Link fault signaling for 2.5/5GBASE-T

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Link fault signaling

- 5GBASE-T and 2.5GBASE-T is based upon the XGMII and associated Reconciliation Sublayer (RS) that performs link fault signaling specified in 46.3.4.3:

  The RS output onto TXC<3:0> and TXD<31:0> is controlled by the variable link_fault.

  a) link_fault = OK
  The RS shall send MAC frames as requested through the PLS service interface. In the absence of MAC frames, the RS shall generate Idle control characters.
  b) link_fault = Local Fault
  The RS shall continuously generate Remote Fault Sequence ordered_sets.
  c) link_fault = Remote Fault or link_fault = Link Interruption
  The RS shall continuously generate Idle control characters.

Link fault signaling

- The purpose and mechanism of link fault signaling are detailed in 46.3.4:

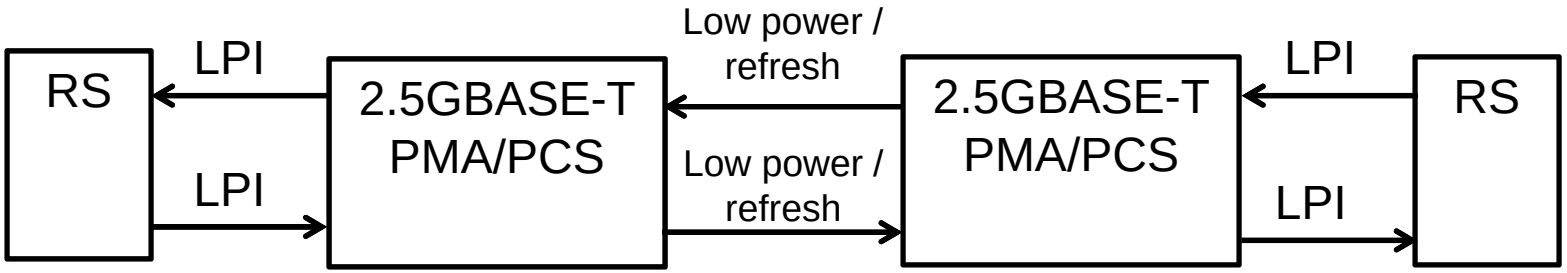
> "Sublayers within the PHY are capable of detecting faults that render a link unreliable for communication. Upon recognition of a fault condition a PHY sublayer indicates Local Fault status on the data path. When this Local Fault status reaches an RS, the RS stops sending MAC data or LPI, and continuously generates a Remote Fault status on the transmit data path (possibly truncating a MAC frame being transmitted). When Remote Fault or Link Interruption status is received by an RS, the RS stops sending MAC data or LPI, and continuously generates Idle control characters. When the RS no longer receives fault status messages, it returns to normal operation, sending MAC data or LPI."

Implications of optional link fault signaling

- Removing the requirement of link fault signaling at the RS will have undesirable consequences on 2.5GBASE-T.
- Example: recovery from a fault during EEE low power idle.
  - During LPI, the transmitters and receivers are powered down except during short refresh transmit periods.
  - Should anything go wrong in the PHY receiver, link fault signaling provides the mechanism for recovery without dropping link and performing a multi-second link retrain.
  - A PHY with a receiver fault during LPI uses fault messaging to wake up the link partner transmitter and clear the fault in order to avoid a link drop.
- Without fault signaling there is no other way to force the link partner to wake and transmit continuous signal for recovery without dropping link and retraining.

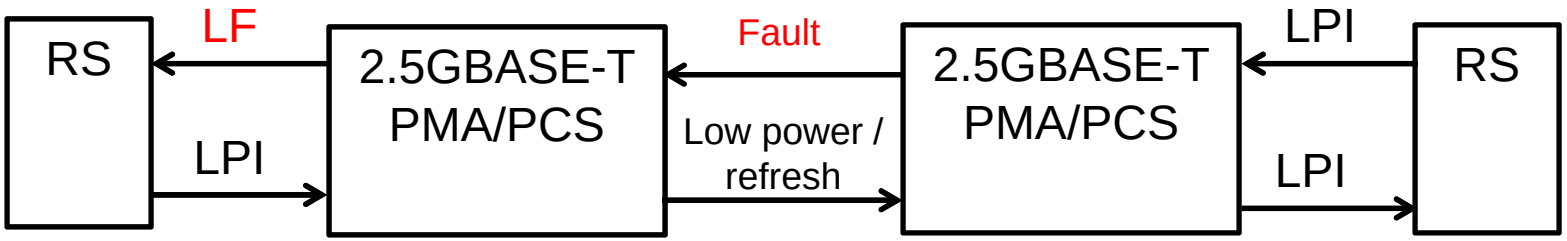
EEE Fault Example

- **Symmetric low power idle – No fault**



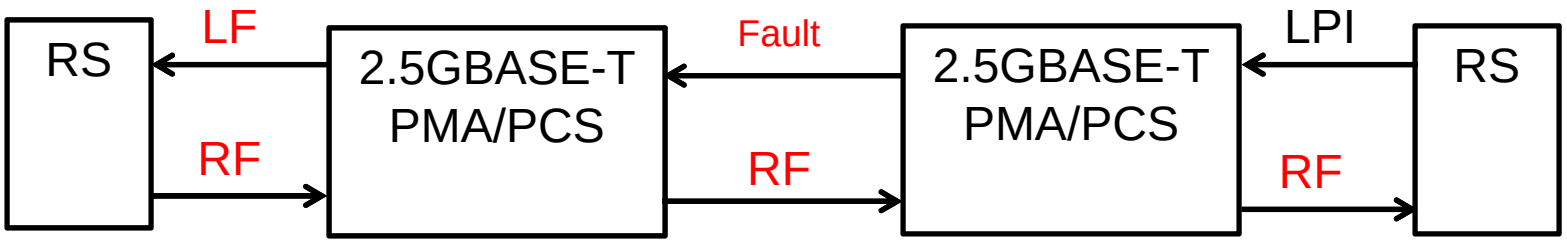
EEE Fault Example

- **Fault condition at local PHY receiver**
  - **Local fault sent toward RS**
  - **Fault continues while link partner transmitter is in low power**
  - **Without link fault signaling at the local RS, this state will persist**



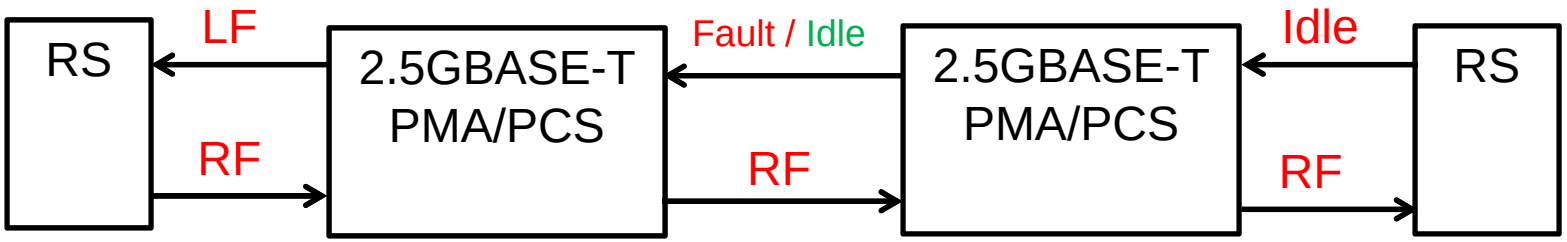
EEE Fault Example

- **RS detects local fault and responds with remote fault**
  - **remote fault sent toward RS**
  - **Local PHY transmitter wakes**
  - **Without link fault signaling at the remote RS, this state will persist**



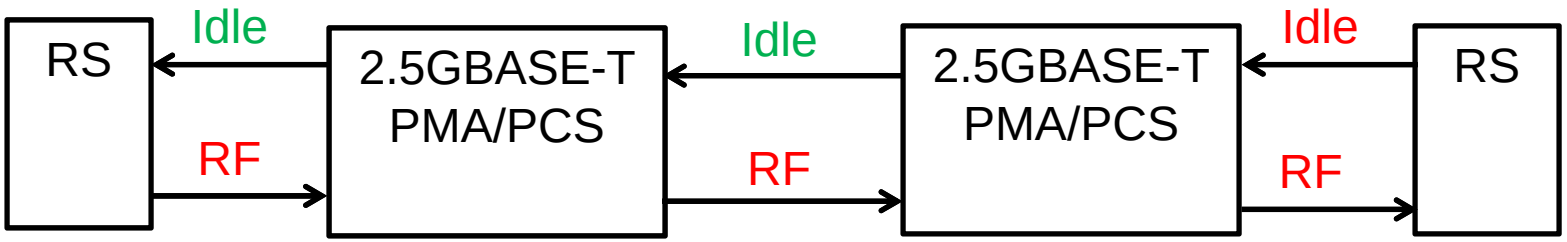
EEE Fault Example

- **Remote RS responds with Idle**
  - **Remote PHY transmitter wakes, sends Idle**
  - **Local PHY receiver may recover from fault**



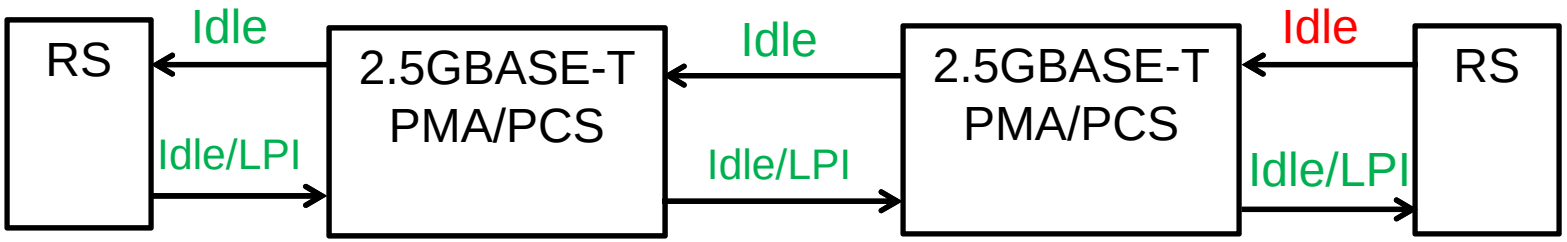
EEE Fault Example

- **Fault is cleared at PHY**
  - **Idle sent toward RS which detects fault is cleared**



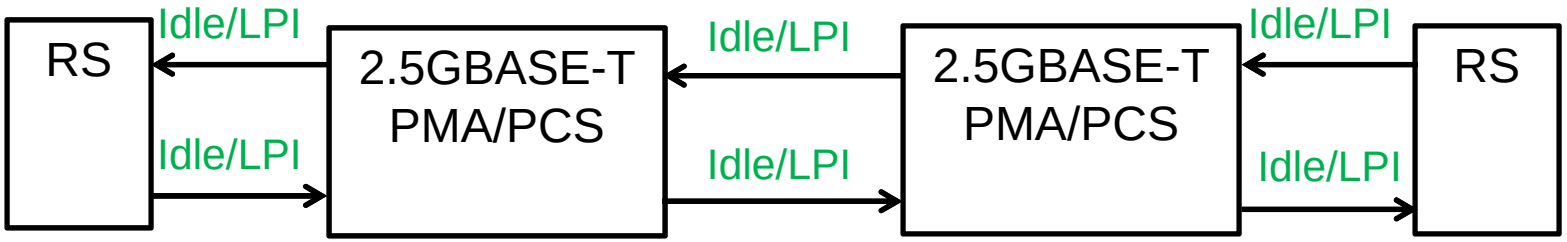
EEE Fault Example

- **RS stops sending remote fault**
  - **Idle or Low Power Idle or data may be sent to link partner**
  - **Remote RS detects fault is cleared**



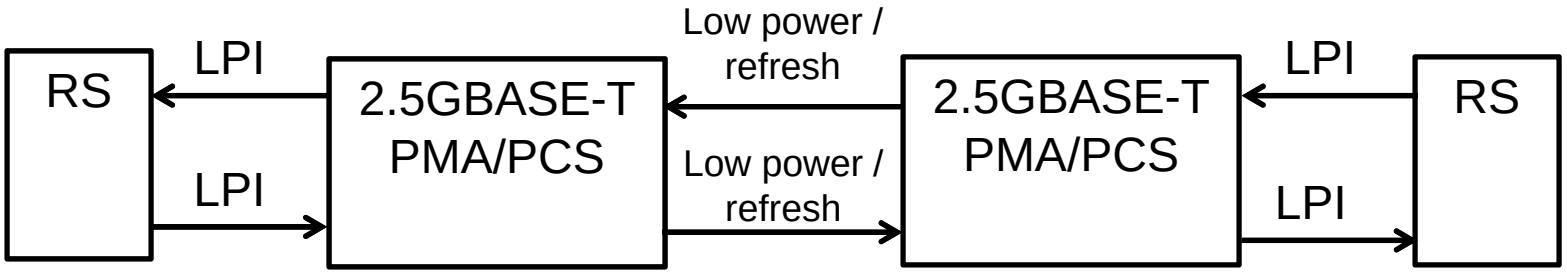
EEE Fault Example

- **Remote RS clears fault condition**
  - **Idle or Low Power Idle or data may be sent toward the local PHY**



EEE Fault Example

- **Symmetric low power idle**
  - **Both sides may return to low power states**



Conclusion

- Removing the requirement of link fault signaling at the RS will have undesirable consequences on 2.5GBASE-T.
  - EEE example shows fault signaling is necessary at both local and remote RS
  - Optional link fault support would need to be coordinated between local and remote devices and between the RS and PHY.
- We should not remove this piece of the system without a thorough understanding of the consequences.