Open Source Automation Development Lab (OSADL) eG

What was believed to be impossible is reality now:
Reliable real-time determinism with Linux

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What was believed to be impossible, is reality now: Reliable real-time determinism with Linux

How to obtain data of the real-time capability of a state-of-the-art computer system?

To determine whether a given system (hardware, firmware and software) is deterministic with respect to a given response deadline is much more difficult now than it was in earlier days. Until 10 to 20 years ago, the worst-case latency of a system could be determined theoretically: Using the so-called path analysis, the longest critical section that ever could be encountered in a system was determined, and the processor cycles required by the instructions of this section were then multiplied with the cycle duration. This procedure, unfortunately, is no longer possible, since in modern high-performance processors there is no way to obtain the computing time of a given section of instructions. Most of the time, it is extremely fast – up to 1 million times faster than 30 years ago, but very rarely it may be very slow – probably even slower than it was back then.

The only alternative to determine whether a system is suitable for a given real-time project is to empirically determine the worst-case preemption latency. However, this sounds easier than it is, since the extremely high number of possible interferences in a state-of-the-art computer system require a very large number of single recordings under as many different conditions as possible. This was one of the reasons to establish the OSADL QA Farm where today more than 50 different Linux systems undergo continuous long-term recordings of a large number of variables. Among others, the worst-case system latency in idle state and under average load and peak-load conditions of the various subsystems is determined repeatedly. All Linux kernels are equipped with the real-time patches developed and maintained by the Linux RT community led by kernel developer Thomas Gleixner.

The OSADL QA Farm celebrates its one-year anniversary and presents long-term latency plots

Several systems of the OSADL QA Farm now run for more than a year under continuous monitoring conditions. With 100 million wakeup cycles used to determine the worst-case latency twice per day, 730 recordings in a year's time are based on a total of 73 billion cycles. This is equivalent to an industrial control system running 365 days at 500 µs cycle interval.

The six 3D graphs in Figures 1a to 1f represent a subsample of the more than 50 systems currently under test in the OSADL QA Farm. Each graph consists of repeated latency plots put before one another with the time scale running from back to front. A latency plot displays the number of samples within a given latency class (resolution 1 μs). The logarithmic frequency values at the y-scale ensure that even a single outlier would be displayed. The total absence of any outlier in all the very different systems clearly demonstrates that the perfect determinism of the mainline Linux real-time kernel is a generic feature; it is not restricted to any particular architecture. In an industrial system that requires asynchronous external events to be processed in user space within 200 μs, for example, this deadline never would be reached by any of the systems throughout an entire year.

OSADL keeps growing

The OSADL QA Farm and the many other activities of the organization are made possible by the contributions of its members that are gratefully acknowledged. It should be emphasized in this context that some OSADL services, such as most of the QA data, are made available to non-members as well. In addition to the 33 members a year ago, five new members have joined OSADL since then and are helping OSADL to further facilitate the use of Open Source software for industrial production and in industrial products. OSADL extends a warm welcome to its new member companies

- Komax AG, Dierikon, Switzerland,
- BELIMO Automation AG, Hinwil, Switzerland,
- Beijing Shenzhou Aerospace Software Technology Co., Ltd., Beijing, China,
- Fr. Sauter AG, Basle, Switzerland, and
- KUKA Laboratories GmbH, Augsburg, Germany

who have been added to our member poster (Figure 2).

Figures 1a to 1f

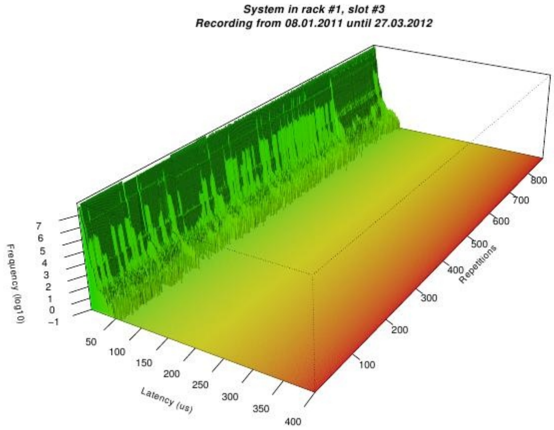

Figure 1a: AMD Athlon 64 bit 2800+

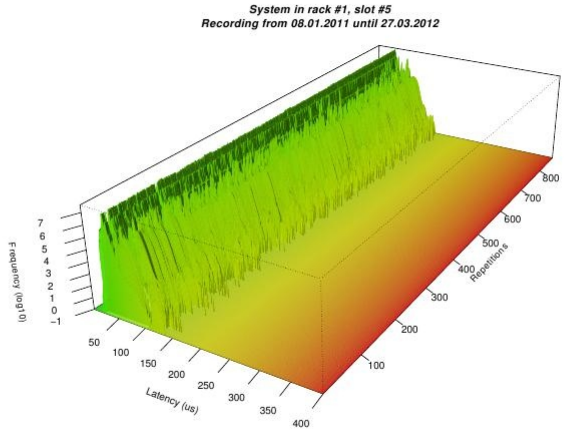

Figure 1b: TI OMAP3517 @496 MHz

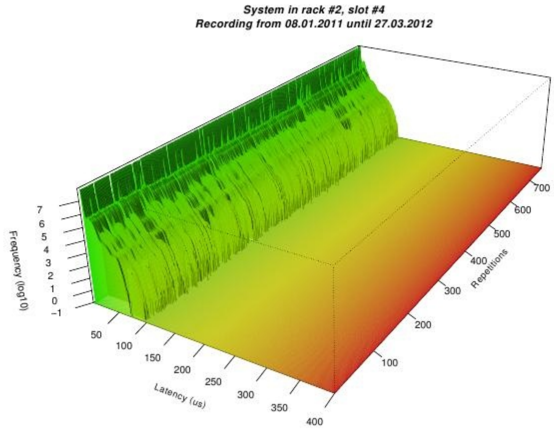

Figure 1c: ICT Loongson-2 MIPS 64 bit @533 MHz

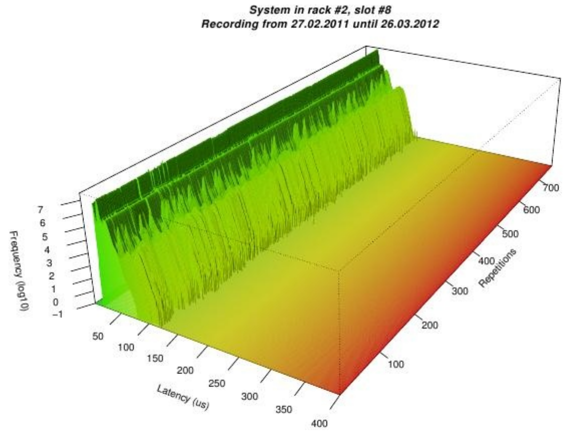

Figure 1d: ARM i.MX35 @533 MHz

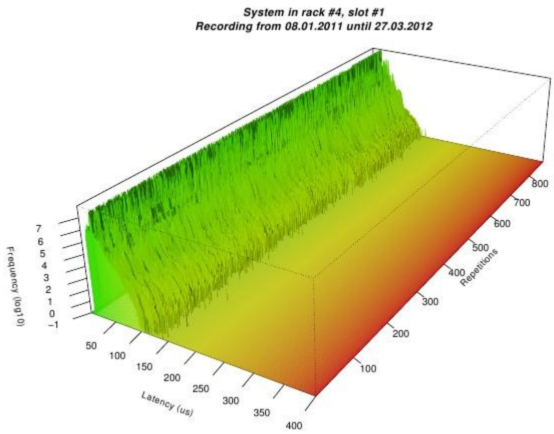

Figure 1e: x86 Intel Atom N270 @1600 MHz

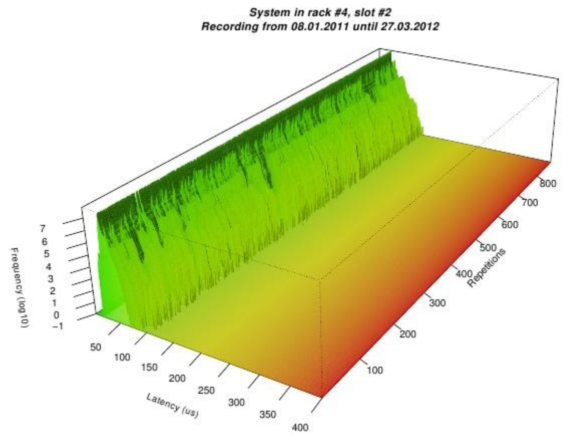

Figure 1f: x86 VIA C7 @1000 MHz

Links to high-resolution vector images in print quality are available at:
https://www.osadl.org/?id=1345 and following

Figure 2

OSADL Member Poster as of April 2012

A high-resolution bitmap file of this image is available at:
https://www.osadl.org/uploads/media/OSADL-Members-2012-04.jpg

About the Open Source Automation Development Lab (OSADL):

The Open Source Automation Development Lab (OSADL) started its activities in summer 2006 and is organizing since then the development of Open Source software to be used for industrial production and in industrial products. Among others, OSADL is acting as a "purchase community" of Open Source software, i.e. the membership fees are used to develop Open Source software projects that the majority of the members is requesting for or agreeing to. In addition, OSADL provides support with practical and commercial aspects of using Open Source software in the industry. This includes subexhibitor booths at relevant trade fairs, seminars and workshops, legal assessments and collaboration with academia. Current OSADL software projects focus on real-time and safety critical Linux, real-time Ethernet and other special drivers for the Linux mainline kernel as well as virtualization and tools to migrate existing projects to Linux.

The OSADL member companies employ altogether more than 100,000 people, generate a sales volume of more than 100 billion euros and are machine companies, manufacturers of automation hardware and software, semiconductor companies, Open Source software service providers and user associations.

More information at: http://www.osadl.org/

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