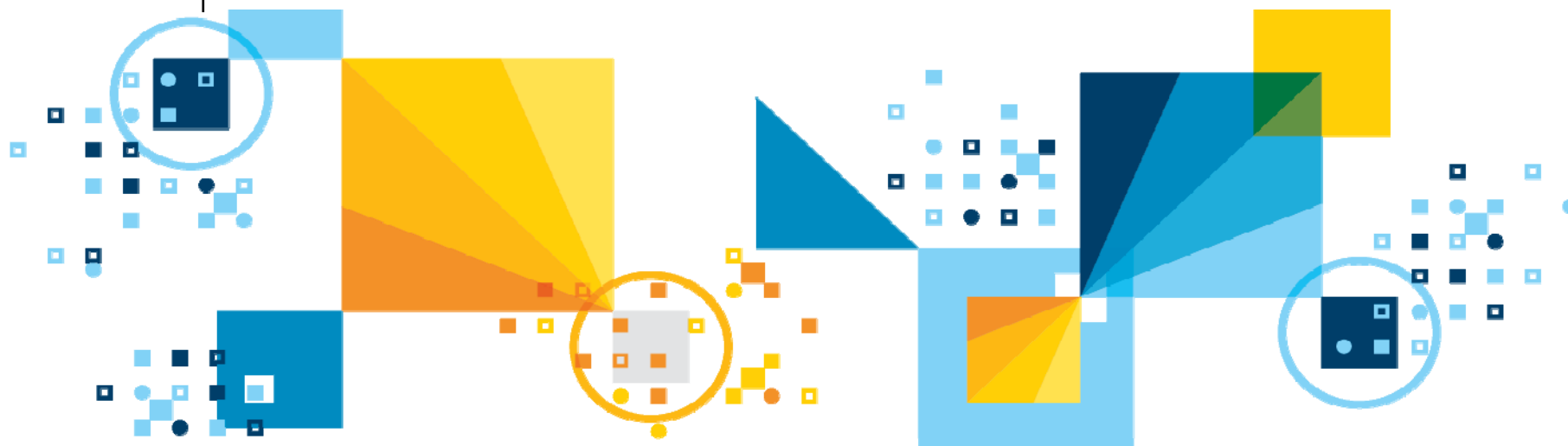


Backup and Recovery

Module ID | 10105

Length | 30 minutes + 1 hour hands on lab



For questions about this presentation contact askdata@ca.ibm.com

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Module Information

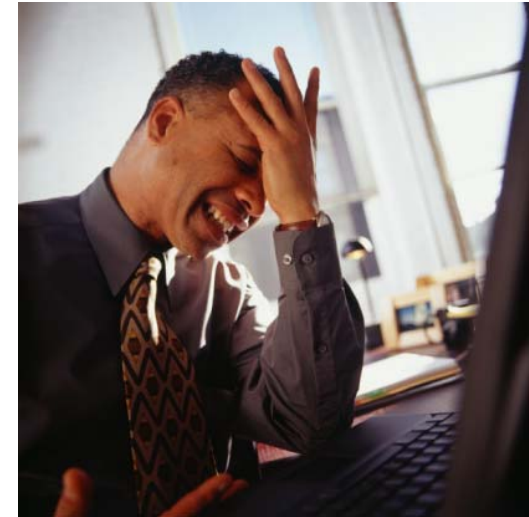
- You should have completed or acquired the necessary knowledge for the following modules in order to complete this module:
 - DB2 Fundamentals
- After completing this module, you should be able to:
 - Describe the reasoning behind backing data up
 - Explain the concepts of backup and recovery
 - Be able to perform the following tasks:
 - Determine the type of logging used by a DB2 database
 - Identify backup images and how to create them
 - How to recover a database

Module content

- Why back up data
- Basic backup and recovery concept
- Logging
 - Log file states
 - Logging types
 - Infinite logging
 - db2cklog
- Backup
 - Backup modes
 - Partitioned database
 - Table spaces
 - Incremental backup
 - db2ckbkp
- Recovery
 - Recovery types
- Restore
 - Table space restore
 - Incremental restore
 - Redirected restore
 - Recover Utility
 - IBM DB2 Advanced Recovery Feature

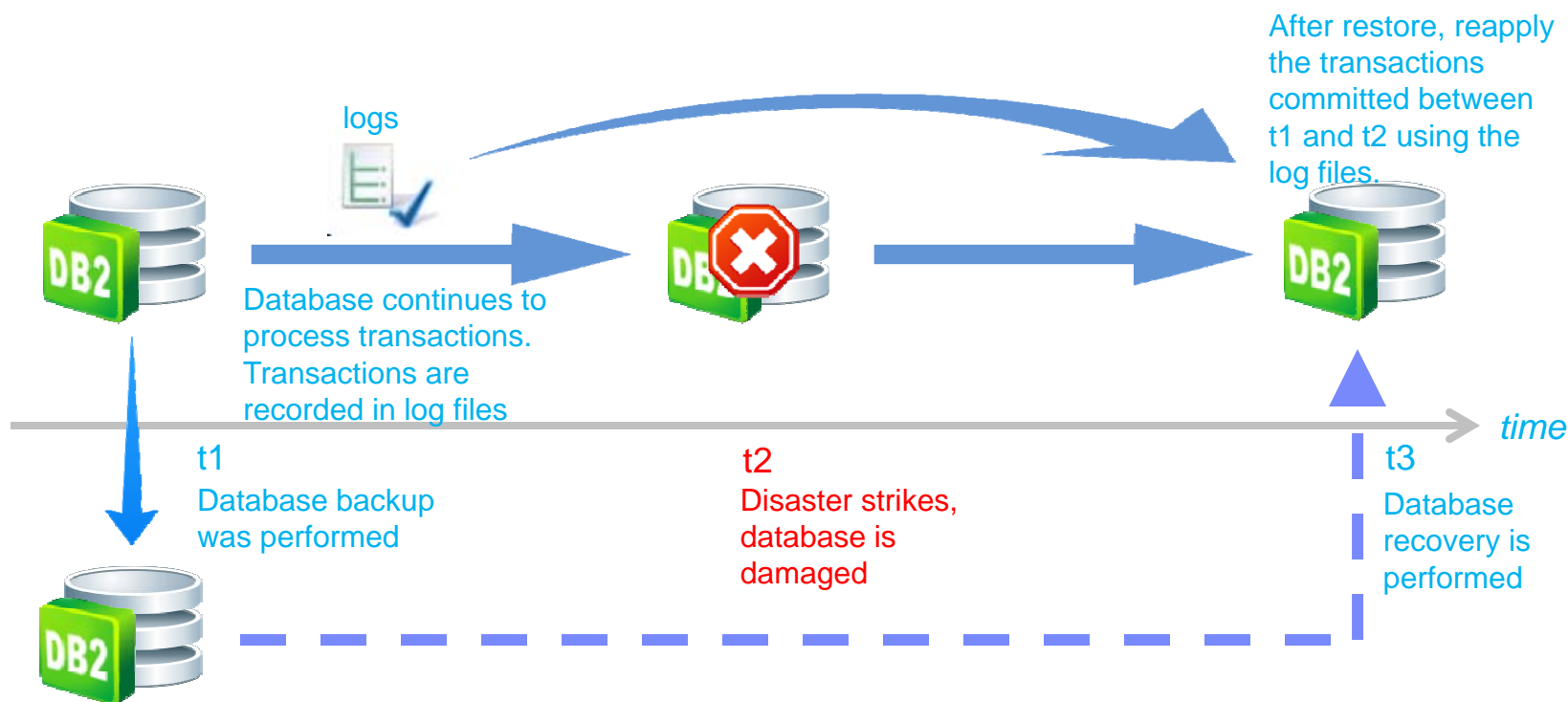
Why Backup Data

- Backing up data is vital for businesses
 - Lost information can cause a major crisis or worse, lead to business failure.
- Common problems:
 - System outage
 - Power failure
 - Hardware failure
 - Transaction failure
 - Users may inadvertently corrupt the database
 - Media failure
 - Disk drive becomes unusable
 - Disaster
 - Database facility damaged by fire, flooding or other catastrophe
- DB2 backup and recovery methods are designed to help you keeping your information safe!




Basic Concept of Backup and Recovery

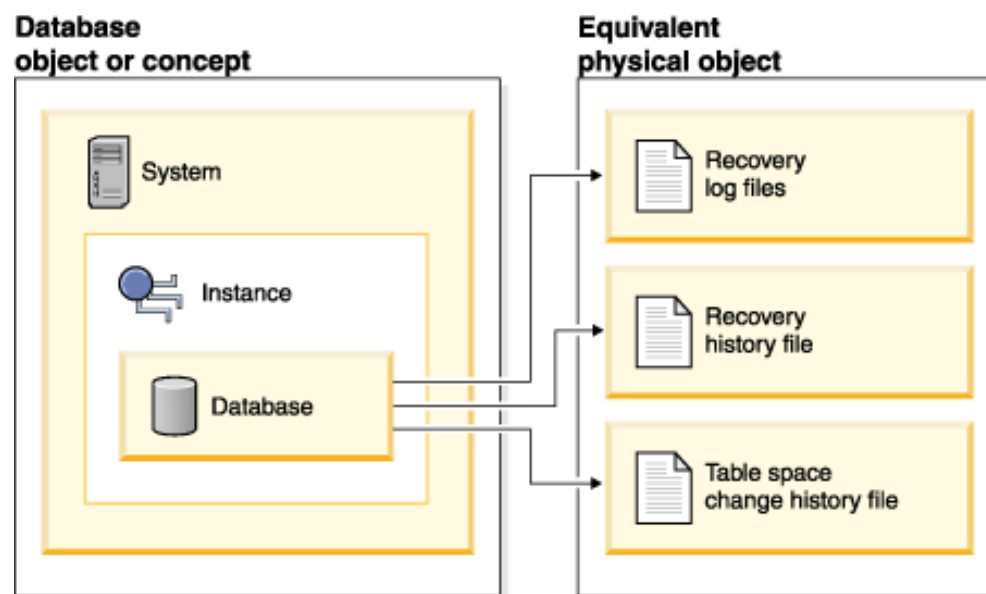
- Process of making copies of data and which may be used to restore the original in case of failure or loss of data
 - E.g.
 - At t1, a database backup operation is performed
 - At t2, a problem that damages the database occurs
 - At t3, all committed data is recovered



Database Logging

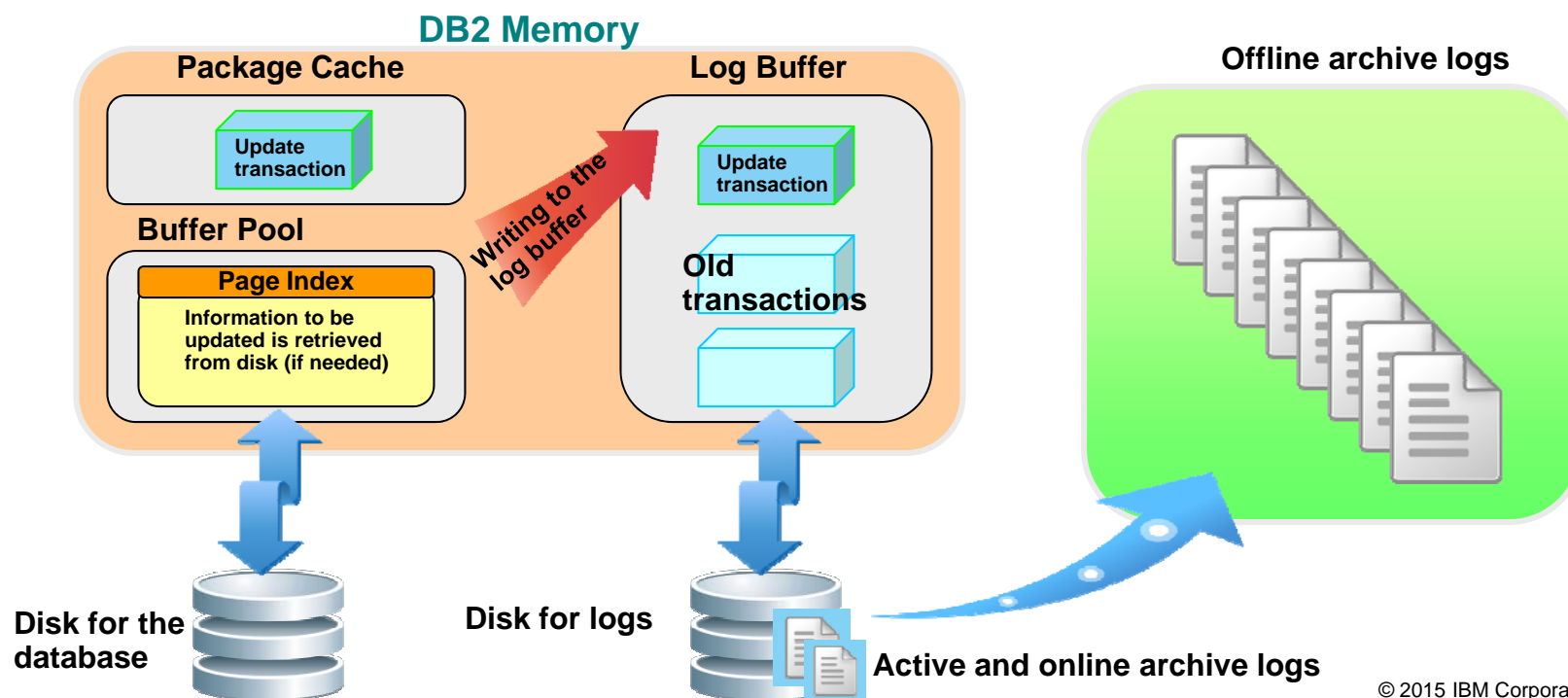
- **Keep track of changes** made to database objects and data
- During the recovery process, DB2 examines these logs and decides which changes to redo or undo
- Key element of any **high availability** strategy
- Can be stored in **files** or on **devices**
- Log records are written to disk when one of the following occurs:
 - Log buffer is full
 - A transaction commits
 - A group of transactions commit, as defined by the **mincommit** value

 **Deprecated in DB2 10**



Log File States

- Active logs
 - Contain at least 1 transaction that has not been committed or rolled back
- Online archive logs
 - Contain committed and externalized transactions in the active log directory
- Offline archive logs
 - Contain committed and externalized transactions in a separate repository

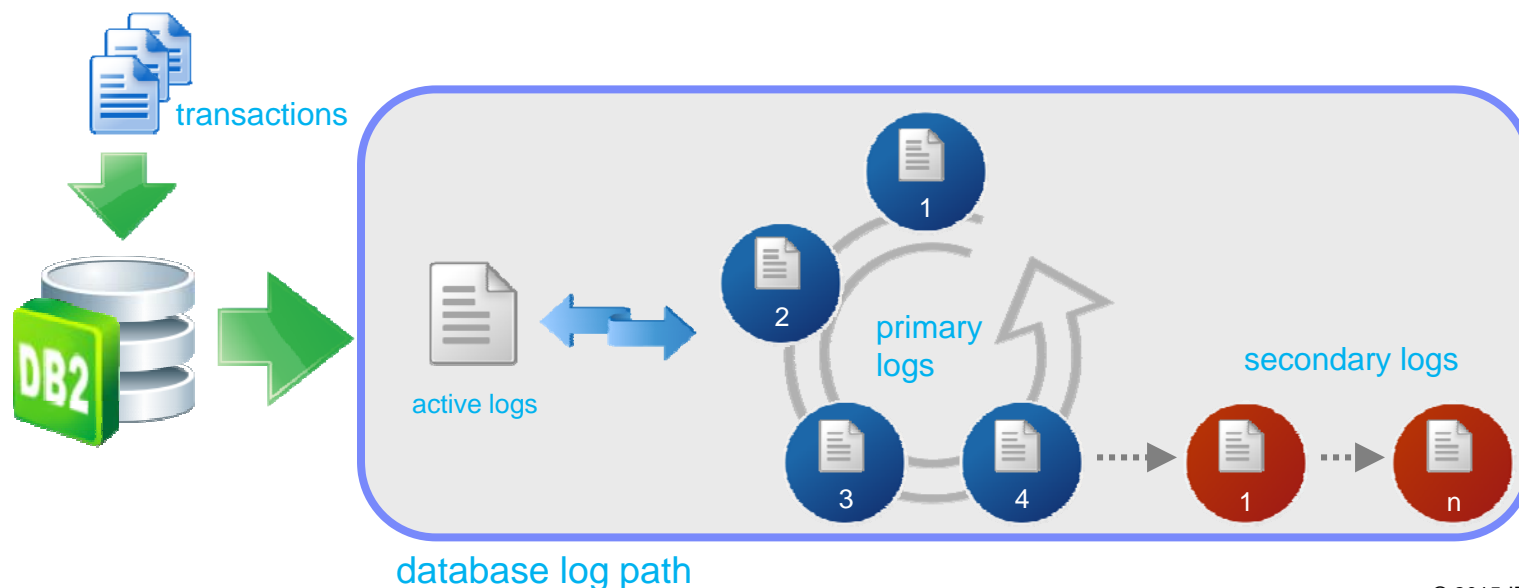


Key Logging Configuration Parameters

- **LOGPRIMARY**
 - number of primary log files to be pre-allocated in the active logs directory
- **LOGSECOND**
 - number of secondary log files that are created and used for recovery log files (only as needed).
- **LOGBUFSZ** (Log Buffer Size)
 - amount of the database heap (defined by DBHEAP parameter) to use as a buffer for log records before writing these records to disk
- **LOGFILSIZ** (Log File Size)
 - size of each primary and secondary log file in unit of 4KB pages.
- **LOGPATH** and **NEWLOGPATH**
 - LOGPATH is the default active log directory
 - Changed to a user defined location using NEWLOGPATH.
- **FAILARCHPATH** (Failover log archive path)
 - Specifies a third target to archive log files if the primary and secondary archival paths fail

Logging Types - Circular

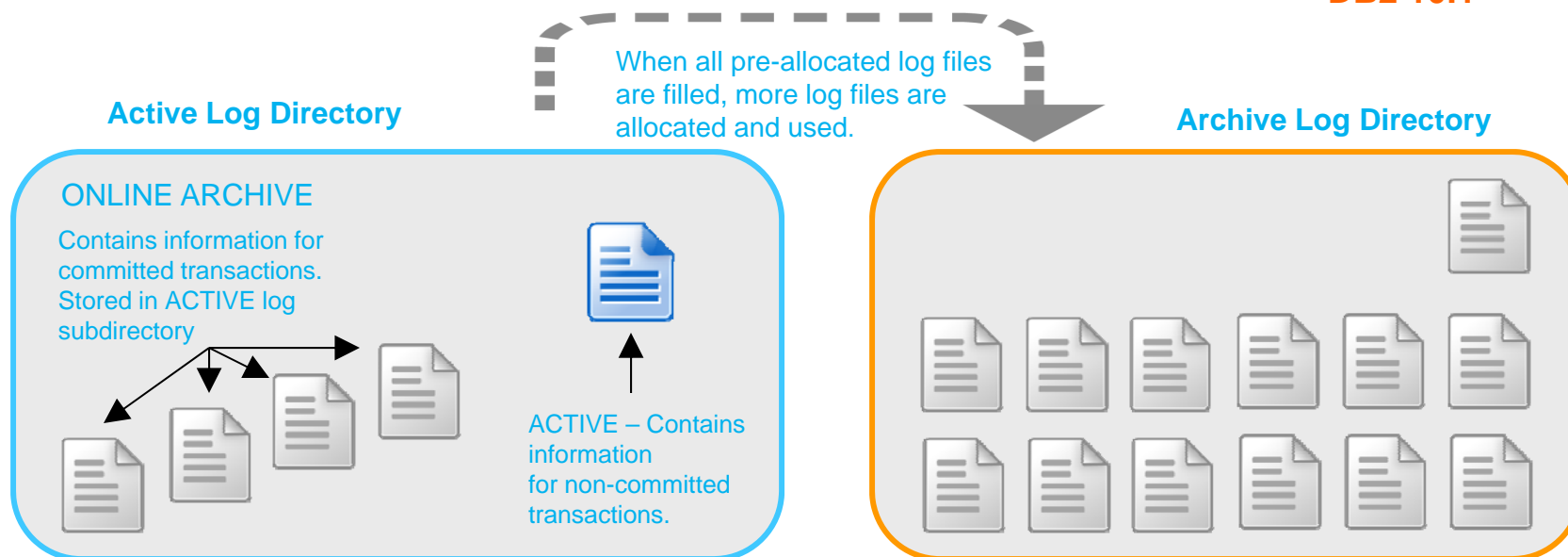
- Ring of online primary logs provide version recovery in case of failure
 - Secondary logs used when next primary log is not available
- Default logging for DB2
 - DB configuration parameters **logarchmeth1** and **logarchmeth2** are set to OFF
- Only full, offline database backups are allowed
 - Only ensures integrity of current transactions



Logging Types - Archive

- Maintain a history of log files
 - Enable with **LOGARCHMETH1** DB configuration parameter
 - **LOGRETAIN** and **USEREXIT** have been discontinued in DB2 10. They have been replaced with **LOGARCHMETH1**.
 - Allows roll-forward recovery or online backup
- Logs can be archived externally when no longer active to avoid exhaustion of log directory
- As of DB2 10.1, archived log files can be compressed

★ New in
DB2 10.1



Infinite Logging

- Issue with limited number of logs
 - A long running transaction can exhaust logs allocation, even after secondary log files are allocated
 - The number of primary and secondary log files must comply:
 - If logsecond has a value of -1, logprimary ≤ 256 .
 - If logsecond does not have a value of -1, (logprimary + logsecond) ≤ 256 .

Solution: Infinite Logging

- No limit on the size or the number of in-flight transactions running
- Enabled by setting logsecond to -1
- Database must be configured to use archive logging
 - Can hinder performance for rollback and crash recovery
- Other control parameters

num_log_span: number of log files an active transaction can span

max_log: percentage of the primary log space that a transaction can consume

DB2CKLOG - DB2 CHECK LOG

- Check the validity of archive log files
 - Determine whether the log files can be used during roll-forward recovery
 - A single archive log file or a range of archive log files can be checked

```
DB2CKLOG log_num ARCHLOGPATH path
```

```
DB2CKLOG log_num to log_num2
```

Validating a range of logs:

```
$ db2cklog 3 to 5
```

```
_____
          D B 2 C K L O G
          _____
          DB2 Check Log File tool

...
"db2cklog": Finished processing log file "S0000003.LOG". Return code: "0".
...
"db2cklog": Finished processing log file "S0000004.LOG". Return code: "0".
...
"db2cklog": Finished processing log file "S0000005.LOG". Return code: "0".
```

**Successful
Validation**

Recovery History File

■ Purpose

- In addition to recovery log files, the recovery history file is also created automatically when a database is created.
- Used to recover all or part of a database to a point in time using the summarized backup information in this file

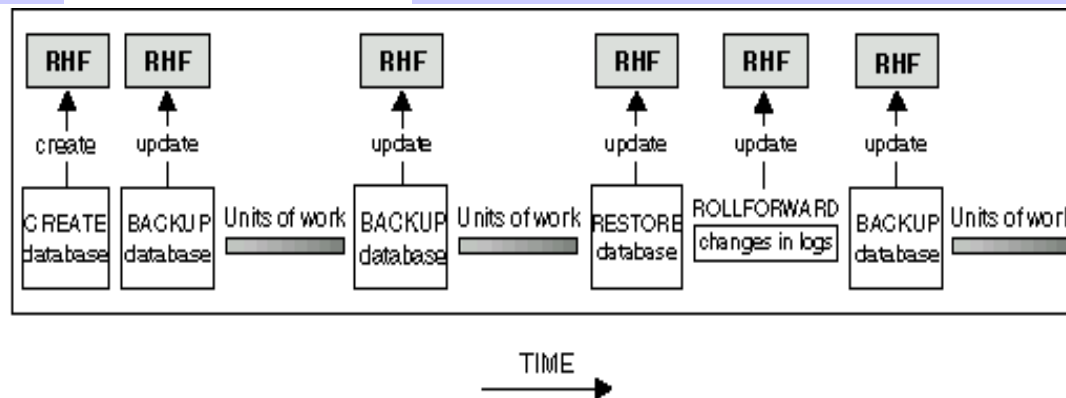
■ View

- To see the entries in the recovery history file:

LIST HISTORY

OR

SELECT * FROM SYSIBMADM.DB_HISTORY



■ Pruning

- Recovery history file cannot be directly modified, but entries that are no longer relevant can be pruned from the file using command **PRUNE HISTORY**

Database Backup

- Copy of a database or table space
 - User data
 - DB2 catalogs
 - All control files, e.g. buffer pool files, table space file, database configuration file
- Backup modes:
 - Offline Backup
 - Does not allow other applications or processes to access the database
 - Only option when using circular logging
 - Online Backup
 - Allows other applications or processes to access the database
 - Available to users during backup
 - Can backup to disk, tape, TSM and other storage vendors



Database Backup

- Command-line:

```
db2 backup database <db_name> <online> to <dest_path>
```

- Online backup example

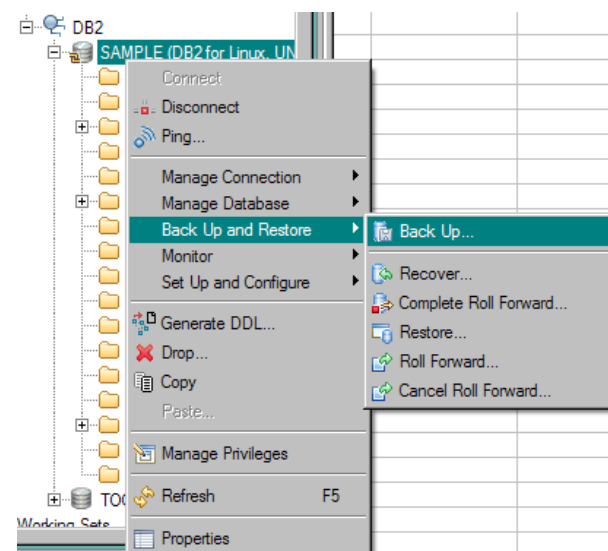
```
db2 backup database mydb online to /home/db2inst1/backups
```

- Offline backup example

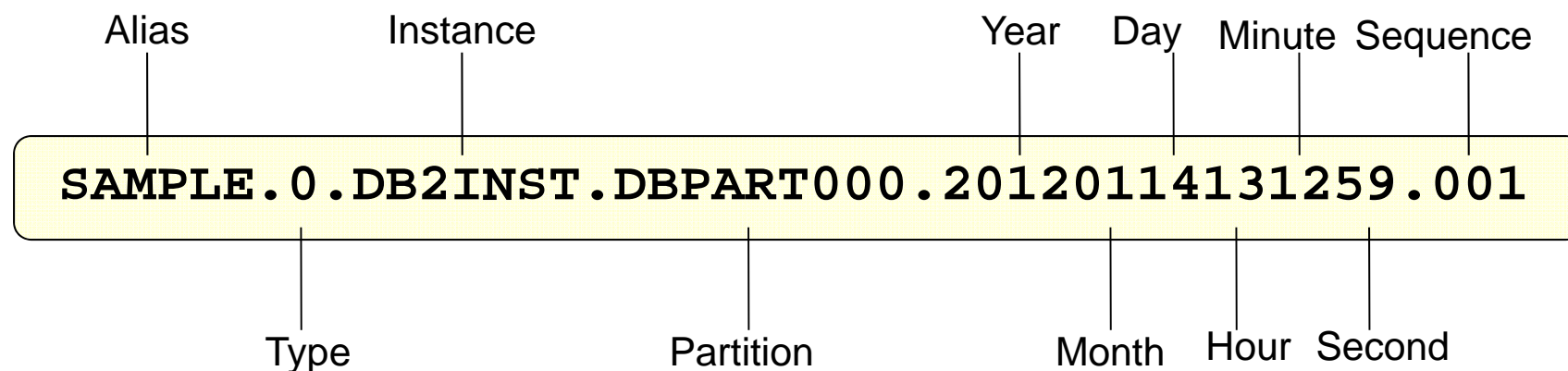
```
db2 backup database mydb to /home/db2inst1/backups
```

- IBM Data Studio:

1. Connect to target database
2. Right click on database
3. Select “Back Up and Restore” then “Back Up”



Database Backup – File Naming Convention



Backup Type:

- 0 = Full Backup
- 3 = Table space Backup
- 4 = backup image generated by the LOAD COPY TO command

Backing Up Partitioned Databases

There are four possible ways:

- Back up each database partition one at a time
- Use the `db2_all` command
 - Backup specified partitions
- Run a single system view – SSV (**Recommended**)
 - Backup some or all of the database partitions simultaneously
 - Database can be online or offline
 - Use the **ON DBPARTITIONNUMS** parameter to specify the partitions

```
db2 backup database mydb1 ON ALL DBPARTITIONNUMS
db2 backup database mydb1 ON DBPARTITIONNUMS ( 2 , 4 )
```

- Log files are included by default
- Old backup images can be deleted
- Use backup task assistant in **IBM Data Studio**

Table Space Backup

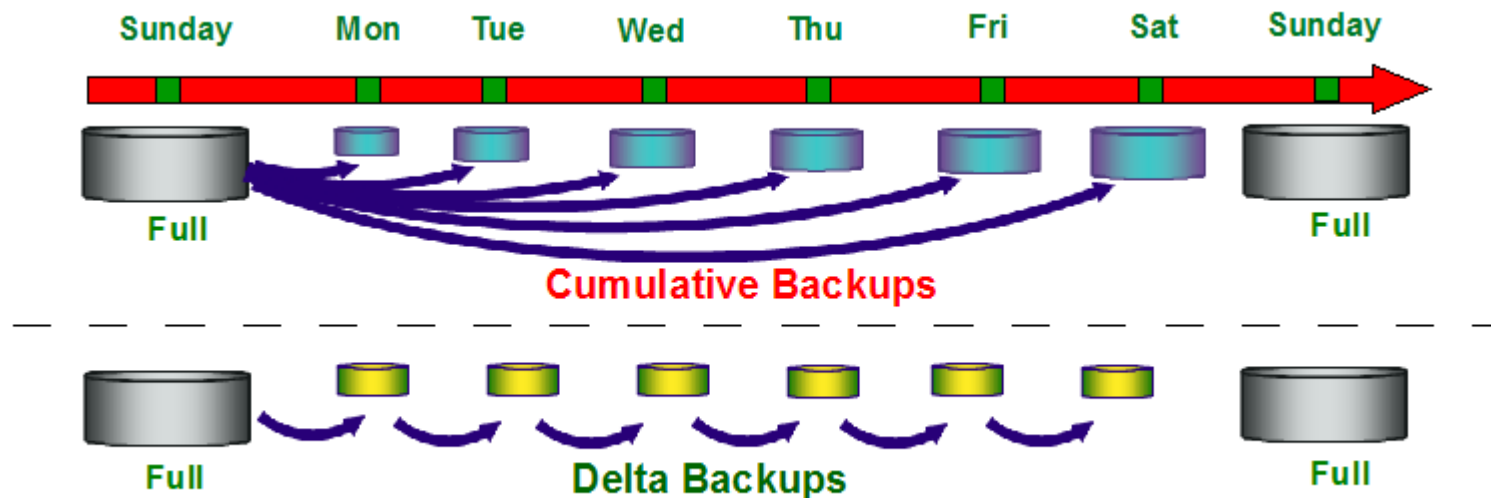
- Enables user to backup a subset of database
- **Multiple** table spaces can be specified
- Database must be using **archive logging**
- Table space backup can run in both **online** and **offline** backup
- Table space can be restored from either a database backup or table space backup of the given table space
- Use the keyword **TABLESPACE** to specify table spaces

```
db2 backup database mydb1 TABLESPACE (TBSP1) ONLINE to  
/home/db2inst1/backup
```

- Supported in DB2 pureScale environment

Incremental Backups

- **Incremental** (a.k.a. cumulative) - Backup of all database data that has changed since the most recent, successful, full backup operation
- **Incremental Delta** - Backup of all database data that has changed since the last successful backup (full, incremental, or delta) operation.
- Requires **TRACKMOD** database configuration parameter set to ON
 - Supports both database and table space backups.
- Suitable for large databases, considerable savings by only backing up incremental changes.



Database Backup – Compression

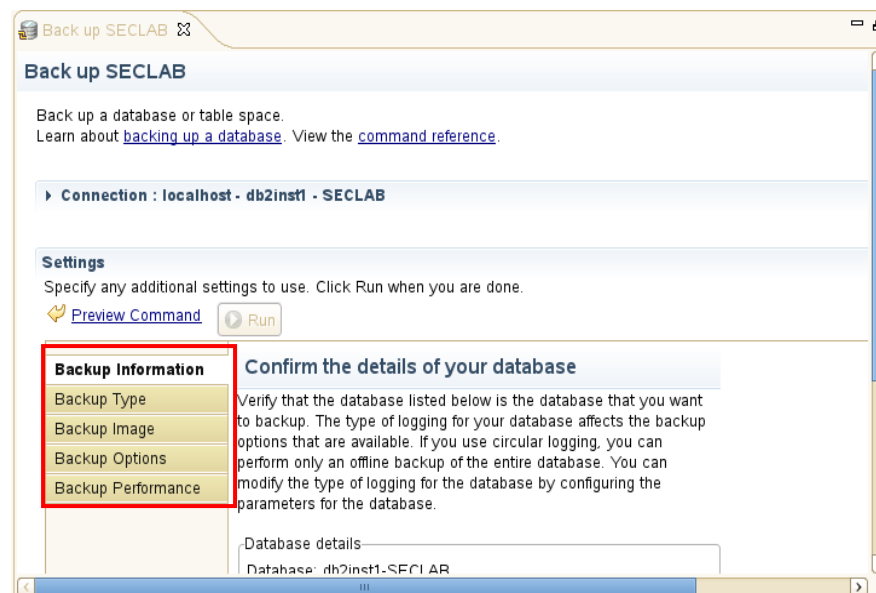
- DB2 backups can be automatically compressed
 - Significantly reduce backup storage costs
- Performance characteristics
 - CPU costs typically increased (due to compression computation)
 - Media I/O time typically decreased (due to decreased image size)
 - Overall backup/restore performance can increase or decrease; depending on whether CPU or media I/O is a bottleneck

```
db2 backup database DS2 to /home/db2inst1/backups compress
```



Automatic Database Backup

- Simplifies database backup management tasks for the DBA
- Ensures that the database is backed up both properly and regularly
- To configure automatic backup
 - DB configuration parameters
 - **AUTO_DB_BACKUP**
 - **AUTO_MAINT**
 - Graphical user interface tools
 - Data Studio's "Backup Task Assistant"
 - System stored procedure
 - **AUTOMAINT_SET_POLICY**



Optimizing Backup Performance

- During a backup operation, DB2 **automatically** chooses an optimal value for:
 - **PARALLELISM n**
 - Number of table spaces backed up in parallel
 - **WITH num_buffers BUFFERS**
 - Number of buffers used
 - Use at least **twice as many buffers** as backup targets (or sessions) to ensure that the backup target devices do not have to wait for data.
 - **Buffer buffer-size**
 - Backup buffer size
- Allocate more memory to backup utility by increasing utility heap size (**UTIL_HEAP_SZ**) configuration parameter.
- Backup subset of data where possible:
 - Table space backups
 - Incremental backups
- Use **multiple target** devices

DB2CKBKP – Check Backup

- This utility can be used to test the integrity of a backup image
 - determine whether the image can be restored.
 - display the meta-data stored in the backup header.

```
$ db2ckbcp -h SAMPLE. 0. moba. NODE0000. CATN0000. 20041008013428. 001

=====
MEDIA HEADER REACHED:
=====

Server Database Name      -- SAMPLE
Server Database Alias    -- SAMPLE
Client Database Alias     -- SAMPLE
Timestamp                 -- 20041008013428
Database Partition Number -- 0
Instance                  -- moba
Sequence Number          -- 1
Release ID                -- A00
Database Seed             -- 92DBF20F
DB Comment's Codepage (Volume) -- 0
DB Comment (Volume)       --
DB Comment's Codepage (System) -- 0
DB Comment (System)       --
Authentication Value      -- 255
Backup Mode               -- 1
Includes Logs             -- 1
Compression               -- 0
. . . (略) . . .
```

This backup is an online backup with INCLUDE LOGS option
0: Not included in the log file
1: contains log file

Backup is not compressed
0: not compressed
1: compressed

Database Recovery

- Recovery is the rebuilding of a database or table space after a problem such as media or storage failure, power interruption, or application failure.
- Types of Recovery
 - **Crash** or **restart** recovery
 - Protects the database from being left inconsistent
 - **Version** recovery
 - Restores a snapshot of the database
 - **Roll forward** recovery
 - Extends version recovery by using full database and table space backup in conjunction with the database log files
- **Crash** recovery and **Version** recovery are enabled in DB2 by **default**

DB2 Restore Utility

- Restores database or table space from a previously taken backup
- Invoked using:
 - The **RESTORE** Database command
 - The **db2Restore** API
 - IBM Data Studio Restore task assistant
- **TAKEN AT** - Specify the time stamp of the database backup image
- **WITHOUT PROMPTING** – Overrides any warnings
- Example:

SAMPLE.0.DB2INST.DBPART000.20120114131259.001



```
RESTORE DATABASE dbalias FROM <db_path> TAKEN AT 20120114131259
```

Table Space Restore Operation

- Table space restore occurs in **offline** and **online** mode
 - Other table spaces can be used concurrently while restore in progress
- Restored table space is in **Roll Forward Pending** state
 - can be either rolled forward to **END OF LOGS** or to a **Point In Time**.
- Minimum recovery time can be checked using

```
LIST TABLESPACES SHOW DETAIL
```

- User table space must be in line with catalog table space
 - Example: if catalog indicates table T1 exists in table space TSP1, table T1 must exist in the TSP1 table space, otherwise database becomes inconsistent
- Recommended to take a table space backup after restore to a Point In Time
 - Transactions that come after the point in time are lost
 - backup required as new point of reference for future recoveries

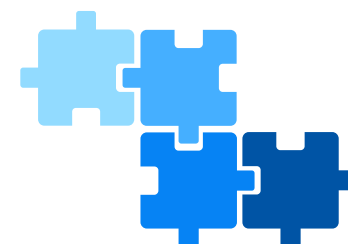
Incremental Restore

- Restore a database with incremental backup images
- **AUTOMATIC** (recommended) - All required backup images will be applied automatically by restore utility
- **MANUAL** – User applies the required backups manually
 - **db2ckrst** can provide the sequence for applying backups
- **ABORT** - aborts an in-progress manual cumulative restore

```
RESTORE DATABASE sample INCREMENTAL AUTOMATIC FROM /db2backup/dir1  
ROLLFORWARD DATABASE sample TO END OF LOGS AND COMPLETE
```

Redirected Restore

- A redirected restore operation is performed when:
 - Restore a backup image to a machine that is different than the source machine
 - Restore table space containers into a different physical location
 - One or more containers is inaccessible
 - Redefine the paths of a defined storage group
- Restrictions
 - Cannot use a redirected restore to move data from one operating system to another
 - Cannot create or drop a storage group during the restore process
 - Cannot modify storage group paths during a table space restore process
- Two-step database restore process with an intervening table space container definition step
 - Issue **RESTORE DATABASE** command with **REDIRECT** option
 - Take one of the following steps:
 - **SET TABLESPACES CONTAINERS**
 - **SET STOGROUP PATHS**
 - Issue **RESTORE DATABASE** command with **CONTINUE** option



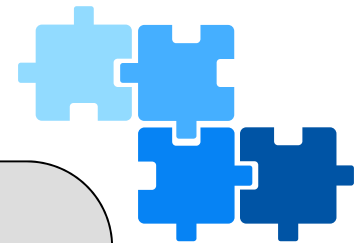
Restore with Transport

- The **RESTORE DATABASE** command can transport a set of table spaces or schemas
 - The **TRANSPORT** option of the **RESTORE** command copies objects from a backup image to a database
 - Database objects are re-created to reference the new database and the data is restored
- Transporting a database schema involves:
 - Backup **valid transportable sets** from the source database
 - Restore transportable sets on the target db using the **TRANSPORT** option
 - **Optionally**, you can redirect the container paths for the table spaces being transported
- Restrictions
 - Database Schema must be transported in its entirety.
 - Source and Target should not share the same schema names

```
RESTORE DATABASE originaldb TABLESPACE (mydata1)
SCHEMA(schema1,schema2) FROM <Media_Target_clause> TAKEN
AT <date-time> TRANSPORT INTO targetdb REDIRECT
```

```
LIST TABLESPACES
SET TABLESPACE CONTAINERS FOR
<tablespace ID for mydata1> USING (PATH '/db2DB/data1')
```

```
RESTORE DATABASE originaldb CONTINUE
```



DB2 Recover Utility

- DB2 Recover Utility:
 - Performs restore and roll forward operations to recover a database to a specified time, based on information found in the recovery history file or to the end of logs
 - Can be issued for an incomplete recover operation that ended during the roll forward phase, the recover utility attempts to continue the previous recover operation without redoing the restore phase
 - Automatically establishes connection to the database
- In IBM® Data Studio Version 3.1 or later, you can use the task assistant for recovering databases
- To invoke the recover utility use
 - **RECOVER** DATABASE command
 - **db2Recover** application programming interface (API)
- Restrictions
 - Does not support table space & incremental restore operations
 - If it is interrupted during the restore phase, it cannot be continued. **RECOVER** command has to be re-issued

```
RECOVER DATABASE SAMPLE TO 2001-12-31-04.00.00
```

```
RECOVER DATABASE SAMPLE TO END OF LOGS
```

IBM DB2 Advanced Recovery Feature

***New – Buy all 3 products in one bundle**

DB2 Merge Backup

- Improve speed of your backup & recovery processes
- Minimize application impact

Backup

DB2 Recovery Expert

- Recover faster with greater granularity while protecting your critical business data
- Eliminate data errors before they compound into costly business mistakes
- Track and report data changes in response to auditing requests

Recover

Optim High Performance Unload

- Extract large amounts of data quickly and with minimal impact on system productivity
- Perform full data and system migrations from one DB2 instance to another

Unload

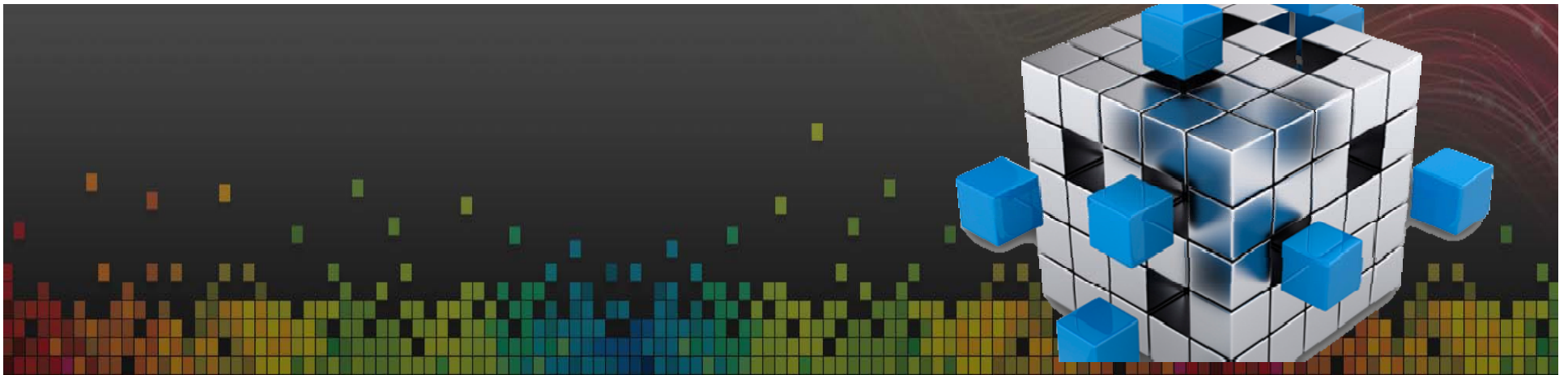
IBM DB2 Advanced Recovery Feature can be purchased separately and used with various DB2 Editions (except DB2 Express-C)

All products support DB2 10.5 for LUW

Summary

- In this Module you learned about:
 - How and why you should backup a database
 - How to restore the database from a backup image, and the options available for restoring

The next steps...



The Next Steps...

- Complete the Hands on Lab for this module
 - Log onto SKI, go to “My Learning” page, and select the “In Progress” tab.
 - Find the module
 - Download the workbook and the virtual machine image
 - Follow the instructions in the workbook to complete the lab
- Complete the online quiz for this module
 - Log onto SKI, go to “My Learning” page, and select the “In Progress” tab.
 - Find the module and select the quiz
- Provide feedback on the module
 - Log onto SKI, go to “My Learning” page
 - Find the module and select the “Leave Feedback” button to leave your comments



Questions?
askdata@ca.ibm.com

