Automation technology advances in Windows Embedded CE 6.0 release

By Ramon Barth, Beckhoff

Windows Embedded CE 6.0 provides an operating system for general embedded devices, now enhanced by the R2 release bringing additional embedded functionality, of particular importance for applications in industrial automation.

The main innovation of Windows CE 6.0 is the actual operating system kernel. Compared with version 5.0, Windows CE 6.0 features a fully revised operating system architecture with the result that each process now has up to 2 Gbytes of address space available (previously 32 Mbytes). Furthermore, the possible number of processes has increased dramatically from 32 to 32,000. Like its predecessors, Windows CE 5.0 was based on a 32 MB memory slot concept and the overall architecture is mapped to 32 possible memory slots (32 processes). Extension of the system limits required redesign of the kernel. Notwithstanding the far-reaching modifications, Windows CE 6.0 still offers hard real-time capability. In certain configurations even better jitter values have been measured compared to Windows CE 5.0. For a 1 GHz Intel Celeron M processor in a CX1020 embedded PC from Beckhoff, a maximum jitter of 2 µs was measured in the ISR (interrupt service routine). In the IST (interrupt service thread) – i.e. after processing by the operating system – the maximum jitter was 8 µs.

The R2 release provides new drivers and BSPs. There are also technology improvements for Internet Explorer, VoIP and terminal service clients. But most interesting from the industrial automation point of view is WSD (web services on devices), which is a methodology for detecting network-attached devices and the web services they provide. WSD is a Microsoft implementation of the devices profile for web services standard. The Windows Embedded CE implementation of WSD allows it to provide web services through this method as well as detect and consume web services using WSD. It provides the complete web services on devices API (WSDAPI) that is provided on Windows Vista.

In CE 6.0, the device drivers now operate in the same address space and with the same access rights as the operating system kernel, similar to Windows XP. This leads to improved interrupt response times and also speeds up operating system calls. In practice this change results in higher network communication data throughput, for example, and offers ideal preconditions for higher graphics performance. However, there is no light without shadow: unstable device drivers can impair the operating system kernel and cause the overall system to crash. Windows CE 6.0 therefore offers a user mode driver framework for running device drivers separately from the kernel in their own address space, although with certain performance implications. Should this driver crash, only the functionality of the driver is affected – not the rest of the system. This functionality is configured via the registry and is subject to associated user rights. In this way a system designer can create the best combination of stability and performance for their respective automation system. A further substantial innovation is the development tool (platform builder) for setting up Windows CE 6.0 systems. The previously independent development environment has become a Visual Studio 2005 component. All Windows development tools have been consolidated in Visual Studio. The Windows CE kernel debugger is also integrated in VS and works in the same way as the debugger for Win32 or .NET applications.

Through the integration into a development environment, the developers can debug any component, including Win32 applications, driver functions or the kernel, for example. This makes for convenient development with short turnaround times. The new ARM-based device emulator enables the full development cycle to be completed without target hardware. Optimized communication channels (DMA transport) increase communication speed between Visual Studio and the device emulator. An evaluation version of the complete package, including the kernel source code, can be downloaded free of charge from the internet so that interested developers can experience the functionality without facing a significant initial hurdle. Microsoft Visual Studio 2005 comes complete with compilers that meet current standards. Through the integration of platform builders in VS 2005, Windows CE developers

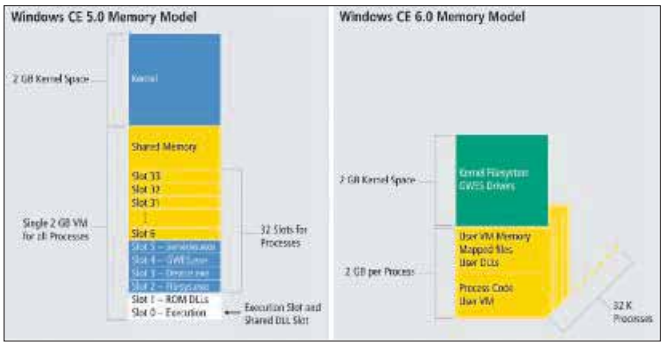

Figure 2. Comparison of the address space under Windows CE 5.0 and 6.0

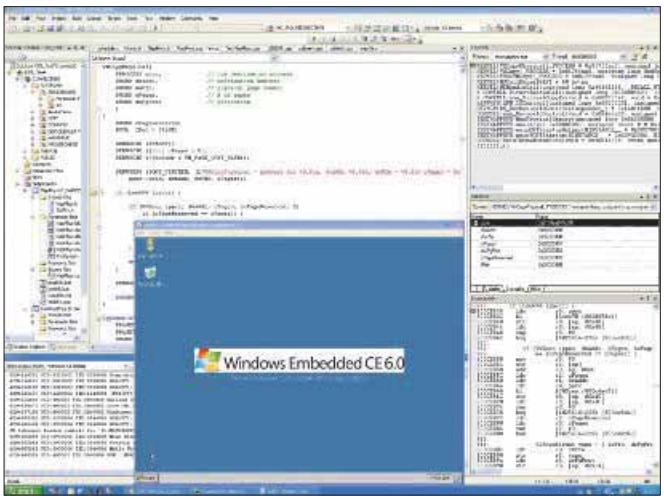

Figure 3. Debugging in Windows Embedded CE 6.0

benefit from the front end of these compilers. The platform builder plug-in includes the compiler back ends required for cross-development of the processor architectures supported by Windows CE (ARM, x86, MIPS and SH). Advanced Visual Studio editors with syntax highlighting and outlining functionality facilitate code input by developers and improve transparency. The Team Suite version of VS 2005 offers additional tools for version and development control. In conjunction with the MS team foundation server, Visual Studio effectively supports team-based software development. Beyond the integration in Visual Studio, PB 6.0 offers new useful tools such as run-time image viewer, reg-file editor and bib-file editor. The run-time image viewer enables the analysis of binary CE images and the comparison of different versions. In addition, files contained in the image can be extracted.

With the new exFAT file system, Windows CE 6.0 addresses growing demands relating to persistent data storage. exFAT removes existing storage limitations and is able to execute secure file operations. It supports file sizes in excess of 4 Gbytes (the theoretical exFAT limit is 264 compared with 232 with FAT32) and is supported by Windows Vista. In addition to overcoming existing size limitations, further exFAT development aims were maximum expandability and optimization for flash media (minimization of access to the storage medium). The simplicity of FAT was to be maintained in the interest of implementability. The mobile CellCore component was implemented in Embedded CE. CellCore provides the software infrastructure and drivers for mobile data and voice communication. SMS, SIM, telephony and WAP are offered as services or APIs. In practice this means that an Embedded Windows CE device can exchange data with the outside world via GSM without an external modem, provided that suitable hardware is available. The technology is used in telecontrol and other areas of application.

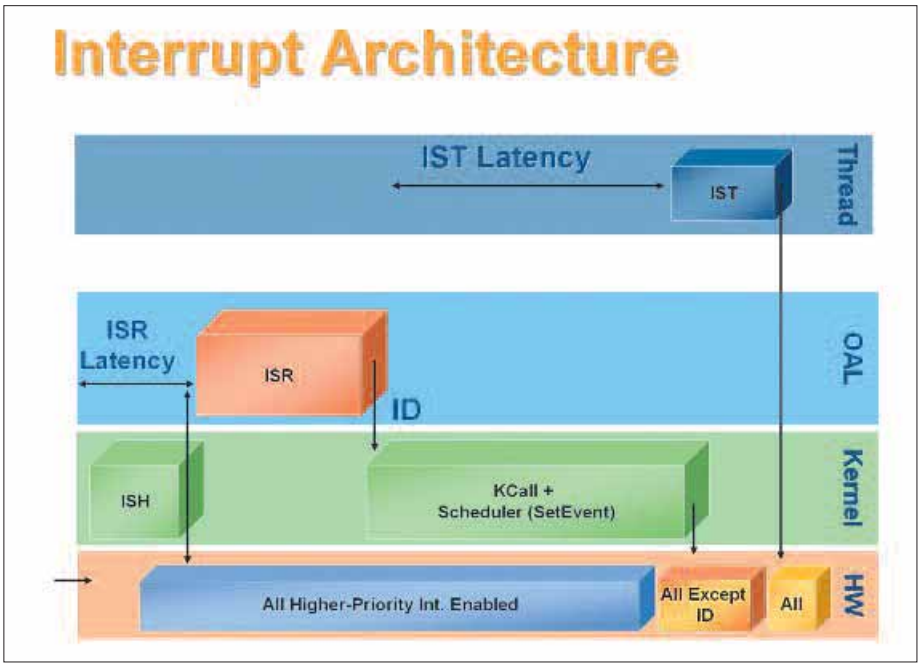

Figure 4. Interrupt architecture of Windows Embedded CE 6.0

Together with Windows CE 6.0, Microsoft has published the whole source code of the Windows CE kernel. It can be downloaded with the evaluation version of Windows CE from the Microsoft server. In combination with the integrated kernel debugger, the source code can be very helpful during software development. Through an extended license agreement, Microsoft allows the source code to be changed and used in products without an obligation from the user to disclose any modifications. As a result, external know-how is protected.

When it comes to support for general commercially available hardware (graphics cards, frame grabbers, printers, etc), the user still has to take a close look at Version 6 of Windows CE. If possible, Windows CE should be used in embedded systems with defined hardware configuration. In applications where flexibility in terms of hardware and software is required, a desktop version of Windows may well be the better choice. In addition, Windows CE is not suitable for standard Windows programs developed for desktop Windows. For reasons of footprint reduction, Windows CE 6.0 only offers a subset of the Win32 API. This means that programs must be developed and compiled for Windows CE. However, the close relationship to the "big" Windows versions greatly simplifies parallel development for both worlds.

Windows CE 6.0 enables the full utilization of the performance potential of an advanced 32-bit CPU. At the same time the system requirements for the application of Windows CE have hardly changed. This means excellent scalability, ranging from small 32-bit controllers (provided they have MMU) with low-capacity flash or RAM memory to full-grown, high-performance IPCs. A standardized operating system is thus available for a wide range of applications, from simple PLC controllers to memory-hungry visualization systems. Visual Studio 2005 features integrated, advanced and convenient development tools, that speed up software development and simplify troubleshooting. Relatively low unit costs and low one-off cost for commercially available development tools are further benefits for automation applications, where low initial costs and short development times are often prerequisites for small or medium-sized production runs.

With the Embedded PC and Panel product range, Beckhoff fully embraces Microsoft Embedded operating systems. The relationship within the Windows family supports consistent scalability of Beckhoff products. Thanks to an identical code basis, almost all functions of Beckhoff TwinCAT automation systems based on an IPC under Windows XP or Vista are also available on an ARM-based DIN rail PC, albeit with reduced performance. The new kernel and driver architecture of Windows CE 6.0 offers up to 30% higher performance compared with Windows CE 5.0. For example, a real-time application created in C++ can access the TwinCAT I/O API in a 100 µs cycle under Windows CE and take full advantage of the performance of advanced CPUs using EtherCAT.

Beckhoff offers software components, such as an IEC 61131-based soft PLC and soft motion controller for up to 5-axis CNC, to expand automation systems as required. A comprehensive collection of IEC 61131 function blocks complements the automation package. ■