

Sybase® IQ Multiplex:

Delivering Elastic Capacity for High Performance
Enterprise Data Warehousing

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INTRODUCTION

Ever-increasing data volumes coupled with growing demand for trustworthy knowledge has led to increased investment in business intelligence technologies as new analytic and BI applications are built and deployed. Consequently, there is a corresponding expectation for increased analytics capacity that goes beyond traditional reporting. Along with the desire to optimize expenditures, maximize revenues, and adjust business models and processes, the demand for different types of business intelligence systems, reporting, and analytics must contend with limits on existing budgets, hardware, and services. This growth is powered by factors such as larger user communities, more data, the need for deeper insight and additional detail, all delivered to the right people in near real-time.

In order for an organization to meet these demands, the technical business intelligence infrastructure must not only provide the capacity to meet the analytic needs, it must also dynamically adjust according to the data volumes, reporting expectations, and computational requirements associated with many different BI usage scenarios. To meet these capacity and elasticity requirements, the technology must focus on methods, techniques, and tools that:

- Serve a growing and diverse user population;
- Feasibly integrate structured and unstructured data;
- Accommodate fine levels of data detail;
- Meet regulatory data retention requirements;
- Deliver actionable knowledge through a multitude of communication channels that meet mobility needs and usage patterns.

Sybase IQ is designed to meet these growing organizational reporting and analysis needs. Engineered to support large numbers of users and large amounts of data, Sybase IQ can deliver high-speed access to business information 10 to 100, or even 1,000 times faster than conventional relational databases. Sybase IQ leverages scalable memory, extremely fast CPUs, unlimited disk fabric storage, I/O channels, and an approach called multiplexing, which takes advantage of individual servers performing specific functions while sharing common disk storage. Multiplexing allows for number of different usage scenarios such as fast parallel analytics and reporting to operate simultaneously with high velocity real time loading, batch data integration tasks, and ad hoc client loads and queries.

This paper looks at the growing demand for business intelligence and analytics, and explores how the multiple processor architecture of Sybase IQ Multiplex provides benefits for flexible and cost-effective performance, capacity, scalability, and elasticity.

THE GROWING DEMAND FOR BUSINESS INTELLIGENCE AND ANALYTICS

The confluence of ever-increasing data volumes with the recent periods of economic stress can teach us an interesting lesson about the value of business intelligence (BI) and analytics. Despite greater conservatism regarding technology spend, investment in business intelligence has grown as new analytic and BI applications are built and deployed, attracting legions of new users, both inside and beyond the traditional boundaries of the organization. And consequently, there is a corresponding expectation for an increase in analytics capacity that does not impose artificial storage or computation constraints on the enterprise.

Increasing use and reliance on analytics goes beyond traditional reporting. Over time, decision support systems have matured through the development of advances in platforms, tools and techniques needed to advance the state of the BI art well beyond traditional reporting. Today, the BI environment supports increasingly pervasive use of analytics embedded in operational applications, widely-distributed dashboards presenting business results, and methods for communicating key organizational performance and productivity metrics.

This increased demand is accompanied by new challenges. Along with the desire to optimize expenditures, maximize revenues, and adjust business models and processes, the demand for different types of business intelligence systems, reporting, and analytics must contend with limits on existing budgets, hardware, and services. And along with growth has come risks, particularly in ensuring the availability of systems and databases required to serve the new needs. Driving this growth are four factors:

1. **More Users:** The mainstreaming of BI has driven double-digit growth in user populations, along with “virtual users” — automated applications also competing for shared resources with “flesh and bone” users.
2. **More Data:** With each new group of users — whether human or system — has come multiple new data sources — in-organically growing data volumes required to be stored within the analytic infrastructure.

3. **Additional Detail:** The sheer needs of deeper insight and regulatory retention requirements exponentially affect the storage footprint for analytics and BI. The need to eke out even the most subtle knowledge from a sea of data, combined with mandated retention over longer time spans combine to overburden many storage infrastructures as they amass a sea of detail data.
4. **Faster:** The effectiveness of predictive modeling has raised stakes in the challenge to deliver data into the analytic infrastructure in near real-time.

Additional Considerations

At the same time, emerging business realities consume a variety of uses for analysis and reporting, including:

- **Social Media:** For marketers, the emergence of this new class of web application has produced an unending treasure-trove of personal, social, and societal behavioral information to feed ever-more-complicated marketing models, drive new business models and with them, new privacy concerns. This rapidly-changing field presents opportunities, but is not without very large challenges in managing both the vast seas of data, but also in discriminating between that which can be revealed and that which constitutes significant privacy challenges.
- **Retention:** It's not only practical to retain data with greater granularity, but increasing regulations impose additional storage and retention demands, leading to greater storage challenges for physical storage as well as the complex processes for long-term retention supporting compliance, audit, and legal retention requirements.
- **User-Friendly BI:** Over the past few years, the community of BI users has expanded across the management chain. But backlogs in IT have driven users to acquire tools and enable end-user populations to create and deploy their own BI applications. While democratization of BI has great advantages, an ungoverned application environment introduces inefficiencies as a result of poor system design and poor data architecture.

Capacity and Elasticity

These ideas can be summarized with a straightforward question: how can an organization satisfy the appetite for faster, deeper analytics running over ever-larger, and lower-latency analytic repositories? More to the point: the technical business intelligence infrastructure must not only provide the capacity to meet the analytic needs, it must also dynamically adjust according to the data volumes, reporting expectations, and computational requirements associated with many different BI usage scenarios.

To meet these capacity and elasticity requirements, the technology must focus on methods, techniques, and tools that:

- Serve an exponentially-growing and diverse user population in a minimally invasive manner;
- Feasibly integrate structured data with a variety of unstructured sources (such as web and social media data, , images, documents, browsing histories, search analytics, message streams and other un-structured and semi-structured data) to deliver greater insight into customers and trading partners;
- Accommodate the level of data detail needed for fine-grained behavior prediction;
- Align with increased regulatory data retention requirements;
- Provide predictable capacity for assessing and managing the risk of a catastrophic outage with widespread business interruption if a critical, pervasive analytic infrastructure fails; and
- Deliver actionable knowledge through a multitude of communication channels that meet mobility needs and usage patterns.

THE CHALLENGE OF MASSIVE PARALLELISM

A typical response to meeting capacity requirements is massive parallelism, which for decades has been considered the standard for managing large amounts of data through distribution of data to separate, independent servers operating on sections of the data at the same time. Massive numbers of CPUs can work in parallel in Massively Parallel Processing (MPP) systems to solve problems by leveraging massive amounts of memory layered on top of massive amounts of disk and I/O. The intent is for the massive parallelism to deliver the scalability and performance. But to achieve this scalability, all queries, data loads and maintenance must be parallelized across every server processor node to gain optimal performance. Within the shared-nothing architecture in which each server owns and manages its own CPUs, memory, data and disks, each server must find the piece of data needed to respond to queries with the interim results shared and assembled into a final result.

There are drawbacks to this shared-nothing approach. Every query must leverage every server to be effective and every server node must be equally fast to be effective. There is limited capability for mixed-use operations, so the system must usually be dedicated to only addressing one type of user's needs at a time. All nodes need to collaborate on each query, and this means that if one node is lost, the entire shared nothing MPP system is lost. And while shared nothing MPP provides excellent performance in situations where a problem can be partitioned so that all nodes can run in parallel with little need for the nodes to share data, the performance of the system for queries that need to share data (such as multi-way joins) are going to stall in performance.

This is good when you have specific knowledge about the usage scenarios and know that they map to the shared nothing MPP model. But most environments are not limited to one or two user types running the same, predictable queries day-in and day-out. On the contrary: most organizations need to support a broader user community of strategic decision-makers, operational and tactical analysts, power users, and general practitioners requiring a mixed load of reporting and analyses, ranging from rolled-up reports (for dashboards and scorecards), pre-designed reports, reporting and analytics prepared by power users, ad hoc queries, interactive analysis, as well as interactive drill down into the supporting data sets. And to meet the needs of this broad community, one cannot impose limits on the types of applications and queries, nor the characteristics of the workloads assigned to the analytical database platform.

ADDRESSING THE NEED WITH SYBASE IQ MULTIPLEX

Sybase IQ is designed to meet the growing (and diverse) organizational reporting and analysis needs. Sybase IQ is engineered to support large numbers of users and large amounts of data, and can deliver high-speed access to business information 10 to 100, or even 1,000 times faster than conventional relational databases. In contrast to traditional relational databases that store data by row, Sybase IQ uses a high performance data storage strategy called Vertical Partitioning that stores the data by column. With Sybase IQ, analysis queries are directed to examine only the columns that you need, while conventional relational databases slowly slog through each row of the entire table, clogging I/O channels, memory and disk.

For example, if two columns out of 20 are used from a table for an ad-hoc query, with Sybase IQ only those two columns are passed through from disk to the I/O buffer and into memory. With traditional relational databases (again designed for OLTP), the entire row must be processed. Also, Sybase IQ uses a 512KB buffer designed to pass large amounts of detail data into memory for fast, on the fly access.

Benefits of the Columnar Approach

There are many benefits to the columnar approach especially for those seeking a high performance environment to meet the growing reporting and analysis needs, such as:

- **Streamlined access performance:** Row-oriented systems are limited in supporting simultaneous diverse queries, but column-oriented systems only need to make selective traversal of the columns necessary for each query. In addition, employing commonly-used caching strategies will also increase data access speed.
- **Rapid joins and aggregation:** Data access streaming along column-oriented data allows for rapid join condition evaluation as well as incrementally computing the results of aggregate functions. Multiple processing units accessing and aggregating different columns in parallel increases overall query performance.
- **Suitability for enumeration compression:** The columnar alignment exposes opportunities for compressing data that can result in a significant decrease in storage needs while maintaining high performance. When employing an enumeration approach, there is no associated decompression burden, thereby not incurring additional computational load.
- **Rapid data loading:** The typical process for loading data into a data warehouse involves extracting data into a staging area, perform transformations, load de-normalized representations into the warehouse fact and dimension tables, and create the collection of required indexes and views. In a row-based arrangement, all of the data values in each row need to be stored together, but the columnar arrangement effectively allows one to segregate storage by column. This means that each column could, in principle, be stored separately, which would allow the database system to load columns in parallel using multiple threads.

SYBASE IQ MULTIPLEXING

Sybase IQ leverages scalable memory, extremely fast CPUs, unlimited disk fabric storage, and I/O channels. In turn, Sybase IQ employs an approach called multiplexing, which takes advantage of individual servers performing specific functions while sharing common disk storage. Multiplexing differs from traditional shared nothing MPP, which attempts to leverage all the servers in parallel for an individual query, data load or maintenance operation and isolates storage, memory and CPUs per server. Instead, multiplexing allows for number of different usage scenarios such as fast parallel analytics and reporting to operate simultaneously with high velocity real time loading, batch data integration tasks, and ad hoc client loads and queries.

The highly scalable shared disk grid technology allows concurrent data loads and queries via independent nodes connected to a shared data source. This flexibility and availability enables partitioning of available resources across different performance and usage dimensions — by user type, business user community, workload, or even at the application level. And while the approach allows user communities to be isolated from each other, it is still flexible enough to allow the appropriate level of hardware capability to be supplied for each user community

ADVANTAGES AND KEY BENEFITS OF SYBASE IQ MULTIPLEX

Sybase IQ multiplex supports a hybrid cluster architecture that uses shared storage for permanent Sybase IQ data and independent node storage for catalog metadata, temporary data, and transaction logs. This architecture enables you to manage large workloads using multiple nodes. With Sybase IQ multiplex, you can load data from multiple writer nodes and allow shared database objects written by one user to be queried by multiple users simultaneously. This section elaborates on a number of valuable advantages, including:

- Scalability
- High Availability
- Economy and flexibility
- Elasticity
- High Performance

Scalability

The growing data volumes imply a need for database systems that support the corresponding growth in capacity. Many vendors argue that segmentation and distribution of the large databases is the only way to increase capacity. However, there are implications of distributed databases — namely, their role in requiring increased storage space due to duplication and more frequent disruptions brought on by the need to periodically adjust and re-balance the distributed tables to meet performance expectations.

Sybase IQ Multiplex avoids these issues altogether. By allowing server nodes that access a highly-efficient shared database image, rather than a distributed one, new machines can be added quickly, without disruption, and still deliver near-linear performance improvements. In other words, with Sybase IQ Multiplex, you can continue to add additional computing nodes without adding additional storage, and vice versa. This means that both the computational power and storage capacity can be scaled independently, which means that you can adjust the system to meet the changing demands on your analytics environment grows. In fact, you can scale your Sybase IQ environment to support tens of thousands of users and concurrent mixed workload jobs without having to worry about slow-downs in data load speeds or query performance.

High Availability and Fault-Tolerance

By combining Sybase IQ Multiplex with load balancing and newer application cluster control solutions, great increases in availability become practical with minimal added expense. The Sybase IQ multiplex architecture allows for addition of servers independent of addition of storage capacity. The servers may be heterogeneous with respect to the number of CPUs; i.e., different servers in the Sybase IQ Multiplex may contain varying number of CPUs.

Sybase IQ Multiplex synchronizes database metadata for harmonious sharing of the shared database image, allowing query nodes to behave in a completely independent manner. For loading and updates, Sybase IQ Multiplex provides update coordination, version locking, and cleanup, so that loading activities can run on multiple servers within the cluster, segregated from ongoing queries.

Sybase IQ Multiplex combines clustered nodes with SAN mirroring technology, commonly available from leading storage vendors. Not only can a Sybase IQ Multiplex cluster provide independent capacity, but nodes in a cluster can also be switched from primary database storage to mirror copies in a SAN Environment, providing a warm-standby capability that greatly reduces outages and provides even greater reliability.

This high availability provides a strong measure of fault-tolerance: individual machines can fail and be excluded from the cluster, with no single point of failure within the cluster causing an overall outage. Failure of any node leaves query jobs unaffected on other nodes. Node failures, if any, can be easily monitored, detected and administered such that failed jobs are migrated to other nodes.

Economy and Operational Efficiency

Sybase IQ multiplex enables you to deploy a powerful reporting or analytics solution using the resources that are right for you and your organization, including low-cost hardware and operating systems, with no need to purchase any additional, third-party clustering software.

Efficient storage allocation and compression strategies reduce the overall data footprint because the clustering of servers around a single logical database stored in a SAN significantly shrinks the “islands of data” typical of many business intelligence deployments. In these typical environments, much duplication of shared tables is required that consumes significant additional storage space. Sybase IQ Multiplex clusters leverage the storage efficiency of column-oriented databases, reducing the tendency to load the same data into multiple departmental or divisional warehouses. This enables large clusters of servers to share a single, un-duplicated, space-efficient and bandwidth-efficient database image, eliminating the need for duplicated tables the resulting storage bloat.

Sybase IQ Multiplex allows multiple generations of machines to cooperate within a cluster. The environment even allows for incorporation of computing resources of various capacities in terms of computational power, effectively enabling a “heterogeneous” grid. The key advantage is that addition of a new generation of hardware is independent from servers also running in the cluster. So, if conditions permit the addition of a large new server, there is no need to replace the older machines in the cluster so long as they continue to meet the need. The ability to isolate queries on one or more CPU cores within a single server lengthens the lifetime of each individual resource, thereby eliminating early obsolescence of older servers. This lies in stark contrast to common distributed query processing platforms that de-construct queries to run many parts that are then farmed out to multiple serves in the cluster. This scheme, while attractive early-on, becomes a burden, as new, faster query engines wind up waiting for completion of subqueries that have been distributed to older engines running in the cluster. The result is often a strong need to obsolete older cluster elements long before their useful life has ended, so as to maximize the utility and performance of newer elements.

Sybase IQ multiplex provides a degree of flexibility that allows you to easily and quickly configure your Sybase IQ Multiplex environment using a user friendly GUI or command line interface. Sybase IQ Multiplex scales a single database image far beyond other solutions, due to the efficiencies of column-oriented storage. As a result, administrators of Sybase IQ Multiplex can often avoid the tedious periodic rebalancing and redistribution of database tables and data objects across distributed resources.

Elasticity

The typical reporting and analysis performed by a large cumulative percentage of the reporting and analysis user community incorporates rolled-up and pre-designed reports, reporting and analyses prepared by power users, ad hoc queries, interactive analysis, while allowing for interactive drill down into the supporting data sets. Environments supporting this mixed-load of analytical activities must contract and expand resource allocation to provide fair and predictable performance to all, requiring an elastic capacity for loading, queries, and other operations.

Within a Sybase IQ Multiplex grid, each new server can be provisioned into the cluster with only a few mouse-clicks. Nodes can be temporarily removed from a cluster just as easily and allocated to support other applications. Similarly, nodes can be switched from read-only operation to read-write operation in only a few clicks to help overcome narrow batch loading windows.

This elasticity provides sustained multi-user responsiveness. By isolating servers from each other, Sybase IQ Multiplex assures more consistent loading and query times by segregating workloads onto independent servers, rather than decomposing and distributing them across a shared server farm. This is most useful when unpredictable or “burst” workloads are anticipated to run alongside day-to-day query workloads. Without isolation, large bulk loads, complex ad-hoc queries and other complex tasks have a measurable impact on the responsiveness to all users of a database.

Simple and efficient management of capacity is not limited to run-time demands. Available resources and associated capacity can be dedicated to departments, groups of users, or specific application workloads. Sybase IQ Multiplex permits machines of different sizes and capacities to interoperate within a cluster, which permits administrators to mix small and large machines (from 1-2 cores all the way up to hundreds of cores) and dedicate them to particular departments and loading tasks.

Isolation and dedication of workloads by user groups and by applications allows groups or departments to achieve sustained levels of service. Data sets can be isolated as well, and when proper security is in place, additional tables (that are visible only from their node in the IQ Multiplex cluster) can be used for data that is only used in one group, sensitive data, or data that is temporary in nature, and whose lifecycle is a burden to other servers if visible.

High Performance

You might say that the fundamental driver for analytical database systems is the need for high performance, and Sybase IQ Multiplex will not disappoint along this dimension. Multiple processor systems can provide a high level of performance once the data has been brought into the environment. However, moving massive amounts of data through limited-bandwidth channels into the analytical database system is the Achilles heel of business intelligence.

Sybase IQ Multiplex provides faster batch and real-time loading. Extending upon the value of node isolation, Sybase IQ Multiplex supports multiple-writer clusters, where multiple servers within Sybase IQ Multiplex cluster can write to the database simultaneously. As a result, loading can be scaled linearly with minimum constraints on which server updates which parts of the database at any time. In addition, Sybase IQ Multiplex allows for parallel loading from disparate sources, combining internally-captured data with bulk loads from alternates sources such as search engines, social media, and ongoing transaction processing systems.

Sybase IQ Multiplex employs an automatic workload re-balancer aggressively works to avoid contention among users for system resources, thereby providing predictable high performance for a spectrum of concurrent workloads. As a result, Sybase IQ Multiplex enables linear compute scalability to support concurrent queries while providing linear compute scalability to support concurrent loads.

SYBASE IQ MULTIPLEX: ARCHITECTURE

Sybase IQ Multiplex is a highly scalable shared disk grid technology that allows concurrent data loads and queries via independent data processing nodes connected to a shared data source. In essence, a Sybase IQ Multiplex grid is a group of database servers, each running Sybase IQ, and each connected to a single shared database containing persistent data. Allowing data loads and queries to be concurrent relies on underlying read/write locking that ensures that each user always sees a transactionally consistent view of the same data.

By relying on a highly scalable grid architecture layered on top of a shared disk database cluster (more specifically, an asymmetric shared disk cluster in capacity and function), the Sybase IQ Multiplex architecture provides a number of tremendous advantages for deploying a high-powered and efficient reporting or analytics environment. As is shown in Figure 1, the Sybase IQ multiplex hybrid shared disk cluster architecture provides:

- Shared storage for all persistent data, typically on a shared disk array(s)
- Independent storage for all temporary data
- Semi-independent storage for catalog metadata and transaction logs that are physically independent yet logically replicated

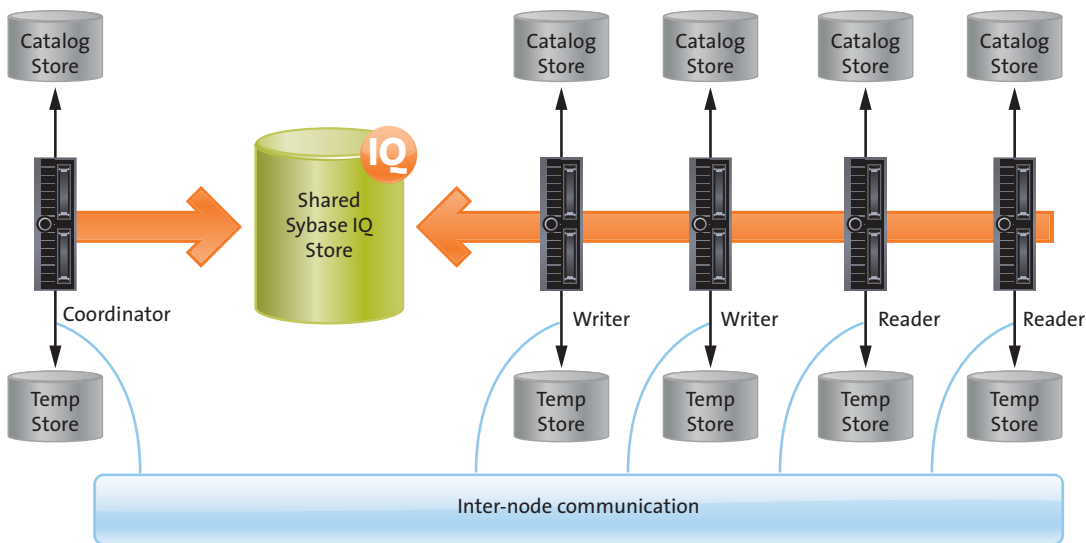


Figure 1: The Sybase IQ Multiplex grid.

Sybase IQ Multiplex's server clustering technology extends the scalability of Sybase IQ, permitting the clustering of multiple servers around a single, shared, easily-administered database image.

System Characteristics

A Sybase IQ Multiplex grid is composed of compute nodes and shared (SAN) storage, communicating via a network interconnect. The Multiplex grid is asymmetric in that it allows multiple servers, each with an arbitrary number of CPU cores, to simultaneously modify the shared persistent data. There are three server node types:

- A single **Coordinator** node that manages cluster membership information, the global transaction clock, as well as the read and write locks for each persistent table. The coordinator node also manages coarse-grain main database free space management, the final stage of all global transaction commits, and propagation of committed transaction information to all nodes. The coordinator is also responsible for clean-up of old version pages.
- Zero or more **Writer** nodes, which manage the local transaction clock and are responsible for fine-grain main database free space management. In addition, writer nodes read committed transaction information from the coordinator, requests Read/Write locks for persistent tables for data manipulation language (DML) statements, the modification of those persistent tables via any DML statement, and flushing any modified pages that is required before the final stage of a commit of a global transaction.
- Zero or more **Reader** nodes, which manage the local transaction clock and read committed transaction information from the coordinator.

All node types (reader, writer, coordinator) have the ability to create and manipulate IQ temporary tables, IQ global temporary tables and "In System" tables.

Within a Multiplex platform there may be nodes of heterogeneous capacity and generation. Because the coordinator node is able to manage the configuration of partitions based on available resources, you can scale out nodes and scale up the storage independently. The available storage is partitioned into dbpsaces that can be assigned to nodes, and server nodes can be added or removed from clusters, providing the desired capability for elastic expansion and shrinkage.

While a table can only be modified by one writer node at a time, it can be read by multiple reader nodes simultaneously. Within a Multiplex node, queries and loads are highly parallelized with dynamic scaling of CPU cores. As a result, the system can achieve more effective load balancing across the set of available nodes.

PUTTING SYBASE IQ MULTIPLEX INTO ACTION

In this section we provide some additional technical details surrounding Sybase IQ Multiplex version 15.

Creating and Administering Multiplex Servers

Sybase IQ Multiplex incorporates a number of new features. There is a new SQL interface for Multiplex server configuration. There is a new Inter-node communication layer, and there is a simple one-step coordinator failover procedure. Sybase IQ Multiplex allows for multiple writer nodes, any of which is able to modify shared IQ data. In addition to improvements in Sybase Central for Multiplex configuration and management, there is also new login management.

Multiplex Configuration

Sybase IQ Multiplex provides new DDL commands for manipulating the multiplex configuration:

- CREATE MULTIPLEX SERVER
- ALTER MULTIPLEX SERVER
- DROP MULTIPLEX SERVER

These commands may be run from any server in the multiplex, as long as a Coordinator server is running. Any configuration changes are propagated to all servers in the multiplex.

Multiplex Transactions

Sybase IQ Multiplex allows both local and global transactions:

- A **local transaction** is defined as any transaction which does not modify a shared object. A local transaction may be read only or may be read write but modify data in local objects only. Local transactions may be performed on any multiplex node, and the effects of the transaction are only visible to that node.
- A **global transaction** is any transaction that modifies data in shared objects or changes the schema of any persistent object. Global transactions may only be performed on the coordinator node or a writer node. The effects of a global transaction are visible on all nodes of the multiplex. The Coordinator node must be running for any global transaction to be performed.

Inter-node Communication

New inter-node communication (INC) supports two-way server-to-coordinator communication within a Multiplex, and provides infrastructure for robust Multiplex monitoring, messaging, and data propagation, including:

- Two-way Heartbeat monitoring to maintain real-time server-to-server link status (Connected, Not Responding, or Timed Out)
- Internal server-to-server command execution

The new intern-node communication completely replaces DBRemote for replication of Multiplex configuration data.

Local Stores

Sybase IQ 15.X has no “local stores,” but a combination of login management and Tablespaces can provide similar node level isolation as provided by the “local stores” provided in earlier Sybase IQ versions. There are no SQL Remote dependencies; rather Inter Node Communication replaces SQL Remote for multiplex configuration and version data synchronization.

Version Maintenance

Snapshot versioning creates new versions of pages within IQ objects whenever they are modified. Versions of pages are preserved as long as any active transactions exist that might refer to those versions. New transactions see only the latest version as of the time that the transaction was initiated. Database pages that belong to older versions that are no longer referenceable are reclaimed as free space. Multiplex nodes report changes to their versions in use back to the coordinator node via the intern-node communication facility.

Monitoring

Sybase IQ Multiplex provides a variety of statistics that let you monitor the availability and performance of the system. Overview statistics provide details about the nodes within the multiplex, along with usage characteristics such as:

- Number of committed versions: the number of table versions in the servers.
- Total version space used (MB): total space consumed by all the table versions.
- Oldest version ID: the oldest table version identifier on the server.
- Number of active versions: total number of active write table versions on the servers.
- Total active version space created (MB): amount of data created by active write transactions.
- Total active version space to be destroyed (MB): amount of data destroyed by active write transactions. If these transactions commit, the destroyed data becomes an old version and is eventually dropped. If the transactions roll back, the created data is released.

Other monitoring capabilities include:

- Server and topology statistics, which show a representation of the entire multiplex grid showing the included nodes and their corresponding connections, including node name, current state, the role the node plays in the multiplex configuration, and the current status of the server in the multiplex.
- Connection statistics detailing the name of those users currently connected to each server, as well as connection IDs and the times the connections were established.
- Transaction statistics including unique identification numbers for selected transaction, their current states, when the transactions were created, and whether the transaction has completed.
- Cache statistics, such as the number of cache reads per second for the catalog, main, and temporary caches.

Workload Balancing

The shared-disk approach that is employed by Sybase IQ Multiplex dynamically manages and balances query workloads within a node. The environment is suitable to a mixed query workload because external load balancer can point incoming jobs to relevant nodes and the jobs are automatically parallelized and load balanced further within the target node. The combination of external load balancing between nodes and the internal load balancing within the nodes provide an excellent predictable workload isolation mechanism that is highly scalable and powerful in concurrent, mixed workload environment. This workload balancing is more effective than typical shared-nothing MPP architectures, thereby providing better concurrency, self-service ad-hoc queries, and independent scalability of compute and storage resources.

Failover and Recovery

Sybase IQ incorporates automated failover monitoring and recovery. During any application, even if there are node failures during the execution, consistency will be preserved. For example, for a read transaction, if a reader node goes down or is not responding, there will be no impact to other reader nodes and no impact to writer nodes. The coordinator node will remove the failed reader node's versions-in-use information. If the coordinator node fails or is not responding, there is no impact to the reader node. Similarly, for write transactions: if a writer node fails or does not respond, there is no impact to the reader nodes or the other writer nodes. The coordinator will remove the failed writer's table locks as well as the writer's versions-in-use information. If the coordinator fails during a write, all global transactions will be rolled back.

In general, if the coordinator node fails or is not responding, there is no impact to readers, all global transactions will be rolled back, and the versions-in-use info for all nodes will be automatically recovered when the coordinator either becomes available again or is failed over to the designated coordinator failover node.

CASE STUDY: COMSCORE

comScore, a provider of data-based infrastructure services and solutions for the e-commerce marketplace, realized when it began operations that the focus of Internet marketing was shifting from visitor counts to profitability. To meet this new focus, comScore leveraged Sybase IQ Multiplex to develop their Customer Knowledge Platform application.

The Customer Knowledge Platform provides a 360-degree view of customer behavior and preferences as customers visit sites throughout the Internet. The service monitors surfing and buying behavior at every site visited by consumers who have opted to have their Internet behavior analyzed. This type of data collection, aggregation, and analysis demanded a database architecture that would allow its software to smoothly handle rapid growth, handle huge amounts of data, yet still provide satisfactorily response times for a wide range of intense data queries from users.

Sybase IQ Multiplex enabled a cost effective high-performance solution, building upon a variety of high volume storage devices, a heterogeneous mix of computing devices to not only provide continuous, real-time measurement of the myriad ways in which the Internet is used, but also improve data mining and deliver faster results.

SYBASE IQ MULTIPLEX IN THE REAL WORLD

As data volumes grow, especially in the context of web statistics, web analytics, text analysis, social network analytics, and corresponding activities such as sentiment analysis, stream processing, and complex event processing, we expect that the demand for analytics will ebb and flow during the day in order to support a mixed query load to satisfy different types of user applications, such as:

- **Traditional reporting:** As the significant majority of the user community, business users, casual users, and extended enterprise users generally use reporting that depends on massive amounts of data, whether that is a result of aggregate reporting of transactions, online analytical processing (OLAP) along various predefined dimensions, or summarized reporting through scorecards or dashboards. Most of the processing for most of these activities is either pre-designed reports or selective ad hoc querying performed by business users, creating an environment with varying degrees of performance demands that changes throughout the day.
- **Data aggregation:** There is a growing number of organizations that accumulate data from multiple sources and make that data available for hundreds or thousands of simultaneous ad hoc queries to support customer-facing data services. Data aggregation applications perform tasks such as the generation of reports and analyses of managed data, to collecting, organizing and provisioning the delivery of news, weather, financial, transportation, and many other types of streamed data. In turn, both the aggregated data sets as well as analytical results provide revenue streams for the aggregator organizations.
- **Complex and advanced analytics:** Despite today's relatively small size of the set of power users, their development and use of complex analytics spans two application spaces, and all signs suggest that the size and prominence is growing, and that there is significant momentum driving increasing development of these types of applications. In order to develop quantitative models, large data sets are subjected to statistical analyses, data mining, and other sophisticated, computationally-intensive algorithms. These models are then incorporated as evaluation, scoring, or segmentation techniques applied to input data and to data in the data warehouses as a way to improve decision-support processes.

Due to its configurable nature, Sybase IQ Multiplex is particularly well-suited to satisfy the mixed workloads that are increasingly emerging at innovative companies.

CONCLUSION

In summary, Sybase IQ Multiplex is engineered to address the continually exploding business intelligence and analytics needs of competitive organizations. By enabling fast parallel analytics leveraging a configurable hybrid architecture (employing both computational and storage servers), Sybase IQ Multiplex serves a rapidly-growing user population with a wide spectrum of application needs.

Sybase IQ multiplex takes advantage of multiple reader and writer nodes and allows shared database objects written by one user to be queried by multiple users simultaneously, providing significant advantages such as increased capacity, system scalability, high availability, and elasticity. These advantages are perfect for supporting scenarios involving a combination of structured and unstructured data analysis utilizing high velocity real time loading, batch data integration tasks, and ad hoc client loads and queries to deliver actionable knowledge through a multitude of communication channels that meet mobility needs and usage patterns.