HP NonStop Business Continuity Product Suite: An Introduction

Protecting Your Data, Your Applications, and Your Business

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In today's global business environment, companies must maintain their business services capabilities 24 hours a day, every day. Any interruption in service can alienate customers and can cost the company customers and thousands of dollars a minute in lost sales. It is imperative that the IT systems that are the backbone of these critical services never fail.

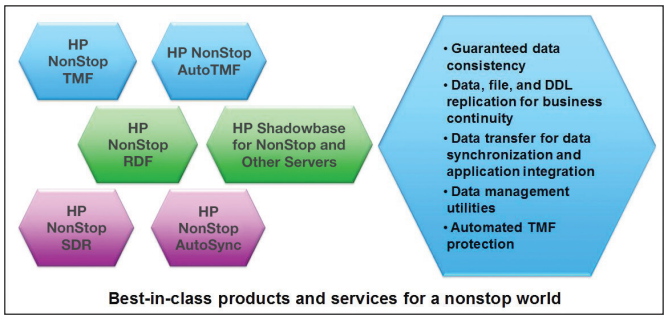
HP NonStop servers deliver this level of reliability. Incorporating a fault tolerant architecture with multiple processors and fully mirrored disks, a NonStop server will survive any single point of failure with no interruption of service. However, a NonStop server can be taken down by catastrophes such as fire, flood, or earthquake, causing an unplanned outage. In addition, planned outages occasionally may be necessary for hardware or software maintenance and upgrades.

The only protection against a system outage is to have another system, a backup system, ready to take over the provision of IT services if the primary system fails. To provide this capability, the backup system must be kept synchronized with the primary system so that the backup system always has the same application state as the primary system and can therefore continue processing from where the primary system leaves off.

In transaction-processing systems, the application state is represented by the contents of the application's database. Therefore, for business continuity purposes, it is important to keep the application databases of the primary and backup systems synchronized. This is accomplished via data replication. Whenever a change is made to the primary database, that change is immediately replicated to the backup system to keep its database synchronized.

The HP NonStop data replication software suite supplies several key products to synchronize application databases and other essential application files across multiple systems, thereby ensuring continued service availability in the event of a planned or unplanned system outage. The product suite comprises:

- *HP NonStop Transaction Management Facility (TMF)*
- *HP NonStop AutoTMF*
- *HP NonStop RDF*
- *HP Shadowbase for NonStop and Other Servers*
- *HP Nonstop SQL Data Definition Language Replicator (SDR)*
- *HP NonStop AutoSYNC*



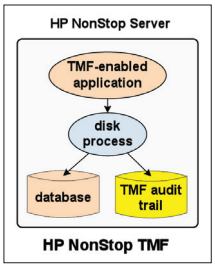
Best-in-class products and services for a nonstop world

In addition, Pathway domains implemented by HP NonStop TS/MP allow applications to be replicated across multiple systems, maintaining Pathway application availability in the event of a system outage.

The power of data replication is not limited to ensuring business continuity. It is also valuable to integrate disparate databases and applications. Database changes in a system can be transformed and replicated to another database or sent as events to be processed in real time by an application running on another system.

HP NonStop Transaction Management Facility (TMF)

The HP NonStop TMF transaction manager is the foundation for building fault-tolerant and disaster-tolerant applications on HP NonStop servers. For applications that are TMF-enabled, TMF guarantees the consistency and the correctness of the Enscribe and NonStop SQL databases maintained by the applications. It accomplishes this ability by ensuring that either all of the operations included in the application's transactions are applied to the database, or none are.



Transactions are durable, surviving any fault in a NonStop server, by safe-storing all changes to the database in a mirrored, disk-based audit trail. The TMF audit trail is the heart of TMF. An application is not informed of the completion of a transaction until its changes have been safe-stored in the audit trail. After a system recovers from a failure, the audit trail's contents are used to roll back any incomplete transactions. The audit trail can be used to restore files that have been corrupted or that have been accidentally deleted.

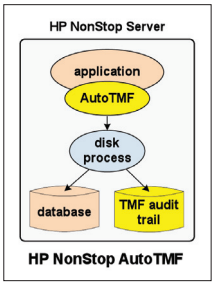
TMF allows databases to be reorganized online. Backups can be written to physical or virtual tape without application downtime. Archived audit trails can be accessed to restore corrupted or deleted files while the system is fully operational.

Because transaction durability is guaranteed by the audit trail, the actual data in the databases does not have to be written to disk immediately. Instead, updated data blocks can be batched and written to disk at the convenience of the operating system. Thus, application processing capacity and response times are significantly enhanced by TMF.

TMF provides an interface which allows it to support the management of transactions distributed across a heterogeneous network of other systems.

As will be described in upcoming sections, the TMF audit trail plays a key role in many of the HP NonStop data replication facilities. It provides a log of all database changes to be replicated to other systems.

HP NonStop AutoTMF



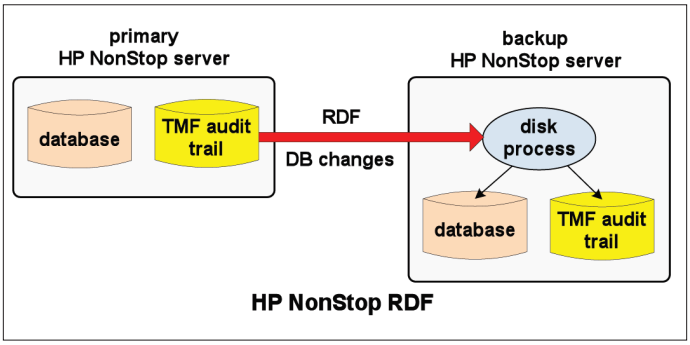
Many legacy applications have been written without using the HP NonStop TMF transaction manager. In such instances, HP NonStop AutoTMF supports existing application unaudited Enscribe files, allowing applications to be TMF-protected without the need for coding changes or recompiling. AutoTMF permits such applications to take advantage of the TMF transaction protection of audited databases and to benefit from the performance improvements delivered by TMF.

AutoTMF can be configured to audit only one or any subset of applications or files. Once a file is placed under AutoTMF protection, AutoTMF will dynamically determine effective and efficient transaction boundaries within the application. These delineated transactions are then written to the database under the TMF transaction manager.

By instrumenting an application with AutoTMF, changes to unaudited files are written to a TMF audit trail. This is a requirement for replicating the data in unaudited files to other databases.

HP NonStop Remote Database Facility (RDF)

HP NonStop RDF extends the NonStop server's fault tolerance to disaster recovery. Using the audit trail generated by NonStop TMF and operating-system level services, RDF instantly replicates audited database changes to identical target databases on one or more target systems. Thus, in the event of a failure of a primary system, the application can be recovered to a backup system within minutes and with minimal data loss. RDF will back out any incomplete transactions on the target system when the target system takes over processing.



RDF can be configured to protect individual audited files or tables, the contents of one or more subvolumes, or entire disk volumes. It can replicate changes to one or more target systems. Alternatively, it can replicate changes from many source databases to a single target database to provide a single backup for multiple production systems.

RDF is useful for upgrading hardware and software with no application downtime. The backup system is taken offline and upgraded. Application processing is then redirected to the upgraded backup system, and the other system is upgraded.

Though applications on the target system cannot open databases for write access that are being replicated by RDF, they can read the target databases. On the target system, other applications can be running, replicating their database changes to other target systems. If the backup system has to take over processing, the backup applications open the application databases for write access before continuing application processing.

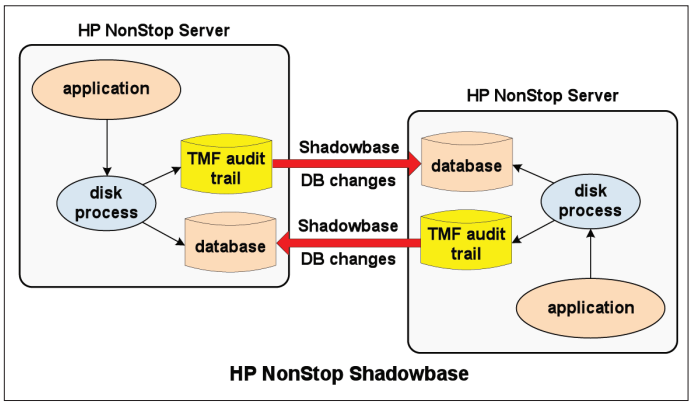
There is a small time latency between when transactions are executed on the source system and when they have been successfully replicated to the target system. Thus, transactions in the replication pipeline may be lost due to a primary system failure. If this loss is unacceptable, RDF implements a Zero Lost Transaction (ZLT) feature. With ZLT, the audit trail disk mirrors are split; and one mirror is located up to 100 kilometers from the production system. No transaction completes until it has been successfully written to the remote mirror. The remote mirror is available to a backup system if the backup system needs to take over processing with no lost transactions.

HP Shadowbase for NonStop and Other Servers

Similar in nature to RDF, HP NonStop Shadowbase replicates audited database changes that have been recorded in the database's TMF audit trail to one or more remote target databases. However, Shadowbase brings many additional advantages to data replication.

Shadowbase allows a target database to be opened for read/write access by applications on the target system. Consequently, Shadowbase supports bi-directional replication. An application can be running on more than one NonStop server, each server updating its own copy of the application database. The databases are kept synchronized via Shadowbase data replication. Whenever a change is made to one copy of the database, that change is immediately replicated to the other databases in the application network. Thus, all nodes in the application network are actively processing transactions and are sharing the transaction load amongst themselves. *This is called an active/active network.*

Besides load sharing, an important characteristic of Shadowbase active/active networks is that recovery time from a node failure is nearly instantaneous (and in a two node configuration, half the users do not even notice an outage at all). If a node fails, then transactions are rerouted from the failed node to one or more surviving nodes. There are no failover faults because it is known that nodes being used for recovery are operating properly – after all, they are themselves currently processing transactions.



If the structure of an application is such that it cannot run in a distributed environment, the Shadowbase active/active architecture can be applied to a *sizzling-hot-takeover* (SZT) configuration. In this mode, applications are up and running in two nodes; but all transactions are routed to only one node. If that node fails,

then transactions are routed instantly to the surviving node. SZT offers the same rapid recovery that an active/active configuration provides, but without the problems facing a fully active/active application (i.e., the possibility of data collisions).

With its rapid and reliable failover capabilities, Shadowbase offers Zero Downtime Migration (ZDM). If an application, operating system, or hardware needs to be upgraded, all one has to do is to take one node offline, perform the upgrade, and then return it online. The process is then repeated on the other nodes in the application network. Because node outages can be recovered with little or no user impact, this upgrade process eliminates planned downtime while nodes are being switched in and out of the application network for maintenance.

Shadowbase does not require the source and target databases to have the same structure nor that the source and target systems be running the same operating system. In fact, the source and target databases can be from different vendors running on different operating systems. Shadowbase supports powerful data transformation capabilities to modify source database changes that meet the requirements of the target database. Thus, Shadowbase supports highly heterogeneous application networks.

Supported databases include NonStop Enscribe, NonStop SQL, Oracle, Microsoft SQL Server, Sybase, IBM DB2, MySQL, among others. These databases may be running under the NonStop Kernel OS, NonStop OSS, HP-UX, Microsoft Windows, Red Hat Linux, or Oracle Sun Solaris operating systems.

The heterogeneous capabilities of Shadowbase allow it to offer important functionalities beyond data replication. Predominant among these other capabilities are data integration and application integration. Changes to one or more source databases can be added to target databases that are used for entirely different purposes but which need to be kept current with the data generated by other applications. This is data integration. Likewise, changes to a source database can be sent by Shadowbase directly to remote applications for real-time event processing. This is application integration.

Shadowbase also offers data management utilities necessary for managing distributed data environments. The utilities include:

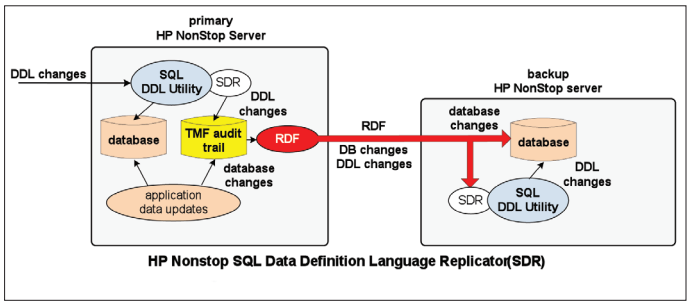
- UNDO: Database "rewind" utility to undo changes made to a set of source files and/or tables while the database remains online and available to applications.
- REDO: Rolls forward selected database changes onto an earlier (typically saved/restored) copy of the database to recover the database to a prior, correct version, after various forms of database corruption occur.
- SAL (Shadowbase Audit Log): Creates a searchable archival database of NonStop transactional activity (inserts, updates, and deletes) on a reporting database for application change data-auditing purposes (for NonStop Enscribe, NonStop SQL/MP, and NonStop SQL/MX, as source databases).
- SAR (Shadowbase Audit Reader): Analyzes and displays all audited database activities, using the NonStop TMF audit trail files, and optionally reads “foreign” audit (audit produced on another system).

HP Nonstop SQL Data Definition Language Replicator (SDR)

The structure of NonStop SQL databases occasionally needs a change. IT staff enters data definition language (DDL) operations, such as creating a table, adding a column, or moving a partition. DDL operations normally are not replicated by RDF, as they do not appear in the audit trail. HP NonStop SDR handles this role. It replicates DDL operations made to SQL/MP databases to backup target databases via RDF.

Without SDR, the IT staff must down TMF and RDF on both the primary and backup systems, invoke the DDL operation on both systems, and then restart the systems. The result is a planned outage that typically must be scheduled for off hours. It is a manual process and thus is subject to human error. It must be performed identically on both the primary and backup systems. Otherwise, the structure of the primary and backup databases will be different, and subsequent RDF data replication will fail.

When SDR is used, DDL statements are intercepted on the primary system and are inserted into the TMF audit trail, from where they are then replicated by RDF. The DDL statements are applied to the backup database by RDF via SDR in the proper order with respect to the stream of database changes. Therefore, no downtime is required to restructure an application database; and the possibility of an RDF failure due to manual errors is eliminated. As an option, DDL operations on unaudited SQL tables can be replicated by SDR.



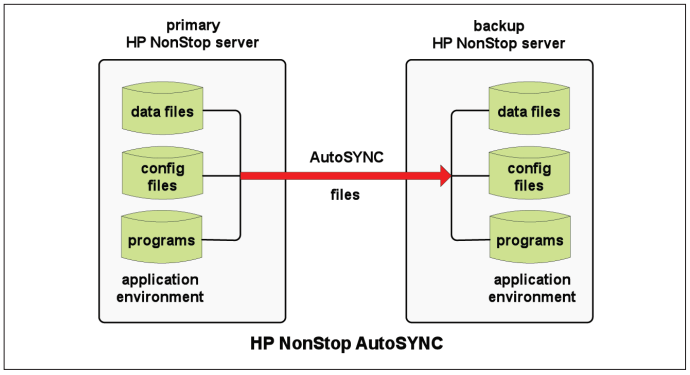
HP Nonstop SQL Data Definition Language Replicator(SDR)

HP NonStop AutoSYNC

From a disaster-recovery viewpoint, the role of RDF and Shadowbase is to maintain an accurate and current image of audited databases on a backup system. However, this role is not sufficient to ensure reliable takeover by a backup system if the primary system fails. There are numerous other files that define the application environment, and these files must all be mapped accurately to the backup system. They include unaudited data files, configuration files, and program executables.

Typically, when a critical file is changed on the primary system, manual operations must be executed to move a copy of the file to the backup system. This procedure is subject to human error and can lead to *configuration drift*. If the configuration of the backup system is not identical to that of the primary system, a failover fault is likely if the primary system fails. The backup system may refuse to come up or be restarted with an incorrect version of software.

HP AutoSYNC addresses this challenge. It automatically ensures that the application environment on the backup system is identical to that of the primary system. Using a configured list of files that are important to the application environment, AutoSYNC monitors these files on the primary system and immediately replicates changed files to the backup system. The backup system configuration is therefore always synchronized with the primary system, thereby guaranteeing a successful failover. AutoSYNC can be configured to replicate files to any number of target systems.



HP NonStop AutoSYNC

Virtually all file types are supported, including audited and unaudited NonStop SQL tables; audited and unaudited structured files; unstructured files such as edit files, OSS files, and directories; and partitioned files. Files necessary to start and maintain applications also are handled by AutoSYNC. Included are configuration files, batch files, object/source files, OSS files, BLOBs, TACL macros, and Obey files.

AutoSYNC supports triggers that can initiate any function whenever a file is changed. Triggered functions can include executing a TACL command, compiling a SQL program, or starting a program such as a batch job. AutoSYNC also supports automatic software distribution and can be used to initially load systems being brought online by synchronizing the files of the new systems with those of a primary system.

HP NonStop TS/MP and Pathway Domains

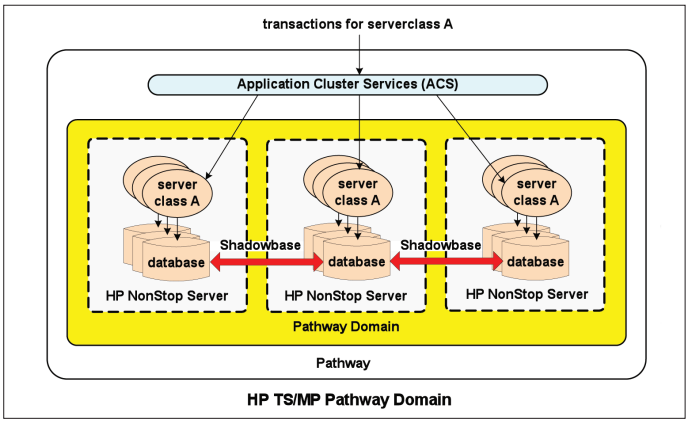
Maintaining a copy of the application database on remote systems is only one requirement for disaster recovery. The application must be resident on the remote systems as well. Equally important is that the applications and the application environment be identical (or at least similar) on all systems in order to avoid failover faults. This requirement adds to the complexity of managing active/backup configurations and exposes these systems to human error.

HP NonStop TS/MP offers an elegant solution to this conundrum, Pathway domains. In a single NonStop system, Pathway provides an environment (PATHMON) that implements application scalability by distributing workloads across dynamic pools of application server processes (serverclasses). A serverclass spans multiple processors within the NonStop system. The number of servers in a serverclass can be dynamically scaled up or down to meet existing transaction loads. Pathway's Application Cluster Services (ACS) distributes transactions to servers in a serverclass to maintain load balancing.

If a processor fails in a NonStop server, ACS distributes transactions to application servers residing on surviving processors. Thus, recovery from a processor failure in a NonStop system is virtually instantaneous. PATHMONs are a fundamental mechanism of the fault-tolerant capabilities of NonStop servers.

PATHMONs can be distributed across multiple NonStop servers in an application network. Such a set of distributed PATHMONs is called a *Pathway domain*. In a Pathway domain, serverclasses are distributed not only among processors within a NonStop node but also among NonStop nodes in an application network.

Pathway domains furnish three important advantages for business continuity. The system administrator, when configuring the domains, can ensure that all processes in a server class across all domains are derived from a common executable. Consequently, the application processes are automatically consistent across all NonStop nodes, thus eliminating failover faults. Another advantage is that if a NonStop system fails, further transactions are routed instantly by ACS to application processes running in surviving nodes. Thus, recovery from a system failure is instantaneous. Finally, since all of the domains in a Pathway domain are independently configured, upgrades may be made with zero downtime by taking down a domain, upgrading it, returning it to service, and rolling the upgrade through the other domains one at a time.



HP TS/MP Pathway Domain

To avoid a single point of failure, that portion of each serverclass resident in a NonStop server node should have its own local application database. These databases must be kept synchronized so that the applications in each node have the same view of the application database. It is a function satisfied by the use of Shadowbase active/active replication. Shadowbase ensures that an update to any one database is immediately reflected in all of the application's distributed databases.

Summary

HP NonStop servers achieve an extraordinary level of business continuity by providing a fault-tolerant environment in which applications can run. HP NonStop's suite of replication products extends the NonStop server fault-tolerant capabilities to geographically distributed networks of NonStop servers, thus protecting against the total failure of a single NonStop system.

Data replication begins with HP NonStop TMF and HP NonStop AutoTMF audit trails, which supply a queue of database changes for replication to remote target databases. RDF uses operating-system level services to deliver nearly instantaneous uni-directional data replication of audited databases. Shadowbase supports bi-directional data replication of audited databases. With Shadowbase, active/active systems can be configured so that all nodes are actively processing transactions for a specific application. Recovery from a node fault is nearly instantaneous with active/active systems. Shadowbase also supports sizzling-hot-takeover, which provides almost the same levels of availability of active/active systems, but without the headache of data collisions.

The RDF and Shadowbase data replication products are augmented by HP NonStop SDR and HP NonStop AutoSYNC. SDR provides replication of DDL changes made to NonStop SQL

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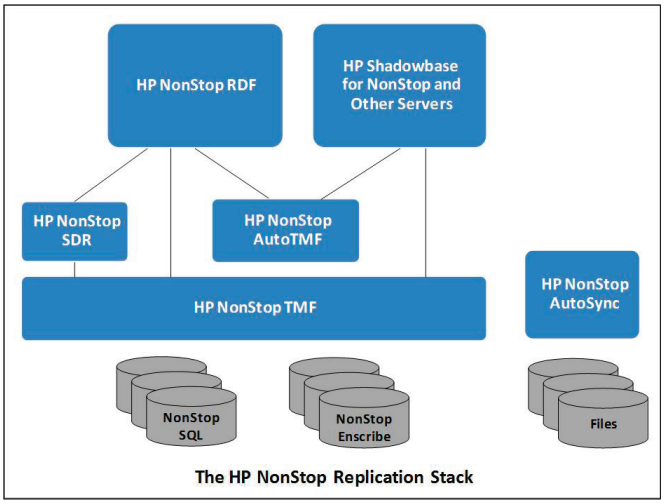

The HP NonStop Replication Stack

databases. AutoSYNC implements replication of unaudited files to ensure that the application environment is consistent across all nodes, a necessary condition for reliable failover in the event of the outage of a primary system.

Pathway domains extend the data replication capabilities of the HP replication suite to include application replication. Pathway domains can be configured to maintain Pathway application availability when a node outage occurs.

With its extensive heterogeneous capabilities, the Shadowbase data replication engine also implements data integration and application integration. For data integration, the changes to a source database can be replicated as modifications to data stored in other databases, thereby allowing disparate databases being used for other purposes to maintain data synchronization with the source database. For application integration, Shadowbase can replicate changes being made to a source database to other applications, allowing those applications to process events in real time.

Today's HP NonStop servers are the culmination of more than 40 years of continuous availability expertise. No other platform provides such a comprehensive and powerful processing architecture as the NonStop server, the best choice for enterprises that cannot risk data loss or service downtime.

Ajaya Gummadi is currently the Worldwide Product Manager with HP's Mission-Critical NonStop Servers Business Unit. In this role, she is responsible for driving the database and cloud product strategy for NonStop servers, managing NonStop ecosystem, and working with NonStop R&D developers on delivering product innovations that enable HP customers to create scalable and always available applications for their business needs. She has an EMBA from GSBM, Pepperdine University, and a Master's degree in Computer Science from BITS Pilani, India.