Monitoring and management of technology processes

POMFFYOVÁ MÁRIA

Institute of Managerial Systems, Faculty of Economics,
Matej Bel University,
Franciscihо 910/8, 058 01 Poprad, SLOVAK REPUBLIC
maria.pomffyova@umb.sk

Abstract. This study describes the ways how to realize and secure the communication between any controlled processes and any user various information systems which they use to connect to them via the Internet or other private networks. It assesses the current state of software support in the area of communication protocols used as tools of data flows and system integration. The goal of the study is to propose a hardware and software interface solution aimed to monitoring, recording, assessing as well as managing communications over a secure internet or intranet connection. It will be presented by the practical solution of case study in the selected company.

1 Introduction

Availability of information as well as globalization of business environment have caused that companies have much more to seek how to obtain and to maintain control of their business by electronic ways. There are many various solutions how to exploit possibilities offered by intranet, extranet or by internet or other forms of virtual communication. These media bring more possibilities to exchange information accessed in many various forms as well as formats. We can communicate on-line (by data flow exchange, by chat, IP phones, Skype, ICQ, social sites, etc.) as well as off-line (send paper documents by fax, scan or as an attachment of e-mail, SMS, instatnt messages, etc.), but all these tools increase the potential threat of enterprise information leakage. It is difficult to secure enterprise data transported by electronic ways and accessed via virtual connection, but the benefits outweigh the effort and all the associated costs.

In this study we deal with the possibility how to connect cotrolled technology and to maintain security of internet or intranet connection, realized through hardware and software solution. We will point out the possibilities how to carry out the electronic communications more safely. It will be presented by a practical solution of case study in the selected company.

2 Electronic ways of communication and their basic assumptions

Successful business doing is closely related with the correct management decisions based on right information from enterprise's internal environment, as well as from its external environment. To have required and actual valuable information is the key to whichever successful business deal and effective collaboration between partners or clients.

Therefore, it is necessary to:
- dispose with information that they need quickly, accurately and helpfully,
- be able to interact with co-workers in a way that suits them best, whether personally, over the phone, SMS, via email or a website [1].

It means, enterprise have to dispose with solutions that support:
- clear and consistent processes for handling partners' interactions,
- back office systems accessible through a common interface - so information related to enterprise's processes, its activities or service information are instantly retrievable.

It is required to achieve an integrated access to such information, related to changes in the development of ongoing processes as well as to the tools, enabling simulation and modelling of their future development.

Few years ago, enterprises permanently upgraded their processes; they purchased the newest solutions, supported by latest information and communication technologies with the aim to achieve the highest quality of data processing. It is common, they do not use all the possibilities offered by them. It increases amount of

processed data stored in data warehouses or database systems, but managers almost do not know how to exploit available possibilities. More and more sophisticated tools require wider soft skills of their users. They can not use all the possibilities of these systems, because they do not know how to perform data analyses, prepare the necessary reports or to create forecasts of future developments of controlled and managed processes. It is due to continued requirements towards users quickly to adapt to the latest technology as well as to the functionalities and tools, offered by them. Because the managers refuse to constantly learn and adapt to this situation, there is a growing problem with the use of their capabilities.

The next problem is related with heterogeneity and inhomogenity of platforms of technology and user information systems. There should be solved the problem related to the selection of suitable interface aimed to gathering measured data of controlled technology, their transformation to the obtained forms, storing and accessing them as well as ensuring co-operation in such environment.

All these problems have to be solved if we want to obtain well controlled processes by using of electronic ways of communication.

3 Definition of information requirements for intelligent decision-making process

In order to achieve creation of conditions for successful intelligent decision-making processes we should thoroughly know the demands of technology or processes, ways and means of measuring its state values, method of its recording and analysis. It means, rather than we define other requirements, must be defined the key intelligence topics, as well as key intelligence questions, related to controlled processes. On this basis, it is possible to define precisely what information will be collected, how they will be analyzed and to whom and in what form they will be provided.

Such information support should be prepared by exact and precise specified information available from the internal environment of the company relating to managed processes or even by IT specialists, whose dispose with relevant knowledge and experience. Afterwards should be created assumtion to inteligent decision-making based on exact information as well as well experienced managers.

We can find in the literature [2] three main steps of cycles of intelligent data processing (information gathering, extracting and distribution). Intelligent data processing cycle were enhanced into five steps by Bartes [3], 2012:

- Management
- Information gathering
- Information extracting
- Information analyzing and applying into context
- Information distribution

It is assumed as a relatively independent system that consists of processes of definition, gathering, collection, analysing, placing into context and distribution of information within an enterprise [4].

It means, if we want to obtain an access to enterprise processes or to selected technology, we should know how to ensure measurement of all theirs state values, their gathering and transporting, as well as processing all the related communication flows. Subsequently there follows preparation of information support. Data should be transported to their processing, storing, analyzing and placing information into context, giving into the suitable form, as well as distributed to the competent managers in suitable form as a support of their management processes [3-4]. The most important phase is the feedback control of managed processes. All these processes can be described by diagram of intelligent data processing, shown on the Figure 3.

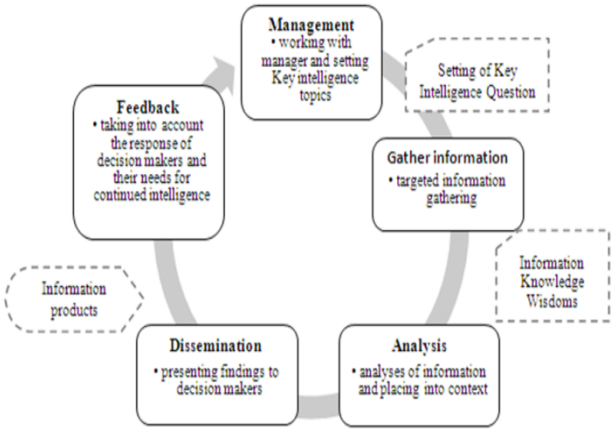

Figure 1. Intelligent data processing

Afterwards, managers are aimed to predict future development in controlled processes. Such intelligent support them in the strategic planning process, as well as in determining the behavior of the technology and also in a better estimation of the extent of the risk to which enterprise may be exposed [5].

4 The role of communication protocols

It is often necessary to seek access to data that provides information about the status of controlled processes. It is difficult due to the different platforms of controlled technology as well as user information systems, from which user accesses to them via intranet, extranet or through a web access. These forms of data accessing require also protection and security of data transmissions as well as ensuring access only for authorized persons.
As we have already pointed out there is a real need for a communication protocol to establish.

The International Standards Organisation (ISO) defines a 7 layer model for network communication protocol. The model is more formally called the Open Systems Interconnection (OSI) model. It should exist in any network. OSI model is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to their underlying internal structure and technology. Its goal is the interoperability of diverse communication systems with standard protocols [6].

The physical layer is layer where the interface between the communication medium and the device is

attached. The layer transmits bits (ones and zeros) and defines how the data is transmitted over the network.

On the Data link layer bits are put together into packets on data link layer, on the network layer is created datagram of data flows, on the transport layer are data gathered and made available to the user in suitable form.

Various types of communication are realized due to TCP/IP (Transmission Control Protocol/Internet Protocol) protocol, used on the transport layer. TCP/IP protocol is the basic communication language or protocol of the Internet that can also be used as a communication protocol in a private network (either an intranet or an extranet) [7].

Internet users are familiar with the even higher layer application protocols based on TCP/IP protocol to get access to internet and to ensure transport of all data flows required by them. There are available many various protocols, including the World Wide Web's Hypertext Transfer Protocol (HTTP), the File Transfer Protocol (FTP), as well as Telnet (Telnet) which allows to login to remote computer, and also the Simple Mail Transfer Protocol (SMTP) designed for e-mail communication. These protocols are obviously designed for using of typical connections as well as data transmission via the internet and other private sites.

4 Case study: Monitoring technology processes

We consider a model situation where should be monitored, measured and evaluated the values of controlled processes (their pressure, temperature, etc.) or state of leaks of dangerous chemicals, noxious waste products or other harmful substances into the air in some industrial enterprise or in its external surroundings (for example refinery, factory aimed to production of aluminium castings, etc.) [8].

As we found out by using of analyses, comparison as well as deduction methods, most of the programs designed as analytical software for major emergencies at industrial enterprises and their surroundings in terms of emissions and air pollution from scattering leaks, explosions, fires and other substances, are not able to provide data in the suitable form. These programs are not able to monitor all measured values in real time, evaluate their progress or their output information is available in the form of text files or MS Excel spreadsheets [9]. Therefore, their evaluation is time consuming and labor.

Another problem is that the systems do not support the integration of Slovak maps into these programs and also their integration within databases of permissible or limited values of harmful substances, valid in Slovakia.

We also pointed, a lot of programs are available, but most of them are intended for single-use statistical data processing. The issue of transfer and storage in the database tables to their long-term monitoring, measurement, evaluation and visualization address marginally or do not work with these forms of data at all.

Therefore, it is difficult to visualize or evaluate common situation. That is why the assessment of the situation is protracted, prediction of future forecasts is not available and estimation of probability of occurring of some particular conditions is very low.

Our server application solves this kind of working with data complexly and combines them into one system that allows: measurement, data gathering, visualization, communication, decision-making support as well as control and alerts giving. In this way, the application extends the support of mutual communication with users and supports intelligent decision-making processes.

Next problem, related with the need to inform its surrounding about the evolving of real situation, is solved not only by data view accessed by web access point, as well as by e-mail alerts, sent in the case, when minor obstacles is occurred and by SMS and e-mail, sent when major obstacles is occurred. Enterprises at the time of prevention largely inform its surrounding only through your website in the form of static information, what is not sufficient. Particularly in the context of emergencies, information should be updated within the actual measured values of monitored parameters.

4.1 Measurement of state values of controlled processes

If we want to control some technological process or detect values of harmful waste products (CO, SO2, CH4, H2S, etc.), generated as a result of any related production processes, we can use programmable logic controller (PLC) module. It enables gather all the measured data from controlled technological processes. It also enables the supervision, management and collection of all information related to these processes.

PLC controller is produced by allsystems.sk [10]. It is mainly oriented on the reliability and the stability (low error rate) of the transmitted data in real time under extreme mechanical and climatic conditions.

Their designs are displayed on Figure 2:

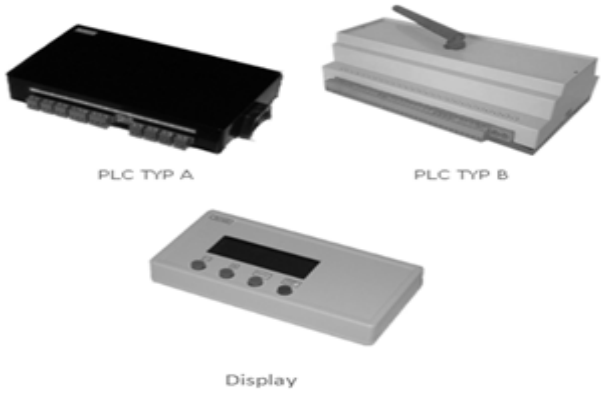

Figure 2. PLC modules

Related data are stored in database server and analyzed using the built-in statistical tools. After them the information is distributed and shown either on the intranet or website.

In the Figure 2 is given the comparison of their parameters:

Parameter	TYPE A	TYPE B	description
temperature inputs	4	4	temperature Ni1000
binary inputs	3	5	0 ~ 24 V
universal inputs	2	4	0 ~ 10 V
continuous output	3	4	0 ~ 10 V
relay	6	7	24 ~ 230 VAC
comm. interface	1	2	RS232/485
comm. interface ext.	-	1	WiFi/GSM/LAN
Display	1	-	4x20 characters

Figure 3. Parameters of PLC modules

4.2 The basic characteristics of PLC module communication

The PLC modul has its internal system, which parameters can be configured with push-button control after entering the user password. It allows setting three parameters that are measured twice per day by week program. Measured data are processed, stored, evaluated, transported and controlled on a remote server accessed by intranet or internet.

Display immediately shows the measured values of inputs/outputs parameters. There are three types of PLC units [10]:

- PLC with display without communication support – is designed as relatively separate units, that do not require software; it is a client,
- PLC module with LAN connectivity, this unit requires software; it works as a client, run as a service on a computer in a local network; state of measured values are stored as inputs processed by program, where it is enabled recording of them to the log file in the .csv format. It is also supported bi-directional communication with a local server or with a server on the internet. A client can communicate with multiple PLCs on a local network,
- PLC with GSM or WiFi module; it communicates directly with a local server or with server placed on the internet. Such module does not require any software.

Database technology solution uses a client - web server in the internet as well as in a local version.

By default, the database server MySQL 5.1.36-community is supplied with the Web server Apache/2.2.11 mod_ssl/2.2.11, OpenSSL/0.9.8g, PHP/5.3.0 (XP/W7 Windows, Linux). Thanks to these technologies, a high security of the database is in this way guaranteed against unauthorized interference and disruption of consistency, because of failure of a computer or a computer network. This technology is accessible for any platforms and for any number of clients. Access rights of users are assigned to them as well as stored in the individual tables of the database.

Data and computational operations are handled through the standard set of statistical functions (Min, Max, Avg, Median, Standard mean, etc.). For better visibility can be viewed in addition to color charts and graphs with observed data. Obtained information gives support for creating of prediction of controlled processes. This module can be varied depending on the kind of controlled process.

4.3 Communication between PLC units and other standards

An essential condition for the operation of client/server application is the development of modules that have a direct access to the remote server on the Internet. The basic condition is only to have any connection with the Internet (without the need have a public IP) in the case of solution with WiFi module and in the case with GSM module it is required a SIM card with an active Internet connection [10].

It depends on the type of hardware how module will communicate, for example, via USB, RS232 or RS485 (master-slave) device with the usual protocols (BACnet, Modbus, Profibus).

With the Internet it can communicate via WiFi, GSM or via Local Area Network (LAN) modules. LAN module allows extension of the classical connection through RS232/485 for greater length using traditional LAN with all its advantages. The local PC must run our communication program which connects modules LAN and routes to local or remote server.

A software interface standard that allows Windows programs to communicate with industrial hardware devices is OLE for Process Control (OPC) standard.

The OPC client uses the OPC server to get data from or send commands to the hardware. The value of OPC is that it is an open standard, which means lower costs for manufacturers and more options for users [11].

This connection can be described by scheme on the Figure 4:

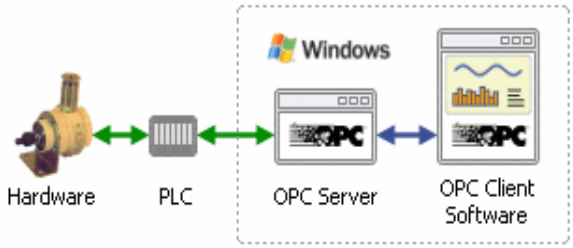

Figure 4. Connection hardware and Windows program

If we should decide to what type of protocol we want to choose, we should to know what type of change we manage and control.

If we want to manage and control fast technological processes with low level of security we should use BACnet protocol (f.e. management of central heating or cooling). OPC protocol is designed to control and manage slower process (operation control air handling units, measurement and management dangerous waste products, etc.), but width high level of security.

The advantages of this solution consist mainly in the possibility easy to extend used technology and to obtain energy savings - there is eliminated the need to access a server on a local network, it is not necessary to backup power supply as well as it is not required the public IP address, etc. The biggest advantage is the possibility of supervision and management of technology by any web client (Chrome, Firefox, Opera, IE ...) either on the desktop PC or through mobile connection (by tablet,

phone) from anywhere where you can be connected to web server of this application.

5 Location and functionality of described software equipment

The next product offered by allsystems.sk [10], is the software support of intelligent management decision-making. It is due to software support that allows daily monitoring, measuring and visualization of actual values of controlled processes (by table or graph views), analyzing measured data by ad hoc analyzes and modeling and prediction of controlled technological processes. At the end, it supports communication between managers, involved to the managed processes at any management levels, regardless their access point. Web application menu is displayed at the Figure 5:

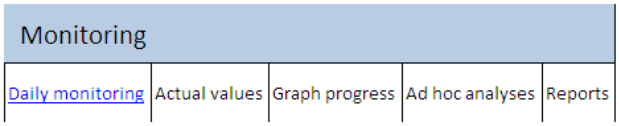

Figure 5. Menu of web application

This software solution is located on free host server (freeserver.sk) that allows accessing to the services, 24 hours daily. There are also stored data in database server, obtained by measurement the states of managed processes. Web application was created by using PHP and HTTP language commands in PsPad editor. It supports also viewing data in graph, table or text design regardless user operating systems or browsers. Therefore offers the high level of compatibility as well as data integrity.

In the submenu **Daily monitoring** of this application user can views all the measured values at their daily progress. On the Figure 6 are viewed daily measured values of harmful substances (CH4, CO, SO2, H2S, etc.).

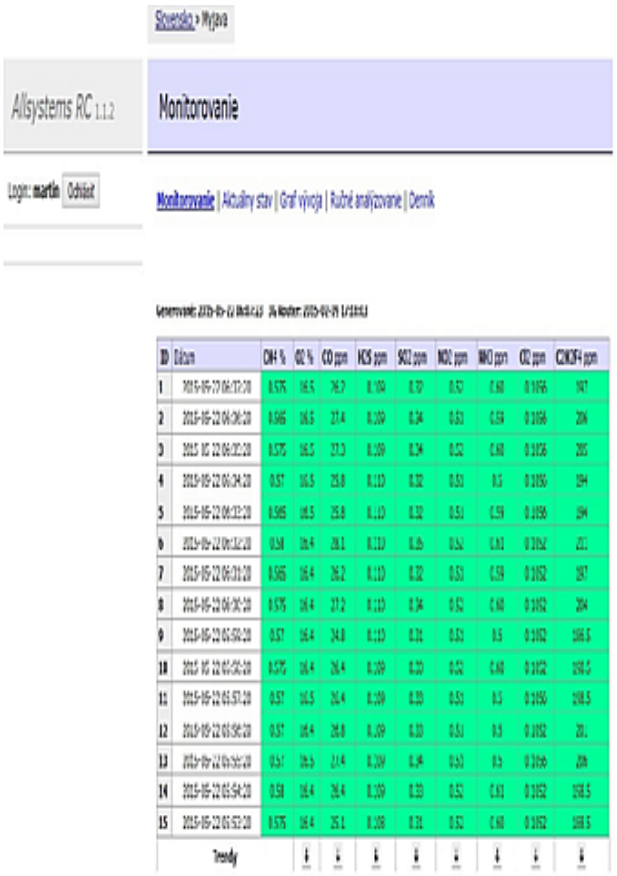

Figure 6. Submenu Daily monitoring – viewing values of measured data

In the last line is displayed progress of their values – their declining or growing tendency in the interval minute by minute.

In the submenu **Actual values** is displayed detailed review of selected variables (Figure 7).

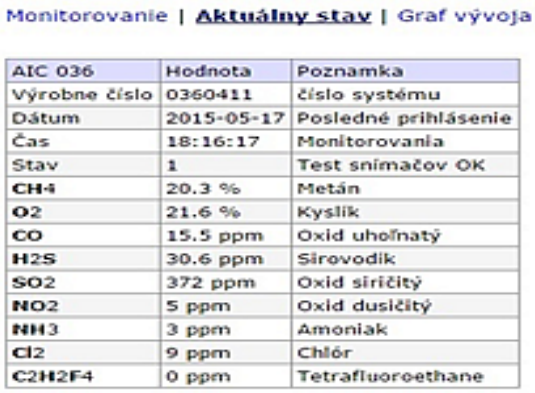

Figure 7. Submenu Actual values – Detail values of selected record

It is also displayed login parameters, number of selected technology, date and time of measuring, etc.

The next submenu is **Graph progress**. This function is used to clear graphical display of measured values trend for 24 hours (Figure 8).

Figure 8. Submenu Graph progress

It can further analyze critical points when the values approached the threshold, or to determine the repeatability of the waveform in the same period, for example, by day, month or year ago.

In the submenu **Ad hoc analyses** user can user can analyze data according to selected criteria – type of substance, date and time of measurement, state of LAN, state of monitoring status or History (Figure 9). It is also displayed color scale of measured values as well as graphical analysis and time of duration of selected data analysis. State of monitoring status - inactive, gives information about the time of failure, it can be determined the reliability and functionality of the system, as well as the expected evolution of its status.

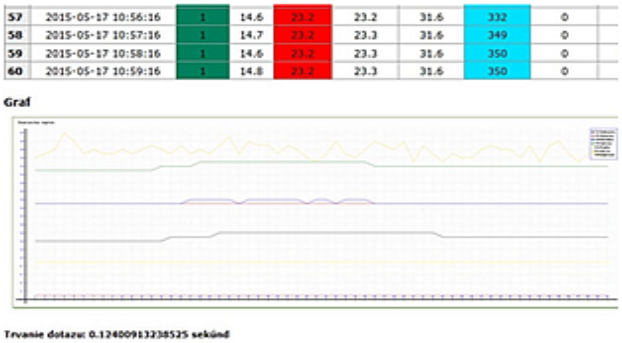

Figure 9. Submenu **Ad hoc analyses** – Table and Graph views

The last Submenu **Reports** offers user on-line communication by chat. Users can comment the state of controlled technology, its failures, as well as solutions of Key Topic Questions and tasks proposed by managers, which can be discussed before their implementation. It also supports sending alerts by e-mail or by SMS, as has been described above.

All that information is also stored in the selected databases. It gives assumptions for creating of enterprise knowledge database, based on raw data, obtained from real managed processes. Regardless their time progress storage and accessibility of database accidents for all 24 hours daily are made the assumptions for intelligent management.

Conclusion

Enterprises need much more often to manage their processes as soon as possible. Therefore, managers have to dispose with very specialized information that allowed them to make the right decisions at the right time. It increases the need to be well informed about what has happened in the company, it means, about the accidents or unexpected events and their causes. It increases the amount of information that all about the accidents or unexpected events and their causes. It increases the amount of information that should be processed promptly and verified their authenticity. Therefore, it increases the role of intelligent management solution, supported by right information of controlled processes.

Currently, there are a few such systems that allow managing, monitor and, at the same time, to create a feedback between all processes and their management by electronic means and in real time. There was presented the solution how to obtain detailed information from controlled technology. We explain solution based on the combination of hardware and software solution and their management via electronic ways.

It is offered solution that solves the problem related with creation of unified access to controlled technological processes from many various user platforms, as well as making available the sophisticated data analyzes by using of built-in analytical tools.

Designed web application solves the problem, which often occurs in practice, due to incompatibility of data, obtained from controlled processes. Storing of measured data into online databases, its transportation, processing, analyzing and comparing with knowledge databases of accidents or events, create the assumptions on finding the right solution of managed situations.

At present, there are a lot of available programs, designed for data analyzes, but most of them are intended for single-use statistical data processing. The issue of data transfer and storage in the database tables as a result of long-term monitoring, its analyzing, evaluation and their visualization is not as a common part of offered software solution or it is not comprehensively supported work with these forms of data at all.

Described web server/client application solves this kind of working with data complexly and combines them into one system: it integrates the measurement of data and its visualization with intelligently created base for decision-making where knowledge forms online knowledge database of events or accidents. In this way, the application extends the support of mutual communication with users and complies with the specific requirements and demands.

To be well informed that is the way how to get relevant information and to achieve competitive advantage.

References

1. M. Pomffyová, M. *Process Management*, (2010)

2. T. Hiltbrand, Learning Competitive Intelligence From a Bunch of Screwballs. Business Intelligence Journal, **15**, 8-16 (2010)
3. F. Bartes, *Competitive Intelligence – Základ pro strategické rozhodování podniku*, (2012)
4. Z. Molnár, J. Střelka, Competitive Intelligence v malých a středních podnicích. E+ M: Ekonomie a Manažment. **3**, 156–169 (2012)
5. L. Štefániková, M. Rypáková, K. Moravčíková, The impact of competitive intelligence on sustainable growth of the enterprises. *Procedia Economics and Finance*, **26**, 209-214 (2015)
6. http://www.cs.cf.ac.uk/Dave/Internet/node51.html.
7. http://searchnetworking.techtarget.com/definition/TCP-IP.
8. https://www.enviroportal.sk/en/about-enviroportal.
9. https://www.enviroportal.sk/environmentalne-temy/starostlivost-o-zp/pzph-prevencia-zavaznych-priemyselnych-havarii/poziadavky-vyplyvajuce-zo-zakona/.
10. www.allsystems.sk
11. http://www.opcdatahub.com/WhatIsOPC.html.