Getting the Most from Query Plan Reuse

Andrew J. Kelly

akelly@SolidQ.com

Who Am I?

- Mentor with SolidQ
- Data Platform MVP since 2001
- Contributing editor & author for SQL Server Pro Magazine
- Over 20 years of development and database experience
- Specialize in performance tuning and maintenance of VLDB / High-volume SQL Server databases

SolidQ
Think Big. Move Fast.

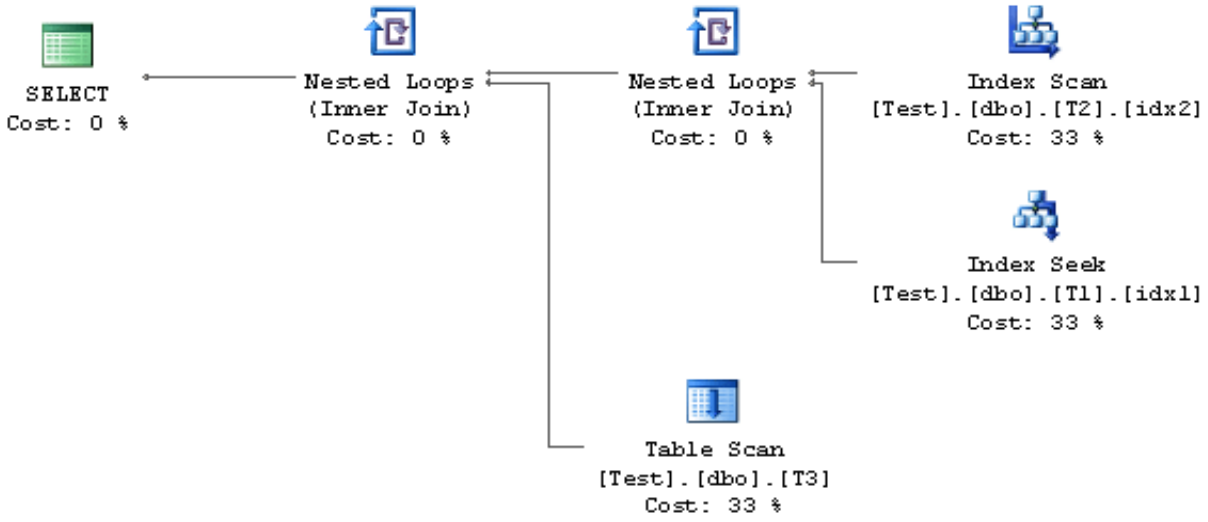
Agenda

- What is a query Plan?
- Who gets their own plan?
- Plan Cache
- Plan Compiles
- Plan Re-Use

- Questions & Answers

What is a Query Plan?

- **Set of instructions that tell the engine exactly how to perform the operations required to obtain the data requested**
  - Joins
  - Seeks
  - Scans
  - Inserts
  - Updates
  - Deletes
  - Etc.



- **It can generate a Single and a parallel plan**

Who gets their own plan

- Batches
- Stored Procedures
- Triggers
- EXEC (@sql)
- sp_executeSql
- Some Individual statements

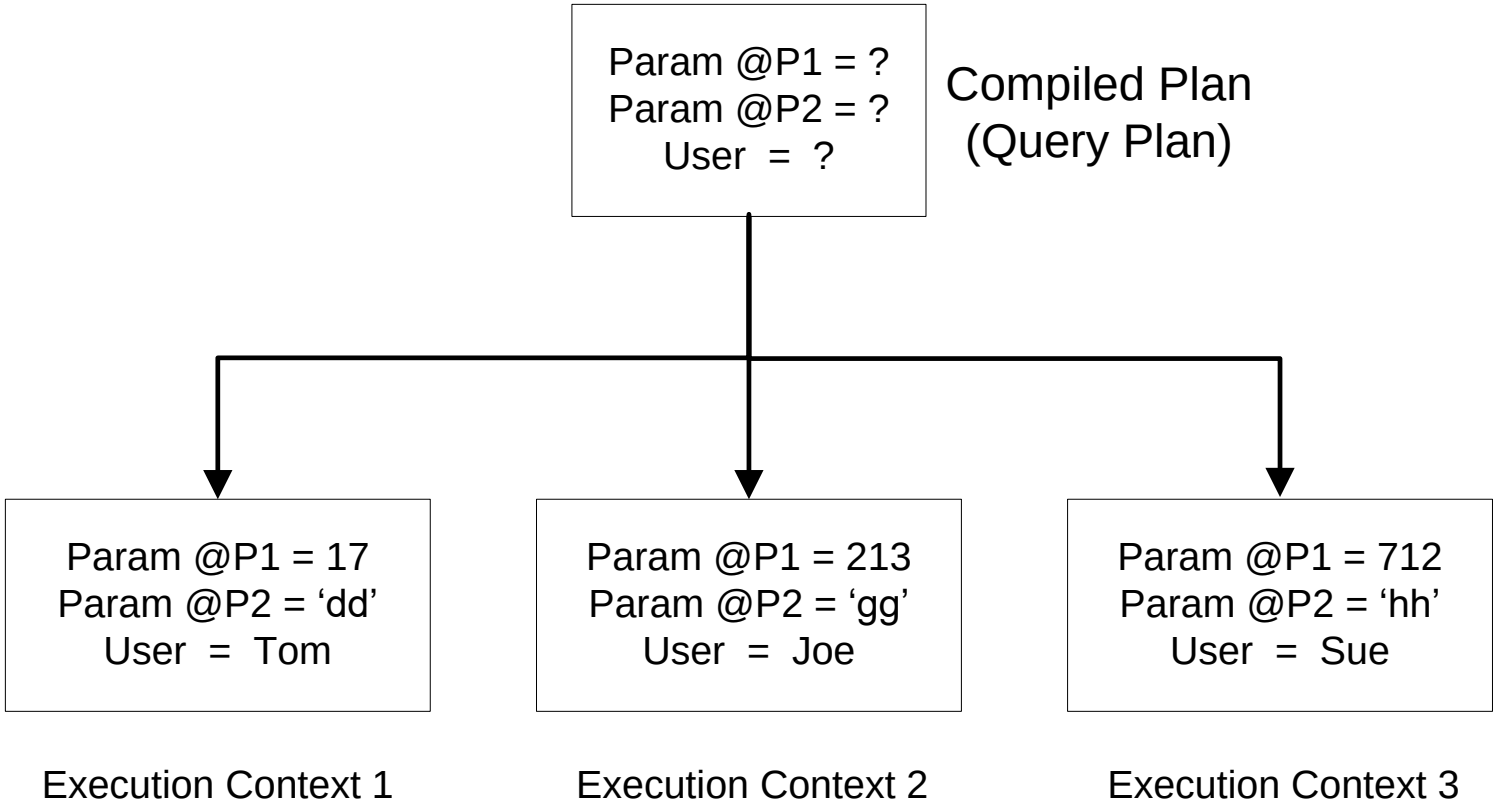
What good are query plans?

- **They allow for Plan Reuse**

So why do we care about plan reuse?

- **It's all about Performance**
  - Compiling a complex query plan is one of the most expensive things the engine does
  - Too many compiles or recompiles can easily make you CPU bound on a busy system
  - Additional time per query execution to compile the plan vs. doing the work just once
  - The query lookup time can be much longer than you imagine
  - Lack of plan reuse leads to excessive Memory usage and overhead to manage it

Beginnings of plan reuse



Where do the plans live?

- **In several DMV's**
  - sys.dm_exec_cached_plans
  - sys.dm_exec_plan_attributes
  - sys.dm_exec_sql_text

- **How important is this information?**
  - When it comes to performance you should know this information as well as any other on your server
  - However there is a lot of junk in here as well

Plan Cache Memory

- **The plan cache memory is comprised of 4 main cache stores:**
  - Object Plans
  - SQL Plans
  - Bound Trees
  - Extended Procs
- **For more details of the plan cache memory see here:**
  - http://blogs.msdn.com/b/sqlprogrammability/archive/2007/01/09/1-0-structure-of-the-plan-cache-and-types-of-cached-objects.aspx

SQL Server Version	Cache Pressure Limit
SQL Server 2005 SP2 and >	75% of visible target memory from 0-4GB + 10% of visible target memory from 4Gb-64GB + 5% of visible target memory > 64GB
SQL Server 2005 RTM and SQL Server 2005 SP1	75% of visible target memory from 0-8GB + 50% of visible target memory from 8Gb-64GB + 25% of visible target memory > 64GB

Plan Costs and Retention

- **Each plan and execution context gets a cost associated with it**
  - This is assigned at compile time with max of 31
  - Based on several factors gathered during compile:
    - I/O cost
    - Context switch cost
    - Memory cost
- **Plans that are more costly to produce will stay in the cache longer**
- **Adhoc plans get an initial cost set to 0**
- **Factors can force a decrement of the cost by 1 on a periodic basis**
  - Can be in a lazy thread fashion
  - Or a more aggressive dedicated thread fashion
- **When a plan is reused it's cost gets set back to the original value**

Demo

Peeking at the Plan Cache

When does a plan get compiled?

- **Not at creation time. This is a myth**
- **The first time the batch, stored procedure, trigger etc. is called and the plan does not already exist in cache**
- **This will generate a compiled plan that hopefully will get cached in the procedure cache**
    - Trivial or adhoc plans may not be cached
- **An Execution plan is created when the compiled plan is used to actually return the results**
- **Keep in mind that the plan is case and space sensitive**
- **So what is the goal in regards to Compiles?**

When does a plan get recompiled?

- **That depends. It may never recompile or it might recompile each time it is executed**
- **What causes a plan to recompile?**
  - Changes to DDL for relevant objects
  - Mixing DDL and DML in the batch
  - Changes to statistics on relevant objects
  - Adding or dropping an index
  - # of changes to a table or to a particular column
  - SET Options
  - sp_recompile or WITH RECOMPILE
  - Host of Database level options
- **So what is the goal in regards to Recompiles?**

SET options that affect re-use

Number	SET Option Name
1	ANSI_NULL_DFLT_OFF
2	ANSI_NULL_DFLT_ON
3	ANSI_NULLS
4	ANSI_PADDING
5	ANSI_WARNINGS
6	ARITHABORT
7	CONCAT_NULL_YIELDS_NULL
8	DATEFIRST
9	DATEFORMAT
10	FORCEPLAN
11	LANGUAGE
12	NO_BROWSETABLE
13	NUMERIC_ROUNDABORT
14	QUOTED_IDENTIFIER

Object Name Resolution

- **Best practice is to ALWAYS schema qualify objects**
- **Take the statement "SELECT * FROM Person". Which schema does it use?**
- **If this is an adhoc or prepared statement it depends on the users default schema**
  - If it's HR then we get "SELECT * FROM HR.Person"
  - If it's Sales then we get "SELECT * FROM Sales.Person"
- **If name resolution needs to occur for this scenario you won't get plan reuse**
- **Stored procedures and triggers don't suffer this same fate**

Plan reuse (cont)

- **Main ways to issue Sql statements**
  - Batches: Adhoc sql Statements
  - Batches: Adhoc Parameterized Statements
  - Batches: Adhoc Stored Procedure calls
  - Batches: sp_executeSql
  - RPC: Remote Procedure Calls

Batches: adhoc sql statements

```
SqlCmd.CommandText = "SELECT TOP 5 a.[OrderID], a.[CustomerID] FROM
    Orders AS a  WHERE  [OrderID] = 11048"
SqlCmd.CommandType = CommandType.Text
SqlDataReader DR = SqlCmd.ExecuteReader()
```

- **Typically results in a SQL:BatchCompleted event**
- **This may or may not be cached**
- **This call will not reuse the plan from above even if it was cached:**
  - SqlCmd.CommandText = "SELECT TOP 5 a.[OrderID], a.[CustomerID] FROM Orders AS a WHERE [OrderID] = 11049"

Auto parameterization

SqlCmd.CommandText = "SELECT a.[OrderID], a.[CustomerID]
FROM Orders AS a WHERE [OrderID] = 11048"

- **Auto parameterization**
  - The engine will turn the query plan into one with parameters in place of the OrderID literal
  - SELECT a.[OrderID], a.[CustomerID] FROM Orders AS a WHERE [OrderID] = @p1 , @p1 INT , 11048

Batches parameterized queries

```
SqlCmd.CommandText = "SELECT a.[OrderID], a.[CustomerID] FROM Orders AS a
                                WHERE  [OrderID] = ?"
SqlCmd.Parameters.Add("@OrderID",SqlDbType. Char,5,“OrderID") ;
SqlCmd.Parameters["@OrderID"].Value = “11048" ;
SqlCmd.CommandType = CommandType.Text
SqlDataReader DR = SqlCmd.ExecuteReader()
```

- **Typically results in a SQL:BatchCompleted & SP:Completed event as a sp_executeSql call**
- **This may or may not be cached**
- **However this call will reuse the plan from above if it was cached:**
  - SqlCmd.CommandText = "SELECT a.[OrderID], a.[CustomerID] FROM Orders AS a
    WHERE [OrderID] = ?“
  - SqlCmd.Parameters["@OrderID"].Value = “11049"

Batches: adhoc stored procs

SqlCmd.CommandText = "EXEC [dbo].[test_cache_1] @CustomerID = 'MAISD'"

SqlCmd.CommandType = CommandType.Text

SqlDataReader DR = SqlCmd.ExecuteReader()

- **Typically results in a SQL:BatchCompleted event**
- **This may or may not be cached. This will generate two plans, one for the batch and one for the sp execution**
- **This call will not reuse the batch plan from above but may reuse the sp plan:**
  - SqlCmd.CommandText = "EXEC [dbo].[test_cache_1] @CustomerID = 'DESF'"

Rpc’s

SqlCmd.CommandText = “[dbo].[Your_sp] "
SqlCmd.Parameters.Add("@OrderID",SqlDbType. Char,5,“OrderID") ;
SqlCmd.Parameters["@OrderID"].Value = “11048" ;

SqlCmd.CommandType = CommandType.StoredProcedure

SqlDataReader DR = SqlCmd.ExecuteReader()

- **Results in a RPC:Completed**
- **This will be cached (unless a hint prevents it)**
- **This call will reuse the plan from above:**
  - SqlCmd.CommandText = “[dbo].[Your_sp]
  - SqlCmd.Parameters["@OrderID"].Value = “11049"

Query hints & forced parameterization

- **Parameterization**
  - ALTER DATABASE SET PAPARAMETERIZATION { SIMPLE | FORCED }
- **Instance Level**
  - Optimize for Adhoc Workloads
- **RECOMPILE**
- **KEEP PLAN**
- **KEEP_FIXED_PLAN**
- **OPTIMIZE FOR**
- **USE PLAN**

Query Plan Documents

Plan Caching in SQL Server 2012
http://msdn.microsoft.com/en-us/library/dn148262.aspx

Statistics used by the Optimizer in SQL2008
http://technet.microsoft.com/en-us/library/dd535534.aspx

How to troubleshoot the performance of Ad-Hoc queries
http://support.microsoft.com/default.aspx?scid=kb;en-us;243588

SP's & Caching (oldie but goodie)
http://www.sqlservercentral.com/columnists/bkelley/procedurecache.asp

Optimizing sp Recompiles
http://www.sql-server-performance.com/rd_optimizing_sp_recompiles.asp

Demo

Query Plan Reuse

Questions?