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The Study on Migration Strategy of Legacy System

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***Abstract*—**In the upgrade process of enterprise information systems, whether new systems will be success and their development will be efficient, depends on how to deal with and utilize those legacy systems. We propose an evaluation system, which comprehensively describes the capacity of legacy information systems in five aspects. Then a practical legacy systems evaluation method is scripted. Base on the evaluation result, we put forward 4 kinds of migration strategy: eliminated, maintenance, modification, encapsulating. The methods and strategies play important roles in practice.

***Keywords*—**Legacy Systems, Evaluation Method, Migration Strategy.

I. Introduction

AT present, with the rapid development of computer technology, many enterprises need to rebuild their enterprise information systems because of business development and market competition pressure. In the process of upgrading, how to deal with and utilize those legacy systems affects the efficiency of construction and development of the new system.

In the section II we discuss the evaluation index system which is the basement of the legacy system evaluation. In the section III a practical evaluation method for legacy systems is descript. And in the section IV we discuss the migration strategy of legacy systems.

II. Evaluation Index System

Legacy systems is composed of software, hardware, data, personnel, business processes and other factors, it is a man-machine system with social and technical factors [1]. The evaluation index system should be a system that can objectively reflect the overall situation and characteristics of the legacy system, and it also should be a collection of indexes, all the indexes in it are intrinsically linked and complementary.

The development of the evaluation indexes depends on the information source which reflects the characteristics and conditions of the legacy system. We can get information sources from the following three aspects:

1. the system itself, including source code, user manuals and operating systems.
2. the system-related experience and the system understanding hold by system users, maintenance personnel and the developers.
3. the error reporting and system maintenance log of the legacy system. Through the analysis of the system maintenance history, we can deepen understanding of the legacy system.

Through high-level summary, we establish a relatively complete evaluation system that can describe the characteristics of legacy systems, shown in Figure 1.

For a legacy system, the final evaluation result is a comprehensive result which is came from the evaluation result of each index. So, in order to determine the overall evaluation results, we accurately evaluate each index, and must carefully examine the relationship among the indexes.

III. Evolution Implementation

The purpose of the Legacy systems evaluation is to obtain the deeply understanding of legacy system, and it is the basis and starting point of legacy system migration. To evaluating legacy systems, we must take account of two different points of view. From the business perspective, in order to judge that if the legacy system can adapt the new business demands, and the degree of adaption. The business value of legacy systems must be evaluated by the infrastructure of legacy systems. From the technical level perspective, the external technology environment of legacy systems must be evaluated through the state of hardware supporting environment, software supporting environment, application software. As an example we evaluate the hardware supporting environment of the legacy system capability description framework, and the evaluation procedure and method [2] is introduced below.

A. Hardware Support Environment Evaluation

Through an example, hardware support environment evaluation, the evaluation procedure and method are introduced.

System hardware includes a number of hardware which needs routine maintenance, maybe located in a site, or distributed in a number of sites connected by a network. In general, the legacy system's hardware includes clients, servers, storages, printers and network equipment. Network equipment is usually looked as a kind of auxiliary equipment, and is not included in this evaluation. The contents of hardware support environment includes: clients, servers, storages and printers. The hardware support environment indexes are: system failure rate (SFT), system life (SL), functional maturity level (FM), performance satisfaction level (PS), support situation of vendor (SSV), maintenance costs (MC). Evaluation level is the outline level.

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Legacy System Evaluation Index System	Aspect	Evaluation Index
	Business Value	Match degree of demand.
		Support ability of information demand.
		Degree of specialization.
	Hardware support environment	System failure rate .
		System life.
		Functional maturity.
		Performance Satisfaction.
		Support situation of vendor.
		Maintenance costs.
	Software support environment	System failure rate.
		Frequency of the system upgrade.
		Degree of functional.
		Performance Satisfaction.
		Hardware-dependent level.
		Technology level of support staff.
		Vendor stability.
		Maintenance costs.
	Infrastructure	System development approach.
		Development organizations.
		Technology maturity of development organization.
		Training system.
		Technology Level of support staff.
	Application software	System failure rate.
		Degradation degree of development tools.
		Well-documented level.
		External dependence.
		System Security.
		Structural complexity of the system.
		Level of data standardization.
		Module independence.
		Maintenance costs.

Fig. 1 Legacy System Evaluation Index System

Specific evaluation method is shown as follows: for a kind of hardware, each index is assigned a score (values 1-4), then to work out the score of this hardware, all scores are added together.

Here, for example, we show in details that how to get the score of situation of vendor support. The scores of other indexes in the evaluation index system can get in the same way.

1) If the hardware ventors have closed down, the scor can only take the value 1.

2) If the hardware ventors have closed down, but there are a third-party supporter exists, the score can take value 2.

3) If the vendor still exists, but its future is uncertain, the score can take value 3.

4) If the vendor exists, and its development can be fully guaranteed, the score can take value 4. In this way, we can get hardware support environment evaluation matrix, as shown in Table I.

TABLE I
HARDWARE SUPPORT ENVIRONMENT EVALUATION MATRIX

	SFT	SL	FM	PS	SSV	MC
clients	A11	A12	A13	A14	A15	A16
servers	A21	A22	A23	A24	A25	A26
storages	A31	A32	A33	A34	A35	A36
printers	A41	A42	A43	A44	A45	A46

The total score of hardware support environment is worked out as follows:

$$ORH = \sum_{i=1}^{n} P_i \sum_{j=1}^{m} A_{ij} \quad (1)$$

In equation (1), n is the number of hardware evaluated_items, m is the number of indexes of each hardware, $1 \leqslant A_{ij} \leqslant 4$ is the score of index i, item j, P_i is the weight coefficient of index i.

$$ORH_i \sum_{j=1}^{m} A_{ij} \quad (2)$$

Equation (2) is the total score of evaluated item i. If the score of an evaluated item is less than m * 4 / 2, it shows that the evaluated item need to be upgraded or modified.

The evaluation matrixes of Business value, software support environment, application software, infrastructure can be created as the same as hardware support environment evaluation matrix, all the indexes of them are described in Table I. The value and the weight of each index dependents on the actual situation of the legacy systems.

B. Evaluation Result

The scores get by the evaluation matrix of hardware support environment, software support environment, software applications and infrastructure reflect the technical factors in current state, the weighted average of the matrixes represents

the technical level of the legacy system. The equation is as follows:

$$OR = \frac{P_1 * ORH + P_2 ORS + P_3 * ORA + P_4 OAF}{4} \quad (3)$$

In equation (3), ORH is the evaluation value of hardware support environment, ORS is evaluation value of software support environment, ORA is evaluation value of application software, OAF is evaluation value infrastructure, P_i ($1 \le i \le 4$) are their weights respectively.

Comparing the score of the technology level to the score of business value, we can get the comprehensive evaluation results of the legacy system. Based on the relative size of the scores get from technical level and business value, we divided the space into four areas, and the results of the legacy software evaluation is divided into four categories [3], shown in Figure 2.

Business Value / Technical Level	High	Low
High	High Level, High Value	High Level, Low Value
Low	Low Level, High Value	Low Level, Low Value

Fig. 2 Analysis of Evaluation Result

Based on score of technical level and business value, we can determine the location of the legacy system:

1) "Low Value, Low Level" area. Operation cost of the legacy system is high, but the return is low.

2) "High Value, Low Level" area. The business value of the legacy system is high, but the functionality or performance is poor.

3) "Low Value, High Level" area. Business contribution of the legacy system is small, and the maintenance cost is low.

4) "High Value, High Level" area. The legacy system is well-functioning.

IV. Migration Strategy

After determining the state of the legacy system by evaluating it, according to the software engineering theory, and the succession degree of the new system from legacy systems, we propose four migration strategies, eliminate, maintenance, reengineering, encapsulating.

A. Elimination Strategy

Legacy systems in the low value, low level area can be migrated by elimination strategy. This is an extreme case. Generally, business demand produced fundamental change, the original system could not adapt to the new demands of the business; or legacy system maintenance personnel, maintenance documentation is lost. After analysis, we find that the cost of the development of new system is cost-effective than the cost of the migration of the old system.

Usually the legacy system can more or less reflect the user`s new requirement in the system function, the understand of legacy systems can help programmer develop the new system design quickly, and reduce the risk of the new system development.

B. Maintenance Strategy

Legacy systems in the high value, high level area can be migrated by maintenance strategy. The legacy system has high technological contents, and has a high business value. It can basically reach the requirements of the business operation and the decision support.

Software maintenance includes corrective maintenance, perfection maintenance, adaptability maintenance, is incremental and iterative process, but does not involve structural modification.

C. Reengineering Strategy

Legacy systems in the high value, low level area can be migrated by reengineering strategy, the function and performance of legacy system is poor, but the business value is higher, Compare with maintenance; software reengineering is a kind of further evolution, the content of reengineering includes source code, design specifications and other documents resource. Based on the level of the program understanding, the transformation can be divided into the black box and white box reengineering. Reengineering may involves many changes such as system reconstruction, system structure evolution, software attributes modification. Usually in the reengineering process, in order to ensure the continuity of the business flow, new and old system must be run in parallel for some time, then the business flow gradually switches to running on the new system.

D. Encapsulating Strategy

Legacy systems in the low value, high levels area can be migrated by encapsulating strategy, For the low value, high levels of regional left the military information system can be used to enclose strategy. The technical level and the business value of the legacy system too low that the business can only rely on the part function of the legacy system. The legacy system can be encapsulated by the dedicated middleware, and can interact with the new system also by the dedicated middleware. Encapsulated legacy system can be looked as a slave system of the new system.

V. Summary and Future Work

The evaluation index system and evaluation method of legacy system have been studied. We propose a practical evaluation index system, in which the capacity of a legacy information system is comprehensively described. It is a universal evaluation index system. The evaluation does not involve technical details, so the evaluation system applies to both stand-alone mode legacy systems and distributed legacy systems. It also applies to the SOA legacy systems. Data processing of each index is easier. By analyzing the data, we can develop value grade and uniform calculation method for each index.

Then a practical evaluation method for legacy systems was described. It can evaluate each index in the evaluation index system, and then calculate the final score which can show the current state of legacy systems.

Based on the evaluation result of legacy information systems, we put forward four kinds of migration strategy: eliminated, maintenance, reengineering, encapsulating, according to the upgrading of the new system for legacy system degree of inheritance. In many cases, for a legacy system, the migration strategy should be used in combination, that is, the subsystems in a legacy system can use different strategies respectively. A certain part of legacy system may be maintained to meet requirements. While the other part of the legacy system needs white box and black box reengineering, and then may be need encapsulating. The rest can be replaced by the new WEB service system. Usually, this combination strategy is the most reasonable, and it is also the highest cost-effective.

The development of SOA is on the basis of the object-oriented technology and component-oriented technology; it uses “services" to realize software reuse, provide a more effective reuse method for software developers. Now SOA has been widely applied. The WEB service technology is well encapsulated and loose coupled, it is based on open standards (XML, WSDL, and SOAP), so the WEB service has become the first choice [5] for implementation of SOA. Therefore encapsulating legacy systems as WEB services has become an important method for the legacy system migration and integration [5]. And RESTful service is a new technology, which is more suitable to be composition in SOA [6]. Our future work will be the service-oriented encapsulating through WEB service and RESTful service to migrate legacy systems to the SOA.

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