A DB2 Performance Tuning Roadmap:

A High-Level View on Managing the Performance of DB2 for z/OS

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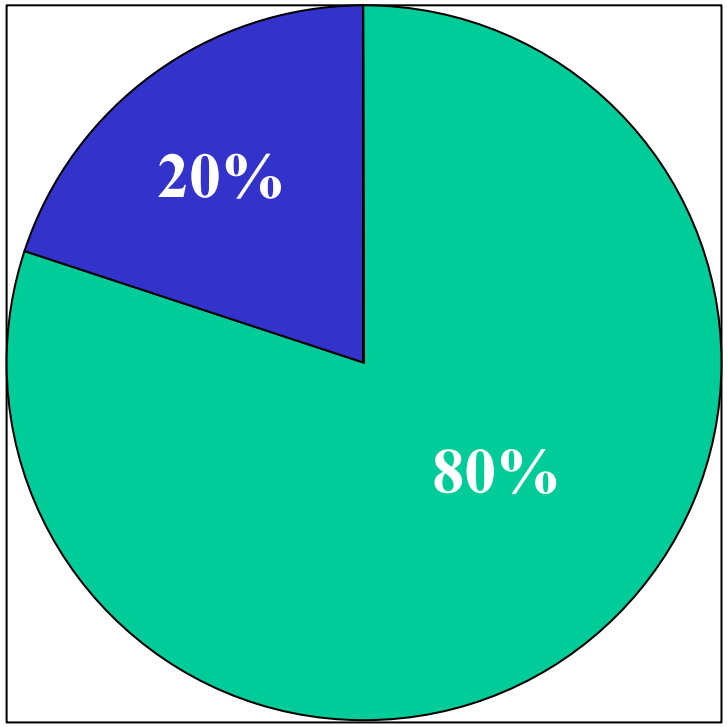
1. The Tuning Progression

Problem Resolution

- Application
  - SQL
  - Host Language Code
- Database
  - Indexes
  - Database and Index Organization
  - Database Design (normalization / denormalization)
- DB2 Subsystem
  - ZPARMs, Pools, Locking, IRLM, DDF, etc.
- Environment
  - Network
  - TP Monitor (CICS, IMS/TM)
  - Operating System

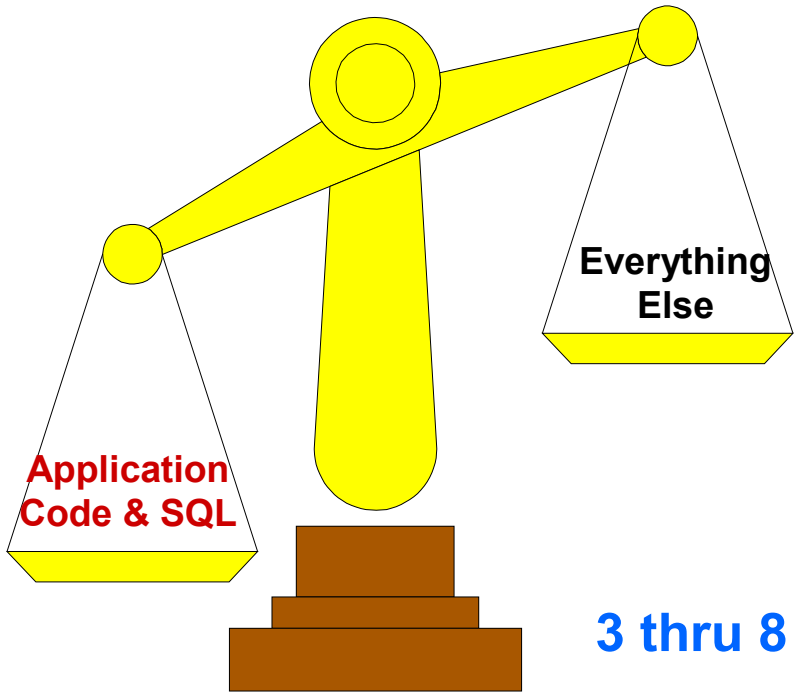
2. Basic Tuning Rules

- 80% of the results of tuning come from 20% of the tuning effort ***-and-***
  - 20% of your DB2 applications cause 80% of your problems
- Tune one thing at a time
  - How else do you know whether the action helped or not?
- All tuning optimizes:
  - **CPU, I/O** or **concurrency**



Application Code and SQL

- Most relational tuning experts agree that the majority of performance problems with applications that access a relational database are caused by poorly coded programs or improperly coded SQL…
  - *as high as 70% to 80%*

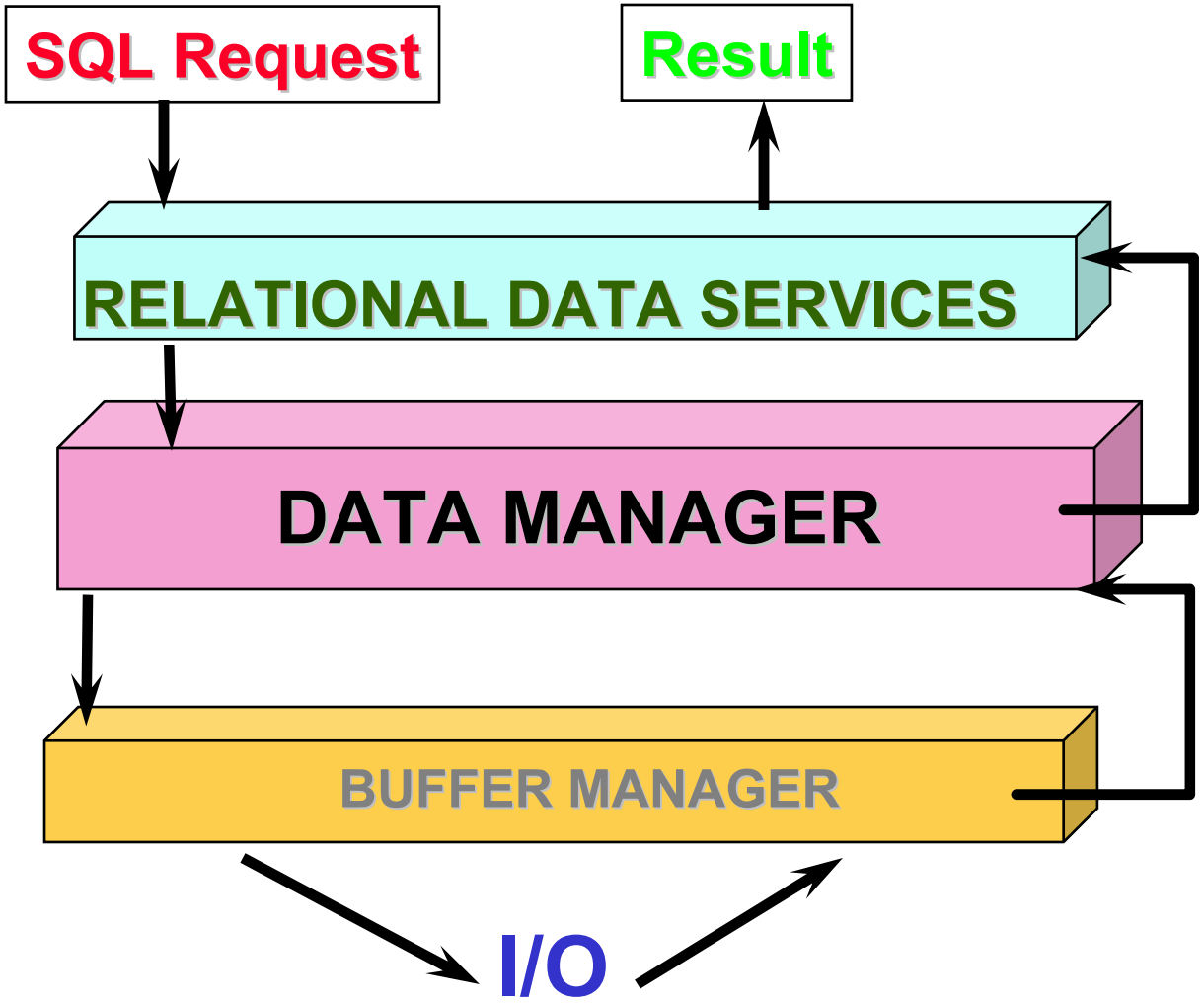


3 thru 8

3. Application Tuning: SQL

- Simpler is better, but complex SQL can be efficient
- In general, let SQL do the work, not the program
- Retrieve the absolute minimum # of rows required
- Retrieve only those columns required - never more
- Always provide join predicates *(i.e. no Cartesian products)*
- Favor Stage 1 and Indexable predicates
  - Host variable data type/length should match column
- Avoid tablespace scans for large tables *(usually)*
- Avoid sorting when possible:
  - indexes for ORDER BY and GROUP BY
  - judicious use of DISTINCT
  - UNION ALL versus UNION *(if possible)*

3. Application Tuning: Stage 1 and 2

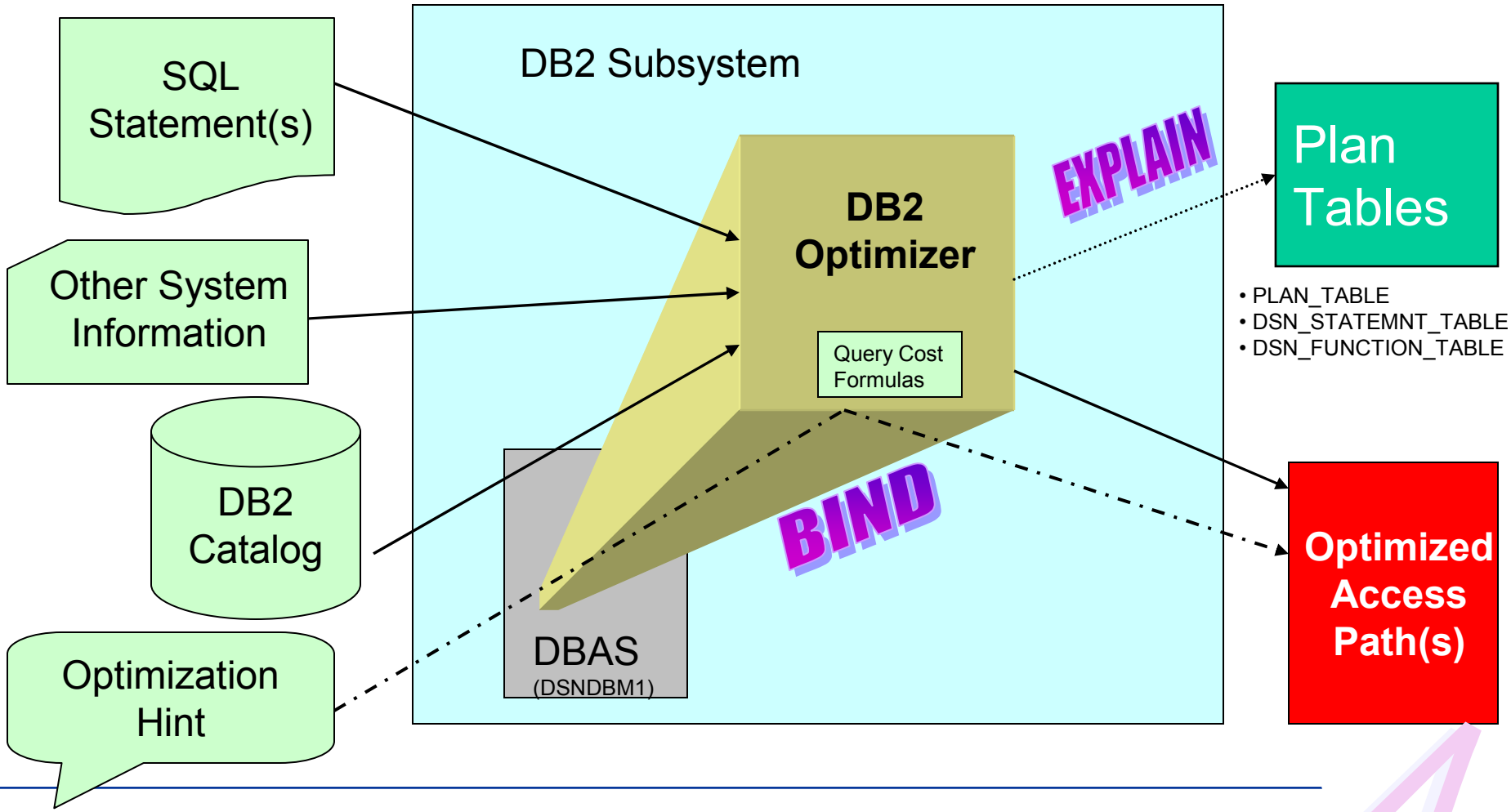


STAGE 2 - Evaluated after data retrieval (non-sargable) via the RDS (Relational Data Services) which is more expensive than the Data Manager.

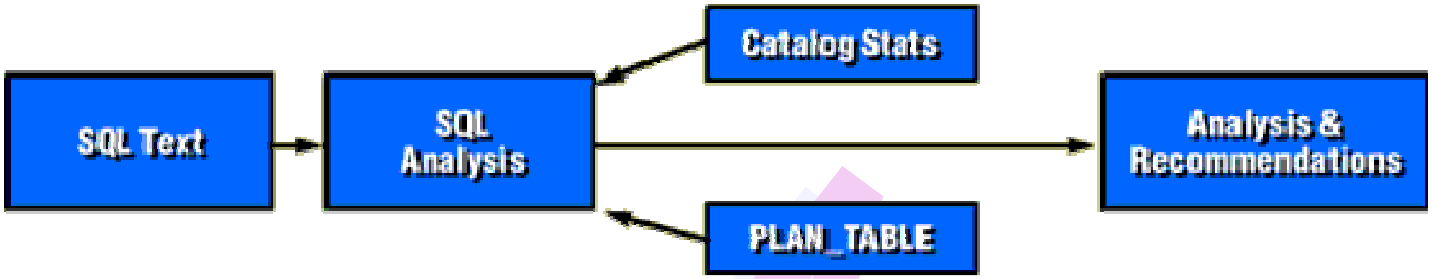
STAGE 1 - Evaluated at the time the data rows are retrieved (sargable). There is a performance advantage to using Stage 1 predicates because fewer rows are passed to Stage 2 via the Data Manager

Avoid Black Boxes

4. Application Tuning: Optimization



4. Application Tuning: *EXPLAIN Analysis*



- **Hint used?**
- **Index used?**
  - Single, Multiple
- **Matching column(s)?**
- **Index only?**
- **TS scan** *(page range)*
- **Type of Join?**
  - Nested Loop
  - Merge Scan
  - Hybrid

- **SQL Text**
- **Table & Index Information**
  - DDL
  - Stats
- **Cardinality**
- **Other Stuff**
  - Triggers
  - RI
  - Constraints

- **Prefetch?**
  - Sequential
  - List
- **Parallelism used?**
  - I/O, CPU, Sysplex
  - Degree
- **Sort required?**
  - Join, Unique, Group By, Order By
- **Locking**

5. Application Tuning: Locking

- Avoid deadlocks by coding updates in the same sequence regardless of program
- Issue data modification SQL statements as close to the end of the UOW as possible
  - the later in the UOW the update occurs, the shorter the duration of the lock
- Encourage Lock Avoidance
  - ISOLATION(CS) / CURRENTDATA(NO)
  - Can be used only by read only cursors
- Use LOCK TABLE judiciously
- Consider ISOLATION(UR) to avoid locking

6. Application Tuning: Commit

- Avoid Bachelor Programming Syndrome

Fear of COMMITing

- Plan and implement a COMMIT strategy
  - or experience TIMEOUTs and DEADLOCKs

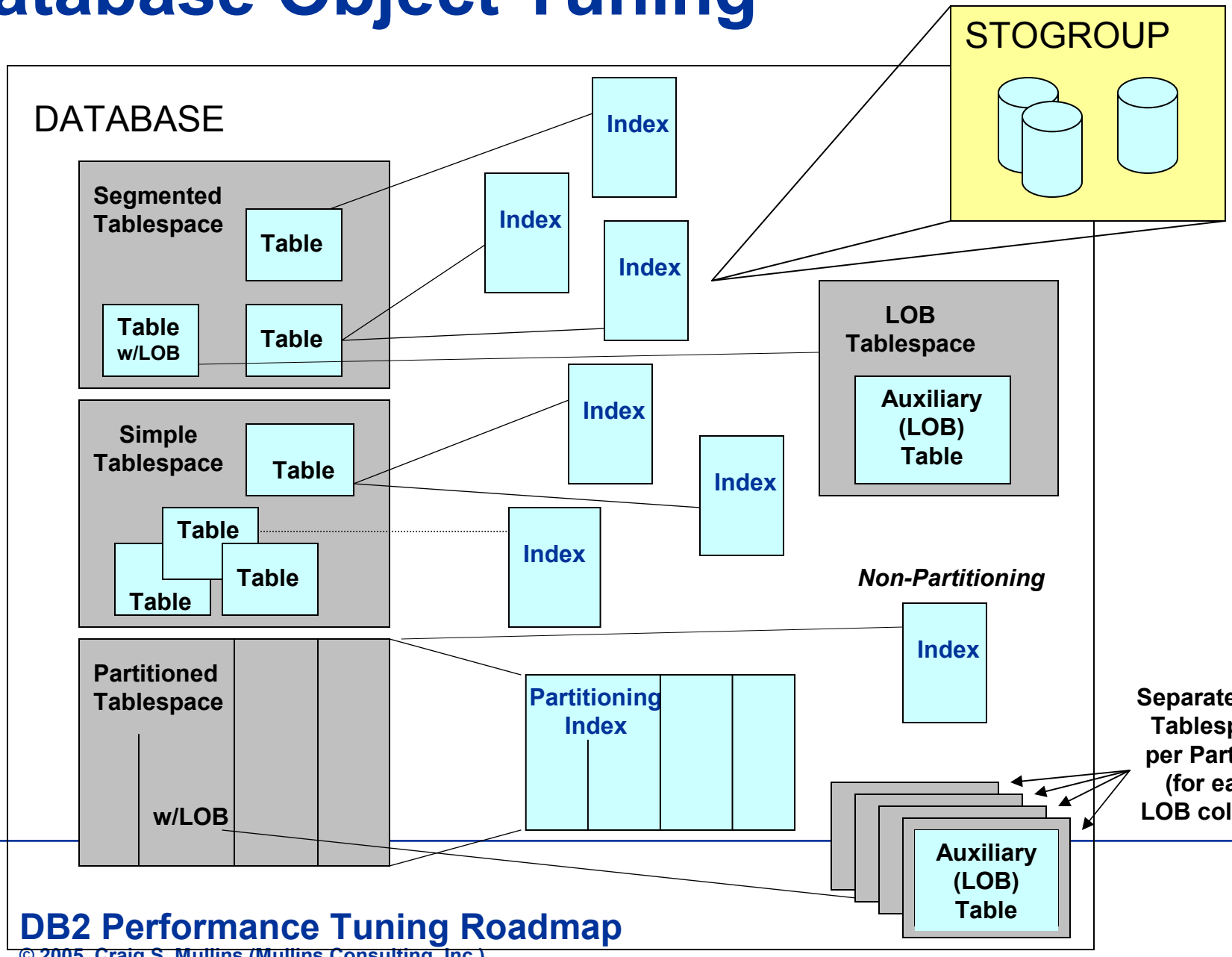
7. Application Tuning: Program

- Do not embed efficient SQL in inefficient program logic
  - Classic example: finely tuned, efficient SQL inside of a program loop that executes 3,510,627 times!
- Let SQL do the work when possible
  - e.g.) do not code “program” joins
- Sign of trouble: SQL followed by lots of IF...ELSE or CASE statements
- If you are only going to retrieve one row, consider coding a singleton SELECT *(usually)*

8. Application Tuning:
Online vs. Batch

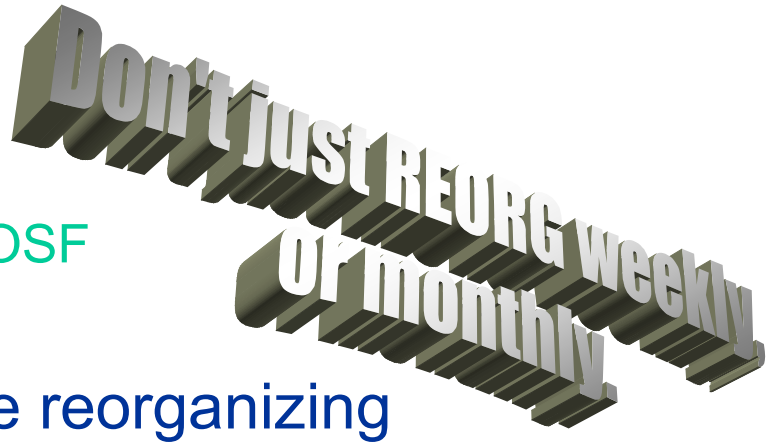
- When designing online transactions, limit the amount of data to be retrieved to a reasonable amount
  - No one reads hundreds of pages/screens online!
- Limit online sorting and joining *(but be reasonable)*
- Consider OPTIMIZE FOR 1 ROW to disable list prefetch
  - With LP DB2 acquires a list of RIDs from a matching index, sorts the RIDs, & accesses data by the RID list
  - Can be very inefficient for a multiple page transaction

Database Object Tuning



9. Database Organization

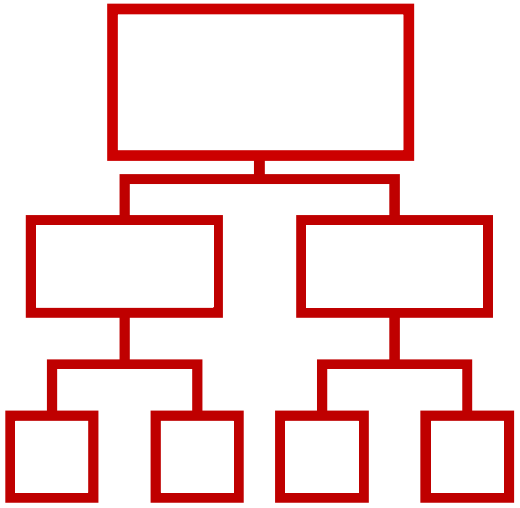
- Be sure to run RUNSTATS
  - as data volume changes, new data structures added
  - followed by (RE)BIND with /EXPLAIN(YES)
- Review statistics to determine when to REORG
  - NEARINDREF and FARINDREF
  - LEAFDIST, PERCDROP
  - For clustering indexes
    - NEAROFFPOSF and FAROFFPOSF
    - CLUSTERRATIOF
  - Analyze access patterns before reorganizing
    - Random vs. sequential
    - Consider automation



10. Database Design: The Basics

- As normalized as possible, but performance before aesthetics; normalization optimizes “update” at the expense of “retrieval”
  - Don’t let data modelers dictate “physical” design
- One table per tablespace *(usually)*
- Partitioned or segmented over simple TS
  - DSSIZE < 4GB unless you definitely need large TS
- Do not create base table views
- Avoid the defaults - they are usually wrong
- Determine amount of free space *(PCTFREE & FREEPAGE)*
  - Based on volatility – don’t just let everything default to 10.

11. Database Design: Indexes

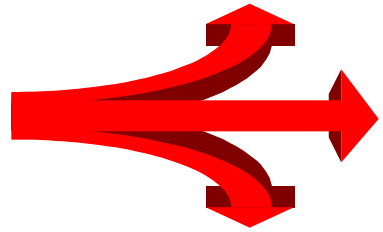


- A proper indexing strategy can be the #1 factor to ensure optimal performance
- First take care of unique & PK constraints
- Then for foreign keys *(usually)*
- Heavily used queries - predicates
- Overloading of columns for IXO
- Index to avoid sorting
  - ORDER BY, GROUP BY
- Consider I/U/D implications
- Sequence columns wisely in multi-col indexes
- Avoid indexing variable columns →

12. Database Design: Data Types

- Use NULL sparingly
- Use appropriate DB2 data types
  - Use DATE instead of CHAR or numeric for dates
  - Store numeric data using a numeric data type
    - INTEGER, SMALLINT, DECIMAL, etc.
  - INTEGER versus DECIMAL(x,0)
    - Control over domain vs. storage requirements
  - "DATE and TIME" versus TIMESTAMP
    - Ease of use/storage vs. precision/arithmetic
- Compression versus VARCHAR
    - Compression = less overhead (no 2 byte prefix)
    - Compression requires no programmatic handling

13. Database Design: Integrity



- Use DB2 declarative RI instead of program RI *(usually)*
  - performance and ease of use
  - ensure integrity for planned and ad hoc database modification
- Do not use RI for lookup tables *(overkill)*
  - consider CHECK constraints vs. lookup tables
- Use triggers only when declarative RI is not workable
  - Triggers are less efficient *(usually)* than RI
    - but usually better than enforcing in application programs
- Specify indexes on foreign keys

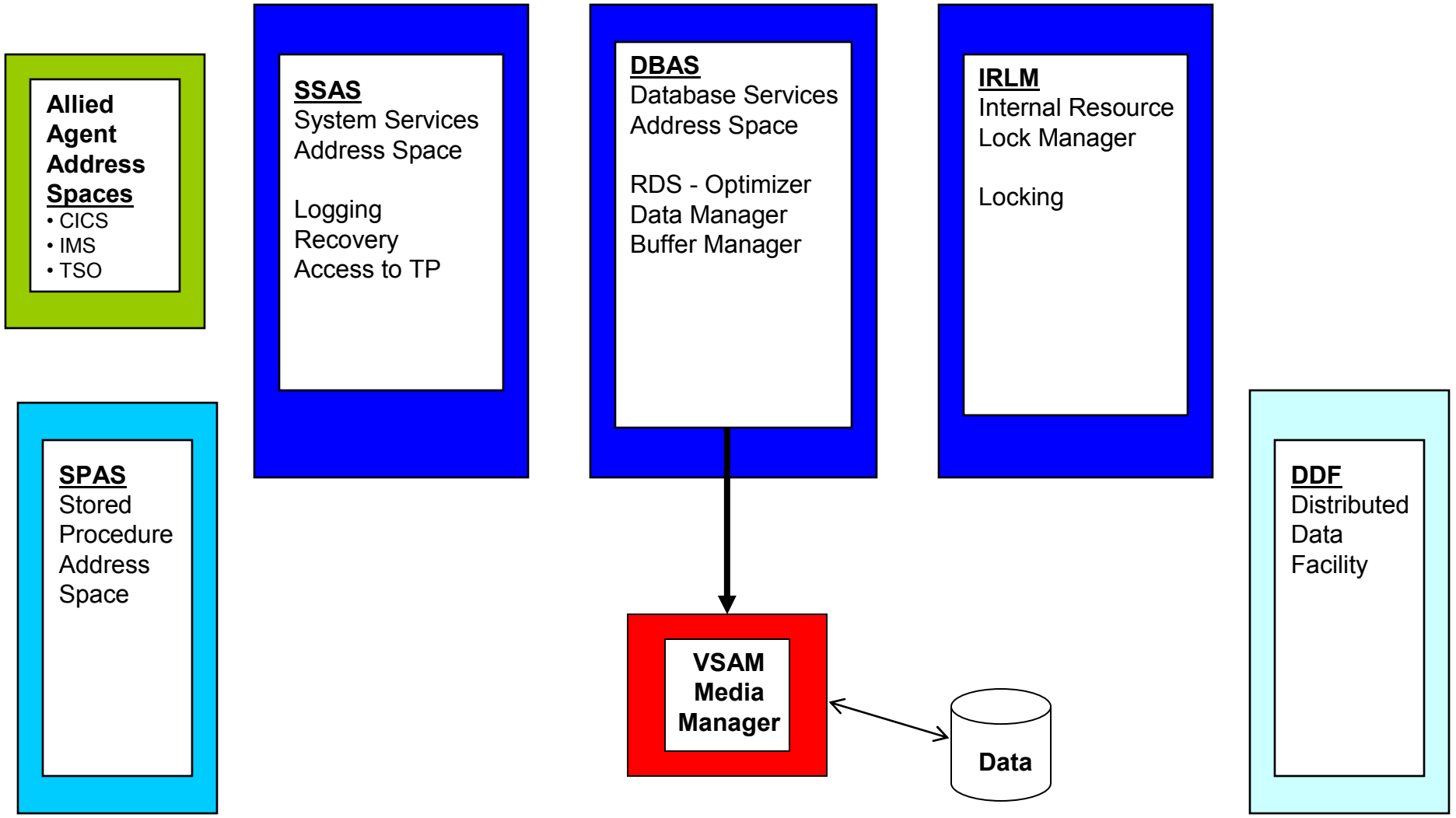
14. Database Design: BP, part one

- Bufferpool allocations - do not default everything to BP0
  - Explicitly specify a buffer pool for every TS and IX
- Ideas:
  - isolate the catalog in BP0
  - separate indexes from table spaces
  - isolate heavily hit data
  - isolate sort work area
  - optimize BP strategy for your data & app processing mix: sequential vs. random
  - there is no “silver bullet” approach
    - more on bufferpool tuning coming up!

15. Database Design: Rows & Columns

- Avoid wasted space *(page size?)*
  - Row length > 4056 requires larger page size
  - Row length 2029 - 4056 = one row per page
  - Row length < 15 wastes space (max 255 rows/page)
- Sequence columns based on logging
  - Infrequently updated non-variable columns first
  - Static (infrequently updated) variable columns
  - Frequently updated columns last
  - Frequently modified together, place next to each other

System & DB2 Subsystem Tuning



16. - 19. Subsystem Tuning: Pools

- DB2 uses four types of pools; memory structures to cache data and information to avoid costly disk I/O
  - ❶❻ – Buffer Pools - used to cache data in memory when it is read from disk.
  - ❶❼ – RID Pool - used to sort RIDs (record identifiers) for List Prefetch, Multiple Index Access, and Hybrid Joins.
  - ❶❽ – EDM Pool - used to cache program details (access paths, dynamic PREPARE, authorization) and database structural information (DBD).
  - ❶❾ – Sort Pool - used when DB2 must sort data.

16. Subsystem: Buffer Pools, part two

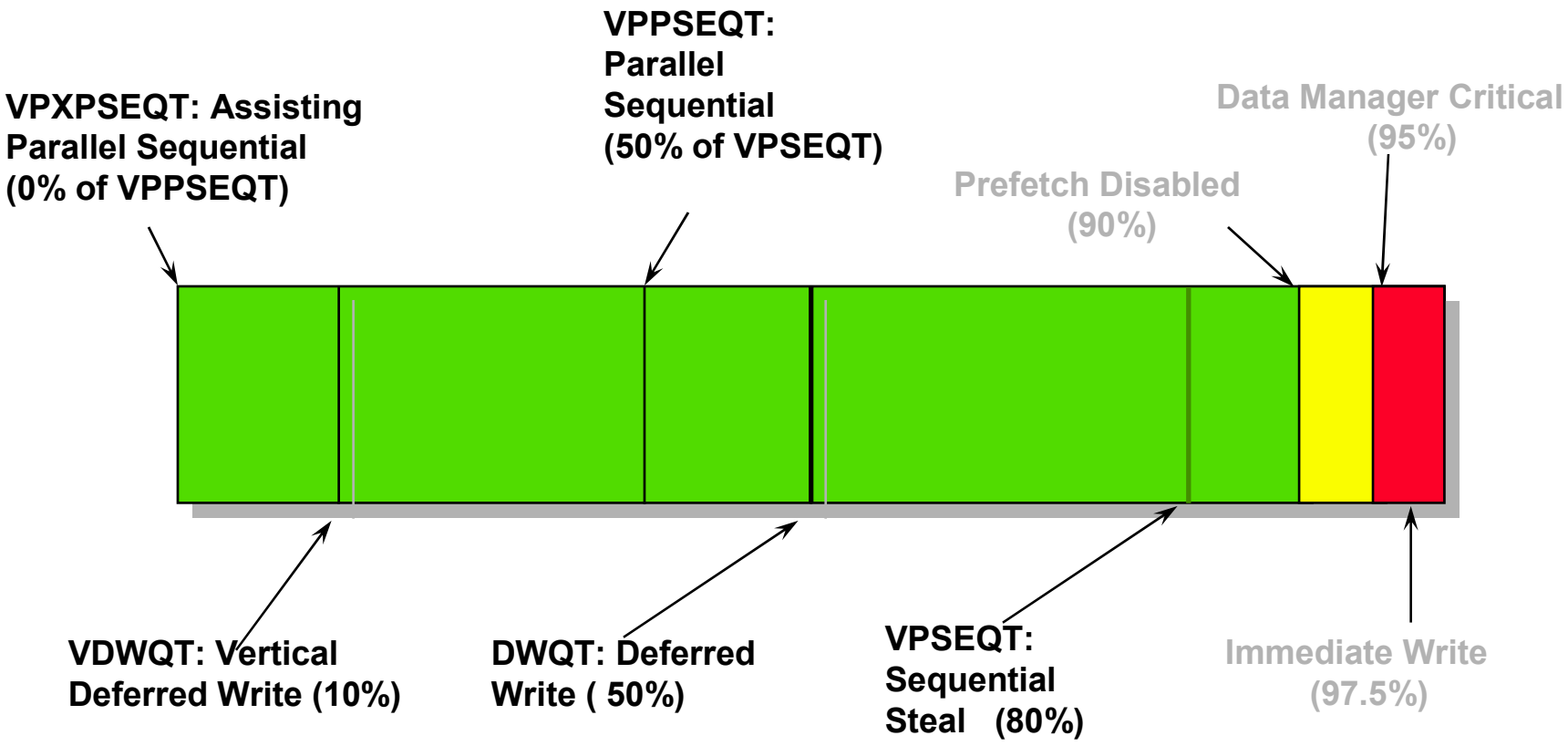
- DB2 provides up to 80 buffer pools - USE THEM!
  - 4K: BP0 thru BP49
  - 8K: BP8K0 thru BP8K9
  - 16K: BP16K0 thru BP16K9
  - 32K: BP32K thru BP32K9
- Consider reserving a bufferpool for tuning
  - Move problem objects there to isolate for tuning
- DB2 V8 significantly increase buffer pool storage
  - 1TB new limit for buffer pools
  - No more hiperpools
  - No more bufferpools in data spaces
- Monitor hit ratio: % times a page is found in the buffer pool
  - The higher the ratio the better

→ **(GETPAGES – PAGES READ) / GETPAGES**

→ **SYNC I/O + ASYNC I/O**

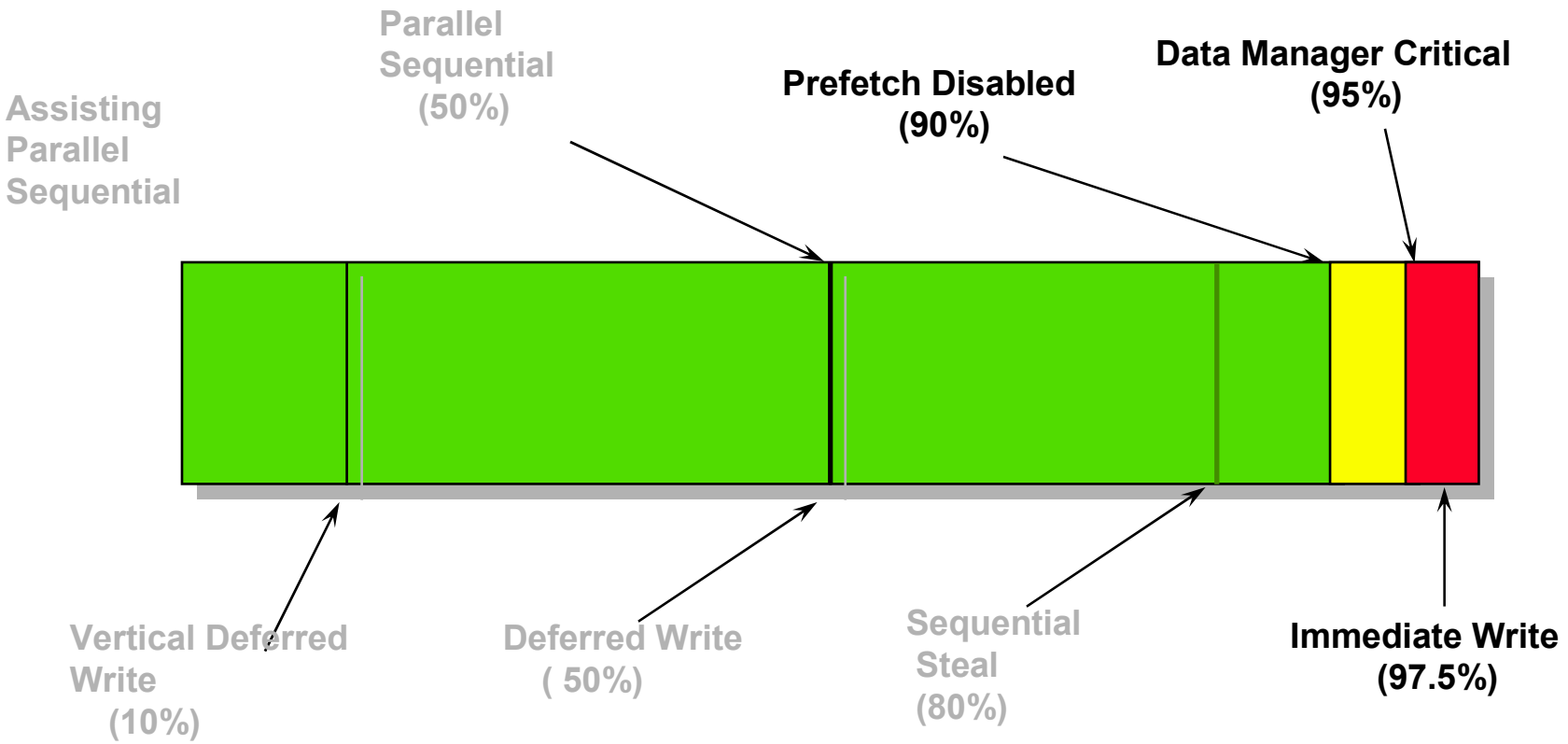
16. Buffer Pools: Tune Thresholds

- Variable Thresholds



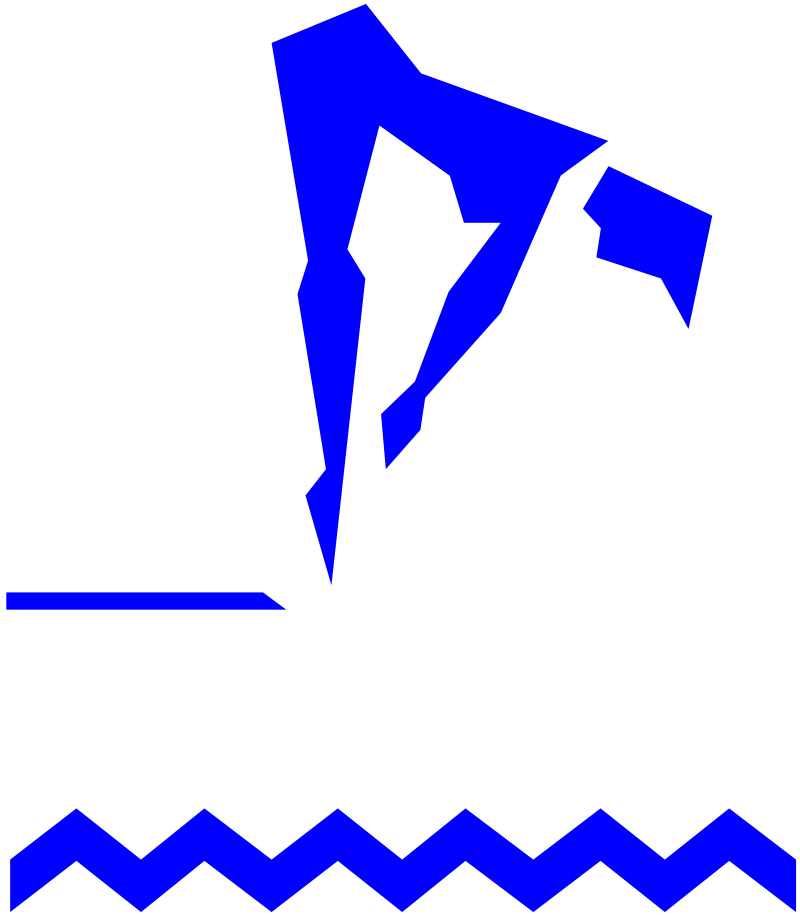
16. Buffer Pools: Monitor Thresholds

- Fixed Thresholds

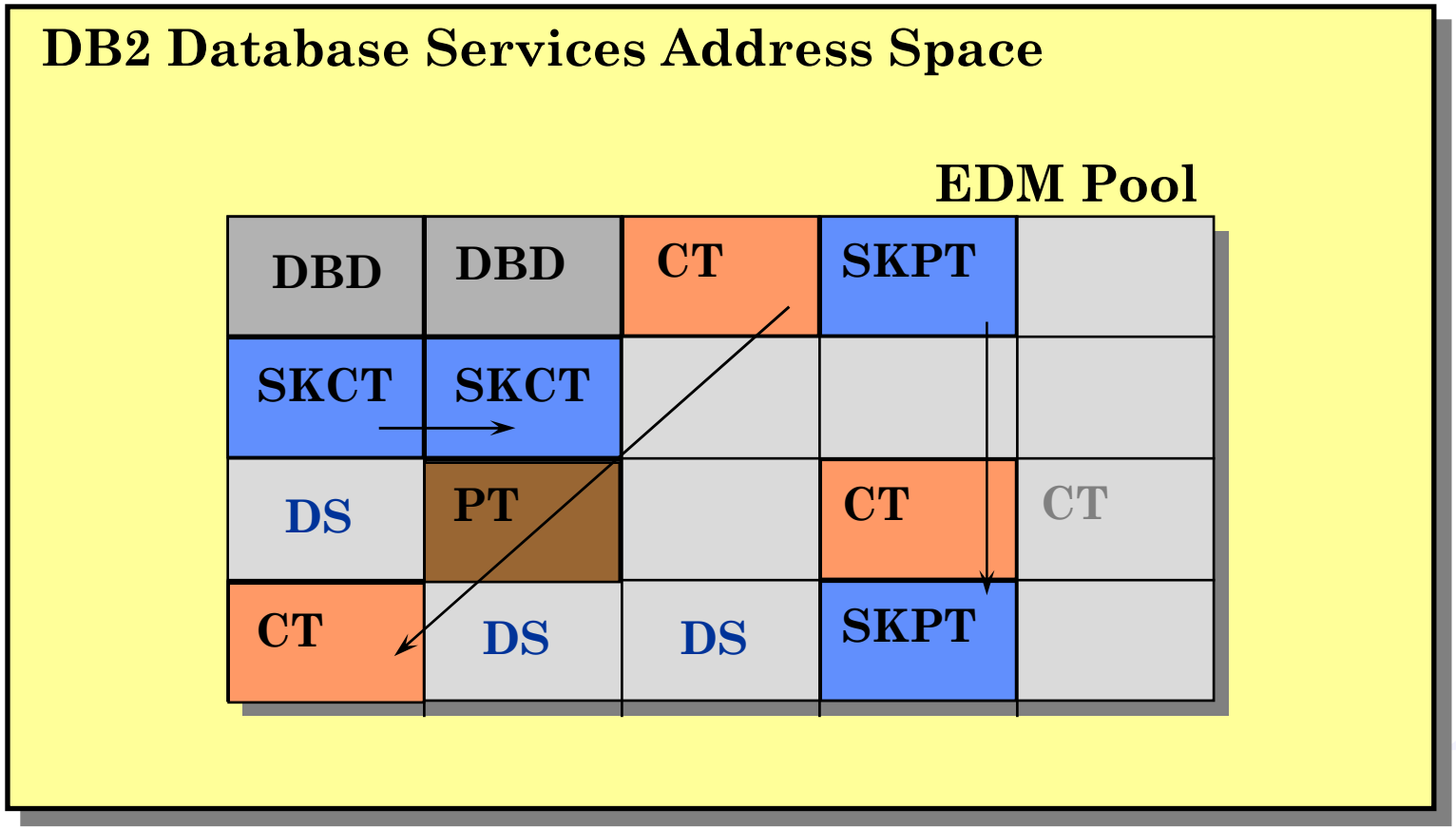


17. Subsystem: RID Pool

- One RID pool for all processing.
- The default RID pool size is 4 MB. Can be changed.
- RID Pool is used for:
  - enforcing unique keys while updating multiple rows
  - sorting RIDs during the following operations:
    - List prefetch, including single index list prefetch
    - Access via multiple indexes
    - Hybrid Joins



18. Subsystem: EDM Pool



What's in EDM Pool

- DBDs
- SKCTs
- CTs
- SKPTs
- PTs
- Auth Cache
- Dyn SQL Prep
- Free pages

V8 breaks each out into separate "pools"

General ROT: shoot for 80% efficiency; (1 in 5 DBD/SKPT/SKCT needs to be loaded)

19. Subsystem: Sort Pool

- Sort Pool value is the maximum size of the sort work area allocated for each concurrent sort user.
- The default Sort Pool size is 1 MB. It also can be changed on install panel DSNTIPC.
- In general, the larger the Sort Pool, the more efficient sorting will be.
- Need to understand the way DB2 sorts to understand tuning.

19. DB2 Tournament Sort

- DB2 uses tournament sorting…
  - rows to be sorted are passed through a tree structure, entering at the bottom; each row is compared to rows already in the tree and the lowest (ASC) or highest (DESC) are moved up the tree
  - when a row emerges from the top it is placed in an order set of rows in memory (Sort Pool)
  - when a row does not fit in the current ordered set (out of range) the complete ordered set (called a run) is moved to a work file
  - logical work files are in memory; if too big, moved to DSNDB07
  - all runs are merged to form a sorted results set

20. Subsystem: Logging

- DB2 will only run as fast as the log
- Log Tuning Parameters
  - Input Buffer Size
  - Output Buffer Size
  - Write Threshold
- Log Configuration
  - Dual Active Logging is the preferred configuration
  - Preferably with each log defined to separate devices and on separate channels
- DB2 rollbacks from log data on DASD
  - Consider keeping archive logs on DASD
  - Migrate archive logs to tape after a specified period of time (HSM)

Waits occur if OUTBUFF is too small

At the Write Threshold, data is written to the Active Log

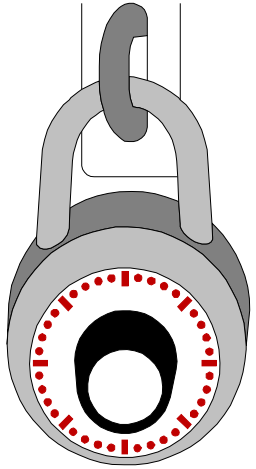
20. Subsystem: System Checkpoint

- Periodically DB2 takes a checkpoint, containing:
  - currently open unit of recoveries (UR) within DB2, all open page sets, a list of page sets with exception states, and a list of page sets updated by any currently open UR
- Specified in the CHKFREQ parameter in DSNZPARM
  - Number of log records written
  - Or, as of V7, number of minutes
- Can be changed dynamically using:
  - SET LOG or *(temporary)*
  - SET SYSPARM (V7) *(permanent)*

15 minute intervals for checkpoints during peak processing times.

CHKFREQ **replaced** LOGLOAD **in V7**

21. Subsystem Tuning: IRLM



- MAXCSA **= 250×(LOCKS PER USER)×(MAX USERS).**
  - 250 bytes of storage for each lock.
- ITRACE=NO
  - do not use ITRACE; instead, use DB2 lock traces
- PC=NO vs. PC=YES — DB2 V8 eliminates PC parameter

↑CPU ↓ECSA
- YES: locks held in the IRLM private address space; DB2 uses cross memory for IRLM requests

↓CPU ↑ECSA
- NO: locks held in the extended common storage area

- DEADLOK
  1. The number of seconds between two successive scans for a local deadlock
  2. The number of local scans that occur before a scan for global deadlock starts

22. Environment

- Operating System
  - version, memory, JCL, RACF, etc.
- TP Monitors
  - CICS, IMS/TM, C/S GUI, web, etc.
- Networking
  - TCP/IP, SNA, DRDA, stored procedures, etc.
- DASD
  - storage, ESS/Shark, placement, etc.

Summary

Application

Database

DB2 Subsystem

Environment

Do one thing at a time and;

You ***can*** tune DB2!

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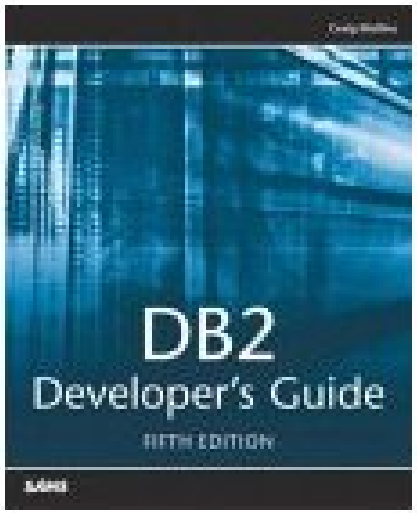
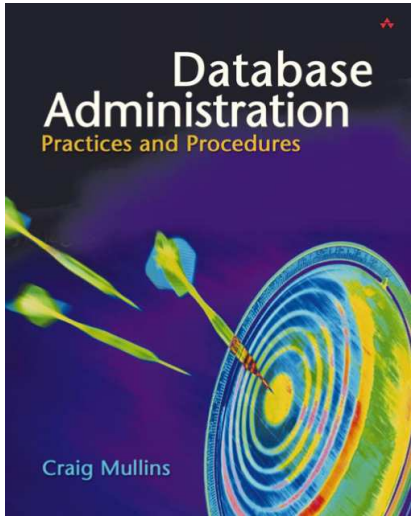


DB2 Developer's Guide, *5ed*

www.craigsmullins.com/cm-book.htm



DBA: Practices & Procedures

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