FROM STRATEGIC TO CONCEPTUAL ENTERPRISE INFORMATION REQUIREMENTS
A Mapping Tool

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Abstract: Enterprise Information analysis can be modeled on three levels: Logical, Conceptual and Strategic. Logical level is used daily on thousand of projects to design databases. Conceptual level is used by analysts to structure detailed information needs expressed by users. Strategic level is used by IT and user management to define Enterprise Information Architecture and/or to assess the viability of the current information assets. While mapping conceptual onto logical modeling is well-established, strategic and conceptual levels are poorly linked. This drawback very often prevents enterprise to implement a sound information strategy. We here present a method that maps strategic enterprise information into conceptual information modeling. For strategic modeling a comprehensive framework is used that enables to readily identify information domains of a wide range of enterprises. Mapping strategic to conceptual models is performed by a set of simple and predefined rules. The paper also illustrates the tool that has been developed to assist the whole design and mapping process. Finally a case study on materials handling exemplifies our approach.

1 INFORMATION REQUIREMENTS LEVELS

It is a common practice to classify enterprise information requirements in two abstraction levels, logical and conceptual. The former is represented by Relational models (Elmasri, 2004) and the latter by Entity Relationship (ER). Of course, over years other modeling techniques have been developed. For instance Dimensional Fact Model (Golfarelli, 1998) focuses at the conceptual level. Other modeling technique families as Unified Modeling Language (Object Management Group, 2005) cross levels.

Each abstraction level is for a certain community of users. Typically the conceptual level is for analysts and logical one is for Database Administrators (DBA) or generally for implementation engineers. However, ER is too detailed for an overview of an even limited domain. Actually an ER schema of the customer/order domain in an enterprise may count hundreds of entities! Therefore, above the conceptual level, a third abstraction level is needed. This third level shall address enterprise information as a whole and also target the strategic needs that are of key interest for management. In short it shall be the backbone of IT strategy and planning. The positions of the three abstraction levels are represented by Figure 1.

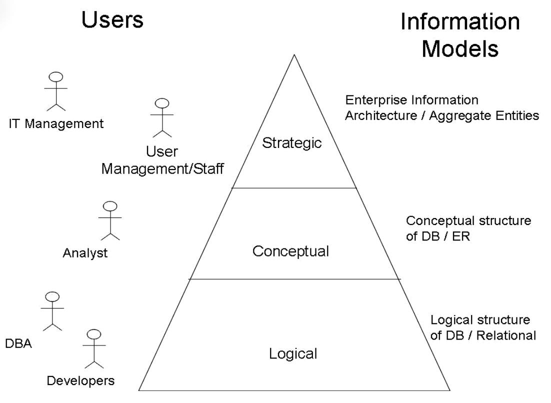

Figure 1: Abstraction levels of enterprise Information.

In short, the strategic level should represent information in a very aggregated and compact form that can be understood by IT and user management and can be used in IT strategic planning. The strategic level issue is in Enterprise Information Architecture (Josey, 2009) and in Enterprise Information Integration (EII). The latter has the

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purpose of combining into an unified format information from diverse sources (Bernstein 2008; Halevy, 2005).

Strategic Information requirements have been specifically addressed by Enhanced Telecom Operations Map® (eTOM). The eTOM framework (TMForum, 2003) includes the Shared Information Data model (SID) that offers a normative paradigm for shared information / data, based on the concepts of Business Entities and Attributes (TMForum 2003, 2005). A Business Entity is a thing of interest to the business, while Attributes are facts that describe the entity. In short "an Aggregate Business Entity (ABE) is a well-defined set of information and operations that characterize a highly cohesive, loosely coupled set of business entities". The framework is shown in Figure 2 where each block represents an Aggregated Business Entity. By defining ABEs in telecommunications domain, SID is a normative framework for information but it lacks universality, since it is oriented to telecommunications nor it provides an axiomatic approach to identify Entities.

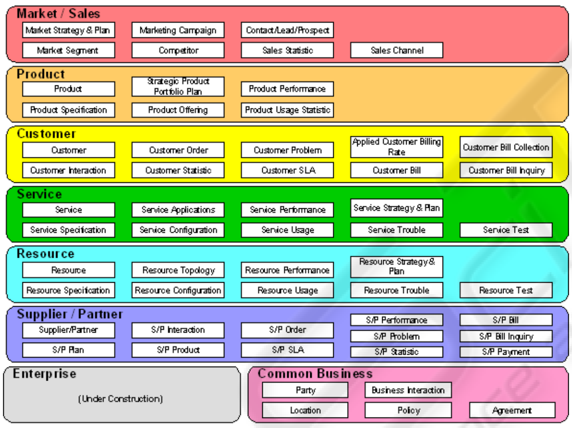

Figure 2: SID, TMForum 2005.

Actually a really universal, not domain specific, approach to Strategic Information Requirements modeling is an issue since the heydays of information systems and it has been addressed by different techniques families.

The analyst uses these methods to structure information needs, gathered from management, through interviews or other sources. Business Systems Planning (BSP), very popular in Eighties (IBM 1975) associates data classes and processes in a grid, that shows which process uses which data. Later, Information Strategy Planning - ISP (Martin 1990) integrates different information models, such as BSP, Entity Relationships and Data Flow Diagrams (DFD). Finally, with the success of ERP (Enterprise Resource Planning) software, a new family of information analysis techniques integrates information, processes and organizational structures, such as the successful ARIS (Architecture of Integrated Information Systems), that provides some normative definition of high level information, but it mirrors SAP (Scheer, 2000).

With this same purpose of universality, a recent technique called Strategic Information Requirements Elicitation - SIRE (Motta, 2008) contains a universal catalogue of enterprise Strategic Information Entities-SIE (Table 1). Each SIE results from crossing Information Types and Information Domains. Information Types reflect the nature of Information that may be structural (Master Data) or describe events (Transaction Data) or define computed indicators (Analysis Data). In turn, Information Domains describe the universe about which information recorded and are conceptually similar to SID's ABEs.

By a sequence of steps, Strategic Information Entities (SIE) are tailored to a specific enterprise.

Potentially, SIRE offers a flexible approach that can be incorporated in methodological containers as TOGAF. Actually it is not bounded to a specific industry and customization method comply specific needs.

Table 1: SIRE catalogue of Strategic Information Entities.

			INFORMATION TYPE		
			Master Data	Transaction Data	Analysis Data
INFORMSTION DOMAIN	Stakeholders	Law			
		Competitor			
		Customer			
		Supplier			
		Broker			
		Shareholder			
	Resources	Personnel			
		Plants			
		Raw materials			
		Cash			
	Context	Structure			
		Project			
		Region			
	Output	Process			
		Product			
		Service			

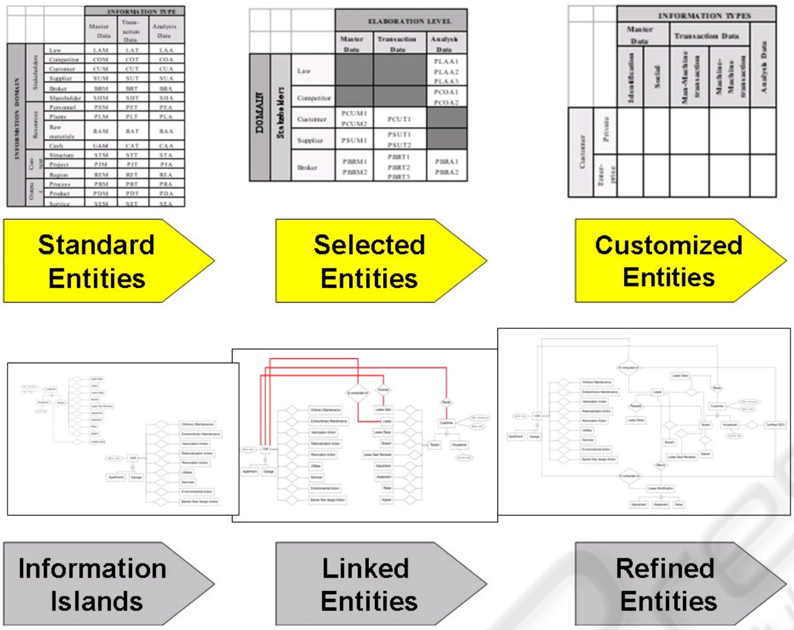

Figure 3: Stages of the Strategic-to-conceptual mapping.

Table 2: Mapping steps.

Step	Input	Output	Activities
Selection	Standard Information Catalogue	Selected Strategic Information Entities	a) Define the scope of analysis b) Select SIEs and add properties
Customization and Refinement	Selected Strategic Information Entities	Customized Strategic Information Entities	Creation / Specialization / Decomposition of Strategic entities
Course Mapping	Customized Strategic Information Entities	Conceptual Information Islands	Link Strategic Master Data to Strategic Transaction Data
Link of Information Islands	Conceptual Information Islands	Conceptual Linked Entities	Link between Information Domain
Refinement	Conceptual Linked Entities	Refined Conceptual Entities	a) Creation / Specialization / Decomposition of Conceptual entities b) Creation of new Relationship as needed

Our work intends to illustrate a model and a tool to map SIE at strategic level down to the Entities at conceptual level. In an ideal Information Engineering, each abstraction level can be mapped over the lower one. Therefore in our level pyramid (Figure 1) we should have two top-down mappings namely, the strategic-to-conceptual and the conceptual-to-logical. Numberless model-to-model transformation techniques and tools have been developed and used for conceptual-to-logical mapping. Our purpose is to present a technique and tool to support strategic-to-conceptual mapping.

2 THE MAPPING METHOD

This section addresses the transformation of the Strategic Information Catalogue in a standard ER Schema. In order to obtain a viable conceptual schema from the initial catalogue of SIEs we have defined six abstraction stages (Figure 3). The first three stages actually fall into the area of strategic information requirements elicitation and have been already illustrated (Motta, 2008). The subsequent stages fall within conceptual analysis and are based on ER schema. Table 2 summarizes input, output and activities of each step (Motta, 2009).

The model transformation includes three steps (1) Course Mapping, (2) Link of Information Islands, (3) Refinement. Mapping has in input the SIE model and converts it into a preliminary ER model. The mapping is applied for each domain in the model and could be summarized in Table 3.

Through this step analysts delete the "horizontal discontinuities", and link master and transaction data within the same information domain.

The first step is domain-centered and the preliminary ER schema is made of low-coupled "Conceptual Information Islands". An Information Islands is the association between a Master Strategic Entity and its related Transaction Strategic Entities. The name island underlies that no cross domain links exist but only master-to-transaction.

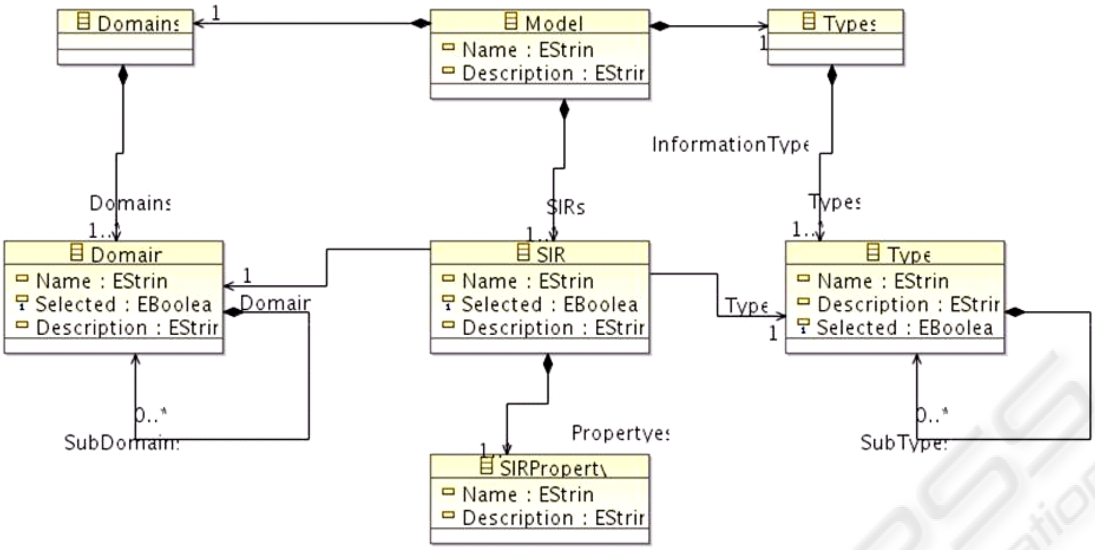

Figure 4: SIE meta-model (UML class notation).

As a second step the analyst links Information Islands by identifying common entities, attributes and relations between domains and obtains a more cohesive ER schema. By this step the analyst overcomes "vertical discontinuities" between master information belonging to different information domains and also "diagonal discontinuities" between master information and transaction information belonging to different information domains. As a third step the analyst inserts new relations between entities, specializes or decomposes entities and attributes and aggregates or generalizes entities. The last step enhances the ER schema by inserting deeper domain competences.

Table 3: Mapping algorithm of SIE to ER model.

SIRE Model	ER Model
Specialization	Enhanced ER Specialization (Overlap or Disjoint)
Decomposition	Compound ER or Compound/Complex attribute
Property of Master Data	Entity Type or Attributes
Property of Transaction Data	Entity Type and Relationship Type
Property of Analysis Data	Calculated attributes

3 TOOL

In order to support the analysts in identifying Strategic Information requirements and map them on the Conceptual level, we have designed an Eclipse based tool that enables the creation of well-formed SIRE models and related ER schemas. The tool follows the six steps discussed above. The development of such a tool overcomes the scarcity of tools for modeling conceptual information level and moreover for mapping strategic level into conceptual level.

Data Tool Platform (DTP) project (http://www.eclipse.org/datatools/) is a powerful Eclipse project but it produces only relational schemas. Eclipse plug-in central (http:// www.eclipseplugincentral.com) provides 28 plug-ins for relational modelling such as CLAY MARK II, *ERMaste*, AMATERAS ERD and Mogwai ERDesigner. Alas no conceptual modelling tool is provided. The commercial DATABASE VISUAL ARCHITECT (http://www.visual-paradigm.com/) provides the design conceptual models but it is not open and it does not map strategic requirements on conceptual level.

Our tool is based on the SIE meta-model that has been developed with the Graphical Modeling Framework (GMF, http://www.eclipse.org/gmf/) provided by the Eclipse platform (Figure 4). The upper entity classes represent the catalogue containers and are ancillary classes. In the lower row are represented the super-types respectively the [Information] Domain, [Information] Type and SIE entity.

The conceptual meta-model (Figure 5) reflects the well-known Elmasri's (Elmasri, 2004) representation and, therefore does not need to be explained in detail.

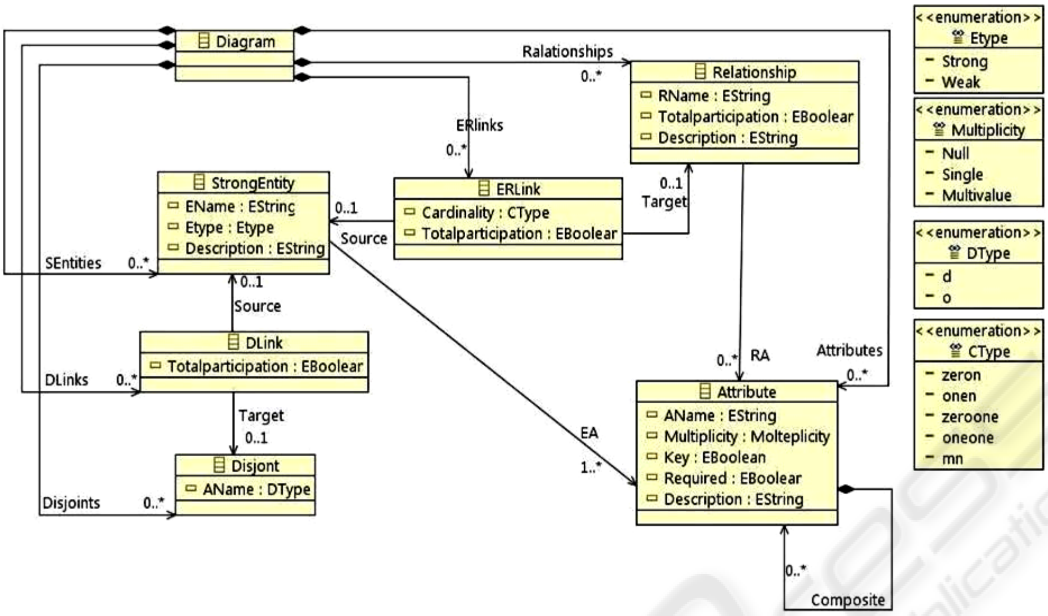

Figure 5: ER metamodel (UML class notation).

3.1 The Case Study

To illustrate how the mapping method and its related tool work we will use a very easy case study.

MACINE manufactures about 50,000 tractors. Products models are about 2.000, and result from combinations of base models and optional parts. Production is performed in one plant, and products are sold by dealers. Below we describe materials handling operations; candidate entities are in capital letters.

3.1.1 Receiving

Suppliers ship pallets according the deadlines specified on MONTHLY SUPPLY PLAN (MSP). Shipments are described a BILL OF MATERIAL (BOM). The formal correctness of supplier's information is checked against information stored in PART, supplier orders (ORDER) and SUPPLIER. An ENTRY BILL (ENB) for is issued, in which are recorded the details of the arrival. For each received pallet, a LOADING UNIT record is created. It specifies details of delivery. A paper copy of LOADING UNIT (LUN) follows the material.

Quantity and quality differences are recorded on the ENTRY BILL, ORDER and PART files. Differences in quality are recorded on a DISCARD BILL (DSB) and related material is put in an ad hoc area.

Hot requests (MATERIAL REQUEST) are flashing in the arrival area and are satisfied by immediately dispatching the arrived material to the plant, with a paper copy of MATERIAL REQUEST (MRQ). Direct dispatch is documented by the same record as for picking, described below.

3.1.2 Storage

The material is moved to the warehouse entry. Free warehouse cells are identified and reserved on the warehouse map (MAP). The material is stocked in the warehouse and its actual position is recorded on LOADING UNIT and MAP.

3.1.3 Picking

The production requires picking by a MATERIAL REQUEST form. The location is identified on PART and MAP. If the material is found, the corresponding LOADING UNIT are booked. If the material is not found, the MATERIAL REQUEST is forwarded to the receiving staff. When picking is over, related LOADING UNIT are "erased"; also MAP (locations vacated) and PART are updated. Figure 6 reflects the third step of the method in which the analyst is customizing the Strategic information entities of the case study. At this point the analyst can launch the transformation of his table of customized strategic information entities in course conceptual entities. Transformation associates to each Master information its related Transaction. Specifically you have three Master entities that, respectively, reflect the domains of Resources-Material, Stakeholder-Supplier and

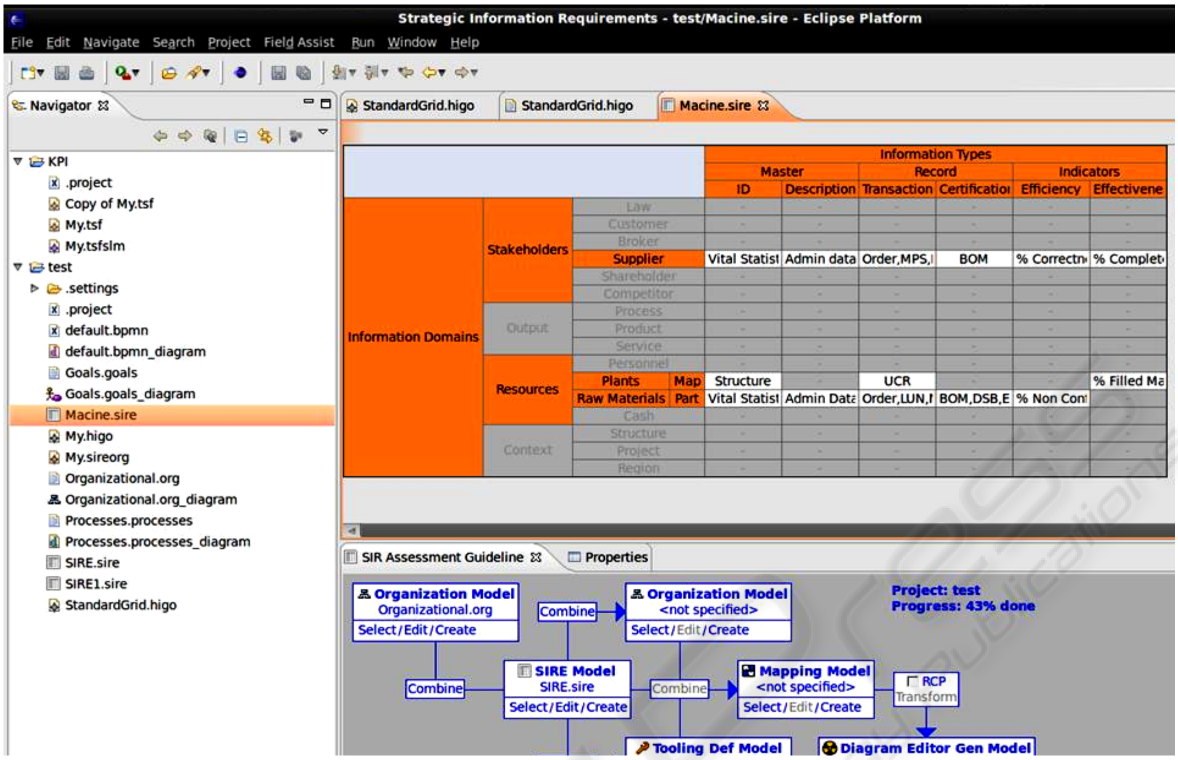

Figure 6: A screenshot of the tool representing the customized strategic entities.

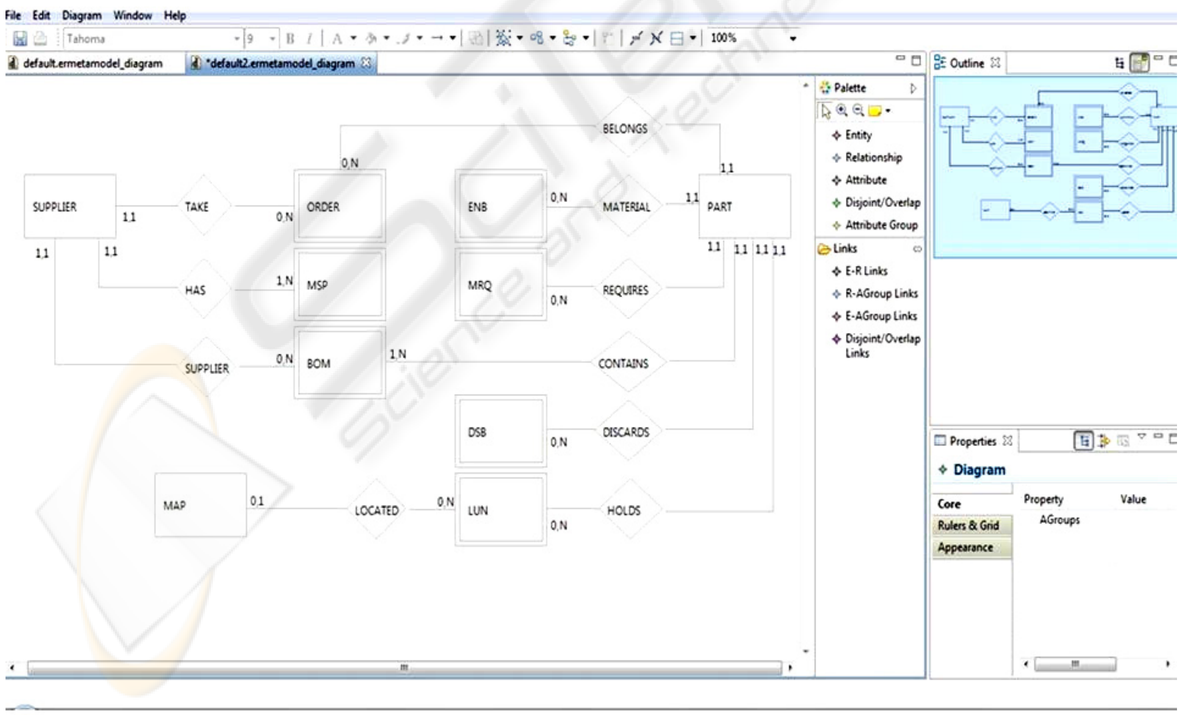

Figure 7: A screenshot of the linked conceptual entities.

Resources-Plant. Each Master entity is related in 1-to-N associations to a set of Transaction entities. The subsequent model of linked entities is obtained through a manual linkage (Figure 8). The links typically reflect a multiple association of a transaction entity to master entities. In our case study this happens for BOM and ORDER (both linked to PART and SUPPLIER) and for LUN (linked to PART and MAP. Though links are identified by domain knowledge, we are planning to develop a guidance that helps the analyst in identifying potential cross-domain links already at strategic level and implementing them at conceptual level.

Finally the analyst will refine the schema by well-known ER elementary operations (e.g. specialization, N-ary relationships, etc…).

4 CONCLUSIONS

We have illustrated a technique and a tool that enables to design a complete and consistent Enterprise Information Architecture from the strategic level down to the conceptual level. The approach is consistent as is based on robust models. Actually strategic modelling is based on a normative framework (SIRE, Motta, 2008) that generalizes some concepts extensively tested by eTOM SID (TMForum, 2005). In turn the conceptual level uses the universally known ER notation. The approach is complete as it provides simple rules to map the strategic level onto the conceptual level.

Furthermore the approach can be usefully integrated in more general frameworks such as TOGAF and it is supported by a open source tool based on the Eclipse suite.

Future developments include extended coverage, tool enhancement and extended validation.

The coverage will be extended by the introduction of a bottom-up mapping from conceptual to strategic level. This mapping could help IT management to extract a strategic view from the current heterogeneous and diverse databases. A very similar research direction is to structure a strategic information architecture from unstructured text documents (e.g. manuals, organization charts, interviews and alike).

The tool enhancement will include the integration of the conceptual modelling tool with logical modelling tools and, also, guidance in model-to-model transformation.

Finally we are planning to apply out approach to other real-life cases mainly in service and government sectors.

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