Integration Architecture Design and Application in Digital Mine

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Abstract. Integration plays an important role between enterprise system and control systems. ISA-95 is an international standard to develop the automated interface and MII is a platform to do data exchange between various systems. In this paper we use ISA-95 standard to establish the integration architecture and use MII platform to achieve integration in a digital mine.

Introduction
Within any mining operation, there is a requirement for a multitude of manufacturing and expert systems, such as manufacturing execution system, laboratory management system, and fleet management system, in the mining and plant operations. The mine, typically also requires a business system that takes care of functions such as accounting, materials management and plant maintenance. With many of these systems performing complementary functions, there is a definite need for integration of certain transactions and data points between these systems.

In the past, there has been a tendency to integrate these systems on a “point to point” integration basis, as and when required. Although this method does deliver system integration, it creates a complicated integration that is inefficient, prone to failure and costly to maintain.

In terms of modern enterprise architecture, best practice dictates that modern enterprises need a good integration architecture and effective integration platform when connecting various shop floor systems and business systems together during building up digital mine which is supposed to achieve manufacturing automation, management and controlling integrated, decision-making visualization. It’ll reduce the complexity, increase the efficiency of integration landscapes and create a harmonized data landscape.

Methodology
One international standard ISA95 and one integration platform MII (Manufacturing Integration and Intelligence) is brought in to achieve the effective integration target. ISA-95 as it is more commonly referred, is an international standard from the International Society of Automation for developing an automated interface between enterprise and control systems. This standard was developed to be applied in all industries, and in all sorts of processes, like batch processes, continuous and repetitive processes [1].

ISA-95 has 5 Levels. Level 0 defines the actual physical processes. Level 1 defines the activities involved in sensing and manipulating the physical processes. Level 2 defines the activities of monitoring and controlling the physical processes. Level 3 defines the activities of the workflow to produce the desired end-products. The time frame is shifts, hours, minutes, seconds based. Level 4 defines the business-related activities needed to manage a manufacturing organization [2]. The time frame is months, weeks, days, shifts based. The ISA-95 levels are shown in Fig. 1.
MII (Manufacturing Integration and Intelligence) is an SAP application for synchronizing manufacturing operations with back-office business processes and standardize data. If functions as a data hub between SAP ERP and operational applications, such as manufacturing execution system, and provides analytics and workflow tools for identifying problems in the production process and improving its performance.

As its name implies, MII consists of two main components. The integration component uses Web standards, such as the XML and the java programming language, to link SAP ERP and related business applications, with plant floor applications in a consistent user interface. It employs web server technology to extract and aggregate data from multiple sources and make it accessible from a variety of devices.

The intelligence side is intended to provide real-time analytics of manufacturing operations, using visualization tools and dashboards to show key performance indications and alerts [3]. MII could not only extract data from SAP and provide real-time visibility and distribution equipment of driver instructions, environmental info etc., but also could perform transaction execution info SAP to enable automated, plant-level creation of equipment health check, event data, engine data and maintenance notifications etc. MII delivers computer-integrated manufacturing, industrial Internet of Things and machine-to-machine capabilities, real-time manufacturing intelligence to boost employee productivity by delivering actionable information to the shop floor, to enterprise-wide insights from real-time event processing, and to sync the shop floor with SAP ERP and manufacturing execution system processes.

Based on the ISA-95 international standard and MII platform, the integration architecture is designed in a uranium digital mine. It is built up from level 0 to 4, which includes equipment, instrument, interpreter, manufacturing operations management system, and management application systems and reports. In mining area, the operational data of survey equipment, trucks, shovels, support fleet could be gathered through loggers, measuring instruments and monitoring equipment and then be stored in mining related management system such as fleet management system, survey software, fuel management and tire management system. If there’s data exchange requirement between some modules such as FICO, HR or MM in enterprise management system SAP ERP and the
Mining systems, MII will play an important role in this regard. It’s the same theory with the integration in plant area. The integration architecture is shown in Fig. 2.

Application

Manufacturing execution system (MES) is a key system in processing plant. In order to achieve data exchange between MES and the core business management system SAP, MII is used to do the integration between these two systems. The MES system resides on the company management network and data is acquired from the PCS Network as well as other systems. It has been decided that data from MES shall be transferred to a data warehouse by means of ETLs (Extract, transform and load transactions); MII shall connect to staging tables in the data warehouse to retrieve MES data via a JDBC connection. JDBC is a Java database connectivity technology developed by the Oracle Corporation. It is an API (for the Java programming language) that defines how an application (or client) may access a database. It exposes methods for querying data from and writing data to database.

The exchange data of MII-MES, MES-MII, SAP-MII, and MII-SAP are listed out and the high level interface architecture between MES and SAP is shown in Fig. 3.

1. Outbound from MII to MES
   - Planned Maintenance Notification [MES01] [M1 & M3]
   - Unplanned Maintenance Notification (Status) [MES02] [M2]
   - Calibration [MES04]
   - Material Stock Level [MES05]
   - Ore Movements (Real-time) [MES06]
   - Ore Movements (Recon) [MES07]
   - Ore Stockpile (Recon) [MES08]
   - Stock Movements [MES09]

2. Inbound from MES to MII
   - Production Actuals [MES57] - MIGO
   - Material Consumption [MES58]
Conclusions

In this paper, ISA-95 standard and MII platform is introduced. MII plays an important role in the integration between enterprise business system SAP and plant/mining control systems in a mine. The project development should take further to solve the current information isolation island issue.

References

