To: Distribution
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Subject: Changes to User Ring Programs for New Storage System

INTRODUCTION

This memorandum describes the necessary changes to the system command and subroutine library and to user programs to handle the new interfaces provided by the new Multics Storage System.

NEW STATUS CODES

Several new status codes can be returned by the storage system when users attempt operations present in the current system.

Logical Volume Not Mounted

The code error_table$_$mount_not_ready indicates that the storage for a segment resides on a non-permanent volume which the user has not mounted. This code should be returned only for attempts to reference the data or VTOR attributes of a segment; that is, it should be possible to list the ACL of a segment or to rename it even though its logical volume is not mounted. The code can be returned by initiate, truncate, delentry, and by the following other hcs_ entries:

set_max_length, set_max_length_seg
reclassify, access_class_check
status_long, status_
star, star_list, list_dir
**Physical Volume Not Found**

This code is returned if the physical volume unique ID for a segment cannot be translated into a pvt index. If the logical volume check above has succeeded, this code indicates that the physical volume has been deleted from the logical volume, perhaps due to damage to the volume, or that the branch is damaged, or that the logical volume is being demounted. This code can be returned as a subcondition of seg_fault_error.

**Segment Is Page Control Out Of Service**

The code error_table_$seg_busted is returned as a subcondition of seg_fault_error when an I/O error has occurred on the segment. A new hcs_entry is provided to reset the switch which causes this error.

**Logical Volume Full**

The status code error_table_$log_vol_full is also a subcondition of seg_fault_error. It occurs when a segment cannot be moved to any other pack in a logical volume, and when the pack the segment is on is full.

**Physical Volume Out of Service**

The status code error_table_$volume_error results when a physical volume is determined to be out of service. This code can be returned as a subcondition of seg_fault_error.

**Connection Failure**

The status code error_table_$vtoc_connection_fail is returned as a subcondition of seg_fault_error when a segment's branch does not match its VTOC entry. The condition may arise due to unique ID or directory switch mismatch.
New Case for Access Isolation Error

The code error_table汕ai_restricted can be returned for a new case, if the access class of the segment or directory being appended does not fall within the access class bracket of the logical volume where the storage will reside.

Master Directory

The status code error_table汕master_dir will be returned when attempts are made to move quota down to or up from a master directory. This error will also occur for attempts to delete an empty master directory from the user ring. (If the directory is nonempty, error_table汕fulldir will be returned.)

QUOTA

In the old storage system, quota was a one-dimensional quantity. In the new system, quota on one logical volume is different from quota on another, and those programs which manipulate quota must be aware of the difference. The system will refuse to move quota down to or up from a master directory. In addition, every directory now may have two quotas, one for directory pages and one for segment pages.

Directory quota is handled just like regular quota. New tools commands will be provided as follows:

set_dir_quota
move_dir_quota
get_dir_quota

The administrative tools will not, initially, set a directory-page quota on project directories; it will therefore be an installation option whether to use directory quota at all. A site which wishes to use directory quota will modify its master.ec to give a directory quota to each project directory.

The administrative tools for charging for disk usage will be modified to record the sons_lvid for each directory with quota when collecting disk usage information. The sons_lvid will be returned in the argument which now contains "infqcnt," the inferior quota count, which is not maintained under the new storage system. The program charge_disk will be modified to charge only for page-seconds on system-owned volumes. The system tools for disk usage recording will be modified to be usable by
the owners of private volumes so that they can manage quotas on their private packs as well.

**CHANGES TO STORAGE SYSTEM PRIMITIVES**

In addition to returning new status codes in the circumstances described above, the storage system primitives have changed in several other respects.

**Status**

The entry hcs_$status_long will return the logical volume ID (lvid) for a segment in the field now labeled "account." In the current system this field is always returned zero. For directories, the lvid is always the root logical volume: so status_long will return the sons_lvid for the directory instead.

Both hcs_$status_ and hcs_$status_long will return a single bit for directories in what is now a pad field, to indicate whether a directory is a master directory or not.

All entry points to status including $status_minf and $status_mins will return error_table_$mount_not_ready if the logical volume which contains the contents of the segment has not been mounted by the process. When this status code is returned, any information which is determinable from the directory (which is always online) will be filled in.

The entry status_for_backup will return physical volume ID as well as lvid, sons_lvid, and master_dir switch. The number of words returned by this entrypoint may increase.

**Star**

Both hcs_$star and hcs_$star_list will work whether or not the logical volume which has the storage for the sons of a directory has been mounted by the process; but error_table_$mount_not_ready will be returned along with whatever valid information is available. This situation will occur even if a directory has no segments in it (and thus no information is unavailable).

Similar changes will be made to list_dir.
Application programs must not use values of the following items about segments when the status code $mount_not_ready is returned:

- date and time modified
- date and time used
- current length
- records used

Complete information is returned about directories and links in all cases.

A new entry point for the use of the list command will be provided. It is described below in the section on list.

Delete and Truncate

These primitives work normally unless the logical volume containing the segment has not been mounted by the process. If the volume is not mounted, error_table_$mount_not_ready is returned.

This change means that there are some segments which a process may find it cannot delete, and cannot use.

Command Changes

list

Calls to hcs$_star_list will take much more real time and some additional CPU time because the VTCC reads needed to obtain the dates and records used will, in general, require an arm motion for each entry.

The list command will be modified to change the standard output as follows: instead of records used, list (bitcount/366b4). Also, list date and time branch modified when -dtm is requested, only returning date and time segment modified when a new control argument, -dtcm, is supplied. A new entrypoint to star_ will be provided which returns all the information which can be given without going to the VTCC.

For those entries to star_ which do require VTCC I/O,
realtime wait should be improved by sorting the entries by physical volume id and WTGC index, to attempt to minimize seek time.

dir info

The programs save_dir_info, comp_dir_info, and list_dir_info deal with segments which contain listings of a directory's contents. These programs must be updated to handle at least the lvid (son_lvid for directories) and master_dir switch. Physical volume id (pvid) should probably also be saved and checked. These changes will necessitate a redeclaration of the dir_info segment and compatibility code so that old and new formats can be compared and listed. The lvid and pvid should be stored in character string form rather than in binary.

new utility Subroutine

As part of the volume registration package the system must be able to translate from a 36-bit binary lvid to a 32-character logical volume name, and similarly for pvid. The hardcore has no knowledge of the logical or physical volume name: this information must be retrieved from the ring-1 RCP data bases. This poses a slight problem: should the user be able to determine the name of volumes to which he doesn't have access?

Question Handlers

The programs nd_handler_ and ol_handler_ should be modified to know that some segments cannot be deleted, and to tell the user why.

Create_dir

The create_dir command will need to accept a new control argument,

-volume LVname

and know, when this argument is specified, that -quota must also be given and that master directory control (mdc_) must be called.