Virtualization ready to fly

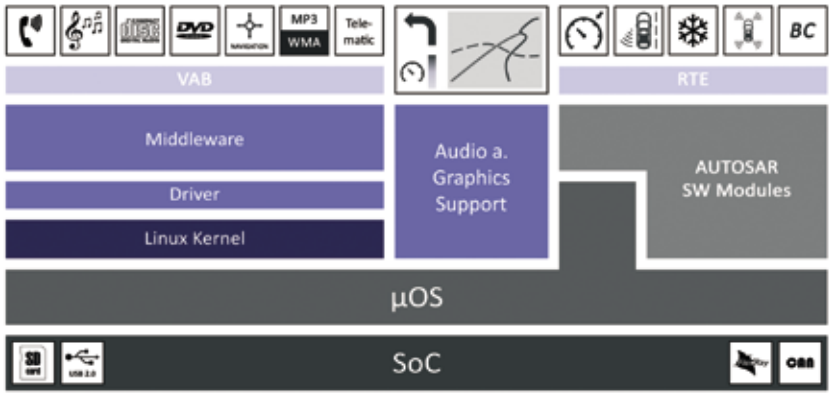
By Christoph Hammerschmidt

WHEN AIRBUS DESIGNERS decided to reduce the complexity of the internal electronic systems for the long-range wide-body A350 airplane, currently under development, they dug out a concept that's been known in business IT for decades - virtualization. The concept allows several applications to run on a single computer and thus reduce the number of boxes inside the aircraft. As well as reducing hardware complexity it is expected to reduce weight, an important factor in this specific industry segment.

Virtualization has been in use in military avionics environments for some time and over the last decade civil aircraft manufacturers such as Airbus and Boeing have standardized on it, baptized it with the acronym IMA (Integrated Modular Avionics) and streamlined it for civil use. Thus, for instance, a computer in the aircraft can control flight-critical displays under real-time conditions and at the same time run less sensitive service data acquisition applications under a standard operating system such as Linux. In the case of Airbus, reducing the number of computers on board the aircraft led to reduced complexity of its wiring harnesses – something that has caused problems on the long-range A380 aircraft.

Whereas virtualization used to be a high-end, high-cost technology, with the availability of microprocessors powerful enough to run multiple applications and equipped with memory management units or memory protection units, virtualization concepts are increasingly finding their way into novel applications areas. While multicore processors are not necessarily a prerequisite to create virtual environments, the computing power they are offering certainly helps to run several applications and operating systems on top of them, says Boris Vitorelli, segment marketing manager for ARM in Germany. What is necessary is a processor's ability to support at least two different levels of access to the hardware resources.

Such microprocessors are, besides the usual suspects from the commercial IT world, certain spins of Intel's Atom, some ARM types including Freescale processors based on the ARM architecture such as the iMX35 or the iMX51, as well as Freescale's own PowerPC and Coldfire architectures. Also the MIPS architecture offers the possibility to run virtualized environments.



Keeping consumer and engine separated: Virtualization in the COQOS operating system.

Virtualization provides the possibility to run multiple virtual machines on the same hardware. However, not all virtual environments are created equal. The most popular approaches are the hypervisor technology and the so called paravirtualization. While many virtualization schemes in commercial IT are based on hypervisor approaches, embedded and industrial programmers frequently prefer paravirtualization. Hypervisors can eat up 10 to 15 percent of the computing performance while paravirtualization only causes a performance loss of 3 to 5 percent, according to programmers.

Thus, paravirtualization seems to be the approach of choice for deeply embedded systems in vehicles and other application segments where the computing resources are not overly abundant or where the hardware resources have to be utilized particularly well. For instance, German software company Sysgo AG (Klein Winternheim, Germany) follows that approach for its PikeOS real-time operating system. "With hypervisors, you can forget real-time behavior," said Sysgo supervisory board chairman Knut Degen.

Also betting on paravirtualization approaches is OpenSynergy, a Berlin-based software company focusing on automotive environments. In terms of hardware, the company's COQOS real-time operating system currently supports ARM9 and Intel Atom platforms. Typically, the company's software runs in an environment in which Linux is involved. "Since Linux is not a real-time operating system, we have to keep performance losses through virtualization in mind, and this is why we bet on paravirtualization," said OpenSynergy marketing manager René Drescher.

Not all experts agree. Board computer manufacturer Congatec AG, for instance, prefers the hypervisor technology for its Intel-based platforms used to control machine tools as well as for other time-critical industrial and medical applications. For real-time requirements, the company collaborates with RealTime Systems GmbH (Ravensburg, Germany) which has developed a real-time hypervisor software for Intel processors as well as other middleware for time-critical industrial applications.

In factory-floor applications, single-task machine-control computers are being integrated into corporate networks where they also

take over business tasks such as transmitting utilization and service status reports. In such cases, the same hardware needs to be able to run a standard operating system besides the real-time operating system. Frequently, for communication tasks Linux is used since it already offers all the communication and network middleware often missing in real-time systems.

"Virtualization is the method of choice wherever applications with different degrees of criticality are combined on a common hardware," said Sysgo's Degen. The rising degree of heterogeneity observed in real-world environments is an additional driving factor for virtualization. For instance, virtual environments can help to reuse existing software. Degen said he sees some users running the PikeOS real-time system along with the older pSOS from competitor Wind River, separated by means of virtualization.

In addition, users might want to use the abundance open-source software. Again, Linux with its open network interfaces and its ability to run Java software or Adobe Flash graphics applications attracts many developers. Virtualization then is the best way to get the best of both worlds.

And in the car genuine automotive software applications, which typically are very safety-critical such as engine, undercarriage control and ABS, have to be strictly shielded from the potentially negative impact of infotainment applications. Again, virtualization is the method of choice.

Autosar yet to fully embrace virtualization

While the automotive industry's Autosar initiative has established a structured software domain that contains some elements separating different applications and the underlying hardware, it does not yet fully embrace virtualization. OpenSynergy offers an environment consisting of a micro operating system running on top of Autosar's own operating system – and on top there is a virtualization layer which in turn allows system designers to install and run several different operating systems independently in this environment. In addition, OpenSynergy's operating system also manages the communication across the different worlds.

While the system is aimed at automotive infotainment applications, OpenSynergy marketing manager Drescher believes the concept could be ported to other market sectors. "We have already had inquiries from energy suppliers," said Drescher.

A 'virtualization enabler' such as the COQOS operating system could enable automotive OEMs to reduce the number of computers and ECUs within a vehicle, said Drescher.

Other insiders do not agree. While this may be technically possible, the commercial fragmentation of the automotive supply chain means tier ones and OEMs do not collaborate at this level, said an expert who asked not to be named.

Where commercial and technical considerations are aligned virtualization offers a variety of implementation options for a range of embedded and industrial control markets. The Open Source Application Development Lab (OSADL) is a non-profit organization dedicated to promoting open software in embedded and machine control applications. It estimates that within a few years 10 to 20 percent of all machine control systems will use virtualization techniques.

OpenSynergy CTO Stefaan Sonck Thiebaut agrees. "Virtualization is gaining traction in the embedded systems market. It allows safe and secure partitioning of software functions on a common hardware platform and thus reduces the development costs as well as the costs for the hardware". ■