How to Ensure Data Continuity Through Resilience, Failover, and Recovery

Under the Hood of the High Availability Option
Now Available Through Informatica PowerCenter 8
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Executive Summary

Ten years ago, when data integration technology was used principally to move data from operational applications into a data warehouse, high availability was not a paramount concern. In most cases, a system failure during a nightly extract, transform, and load (ETL) process could be tolerated with minimal disruption to business continuity. Back then, data warehousing was still an emerging technology and, in many organizations, not regarded as a mission-critical system. At the same time, high costs and limited capabilities of the high availability technology of the mid-1990s often made data warehousing more trouble than it was worth.

Times have changed. Today, data warehousing—and the data integration technology that makes it possible—is a vital activity that enterprises depend on for insights into business performance. A disruption to data warehouse availability can mean a disruption to business performance.

Moreover, data integration technology is evolving beyond data warehousing to support a variety of mission-critical and time-sensitive operational applications across multiple business and functional areas. Organizations are increasingly taking advantage of enhanced capabilities in data integration platforms for:

- Multidirectional data synchronization among applications
- Mainframe/legacy systems data migration
- Real-time order processing, supply chain, and financials
- Service-oriented architectures

In the operational arena, high availability is imperative. To ensure the reliability of data integration services in mission-critical operational systems, a data integration platform must be expressly engineered for high availability. The incorporation of high availability characteristics for resilience, failover, and recovery is vital if organizations are to avoid data downtime that can interrupt business continuity, alienate customers and partners, and result in millions of dollars in losses.
Many organizations are migrating from large, expensive symmetric multi-processing (SMP) servers to less costly, commodity x86 platform servers or blade systems in a multi-node grid and cluster computing environments. While such a horizontal architecture can improve scalability by balancing loads across available resources, it also introduces more potential points of failure. And as more companies invest in Integration Competency Centers (ICCs), highly available systems are recognized as increasingly important to underwriting strict service-level agreements between ICCs and their internal customers.

For those reasons, organizations strive to ensure that operating systems, applications, and databases running on a grid or cluster are fault tolerant and provisioned with failover capabilities that enable them to run on a secondary machine if a primary machine goes offline, either because of a network failure or planned maintenance.

Informatica has developed a solution that offers advanced resilience, failover, recovery, and load balancing technology in the enterprise data integration platform: the PowerCenter® High Availability Option now available through Informatica® PowerCenter 8. PowerCenter 8 is the latest release of Informatica’s single, unified enterprise data integration platform for accessing and integrating data from virtually any business system, in any format, and delivering that data throughout the enterprise at any speed.

This white paper examines the business drivers for fault-tolerant data integration, high availability features in PowerCenter 8, and how this new technology can:

• Eliminate single points of failure
• Reduce costs and risks of downtime
• Support mission-critical deployments
• Boost scalability with multi-node load balancing
The Need for “Always On” Data Integration

Data integration technology continues to take on a mission-critical role in the enterprise. This trend will continue over the next five to 10 years as organizations continue to progress towards a truly data-enabled enterprise extending across multiple business units, functional areas, and geographic locations.

Manufacturers are networking data integration platforms across time-sensitive supply chain systems for procurement, distribution, inventory management, and radio frequency identification (RFID). Customer service departments are enriching call centers with real-time customer data integration. Financial services and insurance firms are implementing integration platforms for data functions behind minute-to-minute operational decisions that can involve millions of dollars in profit or loss.

This evolution is helping to fuel growth in the data integration market. New license revenue is forecasted to grow at a 6.3 percent compound annual growth rate through 2009, to $505 million worldwide, according to a study by IT analyst firm Gartner in November 2005.1

According to the Gartner study, “the ETL market experienced stronger than expected growth in 2004 and the first half of 2005 as it began to evolve into a market of multipurpose data integration platforms suitable for use beyond the traditional domain of business intelligence (BI) and data warehousing. As the market continues to evolve, larger vendors are building out their products toward this end, putting increased pressure on small pure-play ETL vendors and resulting in additional market consolidation. As a result, ETL as a market will not exist in the long term, but instead ETL will be one integration pattern among many that is supported by the new breed of data integration platforms.”2

“Organizations are using the expanded capabilities found in many ETL providers’ offerings to broaden their intent and vision for deployment of these tools. Tools and vendors are being evaluated for suitability not only for use in the traditional BI use cases, but also for use in delivery of data integration capabilities for service-oriented architecture (SOA), batch-oriented application integration and system migrations. Some organizations are beginning to deploy the tools as an enterprise wide standard for bulk data movement and integration.”3

In short, organizations are deploying data integration technology in the core operational IT infrastructure upon which business depends for efficiency, productivity, communications, and profit. High availability of these systems is essential for business continuity.

High Availability in the Core IT Infrastructure

Businesses’ reliance on IT systems to support mission-critical functions is a double-edged sword. On the one hand, IT systems have enabled businesses to realize enormous gains in productivity, revenue, and competitive advantage. On the flip side, that reliance on IT has become so categorical that an IT failure often means a business failure—millions of dollars in losses, idled employees, disgruntled customers, and bad press.

As a result, most IT organizations have engineered into their core IT infrastructure high availability characteristics towards the proverbial goal of the “five 9s,” or 99.999 percent availability. Many companies have taken advantage of built-in or add-on high availability features available from such infrastructure vendors as HP, Sun Microsystems, and IBM for operating systems, servers, and storage, and from third-party providers such as BMC, CA, and VERITAS.

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2 Ibid.
3 Ibid.
With the High Availability Option, PowerCenter 8 builds on the widely recognized fundamentals of IT infrastructure high availability with a service-oriented architecture that provides the ability to scale services and share resources across multiple machines. It also expands on basic fault tolerance in the basic edition with greater automation and flexibility for configuration and management.

This new environment helps minimize service downtime due to unexpected failures or scheduled maintenance of machines in the PowerCenter environment. It supplies three key components essential to high availability:

1. Resilience
2. Failover
3. Recovery

Fault-Tolerant Data Integration: Resilience, Failover, and Recovery

At a high level, the PowerCenter 8 architecture is based on a domain that serves as a foundation for PowerCenter services. A domain is comprised of nodes and services. Nodes are the machines in the domain, and services are the PowerCenter processes than run on the nodes.

(This white paper focuses on Data Integration Services; more detailed guidance on Repository Service, Web Service Hub Service, and SAP BW [Business Warehouse] Integration Service is available in the PowerCenter Administrator Guide).

Resilience

Resilience is the enhanced capability in the PowerCenter 8 High Availability Option to automatically attempt to re-establish connectivity in the event of a transient, or temporary, failure of a network component. It eliminates the need for administrators to manually restart data extraction, transformation, or load processes, and it may be precisely configured with specified timeout periods and retry frequency.

Resilience extends across all interdependent PowerCenter 8 clients and services. For instance, a Data Integration Service may depend on a Repository Service and its metadata management function. If the node on which the Repository Service runs becomes unavailable, PowerCenter Data Integration Service will attempt to resume processing at administrator-specified intervals.

Resilience similarly covers interruptions to connectivity involving external source and target databases and applications and FTP servers. PowerCenter interoperates with these external systems; of course, they must supply their own mechanisms for high availability.

Because network component failures are often short-lived, resilience built into the PowerCenter 8 High Availability Option enables the enterprise to minimize downtime and eliminates the risk of extended unavailability that can ensue from manual approaches to problem detection and resolution. Generally speaking, resilience may serve as a first line of defense before failover capabilities are executed. 

The PowerCenter High Availability Option provides high availability of all PowerCenter components, seamless failover and recovery of stopped or interrupted work, and simplified setup and management through a configurable services framework. With the High Availability Option, PowerCenter:

- Eliminates all single points of failure, guarding against platform outage and ensuring platform uptime
- Reduces costs and risks associated with data downtime
- Enables mission-critical deployment of PowerCenter for enterprise data integration initiatives
Failover

Failover is the ability for PowerCenter services to run without interruption on a secondary node if a primary node fails or is removed from service for maintenance. Failover is an essential ingredient in ensuring high availability in multi-node cluster and grid environments, but it can be difficult and time-consuming if designed with custom scripts:

• **Manual Restart.** Many homegrown failover mechanisms require an administrator to manually restart a job (sometimes after a pager call in the middle of the night).

• **Start from Scratch.** Similarly, most jobs need to be rerun from scratch—particularly costly and time-consuming if failure occurred 99 percent through a 3-hour job.

PowerCenter 8 High Availability Option enables administrators to select automatic restart, sparing manual intervention and the time required to correct a problem. Based in part on a sophisticated load-balancing algorithm, PowerCenter failover may be fine-tuned as instant or per a specified time, say, after 10 minutes of unsuccessfully attempting to re-establish "resilience" connectivity.

Administrators may specify the node for restart, authorize PowerCenter to automatically detect the optimal node based on existing load and resource availability, and configure any number of secondary, tertiary, and backup nodes. (At present, PowerCenter does not support failback; i.e., migrating the service back to the primary node once it becomes available).

The native failover capabilities in PowerCenter 8 eliminate the need for customers to write custom scripts or deploy costly cluster framework software to cover data integration processes. Conversely, PowerCenter 8 failover does not interfere with existing cluster framework systems. The “start from scratch” problem is addressed by its built-in capabilities for recovery.

Recovery

Recovery is the ability to resume and complete a task on a secondary node after failover from the primary node. PowerCenter services are stateful, or exist in a certain condition based on a sequence of processes, and as such PowerCenter records service states on an ongoing basis. Recovery provides for the reconstruction of the service state on the secondary node, and the resumption of the service.

The PowerCenter 8 High Availability Option offers built-in mechanisms for recovery of Data Integration Services (both single-job sessions and multi-job workflows) and Repository Services. Recovery may be invoked automatically as a specified task in the failover process, or manually using `pmcmd` or Workflow Manager.

Recovery is designed to ensure that the workflow or session job produces the intended results, as if a failure had never occurred. As successful failover of Data Integration Services will be of the greatest concern in most instances, let’s examine how recovery applies to both workflow and sessions.
Data Integration Service Workflow Recovery
Workflow execution of a Data Integration Service may be interrupted by a node failure, or by an explicit stop/abort command from an administrator. If interrupted, PowerCenter 8 will record the execution state in shared storage (e.g., storage area network file systems), including the status of task completion, which tasks were running at the point of cessation, and the value of workflow variables.

Once the Data Integration Service fails over to a secondary node, PowerCenter accesses the shared storage to recreate the execution state as it existed immediately before cessation. Tasks that had been completed need not be rerun; interrupted command tasks are rerun from scratch in either normal or recovery mode, based on administrator configuration.

Data Integration Service Session Recovery
Generally, session recovery for a Data Integration Service is more complex than workflow recovery. PowerCenter 8 provides the administrator flexibility to specify a strategy for recovering an interrupted session task as follows:

- **Skip.** No recovery is performed for the session.
- **Restart.** The session is rerun from scratch.
- **Resume.** The session state is preserved and resumed on the backup node.

Repository Service Recovery
For Repository Services, PowerCenter 8 Repository database records the state of metadata objects, such as objects locked by a specific Designer or Workflow Manager application. This is particularly essential to ensuring that personnel in distributed IT organizations have constant access to common object definitions.

When the secondary node restarts the Repository Services (upon failure of the primary node), the state of the Repository Service is reconstructed (immediately before the failure) before handling new requests. The processes are transparent to active repository clients.

Resource Availability Mapping
The PowerCenter 8 High Availability Option provides administrators with a resource availability map to specify resources available on each node. (In this context, “resources” refers to something required to run a task, e.g., a database connection or file server directory). Available resources may be set statically during node setup, or dynamically by executing a node manager command line utility to add, update, or remove resource availability on certain nodes.

With centralized administration to simplify tasks, this functionality is critical to dynamically reconfigure the grid and redirect session execution to desired nodes by command from session, scheduler, or other applications.
Managing Domains, Nodes, and Services for High Availability

To better understand how PowerCenter 8 helps simplify the management of high availability, it will be helpful to drill down into the platform’s service-oriented architecture and its constituents—domains, nodes, and services. (For more detailed guidance, please see the updated PowerCenter Administrator Guide). The terms domains, nodes, and services are new or revised to PowerCenter 8:

- **Domain.** A PowerCenter domain consists of one or more nodes, or computers, interconnected in a network. PowerCenter services run on the nodes. A domain is the foundation for PowerCenter service administration and may be likened to a cluster or a grid in a network computing environment.

- **Node.** A node is a logical representation of a physical machine that runs a PowerCenter service.

- **Services**. Services are PowerCenter processes that run on the nodes; as noted earlier, they include of Data Integration Services, Repository Services, Web Services Hub Services, and SAP BW Integration Services.

A PowerCenter domain consists of one or more nodes running PowerCenter services. Services are controlled by a Service Manager, a lightweight, non-invasive process that functions as the primary point of control for PowerCenter services running on the nodes. In PowerCenter 8, an administrator may designate one domain node as the **gateway node**. All Service Manager requests are routed through the gateway node.

To provide for automatic failover, the PowerCenter 8 High Availability Option enables administrators to configure multiple nodes to serve as gateway nodes. Thus, if the primary gateway node becomes unavailable, the Service Manager fails over to a secondary gateway node and to help ensure:

- Domain control by monitoring the availability of secondary nodes in the domain
- Dynamic service address redirection and lookup for client applications
- Uninterrupted management of application and core services

**Ensuring Continuity of Dependent Data Services**

Consider a hypothetical example. PowerCenter 8 is configured to provide services across heterogeneous systems in a service-oriented architecture with the following sample components:

- A Web-based order processing platform
- A homegrown supply chain procurement and logistics system
- An SAP Financials application running atop an IBM DB2 database
- An SAP BW instance to capture transactional data for reporting and analysis.

Such a scenario involves multiples service types that may reside in multiple nodes across the same domain, or even in multiple nodes across multiple domains. These services are called dependent services. In other words, one service depends on another service to enable closed loop, event-driven process execution. For example, a Data Integration Service may depend on a Repository Service for job metadata, or a Web Service Hub Service may depend on Data Integration and Repository Services to which it provides interfaces.
In a business context, our hypothetical SOA is a mission-critical system that supports online customer ordering, product distribution and fulfillment, raw materials replenishment, and accounts receivable reconciliation. Disruption of any of the interdependent data integration services can exact stiff penalties ranging from lost revenue to customer dissatisfaction.

The High Availability Option enables IT architects to build in high availability characteristics for resilience, failover, and recovery across the disparate systems. An administrator may configure primary and secondary nodes for Service Manager execution. Figure 1 illustrates a representative service architecture for high availability.

![PowerCenter Service Architecture for Failover and High Availability](image)

**Figure 1: PowerCenter Service Architecture for Failover and High Availability**

**Configurations for Maximum Availability**

The degree of high availability achievable with PowerCenter 8 High Availability Option depends on the administrator’s configuration of nodes and services within a domain, storage systems for shared files used by services, and external systems, such as databases and FTP servers.

**Nodes and Services**

When configuring and tuning nodes and services, greater availability may be realized by:

- Configuring the service to restart in the event of a failure
- Installing and configuring the services on multiple nodes
- Choosing at least two gateway nodes to route Service Manager requests
- Making resources (e.g., database connections, file server directories) available to at least two nodes
Administrators should also select highly available storage and external systems to support and maximize the high availability capabilities of PowerCenter 8:

• **Storage Systems.** A shared file system (such as a storage area network) should support PowerCenter 8 High Availability Option to store domain configuration files, log events, recovery information, and Data Integration Service files, including cache and workflow and session recovery information. The storage system should be accessible to all pertinent gateway nodes.

• **External Systems.** As PowerCenter depends on databases and other external systems as repositories, source and target applications, and file systems, it’s important that those supporting systems be configured for high availability as well. The Oracle 10g database, for instance, provides a number of features intended to ensure continuity, including backup and recovery and support for cluster- and grid-based networks.

**Scalability and Extensibility of Highly Available Data Services**

Besides enabling failover to secondary or backup nodes, PowerCenter 8 High Availability Option enables administrators to increase scalability of data services by specifying multiple nodes in grid and cluster environments. This capability will be particularly valuable in optimizing resource utilization and providing capacity on demand in time-sensitive and transaction-heavy IT infrastructures tasked with high numbers of concurrent sessions and client applications and services.
The new load balancing technology enables PowerCenter 8 to distribute data services session and command tasks across multiple nodes based on CPU usage, memory, and other criteria. In configuring for scalability, there is no concept of a primary node. Rather, data services are dynamically and evenly distributed across all specified nodes based on each node’s capacity.

**Boosting Scalability in Grid and Cluster Environments**

Resilience, failover, and recovery capabilities are inherent in the sense that a data service running on a node that becomes unavailable are transferred and resumed to an available node. PowerCenter 8 High Availability Option can enhance data services scalability in both grid and cluster environments:

- **Grid.** Grid environments consist of heterogeneous nodes that may run a variety of blade system, commodity x86 servers, and proprietary hardware and operating system platforms from HP, Sun Microsystems, and IBM. Applications in a grid environment often require different types of resources, i.e., an application that processes SAP data requires SAP connectivity, and a data cleansing application may require a U.S. postal directory located on a specific node.

  The grid will dispatch the jobs across various nodes based on resource requirements with the objective of evenly balancing the load, and enables administrators to add or remove nodes with no or negligible impact on system performance and scalability.

- **Cluster.** Cluster environments are generally comprised of homogenous nodes and operating systems. Cluster management software from such vendors as HP, Sun Microsystems, and IBM, is frequently deployed as a cluster framework.

  Clusters may be configured as shared disk, by which all nodes in the cluster may access data on any disk via independent software called a distributed lock manager (DLM), or shared nothing, in which each nodes “owns” its disks without sharing; this may enable greater scalability by eliminating DLM bottlenecks but can complicate failover.

**Integration Competency Centers: Extensibility for Highly Available Data Integration**

For many organizations, the deployment of highly available data integration technology in support of mission-critical systems and service-oriented architectures will encompass multiple business units, functional areas, and geographic locations across the enterprise. Those organizations may benefit from the creation of an Integration Competency Center, or ICC.

ICCs are an organizational approach designed to increase agility and lower costs by creating a central pool of skilled resources, promoting reuse, sharing best practices, and establishing common processes and standards for integration. They are particularly relevant in providing extensibility across the enterprise for PowerCenter 8’s high availability capabilities.

Informatica supports and encourages organizations to establish ICCs. ICCs have four basic models:

1. **Best Practices.** This ICC model defines processes for data integration initiatives and recommends appropriate technology, but does not share the development workload with individual project teams. The result is a higher overall return on investment (ROI) for each data integration initiative.

2. **Technology Standards.** This ICC model standardizes development processes on a single, unified technology platform, enabling greater reuse of work from project to project. Although neither technology nor people are shared, standardization creates synergies among disparate project teams.
3. **Shared Services.** In this ICC model, processes are defined, architecture is standardized, and a centralized team maintains shared work and environment, but most development work occurs in the distributed lines of business. This hybrid centralized/decentralized model optimizes resources.

4. **Central Services.** Centralized integration initiatives can be the most efficient and has the most impact on the organization. In this ICC model, standards and processes are defined, technology is shared, and a centralized team is responsible for all development work on integration initiatives.

**Conclusion: Meeting the Highly Available Data Integration Challenge**

The increasing deployment of data integration technology in both the data warehousing and operational realms brings both risk and reward. The reward is a robust platform that can source data from virtually any source, flexibility for right-time delivery to multiple targets, and enhanced capabilities for data lineage and auditing that are essential to achieving regulatory compliance.

The risk is that many organizations cannot afford mission-critical data integration functions to fail. At the same time, they require “always on” data integration availability to accommodate planned maintenance with no interruptions to business continuity. As organizations transition from monolithic SMP servers to grid and cluster environments, they have the opportunity to extend data integration technology across multiple nodes to realize greater scalability and resource optimization through load balancing, and to provide the high availability that today’s business climate demands.

The High Availability Option now available through PowerCenter 8 supplies that assurance with built-in capabilities for resilience, failover, and recovery. It is expressly engineered to automate tasks that are often costly and time-consuming with homegrown high availability mechanisms. Its centralized configuration and administration builds on PowerCenter’s renowned ease of use with a single point of control that extends across grid or cluster environments ranging from a handful to thousands of nodes. As data integration technology continues to assume a more prominent role in the enterprise, so too will high availability grow in importance among the features sets of data integration platforms.

For more information about PowerCenter 8 and the PowerCenter High Availability Option, please visit us at www.informatica.com/powercenter8 or call (800) 653-3871.