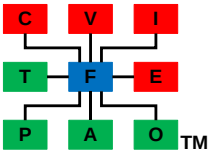

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The Enterprise Architecture Model

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Biography

Rainer Schoenrank is the senior data warehouse consultant for The Data Organization. He has degrees in physics from the University of Victoria and computer science from the University of Victoria and California State University Hayward. He has built data warehouses for clients such as Pacific Bell (Financial), Genentech (Personnel), GE Leasing (Sales), SGI (Personnel), PPFA (Healthcare), Brobeck (Personnel), BofA (Merger and Acquisition), Clorox (Financial), Leapfrog (Financial) and Intuitive Surgical (Quality Assurance). He can be reached at rschoenrank@computer.org.

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1. INTRODUCTION

To understand how the processes of the business interact, we build a model of the business at a fairly high level of abstraction. This model is called an enterprise architecture.

The definitions of architecture are:

1. "An architecture is both the process and the product of planning, designing, and constructing the conceptual structure and logical organization of a computer-based system" – Wikipedia
2. "The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution" – ANSI/IEEE
3. "The structure of components, their inter-relationships, and the principles and guidelines governing their design and evolution over time" – TOGAF (The Open Group – Architecture Forum).
4. A formal description of a system, or a detailed plan of the system at component level to guide its implementation

Applying these definitions to the business (enterprise) as a system should give us

- Well organized processes – for example, an organization chart (www.apqc.org)
- Well documented processes – for example, ISO 9000

The enterprise architecture model forms the basis for organizing the information technology components required to meet business processing goals. According to TOGAF, the enterprise architecture has these components:

1. Business Architecture – defines the business tasks, their organization, standard operating procedures and policies.
2. Application Architecture – is the blueprint for the application systems and their and relationship to key business processes.
3. Data Architecture – describes the meaning and structure of the enterprise data, the process used to consolidate the application data and the business intelligence framework.
4. Technology Architecture – describes the middleware, hardware and network to support the processing, application and data architectures.

The terminology surrounding the architecture model can be confusing. Sometimes, the application architecture and the data architecture together are referred to the Information Systems Architecture. Also, the term Information Technology (IT) Architecture is used to refer to the application, data and technology architectures of the enterprise architecture model.

An enterprise architecture should be documented as described in the Zachman Framework. This documentation should enable us to understand the relationships between the enterprise architectural components in new ways. For example, the vertical enterprise architecture will uncover the Data Life Cycle and the horizontal architecture should uncover the IT architecture.

The enterprise architectural model is an emergent structure that is the result of a three-step process:

1. Setting up a business
2. Automating the business record keeping processes which results in a number of separate application silos
3. Consolidating the data in the silos to get cross-application or enterprise wide reporting

The emergent steps and their associated architectural models will be examined in detail below, with the goals of discovering what organizations need to be created, what choices are available and what decisions need to be document for a clear understanding of the enterprise architecture.

2. BUSINESS ARCHITECTURE

Engaging in business is a uniquely human endeavor. When this activity is looked at systematically and at a certain level of abstraction, you get that the business consists of processes to make money and records to keep track of the money, that is, the business is

(policies, procedures, functions) + (accounts) + (journals, registers, ledgers)

The current model of business organization is hierarchical:

- processes are organized by the organization chart
- money is organized by the chart of account
- records used to be organized by the business' central records office catalogs, but now data is organized by the enterprise logical data model

These organizations are unique to an individual business because there are too many variables involved in creating the hierarchies by classifying the processes, money and records (Jevons). So, just as no two businesses have the same chart of accounts (money) or organization chart (processes), every business has a unique enterprise logical data model (records).

At the start of operating a business, none of the record keeping processes are automated and a completely manual business has only the business processing architecture of processes and the technology architecture of office productivity applications as shown in Figure 1.

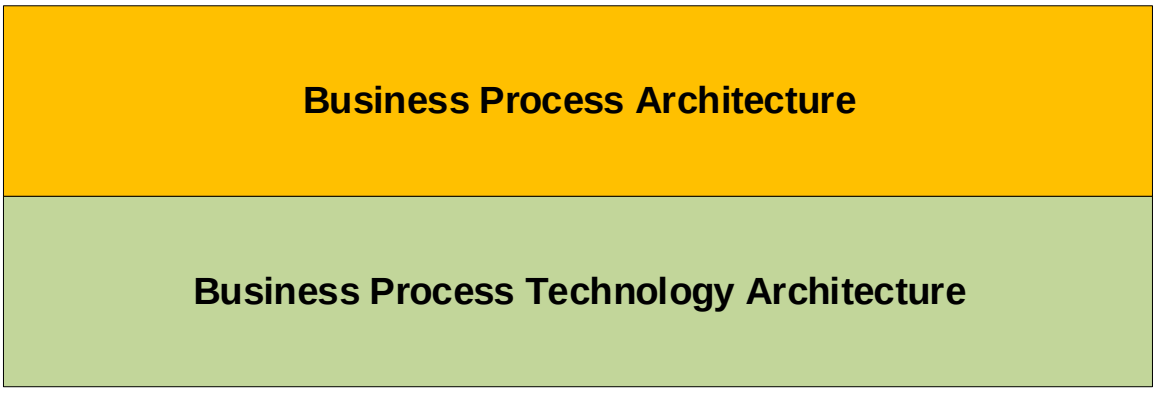

Figure 1: Business Architecture

2.1 Business Process Architecture Components

The business architecture consists of the organization chart of the processes that the company workers use to create and sell products, define business strategy, and execute their standard operating procedures. The business organization chart (www.apqc.org) can be organized into three areas:

- The management processes – these are the bonds that hold the company together
  - Create a vision and strategy
  - Manage change and improvements
  - Manage external relationships
- The operating processes – these are the core competencies of the company; this is why the company is in business
  - Develop and manage products and services
  - Market and sell products and services
  - Deliver products and services
  - Manage Customer service
- The supporting processes – these are the processes that ease the burden on the operating processes. They are also the first processes that have been outsourced, for example, auditing, payroll, recruiting, etc.
  - Develop and manage human capital
  - Manage information technology
  - Manage financial resources
  - Acquire and manage real estate
  - Manage environmental health and safety (EHS)

2.2 Business Process Technology Architecture Components

At this point in the business lifecycle, the technology architecture describes the office productivity applications, physical hardware and network required to support the manual business processes.

List of Business Processing Technology Components

- Middleware
    - Word processing
    - Document management
    - Meeting Scheduling
    - Email
    - Financial analysis (spreadsheets)
    - Google or Bing or …
- Hardware
    - Document Printers
    - FAX
    - Email Servers
    - Document storage servers
- Network
    - LAN routers and switches
    - Internet gateway (modem)
    - ISP

3. ENTERPRISE AUTOMATION GOALS

As the business grows, there is a need to standardize and automate some of the business processes, especially sales, purchasing and time tracking The enterprise architecture framework is used to achieve the three goals of the enterprise automation, but to achieve these goals the process makes a number of assumptions.

3.1 Goal 1 – Automating Business Processes

The first business goal is to improve efficiency and reduce costs by automating the manual processes of the business processing layer seen at the top of Figure 1. As each manual function of the business process architecture layer is automated, a new application silo is created is created the application layer and new business data objects are created in the data architecture layer.

This collection of applications creates the application architecture described in the next section. These applications are built for individual business units and the business processes specify what data is required and stored,

3.2 Goal 2 – Automating Business Record Keeping

Achieving the goal of cross-application reporting means inserting another layer between the application architecture layer and the technology layer as shown in Figure 2 creating the complete enterprise architecture model according to TOGAF.

If an Enterprise Logical Data Model is available, then an analysis would show that each application function maps onto a path in that data model.

3.3 Goal 3 – Cross Business Process Reporting

As the number of silos in the application architecture layer grows, the business observes that there is lots of data, but no cross-application reporting that enables comparisons and contrasts of current business processes to recommend changes and improvements, such as the labor cost per product item produced, etc.

The cross-application reporting can be achieved using OLAP applications such as Tableau, OBIEE, etc. The OLAP applications use views on the ELDM that cross the subsets of the ELDM that are used by the automated silos.

3.4 Assumptions

The enterprise architecture makes a number of assumptions on the structure and capability of the business automation layers. These assumptions are:

- The application architecture layer does not store any business data.
- The data architecture layer does not do any business processing.
- The interfaces between the architecture layers are well documented and do not have any dependency on the components of each of the layers. This assumption has led to the concept of cloud computing.
- There exists sufficient computer processing power to execute all the data processing in the time allotted.

These assumptions are critical to the framework because if the assumptions cannot be met, then compromises must be engineered into the implementation of the business automation.

4. AUTOMATION ARCHITECTURE

The business processing architecture is supported by the application architecture which organizes and automates some business processes and by the data architecture which organizes, manages and stores the business data in the implemented enterprise logical data model (ELDM).

The application architecture is the inventory of the online transaction processing (OLTP) applications which automate the business processes and the online analytical processing (OLAP) tools used for cross-application reporting.

In the application architecture the OLTP and OLAP applications do not interact with each other and automating the business record keeping processes results in a number of separate application silos, such as payroll, account receivable, accounts payable, order entry, etc.

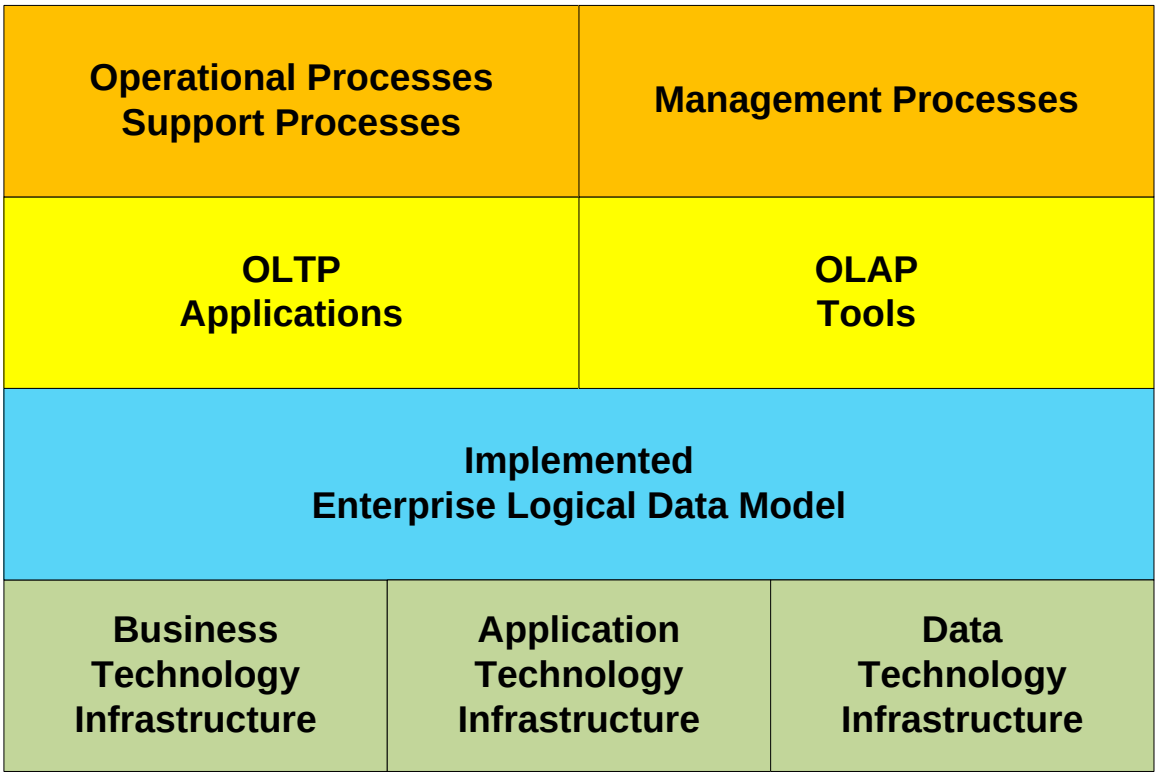

Figure 2: Enterprise Automation Architecture

4.1 Business Processing Architecture

The list of Business Processing Architecture Components has not changed.

4.2 Application Architecture

The operational applications make assumptions and simplifications (shortcuts) in their processing since some data is not necessary for efficient processing and can be defaulted in the ELDM.

For example in the sales application, invoices are aggregations of line items sold and the invoice assumes all the line items are dispatched from the same place and get delivered to the same shipping address. This allows the tax and freight to be calculated for the aggregated invoice rather than assigned to individual line items.

Similarly, in the payroll application, it assumes that salaried employees work 40 hours a week, so no time card records are created for salaried employees to save on space and compensated time off is treated as an exception. Having all workers timecards in the OLTP application explicitly would make labor and cost reporting more general and much simpler.

Since OLTP applications are non-overlapping, that is the payroll application does not do sales, the sales application does not do purchasing, etc., some data is replicated in each application. This creates a management issue when that data has to be reconciled.

The OLTP application are difficult to develop from scratch, therefore, many businesses decide to buy the applications from software vendors. These applications are do not follow the architectural framework. These application contains both the application architecture layer and the data architecture layer. This means that the application implicitly contains a data model and organization of the business for which they were developed. This process, organization and data model are not necessarily the ones that the business would choose for itself. For example, ORACLE Financials (many individual OLTP applications bundle into a single package) is based on 1980's American accounting practice while SAP R/3 is based on batch job manufacturing and 1970's European accounting practice. **The major assumption that was made when these applications were created is the record keeping is done on paper.**

4.2.1 Application Architecture Components

The components of the application architecture are the OLTP applications that can be organized by the business processes. The listed applications are only representative, since there are many packaged (COTS) and DIY applications available.

- Operational Applications – data sourcing applications (OLTP)
  - Product Design Management
  - Purchasing
  - Inventory Management
  - Supplier Management
  - Marketing and Sales Automation
  - Order Fulfillment
  - Customer Relationship Management
- Organizational Applications – support applications (OLTP)
  - Human Resources Information Systems
  - Time Card Capture
  - Payroll
  - Accounts Receivable
  - Accounts Payable
  - General Ledger
  - Fixed Assets Management
  - Real Estate Management
- Strategic Reporting Applications
  - OLAP tools

These applications contain the current state of the business process only. The history of the process is not usually saved past the end of the fiscal year reporting requirement.

4.3 Data Architecture

The data architecture layer contains the organization and the structure of the business record keeping data. This data may be stored in many databases from the purchased OLTP applications, so an enterprise logical data model (ELDM) is necessary to reconcile all the different views of the data. The ELDM forms the basis for organizing the information technology components required to meet business processing goals.

4.3.1 Data Architecture Components

The data architecture gathers, reconciles and organizes the enterprise data storage. The components of the ELDM are:

- Business Measurements – storing the business transaction data (extraction from OLTP)
  - Sales transaction data – the dollars received by the business
  - Labor Time card data – for people working for the company
  - Inventory Time card data – for inventory creation, quality assurance, etc.
  - Purchasing transaction data – the dollars spent by the business
- Operational Master Data – storing the data about the external entities of the business
  - Customer – the list of entities that have paid for our products and services
  - Employee – the list of people that have executed the business processes
  - Inventory – the list of items that have been purchased
  - Supplier – the list of other businesses that provided parts, inventory or services
- Organizational Master Data – storing the data about how the business is organized
  - Position – the list of positions at the bottom of the organization chart
  - Product – the list of products (goods, services or information) offered for sale and their organization
  - Activity – the list of activities done during business transactions
  - Calendar – the organization of days into operational weeks, months, and quarters (financial calendar)

There are well defined interfaces between the application technology components and the data architecture components.

4.4 Technology Architecture

There are now three different sets of components with the Technology Architecture Layer. One set of components for each of the architecture layers.

4.4.1 Business Processing Technology

The list of Business Technology Components has not changed.

4.4.2 Application Processing Technology

The technology architecture now contains a second component that describes the middleware applications, physical hardware and network required to support the applications for the automated business processes. The flexibility of this architecture has led to the concept of cloud computing.

The list of Application Technology Components is:

- Middleware
    - Batch process controller
    - Application processing
- Hardware
    - Application Servers
- Network
    - LAN routers and switches

4.4.3 Data Processing Technology

The technology architecture contains a third component that describes the middleware applications, physical hardware and network required to support the ELDM of the data architecture.

List of Data Architecture Components

- Middleware
  - DBMS
- Hardware
  - DBMS Servers
- Network
  - LAN routers and switches

5. HORIZONTAL ARCHITECTURE

An alternative to the assumed stacked vertical architecture described in section 4 is a horizontal architecture that assumes that the technology architecture that underlies each of the other architectural layers is independent of the other technology.

Figure 3 shows the relationship between the architectural layers:

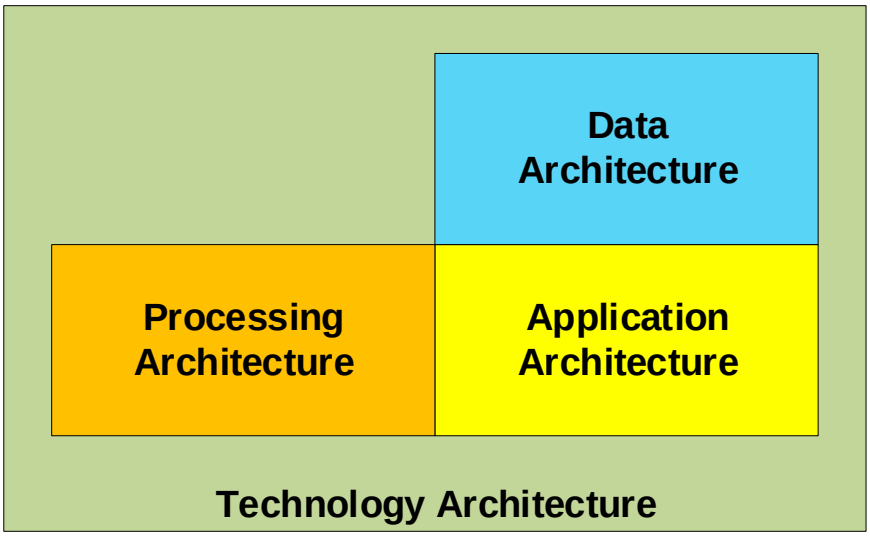

Figure 3: Horizontal Architecture

The components of the horizontal architecture are:

- Business Processing Architecture – the enterprise organization chart, its business units and subunits
- Data Architecture – the enterprise conceptual data model, its master data entities and business process measurements
- Application Architecture– the automated applications that exist at the intersection of the business unit and the master data entities

These three architectural layers all rest on top of the Technology Architecture because each of the architectural layers relies on its own available technology components.

This also shows that the technology architecture has three separate and non-overlapping sections as shown in Figure 3. A section each for:

1. Business Processing technology – that supports email, document handling, word processing, scheduling, internet access, etc.
2. Application and OLAP technology – that supports the business application processing and cross-application reporting
3. Data technology – that supports the implemented enterprise logical data model and the all the operations necessary for the database.

There is no need for a horizontal interface between the three technology architecture components. The three separate technology components do not overlap

.

5.1 Enterprise IT Architecture

When we add the architectural component details to the horizontal enterprise architecture, we get the IT architecture shown in Figure 4.

The diagram shows how the business, application and data architecture layers of the enterprise architecture model are related.

On the left side of the diagram, the details of the business architecture layer are labeled as rows. The components of the business architecture are shown as individual business functions. These business functions are modelled on the APQC Process Classification Framework, available at www.apqc.org/portal/apqc/ksn/.

The details of the data architecture are labeled as columns in the diagram. The data architecture components are the entities and business measurements described in the conceptual data model.

The individual applications of the application architecture reside in one or more cells at the intersections of the rows (processes) and columns (data).

Company Organization Chart / Conceptual Data Model		Master Data								Measurement Data			
		Operational Data				Organizational Data							
		Customer	Employee	Inventory	Supplier	Position	Product	Activity	Calendar	Sales	Buy	Labor Time	Inventory Time
Management Processes	Manage Improvements and Change	Cross-Application Reporting / Business Intelligence Reporting / OLAP / Data Architecture											
	Develop Vision And Strategy	Marketing Analytics				Marketing Analytics	Marketing Analytics		Marketing Analytics				
	Manage External Relationships				Capital Management				Capital Management				
Operational Processes	Develop and Manage Products and Services			Receiving	Supplier Management		Product Design Management	Product Design Management	Purchasing / Receiving		Purchasing		Product Creation Management
	Market and Sell Products and Services	Sales Force Automation	Sales Force Automation	Sales Force Automation		Sales Force Automation	Sales Force Automation		Sales Force Automation	Sales Force Automation			
	Deliver Products and Services	Fulfillment	Fulfillment	Fulfillment			Fulfillment	Fulfillment	Fulfillment	Fulfillment			Inventory Delivery Management
	Manage Customer Service	Customer Relationship Management					Customer Relationship Management		Customer Relationship Management	Customer Relationship Management			
Support Processes	Develop and Manage Human Capital		HRIS			HRIS		Employee Time Card Capture	Employee Time Card Capture			Employee Time Card Capture	
	Manage Information Technology			Fixed Assets					Fixed Assets				
	Manage Financial Resources	A/R	Payroll		A/P	G/L			G/L A/P A/R	G/L A/R	G/L A/P	Payroll	
	Acquire and Manage Property			Real Estate					Real Estate		Real Estate		
	Manage Environmental Health and Safety												

Figure 4: Detailed Enterprise Architecture

The diagram in Figure 4 looks like the bus matrix described by Ralph Kimball or the matrix cross checking described by James Martin. Using this diagram at an enterprise level has a certain explanatory power. The diagram shows:

- The OLTP applications (e.g., time capture, A/R, A/P, etc.) and OLAP reporting tools residing at the intersection of a data column and a process row.
- An end to end business process – A horizontal row – sales, e.g., saleforce.com
- Master data management – A vertical column – customer
- The Enterprise Logical Data Model (ELDM) – the entire set of vertical columns.

The diagram in Figure 4 can be used to evaluate the impact of change to the requirements of a process, an application and master data. When master data changes, you can read down the column to identify all the applications and processes that will be impacted. Similarly, when a process or an application changes, you can read across the row to identify all the master data that will be impacted.

6. REFERENCES

American Productivity and Quality Center (APQC), https://www.apqc.org/

Kimball, Ralph. https://en.wikipedia.org/wiki/Enterprise_bus_matrix

Martin James, https://en.wikipedia.org/wiki/Information_engineering

The Open Group Architecture Framework (TOGAF), https://www.opengroup.org/togaf

W. S. Jevons, “The Principles of Science”, Chapter 30, Dover Publishing Inc., New York, 1958 https://archive.org/details/theprinciplesof00jevoiala/page/n8

