Kontron Solutions@Work

VME in the Warsaw subway for 12 years and no end in sight

Always up to date with VMEbus Control

In the 25 years since its introduction in 1981, VMEbus has proven its worth as an open industry standard for both 3U and 6U boards/systems. Some VME solutions from Kontron have been in continuous use for 15-20 years and replacement parts can still be supplied for them today. Alternatively, fully backward compatible parts, like the latest Kontron VME CPU VMP3, can be used as upgrades. A fundamental advantage of VME is that individual components can have a long service life, despite increases in both performance and the scale of integration of an overall system. Technically, this is made possible by the asynchronous architecture, in which old cards cannot slow down new cards. For this reason, VME is still the first choice for many designs because upgrades are comparatively cost-effective to obtain. If an application needs greater performance because of extensions, for instance, in many cases it is enough simply to change the CPU. The Metro in Warsaw still uses basically the same control concept for railway control, station management and electrical monitoring that was first installed 12 years ago; in addition, new RoHS compliant parts are being used for further expansions.

The capital of Poland, Warsaw (Warszawa), has a population of about 1.6 million people. They create an ever increasing amount of traffic that expects reliability and punctuality from the metro. Warsaw Metro Line 1 was built between the southern terminus Kabaty and Politechnika (11.5 km, all underground). Before its grand opening in 1995, many years of planning had to be done and there were numerous building sites along the new line. The planning and development of the entire control system for the subway and suburban railway network in Warsaw was carried out by the Faculty of Transport at the Warsaw University of Technology. The world-renowned 'Remote Control and Supervisory System' was first installed in 1994. The subway system has expanded rapidly and so too has the control technology. The last upgrade to the control system was supplied by Kontron in 2005, when the length of the lines had reached 17.3 km.

Initially, Russian-built rolling stock (60 cars of 81-series, identical to those operating in Moscow, Prague, St. Petersburg, etc.) was bought; in the spring of 98 more than 108 new cars were ordered from Alstom to add to the Metro's rolling stock. The cars' vendors and technologies have been changed, but the control system has remained the same.

From the outset, the system architecture has been based on VME in 3U and 6U; it operates on OS-9. Profibus in fiberglass modulation is used as the communication bus for real time applications. In addition, Ethernet (likewise via fiberglass cable) is used for the service network. A distinctive technical achievement for rail transport safety is the computer interlocking system, which complies with SIL-4, the highest railway safety standard. This guarantees the correct interaction of more than 3,000 real-time I/Os. The hardware configuration will be available for years on end and offers an extremely high MTBF. After many years of valuable cooperation with the University of Technology, Kontron recently signed an installation and system service agreement with the operating company. Further new solutions are currently in planning: Station number 19 ("Marymont") and, for 2007-2008, 4 further stations with the Warsaw University of Technology.

Years of Real-Time Systems Experience

Networking in an industrial and technical environment is a demanding task.

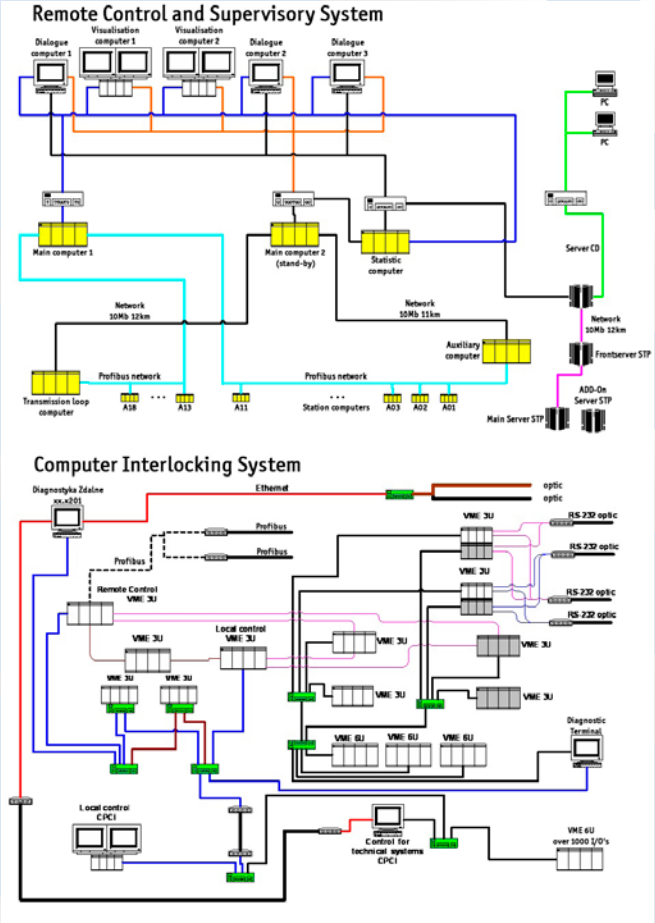
It is intolerable in a real-time application to lose too much performance under a heavy workload. It could endanger the lives of passengers who have come to rely on the subway. The subway transport system in Warsaw uses VMEbus computers developed by Kontron connected via a real time PROFIBUS network. This type of system guarantees a smooth traffic flow in Warsaw. Safety, reliability and predictable behavior of the entire system were crucial requirements for this networking system. That's why the key components are computer and I/O boards in 3U form factor using the VMEbus (IEC 821), the real-time operating system OS-9, SCSI based (ANSI X3.131) mass storage and fibreglass connections via PROFIBUS (DIN 19245). The Profibus Network uses fibreglass for data transmission. This reduces disturbances in an environment with large electrical currents in drive motors, which create electro-magnetic interference. RS485 interfaces and converters for the fibreglass transmission lines are used for data transfer via PROFIBUS. Especially secure procedures are used for error detection and correction. All messages are sent via two routes: directly to the destination and via the end station to the target station. If the central station does not receive information via these two routes, then there are two slow but independent RS232 transmission lines used for backup, which also previously used fibreglass. Since 2002, Ethernet fibreoptic transmission has been used in new installations. These slow secondary transmission lines have even more protection against errors. Train schedules are sent to the local stations ahead of the trains. They are then converted into data telegrams for direct transmission into the trains. Besides the scheduling data, other information such as the maximum permitted speed, which side of the train to open the doors as well as the distance to the train ahead is transmitted.

The central computer requests new data at intervals of 660 ms. The end station requests new data every 1320 ms. The central station transmits messages to all stations at 800 ms intervals. Every 1.5 s the end station sends a status report about the entire subway net to the central computer. The network is transparent with respect to the connected computers and their peripheral equipment. Aside from this, the entire system status is transmitted in real-time, not just individual messages. The system is

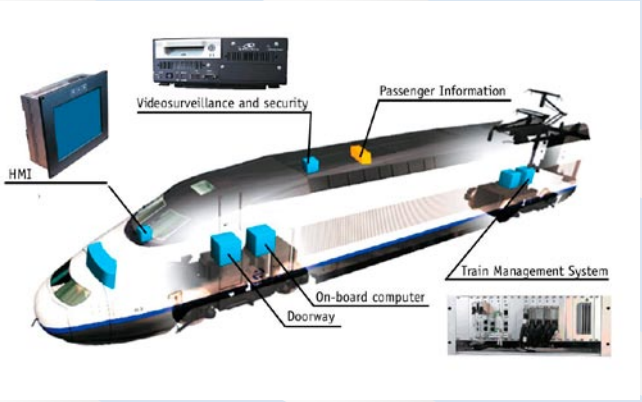
always synchronized. Control, supervision and reaction to events are done in real-time, not just logged after the events took place. Every CPU card and I/O controller is equipped with several Profibus and RS232 interfaces for redundant network connections. Routing information for the administrative section is done using the Ethernet interfaces on the VMEbus boards. This type of networking is also transparent to the user of Kontron boards and OS-9 operating system.

Future Installations are Shifting to RoHS

Even though there is no need for the Metro to change the control system for RoHS compliant, environment friendly products, this would not pose a problem. Even the replacement of old installations will not cause any compatibility problems. All the normal functions can be retained with the installation of RoHS compliant products. When Kontron changed the VMEbus over to RoHS, 80% of the products that were listed could be switched successfully to RoHS. Only a few products had to be discontinued, for example an old serial interface card with 2X RS232. Nevertheless, 100% of the functional requirements could be switched over to the new RoHS compliant solutions because, for example, many of the interfaces that used to be located on external expansion boards are now integrated on the new CPU boards or on more closely integrated expansion boards that are comparable in terms of price. Kontron even still supplies the 68040/68060-based 3U and 6U VME CPUs in accordance with the new RoHS directive so that customers can continue to safeguard their investments in the coming years. In places where, for instance, the DRAM memory was not available with RoHS compatibility, a new layout of the memory sub-module was implemented so that form-fit-function compatibility is guaranteed. Kontron therefore continues to offer its customers the entire range of VMEbus-based solutions – not only for the Warsaw Metro.



The Warsaw Metro's Remote Control and Supervisory System and the Computer Interlocking System



Kontron products are not only used in the rail infrastructure. EN50155-certified solutions by Kontron have been implemented in the train management systems of leading rail vehicle manufacturers for decades and are still being used in designs today.

VME-CPU boards: Then and Now

The VME 3U CPU VMPM68KA introduced by Kontron (previously PEP) in 1985 was fitted with the MC68000/ MC68010 processor 8/10/12 MHz and had 2 sockets each for RAM and ROM, whereby 32 MB ROM or 8/32 KB SRAM, i.e. 64 KB ROM and 64 KB SRAM could be inserted into each socket. A 68000 with 10 MHz could process the quickest commands such as a "MOVE reg,reg" in 4 cycles and reached around 2.5 MIPS. However, due to space restrictions, there was only one RS232 port with 25 Pin DSUB. RSxx ports, DRAM, ROM and Ethernet had to be expanded with additional cards. The first intelligent 3U VME Ethernet card VLAN with a local 68000 CPU, 256KB of RAM/ROM and a local RTOS kernel was released in 1988, after more Ethernet/IP was required for communication in control systems. Then 68020, 68030, 68040/68060-based VME CPUs with 33 or 66 MHz, 45 or 80 MIPS and up to 64MB DRAM, 1MB SRAM and 4 MB FLASH plus 10 Base 2/5/T and 4 RSxx ports gradually came onto the market.

Today the latest 3U VME assemblies by Kontron VMP3 offers the most up-to-date PowerPC technology with the PMC8540 @660MHz, 1520 MIPS 128MB SDRAM, 1MB SRAM, 16MB on-board FLASH, 1MB NVRAM 2x10/100/1000BaseT, 1x10/100 BaseT as well as a top-performance serial port with the greatest networking capability.

Caption: The VMP3 with PowerPC processor, clocked to a maximum of 660 MHz, is remarkable for its outstanding performance (1520 MHz according to Dhrystone 2.1) with low energy consumption.

About Kontron

Kontron designs and manufactures standard-based and custom embedded and communications solutions for OEMs, systems integrators, and application providers in a variety of markets. Kontron engineering and manufacturing facilities, located throughout Europe, North America, and Asia-Pacific, work together with streamlined global sales and support services to help customers reduce their time-to-market and gain a competitive advantage. Kontron's diverse product portfolio includes: boards and mezzanines, Computer-on-Modules, HMIs and displays, systems, and custom capabilities. Kontron is a Premier member of the Intel® Embedded and Communications Alliance. The company is a recent three-time VDC Platinum vendor for Embedded Computer Boards. Kontron is listed on the German TecDAX stock exchange under the symbol „KBC". For more information, please visit: www.kontron.com.

Corporate Offices

Europe, Middle East & Africa
Oskar-von-Miller-Strasse 1
85386 Eching/Munich Germany

Tel.: +49 (0)8165/ 77-777
Fax: +49 (0)8165/ 77-279

sales@kontron.com
www.kontron.com

North America
14118 Stowe Dr
Poway, CA 92064-7147

Tel.: +1 (888) 294-4558
Fax: +1 (858) 677-0898

sales@us.kontron.com
www.kontron.com

Asia Pacific
17 Building,Block #1,ABP.
188 Southern West 4th Ring Road
Beijing 100070,P.R.China
Tel.: + 86 10 63751188
Fax: + 86 10 83682438

kcn@kontron.cn
www.kontron.cn