**Systems Integration and Architecture**

**Summary of Chapter 01: Overview of Systems Integration: Challenges and Drives**

Systems integration means that you allow an heterogeneous Information System (IS) to communicate or integrate and share information (or data) seamlessly with one another.

Enterprise Resource Planning (ERP) systems are a major kind of information system allowing organizations to integrate different systems into one organization-wide application with an integrated database management system.

Silos are 2 types:

**Horizontal Silos** – Classification of organizations into departments like Accounting and Human Resources, reflects the breaking of complex tasks into smaller manageable tasks.

**Vertical Silos** – Organizations also divided roles in hierarchical layers from strategic planning to management control and operation control.

Information Systems play a major role in primary and secondary activities of an organization’s value chain.

Information Systems provide a high level of computer automation to support business functions such as: Accounting, Finance, Marketing, Customer Service, Human Resource Management, Operations, Manufacturing

– Supporting horizontal silos of organization

Information systems provide analytical and decision making support for management, which is generally categorized into three levels- Strategic, Middle, and Operational.

– Supporting vertical silos of organization

Each management level has different information requirements.

Diagram

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IS as Categorized by Functional and Hierarchical Models

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Systems Integration

**Logical or human level**

• Develop information systems that allow organizations to share data with all of its stakeholders based on need and authorization.

**Physical or technical level**

• Provide seamless connectivity between heterogeneous systems.

Benefits and Limitations of Systems Integration

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**Enterprise Resource Planning (ERP)**

Goal of ERP is to integrate departments and functions across an organization into a single infrastructure sharing a common database and serving the needs of each department.

• ERP systems are integrated, multi-module application software packages designed to serve and support several business functions across an organization.

• ERP systems are typically commercial software packages that facilitate collection and integration of information related to various areas of an organization.

• ERP systems enable the organization to standardize and improve its business processes to implement best practices for its industry.

ERP’s Role in Logical Integration

• ERP systems require organizations to focus on business process rather than on functions.

• ERP systems come with built-in processes for a wide variety of common business functions.

ERP’s Role in Physical Integration

• Before installing the ERP system, an organization may have to upgrade or install middleware or get rid of their legacy system’s hardware and software.

• Integration is also required at the Data level, Client level, and at the Application level.

E-Business and ERP

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ERP Systems Components

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Logical Architecture of an ERP System

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System Benefits of an ERP System

• Integration of data and applications across functional areas (i.e., data can be entered once and used by all applications; thus improving accuracy and quality of the data).

• Improvements in maintenance and support as IT staff is centralized.

System Limitations of an ERP System

• Complexity of installing, configuring, and maintaining the system increases, thus requiring specialized IT staff, hardware, and network facilities.

• Consolidation of IT hardware, software, and people resources can be cumbersome and difficult to attain.

Business Benefits of an ERP System

• Agility of the organization in terms of responding to changes in environment for growth and maintaining market share

• Sharing of information across functional areas helps collaboration between employees.

Business Limitations of an ERP System

• Retraining of all employees with the new system can be costly and time consuming.

• Change of business roles and department boundaries can create upheaval and resistance to the new system.

**Software and Vendor Selection**

• Before selecting a vendor, the organization must carefully evaluate its current and future needs in enterprise management systems.

• Review the organization’s existing hardware, network, and software infrastructure, and the resources available for the implementation.

Vendor Evaluation

• Business functions or modules supported by their software

• Features and integration capabilities of the software

• Financial viability of the vendor as well as length of time they have been in business

• Licensing and upgrade policies

• Customer service and help desk support

• Total cost of ownership

• IT infrastructure requirements

• Third-party software integration

• Legacy systems support and integration

• Consulting and training services

• Future goals and plans for the short and long term

**People and Organization**

Project Management

For an ERP system to be implemented successfully, project management must provide strong leadership, a clear and understood implementation plan, and close monitoring of the budget.

Consultants

It is often the case for organizations without much ERP implementation experience to use implementation partners such as consultants.

Change Management

Role is essential because it prepares for changes to how business is done. In implementing new systems, communicating, preparing, and setting expectations is as important as providing training and support.

Business Process Re-engineering

Business processes will need to be changed, adjusted, or adapted to the new system to use the functionality of an ERP system fully.

Global, Ethical and Security Management

Outsourcing overseas, ethical issues, and problems with system security have also attracted a lot of attention in ERP implementation.

**Summary of Chapter 02: Systems Integration Approaches**

• Supports information exchange

• Provides ability to do business in real-time

• Technical as well as strategic value

• Need integration solutions to support

* Electronic markets, supply chain enablement, web visibility, customer relationship management (CRM)

• Success and value of application integration depends on

* how well you understand the problem domain
* the architecture you employ
* technology you leverage

**Software applications can be integrated using different approaches**

* Information-oriented
* Business process integration-oriented
* Service-oriented
* Portal-oriented

**Information-Oriented**

Integration of two or more systems by allowing simple exchanges of data between applications

* Connecting databases
* Deals with simple exchanges of data between two or more applications
* Migrates data from source database to target database

• Disadvantage

* Designers need to know all integrated systems in detail

Example

Moving information between systems may require changing both the content and schema on the fly

Information-Oriented: Integration Concepts

• Coupling

* Bind applications together in such a way that they are dependent on each other, sharing the same methods, interfaces, and perhaps data
* Needs extensive changes in applications

• Cohesion

* “Act or state of sticking together” or “the logical agreement”
* Applications and databases are independent of each other

Information Producers and Consumers

Source and target systems are the entities that produce and consume information

Types of systems that produce and consume information are

* Database (integration using SQL, JDBC)
* Application (API, adapters)
* User interface (screen scraping)
* Embedded devices (temperature sensors, call-counting machines)

Approaching Information Integration

Steps to approach information integration

* Identify the data
* Catalog the data
* Build the enterprise metadata model

Information-Oriented: **Data Replication**:

• Moving data between two or more databases

• Accomplished by placing a software between databases

* Extracts data from source database
* Places data in the target database

• Advantage

* Low cost and easy to integrate

• Disadvantage

* Not suitable for integrating functions in applications
* Requires changes in source and target applications

Information-Oriented: **Data Federation**

Integrating multiple databases into a singe virtual database

• Application access virtual databases

• Advantage

* Can integrate different types of databases

• Disadvantage

* Interface between application and database need to be changed

Information-Oriented: **Interface Processing**

• Integrating packaged and custom applications

– Example: Enterprise Resource Planning (ERP)

• Adapters to connect custom and packaged applications

• Most popular integration approach

• Advantage

* Efficient integration for commercially available software products
* Includes screen scrappers as points of integration

• Disadvantage

* Little regards to business logic

**Business Process Integration-Oriented**

The goal of business process integration is to allow integration not only by sharing information but also by managing the sharing of that information with easy to use tools

* Focuses on coordinating or managing information flow between source and target applications
* Focuses on process logic while separating application logic

Binds disparate processes and create process-to-process solutions

* Automates tasks performed by humans

• Advantage

* Supports information and control logic flow
* Automates tasks performed by humans

• Disadvantage

* Focuses on process flow and integration of processes only

Technology Components

• Graphic modeling tool

* Where business model is created and defined

• Business process engine

* Controls the execution of the multi-step business process and maintainsstate and the interactions with the middleware

• Business process monitoring interface

* Allows end users to monitor and control execution of a business process in real time and optimize where needed

• Business process engine interface

* Allows other applications to access the business process engine

• Integration technology (middleware)

* Connects the source and target systems

Technology Levels

– Process modeling

* + Information movement is defined here

– Transformation, routing and rules

* + Information movement and formatting occurs here
  + Routing allows relevant information to be extracted from any source application, target application, or data store

– Messaging service

* + Responsible for moving information between all connected applications

**Service-Oriented Application Integration**

* Provides mechanism to bind applications together at service level
* The goal is to leverage power of Internet to provide access to remote application services through well-defined interface and directory services
* Web services is the technology to realize above goal

• Advantage

* Allows reusability of applications

• Disadvantage

* Need to change application logic
* High cost for implementation

**Portal-Oriented Application Integration**

Allows to view a multitude of systems (both internal and external enterprise systems) through a single user interface or application

– Most often using web browser

– Avoids back-end integration altogether

• Advantage

* No back-end integration
* Ease of use (browser user interface)

• Disadvantage

* Not real-time integration

Portal Categories

• Single-System Portals

* Single enterprises that have their user interfaces extended to the web

• Multiple-Enterprise-System Portals

* Extending single-system portal architecture to multiple enterprise systems
* Application server architecture

• Enterprise Portals

* Extending multiple-enterprise system portal to include systems that exist within many companies

**Components of Portal Architecture**

• Web clients

• Web servers

• Database servers

• Back-end applications

• Application servers

**Summary of Chapter 03: Middleware**

Middleware is any type of software that facilitates communication between two or more software systems

* Can be simple communication connection between applications
* Can be as sophisticated as information sharing and logic execution mechanisms

There two types of middleware models

– Logical middleware model

* + Depicts how information moves throughout the enterprise conceptually

– Physical

* + Depicts both the actual method of information movement and the technology employed

Point-to-Point Middleware

Point-to-point middleware uses a simple pipe to allow one application to link to another application

* Provides point-to-point connection between a source and a target application

Many-to-Many Middleware

Links many applications to many other applications

* Can deal with more than two source or target applications

Synchronous vs Asynchronous

***Asynchronous middleware*** moves information between one or many applications in an asynchronous mode

– i.e., the middleware software is *decoupled* from the source or target applications

***Synchronous middleware*** is *tightly coupled* to applications

– The applications are dependent on the middleware to process one or more functions calls at a remote application

Asynchronous is preferred over synchronous application integration solution

Communication Models

• Connection-oriented communication

* Two parties connect, exchange messages and then disconnect
* Typically synchronous process, but it can be asynchronous

• Connectionless communication

* Calling program does not enter into a connection with the target process

• Direct communication

* Middleware layer accepts the message from the calling program and passes it directly to the remote program
* Usually synchronous in nature

• Fire and forget

* This model allows the middleware user to “fire off” a message and then “forget” about it,

**Types of Middleware**

• **RPC**

* + Oldest type of middleware
  + RPC are synchronous

Advantage of RPC is its

* + simplicity for
  + mechanism and
  + programming

Disadvantage is are its

* + huge performance cost
  + and inability to scale

**• Message-oriented middleware (MOM)**

* + MOM is queuing software that uses is messages as a mechanism to move information from point to point
  + MOM uses the notion of messages to communicate between applications,

**• Distributed objects**

Small application programs that use standard interfaces and protocols to communicate with one another

**• Database-oriented middleware**

Facilitates communication with a database, whether from an application or between databases

Works with two basic database types

* Call-level interfaces (CLI)
* Native database middleware

**• Transactional middleware**

Provides mechanism for coordination information movement and method sharing between many different resources

Two types of transaction-oriented middleware

* TP monitors
* Application servers

**• Integration servers**

Provide application logic sharing and processing and for connections to back-end resources

**Summary of Chapter 04: ERP Systems and Processes**

**Enterprise Resource Planning (ERP)** programs:

Core software used by companies to coordinate information in every area of business

– Help manage companywide business processes

– Use common database and shared management reporting tools

**Business process**: Collection of activities that takes some input and creates an output that is of value to the customer

**Functional Areas of Operation**

* Marketing and Sales (M/S)
* Supply Chain Management (SCM)
* Accounting and Finance (A/F)
* Human Resources (HR)

**ERP vendors**, including SAP, Oracle, and Microsoft, etc. provide modules that support the major functional areas of a business.

**Marketing and Sales**

Functions:

* Advertising and Marketing products
* Determining pricing
* Promoting products to customers
* Taking customers’ orders
* Helping create a sales forecast
* Customer support
* Customer Relationship Management

Inputs for M/S

* Customer data
* Order data
* Sales trend data
* Per-unit cost
* Travel expense company policy

Outputs for M/S

* Sales strategies
* Product pricing
* Employment needs

**Supply Chain Management**

Functions:

* Making the product (manufacturing/production)
* Buying raw materials (purchasing)
* Receiving goods and raw materials
* Transportation and logistics
* Scheduling production of products
* Plant maintenance

Inputs for SCM

* Product sales data
* Production plans
* Inventory levels
* Layoff and recall company policy

Outputs for SCM

* Raw material orders
* Packaging orders
* Resource expenditure data
* Production and inventory reports
* Hiring information

**Accounting and Finance**

Functions:

* Recording raw data about transactions (including sales), raw material purchases, payroll, and receipt of cash from customers, planning & budgeting, cost allocation & control

Inputs for A/F

* Payments from customers
* Accounts receivable data
* Accounts payable data
* Sales data
* Production and inventory data
* Payroll and expense data

Outputs for A/F

* Payments to suppliers
* Financial reports
* Customer credit data

**Human Resources**

Functions:

* Recruit, train, evaluate, compensate employees, benefits, government compliance

Inputs for HR

* Personnel forecasts
* Skills data

• Outputs for HR

* Regulation compliance
* Employee training and certification
* Skills database
* Employee evaluation and compensation

**Other ERP Modules**

• **Production**

– Helps in the planning and optimizing of the manufacturing capacity, parts, components, and material resources using historical production data and sales forecasting.

• **Purchasing**

– Streamlines the procurement process of required raw materials and other supplies.

**• Inventory Management**

– Facilitates the processes of maintaining the appropriate level of stock in a warehouse.

**• Miscellaneous Modules**

– Nontraditional modules such as business intelligence, self-service, project management, and e-commerce.

**Enterprise Systems Architecture**

Architecture helps implementation teams to understand in detail the features and components of

the enterprise system.

**Three-Tier Architecture**

Benefits

* Scalability - Easier to add, change, and remove applications.
* Reliability - Implementing multiple levels of redundancy.
* Flexibility - Flexibility in partitioning is very simple.
* Maintainability - Support and maintenance costs are less on one server.
* Reusability - Easier to implement reusable components.
* Security - IT staff has more control system to provide higher security.

• Limitations

* Can be very expensive and complex.

**Tiers**

The Web Tier

* Web-based portal allows users the ability to access and analyze information through their Web browser.

The Application Tier

* Consists of a Web browser and reporting tool where business processes and end-users interact with the system.
* It shields the business users from the inner workings of an ERP system, but still provides the information relevant to their job and business process.

The Data Tier

* Focus is on structure of all organizational data and its relationships with both internal and external systems.

Good Luck

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