Options to fix fault in LPI Receive state diagram (Figure 82–17)

Background

Rapid Alignment Markers (RAMs) are used to convey state information from the Transmit LPI function through the transmit and receive PHY subsections to the Receive LPI function. In order to support compatibility with OTN, the RAMs were removed for fast wake operation. This caused a problem for the LPI receive state diagram (Fig 82-17) as it relies on the variable received_tx_mode to control transitions from the RX_SLEEP and RX_FW states. Since received_tx_mode is derived from the received RAMs, it cannot be used for fast wake operation.

This document is intended to explore the options available to resolve this problem. It describes the advantages and disadvantages of each option but it is not intended to advocate for any particular option.

Options

There are four sets of changes that might be used to fix the fast wake operation:

1. Restore RAMs for fast wake.
2. Remove "refresh and wake" operation for fast wake.
3. Force periodic wake for fast wake.
4. Use short normal idle burst in place of refresh.

Restore RAMs

Change the definition in 82.2.8a so that RAMs are sent regardless of the state of LPI_FW. Strengthen the warning that LPI should not be enabled for links that will be transported using a transcoded interface (such as OTN). Suggest that work should be started in ITU to define the transport of LPI.

Advantages

This is the simplest change from the perspective of the LPI definitions. No change is required to the state machines. There is a secondary advantage that intermediate PHY components may also use the presence of RAMs to enhance energy savings during fast wake operation.

Disadvantages

Compatibility with OTN was a critical factor in the support for adoption of EEE for optical interfaces. It is very likely that removing fast wake compatibility with existing OTN implementations will be acceptable.

Remove refresh and wake operation for fast wake

The transition from RX_SLEEP to RX_FW changes to LPI_FW = TRUE (with no other conditions); the only transition out of LPI_FW becomes R_TYPE(rx_coded) = IDLE going to RX_ACTIVE. This makes the timers rx_tq_timer and rx_tw_timer redundant for fast wake operation. The down_count operation could be removed for the fast wake option of the transmit LPI function .

Advantages

This change preserves the compatibility with OTN for fast wake. It is a minimal change to the receive function, transmit PHY components can still use the tx_mode signaling for fast wake.

Disadvantages

The receiver has no timeout to detect a frozen transmit function, this could reduce the robustness of operation in the presence of faults. The LPI receive state diagram would rely on a PHY reset to get out of the RX_FW state. The transmit LPI function maintaining the refresh-like behavior for fast wake is redundant.

Force periodic wake

The transmit state machine (Fig 82-14) can be modified so that the tx_coded output is forced to IDLE during refresh-like states so that the receive LPI function can detect failures. The LPI transmit state diagram will be modified to add an explicit state for FW_REFRESH so that the state can be used to drive the transition of transmit state machine. The receive LPI function still needs to be changed as there is no way to derive received_tx_mode. The change proposed for option 2 should be sufficient to overcome this issue.

Advantages

This change removes stuck state problem described for the previous option. The receive LPI state machine will periodically transition between from the RX_FW state through RX_WAKE, RX_ACTIVE, RX_TIMER and RX_SLEEP states. Thus the timer rx_tq_timer will detect if the link partner has stuck.

Disadvantages

This solution will cause the receive components above the PHY to exit from the LPI state for each refresh-like interval. This could significantly reduce the effectiveness of fast wake operation – particularly as most of the energy savings are expected to be in the higher layer components for fast wake.

Normal idle burst

If the changes for the “force periodic wake” solution are combined with changes to the receive state diagram (Fig 82-15), the normal idles sent during the refresh-like burst can be suppressed. This is achieved by delaying the transition from RX_LI to RX_C for a number of idle cycles greater than the number of idles generated by the refresh-like operation. This should only be enabled for fast wake operation, so that normal wake is not delayed.

Advantages

This restores the apparent behavior of fast wake operation to the equivalent behavior that was achieved using RAMs, without the incompatibility with OTN.

Disadvantages

This solution is much more complex than any of the other solutions and that complexity will cause problems with debugging and testing. The delayed response to normal idles also adds a delay to the system level wake time for fast wake operation (that was currently defined to be the same as the PHY-layer wake time).