

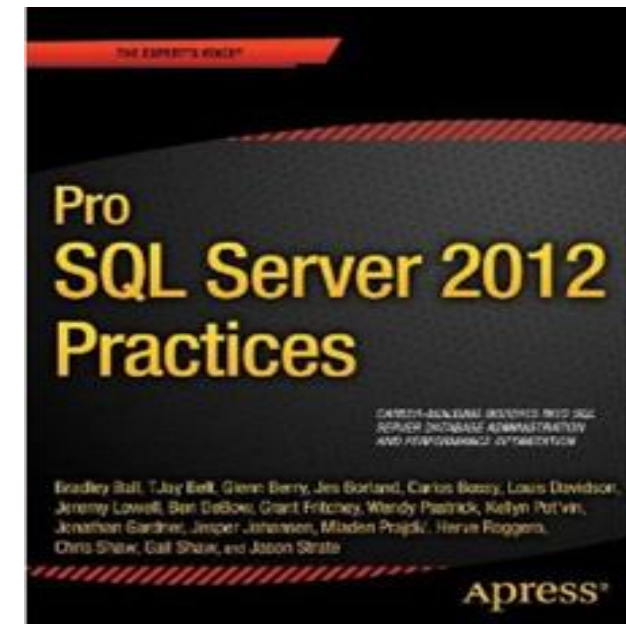
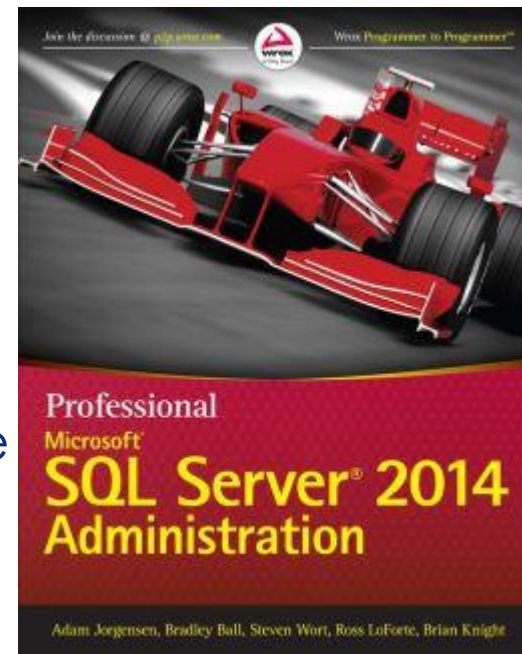


Performance Troubleshooting

Speaker Introduction

Bradley Ball

- Almost 15 Years IT Experience
- Previous experience DBA, for the U.S. Army, The Executive Office of the President, Sr. SQL DBA Staff Specialist at Publix
- Currently the Data Platform Management Lead for [Pragmatic Works](http://www.pragmaticworks.com)
- Microsoft VTSP for the Greater North East
- MCITP SQL 2005 DBA & SQL 2008 DBA
- Blog: <http://www.SQLBalls.com>
- Twitter: @SQLBalls @BradleyBall_PW
- Email: bball@PragmaticWorks.com
- Pro SQL Server 2012 Practices Author
- Chapter 14 PAGE & ROW COMPRESSION!
- Managing Author on Pro Admin 2014 Guide



Agenda

- **Wait Stats**
- **Baseline Disks**
- **Power Configuration**
- **Instant Database File Initialization**
- **Locks and Blocking**
- **Joins**
- **Execution Plans**

SQLOS

- **Preemptive Scheduling (OS)**
- **Cooperative Scheduling (SQL)**

Dynamic Management Views and Functions

- **sys.dm_os_wait_stats**
 - Server-level
 - Contains aggregated wait statistics by wait type since last restart of SQL
 - DBCC SQLPerf('sys.dm_os_wait_stats',clear)
- **sys.dm_os_waiting_tasks**
 - Task-level
 - Displays all waiting sessions (waiter list)
- **sys.dm_exec_requests**
 - Describes each SQL Server Session (spid)

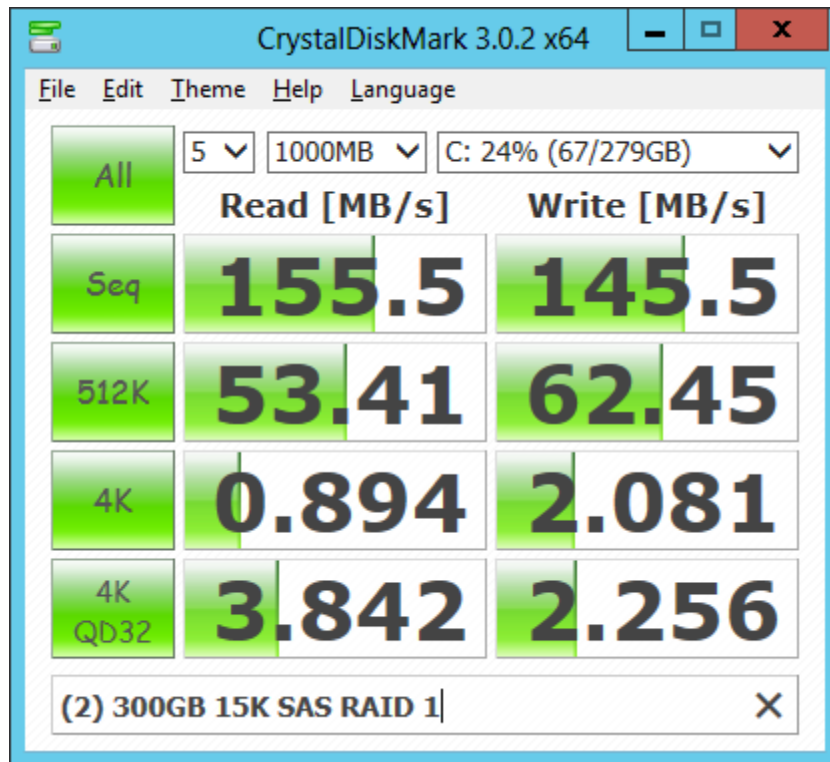
Demo



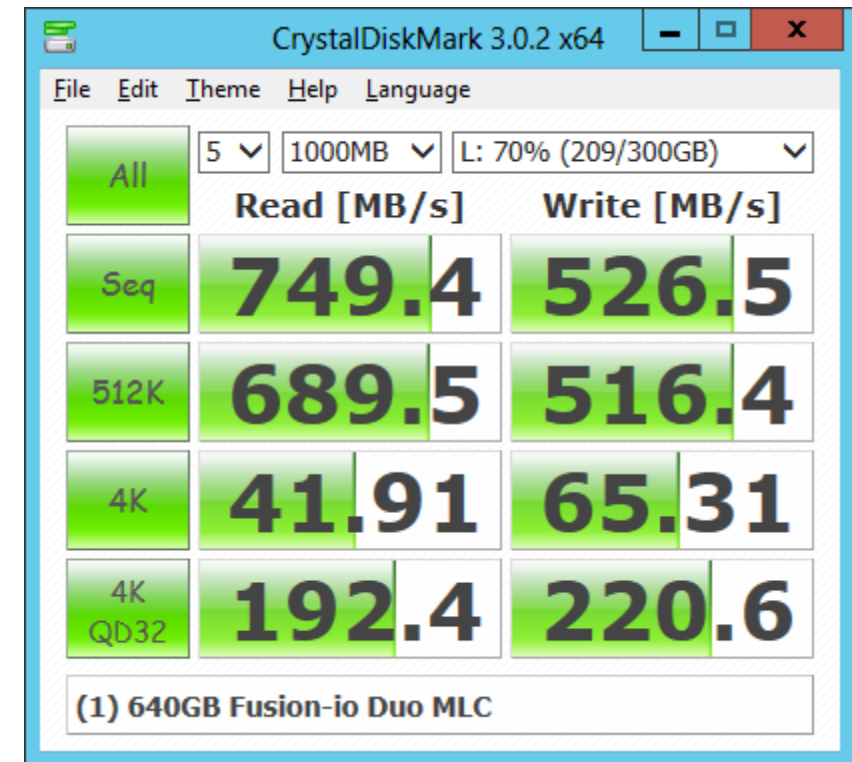
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Disk Performance Baseline



Two 300 GB 15K SAS drives in
RAID 1



One 640 GB Fusion-IO Duo MLC
device

Server Power Settings

- **Balanced *DEFAULT**
 - Default Setting. Targets good energy efficiency with minimal performance impact. Matches capacity to demand. Energy-Saving features balance power and performance.
- **High Performance**
 - Increases performance at the cost of high energy consumption. Power and thermal limitations, operating expenses, and reliability considerations apply
- **Power Saver**
 - Limits performance to Save Energy and reduce operating costs. Caps processor frequency at a percentage of maximum (if supported), and enables other energy-saving features.

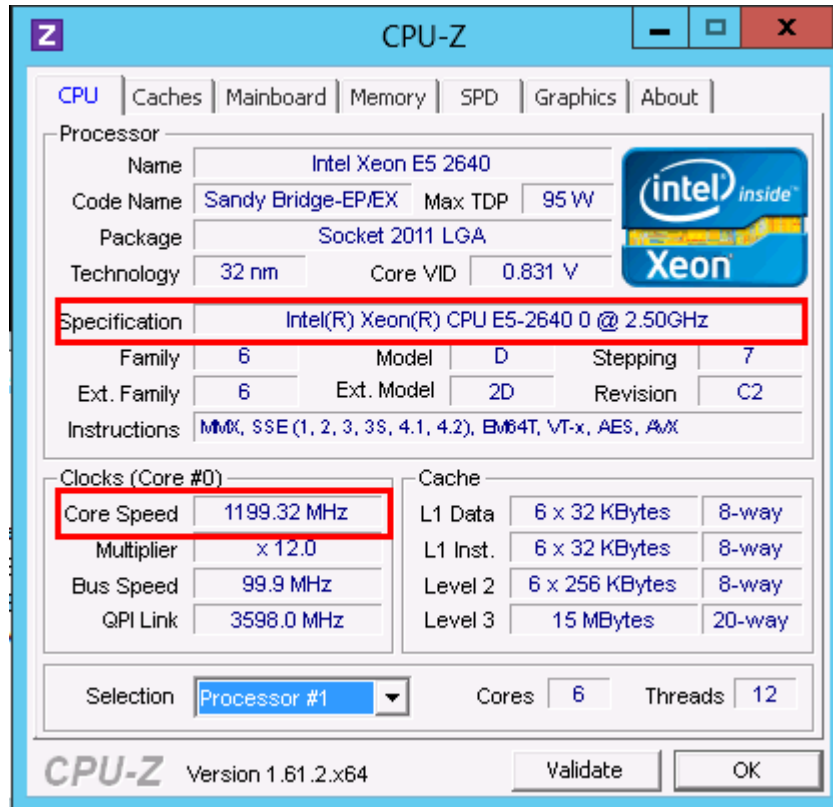
Server Power Settings

- Balanced
 - Default Setting. Targets good energy efficiency with minimal performance impact. Matches capacity to demand. Energy-Saving features balance power and performance.
- High Performance
 - Increases performance at the cost of high energy consumption. Power and thermal limitations, operating expenses, and reliability considerations apply
- Power Saver
 - Limits performance to Save Energy and reduce heat. Caps processor frequency, caps processor power (if supported), and enables other energy-saving features.

Server Power Settings



Server Power Settings



CPU-Z Version 1.61.2.x64

Processor: Intel Xeon E5 2640, Sandy Bridge-EP/EX, Socket 2011 LGA, 32 nm, Core VID 0.831 V

Specification: Intel(R) Xeon(R) CPU E5-2640 0 @ 2.50GHz

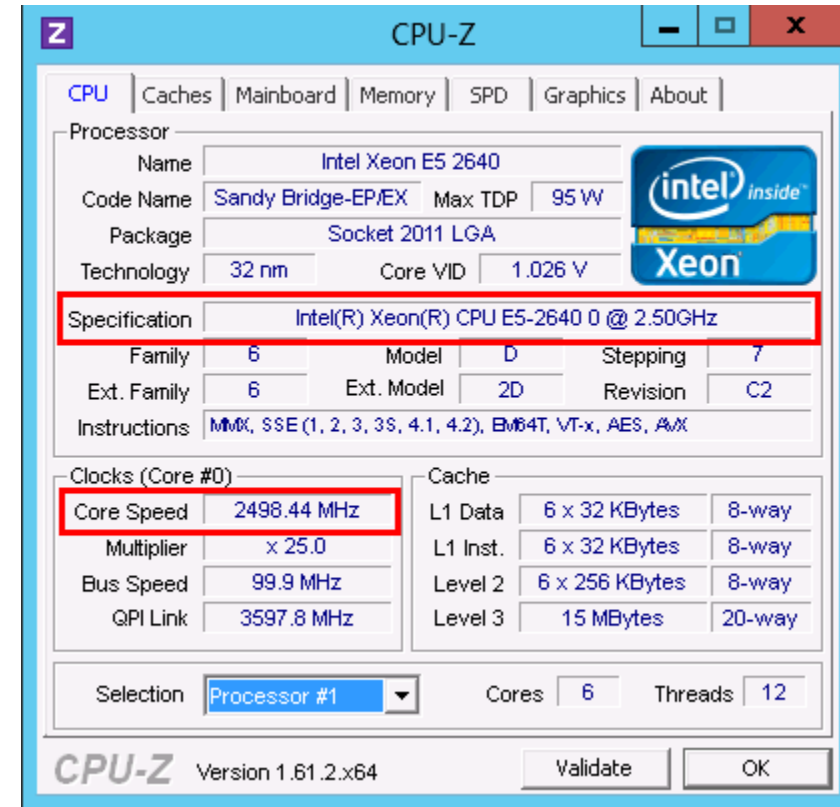
Family	6	Model	D	Stepping	7
Ext. Family	6	Ext. Model	2D	Revision	C2

Instructions: MMX, SSE (1, 2, 3, 3S, 4.1, 4.2), BMI1, VT-x, AES, AVX

Clocks (Core #0): Core Speed 1199.32 MHz, Multiplier x 12.0, Bus Speed 99.9 MHz, QPI Link 3598.0 MHz

Cache: L1 Data 6 x 32 KBytes 8-way, L1 Inst. 6 x 32 KBytes 8-way, Level 2 6 x 256 KBytes 8-way, Level 3 15 MBytes 20-way

Selection: Processor #1, Cores 6, Threads 12



CPU-Z Version 1.61.2.x64

Processor: Intel Xeon E5 2640, Sandy Bridge-EP/EX, Socket 2011 LGA, 32 nm, Core VID 1.026 V

Specification: Intel(R) Xeon(R) CPU E5-2640 0 @ 2.50GHz

Family	6	Model	D	Stepping	7
Ext. Family	6	Ext. Model	2D	Revision	C2

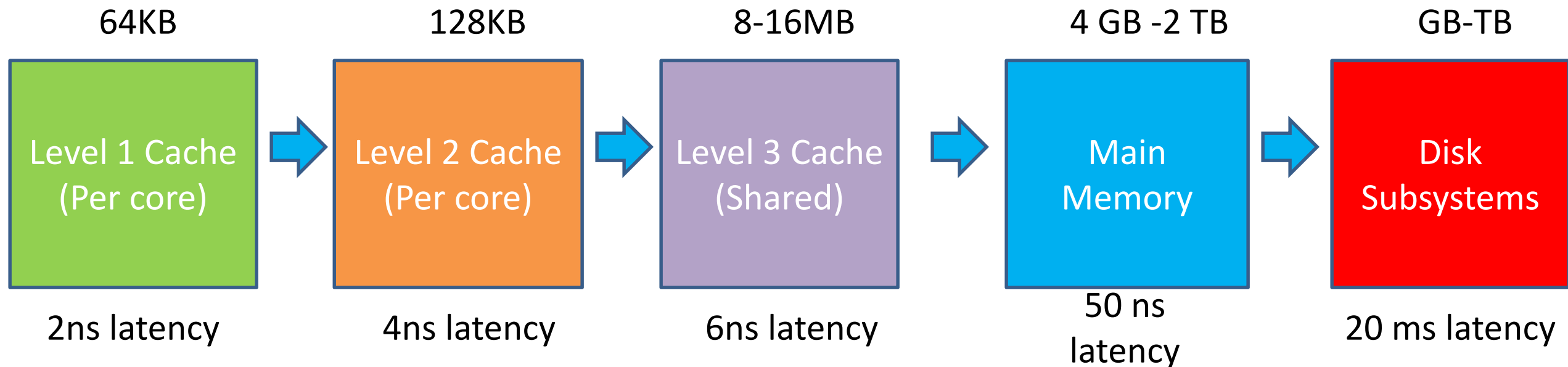
Instructions: MMX, SSE (1, 2, 3, 3S, 4.1, 4.2), BMI1, VT-x, AES, AVX

Clocks (Core #0): Core Speed 2498.44 MHz, Multiplier x 25.0, Bus Speed 99.9 MHz, QPI Link 3597.8 MHz

Cache: L1 Data 6 x 32 KBytes 8-way, L1 Inst. 6 x 32 KBytes 8-way, Level 2 6 x 256 KBytes 8-way, Level 3 15 MBytes 20-way

Selection: Processor #1, Cores 6, Threads 12

Data Retrieval Time



Instant DB File Initialization

*Hardware: Lenovo ThinkPad i7-2640 Dual Core, 16 GB Memory, 1 TB External HD 5400

Performance Test **WITHOUT** Instant Database File Initialization

CREATE DATABASE w/ 20 GB Data file = 11:57 min/seconds

ALTER DATABASE by 10 GB = 5:59 min/seconds

BACKUP 30 GB DATABASE(Empty) = 00:17 min/seconds

RESTORE 30 GB DATABASE (Empty Backup) = 17:46 min/seconds

RESTORE 30 GB DATABASE (12 GB Backup) = 25:07 min/seconds

BACKUP 30 GB DATABASE (12 GB of Data) = 17:21 min/seconds

Performance Test **WITH** Instant Database File Initialization

CREATE DATABASE w/ 20 GB Data file = 00:12 min/seconds

ALTER DATABASE by 10 GB = 00:00 min/seconds

BACKUP 30 GB DATABASE(Empty) = 00:13 min/seconds










RESTORE 30 GB DATABASE (Empty Backup) = 00:07 min/seconds

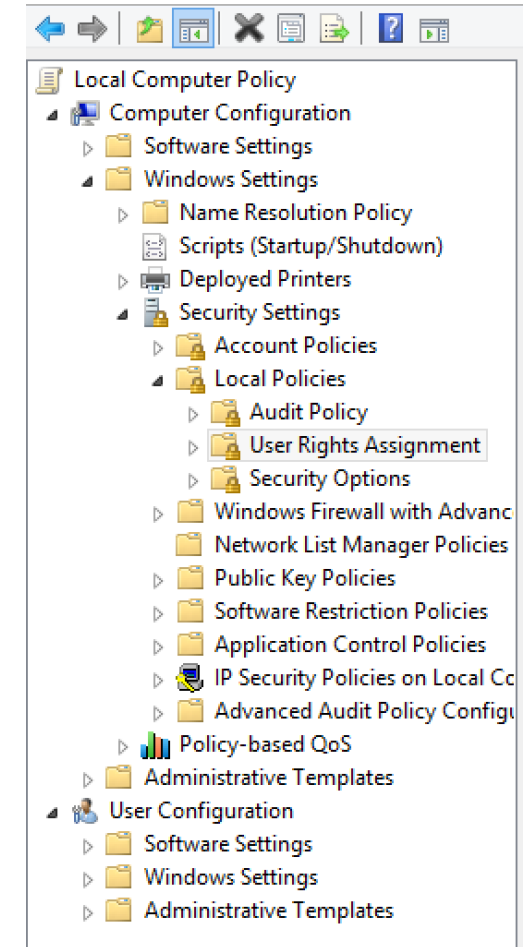
RESTORE 30 GB DATABASE (12 GB Backup) = 6:50 min/seconds

BACKUP 30 GB DATABASE (12 GB of Data) = 13:43 min/seconds

Instant Database File Initialization

- SQL Service Account
 - Must be in the Local Admin Group
 - Must Have Group Policy Right: Perform Volume Maintenance Tasks
- Allows SQL to call the Windows API SetFileValidData
- Requires a SQL Service Restart to Add
- Requires a Server Restart to Remove

	Log on as a service	LOCAL SERVICE,NETWO...
	Manage auditing and security log	Administrators
	Modify an object label	
	Modify firmware environment values	Administrators
	Perform volume maintenance tasks	s-sqlsrv,PWCORP\bball
	Profile single process	Administrators
	Profile system performance	Administrators,NT SERVI...
	Remove computer from docking station	Administrators,Users
	Replace a process level token	LOCAL SERVICE NETWO



Demo



Agenda

- ~~Wait Stats~~
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ACID

Atomicity

Consistency

Isolation

Durability

Begin Transaction

Withdraw \$1000 Savings

Deposit \$1000 Checking

Commit Transaction

Transaction Isolation Levels

- Serializable
- Read Committed
- Read Uncommitted
- Repeatable Read
- Snapshot Isolation

Lock Matrix

	NL	SCH-S	SCH-M	S	U	X	IS	IU	IX	SIU	SIX	UIX	BU	RS-S	RS-U	RI-N	RI-S	RI-U	RI-X	RX-S	RX-U	RX-X
NL	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
SCH-S	N	N	C	N	N	N	N	N	N	N	N	N	N	I	I	I	I	I	I	I	I	I
SCH-M	N	C	C	C	C	C	C	C	C	C	C	C	C	I	I	I	I	I	I	I	I	I
S	N	N	C	N	N	C	N	N	C	N	C	C	C	N	N	N	N	N	C	N	N	C
U	N	N	C	N	C	C	N	C	C	C	C	C	C	N	C	N	N	C	C	N	C	C
X	N	N	C	C	C	C	C	C	C	C	C	C	C	C	C	N	C	C	C	C	C	C
IS	N	N	C	N	N	C	N	N	N	N	N	N	C	I	I	I	I	I	I	I	I	I
IU	N	N	C	N	C	C	N	N	N	N	N	C	C	I	I	I	I	I	I	I	I	I
IX	N	N	C	C	C	C	N	N	N	C	C	C	C	I	I	I	I	I	I	I	I	I
SIU	N	N	C	N	C	C	N	N	C	N	C	C	C	I	I	I	I	I	I	I	I	I
SIX	N	N	C	C	C	C	N	N	C	C	C	C	C	I	I	I	I	I	I	I	I	I
UIX	N	N	C	C	C	C	N	C	C	C	C	C	C	I	I	I	I	I	I	I	I	I
BU	N	N	C	C	C	C	C	C	C	C	C	C	N	I	I	I	I	I	I	I	I	I
RS-S	N	I	I	N	N	C	I	I	I	I	I	I	I	N	N	C	C	C	C	C	C	C
RS-U	N	I	I	N	C	C	I	I	I	I	I	I	I	N	C	C	C	C	C	C	C	C
RI-N	N	I	I	N	N	N	I	I	I	I	I	I	I	C	C	N	N	N	N	C	C	C
RI-S	N	I	I	N	N	C	I	I	I	I	I	I	I	C	C	N	N	N	C	C	C	C
RI-U	N	I	I	N	C	C	I	I	I	I	I	I	I	C	C	N	N	C	C	C	C	C
RI-X	N	I	I	C	C	C	I	I	I	I	I	I	I	C	C	N	C	C	C	C	C	C
RX-S	N	I	I	N	N	C	I	I	I	I	I	I	I	C	C	C	C	C	C	C	C	C
RX-U	N	I	I	N	C	C	I	I	I	I	I	I	I	C	C	C	C	C	C	C	C	C
RX-X	N	I	I	C	C	C	I	I	I	I	I	I	I	C	C	C	C	C	C	C	C	C

Key

N	No Conflict	SIU	Share with Intent Update
I	Illegal	SIX	Shared with Intent Exclusive
C	Conflict	UIX	Update with Intent Exclusive
NL	No Lock	BU	Bulk Update
SCH-S	Schema Stability Locks	RS-S	Shared Range-Shared
SCH-M	Schema Modification Locks	RS-U	Shared Range-Update
S	Shared	RI-N	Insert Range-Null
U	Update	RI-S	Insert Range-Shared
X	Exclusive	RI-U	Insert Range-Update
IS	Intent Shared	RI-X	Insert Range-Exclusive
IU	Intent Update	RX-S	Exclusive Range-Shared
IX	Intent Exclusive	RX-U	Exclusive Range-Update
		RX-X	Exclusive Range-Exclusive

Locks

Shared - Reader Lock. Universal Giver.

Update - Hybrid lock that starts out with properties of a Shared lock and moves toward an Exclusive.

eXclusive – Data has been modified, within this transaction and cannot be accessed until it is hardened to Disk.

		Currently Acquired		
		<u>S</u>hared	<u>U</u>pdate	e<u>X</u>clusive
Requested Locks	<u>S</u>hared	<u>Y</u>	<u>Y</u>	<u>N</u>
	<u>U</u>pdate	<u>Y</u>	<u>N</u>	<u>N</u>
	e<u>X</u>clusive	<u>N</u>	<u>N</u>	<u>N</u>

Locks

Intent Locks- Qualifier to all previous modes. IS, IX, IU.

SCHema Stability Locks - When a query is being Compiled, SS locks is acquired to prevent Schema Modification Locks.

SCHema Modification Locks – SM Locks are taken as a Table's structure is being modified i.e. DDL Commands.

Bulk Uppdate Locks– When BCP is used or a Bulk Insert Command is Called. Can be set by User (TABLOCK) or Table setting 'table lock on bulk'=TRUE

Locks

Conversion Locks – Requested when SQL Server needs to convert a lock within a Transaction. SIX, SIU, UIX

Shared Intent eXclusive- a resource holding a Shared lock also has a component (page or row) locked with an eXclusive lock.

Shared Intent Update- a resource holding a shared lock also has a component (page or row) locked with an Update lock.

Update Intent eXclusive- resource holding an update lock also has a component (page or row) locked with an eXclusive lock.

Key Range Locks-Locks entire Range of a transaction in Serializable Isolation Level.

Key Locks- Taken on modifications on a Clustered Index instead of Row locks

Lock Matrix

	NL	SCH-S	SCH-M	S	U	X	IS	IU	IX	SIU	SIX	UIX	BU	RS-S	RS-U	RI-N	RI-S	RI-U	RI-X	RX-S	RX-U	RX-X
NL	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
SCH-S	N	N	C	N	N	N	N	N	N	N	N	N	N	I	I	I	I	I	I	I	I	I
SCH-M	N	C	C	C	C	C	C	C	C	C	C	C	C	I	I	I	I	I	I	I	I	I
S	N	N	C	N	N	C	N	N	C	N	C	C	C	N	N	N	N	N	C	N	N	C
U	N	N	C	N	C	C	N	C	C	C	C	C	C	N	C	N	N	C	C	N	C	C
X	N	N	C	C	C	C	C	C	C	C	C	C	C	C	C	N	C	C	C	C	C	C
IS	N	N	C	N	N	C	N	N	N	N	N	N	C	I	I	I	I	I	I	I	I	I
IU	N	N	C	N	C	C	N	N	N	N	N	C	C	I	I	I	I	I	I	I	I	I
IX	N	N	C	C	C	C	N	N	N	C	C	C	C	I	I	I	I	I	I	I	I	I
SIU	N	N	C	N	C	C	N	N	C	N	C	C	C	I	I	I	I	I	I	I	I	I
SIX	N	N	C	C	C	C	N	N	C	C	C	C	C	I	I	I	I	I	I	I	I	I
UIX	N	N	C	C	C	C	N	C	C	C	C	C	C	I	I	I	I	I	I	I	I	I
BU	N	N	C	C	C	C	C	C	C	C	C	C	N	I	I	I	I	I	I	I	I	I
RS-S	N	I	I	N	N	C	I	I	I	I	I	I	I	N	N	C	C	C	C	C	C	C
RS-U	N	I	I	N	C	C	I	I	I	I	I	I	I	N	C	C	C	C	C	C	C	C
RI-N	N	I	I	N	N	N	I	I	I	I	I	I	I	C	C	N	N	N	N	C	C	C
RI-S	N	I	I	N	N	C	I	I	I	I	I	I	I	C	C	N	N	N	C	C	C	C
RI-U	N	I	I	N	C	C	I	I	I	I	I	I	I	C	C	N	N	C	C	C	C	C
RI-X	N	I	I	C	C	C	I	I	I	I	I	I	I	C	C	N	C	C	C	C	C	C
RX-S	N	I	I	N	N	C	I	I	I	I	I	I	I	C	C	C	C	C	C	C	C	C
RX-U	N	I	I	N	C	C	I	I	I	I	I	I	I	C	C	C	C	C	C	C	C	C
RX-X	N	I	I	C	C	C	I	I	I	I	I	I	I	C	C	C	C	C	C	C	C	C

Key

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		RX-X	Exclusive Range-Exclusive

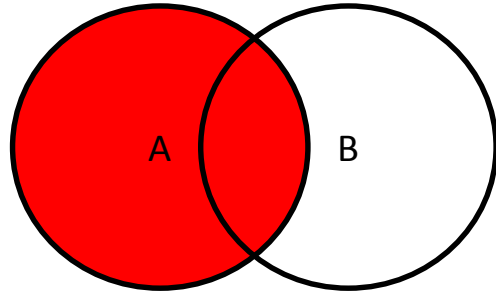
Demo



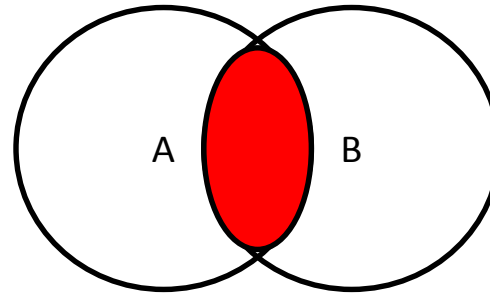
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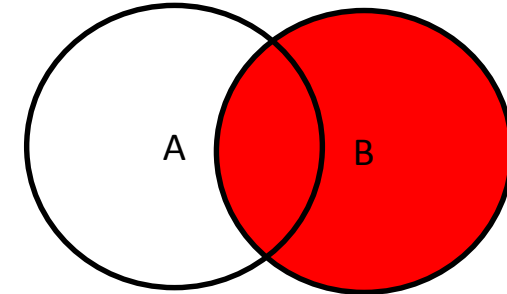
Syntactical Joins



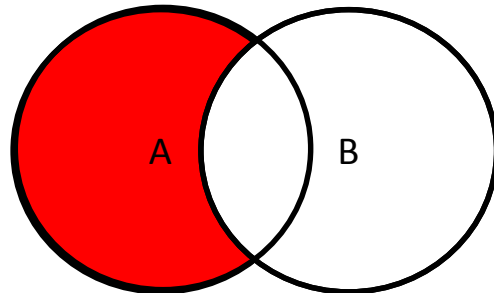
```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
On A.Key=B.Key
```



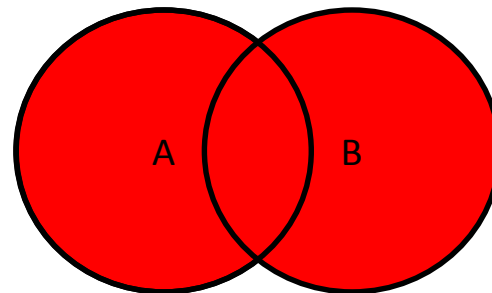
```
SELECT <select_list>
FROM TableA A
INNER JOIN TableB B
On A.Key=B.Key
```



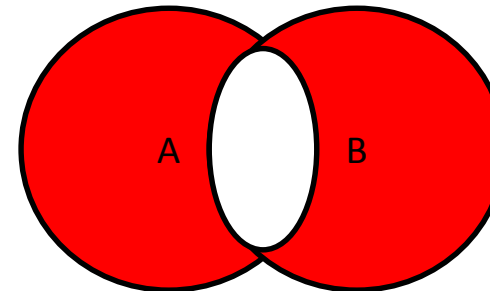
```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
On A.Key=B.Key
```



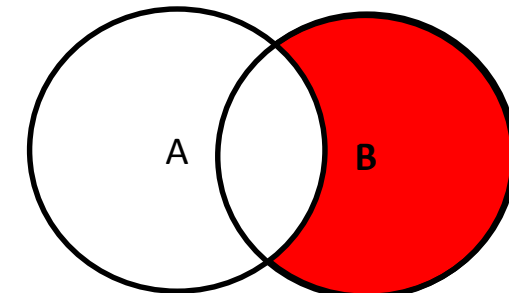
```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
On A.Key=B.Key
WHERE B.Key IS NULL
```



```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
On A.Key=B.Key
```



```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
On A.Key=B.Key
Where A.Key IS NULL OR B.Key IS
NULL
```



```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
On A.Key=B.Key
WHERE A.Key IS NULL
```

Physical Operators

Joins

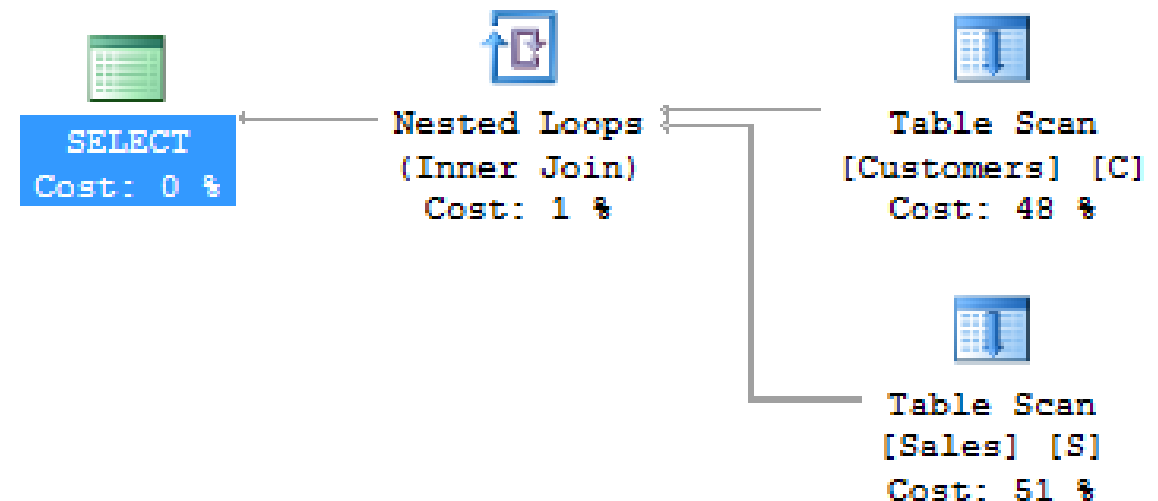
- Syntactical Joins
 - Inner Join
 - Outer Join
 - Cross Join
 - Cross Apply
 - Outer Apply
 - Semi-Join
 - Anti-Semi Join
- Physical Joins
 - Nested Loop Join
 - Merge Join
 - Hash Join

***If no Syntactical Join Type is specified Inner Join is the default**

Nested Loop Join

Compares Each Row from the Outer Table To Each Row in the Inner Table

```
for each row R1 in the outer table
begin
  for each row R2 in the inner table
    if R1 joins with R2
      return (R1, R2)
      if R1 did not join
      return (R1, NULL)
    end
  end
end
```



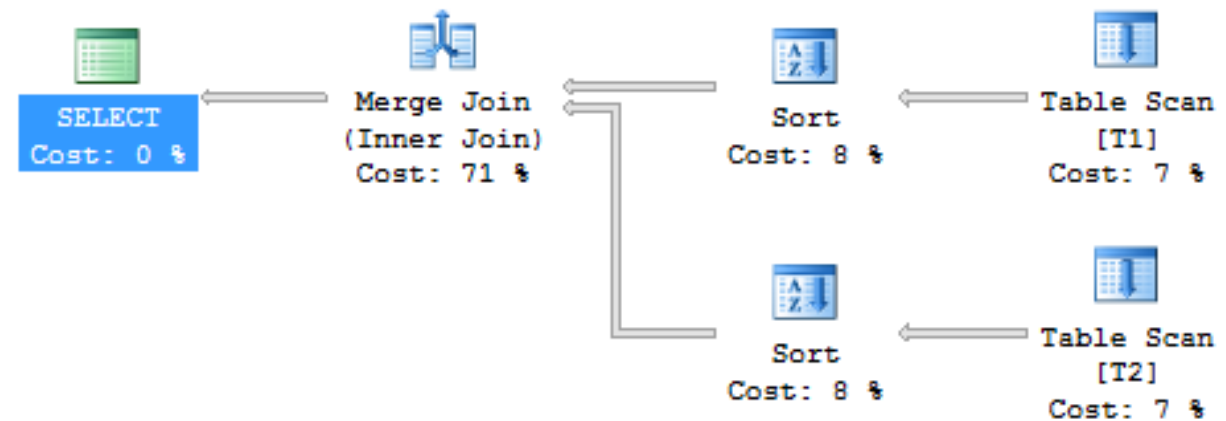
Sorted Merge Join

Simultaneously Reads and Compares two Sorted Inputs One Row at a Time

```

get first row R1 from input 1
get first row R2 from input 2
while not at the end of either input
  begin
    if R1 joins with R2
      begin
        return (R1, R2)
        get next row R2 from input 2
      end
    else if R1 < R2
      get next row R1 from input 1
    else
      get next row R2 from input 2
    end
  end

```



Hash Join

Join Heavy Lifter. Built in Two Phases: Build & Probe.

- Build

- Reads Rows from 1st Input
- Hashes on Equijoin Keys
- Creates In-Memory Hash Table

- Probe

Reads All Rows from 2nd Input
Hashes on Same Equijoin Keys
Probes for Matching Rows in Hash Table

for each row R1 in the build table

begin

calculate hash value on R1 join key(s)

insert R1 into the appropriate hash bucket

end

for each row R2 in the probe table

begin

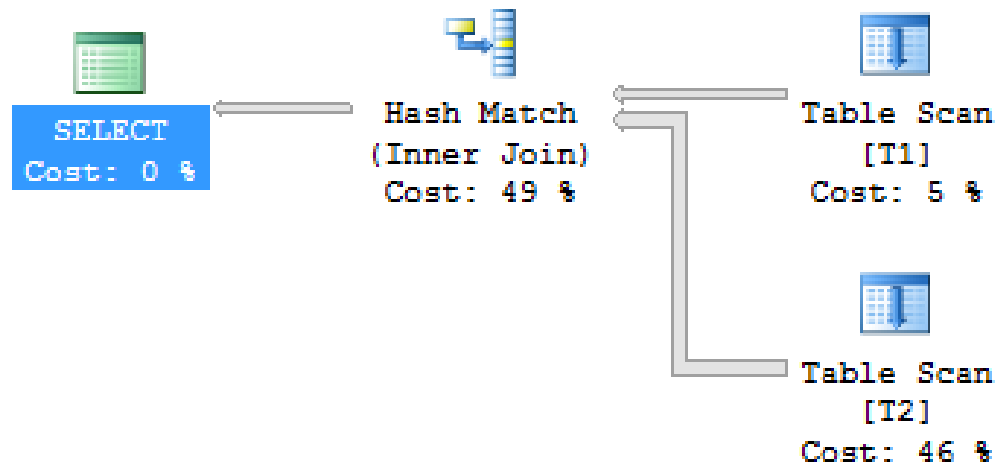
calculate hash value on R2 join key(s)

for each row R1 in the corresponding hash bucket

if R1 joins with R2

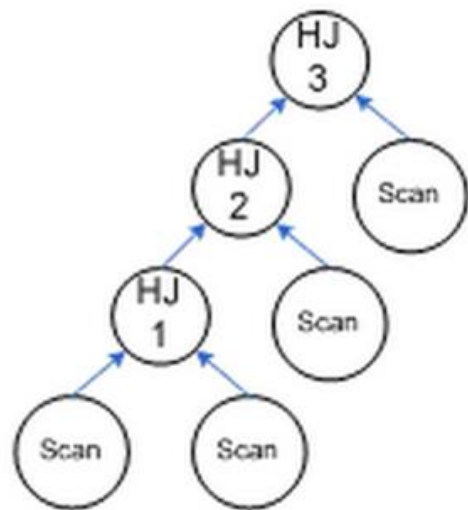
return (R1, R2)

end

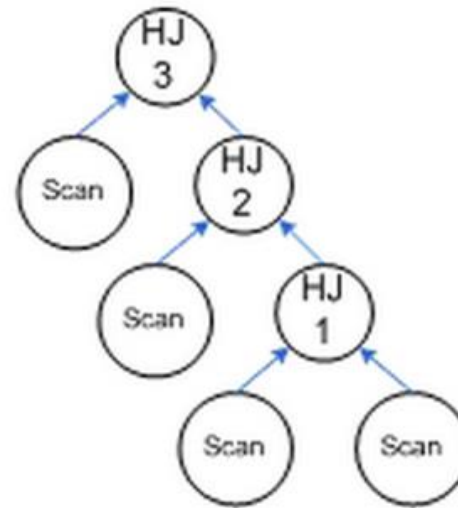


Hash Join

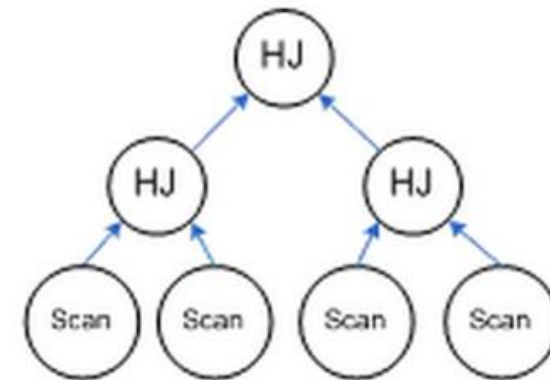
Has 3 Types of Tree Structures



Left Deep



Right Deep

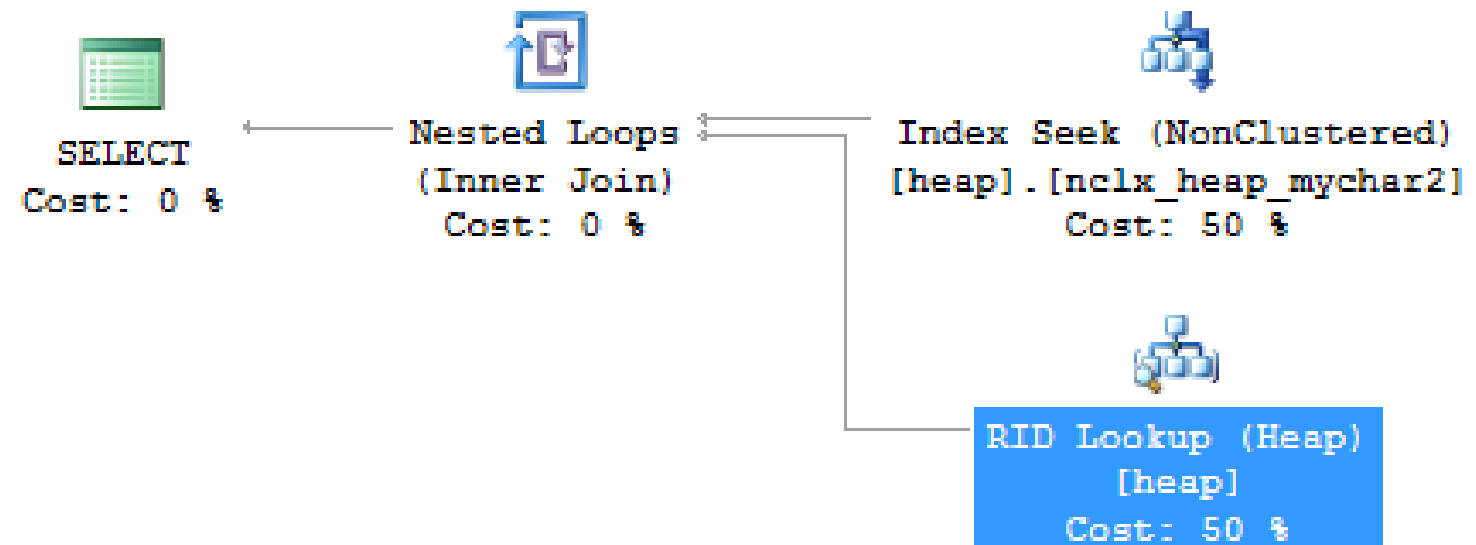


Bushy

Execution Plans

RID Lookup

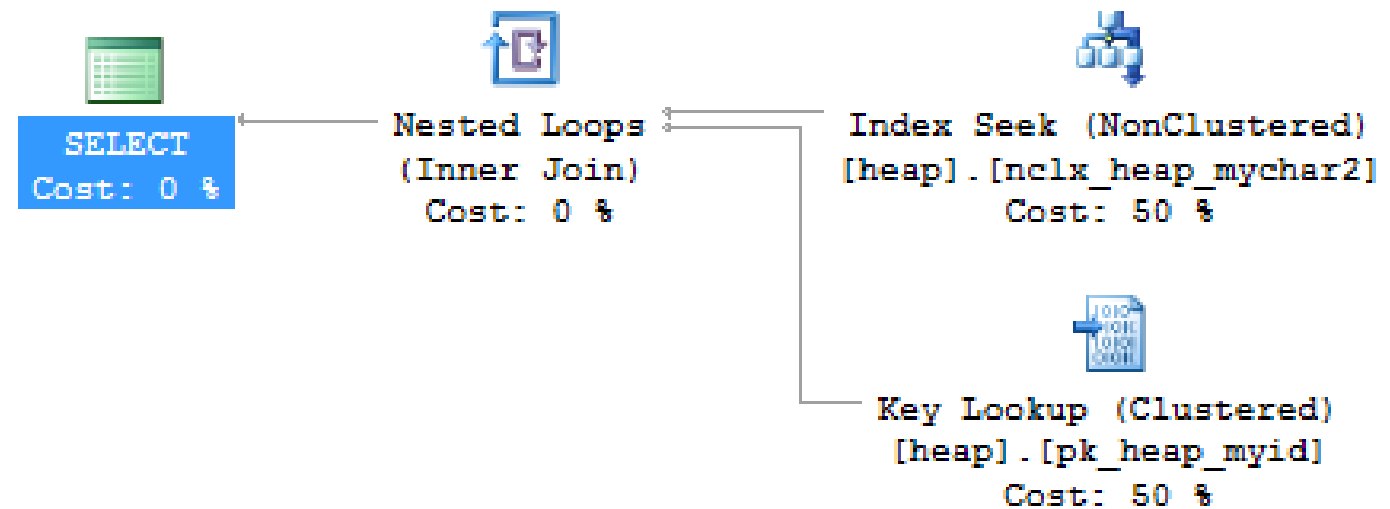
- When a Query Must Point Back to the Clustered Index For Additional Rows



Execution Plans

Key Lookup

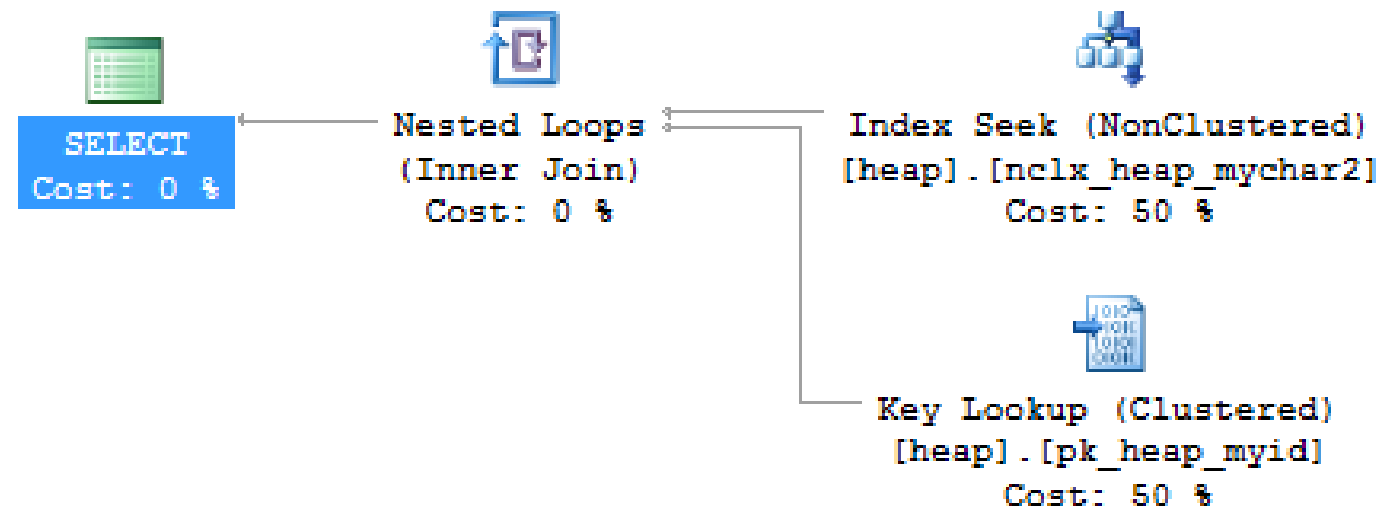
- When a Query Must Point Back to the Clustered Index For Additional Rows



Execution Plans

Key Lookup

- When a Query Must Point Back to the Clustered Index For Additional Rows

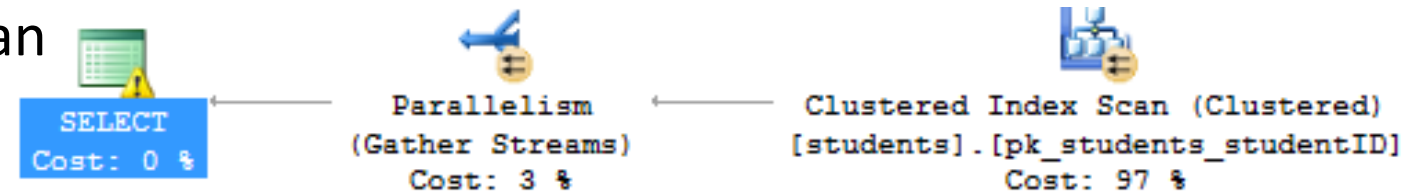


Execution Plans

Warnings

- Yield Sign in Query Plan

SELECT	
Cached plan size	24 KB
Degree of Parallelism	4
Estimated Operator Cost	0 (0%)
Estimated Subtree Cost	9.39512
Memory Grant	72
Estimated Number of Rows	1.00006
Statement	
select * from students	
where ssn=@ssn	
Warnings	
Type conversion in expression (CONVERT_IMPLICIT(nchar(9),[college].[dbo].[students].[ssn],0)) may affect "CardinalityEstimate" in query plan choice, Type conversion in expression (CONVERT_IMPLICIT(nchar(9),[college].[dbo].[students].[ssn],0)=[@ssn]) may affect "SeekPlan" in query plan choice	



Types

- Implicit Conversion
- Sort
- Unmatched Indexes
- Spill

Demo



Agenda

- ~~Wait Stats~~
- ~~Baseline Disks~~
- ~~Power Configuration~~
- ~~Instant Database File Initialization~~
- ~~Locks and Blocking~~
- ~~Joins~~
- ~~Execution Plans~~

Resources



Questions?

