
Oracle Resource Manager

An underrated feature?

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ORACLE | CERTIFIED
M A S T E R

- Oracle database specialist since 1993
- 24 years experience with Oracle database high end consulting and troubleshooting

Resource Management - an underrated Feature?

Facts about DB Masters

- founded 12/2010
- currently 8 employees, 6 consultants, 5 OCMs
- Oracle specializations for Oracle Database, Oracle Real Application Cluster and Oracle Performance Tuning

Agenda

- Definition
- Market Survey
- Oracle Database Resource Management 1.0
- Oracle Database Resource Management 2.0
- Summary
- Q & A

Definition



Divide et Impera!

Definition

- fixed Percentage (%)
 - total per level = 100
 - new consumer – manual redistribution
- Shares
 - no fixed total per level
 - new consumer – dynamic redistribution (equity dilution)
- Limits
 - absolute limit
 - also active if there are free resources

Definition – Example fixed Percentage (%)



Definition – Shares

A 50/100	B 30/100	C 20/100	D 20
A 50/120	B 30/120	C 20/120	D 20/120

Market Survey

- OS Resource Manager



easy implementation



no detailed knowledge about workload

- Database Resource Manager



complex implementation



detailed knowledge about workload

OS Resource Manager



- AIX – AIX Workload Manager
- Linux – Control Groups (“cgroups”)
- HP-UX – HP-UX Workload Manager
- Solaris – Solaris Resource Manager
- Windows – Windows System Resource Manager

OS Resource Manager

OS	CPU	Memory	Physical I/O	Network
AIX	✓	✓	✓	✗
Linux	✓	✓	✓	✓
HP-UX	✓	✗	✗	✗
Solaris	✓	✓	✗	✗
Windows	✓	✓	✗	✗

Database Resource Manager



- DB2/UDB
- MS-SQL Server
- PostgreSQL



- up to Version 9.5: DB2 Governor and Query Patroller
- since Version 9.5: DB2 Workload Management (AWSE / AESE)
- Management of CPU, Memory and physical I/O
- Service Class

Distribution of resources to Service Class using

(soft / hard) shares and limits (CPU)

Bufferpool Priority (Memory)

Prefetch Priority (physical I/O)



- Work Load

 - direct mapping to Service Class

 - Sessions are mapped to Work Loads using session attributes

- Work Class

 - indirect mapping to Service Class (using Work Action Sets)

 - Sessions are mapped to Work Classes using session type

- Work Action Set

 - Mapping of Work Classes to Service Classes

 - Definition of limits



- Integration with OS Workload Management
- AIX – AIX Workload Manager

direct Mapping of Service Class to AIX WLM Class

AIX WLM Class manages only CPU Resources

CPU Pinning

- Linux – Control Groups („cgroups“)

direct Mapping of Service Class to Linux Control Group

Control Group manages only CPU Resources

CPU Pinning

- since SQL Server 2012: Resource Governor (Enterprise Edition)
- Management of CPU, Memory and physical I/O
- Limitations
 - only within one SQL Server Instance
 - only for SQL Server Database Engine
- Resource Pool
 - min. / max. CPU (%) a/o CPU Limit (%)
 - min. / max. Memory (%)
 - min. / max. IOPs per Volume

- Workload Group

 - direct mapping to Resource Pool

 - Mapping of Sessions to Workload Groups using classifications

 - Priorities on Resource Pool level (“Importance”)

 - Limits on Workload Group level (CPU, Memory, DOP)

- Classification

 - UDF – returns Workload Group

 - (NULL = “default” Workload Group)

- Resource Management only available with PostgreSQL Plus Advanced Server
- Management of CPU and Memory
- Resource Group

Parameter „edb_max_resource_groups”

cpu_rate_limit (%)

dirty_rate_limit (writing to shared buffers, kb/s)

mapping of Sessions using parameter “edb_resource_group”

Oracle Database Resource Management 1.0

- Profiles
 - since Oracle 7.0 (June 1992)
- Instance Caging
 - since Oracle 11.2.0.1 (September 2009)
 - needs Enterprise Edition (since 12.1.0.2 supported in SE2)
- Resource Management (DBMS_RESOURCE_MANAGER)
 - since Oracle 8.1.5 (February 1999)
 - needs Enterprise Edition

Profiles 1.0

- Parameter „resource_limit“ = TRUE (dynamic)
- Limits

SESSIONS_PER_USER

CONNECT_TIME/IDLE_TIME (in minutes, checked every 5 minutes)

CPU_PER_CALL/SESSION (in 1/100s)

LOGICAL_READS_PER_CALL/SESSION

PRIVATE_SGA (in bytes, private SQL/PL-SQL Areas)

COMPOSITE_LIMIT

Profiles 1.0

- Session Level Limits

 - if limits are exceeded rollback of current statement
only rollback, commit or disconnect is possible

- Call Level Limits

 - if limits are exceeded rollback of current statement
session is kept

- Info

 - DBA_PROFILES

Instance Caging 1.0

- Inter-Instance Resource Management
- Parameter “cpu_count” (dynamic)
- Parameter “resource_manager_plan” (dynamic)
- thin provisioning or partitioning



Resource Management - an underrated Feature?

Resource Management 1.0

- DBMS_RESOURCE_MANAGER
- Intra-Instance Resource Management
- CPU Management will be invoked on shortages only (CPU utilization limits will be honored in every case)
- Resource Plan
- Resource Plan Directive
- Resource Consumer Group

Resource Plan 1.0

- Plan or Subplan
- Mapping of Subplans to Plans using Plan Directives
- Plan Hierarchy
- „Simple Plan“
- MGMT_MTH (CPU Management)
 - Emphasis (default Value, %)
 - Ratio (only CPU Level 1, Shares)
- predefined Plans

Resource Plan 1.0

- Plan Changes

Parameter “resource_manager_plan” (dynamic, FORCE)

DBMS_RESOURCE_MANAGER.SWITCH_PLAN

Scheduler Window

- Limits

max. 28 Resource Consumer Groups per Plan

max. 28 Subplans per Plan

- Info

DBA_RSRC_PLANS, V\$RSRC_PLAN, ...

Resource Plan Directive 1.0

- Mapping of Resources to Resource Consumer Group / Subplan
 - CPU Level 1 – 8 (%), total per level = 100, MGMT_MTH Emphasis)
 - CPU Level 1 (shares, 1 – 32, default value 1, MGMT_MTH Ratio)
- Limits
 - CPU Utilization (%), absolute limit, default value 100
 - CPU / Elapsed Time
 - Idle (Blocker) Time (checked every minute)
 - Physical / Logical I/O (MB or Requests), Parallel Servers, DOP, Undo

Resource Plan Directive 1.0

- if limits are exceeded

switch Consumer Group

for session

for call

LOG_ONLY (MONITORING)

CANCEL_SQL

KILL_SESSION

- Info

DBA_RSRC_PLAN_DIRECTIVES

Resource Consumer Group 1.0

- Mapping of Session to Resource Consumer Group using session attributes

login time

ORACLE_USER, SERVICE_NAME

CLIENT_OS_USER, CLIENT_PROGRAM

CLIENT_MACHINE, CLIENT_ID

run time

MODULE_NAME[_ACTION]

SERVICE_MODULE[_ACTION]

Resource Consumer Group 1.0

- predefined Groups

SYS_GROUP - ORACLE_USER IN ('SYS','SYSTEM')

OTHER_GROUPS

- Priorities for conflict resolution on ambiguous group membership
- Privileges are needed to switch into another group

Resource Consumer Group 1.0

- Info

DBA_RSRC_CONSUMER_GROUPS

DBA_RSRC_CONSUMER_GROUP_PRIVS

DBA_RSRC_GROUP_MAPPINGS

DBA_RSRC_MAPPING_PRIORITY

V\$RSRC_CONSUMER_GROUPS

V\$RSRC_SESSION_INFO

V\$SESSION (Column RESOURCE_CONSUMER_GROUP)

DBA_HIST_RSRC_CONSUMER_GROUP (AWR)

Wait Event "resmgr:cpu quantum"

- Resource Manager was active
- CPU Usage was adjusted
- P1: Location (Internal Location – CPU Level ?)
- P2: Consumer Group ID (DBA_RSRC_CONSUMER_GROUPS)



Oracle Datenbank Resource Management 2.0

- Database Resource Management and Multitenant Architecture
- Profiles
- Instance Caging
- Resource Management (DBMS_RESOURCE_MANAGER)

Profiles 2.0

- Parameter "resource_limit" modifiable on PDB Level
- „Local Profile“
 - only in PDB (optional CONTAINER=CURRENT)
- „Common Profile“
 - only in CDB\$ROOT (optional CONTAINER=ALL)
 - is not modifiable on PDB Level
- Info
 - CDB_PROFILES, DBA_PROFILES

Instance Caging 2.0

- Parameter “cpu_count” modifiable on CDB level only
- no difference compared to non-CDB databases

Resource Management 2.0

- DBMS_RESOURCE_MANAGER
- Intra-Instance Management
- Inter-PDB Management
- Intra-PDB Management (with limitations)

CDB Resource Plan 2.0

- Management of resource usage between PDBs
- CPU (shares)
- CPU Utilization (absolute limit, %)

CPU Throttling

- PX Server (shares)
- PX Server Utilization (absolute limit, % of „parallel_servers_target“)

Statement Queueing

CDB Resource Plan 2.0

- since 12.1.0.2 minimum and limits for Flash Cache (Exadata)
- standard directive
(shares=1, cpu_utilization=100, parallel_server_limit=100)
- Autotask directive
(cpu_utilization=90, parallel_server_limit=100)
- standard Plan (DEFAULT_CDB_PLAN)
- Info

DBA_CDB_RSRC_PLANS, DBA_CDB_RSRC_PLAN_DIRECTIVES

PDB Resource Plan 2.0

- manages resource usage within a PDB after distribution of resources from CDB
- works like non-CDB Plan but with limitations
- every PDB may have a different resource plan

Parameter „resource_manager_plan“ is modifiable on PDB level

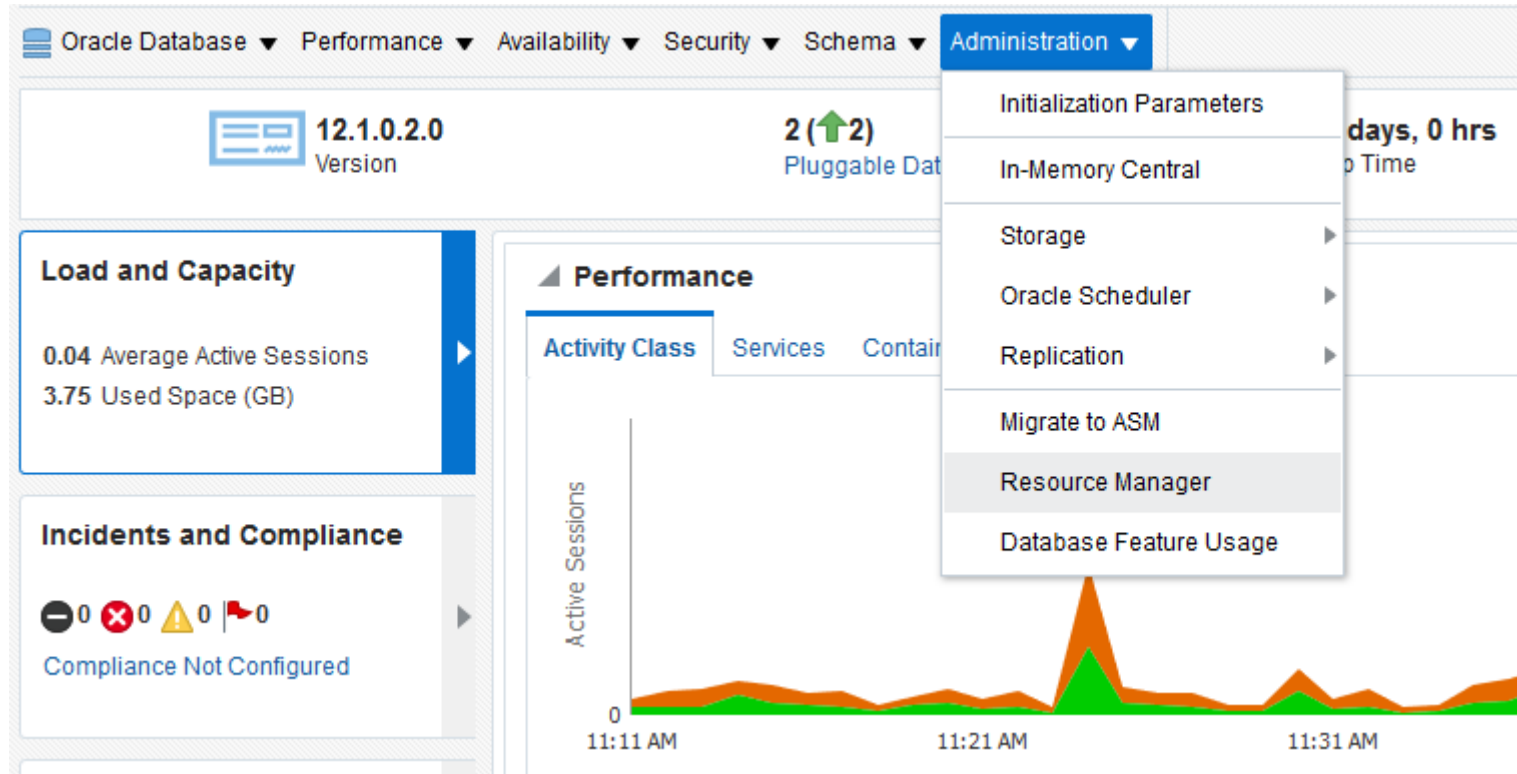
PDB Resource Plan 2.0 (Limitations)

- no subplans
- max. 8 Resource Consumer Groups
- only 1 level for CPU Management (%)
- after Plug-In of a non-CDB existing plans will be converted (Status “LEGACY”)

Code Sample

```
begin
  dbms_resource_manager.clear_pending_area;
  dbms_resource_manager.create_pending_area;
  dbms_resource_manager.create_cdb_plan(plan => 'MULTIT01_CDB_PLAN', comment => 'VXFIELD highest priority');
  dbms_resource_manager.create_cdb_plan_directive(plan => 'MULTIT01_CDB_PLAN', pluggable_database => 'VXFIELD',
    shares => 10, utilization_limit => 100, parallel_server_limit => 100);
  dbms_resource_manager.create_cdb_plan_directive(plan => 'MULTIT01_CDB_PLAN', pluggable_database => 'VXFIELD_TEST',
    shares => 1, utilization_limit => 10, parallel_server_limit => 10);
  dbms_resource_manager.create_cdb_plan_directive(plan => 'MULTIT01_CDB_PLAN', pluggable_database => 'TST_APEX',
    shares => 1, utilization_limit => 10, parallel_server_limit => 10);
  dbms_resource_manager.create_cdb_plan_directive(plan => 'MULTIT01_CDB_PLAN', pluggable_database => 'PDB$SEED',
    shares => 1, utilization_limit => 10, parallel_server_limit => 10);
  dbms_resource_manager.validate_pending_area;
  dbms_resource_manager.submit_pending_area;
end;
/
```


Enterprise Manager



Resource Management - an underrated Feature?

Oracle 12.2



- PDB IO Limits

(Parameter “max_iops” and “max_mbps”)

- PDB Memory Tuning

(Parameter “sga_target” and “pga_aggregate_target”)

- PDB Performance Profiles

Aggregation of PDB Resource Plans

Parameter „db_performance_profile“

DBMS_RESOURCE_MANAGER.CREATE_CDB_PROFILE_DIRECTIVE

Oracle 12.2



- new performance views

V\$RSRCPDBMETRIC

V\$RSRCPDBMETRIC_HISTORY

DBA_HIST_RSRC_PDB_METRIC (AWR)

Summary

- Oracle Database Resource Management
 - optimizes available resources (CPU, IO, Memory)
 - offers protection against "run-away" queries
 - now supports Multitenant databases
 - will be permanently enhanced and improved



Q & A



Resource Management - an underrated Feature?