# Technical Feasibility and Definition of Worst Case Channel

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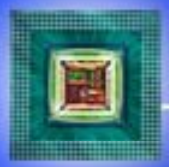





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# Today's Key Messages

- **An EDC solution for 300 meter MMF is technically feasible.**
- **Several constrains limit in practice the maximum complexity of the EDC filter.**
- **The definition of a channel compliance model provides a structured platform to achieve a balanced agreement.**

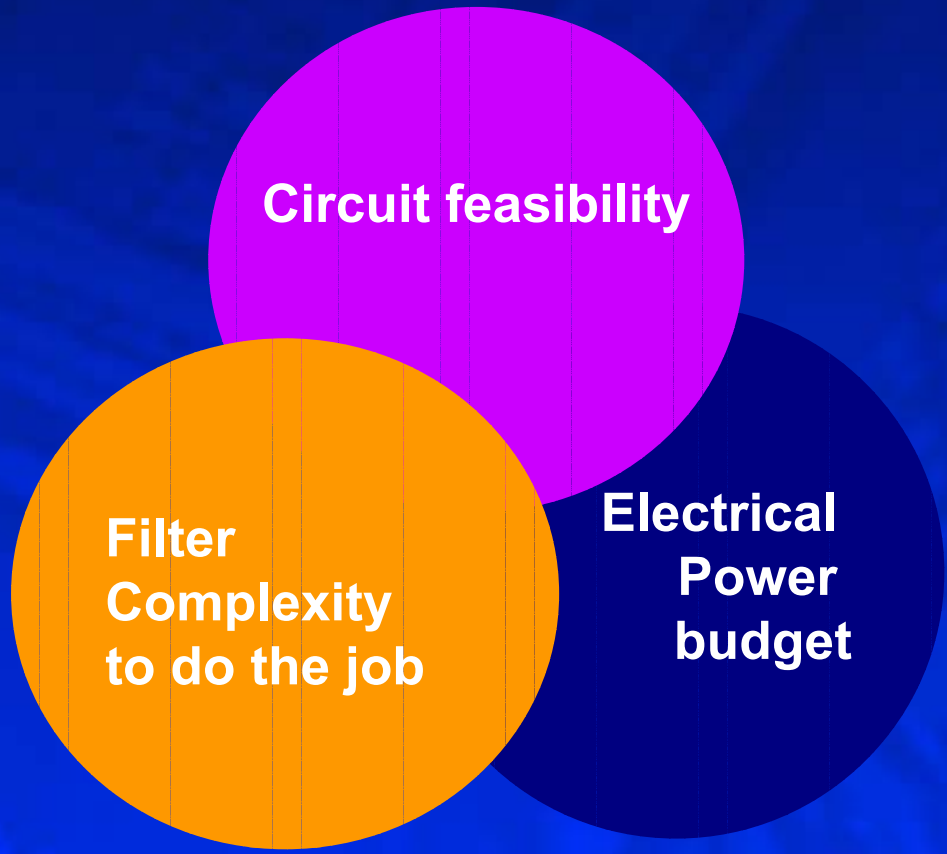
**Channel compliance model:**

Channels (impulse responses) that can be equalized using an ideal x-tap FFE + y-tap FBE filter with a maximum penalty* of z dB @ BER ≤ $10^{-12}$



* compared to back-to-back

# Feasibility – constrains

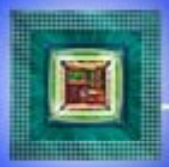



We need to explore the constrains and agree on highest possible filter complexity within these constrains

# Required filter complexity - summary

- Presented data show impulse width ≤ 500ps ~ 5 bits @ 10G
  - Defines the ballpark of filter complexity
- Filter requirements achieving 300m (based on study group data):
  - 5-T FFE + 3 FBE (R. Penty)
  - 7-9 T/2 FFE + 1-2 FBE (J. Hanberg)
  - 10-15 T/2 FFE + 1-3 FBE taps (S. Bhoja)
- Optical power penalty budget range
  - 6- 7 dB total penalty
  - 1-1.5 dB Implementation loss/penalty
- Filter architecture trade offs versus distance:
  - 220 m @ 99% coverage possible by FFE architecture
  - 300 m @ 99% coverage possible by DFE architecture

**Complexity is dependant on boundary conditions, target distance and Optical Power Penalty**



# Power budget - EDC Application


Power budget is defined

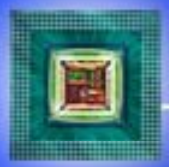
| Module | Module Power budget | Budget for EDC function* |
|---|---|---|
| XENPAK | 6 Watts | 750 mW |
| XPAK | 4 Watts | 500 mW |
| X2 | 4 Watts | 500 mW |
| XFP – class 1 | 1.5 Watts | 250 mW |

* Based on market survey

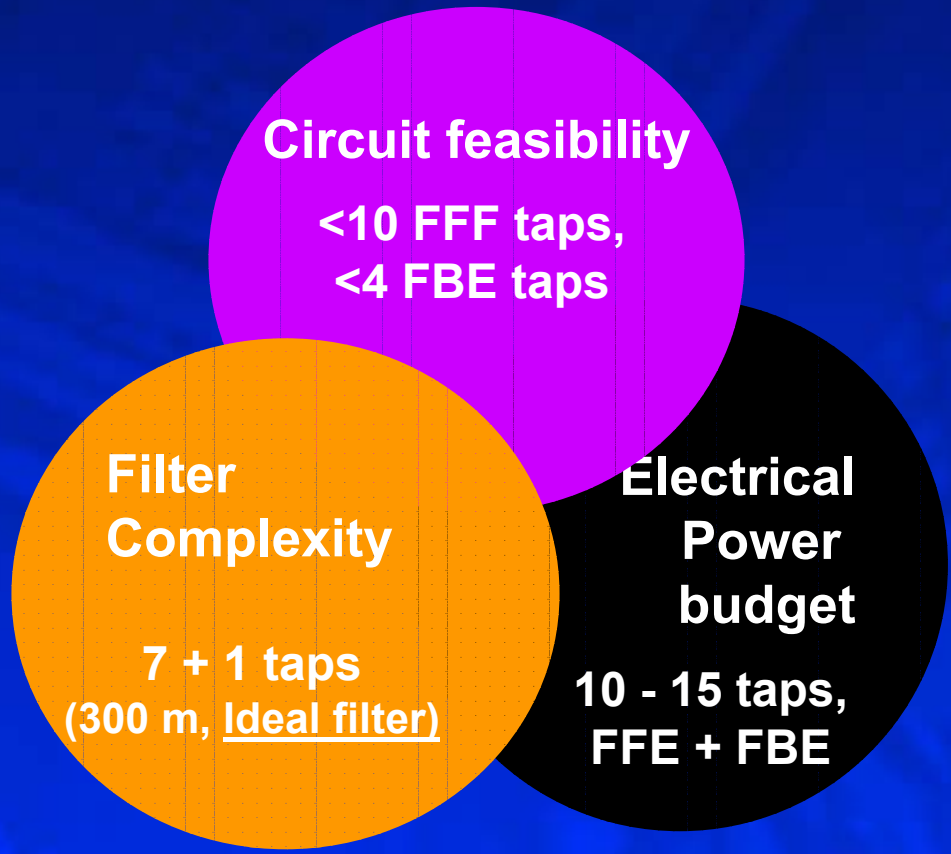
# Circuit considerations

- Bandwidth, Linearity, Noise
  - Analog nature of FFE limits max no. of taps to ≤ 10 (T/2)
  - No FBE constrains within required taps ≤ 4
- Power, ballpark numbers
  - FFE T/2 tap ~40 –> 20 mW
  - FBE tap ~40 –> 20 mW
  - Includes overhead, control, I/O etc.

**Circuit complexity will limit filter size even if power is acceptable**



# Feasibility – finding the sheet spot




The sheet spot seems to exists – EDC for 300 meter is feasible

# Definition of channel compliance model

**Channels / impulse responses that can be equalized using an ideal x-tap FFE + y-tap FBE filter with a maximum penalty* of z dB @ BER ≤ $10^{-12}$**

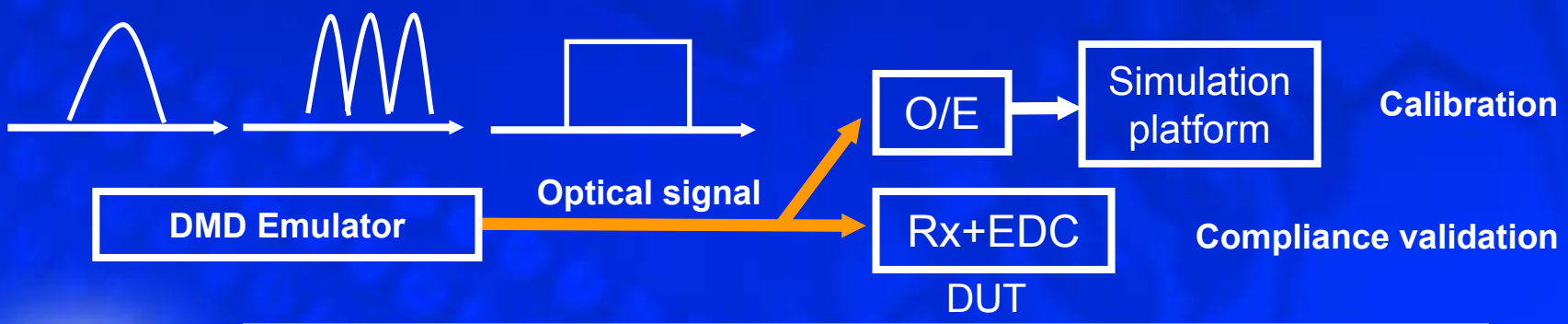
- Channel compliance defined by inverse filter response
  - Allows exact and simple compliance validation of any channel
- Distance options
  - 220 m class: x = k, y = zero and 300 m class: x = m, y = n
- Penalty at defined BER (10^-12)
  - Determines (or is driven) by optical power budget
- Fiber type (50/62.5 um) and wavelength (850/1310) dependency
  - Simple mapping (x, y and z) for various combinations
- Ideal compliance filter
  - x, y, and z combination must leave margin for implementation loss/penalty
- Common ground for modeling platform
  - Noise aspects and calculation of BER estimate of equalized signal

**Agreement on x and y link penalty z with target distance and influences optical power budget**

*) compared to back-to-back

# Compliance testing

- Golden fiber approach not adequate
  - Impossible to establish set of worst case fibers (and conditions)
- DMD emulator for worst case conditions
  - Optical impulse response required
  - Could be DMD emulator suggested by P. Kirkpatrick, Vancouver meet.
  - Several other options for implementation (V. Bhatt, Vancouver meet.)
- Simple calibration by trace records verification
  - Generated responses can be trimmed against the channel compliance definition
  - Definition of minimum set of responses for validation




**Channel compliance model provides foundation for calibration and robust worst case validation**

# Recommendations

- Agree on channel compliance model:

Channels (impulse responses) that can be equalized using an ideal x-tap FFE + y-tap FBE filter with a maximum penalty of z dB @ BER ≤ $10^{-12}$

- Suggested parameters (starting point):
  - X = 7-taps, Y = 1-tap, Z = 5 dB @ 500 MHz km (62.5 um)

Assumption:

- Present data is representative of the worst case 5% of installed fiber base.

Question:

- Is the statistics correct? (is the worst case fraction 5% or x%?)

**Recommendation matches practical implementation space within electrical power budget of 250-500 mW**