



Memory Troubleshooting Guide for Cisco 4000 Series ISRs

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This document provides a high-level overview of memory systems in the Cisco 4000 Series Integrated Services Routers (ISR), and describes how to check system memory and troubleshoot memory related issues on the Cisco 4000 Series ISR.

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Feature Information

For the latest information about features and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the “[Additional References](#)” section on page 11.

Use the Cisco Feature Navigator to find information about platform support and Cisco IOS and Cisco IOS XE operating system software image support. To access the Cisco Feature Navigator, go to <http://www.cisco.com/go/cfn>. An account on Cisco.com is not required.

Overview

Cisco 4000 series ISR routing platforms run Cisco IOS XE that has a distributed software architecture running a Linux kernel where Cisco IOS runs as one of many Linux processes. Cisco IOS runs as a daemon, which hereafter is referred to as Cisco IOSd (IOS-Deamon). This allows other Linux process to share responsibility for the operation of the router. A distinction must be made between system memory (which is managed by the base operating system, that is the Linux kernel), and memory that is allocated for, and managed by the Cisco IOSd process. In addition, the data plane (referred to as QFP for Quantum Flow Processor) runs outside the context of Cisco IOSd. Depending on the platform, the QFP may run on a separate hardware device with its own dedicated memory (Cisco 4400 ISR), or it may run as separate Linux processes on the main CPU (Cisco 4300 Series ISR) sharing memory with the rest of the system.

DRAM Options

For the Cisco 4400 Series ISRs, the default control-plane memory is 4 GB, upgradeable to 16 GB to provide additional scalability for control-plane features. The default data-plane memory is 2 GB. For the Cisco 4300 Series ISRs, the default memory is 4 GB, upgradeable to 16 GB (only 8GB for 4321) to provide additional scalability. The ISR 4200 Series comes with 4GB fixed DRAM.

DRAM for Cisco 4400 Series ISRs

Cisco 4400 series platforms use 1333MHz DIMMs for memory. The platforms have three DIMM slots, two for main system memory (labeled CP1 and CP2 on the motherboard where CP is for Control Plane), and one for data plane memory (labeled FFP on the motherboard). Both DIMMs in the CP slots must be populated with the same memory size as these systems use interleaving for maximizing performance; unmatched DIMMs are not tested or supported by Cisco. [Table 1-1](#) indicates the DIMM size options available.

Table 1-1 DIMMs on Cisco 4400 Series ISR

Product ID	Description
MEM-4400-2G=	2G DRAM (1 DIMM) 1333 for Cisco 4400 series ISR
MEM-4400-4G=	4G DRAM (1 DIMM) 1333 for Cisco 4400 series ISR
MEM-4400-8G=	8G DRAM (1 DIMM) 1333 for Cisco 4400 series ISR

Table 1-2 indicates the supported memory options on Cisco 4400 Series ISRs.

Table 1-2 Memory Options Supported on Cisco 4400 Series ISR

Supported System Memory	Cisco 4451 ISR	Cisco 4431 ISR
4GB	CP: 2 x 2GB DP: 1 x 2GB	CP: 2 x 2GB DP: 1 x 2GB
8GB	CP: 2 x 4GB DP: 1 x 2GB	CP: 2 x 4GB DP: 1 x 2GB
16GB	CP: 2 x 8GB DP: 1 x 2GB	CP: 2 x 8GB DP: 1 x 2GB

DRAM for Cisco 4300 Series ISRs

Cisco 4300 Series platforms use 1600MHz DIMMs for memory. The platforms have one or two DIMM slots for main system memory. For platforms with two DIMM slots, both slots must be populated with the same size memory as these systems use interleaving for maximizing performance; unmatched DIMMs are not tested or supported by Cisco. Table 1-3 indicates the DIMM size options available on Cisco 4300 Series ISRs.

Table 1-3 DIMMs Size on Cisco 4300 Series ISRs

Product ID	Description
MEM-4300-2G=	2G DRAM (1 DIMM) 1600 for Cisco 4300 series ISR
MEM-4300-4G=	4G DRAM (1 DIMM) 1600 for Cisco 4300 series ISR
MEM-4300-8G=	8G DRAM (1 DIMM) 1600 for Cisco I 4300 series SR

Table 1-4 indicates the supported memory options on Cisco 4300 series ISRs.

Table 1-4 Memory Options Supported on Cisco 4300 Series ISRs

Supported System Memory	Cisco 4321 ISR	Cisco 4331 ISR	Cisco 4351 ISR
4GB	0 x DIMMs 4GB onboard	2 x 2GB	2 x 2GB2
8GB	1 x 4GB DIMM 4GB onboard	2 x 4GB	2 x 4GB
16GB	Not supported	2 x 8GB	2 x 8GB

**Note**

Cisco ISR 4351 and 4331 devices can operate with only one DIMM (minimum 4 GB), installed in slot 0. Older ROMMON versions may flash a warning message for both DIMMs to be installed before boot. To override this warning, upgrade to ROMMON 16.7(3r) or higher.

Memory Usage

You can track the memory usage of system memory, within Cisco IOSd, and the data plane. Each of these is described further below. To determine the amount of physical memory in the system, use the **show version** command as indicated below:

```
Router# show version
<snip>
System image file is "bootflash:/isr4400-universalk9.03.13.01.S.154-3.S1-ext.SPA.bin"
<snip>

cisco ISR4451-X/K9 (2RU) processor with 1687854K/6147K bytes of memory.
Processor board ID FGL165210MU. 1687854K is the maximum IOSD memory.
4 Gigabit Ethernet interfaces
32768K bytes of non-volatile configuration memory.
4194304K bytes of physical memory.
7393215K bytes of flash memory at bootflash:
```

System Memory Usage in Cisco IOS Daemon

Cisco IOSd runs as its own process and it allocates memory from the system. It uses its own memory manager for features running within Cisco IOSd. In general, Cisco IOSd is allowed to use a maximum of approximately 1/2 of the total system memory. However, it uses less system memory depending on the configuration. IOS will consume system memory as needed to satisfy memory requests for features within Cisco IOSd. To do this, it uses a feature referred to as Cisco IOSd Dynamic Heap (dHeap). With dHeap, Cisco IOS will request memory from the operating system based on demand as indicated by the dHeap output indicated in the **show memory** command.

To find out the total amount of system memory that is in use by Cisco IOSd, use the Cisco IOS XE system memory commands.

```
Router# show memory
Head   Total(b)   Used(b)   Free(b)   Lowest(b)  Largest(b)
Address  Bytes     Prev     Next Ref  PrevF      NextF Alloc PC  what
Processor 7F4A5B545010 1728363504 284041616 1444321888 679710664 1048575908
lsmpi_io 7F4A5AE431A8 6295128 6294304 824 824 412
Dynamic heap limit(MB) 1000 Use(MB)
0
11728363504 is the maximum amount of memory IOSd has for its heap, this value includes the
1000MB memory from dHEAP.
```

To get more detailed information on Cisco IOS process memory use, use the **show process memory** command. Note that the following commands display only information that is within Cisco IOSd, and it does not indicate memory use in the Cisco IOS XE operating system.

The **show processes** command displays information about the active processes. Use the **show processes memory** command to show the amount of memory used within Cisco IOSd.

```
Router# show processes memory
```

```

rtp-overlord-81#show process memory
Processor Pool Total: 7990846432 Used: 305365544 Free: 7685480888
lsmpi_io Pool Total: 6295128 Used: 6294296 Free: 832

PID TTY Allocated Freed Holding Getbufs Retbufs Process
0 0 493378864 210687712 262655736 570 619186 *Init*
0 0 288 336064 288 0 0 *Sched*
0 0 860480 391632 482344 0 0 *Dead*
0 0 0 0 395520 0 0 *MallocLite*
1 0 1926560 16632 1939792 0 0 Chunk Manager
2 0 448 448 17864 0 0 Load Meter
3 0 37256 36832 30288 12 12 OVLD SPA Backgro
4 0 0 0 29864 0 0 Retransmission o
5 0 0 0 29864 0 0 IPC ISSU Dispatc
6 0 525744 21872 461392 0 0 RF Slave Main Th
7 0 65632 0 167496 0 0 EDDRI_MAIN
8 0 0 0 29864 0 0 RO Notify Timers
9 0 6240 448 35656 0 0 Check heaps
10 0 1391144832 1391186176 215016 51 0 Pool Manager
11 0 0 0 29864 0 0 DiscardQ Backgro
12 0 448 448 29864 0 0 Timers
13 0 0 0 17864 0 0 WATCH_AFS
14 0 0 0 29864 0 0 MEMLEAK PROCESS
15 0 63728520 63695656 62728 638371 638371 ARP Input

```

System Memory Usage in Cisco IOS XE Software

To inspect the system memory usage in Cisco IOS XE software, the following show commands can be used. As mentioned earlier, IOS-XE relies on the Linux kernel which provides the system memory management. For more information on Linux memory management, it is recommended to learn how Linux memory management works. Also, you can refer the book *Understanding how the Linux Virtual Memory Manager Works* available on www.kernel.org. To see current system memory usage on Cisco IOS XE, use the **show platform software status control-processor brief** command.

```

Router# show platform software status control-processor brief
Load Average
Slot Status 1-Min 5-Min 15-Min
RP0 Warning 10.29 8.00 7.66

Memory (kB)
Slot Status Total Used (Pct) Free (Pct) Committed (Pct)
RP0 Healthy 16339708 15612240 (96%) 727468 ( 4%) 1886792 (12%)

CPU Utilization
Slot CPU User System Nice Idle IRQ SIRQ IOwait
RP0 0 1.02 15.74 0.00 83.23 0.00 0.00 0.00
1 0.50 17.07 0.00 82.41 0.00 0.00 0.00
2 1.19 16.58 0.00 82.22 0.00 0.00 0.00
3 0.67 16.73 0.00 82.58 0.00 0.00 0.00
4 0.51 15.23 0.00 84.25 0.00 0.00 0.00
5 0.42 16.32 0.00 83.24 0.00 0.00 0.00
6 0.17 17.70 0.00 82.12 0.00 0.00 0.00
7 0.51 25.51 0.00 73.97 0.00 0.00 0.00

```

Memory **used** for the above command includes filesystem cache, much of which can be used when the system memory requires it. In general, used memory does not reflect how much more memory can be used by the new feature configuration; a more accurate estimate from this command comes from using the committed memory (in this example, about 12% of the system memory is in use).

The following command displays a high level view of the system utilization (which is available from Cisco IOS XE release 3.14 or later).

```

Router# show platform resources

**State Acronym: H - Healthy, W - Warning, C - Critical
Resource                Usage                Max                Warning            Critical State

RP0 (ok, active)
  Control Processor      10.64%              100%              80%              90%            H
  DRAM                  2131MB (54%)        3926MB            88%              93%            H
  bootflash             5362MB (85%)        6343MB            70%              90%            W
ESP0 (ok, active)
  QFP
  DRAM                  24344KB (9%)        262144KB          85%              95%            H
  IRAM                  213KB (10%)         2048KB            85%              95%            H
  CPU Utilization       0.00%              100%              90%              95%            H
**State Acronym: H - Healthy, W - Warning, C - Critical

```

Memory Usage for Display Process

To display system memory utilization for individual processing running in Cisco IOS XE operating system, use the **show processes memory platform sorted** command which is available from Cisco IOS XE release 3.14 or later. You can sort the processes memory using the Resident Set Size (RSS). For previous releases, the **show platform software process memory R0 all sorted** command is also available to obtain per-process memory use in the system.

```

Router# show processes memory platform sorted
System memory: 16339708K total, 1888316K used, 14451392K free
Lowest: 726192K
  Pid   Text      Data   Stack  Dynamic   RSS     Total      Name
-----
  4702  11377  173556  204    20244    8696504 10256632  fman_fp_image
  3415   78    159380  128    20344    8679096  9807832  cpp_cp_svr
  4408   62    113332   84    2024    8633048  9211508  cpp_sp_svr
  4190   323   93784   88    3204    8613500  9184072  cpp_ha_top...
  3783   144   91532  152    2520    8611252  9170844  cpp_driver
  3065    59   23584   84     988    8543300  9091828  cpp_cdm_svr
  26530 377371 771772  216     56    772004  2426664  linux_iosd...
  24860 6380  81496  188    1684    81496   1057452  fman_rp
  2786   101  19724   84    3280    19732   398052  cman_fp
  23458  241  76728   88    5584    85180   304192  bsm
  31394  754  16536   88     960    16536   179756  vman
  29446  385 120388  112  109644  120396  128716  smand
  15721   29  10036   88     280    75588   79824  ngiolite
  17264  409  26700   84    3504    26712   77668  iomd-0_4
  16628  409  26628   84    3508    26640   77412  iomd-0_2
  15557  409  27500   84    3508    27512   77412  iomd-0_0
  24126  933  33428   88    3936    33460   53488  cmand
  25722  303  31092   88    1084    31092   41584  hman
  12409  303  29400   84     844    29400   39240  hman

```

For example, in the above command, you can see that the amount of system memory used by Cisco IOSd is 4979144kB as represented in the RSS (Resident Set Size) for the linux_iosd process. The Total memory column refers to the VSZ (Virtual Set Size) for each process.

Memory Usage for Monitoring Process

To interactively monitor system memory usage for each process running in Cisco IOS XE, use the **monitor platform software process rp active** command. After the screen appears, you can type shift + M to sort displayed processes with memory usage. RES (same as RSS) indicates the non-swapped physical memory and SHR indicates the amount of shared memory used by a process.

```
Router# monitor platform software process rp active
top - 05:18:46 up 14 days, 17:33, 0 users, load average: 0.00, 0.01, 0.00
Tasks: 119 total, 1 running, 118 sleeping, 0 stopped, 0 zombie
Cpu(s): 0.4% us, 0.4% sy, 0.0% ni, 99.1% id, 0.0% wa, 0.0% hi, 0.0% si
Mem: 3714760k total, 1454344k used, 2260416k free, 97952k buffers
Swap: 0k total, 0k used, 0k free, 875376k cached
PID USER PR NI VIRT RES SHR S %CPU %MEM TIME+ COMMAND
17385 root 20 0 1874m 338m 75m S 0.2 9.3 65:59.18 linux_iosd-
18098 root 20 0 71880 59m 6324 S 0.2 1.6 10:48.84 smand
16521 root 20 0 87868 51m 47m S 0.0 1.4 0:02.80 fman_rp
16903 root 20 0 27788 16m 14m S 0.0 0.5 15:41.61 imand
15957 root 20 0 24776 9696 6880 S 0.2 0.3 12:49.67 cmamd
17697 root 20 0 19504 6160 4544 S 0.0 0.2 0:00.95 psd
16316 root 20 0 18232 5972 3736 S 0.0 0.2 12:43.32 emd
16732 root 20 0 16184 5556 3900 S 0.4 0.1 21:22.61 hman
17237 root 20 0 15892 5456 3088 S 0.0 0.1 0:00.99 plogd
15166 root 20 0 4056 2396 1248 S 0.0 0.1 0:00.72 pvp.sh
16937 root 9 -11 3992 2308 1232 S 0.0 0.1 0:00.13 pman.sh
15559 root 9 -11 3992 2304 1228 S 0.0 0.1 0:00.13 pman.sh
17978 root 9 -11 3992 2304 1228 S 0.0 0.1 0:00.13 pman.sh
```

Memory Usage for Data Plane

To display the information about the memory usage of the data plane or QFP, use the **show platform hardware qfp active infrastructure exmem statistics** command.

For the Cisco 4400 Series ISR platforms, the data plane DRAM is located on a 2GB DIMM, which is physically separate from the system DRAM memory as describe above. Most of the data plane DRAM is used for system purposes. About 750 MB is used for buffering and another 750 MB is used to store the microcode that runs the data plane packet forwarding process. The remaining 512 MB is used for EXMEM, which is the dynamic memory that allows the actual packet handling and for features to scale.



Note

The displayed memory usage information of the data plane on Cisco 4400 Series ISR platforms differs depending on the IOS version that runs on the platform.

The display information of Cisco 4400 Series ISR platforms that are running IOS versions earlier than 16.x reflects the total 2GB DRAM as shown below.

Example: Cisco 4451 ISR with IOS version 3.16

```
Router# show platform hardware qfp active infrastructure exmem statistics
QFP exmem statistics
Type: Name: DRAM, QFP: 0
Total: 2147483648
InUse: 1648148480
Free: 499335168
Lowest free water mark: 432488448
```


When you check the DRAM usage in this command, 75% of the DRAM memory is used. However that includes the 750 MB for fixed part of microcode and another 750 MB for buffering. The remaining is the dynamic EXMEM part, which is used for features. In this case, there is 499 MB EXMEM available out of the total 512 MB. So, this router's data plane memory utilization is only about 2%.

For Cisco 4400 Series ISR platforms that are running IOS versions 16.x and later, this command reflects only the actual EXMEM usage. This is the same for Cisco 4300 Series ISR, in which the data plane is not located on a separate DIMM. However, Cisco 4300 Series ISR uses a portion of the overall system memory.

Example: Cisco 4451 ISR with IOS Version 16.5.1

```
Router# show platform hardware qfp active infrastructure exmem statistics

QFP exmem statistics
Type: Name: DRAM, QFP: 0
  Total: 536870912
  InUse: 21627904
  Free: 515243008
  Lowest free water mark: 515234816
```

Troubleshooting Commands

The following commands help to troubleshoot the resource utilization:

- show platform hardware qfp active datapath utilization summary
- show platform hardware resource datapath
-

Show Platform Hardware QFP Active Datapath Utilization Summary

This command reveals the load on the Cisco 4300 and 4200 Series ISRS. The **show platform hardware qfp active datapath utilization** command includes the information on IO/crypto core utilization. If the row Processing: Load has high values, it indicates the utilization is high and needs further troubleshooting to see if it is caused due to features configured on the router or high traffic rate.

```
Router0#show platform hardware qfp active datapath utilization
CPP 0: Subdev 0
Input: Priority (pps)      5 secs      1 min      5 min      60 min
      (bps)              0           0           0           0
      Non-Priority (pps)  62214      6324      1270      118
      (bps)             78636120  8005552  1603352  144128
      Total (pps)       62214      6324      1270      118
      (bps)             78636120  8005552  1603352  144128
Output: Priority (pps)      0           0           0           0
      (bps)              0           0           0           0
      Non-Priority (pps)  62213      6312      1266      117
      (bps)             88589528  8975000  1803664  165648
      Total (pps)       62213      6312      1266      117
      (bps)             88589528  8975000  1803664  165648
Processing: Load (pct)    100         17          4          2
COPROC: Load (pct)       23          2           0           0
  RX: Load (pct)         43          25          20          27
  TX: Load (pct)         33          6           3           3
  Idle (pct)              0           66          76          69
```

If the system indicates that the qfp memory utilization is high, the following message is displayed:

```
Jan 17 06:19:45.849: %QFPOOR-4-LOWRSRC_PERCENT_WARN: R0/0: cpp_ha_top_level_server: QFP 0
DRAM (EXMEM) at 85 percent, exceeds warning level 85
*Jan 17 06:19:45.849: %QFPOOR-4-TOP_EXMEM_USER: R0/0: cpp_ha_top_level_server: EXMEM_USER:
NAT, Allocations: 371, Bytes-Alloc: -1917190944, Bytes-Total: 1916886016
*Jan 17 06:19:45.849: %QFPOOR-4-TOP_EXMEM_USER: R0/0: cpp_ha_top_level_server: EXMEM_USER:
CVLA, Allocations: 93, Bytes-Alloc: 336530288, Bytes-Total: 336591872
```

Also, when the IOSd reaches a low memory level, the following message is displayed:

```
*Jan 18 07:23:39.090: %SYS-4-FREEMEMLOW: Free Memory has dropped below low watermark.
Pool: Processor Free: 235388376 Threshold: 394129408 Top Allocator Name: BGP net chunk, PC:
iosd_shr_m_uk9_ROUTING_crb:7FF3B55F3000+907D18, Size: 212582048, Count: 3239 Largest
block: 426644
```

```
*Jan 18 07:23:39.090: %SYS-4-FREEMEMLOW: Free Memory has dropped below low watermark.
Pool: Processor Free: 235388376 Threshold: 394129408 Top Allocator Name: BGP net chunk, PC:
iosd_shr_m_uk9_ROUTING_crb:7FF3B55F3000+907D18, Size: 212582048, Count: 3239 Largest
block: 426644
```

The memory consumption details are saved in the bootflash memory.

Additional References

The following sections provide references related to this function.

Related Documents

Related Topic	Document Title
Hardware Installation Guide for the Cisco 4000 Series Integrated Services Router	http://www.cisco.com/c/en/us/td/docs/routers/access/4400/hardware/installation/guide4400-4300/C4400_isr.html

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