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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 a world'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 most complex aspect of the system to design and implement as it constantly changes according to the requirements of the Regulator.

Table 1: Deficiencies of Information Systems Architecture

Deficiency	Description	Reference
Lack of Integration	Integration refers to information systems operating in concert with one another based on some shared data such that no redundant data will be created and that the benefit of an update to the data will be shared across all information systems using the data. Without the benefit of top-down guidance from an Enterprise Model, it is impossible to achieve any degree of integration.	Boar, 1993 & 1995; Gale and Eldred, 1996; Gillensons and Goldberg, 1984; Inmon, 1998; Mattison and Sipolt, 1994; Mowbray and Zahavi, 1995; Sowa and Zachman, 1992b; Spewak, 1993; Taylor, 1992 & 1995
Poor Data Integrity	Data integrity (that is, correctness of data) can only be assured by first coming up with a data architecture, as part of the Enterprise Model, by performing data modelling to capture all the relevant business policies and business rules which forms a basis for designing the databases. Unless the Enterprise Model is used as a basis for subsequent data modelling, this will ultimately corrupt the data and thus undermine the validity of the information systems that use the data.	Boar, 1993 & 1995; Gale and Eldred, 1996; Gillensons and Goldberg, 1984; Inmon, 1998; Mattison and Sipolt, 1994; Sowa and Zachman, 1992b; Spewak, 1993; Taylor, 1992 & 1995

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.

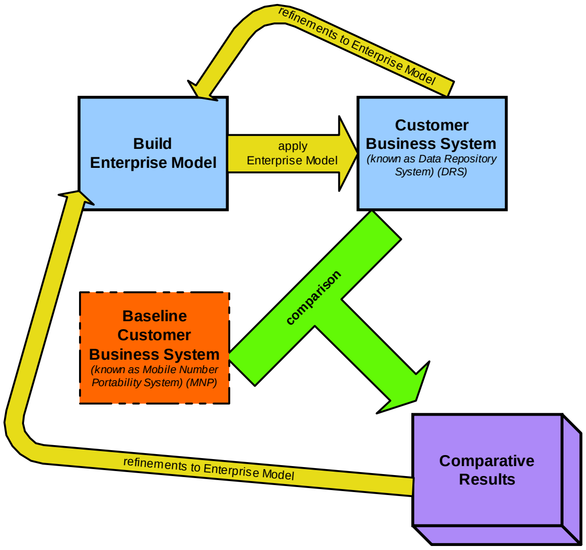
This paper first discusses the purpose of the research and how it was conducted. It next describes in summary form the Enterprise Modelling process and its major output the Enterprise Model. Next it discusses the performance of the DRS, after application of the EM, and compares that with the performance of the MNP. Finally, it discusses the findings, draws conclusions and indicates future research directions.

RESEARCH METHOD

Introduction

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

Figure 1: Stages of the Investigation



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
- *Functional Analysis* (Martin, 1989 and 1990).
- *Business Information Modelling* (Chen, 1976; Nijssen & Halpin, 1989; Halpin, 1995).
- *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.

Figure 2: Partial Information Flow Schema

Business Theme / Functional Outline	WHOLESALE PRODUCT T9	WHOLESALE PRODUCT OFFER T10	SERVICE PROVIDER T101	NETWORK PROVIDER T102	INDUSTRY REGULATOR T20	MSN MOVEMENT T21	INVLVD PRTY MSN MVMNT PRGRS T22	CRR RRT BRDCST MSN MVMNT T23	REJECT PARTY T24	MSN MVMNT INDSTRY DLG TP T25	MSN MVMNT PRGRS PERF MSR T26	COMPETITOR T27
F4.0 Manage Industry & Regulatory Environment												
F4.1 Manage Regulatory Strategy	U	U	C	C	U							
F4.2 Manage Regulatory Communication			U	U	U							U
F4.3 Manage Regulatory Product Request												
F4.3.1 Capture Regulatory Product Request	U	U	U	U	U	C	C	C	C	C		
F4.3.2 Process Regulatory Product Request	U	U	U	U	U	U	U	U	U	U		
F4.3.3 Validate Regulatory Product Request	U	U	U	U	U	U	U	U	U	U		
F4.3.4 Analyse Customer Product Movement Request	U	U	U	U	U	U	U	U	U	U	C	
F4.4 Monitor & Assess Regulatory Product Request Impact	U	U	U	U	U	U	U	U	U	U	U	
F4.5 Take Regulatory Product Request Impact Minimisation Measures	U	U	U	U	U	U						U
F4.6 Manage Regulatory Product Request Compliance	U	U	U	U	U	U	U	U	U	U	U	U

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

Criteria	Relative Weighting	Measure	Data Collection Source
1. Architectural Principles A. Data Captured at Source B. Data Consistency & Data Maintainability C. Data Redundancy D. Data Independence E. Modularity & Maintainability of Software	1.5	A (1) Source of Data Capture A (2) Number of Business Functions that Capture Data B (1) Basis of Data Structure B (2) Adherence to 100% Principle C (1) Same Data Captured & Stored more than once C (2) Poor structuring of Data D (1) Ability to change Data View of a Program E (1) Well-defined Program Modules	Mapping of Source Systems Design Documents & Physical Database Schema to the Enterprise Model to identify duplicates & gaps & adherence to the defined Architectural Principles
2. Fundamental Business Rules	2	Ability of the Data Structure (Conceptual Schema) to support the defined Business Rules based on the Enterprise Model	Mapping of Source Systems Design Documents & Physical Database Schema to the Enterprise Model to identify the Business Rules that are supported
3. Functional Scope & Interfaces	1.25	The Totality of the Business Functions performed by the System	Mapping of Source Systems Design Documents & Physical Database Schema to the Enterprise Model to identify the Business Functions performed by the System & those Business Functions that can be supported by the System in the future
4. Data Sharing	1	Ability of different Functions in the System to use the same Data	Mapping of Source Systems Design Documents & Physical Database Schema to the Enterprise Model to identify the Functions that must use the same Data

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 Unitising 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. Unitise the raw score as follows:

$$\text{Unitised Score (US)} = \frac{\text{Raw Score * WF}}{\text{UF}}$$

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

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

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

Architectural Evaluation Criterion	Weighting Factor	Raw Score		Weighted Score		Unitised Score	
		MNP	DRS	MNP	DRS	MNP	DRS
1.Architectural Principles	1.5	3	9	4.5	13.5	0.78	2.35
2. Fundamental Business Rules	2	2	10	4	20	0.7	3.48
3. Functional Scope & Interfaces	1.25	4	9	5	11.25	0.87	1.96
4. Data Sharing	1	2	10	2	10	0.35	1.74
TOTAL SCORE	5.75	11	38	15.5	54.75	2.7	9.53

the MNP System's current data architecture, data concerning the relationships among "Unacknowledged Cutover Customer MSN Movement", "Acknowledged Cutover Customer MSN Movement" and "Rejected Cutover Customer MSN Movement" are stored as relationships between "Request" and "Request Status", and between "Request Transaction" and "Request Transaction Status". This is architecturally unsound in that Resubmissions will be stored redundantly because Resubmission data are largely business facts concerning the relationship among "Unacknowledged…", "Acknowledged…", and "Rejected…" and not between any two of the three concepts. This redundancy will ultimately render the data incorrect because it is impossible to keep different copies of the same data consistent with one another.

According to the Conceptual Schema (Data Model) there are 156 fundamental business rules that the system must support in order to meet the business requirements. The MNP System implements 25 of these business rules, which are only 16%, compared with the DRS which implements 100% of business rules. As a result MNP scores a "2" out of a possible "10" and DRS scores a "10" out of "10".

The MNP System should be flexible enough to interface, in future, with other churn systems to take advantage of SLAs. If the MNP System is not flexible enough, then full benefits of SLA processing cannot be easily derived and taken advantage of. Integration of the MNP System with other churn systems cannot be achieved.

Of all the entity types identified in EM, not less than 75% are shared across more than one component. It is important that these shared entity types are implemented once only and the business rules that apply to them are also implemented once only. In the MNP System, these shared entity types are implemented, not necessarily consistently, more than once across different components without even being aware of it. This creates uncontrolled data redundancy, which will in turn lead to data corruption.

Table 3 System Performance Results summarise the performance for each system in terms of the Information Systems Architectural Criteria.

Based on the above figure-of-merit analysis, using weighting factors and scoring out of ten, the relative strengths of the two business systems are reflected by their respective unitised scores as follows:

The threshold for acceptance is 50%. It is clear that the MNP System (scored at 27.00%) is not architecturally sound as it now stands. On the other hand, the DRS scored at 95.30%, meeting all required business needs and is architecturally sound with its flexibility to meet changing business needs in the future.

DISCUSSION AND CONCLUSION

In the comparative study it was found that all three existing systems at Telstra, the MNP System, its client Wholesale Mobile Connect and the Mobile Provisioning System all suffer from lack of integration and poor data integrity. Both the MNP System and Wholesale Mobile Connect were developed using the latest object-oriented system design techniques. Each of these systems was documented with detailed Process Models and Use Case Models but does not have a Class Diagram or Object Model defined at the conceptual level. Neither system were developed on the basis of an Enterprise Model, that is, top-down, business driven and customer focused. The observation of the Regulator and key Telstra MNP managers has been that no other carrier in the Australian market has been able to implement the ACIF Code and in particular, the performance measurements with SLAs. Hence, Telstra have been given responsibility for managing the industry from a regulatory reporting perspective

The MNP System (scored at 27.00%) does not meet the currently defined set of business requirements and is not architecturally sound. That is, the MNP System foundation ensures that it will not be capable of adaptation in meeting perceived future business needs. This architectural failure with the MNP System means that business system integration is not possible now or in the future and its poor data integrity will continue to become more prevalent as the system is modified. On the other hand, the Data Repository System (DRS) scored at 95.30%, meeting all required business needs and is architecturally sound with its ability to adapt in meeting changing business needs.

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 organisation.

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