Record-Length 10.7 Gb/s Uncompensated Transmission Experiment over Installed Fiber Using Narrow-Filtered Duobinary and a Correlation-Sensitive MLSE-Rx

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Outline of the presentation

- State of the art and motivations
- Experimental set-up
- Off-line processing results
- Conclusions

State of the art

- Several experimental results have suggested that MLSE should have the potential for reaching *long-haul* distances without any dispersion compensation

- 600 km of G.652 fiber have been demonstrated experimentally (off-line) at 10 Gbit/s, using 64 states only thanks to the use of a narrow filter limiting the spectral width of the TX signal.
  - *N. Alic et al., "Experimental Demonstration of 10 Gb/s NRZ Extended Dispersion-Limited Reach over 600km-SMF Link without Optical Dispersion Compensation," OFC 2006, paper OWB7, March 5-9, 2006.*

- 1,040 km of G.652 fiber have been demonstrated experimentally (off-line) at 10 Gbit/s in a conventional, externally-modulated IMDD-format experiment. The OSNR penalty with respect to back-to-back was about 3.2 and 3.8 dB at 8192 and 4096 states, respectively.
  - *P.Poggiolini, G.Bosco, S.Savory, Y.Benlachtar, R.I.Killey, J. Prat, "1,040 km Uncompensated IMDD Transmission over G.652 Fiber at 10 Gbit/s using a Reduced-State SQRT-Metric MLSE Receiver", post deadline paper 4.4.6, ECOC 2006, Sep. 2006.*

Summarizing…

Bit-rate: 10 Gb/s

Record efficiency

Length of SSMF (L)	Number of States (N_s)
600 km	64
1040 km	8192

Record distance

Scaling the results at 10.7 Gb/s…

Bit-rate: 10.7 Gb/s

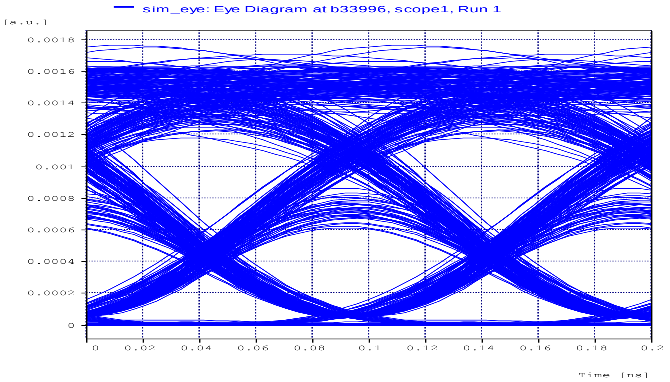
Record efficiency

Length of SSMF (*L*)	Number of States (N_s)	Efficiency
524 km	64	1 bit of memory every 87 km
908 km	8192	1 bit of memory every 70 km

Record distance

An idea to beat the records…

- Reducing the impact of chromatic dispersion by using a duobinary signal, which is per se substantially band-limited, and then applying drastic further optical filtering at the Rx.
- The eye in back-to-back is affected by ISI, but the MLSE processor can easily deal with it.



- The narrow optical Rx filtering correlates ASE noise and, to exploit such correlation to improve the BER, we use a noise-correlation-sensitive MLSE Rx.

M. Rubsamen et al., "MLSE receivers for narrow-band optical filtering," OFC 2006, Anaheim, Mar. 2006, paper OWB6.

F. Buchali, H Bulow, "Correlation sensitive Viterbi equalization of 10 Gb/s signals in bandwidth limited receivers," OFC 2005, Anaheim, Mar. 2005, paper OFO2.

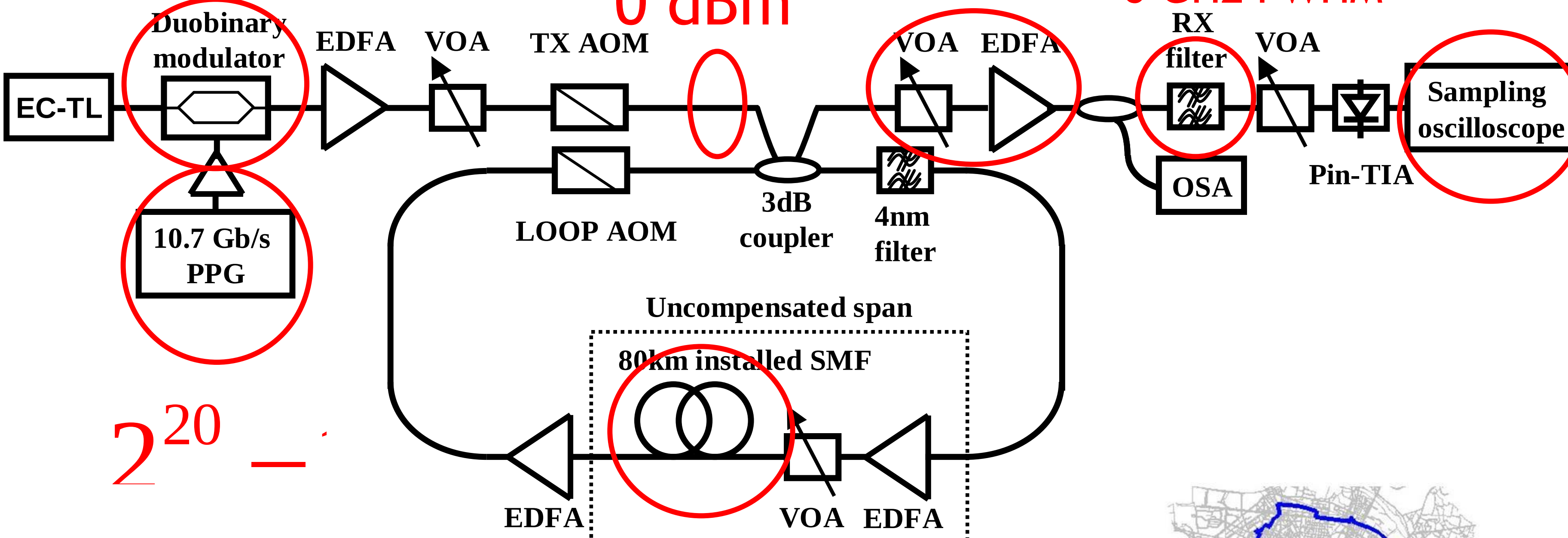
Experimental set-up

2.7 GHz

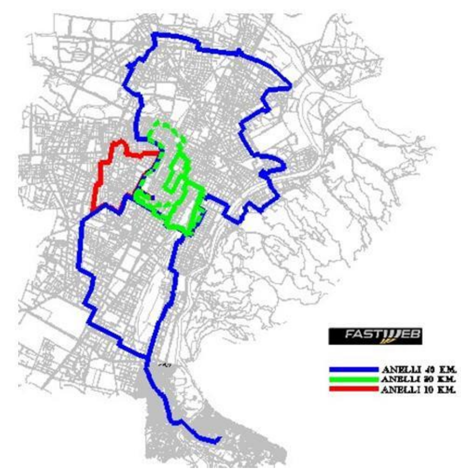
0 dBm

Gaussian with

6 GHz FWHM



$2^{20} -$



Signal sampling

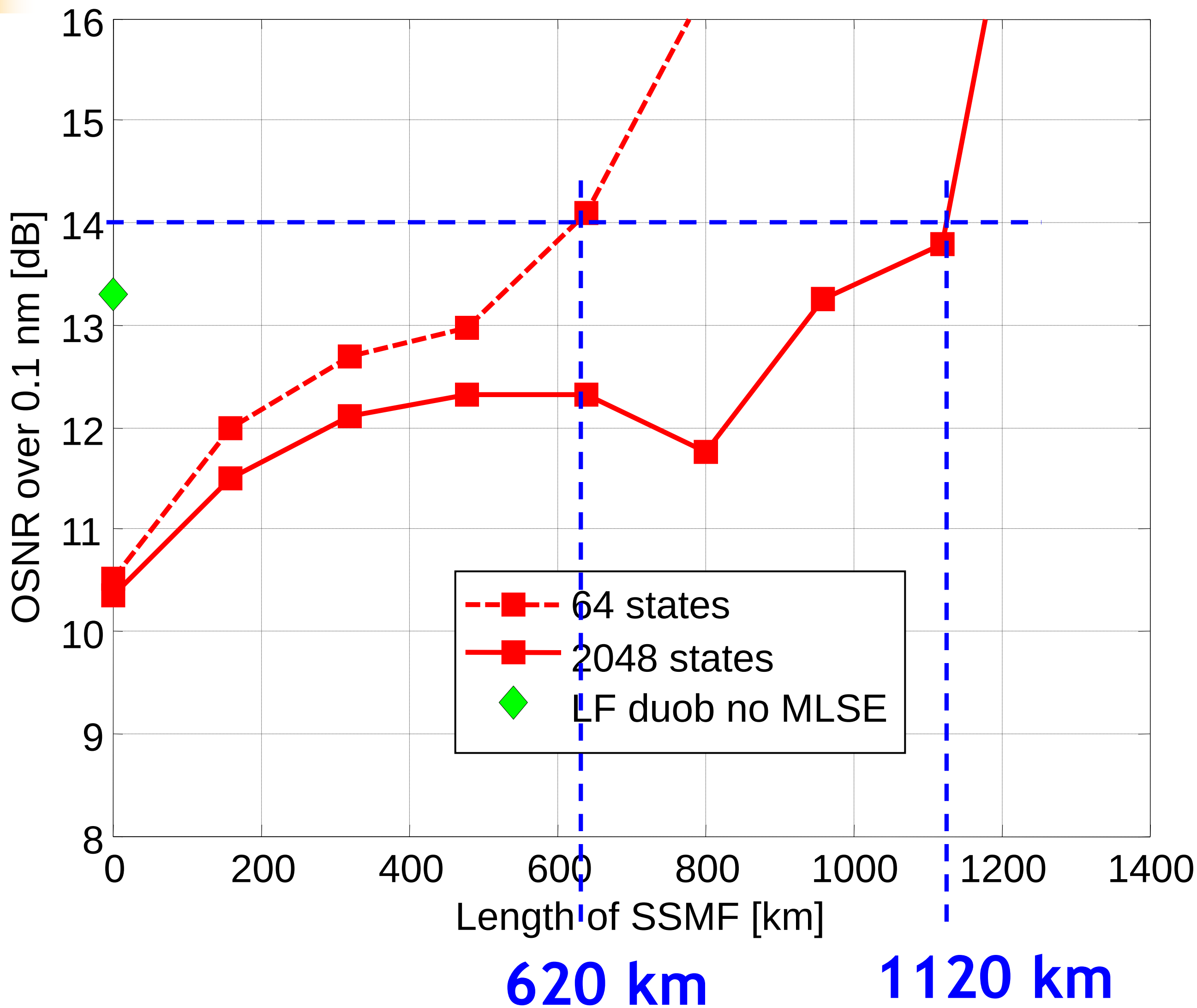
- A TekTronix TDS6154C real-time oscilloscope was used to sample the electrical RX signal, set at its top sampling speed of 50 Gsamples/s, resulting in 4.7 samples/bit.
  - This large oversampling value was used only to simplify clock-recovery. Then, down-sampling to *2* samples per bit was carried out.
- The A/D resolution was about *5 bits*
- The re-clocked and down-sampled signal samples were then passed on to the MLSE processor.

Post-processing

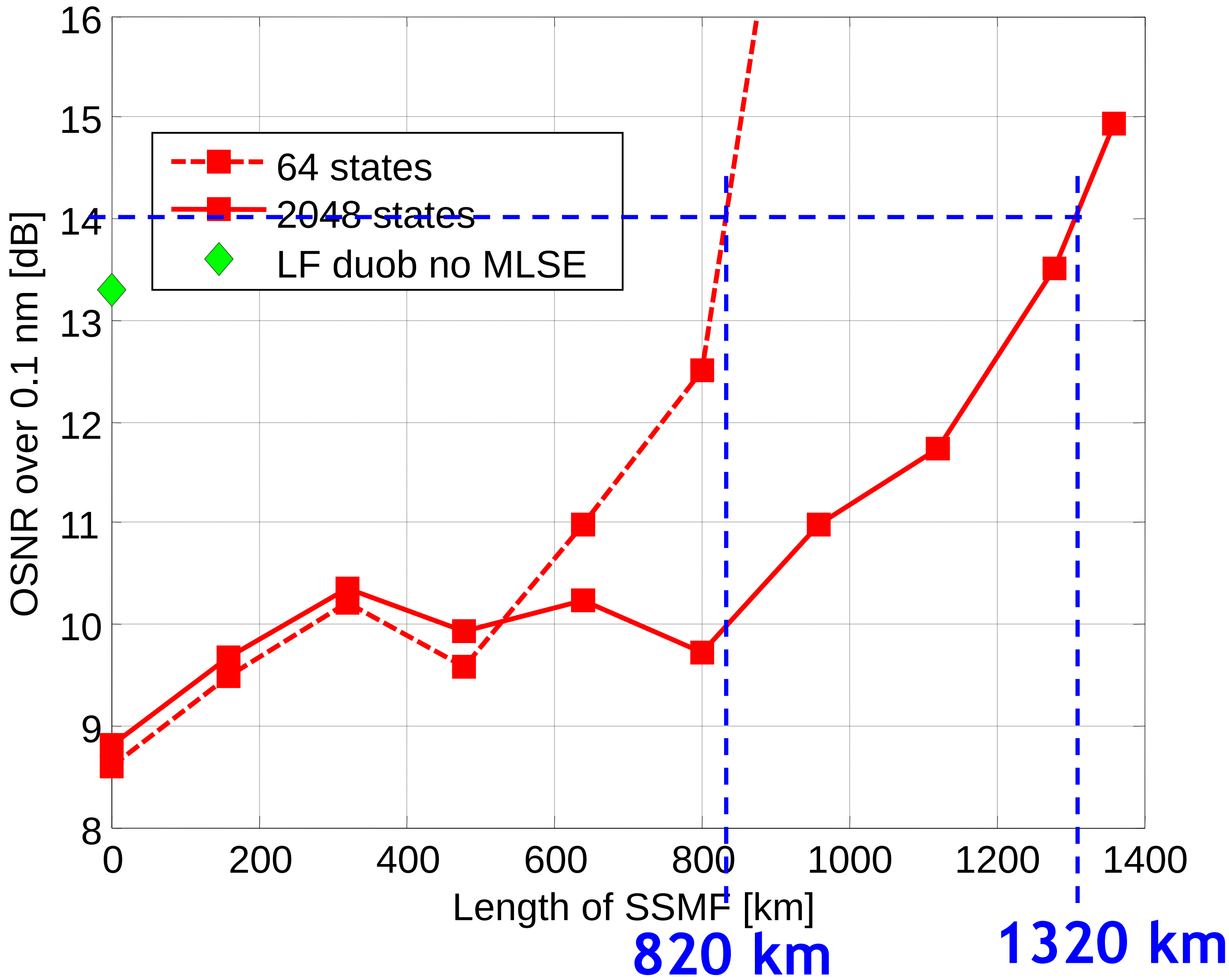
- Number of samples per bit: 2
- Number of processor states: 64 and 2048.
- Pre-distortion of signal samples taking their square-root, to make the noise statistics more Gaussian-like and less signal-dependent.
- Trellis instruction performed over the first million bits of each data run, demodulation and BER evaluation performed over the following million bits.
- Since the narrow Rx filter correlates noise samples across adjacent bits, a correlation-sensitive MLSE algorithm was used.
- The branch metric we used is the one proposed in [*] in the context of magnetic-recording devices.
- The data were also processed using conventional non-correlation sensitive MLSE, for comparison.

[*] A. Kavcic and J. M. F. Moura, “Correlation-sensitive adaptive sequence detection” IEEE Trans. Magnetics, vol. 34, no. 3, May 1998, pp 763-771.

Results (conventional MLSE)



Results (correlation-sensitive MLSE)



Conclusions

- Record-efficiency (SSMF at 10.7 Gb/s):

Previous results: Our experiment:

530 km → 620 km → 820 km

64 states Conventional MLSE	64 states Conventional MLSE	64 states Correlation-sensitive MLSE

1 bit of memory every:

87 km → 103 km → 136 km

Conclusions

- Record-length (SSMF at 10.7 Gb/s):

Previous results: Our experiment:

930 km → 1120 km → 1320 km

8192 states
Conventional
MLSE

2048 states
Conventional
MLSE

2048 states
Correlation-
sensitive
MLSE

Acknowledgments

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