Size Does Matter

3-5 ways to reduce DB size and improve performance

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Good morning!

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- Pro SQL Server Internals (v1-2)
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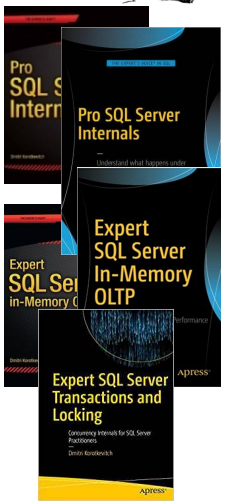
- Expert SQL Server Transactions and Locking



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Why bother reducing DB Size?

Improves Performance

Simplifies SLA, RTO, RPO Compliance

Makes Administration and Maintenance Easier

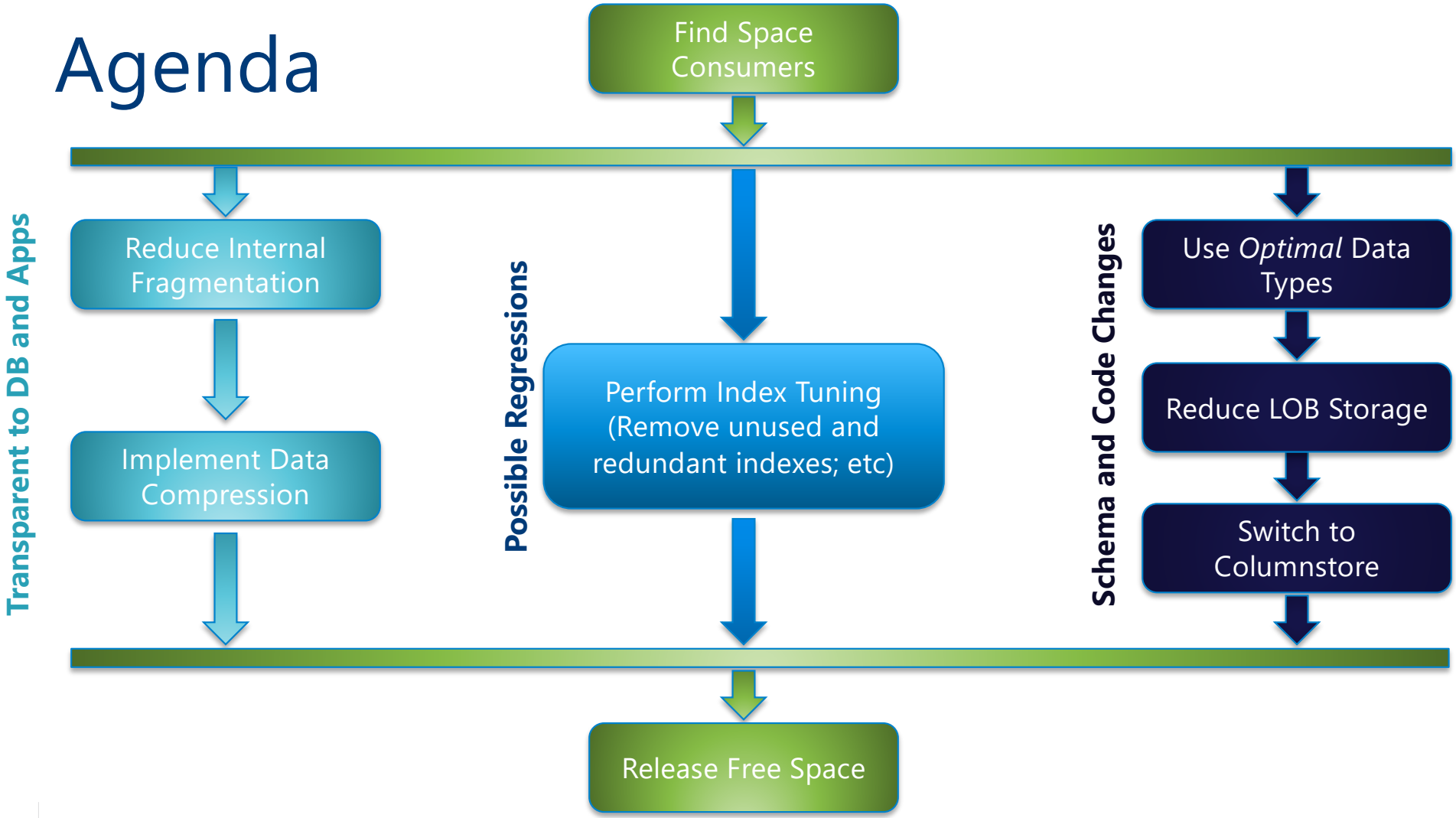
Reduces Hardware Cost

Picture from: https://openclipart.org/detail/172012/award-by-gnokii-172012

DBCC_SMARTSHRINK()

Demo

Agenda


Find Space Consumers
Transparent to DB and Apps
Reduce Internal Fragmentation
Implement Data Compression
Possible Regressions
Perform Index Tuning (Remove unused and redundant indexes; etc)
Schema and Code Changes
Use *Optimal* Data Types
Reduce LOB Storage
Switch to Columnstore
Release Free Space

Best Practices

Auto Shrink is OFF

- Greatly increases index fragmentation
- Contributes to I/O, CPU load and T-Log overhead
- Absolutely useless

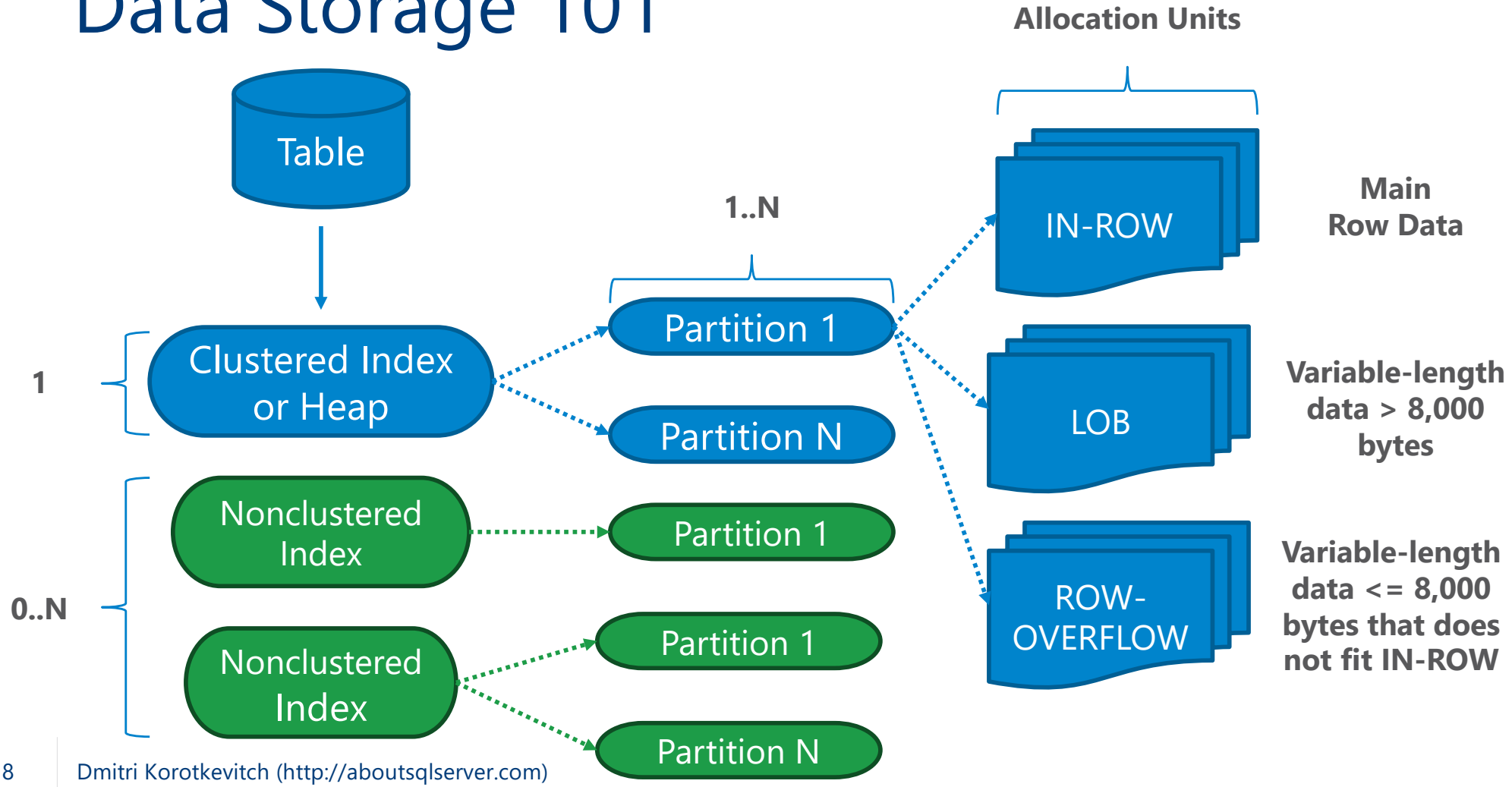
Instant File Initialization is ON

- Prevents zeroing-out of the newly allocated space in the data files
- Speed-up data file (auto)-growth and database restore
- Does not affect T-Log growth (it is always zeroing out)

Instant File Initialization

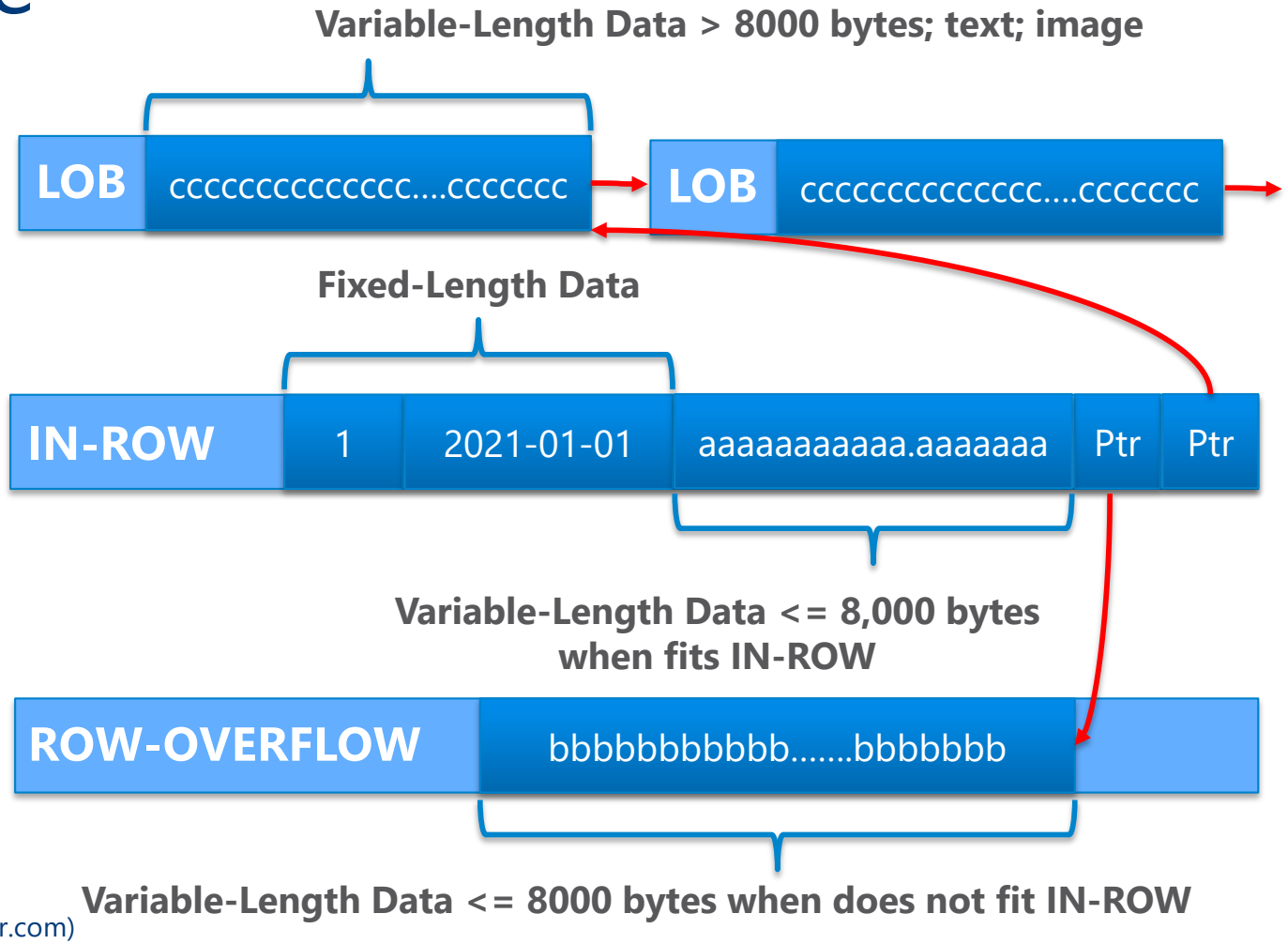
Demo

Data Storage 101



Data Storage

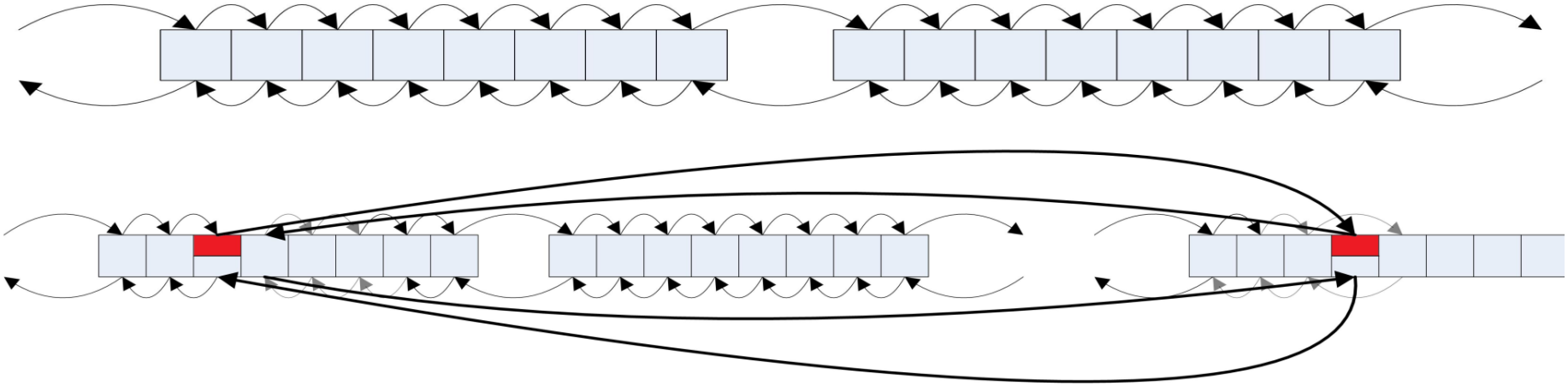
```
create table T
(
    ID int,
    DateCol datetime,
    VarCol1 varchar(max),
    VarCol2 varchar(5000),
    VarCol3 varchar(max)
);

insert into T values
(
    1
    ,'2021-01-01'
    ,REPLICATE('a',5000)
    ,REPLICATE('b',5000)
    ,REPLICATE('c',32000)
);
```



Find Space Consumers

Demo

Page Split & Fragmentation



Page Split moves ~50% of the data to another page

FILLFACTOR allows to reserve some space on the page

- Applies only at CREATE INDEX/ALTER INDEX REBUILD stages
- Decreases Page Splits / Fragmentation; however, increases index size

Internal Fragmentation

Demo

Data Compression

Uncompressed rows:

- Fixed-length columns: Storage size depends on the data type
- Variable-length columns: Storage size depends on the data value + 2 bytes (in most cases)

ROW compression:

- Reduces fixed-length columns storage overhead
- Extra 4-bit per column. Bad choice for fully-populated data types

PAGE compression:

- ROW compression + Prefix compression + Dictionary compression
- Done on data page scope

ROW and PAGE compression works only with IN-ROW data

Data Compression

Demo

Data Compression

My rule of thumb:

- Enable ROW compression in OLTP
- Enable PAGE compression for static data
  - Partition the data

PAGE compression may help even with the volatile data when disk is the bottleneck

LOB Compression (Pre SS2016)

```
[Microsoft.SqlServer.Server.SqlFunction
    (IsDeterministic = true, IsPrecise = true,
        DataAccess = DataAccessKind.None)]
public static SqlBytes BinaryCompress(SqlBytes input)
{
     if (input.IsNull)
         return SqlBytes.Null;

    using (MemoryStream result = new MemoryStream())
    {
        using (DeflateStream deflateStream = new DeflateStream(resul
            CompressionMode.Compress, true))
        {
            deflateStream.Write(input.Buffer, 0, input.Buffer.Length
            deflateStream.Flush();
            deflateStream.Close();
        }
        return new SqlBytes(result.ToArray());
    }
}
```

```
[Microsoft.SqlServer.Server.SqlFunction
    (IsDeterministic = true, IsPrecise = true,
        DataAccess = DataAccessKind.None)]
public static SqlBytes BinaryDecompress(SqlBytes input)
{
    if (input.IsNull)
        return SqlBytes.Null;

    int batchSize = 32768;
    byte[] buf = new byte[batchSize];

    using (MemoryStream result = new MemoryStream())
    {
        using (DeflateStream deflateStream =
                new DeflateStream(input.Stream,
                    CompressionMode.Decompress, true))
        {
            int bytesRead;
            while ((bytesRead = deflateStream.Read(buf, 0, batchSize)) > 0)
                result.Write(buf, 0, bytesRead);
        }
        return new SqlBytes(result.ToArray());
    }
}
```

LOB Compression (SS 2016+)

Use COMPRESS/DECOMPRESS functions

Consider to store LOB data outside of DB

LOB Compression

Demo

Use Appropriate Data Types

Obvious Mistakes:

- Boolean -> tinyint, smallint, int
- (n)char(N)

What kind of precision do you need?

- DateTime -> SmallDateTime or DateTime2
- Float -> Decimal

Do not use LOB data types unless you need them

Use Appropriate Data Types

1,000 rows - 15K
1,000,000 rows - 15M
365,000,000 rows - 5.4Gb

```
create table Positions
(
    ATime datetime not null, -- 8 bytes
    Latitude float not null, -- 8 bytes
    Longitude float not null, -- 8 bytes
    IsValid int not null, -- 4 bytes
    IsAssistanceUsed int not null, -- 4 bytes
    -- total: 32 bytes
)
```

```
create table Positions2
(
    ATime datetime2(0) not null, -- 6 bytes
    Latitude decimal(9,6) not null, -- 5 bytes
    Longitude decimal(9,6) not null, -- 5 bytes
    IsValid bit not null, -- 1 byte
    IsAssistanceUsed bit not null, -- 0 bytes
    -- total: 17 bytes
)
```

Think about future and do not be cheap

Rebuild indexes after table alteration

ALTER TABLE & Row Size

Demo

sys.dm_db_index_usage_stats

How often index appears in execution plans

- Seeks: Index Seek operation
- Scans: Index Scan operation
- Lookup: Key Lookup or RID Lookup operations
- Reads: Seeks + Scans + Lookups
- Updates: INSERT + UPDATE + DELETE

	Table	Index	Seeks	Scans	Lookups	Reads	Updates	Last Seek	Last Scan
1	[redacted]		74567916	0	755160	75323076	1510669	2016-11-18 07:32:15.437	NULL
2			57940278	0	0	57940278	1510669	2016-11-18 07:32:15.537	NULL
3			16724	0	0	16724	1510669	2016-11-18 07:00:20.827	NULL
4			1003195	1090508	0	2093703	1136428	2016-11-18 07:32:08.700	2016-11-1
5			544501	0	0	544501	1510669	2016-11-18 07:32:10.540	NULL
6			1	0	0	1	680021	2016-11-02 14:17:28.843	NULL
7			5210970	0	0	5210970	1510669	2016-11-18 07:32:14.423	NULL
8			0	0	0	0	1510669	NULL	NULL
9			7049584	0	0	7049584	2403273	2016-11-18 07:32:14.423	NULL
10			377572	0	0	377572	2403273	2016-11-18 07:32:08.750	NULL

sys.dm_db_index_operational_stats

Access methods, I/O, locking, latching activity

- Insert, Update, Delete counts (# of rows)
- singleton_lookup_count: Single-row Index Seek operations
- range_scan: Index Seeks on the range of rows + Index Scans
- LOB and ROW_OVERFLOW statistics
- Lock counts and waits on row- and page-levels
- Page latch count and waits
- Page IO latch count and waits
- And more..

	index_id	Table	Index	range_scan_count	singleton_lookup_count	row_lock_wait_in_ms	page_latch_wait_in_ms	page_io_latch_wait_in_ms
1	1	[redacted]	[redacted]	1411162	3638897399	0	71286	13634302
2	2	[redacted]	[redacted]	774	0	0	338	283589
3	3	[redacted]	[redacted]	760095	0	0	121	329284
4	4	[redacted]	[redacted]	32726	0	0	828	7878183
5	5	[redacted]	[redacted]	358	0	0	66	3138358
6	6	[redacted]	[redacted]	21	0	0	124	138602
7	8	[redacted]	[redacted]	0	0	0	519	68238
8	33	[redacted]	[redacted]	1	0	0	60	574234
9	34	[redacted]	[redacted]	11012	0	0	490	626016
10	35	[redacted]	[redacted]	0	0	0	126	23540

Usage and Operational Stats, and TableInfo

Demo

Index Tuning: Detecting Redundant Indexes

IDX1(A, B) & IDX2(A) -> IDX2 is redundant

IDX3(A) INCLUDE (B) & IDX4(A) INCLUDE (C) -> IDX5(A) INCLUDE(B,C)

IDX6(A,B) & IDX7(A,C) ->

- IDX8(A,B) INCLUDE (C)
- IDX9(A,C) INCLUDE (B)
- Or keep IDX6 and IDX7

Redundant Indexes

Demo

Releasing Empty Space

DBCC SHRINKFILE

- Introduces Fragmentation (consider to REORG indexes afterwards)
- Challenging in case of multiple files in the filegroup
- Extremely slow especially with LOB data

INSERT INTO NewTable SELECT FROM OldTable

- Offline Operation

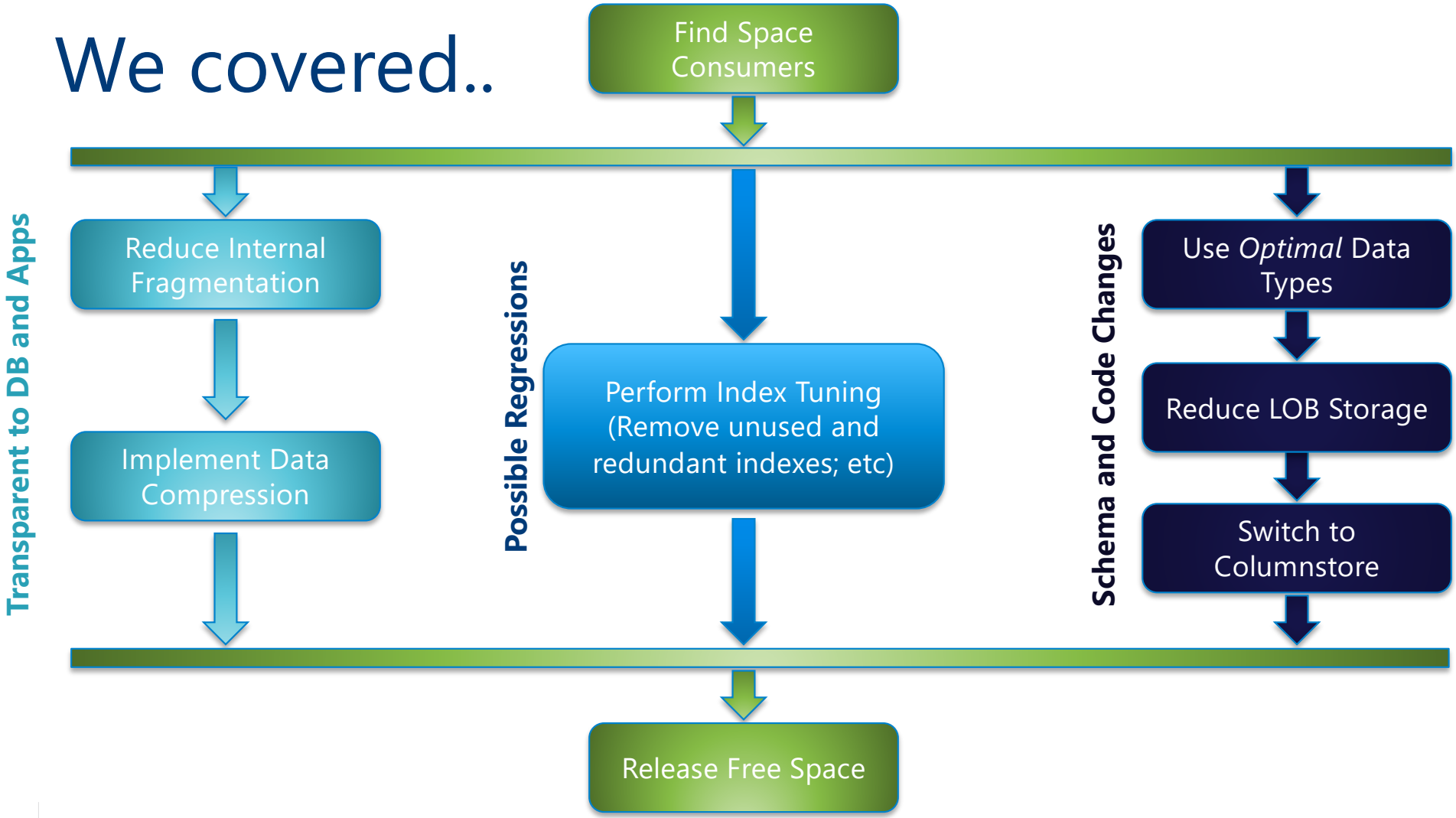
CREATE INDEX WITH (DROP_EXISTING=ON) ON [NewFileGroup]

- Issues with LOB Data

Moving Data

Demo

We covered..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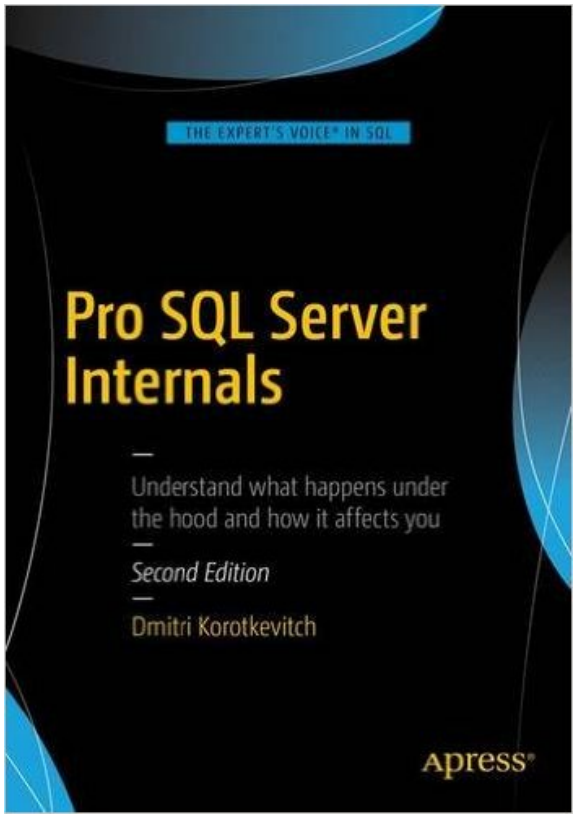
Additional Resources



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- Scripts are available for download: http://aboutsqlserver.com/presentations
- Recent post: "Size Does Matter..": http://goo.gl/J644Zz

Thank You