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LOS Reporting and XGXS Signal Detect

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Hilton Head, SC

Agenda

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- **How we got here**
- **Part 1: Loss of Signal reporting from PMA up through XGXS**
- **Part 2: XGXS Signal Detect**
- **Appendix**
  - **Signal Detect Overview**
  - **Top 10 Ways to Fool an Analog Signal Detect**

Part 1: Loss of Light Reporting

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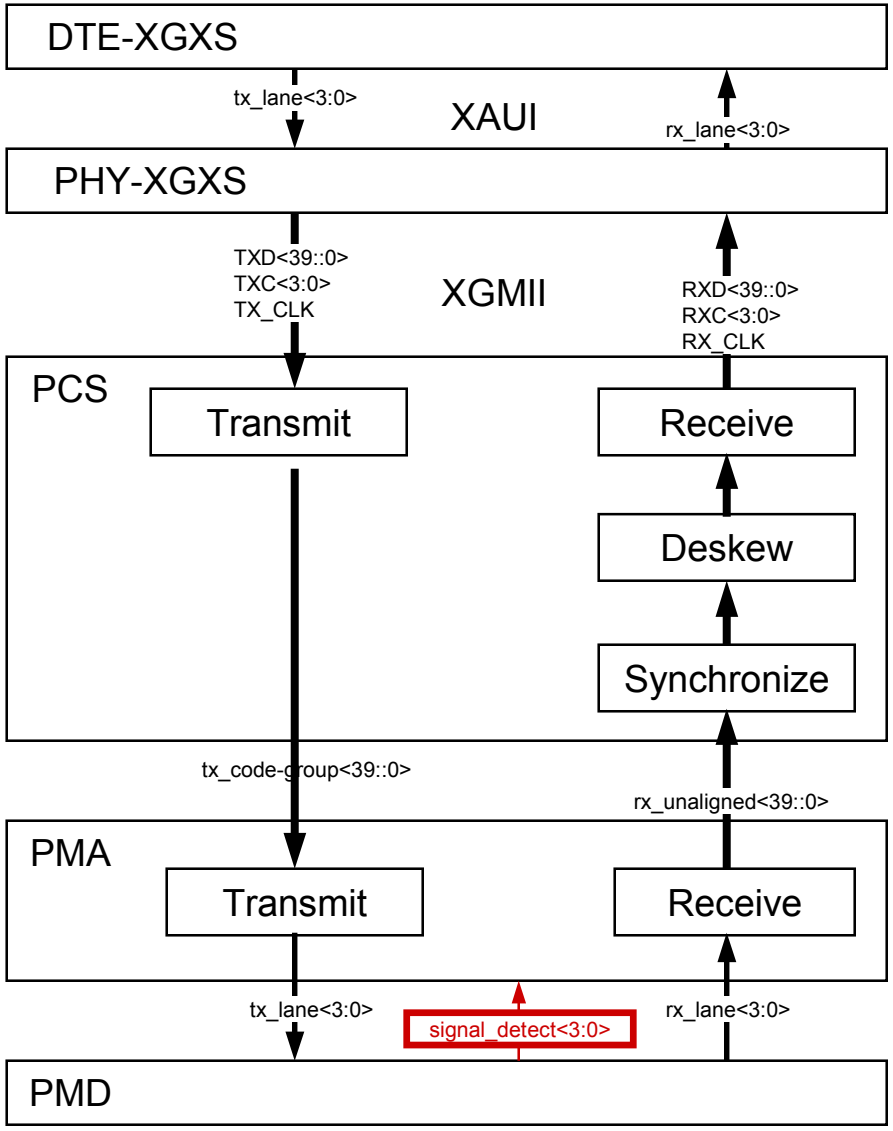

2. **Editor's solution solved a different problem: Detecting a fault on XGXS itself!**

1. **Original issue: how to communicate fault detected by the optics across XGXS**

Loss of Light Reporting – the existing method

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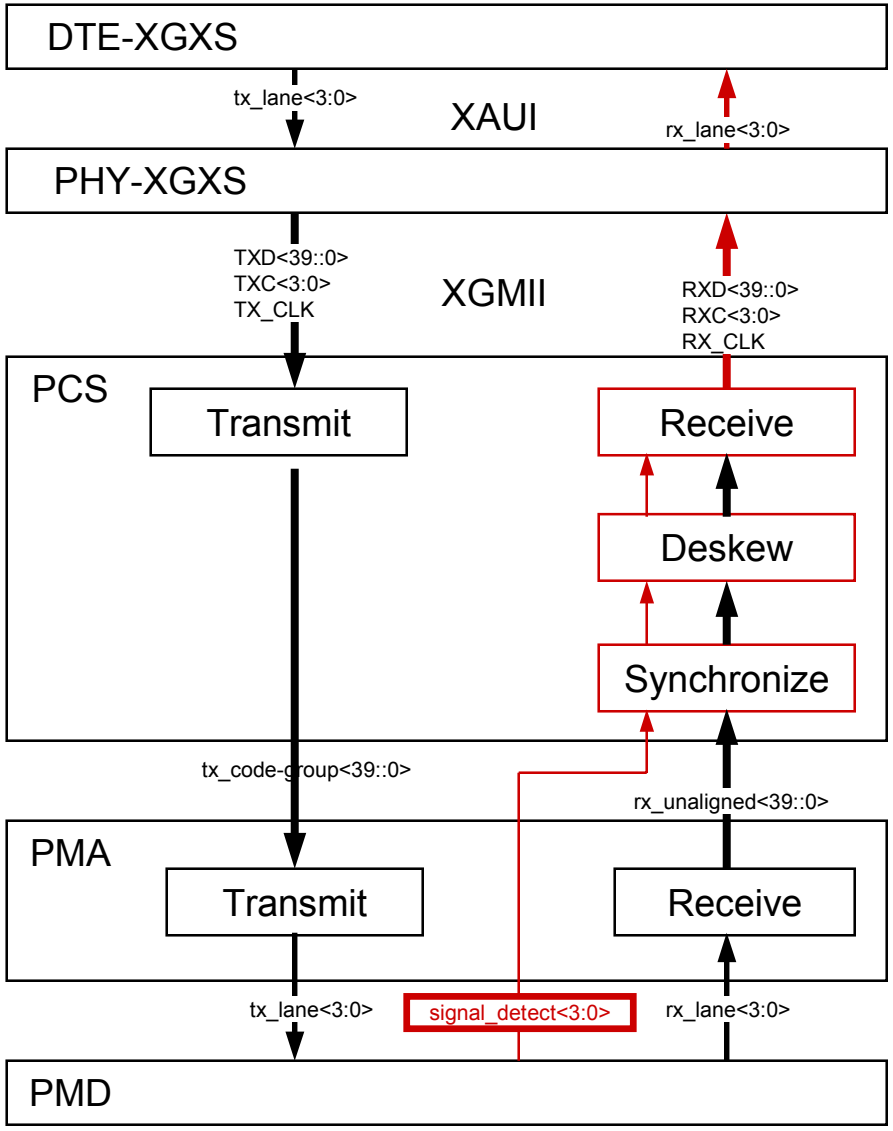

- **Fault Signalling is Inband on XGXS**
- **Receive process generates LF messages**
- **Sync process jumps to Loss of Sync state on signal detect change**
- **PMD (optics) indicates loss of light via signal_detect<3:0. Variables**
- **Implementation of PMD service I/F not specified, but fault signalling clearly out of band here**

One Implementation of 10G Base-X

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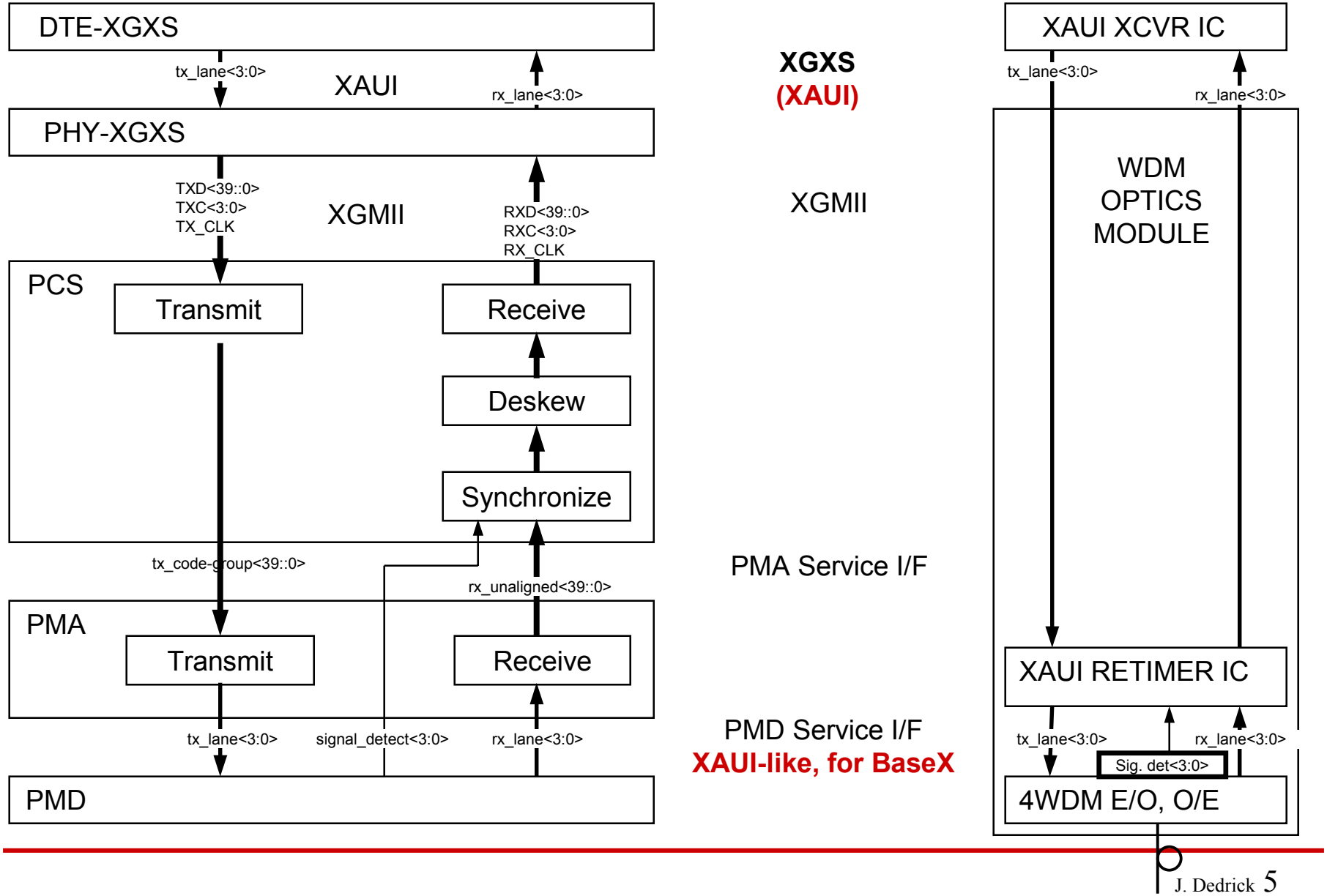

Loss of Light Reporting for one Implementation of 10G Base-X

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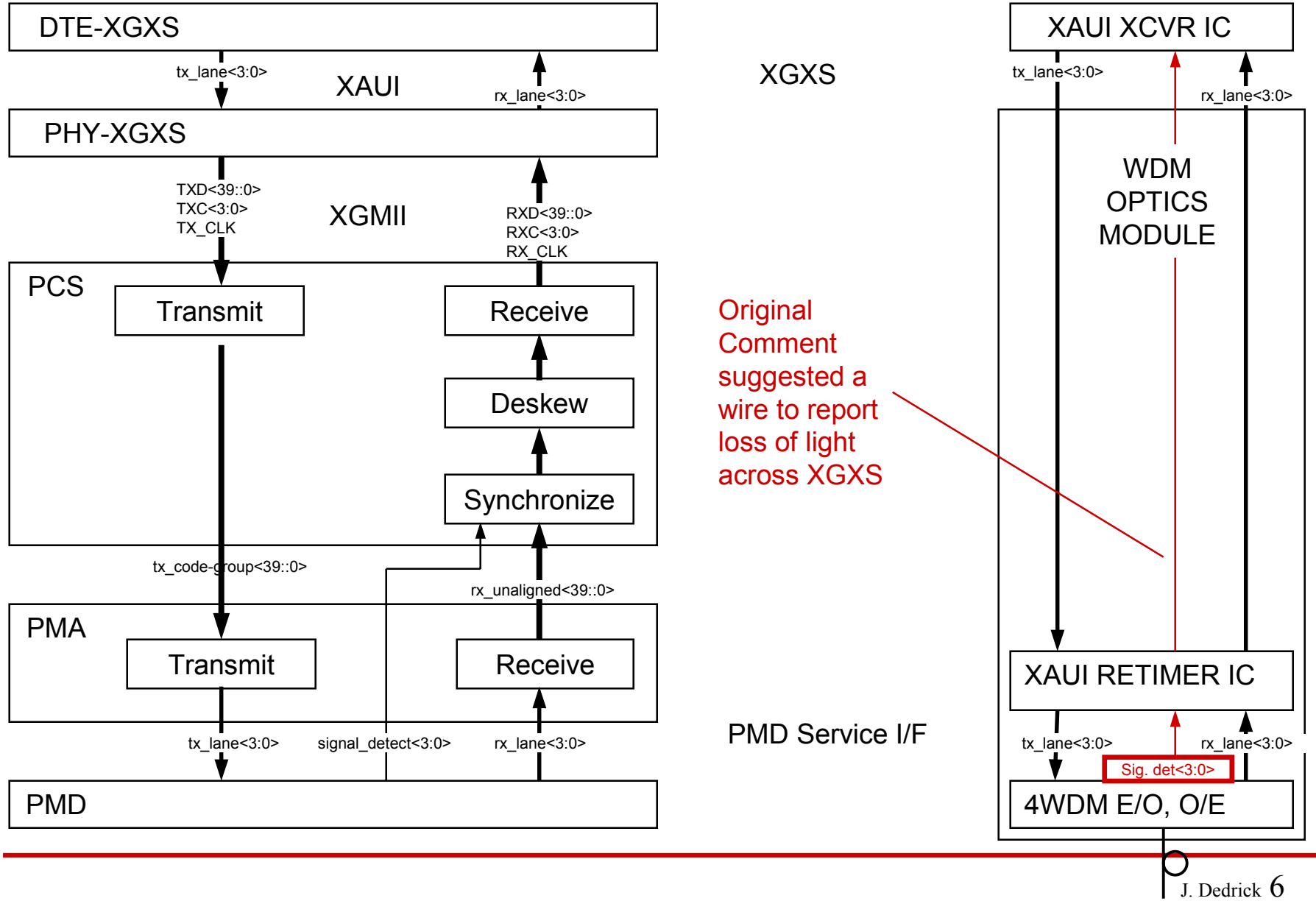

Original Comment suggested a wire to report loss of light across XGXS

Where to go In-band?

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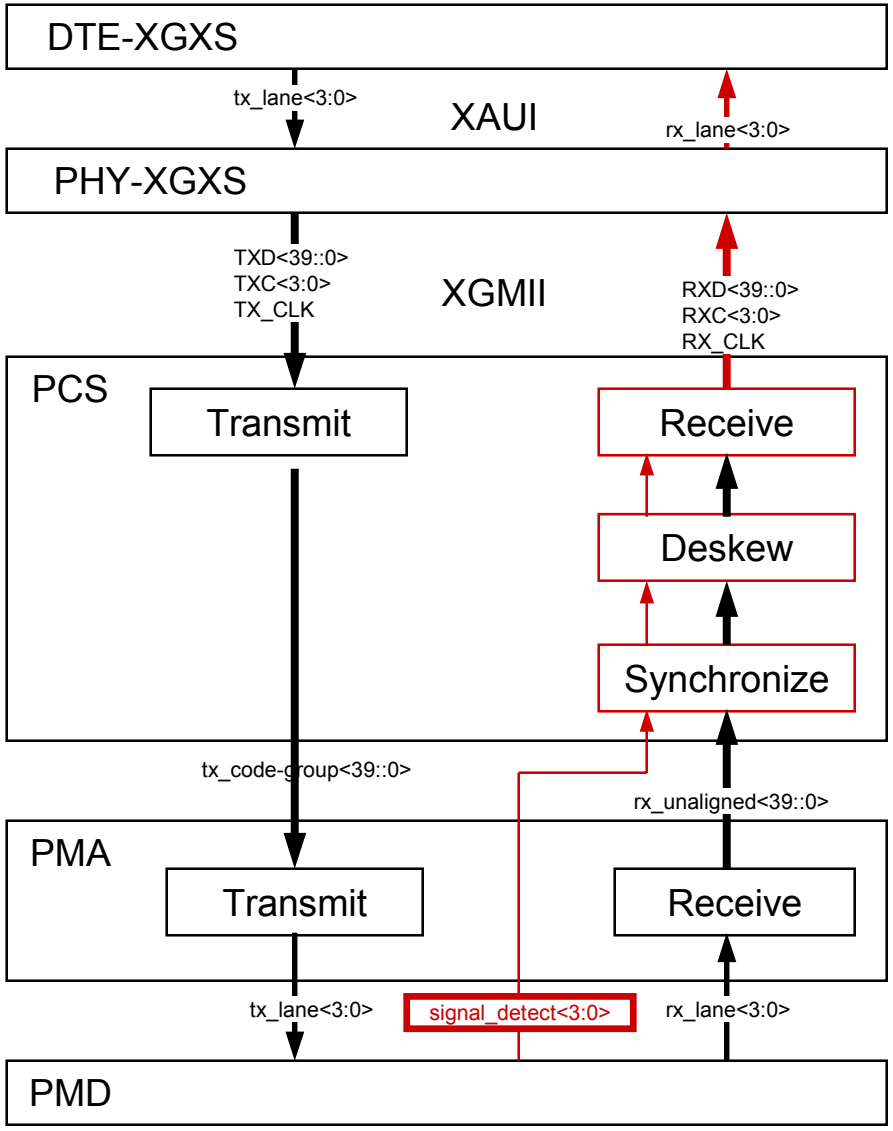
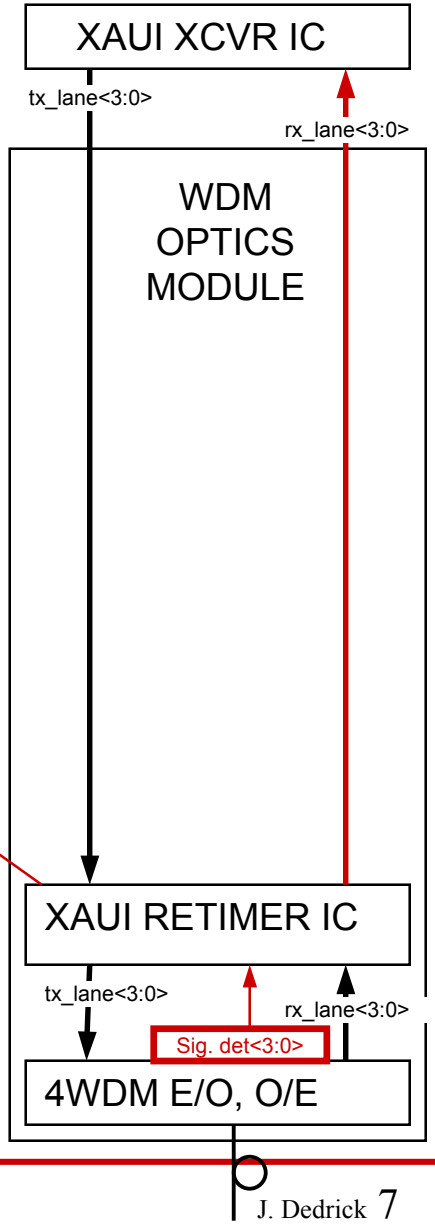


Fault Signalling is Inband on XGXS

XGXS fault signaling should be inband for 10GBase-X, just like all other phy's.

Obvious (only) place to encode LF message

Fault Signalling is Out of Band on PMD Service I/F



Summary -- LOS Reporting

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- **LOS Reporting at PMA:**
  - **PMD or PMA interfaces are abstract – we don't define how signal detect (or data) are communicated from PMD to PMA or PMA upward**
- **LOS Reporting up through XGXS**
  - **Interfaces are fully defined – including error reporting**
  - **This is part of what Local Fault is for**
- **Issue is where to go in-band.**
  - **LX4 should be done the same as all other phy's.**

Part 2: -- XGXS signal detect

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- **This has never been a requirement**
  - **Other chip to chip interfaces always assumed reliable - no signal detect on XGMII, for example**
  - **No obvious reason to make it one now**
- **Nonetheless, high quality fault detect functionality over XGXS is already present**
  - **PCS Align, Deskew state machines are very effective**
  - **Much better than any analog approach**
- **Adding analog signal detect will degrade XAUI performance for all applications to ease some LX4 implementations**

Other Arguments for XGXS Signal Detect

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- **Jonathan says all sublayers should do "data qualification" (indicate that their data is good)**
  - **XGXS does that already via Local Fault**
  - **XGXS is an XGMII extender. XGMII only indicates status via Local Fault -- There is no XGMII signal detect**
- **Infiniband has it**
  - **Infiniband is a cable, which can be unplugged or tripped over**
  - **Infiniband has a "wake-on-lan-event" requirement. Unlikely 10GE devices will need "wake-on-10GE-event", even in California**
  - **No one has built it yet – it may well not work (see appendix)**

Summary

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- **Do we need (another) XGXS error reporting mechanism? -- No**
  - **Local Fault is trivial and well defined. Use it.**
  - **Shouldn't penalize all XAUI implementations to make LX4 slightly easier**
  - **Extra wires defeat original goal of XAUI**
- **Do we need (another) XGXS signal detect? -- No**
  - **Function isn't required**
  - **PCS state machines detect XGXS faults far better than any other method could anyway**

Recommendation:

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- **Reject original comment 930 to D2.0**
- **Draft language requiring failures detected below XGXS to be reported via Local Fault message**

Appendix A

Digital vs. Analog Signal Detection, and Top 10 Ways to Fool an Analog Signal Detect

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General Requirement: Distinguish valid signal from interferers:

- **Methods:**
  - **Analog – Discrimination based on input signal amplitude**
  - **Digital – Discrimination based on detectable patterns in the received signal**

Analog Signal Detect -- Summary

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- **Very unreliable**
  - **Fooled by many common error scenarios (more info later)**
- **Affects reliability of underlying channel**
  - **Higher receiver parasitic load**
  - **Temptation to offset-bias inputs**
- **Power hungry & complex**
  - **secondary wideband receivers per input with process compensated threshold**
  - **Bandgap reference**
  - **Etc.**

- **Best case would have been a lane-ID per lane with known alignment**
  - **Almost impossible to fool**
- **Current PCS is almost that good**
  - **Deskew state machine (lane alignment detect) catches:**
    - **Receiver oscillation**
    - **Single open trace**
    - **Reverse crosstalk**
    - **Any other noise source**
  - **Might be fooled only by forward crosstalk (e.g. lane 1 is a copy of lane 2)**
- **Implementation cost is trivial**

*Top 10 Ways to fool an Analog Sig Det. -- #**10**: Receiver Oscillation*

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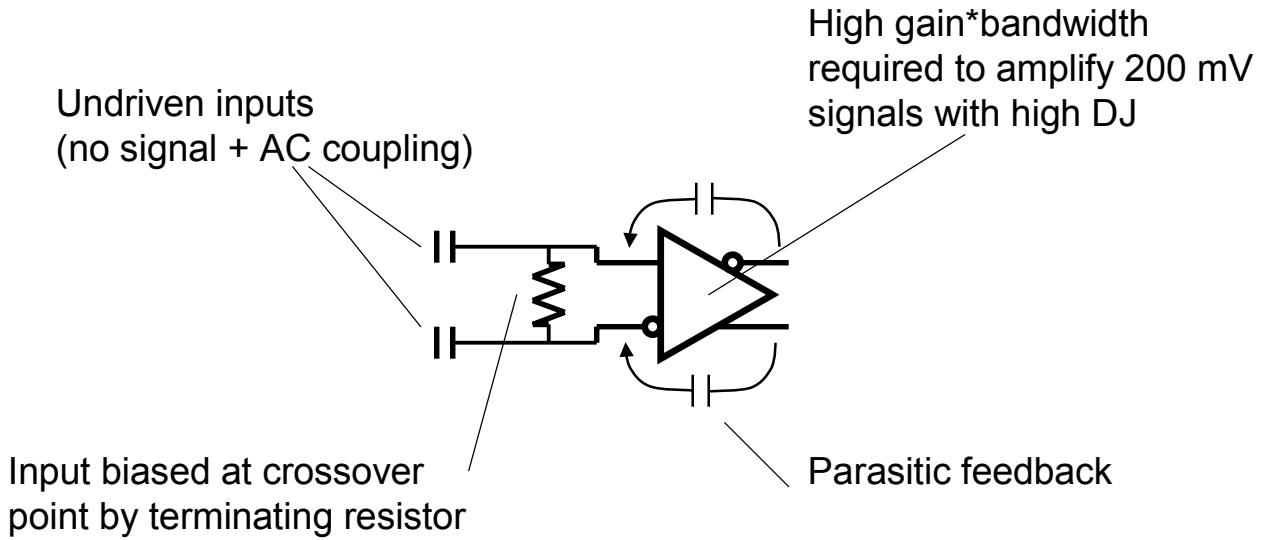

- **XAUI Receiver with Squelched Input**
  - **High gain is required, and parasitic feedback is unavoidable**
- **This circuit commonly known as an oscillator**
  - **Amplitude detector sees oscillation – indistinguishable from real signal**
- **Input offset is not a solution**

  40mV of offset is 0.1 UI of Deterministic Jitter!*

* Slope of far end template eye is 100mV/0.125 UI or 0.1UI/80mV. Doubled because offset distorts both leading and trailing edge

*Top 10 Ways to fool an Analog Sig Det. -- #**9**: Single open trace*

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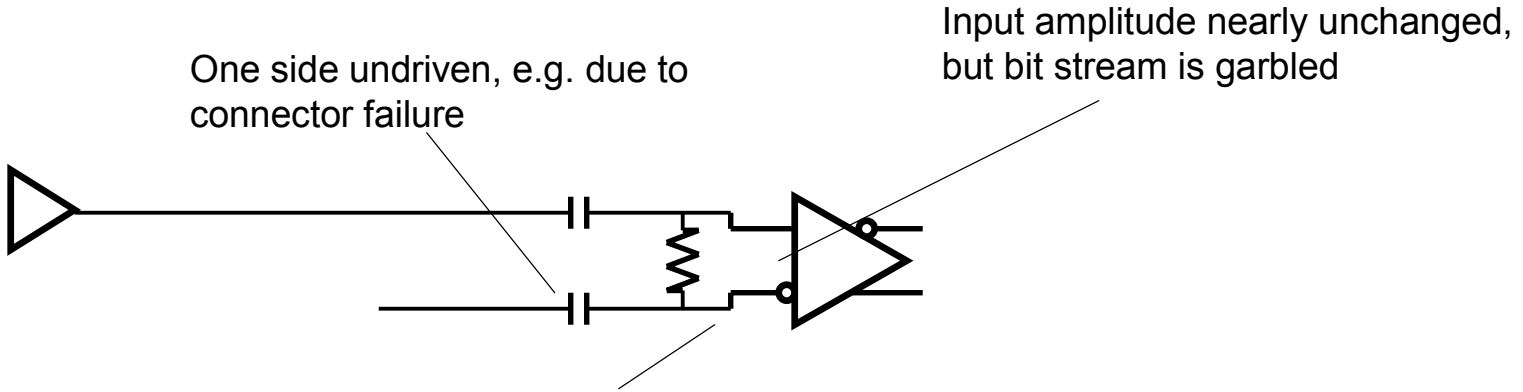

Undriven side follows driven side, with small phase delay.
(100 Ohms & 1pF gives RC tau of 100 ps., or 1/3 baud)

- **Single-ended drive (e.g. connector pin failure)**
  - **Undriven input tracks driven one with phase delay**
  - **No amplitude reduction (even differential)**
  - **Huge deterministic jitter (unrecoverable)**
- **Amplitude detector can't see this failure**
  - **Probably the most frequent real failure type!**

Top 10 Ways to fool an Analog Sig Det. -- #8: Reverse Crosstalk

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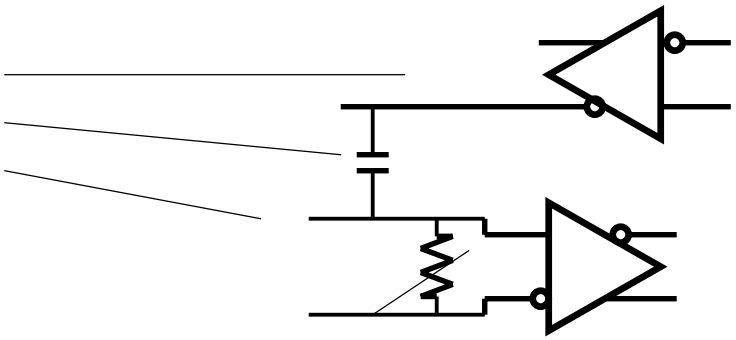
Assumptions:
800mV sinusoid at 1.56GHz (e.g XAUI driver)
0.1 pF parasitic coupling cap (e.g. bond wire)
25 Ohm load (victim wire is 50 Ohm trace)



- **Local driver crosstalk to receiver**
  - **Valid input signal may be as small as 200mV differential**
  - **Local drive can be > 800 mV with preemphasis**
  - **0.1pF coupling capacitance = 1 KOhm at 1.5 GHz**
- **Crosstalk from one neighboring driver is 20mV**
  - **Very conservative assumptions – could easily exceed 50mV**
- **Amplitude detector sees reverse crosstalk as signal**

Top 10 Ways to fool an Analog Sig Det. -- #7: Forward Crosstalk

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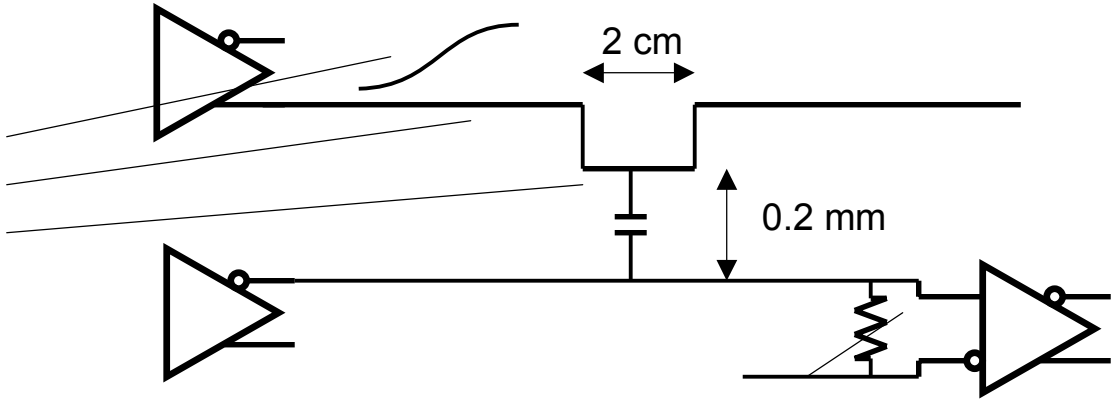
Assumptions:
800 mV swing,
125 ps. risetime (XAUI tx mask)
Stripline, 9 mil space
Coupled length < 2 cm



- **Far end driver crosstalk to receiver**
  - **Effect saturates in distance equivalent to ½ risetime**
  - **A very short distance! 1.5cm**
  - **Effect is about 5% for typical geometry.**
- **Crosstalk from one neighboring driver is 40mV**
  - **Very conservative assumptions – could easily be more than one**
- **Amplitude detector sees forward crosstalk as signal**

*Top 10 Ways to fool an Analog Sig Det. -- #**...1**:*

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- #6 – Offset bias needed to damp oscillation creates deterministic jitter, resulting in high BER
- #5 – Additional load on input causes failure to meet return loss spec
- #4 – Amplitude detect limit drifts over process and false-triggers on real signal
- #3 – Supply noise mistaken for real data
- #2 –
- #1

You get the idea.