TO: Operations
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DATE: October 5, 1973
SUBJECT: Reconfiguration of Memories, Processors and Bulk Store

This document gives instructions for doing dynamic reconfiguration of CPU's, memories and the Bulk Store. There are six commands which can be used to reconfigure and all of them are recognized by the Answering Service (without entering admin mode). In addition, any of the commands can be called from any SysDaemon or SysAdmin process in the event the Answering Service can not be used.

The processor and memory reconfiguration commands are all controlled by a reconfiguration "lock". If a reconfiguration attempt aborts for some reason this lock may be left ON. When this happens any further attempts to reconfigure will result in a message saying that reconfiguration is currently in progress. If this happens the following command may be executed:

reconfigure$force_unlock

This will unlock the lock so that further reconfiguration attempts may be made. However, it is quite possible that the reconfiguration data bases are still in an inconsistent state (e.g. thinking a CPU was added when it really wasn't). If this is the case all reconfiguration requests for CPU's and memories should be delayed until after the next bootload.

Terminology and Switches
1. Each memory has one and only one "control CPU". This is the CPU that receives interrupts that are set in the memory. This is also the CPU that is pointed to by the EXECUTE INTERRUPT MASK ASSIGNMENT (EIMA) switch A on the memory. (Note that EIMA switches B, C, and D should always be OFF.)

2. Each CPU has one memory which is called its "control memory". This is the memory to which interrupts are sent which are directed to the CPU. Note that each CPU must have a memory associated with it --- there must be at least as many memories in the system as CPU's.

3. The PORT ENABLE switches on the CPU (and IOM and Bulk Store) determine which memories the CPU (or IOM or Bulk Store) may access. When reconfiguring, these switches control the effect of the other switches in the same row on the maintainance panel. It is imperative that all other switches (INITIALIZE ENABLE, ASSIGNMENT, INTERLACE, ADDRESS RANGE) in the same row as a given PORT ENABLE switch be correct before the PORT ENABLE switch is turned ON. In particular, if any switches in the same row are to be changed, the PORT ENABLE switch should be turned OFF. The IOM and Bulk Store switches work in the same way with the additional restriction that on the Bulk Store the PORT GROUP switch should also be set correctly before turning on the PORT ENABLE switch.

4. The INITIALIZE ENABLE switch on the CPU's, IOM's and Bulk
Store only come into play when the ROS (or T and D) system is bootloaded. When this is done all of these switches should be ON so that the initialize signal can be reflected to all modules of the system being bootloaded. After ROS is bootloaded all INITIALIZE ENABLE switches should be turned OFF. The Bulk Store, however, should never have its INITIALIZE ENABLE switches in the ON position. The Bulk Store should be initialized manually prior to bootload of either service or development system. If either system is using the Bulk Store it need not (and should not) be initialized.

5. The ASSIGNMENT switches on the CPU's, IOM's and Bulk Store specify in which order the memories are to be used. All assignment switches for a given system should be the same on all active modules in the system. (An active module is a CPU, an IOM or a Bulk Store.) Note that if it is necessary to change an ASSIGNMENT switch (e.g. to add a memory) on an active module, the PORT ENABLE switch corresponding to the ASSIGNMENT switch should first be set OFF.

5. The INTERLACE switches on the active modules should be set as indicated in any reconfiguration instructions. These switches reflect the state of the "external" interlace between two memory controllers. (The INTERLACE switches on the memories indicate "internal" interlace and should always be left in the ON position.)
7. The ADDRESS RANGE switches on the active modules should always be left in the FULL position. (At times of specific hardware problems FED may recommend changing these.)

8. The EXECUTE INTERRUPT MASK ASSIGNMENT (EMMA) switches on the memories control where interrupts sent to that memory will be directed. (These switches correspond to the CONTROL PROCESSOR switch on the 645 memories.) Only switch A should ever be in a position other than OFF.

9. The PORT CONTROL switches on the memories control which active modules have access to the memory. When in the PROC CONT position, the software can and does control this access by enabling only those active modules which are currently configured. (see later)

Adding Bulk Store (Paging Device)

To add a region of the Bulk Store to the Multics configuration the following command is used:

```
addpar first count
```

where first is the (octal) number of the first Bulk Store record to add and count is the (octal) number of records to add. The block of records starting at first and going for count records will be set up for use by the software. The hardware switches enabling the given region of the Bulk Store must already have been set up before this command is issued. (See MOSH-4.4.4.3 for information about setting the Bulk Store configuration switches.)
Deleting Bulk Store (Paging Device)

To delete a region of the Bulk Store from the Multics configuration the following command is used:

```
delpag first count
```

"first" and "count" are the first record and size, respectively, of a region to be deconfigured. They should both be octal. This command tells the software not to use the specified region of the Bulk Store and hence after it is issued the region may be physically reconfigured if desired.

Adding a Processor

To add a processor to the system a well defined sequence of events must be followed. The script that follows is a sample output from a console session for adding a CPU:

```
|-----------------------------------------------|
addcpu b 6 b
|-----------------------------------------------|
```

Check that the following has been done (if not, do it in the following order):

All memories: PORT CONTROL (port 6) set to PPRG CONT
cpu b must have the following switch settings:

- memory a: Assignment 0 Interlace OFF PORT ENABLE OFF
- memory b: Assignment 1 Interlace OFF PORT ENABLE OFF
- memory c: Assignment 2 Interlace OFF PORT ENABLE OFF
- CPU NO: 2

Have all the above been done?(yes/no and initials): yes shw

***Remember to initialize and enable cpu b after changing the EIMA switch.***

You will change EIMA switch / on memory b to port 6.
Wait until instructed to change them. Are you ready? (yes/no): yes
Change switch(es) now. Type 'done' when done: done
cpu b is now running.
In essence the following steps must be taken after the second answer "yes":

1. Change EIMA switch A on the control memory to the given port for the processor being added.
2. Initialize the processor to be added (by pressing INITIALIZE & CLEAR).
3. Set the PORT ENABLE switches ON (for all memories in the system) on the CPU to be added.
4. Answer "Done".

If the CPU fails to start running for some reason the software will automatically instruct the operator to change the EIMA switch back to its original position. Another attempt to add the CPU can be issued when the command finishes its cleanup.

A second CPU to be added to the system should be added after the STARTUP command has been issued.

Deleting a Processor

To remove a processor from the system the operator types
\[ \text{delcpu H} \]
where H is the name (e.g. "a", "b", etc.) of the processor to be deleted. The program will instruct the operator to change EIMA switches on all memories which are controlled by the CPU being deleted. After the delcpu command has finished the processor switches can be changed as desired --- the system software insures that the processor can not access any of the service memories. (It is not necessary to change the PORT CONTROL switches on all memories for the processor being deleted.)

Adding a Memory
The following is a sample console output for adding a memory to the system:

```
addmem c a
```

Make sure

PUM A, BULK STORE A, CPU A

have the following switch settings:

- **memory a**: Assignment 0  Interlace OFF  PORT ENABLE ON
- **memory b**: Assignment 1  Interlace OFF  PORT ENABLE ON
- **memory c**: Assignment 2  Interlace OFF  PORT ENABLE ON

Perform the following (in the order given) on system controller c.

- PORT CONTROL set to DISABLE for all ports.
- Initialize controller at its maintenance panel.
- Change EXECUTE INTERRUPT MASK ASSIGNMENT switch A to port 7.
- PORT CONTROL set to PROG CONT for ports 0, 2 and 7.

Have all the above been done?(yes/no and initials): yes shw

You have added memory controller c.

The argument to the addmem command is the memory name (e.g. "c") as on the POS configuration card. An additional argument can optionally be provided to specify a particular CPU (e.g. "a") as the control processor for the memory being added.

**Removing a Memory**

To remove a memory from the system the following command should be issued:

```
remem W
```

where "W" is the name of the memory as on the POS configuration card. Deleting a memory which is the control memory for some
processor will trigger code instructing the operator to change the SIMA switch on a memory to be control memory for the CPU. Note: the bootload (low-order) memory can not be deleted.

Notes
When the reconfiguration commands request the operator to give a "yes/no" answer, then any answer other than "yes" will be interpreted as "no" and will properly terminate the reconfiguration request. When the operator is asked for a "yes" or "done" answer, he must do as directed and answer appropriately or risk crashing the system. If the error message "program error -- notify programmer" ever occurs, DO NOT try to use any reconfiguration command again until cleared by a programmer, or until after the next bootload.

Note that when the configuration is changed dynamically, the BOS cards for processors, memories and Bulk Store may no longer reflect the true configuration. Therefore, before the next bootload or salvage the hardware configuration and the BOS configuration deck must be made consistent with each other (the CONFIG U command in BOS should probably be used).

It is only possible to add Bulk Store to a system if the system was informed about the ultimate possible size of the paging device at system bootload time. This is indicated on the page configuration card which specifies the maximum size of the Bulk Store as well as optional regions which should not be used.
(See HOSH-4-3 for a description on the page configuration card.)

Only memories that are defined by DOS cards at bootload time can be added. The configuration card for a memory has a field to indicate if it is on-line or off-line at bootload time. All the memories actually being used at the time of the bootload must have an ON in the last field in the DOS configuration card. These memories should be the first in the configuration deck. Memories which might be added later have an OFF in this field. These should follow the other memory cards (i.e., these are the high order memories). Normally, in the service machine DOS deck there should be a memory card (either ON or OFF) for every memory in the installation.

The PORT CONTROL switches for all memory controllers running on the service system should be set in the PROG CONT position for all ports at all times. For the development system, all ports should be ENABLED or DISABLED to reflect the running development configuration. Note that after adding a memory unused ports are left in the OFF position. After the adding of the memory is completed the operator will put ALL PORT CONTROL switches in the PROG CONT position.

Returning to DOS

Under normal running conditions the EXECUTE button is used to force the system to enter DOS. This can be done in one of two ways:
1) Usually BOS will be entered by causing an execute fault. For this to occur, the EXECUTE SWITCHES switch must be **down** when the EXECUTE button is pushed. The switch should normally be left in the down position. **DO NOT** put the processor in "step" when using the execute fault.

2) BOS can also be entered by executing the instruction pair located at location 4999 or 4992 in memory. In this case, the desired address (viz. 4999 or 4992) is set in switches 0-17 and an execute double (XED) instruction is set in switches 18-35 (the octal value of the switches should be either 994999717200 or 004002717200). If the EXECUTE SWITCHES switch is in the up position when the EXECUTE button is pushed the XED will be executed; the processor should be in "step" when the button is pushed. BOS should be entered with an XED only in the cases noted below, or as a last resort.

**BOS Configuration Deck**

The order of the cards in the configuration deck is important for cpu's and memories. The first CPU card is for the bootload CPU; the second cards must be in the order of increasing address.

**Crashes and Shutdowns**

If the above instructions are followed, then whenever Multics crashes and BOS is entered either by Multics or manually, the normal dump procedures (FDUMP, etc.) should be followed. This is independent of the number of processors running. It is not
necessary to explicitly dump the process that was executing on the non-bootload CPU. (It is still useful to copy down the DRR of the non-bootload CPU). If Multics will not go back to POS for some reason, place both CPU's in "step" and transfer back to POS on the bootload CPU using 004000717200 in the switches and the EXECUTE SWITCHES switch in the up position. If this succeeds, proceed normally. If this fails, try 004002717200. If this succeeds do not attempt an ESD; proceed to the salvager directly.

Before attempting an ESD, or a Salvage, all EMMA switches on all memories should be pointing at the bootload CPU.

**Warning:** With two processors, **NEVER** put either processor in "step" (except in the case Multics will not reenter POS). If either or both processors must be put in "step" (e.g., for work by the FE's) then enter POS with the "bos" command on an initializer console; put both processors in "step" only while in POS.