Fiber Cabling Trends in Data Centers

Paul Kolesar, CommScope

IEEE 802.3

Next Generation Optics Study Group

September, 2011

Objective & Methodology

- Examine fiber cabling channel length distributions over time to identify trends that will allow informed determination of reach targets

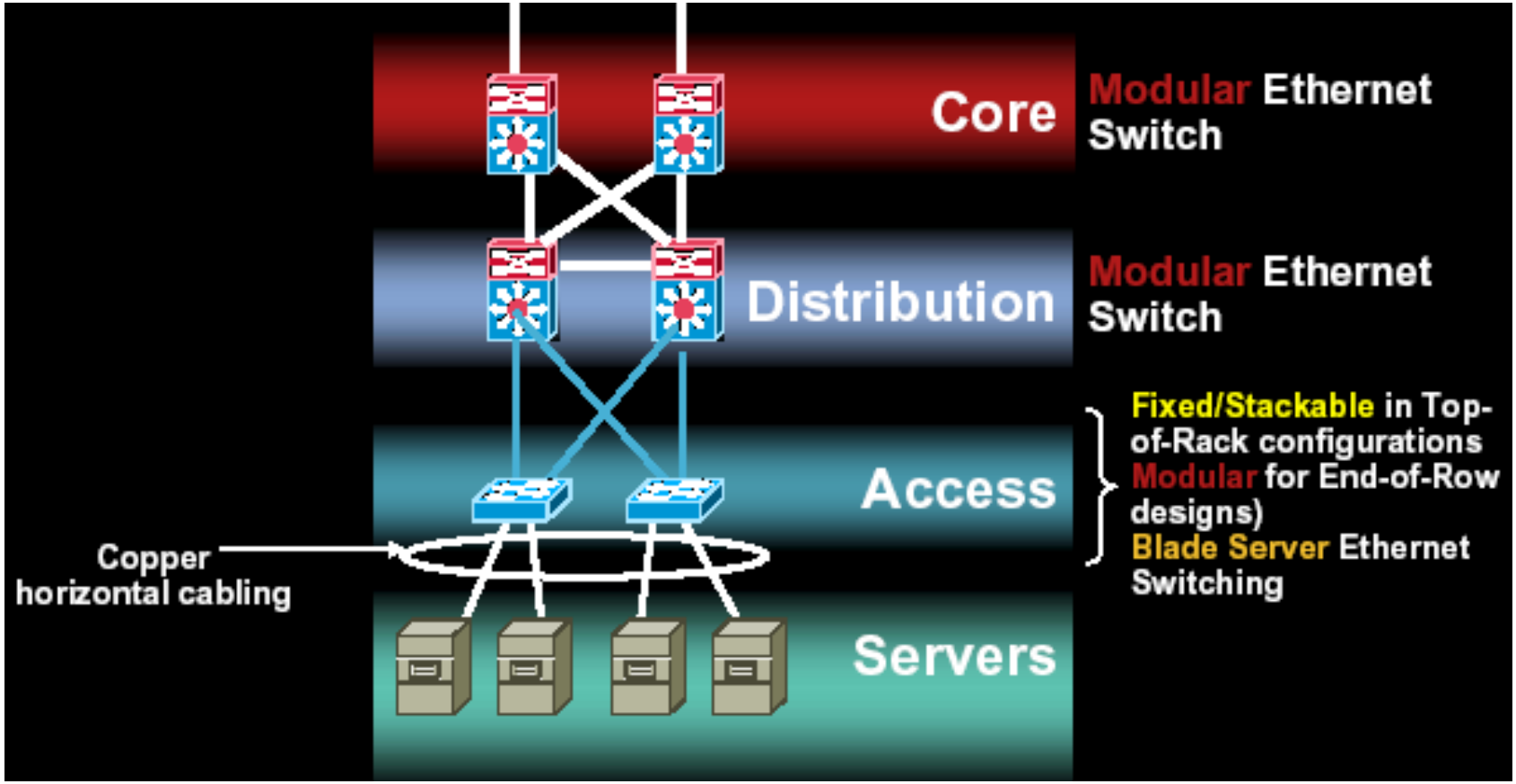
- Extract length distributions from CommScope sales data base of factory-terminated fiber cabling assemblies used in building data centers

Disclosure:
Similar material was contributed to Ethernet Alliance in May 2011, and INCITS T11.2 in August 2011

Outline

- Architecture and cabling terminology
- Fiber type trends
- Generating channel length distributions
  - Cords
  - Permanent Links
  - Channels
- Reach coverage
- Channel length trends
- Future Work
- Summary

Data Center Architecture Terminology



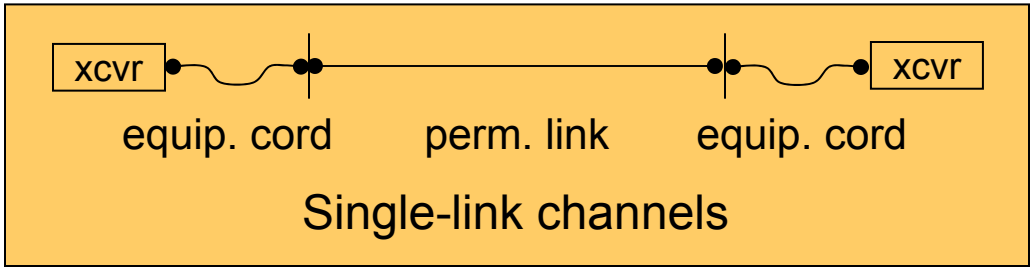
source: IEEE 802.3 contribution barbieri_01_0107.pdf

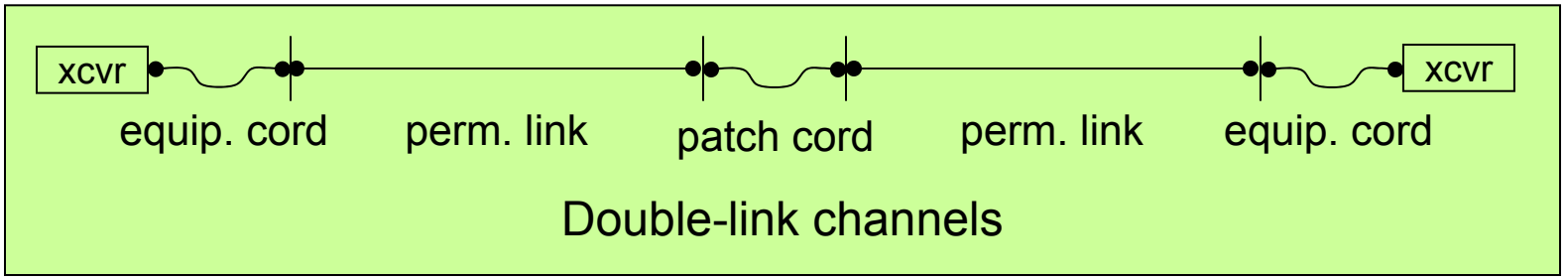
Cabling Terminology

Cords – used to administer connectivity from:
1. equipment (transceivers) to patch panel, called equipment cords
2. patch panel to patch panel, called patch cords

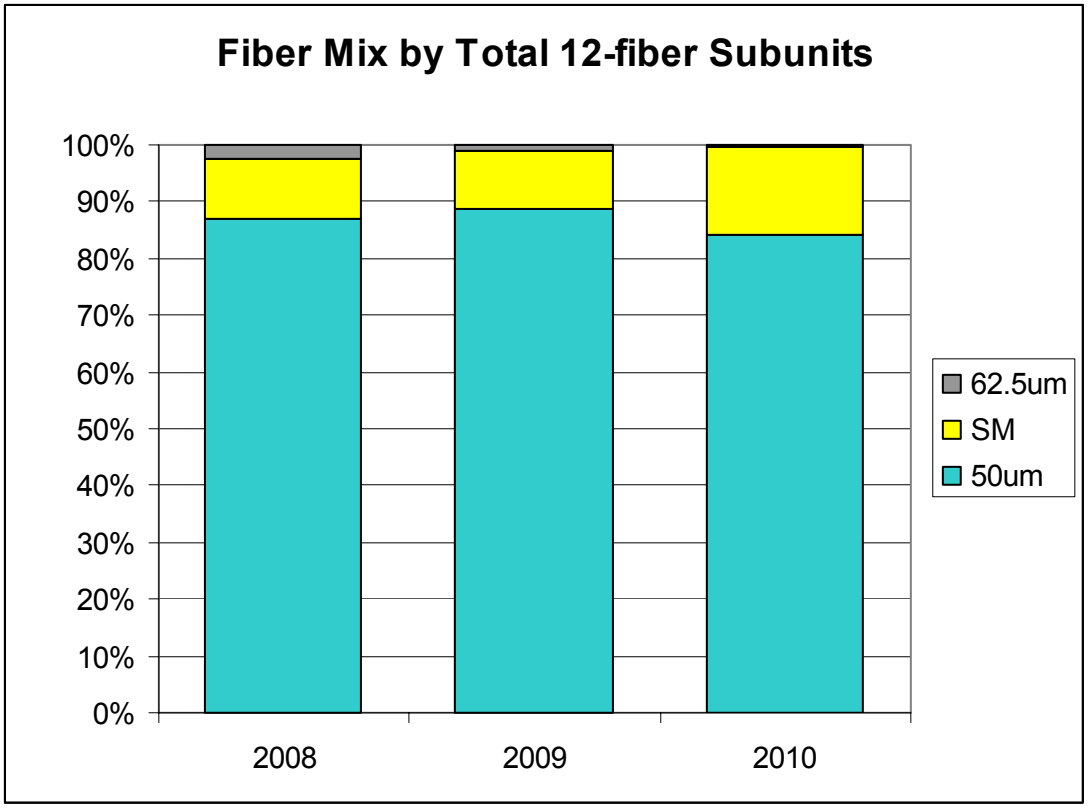
Links – permanent cabling between two patch panels,
built in Data Centers primarily using 12-fiber cable subunits

Channels – complete end-to-end connectivity between equipment
consisting of concatenations of cords and permanent link(s)



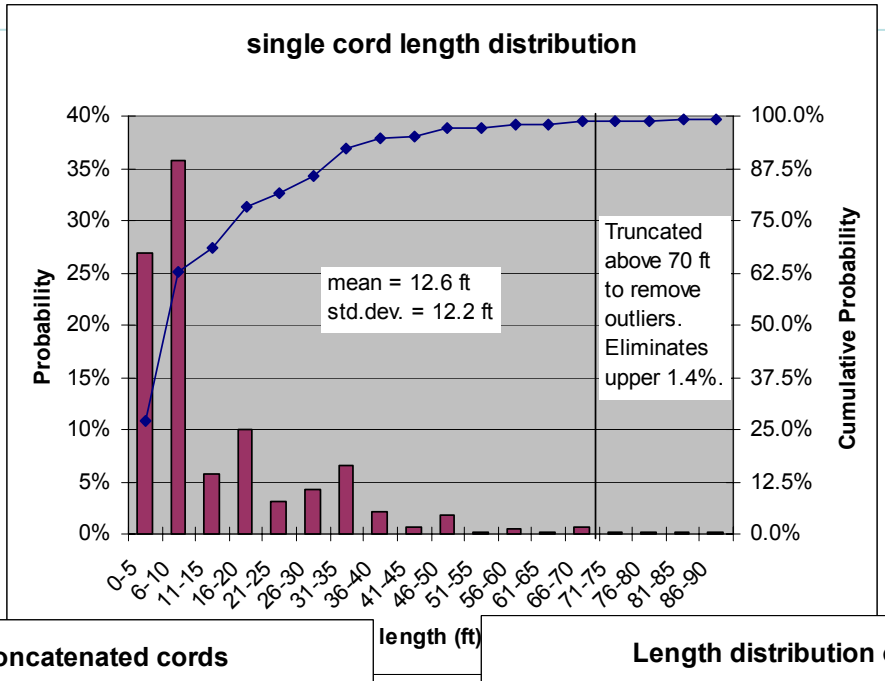


Fiber Media Mix 2008 - 2010



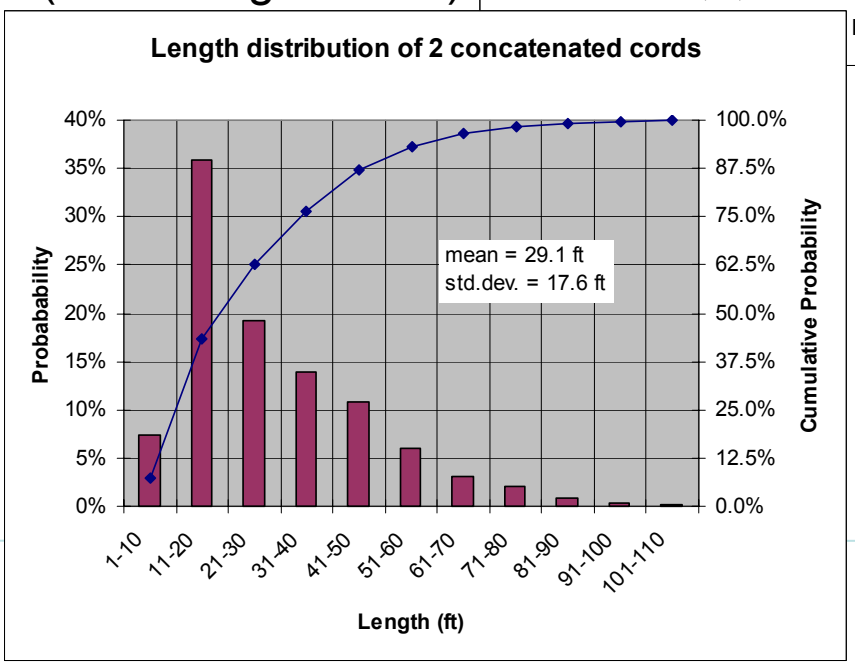
- Laser-optimized 50 µm dominated (~85%)
- Single-mode varied between 10 – 15%
- 62.5 µm faded to insignificance

Cord Distributions



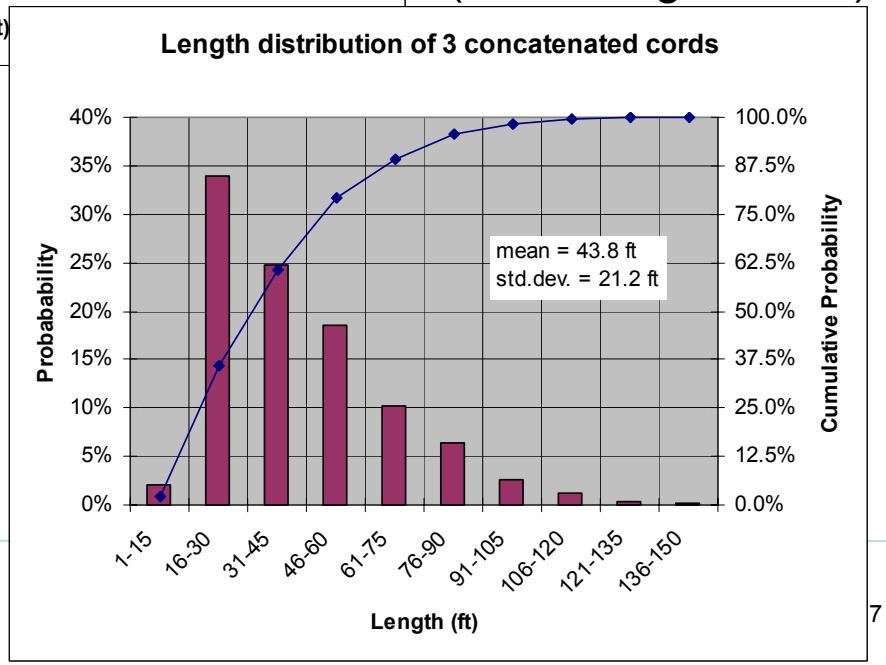
Convolved once with itself

For 1-link channels (containing 2 cords)

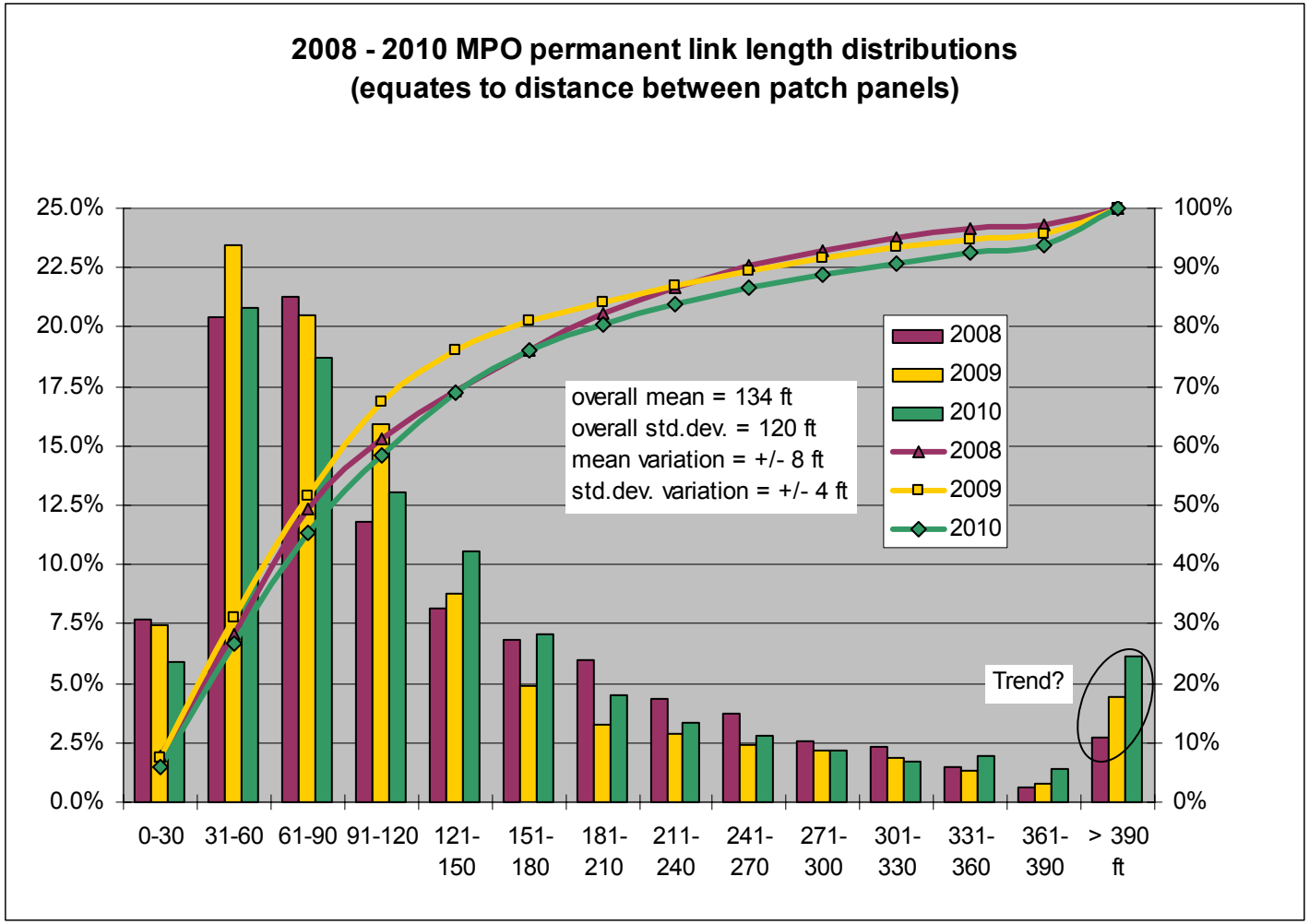


Convolved twice with itself

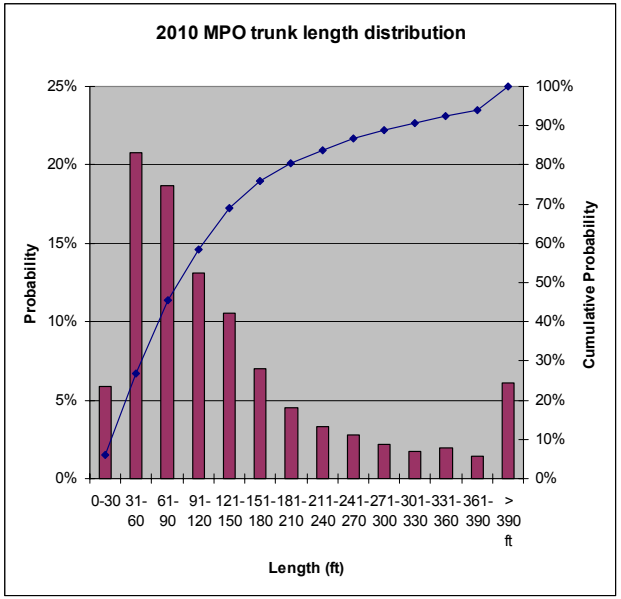
For 2-link channels (containing 3 cords)



Permanent Link Distributions 2008 - 2010



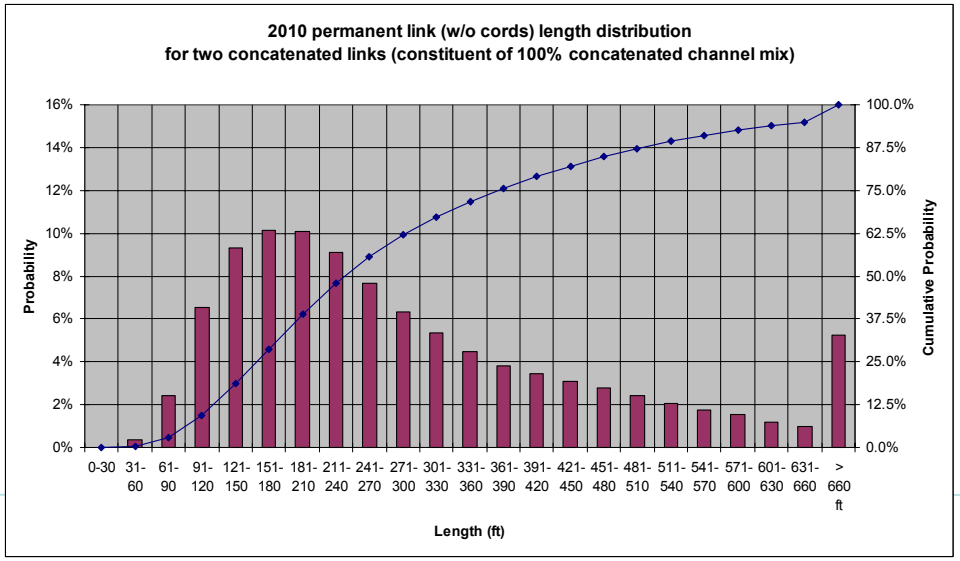
Permanent Link Concatenation



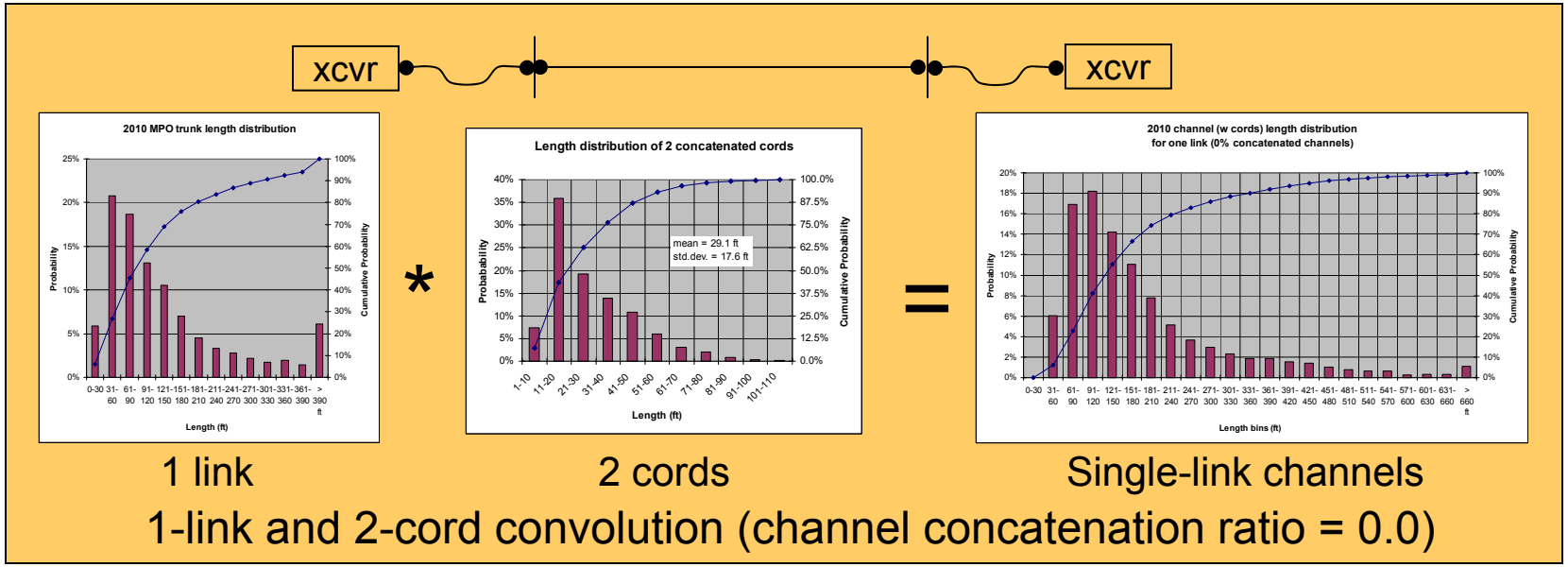
Convolved once with itself.

Yields 2-link distribution.

Concatenation ratio = 1

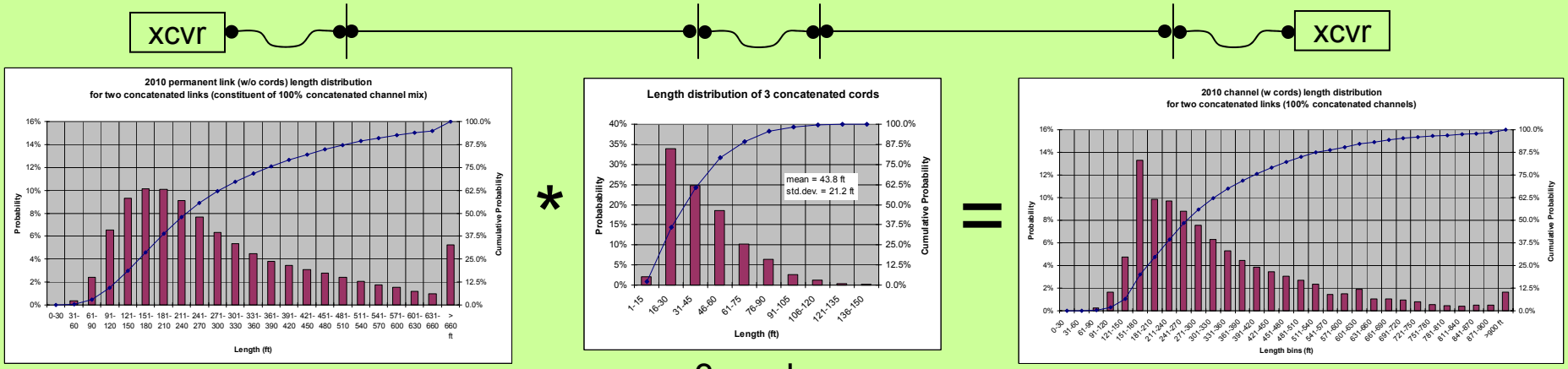


Channel Development



1 link 2 cords Single-link channels

1-link and 2-cord convolution (channel concatenation ratio = 0.0)

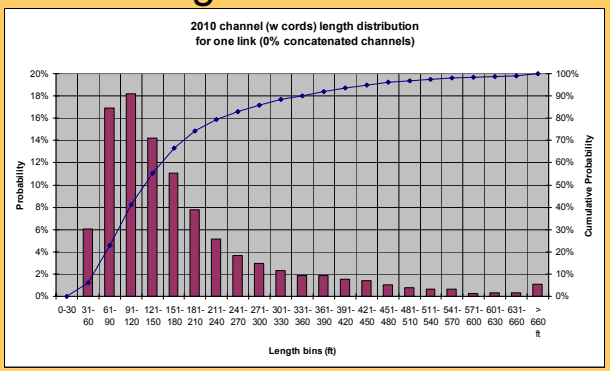


2 links 3 cords Double-link channels

2-link and 3-cord convolution (channel concatenation ratio = 1.0)

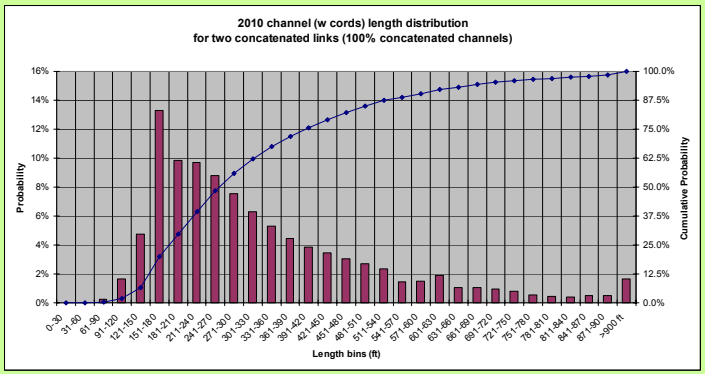
Channel Mixture Example

Single-link channels



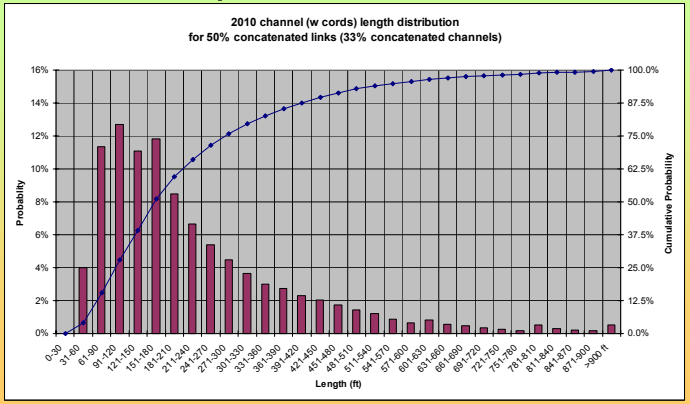
⅔ +

Double-link channels



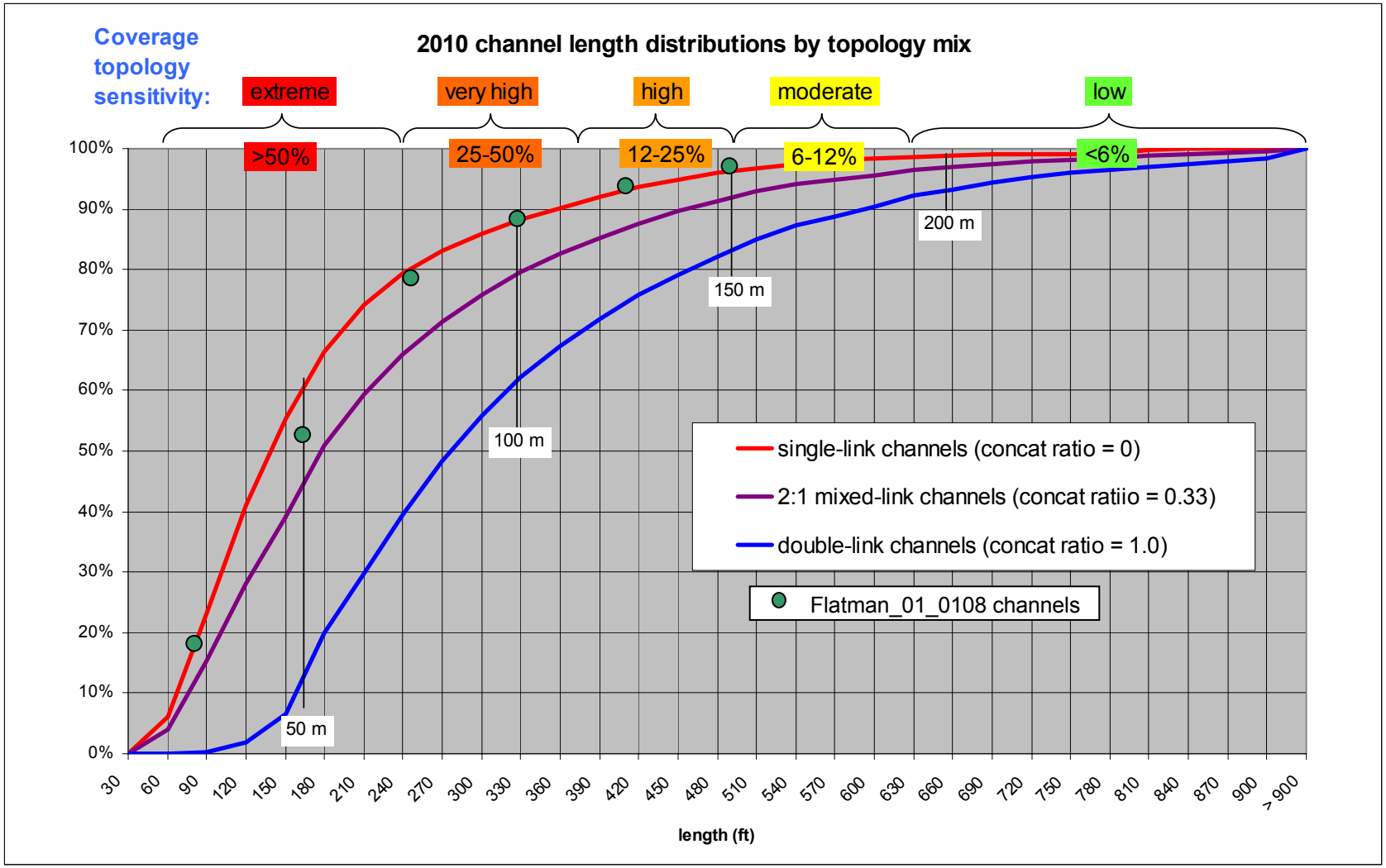
⅓ =

2:1 composite mix of channels



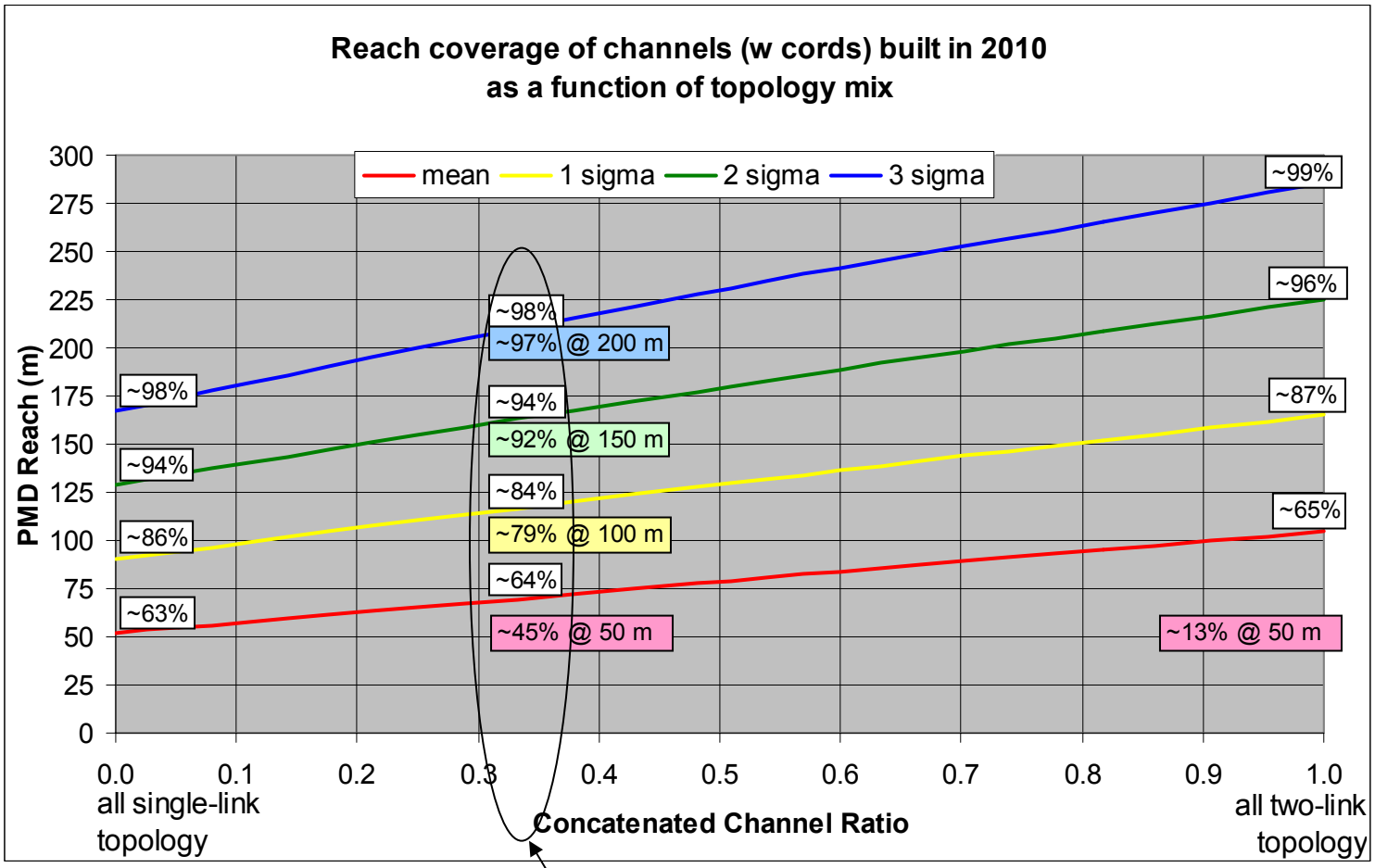
2:1 channel mixture
(channel concatenation ratio = 0.33)

Channel Length Distributions



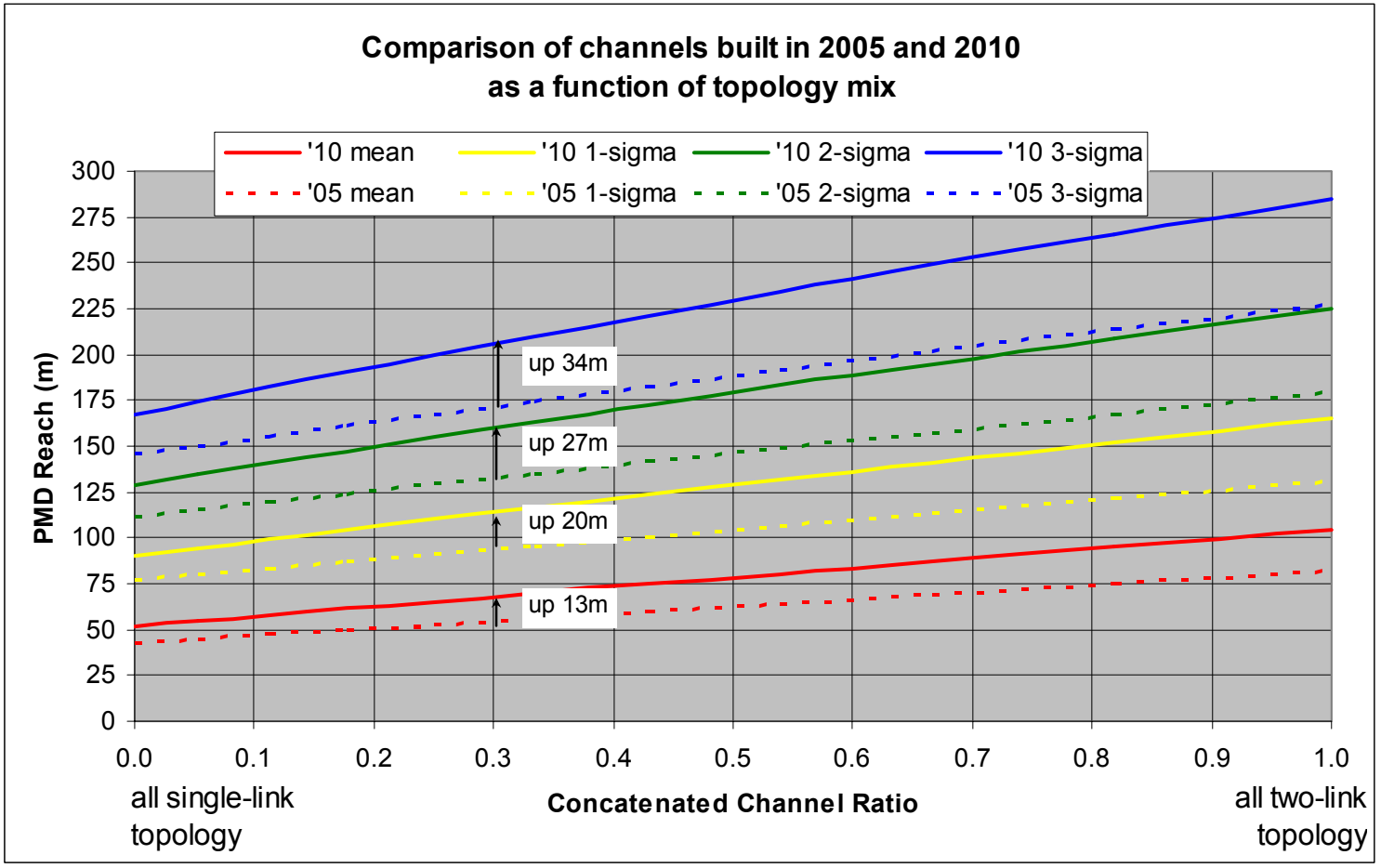
Coverage topology sensitivity = (single-link coverage - double-link coverage) / single-link coverage

Reach Coverage of Channels



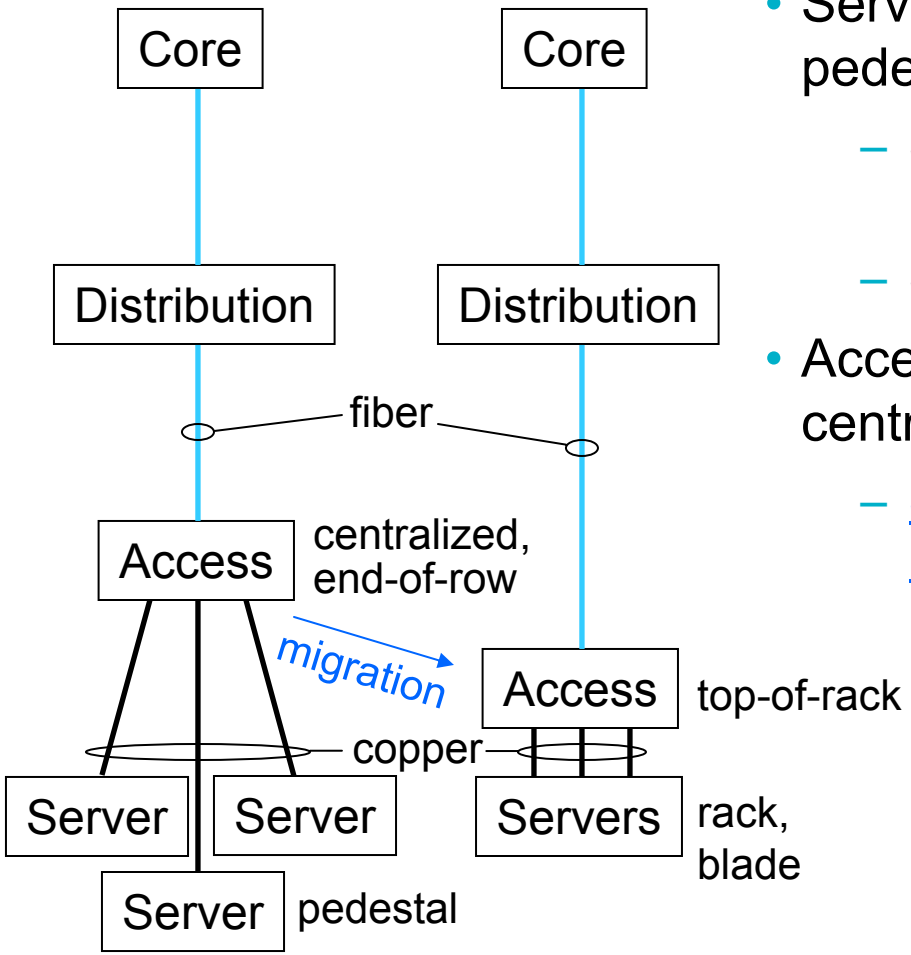
Important region. Recall reading recent report that shows this represents aggregate mix. Also this mix of 2005 CommScope data best aligned with Flatman survey of 2007.

Comparison of Channel Lengths 2005[a] vs 2010

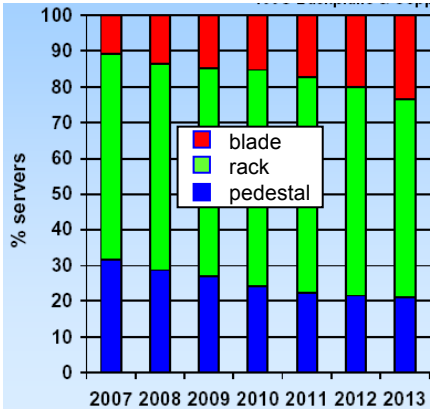


a. sources: IEEE 802.3 contributions Kolesar_1_0906.pdf and kolesar_01_0308.pdf

Possible Explanation for Length Increase



- Server form migration trend: pedestal ▸ rack ▸ blade
  - Server density increase drives localization of access switch
  - Single server rack can consume switch
- Access switch placement migration: centralized ▸ end-of-row ▸ top-of-rack
  - Shortening copper access channels lengthens fiber aggregation channels



Sources: IDC, Sep. 2010
IEEE 802.3 CFI_01_1110.pdf
flatman_01_0311.pdf

Future Work

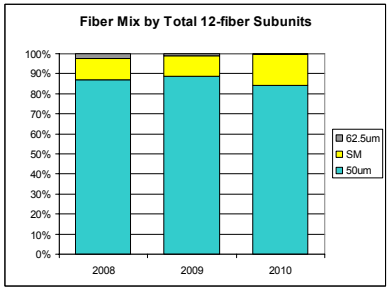
- Estimate solution costs by examining technologies vs. reach coverage
  - MM and SM optics
  - Retiming
  - Equalization
  - Encoding
  - Dispersion reduction

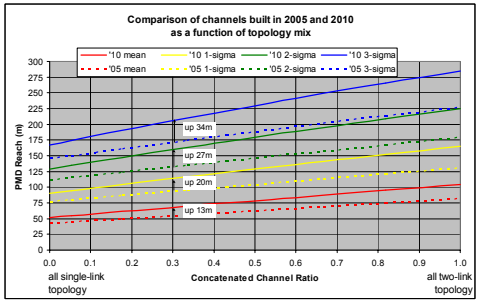
Great topics for this study group

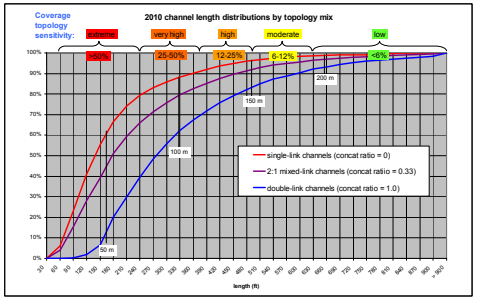
- Calculate optimal combinations that give lowest overall data center cost
  - Calculator for PMDs prepared for use
  - Input reaches and relative costs for PMD solution set members
    - (e.g. -CR4, -SR4, -LR4)
  - Outputs relative cost for each topology mix on slide 12

Summary

- Fiber types have evolved
  - Laser-optimized 50 µm now dominates
  - SM minor share varies, 62.5 µm faded away
- Channel lengths have increased
  - Up an average of 13 m at 0.33 concatenation ratio
  - Follows access switch localization to server
- Reach coverage became more topology dependent
  - Advisable to strive for sufficient reach to achieve moderate to low sensitivity
  - Examine technology trade-offs to optimize overall cost of DC solutions







Thank You