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MySQL Cluster Carrier Grade Edition: Building a Carrier-Grade Platform for Telecom Data Management

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Introduction

The convergence of communication networks onto one that is IP based is revolutionizing today's telecommunications industry. Communication service providers (CSPs) are challenged to deliver compelling, personalized services with greater agility and lower costs than ever before. The very survival of CSPs depends on their ability to generate new revenue streams and increase average revenue per user (ARPU), while at the same time delivering significant improvements in operational efficiency and time to market.

Network and IT infrastructure used for service delivery has traditionally been based on proprietary hardware and software, either developed in-house or supplied by highly specialized proprietary vendors. The challenge this has presented to network equipment providers (NEPs) and CSPs is that the infrastructure is inflexible and carries a high total cost of ownership (TCO).

In addition to the challenges described, risk of vendor lock-in and the need for interoperability through open APIs have driven the migration to standards-based hardware and open source software for new carrier-grade systems used in next-generation networks. This white paper refers to such systems as "open source, carrier-grade platforms."

The drive to adopt open architectures extends into a core enabler of network convergence and service delivery: the database. Whether service providers are looking to deploy new telco and Web 2.0 applications to mobile internet users or consolidating subscriber data within the network to support greater service personalization and targeted advertising, the database plays a key enabling role.

These databases must make information available to new and existing applications to maximize interoperability and streamline operations. It is this trend that puts even more demands on the availability, scalability, and performance of the database. Real-time, carrier-grade databases with dynamic scalability, flexible data access methods, broad platform

support, and simplified administration are crucial to meet the demands of many of these new communication services.

With the rapid shift from closed, expensive, and proprietary technology, MySQL has grown to become the world's most popular open source database. This white paper explores how an open source, carrier-grade platform is able to cost-effectively meet the communication industry's high availability, scalability, and real-time performance requirements. At the same time, the issues of cost and interoperability with established and emerging technology standards are discussed. The document examines the unique architecture and features of MySQL Cluster Carrier Grade Edition, and how they can help both equipment manufacturers and service providers overcome some of the biggest challenges facing their industry today.

Challenges Facing the Telecommunications Industry

As a result of intense competition, CSPs—those in fixed line and wireless voice and data communications, as well as cable companies and ISPs—are being forced to operate more efficiently. However to grow their revenues, they must be able to increase their ARPU and accelerate customer acquisition by rapidly delivering new value-added content and services to their subscribers. They must also enhance their quality of service to reduce customer turnover.

Business Challenges

The market conditions listed above have led to a host of business and technical challenges, which organizations must address to remain profitable and competitive.

- Intense competition from direct and indirect competitors in the value chain
- Global economic uncertainty driving significant reductions in capital and operating expenses
- An accelerating pace of mergers, acquisitions, and consolidation
- Diminishing customer loyalty and increased customer turnover
- Collapsing margins, requiring product and operational efficiency
- Need for the rapid introduction of new products and services
- Lower-cost vehicles for entering emerging markets
- New partnerships and business models with application and content providers

Technical Challenges

Business challenges, in turn, create technical challenges for the development, network, and IT groups within service providers.

- Opening up of networks and service delivery platforms (SDPs) to new technology and business partners
- Migrating existing applications to standards-based open source technology stacks and commodity off-the-shelf systems
- Real-time data management
- Rapid development, deployment, and upgrading of database-driven applications
- Seamless scalability from several thousands to more than 100 million subscribers or transactions
- Reducing integration costs and increasing interoperability by adopting open standards
- Maintaining maximum uptime and scalability without sacrificing performance
- Centralized and unifying data stores containing subscriber and network operational data

"We view MySQL Cluster Carrier Grade Edition as a strategic technology in our applications portfolio, enabling our customers to expose the rich capabilities of their networks to drive a long-tailed innovation model. As a result, the operator can leverage the creativity and agility of the Web ecosystem to deliver new compelling, personalized, and targeted services to their subscribers without compromising reliability and scalability."

—Jeff Cortley, Vice President, Subscriber Data Management, Alcatel-Lucent

Open Source, Carrier-Grade Platform Architecture

Budgetary constraints, eroding margins, and fierce competition are forcing CSPs to meet demands for new services in a more cost-effective manner than can be achieved with the continued use of rigid, proprietary architectures, which dominated the industry in previous years. These proprietary hardware and software systems demanded high acquisition and running costs. Extending these systems with the new functionality being demanded to accelerate service delivery is also proving to be a challenge. For many organizations, developing and maintaining in-house systems is simply a technological dead end and cost prohibitive.

The rapid development and maturity of today's commodity hardware and open source software—driven by cross-industry standards bodies, vendors, and user communities—have relegated that old proprietary model to history. Commodity hardware and open source software are now proven to deliver greater flexibility with carrier-grade performance and availability at a fraction of traditional prices, running the most mission-critical workloads in communication networks and IT systems.

Adopting an open source, carrier-grade platform architecture enables NEPs and CSPs to reduce costs, risks, and time to market at every stage of the service lifecycle, from development through deployment to management, upgrade, and retirement.

The pervasiveness of open source frameworks—such as the LAMP stack (Linux, Apache, MySQL, PHP/Perl/Python) and Java—provides access to an immense pool of ready-made application development skills and all the tools needed to embark on new projects, while eliminating costly up-front licensing fees. Commodity hardware systems, now supporting much-higher levels of scalability than ever before with multicore, multithread CPU architectures, are available at a fraction of the cost of traditional proprietary symmetric multiprocessing systems.

Support and maintenance costs of open source, carrier-grade platform architectures are significantly lower than proprietary systems—ensuring that both capital costs and TCO are minimized.

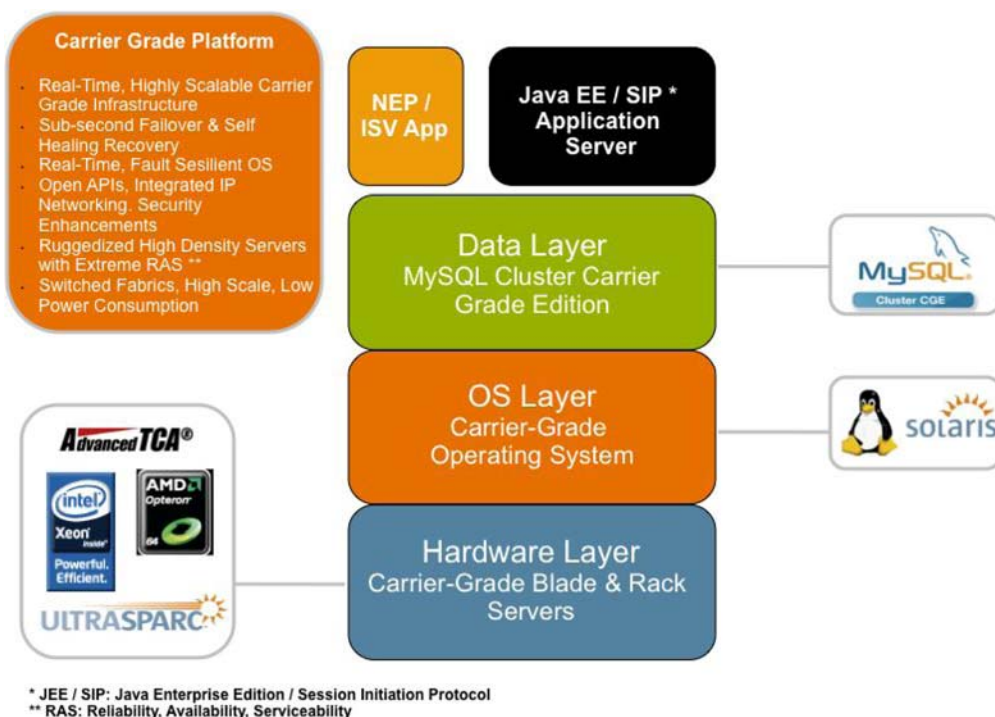


Figure 1. An open source, carrier-grade platform architecture provides a standardized approach to building highly available service delivery infrastructures.

The framework previously described is a generic platform, designed as a starting point for the delivery of a diverse range of communication services. It enables components to be substituted, modified, or reused to meet specific operational and business requirements.

This flexibility is an important differentiator because traditional vertically integrated solutions involved significant re-engineering to accommodate any type of modification.

With the increasing demand for new services, new features, and higher transaction and data volumes, a horizontally layered platform—such as the one described above, comprising individual tiered components based on open source and industry-standard components—enables unprecedented levels of infrastructure agility. This is especially important as the typical seven-year planning cycles for capital expenditure and ROI within the telecommunications industry is reduced to as little as six months.

Each layer is isolated to allow maximum flexibility but is also built on open interfaces, enabling easy integration within the stack and without sacrificing performance or availability requirements. With the applications and their associated services (that is, databases) being cross-platform, they can be designed without specific hardware or operating system (OS) platforms dictating functionality. The hardware and OS can be selected late in the development cycle and can be scaled horizontally or vertically, depending on application requirements.

Within this open source, carrier-grade platform architecture, network and IT data can be centralized and accessed via multiple interfaces by different application servers, authentication mechanisms, network elements, and call control services. Such an approach significantly reduces the cost and effort

of maintaining multiple, disparate data stores, while accelerating time to market of new data-driven services. More important, it allows operators to generate a more-complete view of their subscribers, providing significant opportunity to cross-sell and up-sell new offerings, while enabling the development of new, advertising-funded business models.

An open source, carrier-grade platform architecture is perfectly aligned to the challenges of today's communications industry. Delivering reduced cost and risk, eliminating vendor lock-in, and providing unprecedented levels of flexibility and reusability, all while maintaining carrier-grade capabilities, NEPs and CSPs can accelerate time to market while transforming their internal cost models.

An Introduction to MySQL Cluster Carrier Grade Edition

MySQL Cluster Carrier Grade Edition is a real-time, distributed database combining the flexibility of a highly available relational database with the low TCO of open source.

"Telenor has been using MySQL for fixed IP management since 2003 and is extremely satisfied with its speed, availability, and flexibility. Now we also support mobile and LTE [Long Term Evolution] IP management with our solution. Telenor has found MySQL Cluster to be the best-performing database in the world for our applications."

—Peter Eriksson, Manager, Network Provisioning, Telenor

Featuring a "shared-nothing" distributed architecture with no single point of failure, MySQL Cluster Carrier Grade Edition is designed to deliver five 9s availability demanded by carrier-grade network and telecommunications services.

The real-time design of MySQL Cluster Carrier Grade Edition delivers predictable, millisecond response times with the ability to service tens of thousands of transactions per second. Support for in-memory and disk-based data, automatic data partitioning with load balancing, and the ability to add nodes to a running cluster with zero downtime enables linear database scalability to handle the most unpredictable Web-based workloads.

MySQL Cluster Carrier Grade Edition is already proven in the toughest telecommunications environments, delivering higher database throughput and faster response times at 10x lower cost than proprietary, clustered, shared-disk databases, with the added benefit of running on commodity hardware and operating systems.¹ Customers include Alcatel-Lucent, Cisco, Deutsche Telekom, Ericsson, Telenor, and UTStarcom.

¹ mysql.com/why-mysql/case-studies/mysql-cs-alcatel.php

Specifically Designed for Communications Services

MySQL Cluster Carrier Grade Edition began as a technology acquired from Ericsson in 2003. The design objective was to provide a high-availability data management system specifically for telecom applications and IP network environments.

In 2004, MySQL announced the general availability of MySQL Cluster 4.1 and, in 2007, created an additional offering called MySQL Cluster Carrier Grade Edition. Over this time, MySQL has continually evolved the product with an extensive range of new capabilities, including

- Multithreaded execution
- Geographic replication of clusters
- SQL, Java / Java Persistence API (JPA), LDAP, and Web services data access
- Mixed memory and disk-based tables
- Real-time extensions
- Online addition of new nodes and automated recovery

Collectively, these new capabilities have enabled MySQL Cluster Carrier Grade Edition to deliver enhanced performance, scalability, availability, and flexibility to a broader range of environments and applications.

Applications That Can Benefit Most from MySQL Cluster Carrier Grade Edition

"We decided to use MySQL for our products because we found that it had widespread, proven deployments—and met our stringent reliability and scalability requirements for the communications industry."

—Franco Serio, Italtel

MySQL Cluster Carrier Grade Edition is being widely deployed for an extensive range of next-generation services over converged IP networks—including subscriber and equipment databases, SDPs, and value-added services such as the following:

- Subscriber databases (home location register / home subscriber server)
- Telecom application servers
- AAA, RADIUS, and Diameter servers
- Broadband access and hosting services
- Call completion services
- IP Multimedia Subsystem application services
- Intelligent network nodes
- IPTV and video on demand
- LDAP data stores

- Location-based services and presence management
- Message stores
- Pre- and postpayment processing and validation
- SDP service execution environments
- Softswitches
- Value-added services
- VoIP systems
- Wireless access services

Advantages of MySQL Cluster Carrier Grade Edition

With MySQL Cluster Carrier Grade Edition deployed as the database component within a carrier-grade architecture, the most demanding requirements for converged communications services can be met, as shown in the table.

MYSQL CLUSTER CARRIER GRADE EDITION MEETS THE TOUGHEST CHALLENGES OF CONVERGED COMMUNICATIONS SERVICES

REQUIREMENT OF ONLINE APPLICATION	MYSQL CLUSTER CARRIER GRADE EDITION CAPABILITY
Carrier-grade availability	<ul style="list-style-type: none"> • Support for atomicity, consistency, isolation, durability transactions • Distributed shared-nothing architecture • Synchronous data replication • Automated subsecond failover • Automatic recovery and data synchronization • Local and global checkpoints to disk for durability • Geographic replication between clusters • Online upgrades • Online add nodes • Online backup • High-availability consulting • 24/7 technical support • Professional training and certification
Performance and scalability	<ul style="list-style-type: none"> • Hybrid in-memory and disk-based storage • Parallel server architecture for high read/write performance • Automatic data partitioning enabling load balancing • Distributed database for scaling out • Multithreaded data nodes for scaling up • Online add nodes for on-demand scaling

Interoperability	<ul style="list-style-type: none"> • World's most popular open source database • Support for multiple hardware platforms and OSs • SQL, Java/JPA, C++, LDAP, and Web services data access • Support for full range of MySQL Connectors
Low TCO	<ul style="list-style-type: none"> • Open source freedom, standards, and economics • Low-cost service offerings • Commodity hardware: NEBS-certified racks and ATCA blades • Eliminates costly shared storage • Minimized design complexity and maintenance

MySQL Cluster Carrier Grade Edition Architecture

MySQL Cluster Carrier Grade Edition is a high-availability database, which leverages a shared-nothing data storage architecture. The system consists of multiple nodes that can be distributed across hosts to ensure continuous availability in the event of a data node, hardware, or network failure. MySQL Cluster Carrier Grade Edition uses a storage engine, consisting of a set of data nodes to store data, with data accessed through either native APIs (C++, Java/JPA, LDAP, HTTP) or a standard structured query language (SQL) interface implemented by the MySQL server.

MySQL Cluster Carrier Grade Edition can tolerate the failure of multiple data nodes and reconfigure itself on the fly to ensure no data loss. These recovery capabilities, as well as the transparency of data distribution and partitioning from the application layer, result in a simpler programming model that allow developers to easily include high availability in their applications—without coding complex, low-level failover, or data resynchronization operations.

MySQL Cluster Carrier Grade Edition supports the ability to perform many administrative tasks online without affecting service, such as scaling processing and data storage, performing backups, updating database schemas, and upgrading hardware and software within the cluster.

MySQL Cluster Carrier Grade Edition requires no additional infrastructure, such as shared storage, and runs on a range of commodity hardware and OS platforms, making it the most open and cost-effective database solution for mission-critical applications anywhere.

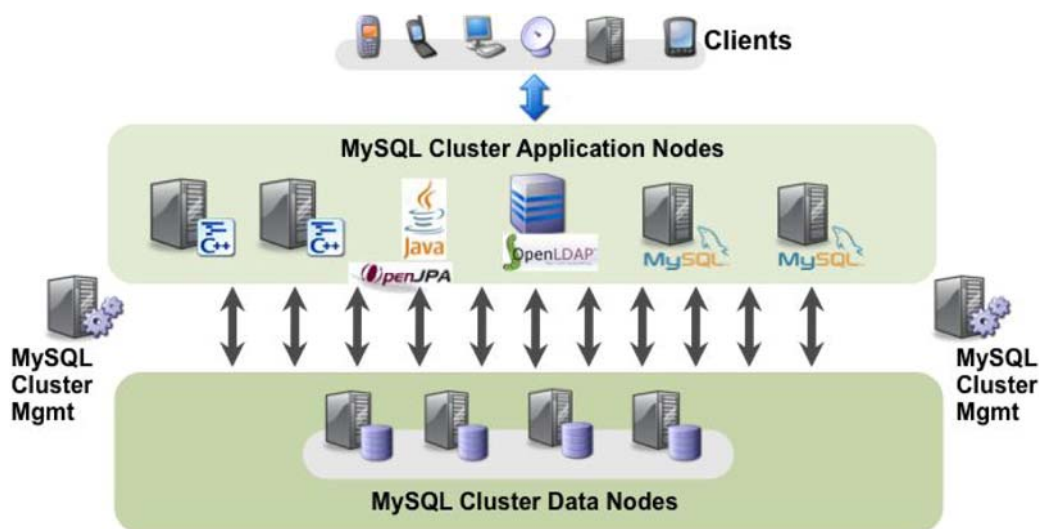


Figure 2. The MySQL Cluster Carrier Grade Edition architecture delivers carrier-grade availability and performance, without the traditional carrier-grade price.

MySQL Cluster Carrier Grade Edition consists of three different types of nodes, each providing specialized services within the cluster: data nodes, application nodes, and management nodes.

Data nodes are the main nodes of the cluster, providing the following functionality:

- Data storage and management of both in-memory and disk-based data
- Automatic and user-defined partitioning of data, even as new nodes are added to a running cluster
- Synchronous replication of data between data nodes using a two-phase commit protocol
- Transactions and data retrieval
- Automatic failover
- Resynchronization after failure

If a data node happens to fail, there will always be at least one additional data node storing the same information, because data is distributed in a shared-nothing architecture, and synchronous replication with a two-phase commit protocol is supported. This enables requests and transactions to continue to be satisfied without interruption. Data nodes can also be added online, allowing for unprecedented scalability of data capacity and processing.

Application nodes are responsible for connecting applications to the data nodes. This can take the form of an application embedding the high-performance NDBCLUSTER (NDB) or Java APIs, or they can connect to MySQL servers, which provide an SQL interface into the data stored within the cluster. Thus, applications can simultaneously access the data in MySQL Cluster Carrier Grade Edition using a rich set of interfaces with any updates to the underlying data instantly accessible to any application node accessing the cluster. Application nodes can also be added online without disrupting service from the cluster.

Management nodes are responsible for managing the cluster and making cluster configuration information available to other nodes. The management nodes are used at startup and when there is a system reconfiguration. Management nodes can be stopped and restarted without affecting the ongoing execution of the data and application nodes. By default, the management nodes also provide arbitration services in the event of a network failure, leading to a “split-brain” scenario or a cluster exhibiting network partitioning.

With this distributed architecture, where dependencies have been minimized, applications continue to run and data remains consistent, even if any one of the data, application, or management nodes fails.

Dramatically Lower Total Cost of Ownership

As previously discussed, as a key enabler to accelerated time to market and reduced costs, NEPs and CSPs are rapidly migrating toward commodity hardware, especially that which is based on Advanced Telecommunications Computing Architecture (ATCA). MySQL Cluster Carrier Grade Edition is specifically designed for commodity hardware, including rack and blade servers equipped with Intel, AMD, and SPARC processors running a range of industry-standard OSs.

“MySQL Cluster delivers carrier-grade levels of availability and performance with linear scalability on commodity hardware. It is a fraction of the cost of proprietary alternatives, allowing us to compete aggressively, and enabling operators to maximize their ARPU.”

—Jan Martens, SPEECH DESIGN Carrier Systems GmbH

The shared-nothing architecture of MySQL Cluster Carrier Grade Edition eliminates the cost of centralized data storage, or a storage-area network (SAN), which requires dedicated hardware and introduces a single point of failure. Furthermore, to eliminate this single point of failure, a shared-disk architecture requires even more hardware for the SAN to effectively fail over.

MySQL Cluster Carrier Grade Edition is available under open source licenses, allowing developers to download and start building their next-generation services without the usual costs and time to market delays traditionally associated with closed source software. Consulting services, 24/7 technical support, and affordable licensing for MySQL Cluster Carrier Grade Edition are all available at a fraction of the cost of proprietary solutions.

“MySQL Cluster Carrier Grade Edition is a product of high quality, extremely robust, and meets our demands in terms of performance and high availability. We evaluated shared-disk clustered databases but the cost would have been at least 10 times more.”

—Francois Leygues, Alcatel-Lucent

Running MySQL Cluster Carrier Grade Edition on commodity hardware systems has enabled both NEPs and CSPs to radically transform their development cycles and cost models to accelerate the delivery of new services while improving ARPU with increased margins.

The architecture of MySQL Cluster Carrier Grade Edition is designed to deliver five 9s availability, which includes both regularly scheduled maintenance operations as well as system failures—planned and unplanned downtime.

This level of availability is achieved via a distributed, shared-nothing architecture and by synchronous replication of data, which automatically propagates transaction information to all appropriate data nodes before completing the transaction. If one or more database nodes fail during a transaction, the application simply retries the transaction and the remaining data nodes will successfully satisfy the request.

The advantage of synchronous replication is that it eliminates the time consumed by shared-disk architectures recreating and replaying log files in order for the application to fail over.

MySQL Cluster Carrier Grade Edition detects any failures instantly, and control is automatically failed over to other active nodes in the cluster, without interrupting service to the clients. In the event of a failure, the MySQL Cluster Carrier Grade Edition database nodes are able to automatically restart, recover, and resynchronize themselves with the active cluster, all of which is completely transparent to the application. See Figure 3.

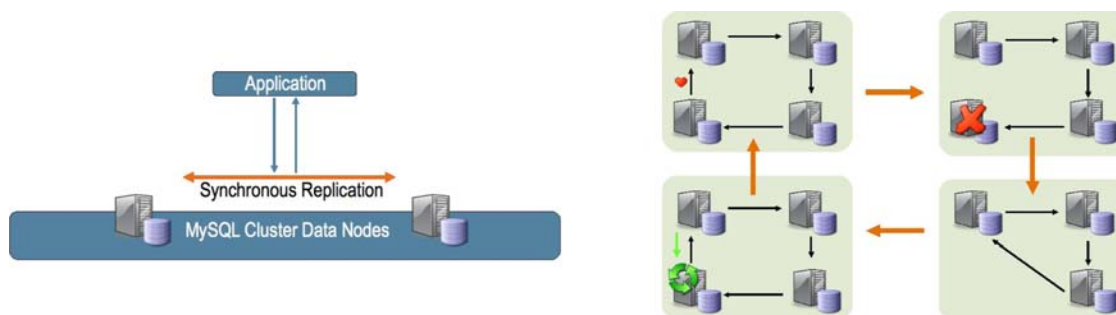


Figure 3. MySQL Cluster Carrier Grade Edition automates fault detection, failover, and recovery to provide a fully self-healing cluster environment.

If all nodes fail due to a complete power failure or multisystem hardware failure, MySQL Cluster Carrier Grade Edition ensures that an entire system can be safely recovered to a consistent state. This is achieved by replaying a log, which contains all operations (inserts, deletes, updates) necessary to get the data node back online and up to date. This log is stored on the file system of each data node. A local checkpoint protocol is used to create a transaction-consistent snapshot of all the data on disk.

To further support continuous operation, MySQL Cluster Carrier Grade Edition has the ability to add nodes online to a running cluster by automatically repartitioning data as new node groups are added, ensuring the cluster maintains continuous operation and application connectivity. MySQL Cluster Carrier Grade Edition also enables online updates to a live database schema, in addition to upgrades and maintenance to the underlying hardware and software infrastructure. The ability to withstand site failures by replicating clusters across multiple remote locations is an important capability for many deployments. Geographic replication is available with MySQL Cluster Carrier Grade Edition and ideally suited to network operators servicing a distributed subscriber base from multiple datacenters.

"Since deploying our latest AAA platform, the MySQL environment has delivered continuous uptime, enabling us to exceed our most stringent SLAs [service-level agreements]."

—Geoff Mitchell, Network Engineer, Plusnet PLC

Figure 4 shows how MySQL Cluster Carrier Grade Edition fits into a service-centric architecture, including the use of geographic replication for high availability across multiple sites.

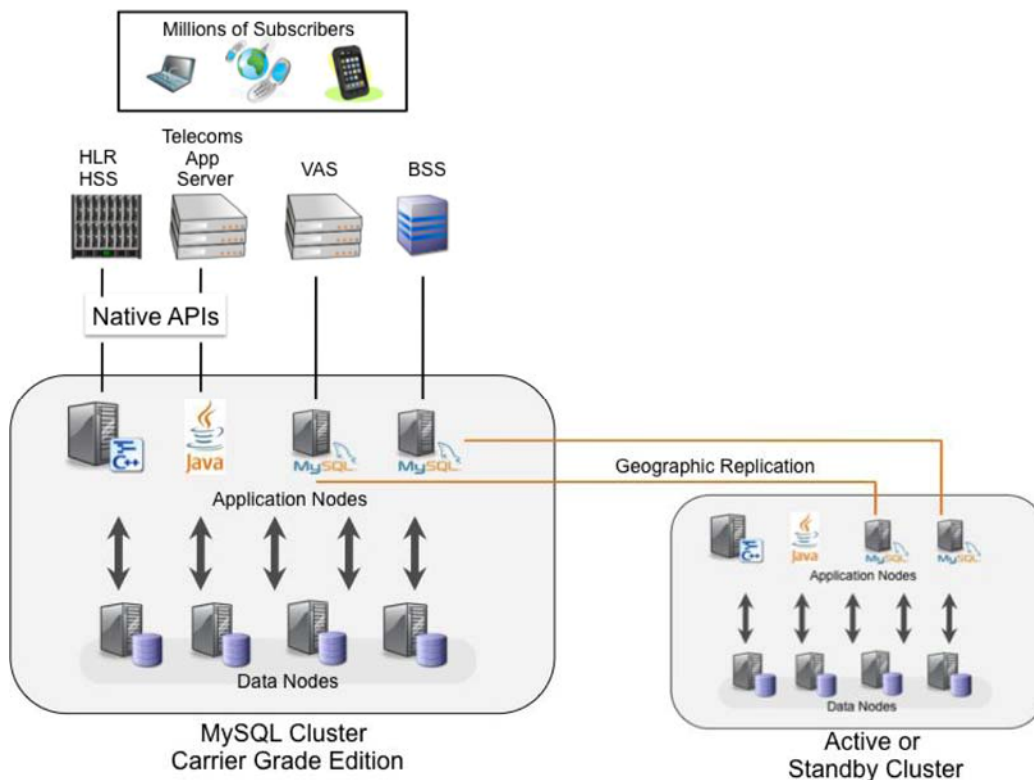


Figure 4. Geographic replication delivers five 9s database availability across remote locations.

Through the previously described capabilities, MySQL Cluster Carrier Grade Edition is able to eliminate both planned maintenance and unplanned downtime to support your most mission-critical applications.

Performance and Scalability

In addition to five 9s availability, high performance is a critical requirement to accommodate the massive volumes of database requests and transactions typically associated with communications services. Database performance requirements are typically tens of thousands of requests per second, with a consistent response time latency of just a few milliseconds. These performance requirements need to be met while still maintaining carrier-grade levels of availability.

As a distributed database, MySQL Cluster Carrier Grade Edition employs a parallel server architecture with multiple active master nodes. This ensures transactions (both reads and writes) can be load balanced and automatically scaled across multiple SQL servers and application nodes simultaneously, with each node able to access and update data stored by any data node in the cluster.

Another way in which communications services improve their performance is through the use of native data access available through the Network Database (C++), Java/JPA, LDAP, and HTTP APIs that provide applications with the fastest and lowest-level data access available by eliminating transformations into SQL.

MySQL Cluster Carrier Grade Edition offers a flexible architecture with the ability to store both indexes and data in memory or data on disk. As a result of this in-memory characteristic, MySQL Cluster Carrier Grade Edition is able to limit disk-based I/O bottlenecks by asynchronously writing transaction logs to disk, thereby maintaining real-time performance.

MySQL Cluster was recently benchmarked using the DBT2 test suite and achieved 251,000 transactions per minute with just four data nodes.² Each transaction involved approximately 30 database operations, and MySQL Cluster was able to sustain approximately 125,000 operations per second with an average response time of just three milliseconds. See Figure 5. These performance increases represented a 4x improvement in scalability over previous versions of MySQL Cluster.

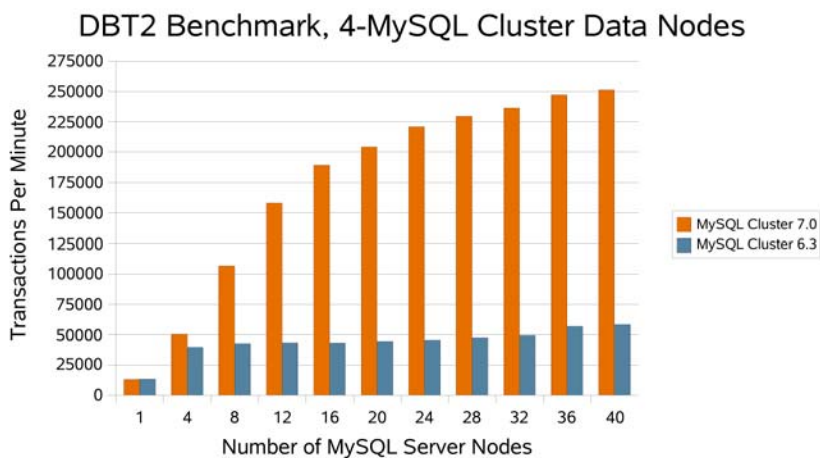


Figure 5. MySQL Cluster achieves 251,000 transactions per minute or 125,000 operations per second with an average latency of 1.5 ms.

Note: More than one MySQL server node was installed on each physical server, with a number of the server instances used as load generators to the MySQL Cluster database. An alternative deployment could use multiple connections from each MySQL server, which would have resulted in fewer MySQL server nodes being used.

In addition to scaling performance, MySQL Cluster Carrier Grade Edition can be deployed into a range of scaling scenarios. The distributed architecture enables it to be easily scaled across multiple low-cost servers. Using the latest multithreaded data nodes, MySQL Cluster Carrier Grade Edition can be used in server architectures equipped with multiple cores and threads. MySQL Cluster Carrier

²Hasham Pathan, MySQL Cluster Database 7: Performance Benchmark, blogs.sun.com/hasham/entry/mysql_cluster_7_performance_benchmark.

Grade Edition supports the addition of nodes to a running cluster without interruption to the applications or users, enabling it to handle the most unpredictable and volatile workload demands of Web-based applications.

With support for up to 255 nodes, network operators have the flexibility to start small and make incremental investments to increase capacity as service adoption and revenue streams grow. This eliminates the need for a large initial hardware and software investment in what tends to be overpowered and costly configurations.

Through the combination of a distributed, parallel server architecture coupled with in-memory index and data support and choice of scaling options, MySQL Cluster Carrier Grade Edition is highly suited to demanding, transaction-intensive communications services.

“Paggo would not have been possible without MySQL Cluster. No other product would have given us the ability to start small, scale quickly, and provide 24/7 availability for our financial payment system over mobile networks.”

—Cicero Torteli, Founder, Paggo

Flexible Data Access

Application developers can easily integrate new and legacy applications using their preferred database independent method. MySQL Cluster Carrier Grade Edition provides multiple data access methods that work together. These include SQL and native APIs such as C++, Java, LDAP, and Web services.

Designed for Java developers, the new MySQL Cluster Connector for Java implements a high-performance and easy-to-use native Java interface and OpenJPA plug-in that directly maps Java objects to relational tables stored in the MySQL Cluster Carrier Grade Edition database.

By eliminating data transformations into SQL, users get lower data access latency and higher throughput. In addition, Java developers have a more-natural programming method to directly manage their data, with a complete, feature-rich solution for object-relational mapping. As a result, the development of Java applications is simplified with faster development cycles, accelerating time to market for new services.

The OpenLDAP Driver for MySQL Cluster enables the OpenLDAP directory server to use the MySQL Cluster Carrier Grade Edition database as its back-end data store.³ As a result, operators can leverage standard LDAP interfaces for the authentication and authorization of devices and subscribers with real-time performance and carrier-grade availability.

³For more information on MySQL Cluster features, visit mysql.com/products/database/cluster/features.html#data_ldap.

By providing a range of data access methods, developers can select an API that best fits their development and application requirements. It also allows a single instance of MySQL Cluster Carrier Grade Edition to service a range of applications that previously would have required their own local database.

"Many of our users rely on OpenLDAP to run their most critical directory services, and with the addition of MySQL Cluster at the back end, can support highly dynamic and scalable directory databases. The release of MySQL Cluster 7.1 can enhance manageability and platform choice for our communities and customers."

—Marty Heyman, CEO of Symas and OpenLDAP Project Member

Simplified Management and Monitoring

Based on industry research, staffing and downtime account for almost 50 percent of a database's TCO.⁴ At the same time, IT budget and staffing levels are declining or flat, while demand for IT services continues to increase. Simplified management and monitoring tools for MySQL Cluster Carrier Grade Edition help to address these challenges by

- Maximizing administrator productivity with tools to manage database clusters more efficiently
- Minimizing database downtime caused by human error
- Monitoring real-time usage statistics to ensure seamless database operations

Management and monitoring tools for MySQL Cluster Carrier Grade Edition serve to reduce database TCO and create a more-agile, highly available IT environment by slashing management complexity, increasing administrator efficiency, and reducing the risk of downtime.

MySQL Cluster Manager

The manager feature in MySQL Cluster simplifies the creation and management of MySQL Cluster Carrier Grade Edition by automating common management tasks. As a result, DBAs and system administrators are more productive and available to focus on strategic IT initiatives that support the business and respond more quickly to changing user requirements. At the same time, risks of database downtime, which previously resulted from manual configuration errors, are significantly reduced.

⁴IDC, *Maximizing the Business Value of Enterprise Database Applications*.

As an example, management operations requiring rolling restarts of a MySQL Cluster database that previously demanded 46 manual commands⁵—and which consumed 2.5 hours of DBA time⁶—can now be performed with a single command. They are fully automated, which reduces

- Complexity of management and overhead
- Custom scripting of management commands
- Risk of downtime through the automation of configuration and change management processes

The manager feature, included with the commercial MySQL Cluster Carrier Grade Edition, is also available for a 30-day evaluation, allowing administrators to experience the benefits of automated cluster management, with no risk, cost, or obligation.

You can learn more about the manager feature at mysql.com.

NDBINFO

NDBINFO presents real-time status and usage statistics from the MySQL Cluster data nodes as SQL tables and views, providing developers and administrators a simple and consistent means of proactively monitoring and optimizing database performance and availability.

NDBINFO makes it simple to perform the following:

- Monitor resource consumption against configured limits, including the consumption of data and index memory, along with buffers and log spaces. This approach ensures administrators can reconfigure resources or optimize their tables before performance or availability is impacted.
- Expose statistics on database operations including transactions, reads, writes, table and range scans, and aborts. These statistics can be especially useful to developers in optimizing application access to the database.
- Check the status and uptime of each data node and their connections with all other nodes in the cluster.

⁵Based on a MySQL Cluster configuration comprising 4 x MySQL Cluster data nodes, 2 x MySQL server SQL nodes, and 2 x MySQL Cluster Management nodes implemented across individual servers (8 x total). Total operation comprised the following commands: 1 x preliminary check of cluster state; 8 x ssh commands per server; 8 x per-process stop commands; 4 x scp of configuration files (2 x mgmd and 2 x mysqld); 8 x per-process start commands; 8 x checks for started and rejoined processes; 8 x process completion verifications; 1 x verify completion of the whole cluster. Total command count does not include manual editing of each configuration file.

⁶Based on a DBA restarting 4 x MySQL Cluster data nodes, each with 6 GB of data, and performing 10,000 operations per second (clusterdb.com/mysql-cluster/mysql-cluster-data-node-restart-times/).

Rather than manually searching through logs to find root cause errors or to optimize configurations, NDBINFO allows administrators to quickly and easily monitor MySQL Cluster operations in real time, and to proactively tune configuration parameters and application access to ensure seamless database operations.

Conclusion

This white paper explored how open source, carrier-grade architectures are able to cost-effectively meet the communications industry's high-availability and performance requirements and, at the same time, help to increase interoperability and accelerate time to market. It also examined the unique architecture and features of MySQL Cluster Carrier Grade Edition and how they can help NEPs and CSPs overcome the challenges facing their industry.

In summary, MySQL Carrier Grade Edition is providing organizations with several key benefits and helping organizations deliver innovative solutions with carrier-grade resilience in a highly competitive marketplace. By leveraging MySQL Cluster's flexible, shared-nothing architecture, users can scale applications requiring real-time access and carrier-grade data availability. Finally, because MySQL Cluster Carrier Grade Edition is open source and standards-based, you can avoid lock-in and start lowering your TCO today.

Appendix: Additional Resources

- **MySQL Cluster data sheet:** mysql.com/products/database/cluster/mysql-cluster-datasheet.pdf
- **MySQL in the Telecommunications Industry:** mysql.com/industry/communications/
- **MySQL Cluster 7.1 Architecture and New Features white paper:** mysql.com/why-mysql/white-papers/mysql_wp_cluster7_architecture.php
- **Building Subscriber Databases with MySQL Cluster white paper:** mysql.com/why-mysql/white-papers/mysql_wp_subscriber_db.php
- **MySQL Cluster Evaluation Guide:** mysql.com/why-mysql/white-papers/mysql_cluster_eval_guide.php
- **Customer case studies:** mysql.com/customers/cluster/



MySQL Cluster Carrier Grade Edition: Building a
Carrier-Grade Platform for Telecom Data
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