

# SQL Server Backup & Recovery

Basics

2019 Tribal Data Workshop



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# Transaction Log

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# Recovery Models

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# Backup Types

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# Recommendations

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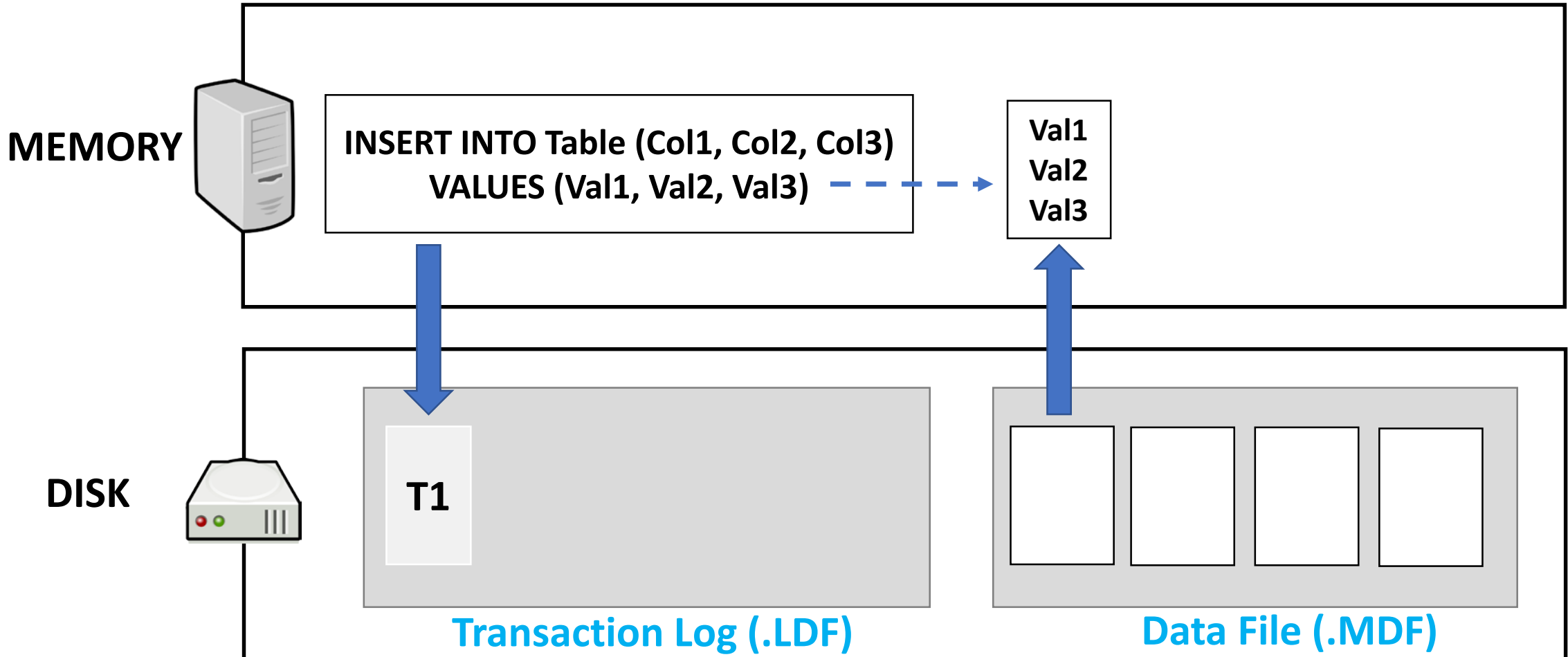
# SSMS Demo

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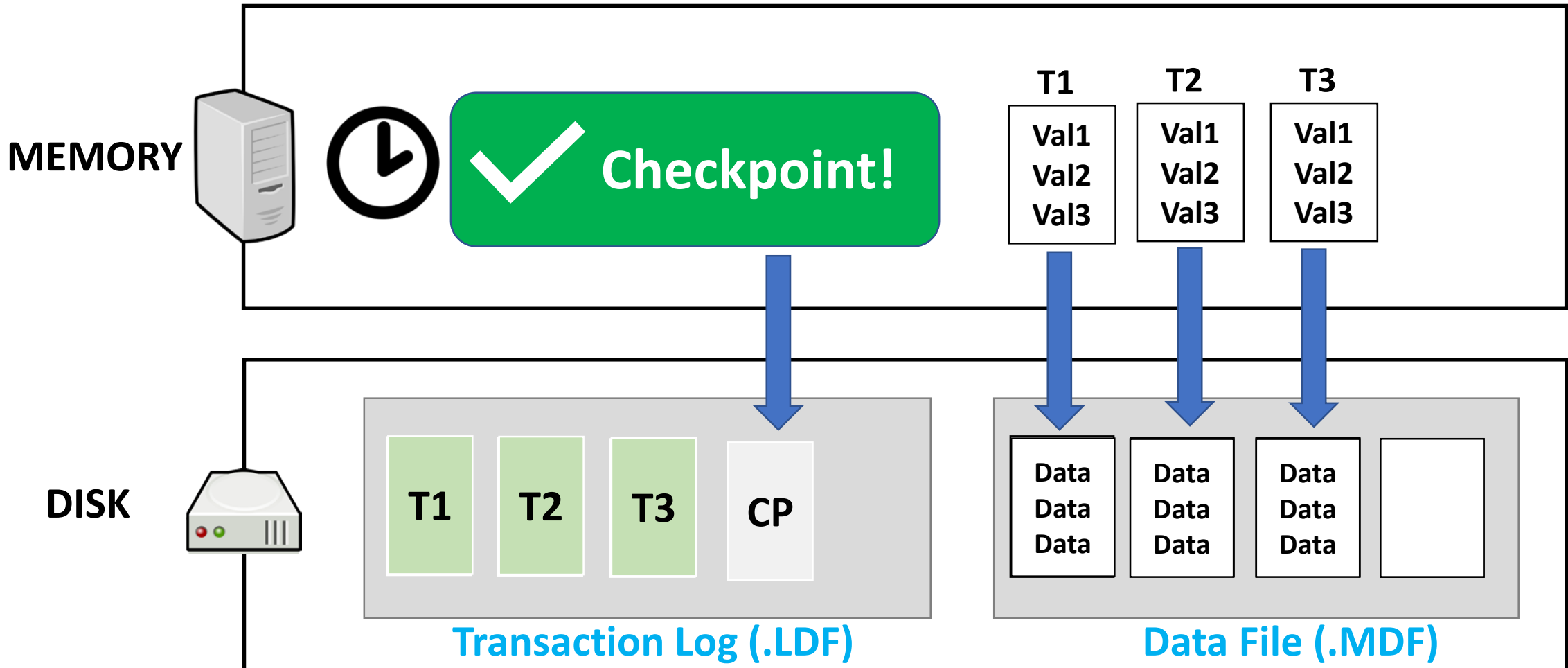
# SQL Server Database Files

- Data File (MDF)
  - Stores all the data
  - Also stores database objects (tables, views, stored procedures, etc)
- Transaction Log File (LDF)
  - Stores a record of modifications to the database
  - Examples: INSERT, UPDATE, DELETE, ALTER, DROP commands
  - [Video: SQL Server Transactions](#)

# Transaction Log

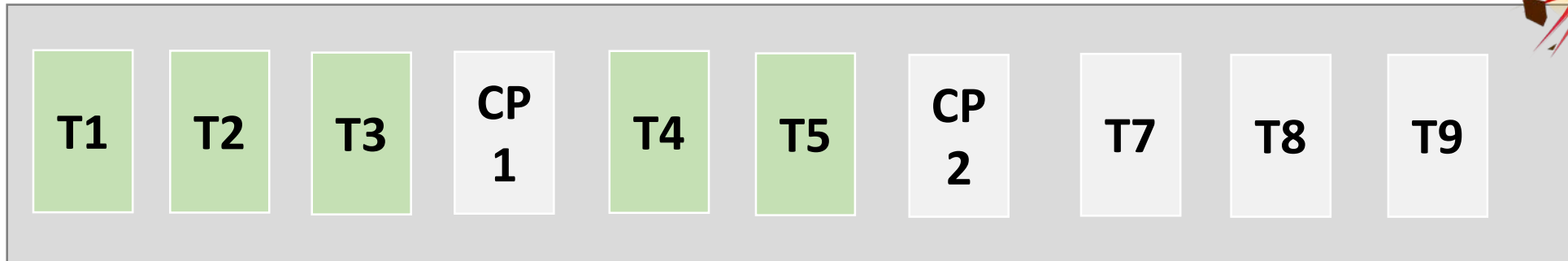


# Transaction Log



# Transaction Log

t



Written To Disk

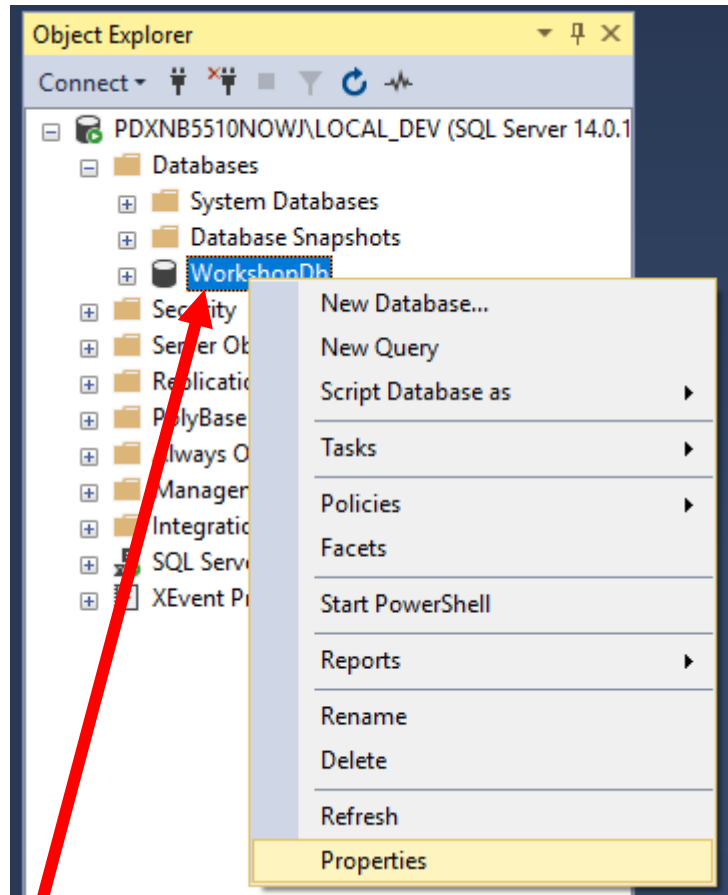
**Active Portion of Log**  
Not Written To Disk

# Database Recovery Models

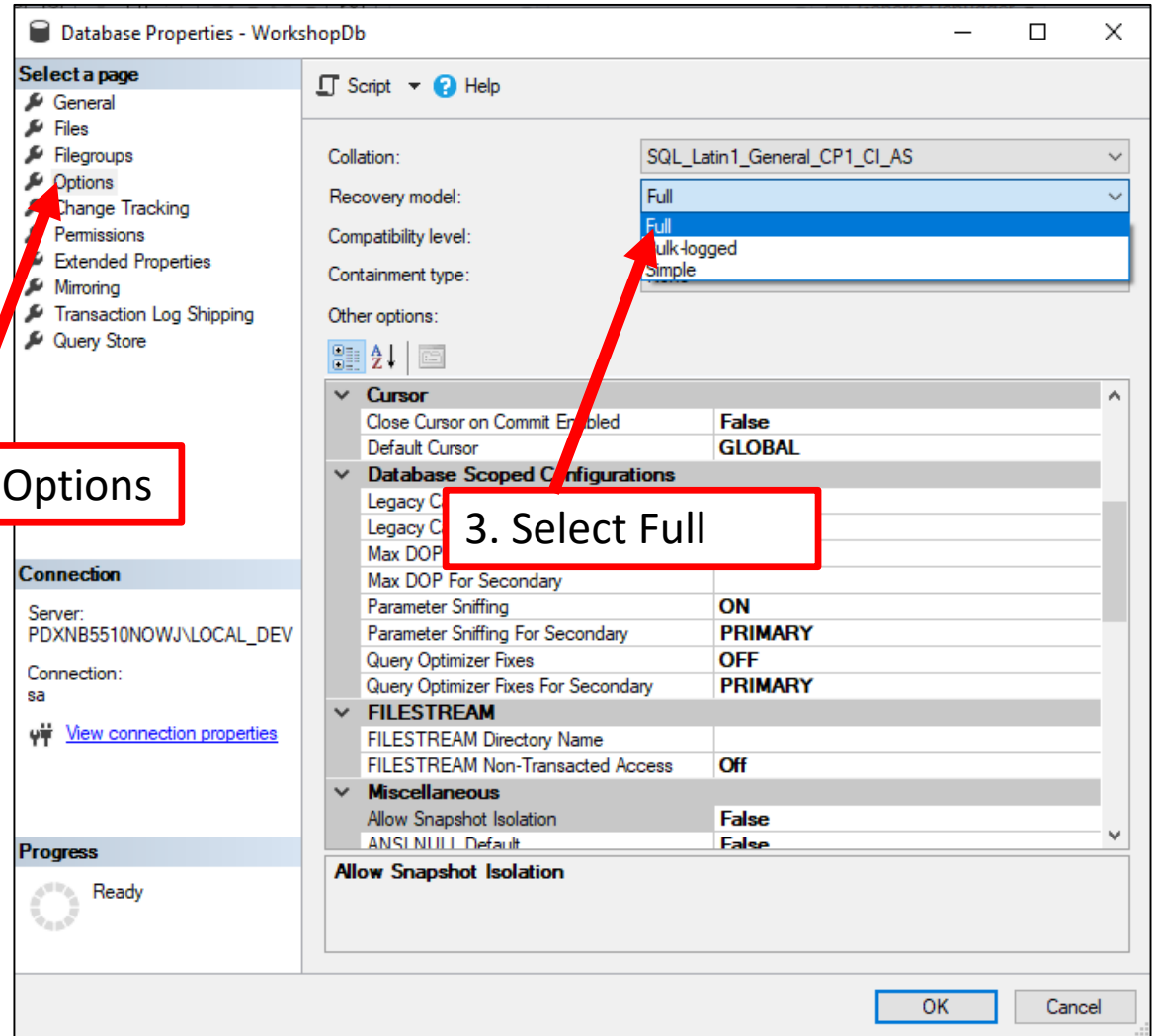
## ★ Full Recovery Model

- All transactions logged and saved
  - Allows Point-in-time recovery
  - Recommended for production databases
- 
- Simple Recovery Model
    - Transactions are deleted after each checkpoint
    - Point-in-time recovery not possible
    - Recommended for development databases
- 
- Bulk-Logged Recovery Model
    - Certain types of transaction are not fully logged

# Configuring Database Recovery Model



1. Right click database and select Properties



2. Select Options

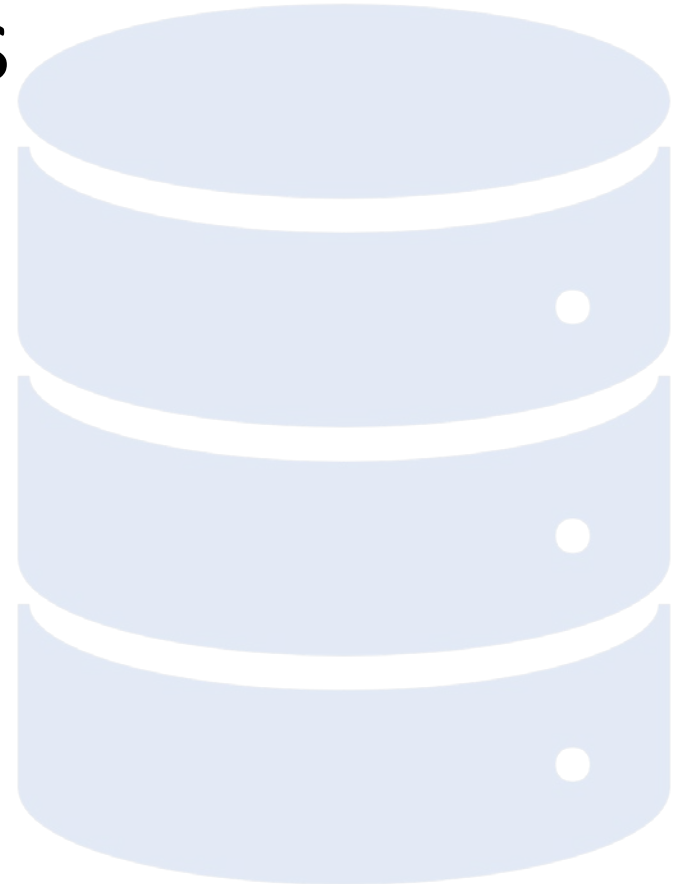
3. Select Full





# SQL Server Backup Types

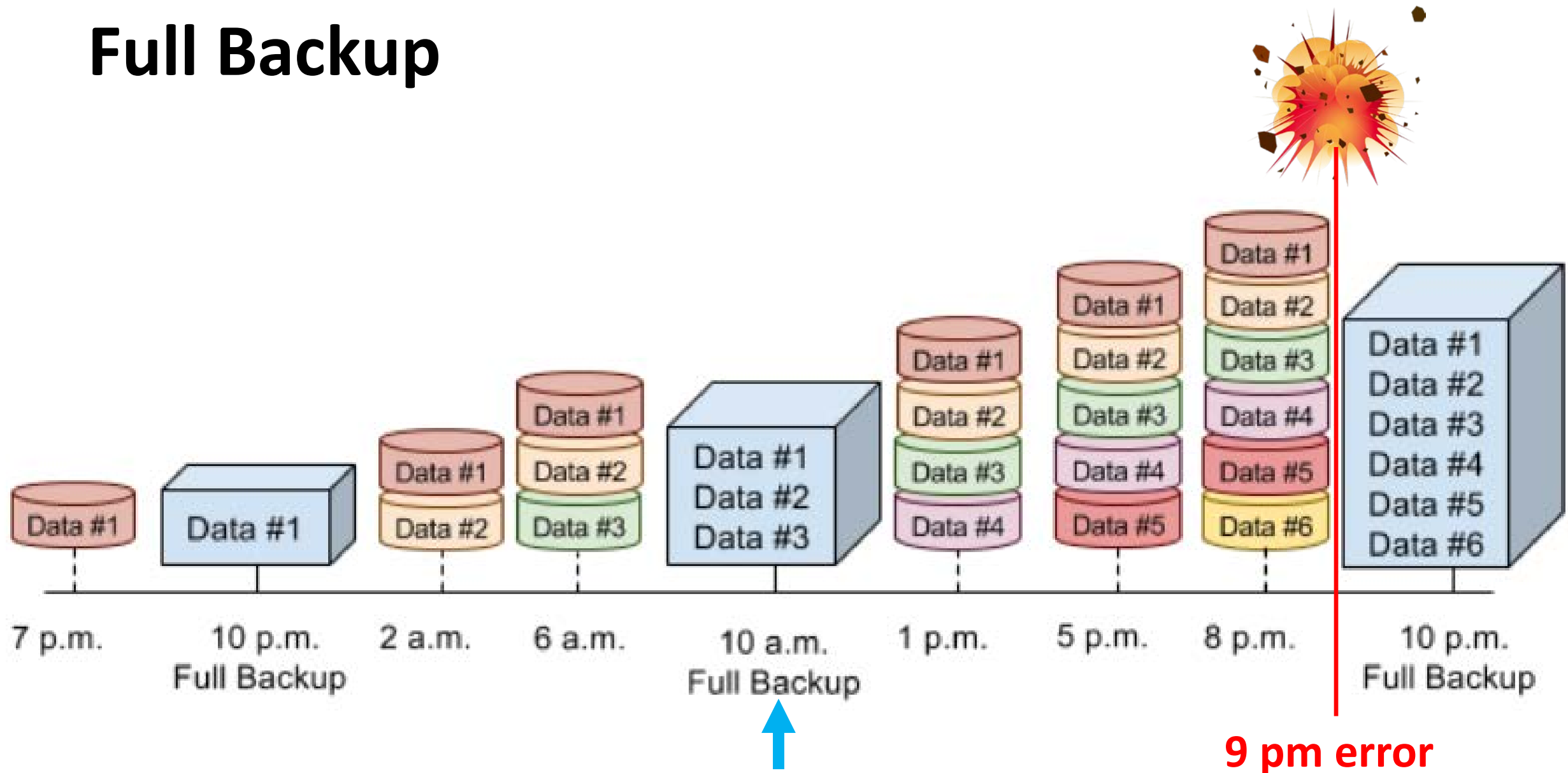
- **Full Backup**
- **Differential Backup**
- **Transaction Log Backup**
- Tail-log Backup
- Copy-Only
- Partial Backup
- File Backup



# Full Backup

- The simplest type of backup
- A complete copy of the database
- File size can be large
- Restores database to a fixed point in time
- Prerequisite for differential or transaction log backups

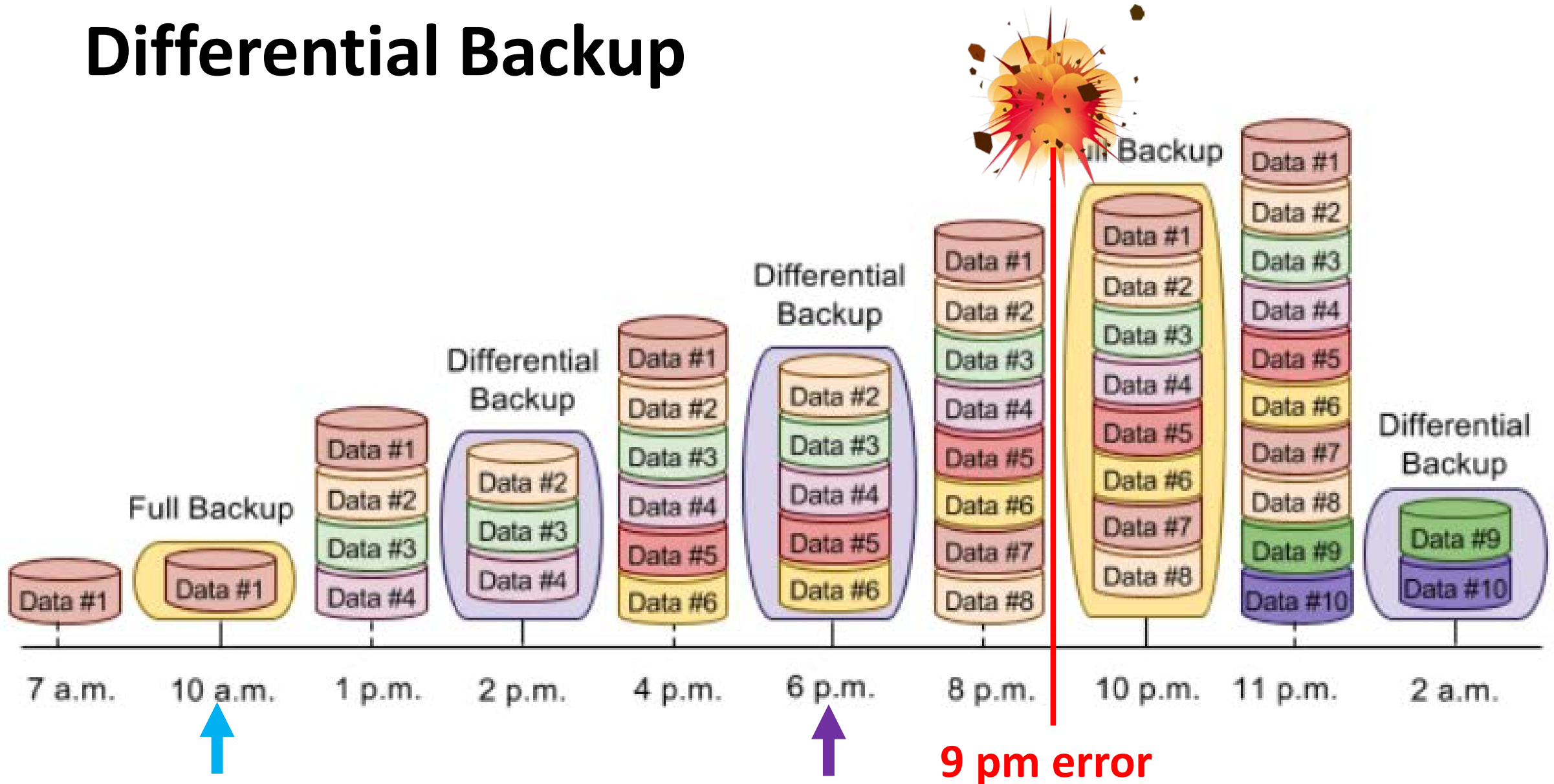
# Full Backup



# Differential Backup

- Contains data that has changed since last full backup
- Based on the last full backup
- File size depends on the amount of data that has changed
- Restores database to a fixed point in time

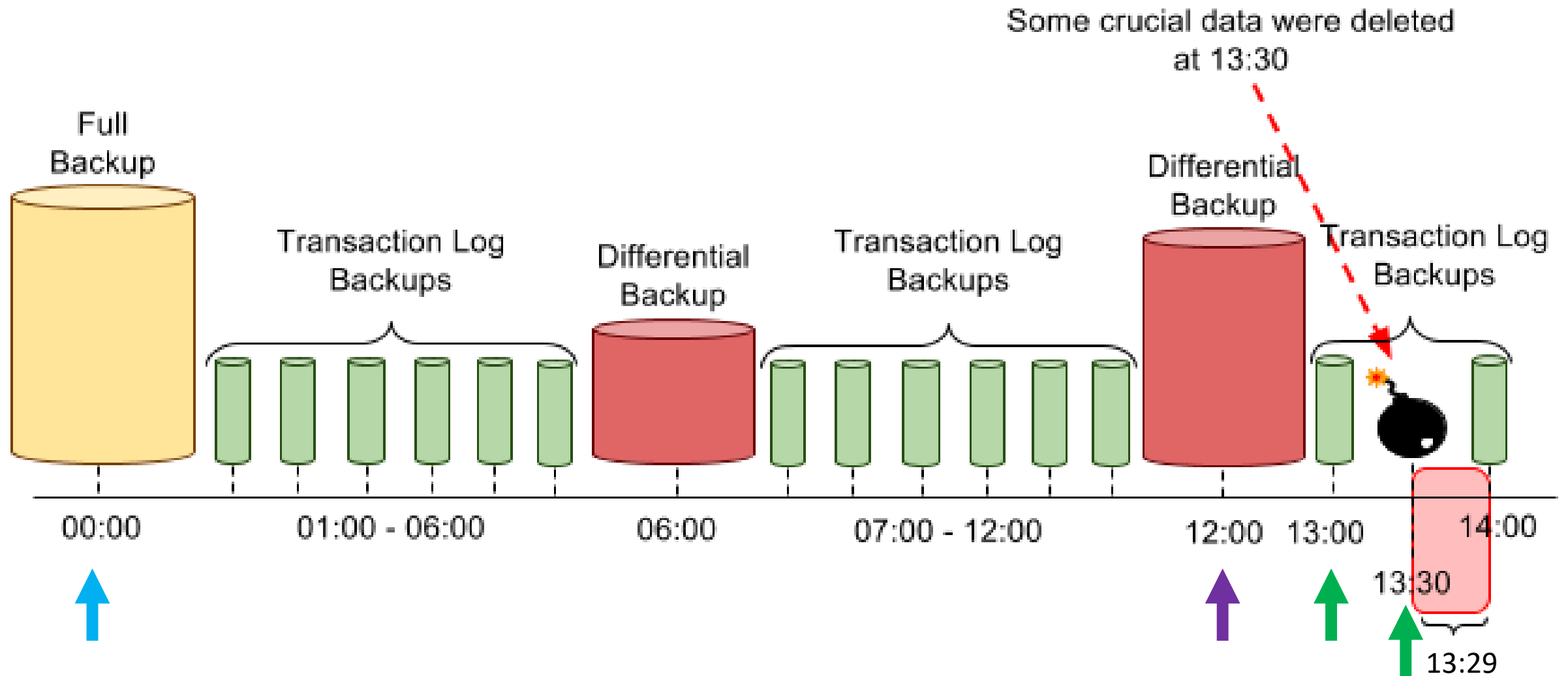
# Differential Backup



# Transaction Log Backup

- Contains all log records since last full or t-log backup
- File size depends on transactions since last backup
- Incremental
- Restores to any point in time within the backup

# Transaction Log Backup



# Tail Log Backup

- Created during the recovery process before restoring a full backup
- SQL Server will prompt to back up the current transaction log
- The last backup to perform before starting the recovery process



# Copy-Only Backup

- Just like a full backup
- A complete copy of the database
- BUT not a based for differential or transaction log backups
- Useful when copying a database from on server to another

# Recommendations

- CRITFC Backup Routine
  - Full backup weekly (Friday 10pm)
  - Differential backup daily (10pm)
  - Transaction log backup hourly (9am-6pm)
- Verify backups weekly (Monday)
  - Confirm backup files were created
  - Restore backup files in test environment

# Recommendations

- Use SSMS to automate database backups
- Use the CHECKSUM and VERIFY options
- Keep differential and t-log backups 3 weeks (minimum)
- Keep full backups for longer (12-24 months)
- Document backup & recovery procedures
- Secure backup files (3-2-1 rule)

## 3-2-1 Backup Rule

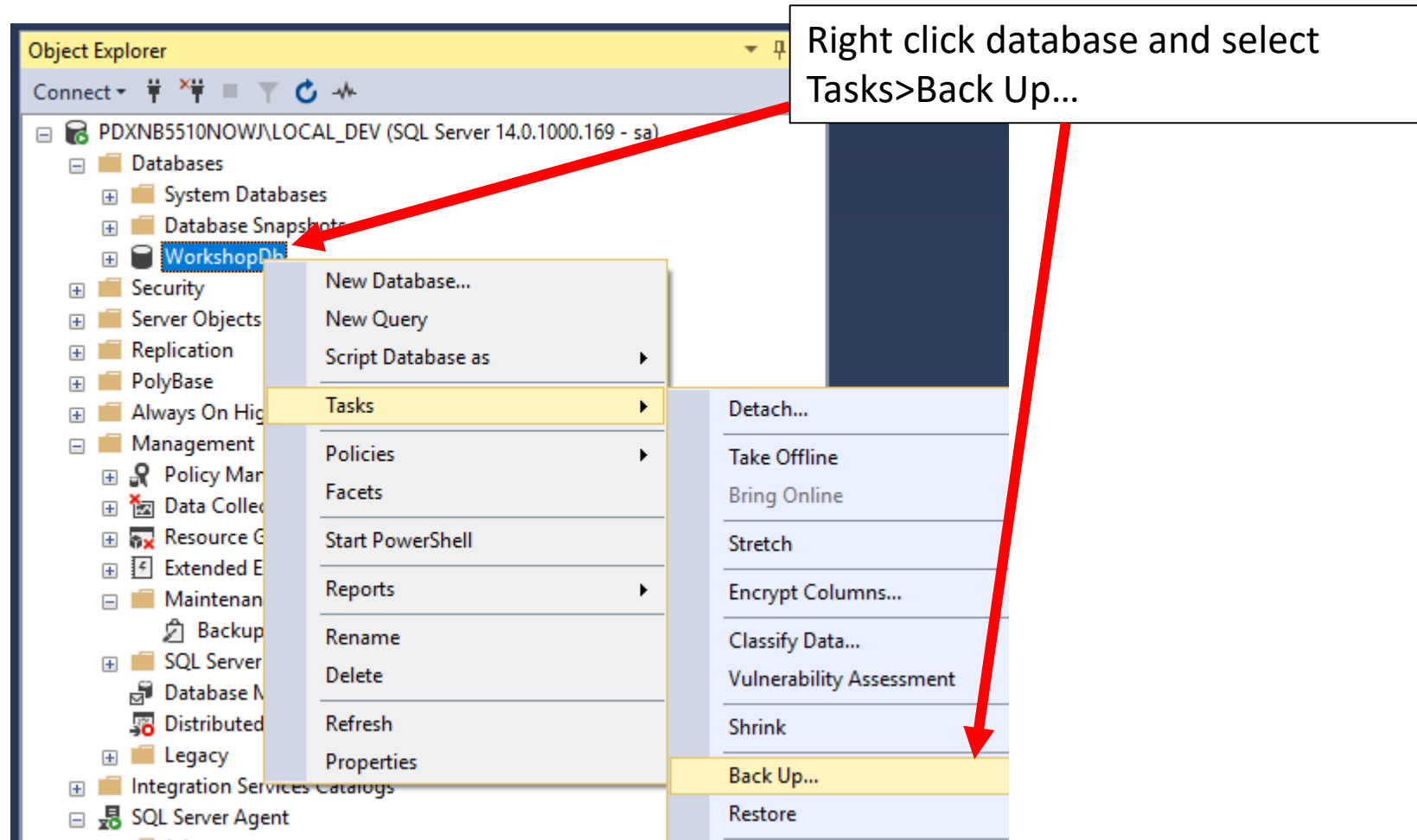
- Keep 3 copies of each database backup
- Keep 2 copies on different devices
- Keep 1 copy offsite

# Links

- <https://sqlbak.com/academy/>
- <https://www.sqlbackuprestore.com/trxlogrestoresequence.htm>
- <https://www.mssqltips.com/sqlservertip/3076/how-to-read-the-sql-server-database-transaction-log/>
- <https://www.sqlskills.com/help/accidental-dba/>

# SSMS Demo: Database Backups

# Manual Back Up



# Manual Back Up

The screenshot shows the 'Back Up Database - WorkshopDb' dialog box. The left sidebar has three tabs: 'General' (selected), 'Media Options', and 'Backup Options'. The 'General' tab contains the following settings:

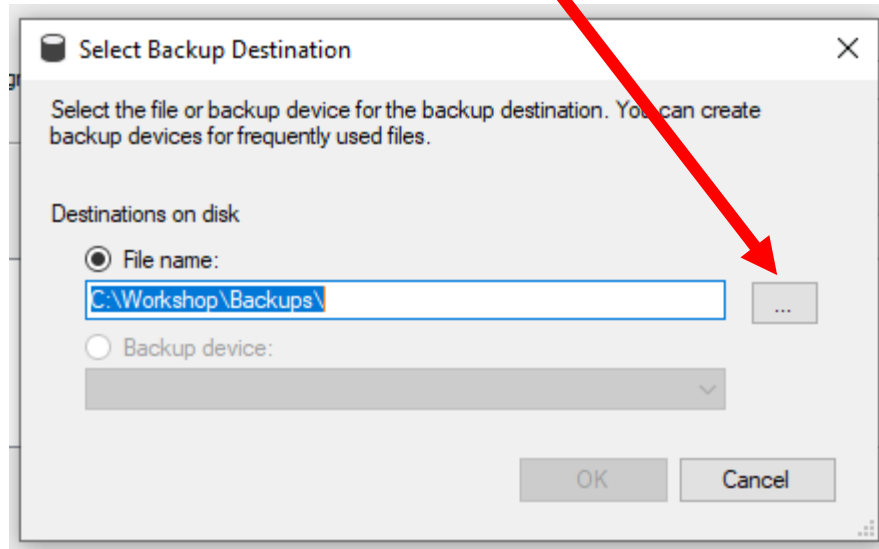
- Source:**
  - Database: WorkshopDb
  - Recovery model: FULL
  - Backup type: Full
- Copy-only backup:** ☐ (An annotation points to this checkbox with the text: 'Select this option to create a backup that will not be part of a backup chain')
- Backup component:**
  - ☒ Database
  - ☐ Files and filegroups: [Empty text box]
- Destination:**
  - Back up to: Disk
- File list:** [Empty list box] with buttons: Add..., Remove, Contents (An annotation points to the 'Add...' button with the text: 'Click Add to enter a path for the new backup file')

The bottom of the dialog has 'OK' and 'Cancel' buttons. The status bar at the bottom left shows 'Progress' with a 'Ready' indicator.

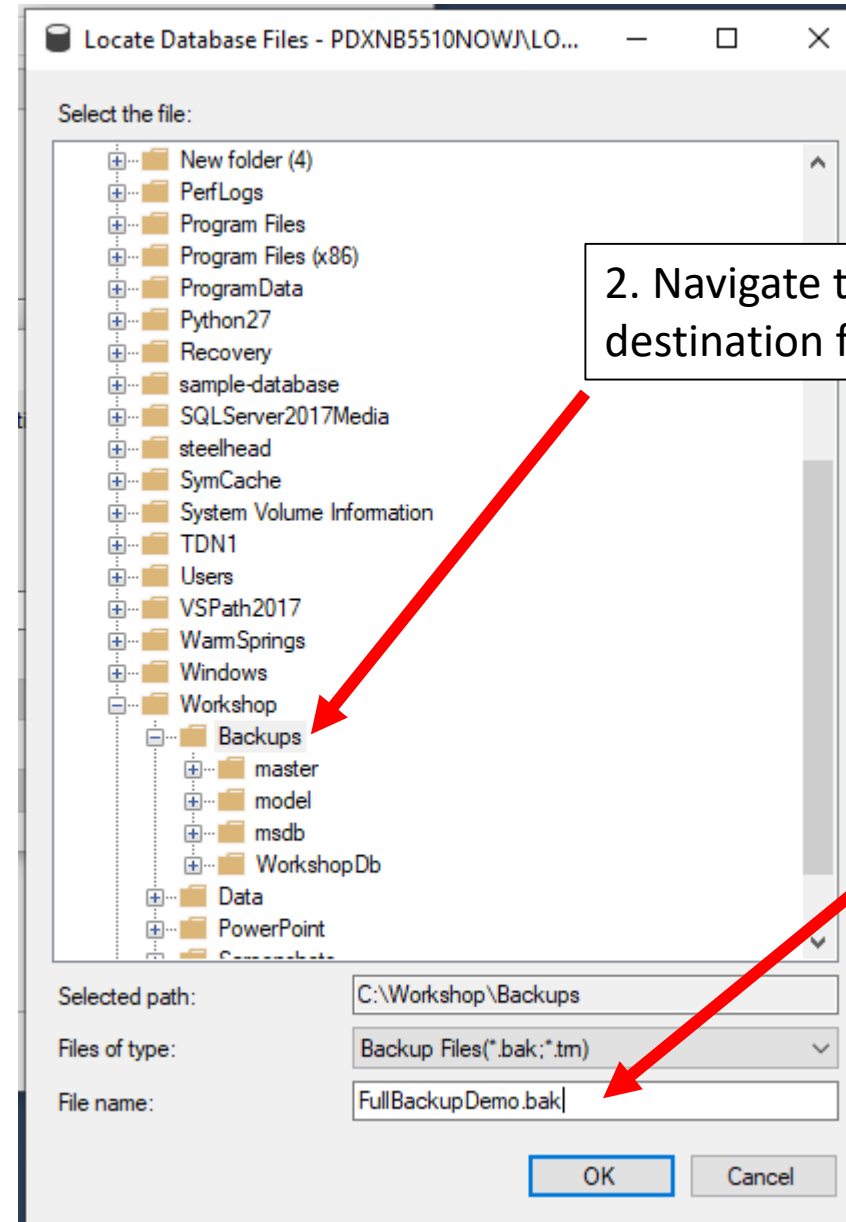


# Manual Back Up

1. Click here



2. Navigate to destination folder



3. Enter file name with extension

FullBackupDemo.bak

# Manual Back Up

1. Select Media Options tab

2. Select both the Verify backup when finished AND Checksum options

3. Click OK to perform the database back up

The screenshot shows the 'Back Up Database - WorkshopDb' dialog box. The 'Media Options' tab is selected in the left sidebar. The 'Overwrite media' section has 'Append to the existing backup set' selected. The 'Reliability' section has 'Verify backup when finished' and 'Perform checksum before writing to media' checked. The 'Transaction log' section has 'Truncate the transaction log' selected. The 'Tape drive' section has 'Unload the tape after backup' and 'Rewind the tape before unloading' unchecked. The 'OK' button is highlighted at the bottom right.

Back Up Database - WorkshopDb

Select a page

- General
- Media Options
- Backup Options

Script ? Help

Overwrite media

- ☒ Back up to the existing media set
- ☒ Append to the existing backup set
- ☐ Overwrite all existing backup sets
- ☐ Check media set name and backup set expiration

Media set name:

☐ Back up to a new media set, and erase all existing backup sets

New media set name:

New media set description:

Reliability

- ☒ Verify backup when finished
- ☒ Perform checksum before writing to media
- ☐ Continue on error

Transaction log

- ☐ Truncate the transaction log
- ☐ Back up the tail of the log, and leave the database in the restoring state

Tape drive

- ☐ Unload the tape after backup
- ☐ Rewind the tape before unloading

Connection

Server: PDXNB5510NOWJ\LOCAL\_DEV

Connection: sa

[View connection properties](#)

Progress

Ready

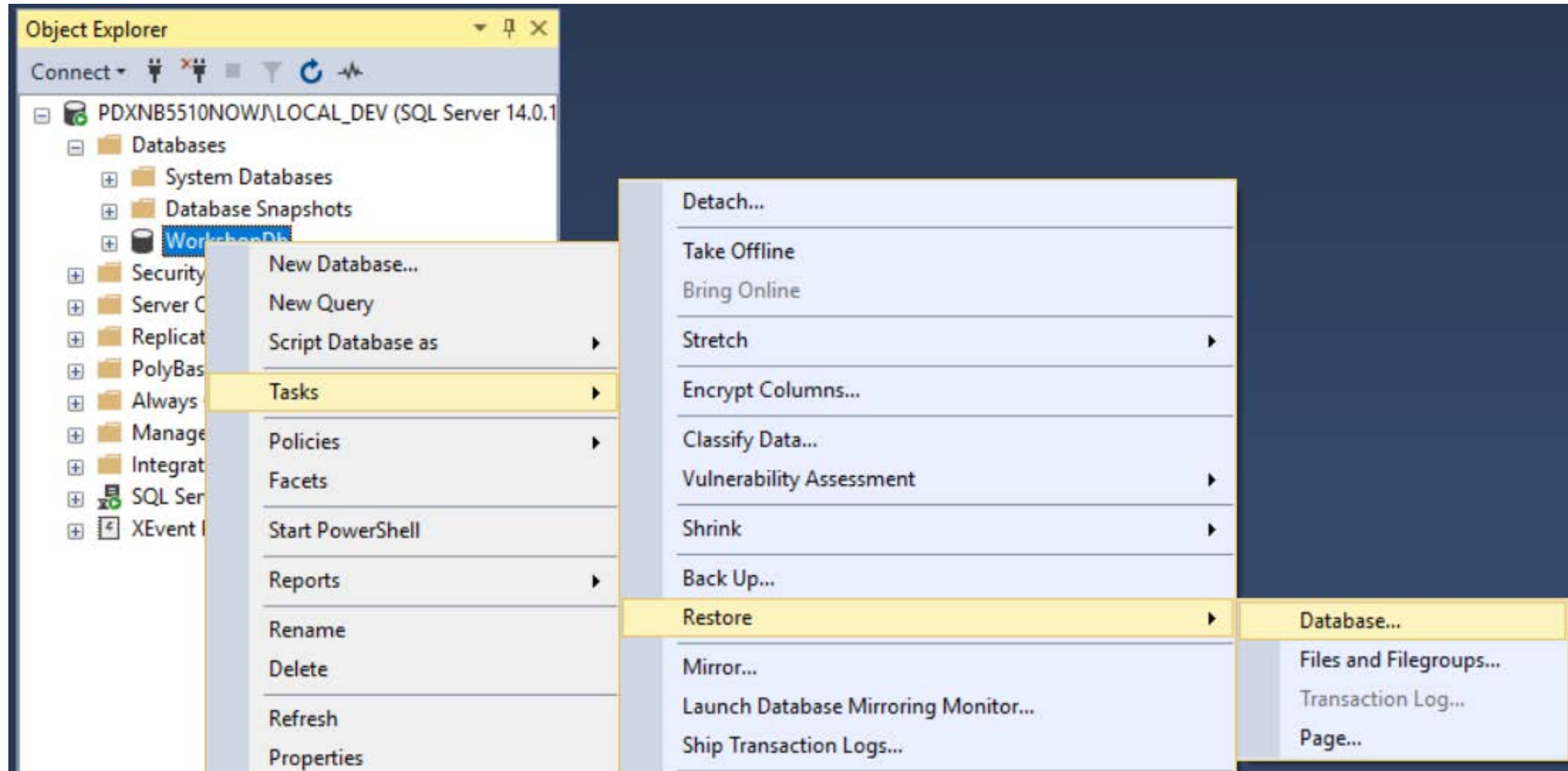
OK Cancel

# SSMS Demo: Restoring Databases

# Restoring Databases

1. Take tail-log backup to save the active portion of log
2. Restore full backup
3. Restore most recent differential backup (if available)
4. Restore all transaction log backups + tail-log backup
5. Use WITH RECOVERY option to bring database back online

# Restoring Databases



# Restoring Databases

Restore Database - WorkshopDb

⚠ A tail-log backup of the source database will be taken. View this setting on the Options page.

Select a page

- General
- Files
- Options

Script | Help

Source

☒ Database: WorkshopDb

☐ Device:

Database:

Destination

Database: WorkshopDb

Restore to: The last backup taken (Saturday, April 13, 2019 9:12:06 PM) Timeline...

Restore plan

Backup sets to restore:

Restore	Name	Component	Type	Server	Database	Position	First LSN
<input checked="" type="checkbox"/>		Database	Full	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000
<input checked="" type="checkbox"/>		Database	Differential	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000
<input checked="" type="checkbox"/>		Log	Transaction Log	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000

Verify Backup Media

OK Cancel Help

Backups available for  
this database

Scroll right for  
details

# Restoring Databases

Restore plan

Backup sets to restore:

Restore	ion	First LSN	Last LSN	Checkpoint LSN	Full LSN
<input checked="" type="checkbox"/>		36000000039000182	36000000046500001	36000000039000182	36000000019100209
<input checked="" type="checkbox"/>		36000000047800039	36000000049600001	36000000047800039	36000000039000182
<input checked="" type="checkbox"/>		36000000031500001	36000000050900001	36000000047800039	36000000039000182

Full backup Log  
Sequence Number  
(LSN)

Differential and Transaction  
log backup full LSNs must  
match the Full backup First  
LSN

The LSN of the full backup  
upon which the Differential  
and Transaction Log  
backups are based

# Restoring Databases

Restore Database - WorkshopDb

⚠ A tail-log backup of the source database will be taken. View this setting on the Options page.

Select a page

- General
- Files
- Options

Script Help

Source

☒ Database: WorkshopDb

☐ Device:

Database:

Destination

Database: WorkshopDb

Restore to: The last backup taken (Saturday, April 13, 2019 9:12:06 PM) Timeline...

Restore plan

Backup sets to restore:

Restore	Name	Component	Type	Server	Database	Position	First LSN
<input checked="" type="checkbox"/>		Database	Full	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000
<input checked="" type="checkbox"/>		Database	Differential	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000
<input checked="" type="checkbox"/>		Log	Transaction Log	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000

Verify Backup Media

OK Cancel Help

Click here to set a specific recovery point in time. Otherwise, database will restore to point in time displayed here



# Restoring Databases

Backup Timeline: WorkshopDb

Ready

Restore to

☐ Last backup taken

☒ Specific date and time





Date: 4/13/2019

Time: 9:12:06 PM

Timeline Interval: Day

<< 18:00 0:00 6:00 12:00 18:00 >>

Legend

	Full Database Backup		Transaction Log Backup
	Differential Database Backup		Tail-Log

OK Cancel Help

Select specific date time radio button and set Date and Time values. This allows a database restore to a point in time just before an error

Click OK to accept this values and return to the main restore screen. This will not run the restore process

# Restoring Databases

Restore Database - WorkshopDb

A tail-log backup of the source database will be taken. View this setting on the Options page.

Select a page

- General
- Files
- Options

Script | Help

Restore options

- ☒ Overwrite the existing database (WITH REPLACE)
- ☐ Preserve the replication settings (WITH KEEP\_REPLICATION)
- ☐ Restrict access to the restored database (WITH RESTRICTED\_USER)

Recovery state: RESTORE WITH RECOVERY

Standby file: C:\Workshop\Backups\WorkshopDb\_RollbackUndo\_2019-04-14\_09-03-56.

Leave the database ready to use by rolling back uncommitted transactions. Additional transaction logs cannot be restored.

Tail-Log backup

- ☒ Take tail-log backup before restore
- ☒ Leave source database in the restoring state (WITH NORECOVERY)

Backup file: C:\Workshop\Backups\WorkshopDb\_LogBackup\_2019-04-14\_09-03-56.ba

Options tab

Select this option overwrite existing MDF and LDF files when database is restored from backup

Select this option to back up the transaction log before restoring the database from backups

Tail-log backup destination

# Restoring Databases

Restores the database from backups and leaves database in an active “online” state ready for use

Leaves database in an “restoring” state ready for additional backup files to be restored. Db is unavailable for use until final backup is restored with recovery

Restore options

- ☐ Overwrite the existing database (WITH REPLACE)
- ☐ Preserve the replication settings (WITH KEEP\_REPLICATION)
- ☐ Restrict access to the restored database (WITH RESTRICTED\_USER)

Recovery state: **RESTORE WITH RECOVERY**

Standby file: **RESTORE WITH RECOVERY**

Leave the database ready to use by restoring **RESTORE WITH NORECOVERY**

Tail-Log backup

- ☒ Take tail-log backup before restore
- ☒ Leave source database in the restoring state (WITH NORECOVERY)

Backup file: C:\Workshop\Backups\WorkshopDb\_LogBackup\_2019-04-14\_10-24-08.ba

# Restoring Databases

Restore Database - WorkshopDb

⚠ A tail-log backup of the source database will be taken. View this setting on the Options page.

Select a page

- General
- Files
- Options

Script | Help

Source

☒ Database: WorkshopDb

☐ Device:

Database:

Destination

Database: WorkshopDb

Restore to: The last backup taken (Saturday, April 13, 2019 9:12:06 PM) Timeline...

Restore plan

Backup sets to restore:

Restore	Name	Component	Type	Server	Database	Position	First LSN
<input checked="" type="checkbox"/>		Database	Full	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000
<input checked="" type="checkbox"/>		Database	Differential	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000
<input checked="" type="checkbox"/>		Log	Transaction Log	PDXNB5510NOWJ\LOCAL_DEV	WorkshopDb	1	3600000

Verify Backup Media

Progress

Ready

OK Cancel Help

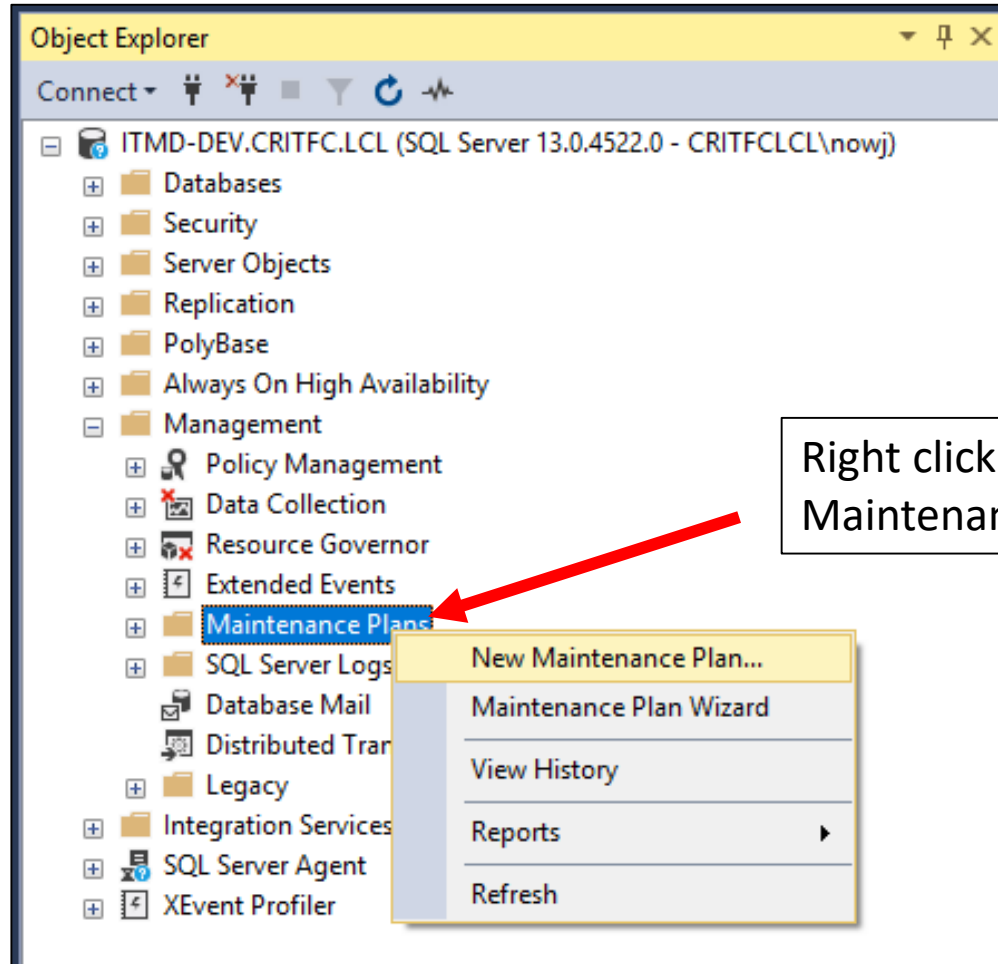
Backups available for  
this database

Click here to test  
backup files

Click OK to restore database  
from backups

# SSMS Demo: Maintenance Plan (Automated Back up)

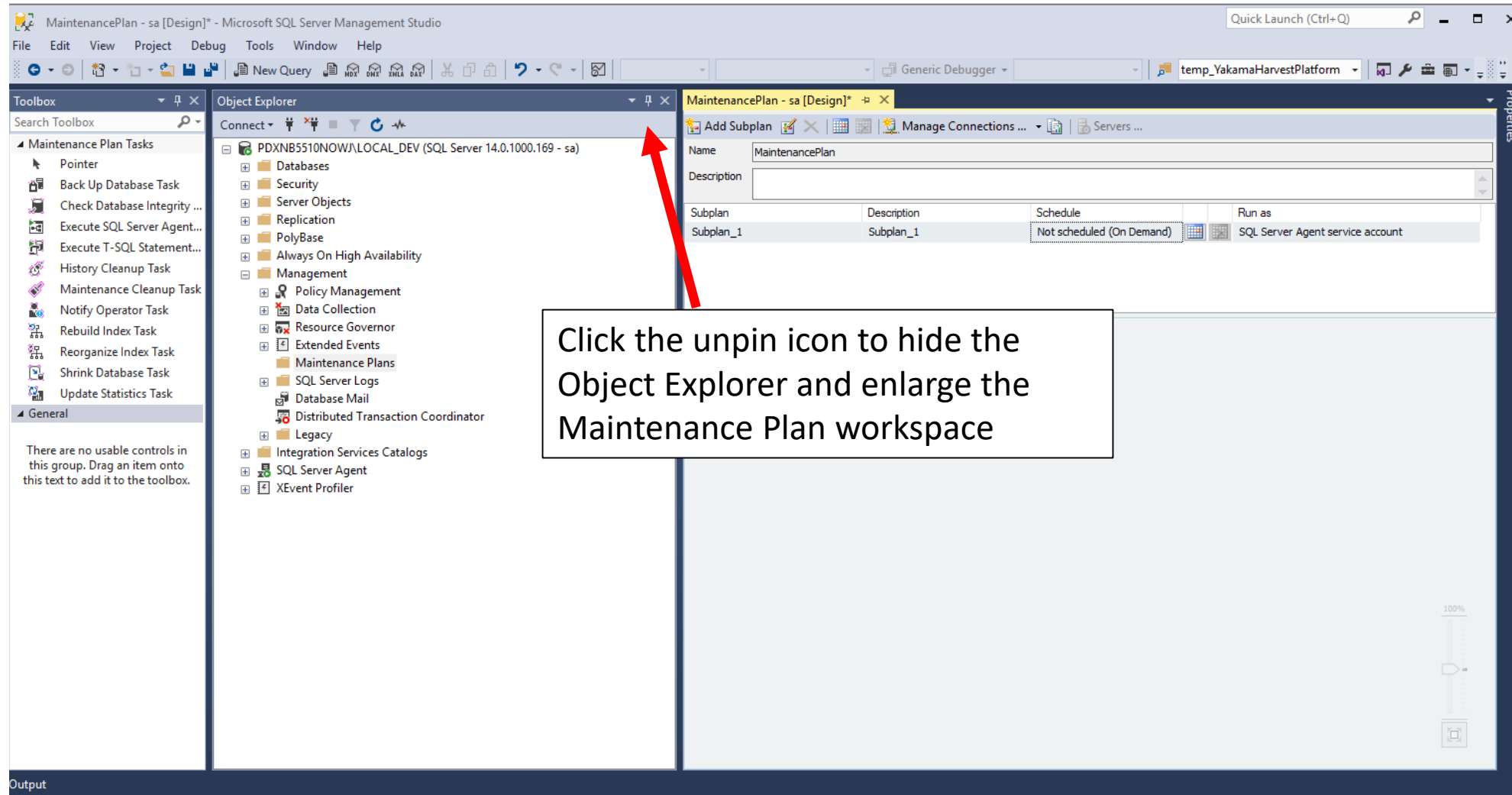
# Automating Backups



We recommend practicing these steps in development environment before implementing on production server

Right click and select Create New Maintenance Plan to begin

# Automating Backups





# Automating Backups

MaintenancePlan - sa [Design]\* - Microsoft SQL Server Management Studio

File Edit View Project Debug Tools Window Help

Search Toolbox

Maintenance Plan Tasks

- Pointer
- Back Up Database Task
- Check Database Integrity ...
- Execute SQL Server Agent...
- Execute T-SQL Statement...
- History Cleanup Task
- Maintenance Cleanup Task
- Notify Operator Task
- Rebuild Index Task
- Reorganize Index Task
- Shrink Database Task
- Update Statistics Task

General

There are no usable controls in this group. Drag an item onto this text to add it to the toolbox.

Name: MaintenancePlan

Description:

Subplan	Description
Subplan_1	Subplan_1

1. Double click Subplan\_1 to open Subplan Properties Window.

2. Enter an appropriate name (like Full Backups) and then click here to open the schedule window

Subplan Properties

Name: Full Backups

Description: Perform Full Backup on all databases

Schedule: Not scheduled (On Demand)

Run as: SQL Server Agent service account

OK Cancel



# Automating Backups

1. Select days of week  
this backup job will run

New Job Schedule

Name: Back Up Demo Full Backup Jobs in Schedule

Schedule type: Recurring ☒ Enabled

One-time occurrence  
Date: 4/ 4/2019 Time: 9:45:08 AM

Frequency  
Occurs: Weekly  
Recurs every: 1 week(s) on  
☐ Monday ☐ Wednesday ☐ Friday ☐ Saturday  
☐ Tuesday ☐ Thursday ☒ Sunday

Daily frequency  
☒ Occurs once at: 12:00:00 AM  
☐ Occurs every: 1 hour(s) Starting at: 12:00:00 AM  
Ending at: 11:59:59 PM

Duration  
Start date: 4/ 4/2019 ☐ End date: 4/ 4/2019  
☒ No end date

Summary  
Description: Occurs every week on Sunday at 12:00:00 AM. Schedule will be used starting on 4/4/2019.

OK Cancel Help

2. Set time of day  
backup job will run

3. Click OK

# Automating Backups

The screenshot shows the SQL Server Enterprise Manager interface. On the left, the 'Object Explorer' pane displays a tree view of 'Maintenance Plan Tasks'. The 'Back Up Database Task' is highlighted. A red dashed arrow points from this task to the workspace. In the workspace, a 'Back Up Database Task' is shown with the following properties:

- Backup Database on
- Databases: <Select one or more>
- Type: Full
- Append existing
- Destination: Disk
- Backup Compression (Default)

A green arrow points down from the task, indicating the next step in the process.

Drag and drop Back Up Database Task from the Tool Bar into the workspace

There are no usable controls in this group. Drag an item onto this text to add it to the toolbox.

# Automating Backups

The image shows a screenshot of the SQL Server Enterprise Manager interface. A task named 'Back Up Database Task' is highlighted in the task list. A red arrow points from a numbered box to this task. Another red arrow points from a second numbered box to the 'Backup type' dropdown in the task's properties dialog. A third red arrow points from a third numbered box to the 'Database(s)' dropdown in the same dialog. The properties dialog has tabs for 'General', 'Destination', and 'Options'. The 'General' tab is active, showing 'Local server connection' for the connection, 'Full' for the backup type, and '<Select one or more>' for the database(s). A sub-dialog box is open for selecting databases, showing radio buttons for 'All databases', 'System databases', 'All user databases (excluding master, model, msdb, tempdb)', and 'These databases:'. The 'These databases:' option is selected, and a list of databases is shown with checkboxes: 'AccordsProjectSummary', 'AnotoLiveFormsQC', 'AnotoLiveFormsTest', and 'AWSBackupMetadata'. The 'Ignore databases where the state is not online' checkbox is also present.

1. Double click to open properties

2. Select Backup type

3. Select database(s) to backup

Back Up Database Task

Backup Database on  
Databases: <Select one or more>  
Type: Full  
Append existing  
Destination: Disk  
Backup Compression (Default)

Back Up Database Task

Connection: Local server connection

General Destination Options

Backup type: Full

Database(s): <Select one or more>

Backup component

☒ Databases

☐ Files and filegroups:

Back up to:

☒ All databases

☐ System databases

☐ All user databases (excluding master, model, msdb, tempdb)

☐ These databases:

☐ AccordsProjectSummary

☐ AnotoLiveFormsQC

☐ AnotoLiveFormsTest

☐ AWSBackupMetadata

☐ Ignore databases where the state is not online

OK Cancel

# Automating Backups

1. Select Destination Tab

2. Set destination path

3. Enter backup file extension

The screenshot shows the 'Back Up Database Task' dialog box. A red arrow points from the '1. Select Destination Tab' text to the 'Destination' tab. Another red arrow points from the '2. Set destination path' text to the 'Folder:' field, which contains 'F:\Backups'. A third red arrow points from the '3. Enter backup file extension' text to the 'Backup file extension:' field, which contains 'bak'. The dialog box has three tabs: 'General', 'Destination', and 'Options'. The 'Destination' tab is active. It contains a list box for backup files, buttons for 'Add', 'Remove', and 'Contents', a dropdown for 'If backup files exist:' set to 'Append', radio buttons for 'Create a backup file for every database' (selected) and 'Create a sub-directory for each database' (checked), and fields for 'SQL credential:', 'Azure storage container:', 'URL prefix:', and 'Backup file extension:'. The 'Folder:' field has a blue ellipsis button next to it. At the bottom are buttons for 'OK', 'Cancel', 'View T-SQL', and 'Help'.

Back Up Database Task

Connection: Local server connection New...

General Destination Options

☐ Back up databases across one or more files:

Add Remove Contents

If backup files exist: Append

☒ Create a backup file for every database  
☒ Create a sub-directory for each database

Folder: F:\Backups ...

SQL credential: Create...

Azure storage container:

URL prefix: https://<storageaccount>.blob.core.windows.net/

Backup file extension: bak

OK Cancel View T-SQL Help

# Automating Backups

1. Select Options Tab

2. Select Perform Checksum and Verify backup integrity options

3. Click OK

The screenshot shows the 'Back Up Database Task' dialog box with the 'Options' tab selected. The 'Connection' is set to 'Local server connection'. The 'Set backup compression' dropdown is set to 'Use the default server setting'. The 'Backup set will expire' section has 'After' selected with a value of 14 days and an expiration date of 4/18/2019. The 'Perform checksum' checkbox is checked, and the 'Verify backup integrity' checkbox is also checked. The 'Copy-only backup' checkbox is unchecked. The 'Backup encryption' section shows 'Algorithm' set to 'AES 128' and 'Certificate or Asymmetric key' set to an empty dropdown. The 'For availability databases, ignore replica priority for backup and backup on primary settings' checkbox is unchecked. The 'Block size' and 'Max transfer size' are both set to 65536 bytes. The 'Continue on error' checkbox is unchecked. The 'OK', 'Cancel', 'View T-SQL', and 'Help' buttons are at the bottom.

Back Up Database Task

Connection: Local server connection New...

General Destination Options

Set backup compression: Use the default server setting

☐ Backup set will expire:

☒ After 14 days

☐ On 4/18/2019

☐ Copy-only backup

☒ Verify backup integrity

☐ Backup encryption

Algorithm: AES 128

Certificate or Asymmetric key:

☐ For availability databases, ignore replica priority for backup and backup on primary settings

☐ Block size 65536 bytes

☐ Max transfer size 65536 bytes

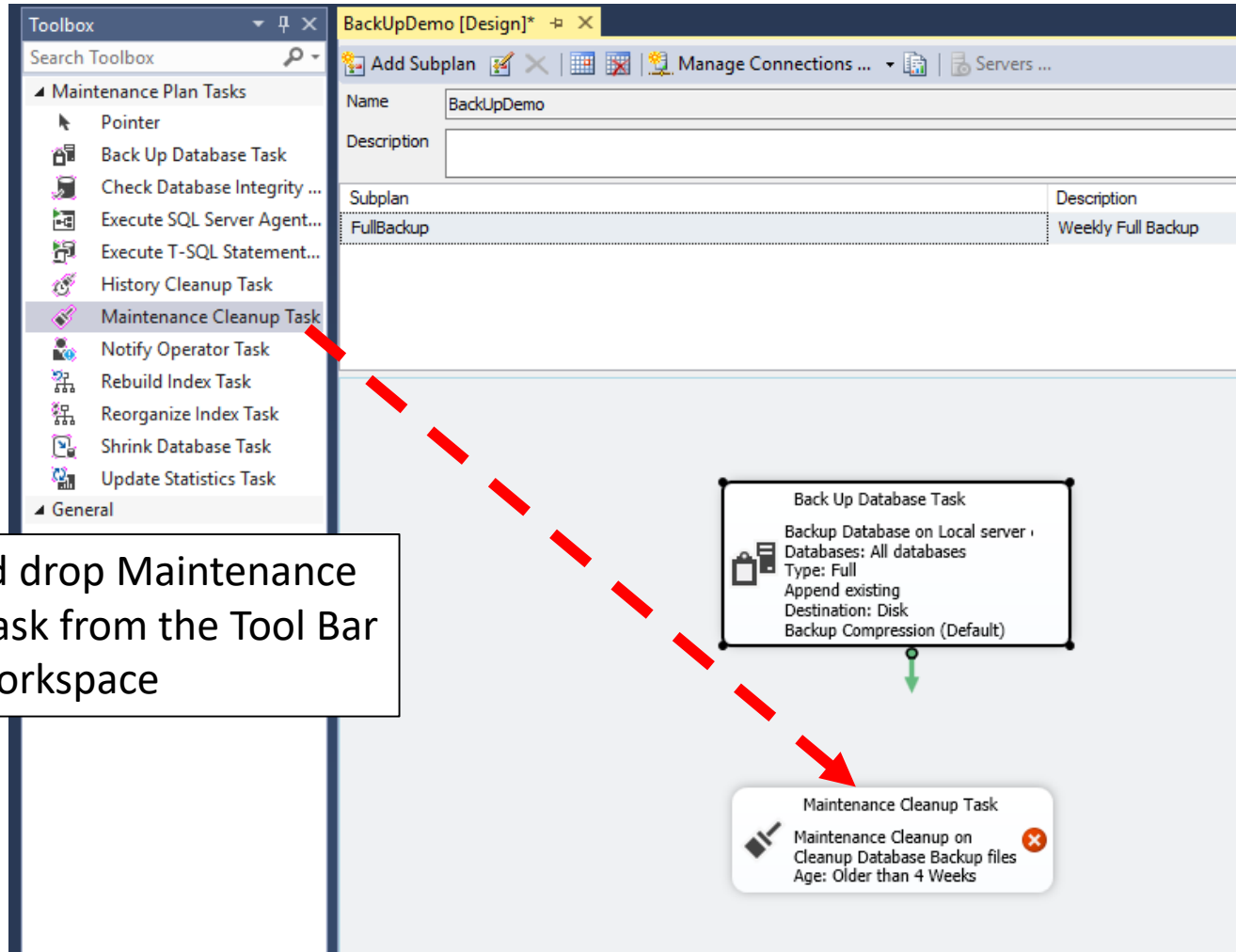
☒ Perform checksum

☐ Continue on error

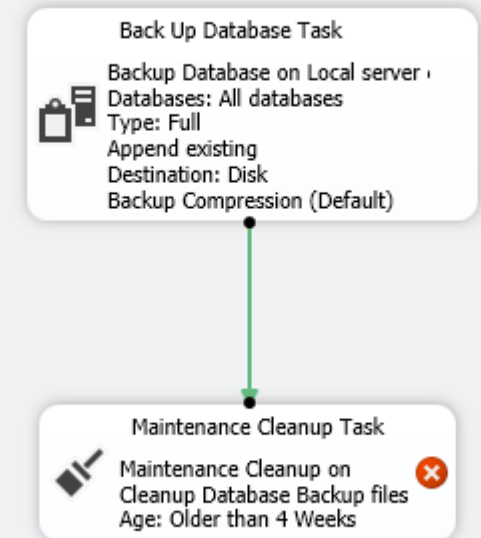
OK Cancel View T-SQL Help

# Automating Backups

1. Drag and drop Maintenance Clean Up task from the Tool Bar into the workspace



2. Drag the green arrow from Back Up task to Clean Up task to set task execution order



# Automating Backups

1. Double click to open properties

Back Up Database Task  
Backup Database on Local server  
Databases: All databases  
Type: Full  
Append existing  
Destination: Disk  
Backup Compression (Default)

Maintenance Cleanup Task  
Maintenance Cleanup on  
Cleanup Database Backup files  
Age: Older than 4 Weeks

Maintenance Cleanup Task

Connection: Local server connection New...

Delete files of the following type:

☒ Backup files

☐ Maintenance Plan text reports

File location:

☐ Delete specific file

File name:

☒ Search folder and delete files based on an extension

Folder: F:\Backups

File extension: .bak

☒ Include first-level subfolders

File age:

☒ Delete files based on the age of the file at task run time

Delete files older than the following:

20 Day(s)

OK Cancel View T-SQL Help

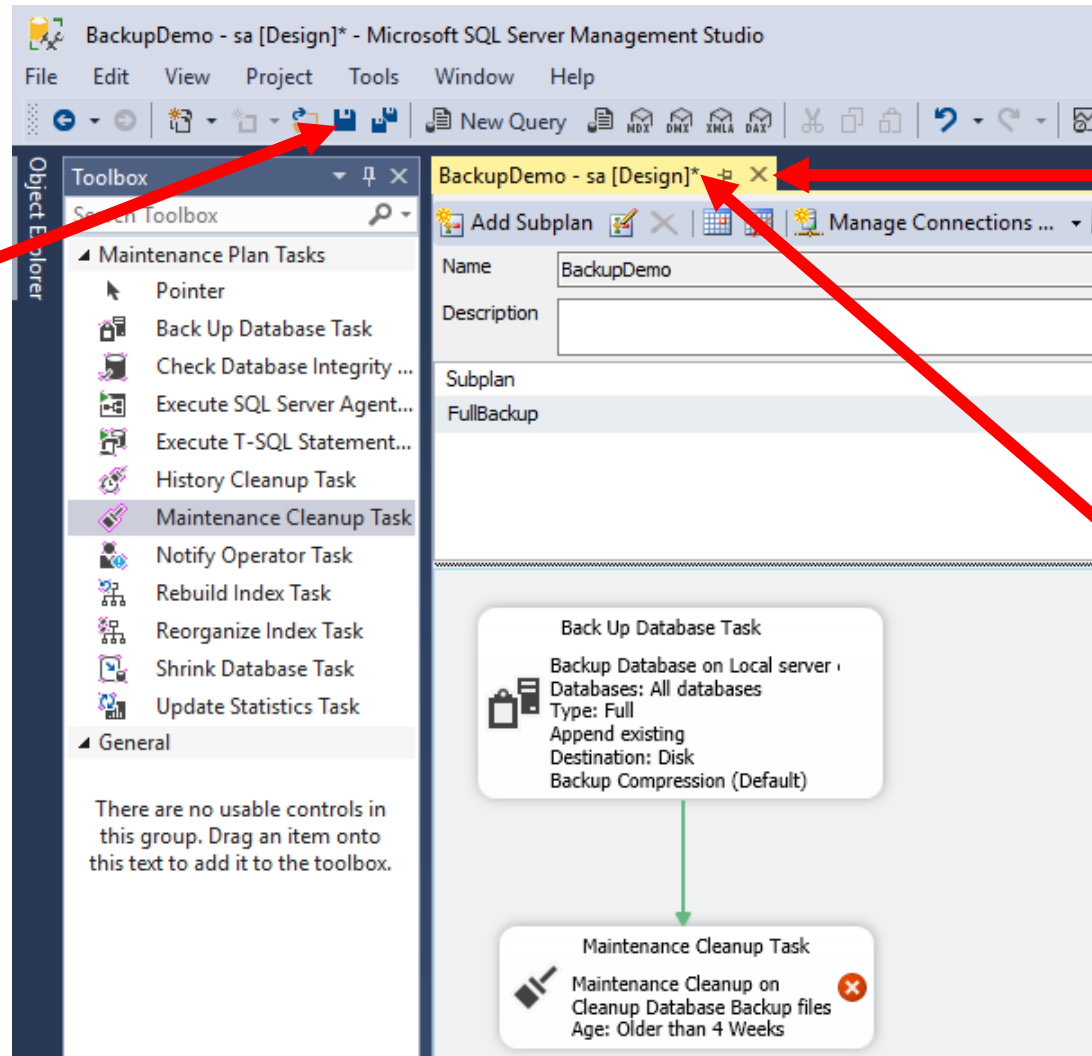
2. Select folder to search

3. Set file type

4. Set as needed. CRITFC saves database backups on the server for 21 days. Old backup files are automatically deleted.

# Automating Backups

1. Save maintenance plan



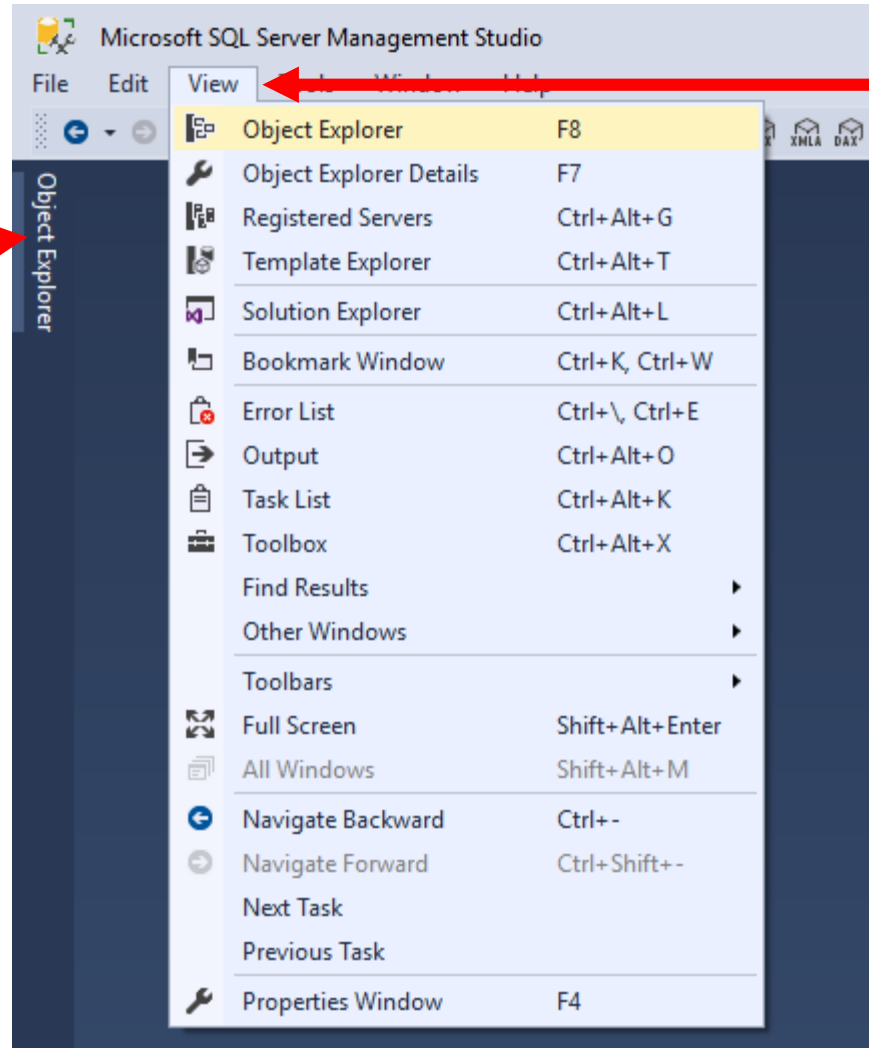
2. Click the X to close maintenance plan tab after saving

Note: an asterisk indicates unsaved changes. This will disappear after saving.



# Automating Backups

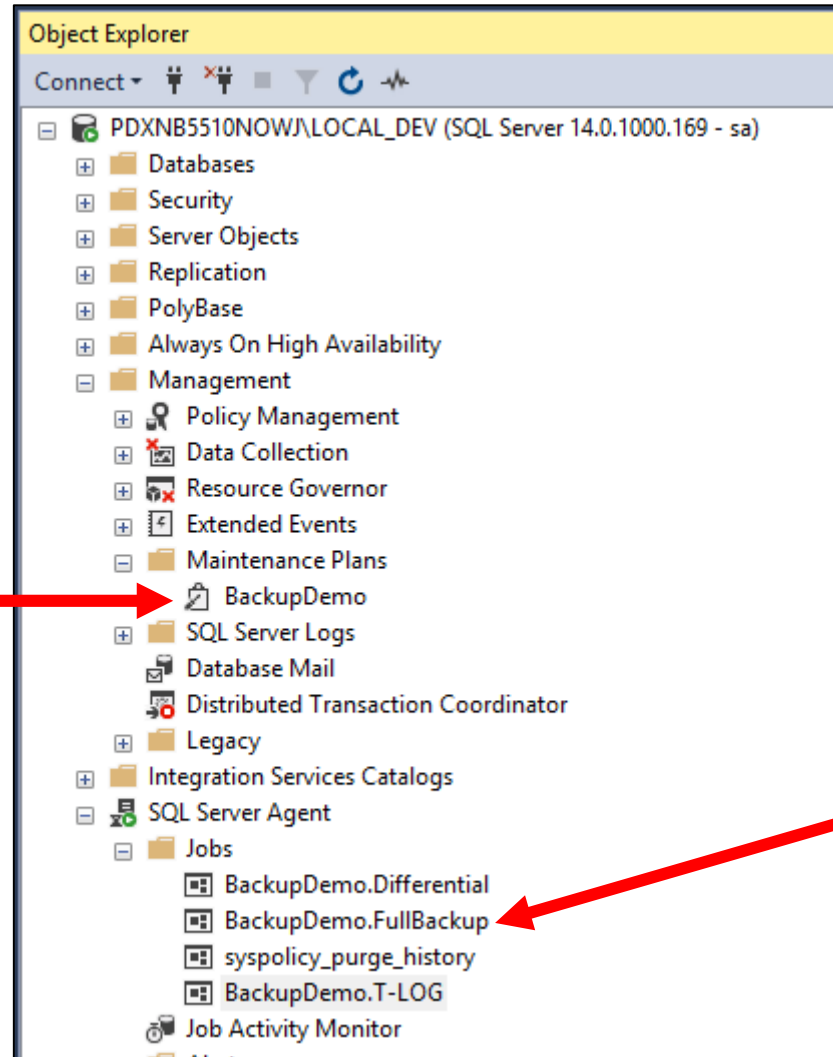
Click this tab to expand the Object Explorer



Or select Object Explorer from the View Menu

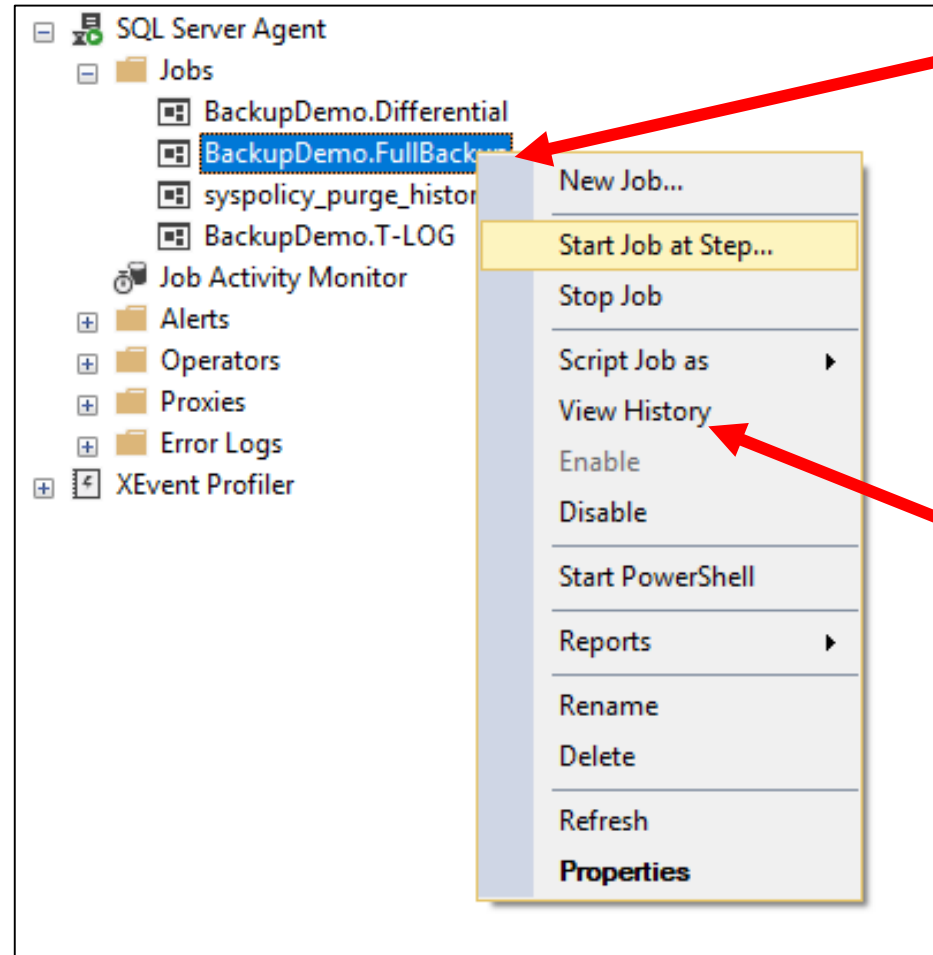
# Automating Backups

Verify new maintenance plan has been saved



Each subplan should appear as a separate Job

# Automating Backups



Test each job:

Right click and select Start Job at Step to manually trigger

View History provides helpful info when job execution fails