# DFE Coefficient Constraints

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# Supporters

- XXXX
- XXXX

# The Issue

- **DFE based receivers have an inherent potential to turn single bit errors into bursts.**
  - This will impact error detection coverage of the packet CRC, and the overall MTTPF of the link.
- **The probability of error multiplication is highly dependant on DFE tap weight distribution**
- **We should restrict DFE Tap weights to prevent worst case problems.**

# Burst Errors and Ethernet MTTPF

- **The Ethernet CRC is very robust in the presence of single bit errors or noise bursts**
  - Guaranteed to detect any 3 bit errors in the frame
  - Guaranteed to detect any 31 bit burst
- **In the presence of Gaussian noise Ethernet MTTPF is of order of the lifetime of the Universe**
  - proportional to $(BER)^{-4}$
- **DFE error multiplication to >2 bits severely impacts MTTPF**
  - CRC is not guaranteed to detect one multiplied error + 1 other error
  - MTTPF proportional to ( (probability of error multiplication) * $(BER)^{-2}$ )
    - MTTPF is a few years if burst probability = 1% and BER=$E^{-12}$
- **Unrestricted DFE tap coefficients can easily produce 1% multiplication**
  - See hamstra_1_0505

# Choosing tap constraints

- **This problem has already been worked on in the OIF.**
  - Jim Hamstra created a spreadsheet to analyze the probability of DFE error propagation and the compare various constraint methods.
  - Jim's spreadsheet has been submitted to 802.3ap by me as hamstra_1_0505 with Jim's permission.

- **His conclusion was**
  - Cumulative Exponential Decay is the most stable way to constrain error propagation under a variety of pessimistic conditions. It is stable independent of the total number of taps in the DFE, the distribution of tap weights, and the raw BER of the data link.

# Tap Constraint proposal

- **Adopt a Cumulative Exponential Decay constraint on tap weights, similar to that in the OIF CEI-2.0 spec.**
  - Maximum cumulative weight
    - Y = (1 - eye opening)/2
  - Exponential parameters
    - decay factor Z = 2/3,
    - Multiplier factor X = Y
- For any tap *n*, its weight/coefficient W(*n*) is constrained by :
  - $W(n) \leq ((1 - \text{eye opening})/2) * 2/3^{(n-1)} - \text{Sum}(W(n+1) + W(n+2) .. + W(m))$