10GEPON PCS Error Handling

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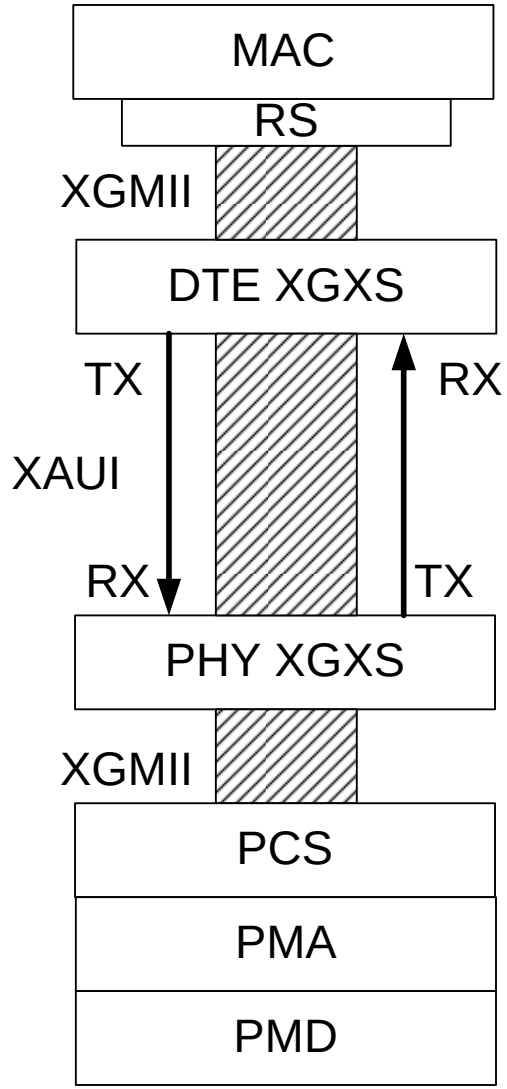
Overview

- Errors within 10GEPON system
- Proposal for increased error handling
- Conclusion

Errors within existing 10G system

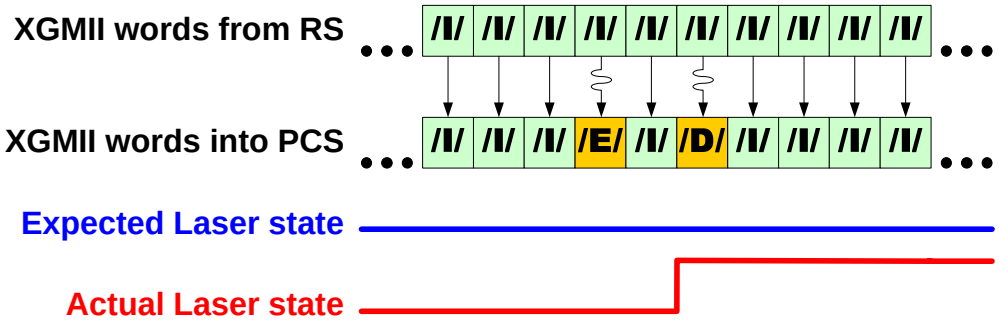
- Traffic can be sent across XAUI, which is electrical interface up to 50cm.
- XAUI maintains BER of 10^{-12}, so it is possible for errors to occur.
- Need to examine effect of receiving errors in PHY XGXS on Data Detector.



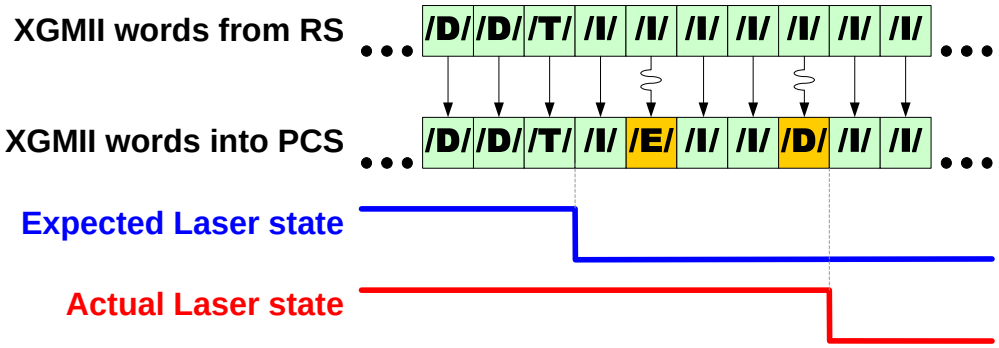
Problem Statement

- Without error protection, due to XAUI errors, an ONU may turn laser ON/OFF at wrong times.
  - Not a problem if laser is turned on late or turned off early.
  - Interference between ONUs may occur if laser is turned on early or turned off late.
- ONU PCS needs to be able to tolerate errors generated over XAUI link.
  - DO NOT want laser to be on out of slot

Turning Laser On Outside the Slot



Keeping Laser On Past the Slot



Proposed error handling for 10GEPON

- Add more error protection at top of PCS to further limit the possible transitions between consecutive XGMII codes
  - Get new txd<71:0> from XGMII
  - Verify transition from previous txd<71:36> to current txd<35:0> and replace txd<35:0> if necessary
  - Verify transition from current/new txd<35:0> to txd<71:36> and replace txd<71:35> if necessary
  - Replace “bad” combinations with error codes
  - Good combinations are left alone
  - Prevent unwanted PCS transitions prior to the encoder
- XGMII codes are checked in same state machine as IDLE deletion / start alignment

XGMII word classification

T_WORD_TYPE = {C, S, T, D, E}

This function classifies each 36-bit XGMII word as belonging to one of the five types depending on its contents.

Values:

C; The word contains one of the following:

- a) four valid control characters other than Sequence, Start, Terminate and Error;
- b) one valid Sequence ordered_set

S; The word contains a Start character in its first lane and Data characters in the remaining three lanes.

T; The word contains a Terminate in one of its characters, all characters before the Terminate are Data characters, all characters following the Terminate are valid control characters other than Sequence, Start, and Terminate.

D; The word contains four data characters.

E; The word does not meet the criteria for any other value.

Proposed ValidTransition function

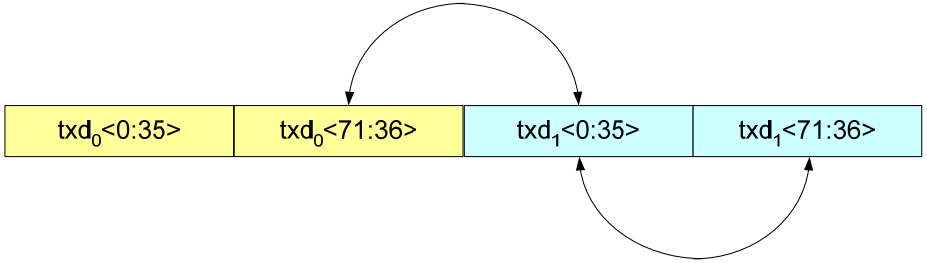
Word A	Word B	Return Value	New Word B
E	E	TRUE	E
E	C	TRUE	C
E	S	TRUE	S
C	E	TRUE	E
C	C	TRUE	C
C	S	TRUE	S
S	E	TRUE	E
S	D	TRUE	D
D	E	TRUE	E
D	D	TRUE	D
D	T	TRUE	T
T	E	TRUE	E
T	C	TRUE	C

Word A	Word B	Return Value	New Word B
E	D	FALSE	E
E	T	FALSE	E
C	D	FALSE	E
C	T	FALSE	E
S	C	FALSE	E
S	S	FALSE	E
S	T	FALSE	E
D	C	FALSE	E
D	S	FALSE	E
T	S	FALSE	E
T	D	FALSE	E
T	T	FALSE	E

XGMII Codes

C = Control
E = Error
D = Data
S = Start
T = Terminate

Step 1. Compare these two words.
Change second word if necessary.



Step 2. Compare these two words.
Change second word if necessary.

Conclusion

- 10GEPON PCS needs to be able to tolerate errors generated over XAUI link.
  - Do NOT want to turn laser on out of slot
  - Do NOT want to keep laser turned on after slot ends
  - Do want to propagate certain errors or reserved codes across the fiber (during a valid slot)

- Additional error protection can be added to PCS prior to encoding that greatly reduces the chance that laser on/off control is improperly handled.