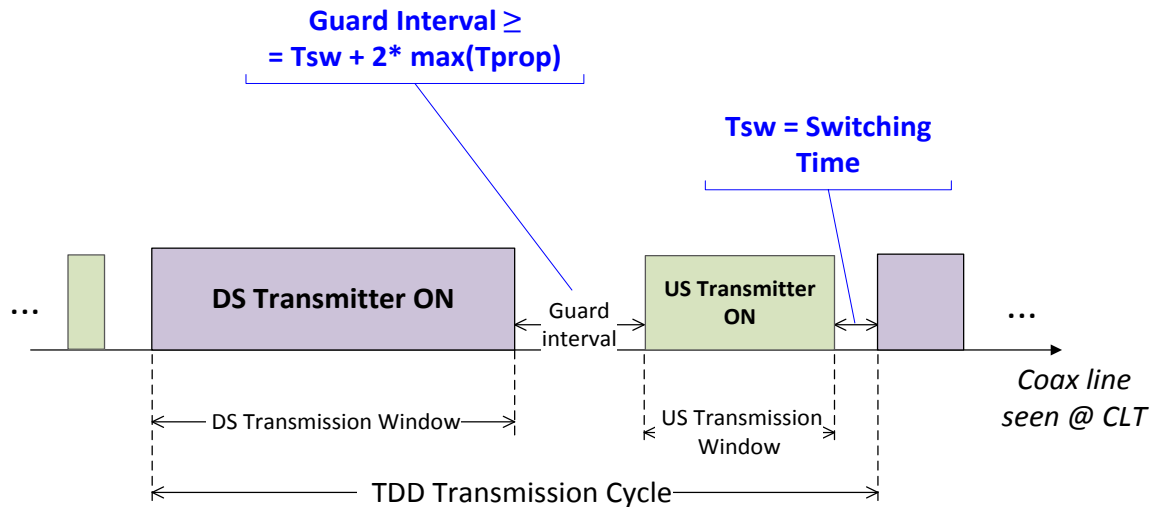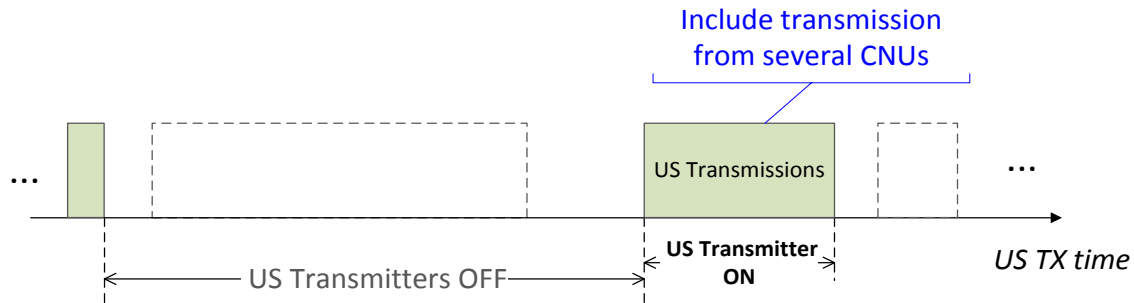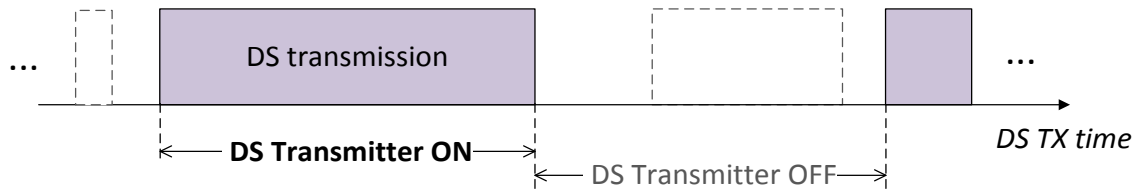# Further Details on TDD

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Background

- During the last IEEE 802.3bn meeting, there has been a large number of presentation from Chinese MSO advocating the need for a TDD solution in EPoC, which is needed for their deployments use case

- This reinforce the overall necessity of a TDD mode of operations, as already highlighted during the Study Group and reflected in the EPoC objectives and some North America operator interest

- An approach for including TDD in EPoC [1, 2] has been recently presented and discussed, suggesting a separate MPCP clause for TDD and some additional changes for configuration, management and for PHY functionality support

- In this presentation, further details are elaborated in this regard and a preliminary assessment of specification impact is included

TDD Timeline on the wire

DS transmission · · ·

DS Transmitter ON ← → DS Transmitter OFF ← →

DS TX time

Include transmission from several CNUs

US Transmissions · · ·

US Transmitters OFF ← → **US Transmitter ON**

US TX time

Guard Interval ≥ = Tsw + 2* max(Tprop)

Tsw = Switching Time

DS Transmitter ON   Guard interval   **US Transmitter ON** · · ·

Coax line seen @ CLT

DS Transmission Window ← →   US Transmission Window

TDD Transmission Cycle ← →

TDD design at MAC-Control – Principles

- As illustrated in [1, 2], a proposed approach for TDD is to implement it via modifications of the MAC-Control
  - The main difference from FDD is in the downstream

- Basic Principles for TDD at MAC-Control:
  - MAC-Control decides on downstream operations based on configured TDD partitioning and guard time in the CLT
  - Upstream uses GATE/REPORT as for FDD mode, whereby the CLT simply stops sending data during the downstream transmit gap – no DS transmission when US is transmitted or during guard time intervals
  - Data Detector in CLT PCS needs to be modified to accommodate switching between transmit and receive in CLT

TDD design at MAC-Control – Impact

- Impacts to the CLT MAC-Control entities

    - Awareness of TDD Cycle (US/DS partitioning and guard time)

    - *MA_control.request* primitive generated only when DS window is open

    - Disable transmission of MAC data packets in DS when the US transmission window is open

    - Required changes: TDD MPCP "mirror" clauses of clause 77.2.2 and 77.2.4

- Impacts to the CNU MAC-Control entities

    - None

TDD design at MAC-Control – DS Transmission

- During the downstream transmit window, Multipoint Transmission Control operates as usual (see clause 77) providing arbitration between the different MAC clients in the CLT via MPCP

- During the downstream transmission gap, the CLT switches from TX mode to RX mode and no data flows in the downstream
  - MAC Control Client disables the arbitration and put the MPCP in suspended status, so no MAC Client can send data
    - To achieve that a new signal is needed (see [2])

- In the PCS, idle deletion takes place and then data detector module is included similar to upstream case in CNU
  - The role of the data detector is to provide indications of switching between TX and RX in the PHY
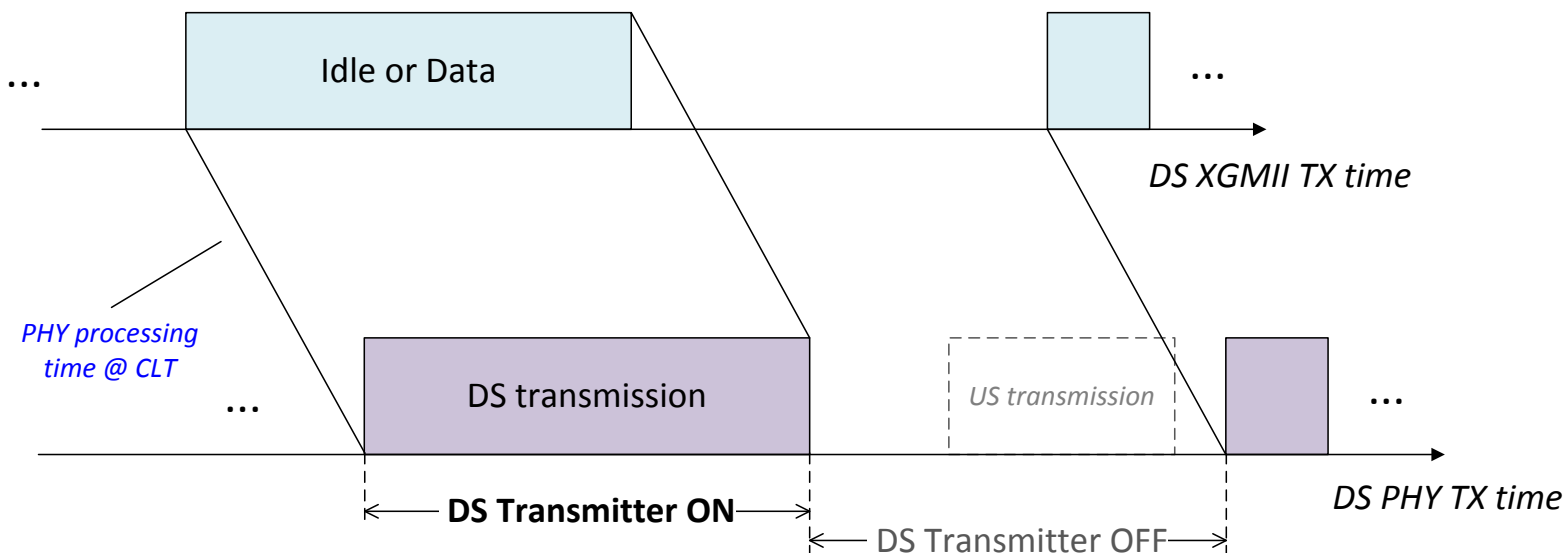
DS Transmission – Specification Impact

- Impacts to the CLT PCS (in addition to what previously mentioned)

  - Needs to trigger the switch between DS (TX) to US (RX) mode (and vice versa)

    - When the DS window is open the PHY layer can transmit also PHY layer signaling

    - When the US window is open the PHY layer shall not transmit also PHY layer signaling

  - Need to handle idle deletion for TDD cycle timeline (e.g. via configuration for TDD parameters)

  - Data detector in the PCS identifies the DS and US window

  - Required changes: EPOC PCS clause "mirror" to clause 76.3.2.5

TDD design at MAC-Control – DS Reception

- CNU RX needs to know when to switch from TX -> RX (and backwards) for the PHY to operate correctly

  - In US, not transmitting does not automatically imply receiving

  - This could be achieved done with special GATE message as proposed in past contributions

  - In this case though it remains unclear how the information will reach the CNU PHY to switch

    - MDIO could be too slow to track any switch dynamically

  - Alternatively the TDD partitioning is exchanged via PHY configuration (via PHY-Link) as part of the PHY parameters – PHY timing advance performed in the same procedure

    - This alternative is preferable and simpler

How does it work

- TDD configuration is established (e.g. via OAM) in the CLT and indicated to the MAC Control agent

- The CLT MAC Control can start transmission according to the configured TDD cycle, which propagates to the CLT PHY

- Downstream is operating properly and CNU can start connecting

The TDD cycle timeline is propagated from MAC Control to PHY at CLT start

How does it work (cont.)

- At power up, the CNU runs the PHY auto-negotiation procedure

    - PHY parameters are exchanged, with proper configuration for TDD (TDD downstream and upstream transmission, TDD bandwidth, guard intervals, etc.)

    - PHY TDD timeline is aligned

- At completion of the PHY procedure, MAC is activated and CNU starts operating in TDD mode

- The first MPCP procedure to run is the CNU registration

DS Reception – Specification Impact

- Impacts to the CNU PCS

  - Needs to trigger the switch between DS (RX) to US (TX) mode (and vice versa)

    - When the DS window is open the CNU PHY layer shall listen the PHY layer signaling (RX mode)

    - When the US window is open the CNU PHY layer shall not listen to the PHY layer signaling (TX mode)

  - Required changes: EPOC clause on PHY layer set up

- No additional changes to MPCP registration procedure needed

Further Enhancements

- Reporting process and REPORT message:
    - Depending on the adopted channel model and available TDD configurability ranges
        - may need to extend RTT range
        - may need to extend the upper bound of reported amount of data in the queues

References

[1]   **law_01_1012**: "IEEE P802.3bn Architecture" – Juan Montojo (Qualcomm), David Law (HP) and Ed Boyd (Broadcom)

[2]   **law_01_1112**: "IEEE P802.3bn Architecture" – David Law (HP)