

TRANSACTIONAL DATA MANAGEMENT (TDM) SOFTWARE PLATFORM

SOLUTION AND TECHNOLOGY OVERVIEW

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ABSTRACT:

As online business applications become more critical for processing transactions, the consumers of those applications must access, analyze, act on, integrate, store, and verify that data faster than ever — often in real time — and without system interruption or downtime. This new reality is accompanied by three major trends:

- › The exponential growth in online transactional data volumes;
- › The enterprise IT environment that is increasingly made up of heterogeneous, cross-platform, and distributed systems; and
- › The need for easier-to-implement solutions that have little to no impact or overhead on business-critical applications.

To meet these requirements, companies often start by evaluating traditional solutions for data replication or data integration. However, such solutions do not offer the more ideal functional capabilities of GoldenGate Software's Transactional Data Management (TDM) platform, which is designed to maximize the availability, accessibility, and performance of applications and databases that rely on transactional data. GoldenGate TDM enables high volumes of transactional data to be moved between different platforms and databases, even bi-directionally, in sub-second speed with accuracy, reliability, and integrity.

GoldenGate Software is the market leader in TDM solutions that enable real-time access to real-time information for key business applications. GoldenGate is used by major Fortune 500 and other large enterprises in more than 2,500 solution implementations worldwide, to build competitive capabilities for High Availability and Real-Time Data Integration.

This white paper provides an overview of the solutions realized through GoldenGate and a detailed review of its TDM technology platform and related products. It is written for both business project owners and stakeholders, as well the IT organization to help better understand the advantages of this technology offering.

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INTRODUCTION

The New Requirement for Competitive Businesses: Real-Time Access to Real-Time Information

Most business activities — whether with customers, partners, employees, or other parties — are conducted through transactions. Common transaction examples would include making purchases, returning an item, placing an order for shipping, managing patient records within hospital networks, bill paying and banking, updating account and customer information, and making or changing reservations.

Today across nearly all industries, an overwhelming majority of those business transactions are executed digitally. As a result, online applications are more important to the business than ever and the volume of transactional data continues to grow exponentially. It is critical that those applications provide users with exceptional access to, and utilization of, the most current, relevant information possible. In the business models of today's successful companies, there is no room for interruption in data availability, sluggish application performance, or having to settle for “older” data.

For such transaction-driven applications, these trends are driving more aggressive requirements in four key areas:

- › **Availability** – Applications and underlying data must be accessible near or at 24x7x365 without service interruption or performance degradation.
- › **Reduced Latency** – The older the data is, the less valuable it becomes. Day-old data is often not current enough to be competitive among industry leaders today.
- › **Heterogeneity and IT Flexibility** – There must be the flexibility to deploy and easily modify data solutions across distributed and diverse IT systems.
- › **Transaction Integrity** – The completeness and accuracy of transactional data should be assured as it is captured and applied to multiple systems.

Essentially, companies need a platform that allows business applications to benefit from real-time access to real-time information, without compromising performance and data integrity or demanding significant resources to deploy and manage.



GoldenGate Software meets those needs, as the leader in Transactional Data Management (TDM) technology solutions that allow high volumes of transactional data to be moved across heterogeneous IT environments – with sub-second latency and guaranteed accuracy, reliability, and integrity. In addition, GoldenGate's technology solutions are designed for easy, low-impact implementation, modification, extension, and maintenance. A number of solutions can be derived from GoldenGate's technology offerings to improve application availability and data integration capabilities that support mission-critical online business processes.

The purpose of this white paper is to present an overview of GoldenGate's core product offering: the GoldenGate TDM Software Platform. Starting with an introduction to the nature of transactional data, it outlines the major solutions that are enabled for transaction-driven applications, specifically in the areas of High Availability/Disaster Tolerance and in Data Integration. Then a more detailed description of the product's architecture, core processes, and key features follows. Finally, it introduces other GoldenGate products and how they relate to the core TDM platform. Customer examples and use cases are highlighted throughout this paper.

UNDERSTANDING THE REQUIREMENTS FOR TRANSACTIONAL DATA

Transactional data — data related to business transactions such as customer orders, payments, shipments, service requests, etc. — and business applications that rely on processing, reporting on, and/or analyzing that transactional data are among the most important assets to the enterprise since they are critical for running day-to-day operations. Businesses need to ensure that transactions, hence transactional data, are stored, accessed and updated properly to avoid errors and delays that can impact customer satisfaction, operational costs and future revenues.

All data is not created equal, and transactional data must be understood in order to evaluate solutions for managing it properly. Each transaction creates a number of data changes in the underlying database, and in the context of this paper, those data transactions collectively are known as transactional data. For example, let's look at a common business transaction that a customer would make with a bank – the online transfer of funds from a checking account to a savings account. The transfer of funds may be seen by the end user as a single business transaction, but it actually requires multiple operations to database tables. In the context of databases, a transaction is a single logical operation on the data (insert, update or delete operations).

The processing of a data transaction within the database involves a number of steps to ensure its integrity, and it is not successfully completed from the application's perspective until all of the underlying tasks are performed. Furthermore, any aborted or failed transactions must be rolled back so that the true business history is preserved. In the example used, if the checking account was debited but the savings account was never credited, the transaction should not be committed.

Once transactions are completed and committed at the database, that new data must be shared with other systems for a wide variety of reasons – such as integration into data warehouses, to support reporting needs, or for making copies of data via replication to back-up systems. As those data transactions are moved from that original source database to other target systems, it is crucial that the integrity of the data transaction is maintained. Otherwise, the true business activity and history can be lost or misrepresented at the target system.

Transactional Data, Databases, and “ACID”

As mentioned previously, in the context of databases a single logical operation on the data is called a transaction. To preserve the integrity of the database, there are four key features for processing transactions that occur within the database. Those features are ACID, which stands for **Atomicity, Consistency, Isolation, and Durability**.

- › **Atomicity** – Either all the tasks of a transaction are performed or none of them are.
- › **Consistency** – A transaction can't break the “rules” or integrity constraints of the database; if it attempts to do so, it is aborted.
- › **Isolation** – The operations in a transaction must appear isolated from all other operations in the application. No operation outside the transaction can ever see the data while it is in an intermediate state.
- › **Durability** – The transaction will persist and not be undone after it is committed. A transaction can only be deemed committed after it is safely written into a database transaction log.

The ACID properties guarantee that such transactions are processed reliably within the database.

GoldenGate's Transactional Data Management (TDM) software platform captures and moves only the committed data transactions that have those ACID properties, and ensures the integrity of that data as it is moved from the source database and applied to any number of target databases.

TRANSACTIONAL DATA MANAGEMENT AND GOLDENGATE

Unlike traditional replication and data integration products, technologies for Transactional Data Management are designed to support solutions that span a variety of critical business needs – and offer functionality ideally suited for today's transaction-driven applications. TDM offerings make it possible for the IT staff to deliver highest data availability to users, fast and easy access to current and accurate data, and the flexibility to quickly adapt to changing business and IT infrastructure needs.

TRANSACTIONAL DATA MANAGEMENT AND GOLDENGATE	
GoldenGate TDM is:	GoldenGate further offers:
› Real Time	› Continuous capture and delivery of data from sources to targets, with end-to-end total latency of only sub-seconds. High performance and low overhead, even at high volumes.
› Heterogeneity	› Supports capture and deliver of data between variety of relational, open systems/open source, and legacy databases on all major platforms.
› Transactional Integrity	› “Transaction awareness” that guarantees the reliability and accuracy of transactional data as it is moved between systems.

To answer those needs, GoldenGate Software offers its Transactional Data Management (TDM) software platform that enables high volumes of transactional data to be moved across heterogeneous IT environments, with sub-second speed and preserved data integrity.

Since 1995, GoldenGate's technology has been time- and stress-tested by transaction-intensive applications for banking, financial services, healthcare, retail, e-business, telecommunications, manufacturing/distribution, sales/CRM, and government. By 2007, more than 350 customers representing 2,500+ solution deployments worldwide had put their trust in GoldenGate TDM to enable the movement and management of their critical, rapidly changing transactional data.

And as the following pages will detail, GoldenGate TDM offers strong competitive advantages when it comes to meeting the combined requirements of real time, heterogeneous, transaction-sensitive high-volume data movement.

ONE PLATFORM, MANY SOLUTIONS

The heart of GoldenGate's solutions is its TDM software platform, which includes processes that are deployed for capturing, routing, transforming, and delivering transactional data between various sources and targets in real time. GoldenGate also offers its Director™ add-on product for visually managing and monitoring those deployments, as well as the stand-alone GoldenGate Veridata™ product that allows for high-speed, high-volume comparison of data that is shared between two in-use databases. (Product and architecture details about the TDM software platform, Director, and Veridata are provided beginning on page 20.)

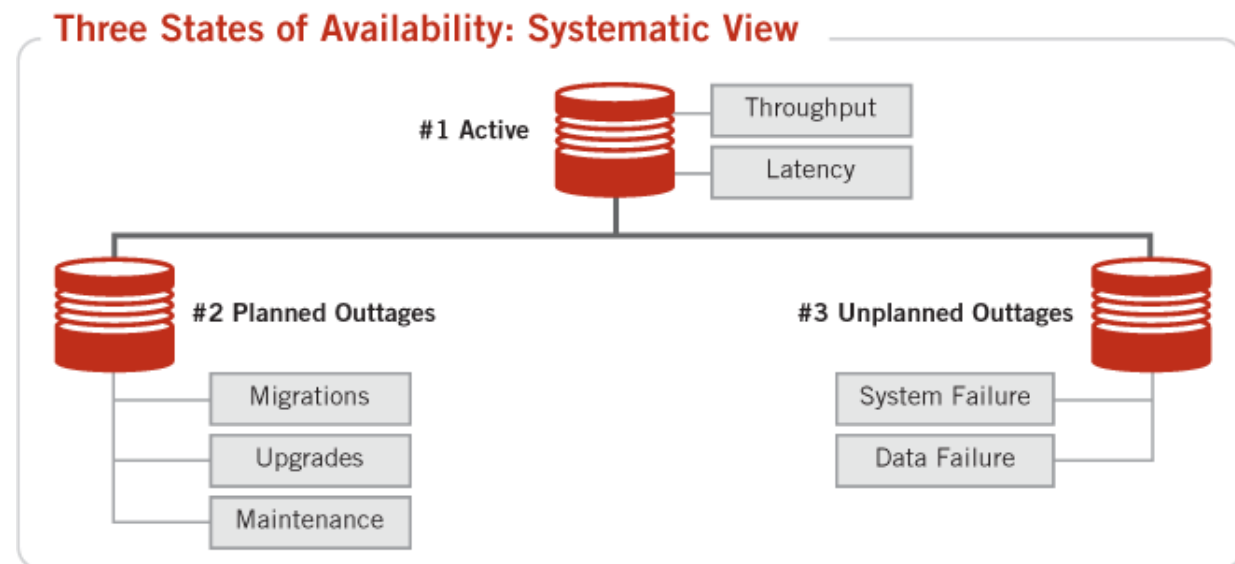
Together, these software products enable companies to easily and successfully implement a variety of solutions for improving the availability, accessibility, performance, and integration of critical data across the enterprise.

The two primary solution areas are: **High Availability/Disaster Tolerance, and Real-Time Data Integration.**

High Availability and Disaster Tolerance

As end users' patience levels decline and they build expectations for 24x7 system availability, businesses face more pressure to meet those expectations and surpass the competition. That means that the IT organization must implement solutions that keep key business applications operating within acceptable criteria under a range of damaging or interrupting conditions.

Typically, companies may first consider traditional Disaster Recovery (DR) products and practices. But for databases that support applications requiring higher availability targets (recovery time objectives/RTOs and recovery point objectives/RPOs), DR technologies alone are not likely to be sufficient.

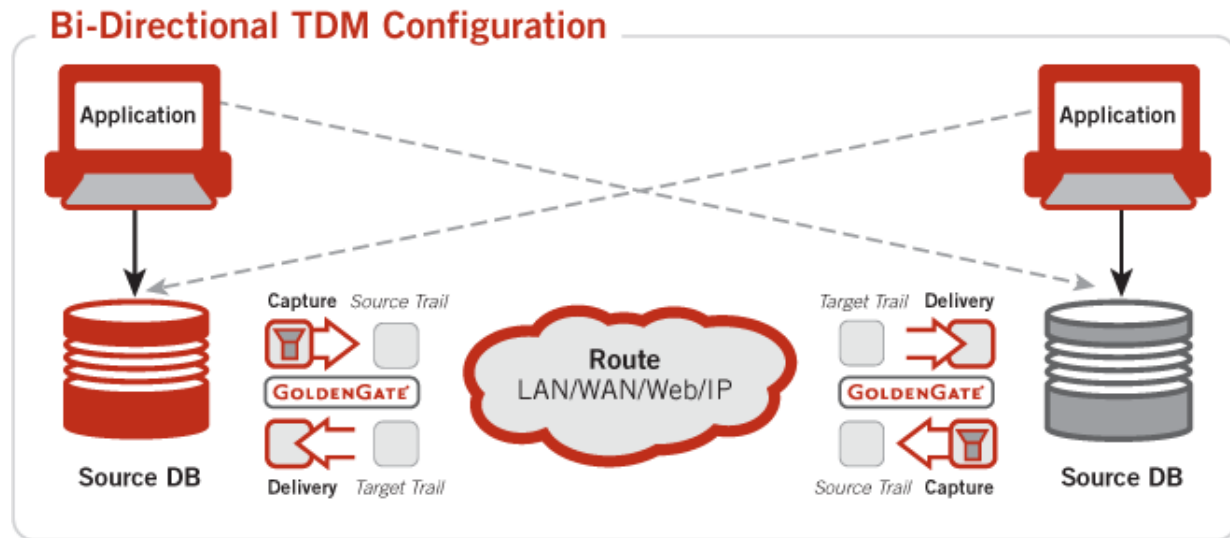


Continuous availability of critical data systems is more than “after the fact” disaster recovery. The GoldenGate TDM software platform allows customers to improve availability when faced with unplanned, planned, and performance-related issues that impact the end users’ perception of availability. In other words, regardless of the root cause, does the user perceive the system to be down or unavailable?

For State #1: Active But With Performance Challenges:

If the application or database is up but experiencing some degradation that is noticeably affecting throughput, and response times, one of the most effective ways to enable increased availability and performance is to off-load and/or distribute processing activity. For such scenarios, GoldenGate offers two primary solutions:

GoldenGate Active-Active/Dual-Active – GoldenGate for Active-Active is a software solution that allows for highest availability and performance on critical systems, by processing, distributing, and synchronizing transactional data across multiple databases – while delivering excellent features for data conflict detection and resolution.



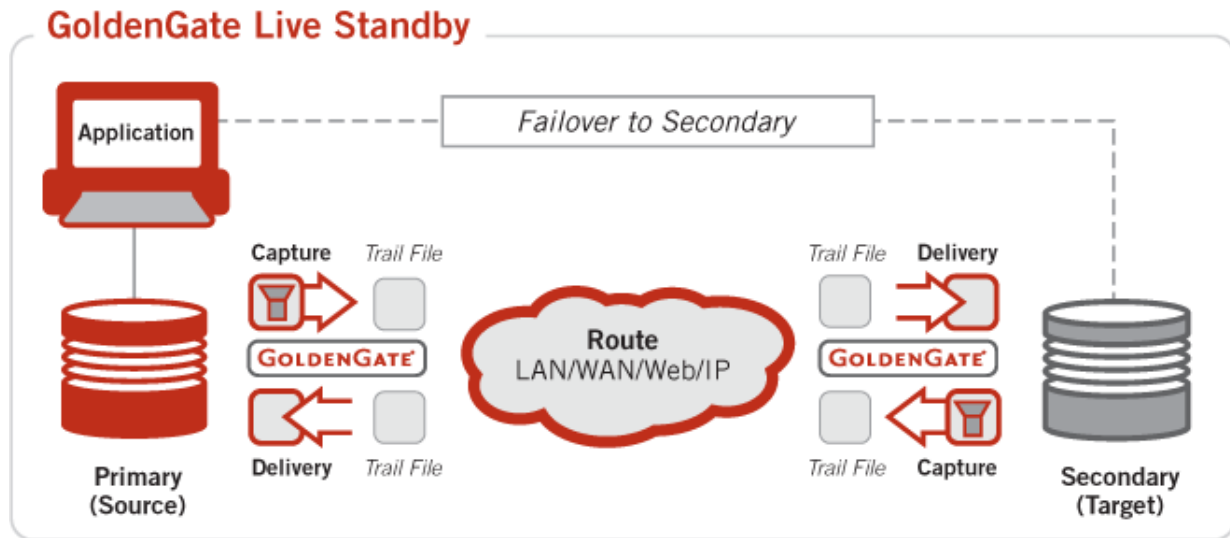
GoldenGate for Database Tiering – An unlimited scalability solution for improved performance and availability of critical systems, achieved by off-loading reporting and read-only activity from critical primary transaction processing systems to numerous low-cost read-only environments.

For State #2: Planned Outages:

GoldenGate Zero-Downtime Operations -- There are essential events that still require the IT group to schedule downtime, such as modifying hardware or database software, upgrading applications or databases, applying software patches, migrating to different computing architectures, etc. Since such events are not conceived via an unplanned or unexpected event, they are aptly classified as “planned outages.” GoldenGate for Zero-Downtime Operations is an exceptional solution for reducing planned outages, by enabling uninterrupted business operations and application high availability during necessary system upgrade, migration, and maintenance activities. Zero-Downtime Operations allows for real-time, bi-directional data movement and synchronization between primary and secondary systems. GoldenGate can support heterogeneous environments, a key requirement for cross-platform upgrades or database migrations. In addition, it provides excellent failback contingencies by keeping the old and new environments in synch in real time, and the ability to verify data between the systems using the GoldenGate Veridata product.

For State #3: Unplanned Outages:

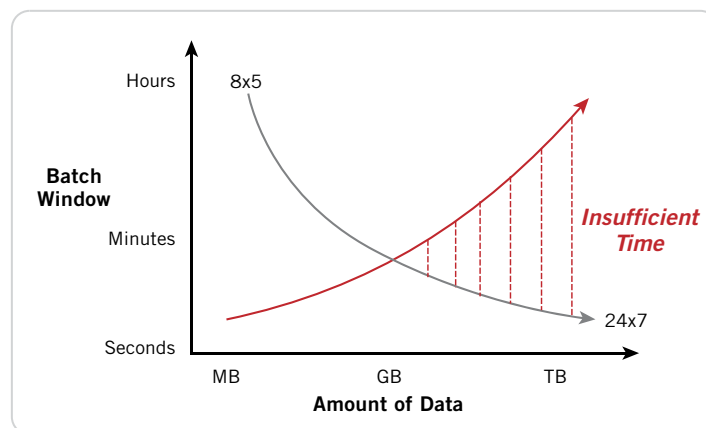
GoldenGate Live Standby – Unplanned outages may be caused by system-level failures or data-level failures. The business will need to confidently failover to a backup as quickly as possible, and also easily revert back to normal operating conditions once the primary system is back online. GoldenGate Live Standby is a high availability software implementation that significantly improves recovery time for business-critical systems. Live Standby delivers up-to-the-second data to the backup system, which the application can confidently point to when the outage occurs. Live Standby then allows any new data processed by the backup to be synchronized with the primary system.



Real-Time Data Integration

The market trend, as reported by leading industry analysts including Gartner and Forrester, is that data coming into the organization from various business applications must be integrated with lower latency -- so that business intelligence and decisions can be more quickly influenced with more timely, accurate information. And because applications increasingly are serving users and processing data on a 24x7 basis, it becomes impractical to impose any outage or delay in the overall IT process in order to integrate data.

As a result, the IT group must drive down the latency in integrating that new information with other enterprise systems, such as with data warehouses, reporting systems, data stores, or other OLTP-supporting databases. For more critical and revenue-generating data, batch loading that data nightly or even several times per day is no longer sufficient for many leading companies -- new data needs to be integrated faster, often within hours, minutes, or even seconds, and without impacting availability.



Companies have generally relied upon traditional data integration technologies, such as ETL products or home-grown scripts, to periodically move large volumes of data to a target system. This requires outage windows and imposes significant overhead on the IT systems involved, which makes these solutions insufficient for modern data integration demands.

Design for Real Time

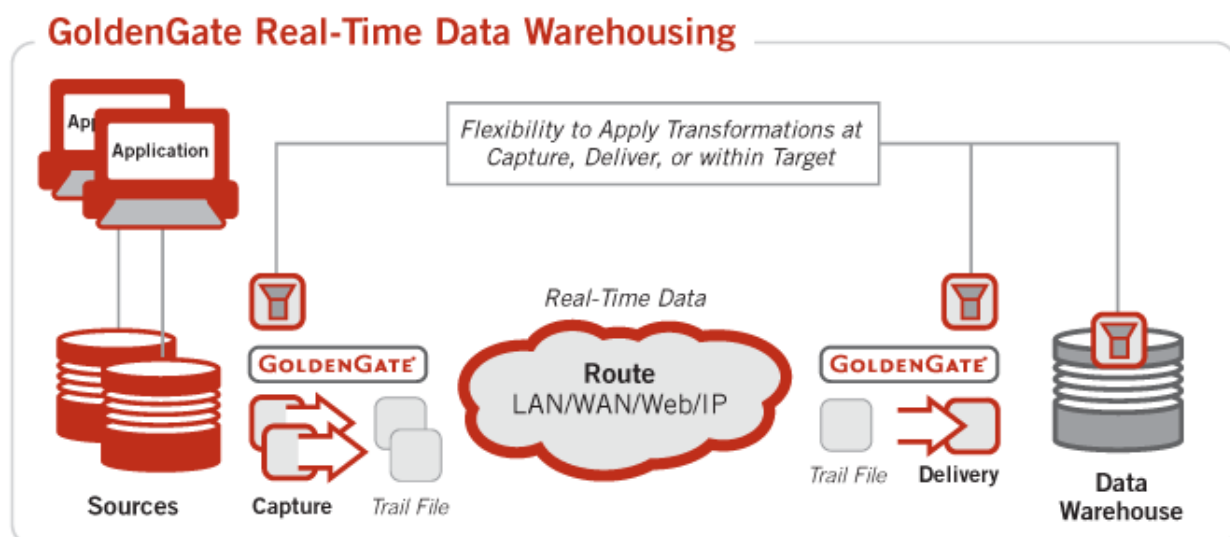
GoldenGate Software, leveraging its Transactional Data Management (TDM) software platform, delivers market-leading solutions that enable the continuous, real-time capture, routing, transformation, and delivery of data transactions across heterogeneous environments. As new or updated data is committed at the source system, it is continuously captured and applied to the target system with only sub-second latency. And because only changed data is moved, there is less burden on the infrastructure.

GoldenGate offers several key advantages over other data integration solutions, particularly batch processing approaches, including:

- › Continuous, real-time data movement (eliminates complexities of running more frequent batch jobs or mini-batches)
- › No need for batch outage windows
- › Significantly lower impact and overhead on source and target systems
- › Can eliminate the need for a middle-tier ETL server
- › Flexibility to apply transformations/mappings within the target database
- › Easier to implement, customize, and maintain
- › Reduce or eliminate planned downtime for performing necessary upgrades and other maintenance operations

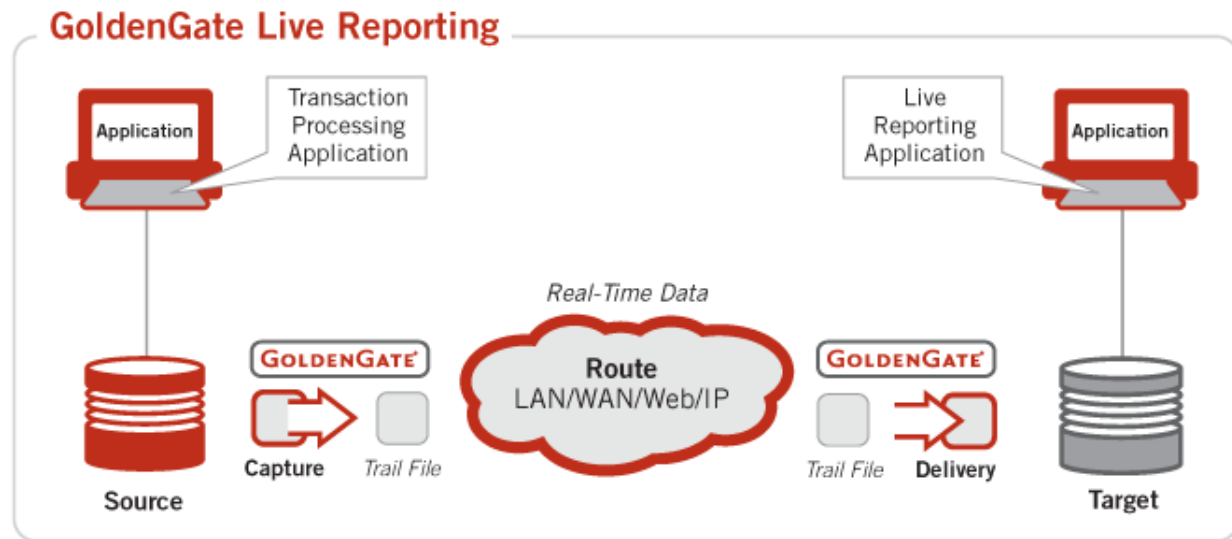
Customers worldwide are increasingly implementing GoldenGate TDM to generate solutions for real-time data integration. Among the popular solutions from GoldenGate in this area are:

GoldenGate for Real-Time Data Warehousing – GoldenGate enables the real-time movement of new transactional data from primary systems into the data warehouse, thereby making the most current data always available to drive enhanced business intelligence. GoldenGate allows companies to advance to the stages of operational and even active data warehousing, empowering a much larger number of front-line users across the enterprise to make better-informed tactical decision making that supports the overall business strategy.



TRANSACTIONAL DATA MANAGEMENT (TDM) SOFTWARE PLATFORM

GoldenGate for Live Reporting – Many reporting activities ideally seek to use the latest data available, and that often means running reports against production databases which in turn degrades performance on those systems. With GoldenGate, a secondary system is deployed to serve the purposes of real-time, “live” reporting, freeing up the resources of the critical source systems.



GoldenGate for Transactional Data Integration – For point-to-point data integration needs, GoldenGate is ideal for moving data in real time with minimal impact and with an architecture that is substantially easier to customize and maintain as application requirements change.

Solutions: In Summary

Fortune 1000 and other large business entities leverage the GoldenGate TDM software platform and products to manage critical initiatives in a range of business areas including High Availability/Disaster Tolerance and Real-Time Data Integration.

As the next section on GoldenGate’s software architecture will detail, GoldenGate’s core technology is extremely versatile in its usage and application to meet a wide variety of today’s business requirements. Companies currently using or evaluating replication, synchronization, ETL, EII, or EAI solutions for the purpose of moving and/or sharing data between systems should strongly consider GoldenGate’s TDM approach as a leading solution contender.

HOW ONE SOLUTION GROWS TO MANY:

GoldenGate customers often expand their use of GoldenGate TDM as benefits and return on investment are quickly realized from initial solution implementations. Here is how GoldenGate deployments have progressed for three such customers:

Overstock.com

Phase 1 = Zero-Downtime Operations

Continuous Operations: Minimized downtime during an enterprise-wide cross-platform migration of its OLTP systems on Oracle 9i to 10g.

Phase 2 = Data Integration

Real-Time Data Warehousing: Real-time data feeds from OLTP systems into the enterprise data warehouse, to enable a “single view of the customer” and improve reporting capabilities.

“With a clear, accurate understanding of the customer, we can give them the right information at the right time which directly impacts satisfaction levels and essentially revenue and growth.”

Sam Peterson,
CIO, Overstock.com



Bank of America

Phase 1 = Disaster Tolerance

High Availability Solution: Data generated by its 18,000+ ATM network is backed up in real time to multiple data centers for immediate failover.

Phase 2 = Zero-Downtime Operations

Continuous Operations: ATM business processes are kept online during large upgrade of production servers.

“We evaluated other products, however GoldenGate offered us benefits that would also enable us to meet our longer-term goals.”

Michele Schwappach,
VP of ATM/Debit Applications,
Bank of America



Montefiore Medical Center

Phase 1 = Data Integration

Real-Time Data Warehousing: New and changed data from its Clinical Information System application is immediately fed to the data warehouse to enhance reporting and business intelligence.

Phase 2 = High Availability

High Availability: Patient data systems are backed up to a Live Standby system for disaster recovery support.

Phase 3 = Veridata

Data Verification: GoldenGate Veridata runs frequent discrepancy checks on data shared between production and secondary databases.

“Accessing the data in real time using GoldenGate, we can immediately see if we’re profitable and if our business processes are working.”

Carl Baylis,
Assistant Director, EHIT/
Montefiore Medical Center.



GOLDENGATE ARCHITECTURE

GoldenGate's TDM architecture is a robust, high-performance yet low-impact solution that focuses on the three pillars of transactional data management:

- › **Real-time** — operating with sub-second latency;
- › **Heterogeneity** — supporting a wide variety of hardware, operating system, and database platforms;
- › **Transactional** — maintaining the integrity of data transactions.

GoldenGate's Transactional Data Management platform consists of a variety of decoupled modules that can be combined across the enterprise to provide maximum flexibility, availability, and performance.

This architecture facilitates the movement of transactional data in four simple, yet powerful steps:

Capture

GoldenGate captures data insert, update, and delete (changed data) operations committed in the database transaction logs in a non-intrusive, high performance, low overhead implementation.

Route

GoldenGate can utilize a variety of transport protocols as well as compress and encrypt changed data prior to routing. Transactions are placed in GoldenGate Trail Files and can be delivered to any data target including message queues.

Transform

At any point prior to applying the data to the target system, GoldenGate can be used to execute a number of built-in functions, such as filtering and transformations.

Apply

GoldenGate applies the changed transactional data to one or more database targets with only sub-second latency, ensuring transactional integrity.

The core process modules of the GoldenGate TDM architecture include: GoldenGate Capture, GoldenGate Trails, and GoldenGate Delivery. Those modules are detailed on the following pages.

GOLDENGATE CAPTURE

The GoldenGate Capture module grabs the result of insert, update, and delete operations executed against a database as they occur, and then routes them for distribution.

Native, High-Speed, Low-Impact Data Capture

GoldenGate Capture does not require any changes to be made to the source database or the application it supports. To maintain optimal performance, GoldenGate Capture employs a range of change data capture techniques against the source database. For instance, in databases including Oracle, Microsoft SQL Server, IBM DB2 UDB, DB2 OS/390, those running on HP NonStop/Enscribe, SQL/MP, SQL/MX, and other major databases, data changes are captured through direct access to native database transaction logs (redo logs, where applicable). Transaction logs contain all changes made to the database and are automatically maintained by the RDBMS independent of GoldenGate. For Teradata at the source, custom APIs have been developed to allow GoldenGate to capture committed transactions with the same efficiencies. Consequently, no additional tables are required to run GoldenGate Capture and overhead is significantly reduced as opposed to trigger-based capture techniques. Customers report only single-digit percentage overhead when running GoldenGate Capture on the source database.

Table, Row, and Column Selectivity

In the case where not all changed data from the source needs to be replicated to the target system – such as for Live Reporting purposes — GoldenGate Capture allows users to filter tables and rows based on user-defined criteria. The module ignores the entries in the transaction log that are irrelevant for TDM operations. Users can optionally select and apply transformation rules to specific columns via built-in GoldenGate functions, user-supplied code, and stored procedures.

Efficient Network Utilization & Large Data Volumes

GoldenGate Capture can route transactions over WAN, LAN, Internet, and IP over fibre channel. It can reduce network bandwidth requirements in a number of ways. Typically, the amount of data transmitted is a fraction of the transaction logs that are generated by the database. Since only committed transactions are propagated, intermediate activities and rolled-back operations are not transferred. Traffic is optimized by bundling individual records into larger, more efficient packets and avoiding record-at-a-time bottlenecks. Several levels of data compression are available to further reduce the amount of network bandwidth required for transmission. Depending on data types, data compression can reduce byte transfer by 75% or more.

For scenarios where end-to-end throughput must support very large changed data volumes, users can deploy multiple GoldenGate Capture modules to maintain minimal lag time between source and target systems.

Checkpoints For Guaranteed Data Delivery

GoldenGate checkpoints the last changed transaction whenever a commit boundary is encountered. This guarantees the delivery of all committed records to the target, even in the event of restart or cluster failover. Checkpoints store the current position as processed by both GoldenGate Capture and GoldenGate Delivery. Following a network or system outage, GoldenGate restarts from the last good checkpoint.

GOLDENGATE TRAILS

GoldenGate Trails — GoldenGate's unique queuing mechanism — contain the most recent changed data operations in a transportable, platform-independent format. GoldenGate Capture can create unique as well as overlapping sets of data into each trail. Trail records are stored in a GoldenGate Universal Data Format (UDF) and users can convert them to XML and other popular formats for consumption by different applications. Based on the requirements of the implementation, users can place Trail files on the target system, the source system, or both. Trails can be delivered to alternative queue types and application interfaces.

Flexible, Decoupled Architecture

A decoupled architecture addresses numerous problems inherent in tightly coupled alternatives. Process-to-process coupling creates a dependency between data capture and delivery. For example, if delivery is slower than capture, capture activities must be held up. In the event of an unplanned outage, decoupling ensures that the non-impacted system continues to operate independently.

Tightly coupled or process-to-process implementations can impose scalability challenges. A great deal of inter-process checkpointing needs to occur to ensure no data is lost, thereby creating many more messages and still more overhead. Network outages lasting more than a few minutes also can cause excessive resource consumption as outstanding transactions need to be queued in memory and eventually swapped to disk. Neither the physical nor the virtual memory activities are persistent, therefore if the process fails, data inconsistencies or even loss ensues.

GoldenGate decouples the data source and target, and facilitates heterogeneity, through staging data in GoldenGate Trails. Unlike architectures that implement a tight “process-to-process” coupling, this decoupled architecture provides each module the ability to perform its tasks independent of other modules or components.

GoldenGate's decoupled architecture utilizing Trails also provides flexibility in the choice of hardware, operating system, and databases for sources and targets, and can accommodate unplanned outages as well as system, database, and application maintenance activities without interruptions.

Data Pump Features

Depending on the configuration and environment GoldenGate is implemented within, it may be preferable to create Trail Files on the source system and use a separate component, called a “Data Pump” to continuously push (“pump”) the Trail Files from the source system to target system(s). This configuration enhances the fault tolerance and reliability of the overall GoldenGate environment. In the event of a network failure (between the source and the target systems), the Capture component can continue to capture transactions since the data can be queued up locally in the trail files on the source, thus enhancing the recoverability in case of database failures.

Further, the Data Pump feature is strongly recommended if data needs to be distributed to multiple targets from the same source (one to many). While the Capture component can focus solely on capturing transactions, individual Data Pumps can be set up to distribute the data to those targets, thus increasing the efficiency of the overall environment. Fault tolerance is also greatly increased in such a configuration as any failure associated with one target has no impact on the source capture or delivery to other targets -- transactions will continue to be captured, routed and applied to the other targets even when one of them is down. Data Pumps can also be used to route data through an intermediate system, even if that intermediate system doesn't have a database installed on it.

Archival and Audit Capabilities

GoldenGate Trails can create an archive of purged information from the source database by transforming delete and update records into inserts in a different location. For auditing and compliance purposes, GoldenGate can also maintain a separate history table to track each update to individual records as they change.

GOLDENGATE DELIVERY

The GoldenGate Delivery component takes any changed transactional data that has been placed in a GoldenGate Trail and immediately applies it to the target database.

Data Integrity, Transaction Consistency

GoldenGate Delivery applies each database change in the same order as they were committed in the source database to ensure data and referential integrity. In addition, it applies changes within the same transaction context as they were on the source system for consistency on the target.

Column Mapping and Transformation

As with GoldenGate Capture, users can configure GoldenGate Delivery via user-defined criteria to not only specify target tables — but also individual rows and columns.

By default, GoldenGate Delivery populates any target table column with data from a source table column if the two columns share the same name, this includes like-named tables as well. However, one can easily configure GoldenGate to move data from a single table into multiple target tables or vice-versa. This can be used to normalize or denormalize data in a data warehouse or OLTP environment.

Users can also define explicit mapping and transformation rules, ranging from simple column assignments to more complex transformations for which GoldenGate provides a suite of date, math, string, and utility functions. The module also supports the use of database stored procedures and functions. Implicit mapping and explicit rules can be combined. If additional transformations, data quality, aggregation and other functionality are required, users can leverage GoldenGate Data Services to integrate with non-GoldenGate applications.

Optimized High-Speed, High-Volume Data Delivery

GoldenGate Delivery provides a variety of techniques to optimize the posting of changed transactions to the target database. GoldenGate's posting processes, where possible, run local to the target database, maximizing throughput by avoiding network limitations. GoldenGate Delivery also minimizes disk I/O while preserving original transaction properties. In addition, where possible, updates are executed via native database interfaces rather than through middleware, and internal caches are utilized to ensure fast execution of repetitive statements.

As with Capture, multiple GoldenGate Delivery modules can be deployed to minimize lag time in the event of higher data volumes during peak processing times or seasonality.

This capture-route-(transform)-apply process runs continuously, to ensure the most recent transactions committed at the source are immediately moved and delivered to the target.

GOLDENGATE MANAGER

To give users control of the GoldenGate processes on a node, GoldenGate Manager provides a command line interface in which to perform a variety of administrative, housekeeping, and reporting activities, such as:

- › Setting parameters to configure and fine-tune GoldenGate processes
- › Starting, stopping, and monitoring Capture and Delivery process modules
- › Critical, informational event, and threshold reporting
- › Resource management
- › Trail File management

GoldenGate Manager executes requests on demand as well as unattended. For example, it can be used to restart GoldenGate components as well as monitor latency. GoldenGate Manager also automatically recycles GoldenGate Trail data when no longer needed, providing insurance against inadvertent disk-full conditions and an alternative to error-prone manual housekeeping procedures.

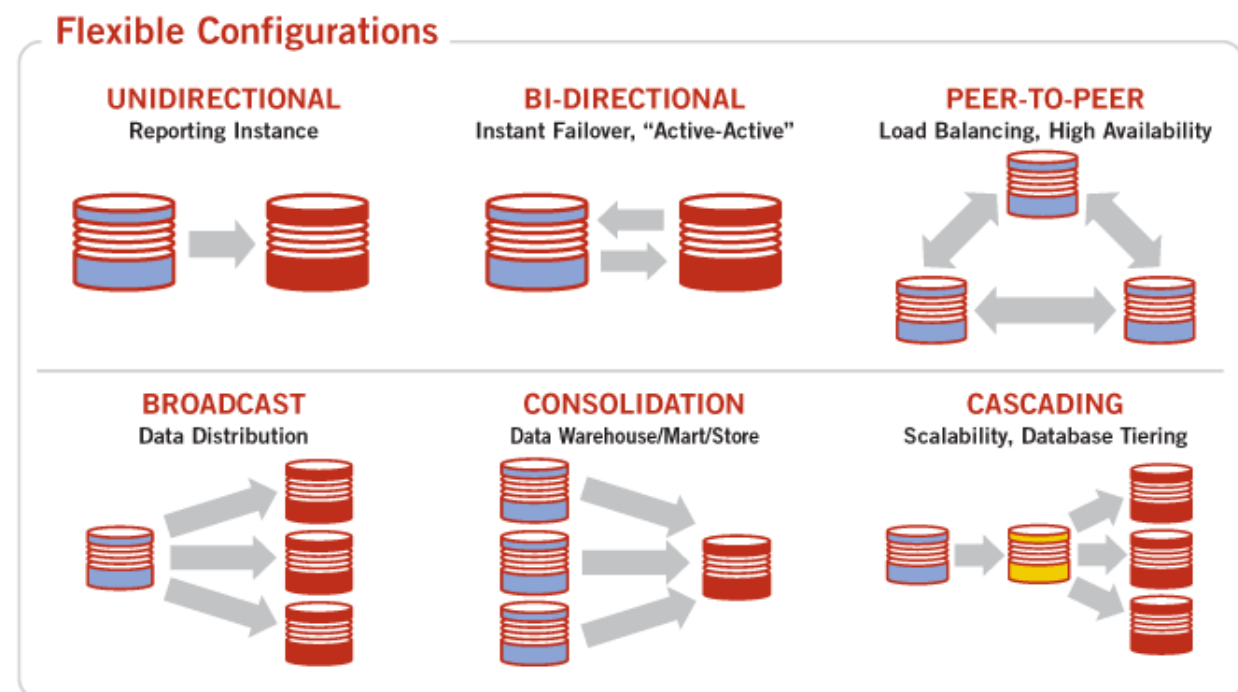
For management of the GoldenGate TDM processes and solutions deployed across the enterprise, customers should consider adding GoldenGate Director™ which is described on page 20.

OTHER KEY FEATURES OF THE GOLDENGATE TDM PLATFORM

Flexible Topology Support and Bi-Directional Configurations

Because of its decoupled modular design, GoldenGate easily supports a wide variety of topologies. These include one-to-one, one-to-many, many-to-one, and many-to-many — for unidirectional and bi-directional configurations.

For unlimited scalability, cascading topologies can be created to eliminate any potential bottlenecks. By staging specific sets of database changes on the source or target system, different TDM requirements can be met through a single pass on the data source. Each set of staged data can contain unique or overlapping sets of data.



Robust Data Security

GoldenGate provides 128-bit encryption utilizing the Blowfish algorithm to ensure secure, confidential data transmissions. Blowfish is a symmetric block cipher that can be used as a drop-in replacement for DES or IDEA. GoldenGate's implementation of Blowfish can take a variable-length key, from 32 bits to 128 bits, making it ideal for both domestic and international use.

Conflict Detection and Resolution

Conflict detection and resolution are key prerequisites of active-active bi-directional implementations. When both systems are processing data transactions and the activity is shared across multiple systems, detecting and addressing data conflicts becomes an essential requirement.

GoldenGate provides a wide variety of conflict detection and resolution options to provide the necessary flexibility and adaptability for a wide range of requirements. Conflict detection and resolution options can be implemented globally, object-by-object, based on data values and filters, or through event-driven criteria including database error messages. (See page 19 for more details.)

Dynamic Rollback

Eliminate the Need for Full Restore

GoldenGate provides effective features for performing selective backout (reverse) processing on enterprise databases and eliminates the need for full restore operations, which for large databases usually require several hours or more to complete. GoldenGate Rollback captures and uses before and after images to undo database changes for user-defined tables, records, and time periods. This makes it ideal in situations where data becomes corrupted or deleted as a result of human error.

Maintain Large Test Databases

Rollback is also very effective for maintaining large test databases. Administrators can restore a test database to its original state before a test run, enabling test cycles to occur more quickly against a predictable baseline of data. Since Rollback can undo all changes, reverting the database takes a fraction of the time compared to a full restore.

Point-in-Time and Selective Data Recovery

Using GoldenGate Capture to retrieve the database changes that have been committed, Rollback can back out to a specific point in time as well as specify tables, files, and other criteria. The data is then analyzed and prepared for rollback by inverting the order of the database operations retrieved. That guarantees that records with the same key will be properly applied when done so in the reverse order. The before or after image indicator in each record is modified, delete operations are changed to inserts, and inserts are changed to deletes. Then, the begin and end transaction indicators are reversed to delimit each transaction. GoldenGate Delivery is invoked to apply the before images back to the database. Prior to execution, users can review the changes about to be applied.

Customizing GoldenGate Processing

The functionality of the GoldenGate TDM platform can be enhanced through custom implementations:

User Exits

User exits are custom routines that can be called at different points during processing. With user exits, customers can respond to database events when they occur without altering production programs. For example, you can:

- › Perform arithmetic operations
- › Implement archival functions
- › Gather statistics
- › Use exit routines as an alternative to GoldenGate's data transformation functions

Stored Procedures and Queries

Stored procedures and queries can be called from GoldenGate to perform custom operations in the database's native procedural language, execute a query, and/or retrieve output parameters for input into GoldenGate's filtering and mapping functions.

Macros

Macros offer a way of easily reusing parameters, commands, and conversion functions. They enhance the productivity of configuring and running GoldenGate by enabling you to implement multiple uses of a statement, consolidate multiple commands, and invoke other macros.

USING GOLDENGATE FOR INITIAL DATA LOADS

GoldenGate allows you to carry out an initial load across multiple systems non-intrusively and without downtime, in three steps:

Start GoldenGate Capture – Places any changed data after its start in a GoldenGate Trail File.

Snapshot Load – Takes a snapshot from the source and loads it directly into the target.

Start GoldenGate Delivery – Applies the data previously placed by GoldenGate Capture in the Trail to the target to “catch-up” the database until both are fully synchronized.

This unique capability ensures continuous uptime and allows GoldenGate to be introduced into the data environment quickly and effectively.

CONFLICT DETECTION AND RESOLUTION ACTIONS SUPPORTED

Action	Description
Replace the existing row	When the primary key of an insert operation matches the key of an existing record, the existing row can be replaced.
Insert the missing row	When the key of an update operation does not exist in the target table, the update operation can be transformed into an insert.
Bypass the operation	The conflict is ignored as if the operation succeeded. Note that this is only an option.
Retry the operation	The operation can be retried at periodic intervals until the conflict is resolved externally. A maximum number of retries can also be specified.
Terminate processing	The conflict causes synchronization to terminate, pending external action. Synchronization can then proceed after external resolution. Processing can also be terminated after a specified number of conflict errors are encountered.
Identify conflicts in “dissimilar” data	GoldenGate facilitates mapping, transformation, combination and normalization between data sources and targets. In these types of scenarios, a more sophisticated detection rule can be created to correctly identify conflict.
Log the operation into an exceptions table	Conflicting operations can be inserted into one or more “exception tables.” Logged data can include column values, the type of operation, timestamp, reason for conflict and other information. Exception tables can subsequently be processed manually or via a custom program to resolve conflicts
Report the conflict	The values of the operation can be logged, along with the cause of error, to a report. In addition, an error summary can also be reported to the system operations console at specified intervals, and distributed by email or page via third party software.
Application-specific detection options	Whether or not a conflict has occurred, and what action to take, can be determined using application-specific rules. Rules can be established by examining the current column values in the row, the column values of the operation, the source row values before the operation, database lookups, stored procedure results and other information.
Apply “delta changes”	In some cases, it may be appropriate to apply “delta changes” for specific columns.
Invoke database stored procedures	Conflict detection and resolution rules can be created in stored procedures via familiar languages such as PL/SQL and Transact-SQL. Associated database events can also be easily executed through these facilities.
Invoke user exits	Custom code can be invoked to both detect and resolve conflicts.
Map specific columns from specific sources	Where appropriate, different data sources can supply different segments of the target row.
Decide based on the data source	Conflicts can be resolved by deciding a “winner” based on the source of the transaction. For example, if one site “owns” the data more than another, this type of strategy may be appropriate.
Wait on an external event	Conflicts can sometimes be avoided by delaying the delivery of data until an external event occurs. Rules can be invoked at multiple levels that ensure operations coincide correctly with dependent actions at the target database.

A COMPLETE TDM SOLUTION: ADDITIONAL GOLDENGATE PRODUCTS

The next several pages provide information on two additional GoldenGate products: GoldenGate Director™ for visually deploying and managing TDM processes across the enterprise, and GoldenGate Veridata™ for quickly comparing data between two online databases and reporting on any discrepancies.

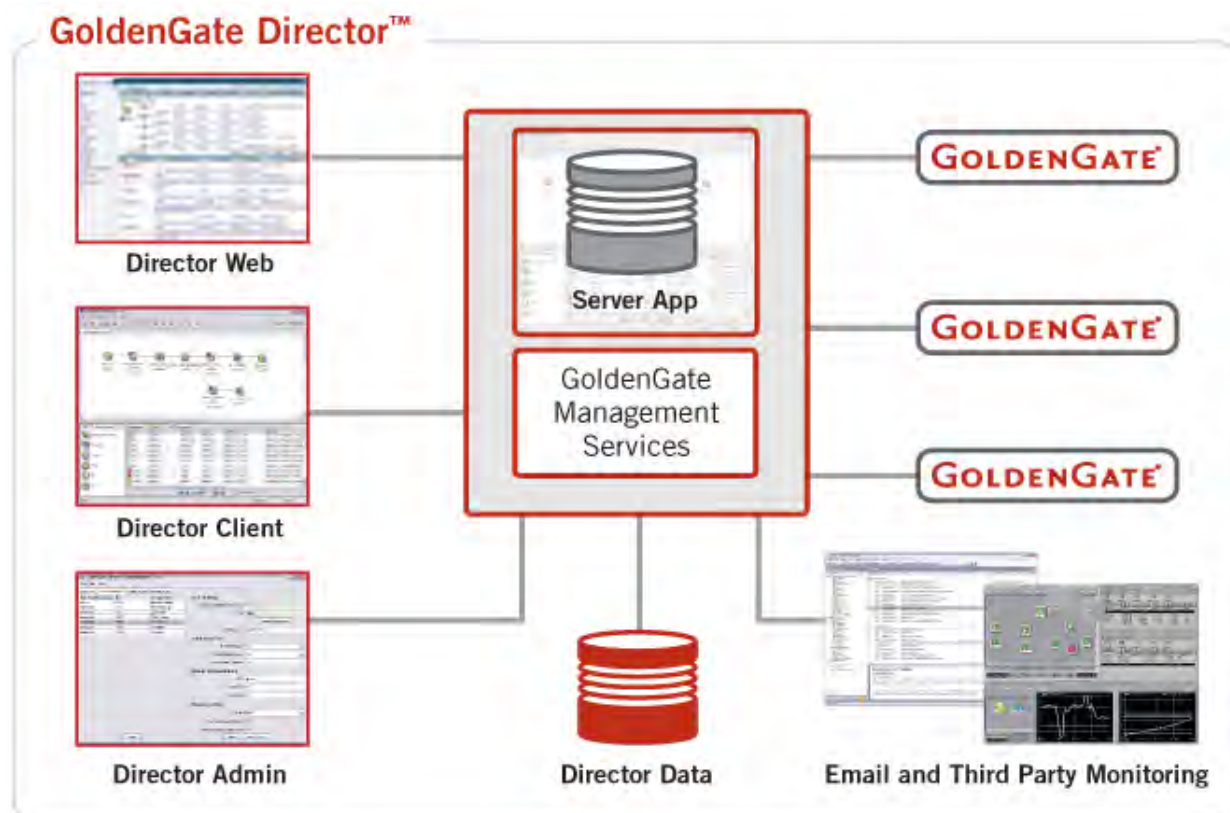
GOLDENGATE DIRECTOR™

GoldenGate Director is a centralized, server-based graphical enterprise application that offers an intuitive way to define, configure, manage, and report on GoldenGate TDM processes. GoldenGate Director leverages the management services of the core GoldenGate platform to help users reduce the deployment time for their TDM solutions.

GoldenGate Director also minimizes human error and enables rapid production of multi-server solutions from a central location — significantly improving productivity and responsiveness while reducing cost and improving return on investment. GoldenGate Director centralizes management processes on multiple hosts and provides real-time feedback on configuration and status changes. Problems are instantly highlighted, so that they can be acted upon immediately.

GoldenGate Director does not impose any additional load on other deployed GoldenGate components. Further, it can be extended to work with third-party infrastructure management solutions to integrate seamlessly into existing enterprise environments.

GoldenGate Director comprises Director Server, Director Client, and Director Web.



GoldenGate Server is the heart of GoldenGate Director, utilizing GoldenGate's Management Services to communicate with the deployed GoldenGate processes and third-party monitoring systems. Director Server runs on the top of a Java application server to facilitate Director Client and Director Web. It provides the following services:

- › centralized repository for security settings, event logs, lag times, records processing, and other statistics about TDM modules
- › establishing and managing connections with the GoldenGate processes
- › triggering of email notification alerts
- › advanced integration with other monitoring solutions through pre-built and custom adaptors
- › support for remote command line sessions

Director Client provides a rich, Java-based client application with extensive capabilities made possible by Director Server. Director Client provides customized network views, easy and visual management of GoldenGate processes and tasks on any number of hosts, consolidated event logs, and email and custom alert notifications.

Director Web is a Web browser-based interface that offers some of the features of Director Client, but without the need to install additional software.

GOLDENGATE VERIDATA™

GoldenGate Veridata is a high-speed, low impact data comparison solution that identifies and reports data discrepancies between two databases, without interrupting those systems or the business processes they support. A stand-alone product, GoldenGate Veridata does not depend on the presence of GoldenGate's core TDM components.

Data discrepancies result from a wide variety of causes. User errors, application errors, and infrastructure problems can lead to out-of-synch conditions. Some of the causes are unintentional, such as input errors, unintended use, application bugs, system failures, disk corruption, or extended network outages. Other causes include malicious activity, with examples being security breaches and employee incidents. Inaccurate data may lead to erroneous or ill-informed decision making, failed service level agreements, and ultimately, financial and legal risk exposure.

GoldenGate Veridata reduces the amount of time and resources required to compare data, eliminates the introduction of human errors, and ensures that potential problems can be instantly identified and addressed. Veridata offers an intuitive web-based graphical user interface as well as command-line capabilities to allow for scheduled comparisons.

- › It can operate against live databases to compare datasets at very high speeds, but with almost no impact on the infrastructure.
- › Unlike an all-or-nothing approach, the user can select pertinent tables or data fields on the source and target databases.
- › The comparison is initiated with just a few simple clicks in GoldenGate Veridata's GUI or through its command line interface.
- › When the user starts the GoldenGate Veridata process, its agents on each data source start to read the data from their respective databases allowing the verification of data to be run unattended.
- › GoldenGate Veridata agents use patent-pending technology to create row signatures that are not only very compact in size, but are also guaranteed to be unique.
- › As the data on the source and target databases continue to change, GoldenGate Veridata's Server compares these row signatures and reports on persistent differences, as well as in-flight data that continues to change during the comparison.
- › Users have the flexibility to determine how to handle in-flight data based on their own business requirements.

CONCLUSION

Today's successful businesses have the ability to access transactional data across disparate systems in real time and can rapidly and accurately convert it into information that is readily available across the enterprise. This enterprise-wide “real-time access to real-time information” enables them to streamline their business processes. With optimized operations, they can service their current customers in the best way and seize the opportunities available in their markets—all contributing to their continuous growth.

Managing transactional data and ensuring its availability, accessibility, and accuracy is not a trivial task. As a core focus, GoldenGate is committed to providing the highest-quality Transactional Data Management software solutions that truly understand and address the needs of customers, while maintaining the highest level of responsiveness that their mission-critical systems require.

GoldenGate enables customers to improve the performance of their transactional systems, ensure uninterrupted availability of mission-critical information, and enable real-time integration of their data across disparate systems. In doing so, customers also fulfill their service level goals and meet transaction accountability objectives.

GoldenGate's TDM software platform and products are used to support a range of IT solutions for hundreds of companies today, spanning business needs for High Availability/Disaster Tolerance and Real-Time Data Integration. The architecture of GoldenGate's core technology allows for rapid deployment and integration for its customers, and enables GoldenGate to deliver upon TDM's promise for:

Real-Time Access to Real-Time Information.

ABOUT GOLDENGATE SOFTWARE

GoldenGate Software, Inc. is the market leader in Transactional Data Management (TDM). GoldenGate's solutions enable customers to effectively maximize the performance, accessibility, and availability of the transactional data that drives their mission-critical business applications.

Providing technologies for capturing, transforming, routing, delivering, and verifying data transactions in real-time and across major databases, GoldenGate helps organizations mitigate risk, reduce costs and increase revenues. Fortune 500 companies leverage GoldenGate solutions to manage critical initiatives for high availability/disaster recovery and real-time data integration.

A privately held company, GoldenGate's more than 300 customers worldwide include Visa, Bank of America, US Bank, UBS, Sabre Holdings, DirecTV, Comcast, Federated Investors, Mayo Foundation and Overstock.com. GoldenGate broadens its global market reach through key relationships with leading application and infrastructure vendors including ACI Worldwide, Business Objects, Amdocs, Eclipsys, GE Healthcare, HP, IBM, Ingres, Oracle, Teradata, and others.



CONTACT INFORMATION

Corporate Headquarters:

GoldenGate Software, Inc.

301 Howard Street

San Francisco, CA 94105 USA

Tel: +1 415-777-0200

Email: sales@goldengate.com

For a list of worldwide offices and for more company information, please visit:

www.goldengate.com