IBM

DB2 BLU inside out

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> “Super analytics made super easy.”

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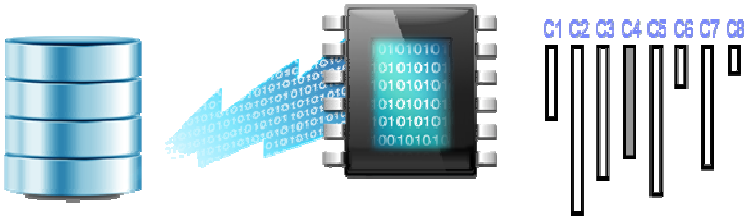
Overview

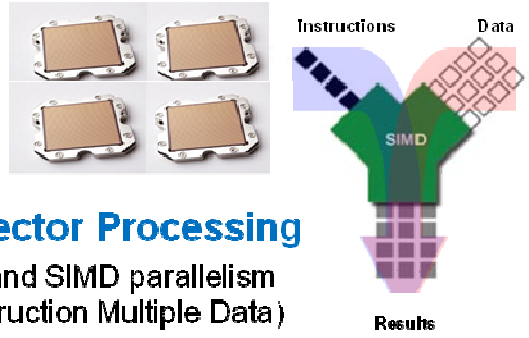
Key ideas

- **Dynamic In-Memory**
  In-memory columnar processing with dynamic movement of data from storage data

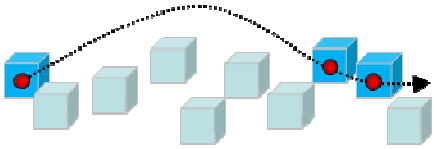


- **Actionable Compression**
  Patented compression technique that preserves order so that the data can be used without decompressing

Encoded



- **Parallel Vector Processing**
  Multi-core and SIMD parallelism (Single Instruction Multiple Data)



- **Data Skipping**
  Skips unnecessary processing of irrelevant data

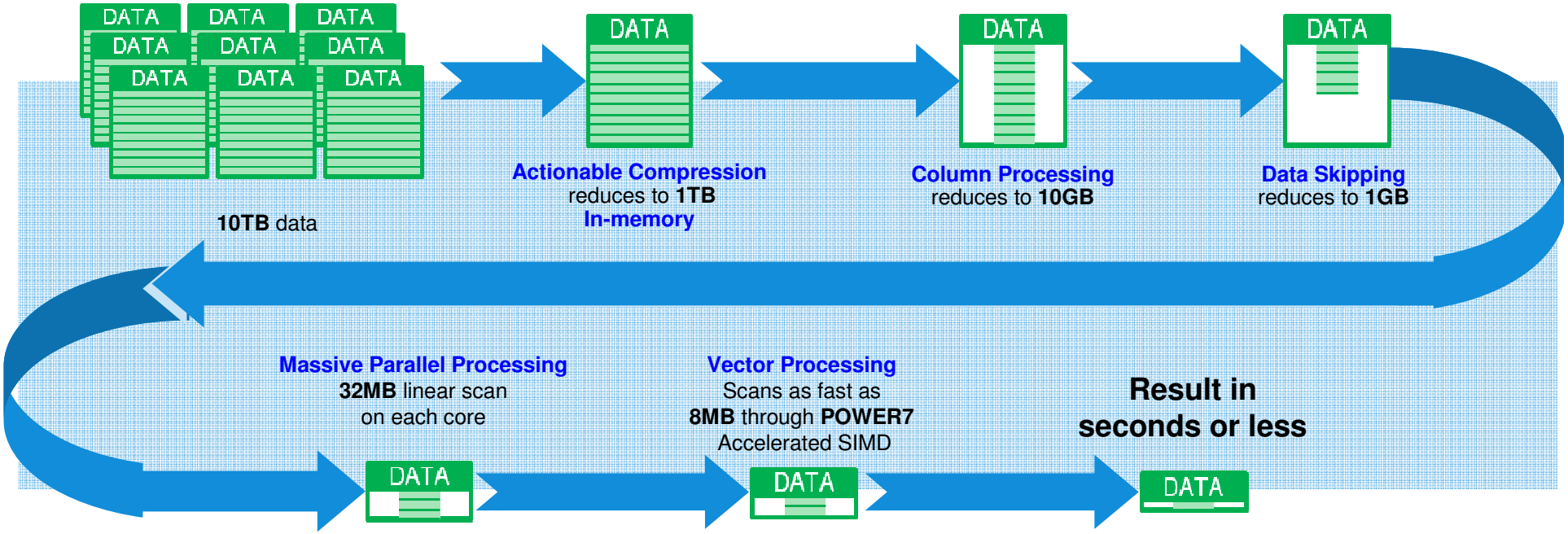
Super Fast, Super Easy — *Create, Load and Go!*

No Indexes, No Aggregates, No Tuning, No SQL changes, No schema changes

BLU Acceleration: 10TB Query, Seconds or Less

32 cores
1TB memory
10TB table
100 columns
10 years data

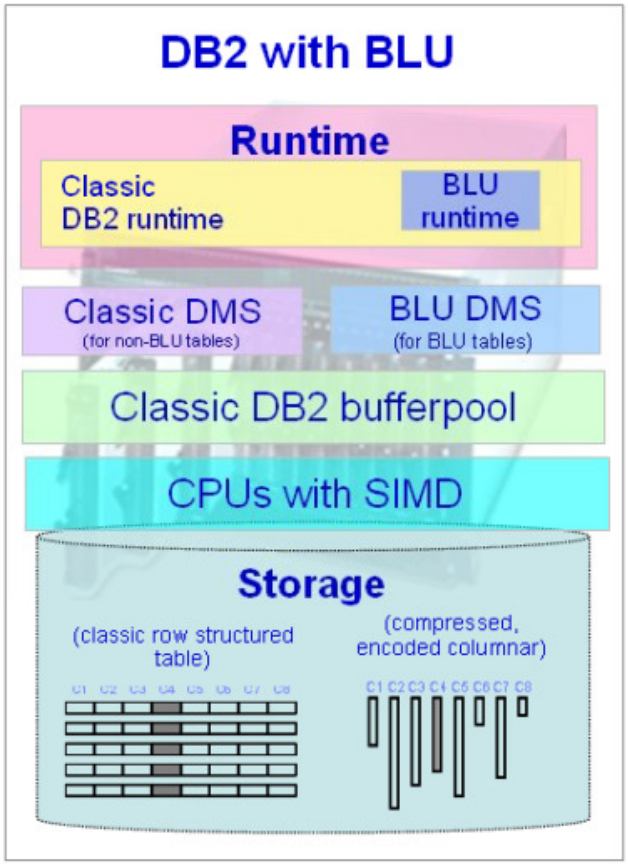
```
SELECT COUNT(*) from MYTABLE
where YEAR = '2010'
```



Seamless Integration into DB2

- **Built seamlessly into DB2 – integration and coexistence**
  - Column-organized tables can coexist with existing, traditional, tables
    - Same schema, same storage, same memory

- **Same SQL, language interfaces, administration**
  - Column-organized tables or combinations of column-organized and row-organized tables can be accessed within the same SQL statement



Creating a column-organized table

- Example:

```
CREATE TABLE sales_col (
  c1 INTEGER NOT NULL,
  c2 INTEGER,
   ...
  PRIMARY KEY (c1) ) ORGANIZE BY COLUMN;
```

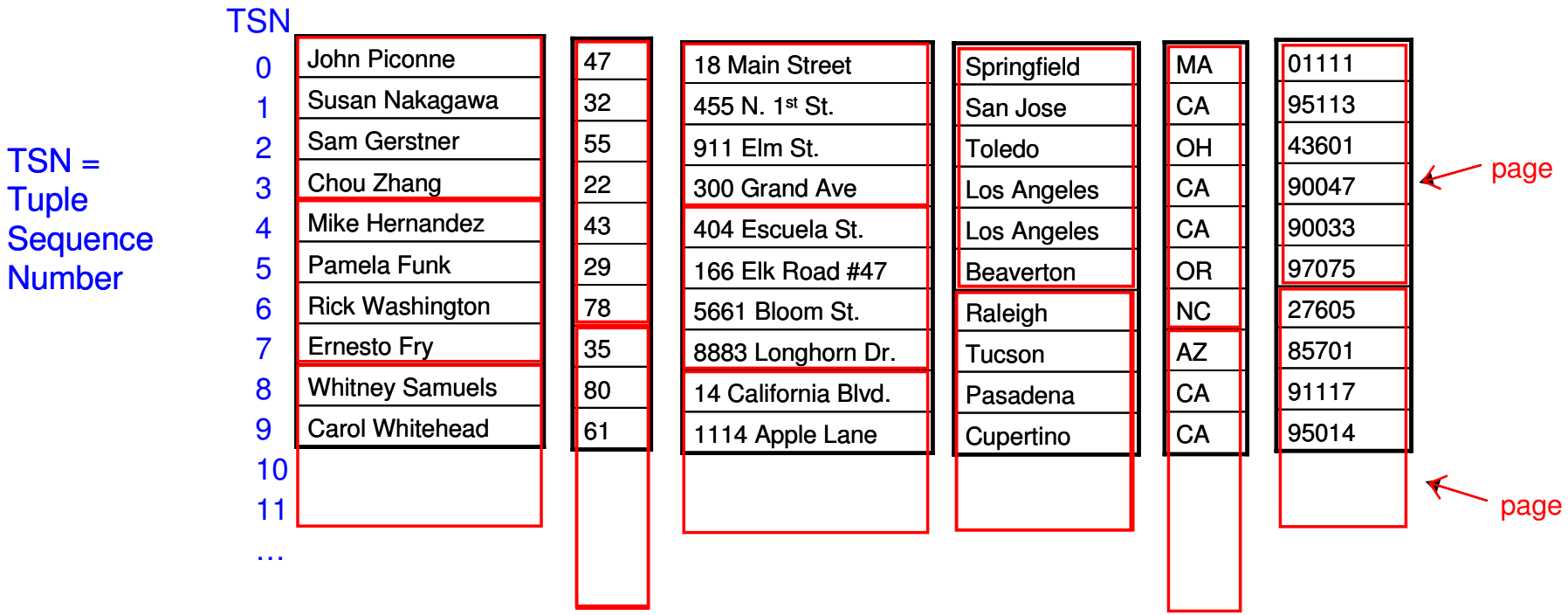
Columnar tables are always compressed by default.

- If dft_table_org = COLUMN (e.g. DB2_WORKLOAD= ANALYTICS):
  - `ORGANIZE BY COLUMN` is the default and can be omitted
  - Use `ORGANIZE BY ROW` to create row-organized tables

Data Layout

Columnar storage in DB2 (conceptual)

- Separate set of extents and pages for each column



Reclaiming Space in the Table

- **Objective:** Find empty storage extents and return pages to table space for re-use
- **Option 1:** If DB2_WORKLOAD=ANALYTICS, automatic space reclamation is active for all column-organized tables
-

```
update db cfg using auto_maint ON auto_tbl_maint ON auto_reorg ON;
```

- **Option 3**: Use REORG TABLE explicitly
  - Can use RECLAIMABLE_SPACE from ADMINTABINFO/ADMIN_GET_TAB_INFO to

```
                                                .-ALLOW WRITE ACCESS--.
>>-REORG-TABLE--table-name--RECLAIM EXTENTS--+---------------------+------><
                                             +--ALLOW READ ACCESS--+
                                             '--ALLOW NO ACCESS----'
```

What you see in the DB2 catalog: TABLEORG

- **Which tables are column-organized?**
  - New column in syscat.tables: TABLEORG

```
SELECT tabname, tableorg, compression
FROM   syscat.tables
WHERE  tabname like 'SALES%';

TABNAME                         TABLEORG COMPRESSION
------------------------------- -------- -----------
SALES_COL                       C
SALES_ROW                       R        N

  2 record(s) selected.
```

For column-organized tables, COMPRESSION is always blank because you cannot enable/disable compression.

What you see in the DB2 catalog: Synopsis Tables

- **For each columnar table there is a corresponding *synopsis table*, automatically created and maintained.**

```
SELECT tabschema, tabname, tableorg
FROM syscat.tables
WHERE tableorg = 'C';

TABSCHEMA       TABNAME                                  TABLEORG
--------------- ---------------------------------------- --------
MNICOLA         SALES_COL                                C
SYSIBM          SYN130330165216275152_SALES_COL          C

  2 record(s) selected.
```

- Size of the synopsis table: ~0.1% of the user table
- 1 row for every 1024 rows in the user table

Synopsis Table

- Meta-data that describes which *ranges* of values exist in which parts of the user table

SYN13033016521627515 2_SALES_COL

TSNMIN	TSNMAX	S_DATEMIN	S_DATEMAX	...
0	1023	2005-03-01	2006-10-17	...
1024	2047	2006-08-25	2007-09-15	...
...				

TSN = Tuple Sequence Number

User table: **SALES_COL**

	S_DATE	QTY	...
0	2005-03-01	176	...
	2005-03-02	85	...
	2005-03-02	267	
	2005-03-04	231	
	...		
1023	...		
1024	...		
2047	...		

- Enables DB2 to skip portions of columns when scanning data during query
- Predicate WHERE S_DATE = 2007-01-01 would skip first range
- Predicate WHERE S_DATE = 2006-09-12 would scan both ranges

What you see in the DB2 catalog: Page Map Index

- **Automatically created and maintained**
- **Used internally to locate column data in the storage object**
- **Maps columns and TSNs to pages**

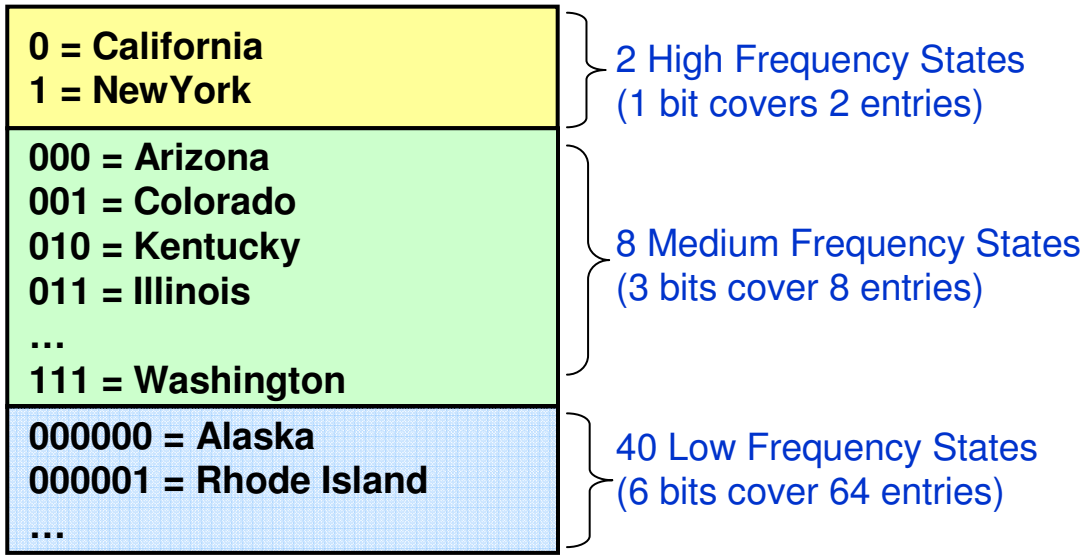
```
SELECT indschema, indname, colnames, indextype
FROM syscat.indexes
WHERE tabname = 'SALES_COL';

INDSCHEMA  INDNAME              COLNAMES             INDEXTYPE
---------- -------------------- -------------------- ---------
SYSIBM     SQL130330165215840   +ID                  REG
SYSIBM     SQL130330165216790   +COLGID+STARTTSN     CPMA

  2 record(s) selected.
```

Compression

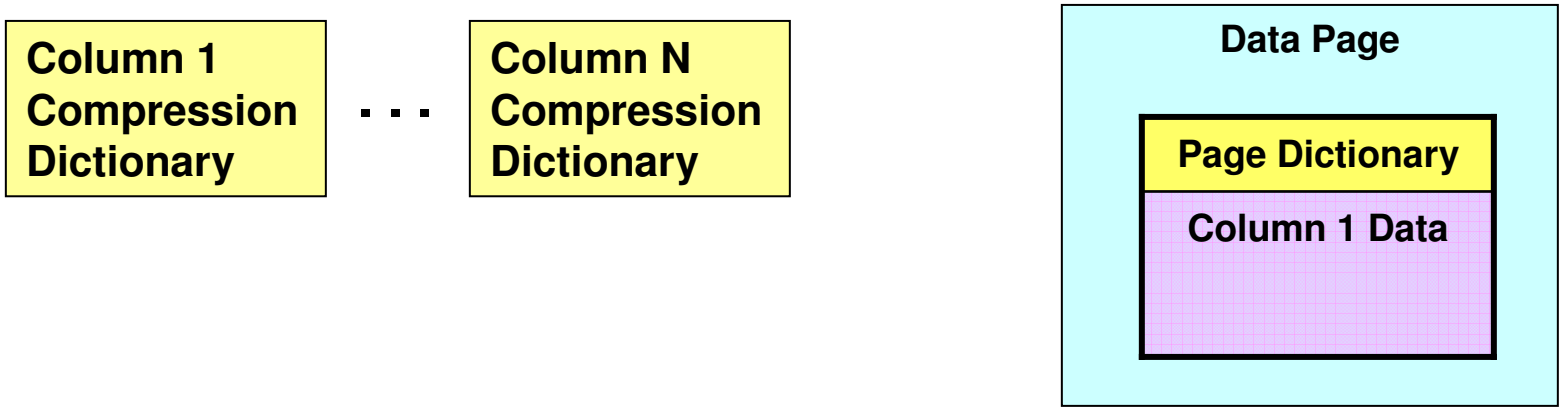
BLU uses Multiple Compression Techniques

- Approximate Huffman-Encoding ("frequency-based compression"), prefix compression, and offset compression
- Frequency-based compression: Most common values use fewest bits

Example showing 3 different code lengths. Code lengths vary depending on the data values.



Compression Dictionaries for Column-Organized Tables



- Column-level dictionaries: Always one per column
  - Dictionary populated during load replace, load insert into empty table
  - Automatic Dictionary Creation during Insert
- Page-level dictionaries: May also be created
  - If space savings outweighs cost of storing page-level dictionaries
  - Exploit local data clustering at page level to further compress data

Actionable Compression

- **Evaluating SQL predicates directly on compressed data**
  - No decompression required for comparisons like BETWEEN, < , >, <>, =
  - Many values can be compared with few instructions (SIMD processing)

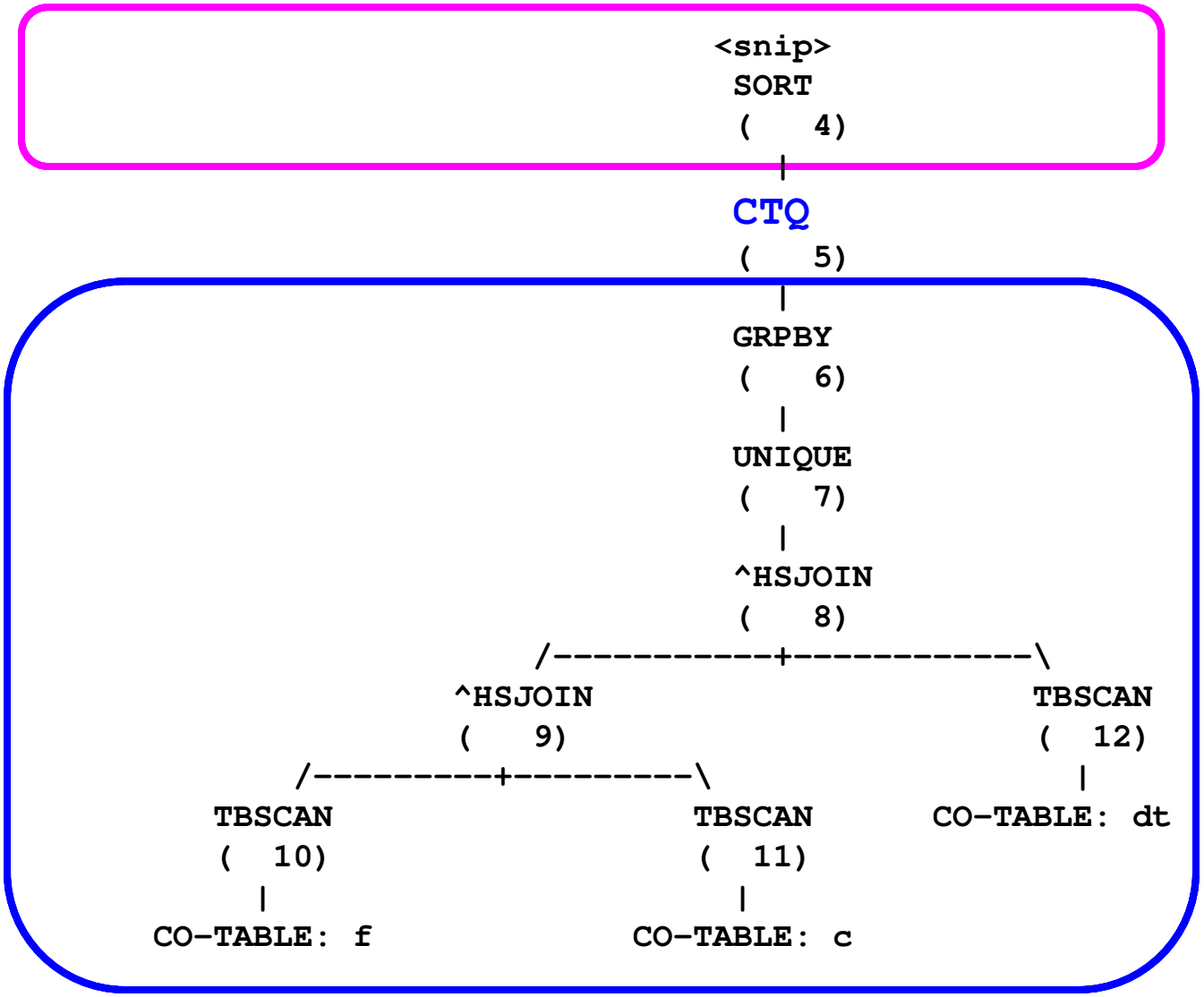
Query Processing

Sample Query

```
SELECT c.trading_name
FROM f, c, dt
WHERE f.client_dim_key = c.client_dim_key
  AND f.trade_dt = dt.dt_dim_key
  AND f.is_cancelled = 0
GROUP BY c.trading_name, dt.year
ORDER BY c.trading_name
```

Let's review the execution plan of this query….

Sample Execution Plan



Operators above CTQ use DB2's regular row-based processing

Operators below CTQ are optimized for column-organized tables

Here: All table scans, hash joins, and grouping are performed in columnar query runtime. (Good.)

Summary

- **What does BLU provide ?**
  - Columnar engine integrated into a traditional database providing excellent performance for analytics workload
- **What are key differentiators ?**
  - Actionable compression
  - Not bound to memory limits, but memory optimized
  - Well integrated into traditional database, which still can be used for high performant OLTP processing.
- **What‘s new ?**
  - SAP has announced support for DB2 BLU Acceleration