Optimal Scale-Up and Scale-Out for MySQL, NoSQL, and Memcached: Transforming Datacenters with Flash- and Multi-Core-Optimized Software Appliances and Clusters

How datacenters can scale smart by leveraging commodity hardware through tightly-coupled MySQL, NoSQL, and caching software that cuts TCO, optimizes performance, minimizes downtime, and simplifies management.

SCHOONER
SCALE SMART

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Executive Summary

With the explosive growth in online data driving performance-sensitive business applications — from Web-2.0 sites to behind-the-firewall financial trading and settlement systems — datacenter workloads are increasing exponentially. IT managers are finding it difficult to meet the accelerating demands for performance, capacity, scalability, and reliability — while meeting budgets, maintaining service level agreements, and making progress with green IT initiatives.

New technologies hold real promise for accomplishing these goals, including scalable database, data store, and caching software technologies and flash memory, multi-core processors, low-latency networking hardware technologies.   But without optimal integration and optimization, these technologies have failed to deliver the benefits that datacenter managers and the business demand.

Schooner Information Technology has pioneered a new generation of highly-optimized data-access Software Appliances specifically architected to provide smart scaling for the MySQL database, NoSQL data store, and Memcached software caching. Schooner's advanced architecture tightly integrates Schooner's leading-edge database, key-value store, and caching software with best-of-breed commodity flash memory, multi-core servers, and networking technologies. Schooner's software products bring all of the benefits of a tightly-coupled dedicated turnkey appliance that is delivered on a fixed hardware configuration -- but on a vast choice of commodity hardware, including the servers you are already using.

Schooner's software transforms standard commodity multi-core servers and flash memory into optimized MySQL or NoSQL super-servers, delivering optimal scale-up. Schooner-powered servers typically result in an 8x performance improvement while consuming 1/8th the power and space. They reduce total cost of ownership (TCO) by 60% when compared with the deployment of other MySQL or NoSQL distributions on the same hardware. Schooner's software also delivers optimal scale-out on standard network technology through transparent data distribution and low-latency synchronous replication, resulting in a 90% reduction in downtime and non-disruptive growth to any data capacity. Schooner's software products are fully standards-based and certified 100% compatible; no application changes are required. Schooner software brings breakthrough improvements in data center quality-of-service and TCO.

This white paper begins with a review of the trends and key challenges facing today's datacenters that run mission-critical applications that use the MySQL database, caching, or NoSQL data stores. Next, the technological opportunities and the limitations of current approaches are examined. This is followed by an introduction to Schooner 's breakthrough data-access software products for standard commodity x86 servers with flash memory: the Schooner Appliance for MySQL® Enterprise™ with InnoDB (referred to as Schooner MySQL in the following) and Schooner Membrain™ (the smart NoSQL data store, based on Memcached). We then quantify the breakthrough performance, power consumption, and availability benefits of Schooner's smart scaling compared with traditional MySQL and NoSQL deployments.   We also present cost breakdowns that demonstrate how Schooner reduces both capital expenditures (capex) and operating expenditures (opex) to maximize datacenter efficiency by making standard x86 multi-core servers do more. The paper concludes with quotes from several noted industry analysts and customers on the Schooner approach, solutions, and demanding deployments.

Datacenter Trends and Challenges

With the explosive growth in the number and complexity of Web 2.0, software-as-a-service (SaaS), cloud computing, and other enterprise applications, datacenter workloads have increased exponentially. The business opportunities created by the deployment of these new applications are substantial, but the demands they place on the datacenter are daunting. Challenges include:

- **Unprecedented data growth.** Recent studies indicate that the amount of data managed by today's datacenters quadruples every 18 months. To complicate matters, online users are getting much more sophisticated, and expectations about response times and availability are at an all-time high.
- **Severe capacity constraints**. Datacenter managers are struggling to manage huge increases in rack, power, and network usage. They are constrained by limited datacenter power and space and are seeking cost-effective ways to expand capacity.
- **Increasing data complexity.** Organizations have too much data to process in a timely and consistent manner. Successful information management requires extensive data partitioning and application-level mapping, caching, replication/recovery, and load balancing, all of which is difficult to implement and manage.
- **The lack of scalability.** Current datacenter environments find it hard to scale effectively to manage peak demand. In standard multi-core server environments, many datacenters have already scaled to the point where they are memory and disk bound.
- **Underutilized resources**. Estimates of current datacenter server utilization rates run between 5–30% for database, caching and NoSQL. Underutilized hardware translates into wasted capex, opex, and power.
- **Severe budget constraints.** Budgets are tighter than ever. Only solutions that are able to provide quick ROI are now being approved. Traditional approaches to datacenter expansion — just throwing more racks of traditional servers at the problem — are no longer viable.
- **The corporate mandate to go green.** According to the 2007 EPA Report to Congress on Server and Datacenter Energy Efficiency, energy consumption of servers and datacenters has doubled in the past five years and is expected to almost double again in the next five years to more than 100 billion kW-h, costing about $7.4 billion annually. Datacenter managers are working hard to save energy, reduce datacenter space requirements, and protect the environment.

Limitations of Today's Technology

The success of modern Web sites and other enterprise applications depends heavily on the ability to effectively scale the database, caching, and data store tiers on which these apps depend. Unfortunately, ordinary server and database, data store, and caching infrastructure is loosely integrated and minimally optimized, resulting in inadequate data center quality of service and cost of ownership. Existing datacenter solutions do not adequately address the performance, capacity, scaling, reliability, power, and TCO challenges of effectively supporting dynamic online data and services.

Key hardware and software technology trends offer the potential to dramatically improve data center quality of service and cost of ownership, but there are fundamental challenges in exploiting these trends.

- ➢ **Multi-core servers**
    - The number of cores in a standard x86 server increases each year.
    - This promises to dramatically improve performance and energy and space efficiency.
    - But current database, data store, and caching software typically utilizes only 15% of processor cores, and the servers cannot be consolidated through virtualization since the database, data store and caching software needs all the DRAM and I/O of the server. As a result many nodes are required with small data partitions on each node in order to achieve the required throughput
    - Effectively harnessing standard commodity multi-core servers requires a new holistic architecture.

- ➢ **Enterprise-class flash memory**
    - The current generation enterprise flash memory is 100x faster than hard disk drives and consumes 1/100th power of DRAM. The capacity per commodity server can easily exceed 1TB, with very attractive cost and durability.
    - Enterprise flash memory promises to dramatically increase server performance and reduce the power and space needed for database, data store, and caching deployments.
    - But current database, data store, and caching software benefit minimally from flash memory, typically only utilizing a fraction of the IOPS provided by flash memory. As a result deployments must still use many nodes, each with small data partitions, to achieve the required throughput.
    - Effectively harnessing flash memory requires a new holistic architecture.

- ➢ **Low-latency networking**
    - Standard 1 and 10 Gb Ethernet provides the ability to send a message in a millionth of a second.
    - This promises transparent high availability and efficient distribution of data.
    - But due to their inability to effectively utilize processor cores and flash memory, current database, data store, and caching software is limited to asynchronous replication, which result in inconsistent data and error prone failure recovery.
    - Effectively harnessing low latency networking requires a new holistic architecture.

- ➢ **Scalable database, data stores and caching services**
  - New clustered relational and NoSQL data store and caching technology can concurrently process large amounts of data and can scale more easily as the amount of data increases and the data organization changes.
  - These offer the promise for on-line computation of large data sets with non-disruptive growth.
  - But due to their inability to effectively exploit high performance multi-core, flash, and networking, these scalable database, data stores and caching services create server sprawl, inconsistent performance, inconsistent data, poor availability and often require application modification or rewrite to non-standard APIs .
  - Effectively harnessing scalable database, data stores and caching technology a new holistic architecture.

The unfortunate reality is that traditional MySQL and NoSQL software distributions fail to effectively exploit the benefits of high performance commodity x86 multi-core servers, flash memory, and low-latency network technologies. Traditional distributions fall short in providing high performance, high availability, low TCO, and easy administration and application migration. Because these distributions are not designed to effectively exploit today's commodity hardwarex86, many more servers are required. These servers have low utilization, accompanied by extensive data sharding and server sprawl with error-prone failure recovery. To deploy these current services, each customer's IT team must do extensive integration and development, often involving projects that can take years to implement and tune. This diverts valuable IT resources from the enterprise's core business, and often results in unmanageable application and administrative complexity and problematic quality of service and TCO.

Schooner MySQL and Schooner Membrain: Software that Fully Exploits Commodity Hardware

Schooner Information Technology has taken a breakthrough approach to solving today's complex data-access challenges. The unique Schooner architecture and implementation results in efficient, optimized software products which tightly integrate Schooner-patented advances in optimized data-access technologies with enterprise flash memory, commodity multi-core servers, and low-latency networking. They deliver scalable, high performance MySQL, NoSQL, and caching with high availability at low cost, on standard x86 servers with flash memory. The net result is not just more efficient datacenter operations, but the creation of new revenue-producing business opportunities based on rapid access to highly available, high capacity performance sensitive data.

"Schooner is singularly focused on providing Web 2.0, Enterprise, and cloud computing datacenters with a means to transform their businesses — to transcend the current boundaries limiting the full utilization of breakthrough industry technologies," explained Dr. John R. Busch, founder and CTO of Schooner Information Technology. "Our customers can now meet their biggest challenges of rapidly increasing datacenter costs, exponential data growth, and compounding business complexity with Schooner software that lets them handle bigger loads with fewer nodes and higher availability."

Schooner's fully-optimized install-and-go MySQL and NoSQL software gives enterprises solutions that eliminate the need for complex, risky integration projects. Schooner software enables IT to surpass corporate goals of increasing capacity, scalability, and reliability, while at the same time slashing costs and dramatically curtailing energy consumption across the datacenter.

Schooner Technology and Product Overview

Many users need a full SQL relational database -- such as MySQL, the world's most popular open-source database -- for its data integrity and extensive functionality. Others need a simple high-performance cache or persistent NoSQL key-value store. Some need both, since a cache or data store is often used to front end a database.

Schooner offers both, in the form of two innovative software products: the Schooner Appliance for MySQL Enterprise with InnoDB (or Schooner MySQL) and Membrain (the smart NoSQL data store, based on memcached). These software products transform standard x86 servers with flash memory into highly-optimized MySQL or NoSQL super-servers. Schooner users handle way bigger loads with way fewer nodes, bringing substantial savings from lower capex and opex. And since Schooner is 100% compatible with the standard APIs, users don't need to rewrite their applications or change their queries one bit to get all of Schooner's benefits.

7   Optimal Scale-Up and Scale-Out for MySQL, NoSQL, and Memcached: Schooner Business White Paper
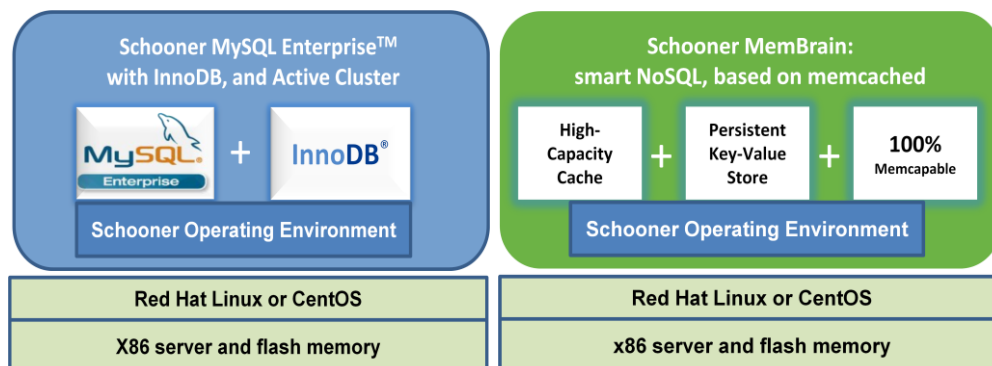
Schooner delivers optimal performance, lowest downtime, easiest scale out, and maximum datacenter efficiency for MySQL with InnoDB, caching, and NoSQL data stores.

Schooner does this using breakthrough, patented technologies. Optimized MySQL and NoSQL data access layer protocols are coupled with the Schooner Operating Environment (SOE) libraries, which together tightly integrate all system resources in a highly-parallel, low-overhead manner to dynamically balance system resources and maximize performance and availability and minimize cost.

Schooner MySQL

With over twelve million installations, MySQL is the world's most popular open-source database. InnoDB is the standard plug-in storage engine for MySQL. Using InnoDB makes MySQL ACID-compliant for mission-critical OLTP applications. MySQL with InnoDB is optimized for Web applications, but scaling it to handle enterprise-class workloads involves extensive data partitioning, server sprawl, and management complexity to deliver high availability and minimal downtime. This approach is time-consuming, difficult to administer, and costly.

In Schooner's solution, MySQL Enterprise™, InnoDB, SOE, and your commodity hardware platform are co-optimized to provide a balanced system, with full utilization of high-performance processors, memory, flash memory, and networking to maximize throughput and availability.
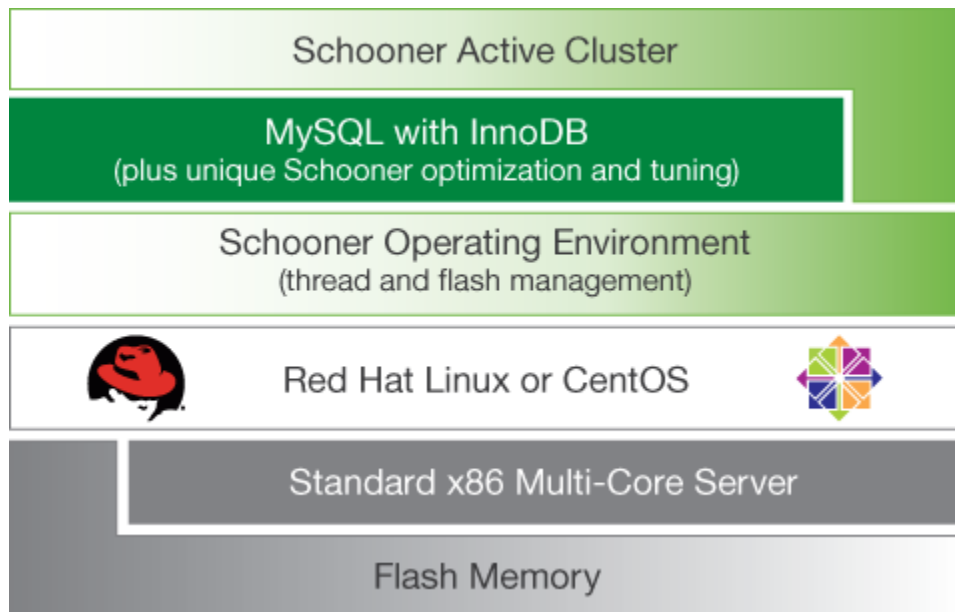
The Schooner software unlocks the full potential of the hardware, optimizes utilization and availability, and eases administration across a broad spectrum of workloads. Schooner MySQL provides:

> ➢ **Full ACID MySQL Database with data durability for demanding OLTP applications**

> ➢ **Optimal Scale Up Resulting in Industry-Leading Performance and TCO**
> - Fully exploits multi-core processors through fine-grained locking and concurrent data structures,

based on extensive instrumentation and analysis of the locking and data structures in MySQL and InnoDB, using these insights to greatly increase the level of parallelism and concurrency, resulting in full exploitation of all available simultaneous multi-threaded cores

- Exploits flash parallelism, high I/O rate, and low latency through highly parallel and intelligent memory and recovery log/checkpoint management, effectively making flash memory an extension of DRAM

- Schooner-patented memory and log management techniques maximize DRAM/flash access concurrency and minimize the time a transaction thread waits to read data or hold a lock, dramatically speeding up index access and transaction throughput

- Provides workload variation resiliency through scan resistance by detecting and limiting DRAM usage by scans

- Allows further performance tuning through specialized InnoDB formats selecting flexible block sizes and enhanced checksum algorithms, which reduces CPU overhead and further improves memory management and flash access utilization

➢ **Optimal Scale-Out Resulting in Industry-Leading High Availability and Dynamic Scaling**
  - Delivers comprehensive, enterprise-class data and service availability through a rich set of High-Availability/Disaster-Recovery (HA/DR) features, including Synchronous Active/Active Replication and transparent fail-over, on line upgrades, Concurrent Backup & Restore, dynamic schemas, and RAID.

  - Cluster-wide High Availability (HA/DR) based on synchronous replication

    - zero slave lag, and fully consistent cluster-wide data at all times

    - automatic immediate fail-over with guaranteed data consistency

    - rapid cluster integration of new or recovered nodes

    - on- line hardware and software upgrades

    - on-line cluster wide backup and restore

    - GUI with single click cluster management (addition of new nodes, upgrades, etc)

  - Dynamic Schemas (in development for customer trials in mid-2011)

    - Cluster-wide dynamic additions/deletions of columns and indexes without interruption of any of the servers

  - Flash-based database durability through log and data synchronization on commits and checkpoints;

  - Improved availability of flash-based MySQL/InnoDB Masters and Slaves through RAID on flash drives and hard drives
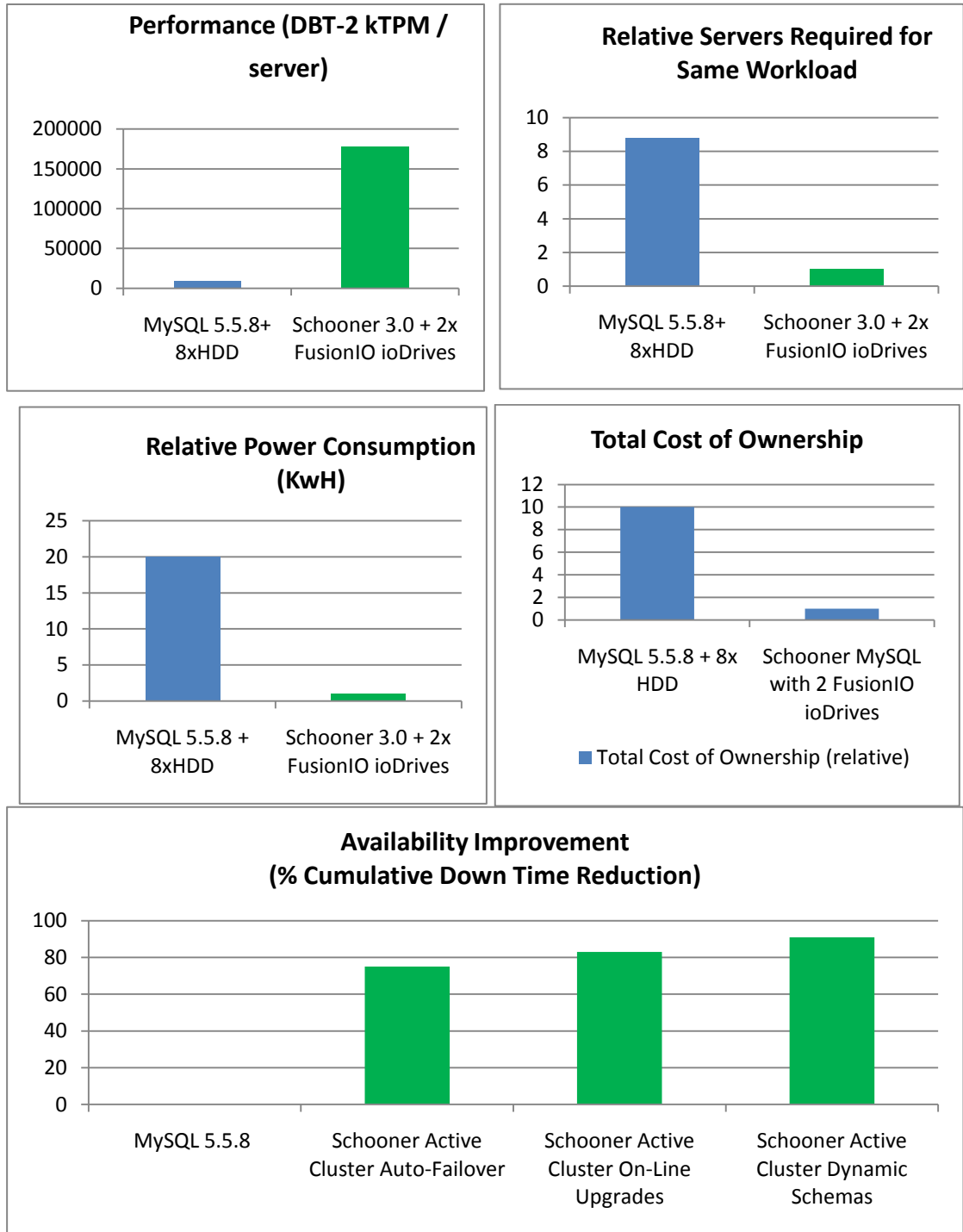
➢ **Easy Install-and-Go Usage**

- Certified 100% MySQL compatible by Oracle

- Provides rich administrative services for easy cluster deployment, management, monitoring, and scaling.

- Integrated with standard third-party management and monitoring tools

Schooner MySQL: Performance, Consolidation, Power, Cost and Availability Benefits

Figure 1 shows the performance improvement, server consolidation, power reduction and availability improvement of Schooner MySQL 3.0 (based on the 5.1.52 MySQL release which is used by almost all MySQL shops) relative to the latest GA release   of MySQL Enterprise, the MySQL 5.5.8 distribution. The comparison is based on the standard DBT-2 benchmark at 1,000 warehouses using a standard commodity 2U 2 socket x86 Westmere server with 64GB of DRAM. MySQL 5.5.8 is optimized across eight 10kRPM hard drives and Schooner 3.0 is optimized with two 640 GB Fusion-io Duo ioDrives. The performance measurement shows the throughput achievable on a single 2U server. The servers, power, TCO and availability comparisons are shown for an 8 Terabyte deployment requiring 2.7M transactions per minute. As shown in Figure 1:

✓ Performance: Schooner MySQL increases database throughput per server by 20x relative to traditional MySQL 5.5.8 with hard drives

✓ Server Consolidation : Schooner MySQL reduces the number of required servers by 9x

✓ Power Consumption : Through dramatic server consolidation and the low power consumption of flash, Schooner MySQL reduces the power required for a scaled workload by over 90% relative to traditional MySQL 5.5.8 with Hard Drives

✓ Total Cost of Ownership (TCO): Through reduced capital servers, DRAM, Flash, hard drives and operating expense power, space, support and maintenance, Schooner 3.0 reduces the power required for a scaled workload by over 90% .

✓ Availability : Through Schooner MySQL Active Cluster synchronous replication with auto-failover, on-line h/w and software upgrades, and dynamic schemas, Schooner MySQL clusters reduce the downtime for a scaled deployment by over 90% and guarantee cluster-wide consistency (99.99995% availability)

Figure 1: Schooner MySQL 3.0 Performance, Consolidation, Power, TCO, Availability Benefits

Performance (DBT-2 kTPM / server)

Relative Servers Required for Same Workload

Relative Power Consumption (KwH)

Total Cost of Ownership

Availability Improvement (% Cumulative Down Time Reduction)

Schooner MySQL: Scale-up and Scale-Out Industry Leadership Across all MySQL Software

Schooner MySQL provides the best scale-up and scale-out of any MySQL distribution. For example, Figure 2 demonstrates Schooner's MySQL 3.0 scale-up performance leadership over MySQL 5.5.8 and Percona 5.1.53 on a two socket Westmere server with 64GB of DRAM and two Fusion-io duo 640 ioDrives on the DBT2 benchmark at 1000 warehouses. Schooner 3.0 outperforms both MySQL 5.5 and Percona by over 75% with dramatically higher performance stability. Furthermore, Schooner 3.0 Active Cluster's scale out leadership provides over 90% downtime reduction and over 50% TCO reduction relative to both Percona 5.1.53 and MySQL 5.5.8.
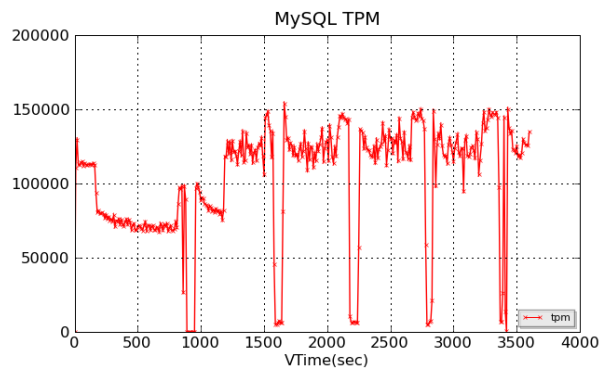
Figure 2: Performance Comparison of Schooner MySQL 3.0,
MySQL 5.5.8, and Percona 5.1.53 with Flash
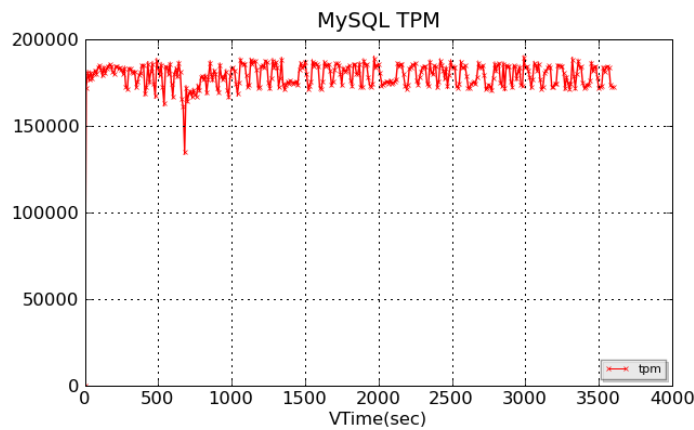
*Schooner MySQL 3.0 + 2x Fusion-io*
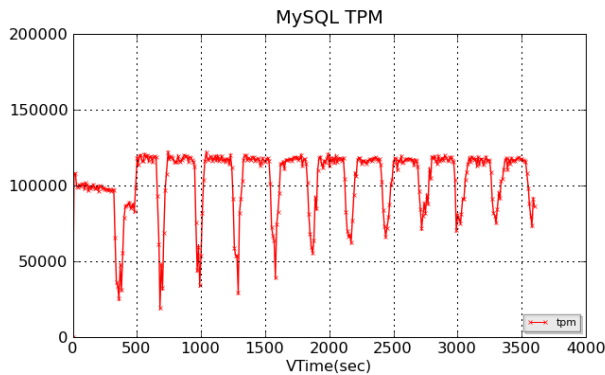
MySQL 5.5.8 + 2x Fusion-io

Percona 5.1.53 + 2x Fusion-io

Membrain: the Smart NoSQL Data Store, Based on Memcached

Membrain seamlessly integrates Schooner's high-concurrency implementation of the Memcached protocol with the SOE libraries, Linux, and commodity x86 servers and flash memory. Membrain is an enterprise-grade cache and NoSQL data store with industry-leading performance, availability, TCO, and functionality.
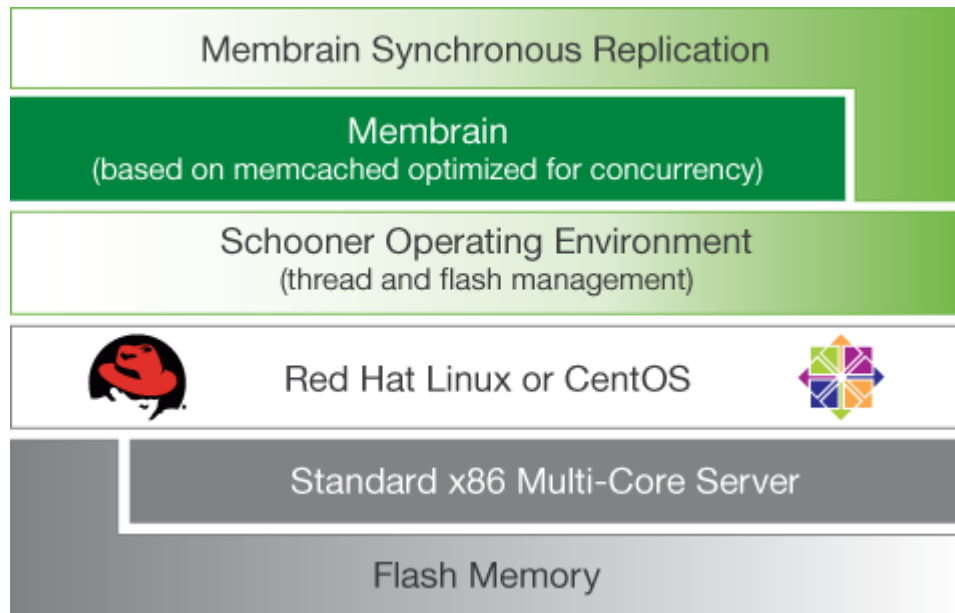
Memcached is an open-source client/server standard providing a low latency, distributed key-value store or caching service. Memcached is generic in nature, providing caching and storing of arbitrary chunks of data associated with a provided key.   Memcached is based on a standard client/server protocol which is maintained by the Memcached open-source community, which also maintains various client libraries and reference server implementations supporting the protocol, as well as management, administrative and compliance tools.

Membrain is an implementation of the standard Memcached client/server protocol, written for maximum parallelism. Membrain is 100% memcapable, including Binary Protocol, and is therefore 100% compatible with all Memcached libraries and Memcached-based client applications.

Schooner chose to use Memcached as the API for our NoSQL data store since it is a rich, mature standard. Using the familiar Memcached APIs, client applications can achieve both distributed caching operations and NoSQL key-value store operations.

Schooner Membrain offers, among other things, the following unique features:

➢ **High-performance access to unlimited, highly available, persistent-caching and key-value store with industry-leading performance, availability, TCO, and ease of administration**

  ▪ Across a broad range of commodity x86 servers and flash memory

  ▪ At much lower cost in terms of both capital expense and power and space consumption. than a DRAM-only solution and much higher performance than a hard drive-based solution

- **100% Memcached-compliant transient cache and persistent key-value store with fine-grained policy control**

    - Membrain's dynamic containers manage consolidation and policy, providing fine-grained control over cached data, with attributes controlling access policies, isolation, size, persistence, key value store vs. cache mode, and replication, individually configurable within and across servers

- **Optimal Scale Up Resulting in Industry leading Performance and TCO**

    - Consolidates typically eight or more alternative Memcached or NoSQL key-value store servers onto a single recommended server configuration, significantly reducing capital expense, power consumption, rack space, and networking requirements. Membrain's unique scale-up technology includes:

        - Fine-grained, highly concurrent and efficient multithreading and core management required to parallelize hundreds of thousands of simultaneous flash and network accesses per second

        - Highly-parallel optimized flash memory access and fast, efficient DRAM-to-flash caching algorithms to increase capacity, reduce power, and provide persistence

        - Intelligent, dynamic DRAM caching required for fast and efficient staging of both small and large objects

        - Highly efficient flash management for space and persistence management across parallel flash devices, including:

            o Mapping object keys to flash locations, employing algorithms that minimize the amount of mapping data that is kept in DRAM so that most of the DRAM can be used for caching Memcached and key-value store data;

            o Maintaining persistent metadata, enabling the preservation of Memcached data across system failures; and

            o Optimizing data placement and replacement across parallel flash devices to balance accesses, maximize effective space usage, and minimize flash wear

- **Optimal Scale-Out Resulting in Industry-leading High Availability and Dynamic Scaling**

    - Delivers comprehensive data and service availability through a rich set of High-Availability/Disaster-Recovery (HA/DR) features, including Persistent Caching, Active/Active Replication, RAID, and Backup & Restore

        o Transparent, highly optimized synchronous data replication and failover.

        o 100% consistent cluster-wide data across, including across replicated servers

        o Non-disruptive, rolling upgrades

        o RAID across SSDs

        o Full / incremental backup and restore of cached and stored data to protect against data corruption or loss;

- Dynamic data and node expansion and contraction (under development for release in 2011)

➢ **Easy Install-and-Go Usage**

- 100% compatible with all existing Memcached client libraries, applications, and tools, and fully Memcapable, making it easy to integrate into existing environments

- Advanced administrative services for deployment management, monitoring and optimization

  - Command Line Interface and GUI

  - Integration with 3rd-party management and monitoring tools

  - Hot-key management providing visibility into frequently used keys and highly active clients

- Remote presence, predictive failure analysis, and automatic restart

Schooner Membrain: Performance, Consolidation, Power, Cost and Availability Benefits

Membrain optimizes flash-memory and multi-core servers to meet the throughput and scaling requirements of Memcached and key-value store deployments at much lower cost than a DRAM-only solution, in terms of both capital expense and power and space consumption, and much higher performance than hard drive based solutions. Schooner's optimal use of commodity flash memory and multi-core servers enables the following new capabilities with Memcached:

- Order-of-magnitude increase in effective capacity per server;

- Order-of-magnitude reduction in power consumption per Memcached or key-value store operation; and

- The ability to persist data across shutdowns/power failures.

The Membrain benchmark results reported use the memslap external workload generator extended and open-sourced by Schooner and available at:

> https://code.launchpad.net/~jake-moilanen/libmemcached/memslap.

Schooner provides superior scale-up performance and scale-out availability relative to Membase. We measured Schooner Membrain 3.0 and the GA release of Membase 1.6.0.1 on a standard commodity 2U server with two socket Westmere processors, 32GB DRAM cache, and a 640 GB Fusion-io PCIe flash ioDrive. In a typical workload consisting of 95% Single Gets and 5% Sets with an average key size of 128 bytes, an average value size of 1024 bytes, and a 35% read miss rate from DRAM to flash, Schooner Membrain delivers 8 times the throughput of Membase both as a single node and a replicated key value store (Figure 3).

Figure 3: Membrain vs. Membase Key-Value Store Performance on 95% single gets:5% sets 1kB Workload
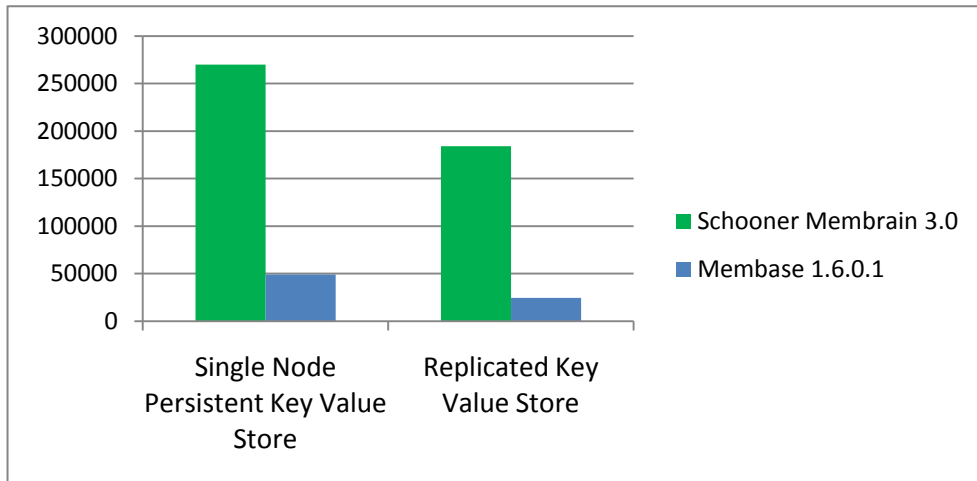
Membrain performs extremely well even when poor locality of the data requires most of the gets to be retrieved from flash rather than from DRAM. Again use a typical workload with 95% Single Gets, 5% Sets, an average key size of 128 bytes, an average value size of 1024 bytes, and varying the % of Gets that require retrieving the data from flash. When all of the Gets are resolved from DRAM, Membrain delivers 400,000 Gets and Puts per second, and still delivers 200,000 Gets and Puts per second when 70% of the reads need to be fetched from flash.

Figure 4: Key-Value Store Performance of Membrain (Per Second) (95% single Gets, 5% Sets)
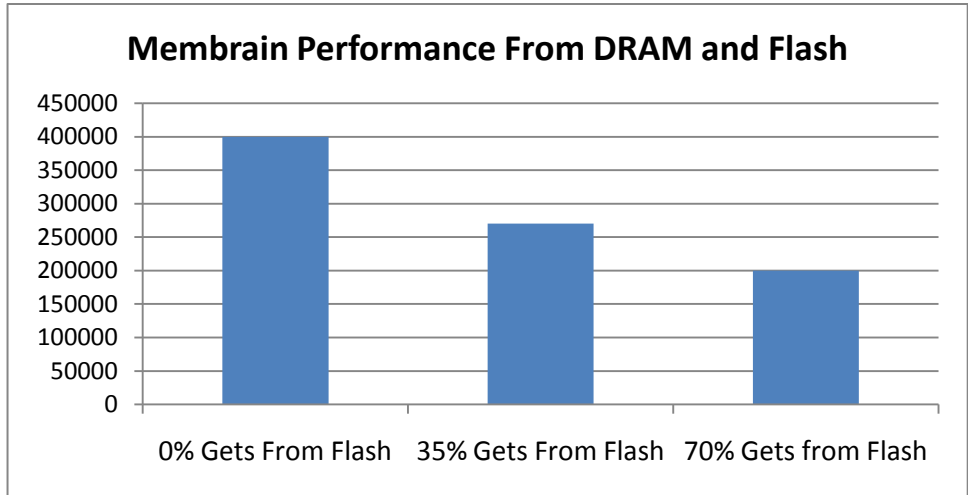
We also compared Membrain and Schooner MySQL relative to Cassandra and Mongo as key-value stores. Cassandra and Mongo per-node performance is also way below both Membrain and Schooner MySQL on both small and large data sets. Their single node performance dropped to below 4,000 TPS per node when the shard size exceeded DRAM and almost all reads had to retrieved from flash (random 1kByte single Get queries across a ½ TB key value store data set executing on a standard commodity 2U server with two socket Westmere processors, 32GB of DRAM cache,, and a 640 GB Fusion-io PCIe flash ioDrive).

| TPS/Node, Random Queries	In DRAM	In Flash
CouchDB	1,100	1,100
Cassandra	10,500	1,790
MongoDB	49,000	4,000
Schooner MySQL	115,000	101,000
Schooner Membrain	310,000	160,000

Schooner's Membrain holds the world's record in absolute key value-store performance on a single commodity server.   The test configuration consisted of a Membrain-powered commodity 2U dual socket Westmere server with 64GB of DRAM and two separate memslap client machines connected to the Membrain server via 10 GbEnet to fully loan the Membrain server. The workload consisted of a key value data set size of 32Gbyte (data set fits in DRAM) using 20 way multi-get, an average key size of 50 Bytes, and an average value size of 256 Bytes,   Schooner 's Membrain achieved *1.4 Million* key value gets per second.

Schooner's highly parallel, optimized flash-memory subsystem is able to increase effective key-value store capacity per server by an order of magnitude relative to alternative Memcached servers or key-value stores which require granular sharding and server sprawl to achieve adequate performance against the key-value data.

For example, an application may require fast performance on a total of 2TB of cache or data store. A typical Memcached or NoSQL data store server would require 32 nodes to get the required performance against the required capacity, with the client workload spread across shards in the nodes. This typically results in poor processor and network utilization (<10%). With Membrain, the entire data set can be stored on four flash-based commodity servers, with synchronous replication for high availability. This great saving is enabled by Membrain's optimal balanced use of processor and networking resources through the SOE and flash.

This consolidation results in over a 60% reduction in TCO, 90% reduction in power consumption, and increased availability:

Figure 5: Membrain's Consolidation and Power Savings Benefits through Optimal Scale-up and Scale-Out
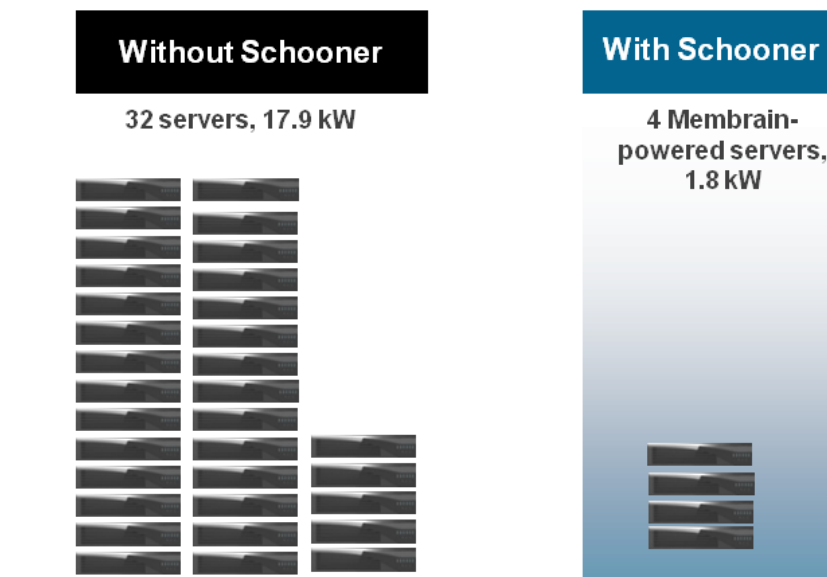
Web sites are increasingly dependent on Memcached and key-value stores to deliver application performance, and failures can lead to significantly degraded end-user experience. Membrain provides a comprehensive set of HA/DR features to ensure a consistent user experience through both planned and unplanned downtime.

Membrain's high availability is a key benefit for many of Schooner's customers. Some Schooner customers are using Membrain as their sole data repository, and for these customers availability is one of its most important benefits.

- Active/active replication fully utilizes all nodes

- No data is lost during outages, because of synchronous replication

- Automated failover delivers continuous service availability and eliminates the need for manual, error-prone user intervention

- Failover is transparent to client-side applications and requires no additional overhead

- Integrated concurrent back-up and restore

Membrain enables a spectrum of availability options for Memcached and key-value store deployments. As shown in Figure 6, Membrain's transparent synchronous replication and fail-over reduces system downtime by more than 90% when combined with Persistent Caching and SSD RAID.

Figure 6: Membrain Combines Multiple Technologies to Cut Downtime by Over 90%
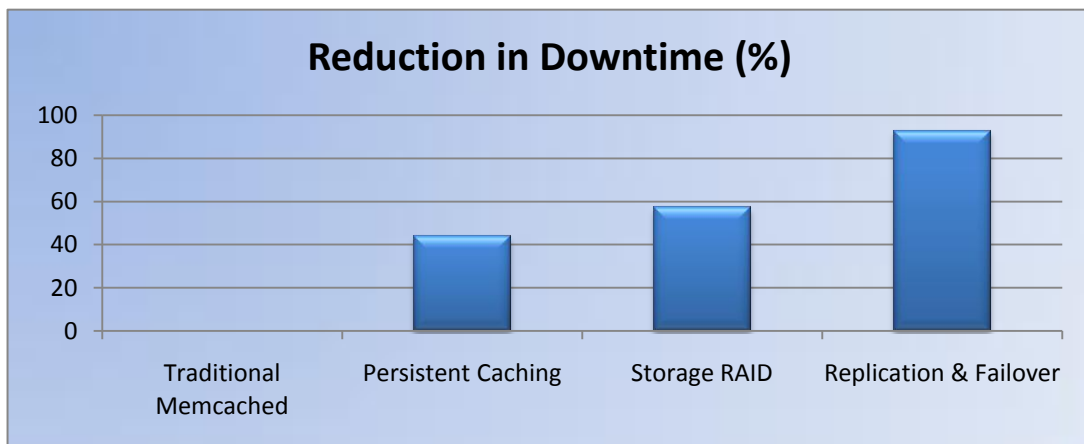
Schooner MySQL and Membrain: Available on a Wide Range of Commodity Servers and Flash Drives

Schooner MySQL and Membrain bring their benefits to a wide range of x86 servers with flash memory. The optimal choice of server and flash technology is dependent on the data center workload and quality-of-service requirements. Schooner benefits are essentially identical across recommended x86 server configurations, including those from IBM, Dell and Hewlett Packard. Flash performance and durability characteristics should be selected to maximize throughput while minimizing the cost over the required deployment lifetime.

For example, Figure 7 shows the performance of Schooner MySQL with several excellent flash choices: eight Unigen Orion 8 eMLC SSDs, two Fusion-io Duo 640 MLC PCIe ioDrives, and two LSI SLC PCIe WarpDrives. Each is on a 2U dual-Westmere server with 64GB of DRAM, running DBT-2. Schooner MySQL exploits these drives to deliver performance increases of 15-20x over traditional MySQL with hard drives.

Figure 7: MySQL Performance Comparison of Schooner 3.0 Across Flash Technologies
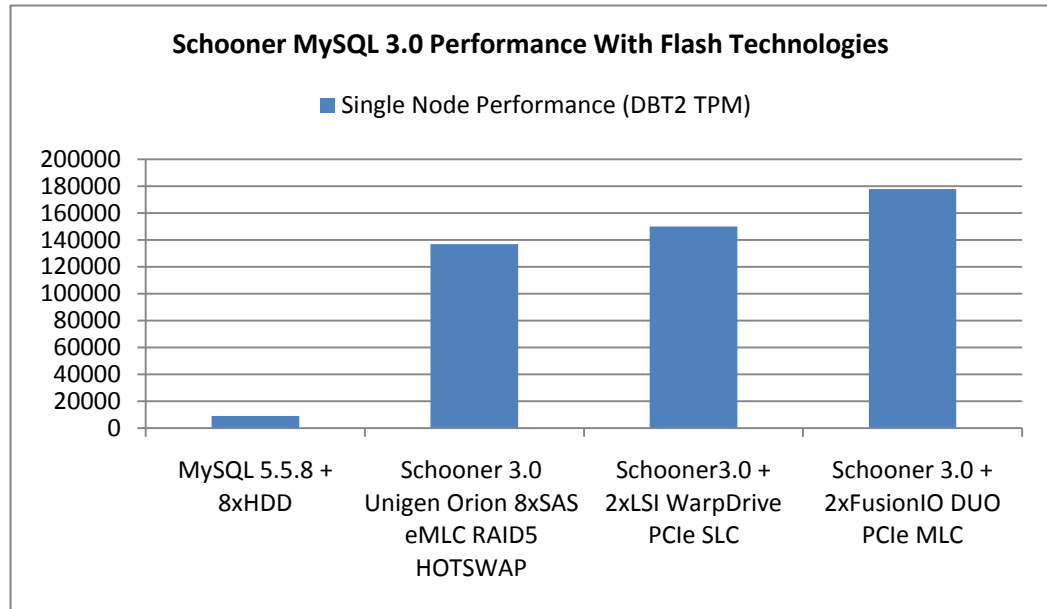
The Schooner Advantage

Schooner's sophisticated, integrated MySQL and NoSQL software products provide optimal solutions for any datacenter that needs MySQL, Memcached or a NoSQL key-value store. Schooner's solutions deliver immediate, real-world benefits:

- **Enjoy optimal scale-up**

  ➢ Vastly higher performance and capacity per servers means fewer servers: 3 – 20x better performance

  ➢ Consolidation greatly lowers your TCO: at least 50%

- **Enjoy optimal scale-out**

  ➢ Vastly higher service availability means 90% less downtime

    - Transparent enterprise-class synchronous replication and recovery

    - Backup, and online upgrades

  ➢ Dynamically vary servers, data, schemas to match changing workload

- **Simple install-and-go usage**

  ➢ Quick deployment: your choice of a wide range of x86 servers with flash drives

  ➢ Seamless operation: 100% compatible with client apps and tools

  ➢ Easy management: centralized integrated reporting

- **Generate more revenue**

  ➢ What can you do with fast, highly-available access to terabytes of consistent MySQL or NoSQL data?

What the Experts Are Saying

Mike Kahn, managing director, The Clipper Group

"While many vendors are focusing on making the datacenter more efficient, few are focusing on processing more transactions more efficiently. However, with Schooner's entry into the business of specialized processing for 21st-century Web 2.0 and cloud computing transactions, its software appliances offer the opportunity to scale quickly while maximizing performance."

Jim Watson, managing general partner, CMEA Capital

"Schooner has addressed the three biggest problems facing today's internet datacenters: cost, complexity, and energy consumption. Schooner is a game-changing solution that's right for today's economic realities. It's not technology for technology's sake. It's technology that solves real-world problems."

Peter Zaitsev, co-founder, Percona (the leading MySQL performance optimization firm)

"The large capacity and increased performance of Schooner enables significant consolidation of existing MySQL servers, as well as addressing many current MySQL industry challenges around scaling and administrative overhead."

Beth Schultz, Network World

"10 Hot Datacenter Tools: These software appliances are representative of the kind of innovation possible when SSDs, or enterprise flash memory, works its way into datacenter gear."

What Customers Are Saying

Schooner's MySQL and Membrain are driving production workloads in leading Web 2.0, SaaS, cloud, and enterprise datacenters today.

Xoom

"Our ad hoc MySQL queries run 5x faster after installing Schooner MySQL. The Schooner software delivers a huge performance benefit and is a breeze to install and manage," said Darryl Weatherspoon, VP of Engineering at Xoom.

MyLivePage

"MyLivePage aims to be the go-to source for sharing, by providing the ultimate in user-generated simplicity and community, so premium performance and load capacity is essential to maintaining MyLivePage's user experience," said Rayes Lemmens, Chief Executive Officer, MyLivePage. "Schooner is the perfect solution for any MySQL enterprise whose business success requires great performance, exceptional reliability and the ability to smoothly scale the datacenter as demand increases. Schooner helps us create a new wave of social networks, bringing technology that helps us create and sustain social communities like never before — efficiently, effectively and effortlessly."

Holzbrinck

"In our business, website performance and efficiency is the key to the success of our web properties and website performance is heavily driven by SQL and Cache performance. Schooner software has significantly helped GuteFrage.net improve their overall website response time while at the same time allowing them to reduce their hardware footprint by consolidating several of their database slaves. This dramatically reduces the effort necessary for administration," said Frank Penning, CTO of Holtzbrinck Digital.

Flixster

Flixster, the world's biggest online movie community, recently experienced growing pains while deploying 12 traditional Memcached servers. While supporting the company's growth, this expansion introduced significant server sprawl, low capacity utilization and decreased performance for such tasks as processing video- and photo-intensive content simultaneously. To address these issues, Flixster chose the initial version of Schooner Membrain on an IBM x86 8-core server with 512 GB of flash memory. Now, the company is more cost-effectively scaling its caching tier, reducing operating expenses and consolidating the existing 12 Memcached solutions into a single, high-capacity, high-performance Schooner-powered flash-enabled server.

"Power is the biggest constraint right now in datacenters, so anything we can do to reduce that footprint is essential," said Saran Chari, CTO and Founder at Flixster. "From an administrative perspective, fewer machines mean a reduction in monitoring and scripting; and from an operating standpoint, fewer, bigger boxes are always preferred. We used to think of Memcached as a space-constrained resource. However, after installing Schooner , we now view it as an unconstrained resource that enables more use cases, such as incorporating higher-order objects in the caching tier."

Plaxo

Plaxo, which operates the largest and fastest growing network of personal address books, was on the verge of purchasing 10 64-GB traditional Memcached servers when it saw the many problems posed by this approach to expanding its caching tier. Determined to avoid the escalating operating costs from the rack space and power increases from additional servers, Plaxo instead deployed two replicated Schooner-powered NoSQL servers to support its online, blog, photo and information sharing capabilities for its 40 million members, and to add full redundancy. The Schooner-powered servers integrated seamlessly, cutting Plaxo's operating costs and power consumption, and enabling Plaxo to deliver faster, high-performance services to its growing user community that relies on fast access to all of the address book data.

Plaxo was able to simplify its application development thanks to Schooner. The developers did not need to spend as much time programming defensibility within applications to compensating for the shortcoming of Memcached when deployed on traditional servers. By minimizing the need to code around Memcached deficiencies, the Plaxo team can focus on creating new services and adding more value to existing offerings, to increase potential revenue streams.

"It is refreshing that Schooner listens to customers' needs, specifically asking about use cases and how they would like to benefit," said Ethan Erchinger, director of operations at Plaxo. "In a Schooner environment, application development is simplified, reducing the amount of time we need to spend coding around

Memcached deficiencies. Additionally, Plaxo utilizes Schooner's built-in replication feature in order to guarantee minimal misses, which were typically produced when dealing with a large number of servers."

How to Start Scaling Smart Today

- If you have servers and flash, just download our software for a free trial

- If you have servers but need flash, first buy a flash upgrade kit from one of our flash partners (including FusioIO, Unigen or LSI) , or order flash on a trial

- If you need fully configured servers, contact one of our SI partners and they'll get you going

- If you need MySQL consulting, contact our consulting and support partners

- If you have questions, contact Schooner: we're always here to help you get there!

About Schooner Information Technology

Schooner MySQL and Schooner Membrain are software products which turn standard x86 servers and flash memory into MySQL database or NoSQL data store super-servers. Schooner brings the datacenter scaling without the sprawl, minimal downtime, and optimal performance. Schooner maximizes datacenter efficiency by slashing the need for servers and the power, pipe, and people to run them. Schooner products outperform hard-drive-based solutions by 10x and other flash-based solutions by 2x - 3x. Datacenters scale smart with Schooner to handle way bigger loads with way fewer nodes. Schooner is privately held and based in Sunnyvale, California. Learn more at www.schoonerinfotech.com.