

High Frequency Trading



As more financial firms engage in high frequency trading, every microsecond can translate to millions of dollars of profits or losses. Data volumes are seeing dramatic growth, bringing existing trading systems to their limits. In a business where profits are directly measured by system speed, a low latency, high volume infrastructure is essential.

Mellanox offers the lowest latency networking solutions for high frequency trading with its unique end-to-end solution (adapters, switching platforms and software), leveraging both InfiniBand and 10/40 Gigabit Ethernet technologies. As a pioneer in the field of high frequency trading networking, Mellanox has deployed its solutions at a large array of investment banks, hedge funds and exchanges. These solutions have been certified and deployed with the leading software providers in this industry.

Mellanox's solutions for financial services repeatedly demonstrate lower application latency, higher application throughput, and higher scalability in

benchmark testing. While Mellanox offers solutions for both InfiniBand and 10/40GbE, InfiniBand continues to deliver the lowest latencies (as much as 30% lower than Ethernet-based solutions), and highest scalability

The Mellanox Solution

Mellanox offers a unique low latency transport solution for high frequency trading environments. Mellanox adapters, switches and gateways provide the lowest latency, lowest jitter and highest message rates of any interconnect in the industry. Supporting both 40/56Gb/s InfiniBand and 10/40GbE, both TCP/UDP and RDMA gives users the optimal combination of high performance and seamless integration with existing infrastructure and software.

Many different products comprise the full end-to-

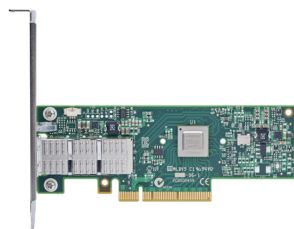
KEY ADVANTAGES

- Ultra-low application latency of as low as 1.0 microseconds for InfiniBand and 1.3 microseconds for 10GigE
- Ultra-low switching latency of less than 100 nanoseconds for InfiniBand and less than 250 nanoseconds for 10/40GbE (port-to-port)
- Extremely high packet per second rate of up to 3 million PPS for sustaining growing market data rates
- No application code changes required and fully compatible with Linux socket API
- Direct L3 connectivity to the Exchange/WAN
- Low jitter minimizing maximum and average latencies
- Fast access to storage for transaction logging and intra-day analytics
- Cost effective optimized products for co-location environments

end low latency portfolio. Below are the cornerstones:

ConnectX-2/ConnectX-3 Network Adapters

ConnectX® adapter cards with Virtual Protocol Interconnect® (VPI) provide the highest performing and most flexible interconnect solution for High Frequency Trading environments. ConnectX adapters use advanced offload capabilities to provide highest throughput and lowest latency, while maintaining extremely low CPU utilization. ConnectX adapters are the only adapters in the industry to support RDMA transmission over both InfiniBand and Ethernet with RDMA over Converged Ethernet (RoCE) allowing them to fully utilize hardware performance capabilities. With auto-sense capability, each ConnectX port can identify and operate on InfiniBand, Ethernet, and Ethernet with RoCE or Data Center Ethernet (DCE) fabrics. ConnectX with VPI simplifies I/O



system design and makes it easier for IT managers to deploy infrastructure that meets the challenges of a dynamic data center.

VMA Messaging Acceleration Software

VMA Messaging Acceleration software is a dynamically-linked user-space Linux library for accelerating messaging traffic, and is proven to boost performance of high frequency trading applications. Applications that utilize standard BSD sockets use the library to offload network processing from a server's CPU. The traffic is passed directly to the IB or 10/40GbE Network adapter (NIC or HCA) from the application user space, bypassing the kernel and IP stack and thus minimizing context switches, buffer copies and interrupts resulting in extremely low latency. VMA software runs on both Mellanox InfiniBand and 10/40GbE switches and requires no changes to the application.

Grid Director™ 4036E InfiniBand-to-Ethernet Gateway Switch

The Mellanox Grid Director 4036E switch is a high performance, low latency, fully non-blocking 40 Gb/s (QDR) InfiniBand switch, which includes a built-in low latency Ethernet gateway for bridging traffic to and from Ethernet-based networks or storage. This self-contained solution combines an InfiniBand switch, an embedded subnet manager, and a built-in, hardware-based low latency Ethernet gateway in a compact 1U device.

The Grid Director 4036E is ideal for seamless exchange connectivity for both market data and trade orders using its built-in low latency Ethernet-to-InfiniBand gateway. Market

data feeds typically run multicast traffic over 1 or 10 Gigabit Ethernet. By mapping it to hardware-based InfiniBand multicast, the Grid Director 4036E can significantly accelerate this traffic. When used with VMA software, even greater latency reduction can be achieved. With 34 40Gb/s InfiniBand ports, the Grid Director 4036E provides low latency and high throughput cluster connectivity.

Vantage™ 6024 L2/L3 10GbE Switch

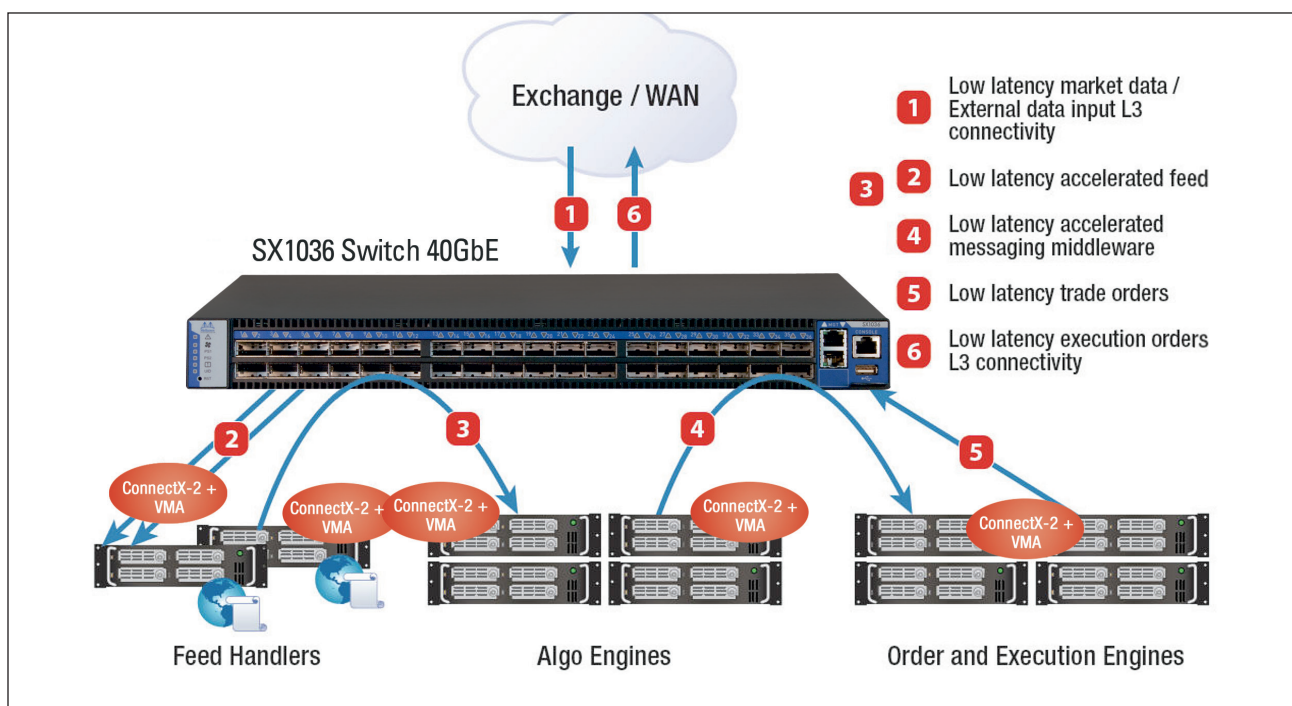
The Vantage 6024 switch is a low latency, high performance Layer 2/3 protocol stack top-of-rack switch optimized for financial services environments, with 24 ports of 10GbE line-rate connectivity. The Vantage 6024 L3 Routing feature may be used for both exchange connectivity as well as external clients. When combined with VMA software, end-to-end application performance is significantly improved without having to modify application code and latency-sensitive applications, and algorithms can perform at their best.

SX1016/SX1036 L2 10/40GbE Switches

The SX1016/1036 switches provide the highest-performing fabric solution in a 1U form factor by delivering up to 2.88Tb/s of non-blocking throughput to High-Performance Computing, High Frequency Trading and Enterprise Data Centers, with ultra low-latency. With port to port latency below 250 nanoseconds the SX1016/1036 are the ideal top-of-rack switches for multi-tiered high frequency trading environments.

VSA Storage Acceleration Software

VSA Storage Acceleration software is a highly scalable, high performance, low-latency software solution for tier-



Industry's Only End-to-End InfiniBand and Ethernet Low Latency Portfolio

Adapter Cards



Acceleration & Monitoring Software



Switches/Gateways



Cables



one storage and gateways that provides ultra-fast remote block storage access and accelerates access to SAN, DAS, or Flash based storage. Supporting up to a million IOPS (I/O operations per second), VSA helps modern traders cope with new regulations requiring faster transaction logging and intra-day analytics.

Integrated with Industry leading Messaging Applications

The Mellanox solution boosts the performance of financial market data and messaging applications from leading vendors such as NYSE Technologies, Informatica (29West), Tibco, IBM WMQ LLM and others, as well as customers' homegrown trading systems. The solution is proven to cut latency by a factor of 2-3X and increases application throughput per server, as compared to applications running on standard Ethernet interconnect networks – all without making any changes to the application.

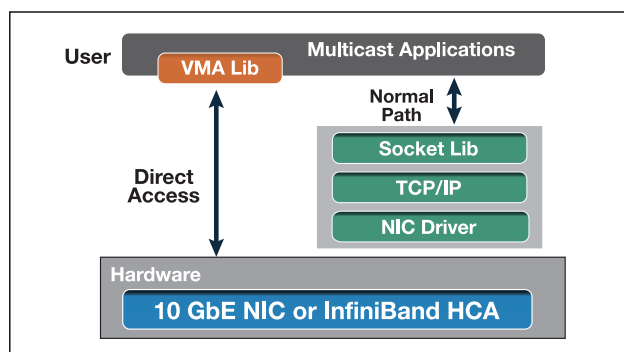


Figure 1. VMA Block Diagram.

Proven Results

Mellanox's solutions for financial services repeatedly demonstrate lower application latency, higher application throughput, and higher scalability in benchmark testing—on both InfiniBand and 10GbE fabrics.

The following benchmarks show the performance of Mellanox VMA Message Accelerator over 10GbE compared to competitive solutions, as well as the value of InfiniBand for

latency and determinism at scale.

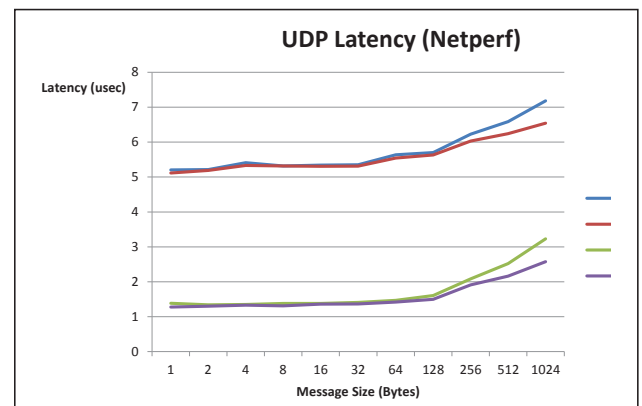


Figure 2. UDP Latency on Intel Romley based HP ProLiant Gen 8 servers with ConnectX-3

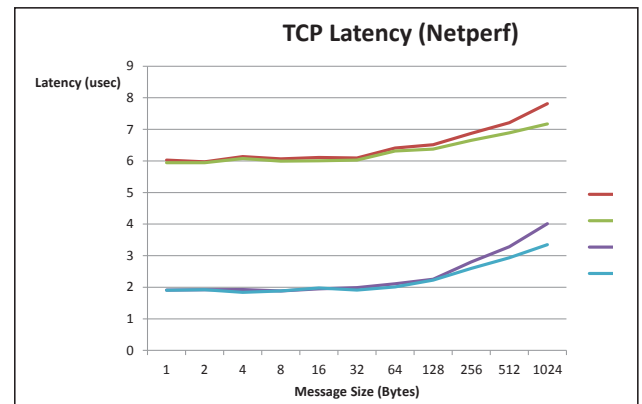


Figure 3. TCP Latency on Intel Romley based HP ProLiant Gen 8 servers with ConnectX-3

Benchmark configuration for figures 2 and 3:

- 2 x HP ProLiantSL390s G7
- Intel x5670 2.93Ghz (12 cores Hyper-threading)
- 24GB memory
- Operating System: RHEL 6.0
- No switch involved
- Measured using Sockperf open source tool

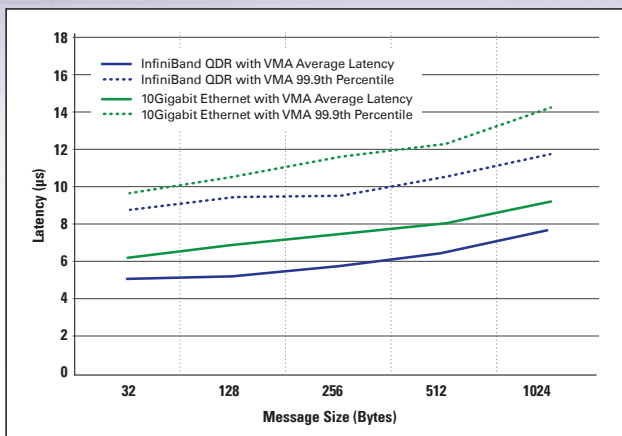


Figure 4. Latency vs Message Size at 100K messages per second with Informatica Ultra Messaging.

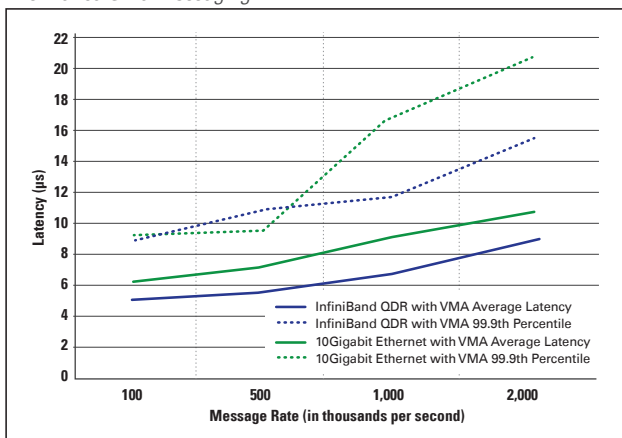


Figure 5. Latency vs Message Rate at 32B message size with Informatica Ultra Messaging.

Benchmark configuration for figures 4 and 5:

- 2x HP ProLiant® DL380 G8 8
- Intel(R) Xeon (R) CPU E5-2690 2.90GHz
- 32GB memory
- Operating System: RHEL 6.1
- No switch involved
- Measured using Netperf_RR
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Solution Components

Part Number	Product Description
Adapters	
MCX354A-FCBT	ConnectX®-3 VPI adapter card, dual-port QSFP, FDR IB (56Gb/s) and 40GigE
MCX312A-XCBT	ConnectX®-3 EN network interface card, 10GigE, dual-port SFP+
MCX314A-BCBT	ConnectX®-3 EN network interface card, 40GigE, dual-port QSFP
Acceleration Software	
SWL-00400	VMA license per server
SWL-00346	VSA license per server
Switches & Gateways	
VLT-30034	Grid Director 4036E, 40 Gb/s (QDR) edge switch with integrated Ethernet gateway
VLT-30057	Vantage 6024, 24 port, 1/10GbE switch
MSX1036B-1SFR	SwitchX® based 36-port QSFP 40GigE 1U Ethernet switch
MSX1016X-2BFR	SwitchX® based 64-port SFP 10GigE 1U Ethernet switch
Cables and Transceivers	
MTM1T02A-SR	10GbE SFP+ SR Transceiver
MTM1T02A-LR	10GbE SFP+ LR Transceiver
OPT-90003	6024 ETH SFP+ SR Transceiver
OPT-90004	6024 ETH SFP+ LR Transceiver
MC2207130-002	Copper cable, 56G FDR, QSFP, 30 AWG, 2 meter
MC2210130-002-002	Copper cable, up to 40GbE, QSFP, 30 AWG, 2 meter
MAM1Q00A-QSA	QSFP to SFP+ cable adapter



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