# AN INTEGRATED DECISION SUPPORT TOOL FOR EU POLICIES ON HEALTH, TRANSPORT AND ARTISTIC HERITAGE RECOVERY

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Abstract: In this paper, we describe an ongoing EU funded project (ISHTAR) that develops an advance integrated decision support tool (ISHTAR suite) for the analysis of the effects of long-term and short-term policies to improve the quality of the environment, citizen's health and preservation of heritage monuments. From the background of the project, this paper goes on to explain the integration of information of a large number of tools aimed at semantic approach integration to allow European cities to make balanced decisions on a wide range of issues such as health, noise, pollution, transport, and historical monument. We also present and suggest solutions to the information integration problem resulted when attempting to represent and share information**.**

## 1 INTRODUCTION

European cities are faced with common challenges concerning their quality of life ranging from degradation of the urban environment, significant risks for citizens health, traffic congestion and economic inefficiency to progressive damage of the artistic and monumental heritage. The process of integrating such issues across organisation boundaries is complicated and multidimensional one. One difficult is derived from the lack of integrated decision support tools that allow cities to make balanced decisions on a wide range of issues such as evaluation of the impacts of various types of urban policies, actions on the quality of life of citizens and in particular on traffic congestion, air quality, citizen health and preservation of cultural heritage.

The integration of information across organisation boundaries is a topic of interest to many enterprises. According to some researchers (Fensel, 2003), (Butler, 2002) between 10% and 30% of future IT spending will go towards Enterprise Application Integration (EAI). Application integration defines a core mission of IT organizations today (Linkin, 2004). There are several reasons for the increase in the need of integration. New systems need to be integrated with the legacy systems, and organisation or company mergers require integration of software tools to overcome problems in heterogeneity between data sources. Also information sharing is a primary emerging function (Figallo, 2002). The continue rise in business opportunities and globalisation requires capabilities that enable information integration to ensure diffusion of information across enterprises. By integrating tools through a middleware, information can be accessed and shared across organisational boundaries.

The Ishtar project aims to overcome the problem of heterogeneity between data sources by integration of data sources or software tools using a central integration manager called Ishtar Suite Manager (ISM). The ISM manages and monitors processes of software tools inside the suite. The Ishtar Data Model (IDM) is proposed as a class/object model. Each data corresponds to an object belonging to a class defined in the metadata model. The metadata model is managed in the ISM by means of a database. Classes and objects are stored inside the database. Objects inside the database represent the actual data exchanged. The Ishtar Suite Interface (ISI) for mapping users and the ISM is also considered.



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In view of the above, this paper presents the process of building an integrated tool for managing and sharing information in the Ishtar project. We present the specification of the architecture of the Ishtar software tool. We also review some applications in recently developed field of EAI. The paper is organised as follows: In section 2, we present the review of the state of the art and then in section 3 we introduce the Ishtar Suite. In section 4, we present the information integration problem and suggest some solutions to the problem. Finally we provide some conclusions in section 5.

# 2 STATE OF THE ART

With globalisation, organisations have become more interconnected. The concept of EAI appeared only a few years ago and it is now widely used and explored because of the necessity for organisations to interconnect their applications and provide new functionalities to their users. The focus of EAI is on process integration, structured data, and getting applications to talk to each other. Although according to InfoWorld (InfoWorld 2002) EAI concept is still a tough and expensive nut to crack despite advances in technology, it is being implemented in a number of organisations (Lejeune, 2003). In this section we observe some of the achievements in the commercial sector and provide a comparative evaluation with our approach.

WebLogic (BEA, 2004) is an integration server with a full-featured platform for delivering enterprise-class applications. WebLogic Integration server not only provides data and application integration but also business-to-business integration and business process management. WebLogic application Integration server is based on the J2EE Connector Architecture (J2EE-CA) framework and XML-based transformation engine. According to Vijay Sarathy, product manager for Connectors and JDBC at sun, the J2EE-CA is trying to extend what JDBC has done for Java and J2EE in terms of providing uniform connectivity with databases to heterogeneous database systems. This application framework links existing systems with new applications. WebLogic supports leading enterprise applications and technologies such as Oracle Applications, MQ Series, SAP, Siebel, etc. It provides a set of J2EE-CA to integrate with back-end systems.

BusinessWare (Vitria, 2003) aims its product’s integration capabilities at technical users. BusinessWare is designed for application as well as business-to-business integration. It offers dozens of adapters for application integration, a connector development kit, publish/subscribe messaging layer, a transformation and data mapping tool, business process management tool, etc. BusinessWare also embeds rational Rose modelling tool for building business processes.

Other applications that are close to WebLogic and BusinessWare include WebSphere, SeeBeyond, and ActiveEnterprise. WebSphere (Canon, 2004) provides an EAI design and business-to-business integration. WebSphere offers a strong administration and deployment of tools. It not only provides application integration but also a common platform for development. This is particularly appealing to companies that have a uniform platform to develop their applications. SeeBeyond provides a flexible way of linking applications and different parts of a customer's supply chain independent of the applications being connected. ActiveEnterprise is designed for enterprise application integration and business-to-business integration. It offers an end-to-end integration product that aim at business users with some technical knowledge. ActiveEnterprise also offers packaged adapters for integration with major databases and business systems such as Oracle applications, SAP, Baan, PeopleSoft, J.D. Edwards, etc.

Although the EAI technology can effectively move data between applications in real time, it does not define an aggregated view of the data objects or business entities. EAI is less adequately addressed the need to merge data and information across the enterprise. Along with the movement to real time, the need to integrate different kinds of information has become more important. The Enterprise Information Integration (EII) does address this issue. Although there has been a flurry of research activities (Bergamaschi, 2001), (Mitra, 2001), (Noy, 2000), (Stefan, 1998), etc, in the EII area, still a lot has to be done especially on the semantic level integration. The work that most related to ours based on semantic integration is the one presented in (Bergamaschi, 2001). The approach of the MOMIS project (Bergamaschi, 2001) is a semi-automatic approach to schema integration. MOMIS has a single mediator, which provides a global data schema and query interface to users. Data sources with an ODL wrapper are connected to the architecture. Differently from our approach, the Description Logics is used as a kernel language to interactively set-up the Thesaurus. In our approach, the structure and context of classes in the schema are defined using the XML language transformation. Also the MOMIS approach has not been used in any major industrial projects and is mainly an academic research activity.

Another interesting work that is built using object integration technologies is in (Stefan, 1998). Stefan focused the attention on suitable architectural abstraction concepts of components and connectors for systems. They propose connectors as pattern-like transferable abstractions of system level component interconnection and interoperation.

Unfortunately the use of the above commercial applications is not contemplated. Most of these application integration approaches are complex, costly, and inflexible and require additional design and development efforts. Moreover, they are aimed at large application integration in the enterprise. The Ishtar suite is developed using ideas from both EAI and EII technologies.

# 3 INTRODUCING THE ISHTAR SUITE & THE ARCHITECTURE

The Ishtar project involves seven European cities (Rome, Bologna, Athens, Paris, Brussels, Graz and Grenoble) and a number of technical and scientific organizations (ENEA, WHO, INRETS, TRAC, ARIA, PHAOS, ASTRAN, etc) having different roles in the integration process of the necessary tools and other data sources for the Ishtar Suite.

The integration process includes both old and new software tools. The suite supports a large number of software tools including TRANSCAD, TISIS, COPERT, dBEL, CALINE, PCRAMMET, WOCCS, SIMT-SSP, ADMS-Urban, SATURN, TRANUS, VISUM, METROPOLIS, TEE-TURBAN, KEMIS, etc. Some of the tools need connection to Microsoft office tools (Excel, Access, etc), GIS and other tools such as Logical Decision for Windows, Hielow, etc. Although most tools run on PC under windows operating system, some run on workstations under UNIX environment causing additional difficult.

The architecture of Ishtar Suite (Figure 1) consists of the following:

- Work packages with connector tools for sending and receiving information to the ISM.
- The Ishtar Suite Manager (ISM) for managing the processes inside the suite.
- The user interface also known as Ishtar Suite Interface (ISI) for connecting users to the Ishtar Suite.

## 3.1 Work packages with connectors

The integration process is based on the seven distinct steps of evaluation of transport policies impacts on health and monuments, defined by the following Work Packages:

- WP1: Urban Policies and Actions selection and analysis
- WP2: Integrated transport Analysis Module
- WP3: Integrated transport Direct Impacts
- WP4: Pollutant and Noise Dispersion Module
- WP6: Advance health Impact Module
- WP7: Damage reduction on Artistic Heritage
- WP9: Overall Analysis of case studies

Each work package tool appears as a separate software tool running its own data input, providing its own output and possibly having its own user interface. Using Connectors, work packages are linked to the ISM (Section 3.2) for exchanging information with other work package. This allows information to be shared among applications. Connectors are pieces of software or interface components that are used in the integration of applications and serve as a "wrapper" that mediates access to an application that was not developed with integration in mind. Connectors are used to move data in and out of applications. This is similar to the ODBC in relational databases, which allow unique interface to each vendor of RDBMS. In the Ishtar suite, a Connector performs two kinds of operations:

- The management of exchanges between ISM and tool in work packages. All data used by work package as input, output or internal data are sent to ISM by the Connector on the form of object corresponding to predefined classes of metadata model. A connector communicates with the ISM by means of messages in XML format. Messages are sent to ISM for each request of data.
- The management of execution of work package tool under the control of ISM. A message may be sent by ISM to start a work package tool, it is the connector's job to prepare the definition of the object used by the work package tool and then send to ISM. After approval by ISM, the work package tool is launched. Two cases are considered when launching the work package tool:
  - One case is when the work package tool provides its own user interface. The data provided by user will be entered through work package tool's own interface. The connector carries out the management of input data building corresponding parameters then send to ISM the object corresponding to the parameters.
  - The other case is when there is no user interface. The data provided will be entered through the ISI. Users parameters are built by ISI and ISM and then provided to the connector.

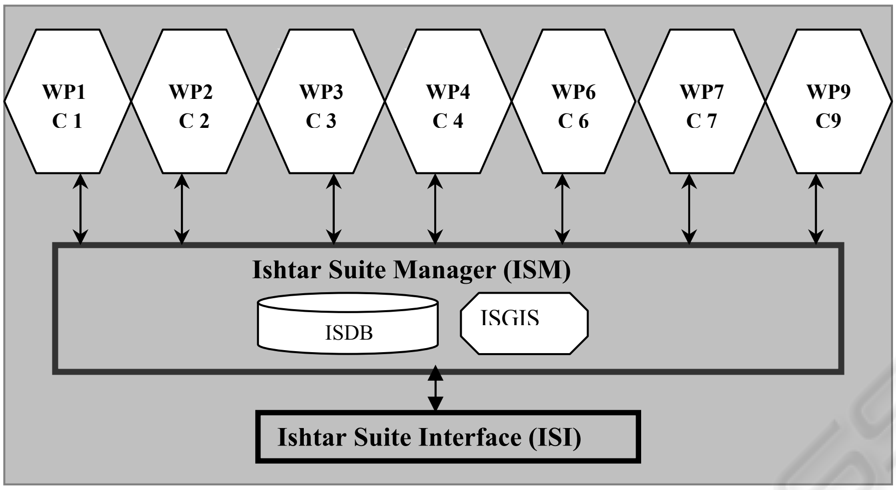


Figure 1: The Architecture and Work Packages (WPs) with *Connectors* (C1 – C9).

## 3.2 The Ishtar Suite Manager (ISM)

The ISM performs the following functionalities:

- Management of data and information exchanged between work packages
- Management of the current scenario execution, keeping trace and archiving of scenarios
- Control of the running process in the suite
- Monitoring processes of each work packages
- Control Ishtar Suite Interface (ISI)
- Store data that is run in each scenario in the suite to a repository called Ishtar Suite Database (ISDB). Also a GIS tool called Ishtar Suite GIS (ISGIS) is used for the management of geographical data and map displays.

Most applications in the EAI domain use message exchange communication to send and receive information (David 1999), (Longo, 2001). The principle of message communication is that a message provides more than simple data. A message contains data and information on action requested by a tool. A Connector undertakes the connection and message exchange of the application to the ISM. Whenever an application needs to be integrated a connector is added to a work package. Applications are no longer tightly coupled. Also there is no longer a bridge via one specific single user interface. The ISM not only controls the processes but also manages the information. Clearly information management in this context is an extremely difficult activity. In particular there is a need for managing information transformation. Further details are articulated in the following subsections.

### 3.2.1 Management of messages, objects and data in ISM

All message or data exchanged are described as objects belong to classes defined as metadata, part of Ishtar Data Model. The kind of data that ISM manages includes traffic data, population data, network data, Meteo data, etc. Data management is according to a transformation or mapping rule. To achieve transformation objects must refer to one of the classes defined in the IDM. The ISM contains a database (ISDB) with a global schema. The global schema is composed of hierarchy of global classes defined for exchange. In each class, attributes are identified and defined with data types in XML format. Figure 2 shows the management of messages, objects and data in the ISM:

- Message management gets the objects sent by tools with associated request.
- Object management checks that the object belongs to a class stored in the class database and stores the object in the objects database.

### 3.2.2 Management of processes

The ISM launches a software tool on the request from user via the interface. It then sends a launching message to the connector tool. The ISM waits for the response of the tool. After receiving message ISM lock all other processes. The ISM is then control the execution of the tool by means of the exchanged messages. At the end of the execution of the tools process, the connector sends a message of execution end to ISM. ISM sends the information to the user and unlocks the other processes. Figure 3 shows management of processes in the ISM phase.

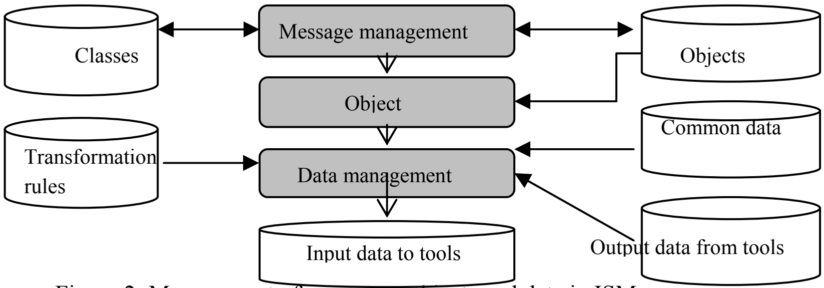

Figure 2: Management of messages, objects and data in ISM.

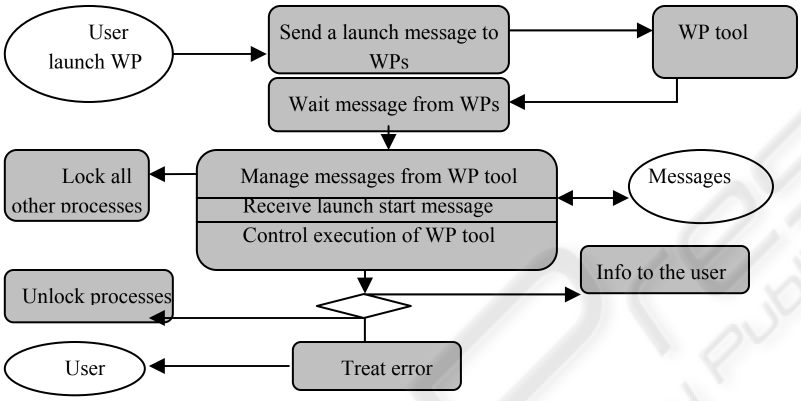

Figure 3: Management of processes in ISM.

### 3.2.3 Management of transformation of data

The ISM undertakes the transformation of data coming from work package tools and requested by the current tool. There are two kinds of transformations. The first one concerns the content of data. In some cases data requested by tool is not directly provided by one tool rather a combination of several data provided by several work package tools. The ISM has a base rules for transformation to assure that all data requested are completed from relevant sources. The other transformation concerns the format of data so that it fits the expected format. ISM uses XML format as a core format for exchanges of data inside the suite.

## 3.3 Ishtar Suite Interface (ISI)

The ISI is part of Ishtar suite through which user controls the execution of processes in the suite. The ISI provides an interactive window where user will have a set of menus to control the process of Ishtar Suite. Each menu corresponds to one of the seven modules defined as work packages. The ISI opens specific interface window when a module of the suite is activated. It also provides an interactive window for each activated module.

The combination of ISM, ISI and connectors create a powerful architecture for information integration in the Ishtar Suite. The architecture now can flow from the ISI to WP9 tool to the ISM then from ISM to WP3 tool. This makes the Ishtar Suite adaptable to any existing software tools and does not force them to conform to any particular form that is existing tools. It is also designed to embrace new applications or technologies as they emerge.

# 4 INFORMATION INTEGRATION

A collection of information or data is needed to support most decision-making processes. Information is a central part of any decision support system. Heterogeneous information drawn from internal operational tools as well as external data sources is mapped to the information specified in a global schema for exchange. Our approach follows the semantic paradigm, in that a global conceptual schema is involved and schema objects (sharable information) are described using a common Ishtar Data Model (IDM) and XML language. IDM is defined as subset of Object Data Model. Information integration is described in detail in (Lejeune, 2003).

## 4.1 The information Integration Problem

When sharing knowledge between applications, integration problems are compounded. Each organisation has its own set of applications, technologies and standards. Information integration is hindered by differences in software and hardware applications and also by syntactic and semantic differences in various data and data sources. This is a recognized problem in the area of EAI where many applications have been created for the purpose of information integration. When broadening the scope of the information integration problem to cross-organisational boundary, the problem becomes even more severe because within an organisation there is certain amount of control over the applications used by one organisation, while there typically is no control over the applications used by other organisations.

What further complicated the matter is the fact that people who are involved in the integration process from existing applications may sometimes have little or no knowledge of the data sources or software tools that are being used which make mapping a hard problem.

## 4.2 Solving Information Integration Problem

Most current tools, however, only addresses the problems of platforms and syntactic heterogeneity. The problem of semantic heterogeneity that is the differences in the meaning of concepts is, in current solutions reduced to syntactic rewriting without explaining the meaning of data. In the Ishtar project, we try to provide a solution for the information integration problem across organization boundaries. We use the Ishtar suite to create integration manager ISM with a well-defined common Ishtar Data Model (IDM). The ISM maps data schemas taken from different sources to the IDM in order to make the meaning of the concepts explicit. Here the ISM enables information integration on a semantic level, but there are still many issues to resolve, such as standardisation in languages for specification of mapping rules and the development of reusable, industrial-strength tools for creation and operational of these mapping. Standards are arising to mitigate these problems, but current approaches are specific for certain organisations and are typically very rigid in what require from anyone using the standard.

# 5 CONCLUSION

We have presented the architecture of integrated tool for the Ishtar project. The architecture is flexible, allowing the integration of interdependent work packages. We base our architecture on the main principles of EAI and EII domains, namely the use of an integration manager, constituting the core of the suite, managing the control of processes and data exchange between software in work packages. The manager also communicates with all tools by means of messages and manages exchange of data based on XML file format. Specific tool called ‘Connector’ is developed by each work package for communication.

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