

# The Research, Development and Application of Operation and Maintenance Management Information Platform (OMIP) of Shanghai Maglev Demonstration Line

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**ABSTRACT:** Based on the research on Shanghai Maglev Demonstration Line, this article summarizes business needs and technical requirements of OMIP, presents the basic structure of the platform, analyzes the core business management support, discusses the importance of OMIP in terms of safety, reliability and economic operation of Shanghai Maglev Demonstration Line and the important development of OMIP. At last, it summarizes some successful OMIP implementation experiences.

## 1 INTRODUCTION

As the world's first commercial demonstration operation line of high-speed maglev transportation, Shanghai Maglev Demonstration Line (in abbreviation, Shanghai Line) has been successfully put into operation for nearly nine years. With the accumulation of operation and maintenance (in abbreviation, O&M) management experience of Shanghai Line, higher requirements on enterprise management information system are proposed, which includes establishing OMIP based on the existing MMS (Maintenance Management System) by integrating information of operation,

maintenance, safety management, in a bid to facilitate operation and maintenance in Shanghai Line.

This article summarizes business and technical requirements of OMIP, presents the basic functions and structure, analyzes the supports to the core business management, discusses the importance of OMIP in supporting the safe, reliable and economic operation of Shanghai Line and the important development of OMIP, and at last summarizes the implementation experiences of OMIP.

## 2 OMIP BUSINESS NEEDS AND STRUCTURE

With the improvement of operation management in Shanghai Line , O&M management staff presents the following requirements.

- By using IT, integrate the functions such as O&M business process, data analysis, safety and quality management, material management, information collection and release, document management and online learning , so as to eliminate the so-called “information island”.
- By using IT, O&M staff can summarize various faults and experiences of troubleshooting occurred in the Shanghai Line operation, in order to improve the capacities of system fault process, preventive maintenance and operation management.
- Due that the existing information management systems lack of functions of system fault and status analysis, it is required to carry out equipment fault and status analysis. Equipment fault and status analysis can help business staff to gradually establish key performance indicators of O&M, provide technical bases for equipment status maintenance , provide references for performance evaluation of O&M work.
- Due that the user interface of the original system is not friendly enough to provide graphic operation , data entry and query of website forms, so that the system is not convenient for O&M staff.

OMIP will eventually realize that the system is simple and practical, unified login interface, database storage, graphical operations interface of operation status, queries and reports in various forms and so on ; via equipment

fault and status analysis , O&M staff can establish fault base data and preventive maintenance program, key performance indicators of O&M, explore and build decision-making model of equipment fault and status analysis, provide technical foundation for various assessments, technical innovation and status maintenance of the maglev system.

Figure 1 shows OMIP main function modules. Figure 2 shows that OMIP get MMS data of external system through an external interface. OCS means operation control system, PPS means propulsion supply system, ODS means online diagnosis system in Figure 2.

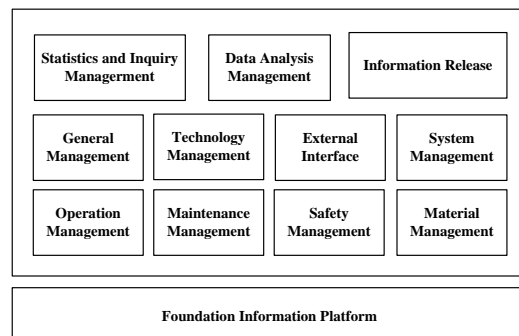


Figure 1 OMIP Functional Structure Diagram

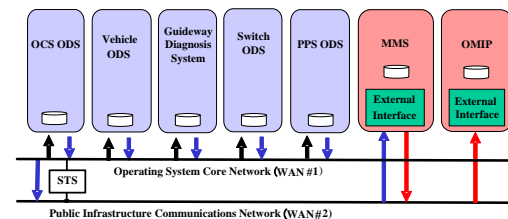


Figure 2 OMIP and MMS, Diagnostic System Data Flow Diagram

Shanghai Line network system is divided into two parts, they are the operating system core network (WAN # 1) and public infrastructure communications network (WAN # 2). The system within WAN #1 is safety-related, professional control system and its diagnostic system locates similarly the WAN # 1. The system within WAN # 2 may be connected to Internet. The converter is used between WAN # 1 and WAN # 2, the converter is called safety connection or security

translate system (in abbreviation, STS). OMIP in the WAN # 2 is use of STS as the information transmission channel, and through it connects with MMS, OMIP gets data of diagnostic system through STS. Shanghai Line also adopts a "physical cut off" approach, cuts off messages channel between OMIP, MMS and Internet to ensure the security of information within the enterprise.

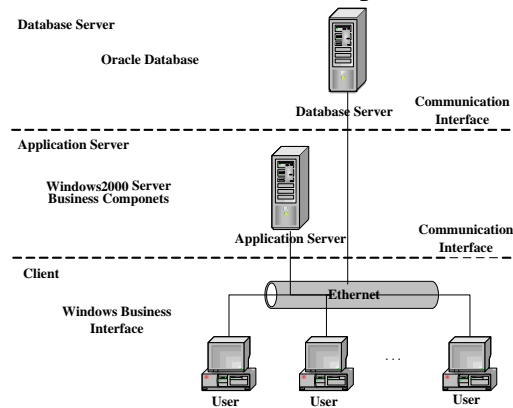


Figure 3 OMIP Technical Structure Diagram  
 Figure 3 shows OMIP technical structure. OMIP based on Ethernet uses middleware. OMIP is application system of three level structure. Server side is divided into two parts, they are the application server and database server. Application server realizes business logic operations, and ensures the system has a strong scalability. Database server realizes inquiry and storage of data, databases uses Oracle. Application server and database server realize operation of data through standard SQL. Client uses standard Windows interface to communicate application server. In system maintenance , because the use of B / S structure, a large number of system maintenance workload are reduced.

### 3 OMIP AND OPERATION MANAGEMENT

The main modules on OMIP interface are O&M data analysis management , operation status diagram, fault base data management, and fault and status analysis of typical equipment.

#### 3.1 O&M Data Analysis Management

O&M data analysis module includes O&M data maintenance application and query reporting application.

O&M data on OMIP includes operation data, maintenance data and data of non business type. Operation data includes daily operation status, fault, abnormal thing, security, hazard and risk associated with fault notice, security incident notice and other information. Maintenance data includes fault process, preventive maintenance and replacement of spare part, inventory and purchasing information. Data of non business type includes qualification management of staff , information notice, document management and other data for operation service.

From the data analysis point of view, type of OMIP data analysis mainly includes four components data , these are operation management data , maintenance management data, safety and quality data, general management data. Operation management data mainly includes operation data and daily data. Maintenance management data mainly includes four components of fault and abnormal thing, risk and hazard, spare parts replacement, maintenance work. Safety and quality data mainly includes security incident, safety inspection , safety exercise case and so on. General management data includes primarily annual goal, staff train, budget, inventory, procurement, asset report and so on.

The data of O&M is filled in the actual situation per day by the relevant professional or department or is got from the MMS , it is basic data of Shanghai Line O&M management. According to data of O&M, OMIP generates daily, monthly, quarterly, annual reports of professional, department. In addition , various data collection and analysis can based on the data of O&M.

### 3.2. Operation Status Diagram

The base data of operation status diagram is information of professional control systems, diagnostic systems, MMS and professional maintenance. Through graphic operation, operation status diagram can help business staff to easily realize monitoring, inquiry, analysis of maglev system operation status, fault conditions and service status in simple graphical presentation. It has capability of data tracing, data analysis and remote management. In aging, it can meet the management requirements of business staff.

Operation status diagram includes the main interface, the history query interface and the detailed interface of fault. Through the main interface, you can check the fault circumstance in system operation, maintenance, security on the same day. The history query interface can display every day fault information in history , it includes mainly number of faults and fault level. At present, the fault level is defined as follows, green means no fault, yellow indicates the one level fault, orange indicates the two level fault , red indicates the three fault. You can query detailed information of each fault , it includes phenomenon, cause and solution of each fault.

Operation status diagram realizes unified management and security of data storage in operation , maintenance and safety work. It reflects comprehensively status of Shanghai Line operation, maintenance, safety , it improves the management of Shanghai Line O&M in efficiency.



Figure 4 The Main Interface of Operation Status Diagram

### 3.3. Fault Base Data Management

After years of Shanghai Line operation, O&M staff needs to summarize various types of faults and solving experience in the operation of Shanghai Line , and to establish rapidly fault base data by means of IT. The work in the management of fault base data has become an urgent important task for operation.

Through fault base data management module in OMIP , for later in fault treatment , O&M staff can record phenomenon, cause and solution of fault and establish relation of them , establish the manual of treatment option in fault. Further, O&M staff can establish fault knowledge database.

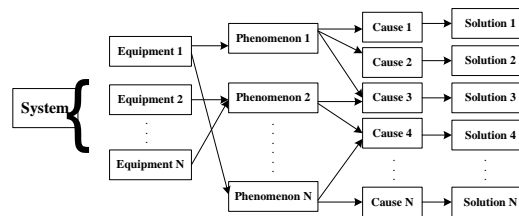


Figure 5 Fault Phenomenon , Cause , Solution Diagram

### 3.4. OMIP Development

OMIP important development applications show in the following two aspects.

First, by OMIP, we can establish key performance indicators of O&M , these indicators can support performance management of Shanghai Line O&M. For instance, for advance in fault treatment , OMIP has functions of MTTR and MTBF , the two key indicators can help O&M staff to evaluate quality of system in O&M , to establish preventive maintenance program. Based preventive maintenance program, O&M staff can eliminate to early faults or operational risks, ensure performance and quality of system equipment , standardization of technical support capabilities , realize O&M goals that preventive is the first and repair is the second.

Second, by O&M data in OMIP and combined with data mining tools, O&M

staff can carry out equipment fault and status analysis. Currently, based on O&M management needs, OMIP R&D staff has launched maglev typical equipment fault and status analysis, by the analysis of typical equipment fault causes, fault handling manual, the three elements analysis of fault, statistical analysis of fault, correlation analysis of fault, and so on, combined with the actual case database of the typical fault, explores the establishment of fault decision-making model for the maglev typical equipment. Through research of preventive maintenance and early-warning model of fault occurrence, OMIP R&D staff can propose key performance indicators and method of preventive maintenance, explore the establishment of status decision-making model for the maglev typical equipment.

#### 4 OMIP IMPLEMENT EXPERIENCE

OMIP R&D team mainly includes O&M and IT staff of Shanghai Line. In one year software development, the work of development includes business requirements analysis, software requirements analysis, software structure design and detailed design, coding, software unit and module testing, system integration testing.

Development and application experience of OMIP can be summed up, the principal should carry out implement work the following aspects.

- Through the business research, information gathering, business needs must be truly understood by software developers, and refined.
- In software requirements analysis stage, through the development of demo version software, IT staff can describe in detail interface, function, operation of the software, so that the business staff can understand vividly the software

function, while also continue to detail business requirements analysis.

- Select the mainstream software technology structure.
- Make the base data preparation work of system implement.
- Set up project leadership group and project implementation team to carry out system implementation work.
- In application process of OMIP, project implementation team needs to continue to detail business requirements and improve functions.

#### 5 CONCLUSION

Under commercial operating environment, it is innovative to use OMIP to carry out the data analysis of O&M in Shanghai Line in application and practice, especially in the operation status diagram, fault handling and preventive maintenance, as well as exploration of equipment fault and status decision-making model.

Currently, the application of OMIP in Shanghai Line to carry out the data analysis of O&M is gradually maturing. With the deepening of data analysis work of Shanghai Line O&M, there is still some space for the management of Shanghai Line O&M to be improved. The practice of Shanghai Line in OMIP is worthy of reference for O&M management of future maglev transportation projects, other rail-transit projects.