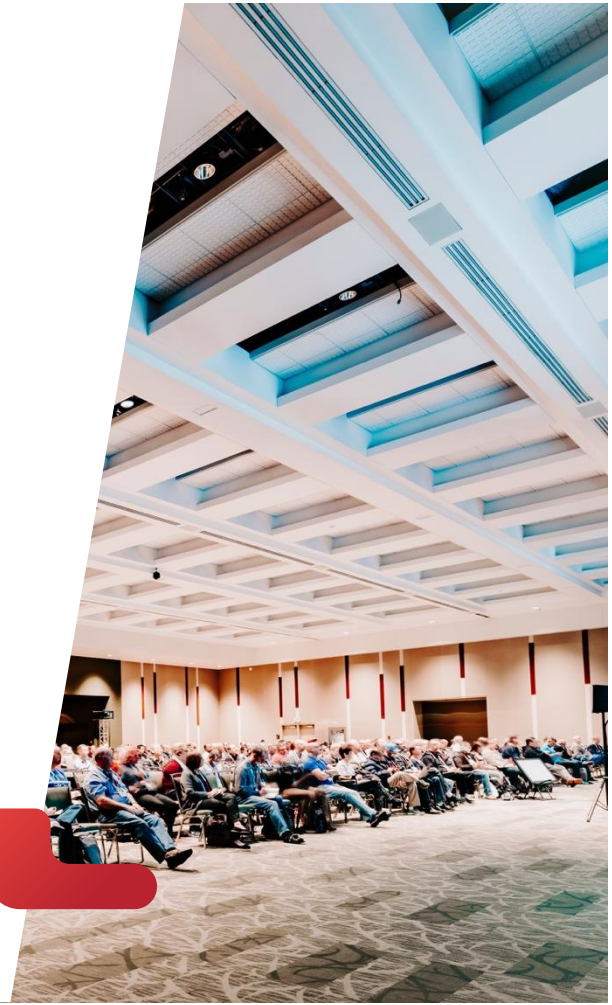
PASS SUMMIT2019

SQL Server Migration

The Last Mile

Pedro Lopes, Program Manager, Microsoft



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Pedro Lopes

Program Manager
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/pedroazevedolopes

@SQLPedro

SQL Server

Relational Engine
Query processing
Performance

PASS Summit Learning Pathway:

Modernizing with SQL Server 2019

SQL Server and Azure Data: What to Use When
Bob Ward & Anna Thomas
Wednesday November 06, 10:45 AM
Room 6E

SQL Server 2019: Your Next Modern Data Platform
Bob Ward
Wednesday November 06, 1:30 PM
Tahoma 3-4

Modernizing Your SQL Server the Right Way
Pam Lahoud
Thursday November 07, 1:30 PM
Tahoma 3-4

SQL Server Migration: The Last Mile
Pedro Lopes
Thursday, November 07, 4:45 PM
Room 3AB

Inside SQL Server on Kubernetes
Bob Ward
Friday, November 08, 8:00 AM
Room 612

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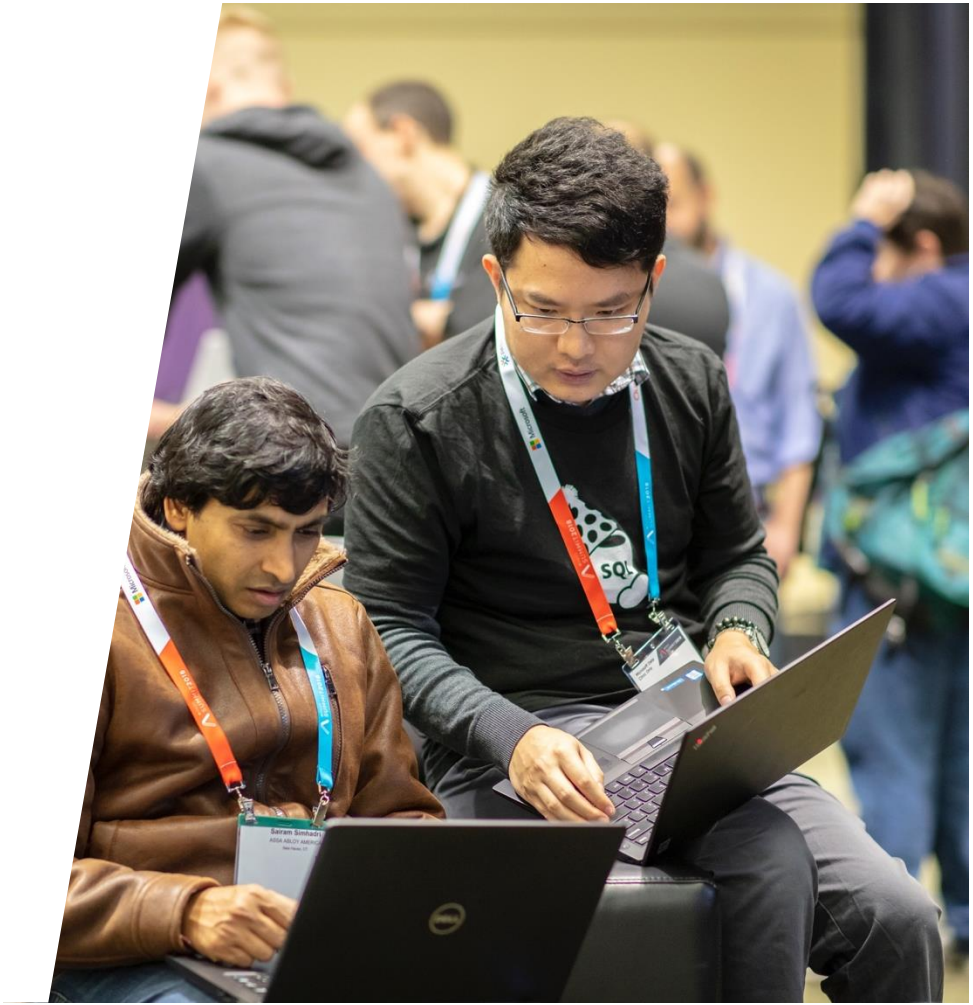
Agenda

1. Compatibility Certification
2. Database Compatibility in detail
3. Post-Migration – you're not done yet!
4. Modernization Tools breakdown

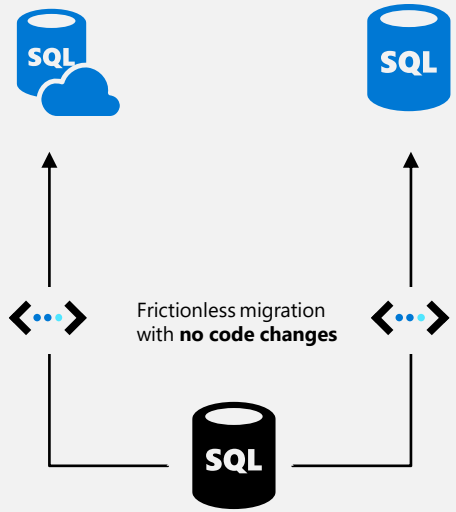
Database Compatibility Certification



Certify once, run on-premises and in the cloud with Compatibility Certification

Upgrade & modernize your SQL Server database on-premises, in the cloud and on the edge with Compatibility Certification that eliminates risks of application compatibility

Upgrade to the latest SQL Server Database Engine without changing your critical applications



Compatibility Certification benefits

Unified application certification

Applications tested and certified on a given SQL Server version are also implicitly tested and certified on that SQL Server version native database compatibility level

Reduce upgrade risks

Separate application and platform layer upgrade cycles for less disruption

Microsoft fully supports Compatibility Certification

Upgrade to latest SQL Database Engine version

Upgrade your SQL Server Database Engine or move instances to the cloud with no code changes

Database Compatibility Level protection with Microsoft

Microsoft provides an ecosystem of tools and services to test whether Compatibility Certification is right for you and protect you as you upgrade

Maintain backwards compatibility

Applications running on a newer SQL Server Database Engine while using an older Database Compatibility Level can still leverage server-level enhancements without application changes

Database Compatibility Level settings affect behaviors for a specified database, not the entire server

Predictable performance

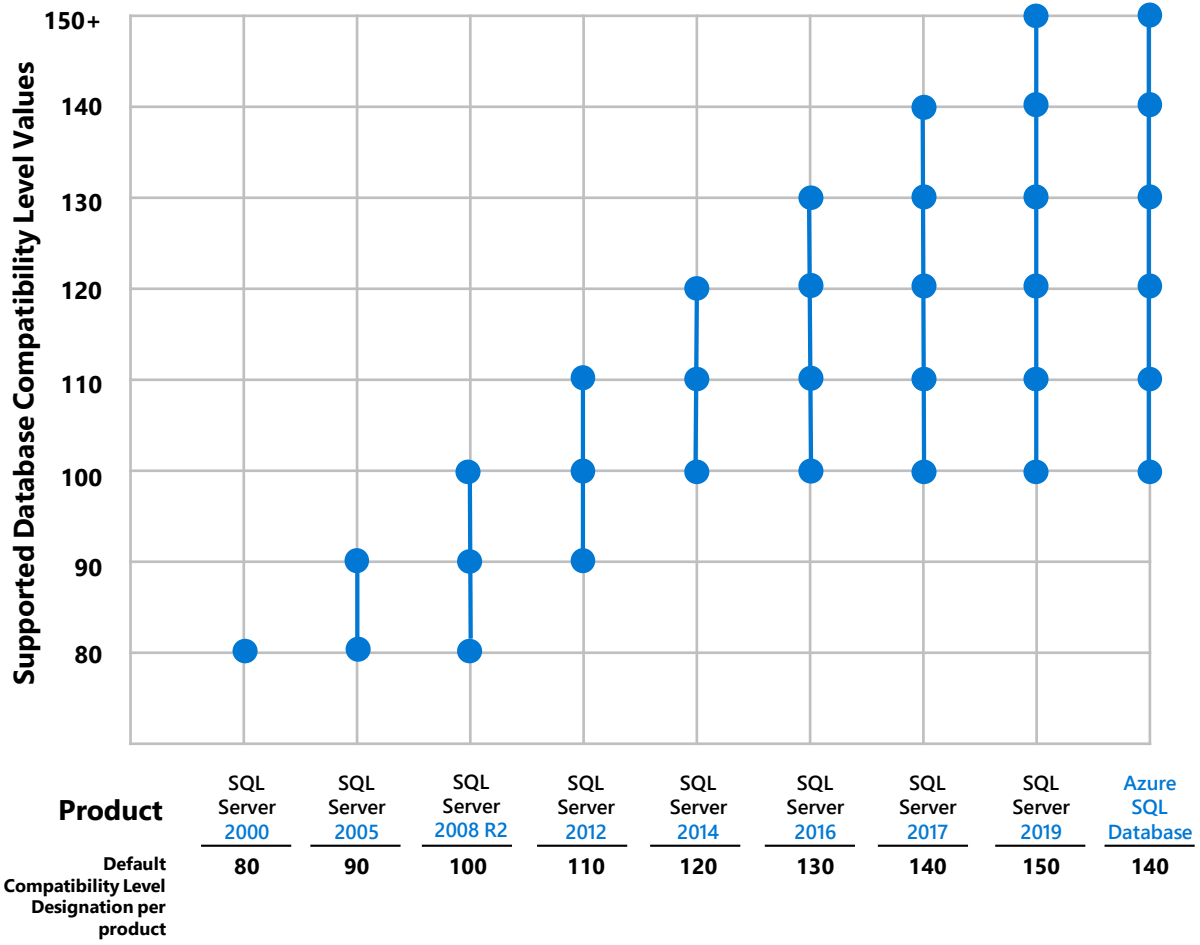
Microsoft gates query optimization changes and improvements behind Database Compatibility Level to upgrade without issues once validation testing is successfully completed

Validation testing tools

Use Data Migration Assistant (DMA) to validate your readiness to upgrade

The DMA tool validation results help protect applications from any functional regressions on target versions

Learn more here: http://aka.ms/dbcompat



Explore your Database Compatibility Level supported values

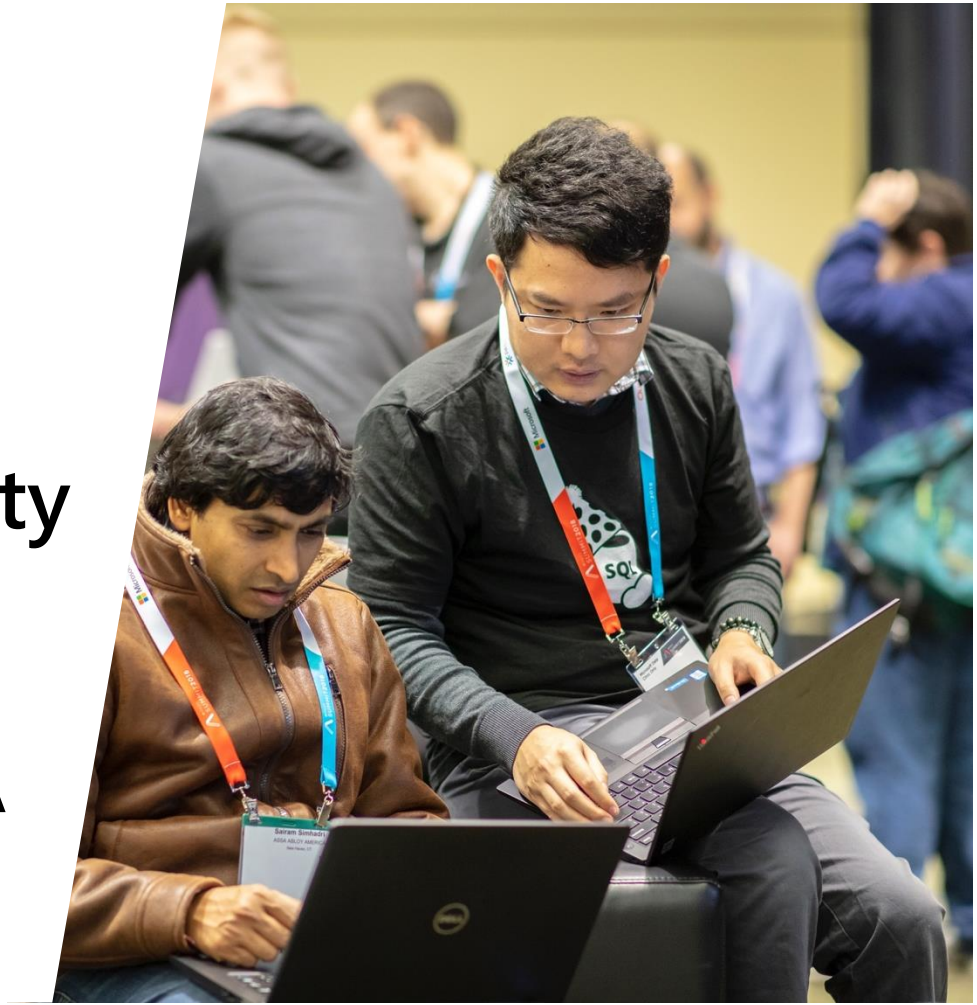
Upgrade from any earlier version of SQL Server and the database retains its existing compatibility level if it is at least minimum allowed for that instance of SQL Server

For example, SQL Server 2008 databases have supported compatibility up to SQL Server 2019 and Azure SQL Database

For new development work, or when an existing application requires use of new features, as well as performance improvements done in the Query Optimizer space, plan to certify on the latest Database Compatibility Level…

Database Compatibility in detail

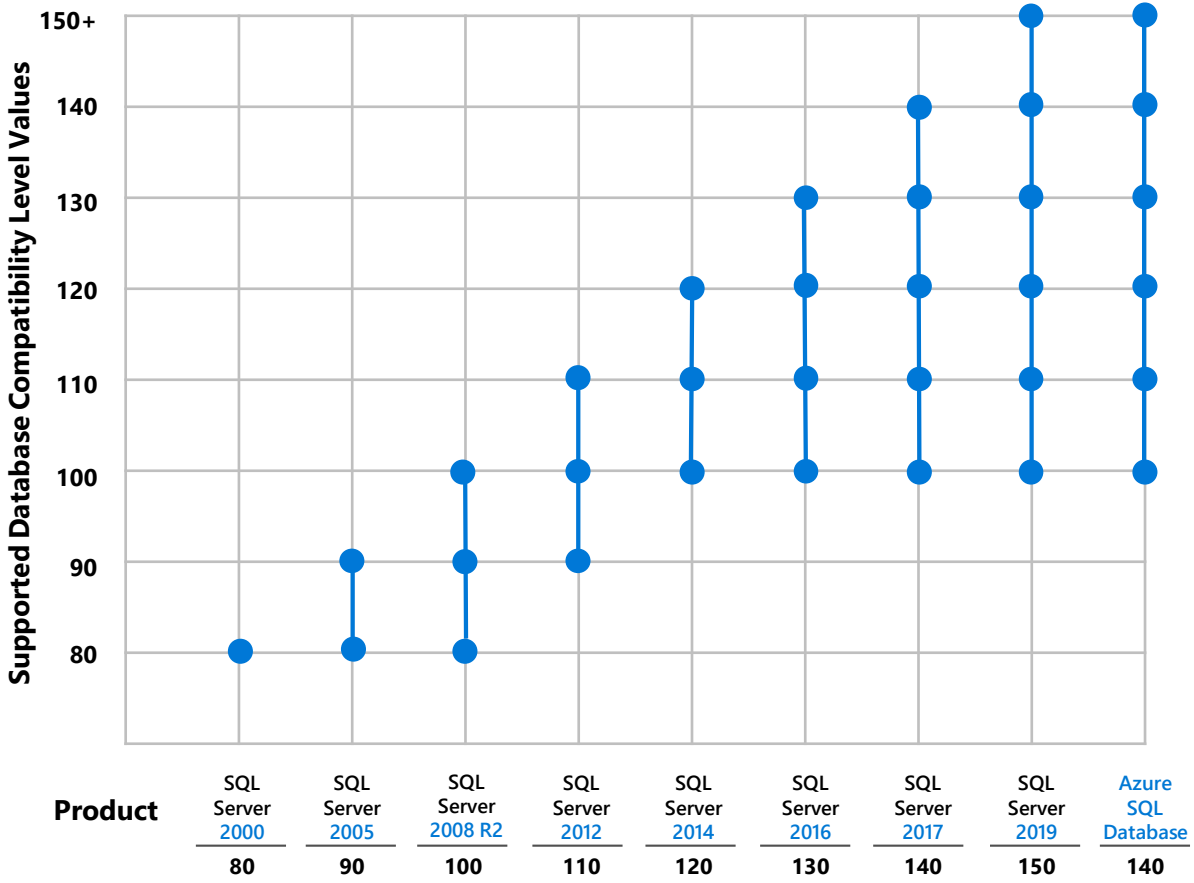
This is why you ran DMA before upgrading from 100 to higher…



Database Compatibility Level behavior

Sets certain database behaviors to be compatible with the specified version of SQL Server.

Compatibility level affects behaviors only for the specified database, not for the entire server.



Database Compatibility and Breaking changes

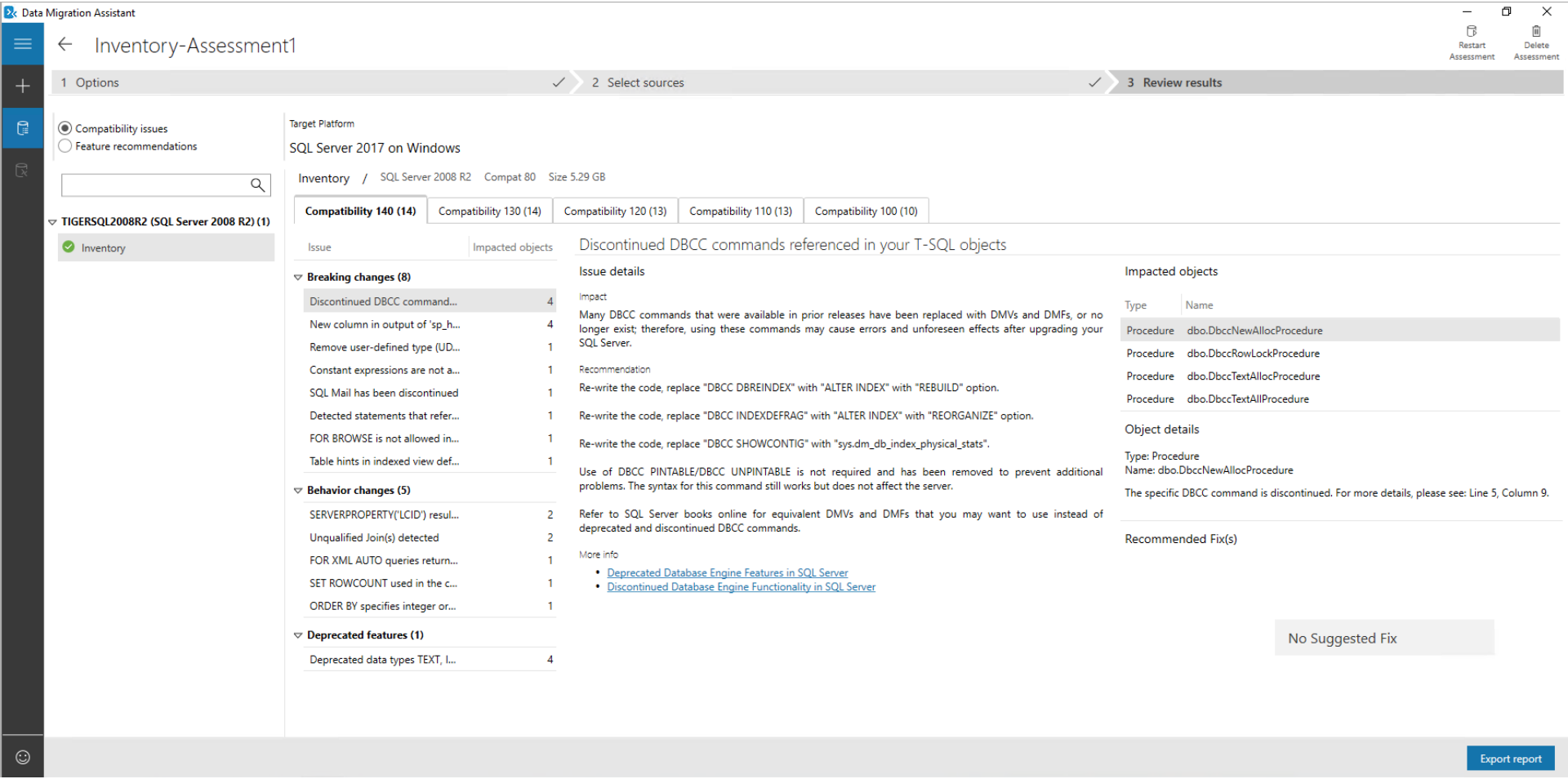
- Breaking Changes = behavior changes resulting in different outcome
- Protected by Database Compatibility:

```
DECLARE @value datetime = '1900-01-01 00:00:00.003'
SELECT CAST(@value AS datetime2)
```

  - In DB Compat 120 or lower, result is:
    `1900-01-01 00:00:00.0030000`
  - Under DB Compat 130, these show improved accuracy by accounting for the fractional milliseconds, resulting in:
    `1900-01-01 00:00:00.0033333`
- Not Protected by Database Compatibility:
  - The query below works until DB Compat 90, but errors out starting with Database Compatibility 100 with **`error 241, conversion fail`**:
    `SELECT DATEPART (year, '2007/05-30')`
  - Instead use:
    `SELECT DATEPART (year, '2007/05/30')` or `SELECT DATEPART (year, '2007-05-30')`

Database Compatibility and *Deprecated / Discontinued* features

- Deprecated means avoid use in new development
  - Deprecated functionality introduced in a given SQL Server version is still protected by that compatibility level.
- Discontinued means removed from product
  - Discontinued functionality introduced in a given SQL Server version is not protected by compatibility level.
  - SQL Server 2012 the `sp_dboption` was removed.
    - Use `ALTER DATABASE CONFIGURATION` instead.
  - SQL Server 2012 the `fastfirstrow` hint was removed.
    - Instead use: `SELECT * FROM HumanResources.Employee OPTION (FAST = <n>);`


Data Migration Assistant
Inventory-Assessment1
Restart Assessment
Delete Assessment
1 Options
2 Select sources
3 Review results
Compatibility issues
Feature recommendations
TIGERSQL2008R2 (SQL Server 2008 R2) (1)
Inventory
Target Platform
SQL Server 2017 on Windows
Inventory / SQL Server 2008 R2 Compat 80 Size 5.29 GB
Compatibility 140 (14)
Compatibility 130 (14)
Compatibility 120 (13)
Compatibility 110 (13)
Compatibility 100 (10)
Issue
Impacted objects
Breaking changes (8)
Discontinued DBCC command... 4
New column in output of 'sp_h... 4
Remove user-defined type (UD... 1
Constant expressions are not a... 1
SQL Mail has been discontinued 1
Detected statements that refer... 1
FOR BROWSE is not allowed in... 1
Table hints in indexed view def... 1
Behavior changes (5)
SERVERPROPERTY('LCID') resul... 2
Unqualified Join(s) detected 2
FOR XML AUTO queries return... 1
SET ROWCOUNT used in the c... 1
ORDER BY specifies integer or... 1
Deprecated features (1)
Deprecated data types TEXT, I... 4
Discontinued DBCC commands referenced in your T-SQL objects
Issue details
Impact
Many DBCC commands that were available in prior releases have been replaced with DMVs and DMFs, or no longer exist; therefore, using these commands may cause errors and unforeseen effects after upgrading your SQL Server.
Recommendation
Re-write the code, replace "DBCC DBREINDEX" with "ALTER INDEX" with "REBUILD" option.
Re-write the code, replace "DBCC INDEXDEFRAG" with "ALTER INDEX" with "REORGANIZE" option.
Re-write the code, replace "DBCC SHOWCONTIG" with "sys.dm_db_index_physical_stats".
Use of DBCC PINTABLE/DBCC UNPINTABLE is not required and has been removed to prevent additional problems. The syntax for this command still works but does not affect the server.
Refer to SQL Server books online for equivalent DMVs and DMFs that you may want to use instead of deprecated and discontinued DBCC commands.
More info
Deprecated Database Engine Features in SQL Server
Discontinued Database Engine Functionality in SQL Server
Impacted objects
Type
Name
Procedure dbo.DbccNewAllocProcedure
Procedure dbo.DbccRowLockProcedure
Procedure dbo.DbccTextAllocProcedure
Procedure dbo.DbccTextAllProcedure
Object details
Type: Procedure
Name: dbo.DbccNewAllocProcedure
The specific DBCC command is discontinued. For more details, please see: Line 5, Column 9.
Recommended Fix(s)
No Suggested Fix
Export report

What else changes when upgrading Database Compatibility?

- Query Optimizer fixes under TF 4199
  - QO fixes released for previous SQL Server versions under trace flag 4199 become automatically enabled in the default compatibility level of a newer SQL Server version.
  - Wrong results and Access Violation fixes are NOT included under 4199.
- Changes to the Cardinality Estimator
  - New changes are gated to the latest (default) Database Compatibility Level.

Plan affecting changes – TF 4199

Database Engine (DE) version	Database Compatibility Level	TF 4199	QO changes from previous database compatibility levels	QO changes for current DE version post-RTM
13 (SQL Server 2016)	100 to 120	Off	Disabled	Disabled
		On	Enabled	Enabled
	130 *	Off	Enabled	Disabled
		On	Enabled	Enabled

* Default Database Compatibility Level for DE version

Plan affecting changes – TF 4199

Database Engine (DE) version	Database Compatibility Level	TF 4199	QO changes from previous database compatibility levels	QO changes for current DE version post-RTM
13 (SQL Server 2016)	100 to 120	Off	Disabled	Disabled
		On	Enabled	Enabled
	130 *	Off	Enabled	Disabled
		On	Enabled	Enabled
14 (SQL Server 2017)	100 to 120	Off	Disabled	Disabled
		On	Enabled	Enabled
	130 → 140 *	Off	Enabled	Disabled
		On	Enabled	Enabled

* Default Database Compatibility Level for DE version

Plan affecting changes – TF 4199

Database Engine (DE) version	Database Compatibility Level	TF 4199	QO changes from previous database compatibility levels	QO changes for current DE version post-RTM
13 (SQL Server 2016)	100 to 120	Off	Disabled	Disabled
		On	Enabled	Enabled
	130 *	Off	Enabled	Disabled
		On	Enabled	Enabled
14 (SQL Server 2017)	100 to 120	Off	Disabled	Disabled
		On	Enabled	Enabled
	130 → 140 *	Off	Enabled	Disabled
		On	Enabled	Enabled
15 (SQL Server 2019)	100 to 120	Off	Disabled	Disabled
		On	Enabled	Enabled
	130 → 140 → 150 *	Off	Enabled	Disabled
		On	Enabled	Enabled

* Default Database Compatibility Level for DE version

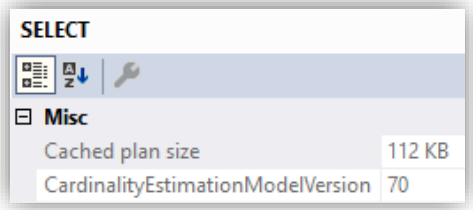
Plan affecting changes – Cardinality Estimator

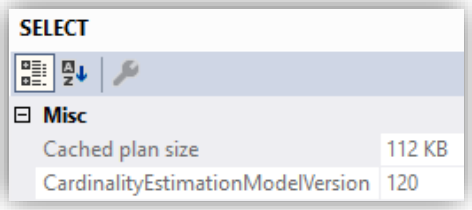
- CE estimates how many rows your query will likely return and is used by the Query Optimizer to generate the optimal query plan.
- Most systems benefit from the latest CE because it is the most accurate.

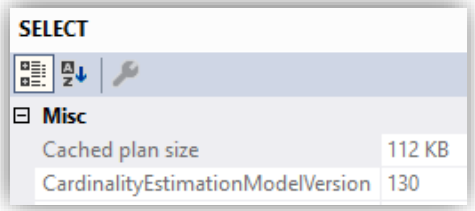
Plan affecting changes – CE

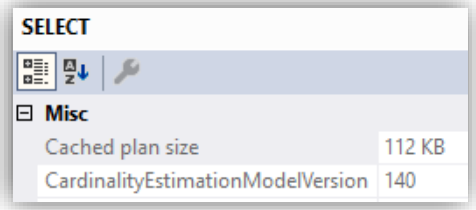
CE versions are tied to the Compatibility Level of the version it was first introduced:

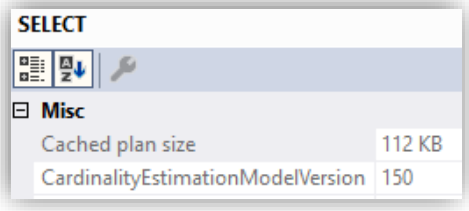
Database compatibility level	CE Version
100 to 110	70
120 (SQL Server 2014)	120
130 (SQL Server 2016)	130
140 (SQL Server 2017)	140
150 (SQL Server 2019)	150



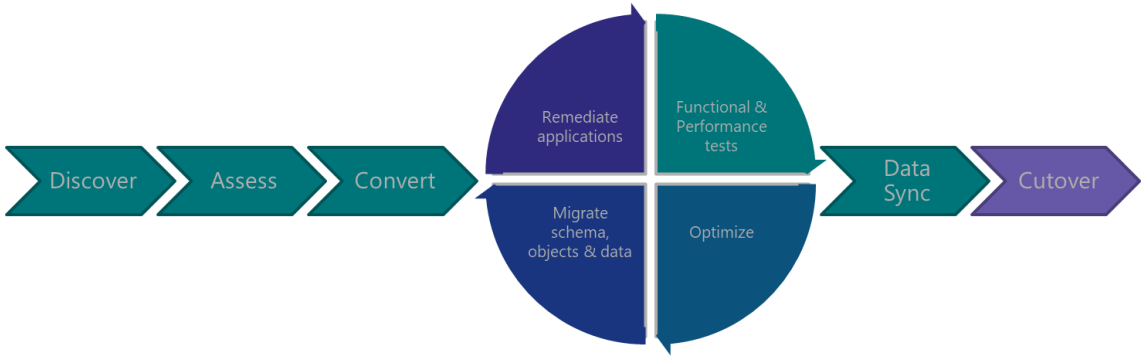








Post-Migration



You’re not done yet!...

I moved the data, am I done?

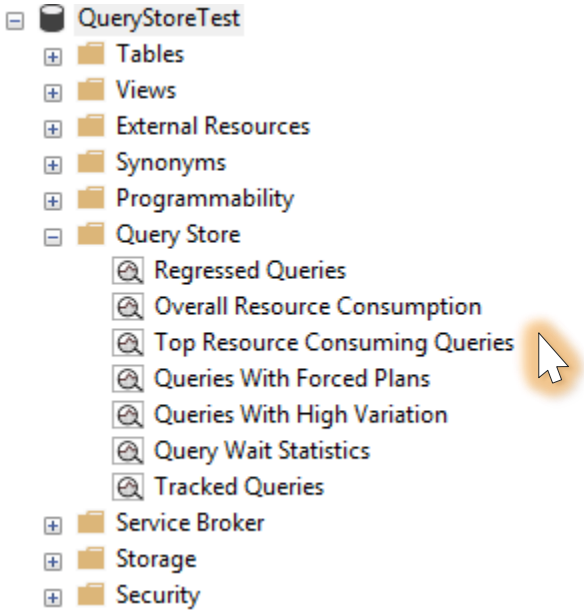
SQL Server post migration step is crucial for reconciling any data accuracy and completeness.

But also to uncover performance issues with the workload.

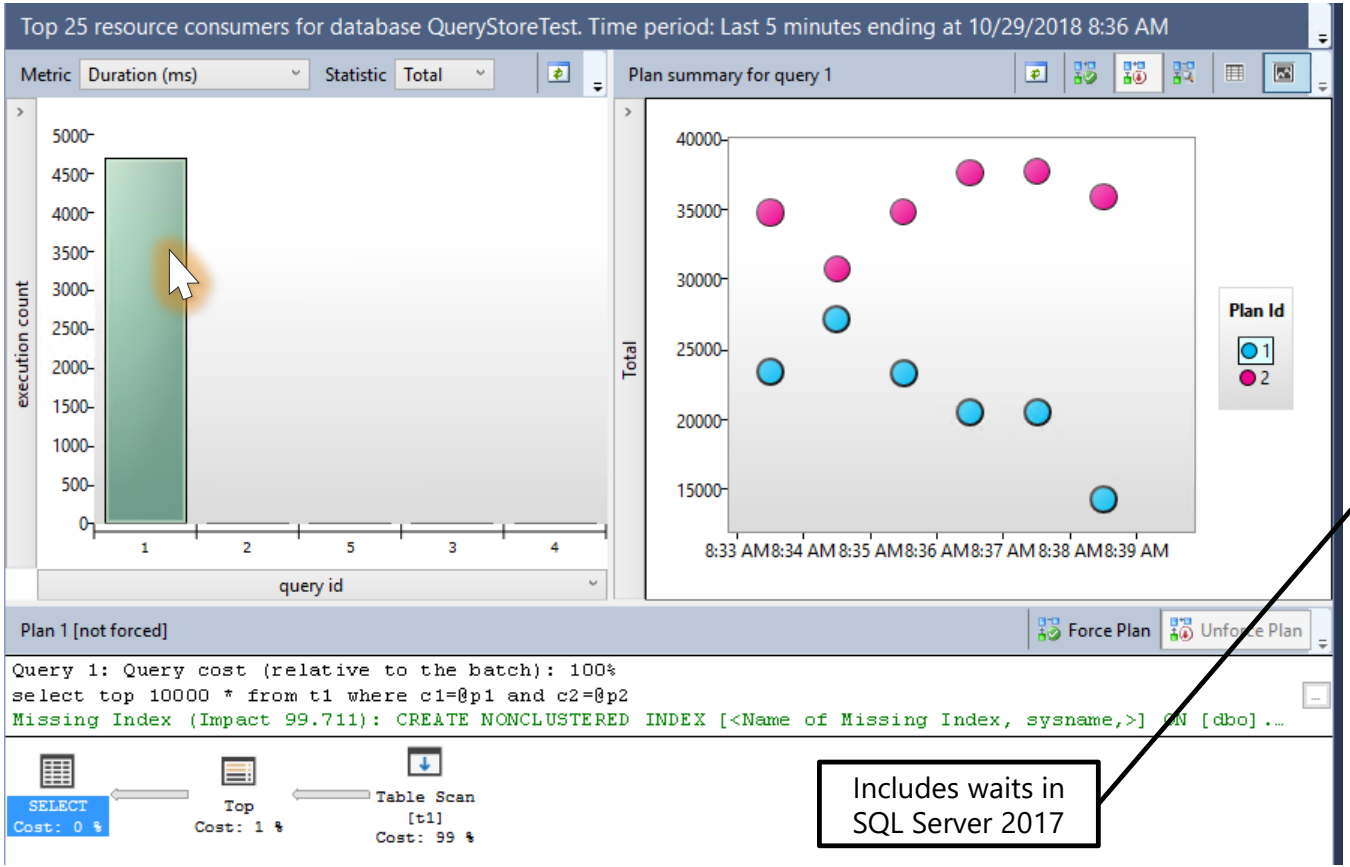
Recommended DB Compatibility Level upgrade process:

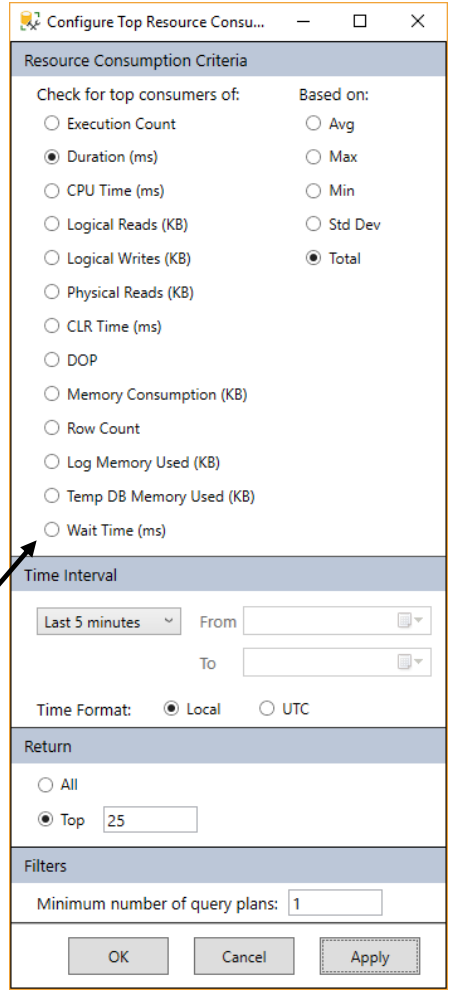
So I need Query Store?

Comprehensive query-performance information when you need it most!



Query Store UI experience



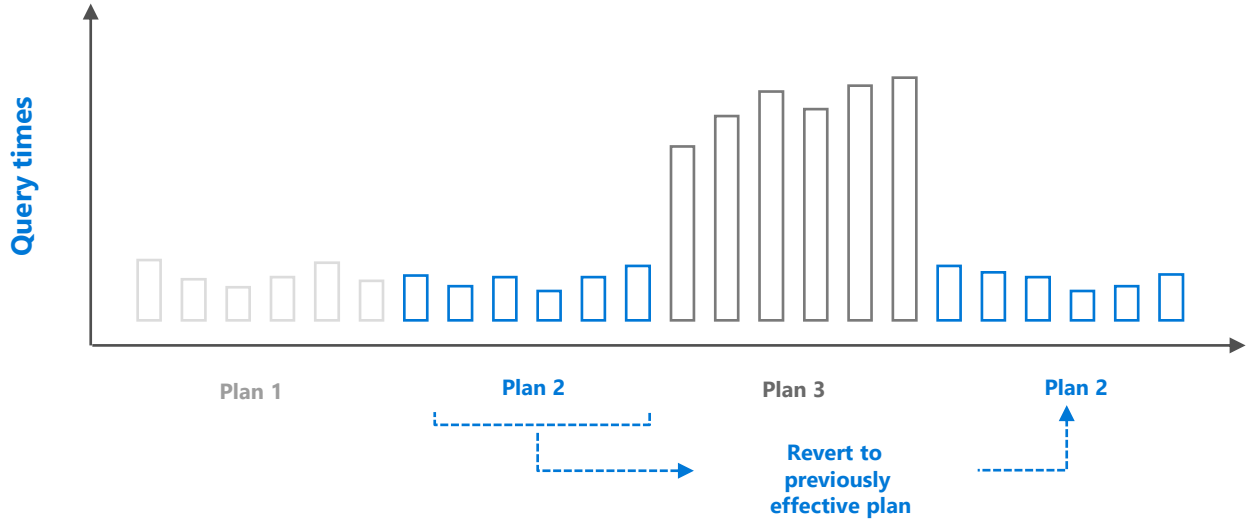


Includes waits in SQL Server 2017

Query Store and Automatic Plan Correction

Identifies the problematic query plan and reverts to a more optimal point in time.

In the scope of a DB Compatibility upgrade, only works if the recommended process was followed!



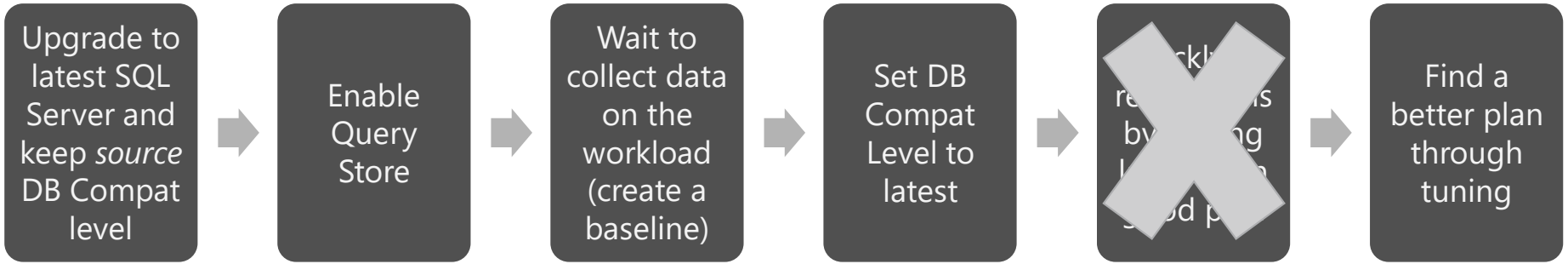
DEMO

Automatic Tuning

Running DB Compatibility Upgrade with Query Tuning Assistant

What if instead of choosing between current and last know good plan, we find a 3rd, better plan?

QTA Priority 1: guide you through the recommended DB Compatibility upgrade procedure.



Query Tuning Assistant (QTA) Workflow

Available in SSMS v18 and soon on Powershell

Analysis and Recommendations

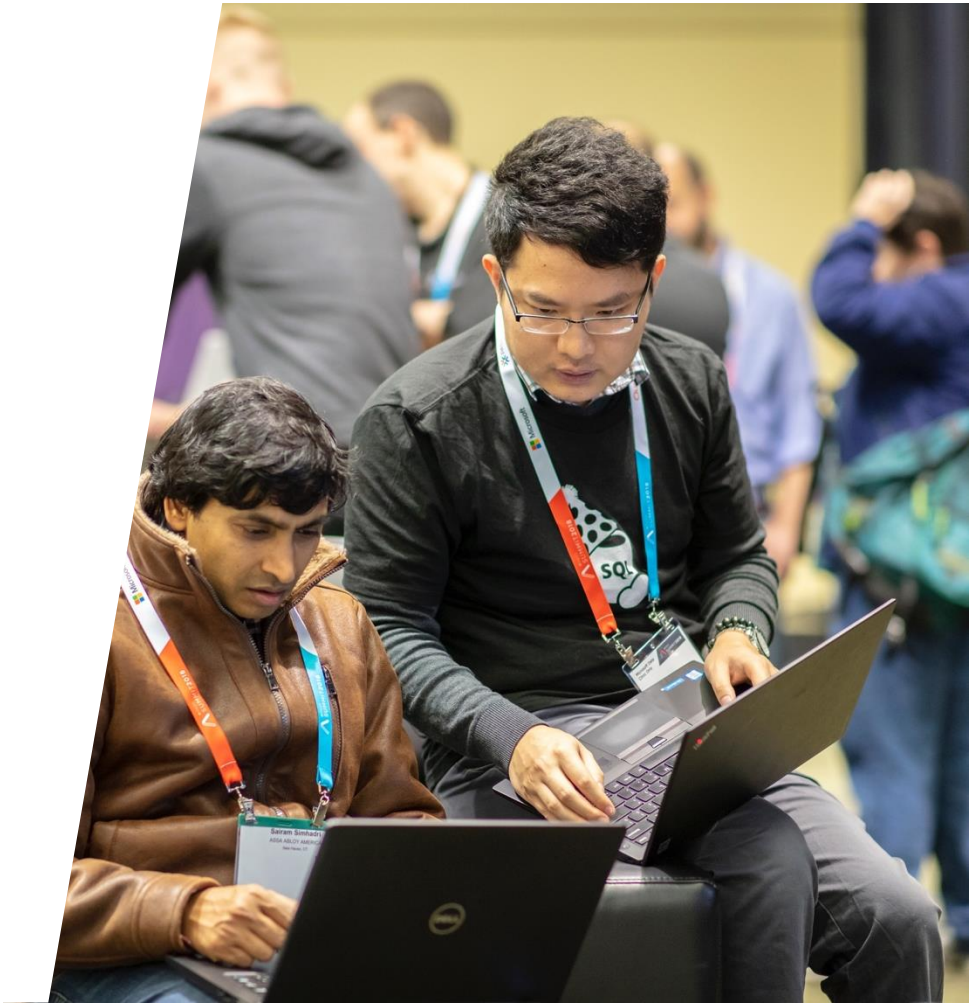
- Correlation vs Independence 'ASSUME_MIN_SELECTIVITY_FOR_FILTER_ESTIMATES'
- Simple vs Base Join Containment 'ASSUME_JOIN_PREDICATE_DEPENDS_ON_FILTERS'
- MSTVF fixed estimation of 100 rows vs 1 row 'QUERYTRACEON 9488'
- As a last resort, full-fledge use of CE 70 is also considered, when all else doesn't yield desired results.

Deployment via Plan Guide

DEMO

Upgrading a database with QTA

Modernization Tools breakdown



Modernization Tools Breakdown

DEA

- A/B Testing
- Capture and Replay workload for performance testing and reporting
- Also reports on migration blockers because of failed T-SQL syntax

DMA

- Readiness assessment: blocking issues breaking changes, behavior changes
- Moves schema, data and uncontained objects (like logins) To Azure SQL Database
- Backup / Restore to another SQL Server
  - Keeps source DB Compatibility Level
- New feature recommendation

QTA

- Upgrade Database Compatibility Model to desired state
- Detects workload regressions, and tests CE model variations (subsets)
  - Does not move to last known good state
- Provides tangible recommendations for tuning queries
  - Tweak most common CE model assumptions
  - Overall keeps use of CE version mapped to the DB Compatibility Level

Tuning Tools Breakdown

Auto Tuning

- Uses Query Store
- Detects regression and moves back to a last known good plan.
- In scope of upgrade, usually means moving between full implementations of CE.
- Ex. Plan with CE 130 is bad, rollback to plan with CE 70.

QTA

- Uses Query Store
- Detects regression and tests CE model variations (subsets) to move to a 3rd state.
- In scope of upgrade, attempts to tweak one or more of the most common CE model assumptions.
- Effectively still uses the CE version mapped to the compatibility level in many other aspects.

Tuning Tools Breakdown

DTA

- Tuning based on improving PDS design as it relates to workload
- Indexes
- Statistics
- Indexed Views

QTA

- Tuning based on using Query Optimization knobs
- Query Store + Hints + Plan Guide
- Correlation vs Independence
- Simple vs Base Join Containment
- TVF fixed estimation of 100 rows vs 1 row

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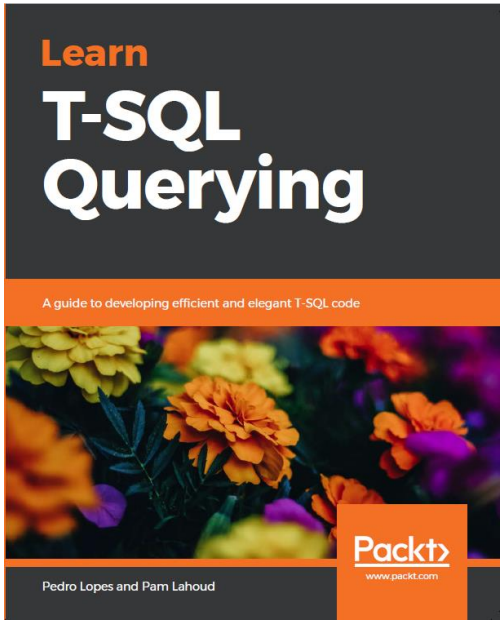

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Thank You

Pedro Lopes

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