

# *MemTool*

## *Installation and Operation*

Alpha Draft



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## Installation

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The Memtool package may be obtained from your local Sun SE, and is at the time of writing available for Solaris 2.5, 2.5.1 and Solaris 2.6.

Installation requires loading a kernel module, and it is recommended that you exercise care when installing, as not to disrupt production workloads.

### Adding the Memtool Package

The package is provided in compress tar format, and uses the standard Solaris pkgadd command.

```
# zcat RMCmem3.5b.tar.Z |tar xvf -
x RMCmem, 0 bytes, 0 tape blocks
x RMCnen/pkgmap, 2343 bytes, 5 tape blocks
.
.
# pkgadd -d .

The following packages are available:
 1 RMCmem      The MemTool Package
                   (sparc) 3.5b

Select package(s) you wish to process (or 'all' to process
all packages). (default: all) [?,??,q]: 1

Do you want the Memtool module loaded now? y
```

The Memtool package uses a loadable kernel module. If you would like this module loaded now so that you may use the tools before reboot, then answer yes to this question. To just install the software without impacting the system, answer no.

Please be aware that loading modules onto a running system should be done without production users on the system.

```
Do you want to install the module loader in /etc/rc2.d? y
```

The loadable kernel module can optionally be loaded at boot time. This is the normal method of installing Memtool. Answer yes to have a script placed in /etc/rc2.d to load the module at boot. If you don't want the module to be loaded at reboot you can answer no.

```
.Do you want the kernel module loaded now? y

Do you want to install the module loader in /etc/rc2.d? y

Using </opt> as the package base directory.
## Processing package information.
## Processing system information.
## Verifying disk space requirements.
## Checking for conflicts with packages already installed.
## Checking for setuid/setgid programs.

This package contains scripts which will be executed with super-user
permission during the process of installing this package.

Do you want to continue with the installation of <RMCmem> [y,n,?] y

Installing The MemTool Package as <RMCmem>

## Executing preinstall script.
## Installing part 1 of 1.
/etc/init.d/memtool
/opt/RMCmem/README
.
## Executing postinstall script.

Installation of <RMCmem> was successful.
```

## *Manually Loading the kernel Module*

If you answered no to loading the kernel loadable module, or have rebooted and the module was not loaded at boot then you will need to manually load the module.

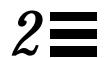
There is a script to do this in the Memtool base directory, /opt/RMCmem/drv.

```
# cd /opt/RMCmem/drv
# ./bunyipload
# modinfo |grep bunyip
110 6167c000 5162 - 1 bunyipmod.56 (VFS and Proc Memory Stats Module)
```





## MemTool Overview



The basis for the operation of MemTool is a loadable kernel module which uses the /proc interface to look at the memory allocation of processes and the UFS buffer cache.

### *Obtaining a summary of the systems memory*

A summary of the systems memory can be reported with the prtmem command.

```
# prtmem
Total Physical Memory: 384 Megabytes
Buffer Cache Memory: 112 Megabytes
Kernel Memory: 63 Megabytes
Free Memory: 17 Megabytes
```

### *Process memory usage and the pmem command*

Traditionally, the only information about process memory utilisation was the virtual memory size and RSS figure available from the *ps* command and *top*.

The virtual address size of a process often bears no resemblance to the amount of memory a process is using because it contains all of the unallocated memory, libraries, shared memory and sometimes hardware devices (in the case of Xsun).

The RSS figure is a measure of the amount of physical memory mapped into a process, but often there is more than one copy of the process running, and a large proportion of a process is shared with another.

The MemTool tools provide a mechanism for getting a detailed look at a processes memory utilisation. MemTool can show how much memory is in-core, how much of that is shared, and hence how much private memory a process has.

The *pmem* command (or */usr/proc/bin/pmap -x* in Solaris 2.6) can be used to show the memory utilisation of a single process.

```
# pmem 25888
or
# /usr/proc/bin/pmap -x 25888

25888: ksh

Addr          Size    Res Shared  Priv Prot          Segment-Name
-----
00010000    184K   184k   184k    0k read/exec      /bin/ksh
0004C000     8K     8k     8k     0k read/write/exec /bin/ksh
0004E000    40K    40k    0k    40k read/write/exec [ heap ]
EF5E0000    16K    16k    8k     8k read/exec      /usr/lib/locale/en_AU.so.1
EF5F2000     8K     8k    0k     8k read/write/exec /usr/lib/locale/en_AU.so.1
EF600000   592K   568k   560k    8k read/exec      /usr/lib/libc.so.1
EF6A2000    24K    24k    8k    16k read/write/exec /usr/lib/libc.so.1
EF6A8000     8K     8k    0k     8k read/write/exec
EF6B0000     8K     0k    0k     0k read/write/exec
EF6C0000    16K    16k   16k    0k read/exec      /usr/lib/libc_psr.so.1
EF6D0000    16K    16k   16k    0k read/exec      /usr/lib/libmp.so.2
EF6E2000     8K     8k    8k     0k read/write/exec /usr/lib/libmp.so.2
EF700000   448K   400k   400k    0k read/exec      /usr/lib/libnsl.so.1
EF77E000    32K    32k    8k   24k read/write/exec /usr/lib/libnsl.so.1
EF786000    24K     8k    0k     8k read/write/exec
EF790000    32K    32k   32k    0k read/exec      /usr/lib/libsocket.so.1
EF7A6000     8K     8k    8k     0k read/write/exec /usr/lib/libsocket.so.1
EF7A8000     8K     0k    0k     0k read/write/exec
EF7B0000     8K     8k    8k     0k read/exec/shared /usr/lib/libdl.so.1
EF7C0000   112K   112k   112k    0k read/exec      /usr/lib/ld.so.1
EF7EA000    16K    16k    8k     8k read/write/exec /usr/lib/ld.so.1
EFFF0000    16K    16k    0k    16k read/write/exec
EFFF0000    16K
-----
                1632K  1528k  1384k  144k
```

The example output from `pmem` shows the memory map of the `/bin/ksh` command. At the top of the output is the executable text and data segments. All of the executable binary is shared with other processes because it is mapped read only into each process. A small portion of the data segment is shared, whilst some is private because of copy-on-write operations (COW).

The next segment in the address space is the heap space, or user application data. This segment is typically 100% private to a process.

Following the heap space is the shared libraries. Each shared library has a text, and data segment, which are partially shared.

At the bottom of the process dump is the stack, which like the heap is 100% private.

A summary of the total Virtual size, resident portion and private memory are printed at the bottom.

## *Buffer cache memory*

Traditionally there has been no method of showing where the pool of buffer cache memory has been allocated. MemTool makes this possible by providing a list of all of the VNODE's in the buffer cache.

The list summarises the size of each VNODE in the buffer cache, and where possible the real filename. If the real filename cannot be determined, then the device and inode number are printed for that VNODE.

The MemTool kernel module collects filenames as each file is opened or referenced. If the kernel module has recently been loaded, then not all of the filenames will be available. The best way to cure this is to use the `/etc/rc2.d` script to load the `bunyip` module at boot, which will capture the first 8192 filenames referenced.

If you have a system with many files, you might like to put the following statement into `/etc/system`. Note that this uses extra kernel memory.

```
set bunyipmod:vfssize_maxitems = 32768
```

The list of VNODE's in the UFS buffer cache can be displayed with the memps command, and with the MemTool GUI.


```
# memps -m |more
SunOS devnull 5.6 SunOS_Development sun4u    07/21/97
11:27:03
  Size  Filename
12152k  /export/home/webarchives/mail/network-engrs
10680k  /export/home/webarchives/mail/sun-managers
 8032k  /2b40001: 370743
 6576k  /15c0007: 709619
 5152k  /export/home/webarchives/mail/unigram
 5056k  /export/home/webarchives/index/work/JAVAINTERNAL.dct
 3744k  /15c0008: 166191
 3288k  /usr/dt/lib/libXm.so.3
 2456k  /15c0007: 709592
 2376k  /export/home/webarchives/mail/firewall
 2272k  /15c0007: 586146
 2264k  /15c0008: 196636
 2016k  /800078: 5970
 1912k  /usr/openwin/lib/libxview.so.3
 1744k  /export/home/webarchives/mail/javaace
 1720k  /15c0007: 709594
 1696k  /15c0007: 132642
 1504k  /2b40001: 1206281
 1504k  /800078: 106190
 1496k  /2b40001: 1204243
 1448k  /15c0007: 709611
 1392k  /export/home/webarchives/index/work/JAVAINTERNAL.inv
 1264k  /usr/lib/libc.so.1
 1256k  /80007b: 182313
 1200k  /15c0007: 132666
 1096k  /800078: 100213
 1096k  /usr/openwin/lib/libX11.so.4
 1088k  /15c0007: 586141
 1080k  /usr/openwin/lib/libtt.so.2
 1072k  /15c0007: 709632
 1056k  /15c0007: 8844
 1032k  /2b40001: 929861
 1000k  /800078: 200260
  952k  /export/local/bin/perl
  880k  /usr/dt/lib/libDtSvc.so.1
  880k  /15c0007: 709610
  856k  /6167clac: 0
  856k  /usr/openwin/lib/libXt.so.4
  800k  /15c0008: 7231
  752k  /80007b: 113922
  720k  /800078: 82526
.
.
.
```





## *The MemTool GUI*

---

3 

The MemTool GUI interface provides an easy method of invoking most of the functionality of the kernel interfaces.

Invoke the GUI as the root user to see all of the process and file information.

```
# /opt/RMCmem/bin/memtool &
```

There are three basic modes on the MemTool GUI, Buffer cache memory, Process memory, and a Process/Buffer cache mapping matrix.

### *Buffer Cache Memory*

The initial screen shows the contents of the Buffer Cache memory.

The Buffer Cache Memory display shows each entry in the UFS Buffer cache. The fields shown are as follows:-

*Table 3-1 Buffer Cache Fields*

<b>Field</b>	<b>Description</b>
Resident	The amount of physical memory that this file has associated with it.
Used	The amount of physical memory that this file has mapped into a process segment or SEGMAP. Generally the difference between this and the resident figure is what is on the free list associated with this file.
Shared	The amount of memory that this file has in memory that is shared with more than one process
Pageins	The amount of minor and major pagein's for this file
Pageouts	The amount of pageouts for this file
Filename	The filename of the VNODE or if not known the device and inode number in the format 0x0000123:456



The screenshot shows the MemTool GUI with the following sections:

- Display Type:**
  - VFS Memory
  - Process Memory
  - Process Matrix
- Displaying:**
  - Processes: 0 out of 0
  - Files: 250 out of 445
- Show:**
  - All/Filter
  - Selected
  - Filters
- Selection Totals:**
  - Private: 0k
  - Text/Library: 0k
  - Total: 0k

The main table displays the following data:

Resident	Inuse	Shared	Pageins	Pageouts	File Name
11296k	11272k	0k	0	0	/2b40001:370743
4920k	4328k	0k	0	0	/15c0007:709619
4816k	4672k	0k	0	0	/export/home/webarchives/mail/netw
4320k	4272k	56k	0	0	/15c0008:166191
4264k	2576k	8k	0	0	/export/home/webarchives/mail/sun-r
3936k	3840k	1328k	0	0	/usr/dt/lib/libXm.so.3
3304k	3224k	0k	0	0	/800078:5970
3216k	3000k	0k	0	0	/export/home/webarchives/index/work
2928k	1840k	0k	0	0	/80007b:5701
2288k	1992k	0k	0	0	/15c0008:196636
2152k	2136k	0k	0	0	/2b40001:1204243
2088k	1312k	0k	0	0	/800078:35827
2056k	1808k	456k	0	0	/usr/openwin/lib/libxview.so.3
1992k	1280k	0k	0	0	/export/home/webarchives/mail/unigr
1840k	1040k	0k	0	0	/80007b:182313
1824k	1032k	0k	0	0	/800078:35831
1712k	1656k	0k	0	0	/800078:106190
1560k	1520k	432k	0	0	/usr/openwin/lib/libX11.so.4
1544k	1448k	0k	0	0	/800078:200260
1480k	1456k	0k	0	0	/2b40001:1206281
1368k	824k	0k	0	0	/800078:129575
1304k	1208k	560k	0	0	/usr/lib/libc.so.1
1272k	1256k	328k	0	0	/usr/openwin/lib/libXt.so.4
1240k	792k	0k	0	0	/export/local/bin/perl
1192k	1096k	352k	0	0	/usr/openwin/lib/libtt.so.2
1184k	1168k	0k	0	0	/2b40001:929861
1120k	1032k	0k	0	0	/800078:100213

Figure 3-2 MemTool GUI - Buffer Cache Memory

The GUI will only display the largest 250 files. A status panel at the top of the display shows the total amount of files and the number that have been displayed.

## Process Memory

The second mode of the MemTool GUI is the process memory display. Click on the “Process Memory” checkbox at the left of the GUI to select this mode.

The process memory display shows the process table with a memory summary for each process. Each line of the process table is the same as the per-process summary from the *pmem* command.

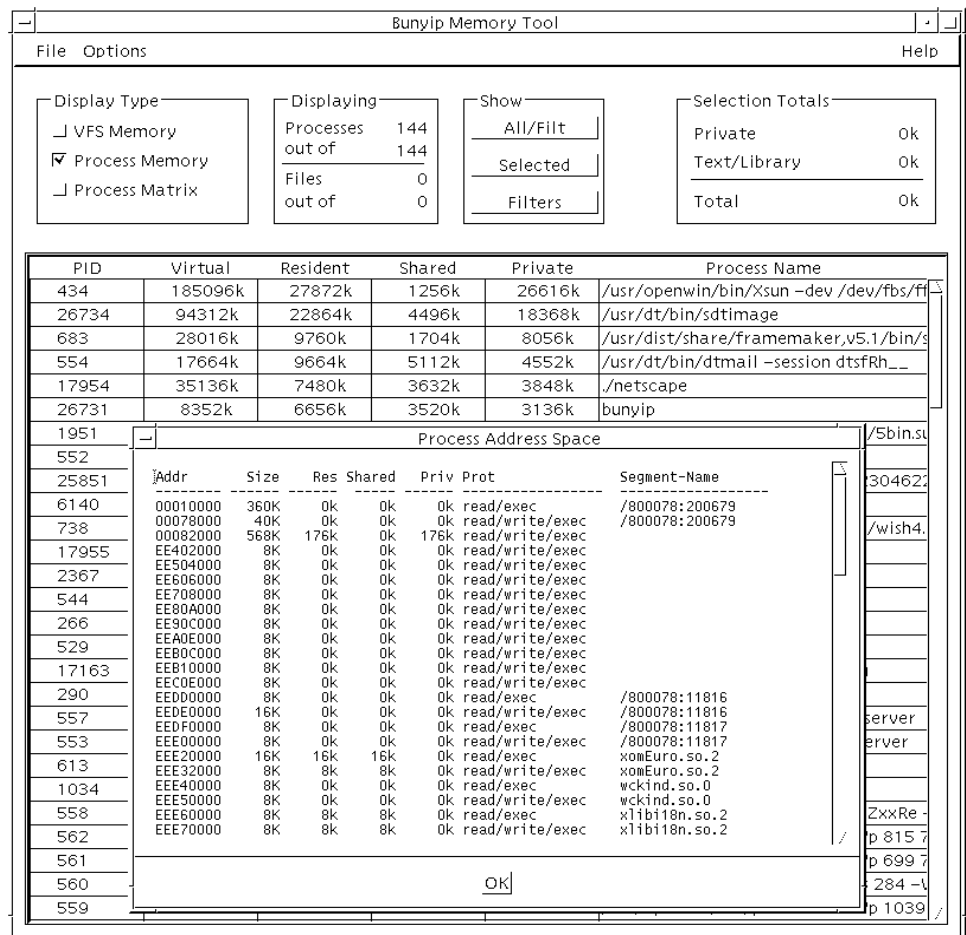


Figure 3-3 MemTool GUI - Process Memory

---

The fields for the Process Memory display are as follows:-

*Table 3-4* Process Memory Fields

<b>Field</b>	<b>Description</b>
PID	Process ID of process
Virtual	The virtual size of the process, including swapped out and unallocated memory
Resident	The amount of physical memory that this process has, including shared binaries, libraries etc
Shared	The amount of memory that this process is sharing with another process, ie shared libraries, shared memory etc.
Private	The amount of resident memory that this process has which is not shared with other processes. This figure is essentially Resident - Shared and does not include the application binaries.
Process	The full process name and arguments

The individual process map for a process can be selected by clicking on one of the process entries.

## Process Matrix

The process matrix shows the relationship between processes and mapped files. Across the top of the display is the list of processes that we viewed in the process memory display, and down the side is a list of the files which are mapped into these processes.

Each column of the matrix shows the amount of memory mapped into that process for each file, with an extra row for the private memory associated with that process.

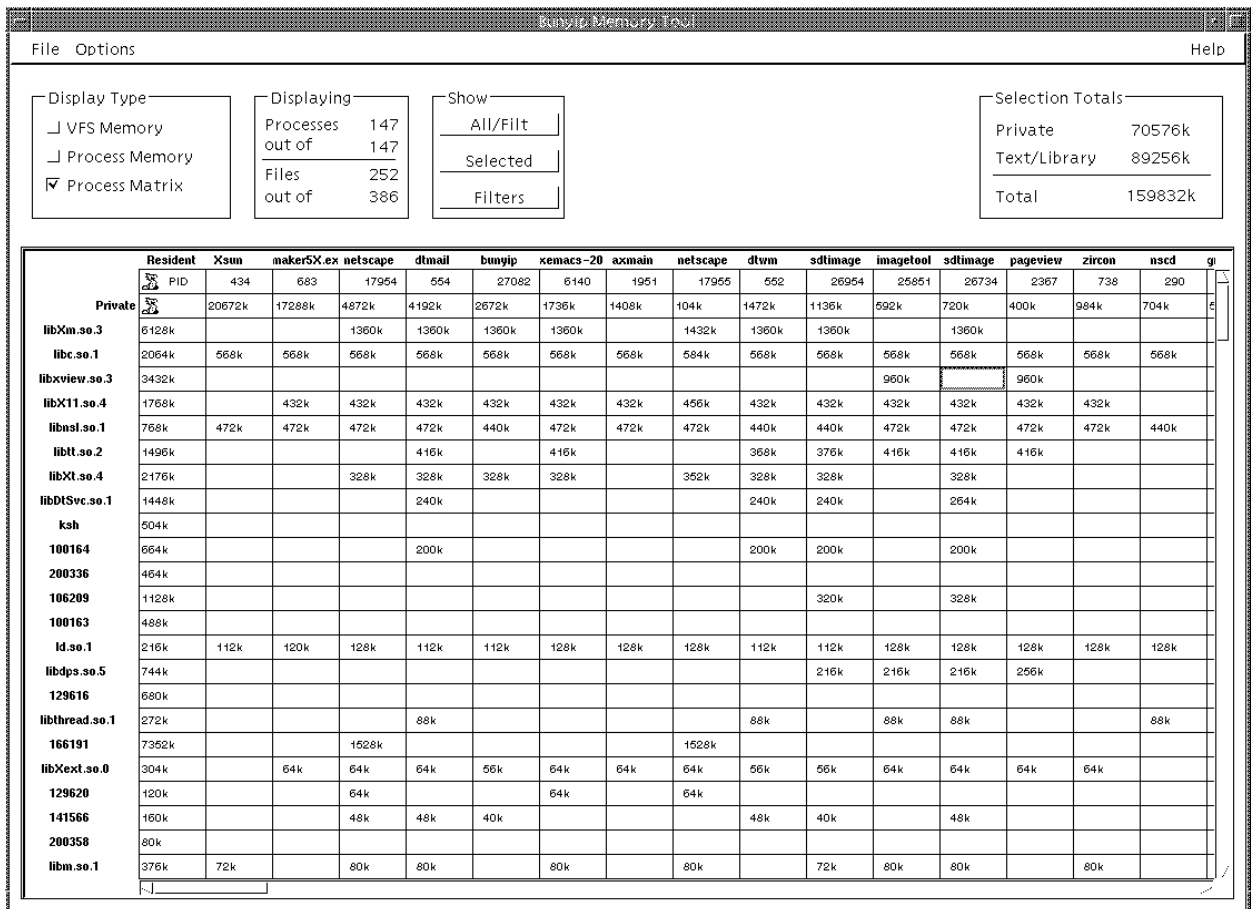


Figure 3-5 MemTool GUI - Process/File Matrix

---

The matrix can be used to show the total memory usage of a group of processes. By default, the summary box at the top right hand corner shows the memory used by all of the processes displayed.

A group of processes can be selected with the left mouse button, and then summarised by hitting the *selection* button at the top-middle of the display. The full display can be returned by selecting the *all/filt* button.

## GUI Options

There are also some options to configure the order of the rows of files or processes displayed. By default, they are sorted in reverse memory size order. The Options menu can be used to select the sort options dialog.

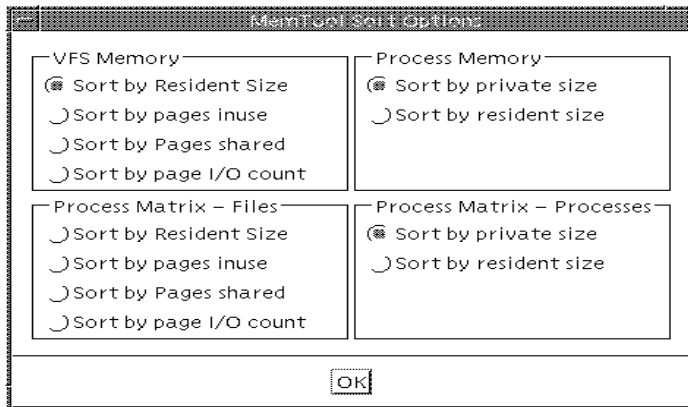


Figure 3-6 MemTool GUI - Sort Options



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