Development of Tools for Accessing Data Retrieved from MES Software Applications

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Abstract

A MES (Manufacturing Execution System) is a system that companies use to measure or control critical production activities. Individual parts of this system can be used as a model for education. Students then can see how manufacturing systems work and which communication standards are used. The communication standards enable data acquisition, data processing, storing and their conversion for any production report. Furthermore interfaces for web clients allow displaying the raw or transformed data as text or graphic charts.
The development of tools for an access to the data retrieved from MES software is described in this paper.

Introduction

MES (Manufacturing Execution Systems) sometimes called the CPM systems (Collaborative Production Management), are used for production measurement and control. When a company implements this system correctly, the productivity and quality of production will increase, because of the very important processing and validation of production data which MES systems offer.
Figure 1 represents the classical structure of company information systems.

Figure 1 Company information systems structure

MES system is reading real time data from processing systems and saving them into an archive. These data are validated, converted and aggregated. During aggregation data size is reduced. After this procedure data are prepared to be transferred into a superior system (ERP systems for example).

Usable communication standards

Communication standards which are used in MES systems must be chosen very carefully, because these standards define system accessibility, stability and security. Company information systems are usually using communication standards on three levels. The first level represents an interface between processing systems and the MES system itself, the second level represents communication between the MES system and databases and the last, third level is between databases and ERP systems or presentation environment. The following text describes the standards which represent these mentioned layers and fulfill requirements of MES systems.

OPC

For real-time data acquisition the OPC (OLE for Process Control) standard can be used, more precisely OPC DA (OPC Data Access). This standard is based on OLE COM and DCOM technologies. This specification defines a set of standard objects, interfaces and methods for production applications.
In this time a new version of OPC is available, namely OPC UA (United Architecture). OPC UA is optimized for web services and it is simpler and more secure than old versions. The OPC standard fulfills the requirements for the first level of information systems.

ADO.NET

ADO.NET is a pack of software components which are used for data access or data services access. These components are implemented in the Microsoft .NET framework. This standard has many advantages, like usage in offline applications, it supports many programming languages or it can access data in different data sources.
ADO.NET is mostly used for access to all databases types or to data access via web services. This standard is usable for the second and third layers of the above mentioned information systems.

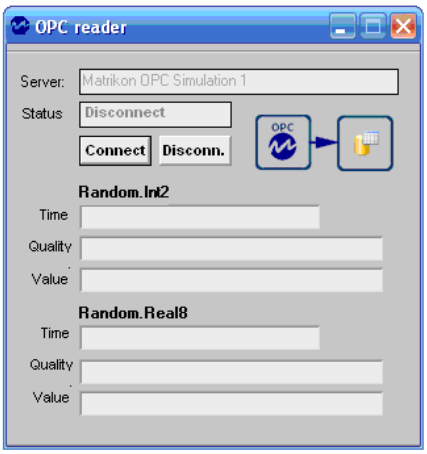
Creating simple MES system

For educational purposes it is useful to create a simple MES system which would use all mentioned standards and would fulfill basic MES functionality. In this simple example students can understand the meaning of data in MES systems and see the practical usage of communication standards in these systems. For simplicity it is better to choose the Windows platform.
The first step of creating a simple MES system is defining a real time data source. As a real time data source Matrikon simulating server can be used. This data source will simulate real data from the manufacturing processes.

OPC client

After we select a suitable data source, we have to create a program to read and store these data. The program will work with OPC DA standard.
Our real time application program will read data using OPC DA from a Matrikon simulation server, display these data on the screen (monitor) and save them into a database using ADO.NET. The database can be MSSQL version 2005 or higher (a relation database type is recommended). Functionality of this program will be simple: by clicking on the "Connect" button a procedure will start connecting to a simulating server and real time data reading. Real time data are displayed on the screen and saved into the database with its own timestamp (reading time). These simulating data can represent nitrogen and dust concentration, for example. Figure 2 represents a possible design of a OPC reader screen.

Figure 2 OPC reader screen



Real time data updating

Since data aggregation is very important in the MES system, we have to create a windows service to data re-computing as a second step. Re-computing means data conversion to statistic values, such as the maximum, minimum, average or standard deviation, etc. Data in this form are useful for managers or workers with decision making authority. Windows service will read real time data from a database using ADO.NET and re-compute them to statistic values in a specific period. This period can be each hour, for example. Converted data will be saved back in the database by ADO.NET standard. Windows service can be started automatically or manually.

Data presentation - web application

Data presentation is also very important. The most suitable form to present data is using web applications. The reason is simple: web applications are accessible from many locations and you don't need to install special software. You only need a connection to the internet.

We can present real time data or statistic data as well. Both choices are needed, because of the data meaning - real time data may be more useful for service engineers and statistic data for managers.

Presentation of these data can be carried out by two techniques. The first technique is displaying data in a text form (values), the second technique is displaying data as figures. Both techniques are essential. A text form can show us the exact numbers which are important for data verification, a graphical form (figures) will show us a better overview about production data in a selected period. In Figures 2 and 3 possible data output are presented (text and graphical forms).

As we suggested before, a web application will read real-time and statistic data from a database using a ADO.NET standard. Data to the text output will be shown in the tables and data to the graphical output can be drawn by a common class which we can program ourselves.

A very important functionality in this type of web application is updating data. Sometimes errors can occur (in production systems) and you will get wrong data into the database. To handle this situation you must have the possibility of changing wrong values by a manual entry.

Figure 3. Web application data output in a text form

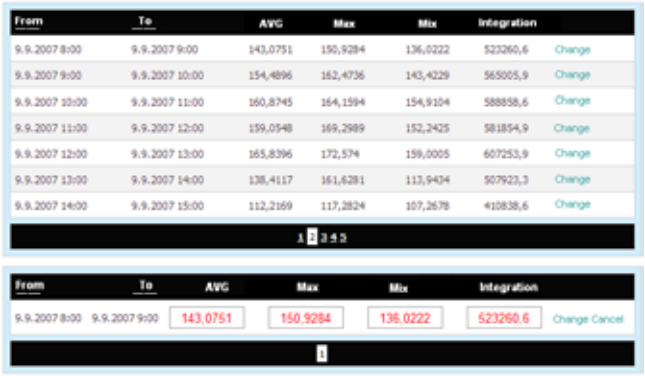
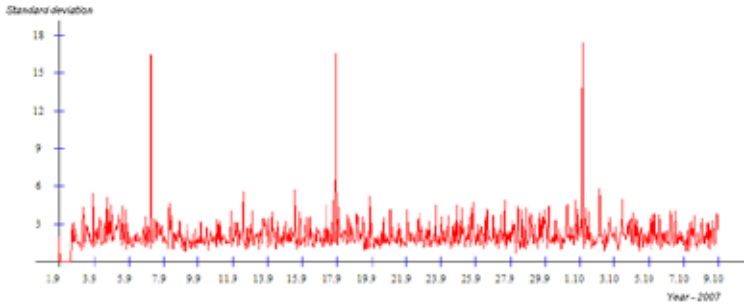


Figure 4. Web application data output in a graphical form



Web applications with this kind of data have to be secured. For this purposes the .NET security provider can be used which is implemented in the .NET Framework. The .NET security provider offers quite a good landscape for programming and it is easy to use. Students don't have to program their own security provider.

Data presentation - web service

An additional feature of MES systems can be the web services. Web services are recently being used increasingly. They are very simple and stable methods how to provide data to the end users (customers). Production or statistic data can be displayed using web services with the same output (text and graphical forms) as in web applications. The great advantage of web services is that customers don't have to implement complicated classes for the data reading. They will only append a few rows with a programming code to their web sites and they will be able to use a web service.

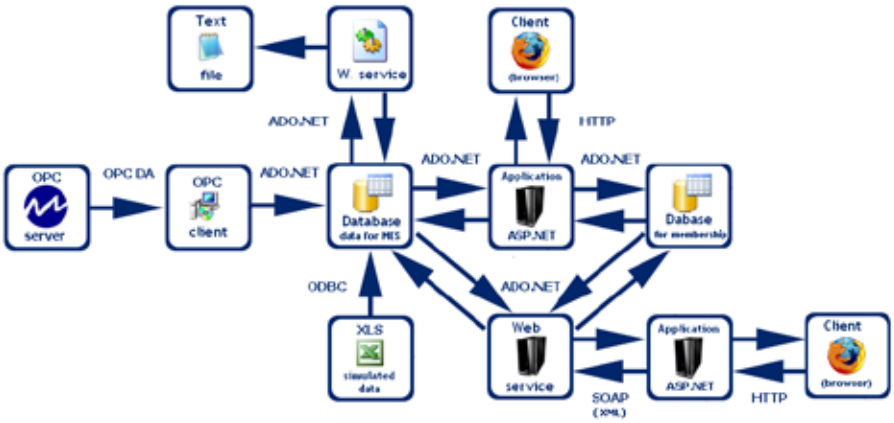
Manipulation with data is almost the same as in web applications, the difference is only at the input – the data are getting in XML format using the ADO.NET standard.

Our web application (mentioned above) can contain a web service class which will work up data to the XML output and send it out to a web service reader. A web service reader will be basically the web application too; the only difference will be in data input. The functionality will be the same (data displaying and updating). As we mentioned earlier, every application with this type of data has to be secured. Our web service reader can be secured by the same security provider as a web application. The same users will be able to login. This functionality will be implemented by logon tickets. Each user will get his/her own ticket after a successful login and with this ticket he/she will be able to browse an application and see all data. The ticket verification will be proceeding on the web application server (not on web service reader server).

Conclusion

This article deals with communication standards in MES control systems. The main point of this work is to help students to easily understand how real production systems work and how communication standards can be practically implemented in these systems. For educational purposes a sample MES application was created and described which meets all the requirements.

Figure 5 Sample MES system overview



A OPC client reads real time data from a Matricon simulating server using a OPC DA standard. These data are stored in the SQL database with their time stamps using the ADO.NET standard. Each hour data is read from a database by a Windows service, which is re-computing these data to statistic values. These processed data are saved back in the database. Statistic values and real time data are presented on a secured web application in a text or a graphic form. An authorized user can change wrong values. The last part of this system is the web service. By using its functionality users can simply read real-time or statistic data from company production and they don't need to program compli-

cated classes for data reading.
If students understand the structure of this example and the implementing process, they will be able to operate with various production systems live in their practice.

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