Link Monitoring

IEEE 802.3bp - Interim Meeting - January 2015

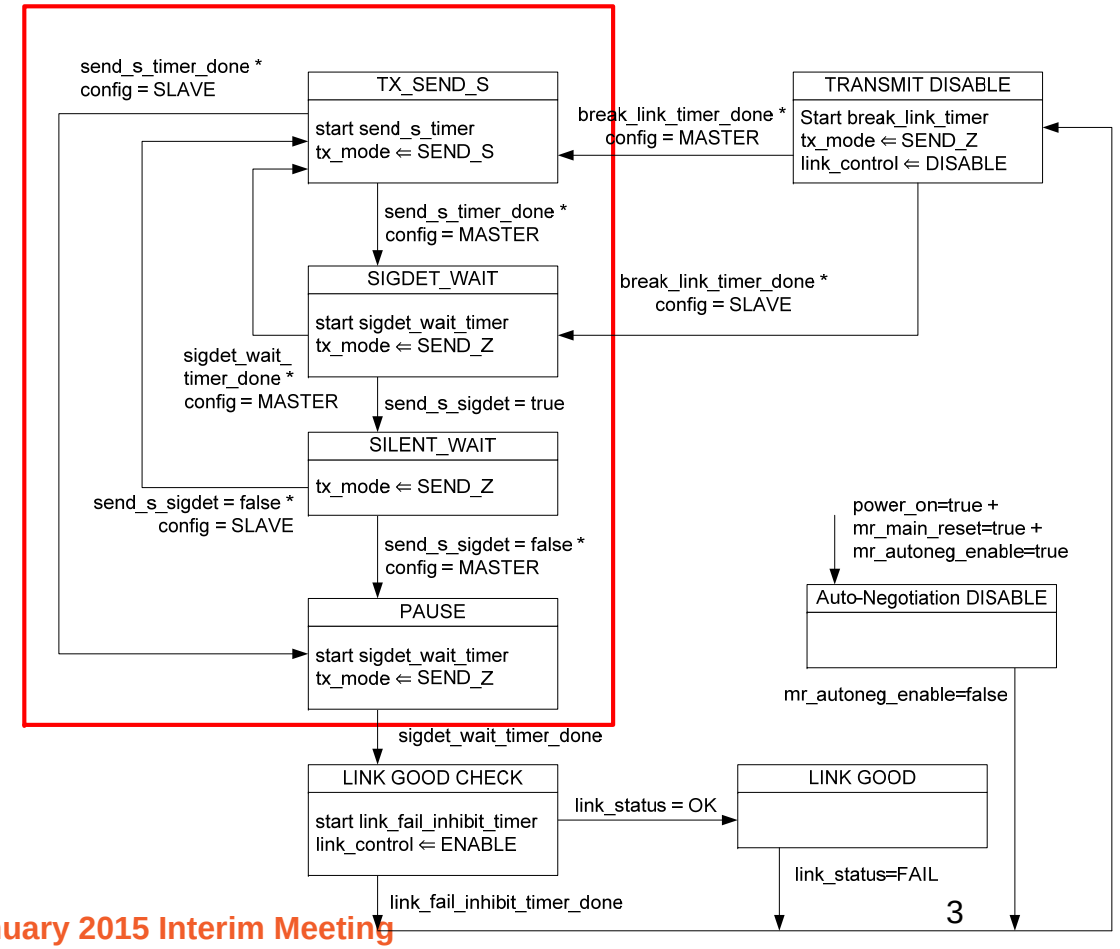
William Lo, Marvell

Objectives

- Unify Auto-Negotiation and Sync using SEND_S
- Speed up link up time by defining a fast way to detect loss of link

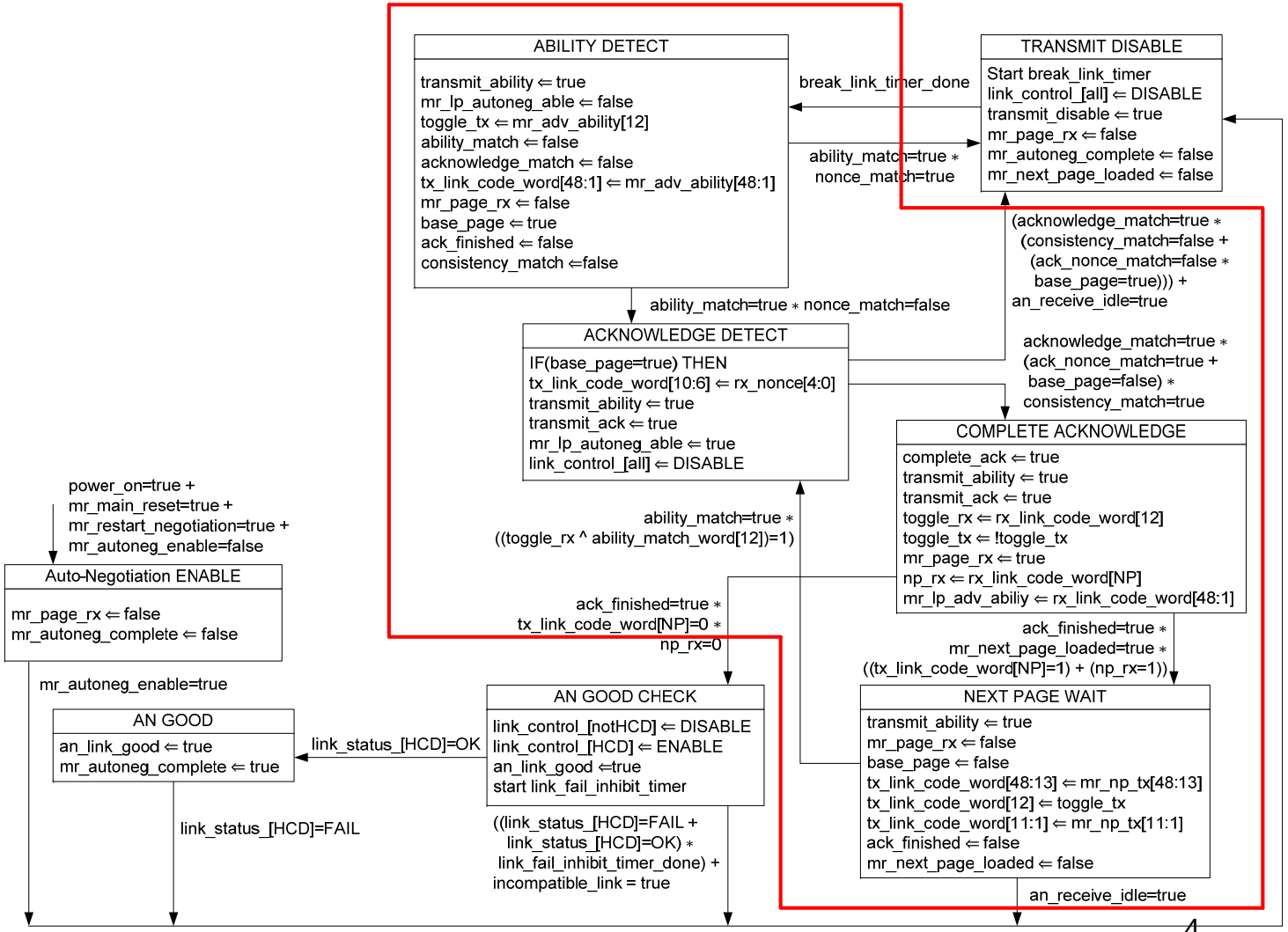
Wrapper around Sync State Machine

- States in red box equivalent to wang_3bp_01_1114.pdf pages 9 and 10 except merged into one.
- Other states (wrapper) similar to Auto-Negotiation Arbitration state machine



Auto-Negotiation Arbitration State Machine

- **States outside red box similar to wrapper in Sync state machine**



Unification of Auto-Negotiation and SEND_S State Machines

- Auto-Negotiation On, use Auto-Negotiation State Machine
- Auto-Negotiation Off, use Sync State Machine
- Both PHYs on or both PHYs off – no mix and match
  - Closed system Auto-Negotiation can be off
  - Open system Auto-Negotiation must be on
- Both SM timers and synchronization mechanism the same
  - Same break_link_timer values
  - Same link_fail_inhibit_timer values
  - Same way to drop link and re-synchronize again

Variables for SEND_S State Machine

Variables

config	Same as the config variable used in the PHY Control State Diagram
link_control	Same as the config variable used in the PHY Control State Diagram. However when DISABLE, it does not block the ability of the PHY to transmit and receive SEND_S signals.
link_status	Same as the link_status variable used in the Link Control State Diagram
mr_autoneg_enable	Same as the mr_autoneg_enable variable used in the Auto-Negotiation Arbitration State Diagram
mr_main_reset	Same as the mr_main_reset variable used in the Auto-Negotiation Arbitration State Diagram
power_on	Same as the power_on variable used in the Auto-Negotiation Arbitration State Diagram
send_s_sigdet	SEND_S pattern detected Values: True: SEND_S pattern detected False: SEND_S pattern not detected
tx_mode	PCS Transmit sends code-groups according to the value assumed by this variable. Values: SEND_S: This value is continuously asserted when transmission of 255 PN sequences generated by: $x^8+x^4+x^3+x^2+1$ for Master and $x^8+x^6+x^5+x^4+1$ for Slave. SEND_Z: This value is asserted when transmission of zero code-groups is to take place.

Timers

All timers operate in the manner described in 14.2.3.2.

break_link_timer	Same as the break_link_timer used in the Auto-Negotiation Arbitration State Machine
link_fail_inhibit_timer	Same as the link_fail_inhibit_timer used in the Auto-Negotiation Arbitration State Machine.
send_s_timer	Timer used to control the duration SEND_S is transmitted. The timer shall expire 1.0us ±0.04 us after being started.
signal_wait_timer	Timer used to control the wait time after transmitting or detecting the end of SEND_S. The timer shall expire 4us ±0.1 us after being started.

The Need to Drop Link Intentionally

- Unsuccessful training
- DSP dying and cannot recover for whatever reason
- Long quiet period used to indicate to link partner to drop link
  - break_link_timer traditionally used prior to training to insure both PHYs will train
  - Defined to be approx 1 second in Clause 28 because no defined standard to force link drop. Assumption is that 1 second should cause link partner to drop link.
  - Cannot afford 1 second to break link prior to training for 1000BASE-T1
    - Link must come up in under 100ms
- Solution:
  - Define clear minimum criteria on when 1000BASE-T1 PHY must drop link
    - Consolidated into variable PMA_watchdog_status
  - Does not preclude PHY from dropping link for other reasons
  - break_link_timer is a lot shorter in Clause 98 – propose 300us to 305us

Criteria to Drop Link – Receiver in Normal Operation

- **PMA_watchdog_status in PMA is forced to NOT_OK if any of the following occurs:**
  - **PAM3 symbol 0 consecutively seen on the line for longer than 2us +/- 0.1us**
  - **PAM3 symbol +1 consecutively seen on the line for longer than 3.9us +/- 0.1us**
  - **PAM3 symbol -1 consecutively seen on the line for longer than 3.9us +/- 0.1us**

- **Normal operation should not trigger above**
  - **Never should see more than two 0s in a row (2.67 ns) due PAM3 mapping limitation**
  - **Never should see consecutive +1s or consecutive -1s more than 17 80/81 blocks (1.2us)**
    - **Killer pattern construction limited by scrambler. Scrambler will preserve data block header bit polarity at most 15 consecutive 80/81 blocks. Add one 80/81 data block before the 15 and assume one control 80/81 block after can be constructed not to cause toggling (probably cannot). In any case 3.9us covers more than one RS frame and parity bits will toggle.**
  - **Burst noise limited to less than 100ns**

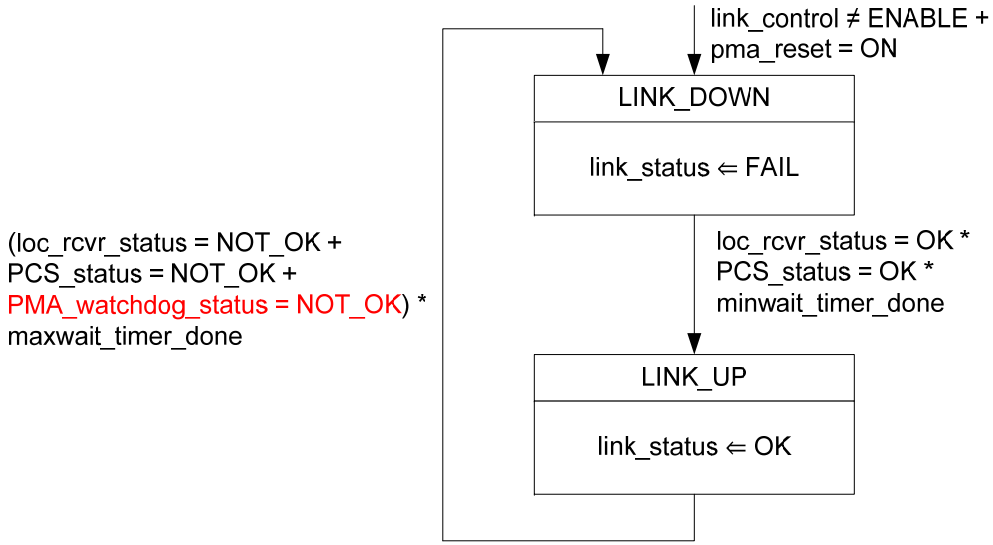
- **Actions to cause intentional link drop**
  - **Restart Auto-Negotiation or Sync - break_link_timer – 300 to 305 us of zeros**
  - **Gap between SEND_S signals - signal_wait_timer in – 4us +/- 0.1 us of zeros**
  - **Gap between Auto-Negotiation pages - backoff_timer at least 6.8 us of zeros**

Criteria to Drop Link – Low Power Idle Operation

- **PMA_watchdog_status in PMA is forced to NOT_OK if the following occurs:**
  - **PAM3 symbol not toggling on the line for longer than 90us +/- 0.1us**
- **Quiet Refresh Cycle should not trigger above**
  - **Refresh cycle is 1.44 us and should be toggling**
  - **Quiet time is just under 85 us**
  - **Burst noise limited to less than 100ns**
- **Actions to cause intentional link drop**
  - **Restart Auto-Negotiation of SEND_S - break_link_timer – 300 to 305 us of zeros**

Link Monitor State Diagram

PMA_watchdog_status
This variable monitors the PAM3 signal on the line.
Values: OK: Received PAM3 signal has sufficient transitions
NOT_OK: Received PAM3 signal has insufficient transitions defined as
During normal operation:
PAM3 symbol 0 consecutively seen on the line for longer than 2us +/- 0.1us
PAM3 symbol +1 consecutively seen on the line for longer than 3.9us +/- 0.1us
PAM3 symbol -1 consecutively seen on the line for longer than 3.9us +/- 0.1us
During Low Power Idle operation:
PAM3 symbol not toggling on the line for longer than 90us +/- 0.1us



Motions

- Amend SEND_S state machine in wang_3bp_01_1114.pdf pages 9 and 10 with the one in Lo_3bp_01_0115.pdf pages 3 and 6.
- Adopt PMA_watchdog_status and Link Monitor State Machine in Lo_3bp_01_0115.pdf pages 10
- Specify send_s_timer limits to be 1.0us +/- 0.04us
  - Ts_timer in wang_3bp_01_1114.pdf is 1us with no min/max
- Specify signal_wait_timer limits to be 4.0us +/- 0.1us
  - Td_timer and Tw_timer in wang_3bp_01_1114.pdf is 4us with no min/max

THANK YOU