ACHIEVING INTEROPERABLE ENTERPRISE APPLICATIONS THROUGH MODEL-DRIVEN INTEGRATION: THE ERP-CRM CASE

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Abstract: Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems pose as the backbone of IT infrastructure for most of European Small and Medium-Sized Enterprises (SMEs). Considering the financial situation of typical SMEs, there is a clear need for ready-made interconnected business applications. The paper elaborates a model-based approach to achieve interoperability among existing enterprise applications, such as ERP and CRM systems, through utilizing XML/B2B interconnection standards, developing components and modifying existing systems where necessary. Using Enterprise Model Integration (EMI), ERP and CRM metamodels are merged into an integrated metamodel to provide a common language for interoperable business and system specifications. Based on this, a specific set of CIM and PIM models are constructed, formally representing processes, information, organizational units and systems representing the as-is and the to-be interoperability requirements. On the PSM level, higher level models are reverse-generated using MDA-compatible mechanisms. These are weaved together with existing software engineering representations, to produce new executable systems in various platforms. Within this context, certain patterns appear in various levels of the modelling representations, both in the problem and in the solution space. These patterns formulate an initial, structured set of concepts such as interoperability types, messaging styles and routings as well as software development patterns providing ways for achieving interoperability.

Keywords: Enterprise Application Interoperability, Model Driven Architecture

1. INTRODUCTION

Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems currently pose as the backbone of the IT infrastructure, when typical European SME's are concerned (Ideas 2002, NoE-Interop, 2004). Although those software applications have gone a long way to offer a complete but also adaptive way of covering user needs, usually fail to deliver an interoperable infrastructure, as:

- Business Processes tend to ignore enterprise systems boundaries and span across them
- Integration between different enterprise systems usually does not correspond to any commercially available product or service but is usually treated as a project, raising risks and overall costs.
- Solutions are usually product specific and made aposteriori, as most ERP and CRM systems were developed without the provision of adhering to any B2B Interoperability standard.

Under the above circumstances, there is a clear need for ready-made interconnected applications, especially within European SME that cannot bear the

costs and effort for a bespoke integration and its support. This integration should be at a product level, allowing for combination of software applications and best-of-breed approaches, thus offering many and diversified options for the final user – the enterprise.

The presented work is an approach for model-driven creation of the necessary artifacts for making ERP and CRM systems interoperable, within the contemporary business environment. Following the methods and techniques of Model-Driven Architecture (MDA) and Enterprise Application Integration (EAI), application integration is first "solved" in the business process level, to be then carried through model mappings and transformations down to creation of software components, that will assist product interoperability in a fully standardized way (user-transparent, real time or off-line information and control transfer between the ERP and CRM applications). The innovative parts of this approach lie in the combination of Enterprise Model Integration and Model Driven Interoperability (MDIo) principles (Charalabidis et al, 2004a) with commercially available tools and applications, provided by BOC Information Systems and Singular Software respectively.

2. MODEL INTEGRATION FOR ERP AND CRM INTEROPERABILITY

Enterprise Application Integration (EAI) is a vital field of delivering technical concepts and technologies for integrating heterogeneous applications and components to support inter-organisational business processes (Johannesson et al, 2000). The main idea of EAI is to provide technical solutions to integrate workflows and heterogeneous parts of enterprise applications – such as ERP and CRM – in a continuous business application environment (Charalabidis et al, 2004b). Integrating ERP and CRM, focus often lies on technical and runtime aspects of interoperability. Additionally, it is necessary to describe applications and interoperability aspects on the business and conceptual level as well. This is especially for pre-packaged, ready-made interconnected applications of high importance. Therefore, "build time aspects" and "runtime aspects" are explicitly distinguished in interoperability modelling, as shown in Figure 1.

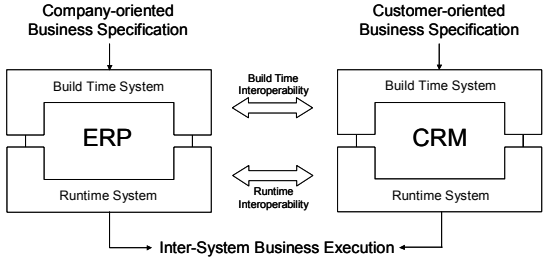

Figure 1: The ERP-CRM interoperability case

On build time level, questions such as the following are raised:

- What is the overall business model to be supported by the enterprise application?
- What is the control flow, material flow and information flow within the business process?
- Which business objects are necessary and where are they used?
- Which business rules exist and how should they be enforced?

In the context of runtime, questions such as the following have to be answered:

- Which data mappings and data correspondences exist?
- How will the inter-system workflows be synchronized and which transaction mechanisms will be used (point-of-no-return, cascading undo etc.)?
- Which audit data will be produced and how can it be used for business monitoring?
- Which security aspects and levels have to be ensured during inter-system communication?

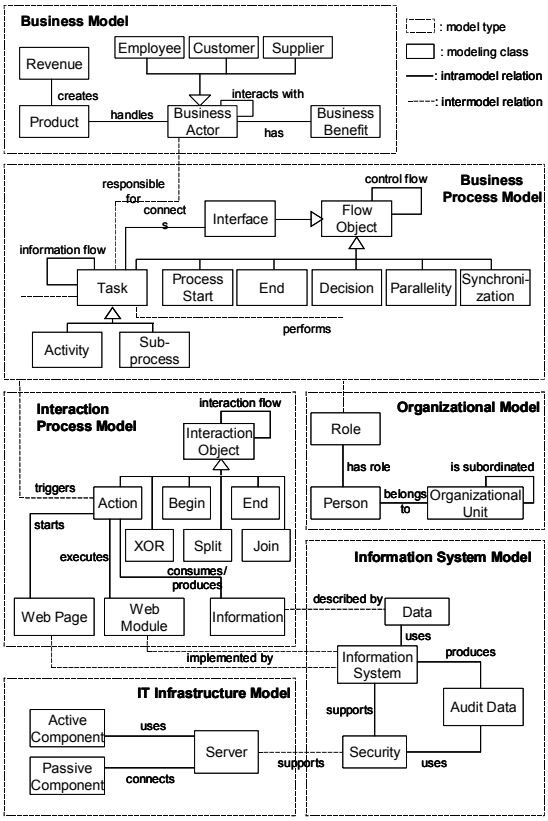

Figure 2: Integrated metamodel for ERP-CRM interoperability specification

For finding and specifying answers for these questions, domain specific modelling languages are being used, described by domain specific metamodels such as ERP-oriented metamodels and CRM-oriented metamodels. Because of the diversity of models and modelling languages in the ERP and

CRM domain (historical reasons, branch-specific reasons, company politics etc.), the Enterprise Model Integration (EMI) approach (Kühn et al, 2003) is applied. EMI is based on object-oriented metamodelling concepts to describe context-specific, integrated modelling languages (BPMI, 2004) and model transformation mechanisms. The EMI approach is compatible to the MDA infrastructure (Czarnecki et al, 2003) and is implemented within the meta model management tool ADONIS (Kühn at al, 2004). Figure 2 shows an integrated metamodel for B2B applications representing some core concepts of the ERP-CRM domain (Kühn at al, 2001). The model types "Business Model", "Business Process Model" and "Organisational Model" focus on build time level, the model types "Interaction Process Model", "Information System Model" and "IT Infrastructure Model" focus on the runtime level (Boucher et al, 2003).

3. INTERCONNECTING EXISTING APPLICATIONS: WEAVING PROCESS AND DATA

ERP and CRM systems may "touch" each other during the handling of various business processes within the enterprise, overlaps and gaps in functionality also being a usual case. As a result, any interconnection has first to be conceptualized at the level of Business Processes (Backlund et al, 2004), as shown in Figure 3, the reverse extraction of which from an existing system is not a trivial sub-project

The integration of business processes usually consists of:

- Identifying which processes exist in both systems, relate to each other and need to be integrated.
- Constructing the information flow within these processes, especially at the point of systems crossing
- Deciding on the master and slave system

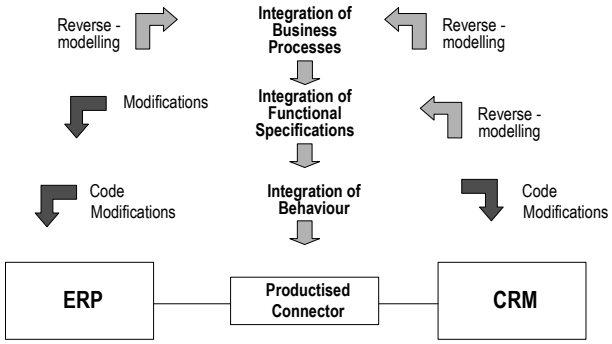

Figure 3 : From Business Processes to Code Components

A set of such processes in a mid-market ERP-CRM integration project, is as following:

i. Customer Data Creation – Update – Deletion (Master: CRM)
ii. Product Data Creation – Update – Deletion (Master: ERP)
iii. Customer Order Creation (Master : CRM)
iv. Customer Invoice Creation (Master : ERP)
v. Customer Payment Creation (Master : ERP)
vi. Customer Request Creation (Master : CRM)
vii. Customer Installed Base Management (Master : CRM)
viii. Customer Contracts Management (Master : CRM)
ix. Customer Qualitative or Derived Information Management (Master : CRM)
x. Customer Financial Information Management (Master : ERP)

Based on the presented metamodel, Business Processes that cross the boundaries of both systems are then modelled , using standard UML notation with the extension of "swimlanes" which has been proven to be a powerful tool, as shown in Figure 4.

After the Business Process modeling, the functionality of the desired solution should be bounded and modeled (or re-engineered). Integration of the functional specifications yields the following deliverables:

- Specification of Data to be matched and exchanged between the two systems, in XML notation with extensive documentation.
- Specification of the exact message-response sequence, in UML sequence diagram notation.
- Clearing out any overlap or filling any possible gap in functionality

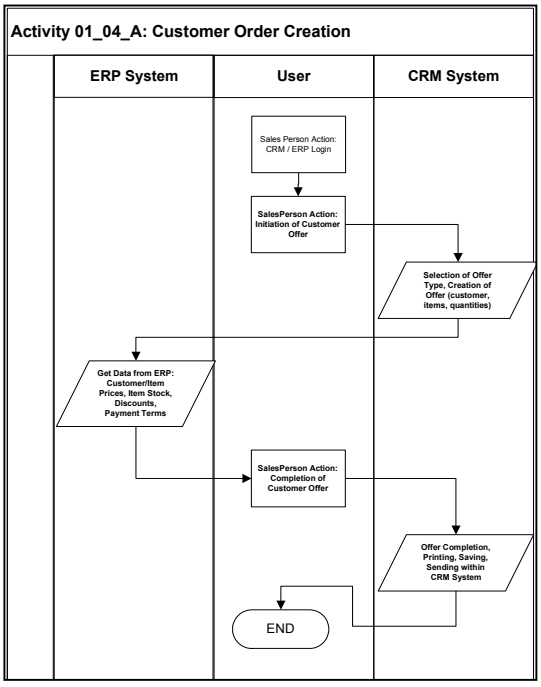

Figure 4: An example System-Crossing activity modeled with UML swimlanes

At this stage, adherence to B2B and relevant standards (information exchange, security, encryption, authentication, etc.) have also to be dealt

with, posing certain directives to the solution to be finally adopted and affecting overall architecture of the integration, specific functionality points and, not less often, the overall adoption of the solution.

Such standards may include (Charalabidis et al, 2004b):

- Underlying technologies standards (e.g. XML, XML/EDI, HTML, D-HTML, etc)
- B2B information exchange standards (e.g. ebXML, RosettaNet, ebisXML, UN/CEFACT standards) that concern both processes and data.
- Security, trustworthiness and encryption standards (e.g. SSL, PKI, Digital Certificates)
- Various standards for the description and modeling of various deliverables (e.g. MDA/UML, Relational Database design standards, various programming languages, etc), usually very important for the technical support and evolution of the solution.

4. RESULTS AND DISCUSSION

The pilot project was the interconnection of Singular mid-market ERP and CRM applications, targeting enterprises with typically up to 500 employees from various sectors of industry, services and commerce. Singular ERP had already been installed in more than 600 enterprises in Greece while Singular CRM was about to be launched in this market.

The relevant project led to the development of the following components:

a. Definition of processes that cross systems, where 15 key processes were identified and formally described using the presented metamodel. The processes allow the everyday operation of both systems in the majority of mid-market situations, covering:
   - Synchronised management of customers and products, including their most important attributes.
   - Flow of orders, invoices and relevant business documents between the two systems.
   - Flow of qualitative and financial information between the two systems.

b. Definition of the information to be exchanged, leading to the specification of the exact XML schemes for orders, invoices, customer and product data, customer information, etc.

c. .Definition of the needed functionality around each process and specifically at the adjacent points (specification of automatic processes, user-enacted processes, off-line scheduled interaction).

d. Formation and description of various non-functional requirements (performance, security, time constraints, availability, etc).

e. Design and development of the needed software components, yielding a Productised Connector – a parameterisable software component that is installed together with the ERP/CRM systems.The development was done in Singular development environment (Microsoft VisualStudio.net – compatible tools)

The pilot application and testing of the resulting infrastructure (ERP, CRM systems, RDBMS, connectors) was performed in a large publishing company in Athens, with 50 users in each of the systems. The conclusions drawn by the pilot are as following:

- Model-driven integration was quite successful both because the key processes were covered but also because there was extensive documentation for the users at all the phases of the project.
- The solution easily out-performed former EAI approaches based on data-only integration (typically RDBMS connections), as it used the core transactional processes of the two systems.
- There was significant new functionality added to the ERP/CRM systems interfaces, relating to what types of messages can be handled – showing that existing systems usually require extensive re-work.
- The extendibility of the approach is very crucial, as user needs evolve every day and want more and more processed covered. In this area, the model-driven approach also provided both a way of integrating new requirements around existing processes but also the methodological framework to assess and streamline any new request.

The initial positive results on the real return of investment for such a solution are now leading to the final packaging of the connector, while in parallel new products following the same principles of interoperability are under development (Figure 5).

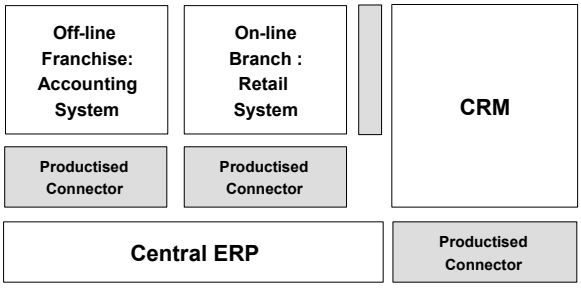

Figure 5 : Enterprise Application Connectors in the IT systems of the mid-market Enterprise

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