IEEE 802.1AS-Rev

Configuration Model and BMCA for Timing and Synchronization with Redundancy in .1AS-Rev

IEEE 802.1 Plenary Meeting – July 2015, Hawaii

Feng Chen, Franz-Josef Goetz, Juergen Schmitt
Siemens AG

SIEMENS

Recap:

- .1AS-Rev will support sync redundancy of various types
  - Path redundancy: one GM + two Sync trees
  - GM redundancy: 2 x (one GM + one Sync tree)
  - Path+GM redundancy: 2 x (one GM + two Sync trees)
- Current decision of the TG on preferred solutions for redundancy
  - using multiple domain numbers for separating redundant Sync trees
  - using external mechanisms for determining redundant Sync trees
- Undecided issues
  - How to select redundant GMs
  - How to distribute Announce msgs
- Our previous proposals
  - Use BMCA as control protocol for selection of (redundant) GMs
  - The tree established by BMCA is used only for distribution of Announce msgs

We continue discussion on this topic and give more details in this presentation

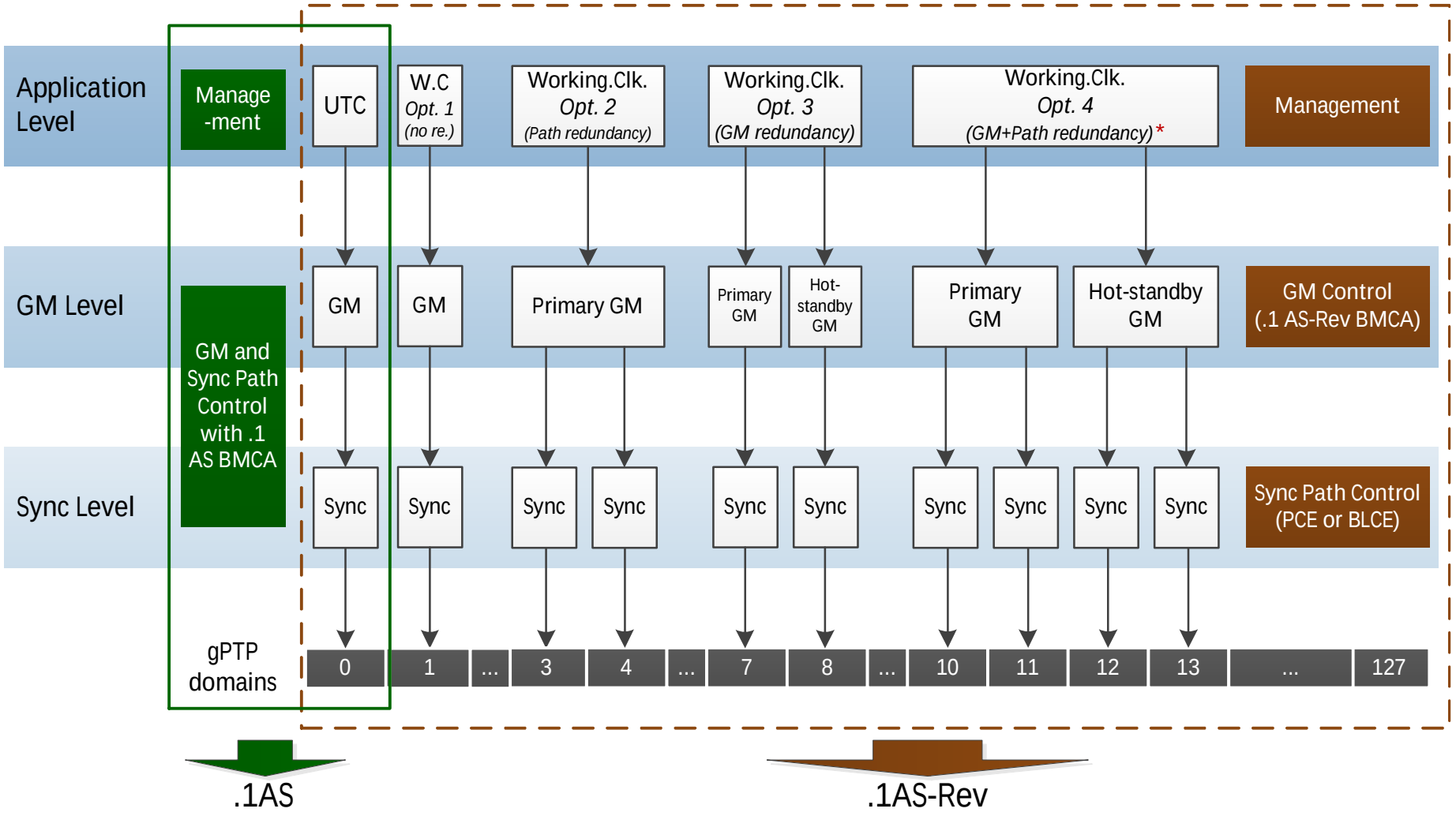
SIEMENS

Assumptions on Configuration of .1AS-Rev

- According to the redundancy type required by sync applications, management is responsible for allocation of domain numbers
  - *e.g. assigning 4 gPTP domains for a working clock application requiring GM+Path redundancy, and specifying two domains for the primary GM with two redundant sync trees and the other two for the hot-standby GM with the other two redundant sync trees*
- Within the allocated domains, GMs (incl. primary and hot-standby) are online selected by a certain control protocol like BMCA
  - *Management could also be used to directly assign GMs, but this method is not the focus of all industrial applications.*
- The used control protocol such as BMCA is only used for selecting GMs and establishing tree for distributing Announce msgs.
- Establishing (redundant) trees for distributing Sync msgs will be done using other control mechanisms other than BMCA , e.g. PCE or BLCE for Sync
  - *This part may be outside the scope of AS-Rev*
  - *But interfaces (namely, configurable port roles per domain) provided for external elements to configure the established sync trees need to be defined by AS-Rev*

A Possible Configuration Model for .1AS-Rev with Redundancy

SIEMENS



* *GM+Path redundancy is a combination of GM and path redundancy*

SIEMENS

Configuration Details for .1AS-Rev

- Management on application level – **YANG or MIB**
  - Requirements of Sync applications
    - time-scale: UTC or working clock
    - redundancy type: no redundancy, GM or/and path redundancy
  - outputs:
    - allocation and mapping of domain numbers for App, GM and Sync levels

- Control on GM level – **.1AS-Rev BMCA *(focus of this presentation)***
  - selection of primary GM (best clock) and hot-standby GM (typically the 2nd best clock, needed by GM redundancy)
  - establishment of one Announce tree per GM
  - outputs: selected GMs and one established Announce tree per GM

- Control on Sync level – **PCE or BLCE for Sync**
  - computation of redundant Sync trees rooted at each GM (one tree per domain)
  - outputs: a set of port roles per domain

SIEMENS

Problems of Using .1AS BMCA for redundancy

- BMCA of .1AS
  - operates in a single gPTP domain
  - selects a single best master clock
  - establishes a common spanning tree for both Announce and Sync msgs

- There are two major problems, if each station simply runs one BMCA instance of the current version in each of its supported domains.
  - In case of **GM redundancy**: the same station will be chosen as GM for both domains, thus no distinguish of primary GM and hot-standby GM

    ⇒ *the hot-standby GM (typically the second best clock) is typically required to be synchronized with the primary GM (the best clock), thus both GMs must share the same domain numbers (visibility for each other)*

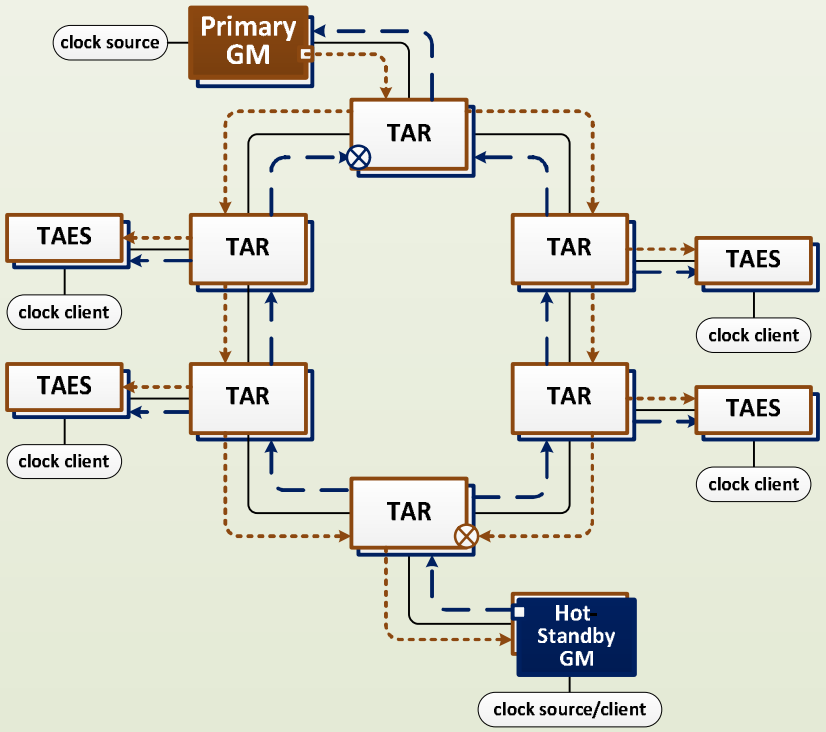
  - In case of **sync path redundancy**: a single GM runs two copies of the same BMCA process including announce msgs in two different domains.

    ⇒ *not necessary! One announcing process per GM is sufficient.*

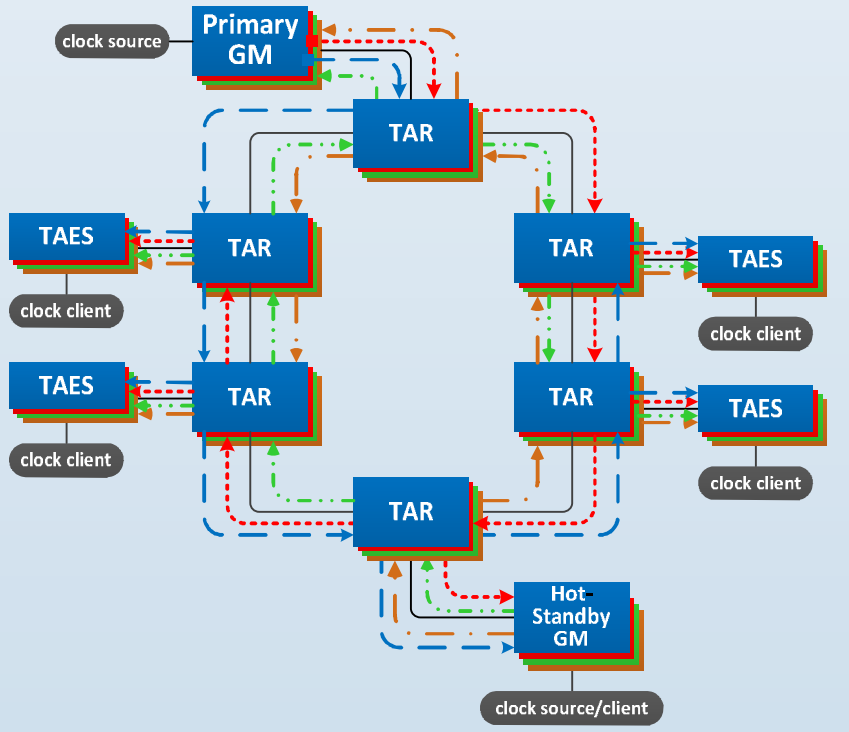
Due to the above problems, the current BMCA in .1AS must be extended and adapted for redundancy support in .1AS-Rev.

Proposal 1:
Run .1AS-Rev BMCA per GM, not per Domain

- Each GM needs only one tree for announcement, which is independent of its Sync trees



GM Level of GM+Path redundancy
Two BMCA processes with two Announce Trees



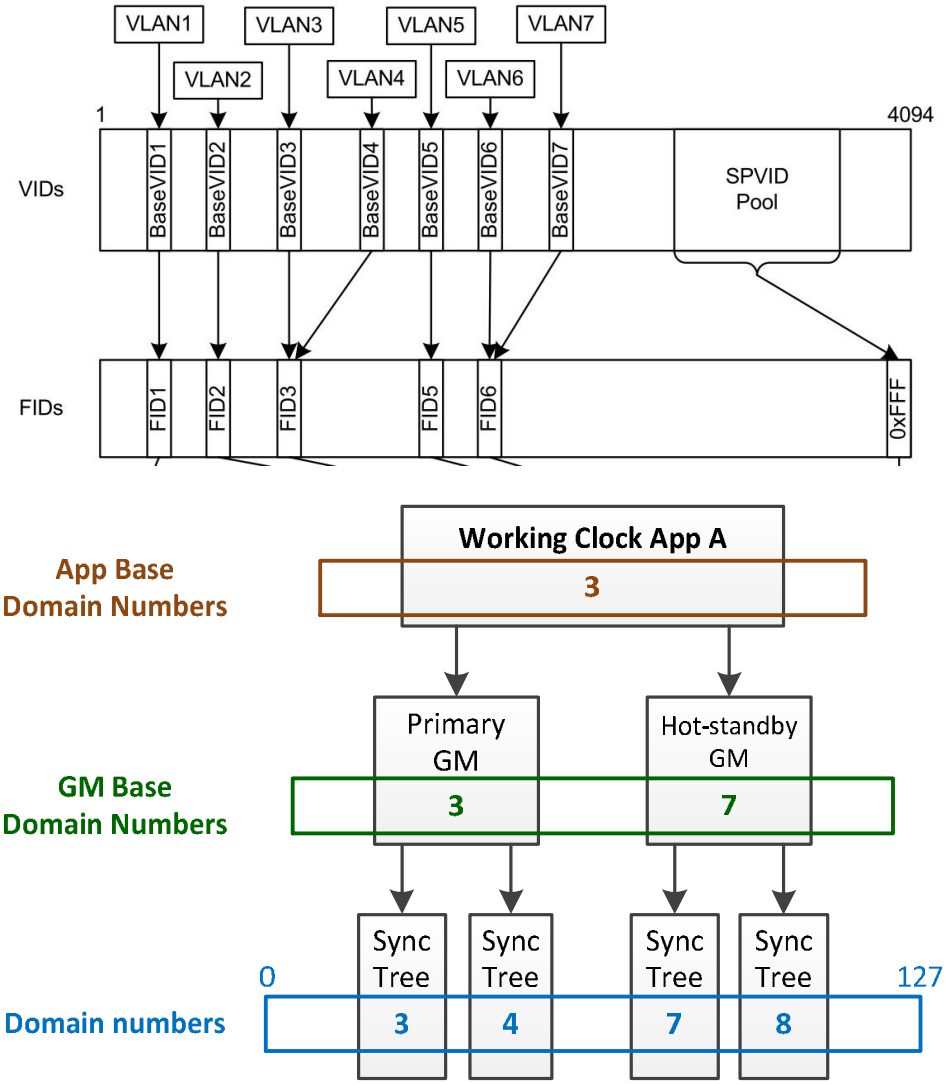
Sync Level of GM+Path redundancy
Four gPTP domains for four Sync trees

Question: *which domain number should be used in Announce msgs?*

Proposal 2:
Mapping of Domain Numbers in .1AS-Rev

- We may use a similar concept as the mapping of *VLAN, base VID, SPVIDs and FIDs* specified for SPB in 802.1Q

- For each sync application, management allocates a range of domain numbers, among which
  - A single ***App base domain number*** identifies the application
  - A ***GM base domain number*** identifies each GM and is transmitted in the domain number filed of Announce msgs of the BMCA process for that GM
  - A ***Domain number*** identifies each Sync tree and is used in the domain number field of Sync msgs transmitting along that Sync tree



Selection of Hot-Standby GM in 1.AS-Rev BMCA
Option 1: 2nd Best Clock Selection Algorithm

SIEMENS

- One possible solution is to define two operation modes for .1AS-Rev BMCA
  - *Best clock selection mode* => for selection of the best clock as primary GM
    - ⇒ exactly the .1AS BMCA
  - *2nd best clock selection mode* => for selection of the 2nd best clock as hot-standby GM
    - ⇒ extension of the .1AS BMCA

- BMCA running in which mode for which gPTP domains is determined by management!
  e.g. management could configure a set of time-aware systems for a specific working clock application requiring GM+Path redundancy as follows
  - *Assign a range of domain numbers **[1,4]** to each of the involved time-aware systems*
  - *In domains **(1,2)**, run one BMCA process in the best clock selection mode to select a primary GM and distribute Announce msgs using GM base domain number **1***
  - *In domains **(3,4)**, run the other BMCA process in the 2nd best clock selection mode to select a hot-standby GM and distribute Announce msgs using GM base domain number **3***

SIEMENS

Algorithm for 2nd Best Master Clock Selection

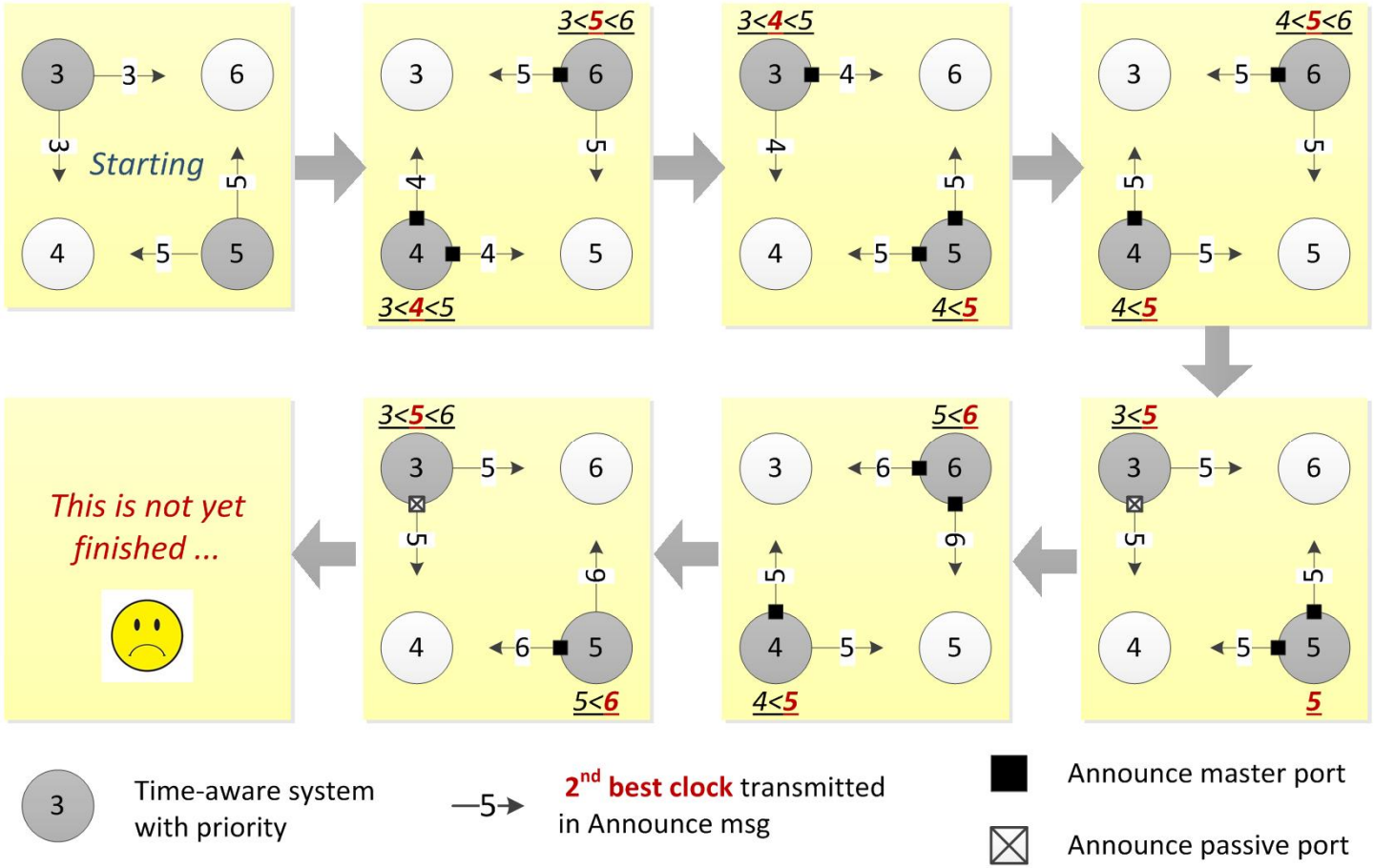
- BMCA in the 2nd best clock selection mode performs
  - selection of the 2nd best clock among a specified set of clocks by comparing their priority vectors
  - establishment of a spanning tree rooted at the second best clock
  - transmission of Announce msgs along the established tree

- Needed additions to the current BMCA for the 2nd best clock selection
  - Add a per-time-aware system global variable indicating in which mode BMCA runs
  - Add a second set of variables for storing information relating to the 2nd best clock
  - Modify sorting/comparing algorithm among a set of received and local priority vectors to output the 2nd best one
  - …

- ***Question:*** if BMCA operates in the 2nd best clock selection mode, which information should be exchanged in the Announce msgs?
  - The current BMCA for best clock transmits in Announce only the root information
  - *Does it still work if the BMCA in the 2nd best clock mode transmits in Announce msgs only the information of the 2nd best clock, which is the root in this case?*

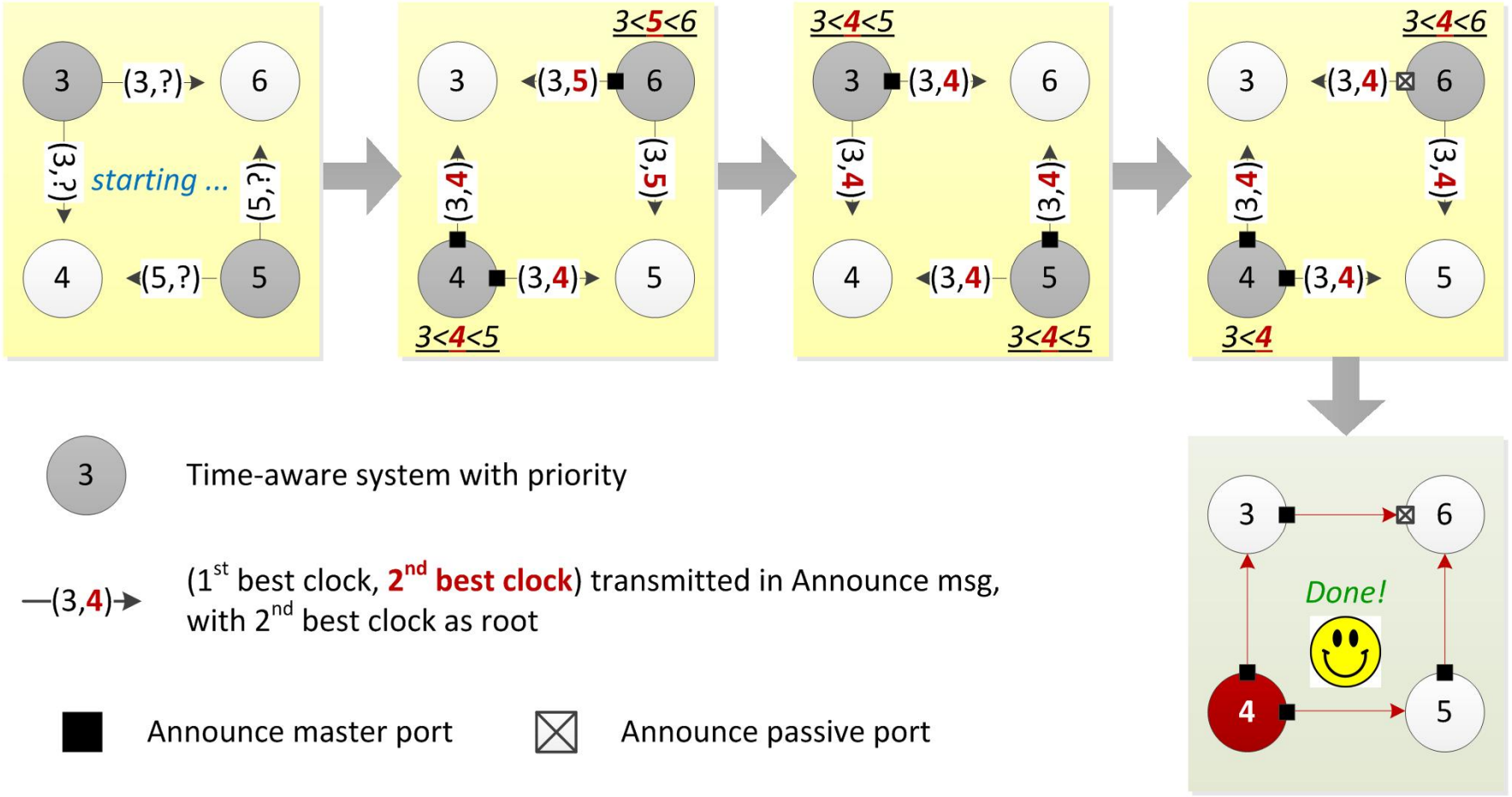
Example for Announcing only 2nd Best Clock

What if exchanging only 2nd best clock info in Announce msgs…



It doesn't work, because the 2nd best clock can never be decided if the best one is not seen by all the participants.

Example for Announcing both 1st and 2nd Best Clocks



We must exchange both 1st and 2nd best clocks info in Announce msgs

Selection of Hot-Standby GM in 1.AS-Rev BMCA
Option 2: Use of Domain-Specific Priority1

SIEMENS

- Another possible solution is to allow each time-aware system to have domain-specific ***priority1*** values, which can be differently configured by management
- In this way, the current BMCA can be applied with no extensions.
- However, management has to ensure in the configuration of ***priority1*** values that the chosen primary GM must be a different clock from the chosen hot-standby GM
- The following table compares the Option 1 and Option 2

	Option 1	Option 2
Use of current BMCA and Announce msgs	extensions needed	yes
Guaranteed different clocks for primary and hot-standby GMs	yes	Not by BMCA itself, management must take care

SIEMENS

Summary

- This presentation shows the following proposals for .1AS-Rev from the perspective of industrial requirements for Sync redundancy
  - A structured configuration model with management and control methods, including a mapping of domain numbers between different levels
  - Separation of controls for sync forwarding (Sync data plane) and Announce transmission (Sync control plane)
  - Two methods for selection of hot-standby GM for GM redundancy

⇒ The first topic is also related to the ongoing discussion of TSN configuration models for support of new TSN features.

⇒ It is to be decided by the TSN TG whether to continue working on these proposals.

Thank you for your attention!

Feng Chen

PD TI ATS TM5 1

Gleiwitzer Str. 555

90475 Nürnberg

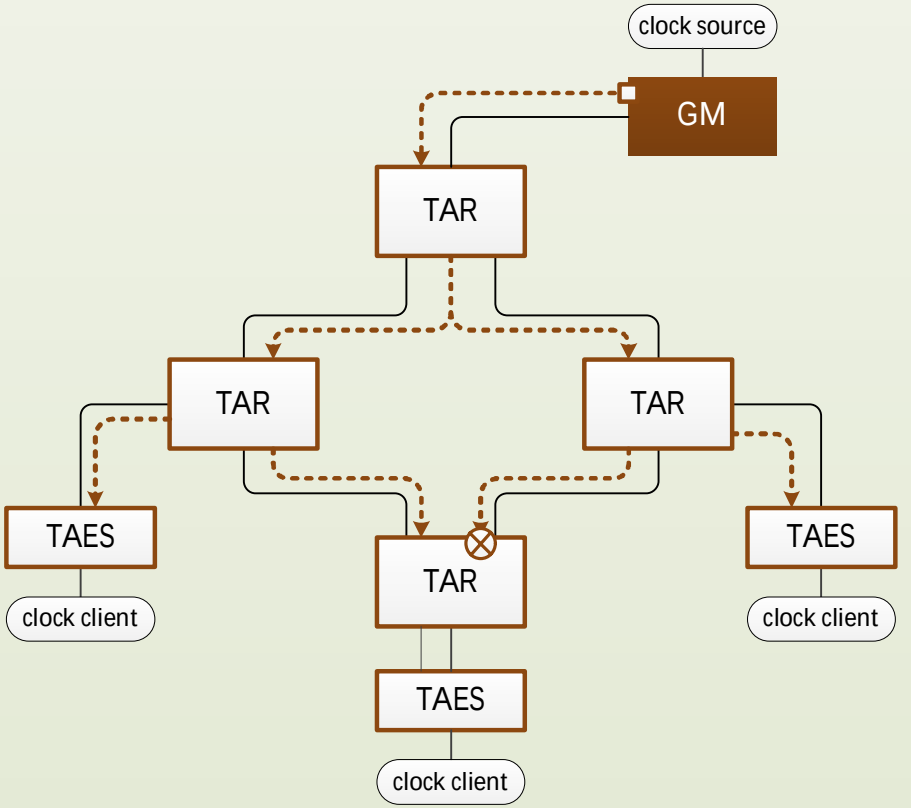
Phone: +49 (911) 895-4955

Fax: +49 (911) 895-3762

E-Mail: chen.feng@siemens.com

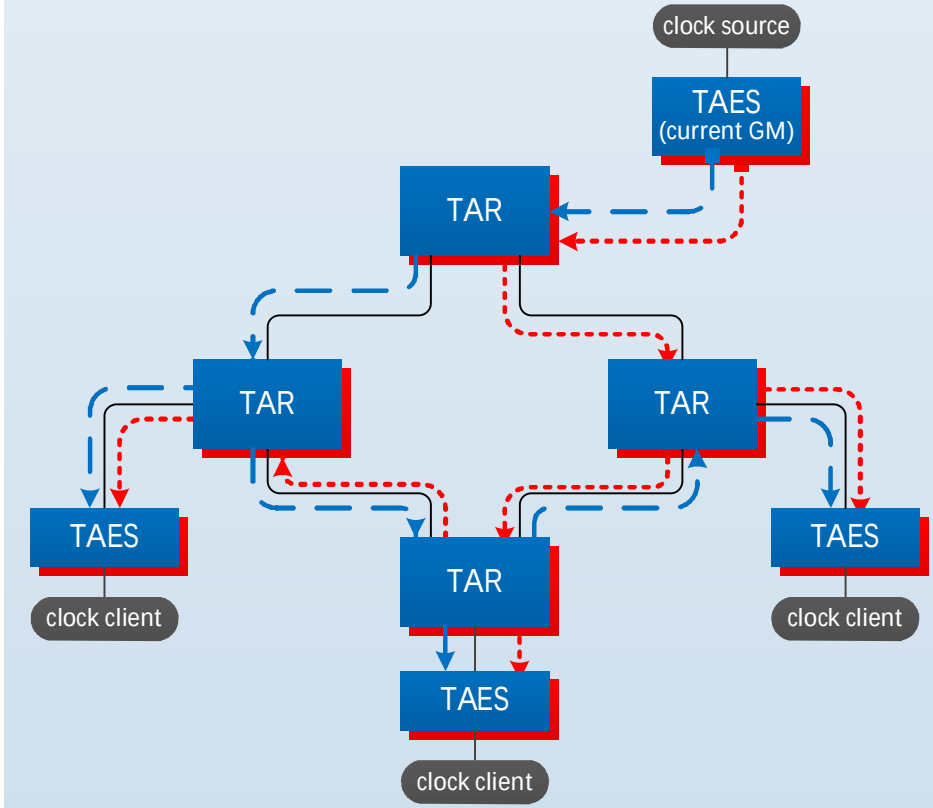
siemens.com/answers

GM Level vs. Sync Level for Path Redundancy



GM Level

One BMCA process with a single Announce tree



Sync Level

Two gPTP domains for two redundant Sync trees