A Knowledge-based Decision Support Workbench for Enterprise Resource Integration and Migration

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Abstract.
Integration and migration (IAM) is an expensive and risky undertaking. At Telcordia Technologies (formerly Bellcore), we have developed an IAM Workbench with the goal of reducing the IAM effort to less than a day and minimizing the risks. This knowledge-based decision support Workbench interactively guides the user, through a small number of questions, to the definition of appropriate strategic choices, architectural configurations, COTS (commercial off the shelf) technology, and project plans.

1. Introduction.
Enterprise resources consist of a variety of corporate databases and applications that are critical to conduct business [Avraham99]. Examples of these resources (some are new but many are legacies) are customer databases, ERP (enterprise resource planning) systems, supply chain management systems, telecom operation support systems, payment/billing systems, and customer relation management systems. Integration and migration (IAM) of these resources is at the core of enterprise management because many business situations require meshing of new enterprise resources with the existing (mostly legacy) resources that raise the intricate issues of integration and migration. In fact, the growth in ERP and EAI (Enterprise Application Integrator) systems can be largely attributed to the numerous IAM problems found in the industry [Clewett99, Lithicum99, Ovum99].

In the course of an IAM project, numerous decisions and activities occur ranging from high level strategic analysis to detailed architectural and project planning choices. Time to make decisions is typically long (two to six months) and the risks of failure are high. IAM Workbench is a knowledge-based decision support system, being developed at Telcordia Technologies (formerly Bellcore), that attempts to reduce this time to less than a day and minimize the risks. The Workbench asks the user a small number of questions that guide him/her to appropriate strategic choices, architectural configurations, COTS (commercial off the shelf) technology, and project plans.

2. Workbench Prototype.
A Web-based prototype (it uses HTML, XML, Java applets, and Java Script) of the IAM Workbench, shown in Figure 1, has been developed at Telcordia Technologies (see [Umar97] for the conceptual foundation of this Workbench). The knowledge
base of this prototype consists of numerous strategies (5 basic choices), architectures (about 30 configurations), COTS tools (more than 100 legacy gateways, object wrappers, reverse engineering tools, and EAI platforms), project plans (5 major customizable plans), and information sources (links to relevant books, articles, and technical analysis reports). The knowledge base is represented for the most part using UML and XML and, and its contents are continually augmented by embedding our practical hands-on experiences in large scale telecom integration into the Workbench. In addition to the general knowledge base, we are building an industry specific knowledge base that contains, for different industry segments, typical classes of applications, architectures, COTS tools, and project plans being used. The industry specific knowledge base is built through use of the IAM Workbench (i.e., user choices are captured) and forms a basis for case-base reasoning.

The overall flow of the IAM Workbench consists of the four major steps shown in Figure 2. These steps are reviewed below (see [Umar97] for a detailed discussion).
3. **Strategic Analysis.**

Given an IAM problem, we concentrate on the following broad strategies:

- **Integrate** - Consolidate the enterprise resources by using mediators such as legacy gateways and EAI platforms;
- **Data warehouse** - build a "shadow" system to house the frequently accessed data;
- **Gradual migration** - re-architect and transition the resources gradually;
- **Cold turkey** - rewrite the resources from scratch (Brodie 1995);
- **Ignore** - discard the existing systems for all future developments.

The exact mix and sequence of these approaches to form a strategy is based on a combination of business drivers, business value and technical status of the legacy application being considered, the flexibility and growth requirements, data currency requirements, the corporate attitude towards IT re-engineering, and several other business as well as technical issues. For example, if data currency requirements are high or updates to the base data very frequent, then data warehousing is not a good choice. Similarly, a legacy wrapper is not suitable if the legacy system in question is of high business value and needs to be constantly modified (migration may be more suitable in this case). In most practical situations, the last two options (cold turkey and ignore) are considered rarely. Most of the IAM time is spent in the first three strategies (access and integration, data warehousing, migration) -- the IAM workbench consequently supports these steps extensively.

4. **Architecture and COTS Selection.**

We now describe the various decision tables that suggest the most appropriate strategy based on various technical and business factors. For each strategy, the IAM Workbench suggests a series of architectural configurations that show the components needed, the functions provided by each component, and the interfaces and interactions between components. In addition, it suggests suitable COTS technology to implement the architectures. Because, in general, buying COTS ends up being a better strategy than developing new components, we provide a repository of COTS packages that can be used by system designers. This step is by far the most time consuming in most IAM projects and is extensively supported by the workbench. The decisions made are dependent on the three major strategic choices: access/integration, data warehousing, and migration.

**Access/Integration Strategy.** For this strategy, the workbench suggests access middleware (e.g., ODBC drivers, CORBA services, message oriented middleware), legacy adapters (e.g., screen scrapers), Web gateways (e.g., IBM Host on Demand) and/or EAI platforms (e.g., Active, Vitria, MQSI) based on integration needs. These choices are made through a series of decision tables. Depending on the differences between the front-end and the back-end systems, and the level of hiding needed, the decision tables suggest technology that range from simple connection software to sophisticated coordination and integration of results from multiple systems by using varying levels of encapsulation. The selection tables are the following:

- An access technology selection table asks users questions about the type of systems to be integrated (e.g., fully decomposable versus monolithic) and the level
of access needed (e.g., data versus function access). Appropriate access technology is suggested based on the user selections. For example, if data of a back-end monolithic system is needed, then screen scraping is the most suitable technology. However, if the system is data decomposable, then ODBC/JDBC are more suitable.

- An integration technology selection table asks additional questions such as the number and nature of systems to be integrated and the type of coupling needed (loose versus tight). Integration technology provide a layer above the access technology and synthesize the access to different resources of one or more applications. Object wrappers are a popular example of integration technology because they can present an integrated OO view of data from many diverse systems. Message-based systems are also popular (message-based integration is usually desirable if loose coupling is desired).

- An EAI selection table asks further questions to help determine the type of EAI-based architectures and technology. The EAI technology are typically needed when a large number of back-end systems of different vintages residing on multiple platforms need to be integrated.

Using the Workbench with the access/integration strategy entails suggesting appropriate architectures and technology, after walking through a series of steps that capture the following requirements:

a) Type of mediation needed such as access versus integration and query versus transaction integration across multiple systems,

b) Front-end requirements such as human access (HTML) versus program access (IIOP, ActiveX/DCOM, RMI),

c) Number and type of back-end systems such as monolithic versus decomposable, and

d) Operational requirements such as security, performance, and fault tolerance.

Data Warehouse Strategy. For this strategy, we suggest suitable data mart or centralized data warehouse configurations with appropriate COTS technology such as data extractors, data modeling, and data access, analysis and mining tools. Again, a suite of decision tools lead the user to appropriate architectural and technological choices. For example, the user may choose centralized versus distributed data warehouses based on the size of data and the operational requirements of security and operability. The data extraction, data modeling and viewing tools are also suggested based on similar considerations. We will not illustrate this case due to space limitations.

Migration Strategy. For this strategy, we suggest a series of migration gateways [Brodie95], reverse engineering, data conversion, and user interface conversion tools. The user is first asked a few questions to determine what type of migration (data migration, user interface migration, complete application migration, or system "re-hosting") is appropriate. For the migration strategy selected, migration gateways and appropriate reverse engineering tools are suggested.
5. **Project Planning.**

Based on the architectural and COTS choices, we suggest key implementation/deployment activities and interdependencies among these activities. For each activity, we produce a rough estimate of resources (time, technology, skills) needed. This work breakdown structure (WBS) is inferred from the detailed information captured in the architecture/COTS selection step. For example, if an EAI-based integration architecture is chosen, then the implementation project plan would consist of EAI platform selection and installation, data translation effort, adapter development, routing selection, etc. However, if a data warehouse strategy is chosen, then the WBS would include data extraction, data modeling, data warehouse design, and other related tasks. The WBS is naturally influenced by the “buy versus develop” decision.

6. **Deployment and Support.**

The current IAM workbench does not include any deployment and support activities other than links to appropriate Web sites. This activity can be included in the future by supporting automatic purchasing of selected COTS and by linking the IAM Workbench to Integrated Development Environments (IDEs) and testing platforms. Management platforms such as Tivoli could be supported to provide runtime monitoring and control capabilities.

7. **Project Status and Future Work.**

We have used this Workbench in its limited form on two projects and found that it considerably reduced the time and effort needed on these projects. Our future work on IAM Workbench is proceeding in several directions. As mentioned previously, we are improving the current knowledge base by gradually embedding our growing domain experience on Software Engineering for telecommunications into the Workbench. In addition, we are exploring capabilities for inference, learning (case-based reasoning), and explanations. We are also considering generation of sample code where possible (i.e., from UML diagrams to sample code, using a UML-based CASE tool like Rational Rose), risk and cost/benefit analysis in project plans, and user interface improvements such as animations and games. A considerable effort is being expended on automatically updating the knowledge base by extracting information from the Internet by using intelligent agents, by taking advantage of mediator sites. In particular, we are planning to adopt XML representations for the description of different COTS technology. So far, we have found that XML DTDs for various domains do exist, but it is unclear whether there are industry standards, let alone standards. We are closely examining the BTB mediator sites (e.g., XML/EDI Group, CEN/ISSS, OASIS, and Ontology.org) and the authoring tools vendors for possible developments. Our overall goal is to make IAM Workbench an extensive decision support tool for enterprises of the 21st century.

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1 We are planning to store this information in the MS Project format.
References.


[Linthicum99] Linthicum, D., "Enterprise Application Integration", Addison-Wesley Information Technology Series, 1999 (target)
