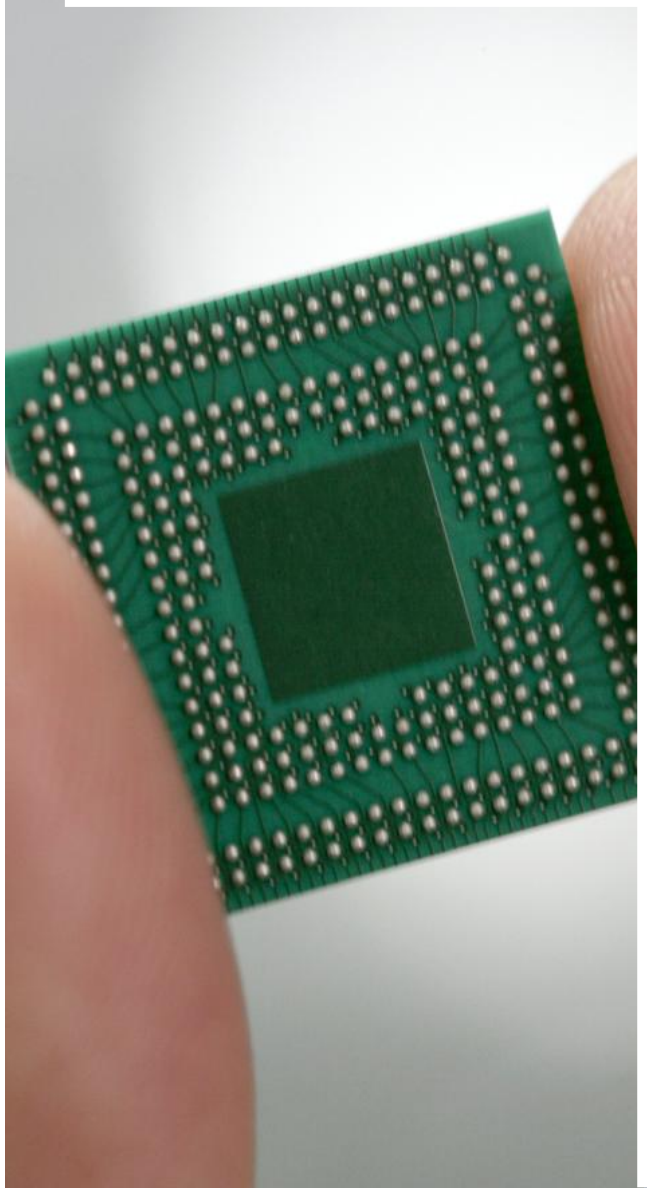
SIEMENS



Which Mechanism for Two Time Scales @ Industry

2012-07-15

IEEE 802.1 AVB Meeting – San Diego

Franz-Josef Goetz, Siemens AG

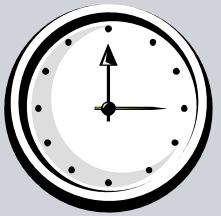
SIEMENS

Why Two Time Scales for Industry?

See: http://www.ieee802.org/1/files/public/docs2012/as-goetz-ind-req-7015-v2.pdf

(1) Universal Time

- **Typical time source**
  - GPS Receiver
  - End station e.g. PLC (universal time set by hand)
  - …
- **Need**
  - Universal time shall be available in the whole network
  - Used to time stamping events (distributed systems)
  - Used to coordinate diagnostic information (e.g. measurement systems)
  - Used for recording process data
  - …

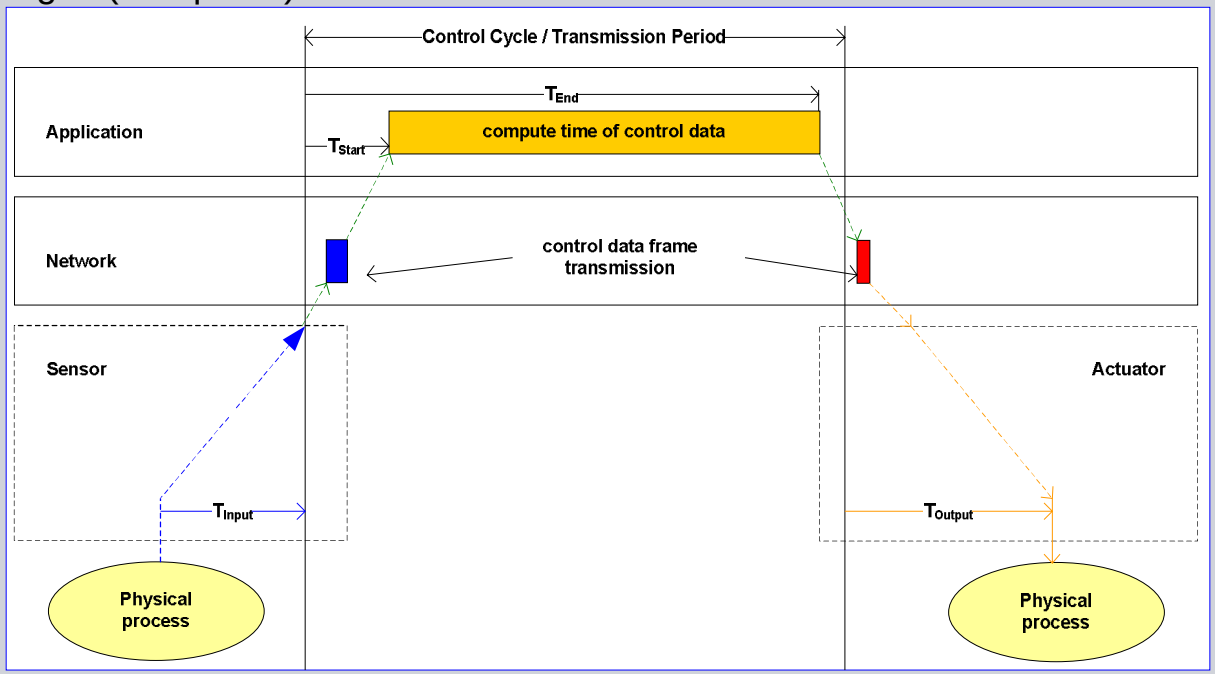


Universal time in each end station

Why Two Time Scales for Industry?

(2) Working Clock

- **Typical time source**
  - End station e.g. PLC
  - …
- **Need**
  - Synchronization for scheduled control data traffic
    - Time aware traffic shaper in end station
    - Time aware traffic shaper in bridges (if required)
  - Synchronization of sampling time
    - Input system (e.g. sensors)
  - Synchronization of actuators
    - Output system
  - Synchronization of applications (e.g. motion control loops)
  - High availability http://www.ieee802.org/1/files/public/docs2011/as-kweber-syncRedundancy-110914.pdf



Proposed Mechanism (1)
Reference Clock Model

SIEMENS

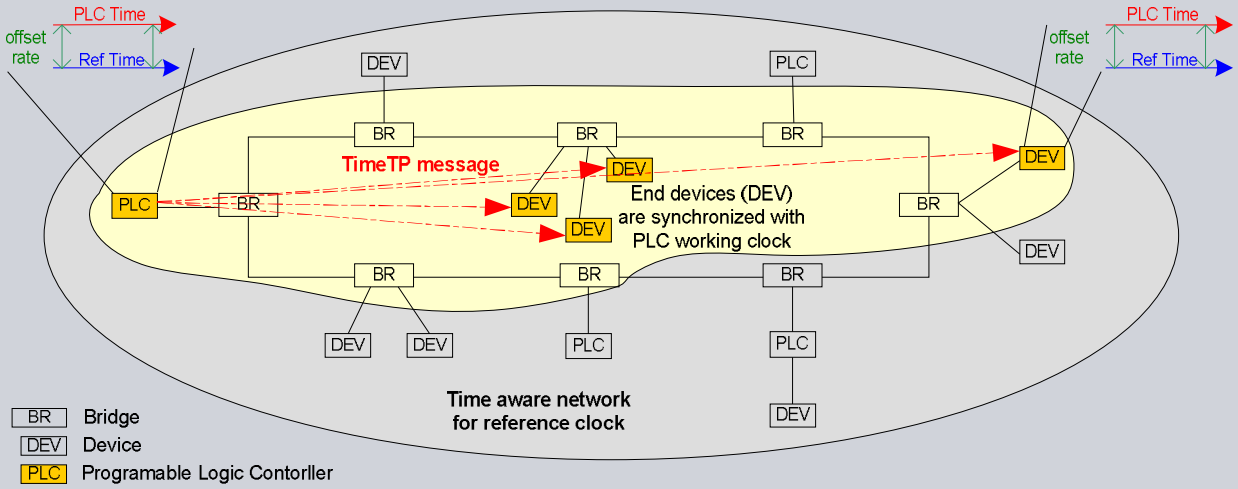
- ***Network is synchronized with reference clock*** *(traceable to TAI or local time)*
  - *The clock that provides Ref_Time is the GM for the entire network*

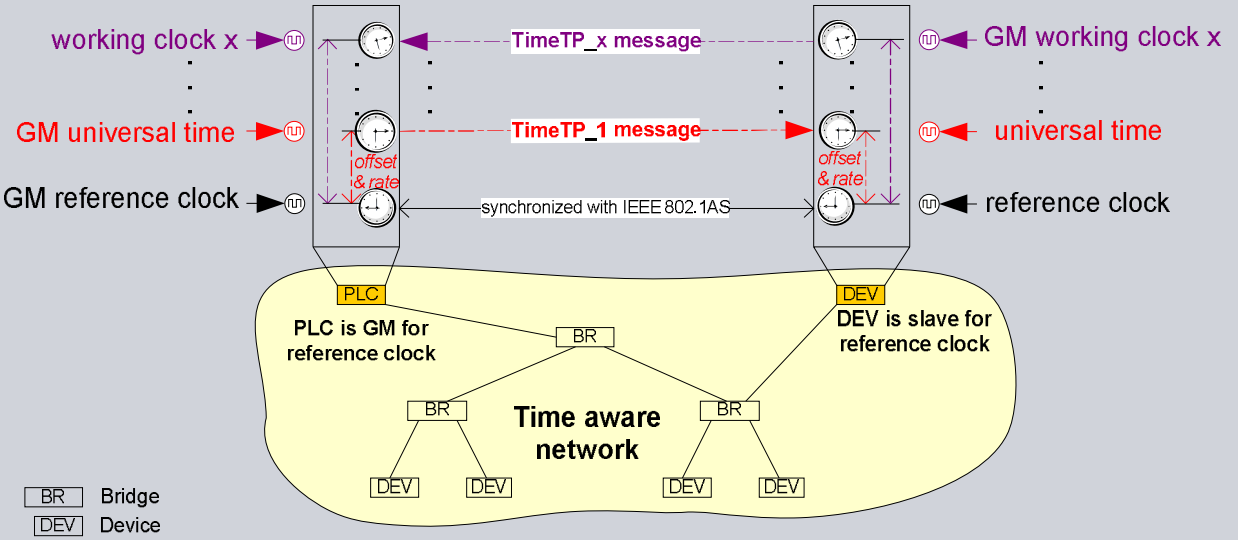
- **When RefTime is available a time aware system can compute time and rate offset between RefTime and local time**
(e.g. PLCTime)
  - PLCTime master is the working clock

- **A Time transport message (TimeTP message) is used to distribute time and rate offset**
(e.g. PLC is PLCTime master and DEV are PLCTime slaves)

- **Information of TimeTP message:**
  - **n** (working clock number)
  - **RefTime** (value of reference time)
  - **CorrespondingTime** (corresponding working clock n time)

- *How to distribute TimeTP messge?*
  - *sync tree*
  - *data tree (RSTP)*
  - *preconfigured path (high availability)*

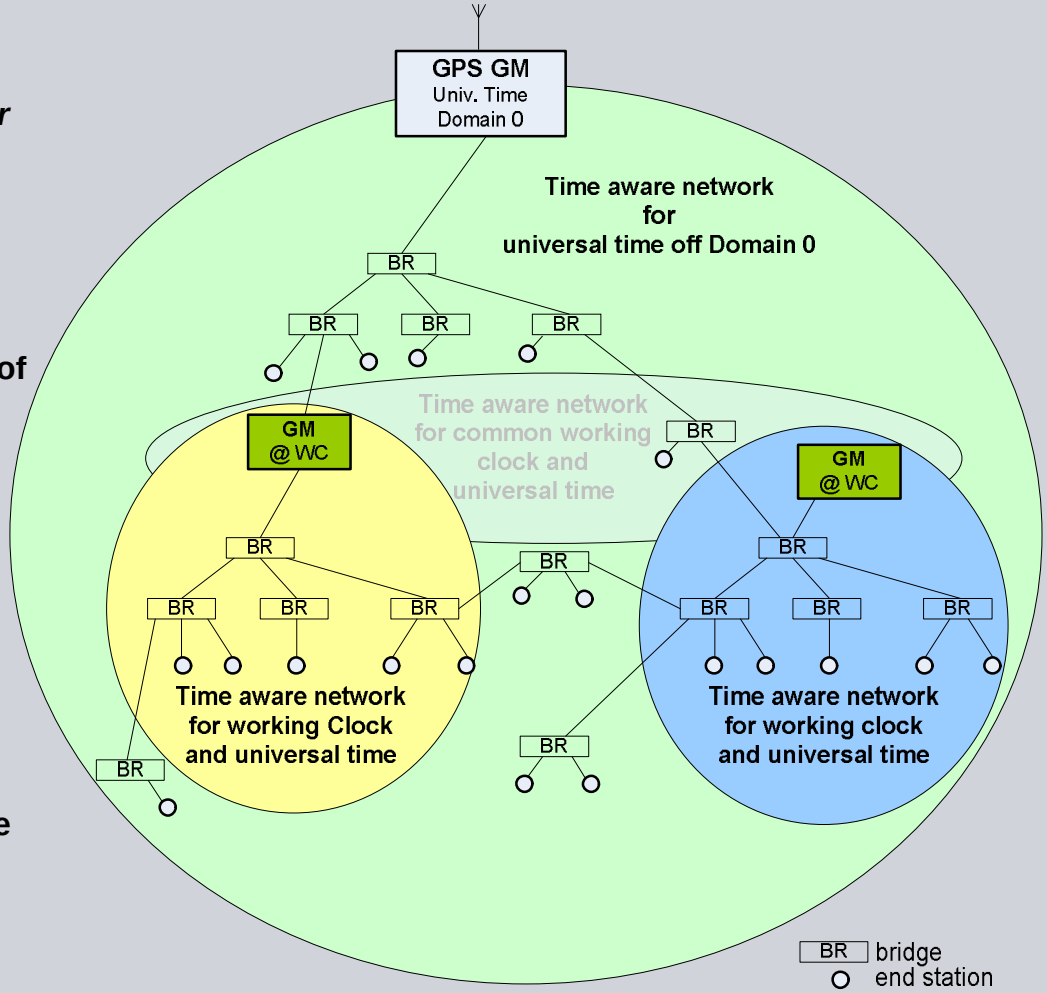




Proposed Mechanism (2)
Multiple Synchronization Domains

SIEMENS

- ***Distributing universal time and working clock over multiple synchronization domains***
  (IEEE 1588-2008 allows multiple domains)
- ***Time is maintained separately for each domain***
  (e.g. port Roles, state machines and BMCA)
- **One common peer delay mechanism at each port of a time aware system**
- **Sync domains are used to synchronize islands within a network**
- **Different sync domains can support different parameter sets and different mechanism for synchronization**
  (e.g. sync interval, sync time out, residence time, preconfigured path and hot stand by master for high availability, higher accuracy)
- **Not all network components within a network have to support Multiple Synchronization Domains**
  (components outside a working clock domain)



Proposed Mechanism (3)
Multip. Non-overlapping Hierarchical Sync-Domains

SIEMENS

- ***Non-overlapping hierarchical sync domains***
  - *The fact that the domains are non-overlapping means that a time-aware system supports at most one PTP domain except at the boundary (and at the boundary any interaction between domains is outside PTP)*
  - *Also means multiple domain numbers are not needed*

- ***A Clock Boundary node (CB) must be located on the border between two domains***

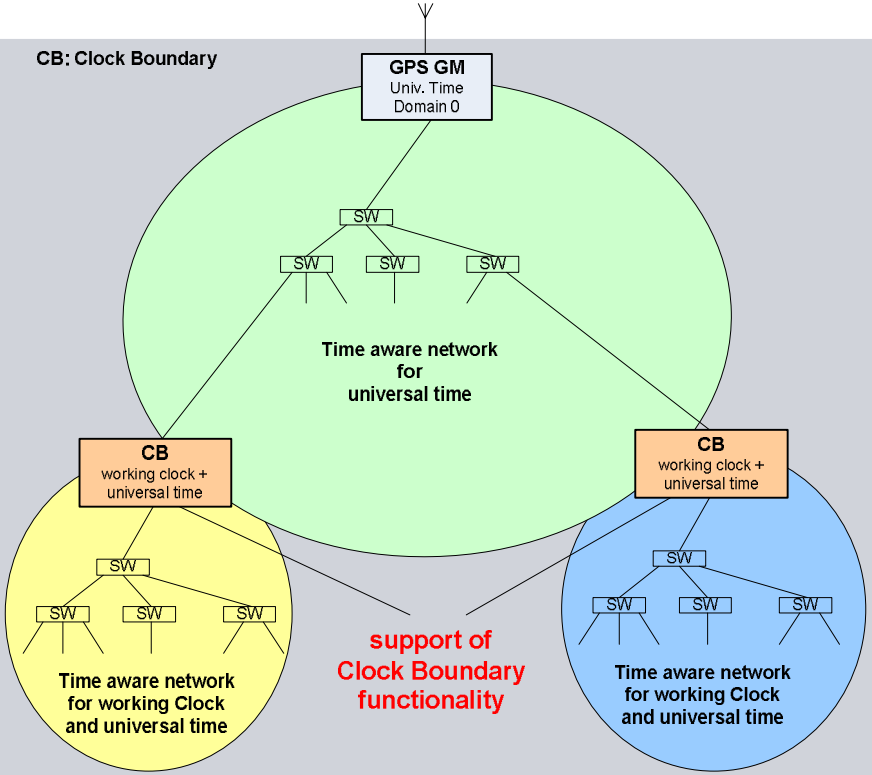
- ***A CB is a node with at least two ports which combines different sync domains***
  - *One port is salve port for upper domain*
  - *A CB is GM for lower domain*
  - *At least port is master port for lower domain*

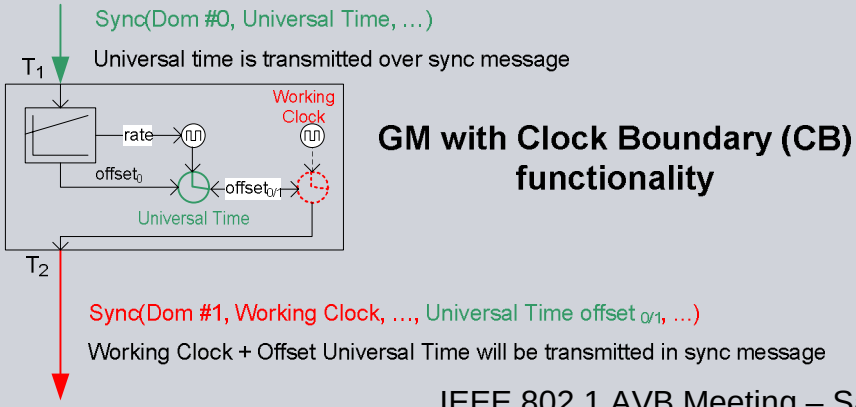
- ***Cock Boundaries measures and calculates***
  - *time offset and*
  - *rate offset*

between universal time GM and working clock GM

- **The ALTERNAT TIME SCALE TLV is attached to Sync or Follow-Up message and is used to distribute time offset rate offset**

See presentation:
http://www.ieee802.org/1/files/public/docs2011/as-goetz-altern-timescale-0311-v01.pdf





GM with Clock Boundary (CB) functionality

SIEMENS

Concept Benchmark

New requirements	**Reference clock model**	**Multiple Sync Domains**	**Alternate Time Scale TLV hierarchical**
Support multiple time scales (e.g. universal time + working clock)	- one common reference clock - time scale synchronization is not independent - data messages (IEEE 1722) or time transport messages are used	- multiple sync messages to support multiple time scales - only network components within regions with multiple time scales must support multiple sync messages	- Alternate Time Scale TLV
High availability & robustness (e.g. - multiples sync messages over preconfigured path - hot standby grand master (i.e., multiple GMs, each sending Sync messages; all Sync messages are processed, with corresponding new Sync messages sent out, but only Sync messages from current active GM are used to produce the synchronized time supplied to the end application. -…)	- all components within a network have to support multiple sync messages	- only components within a high availability region have to support multiple sync messages	- only components within a high availability region have to support multiple sync messages (dependent on topology)
High accuracy regions (e.g. for industrial parameter set - higher sync rate, - short residence time for sync messages - high time stamping accuracy within bridges - …)	- all components within a network have to support high accuracy	- only components within a high accuracy regions have to support multiple sync messages and have to cover high accuracy - a sync domain concept is required	- Clock Boundaries (CB role must be introduced) - can only used in a network with hierarchical time (i.e., the working clock and non-working clock subnetworks must form a tree, with the non-working clock subnetwork at the root. - a sync domain concept is required (but the domains are non-overlapping)

Next Steps?

SIEMENS

Which mechanism will be introduced in gPTP Gen 2

to support multiple time scales with different requirements on

- **accuracy and precision (parameter sets) and**
- **availability (high availability and hot stand by master)**
- **Diagnostic for Synchronization**

???