

# BER Objective for Next-Gen Enterprise Access BASE-T

January 2015

**George Zimmerman**

CME Consulting, Inc.

# BER Objective

- This contribution considers the context of the BER objective with historical models and experience with 10GBASE-T
  - Primary consideration was reasonable test time
  - Experience is that major equipment vendors test well beyond the IEEE BER objective

# BASE-T PHYs have generally follow the Fiber Objectives

Speed	BER Objective
1G (including BASE-T)	$\leq 10^{-10}$
10G (including BASE-T)	$\leq 10^{-12}$
40G (including BASE-T)	$\leq 10^{-12}$
100G (no BASE-T yet!)	$\leq 10^{-12}$
400G (no BASE-T yet!)	$\leq 10^{-13}$
1000BASE-T1	$\leq 10^{-10}$
Exception: 100 Mbps	(no explicit FX BER objective)
100BASE-T4	$\leq 10^{-8}$
100BASE-TX	$\leq 10^{-9}$
100BASE-T1	$\leq 10^{-10}$

# One Reason Why – Test time

Speed	Time for 1X bits / 5X bits
$\cong 10^{-10}$ at 100M(100BASE-T1)	100 sec / 8.3 minutes
$\cong 10^{-10}$ at 1Gb/s	10 sec / 1.7 minutes
$\cong 10^{-12}$ at 10G	100 sec / 8.3 minutes
$\cong 10^{-12}$ at 40G	25 sec / 2.1 minutes
$\cong 10^{-12}$ at 100G	10 sec / 1.7 minutes
$\cong 10^{-13}$ at 400G	25 sec / 2.1 minutes
$\cong 10^{-10}$ at 2.5Gb/s	4 sec / 0.3 minutes
$\cong 10^{-10}$ at 5Gb/s	2 sec / 0.17 minutes
$\cong 10^{-12}$ at 2.5Gb/s	400 sec / 33 minutes
$\cong 10^{-12}$ at 5G	200 sec / 17 minutes

# Experience from 10GBASE-T

---

- BER/time not a major factor in cost
  - PHY BER vs. SNR curve is very steep
- Low noise events caused by transients can dominate
  - Tend to occur on human time scales
  - Externally induced events not proportional to bit times
    - EMI
    - Baseline effects
    - Vibration
- Capturing minutes of time balances utility with test complexity

# Conclusion

---

- Times for  $1e-12$  BER are not too long, minutes, not hours
  - $1e-11$  are shorter than 10GBASE-T, but don't offer a compelling advantage
- Test times for  $1e-10$  BER may be too short to capture transient events on human time scales. (single-digit seconds)

# Recommendation

---

- Support a BER better than or equal to  $10^{-12}$  at the MAC/PLS service interface (or the frame loss ratio equivalent)