



IMPORTANCE OF COMPUTING HEALTH MANAGEMENT

POWER OF DATA DRIVEN TRANSPORTATION

- ▶ THE INTELLIGENCE NEEDED TO MAXIMIZE LONG-TERM RELIABILITY,
MANAGE COSTS AND ENHANCE CUSTOMER SATISFACTION



IMPORTANCE OF COMPUTING HEALTH MANAGEMENT IN TRANSPORTATION SYSTEMS. THE INTELLIGENCE NEEDED TO MAXIMIZE LONG-TERM RELIABILITY, MANAGE COSTS AND ENHANCE CUSTOMER SATISFACTION.



// TRACe B304-TR

The market for transportation systems is forecasted to continue its rapid expansion according to a report by Transparency Market Research that predicts double-digit growth from 2013 to reach \$30.2 billion by 2019. As the use of transportation systems expands to monitor, control and provide a diverse set of operator and passenger capabilities, OEMs must integrate more advanced computing technologies to keep up with growing expectations and next-generation requirements. But providing the latest technologies is only part of the requirements list for this critical arena; computing platforms must also enable design flexibility and deliver long-term availability and value. That is because railway applications are now required to support broad and varied needs from rolling stock and fleet management to video surveillance, Internet for passengers and ticketing or conductor/driver information. In addition, platform reliability must be at the highest level to ensure maximum uptime availability, safety and security and comply with ISO9001, EN50155 and SIL4 standards and possess IRIS and UNIFE certifications.

This shows that railway operations are highly dependent on the status of the computer systems in the field as well as online information that allows real-time access about operational events. Large rolling stock fleets are typically spread over thousands of kilometers of railway operations, which can make remote system status access difficult. A major game-changing innovation that delivers the advanced intelligence needed to cost-effectively manage and monitor system operations are new integrated computing platform health management technologies. Health management capabilities provide the resource allowing system operators to go from simply reactive to positively proactive in managing application functionality and uptime. Significant efficiencies and benefits from remote monitoring, fleet availability, serviceability and anticipated maintenance can be achieved now that were not available previously.

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HEALTH MANAGEMENT CAPABILITIES ARE AN IMPORTANT NEW RESOURCE ALLOWING OPERATORS TO VERIFY VITAL SYSTEM STATUS.

IMPORTANCE OF SYSTEM HEALTH MANAGEMENT

Health management is a relatively new term in transportation system operations. Within embedded computing platforms, health management technologies deliver the ability to verify systems' integrity and operational capacity to perform as specified. The health management information provided needs to be precise when relating the computer's vital status of critical and major resources. In case of loss or defect of one of these resources, it is important that any malfunction be detected, logged and reported so distant operators can remotely access critical status data in order to make actionable decisions. Furthermore, uptime and customer satisfaction can be better managed from essential system resources such as power supply signals, temperature probes, watchdog counter, heart beat signals and major system components that include the main processor, memory subsystem, or interfaces.

To meet the demands of ensuring safety and reliability while reducing maintenance and operations costs, Kontron developed its modular TRACe™ transportation computer system portfolio that features integrated health management capabilities. TRACe allows online access to comprehensive information on the status of each unit giving operators an innovative resource to control the real reliability and effectiveness of the whole installed base.

Health management functionality is uniquely achieved via the TRACe systems' dedicated Health Management Unit (HMU) microcontroller, which is independent from the main processor. This allows separate firmware execution from the operational application running on the main processor, and makes health management autonomous even in the case the main processor stalls or stops. Watchdog counters are also available in TRACe as the ultimate detectors if both the main processor and the health microcontroller have stopped working.

Railways EN15055 certified, the entire TRACe modular transportation system line features leading-edge computer technology such as Intel® processors, multiple memory and storage devices, a large number of supported I/Os including two Gigabit Ethernet links, and three mini-PCI express modules. The TRACe family also offers a comprehensive list of modular and flexible features that adapt easily to various rolling stock requirements.

Customer Benefits

When monitoring a large number of TRACe systems disseminated in rolling stock fleets spread across great distances, it is very important to have real-time status information on each unit and to verify availability. TRACe systems allow this live access to determine which units are failing, have failed or may be showing abnormal behavior. As operators and service providers well know, failures in the field can be extremely costly; not to mention how the failure can affect passenger service disruptions and satisfaction.

Train operators are able to remotely download detailed information logged into TRACe's local permanent memory. What's more, TRACe logs all the health history of past events giving operators online Internet or offline accessibility to the reliability data of every one of the systems in the field.

Health management brings a major value to support current applications and opens a broad new range of application support that includes:

- ▶ Spare-part logistics management
- ▶ Fleet management allowing localization of failed equipment
- ▶ High availability management
- ▶ Preventive maintenance to increase the availability of the fleet
- ▶ Field service support
- ▶ Reliability analysis
- ▶ Acceptance field testing

Depending on user requirements, TRACe can be programmed to self-reboot or self-reset when a major issue is detected. Even power-on/off management is a selectable option from health management. Full manageability is now possible thanks to these user selectable options. Customers benefit from an innovative solution that allows them to control the real reliability and effectiveness of their entire installed base.

VITAL FUNCTIONAL SUPPORT

Health management supports three main functions: monitoring, control and communication. TRACe leverages the advantages of intelligent connected devices that make up the Internet of Things (IoT) regardless if they are Internet, cloud based or restricted to private Intranet. Implementing health management functions on the TRACe family involves verification and tests during power-on, OS boot and application boot in subsequent sequences.

Monitoring

The monitoring of TRACe is performed at two levels. First, at each power-on, a comprehensive self-test verifies the system is functioning at its required level. Then, it continuously monitors vital signals while the system is functioning.

- ▶ Power-On self-tests check the basic functions of TRACe: Processor, memory sub-system, main interfaces and I/Os. The self-test result provides a generic system status:
 - OK,
 - OK with partial restrictions described in the detailed status,
 - KO, with failure status
- ▶ Permanent monitoring of Vital/Critical signals: Voltages, Current, Temperature (processor, PSU, thermal sensors, etc), and the "heart-beat" signals (PCIe buses, clocks, etc.) If the value of these signals is not within a defined range, the on-line monitoring will record the value and generate an event:
- ▶ Watchdog: An independent time counter is available with TRACe. The application can program a duration (for example 10 seconds), and if the application does not reset the countdown, the watchdog time will trigger. This can be used as the ultimate detection of any frozen/stalled status, so as to reset the system.

Control

TRACe's control functionality exploits the monitoring results enabling users to take relevant actions depending on pre-defined strategies relative to the user-case or mission profile.

- ▶ Boot management: depends on power-on self-test status
 - OK: boot OS and application.
 - OK with partial restrictions: depending on failure status, boot OS & application with disabled functions, or reduced performances, depending on application profiles.
 - KO: stop, or restart self-test for double-check (a defined number of self-test restarts can be allowed)
- ▶ Permanent monitoring management: depends on vital /critical signal values
 - Either will record the value out of limit, date and time, with a red flag, accessible to application,
 - Or will trigger a reset, or a new power-off/power-on and a reboot
- ▶ Log all boot/reboot events and status with historical records in the system permanent memory

Communication

Data, status or events logged into the permanent memory of TRACe are available for analysis, either locally or remotely through the Internet TCP/IP and SNMP via OS and/or from the HMI. External network communications are all using secured protocols in order to protect the health management system from intrusions. In addition, MQTT (light weight communications) and TR069 will be made available to complement the interoperability. The user can easily employ these communication layers to access important information and interface it to the application or any web service middleware. Depending upon the application, the emergence of IoT helps enable every mobile device to be connected to the Cloud. Therefore, any transportation system or web service can take advantage of TRACe health management provided to track, monitor, control and engage actions with devices such as palmtops, tablets, laptops, or any other type of connected device. Combining health management capabilities with IoT truly offer the successful building blocks that make up the intelligent future of fleet management.

Health Management KEAPI

Kontron Embedded Application Programming Interface (KEAPI) is adapted to accommodate Health Management primitives so as to give a stable user interface that middlewares or applications can take advantage of. KEAPI neutralizes hardware potential evolutions and allows the software developers to capitalize on their solutions (like fleet management, logistics management, etc.).

KEAPI

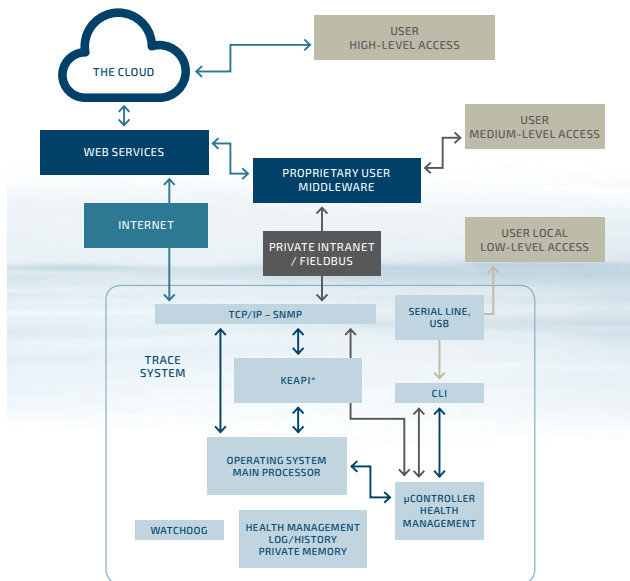
KEAPI is a standard fully supported and maintained by Kontron over a number of various platforms and the health management flavour of KEAPI will be as well supported over the full TRACe family range and its future versions.

CONTROLLED HEALTH MANAGEMENT ACCESSIBILITY

TRACe allows health management monitoring, control and communication layer accessibility based on various levels defined by the user's application.

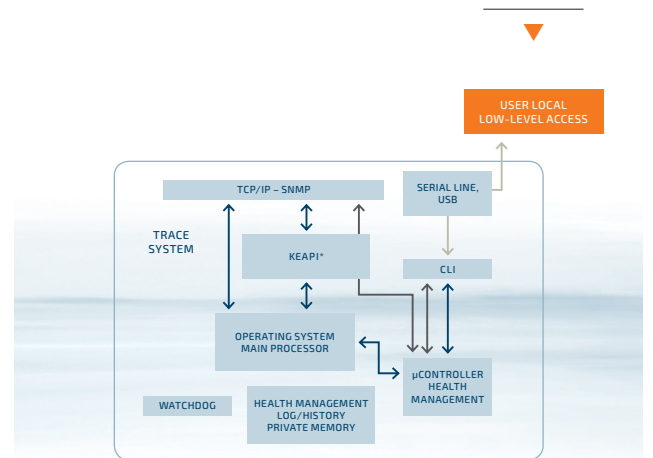
Delivering three levels of low, mid and high-level access, the TRACe family supports extremely flexible interoperability and user requirements. This flexible structure of interaction is designed to serve as many application profiles as possible.

Low-Level Access



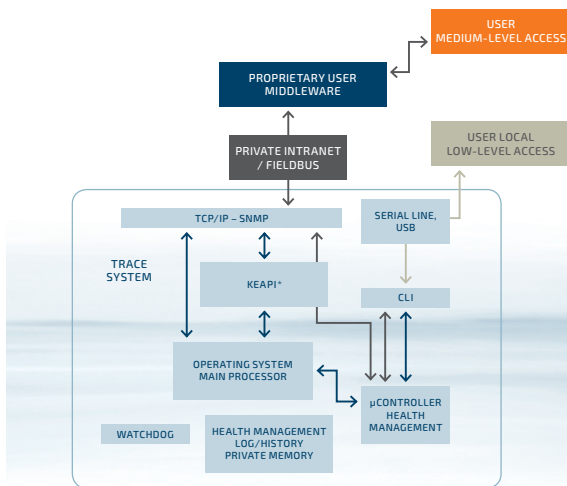
* KEAPI - Kontron Embedded Application Portable Interface

// THE TRACe FAMILY SUPPORTS MULTIPLE LAYERS OF ACCESSIBILITY BASED ON THE NEEDS DEFINED BY THE USER'S APPLICATION



Helping to facilitate installation, verification, test, troubleshooting, maintenance and servicing, the TRACe system enables low-level access from the HMU firmware or the OS. This level of access is provided using the Command Line Interface (CLI) out of TRACe's local I/O (USB or serial lines) and gives direct visibility to hardware resources such as control of internals of the system, registers, counters, event logs and sensors.

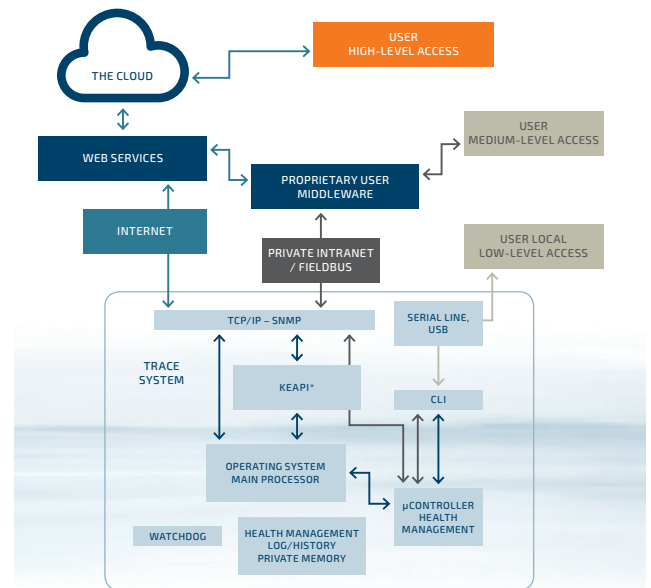
Mid-Level Access



Mid-level access allows users to review status data such as a temperature of the processor or number of failures in the past month, and permits a list of valuable actions to be engaged remotely like reboot, reset, or even power-off/on. TRACe's middleware remotely interact with the Health Management Application Portable Interface (API), which is a set of commands that offers a level of abstraction regarding the hardware topology. The user no longer needs to know the precise physical implementation of TRACe to obtain access to functional information.

For example, fleet management can be monitored with the TRACe API through the Internet or an intranet with private network topology and dedicated user middleware.

High-Level Access



Complex fleet management can be achieved with high-level health management access that allows the user to immediately manage the field database after having set-up its operational parameters, fleet description, geographical distribution, logistic requirements and cost analysis statistics. Based on web service middleware, this access level provides an advanced framework environment that is both application and solution oriented. Web-services are now provided by many suppliers that offer options connected to the Cloud that increase interoperability with multiple applications.

Plus, a powerful combination of all access levels is supported by TRACe. Operators can select that some functions be managed locally, certain functions can be handled through a private Internet and other services supported by web services – all in their control.

A POWERFUL TOOL

The health management capabilities provided by the TRACe family gives transportation system developers and operators a powerful tool to support the varied systems in field operations. Employing TRACe health management gives users a broad range of vital real-time information that enables comprehensive monitoring and control of reliability, availability and serviceability thereby dramatically reducing operational costs over the lifetime of the system. Ease of use is also ensured either from private intranet or the web, virtually from any connected IoT device. TRACe health management capabilities are based on the Kontron KEAPI, which provides hardware access via an easy-to-use, single API. Health management is instrumental in optimizing logistics, inventory and spare-parts management. Likewise, management of contractual and program obligations in terms of long term support and maintenance are streamlined through the ability to build comprehensive databases on the operational life of the fleet.

Helping the bottom line for transportation system operators, the unique autonomous health management capabilities of Kontron's TRACe™ computer family helps ensure safety and reliability while helping manage maintenance and other critical operations. Whether for railways rolling stock or in-vehicle computers, Kontron is committed to innovating smart solutions, leveraging its proven rugged computing, communications and breakthroughs that advance the IoT experience. Kontron knows that to achieve IoT success requires the development of true end-to-end solutions that enable operators to reduce costs while enhancing their revenue streams.

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



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