SQL Server 2016 – Die Evolution der In-Memory Technologien

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Microsoft Certified Master SQL Server 2008
+ Solutions Master Data Platform (SQL Server 2012)

- Datawarehouse & OLTP-System Architecture
- Performance Tuning
- Security

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SSAS, SSRS, SSIS

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Die nächsten SQL Server Master-Classes ab Juni 2016

SQL SERVER MASTER-CLASS
by SARPEDON QUALITY LAB

- Workshop **Hochverfügbarkeit mit SQL Server Always On**
  - Windows Server Failover Clustering
  - SQL Server Clustered Instances
  - SQL Server Availability Groups
  - Logshipping
  - Frankfurt, 30.5.-1.6. *

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- **SQL Server Performance-Analyse** Workshop
  - Frankfurt, 29.6.-1.7. *

*Termine noch unter Vorbehalt

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Agenda

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- Columnstore
- In Memory
- Real-time operational Analytics

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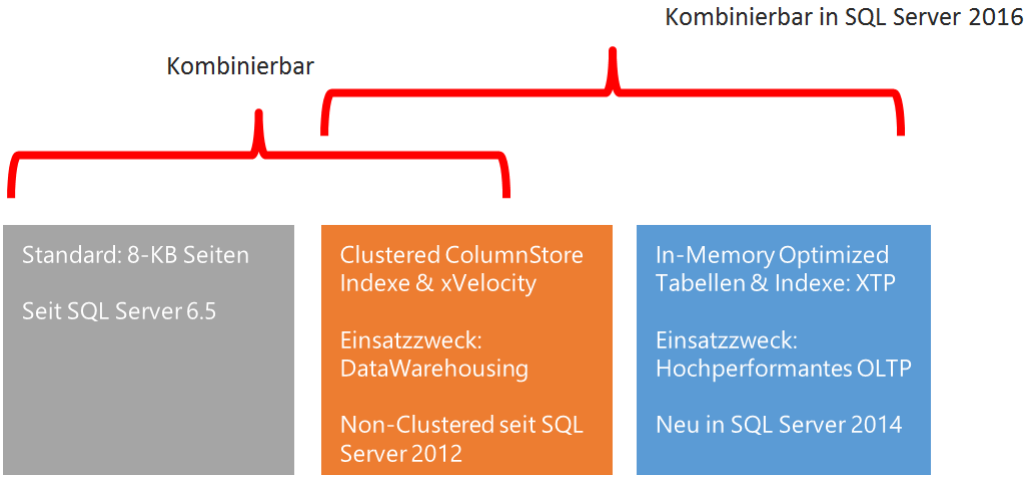
SQL Server Engines seit 2014



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COLUMNSTORE

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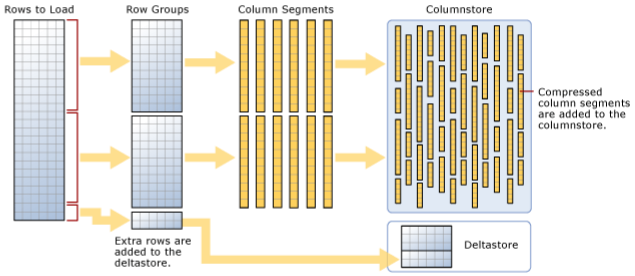
Columnstore, Laden via Rowgroup & Deltagroup

- Ein **Segment** einhält Werte einer Spalte
- Segmente für dieselbe Zeilenmenge bilden eine **Row Group**
  - Für ca. 1 Mio Zeilen
- Segmente sind komprimiert
- Jedes Segment wird in einer separaten BLOB-Struktur gespeichert



- Columnstore Indexes
  - http://msdn.microsoft.com/en-us/library/gg492088%28v=sql.120%29.aspx

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Was ist daran neu?

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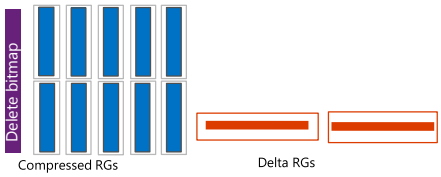
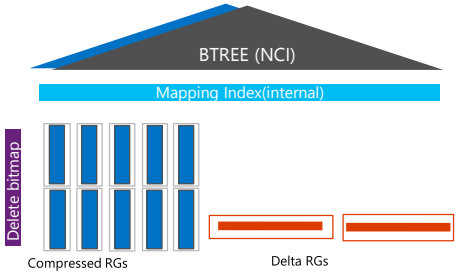
Columnstore Index: Clustered (CCI)



SQL 2014

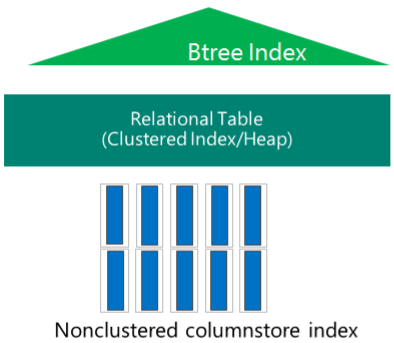
- Master copy of the data (10 x compression)
- Only 1 index supported. Simplified analytics
- No PK/FK constraints. Uniqueness can be enforced through Materialized Views
- Locking granularity for Update/Delete at rowgroup level
- DDL – ALTER, REBUILD, REORGANIZE



SQL 2016

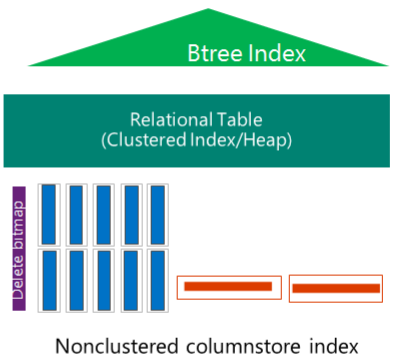
- Additional Btree indexes for efficient equality and short-range searches and PK/FK constraints.
- Can be on Memory optimized Table
- Locking granularity at row level using NCI index path
- support snapshot and read-committed snapshot isolation
- DDL – ALTER, REBUILD, REORGANIZE

Columnstore Index: NonClustered (NCCI) Updateable



SQL 2014

- Introduced in SQL Server 2012
- NCCI is read-only (No delete bitmap and delta store)
- Additionally to NCI(s) and CI or Heap



SQL 2016

- It is updateable!
- You can mix OLTP and Analytics workload
- You can create Filtered NCCI

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IN-MEMORY OLTP

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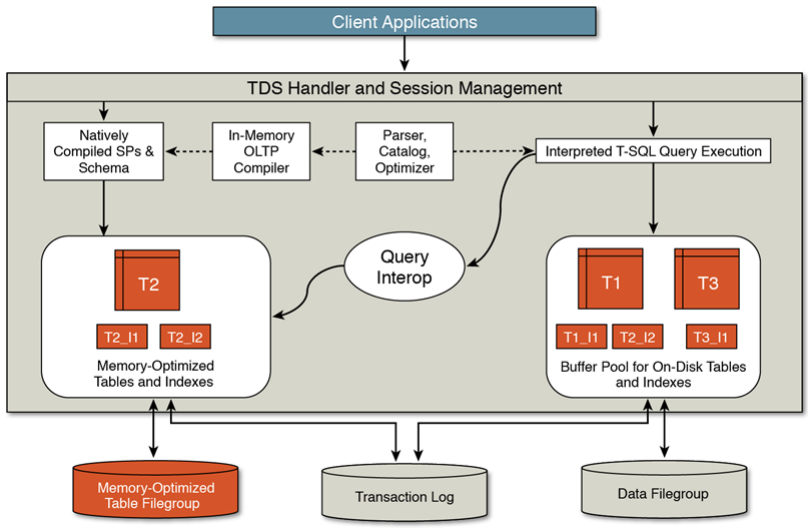
Integration der XTP Engine



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In-Memory OLTP Concurrency Control

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Multi-version	Multi-version data store	Snapshot-based transaction isolation No TempDB
Optimistic	No locks, no latches, minimal context switches No blocking	Conflict detection to ensure isolation No deadlocks

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Populating Data/Delta files

- Data file pre-allocated
- switches to new data file when the current file is full
- Transactions do not span data files
- Once a data file is closed, it becomes read-only
- Row deletes are tracked in delta file
- Files are append only

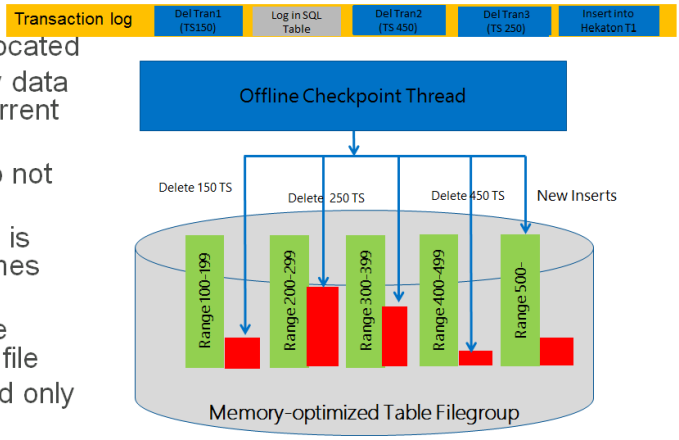

Image: Sunil Agarwal, TechEd 2013

Data file with rows generated in timestamp range

IDs of Deleted Rows (height indicates % deleted)

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Memory-Optimized Indexes

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- Exist only in memory
  - Rebuilt on database startup
    - -> RTO (!)
- Do not contain data rows
  - Indexes contain memory pointers to the data rows
    - All indexes are covering
    - No duplication of data

Nonclustered Indexes

No need to specify any options

Optimized for range lookups and ordered scans
Support search on leading columns of the index key
Support point-lookups, but hash indexes are much faster

Hash Indexes

Need to specify bucket_count – usually 1-2X the number of unique index keys
Optimized for point-lookups
Cannot be used for search on subset of the index key
Cannot be used for range lookups (search on inequality predicate) or ordered scans (for ORDER BY)

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Multiple Hash Indexes & Versioning

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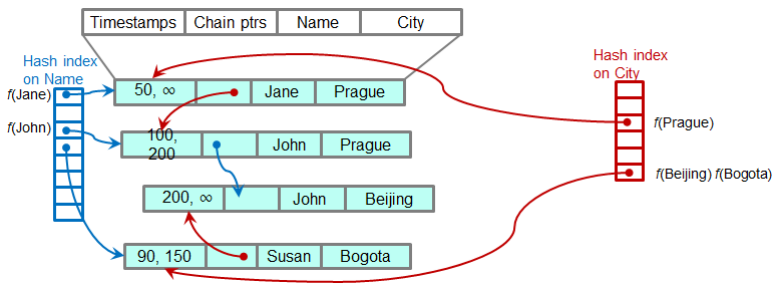

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NATIVELY COMPILED PROCEDURES

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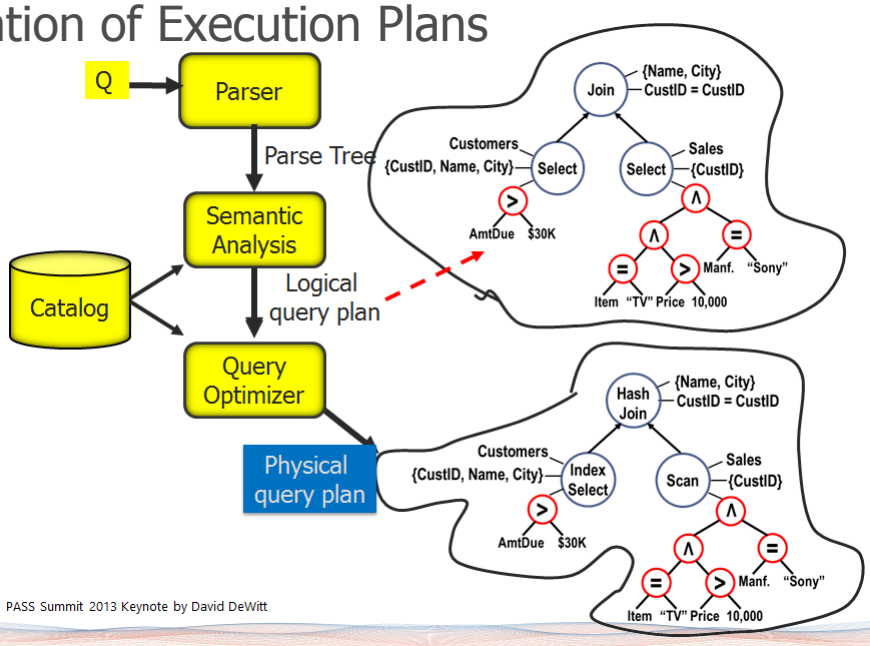
Generation of Execution Plans



PASS Summit 2013 Keynote by David DeWitt

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DLL Generation

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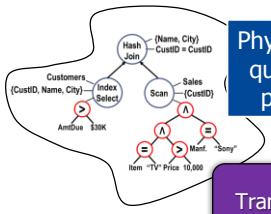

Physical query plan

Translator

C Code

C Compiler

DLL

DLL Loaded & Invoked

- DLL Generation at 1st execution of procedure
  - Aggressively optimized
  - No function calls

Areas of (CPU) Performance-Gains

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- Shared data structures
  - Latches
- Pessimistic Concurency Control
  - Locking
- Query Execution
  - Interpretation

2-5x

10-30x

- Shared data structures
  - Latch-free data structures
- Optimistic Concurency Control
  - Versioning with Timestamps
- Query Execution
  - Compilation in DDL

Performance-Comparison TicketReservation App

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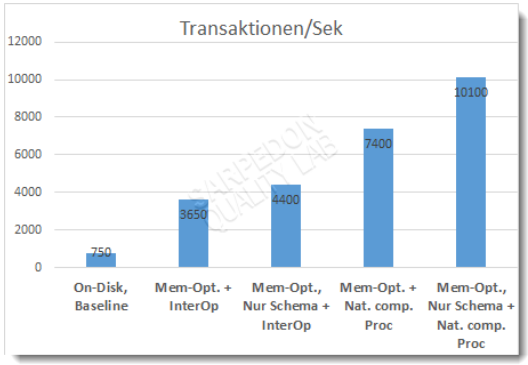

- http://www.insidesql.org/blogs/andreaswolter/2014/05/artikel-sql-server-2014-richtigstellungen

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In-Memory OLTP enhancements

```
ALTER TABLE Sales.SalesOrderDetail
   ALTER INDEX PK_SalesOrderID
   REBUILD
      WITH (BUCKET_COUNT=100000000)
```

```
T-SQL surface area: New

   {LEFT|RIGHT} OUTER JOIN
   Disjunction (OR, NOT)
   UNION [ALL]
   SELECT DISTINCT
   Subqueries (EXISTS, IN, scalar)
```

ALTER support

Full schema change support: add/alter/drop column/constraint
Add/drop index supported
`ALTER PROCEDURE`
Use `sp_recompile` to recompile stored procedures on the next execution

Surface area improvements

Almost full T-SQL coverage including scaler user-defined functions

Improved scaling

Increased size allowed for durable tables; more sockets

Other improvements

Support for Transparent Data Encryption
MARS support

Improved scaling

- Other enhancements include:
  - Multiple threads to persist memory optimized tables
  - Multi-threaded recovery
  - MERGE operation
  - Dynamic management view improvements to `sys.dm_db_xtp_checkpoint_stats` and `sys.dm_db_xtp_checkpoint_files`
- In-memory OLTP engine has been enhanced to scale linearly on servers up to 4 sockets

Greater Transact-SQL coverage

- CREATE PROCEDURE (Transact-SQL)
- DROP PROCEDURE (Transact-SQL)
- ALTER PROCEDURE (Transact-SQL)
- SELECT (Transact-SQL) and INSERT SELECT statements
- SCHEMABINDING and BEGIN ATOMIC (required for natively compiled stored procedures)
- NATIVE_COMPILATION
- Parameters and variables can be declared as NOT NULL
- Table-valued parameters
- EXECUTE AS OWNER, SELF, and user.
- GRANT and DENY permissions on tables and procedures
- Nesting natively compiled stored procedures
- RIGHT OUTER JOIN, LEFT OUTER JOIN, INNER JOIN, and CROSS JOIN in SELECT statements
- NOT, OR, and IN operators in SELECT, UPDATE and DELETE statement
- UNION ALL and UNION
- SELECT DISTINCT
- GROUP BY clause with no aggregate functions in the SELECT clause (<select> list).
- COLUMNSTORE
- COLLATE

Case Studies from Microsoft Customers

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Bwin – large online betting company — **17X**

Application: session state
Read and updated for every web interaction
Current max throughput: 15,000 requests/sec
Throughput with Hekaton: 250,000 requests/sec

SBI Liquidity Market – foreign exchange broker — **2X**

Application: online calculation of currency prices from aggregate trading data
Current throughput: 2,812 TPS with 4 sec latency
Hekaton throughput: 5,313 TPS with <1 sec latency

EdgeNet – provides up-to-date inventory status information — **17X**

Application: rapid ingestion of inventory data from retailers
Current max ingestion rate: 7,450 rows/
Hekaton ingestion rate: 126,665 rows/
Allows them to move to continuous, online
once-a-day batch ingestion

Ferranti Computer Systems — **~200 Mio rows/15 Min**

Analysis of Smart Meter data for power supply

In-Memory OLTP, Reactive Extensions und HDInsight technologies
Standard Hardware

www.microsoft.com/casestudies/Microsoft-SQL-Server-2012/Ferranti-Computer-Systems/Utilities-ISV-Scales-to-Meet-Customer-Needs-for-Storage-and-Analysis-of-Big-Data/710000000701

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REAL-TIME OPERATIONAL ANALYTICS & IN-MEMORY OLTP

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Operational Analytics

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"Ability to run Analytics Queries concurrently with Operational workload using the same schema."

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Klassische Real-time Analytics Architektur

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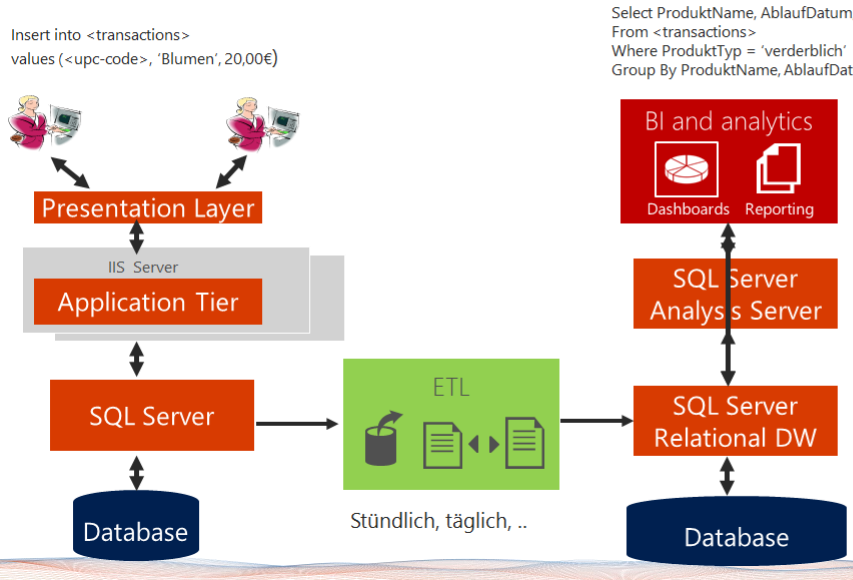

Herausforderungen:

- Komplexe Umsetzung
- Min. 2 Server benötigt (CapEx and OpEx)
- Daten-Latenz während der Analysen
- Fachbereich benötigt immer häufiger "Real-time Analytics"

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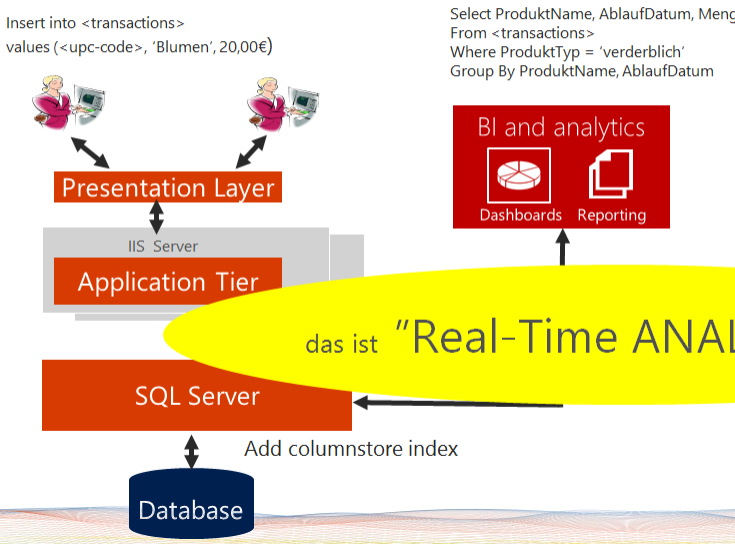
Daten-Latenz Minimierung für Analysen



Vorteile:

- Keine Daten-Latenz
- Kein ETL notwendig
- Kein zusätzliches DW

g:

- Minimierter Einfluss auf den OLTP Workload
- Performante Analysen

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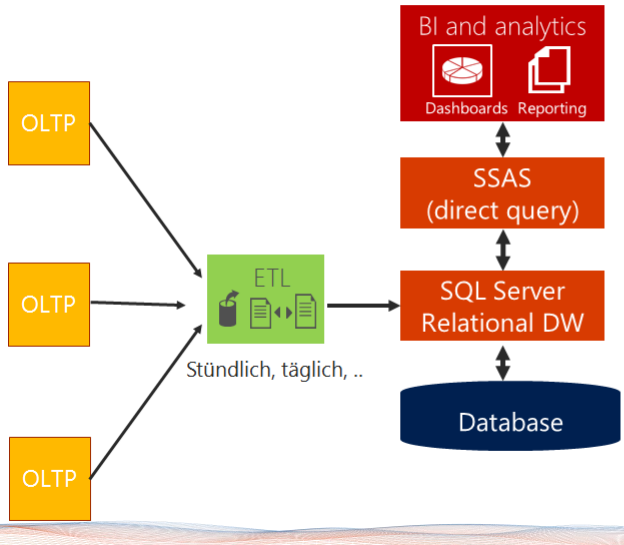
Real-Time Analytics – Wofür NICHT geeignet?



- Verwendung/ Aggregation mehrere OLTP Systeme
- Extreme Analysen
  - Vor-aggregierte CUBEs notwendig
  - Star-Schema
- Schwierigkeiten beim Zugriff auf das OLTP Schema
  - Normalisierte Daten
  - "Multi-table Joins" notwendig

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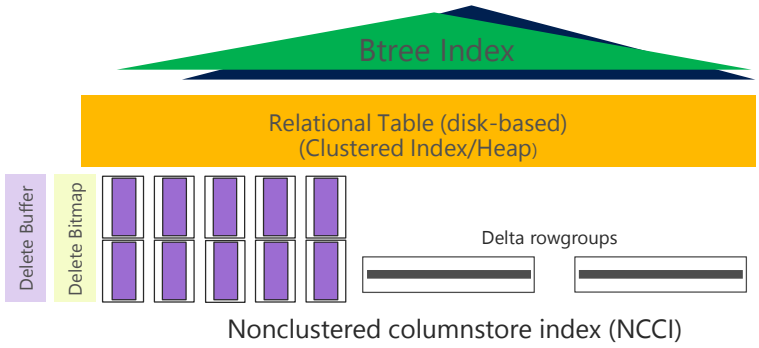
Real-time Analytics: Nonclustered Columnstore Index (NCCI)



Nonclustered columnstore index (NCCI)

Vorgehen

- Erstellung eines "updateable non-clustered columnstore index" (NCCI) für analytische Abfragen
- Löschung aller weiteren Analysebedingten Indexe
- KEINE Änderungen an der OLTP Anwendung notwendig!
- ColumnStore Index wird automatisch über DML Operationen aktualisiert
- Query Optimizer verwendet den NCCI sofern notwendig

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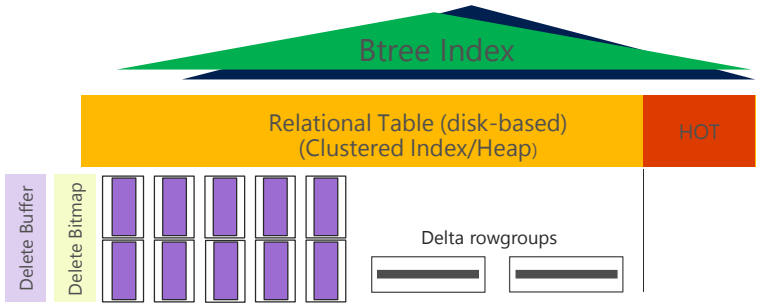
Real-time Analytics: Minimierung der Belastung durch den Columnstore Index



Nonclustered columnstore index (NCCI) – filtered index

Vorgehen

- Erstellung des Columnstore Index NUR auf "kalten" Daten – Filterkriterium minimiert den Wartungsaufwand
- Analytische Abfragen greifen auf heiße & kalte Daten transparent zu
- Syntax:
  Create nonclustered columnstore index <name> on <table> (<columns>)
  where <filter_col> = <value>

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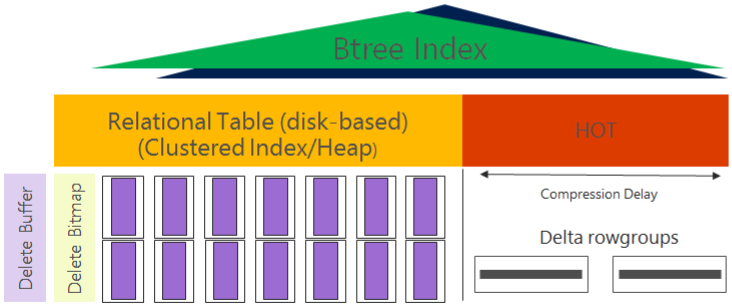
Real-time Analytics: Minimierung der Belastung durch den Columnstore Index



Nonclustered columnstore index (NCCI) – filtered index

Vorgehen

- Delta rowgroup wird erst nach Ablauf des "compression delay" Zeitraums komprimiert
- Minimierung/ Vermeidung von Index Fragmentierung
- Syntax:
  Create nonclustered columnstore index <name> on <table> (<columns>) with (compression_delay = 30 Minutes)

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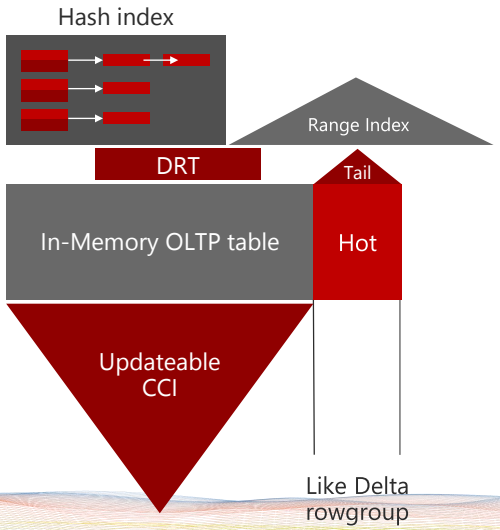
Operational analytics: Columnstore on in-memory tables



Columnstore data fully resident in memory
Persisted together with operational data

Deleted Rows Table (DRT) – Tracks deleted rows

No application changes required

- Rows (tail) not in columnstore stay in in-Memory OLTP table
- No columnstore index overhead when operating on tail
- Background task migrates rows from tail to columnstore in chunks of 1 million rows not changed in last 1 hour – as of CTP3

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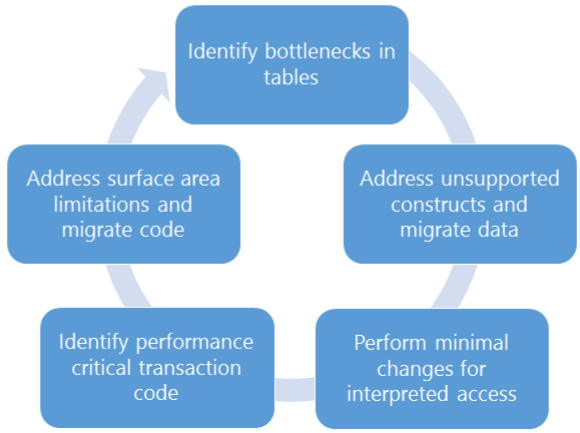
Iterative Approach to Migration



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Vielen Dank für Eure Zeit

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Microsoft CERTIFIED Master SQL Server® 2008

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Xing: www.xing.com/profile/Andreas_Wolter2
Twitter: @AndreasWolter

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Connect Items, which love to get your vote ☺

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- Extended Events UI Export Display Settings: include grouping
  - To improve the XEvent GUI in terms of saving view settings incl. grouping
- Support SQL Broker Service to be a target of Extended Events
- Providing a special Server principal for Database Ownership
  - To solve the problem with the database owner, which unfortunately is sa in 80% of all servers – with all the security risks – explained in my blog:
    - http://www.insidesql.org/blogs/andreaswolter/2013/12/survey-sql-server-database-ownership-datenbankbesitzer
- Allow the use of saved Credentials/Proxy Accounts for Reporting Services Subscriptions
  - Bekommen wir für File-Subscriptions in SSRS 2016 ☺
- Shared Datsets with spatial data - no preview in map pane and as well as in spatial data + analytical dat…
- Group Managed Service Accounts Support for SQL Server Failover Clusters
  - Bekommen wir nun in SQL Server 2016 ☺

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Die nächsten SQL Server Master-Classes ab Juni 2016

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- Workshop **Hochverfügbarkeit mit SQL Server Always On**
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  - SQL Server Clustered Instances
  - SQL Server Availability Groups
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*Termine noch unter Vorbehalt

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