Evolution of Exaquantum to Accelerate Effective Use of Plant Data

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Exaquantum is Yokogawa’s plant information management system (PIMS) software package. This is a core component of manufacturing execution systems (MES), and has evolved over more than 15 years since its release. The package was mostly used for applications in narrow areas such as using accumulated process data of distributed control systems (DCS) for monthly and daily reports. In the last few years, however, Exaquantum has been used by customers to accumulate data across multiple plants and analyze large amounts of process data and alarm messages in order to increase the operation efficiency of entire plants. Exaquantum R3.01, which was released in October 2015, has significantly enhanced data collection throughput and increased the maximum number of tags that can be handled while ensuring a real-time characteristic for improving plant operation efficiency. This paper describes technical features and improvements in R3.01, and introduces its solutions.

INTRODUCTION

Expectations for big data and Industrial Internet of Things (IIoT) have increased in various industries. However, effective use of plant data as big data requires know-how to turn a meaningless sequence of numbers into meaningful information. As a manufacturer of measuring instruments and a supplier of distributed control systems (DCS) who knows everything about plant operations and the significance of data, Yokogawa has a unique approach to committing itself to the fields of big data and IIoT and has strengths that show the significance of its commitment in those fields. Exaquantum is a plant information management system (PIMS) software package that was initially developed not only to provide a process data historian but also to provide such standard functions as those of collecting and accumulating event messages and closing data to ensure that information is made available to users when and in the form it is needed[1].

Over the last several years, Yokogawa has expanded its lineup of products for total solutions by providing a wide range of sensors used in plants, such as those for pressure, temperature, flow rate, and vibration, in order to allow users to concentrate on the diagnosis of the equipment conditions and the prediction of failures. This enhancement has rapidly increased the amounts of data that are measured and accumulated, and the analysis of the large amounts of data enables users to understand more about the behavior of plants.

On the one hand, an increase in the types and amount of data that can be collected provides various benefits, but on the other hand, systems have difficulty in handling large amounts of data. To ensure the various types of data measured in plants can be accumulated reliably, the data must continue to be accumulated without loss while ensuring the real-time characteristic of databases. To meet this requirement, the data collection throughput must be enhanced and the disk access speed for writing the collected data to disk must be increased.

To resolve those issues, Yokogawa has enhanced the performance of Exaquantum and released R3.01 in October 2015. This paper describes the improvements and technical features in Exaquantum R3.01 and presents the solutions that can be provided.

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EXAQUANTUM R3.01

Functions Required by Users

The demand of users to be able to analyze the relationship between trend data and alarm messages to improve the operation efficiency has increased over the last few years. To meet this demand, PIMS must be able to collect data from many tags corresponding to the sensors and accumulate it in the database with a high throughput.

Also the demand of users to be able to view the accumulated plant information using a tablet or smartphone on site to improve the operation efficiency in the field where the equipment is installed has become greater.

Technical Improvements to Handle Large Amounts of Data

To be able to accumulate data with a high throughput, the following two technical improvements on the previous version (R2.85) have been made in Exaquantum R3.01.

The first improvement involves the queue structure. In the previous version, write requests to the database are stored in a single queue and processed in sequence, but processing cannot manage to handle large amounts of data in this structure. To address this problem, the architecture has been modified so the queue is divided into segments for the three types of requests: calculation, aggregation processing, and OPC and manual tags, and can perform write processing to the database in parallel as shown in Figure 1.

The second improvement involves the database engine. Exaquantum incorporates Microsoft SQL Server as the database engine. So the database engine has been modified so it uses only 64-bit SQL Server and 64-bit native OS to make best use of the benefits of high-speed hardware such as CPU processing speed and HDD disk I/O.

These improvements enable the R3.01 to execute the processing of large amounts of data in real-time without loss.

Performance of Exaquantum R3.01

The technical improvements described above enable the R3.01 to be used for systems with a very large number of tags and have enhanced the basic performance such as data collection throughput. Table 1 shows a comparison in the performance with the previous version. The number of tags that can be processed and the processing speed have increased significantly from the previous version.

Table 1 Comparison in performance between previous version (R2.85) and R3.01

<table>
<thead>
<tr>
<th>Comparison item</th>
<th>R3.01 performance</th>
<th>Comparison with R2.85</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data processing speed</td>
<td>Max. 600,000 tags/minute</td>
<td>×6 faster</td>
</tr>
<tr>
<td>Number of tags collected per server</td>
<td>Max. 500,000 tags/server</td>
<td>×5 faster</td>
</tr>
<tr>
<td>Time from server start to data collection start</td>
<td>—</td>
<td>×10 faster</td>
</tr>
<tr>
<td>Number of connectable OPC servers</td>
<td>35 per server</td>
<td>×2 units</td>
</tr>
</tbody>
</table>

To be able to analyze the stored tag data, the detailed plant behavior must be understood, and to do so, the data must be as accurate as possible. As a result, the amount of data tends to increase, because, for example, data is accumulated at one-second intervals instead of the one-minute intervals up until now. R3.01 provides enough performance to meet this demand.

Figure 1 Change in method to access data in R3.01
Increase in Field Operation Efficiency

Exaquantum R3.01 provides a function to check the plant data using a tablet as shown in Figure 2 in an attempt to improve the field operation efficiency. At the same time, a Web function to view the plant data from the website has also been enhanced to increase operability.

![Figure 2 Viewing trend data on tablet](image)

PROPOSAL OF SOLUTIONS EFFECTIVELY USING ACCUMULATED DATA

Exaquantum 3.01 allows users to accumulate large amounts of various types of data, such as process, event, and alarm data, and to implement solutions by effectively using such data.

With plant operation becoming increasingly complicated and sophisticated, in particular, the importance of alarm management for safe plant operation is increasing every day. Under these circumstances, an alarm solution for managing the proper alarm settings and operation came into the spotlight as an application to effectively use the accumulated data.

Functions to Implement Alarm Solution

The following three functions are required to implement the alarm solution.

- **Sequence of Event Recording**
  This function records and displays the alarm information. It can be used to investigate the cause and prevent recurrence when equipment fails due to an unexpected shutdown or trip (one of the abnormal plant conditions).

- **Alarm Reporting and Analysis**
  This function displays the number of times and frequency of alarms. It allows users to check whether the alarms are set properly without causing an unnecessarily large amount of alarms to be generated, thus helping users design the alarms.

- **Alarm Management Database (Management of Change)**
  This function supports the alarm change management, monitoring, and documentation in those processes based on the ANSI/ISA 18.2-2009 (2) standards (ISA 18.2), which define the requirements and recommendations for the alarm management lifecycle.

The following describes each of the functions.

Sequence of Event Recording

This function provides the accumulated system alarm, event, and process data via an interface that makes it easy for users to view the data visually. As shown in Figure 3, the trip alarm sources and categories are displayed for each alarm to help users analyze the root cause of the alarm and the process conditions in plants, as well as to help users prevent recurrence and reduce the alarm generation frequency in the future.

![Figure 3 Trip analysis screen](image)

Alarm Reporting and Analysis

This function allows users to easily visualize the alarm information by effectively using 38 report templates conforming to the ISA 18.2 described above, the Engineering Equipment and Materials Users Association (EEMUA) 191 standards for the design, management, and procurement of alarm systems, and the IEC-62682 alarm management standards, whose first version was published by the International Electrotechnical Commission (IEC) in October 2014. These templates cover the overall plant management, including performance check, operation, and maintenance.

For example, the display on the dashboard shown in Figure 4 allows users to understand the outline of alarms on the summary report screen and to identify more about the situation by displaying more information. This function can also be linked with DCS and supervisory control and data acquisition (SCADA) systems to analyze the alarms in the overall system.

![Figure 4 Dashboard display](image)
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Alarm Management Database

This function supports the alarm management, monitoring, alarm settings, behavior auditing, and documentation based on ISA-18.2. Figure 5 shows the coverage of the alarm management database (alarm DB) by comparison with the alarm lifecycle improvement model in ISA 18.2.

Comparison of the alarm management change, monitoring/assessment, and auditing information accumulated in the alarm DB with the process, alarm, and event data accumulated in the plant information management system allows users to check the alarm settings and plant conditions by associating them with each other. This enables managing the plant alarm lifecycle more effectively. In addition, if the data access needs to be limited for each user role, the security can be set by linking the alarm management DB and PIMS.

Figure 5 Alarm lifecycle improvement model

Exaquantum Solution Deployment

Exaquantum implements these three alarm solution functions using the following products.

- Sequence of Event Recording
  Exaquantum/SER (Sequence of Events Recorder)
- Alarm Reporting and Analysis
  Exaquantum/ARA (Alarm Reporting and Analysis)
- Alarm Management Database
  Exaquantum/AMD (Alarm Master Database)

In addition to those alarm solution functions, Exaquantum provides multiple solutions to improve the safety management, production management, and operability for operators. Those solution functions are products created by Yokogawa based on its experience accumulated in various industries and projects, and new solution functions will be added to solve the problems of users in the future.

FUTURE OF EXAQUANTUM

As described in this paper, the architecture of R3.01 has been improved to ensure that large amounts of data can be collected and accumulated in real-time without loss to cope with the big data and IIoT. In the next release, the data export function will be enhanced to smoothly transfer the data to the analysis functions. In addition, the convenience in using the data accumulated in Exaquantum in the service to solve problems of users provided by Yokogawa will be increased, as well as the functionality to ensure users can effectively use the accumulated data for analysis without feeling stress.

Furthermore, one of the future development items under consideration is support for the OPC Unified Architecture (OPC-UA). OPC-UA is a highly versatile communication architecture standard that is independent from the platform, has a high level of security, and has an information model structure, which can work as a standard interface of the IIoT age. Providing compliance to OPC-UA will improve security, protect user systems against rapidly increasing vulnerabilities, and provide value in terms of safety.

CONCLUSION

Exaquantum is expected to be a platform to support the effective use of plant data in the future. To meet this expectation, Yokogawa will increase the data collection throughput and the maximum number of tags, and enhance the integration platform upon which new solutions can be developed and deployed. New versions of Exaquantum will be continuously released to ensure Yokogawa will be able to provide solutions to solve the problems of users.

Without adhering to product categories such as DCS and PIMS, Yokogawa will provide an environment that allows users to effectively use the integrated data, in addition to the improvement of the human machine interface (HMI) that interfaces between operators and systems. Exaquantum will continuously evolve with a focus on adding value for customers.

REFERENCES


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