

# IEEE P802.3az Wake Time Shrinkage Ad Hoc report

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# IEEE P802.3az Wake Time Shrinkage Ad Hoc

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- Ad Hoc charter
  - Calculate the minimum PHY TX Wake Time shrinkage for each PHY
  - Calculate the minimum PHY RX Wake Time shrinkage for each PHY
  - Calculate the minimum, if any, Assert Low Power Idle times for each PHY
  - Decide the minimum, if any, Wake Time that is specified for the RX System
- Agenda for calls
  - Reviewed patent slide set
  - Review contributions
  - Review calculations

THANK YOU to all that attended the calls and contributed to work !!

# Review of Contributions

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- 3 contributions in total
  - First conference call
    - IEEE P802.3az Proposed Wake Shrinkage Values  
Mike Grimwood, Broadcom
      - Proposed a framework for the 10GBASE-T and 1000BASE-T PHY wake-time calculations as well as summary of values
      - Assumed 10GBASE-T PHY begins to send IDLE as soon as Wake is received
    - PHY wake time shrinkage calculations for 1000BASE-T  
Adam Healey, LSI
      - Provided a framework for the 1000BASE-T PHY wake-time calculations
  - Second conference call
    - 1000BASE-T PHY worst-case wake-time budget  
Jim Barnette, Vitesse
      - Used framework in contribution above to calculate 1000BASE-T PHY worst-case wake-time values

# Consensus definitions

- Transmitter ( $T_{\text{PHY\_SHRINK\_TX}}$ ) – 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 ( $T_{\text{PHY\_PROP\_TX}}$ )

From ‘PHY wake time shrinkage calculations for 1000BASE-T’, Adam Healey, Slide 2  
[http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey\\_01\\_0209.pdf](http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey_01_0209.pdf)

- Receiver ( $T_{\text{PHY\_SHRINK\_RX}}$ ) – 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 ( $T_{\text{PHY\_PROP\_RX}}$ )

From ‘PHY wake time shrinkage calculations for 1000BASE-T’, Adam Healey, Slide 2  
[http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey\\_01\\_0209.pdf](http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey_01_0209.pdf)

- For 1000BASE-T the “start of the wake signal” is the start of transmission associated with entry into the WAKE\_TRAINING state

From ‘PHY wake time shrinkage calculations for 1000BASE-T’, Adam Healey, Slide 4  
[http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey\\_01\\_0209.pdf](http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey_01_0209.pdf)

# Consensus 100BASE-T calculation

$$\begin{aligned} T_{\text{phy\_wake\_tx}} &= \text{TX PCS latency (T4a)} + \text{TX AFE/DSP stabilize time (T4b)} \\ &= 0.1 + 5 = 5.1 \text{ us (max)} \end{aligned}$$

$$\begin{aligned} T_{\text{phy\_shrink\_tx}} &= T_{\text{phy\_wake\_tx}} - T_{\text{phy\_prop\_tx}} \\ &= 5.1 \text{ us} - \text{TX latency (assume 0.1us based on T4a)} \\ &= \underline{5 \text{ us (max)}} \end{aligned}$$

$$\begin{aligned} T_{\text{phy\_wake\_rx}} &= \text{RX signal\_detect assert time (T3a)} \\ &\quad + \text{RX AFE stabilize time (T3b)} \\ &\quad + \text{RX DSP/clock retrain time (T3c)} \\ &\quad + \text{RX PCS descrambling time (T3d)} \\ &= 5 + 5 + 5 + 0.5 = 15.5 \text{ us (max)} \end{aligned}$$

$$\begin{aligned} T_{\text{phy\_shrink\_rx}} &= T_{\text{phy\_wake\_rx}} - T_{\text{phy\_prop\_rx}} \\ &= 15.5 \text{ us} - \text{TX latency (assume 0.5us based on T3d)} \\ &= \underline{15 \text{ us (max)}} \end{aligned}$$

$$\begin{aligned} T_{\text{w\_sys\_tx}} &= T_{\text{w\_sys\_rx}} + T_{\text{phy\_shrink\_tx}} + T_{\text{phy\_shrink\_rx}} \\ &= T_{\text{w\_sys\_rx}} + 5 + 15 \\ &= \underline{T_{\text{w\_sys\_rx}} + 20 \text{ us}} \end{aligned}$$

$$\begin{aligned} T_{\text{w\_phy}} &= T_{\text{phy\_wake}} (\text{min}) + T_{\text{phy\_shrink\_tx}} \\ &= 15.5 + 5 = \underline{20.5 \text{ us}} \end{aligned}$$

From 'IEEE P802.3az Wait time (Tw) from a system design perspective', David Law, Slide 11  
[http://www.ieee802.org/3/az/public/jan09/law\\_1\\_0109\\_V3\\_0.pdf](http://www.ieee802.org/3/az/public/jan09/law_1_0109_V3_0.pdf)

# Consensus 1000BASE-T calculation (page 1 of 2)

Symbol	Description	Min.	Max.	Units	Notes
<b>Specified values</b>					
$T_{TDP}$	Transmit GMII to MDI latency		84	ns	Alias for $T_{PHY\_PROP\_TX}$
$T_{RDP}$	Receive MDI to GMII latency		244	ns	Alias for $T_{PHY\_PROP\_RX}$
$T_M$	Media propagation delay		550	ns	
$T_{TA}$	Transmitter activation time		700	ns	
$T_{SA}$	Signal detect assertion time		500	ns	
$T_{WTX}$	Corresponds to lpi_waketx_timer	1200	1400	ns	
$T_{MZ}$	Corresponds to lpi_wakemz_timer		5000	ns	
$T_W$	PHY wake time		16000	ns	Alias for $T_{W\_PHY}$
<b>For timing budget purposes only</b>					
$T_{TCP}$	Transmit latency for encoded variables		84	ns	
$T_{RCP}$	Receive latency for encoded variables		244	ns	
$T_{SCR}$	SLAVE scrambler acquisition time		TBD	ns	
$T_{RCVR}$	MASTER receiver acquisition time		TBD	ns	
<b>Derived parameters</b>					
$T_{SZ}$	SLAVE WAKE to WAKE_TRAINING time		TBD	ns	

From 'PHY wake time shrinkage calculations for 1000BASE-T', Adam Healey, Slide 5  
[http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey\\_01\\_0209.pdf](http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey_01_0209.pdf)

# Consensus 1000BASE-T calculation (page 2 of 2)

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- $T_{SZ} \leq (T_{TA} + T_M + T_{SA}) + T_{MZ} + (T_{TCP} + T_M + T_{RCP}) + T_{SCR}$
- $T_{TWTS}(M) \leq T_{MZ} + (T_{TCP} - T_{TDP})$
- $T_{TWTS}(S) \leq T_{SZ} + (T_{TCP} - T_{TDP})$
- $T_{RWTS}(M) \leq T_{RCVR} + (T_{RCP} - T_{RDP})$
- $$\begin{aligned} T_{RWTS}(S) &\leq T_{RCP} + T_{SCR} + 2(T_{TCP} + T_M + T_{RCP}) + T_{RCVR} - T_{RDP} \\ &\leq T_W - T_{TWTS}(M) - T_{WSR}(M) = T_{TWTS}(S) - T_{TWTS}(M) + T_{RWTS}(M) \end{aligned}$$

From 'PHY wake time shrinkage calculations for 1000BASE-T', Adam Healey, Slide 9  
[http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey\\_02\\_0309.pdf](http://www.ieee802.org/3/az/public/adhoc/shrinkage/healey_02_0309.pdf)

# Consensus 10GBASE-T calculation (page 1 of 2)

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## Case 1 – Wake during SLEEP condition

$$\begin{aligned}T_{\text{phy\_wake\_tx}} &= T_{\text{phy\_prop\_tx}} + l_{\text{pi\_tx\_sleep\_timer}} + l_{\text{pi\_tx\_alert\_timer}} \\&= T_{\text{phy\_prop\_tx}} + 10 \text{ LDPC frames} + 4 \text{ LDPC frames} \\&= T_{\text{phy\_prop\_tx}} + 3.20\mu\text{s} + 1.28\mu\text{s} \\&= T_{\text{phy\_prop\_tx}} + 4.48 \mu\text{s}\end{aligned}$$

$$\begin{aligned}T_{\text{phy\_shrink\_tx}} &= T_{\text{phy\_wake\_tx}} - T_{\text{phy\_prop\_tx}} \\&= T_{\text{phy\_prop\_tx}} + 4.48 \mu\text{s} - T_{\text{phy\_prop\_tx}} \\&= 4.48 \mu\text{s}\end{aligned}$$

$$T_{\text{phy\_wake\_rx}} = T_{\text{phy\_prop\_rx}}$$

$$\begin{aligned}T_{\text{phy\_shrink\_rx}} &= T_{\text{phy\_wake\_rx}} - T_{\text{phy\_prop\_rx}} \\&= 0\mu\text{s}\end{aligned}$$

$$\begin{aligned}T_{\text{w\_phy}} &= T_{\text{phy\_wake}} + T_{\text{phy\_shrink\_tx}} \\&= 2.88 \mu\text{s} + 4.48 \mu\text{s} \text{ (l}_{\text{pi\_tx\_wake\_timer}} \text{ 9 LDPC frames max)} \\&= 7.36 \mu\text{s}\end{aligned}$$

NOTE:  $T_{\text{phy\_shrink\_rx}}$  computation assumes that the receive PHY begins to send IDLE as soon as Wake is received.  
Otherwise  $T_{\text{phy\_shrink\_rx}} = l_{\text{pi\_tx\_wake\_timer}} = 2.88 \mu\text{s}$

From 'IEEE P802.3az Proposed Wake Shrinkage Values', Mike Grimwood, Slide 7  
[http://www.ieee802.org/3/az/public/adhoc/shrinkage/grimwood\\_01\\_0209.pdf](http://www.ieee802.org/3/az/public/adhoc/shrinkage/grimwood_01_0209.pdf)



# Consensus 10GBASE-T calculation (page 2 of 2)

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## Case 2 – Wake after SLEEP condition

- $T_{\text{phy\_wake\_tx}} = T_{\text{phy\_prop\_tx}} + \text{lpi\_tx\_alert\_timer} + 1 \text{ LDPC frame}$   
 $= T_{\text{phy\_prop\_tx}} + 4 \text{ LDPC frames} + 1 \text{ LDPC frame}$   
 $= T_{\text{phy\_prop\_tx}} + 1.6 \text{ us}$
- $T_{\text{phy\_shrink\_tx}} = T_{\text{phy\_wake\_tx}} - T_{\text{phy\_prop\_tx}}$   
 $= 1.6 \text{ us}$
- $T_{\text{phy\_wake\_rx}} = T_{\text{phy\_prop\_rx}}$
- $T_{\text{phy\_shrink\_rx}} = T_{\text{phy\_wake\_rx}} - T_{\text{phy\_prop\_rx}}$   
 $= 0 \text{ usec}$
- $T_{\text{w\_phy}} = T_{\text{phy\_wake}} + T_{\text{phy\_shrink\_tx}}$   
 $= 9 \text{ LDPC frames} + 1.6 \text{ us}$   
 $= 4.48 \text{ us}$

NOTE:  $T_{\text{phy\_shrink\_rx}}$  computation assumes that the receive PHY begins to send IDLE as soon as Wake is received.  
Otherwise  $T_{\text{phy\_shrink\_rx}} = \text{lpi\_tx\_wake\_timer} = 2.88 \text{ us}$

From 'IEEE P802.3az Proposed Wake Shrinkage Values', Mike Grimwood, Slide 9  
[http://www.ieee802.org/3/az/public/adhoc/shrinkage/grimwood\\_01\\_0209.pdf](http://www.ieee802.org/3/az/public/adhoc/shrinkage/grimwood_01_0209.pdf)

# Other consensus items

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- Global Minimum Low Power Idle assert duration specification not required
  - Provide two sets of wake times for the two 10GBASE-T case (wake during or after SLEEP)
- Wake Time specified for RX System
  - For 1000BASE-T and 10GBASE-T provided by PHY sending IDLE as soon as Wake is received
    - Requires change 10GBASE-T EEE PHY in draft so that begins to send IDLE as soon as Wake is received

# Consensus values

PHY type	Tw_sys_res Default (min)	Tw_phy (min)	Tphy_shrink_tx (max)	Tphy_shrink_rx (max)	Tw_sys_rx default (min)
100BASE-T	30 us	20.5 us	5 us	15 us	10 us
1000BASE-T	TBD	TBD	TBD	TBD	TBD
10GBASE-T	Case 1 7.36 us	7.36 us	4.48 us	0 us	2.88 us
	Case 2 4.48 us	4.48 us	1.6 us	0 us	2.88 us

Note 1 – 10GBASE-T calculation assumes early IDLE detection in Wake

# Summary and motion

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- The wake time Ad Hoc reached consensus on all items with the exception of the two parameters required to define the 1000BASE-T wake time
- The Backplane PHYs are yet to be addressed

## Motion:

The IEEE P802.3az Task Force adopts the wake time related definitions on Page 4, the wake time equations on slides 5 through 9 and the wake time values on slide 11 of law\_1\_0309.pdf

Move: David Law

Second:

# Aggregate attendance

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Hugh Barrass	Cisco	Gavin Parnaby	Solarflare
Jim Barnette	Vitesse	Velu Pillai	Broadcom
Mike Bennett	LBNL	Bob Thelen	Avago
Brad Booth	AMCC	Geoff Thompson	Nortel
Noel Butler	LSI	Jacobo Riesco	LSI
Mandeep Chadha	Vitesse	Jeff Slavick	Avago
Joseph Chou	Realtek		
Wael William Diab	Broadcom		
Niall Fitzgerald	LSI		
John Fuller			
Mike Grimwood	Broadcom		
Adam Healey	LSI		
Rita Horner	Avago		
David Law	3Com		
Shimon Muller	Sun Microsystems		