INFORMATION SYSTEMS FOR TECHNOLOGICAL DATA WITH SUPPORT OF INTERNET OF THINGS

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ABSTRACT:

The paper has focused on possibilities of interconnecting information sources concerning monitoring & control of mining industry technical processes (TP), and the related safety hazards. The key issue is the comprehensiveness of the information presented to users. Information can be presented by virtual reality means, when the seemingly true presentation of the production process scene along with user friendly presentation of related information is available. The user in its role of a process supervisor is not only a mere scene observer but, thanks to the interactive functions of virtual environment, he participates in the scene of his control. As such his control and management abilities increase because he can absorb, more easily understand and asses the information provided.

KEYWORDS

Information technology, mining process, Internet of Things, process control

INTRODUCTION

The Internet technologies are of advantage for people who work with information as it is irrelevant where and in which form the information is stored. The information user simply does not need any special program, X, to retrieve the information required and it is of little importance in which file, Y, this information has been put. What is only needed is the existence and knowledge right reference or link.

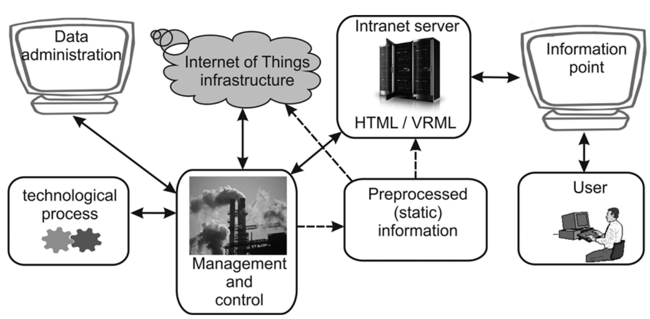

Figure 1 – Basic parts of information system based on Internet of Things

Fig. 1 illustrates a basic information system (IS) structure inclusive data flows that represent both the information demands and the ways of meeting them.

Any Intranet structure provides for interrelated exchange of information for people, who work for the given organization. It is essential that the Intranet structure serves the purpose of a unifying hub for different information flows.

The basic components for this information system are represented by the WWW server, which processes client demands in that it sends them HTML or VRML (Virtual Reality Modeling Language) documents, and a suitable browser facility that makes these documents visually accessible. As such, these components are fully Internet compatible, which implies some advantages.

INFORMATION SYSTEM

The most precious feature of any information system is the quality of the information it can provide. It is about the information topical and temporal accuracies. These qualities are instrumental in structuring information into specific groups that also implies storing conditions of the information for visual presentation within the information system.

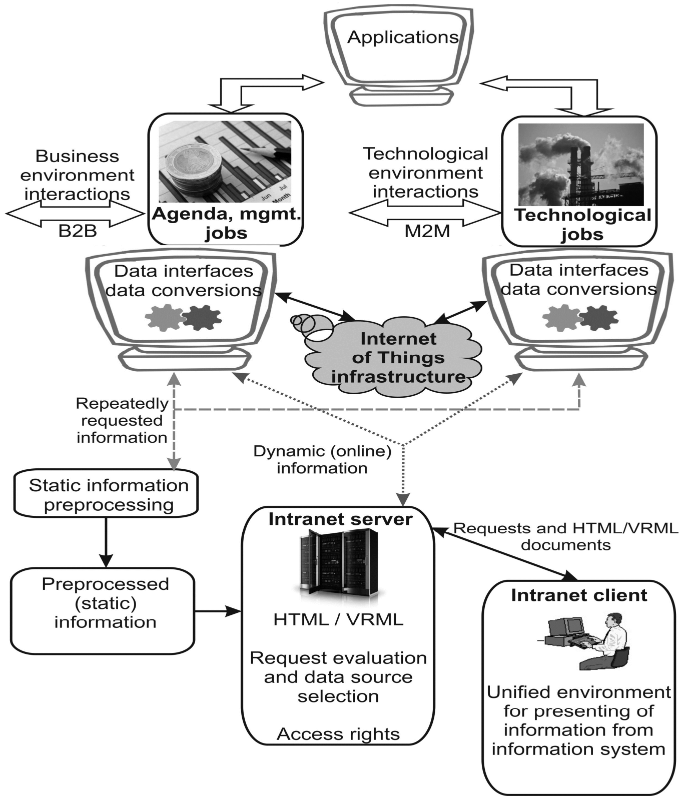

Figure 2 – Basic data interactions [2]

It is of advantage to put information of constant topical and temporal parameters into the HTML or VRML documents that are readily provided by the Intranet. These documents are usually manually or automatically created at the moment, when all the necessary information has been made available. This category of information is typically represented by product specifications, annual reports, past economic performance parameters, etc.

The presentation of technical process data, which change much more rapidly, is another issue. If these are to be relevantly visualized, their presentation must be on a par with the speed of their change. Principally, it might be possible to take advantage of the method mentioned above but it would be rather impracticable for the corporate Intranet application as the number of 'static' documents needed is disproportionally high and sometimes their completion implies inacceptable information delay, which in fact means its irrelevance.

Much information should be presented on-line with minimum delay. This can be realized by incorporating special modules into the control systems. On request, these modules can either directly generate a HTML document or at least yield data that can provide for creating and instant presentation of such document by some accessory programs. The server can start tasks on request from users, who formulate their queries in some appropriate language (for example SQL database or control system) and receive data or directly the documents generated.

Another advantage of the Intranet technologies can be taken for visualization of technical processes, namely the VRML documents that depict the scene in three dimensions. If a suitable browser is available, there is an interactive movement in all three dimensions possible in the scene. Nevertheless, not all production technology visualization software facilities have this 3D ability and therefore both technologies complete each other. The 3D scene interactivity option is considered to be its matter-of-fact characteristics, and incorporation of detail or supplementary references is also possible. As it has been already mentioned, the SCADA (Supervisory Control and Data Acquisition) systems provide for supervision control, i.e. for a higher level of control. By the higher level is meant the fact that the logic of controlling a production process is defined beyond the SCADA level, namely on the PLC (Programmable Logic Controller) level. The data and production process control is structured in these levels: Production process per se; Data control and gathering layer; Communication layer (i/o servers); SCADA/HMI systems; Database; Corporate IS.

The production process represents the lowest level that incorporates means of process instrumentation (sensors and actuators) that provide for:

- Sensing and reading of values and measurement parameters. These are transferred to the superior PLC for further processing (thermometer, position or level sensor, etc.).
- Adjustment of action element values. These are again adjusted by the PLC, for example starting an engine.

A step higher above the production process, there is the layer of data gathering and control. This layer is realized by programmable logic controllers (PLC) and Real Time Units (RTU) that ensure control of technical processes. The reason for employing such control level and not the SCADA level is in the 'closeness' to the production process itself, which is not separated by a complex communication structure but the connections are direct. Another reason why this kind of control is used is in its operation speed and reliability. On the same level, there can be also put the remote inputs and outputs as PLC data feeders or they can directly send their signals to SCADA systems.

MONITORING AND VISUALIZATION

The majority of the SCADA/HMI systems provide for a simple intuitively led creation of the Human Machine Interfaces (HMI). A clear arrangement enables creation of display and control basically geometrical elements (line, circle, ellipse, rectangle, polygon, etc.) and key elements for displaying numeric and text values. For creating of complex objects, which represent technical equipment elements, an advantage can be taken of already predefined graphic elements, such as tanks, pipes, boilers and other technical equipment parts. The HMI creation programs usually contain a large number of such building blocks stocked in large libraries. They can provide for a fairly realistic depiction of technical processes, which makes for their easy operator's control. The individual HMI building block bonds are represented by specific technical process variables, and specific behavioral situation rules are attributed to them. This can be implemented by the so called animation links. They ensure certain dynamism of the whole application because they enable HMI depiction changes related to the condition of individual technical process variables. [4]

The advantage of combining classic SCADA/HMI software with the ActiveX element extensions consists in the fact that the classic interface provides for both the overall communication with the technical processes and its superior information system. During the transfer and interpretation of variables, the ActiveX element ensures visualization by employing techniques of virtual reality. Some authors (Tadisetty) consider the classic HMI to be applications of virtual reality for purposes of technical process control.

The virtual reality space, VR, can be realized by various means. In view of the fact that the standard, X3D (former VRML) [1], is based on the text description of individual items and their properties, an extreme 3D provision possibility exists that would be realized by a simple text editor. Nevertheless, it is of better advantage and more efficient to use realization means implying graphical interface. Many of these exist nowadays, from ad hoc means for creating of simple virtual scenes to complex systems that facilitate both the design and creation of objects or even whole virtual scenes, as well as implementation of other functions. These systems developed by adding X3D functionality to standard products for CAD, CAM, animations and others. The 3D Studio Max is one of the products for creation of virtual objects.

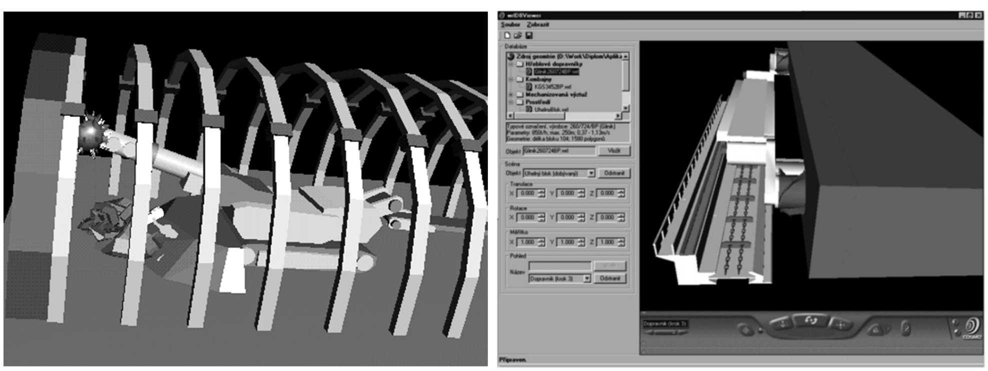

Figure 3 – Examples of particular technological scenes

The virtual scenes that represent production processes are very complex and their assembly from individual l items is only a first step to visualization and its utilization for control purposes. The virtual scene should imply interconnectivity of individual objects, access to specific production parameters either in real time or historic and trend perspectives. The presentation of the magnitude of dynamic data is only possible, if a dynamic link to the information or monitoring systems is realized. Many SCADA/HMI systems are functionally well- suited to provide for such links. With ever increasing interconnectivity of formerly atomic information systems, it is possible to represent visually ever increasing data quantities. Complex information on an object provides for virtual representation of objects' substantial qualities facilitating efficient decision making processes. At the same time, the user is not distracted by any redundant information.

Currently, it is common that linking of local information systems goes beyond boundaries of a single organization. The B2B (business) relationship implies access to some information system sectors beyond boundaries of one's own organization, and conversely the corporate information of one's own is being made accessible to other potential users. This trend increases concerning both batch processing and real-time data provisions. This occurrence is instrumental in the origin of the Internet of Things (IoT).

Presently, being based on the topology of individual processes and partial item quality representation, there can be created virtual reality production scenes also within the corporate information systems themselves.

MODELLING AND SIMULATION

A virtual scene generation is based on data that have been stored in an IS. It contains real-time technical process and spatial data [2], [3]. The preservation of gas flows is important in the mine, where production was terminated, and where methane gas leakage occurs. The CFD (Computational Fluid Dynamics) is a computational technology that allows creating models and simulation of the dynamics of flowing particles. The application of fluid mechanics in these virtual models can predict behavior of fluids.

Pre-processing is the first step in creating a new geometric model usually using CAD (computer-aided design) programs. Here, we have used the Gambit program, which combines two areas in one environment and can create geometric shapes and define a computer network. Gambit implies a networking tool that enables to import data from other CAD systems and to perform all the tasks necessary. Once a network of discretization has been created, it can be exported into various formats that can be processed by a lot of programs such as Ansys Fluent.

The spatial data resource is provided by the information system that contains the basic topological, administrative, and geographic data (mining areas, protected deposit areas, terrain relief, etc.). The management of spatial data is ensured by the ArcSDE application that provides for a custom implementation of spatial data that have been stored in separate larger databases.

Currently, programming of post-processing systems is being developed. The post-processing is necessary as elements of different size are employed by the model. The visualization assumes usage of blocks of unified size so that the results can be properly interpreted. The system developed should be able to import CFD program dynamic outputs as well as spatial data, process them, and present the results in the form of a dynamic 3D virtual scene with full X3D interaction. [7]

INTERNET OF THINGS

The concept of the Internet of Things basically refers to objects (things) and their functional processes, which necessarily implies the environment in which these things operate. The philosophy of the Internet of Things is based on approaches of ubiquitous, unremitting communication and sharing of data that relate to individual occurrences. The implementation of the concept of the Internet of Things enables observation and assessment of processes of which individual actions are fully automated thanks to providing the items of functional equipment with sensors as resources of independent information on the environment in which the things operate.

An indispensable condition for such implementation is the existence of a ‘lingua franca’ for the interconnected applications implying definition and full utilization of standards for identification, communication, and interoperability of systems .

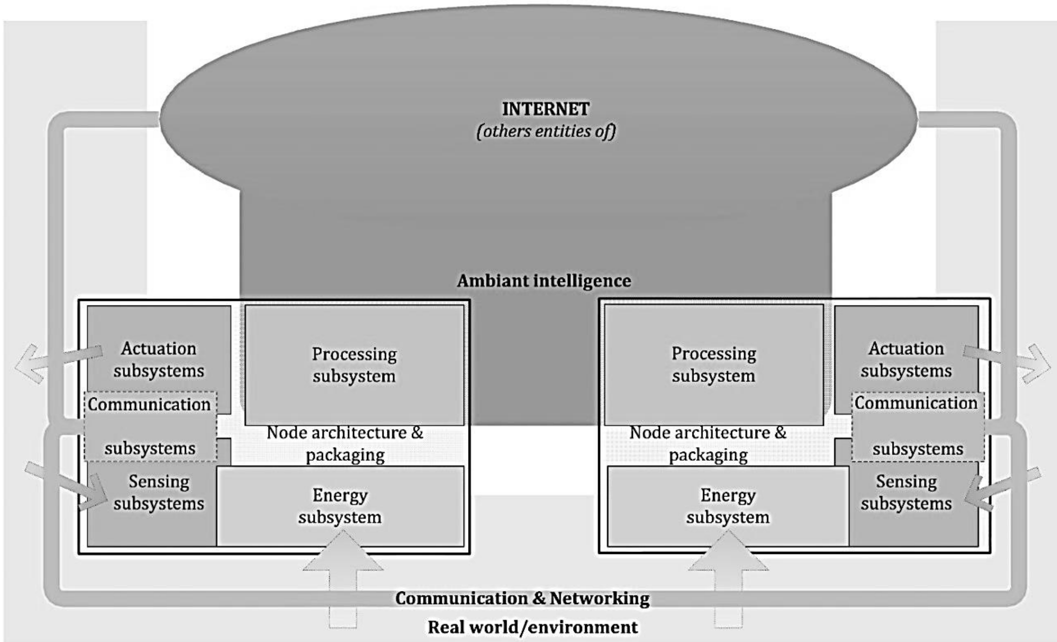

Figure 4 – A local view of objects in IoT [5]

This provides for observation of occurrences in their dynamic existence, which means that we can observe not only an object defined by static characteristics but we can assess its action vis-à-vis the operational environment (see Table 1):

Table 1 – Lifecycle events in IoT

What	• GTIN, EPC or other GS1 number indentifies an object • Manufacturing data such as lot codes and expiration dates • Transactional data such as a PO shipment or invoice number
Where	• A fixed location, which can correspond to a GLN • Location history, using trancaction records that document product movement or chain of custody
When	• Events can be date and time stamped • Elapsed time (e.g. time spent in frozen storage) can be recorded and reported • Electronic proof of delivery (EPoD)
Why	• The business process step that occurred (e.g. receiving, shipping) • State of the item (e.g. sealable, expired, in-transit) • Current conditions (e.g. temperature)

Nevertheless, practical applications of the Internet of Things imply asking ethical questions. If we take mining industry as an example, the ubiquitous monitoring concerns not only things but also people. Where are the limits of employee monitoring, what are the laws for workplace privacy and to what extent they binding? Any mining industry workplace implies high risks and personal-safety hazards. It is only logical to put saving of human lives before strict observance of employee privacy rights. Nevertheless, privacy by design should be a basic principal for collection and processing of data that refer to protecting of the staff privacy right.

CONCLUSION

The idea of the Internet of Things, i.e. *interconnect devices, products and people by Internet, and use the web as database (with hierarchical database model and specialized web query language)* and its realization, can provide for development of a production process model that would utilize virtual reality facilities to make the control of production processes more efficient. The web environment acts as interconnecting network of information sources and targets, whose number increases fast. Initially these were presented by and accessed through usual web servers in mostly flat, non-hierarchical structures. Nowadays, more sophisticated approaches and applications are being developed with a lot of synergy and team effort.

ACKNOWLEDGEMENTS

This paper has been developed under the aegis of the project "Complex Solution of Methan in Abandoned Mines – Revitalization of Moravia-Silesia Region", topic 35/L2-5 Information technologies.

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