Information Management software

High Availability and Disaster Recovery

Creating Robust and Reliable Data Server Clusters with IBM® DB2® Express-C 9.5

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1. Executive Summary

The goal of a High Availability and Disaster Recovery (HADR) solution is to provide a means to shift data processing and retrieval to a standby system in the event of a primary system failure.

The recently announced DB2 Express-C 9.5: 12 Month License and Subscription offering gives companies and organizations with top flight database requirements the ability to run a high availability infrastructure at a very attractive price point.

IBM DB2 products are known for their reliability and their extensive administration and application development toolsets, and the inclusion of a high availability licensing option makes DB2 Express-C an even more attractive choice for your database software needs.

2. DB2 Express-C 9.5: 12 Month License and Subscription

IBM announced that the no-charge DB2 Express-C database will have an available support license offering, aimed at lower and mid-market database segments. This new DB2 Express-C 9.5 offering includes a license for the DB2 High Availability (HA) code, offering customers the ability to create a best of breed database HADR infrastructure within their own organizations for minimal database software costs.

The HADR application code included in this latest offering of DB2 Express-C 9.5 seamlessly manages the replication of logged databases for local or remote systems. Database logs from the HADR primary system are sent via TCP/IP network connection to the HADR standby system where they are applied to the replica database. This standby database is then able to take over data transaction and processing if the primary

system is offline, because of system upgrades, hardware failure, or in the event of a disaster striking the primary data center.

3. HADR Benefits

Why choose to set up an HADR solution for your organization?

The benefits of providing your customer base with uninterrupted data access are clear: more uptime means more bottom line results. There are no worries about being called to account for lost revenue or customers due to system instability or downtime.

A full DB2-supported HADR solution gives you:

- Lightning fast failover capability, with complete transparency for customers and client applications
- Full transaction atomicity to prevent data loss
- The ability to upgrade systems or applications without visible service interruption
- Remote system failover, providing full recovery from local disaster striking the data center
- The ability to run 1 to 1, n to 1, or 1 to n scenarios for primary to standby databases on different systems, since HADR replication occurs at the database level, rather than the DB2 instance level
- Easy management with DB2 graphical tools
- All of this with negligible impact on overall system performance over a standard database

4. HADR Synchronization

Synchronization of DB2 database logs is essential to maintaining the HADR infrastructure between the primary and standby systems. DB2 Express-C offers an HADR administrator several choices for balancing performance and reliability.

The first option is a full **Synchronous** mode. In this scenario, log writes on the primary system are held until the standby system sends an acknowledgment that the same log page has been written to the standby database. The benefit here is that there is no possible data loss between the systems, but this comes at the cost of performance on the primary, because the primary logging is held up until the confirmation message is returned.

The second choice, and the default choice for DB2 HADR, is the **Near Synchronous** mode. In Near Synchronous mode, the primary system again sends the log page to the standby system, and holds the primary log write, but in this mode, the acknowledgement needed for the primary log write is sent back as soon as the standby system has received the log. The standby log writer then proceeds to add the information to the standby database. While this does create the remote possibility of data loss if the standby and primary both fail simultaneously, this mode is the best compromise of speed and reliability for the HADR infrastructure.

The final option is an **Asynchronous** mode, where the primary log writes are written to the primary disk and then sent out to the standby system for the standby log replication. Obviously, any failure of the primary, standby, or the connecting network would cause the loss of the log data; then any failure to the primary system would mean actual data loss after an HADR failover.

The following figure outlines the three possible modes in relation to their position in a successful database transaction.

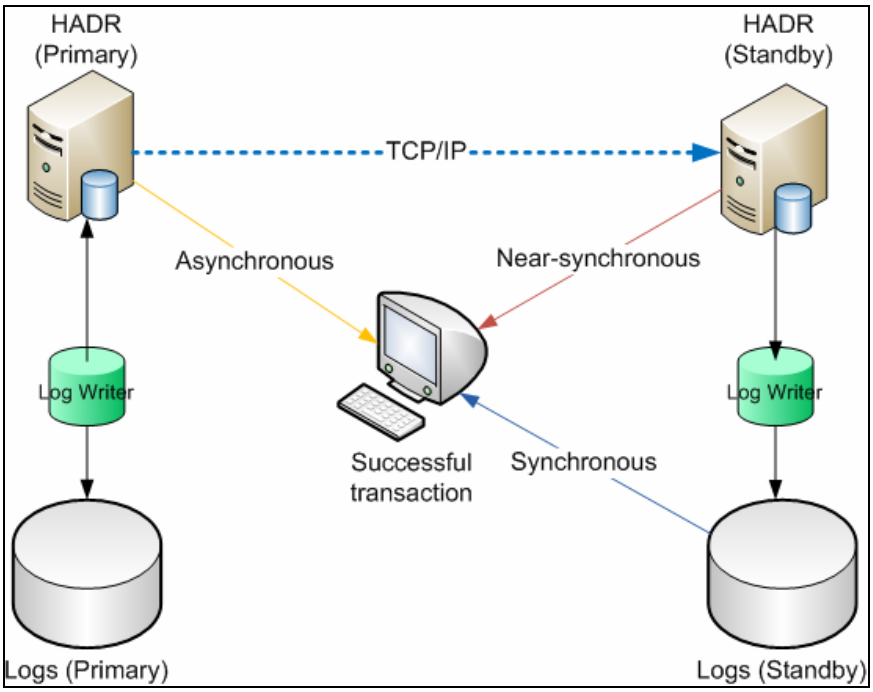


Figure 1: HADR Synchronization Modes

5. HADR Client Routing

Client application connections are the heart of any database processing system. In an HADR infrastructure, DB2 utilizes automated client routing (ACR) settings to properly manage client requests to the database. The ACR is aware of which system holds the primary database in the HADR infrastructure and will direct all incoming client requests there.

The connection information (hostname and service port) for the standby database is set by the HADR administrator on the primary system. This information is transferred to the client when a connection is made to the primary database.

In the event of a primary database failure, the client application will receive a connection failure message and will then attempt to connect to the standby system using the stored ACR information. Once the standby

database has taken over as the new primary through the HADR failover process, it will then accept the client connection and the application can continue uninterrupted.

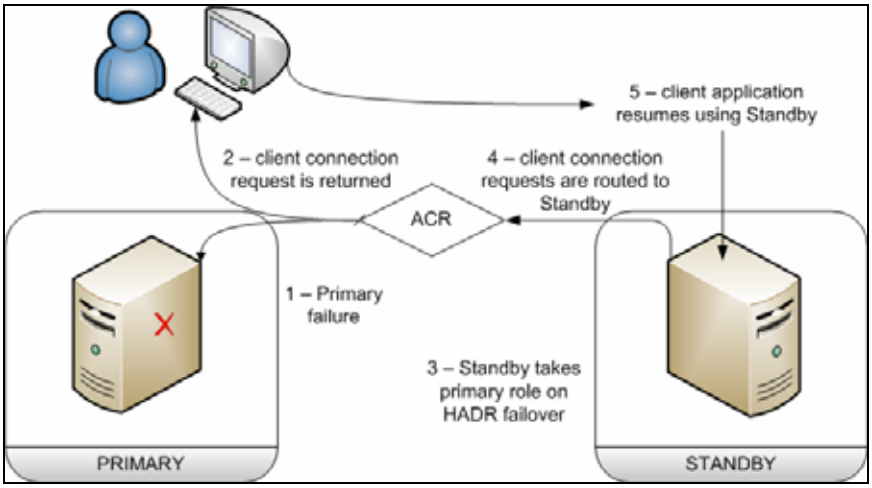


Figure 2: HADR Automatic Client Routing

6. Requirements

To fully enable a DB2 HADR solution, both the primary and standby systems must have:

- A reliable TCP/IP network connection
- A licensed copy of the DB2 Express-C 9.5: 12 Month License and Subscription offering to provide the HA licensing
- The operating system and its level must be the same (either all Windows® or all Linux®, with the same patch level, and, on Linux, the same kernel level)
- The DB2 application version (e.g. DB2 9.5) and bit-level (e.g. 32 or 64 bit) must be the same
- The DB2 databases must have the same database name on each system
- The DB2 database table spaces much be identical in terms of table space type and size, and the container path, size and file type must be the same
- The DB2 buffer pool sizes should be the same

- The space allotted for database log files should be the same

Bear these requirements in mind when planning to implement an HADR solution.

7. Basic HADR Setup

In DB2, a graphical setup wizard provides the HADR administrator an efficient and straightforward means of creating and managing an entire HADR infrastructure from scratch.

A complete step-by-step guide to installing the entire HADR infrastructure is beyond the scope of this document, but the simplified setup is as follows.

On the primary system, select the existing database to be replicated and open the High Availability and Disaster Recovery set up wizard:

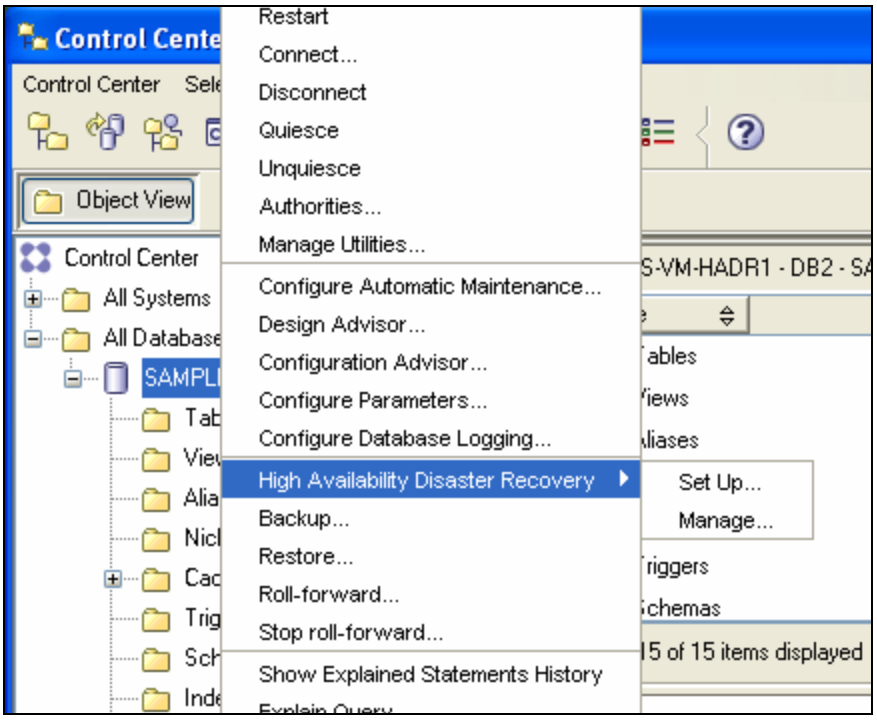


Figure 3: Launch HADR Set Up Wizard

After this, confirm the primary database settings, setting up archival logging (if required), and take a database backup. This backup will be used to create the new standby database.

The next step is to identify the standby system and the specific instance where the standby database will reside:

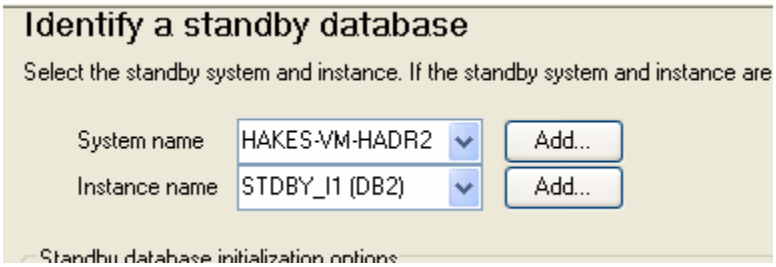


Figure 4: HADR Standby configuration wizard

DB2 must be installed and running on the standby system, and an instance must already exist (this is typically part of a normal DB2 installation). The DB2 database discovery feature can be used here to retrieve the settings for the standby DB2 server.

After the standby system and instance have been set, the HADR wizard will create the standby database. The recommended method is to use a recent backup of the primary database:

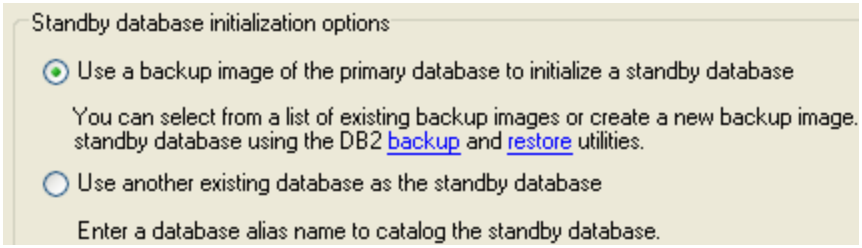


Figure 5: HADR Standby initialization options

There is also an option to copy over any DB2 database objects that are not normally part of a database backup, so that the standby database has all the DB2

objects as the primary database and any potential HADR takeover will go smoothly.

The HADR wizard then configures the network communication parameters, including the HADR ports, and initializes the automatic client routing (ACR):

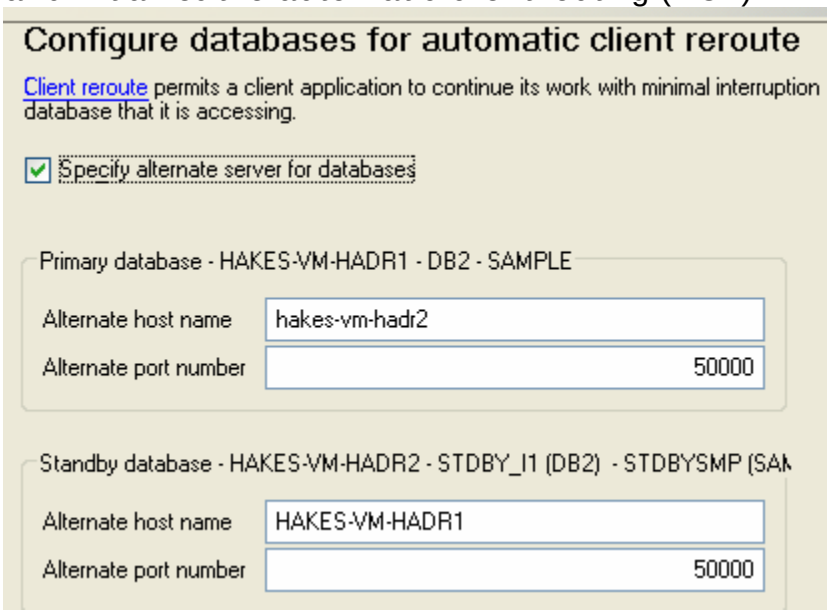


Figure 6: ACR configuration options

After the ACR configuration, the HADR Wizard asks for the database synchronization mode, using one of 3 choices:

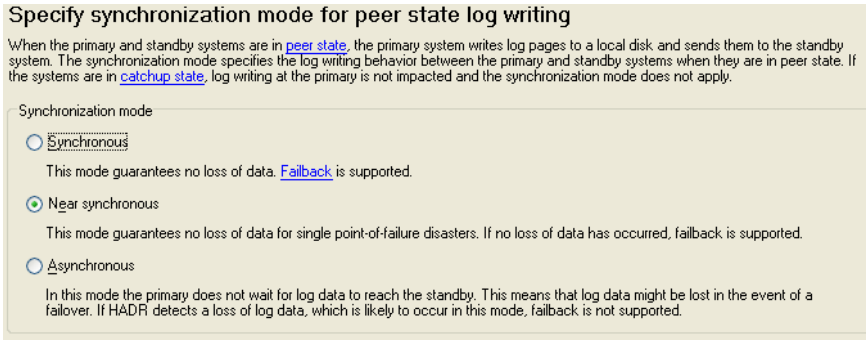


Figure 7: HADR Synchronization options

The final step commits all the changes and starts the HADR on the databases.

While executing all the HADR setup tasks, DB2 announces the status of each task with this dialog:

Figure 8: A successful HADR setup completion dialog

The HADR infrastructure is also managed from inside the DB2 Control Center, providing a graphical view of the HADR system status:

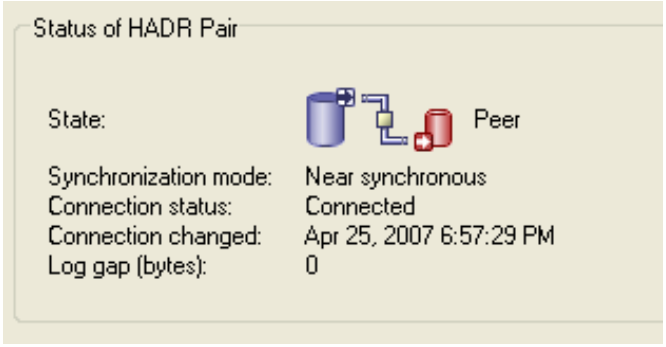
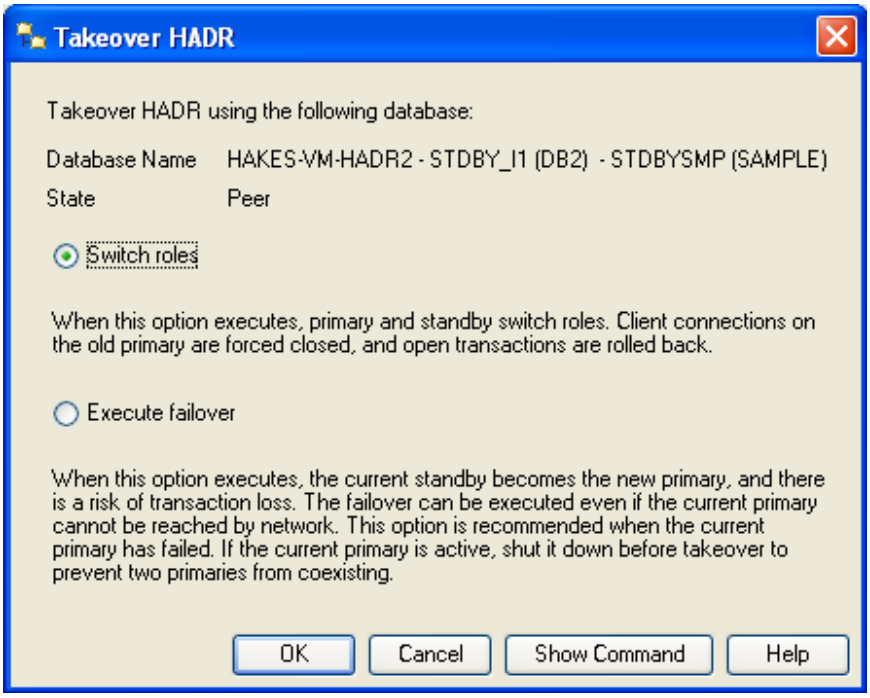


Figure 9: HADR management status

This interface also provides the means to execute HADR takeover tasks:



This is a simplified version of the entire HADR Wizard setup process, but it is instructive to see how thorough the wizard is in creating a customized HADR infrastructure.

8. HADR Recovery

If disaster strikes the primary data server site, or if the primary system or database suffers failure, then the priority of the DB2 HADR system is to execute a failover to the standby system, and thereby maintain data availability for client applications. The HADR failover and recovery process is relatively straightforward:

1. The primary database experiences a failure (due to primary system or database crash, or disaster at the primary site).

2. The standby system detects the communications failure and notifies the HADR administrator that the primary can no longer be reached.
3. After the HADR administrator confirms the primary failure, he or she then executes a "Takeover by Force", thereby turning the standby into the new primary database. (For a fully automated failover solution, third party HA clustering software is required to automatically handle the process).
4. Client applications that have been set up to use Automated Client Routing (ACR) will now access the new primary database for data retrieval.
5. Once the former primary system has been restored to working state, the former primary database is restarted as the new standby database for the HADR infrastructure. This prevents a "split-brain" scenario where the HADR infrastructure has two primary databases.
6. The HADR infrastructure will then use the logs from the new primary to bring the two databases back to a peer state.
7. If desired, once the HADR peer state has been achieved, the HADR roles can be switched back, restoring the HADR databases back to the original locations.

9. Conclusion

Continuous data availability is a business necessity in today's aggressively competitive marketplaces. Application outages are unacceptable: if your customer records, inventory levels, or e-commerce websites are unavailable due to data server downtime, then your organization loses customers and money.

The solution is an HADR infrastructure based on the DB2 Express-C 9.5: 12 Month License and Subscription offering, creating a fault tolerant system to ensure that

your data is always available, always accurate, and always delivering customer satisfaction.

10. Terminology

Active system: Another term for a primary system in an HA infrastructure.

Cluster: A combination of at least two computer systems that act together to appear as a single "virtual" system to end-user applications. In DB2 Express-C 9.5 HADR scenarios, the cluster has a primary system, and a standby system to take over in case of a failure.

DR: disaster recovery. The methodology of having off-site systems available to take over computing operations, and to provide a restoration base for primary systems, in case of catastrophic failure of the local primary systems.

Failover: The transfer of computing operations from the primary system to the standby system.

HA: high availability. The computer systems involved are expected to maintain the availability of data access and processing power at all times. Typical high availability systems have at least 99.99% uptime.

HADR: Acronym for a computing system cluster that offers both High Availiability and Disaster Recovery.

HADR Infrastructure: A term that refers to the primary and standby systems, along with the network connectivity and administration to set up and manage the HADR computer systems

Hardware redundancy: Within a physical computer, the hardware components have backups to handle demand if one component fails. Typical items targeted

for hardware redundancy are hard drives (through a RAID) and power supplies.

Heartbeat: A short communication message, delivered over a TCP/IP connection, between two computer systems providing an indication that the system is online and available.

Node: A single computer that has been incorporated into a cluster.

Primary system: The computer system (hardware, software and network) hosting the primary database in a cluster. In an HADR infrastructure, this system is responsible for primary data processing, as well as managing the HADR synchronization.

Peer state: A term to describe the situation when two systems in an HADR infrastructure have identical information available for processing; in the event of a failure, no data loss occurs during failover.

Secondary system: Another term for a standby system in an HADR infrastructure.

Standby system: The counterpart to a primary system in an HADR infrastructure. The standby system (hardware, software and network) is kept up to date with the information from the primary system. In the event of a primary system failure, the standby system can take over the primary system role.

11. References and Resources

For further information on the DB2 Express-C 9.5: 12 License and Subscription offering or on IBM DB2 High Availability and Disaster Recovery concepts and background, visit any of these online resources:

IBM DB2 Express-C website:

- http://www.ibm.com/db2/express/

High Availability and Scalability Guide for DB2 on Linux, UNIX and Windows Redbook:

- http://www.redbooks.ibm.com/

IBM DB2 Data Recovery and High Availability Guide and Reference:

- ftp://ftp.software.ibm.com/ps/products/db2/info/vr9/pdf/letter/en_US/db2hae90.pdf

IBM DB2 Information Center:

- http://publib.boulder.ibm.com/infocenter/db2luw/v9/

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