PHY wake time shrinkage calculations for 1000BASE-T

Wake Time Shrinkage Ad Hoc
IEEE P802.3az Task Force
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PHY wake time shrinkage (WTS)

- Transmitter ($T_{PHY\_SHRINK\_TX}$) – The difference between…
  - the delay between a transition from “Assert low power idle” to “Normal idle” at the xMII and the corresponding start of the wake signal at the MDI and…
  - the propagation delay of a start of shell delimiter from the xMII to the MDI ($T_{PHY\_PROP\_TX}$)

- Receiver ($T_{PHY\_SHRINK\_RX}$) – The difference between…
  - the delay between start of the wake signal at the MDI and the corresponding transition from “Assert low power idle” to “Normal idle” at the xMII and…
  - the propagation delay of a start of shell delimiter from the MDI to xMII ($T_{PHY\_PROP\_RX}$)

Start of wake signal

- This event is uniquely defined for each PHY
- It should be something that can be clearly measured at the MDI
- It is a matter of convention
  - The definition will be consistently applied to the transmitter and receiver
  - It affects the partitioning of WTS between the transmitter and receiver, but should not affect the total WTS

Start of wake signal – 1000BASE-T

- Wake is distinguished from refresh via the value of loc_lpi_req (received as rem_lpi_req) embedded in idle mode encoding
  - loc_lpi_req = FALSE indicates a request to wake
- Compliant idle mode signaling is not guaranteed until the PHY enters the WAKE_TRAINING state
- The initial wake transmission cannot reliably be used to differentiate a wake from a refresh
  - Its only purpose is to trigger the receiver's signal detector
- Thus, the "start of the wake signal" is proposed to be the start of transmission associated with entry into the WAKE_TRAINING state

Relevant timing parameters

Symbol	Description	Value	Units
T_{TWTS}	Alias for $T_{PHY\_SHRINK\_TX}$	TBD	
T_{RWTS}	Alias for $T_{PHY\_SHRINK\_RX}$	TBD	
T_{TDP}	Alias for $T_{PHY\_PROP\_TX}$	84	ns
T_{RDP}	Alias for $T_{PHY\_PROP\_RX}$	244	ns
T_{TCP}	PCS and PMA transmit latency for control information[1]	TBD	
T_{RCP}	PCS and PMA receive latency for control information[1]	TBD	
T_M	Media propagation delay	550	ns
T_W	PHY wake time	16	μs
T_{WTX}	Corresponds to lpi_waketx_timer	1.2 – 1.4	μs
T_{MZ}	Corresponds to lpi_wakemz_timer	5	μs
T_{SZ}	The total time the SLAVE spends in WAKE_SILENT	TBD	

[1] Introduced to account for a potential difference in the latency of encoded and decoded variables (e.g. loc_lpi_req) and the normal latency for data originating from, or presented to, the GMII.

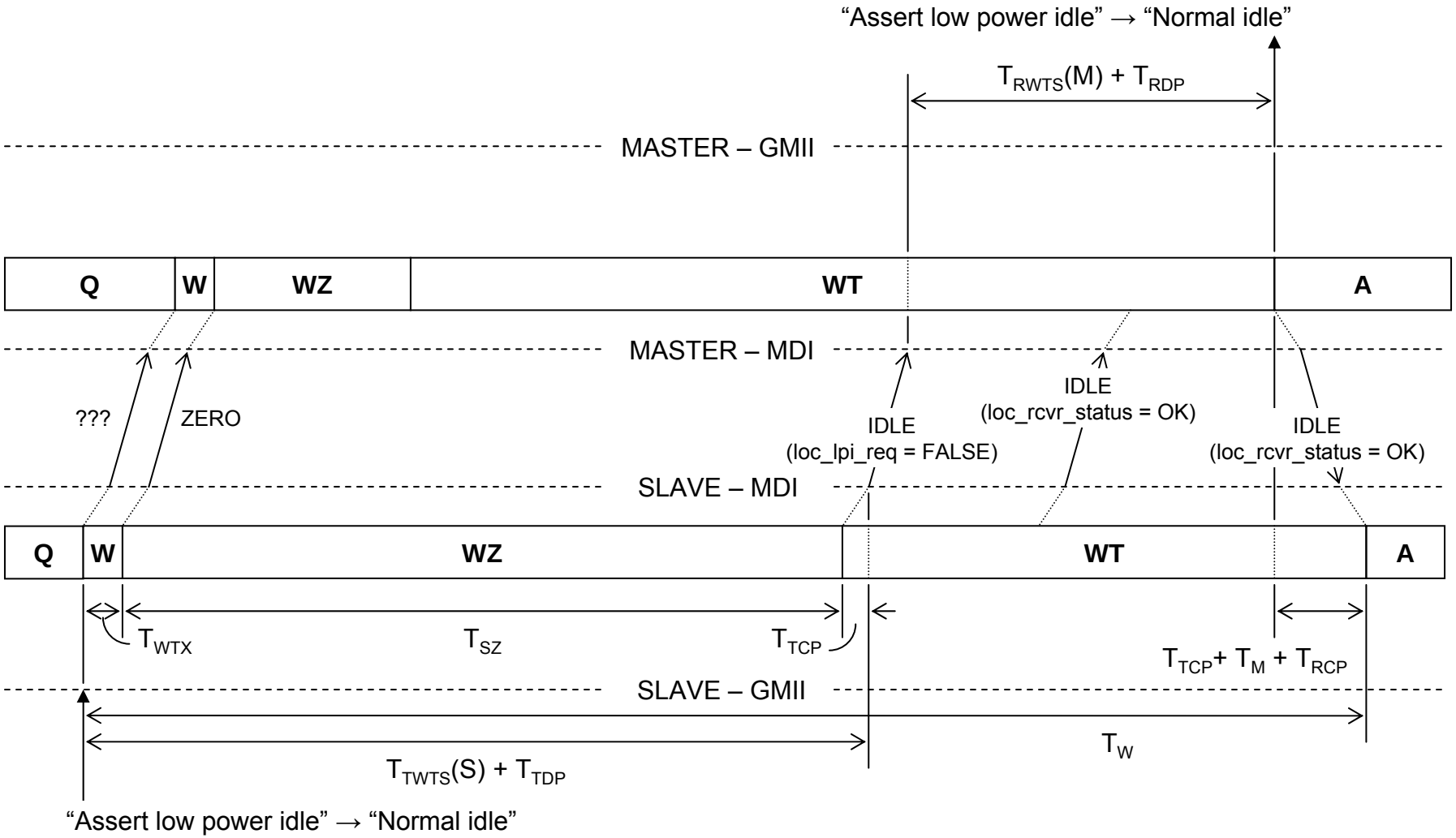
1000BASE-T wake scenarios

- There are a multiple starting points for 1000BASE-T wake
  - Wake from the SEND IDLE OR DATA state
  - Wake from the UPDATE state
  - Wake from the QUIET state

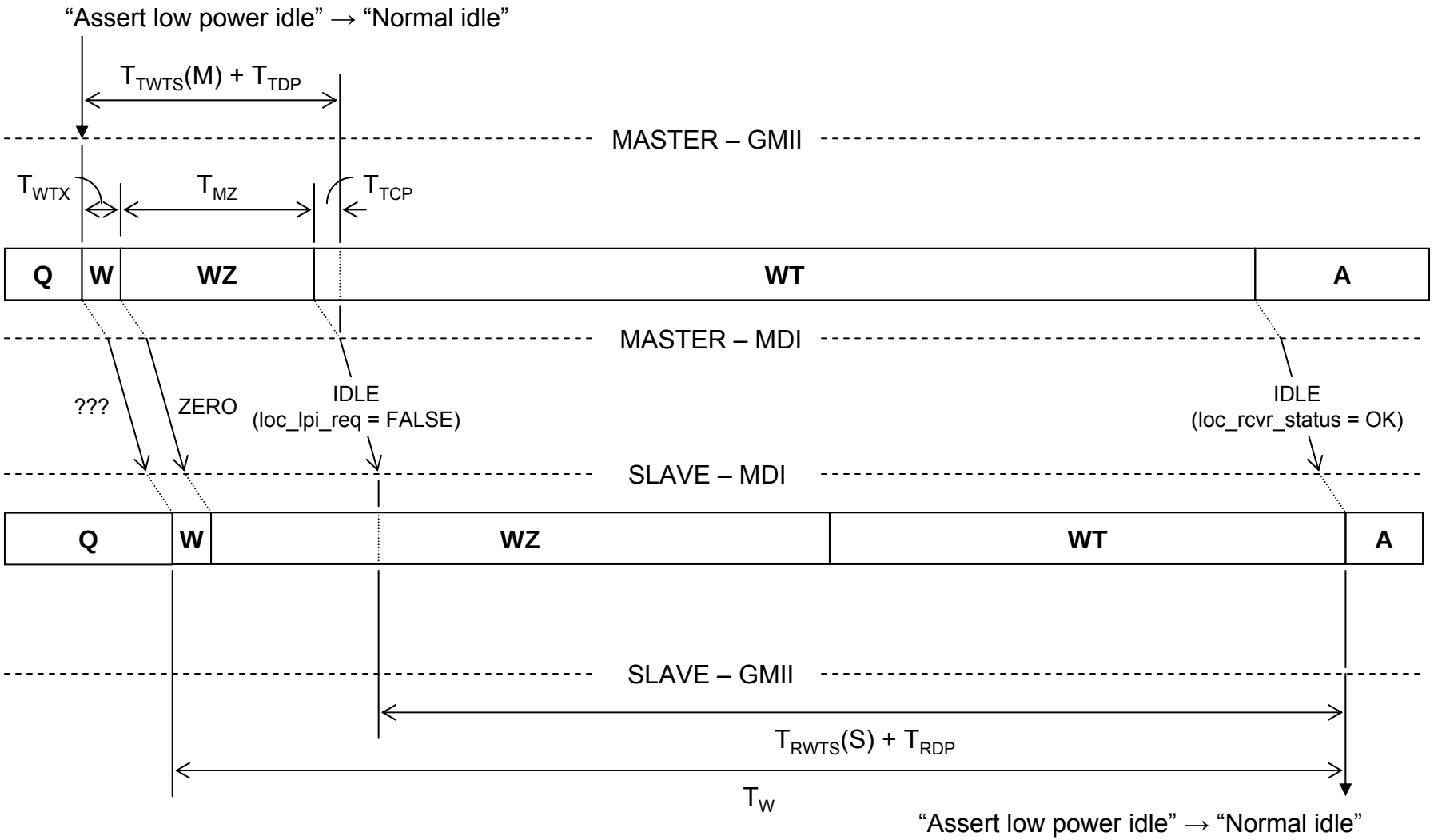
- Wake from the QUIET state will correspond to the largest WTS and should be the basis of the requirements

- In this scenario, WTS is a function of whether it is the MASTER or the SLAVE PHY that initiates wake

SLAVE initiates wake



MASTER initiates wake



Equations

- $T_{TWTS}(M) \leq T_{WTX} + T_{MZ} + (T_{TCP} - T_{TDP})$
- $T_{TWTS}(S) \leq T_{WTX} + T_{SZ} + (T_{TCP} - T_{TDP})$
- $T_{RWTS}(M) \leq T_{W} - (T_{TWTS}(S) + T_{TDP}) - T_{M} - (T_{TCP} + T_{M} + T_{RCP}) - T_{RDP}$
- $T_{RWTS}(S) \leq T_{W} - (T_{TWTS}(M) + T_{TDP}) - T_{M} - T_{RDP}$

Summary

- This framework may be readily used to compute and define the 1000BASE-T PHY wake time shrinkage
- The “SLAVE initiates wake” scenario is the limiting case for the total PHY wake time shrinkage
- The maximum time that the SLAVE is allowed to remain in the WAKE_SILENT state is currently not bounded by the standard
- Limits on transmitter wake time shrinkage may indirectly bound this parameter