

100G Standards Update & Critical Component Technologies

Tom McDermott, Fujitsu
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100G update



- Standards update
 - 111.8 Gb/s OTU4 rate 7% FEC agreed at ITU.
 - 40GE and 100GE IEEE 802.3ab Draft 2.0 is on-track. Estimated standard around June 2010.
 - 40GE SMF serial – Call For Interest (CFI) started.
 - OIF 100G transponder MSA draft
 - OIF-FD-100G-DWDM-01.0

- Critical Component technologies enable increased reach for longer-haul applications at 100G
 - 63 Gs/s ADC converter
 - Soft-Decision FEC
 - Increased WSS passband width
 - Distributed Raman Amplifier

100G Transponder block diagram shown in Framework document (OIF-FD-100G-DWDM-01.0)

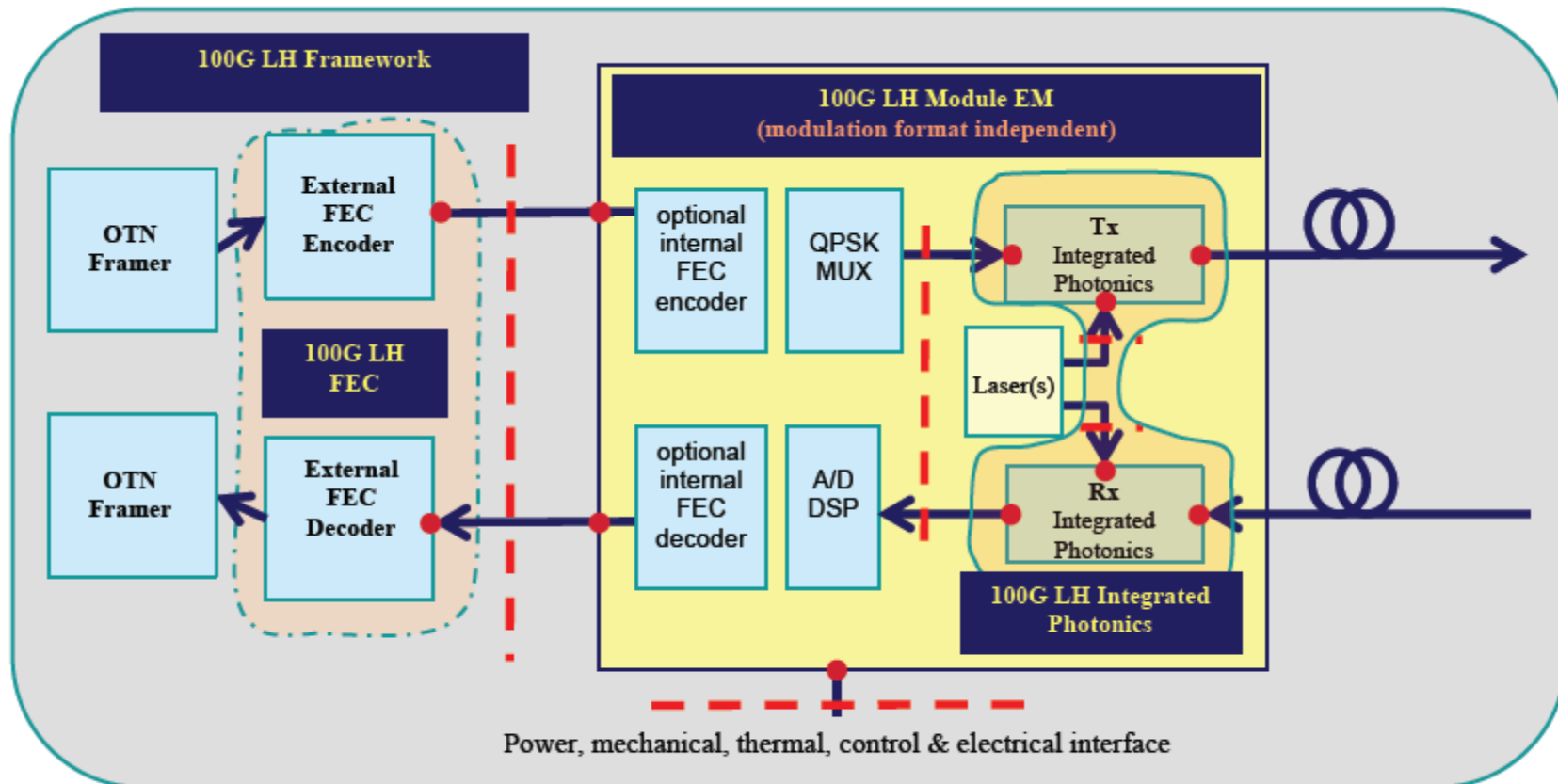
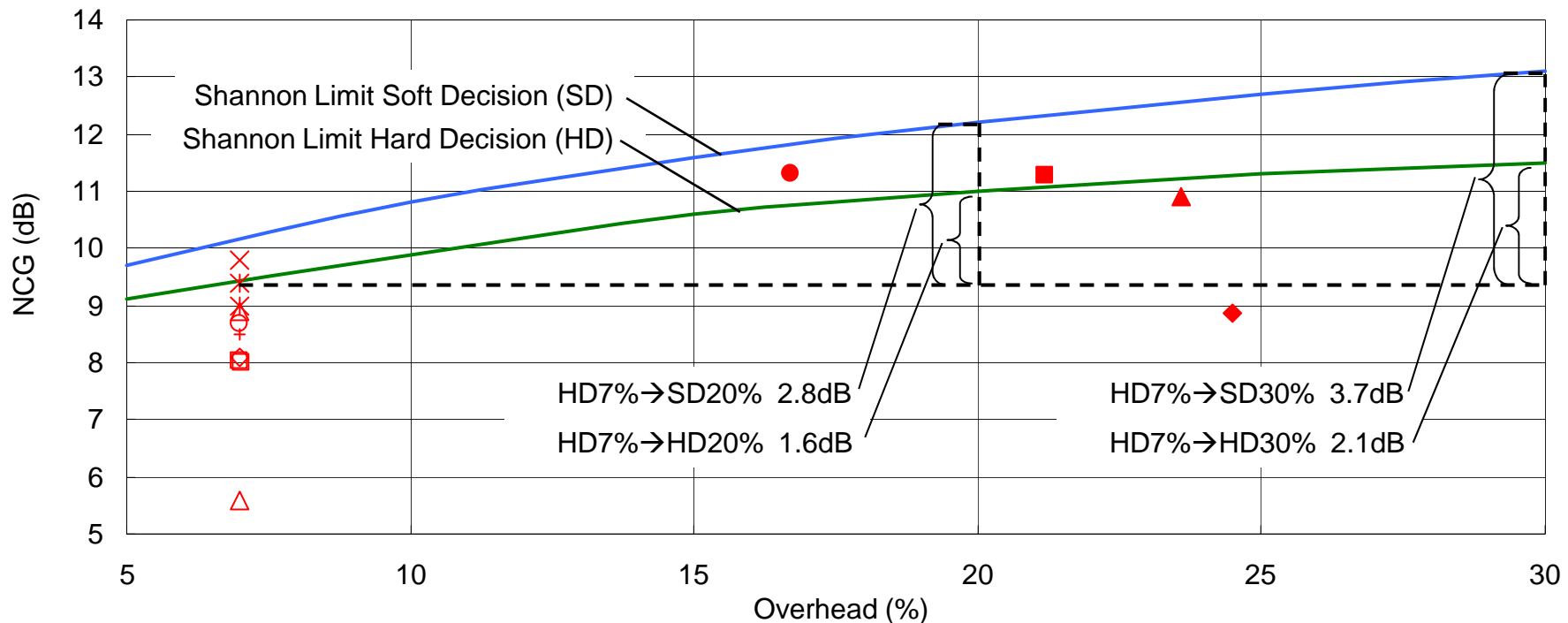


Figure 7. Block diagram of a transceiver module

Long Haul 100G - FEC coding gain



- OTN standard 7% FEC with Hard-Decision (HD) decoding limits the Net Coding Gain (NCG) to 9.4 dB.
- Soft-Decision (SD) decoder plus 20% FEC rate can improve NCG to 12.2 dB (2.8 dB improvement potential).
- 3 dB OSNR improvement *roughly doubles* the noise-limited distance between regenerators.

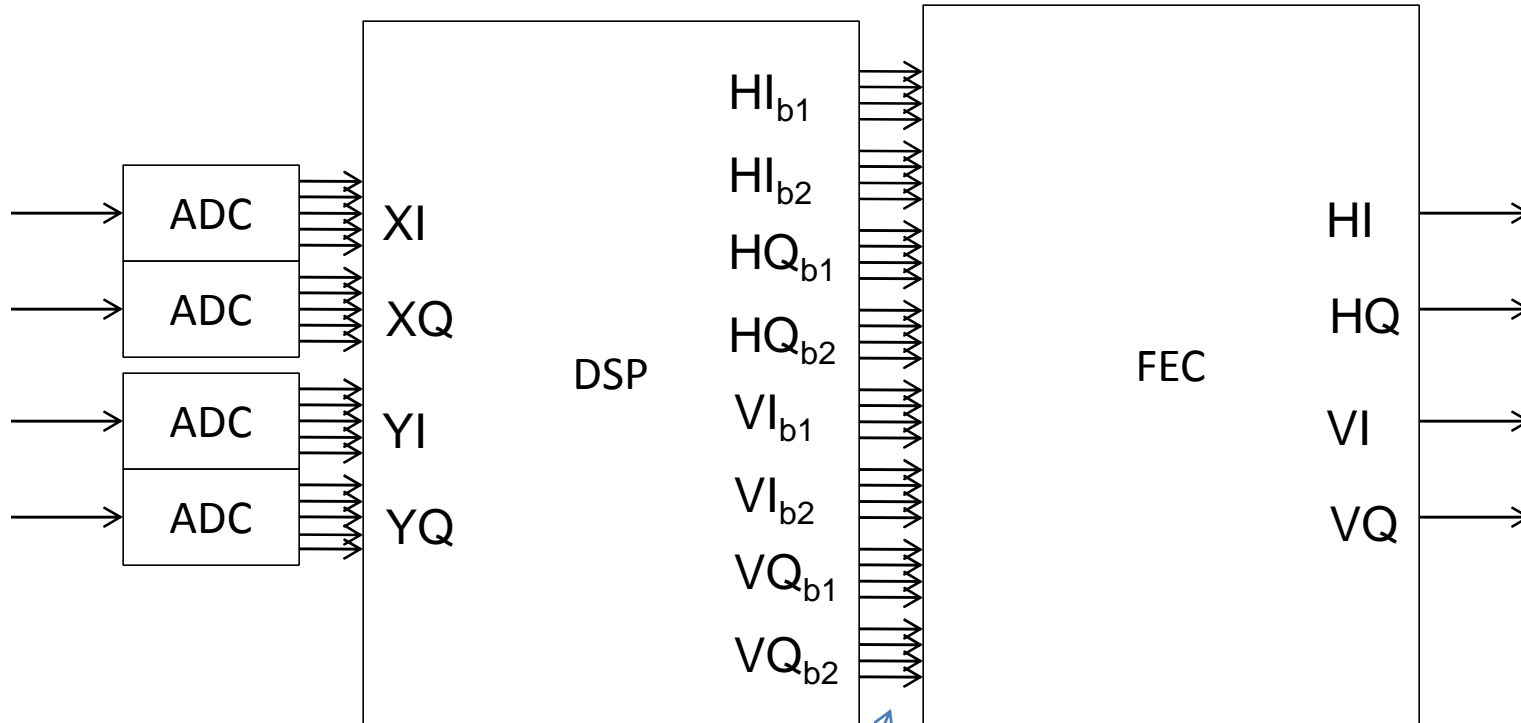


Tradeoff → Soft Decision complicates the FEC, increases bus width



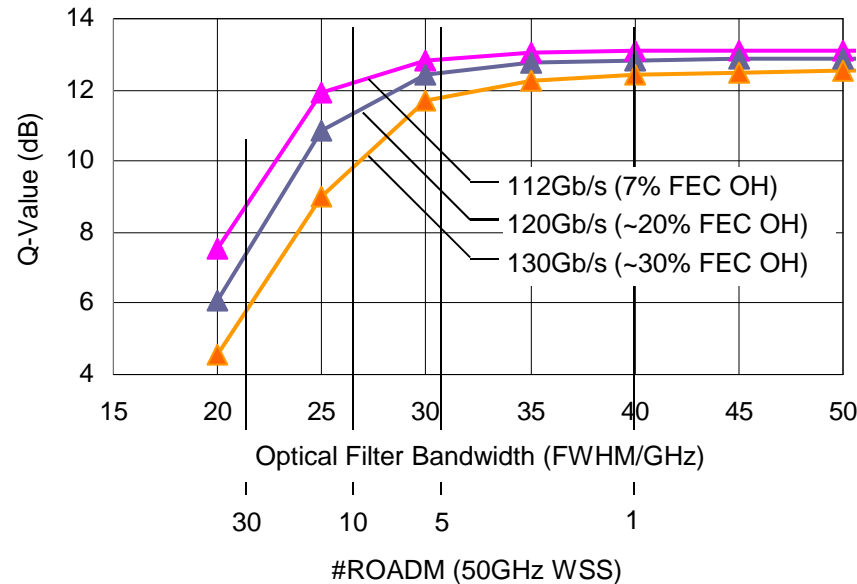
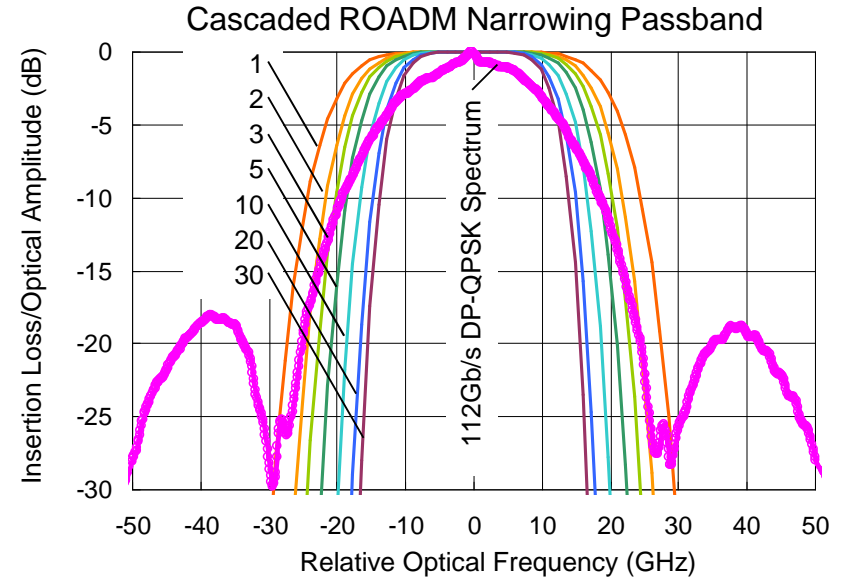
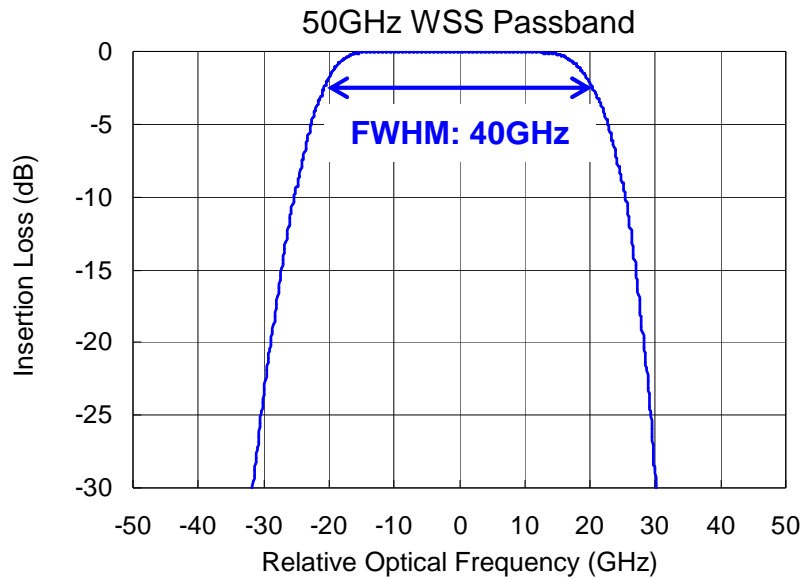
- Hard Decision → 1 bit quantization of each received data bit.
 - Level is one or zero. No information about how noise is corrupting the decision.
- Soft Decision → about 3~4 bits quantization of each demodulated data bit.
 - Value determines 'how close' to a one or zero the estimate is. Provides estimate of noise impact to the bit state.
 - Noise estimate provides additional coding gain.
 - 4 decision quantization bits * 4 data bits * 60 Gs/s → 960 Gbps internal FEC bandwidth (almost a Terabit/sec into FEC block).
 - Integrate FEC + DSP on same IC to eliminate excessive I/O interface bandwidth.

FEC interconnect



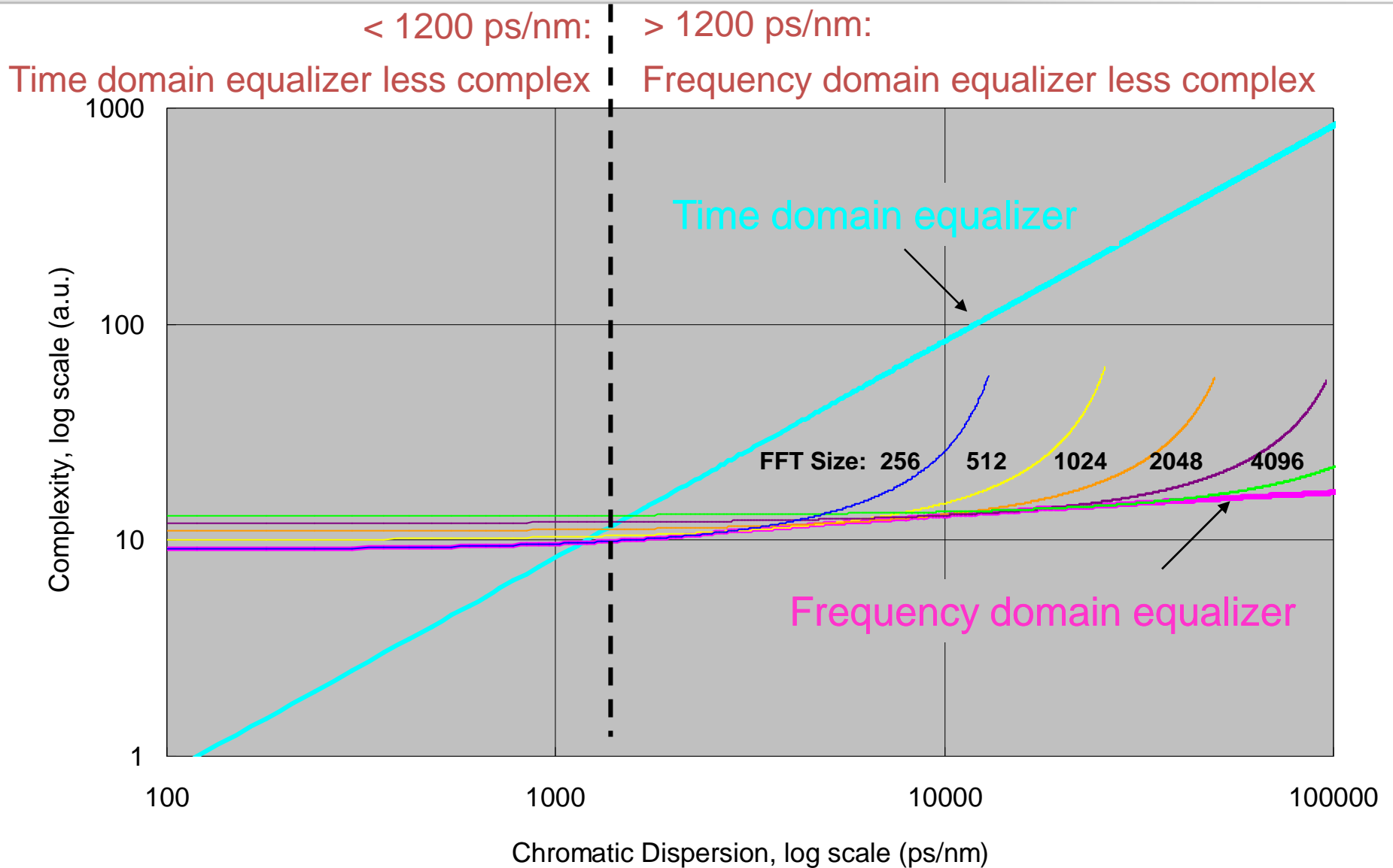
Soft-Decision: ~ 4-bits per bit
Hard-Decision: 1-bit per bit

Tradeoff → Higher symbol rate causes greater PBN penalty



Wider WSS passband enables a greater number of pass through WSS nodes.

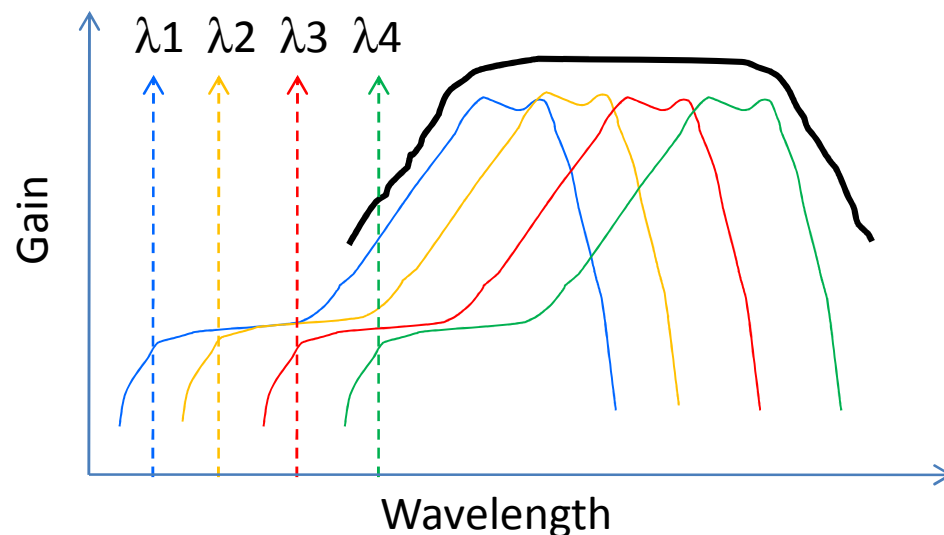
Chromatic Dispersion compensation



Note: Given numbers are estimates, exact numbers depend on specific implementation

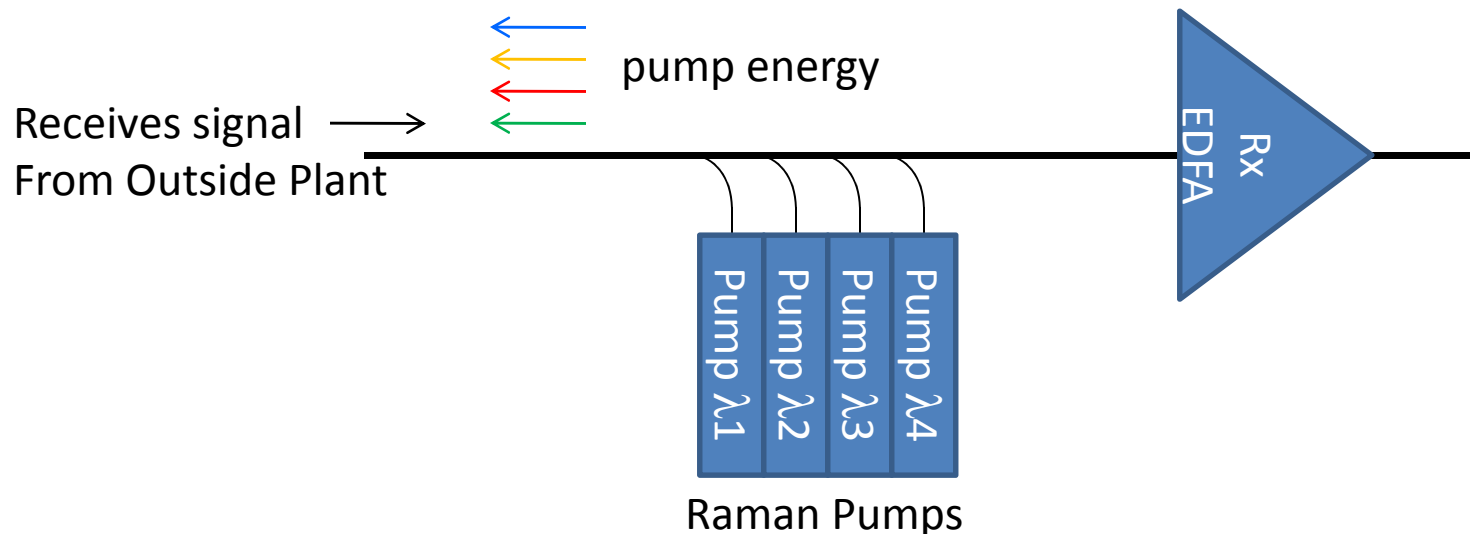
DRA – multiple pumps are used to achieve broadband gain

- DRA typically counter-pumps the receive fiber with a shorter-wavelength set of pumps. Turns the last 0~20 km of fiber (where signals are weakest and noisiest) into a distributed amplifier.



Distributed Raman Amplification

- Similar to making the last portion of the receive fiber have almost no loss.
- Can improve span distance between regenerators by roughly $20\sim 30 \text{ km} * \# \text{ spans}$ by reducing OSNR degradation and/or increasing the number of spans.



Tradeoff → higher symbol rate requires faster ADC



- 112 Gb/s → 56 Gs/s ADC conversion rate.
- 126 Gb/s → 63 Gs/s ADC conversion rate.
 - Based on simulation at 56, this increase appears realizable.



FUJITSU

The image features the word "FUJITSU" in a bold, red, 3D serif font. Above the letter "I" is a red infinity symbol. The text is set against a dark gray background with a soft, glowing light source on the left, creating a lens flare effect. The letters have a slight shadow and a white highlight on their top edges, giving them a three-dimensional appearance.