Evaluating Real-Time Hypervisor (RTS) version 4.1 using Dedicated Systems Experts (DSE) test suite

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1 Overview

Virtualization is an emerging technology which is mostly used in the server and cloud computing arena. In recent years, this technology started to be widely applied to real-time embedded systems with timing constraints. Manufacturers of highly advanced equipment such as medical scanners and electron microscopes still use separate PCs for different applications, such as a real-time regulation system, calculation system or presentation system. Virtualization using real-time hypervisors makes it possible to combine totally different kinds of systems on just one computer.
The big advantage of virtualizing embedded systems is enabling the concurrent execution of heterogeneous (different classes) operating systems: an RTOS for traditional embedded real-time programming, and a fully-featured (rich) operating system to support complex applications such as user interfaces.

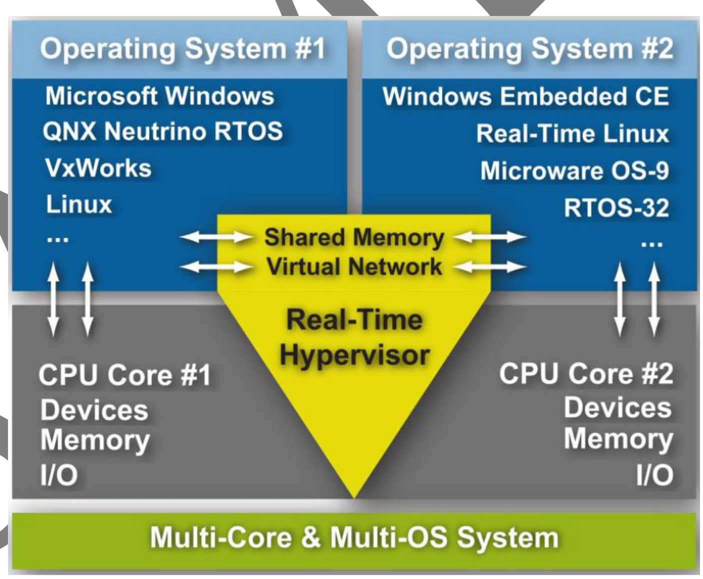
Currently, there are several commercial real-time hypervisors for embedded systems such as Greenhills INTEGRITY MultiVisor, Real-Time Systems GmbH Hypervisor, Tenasys eVM for Windows, National Instruments Real-Time Hyper Hypervisor [11], and so on.

This paper evaluates “Real-Time Systems GmbH Hypervisor” using Dedicated-Systems Experts (DSE) testing suite.
In the next sections, there will be a brief explanation about the RTS Hypervisor, followed by the experimental setup used for evaluating this hypervisor.

Note: Throughout this paper, the ***Real-Time Hypervisor*** is frequently referred to either as ***the RTS Hypervisor*** or sometimes just ***the Hypervisor***.

2 RTS Hypervisor

Real-time Systems' Hypervisor is a software that partitions the hardware resources of a standard x86, multicore-processor execution platform in such a way that multiple operating systems can run concurrently and in complete independence of one another. Under the RTS Hypervisor, multiple operating systems run at full speed, without an intervening software layer to detract from native real-time processing.
RTS Hypervisor partition the hardware resources between the running OSes by appointing physical cores to a specific OS instance. As such, the CPU cores are not shared between these OS and no scheduling decisions between these have to be taken by the hypervisor.
Using this product, one can assemble a system that either runs multiple instances of a real-time operating system (RTOSs) or a heterogeneous mixture of operating systems that can also include a general purpose operating system (GPOS), all on a single multicore execution platform. The number of operating systems that can run simultaneously is limited only by the number of available logical CPUs.
In the **RTS Hypervisor** environment, standard off-the-shelf operating systems run at full speed and full efficiency. The only known limitations are those imposed by the physical characteristics of the execution platform.
They are enough isolated from one another so that an OS can be booted or rebooted without slowing or compromising the ongoing activities of other operating systems.
The figure below describes the RTS Hypervisor way of working.



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3 Experimental setup

This section talks about the software (RTS Hypervisor and guest OSs) and hardware used in this evaluation.

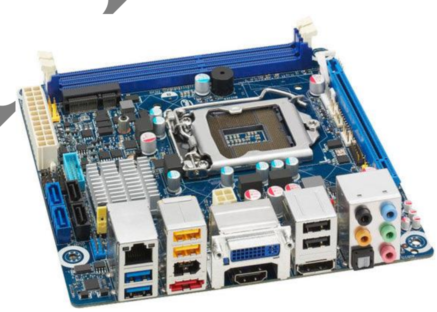
3.1 Software

RTS Hypervisor version 4.1 is evaluated here using Linux PREEMPT-RT 3.8.13-rt11 as the VM guest OS used in which DSE testing suite is performed. This OS version is shipped together with the RTS hypervisor from Real-Time Systems GmbH.

Evaluating this hypervisor version, using the mentioned OS version, is performed using several performance tests. The testing results are applicable only to these versions as other versions may have other significant performance results.

DSE testing software uses `mlockall()` in the Linux kernel to assure that all memory is locked into memory. Further, the application was statically linked and started from a RAM disk (tmpfs) to avoid swapping out read-only code pages.

3.2 Hardware



The hardware used in this work has the following characteristics:

Motherboard: Intel® Desktop Board DH77KC

Processor: Intel® Xeon® Processor E3-1220 v2

- Frequency: 3.1 GHz
- Number of cores: 4
- Number of threads: 4
- L1 cache: 32KB L1 data, 32KB L1 instruction per core
- L2 cache: 256KB per core, inclusive
- L3 cache: 8MB accessible by all cores, inclusive

RAM: 16 GB DDR3