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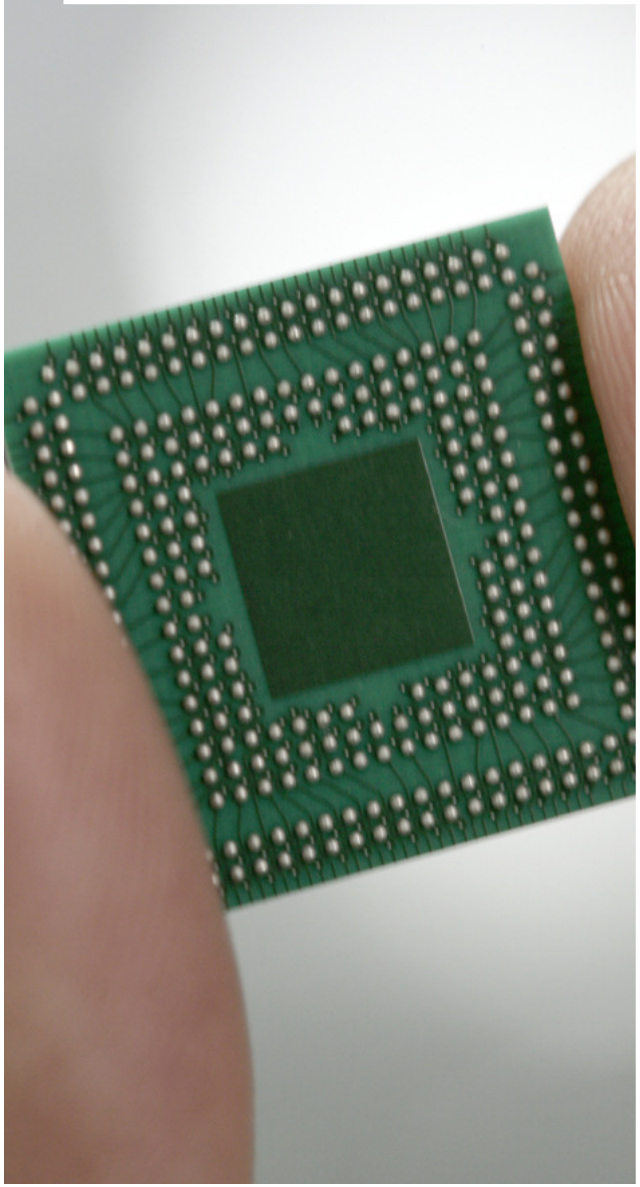

Two Time Scales
@ IEEE 802.1AS bt (Gen 2)

2013-01-14

IEEE 802.1 Interim Meeting

Vancouver

Franz-Josef Goetz, Siemens AG

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Structure of this Presentation

1. **Recap: Why Two Time Scales @ Industry ?**
2. **Requirements on Universal Time @ Industry**
3. **Requirements on Working Clock @ Industry**
4. **Reference Clock Model**
   a) Reference Clock Universal Time
   b) Reference Clock Working Clock

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Recap: Why Two Time Scales @ Industry ?

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

Universal Time

Use Cases:

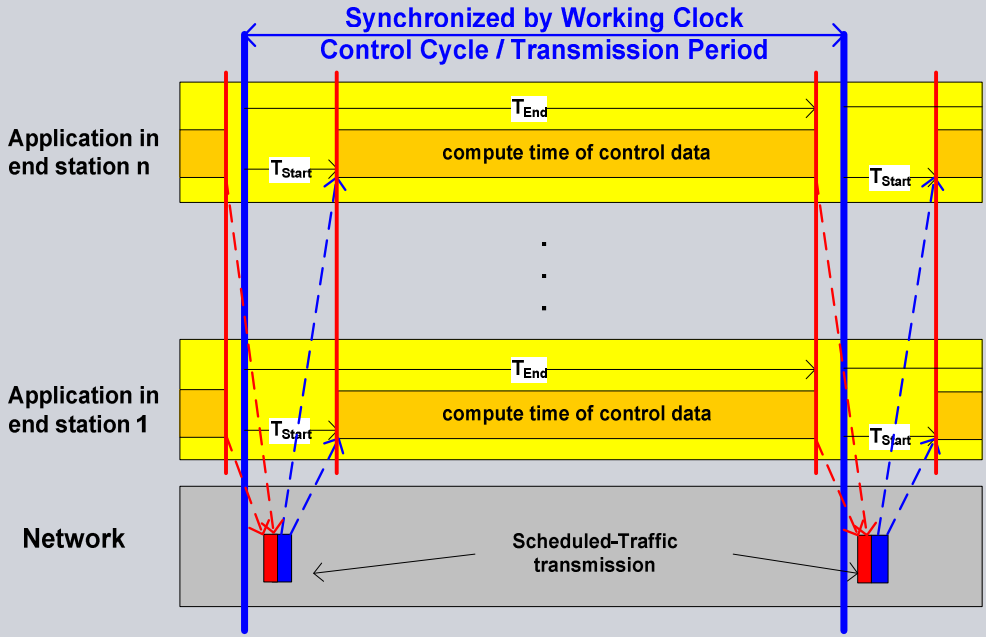
- Wall Clock,
- OS system time
- Time stamp sequence of events
- Time stamp production data
- Time stamp sampled values (measurement)
- ...

Universal time

Working Clock

Use Cases:

- Synchronize applications
  - sensor, actuator, control unit
- For Scheduled Traffic to synchronize
  - time based transmission in end stations
  - time aware shaper (TAS) in bridges



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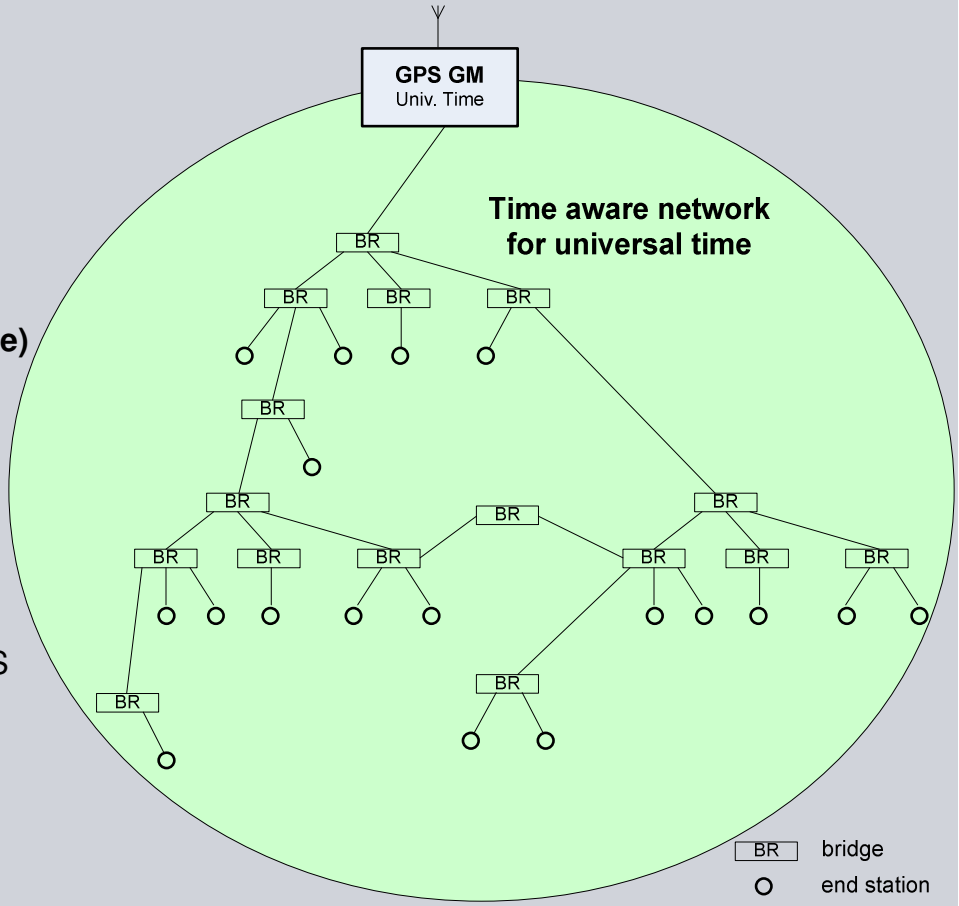
Requirements on Universal Time @ Industry (1)

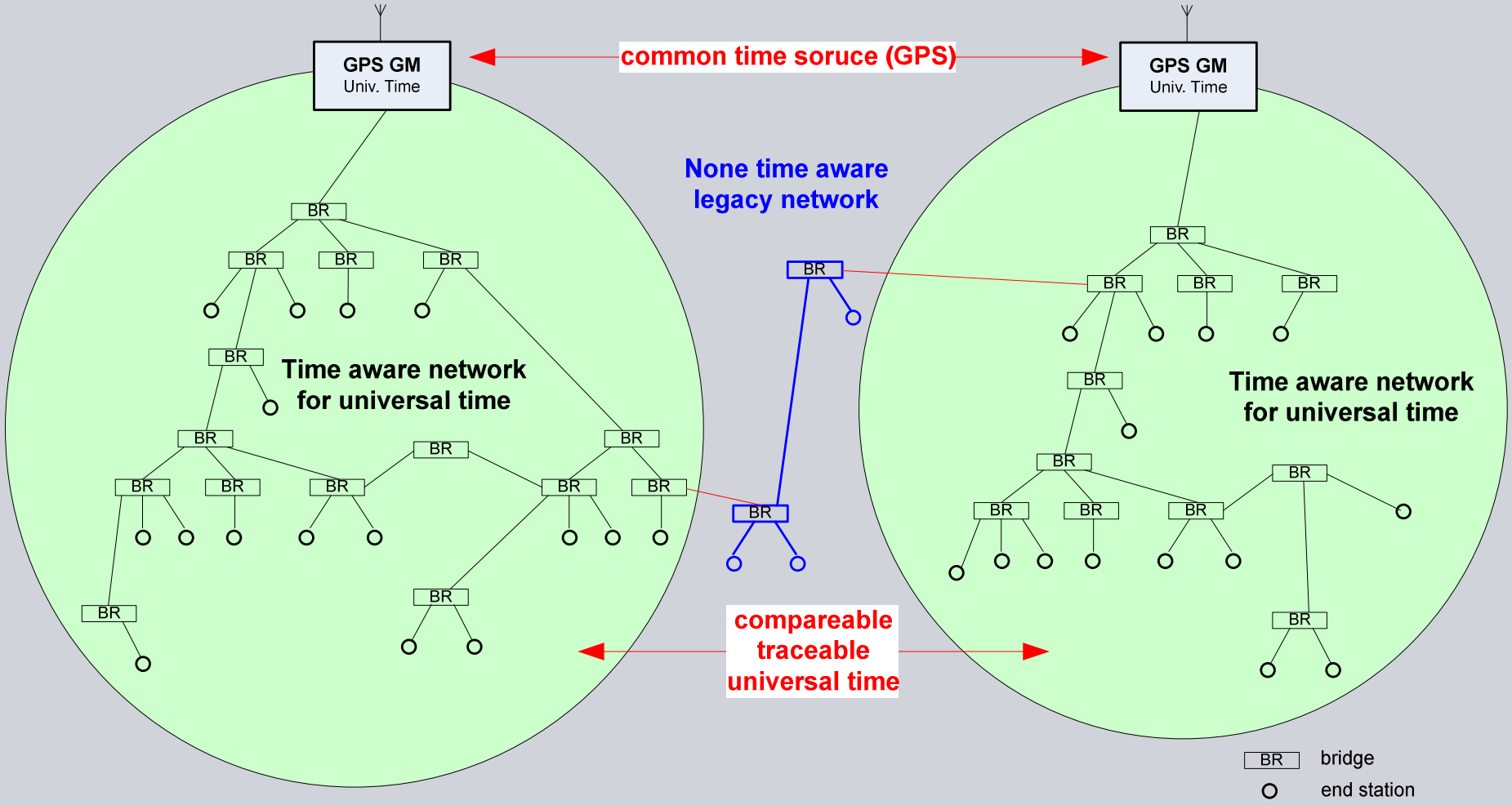
Requirements on universal time (.1AS Gen 1):

- **Available on the whole network**
  - One universal time domain within a network
- **Substitute (S)NTP, …**
  - **Accuracy for universal time**
    < 100µs over 128 hops @ industrial automation
    < 1µs over 16 hops @ energy automation
- **Low requirements on availability of universal time**
  - **Low configuration effort, plug & play (sync tree)**
  - **Flexible (topology independent)**
  - **Only one active GM**
    - BMCA
  - **Inherent loop prevention mechanism**
    - auto-reconfiguration
- **Time jumps are signaled**
  - E.g. switchover from local distributed time to GPS
- **Should cross IP router borderlines**
- **Compatible to .1AS to synchronize COTS nodes**
  - open standard
- **Media independent and also long distance**
  - Wired
  - Wireless



Requirements on Universal Time @ Industry (2)

Requirements on universal time (.1AS Gen 1):



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Requirements on Working Clock @ Industry (1)

Requirements (.1AS bt Gen 2):

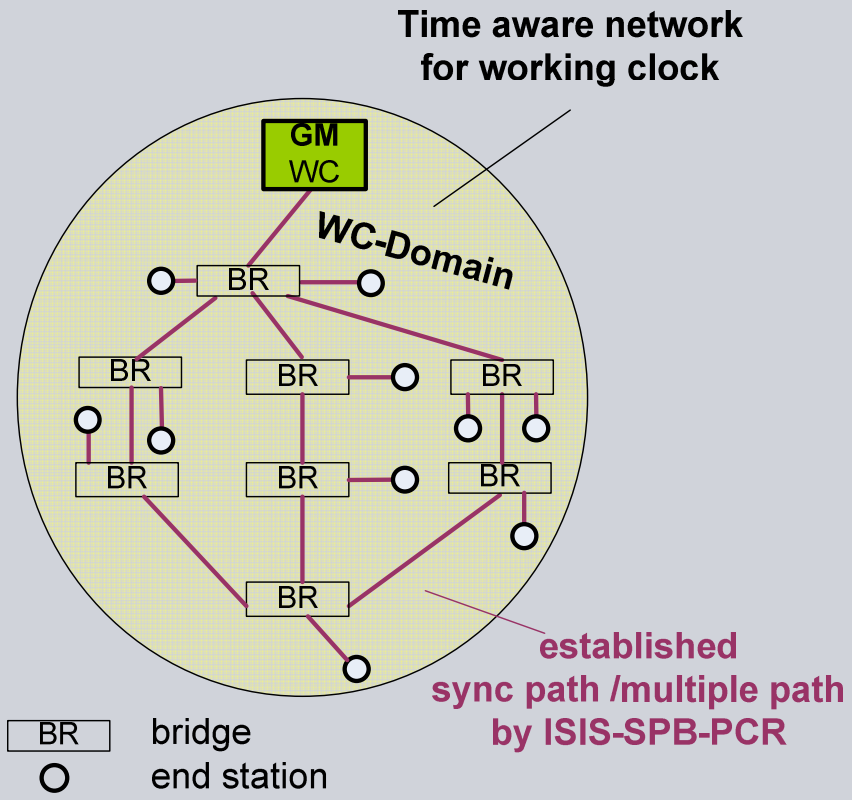
- **Engineered or planned**
  - **To guarantee accuracy primary and secondary GM are engineered**
  - **Must be available only within geographically limited areas**
  - **Independent none overlapping Working Clock domains**
  - **Islands for independent applications**

- **Very high accuracy**
  - **<1µs over 64 hops**
  - **Parameter set for working clock sync interval 32ms (application specific)**

- **Strong monotonic increasing time (no time jumps)**
  - Typical clock source is an free running oscillator
  - ⇒ Not traceable to universal time (independent)
  - ⇒ No time jumps

- **Avoid GM change**
  - even if better GM is available
  - => BMCA must be adapted

- **Robust and high available**
  - **Two sync path for sync messages for each GM**
    => two concurrent sync messages
  - **One active GM + cold- or hot-stand-by GM**
    => multiple sync messages (hot-standby-GM)



Requirements on Working Clock @ Industry (3)
UC 1: Separated Working Clock Islands

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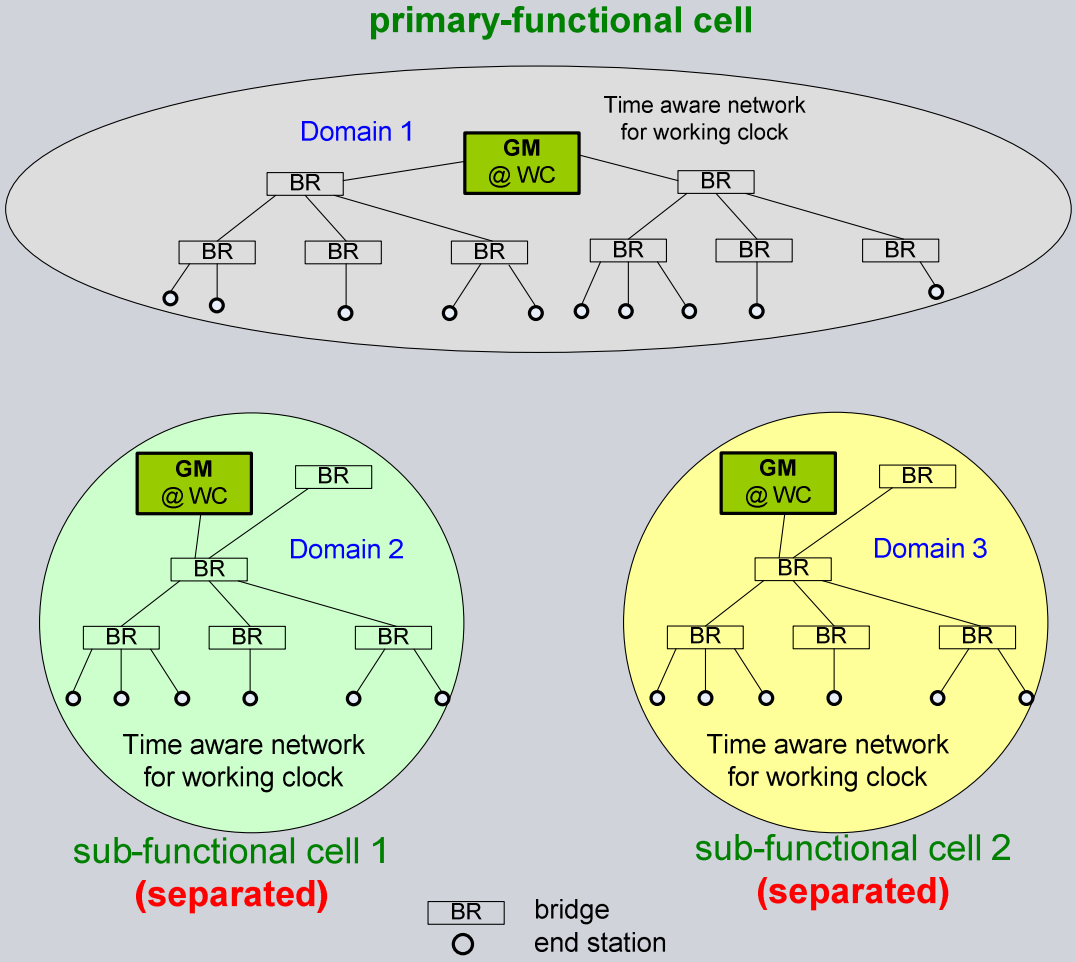

Requirements on Working Clock @ Industry (4)
UC 2: Connected Working Clock Islands

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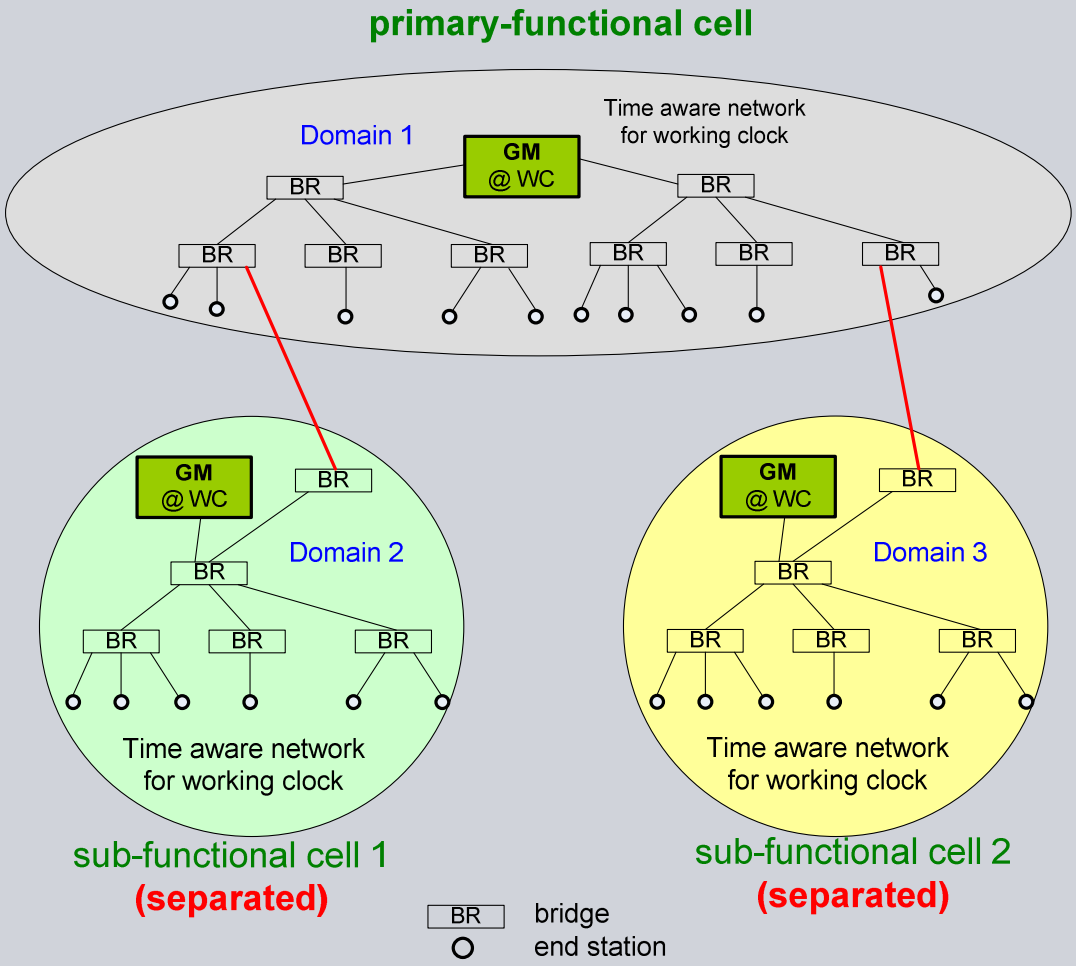

The working clock islands are still separated!

Avoid auto merging of independent sub-functional cell to on sync domain!

Requirements on Working Clock @ Industry (5)
UC 3: Separated & Merged Working Clock Islands

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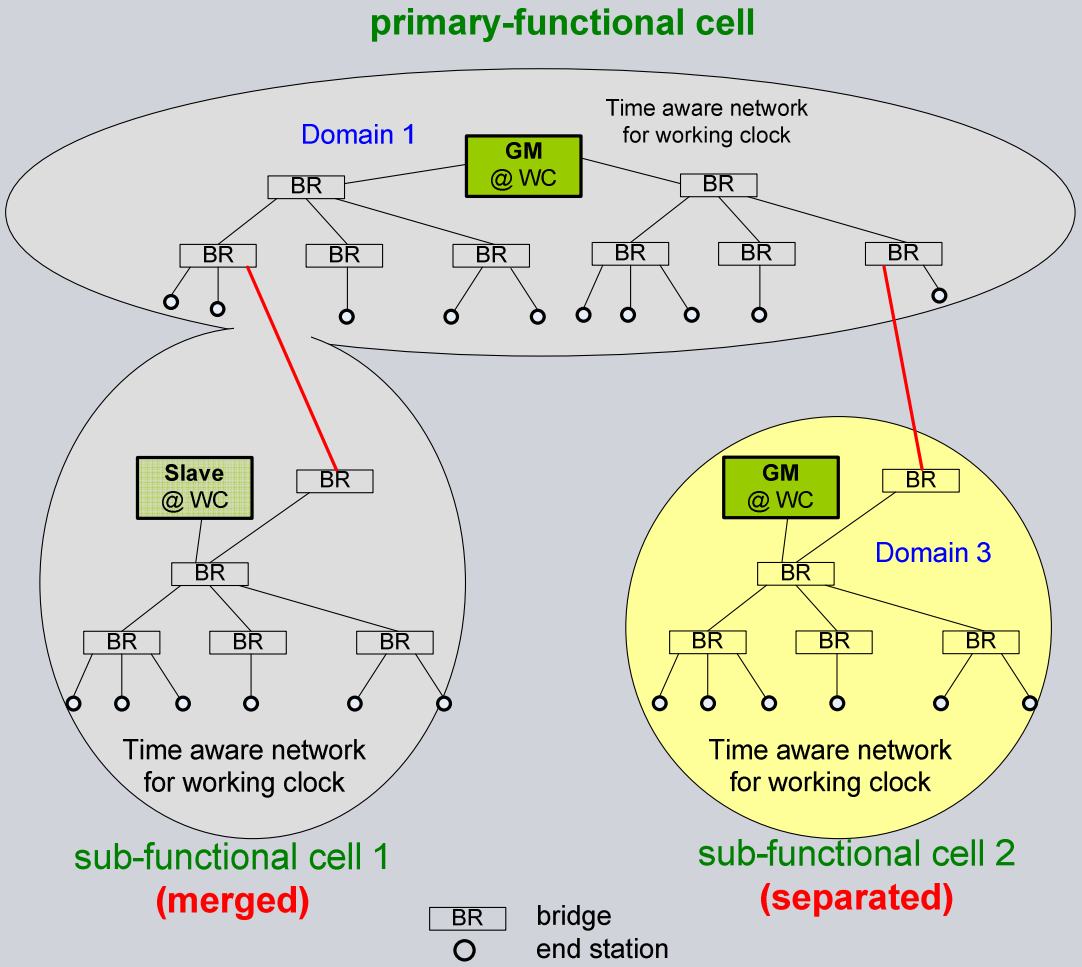

Merged to one domain
(only manually driven)

Keep separated
(keep independent)

Requirements on Working Clock @ Industry (6)
Separated & Merged Working Clock Islands

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Typical use case:

- Pre-commissioning for functional cells
- Printing machines with multiple printing and folding units
- Production lines which consists of a lot of different components
- …

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Two Time Scales within Industrial Networks

Applications using universal time are different from applications using working clock!

They have different requirements on time!

In Industrial networks both applications exist!

=> There is a need for network components e.g. bridges to support two time scales

Example for two Time Scales within an Industrial Network

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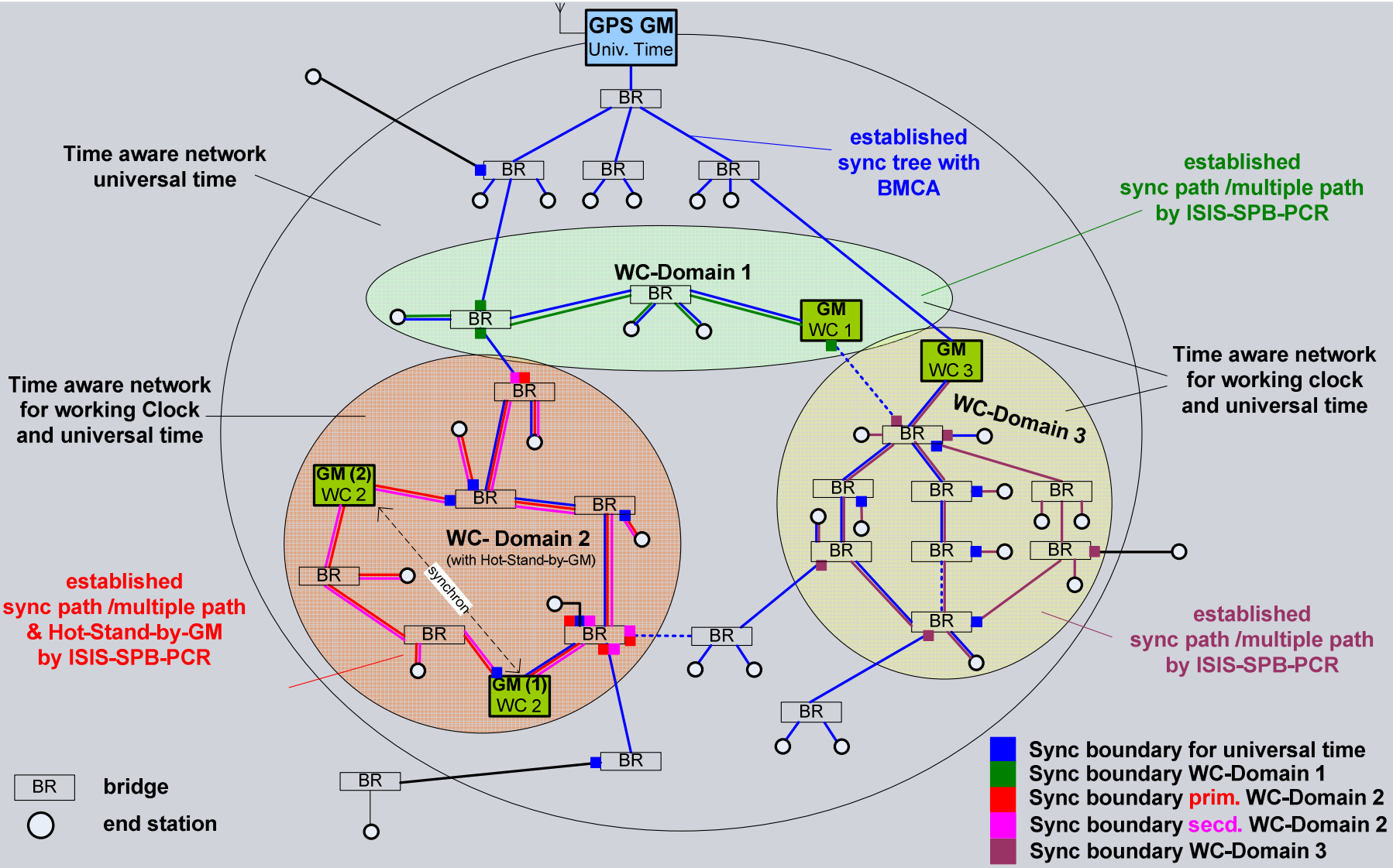

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Recap: Why Sync Boundaries?

- **Avoid flooding of sync messages**
  (For forwarding sync messages get same behavior as specified in .1AS Gen 1)
- **Avoid circulating sync messages while different mechanism are used to create the sync path (s):**
  - P2P announce message + BMCA
    (comparable with RSTP, IEEE 802.1AS Gen 1)
  - ISIS-SPB-PCR
    (Routing, IEEE 802.1AS Gen 2)

Proposal:

- **ONE common PDdelay measurement for two time scales**
- **Usage of LLDP to establish Sync boundary**

Link:
http://www.ieee802.org/1/files/public/docs2012/as-goetz-multiple-sync-domains-1112-v01.pdf

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Multiple virtual Universal Time Domains based on Reference Universal Time (Example)

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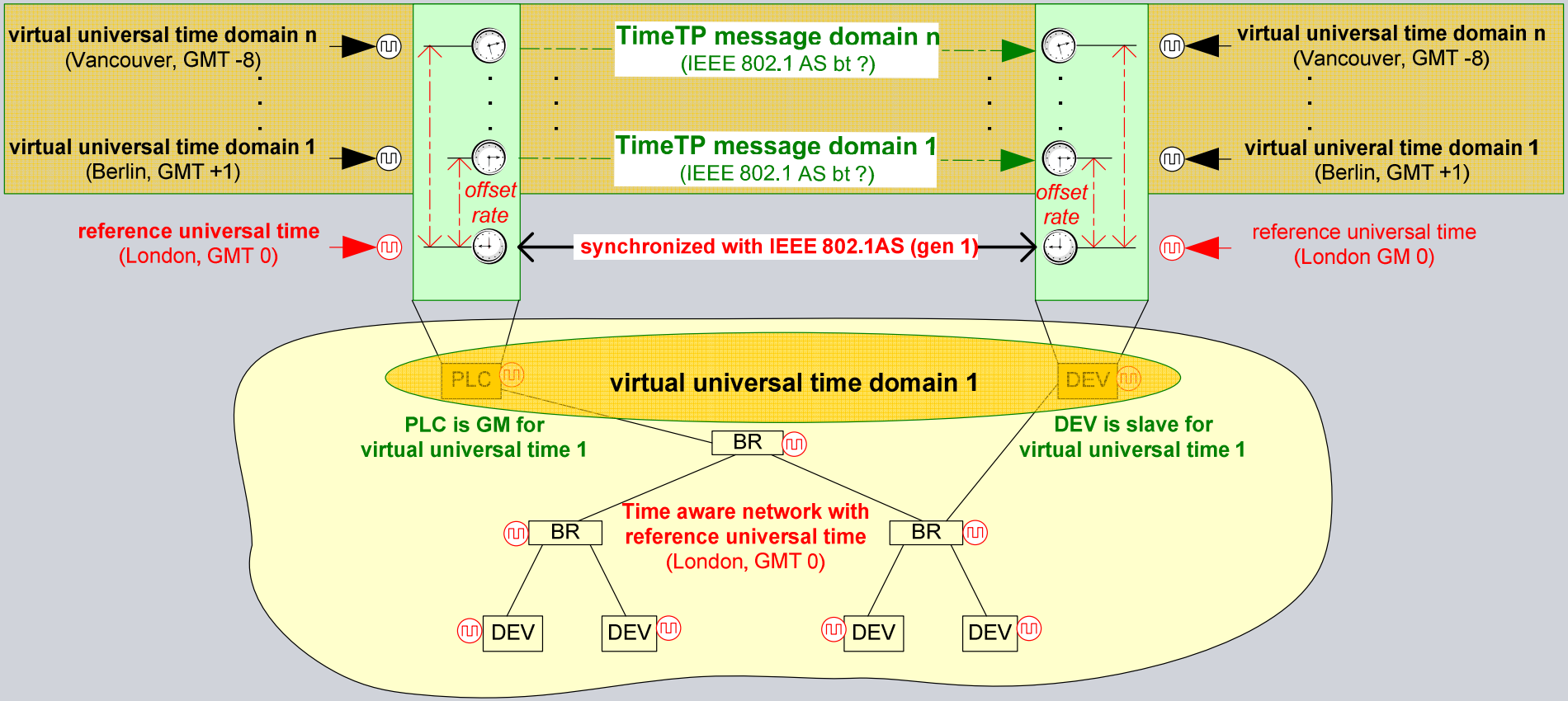

PLC: Programmable logic controller
DEV: Device e.g. sensor or actuator
BR: Bridge

Multiple virtual Working Clock Domains based on Reference Working Clock (Example 1)

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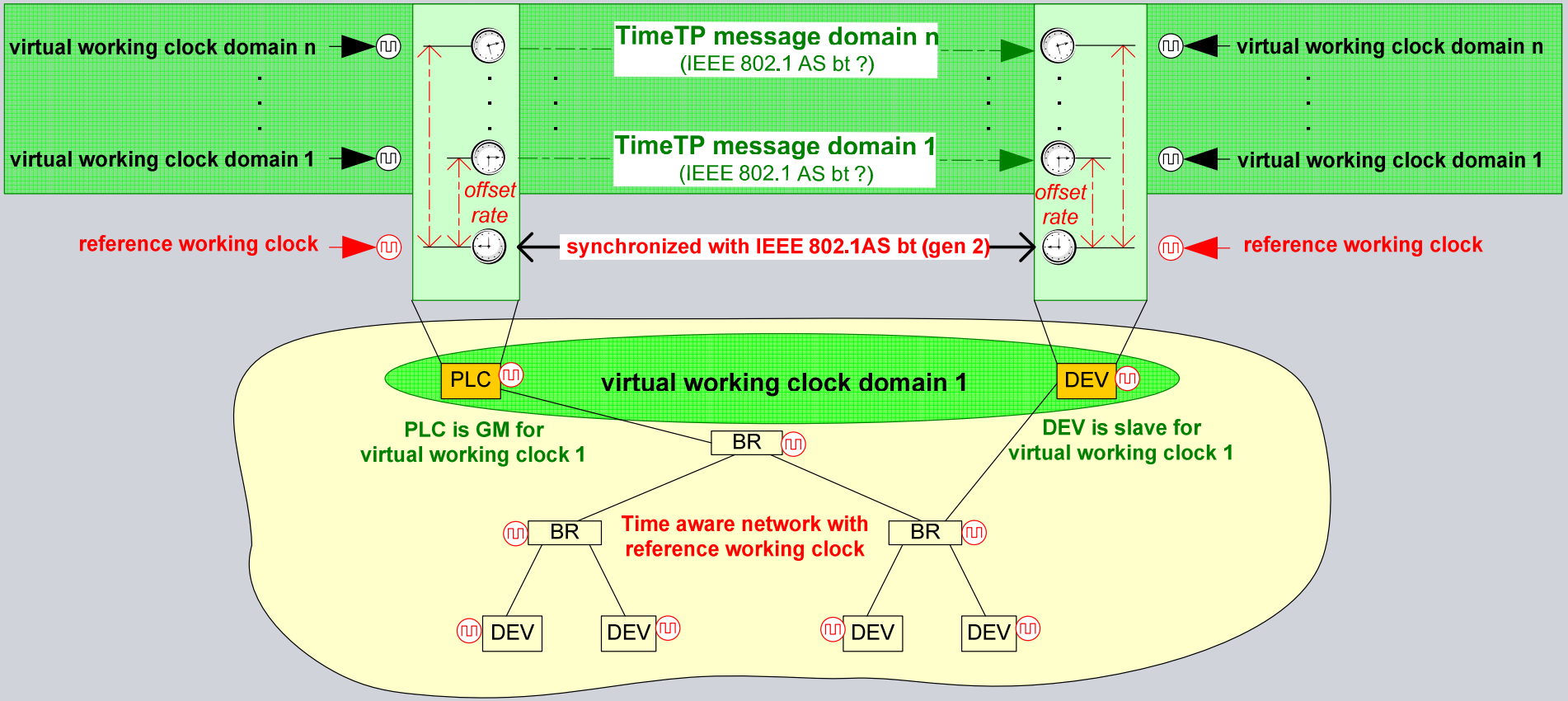

PLC: Programmable logic controller
DEV: Device e.g. sensor or actuator
BR: Bridge

Multiple virtual Working Clock Domains based on Reference Working Clock (Example 2)

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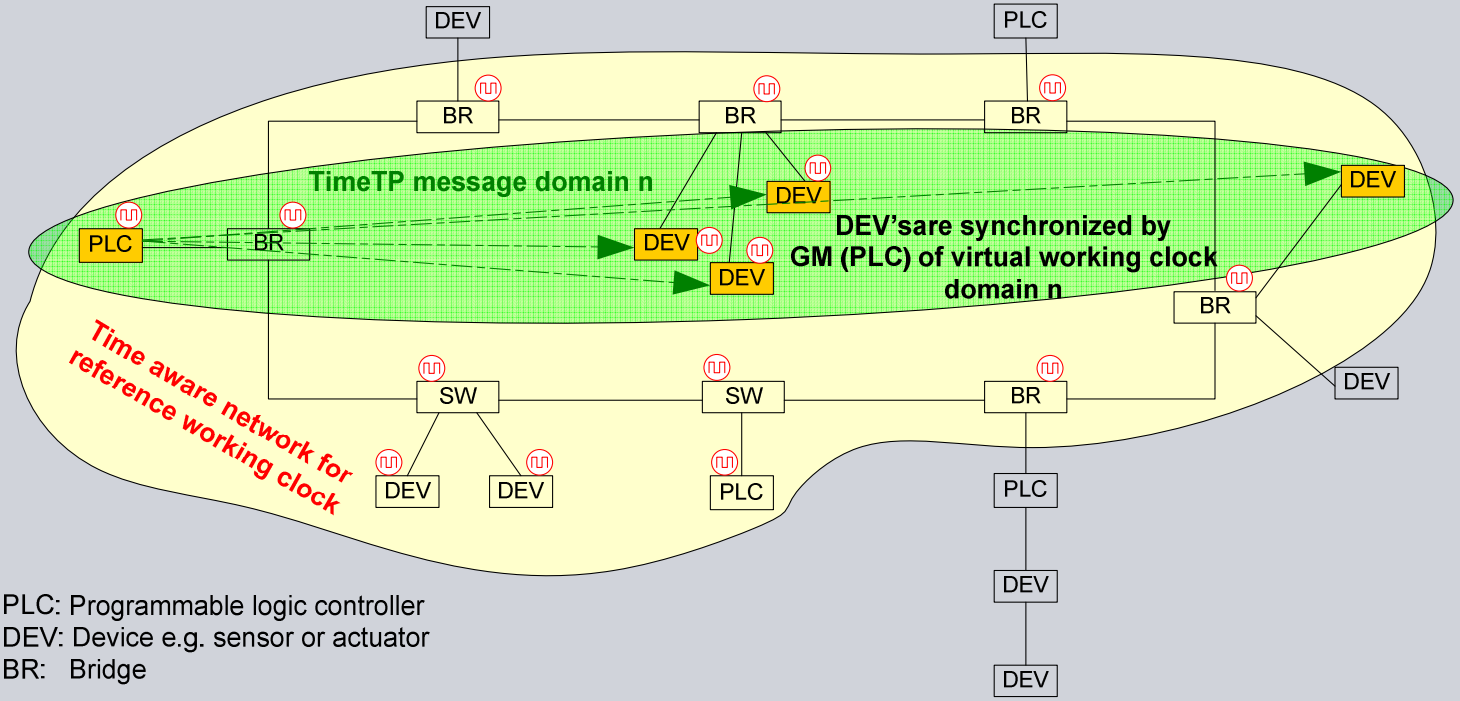
Multiple overlapping virtual working clock domains within a flat network

- One reference working clock domain
- Multiple virtual overlapping working clock domains synchronized by different GM's (e.g. PLC's)
- Each virutal GM synchronize its devices with a TimeTP (time transport) messages
- TimeTP messages is an end-to-end messages and only time stamped by the end devices (e.g. PLC; DEV]
- The network residence time of the TimeTP messages is measured by using the reference working clock



PLC: Programmable logic controller
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Conclusion

The combination

- supporting two time scales: **Universal Time & Working Clock**
  - where each time scale can used as reference clock
  - in combination with virtual time domains

  => enables a huge potential to cover further use cases

=> Mechanism to support both model shall be standardized

Next Steps?

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Thank you for your attention!

Questions?