HIGHLIGHTS

Newsletter No. 8

The eighth and final issue of the COMPLETE newsletter continues to feature a technical material regarding emerging technologies and trends in optical networking in the NREN environment. This issue is dedicated to Data Centre Interconnect and its transport technologies. The material in this newsletter is a result of collaboration between COMPLETE Partners and market vendors.

Dear Readers,

In the last issue of the COMPLETE newsletter series we focus on optical networking technologies developed specifically for Data Centre connectivity and services: Data Centre Interconnect (DCI). This equipment is specifically designed to address Data Centre networking requirements and needs. DCI equipment is being widely adopted in the networking domain, especially in Open Line Systems, as described in the previous newsletter.

Extensive tests of DCI equipment have been performed by COMPLETE Partners and the NREN community. DCI and Open Line Systems together with associated open protocols will change significantly optical networking and create new areas for services development that can be established under the PCP/PPI scheme. DCI in its principles is targeted to reduce Vendor Lock-in and increase the speed of innovation by using open hardware and open protocols.

Yours sincerely,

Bartosz Belter, the Project Coordinator

Introduction to Data Centre Interconnect technologies

In this newsletter we continue the discussion regarding the Open Line and disaggregated systems and focus specifically on the Data Centre Interconnect solutions. This equipment is specifically designed to address the requirements and specifics of Data Centre Networking technologies. DCI equipment is being widely adopted in the networking domain especially in Open Line Systems described in the previous newsletter. It is worth noting that the COMPLETE project partners are involved in DCI technology testing and development and help to shape its development by active collaboration with the leading market vendors. Extensive tests of DCI equipment have recently been performed by the COMPLETE partners and NREN community. DCI and Open Line Systems together with associated open protocols and interfaces standards will change the optical networking in fundamental way and create new areas for services and development that can be established under the PCP/PPI scheme. DCI systems in its principle are also targeted to reduce Vendor Lock-in and speed innovation by using open hardware and open protocols.

Data Centres

Data centres have recently significantly grown: there are now more than 7,500 around the globe, with 2,600 packed into the top 20 global cities alone. The trends can be observed that networking and services are evolving to be cloud-based, web-scale and in such case access to the data is a critical challenge. The latest trends such as Big Data Analytics, Machine Learning and Artificial Intelligence heavily rely on large data set transmission and computing: services that are at the heart of typical Data Centre infrastructure. Data centres do not exist in the isolation form. This infrastructure needs to communicate with each other: share data and content, and provide back-ups and redundancy. DCI technology enables smooth transit of critical assets over short, medium and long distances between data centres. The most effective transport for DCI is high-speed packet-optical connectivity built on technological innovations such as coherent optics. With a fast, reliable connection established, physically separate data centres can more easily share resources and balance workloads. Large operators use DCI to connect their own data centres within extended enterprise infrastructures, while others connect to partners, cloud providers or data centre operators to enable simpler data and resource sharing or handle disaster recovery needs. But one of the most common uses of DCI is to pool resources to scale data centre capacity as demand ebbs and flows. The data centre infrastructure is where the content operates. The instant nature of some services and applications as well as users' expectation that content will be delivered instantaneously and with high quality, have focused operators to aggressively pursue innovative ways to interconnect data centres more effectively and push them farther into metropolitan areas, closer to the end-user services and infrastructures. Part of the content that does not require immediate delivery, such as email and Web pages, can be provided by more distant data centres facilities. Increased usage of mobile devices like smartphones and tablets and new Over-The-Top (OTT) services, such as streaming video, online music and gaming, has influenced the creation of data centres in suburban and rural areas. Moreover, natural disasters, increased use of digital records, and government regulations have pushed enterprises to create data centres for data backup and mirroring applications as part of Business Continuity/Disaster Recovery (BC/DR) scenarios. Such data centres are sometimes located within close proximity of each other for synchronous applications, or they can be hundreds or even thousands of kilometres apart for asynchronous applications scenarios. Multinational teams, companies, and institutions have been creating data centres across the globe to provide a quick and secure data stream to conduct their operations for R&D teams, sales, support, billing, and back-office functions. Data centre development and growth is further stimulated by the increased use of cloud and virtualization tools and scenarios. Over the last years, a new business model for data centers has proven to be effective and beneficial. Companies are building data centres in key locations to offer a wide range of services to users who need to house compute and storage resources. These companies, often referred to as Carrier Neutral Providers (CNPs), offer rack space, power, security, and even cross-connect services to different data centres, public cloud providers, and network service providers.

Evolution of Data Centres

The state of the art Data Centre infrastructure consists of the following three different sets of equipment:

- Compute devices (servers) – Fast compute platforms needed by applications to process data, such as navigation applications calculating different use case scenarios. These compute platforms can also run cloud-based applications, such as data processing, billing, and Customer Relationship Management (CRM).

- Storage devices – High-capacity disk arrays that process data saved or accessed by applications, such as emails, online photos, and videos. Storage arrays are also used to back up enterprise data (data duplication or mirroring) to protect the enterprise information assets from natural disasters or data corruption.

- Network or 'telecom' – This equipment is used to route traffic within data centres, between servers, and storage arrays. Other telecom equipment connects the data centre to the outside transmission infrastructure. Connecting data centres is a crucial task to provide the compute and storage functions to serve the applications and services. Without the networking infrastructure, there is no application and service since the network increasingly sits between an end-user and their content. **The cloud performs only as good as the network that interconnects the data centres.**

Moreover, virtualization is affecting the practical functions of the traditional data centre. With today's technologies, two or more physical data centres can serve as a single logical data centre, sharing the load and dividing tasks to minimize operating expenses and maximize expected performance. In order to address and support today's shifting traffic patterns (resulting from requests for data), bandwidth increases, and the proliferation of applications, most data centres are undergoing a major overhaul. Specifically, Data Centre Interconnect (DCI) has quickly become a key enabler for ensuring the successful implementation of upper-layer applications.

Challenges in DCI

The following points emphasize the technical and physical challenges in connecting data centres:

- Distance Limitations – Data centres require a connection with defined minimum latency to maintain a proper flow of information and synchronization between the servers and the storage devices. In a case where data centres that are to be connected are physically distant, the latency increases as a function of the distance between the data centres and the network equipment that interconnects them. Choosing the shortest physical route can minimize fiber latency; however, software and equipment latency must be minimized with design practices and technologies.

- Capacity – the aggregate and total size of application data sets entering or leaving the data centre can be extensive so the networking equipment connecting to the data centre must be capable of providing reliable, high-capacity connections that can be scaled to higher rates.

- Security – Information stored in data centres, such as financial transactions, personal records, and corporate data, is business-critical and confidential, creating a need to ensure that network connections are trusted, reliable, and secure with network encryption even on a quantum level.

- Operations – Manual network operations are time consuming, complex, slow, and generally inefficient. Minimizing it by automating frequent and recurring tasks is an operational advantage. Turning up a connection, service between two data centres should be fast and reliable, and managing this connection should not require ongoing manual operational tasks. Here the Open Line System philosophy brings its benefits.

- Cost – With expected traffic growth between data centres approaching 30 percent CAGR, network costs must grow at a slower rate if a data centre is to remain financially stable.

Overcoming DCI Challenges

DCI provides high scalability, efficiency, reliability and security to ensure quick access to content across the cloud's building blocks. The latest technology solutions in hardware and software help to overcome challenges.

- Overcoming distance limitations with Digital Signal Processing (DSP) – Fiber impairments such as chromatic or polarization mode dispersion that have been obstacles to implementing high-bandwidth connectivity over long distances are no longer valid. Breakthroughs in DSP technology have allowed networking equipment providers to introduce packet-optical platforms capable of automatically and intelligently compensating for these fiber-optic transmission effects, allowing large data flows to be carried over long distances and different fiber types, without compromising speed for performance. Optical interfaces can be programmed to provide the optimum modulation schemes for different deployments scenarios.

- Overcoming capacity limitation with coherent optics – Coherent optics paved the way to successful transmission of high speed data over almost any distance. Coherent detection created a major increase in transport capacity, a key requirement for today's DCI.

- Overcoming latency limitation with high-performance and ultra-high-speed optoelectronics – Sophisticated hardware design, optimized software engines, innovative Forward Error Correction (FEC) schemes, and high-performance optoelectronics have significantly reduced network equipment latency. Minimizing latency is a key factor in the successful implementation of numerous data center-related applications, scenarios such as data mirroring.

- Overcoming security exposures with wire-speed in-flight encryption – the increasing rate of data breaches has put significant emphasis on ensuring that data is confidential wherever it is stored or transmitted. While encryption and strict rules for access of stored data are widely deployed to protect data, today's networking equipment offers inflight data encryption, allowing increased data protection on the whole transmission path. The evolving technology is quantum level encryption on the transport layer.

- Overcoming manual operations with programmable automation – Data centre networks are constantly changing, resulting in traffic trends that are difficult to predict, given the stochastic nature of access to the resources by a wide variety of users and applications, scenarios. Operational tasks can be automated through the use of APIs, open systems and associated applications. End users can create custom applications and scenarios that execute bandwidth increase requests, set up new connections between endpoints, modify an existing connection, and perform tasks required in data centre-to-data centre operations, without any intervention.

- Overcoming cost increases through application-optimized platforms – the existing latest optical platforms are specifically designed and built around DCI applications and scenarios. Planning, ordering, and installation allow data centres to be interconnected more efficiently. Full programmability and open line systems allow data centre operators to design and build applications and use case scenarios for their specific operational realities. High speed in a small footprint connects data centres with the lowest cost per bit. Small footprint and low power consumption directly and positively impact operating costs, while modularity allows scaling to multiple terabits of transport capacity without significant rise in CAPEX/ OPEX.

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