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POSSILIBITIES OF CONTROL AND INFORMATION SYSTEMS INTEGRATION WITHIN INDUSTRIAL APPLICATIONS AREA

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ABSTRACT: *This article is devoted to possibilities of control systems and information systems integration for industrial applications with the focus on nowadays trends in application of technology implementation in manufacturing facilities. Alternatives of implementations on process virtualization and with open interfaces are described in detail, mostly OPC, which is supported by experiences with implementation of this technology in company Continental, a.s. Púchov, Slovak Republic.*
KEYWORDS: *control system, information system, SCADA, MES, ERP, virtualization, OPC*

INTRODUCTION

Information systems of nowadays companies are based mostly on ERP systems (Enterprise Resource Planning) which allow control of corporate resources and processes. Their primarily functions are to maintain basic functions of company. These functions are [1]:

- *enterprise resource planning,*
- *financial management,*
- *purchase,*
- *human resources management,*
- *logistics,*
- *production planning,*
- *support of maintenance and quality management.*

It is possible to implement these system independently form the level of automation in production process on procedural and operator level.

Control of production machinery, production lines and units is provided through separate control systems of separate producers of machinery DCS (Distributed Control System). Integration of information systems and control systems is natural consequence of the need for advanced control of company's resources and overall optimization of the production process in terms of productivity and production efficiency. A typical requirement of integration includes support for information exchange between information system and control systems. The most important are:

- *materials decays of products and production recipes,*
- *transfer of production orders to individual production lines,*
- *monitoring of production progress of orders,*
- *statistical processing of manufacturing processes,*
- *traceability and validation of materials in the overall manufacturing process.*

A typical configuration of control system and information system interconnection is shown in Figure 1. Control system often uses central control rooms and control centers with production process visualization - SCADA systems (Supervisory Control And Data Acquisition). SCADA/HMI concept describes the supervisory control and data acquisition / human-machine interface. Supervisory control is control where is used the process visualization for graphical representation of technological activities [2]. SCADA/HMI software resources are used for supervisory level DSR what is a higher level of control and is realized on computer servers. Main task of these servers is to provide communication between operator and technology, supervision control and monitoring, collecting data and updating data. SCADA is component which provides collecting of process data, monitoring, supervisory control and management functions. It ensures absolute data integrity and provides distributed network capabilities. It is important to note that SCADA system as currently understood is not just a kind of monitoring and dispatcher element in the overall complex technological system but is particularly effective means of data integration from different sources (sensors, PLC, SLC, information systems, database systems, etc.). HMI displays the information in an easily untestable graphical form, archives received data and if necessary and allows the operator to control the technological process. In fact it provides its own process visualization and interaction between operator and process. By completing the basic functionality of the SCADA system with the possibility of balancing the controlled data we get so called

MES system. While SCADA system provides an overview of the production from the point of view of process variables (technological perspective) MES system provides comprehensive information obtained by balancing of the collected process-material data with regard to the defined period of time (e.g. hour, work shift, etc.). This adds new dimension to the system – the managerial view. Other part of balancing can be also other tool for prediction of future condition of production, support operational planning, etc. Different area where MES systems are helpful is for example manufacturing-energy context monitoring [3].

Interconnection of control systems with information systems ERP/MES (Enterprise Resource Planning)/(Manufacturing Execution Systems) is possible via the corporate LAN (Local Area Network).

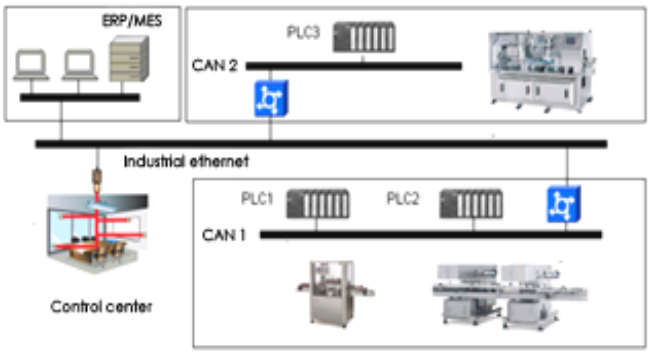

Figure 1. Example of information system and control systems interconnection in company

POSSIBILITIES OF INTEGRATION

System integration of control systems with information systems is a complex process of interconnection of the heterogeneous subsystems into a single logical unit which shall provide support of target functions and services. We can consider application of specialized MES systems for direct support of manufacturing processes and operations as generalization of such approach. These systems provide support for control systems and simple integration to corresponding ERP system. We distinguish the following integration possibilities:

- *direct integration of ERP systems with control systems,*
- *integration with the usage of integration layer (middleware),*
- *integration with the usage of MES information systems.*

Possibilities of control systems and information systems integration in company are shown in Figure 2. Control systems can communicate directly with the information system via a specific API (Application Process Interface), for example interface RDC designed in company SAP. This communication is possible also via integration layer in the form of MES system.

In next sections we will focus on basic trends that are applicable to system integration of control systems with information systems. These trends will be divided to following areas:

- *implementation,*
- *scalability and redundancy of the hardware,*
- *application of open interfaces.*

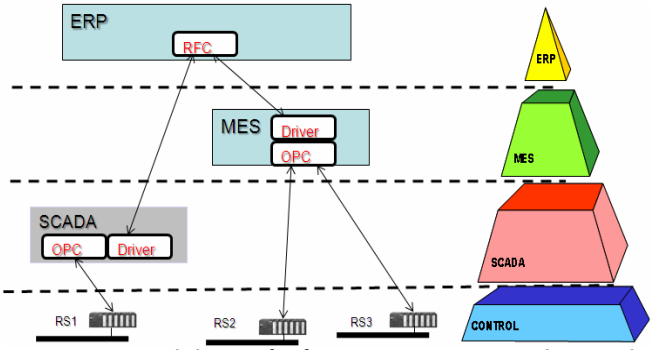

Figure 2. Possibilities of information systems and control systems integration in company

ALTERNATIVES TO IMPLEMENTATION

Control systems are parts of production lines which are implemented for the needs of the control process at the site. In case of information systems we can distinguish with these alternatives of implementation:

- *central implementation,*
- *distributed system,*
- *hybrid architecture.*

ERP information systems perform company-wide functions therefore are in case of corporations implemented in central computing centers. The need of their direct connection with local control systems would require direct communication via WAN networks. Capacity of WAN network is not usually adequate for transmission capabilities of LAN. There are required significant investments in powerful WAN connections with redundancy and adequate service quality (MPLS, QoS). Therefore an alternative solution is to create fully distributed solution with locally implemented ERP information system. In case of corporations is then more frequent variant of hybrid architecture that allows a compromise between the need of central information system and local control systems implementation. Locally implemented MES information system can provides communication with control systems, segregate the required data and provides the follow-up communication with central ERP system.

USAGE OF SCALABILITY AND REDUNDANCY OF HARDWARE ON THE BASIS OF VIRTUALIZATION

The need of work in real-time and need of specific parameters performance makes high demands on information system hardware in production environment. A nowadays trend is therefore to build

redundancy and the possibility of quick system recovery in case of loss of information system. We can mention:

- virtual servers (e.g. VMWare),
- backup data centers (DPC).

With dual-built computer centers and with virtualization we can achieve adequate potential of highly available solution of system integration. Such a solution allows performance scaling (RAM allocation and virtual machines processes), according to the needs of MES information system. In the event of downtime of the server or the data center the backup center automatically overtake the requested resources. Virtualization is a software technology allowing more efficient use of computing performance of system.

Current computers are designed to run with one operation system and applications related to this operation system. Virtualization eliminates this limitation and allows simultaneous operation of multiple operating systems on single hardware as shown in Figure 3. There is several types of virtualization with are used according to specific conditions. It is possible to virtualize desktops and servers also. It is server virtualization which is the latest trend in this area because it allows to significantly investments and operating costs reduction. It uses the hardware more efficiently and also increases its safety. It also allows transfer of virtual machines between physical computers (Load-balancing). It is not suitable for solutions where is needed high processor performance, which is also the most limiting factor of this technology. Virtualization allows running multiple virtual servers on single physical hardware and allows sharing physical resources of the machine. Virtual servers act on the network as any other physical servers and are ideal for simulations hosting of undemanding server applications, test installations or back up servers [4].

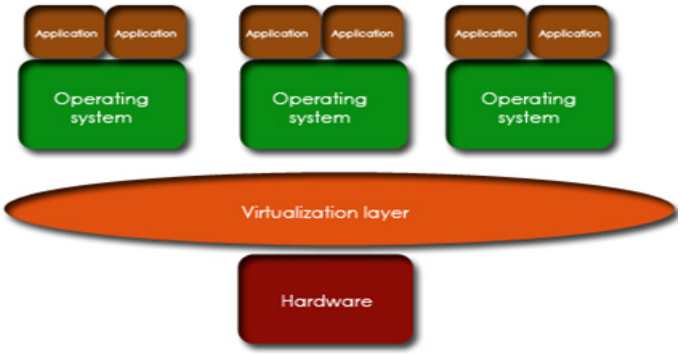

Figure 3. Virtualization layer allows running one or more virtual machines on the same hardware

Each virtual server has its own operating system which is running in environment of so-called hypervisor. This allocates virtual hardware for operating system which appears as real hardware for the operating system. All virtual severs are isolated from each other so one cannot affect another. Choice of the operation system is fully up to the operator because there are supported all modern operating systems based on Linux and Microsoft Windows. Because the virtual severs are isolated there can run side by side for example Microsoft Windows 2008 server and Debian Linux on the same physical hardware.

Most datacenters in the world is working according to model one operating system per one physical server. This fact means that 90% of servers are using only 10-20% of their performance.

APPLICATION OF INTERFACES

Usage of different control system makes high demand on communication protocols between information systems and control systems. We have to consider the size of the transferred data, requirements for the real-time transfer and ensure reliable transition service. The most used interfaces are:

- RFC (Remote Function Call),
- OPC (OLE for Process Control),
- XML (eXtensible Markup Language).

Servers with OPC interface allows to any client access the device. With increasing number of the hardware manufacturers is increasing also number of client applications, which are designed in programing languages as Visual Basic, Dephli, C++ or Java. Microsoft designed OLE/COM (Object Linking and Embedding / Component Object Model) model to allow developers to use software components in their programs in another programming language.

Developers in Microsoft designed software components in C or C++. They made interfaces in those components for accessing data from database sources. Company application developers can design code for example in Visual Basic which uses data directly from industry hardware. Purpose of all specifications is to facilitate development of servers for OPC in C/C++ and to give developers freedom when choosing the programming language [5].

Interfaces design and architecture is designed to support the development of OPC servers also in others programming languages then C or C++. Wide acceptance OPC in industry provides several advantages such as:

- *hardware manufacturers can develop only one set of software components which customers uses in their applications,*
- *software developers do not have to rebuild their application after every change of hardware properties,*
- *customers have more options for integrated company systems development.*

By using OPC is possible simple integration of various software platforms as shown in Figure 4. First OPC versions were limited for areas that were similar for most providers of hardware. Today OPC specification contains rich functionality in almost all areas. OPC architecture uses advantages of COM interface which provides a convenient mechanism to expand its functionality and is designed for use of DCOM (Microsoft Distributed OLE Technology) model. This allows client to connect to remote servers.

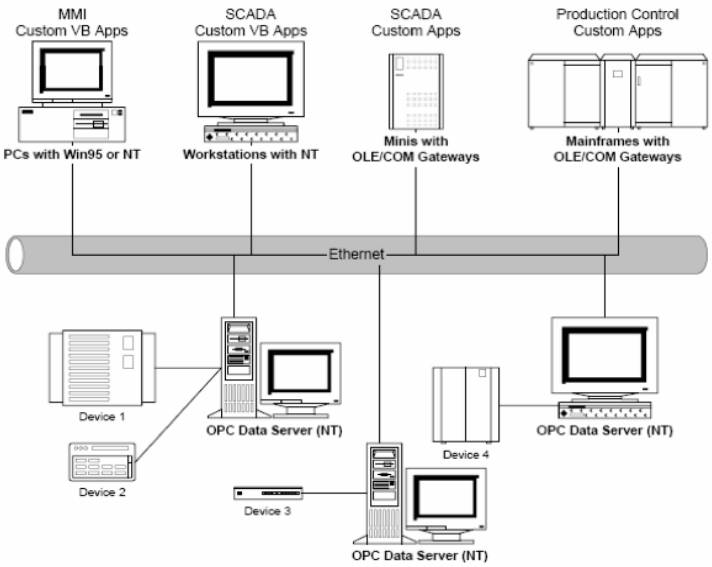

Figure 4. Example OPC with various software platforms

CONCLUSIONS

Information systems of today's manufacturers must be necessarily integrate with control systems. The nature of the production process determines requirements for hybrid implementation and usage of MES specific information systems. Gradually is increasing the usage or open interfaces based on standards such as OPC and XML. Obvious trend is also to build high availability using virtualization technology. Within safety critical control system it is necessary to solve problems of security mainly with using open transmission system on the base of Wi-Fi and ZigBee technology [6].

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