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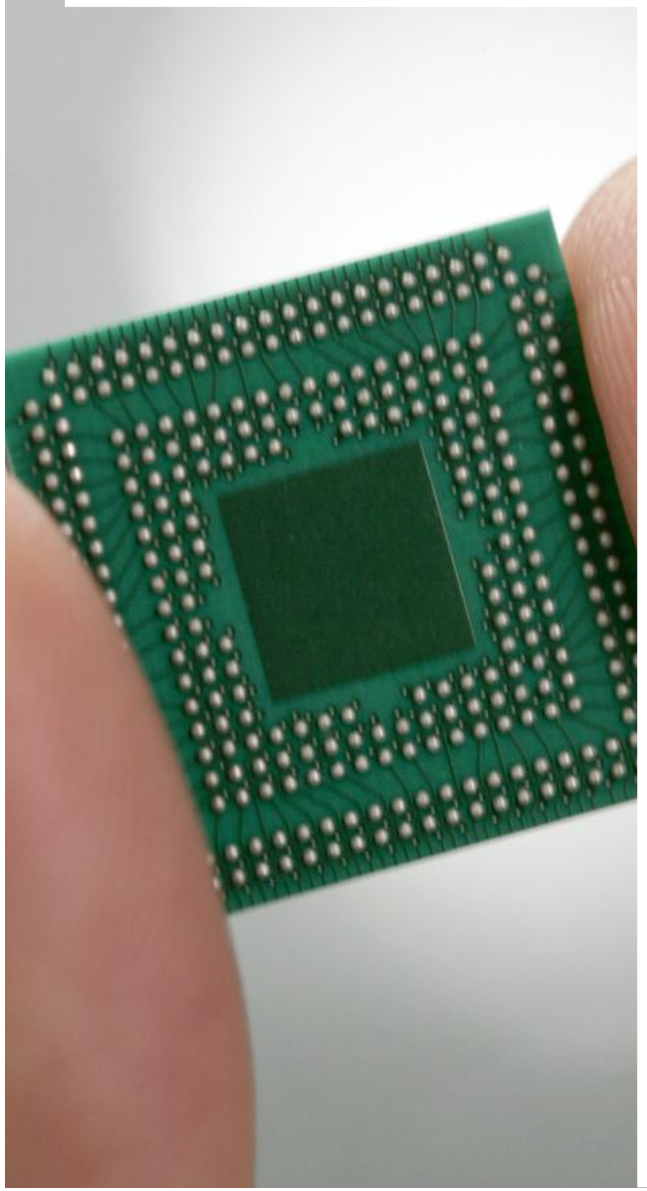

Traffic Shaper for Control Data Traffic (CDT) @ Industry

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IEEE 802 AVB Meeting – San Diego

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Why an ADDITIONAL Shaper for CDT in Bridges?

Reasons:

- **Shaper with less configuration effort in bridges** (only bandwidth – not window size)
  - Adapt to different link speeds within a network
  - Automatically adaption to traffic flow
  - For mashed networks with multiple talker
  - Plugging of new components may change bandwidth but the time schedule must not adapted
- **The shaper shall support periodic and event-based CDT** (bandwidth limitation)
- **Robust for safety critical applications**
  - Emergency operation features – (fail operational behavior)

NEW Shaper has to fulfill the following requirements:

- Guaranteed Low Latency for CTD
- Guarantee for maximum burst size for CTD
- Guaranteed bandwidth also for other traffic classes

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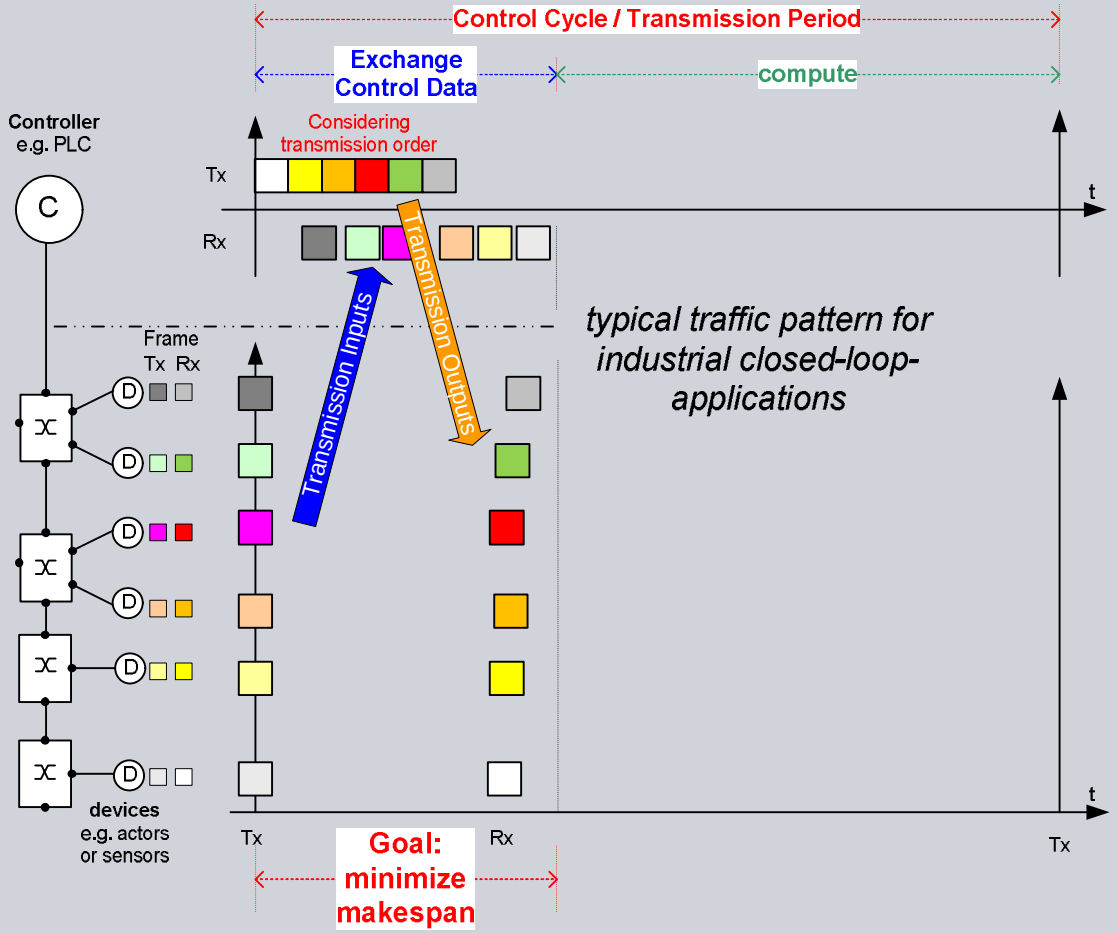
Control Data Traffic Class (CDT) - Basics

Traffic shaper for Control Data Traffic in end stations and bridges

- Support periodic time based transmission of Control Data Frames in **end stations**
  - Transmission timestamp for window (burst)
  - Transmission timestamp per frame
- Specify scheduler for Control Data Traffic in **bridges**
  - **TABS** Time Aware Blocking Shaper with one and multiple windows
  - **BLSA** Burst Limiting Shaper Algorithm for CDT (will be explained in this presentation)

- **Preemption for Control Data Traffic**
  - Peer-to-Peer fragmentation of legacy traffic and AV Streams
  - The preemption mechanism can be used for
    - Periodic CDT
    - Event-based CDT



But mechanism like

- **L2 Routing for CDT**
  (shortest path, multiple path for seamless redundancy),
- **Bandwidth reservation for CDT and**
- **Scheduling of CDT**

to optimize latency, minimize make span and minimize resources in bridges for Control Data Traffic are still required!

Multiple Transmission Periods for CDT

Typical Use Case :

- **CDT high 125µ transmission period**
- **CDT low 1 ms transmission period**

Two CDT Classes within a functional cell because not all physical values (e.g. temperature) do change with same speed

Typical requirement on latency:

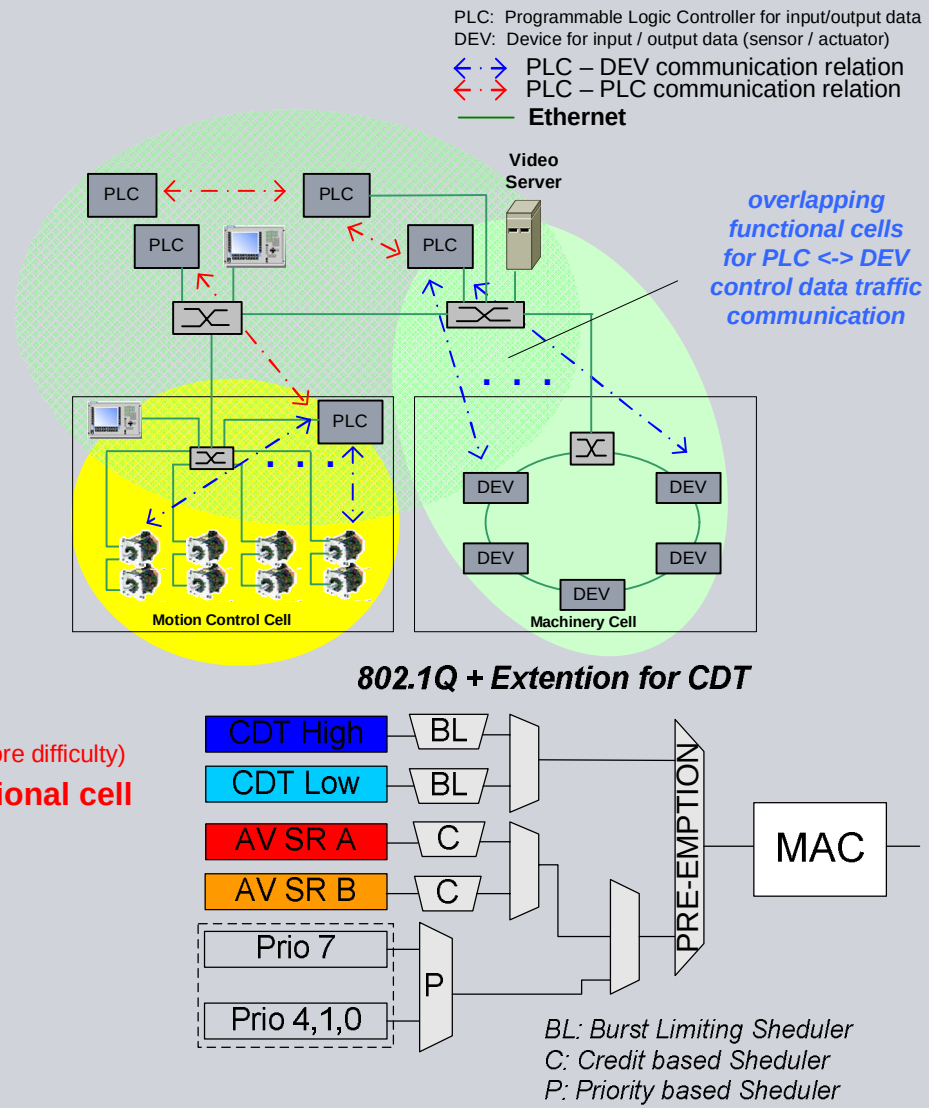
- **Max latency for CDT high < 60µs**
- **Max latency for CDT low < 500µs**

To minimize impact two Class for CDT are helpful

(one CDT Class mandatory, a second or .. optional)

Constrains for CDT Class:

- **Minimum transmission period (minTP): e.g. 31,25µs**
- **To simplify load balancing strategy**
  - **Steps of 2^N x mTP (31,25µs – 1ms) , N ε {1, 5}**
    (odd-numbered shall be avoided -> bandwidth calculation becomes much more difficulty)
- **Only one common transmission period within one functional cell or overlapping functional cells (least common multiple)**
- **Typical CDT frame size in the range of 64 – 400Bytes**



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Mechanism to Guarantee Low Latency for CDT

- **Aging for CDT Frames in CDT transmit queue**
  - Add local time stamp when putting CDT Frame in tx queue
  - Drop CDT Frames when residence time > MaxAge
- **Bandwidth observation for CDT on ingress port**
  - Bandwidth measurement for CDT Interval = “x * TP”
  - Bandwidth limitation and so called network fuses to protect network (e.g. babbling talker)
- **Diagnostic concept**
  - Count packet drop caused by aging
  - Exceeding bandwidth on ingress port
- **Bandwidth limitation for CDT on egress port**
  - Bandwidth reservation and limiting for CDT
  - Limiting burst size for CDT

Proposal:
Burst Limiting Shaper Algorithm for CDT

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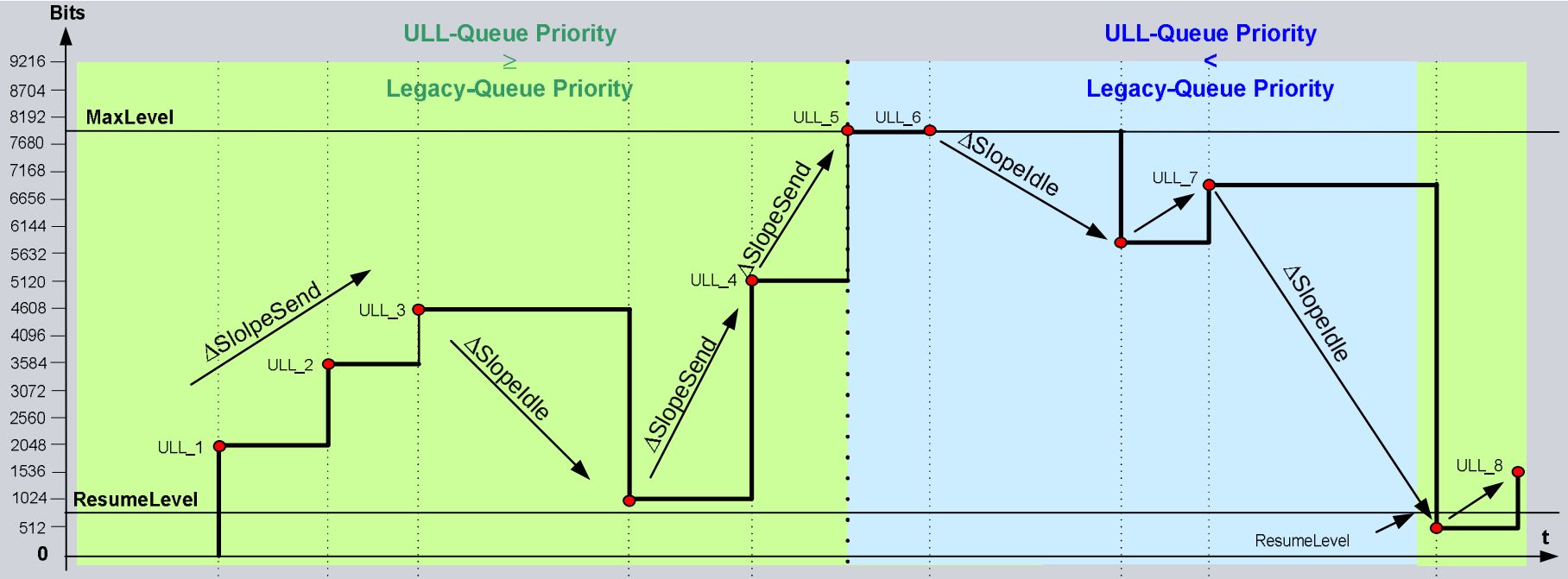

- **While reserved bandwidth for Control Data is available the queue for Control data has highest priority (green area)**
- **While reserved bandwidth for Control Data is consumed the queue for Control data has lowest priority (blue area) to guarantee bandwidth for legacy traffic**
- **When Control Data frames are transmitted in the green area they can preempt transmission of a legacy frame**
- **In the blue area Control Data frames** *can only be transmitted when the queues for legacy traffic are empty*

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Burst Limiting Shaper Algorithm for CDT

Calculations for Burst Limiting Shaper Algorithm (BLSA):

- Link speed (**linkSpeed**)
- Common transmission period (**CTP**)
- Leaky Bucket Bandwidth Fraction (**LB_BwF** is reserverd bandwidth for Control Data in %)
- Leake Rate for Control Data Traffic: **LeakRate** = LB_BwF * linkSpeed
- Mean Frame Size for Control Data Frames in Bits: **MeanCDFrameSize**
- Send Slope for Control Data in bits : **$Slope_{Send}$** = (1 – LB_BwF) * MeanCDFrameSize
- Idle Slope for Control Data in bits: **$Slope_{Idle}$** = – LB_BwF * MeanCDFrameSize
- Maximum number of Bits (maximum burst size) per TP: **MaxLevel** = LeakRate * CTP + **SafetyMargin**
- Mean Control Data Frames per transmission period: **mCDFramesTP** = MaxLevel / $Slope_{Send}$
- Re-priority level: **ResumeLevel** = 0.1 * MaxLevel

Simple example for 10% of the available bandwidth for Control Data Traffic, CTP = 125µs and mean frame size for Control Data Frames: MeanCDFrameSize = 128 bytes

- **linkSpeed** = 1 Gbit/s
- **LB_BwF** = 0.1 (10%)
- **LeakRate** = 0.1 * 1 Gbit/s = 100Mbit/s
- **$Slope_{Send}$** = (1 – LB_BwF) * 8 * 128 bytes = 922 bits
- **$Slope_{Idle}$** = – LB_BwF * 8 * 128 bytes = -103 bits
- **MaxLevel** = 100 Mbits/s * 125µs + **SafetyMargin** = 12500 bits + **SafetyMargin** ≈ 13000 bits
- **mCDFramesTP** = > 13000 bits / 922 bits ≈ 14 Control Data frames
- **ResumeLevel** = 0.1 * 13000 bits = 1300 bits

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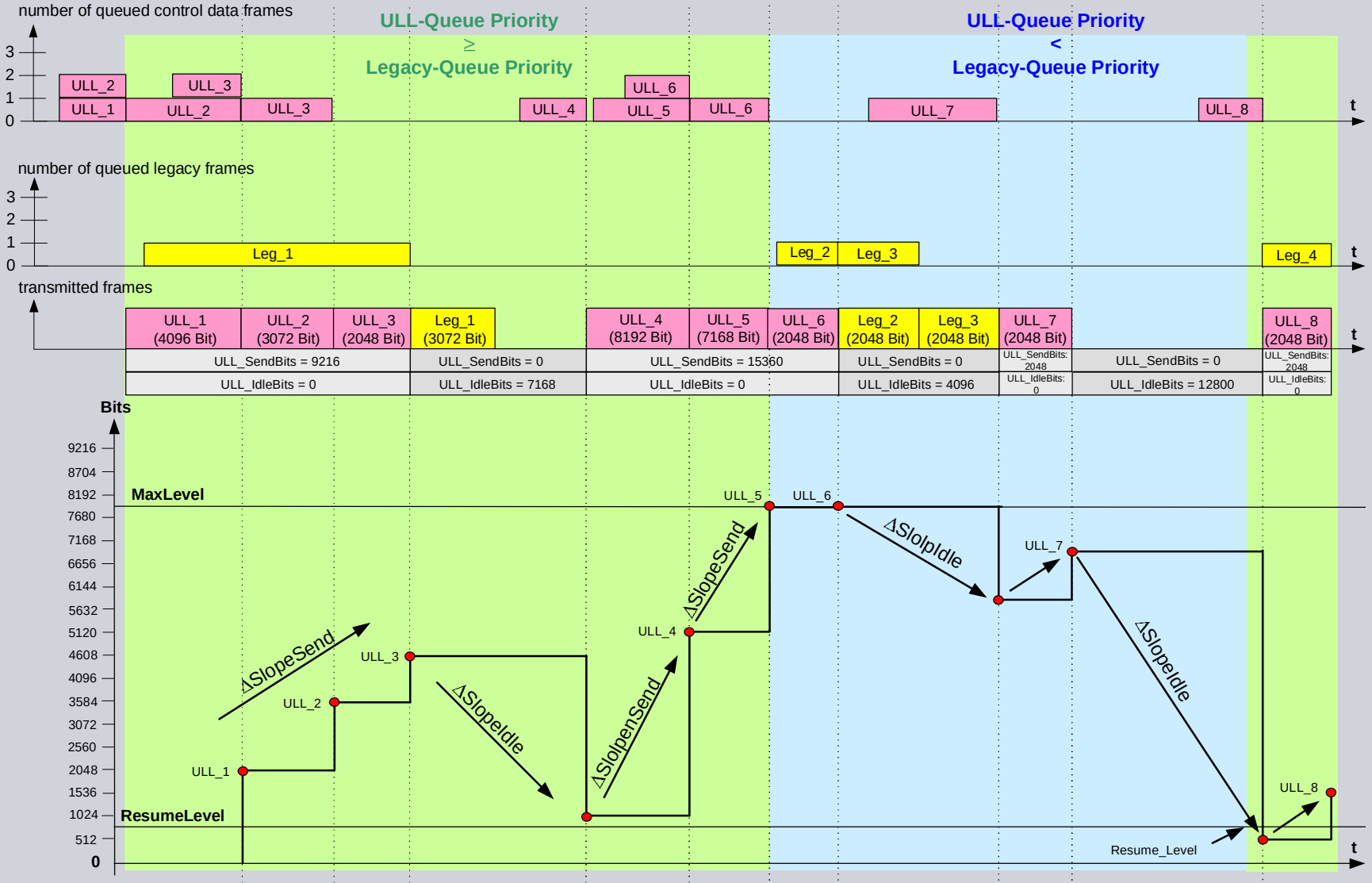
Burst Limiting Shaper Algorithm for CDT



Compare Burst Limiting Shaper Algorithm (CDT) with Credit Based Shaper Algorithm (AV Streams)

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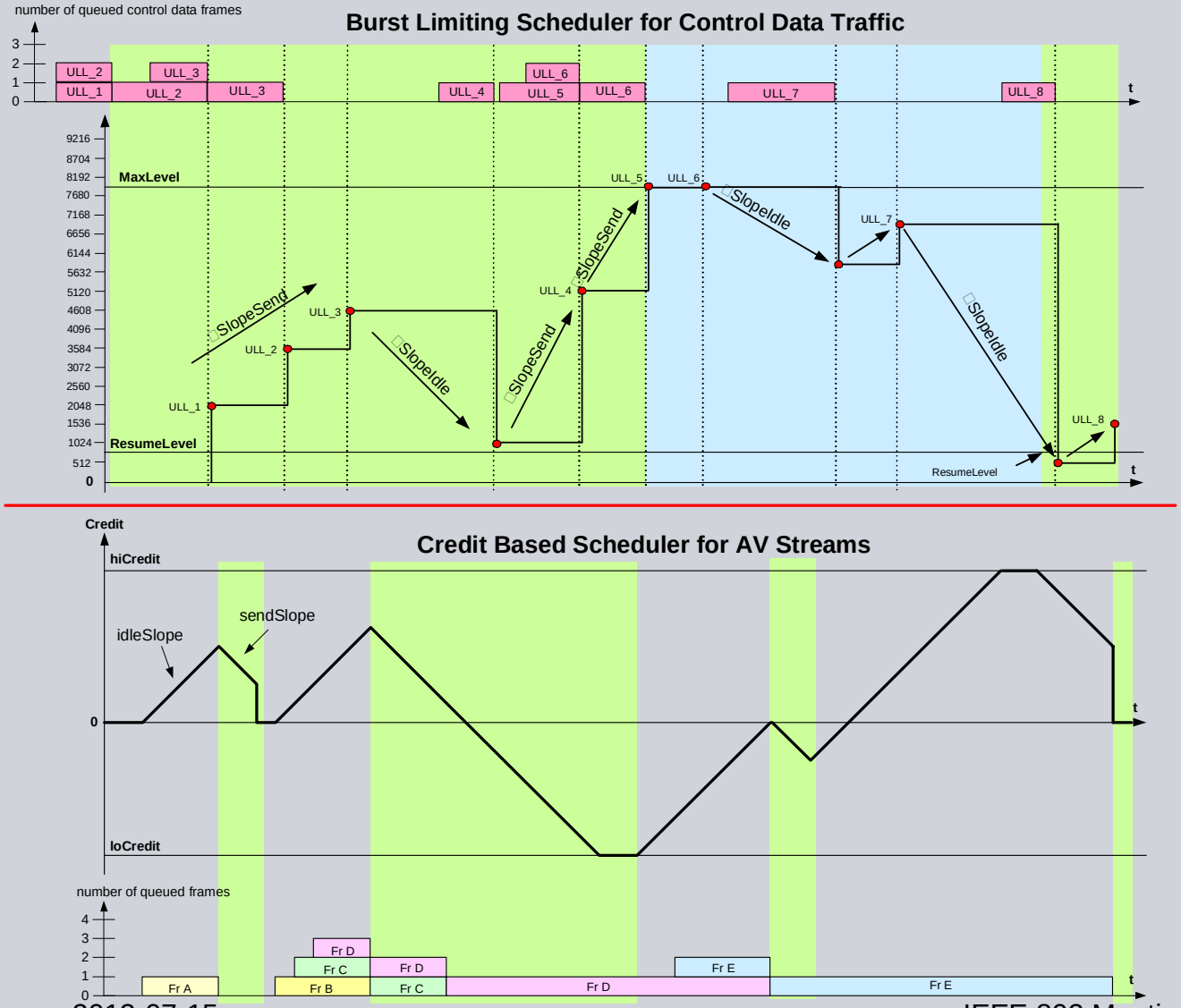

Next Steps?

Which PAR includes

- **Specification for NEW Control Data Traffic Class**
  - **Supported transmission Periods**
  - **Multiple transmission periods**
  - **...**
- **Burst Limiting Scheduler Algorithm (BLSA)**
- **...**

???