Architectures for Globally Integrated Enterprises

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Note: This course won the 'Best Course Proposed' Award from IBM in December 2007.

Background and Motivation

Enterprises in this global economy represent networks of autonomous firms cooperating with each other to achieve common business goals. In this climate, a firm's supply, production, logistics and distribution networks need to be architected in an integrated and flexible fashion to quickly respond to fluctuating market conditions and frequent mergers, acquisitions, and outsourcing operations. To survive and thrive in this rapidly changing environment, modern enterprises need to establish flexible enterprise-wide architectures that can quickly integrate and deliver needed services. For example, when a manufacturing company acquires multiple companies with widely varying systems provided by multiple suppliers based on technologies of different vintages, an enterprise wide architecture is needed that makes the acquired systems and the associated processes work smoothly with existing ones. The current large industrial initiatives on service oriented architectures (SOA) and service innovation provide a conceptual framework, supported by standards and enabling technologies, While professional organizations and industries are moving towards SOA, academia seems to be lagging behind in integrating these concepts into curriculum.

This proposal describes a course that is intended to address this important need and is targeted for students who are interested in all aspects of enterprise-wide systems. Although recent thinking is used, the proposed course is based on systems principles and broad building blocks so that evolving technologies, techniques, methodologies and standards can be easily incorporated as needed. A wide range of case studies (successes and failures) will be discussed and hands-on integration projects on sample applications will be assigned for experimentation using automated decision support systems. Examples and student projects will include manufacturing (e.g., Computer Integrated Manufacturing – CIM), Healthcare (e.g., Healthcare Information Systems), Telecom (e.g., Telecom Operation Support Systems) and retail (e.g., retail supply chains) industries.

This proposal has been greatly influenced by the IBM Seminar 'On Demand Skills for the Globally Integrated Enterprise', Friday, October 26, 2007. Specifically, this course addresses the topics and concerns that were discussed in the seminar. In particular, the proposed course:

- Concentrates on the 'Architectures for Globally Integrated Enterprises' – the main theme of the IBM seminar
- Shows precisely how the skills presented during the IBM seminar can be incorporated into the existing IT programs in business as well as engineering school curriculum.
- Explicitly includes and devotes complete sessions to the following topics that were emphasized in the IBM seminar: a) Infrastructure Challenges in Large Scale Commercial Computing, b) Services Oriented Architecture (SOA), and c) Security in Commercial Computing.
- Is deliberately general to attract people who may be turned off by too much SOA talk. The main idea is that the course should last longer than a particular approach. For example, many universities offered Corba courses in the 1990s that died with Corba. Architectures of globally integrated enterprises is a concept that goes beyond the current thinking in SOA and will not need course title changes that typically require university administrative approvals (a long process).
- Is designed to appeal to business school as well as engineering school students and can be cross listed among different departments. This proposal is an extension of very popular 'Architecture and Integration' courses I have taught at the Fordham Graduate School of Business and University of Pennsylvania School of Engineering. The IBM seminar taught me that indeed the content from the two courses can be combined into one very strong course that could be offered through business or engineering schools, with some adjustments. The proposal discusses how the content can be modified for different audiences.

- Is very complete and is in the format of a typical university course proposal with pedagogical information, suggested texts, additional readings, and projects. This proposal can be submitted to university curriculum committees with minor customization. Once accepted, it can be taught by qualified instructors without a great deal of preparation. I can provide my course slides, exams, projects, and text chapters to help the instructors get started on this course quickly. If needed, I can volunteer to put my course materials on the IBM course website and can also post it on my personal website.

In short, the proposed course directly captures the essence of the IBM seminar and translates the skills presented during the IBM seminar into an academically sound course that can be incorporated into the existing IT programs in business schools as well as engineering schools.

Pedagogical Information

Course Objectives

This course is designed to prepare students to lead and meaningfully participate in architectures for globally integrated enterprises. The course is intended to provide:
- An overall 'system of systems' view of enterprises instead of one narrow view
- A processes, people and technologies perspective instead of purely technical or management view
- Education in critical skills that span large scale computing environments, services oriented architecture, security and governance issues.

In order to meet these objectives, the course topics are divided into the following four parts.

Part 1: Introduction and Methodology (about 3   weeks)

The first part establishes the overall conceptual framework and identifies the key building blocks of globally integrated enterprises. Topics include:

- Modern enterprise models (digital enterprises, extended enterprises, mobile enterprises, on-demand enterprises, specialized enterprises, next generation enterprises)
- Business processes and business process re-engineering in a global economy
- Enterprise Applications in the Digital Age (CRMs, ERPs, eMarkets, ASPs, Portals) and Inter-Enterprise (B2B) Applications (Supply chain management, B2B trade, industrial networks). Discussion of IMPV (Internet-enabled, Mobile, Positional, and Voice-enabled) features of enterprise applications.
- Key business analysis techniques: workflow systems, business process modeling techniques and languages (e.g., BPML, BPEL) and Unified Modeling Language (UML) for business systems analysis and design.

Assignments: A homework assignment to test and smooth the backgrounds of the students. Specifically, the students will be asked to choose an enterprise from a list of possible industry segments (e.g., manufacturing, telecom, healthcare and retail) and develop a model of the enterprise that can be used in business process re-engineering and integration. In addition, 3 case studies will be assigned for classroom discussion.

Part II: Modern Enterprise Computing Architectures and IT Infrastructure (about 3 weeks)

This part introduces and reviews the enterprise computing environments that support modern enterprises. Topics include:

- Enterprise Computing in the Global Economy
- The Role of the Mainframe in a Global Setting
- Middleware Services and Web Technologies
- Distributed Object Technologies and Web Services

Assignments: A group project on developing a model of a given enterprise and developing an enterprise computing plan that shows how a mainframe serves as a central node in these environments and also supports middleware services and Web technologies. In addition, 3 case studies will be assigned for classroom discussion.

Part III: Enterprise Architectures (about 3 weeks)

This part of the course is intended to highlight the issues involved in developing architectures for globally integrated enterprises. Such architectures cross business, applications and technology boundaries. Topics include:

- Service Oriented Architectures
- Business architectures in a global context
- Enterprise application architecture
- Technology architectures
- Relevant architectural frameworks and standards (e.g. OAG, IDEAS, TOGAF, SOA, MDA)
- Security, Performance and QoS issues in global B2B trade

Assignments: A group project on development of an Enterprise Architecture based on SOA. The students will develop this architecture first by hand and then use a decision support tool (currently a prototype) to do the same exercise. The students will then compare and contrast their results against the tool and will experiment with the tool to develop different architectures and do what-if analysis. In addition, 3 case studies will be assigned for classroom discussion.

Part IV: Enterprise Integration (3 weeks)

This part concentrates on integrating the various architectural components (new, existing) into a functioning system. Topics include:

- Integration with Existing (Including Legacy) Systems -- An Overview
- Enterprise and Inter-Enterprise Application Integration using SOA
- System Migration Strategies and Technologies
- B2B and Global Information Systems Integration Issues
- Cost, security and QoS evaluation
- Governance Issues

Assignments: A group 'Free for All' project that allows students to investigate different areas of their interest and show results in presentations. In addition, 3 case studies will be assigned for classroom discussion.

Proposed Course Description (for Catalog)

Modern global enterprises are characterized by increased automation, mobile services, extended B2B operations with global business partners, and on-demand business services. The main issue in such enterprises is to architect and integrate a very wide range of services quickly and effectively to cope with rapidly changing business conditions. This course presents a 'systems' perspective that combines processes, people and technologies and highlights the role of infrastructure challenges, Service Oriented Architecture (SOA) and security plus QoS issues in enterprise computing. Instead of one narrow topic, this course establishes a broad conceptual framework that integrates the key building blocks of enterprise wide systems and addresses new challenges as new technologies, techniques, methodologies and standards emerge. The course is roughly divided into four parts. The first part establishes the overall conceptual framework and identifies the key building blocks (enterprise models, business processes, enterprise applications, and analysis tools). The second part introduces and reviews the enterprise computing environments and the IT infrastructure in the global economy. The third and fourth parts concentrate on developing and evaluating integrated architectures using the latest thinking in service oriented architectures (SOA), architecture frameworks, integration patterns, and evaluation techniques. A wide range of case studies (successes and failures) will be discussed and hands on integration projects will be assigned for experimentation with available tools.

Course Details

Course Prerequisites

- Basic understanding of IT concepts, equivalent to the text: "*Management Information Systems",* Kenneth C. Laudon and Jane P. Laudon, Prentice-Hall, 10th Edition (2007) or later edition
- Additional courses in IS analysis and design or industry experience in IT involving system analysis, system design and architecture, equivalent to the text "*Systems Analysis and Design", by* Satzinger, Jackson, and Burd, Course Technology, latest edition (4th edition or higher)

Suggested Texts

Note: One of the following books, or a combination thereof, could be used for course text. See Appendix II for outlines of these books

- Carter, S., "The New Language of Business: SOA & Web 2.0", IBM Press, Feb 2007

- Bieberstein, N., et al, "Service-Oriented Architecture (SOA) Compass: Business Value, Planning, and Enterprise Roadmap", IBM Press, Oct 2005.

- Umar, A "Enterprise Architectures and Integration in a Global Economy", 2nd edition, NGE Solutions, Inc. Jan 2008 (Target Date).

Suggested Additional Readings

- A course pack consisting of selected research and technical papers from references listed in Appendix III

Suggested IBM Resources

IBM UNIVERSITY RELATIONS WEBSITE: http://www-304.ibm.com/jct09002c/university/scholars/ur/index.html

IBM ACADEMIC INITIATIVE WEBSITE - Faculty, please consider 1) joining and 2) subscribing to the newsletter: http://www-304.ibm.com/jct09002c/university/scholars/academicinitiative/

IBM LARGE SYSTEMS WEBSITES (System z and System i)

http://www-304.ibm.com/jct09002c/us/en/university/scholars/products/zseries/
http://www-304.ibm.com/jct09002c/us/en/university/scholars/products/iseries/

SERVICES SCIENCE, MANAGEMENT, AND ENGINEERING (SSME) WEBSITE: http://www-304.ibm.com/jct09002c/us/en/university/scholars/skills/ssme/

Additional Information from Standards Bodies and Other Vendors

- Websites of relevant standards and industry consortiums (e.g., COBIT, Integration consortium , CIMOSA, OAG, OMG, IDEAS, NOE, TOGAF, and MDA)
- IEEE Computer Society Technical Committee on Services Computing - www.servicescomputing.org.
- Sun site on SOA (www.sun.com/soa)

Instructor

TBD (see Appendix I for suggested instructor background**)**

Course Grade

Three projects (300 Points)
One Examination - in class, open book, open notes (100 Points)
Attendance, participation and homeworks (100 Points)
Total: 500 points
Straight Percentile Grades

Detailed Course Outline With Suggestions for Customizing

Note: The readings are from the suggested course texts (Appendix II) and the additional readings are from the Course Pack (Appendix III)

Legend used for Readings (Text) in the following table (see Appendix OO for contents of these books):

- Carter indicates the text: Carter, S., "The New Language of Business: Soa & Web 2.0", IBM Press, Feb 2007
- Bieberstein indicates the text: Bieberstein, N., et al, "Service-Oriented Architecture (SOA) Compass: Business Value, Planning, and Enterprise Roadmap", IBM Press, Oct 2005.

- Umar indicates the text: Umar, A, "Enterprise Architectures and Integration in a Global Economy", 2nd edition, NGE Solutions, Inc. Jan 2008 (Target Date).

Suggestions for customizing this course:

- This course is positioned as a graduate level course for IS/IT students.
- For more technical audience the course can be offered using more materials from Bieberstein text (this is indicated in blue) and assigning more programming assignments on mainframe.
- For high level managers and marketing professionals, the course can be offered using more materials from the Carter textbook (indicated in red below)

Session	Major Topic	Readings (Texts)	Additional Readings
	Part I: Introduction and Overview		
1	Conceptual framework for globally integrated enterprises. Modern enterprise models (digital enterprises, extended enterprises, mobile enterprises, on-demand enterprises, specialized enterprises, next generation enterprises) Case Study: Owen Corning Integration	Umar--Chapter 1 Carter-- Chapter 1	Cegielski, 2003, Davis 2003, Dibbens 2004, Drucker 2001, Goranson 1999, Kidd 2000, Pohle 2005
2	Business Processes and Enterprise Applications in the Digital Age (CRMs, ERPs, eMarkets, SCM, ASPs, Portals) with IMPV (Internet-enabled, Mobile, Positional, and Voice-enabled) features. Case Study: Enterprise Applications for a small global company .	Umar --Chapter 2 Bieberstein – Chapter 3	Kalakotta 2002a, Kalakotta 2002b, Davis 2003, Dibbens 2004, Umar 2004b (chapter 2)
3	Overview of Business Analysis Tools and Techniques: Workflow systems, business process modeling languages (e.g., BPML, BPEL) and Unified Modeling Language (UML) for business analysis and design Case Study: Modeling for Business Process Re-engineering	Umar--Chapter 3	Vemadat 2003 plus websites on BPML, BPEL, UML

	Part II: Modern Enterprise Computing and IT Infrastructure		
4	Enterprise Computing in the Global Economy: The Role of the Mainframe in a Global Setting,, IT infrastructure for Large Corporations	Umar--Chapter 4	IBM Large System Websites (Selected Readings)
5	Middleware Services and Web Technologies (Classical Web, Semantic Web, Web 2.0)	Umar--Chapter 5 Carter -– Chapter 8	
6	Distributed Object Technologies, Web Services, J2EE and .Net Overview	Umar-- Chapter 6 Bieberstein – Chapter 11	
	Part III: Enterprise Architectures and SOA		
7	Overview of Architectures and recent Architectural Frameworks Case Study: Architectures in Telecom industry (from TeleManagement Forum)	Umar--Chapter 7	Morris 93, Weblink2, Weblink3, Weblink4
8	Service Oriented Architectures (SOA): Principles, Applications and Key Players Case study: SOA in Healthcare	Umar--Chapter 8 Carter – Chapter 5	SOA References in Exhibit 1
9	Enterprise-wide architectures (Business Architectures, Application Architectures, Technology Architectures), Relevant Standards Case Study: Architectures for Financial Services	Umar--Chapter 9 Bieberstein – Chapter 6	Websites for CIMOSA, OAG, IDEAS, NOE, TOGAF, and MDA
10	**Exam**		
	Part IV: Enterprise Integration through SOA		
11	Overview of Enterprise Wide Integration using SOA, Integration with Existing (Including Legacy) Systems Case Study: Computer Integrated Manufacturing	Umar--Chapter 10 Carter – Chapter 4 Bieberstein – Chapter 7	Van der Enden 2001, Sutherland 2002, Linthicum 1999, Weblink1
12	B2B and Global Information Systems Integration Issues Case Study: Limited Supply Chain Management Integration	Umar--Chapter 11 Carter--Chapter 10	Davis 2003, Shore 2006, Linthicum 2001
13	Security Issues in large scale integrated systems: Security patterns for SOA	Umar--Chapter 12 Bieberstein – Chapter 10	Papers (Schneier 1999, Kienzle, 2001)
14	Solution Evaluation and IT Governance Issues Case Study: Evaluating a Business Case for SOA	Umar--Chapter 13 Carter – Chapter 6 Bieberstein – Chapter 4	IBM Web Site for SOA (Process Integration Design Approach Document)
15	Project Presentations by Students		

Suggested Projects and Assignments

The following assignments and projects are suggested (see hints and helpful suggestions):

Homework (30 points). An early homework assignment to test and smooth the backgrounds of the students. Specifically, the students will be asked to choose an enterprise from a list of possible industry segments (e.g., manufacturing, telecom, healthcare and retail) and develop a model of the enterprise that can be used in business process re-engineering and integration.

Team Project 1 (100 points): Enterprise computing plan that shows how the IT infrastructure components (including the mainframe) serve these environments and also support enterprise applications, middleware and Web technologies. (2-3 per Team)
   Part A: Develop the plan by hand
   Part B: Develop by using an automated tool. Compare and contrast the results

Team Project 2 (100 points): Development of an Integrated Enterprise Architecture based on SOA - (2-3 per Team)
   Part A: Develop the architecture by hand
   Part B: Develop using an automated tool. Compare and contrast the results

Team Project 3 (100 points): Free For All: Choose a topic of your choice within the scope of this course and present your findings in class. Your presentation may take one of the following formats:
o Selection and demo of a tool that could be of value in architecture and integration problems. This could be, for example, use of a simulation tool to evaluate architectures
o Research presentation that includes a survey and critical analysis of a topic within the scope of this course. This may show, for example, the use of OR techniques in building and evaluating architectures.
o Examine the decision support tool (PISA) by developing the architecture and integration solution of a real life project chosen by you. Do a critical analysis of the results produced

HINTS AND HELPFUL SUGGESTIONS:

For projects 1 and 2, it is best that the students are given a case study of an actual (or based on actual) company to develop an enterprise computing plan and then develop an SOA-based architecture. To get a complete enterprise wide view, it is best to select a small to medium sized company. The students can choose a company or an instructor can suggest a company. To help the instructors, I am including a sample case for team projects (see below). This case is based on a combination of 2 actual companies and I have used it very successfully for teaching IT planning, architecture and integration concepts. An instructor can easily modify and update this case study and customize it for different audiences.

Another very important aspect of team projects is for the students to first develop the plans and architectures by hand and then use an automated tool to verify and validate their solutions. Unfortunately, good automated tools are not available in the marketplace but some are emerging. The following two are the ones I have used with a great deal of success;

▪ **IBM eBusiness Frameowrk** (http://www-106.ibm.com/developerworks/patterns/). This tool, available free, provides a rich repository of ebusiness patterns, application patterns, and runtime patterns for the common enterprise applications. The tool allows users to construct rough architecture solution sketches and produces good documentation.

- **PISA (Planning, Integration, Security & Administration) Environment (www.ngesolutions.com/pisa)** This is a very powerful integrated consulting environment that allows IT managers, planners, architects and consultants to develop enterprise computing plans, SOA plans, security plans, and project plans. Instead of one large system, this system consists of a family (about 12) of automated consultants ("advisors") that collaborate around a common knowledgebase to help the users to develop scenarios for 10+ industry segments and then quickly develop detailed architecture and integration plans. Beta version of this tool is available free for academic use (please visit the PISA website for details).

Students should, of course, do their own research and find additional tools but these two tools work.

SAMPLE CASE FOR TEAM PROJECTS

XYZCorp was formed in 1995 by a small group of engineers in Chicago to build, repair, and sell electronic devices. The initial business of the company was televisions, radios and calculators. With time, the company included VCRs and PCs into its product lines. In the 2000s, the company entered into business partnerships with numerous suppliers around the globe and acquired a startup company that builds desktops, laptops, and mobile computing devices (e.g., PDA, handsets). XYZCorp also formed partnerships with numerous other computer hardware/software vendors and acquired several retail electronic stores that sell and service computers, televisions, VCRS, radios and mobile devices. These stores also sell, market and service the XYZCorp products. The company now has started thinking about providing technology solutions, consulting, and training services to a diverse array of industries in a global setting. The company management believes in controlled growth, i.e., systematically explore new markets globally and diversify by using new products and services after careful strategic analysis and evaluation of core competencies.

The company headquarters are in Chicago with branch offices in the US, Europe and Asia. The company has currently about 800 employees with a great deal of growth expected in the next 3 years. The company operates many regional offices: Southern (HQ: Atlanta), Western (HQ: San Francisco), Eastern (HQ: New York), European (HQ: Paris), and Asian (HQ: Tokyo). Each region supports between 5 to 10 local offices (some of these offices are stores, the others are marketing, training, consulting and support centers), with an average of 200 staff members per region.

To stay competitive and adapt to new products and services, the company has gone through several re-organizations and its IT infrastructure has changed several times. In its early days, an IBM mainframe with MVS operating system was installed and an IBM network was used to connect the various workers in the corporate office. The manufacturing plant adopted a Unix Sun platform. In the late 1990s, the company started using Web technologies and later adopted Web Services and SOA (without understanding them clearly). In addition, thanks to the acquisitions and mergers, the company has accumulated layers of technologies and applications of different vintages that run on different computing platforms. Most of these systems do not work well together and this is a major deterrent to growth. Introduction of new systems to support new products takes months and responding to simple customer requests takes several weeks. The internal systems need to be overhauled and aligned to the corporate strategy but nobody knows what the corporate strategy is.

XYZCorp has hired a new CEO -- the good Ms Jones (BSCS, MBA). Ms Jones has promised to establish a clear business strategy that will position the company for success in the marketplace. In particular, she wants to explore the Next Generation Enterprise model with increased reliance on Web advertising, Web purchasing, virtual shops, customer relationship management, mobility and electronic intermediaries for success (she does not know what she is getting into!). But seriously, she did form an enterprise-wide architecture planning team. Your group is this team. The main task of the team is to develop an architecture that translates business strategies to working solutions.

Appendix I : Suggested Instructor Background

Ideally.the instructors for this course should have a combination of industry and academic background in IT, especially in architecture and integration issues. This course could be co-taught between academic and IBM staff. It would provide a very good opportunity for IBM and university faculty to collaborate. Specific instructor background includes:

- Understanding of modern enterprise models and global IT issues
- Understanding of business architecture issues
- Knowledge of architecture and integration principles
- Knowledge of B2B trade
- Knowledge of SOA principles and patterns
- Knowledge of enabling technologies such as web services, message oriented middleware. ESB platforms, middleware services
- Knowledge of extant standards
- Knowledge of security and governance issues
- Experience with some real life architecture and integration projects

Appendix II: Suggested Texts

Note – this is second edition of a book that is already in the marketplace – sample chapters are available for review. This book is primarily written as a textbook for university courses and has been tested in classrooms at Fordham University (Graduate School of Business) and University of Pennsylvania (Graduate School of Engineering).

TABLE OF CONTENTS:

MODULE (OVERVIEW): The Big Picture

- Chapter 1: Introduction and the Big Picture. Global IT trends. Modern enterprise models (digital enterprises, extended enterprises, mobile enterprises, on-demand enterprises, specialized enterprises, next generation enterprises.
- Chapter 2: Enterprise Applications (CRMs, ERPs, eMarkets, SCM, ASPs, Portals) and Variants (Mobile, Positional, and Voice-enabled) Applications .
- Chapter 3: Tools and Techniques for Architectures and Integration : Workflow systems, business process modeling languages (e.g., BPML, BPEL) and Unified Modeling Language (UML) for systems analysis and design

MODULE (TECHNOLOGIES): Modern Enterprise Computing and IT Infrastructure

- Chapter 4: Enterprise Computing in the Global Economy: The Role of the Mainframe in a Global Setting, IT infrastructure for Large Corporations
- Chapter 5: Middleware Services and Web Technologies (Classical Web, Semantic Web, Web 2.0)
- Chapter 6: Distributed Object Technologies, Web Services, J2EE and .Net Overview

MODULE (ARCHITECTURES): Architectures and Service Oriented Architectures

- Chapter 7: Overview of Architectures and Architectural Frameworks
- Chapter 8: Service Oriented Architectures (SOA): Principles, Applications and Key Players
- Chapter 9: Enterprise-wide architectures (Business Architectures, Application Architectures, Technology Architectures),

MODULE (INTEGRATION): Enterprise Integration Through SOA

- Chapter 10: Overview of Enterprise Wide Integration by using SOA, Integration with Existing (Including Legacy) Systems
- Chapter 11: B2B and Global Information Systems Integration Issues
- Chapter 12: Security Issues in large scale integrated systems: Security Patterns for SOA,
- Chapter 13: Integrated Solution Evaluation -- Performance, Cost, and QoS issues

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Appendix III: Additional Readings (Suggested)

NOTE: This list will be revised and extended as things evolve

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Exhibit 1: Additional Sources of information (SOA)

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