CommScope®

Towards Extended Reach MM Objectives

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IEEE 802.3ba, Extended Reach on MMF ad-hoc

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Outline

- **5 Criteria examination**
- **XR Objective setting**
- **PAR impact**

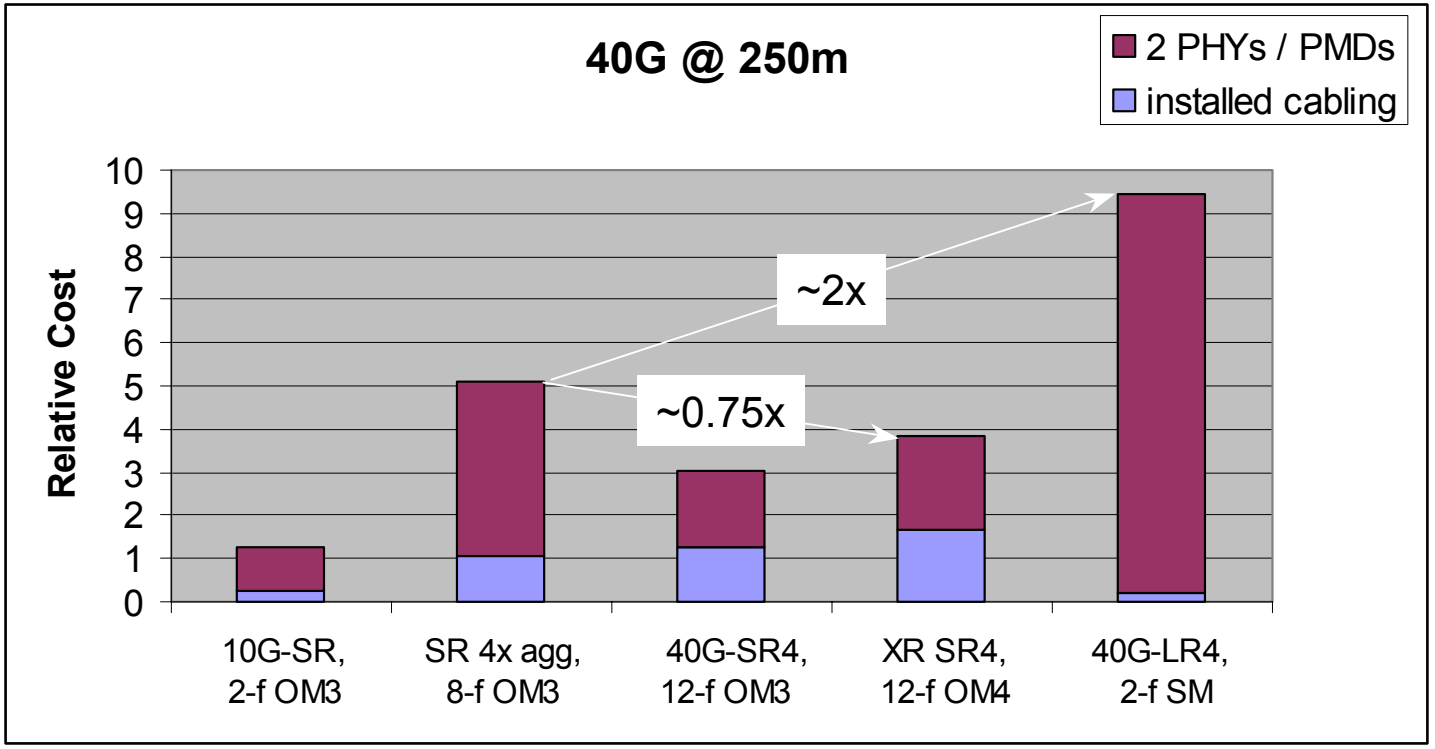
5 Criteria

- **Broad Market Potential**
- **Compatibility**
- **Distinct Identity**
- **Technical Feasibility**
- **Economic Feasibility**

Economic Feasibility Issues of Present Objectives

- **The 10km SM PMDs at 40G and 100G are not economically viable when compared to link aggregation of 10GBASE-SR PMDs in Data Centers**
  - **Even when allowing a reasonable premium for the value of "fat pipes" to aid with link aggregation issues**
- **To support this assertion, the following charts compare the cost of complete channels consisting of 2 PHY/PMDs and installed cabling at 250m lengths**

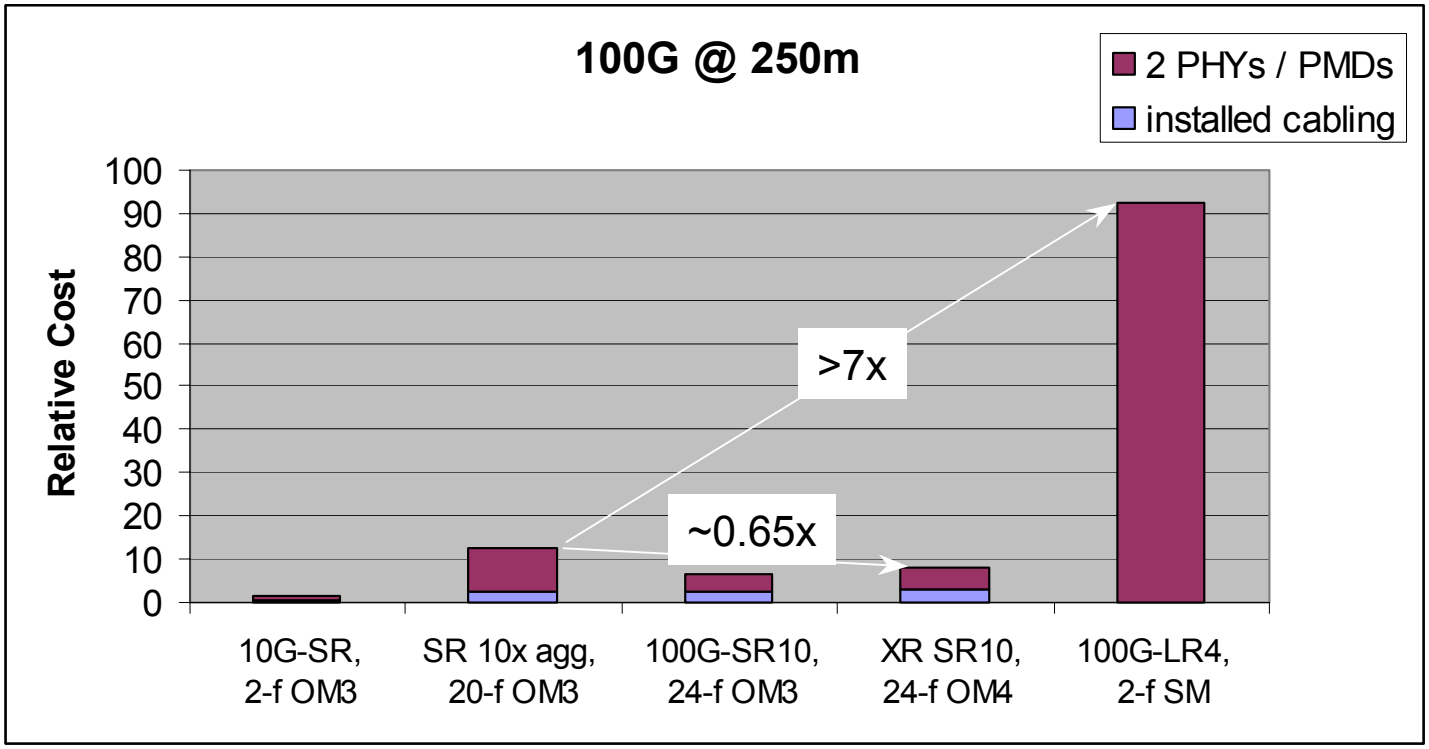
40G Channel Cost Comparisons



- **SM channel is almost twice the cost of 4x aggregated 10G-SR**
  - **Using 6x 10GBASE-LR cost factor for 40GBASE-LR4 (CWDM) PHY/PMD per Traverso and Cole**
- **Extended Reach SR4 is only ~75% the cost of 4x agg 10G-SR**
  - **Using 20% PMD cost premium per Jewell and 34% OM4 cabling cost premium**

Note: baseline 40G-SR4 cabling cost is calculated at 250m for like comparisons, but present baseline PMD is capable of only 100m on OM3

100G Channel Cost Comparisons



- **SM channel is over 7 times the cost of 10x aggregated 10G-SR**
  - **Using 10x 40GBASE-LR4 cost factor for 100GBASE-LR4 PHY/PMD per cole_40_02_0208**
- **Extended Reach SR4 is only ~65% the cost of 10x agg 10G-SR**
  - **Using 20% PMD cost premium per Jewell and 34% OM4 cabling cost premium**

Note: baseline 40G-SR4 cabling cost is calculated at 250m for like comparisons, but present baseline PMD is capable of only 100m on OM3

Consequences of Present Course

- **Few customers will install 40GBASE-LR4 within Data Centers; Even fewer customers will install 100GBASE-LR4 within DCs**
  - **Instead will choose aggregated 10GBASE-SR for >100m channels**
- **High 40G & 100G SM channel costs erect substantial barriers for aggregation applications in Data Centers, causing ripple effects**
  - **Lack of economically advantaged "fat pipe" for aggregation within DCs will impede installation of 10G & 40G at server/storage access level**
    - **because DC backbones needed to support server/storage aggregation will not scale economically**
  - **Market penetration rate for 40G and 100G will be slower than with an economically advantaged "fat pipe" solution in DCs**
    - **because non-optimal DC solutions will drain funds needed for deployment of 40G and 100G in campus & metro**
  - **Little volume will be added to 40G-LR4 PMD, and almost no volume to 100G-LR4 PMD, by remaining with present course**
    - **because all but the most desperate of customers will construct channels using multiple 10G PMDs instead**
  - **Increases risk of market failure**
    - **Incomplete economically-attractive solution becomes weakest link**

An Economically Attractive Solution Enhances Broad Market Potential

- **Extended Reach MM optics on OM3 and OM4 fibers can address DC backbone distances at costs less than the 10G aggregation alternatives**
  - **Savings actually increase with higher aggregation rates**
- **Will drive market demand instead of thwarting it**
  - **Offers efficiencies in handling aggregated traffic while simultaneously providing cost reduction**
  - **Improvement in efficiency at lower cost is a hallmark of all successful Ethernet port types**
- **Broad Market Potential will be enhanced**
  - **Appeals to virtually any customer needing >10G rates**
  - **Accelerates market acceptance overall**
  - **Lowers risk**

Broad Market Potential and Economic Feasibility Criteria

- **The addition of the 40G ≥10km SM objective in March 2008 affected the content of only the Broad Market Potential and Economic Feasibility criteria**
  - **The phrase "including server traffic aggregation" was added to both**
- **This same rationale is driving the need for extended reach on MMF**
  - **Therefore, no additional changes are needed to these two criteria statements with the addition of XR MM objectives**

Distinct Identity Criteria (1 of 3)

- **The 40G ≥10km SM objective was added to address server traffic aggregation**
  - **This same rationale is driving the need for extended reach on MMF, so raises question of distinctness**
- **The difference that provides distinct identity between these:**
  - **MM PMDs economically address aggregation within DCs where distances are relatively short**
  - **SM PMDs address aggregation (and transport) within campus and metro where distances are relatively long**
- **Server access and HPC applications require lowest cost PMDs, but these cover distances too short for the complete Data Center environment**
  - **Baseline MM PMDs provide lowest cost for access and HPC**
  - **XR MM PMDs optimally complete the DC space solutions by providing lowest cost for distribution and core**

Distinct Identity Criteria (2 of 3)

Distinct Identity Matrix			
Application	**SR4(10)**	**XR SR4(10)**	**40/100G-LR**
High Perf. Computing	X		
Server/Storage Access	X		
Agg. Acc.-to-Dist. in DC		X	
Agg. Dist.-to-Core in DC		X	
Agg/Transport in Campus			X
Agg/Transport in Metro			X

Each PMD optimally serves multiple distinct applications

Distinct Identity Criteria (3 of 3)

- Requires “One unique solution per problem”
  - Previous slides show that each PMD type addresses a different problem set
  - Therefore adding XR MM PMDs complies with this criterion
- The approved Distinct Identity statements do not delve into PMD-specific items, other than justifying the need for two data rates
  - Therefore, no modifications are needed with the addition of XR MM objectives

Technical Feasibility Criteria

- **Many proposals to the Extended Reach ad-hoc show there are multiple technically-feasible methods to achieve the needed reach extension**
  - **Jewell – enhanced laser specification (like SR)**
  - **Latchman – clock recovery (like SR/LR/etc.)**
  - **Petrilla – forward error correction (like KR)**
  - **Ghiasi & Dudek – equalization (similar to KR)**
- **All are in practice today illustrating technical feasibility**
  - **The ad-hoc's efforts have concentrated on comparing these to optimize choice of spec, not questioning technical feasibility**
- **Therefore, the existing Technical Feasibility criteria statements need no modification with the addition of XR MM objectives**

Compatibility Criteria

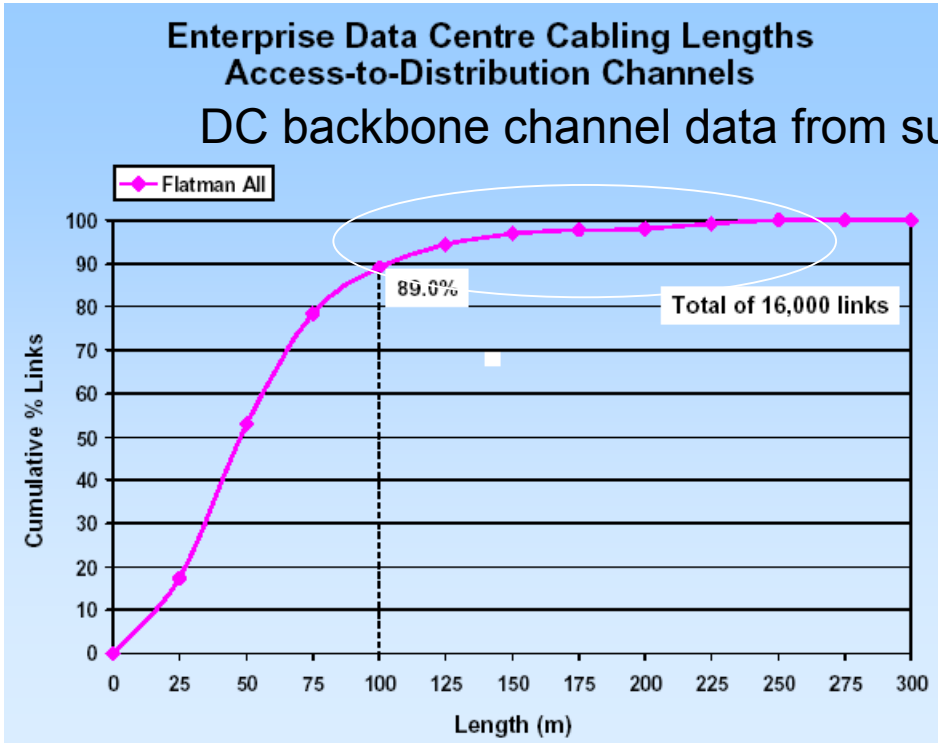
- **The current text most closely related to PMDs states:**
  - **“As was the case in previous IEEE 802.3 amendments, new physical layers specific to either 40 Gb/s or 100 Gb/s operation will be defined.”**
- **Therefore, the addition of XR MM PMD objectives does not impact the existing Compatibility Criteria**

5 Criteria Summary

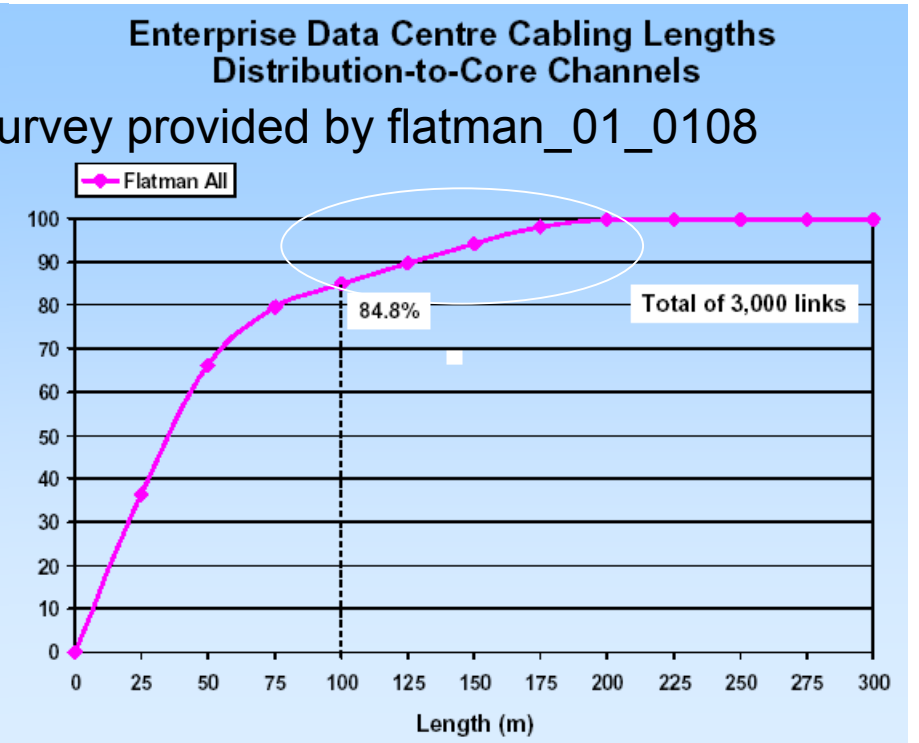
- **Present course does not provide an economically feasible solution to address complete Data Centers**
  - **SM channel costs noncompetitive with aggregated 10G**
- **The addition of XR MM channel objectives:**
  - **enables Economical solution vs aggregated 10G**
  - **Broadens Market Potential**
  - **retains Distinct Identity**
  - **is Technically Feasible in multiple ways**
  - **is Compatible with previous work**
- **No changes are needed to the 5 Criteria statements**

Distilling XR MM Objectives

Distance vs Coverage



DC backbone channel data from survey provided by flatman_01_0108



Coverage of >100m channels by infrastructure subsystem		
distance	access-to-distribution	distribution-to-core
150m	~70%	~60%
200m	~80%	~100%
250m	~100%	~100%

Capability of XR MM Proposals

Distance capability (two-sided)			
Proposal	**Description**	**OM3**	**OM4**
jewell_xr_01_0508	Enhanced laser spec	150m	250m
latchman_xr_01_0508	CDRs in module	208m	251m
dudek_xr_02_0708	Light weight equalization	250m	300m
petrilla_xr_01_0508	FEC in host "big chip"	183m	234m

- **All proposals support at least 150m on OM3**
- **All proposals exceed 230m on OM4**
  - **FEC was least favored by poll of XR ad-hoc in June**
  - **Assuming FEC is dropped, remaining proposals support at least 250m on OM4**

Further Considerations List

Coverage of >100m channels by infrastructure subsystem and media			
distance	access-to-distribution	distribution-to-core	media
150m	~70%	~60%	OM3
200m	~80%	~100%	OM3/OM4*
250m	~100%	~100%	OM4

- **250m on OM4 is the design constraint (rather than 150m on OM3) for CDRs and light weight EQ**
  - **Both methods may see slightly easier implementation if OM4 distance objective is reduced below 250m**
- **Flatman survey indicates access-to-distribution channels outnumber distribution-to-core channels by more than 5 to 1 (16k to 3k)**
  - **Needs of access-to-distribution channels are primary concern**
  - **250m is needed to fully cover these channels**
- **OM4 specification must progress to a stable reference-able state**
  - **Objectives based on OM4 should be stated with that contingency**

* Media capability depends on choice of optical module interface specifications

New Objectives

- **All things considered, the optimal extended-reach objectives for both 40G and 100G are:**
  - **at least 150m on OM3 MMF**
  - **at least 250m on OM4 MMF (contingent on stable OM4 spec)**

- **Propose adding these to the objectives in September**

PAR Impact (1 of 2)

- **Two statements that might be affected by objective changes are sections 5.2 regarding Scope and 5.4 regarding Purpose**
- **Present Scope statement**
  - Define 802.3 Media Access Control (MAC) parameters, physical layer specifications, and management parameters for the transfer of 802.3 format frames at 40 Gb/s and 100 Gb/s.
- **Present Purpose statement**
  - The purpose of this project is to extend the 802.3 protocol to operating speeds of 40 Gb/s and 100 Gb/s in order to provide a significant increase in bandwidth while maintaining maximum compatibility with the installed base of 802.3 interfaces, previous investment in research and development, and principles of network operation and management. The project is to provide for the interconnection of equipment satisfying the distance requirements of the intended applications.
- **Neither of these statements are affected by the addition of the proposed XR objectives**
  - **The underlined sentence supports the addition of the XR objectives to (optimally) satisfy the distance requirements of the intended applications**

PAR Impact (2 of 2)

- **A third statement that might be affected by objective changes is section 5.5 regarding Need**
- **Present Need statement**
  - The project is necessary to provide a solution for applications that have been demonstrated to need bandwidth beyond the existing capabilities. These include data center, internet exchanges, high performance computing and video-on-demand delivery. Network aggregation and end-station bandwidth requirements are increasing at different rates, and is recognized by the definition of two distinct speeds to serve the appropriate applications.
- **This statement is not affected by the addition of the proposed XR objectives**
  - **The underlined words support the addition of the XR objectives to (optimally) provide a solution for network aggregation in data centers**
- **Bottom line: No PAR changes are needed to add XR objectives**

Summary

- Present course does not provide an economically feasible solution to address complete Data Centers
  - SM channel costs impose barrier to market acceptance
- To correct this issue, the proposed new 40G & 100G objectives are:
  - at least 150m on OM3 MMF
  - at least 250m on OM4 MMF (contingent on stable OM4 spec)
- The addition of these XR objectives meets the 5 Criteria:
  - enables Economical solution vs aggregated 10G
  - Broadens Market Potential
  - retains Distinct Identity
  - is Technically Feasible in multiple ways
  - is Compatible with previous work
- No changes are needed to the PAR or 5 Criteria
  - XR objectives are aligned with the PAR purpose and need
  - The PAR supports, and implicitly demands, their addition