EPoC PHY Configuration Switchover

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Supporters

EPoC PHY Configuration Changes

- Conditions on the Coax are not constant.
- Periodically, the configuration of the EPoC PHY will need to be adjusted to deal with different interference, etc.
- Configuration changes will sometimes require changing the data rate from the MAC.
- Periodic switching from one configuration to another should not require a re-registration or re-ranging. It shouldn't result in packet loss. (Hitless)
- This presentation shows a possible solution for hitless configuration changes on the EPoC PHY.

Traffic Effecting and Hitless Switches

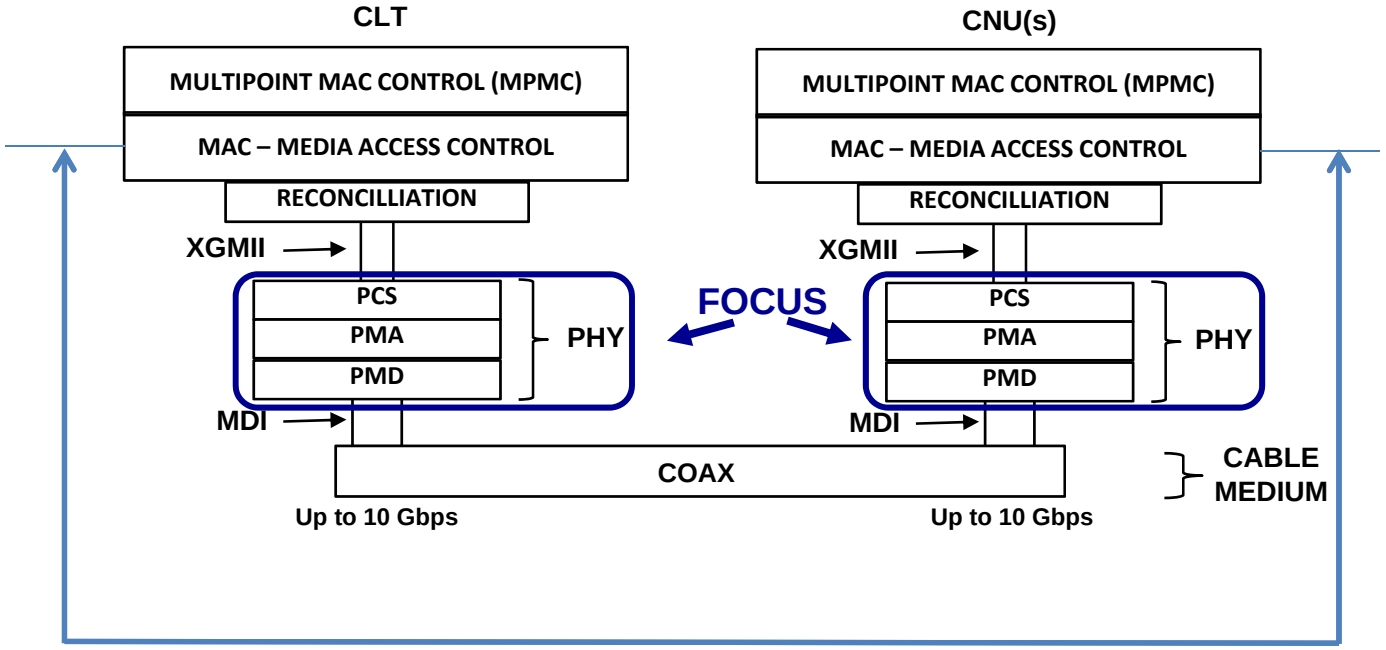
- PHY configuration that rarely changes (These changes are allowed to cause frame loss and even re-registration)
  - Symbol, Cyclic Prefix Size
  - Interleaver Depth
  - FEC Size
  - Etc.
- PHY configuration that changes in normal operation (These should be hitless)
  - Nulling and Enabling Carriers
  - Changing Carrier Bit Loading
  - Enabling and Disabling Pilots & Probes
  - Enable/Disabling Upstream PLC
  - Switching Downstream PLC Frequency
  - TDD Cycle Duration
  - TDD Downstream/Upstream Split

  Required Hitless PHY Configuration Changes should be identified.

EPoC PHY Configuration Switchover

MAC/PHY RATE CHANGES

Basic Requirements



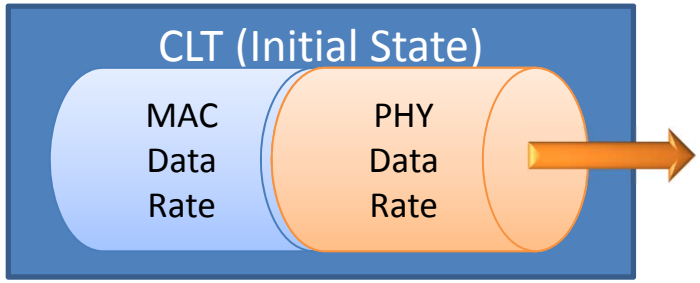
- Delay Must Remain Constant
  - The MAC Control requires a fixed delay (less than 8TQ jitter) from the start of packets into and out of the PHY layer devices.
  - Configuration changes that modify the delay will require re-ranging.
- Rate Adaption
  - Some PHY configuration changes will increase or decrease the capacity of the link.

Rate Configuration

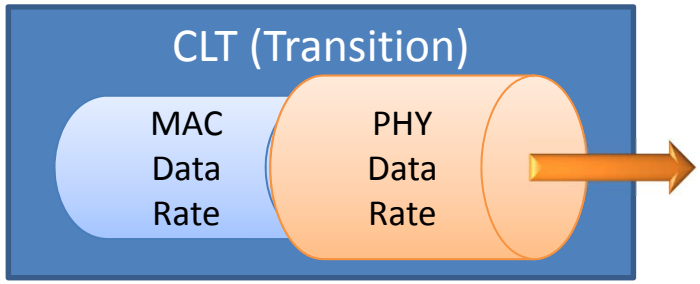
- Rate Configuration
  - EPoC PHYs will Link up at a data rate based on configured overhead, available spectrum, and channel conditions.
  - The EPoC PHY data rate can be read from the MDIO so the MAC can be configured.
  - Idles will inserted to reduce the XGMII effective rate to match the PHY rate.
  - The PHY will delete idles based on the configured MAC rate. (See Marek's presentation)
- What if the rates don't match?
  - If the PHY rate is higher than the MAC rate, extra idles will be transmitted between packets. (OK)
  - If the MAC rate is higher than the PHY rate, the PHY will overflow. (Not Allowed)
  - MAC rate should never exceed the PHY rate.
- How many rates to consider?
  - Range: MAC Rates should be from Lowest Rate: [200Mbps?] to Highest Rate: [8.7Gbps or 10Gbps]
  - Granularity: MAC Rates should be specified to no more than 2 significant digits. (1% precision)
  - Range and Granularity specification allows for better IOP and simplified test plan.
  - Example: PHY configuration supports 1.23589Gbps, MAC rate is 1.2Gbps (always drop extra bits)

Downstream Rate Switchover

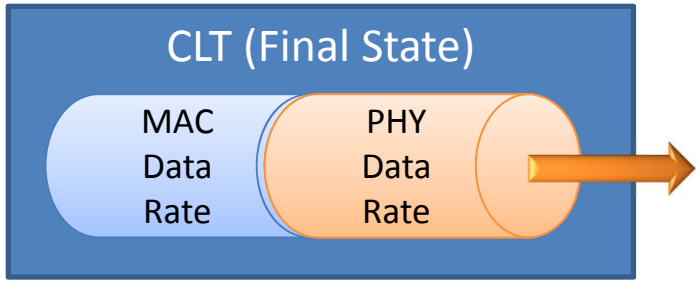
Decreasing CLT PHY TX Rate



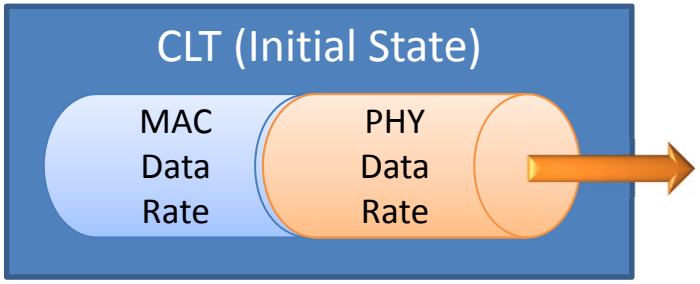
- Decrease the MAC Data Rate first. (Increase the idle insertion)



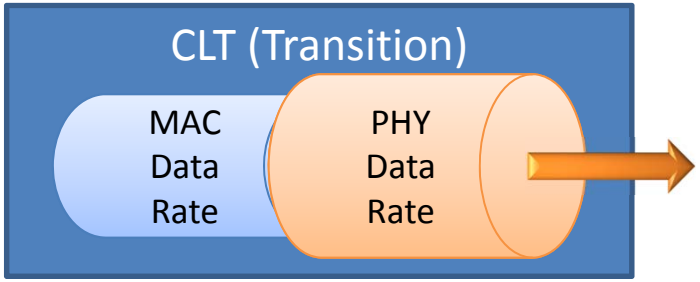
- Decrease the PHY Data Rate second.



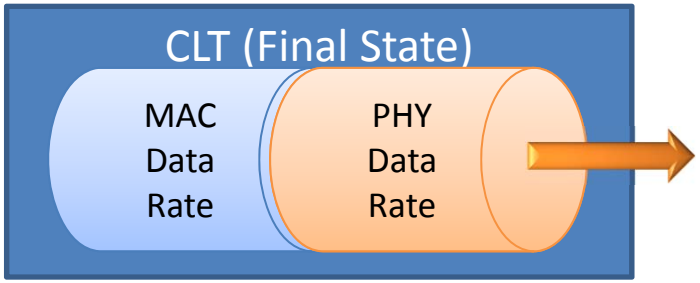
Increasing CLT PHY TX Rate



- Increase the PHY Data Rate first.

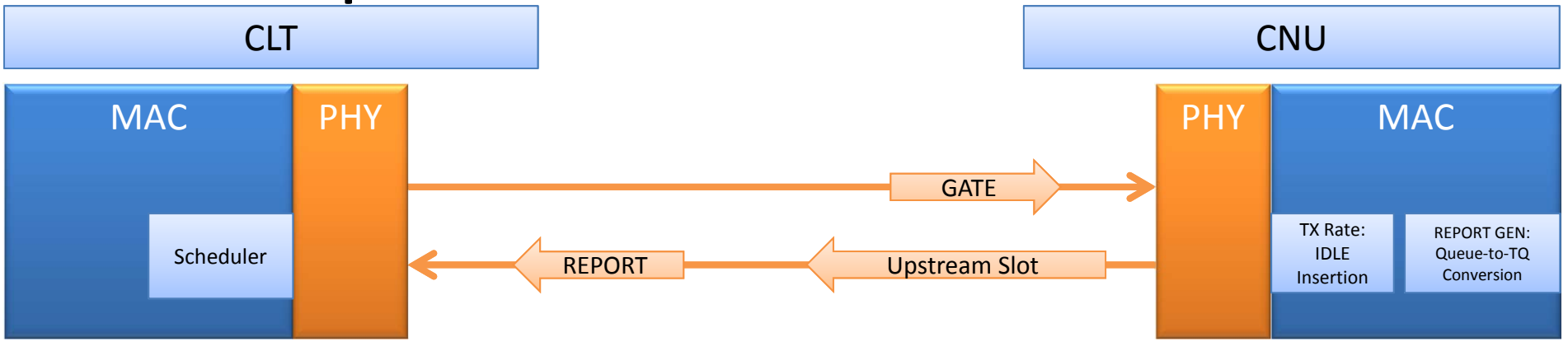


- Increase the MAC Data Rate second. (Decrease the idle insertion)



Rate Changes in the Downstream are relatively easy.

Upstream Rate Switchover



Decreasing PHY Rate Example (Increase PHY Rate is reversed order)

1) Change REPORT frame generation conversion (Bytes-to-TQ). Ask for bigger slots.

2) Scheduler receives bigger slot REPORTs. Resize fixed size grants (i.e. polling).

3) Wait for a minimum of polling time + RTT for larger slots. (allows for bigger slots to reach CNU)

4) Reduce MAC Transmit Rate: Insert more idles

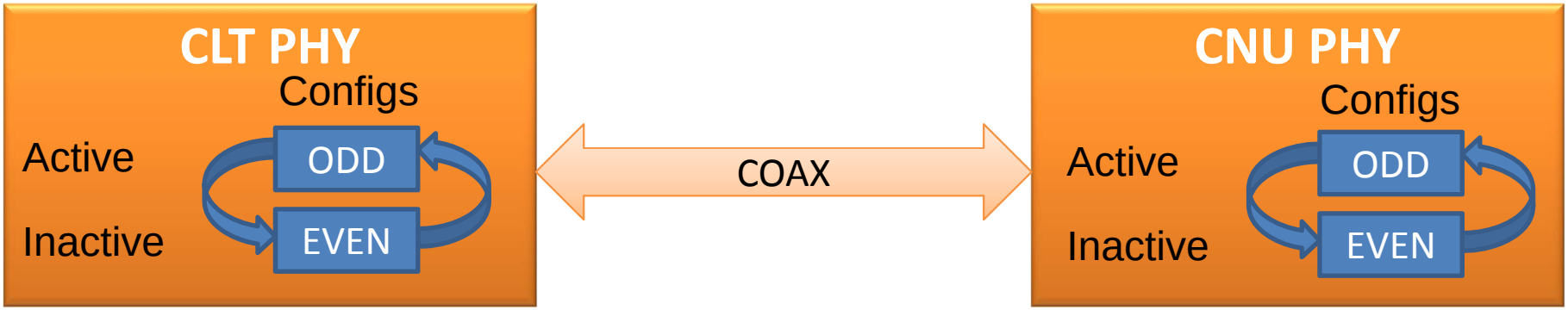
5) Reduce PHY Transmit Rate

Hitless Rate Changes in the Upstream are feasible

EPoC PHY Configuration Switchover

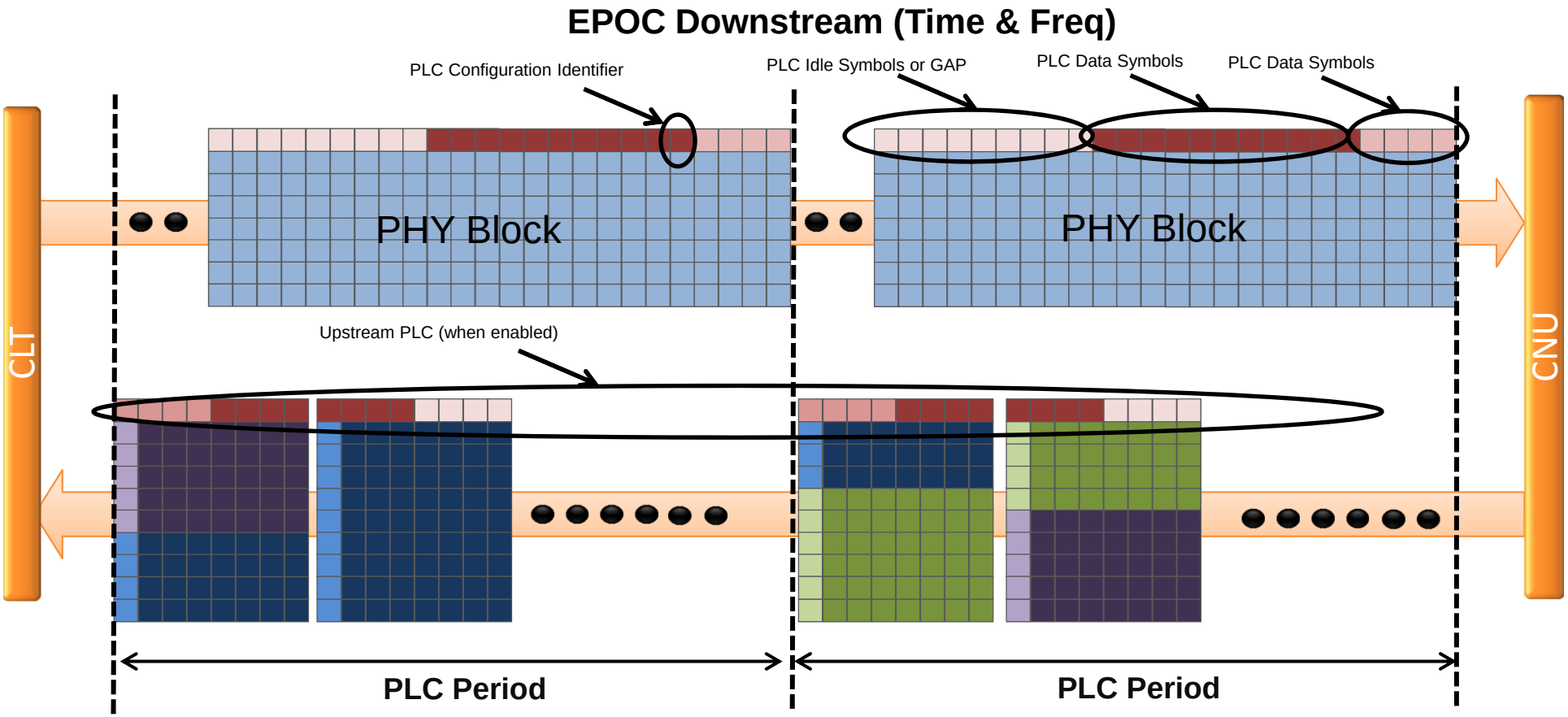
PHY SWITCHOVER COORDINATION

PHY Switchover



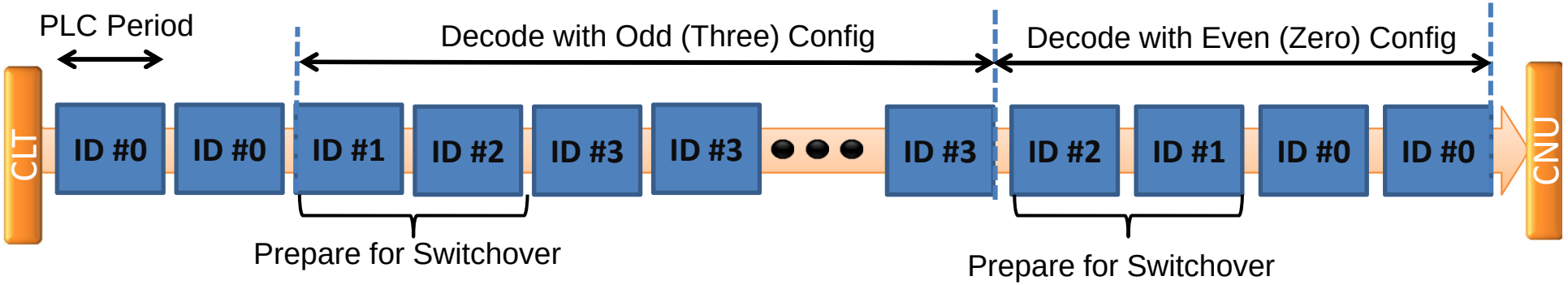
- Uncoordinated switching of PHY configuration will cause packet loss.
  - e.g. CLT PHY has different bit loading than CNU PHY for transition between configurations.
- To provide a coordinated switchover, the PHY must store 2 configurations.
- This presentation refers to the two configurations as ODD and EVEN.
- Either the odd or even configuration is active and the other is inactive.
- The inactive configuration can be modified via MDIO or PLC.
- The CLT PHY and CNU PHY must switch the active configuration between ODD and EVEN at the same symbol to prevent frame loss.
- The PLC can be used to identify a common symbol for configuration switch.

Coordinating TX & RX PHY Switchover



- PLC Repeats at a fixed period in the downstream.
- PLC Upstream (when enabled) repeats at the same fixed period. (same symbol size, ½ symbol size, double symbol size possible)
- PLC PHY Link Process aligns upstream and downstream PLCs in reference to CLT. (see IEEE 802.3bn contribution "EPoC Upstream Mapping" [boyd_01_1112.pdf])
- Every PLC downstream frame carries 2 bit “PLC Configuration Identifier” field.

PLC Configuration ID



- Definition
  - Downstream PLC carries 2 bit field for Configuration Identifier. (Selects between 2 configurations: odd and even)
  - ID 0 indicates blocks to decode with Even Configuration. ID 3 indicates blocks to decode with Odd Configuration.
  - ID 1 & ID 2 are used for switchover to prepare receiver for transition and provide robustness for PLC frame loss.
- Switchover Steps
  - CNU PHY's inactive configuration (odd or even) is updated through PLC or MDIO-via-OAM.
  - CLT PHY inactive configuration is updated.
  - CLT PHY increments or decrements from active ID value to inactive ID value.
  - At ID = 0 or ID =3, new configuration is used for block encoding.

Configuration Change Scale

- Two methods are possible for hitless configuration registers.
- A full mirror of all hitless configuration registers allows for large scale change on a single switchover.
- The selected change method uses fewer registers by limiting the number of changes.
- After identifying the registers and switchover conditions, the method can be selected.

Summary

- EPoC needs to support hitless switchover of certain PHY configurations.
- Downstream and Upstream Data Rate Changes can be handled.
- MAC Data Rate Range and Granularity should be defined.
- Downstream and Upstream PHY changes can be supported.
- The PLC Configuration ID can be used for a hitless and robust switchover for upstream or downstream.

Straw Poll

- EPoC must support hitless switchover for certain PHY configuration (i.e. Bit loading, Nulling)?

- Yes:
- No:
- Abstain:

Straw Poll

- The PLC should include a Configuration ID for hitless switchover?

- Yes:
- No:
- Abstain:

Straw Poll

- The MAC Data Rate should be specified with 2 significant digits?

- Yes:
- No:
- Other Granularity:
- Abstain: