40G and PMD: Market directions

Ian Redpath & Karen Liu

Ovum-RHK

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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
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
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

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
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...
Thank you.

ian.redpath@ovum.com