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40G and PMD: Market directions

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March 2007

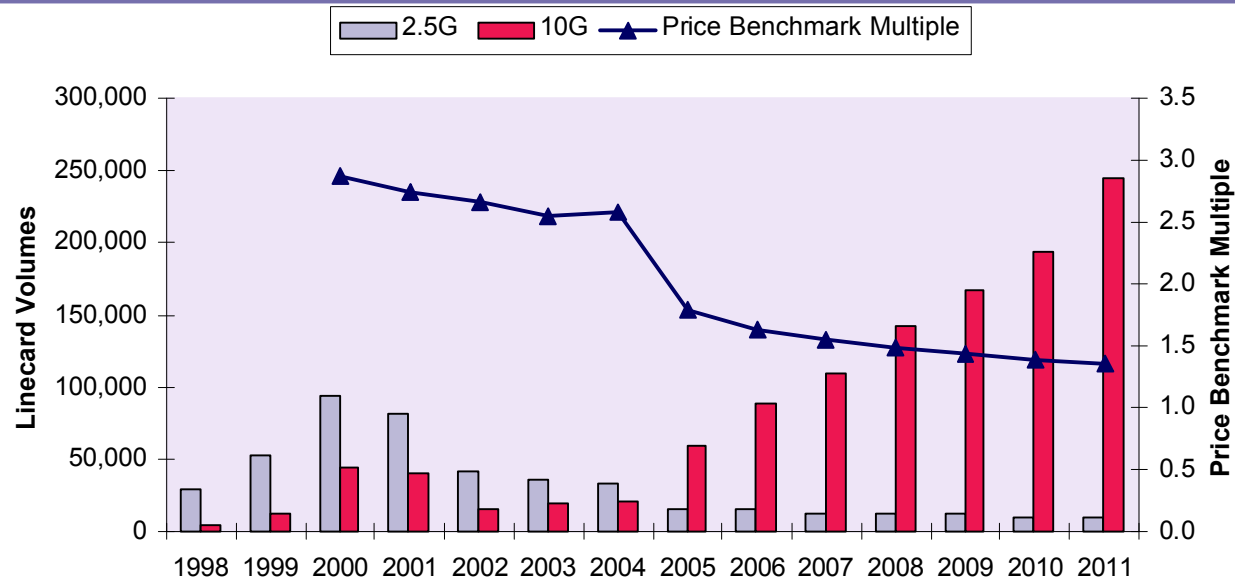
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Agenda

- History: 2.5 to 10G transition
- 40G market phases
- 40G market drivers
- 40G market impediments & uncertainties
- Forecast variables
- 40G forecast
- Summary

Timing of 2.5G to 10G transition



Source: Ovum-RHK ONG Forecast for MR and LH segments
Major model update occurred between 2004 & 2005 data.

- Transition from 2.5G to 10G did take 7 years from commercial inception of 10G
- Cross-over was aided by overall revitalization of the backbone market in '04-'05
 - Network overbuilds in NA and AP
 - Price disruption from Huawei & technology disruption from Infinera
 - Products available were optimized for 10G
- 10G ASPs crossing the 2.5x price benchmark was a key enabler for volume growth

40G market phases

- **Phase 1: Trials, experiments & product roadmap positioning**
 - Many trials in NA, EMEA and AP over a number of years
 - More vendors now support 40G on more product platforms: Multi-Reach (ULH) WDM, metro WDM and OCS
- **Phase 2: Early commercial but not yet entirely economically rational**
 - 2.5x benchmark is not been achieved
 - Economic justification can include market development, factoring in IP router ports, or mitigating exhaust in fiber constraint situation
 - AT&T is the market leader with early commercial deployments on Siemens platform
 - 40G will continue to develop on the long haul backbone platforms prior to the metro/regional platforms based on the extensiveness of the trial track record and early commercial deployment to date. More backbone vendors have been active with 40G longer than the metro/regional vendors.
- **Phase 3: Mass adoption commercial**
 - 2.5x price benchmark with parity system performance (ULH distance capabilities, over the in the ground fiber plant) to 10G is the key enabler

40G market drivers

- Phase 1: ON and IP Router vendors and carriers needed 40G capability for marketing purposes:
 - Carriers targeted their 40G message at their key customer base: Gov't, Fortune 100
 - To demonstrate their technology leadership and that their network is leading edge
 - "40G was funded out of the marketing budget" –carrier
- Phase 2: bridging the gap between 1 and 3 to aid the development of more mature market with more economic pricing
- Phase 3: Long term market drivers
 - Future promise of Capex Cost reduction if and when costs hit mass deployment levels
 - Operational savings from fewer assets to manage

Phase 3 market development impediments

- Today, either the complete **distance requirement is not met** on the market's installed plant with PMD being one impediment
 - “PMD will limit the maximum reach” –carrier
 - “60% of the network has PMD issues and we have an inhomogeneous distribution of PMD” –carrier
 - “80% of fiber deployed has bad PMD” –vendor
- Or the **Cost benchmark is not met**
 - There are technology solutions with promise (DQPSK) but are currently viewed as too immature, too many parts and too expensive
 - “Amplifier and chromatic dispersion have economic solutions –this is the success of WDM. Only PMD does not have a broadband solution.” —carrier
- Carriers are adopting pragmatic approaches: Avoid the PMD problem
 - “Cherry pick fibers and routes that do not have severe PMD impairments” – vendor
 - This is a limited market: ULH circuits will not be addressed without regen
 - Some A-Zs will not be addressed with 40G due to the severe PMD in the fiber plant

Market uncertainty is making an uncertain market

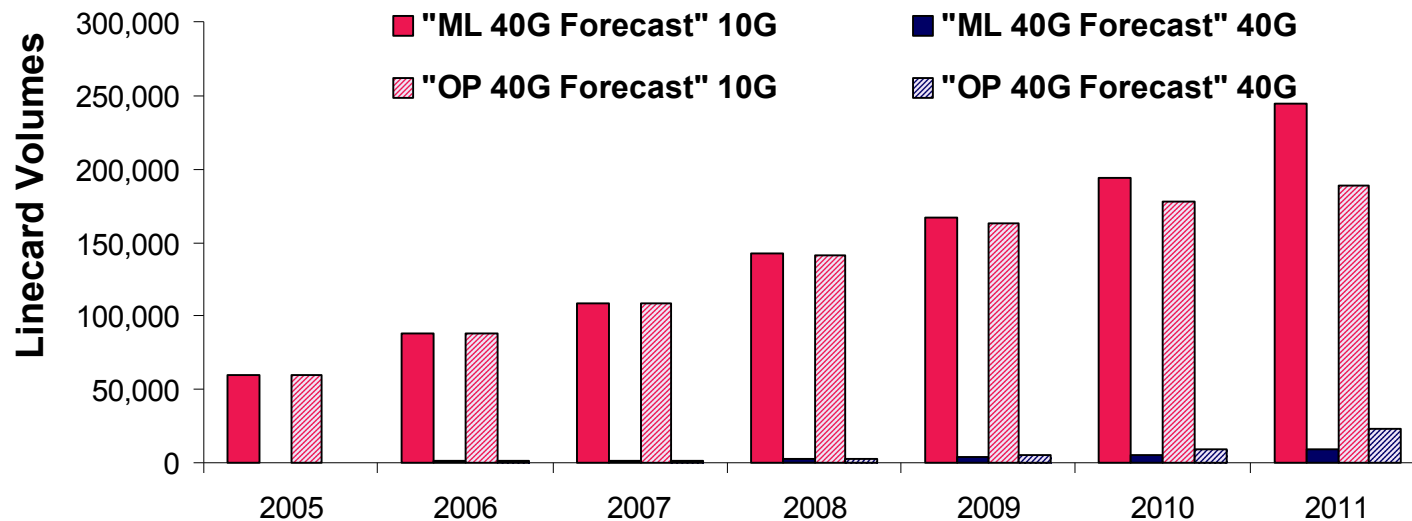
- Dynamics:
 - “Every 6 – 9 months, there emerges a new modulation format. We’re really counting on modulation formats to get us to the magic 1500 km”—carrier
 - “The whole game right now is modulation format. We’re staying pretty open-minded”—carrier
 - “Every application will have its own modulation format”—vendor
- Carriers hoping and prodding for better solution:
 - “It’s been difficult to push vendors to develop solutions against the severe limitations we have.” — carrier
 - “We will defer longer links or high PMD if we can, waiting for vendor roadmaps to longer reach.”— carrier
 - “Except for the shortest links, we will need tunable dispersion comp and PMD comp” .”—carrier
 - “If there is severe distortion by PMD, FEC does not help” .”—carrier
- Vendors are being cautious
 - “Most carriers will select fiber so PMD compensation will not be needed. More than 80% of deployment will not need PMD compensation.”—vendor
 - “Vendors are not aggressive in productizing 40G” —carrier
- The “fluid” modulation situation, is slowing the vendor’s move to productize and holding up the ecosystem development

Key forecast scenario variables

- Overall MR DWDM forecast
 - Driven by service traffic: business to business, residential broadband
 - Build cycles, capex constraints and network refresh
 - Enabled by a new generation of products
- 40G forecast is an component within the overall DWDM forecast
 - If economic PMD compensation (whatever technology) is NOT available, how much will its lack inhibit the 40G market?
 - If PMD compensation (whatever technology) IS available, how large is its available market and is that big enough to justify development of a supply chain?

40G forecast scenarios

40G and 10G Linecard Forecasts for Multi-Reach & LH Markets

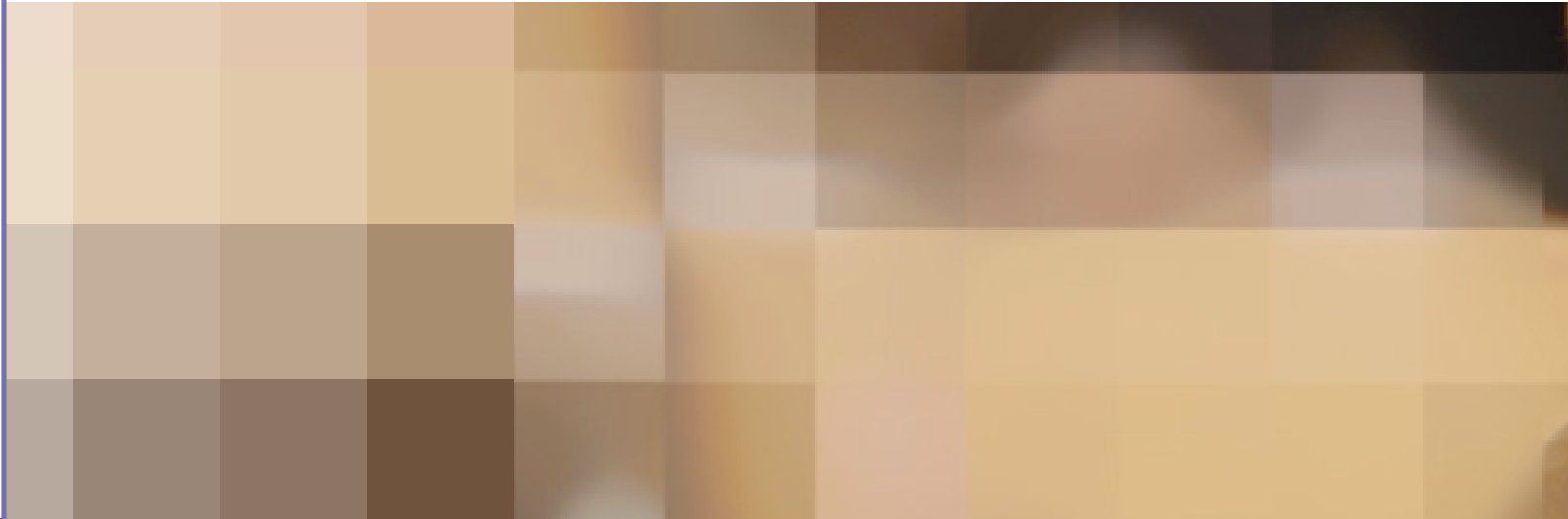


Source: Ovum-RHK ONG Forecast for MR and LH segments

- Most likely: 40G does not achieve 2.5x price benchmark 10G across the full ULH range of distances and fiber types by end of forecast period
- Optimistic: Technology barriers including PMD are resolved, starts 40G on the path to overtake 10G

40G summary

- Based on the industry's trial track record, system vendor product announcements, and preliminary carrier deployments, 40G interest has picked up, but not to the point of mass deployment critical mass
- The market is into Phase 2 early commercial
 - And the signs are this will continue and grow
 - The ecosystem is growing
- Can the market transition on to Phase 3 (mass adoption), and if so when?
 - But we have not yet achieved 2.5x at ULH reaches across all fiber plant
 - Performance can be improved but that will cost, costs can be reduced but are tied to volume, volume is tied to market certainty; market certainty is tied a clear path to performance/cost targets...



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