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Single or Dual Fiber for 100 Mbps over SMF?

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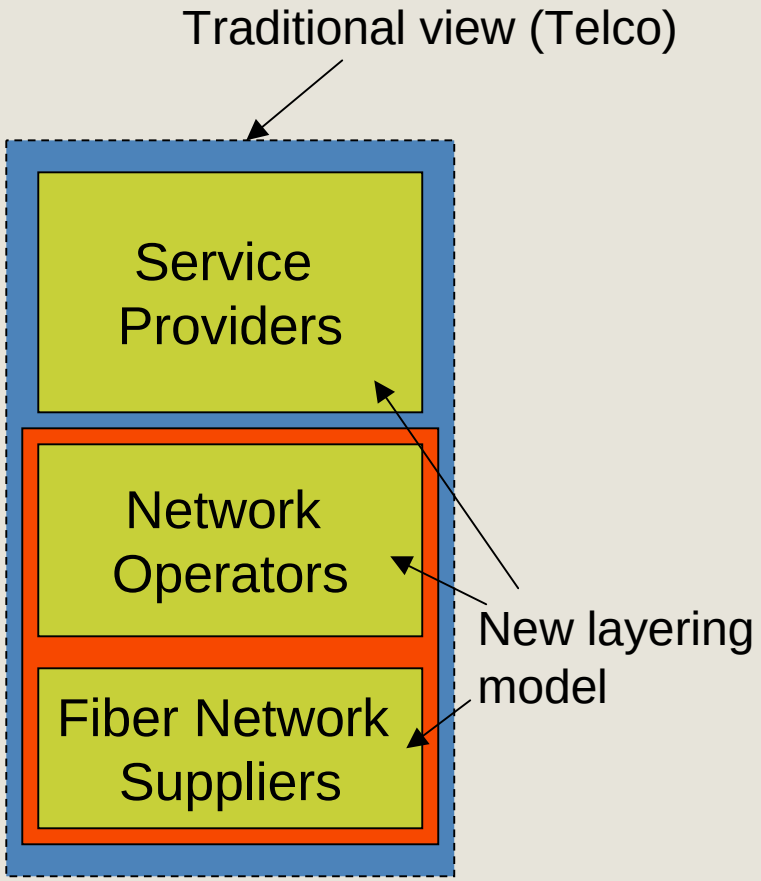
Service – Network Layering

- The infrastructure can be used for different applications such as FTTH, FTTB, Leased Lines, Radio Access but also dark fibre lease.
- The different parts in the access networks are divided by two or more parties.
- Fibers are installed by incumbents, power utility companies, landlords etc.



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Link Budget

- A single fibre TRx has to compensate for splitter/WDM-filter loss.
- By reducing P_{out} the demands on alignment can be relaxed and thereby reducing the assembly cost.
- Reduced P_{out} lowers demands on thermal management
- Dual fibre enables the use of low-cost connectors

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A Simple Low Cost Link Budget Calculation

- Prerequisites: dual fiber, 125 Mbps, 4 connector pairs

Link	*Pout [dBm]*	*Sensitivity [dBm]*	*Optical path power penalty [dB]*	*Dynamic Range [dB]*	*Distance [km]*	*Fiber attenuation [dB/km]*	*Connector attenuation [dB]*	*Total attenuation [dB]*	*Ageing & margin [dB]*	*Excess Margin [dB]*
FDDI, Cat1	-20	-31	0	11	10	0,5	0,5	4	3	1
STM-1 S1.1	-15	-28	0	13	10	0,5	0,5	6	3	3
Low Cost Component	-20	-31	0	11	10	0,5	0,5	4	3	1
Low Cost Component	-15	-25	0	10	10	0,5	0,5	3	3	0

- No power left for splitters/WDMs
- Difficult to obtain a single fiber solution while maintaining a low cost approach

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Cables and Connectors

- The size of a 1-fibre cable is about the same as for a 4-f cable (O.D. ~3-5 mm).
- The cable itself is the costly part, not the fiber.
  - Environmental protection, temperature range etc.
  - Tension force.
- All installations today are based on a 2-fiber modularity.
- A ribbon connector is handled as a single connector but can hold 2 fibers (up to twelve fibers if necessary).

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Installation

- Trenching and installation are the most costly parts, up to 80% of the First Installed Cost.
- Ribbon cables reduces the size and improves the handling.
  - Up to 12 fibres can be fusion spliced simultaneously at the same time as a single fiber.
- Dual fiber connectors (SC, LC, MT-RJ, MU etc.) are all keyed => No risk of crossing Tx and Rx fibers.
- A generous link budget enables simple (low cost) installation methods.

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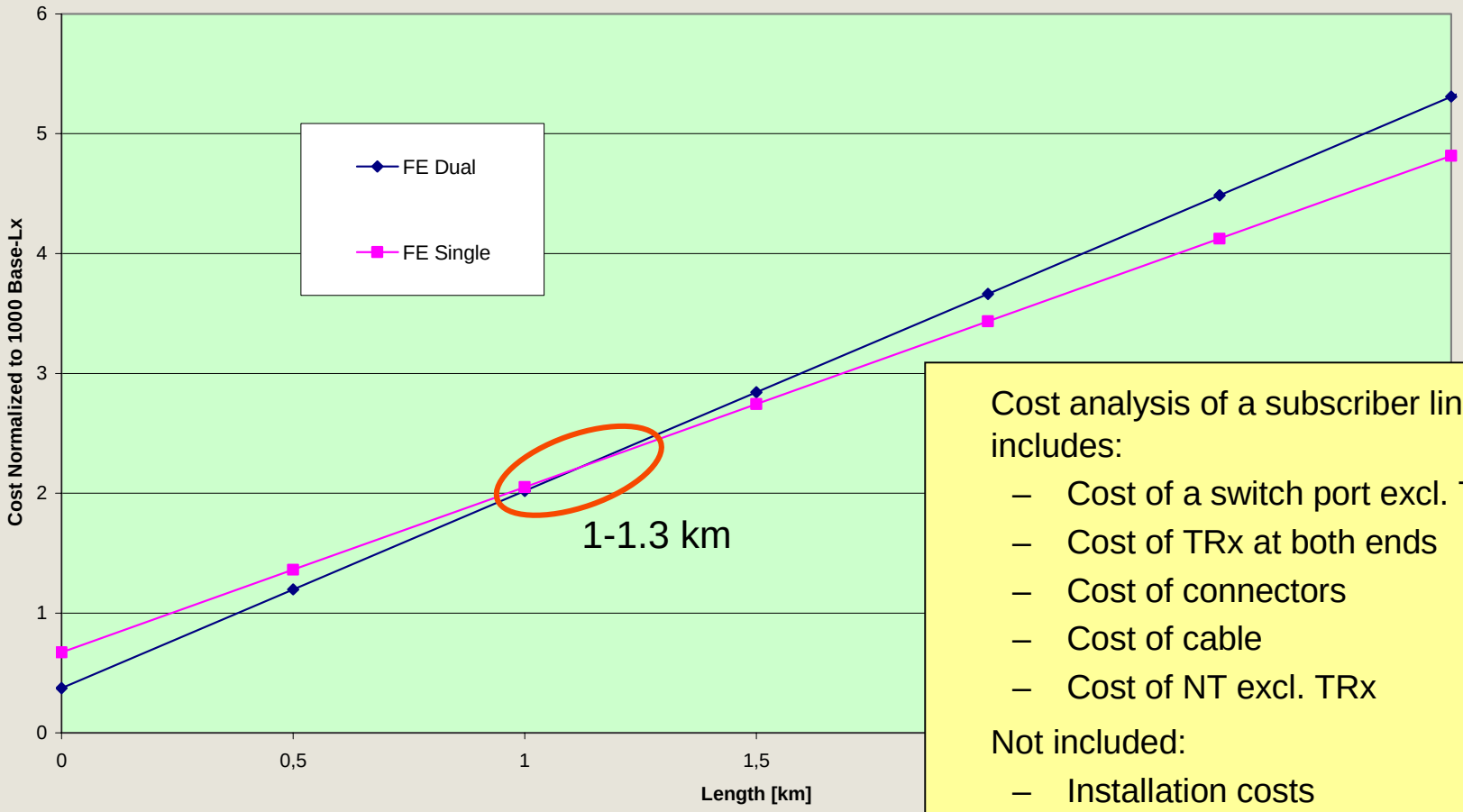
Economics, Cost of HW only



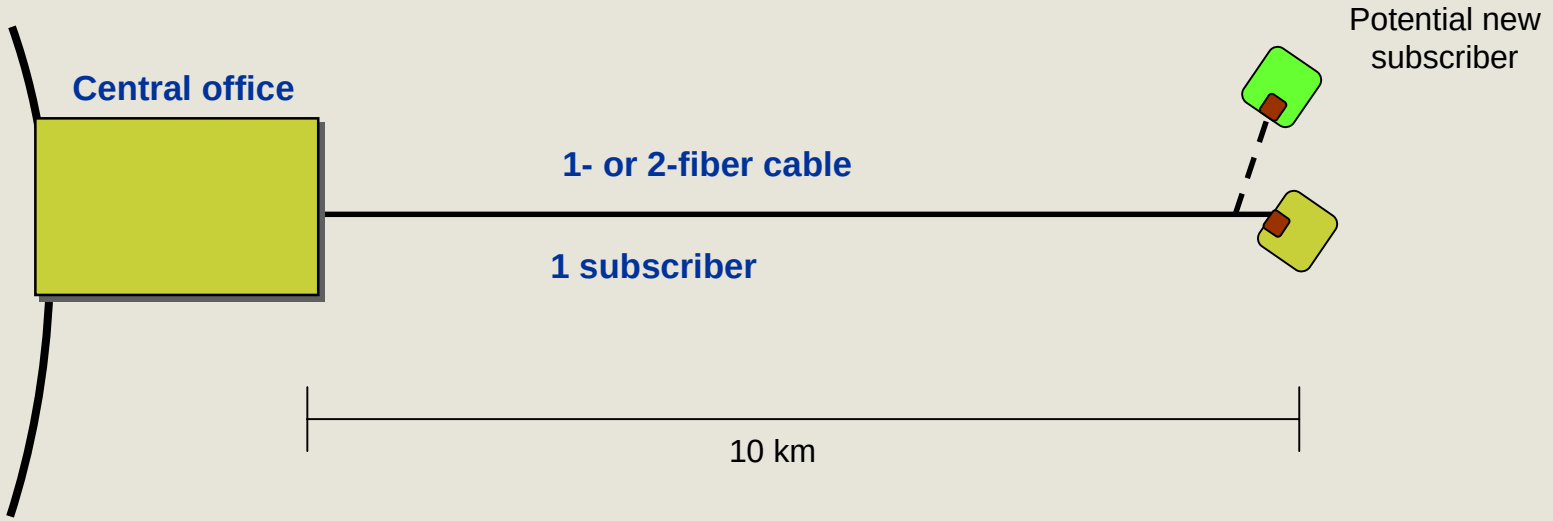
Cost analysis of a subscriber line includes:

- Cost of a switch port excl. TRx.
- Cost of TRx at both ends
- Cost of connectors
- Cost of cable
- Cost of NT excl. TRx

Not included:

- Installation costs
- O&M costs

First Installed Cost - Rural



10 km fiber to each subscriber

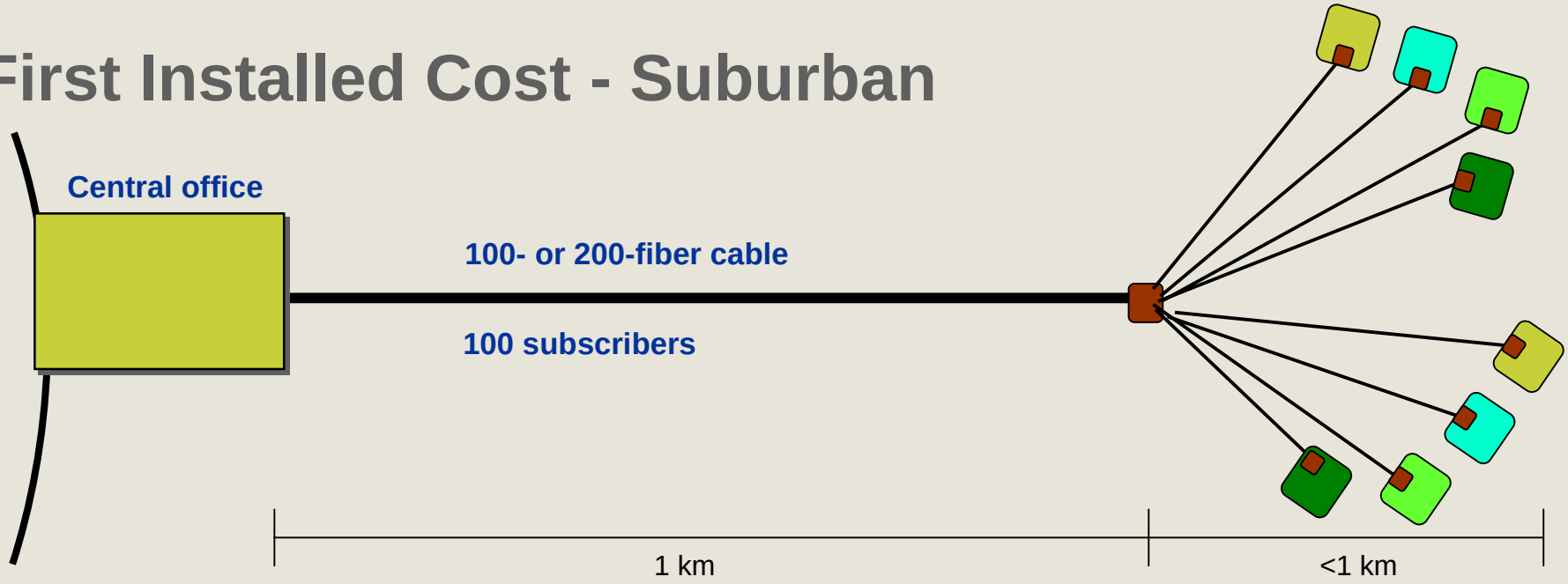
2 fiber
1 fiber
} **Delta cost 0.3%**

Active port cost included => **delta cost = 0.3%**

Relations used in calculation:

Cables		1≠1	Installation	
2-fiber	1.0		Rural	1.0
1-fiber	0.9		Suburban	2.3
100-fiber	12		Urban	4-5
200-fiber	20			

First Installed Cost - Suburban



100 subscribers share fiber cable & trenching 1km, separate 1- or 2-fiber cable last <1km.

2 fiber
1 fiber

Delta cost 0.25%

Active port cost included => **delta cost = 0%**

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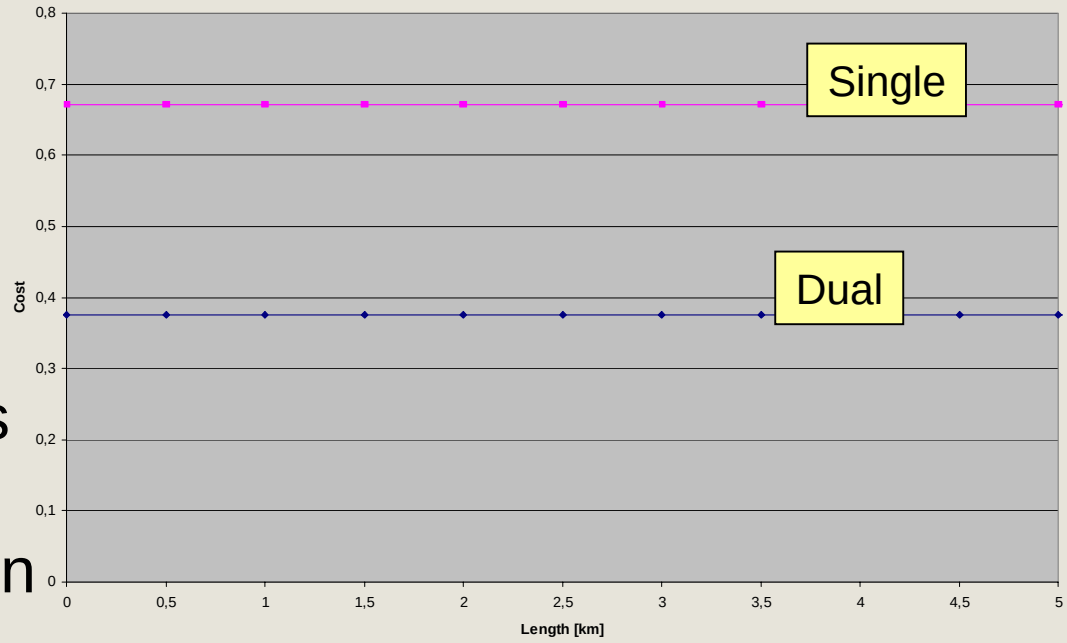
Economics

- Experience shows that most customers are within 1 km. Therefore a large portion of all subscribers can be served by a cost optimized solution.
- Dual fibre TRx will benefit from other short-haul applications that will help drive the volumes. E.g. FTTD, FTTA etc.
- The fibre plant and the active equipment will often be installed at different occasions. A flexible network is therefore necessary in dense populated areas.

Economics for the new business model

- Fibers will be leased from power utility companies, landlords etc.

- The cost for the fibers will be included in the operational cost, not in the FIC!
  Long term lease =>
  low operational cost



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Merits of Single and Dual Fiber

- Why Single
  - Save fiber at long distances
  - Fewer fibres to be handled
- Why Dual
  - Lower cost at short distances
  - Lower cost when fibers already are installed
  - No need for a wavelength plan
  - Other short haul applications will drive volumes (FTTD and FTTA)
  - More rapid to standardise.
  - Ribbon technology enables high packing density
  - “Cheaper dB”

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Conclusion

- Dual fiber will be the most cost efficient solution for short distance installations and it is there the main cost lie.
- A single fiber solution will force us to a narrow specification.
- A PMD optimized for a single fibre solution will be inappropriate for a large number of installations

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Proposal for P2P PMD

One PMD proposal for FE based on 100 Base-Fx standard.

	Dual fiber
Fiber type	SMF
Bit rate	125 Mb/s
Max length	10 km
min. Pout	-20 dBm
Sensitivity	-31 dBm

Minimum Work Option

Details to be defined and agreed by March meeting