Link Status Reporting and Initialization

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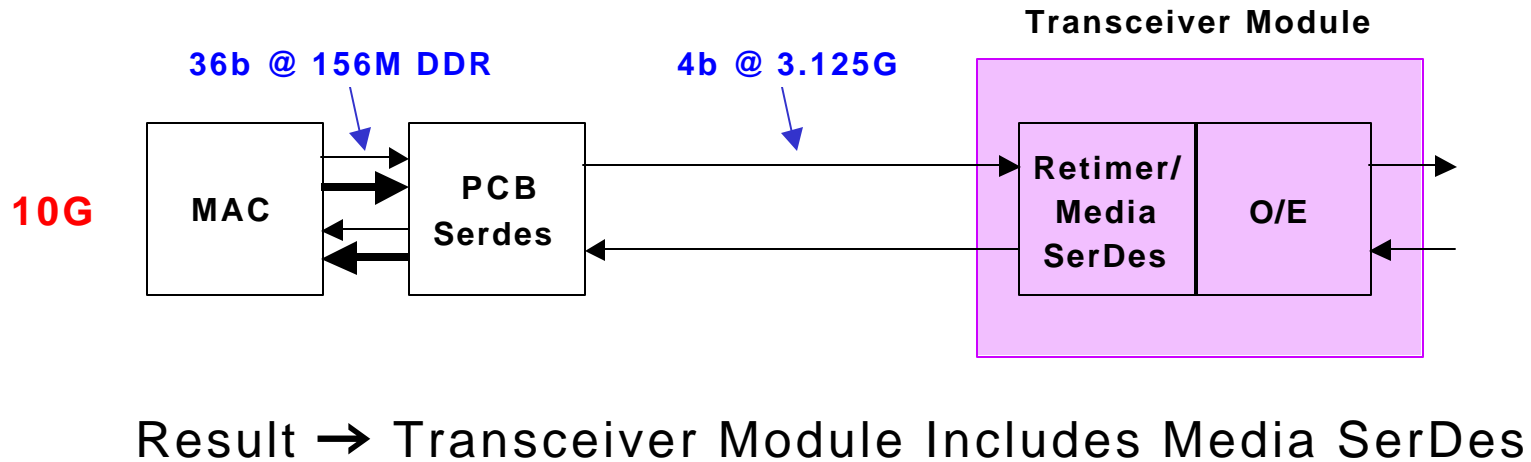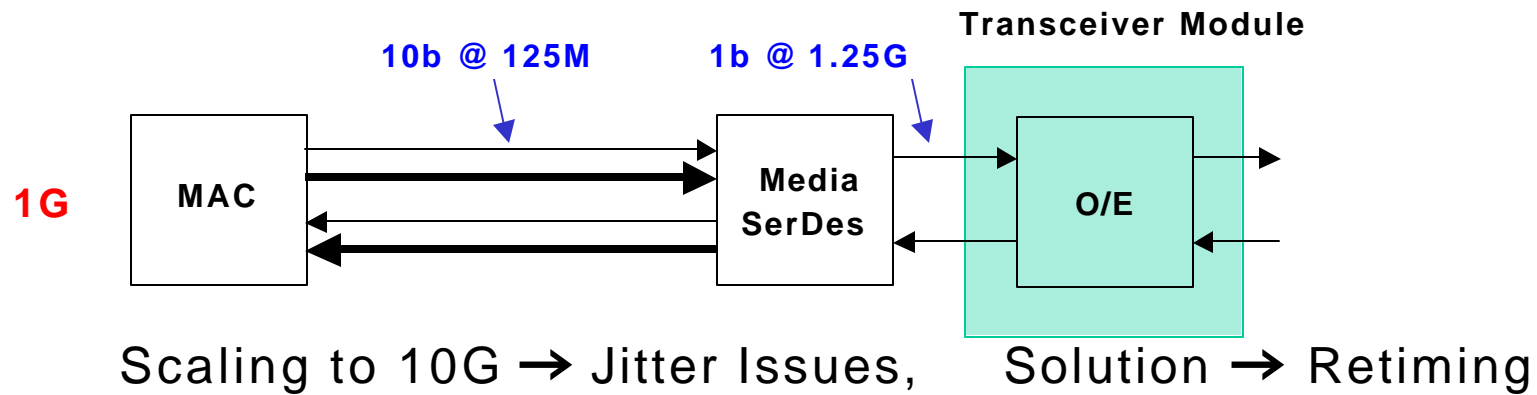
Presentation Purpose

- Describe 10G Link Architecture
- Specify Link Initialization Protocol
- Identify Link/PHY Status Conditions
- Propose Link Status Transport
- Identify Ancillary Issues
- Summary

Link Architecture

- 10GE Link Has More Sublayers and Components Than 1GE
  - LAN & WAN PHY
  - Serial and WDM (4-Lane) PMDs
  - Parallel Bus Extender: XAUI
  - WAN Serial PMA to Common Xcvr: SUPI
  - WDM Repeaters to Insure Signal Fidelity
  - Multiple CODECs and Framers Possible

1G to 10G PHY Differences

Transceiver Module

10b @ 125M   **1b @ 1.25G**

1G

| MAC | | Media SerDes | | O/E |

Scaling to 10G → Jitter Issues,   Solution → Retiming

Transceiver Module

36b @ 156M DDR   **4b @ 3.125G**

10G

| MAC | | PCB Serdes | | Retimer/ Media SerDes | O/E |

Result → Transceiver Module Includes Media SerDes

Link Status

- Required In Both Directions
- Link Status

  RS "Top Level" & Link Elements (E.g. XGXS, etc.)

  1 = Link Up, OK to Send Packets

  0 = Link Down, Block Packets

- Link is Up When:
  - PHY is Reset and Operational
  - All Link Receivers Receiving (Signal Detect)
  - No Link Error Conditions are Being Reported
  - All CODECs and Framers Are In Sync

- Link Status is AND of All PHY/Link OK Conditions
  - Link Status OK = All Signals OK & All Protocols OK

Link/PHY Status Conditions

- ## Serial I/O Signal Detect (SD)
  - Single/Multi-Lane, Optical/Copper

- ## Protocol Detect (PD). Includes:
  - CODEC Synchronization
  - Lane Alignment (Multi-Lane Only)
  - WIS Frame/Payload Acquisition
  - Link Status Report Recognized

- ## "Christmas Tree Light" Problem
  - Some Conditions Can't Get Past Others
  - E.g. Broke XAUI Hides PMD Signal Detect
  - "If You Can't Say Anything Good, Keep Quiet"

Signal Detect (SD)

- Reliable Receiver Operation Implies That a Reliable Signal Is Present
- Signal Detect is Link Reliability Check
  - Don't Bother Looking At Data if No SD
  - Circuitry In TIA for Optics, Serial I/O Rx
  - Applicable to Serial I/O, per I/O
  - Many SD Circuit Variations
  - Multiple SD Points Possible in Link
  - Need To Get SD To Link Status
  - Transport Req'd: Code, Pin, MDIO, etc.
  - Signal Detect Response µs To ms

Protocol Detect (PD)

- ## Includes All Link Status Conditions Associated With Link Data:

  - ### CODEC Lane Synchronization

    - Applicable to All 8b/10b and 64b/66b CODECs

  - ### Lane Alignment

    - Applicable to all 8b/10b Multi-Lane CODECs

  - ### WIS Frame/Payload Acquisition

  - ### Link Status Report Recognized

- ## Transport Req'd: Code, Pin, MDIO, etc.

Link Status Reporting

- ## Real Time Report Forwarding
  - – Enables Rapid Link Fault Detection
  - – Enables Failure Resilient 10GE Equipment
  - – Report Transport
    - MDIO Too Slow. Not Applicable
    - Pins Are Expensive, N/A to Fiber-Optic Cable, Plain Silly For Serial I/O (Clockless, Coded Transport)

    .: Real Time Reporting Should Be By Code/Protocol

- ## Link Debug/Fault Isolation Reporting
  - – Non-Real Time. MDIO Is Adequate.

Link Status Report Requirements

- Purpose Is To Forward SD and PD Link Status
- Must Work For All Interfaces and Codes
- Must Handle Single and Multiple Lanes
- Must Be EMI-Friendly
- Should Be Simple. Must Be Robust.

Next: Specify Messages and Transport

Link Status Messages

- Signal and Protocol Errors May Be Combined for Forward Transport (I.e. Downstream)
  - No Need To Distinguish. Message May Be Lost.
  - E.g. No Signal, No Sync Anywhere Along Simplex Link

- Combine All SD/PD Into Status Messages
  - All Faults Along a Simplex Link Are Local Faults (LF)
  - LF Detected At RS Considered Remote Fault (RF)
  - LF Masks RF Message
    - RF Status Message Is Lost Upon Local Fault Detection

- Define Separate LF and RF Messages

Next: Specify Status Message Transport

Status Message Transport

- RF Issued From RS Only
- LF Issued From Intermediate Link Elements Only
  - E.g. XGXS, Retimer, SUPI
- Should Be Current CODEC Friendly
- Propose Leveraging 10GFC Signal Ordered-Set
  - Same Format As Start Delimiter: /K/D/D/D/
  - RS Alternates Signal With Idle Continuously
  - 8b/10b Continuous Signal after every ||A||
  - Recognized Upon 3 Consecutive Signal Occurrences
  - Both Are 8b/10b, 64b/66B, XGMII, XSBI, SUPI, WIS, etc. Compatible
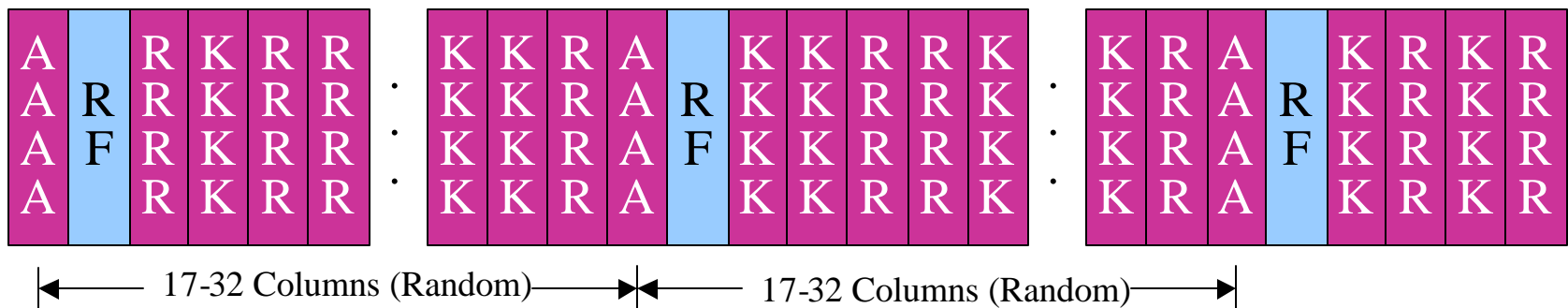
Status Message Signaling

- A Status Message Signaling Condition Exists Whenever a Fault Condition Exists.
  - The Status Message Sets Link Status=FAIL
  - The Fault Condition Sets x.1.2 Link Status=FAIL

- Status Message Signaling Involves the Issuance of the Signal Protocol Indicating the LF or RF Message.

- RS Initiates RF Status Messages In Response to Reception of LF

- Intermediate Link Elements Initiate LF and Forward Status Messages

- Status Message Uses Signal Ordered-Set

8B/10B Status Signal Protocol

- Signal Is An Ordered-Set, Similar To Idle
- Format: /K28.2/Dxx.y/Dxx.y/Dxx.y/ (Similar To Start)
  - K28.2 Same As FC Sequence, Dxx.y TBD
- Signaled Continuously While Status Condition Exists
- Signal Inserted After ||A|| Into ||A||K||R|| Idle Stream

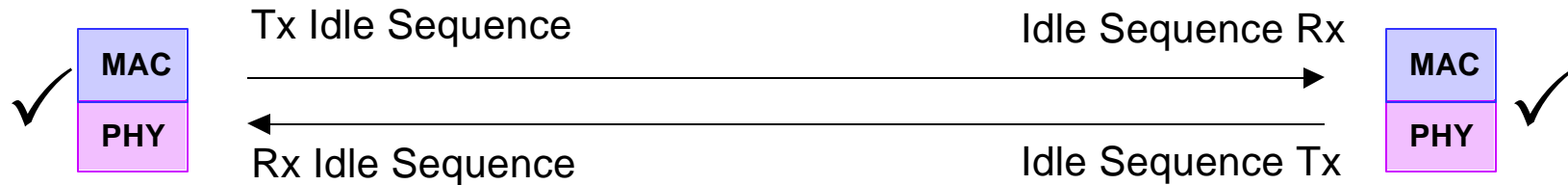Signal Indicated In 8B/10B Idle Stream After Each ||A||

17-32 Columns (Random)   17-32 Columns (Random)

Link Initialization

- Consists of Only Idle Sequence in the Absence of Errors

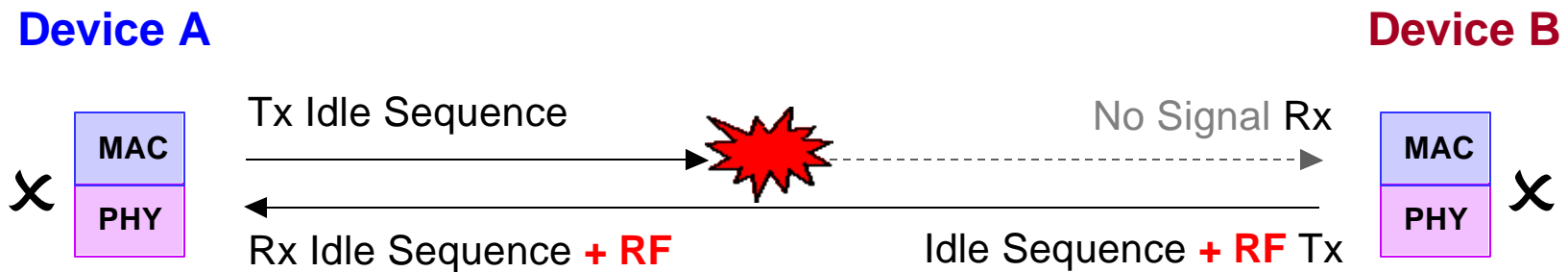- Includes Status Message Signaling in the Presence of Errors

Normal Operation

Device A   **Device B**

MAC	Tx Idle Sequence Idle Sequence Rx	MAC
PHY	Rx Idle Sequence Idle Sequence Tx	PHY

- Simultaneous A and B Power-Up and Reset
- Link Status=OK in Both A & B
- MAC Transmission Enabled In Both A & B
- No Handshakes or Negotiation

Remote Fault

Device A

Tx Idle Sequence

No Signal Rx

| MAC |
| PHY |

✕

Rx Idle Sequence **+ RF**

Idle Sequence **+ RF** Tx

Device B

| MAC |
| PHY |

✕
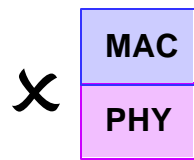
- **Device B** Receiver Detects Fault
  - E.g. Fault In Cable Plant, Media Converter, etc.
- Link Status=FAIL In **Device B**
- **Device B** Signals RF To **Device A**
- Link Status=FAIL In **Device A**
- MAC Transmission Halted In Both **A** and **B**
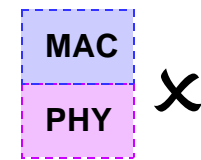
Initialization Snapshot 1

Device A   **Device B**

| MAC | Tx Idle Sequence **+ RF**   Idle Sequence **+ RF** Rx | MAC |

✗ | PHY | | PHY | ✗

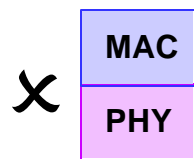Rx No Signal   No Signal Tx

- **Device A** Powered Up and Reset
- **Device B** Powered Down
- **Device A** Receiver Detects Fault
- **Device A** Signals RF To **Device B**
- Link Status=FAIL In **Device A**
- MAC Transmission Halted In **Device A**
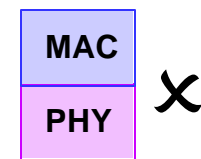
Initialization Snapshot 2

Device A
Device B

|		
MAC	Tx Idle Sequence **+ RF**	Idle Sequence **+ RF** Rx
PHY	Rx No Signal	Idle Sequence Tx

- Device B Powers Up + Resets
- Device B Signals Idle To Device A
- Device B's Idle Hasn't Reached Device A Yet
- Link Status=FAIL In Both A and B
- MAC Transmission Halted In Both A and B

Initialization Snapshot 3

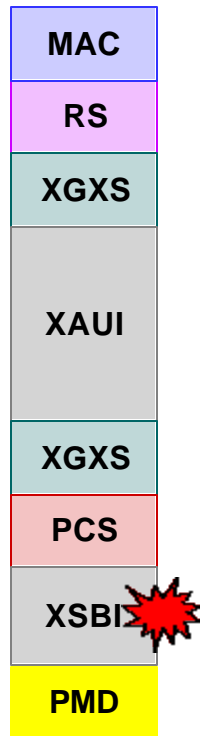**Device A**   **Device B**

Tx Idle Sequence   Idle Sequence **+ RF** Rx

| MAC |
| PHY |

Rx Idle Sequence   Idle Sequence Tx

| MAC |
| PHY |
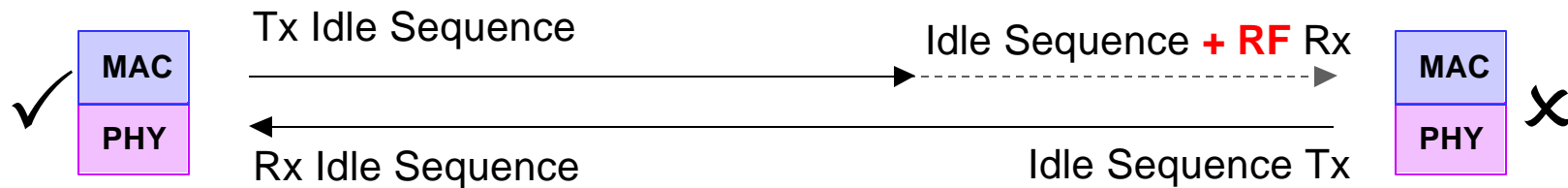
- Device A Receiver Detects Idle Sequence
- Device A Stops Sending RF To Device B
- Device A Sets Link Status=OK
- MAC Transmission Enabled In Device A
- Device A Idle Hasn't Reached Device B Yet
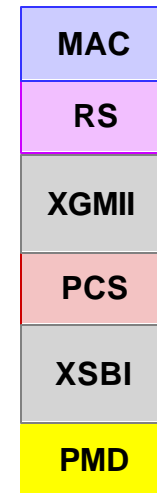- When It Does It Becomes Normal Operation

PHY XSBI Error Example

Device A

Device B

MAC
RS
XGXS
XAUI
XGXS
PCS
XSBI
PMD

MAC
RS
XGMII
PCS
XSBI
PMD

Device A XSBI Receive Path Broken

Device A PCS Recognizes Fault

Device A PCS, 64b/66b, Indicates LF

Device A XAUI/XGXS Forwards LF

Device A RS Sets Link Status=FAIL

Device A Sends RF To Device B

Break Link Issue

- ## Break Link (BL) Historically Starts AN
  - ### No Apparent Need For BL in 10GE
  - ### If Desired, BL May Be Effected By Defining a Management Register Control bit for BL.
    - Note: BL May Become LF Upon Link Error

- ## Should Break Link Be Defined?
  - ### How Should It Be Signaled?
    - MAC Frame
    - MAC Control Frame
    - Link Status Signal

Summary

- Robust Link Status Recognition, Signaling and Reporting Protocol

- Link Status & Packet Transmission Is Mutually Exclusive

- Simple Link Initialization

- No Auto-Negotiation

- Synergy With 10GFC Protocol

- Link Status Consensus Achieved