Collect and Graph CPU Statistics using "PERF" Tool in NSO

Contents

Introduction

This document describes how to use the perf tool on NSO hosts to investigate performance issues.

Prerequisites

Requirements

Cisco recommends that you have knowledge of these topics:

- Basic Linux/Unix command line usage
- NSO (Network Services Orchestrator) system architecture and operation
- CPU profiling and analysis concepts
- Familiarity with performance troubleshooting workflows

Components Used

The information in this document is based on these software and hardware versions:

- NSO system or local installation on a supported Unix/Linux host
- Linux distributions such as Ubuntu, Debian, Fedora, or RedHat derivatives
- perf tool (Linux performance analysis tool)

The information in this document was created from devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Background Information

Perf is a powerful performance analysis tool in Linux, used primarily for CPU profiling. It provides insights into what the CPU is currently working on by capturing and analyzing the load of lower-level functions. This helps identify which functions or processes are occupying the CPU and is essential for pinpointing performance bottlenecks.

Perf can also generate flame graphs, which are special charts that visually represent which parts of a program use the most CPU time. Flame graphs make it easier to spot areas in code that must need optimization.

Importantly, perf is also included in the main data collection checklist for Out of Memory (OOM) cases as recommended by the NSO Business Unit (BU). For more detailed guidance on OOM troubleshooting please contact Cisco TAC.

Troubleshoot Perf Usage for NSO Performance Issues

This section provides a comprehensive workflow for installing, using, and analyzing data from the perf tool on NSO hosts to troubleshoot performance problems.

Install Perf

Step 1: Install perf on your Linux distribution. Use the appropriate command for your OS:

For Ubuntu:

```
apt-get update && apt-get -y install linux-tools-generic
```

For Debian:

```
apt-get update && apt-get -y install linux-perf
```

For Fedora/RedHat derivatives:

```
dnf install -y perf
```

For more information about known caveats while installing perf, please contact Cisco TAC team.

Sampling the Data

Step 1: Identify the main NSO process.

Use the below given command to locate the NSO process (ncs.smp):

```
ps -ef | grep ncs\.smp
```

Example output:

```
root    120829       1  16 13:23 ? 00:11:08 /opt/ncs/current/lib/ncs/erts/bin/ncs.smp -K true -P 277140
root    121424   120604  0 14:30 pts/0 00:00:00 grep --color=auto ncs.smp
```

Step 2: Alternatively, you must use the PID of the main Java process tied to NSO, especially if focusing on Java operations. Run:

```
ps -ef | grep NcsJVMLauncher
```

Example output:

```
root    120903   120833  6 13:32 ? 00:03:40 java -classpath :/opt/ncs/current/java/jar/* -Dhost=127.0.0
root    121435   120604  0 14:33 pts/0 00:00:00 grep --color=auto NcsJVMLauncher
```

Step 3: Execute the problematic test case or use-case to validate the performance scenario.

Step 4: On a different terminal window, run perf against the relevant process IDs (PIDs). Use the below given command format, replacing XX,YY,ZZ with the PIDs obtained above:

```
perf record -F 100 -g -p XX,YY,ZZ
```

For example, to profile system-wide and gather call graphs at 99Hz for specific PIDs:

```
perf record -a -g -F 99 -p 120829,120903
```

Example output:

```
Warning:
PID/TID switch overriding SYSTEM
```

Option Descriptions:

- **-a:** All-CPUs; system-wide collection from all CPUs (default if no target is specified).
- **-g:** Capture call graphs (stack traces). Identifies where functions are being called.
- **-F:** Frequency of sampling in Hz. Higher frequencies increase precision but add overhead.

- **-p:** Specifies the process ID(s).

Step 5: When you are done collecting samples, stop perf with Ctrl+C:

```
^C
[ perf record: Woken up 1 times to write data ]
[ perf record: Captured and wrote 0.646 MB perf.data (4365 samples) ]
```

You now see a **perf.data** file in the current directory.

Step 6: Generate a summary report with this command:

```
perf report -n --stdio > perf_report.txt
```

Option Descriptions:

- **-n:** Show symbols without grouping (flat view).
- **--stdio:** Force output to standard output (the terminal).

At this point, you must save both files (**perf.data** and **perf_report.txt**) and share them with your support contact before moving on to further analysis.

If the capture was successful, **perf_report.txt** shows a tree-like structure representing a hierarchical call graph. Percentages help you identify hotspots where most CPU time is being spent.

Example excerpt:

```
# Children      Self       Samples  Command          Shared Object         Symbol
# ........  ........  ............  ...............  ....................  ............................
#    30.61%     0.00%             0   C2 CompilerThre  libc.so.6             [.] start_thread
#            ---start_thread
#               thread_native_entry(Thread*)
#               Thread::call_run()
#               JavaThread::thread_main_inner()
#               CompileBroker::compiler_thread_loop()
#                          --30.58%--CompileBroker::invoke_compiler_on_method(CompileTask*)
#                                     --30.47%--C2Compiler::compile_method(ciEnv*, ciMethod*, int, bool
#                                     Compile::Compile(ciEnv*, ciMethod*, int, bool, bool, bool, bool, 
#                                               |--17.57%--Compile::Code_Gen()
#                                               |          |--12.46%--PhaseChaitin::Register_Allocate()
#                                               |          |          |--2.79%--PhaseChaitin::build_ifg
#                                               |          |          |           --1.05%--PhaseChaitin
#                                               |          |--1.49%--PhaseChaitin::Split(unsigned int, 
#                                               |          |--1.26%--PhaseChaitin::post_allocate_copy_r
```

Interpretation:

- **Process/Thread:** The C2 CompilerThre thread is being analyzed.

- **Total CPU Usage:** This thread is responsible for 30.61% of CPU time.
- **Function Flow:** The thread starts with `start_thread` and delegates work across several layers. The bulk of CPU time (30.47%) is spent in `C2Compiler::compile_method`, indicating a potential hotspot.

Generating a Flame Graph

Step 1: Generate a performance sample from all CPUs and processes over a defined interval (e.g., 60 seconds):

```
perf record -a -g -F 99 sleep 60
```

Example output:

```
[ perf record: Woken up 32 times to write data ]
[ perf record: Captured and wrote 10.417 MB perf.data (67204 samples) ]
```

Step 2: Copy or transfer this **perf.data** file to a host from which you can download the flamegraph template repository.

Step 3: Convert the perf.data file to a text format:

```
perf script > data.perf
```

Step 4: Clone the **FlameGraph** GitHub repository and place **data.perf** into this directory:

```
cp data.perf $PWD/FlameGraph/.
```

Step 5: Collapse the stack traces for flamegraph processing:

<#root>

```
cat data.perf | ./stackcollapse-perf.pl > data.perf-folded
```

Step 6: Generate the flame graph SVG file:

<#root>

```
./flamegraph.pl data.perf-folded > data.svg
```

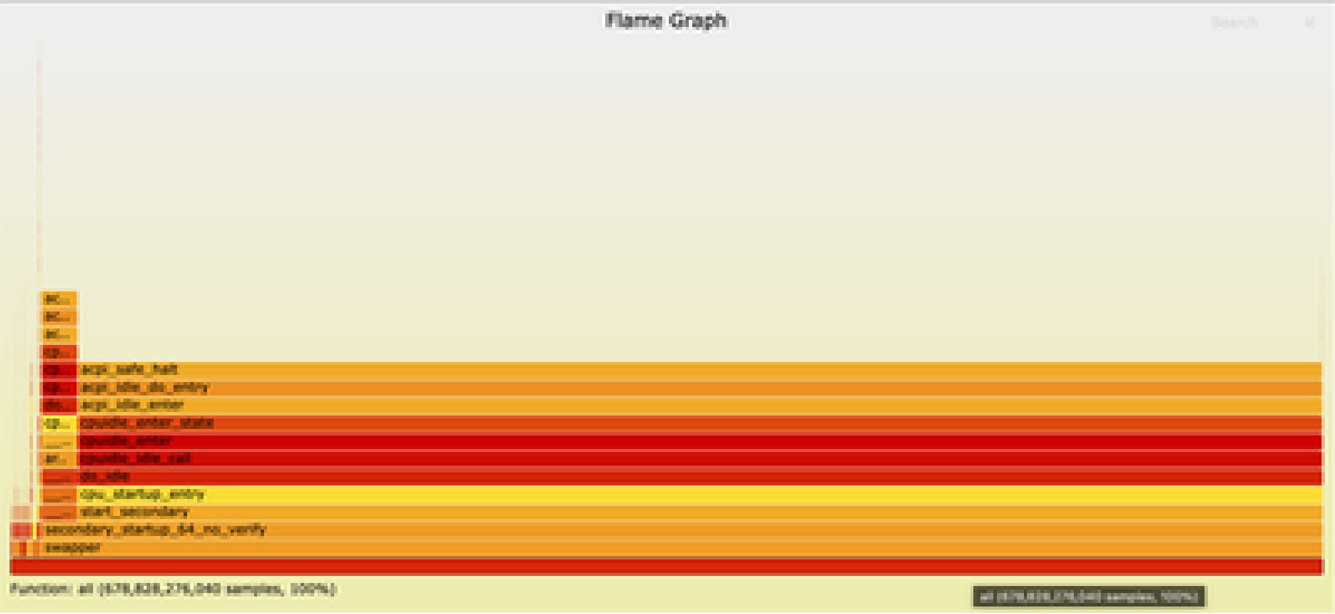
Note: If you encounter the "can not locate open.pm in @INC" error on CentOS or RHEL, install the required Perl module:

```
yum install perl-open.noarch
```

Step 7: Open the **data.svg** file in your preferred web browser to visualize the flame graph.

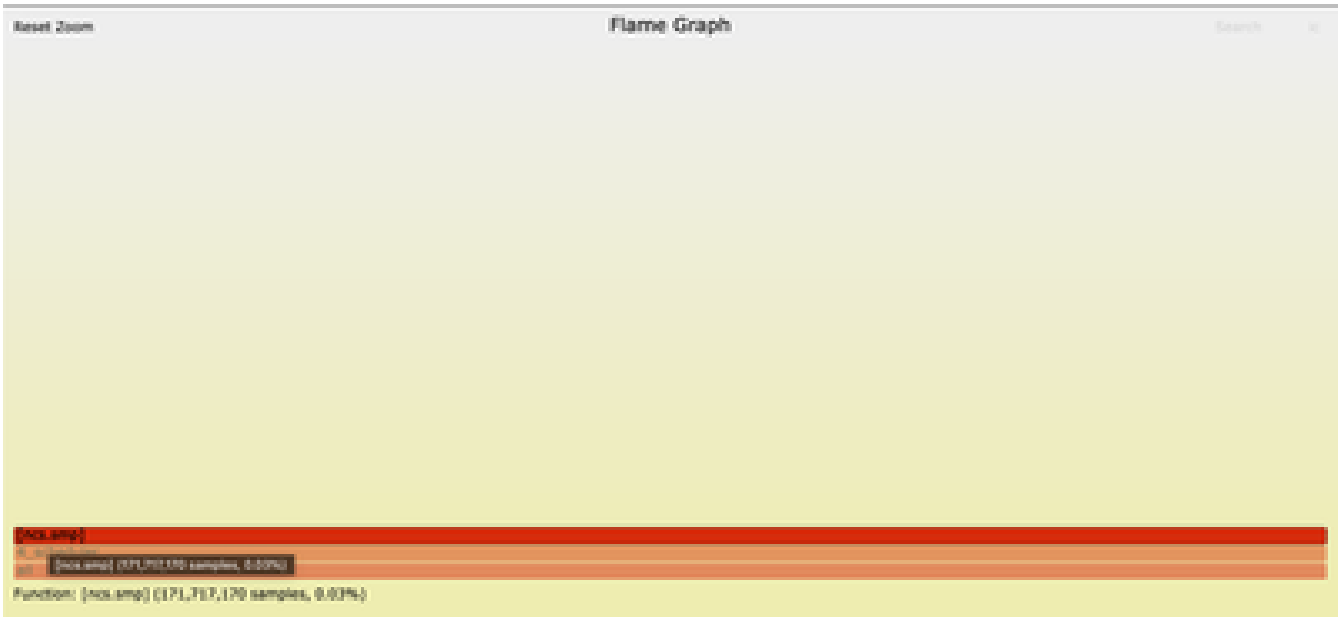
Browse the Flame Graph

Once the flame graph file is open in your browser, you can interact with it by clicking any box to zoom into that function and its call stack. The length of each box represents the amount of CPU time spent in that function and its call stack. This visualization makes it easy to identify hotspots and areas for optimization.



Function: all (678,828,276,040 samples, 100%)

Zoomed in ncs.smp:



Function: [ncs.smp] (171,717,170 samples, 0.03%)

Related Information

- Linux Perf Known Caveats
- Cisco Technical Support & Downloads