

Application of InfiniBand and Ethernet Converged Architecture in Seismic Processing and Interpretation System of Petroleum Industry



Mellanox VPI datacenter network solution provides VMS as Ethernet core switches of our datacenter and interconnects multi-vendor Ethernet switches and two InfiniBand Clusters. Both Ethernet and InfiniBand can communicate each other, dramatically increasing our productivity

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Upgrading Seismic Processing and Interpretation System Becomes the Development Trend of Petroleum Industry

The seismic processing and interpretation system plays a crucial role in the production process of the petroleum industry, and its efficiency directly affects the productivity and economic benefits of enterprises. As a massive and complex application that is both data-intensive and compute-intensive, it is demanding for high computing and I/O processing capabilities. With the rapid development of high and new technologies in seismic geophysical exploration worldwide, the seismic processing and interpretation system is facing a huge challenge.

On the one hand, seismic blocks and data amount are growing continuously, and the long duration, large storage capacity and high complexity features directly force the seismic processing and interpretation system to expand gradually in terms of cluster, storage and network. On the other hand, the system software and development environment are also being upgraded constantly, including common processing software, prestack depth migration and modeling software, and interpretation software, raising higher requirements for the computing capability of the whole system.

Functions including centralized management, collaborative work, and remote control have become the development trend of the seismic processing and interpretation system. Besides upgrade, the application of network technology and the design of network topology play a key role. In addition to superior network performance with high bandwidth and low latency provided for computing and storage clusters, linear system scalability, integration with the existing system, as well as management and monitoring of cluster equipment need to be considered as well.

InfiniBand and Ethernet Convergence Implements Optimal Network Architecture

According to the business requirements and network characteristics of the seismic processing and interpretation system, Mellanox proposes the converged network architecture design of InfiniBand and Ethernet. This architecture gives full play to the respective advantages of Mellanox InfiniBand network and Ethernet network, and achieves optimal performance, compatibility, scalability and high availability based on the seismic processing and interpretation business system and its function modules.

The network architecture is shown in the figure below. The whole system consists of three parts: InfiniBand cluster, Ethernet cluster and InfiniBand/Ethernet gateway.

The InfiniBand cluster runs seismic exploration software and collaborative work environments, that is, the processing system, interpretation system, logging system, digital-analog system and data processing system. The cluster adopts FDR 56Gbps InfiniBand network interconnection and is compatible with the existing QDR 40Gbps InfiniBand, which gives full play to the performance advantages of high bandwidth and low latency of InfiniBand to provide strong support for the core computing system. Meanwhile, Remote Direct Memory Access (RDMA) hardware acceleration is applied in the InfiniBand cluster to maximize the efficiency of the CPU/GPU server cluster, thereby improving the performance of the application system.

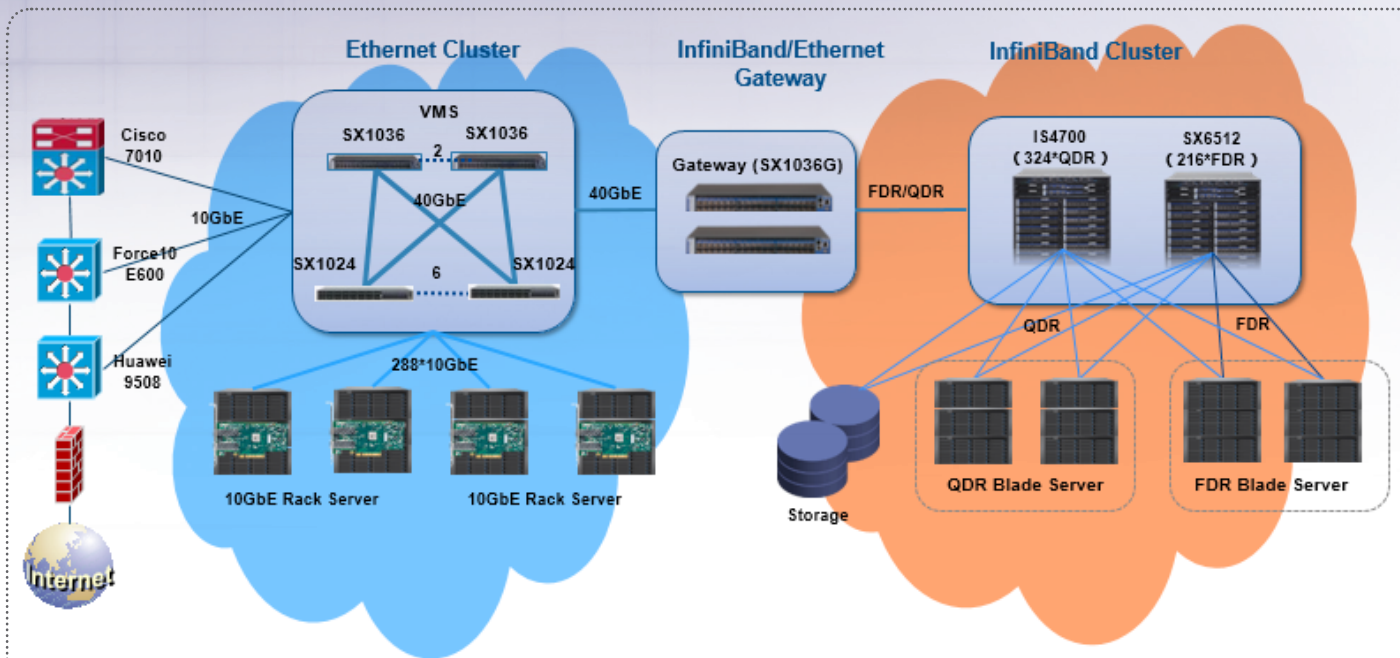


Figure 1 InfiniBand and Ethernet Converged Network Architecture

The Ethernet cluster runs the seismic exploration management system, information system, geo-scientific system, 2D/3D visualization service, and remote login service. The Ethernet core switching builds on Mellanox Virtual Modular Switch (VMS) network architecture, which comprises 40Gbps Spine switch and 10/40Gbps Leaf switch. The Spine and Leaf implement 40Gbps high-speed aggregation communication, meanwhile the Leaf switch provides 10Gbps non-blocking uplink bandwidth for the server cluster. The OSPF+ECMP load balancing scheme is employed so that routing can be recovered automatically when any equipment or line fails, ensuring network resilience and reliability. In addition, VMS, as the core switching system, connects and manages traditional switches such as Cisco7010, Force10 E600, and Huawei9508.

The InfiniBand/Ethernet gateway establishes redundancy connections over cross links with InfiniBand core and Ethernet core, to implement interconnection and protocol conversion between the InfiniBand cluster and the Ethernet cluster. In addition, the dual-node redundancy design is applied for the gateway system to ensure high availability.

Network Components

The SX6512 FDR switch is deployed as the core switch in Mellanox InfiniBand cluster. In full configuration, SX6512 provides 216 FDR 56Gbps ports and 24.2 Tbps throughput, also supports line-rate non-blocking and packet lossless switching. The SX6512 is integrated with the existing IS4700 QDR switch, while implementing unified subnet management and automatic multi-path load balancing among nodes.

For Mellanox VMS, two 36-port 40Gbps SX1036 switches in redundancy mode are deployed as the Spine switch. The unique non-blocking ToR switch SX1024, which provides 48 10Gbps and 12 40Gbps ports of line-rate switching, are deployed as the Leaf switch. Totally six SX1024 are deployed to provide 288 10Gbps non-blocking uplink bandwidth, which can expand to thousands of 10Gbps nodes easily.

The gateway SX1036G building on the dual-node redundancy design functions as the InfiniBand/Ethernet gateway. SX1036 is 1RU switch and can provide 8 40/56GE ports and 28 InfiniBand FDR ports.

Network Management System

The InfiniBand cluster is managed by Mellanox Unified Fabric Manager (UFM). UFM performs resource management, network monitoring, performance optimization, and provides visual Web interface for unified dispatching and management of InfiniBand network.

In addition, for the converged InfiniBand and Ethernet network, Mellanox collaborated with partners to develop the IT integrated management system, which performs comprehensive monitoring and management of the InfiniBand, Ethernet and gateway through one single platform, thereby realizing global network management.

Solution Deployment and Benefits

Mellanox InfiniBand and Ethernet converged solution has been deployed in the seismic processing and interpretation

system of the investigation and research institute of Petro China. The solution significantly improves the processing capacity of the enterprise and greatly enhances the system efficiency, and therefore has been recognized by the customer.

The advantages of the InfiniBand and Ethernet converged architecture are as follows:

- High performance: Mellanox InfiniBand and Ethernet core switch provides ultrahigh bandwidth of 40/56Gbps and achieves Tb-level aggregation and nanosecond-level latency.
- High flexibility: Mellanox VMS implements flexible configuration of Ethernet core switching, simplifies deployment, and greatly reducing the hardware cost.
- RDMA acceleration: Mellanox network adapter supports RDMA hardware offloading and acceleration. This enhances the application performance and significantly improves the CPU usage.
- Multi-network convergence: The convergence takes full advantage of performance features of InfiniBand network and Ethernet network, meanwhile providing integrated network management capabilities.
- Linear scalability: Online linear scalability is supported to meet business upgrade and expansion requirements.



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