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Offered for discussion during the May 23 teleconference of the Extended Reach MMF ad-hoc.

These notes offer a way of examining the basic interoperability and reach extension capability of the various reach enhancement techniques. It is clearly a work in progress, but one that hopefully will lead to consensus building and perhaps to become a framework for such information within the annex the ad-hoc is charged with creating for baseline adoption.

Example of a Technique Interoperability Matrix for Extending Reach over OM3 MMF

		Interoperable Distance (m)						
end 1 end 2	Basic spec	Basic + FEC	Basic + CDR _{tx}	Basic + EDC _{rx}	Enhanced laser	E laser + FEC	E laser + CDR _{tx}	E laser + EDC _{rx}
Basic spec	100	100	100	100	100	100	100	150
Basic + FEC	100	150	100	100	100	150	100	150
Basic + CDR _{tx}	100	100	150	100	150	150	150	150
Basic + EDC _{rx}	100	100	100	150	100	100	100	150
Enhanced laser	100	100	150	100	150	150	150	150
E laser + FEC	100	150	150	100	150	175	150	150
E laser + CDR _{tx}	100	100	150	100	150	150	175	150
E laser + EDC _{rx}	150	150	150	150	150	150	150	175

Notes:

- Distances in **green** are guesses. A value of 150 is used where a single enhancement is effective in both directions. A value of 175 is used where a double enhancement is active in both directions.
- Combinations with gray shaded cells provide no reach extension.
- Enhanced laser specification per jewell_[ExRchMMF]_01_0508 (suggested file name of ppt contribution that Jack distributed yesterday).
- FEC sensitivity improvement depends on strength of code.
- CDR distance capability depends on where the CDR device is placed, i.e. at Tx or Rx or both, integrated in optics module or separated on host. Here, the CDR is assumed to be on the transmit side (CDR_{tx}).
- EDC capability depends on equalizer design, i.e. the number and type of taps, and placement, i.e. at Tx (pre-emphasis) or Rx (dispersion cancellation). Here the EDC placement is assumed to be on the receive end (EDC_{rx}).
- A similar table with longer distance values can also be created for OM4.

Observations:

Only a single electronic enhancement (i.e. FEC, CDR, EDC) per end has been examined here. Multiple electronic technique combinations are possible and exploration of them is encouraged. With the above assumptions, only the combination of E Laser and EDC_{TX} provides universal reach extension with all other techniques, and perhaps most significantly with the Basic Spec, because this combination improves capability in both directions. However, in seemingly odd contrast, the use of EDC_{TX} with the Basic Spec laser offers the fewest extended reach interoperability choices because the transmit capability is not enhanced.

To help see the enhancement capability of a particular electronic technique, the following tables offer pared-down views.

Just FEC and E Laser

end 1 end 2	Basic spec	Basic + FEC	Enhanced laser	E laser + FEC
Basic spec	100	100	100	100
Basic + FEC	100	150	100	150
Enhance laser	100	100	150	150
E laser + FEC	100	150	150	175

Just CDR_{TX} and E Laser

end 1 end 2	Basic spec	Basic + CDR _{TX}	Enhanced laser	E laser + CDR _{TX}
Basic spec	100	100	100	100
Basic + CDR _{TX}	100	150	150	150
Enhance laser	100	150	150	150
E laser + CDR _{TX}	100	150	150	175

Just EDC_{TX} and E Laser

end 1 end 2	Basic spec	Basic + EDC _{TX}	Enhanced laser	E laser + EDC _{TX}
Basic spec	100	100	100	150
Basic + EDC _{TX}	100	150	100	150
Enhance laser	100	100	150	150
E laser + EDC _{TX}	150	150	150	175

With the above tables we can more clearly see that:

- 1) The FEC technique offers fewer distance extension combinations than the other techniques.
- 2) The CDR_{TX} offers the most distance extension combinations for a Basic Spec module. From an administrative perspective, the presence of a Basic Spec

module (without CDRtx) in the channel universally dictates that the distance capability is not enhanced.

- 3) EDCrx with E Laser offers the only distance extension that works with a Basic Spec module, and can therefore provide distance extension with an upgrade of the module on only one end of the channel.