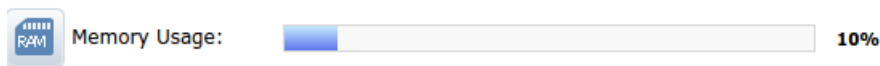


# Memory usage insights in FortiOS v5.0

Memory usage on the Fortigate is represented as a single gauge in the GUI or a counter in SNMP, ranging from 0 to 100%.

Even though this counter is easy to read, it needs to be analyzed with deeper attention when reaching high values as it mixes multiple memory related indicators.

## 1. One gauge, many memory usages



The 10% memory usage reported in this sample GUI widget (or get sys perf status) is a top-level view of used physical memory.

“diag hard sys memory” gives further details about how the memory is allocated.

```
# diag hard sys mem
Mem: total: used: free: shared: buffers: cached: shm:
Mem: 8350306304 874483712 7475822592 0 117002240 283897856 274530304
Swap: 0 0 0
MemTotal: 8154596 kB
MemFree: 7300608 kB
MemShared: 0 kB
Buffers: 114260 kB
Cached: 277244 kB
SwapCached: 0 kB
Active: 125748 kB
Inactive: 265840 kB
HighTotal: 0 kB
HighFree: 0 kB
LowTotal: 8154596 kB
LowFree: 7300608 kB
SwapTotal: 0 kB
SwapFree: 0 kB
```

It is interesting to note that

- The value displayed in the GUI widget is the ratio used / total
- Used memory is dispatched between buffers, cached, shared memory and the non-system area (aka user space)

## 2. User / application memory space

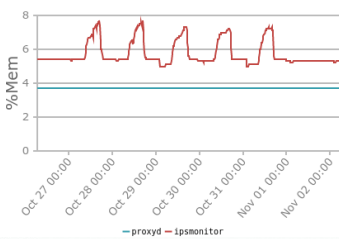
FortiOS applications, such as the UTM components, web and CLI based interfaces, run in the user space (non-system area). Application memory usage can be viewed using

```
# diag sys top-summary -sort=mem
```

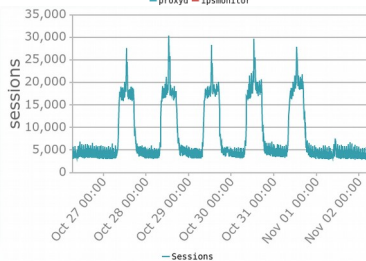
```
CPU [ | ] 4.3%
Mem [||||] ] 10.0% 807M/7963M
Processes: 20 (running=1 sleeping=99)
```

PID	RSS	CPU%	MEM%	FDS	TIME+	NAME
* 97	150M	0.0	1.9	6726	00:00.88	proxyd [x8]
93	90M	0.0	1.1	14	00:04.82	reportd
957	30M	0.0	0.4	12	00:00.80	pyfcgid [x4]
107	27M	0.0	0.3	30	00:40.28	hasync
116	26M	3.8	0.3	15	00:01.60	sshd [x4]
52	25M	0.0	0.3	13	00:05.96	cmdbsvr
76	25M	0.0	0.3	18	00:05.51	httpsd [x4]
73	24M	0.0	0.3	28	00:00.80	miglogd [x2]
79	22M	0.0	0.3	18	00:00.40	ipsmonitor [x2]
94	22M	0.0	0.3	30	00:00.24	sslvpd [x4]
125	15M	0.0	0.2	16	00:00.00	fgfmd
98	14M	0.0	0.2	31	01:12.68	iked
126	14M	0.0	0.2	24	00:00.20	cw_acd
144	14M	0.0	0.2	14	00:01.16	updated
122	13M	0.0	0.2	29	00:36.21	dnsproxy

This command shows the memory allocated for each process tree (parent and children), as amount of memory held in RAM (RSS) and its ratio over the total memory (MEM%).



Application memory usage fluctuates with the process activity. On a busy UTM system, it is expected to see IPS engine (ipsmonitor) or the transparent proxies (proxyd) owning a lot of memory (up to 50~60%). When activity decreases, memory gets released.



In this example, showing “diag sys top-summary” over 1 week, ipsmonitor allocates memory during the day and releases it every night, when activity is quieter.

Note that Shared Memory is not accounted here.

### 3. Kernel buffers

The kernel buffers are allocated for all system related tasks. These are mainly for network buffers, filesystem structure buffers, and generic usage fixed-size buffers.

Detailed listing of the kernel buffers is available with

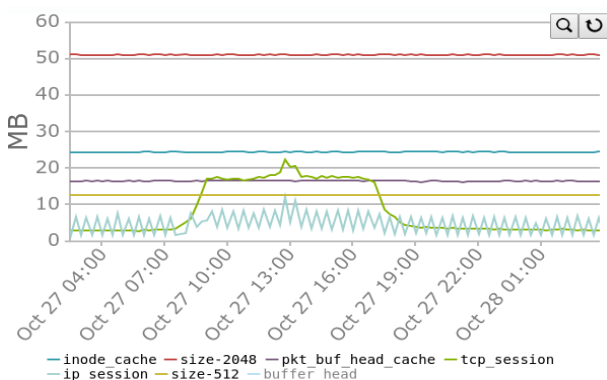
# diag hard sys slab

```
slabinfo - version: 1.1 (SMP)
sctp_session          0          0 1152      0      0      2 0 : 60 30
tcp_session           442        3052 1152     98    436     2 338 : 60 30
ip_session            5859       7749 1088    867  1107     2 240 : 60 30
tcp_open_request      634        760   192     38    38     1 0 : 252 126
inet_peer_cache       504        630   128     18    21     1 3 : 252 126
ip_dst_cache          3230       3912  320    302  326     1 24 : 124 62
ip_fib_hash           448        448    32      4     4     1 0 : 252 126
arp_cache             984       1110   256     72    74     1 2 : 252 126
mnt_cache             120        120   128      4     4     1 0 : 252 126
inode_cache          12013     12075  768  2415  2415     1 0 : 124 62
dentry_cache          12280     12280  192    614   614     1 0 : 252 126
buffer_head           41740     41740  192  2087  2087     1 0 : 252 126
fs_cache              354        354    64      6     6     1 0 : 252 126
size-2048(DMA)        540        660  2048    274   330     1 56 : 60 30
size-2048              500        500  2048    250   250     1 0 : 60 30
size-1024(DMA)        258        444  1024    88   111     1 23 : 124 62
size-1024              820        820  1024    205   205     1 0 : 124 62
...
```

Kernel buffers are using a “slab” memory management mechanism, where each buffer has a fixed size (1<sup>st</sup> column), that is adjusted to store the underlying kernel object.

The kernel can then allocate the number of buffer objects required to store the related object type (3<sup>rd</sup> column).

In the above example, FortiOS has allocated 1152 buffers of 442 bytes each to store objects of type 'tcp\_session', which represents a total of 509184 bytes, or approximately 500kB.



This example shows 'diag hard sys slab' over 1 day. We can note the firewall activity as 'tcp\_session' between 09:00 and 18:00

### 3. Cache memory

This memory area is mainly used for disk I/O buffering. It caches program/data files instead of reloading them from the slow storage device.

It comprises two sections: Active + Inactive.

Active memory is considered as busy memory. It contains data related to files that are currently open.

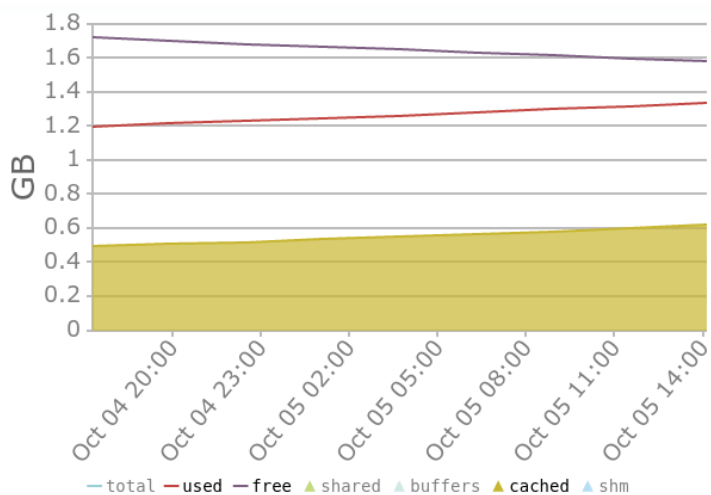
Inactive memory is almost free memory, albeit accounted as “used”. It contains data that are no longer being accessed by processes, such as recently closed files. FortiOS considers it is judicious to keep this data held in RAM, so that if it needs to be accessed again, no time is spent in accessing the storage device.

As long as the system is not under memory pressure, the inactive cache will slowly grow over time if disk related features are enabled.

However, when memory usage reaches ~70%, the system will reclaim memory from the inactive cache and stabilize at this level.

```
# diag hard sys mem
```

```
total:      used:      free:      shared:  buffers:  cached:      shm:
Mem: 8350306304 874483712 7475822592      0 117002240 283897856 274530304
Swap:      0          0          0
MemTotal:      8154596 kB
MemFree:      7300608 kB
MemShared:      0 kB
Buffers:      114260 kB
Cached:      277244 kB
SwapCached:      0 kB
Active:      125748 kB
Inactive:      265840 kB
HighTotal:      0 kB
HighFree:      0 kB
LowTotal:      8154596 kB
LowFree:      7300608 kB
SwapTotal:      0 kB
SwapFree:      0 kB
```



## 4. Shared Memory

This memory area primary purpose is to allow fast passing of data between processes. Shared memory blocks are owned by the process who allocated them, but they can be used by other processes.

Shm is allocated/released on demand and is expected to vary along with the system load.

```
# diag hard sys mem
                total:    used:    free:    shared:  buffers:  cached:  shm:
Mem:  8350306304 874483712 7475822592      0 117002240 283897856 274530304
Swap:      0      0      0
```

## 5. memory pattern

Monitoring memory usage of the Fortigate shows continuous evolution around an average value throughout the day, with slow increases and sudden drops.

This typical pattern shape is related to FortiOS memory manager, who allocates memory pages on demand (slow increase), and release them in groups (sudden drop).

