CHAPTER 3: ENTERPRISE SYSTEMS ARCHITECTURE

CHAPTER OBJECTIVES:

- Examine in detail the enterprise systems modules and architecture.
- Understand the implication of good architecture on ERP implementation.
- Know the various types of ERP architectures and the related benefits and drawbacks of ERP architecture.
- Learn about Service Oriented Architecture and its impact on an ERP system.
- Learn about cloud architecture and its impact on an ERP system.

CHAPTER OUTLINE:

  I. Opening Case: Nestlé's ERP Implementation
 II. Preview
      a) Why Study Enterprise System Architecture?
III. ERP Modules
      a) Production Module
      b) Purchasing Module
      c) Inventory Management Module
      d) Sales & Marketing Module
      e) Finance Module
      f) Human Resource Module
      g) Miscellaneous Modules
      h) Benefits of Key ERP Modules
      i) Self-Services
      j) Performance Management
      k) Financials
      l) HR Management
      m) Procurement and Logistics Execution
      n) Product Development and Manufacturing
      o) Sales and Service
 IV. ERP Architecture
      a) Layered Architecture Examples
      b) Data Tier
      c) Application Tier
      d) Web Tier
      e) Infrastructure Requirements
  V. Types of ERP Architectures
      a) Three-tier Architectures
      b) Web Services Architectures
      c) Service-Oriented Architectures
      d) SOA and Web Services
      e) Enterprise Content Management and SOA

f) Cloud Architecture
  VI. Implications for Management
 VII. Real-World Cases: WiPro and MBH

CHAPTER OVERVIEW:

Chapter 3 provides an overview of the enterprise system architecture, the different major modules that make up an ERP system and why they are beneficial, and the different architectures that can be used in an ERP implementation.

The concept of enterprise system architecture revolves around the functional and technical needs of an organization in order to build a successful system foundation. Both organizational functions and technical components of enterprise systems are not only complex in and of themselves, but also have a complex relationship that must be understood by management and the implementation teams. When applied to an ERP system, the enterprise system architecture identifies the ERP modules required for the organizational functions (accounting, human resources, sales, production, etc), while the technical components (servers, networks, software, clients, etc.) are identified in the layers or tiers of the infrastructure.

The primary purposes of an ERP system are to support the different functions of an organization, share information across the enterprise, and reduce/eliminate storing data more than once. Some of the more common modules that allow an ERP system to perform its function are listed below:

PRODUCTION MODULE: previously known as Manufacturing Requirements Planning (MRP) systems, this module assists in planning and optimizing the manufacturing function by using historical data to project production and sales and determine what resources will be needed at a given time. *Benefits: shorten time-to-market and delivery of higher-quality products.*

PURCHASING MODULE: this module assists the purchasing functions of an organization by identifying existing and potential suppliers of raw materials and supplies, negotiating prices, awarding sales to suppliers, and billing. This module is often integrated with supply chain management software and business-to-business applications so that orders with suppliers can take place electronically and with limited intervention. *Benefits: cost savings, improved resource utilization, and improved productivity.*

INVENTORY MANAGEMENT MODULE: this module supports the inventory management functions of an organization by managing appropriate levels of materials and supplies based off projected needs. Inventory is monitored, reconciled, replenished, and reported on by the module so that inventory is on target and not over-stocked or under-stocked. *Benefits: cost savings, improved resource utilization, and improved productivity.*

SALES & MARKETING MODULE: the sales portion of this module supports the revenue-generating functions of an organization through entry, scheduling, shipping, and invoicing of customer orders. This function is often front-ended through e-commerce websites and online stores. The marketing portion of this module supports the generation of sales leads and advertising. *Benefits: increased sales and incentive/commission performance measuring.*

FINANCE MODULE: this module compiles financial data from the other functional modules of the ERP system and generates reports that describe the financial position of an organization. Reports include budgets, balance sheets, general ledger, trial balance, and financial

statements. *Benefits: cost control, regulation compliance, and financial/accounting automation.*

HUMAN RESOUCE MODULE: this module manages all of the human resource information of an organization, such as employee demographics, salaries, benefits, performance evaluation, and promotions. Often this module is integrated with Knowledge Management Systems (KMS) that can compile employee data and allows an organization to best utilize the skills of each employee. *Benefits: employee attraction and retention and increased efficiency.*

While the modules of an ERP system support the functional silos, ERP architecture also defines the system components required of an organization. The four ERP system architectures are listed below:

Three-Tier: Composed of the Presentation, Application, and Database layers, the ERP servers no longer share the responsibility of application and database functions as they are split. The primary benefits of this architecture are scalability, reliability, and flexibility; however, infrastructure cost and complexity are greatly increased.

Web-Based: Composed of the Web Services, Web Browser, Application, and Database layers, the ERP system splits the Presentation layer so that use of the system can extend beyond the walls of the enterprise and can be used by remote users or third-party organizations via web-based technologies. The primary benefit of this architecture is expandability since anyone with appropriate permissions can access the ERP application from anywhere there is Internet connectivity; however, security and performance can be impacted since data transmission has left the control of the organization.

Service Oriented Architecture (SOA): More of a methodology than a technology, the functions of a business are broken up into application services that can be reused in other modules throughout the organization. Unlike object-oriented architectures, SOA can extend beyond the walls of the enterprise much like Web-Based architecture. The benefits of SOA are reuse of software services across the enterprise, and location/system independence; however, because of its complex design, performance can be impacted, security must be sophisticated, and it's costly.

Cloud computing architecture has gained tremendous popularity in the last few years with all major vendors announcing cloud-based services. All organizations should keep an eye on this platform as Internet connectivity improves both in speed and reliability. There are some privacy and security concerns, which limit the use of this platform currently for ERP; however, this will change in the near future.

When an organization has made the commitment to implement an ERP system, managers must keep a few things in mind: As the foundation of a successful ERP implementation, proper enterprise system architecture must be identified and used; ERP architecture is complex and requires vigorous attention, commitment, and involvement from the entire organization, not just Information Services. In order to take advantage of an ERP system over the long term, organizations must identify one that is flexible with respects to infrastructure, accessibility, and reach. Organizational management must perform an unbiased evaluation of ERP systems by

filtering out vendor hype as the best system is the one that fits an organizations culture, business needs, processes and procedures, and budgets.

ADDITIONAL RELATED INFORMATION:

1. "Service-oriented architecture." Wikipedia: The Free Encyclopedia. 28 March 2008 <http://en.wikipedia.org/wiki/Service-oriented_architecture>.
2. "Enterprise resource planning." Wikipedia: The Free Encyclopedia. 21 March 2008 <http://en.wikipedia.org/wiki/Enterprise_resource_planning>.
3. *Google App Engine*. (n.d.). Retrieved July 16, 2010, from Google: http://code.google.com/appengine/
4. Greengard, S. (2010). Cloud Computing and Developing Nations. *Communications of the ACM, Vol. 53 Issue 5* , 18-20.
5. Knorr, E., & Gruman, G. (n.d.). *What cloud computing really means*. Retrieved July 16, 2010, from InfoWorld: http://www.infoworld.com/d/cloud-computing/what-cloud-computing-really-means-031
6. Nicholson, J. L. (2009, June). *Cloud Computing's Top Issues for Higher Education*. Retrieved July 16, 2010, from University Business Magazine: http://www.universitybusiness.com/viewarticle.aspx?articleid=1342&p=2#0
7. *VMware and SAP Virtualization, Run SAP Software Virtual to Reduce IT Costs*. (n.d.). Retrieved July 16, 2010, from VMware: http://www.vmware.com/solutions/business-critical-apps/sap/

ANSWERS TO END-OF-CHAPTER REVIEW QUESTIONS:

1. **What is necessary for the ERP implementation to be successful?**
   Enterprise system architecture takes the functions of an organization into consideration to define the necessary ERP modules, as well as the physical components such as hardware, software, and networks necessary to operate the ERP system.

2. **What is ERP system architecture?**
   It's a methodology of separating the components of an ERP system into tiers or layers that make it easier to manage and provide scalability/flexibility.

3. **Why is it important to have good enterprise system architecture?**
   Because it explains the relationships between complex information systems components such as hardware and software, with complex organizational components such as business functions, processes, and people. Without both, there is not a complete understanding of the system and therefore, it will fail.

4. **What is the role of architecture in ERP implementation?**
   To provide support for the various business functions such as accounting, human resources, inventory, etc.

5. **List 5 of the major functional modules of ERP.**
   Self-services, performance management, financials, procurement and logistics execution, and product development and manufacturing.

6. **Discuss the different types of ERP architectures.**
   Two-tier: server handles application and database duties. Clients are responsible for presenting the data and passing input back to the server.
   Three-tier: application, database, and presentation are separated into layers that communicate with each other.
   N-tier: any number of tiers defined in an architecture.
   Web Services: splitting the presentation tier in two additional layers, Web Services and Web Brower.
   SOA (Service Oriented Architecture): object-oriented architecture that can extend beyond the corporate firewall onto the web.

7. **List benefits and limitations of one ERP architecture.**

Two-Tier		Three-Tier	
Benefits	**Limitations**	**Benefits**	**Limitations**
Easy to use	Inflexible for growth	Can scale well	Higher infratructure costs
Low infrastructure costs	Requires expensive middleware	More reliable	Complex
High-performing small workgroups	Changes in database affect application	Flexible to changes	
	Proprietary restrictions	Lower support and maintenance costs	
	Limited flexibility	Able to reuse components	
		More secure	

8. **What is Service Oriented Architecture and how is it different from Web Services architecture?**
   SOA is object-oriented architecture that can extend beyond the corporate firewall onto the web and is more of a software development methodology that is independent of technology than an application, such as Web Services that use specific technologies, such as SOAP or XML.

9. **What are the key benefits and limitations of systems integration?**
   Benefits: better data sharing, improved decision making, cost efficiency, less duplication, and necessary for e-commerce, SCM and CRM
   Drawbacks: requires initial setup costs, data sharing can create political problems within department and divisions, more security and privacy risks, etc.

10. **What is the role of management in designing enterprise systems integration?**
    Management plays a crucial role in e-integration. People involvement and change management are crucial for enterprise integration and without management support this task can become very difficult.

DISCUSSION QUESTIONS

1. **Discuss the objective of ERP Implementation at Nestlé USA. Did they achieve these objectives?**

   Great discussion! I think you guys get the main issue from this case. The project's initial objective or main aim was to use common business processes or standardize, systems and organizational structures across the autonomous divisions within the USA. These common systems across Nestle USA would create savings through group buying power and facilitate data sharing between the subsidiaries.

   Nestle achieved its goals, after regrouping and starting again from scratch, with SAP in place, Nestle USA achieved significant **ROl.** The common databases and business processes lead to more trustworthy demand forecasts for the various Nestle products. This also allowed the company to reduce inventory and reduce the redistribution expenses.

2. **Refer to the Nestlé Case in the chapter. What problems were faced by Jeri Dunn, CIO and what do you think would be the right systems architecture for Nestlé?**

   Dunn was faced with having to change the way Nestle USA did business and facing employee resistance to the new business process he tried to push through. He assembled a team of stakeholders that did not have a stake in the new processes. He had a lack of communications with employees about future changes and was thinking to much about the system architecture and not enough about implementation across the board. For Dunn, a Web-based architecture system would likely be most appropriate. His company is big, to say the least, has thousands of employees and is spread many miles apart. His company has many different products, and many different subsidiaries or corporate partners. Dunn needs something that is easy to integrate with existing internal systems and external trading partners. In other words Dunn needs an Internet platform which can provide a wide range of end users with access to ERP applications over many different locations through the net. Because his employees initially resisted the change, he should also look to make the integration easy to learn and adjust too, and most people are comfortable with Web based platforms.

   As stated before, Dunn's main problem was trying to integrate "seven separate companies" onto one main system. Since the products that Nestle sells are not related, it was extremely hard to get everything in sync.

   It is said that Dunn knew the technology very well and her main goal was to have data sharing to enable group buying in return reducing costs.

   "Dunn actually knew Nestlé technology unusually well because of her long history with the company. In 1991, as associate director for application systems at Nestlé-owned Stouffer's Hotels, she was sent to Switzerland to participate in an effort to establish a common worldwide methodology for Nestlé projects. In 1995, she was promoted to assistant vice president of technology and standards for Nestlé SA, and while there came to understand and agree with the value of establishing common systems throughout global Nestlé because such a change would enable group buying which in turn would

reduce costs. Dunn also realized that common systems would facilitate data sharing among subsidiaries. When she was moved to Nestlé USA in 1997 at age 42, she found that her earlier recommendations from Vevey were mostly ignored. "My team could name the standards," Dunn said, "but the implementation rollout was at the whim of the businesses."

3. **Discuss the benefits and limitations of ERP implementation at Nestlé USA.**

The benefits at Nestlé and many other organizations are as follows:

- Integration of customers, suppliers, and partners;

- Improvement of customer and business partner satisfaction;

- Establishment of a Global Asset Recovery Services brand;

- Reduction of administrative costs;

- Raised productivity;

- Lowered IT operations and systems maintenance costs; and

- Enhanced security and business controls.

Nestlé's new system integrated the extended enterprise and linked all offices in all locations. It transformed a geographically dispersed organization with independent systems into one virtual company capable of competing in an e-business environment through the next decade and beyond.

System Limitations

- The data conversion and transformation from the old to new system was an extremely tedious and complex process.
- Consolidation of IT hardware, software and people resources was cumbersome and difficult to attain.
- Retraining of IT staff and personnel to the new ERP system caused resistance and reduced productivity over a period of time.
- Complexity of installing, configuring and maintaining the system increased thereby requiring specialized IT staff, hardware, network, and software resources.

Business Limitations

- The change of business roles and department boundaries created upheaval and resistance to the new system.
- Retraining of all employees with the new system became costly and time consuming.
- Nestlé incurred high initial costs of purchasing software, consultant costs and disrupting the work flow of its employees

4. **Why should ERP architecture include a discussion on organization structure, business process and people, instead of just information technology and systems?**

    As discussed on this thread, technology should not be the only focus in ERP implementations. It is necessary to focus on business process architecture, business requirements, budget, project management, commitments from top management, and continuous communication with employees informing them about future changes. A systems value is determined by its usage or end-users!

    If the **ERP** software is installed with a focus only on the system architecture, you may have a successful installation of software but an unsuccessful implementation. ERP implementation isn't just about the software. It's easy to install a new system. The hard part is changing the business processes of the people who will use the system. Nobody likes process change, particularly when they do not know what is coming. This makes it even more important, and indeed necessary to include a discussion on organization structure, business process and people, instead of just information technology and systems.

5. **Why is server-centric architecture better than client-centric architecture?**

    Great discussion - one is not good and other bad. It all depends on your corp strategy, people skills and culture!

    In server-centric environments clients only need access to the Internet and a standard browser like Internet Explorer or Firefox with a few plug-ins like Java Virtual Machine and others. There are no other user interface applications required on the client. Thus, the client can use any Internet device that uses standard Internet technologies such as **Hypertext Transport Protocol (HTTP), Hypertext Markup Language (HTML)** for user access or **eXtended Markup Language (XML)** for back-end communication between an application and third-party system with the Internet Application Server.

    In client-centric environments client devices will need installation of **Software Development Kits (SDKs)** and proper configuration and integration with the client device for the application to work properly. However, client-centric platforms are popular in other devices like **Personal Digital Assistants (PDAs),** Blackberry, and Mobile phones that are increasingly used to access information from the enterprise systems.

6. **Discuss the benefits of Service Oriented Architecture over the traditional three-tier architectures.**

    In general, SOA allows for more flexibility, scalability and reusability than do the traditional architectures. It reduces cost, accelerates movement, and provides a data bridge --- these are some of the short term benefits. A major longer term benefit is that it provides flexibility that the traditional systems do not have by providing services anywhere on any system or network.

Benefits:
Business-level software services across heterogeneous platforms
Complete location independence of business logic
Services can exist in any system and network
Loose coupling across application services
Granular authentication and authorization support at service unit level
Dynamic search and connectivity to other services

Short-term benefits:
Enhanced reliability
Reduced hardware acquisition costs
Leveraged development skills
Accelerated movement to standards-based server and application consolidation
Provide a data bridge between incompatible technologies

Long-term benefits:
Provides the ability to build composite applications
Creates a self-healing infrastructure that reduces costs
Provides a real-time decision making application
Enables the compilation of a unified taxonomy of information across an enterprise and its
customers and partners

Business Value benefits:
Meet customer demands faster
Cheaper acquisition and maintenance of technology
Empowers the management of business functionality
Leverages existing investments
Reduces reliance on expensive custom development

Limitations:
Inconsistent performance
Requires enterprise-level focus for implementation to be successful
Security system has to be sophisticated
Costs can be high due to services being junked often

WIPRO & MHB CASE STUDY QUESTIONS

1. **Compare and contrast the self-service implementation between Wipro and MHB. According to you, which company did a better job? Explain.**

   Wipro's implementation goals were achieved based on a proven methodology that analyzed the organization and employees needs. The implementation success factors were the focus of the company and its employees. The MHB implementation was primarily focused on the technology and how to implement self-service to employees and link it to existing back office processes. Who did a better job depends on what you think is important. Wipro did

better if organization issues are more important than technical issues or, vice versa, MHB did better if you think technology issues are important.

2. **Are the measures used by Wipro (i.e. costs, returns, and cycle time) appropriate for evaluating their self-service implementation?**

    These measures are just one means of evaluating the success of the self-service implementation. Other intrinsic success factors include collaboration, budget, CEO commitment, strategic planning, re-engineering, marketing-employee communications, corporate standards for technology solutions, business case, anytime anyplace access, consistent look and feel and consistent interface across media.

3. **What would happen to the self-service implementation at MBH if the company decided to adapt the SOA model? Does self-service implementation make it easier or more difficult to implement SOA? Explain.**

    Using an SOA model at MBH would become increasingly more difficult to implement. With different back office systems the sharing objects will be increasingly complex and difficult to maintain to remain current and competitive.