Complexity of TDD vs ACT PHY

IEEE 802.3dm

March, 2025

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Background

- There has been significant discussion on complexity of ACT vs TDD PHYs.

- Downstream PHYs and **receivers for TDD are very simple** and result in lower complexity PHY compared to ACT
  - Simple digitally controlled schedule to transmit and receive
  - No overlap of signals in time

- Claims of TDD being more complicated are focused on the opposite side (upstream PHY).

- Upstream receivers have tradeoff between
  - Separation of overlapping signals in normal mode of operation (ACT)
  - Higher Baud rate (TDD)

- This presentation takes a look at the **startup aspects of TDD and ACT** PHYs beyond the normal mode of operation to provide a ***more complete picture!***

PHY Startup and Normal Operation

Most Ethernet PHYs perform a bring up process prior to normal operation (data mode)

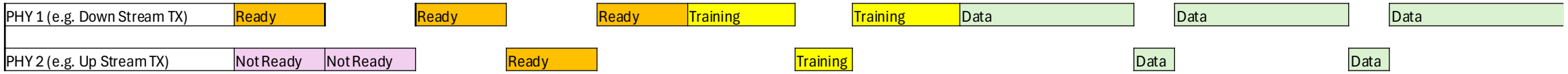
Normal operation is the mode during which a PHY can transmit the data sent to it by the MAC

Steps taken prior to this are performed at the Physical Layer level and are meant to facilitate smooth bring up

Some example of pre data steps are Auto Negotiation, Link Sync etc.

Next, we look at this process for TDD and ACT PHYs.

Startup and Normal Operation for TDD PHY



One side (typically Master) starts transmitting.

Other side listens and transmits based on the received signal in a SAFE window

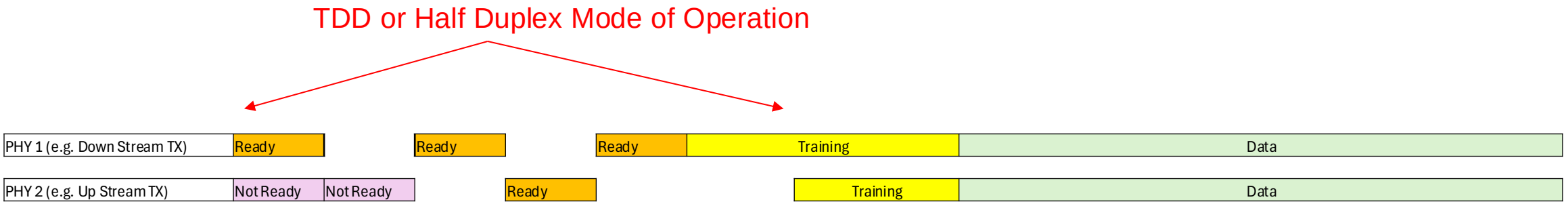
This ensures robust start and smooth link up process.

This method of operation is called “TDD” or “Half Duplex”

After completing training, PHYs move to normal operation in TDD, whereby they change baud rate, modulation etc.

PHYs start with TDD and remain in TDD from start to end ☺

Startup and Normal Operation for ACT PHY



One side (typically Master) starts transmitting.

Other side listens and transmits based on the received signal in a SAFE window

This ensures robust start and smooth start of the linkup process.

This method of operation is “TDD” or “Half Duplex”!!

After training, PHYs switch to data mode and may use echo-cancellation type techniques

Thus, an ACT PHY first performs TDD ☺ and then changes to ACT for data ☹

Why would an ACT PHY perform TDD first?

….Because TDD is simpler to perform and is robust transmission mechanism

- At the beginning of time, the PHYs don’t have the knowledge of the channel characteristics such as cable length and noise profile
- Overlapping the TX signals from both sides makes the linkup more problematic
- To mitigate this, the TX signals are typically separated in time (which is what TDD is!)
- Separation of signals in time allows each side to train independently and results in robust bring up sequence

If TDD is more robust, why do Base-T PHYs not use it?

- Previous Base-T and Base-T1 PHY in 802.3 were focused on SYMMETRICAL transmission
- For given channel capacity and target baud rates, it often became necessary to overlap the signals during data mode.
- The target channel characteristics combined with desired data rates forced past Base-T and Base-T1 PHYs to overlap the signals and use echo-cancellation to separate them.

What’s different now?

- Answer = ASYMMETRY & CHANNEL
- In 802.3dm, there is sufficient channel capacity to achieve target data rates in the upstream and downstream directions without being forced to overlap the signals.
- TDD is a more natural choice for highly Asymmetrical systems and the channel profile being considered in 802.3dm

Summary

- **TDD PHY:** Starts in TDD mode and remains in TDD mode
- **ACT PHY:** **Starts in TDD mode** and switches to ACT mode
- When considering the complexity of ACT PHYs, it is prudent to take the above into account. Not just look at the operation in “data mode”.
- TDD is a more robust mechanism and a natural choice for **asymmetrical systems** such as 802.3dm

Thank You!