SUSE

SUSE Linux Enterprise Real Time 15 SP7

SLE RT Hardware Testing

Using SUSE® Linux Enterprise Real Time needs real-time capable hardware. This paper describes the tools that can be used to determine if a specific hardware has the needed real-time capabilities. Specifically, it describes `cyclictest` and "hardware latency detector" and the ways to analyze their results.

Both the `cyclictest` and the "hardware latency detector" are parts of the SUSE Linux Enterprise Real Time product.

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1 General testing procedure and analysis

The first task you need to do when evaluating hardware for real-time is described in the following procedure:

1. Determine the largest allowable latency of the system using the hardware latency detector:
    a. Set the machine for real-time performance.
    Some servers have special settings for real-time, but they are strictly vendor specific.
    b. Set everything to lowest possible latency.
    c. Turn memory scrubbing down to as little as possible.
    d. Use the hardware latency detector (see *Section 3, "Determining latencies with the hardware latency detector"* for details).
2. Check the latencies measured by the hardware latency detector.
    The latencies should be low enough to support your real-time application with enough of a margin to meet its deadlines. If it is not the case, even after tweaking the machine setting for better real-time performance, the hardware is not good enough for your application. Use a different hardware.
3. Measure latencies using **`cyclictest`** (see *Section 2, "Determining latencies with* **`cyclictest`***"* for details).
    In a typical situation the latencies measured with **`cyclictest`** should be mostly the same from those measured by the hardware latency detector. Latencies measured by **`cyclictest`** include the latencies caused by the operating system and are thus closer to latencies measured in a real computing situation.

If you encounter a significant difference between latencies measured by both methods there might be a software bug involved. Such latencies are a significant part caused by the operating system, not the hardware. In such a case, contact SUSE for support.

2 Determining latencies with **`cyclictest`**

The **`cyclictest`** command is part of the real-time kernel test suite contained in the `rt-tests` RPM package. This package is distributed as part of SUSE Linux Enterprise Real Time.

Make sure to be `root` or use **`sudo`** to run **`cyclictest`**.

When `cyclictest` is running, it shows the number of cycles performed and the minimal, actual, average and maximum latency measured. To change the behaviour of `cyclictest`, the following list gives you an overview of the available options:

- The values shown are in microseconds. To use nanoseconds instead of microseconds, use the `--nsec` option.
- By default, `cyclictest` runs forever. The number of cycles can be limited with the `--loops=NUMBER_OF_CYCLES` option.
- By default, only one thread is run. You can use the `--threads=NUMBER_OF_THREADS` option to set the number of threads used. Without specifying a number, all available processors are used. With the `--affinity` option, the threads are pinned to the processors with the same number.
- To create a histogram with the latency values, use the `--histogram=NUMBER_OF_MICROSECONDS` option, where `NUMBER_OF_MICROSECONDS` determines the maximum tracking time. Larger values are reported as histogram overflows. The histogram is written to standard out (STDOUT), but you can redirect it to a file:

```
cyclictest --loops=1000 \
--histogram=1000 > histogram
```

3 Determining latencies with the hardware latency detector

The *hardware latency detector* (`hwlatdetect`) is a program that controls the kernel latency detector module (`hwlat_detector.ko`), installed with the real-time debug kernel (the `kernel-rt_debug` package). This is a special kernel module that is used to detect large system latencies, caused by the behavior of the underlying hardware or firmware, independent of Linux itself (system management interrupts, SMIs).

The hardware latency detector module works by making all CPUs busy for configurable amounts of time. This is done by calling `stop_machine()`, polling the CPU Time Stamp Counter (TSC) for some period, and then looking for gaps in the TSC data. These gaps indicate times when the polling was disturbed by SMIs.

To start using hardware latency detector, use as `root`:

```
hwlatdetect --threshold=10
```

The `threshold` value is the minimum latency value to be considered in microseconds. Use the value which is relevant for your particular situation.

`hwlatdetect` has the following options:

`--duration="`*`VALUE`*`"{s,m,h,d,w}`

Run the detector logic for the specified duration. Provide the duration as a decimal integer value. The default duration unit for this value is seconds. To use a different unit, append `m` (minutes), `h` (hours), `d` (days), or `w` (weeks) to the value.

`--threshold="`*`VALUE`*`"{us,ms,s}`

Specify the TSC gap used to detect an SMI. Any gap value greater than threshold value is considered to be the result of an SMI occurring. The default duration unit for this value is microseconds. To use a different unit, append `ms` (milliseconds) or `s` (seconds) to the value.

`--hardlimit="`*`VALUE`*`"{us,ms,s}`

The test is considered to have failed if a value above the hard limit value occurs. The default duration unit for this value is microseconds. To use a different unit, append `ms` (milliseconds) or `s` (seconds) to the value.

`--window="`*`VALUE`*`"{us,ms,s}`

Specify the size of the sample window. The default duration unit for this value is microseconds. To use a different unit, append `ms` (milliseconds) or `s` (seconds) to the value.

`--width="`*`VALUE`*`"{us,ms,s}`

The amount of time within the sample window where the detector is actually sampling. Must be less than the `--window` value. The default duration unit for this value is microseconds. To use a different unit, append `ms` (milliseconds) or `s` (seconds) to the value.

`--report=`*`FILE_NAME`*

Specify the output file name of the detector report. The default behavior is to print to standard output.

`--debug`

Turn on debug output

`--quiet`

Turn off information output.

`--watch`

Print sample data to stdout as it arrives.

4 More information

For more information on **`cyclictest`**, see **`man 8 cyclictest`**.

For more information on the hardware latency detector, see `/usr/src/linux/Documentation/hwlat_detector.txt`.

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