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Lecture Series on Relational Database Technology

Introduction into key Concepts of Relational DataBase Management Systems (RDBMS)

Summer Term 2011

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DB2 Information Management Software

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Introduction into RDBMS
DB2 Overview and Editions
Exercises

DB2 Information Management Software

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Introduction into RDBMS

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Detailed Content (1 of 4) – Morning Lecture

Day	*Lecture Topics*
13.05.2011	*Introduction & Lecture Objectives/Scope*
	Overview of Relational DataBase Management Systems (RDBMS) §DB2 –Overview –Key Concepts –Architecture –Editions §Exercises
	Database Security Aspects (Athentication, Authorization, Priviledges, ...) §Exercises
	…

Development of RDBMS – „Early“ History

- 1968 IBM Information Management System
- 1970 Dr. E F Codd, „Relational Model“
- 1977 IBM System R (1st relational DB)
- 1979 Relation Inc. makes Oracle V1 available
- 1980 Oracle V2
- 1980 IBM SQL/DS
- 1982 Oracle V3
- 1983 DB2/MVS
- 1985 INGRES (foundation for PostgreSQL)
- 1986 Sybase and ANSI Standard for SQL
- 1992 DB2 for Unix

Requirements for any Database System

- Standard access interfaces
- Abstraction and transparency of data storage
- Data security
- Fault tolerance, disaster recovery, continuous availability
  - Unplanned outages
  - Planned outages
- Data logistics, backup/restore
- Scalability
- Support for multiple users
- Integration interfaces
  - Replication, WebServices, federation, …

Requirements for Data Security

- ACID principle (Haerder, Reuter 1983)
  - **Atomicity**
    Transactions are executed in its entirety (commit or rollback)
  - **Consistency**
    DBS keeps data in consistent state (according to data model)
  - **Isolation**
    Parallel transactions are executed independently
  - **Durability**
    Commit of transaction will store data safely

Usage of DataBase Systems

- OLTP (OnLine Transaction Processing)
  - High # of transactions (several throusand(sec)
  - Short transaction execution time (~ <1min.)
  - High # of parallel users
  - Goal: high transaction throughput

- OLAP (OnLine Analytical Processing)
  - Low # of transactions
  - Long transaction execution time (>10min–several hours)
  - Low # of parallel users
  - Goal: high performance of single transactions

Types of DB Systems

- Hierarchical DB systems
  - IBM Information Management System (IMS) **à** used in large customer environments
  - Software AG Tamino XML Database, DB2 9
    - XML is a hierarchical data format
- Relational DB systems
  - IBM DB2, Oracle Postgres, MySQL, Adabas, Informix
- Object-oriented DB systems
  - O2, Poet

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DB2 Overview

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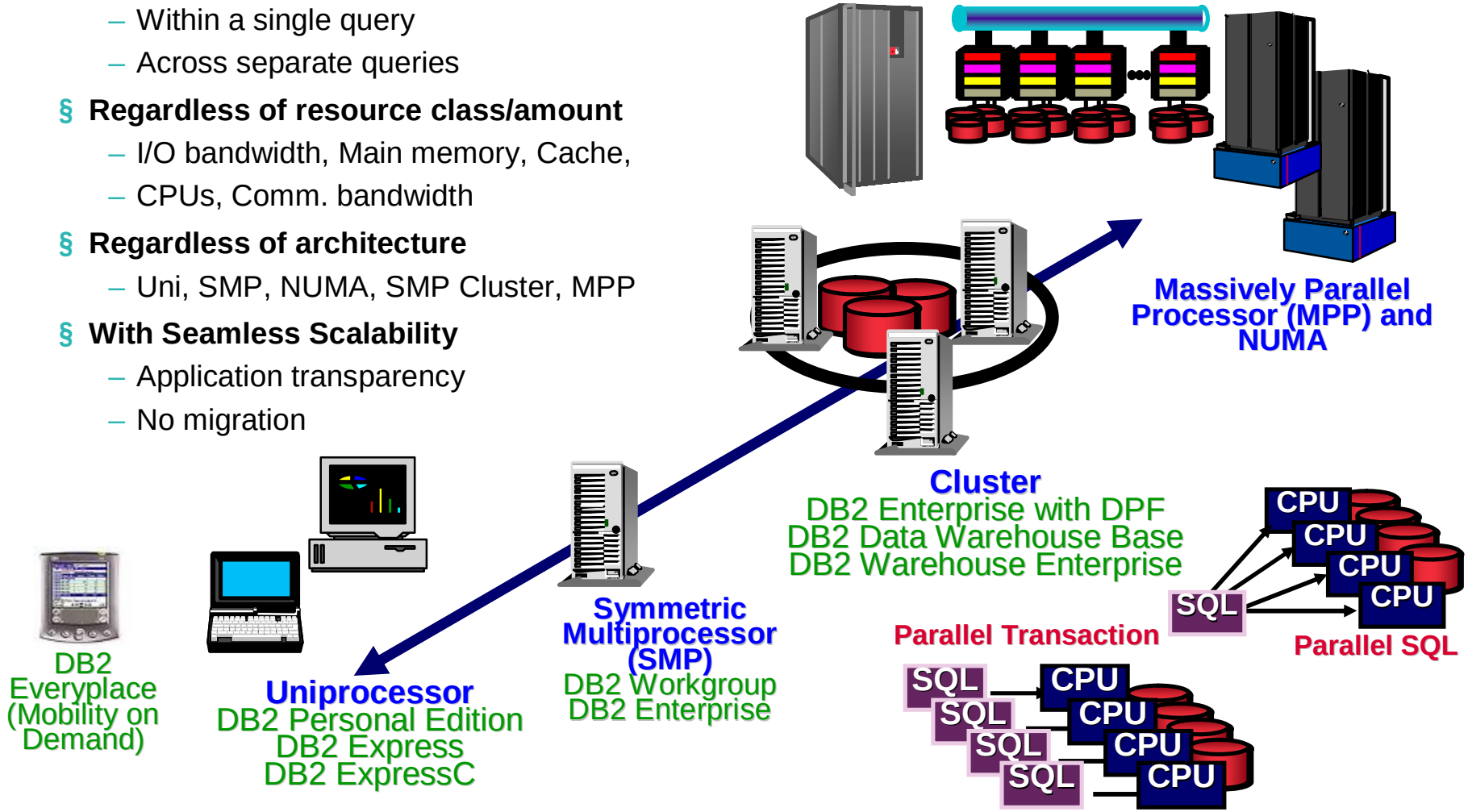
Introduction into DB2 Editions

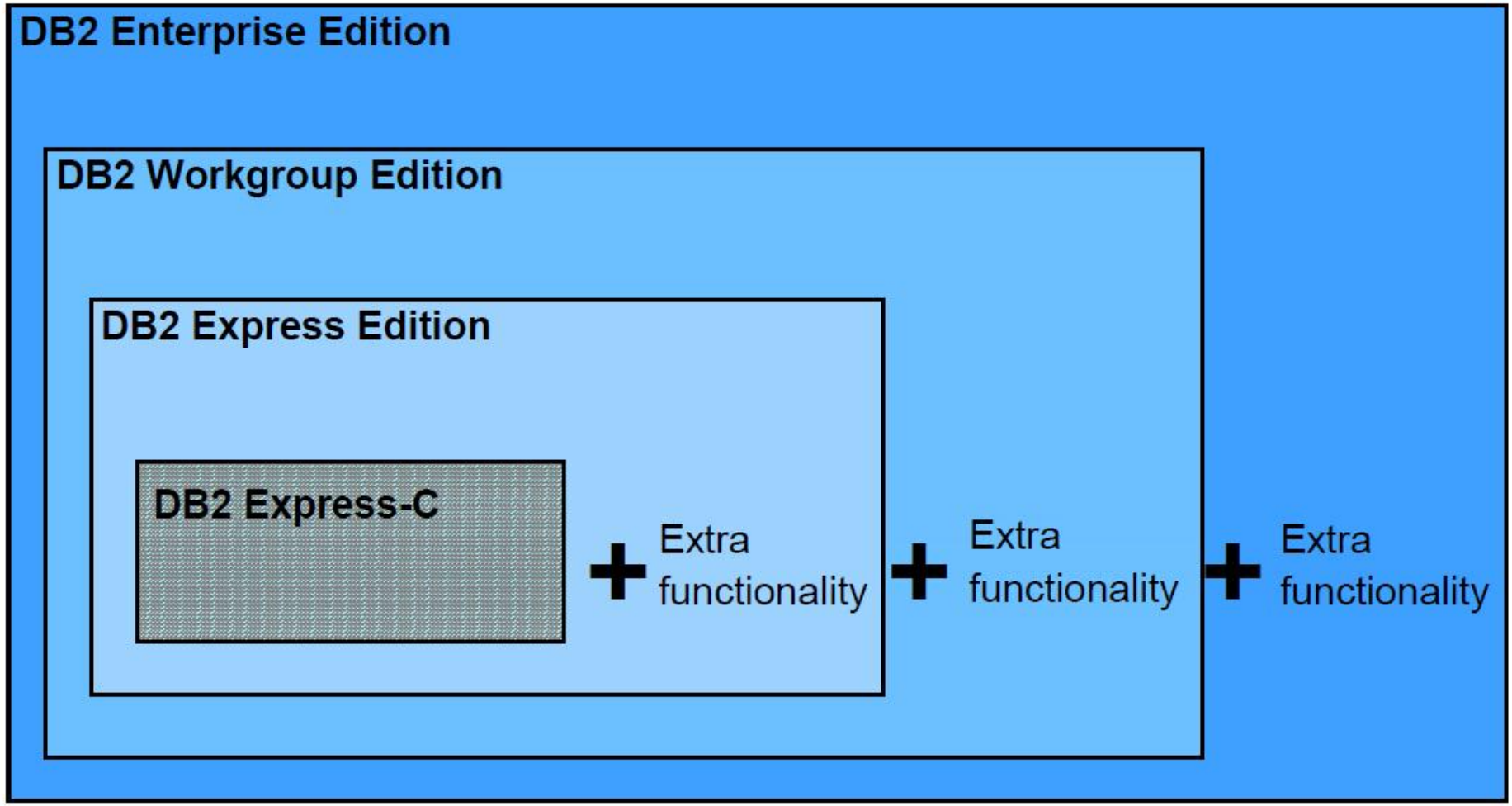
DB2 Information Management Software

Theme: Fully Exploit All Resources

- **Full exploitation of ALL available resources**
  - Within a single query
  - Across separate queries
- **Regardless of resource class/amount**
  - I/O bandwidth, Main memory, Cache,
  - CPUs, Comm. bandwidth
- **Regardless of architecture**
  - Uni, SMP, NUMA, SMP Cluster, MPP
- **With Seamless Scalability**
  - Application transparency
  - No migration



DB2 Server Editions



DB2 Editions

- DB2 Editions
  - DB2 Everyplace
  - DB2 Personal Edition (PE)
  - DB2 Express-C
  - DB2 Express
  - DB2 Workgroup Edition (limited and unlimited)
  - DB2 Enterprise Edition
  - Data Enterprise Developer Edition (DEDE)
- DB2 Clients
  - DB2 Run Time Client
  - DB2 Client
  - Java Common Client (JCC)
  - DB2 Client Lite

DB2 Editions (*continued*)

- DB2 Everyplace
  - Small footprint (less than 200 KB) for small devices
  - Allows mobile workers to access DB2 data sources through handheld devices and a synchronization server to replicate data in both directions
  - Application development tool to build handheld apps with drag-and-drop ease
- DB2 Personal Edition (PE)
  - A fully functional database for personal computers on Linux and Windows
  - Has all features of DB2 Express, but does not support connectivity to act as database server for remote clients but provides client for other DB2 servers
  - Audio, Image, Spatial and Video Extenders (single user)
  - For example, you can use DB2 PE to develop DB2 applications and rolling them out into a production environment on DB2 ESE V9, e.g. on AIX.

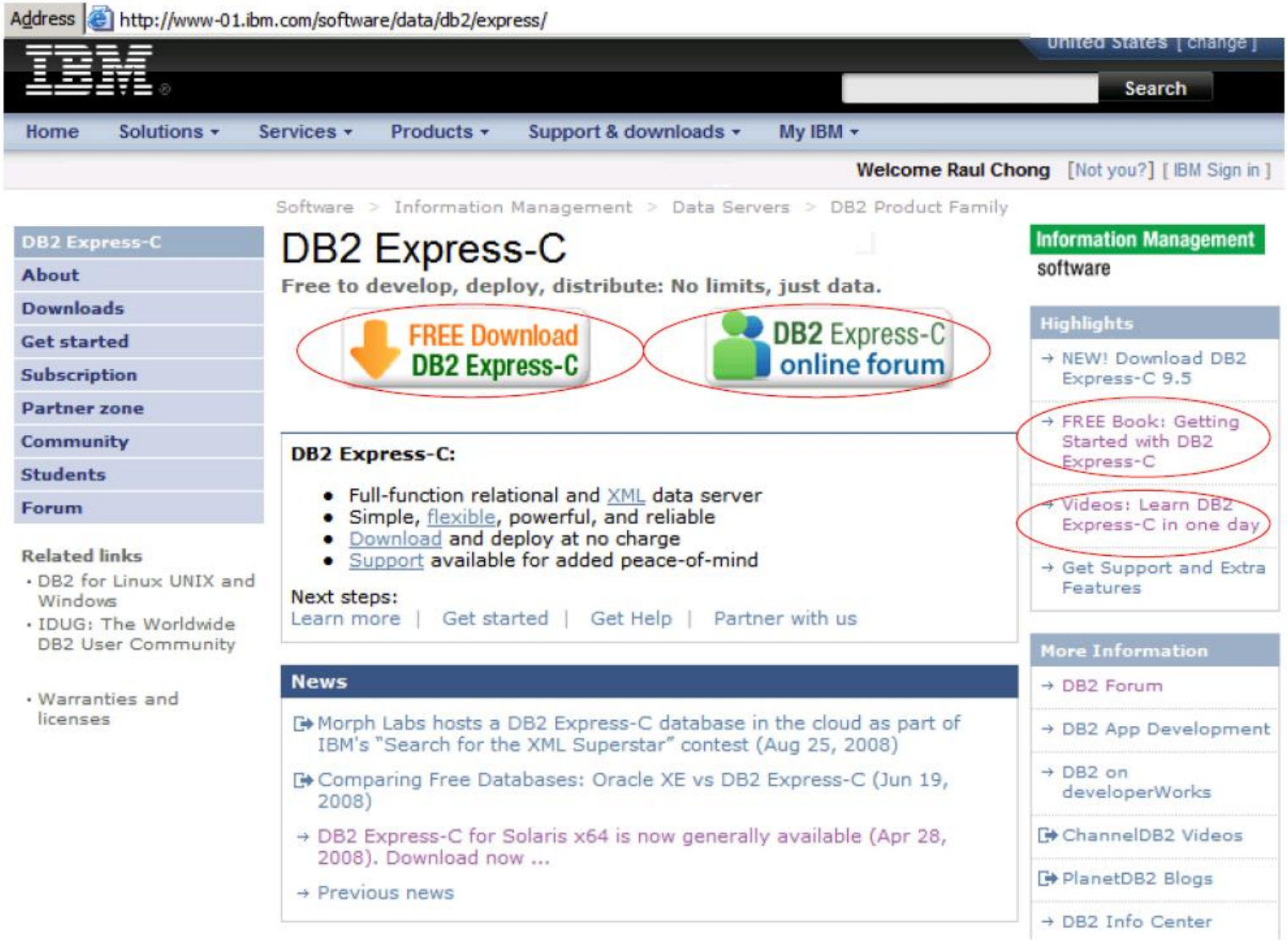
DB2 Editions (*continued*)

- DB2 Express Edition (DB2 Express)
  - Priced for small & medium business
  - Supports up to 2 CPUs
  - Linux and Windows only
  - Same functions as DB2 Workgroup Edition, but different by the amount and value unit (which equate to the power of a server‘s processor cores) you can have on a server. E.g.
    - Automates administration adaptive memory allocation, automatic storage management
    - Keeps data protected and available 24/7
    - Cuts costs with unique workload management capabilities
    - Powers the next generation of agile SOA applications with pureXML™

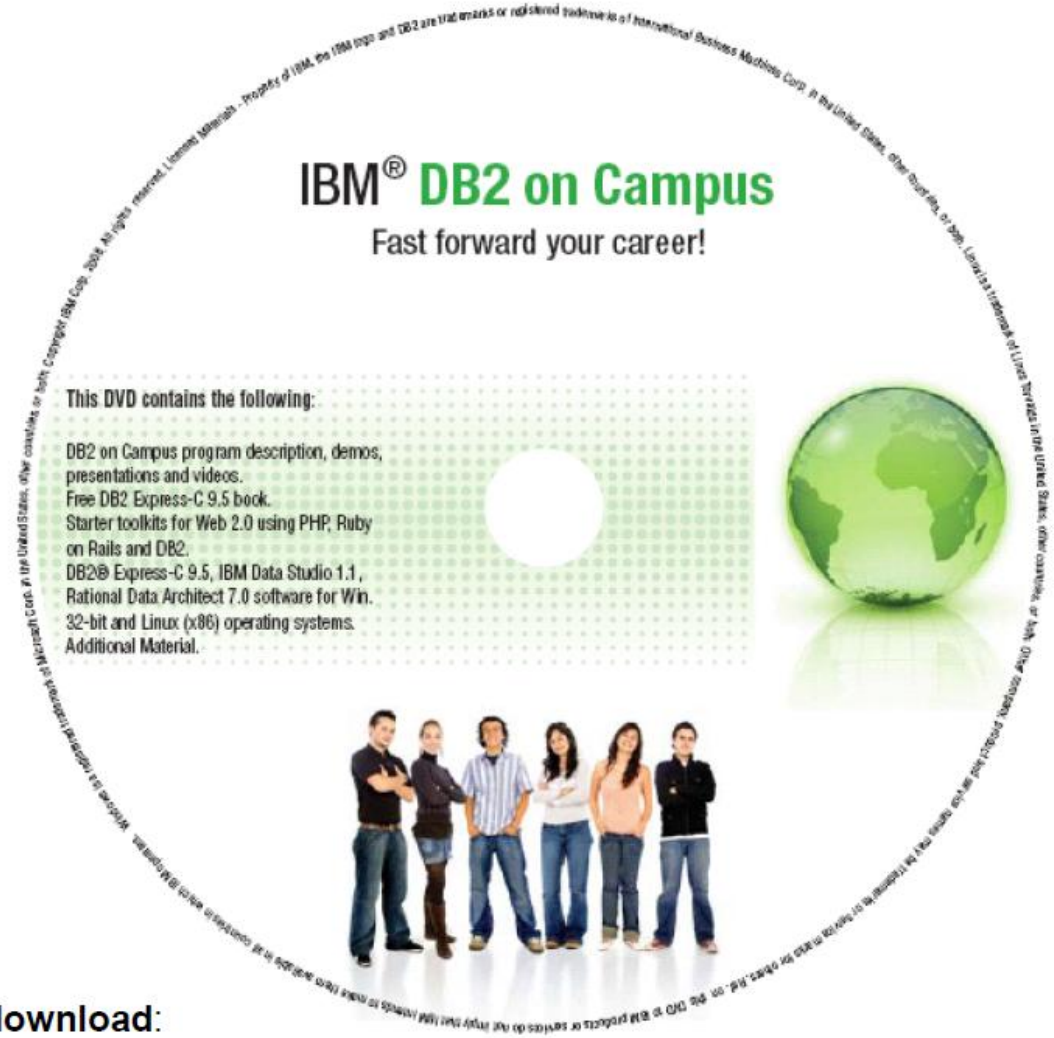
DB2 Editions (*continued*)

- DB2 Express-C
  - Freely licensed version for developers and community
  - http://www.channelDB2.com/oncampus Community
  - 64-bit enabled
  - Minus some extended features of EE:
    - HADR
    - Replication Data Capture
    - 24x7 Passport Advantage support model

DB2 Express-C Home Page: ibm.com/db2/express



Free DB2 on Campus DVD



DB2 Discovery Kit 9.7 download:

https://www14.software.ibm.com/webapp/iwm/web/preLogin.do?lang=en_US&source=swg-dmpr

DB2 Editions (*continued*)

- DB2 Workgroup Server Edition (WSE)
  - Authorized User (Min. 5 per Server), or Per Processor
  - For low user departmental machines using up to 4 CPUs
- DB2 Workgroup Server Unlimited Edition (WSUE)
  - Per Processor Licensing
  - Ideal for high user or web use
  - Up to 4 CPUs

DB2 Editions (*continued*)

- DB2 Workgroup Highlights
  - Powers the next generation of agile SOA applications with pureXML™
  - Minimizes costs with adaptive memory allocation, automatic storage management and more
  - Maximizes data availability by reducing planned and unplanned downtime
  - Cuts costs with unique workload management capabilities
  - Speeds performance of complex query workloads

DB2 Editions (*continued*)

- DB2 Enterprise Server Edition (ESE)
  - Authorized User (min. 25 per CPU) or Per Processor
  - Ideal for enterprise environments
    - CRM, ERP, SCM, Data Warehouses
  - Includes Host Database Connectivity
  - Informix Integration
  - Options Available:
    - Database Partitioning Feature (DPF)
    - Reduces storage needs by up to 80% using industry unique data compression capabilities
    - Powers the next generation of agile SOA applications with pureXML™
    - Reduces risk of unauthorized access with an innovative label based security model
    - Avoids unexpected performance problems with proactive query management and predictive analysis
    - Minimizes costs with adaptive memory allocation, automatic storage management and more
    - Scales with your preferred architecture: single-server, clusters of servers, or both with database partitioning and table partitioning
    - Maximizes data availability by reducing planned and unplanned downtime

Which DB2 9 Data Server is the right one?

	DB2 Express	DB2 Workgroup	DB2 Enterprise
Function	DB2 Express is a full-function hybrid data server, which provides very attractive entry-level pricing.	Includes all of the features of DB2 Express with scalability to larger servers.	Includes all of the features of DB2 Workgroup plus features required to provide the scalability to handle high user loads and provide 24x7x365 availability, including:
			• High Availability Disaster Recovery (HADR)
	• Simple installation including silent installation capability		• Tivoli System Automation
	• Self managing		• Table Partitioning
	• Optimized interfaces and tools for application developers		• Multi-dimensional data clustering
	• Supports wide array of development paradigms		• Materialized Query Tables
	• Minimal disk space requirements		• Full intra-query parallelism
	• Worldwide 24x7 Service and Support		• Connection concentrator

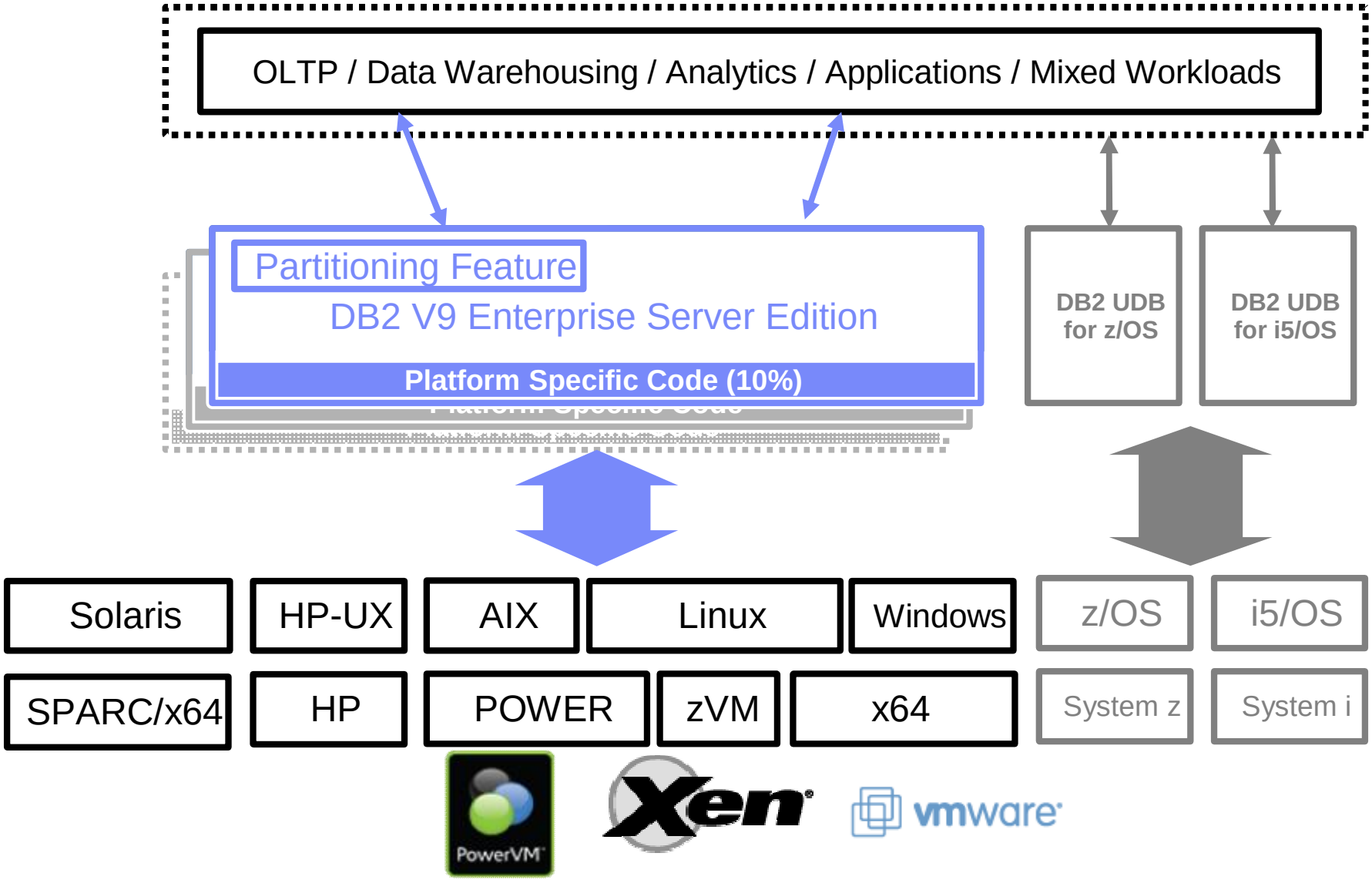
Which DB2 9 Data Server is the right one? (*continued*)

	DB2 Express	DB2 Workgroup	DB2 Enterprise
Customizable	Expandable with pureXML and optional enterprise class features to preserve improve performance, workload management, and high availability	Expandable with pureXML and optional enterprise class features to preserve improve performance, workload management, and high availability	Expandable with pureXML and advanced features like storage optimization, performance optimization, advanced access control, scale-out clustering, geodetic data, and more
Scalable	2 CPUs / 4 GB RAM max. (may run on machines with more than 4 GB)	4 CPUs / 16 GB RAM maximum	Unlimited
Platforms	Linux®, Solaris x86 and Windows®	Linux, UNIX® and Windows	Linux, UNIX and Windows
Pricing Metrics	Authorized User (Min 5 per server), or Per Processor	Authorized User (Min. 5 per Server), or Per Processor	(Authorized User (Min. 25 per CPU) or Per Processor

DB2 Host Databases

- DB2 for i5/OS
  - http://www.ibm.com/servers/eserver/iseries/db2/
- DB2 for z/OS
  - http://www.ibm.com/software/data/db2/os390/
  - also available: DB2 ESE for Linux on z/OS (just like DB2 for Linux on Intel)
- DB2 for VSE & VM
  - http://www.ibm.com/software/data/db2/vse-vm/

DB2 Platform Availability



DB2 v9 Family

DB2 Edition Comparisons

Express 9

- Linux (POWER, x86), Solaris/x64, & Windows, 32 and 64-bit platforms
- 200 PVUs
- 4GB Memory
- XML included
- SQL Replication
- Homogeneous Federation
- Online Reorg
- Backup Compression

Workgroup 9

- Linux (POWER, x86), Windows, AIX, Solaris (SPARC, x64), HP-UX IA-64
- 480 PVUs (480 PVU Server), 16GB Memory
- HADR, TSA included
- XML included
- SQL Replication
- Homogeneous Federation
- Online Reorg
- Advanced Copy Services
- Backup Compression

New Socket Based Option available

* 4 x socket limit per server

Enterprise 9

- Linux (POWER, x86, System z), Windows, AIX, Solaris (SPARC, x64), HP-UX IA-64
- No limits
- HADR, TSA included
- MQTs, MDCs included
- Eligible for Compression
- Table Partitioning
- XML included
- SQL Replication
- Homogeneous Federation
- DB2 Governor
- Connection Concentration
- Online Reorg
- Advanced Copy Services
- Backup Compression

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DB2 Family Platform Support

Personal & Express

- Windows
- Linux
- Solaris

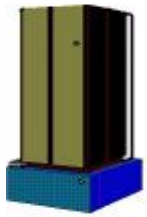
Workgroup

- AIX
- HP-UX
- Solaris
- Windows
- Linux

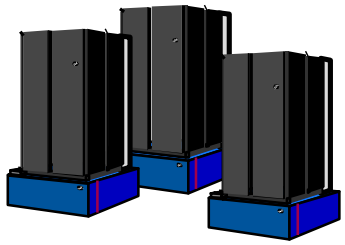
Hosts

- DB2 for i5/OS
- DB2 z/OS
- DB2 VM/VSE

ESE



ESE + DPF



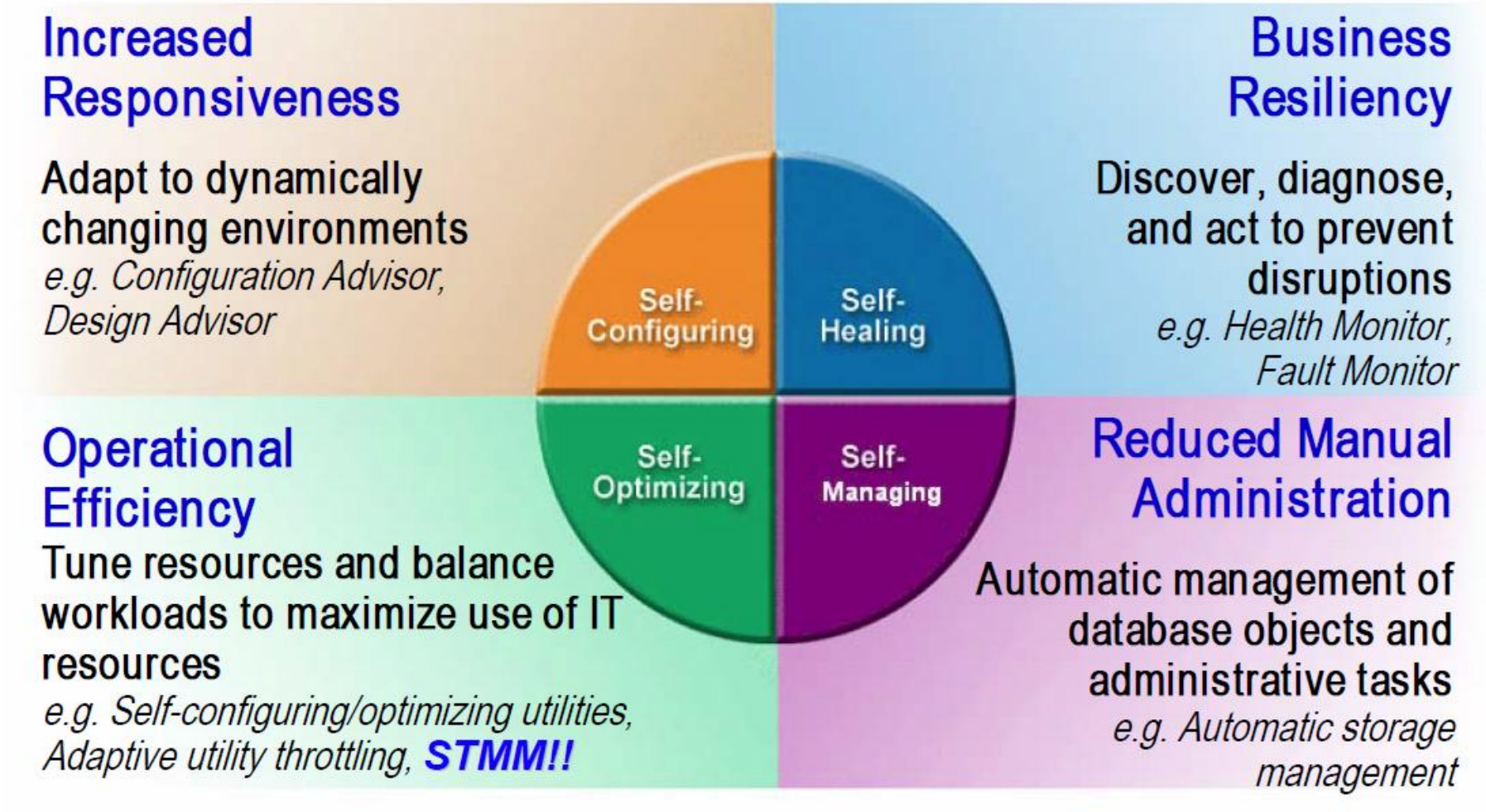
Enterprise Server Edition

- AIX
- HP-UX
- Solaris
- Windows
- Linux

Everyplace

- Pocket PC
- Linux
- PalmOS
- QNX Neutrino
- Symbian EPOC

Autonomic Computing Attributes & Examples with DB2



DB2 Client Software

- DB2 Run-Time Client
  - Best option if your only requirements are to enable applications to access DB2 9 data servers. They provide the APIs necessary to perform this task, including Java Common Client
  - Comes with no management tools
- DB2 Client
  - Includes runtime client
  - Provides tools to administer DB2 servers and libraries to develop applications that access DB2 servers
- Java Common Client (JCC)
  - 2 MB fully redistributable client
  - Provides JDBC and SQLJ applications access to DB2 data servers without installing and maintaining DB2 client code
  - Use the DB2 Connect product for connecting to a DB2 for System i or DB2 for System z data server

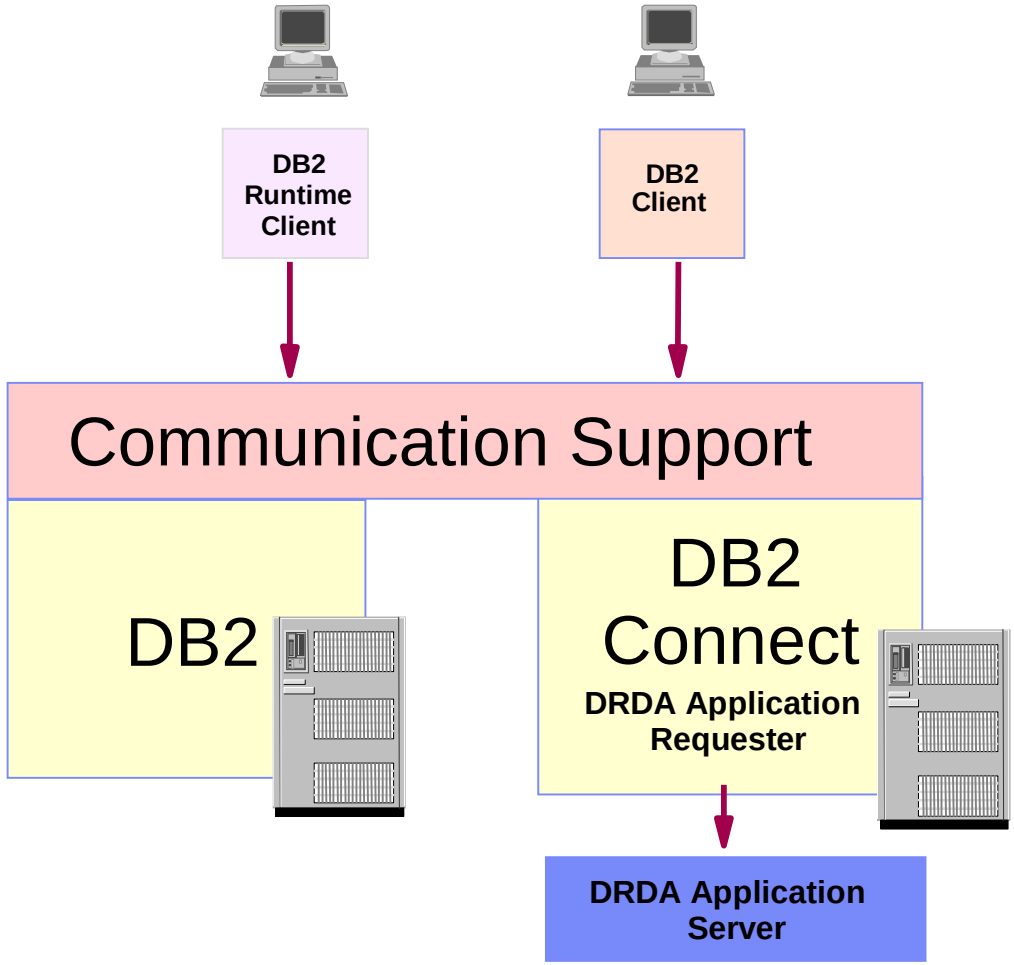
DB2 Client Software (*continued*)

- DB2 Client Lite
  - Small footprint
  - Provides similar functions as the JCC client and is used for CLI/ODBC applications.
  - Especially well suited for ISVs that want to embed connectivity in their applications without redistributing and maintaining DB2 client code.

DB2 Connect Editions

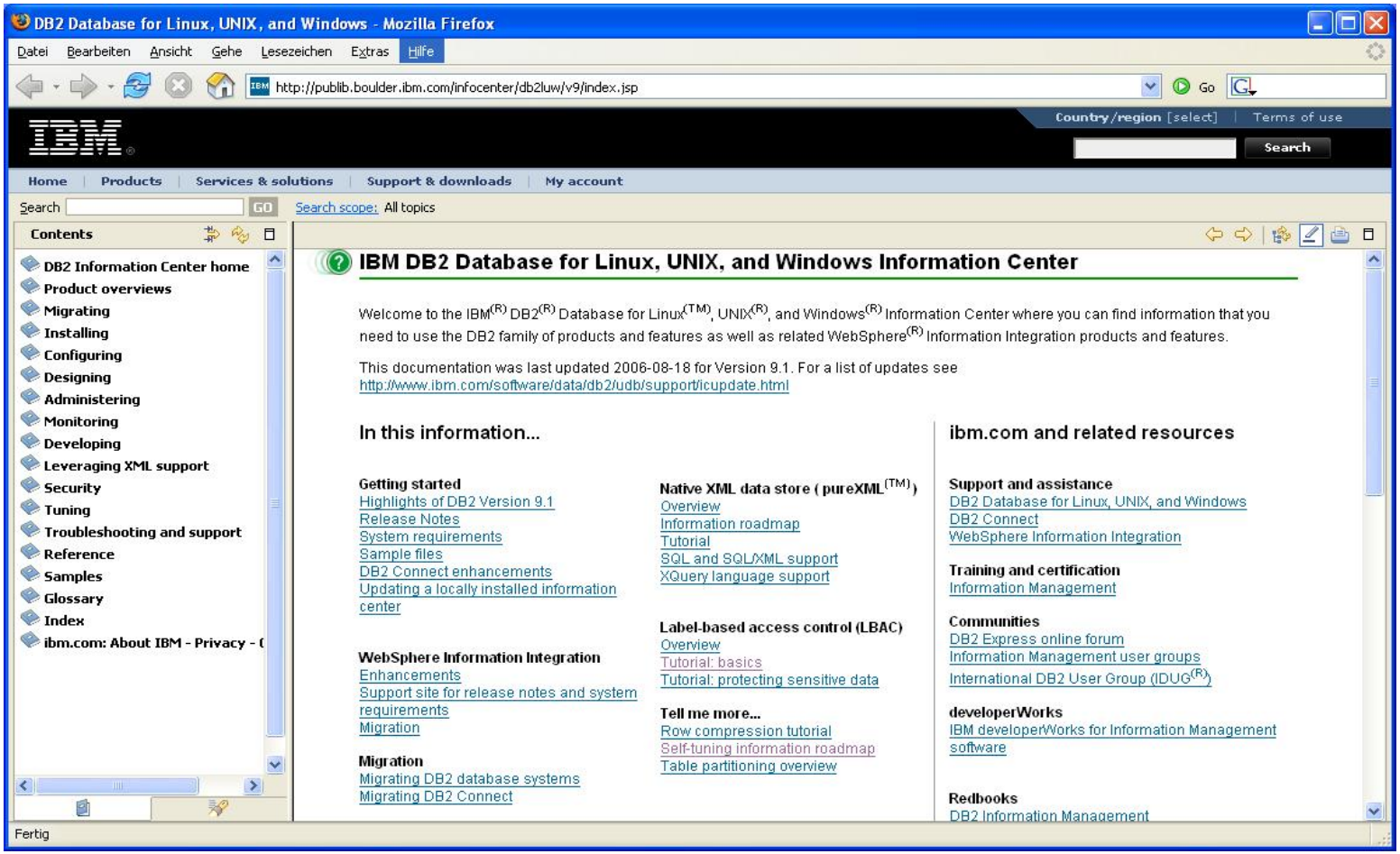
- DB2 Connect Enterprise Edition
- DB2 Connect Personal Edition
- DB2 Connect Unlimited Edition
- DB2 Connect Unlimited Edition for iSeries
- DB2 Connect Application Server Edition

Overview of DB2 Clients and Server Connectivity



Getting Help via DB2 Information Center

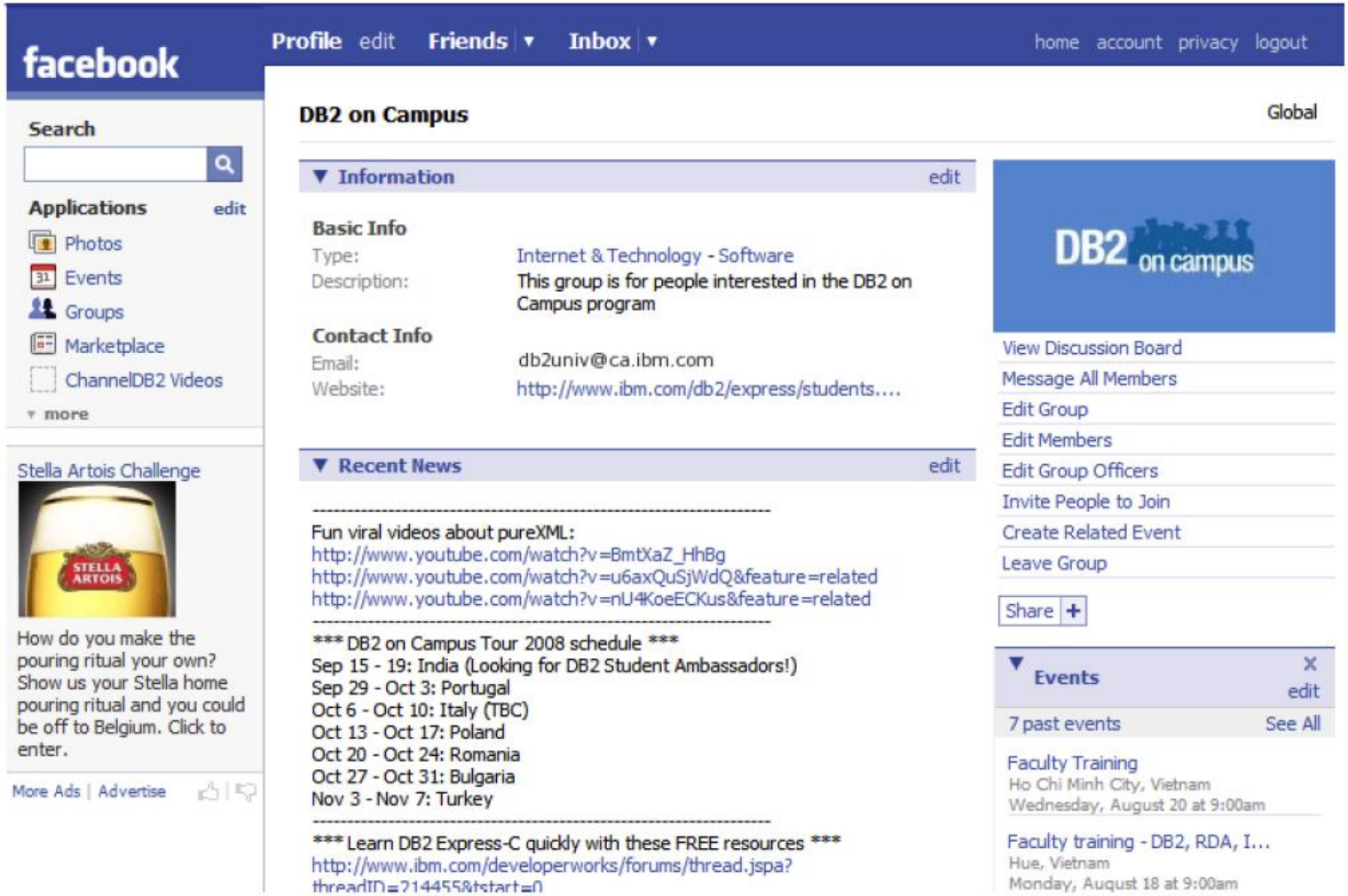
http://publib.boulder.ibm.com/infocenter/db2luw/v9/index.jsp



Google Support

- Google indexes the DB2 UDB Technical Library
- Look for search results from the “/infocenter/”
- Search is also possible through the DB2 News Groups

DB2 on Campus Group in facebook.com



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DB2 Instances

DB2 Information Management Software

DB2 Instances

- A DB2 instance is an environment in which DB2 commands and functions are executed
- It is also referred to as a DB2 database manager
- More than one instance can be defined on a server machine and each of them can be managed independently
- To start an instance
  - db2start
  - Starts the instance remotely
    - db2start REMOTE <instance node name>
  - Starts the instance in quiesced mode for administration purposes
    - db2start ADMIN MODE
- Terminate all database connections and stop an instance
  - db2stop force

Creating and Dropping DB2 Instances

- An instance is created on install by default
  - db2inst1 (UNIX and Linux)
  - DB2 (Windows)
- To create additional instances
  - db2icrt -u <fenced user ID> <instance name>
    - must specify fenced user ID for UNIX and Linux platforms
  - db2icrt <instance name>
    - for Windows platforms
- Terminate all database connections and drop an instance
  - db2idrop -f <instance name>
- To list existing instances defined in a server
  - db2ilist

Upgrading DB2 Instances

- To update a DB2 instance for access to functions associated with installation or removal of certain product options or fixpaks
  - db2iupdt <instance name>
- To migrate an existing instance, for UNIX and Linux platforms only
  - db2imigr <instance name>
    upgrades existing instance from older to newer version
- To create, drop, update, or migrate an instance, root or administrative access is required

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DB2 Environment

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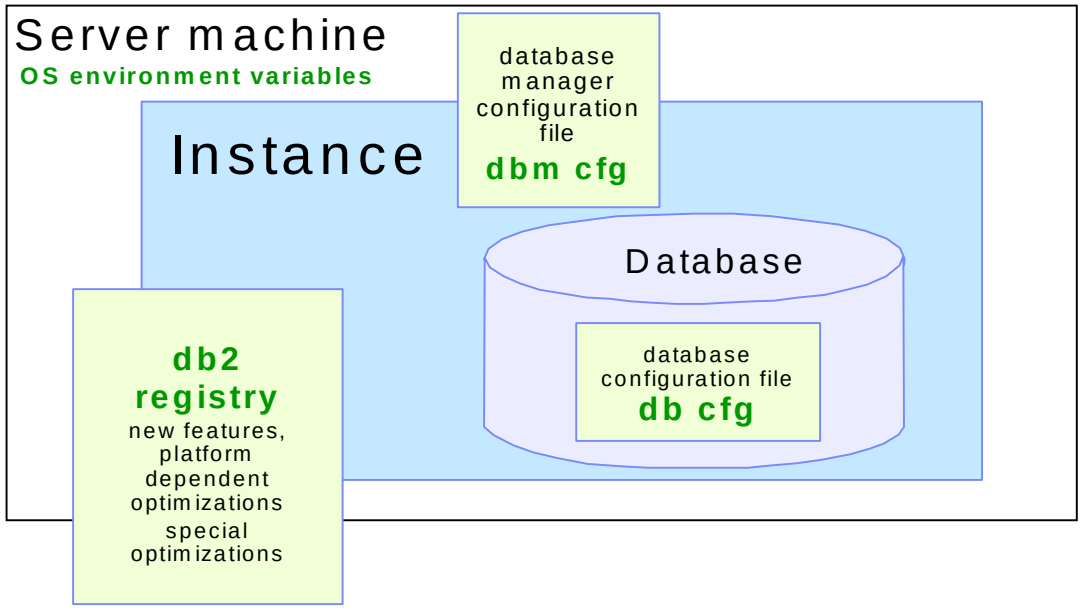
DB2 Environment

- Configure the DB2 environment via:
  - DB2 Profile Registry
  - Operating System (OS) Environment Variables
  - DB2 Database Manager Configuration Parameters
  - DB2 Database Configuration Parameters



DB2 Profile Registry (1)

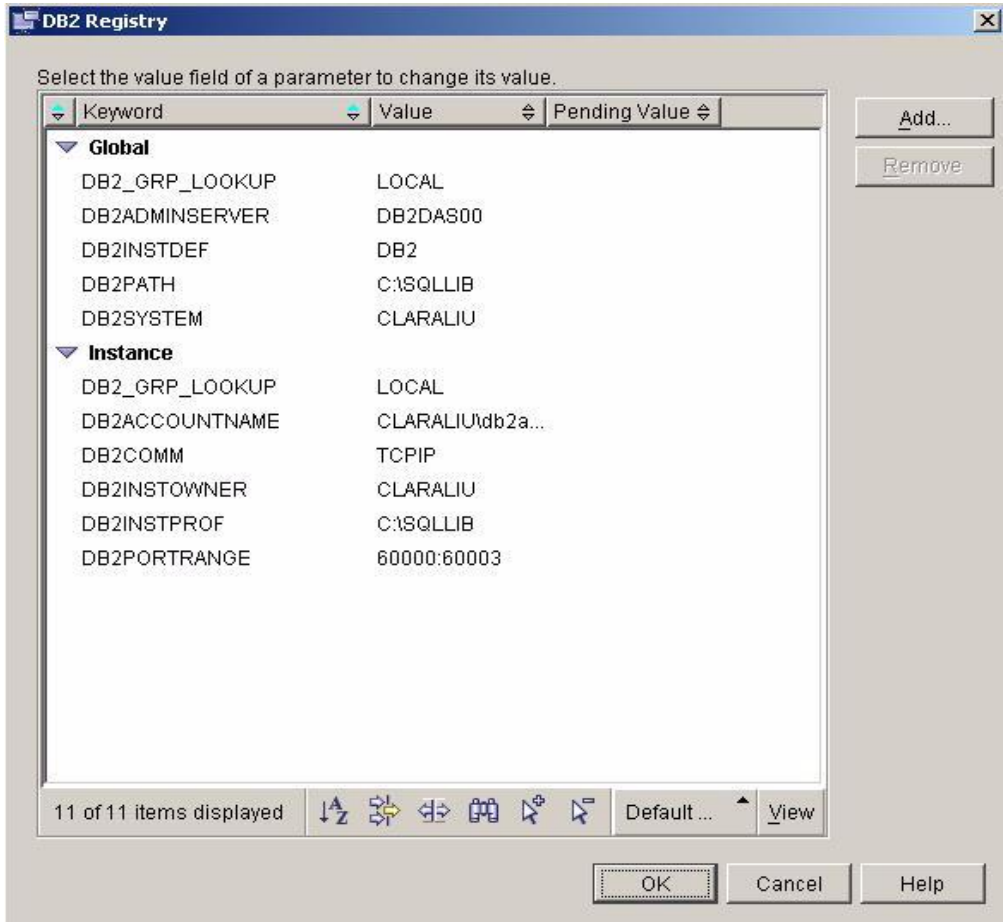
- DB2 profile registry allows for centralized control of the DB2 environment settings
- Usually platform-specific settings are configured using the DB2 profile registry
- No need to reboot the system after making changes to DB2 Registry, but may need to stop and restart the instance
- At its various level, controls many aspects of the DB2 UDB environment
  - DB2 Instance-Level Profile Registry **à** for 1 instance
  - DB2 Global-Level Profile Registry **à** for all instances
  - DB2 Instance-Node-Level Profile Registry **à** for 1 node
  - DB2 Instance Profile Registry **à** list of instances

DB2 Profile Registry (2)

- To list all DB2 registry variables currently set
  - db2set -all
- To display global registry variables
  - db2set -g
- To display instance registry variables
  - db2set -i <instname>
- To list all supported registry variables
  - db2set -lr
- To set a DB2 registry variable
  - db2set <parm>=<value>
    - e.g. db2set DB2COMM=TCPIP
  - Restart the instance for new changes to be in effect

Display DB2 Registry Variables

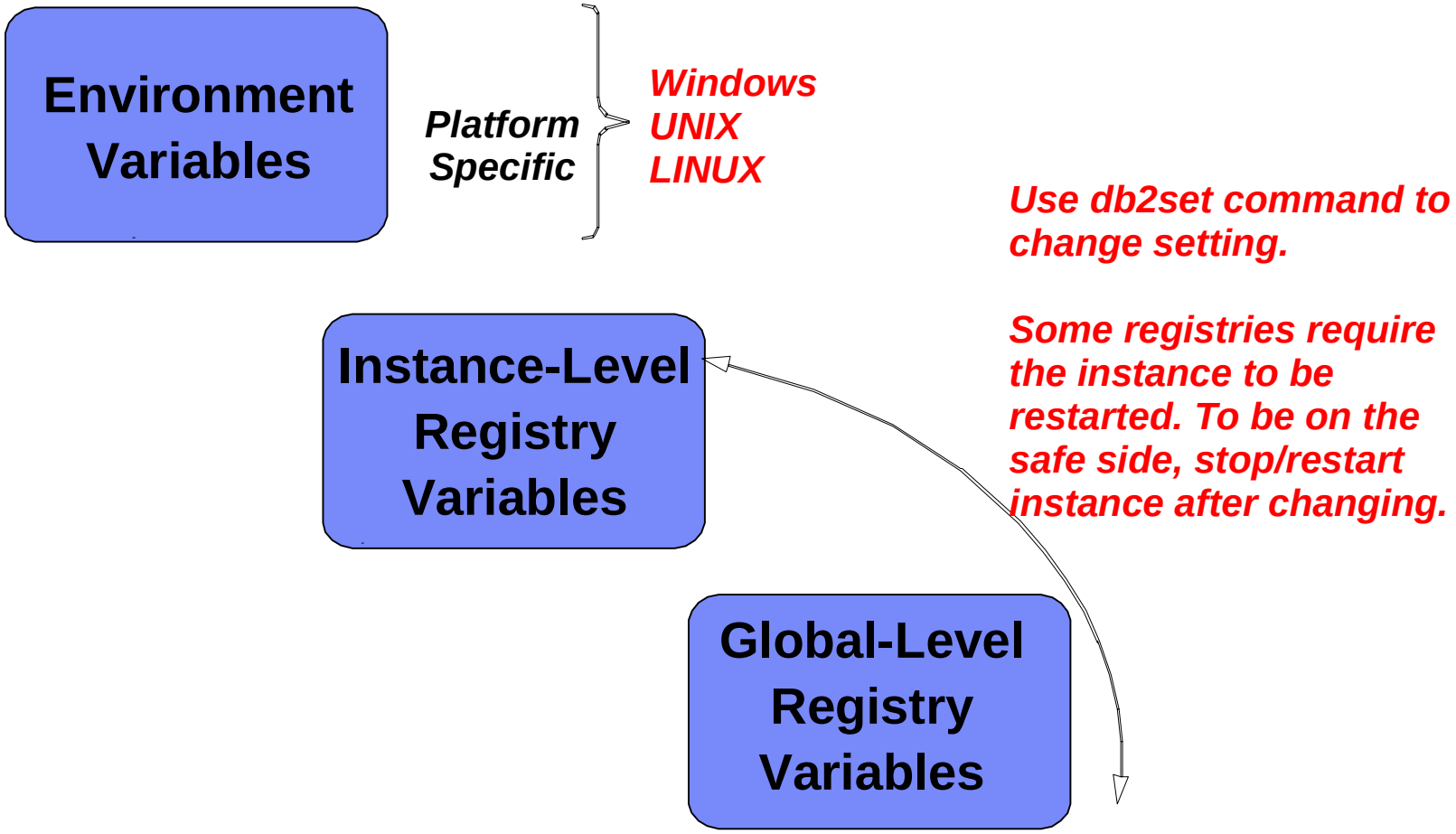
- Display with the DB2 Configuration Assistant



Operating System Environment Variables

- Most environment variables are controlled by the DB2 Profile Registry - those not stored in the DB2 Profile Registry can be referred to as system environment variables, and are set in a location where the platform stores its system variables:
  - Windows- Control Panel -> System -> Environment Variables
  - UNIX - .profile or .kshrc or .cshrc, they are typically incorporated with db2profile (Bourne or Korn shell) or db2cshrc (C shell) found in the instance owner's home directory
- Examples:
  - Windows - set DB2INSTANCE=PROD
  - UNIX - export DB2INSTANCE=PROD

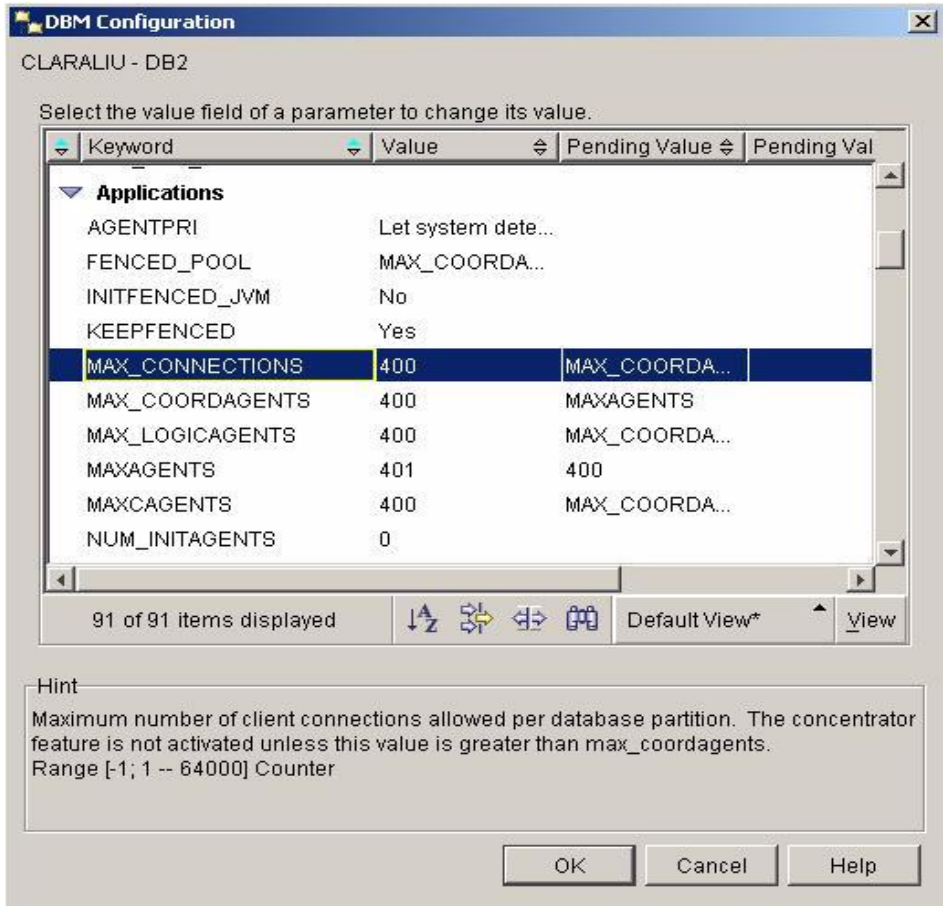
Setting DB2 Environment Variables



DB2 Configuration Parameters

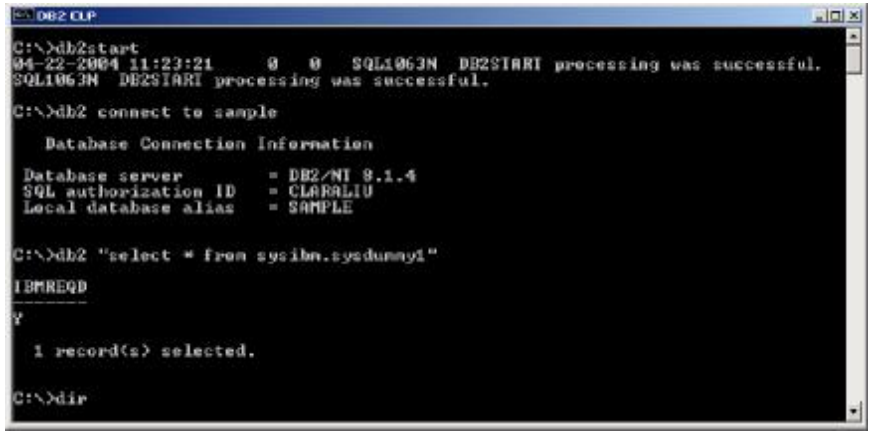
- Get/Set/Reset the Database Manager Configuration
  - GET DBM CFG [SHOW DETAIL]
    - show detail displays current and delayed values
  - UPDATE DBM CFG USING <param> <value>
  - RESET DBM CFG
- Get/Set/Reset the Database Configuration
  - GET DB CFG FOR <db> [SHOW DETAIL]
    - show detail displays current and delayed values
  - UPDATE DB CFG FOR <db> USING <param> <value>
  - RESET DB CFG FOR <db>
- DB2 Control Center can be used to display, update, and reset the DBM and DB configuration parameters

Display DBM Configuration Parameters with DB2CC



DB2 Command Window (Windows Only)

- DB2 Command Line Window (Windows Only)
  - click on the DB2 Command Window entry in the menu
  - invoke the interpreter by prefacing commands and SQL with 'db2'
    - e.g. db2 connect to sample
    - e.g. db2 "select * from employee"
    - e.g. db2 -tvf createtab.db2



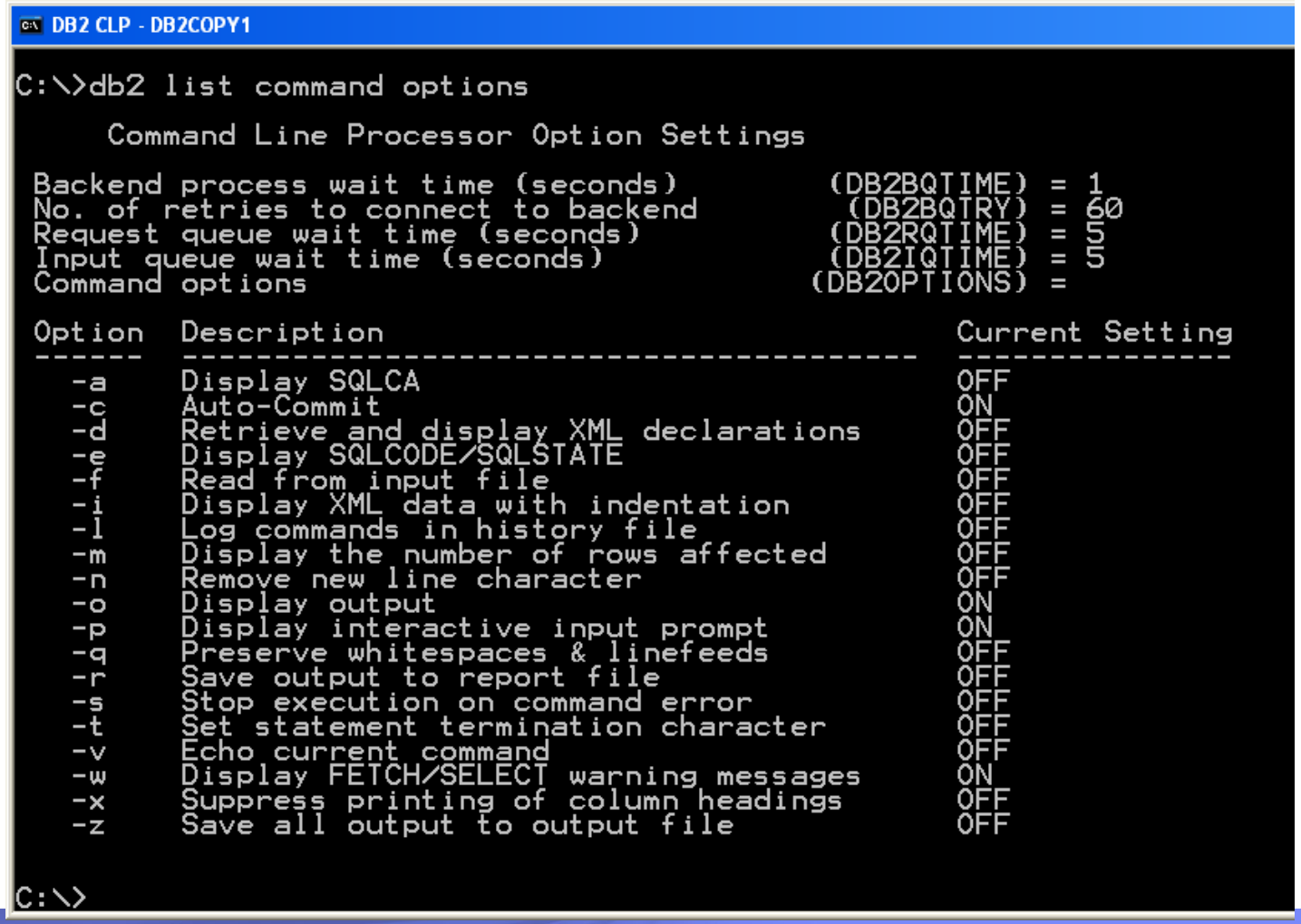
  - to end command line mode and terminate the DB2 backend process (db2bp), enter db2 terminate
  - all OS commands can be issued from the DB2 Command Window

DB2 Command Line Processor (CLP)

- click on the DB2 Command Line Processor icon or enter db2 at a command prompt in the DB2 Command Window
- an interactive input prompt appears:
  - db2 =>
- no need to prefix commands with 'db2'
  - e.g. db2 => connect to sample
- to end the interactive mode, enter quit
- to disconnect from the database and terminate the DB2 backend process (db2bp), enter terminate
- to execute OS commands, enter
  !<OS command>

Command Line Options

db2 list command options



Getting Help

- Obtain syntax and information for DB2 commands from the command line
  - db2 ? — list of all DB2 commands
  - db2 ? <db2-command> — get syntax help for a specific command
  - db2 ? SqlnnnN — get message and brief description of a specific SQLCODE
  - db2 ? db2nnnn — get message and brief description of a DB2 error code
- For example:
  - db2 ? catalog tcpip

```
CATALOG [ADMIN] TCPIP NODE node-name REMOTE hostname
  [SERVER service-name] [SECURITY {SOCKS}]
  [REMOTE_INSTANCE instance-name] [SYSTEM system-name]
  [OSTYPE os-type] [WITH "comment string"]
```

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Tools

DB2 Information Management Software

DB2 Governor and Query Patroller

- DB2 Governor Utility
  - A governor instance consists of a front-end utility and one or more daemons.
  - Collect information about the applications that run against the database.
  - Check the information collected against the rules in the governor configuration file.
  - Takes actions if specified.
  - The governor logs any actions that it takes.
- DB2 Query Patroller is a query management system.
  - It is included in DB2 Data Warehouse Enterprise Edition. It is also available separately.
  - Allow you to regulate your database's query workload so that small queries and high-priority queries can run promptly.
  - Track and cancel runaway queries.
  - Collect and analyze information to determine trends across queries, heavy users, and frequently used tables and indexes.

DB2 GUI Tools

- Control Center
  - Central point of administration
- Command Center
  - GUI wrapper for command line processor (CLP)
- Journal
  - Central point for logging DB2 Activities
- License Center
  - Central point of DB2 license management
- DB2 Developer Workbench
  - Central point for developing
- Task Center
  - Central point for scheduling database jobs
- Health Center
  - Central point for DB2 Health Montoring
  - Memory Visualizer
- Configuration Assistant
  - Tool to configure the client
  - A light-weight version of the Control Center
- Replication Center
  - A GUI tool to set up and administer a replication environment and to run the Capture and Apply programs

DB2 Administration Server (DAS)

- A background process to support instance administration
  - db2as on UNIX and Linux (default)
  - DB2DAS service on Windows (default)
- Provides support services for DB2 tools such as the Control Center, Configuration Assistant, Replication Center, and Development Center
- Some DAS commands:
  - `db2admin create`
  - `db2admin` (to obtain the name of the DAS on the machine)
  - `db2admin start`
  - `db2admin stop`
  - `db2 get admin cfg`
  - `db2 update admin cfg using <parm> <value>`

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System Catalog

DB2 Information Management Software

Roadmap to Catalog Tables (1)

- Schema: Table = SYSIBM View = SYSCAT

TABLE	VIEW	DESCRIPTION
SYSDBAUTH	DBAUTH	Authorities on database
SYSCHECKS	CHECKS	Check constraints
SYSCOLUMNS	COLUMNS	Column definitions
SYSCOLCHECKS	COLCHECKS	Columns referenced by check constraints
SYSCOLDIST	COLDIST	Detailed columns statistics
SYSKEYCOLUSE	KEYCOLUSE	Columns used in keys
SYSCONSTDEP	CONSTDEP	Constraint dependencies
SYSDATATYPES	DATATYPES	Datatype definitions (built-in & UDT)
SYSEVENTMONITORS	EVENTMONITORS	Event Monitor Definitions
SYSEVENTS	EVENTS	Events currently monitored
SYSFUNCPARMS	FUNCPARMS	Definitions of Parameters/ Results of UDFs
SYSFUNCTIONS	FUNCTIONS	UDF definitions
SYSINDEXAUTH	INDEXAUTH	Index privileges
SYSINDEXES	INDEXES	Index definitions

Roadmap to Catalog Tables (2)

- Schema: Table = SYSIBM View = SYSCAT

TABLE	VIEW	DESCRIPTION
SYSPACKAGEAUTH	PACKAGEAUTH	Authorities on packages
SYSPACKAGEDEP	PACKAGEDEP	Package dependencies
SYSPACKAGES	PACKAGES	Package definitions
SYSREFERENCES	REFERENCES	Referential constraints definitions
SYSSTATEMENTS	STATEMENTS	Details of package SQL Statements
SYSTABAUTH	TABAUTH	Table Authorities
SYSTABCONST	TABCONST	Table constraint definitions
SYSTABLES	TABLES	Table definitions
SYSTABLESPACES	TABLESPACES	Table Space Definitions
SYSTRIGDEP	TRIGDEPEVENTS	Trigger dependencies
SYSTRIGGERS	TRIGGERS	Definitions of triggers
SYSVIEWDEP	VIEWDEP	View dependencies
SYSVIEWS	VIEWS	View definitions

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Process and Memory Model

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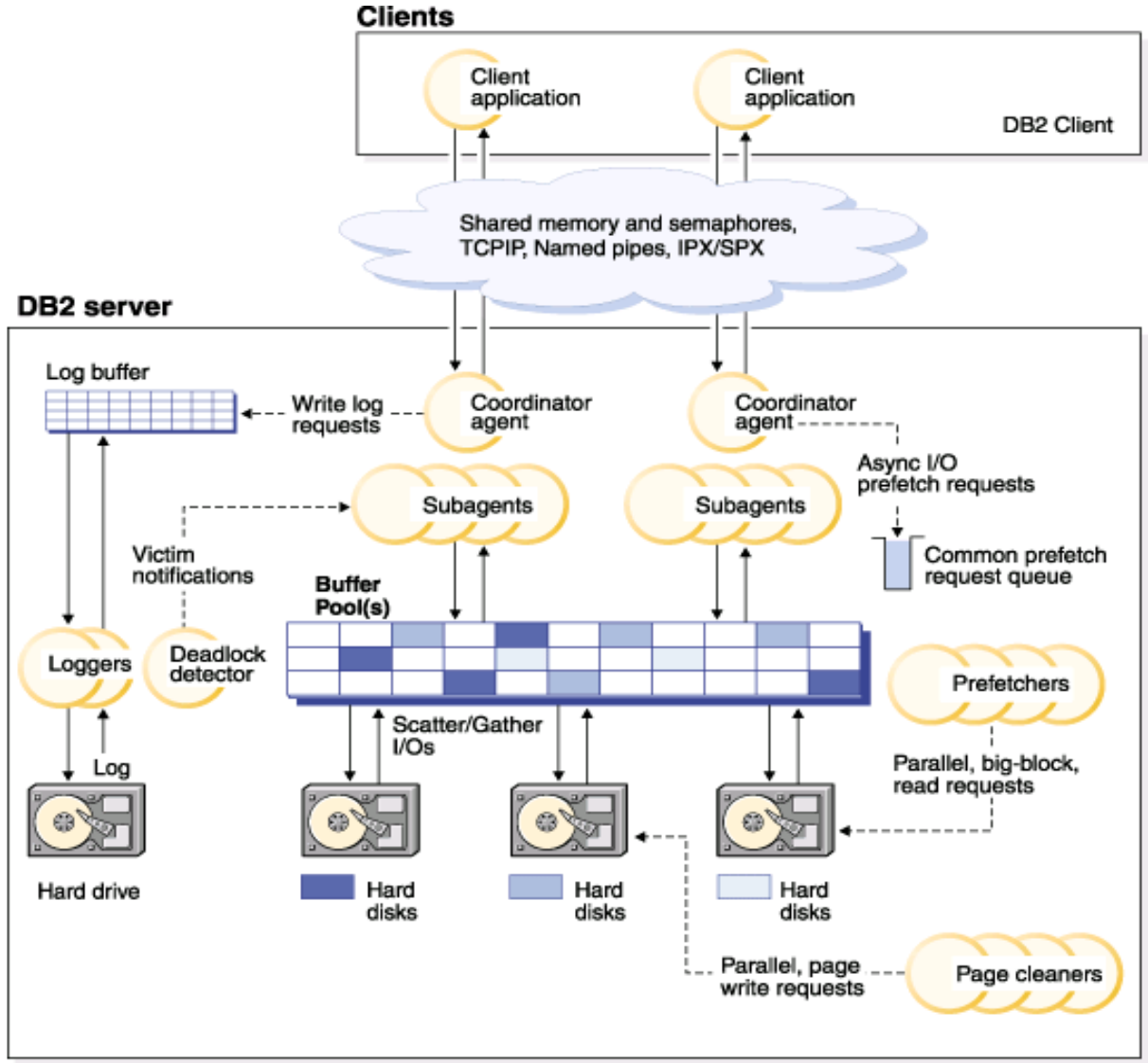
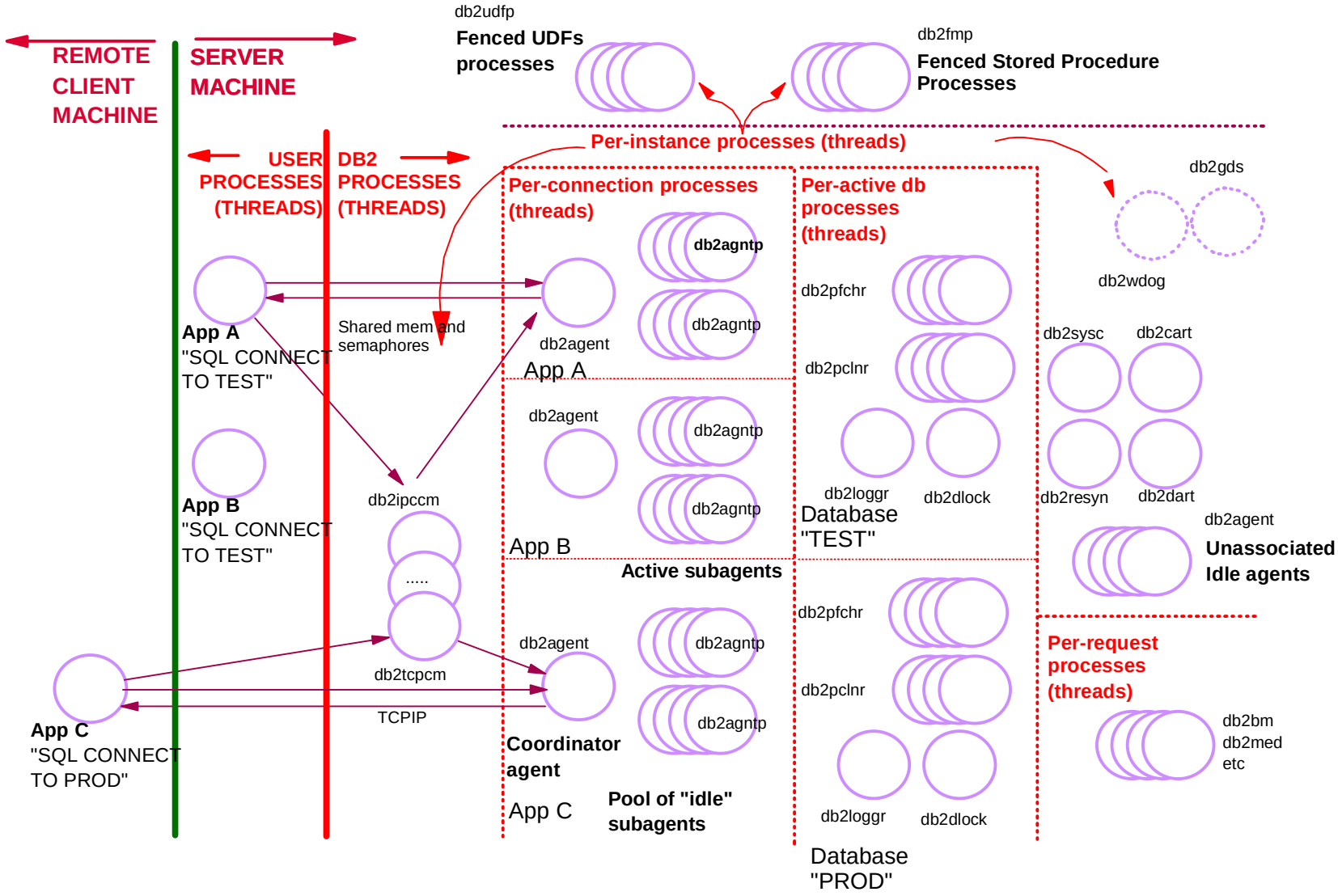
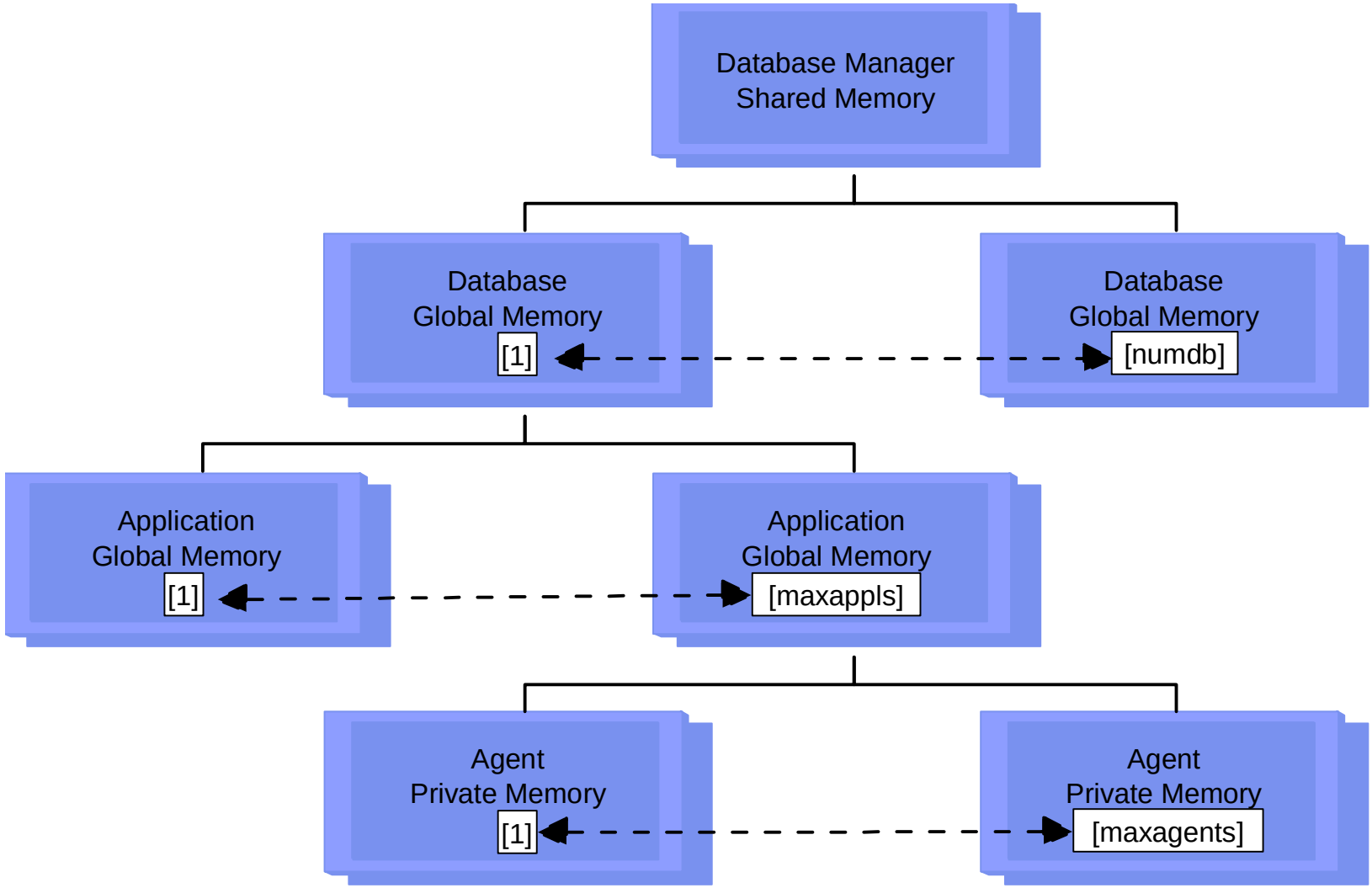
DB2 Architecture and Process Overview



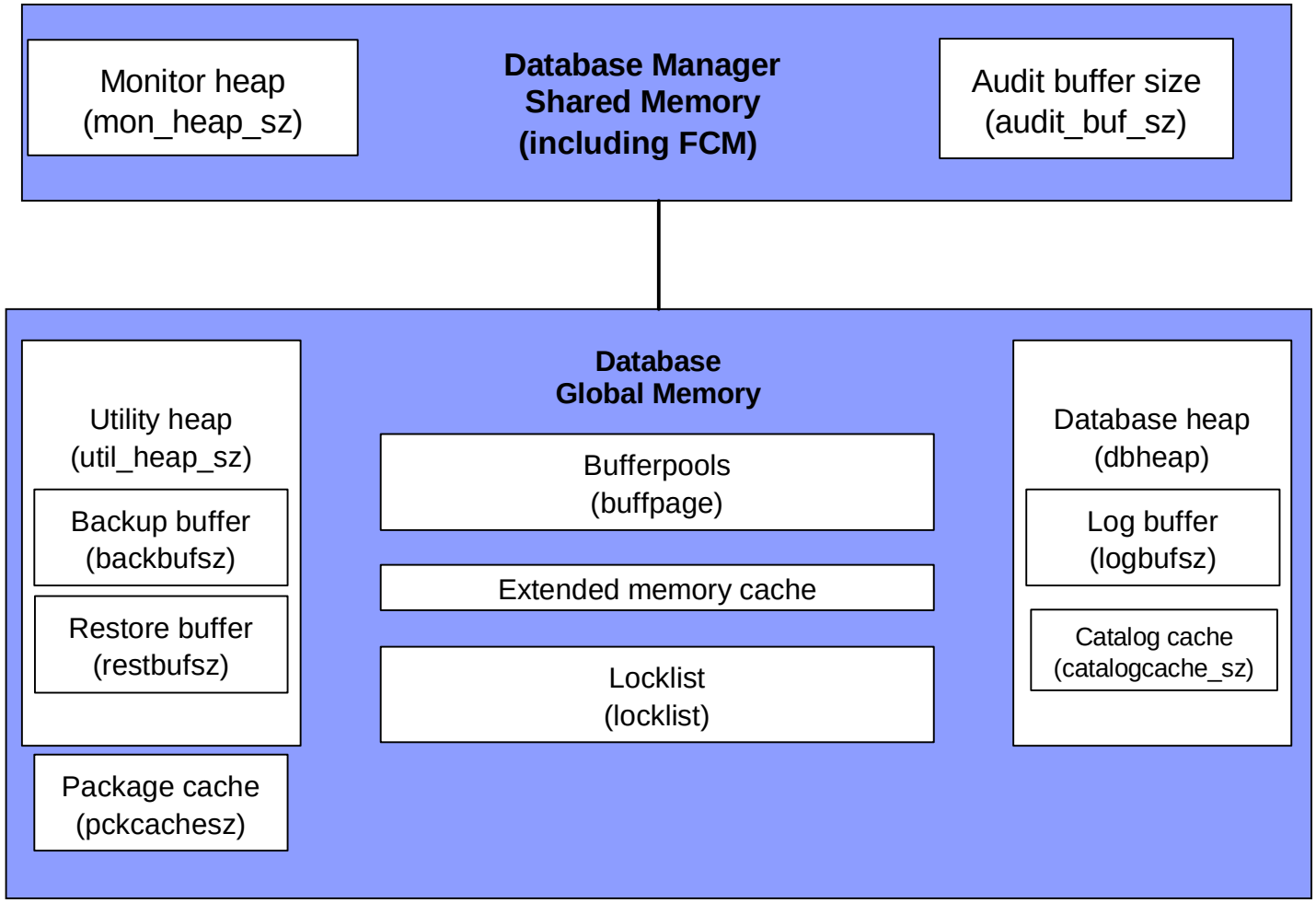
DB2 Process Model



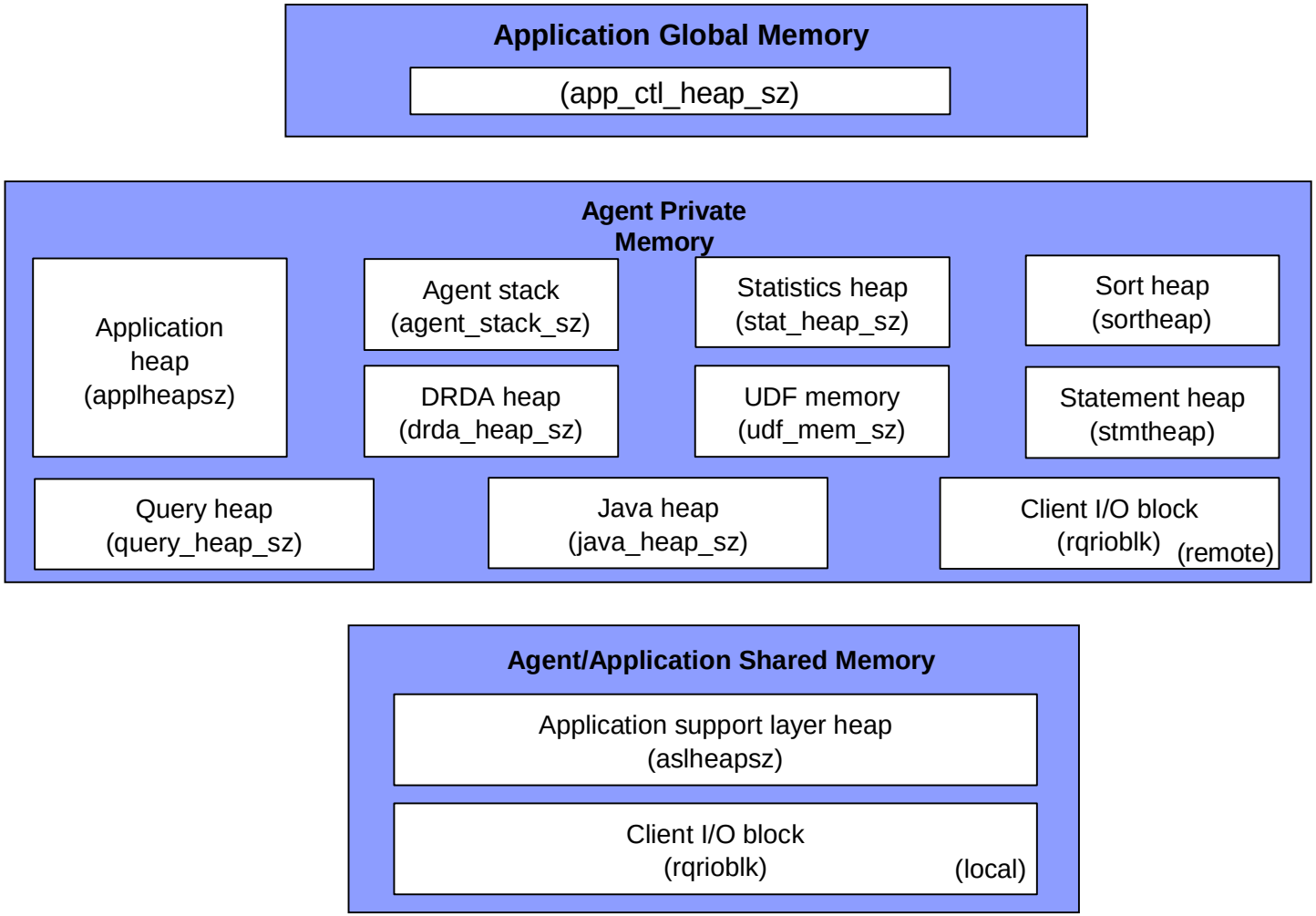
DB2 Memory Model (1)



DB2 Memory Model (2)



DB2 Memory Model (2) – (*continued*)



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Database Security Aspects

DB2 Information Management Software

DB2 Security Overview

- There are three main mechanisms within DB2 that allow a DB2 to implement a security plan
  - ***Authentication***
    - DB2 works closely with the security features of the underlying operating system to verify user IDs and passwords. In other words “you are who you say you are”
  - ***Authorization***
    - Determines the operations that users and/or group authorities can perform and the data objects that they may access
    - Examples of authorities: SYSADM, DBADM, SECADM
  - ***Privileges***
    - Privileges are more granular than authorities and can be assigned to users and/or groups. Privileges help define the objects that a user can create, access and drop, etc. New in DB2 9 is LBAC which provides a more granular approach to granting privileges!

Changes to Authorities in DB2 9.7

- **System Monitor** (SYSMON) authority scope has been **extended**
  - Now able to use the db2 memory tracker (db2mtrk) for a report of memory status
  - Now able to use the LIST commands to better monitor the system. Affected list commands:
    - LIST DATABASE PARTITION GROUPS, LIST DRDA INDOUBT TRANSACTIONS, LIST PACKAGES, LIST TABLES, LIST TABLESPACE CONTAINERS, LIST TABLESPACES, LIST UTILITIES

- **System Administrator** (SYSADM) authority scope has been **reduced**
  - No longer has implicit DBADM authority
  - They are automatically grant DATAACCESS, ACCESSCTRL, SECADM and DBADM for that database, which gives them the same abilities as in Version 9.5
  - No longer able to grant any authorities or privileges except tablespace privileges

Changes to Authorities in DB2 9.7

- **Security administrator** (SECADM) abilities have been **extended**
  - Now grant and revoke all authorities and privileges, including DBADM and SECADM
  - Now grant SECADM authority to roles and groups
  - SECADM authority is no longer necessary to run the audit stored procedures and table functions
    - AUDIT_ARCHIVE AUDIT_LIST_LOGS AUDIT_DELIM_EXTRACT

- **Database administrator** (DBADM) authority scope has been **reduced**
  - No longer automatically grants : BINDADD, CONNECT, CREATETAB, CREATE_EXTERNAL_ROUTINE, CREATE_NOT_FENCED_ROUTINE, IMPLICIT_SCHEMA, QUIESCE_CONNECT, LOAD
  - When the security administrator grants DBADM authority, they can choose whether to give the database administrator the ability to perform the following operations:
    - Accessing data within the database..
      - GRANT option WITH DATAACCESS or WITHOUT DATAACCESS
    - Granting and revoking privileges and authorities.
      - GRANT option WITH ACCESSCTRL or WITHOUT ACCESSCTRL

Authority: SQLADM

- SQLADM authority can be granted by the security administrator (who holds SECADM authority) or a user who possesses ACCESSCTRL authority
- SQLADM authority can be granted to a user, a group, a role, or to PUBLIC
- SQLADM authority gives a user the ability to perform the following functions:
  - Execution of the following SQL statements:
    - CREATE EVENT MONITOR
    - DROP EVENT MONITOR
    - EXPLAIN
    - FLUSH EVENT MONITOR
    - FLUSH OPTIMIZATION PROFILE CACHE
    - FLUSH PACKAGE CACHE
    - PREPARE
    - REORG INDEXES/TABLE
    - RUNSTATS
    - SET EVENT MONITOR STATE
  - Execution of certain clauses of the workload manager SQL statements

Authority: WLMADM

- WLMADM authority can be granted by the security administrator (who holds SECADM authority) or a user who possesses ACCESSCTRL authority
- WLMADM authority can be granted to a user, a group, a role, or to PUBLIC
- WLMADM authority gives a user the ability to perform the following operations:
  - Create, alter, comment on, and drop the following workload manager objects:
    - Histogram templates
    - Service classes
    - Thresholds
    - Work action sets
    - Work class sets
    - Workloads
  - Grant and revoke workload privileges
  - Execute the system-defined workload management routines

Authority: EXPLAIN

- EXPLAIN authority can be granted by the security administrator (who holds SECADM authority) or by a user who possesses ACCESSCTRL authority
- The EXPLAIN authority can be granted to a user, a group, a role, or to PUBLIC
- It gives the ability to execute the following SQL statements:
  - EXPLAIN
  - PREPARE
  - DESCRIBE on output of a SELECT statement or of an XQuery statement

Authority: DATAACCESS

- DATAACCESS authority can be granted only by the security administrator (who holds SECADM authority)
- It can be granted to a user, a group, or a role. PUBLIC cannot obtain the DATAACCESS authority either directly or indirectly
  - For all tables, views, materialized query tables, and nicknames it gives these authorities and privileges:
    - LOAD authority on the database
    - SELECT privilege (including system catalog tables and views)
    - INSERT privilege
    - UPDATE privilege
    - DELETE privilege
  - In addition, DATAACCESS authority provides the following privileges:
    - EXECUTE on all packages
    - EXECUTE on all routines (except audit routines)

Authority: ACCESSCTRL

- ACCESSCTRL authority is the authority required to grant and revoke privileges on objects within a specific database. ACCESSCTRL authority has no inherent privilege to access data stored in tables, except the catalog tables and views.
- ACCESSCTRL authority can only be granted by the security administrator (who holds SECADM authority). It can be granted to a user, a group, or a role. PUBLIC cannot obtain the ACCESSCTRL authority either directly or indirectly. ACCESSCTRL authority gives a user the ability to perform the following operations:
- Grant and revoke a subset of administrative authorities:
  - NOT DATAACCESS
- Grant and revoke the following database authorities:
- Grant and revoke all privileges
- This authority is a subset of security administrator (SECADM) authority.