define an new per-port attribute **"*portRole4Sync*"** (only for Sync tree)
  - specify that if *externalPortConfiguration* is enabled,
    - external configures ***portRole4Sync*** to establish Sync trees for sync forwarding
    - BMCA can be active for GM selection and the spanning tree established by BMCA in the existing portRole attributes is used only for Announce transmission.

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Conclusion

The proposals in this presentation:

- should be regarded as extensions to the 1588's method that focuses primarily on a fully centralized configuration model with management.
- provide concrete solutions with protocols and algorithms to support run-time control for dynamic configuration of sync redundancy, which is required by industrial automation applications.
- but still stay consistent with the principles defined by 1588 such as usage of domains and configuration of redundant sync path via external interfaces
- are mainly based on the existing mechanisms of 802.1 standards
  - BMCA in .1AS
  - ISIS-PCR in .1Qca

If the group agrees on these proposals, the author will assist the editor to prepare texts and figures for the draft by the November plenary.

Thank you for your attention!

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