To: Distribution

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Date: December 19, 1975

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 VTOC 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_$vtoce_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_$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_$master_dir will be returned when attempts are made to move quota down to or up from a master directory. This error will also occur for attempts to delete an empty master directory from the user ring. (If the directory is nonempty, error_table_$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 quota 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.

Delentry 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 VTOC 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/36864). 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 VTOC.

For those entries to star_ which do require VTOC I/O,

realtime wait should be improved by sorting the entries by
physical volume id and VTOC 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 (sons_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 dl_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.