Quartzite: A Campus-Scale Hybrid Networking Infrastructure

Philip Papadopoulos, Brian Dunne, Larry Smarr, Joseph Ford, Shaya Fainman
University of California at San Diego
Contact: ppapadop@ucsd.edu

Abstract: Quartzite is a hybrid wavelength - packet switched network on the campus of the University of California, San Diego. One of the key goals is to enable reconfigurations of the network at the physical (fiber, wavelength) and logical level (VLAN and routed) to support bandwidth intensive applications, non-standard protocols and other experiments that are usually incompatible with "production" networks. The structure of Quartzite is to connect laboratories on campus to a hybrid network core consisting of a standard, production switch router, and all-optical switch, and DWDM wavelength-selective switch (WSS). All components of Quartzite (except a custom-built WSS) are available as commodity parts. Most links feeding into the core are 10Gigabit/s ethernet (long reach grey, and C-band DWDM) with a smaller number of 1 gigabit/s links. More than 0.5 Terabit/s is currently provisioned to connect layer2 switches and directly-connected computing or storage endpoints. The entire infrastructure (including connected endpoints) can be reconfigured to suit the needs of specific experiments. The all-optical switching and wavelength switching are signal agnostic allowing non-ethernet transports to utilize the network/fiber infra-structure.
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An Overview of Quartzite

Quartzite is an integration of rapidly changing technologies and has served as a platform to test the practicality of delivering O(Terabit/s) of bisection bandwidth at the campus level. While networking technologies such as Myrinet and Infiniband achieve this capability within a single cluster or machine room, their fixed structure does not enable nearly the variety of configurations that we can achieve within Quartzite. With the bandwidth deliverable by the network, the natural endpoints are clusters of all types and data-intensive instruments. At UCSD, more than 500 gigabit ethernet-connected compute, storage, and tiled-display clusters are connected to the core through layer2 edge switches. A smaller number of 10-GigE endpoints(Storage, compute) are directly connected to the core. The following figure illustrates the hybrid switch core of Quartzite.

Quartzite construction is nearly complete; the last stage (2008) dramatically increases the number of DWDM-connected endpoints (or switches) and fields the custom wavelength-selective switch. The packet switch and optical switch core were delivered in 2005 to support the iGrid2005 conference at UCSD. The packet switch has been expanded to meet increasing network demands. Since the beginning of the project, DWDM 10-Gigabit optics and passive (de)multiplexers have fallen in price by a factor of 50 allowing us to economically provision the infrastructure and remove inter-lab bandwidth as a constraint.

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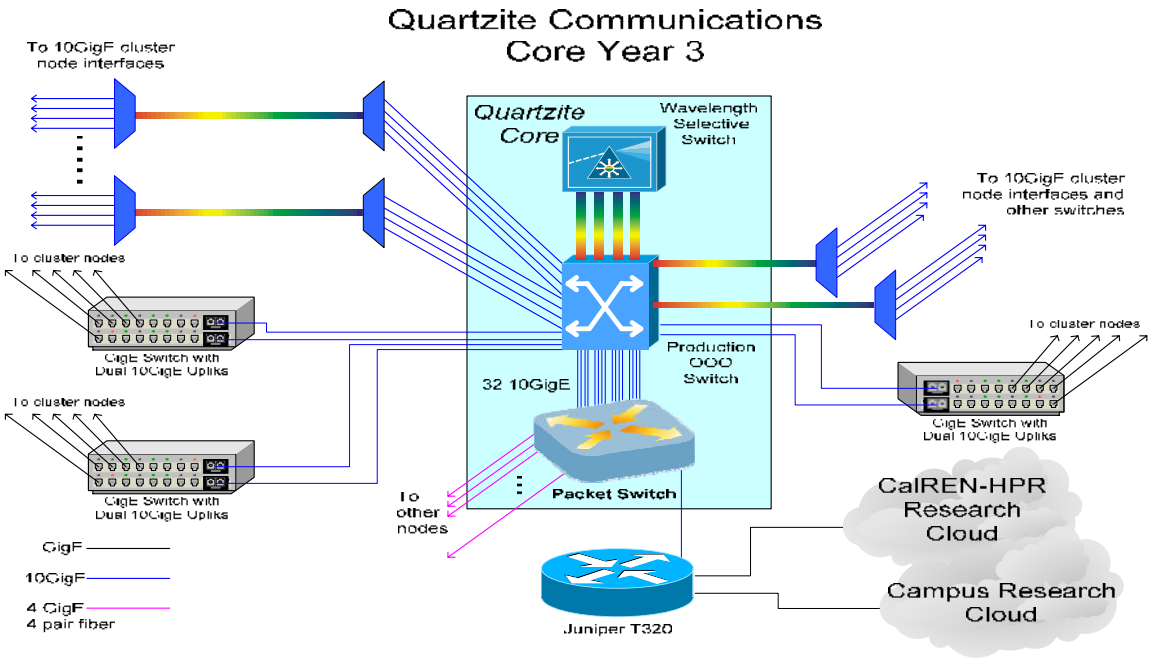


Figure 1 Quartzite Hybrid Core (Wavelength, All Optical, and Packet Switching) as proposed

Integration with Campus, CAMERA, and OptIPuter Networks.

Quartzite is a "breakable/reconfigurable" networking infrastructure. However, it does practically interact with production networks on campus. The switching core has a commercial switch router (Force10 E1200) to enable standard packet connectivity within the campus-wide experimental network and integration with existing external network sources. That is, devices on the Quartzite switch can interact with external networks as needed. Because of the experimental nature of research activities running on Quartzite, the packet interface to the UCSD production network is filtered (most external traffic is blocked at the Quartzite border). The following figure shows the integration of Quartzite with Campus, CAMERA (Marine Metagenomics), and our sister project, OptIPuter. In this figure, all packet filtering occurs on the Cisco Systems 6509. External connections (OptIPuter Cavewave, CENIC HPR, and Campus Production) are available to all nodes on the Quartzite network.

The core is currently made up of a Glimmerglass All optical Switch (64 ports) and an E1200 packet switch Router provide more than 400Gbps of network switching. More than 500 endpoints are connected to Quartzite through access or direct connection to the core switch. The figure does not show the geographic placement of connected nodes, but these are located in 7 different buildings (Scripps Institution of Oceanography (2 buildings), School of Medicine (2 buildings), Atkinson Hall (Calit2), Engineering Unit 1, Computer Science, and the San Diego Supercomputer Center) and 17 physical laboratories within these buildings.

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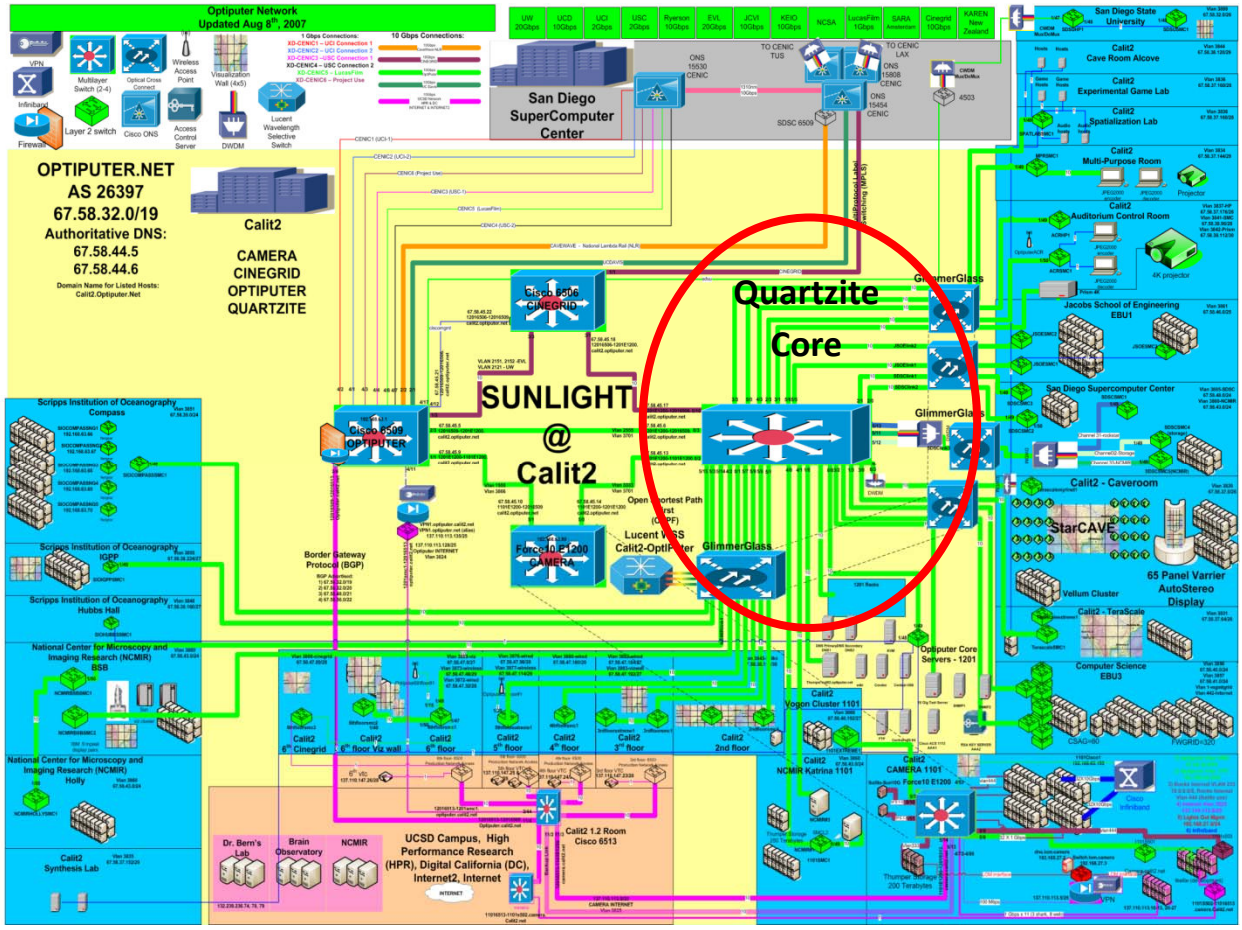


Figure 2 Integration of Quartzite with Other Networks. Total Quartzite switching capacity in the Packet Core is greater than 400Gbps

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