

A Call for Interest on 10BASE-T1S PLCA Latency Reduction Study

A Consensus Promoting Presentation for IEEE 802.3 CFI

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Why Are We Here?

In regard to achievable network latencies with 10BASE-T1S using PLCA,

- It's too long.
- We want it to be shorter.
- We want it to be more deterministic (constrained latency variability)

Why Are We Here? More specifically,

- 802.3cg includes PLCA (Physical Layer Collision Avoidance) operation using 10BASE-T1S in shared medium. And it is deployed on production vehicles.
- PLCA provides fair and equal access to all nodes, and
- Its maximum latency is bounded, by number of nodes, max packet sizes, number of packets in a burst. But....
- It's too long (for control loop applications). And it's not deterministic enough due to unconstrained latency variability.
... even for a small number of nodes in a segment.
- This need and the gap in current standard is impeding the optimized system design, often adding cost and power (either via added network segments and internetworking components, or sub-optimal system design).

But first, what is PLCA?

noting only the relevancies to this presentation...

- It's entirely in Reconciliation Sub-layer (RS)
- It works with CSMA/CD MAC (Clause 4)
- Signals bus cycle start ('beacon') and then all nodes send its packets in round-robin. by every node by ID. Packet burst by configuration.
- When all nodes are operating in PLCA, max latency is bounded.
 - Theoretical: 255 nodes, 1536 octets, 256 packet burst = 80.2 sec.
 - Practical: 8 nodes, 1536 octets, 1 packet burst = 9.83 msec.
 - Single packet transit latency (1536 octets): 1.22 msec....

And system designer then start to play with max burst for the server-side port, max MTU less than 1536 octets, number of nodes on the segment, etc, to achieve the acceptable latency.

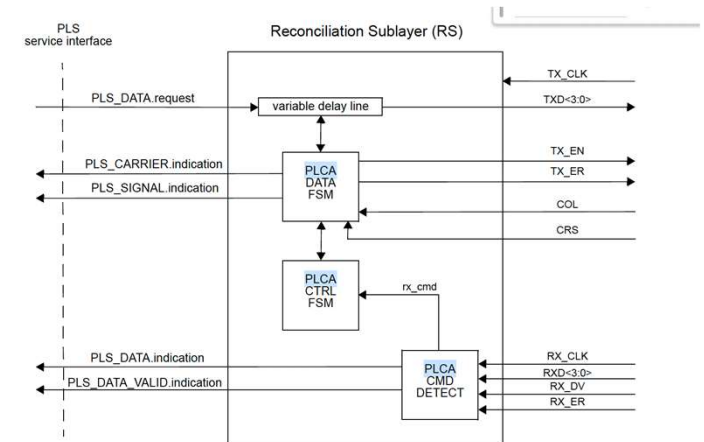


Figure 148-2—PLCA functions within the Reconciliation Sublayer (RS)

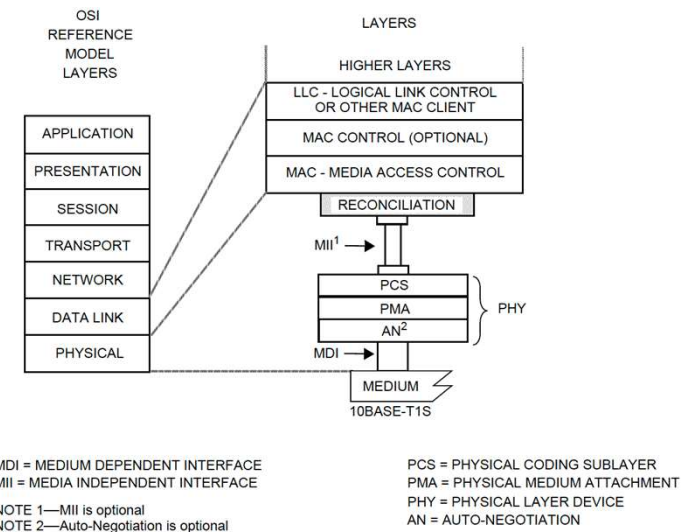


Figure 148-1—Relationship of PLCA Reconciliation Sublayer to the ISO/IEC OSI reference model and the IEEE 802.3 Ethernet model

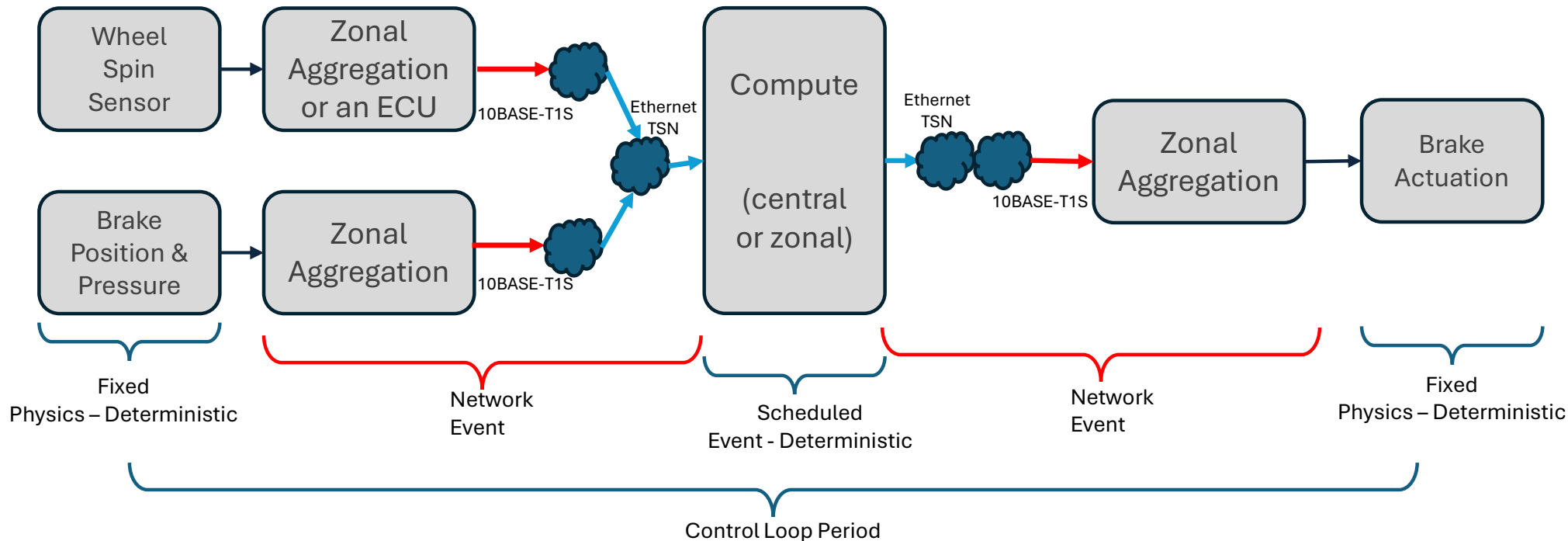
What do we need to study?

- Could the maximum latency be constrained such that both bandwidth and latency may be deterministic on this shared bus?
 - In this context, latency variability to be bounded, and absolute latency value to be much smaller value.
 - Bandwidth contract is directly related to latency bounds.
- Unequal access (differentiated services*) over fair access must avoid any starvation of lower class of service.
- Achieve bounded and constrained latency for every PLCA cycle (transmit opportunity cycle).

* Note: Yes, we want to study differentiated services. DiffServ serves the same objectives in IP network. Will not be apologetic for using the same terms to mean the same objectives.

Control Loops (or Controls Applications)

- [Sense] → [Compute] → [Actuate] control loop.
- The worst case end-to-end latency often determine the robustness and feature of the controls applications.



Possible Layering

- Controls Application needs deterministic latency through the shared medium network (and TSN network backbone).
- Differential Services enabled PLCA participates in unequal transmit opportunity (TO) toward bounded PLCA cycle latency over the shared medium.
- PLCA acts on Differential Services function, i.e. unequal access provisioning (new) over existing fair access mechanism.
- This is per PLCA node behavior.

Note: TimeSync Client diagram from CL90 used as a reference to the proposed layering.

90.4.1.1 Interlayer service interfaces

Figure depicts Differential Services Client and RS interlayer service interfaces.

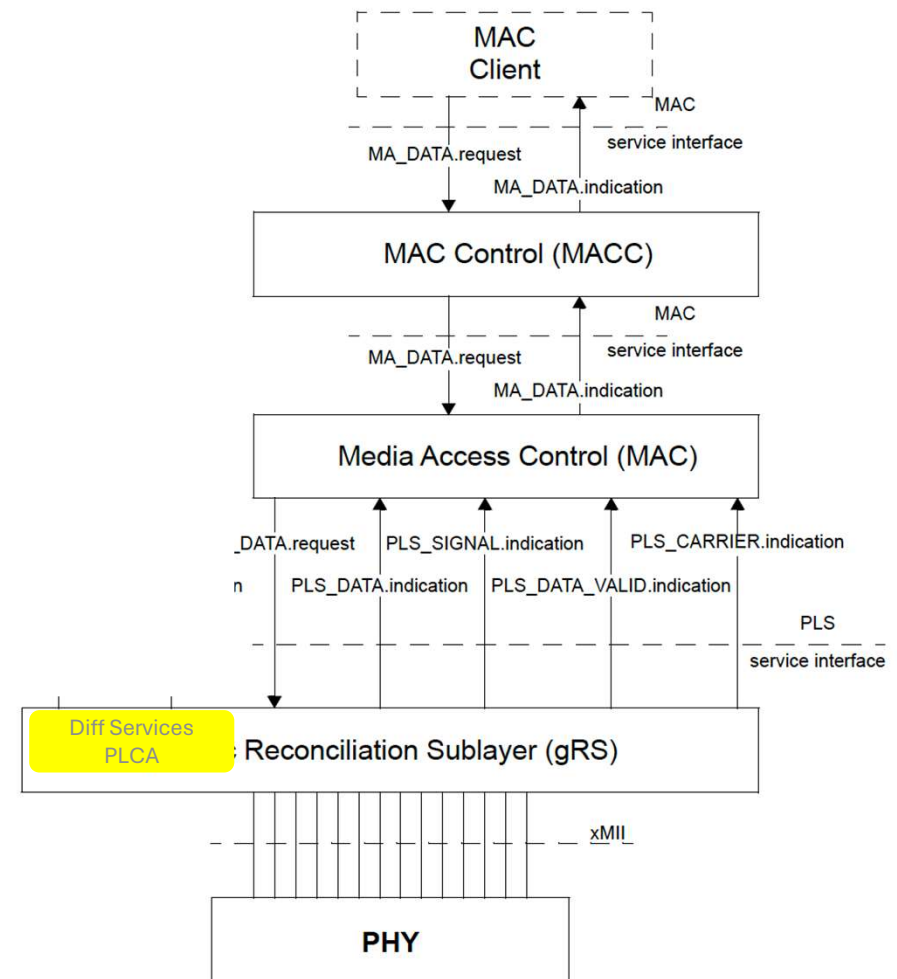


Figure 90-1 Relationship of the TimeSync Client, TSS, and gRS sublayer relative to MAC and MAC Client and associated interfaces

Possible Layering with PCP mapping

- Controls Application is aware of the differential services performance requirement.
- Differential Services Client service interface may be defined in parallel with MAC client and MAC services interface.
- PLCA acts on Differential Services function, i.e. unequal access provisioning (new) over existing fair access mechanism.
- This per Priority Code Point (PCP) per node behavior.

Note: TimeSync Client diagram from CL90 used as a reference to the proposed layering.

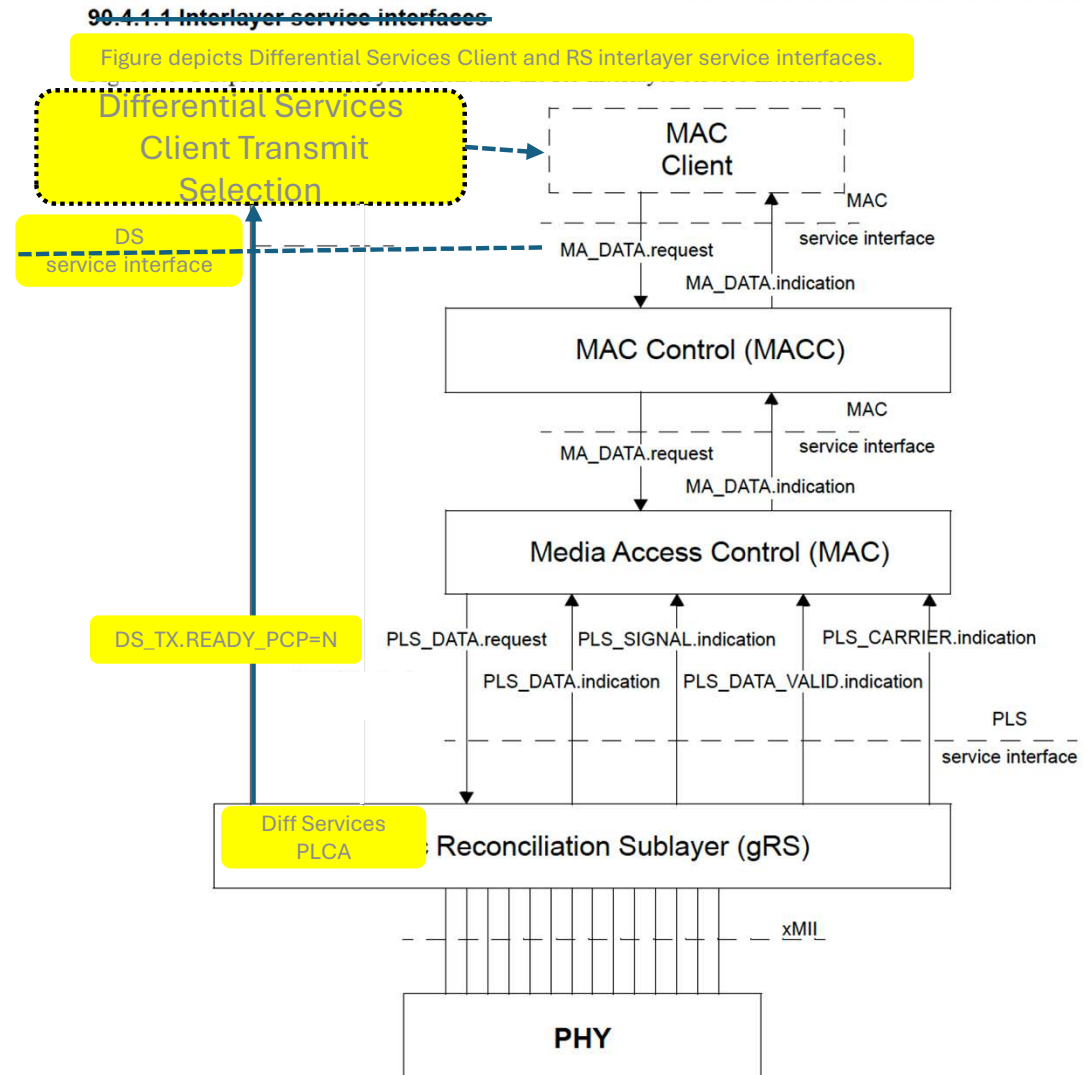
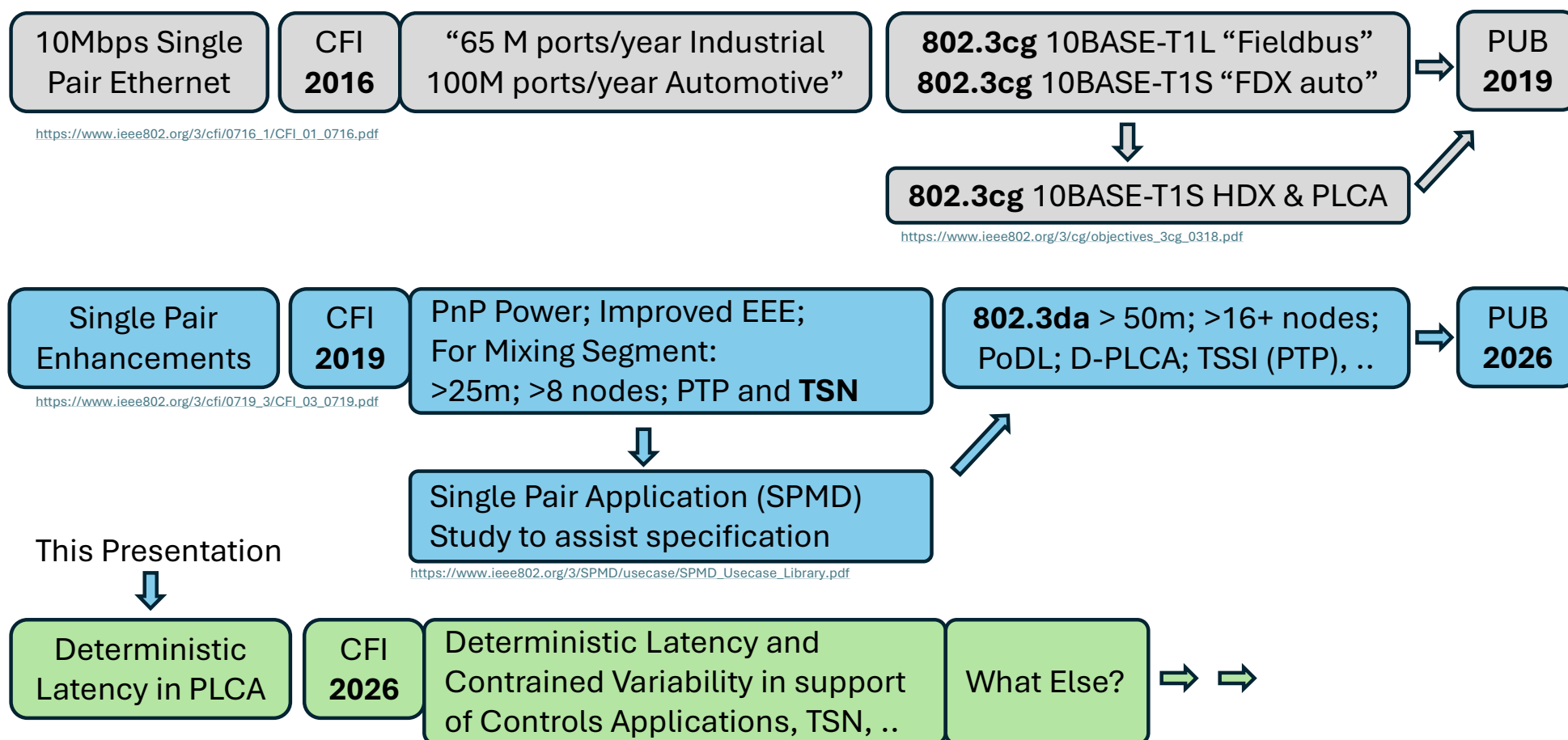


Figure 90-1 Relationship of the TimeSync Client, TSS, and gRS sublayer relative to MAC and MAC Client and associated interfaces

A Short Review of Single Pair Ethernet



FAQ: (Relative) Priorities vs Determinism

- Relative Priorities (High, low, etc.) are great. But it does not help with bounded latency and determinism.
- If determinism is not given, everyone would request high priority. If everyone is important, no one is important.
- Determinism does not mean lowest latency. It means bounded latency, constrained latency variability, and assured delivery.



Thank You

[Expected] Supporters

To Be Replaced with
Real Supporters List

Individuals from Automotive OEMs and Tier 1 Suppliers who have tried to engineer 10BASE-T1S networks for both controls applications (tight timing specs) and best effort traffics.

Individuals who needs to deliver on deterministic and bounded latencies in networks without re-engineering every time there is a move/add/delete.

Individuals from Industrials and Automation who have tried to engineer 10BASE-T1S networks for both controls applications (tight timing specs) and event based traffic while allowing best effort traffic and meet all timing requirements.

Individuals who understands networking and generally support addressing this gap in our standard.