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DATABASE TECHNOLOGY AND REAL TIME INDUSTRIAL TRANSACTION TECHNIQUES IN CONTROL

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Abstract: *The paper discuses about features and facilities of industrial database systems in distributed control systems. It describes the control laboratories and concept of some courses with several examples of student projects at two departments in Slovak republic.*

Keywords: *Control System, Information Technology, Database Management Systems, Relational Databases, Control Education, SCADA/HMI – Supervisory Control and Data Acquisition/Human Machine Interface*

1 INTRODUCTION

Rapid developments that are taking place in the areas of computer science and communications influence the field of computer control. Systems are subjected to many constraints concerning energy consumption, safety and reliability conditions, environment protection, next to ever-increasing demands on economical production and trading-results.

Notions of **control** are expanding from the traditional loop-control concept to include such others functionalities as supervision, coordination and planning, situation awareness, diagnostics, and optimization (Vebruggen et al. 2002). Complex dynamic distributed systems are demanding new capabilities that traditional control technology is not offering. Among these capabilities the following software issues will be of major importance in this area:

- openness,
- adaptability/dynamic reconfigurability,
- real-time operating systems functionality for control and supervisory control,
- networking, plug-and-play extensibility, remote diagnosis,
- **embedded databases and database systems for look up tables, process archives and production analysis,**
- specific solutions for the plants,
- multi-process control task and adaptive learning.

Internet techniques play and will play an important role in this area, such as internet-based communication, web-based remote sensing, monitoring and management, industrial portal.

2 THE DATABASE TECHNOLOGIES OF CONTROL SYSTEMS

Among software industries, the database industry is second only to operating system software and it is growing at 35% per year. The research community (both industry and university) embraced the relational data model and extended it.

Manufacturer	**Product(s)**	**Integrated DBS**
Wonderware	FactorySuite	InSQL Server - MS SQL Server
RockwellSoftware	RSViewStudio	SQL AnyWhere, Dbase
RSBizWare	RSBizware	Historian
		MS SQL Server
Siemens	WINCC,WINAC	Sybase SQL AnyWhere
Honeywell	Security Manager	MS SQL Server
Foxboro	I/A Series software	Informix-SQL (ISQL)
	I/A Series I-MS SQL Server, SCADA NT	(Unix) Informix ESQL/CC
Intellution	iFIX, iHistorian	MS SQL Server
Aspentech	CimView	IBM DB2

Table 1 Relational database systems integrated in the software of control systems

Manufacturers of modern control systems guarantee absolute openness and modular structure of their products. They often use the latest information technology (OPC, ODBC, OLE DB, COM+, ADO, ADC, XML, etc), integrate real-time SQL databases and provides access to leading database programs including Microsoft SQL Server, Oracle, Sybase, dBase and others. In the cases where the conventional relational database technology is not suited to high-speed acquisition and storage of plant data, the manufacturers offer their own high-quality features and technologies providing fast real-time database access and high-volume data collection and retrieval delivery. The exploitation of RDBS (Relation Database System) can be found not only in their traditional applications – components of control systems like history collections, storage option packages, alarm, event summaries, reporting packages, statistical analysis packages, but in real-time process data acquisitions and real-time data managers and security managers too. List of several products, manufacturers and their integrated RDBS I s in the table 1.

3 INSQL AND RSSQL – INDUSTRIAL TRANSACTION PLATFORMS

An industrial transaction links control systems to database systems, so that they act as one. A true, end-to-end link is established that provides the level of reliability required to support enterprise-wide integration.

IndustrialSQL Server software is at the core of Wonderware's plant intelligence solutions. Its historian and associated data analysis tools:

- ActiveFactory™ software analyzes real-time and historical data to detect small but costly process issues,
- DT Analyst™ software calculates real-time Overall Equipment Effectiveness (OEE) and analyzes equipment downtime trends to help plant managers improve plant efficiency and quality,
- QI Analyst™ software provides powerful statistical process control (SPC) functionality to maximize product quality,
- SuiteVoyager® software provides customized plant information via a Web browser, giving plant personnel exactly the information they need to optimize plant operations,

provide plant decision makers with immediate access to detailed, real-time plant information, which leads to plant intelligence. The IndustrialSQL Server historian provides a complete picture of your plant's processes because it automatically acquires real-time production data, at high speeds, at full resolution, and from multiple simultaneous data sources. With this level of visibility, subtle process inefficiencies and product quality problems can be corrected immediately.

RSSQL is a Windows based industrial transactions processing system for sharing manufacturing data between enterprise systems and shop-floor control systems. As part of the RSBizWare framework, RSSQL provides a bi-directional link between control systems and enterprise database systems. Its architecture consists of four primary components: a graphical interface and three services (Transaction Manager, Control Connection, and Enterprise connection). The Transaction Manager executes transactions, controlling the collection, manipulation, and storage of data. The Control Connections are the interfaces to the process control systems; the Enterprise Connections provide links to the relational database management systems.

On the control side, RS SQL can connect to RSLinx, RSView32 or RSView Studio or any AdvanceDDE or OPC server. On the enterprise side, RSSQL can connect to any ODBC compliant-databases including Microsoft SQL Server, Access, Sybase, Informix and others or to Oracle via their direct callable interface (OCI) – a native connectivity to Oracle on any of the supported OS including UNIX and AS-400. The services connect to each other using TCP/IP sockets. This provides the ability to operate as a single system even when the components are distributed over multiple computers on a network. RSSQL supports bi-directional transactions in one of two ways and provides three primary ways to trigger transactions; internal scheduler trigger, control execution trigger and external trigger. It can be configured to execute a transaction at time-base events or at regular intervals. The control system can also control transaction execution, RSSQL provides the ability to trigger a transaction when a control point changes, when it goes high (or low) only, or it can be configured to run at defined intervals while a control points is high.

4 THE CONTROL LABORATORIES AT THE DCAI FEI TU AND DACS FEI STU

At the Department of Cybernetics and Artificial Intelligence - DCAI FEI TU in Košice in the several laboratories, a unique model of Information and Control System has been built. It serves as a scientific-research, educational, and demonstration workshop (Zolotová et al. 2004). Two main connections between technological level and databases (Fig.1.) were realized:

- data transfer data from the PLCs (Programmable Logic Controllers) on the technological control level to the Industrial SQL Server by its DDE/OPC input/output system,

- data transfer by Rockwell Software transaction manager RSSQL to the Microsoft SQL Server and to the Oracle SQL Server by DDE/OPC protocols.

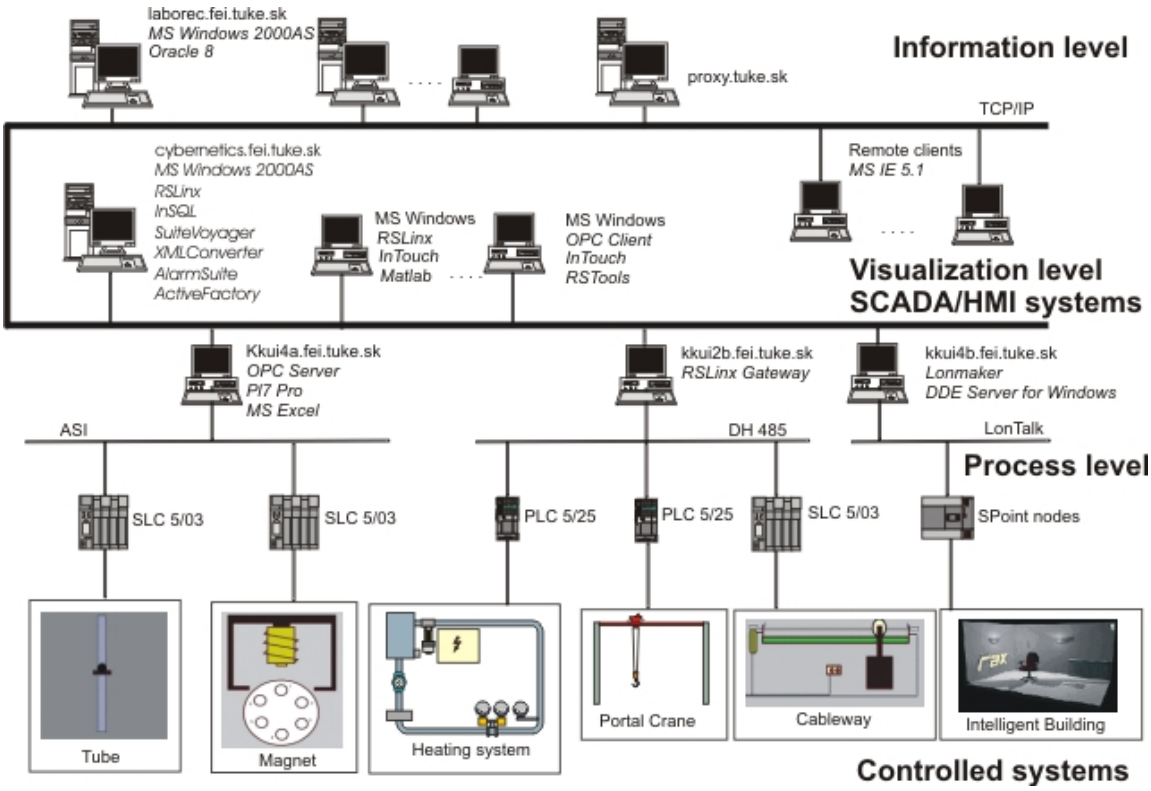

Fig. 1 Physical model ICS of real laboratory models.

Two laboratories - PLC laboratory and Industrial information systems laboratory support the courses of DACS – Department of Automatic Control systems FEI STU in Bratislava. The present equipment covers PCs Pentium, Windows NT/2000 OS, six SLC500 systems, four Micrologix systems, two PLC 5 processors, PanelView - operator terminals, corresponding communication drivers, control, and SCADA/HMI software, RSSQL and models of real plants.

The DH485, DH+, ControlNet, DeviceNet and Ethernet networks have been built in the laboratory to establish the communications of all PLC and PC nodes. An Ethernet link connects the AB laboratory and the laboratory for industrial information systems design and information technologies. The equipment of IT laboratory consists of OS Windows 2000, MSOffice2000, Visual Studio, Microsoft SQLServer, RSSQL, Sybase PowerDesigner, CAD tools, Siemens SCADA/HMI application WinCC and Yokogawa (Flochová and Hüber 2000).

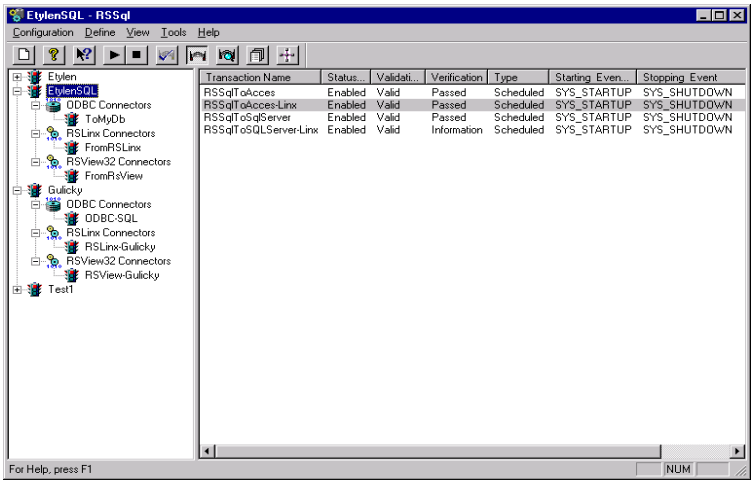

Fig. 2 Industrial transactions monitoring with RSSql

All laboratories at both departments have been used for teaching following topics: PLC programming techniques, IEC61131-3, SCADA/HMI design, industrial information and communication technologies; the concepts of RDBS and real-time DBS; their use in control systems design and logistic principles, linking of control systems and RDBS, industrial transactions data integrity, DBS in SCADA/HMI, data archives, statistical analysis and WEB monitoring of the colleted data.

Concepts taught through lectures are complemented by laboratory exercises and projects. The first four weeks of exercises are spent with database skills and techniques, during the second period students work on software projects. Any group of two students elaborate two projects in the areas of classical RDBS, SCADA real-time databases, RSSQL, RDBS process archives and web-real time monitoring and control of a plant models. The figures 2-6 represent a collection of student projects.

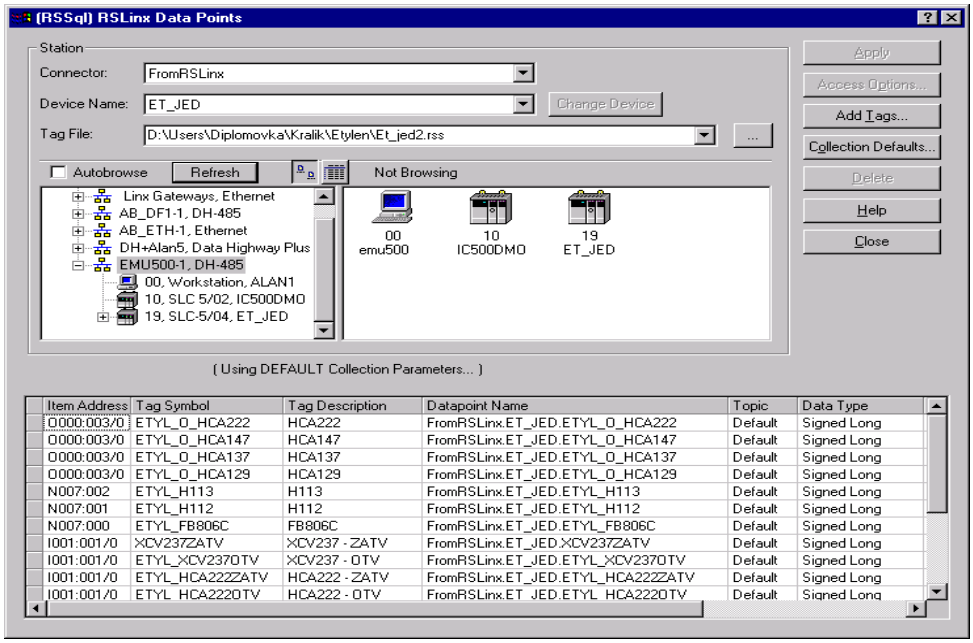

Fig. 3 RSLinx Data points processed in RSSQL transactions

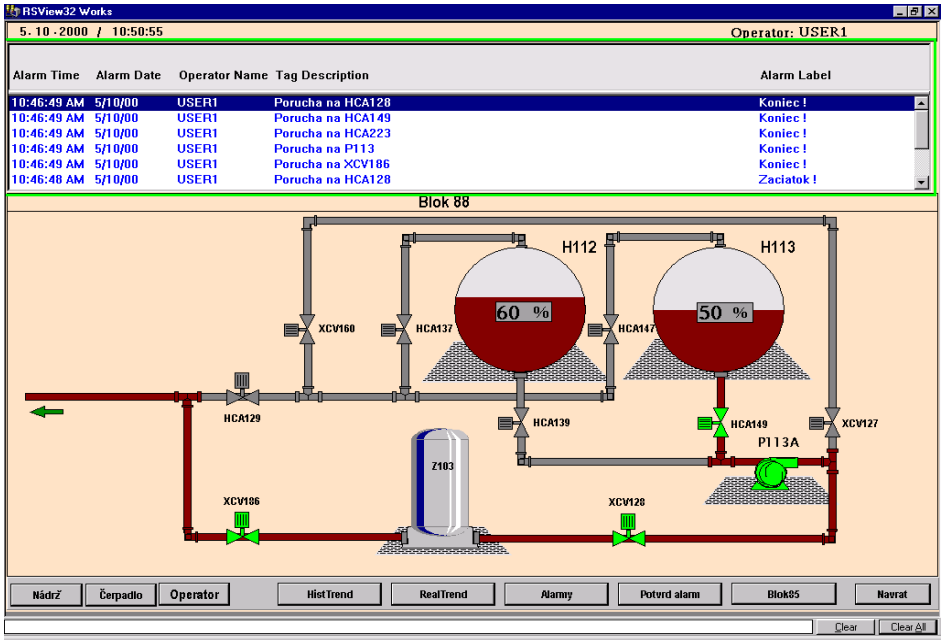

Fig. 4 RSView32 SCADA/HMI, the plant model has been used as a source for real-time process data for a RSSQL configuration and in two web-based monitoring applications

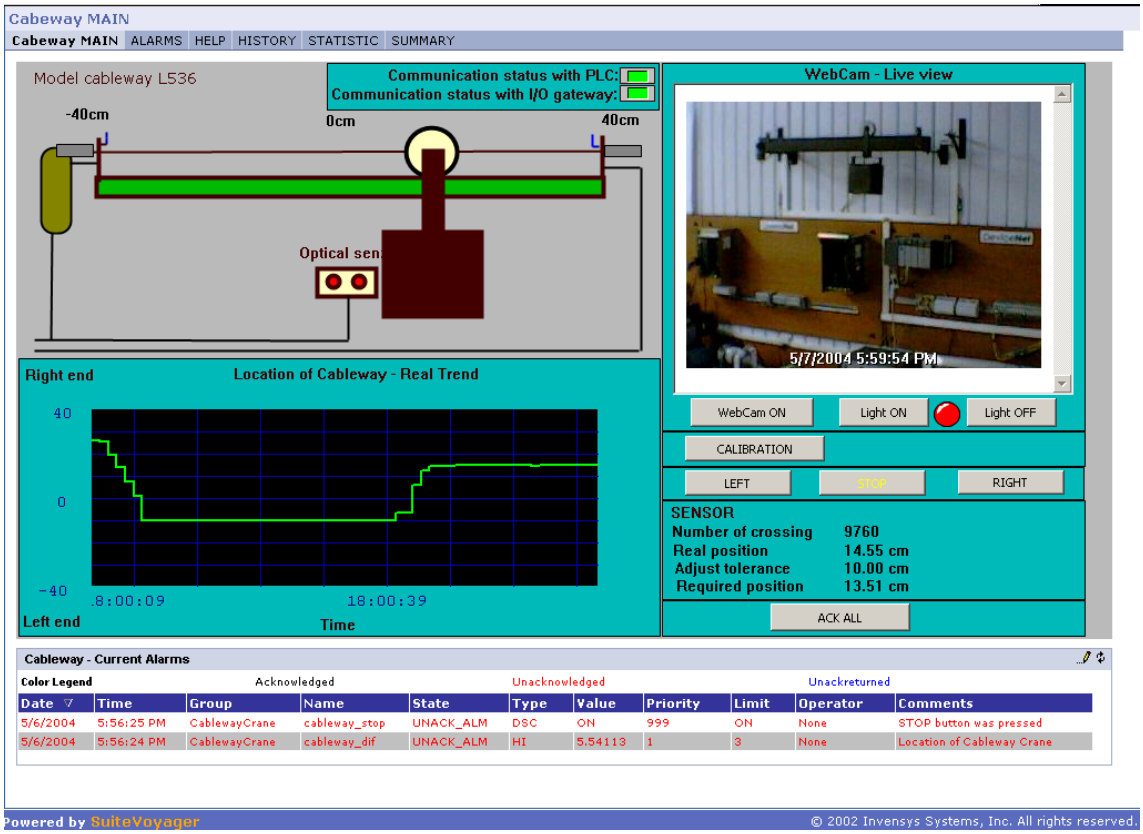

Fig. 5 HMI for cableway and summary alarms from InSQL database

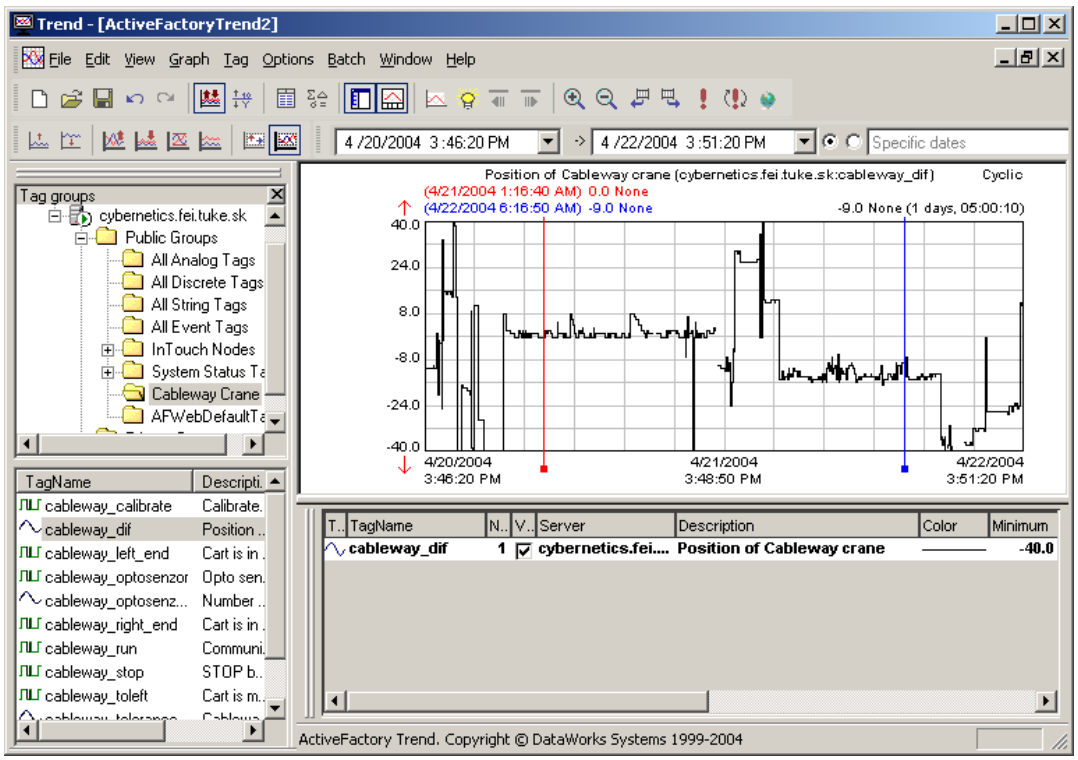

Fig. 6 Active Factory trend – analysis tools of data from InSQL database

5 CONCLUSIONS

Developments in computer networks and communications provide new possibilities for control purposes. New software infrastructure for control systems is needed that exploits these new emerging software technologies. An open control platform for complex systems, and the issues of new information and communication technologies will be of major importance in the areas of control engineering and of control education. The students need a better background of newest information technology among others the background in the field of database systems; industrial transaction management of real-time databases and internet based monitoring. It will help them to identify potential problem areas, analyze the failures in control systems, minimize errors, improve control efficiency and other key performance indicators, get the data to optimize and improve the manufacturing effectiveness.

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