



## **Recap: Enhanced Link Budget Spreadsheet**

Piers Dawe, Dave Dolfi,  
Petar Pepeljugoski, Del Hanson

New Orleans, September 2000



## **What is it?**

- “The model”
- A spreadsheet with equations
- Can be populated with parameter values to represent different PMDs
- Runs in Excel
- Available to all on [www](http://www)

## Purpose

- Used for developing Ethernet optical spec numbers
- Uses engineering theory, mostly available in textbooks
- Gigabit model was validated by experiments in multiple labs
- Not intended as a transceiver design tool

## History

- Model was developed for Gigabit Ethernet
- It handles:
  - Short block codes
  - Multimode fibre, Single mode fibre
  - "First and second windows" (850 and 1310 nm)
  - Fibre attenuation, Connector attenuation
  - Fibre modal bandwidth
  - Mode partition noise
  - Duty cycle distortion
  - Extinction ratio
  - Receiver eye opening requirement
  - Laser Relative Intensity Noise (RIN)
  - Laser Mode Partition Noise (MPN)

## Advantages of Gigabit model

- Trusted and familiar
- Seen as official
- Source code can be inspected
- Clean, not over complicated
- “Fit for purpose” (Gigabit Ethernet)

## Disadvantages for us, of original Gigabit model

Does not handle well:

- Scrambled line codes
- Interactions between impairments
- Chirp
- Laser Mode Partition Noise
- Polarisation Mode Dispersion (PMD)
- Jitter

## Two recent updates to Model

- Now handles scrambled as well as block line codes
- Addresses some interactions between impairments
- Uses more self-consistent internal equations
  - Preparation for revised MPN formula
- Presentational improvements
- Available on [www](#): see references
- Needs experimental verification
- Not "official"

## Next steps

- We must adopt the March model extensions (or similar) to manage adopted 64B66B line code
- We should adopt the July model revisions for enhanced accuracy, flexibility and foundation for any future revisions

## Please vote for the motion!

Move that the P802.3 work group adopt the model structure and equations version 2.3.4 as found in the spreadsheet

[http://www.ieee802.org/3/10G\\_study/public/email\\_attach/3pmd046.xls](http://www.ieee802.org/3/10G_study/public/email_attach/3pmd046.xls)

, but note that the MPN calculation is believed to be pessimistic and is under active review, and that the effect of transmitter chirp is not well covered.

Proposed: Piers Dawe

Seconded: Petar Pepeljugoski

## References

- Hanson and Cunningham,  
[http://www.ieee802.org/3/10G\\_study/public/email\\_attach/All\\_1250.xls](http://www.ieee802.org/3/10G_study/public/email_attach/All_1250.xls)
- Petrich, "Methodologies for Jitter Specification" Rev 10.0,  
[ftp://ftp.t11.org/t11/pub/fc/jitter\\_meth/99-151v2.pdf](ftp://ftp.t11.org/t11/pub/fc/jitter_meth/99-151v2.pdf)
- Hanson, Cunningham, Dawe,  
[http://www.ieee802.org/3/10G\\_study/public/email\\_attach/All\\_1250v2.xls](http://www.ieee802.org/3/10G_study/public/email_attach/All_1250v2.xls)
- Hanson, Cunningham, Dawe, Dolfi,  
[http://www.ieee802.org/3/10G\\_study/public/email\\_attach/3pmd046.xls](http://www.ieee802.org/3/10G_study/public/email_attach/3pmd046.xls)
- Dolfi, [http://www.ieee802.org/3/10G\\_study/public/email\\_attach/new\\_isi.pdf](http://www.ieee802.org/3/10G_study/public/email_attach/new_isi.pdf)
- Cunningham and Lane, "Gigabit Ethernet Networking", Macmillan Technical Publishing, ISBN 1-57870-062-0
- Pepeljugoski, Marsland, Williamson,  
[http://www.ieee802.org/3/ae/public/mar00/pepeljugoski\\_1\\_0300.pdf](http://www.ieee802.org/3/ae/public/mar00/pepeljugoski_1_0300.pdf)
- Dawe, [http://www.ieee802.org/3/ae/public/mar00/dawe\\_1\\_0300.pdf](http://www.ieee802.org/3/ae/public/mar00/dawe_1_0300.pdf)
- Cunningham, Nowell, Hanson, "Proposed Worst Case Link Model for Optical Physical Media Dependent Specification Development",  
[http://www.ieee802.org/3/z/public/presentations/jan1997/dc\\_model.pdf](http://www.ieee802.org/3/z/public/presentations/jan1997/dc_model.pdf)
- Nowell, Cunningham, Hanson, Kazovsky, "Evaluation of Gb/s laser based fibre LAN links: Review of the Gigabit Ethernet model", Optical and Quantum Electronics, 32, pp 169-192, 2000.
- Gair D. Brown, "Bandwidth and Rise Time Calculations for Digital Multimode Fiber-Optic Data Links", JLT, vol. 10, no. 5, May 1992, pp. 672-678.
- Dawe and Dolfi, [http://www.ieee802.org/3/ae/public/jul00/dawe\\_1\\_0700.pdf](http://www.ieee802.org/3/ae/public/jul00/dawe_1_0700.pdf)
- This presentation to be: [http://www.ieee802.org/3/ae/public/sep00/dawe\\_1\\_0900.pdf](http://www.ieee802.org/3/ae/public/sep00/dawe_1_0900.pdf)
- More references listed at [http://www.ieee802.org/3/10G\\_study/email/msg01127.html](http://www.ieee802.org/3/10G_study/email/msg01127.html)