VTCS

Enhanced Migration Scheduling

Version 1.0

An Oracle White Paper

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1. Introduction

VTCS at version 7.0.0 has been modified to allow more control over managing migration activity based on business priorities. This paper provides an overview of this new capability and how to implement it.

The scope of this change is confined to migration scheduling and influencing migration request generation. This change does not modify RTD scheduling or RTD allocation.

1.1 Background

Prior to version 7.0.0 the only control VTCS provided over migration scheduling was through parameters (MINMIG and MAXMIG) that define the minimum and maximum number of migration requests that can be started on a VTSS. It is not possible to deduce priorities of migration work using these parameters. Furthermore, MINMIG and MAXMIG only apply to automatic, demand migrate-to-threshold and immediate migrations. They do not apply to migrations resulting from drain, reclaim, commands or batch utilities.

VTV management class policy (or VTV migration management) is also limited to migration copies being requested immediately or at some point in time determined by migration algorithms. RESTIME attempts to retain VTV's in the VTSS buffer for an amount of time prior to auto migration but no other options are available for scheduling VTVs for migration.

1.2 Modification Overview

VTCS changes at version 7.0.0 have been implemented to provide finer control over VTV migration scheduling. These changes consist of:

The ability to influence an increase or reduction in the number of migration requests by storage class. This allows both prioritization of work and the protection of resources for processing such as recall. This new capability can minimize the number of MVCs used for vaulting.

The ability to react to workload demands and influence the allocation of resources accordingly (i.e. RTD's)

The ability to better control immediate VTV migration copies

Enhanced scheduling of automatic VTV migrations to storage classes

New MGMTDEF rule statements have been established to manage this control. These are explained in the following section.

2. Implementing Enhanced Migration Scheduling

Customers enabling enhanced migration scheduling will have the ability to better manage migration activity based on their business priorities. This new control allows customers to better manage RTD usage by giving priority for certain workloads while protecting RTD resources for other processing (e.g. RECALL). This control applies to both automatic and requested migrations.

Additionally, customers will have the ability to better manage VTV immediate migration copies and control when VTV copies are discarded from the VTSS buffer.

2.1 New MGMTDEF Control Statements

Two new MGMTDEF control statements have been added to support enhanced migration control. These are:

MIGRSEL – this control statement provides finer control over the number of migration requests allocated to storage classes.

MIGRVTV – this control statement allows the customer to better control individual VTV migration copies.

MGMTCLAS changes have also been made to support finer controls over individual migration copies.

Both MIGRSEL and MIGRVTV statements require the VSM Advanced Management feature to be active.

3. MIGRSEL

The MIGRSEL statement controls the number of migration requests for a given workload by establishing SCHPREF and/or SCHLIMIT values. SCHPREF values influence an increase in the number of migration requests that can be assigned to a workload. SCHLIMIT values influence a reduction in the number of migration requests that can be assigned to a workload.

This new statement is established as a rule in that it will have selection criteria parameters and action parameters. When all selection criteria is met or matched, actions are applied.

The selection criteria parameters are:

STORclas

VTSS

HOST

FUNCtion

IMMWAIT

The action parameters are:

SCHPREF

SCHLIMIT

The input search parameters can be specific – explicitly stated, or generic – not specified. If a particular selection parameter is not specified the rule will apply to all instances of that selection parameter.

3.1 MIGRSEL Control Statement Syntax

STORclas

specifies a Storage Class name. Specified STORclas names must be valid. If you do not specify a storage class name, the statement applies to all storage classes.

stor-clas-name

the name of the Storage Class that you defined on a STORclas control statement.

VTSS

specifies the VTSS whose migration parameters you want to change. If you do not specify a VTSS, the rule statement applies to all VTSS's.

vtss-name

the VTSS identifier.

HOST

specifies one or more hosts to which the rule applies. Any hosts not specified on this parameter ignore the rule. If keyword HOST is not specified the rule applies to all hosts. If keyword HOST is specified, any host ids not listed ignore the rule.

host-id

a host identifier (maximum 8 characters).

FUNCtion

specifies the type of migrate that this rule applies to. If keyword FUNCtion is not specified the rule applies to all migration types.

IMMED

migrations resulting from:

MGMTclas IMMEDmig(KEEP) **or**

MGMTclas IMMEDmig(DELETE) **or**

MGMTclas IMMDELAY(<9999) **or**

MIGRVTV IMMDELAY(<9999)

AUTO

automatic migrate to threshold migration processing.

RECLAIM

migrations resulting from MVC DRAIN or RECLAIM requests.

DEMAND

migrations resulting from a MIGRATE command or utility.

IMMWAIT

The IMMWAIT parameter makes the MIGRSEL rule sensitive to the state of the current immediate migration work load. This allows a re-balance of migration scheduling depending upon the current immediate migrate backlog. The specified value provides an immediate migration wait time or age, in minutes, that this MIGRSEL migration rule will apply to. This value is compared against the amount of time VTVs have been waiting for immediate migration within a particular storage class. If the amount of time (minutes) that VTVs have been waiting is less than or equal to the IMMWAIT value the MIGRSEL rule will apply.

n

Valid values are 0 to 999, the default is 999. The default value of 999 makes the rule apply to all VTV wait times. A value of zero is used for applying MIGRSEL rules if immediate migration is not active.

SCHPREF

This parameter provides input to the process that manages the generation of migration requests for servicing auto and immediate migrate requests. The relative values assigned by this parameter for the movement of VTVs from an individual VTSS to an individual storage class is used to decide upon the

allocation of migration requests.

Higher values of this parameter will cause more migration requests to be scheduled overall or cause more migration requests to be allocated to a storage class for a given fixed workload or backlog. The effect of changes to this parameter for a VTSS to storage class relationship maybe mitigated by limits upon the number of RTD's available and the SCHLIMIT parameter on this or another rule. VTSS MINMIG and MAXMIG values remain in effect and maintain (at the overall VTSS level) migration request boundaries.

This parameter has no effect on demand based migration requests i.e. requests generated from the MIGRATE, RECLAIM or MVCDR commands.

n

Valid values are 0 to 9, the default is 0 meaning no preference.

SCHLIMIT

optionally, limits migration per storage class.

n

the limiting value. Valid values are 0 to 99. The default is 99, which indicates no limit, up to the VTSS MAXMIG value. Lower values limit migration, and you can specify automatic, immediate, demand, and reclaim migrates.

Lower values can do the following:

Optimize MVC usage.

Place limits on storage classes in order to prefer migration to other storage classes.

Place limits on migration in order to keep RTD's available for auto recalls.

Reduce MVC swapping when workloads change.

For the auto and immediate migration processing, MIGRSEL SCHLIMIT places a limit on the number of migration requests that will be generated for the VTSS to storage class relationship. This comparison is not global and only effects requests driven by the individual VTCS host performing the migration.

MIGRSEL SCHLIMIT will cause the request to be held if the scheduling of it would cause the number of globally active migration requests on the VTSS that satisfy the same FUNCTION and STORCLAS selection criteria to be exceeded. This would also apply to Demand migration requests, which may not necessarily be actioned upon immediately under this circumstance. The migration requests will be released and a MVC picked once the constraint subsides.

3.2 MIGRSEL Samples

The following examples serve as possibilities for MIGRSEL usage. Consider global MINMIG and MAXMIG values set as 3 and 7 respectively.

1) A total of 4 storage classes are defined with the following MIGRSEL SCHPREF rules in place:

MIGRSEL STORCLAS(S1) SCHPREF(6)
MIGRSEL STORCLAS(S4) SCHPREF(4)

Storage classes S2 and S3 use the default SCHPREF of zero which means no preference. These rule constructs would allow the migration workloads for storage class S1 to get more resources than S2, S3 and S4. Storage class S4 would get less resources than S1 but more than S2 and S3.

The migrations will be scheduled based on the work queued to each Storage Class, but Storage Class S1 will be scheduled more frequently than the other Storage Classes that have a preference value defined that is less than 6, or ones that do not have a MIGRSEL SCHPREF rule defined, which would then default to SCHPREF(0). Since the Host and VTSS parameters are not specified, this would apply to all Hosts and all VTSSs.

The SCHPREF parameter could be used to get more resources for a busy workload. If a workload is over-monopolizing resources, then you would need to decrease the SCHPREF value, if a SCHPREF rule is defined, or eliminate the rule.

2) The following simple construct will attempt to cause more migration requests, relative to all other storage classes which have defaulted to SCHPREF(0), to be allocated to storage class S1 for VTSSA only on all hosts:.

MIGRSEL VTSS(VTSSA) STORCL(S1) SCHPREF(6)

3) The following construct attempts to limit demand migrations to a single migration request for any host, VTSS or storage class.

MIGRSEL FUNC(DEMAND) SCHLIMIT(1)

4) The following construct would attempt to limit the migration requests for VTSSA to 1 migration request for Storage Class S1. Since the Host parameter was not specified, it would apply to all Hosts.

MIGRSEL STORCLAS(S1) VTSS(VTSSA) SCHLIMIT(1)

5) The following construct attempts to limit storage class S1 to a single migration request. Since there are no Host(s) and no VTSS(s) specified, this construct would attempt to limit the migration requests for Storage Class S1, for all Hosts and all VTSSs, to 1 migration request for each VTSS in the configuration. So, if you have 3 VTSSs, this would mean that you will get up to 1 migration request for each VTSS for Storage Class S1.

MIGRSEL STORCL(S1) SCHLIMIT(1)

6) This construct would attempt to limit the migration requests for Storage Class S1 to one per each VTSS in the configuration for Host MVSA only. Since the VTSS parameter was not specified, it would apply to all VTSSs.

MIGRSEL STORCLAS(S1) HOST(MVSA) SCHLIMIT(1)

The following examples demonstrate rules that are sensitive to the state of immediate migration wait times by making use of the IMMWAIT parameter. However, before proceeding, a brief explanation of migration wait time or age is given to aid in understanding.

A storage class will always have an immediate wait age greater than zero when immediate migrates are active. When no immediate migrates are active for the storage class the immediate wait age will be zero. Therefore the first MIGRSEL statement in the following example will match (affect migration scheduling) when immediate migrates are not active, when immediate migrates are active the second MIGRSEL will match (affect migration scheduling).

7) The following construct shows how demand migrates could be held if there are immediate migrates in process. If immediate migration is not occurring demand migration can generate up to 4 migration requests.

```
MIGRSEL FUNCTION(DEMAND) IMMWAIT(0) SCHLIMIT(4)
MIGRSEL FUNCTION(DEMAND)            SCHLIMIT(0)
```

8) The following construct would indicate that VTSS MINMIG/MAXMIG values be used for allocating migration requests to storage class S1 until the immediate migration wait time ages beyond 20 minutes after which time an attempt will be made to cause more migration requests be allocated to storage class S1.

```
MIGRSEL STORCLAS(S1) IMMWAIT(20)
MIGRSEL STORCLAS(S1) SCHPREF(6) SCHLIMIT(99)
```

3.3 MIGRSEL Usage Rules

Storage class names must be valid (defined by a STORCL statement), or MGMTDEF parameters fail to load

VTSS names specified are NOT validated. Care must be taken when specifying VTSS names as any invalid name will create a MIGRSEL rule that will never match (be used).

HOST name mismatches cause that particular MIGRSEL statement to be ignored. Care must be taken when specifying host specific MIGRSEL control statements. It should be noted that this falls in line with other control statement HOST processing meaning HOST mismatches will not generate any messages.

When establishing multiple MIGRSEL statements they must be ordered most specific to least specific.

Only SCHLIMIT values are used to influence demand and Drain/Reclaim migrations.

The SCHPREF parameter attempts to increase the number of migration requests for a given migration workload. It should not be used as a means to decrease or limit the number of migration requests.

The SCHLIMIT parameter attempts to decrease or limit the number of migration

requests for a given workload. It should not be used as a means to increase the number of migration requests.

An IMMWAIT value of zero can be used to tune migration scheduling in determining if immediate migrates are active or not. This allows all other migrates to be sensitive as to whether immediate migration is active. (See last 2 MIGRSEL examples)

Most of the enhanced migration changes work within the boundaries established by VTSS MINMIG / MAXMIG values.

SCHPREF values work within the VTSS MINMIG / MAXMIG framework. The number of migration requests created by SCHPREF values will never be less then MINMIG or be greater than MAXMIG.

SCHLIMIT values greater than VTSS MAXMIG have no effect and will cause the VTSS MAXMIG value to apply.

The number of storage classes and different device types that are in the configuration can impact this enhancement. In an environment where a high number of storage classes are defined and many different RTD device types exist, the less of a noticeable impact enhanced migration control will have. In an environment where there are fewer storage classes defined and RTD devices are of the same device type, the more noticeable impact migration control will have.

4. Changes to MGMTCLAS Control Statements

The MGMTclas control statement has new parameters added for better control over VTV migration copies. These new parameters are available to both basic and advanced management feature users.

DISCARD – is the inverse of RESTIME and controls when a VTV will become preferred for auto-migration and subsequently removed from the buffer – specified in hours

IMMDELAY – specifies the time in minutes to wait before placing the VTV on the immediate migrate queue

4.1 New MGMTCLAS Parameter Syntax

DISCARD

specifies the discard time in hours. This value represents the time after a VTV is dismounted that the VTV is kept in the buffer. After this time value expires, the VTV will be preferred for deletion from the VTSS buffer if all required copies of the VTV exist on MVCs

nnn

This parameter is optional; the default value is 9999. Valid values are 0 to 9999.

Note: *If RESTIME has also been specified for a VTV, it will override the DISCARD value.*

Note: *When IMMEDmig is specified, DISCARD is not used for immediate migration processing, it is only applicable for AUTO migration requests.*

IMMDELAY

specifies the immediate delay time in minutes.

nn

This parameter is optional; the default value is 9999. Valid values are 0 to 9999.

This specifies the amount of time in minutes to wait until immediate migrate selects VTVs for migration. This allows VTVs used in multi-step jobs to remain resident for a specified time before being processed for immediate migration.

A value of 9999 indicates that immediate migrate should not process VTVs associated with this control statement.

This parameter is mutually exclusive with the IMMEDmig parameter.

4.2 MGMTCLAS Samples

The following examples serve as possibilities for using the new MGMTCLAS parameters.

1) The following MGMTclas statements indicate immediate migrate and keep VTV resident.

   MGMTCLAS IMMED(KEEP)

MGMTCLAS IMMDELAY(0) DISCARD(9999)

2) The following MGMTclas statements indicate immediate migrate and delete VTV from buffer.

   MGMTCLAS IMMED(DELETE)
   MGMTCLAS IMMDELAY(0) DISCARD(0)

3) The following MGMTclas statements indicate no immediate migrate.

   MGMTCLAS IMMED(NO)
   MGMTCLAS IMMDELAY(9999)

   Note: Lack of IMMEDmig and IMMDELAY on a MGMTclas definition also implies no immediate migrate.

4) The following MGMTclas statement delays immediate migration for 10 minutes and states that after 24 hours VTVs are preferred for deletion by auto-migration.

   MGMTCLAS IMMDELAY(10) DISCARD(24)

5. MIGRVTV

This new statement provides the ability to control individual VTV copies being processed by immediate migration. VTVs that are immediate migrate candidates based on management class definitions can now have additional control at the storage class level by using the MIGRVTV statement.

For instance a management class will state migrate n copies to S1,S2,,,,Sn and also state an immediate migrate policy. The immediate migrate policy applies to all migration copies. Using MIGRVTV policies, the user can override the management class immediate migrate policy on a copy by copy basis by stating that the copy should be:

not immediately migrated

delayed for a number of minutes

deferred until auto-migrate time

This new statement is also established as a rule in that it will have selection criteria parameters and an action parameter. When all selection criteria is met or matched, the action is applied.

The selection criteria parameters are:

MGMTclas

STORclas

VTSS

The single action parameter is:

IMMDELAY

The input search parameters can be specific – explicitly stated, or generic – not specified. If a particular selection parameter is not specified the rule will apply to all instances of that selection parameter.

5.1 MIGRVTV Control Statement Syntax

MGMTclas

specifies a Management Class name. If you do not specify a management class name, the changes affect all management classes.

mgmt-clas-name

the name of a Management Class that you defined on the MGMTclas control statement.

STORclas

specifies a Storage Class name. If you do not specify a storage class name, the

changes affect all storage classes.

stor-clas-name

the name of a Storage Class that you have assigned to a STORclas control statement.

VTSS

specifies the VTSS whose migration parameters you want to change. If you do not specify a VTSS, the changes affect all VTSS's.

vtss-name

the VTSS identifier.

IMMDELAY

specifies the immediate delay time in minutes.

nn

This parameter is optional; the default value is 9999. Valid values are 0 to 9999.

This specifies the amount of time in minutes to wait until immediate migrate selects VTVs for migration. This allows VTVs used in multi-step jobs to remain resident for a specified time before being processed for immediate migration.

A value of 9999 indicates that immediate migrate should not process VTVs associated with this control statement.

Note: Setting IMMDELAY(9999) for all applicable storage classes will effectively null an immediate migrate request in the management class definition.

Note: Setting IMMDELAY(9999) for any applicable storage class will stall the delete request in the management class definition. The VTV will not be deleted until all copies are migrated.

5.2 MIGRVTV Sample

The following example serves as a possibility for MIGRVTV usage.

1) The example below illustrates how MIGRVTV can be used to prefer migrations to different storage classes in a local/remote configuration where it is desired to migrate the remote copy as soon as possible. The local copy can be migrated at leisure.

The LOCAL immediate migration will be delayed 5 minutes, the REMOTE migration happens immediately. The global IMMDELAY value of 100 minutes is overridden by the MIGRVTV statements.

```
MGMTCLAS NAME(PROD)  MIGPOL(LOCAL,REMOTE) IMMDELAY(100)


MIGRVTV  STORCLAS(LOCAL)  IMMDELAY(5)
MIGRVTV  STORCLAS(REMOTE)   IMMDELAY(0)
```

5.3 Interaction Between IMMEDmig and IMMDELAY Parameters

The new parameters IMMDELAY and DISCARD allow finer control of when migrations will occur for VTVs. IMMEDmig and IMMDELAY are mutually exclusive and can not be specified on the same statement.

Values specified on the MGMTclas parameter are 'global' in nature and apply to all VTV copies.

Specifying IMMDELAY on a MIGRVTV statement will override values from the MGMTclas statement. This allows the 'global' value to be overridden at the storage class level if desired.

Note: If the MGMTclas statement does not specify immediate migrate, specifying IMMDELAY on the MIGRVTV statement will not make the VTV an immediate migrate candidate. Immediate migrate status for a VTV can only be enabled by the MGMTclas definition.

5.4 MIGRVTV / MGMTCLAS Copy Control Usage Rules

Storage class names specified on the MIGRVTV statement must be valid.

Management class names specified on the MIGRVTV statement must be valid.

VTSS names specified on the MIGRVTV statement must be valid.

Setting MIGRVTV IMMDELAY(9999) for all applicable storage classes will effectively null an immediate migrate request in the management class definition.

Setting MIGRVTV IMMDELAY(9999) for any applicable storage class will stall the delete request in the management class definition. The VTV will not be deleted until all copies are migrated.

If RESTIME has been specified for a VTV, it will override the DISCARD value.

When IMMEDmig is specified, DISCARD is not used for immediate migration processing, it is only applicable for AUTO migration requests.

If the MGMTclas statement does not specify immediate migrate, specifying IMMDELAY on the MIGRVTV statement will not make the VTV an immediate migrate candidate.

An IMMDELAY value specified on a MIGRVTV statement will override the associated IMMDELAY or IMMEDmig attributes for immediate migrate VTVs.

For immediate migrate requests specified via IMMEDmig, DISCARD is not used. When used in conjunction with MIGRVTV IMMDELAY, DISCARD=0 means DELETE. Any other value implies KEEP.

When DISCARD is specified on a MGMTCLAS statement and VTVs with that management class are selected for AUTO migration, they will be sorted in the following order:

Expired (or no) RESTIME and DISCARD expired	Highest
Expired (or no) RESTIME and DISCARD not expired or not specified	
Unexpired RESTIME, ignore DISCARD	
RESTIME(9999) set, ignore DISCARD	Lowest

5.5 General Usage Considerations

This section serves to point out general considerations when implementing enhanced migration scheduling. Additionally, it points out some configuration and policy settings that could possibly impact your implementation.

Do not attempt to over parameterize and micro-manage your migration workload. Being over complicated and over aggressive can lead to undesirable effects. Start with simple rule constructs that balance behavior slowly, monitor results and change as necessary.

Beware of over limiting a workload. For example applying SCHLIMIT=1 to a storage class that is not important but generates a lot of data will become important if the resultant VTV backlog causes the VTSS to fill up.

Over specifying search criteria across all statements and making invalid assumptions about the environment can lead to implicit conflicts. Every parameter need not be specified to achieve the desired result. For example when specifying MVCPOOL, MEDIA and ACS on a STORCLAS statement when it is only important that a MVC is placed at a specific location (ACS) could lead to migration failures due to a shortage of media.

STOR NAME(S) MVCPOOL(M) ACS(00) MEDIA(STK1RC) **<-**limits class to 9840C media

STORCLAS NAME(D1) MVCPOOL(MP1) ACS(00) **<-**no limitations on media type

Be aware of missing the implicit effect of certain parameters. Consider a configuration with two 9840 RTD's and six T10K RTD's and no MEDIA specification is made. Given that the default media selection order chooses 9840 before T10K drives VTCS will exhaust the 9840 media regardless of raising preference values for a storage class in a MIGRSEL rule. In this situation, different device types can have a limiting effect on this enhancement.

VTCS considers some action parameters as advisory rather than absolute. As an

example SCHPREF=7 may not always result in more RTD's being allocated than SCHPREF=2 because of workload types and amounts being factored into the migration scheduling algorithms.

The number of storage classes that are defined can impact this enhancement, beware of too many. Although it is nice to be able to categorize your data for business need, there is a cost. RTD's are a scarce resource and the only way that VTCS may be able to achieve both the goal of categorizing the data and meeting DBU or immediate migrate targets is to switch MVCs on and off the RTD's. This is a very slow process especially with T10K drives.

VTCS has to make assumptions about what it should do when it doesn't have specific input to the contrary. VTCS may have to balance out conflicting requirements. VTCS does not always react immediately to a change of circumstances. This is a deliberate policy to avoid unstable behavior.

6. Display MIGrate Output Changes

Display Migrate DETAIL display output has been changed to support enhanced migration scheduling. The changes are as follows:

The VTV count for both immediate and auto migrates for the storage class are removed and added to the Q MIG DIAG output.

MIGRSEL SCHLIMIT and SCHPREF values that apply to the current migration activity are added.

Note: When the storage class shows both auto and immediate migrations, the SCHLIMIT and SCHPREF values in effect for auto migrations will display, as auto migrates take precedence when both are active.

When no MIGRSEL statements apply to current migration processing or no MIGRSEL statements exist a dash (-) will display in the SCHLIMIT and SCHPREF columns. In this situation MINMIG and MAXMIG values apply to migration scheduling allocations.

The number of VTVs on the delay queue have been added. When no MIGRVTV statements or MGMTCLAS additions apply or are not present the delay queue will display “Not active”.

6.1 Sample Display Migrate Display Output

The Display Migrate display output changes are highlighted in red. For each example shown any established MIGRSEL or MIGRVTV statements are listed.

All display examples shown are using the same MAXMIG/MINMIG configuration values to show the impact of this change.

6.2 Display MIGrate DETail

1) For the following example auto migration is running with no MIGRSEL or MIGRVTV statements in place.

```
/SLS0000I D MIG DET
/SLS6603I Migration information:
VTSSNAME: DVTSS16
Active migration tasks: 5
Immediate migrate: Not active
Immediate delay queue: Not active
Auto migrate: Host: EC21 Migration target: 60%
 Storage   ACS  Max/Onl  ---SCH--  Req  --Auto--  ---Immed---   Weight
  Class          RTDs    Lim Pref  Act      GB    Delay    GB    /Skip
 S1        00   16  16     -   -     2      12       -      -    45/ 0
 S2        00   16  16     -   -     3      12       -      -    55/10
```

2) For the following example, auto migration is running with the following MIGRSEL rule in place:

MIGRSEL FUNC(AUTO) STORCL(S1) VTSS(DVTSS16) SCHLIMIT(1)

Note: This construct will give a scheduling limit value of 1 only to storage class S1while maintaining global VTSS migration boundaries for remaining storage classes. i.e. storage class S1 is a lower priority for auto migrates than other storage classes within VTSS DVTSS16.

```
/SLS0000I D MIG DET
/SLS6603I Migration information:
VTSSNAME: DVTSS16
Active migration tasks: 5
Immediate migrate: Not active
Immediate delay queue: Not active
Auto migrate: Host: EC21 Migration target: 60%
 Storage   ACS  Max/Onl  ---SCH--  Req  --Auto--  ---Immed---   Weight
  Class          RTDs    Lim Pref  Act      GB    Delay    GB    /Skip
 S1        00   16  16     1   0     1      12       -      -    62/30
 S2        00   16  16     -   -     4      12       -      -    38/ 0
```

3) For the following example, auto migration is running with the following MIGRSEL rule in place:

MIGRSEL FUNC(AUTO) STORCLAS(S1) VTSS(DVTSS16) SCHPREF(4)

Note: This construct will give a scheduling preference value of 4 only to storage class S1 while maintaining global VTSS migration boundaries for remaining storage classes, i.e. storage class S1 requires higher priority for auto migrates than other storage classes within VTSS DVTSS16.

```
/SLS0000I D MIG DET
/SLS6603I Migration information:
VTSSNAME: DVTSS16
Active migration tasks: 7
Immediate migrate: Not active
Immediate delay queue: Not active
Auto migrate: Host: EC21 Migration target: 60%
 Storage   ACS  Max/Onl  ---SCH--  Req  --Auto--  ---Immed---   Weight
  Class          RTDs    Lim Pref  Act      GB    Delay    GB    /Skip
 S1        00   16  16    99   4     6      12       -      -    84/10
 S2        00   16  16     -   -     1      12       -      -    16/ 0
```

4) For the following example, immediate migration is running with the following MIGRSEL rules in place:

MIGRSEL FUNC(IMMED) STORCLAS(S1) VTSS(DVTSS16) SCHPREF(4)

MIGRSEL FUNC(IMMED) STORCLAS(S2) VTSS(DVTSS16) SCHLIMIT(1)

Note: This construct will give a scheduling limit value of 1 to storage class S2 and a scheduling preference of 4 to storage class S1. This attempts to increase the priority of immediate migrates for S1 while decreasing the priority on immediate migrates from S2.

```
/SLS0000I D MIG DET
/SLS6603I Migration information:
VTSSNAME: DVTSS16
```

```
Active migration tasks: 7
Immediate migrate: Max wait: 1 minutes
Immediate delay queue: Not active
Auto migrate: Not active
 Storage   ACS  Max/Onl  ---SCH--  Req  --Auto--  ---Immed---   Weight
  Class          RTDs    Lim Pref  Act      GB    Delay    GB    /Skip

 S1        00   16  16    99   4     6       -       1      2    86/31
 S2        00   16  16     1   0     1       -       1      2    14/ 0
```

6.3 Display MIGrate DELAY

A new DELAY option on the Display MIGrate command will list the VTVs on the delayed queue and the time remaining on the delayed queue of those VTVs. The time remaining is referred to as the age.

The following display lists the VTVs and the associated age range of those VTV's. Specifically, 2 VTVs are in the delayed queue with time remaining on the queue ranging from 3 minutes to 5 minutes.

```
/SLS0000I D MIG DELAY(S1) VTSS(DVTSS16) LISTVTVS
/SLS6603I VTVs awaiting migration:
*** Queue empty ***
/SLS0000I D MIG DELAY(S2) VTSS(DVTSS16) LISTVTVS
/SLS6603I VTVs awaiting migration:
DX0800  DX0900
2 volumes with an age range of 3-5 in the queue
```

VTCS
Enhanced Migration Control
Author: VTCS Software Engineering

Oracle Corporation
World Headquarters
500 Oracle Parkway
Redwood Shores, CA 94065
U.S.A.
Worldwide Inquiries:
Phone: +1.650.506.7000
Fax: +1.650.506.7200
oracle.com