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The potential of OPC technology for monitoring and maintenance of hydropower plants

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The paper presents a system based on the OPC technology that is used to collect process data obtained from eight hydropower plants situated along the Drava River in Slovenia. The system gathers a large amount of process data in the central historical database and makes it available to all potential users – from specialists that perform deep analysis of the power plants operation to the less experienced personnel. Currently, around 4000 measurements are saved in the Historian database and as the project continues, it is estimated that this number will grow above 10,000 in the next two years. The focus of the paper is to show a wide range of possibilities and advantages that arise from synergy between the OPC technology and the MATLAB/SIMULINK environment, especially in the field of maintenance of the hydropower plants. The paper also describes new emerging approaches where artificial neural networks are used for condition-based maintenance (CBM) of power plants.

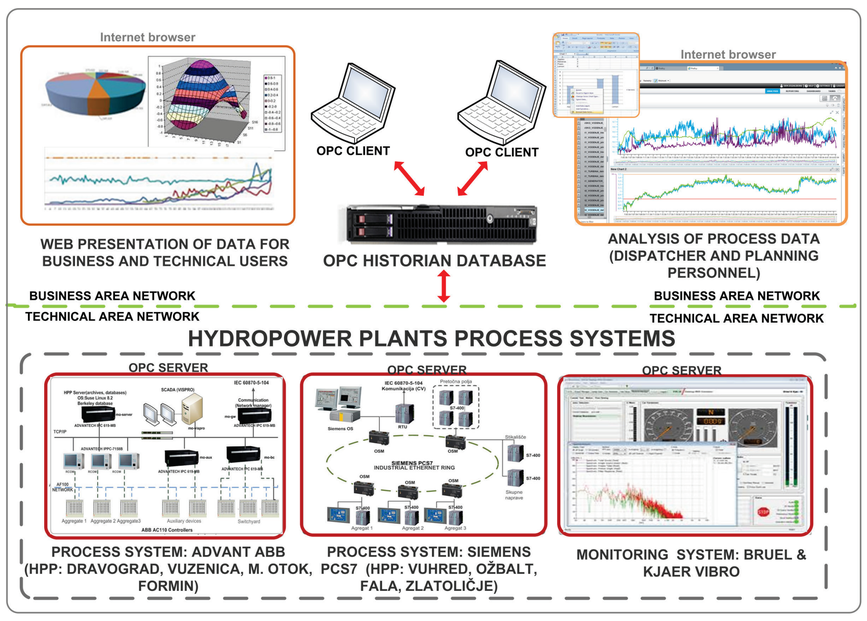

Fig. 1. The concept of the ZVAPS system.

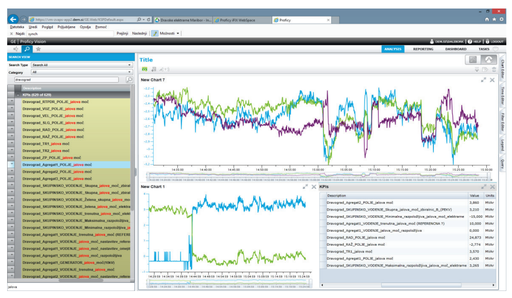

Fig. 3. The Historian Analysis tool.

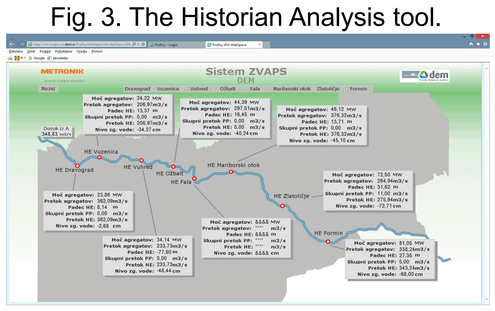

Fig. 4. The Web SCADA (Proficy iFIX) showing the chain of hydropower plants on the Drava River.

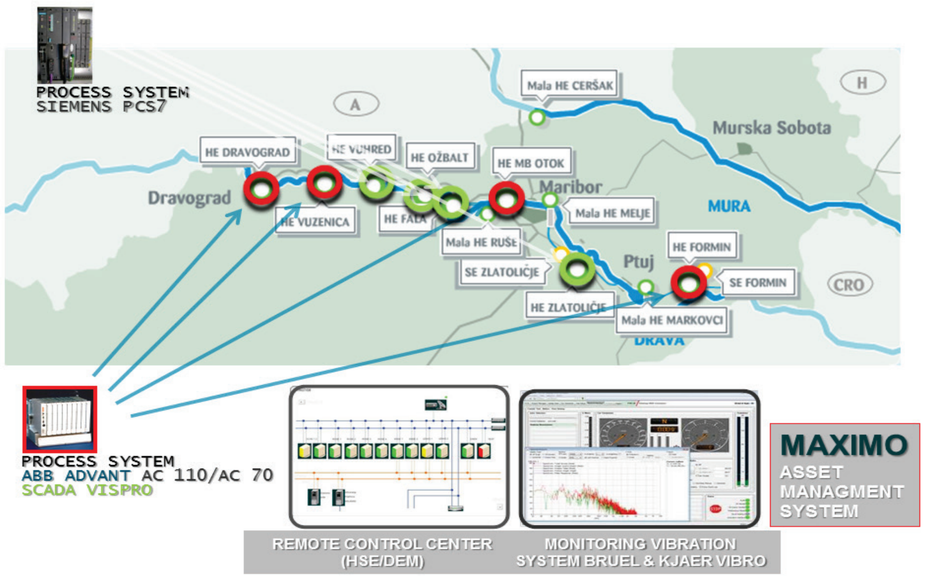

Fig. 2. Process/technical systems providing data to the ZVAPS system.

The ZVAPS system refers to the system based on the OPC technology that is used to collect, validate, analyze, present and centrally archive process data obtained from eight power plants belonging to the Slovenian Drava River Power Company (DEM). The idea of the system is to collect data from various sources (i.e. hydropower plants process/technical systems) and to represent it in a modern web-accessible environment (see Fig. 1). The system is built on Proficy Historian database (GE Intelligent Platforms) and accompanying tools: iFIX Web SCADA, Proficy Historian Analysis and Proficy Historian Calculation (Fig. 3-4). Around 4000 data points (measurements) are being collected, mainly in real-time, via the OPC protocol from various process/technical systems (see Fig. 2).

The availability of crucial hydropower plants data, gathered in the centralized database from various process/technical systems, holds an enormous potential for deep analysis of the hydropower plants operation. This potential becomes even bigger when modern mathematical tools, with the capacity of communicating via the OPC protocol, are being applied. Thus, with the possibility to access live and historical OPC data (i.e. OPC DA and OPC HDA respectively), the widely used MATLAB/SIMULINK mathematical environment allows a wide range of options in terms of data analysis. It was a logical step to foresee the potential of the MATLAB/SIMULINK environment and to include it in the second phase of the project, with the aim to perform complex calculations with data gathered in the Historian database (i.e. the measurements gathered from the hydropower plants) - see Fig 5.

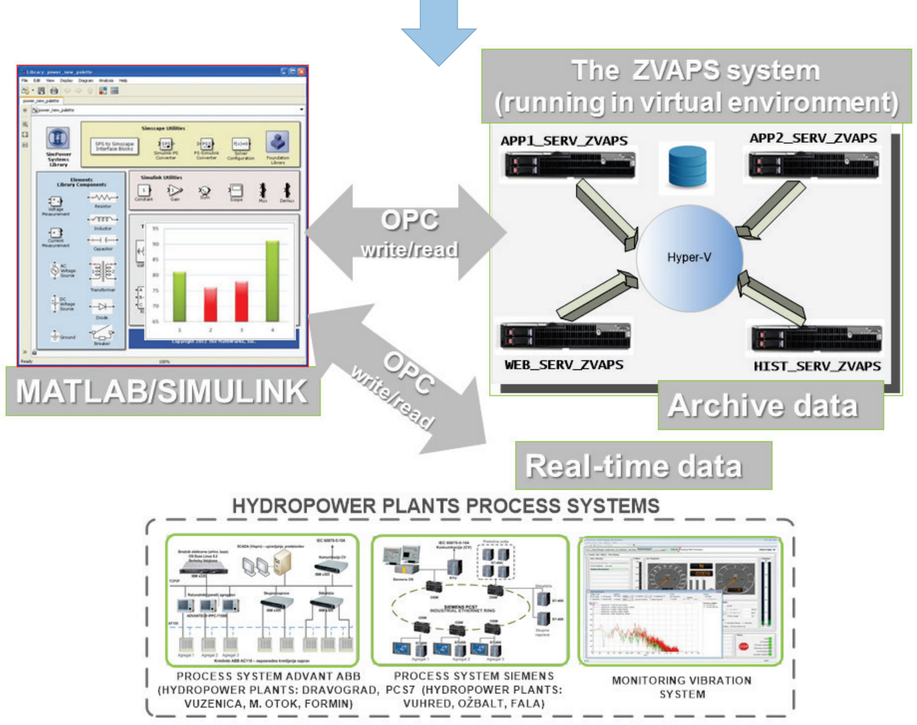

Fig. 5. Communication between MATLAB/SIMULINK environment and the ZVAPS system.

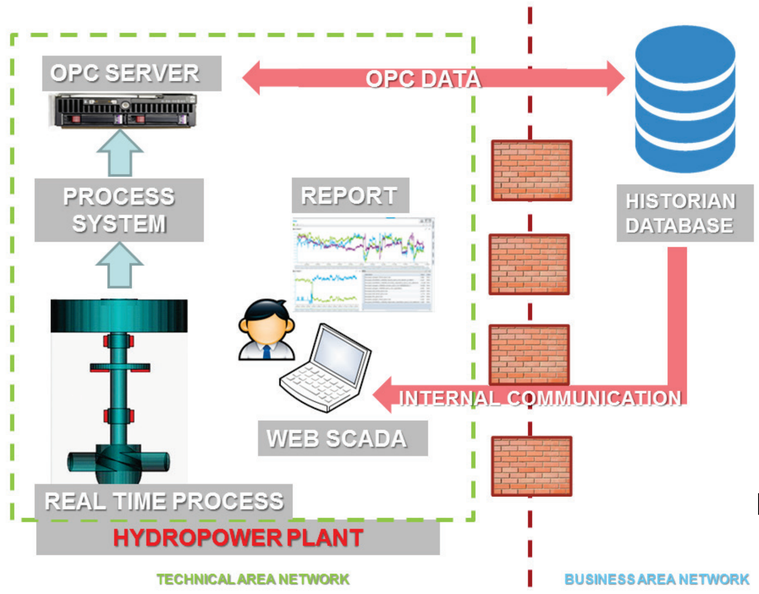

Fig. 6. Automated measurement system.

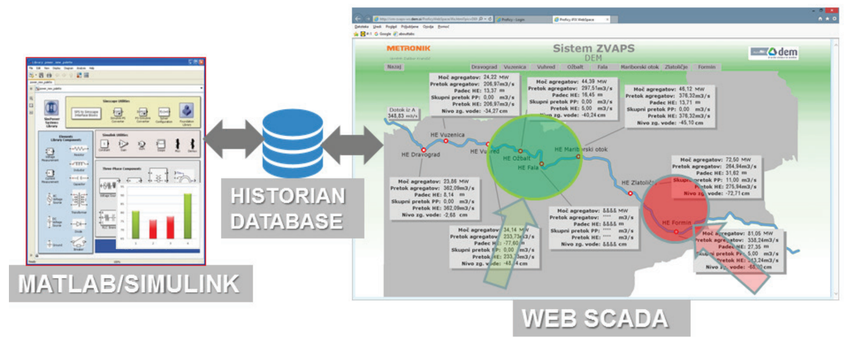

Fig. 7. Dynamic visualization of process data – an example.

The following new functionalities are being introduced in the second phase of the project:

- Integration of the vibration monitoring system **Bruel & Kjaer Vibro**.
- Creation of **automated measurement system** (Fig. 6).
- **Dynamic visualization of process data** – this feature allows dispatchers and planning personnel to visually track crucial parameters (e.g. rate of change of heads, discharge…) in the process of generation of power. The observed data is gradually colored depending on the current values (see Fig. 7).
- Public presentation of the process data on the company (internet and intranet) web pages.
- **Integration of the asset management system MAXIMO** (IBM) – the integration is performed by using the OLE-DB technology.

The simultaneous use of the MATLAB/SIMULINK environment and the OPC technology opens many new possibilities in the field of maintenance of hydropower plants. Indeed, there is a growing trend towards the use of the MATLAB/SIMULINK environment and the OPC technology in the CBM of power plants, with the particular emphasis on the introduction of artificial neural networks (ANN).

The ANN is used to recognize functional relationship between the variable determining the state of a certain component (i.e. the output variable of an ANN) and input variables assumed to have an influence on the condition of that component. To determine this functional relationship, the ANN is first trained offline by using as set of historical input and output data gathered during normal operation of the wind power plant. After completion of the learning phase, the real-time data (i.e. the control data) is applied to the ANN.

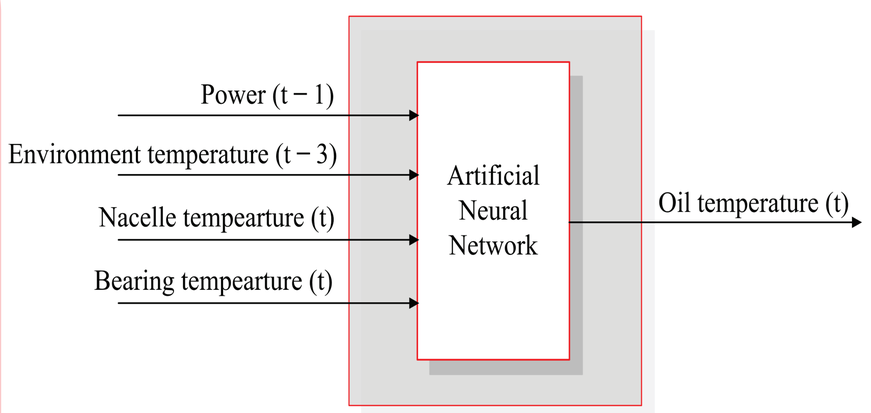

Fig. 8. An example of the ANN model used to monitor the health condition of the wind turbine gearbox.