Intel – exciting processor trends for IT and industrial automation

The future belongs to intelligent and connected devices

In the future, the Internet will interconnect a large number of intelligent devices in your house, office, car and in your pocket. Intel offers the technologies for a uniform "personal computing experience" across all of these platforms. This revolves around energy-efficient performance, security and Internet access.



The computer has now become an indispensable part of our lives and the trend continues towards so-called "Pervasive Computing." This concerns the all-encompassing networking of everyday professional and private life via the Internet using "intelligent devices." These terminal devices are not just servers, PCs, notebooks, tablets or smartphones. The Internet interconnects objects of all kinds: cars, digital signs that adapt their contents by remote control, smart TV devices, domotics systems for the intelligent management of energy in the home and much more.

The way in which we use all of these devices has changed and continues to change: today, people want to contact their friends, get information and be entertained with familiar applications — seamlessly and across different device platforms. In doing so they will reach for the device that best serves each respective purpose. Intel's vision is that of a uniform, cross-platform and seamless "personal computing" experience across all devices connected with the Internet. Intel technology is to form the heart of this solution.

Intel is therefore changing from a manufacturer of chips for PCs to a supplier of complete hardware and software platforms, including services. In doing so, Intel is placing

Andreas Thome, Beckhoff: Beckhoff has been using Intel CPUs for over 25 years in its own products. In order to successfully use PC technology specifically in the automation industry, it is necessary to have profound knowledge of processor and PC electronics in general as well as the ability to manufacture motherboards with their own form factors at any time. For this reason Beckhoff develops and manufactures the motherboards itself and adapts the BIOS to requirements. Companies such as Intel and Microsoft represent important and reliable technology partners for Beckhoff.

technology 25 Years of PC Control | 08/2011



the emphasis on energy-efficient performance and security as well as Internet capability for a large range of device categories. Here, Intel is transferring the advantages of Moore's Law and its leading transistor technology for higher performance and more energy-efficient processors to other computing segments.

Energy efficiency and Moore's Law

Microprocessors are becoming ever faster and smaller; they use energy efficiently and integrate an ever increasing number of functions on one chip. The rapidity with which semiconductor technology has developed is shown by the number of the transistors, the core element of microprocessors. The 2,300 transistors of Intel's first microprocessor, the 4004 in 1971, has in the meantime become 1.17 billion transistors in the Intel®-Core™i7-Extreme processor. A nanometer (nm) is a billionth of a meter – that is equivalent to a width of approx. three neighboring atoms in a piece of metal. Compare this to a human hair which is about 90,000 nm thick.

Intel is obeying Moore's Law, postulated as far back as 1965 by the joint founder of Intel, Gordon Moore. This rule has remained valid to the present day and is one of the most important guiding principles of the IT industry. Moore's Law states that the transistor density (the number of transistors per unit area) on a microchip doubles about every 24 months. The doubling of the usable surface area and the miniaturization of the circuit structures leads to new functions, higher computing performance and smaller production costs per chip, because smaller transistors are less expensive to manufacture, switch faster, require a lower supply voltage, generate less heat and have a lower power consumption.

Intel has dedicated itself to continual innovation in order to obey Moore's Law. The socalled Tick-Tock model for processor design stands for this. It is based on the annual alternation of structural miniaturization in the manufacturing of the chips (Tick) and new processor architecture (Tock). 2010 was a Tock year, i.e. a new processor architecture was presented in the second generation of the Intel® Core™ processors (code name Sandy Bridge), which will be manufactured until the end of 2011 using the tried-andtested 32 nm process. The shrink in the manufacturing to 22 nm will then follow at the end of 2011 (Tick; code name Ivy Bridge), and in 2012 there will be a new processor architecture once again (Tock; code name Haswell).



Trend: processor with integrated graphics

Intel shows where the journey is going in the future with its current processors (Sandy Bridge): namely toward processors that integrate an ever increasing number of functions on one chip and intelligently adapt their performance and power consumption depending on the requirements of the application. The second generation of the Intel® Core™ processors combines visual and 3D graphic technology with high-performance microprocessors on a single piece of silicon.

This integration improves the graphic performance through an even closer coupling of GPU and CPU. The graphic engine is connected directly to the cache of the processor. Therefore, this is no longer called L3-Cache, but Last-Level-Cache. It intercepts memory access both from the CPU cores and from the graphic engine. In this "ring" architecture the graphics and the processor cores share resources such as the cache or the memory areas. Access to the cache results in a considerably higher throughput for the graphics than with traditional memory access.

A further emphasis is placed on improved and accelerated multimedia functions for applications such as professional image processing, 3D graphics, (HD) video processing and gaming. For instance, the new Intel® Advanced Vector Extensions instruction set (Intel® AVX), which is extended to 256 bits, will approximately double the performance of floating point applications (e.g. image processing, video, 3D modeling, scientific simulations, financial analyses) as well as multimedia applications.

Andreas Thome, Beckhoff: The graphics integrated in Intel® processors are sufficient for the majority of applications in the field of industrial control, even up to three-dimensional moving graphics with hardware acceleration. Typically, the employment of dedicated graphic hardware does not make sense here for cost reasons. In addition, CPU manufacturers such as Intel and AMD are continuing the rapid development of their integrated graphic units thanks to the increasingly demanding "multimedia Internet devices," so that the graphic unit also offers increasing competition to the main CPU as a general "number cruncher."

Andreas Thome, Beckhoff: Both "Tick"

the power dissipation of the processors

and "Tock" are useful steps for the automation industry; on the one hand

is reduced, and on the other each new processor architecture increases

the performance capability and typically also the processing speed

Industrial PCs can thus be given

control cabinets. In the future.

Beckhoff industrial products.

of control and regulating algorithms.

smaller dimensions and save space in

the processors from the Sandy Bridge/ Ivy Bridge series will also be used in



The Intel® Core™ i7 Extreme Processor meanwhile integrates 1.17 billion transistors.



With the new version 2.0 of the Intel® Turbo Boost Technology, Intel makes optimum performance available for individual requirements.

Trend: Intelligent performance

A further factor that increases performance is Intel® hyper-threading technology. Four processor cores of the second generation of the Intel® Core™ processor can process up to eight threads at the same time together using this technology. In addition to that there is the new version 2.0 of the Intel® turbo-boost technology. It is optimized for the new micro-architecture and accelerates every application, regardless of whether it is based on one or eight threads. Intel has also extended its turbo-boost technology to the graphic cores in the new processors.

Depending on the workload, Turbo Boost 2.0 automatically selects whether the processor cores or the graphics should be accelerated and always makes the optimum performance available depending on the individual requirements. For example, if a program is used that needs only two of four cores, two cores are switched off and the remaining two active cores are automatically clocked up. If only one core is needed, this is over-clocked up to a reasonable limit. As a result, the processor automatically reacts to current requirements and always makes the maximum performance available.

Andreas Thome, Beckhoff: Turbo Boost is useful in automation only if the Industrial PC is not called upon for control purposes in the range of milliseconds or even microseconds, but has other tasks to attend to, e.g. visualization or functioning as a database server. The temporary over-clocking of a core leads to fluctuations in the execution time and collides with the requirements of the control technology with respect to real-time capability.

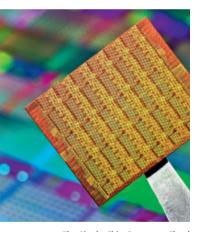
Trend: Many-core

Over the course of 2011 Intel will bring out new versions of the second generation of the Intel® Core™ processors with eight processing cores. Intel's long-term goal is to accommodate a large number of processor cores on one chip. Future computers could thereby make completely new software applications and man-machine interfaces possible. The 48-core research processor Single-Chip Computer Cloud (SCC) by Intel represents a milestone along this road. The SCC was introduced in December 2009 and was essentially co-developed by Intel in Braunschweig, Germany. It encompasses 48 fully programmable processing cores with an Intel architecture — more than have ever been integrated before on a single silicon chip. In addition, the chip has a very fast network, which enables the exchange of data between the computing cores as well as new power management technologies for extremely high energy efficiency. The 48 cores require only 25 Watts in the idle state or 125 Watts at maximum performance — that is comparable to the power consumption of two standard household light bulbs.

In order to accelerate the development of next-generation applications and software for many-core processors (parallel programming), Intel established the MARC initiative (Many-Core Applications Research Community) in September 2010. MARC encompasses more than 80 research establishments worldwide with over 100 projects that use the 48-core research processor Single-Chip Computer Cloud (SCC) from Intel. Unlike four-core processors, the challenge in programming many-core software lies in the distribution of different parallel-executed applications to the right number of cores. At the same time, the standard requirements such as memory, I/O interfaces and efficient data transfer must be ensured.

Andreas Thome, Beckhoff: With

TwinCAT 3 software, Beckhoff is initially taking the multi-core road, i.e. individual tasks of the automation solution are distributed to individual physical cores of the multi-core CPUs (typical today are four cores, which are also capable of hyperthreading, depending upon the CPU, hence in total eight "visible" cores). The many-core approach is still a long way off for automation, since corresponding programming tools would still have to be defined and developed.



The Single-Chip Computer Cloud (SCC) from Intel unites 48 processor cores on one chip.

Market with a future: Embedded processors

All of the developments mentioned, such as higher computing performance, lower power consumption, many integrated functions and flexibility, apply also to the Intel® AtomTM processors, which are used in the growing Embedded market alongside the Intel® CoreTM and Xeon® processors. The areas of application include industrial automation, medical technology, In-Vehicle Infotainment (IVI) systems in cars, multimedia phones, intelligent electricity meters or digital signs that can adapt their contents by remote control. Frequently, the Embedded variants of the AtomTM processors are specially adapted versions of the AtomTM models that were originally tailored to smartphones (code name

Frequently, the Embedded variants of the Atom™ processors are specially adapted versions of the Atom™ models that were originally tailored to smartphones (code name Moorestown, future version Medfield) or tablet PCs (code name Oak Trail). For example, the Intel® Atom™ processors of the E6xx series (code name Tunnel Creek; "E" stands for Embedded) were derived from the processor in the "Moorestown" smartphone platform. The 45 nm System-on-a-Chip (SoC) solution integrates processor, memory controller,

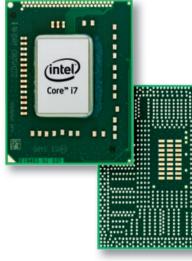
Andreas Thome, Beckhoff: In this respect, "Embedded" means the upgrading of processors by the implementation of auxiliary hardware and functions, in order to purposefully serve selected market segments. In another context, the word "Embedded" stands for processors with a 7-year delivery promise on the part of Intel. Beckhoff exclusively uses processors, chipsets and Ethernet controllers from these Embedded product series with long-term-availability.



Michael Vierheilig, Architecture Conversion Manager, EMEA-ESG, Intel GmbH

graphics, video encoding and decoding as well as audio in a single package. In addition, the Intel® Atom™ E6xx series offers the possibility to connect segment-specific I/O hubs, ASICs, FPGAs or discrete interface function blocks directly to the CPU complex using PCI express. This ensures the necessary flexibility for the Embedded world and its various interface requirements.

A further development is the Intel® Atom™ E6x5 processor, known so far under the code name Stellarton. It is based on the Atom™ processor E6xx as well as an FPGA from Altera, which is implemented as a multi-chip package. The Intel® Atom™ E6x5 is thus the first configurable Intel® Atom™ processor. It creates additional flexibility for customers that want to install their own proprietary I/Os or accelerate specific algorithms. In addition, it allows developers to adapt their designs quickly to changing requirements. Future Atom™ processors from Intel will be manufactured with smaller structural widths than the current 45 nm. For example, the next generation of the Intel smartphone platform "Medfield" will be a 32 nm System-on-a-Chip (SoC) solution, which will make even smaller form factors and lower power consumption possible. In addition, the future Embedded Atom™ processors will be even more scalable with regard to performance, power consumption and functionality. Embedded Atom™ processors are already available today in single and dual-core variants, i.e., they offer one or two processor cores on a chip. In addition, the processors will continue to be optimized for the hard real-time requirements of high-performance electronic control units in the manufacturing of cars, aircraft and machinery.



In addition to the Intel® Atom™ and Xeon® processors, the Intel® Core™ processors are also gaining a foothold in the Embedded sector.

Security and Internet access

Apart from energy-efficient performance, security is a central concern for computer users. Today's safety solutions are not completely aligned to billions of devices and the associated dangers in the Internet, such as mobile telephones, cars, televisions, medical devices and cash dispensers. In order to successfully offer protection to such an extremely diverse online world, a fundamentally new approach to the software, hardware and services used is required. In order to cater for these requirements, Intel has taken over the safety specialist McAfee.

The size of the role that security plays in Intel products is shown by the current second generation of the Intel® Core™ vPro processors. With the Intel® Anti-Theft Technology version 3.0 (AT 3.0) it protects against the loss of data in the event of the theft of a PC or a notebook. With this technology, an administrator can now send a "poison pill" to deactivate the stolen device as a text message via a 3G mobile telephone network within a few moments of the stolen notebook being switched on. Once the PC is in the hands of its rightful owner again, it can be reactivated in a similar way by SMS. The new Locator Beacon function, for example, provides authorities with the possibility to track down a lost notebook by GPS using selected 3G modems.

New Intel® Identity Protection Technology (IPT) improves defense against phishing attacks, i.e. the attempt to gain unlawful access to the websites of companies, banks etc. IPT replaces the conventional password protection by generating a new six-digit numeric password every 30 seconds. This ensures that only authorized persons are granted the corresponding access.

In order to accelerate the spread of more intelligent Internet-bound devices such as notebooks, cars, smartphones, tablets and smart TVs, Intel has also acquired Infineon Technologies AG's mobile telephone business (Wireless Solutions - WLS). The acquisition extends Intel's WiFi and 4G-WiMAX product range with 3G technology from Infineon WLS and additionally supports Intel's plan to accelerate the 4G-LTE development. The new business unit, Intel Mobile Communications (IMC), provides its customers with state-of-the-art wireless and mobile telephone platforms worldwide.



Intel Mobile Communications (IMC) will specialize in intelligent mobile telephone devices in the future.

Andreas Thome, Beckhoff: The takeover of McAfee by Intel can be considered in connection with the efforts on the part of Intel to offer more than just the functionality of a processor. Details on the further fusion of security software and Intel hardware are also relevant to automation technology, but have not yet been revealed by Intel in any greater detail. The merger is to be welcomed if the solutions that arise from it are also available to other suppliers of security products.