DB2 Storage Optimization

Current IT Storage Spending

IDC Analyze the Future

"Reducing storage-related costs is again a top priority in 2011, as many organizations continue to struggle with taming data growth"

Gartner

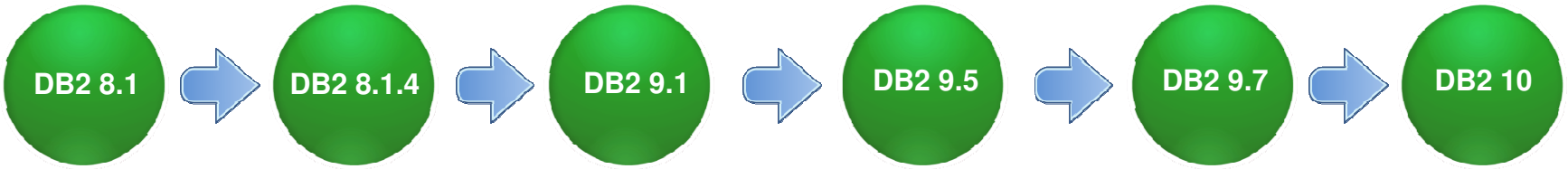
"Data growth is the biggest data center hardware infrastructure challenge for large enterprises"

"…power consumption by data centers doubled from 2000 to 2005 …in 2012, [the census] did predict growth in the Eastern United States of some 22 percent"

The New York Times

Storage Optimization in DB2

- **Provides storage compression services to optimize the performance and footprint of your data**
- **Basic compression features included in several editions**
- **Advanced compression features bundled as DB2 Storage Optimization Feature, included in Advanced Enterprise Server edition**
  - Available for DB2 Enterprise Server edition with a PVU license



- Value Compression
- Backup Compression
- Row Compression*
- Automatic Dictionary Creation (ADC)*
- XML compression*
- Temporary table compression*
- Index compression*
- LOB inlining
- Adaptive compression*

** Included in DB2 Storage Optimization Feature*

Row Compression

- **Also known as deep compression**
- **Uses a dictionary-based compression algorithm to replace recurring strings with shorter symbols within rows**
- **Continuous enhancement since it was introduced in DB2 9.1**

- Row Compression*

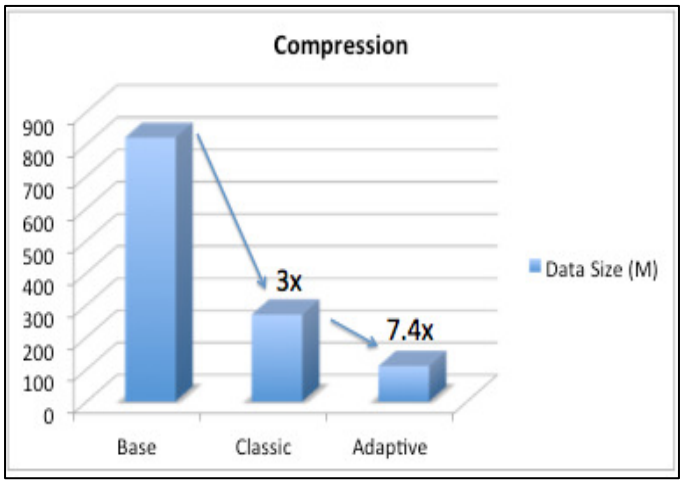
- Automatic Dictionary Creation (ADC)*

- XML compression*
- Temporary table compression*
- Index compression*
- LOB inlining

- Adaptive compression*

- **Two types available:**
  - **Classic** (static) row compression
  - **Adaptive** row compression
    - An enhancement to classic row compression to provide extra storage savings

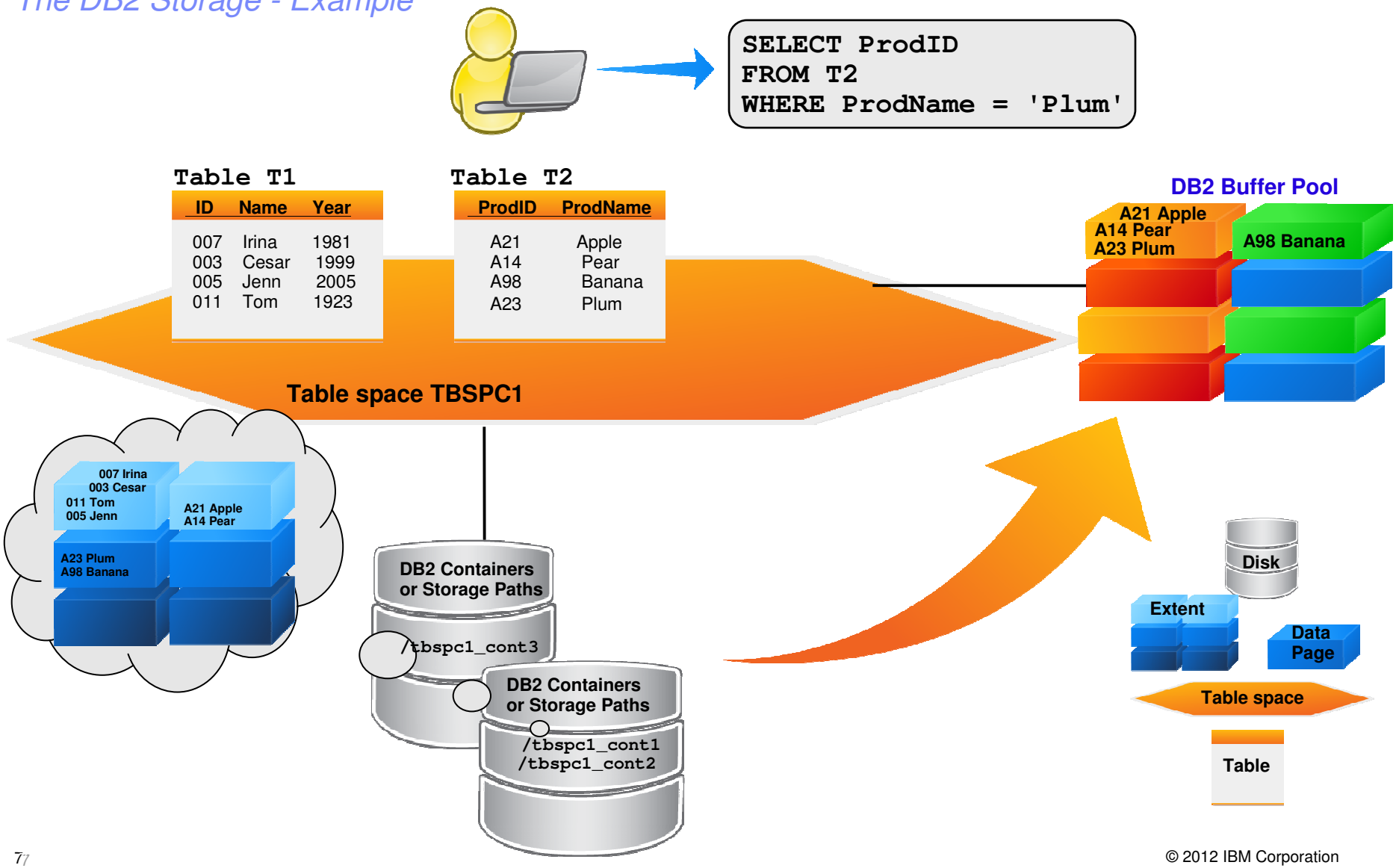
New in DB2 10



- **Included in DB2 Storage Optimization Feature**

Understanding the Basics

The DB2 Storage - Example

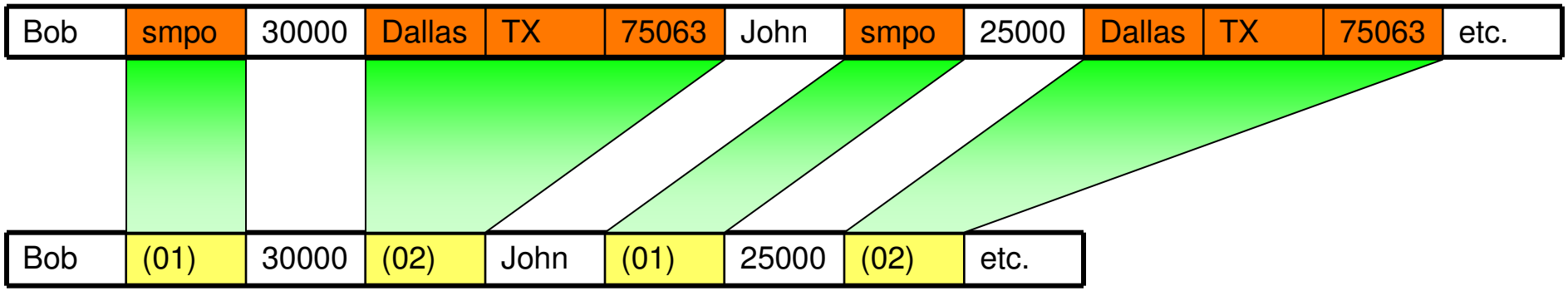


Row Compression – Classic

- **Also referred to as static row compression**
- **Uses a table-level compression dictionary (1 dictionary per table) to compress data by row, across multiple columns**
- **Dictionary is used to map repeated byte patterns to smaller symbols. These smaller symbols replace long patterns in table rows.**
- **After dictionary is created, data is compressed as it is inserted/updated in the table.**
  - DB2 automatically creates the dictionary when enough the table has enough data for sampling

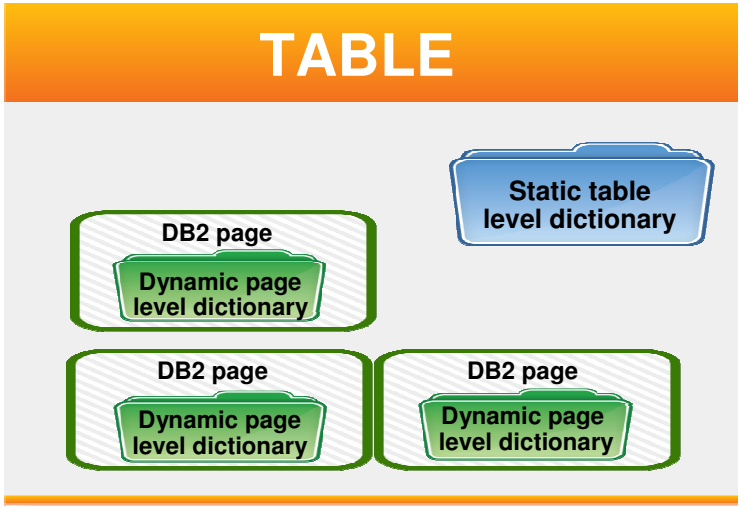
Name	Dept	Salary	City	ST	ZIP
Bob	smpo	30000	Dallas	TX	75063
John	smpo	25000	Dallas	TX	75063

Dictionary	
(01)	smpo
(02)	Dallar, TX, 75063



Row Compression – Adaptive

- Adaptive Compression is an enhancement to the Classic Row Compression
  - Compress rows by using a combination of two types of dictionaries
    - Global static table level dictionary
    - Local page level dictionaries



- Benefits
  - Page level dictionaries adapt to data skew over a period of time
  - No REORGs required to maintain high compression ratio
  - Less disk space for data and logs
  - Reduced I/O. Fewer pages to process

- **Better compression ratios than Classic Row Compression**
- **Over time reduces need of a REORG as page-level dictionaries adapt to data skew over time (i.e. maintain compression rates)**
- **Default row compression method in DB2 10**

How Does Adaptive Compression Work?

- **Step 1: Compression with static table level dictionary**

Christine	Haas	(408) 463-1234	555 Bailey Avenue	San Jose	California 95141
John	Thompson	(408) 463-5678	555 Bailey Avenue	San Jose	California 95141
Jose	Fernandez	(408) 463-1357	555 Bailey Avenue	San Jose	California 95141
Margaret	Miller	(408) 463-2468	555 Bailey Avenue	San Jose	California 95141
Bruce	Kwan	(408) 956-9876	4400 North 1st Street	San Jose	California 95134
James	Geyer	(408) 956-5432	4400 North 1st Street	San Jose	California 95134
Linda	Hernandez	(408) 956-9753	4400 North 1st Street	San Jose	California 95134
Theodore	Mills	(408) 927-8642	650 Harry Road	San Jose	California 95134
Susan	Stern	(408) 927-9630	650 Harry Road	San Jose	California 95134
James	Polaski	(415) 545-1423	425 Market Street	San Francisco	California 94105
John	Miller	(415) 545-5867	425 Market Street	San Francisco	California 94105
James	Walker	(415) 545-4132	425 Market Street	San Francisco	California 94105
Elizabeth	Brown	(415) 545-8576	425 Market Street	San Francisco	California 94105
Sarah	Johnson	(415) 545-1928	425 Market Street	San Francisco	California 94105

[1]	California 9
[2]	San
[3]	Jose
[4]	Francisco
[5]	Avenue
[6]	Street
[7]	Road

Compression with global table static dictionary

Christine	Haas	(408) 463-1234	555 Bailey [5]	[2][3]	[1]	95141
John	Thompson	(408) 463-5678	555 Bailey [5]	[2][3]	[1]	95141
[3]	Fernandez	(408) 463-1357	555 Bailey [5]	[2][3]	[1]	95141
Margaret	Schneider	(408) 463-2468	555 Bailey [5]	[2][3]	[1]	95141
Bruce	Kwan	(408) 956-9876	4400 North 1st [6]	[2][3]	[1]	95134
James	Geyer	(408) 956-5432	4400 North 1st [6]	[2][3]	[1]	95134
Linda	Hernandez	(408) 956-9753	4400 North 1st [6]	[2][3]	[1]	95134
Theodore	Mills	(408) 927-8642	650 Harry [7]	[2][3]	[1]	95134
Susan	Stern	(408) 927-9630	650 Harry [7]	[2][3]	[1]	95134
James	Polaski	(415) 545-1423	425 Market [6]	[2][4]	[1]	94105
John	Miller	(415) 545-5867	425 Market [6]	[2][4]	[1]	94105
James	Walker	(415) 545-4132	425 Market [6]	[2][4]	[1]	94105
Elizabeth	Miller	(415) 545-8576	425 Market [6]	[2][4]	[1]	94105
Sarah	Johnson	(415) 545-1928	425 Market [6]	[2][4]	[1]	94105

- Table level compression symbol dictionary containing globally recurring patterns
- Table-level dictionary can only be rebuilt during Classic Table REORG
  - Involves re-compressing all data

How Does Adaptive Compression Work?

- **Step 2: Compression w/ Page-Level Dictionaries**

Data page

Christine	Haas	(408) 463-1234	555 Bailey [5]	[2][3]	[1]	5141
John	Thompson	(408) 463-5678	555 Bailey [5]	[2][3]	[1]	5141
Ellen	Fernandez	(408) 463-1357	555 Bailey [5]	[2][3]	[1]	5141
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Linda	Hernandez	(408) 956-9753	4400 North 1st [6]	[2][3]	[1]	5134

Data page

Theodore	Mills	(408) 927-8642	650 Harry [7]	[2][3]	[1]	5134
Susan	Stern	(408) 927-9630	650 Harry [7]	[2][3]	[1]	5134
James	Polaski	(415) 545-1423	425 Market [6]	[2][4]	[1]	4105
John	Miller	(415) 545-5867	425 Market [6]	[2][4]	[1]	4105
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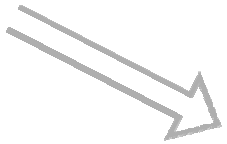
Sarah	Johnson	(415) 545-1928	425 Market [6]	[2][4]	[1]	4105

Christine	Haas	(2)1234	(4)
John	Thompson	(2)5678	(4)
Ellen	F(1)	(2)1357	(4)
Margaret	Schneider	(2)2468	(4)
Bruce	Kwan	(3)9876	(5)
James	Geyer	(3)5432	(5)
Linda	H(1)	(3)9753	(5)

(1)	ernandez
(2)	(408) 463-
(3)	(408) 956-
(4)	555 Bailey [5] [2][3] [1] 5141
(5)	4400 North 1st [6] [2][3] [1] 5134

Page level dictionary



Theodore	(3)s	(4)8642	(6)
Susan	Stern	(4)9630	(6)
(1)	Polaski	(5)1423	(7)
(2)	(3)er	(5)5867	(7)
(1)	Walker	(5)4132	(7)
Elizabeth	(3)er	(5)8576	(7)
Sarah	(2)son	(5)1928	(7)

(1)	James
(2)	John
(3)	Mill
(4)	(408) 927-
(5)	(415) 545-
(6)	650 Harry [7] [2][3] [1] 5134
(7)	425 Market [6] [2][4] [1] 4105

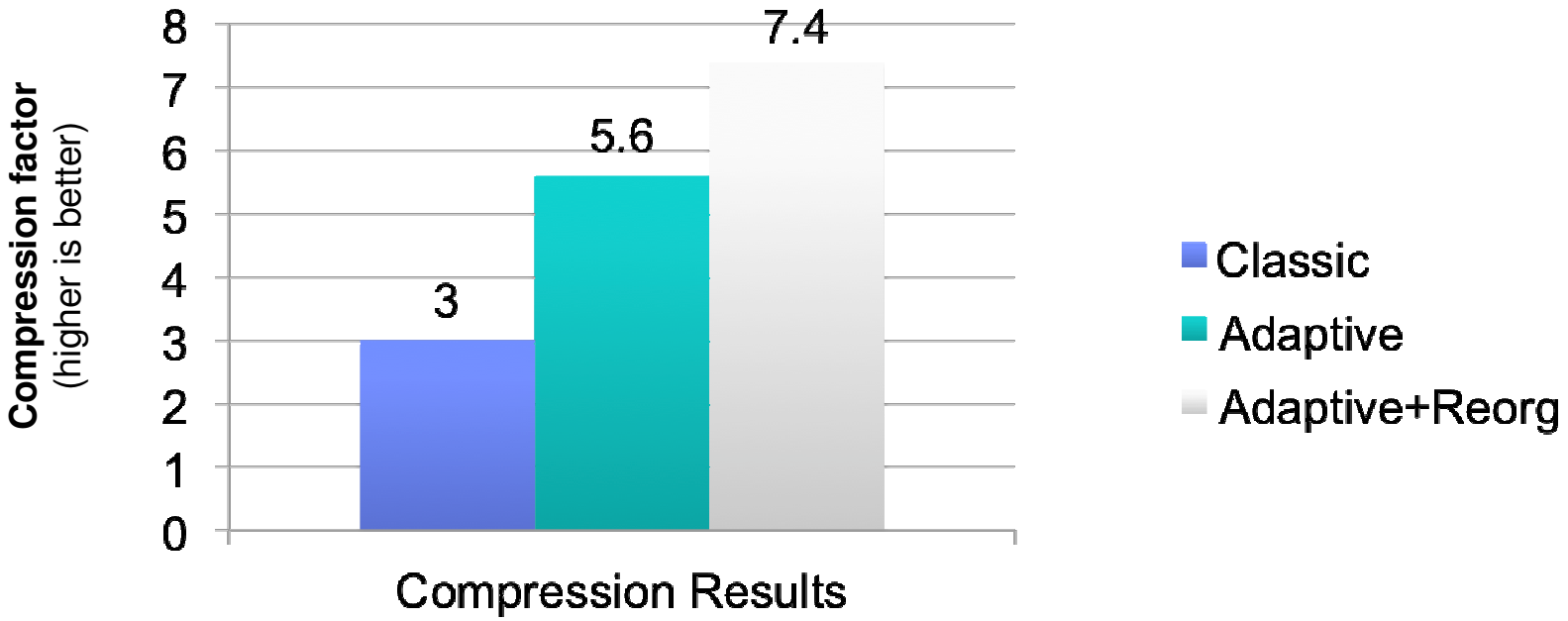
Page level dictionary

- Page-level compression dictionaries contain locally frequent patterns
- Page-level compression dictionary building & rebuilding is fully automatic
- Algorithm optimized for compressing data already compressed by table-level dictionary
- Page-level compression dictionaries are stored as special records in each page

Data Warehouse Compression Results

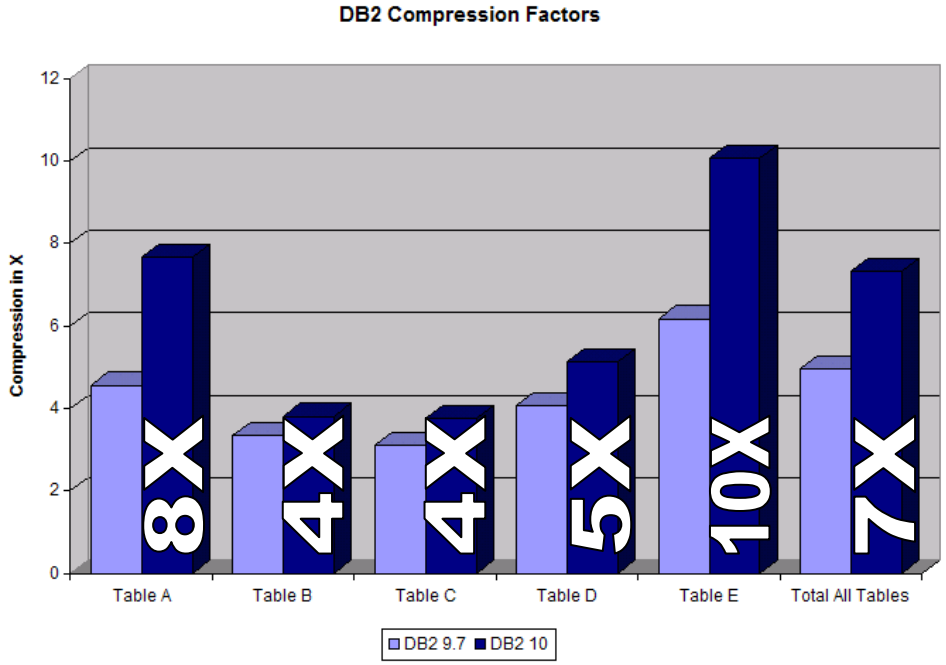
230GB raw size - Most of the data in a single table

- **Graph – Storage Savings**
- **Increase in savings by Adaptive Compression**
  - 3x Compression with Static Compression using reorg
  - 5.6x Compression with Automatic dictionary creation and Adaptive Compression
  - 7.4x Compression with Adaptive Compression and full reorg



Real Customer Results with Adaptive Compression

- **Customer top 5 tables**
  - DB2 9.7 – compression rates between 3X and 6X
  - DB2 10 – compression rates between 4X and 10X
- **Sum of all tables DB2 9.7 delivered 5X compression**
- **Sum of all tables DB2 10 delivered 7X compression**



Row Compression – Enablement & Tools

- **How to enable row compression?**
  - Must have DB2 Storage Optimization Feature
  - To enable classic row compression

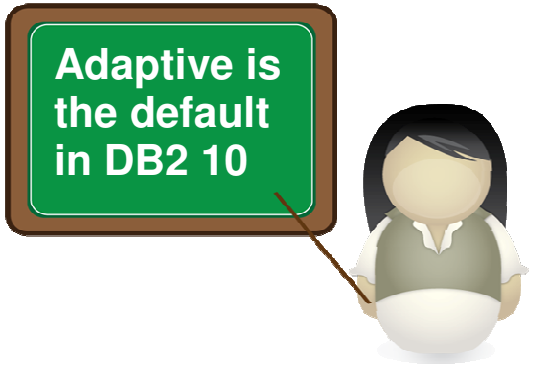
```
CREATE TABLE / ALTER TABLE … COMPRESS YES STATIC
```

  - To enable adaptive row compression

```
CREATE TABLE / ALTER TABLE … COMPRESS YES
```

  - To disable compression

```
CREATE TABLE / ALTER TABLE … COMPRESS NO
```



- **Data is compressed after the table dictionary is created.**
  - **INSERT/UPDATE/LOAD/IMPORT** can trigger the automatic dictionary creation
  - Classic **REORG** with **RESETDICTIONARY** option will always generate a new dictionary and compress all table data

Row Compression - Example Scenarios

1) Compressing data for new table

```
CREATE TABLE Sales (<columns definition>) COMPRESS YES
```

Load data… Automatic Dictionary Creation (ADC) will kick off and create compression dictionary. Once dictionary is built, new data put into the table is compressed:

```
LOAD FROM file OF DEL REPLACE INTO NewSale
```

2) Compressing data in existing tables

```
ALTER TABLE Sales COMPRESS YES
```

Data is still un-compressed. Explicitly compress data via REORG:

```
REORG TABLE Sales
```

3) Recreating the dictionary to optimize compression

(Classic Row Compression) Data has changed a lot so current dictionary is not so effective anymore. Use REORG to recreate dictionary and re-compress data:

```
REORG TABLE Sales RESETDICTIONARY
```

Adaptive Compression greatly reduces the need for REORGs to maintain the compression ratio.

4) Uncompressing your data

Disable compression:

```
ALTER TABLE Sales COMPRESS NO
```

Uncompress data:

```
REORG TABLE Sales
```

Row Compression – Enablement & Tools

- **Estimating storage savings**
  - ADMIN_GET_TAB_COMPRESS_INFO_V97 ← **Deprecated in DB2 10!**
  - Instead use: ADMIN_GET_TAB_COMPRESS_INFO and ADMIN_GET_TAB_DICTIONARY_INFO

```
SELECT SUBSTR(TABNAME,1 ,10) tabname, OBJECT_TYPE, ROWCOMPMODE,
PCTPAGESSAVED_CURRENT current, PCTPAGESSAVED_STATIC with_static,
PCTPAGESSAVED_ADAPTIVE with_adaptive
FROM TABLE(SYSPROC.ADMIN_GET_TAB_COMPRESS_INFO 'DB2INST1','CUSTOMERS')) AS T;
```

```
TABNAME    OBJECT_TYPE  ROWCOMPMODE  CURRENT WITH_STATIC WITH_ADAPTIVE
---------- ------------ ------------ ------- ----------- -------------
CUSTOMERS  DATA                    S       60          68            81
CUSTOMERS  XML                     S       58          62            62
```

Temporary Table Compression

- **Enabled automatically with the DB2 Storage Optimization Feature**
- **Only classic row compression is used for temporary tables**
- **System temporary tables**
  - DB2 Optimizer analyzes storage savings and performance impact, if it is worthwhile to compress, classic row compression is used automatically
- **User temporary tables**
  - Created global temporary tables (CGTTs) and declared global temporary tables (DGTTs) are always compressed
- **Use `db2pd` to see whether the optimizer used compression for system temporary tables**

```
db2pd -db <database> -temptable
```

Index Compression

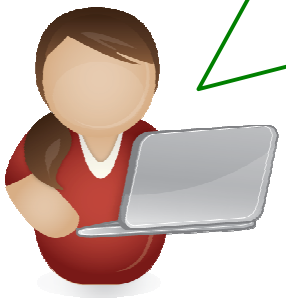
- **Especially useful for large OLTP and data warehouse environments**
- **Index is compressed by default for compressed tables**
- **Can specify `COMPRESS YES` option in `CREATE INDEX`**
- **Different algorithms implemented by the DB2 engine for:**
  - RID list compression
  - Prefix compression
  - Variable slot directory
  - Key compression

```
CREATE INDEX <index_name> COMPRESS YES

ALTER INDEX <index_name> COMPRESS YES
REORG INDEXES ALL FOR TABLE <table_name>
```

Index Compression – Monitoring

- **How much space *could I* save by compressing the indexes on table T1 ?**

```
SELECT index_name, pages_saved_percent, compress_attr, index_compressed
FROM TABLE(SYSPROC.ADMIN_GET_INDEX_COMPRESS_INFO ('T', 'myschema', 'T1', NULL, NULL)) AS T
```



```
INDEX_NAME          PERCENT_PAGES_SAVED   COMPRESS_ATTR   IN
----------------    --------------------  --------------  ----------
INDEX1               57                    N                N
```

Index Compression – Monitoring

- **How much space *did I* save by compressing the indexes on table T1 ?**

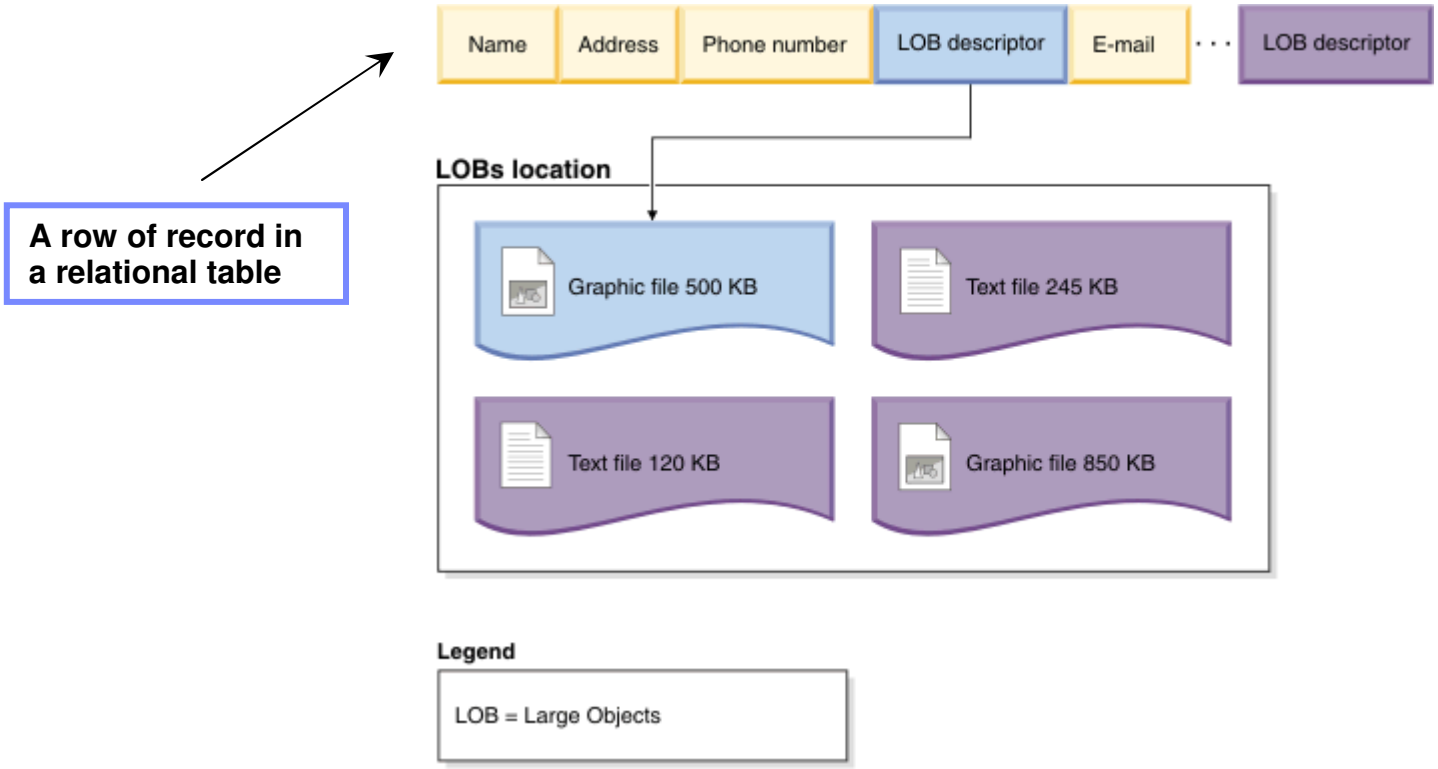
```
ALTER INDEX index1 COMPRESS YES
REORG INDEXES ON TABLE t1
RUNSTATS ON TABLE t1

SELECT index_name, pages_saved_percent, compress_attr, index_compressed
  FROM TABLE (SYSPROC.ADMIN_GET_INDEX_COMPRESS_INFO 'T', 'myschema', 'T1', NULL, NULL)) AS T
```

```
INDEX_NAME          PERCENT_PAGES_SAVED    COMPRESS_ATTR          INDEX_COMPRESSED
--------------- -------------------- ---------------------  --------------------------
INDEX1                          58                      Y                             Y
```

actual savings

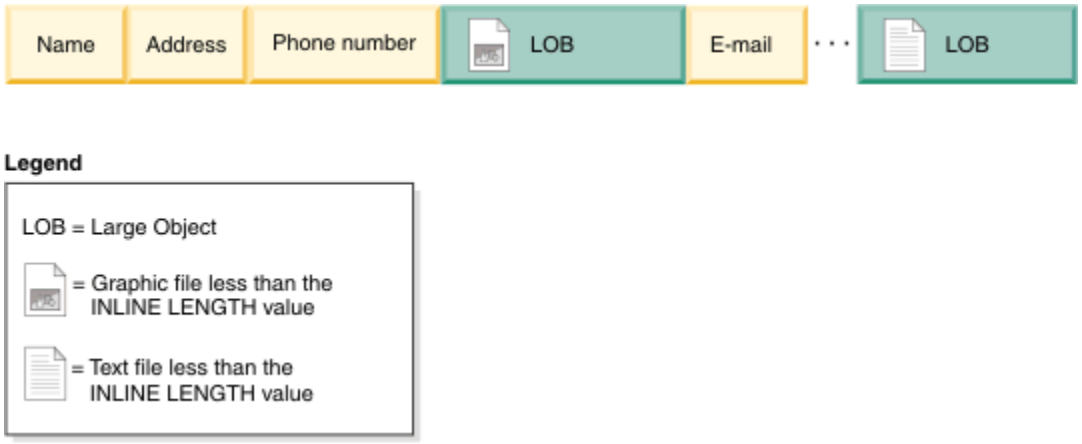
XML and LOB Inlining

- **Default storage behavior**
  - All XML documents stored in XML storage object, also referred to as XDA (XML Data Area)
  - All LOB (Large Objects) stored in LOB storage object
  - Descriptors in rows identify location of each object



XML and LOB Inlining

- **Inlining**
  - Allows small (<32KB) XML documents and LOBs to be stored in the base table row
  - Better performance and reduced storage needs




```
CREATE TABLE PROJECTS (PID INTEGER, PLAN XML INLINE LENGTH 300, STARTDATE DATE, …)

ALTER TABLE PROJECTS ALTER COLUMN PLAN SET INLINE LENGTH 1004
```

XML and LOB Compression

- **XML (XDA) Compression**
  - Available since DB2 9.7
  - Same dictionary approach used for Table Compression
  - Enablement is via the table `COMPRESS YES` option
  - Classic/'Offline' REORG table based
    - Use LONGLOBDATA option to compress XML data

```
CREATE TABLE mytab1 COMPRESS YES
ALTER TABLE mytab1 COMPRESS YES
```

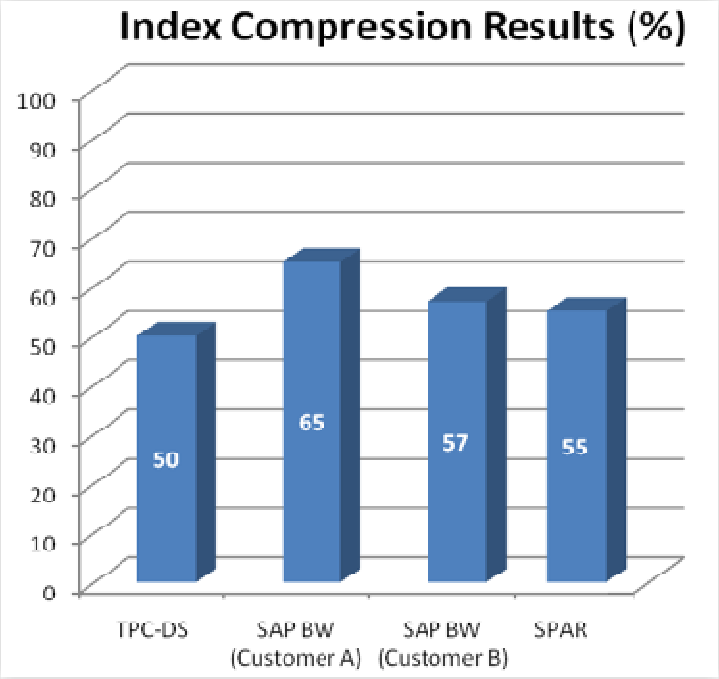
- **Inlining**
  - Inlined XML or LOB data can be compressed with both adaptive and classic row compression

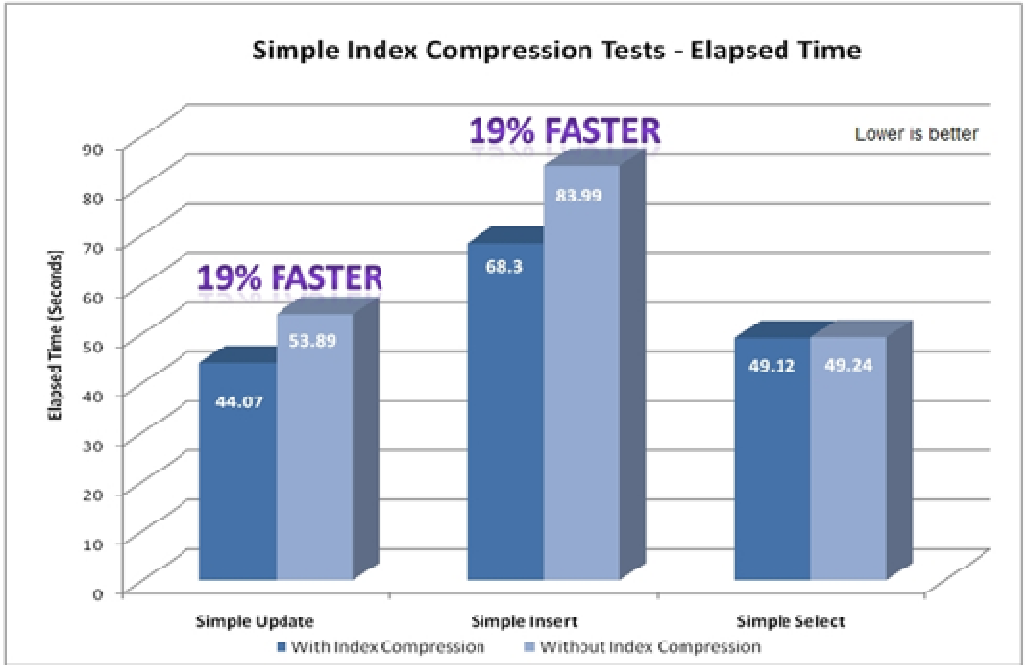
New in DB2 10

Compression Benefits

Index Compression

- Fewer index levels
  - Fewer logical and physical I/Os for key search (insert, delete, select)
  - Better buffer pool hit ratio
- Fewer index leaf pages
  - Fewer logical and physical I/Os for index scans
  - Fewer splits
  - Better buffer pool hit ratio

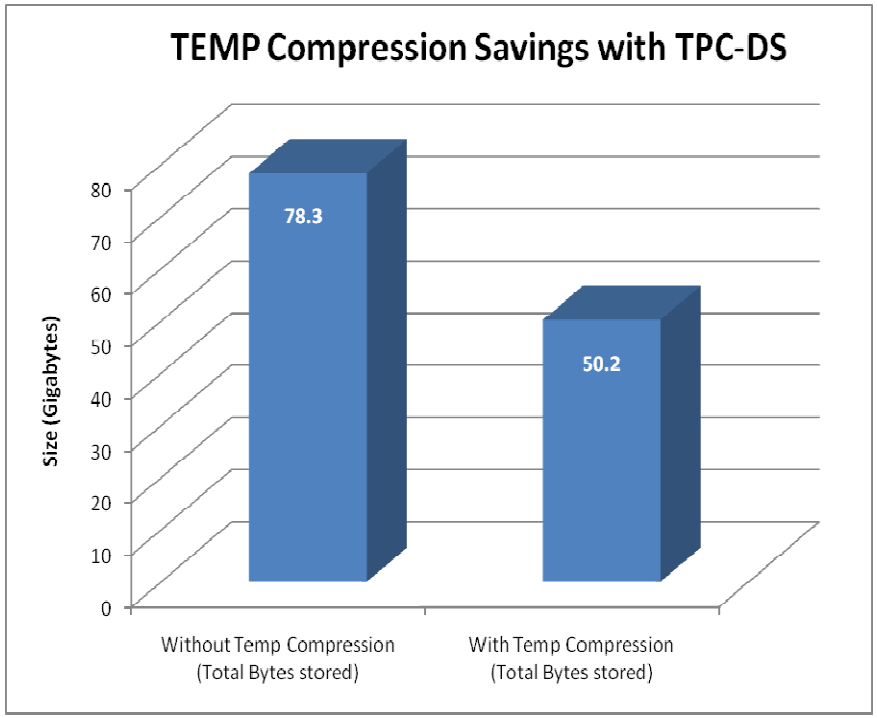


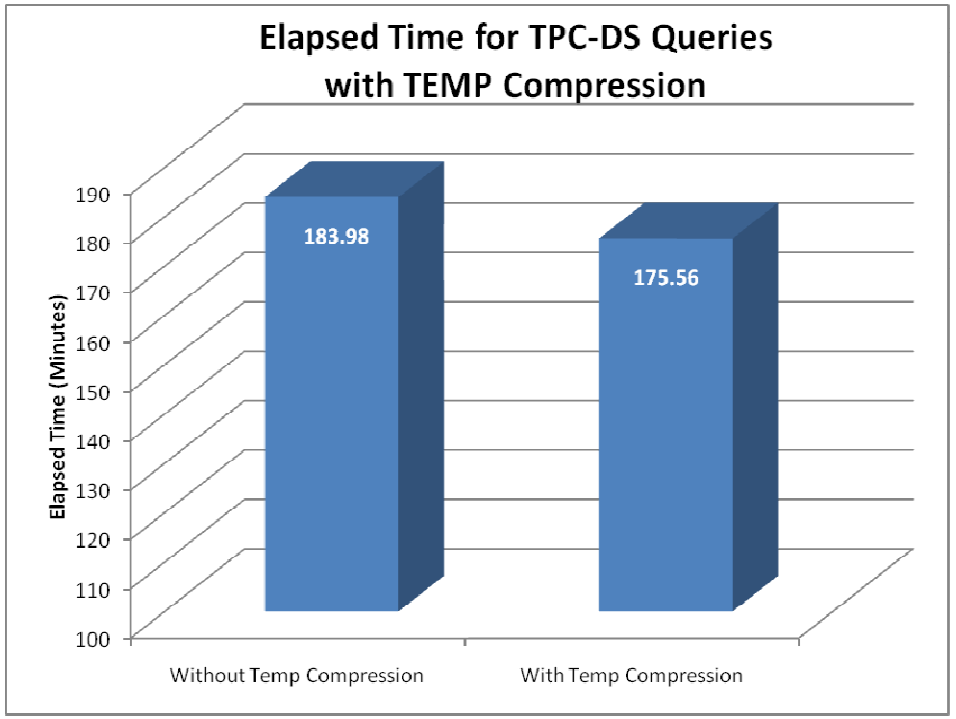


Compression Benefits

Temp Table Compression

- Only vendor in industry to compress temp tables
  - Internal (DB2 utilities, SORT) and external (DGTTs) compressed
- Savings and performance benefits require no DBA intervention





Archive Log Compression

- **New in DB2 10 – archive log compression reduces log archive storage**
- **Simply turn it on and DB2 does the compression for you**
  - `logarchcompr1` database configuration parameter set to ON
- **Large SAP customer generates 60GB of log per day and they keep 8 weeks of archives**
  - Storing 3.3TB of archived log files
  - Compression of 4x results in storage of only 825GB for 8 weeks

Client Success

What Customers are Saying ...

- **Customer experiences are consistent**
  - Tables will compress in the range of 60% - 80%
  - Indexes compress around 50%
  - Temp space will compress around 35%
  - Overall database storage savings will be between 50% and 65%

Summary

- **Storage optimization through DB2 10 compression can save 55-70% of your database storage requirements**
- **You not only see your online database shrink but often more importantly, your backup storage and disaster recovery storage is cut in half as well**
- **In real customer examples storage savings are realized and performance benefits are apparent**
- **DB2 10 offers better compression ratios, improved ease of use and higher data availability**
  - Adaptive compression provides better compression than classic row compression
  - Adaptive compression adapts to date skews over time – i.e. no REORG needed to maintain compression ratio

Questions?

E-mail: techcamp@ca.ibm.com
Subject: “DB2 10 Bootcamp”

Backup Slides

Value Compression

- **Removes duplicate entries for a value, only storing one copy**
- **Can offer savings if your table:**
  - has many rows with columns that contain the same value, such as a city name
  - has columns that contain the default value for the data type of the column
- **Can be used in combination of either adaptive row compression or classic row compression**
- **Enabled with `VALUE COMPRESSION` option in `CREATE TABLE`**
- **Compress system default column values with clause `COMPRESS SYSTEM DEFAULT`**

```
CREATE TABLE EMPLOYEE_SALARY
         (DEPTNO CHAR(3) NOT NULL,
          EMPNO CHAR(6) NOT NULL,
          SALARY DECIMAL(9,2) NOT NULL WITH DEFAULT COMPRESS SYSTEM DEFAULT)
         VALUE COMPRESSION;
```

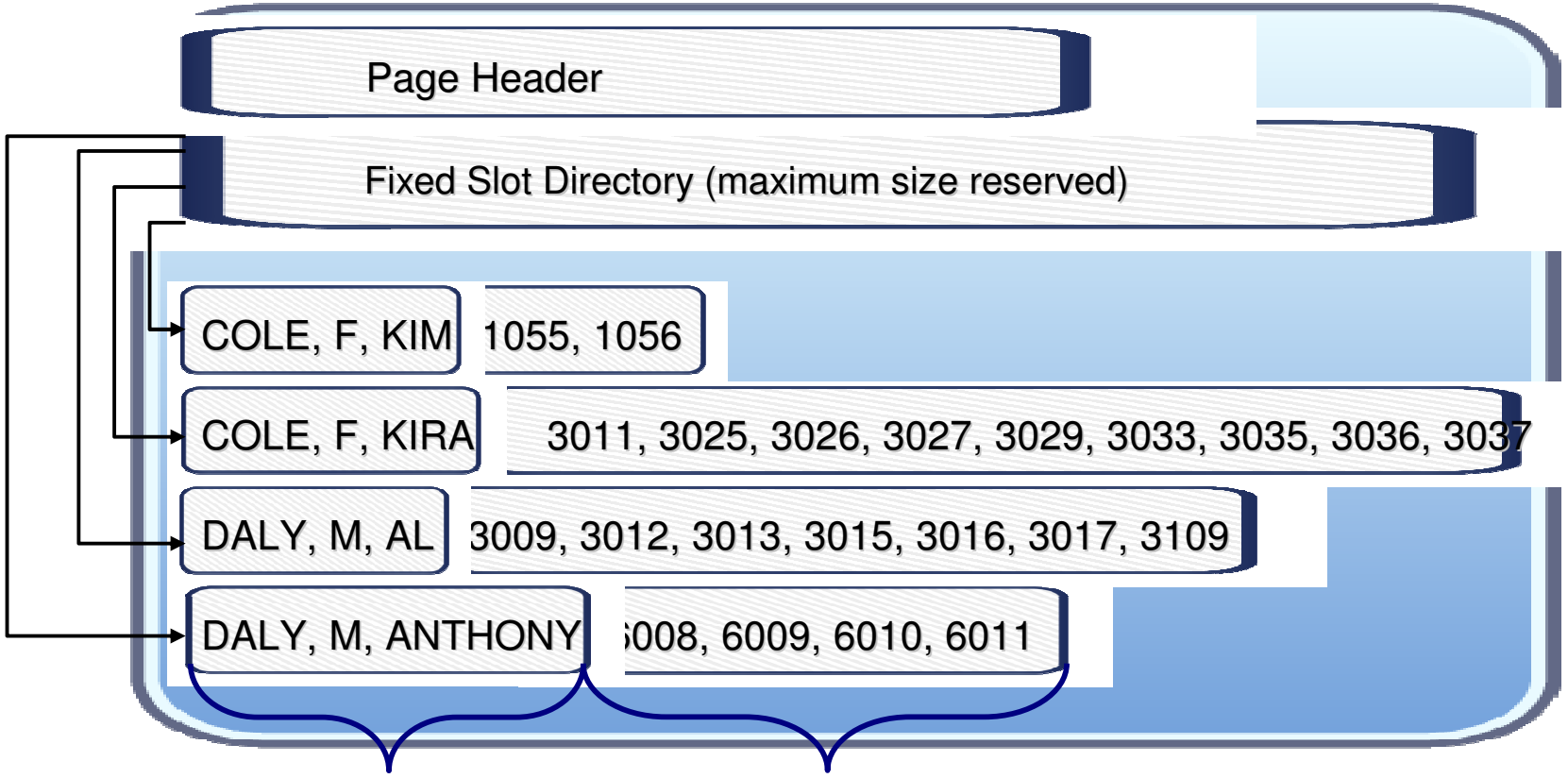
Backup Compression

- **Reduce size of database backups *in addition to* other table-level compressions**
- ***All* of data in backup image is compressed, including**
  - Catalog tables
  - Index objects
  - LOB objects
  - Auxiliary database files
  - Database meta-data
  - more
- **Enable with `COMPRESS` option in `BACKUP DATABASE`**

```
BACKUP DATABASE <database> … COMPRESS
```

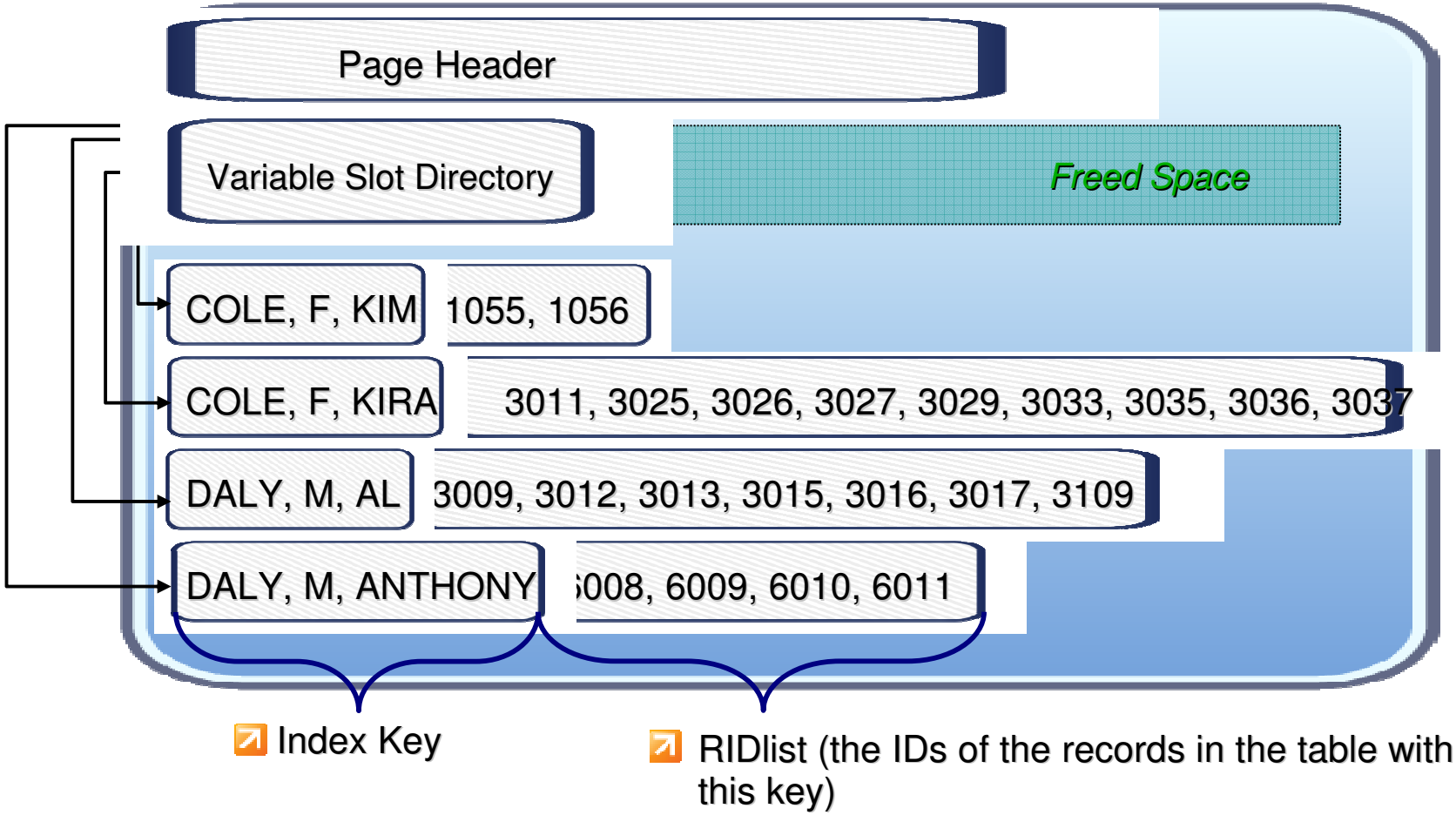
Index Compression

Page Format Overview



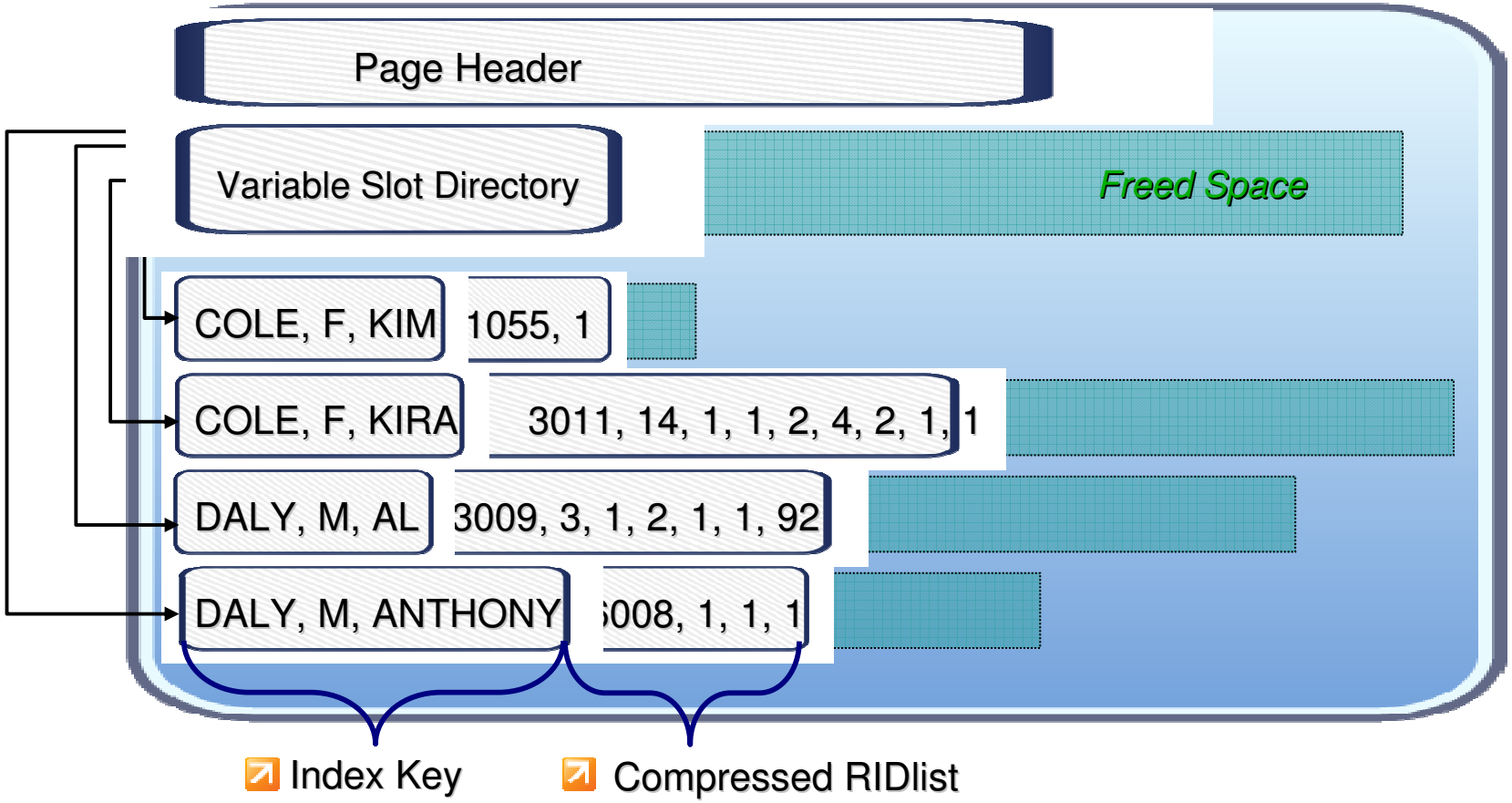
Index Compression

Variable Slot Directory



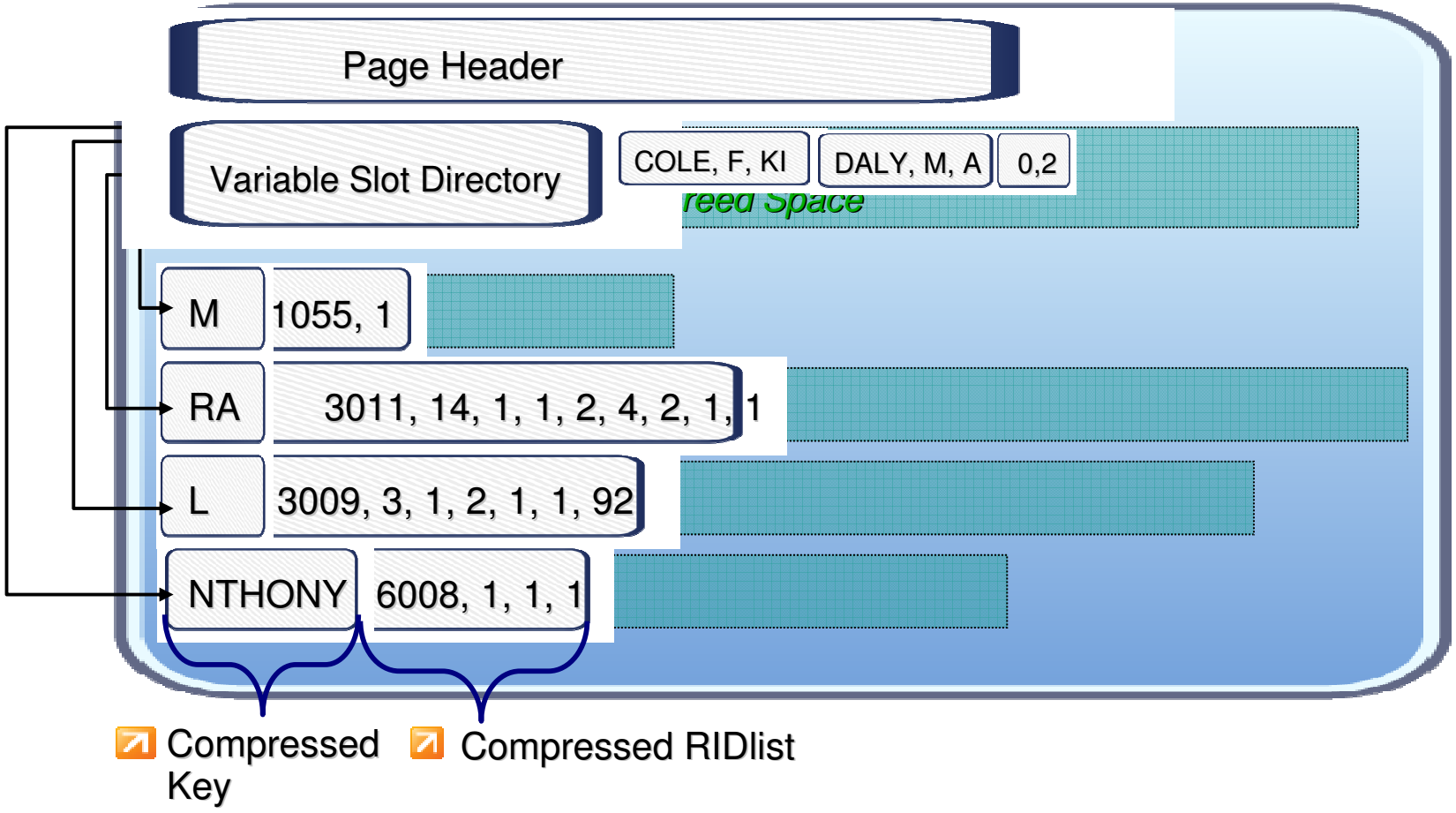
Index Compression

RIDlist Compression



Index Compression

Prefix Compression



Questions?

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