



Whitepaper / Benchmark

**Web applications on LAMP run up to 8X
faster with Dolphin Express**

**DOLPHIN DELIVERS UNPRECEDENTED PERFORMANCE
TO THE LAMP-STACK MARKET**

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1. INTRODUCTION

The most prominent development environment for building web applications is known as the LAMP stack (Linux, Apache, MySQL and PHP/Python/Pearl). In this white paper we show how the LAMP stack in combination with Dolphin Express (cluster interconnect) creates a real-time web store, suitable for markets with low latency or real-time requirements. Low latency is important in delivering fast response time in any LAMP stack application, but for some markets such as telecom, financial services and many embedded systems, this is a critical requirement. Our results demonstrate that Dolphin Express provides **response time improvements of up to 712%** compared to Gigabit Ethernet, as well as significant performance increases in both low and high-load cases. This makes it ideal for any performance sensitive web application and uniquely able to meet the needs of real-time e-commerce applications.

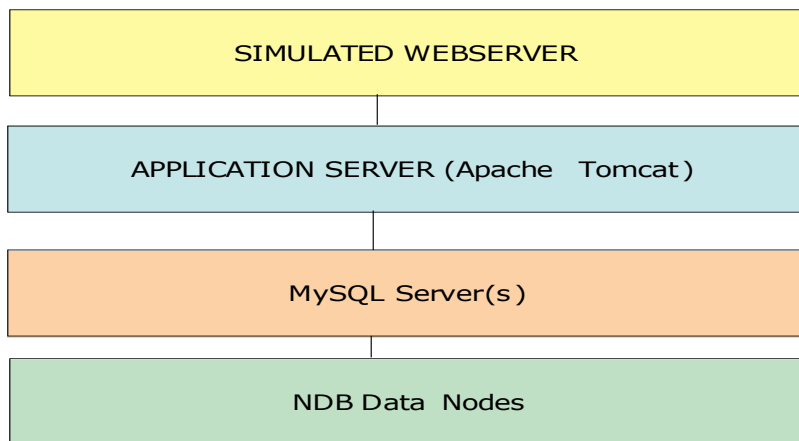
2. DESCRIPTION OF BENCHMARK

The benchmark executed was a TPC-W implementation in Java on Tomcat and MySQL Cluster developed by students at the University of Wisconsin.

The benchmark implementation was slightly adjusted from the TPC-W specification in the areas of security and loading. It simulates a web store with online browsing, shopping and ordering. The performance is measured in processed web-interactions per second. The benchmark strives to be as close to a real web store as possible:

-  Multiple on-line browser sessions
-  Dynamic page generation with database access and update
-  Consistent web objects
-  Simultaneous execution of multiple transaction types that span a breadth of complexity
-  Databases consisting of many tables with a wide variety of sizes, attributes, and relationships
-  Transaction integrity (ACID properties)
-  Contention on data access and update

The below illustration shows the system architecture



2.1 SOFTWARE AND HARDWARE SPECIFICATION

The LAMP stack consisted of Fedora 8 for the Dolphin Express tests and Red Hat Linux 4.4 for Gigabit Ethernet tests, Apache Tomcat and MySQL Cluster.

All tests, both Gigabit Ethernet and Dolphin Express, were run on Intel Xeon computer clusters where each server had 2 CPUs with 4 cores each.

Each server had one disk, which made us decide to perform the test runs without disk writes. To sustain disk writes from 4 data nodes on an eight-core machine, it is necessary to have about 8 disks. Every computer had 2 gigabit Ethernet connections on the motherboard and Dolphin Express cards connected to the PCI Express bus.

The Dolphin Express benchmarks were run on 2 computers each having 2 quad core, 2.67 GHz CPUs and 4GB of RAM. D350 cards were used for Dolphin Express testing.

The benchmarks for Gigabit Ethernet were run on 2 computers, each having 2 quad core 3 GHz CPUs and 16GB RAM which provides 10 to 15 % better performance than those run for Dolphin Express tests. The results shown in this whitepaper are the raw results, not adjusted for differences in CPU performance.

This benchmark shows the benefits of using Dolphin Express versus Ethernet in every tested scenario.

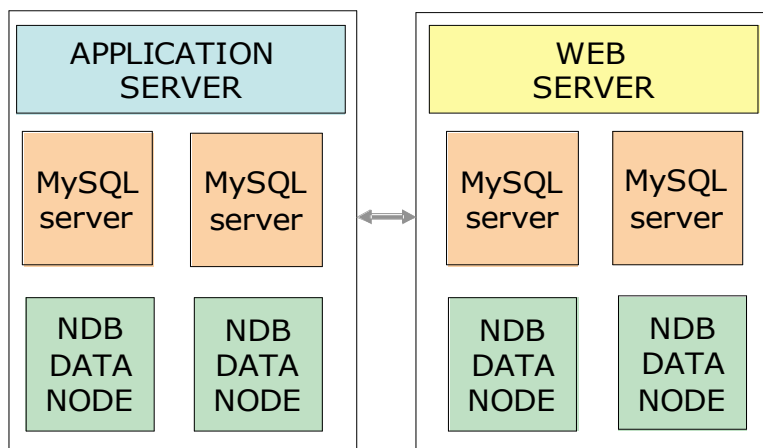
2.2 DIFFERENT CONFIGURATIONS

When running the tests we used four different configurations

1. 2 MySQL servers and 2 data nodes
2. 4 MySQL servers and 4 data nodes
3. 4 MySQL servers and 6 data nodes
4. 6 MySQL servers and 6 data data nodes

The application server and web server are always on different computers.

4-NODES MINI CLUSTER



2.3 MYSQL CLUSTER AND DOLPHIN EXPRESS

MySQL Cluster is an Open Source Database technology developed by MySQL AB that brings High Availability, Scalability and High Performance to database applications. MySQL Cluster uses the standard MySQL technology with a clustered database backend, NDB Cluster. MySQL Cluster can be accessed from the MySQL Connector's which provides access to the full LAMP stack, or it can also be accessed from the NDB API that works directly with NDB Cluster

Given that MySQL Cluster is a clustered backend, communication performance is important and therefore the choice of cluster interconnect technology is very important. There are many important aspects of the cluster interconnect, but probably the most important is the integration of the interconnect software with MySQL Cluster and the latency of the interconnect hardware.

Dolphin Express cluster interconnect consists of a low latency hardware/software combination. Using Dolphin Express in the LAMP stack installation requires no application level changes. The Dolphin Express software component, named Supersockets™, provides a socket API implementation optimized for Dolphin's cluster interconnect hardware. The Supersockets implementation is well engineered and utilizes 3 different schemes for performing write operations dependent on write size. A tight integration of interrupt mechanisms within Supersockets makes it possible to very quickly wake any process waiting for messages on the socket, along with locally shutting off those interrupts if the software is not currently waiting for messages. In many instances, it is possible to entirely remove the cost of interrupts. This feature helps make Dolphin Express a very efficient solution in high-load cases and is particularly true in configurations where all CPU's are kept busy. Dolphin and MySQL developed features in MySQL Cluster that fully takes advantage of this efficiency in Dolphin Express.

Furthermore, for the real-time web store market, it is not enough to simply be able to process many messages at peak loads. It is also important to have very low latency with very stable response times. As an example in financial markets many companies receive the same information simultaneously and the company that can process the information first has a first-mover advantage and the best opportunity to make money for its clients. Faster response time of the DBMS is an important part of such information processing for the financial markets.

3. PERFORMANCE ASPECTS OF INTERCONNECT HARDWARE

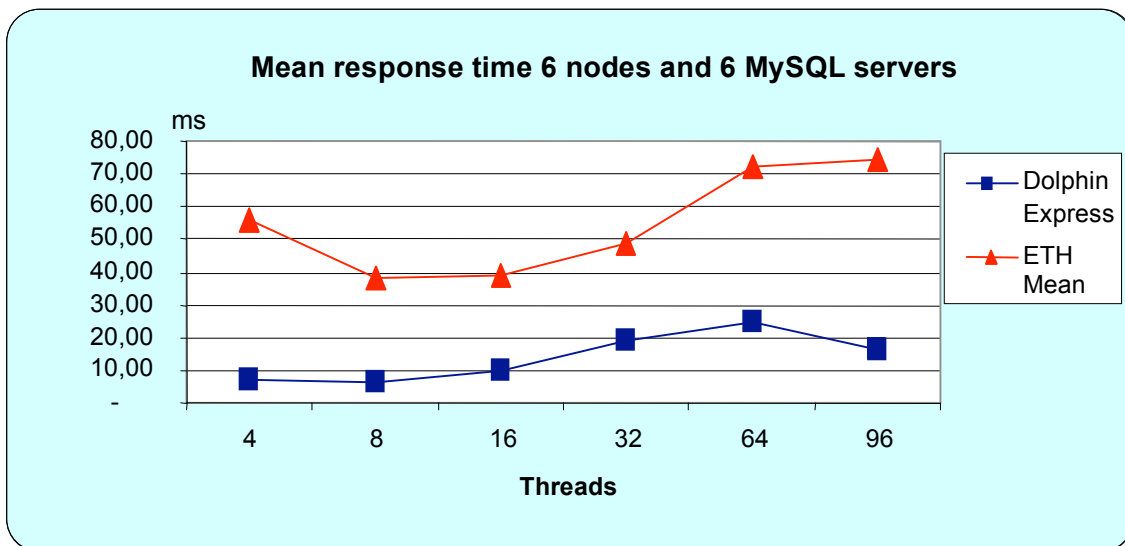
The cluster interconnect can improve a number of performance parameters. These are:

- 1) Latency Improvements
- 2) Efficiency Improvement in CPU-limited scenarios
- 3) Efficiency Improvement where there are unused CPU resources
- 4) Bandwidth Improvements

We separate efficiency improvements in CPU-limited scenarios and scenarios where there is abundant CPU resources, due to the fact that they are affected by different factors.

3.1 LATENCY IMPROVEMENT

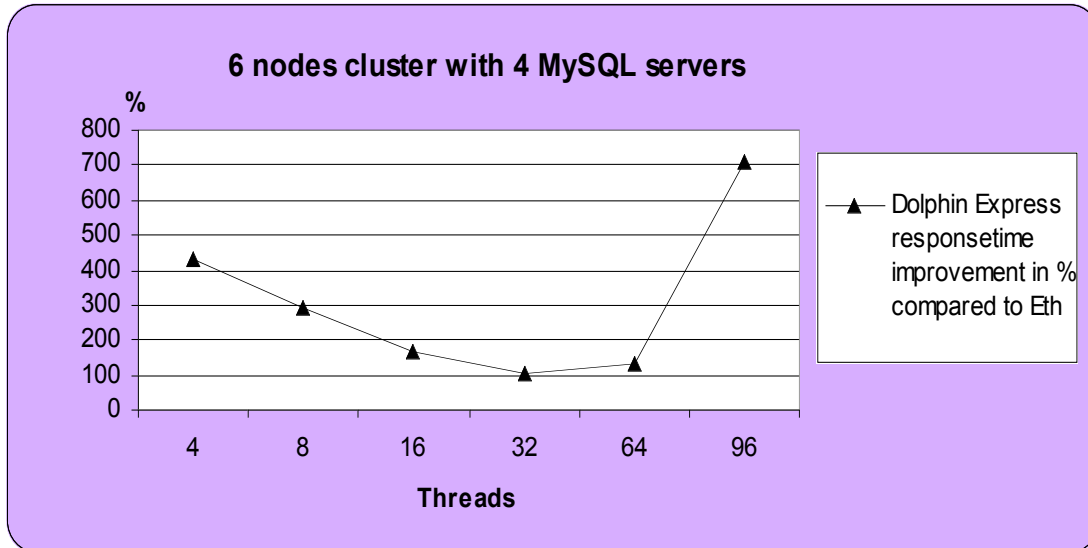
Low latency has a great effect on response time and Dolphin Express is truly optimized for low latency through the combined hardware/software solution. Depicted in the graph below are the results from the test runs showing Dolphin Express response time improvements over Gigabit Ethernet of as much as a factor of seven with 4 threads. Throughout the benchmarks we demonstrate that latency represents a very dominant performance factor increasing with higher number of parallel threads.



3.1.1 LATENCY IMPROVEMENT IN CPU LIMITED SCENARIOS

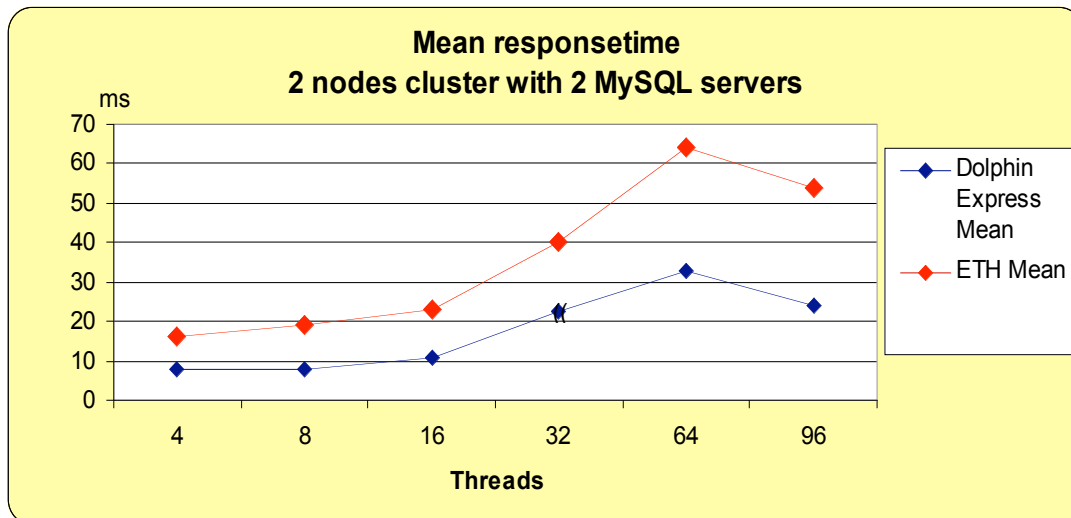
When CPU resources are limited and the load is high the chart below shows how Dolphin Express gives a 712% response time improvement compared to Gigabit Ethernet.

The larger the cluster the more communication and therefore the benefits of Dolphin Express are greater.



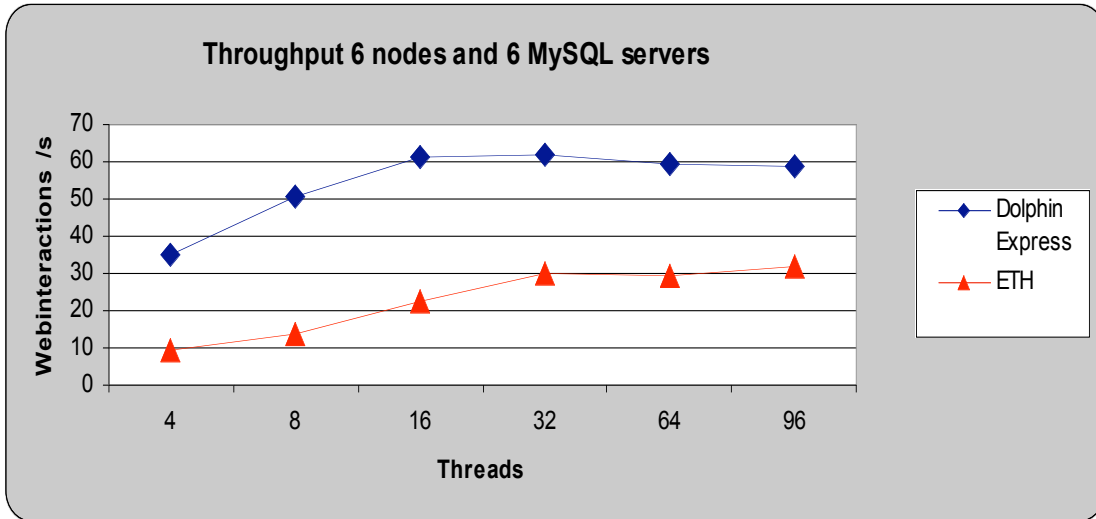
3.1.2 LATENCY IMPROVEMENT IN CPU ABUNDANT SCENARIOS

When CPU resources are abundant and the load is high the diagram below shows how Dolphin Express still consistently delivers much lower latency and thus response time, in most cases improved by more than 100%.



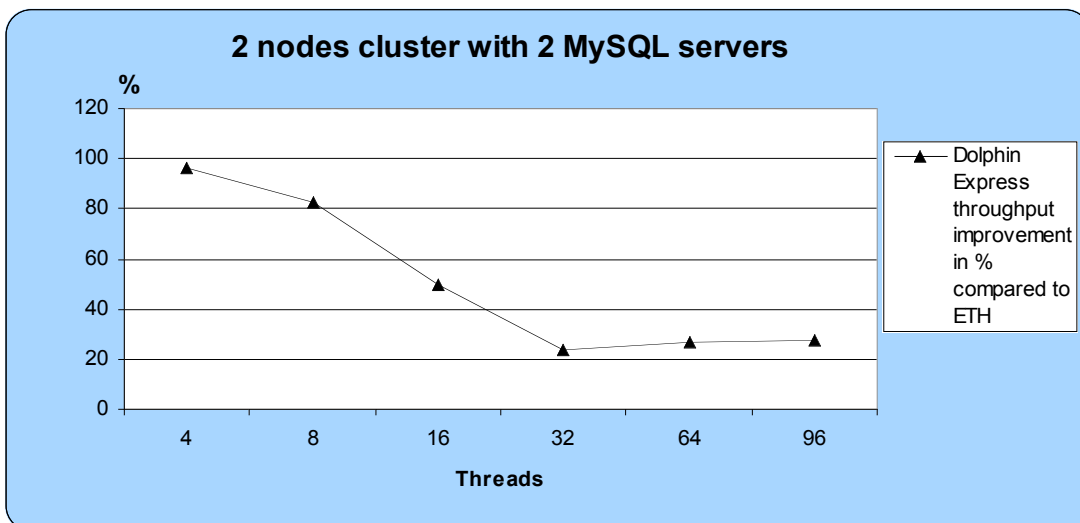
3.2 EFFICIENCY IMPROVEMENT IN CPU-LIMITED SCENARIOS

When there aren't enough CPU resources and the system is heavily loaded, the CPU resources required to handle communication are the decisive factor in system efficiency. As shown below, Dolphin Express provides between 90% and 425% system efficiency improvement measured in web interactions per second in heavy load scenarios.



3.3 EFFICIENCY IMPROVEMENT WHERE CPU RESOURCES ARE ABUNDANT

When there are abundant CPU resources available, the decisive efficiency factor of a cluster interconnect, is dependent on how it manages interrupts to the processor. In cases with high load and abundant CPU resources Dolphin Express still outperforms the Gigabit Ethernet interconnect with up to 97% higher message rate even in small clusters.



3.4 BANDWIDTH IMPROVEMENTS

The Dolphin Express hardware can handle 3-5 times higher bandwidth compared to Gigabit Ethernet. In this white paper we did not benchmark bandwidth improvements.

4 STANDARD DEVIATION

The standard deviation of the test is consistently lower for Dolphin Express and most often by more than 100%.

5 CONCLUSION

The LAMP stack using Dolphin Express builds a real-time web store product with very high performance, low response time and very high availability. Our results demonstrate that Dolphin Express provides response improvements of up to 712% as well as significant performance increases in high load cases, especially in larger clusters. Throughput is increased with up to 425%.

Small clusters give significantly better results while large clusters give even better results. Larger clusters means more communication which increases the benefit of Dolphin Express even further.

In all the tested scenarios Dolphin Express consistently outperformed Gigabit Ethernet.