EPoC TDD (baseline proposal)

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Supporters

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Background

- During the last IEEE 802.3bn meeting, a separate track for TDD has been approved by the IEEE 802.3bn Task Force, to continue work as started in law_01a_1112.pdf and contribute recommendations to Task Force for approval:
  - Minimal augmentation to MPCP “logic” to support TDD operation mode for EPoC PHY
  - Communicate “operational needs” to PHY sub-Task Force and Task Force, e.g. delay and delay variation tolerances, CLT downstream transmitter control, etc.
  - Maintain approved MPCP clause amendments
- An approach for including TDD in EPoC [1, 2] has been recently presented and discussed in more details [3], suggesting a separate MPCP clause for TDD and some additional changes for configuration, management and for PHY functionality support

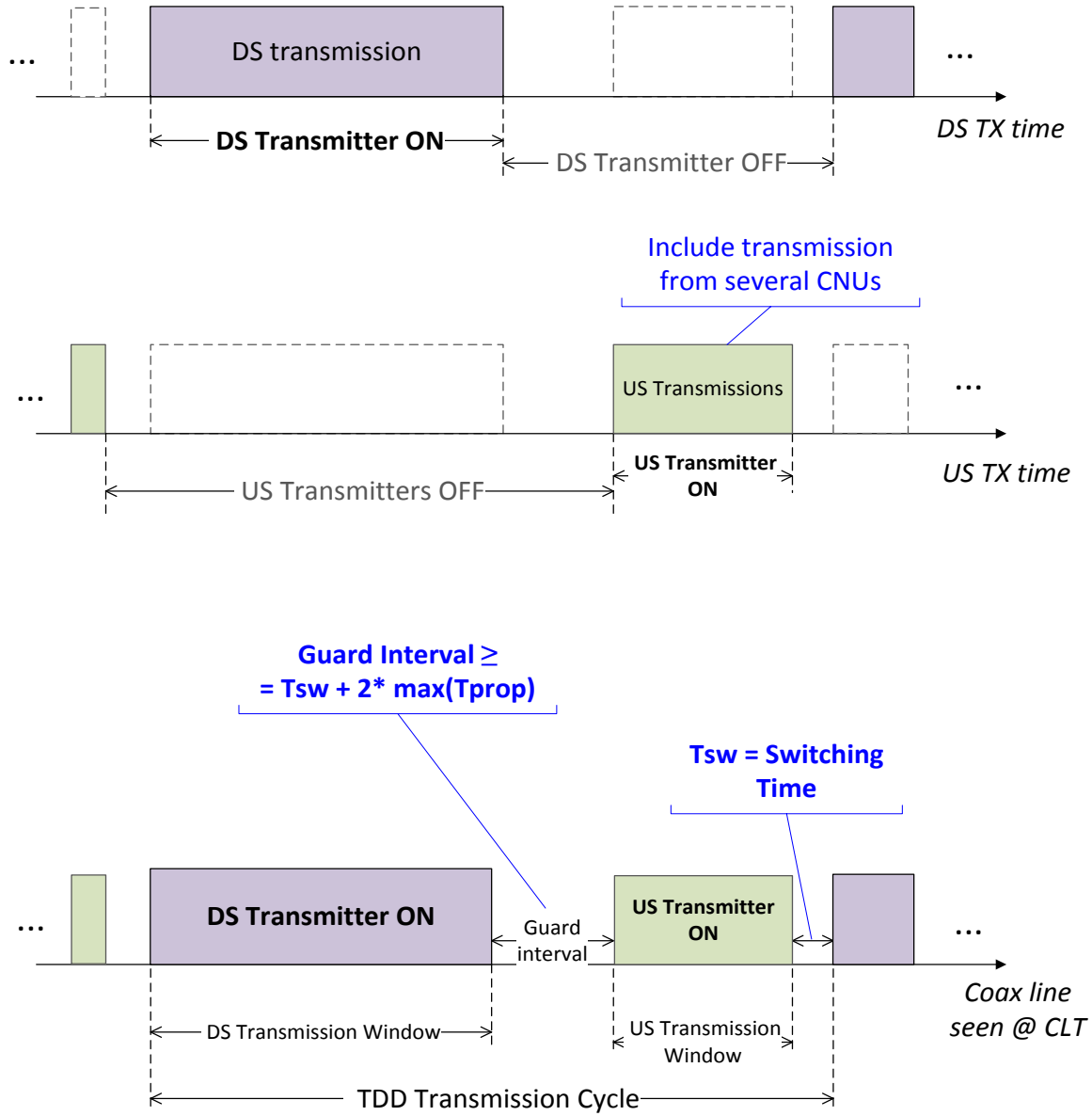
Scope

- In this presentation, a baseline proposal for EPoC TDD is presented following the recommended approach above –the focus is on presenting changes to Clause 77 MPCP definition, to be included in a new MPCP Clause Z for EPoC TDD mode

- Additional aspects for the TDD mode have been presented in [3] and reported here again for convenience – baseline proposal for those aspects is not covered in the current presentation

This presentation focuses on TDD specifics for MPCP and the presented material does not mean to preclude further changes to accommodate other EPoC functions

TDD Timeline on the wire

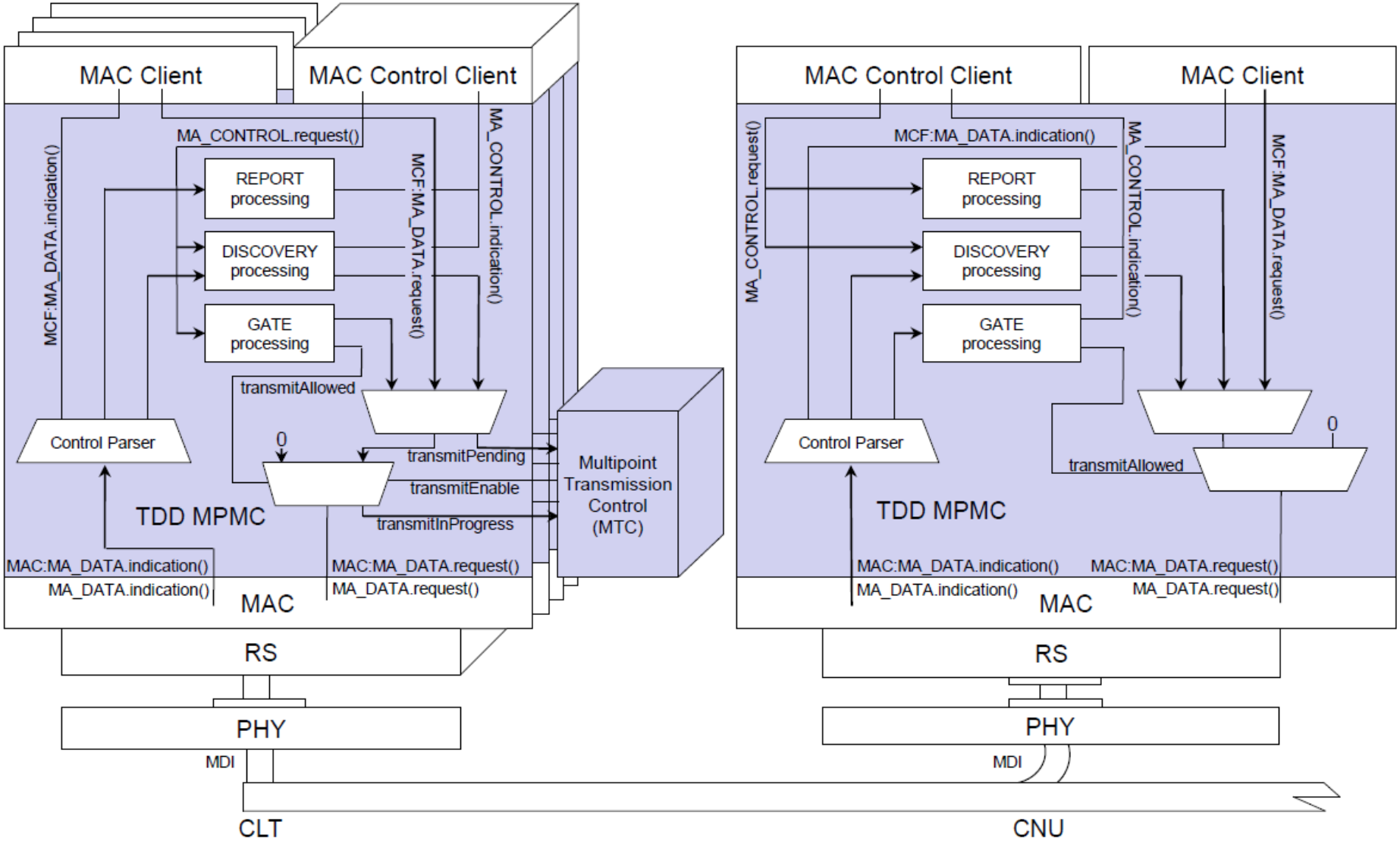


TDD design at MAC-Control – Principles

- As illustrated in [1-3], a proposed approach for TDD is to implement it via modifications of the Multipoint MAC Control (MPMC)
  - The main difference from FDD is in the downstream, among others
- Basic Principles for TDD at MPMC:
  - MPMC decides on downstream operations based on configured TDD partitioning and guard time in the CLT
  - Upstream uses GATE/REPORT mechanism as for FDD mode, whereby the CLT stops sending data during the downstream transmit gap
    - no DS transmission when US transmits or during guard intervals
    - For US, GATE assigns grants active only during US transmit window – no US transmission when DS is transmitted or during guard intervals
    - Whether GATE/REPORT are new or existing ones is for further study
  - CLT PCS needs to be modified to accommodate switching between transmit and receive in CLT

MPCP for TDD – Clause Z

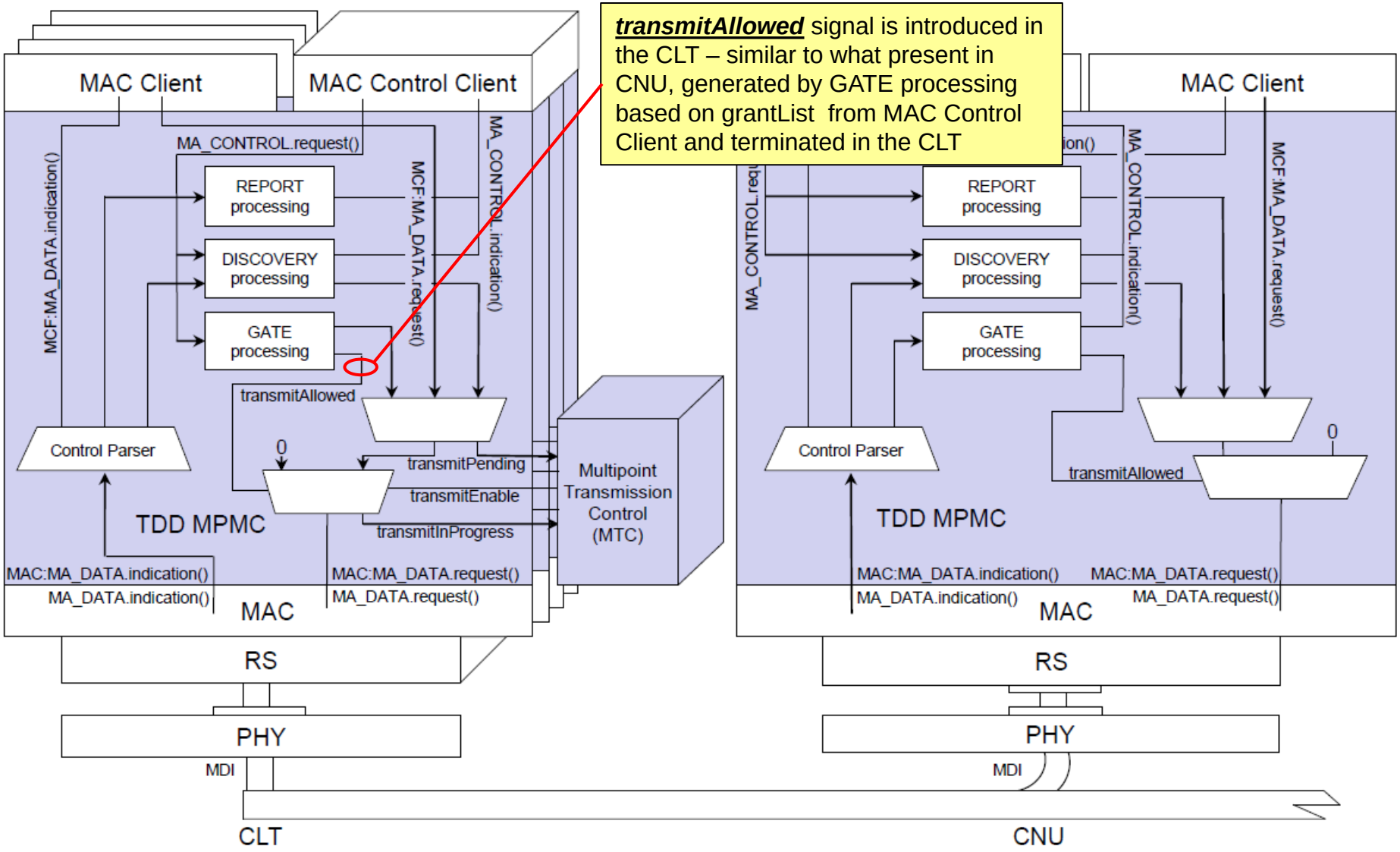
TDD operation – CLT Multipoint MAC Control



Multipoint MAC Control – from [2] "IEEE 802.3 Architecture" – law_01a_1112.pdf

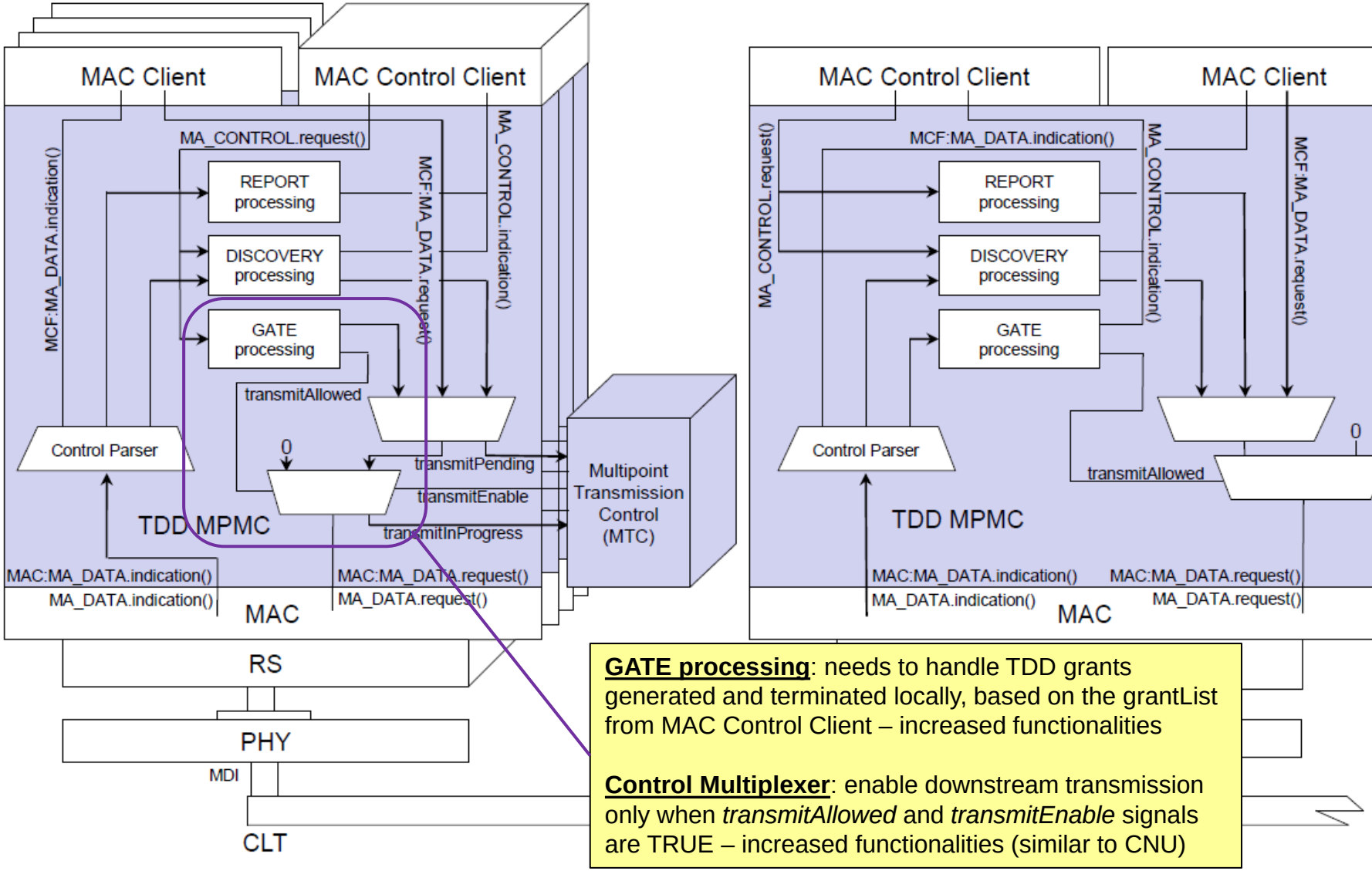
TDD operation – CLT Multipoint MAC Control

transmitAllowed signal is introduced in the CLT – similar to what present in CNU, generated by GATE processing based on grantList from MAC Control Client and terminated in the CLT



Multipoint MAC Control – from [2] "IEEE 802.3 Architecture" – law_01a_1112.pdf

TDD operation – CLT Multipoint MAC Control

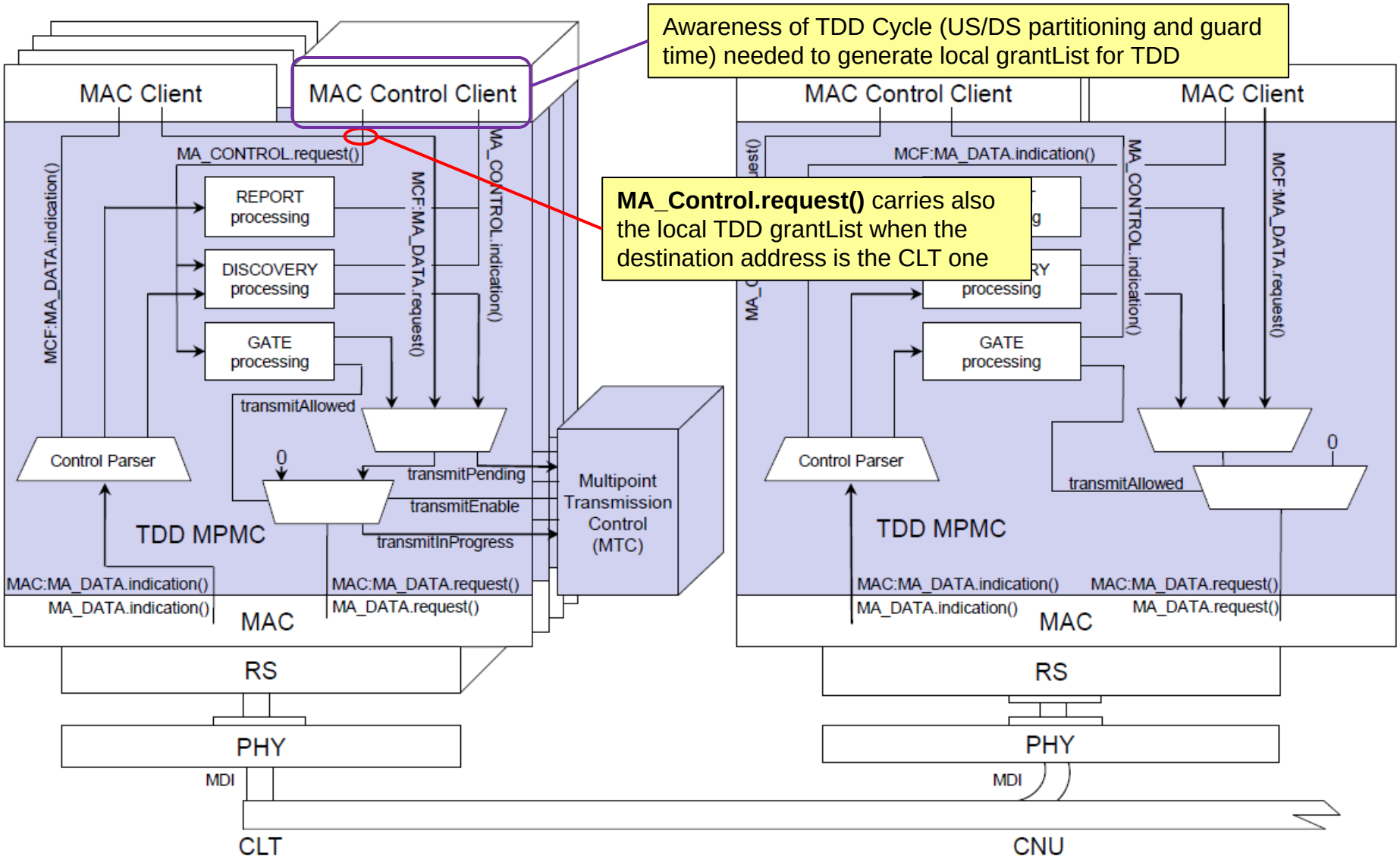


GATE processing: needs to handle TDD grants generated and terminated locally, based on the grantList from MAC Control Client – increased functionalities

Control Multiplexer: enable downstream transmission only when *transmitAllowed* and *transmitEnable* signals are TRUE – increased functionalities (similar to CNU)

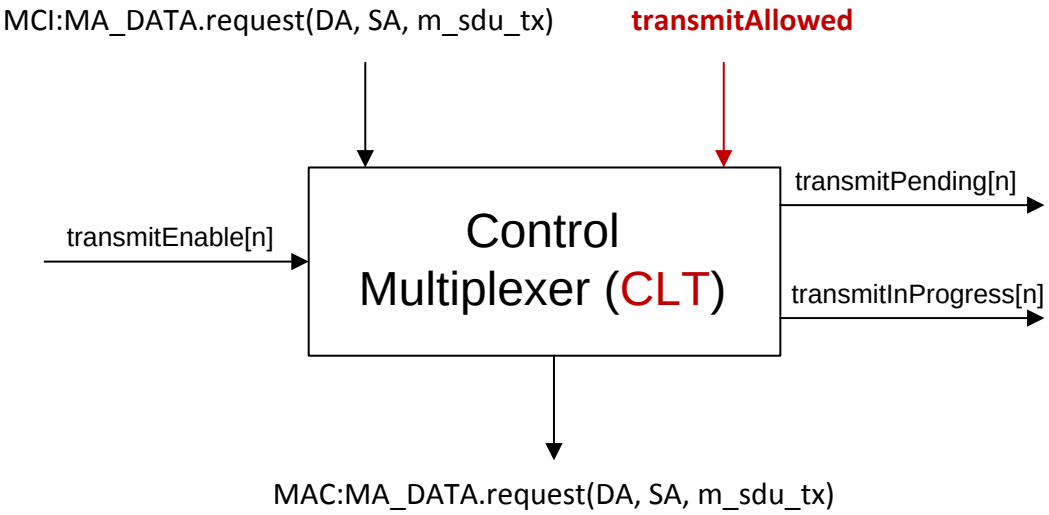
Multipoint MAC Control – from [2] "IEEE 802.3 Architecture" – law_01a_1112.pdf

TDD operation – CLT Multipoint MAC Control



Multipoint MAC Control – from [2] "IEEE 802.3 Architecture" – law_01a_1112.pdf

CLT Control Multiplexer - Service Interfaces



Applicability of *transmitAllowed* (in clause Z.2.2.3 – Variables)

transmitAllowed

TYPE: Boolean

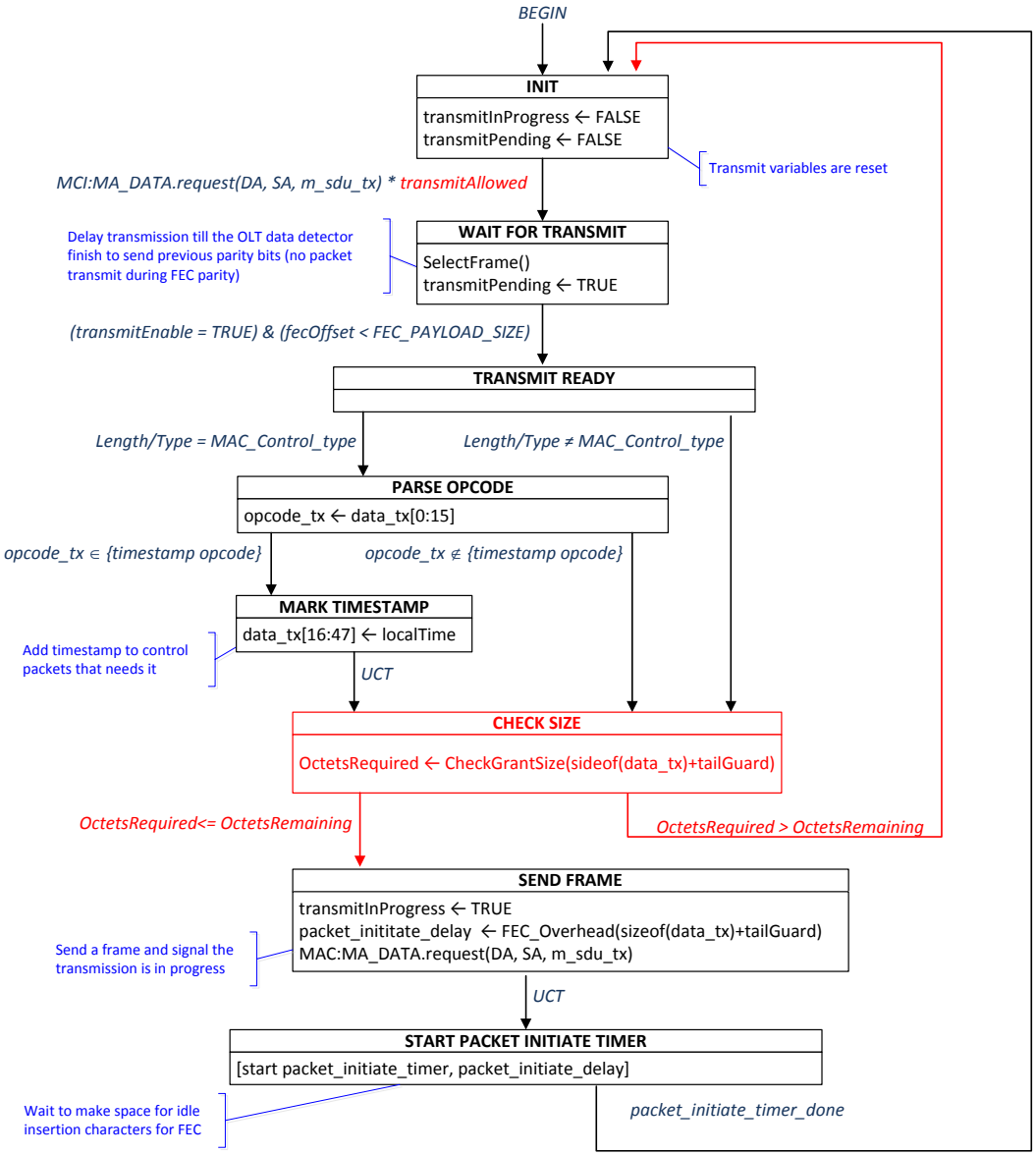
This variable is used to control PDU transmission at the CNU and at the CLT. It is set to true when the transmit path is enabled, and is set to false when the transmit path is being shut down. transmitAllowed changes its value according to the state of the Gate Processing functional block.

State Machine of CLT Control Multiplexer

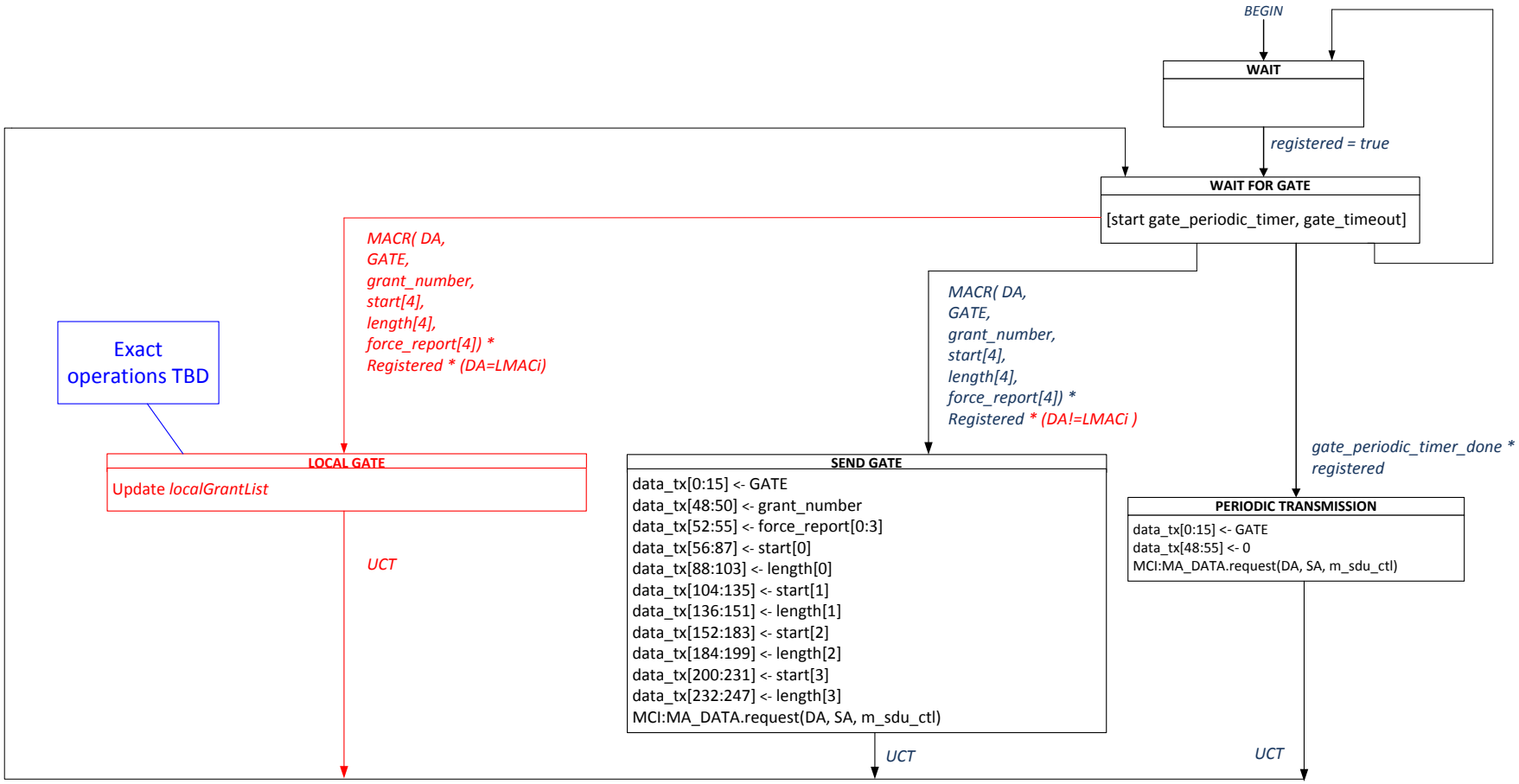
Note: new variables/constants introduced by these changes need to be reflected in the corresponding sections too

Source: Figure 77-13 (OLT Control Multiplexer state diagram) in Clause 77.2.2.7

Extended with parts of Figure 77-14 (ONU Control Multiplexer state diagram)



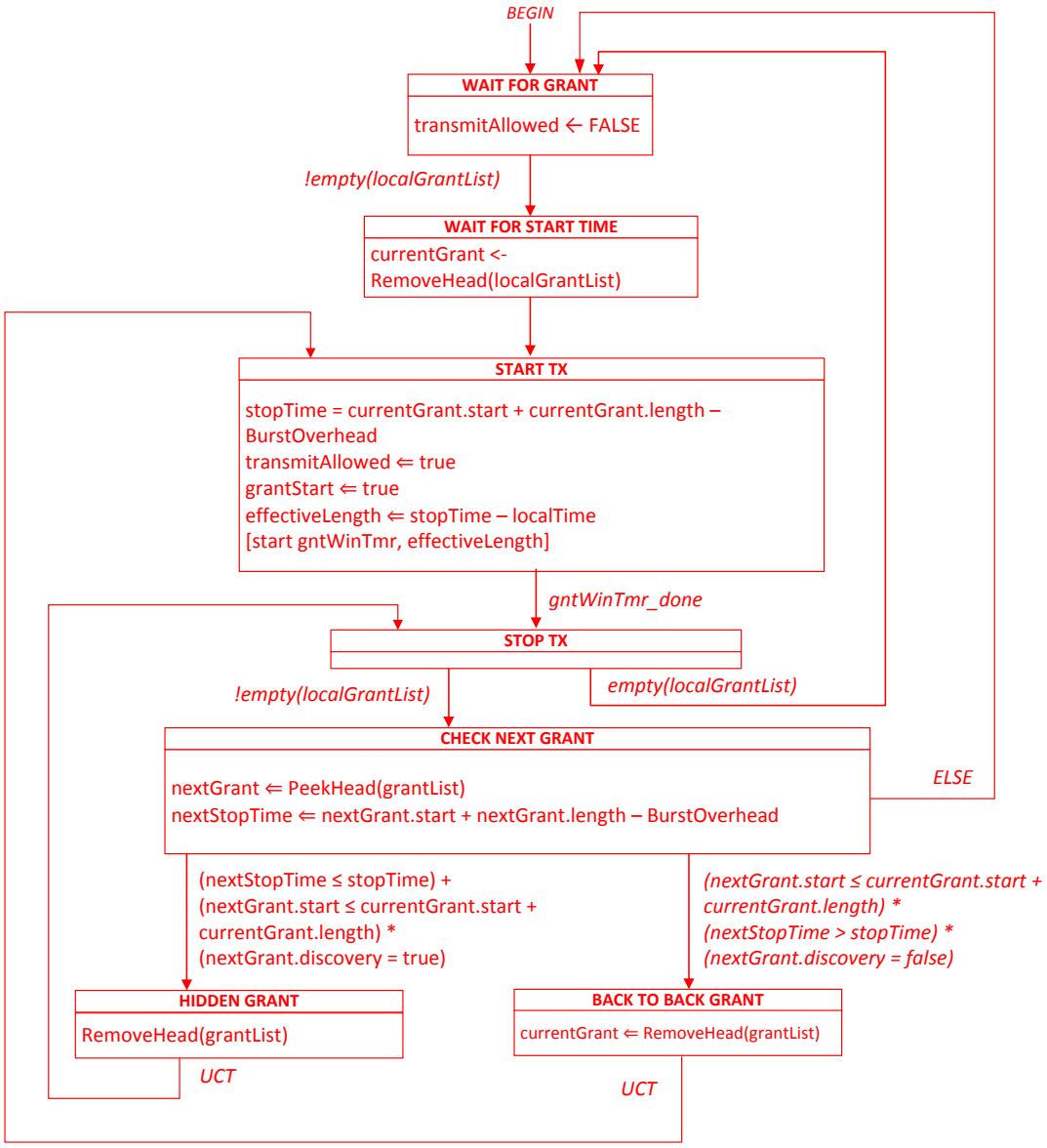
Gate processing in CLT for local (TDD) grant



Note: new variables/constants introduced by these changes need to be reflected in the corresponding sections too

State machine derived by extending state machine defined in Figure 77-28 (Gate Processing state diagram at OLT) from clause 77.3.5.6

Gate processing CLT local (TDD) grant Activation (new)



State machine derived by simplifying state machine defined in Figure 77–30—Gate Processing ONU Activation state diagram from clause 77.3.5.6

Note: new variables/constants introduced by these changes need to be reflected in the corresponding sections too

Editorial Changes– description text

Text describing TDD enhancements

- In “Z.1 Overview”
  - provide high level description of TDD
- In “Z.1.1 Goals and objectives”
  - List TDD as part of the objectives
- In “Z.2 Multipoint MAC Control operation”
  - List TDD as part of the Multipoint MAC control operations

Additional TDD aspects – Clause Y (EPoC PHY)

TDD DS Transmission – CLT PCS Impact

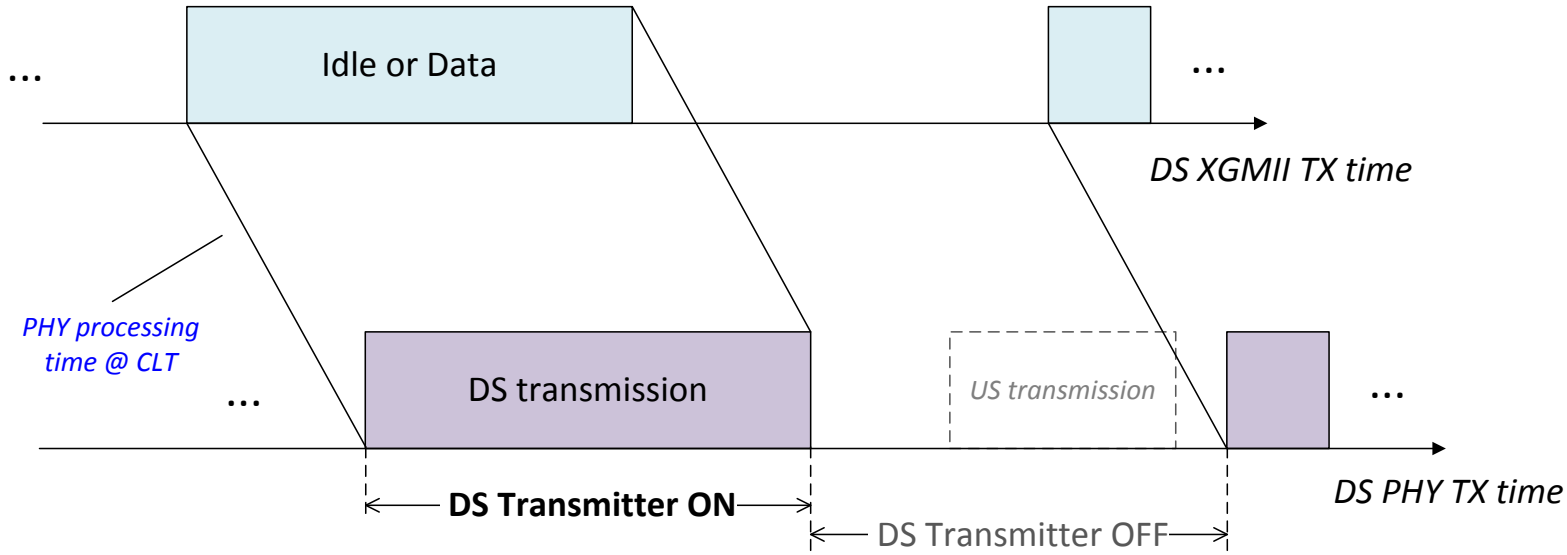
- Impacts to the CLT PCS (in addition to what previously mentioned)
  - Needs to trigger the switch between DS (TX) to US (RX) mode (and vice versa)
    - When the DS window is open the PHY layer can transmit also PHY layer signaling
    - When the US window is open the PHY layer shall not transmit also 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 and provide indications of switching between TX and RX in the PHY
  - Required changes: EPOC PCS clause “mirror” to clause 76.3.2.5

TDD DS Reception Activation at CNU

- 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

TDD DS Reception – CNU PCS 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

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)

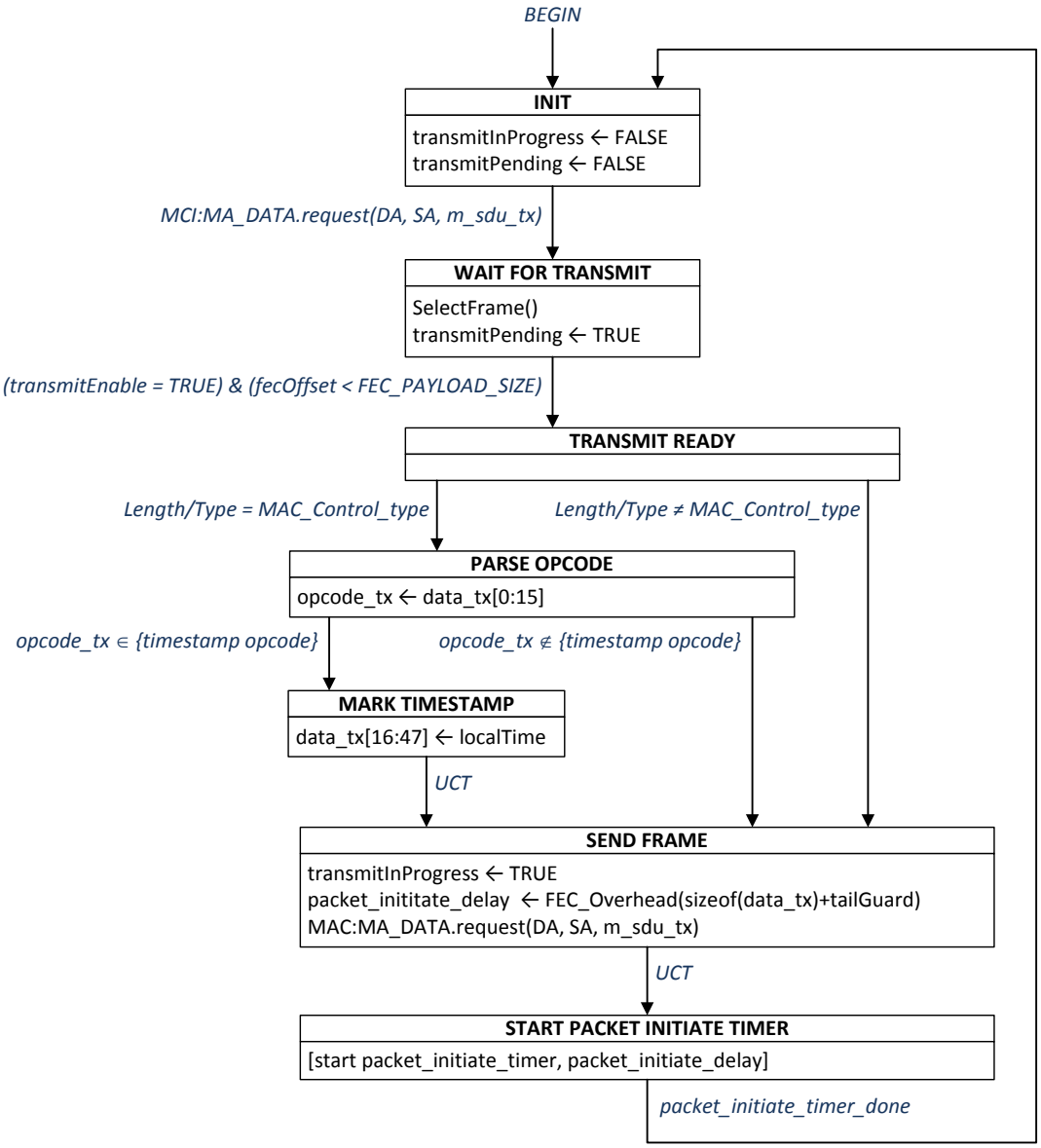
[2] **law_01_1112**: “IEEE P802.3bn Architecture” – Juan Montojo (Qualcomm), David Law (HP), Marek Hajduczenia (ZTE), Ed Boyd (Broadcom)

[3] **garavaglia_02a_1112**: “Further Details on TDD” – Andrea Garavaglia (Qualcomm)

Backup material (from IEEE 802.3-2012 Clause 77)

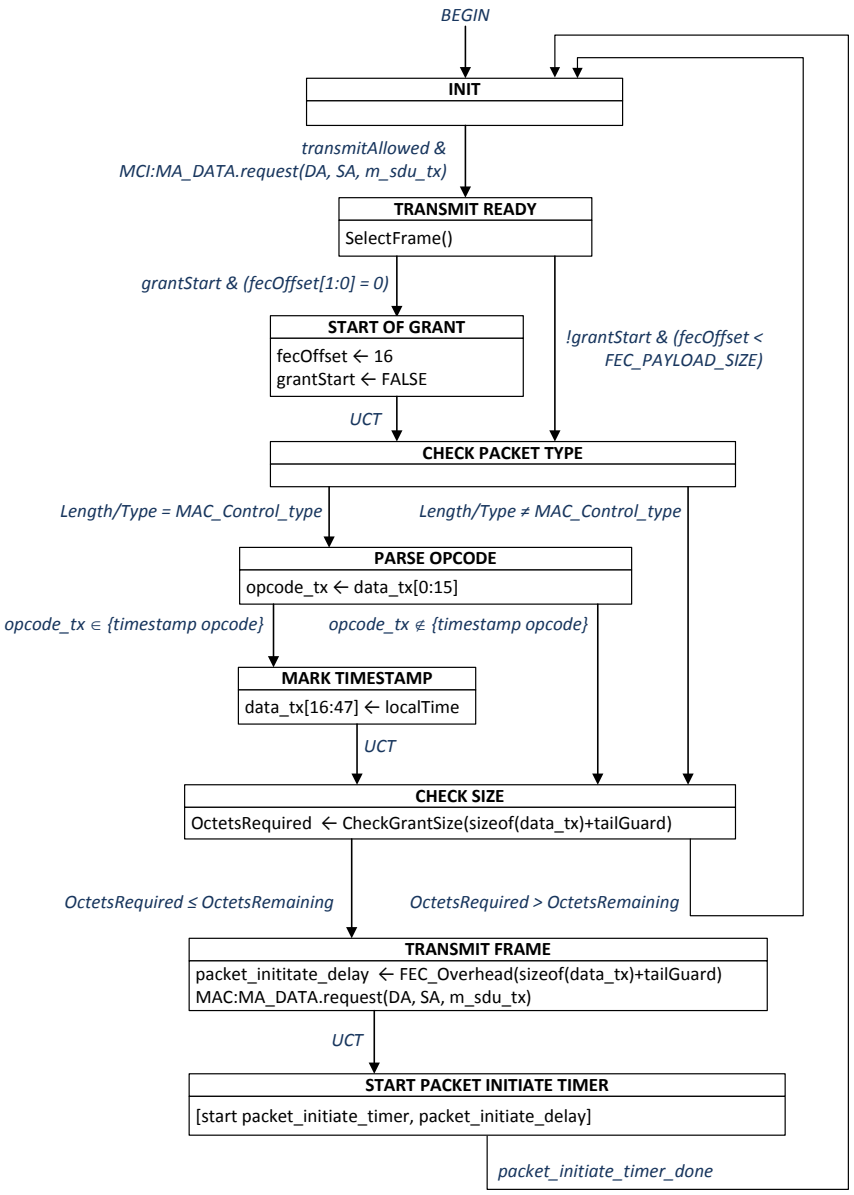
Source state diagram – OLT control multiplexer

Source: figure 77-13
clause 77.2.2.7



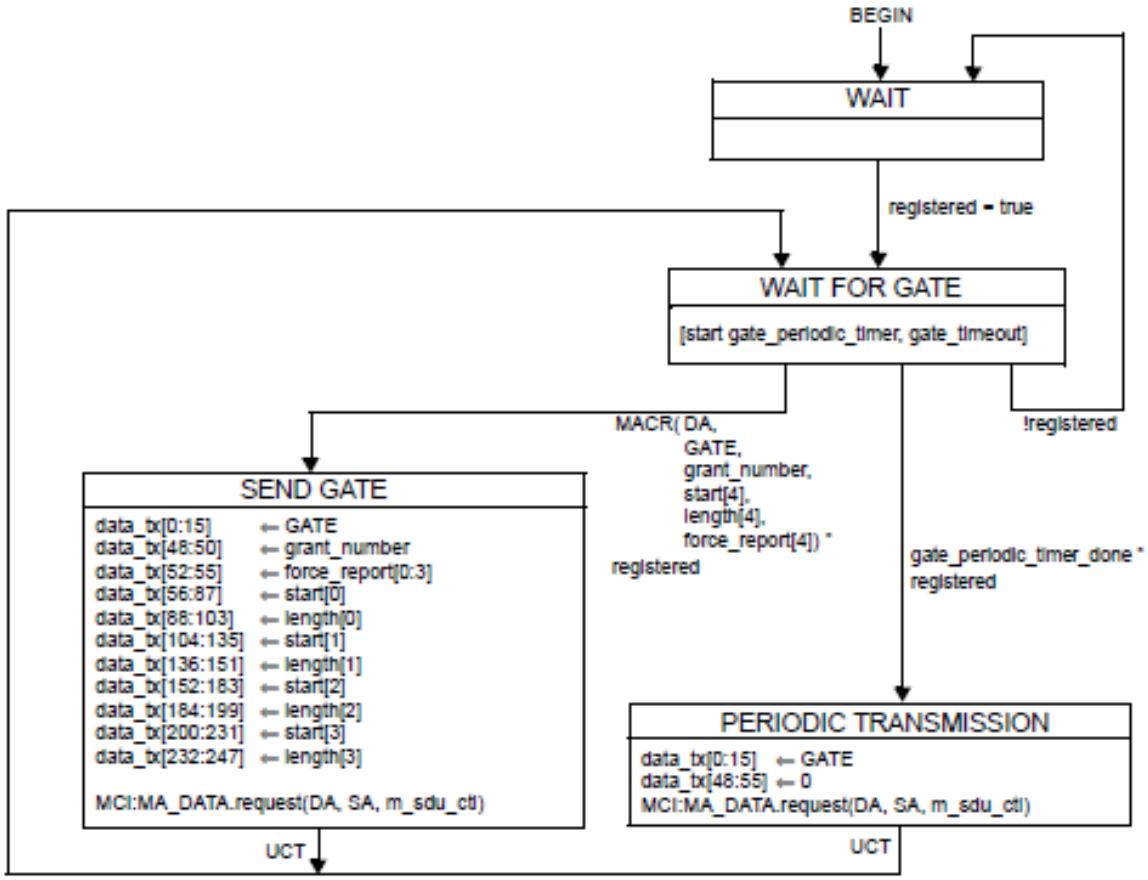
Source state diagram – ONU Control Multiplexer

Source: figure 77-14
clause 77.2.2.7



Source state diagram – Gate processing at OLT

Source: figure ure 77-28
clause 77.3.5.6



Source state diagram – Gate Processing ONU Activation

Source: figure 77-30
clause 77.3.5.6