Terawave Communications

MPCP: An EPON System 2

Lighting The First Mile™

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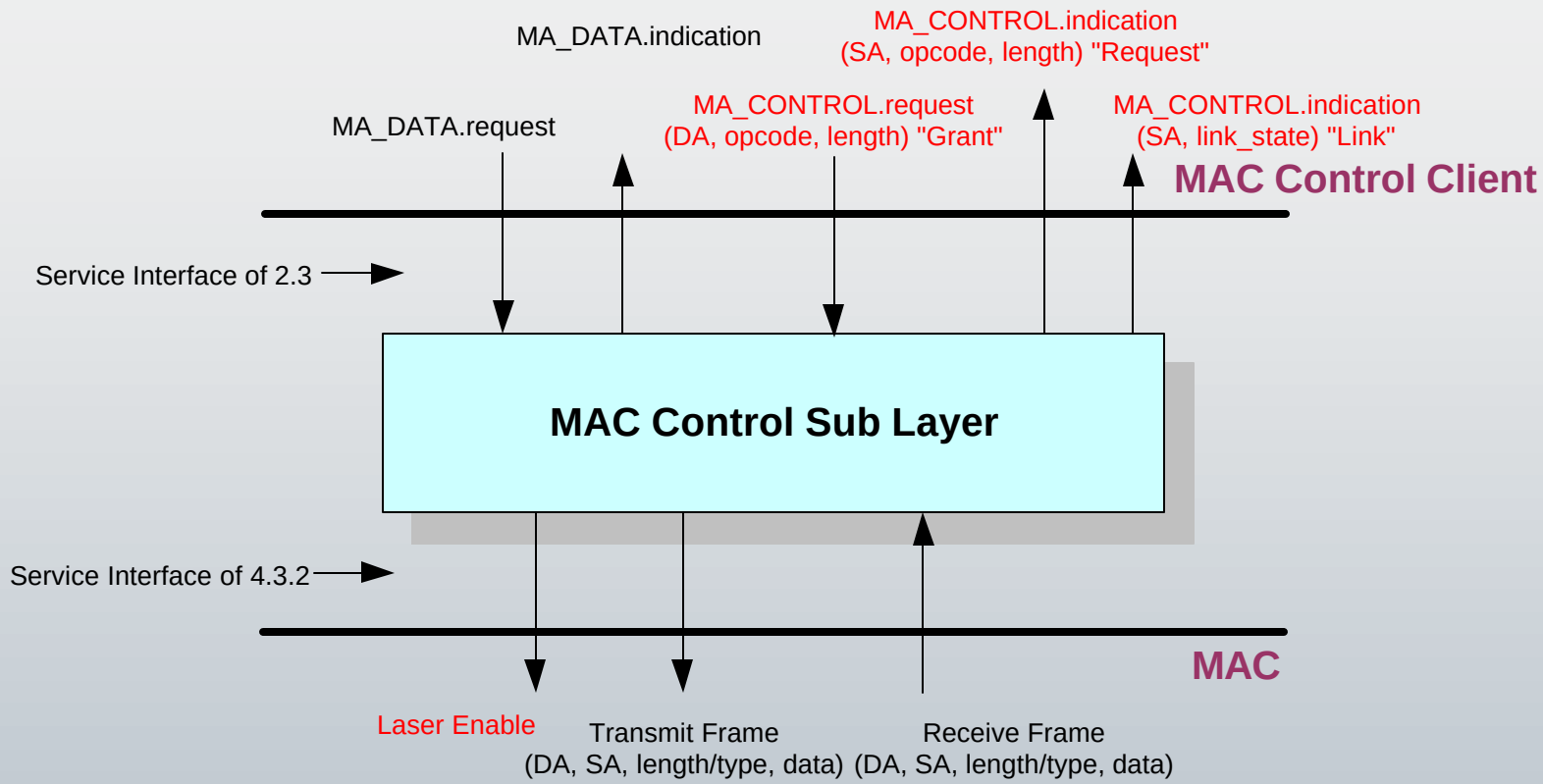
IEEE 802.3ah EFM – Austin, TX

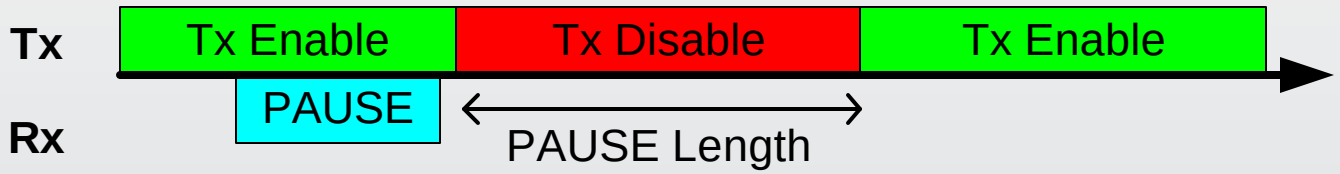
MAC Control



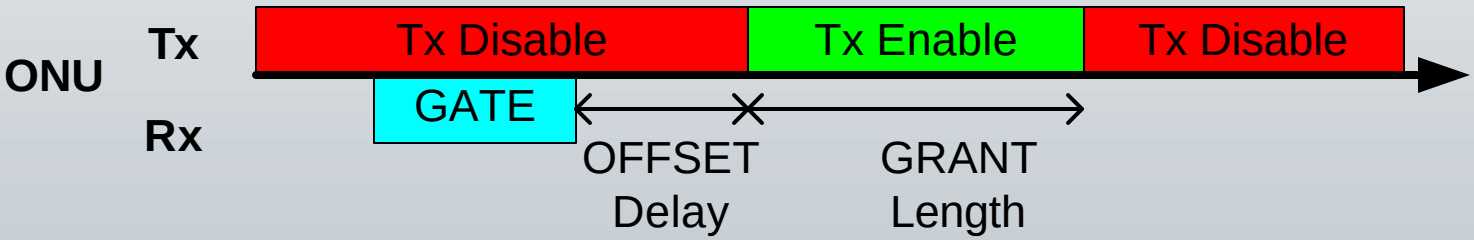
- ✓ MAC Control Client receives “requests” and generates “grants”
- ✓ All PON Timing in MAC Control Sublayer
- ✓ Link State is maintained for each ONU

PAUSE vs. GATE (Grant Transmit Enable)

PAUSE



GATE

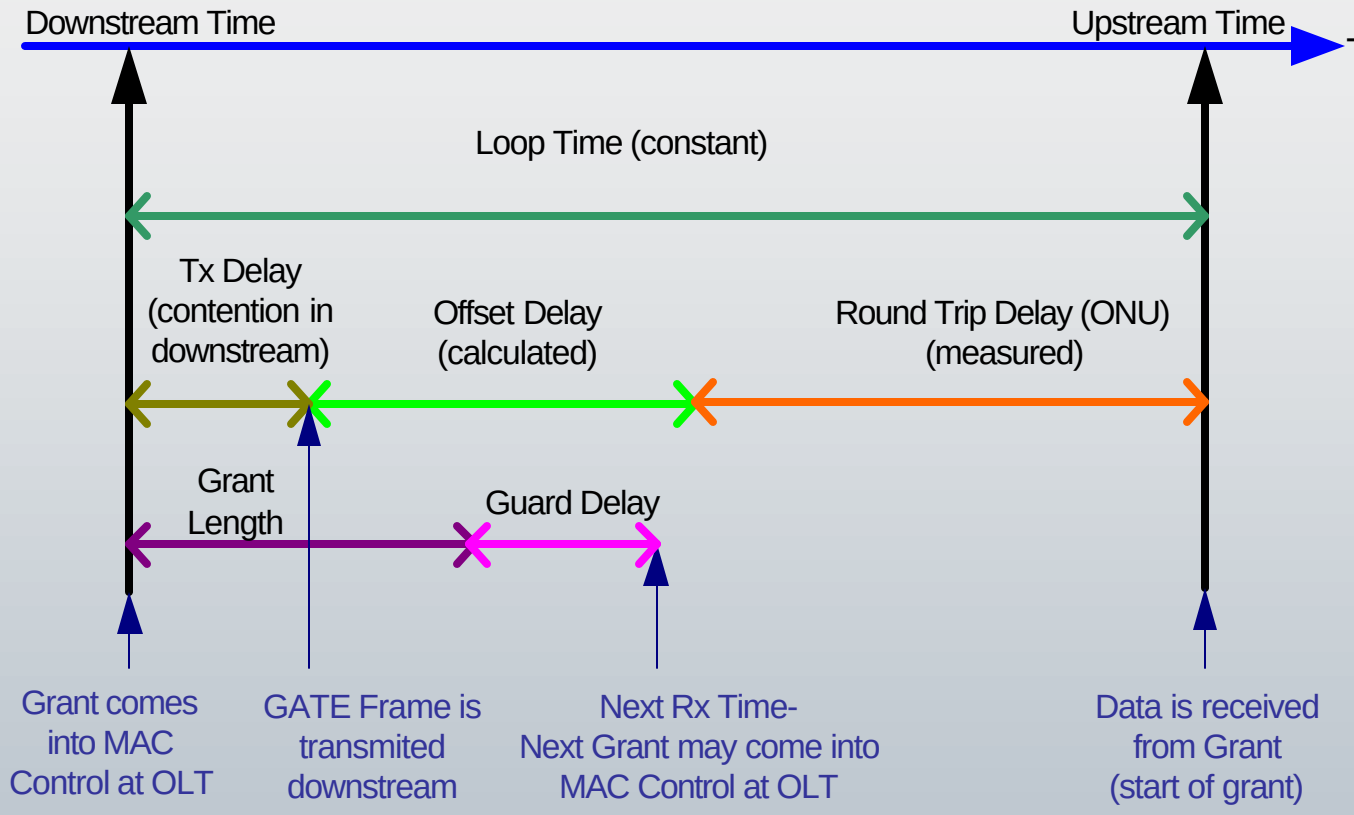


- ✓ PAUSE operates within MAC Control
- ✓ PAUSE Disables Transmit
- ✓ PAUSE contains a PAUSE Length

- ✓ GATE operates within MAC Control
- ✓ GATE Enables Transmit
- ✓ GATE contains an OFFSET Delay and a Grant Length

Relative Timing

Timing Reference



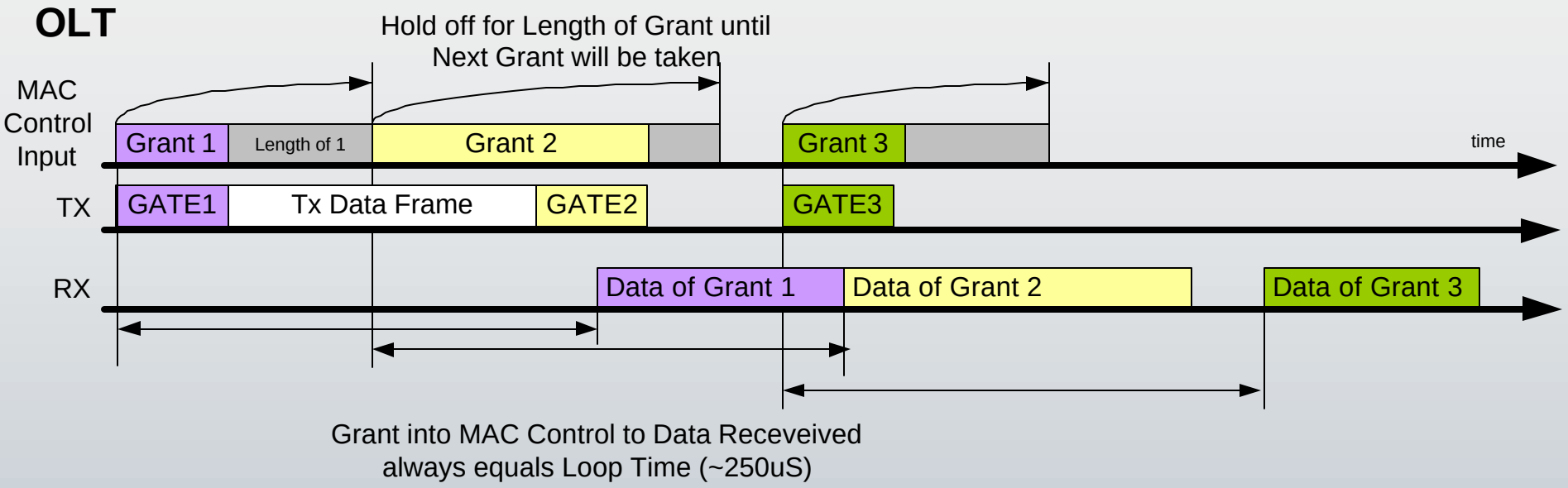
Downstream Time
+ Loop Time (constant)
= Upstream Time

Upstream Time
- Round Trip Delay
- Downstream Time
- Tx Delay
= Offset Delay

Upstream Time
+ Grant Length
+Guard Delay
= Next Rx Time

- ✓ ONU does not need common time with OLT
- ✓ Provides accurate upstream time

MAC Control Client - OLT



- ✓ MAC Control Client Passes Grant to MAC Control
- ✓ Data for Grant is received 1 loop time later
- ✓ MAC Control does not accept next grant from MAC Control Client until ready to prevent overlapping receive data

Offset Delay Jitter

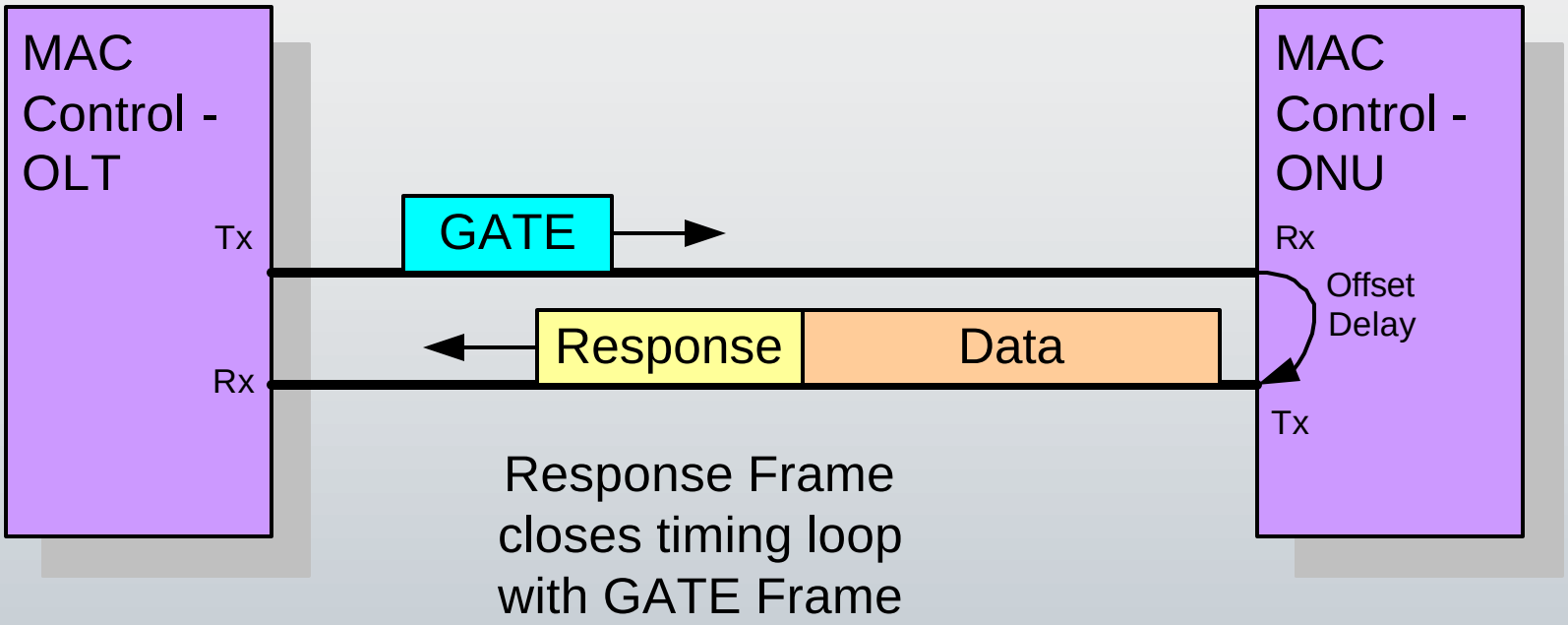
- ✓ The ONU may use the Receive clock for Offset Delay for the least jitter
  - Ideal since this is the same clock as the OLT
- ✓ The ONU may use another clock for Offset Delay
  - Jitter does not equal +/- PPM of two clocks with relative timing!
    - ?f results in ?t which is Ranged out

      +/-200ppm over 250us equals a **constant** 50nS
    - ?f/?t results in jitter on start of receive

      8° of phase jitter above 20Khz (100Mbit standard) results in less than 0.2 bit of jitter over 250us!
  - Change in Offset delay results in jitter
    - The maximum change in Offset delay is 1 Max Length frame

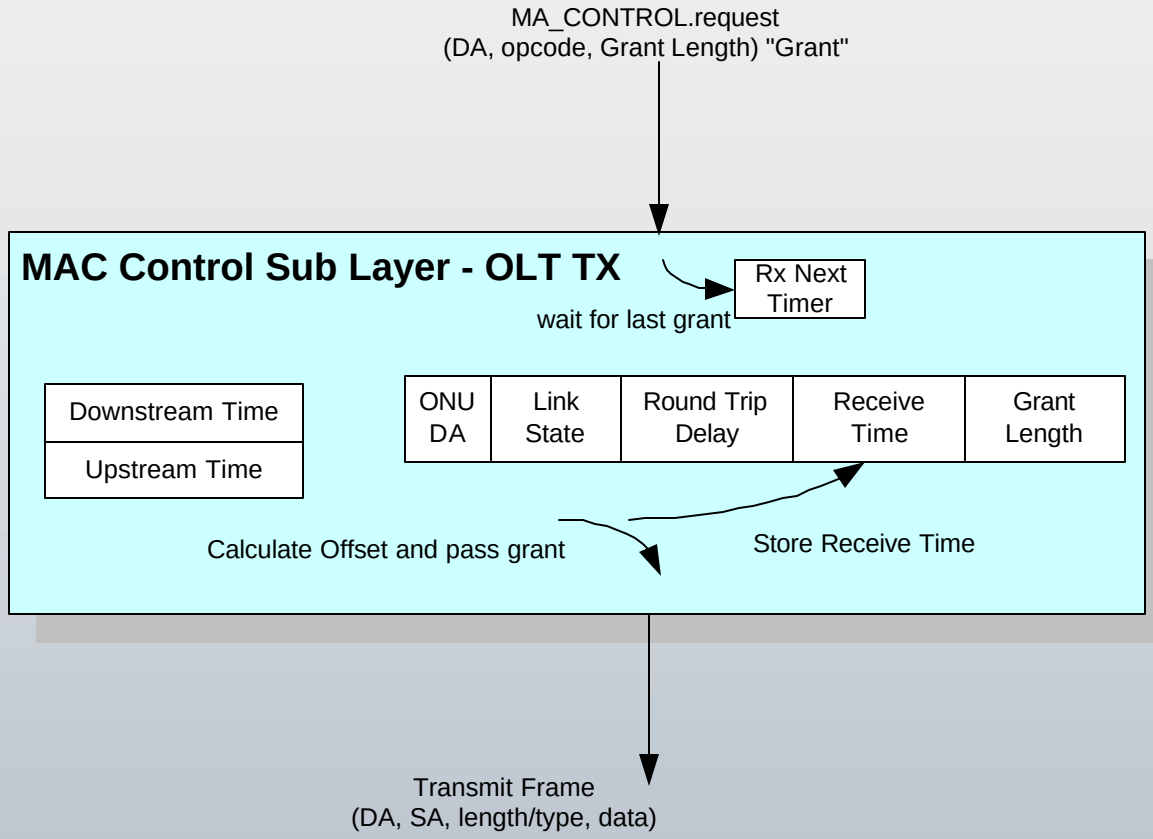
      +/-200ppm over 1522 byte frame is 2.5 bits
- ✓ Grant Length jitter is still dependent on +/-PPM of two clocks
  - Most significant source of guard time
  - Depends on maximum length of grants

Round Trip Timing



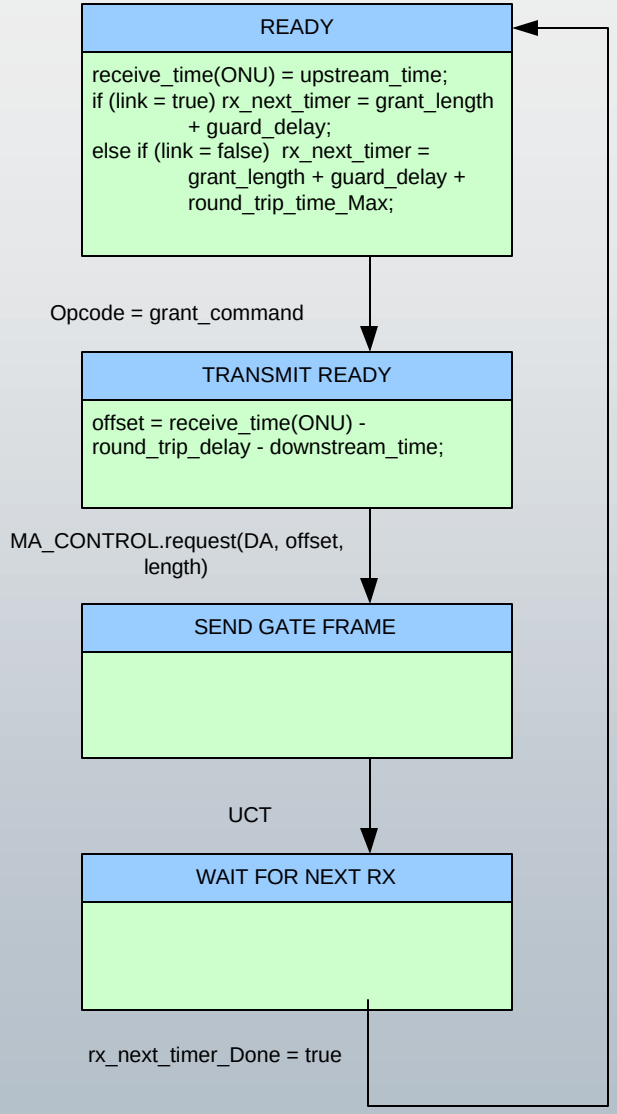
- ✓ ONU starts all Transmit opportunities with MAC Control Response Frame
- ✓ OLT measures Round trip delay from GATE to Response

OLT – TX overview



1. OLT gets Grant from MAC Control Client
2. OLT waits for Transmit opportunity
3. OLT Calculates Offset and sends MAC Control Frame with grant
4. OLT stores the Receive Time and Grant Length
5. OLT waits for Grant Length to prevent overlap

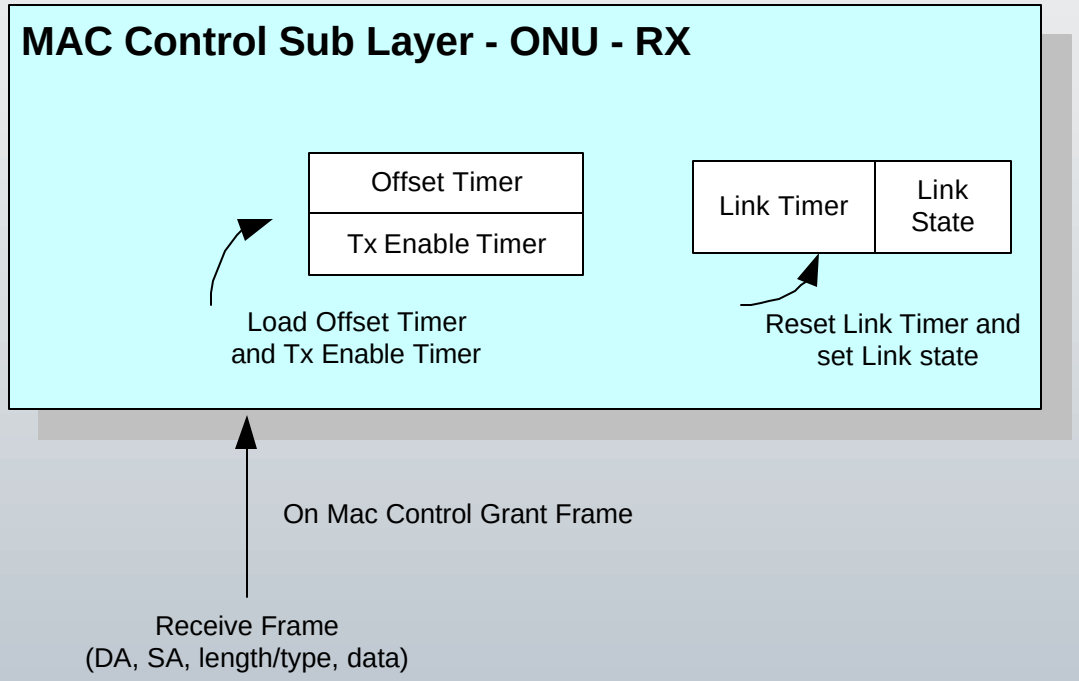
OLT- TX MAC Control State Machine



- ✓ Grants are received in the order in which they come from the MAC Client
- ✓ MAC Control does not accept another Grant from Client until previous completes

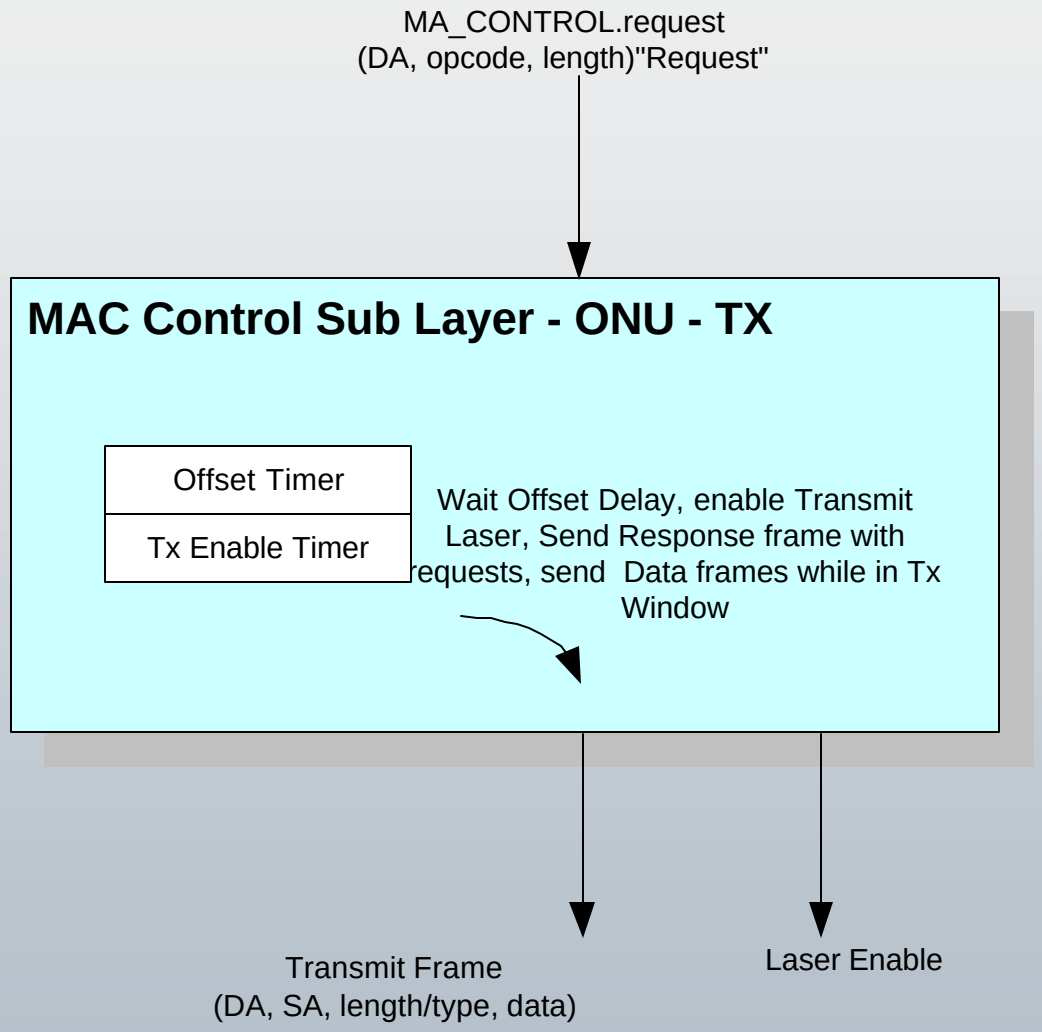
MAC Control - OLT-TX

ONU – RX - Overview



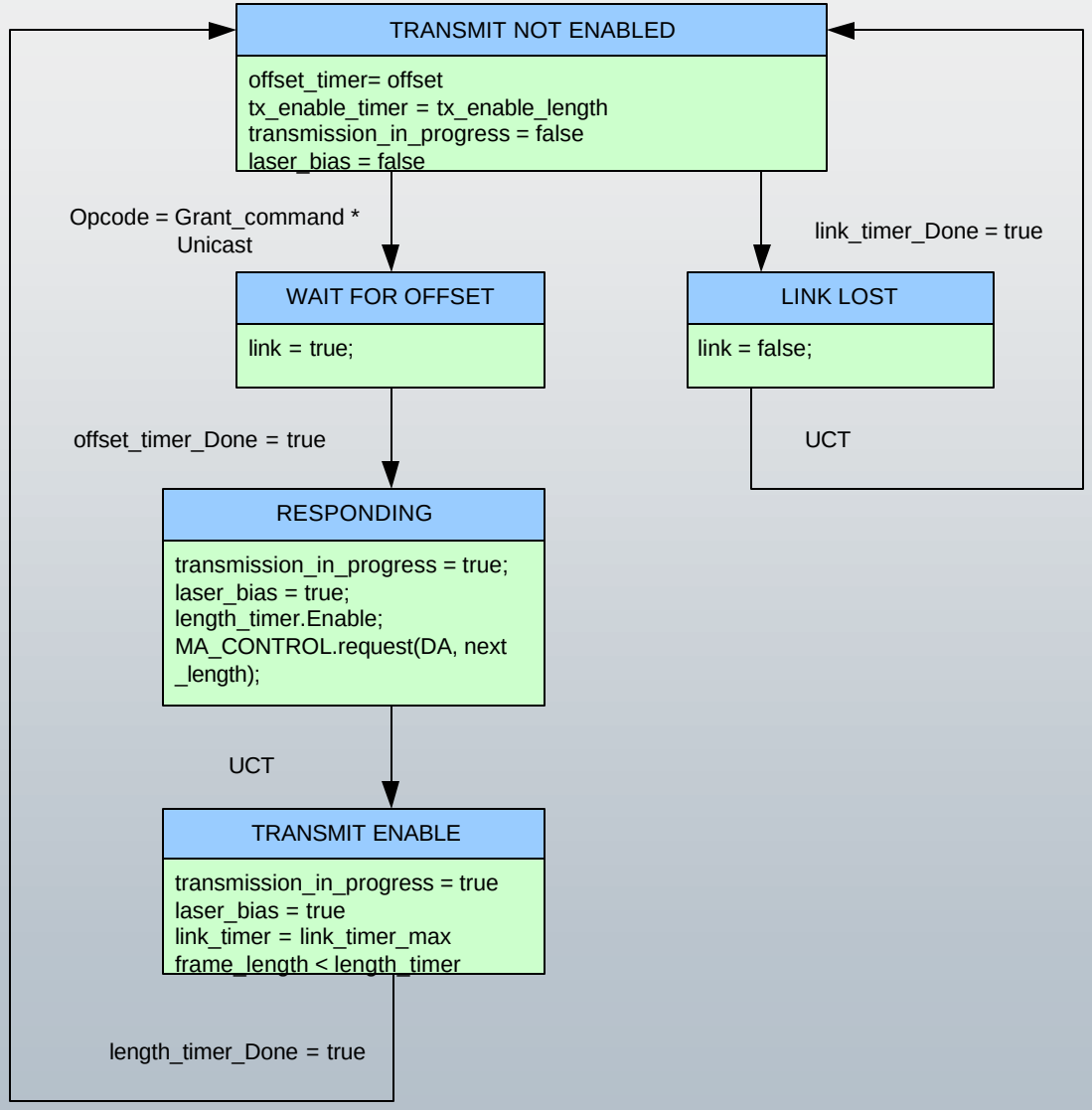
1. ONU Receives GATE Frame
2. ONU Loads Offset and Tx Enable Timers
3. ONU resets Link Timer

ONU – TX Overview



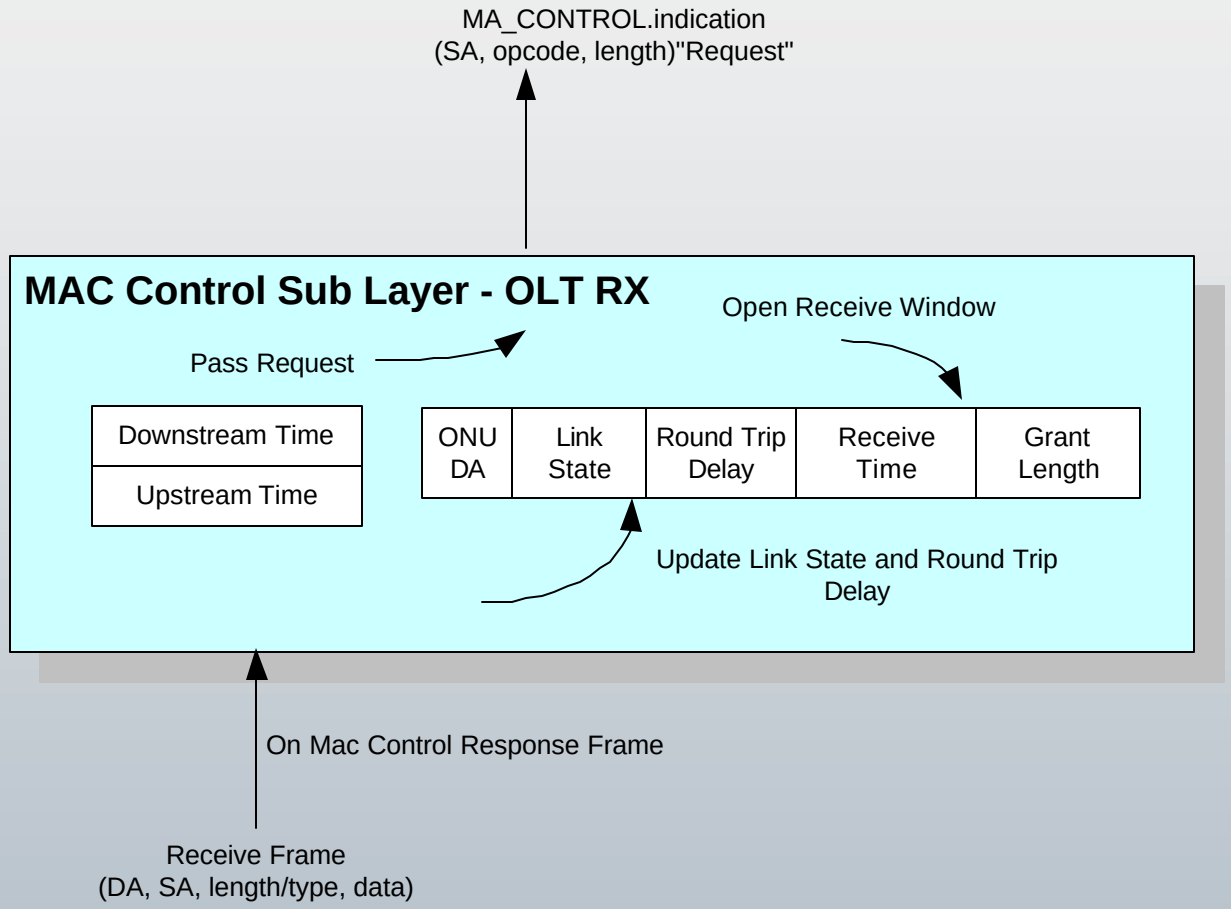
1. ONU waits Offset delay
2. ONU enables Laser
3. ONU sends MAC Control Response Frame with Requests
4. ONU passes data frames while in Tx Window
5. ONU disables Laser

ONU – State Machine



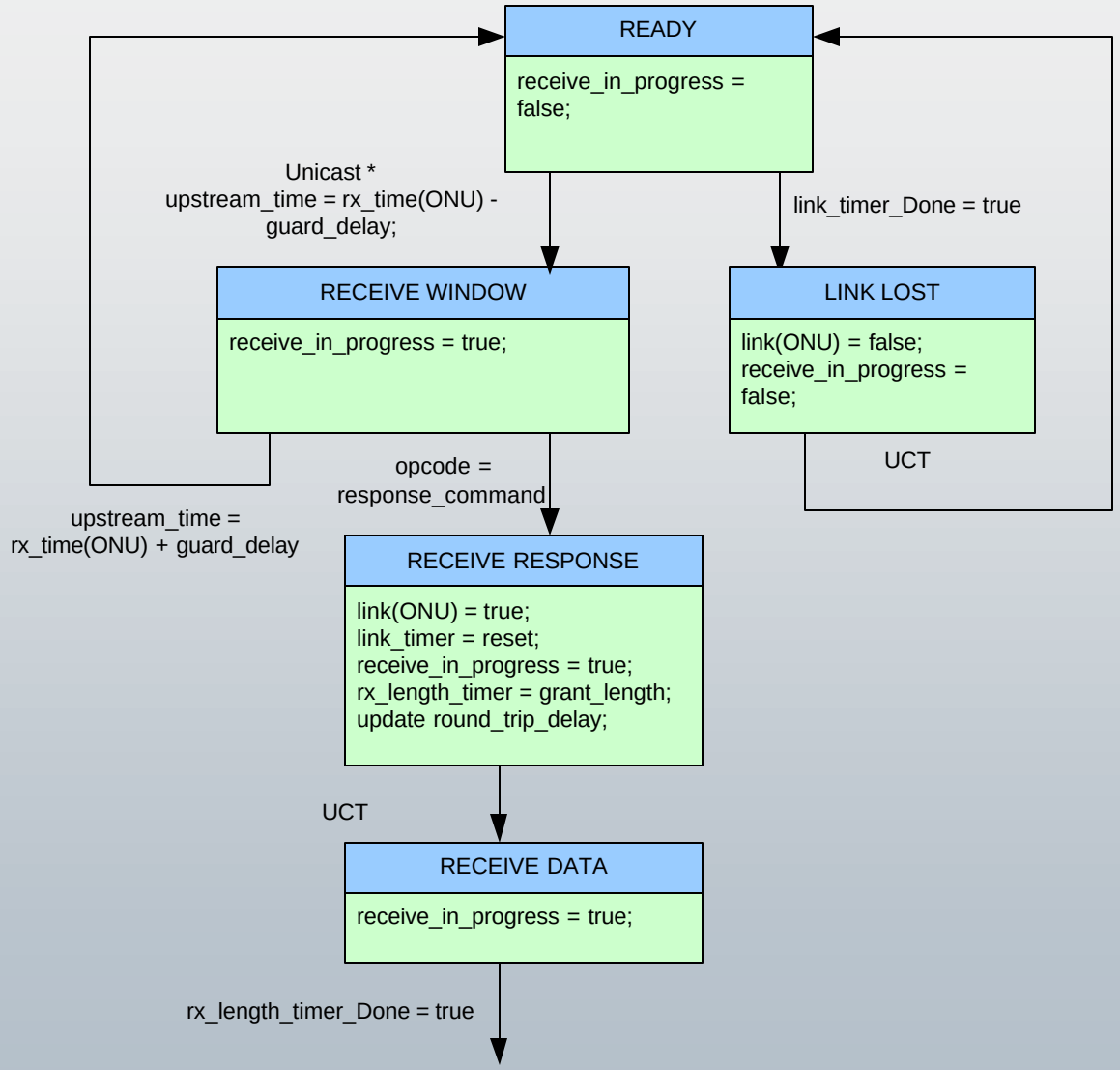
MAC Control - ONU

OLT – RX Overview



1. OLT Opens Receive Window at Receive Time
2. OLT Receives Response Frame
3. OLT resets Link Counter and updates Round Trip Delay
4. OLT passes any Requests in Response frame to MAC Control Client
5. OLT Continues to receive data frames for the Grant Length

OLT RX State Machine

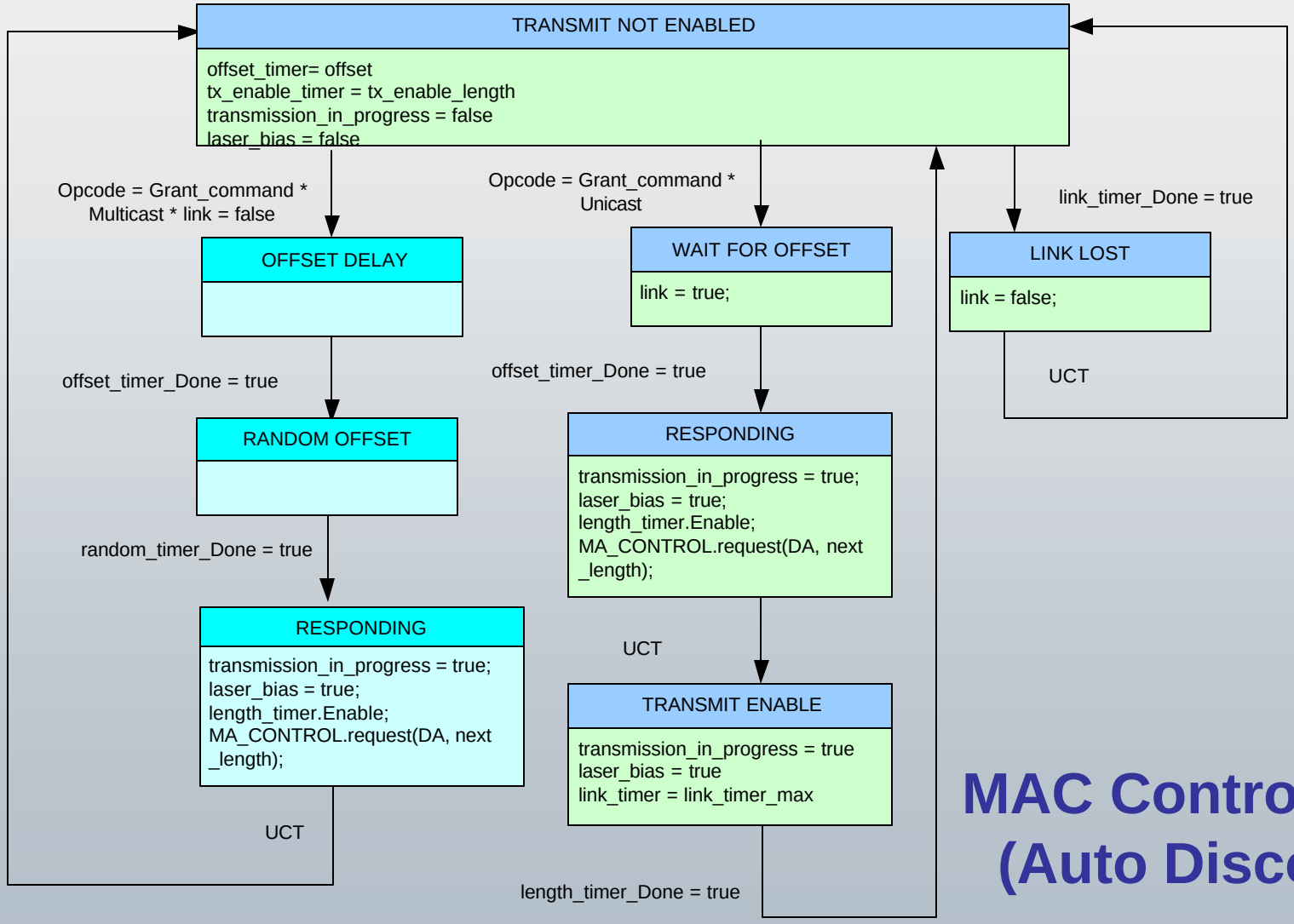


MAC Control - OLT RX

Summary

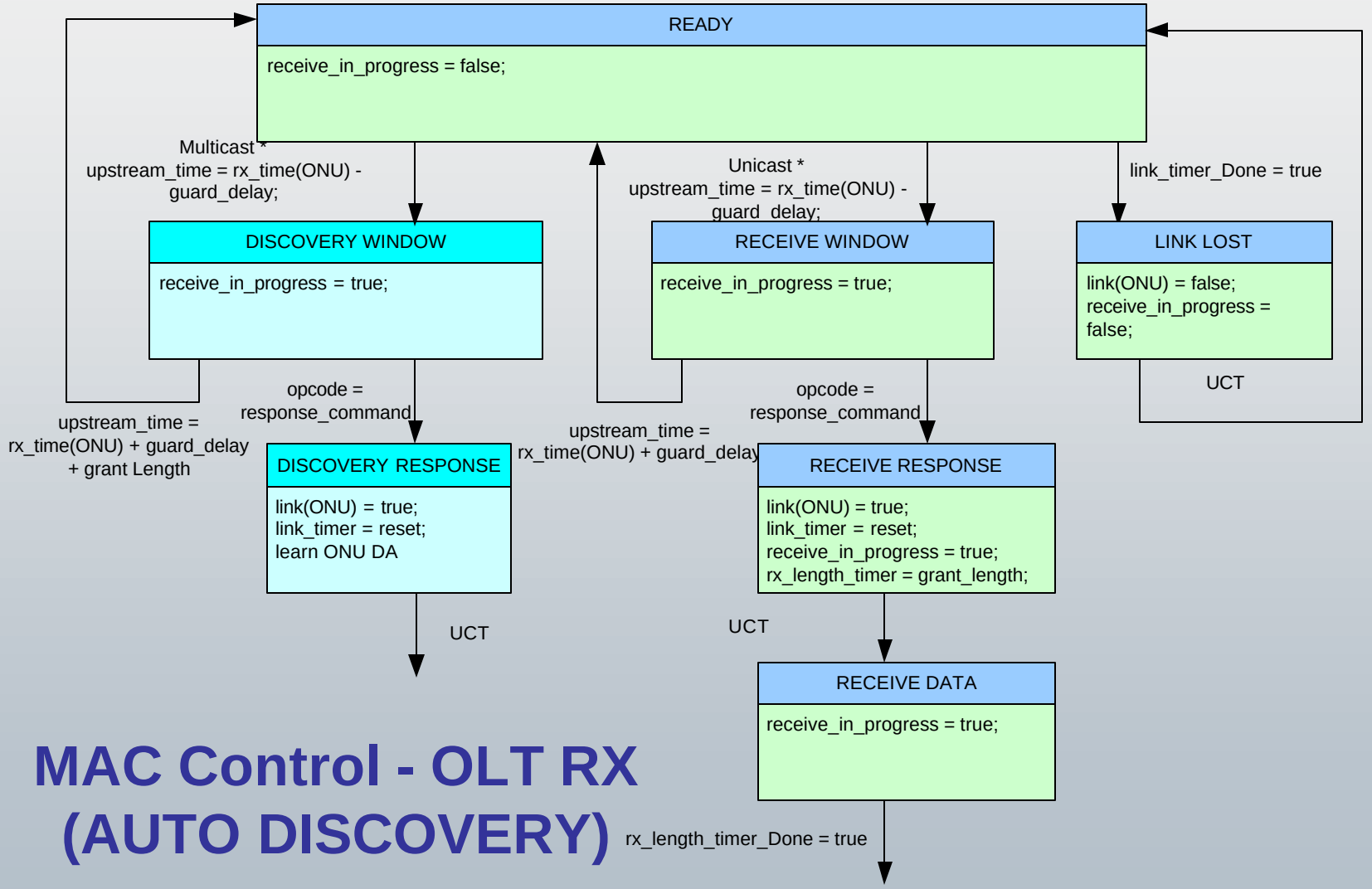
- ✓ GATE Frame works like PAUSE Frames
- ✓ MAC Control Client generates grants
- ✓ All PON Timing in MAC Control Layer
- ✓ Timing Reference and Delay Compensation in OLT
- ✓ All timing in ONU is relative
- ✓ No Synchronization
- ✓ No Periodic Framing
- ✓ No Distributed States (delay values in ONU)
- ✓ MAC Control Maintains “Link” with each ONU
- ✓ Fits Ethernet model!

Annex 1 - ONU State Machine with Auto Discovery



MAC Control - ONU (Auto Discovery)

Annex 2 – OLT RX State Machine with Auto Discovery



MAC Control - OLT RX (AUTO DISCOVERY)