

How is the Concept of Diagnostics used outside the Automotive Industry?

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2 Introduction

This document aims to outline how the “Diagnostics” concept used in the vehicle industry relates to similar concepts in other industries.

It also aims to describe the work of standard bodies related to the subject, and list some of the exhibitions that might be interesting.

3 Diagnostics

This section aims to outline what the vehicle industry regard as Diagnostics, the general view in other industries of Diagnostics, and the differences between the definitions.

3.1 Vehicle Industry Definition

We define Diagnostics as the management of the properties of computer-based products. It involves:

- fault tracing
- software download
- configuration
- data readings
- verification

3.2 General Definition of Diagnostics

Internet-usage of Diagnostics:

- Search for “diagnostik” (Swedish pages): 284.000 hits. Area: medical (except for network surveillance).
- Search for “digital diagnostik” (Swedish pages): 52.400 hits. Area: medical (except for network surveillance).
- Search for “remote diagnostik” (Swedish pages): 52.400 hits. Area: mainly medical, but also some hits referring to operations of different kinds of equipment and units.

Conclusion: Diagnostics is commonly used as to denote fault management.

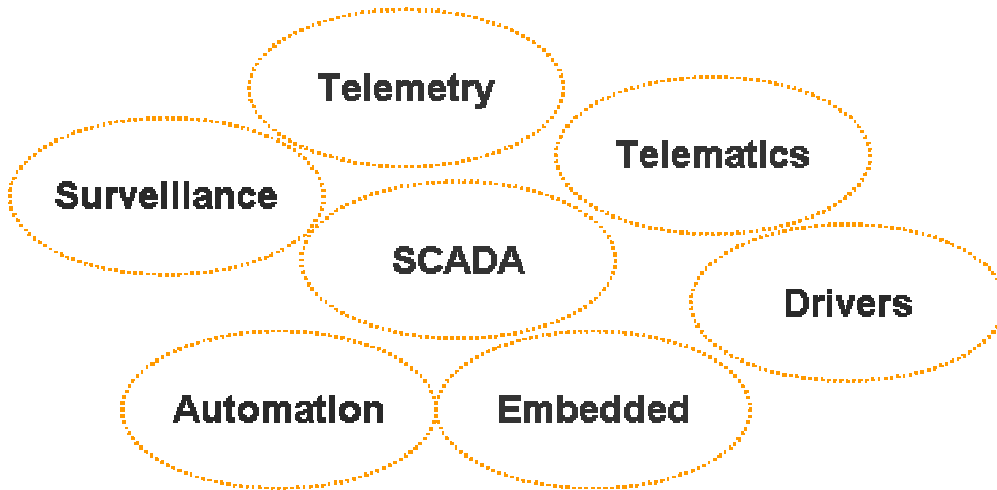
3.3 Gap analysis

While Diagnostics in the vehicle industry embraces Fault Management, Software Download, Configuration, Data readings, and Verification, the common notation of what Diagnostics is more restricted – it refers to the process of ensuring that the unit of interest is maintained in a healthy state.

The following section will elaborate on some concepts that are more close to Diagnostics as defined by the Vehicle industry.

4 The Related Concepts

The following pictures outlines some concepts that are related to Diagnostics as defined by the vehicle industry:



Each concept will be described / defined below, together with company offerings serving as example of vendors and their customers. The examples aim to provide insight into how the system suppliers formulates their offerings in the business.

4.1 Telemetry

4.1.1 Definition

Definitions found on the Internet include:

- The transmission of data collected at a remote location over communications channels to a central station.
- A control station regarding the health and well being of a device, such as a satellite in orbit.
- A computer-based means of monitoring and communicating with remote sites.
- Automatic transmission and measurement of data from remote sources by wire or radio or other means.
- Telemetry is a technology which allows the remote measurement and reporting of information of interest to the system designer or operator.
- A way of transmitting data electronically from a moving object to a stationary central location. For example, the transmission of engine and other data from the racing car by secure, coded radio links to computers situated in the pits.
- An electronic device which transmits specific data (measurements) to a remote site. It electronically records performance of engine and actuation of controls by the driver. The data is then used as a foundation for determining car setup.
- A system of remote monitoring, and in some cases controlling, outstations comprising pumping stations or sewage treatment systems from a central control point. The transmitting of information between locations may be carried out via a radio system or land lines. Sometimes referred to as a SCADA system.

Conclusion: the concept Telemetry is closely related to Diagnostics as used in the vehicle industry. However, Software Download is not taken into consideration, and there is some emphasis on Remote.

4.1.2 Telemetry and SonyEricsson

For SonyEricsson, Telemetry and M2M is the same thing. They claim that “You can depend on M2M's devices and terminals to deliver high speed data communication, globally. They require minimal modification to integrate with your existing systems and applications, providing optimized, cost-effective business, commercial and industrial solutions.” and “Make information work for you. M2M wireless applications - facilitated by reliable communications - take the legwork out of data management. Remotely collect service and maintenance information, update public information displays and more - easily, reliably, wirelessly.”

SonyEricsson offers:

GSM/GPRS Terminals – dual band, self-contained terminals providing M2M wireless communications links to fixed and mobile applications. Products: GT47/GT48 and GM28/GM29.

GSM/GPRS Radio Devices - quad band, powerful processor, highly compact and slimline designs providing M2M wireless communications links to fixed and mobile applications. products: GR47, GR48, GR64, GS64, and GM47/GM48.

EDGE Radio Devices - quad band, powerful processor, compact and slimline design providing M2M wireless communications links to fixed and mobile applications.

SonyEricsson lists a number of application domains where their Telemetry products might be useful:

- Emergency services (read what Accenture says about this at http://www.accenture.com/Global/Services/Accenture_Technology_Labs/R_and_I/IndustryIndustries.htm)
- Healthcare (see case study at <http://www.plextek.com/brochure/millen.pdf>)
- Metering and monitoring (see case study at http://www.pwr.com/solutions/case_studies/lexisnexis/)
- Power and energy (see case study at http://www.pwr.com/solutions/case_studies/dte_energy/)
- Public traffic systems (see case study at <http://www.radiodata.co.uk/Applications/rdt-m60monitor.htm>)
- Public information displays
- Security and surveillance
- Vending and retail (read more at the e-magazine Vending Times <http://www.vendingtimes.com/>)

For the Automotive / Fleet domain, Sony Ericsson says that “If it moves, it's measurable and traceable. M2M offers dependable wireless solutions that monitor and manage single vehicles or large fleets. Whether you need to plan logistics and manage cargo, or keep your car secure, M2M keeps you in control.” The SonyEricsson Automotive applications include Driver navigation, Safety, Vehicle diagnostics, Car security, Mobility services and Traffic information. They state that “Wireless communications devices that are integrated into already complex vehicular systems must be highly reliable. They also need to address the need for future system growth and scope for upgrades. Sony Ericsson works closely with auto makers and the telematics value network— system designers, content providers, hardware and software manufacturers, application developers, service integrators, and network operators - to ensure that both backward and forward compatibility as chip sets become obsolete.” Sony Ericsson has developed a suite of GSM and CDMA rugged modules specifically for use in automotive telematics applications.

4.2 Telematics

Definitions found on the Internet include:

- The collection and monitoring of vehicle diagnostics such as oil pressure, braking, hours of operation and engine temperature.
- A wireless communications system designed for the collection and dissemination of information, particularly refers to vehicle-based electronic systems, vehicle tracking and positioning, on-line vehicle navigation and information systems and emergency assistance.
- The convergence of computing and communications technologies, thus the use of telephone or radio to link computers and the use of computers to send messages via telephone or radio links.
- The integration of wireless communications, vehicle monitoring systems and location devices.
- The use of computer-based information processing in telecommunications and the use of telecommunications to allow computers to transfer programs and data to one another.
- The use of telecommunication in conjunction with informatics, e.g. the passing of information from one computer to another via a telephone line or other electronic link. The basic promises of telematics are obvious: by giving access to any form of knowledge anywhere, it speeds up the diffusion of information, saves time, increases collaboration between individuals and groups, and improves the quality of decisions.

Conclusion: the concept Telematics is closely related to Diagnostics as defined by us.

4.2.1 Telematics and SonyEricsson

For the Automotive / Telematics application domain, SonyEricsson says “Telematics is a rapidly growing automotive technology business. Automobiles are evolving into mobile information systems that can react to events instantaneously and guarantee continuous connection via wireless communication devices. To remain competitive, automobile manufacturers must add more functionality to the already impressive range of features currently provided in the modern car, in order to meet the ever-changing expectations of discerning customers.”

The expected customers of SonyEricsson's offerings can be found primarily amongst the automotive vendors.

4.3 SCADA

4.3.1 Definition

Definitions found on the Internet include:

- *System Control and Data Acquisition / Supervisory Control and Data Acquisition / Security, Control and Data Acquisition*
- *A common process control application that collects data from sensors in remote locations and sends them to a central computer for management and control.*
- *A generic architecture for industrial monitoring and control systems, especially those with widely separated stations.*
- *Systems that are based on a central processor which receives information from sensors, determines the control requirements and sends commands to control actuators.*
- *Software systems and algorithms used to provide real-time instructions to plant automation equipment such as PLCs.*
- *A category of software application program for process control, the gathering of data in real time from remote locations in order to control equipment and conditions. SCADA systems include hardware and software components. The hardware gathers and feeds data into a computer that has SCADA software installed. The computer then processes this data and presents it in a timely manner.*
- *... used in industrial and civil engineering applications to control distributed systems from a master location. SCADA is a very broad umbrella that describes solutions across a large variety of industries, including but not limited to Electric power generation, Transmission and distribution, Environmental control systems, Traffic signals, Water management systems, Mass transit systems, Manufacturing systems ...*

Conclusion: the concept SCADA is closely related to Diagnostics as defined by us.

4.3.2 The concept

SCADA systems typically implement a distributed database which contains data called *points*. A point represents a single input or output value monitored or controlled by the system. Points can be either "hard" or "soft". A hard point is representative of an actual input or output connected to the system, while a soft point represents the result of logic and math operations applied to other hard and soft points.

The Host computers allow for "supervisory level" control of the remote site. The bulk of the site control is actually performed automatically by RTUs. Host control functions are almost always restricted to basic site over-ride or supervisory level capability. Data acquisition begins at the RTU level and includes meter readings and equipment statuses that are communicated to the SCADA as required. Data is then compiled and formatted in such a way that a control room operator using the SCADA can make appropriate supervisory decisions that may be required to over-ride normal RTU controls.

Solutions sold as SCADA also often have Distributed Control System components. Use of "smart" RTUs or PLCs, which are capable of autonomously executing simple logic processes without involving the master computer, is increasing. A functional block programming language, IEC 61131-3, is frequently used to create programs which run on these RTUs and PLCs.

The three system components of a SCADA system are:

- Multiple Remote Terminal Units (also known as RTUs or Outstations)
- Central Control Room with Host Computer(s)
- Communication Infrastructure

The Remote Terminal Unit (RTU) connects to physical equipment such as switches, pumps and other devices, and monitors and controls these devices.

An important part of most SCADA implementations are alarms. Alarms can be created in such a way that when their requirements are met, they are activated. The SCADA operator's attention is drawn to the part of the system requiring attention by the alarm. Emails and text messages are often sent along with an alarm activation alerting managers along with the SCADA operator.

SCADA systems have traditionally used combinations of radio and direct serial or modem connections to meet communication requirements (although Ethernet and IP is also frequently used at large sites such as railways and power stations). This has also come under threat with some customers wanting SCADA data to travel over their pre-established corporate networks, or to share the network with other applications. The legacy of the early low-bandwidth protocols remains, though. SCADA protocols are designed to be very compact and many are designed to send information to the master station only when the master station polls the RTU.

Current standard SCADA protocols include Modbus, Conitel, DNP3, IEC 60870-5-101 and RP-570. Many of these protocols now contain extensions to operate over TCP/IP, although it is good security engineering practice to avoid connecting SCADA systems to the Internet so the attack surface is reduced.

SCADA usually presents the information in the form of a mimic. This means that the operator can see a representation of the plant being controlled. For example, a picture of a pump connected to a pipe can show the operator that the pump is running, and how much fluid it is pumping through the pipe at the moment. The operator can then switch the pump off. The flow rate of the fluid in the pipe decrease is shown in real time.

The HMI package for the SCADA system typically includes a drawing program which the operators or system maintenance personnel use to change the way these points are represented in the interface. These representations can be as simple as an on-screen traffic light which represents the state of an actual traffic light in the field, or as complex as a multi-projector display representing the position of all of the elevators in a skyscraper or all of the trains on a railway.

Instead of relying on operator intervention, or master station automation, RTUs may now be required to operate on their own to control tunnel fires or perform other safety-related tasks. The master station software is required to do more analysis of data before presenting it to operators including historical analysis and analysis associated with particular industry requirements. Safety requirements are now being applied to the system as a whole, and even master station software must meet stringent safety standards for some markets.

Hardware for SCADA systems is generally rugged to withstand temperature, vibration, and voltage extremes, but in these installations reliability is enhanced by having redundant hardware and communications channels. A failing part can be quickly identified and its functionally automatically taken over by backup hardware.

In the mid 1990's, the manufacturers offered their own proprietary communications protocols over a suitable-distance carrier like RS-485. Towards the late 1990's, the shift towards open communications continued with manufacturers offering support of open message structures like Modicon MODBUS over RS-485, and by 2000 most I/O makers offered completely open interfacing such as Modicon MODBUS over TCP/IP.

The primary barriers of Ethernet TCP/IP's entrance into industrial automation (determinism, synchronization, protocol selection, environment suitability) are still a concern to a few extremely specialized applications, but for the vast majority of SCADA markets these barriers have been broken.

4.3.3 Vendors and Customers

SCADA System Providers include for example Axeda¹, Jumo², Sielo³ and Citect⁴.

Their customers commonly operates railways and other traffic systems, industrial plants, environmental metering systems, and utility systems such as for power generation and water management.

4.4 Automation

4.4.1 Definition

Definitions found on the Internet include:

- *The art of making processes or machines self-acting or self-moving. Also pertains to the technique of making a device, machine, process or procedure more fully automatic.*
- *The automatic, self regulating control of equipment, systems, or processes*
- *Automation is usually characterized by two major principles: (1) mechanization. i.e. machines are self-regulated so as to meet predetermined requirements (a simple example of self-regulation can be found in the operation of a thermostatically controlled furnace); (2) continuous process, i.e. production facilities are linked together, thereby integrating several separate elements of productive process into a unified whole.*

Conclusion: the concept Automation is somewhat related to Diagnostics in that it aims to regulate equipment in an automated manner.

4.4.2 Automation and National Instruments

National Instruments offers solution to “Test, Measure, and Automate your World through Virtual Instrumentation”. Some of their interesting application areas include Life Sciences, where they offer “Device testing and verification” based on the product LabVIEW for “monitoring and diagnosing real world data”. Under the heading Industrial Measurements and Control, NI “delivers an industrial measurement and control platform to provide easy-to-build, customizable, and turnkey measurement and control solutions for a wide range of industrial applications.” For Industrial Inspection purposes, LabVIEW can be used to “*reliably acquire and analyze images even in the toughest industrial environments. Develop your machine vision applications on the Compact Vision System using Vision Builder for Automated Inspection or the LabVIEW graphical development environment.*”. For Environmental Control, NI states that “*Efficiency, quick response and flexibility in storing and analyzing data are important factors in environmental control applications like HALT & HASS testing, water temperature and flow control, and air quality maintenance and purification among others.*” LabVIEW is summarized as “*the graphical development environment for creating flexible and scalable test, measurement, and control applications rapidly and at minimal cost. With LabVIEW, engineers and scientists interface with real-world signals, analyze data for meaningful information, and share results and applications.*”

¹ <http://www.axeda.com>

² <http://www.jumo.se>

³ <http://www.sielcosistemi.com>

⁴ <http://www.citect.com/>

Boeing is provided as an success case: *"Boeing is measuring the effectiveness of noise-reducing technologies for its aircraft using NI LabVIEW and PXI. A test facility is outfitted with more than 600 ground-based microphones to acquire the noise from a 777 as it flies overhead. The data is then analyzed to get an acoustical image of the airplane so that engineers can see where improvements can be made."*

4.4.3 Automation and Siemens

In their "Automation & Drivers" business, Siemens maintains a section called "Sensor, measuring and testing" with solutions such as:

- SIMATIC Sensors - *"the globally established automation system for solving the most diverse automation tasks in all sectors"*.
- Proximity Switches
- Fail-Safe Sensors
- SIMODRIVE sensor Measuring Systems - *"rotary measuring systems (encoders) for sensing the position, angle and speed or velocity on machines"*

Siemens lists the industries Chemicals, Food and Beverage, Glass, Metals & Mining, Oil & Gas, Pharmaceuticals, Pulp & Paper, Water/Waste Water, Airports and Airlines, Cranes and Marine as possible application areas.

Example cases includes that Siemens has equipped Kuala Lumpur Airport with high-speed baggage handling system, and that a Simatic controller ensures reliable control of ambient conditions for fully air-conditioned isolators from M+W Zander Products GmbH.

4.5 Embedded

Definitions found on the Internet include:

- Computer system that is an integral part of a larger system or subsystem that performs or controls a function, either in whole or in part.
- A special-purpose computer system, which is completely encapsulated by the device it controls. An embedded system has specific requirements and performs pre-defined tasks, unlike a general-purpose personal computer.

Conclusion: Embedded systems might be regarded as a component in Diagnostics as defined by us

4.5.1 Embedded and SonyEricsson

Sony Ericsson's M2mpower software provides a support environment designed to facilitate the development of wireless M2M applications. M2mpower enables system integrators to develop new applications and embed them onto Sony Ericsson's M2M products using specifically designed development tools. Current products for use with M2mpower include the GR47 / GR48 GSM Radio Devices and the GT47 / GT48 GSM Terminals (see section "Telemetry and SonyEricsson" above).

The expected customers of M2mpower software are system integrators and end-customers aiming to utilize SonyEricsson's devices and terminals.

4.6 Machine-to-machine / M2M

Definitions found on the Internet include:

- *M2M communication is the ability of machines, assets and devices to exchange information with people or companies' management systems.*
- *Communications between a device containing some amount of data and another device that requires the use of that data.*
- *M2M is commonly translated as Machine-to-Machine or Man-to-Machine.*
- *The most common implementation of M2M is through telemetry systems.*

Conclusion: the concept M2M is closely related to Diagnostics as defined by us. There is some emphasis on Remote, though.

4.6.1 M2M and Comtech

Comtech⁵ is a British company that provides extensive information on what a M2M offering can look like. Their solutions include:

Automatic Meter Reading (AMR) - GSM/GPRS modems provide simple telemetry solutions, whereby a central application polls the remote meter using protocols such as IEC 1107.

Digital Signage - Intelligent modems and routers provide remote access to digital signs. Content delivery provides telemetry solutions at the system level.

Vending Telemetry Solutions - Automatic vending refers to sales from machines, which are available to dispense a range of goods and services 24 hours a day.

Beer Monitoring - Beverage dispense equipment can be monitored through M2M telemetry including fonts, chillers, coolers, carbonators, pumps and compressors.

Remote Temperature Monitoring - System level telemetry solutions enabling OEMs and VARs to monitor temperatures at remote sites.

Field Service Automation - Enabling field service operators to enhance operations through real-time machine status.

Remote Alarm Monitoring - enabling installers and service providers to monitor alarms at remote sites.

Cold chain solutions - Transportation of chilled and frozen foods requires temperature monitoring within the cold chain. M2M telemetry solutions ensure food standards are not compromised during transit.

Wireless displays - Wireless telemetry solutions enable displays to be deployed anywhere! Electronic displays are becoming widespread to convey information.

Remote site - Remote site with no Ethernet network? Create your own network using a router to access your remote machines.

Remote access - Remote access to machines on your customers Ethernet network can be difficult. Create your own remote Ethernet network GSM/GPRS or PSTN routers.

5 Domains

Below, sections will follow that outline the use of related technologies in the following domains:

- Medical
- Telecommunication Networks

⁵ <http://www.comtechm2m.com/>

- Buildings & Facilities
- Utilities
- Construction Equipment / Rough Vehicles

Examples of other domains include Manufacturing, Transportation, Pharmaceutical, and Mining & Minerals.

5.1 Medical

There is a possible parallel to draw between the data collection part of the vehicle Diagnostics concept and the clinical health screenings made with digital equipment such as ultrasound scanners and x-rays. However, Johan Hedenfeldt, previously employed by at the Swedish medical equipment vendor Sectra, says that “Diagnostics” in the Medical industry is a process where the gathering of patient data is just one of many parts; the system support is of secondary interest.

When searching for “Diagnostics” amongst the Sectra system offerings, one finds the Medical solution called PACS. PACS is a family of solutions for digital radiology. It encompasses the PACS-Guard: *“Cost-efficient tool for critical system support - a family of products and services designed to provide a cost-effective, safe, reliable and efficient operation of medical IT systems”*. PACS-Guard utilizes proactive and remote concepts such as:

- PACS-Guard Monitoring - a monitoring tool, 24x7 remote monitoring, automatic alert escalation, proactive and reactive services, full access to statistics and history.
- PACS-Guard Assistance – secure communication and authentication from support center to customer network, real-time resolution to end user’s problems and questions, remote viewing as well as remote control of applications, quick and secure access to servers.
- PACS-Guard Administration - system administration, remote or onsite, working together to provide cost-efficient services to users.
- PACS-Guard Disaster recovery - database backups, complete mirror copy of all archived data, restore operation in 72 hours.

Solutions such as the PACS-Guard seem to be a fairly common concept related to Diagnostics – monitoring equipment together with remote tools for operations and maintenance.

While Sectra can serve as example of a medical system vendor, providers of medical care such as the Swedish Landstinget are the given utilizers.

5.2 Telecommunication Networks

Diagnostics for a Network Operator is about surveillance and monitoring their telecommunications network.

Software Download can not be regarded as part of the Diagnostics process. Updating the software of telecommunication network equipment such as switches and base stations is an extensive process that is time-consuming and critical. It has to be well planned in time, since any network down-time means severe loss in customer service accessibility.

National Instruments provides a solution for Network Diagnostics called LabVIEW (see also section "Automation and National Instruments" above): *“You can use NI LabVIEW add-ons for RF and communications test , to synthesize digital and baseband analog test signals, with channel coding, digital/analog modulation, and impairments. In addition, you can apply robust signal processing to calculate power in band, adjacent channel power, bit error rate, modulation error ratio, and many other RF / communications related measurements.”*

Ericsson’s TEMS solution is another example:

- TEMS Investigation - *TEMS Investigation is the industry-leading tool for troubleshooting, verification, optimization, and maintenance of wireless networks.*
- TEMS DeskCat - *TEMS DriveTester is a powerful solution for isolating trouble spots in a network in real time.*
- TEMS Indoor - *TEMS Indoor is a powerful hand-held tool that is designed to capture in-building measurements.*
- TEMS Pocket - *TEMS Pocket is an Ericsson mobile phone with built-in basic features for testing the digital air interface.*
- TEMS DriveTester - *TEMS Transmitter is a small and handy, but powerful, test transmitter.*
- TEMS Transmitter - *TEMS DeskCat is an advanced post-processing software tool for wireless voice and data network optimization.*

While National Instruments and Ericsson can serve as examples of network equipment system vendors, the Networks Operators constitutes the customers. In Sweden, Telia Sonera, Tele2/Comviq, Vodafone and 3 operates mobile networks, while Telia Sonera is the main provider of fixed telephony network services. Other network operators include TDC Song and Telenordia, who operates data networks for services such as Internet access.

5.3 Building & Facilities

Citect⁶ provides solutions for monitoring and controlling equipment in the Buildings & Facilities business:

”Building Automation and Facilities management software that integrates multiple networks to monitor and control security, HVAC, electrical distribution, fire detection, elevators, and related building, facility and shipboard management reporting functions. Property management companies face expanding responsibilities beyond the traditional parameters of building automaton functions. Our dedicated Facilities management software, CitectFacilities provides a specialized solution for the facilities and building automation industry, providing management and environmental control from the world leader in remote monitoring and control systems. It integrates climate, lighting and other controllable devices, in single or multiple sites, creating an enterprise-wide monitoring and control system. Citect's building automation and facilities management software can be scaled to fit any size building, complex or even a large integrated facility such as a ship. It centralizes operations across all size networks and ensures round-the-clock reliability and regulatory compliance. A library of specialized graphics makes creation of custom displays simple and shortens the development phase. CitectFacilities provides safe, cost-effective, and reliable control for an entire facility. Implemented as either a standalone environmental control system or integrated with CitectSCADA Reports, a CitectFacilities solution ensures continuous monitoring and control of facility functions such as: security and access control; HVAC: heating, chillers, ventilation, air filtration; electrical distribution and energy use; lighting; fire detection and suppression; elevators, reporting and preventive maintenance.”

While Citect can serve as an example of a system vendor in the Buildings & Facilities business, the typical customer is an owner / maintainer of properties, such as Vasakronan and the Swedish municipalities.

5.4 Utilities

Citect⁷ provides solutions for monitoring and controlling equipment in the Utilities business:

⁶ <http://www.citect.com/>

⁷ <http://www.citect.com/>

“Remote Monitoring and Control Systems for Power Distribution/Utilities & Generation - Power distribution monitoring and control systems that increase efficiency and reduce downtime for any size power generation plant and transmission network. Deregulation of electric utilities has stepped up the demand for efficiencies at every level of operation, from planning for fluctuations in demand or outages in generating capacity to changes in load across vast distribution networks spanning thousands of miles. Citect helps power generation plants through efficient power distribution monitoring and control systems, whether an industrial in-house operation or a plant operated by a public utility, to provide higher-quality service, lower costs, improved productivity and remote monitoring and control solutions. From simple boiler-based generators to large transmission lines, hundreds of Citect power projects have come on line within budget and on time. CitectSCADA can monitor, log and operate turbines, boilers, natural gas and air compressors, cooling towers, vibration monitors, switchgear, power distribution and electrical substations. Built-in redundancy at each level ensures total reliability, and its scalable global database can handle any size project - a statement that no other SCADA software can make. Citect systems and solutions provide excellent ROI by delivering improved power reliability and equipment performance. Costly maintenance on proprietary DCS control systems are eliminated, and downtime and operational expenses reduced. Transmission and power distribution networks have their own specialized requirements for monitoring power usage, substation status, handling load shedding and service restoration. CitectSCADA's high-speed data acquisition over extremely wide areas is capable of meeting these requirements. Using the Ampla suite then allows you to streamline your process - increase throughput, eliminate downtime, reduce wastage, improve quality levels, track resource genealogy and more.”

While Citect can serve as an example of a system vendor in the Utilities business, LKAB as their customer can serve as an example of an utilizer. LKAB, one of Sweden's largest electrical-energy consumers, states that Citect's SCADA software enables *“better control of our power distribution. The results are: better control over disturbances and the accessibility has increased”*. Other utilizers of systems in the Utilities domain include energy suppliers such as China Gas Company (another customer of Citect).

5.5 Construction Equipment / Rough Vehicles

CC Systems⁸ is a Swedish company that develops and delivers electronic solutions and software for machines and vehicles in harsh environments.

Examples of applications include:

- Forestry machines
- Construction equipment
- Trucks
- Marine vessels
- Industrial automation
- Railway vehicles
- Military vehicles

Under the heading “Diagnostics”, CC Systems offers systems that makes it possible to follow up on a machine's condition and performance, to plan maintenance, to perform fault detection and to make changes in the control system. CC Systems defines Diagnostics systems as *“systems that help machine manufacturer and end-user to take proper care of a machine over its lifetime, contribute to lowering the life cycle cost”*.

⁸ <http://www.cc-systems.com>

For **Industrial** applications, CC Systems provides ESAT, *“a system that is used for servicing welding and cutting machines. The diagnostics program itself is run on a laptop that connects to the welding equipment via a CAN field bus. The program makes it possible to diagnose and set different parameters in the welding equipment and thereby optimize the machine for its task. ESAB refines and improves the functionality in welding equipment through permanent further development of the software. ESAT is therefore also used to handle downloading of new software to the welding equipment.”*

For **Harbour** applications, CC Systems provides a service tool called BMS. *“The BMS- system is run on a laptop or other PC that connects to the container spreader via the serial port on one of the systems nodes. Connection is made with either a cable or wireless via a Bluetooth-module. The BMS-system makes it possible to monitor I/O-signals, set parameters, read logs and make updates of the control system application (load new software). With help from the BMS-system, fault detection is simplified and the availability of the container spreader rises. Through the use of a wireless connection via Bluetooth it is easier to access the system and faster to take the necessary measures. Instead of running the diagnostic system on a laptop it can also be integrated in the control system. This is done with the help of a so-called WEB enabler, an embedded web server with Bluetooth that is mounted on the container spreader and connected to the control system via RS232. With the help of a PDA, laptop or other equipment supplied with Bluetooth and web browser you can connect to the system to, for example, supervise or control chosen functions. The web enabler gives information about the system with the help of dynamic HTML which allows values on the page to be continuously changing. Thanks to the web enablers embedded file system, custom-made solutions for function and appearance can easily be downloaded, i.e. The customer can create adapted web pages for their diagnostics.”*

CC Systems has also provided Renova with a **Fleet Management** system. *“For the company Renova in Gothenburg we have developed an FMS-system. The system consists of the vehicle application, FMS Monitor, which logs and shows FMS-data in real-time to the driver, and the back office application FMS Admin, which is used for analyses of data in the office. FMS Admin is used by foremen, environmental coordinators or the like. It enables analyses of a respective vehicle or group of vehicles over a chosen time period. Via a number of views with diagrams you get an overview of the handling and behavior of the vehicles. This gives opportunities to monitor respective vehicles to optimize service intervals and maintenance schedules. With FMS Monitor and FMS Admin, greater opportunities are provided to fulfill the environmental demands, raise productivity, lower fuel consumption and keep the costs down compared to a suboptimal way of driving.”*

While CC Systems can serve as an example of a system vendor in this business, their customers Renova and Timberjack can serve as utilizing companies. Renova operates a fleet of garbage trucks, while Timberjack manufactures construction & forestry equipment.

6 Exhibitions

6.1 Swedish Exhibitions

6.1.1 Electronix Scandinavia (Svenska Mässan)

5-7 September 2006

Focus: "Komponenter, Elektronikproduktion, Test & Mät, Embedded".

http://nemonet.swefair.se/templates/StartPageMain____903.aspx

6.1.2 Tekniska Mässan (Älvsjö)

3-6 October 2006

The exhibition is called "Industriteknik" with the sub-exhibition "Embedded Technology".

<http://www.tekniskamassan.se/>

6.2 International Exhibitions

6.2.1 Embedded World

The embedded world Exhibition&Conference is the world's biggest exhibition of its kind and the meeting-place of the international embedded community. Embedded technologies are in action everywhere - whether in the car, data and telecommunication systems, industrial and consumer electronics, military systems or aerospace. Almost 500 exhibitors from approx. 27 countries showed the full range of products for embedded technologies in 2006: hardware, software, tools, services and lots more. Nuremberg, Germany, 13. - 15. 2. 2007

<http://www.embedded-world-2005.de/main/Page.html>

6.2.2 Embedded Systems Conference 2006

See the latest hardware, software, and development tool solutions from leading vendors in the electronics industry. Watch product demonstrations and hear about new product launches. Speak to product experts, compare products side-by-side and share experiences with your peers. Hear first-hand about tomorrow's technology today. San Jose, CA (US) 3-7 April 2006

<http://www.embedded.com/esc/sv/exhibitflr/>

6.2.3 Automotive Electronics 2006

Key Topics: Automotive Software and Systems, The Future of Road Transport, Electronic and Powertrain Control Architectures, Vehicle Highway Communications. "This conference is a key event for engineers and software developers who need a detailed understanding of the key issues in the field of automotive electronics. It will be of interest to those involved with automotive electronics, vehicle design, telematics, traffic planning, environmental policy, fleet management and law enforcement." London, UK 2006: 20-21/3

<http://conferences.iee.org/autoelec/>

6.2.4 Management Briefing Seminars 2006

"CAR maintains strong relationships with industry, government agencies, universities, research institutes, labor organizations, and other major stakeholders of the international automotive community. One way CAR enhances and strengthens those relationships is through the annual Management Briefing Seminars." Grand Traverse Resort and Spa, Traverse City, Michigan, August 7-11, 2006

<http://www.cargroup.org/conferences.html>

7 Standard Bodies

There are a number of related standard bodies:

- ISO – International Organization for Standardization
- ETSI - the European Telecommunications Standards Institute
- IEEE – the Institute of Electrical and Electronics Engineers
- SAE – Society of Automotive Engineers
- OPC – Automation Interoperability
- LIN – Local Interconnect Network
- AUTOSAR – AUTOmotive Open System ARchitecture

7.1 ISO

ISO is the world's leading developer of international standards. ISO standards specify the requirements for state-of-the-art products, services, processes, materials and systems, and for good conformity assessment, managerial and organizational practice. ISO standards are designed to be implemented worldwide.

A complete list of ISO fields is available in Appendix A – ISO Fields.

Two categories of ISO members participate in the technical work:

- **Member bodies:** A *member body* of ISO is the national body "most representative of standardization in its country". Only one such body for each country is accepted for membership of ISO. Member bodies are entitled to participate and exercise full voting rights on any technical committee and policy committee of ISO.
- **Correspondent members:** A *correspondent member* is usually an organization in a country which does not yet have a fully-developed national standards activity. Correspondent members do not take an active part in the technical and policy development work, but are entitled to be kept fully informed about the work of interest to them.

In Sweden, the Member Body is SIS, Swedish Standards Institute⁹.

7.2 ETSI

The European Telecommunications Standards Institute (ETSI) is an independent, non-profit organization, whose mission is to produce telecommunications standards for today and for the future. ETSI is officially responsible for standardization of Information and Communication Technologies within Europe. These technologies include telecommunications, broadcasting and related areas such as intelligent transportation and medical electronics. ETSI plays a major role in developing a wide range of standards and other technical documentation as Europe's contribution to world-wide ICT standardization. ETSI's prime objective is to support global harmonization by providing a forum in which all the key players can contribute actively. ETSI is officially recognized by the European Commission and the EFTA secretariat.

ETSI unites 688 members from 55 countries inside and outside Europe, including manufacturers, network operators, administrations, service providers, research bodies and users. ETSI's Members determine the Institute's work programme, allocate resources and approve its deliverables. Annual fee: 6000€.

⁹ <http://www.sis.se>

7.3 IEEE

IEEE calls itself "the world's leading professional association for the advancement of technology". Through its global membership, the IEEE is a leading authority on areas ranging from aerospace systems, computers and telecommunications to biomedical engineering, electric power and consumer electronics among others. The designated fields are, in broad terms Engineering, Computer Science and Information Technology, Physical Sciences, Biological and Medical Sciences, Mathematics, Technical Communications, and related Education, Management, Law, and Policy.

IEEE has more than 365,000 members in over 150 countries. Membership in the IEEE is open to individuals who by education or experience give evidence of competence in an IEEE designated field of interest. The applicable annual membership fee is \$130.

There are about 900 active IEEE standards and more than 400 in development.

7.4 SAE

SAE - "The premier society dedicated to advancing mobility engineering worldwide" - maintains over 8,300 technical standards and related documents. SAE is a group of nearly 80,000 engineers, business executives, educators, and students from more than 97 countries who share information and exchange ideas for advancing the engineering of mobility systems.

The topics range from Accident Reconstruction to Wiring, including:

- Communication Buses
- Communications and Controls
- Connectors/Terminals
- Control Modules and Systems
- Microprocessors / On Board Diagnostics (OBD)
- Test Equipment / Instruments
- Vehicle Electronics

A complete list of topics is available in Appendix B – SAE Topics.

The SAE members include organizations that design, manufacture, test, market, and maintain self-propelled land, sea, air, and space vehicles, their components and systems. Engineers from every technical discipline and the professionals who work closely with them improve vehicle efficiency, performance, reliability, and safety. Many SAE members are leaders in the field who serve as key resources for the engineering community.

The membership fee is \$100 for professionals and the application procedure is supported by the SAE web site¹⁰.

7.5 OPC

OPC¹¹ works for open connectivity in industrial automation and the enterprise systems that support industry. The current and emerging OPC specifications include:

1. OPC Data Access - used to move real-time data from PLCs, DCSs, and other control devices to HMIs and other display clients.
2. OPC Alarms & Events - provides alarm and event notifications (process alarms, operator actions, informational messages, and tracking/auditing messages) on demand.

¹⁰ <http://www.sae.org>

¹¹ <http://www.opcfoundation.org/>

3. OPC Batch - provides interfaces for the exchange of equipment capabilities and current operating conditions.
4. OPC Data eXchange - server-to-server communication across Ethernet fieldbus networks, adding remote configuration, diagnostic and monitoring/management services.
5. OPC Historical Data Access - provides access to data already stored.
6. OPC Security - controlling control client access to protect sensitive information and to guard against unauthorized parameter modification.
7. OPC XML-DA - provides flexible, consistent rules and formats for exposing plant floor data using XML.
8. OPC Complex Data - allows servers to expose and describe more complicated data types such as binary structures and XML documents.
9. OPC Commands - a set of interfaces that allow OPC clients and servers to identify, send and monitor control commands executing on a device.

There are about 400 members, including the Swedish organizations AF Process, Beijer Electronics, Benima, GE Healthcare Bio-Sciences, NOVOTEK, Saab Rosemount, Syntronic, TAC, Tetra Pak Carton Ambient, Vattenfall Utveckling and WM-data.

There are three types of membership – Corporate Members, End-User Members, and Affiliate Members, all with different fees and benefits attached. The application form and current fees are available on the website¹².

7.6 LIN

LIN is a single-wire serial communications protocol based on the common SCI (UART) byte-word interface. UART interfaces as available as low cost silicon module on almost all micro-controller and can also be implemented as equivalent in software or pure state machine for ASICs. The medium access in a LIN network is controlled by a master node so that no arbitration or collision management in the slave nodes is required, thus giving a guarantee of the worst-case latency times for signal transmission.

Typical applications for the LIN bus are assembly units such as doors, steering wheel, seats, climate regulation, lighting, rain sensor, or alternator. In these units the cost sensitive nature of LIN enables the introduction of mechatronic elements such as smart sensors, actuators, or illumination. They can be easily connected to the car network and become accessible to all types of diagnostics and services.

In the LIN Steering Committee, one can find major OEMs such as Audi, BMW, DaimlerChrysler and Volvo Cars. The associated members consists mainly of different electronic component manufacturers such as Infineon Technologies, Texas Instruments and Delphi Deutschland. Please note that there is a German dominance amongst the members.

To become a member, one fills in an application form that is subject to approval by the Steering Committee. The membership costs \$10.000 annually and brings benefits such as specification access to work papers and interim specifications, participation in working groups discussing LIN specification enhancements, rights to use the LIN Trademark, etc.

7.7 AUTOSAR

The objective of the AUTOSAR partnership is the establishment of an open standard for automotive E/E architecture. It will serve as a basic infrastructure for the management of functions within both future applications and standard software modules. The goals include:

¹² http://www.opcfoundation.org/Default.aspx/01_about/01_how2join.asp?MID=AboutOPC

- Implementation and standardization of basic system functions as an industry wide "Standard Core" solution
- Scalability to different vehicle and platform variants
- Transferability of functions throughout network
- Integration of functional modules from multiple suppliers
- Consideration of availability and safety requirements
- Redundancy activation
- Maintainability throughout the whole "Product Life Cycle"
- Increased use of "Commercial off the shelf hardware"
- Software updates and upgrades over vehicle lifetime

The AUTOSAR standard will serve as a platform upon which future vehicle applications will be implemented, and will also serve to minimize the current barriers between functional domains. It will, therefore, be possible to map functions and functional networks to different control nodes in the system, almost independently from the associated hardware. The AUTOSAR project plan was released in May 2003 and foresees the completion of the test and verification phase in August 2006.

A three tier structure of Core Partners, Premium members, Associate members, Development Members, and Attendees is implemented for the development partnership. Appropriate rights and duties are allocated to the various tiers. The AUTOSAR Partnership is currently accepting applications for new members at the Premium Member (at an annual fee of \$15.000), and Associate Member (at an annual fee of \$7.500) levels. The current Core and Premium Members include the major OEMs and significant automotive system suppliers.

8 Infosites

Automotive Exhibitions:

<http://www.automotive-technology.com/exhibitions/>

Evertiq - news about electronics, components etc:

<http://www.evertiq.se/newsx/default.aspx>

M2M Magazine:

<http://www.m2mmag.com/>

Center for Automotive research:

<http://www.cargroup.org/>

9 Appendix A - ISO Fields

Generalities	Information technology
Terminology	Office machines
Standardization	Image technology
Documentation	Precision mechanics
Services	Jewellery
Company organization, management and quality	Road vehicles engineering
Administration	Railway engineering
Transport	Shipbuilding and marine structures
Sociology	Aircraft and space vehicle engineering
Mathematics	Materials handling equipment
Natural Sciences	Packaging and distribution of goods
Health care technology	Textile and leather technology
Environment	Clothing industry
Health protection	Agriculture
Safety	Food technology
Metrology and measurement	Chemical technology
Physical phenomena	Mining and minerals
Testing	Petroleum and related technologies
Analytical chemistry	Metallurgy
Mechanical systems and components for general use	Wood technology
Fluid systems and components for general use	Glass and ceramics industries
Measurement of fluid flow	Rubber and plastic industries
Manufacturing engineering	Paper technology
Energy and heat transfer engineering	Paint and colour industries
Electrical engineering	Construction materials and building
Electronics	Civil engineering
Telecommunications	Military engineering
Audio and video engineering	Domestic and commercial equipment
Appendix B – SAE Topics	Entertainment
	Sports

Accident Reconstruction
Active Restraint Systems
Adhesives/Sealants
Aerodynamics
Air Conditioning & Refrigerants
Alternate Fuels
Aluminum
Auxiliary Power Units
Basic Parts
Batteries & Charging Systems
Bearings
Bodies/Structures
Braking Systems & Fluids
CAD/CAM/CAE
Cabin Safety
Ceramics
Coatings/Paint
Collision/Crash Avoidance
Communication Buses
Communications and Controls
Connectors/Terminals
Control Modules
Control Systems
Controls

Cooling Systems & Coolants
Corrosion
Crash Research & Biomechanics
Crashworthiness
Design Processes
Diesel Fuels
Diesel/Compression Ignition/HCCI Engines
Drivetrain Components
Electric/Fuel Cell Vehicles
Electrical & Electronic Diagnostics
Electrical Systems
Electromagnetic Compatibility (EMC)
Emissions
Emissions Testing
Engine Components
Engines & Propulsion
Environment
Ergonomics
Exhaust Systems
Extreme Temperature & Environmental Testing
FMEA (Failure Mode and Effects Analysis)
Fabric
Fasteners/Clamps
Ferrous Materials
Fittings
Fuel Additives
Fuel Economy
Fuels/Energy Sources
Gas Turbine/Fan Engines
Gaseous Alternate Fuels
Gasoline
Gearing
Glass
Grease
Ground Vehicle Operations
Hose Assembly
Human Factors

Hydraulic Systems & Fluids
Insulation
Intelligent Vehicles/ITS
Interior Controls & Displays
Interiors
Light Maintenance & Repair
Lighting Systems
Liquid Alternate Fuels
Lubricants
Machinery
Magnesium
Maintenance and Operations
Major Maintenance & Repair
Management & Education
Manufacturing
Manufacturing Processes
Materials/Chemicals
Microprocessors/On Board Diagnostics (OBD)
Multiplexing
Nickel
Noise/Vibration/Harshness (NVH)
Non-Destructive Testing (NDT)
Nonferrous Materials
Oil
Passive Restraint Systems
Plastics/Fiberglass
Product Liability
Propellers/Rotors
Protective Structures
Quality Assessment
Reference Books
Reliability
Reliability, Maintainability, Supportability
Repair & Service Operations
Restraint Systems
Rubber/Elastomerics
Safety

Seals & Gaskets
Seats & Seating
Security/Antitheft Systems
Shafts/Axles
Spark Ignition Engines
Springs/Torsion Bars
Steering & Suspension Systems & Fluids
Switches/Relays
Systems & Components
TQM
Terminology
Test Equipment/Instruments
Tests & Testing
Tires/Wheels
Tooling
Tools & Equipment
Transmissions & Fluids/Clutches/Flywheels
Two-Stroke Cycle Engines
Universal/Constant Velocity Joints
Vehicle Dynamics & Handling
Vehicle Electronics
Welding/Joining
Wiring