Automated data integration system at the aircraft factory

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Abstract. The paper discusses the experience of introducing a developed automated system for integrating data directories from various, often unrelated and heterogeneous, information sources at the aircraft manufacturing enterprise Aviastar-SP JSC (Ulyanovsk, Russia). This automated system allows both manual and automatic modes to integrate the databases of directories used at the enterprise. To test the operability on real data, the developed system went through trial exploitation and gave good results.

1. Introduction
In the past few years, various automated systems (AS) have been introduced at machine-building enterprises for managing the enterprise’s resources, for designing the design part of the product, for developing technological processes for manufacturing designed parts, as well as various kinds of help systems [1–4]. In connection with such a high pace, the volume of processed data used in AS data is growing. On the one hand, a wide choice of speakers allows you to simplify routine activities, automate business processes, and also helps to reduce the costs of the enterprise, however, at the same time, the reverse side is the complexity of the enterprise IT infrastructure and the complexity of the operational exchange of data between the introduced speakers.

The extraction of data from different types of sources, and their careful processing are associated with a number of problems, [5]. The source data is located in the sources of a wide variety of types and formats created in various speakers. In addition, the data can use a different encoding, while to solve the problems of analysis, the data must be converted into a single universal format, which is supported by the enterprise. Often, the reference data in one AS is too detailed, while for solving problems in another AS they need to be generalized, [6–8]. To solve such problems, an AS of data integration between enterprise help systems has been developed. This automated system allows both manual and automatic integration of the databases of directories used in the enterprise AS. In order to test the operability on “big” real data, the developed system was tested at the aircraft manufacturing enterprise Aviastar-SP JSC (Ulyanovsk).

The main aim of this work is to present the developed automated system that provides an efficient exchange of mobile device management (MDM) between the automated systems (AS) existing at the aircraft building enterprise and the Semantic MDM control system (developed by SDI Solution).

Currently, the enterprise in question uses various ASs, such as CAD of technological processes “TeMP2” (CAD TP “TeMP2”), AS of design and technological preparation of production (AS DTPP), database of “Electronic Product Definition” (DB “EPD”), AS of production resources management (AS PRM), AS “1C Enterprise”, ACS MDM “Semantic” and others. In this regard, the development of an automated data integration system between existing enterprise systems is relevant and is aimed at solving the following tasks of the enterprise:
• bringing to a single source the entire MDM used at the enterprise, with the aim of eliminating the misunderstanding of the same element of information in different enterprise ASs;
• ensuring the exchange of MDM between the enterprise AS, guaranteeing the unity of information, its technical and legal representation in databases and documents;
• maintaining a single information space of the enterprise;
• filling out directories newly created by speakers;
• addition and corrections of directories of ACS MDM “Semantic” from directories of primary sources in other AS of the enterprise;
• automatic integration of MDM data from the automated control system of the Semantic MDM into various enterprise automation systems and vice versa;
• control over variable MDM data in various enterprise systems.

The object of automation is the activity of members of the departments responsible for maintaining the MDM in various enterprise automation systems and the Semantic MDM for the integration of MDM data between systems of various types. At the same time, the integration of RRI data includes the following tasks:

• adding a new position to the directory/group of positions;
• adding a new group of positions to the directory;
• change of a certain attribute of a position;
• removal of a position from the directory/group of positions.

Automation of these tasks should simplify the maintenance of a single information space of the enterprise.

2. Materials and methods
An automated system should integrate MDM between two systems according to predefined rules. To bring the whole MDM used at the enterprise to a common value, it is necessary to integrate all systems with the source system for each directory. The proposed integration scheme for these directories is presented in figure 1.

![Diagram](attachment:image.png)  
*Figure 1. Regulatory integration scheme using AS integration.*
The considered automated system integrates not only reference books (lists of materials, equipment, purchased tools, special equipment, regulatory documents, technological operations and transitions), but also tabular reference books (reference of time standards). To integrate reference books of time standards together with the automated control system of the Semantic MDM, the system has the ability to obtain additional data from alternative sources. If there are directories that are not maintained in the automated control system of the Semantic MDM, the system allows data exchange between systems using similar directories, where the directory of one of the systems acts as the original (source).

AS uses one of the databases used at the enterprise as a storage of its own data. For user identification, user accounts already existing in the main database of the enterprise are used.

Before starting work, AS integration is pre-configured according to the following parameters:

- a list of types of directories;
- a list of integration systems is specified;
- the declaration of directories is carried out (setting the parameters of connection to the system for receiving MDM data, determining the necessary database tables and reference levels of the ACS MDM Semantic, determining the technological details required for reading, setting up data acquisition);
- an integration scheme is created and configured (a rule for integration between two declared directories).

Description of the integration scheme is a complex task and requires the involvement of both the system administrator of the AS and the company's technologists. Moreover, the integration scheme includes the following parameters:

- type of direction of integration (one-way/two-way);
- compliance of individual details of one directory with the details of another;
- compliance of complex details;
- integration groups;
- custom filters.

Automated data integration system supports manual integration mode and automatic. Manual mode is used for initial data integration and the integration of complex and ambiguous positions. Automatic mode can be used to integrate proven directories and systems. When conducting manual integration, the user has full control to select integration positions and details. With automatic integration, all actions on MDM data are performed according to the “Default” rule.

Manual integration mode supports two integration subtypes: “Rough” and “Fine”. “Fine” integration mode is used when two integrated systems have the same props to determine the uniqueness of a position. In this case, matching positions in different directories are easily determined.

“Rough” integration mode is intended for systems that use different details to determine uniqueness, thereby preventing the comparison of positions. The meaning of this mode is to determine the common requisite between the two systems by which you can identify the position (usually the designation or name of the position). When carrying out integration in this mode, an initial comparison of the positions of systems is carried out according to a given attribute, and the user must choose the same positions from the list of proposed ones. For a better initial comparison, it is possible not to take into account user-defined symbols in the values of the attribute.

When carrying out especially dangerous actions (for example, canceling/deleting positions in the current directory), which should be performed only after agreement with the senior management or system administrators, a notification is generated in the AS integration to perform such an action. Subsequently, the administrators of the AC make a decision (based on the created notice) on the
removal or cancellation of these records. During the integration process, all changes to the MDM data are saved in the internal tables of the system database and are available for viewing in the results and corrections logs.

To work with AS data integration, the following roles are provided (depending on the function):

- Administrator. It has the maximum possible rights and implements the following functions:
  - adding new users;
  - changing roles;
  - editing and adding new types of directories to the list for integration;
  - editing and adding new systems to the list for integration;
  - declaring, amending and deleting declared directories;
  - creating, modifying and removing integration schemes;
  - carrying out manual integration;
  - creating, editing and removing auto-integration;
  - viewing, approving and cancelling notices;
  - viewing the log of adjustments and results.

- System programmer. The main task is to set up and declare directories, control over changes in the MDM data. The main functions of this role:
  - installation and initial configuration of the system and databases;
  - development of requirements for connecting a new integration scheme.

- Specialist. The main task is the creation and implementation of automatic integrations, coordination and cancellation of notifications. The main functions of the role of "Specialist":
  - drawing up an appeal to the appropriate unit with the requirement to create a new one, changing or deleting the current scheme;
  - carrying out manual integration;
  - viewing, approval and cancellation of notices;
  - viewing the results log;
  - statement of notices.

- Operator. The main task is the creation/editing of integration schemes, manual integration. The main functions of this role:
  - manual integration in the “exact” mode;
  - viewing notifications;
  - viewing the results log.

- The guest. Only viewing integration results is possible.

The system also has the ability to add new roles, customize the list of form components available for each role.

To achieve the stated goal, an automated data integration system includes the following eight functions, each of which contains specific tasks and procedures:

1. The function of the announcement (declaration) of AS, their composition and integration participants.
   - This function is designed to configure the connection with the speakers, select the details for integration and establish relationships between project database tables. The function consists of four tasks and procedures.
     - The task of adding/editing/deleting/viewing current speakers and types of directories:
- The task of adding / configuring / deleting / viewing directories:
  - procedure for adding / editing / deleting / viewing the declared directory;
  - procedure for setting up a connection to the speaker system via login, password and database;
  - procedure for setting up connection with speakers through the driver;
  - procedure for setting up connection with speakers via an EXE / DLL file;
  - procedure for setting up user access to the directory.

- The task of setting the details of the directory of an automated system based on DBMS
  - the procedure for selecting a database schema and table for setting integration details;
  - the procedure for selecting certain fields of the database tables to include them in the list of details used during integration;
  - procedure for entering details of the description of the property;
  - procedure for adding / editing / deleting / viewing position selection filters;
  - procedure for adding / editing / deleting / viewing links between database tables;
  - procedure for adding / editing / deleting / viewing position group settings.

- The task of setting details of the ACS MDM “Semantic” reference
  - procedure for adding / editing / deleting / viewing the declared directory of the automated control system of the MDM “Semantic”;
  - the procedure for selecting the details of the ACS MDM “Semantic” directory for inclusion in the list of details used during integration.

2. The function of setting up and maintaining integration schemes and processes.
   This function is designed to configure integration circuits, i.e. conformity schemes of details of various declared directories. The function consists of one task:
   - The task of adding / editing / deleting / viewing integration schemes:
     - procedure for adding / removing an integration scheme
     - the procedure for setting up correspondence between the details of directories of two systems;
     - procedure for adding / editing / deleting / viewing complex details;
     - procedure for adding / editing / deleting / viewing integration groups.

3. The function of conducting the integration process and feedback.
   This function is intended for data integration between directories of various systems. The function consists of three tasks.
   - The task of carrying out integration in manual mode:
     - procedure for the integration of reference lists in the "Fine" mode;
     - the procedure for integrating reference lists in the "Rough" mode;
     - procedure for selective integration of details of reference lists;
     - data transfer procedure for integration into a third-party EXE / DLL file.

- The task of integrating reference books of time norms:
- procedure for adding / editing / deleting / viewing reference books of time norms for AS based on DBMS;
- procedure for adding / editing / deleting / viewing reference books of time norms for the automated control system of the Semantic MDM;
- the procedure for the integration of reference time standards for the automated control system of the Semantic MDM.

- The task of setting up and conducting integration in automatic mode:
  - procedure for setting up automatic integration mode;
  - automatic integration procedure.

4. The function of monitoring the results of integration and adjustment of integration.
The function is intended for viewing / deleting integration results and viewing / canceling corrections made during the integration process. It consists of two tasks.
  - The task of viewing the results of integration;
  - The task of viewing and canceling corrections.

5. The function of creating, maintaining notifications and controlling the execution of notifications.
The function is designed to create, maintain and coordinate notifications for deletion and cancellation. The function consists of two tasks.
  - The task of viewing and creating notifications;
  - The task of approving notices.

6. Function to create / configure / delete / authorize users of the program.
The function is designed to manage user authorizations. The function consists of:
  - The task of user authorization;
  - The task of identifying and deleting users;
  - The task of changing user roles;
  - The task of appointing a person responsible for integration schemes, integration groups, directories, filters, table relationships, position groups.

7. Function to create / configure / delete program roles.
The function is designed to manage roles and display help information. The function consists of five tasks.
  - The task of viewing the manual for a separate role;
  - The task of creating / editing / deleting roles;
  - The task of setting the availability of menu items;
  - The task of configuring the availability of form components;
  - The task of displaying prompts.

8. The function of monitoring the change of AS data.
The function is designed to control changes in speaker data. The function consists of six tasks.
  - The task of logging changes in integration schemes, integration groups, directories, filters, table relationships, position groups;
  - The task of viewing changes in speaker data;
  - The task of blocking integration schemes, integration groups, directories, filters, table relationships, position groups;
  - The task of checking access to menu items and form components for the user role;
  - The task of checking the availability of the directory to a specific user;
  - The task of checking the object lock.
3. Conclusion
Implementation of the above functions in a single software package for data integration of various enterprise ASs was carried out in the Microsoft Visual Studio development environment using the .NET Framework software platform and Oracle DBMS.

All actions with system functions are carried out from the main menu of the program. The integration algorithm consists of five main operations: register and configure user rights and roles, declare the necessary systems and directories, configure the integration scheme, integrate data in the required b mode, analyze and accept the integration results.

Real data testing was successfully carried out as part of the pilot operation of the system at Aviastar-SP JSC. The results of the pilot operation showed that the use of such systems allows bringing the required regulatory and reference information used at the enterprise to a single source, ensuring the exchange of data between different systems and maintaining a single information space of the enterprise.

Acknowledgments
This work has been done as a part of the state task of Ministry of Education and Science of the Russian Federation N 2.1816.2017/4.6.

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