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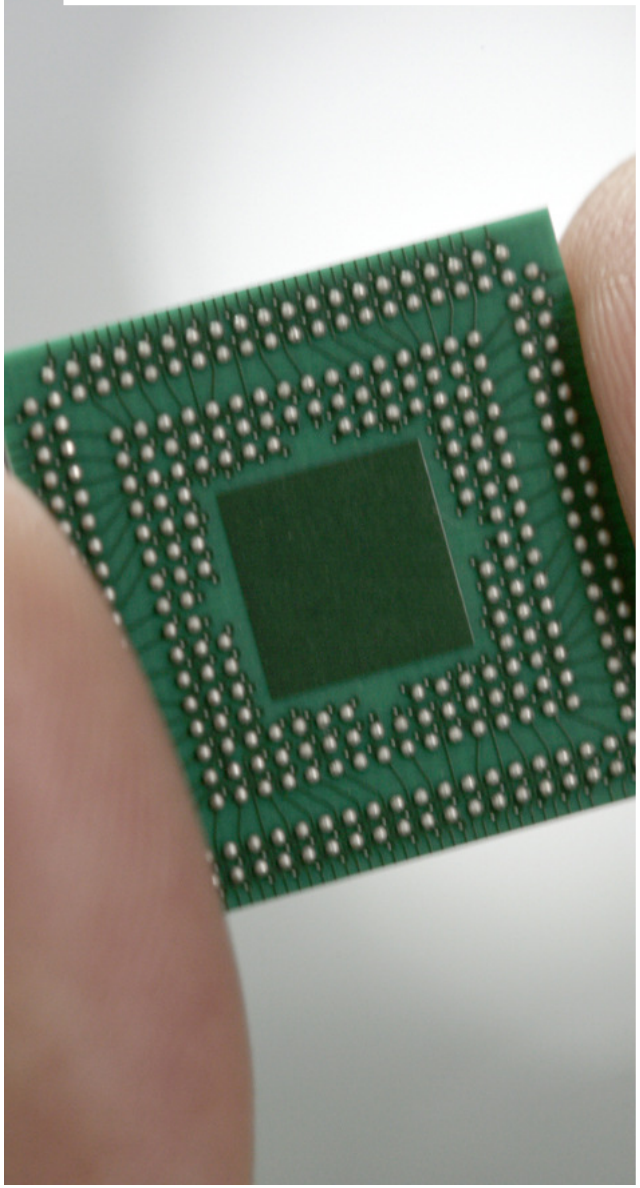

L2 Routing for Control Data Traffic @ Industry

2012-03-11

IEEE 802.1 AVB Meeting – Waikoloa

Franz-Josef Goetz, Siemens AG

Typical Engineering Environment for Control Data Traffic in Industry

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Typical jobs for an engineering tool for designing one control function

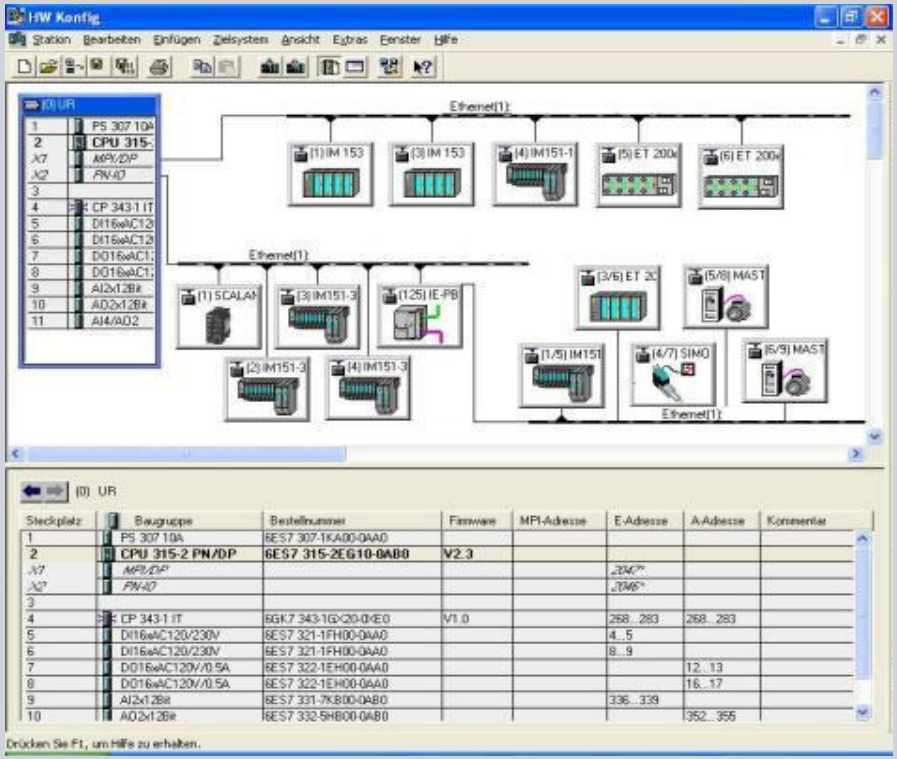
Offline – Conifguraton

- Devices
  - Programmable Logic Controller (PLC), Sensors, Actuators
- Communication Relation & Performance
  - Sensor – PLC – Actuators
  - Control data size
  - Transmission period
  - Max. latency
  - High availability

  => Bandwidth requirement
- Network Topology
  - Line, ring, star, mesh, and combinations
  - Link speed
  - Traffic load
- Consistency Check
  - Valid configuration

Online

- Configuration Download
  - End System e.g. PLC, Sensor, …
- Failure Notification
- Failure Reaction
- …



- *Restricted view of the whole communication network*
- *Only control data traffic off one application is considered*

Hierarchical Industrial Communication within one network @ Industry

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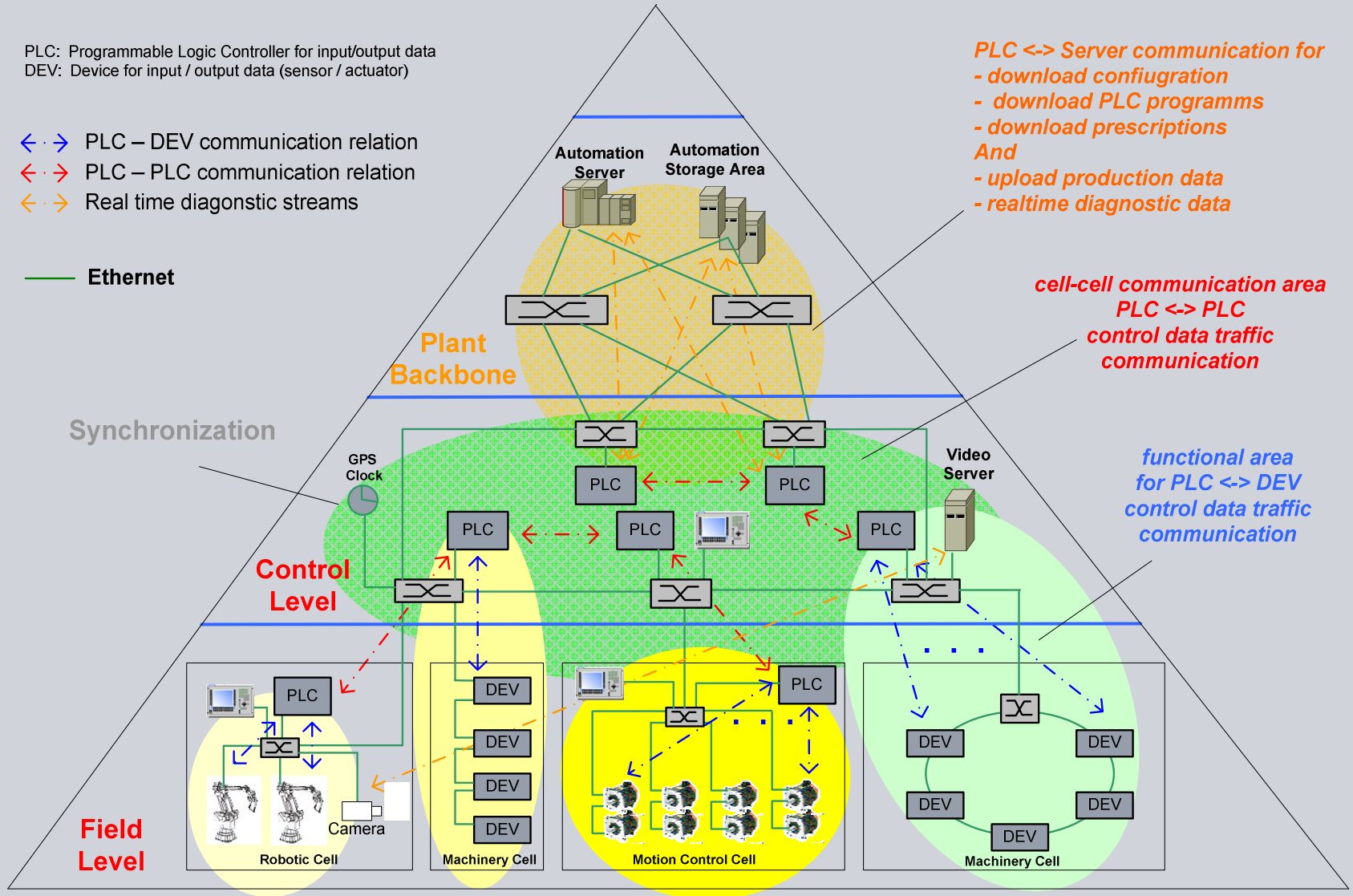

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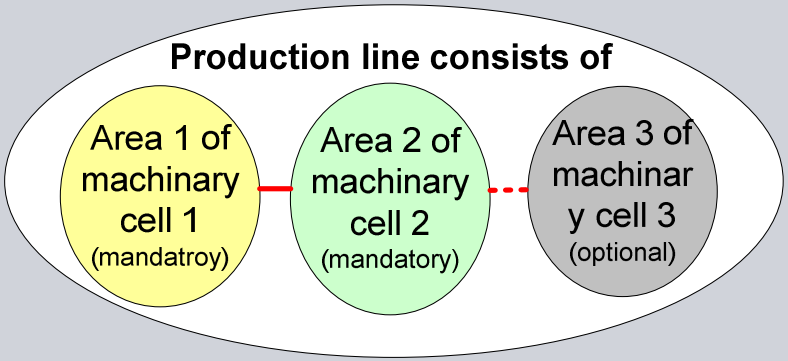
Why Control Data Traffic L2 Routing

Reasons:

- Usage of shortest (best) path between source and destination
- Predictability of
  - communication path
  - bandwidth on each link
- Avoid communication loops for control data traffic
- Provides mechanism (algorithm) to support multipath to cover the requirement of high availability
- Support multiple independent overlapping engineered control functions within one network
- Support control functionality which is divided in different geograhpical areas within one network
- Guarantee independence for functional cells
  - Support join and divide areas at runtime
- Guarantee a scalable L2 network for control data traffic



L2 Routing for control data traffic has to combine real existing network (system) with planned control data traffic which is determined by industrial application based on a given network topology

L2 Routing is an essential component to guarantee low latency for control data traffic

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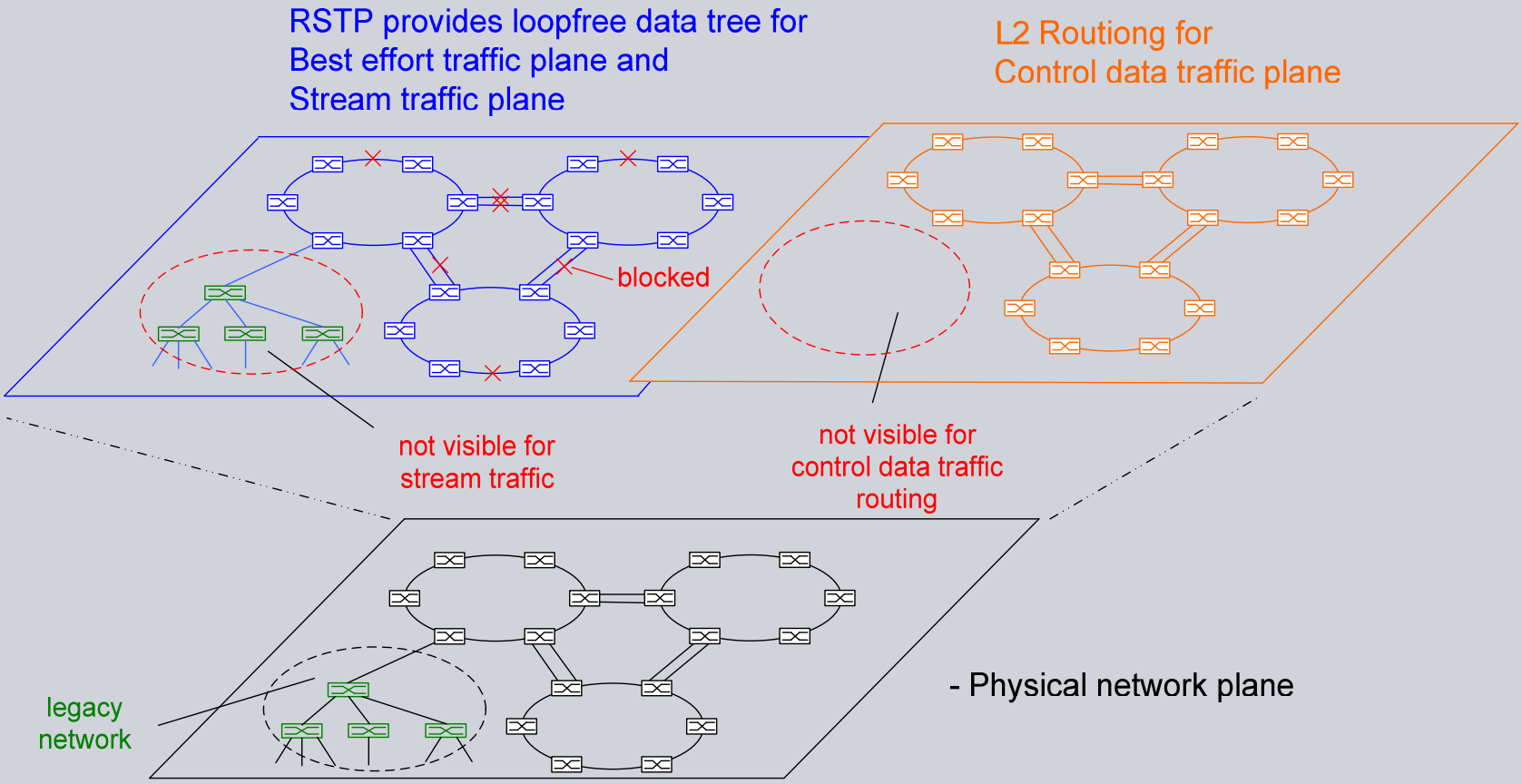
Proposal for a Industrial Network Layer Model

Loop prevention protocols (RSTP, MSTP) are required for convergent networks to avoid communication loops for

- *Best effort traffic*
- *AV Streams (Real time diagnostic data streams)*

L2 Routing for control data traffic L2 routing (shortest and multi path) is required



Communication Characteristics for Control Data Traffic in Industry

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Constraints:

- **The relationship between source and destination(s) is already known**
  - Derived from industrial application
  - Higher layer protocols (establish connectivity)
  - Planning with engineering tool
- **A typical control network is a hierarchical network which consists of**
  - A small number of PLCs communicating with a huge number of sensors and actuators (n : m)
  - A huge number of sensors and actuators communicating with a small number of PLCs (m : n)
  - Only the small number of PLC may communicate with each other
- **The communication for control data is typically bidirectional**
  - Symmetric paths are expected (equal latency for both directions)
- **Already 10% of the currently available bandwidth is considered to be sufficient for control data traffic in a convergent network**

Communication Characteristics for Control Data Traffic in Industry

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Dynamics of Topology Changes :

- **Add new device (sometimes)**
  - ⇒ Incremental routing for paths to new device
  - ⇒ New streams – incremental reservation
- **Link failure (very rare)**
  - Caused by mechanical stress (cable, connector)
- **Device failure (very rare)**
- **Lifetime of streams (very long)**
  - hours
  - days
  - years
- **Bandwidth requirements for control data traffic (very stable)**

Communication Characteristics for Control Data Traffic in Industry

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Dynamic re-routing:

- **Typically no dynamic re-routing during production time**
  - changes to communication path will disrupt continuous flow of control data
  - computed path is used as long as it is suitable
- **Re-routing only**
  - In case of failures, re-routing of affected paths
  - During maintenance

=> Robustness and Reliability for control data traffic is required

Potential Rules for Rule Based Control Data Traffic L2 Routing

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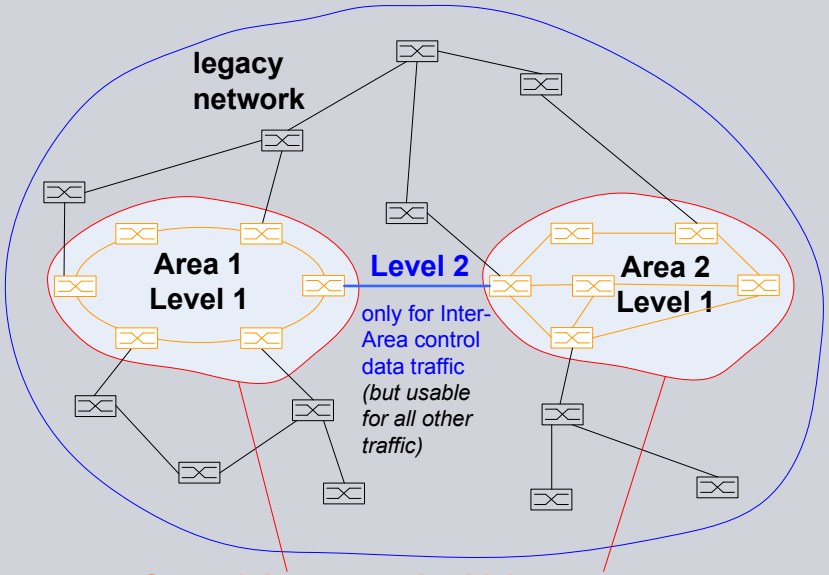
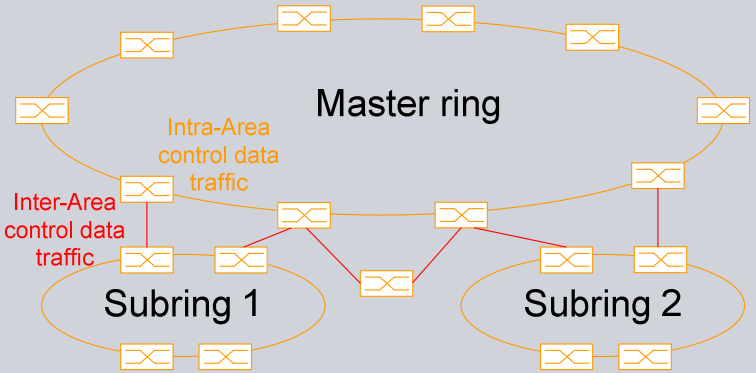
- **If no rules are given default rules are used**
  - Default rules for simple networks (low requirements)
- **Potentially optional rules**
  - **Intra-Area control data traffic** must not be routed outside an area in order to protect functional cells (see page 3 and 4)
  - **Inter-Area control data traffic** can only use given path by level 2 routing in order to support join and split cells (see page 4)
  - **Max. latency** or max. hop count (e.g. 8 hops)
    - General or per control data stream
  - **Minimal link speed** e.g. 1Gb/s
  - Restricted topology (management functionality)
    - Neighbors
    - Uplink
- **Defined reaction at violation of routing rules**
  - Links without sufficient bandwidth (or similar) are not considered for routing (pruning)
  - Re-routing, e.g. if link speed drops below required value



Control data network which supports control data traffic L2 routing



Control data network

⇒ ***Ensures that constraints of Control Data Traffic are fulfilled***

⇒ ***Could help to improve routing performance***

⇒ ***Mechanism to correlate planned control data traffic with existing network***

Is ISIS the right Choice for Control Data Traffic L2 Routing?

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ISIS for control data traffic routing

- **Control Data Traffic L2 Routing restricted to control data traffic plane**
- **Reuse of IS-IS for distribution of link state information**
  - same as in IEEE 802.1aq Shortest Path Bridging
- **Extended with TLVs and sub-TLVs for link-state information specific to multipath routing and control data traffic**
- **Path computation based on link state distributed by IS-IS with multipath routing protocol**
  - constrained-based
  - loop-free

Link State

- **Distributed by IS-IS (same as in Shortest Path Bridging (SPB))**
- **Available bandwidth is part of link state**
- **No re-routing based on changed available bandwidth**
  - only saving of available bandwidth for routing

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Finish

Further Questions?