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Achieving High Availability with DB2 HADR and TSAMP

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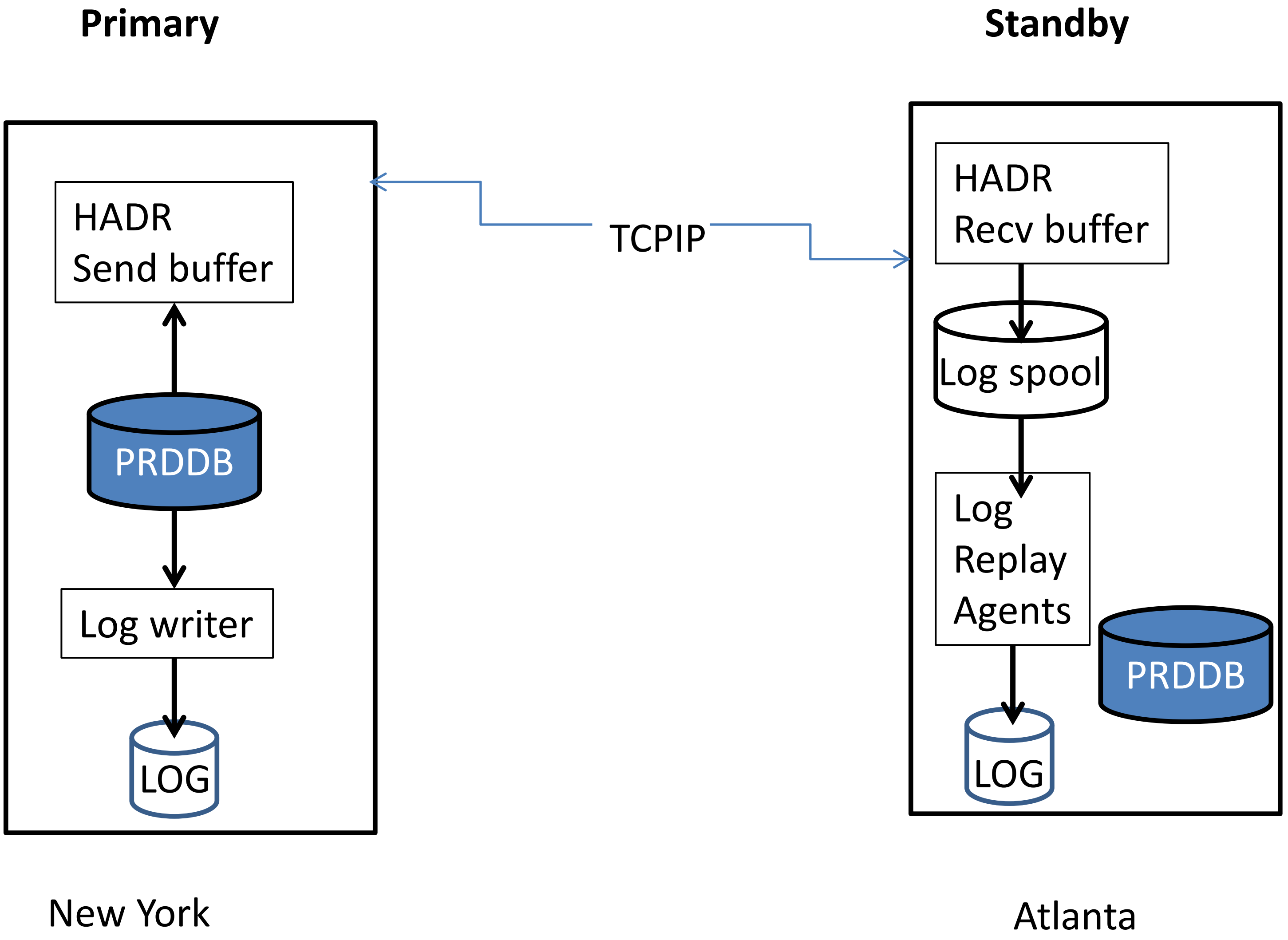
What is HADR?

- High Availability Disaster Recovery (HADR)
  - Introduced in DB2 V8.2
  - Log based replication using existing network infrastructure
  - Ported from Informix after acquired by IBM
  - Provides for High Availability (HA) in same data center or Disaster Recovery (DR) at remote data center
  - Many improvements over the years based on customer feedback and technology improvements

HADR

- Bundled with all versions of DB2 except DB2 Express-C
- Easy to setup and monitor
- Provides additional flexibility for report only databases while providing a degree of high availability
- Multiple synchronous modes to choose some
- Synchronization mode should be chosen based on BUSINESS REQUIREMENTS
  - Many times the business doesn't know there requirements
  - That's where you provide recommendations based on analysis of application requirements

HADR Overview



Configuring Databases for HADR

- Before you can use HADR you have to determine the SYNC mode you will use and then create a template of ports, service names, and IP addresses you will use
- You normally need to coordinate this with network support personnel or server ADMINS
- Properly size the STANDBY server or servers
  - The primary STANDBY should have same amount of RAM and CPU as the primary in the event of a failover or takeover (for takeover purposes and log replay agents)
  - It is recommended that the hardware be identical

Synchronization Modes

- **hadr_syncmode** – Database Configuration Parameter that controls the HADR synchronization mode
- Four possible values:
  - SYNC
  - NEARSYNC
  - ASYNC
  - SUPERASYNC

Hadr_syncmode

- **SYNC** Mode (Think LAN)
- SYNC mode offers the best protection of data. Two on-disk copies of data are required for transaction commit. The cost is the extra time for writing on the standby and sending an acknowledgment message back to the primary. In SYNC mode, logs are sent to the standby only after they are written to the primary disk. Log write and replication events happen sequentially. The total time for a log write event is the sum of (primary_log_write + log_send + standby_log_write + ack_message). The communication overhead of replication in this mode is significantly higher than that of the other three modes.

Hadr_syncmode

- **NEARSYNC** Mode (Think LAN)
- NEARSYNC mode is nearly as good as SYNC, with significantly less communication overhead. In NEARSYNC mode, sending logs to the standby and writing logs to the primary disk are done in parallel, and the standby sends an acknowledgement message as soon as it receives the logs in memory. On a fast network, log replication causes no or little overhead to primary log writing. In NEARSYNC mode, you will lose data if the primary fails and the standby fails before it has a chance to write the received logs to disk. This is a relatively rare "double failure" scenario. Thus NEARSYNC is a good choice for many applications, providing near synchronization protection at far less performance cost.

Hadr_syncmode

- **ASYNC** Mode (Think WAN)
- In ASYNC mode, sending logs to the standby and writing logs to the primary disk are done in parallel, just like in NEARSYNC mode. Because ASYNC mode does not wait for acknowledgment messages from the standby, the primary system throughput is min(log write rate, log send rate). ASYNC mode is well suited for WAN applications. Network transmission delay does not impact performance in this mode, but if the primary database fails, there is a higher chance that logs in transit will be lost (not replicated to standby).

Hadr_syncmode

- **SUPERASYNC** Mode (Think WAN)
- This mode has the shortest transaction response time of all synchronization modes but has also the highest probability of transaction losses if the primary system fails. The primary system throughput is only affected by the time needed to write the transaction to the local disk. This mode is useful when you do not want transactions to be blocked or experience elongated response times due to network interruptions or congestion. SUPERASYNC mode is well suited for WAN applications. Since the transaction commit operations on the primary database are not affected by the relative slowness of the HADR network or the standby HADR server, the log gap between the primary database and the standby database might continue to increase. It is important to monitor the log gap in this mode as it is an indirect measure of the potential number of transactions that might be lost should a true disaster occur on the primary system.

Hadr_syncmode Summary

- **SYNC:** Log Write on primary requires replication to the persistent storage on the standby (Think LAN)
- **NEARSYNC:** Log write on primary requires replication to the memory on the standby (Think LAN)
- **ASYNC:** Log write on primary requires a successful send to standby (receive is not guaranteed) (Think WAN)
- **SUPERASYNC:** Log Write on primary has no dependency on replication to standby (Think WAN)

Configuring Databases for HADR

- Setup separate dedicated NETWORK for HADR PRIMARY to SECONDARY connection
- Open HADR ports in Firewalls else HADR will fail and can be difficult to diagnose!

HADR Design RECAP

- Before you can use HADR you have to determine the SYNC mode you will use and then create a template of ports, service names, and IP addresses you will use
- Create a diagram of the proposed architecture, so all involved have a common picture of the setup
  - Helps to avoid confusion and misconceptions!

DB CFG HADR Parameters -- Primary

```
HADR local host name                    (HADR_LOCAL_HOST) = 10.221.37.1
 HADR local service name                  (HADR_LOCAL_SVC) = db2h_DB2_1
 HADR remote host name                    (HADR_REMOTE_HOST) = 10.221.37.2
 HADR remote service name                  (HADR_REMOTE_SVC) = db2h_DB2_2
 HADR instance name of remote server  (HADR_REMOTE_INST) = DB2
 HADR timeout value                       (HADR_TIMEOUT) = 120
 HADR log write synchronization mode     (HADR_SYNCMODE) = SUPERASYNC
 HADR peer window duration (seconds)  (HADR_PEER_WINDOW) = 600
```

/ETC/SERVICES Entries -- Primary

- db2h_DB2_1   58101/tcp   #DB2 HADR GCPROD Port
- db2h_DB2_2   58102/tcp   #DB2 HADR GCPROD Port

DB CFG HADR Parameters -- Standby

```
HADR local host name                (HADR_LOCAL_HOST) = 10.221.37.2

 HADR local service name              (HADR_LOCAL_SVC) = db2h_DB2_2

 HADR remote host name                (HADR_REMOTE_HOST) = 10.221.37.1

 HADR remote service name              (HADR_REMOTE_SVC) = db2h_DB2_1

 HADR instance name of remote server  (HADR_REMOTE_INST) = DB2

 HADR timeout value                    (HADR_TIMEOUT) = 120

 HADR log write synchronization mode     (HADR_SYNCMODE) = SUPERASYNC

 HADR peer window duration (seconds)  (HADR_PEER_WINDOW) = 600
```

/ETC/SERVICES Entries -- Standby

- db2h_DB2_1   58101/tcp   #DB2 HADR Port gcprod
- db2h_DB2_2   58102/tcp   #DB2 HADR Port gcprod

DB2 Registry Settings -- Primary

```
[e] DB2PATH=C:\Program Files\IBM\SQLLIB
[i] DB2_STANDBY_ISO=UR
[i] DB2_HADR_ROS=ON
[i] DB2_CAPTURE_LOCKTIMEOUT=ON
[i] DB2_CREATE_DB_ON_PATH=YES
[i] DB2_SKIPINSERTED=yes
[i] DB2_USE_ALTERNATE_PAGE_CLEANING=on
[i] DB2_EVALUNCOMMITTED=yes
[i] DB2_SKIPDELETED=yes
[i] DB2INSTPROF=C:\ProgramData\IBM\DB2\DB2COPY1
[i] DB2COMM=TCPIP
[i] DB2_PARALLEL_IO=*
[g] DB2_EXTSECURITY=YES
[g] DB2_COMMON_APP_DATA_PATH=C:\ProgramData
[g] DB2SYSTEM=CW-DB01
[g] DB2PATH=C:\Program Files\IBM\SQLLIB
[g] DB2INSTDEF=DB2
[g] DB2ADMINSERVER=DB2DAS00
```

DB2 Registry Settings -- Standby

```
[e] DB2PATH=C:\Program Files\IBM\SQLLIB
[i] DB2_STANDBY_ISO=UR
[i] DB2_HADR_ROS=ON
[i] DB2_CREATE_DB_ON_PATH=YES
[i] DB2_SKIPINSERTED=YES
[i] DB2_USE_ALTERNATE_PAGE_CLEANING=YES
[i] DB2_EVALUNCOMMITTED=YES
[i] DB2_SKIPDELETED=YES
[i] DB2INSTPROF=C:\ProgramData\IBM\DB2\DB2COPY1
[i] DB2COMM=TCPIP
[i] DB2_PARALLEL_IO=*
[g] DB2_EXTSECURITY=YES
[g] DB2_COMMON_APP_DATA_PATH=C:\ProgramData
[g] DB2SYSTEM=CW-DB02
[g] DB2PATH=C:\Program Files\IBM\SQLLIB
[g] DB2INSTDEF=DB2
[g] DB2ADMINSERVER=DB2DAS00
```

HADR LOG SPOOLING

- **LOG Spooling** introduced in DB2 10.1 to resolve HADR receive buffer full issues with slow STANDBY which blocks primary in all but SUPERASYNC mode
  - **CAN BE USED WITH ANY SYNC_MODE Setting**
- **HADR_SPOOL_LIMIT** DB CFG parameter
  - As of DB2 10.5 set to **AUTOMATIC** by default
    - Value of (LOGPRIMARY + LOGSECOND) * LOGFILSIZ)
  - Value of 0 turns it off
- Ensure disk space for active logs is large enough when using log spooling

HADR Log Spooling Gotcha

- HADR_ROLE = STANDBY
- REPLAY_TYPE = PHYSICAL
- HADR_SYNCMODE = SUPERASYNC
- STANDBY_ID = 0
- LOG_STREAM_ID = 0
- HADR_STATE = REMOTE_CATCHUP
- **HADR_FLAGS = STANDBY_RECV_BLOCKED STANDBY_LOG_DEVICE_FULL**
- PRIMARY_MEMBER_HOST = 10.40.40.95
- PRIMARY_INSTANCE = db2inst1
- PRIMARY_MEMBER = 0
- STANDBY_MEMBER_HOST = 10.30.83.160
- STANDBY_INSTANCE = db2inst1
- STANDBY_MEMBER = 0
- HADR_CONNECT_STATUS = CONNECTED
- HADR_CONNECT_STATUS_TIME = 03/17/2015 10:06:01.568718 (1426601161)
- HEARTBEAT_INTERVAL(seconds) = 30
- HEARTBEAT_MISSED = 17
- HEARTBEAT_EXPECTED = 35

HADR Setup Steps

- Update primary DB CFG parameters
- Update /ETC/SERVICES ports and service names on primary
- Make DB2 HADR registry settings
- Deactivate and Activate the database or stop and start the instance for settings to take effect
- Catalog database and standby node

HADR Setup Steps

- Backup the primary database online include logs
- Ship backup to standby server
- Make DB2 registry settings
- Update /ETC/SERVICES ports and service names on standby
- Catalog the database and primary node
- Restore the database to the standby instance without rolling forward
- Update the HADR DB CFG parameters
- Stop/Start the standby instance
- Activate the standby database
- Start hadr on the standby
- Activate the primary database
- Start hadr on the primary

HADR Setup Steps

- Alternatively, use the DB2 Control Center (9.7 and below) or IBM Data Studio to setup the primary and standby to include starting HADR
- Sit back, relax, and monitor!

HADR Database Snapshot -- Primary

```
HADR Status

 Role                 = Primary

 State                = Remote catchup

 Synchronization mode   = SuperAsync

 Connection status      = Connected , 03/14/2014 09:56:39.738078

 Heartbeats missed      = 0

 Local host           = 10.221.37.1

 Local service          = db2h_DB2_1

 Remote host            = 10.221.37.2

 Remote service         = db2h_DB2_2

 Remote instance        = DB2

 timeout(seconds)       = 120

 Primary log position(file, page, LSN) = S0338748.LOG, 13150, 00004D16BD4B6CFF

 Standby log position(file, page, LSN) = S0338748.LOG, 12650, 00004D16BD2C2084

 Log gap running average(bytes) = 15109
```

DB2 9.7 db2pd –gc_prod –hadr -- OUTPUT - Primary

```
Database Partition 0 -- Database GC_PROD -- Active -- Up 10 days 09:42:00 -- Date
2014-03-24-19.37.51.674000

HADR Information:
Role    State             SyncMode   HeartBeatsMissed   LogGapRunAvg (bytes)
Primary RemoteCatchup       SuperAsync 0                17746

ConnectStatus ConnectTime                          Timeout
Connected     Fri Mar 14 09:56:39 2014 (1394805399) 120

LocalHost                         LocalService
10.221.37.1                        db2h_DB2_1

RemoteHost                          RemoteService     RemoteInstance
10.221.37.2                        db2h_DB2_2        DB2

PrimaryFile  PrimaryPg  PrimaryLSN
S0338748.LOG 5055      0x00004D16BB517AA1

StandByFile  StandByPg  StandByLSN
S0338748.LOG 4911       0x00004D16BB487911
```

HADR Database Snapshot -- Standby

```
HADR Status
 Role                 = Standby
 State                 = Remote catchup
 Synchronization mode   = SuperAsync
 Connection status      = Connected , 03/14/2014 09:56:41.042773
 Heartbeats missed      = 0
 Local host            = 10.221.37.2
 Local service          = db2h_DB2_2
 Remote host            = 10.221.37.1
 Remote service         = db2h_DB2_1
 Remote instance        = DB2
 timeout(seconds)       = 120
 Primary log position(file, page, LSN) = S0338747.LOG, 5370, 00004D16B6832E27
 Standby log position(file, page, LSN) = S0338747.LOG, 5370, 00004D16B6832E27
 Log gap running average(bytes) = 529199
```

DB2 9.7 db2pd – gc_prod –hadr OUTPUT -- Standby

```
Database Partition 0 -- Database GC_PROD -- Active Standby -- Up 376 days 07:15:45 -- Date 2014-03-24-
19.26.22.802000

HADR Information:
Role    State            SyncMode   HeartBeatsMissed   LogGapRunAvg (bytes)
Standby RemoteCatchup       SuperAsync 0               491834

ConnectStatus ConnectTime                     Timeout
Connected     Fri Mar 14 09:56:41 2014 (1394805401) 120

ReplayOnlyWindowStatus ReplayOnlyWindowStartTime          MaintenanceTxCount
Inactive          N/A                         0

LocalHost                         LocalService
10.221.37.2                        db2h_DB2_2

RemoteHost                          RemoteService     RemoteInstance
10.221.37.1                        db2h_DB2_1       DB2

PrimaryFile  PrimaryPg  PrimaryLSN
S0338747.LOG 9862       0x00004D16B79BE3C5

StandByFile  StandByPg  StandByLSN        StandByRcvBufUsed
```

Enhanced Monitoring Information in DB2 10.5 (1 of 2)

- Output of db2pd –d fdxdb –hadr

```
HADR_ROLE = STANDBY
                   REPLAY_TYPE = PHYSICAL
                 HADR_SYNCMODE = SUPERASYNC
                    STANDBY_ID = 0
                 LOG_STREAM_ID = 0
                    HADR_STATE = REMOTE_CATCHUP
                    HADR_FLAGS =
           PRIMARY_MEMBER_HOST = 10.40.40.95
              PRIMARY_INSTANCE = db2inst1
                PRIMARY_MEMBER = 0
           STANDBY_MEMBER_HOST = 10.30.83.160
              STANDBY_INSTANCE = db2inst1
                STANDBY_MEMBER = 0
           HADR_CONNECT_STATUS = CONNECTED
      HADR_CONNECT_STATUS_TIME = 03/17/2015 11:11:27.371949 (1426605087)
   HEARTBEAT_INTERVAL(seconds) = 30
              HEARTBEAT_MISSED = 0
            HEARTBEAT_EXPECTED = 191
         HADR_TIMEOUT(seconds) = 120
 TIME_SINCE_LAST_RECV(seconds) = 7
      PEER_WAIT_LIMIT(seconds) = 0
```

Enhanced Monitoring Information in DB2 10.5 (2 of 2)

- continued Output of db2pd –d fdxdb –hadr

```
 LOG_HADR_WAIT_CUR(seconds) = 0.000
  LOG_HADR_WAIT_RECENT_AVG(seconds) = 0.000000
 LOG_HADR_WAIT_ACCUMULATED(seconds) = 0.000
         LOG_HADR_WAIT_COUNT = 0
SOCK_SEND_BUF_REQUESTED,ACTUAL(bytes) = 0, 23720
SOCK_RECV_BUF_REQUESTED,ACTUAL(bytes) = 0, 87380
      PRIMARY_LOG_FILE,PAGE,POS = S0387837.LOG, 11060, 42916322448579
      STANDBY_LOG_FILE,PAGE,POS = S0387837.LOG, 11060, 42916322448579
         HADR_LOG_GAP(bytes) = 44368729
  STANDBY_REPLAY_LOG_FILE,PAGE,POS = S0387837.LOG, 11060, 42916322448579
   STANDBY_RECV_REPLAY_GAP(bytes) = 204610
          PRIMARY_LOG_TIME = 03/17/2015 12:47:36.000000 (1426610856)
          STANDBY_LOG_TIME = 03/17/2015 12:47:36.000000 (1426610856)
       STANDBY_REPLAY_LOG_TIME = 03/17/2015 12:47:36.000000 (1426610856)
    STANDBY_RECV_BUF_SIZE(pages) = 2048
      STANDBY_RECV_BUF_PERCENT = 0
     STANDBY_SPOOL_LIMIT(pages) = 3686400
        STANDBY_SPOOL_PERCENT = 0
         STANDBY_ERROR_TIME = 03/17/2015 12:38:13.000000 (1426610293)
        PEER_WINDOW(seconds) = 0
      READS_ON_STANDBY_ENABLED = Y
  STANDBY_REPLAY_ONLY_WINDOW_ACTIVE = N
```

MON_GET_HADR Table Function

- Sample output – (DB2 10.1 and above)

```
SELECT HADR_ROLE, STANDBY_ID, HADR_STATE, varchar(PRIMARY_MEMBER_HOST
,20)
 as PRIMARY_MEMBER_HOST,
 varchar(STANDBY_MEMBER_HOST ,20) as STANDBY_MEMBER_HOST
 from table(MON_GET_HADR(NULL))

HADR_ROLE     STANDBY_ID HADR_STATE             PRIMARY_MEMBER_HOST
STANDBY_MEMBER_HOST
------------- ---------- ---------------------- -------------------- --------------------
STANDBY                0 REMOTE_CATCHUP         10.40.40.95          10.30.83.160

  1 record(s) selected.


ceteqprlndb1@db2inst1>
```

- To use on STANDBY Read on Standby must be enabled, use db2pd –d dbname –hadr (preferred)

HADR Shutdown and Startup Log Messages

- HADR startup messages recorded in db2diag.log file
- Error messages
- HADR state changes
- Important tool when troubleshooting HADR problems prior to DB2 10.1
- New db2pd –hadr output provides much more information for status and troubleshooting

Failover: **TAKEOVER** Command

- Primary and standby switch roles
  - Standby tells primary that it is taking over
  - Primary forces off all connections and refuses new connections
  - Primary rolls back any open transactions and ships remaining log, up to end of log to standby
  - Standby replays received log, up to end of log
  - Primary becomes new Standby
  - Standby becomes new Primary
- Command: Takeover HADR on Database <dbname>

Forced
T**AKEOVER** (Emergency)

- Primary and standby switch roles
  - Standby sends notice asking primary to shutdown
  - Standby does not wait for ACK from primary to confirm receipt or has shut down
  - Standby stops receiving logs from primary, finishes replaying the logs and then becomes the Primary
- Command: Takeover HADR on Database <dbname> BY FORCE
- Can be automated via TSAMP, etc

Primary Reintegration

- After primary failure and forced takeover, allow old primary to reintegrate as a standby with the new primary
- Possible if old primary can be made consistent with new primary
- Possible if old primary crashed in peer state and had no disk updates that were not logged on old standby
  - Success most likely in SYNC mode

HADR Multiple Standbys

- Traditional HADR features and functionalities work with multiple standbys as well
- Any standby can perform a normal or forced takeover
- TSAMP supports multiple standby configuration with a primary database and **one standby**
- Rolling upgrade supported by multiply standby feature
- Conversion of single standby configuration to multiple standby supported

HADR Multiple Standbys

- Multiple standbys implemented via new DB configuration parameter as of DB2 10.1
- **HADR_TARGET_LIST** parameter value is pipe ‘**|**’ character delimited list of remote HADR addresses
  - First entry in the list is the principal standby
  - Each address is in the form of ***host:port***
  - ***Host*** can either be a **host name** or an **IP address**
  - ***Port*** can be either a **service name** or a **numeric TCP port number**
- Address is used to match the **hadr_local_host** and **hadr_local_svc** parameter values on the remote database
- For matching purposes hostnames are converted to IP address and service names converted to port number before the actual comparison is done
- Host names can be specified in the hadr_target_list parameter while an IP address is used in the hadr_local_host parameter
- IPv6 is supported
- All addresses in the hadr_local_host, hadr_remote_host, and hadr_target_list values for a database be resolved to the same format (either all are IPv4 or all are IPv6)
- **HADR_TARGET_LIST**
  - Used to specify all standbys, both auxiliary as well as principal standby
  - Number of entries specified by this parameter on the primary determines the number of standbys a primary has
  - If set on primary it must be set on standby
    - Ensures if primary configured for in multiple standby mode then so is the standby

HADR Multiple Standbys

- If only set on the standby or primary but not both the primary rejects connection request from standby and standby shuts down with an invalid configuration error
- On each standby the HADR_REMOTE_HOST, HADR_REMOTE_INST, HADR_REMOTE_SVC must point to the current primary
- Primary validates hostname and port number upon handshake from auxiliary standby

HADR Multiple Standbys

- If the HADR_TARGET_LIST is set on the primary then it must be set on the standby
  - Ensures that if primary configured in multiple standby mode then so is the standby
- If set only on the standby or primary but not both, the primary rejects a connection request from the standby and standby shuts down with an invalid configuration error
- If a standby is not listed in the HADR_TARGET_LIST on the primary or the primary is not listed in the HADR_TARGET_LIST on the standby, the connection is rejected
- Include all would-be standbys in the HADR_TARGET_LIST on a standby
  - Ensures that when a standby becomes a primary it is ready to communicate with all the standbys.
- In a symmetrical setup the HADR_TARGET_LIST on each database lists all other databases which has the advantage of simplicity
- CONFIGURE your system in accordance with your business requirements!

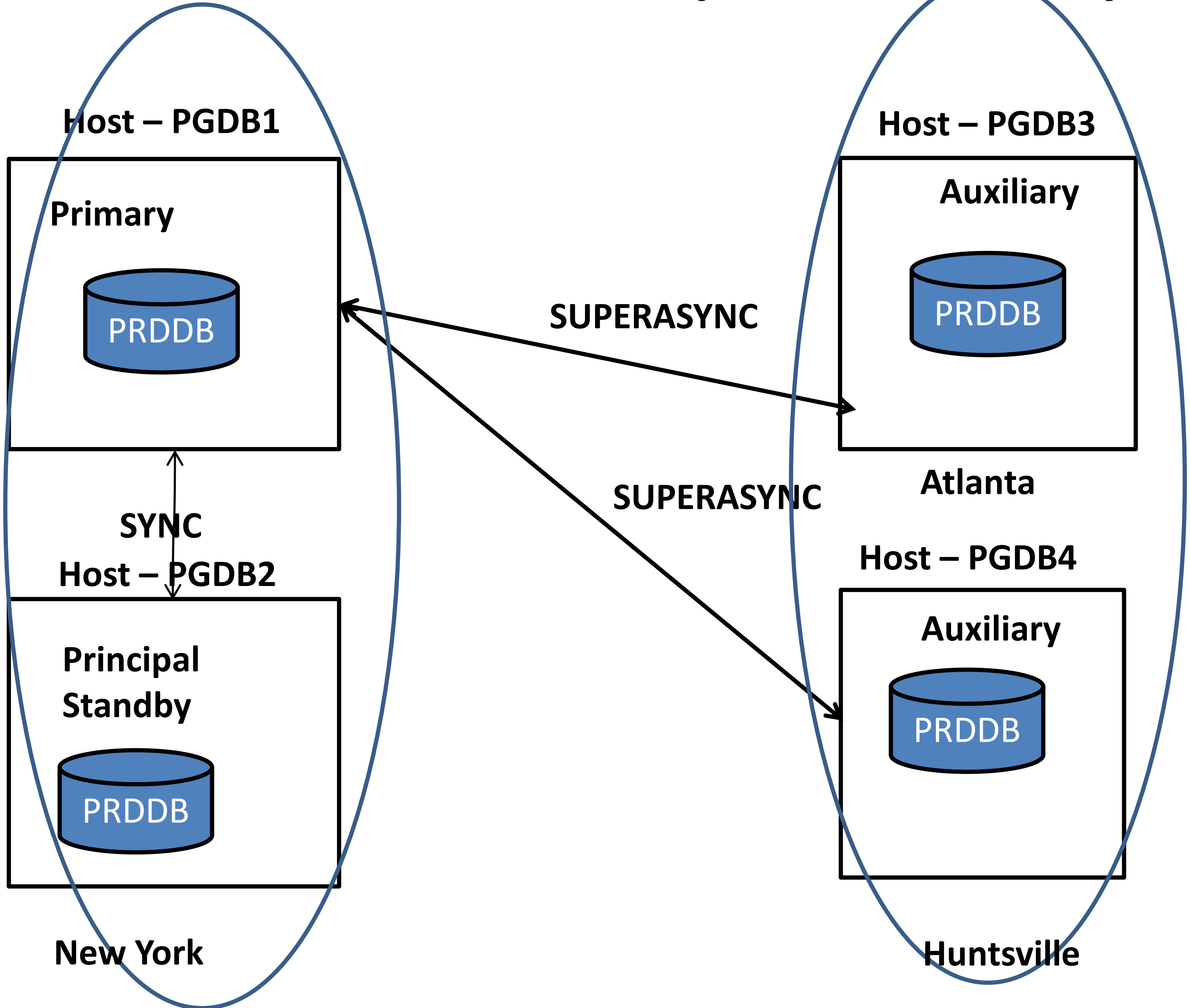
HADR Multiple Standbys

- In multiple standby mode up to 3 standby databases supported
  - One database designated as principal standby and any other database is an auxiliary database
- Both types synchronized with the primary database through a direct TCP/IP connection
- Both types support reads on standby
- Both types can be configured for time-delayed log replay
- TSAMP automated failover only supported for principal standby
  - A takeover on one of the auxiliary standbys must be done manually to make one of them the primary

HADR_SYNCMODE in Multiple Standbys

- In an HADR single standby configuration primary and standby must have the same **HADR_SYNCMODE DB CFG value**
- With multiple standby mode this parameter behaves differently
- **The HADR_SYNCMODE** parameter on the primary defines the synchronization mode for the connection between the **primary and its principal standby**
- **Auxiliary standbys** synchronization mode is always **SUPERASYNC**
- On the **standbys,** the defined **hadr_syncmode** is the mode that is used for the **principal standby** when it becomes the **primary through a takeover operation**

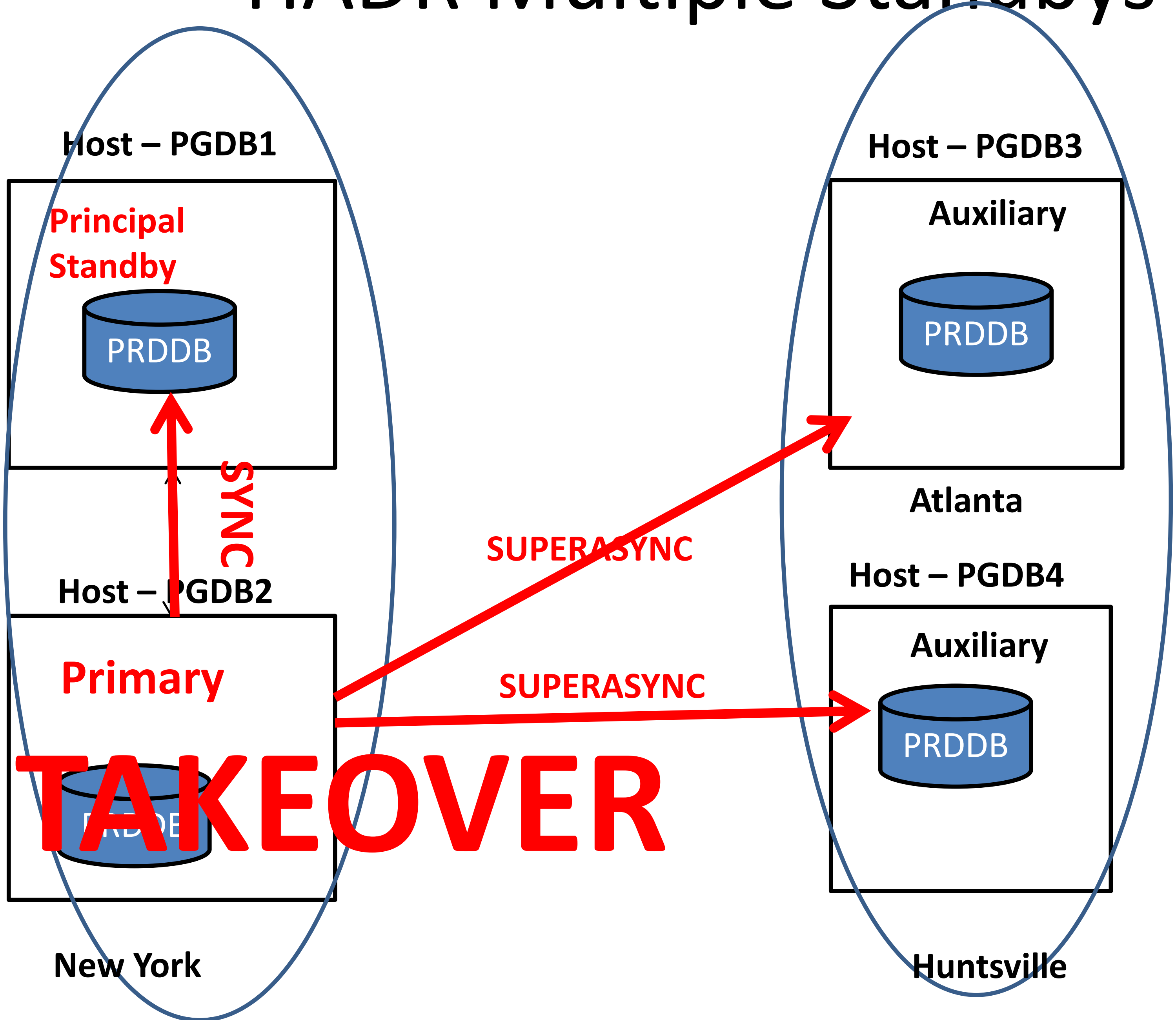
HADR Multiple Standbys



Multiple Standby Template

Configuration Parameter	PGDB1 (Primary)	PGDB2 (Principal Standby)	PGDB3 (auxilliary)	PGDB4 (auxilliary)
Hadr_target_list	PGDB2:58102| PGDB3:58103| PGDB4:58104	PGDB1:58101| PGDB3:58103| PGDB4:58104	PGDB2:58102| PGDB1:58101| PGDB4:58104	PGDB2:58102| PGDB1:58101| PGDB3:58103
Hadr_remote_host	PGDB2	PGDB1	PGDB1	PGDB1
Hadr_remote_svc	58102	58101	58101	58101
Hadr_remote_inst	db2inst1	db2inst1	db2inst1	db2inst1
Hadr_local_host	PGDB1	PGDB2	PGDB3	PGDB4
Hadr_local_svc	58101	58102	58103	58104
Operational Hadr_syncmode	Sync	nearsync	Async	Async
Effective Hadr_syncmode	N/A	Sync	Superasync	Superasync

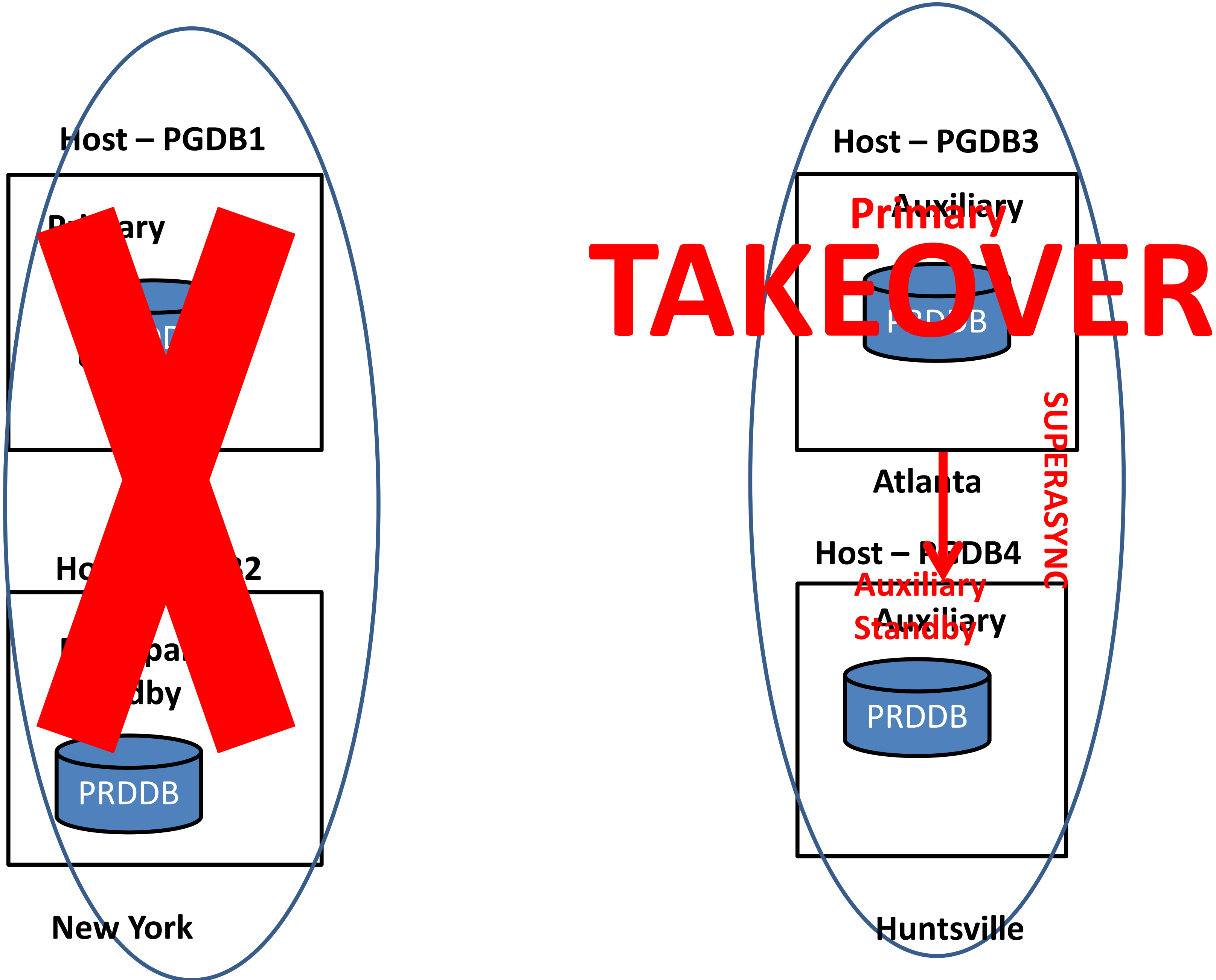
HADR Multiple Standbys



After issuing Takeover on PGDB2 (automatically reconfigured)

Configuration Parameter	PGDB1 (Primary)	PGDB2 (Principal Standby)	PGDB3 (auxilliary)	PGDB4 (auxilliary)
Hadr_target_list	PGDB2:58102| PGDB3:58103| PGDB4:58104	PGDB1:58101| PGDB3:58103| PGDB4:58104	PGDB2:58102| PGDB1:58101| PGDB4:58104	PGDB2:58102| PGDB1:58101| PGDB3:58103
Hadr_remote_host	PGDB2	PGDB1	PGDB2	PGDB2
Hadr_remote_svc	58102	58101	58102	58102
Hadr_remote_inst	db2inst1	db2inst1	db2inst1	db2inst1
Hadr_local_host	PGDB1	PGDB2	PGDB3	PGDB4
Hadr_local_svc	58101	58102	58103	58104
Operational Hadr_syncmode	Sync	nearsync	Async	Async
Effective Hadr_syncmode	nearsync	N/A	Superasync	Superasync

HADR Multiple Standby – Forced Takeover



After issuing Takeover on PGDB3 (automatically reconfigured)

Configuration Parameter	PGDB1 (Primary)	PGDB2 (Principal Standby)	PGDB3 (auxilliary)	PGDB4 (auxilliary)
Hadr_target_list	PGDB2:5 | PGDB PC	PGDB1:5 | PGDB PG	PGDB2:58102| PGDB1:58101| PGDB4:58104	PGDB2:58102| PGDB1:58101| PGDB3:58103
Hadr_remote_host	PGDB2		PGDB2	PGDB3
Hadr_remote_svc	58102		58102	58103
Hadr_remote_inst	db2i		db2inst1	db2inst1
Hadr_local_host	PGD	PGD	PGDB3	PGDB4
Hadr_local_svc	58101	58102	58103	58104
Operational Hadr_syncmode	Sync	nearsync	Async	Async
Effective Hadr_syncmode	N/A	sync	N/A	Superasync

HADR TIME DELAY

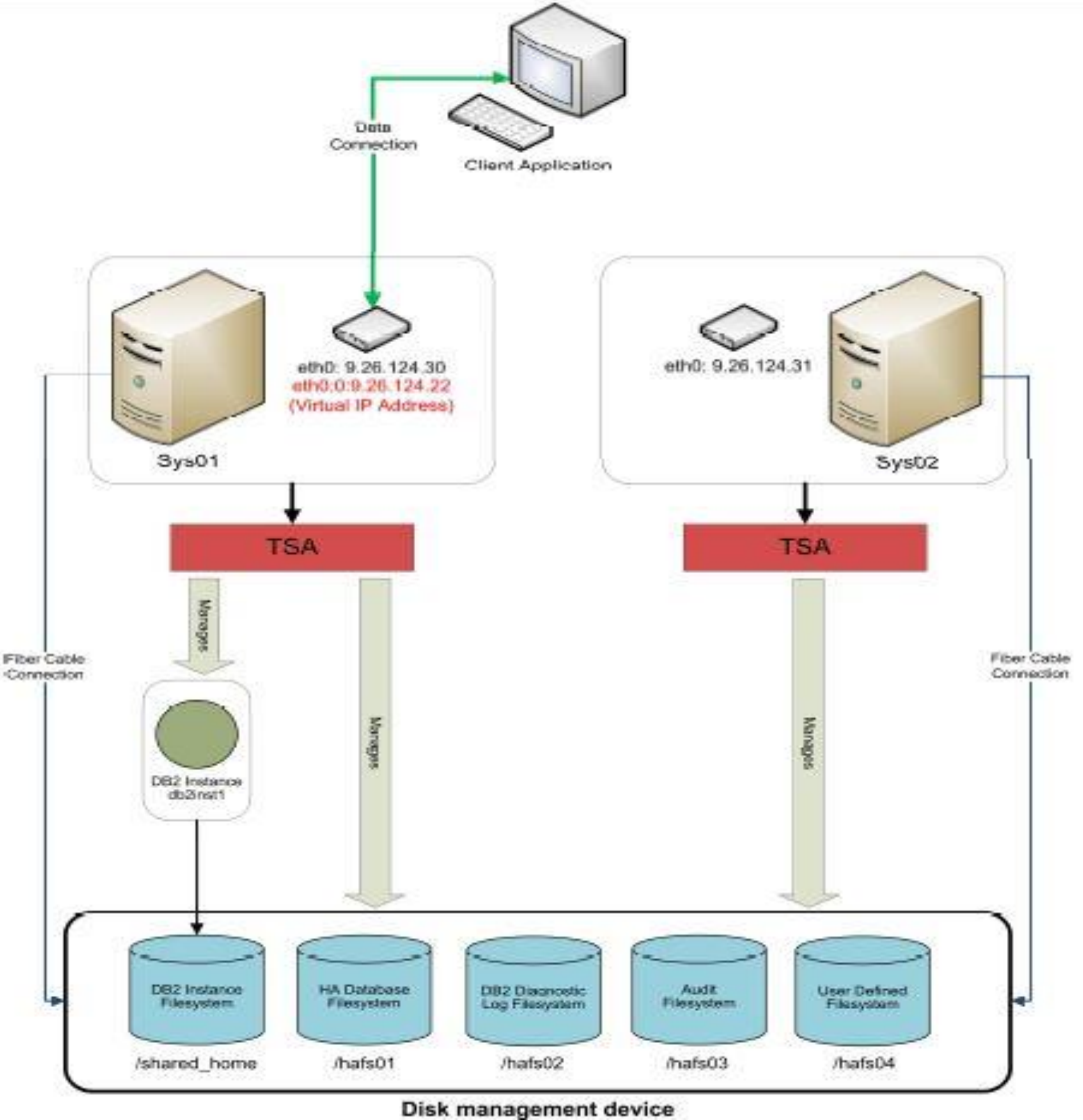
- New configuration parameter which will control how far behind the standby will remain at all times to prevent data loss due to rogue transaction
- **HADR_REPLAY_DELAY**
  - **Specifies the time that must have passed from when the data is changed on the primary database before these changes would be reflected on the standby database in number of seconds**

Clustering

- Everyone wants it but few want to take the time to understand it and support it properly
- Achieve High Availability and Reliability if properly implemented
- Disaster waiting to happen if not properly implemented and understood

TSAMP

- Tivoli System Automation for Multiplatforms (TSAMP)
- Bundled with DB2 since DB2 9.5
- Comes with all editions of DB2 except DB2 Express-C
- Seeing widespread implementation in 9.7 and above
    - Uses IBM Reliable Scalable Cluster Technology (RSCT) under the covers


Client Application
Data Connection
eth0: 9.26.124.30
eth0:0:9.26.124.22
(Virtual IP Address)
Sys01
eth0: 9.26.124.31
Sys02
TSA
TSA
Manages
Manages
Manages
IFiber Cable Connection
Fiber Cable Connection
DB2 Instance db2inst1
DB2 Instance Filesystem
HA Database Filesystem
DB2 Diagnostic Log Filesystem
Audit Filesystem
User Defined Filesystem
/shared_home
/hafs01
/hafs02
/hafs03
/hafs04
Disk management device

TSAMP Prerequisites

- TSAMP Prerequisites should be met by successfully running db2prereqchk
- Run preprpnode once on each node in the cluster
- TSAMP installed (automatically on UNIX when DB2 installed, manual on Windows)
- Shared storage
- Shared filesystems / mount points
- Primary node and secondary node
- DB2 installed at same level on both primary and secondary node
- Same DB2 instance owner id, group and group id on both system
- Same major number for volume groups
- /ETC/SERVICES updated to contain DB2 service names and ports
- These are the main requirements, follow the whitepaper or DB2 HA Redbook, SG 247363

TSAMP

- DB2 TSAMP clustering program bundled with as **db2haicu**
- **Use in conjunction with the DB2 TSAMP setup whitepaper**
- **Diagram and template what you will need for the cluster in advance**
- **You need inputs to db2haicu in advance**
- **Unlike HADR, TSAMP is at the instance level**

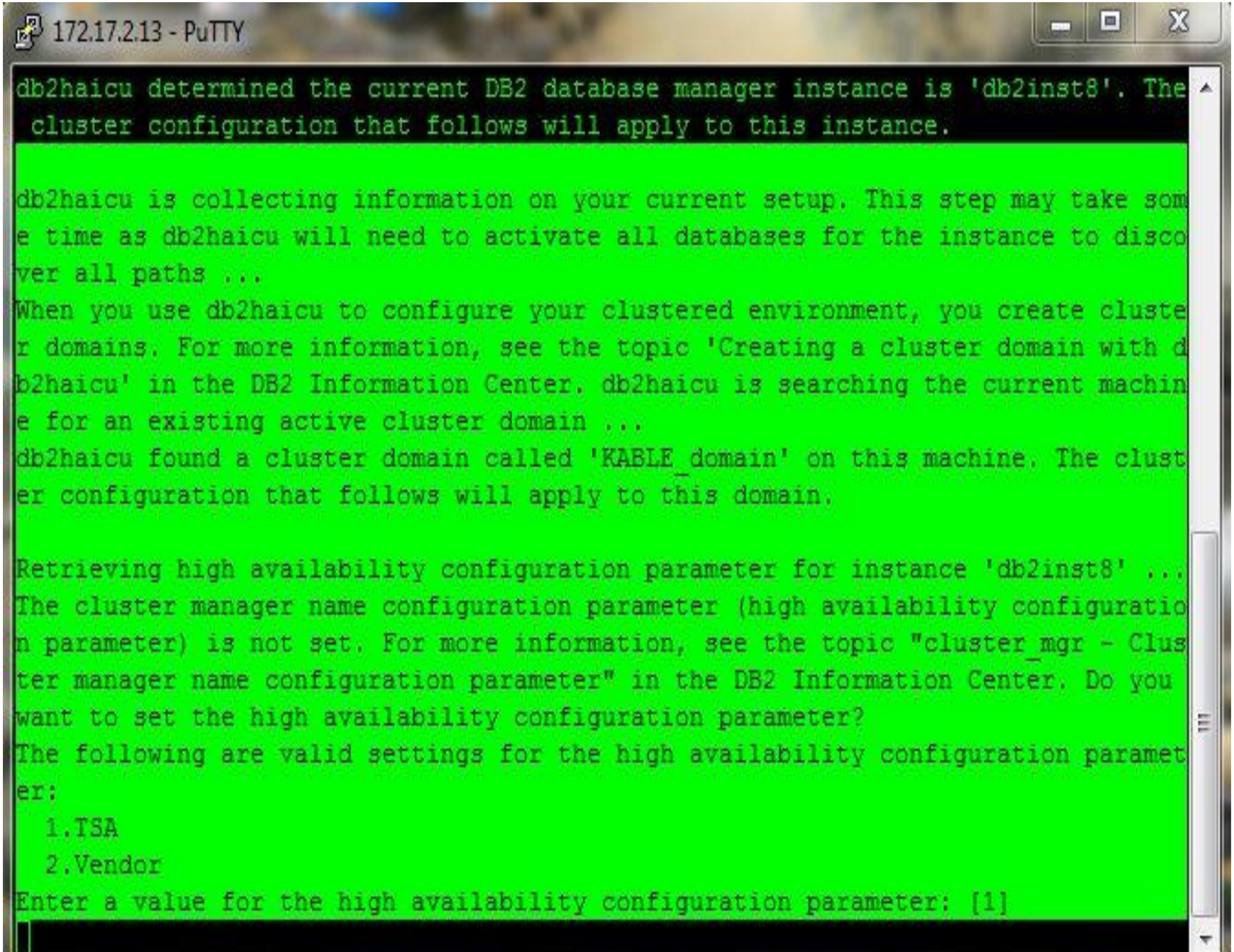
TSAMP

- db2haicu is a menu-driven script that you use to setup a cluster
- Defines the cluster domain and defines cluster resources
- db2haicu can also use an XML file as input
- Typical cluster setup is active – passive with one active node and a passive node ready for failover

TSAMP

- db2haicu inputs:
- Shared storage paths and filesystems
- Mount points not set to auto mount
- IP address of primary and secondary node (server)
- Virtual IP address to use for the cluster
- Quorum IP address
- DB2 TSAMP clustering program bundled with as **db2haicu**
- **Use in conjunction with the DB2 TSAMP setup whitepaper**
- **Diagram and template what you will need for the cluster in advance**
- **You need inputs to db2haicu in advance**

db2haicu



```
db2haicu determined the current DB2 database manager instance is 'db2inst8'. The
 cluster configuration that follows will apply to this instance.

db2haicu is collecting information on your current setup. This step may take som
e time as db2haicu will need to activate all databases for the instance to disco
ver all paths ...
When you use db2haicu to configure your clustered environment, you create cluste
r domains. For more information, see the topic 'Creating a cluster domain with d
b2haicu' in the DB2 Information Center. db2haicu is searching the current machin
e for an existing active cluster domain ...
db2haicu found a cluster domain called 'KABLE_domain' on this machine. The clust
er configuration that follows will apply to this domain.

Retrieving high availability configuration parameter for instance 'db2inst8' ...
The cluster manager name configuration parameter (high availability configuratio
n parameter) is not set. For more information, see the topic "cluster_mgr - Clus
ter manager name configuration parameter" in the DB2 Information Center. Do you
want to set the high availability configuration parameter?
The following are valid settings for the high availability configuration paramet
er:
  1.TSA
  2.Vendor
Enter a value for the high availability configuration parameter: [1]
```

TSAMP Quorum Definition

- A quorum definition is required to enable TSAMP to decide which node to use as a tiebreaker during a node failure. TSAMP supports a ‘network quorum’.
- A network quorum (or network tiebreaker) is a pingable IP address that is used to decide which node in the cluster will serve as the active node during a site failure, and which nodes will be offline. Note that the machine hosting this IP address does not need any particular software or operating system level installed; its primary requirement is that it can be pinged from all nodes in the cluster, and must remain pingable in the case of cluster node failures
- db2haicu will prompt you for the IP address

db2haicu

- Upon successful completion of defining all the resources to db2haicu, the cluster will be started and active
- Use db2pd –ha or lssam command to monitor status of HA for the instance

lssam output

```
$ lssam
Online IBM.ResourceGroup:db2_db2inst8_0-rg Control=MemberInProblemState
Nominal=                              Online
    |- Online IBM.Application:db2_db2inst8_0-rs
        |- Online IBM.Application:db2_db2inst8_0-rs:dist-db2-t1
        '- Offline IBM.Application:db2_db2inst8_0-rs:dist-db2-t2
    |- Online IBM.Application:db2mnt-db2home_db2inst8_db2-rs Control=MemberI nProblemState
        |- Online IBM.Application:db2mnt-db2home_db2inst8_db2-rs:dist-db2-t1
        '- Failed offline IBM.Application:db2mnt-db2home_db2inst8_db2-:dist-db2-t2
    |- Online IBM.Application:db2mnt-db2home_db2inst8_db2data-rs Control=Mem berInProblemState
        |- Online IBM.Application:db2mnt-db2home_db2inst8_db2data-
rs:dis                             t-db2-t1
        '- Failed offline IBM.Application:db2mnt-db2home_db2inst8_db2data-rs:dist-db2-t2
    '- Online IBM.ServiceIP:db2ip_172_17_3_160-rs
        |- Online IBM.ServiceIP:db2ip_172_17_3_160-rs:dist-db2-t1
        '- Offline IBM.ServiceIP:db2ip_172_17_3_160-rs:dist-db2-t2
Online IBM.Equivalency:db2_db2inst8_0-rg_group-equ
    |- Online IBM.PeerNode:dist-db2-t1:dist-db2-t1
    '- Online IBM.PeerNode:dist-db2-t2:dist-db2-t2
Online IBM.Equivalency:db2_public_network_0
    |- Online IBM.NetworkInterface:en0:dist-db2-t1
    '- Online IBM.NetworkInterface:en0:dist-db2-t2
```

db2pd –ha output

db2pdhaout.txt

```
$ db2pd -ha
          DB2 HA Status
Instance Information:
Instance Name                  = db2inst8
Number Of Domains              = 1
Number Of RGs for instance     = 1

Domain Information:
Domain Name                    = KABLE_domain
Cluster Version                = 3.1.4.4
Cluster State                  = Online
Number of nodes                = 2

Node Information:
Node Name                      State
---------------------          -------------------
dist-db2-t2                    Online
dist-db2-t1                    Online
```

TSAMP

- Conduct failure testing
  - Network
  - Storage
  - Server
- Learn TSAMP and RSCT commands to use to monitor status of cluster, stop cluster, and move cluster to secondary node for maintenance or other reasons
- Learn how to know if the cluster has failed over and what to do to get it back to the primary
- Test all of the above and document

Summary

- DB2 HADR what it is, how it works and how to implement and monitor it
- DB2 HADR Multiple Standbys
- New features in DB2 10.5
- Described how to define, setup and integrate TSAMP clustering
- Provided DB2 HADR and TSAMP references and best practices

HADR and TSAMP References

- **Whitepaper - DB2 HADR Multiple Standbys** http://public.dhe.ibm.com/software/dw/data/dm-1206hadrmultiplestandby/HADR_Multiple_Standbys_jn20.pdf
- DBA HA Redbook: http://www.redbooks.ibm.com/redbooks/pdfs/sg247363.pdf
- Remove and Reintegrate Auxiliary Standby http://www.ibm.com/developerworks/data/library/techarticle/dm-1408standbyhadr/index.htm
- |

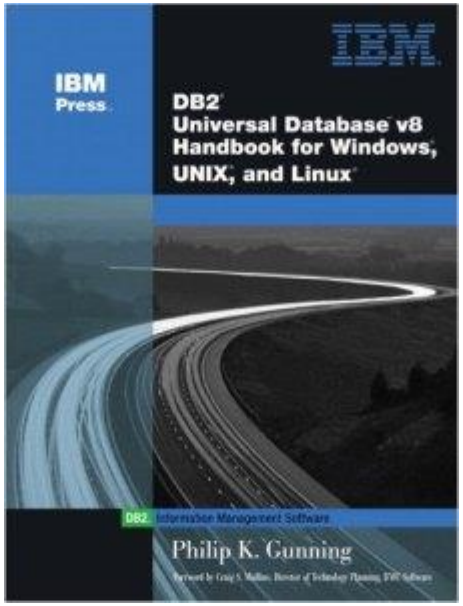
HADR and TSAMP References

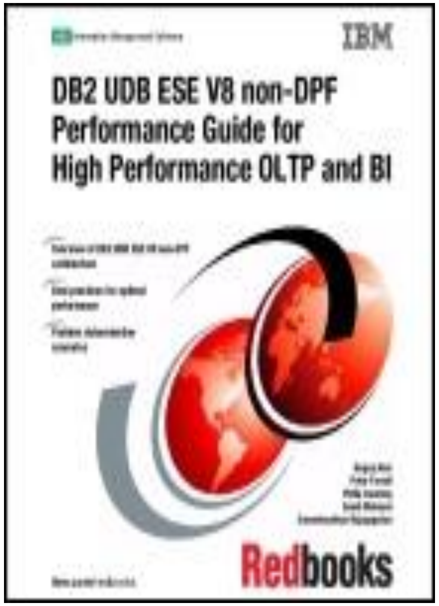
- DB2 HADR Best Practices https://www.ibm.com/developerworks/community/wikis/home?lang=en_US#!/wiki/Wc9a068d7f6a6_4434_aece_0d297ea80ab1/page/High%20Availability%20Disaster%20
- Setup HADR with Data Studio http://www.ibm.com/developerworks/data/tutorials/dm-1003optimhadr/index.html?ca=dat

HADR and TSAMP References

- DB2 HADR Simulator – whitepaper http://www.ibm.com/developerworks/data/library/techarticle/dm-1310db2luwhadr/dm-1310db2luwhadr-pdf.pdf
- DB2 and TSAMP Setup Whitepaper https://www.ibm.com/developerworks/data/library/long/dm-0909hasharedstorage/
- HADR Performance Wiki https://www.ibm.com/developerworks/community/wikis/home?lang=en#!/wiki/DB2HADR/page/HADR%20perf

DB2 Books by Phil


IBM
IBM Press
DB2 Universal Database v8 Handbook for Windows, UNIX, and Linux
DB2 Information Management Software
Philip K. Gunning


IBM
DB2 UDB ESE V8 non-DPF Performance Guide for High Performance OLTP and BI
Redbooks

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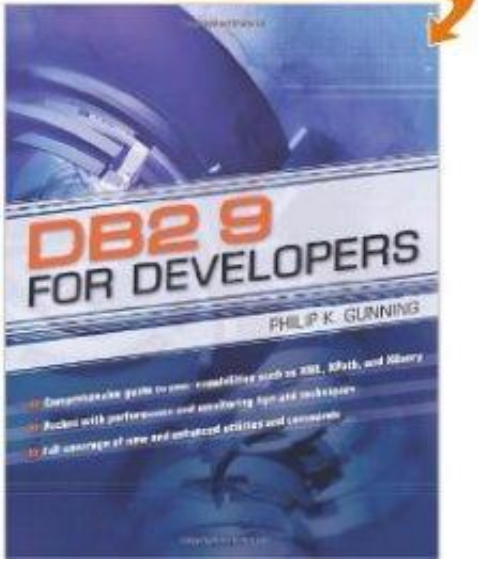

Achieving High Availability with DB2 HADR and TSAMP

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