What will be the first SDM fiber deployed and for which applications?

Lars Grüner-Nielsen

Danish Optical Fiber Innovation

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Application areas

- Submarine
  - The limiting factor for cable capacity is amount of electrical power, which can be delivered to undersea repeaters
- Terrestrial long haul and metro
  - Huge installed base of standard single mode fibers
- Datacenters
  - Open for new technology
  - Cost driven

Prices for simulations

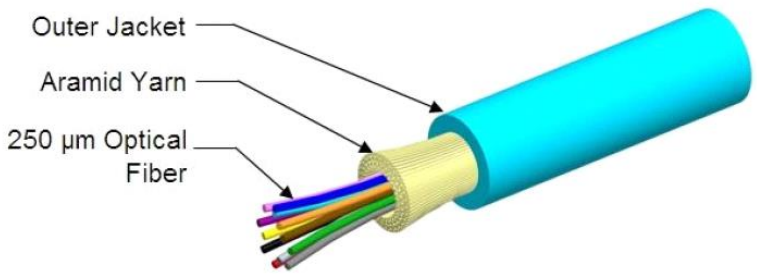
Fiber type	Fiber price, relative to SM
SM	1
MM OM2	2.5
FMF 4 modes	2
MC-SM 4 cores	2.5

Cable type	Estimated cable price, relative to SM fiber price
2 fiber SM	22
8 fiber SM	36
2 fiber MM	29
2 fiber MC-SM	29
2 fiber FMF	27

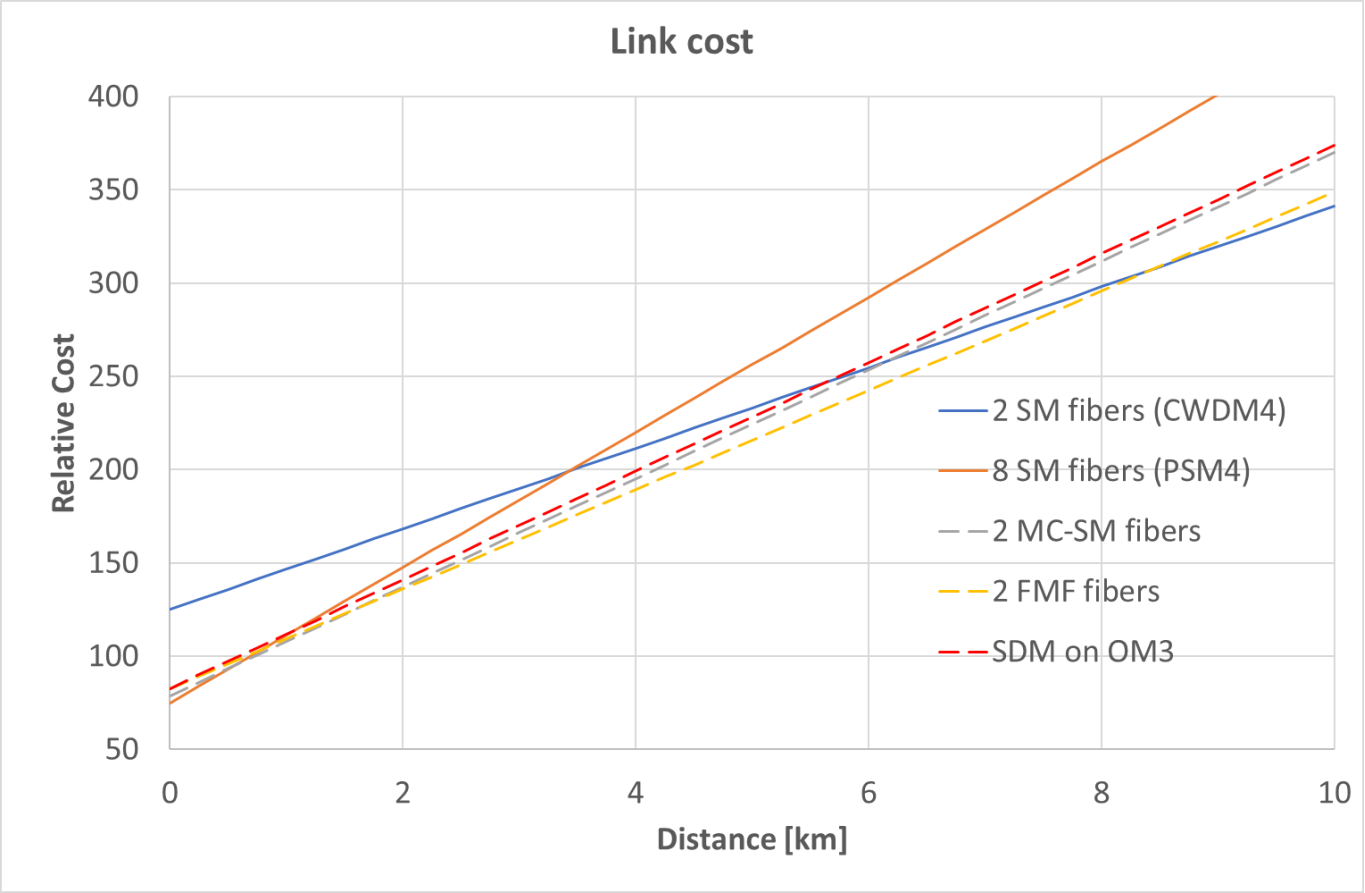
100 G transponder type	Price, relative to 1 km SM fiber price
4 parallel SM, PSM4	38
4 wavelength, CDWM4	63
FM 4 modes	41
MC 4 cores	39

Prices are assuming high volumes production. I.e. millions of km/year.

Green color: Available today
Yellow color: Some confidence in projection for mass production
Red color: Very uncertain projection



Comparing, multi fibers, WDM and SDM



Observations

For very long distances WDM on a standard SM fiber pair will always be cheapest.

As a PSM4 transponder always will be cheaper than a SDM transponder PSM4 will always be cheapest for shortest reach.

If a SDM transponder can be made sufficient cheaper than a WDM transponder ,SDM will be cheapest for medium distances.

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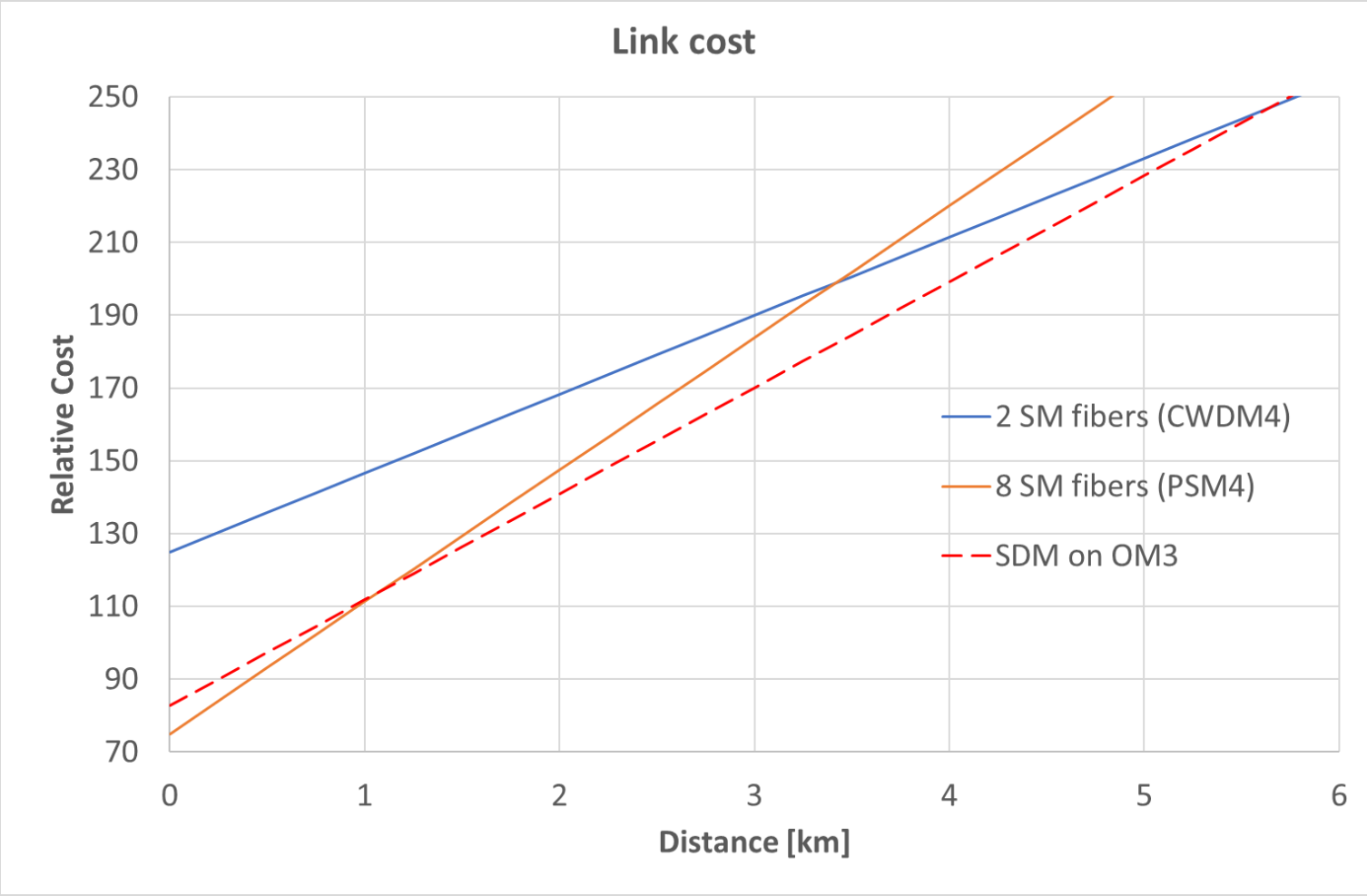
Focusing on fibers which are available at high volume prices today



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Recent demonstration of SDM on OM2 fiber

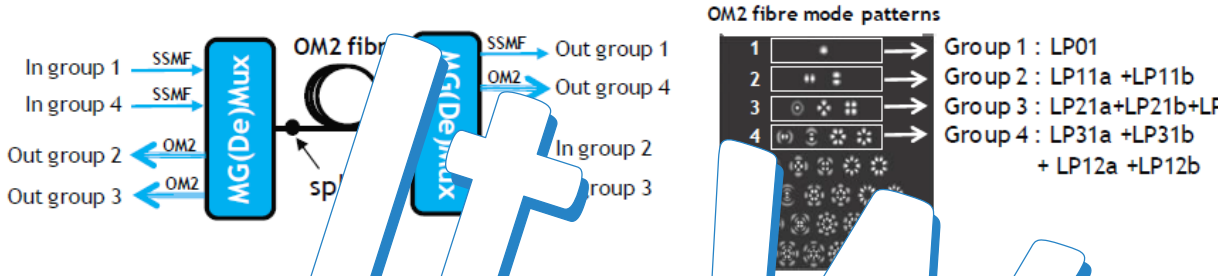

Fig. 1 rectionnal Mode Gro)M

	loss	crosstalk
Mode group 1	-4.8dB	-21.4dB
Mode group 2	-4.9dB	-14.8dB
Mode group 3	-5.6dB	-14.9dB
Mode group 4	-6.5dB	-14.8dB

***Tab. 1:** Loss and crosstalk for each mode group*

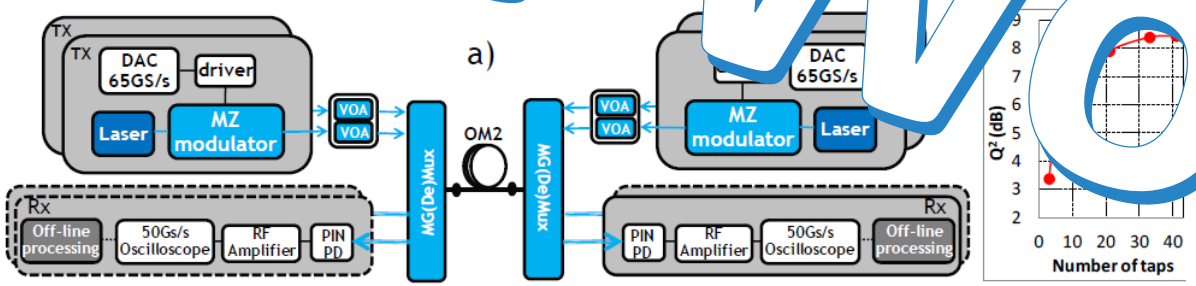

Fig. 2: a) Transmission experiment set-up, b) Evolution of the Q^2 factor as a function of the number of taps of the feed- forward equalizer for mode group 4 after 4.4km of propagation

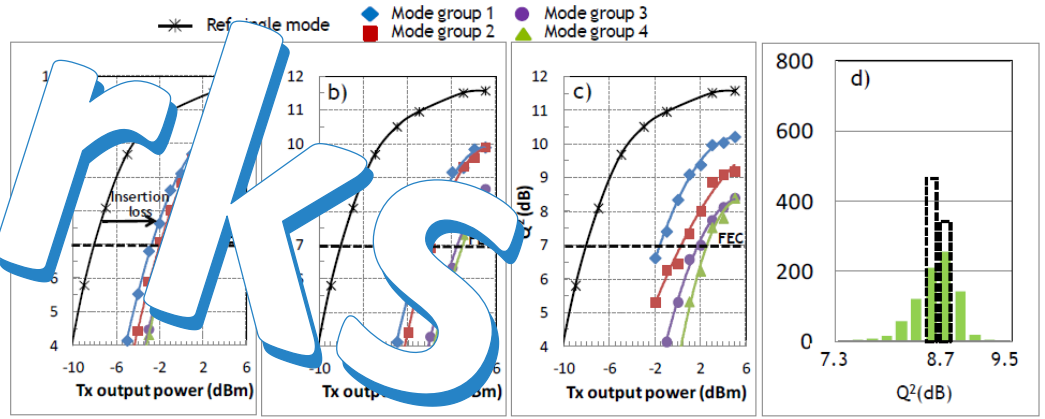

Fig3. : Q^2 factor measurement a) back to back with 10m of OM2 fiber, b) with 4.4km of OM2 fiber c) with 4.4km of OM2 fiber and additional coiling with 10 turns on a 35mm diameter cylinder d) : Q^2 factor distribution during 1 hour for single mode reference (empty dotted rectangle), and for mode group 4 over with 4.4km of OM2 fibre and 10 turns on a 35mm cylinder(filled rectangle)

Christian Simonneau et al., "4x50Gb/s transmission over 4.4 km of multimode OM2 fiber with direct detection using mode group multiplexing, " OFC paper Tu2J.3 (2016)

Further results ECOC'17 Th.2.A.3

Conclusion

- There is potential for application of SDM in Datacenters
- Special SDM fibers (few mode fibers, multicore fibers) are not available at high volume pricing today
  - Focus on SDM on OM2 fibers
- Key will be very low cost and high performance mode multiplexers

- First deployed SDM fiber might be standard 50/125 MM fibers for medium distances in datacenters

Acknowledgement

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