The challenges of supporting 25G/10G operation

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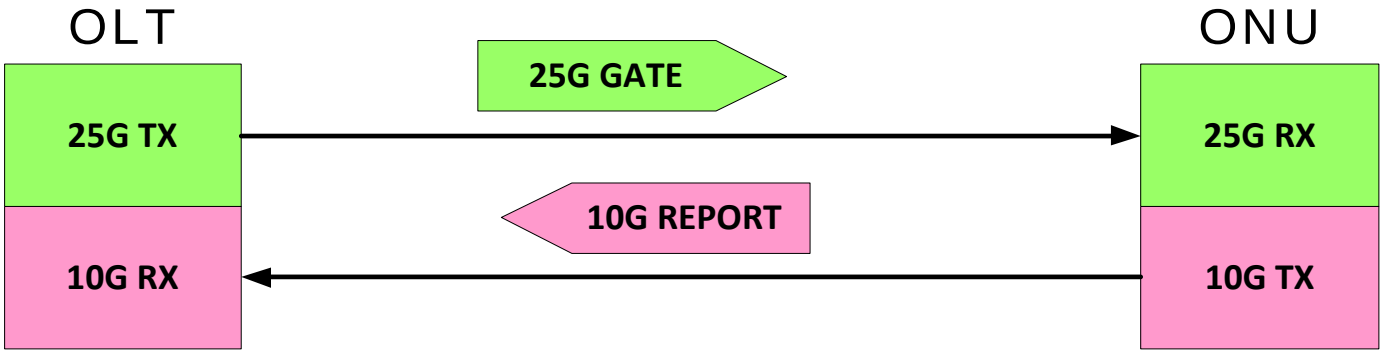
.3av and .3ca MPCP differences

- It is hard for the OLT scheduler to combine .3av and .3ca data formats in the same time domain
  - Different burst overhead
  - Different FEC
  - Different line coding
  - Different units (TQ vs EQ)

- MPCP Clock differences
  - .3av clock base (all values in units of TQ)
    - GATE Timestamp = OLT local_time
    - ONU local_time = OLT local_time - DS_delay
    - OLT receive_time = grant_start_time + RTT
  - .3ca clock base (all values in units of EQ)
    - GATE Timestamp = OLT local_time + RTT
    - ONU local_time = OLT local_time + US_delay
    - OLT receive_time = grant_start_time

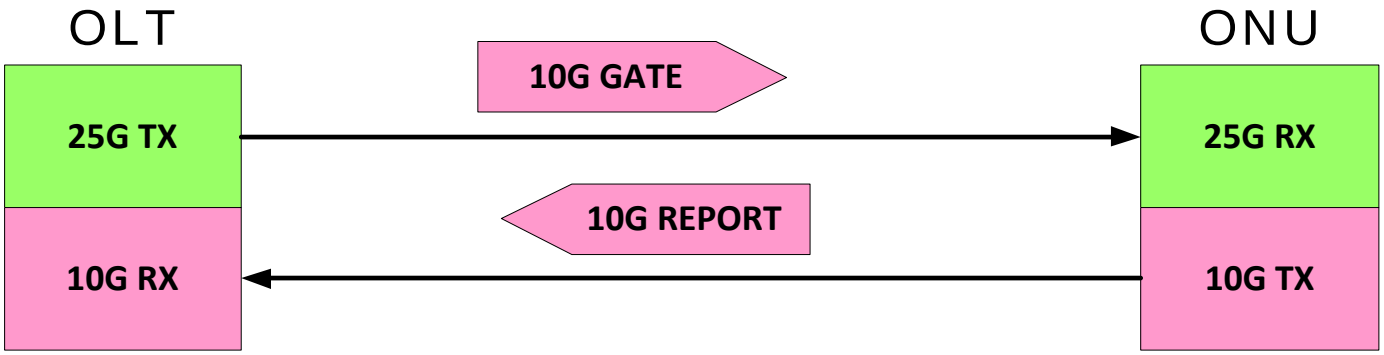
MPCP Issues

- If we use 25G GATEs and 10G REPORTs
  - ONU can never obtain the absolute value of MPCP time in TQ to use in REPORT timestamp.
  - Each upstream LLID needs its own MAC address to use in REPORT SA, but downstream, there is only one MAC address per PLID.



MPCP Issues

- If we use 10G GATEs and 10G REPORTs
  - ONU locked on 25G downstream clock, but timestamps arrive in TQs.
  - In 25G architecture, only PLID has MPCP function and can process GATEs. But in 10G, GATEs are addressed to individual LLIDs. How to reconcile?



Problem with 25G/10G option

- **A lot of extra standards work**
  - Control and Data paths need to be completely redesigned to support 25G/10G operation.
    - Need new MPCP and MPRS state diagrams.
    - Much more work than what we had to do to design 25G MPCP from scratch.
  - Also OAM needs to be redesigned.
    - In 25G downstream, there is one OAM connection per ONU (PLID). In 10G upstream, there is one OAM connection per each LLID

- **Implementation will be very hard and costly**

Decision Matrix

- Three decisions affect technical feasibility and cost of asymmetric option:
  - **Upstream data format:**
    - EQ-based or
    - TQ-based?
  - **Upstream line rate:**
    - 12.890625 GBd or
    - 10.3125 GBd?
  - **Upstream wavelength:**
    - 1260-1280 nm or
    - 20 nm somewhere else or
    - 3-4 nm somewhere else?

- 12 possible configurations

Upstream options

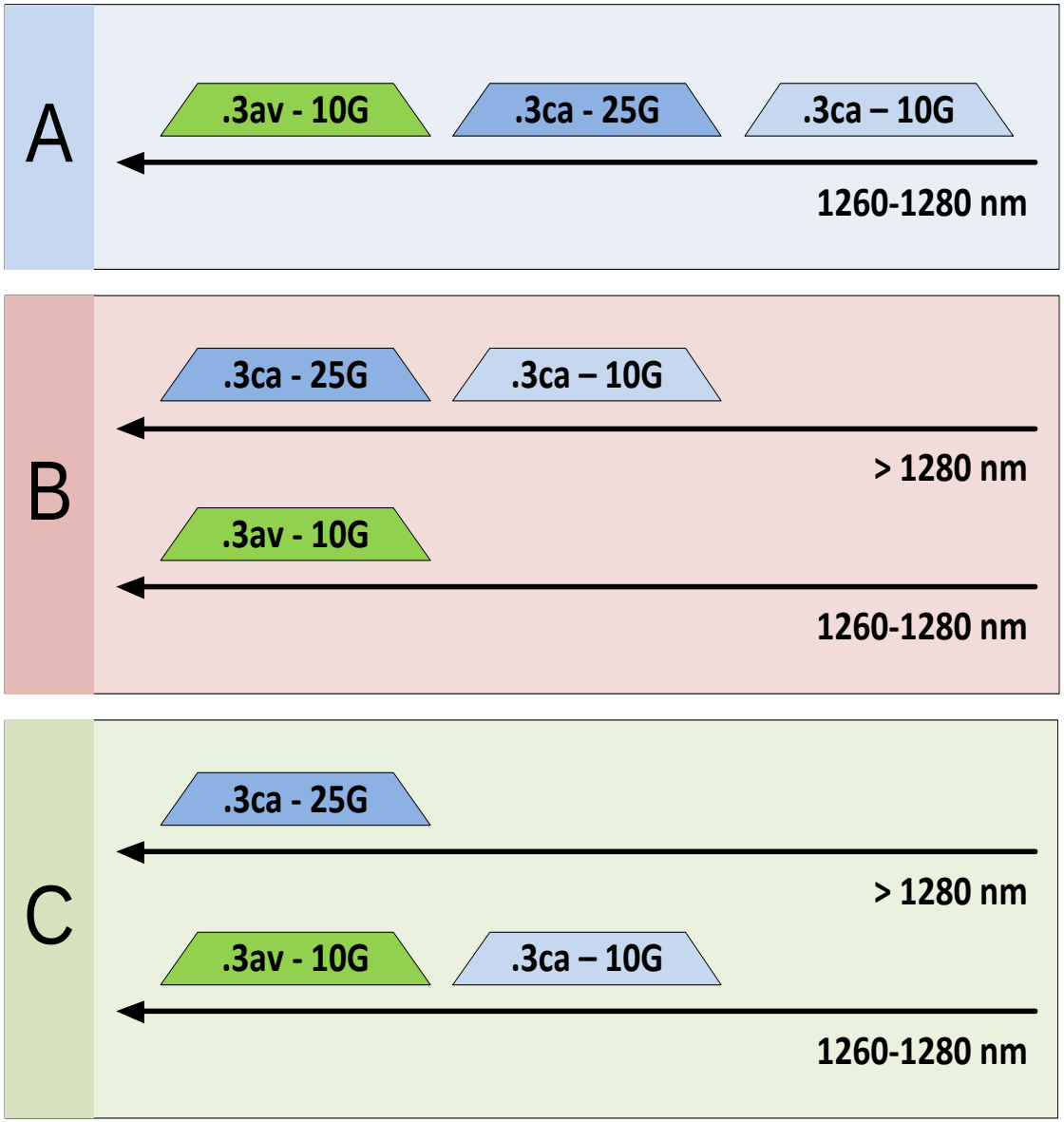
		A	B	C	D	E	F	G	H	I	J	K	L
	US Line Rate	10G	10G	10G	10G	10G	10G	12.5G	12.5G	12.5G	12.5G	12.5G	12.5G
	US λ	1270 ±10nm	1270 ±10nm	X ±10nm	X ±10nm	X ±2nm	X ±2nm	1270 ±10nm	1270 ±10nm	X ±10nm	X ±10nm	X ±2nm	X ±2nm
	US Data Format	.3av	.3ca	.3av	.3ca	.3av	.3ca	.3av	.3ca	.3av	.3ca	.3av	.3ca
Component	ONU SoC	Hard	Medium	Hard	Medium	Hard	Medium	Hard	Easier	Hard	Easier	Hard	Easier
	10G OLT Line Card	Replace	Replace	Keep	Keep	Keep	Keep	Replace	Replace	Keep	Keep	Keep	Keep
	OLT SoC	Hard	Hard	Medium	Easier	Medium	Easier	Hard	Hard	Medium	Easier	Medium	Easier
	ONU Laser	Reuse 10G	Reuse 10G	New un-cooled	New un-cooled	New cooled	New cooled	New un-cooled	New un-cooled	New un-cooled	New un-cooled	New cooled	New cooled
	LD & TIA	Reuse 10G	Reuse 10G	Reuse 10G	Reuse 10G	Reuse 10G	Reuse 10G	New parts	New parts	New parts	New parts	New parts	New parts
	APD	Reuse 10G	Reuse 10G	Reuse 10G	Reuse 10G	Reuse 10G	Reuse 10G	New parts	New parts	New parts	New parts	New parts	New parts

Upstream Options

- No clear winner
- From the ONU SoC point of view:
  - Options J and L are favorites
  - Options D and F may be OK
- From optics point of view
  - Options A and B are favorites
  - Options C, D, [G-J] may be OK.
- From the system point of view
  - Only options D and J are candidates
  - Option D may be more preferable overall

- **Proposal**: Agree on upstream 10G transmission format being the same as 25G upstream.

Upstream Wavelengths Options



A: Common Upstream

- Dual-rate OLT bCDR
- Dual-format OLT SerDes
- Complicated scheduler

B: Group by Data Format

- Dual-rate OLT bCDR
- Simple OLT SerDes
- 25G-EPON can coexist with XGS-PON
- .3av line cards can remain in use

C: Group by Line Rate

- Simple OLT bCDR
- Dual-format OLT SerDes
- Complicated scheduler

Proposal

- Asymmetric 25G/10G-ONU should be defined as following:
  - Line Coding, Envelope Format, and FEC identical to 25G upstream
  - All sub-layer interfaces are the same as in 25G case
  - MPCP local time is based on the RX EQ clock
    - Upstream transmission starts based on MPCP EQ clock
    - US timestamps represent MPCP EQ clock (no conversion necessary)
  - TX clock runs at 1÷2.5 rate
    - In upstream, EQ takes 6.4 ns
  - No changes to MPRS state diagrams, except the definition of clocks
    - In the ONU: IN_CLK and TX_CLK
    - In the OLT: RX_CLK and OUT_CLK
  - For the identical GATEs sent to 25/25G-ONU and 25G/10G-ONU, the OLT should expect
    - The same number of bytes (EQs) from both ONUs
    - Transmission from 25/10-ONU taking 2.5x as long

Thank You