APPLICATION STORY

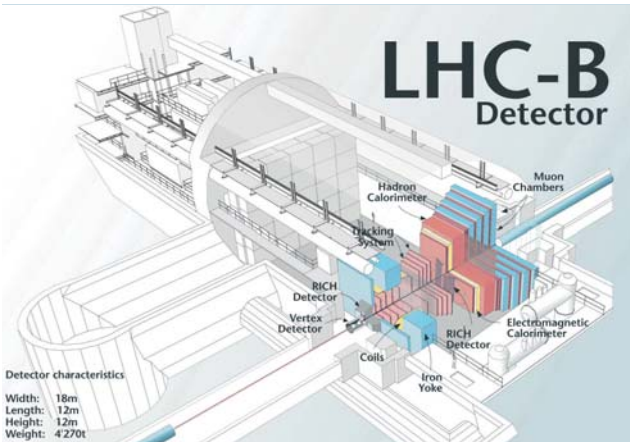
// PHOTO: THE LHCB MAGNET AT CERN (COPYRIGHT CERN / PHOTOGRAPH: PETER GINTER)

SMALL MODULE FOR BIG JOBS

CERN, THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH, NEEDED A SAFE, VIRTUALIZED ENVIRONMENT TO MONITOR PARTICLE ACCELERATOR

▶ KONTRON TECHNOLOGY OPENS NEW DOORS FOR COMPACT, EFFICIENT AND RELIABILITY-CRITICAL SOLUTIONS

CERN, THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH, IN GENEVA WAS LOOKING FOR SMART NODE POINTS TO VIRTUALIZE THE SERVERS USED TO MONITOR ONE OF THE EXPERIMENTS IN THE PARTICLE ACCELERATOR. THE SOLUTION: SLIM 1U RACK SYSTEMS, EACH WITH FOUR PROCESSOR MODULES THAT NOW ENSURE THAT THE DATA PROCESSING IS ESPECIALLY EFFICIENT AND FAIL-SAFE.



// DIAGRAM: THE LHCB DETECTOR COPYRIGHT CERN

LHCB IS ONE OF FOUR EXPERIMENTS BEING CONDUCTED WITH THE LARGE HADRON COLLIDER (LHC), BETTER KNOWN AS A PARTICLE ACCELERATOR.

The experiment is investigating the small differences between matter and antimatter in order to explore the question of why our universe is primarily composed of matter and not antimatter. These experiments, which are scheduled to run until at least 2018, use a 4,500-tonne detector system with around 1 million sensors. These sensors register the various particles that result from the collision of protons travelling nearly at the speed of light in the roughly 27-km long circular accelerator. The detector system comprises a number of subdetectors, each of which specializes in measuring various parameters such as trajectories or energy levels. With 2,000 events per second, a substantial 250 GB of data are created each hour.

CONTENT

THE GLOBAL LEADER AND STANDARD INITIATOR, KONTRON, WAS SELECTED FROM AMONG THE COM EXPRESS MANUFACTURERS AVAILABLE ON THE MARKET. THE DECISION WAS BASED ON ITS OUTSTANDING MARKET POSITION, AS WELL AS ON THE WELL-ENGINEERED PRODUCT RANGE.

THE DETECTION SYSTEM

The sensors in the detector electronics guide these data via fiber optic cables to modular computer systems which pre-process the experiment's data. Each system has its own job and processes up to 38 gigabits of raw data per second. It then sends these data to a data recording system via 4 GbE links. The detection system's computer systems actually use a total bandwidth of around 50–60 gigabytes per second, and these data form the basis for the experiment's analysis and results. These systems are executed in around 100 VME and 400 ELMB (Embedded Local Monitor Board) systems.

THE CONDITION MONITORING SYSTEM

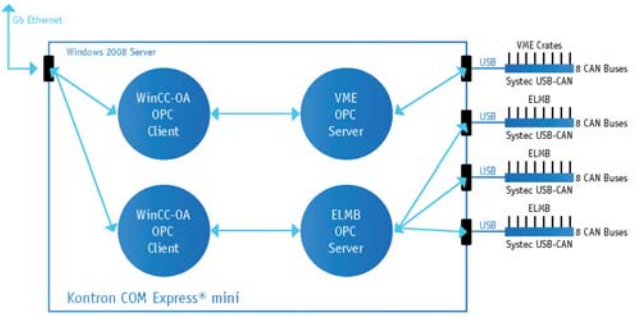
In order to ensure constant availability of the extremely complex detection system with its 1 million sensors during the no less complex experiments, it is monitored by its own control system. This system works to guarantee that all elements in the detection system are in the specified state in order to ensure that the expensive experiments are not carried out in vain. The control system also makes it possible to carry out actions, such as switching the system on and off, setting the output voltages, setting the limits for output currents, and changing the systems' fan speed. The VME and ELMB systems are monitored according to a simple principle: As long as no anomaly is detected during the component monitoring, all necessary parameterizations of the state of the electronics are handled automatically. The only time that a staff member has to intervene and remedy an error is when the continuous component monitoring detects an anomaly in the system.

Integrated in each computer in the detection system is a CAN slave that represents the networked monitoring system's local monitoring entity. In the past, these slaves were monitored and controlled via monitoring servers with a direct connection (via USB) to a CAN master.

THE VIRTUALIZATION

"These monitoring servers are now to be replaced because of their age," explains Beat Jost, project leader. "We have chosen a virtualization solution as the replacement in order to optimize our server infrastructure's resource utilization and increase the capacities for the experiment." Previously a complete WinCC SCADA software system was implemented on the distributed 1U servers and the software was accessed from the control system. Then the servers were virtualized on a central system.

Now all monitoring functions are administered on this system. In addition to virtualization's general benefits such as energy efficiency and increased availability, it also facilitates a flexible hardware design. The virtual machines furthermore can be more flexibly adapted to the particular application. As a result, when the researchers make further unexpected discoveries, they can examine an ever broader range of processes by simply using virtualization to expand the server capacity. Because all communication runs over Ethernet at the control system's upper levels, the virtualization of the corresponding computers also makes it possible to replace a defective computer without direct hardware intervention.



// DIAGRAM: KONTRON ACCORDING TO CERN SOURCE

THE SMART NODE POINTS

At the point at which the distributed servers used to stand, now smart node points are at work ensuring the transfer of the condition monitoring data between the detection system's distributed computer systems and the central, virtualized condition monitoring servers. The node points offer x86 intelligence for this job and host an integrated ELMB-OPC server, each of which can handle three ELMB systems connected via CAN and an OPC server for the VME systems, which are likewise connected via CAN. In addition, a Win-CC OPC client accesses this OPC server in order then to provide monitoring data to the central virtualized servers. The new smart node points that are now in use are consequently primarily responsible for driving the CAN master to the field and for communicating with the central virtual servers via Ethernet.

THE SYSTEM STRUCTURE

In order to achieve the high availability, low-power system with the greatest possible density as specified by the head of the experiment, an individual system was developed that contains four sub-systems. A 19-inch 1U system holds four independent carrier boards with four computer-on-modules so that a 4-in-1 system results. The four sub-systems have GPIO which allows them to reset one another. This increases the system installation's availability and reliability. In addition, maintenance work at the site is reduced – and this is essential given the distances in the distributed CERN infrastructure.

The design with four full-fledged computer sub-systems in a single 1U system chassis is also extremely space-saving. All external interfaces, such as 6 USBs, 1 GbE and 1 DVI per sub-system, are integrated onto the carrier board and consequently executed without cables. The carrier boards used in the overall system were designed specifically for this customer requirement. They are connected to the systems of the detection system via external USB-to-CAN converters. Up to 32 CAN buses can be connected to one 4-in-1 system via these converters. And in turn up to 64 slave modules can be addressed via one CAN bus. This means that each 4-in-1 system can be used to administer up to 2048 slaves. Currently between 10 and 20 CAN buses are attached per 4-in-1 system so that with a view to the experiment's long lifespan, there is still sufficient capacity for extensive expansion of the entire CERN installation.

THE MODULE STANDARD

The COM Express® Standard was chosen from among the various module specifications available on the market. On the one hand, COM Express® is the leading standard for computer-on-modules around the world and it therefore enjoys particularly broad manufacturer support. On the other hand, this standard also offers COM Express® mini, a very compact, credit-card-sized form factor that ideally fits the compact system design that CERN requires. Because modules that comply with the COM Express® interface specifications are easily interchangeable and carrier board designs and development experience can consequently be repeatedly used, COM Express® ensures a highly sustainable design that also conserves resources and cuts costs.

CERN IS MORE THAN SATISFIED WITH THE RESULTING INNOVATIVE SOLUTION. BEAT JOST SAYS APPROVINGLY: "THE FIRST DEMONSTRATION OF THE SMART NODE POINT WAS ALREADY SO AMAZING THAT THIS VERY SYSTEM IS NOW GOING INTO PRODUCTION. WE ARE VERY SATISFIED."

THE APPLICATION PROGRAMMING INTERFACE

The global leader and standard initiator, Kontron, was selected from among the COM Express manufacturers available on the market. The decision was based on its outstanding market position, as well as on the well-engineered product range. Kontron offers COMs with KEAPI (Kontron Embedded Application Programming Interface), cross-platform middleware that significantly simplifies the access and control of hardware resources in embedded applications. Application developers can use an extensive library of polished API functions that provide hardware information on all new Kontron embedded platforms. For example, KEAPIs offer pre-integrated APIs with which the COMs can reset one another via I^2C. If developers use these APIs, there is no need for complex reprogramming of the application in order to adjust to the different APIs of the deployed components when the module is replaced. KEAPI consequently naturally also accelerates new designs and platform integration and reduces the amount of work during validation and verification. KEAPI also offers valuable functionalities for remote control and remote monitoring, which simplifies maintenance and reduces the total cost of ownership.

THE PEOPLE BEHIND THE SOLUTION

In addition to selecting the right technologies and hardware platforms, working with the right experts is also at least as important for CERN. Development and production were carried out by Robert Brunner from Brunner Elektronik AG in Hittnau, Switzerland, which specializes in the area of CAN technology, working in cooperation with Walter Weber, Sales & Marketing Manager Embedded Computing from Swiss Kontron sales partner Ineltro with headquarters in Regensdorf.

KONTRON'S PORTFOLIO OF CREDIT-CARD-SIZED COM EXPRESS MINI MODULES WAS RECENTLY EXPANDED WITH A VERY HIGH PERFORMANCE GROUP:

The new Kontron COMe-mBT10 COM Express® mini computer-on-module family (55 mm x 84 mm) with Pin-Out Type 10 is equipped with Intel® Atom™ processors from the E3800 family or Intel® Celeron® processors from the N2900 and J1900 families. Seven module versions offer broad scalability, from the low-power single-core Intel® Atom™ processor (1.46 GHz/5 W TDP) for energy-sensitive applications all the way to real Quad-Core performance for high-end applications with Intel® Atom™ processors (4 1.91 GHz/10 W TDP) and Intel® Celeron® processors (4 2.42 GHz/10 W TDP). And although all modules with Intel® Atom™ E3800 processors are designed for the extended temperature range from -40 °C to +85° C, they offer a comprehensive feature set including PCIe expansion options, new security functions and optional ECC memory.

In the system solution that Brunner Elektronik AG and Ineltro developed together, four sub-systems based on COM Express mini computer-on-modules are packaged in a single 1U system and networked to achieve maximum failure safety, system stability, and performance.

// SOURCE FOR SYSTEMS PICTURES:
BRUNNER ELEKTRONIK AG, WWW.BEH.CH

SOURCES:

http://lhcb-public.web.cern.ch/lhcb-public/
http://www.weltmaschine.de/news/16112011/ (first results)
https://ph-collectif-lecc-workshops.web.cern.ch/ph-collectif-lecc-workshops/LEB01_Book/daqdcs/hallgren.pdf

About Kontron

Kontron, a global leader in embedded computing technology and trusted advisor in IoT, works closely with its customers, allowing them to focus on their core competencies by offering a complete and integrated portfolio of hardware, software and services designed to help them make the most of their applications.

With a significant percentage of employees in research and development, Kontron creates many of the standards that drive the world's embedded computing platforms; bringing to life numerous technologies and applications that touch millions of lives. The result is an accelerated time-to-market, reduced total-cost-of-ownership, product longevity and the best possible overall application with leading-edge, highest reliability embedded technology.

Kontron is a listed company. Its shares are traded in the Prime Standard segment of the Frankfurt Stock Exchange and on other exchanges under the symbol "KBC". For more information, please visit: **www.kontron.com**

CORPORATE OFFICES

EUROPE, MIDDLE EAST & AFRICA

Lise-Meitner-Str. 3-5
86156 Augsburg
Germany
Tel.: +49 821 4086-0
Fax: +49 821 4086-111
info@kontron.com

NORTH AMERICA

14118 Stowe Drive
Poway, CA 92064-7147
USA
Tel.: +1 888 294 4558
Fax: +1 858 677 0898
info@us.kontron.com

ASIA PACIFIC

1~2F, 10 Building, No. 8 Liangshuihe 2nd Street,
Economical & Techonological Development Zone,
Beijing, 100176, P.R. China
Tel.: +86 10 63751188
Fax: +86 10 83682438
info@kontron.cn