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IEEE 802.3cg

10BASE-T1S Autoneg and Link Status Indication

November 7th, 2018



- Problem statement:
 - 10BASE-TIS defines support for Clause 98 Auto-Negotiation (AN)
 - AN requires a link status indication to work properly
 - Comment #204 on D2.0 from Steffen Graber
 - **10BASE-TIS in current draft has no such concept of link status**
 - There is no training phase and no continuous IDLE indication on the line
- Background
 - AN is optional
 - AN is not defined for multi-drop
 - With an AN/non-AN link, AN cannot complete and link will stay down forever
 - Remark: only true for Clause 98 AN



- Requirements for link status indication:
 - Reception of a number of HB in a certain time indicates the link is up
 - Missing HB / data (RX_DV) for a certain amount of time results in a link down
 - HB should not affect traffic during normal operation
- Proposed solution
 - Add a link monitor state machine in the PMA
 - Add FSMs in PCS to transmit a heartbeat (HB) signal on the line periodically
 - HB is preempted by the MAC transmitting and by PLCA
 - Reception of a valid data packet counts as an HB
 - Add FSM in PCS to generate a PCS status indication based on HB / packet reception
 - Report link up when at least two HB / packets are received
 - Report link down if no HB / valid packets are received in a certain time interval



Problems & proposed solutions

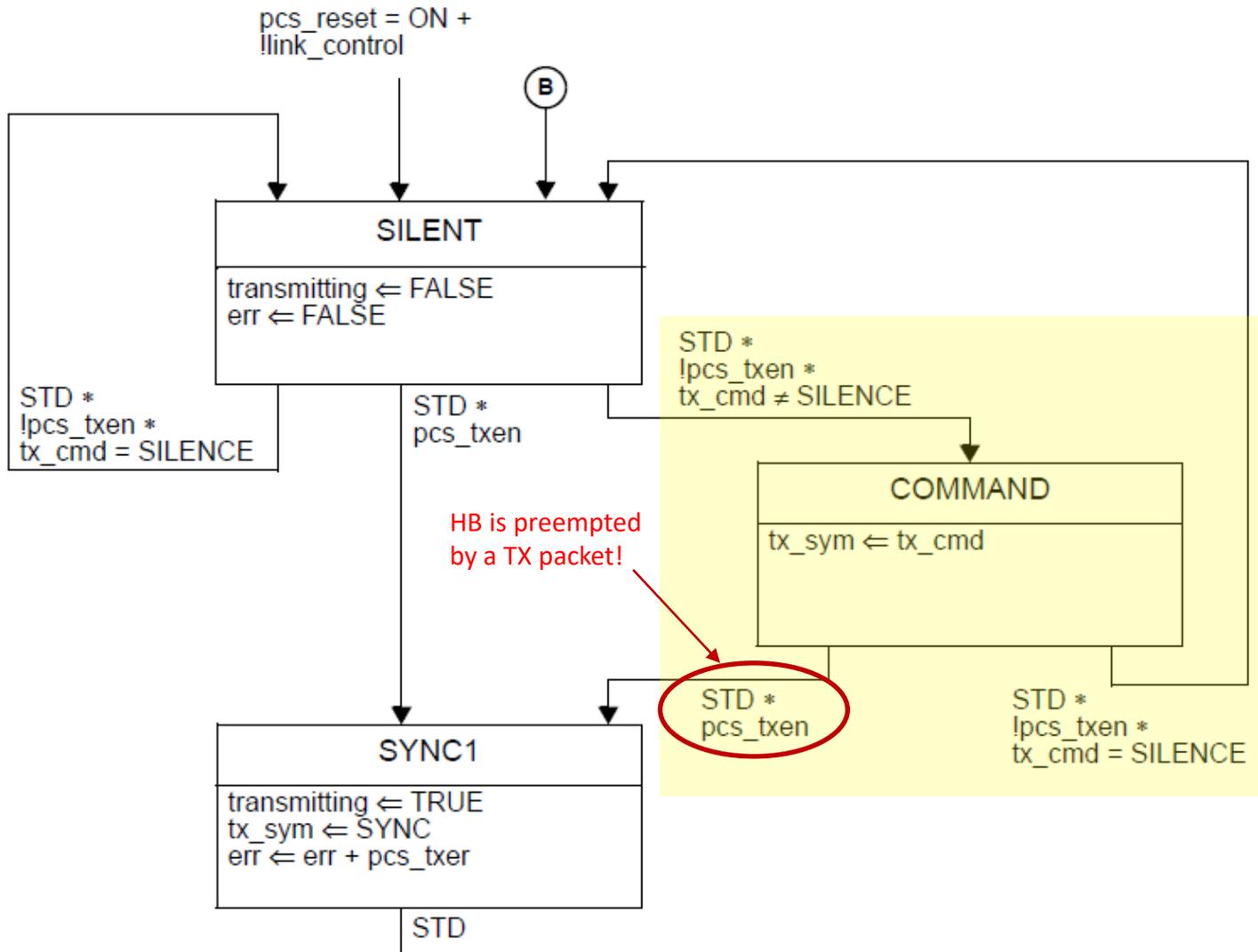


Figure 147-4 PCS Transmit state diagram (part a)

Not interfering with TX from MII: re-use of PCS TX COMMAND state to send HB on the line

HEARTBEAT is a repeated 'T' (01101) 5B symbol. Such symbol is already used as ESD but it can be re-used for this purpose (no ambiguities)

It is transmitted by PCS TX, using the already available `tx_cmd` variable.

The `tx_cmd` variable is used by PLCA RS to convey BEACON and COMMIT commands to the PHY. PLCA takes precedence over the HB.



- Point-to-Point full-duplex case
 - No additional problems (HBs cannot collide!)
- Point-to-Point half-Duplex case
 - Possible collisions between HB and data packets
 - Data will be re-transmitted by MAC (normal CSMA/CD behavior)
 - HB re-transmitted after jamming, during IPG (collisions are no more possible)
 - Use auto-neg master/slave negotiation to select which PHY has to send unsolicited HB
 - Only the master sends unsolicited HB
 - Slave PHY replies to HB messages with HB in turn
 - This minimizes the chance of collision between packets and HB
 - » Collisions between HBs are not possible
 - NOTE: 10BASE-T1S does not require master/slave negotiation for normal operation
 - Not a far-end echo canceled system, no clock looping
 - PLCA works on multi-drop networks where AN is not defined, thus it does not need an HB concept.
 - Disable HB if PLCA is enabled / detected



- Adding a link status indication requires several text changes throughout Clause 147
- The following slides show the conceptual changes
- The complete list of changes can be found here:
 - http://www.ieee802.org/3/cg/public/Nov2018/Clause%20147%20-%20Link%20Status%20for%20AN_changesonly.pdf



Change Figure 147-2 as shown (red dashed boxes indicate changes – these are not intended for the final figure):

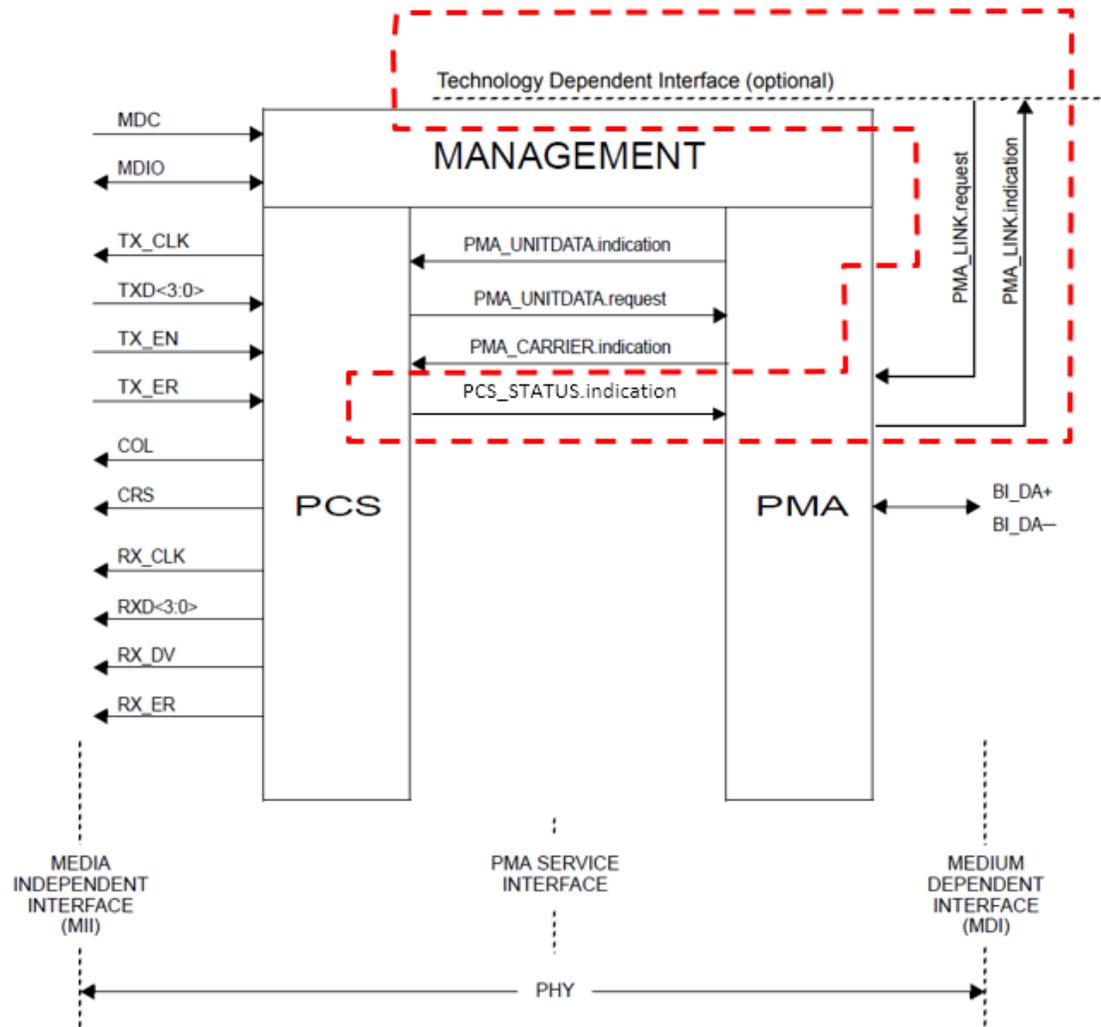


Figure 147-2—10BASE-T1S PHY interfaces

- Change Figure 147-2
 - Add PMA_LINK.indication
 - Add PMA_LINK.request
 - Add PCS_STATUS.indication
 - Add Technology Dependent Interface



Change Figure 147-3 to add PCS_STATUS.indication primitive as shown (changes in red):

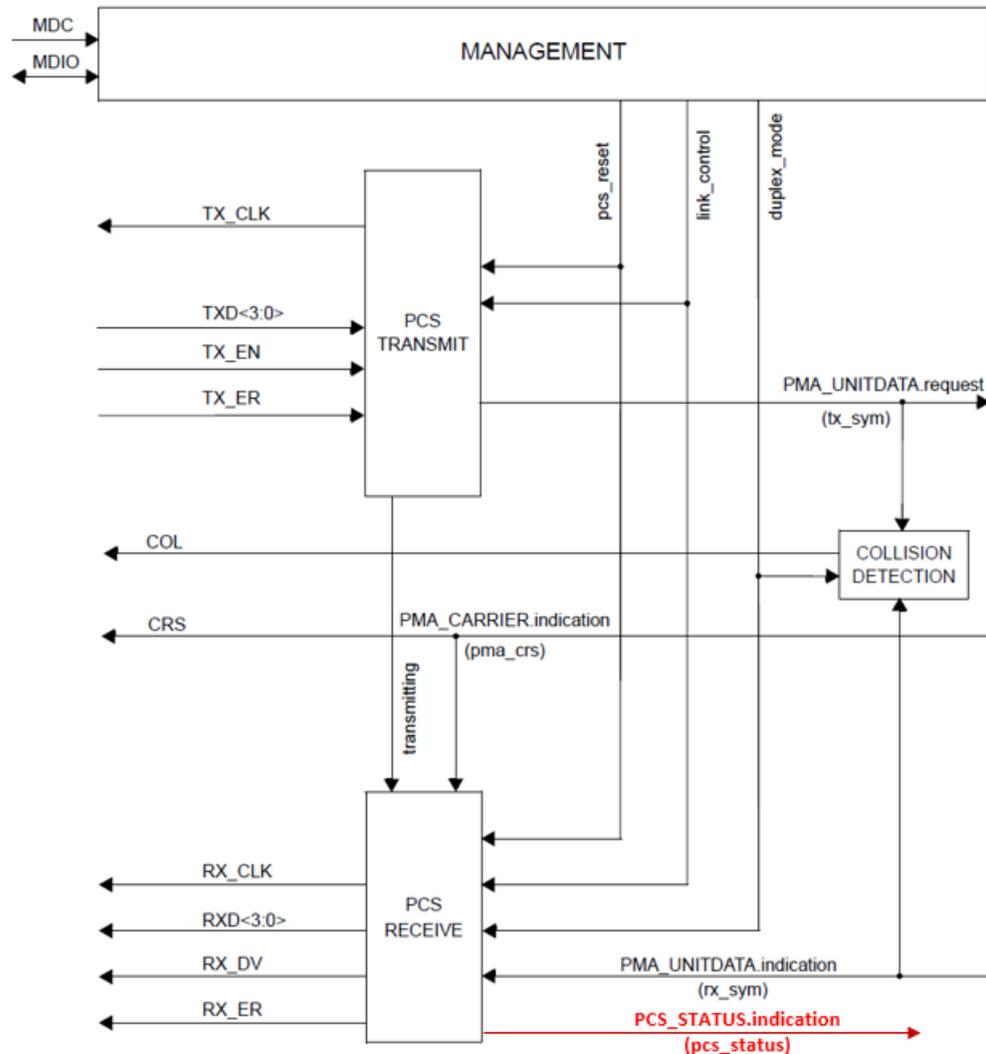


Figure 147-3—PCS reference diagram

- Change Figure 147-3
 - Add PCS_STATUS.indication primitive as in the left picture (red)



Change Figure 147-10 to add LINK MONITOR and primitives as shown (changes in red):

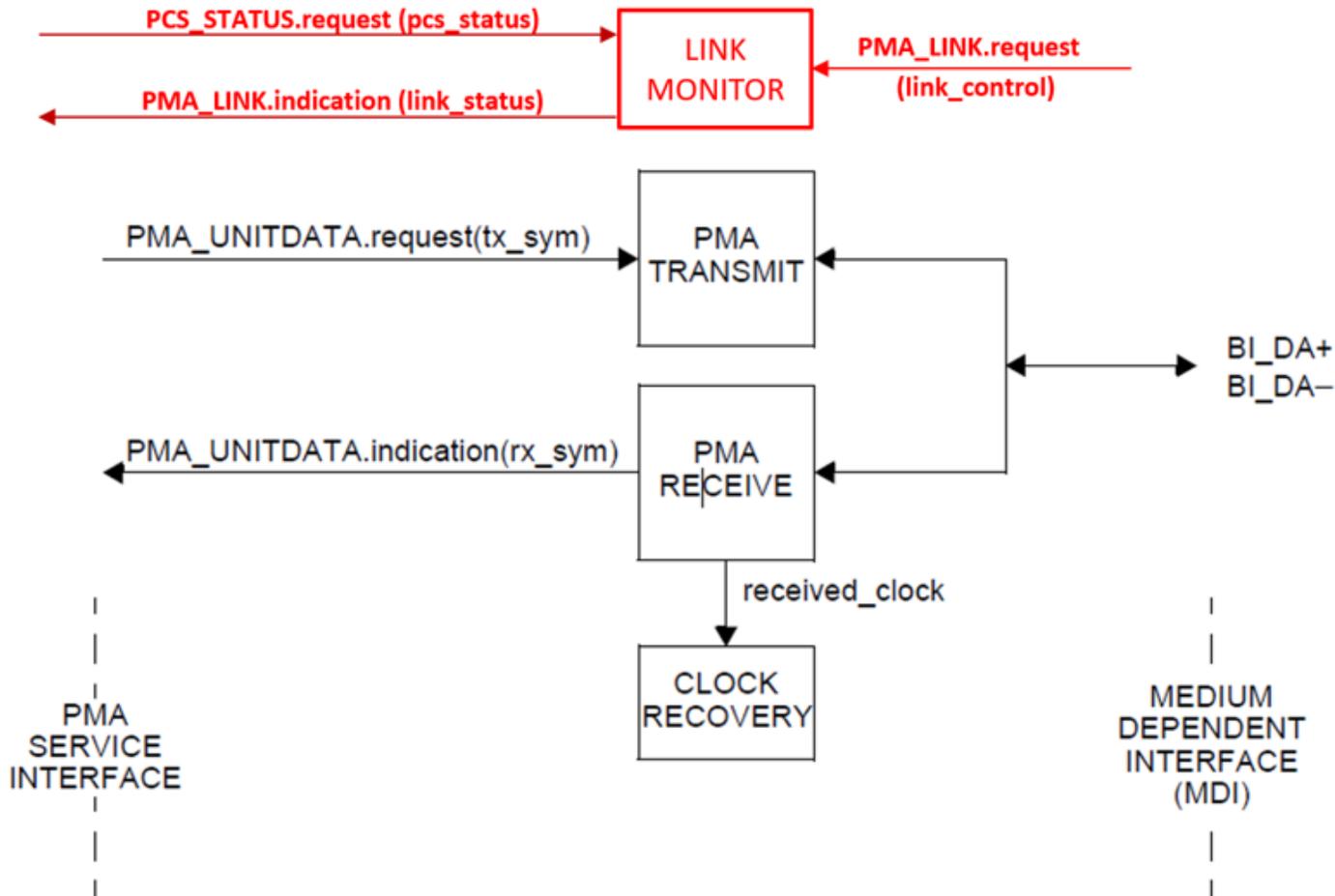


Figure 147-10—PMA functional block diagram

- Change Figure 147-10
 - Add Link Monitor block and related primitives as depicted in red



In clause 147.3.2.2, change description of tx_cmd as follows:

5B symbol to be transmitted when the PCS Transmit function is in ~~SILENT~~ COMMAND state. The tx_cmd variable is assigned according to ~~the~~ PLCA RS signaling over MII interface, as defined in 22.2.2.4, 148.4.3.1.1, and 148.4.3.1.2. in conjunction with value of the hb_cmd variable, defined in 147.3.8.2.

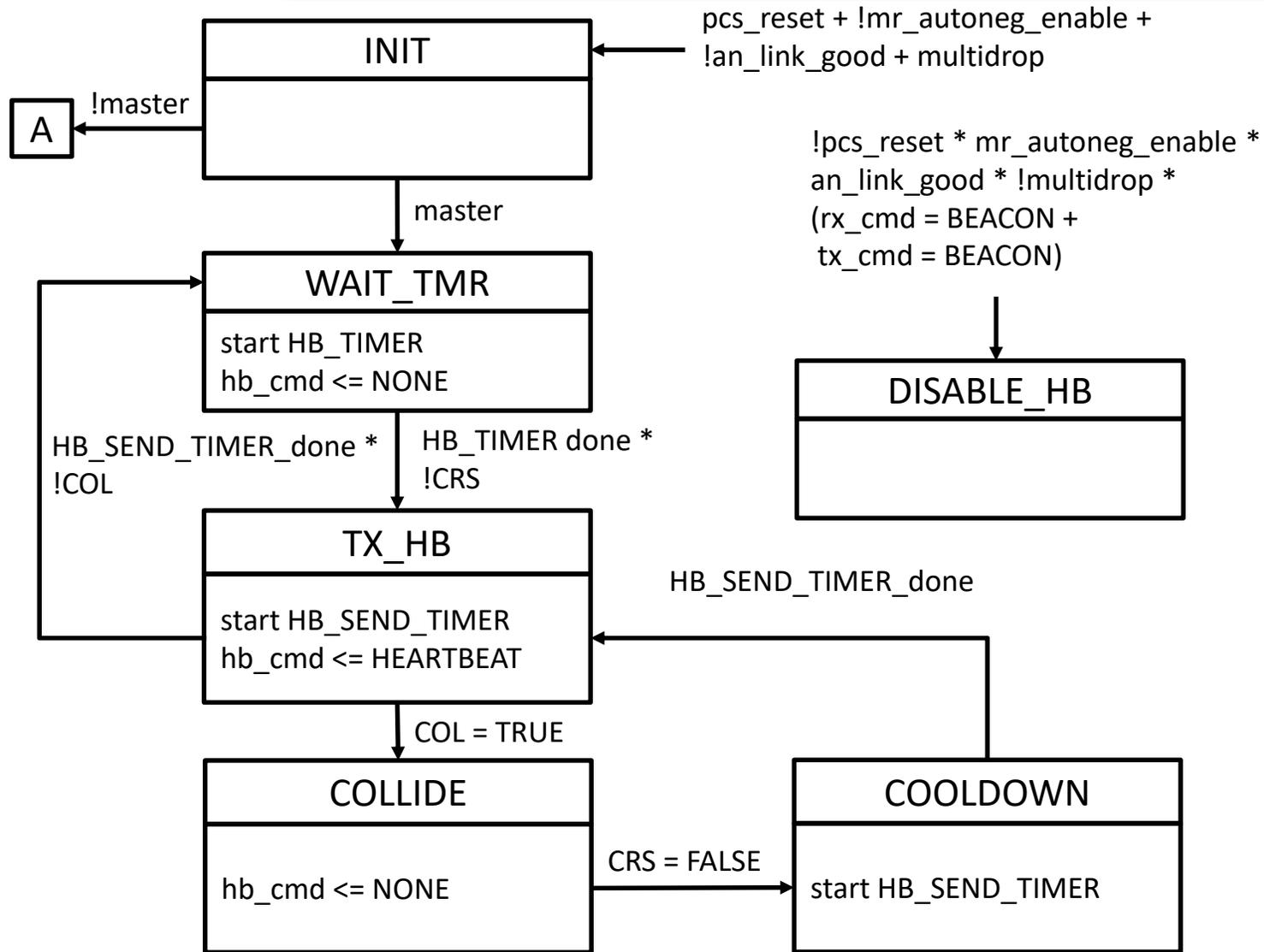
The following mapping shall be used:

- tx_cmd <= 'N' when a BEACON request is asserted,
- tx_cmd <= 'J' when a COMMIT request is asserted,
- tx_cmd <= 'T' when hb_cmd variable is set to HEARTBEAT and none of the previous requests is asserted,
- tx_cmd <= 'I' otherwise.

~~When PLCA capabilities are not supported or disabled, tx_cmd shall be set to the special 5B symbol 'I' (binary vector of 1,1,1,1,1) representing SILENCE~~



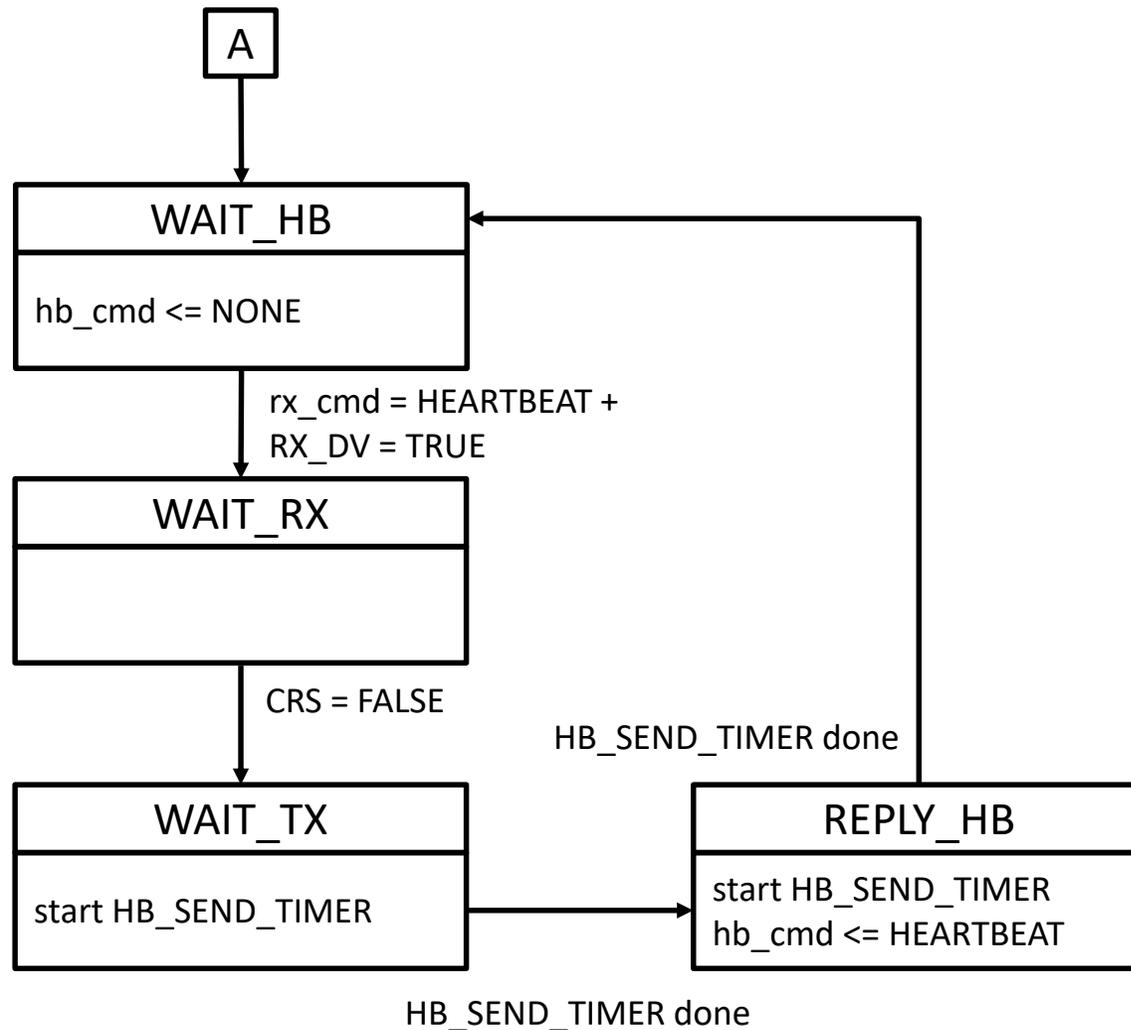
HB Transmit State Diagram 1/2



- $HB_TIMER = 50\text{ ms}$
- $HB_SEND_TIMER = \text{duration of HB on the line} = 20\text{ bit-times}$
- $mr_autoneg_enable = \text{Auto-Negotiation supported and enabled}$
- $an_link_good = \text{Auto-Negotiation complete}$
- $multidrop = \text{Multidrop mode (register 1.2299.10)}$
- $master = \text{TRUE}$ when master role negotiated using method in 98.2.1.5 and Table 98-4
- $rx_cmd = \text{enumerated value set to 'BEACON'}$ when a BEACON indication is generated as specified in 147.3.7.1. Set to 'COMMIT' when a COMMIT indication is generated as specified in 147.3.7.2. Set to 'HEARTBEAT' when a HB is detected on the line. Set to 'NONE' otherwise.



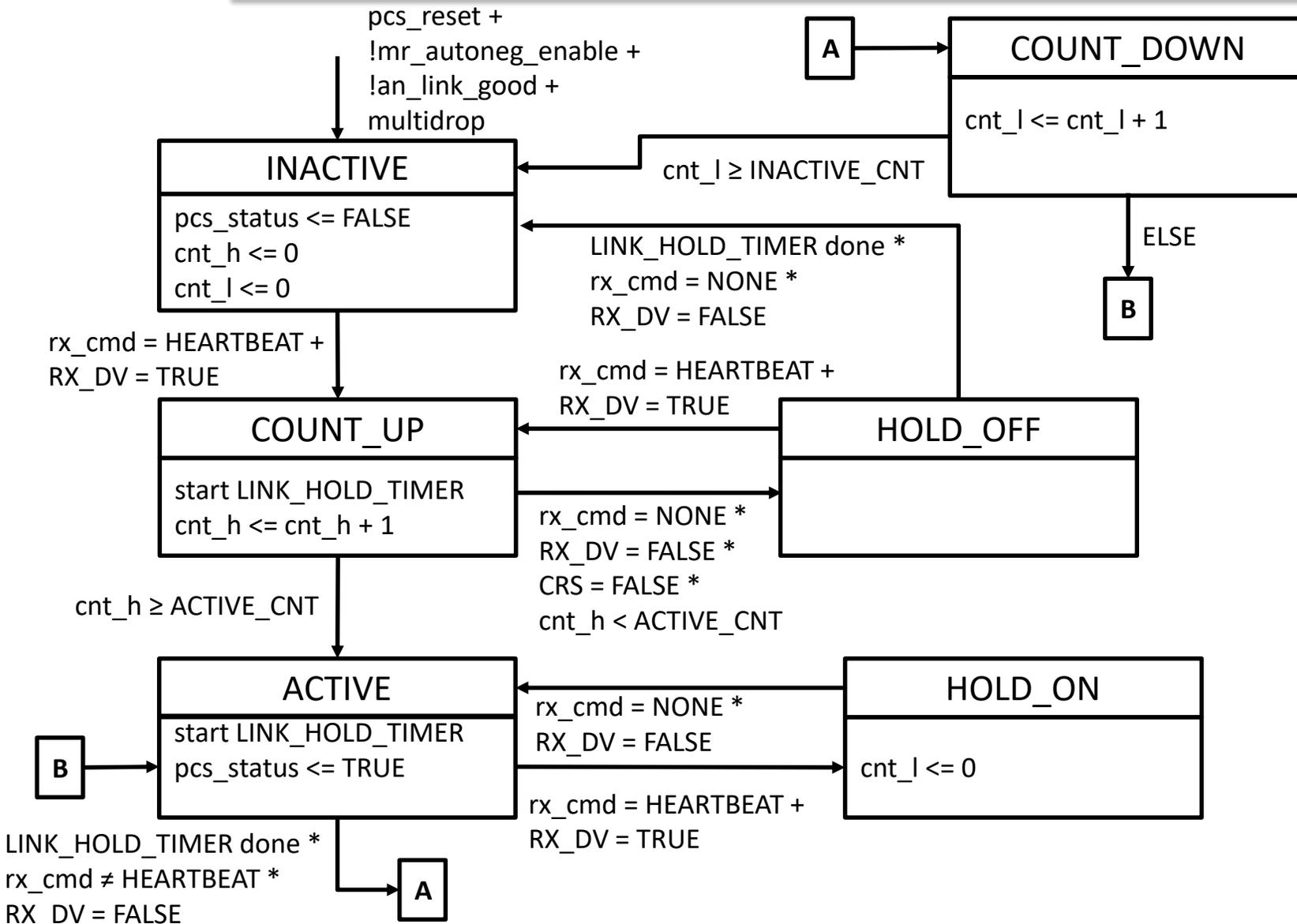
HB Transmit State Diagram 2/2



- **HB_SEND_TIMER** = duration of HB on the line = 20 bit-times
- **mr_autoneg_enable** = Auto-Negotiation supported and enabled
- **an_link_good** = Auto-Negotiation complete
- **multidrop** = Multidrop mode (register 1.2299.10)
- **hb_cmd** = enumerated value. Values: HEARTBEAT, NONE.



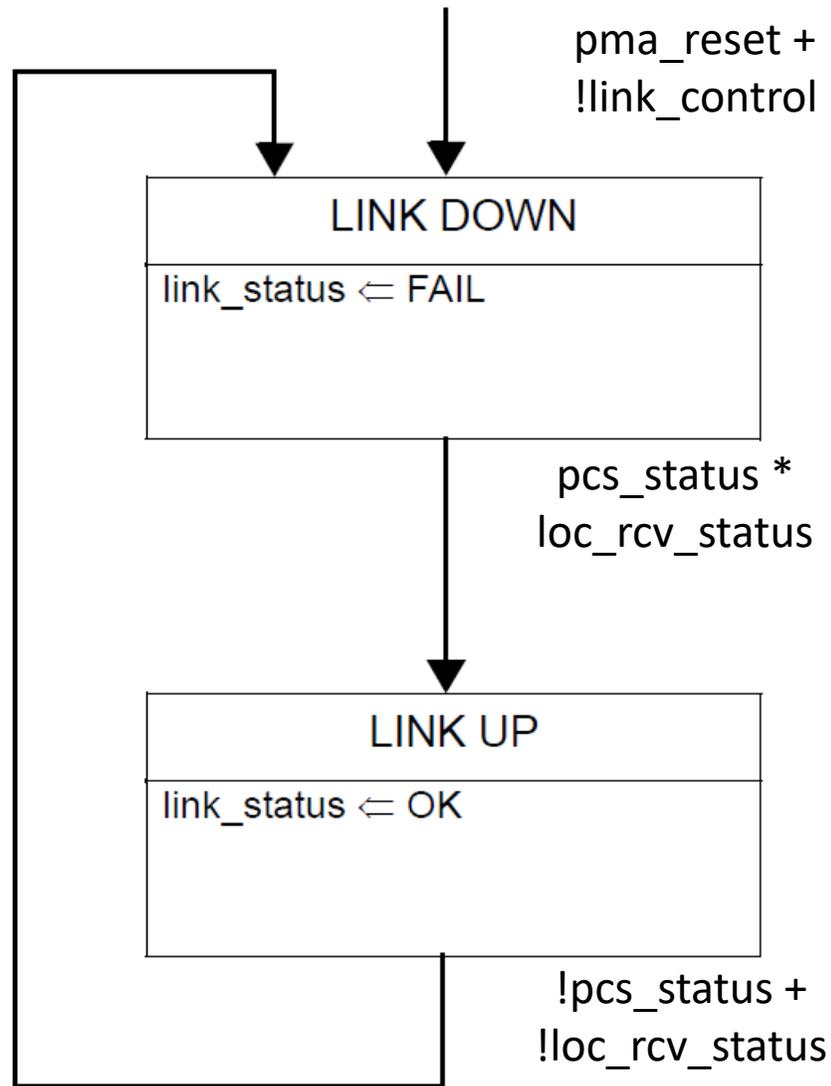
HB Receive State Diagram



- cnt_l = counter of HB when pcs_status is TRUE
- cnt_h = counter of HB when pcs_status is FALSE
- ACTIVE_CNT = number of HB required to signal pcs_status = TRUE
Value: **2**
- INACTIVE_CNT = number of HB required to signal pcs_status = FALSE
Value: **5**
- LINK_HOLD_TIMER: time after which the count of HB is reset
Value: **50 ms**



Link Monitor State Diagram



- `link_control`: generated by management
- `pcs_status`: conveyed by PCS via the `PMA_PCSSTATUS.request` primitive
- `loc_rcv_status`: implementation defined variable, indicating the PMA is ready to receive data from the line
- `link_status`: parameter of the generated `PMA_LINK.indication` primitive

THANK YOU!