

[Solution Review]

New and Enhanced Features of 'Tibero 6'

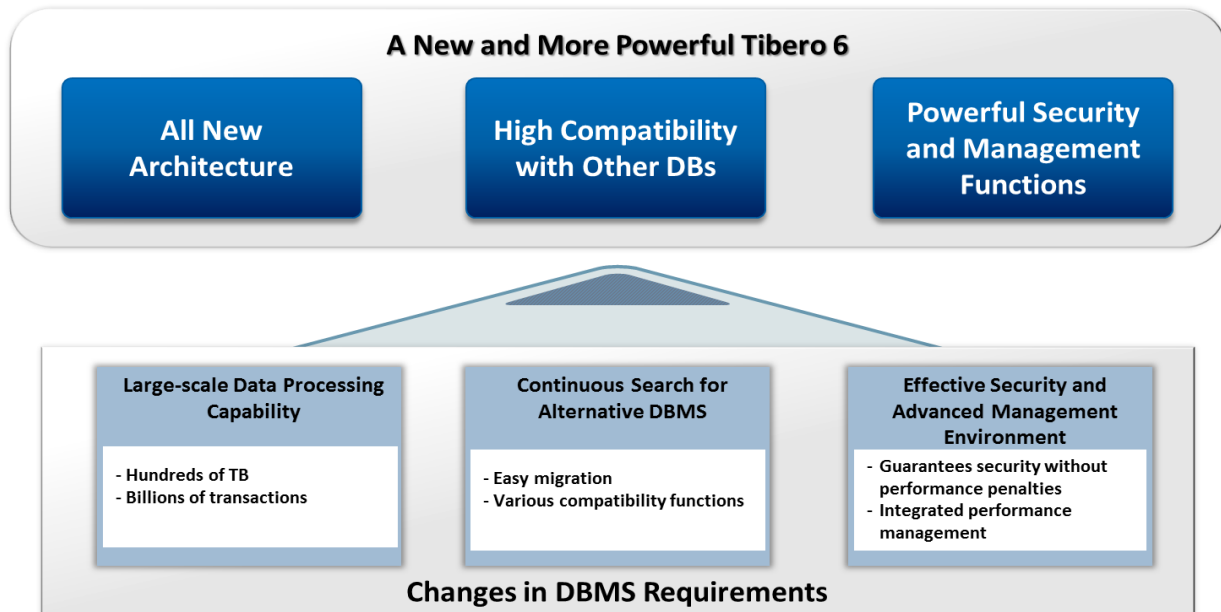
TmaxSoft 「Tibero 6」

[Computer World] Recent trends and demands in the RDBMS market are having serious implications on the future of DBMS.

The greatest implications come from the dramatic increase in data and transaction sizes. The introduction of new IT paradigms, such as big data and IoT (Internet of Things), has resulted in an unprecedented demand for DBMS systems with high performance and optimized resource efficiency.

As a result, DBMS adoption and maintenance costs have dramatically increased. To combat these costs and to avoid vendor lock-in, clients are becoming increasingly selective in their DBMS purchases and are demanding a new alternative DBMS.

Lastly, demand for personal information protection and data confidentiality is at its highest ever. Vendors face the challenge of meeting those demands without compromising performance. All the while database administrators face the endless problem of effective and efficient management of increasingly complex IT system (including DBMS).



▲ **New Features of Tiberio 6**

To answer these trends and client demands, Tiberio 6 has adopted a completely new architecture. The architecture supports high performance and large-scale processing to maintain compatibility with other databases, and it provides more powerful security and management functions.

No longer just an "alternative solution", Tiberio 6 fulfills the architectural, functional, and performance requirements necessary to perform the core business workloads of processing high-capacity data and massive transaction volumes.

Key Features of Tiberio 6

As previously mentioned, the following are required for a DBMS to perform core business workloads.

First, the DBMS must ensure reliable processing of large volumes of data. Existing DBMS architectures and technology are considered insufficient to handle the new trends of big data and massive transactions. Tiberio 6 was redeveloped and employs an all new architecture to achieve optimal transaction processing and performance.

Second, the DBMS must flexibly integrate with various third party solutions. These solutions can be connected to the existing system, applications, and the DBMS. In the past, the adoption of a new DBMS or the replacement of an existing DBMS was only considered when the existing system had to be redeveloped as part of a next generation development project or when a new system was required for additional workload. This was because DBMS is software that lays the infrastructure for enterprise information system.

However, DBMSs are now often replaced due to cost considerations directly related to monopolistic licensing and maintenance charges. After a new system adoption, clients often employ the new system in conjunction with most of the existing environment including applications, DBMS integration solutions, and interfaces. A new DBMS solution is required to ensure high compatibility with existing assets.

Tibero 6 is that solution. Tibero provides compatibility functions and easy migration to offer greater compatibility with existing DBMS.

Third, in the past, enterprise security only required the use of an authentication security solution to comply with security laws and regulations. However, today's security is evolving rapidly, requiring security that is more practical than theoretical.

Performance degradation was once considered inevitable because data had to pass through a security solution. However, Tibero, as a real core DBMS, guarantees performance without degradation and supports an intuitive process for detecting security problems.

Innovative Hyper Thread Architecture

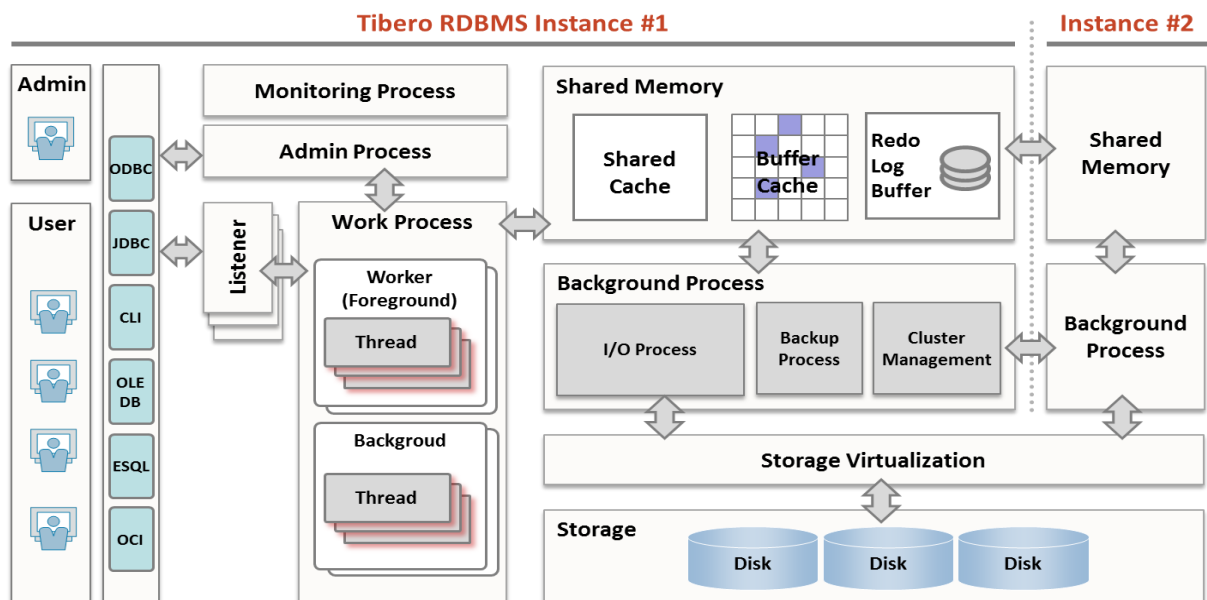
Tibero 5 was based on a multi-process and multi-thread architecture. It accommodated simultaneous client requests through efficient resource utilization and rapid access processing.

In the multi-process architectures employed by other vendors, a process is in charge of handling client requests, which can waste resources. When a large number of clients

simultaneously access the database, a process must be newly created and then removed if the connection is lost. Furthermore, resources are also wasted during context switching between different processes, which divides client requests.

Through its advanced technologies, development, and references, Tiberio was able to stabilize the thread-based architecture. The architecture boasts improved listeners for receiving client requests, work processes for directly processing SQLs, shared memory for caching data and storing data structures, background process for ensuring transaction continuity and consistency, and disk storage for saving actual data.

Tibero 6 employs a hyper thread architecture for communication between processes. The architecture optimizes performance by processing disk I/O through multiple threads. The hyper thread architecture clearly divides the roles among threads to minimize messages between threads. Tibero offers superior processing performance over its competitors when database load increases.



▲ Hyper thread Architecture

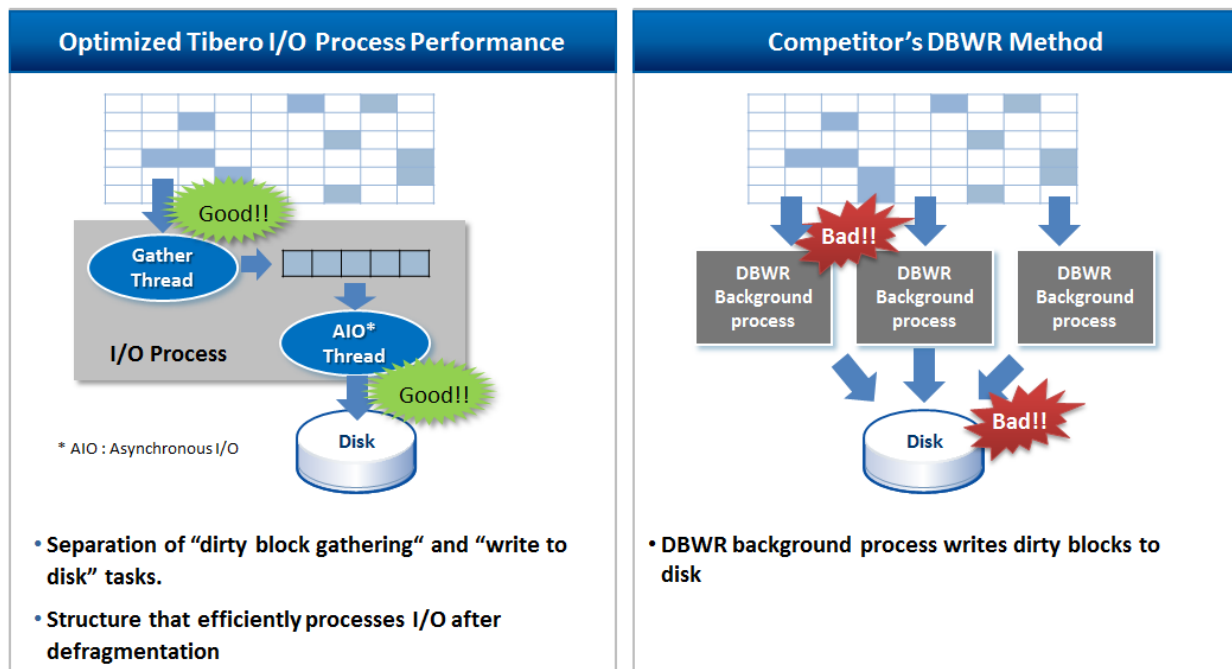
Optimized I/O Process Performance

The most important element that determines DBMS performance is disk I/O performance. Maximizing I/O performance is the most important aspect when tuning database performance because the majority of system bottlenecks occur during physical I/O reads from disk and writes to disk.

The performance of the entire database can be significantly improved when physical I/O wait time is reduced. Among the background processes that reside between the shared disk and storage disk, the I/O process plays the role of disk I/O.

In existing DBMSs, multiple DBWR (DB Writer) processes are started based on the number of CPUs and cores. Each DBWR process directly gathers modified dirty blocks in the memory area and writes to disk. Tibero 6 integrates the DBWR processes into the I/O process and also creates multiple threads for parallel processing.

Tibero employs separate threads for gathering and writing: a gather thread for gathering dirty blocks and an asynchronous I/O thread for writing to disk. Gather threads gather the maximum number of adjacent data blocks at one time, and asynchronous I/O threads write the gathered blocks to disk. I/O threads can efficiently process I/O and maximize processing performance by analyzing the location of dirty blocks to minimize disk head movement and write data to the adjacent disk block.



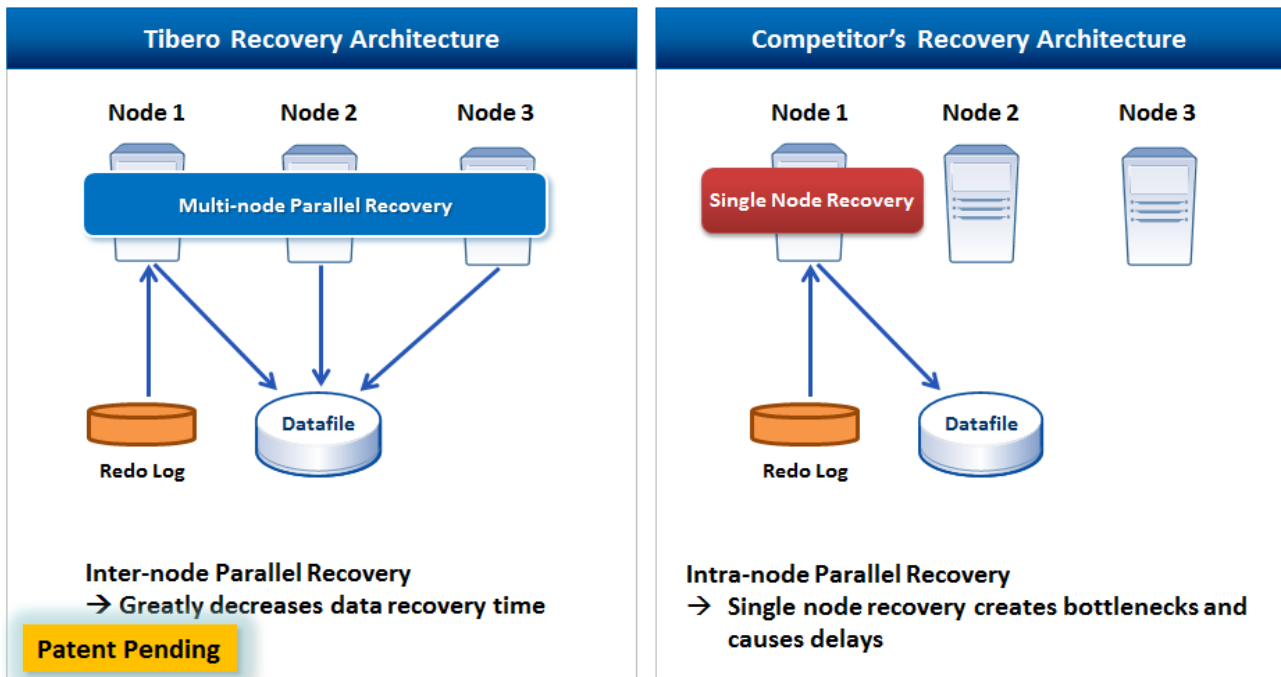
▲ Optimized I/O Process Performance

Multi-node Parallel Recovery

Tibero Active Cluster (TAC), Tibero's shared disk based clustering technology that corresponds to Oracle RAC, allows parallel recovery of multiple nodes to provide stable services when restarting a node that abnormally terminated.

In a TAC environment configured for high availability, service interruption is a significant event. If the service of a specific server stops due to a failure, including hardware errors, the remaining nodes must recover the transactions from the failed node. This recovery of transactions results in an unavoidable service interruption called 'stop the word'.

Minimizing the 'Stop the world' period is very crucial. Tibero 6 minimizes service interruption time by recovering transactions from a failed node in parallel.



▲ Multi Node Parallel Recovery

Storage Virtualization Technology – Tibero Active Storage

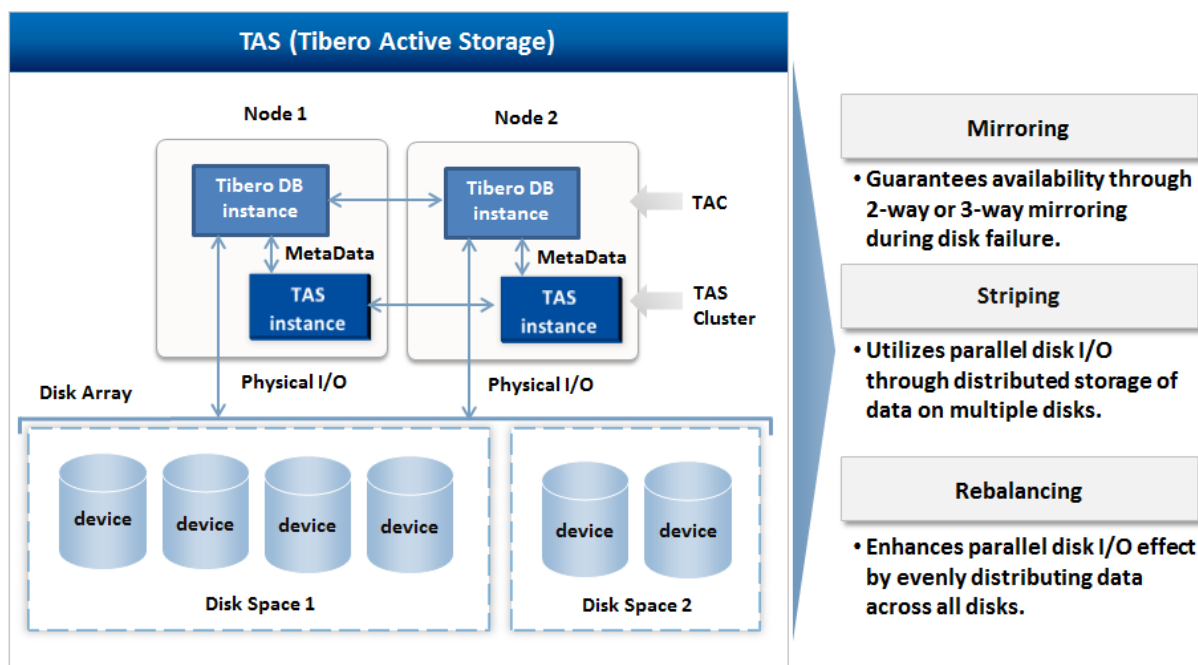
Storage virtualization is a technology that independently manages a DBMS and storage. A software or hardware layer is added between the storage and server so that applications (DBMS) do not need to discern the disk drives, partitions, or storage subsystems when searching data.

In the past, the ability to independently manage DBMS and storage required purchase of an expensive volume manager. However, Tibero 6 eliminates this requirement with its storage virtualization technology. Tibero uses TAS (Tibero Active Storage), Tibero's proprietary technology, to virtualize multiple storage volumes into a single logical data volume. These virtualized volumes are recognized by the DBMS as a single data storage volume.

The TAS service is located on a layer physically separated from TAC. It is a logical volume manager that configures a storage cluster to directly manage disk devices (without an external solution) and stores data files and log files required for running Tibero. TAS also provides the clustering function, which can enable TAC when using a shared disk.

TAS can manage multiple disks in a disk space. A disk space is similar to a file system on top of a logical volume, and Tibero can store files in a disk space. Disks can be added or removed from a disk space. When adding or removing a disk, TAS automatically redistributes the stored data. When a disk is added, data is redistributed to balance load. When a disk is deleted, data is redistributed to ensure no data is lost.

TAS also manages disk spaces through mirroring and striping. Striping utilizes parallel disk I/O through distributed storage of data on multiple disks. Mirroring guarantees availability through 2-way or 3-way data replication during disk failure.



▲ Storage Virtualization Technology - TAS

Compatibility with Other DBMSs

In addition to optimized I/O process performance, compatibility is another key feature and advantage of Tibero 6.

The primary concerns with DBMS migration are difficulties with migrating existing data and the reuse of existing applications. These concerns stem from client concerns with migration costs and system age.

To ease these concerns, Tiberio provides the tbMigrator utility to automatically migrate database objects such as SQLs, procedures, and data from Oracle to Tiberio. Not only is automated migration provided for Oracle systems, Tiberio 6 recently expanded its scope to provide automated migration for DB2, MS SQL server, Sybase, PostgreSQL, and MySQL.

Among commercial DBMSs, Tiberio 6 provides the greatest number of database links to heterogeneous DBMSs. Not only does Tiberio provide gateways for DB links to Oracle, DB2, SQL server, MySQL, Cybase, Informix, and PostgreSQL, the gateways support XA transactions. Through these gateways, distributed transactions that often occur in an enterprise system can be processed across the heterogeneous DBMSs that are connected to Tiberio.

SQL Translation Framework & tbOCI Manager

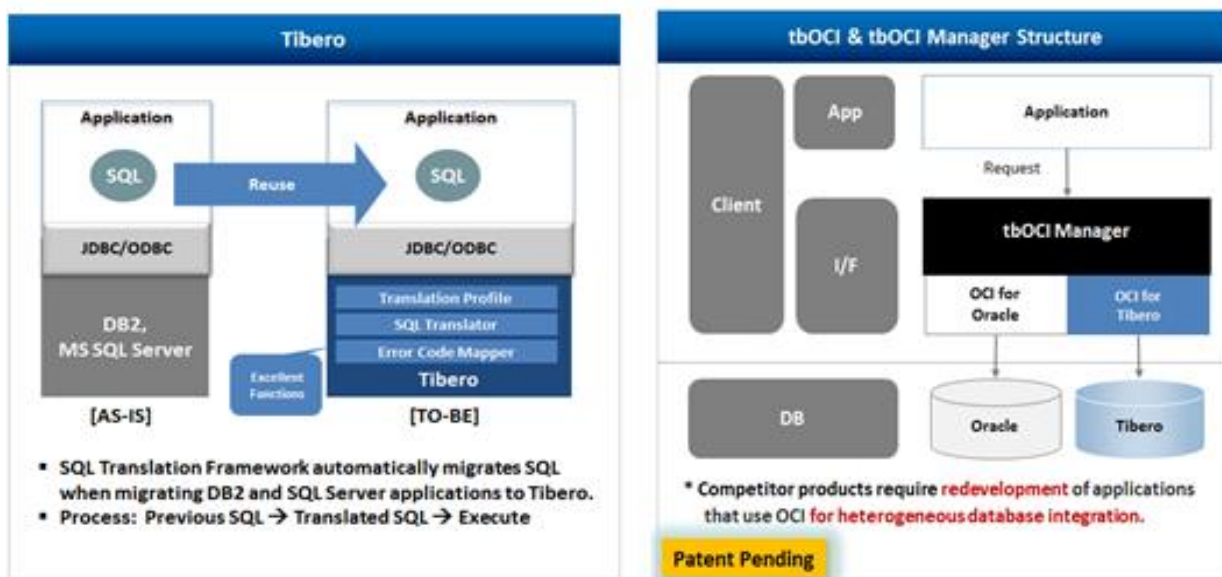
Tiberio 6 provides a SQL translation framework that maximizes compatibility with existing client applications. During DBMS migration, verifying the range of applications that can be reused is crucial. Tiberio 6's SQL translation framework enables applications from other DBMSs to operate in Tiberio without any program modifications.

When receiving an SQL request for another DBMS, the Tiberio 6 engine is able to recognize the SQL and automatically convert it. However, Oracle SQL syntax does not require conversion thanks to its high compatibility with Tiberio. Currently, Tiberio 6 supports SQL conversion for DB2 and SQL servers.

Note: Although the Tiberio's SQL translation framework can be applied to a general DBMS migration, it is generally recommended for existing client applications that cannot be modified.

Tiberio 6 enables OCI-based Oracle applications to access Tiberio without changing the OCI settings or modifying the application. Oracle Call Interface (hereafter OCI) is the high performance Oracle C language interface for the Oracle database.

In Tibero 6, tbOCI Manager allows Oracle and Tibero to be used simultaneously when an application using Oracle OCI requires Tibero for select tasks. This function is recommended when the OCI that is connected to existing Oracle applications cannot be modified or only parts of the OCI applications require a connection to Tibero.

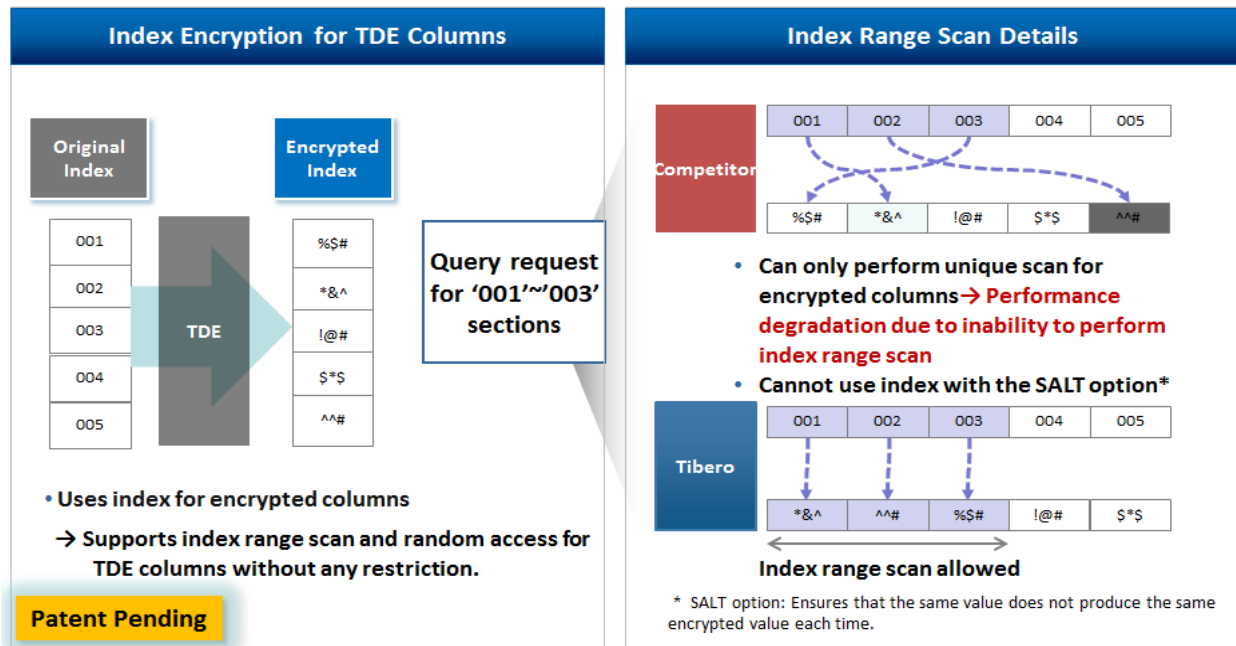


▲ SQL Translation Framework & tbOCI Manager

Security without Performance Degradation

Performance degradation due to the introduction of a security solution has been considered unavoidable. One of the biggest reasons is because index range scans cannot be performed due to changes to values and the sort sequence. To minimize the impact of encryption on performance, columns that are less frequently accessed are more encrypted than normal columns.

However, as the level of data security required increases, frequently access columns must also be encrypted while ensuring performance. Tibero 6 supports index range scans for Transparent Data Encryption (TDE) columns to provide security without performance degradation. This allows SQL to be executed smoothly with the highest level of security.



▲ Security without Performance Degradation

Integration with Security Solutions based on High Performance EPL and Encryption Algorithms

Algorithms

Security in Tibero 6 does not only consist of data encryption, Tibero can also integrate with third party security solutions.

In previous versions of Tibero, External Procedure Agent (hereafter EPA) was used for integration between the DBMS and a security solution. An agent provided with a security solution resides outside of the DBMS engine, and the agent is built with a security function to communicate with the DBMS. Performance degradation is unavoidable due to the communication loads between the DBMS engine, agent, and security solution.

Integration with external solutions through External Procedure Loading (EPL) provided by Tibero 6 guarantees up to 5x greater performance than EPA by directly executing the library of the security solution used within the DBMS engine.

In addition to general encryption algorithms, Tibero 6 also supports Korean standard algorithms (ARIA, SEED), which are not supported by global competitors, and SM4, the

standard mobile encryption algorithm of China. Tibero has greatly expanded support for country-specific encryption algorithm standards in order to facilitate Tibero's successfully expansion into global markets.

3rd Party Solution Integration via EPL Method

Typical DBMS Support

Communication overload → Reduced integration performance

Only for Tibero

Directly uses solution's functions via function call in the engine → Improved performance

Supports Various Encryption Algorithms

Encryption Algorithm	Tibero	Oracle
ARIA128	Supported	Not supported
ARIA192	Supported	Not supported
ARIA256	Supported	Not supported
SEED	Supported	Not supported
SMS4	Supported	Not supported
DES	Supported	Supported
3DES168	Supported	Supported
AES128	Supported	Supported
AES192	Supported	Supported
AES256	Supported	Supported
SHA-1	Supported	Supported
MD5	Supported	Supported
MD4	Supported	Supported


Tibero has developed additional encryption algorithms to support country-specific encryption algorithm standards.
Example: Tibero supports SMS4, a standard mobile encryption algorithm used in China.

▲ EPL-based Integration with Security Solutions & Specialized Encryption Algorithms

Tibero Manager, A Management Tool of Tibero 6

Tibero Manager is a tool provided by Tibero 6 for administrator and DBA convenience. This tool is an upgraded and expanded management tool based on tbAdmin. Tibero Manager is a built-in monitoring and management GUI tool that provides performance manager that monitors transaction processing and resource status in real time. Tibero Manager also provides the Tibero DBMS Admin function, which includes backup/recovery, security management, and schema management.

In addition to Tibero Manager, Tibero 6 also provides 'SysMaster for Tibero'. SysMaster for Tibero is an upgraded application performance monitoring solution for performance and error management. This tool enables real-time monitoring, diagnosis, measurement, post-analysis, and performance tuning.



Function	Description
Monitoring	<ul style="list-style-type: none"> Real-time SQL, and session monitoring TPR (Tibero Performance Repository) query and comparison ASH(Active Session History) query and analysis Trace Log query and analysis (log file and out file)
Availability	<ul style="list-style-type: none"> Backup & Recover (RMGR integration)
Security	<ul style="list-style-type: none"> User, role, profile management (add/modify/delete) Audit configuration
Schema	<ul style="list-style-type: none"> Queries and modifies DB objects DB Export/Import
Administration	<ul style="list-style-type: none"> Queries and modifies initialization parameter Storage management Scheduler management

Single Integrated Tool
(Built-in)

Expanded Monitoring
Environment

Real-time Monitoring via
Shared Memory Access

▲ Tibero Manager

Over 300 New Functions added to Tibero 6 - From an "Alternative" to a Core Solution

Tibero has secured over 1,100 references based on the reliability of its Tibero 5 TAC technologies. This reliability helps make Tibero 6 the perfect solution for enterprise-level core workloads and has help Tibero tightening its grip on the market as an alternative to the near market monopoly.

Tibero's performance and reliability has been further enhanced with an all new architecture based on cutting-edge technology. An automated data migration tool and perfect compatibility with existing applications minimize client burdens during DBMS migration. The highest level of security is implemented in data encryption while ensuring high performance.

To initially gain a DBMS market presence and to ease client operations, Tibero focused on implementing existing DBMS functions. This level of compatibility and simplicity successfully opened the DBMS market for Tibero. Tibero's future looks even brighter as both clients and experts anticipate that Tibero will lead the DBMS market in the era of big data through its technological innovations and fast answers to client needs.