WLM, DB2, and enclaves: the inside story

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Agenda

- ■ What is an enclave anyway?
- ■ What problems are being solved?
  - – DB2 V4 - distributed DB2 requests (DDF)
  - – DB2 V5 - sysplex query parallelism
  - – DB2 V5 - stored SQL procedures
- ■ Other workloads using enclaves

What is an enclave?

- Represents a "business unit of work"
- Is managed separately from the address space
- Can include multiple SRBs/TCBs
  - SRBs are preemptible type
- Can span multiple address spaces
- Can have many enclaves in a single address space
- Exists in both goal and compatability mode
  - assigned to service class or PGN
  - managed separately from address space

DDF

Management of DDF Work
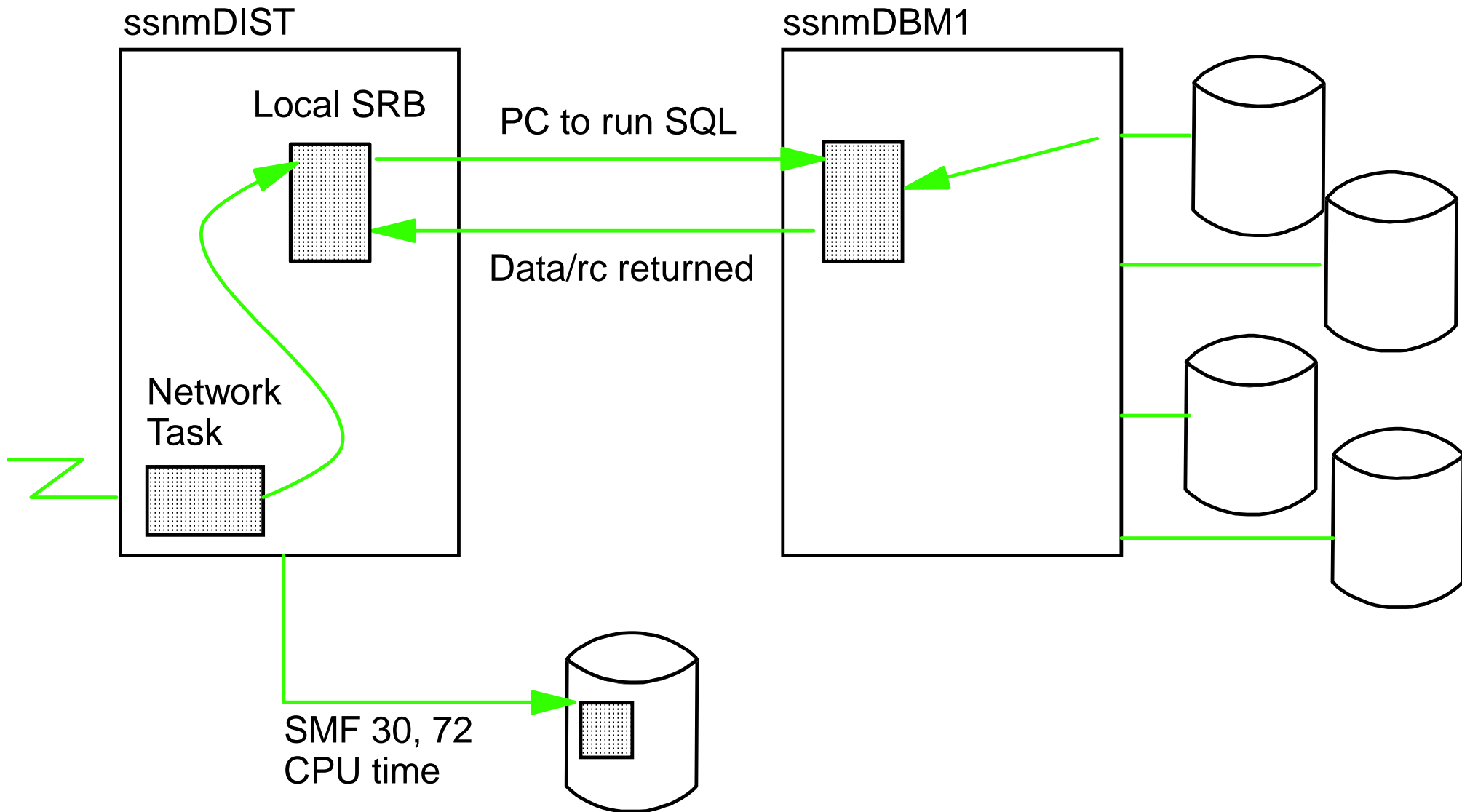
- **Problem**:
  - Heavy DDF loads can prevent entry of new requests
  - No way to manage DDF transactions individually...everything runs with the ssnmDIST address space's controls
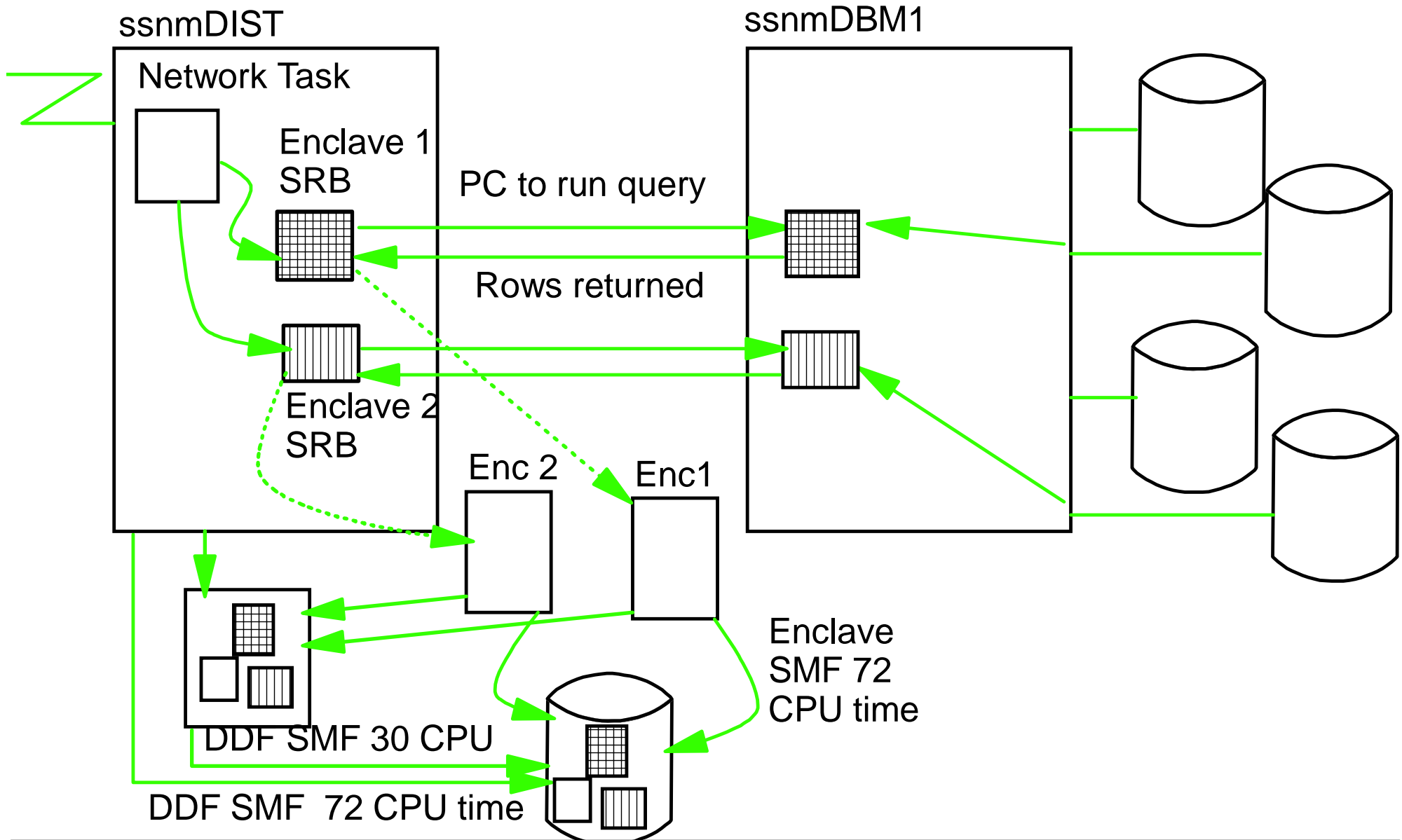
- **Solution:**
  - Make DDF transactions visible to SRM as enclaves
    - ▸ Individually, classified, managed, and reported
    - ▸ Subject to period switch
  - Work is run under SRBs that are dispatched like tasks rather than like local SRBs

Previous DDF Implementation

ssnmDIST

ssnmDBM1

Local SRB

PC to run SQL

Data/rc returned

Network
Task

SMF 30, 72
CPU time

Managing DDF Work in DB2 V4R1

ssnmDIST

ssnmDBM1

Network Task

Enclave 1
SRB

PC to run query

Rows returned

Enclave 2
SRB

Enc 2

Enc1

Enclave
SMF 72
CPU time

DDF SMF 30 CPU

DDF SMF 72 CPU time

Enclave Accounting

- Each enclave represents an individual SRM transaction

- Transaction counts and resource usage are recorded in the SMF 72 record for the enclave's service class and report class

- No SMF 30 records for enclaves themselves. Transaction counts and resource usage are recorded in the SMF 30 of the owning address space.

- CPU time consumed by enclaves is recorded in the SMF 89 records of home address space for usage-based pricing.

- SRBs scheduled to an enclave are preemptible, like tasks.

Each enclave represents an individual SRM transaction. An enclave transaction is assigned to a service class or pgn, and its resource usage and execution delays are tracked separately from the address spaces where it runs.

Enclave transaction counts and resource usage are recorded in the SMF 72 record for the enclave's service class/pgn and report class/rpgn for installation accounting and chargeback. In addition, the resource using and delay data for enclaves is reported with the service/report class of the enclave, not with the service/report class of the address space where it runs.

Enclave transaction counts and resource usage are recorded in the SMF 30 records for the address space which created the enclave (the owner address space). There are no separate SMF 30 records for enclaves.

CPU time consumed by enclaves is recorded in the SMF 89 records of each home address space in which an enclave SRB runs (the participating address space(s)) for usage-based pricing but is not included in the SMF 30 or 72 records for those address space(s).

Because SRBs scheduled to an enclave are preemptible, like tasks, their CPU time is counted as CPU service, not SRB service.

Classifying DDF Transactions

- All enclaves, including DDF transactions, are classified using the active MVS WLM policy in both compatibility and goal modes

- In compat mode the ICS can be used to map a service class to a performance group, and likewise for reporting

- Can classify using new attributes: plan, package, etc.

- **Defaults** if you do not classify in WLM policy:
  - **Goal mode:** enclaves default to the SYSOTHER service class which has a discretionary goal!
  - **Compat mode**: any enclaves run in the pgn/rpgn of the owning address space (DDF) as they did before

You do not have to be in a multisystem sysplex or running in WLM goal mode to exploit transaction management via DDF enclaves. DB2 V4 DDF always creates enclaves for its work when running on MVS 5.2.0 or above, or on OS/390.

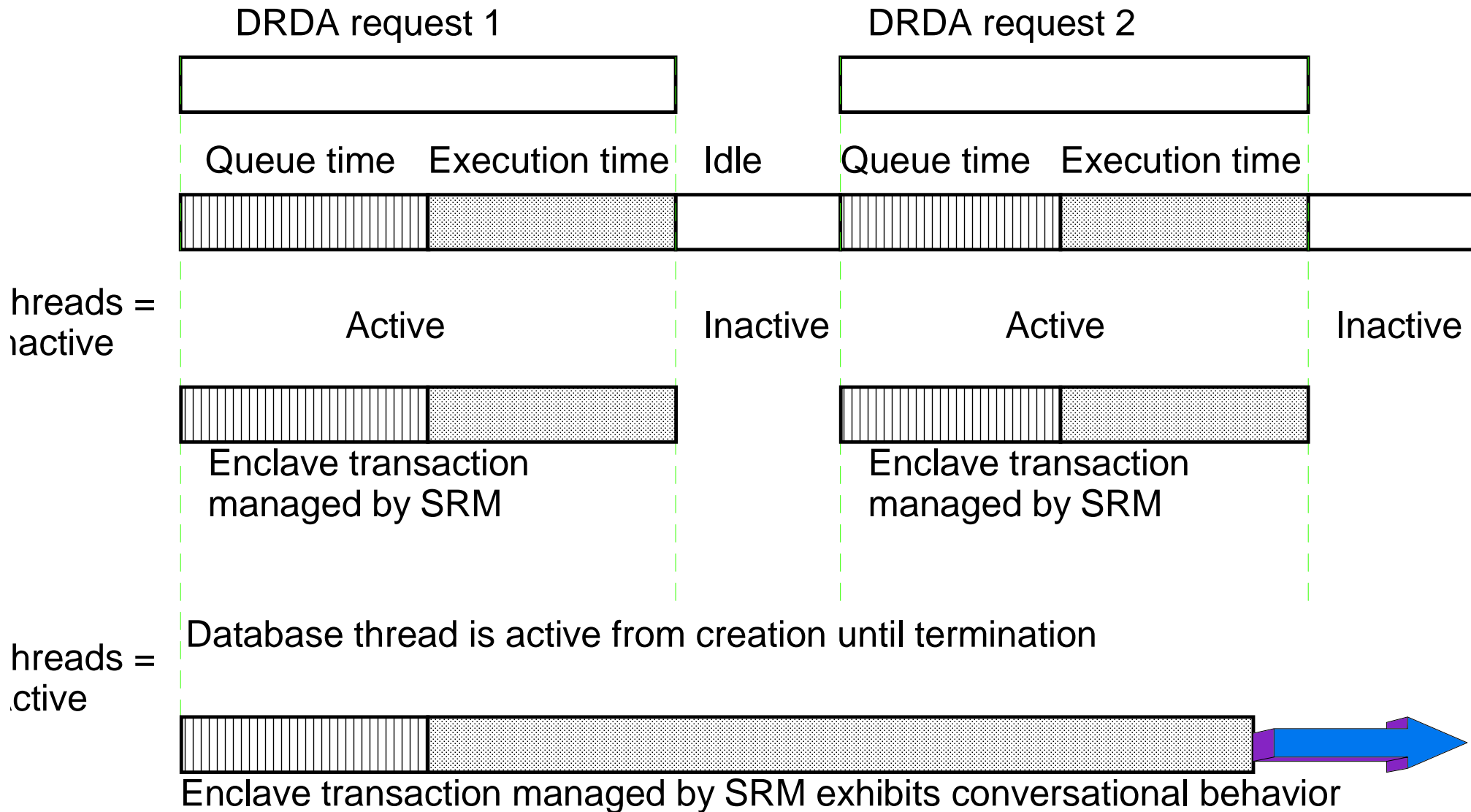To classify DDF enclaves you must do all of the following:
1. Format a MVS Workload Manager couple dataset.
2. Use the WLM administrative application to create a service definition with classification rules for subsystem type DDF, and at least one service class. The goal of the service class(es) is irrelevant if you are running in WLM compatibility mode, that is using parmlib members IEAIPSxx and IEAICSxx to manage work.
3. Install the service definition on the WLM couple dataset and activate a policy.
4. If you are running in WLM compatibility mode, you must also update the IEAICSxx parmlib member by adding rules for subsystem DDF:
        SUBSYS=DDF,   /* a pgn here is ignored if coded */
        SRVCLASS=x,PGN=y,RPGN=z /* "x" is the service class assigned in
                                                    the WLM classification rules */

Managing DDF Work (Enclaves)

- Transactions are subject to period switch

- Goal mode:
  - All goal types allowed

- Compat mode:
  - Performance groups and report performance groups can be assigned using SUBSYS=DDF
  - Limit of one rpgn
  - Time slicing is ignored
  - Domain is ignored

What is a Transaction?

DRDA request 1   DRDA request 2

| Queue time | Execution time | Idle | Queue time | Execution time |

threads =
inactive

Active		Inactive	Active	Inactive

Enclave transaction
managed by SRM

Enclave transaction
managed by SRM

threads =
active

Database thread is active from creation until termination

Enclave transaction managed by SRM exhibits conversational behavior

What Goals Should I Use?

- **WLM compatibility mode**
  - Goal does not matter. Service class used only to associate an enclave with a performance group.

- **WLM goal mode**
  - THREADS=INACTIVE **and** RELEASE(COMMIT)
    - ► DDF creates one enclave per active interval
    - ► Response times do not include think time
    - ► Response time goals and multiple periods can be used
  - THREADS=ACTIVE **or** RELEASE(DEALLOCATE)
    - ► DDF creates one enclave for the life of the thread
    - ► Enclave response time includes think time
    - ► Response time goals should not be used
    - ► Multiple periods should not be used

Definition of CPU Service has Changed

- Philosophical refinement

- Compatible with the existing definition

- CPU time/service are no longer synonymous with "task time/service"

- CPU time/service now includes contributions from all preemptible dispatchable units: tasks, client SRBs, enclave SRBs

- SRB time/service is unchanged - it includes contributions from all non-preemptible dispatchable units: local and global SRBs

SMF Type 30 Record Changes

- No changes are required to existing accounting packages

- Existing CPU time and service fields include enclave SRB contributions

- For all enclaves created by the address space, new fields contain:
  - enclave active time
  - transaction count
  - CPU time and service
  - I/O times and I/O count

SMF Type 72 Record Changes

- No changes are required to existing accounting packages

- Existing CPU service fields include enclave SRB contributions

- Other existing fields include data from enclave transactions:
  - Active time
  - Response time
  - Transaction count
  - Number of "address spaces" sampled
  - I/O times and I/O count

- Resources consumed by the DDF transactions are no longer reported in the DDF address space's SMF 72 record unless the enclaves are in the same service class/pgn as DDF

Enclave System Effects (DDF)

- (Lots) more transactions. Each DDF transaction used to be part of the DDF address space SRM transaction, now SRM sees each DDF transaction.

- Increased active time since more transactions exist

- Large decrease in DDF SRB time/service in SMF 30 record

- Corresponding increase in CPU time/service in the service classes/performance groups where enclaves are running

- MSO and I/O service is unchanged

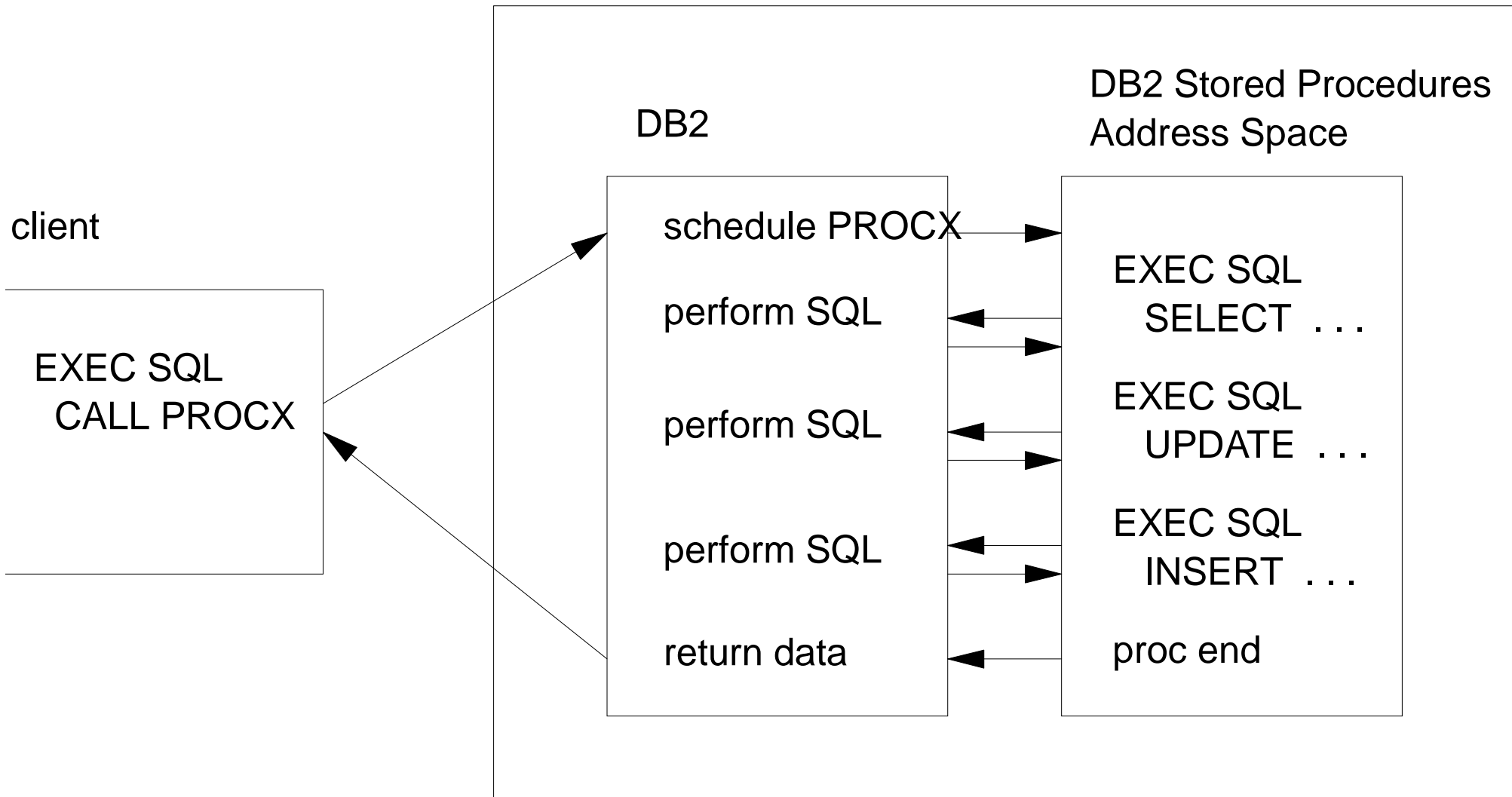- DDF logons are not held up by existing DDF work

Sysplex Query Parallelism

Sysplex Query Parallelism

- Supports data mining applications
- DB2 query can be split across parallel sysplex
- Requires DB2 V5.1 and DB2 data sharing
- Classification of originator doesn't change
- Classification of participants is under 'DB2' rules
  - ► Classification attributes inherited from originator
- Accounting is done on the system where enclave runs
- Each remote piece starts in 1st period

DB2 Stored Procedures

What is a stored procedure?

MVS

client

DB2

DB2 Stored Procedures
Address Space

EXEC SQL
CALL PROCX

schedule PROCX

perform SQL

EXEC SQL
SELECT . . .

perform SQL

EXEC SQL
UPDATE . . .

perform SQL

EXEC SQL
INSERT . . .

return data

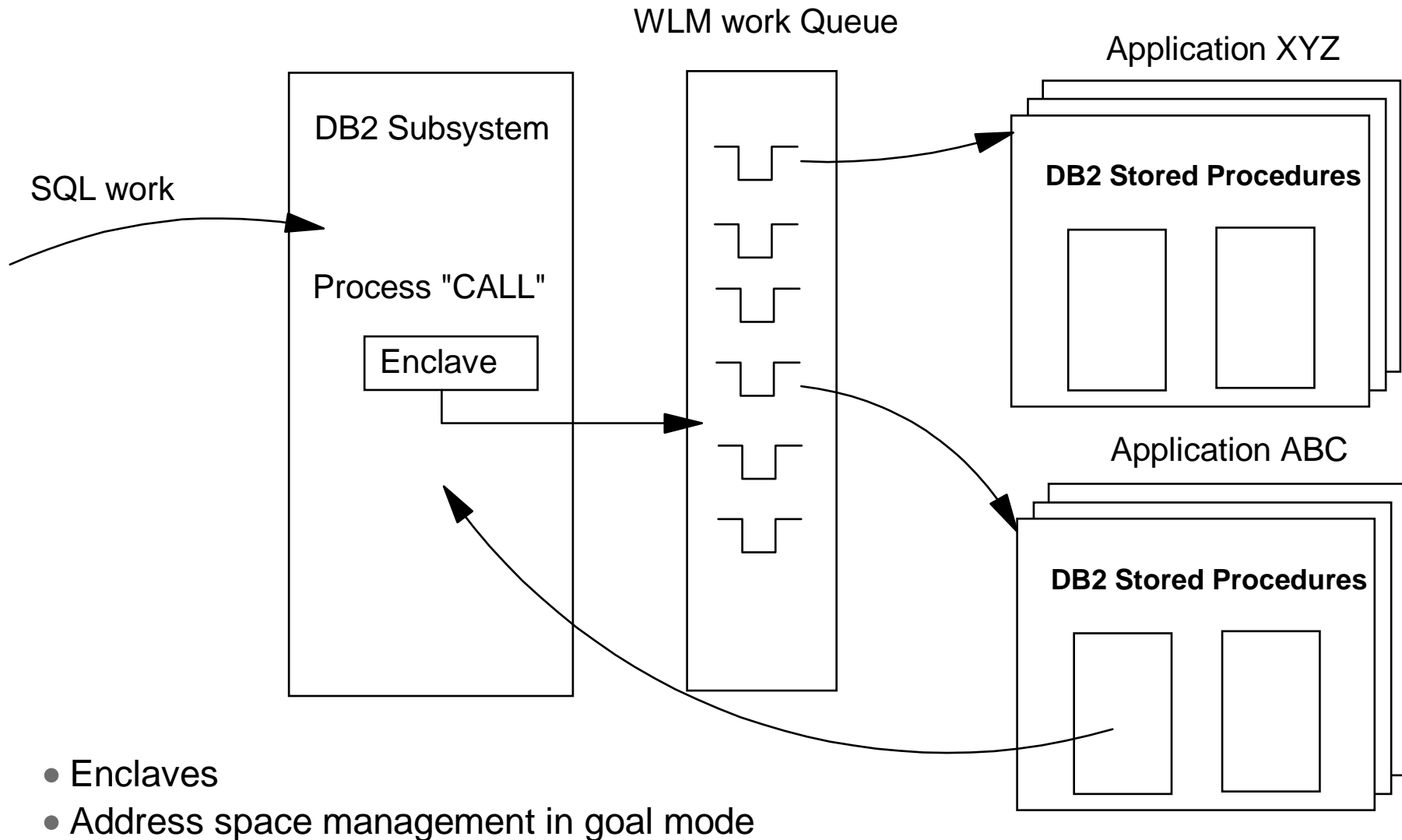proc end

Why Use Stored Procedures?

- Reduce network send/receive operations for distributed applications
  - Reduce elapsed time

- Encapsulate business logic and database design at the server
  - Protect sensitive data
  - Eliminate need for end user DB2 table authority

- Simplify management of application programs
  - Perform online change without impacting clients
  - Reduce cost of porting client code to other platforms

Limitations in DB2 V4R1

- All stored procedures execute in 1 address space
  - Multiple procedures can execute concurrently (NUMTCB parameter in ssnSPAS JCL procedure)
  - Number of tasks limited by storage constraints below 16M
  - A programming error in one stored procedure might affect other procedures running at the same time

- All stored procedure requests are treated equally
  - Queued FIFO
  - Executed at dispatch priority of ssnSPAS address space

- From an MVS perspective, CPU time is charged to the ssnSPAS address space

- RACF userid of ssnSPAS address space is used for access to non-SQL resources

Stored Procedures in DB2 V5R1 and OS/390 R3

WLM work Queue

Application XYZ

DB2 Subsystem

SQL work

Process "CALL"

Enclave

DB2 Stored Procedures

Application ABC

DB2 Stored Procedures

- Enclaves
- Address space management in goal mode

Preparation

- Code the stored procedure

- Bind the stored procedure to a package

- Code the application to call the stored procedure

- Grant authorization to execute the stored procedure to the application

Definition

- Create a JCL procedure for the stored procedure address space

- Define an application environment to WLM

- Authorize the stored procedure address space to connect to DB2 and WLM
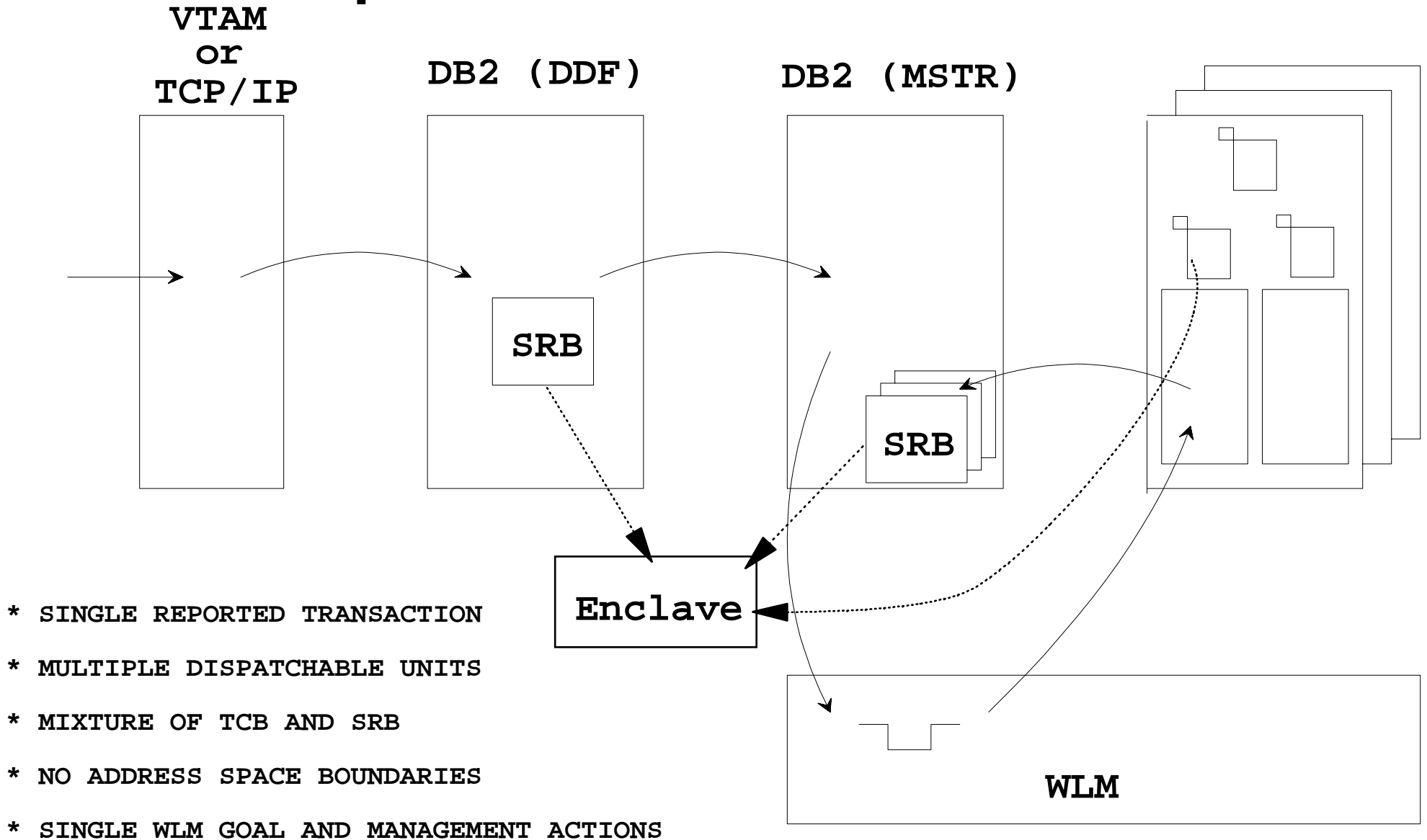
- Define the stored procedures to DB2

Accounting

Where is service for stored procedures accumulated?

- **For DDF work**
  - CPU service is included in the SMF 30 record for the DDF address space, and the SMF 72 record for the enclave's service class period

- **For all other work**
  - CPU and MSO service is included in the SMF 30 record of the client's address space, and the SMF 72 record for the client's service class period

- **IOC and SRB service is included in the SMF 30 and 72 records for the stored procedure address space**

Stored Procedures Summary

- Use stored procedures to improve the response time of distributed applications, and to encapsulate data management logic at the server

- Use WLM to
  - manage the number of stored procedure address spaces to meet clients' goals
  - run stored procedures with controls appropriate to clients' goals

- Use application environments to group related stored procedures

Complex transactions and enclaves

VTAM
or
TCP/IP

DB2 (DDF)

DB2 (MSTR)

SRB

SRB

Enclave

WLM

* SINGLE REPORTED TRANSACTION

* MULTIPLE DISPATCHABLE UNITS

* MIXTURE OF TCB AND SRB

* NO ADDRESS SPACE BOUNDARIES

* SINGLE WLM GOAL AND MANAGEMENT ACTIONS

Putting the Pieces Together

- DB2 gives you:
  - V4R1: DDF exploitation of enclaves
  - V5R1: Sysplex query parallelism
  - V5R1: Stored SQL procedures

- MVS gives you:
  - MVS 5.2: Refined definition of CPU time and service
  - MVS 5.2: SRM transactions: enclaves
  - OS/390 R3: TCBs in enclaves, server management

  - Together these can improve the response time and systems management of DB2 work.

Who else uses enclaves?

Other workloads using enclaves include:

- ➤ Websphere http Server for OS/390 (IWEB)
- ➤ LAN Server for MVS (LSFM)
- ➤ Component Broker (CB)
- ➤ MQ/Series Workflow
- ➤ . . . (expect more)

In goal mode, make sure you classify them...
    default is SYSOTHER.
Keep SYSOTHER empty so it can be used
    as warning signal.

Hot tips

- ➤ Don't forget to classify.
- ➤ Keep work out of SYSOTHER service class.
- ➤ Know how your DDF transactions are defined.
- ➤ Check out WLM home page.
- ➤ If new to goal mode, start with Cheryl Watson's Quick Start Policy.
- ➤ Select initial goals from peak periods in compat mode.
- ➤ When adding new workloads, classify them.

Summary

- ➤ Enclaves enable full WLM control
- ➤ DB2 is a premier user of enclaves
- ➤ Expect other workloads to use enclaves in future
- ➤ Often used in conjunction with sysplex routing and server space management
- ➤ Enclaves strengthen S/390's industry-leading workload management

WLM, DB2, and enclaves - the inside story

IBM Education Courses

H3995	Parallel Sysplex Implementation (45 minutes on WLM)
H4013	Workload Manager Workshop
H3986	Migration
H3988	Measurement and Tuning - compatibility to goal mode migration
H3989	Migration
ES540	OS/390 Workload-Based Performance Management (new!)
	(check **http://www.training.ibm.com** around 4/1/99)

MVS Planning: Workload Management (GC28-1761) -- a must have.

MVS Programming: Workload Management Services (GC28-1773)
>   Chapter on Enclaves including a chart showing how accounting is done.
>   Chapter on Queueing Manager Services shows DB2 model

DB2 for OS/390 V5 Administration Guide (SC26-8957) -- DB2 use of enclaves

WLM home page: http://www.ibm.com/s390/wlm
>   For latest papers, presentations, and frequently asked questions