PLCA FAQ

Frequently Asked Questions (FAQ)

Q: What is PLCA?

A: It's a new generic reconciliation sublayer, defined within 802.3 clause 148, meant to achieve deterministic performance out of CSMA/CD for half-duplex, mixing-segment (i.e. multidrop) networks featuring a low number of nodes.

Q: What it is for?

A: CSMA/CD exhibits random, unbounded latencies (due to possible collisions) which preclude using Ethernet in many Industrial, Automotive and Automation Control use cases, where determinism is required. PLCA provides a guaranteed maximum latency along with improved throughput and access fairness, effectively overcoming these limitations.

Q: What PLCA stands for?

A: PLCA is an acronym for PHY-Level Collision Avoidance

Q: Why is PLCA described as a generic Reconciliation Sublayer ?

A: PLCA could in principle be described also as an optional PCS feature. The gRS description, however, better fits what PLCA really does, and it's more in-line with what has been done in other standards. Besides, it's a convenient way of having it work properly with TSSI (Clause 90).

Q: So, PLCA is a new media access method?

A: NO, media access is still handled by existing CSMA/CD functions defined in Clause 4. PLCA maps MII signals on top of MAC primitives (e.g. Carrier Sense, Collision Detect) in such a way that physical collisions on the media are avoided.

Q: How does it work?

A: PLCA working principle is to dynamically create transmit opportunities so that only one node at a time is allowed to send a packet over the media.

Each node is assigned a unique ID.

The node which ID = 0, namely PLCA coordinator, starts a cycle by sending a BEACON signal on the line, then meets his own transmit opportunity.

If no data is available, after 20 bit times the transmit opportunity is yielded and the next node is granted a transmit opportunity in turn. Otherwise, the transmit opportunity is kept until a packet has been transmitted.

A new cycle is started by the coordinator whenever the last node has been granted a transmit opportunity (despite it was yielded or taken to transmit data).

Q: hold on, how does a node know whether it has something to transmit? There's no such signaling between the MAC and the RS.

A: Indeed, the RS needs to detect such condition on its own. When the MAC delivers data to be transmitted, the RS defer the transmission until a transmit opportunity is met by the means of a short delay line, or by raising a "logical" (local) collision.

Q: so, the RS is supposed to buffer whole packets?

A: NOT AT ALL, the cycle time is very short (20 bits x number of nodes) and nodes get one transmit opportunity at each cycle. If another node initiates a transmission during its own transmit opportunity while data is being buffered, a local collision is raised instead, relying on the MAC to back-off and perform a new transmit attempt at a later time.

Q: I'm confused, wasn't PLCA supposed to avoid collisions?

A: PLCA avoids physical collisions on the media, so that a reception is never disrupted. Logical collisions affect only the local node, before any physical transmission is performed.

Q: Doesn't this lead to multiple collisions (and unwanted exponential back-off)?

A: NO, the MAC won't perform a new transmission attempt while the line is reported to be busy (Carrier Sense asserted). After reporting a logical collision, PLCA waits for a new transmit opportunity before de-asserting Carrier Sense.

Q: Can you miss a transmit opportunity? Back-off time is random and can be long.

A: NO, at first transmit attempt the back-off time can be either 0 or 512 bit times. Since the (logical) collision can only occur at the very beginning of a transmission, and 512 bit times is less than the minimum packet size being received, the MAC will always be ready to perform a new transmit attempt before the next transmit opportunity is met. Besides, the next transmit attempt is always guaranteed to succeed, so the back-off time will never grow past 512 bit times.

Q: What about fairness? Sounds to me that nodes with higher IDs have less chance to get access to the media

A: The BEACON cycle duration is dependent on the length of data being sent by all nodes, and it's totally asynchronous in regards to MAC processes anyway. This means that any node, independently of which ID is given, could get a transmit opportunity anytime.

Q: PLCA provides packet fairness in a round-robin fashion, but what if nodes transmit packets of different sizes? Wouldn't this affect fairness as well?

A: yes, PLCA is fair in giving each PHY exactly one transmit opportunity at each BEACON, regardless of packet sizes. This behavior is in line with CSMA/CD fairness policy. Data fairness is not addressed by current PLCA definition, although there are ongoing discussions along with proposals to add this feature, if needed.

Q: What about CSMA/CD capture effect?

A: capture effect is not possible because multiple collisions are not possible with PLCA. Besides, transmit opportunities are generated in a round-robin fashion, avoiding starvation.

Q: Isn't PLCA a kind of TDMA?

A: NO, TDMA works at a different layer, reserving time slots for whole packets assuming time synchronization among the nodes, which is somewhat against the base philosophy of Ethernet (asynchronous, optimized for throughput). PLCA transmit opportunities are created dynamically, adapting to the traffic conditions (packets rate and size).

Q: right, but what about performance compared to TDMA?

A: PLCA overcomes TDMA problem of wasted time-slots, making a very efficient usage of the available BW. Besides, PLCA worst case latency is equal to TDMA constant latency. Last but not least, TDMA is suitable for engineered systems, while PLCA is in principle plug & play.

Q: Does PLCA replace TSN?

A: NO, TSN is expected to run on top of PLCA, taking advantage of its improved determinism to achieve better clock synchronization.

Q: What if a node misses a BEACON?

A: It won't transmit until a BEACON is properly detected

Q: What if a node fails to properly decode a packet? Wouldn't that cause misalignment of transmit opportunities tracked by each node?

A: A node detecting activity on the line, but failing to properly decode the packet, will not attempt any transmission until a new BEACON is received and a new transmit opportunity is met.

Q: how are the unique IDs assigned?

A: this is out of scope of clause 148 to define, but it's reasonable to assume it will be given by the means of a management interface such as MDIO or equivalent interface. Assignment by the means of a higher-level protocol running on top of plain CSMA/CD is also not precluded.

Q: Does PLCA modify the MAC specifications?

A: absolutely NOT, it's all specified as a reconciliation sublayer

Q: it looks like PLCA RS is doing more than just remapping MAC primitives to MII signals. Is this allowed?

A: yes, this has been done in other RS as well. E.g. in Clause 78 (Energy Efficient Ethernet) MII signal CRS is used to prevent the MAC from transmitting under some circumstances. In Clause 47 the RS performs multiplexing to lanes. Clause 65 further extends the idea of multiplexing to "routing" between a PHY and multiple MACs, including processing the preamble for identifiers, altering the preamble, checking the integrity of a preamble through a CRC, and discarding frames due to corrupt preamble or invalid MAC destination (packet filtering).

Q: Doesn't PLCA create a problem by reflecting transmissions?

A: The reflection of transmissions by half-duplex PHYs is not new. 10BASE-T1S exhibits reflective behavior with or without PLCA enabled. Reflective behavior is noted in both 802.3 and 802.1. Existing PHYs exhibit this behavior and vendors have adapted bridges to tolerate and operate correctly with this behavior. In any case, reflective behavior is compliant with 802.3 PHY and MAC, and corrective changes are out of scope for 802.3cg. Alteration of PLCA mode would not change the situation for non-PLCA mode or the other pre-existing half-duplex PHYs.

Q: from an implementation perspective, does PLCA require new MAC products?

A: Being specified as an RS (between MAC and MII) implementing PLCA in a PHY Product (e.g. an I.C.) is not precluded. Take TSSI (Clause 90) as an example.

Q: How did you get this * crazy idea of PLCA?**

A: I was far too drunk to remember