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PERMANENT FILE BACKUP FOR THE CDC MASS STORE SYSTEM

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Bethesda, Maryland 20084

PERMANENT FILE BACKUP FOR THE CDC MASS STORE SYSTEM

by

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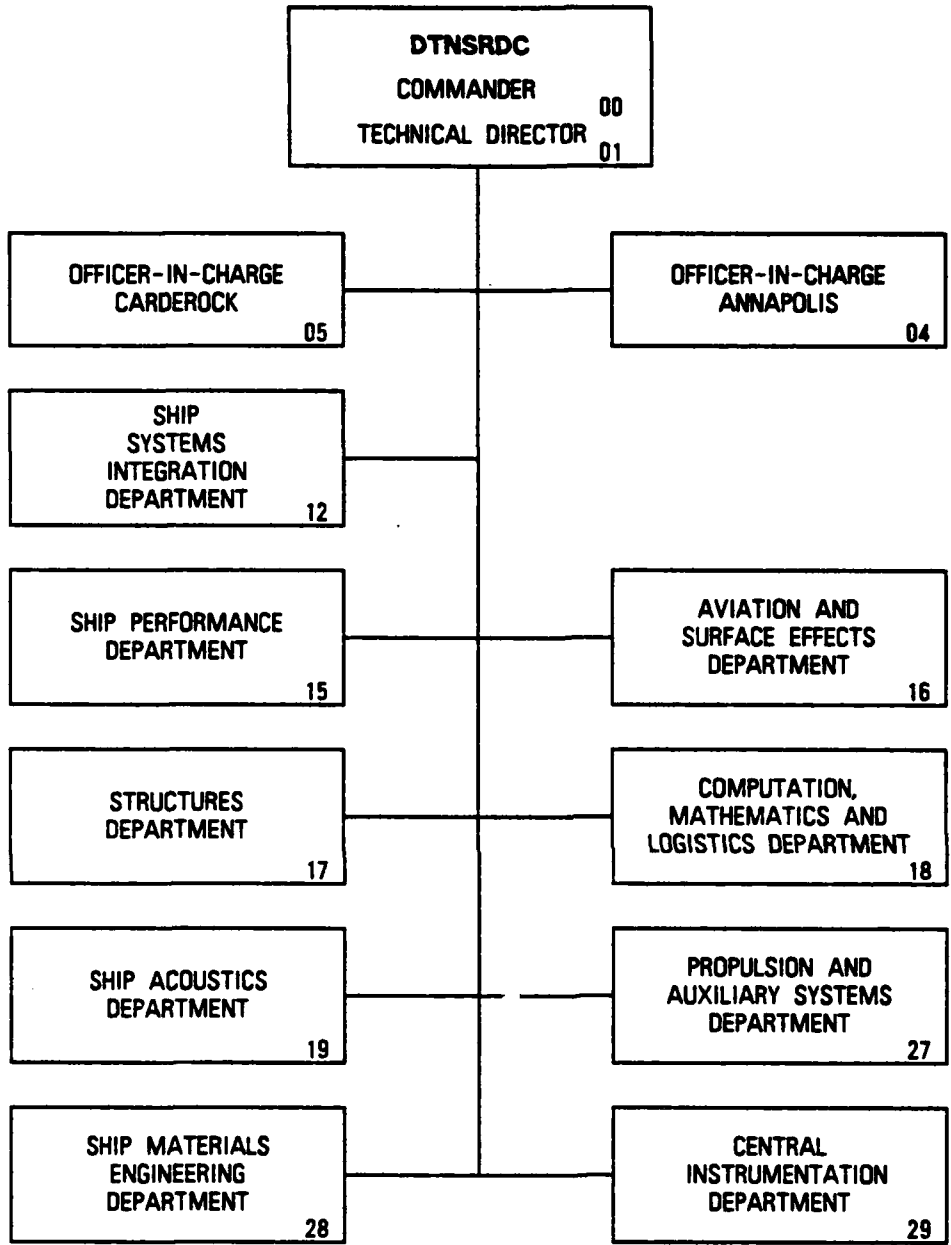
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## ABSTRACT

The Mass Store system is used to store a large number of user files. Users store files on Mass Store from the NOS/BE machines.

The idea behind storage on Mass Store is that a large amount of information can be saved on Mass Store with no worries of reaching full disk capacity. Files that have not been accessed recently are written to cartridge and the disk space is released. Also, there is no limit to how long a file can exist; a file will not be purged due to lack of use.

This document is a presentation of a locally designed procedure that ensures that each file stored on Mass Store is also backed up by Mass Store. This procedure replaces the previous method which used standard nine-track tapes as the backup media.

*Keywords:*  
*computer files, Mass storage;*  
*Backup systems, Algorithms.*

## GENERAL DESCRIPTION OF MASS STORE

The Mass Storage Subsystem (MSS) at DTNSRDC is driven by a Cyber 825 machine running NOS (Network Operating System). Two CDC NOS/BE machines, the CYBER 176 and the CYBER 750, are linked to the 825 by satellite couplers. By using these couplers, users can store and fetch files from MSS. The files that are sent to MSS are initially stored on disk. Eventually, a file will be written to cartridge. If that file has not been accessed recently, it will be released from disk. Once a file resides on cartridge only, it can still be fetched by the user. The file is staged; i.e., the file is read from the cartridge and written to disk.

The equipment that houses cartridges is called a Cartridge Storage Unit (CSU). At the time of this document, DTNSRDC has six CSU's. Each CSU has two Mass Storage Transports (MST's). An MST reads from and writes to cartridges.

## THE OLD METHOD -- A GENERAL OVERVIEW

The previous method of backing up files on Mass Store was to dump files to tape. One night a week, every file on the system, whether on disk or cartridge, was dumped to tape. All files residing on cartridge were staged and copied to dump tapes. On the other nights, files that had been changed since the last dump were dumped to tape.

One problem with this method of backing up files was the lack of efficiency. Each file on MSS was dumped to tape weekly, regardless of when the file was modified. Since unused files were not being purged periodically, the total number of files on MSS was growing larger. Therefore, the amount of time and the number of tapes it took to complete the procedure was intolerable. The procedure was employing approximately 50 tapes and took as long as 20 hours.

A lengthy dump caused a few problems. If a dump ran over into production time, users needing files on Mass Store would be affected; the request for a file was competing with the dump for MSS processing.

Control Data Customer Engineers (CE's) were also affected. They lost preventive maintenance time.

## THE NEW METHOD -- AN OVERVIEW

A new dump procedure that reduced both the number of files dumped and the number of tapes needed to retain a full backup of the files on MSS was highly desirable. This new procedure was designed and implemented in June 1983.

For the new version of the backup procedure, there are two concepts of backing up files. First, every file that has been modified since the last time the procedure was run is dumped to a "backup" cartridge on Mass Store. This creates a second copy of each file on an alternate, or backup, family. Every file that resides on disk is copied to dump tapes. In addition, the permanent file catalog (PFC) of every file that resides on disk, MSF, or in both places is copied to dump tapes. This involves no staging of files.

The new backup procedure is much more efficient than the previous one. A file is dumped to tape depending upon where it resides on Mass Store. If a file resides on disk only, it is dumped; however, if a file resides on MSF at all, just its PFC is dumped. This reduces the number of tapes for a permanent file dump to approximately one or two and the number of hours to six. The same procedure is run every night. Because the dump rarely runs into production time, there is less interference to the users. Also, there is now adequate preventive maintenance time for the CDC CE's.

Another nice feature of the new procedure is that if a permanent file disk crashes, the whole system can be reloaded from just one set of tapes. (This is explained more thoroughly later in this document.)

As stated before, this procedure causes two copies of a file to be created. Therefore, if one of those files becomes bad, the other can be used to restore it. No tapes would be involved in the restoration.

## PREPARATIONS FOR IMPLEMENTATION

In preparation of the implementation of the new method of backing up files on Mass Store, certain changes had been made to the MSS configuration. A new family, BACKFAM, was defined on the NOS system. All backup files reside in this family. The logical devices included in this family are two CSU's (C and D) and one full-track disk drive.

All the files that currently resided on the system were dumped to BACKFAM. This ensured that every file had a backup copy.

PERMANENT FILE BACKUP PROCEDURE ALGORITHM  
(program related to each step in parens)

- A. Backup special MSS system files
- B. If legal user index range specified
  - continue
  - else
  - abort
- C. If restart requested then
  - if restart file exists then
  - continue
  - else
  - abort
  - else
  - if restart file exists then
  - if restart desired
  - drop job
  - else
  - continue
  - else
  - continue
- D. If initial call for daily permanent file dump then
  - copy files created that day on the production family to
  - cartridge (MOVE)
  - release disk space in production family of files not accessed
  - in four days (MOVE)
  - release cartridge space in production family (RELRFDS)
  - else
  - continue
- E. Save system date and time (SAVDATE)
- F. Perform audit to obtain an unsorted list of users who have created or modified files since the last dump (AUDIT)
- G. Sort user list (SORTUIS)

H. For each user in user list

1. set user index
2. perform catlist
3. perform PFCAT for indirect access files (PFCATS)
4. perform PFCAT for direct access files (PFCATS)
5. perform one PFDUMP to BACKFAM for all indirect access files  
(IBACKUP)
6. perform one PFDUMP to BACKFAM for each direct access file (DBACKUP)
7. set family to BACKFAM
8. perform catlist
9. for each file in production family catlist (COMPARE)
  - a. if not in BACKFAM then  
perform PFDUMP to BACKFAM
10. for each file in BACKFAM catlist (COMPARE)
  - a. if not in production family then  
purge file in BACKFAM
11. move files from disk in BACKFAM to cartridge in BACKFAM (COMPARE)
12. set family to production family

I. Dump BACKFAM PFC's to tape and create RDF for BACKFAM  
(MSSINGA)

J. Release cartridge space in BACKFAM (MSSINGA)

K. For every file in production family (MSSINGA)

if file resides on disk alone then  
dump to tape  
elseif file resides on MSF alone then  
dump PFC's to tape  
elseif file resides on both disk and MSF then  
dump PFC's to tape

L. Create RDF for production family (MSSINGA)

M. If restart file exists then  
purge it

ERROR EXIT PROCESSING

A. Save user index being processed at time of exit, the  
last user index to be processed, and the remaining  
parameters as requested in the initial call (ERROR)

## PROGRAMS, PROCEDURES, AND SPECIAL FILES

The procedure references other procedures and FORTRAN V programs. Each program creates small procedures and/or data files to be used by another program. Furthermore, special files are created and saved by the main procedure so that they can supply initial parameters if so desired.

### FORTRAN V PROGRAMS

#### REINIT

- used if the procedure is restarted
- reinitializes the parameters of the procedure so that it may begin where it left off
- input is the restart file REINSTS
- output is the files TAPE30, TAPE40, TAPE50, and TAPE60 containing the input parameters that were saved during error exit processing

#### SAVDATE

- saves the system date and time the procedure begins
- input is the date and time obtained from the operating system
- output is the file DATTIM containing the system date and time; if the procedure is the initial call of the daily dump procedure coming to an end, this file is saved as DMPDATE to determine the default AD and AT parameters for the next day's dump procedure

#### MOVE

- used if the initial run of the day's dump
- creates the procedure MOVPROC that performs an ASMOVE that releases files from disk and moves them to cartridge if they have not been accessed in four days
- input is the file DATTIM and the file TAPE60 containing the family being processed
- output is the procedure MOVPROC

#### AUDCAT

- creates the procedure AUDCAT that performs PFCAT's for the production family
- input is the file DMPDATE and the file TAPE40 containing the date and time obtained from the procedure call
- output is the procedure AUDCAT

## RELRDFS

- used if the initial run of the day's dump
- creates the procedure RDFPROC that performs an ASVAL on the production family using RDF's (release data file) from a month and one week ago until a month ago (if they exist); the RDF's are then purged
- input is the file DATTIM and the file TAPE60 containing the family being processed
- output is the procedure RDFPROC

## SORTUIS

- sorts the list of users in numeric order
- input is the file MARY containing the unsorted list of user indices; MARY is created by the normal audit procedure that uses the output from the procedure AUDCAT as input
- output is the file TAPE2 containing the sorted list of user indices

## BACKUP

- sets up the files used by the DMPROC procedure using the input parameters from the initial call
- input is the files TAPE30 containing the user index range, TAPE40 containing the date and time of the previous dump, TAPE50 containing the permanent file (if any), TAPE60 containing the family being processed and TAPE2 containing the sorted list of user indices
- output is the file INDXLST containing the sorted list of user indices beginning and ending within the range specified, the file LAST containing the last user index to be processed, the file DATELST containing the date and time to be processed, and the procedure DUMP that processes the user indices

## PFCATS

- creates the procedure PFCPROC that sets the user index to be processed and performs a catlist and PFCAT's for indirect and direct access file; saves the next user index to be processed
- input is the files INDXLST, TAPE40, TAPE50, and TAPE60
- output is the procedure PFCPROC, the file NEXT containing the next user index to be processed, and the file NOW containing the user index currently being processed

#### IBACKUP

--creates the procedure IPROC to perform a PFDUMP for a user's indirect access files  
--input is the output for the PFCAT of the indirect access files  
--output is the procedure IPROC

#### DBACKUP

--creates the procedure DPROC to perform PFDUMP's for a user's direct access files  
--input is the output for the PFCAT of the direct access files  
--output is the procedure DPROC and the file NODUMP containing the files with the backup requirement of no or media dependent

#### COMPARE

--compares the catlist output of the user's files in the production family with the corresponding catlist output in BACKFAM and creates the procedure CMPPROC that purges and dumps files accordingly (if a file in the production family but not in BACKFAM, it is dumped to BACKFAM; if a file is in BACKFAM but not in the production family, it is purged in BACKFAM) and performs an ASMOVE on the user in BACKFAM  
--input is the files FCATLST and BCATLST containing the catlist outputs for the production family and BACKFAM respectively, the file NODUMP, and the file NOW  
--output is the procedure CMPPROC

#### MSSINGA

--creates the procedure IMGPROC that performs PFDUMP's of BACKFAM and the production family to tape and an ASVAL on BACKFAM with an RDF that was created during the last time the procedure was run  
--input is the file DATTIM  
--output is the procedure IMGPROC

## ERROR

- used if the procedure aborts prematurely
- saves all the parameters needed to reinitialize the procedure
- input is the file NOW, the file LAST, the file DATELST, and the files TAPE50 and TAPE60
- output is the file REINSTS containing the range of indices that still need to be processed, the date and time, the permanent file (if any), and the family that was being processed

## PROCEDURES

### AUDIT

- creates the file MARY containing the unsorted list of user indices

### DMPROC

- used for each user in the file INDXLST
- for each user index executes the FORTRAN V programs PFCATS, IBACKUP, DBACKUP, and COMPARE for the family specified by the FM parameter

## SPECIAL FILES

### DMPDATE

- contains the date and time of the last time the procedure was called using UI=ALL
- format: (beginning in column 1)
  - YYMMDD (date)
  - HHMMSS (time)

### REINSTS

- restart file
- contains the parameters needed to restart the procedure if it had ended prematurely
- format: (beginning in column 1)
  - UI-LUI (beginning and ending user index, one-to-six digits)
  - AD (after date, YYMMHH)
  - AT (after time, HHMMSS)
  - PF (permanent file name, seven alphanumeric characters)
  - FM (family, seven alphanumeric characters)

## DESCRIPTION OF CONTROL PARAMETERS

The procedure accepts parameters to precisely control which files are to be processed. Seven parameters are allowed when invoking the procedure. The parameters are specified in keyword format. The call statement is

X.INCDMP (UI=ui,LUI=lui,AD=yymmdd,AT=hmmss,PF=filename,  
FM=family,RESTART=no/yes)

KEYWORD	OPTION	DESCRIPTION
UI -	ALL	Process all user indices in index list. (Default)
	ui	Process single user index.
	uil	Process range of user indices beginning with uil.
LUI -	0	No last user index. Used if UI=ALL or UI=ui. (Default)
	lui	Process range of user indices ending with lui.
AD -	yymmdd	Date in 6-digit format of year, month, day. Files created or modified after this date are to be processed. (Default-date of last permanent file dump saved in file DMPDATE)
AT -	hmmss	Time in 6-digit format of hour, minute, second. Files meeting the AD=yymmdd criterion and created after this time are to be processed. (Default-time of last permanent file dump saved in file DMPDATE)
PF -	filename	Name of permanent file to be processed. If the PF parameter is specified, then the UI parameter must also be specified for a single user. (No default; not a required parameter)
FM -	family	Name of family to be processed. (Default-SYST75)
RESTART -	yes	The procedure had ended prematurely and needs to be restarted where it left off. All the information needed is contained in the file REINSTS.
	no	This is an initial call to the procedure. (Default)

## HOW IS THE PROCEDURE ACTUALLY IMPLEMENTED?

The backup procedure is invoked by entering the command at the console. By supplying a combination of parameters, the procedure can be used in a number of different ways.

### X.INCDMP.

The operator begins the daily permanent file dump by entering the above command. The default parameters are used.

### X.INCDMP(UI=ui)

All this user's files that have been created or modified since the last permanent file dump will be dumped to BACKFAM.

### X.INCDMP(UI=uil,LUI=lui)

All the files for all the users whose user index lies within the range uil and lui that have been created or modified since the last permanent file dump will be dumped to BACKFAM.

### X.INCDMP(UI=ui,PF=filename)

The permanent file "filename" under this user will be dumped to BACKFAM. Any AD or AT parameters will be ignored.

### Using the FM parameter

Files on the family specified will be processed.

#### Using the AD and AT parameters

The information on the file DMPDATE is ignored and the date and the time specified on the procedure call will be used. Files created or modified after this date and time will be processed.

#### X. INCDMP (RESTART=YES)

This option assumes that the restart file REINSTS exists. The procedure will use the information on this file as input parameters. Any other parameters given when "RESTART=YES" is entered are ignored. If REINSTS does not exist, a dayfile message stating that there is no restart file is displayed and the procedure terminates. If REINSTS does exist but this option was not chosen, a dayfile message is displayed giving the operator an option to either continue the procedure or drop it and begin again with "RESTART=YES". If he/she chooses to continue and the procedure ends prematurely, the current version of REINSTS will be replaced by a new one.

## POSSIBLE PROBLEMS

Sometimes the procedure may terminate prematurely. This can occur because of either a software or hardware problem, or the operator dropped the job for some reason. In a case like this, the operator can reinitialize the job by entering the "RESTART=YES" option.

However, there are a few instances when the file REINSTS will not be saved. For example, if there is a power outage while the procedure is running, obviously the error exit processing will not be performed. So when the operator tries to reinitialize the job by entering the "RESTART=YES" option, a dayfile message will appear informing him/her that REINSTS does not exist and to enter the procedure REDUMP.

REDUMP is a system procedure that the operator enters when there is no restart file. REDUMP checks the dayfile to determine what user was being processed when the system went down.

The worst problem concerning the daily permanent file dump occurs when a user creates or modifies so much information that the disk assigned to BACKFAM runs out of space. A message flashes at the console informing the operator that the device for BACKFAM is full. The operator then drops the job and enters the system procedure MOVE which performs an ASMOVE for BACKFAM. When this procedure finishes, the dump can be restarted. However, it is not desirable to use the "RESTART=YES" option because the procedure would start with the very same user that caused the problem in the first place. The operator must enter the procedure with the following parameters: 1) UI=the next user index; 2) LUI=377777 (the last user index); 3) AD=the date of the last dump; and 4) AT=the approximate time of the last dump (160000 is usually entered). The procedure would then begin with the user index following the user who had filled the disk space.

To complete the dumping of that user's files, a system analyst is needed. It is possible for the analyst to determine what was the last file that the job had dumped and continue with the rest of the user's files.

## THE ADVANTAGES OF USING THIS PROCEDURE

Many things can happen in the every day use of the Mass Store software and hardware that will cause problems that can be solved semi-easily because this procedure is in production.

Daily reports are run that inform the system analyst what files have been flagged with an error. Sometimes, depending on the error, it is impossible for the user to attach that file. The analyst can clear the flag and attempt to reattach the file. If this attempt fails again, the archive copy of this file can be reloaded from BACKFAM to the production family using a locally designed maintenance procedure called RELOAD. If for some reason the archive file on BACKFAM is bad, its PFC may be reloaded using the previous night's tapes containing BACKFAM PFC's. Then RELOAD can be used.

If the reports reveal that a file cannot be attached because of a missing cartridge, the file can be restored using RELOAD.

If, for some reason, a permanent file disk for the production family is lost, the files on this disk can be reloaded using the production family dump tapes. Because a full permanent file dump is performed every night, only the previous night's permanent file dump tapes are needed to reload the disk.

If a user accidentally purges a file, that file can be reloaded if User Services is informed within 30 days. The file will be reloaded from the last set of dump tapes that the file was on. If 30 days have passed, the space on which this file resided on cartridge would have been released and, at this time, the file can not be reloaded.

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## GLOSSARY

The following terms are used in the explanation of the MSS backup procedure:

- archive file--a file to which a dump of a permanent file is made; the backup file for a permanent file.
- cartridge--plastic housing enclosing 2540 mm (100 in) of magnetic tape on which data is stored under program control.
- cartridge storage unit (CSU)--unit which includes storage cells (cubicles) for 2052 cartridges. DTNSRDC at the time of this document has 6 CSU's. Each CSU is associated with a letter A through F, which is the CSU identifier.
- catalog image record (CIR)--record created during an incremental dump for every permanent file in the family being dumped; it contains the name of the permanent file, the user index under which the file is catalogued, the number of times the file has been accessed, the device number of the device on which the file resides if it is a direct access file, and the date and time the file was last accessed.
- CATLIST--a NOS command similar to the NOS/BE command AUDIT that creates a list of a user's files.
- destage--to copy a direct access files from disk to MSF.
- direct access file--type of mass storage file used by most users of the Mass Store. These files can be destaged to MSF to release disk space.
- family--collection of logical devices identified by a one-to-seven-character family name; users and their files are grouped together according to the family assigned to them.
- indirect access file--type of mass storage file that resides on disk at all times.
- Mass Storage Facility (MSF)--a large capacity on-line mass storage device on which data is stored and can be moved to disk upon request for access by an authorized user; the Mass Storage Subsystem (MSS) controls MSF.
- permanent file catalog entry (PFC)--created whenever a permanent file is created, it specifies the characteristics of the file.

release data file (RDF)--file created during the dump identifying files residing on cartridge that are pointed to by a permanent file catalog entry; files that have been purged but are still on the system do not have permanent file catalogs. This file will be used in a future dump by ASVAL to release files from MSF that no longer have PFC's (i.e., the files have been purged).

stage--to copy a direct access file from MSF to disk.

user index--a one-to-six-digit octal number that is associated with a particular user; there is a one-to-one correspondence between a user and a user index.

**Permanent File Utilities Used:**

PFCAT--produces a catalogued directory of file information.

PFDUMP--dumps files from a permanent file device to backup files.

**MSS Utilities Used:**

ASMOVE--destages disk files to MSF and releases disk space.

ASVAL--releases cartridge space of files that have been purged.

NOTE--The above information was obtained from NOS 2 SYSTEM MAINTENANCE REFERENCE MANUAL, rev. C, pages 1-1,3,9,19,35,48;3-1,2, and NOS 2 REFERENCE SET VOL. 3, rev. C, page 2-14.

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