

EEE Compatible 100Base-TX

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IEEE 802.3az Interim Meeting

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- ❑ Robert Hays (Intel)
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Outlines

- ❑ Scopes
- ❑ Signals among MAC and local/remote PHYs
- ❑ EEE State Diagram Variables and Timers
- ❑ EEE State Diagrams
- ❑ Transition Timing Diagrams
- ❑ Summary

Scopes

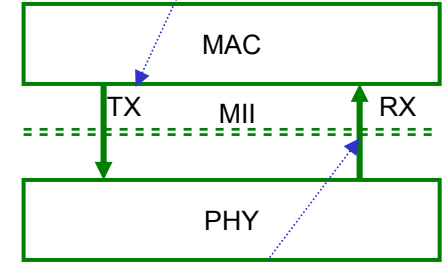
- ❑ Support LPI based EEE 100Base-TX proposal
- ❑ Provide the signaling between MAC and PHY, and between Local PHY and Remote PHY
- ❑ Refine the State Diagrams proposed in chou_01_0308 to meet the documentation requirement of 802.3 standard
- ❑ Define the necessary variables and timers used for State Diagrams

Signals between MAC and PHY (MII)

TX_EN	TX_ER	TXD<3:0>	Indication
0	0	0000 through 1111	Normal inter-frame
0	1	0000	Reserved
0	1	0001	EEE Low Power IDLE
0	1	0010 through 1111	Reserved
1	0	0000 through 1111	Normal data transmission
1	1	0000 through 1111	Transmit error propagation

RX_DV	RX_ER	RXD<3:0>	Indication
0	0	0000 through 1111	Normal inter-frame
0	1	0000	Normal inter-frame
0	1	0001	EEE Low Power IDLE
0	1	0010 through 1111	Reserved
0	1	1110	False Carrier indication
0	1	1111	Reserved
1	0	0000 through 1111	Normal data reception
1	1	0000 through 1111	Data reception with errors

EEE_LPI
Opcode from
MAC to PHY



EEE_LPI
Opcode from
PHY to MAC

Note: From 802.3az Task Force Dove_01_0108.pdf

Signals between PHYs

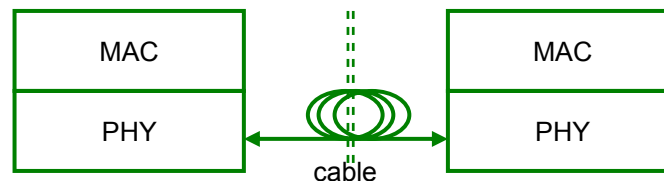
- Sleep/Wake Request Code-groups

Table 24-1 —4B/5B code-groups

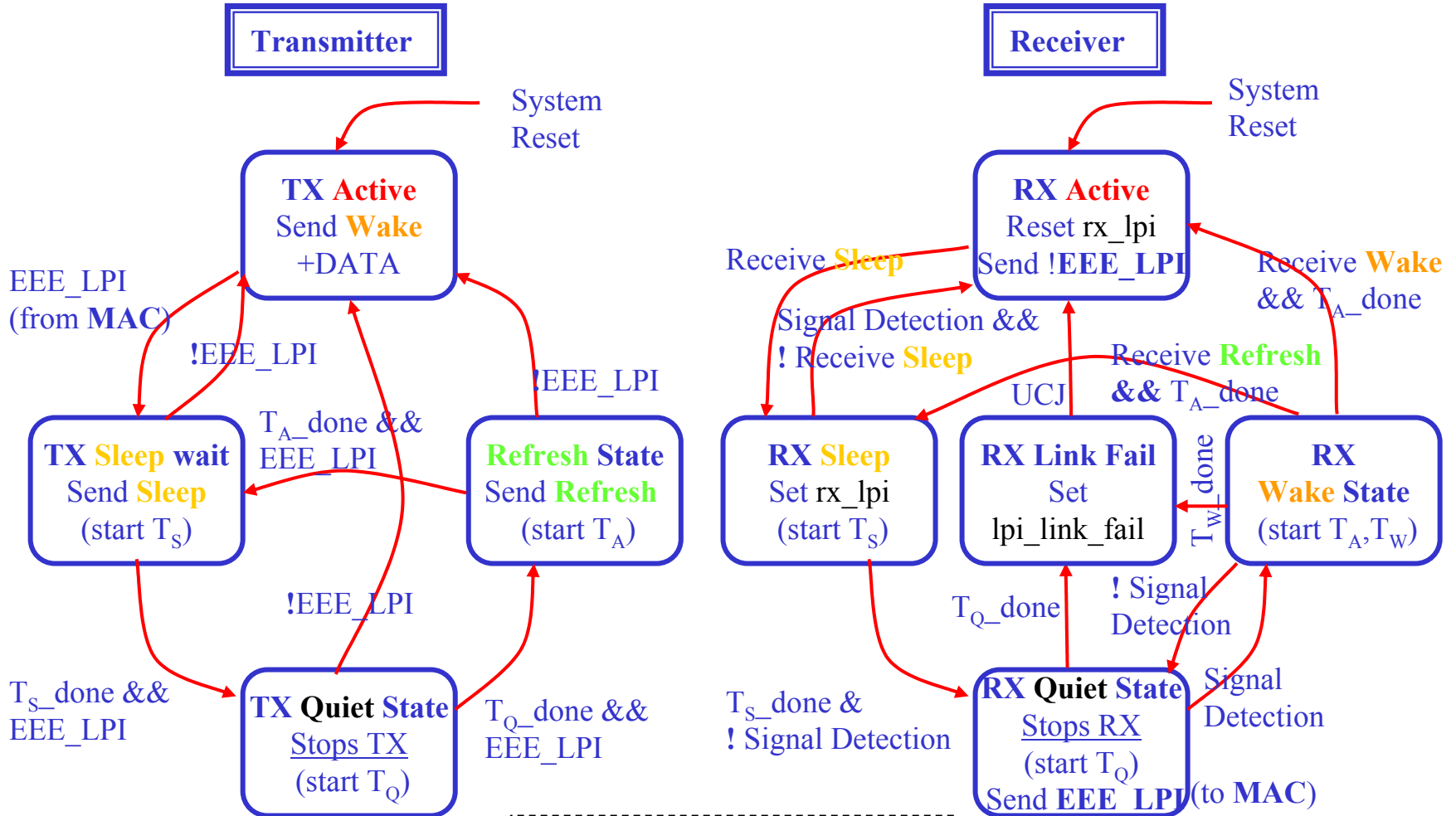
PCS code-group [4:0] 4 3 2 1 0	Name	MII (TXD/RXD) <3:0> 3 2 1 0	Interpretation
1 1 1 1 1	I	undefined	IDLE; used as inter-stream fill code
0 0 1 0 0	H	Undefined	Transmit Error; used to force signaling errors
0 0 0 0 0	P	Undefined	LPI
0 0 0 0 1	V	Undefined	Invalid code
0 0 0 1 0	V	Undefined	Invalid code
0 0 0 1 1	V	Undefined	Invalid code
0 0 1 0 1	V	Undefined	Invalid code
0 0 1 1 0	V	Undefined	Invalid code
0 1 0 0 0	V	Undefined	Invalid code
0 1 1 0 0	V	Undefined	Invalid code
1 0 0 0 0	V	Undefined	Invalid code
1 1 0 0 1	V	Undefined	Invalid code

Normal IDLE code-group to **Wake** the Remote PHY

Unused code-group for Low-Power Line Signal to Request **Sleep** or **Refresh** the Remote PHY



100BT LPI Line State Diagrams (PHY)



Note: Addition to Figure 24-8 PCS Transmit state diagram

Note: rx_lpi, lpi_link_fail, new signals for Figure 24-15 Link Monitor State Diagram

Note: Addition to Figure 24-11 PCS Receive state diagram

New State Diagram variable Definitions

□ Variables

➤ rx_lpi

- Status indicating whether the local PHY is in Low Power Idle operating state
- Values: TRUE; local PHY is in Low Power Idle mode
FALSE; local PHY is in Active mode

➤ lpi_link_fail

- Controls the transition to a Link Fail state during the Low Power Idle mode
- Values: TRUE; Link of local receiver is down
FALSE; Link of local receiver is up

➤ receiver

- Controls the Receiving function of local device
- Values: STANDBY; The local Receiver is in power down state
ACTIVE; The local Receiver is in active operating state

➤ transmitter

- Controls the Transmitting function of local device
- Values: STANDBY; The local Transmitter is in power down state
ACTIVE; The local Transmitter is in active operating state

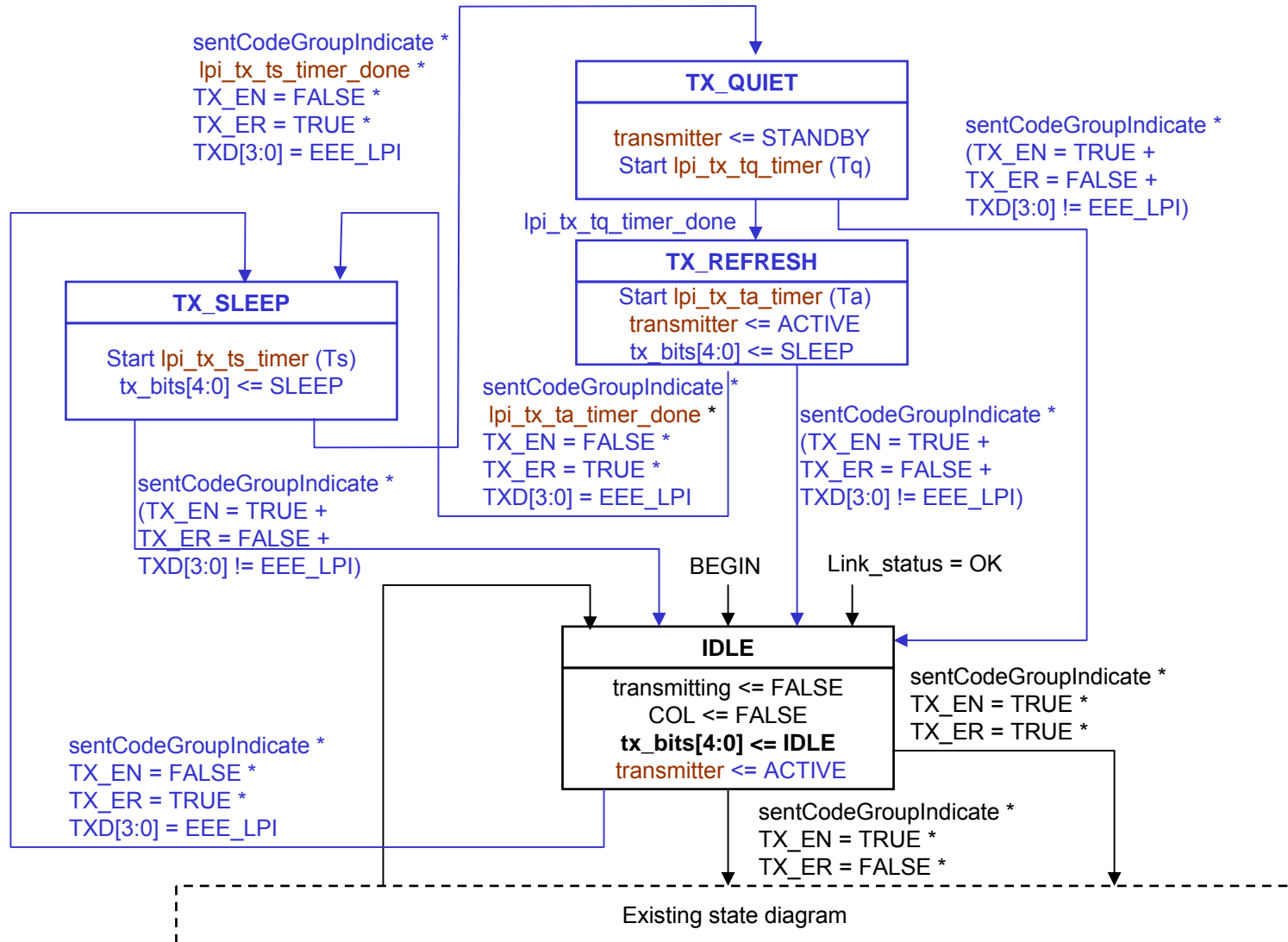
New State Diagram variable Definitions

□ Timers (default value in parenthesis)

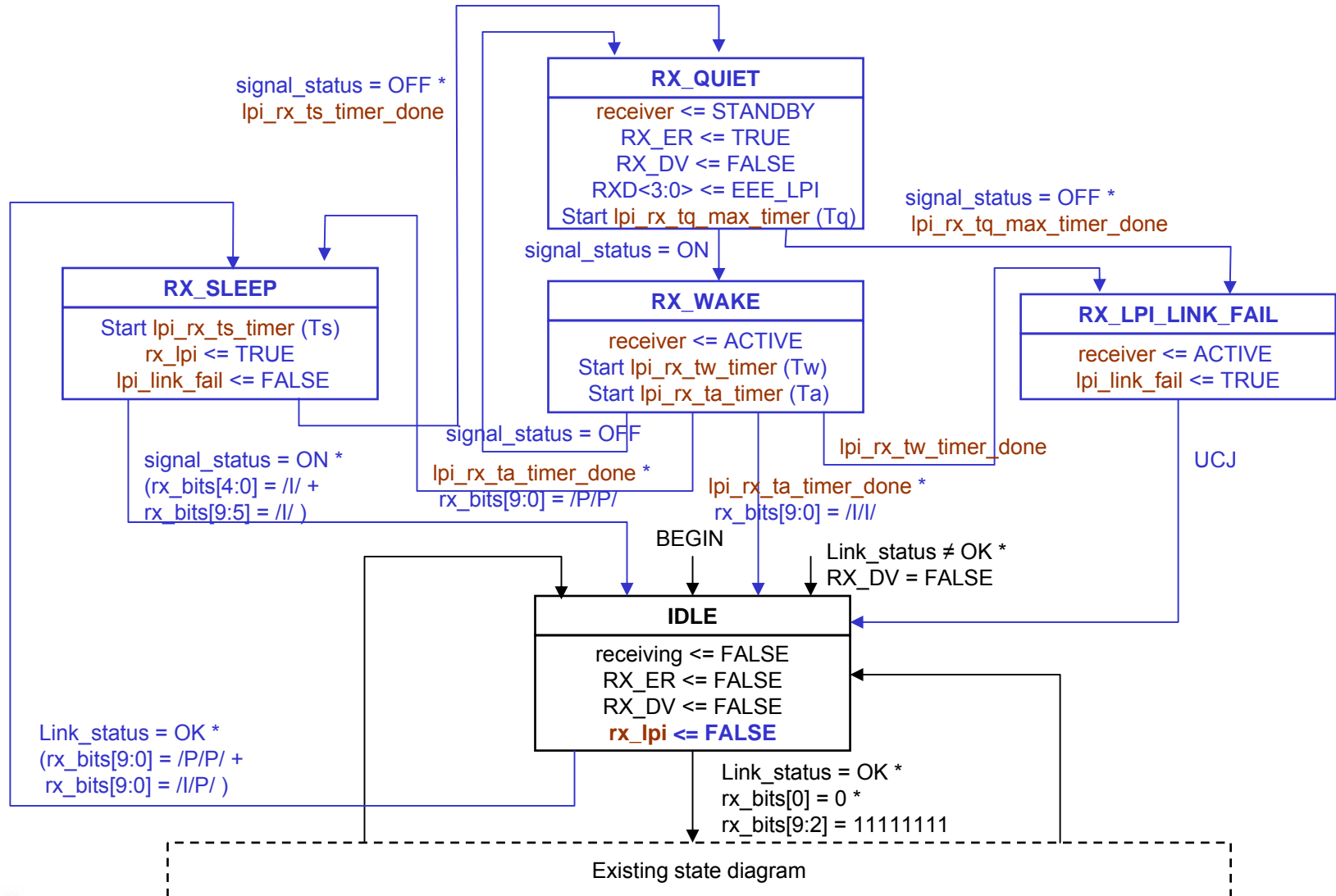
- **Lpi_tx_ts_timer**: Sleep state timer for Transmitter (1us)
- **Lpi_tx_tq_timer**: Quiet state timer for Transmitter (10ms)
- **Lpi_tx_ta_timer**: Intermediate Wake or Refresh state timer for Transmitter (8us)

- **Lpi_rx_ts_timer**: Sleep state timer for Receiver (1us)
- **Lpi_rx_tq_max_timer**: Maximum time allowed for Quiet state for Receiver (11ms)
- **Lpi_rx_ta_timer**: Intermediate Wake or Refresh state timer for Receiver (8us)
- **Lpi_rx_tw_timer**: Wake state timer for Receiver (10us)

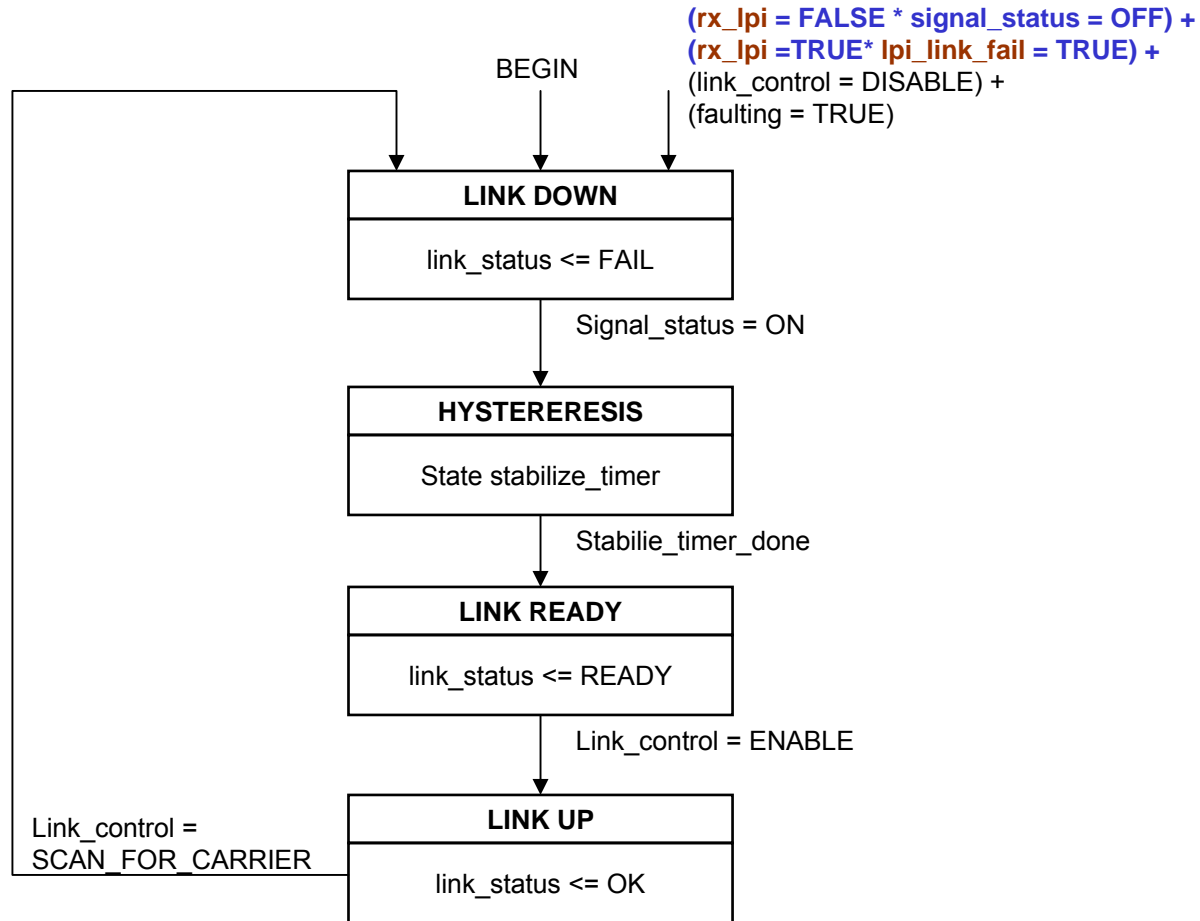
PCS Transmit State Diagram, Fig 24-8



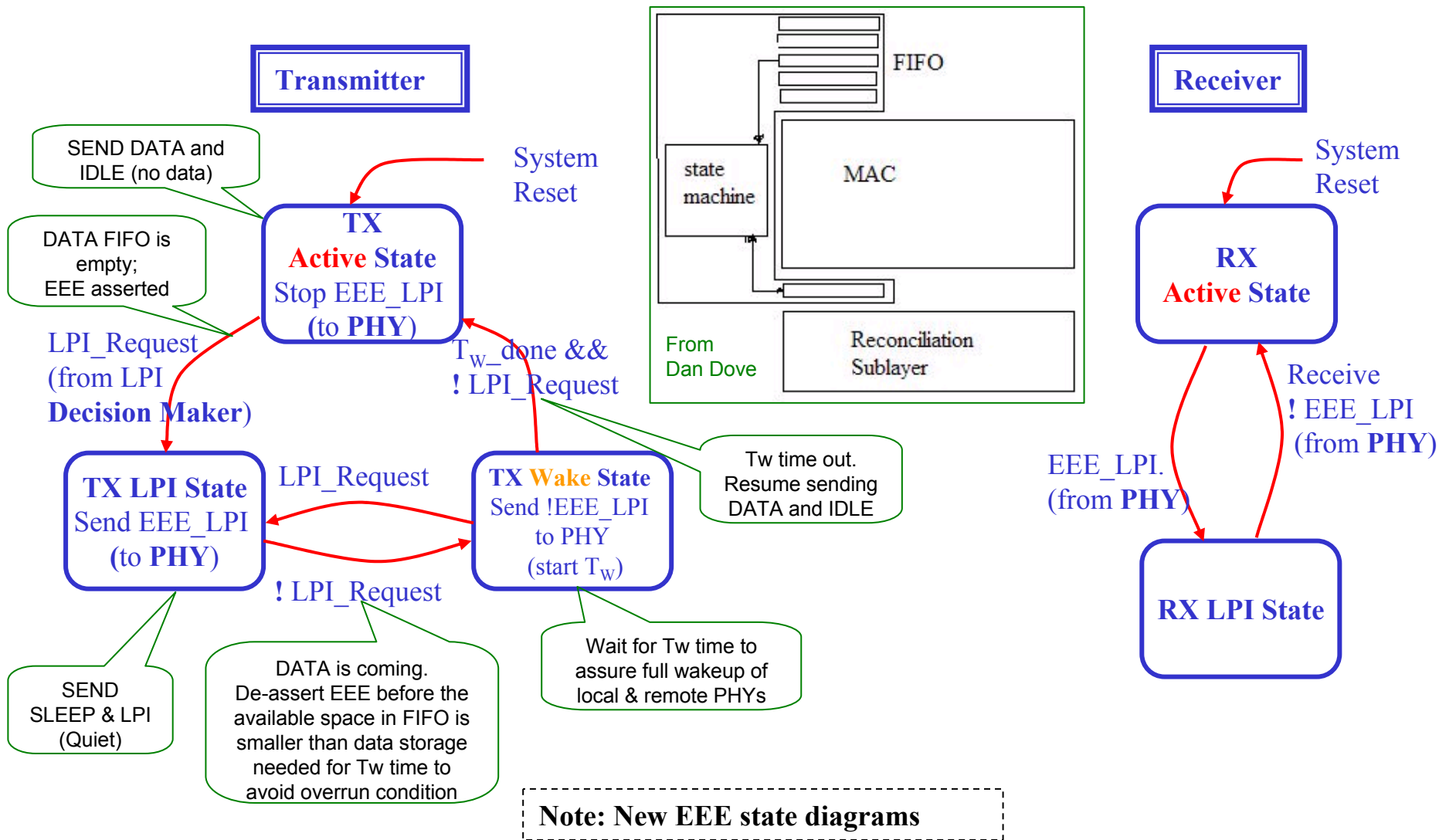
PCS Receive State Diagram, Fig 24-11



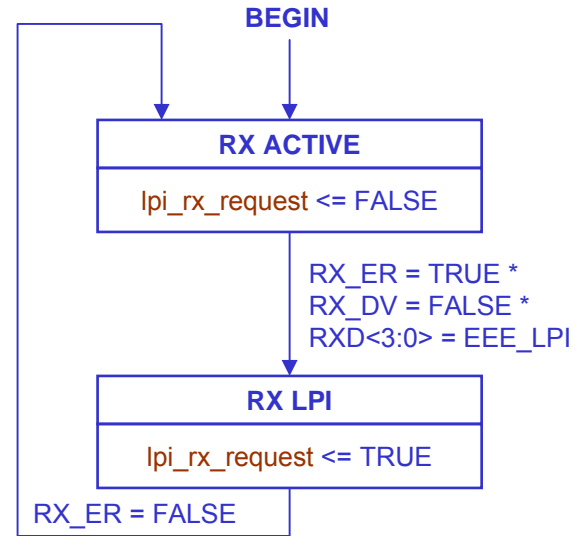
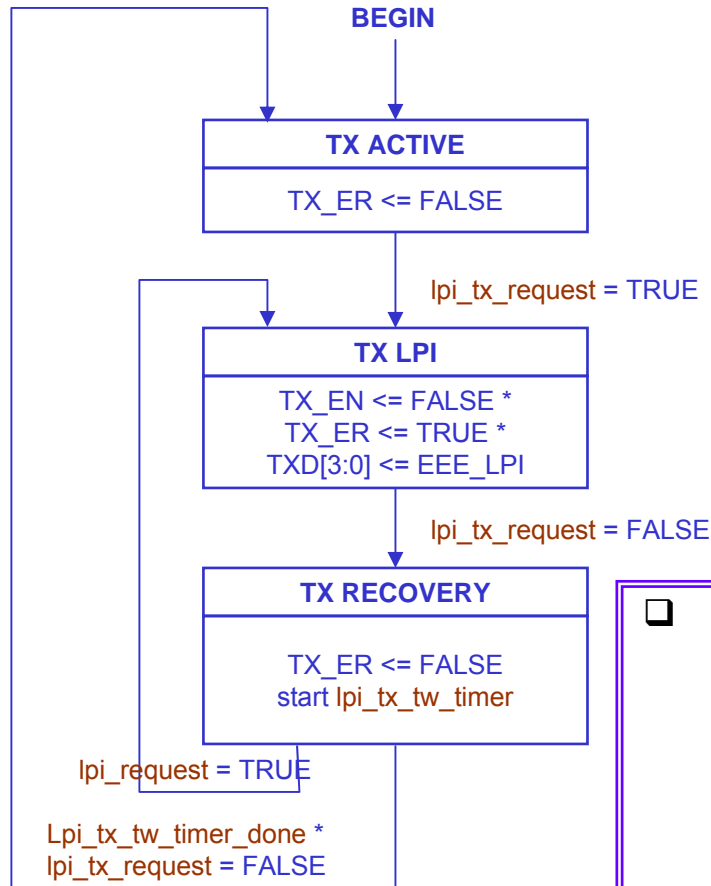
Link Monitor State Diagram, Fig 24-15



100BT LPI Operating State Diagrams (above PHY)



LPI Operating State Diagrams (above PHY)



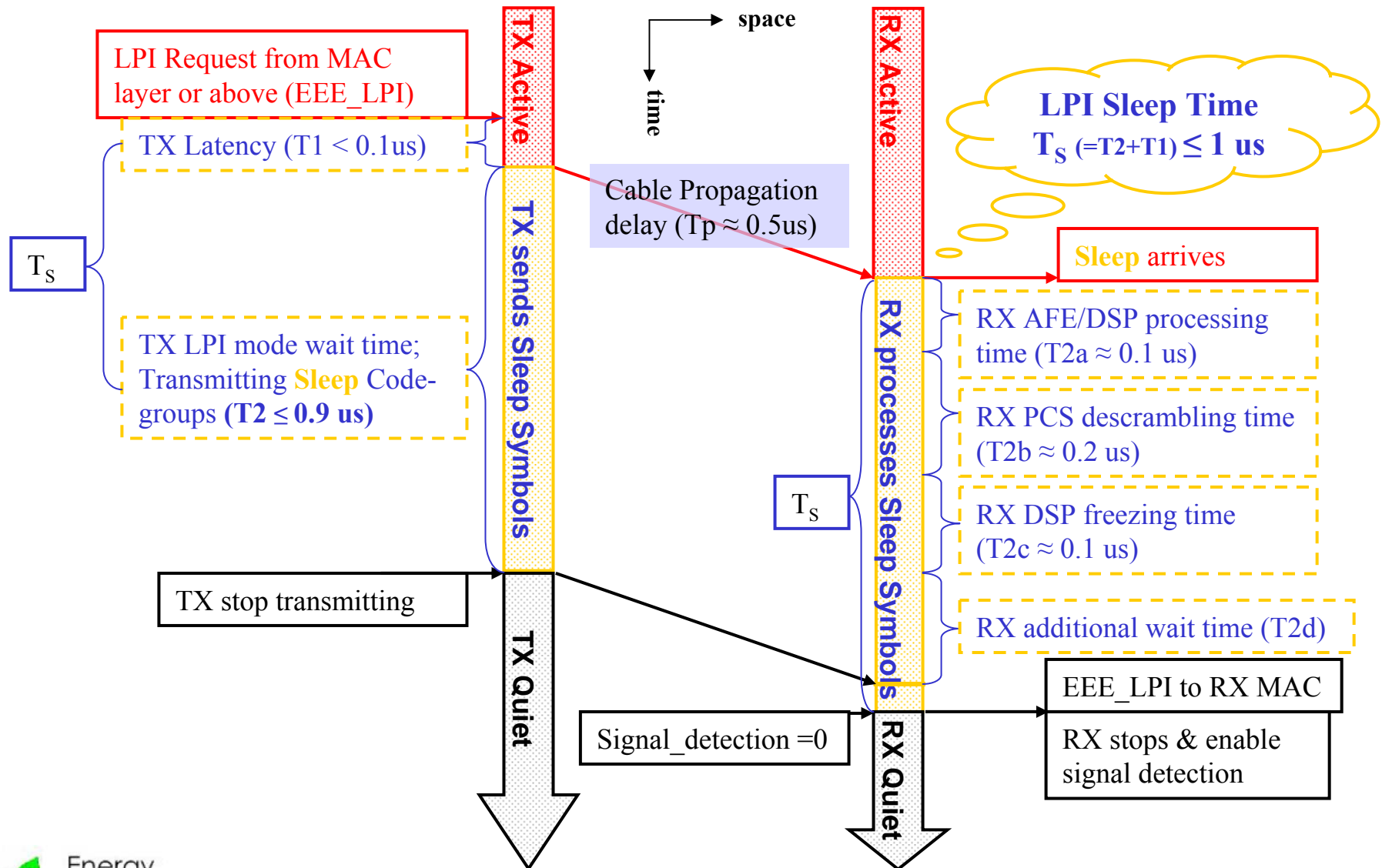
Variables

- **lpi_tx_request**
 - Controls the transition to Transmitter Low Power Idle mode
 - Values: TRUE; Transmitter goes into Low Power Idle mode
FALSE; Transmitter exits from Low Power Idle mode
- **lpi_rx_request**
 - Status indicating whether the Receiver is in Low Power Idle operating state
 - Values: TRUE; local Receiver is in Low Power Idle mode
FALSE; local Receiver is in Active mode

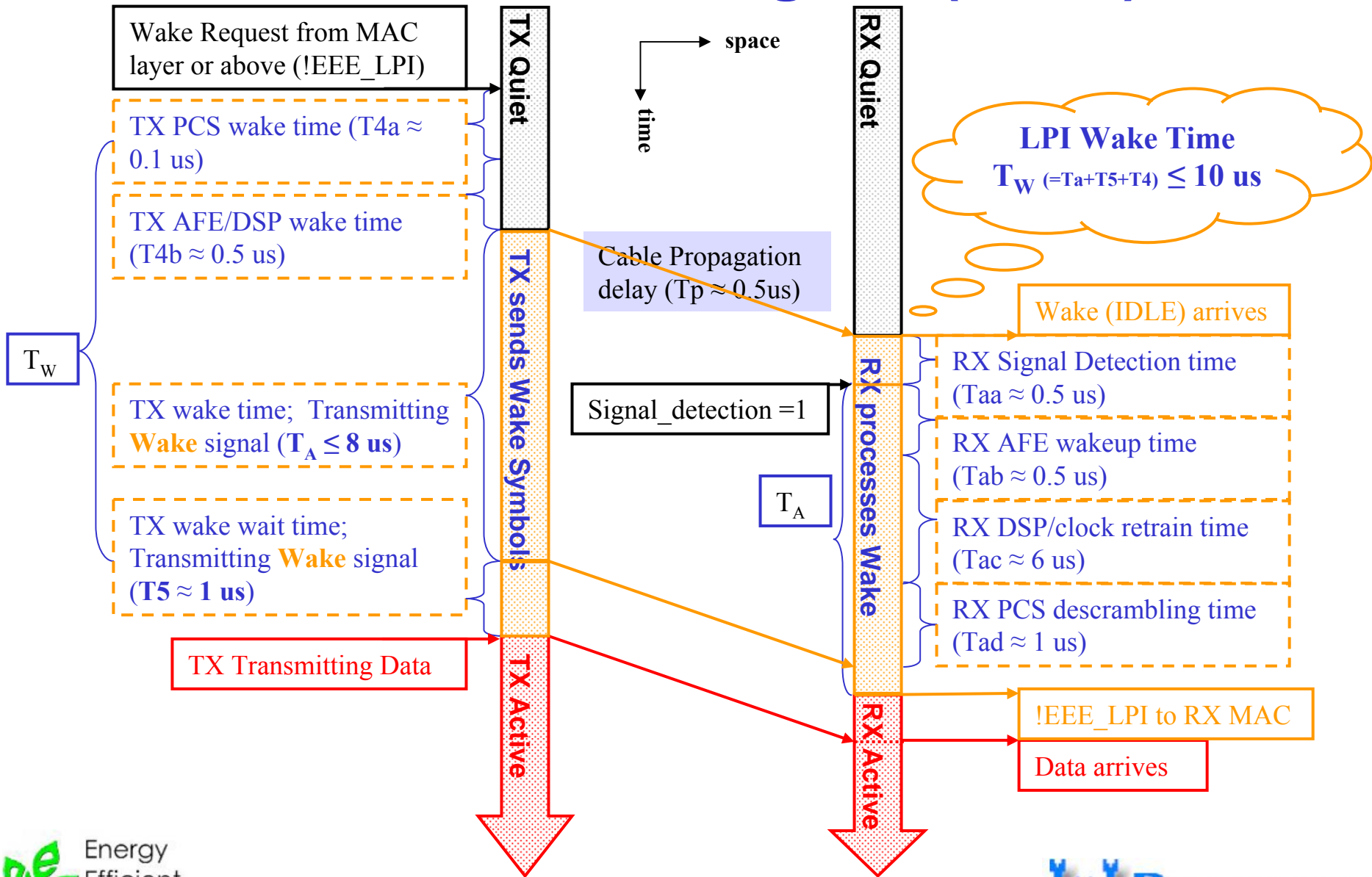
Timer (default value in parenthesis)

- **lpi_tx_tw_timer**: Wake state timer for Transmitter (10us)

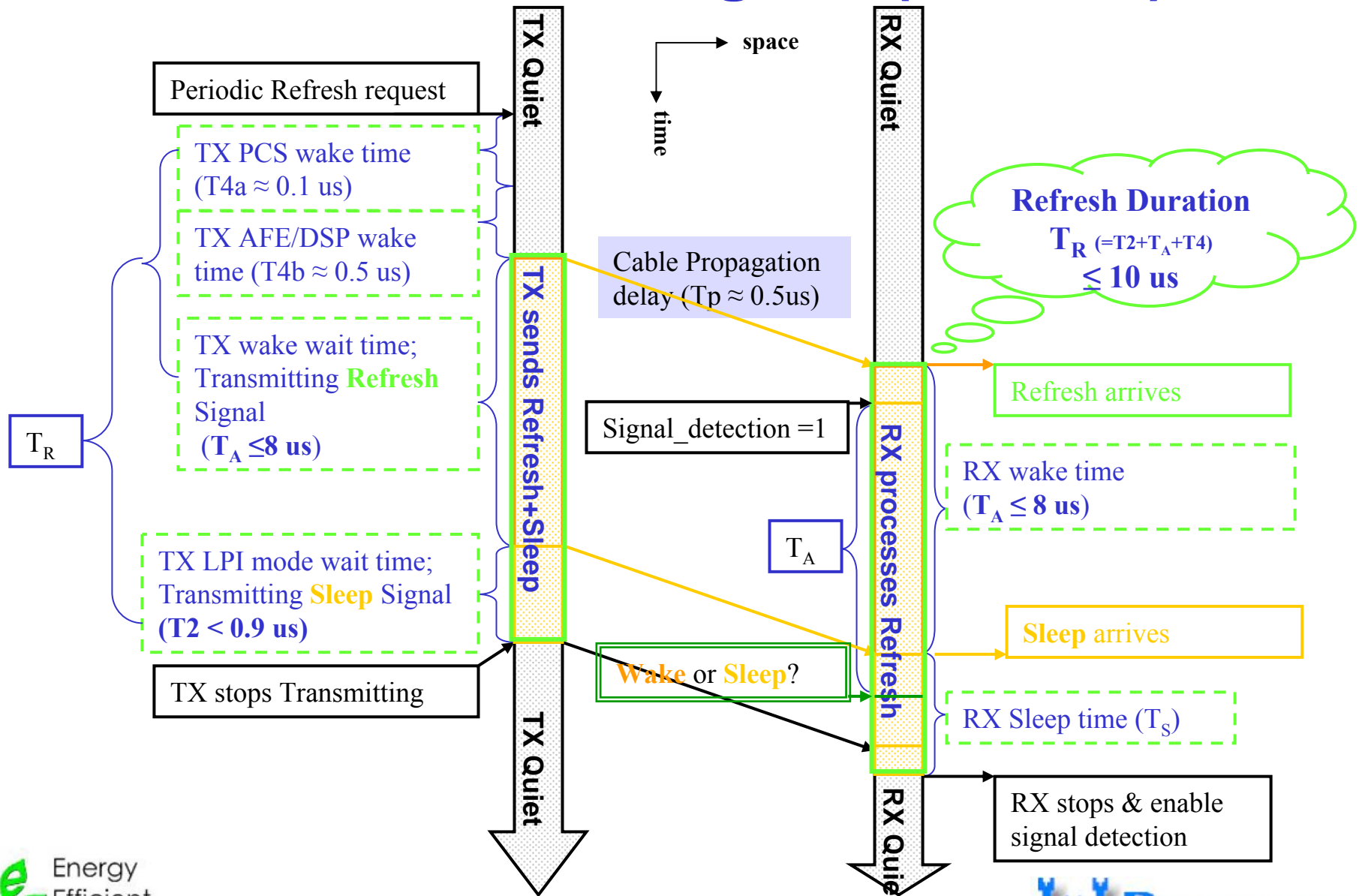
LPI Transition Diagram (Sleep)



LPI Transition Diagram (Wake)



LPI Transition Diagram (Refresh)



Summary

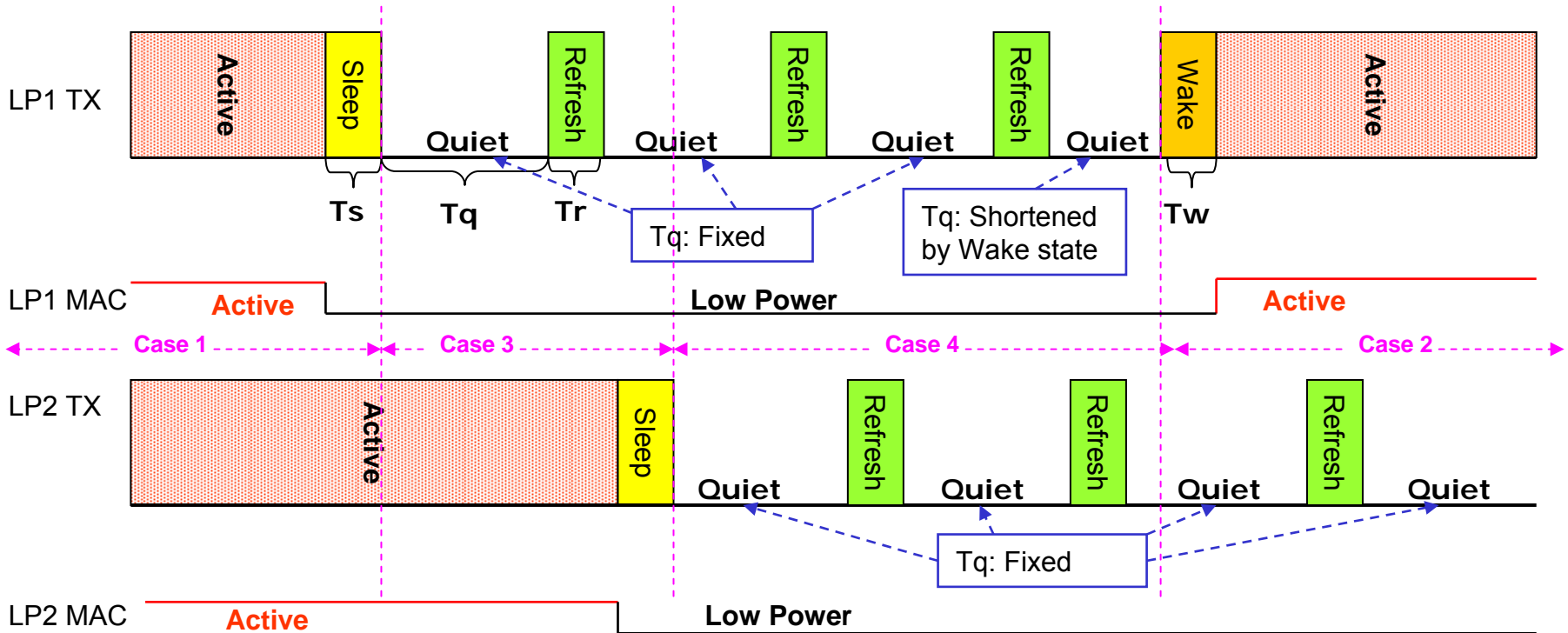
- ❑ Low Power Idle based EEE 100Base-TX can be implemented with minimum modifications of existing standard
- ❑ State Diagrams, Timers, and Parameters to facilitate the implementation of EEE standard have been defined and simulated
- ❑ Related works done in backup slides:
 - Old illustration of LPI 100Base-TX Operations
 - MII Interface signaling
 - Auto-negotiation state diagram modifications

Thank you

Questions?

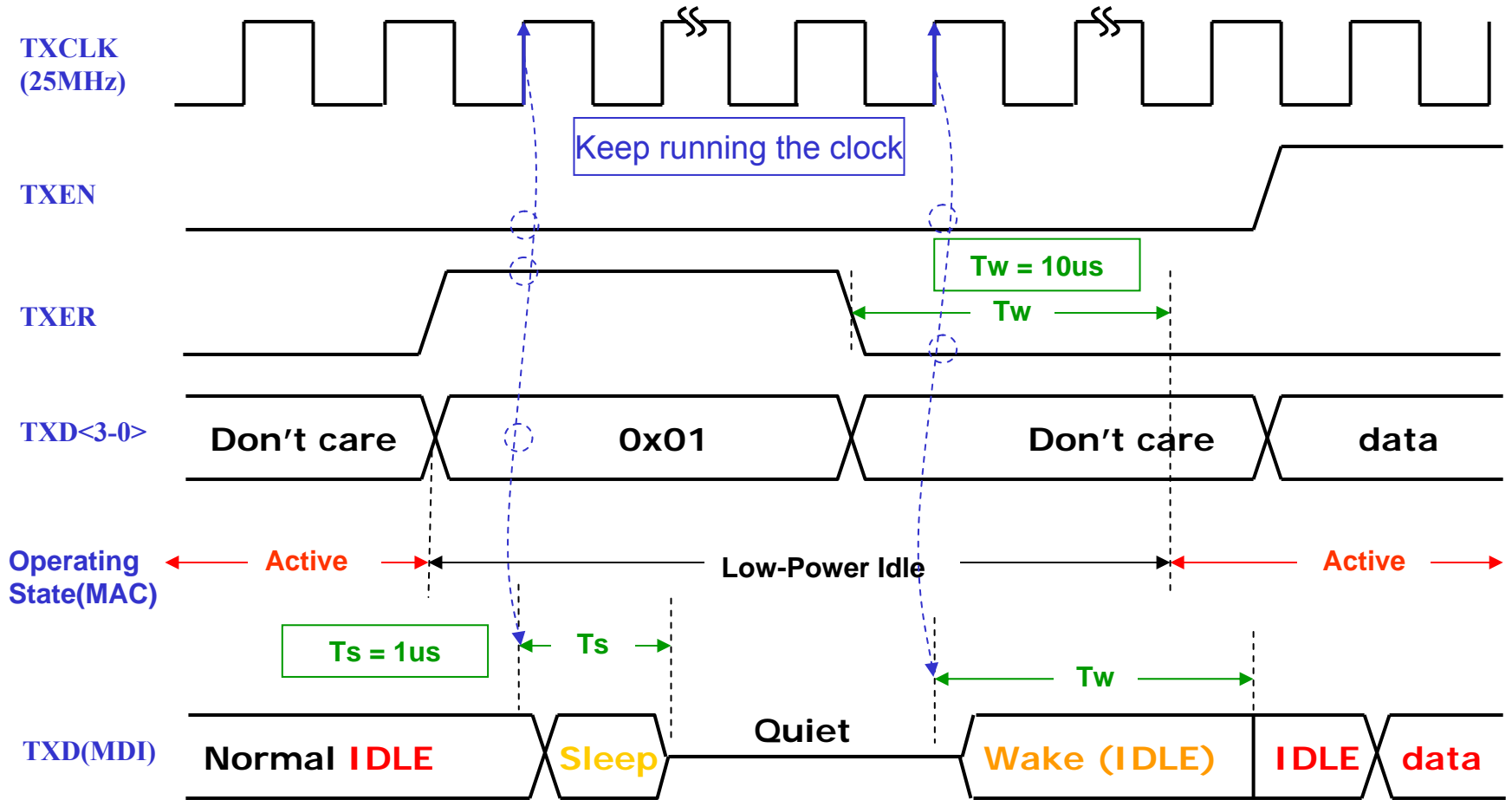
Backup

EEE FE Fully Asymmetric Operations

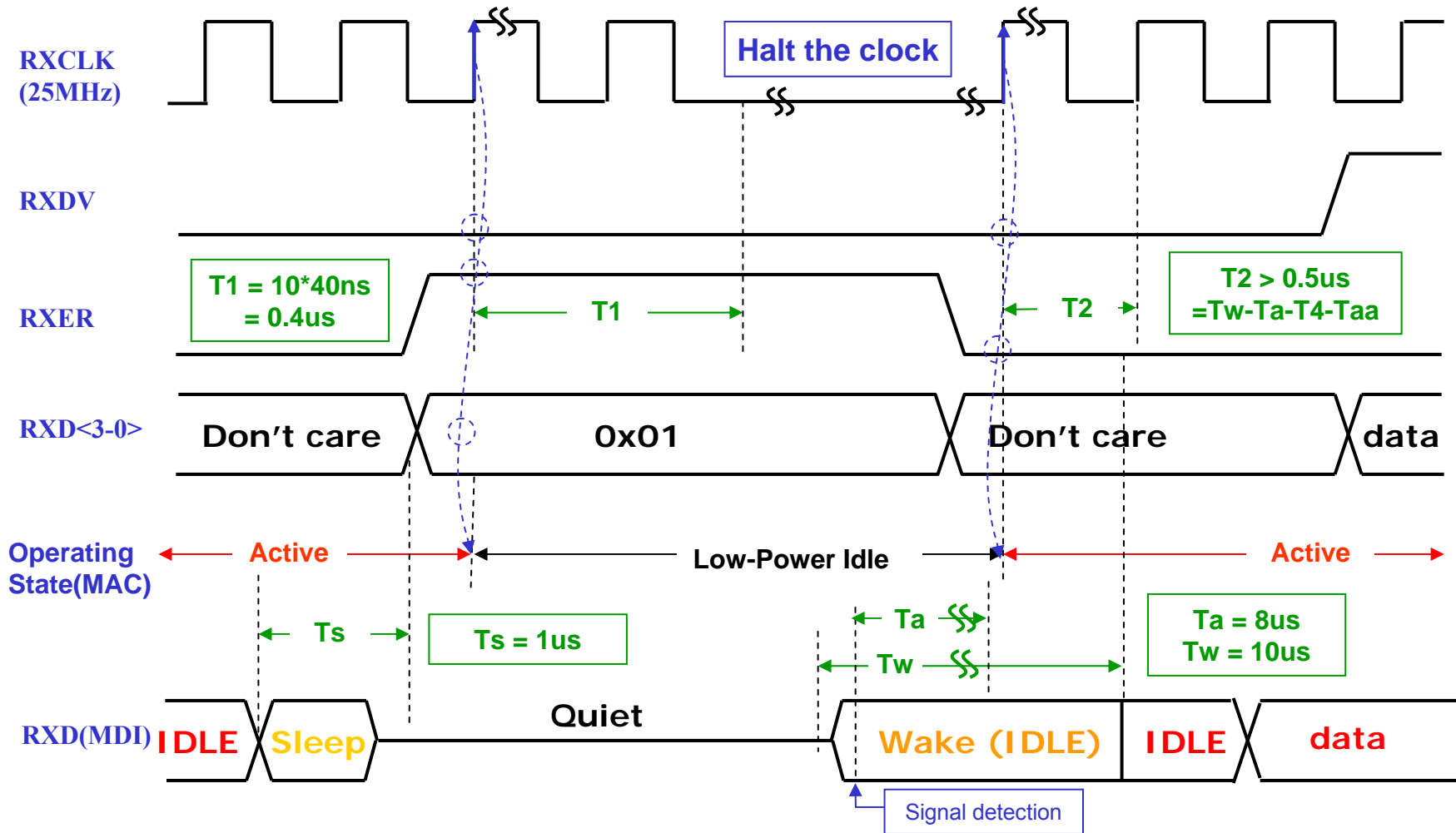


Line State	Timing Parameter (suggested)	Signal (suggested)
Sleep	$T_s = 1\mu s$	4B5B code-group 5b00000
Quiet	$T_q = 1 - 100ms$ (10ms?)	Electric differential DC 0V
Wake	$T_w = 10\mu s$ ($T_A=8\mu s$ internal)	Existing IDLE code-group
Refresh	$T_r = 10\mu s$ (derived)	= Sleep

MII Interface – Transmitter Path



MII Interface – Receiver Path



Auto-negotiation - Transmitter , Fig 40C-2

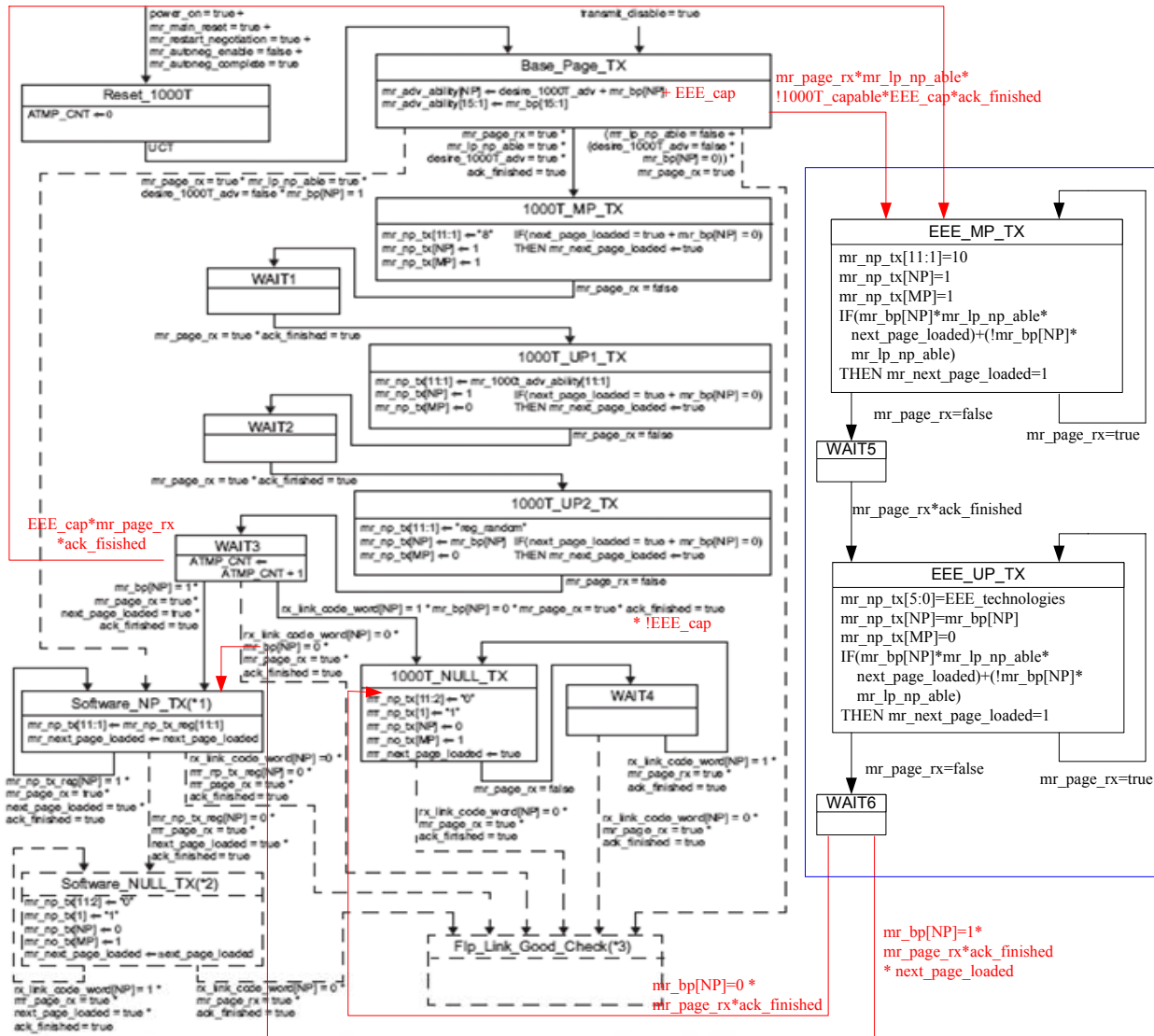


Figure 40C-2—Auto-Negotiation Transmit state diagram add-on for 1000BASE-T

Auto-negotiation – Receiver, Fig 40C-3

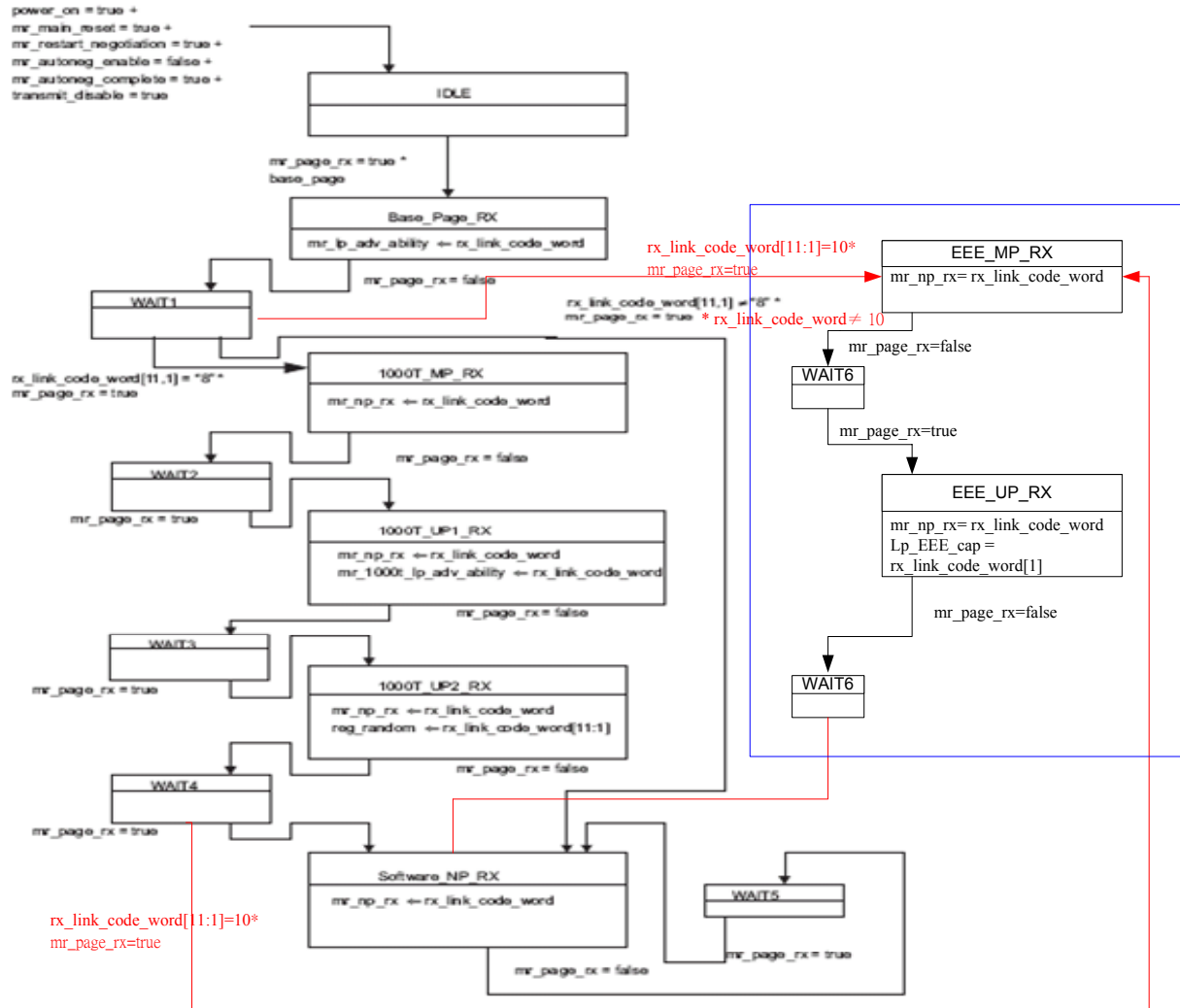


Figure 40C-3—Auto-Negotiation Receive state diagram add-on for 1000BASE-T