Further Details on TDD

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Background

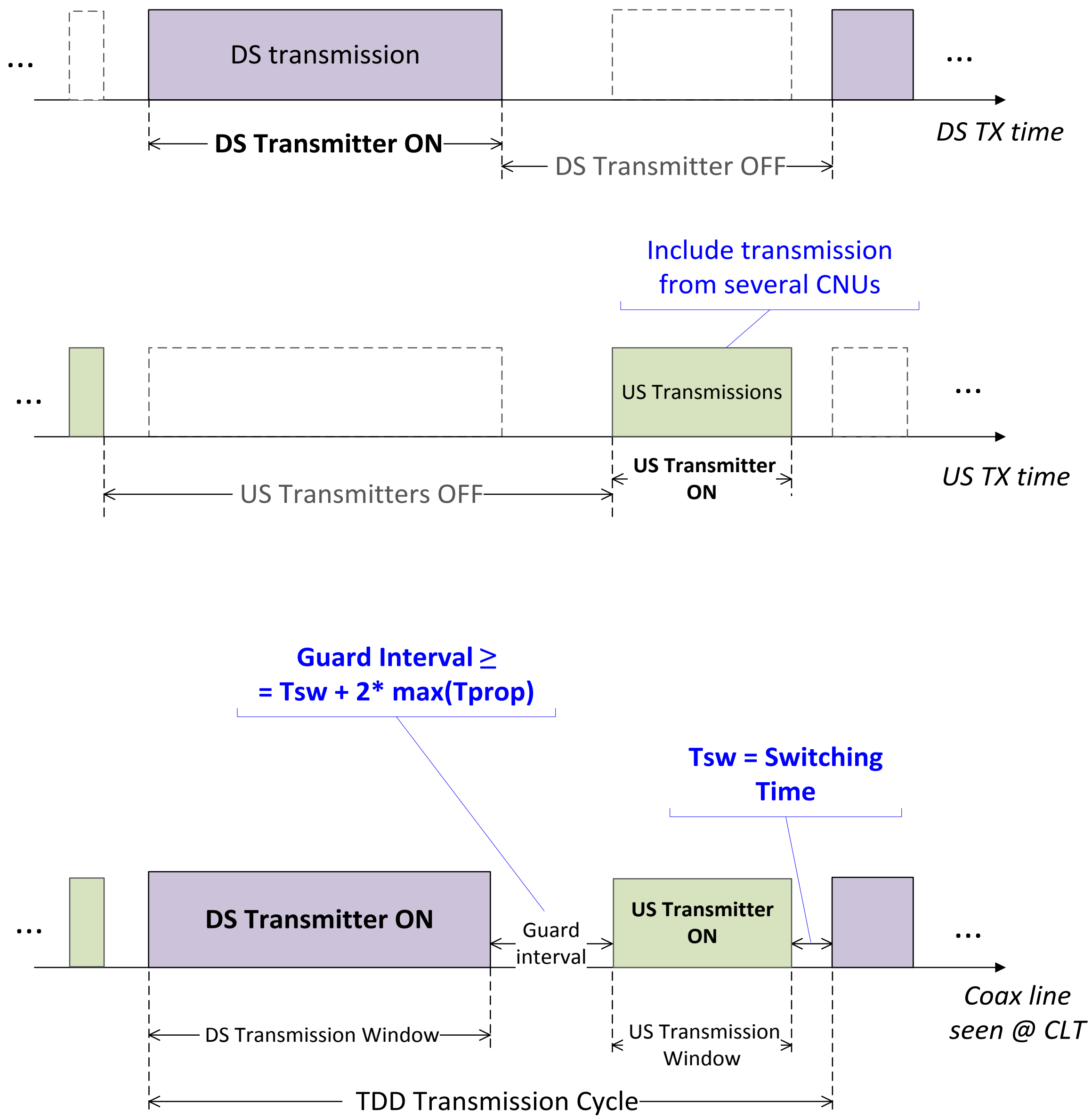
- During the last IEEE 802.3bn meeting, there has been a large number of presentation from Chinese MSO advocating the need for a TDD solution in EPoC, which is needed for their deployments use case

- 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



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)
  - 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

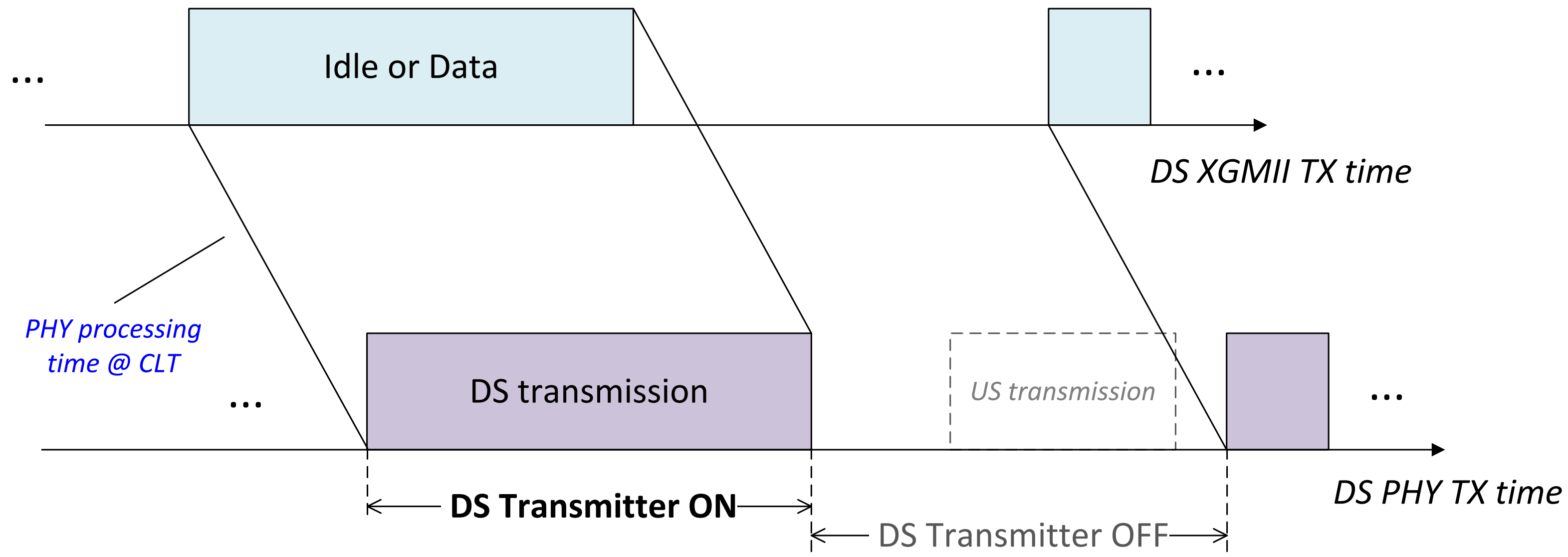
- Impacts to the CLT PCS (in addition to what previously mentioned)
  - Needs to trigger the switch between DS (TX) to US (RX) mode (and vice versa)
    - When the DS window is open the PHY layer can transmit also PHY layer signaling
    - When the US window is open the PHY layer shall not transmit also 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” – "IEEE P802.3bn Architecture" - Juan Montojo (Qualcomm), David Law (HP), Marek Hajduczenia (ZTE), Ed Boyd (Broadcom)