Enterprise Modelling: Its Use in Enabling Near Real-Time Implementation of Mobile Number Portability- A World's First

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ABSTRACT
The Enterprise Modelling (EM) approach to systems design can promote systems integration and data integrity. This results in greater business efficiency and improved customer service. This paper reports on a comprehensive case study of Telstra, which is Australia’s leading telecommunications carrier. Specifically, it reports on Service Level Agreement and reporting performance of two similar systems evaluated in terms of accepted Information Systems Architectural Criteria. One system named Mobile Number Portability (MNP) was designed using the latest object-oriented tools. The other named Data Repository System (DRS) was designed using the EM approach. DRS significantly outperformed MNP confirming the claims made for the EM approach.

INTRODUCTION
The advent of Mobile Number Portability (MNP) into the Australian telecommunications market on 25 September 2001 was Australia’s first. A new Virtual Private Network (VPN) was built for use by each of the seven major mobile carriers. Each of these carriers was represented in the Australian Communications Industry Forum (ACIF) where the MNP business processes were jointly designed and agreed over a period of 18 months. Each carrier then designed and built its MNP System to address the business requirements and processes defined in the ACIF Code. Telstra is Australia’s leading telecommunications company and is the case study reported here. Its purpose built operational system (MNP) was designed and built using the latest object-oriented tools and technologies and was implemented prior to the cutover of MNP.

The MNP System failed to meet SLA functionality and reporting functionality. It performed poorly when evaluated in terms of accepted Information Systems Architectural Criteria. For example, the MNP System’s support of fundamental business rules is extremely poor. It should be noted that the Service Level Agreement (SLA) functionality was the complex aspect of the system to design and implement as it constantly changes according to the requirements of the Regulator. Hence, it was decided to build this functionality into a separate system named Data Repository System (DRS) using a different approach based on Enterprise Modelling (EM). The new system was designed using this top-down technique. The DRS successfully met the SLA functionality and reporting functionality. It performed extremely well when evaluated against the Information Systems Architectural Criteria.

The successful use of EM at Telstra is an example of a success story. Its “telling” may prove useful to other organizations not only in Australia but also worldwide.

BACKGROUND
Currently a knowledge crisis exists. There is data chaos in most organisations with islands of information still in existence (Bellini, 1999; McFarlan & McKenney, 1983; McFarlan, McKenney & Pyburn, 1983; Taylor 1995). Information is not seen as a strategic asset. Most organisations have incompatible legacy systems with no strategy for ‘knowledge audit’ and a distrust of the IT function. There exists a need for ‘knowledge mapping’, knowledge stewards and knowledge directors (Bellini, 1999; Taylor 1995).

Table 1 Deficiencies of Information Systems Architecture briefly describes the two most important deficiencies of information systems architectures long identified in the literature. They are the lack of integrated system architecture together with poor data integrity.

RESEARCH PURPOSE AND HYPOTHESIS
The aim of this research is to evaluate the usefulness of the EM approach by comparing the performance of two systems of similar functionality in a large organization where one uses the EM approach and the other does not.

The major hypothesis is that the use of EM will result in significantly improved performance of its business systems. This improved performance will be evidenced by a high degree of integration and high data integrity.

RESEARCH METHOD
Telstra was selected as the case study company as it is typical of telecommunications companies worldwide. It is a mature company and relies heavily on quality information and strategic application of

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information technology (IT) for successful business performance. The MNP is an ideal case study, as all Australian carriers are required to conform to the regulatory requirements defined by the ACIF. It is expected that the findings will be directly applicable to all other carriers and service providers in the telecommunications industry and to have relevance worldwide.

The investigation consisted of five main stages that are summarised as Figure 1 Stages of the Investigation:

1. Develop the Enterprise Model.
2. Define the Baseline Architecture.
3. Apply the Enterprise Model
4. Test the Usefulness of the Enterprise Model
5. Refine the Enterprise Model

Refinements to the EM are iterative, occurring throughout its application to the new Customer Business System (DRS) and with the comparison of the DRS with the baseline Customer Business System (MNP).

The investigators had access to all senior executives of Telstra, permission to interview relevant staff and conduct surveys within the company. Interviews were conducted with all Divisional, Group and Activity Managers in all states and the national office. The investigators also had access to all relevant documentation associated with MNP and DRS. Focus groups with key stakeholders within Telstra were conducted that included confirmation of the relative importance of the architectural criteria and identification of the sources of data required for the investigation.

The Enterprise Model

EM allows one to depict the inner working of an organisation or a large functional area at a high level. Specifically, this is revealed in terms of the constituent business functions and the information flows among these functions. Apart from providing top-down guidance to subsequent systems development effort and project planning, it also provides major insight as to how an organisation works in terms of information flows. This insight is essential to a business process re-engineering (BPR) undertaking. Information architecture, based on its corresponding EM, is a blueprint for building business systems that dovetail together in support of the business to achieve its goals. As the case study shows, both an EM and its corresponding Information Architecture are essential to information systems planning and systems development.

The following commonly used analysis techniques were performed on the data gathered during the interviews to develop the EM at Telstra.

- **Stakeholder Analysis** (Hammer & Champy, 1993; and Tregoe et al, 1989).
- **Customer - Supplier Analysis** (Gale & Eldred, 1996; Hammer & Champy, 1993; Porter, 1980; 1985; and 1990; and Tregoe et al, 1989).
- **Strategy Set Transformation** (Boar, 1995; Gale & Eldred, 1996; Porter, 1980; 1985; and 1990).
- **Information Systems Architecture** (Gale & Eldred, 1996; Gillensons & Goldberg, 1984; Sowa, 1984; Sowa & Zachman, 1992b; Zachman, 1987).

Development of the EM draws upon the insights and contributions from the literature of those researchers identified above and also to the researchers / authors whose work and ideas have significantly influenced the development of the EM approach to business systems architectures (Henderson-Sellers & Simons, 2000; Jacobson, I., Booch, G. and Rumbaugh, J., 1999; Jacobson et al, 1995).

Figure 2 Partial Information Flow Schema is a small section of the EM at Telstra. The functional area highlighted against Function 4 Manage Industry and Regulatory Environment was used as the basis for developing the DRS. This Information Flow Schema identifies how information flows across the enterprise, that is, how information is created, used and shared. Commonly accepted symbols like C = Create and U = Use of information is employed in the model.

### 4.3 Baseline Architecture

The baseline architecture was the SLA functionality of the MNP business processes. As was indicated previously it was designed and built using the latest object-oriented tools and technologies. The EM approach was not used for the design of the SLA and reporting functionality.

### 4.4 Application of EM

The SLA and reporting functionality was incorporated in the DRS. This system was designed using the EM approach. This provided a rare opportunity in a “real-world” project environment to evaluate the performance of two similar systems designed with a different approach. Performance was evaluated in terms of the agreed Information Systems Architectural Criteria. These are now discussed.
Information System Architectural Criteria

The Information System Architectural Criteria used to evaluate and compare the performance of the MNP and DRS are:

- Architectural Principles
- Fundamental Business Rules
- Functional Scope and Interfaces
- Data Sharing

Each of these is now described together with a discussion on the relative importance of each.

**Architectural Principles** refer to the good practices in the overall design of business systems. In the architectural evaluation of the systems designed specifically to meet its requirements, the following architectural principles are used:

- Data Captured at Source: Capturing data where it occurs, that is, at its source, is deemed to be a good system design practice. If the same kind of data is captured by different business functions and not centrally co-ordinated, duplicated capturing of the same data may result. This in turn leads to data inconsistency and data redundancy.
- Data Consistency and Data Maintainability (100% Principle): The way the data is structured must be based on the inherent nature of the business. If the data is not structured properly it is impossible to maintain its accuracy. Hence, the data will become inconsistent and not maintainable. A well accepted good practice called the 100% Principle, advocates that all (i.e. 100%) rules concerning the updates of data be handled centrally by the database management system rather than by each and every one of the application programs that invoke the rules. Apart from eliminating duplicated efforts it guarantees that the data is updated consistently across the board and renders the data more maintainable.
- Data Redundancy: Data Redundancy results from the same data being captured and stored more than once or poor structuring of the data. Apart from wasting data storage it renders the data accuracy and quality not maintainable.
- Data Independence: Data Independence refers to the database management system’s ability to allow the data view of a program to be changed without affecting other programs’ data views. This can significantly reduce maintenance costs of the system.
- Modularity and Maintainability of Software: If a system is highly modularised, that is, broken down into program modules in a well-defined manner, then changing the logic of a program module may not affect other program modules. This can significantly reduce maintenance costs of the system.

**Fundamental Business Rules** are the rules necessary for a business to operate efficiently and effectively. If the data structure does not reflect these business rules it is impossible for the system to satisfy the business requirements. These business rules and their corresponding data structure (conceptual schema) are found in EM.

**Functional Scope and Interfaces** refers to the totality of the functions performed by the system. The interfaces refer to the interfaces among these functions. This evaluation criteria looks at the coverage of the system in terms of the functions and their interrelationships.

**Data Sharing** refers to sharing the same data across the functions of different systems is the basis for architectural integration. If the data is shared properly then the benefit of an update to a piece of shared data is automatically shared across these systems. This eliminates the need for duplicating data and reduces the overall costs of the systems.

**Performance Evaluation**

To perform the evaluation of each system and compare their performance measurement data was required for each criterion. Judgements were made with reference to the literature and the stakeholders of MNP as to the relative importance of the criteria. The following weightings were used to evaluate and compare performance. Thus, support of fundamental business rules was judged to be twice as important as data sharing. Table 2 Data Collection Source for each Architectural Criteria identifies the criteria, the relative weightings, measures employed and the data collection source used.

### Table 2: Data Collection Sources for each Architectural Evaluation Criterion

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Relative Weighting</th>
<th>Measure</th>
<th>Data Collection Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Architectural Principles</td>
<td>12</td>
<td>A (1) Source of Data Capture</td>
<td>Mapped to Business System’s Design/Declaration and Physical Database Scheme to the Enterprise Model to identify the Data Sources and their Data Views.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B (2) Number of Business Functions that Capture Data</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C (1) Data Consistency &amp; Data Maintainability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D (1) Data Independence</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E (1) Modularity &amp; Maintainability of Software</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F (1) Data Redundancy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>G (1) Data Sharing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>H (2) Adherence to 100% Principle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>I (1) Source of Data Collection</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>J (1) Ability to Change Data Views of a Program</td>
<td></td>
</tr>
<tr>
<td>2. Fundamental Business Rules</td>
<td>3</td>
<td>A (1) Source of Data Capture</td>
<td>Mapped to Business System’s Design/Declaration and Physical Database Scheme to the Enterprise Model to identify the Business Rules that are supported.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B (1) Basis of Data Structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C (2) Adherence to the 100% Principle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D (2) Ability to change Data Views of a Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E (1) Well-defined Program Modules</td>
<td></td>
</tr>
<tr>
<td>3. Functional Scope &amp; Interfaces</td>
<td>1.25</td>
<td>A (1) Totality of the Business Functions performed by the System</td>
<td>Mapped to Business System’s Design/Declaration and Physical Database Scheme to the Enterprise Model to identify the Business Functions supported by the System in the Enterprise Model.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B (1) Totality of the Business Functions performed by the System</td>
<td></td>
</tr>
<tr>
<td>4. Data Sharing</td>
<td>1</td>
<td>A (1) Data Sharing between the System and the same Data</td>
<td>Mapped to Business System’s Design/Declaration and Physical Database Scheme to the Enterprise Model to identify the Functions that must use the same Data.</td>
</tr>
</tbody>
</table>

**RESEARCH FINDINGS**

This comparative investigation assessed and compared the performance of the baseline MNP system with the DRS. The DRS was designed and developed using the EM approach. The technique used to provide a quantitative perspective of system performance is called Figure-of-Merit Analysis. The steps in the Figure-of-Merit Analysis are:

1. Based on the Dimensions or Architectural Evaluation Criteria and their relative significance, assign a Weighting Factor (WF) to each of the Architectural Evaluation Criterion to reflect its relative significance.
2. Calculate the Uniting Factor (UF) as follows:

   \[ UF = \frac{\text{Sum of WFs}}{\text{Number of WFs}} \]

3. For each of the Business Systems assign a raw score on a relative scale of 1 to 10 with respect to each of the Architectural Evaluation Criterion.
4. Unite the raw score as follows:

   \[ \text{United Score (US)} = \frac{\text{Raw Score} \times \text{WF}}{\text{UF}} \]

5. Calculate the Average United Score (AUS) for each Business System:

   \[ \text{AUS} = \frac{\text{Sum of US}}{\text{Number of Architectural Evaluation Criteria}} \]

The AUS is the best indication of how well a Business System is rated against the Architectural Evaluation Criteria. The rounded off AUS is thus the Figure-of-Merit (FoM).

The MNP System fails to abide by two fundamental architectural principles. Firstly, it does not abide by the 100% Principle as it hard codes the business rules in its application programs and therefore data integrity (that is, data correctness) cannot be guaranteed. Secondly, in
Table 3: System Performance Results

<table>
<thead>
<tr>
<th>Architectural Evaluation Criterion</th>
<th>Weighting Factor</th>
<th>Raw Score</th>
<th>Weighted Score</th>
<th>Unweighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Architectural Principles</td>
<td>1.5</td>
<td>3</td>
<td>4.5</td>
<td>0.78</td>
</tr>
<tr>
<td>2. Fundamental Business Rules</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>3. Functional Scope &amp; Interfaces</td>
<td>1.25</td>
<td>4</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>4. Data Sharing</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL SCORE</td>
<td>5.75</td>
<td>11</td>
<td>38</td>
<td>15.5</td>
</tr>
</tbody>
</table>

The use of enterprise modelling is a key to integrated business systems improved the quality of service delivery and regulatory capability to a major Australian telecommunications provider. The study demonstrates that substantial benefits can be achieved with a minimal investment by understanding the way in which information flows throughout the organization.

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