

Intel® SoC Watch for Linux* Release Notes

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Legal Information

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Version History

These are the main releases of Intel SoC Watch for Linux* OS

Date	Revision	Description
July 2015	2.0	Initial release for 2.0 Product
October 2015	2.1	Update to 2.1 Product release
June 2016	2.2	Update to 2.2 Product release
October 2016	2.3	Update to 2.3 Product release
April 2017	2.3.1	Update to 2.3.1 Product release
November 2017	2.4	Update to 2.4 Product release. First release that aligns command line parameters and output formats across all supported operating systems.
February, 2018	2.5	Includes support for Intel platform code named Gemini Lake and other fixes.
May, 2018	2.6.1	Enhancements include new hw-cpu-hwp metric, --log option, and improved support in gfx metrics.
August, 2018	2.7	Added average frequency report, new options (program-delay, disable-alts), new metric (pkg-pwr), new group names, fixed issues in ddr-bw, automation summary, and multiple pkg handling.
November, 2018	2.8	Added support for new metrics (fpga-pwr, fpga-temp). Fixed errors in hw-cpu-cstate PC10 reporting (requires kernel version 4.4 or newer).
January, 2019	2.9	Added trace file report grouping and informational messages.
March, 2019	2.10	Added histogram for CPU frequency, added bandwidth metrics for FPGA, and bug fixes.
June, 2019	2.11	Added support for CentOS/RedHat 7. Added option (-z) to automatically put the system into suspend state during a collection. Added reporting of power limits (PL1 and PL2) to feature -f pkg-pwr on Intel platform code named Apollo Lake. Includes support for Intel platform code named Cascade Lake-Xeon. Improves handling of unrecognized CPUs, reporting S-state when hibernation occurs, and other bug fixes.

Customer Support

For technical support, including answers to questions not addressed in this product, visit the technical support forum, FAQs, and other support information at: Intel System Studio forum (https://software.intel.com/en-us/forums/intel-system-studio) discuss issues with your peers, ask questions of the development team, etc.

To submit an issue, go to Intel® Premier Support: (https://employeeportal.intel.com/irj/portal/IntelPremierSupportUser)

Please remember to register your product at https://registrationcenter.intel.com/ by providing your email address. Registration entitles you to free technical support, product updates and upgrades for the duration of the support term. It also helps Intel recognize you as a valued customer in the support forum.

1 Introduction

Intel® SoC Watch is a data collector for power-related data that can help identify issues on a platform that prevent entry to power-saving states. Captured metrics include:

- System sleep states
- CPU and GPU sleep states
- Processor frequencies
- Temperature data
- Device sleep states
-

You can correlate the collected data and visualize over time using Intel® VTune™ Amplifier.

This document provides system requirements, installation instructions, issues and limitations, and legal information.

To learn more about this product, see:

- New features listed in the New in This Release section below, or in the help.
- Reference documentation listed in the Related Documentation section below
- Installation instructions can be found in the Installation Notes section below.
- For a detailed quick start guide to running the tool, see the *Intel SoC Watch User's Guide* in your installed documentation.

2 New in This Release

Release v2.11 includes these changes:

- Added option (-z) to automatically put the system into suspend state for the collection duration on ChromeOS and Linux. For metrics reporting state residency, time in suspend state is reported as "Unknown".
- Added reporting of package power limits (PL1 and PL2) to feature -f pkg-pwr on Intel platforms code named Apollo Lake.
- Added support for CentOS/RedHat 7.
- Added limited support for Intel platform code named Cascade Lake-Xeon.
- Install package no longer includes libraries libstdc++ and libgcc_s libraries. They should be available on the target system. While these libraries are included in most Linux distributions, if the target system is running a minimal OS distribution (such as Yocto or Wind River* Linux), these libraries may not be present by default. Refer to the Installation Notes section for instructions on installing these required libraries.
- Removed support for 32-bit Linux OS.

3 System Requirements

Supported Architectures

Intel SoC Watch supports these Intel microarchitecture or platform code names:

- Anniedale
- Cherryview (Cherry Trail)
- Denverton
- Apollo Lake
- Gemini Lake
- Broadwell
- Skylake
- Kaby Lake
- Coffee Lake
- Whiskey Lake
- Amber Lake
- Cascade Lake-Xeon

Dependencies

Intel SoC Watch depends on specific OS configurations and hardware capabilities. If these are not present on the target system, Intel SoC Watch may fail to work properly.

- Linux Kernel version needs to be 2.6.32 or later.
- GNU C Library version must be GLIBC_2.17 or later.
- KERNEL_CONFIG_TRACEPOINTS must be enabled.
- Kernel should be compiled with "CONFIG_MODULES" enabled.
- P States
  - Kernel config CONFIG_X86_SFI_CPUFREQ or CONFIG_X86_ACPI_CPUFREQ must be enabled (i.e. set to 'y' or 'm').
  - One of these pstate drivers must be utilized: sfi-cpufreq, acpi-cpufreq, or intel_pstate. To determine which driver is loaded, check the sysfs /sys/devices/system/cpu/cpu0/cpufreq/scaling_driver file.
  - If one of these pstate drivers is not loaded, the kernel needs to be reconfigured and recompiled.
- C States
  - Kernel config CONFIG_TIMER_STATS must be enabled.
  - Kernel config CONFIG_INTEL_IDLE must be enabled and the intel_idle kernel module has to support the core of the target platform.
  - To determine if the intel_idle kernel module is loaded, check the sysfs /sys/devices/system/cpu/cpuidle/current_driver file. It must equal intel_idle. If it equals acpi_idle, only C0 and C1 will be used by the core.

4 Where to Find the Release

Go to the Intel® System Studio website (https://software.intel.com/en-us/intel-system-studio) to get either an Evaluation (30-day trial release) license or a commercial license, and download the package from the Intel Registration Center (http://registrationcenter.intel.com/).

5 Installation Notes

Intel SoC Watch for Linux* OS is available as part of Intel® System Studio. Use the steps below to install Intel SoC Watch on a target Linux system.

Intel SoC Watch Prerequisites for Yocto and Wind River* Linux

The Intel SoC Watch binary is a C++ program that requires libstdc++ to be present on the target system in order to function. Although most Linux distributions provide this by default, there are some minimal distributions of Yocto and Wind River Linux that may not.

To check if your OS image contains libstdc++, run this command:

```
find / -name "libstdc++*"
```

If the library is present, you should see an output similar to:

```
/usr/lib64/libstdc++.so.6
```

If you see no output, the required library is missing. To fix this, do one of these steps:

- Rebuild Yocto or Wind River Linux with an option to include libstdc++.so file in the image.
- Provide the library file directly to Intel SoC Watch.

Rebuild OS image to include libstdc++.so file

1. Open the projectDir/local.conf file in a text editor.
2. Add the library with the IMAGE_INSTALL_append option and save the file:

```
IMAGE_INSTALL_append = " libstdc++"
```

> **NOTE** Make sure that you include the leading space as it will be concatenated with any libraries previously added in a list.

3. Rebuild the platform project by running the following command from the projectDir:

```
make
```

Once the build completes, the library will be part of the project image rootfs. Proceed with reflashing the OS image to the target system and subsequently installing Intel SoC Watch.

Provide libstdc++.so library file directly to Intel SoC Watch

If you are unable to rebuild the OS image, but are able to obtain a valid libstdc++.so file (you can copy it from another system or build it yourself):

1. Unpack the SoC Watch package.
2. Copy the file into the /libs subfolder where it will be picked up at runtime.

libgcc_s.so Library

Some minimal Yocto distributions may also lack another library: libgcc_s.so. In this case, follow either of the aforementioned solutions.

Build the OS and include the image:

Use this command when building the OS.

```
IMAGE_INSTALL_append = " libgcc_s"
```

Copy file into Intel SoC Watch package:

Copy the library libgcc_s.so file into the /libs folder of the Intel SoC Watch package.

Extracting the Intel SoC Watch Package

Users will need to extract the Intel SoC Watch package to the system containing the target device's kernel.

By default the package can be found in the following locations:

- On Linux systems: `/opt/intel/system_studio_<version>/energy_profiler_and_socwatch/socwatch_for_target`
- On Windows* systems: `C:\Program Files (x86)\IntelSWTools\energy_profiler_and_socwatch\socwatch_for_target`

Use the `find . -name Module.symvers` command on the device containing the target system's kernel to determine the kernel build directory.

Build the Kernel Modules

If the Intel SoC Watch kernel modules (i.e. device drivers) are not present in the OS image of the target system, you will need to build and possibly sign them. Building and signing device drivers requires access to the kernel build directory for the OS image running on your target device. A kernel build directory is generated while building the OS image of the target system.

When building the kernel modules, do not open (or unzip) the Intel SoC Watch package (i.e. tar.gz file) on a Windows* based system and copy a Linux system. Unzip the package on the Linux build system using the unzip command to make sure the build scripts and make files are unmodified.

If a kernel is built with the CONFIG_MODULE_SIG kernel config enabled, any device driver loaded into that kernel must be signed with the same keys used to build the kernel. In general, drivers built for Linux targets do not need to be signed and the following description assumes the drivers do not need to be signed. But, if an end user tries to load an unsigned driver into a kernel that requires signed drivers, the `insmod` command will fail with the error Required key not available. If a signed driver is loaded into a kernel that does not require signed drivers, the load will succeed.

The build_drivers script is provided to simplify building all of the drivers. The script supports multiple switches including;

`-n` // do not build the socperf driver; used for Intel® Core™ processor based systems

`-l` // build the kernel for a Linux target

`-s <full path to sign-file>` // signs the drivers; the path is normally .../kernel/*/scripts/sign-file

Building Linux* Kernel Modules

Linux kernel modules may only be built after the Intel SoC Watch package and kernel headers are copied to and installed on the target. See the section Intel SoC Watch for Linux Installation below for instructions on how to build the kernel modules for a target device running Linux.

Install Intel SoC Watch

Host: laptop, desktop, or server used to communicate with target device.

Target: device to be analyzed with Intel SoC Watch.

Intel SoC Watch for Linux* Installation

If Intel SoC Watch was previously installed on the target, delete the `socwatch_linux_*` directory before installing a new version. Then, perform the following steps on the target device.

1. Login to the target as root:

```
ssh root@<your_target_IP>
```

2. Extract the Intel SoC Watch package to the target Linux system. The *<extract_dir>*/`socwatch_linux_v`*<version>*`_x`*<architecture>* directory will be created.
3. Copy the Intel SoC Watch package to a working directory:

```
mkdir -p /home/socwatch
```

```
cp <extract_dir>/system_studio_target/socwatch_linux_v<version>_x<architecture> /home/socwatch/.
```

4. Navigate to the Intel SoC Watch directory:

```
cd /home/socwatch/socwatch_linux_v<version>_x<architecture>
```

5. Use one of the following commands:
   a. If the target system has an Intel Atom® processor, use the following command to build the `socwatch2_10.ko` and `socperf3.ko` files.

```
sh ./build_drivers.sh -l -k <kernel-build-dir> -s <full-path-to-sign-file>
```

   b. If the target system has an Intel® Core™ processor, use the following command to build the `socwatch2_10.ko` file.

```
sh ./build_drivers.sh -l -k <kernel-build-dir> -n -s <full-path-to-sign-file>
```

Prerequisites for FPGA metric collection using Intel SoC Watch

Intel SoC Watch leverages Open Programmable Acceleration Engine (OPAE) drivers to collect data on supported FPGA platforms. OPAE drivers must be loaded on the system containing one of the supported FPGA architectures (see System Requirements) prior to running Intel SoC Watch collections. Source code for OPAE drivers may be downloaded from the OPAE GIT repository located at the following link: https://github.com/OPAE/opae-sdk/releases

The OPAE installation guide provides more information on the installation requirements for OPAE drivers. The guide may be downloaded from the following location:https://opae.github.io/latest/docs/install_guide/installation_guide.html

Follow these instructions to build the OPAE drivers for your system:

1. Download the kernel headers to your system.
2. Download and extract the file starting with `opae-intel-fpga-driver*.tar.gz` to your system.
3. Change to the extracted directory, locate the file named `Makefile`, and run the `make` command in that directory.

This process will generate several files with a `.ko` extension. These are the OPAE drivers that need to be loaded to enable Intel SoC Watch collections. Load these driver files using the following commands:

```
sudo insmod fpga-mgr-mod.ko
sudo insmod intel-fpga-pci.ko
sudo insmod intel-fpga-fme.ko
sudo insmod intel-fpga-afu.ko
```

Key Files

The following table describes the key files.

File	Description
build_drivers.sh	The build script used to build all of the device drivers utilized by Intel SoC Watch.
socperf3.ko	The socperf kernel module used to measure bandwidth and DRAM self refresh on systems with an Intel Atom® processor.
socwatch2_x.ko	The Intel SoC Watch kernel module used to collect both hardware and kernel data at runtime.
setup_socwatch_env.sh	The script used to setup the Intel SoC Watch runtime environment.
socwatch	The Intel SoC Watch executable built as a native application. Use this file to collect data and generate additional results from a raw SW2 file.
SOCWatchConfig.txt	The Intel SoC Watch configuration file. The configuration file is read by Intel SoC Watch immediately before each collection. It contains hardware addresses utilized by the device driver during the collection.
EULA.txt	End User License Agreement file.
third-party-programs.txt	List of third party programs included in the package.
plugins/libSWCore.so	A library providing Intel SoC Watch functionality.

Remove the Intel SoC Watch Drivers

After using Intel SoC Watch, remove the drivers using the `rmmod` command (e.g. `rmmod socwatch2_10`). The `socwatch` driver must be unloaded before the `socperf` driver is unloaded.

6 Fixed Issues

Release v2.11 has a fix for these issues.

- ACPI S-state (-f acpi-sstate) and its associated groups (sys and sstate) now properly display a hibernation message when hibernation is detected during the collection.
- Improved reporting of an unrecognized CPU and PCH. The error message reports both IDs.
- On Intel server platforms code named Cascade Lake-Xeon (AP), the features -f pkg-pwr and -f hw-cpu-cstate detect if the CPU topology includes multiple Die and label the reports accordingly. Previously, the data was reported as Package level. There is no package-level residency when multiple Die are present.
- Corrected CPU C-state reporting for server platforms. Removed reporting of unused Core C3 state and Package C7-C10 state residency for Intel platforms code named Skylake-Xeon and newer from feature -f hw-cpu-cstate reports.
- Package power (-f pkg-pwr) feature no longer reports extremely large values if the system entered hibernation during collection.
- Previously, if the SoC Watch installation was corrupted such that the SoCWatchConfig.txt file was missing, a message displayed indicating unknown processor error. An improved error message now displays when the configuration file (SoCWatchConfig.txt) is missing or corrupt.
- Corrected an error in the Core ID reported in the Core P-State/Frequency table for Intel server platforms code named Skylake-Xeon. The tool now checks for the presence of a core so that frequency data is not attributed to wrong core ID.

7 Known Issues

Bandwidth (on Intel Core Platforms)

Improves handling of unrecognized CPUs, reporting S-state when hibernation occurs, and other bug fixes.

- The presence of EDRAM on a system may not be detected by Intel SoC Watch. This is known to occur when the accelerator card VCA2, which contains EDRAM, is present.
- Total DDR bandwidth does not include EDRAM. On systems using EDRAM, the `ddr-bw` feature report may have a discrepancy between the total data reads and writes and the total component requests. The Data Reads+Data Writes will be significantly higher than the total IA+GT+IO requests, because the EDRAM requests are not included.

Bandwidth and DRAM Self Refresh (on Intel Atom® Platforms)

- On Intel platforms code named Apollo Lake and Gemini Lake, memory bandwidth and memory self-refresh metrics are not available. These features are not supported: `ddr-bw`, `cpu-ddr-bw`, `cpu-ddr-mod0-bw`, `cpu-ddr-mod1-bw`, `disp-ddr-bw`, `isp-ddr-bw`, `gfx-ddr-bw`, `io-bw`, `all-approx-bw`, `dram-srr`.
- Intel SoC Watch v2.10.0 and later versions require loading the socperf v3.0 driver to measure bandwidths or DRAM self-refresh on Intel platforms code named Cherry View, Broxton, and Apollo Lake. This version can automatically detect if the system is configured to support use of the hardware signals required to collect these metrics (`ddr-bw`, `gfx-ddr-bw`, `cpu-ddr-mod0-bw`, `cpu-ddr-mod1-bw`, `disp-ddr-bw`, `isp-ddr-bw`, `all-approx-bw`, `io-bw` and `dram-srr`). In older releases, these metrics were disabled completely on Apollo Lake platforms to avoid a system crash. If the system does not support these metrics, use `dram-bw` as an alternative for collecting bandwidth. Use the –v option to determine which version of the socperf driver is loaded. If a mismatch occurs (socperf v1.2.0 used with socwatch >=v2.6.1), Intel SoC Watch will report this error: *-1, SOCPERF ERROR configuring SOCPERF interface.*
- If Intel SoC Watch crashes while collecting a bandwidth feature (e.g. –f ddr-bw) or the DRAM self-refresh feature (i.e. –f dram-srr) AND a subsequent collection prints the error: `ERROR: ERROR configuring SOCPERF interface!` then both the socperf3.ko and socwatch2_10.ko kernel modules must be unloaded with the rmmod command and reloaded with the insmod command before Intel SoC Watch can be used to collect additional data.
- When measuring DRAM self refresh using the `-f dram-srr` feature on cost reduced systems (e.g. Intel platforms code named CherryTrail cost reduced), Intel SoC Watch may report 100% self refresh residency on Channel 1. These systems are single channel systems and therefore, the result should be 0%.
- On a very small number of systems, results from the all-approx-bw feature may be one half of the correct result. During testing, this issue was only experienced on the first collection after the system was booted. All subsequent collections correctly measured the systems bandwidth as expected.
- If socperf reads occur before the start of collection, a dmesg error message is generated: “socperf3: [ERROR] ERROR: RETURNING EARLY from Read_Data”. This message is benign and can safely be ignored.

C-States / P-States

- On Intel platforms code named Broxton and Apollo Lake, the `cpu-cstate` metric results do not contain module C-state information.
- On Intel Atom® platforms, if all cores in a module request C6FS but actual sleep time is short, the Auto-Demotion logic of the hardware resolves the module state to module C0. Consequently, you may find module C0 to be greater than the sum of core C0 and C1 on all the cores in a module. On the same lines (auto demotion at the package level), the package C0 may be greater than module C0 residencies of the two modules.

- During the transition time from core C1/C1e/C6 to core C0, a core may run in LFM which will be properly measured by Intel SoC Watch. Therefore, results that include a large number of C1/C1e/C6 residencies may show a lower PState than expected.
- The `gfx-cstate` metric is obtained by frequently polling GPU counters that provide the graphics c-state residencies. On some Intel Atom® platforms, we have noticed that for 1 out of every ~3000 samples the residency of one of the c-states (Render C0, C1, C6 or Media C0, C1, C6) as obtained from the GPU counters is greater than the sample duration by 5% or more. When this happens Intel SoC Watch discards that sample and throws the error, "ERROR: Residency counter for GPU C-state = xxxx TSC ticks, but actual sample duration = yyy TSC ticks. Difference is more than 5.000000 percent." The error by itself is non-fatal and Intel SoC Watch results give a good idea about the gfx-cstate residencies since the bad sample is collected only 1 out of ~3000 samples.
- In order to visualize graphics C-states that are reported as Render and Media, the table headers in the trace file (generated with option -r int), must be manually modified, adding *Render* and *Media* to the appropriate C0, C1, and C6 column headers.

S States & D States

- On Intel platform code named CherryView based devices:
  - Even when the device's screen is off, the NC DState called Display DPIO is reported in the D0i0 state 100% of the time. This result may or may not be correct.
  - When collecting NC D0ix states with the `-f nc-dstate` switch, note that the Display Island B (HDMI) IP block will remain in D0i0 when the primary display is enabled even if an HDMI cable is removed.
  - When using the `sc-dstate` feature, the SEC IP block results are incorrect and should be ignored. Also, the UFS IP block results are incorrect because an internal fuse is disabled.

Miscellaneous

- Feature -f dram-pwr is not supported by all versions of the server Intel platforms code named Skylake-Xeon, Cascade Lake-Xeon, and Denverton). The report contains all zero values in this case.
- Metrics report Unknown 0 when `-m` is not used and hibernation occurs. Metrics with a snapshot default collection mode, such as CPU C-state, will show the Unknown state with 0 time and the remaining states will not sum to the total collection duration if the system entered hibernation during the collection and the `-m` option was not specified. The snapshot metrics are only collected at the start and end of a collection by default, but finding hibernation time requires samples taken throughout the collection. Including `-m` will cause continuous sampling to occur for all metrics. When hibernation occurs, a message reporting time spent in hibernation appears at the beginning of the summary report. The Unknown state is then included for all appropriate metrics and the time in hibernation is included in that state. Refer to the *Intel SoC Watch User's Guide* "Options Quick Reference" section to learn which metrics have a snapshot collection mode by default.
- Intel SoC Watch reads PMIC and Skin Temperatures from the system's sysfs. Rarely, a sysfs read may not return before a subsequent sysfs read occurs. When this occurs, specific sample results may be missing in the timed trace CSV and raw text files.
- Permission issues with SELinux will cause Intel SoC Watch collection to fail. Some distributions enable SELinux by default. If you have the following file your system may have SELinux enabled:

```
/selinux/enforce
```

  If that file exists, you can disable by issuing:

```
'echo 0 > /selinux/enforce
```

- Syntax errors in the command line may not report a visible error message. If a collection did not run and you are not seeing any error message, add option `-d 2` to your command line to get more information.

Intel® VTune™ Amplifier Visualization

- Intel VTune Amplifier 2017 for Systems Update 1 or later is required for visualizing and analyzing Intel SoC Watch v2.10.0 and newer PWR files. We recommend using the latest version of Intel VTune Amplifier.
- If the bandwidth is 0 Mb throughout the collection for a particular bandwidth type, Intel VTune Amplifier will not show a timeline entry for it. The timeline is shown only if there is at least one non-zero value.
- In some cases, the summary CSV results produced by Intel SoC Watch can vary from the summary results shown by Intel VTune Amplifier even though they represent the same collection. For example, the summary CSV file may report a specific cpu-pstate residency of 50.78% and Intel VTune Amplifier may report the same cpu-pstate residency as 50.8%.
- Intel VTune Amplifier currently does not support bandwidth ranges used for ReadPartial and WritePartial. In order to keep the visualization consistent with Intel SoC Watch v1.x, Intel VTune Amplifier uses the upper bound of the range to visualize the bandwidth.
- The minimum and average calculations displayed in the grid for Sampled Value metrics don’t take 0 values into consideration in older versions of Intel VTune Amplifier. For example, Sampled Graphics P-States minimum values may show a value higher than 0 Mhz even when some samples have 0 Mhz values. This in turn affects the average value calculation.

8 Related Documentation

The below documents are available with this release.

- Intel® SoC Watch for Android* OS and Linux* OS User's Guide
- Energy Analysis help (https://software.intel.com/en-us/energy-analysis-user-guide)