WHITE PAPER

July 2014

Achieving Real-Time Business Solutions Using Graph Database Technology and High Performance Networks

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Executive Summary

Companies today are finding that the size and growth of stored data is becoming overwhelming. As the databases grow, the challenge is to create value by discovering insights and connections in the big databases in as close to real time as possible. In this paper, we describe a combination of technologies from Objectivity, Inc., and Mellanox Technologies which offers a solution to this need.

Objectivity, Inc, provides tools, such as Infinite Graph, that enable users to find hidden insights in their Big Data. In order to do that, Objectivity's tools must be very scalable to ingest and analyze very large data sets. That scalability is achieved by having many computers work on the data simultaneously - distributing the data and processing across multiple computers.

Because Infinite Graph is distributed, performance depends not only on the speed of each machine in the network, but also on the speed of the network itself. Understanding this need, Objectivity has partnered with Mellanox, a provider of high performance networking elements. In this paper, we showcase several examples of Infinite Graph performance, and illustrate the performance improvement achieved by using a Mellanox enabled network.

Each of the examples is based on an element of a typical Big Data analysis solution. In the first example, involving Vertex Ingest Rate shows the value of using high performance equipment to enhance real-time data availability. Vertex objects represent nodes in a graph, such as Customers, so this test is representative of the most basic operation - loading new customer data into the graph. In the second example, Vertex Query Rate highlights the improvement in the time needed to receive results, such as finding a particular customer record, or a group of customers. The third example, Distributed graph navigation processing, starts at a Vertex and explores its connections to other Vertices. This is representative of traversing social networks, finding optimal transportation or communications routes and similar problems. The final example, Task Ingest Rate, shows the performance improvement when loading the data connecting each of the vertices. This is similar to entering orders for products, transit times over a communications path and so on. Each of these elements is an important part of a Big Data Analysis solution. Taken together, they show that InfiniteGraph can be made significantly more effective when combined with Mellanox interconnect technology.

Solving the "Big Data" problem is about being able to go massively parallel on both data storage and processing on commodity hardware. This is typically achieved by deploying in a distributed environment across multiple servers with many processors/cores, and multiple disks with local and remote access. Objectivity's distributed architecture is ideally suited for these types of deployment. In such deployments you have a choice of moving the data to the processing, or moving the processing to the data, or a combination. In any case the performance of the network can have a significant impact on overall throughput of the system. Deploying InfiniteGraph in a distributed environment with Mellanox end-to-end 40GbE solutions, can improve overall system performance, without requiring large amounts of shared memory. In this benchmark we show improvements of several 100% using Mellanox's 40GbE infrastructure with a simple graph model and InfiniteGraph.

Being able to utilize increased bandwidth is a key factor for solutions that require immediate response, such as security applications, geo-location based recommendation engines, manufacturing/product life cycle management applications, healthcare, finance, and mobile applications, as well as all types of networking applications.

Background

Graph databases provide direct connectivity between adjacent data elements without the use of indexes, which makes them a powerful tool for graph-like queries in social media applications, network diagnostics and more. By treating data and the connections between data as first class citizens in the database, graph technology can be used to leverage the information in the connections between nodes (vertices) to understand relationships and derive business value from the behavior of users, entities, groups, and their interactions.

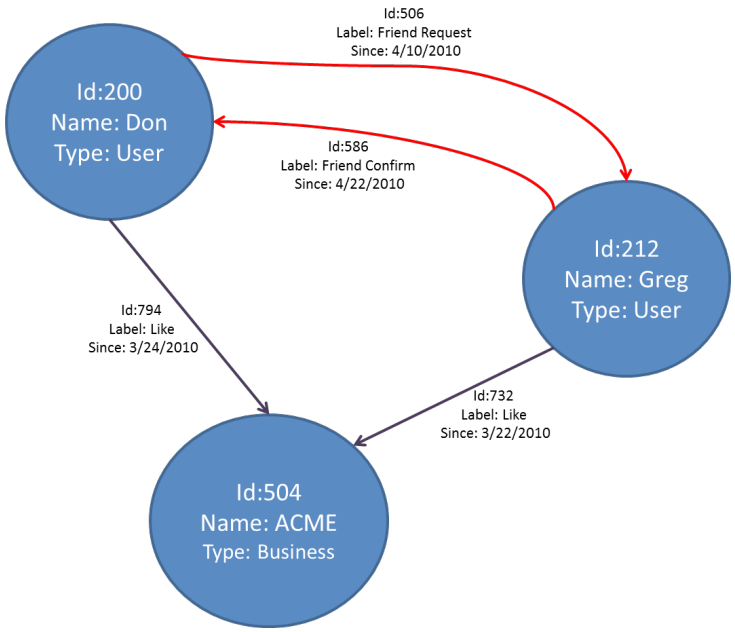

Figure 1: *Graph Database*

InfiniteGraph

InfiniteGraph is the leading distributed graph database that enables Big Data Analytics in real-time. Using InfiniteGraph as an embedded technology, organizations can build applications that discover hidden connections and relationships in their data on a global scale, helping to reduce analyst time, improve decision support, and maximize ROI on existing infrastructure and investments.

InfiniteGraph is implemented in Java, and is from a class of NOSQL (or Not Only SQL) data technologies focused on graph data structures. Graph data typically consists of vertices and the various relationships (edges) that connect them. Developers may use InfiniteGraph to build applications and services to solve graph problems or answer complex analytical questions that may include "Who are the key influencers in my network and their followers", "How am I connected to my customers, partners and prospects?", and "Which customer accounts are at risk and how can I customize services and marketing to keep those customers satisfied and loyal?"

Unlike other similar technologies InfiniteGraph is able to effectively handle graphs spread across multiple physical nodes using its unique Advanced Multithreaded Server (AMS) to access data when applications are connecting to a graph database with multiple distributed storage locations. AMS is an alternative to native file servers such as NFS or Microsoft Windows Network.

The following figure shows two InfiniteGraph applications, each with its own property file, accessing a distributed graph database. One lock server handles contention for the graph, and an AMS server on each remote machine serves data.

Each application has an XML rank file that designates its preferred storage locations.

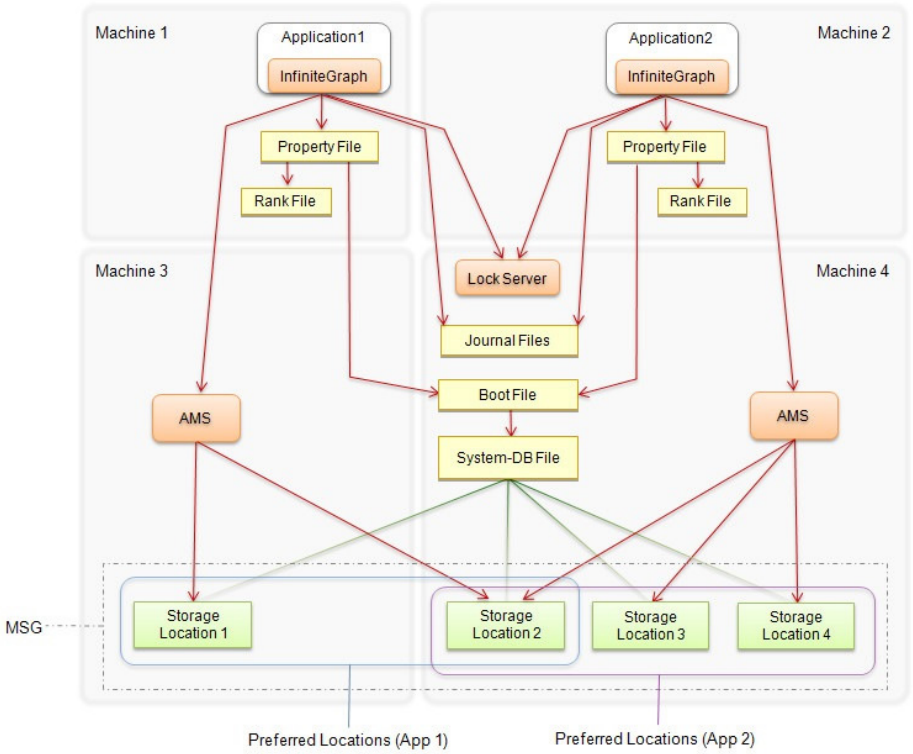

Figure 2: *InfiniteGraph Application*

Mellanox's High Performance Networks

The ever increasing demand for higher performance, efficiency and scalability in data centers drives the need for faster server and storage connectivity. 40Gb/s Ethernet is one of the leading standardized interconnect solutions that provides high bandwidth, lower latency, and lower power consumption for maximizing compute systems productivity and overall return on investment.

Mellanox 40GbE combined with low latency Remote Direct Memory Access (RDMA) guarantees that applications taking advantage of the RDMA protocol can achieve the lowest application-to-application communication latency. Requirements for memory-to-memory transactions and solid state drive throughput can be met by the 40GbE network, which delivers the needed data bandwidth without becoming the data pipe bottleneck.

ConnectX-3 Pro adapter cards with Virtual Protocol Interconnect (VPI), supporting InfiniBand and Ethernet connectivity with hardware offload engines to Overlay Networks ("Tunneling"), provide the highest performing and most flexible interconnect solution for PCI Express Gen3 servers used in public and private clouds, enterprise data centers, and high performance computing.

Public and private cloud clustered databases, parallel processing, transactional services, and high-performance embedded I/O applications will achieve significant performance improvements resulting in reduced completion time and lower cost per operation. ConnectX-3 Pro with VPI also simplifies system development by serving multiple fabrics with one hardware design. ConnectX-3 with VPI also simplifies system development by serving multiple fabrics with one.

Mellanox's SX1036 switch systems provide the highest-performing fabric solutions in a 1RU form factor by delivering 4.032Tb/s of non-blocking bandwidth to High-Performance Computing and Enterprise Data Centers, with 200ns port-to-port latency. Built with Mellanox's latest SwitchX®-2 Ethernet switch device, the SX1036B provide up to 56Gb/s full bidirectional bandwidth per port. This stand-alone switch is an ideal choice for top-of-rack leaf connectivity or for building small to medium sized clusters. It is designed to carry converged LAN and SAN traffic with the combination of assured bandwidth and granular Quality of Service (QoS).

Test Environment and Results

Our test environment includes a four- server nodes cluster and one client node. The servers' configuration is as follows:

CPU: 2x Intel E5-2680

DRAM: 128GB

Media:

1x 256GB SSD, Boot drive

6x 600GB, 10K RPM Hard drives

1x800GB, PCIe Gen2x4 SSD Card

Network: Mellanox ConnectX®-3 Pro Dual Port 10G/40Gb Ethernet NICs, MCX314A-BCBT

OS: Red Had Enterprise Linux 6.3

Switching solution: MSX1036B, based on Mellanox SwitchX-2, 36 ports, 40GbE QSFP

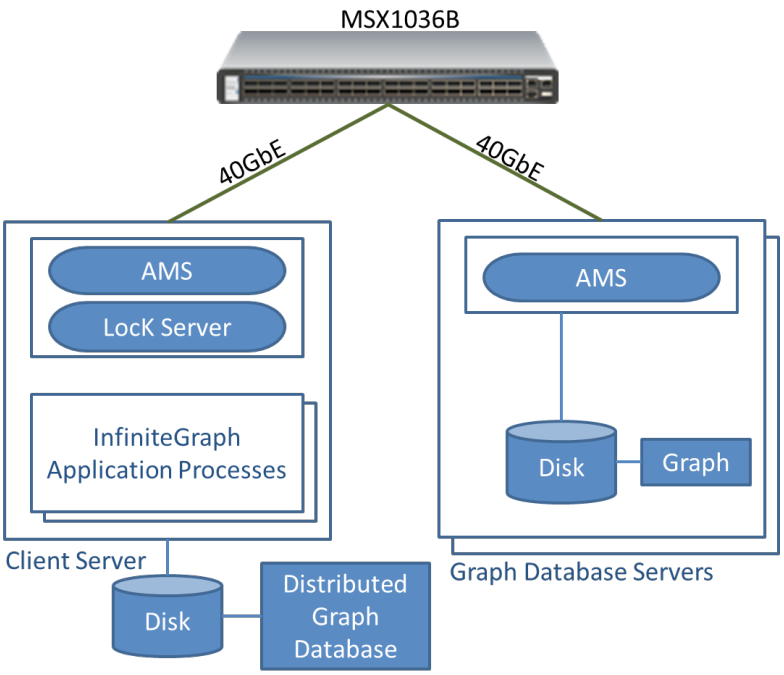

Figure 3: *Testing Environment*

Vertex Ingest Rate

The first set of tests attempted to ingest the highest number of vertices possible using remote database servers running at the location where the data storage resides. Separate tests were run on both a solid state drive (SSD) and a standard spinning disk.

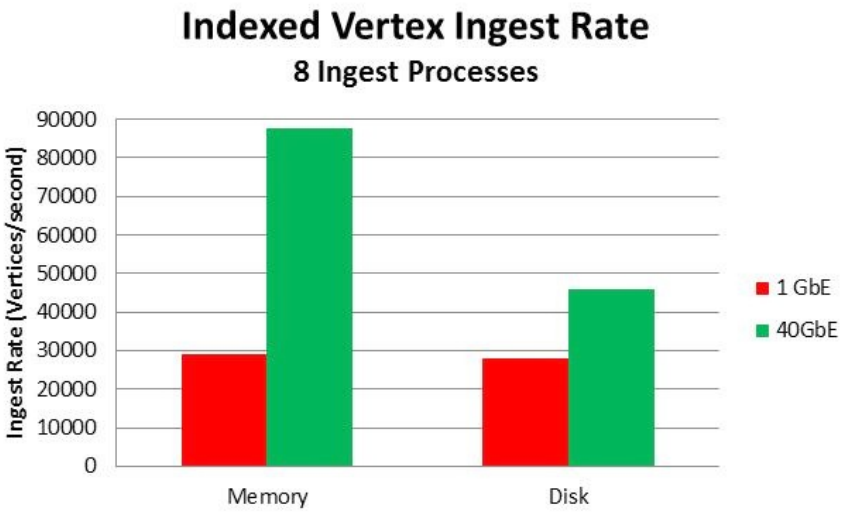

Figure 4: *Indexed Vertex Ingest Results*

The results show that for an ingest using a spinning disk and for an ingest using an SSD, the ability to write new data into the storage solutions increases significantly with the 40GbE fabric. The spinning disk ingest rate is limited by the ability of the SAS controller to drive data to the slower disk media. It is worth noting that the improvement with the SSD is almost threefold, maximizing the return on the more expensive storage medium.

Vertex Query Rate

The second test measures the ability to perform database-wide queries (that leverage indexing) to qualify vertices on a remotely connected graph database. The test was completed for in-memory data querying.

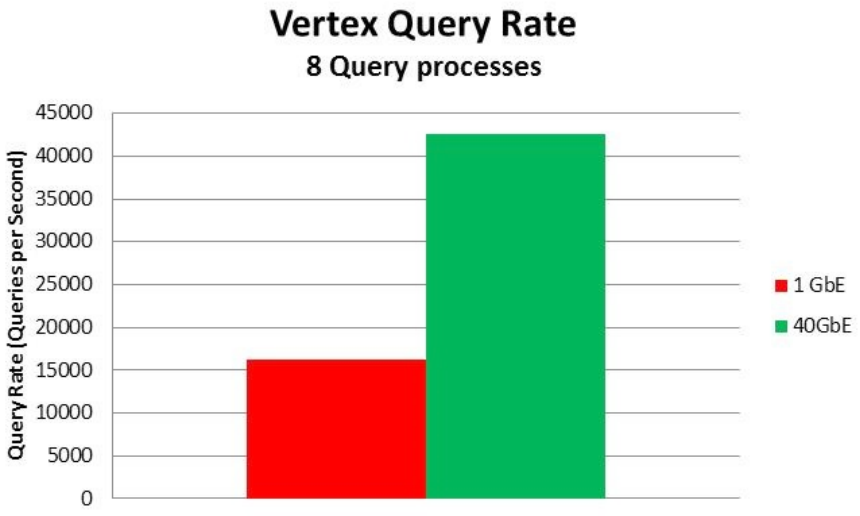

Figure 5: *Vertex Query Rate Results*

The results show an increased capability of over 160% in retrieving insights from the InfiniteGraph database in cases where the data resides in the database's server memory.

Distributed Graph Navigation Processing

The third test calculates the ability to find connecting paths between vertices in the InfiniteGraph database. Higher ability to calculate possible paths enables data scientists to explore new connections and introduces a better way to understand the relationships between data points in the database.

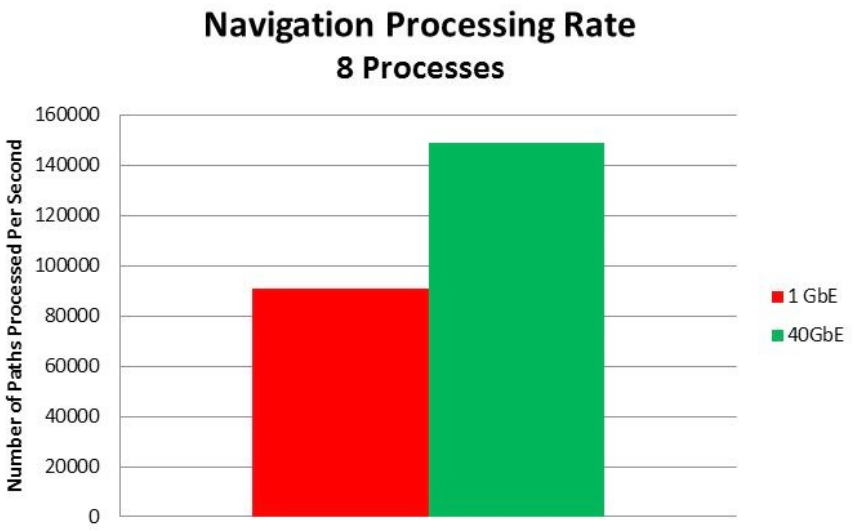

Figure 6: *Navigation Path Processing Rate Results*

The results show an increased capability of over 60% in retrieving insights from the InfiniteGraph database, when using the 40GbE fabric. Note that the unique client-side caching inherent in the InfiniteGraph architecture explains the smaller performance gain here than in the other tests. The gain would probably be greater when navigating a much larger graph, which would be less likely to be cached locally and would require extra transfers across the network.

Edge Ingest Rate

The last test conducted is the Edge Ingest Rate test.

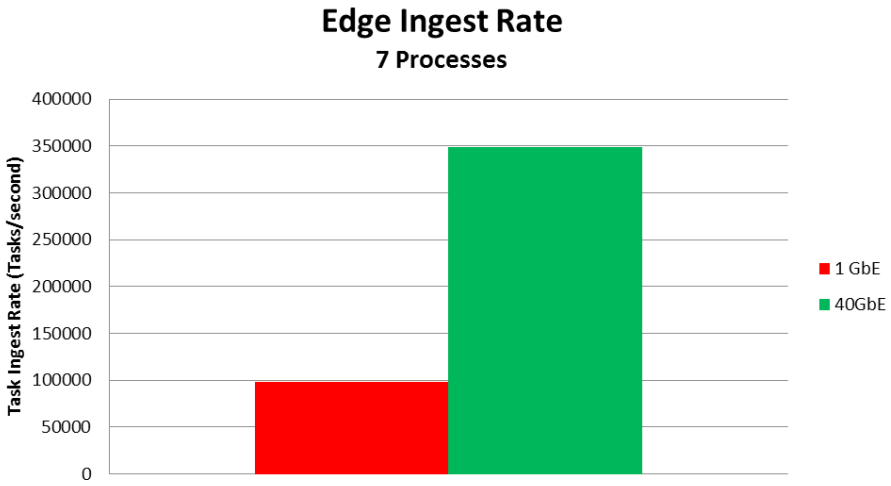

Figure 7: *Edge Ingest Test Results*

The result shows an increased ingest capability of over 250% in driving tasks into InfiniteGraph database, when using the 40GbE fabric.

Conclusion

The ability to harness the value from Big Data in enterprise applications is invaluable. In order to effectively compete in the fast moving markets of today, it is imperative for businesses to stay a step ahead of the competition. By utilizing InfiniteGraph, the only enterprise proven, distributed and scalable graph database in conjunction with Mellanox 40GbE interconnect solutions enable organizations to efficiently identify and understand complex relationships between distributed data with many degrees of separation. The Benchmark findings illustrate the reasons to use Mellanox 40GbE and InfiniteGraph as a choice in large-scale graph processing and analytics for organizations seeking valuable connections in data and information. The results are consistent for both ingest rate requirements and analytics targets, delivering better data value to customers deploying InfiniteGraph database over Mellanox 40GbE.

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