ZR 400G & 800G Use Cases, Trials, Deployments and Future Prospects

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Abstract: The paper will review options and use cases for 400Gbit/s and 800Gbit/s deployed in the core of a major national operator, including 400Gbit/s ZR/ZR+ optics embedded in routers and external transponders.

Introduction

Core network bandwidths seem set to continue to grow driven by broadband services, FTTP and 5G. For example, BT in the UK have in 2022 published a peak bandwidth of 28 Tbit/s [1]. A challenge for network operators is to support this growth while making efficient use of available capital, operational manpower and electrical power [2]. Increasing bitrate, driven by advances in coherent optical transmission, digital signal processing and optical component integration has been a key tool to meet this challenge, but more is needed especially as we approach the Shannon limit. The concept of IP-optical integration has been proposed for many years as a further opportunity. This involves embedding DWDM optics directly into routers, thus avoiding the need for external transponder cards and reducing optical-electrical-optical conversions. However, until recently IP-optical integration involved a decrease in router port density which was unacceptable to most operators. This changed with the emergence of 400Gbit/s ZR optics as defined by the OIF [3], in which 400Gbit/s coherent DWDM optics became possible in the same small pluggable optics (e.g., QSFP-DD) that are used for "grey" short reach intra-building connections between routers (or between routers and transmission equipment) and at transformational cost points. The initial 400Gbit/s ZR optic as defined by the OIF was aimed at two specific use cases for datacentre interconnect: (1) single channel dedicated fibre; (2) point-to-point line systems using fixed DWDM filters. 400Gbit/s ZR optics has unquestionably found an important role in greenfield datacentre interconnect deployments requiring massive capacity between two fixed locations. However, network operators have a diverse range of geographies and traffic distributions so that ROADM based mesh architectures are often deployed and these are not optically compatible with the OIF ZR spec. However, further developments in pluggable coherent transceivers quickly followed leading to higher performance ZR+ optics including most recently higher power (0 dBm) variants which can give useful reaches over ROADM networks, ultimately quite comparable to external transponders. As such the network operator is faced with a menu of options in designing their core network, with the optimum solution(s) dependent on bandwidth and geography [4]. The combination of high router port densities and economic DWDM pluggable optics means operators can face choices between "hop-by-hop" architectures where traffic passes through multiple intermediate routers versus "optical express" architectures in which ROADMs allow the bypass of intermediate routers. The emergence of 800Gbit/s and higher bandwidths potentially leads to additional options. The presentation will provide a current review of options from the perspective of a major network operator including capex and electrical power consumption comparisons.

References

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