# Considerations for Technical Feasibility of EEE with 10GBASE-T

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# Outline

- Strawman for EEE in 10GBASE-T
- Longevity of Stored Transceiver States
  - Experimental Setup
  - Experimental Results
- Restart Sequence
- Restart Time Considerations
- Conclusions

# Strawman for EEE in 10GBASE-T (1)

- Discussion has focused on adaptive PHY line rates
  - Transition to defined 802.3 lower rates is assumed
    - Assume an exit from 802.3an transmission, and use of the channel by some alternate transmission
  - MAC interfaces are assumed constant
    - Often outside of 802.3 specification(e.g., SGMII, XFI)
    - Focus only on PHY control and acquisition
  - Transition would minimally impact existing specifications
    - Reuse of existing 802.3an PHY control as much as possible
  - Transition times around 1 msec assumed in analysis
    - Need to minimize training time

# Strawman for EEE in 10GBASE-T (2)

- Strawman:
  - Freeze stored 10GBASE-T state while lower speed was running
    - Feasibility Question: How long before the transceiver state typically gets stale?
  - Restart 10GBASE-T transmission by entering final stages of PHY-control startup sequence
    - Feasibility Question: How short might a transition be made using the existing framework

# Longevity of Stored States

- In *principle*, transceiver coefficients, canceller, and timing states can last indefinitely
  - Limited by environmental disturbances
- In *practice*, the channel environment subtly shifts with vibration, temperature, and physical disturbance.
  - Timing also diverges without update
- Experimental data was gathered using existing 10GBASE-T PHYs operating on 100m Category 6a cabling

# Experimental Setup

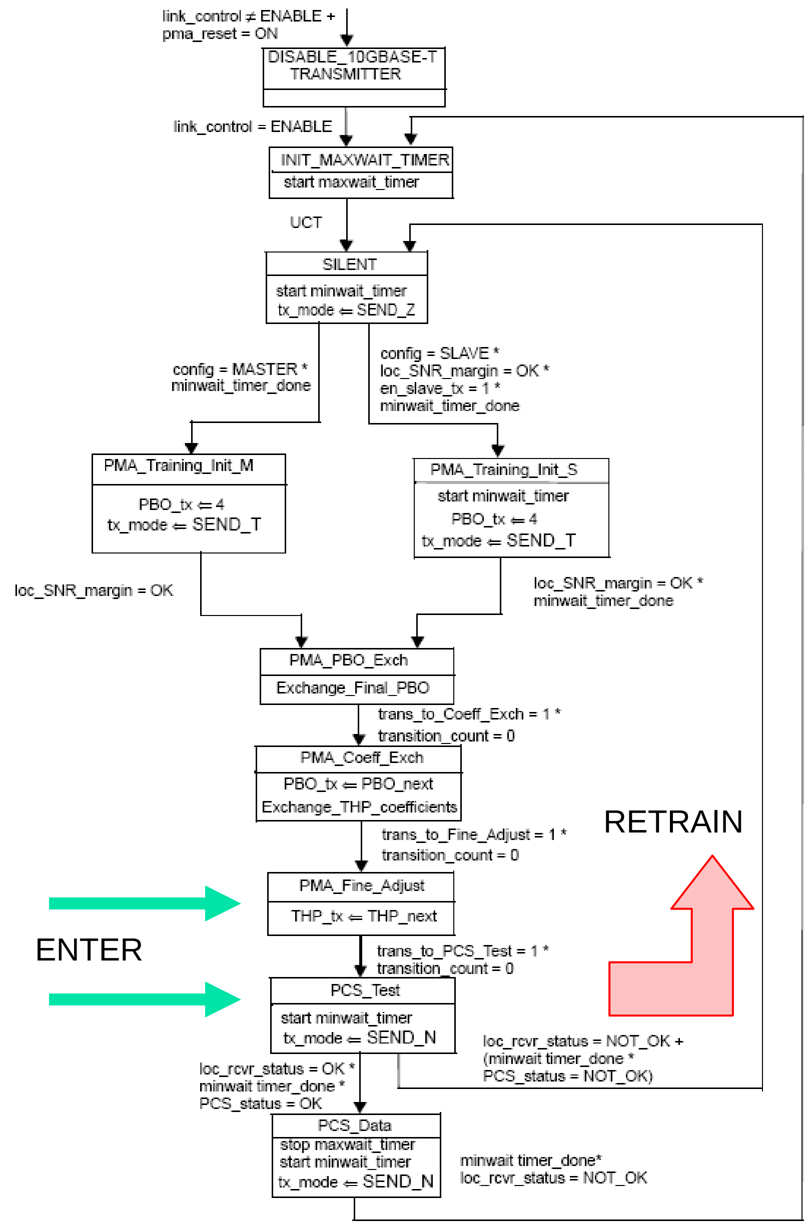
- Error-free link established on 100m 4-conn Cat6a channel
  - Environment was typical, air-conditioned, enterprise environment (not especially controlled)
    - No temperature extremes or cycling, undue physical manipulation
    - Cabling laid in raceways, exposed to airflow
- Link FER performance was measured using packet generating and testing equipment
- Slave (loop-timed) receiver state was frozen and not allowed to track the channel state
  - Channel timing recovery was frozen as well
- Link SNR and FER were monitored until link drop

# Experimental Results

- Multiple runs gave consistent results
- Link degradation began ~ 3 minutes after freeze
  - First errors occur, few and far between
- Link degradation accelerated between 3-5 minutes, resulting in link drop at between 5 and 5.5 minutes
  - Errors come rapidly, but still tracking until 5-5.5 minutes
- Conclusion:
  - Stored state can be used with minimal retune up to 3 minutes
  - Fine adjustment of stored state may be necessary up to 5 minutes, but fast-startup without sequencing PAM-2 and THP adjustments should be OK
  - Beyond 5 minutes, more complete, staged startup may be necessary, going back to PAM-2 states

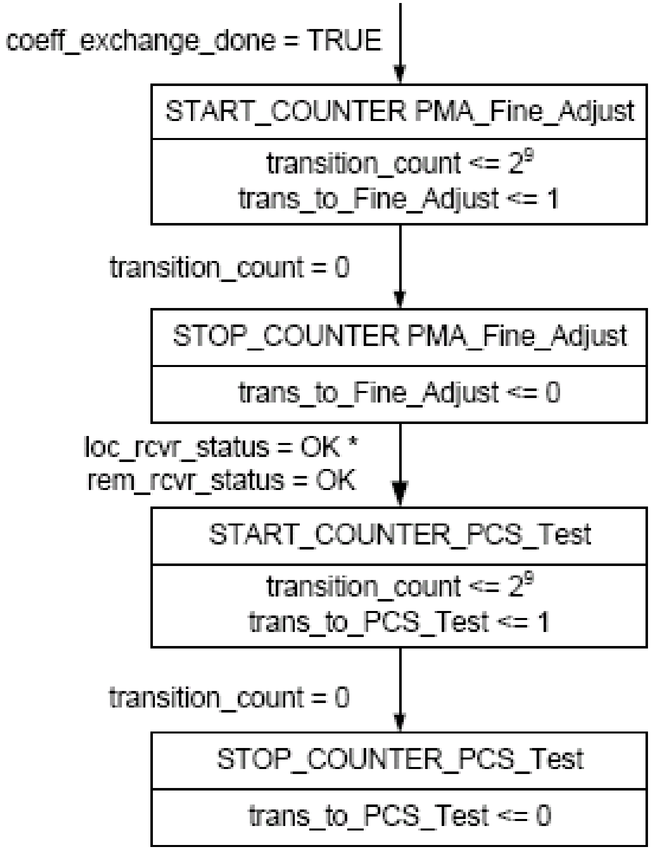
# Restart Sequence

- 10GBASE-T PHY Control
- Likely entrance points for EEE state-restoral
  - PMA_Fine_Adjust
  - PCS_Test
- Would require periods of silence and signalling to indicate transition to training
- Failure of PCS_Test would trigger retrain, returning to SILENT state



# Restart Time Considerations

- PCS_Test time is 1msec
  - Any signalling or entry time is in addition
- When PMA_Fine_Adjust is required, time is controlled by Infofield protocol
  - Infofield every 16384 symbols (20.48 usec)
  - Count down 512 infofields
  - 10.48 msec state transition + retraining time + PCS_Test (1msec)




- Conclusion: 1msec is probably too optimistic – recommend 20msec minimum for simulations

# Conclusions

- Fast restart of 10GBASE-T from stored state appears feasible
  - Preliminary experiments suggest state should be current within 3 minutes
- Fast restart can reuse existing PHY control states
  - Fine Adjust, PCS_Test and retrain mechanisms exist
- 1 msec restart time is probably too optimistic
  - Recommend considerations use 20msec