AVB for Low Latency Networks

Aims of this Presentation:

- Define requirements for low latency Streams
- Show possible solutions
- Trigger discussions

=> Define new work items for AVB TG which includes requirements for industrial communication
Broad Classification of different (industrial) Applications

- **Process Industry**
  - Machine Monitoring

- **Factory Automation**
  - Energy Automation
  - Power Distribution
  - Building Automation

- **Hardware-In-The-Loop Test Systems Automotive / Aerospace**

- **Motion Control**
  - Safety Systems
  - Robotics
  - Automotive in Vehicle Control Big Physics – (Telescope Control, LHC)

**Application Cycle Time**
- **SLOW** 100ms
- **FAST** 50µs

**Average Frame Size**
- **LARGE** 1000 bytes
- **SMALL** 100 bytes
Typical Topology for Bridged LANs in Industry: Line, Ring and Star

Control Level

Field Level

CycleTime: 50µs – 1ms
Data Size / Node < 300 bytes

CycleTime: 1ms – 10ms
Data Size / Node > 300 bytes

Bridge

End Station
C: Controller
D: Device

LAN

Port

Bridged End Station (BEST)
Traffic Pattern for low latency SRclass

Properties of low latency SRclass:
- Bursty
- Small frame size (typ. <100 Bytes)
- Listeners receive low latency frames at roughly the same time (if possible within the same transmission period)
- Huge number of small frames

[Diagram of traffic pattern with talker and listeners, showing transmission period, burst size, and network transmission time.]
Scheduler for low latency SRclass

HiCredit_A

LoCredit_A

Increasing credit

idleSlope R_x

Credit limit = 0 when no frames are waiting

Increasing time

conflicting traffic present, so frame A immediately dequeed after the legacy Frame is transmitted

conflicting traffic

transmitted data

transmitted data

present AVB

allow, „bursty“ traffic with certain burst size

fun-out scenario

Low latency Traffic Pattern

AVB Traffic Pattern
Multiple Talker with TDMA

Requirements:
- Synchronized end stations
- Common Cycle Time (i.e. 1ms)
- Common Transmission Period (i.e. 125µs)
- Common reservation for one Stream by MSRP
- Defined slot reservation mechanism in MSRP

MaxSlot = CycleTime / Transmission Period
i.e.
MaxSlot = 1ms / 250µs = 4
Multiple Talker with TDMA: „striking example“

The listener is a speaker that receives the whole stream

„assembled stream = music“

Each talker is a flute, able to produce one distinct tone

Europe / America

The controller (C) is the device that controls the TDMA system. The devices (D) are connected to the controller through LAN ports. The controller assigns time slots to the devices, allowing each to transmit its signal for a short period during a cycle time. This way, multiple devices can transmit simultaneously without interference.
Requirements for MSRP to support low latency SRclass

- **Low Latency SRclass with Burst**
  - Low Latency < 125µs over ~32 hops, data < 300 Bytes
  (-> avoid interference Best Effort Traffic with Low Latency Traffic)

- **Stream Preemption**
  - Defined Ranking for SR
  - Higher ranking SR must be able to preempt lower ranking SR

- **Multiple Talker with TDMA**
  - Mechanism to allocate fixed slot numbers to talkers
Additional Transmission Selection Scheduler for low latency SRclass

- Support bursty low latency SRclass
- Fair scheduling behaviour with
  - Guaranteed bandwidth and burst size for low latency SRclass
  - Guaranteed latency
  - Guaranteed resources
  - Guaranteed bandwidth for legacy traffic
Requirements for Synchronization in Industry

I: Cloud is synchronized

- Tracable Time
- Cloud shall be sync. with traceable time on Domain 0

II: Cloud is syntonized

- Tracable Time
- Cloud is sync. with non traceable time on Domain 1

III: Cloud is not syntonized

- Tracable Time
- Cloud is sync. with non traceable time on Domain 1

- More than 7 hops will be the normal case and accuracy < 1µs
- Support for One-Step-Clock as an option?
- Determinable holdover time

- Alternate Timescale + Domain 0 in FollowUp or Announce Message
- TLV for Alternate Timescale Value + Frequency Offset + Domain 0 in Sync or FollowUp Message
Thank you!