Expanding Passive Optical Network

Francis Nedvidek, Chief Executive Officer (CEO), Sven Krüger, Director of Carrier Sales and Ralf Lohrmann, Director of Product and Program Management at Cube Optics AG, Mainz, Germany on the Expanding Passive Optical Network/Fibre to the Premises Network Access Bandwidth with Passive Coarse Wavelength Division Multiplexing

Francis Nedvidek

Francis was born in Canada and holds a PhD in Electrical Engineering. His early career focused on technology, product and market development. Later, he held senior Program Management, Marketing, Sales and General Management positions with companies including Leica, Black & Decker, Von Roll Corporation and present day subsidiaries of Raytheon and SAGEM on both sides of the Atlantic Ocean. More recently he has led new ventures and startups from conception to exit. He became CEO of Cube Optics in 2004.

Sven Krüger, Director of Carrier Sales

Sven Krüger is responsible for marketing and sales to Carriers and Network Operators at CUBO. Before joining Cube Optics as a member of the founding team he worked as a technology consultant for the IRC of the European Commission, and prior to that at the Institute for Microtechnology Mainz in research and development of integrated optical components. He holds a Master degree in Physics.

Ralf Lohrmann

Ralf was born in Germany, earned a PhD in Physics and performed post-doctoral work in laser spectroscopy at the University of Arizona. Ralf's experience spans production, product management, market development and account management with Melles Griot and Corning. More recently he led the product engineering support for a US/Asian joint venture. He serves as the Director of Product and Program Management activities at Cube Optics since 2003

As Fibre to The Home (FTTH) deploys into less densely populated areas, upgrading access networks between the Central Office (CO) and subscribers becomes an essential priority. Coarse Wavelength Division Multiplexing (CWDM) is ideally suited for aggregating bandwidth over fibre since it is inherently transparent to protocol, coding and bit rate. CWDM is fully compatible with Broadband PON (BPON ITU-T G.983.x), Gigabit capable PON (GPON ITU-T G.984.x), or Ethernet PON (EPON IEEE 802.3ah) and interoperable with topologies applying ATM, TDM/TDMA or SONET/SDH. CWDM even accommodates network schemes using 1310 nm/1490 nm and 1550 nm analog modulation overlays along side of digital transmissions. What really makes the business case for a passive CWDM upgrade, such as the solutions offered by Cube Optics, is its low cost. Bandwidth capacity upgrades, exploiting passive CWDM, consume far less CAPEX and OPEX compared with laying additional fibre lines, not to mention the expense of purchasing and maintaining active network equipment. When given the option to outfit a fibre link with CWDM, rather than lease an additional dark fibre strand, installing four channels of CWDM typically achieves payback well within a year.

Passive CWDM requires no electrical power and is sufficiently robust and reliable for installation in the most demanding environmental conditions – as in accordance with Telcordia GR-1209/1221 CORE for uncontrolled environments. Cube Optics offers a line of passive miniature multi-channel Mux/Demux and Add/Drop devices that enhance flexibility in terms of network planning, installation and network utilisation, while preserving scalability to handle far higher data transmission volumes as bandwidth needs grow. Access platforms exploiting such miniature passive CWDM components offer the unique advantage of being compact enough to easily retrofit existing splice cassettes, street cabinets or other forms of outside enclosure without the need for adding further infrastructure.

A Generic CWDM PON

The typical access architecture uses an optical platform, traditionally located in the CO, known as an Optical Line Terminal (OLT) to transmit traffic to 32 or more residential drop points. Passive optical devices called splitters/combiners are located at fibre distribution hubs situated between the OLTs and subscribers' Optical Network Terminals (ONTs). The OLT was the point where the access fibre line was usually converted to a copper twisted pair although today OLTs may serve as drop-off points for DSL, as fibre distribution hubs or a combination of the two. The passive optical splitters/combiners divide a single downstream transmission into multiple fibre drop streams as well as collect upstream traffic from multiple ONTs on to a common stream travelling back to the CO.

As fibre gradually penetrates deeper into the access edge, the OLT is slowly shifting out of the CO as depicted in Figure 1. The reason for this trend is to better extend network reach to more ONTs, and therefore to more subscribers and subsequently attain higher penetration densities. Higher bandwidths permit the sale of new services including IPTV, video on demand, security surveillance, VoIP, internet, on-line storage and gaming. Cost-effective PONs utilise passive optical splitters/combiners at this point to distribute the cost of one OLT port and the associated laser transceiver across many drop points. The goal is to provide ever more subscribers with service while containing the cost to reach each additional customer and today, it is technically and economically viable to extend fibre directly to businesses and homes. In such cases, the optical network termination effectively moves all the way to the enterprise office building or customer premises.

Passive CWDM enables operators to better utilise fibre capacity and support far greater data traffic as the bandwidth demand at the ONTs increases. With virtually no additional running cost, CWDM permits network operators to implement many more optical nodes over multiple locations with minimal capital investment. Enterprise and business users of storage area networks experiencing fibre exhaustion are also using passive CWDM upgrades for this reason.

Figure 1 shows an FTTX access PON where each remote OLT is served from one pair of optical fibres. Possible in theory and in practice are OLT uplinks utilising a bidirectional single fibre architecture. The distance between the CO to the farthest ONT spans the range of approximately 19 to 96 kilometres. The fibre distribution points contain the passive splitters/combiners and connect the fibre line from 16 to 32 or sometimes more subscribers according to the available signal strength and the severity of the fibre induced signal attenuation.

Upgrading Network Bandwidth

Figure 2 represents a situation where:

1) existing customers have purchased subscriptions for upgrading to higher value-added bandwidth hungry services; and,
2) network operators also wish to reserve ample bandwidth for anticipated new customers.

In order to satisfy IPTV, VoIP and video on demand from present subscribers and also remain capable to service new customers, the 622 Mb/s downstream bandwidth from the CO to the OLT must increase to 2.5 Gb/s.

Figure 2 shows the target bandwidth needed to satisfy the growing demand may be achieved simply and quickly by adding a four channel rack-mounted passive CWDM Mux/Dmux module in the CO and a miniature passive four channel Mux/Dmux cassette in the remote OLT. This straightforward deployment increases the number of transmission wavelengths by a factor of four. Corresponding to three channels in addition to the original one channel, the upgrade relieves the fibre exhaust over this link.

Figure 3 shows the upgraded network. The existing CO rack hardware, existing street cabinet OLT and the available fibre distribution panels all remain unaffected. The complete installation requires four channel-specific (colour coded) pluggable transceivers interfacing with the router/switch and their associated patch cables, the rack-mounted CWDM module and finally the plug-in CWDM cassette

Figure 1. Generic PON network using remote OLTs

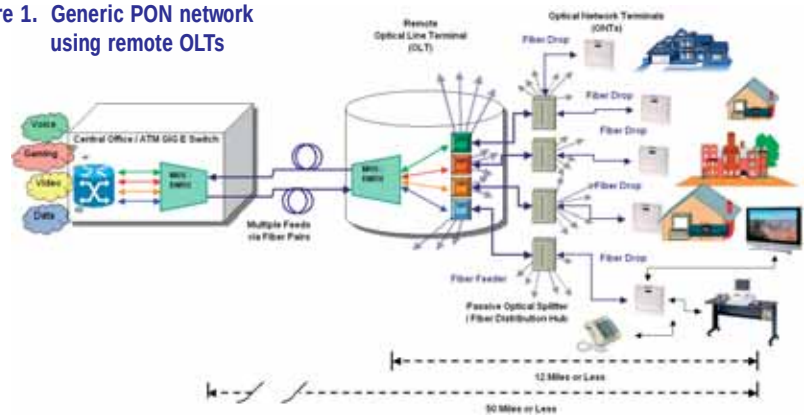


Figure 2. Limited fibre capacity – insufficient bandwidth for new services/new subscribers

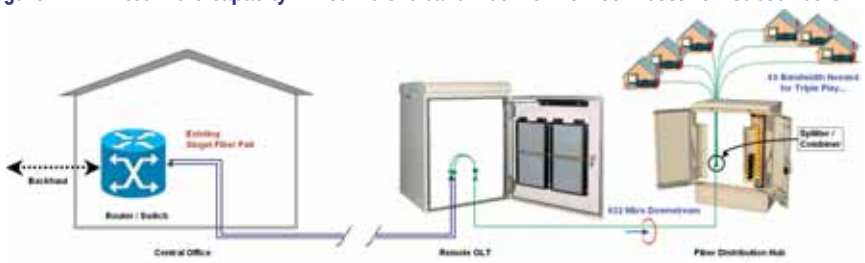
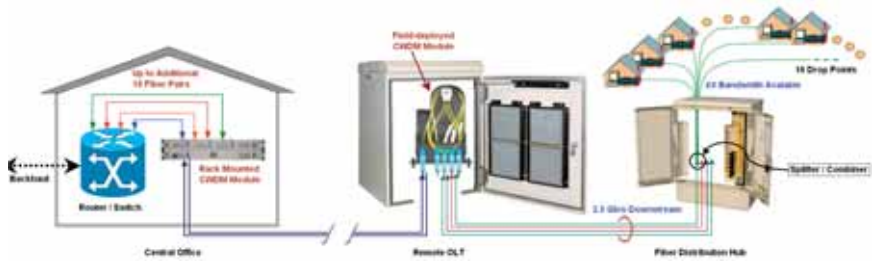


Figure 3. CWDM overcomes limited fibre capacity – more bandwidth for all



located in the OLT. Service interruption is required at the CO to make the connection of the CWDM to the router and at the OLT when the pre-packaged CWDM cassette or cassettes are clipped into the outdoor cabinet and then spliced into the fibre network. Although cassettes typically come ready for splicing, connectorised versions may be specified. Training of the field installers is minimal since the passive CWDM module may be installed in much the same way as any fibre tray used for fibre distribution or multiple drop distribution fan-outs.

In conclusion, the expense of physically laying and connecting fibre cable may run as high as 10,000 Euros per kilometre in a developed European country such as Germany. The business case to upgrade CO/OLT fibre capacity using CWDM instead of installing additional fibre is therefore compelling. A passive CWDM approach can multiply the capacity of access links within a few hours, with very modest equipment, material and training cost. Already deployed by many first tier carriers, Datacom and storage area network operators and ISPs in Europe, we are experiencing increasing demand from:

1) startup FTTX networks;
2) city and regional carriers;
3) Internet Service Providers (ISPs); as well as,
4) companies operating Hybrid Fibre Cable (HFC) networks both in Europe and in North America.

With so many advantages and benefits, we therefore expect deployment of simplified network capacity upgrades based on passive CWDM to continue to grow worldwide.

For more information, please contact Francis Nedvidek, nedvidek@cubeoptics.com or visit www.cubeoptics.com

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Cube Optics AG

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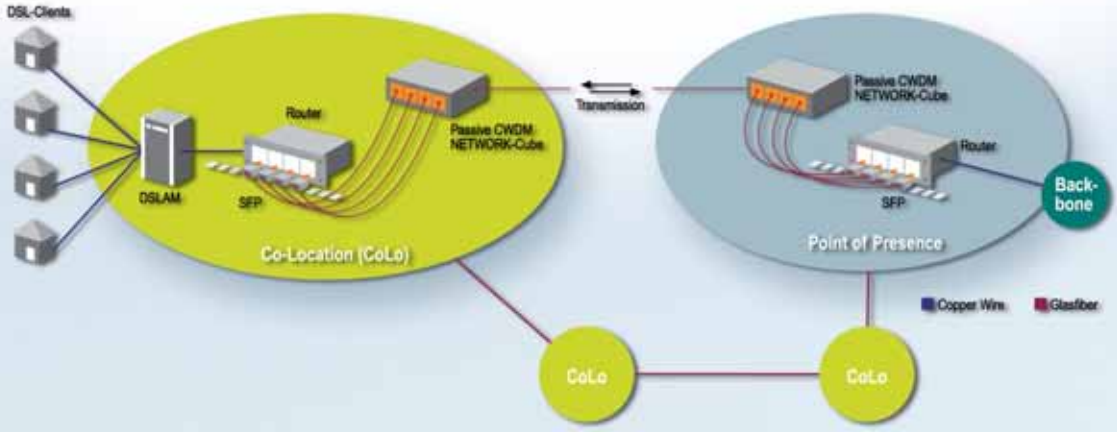
- CWDM, DWDM, WWDM, taps, monitoring
- Fully customizable configurations and your choice of connectors
- Packaging options for Street Cabinets, Splice Enclosures and Outside Plant environments
- Telcordia qualified, NEBS compliant
- Proven interoperability with any Router, DSLAM, Switch

Contact us, and learn why our solution was chosen by Europe's tier-1 competitive ISPs and Operators – over 5000 units deployed.



CUBO's Simplified Passive WDM Access Networks

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