

Third Generation Distributed Computing Environments

Middleware, Web Services, Platforms, and Architectures

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BOOK OUTLINE

PREFACE

SUGGESTED USAGE IN A COURSE

ACRONYMS

MODULE (OVERVIEW): The Big Picture and Case Studies

Chapter 1: The Big Picture

Chapter 2: Modern Distributed Applications (CRMs, ERPs, eMarkets, SCM, Portals, Mobile Applications)

Chapter 3: Examples and Case Studies

MODULE (MIDDLEWARE) : Application Interconnectivity Through Middleware

Chapter 4: Middleware Principles and Basic Middleware Services

Chapter 5: Web, XML, Semantic Web, and Web Services

Chapter 6: Web Services, Distributed Objects, .NET and J2EE

Chapter 7: Enterprise Data and Transaction Management

Chapter 8: Middleware State of the Practice, Market, and Art

MODULE (PLATFORMS): Application Servers for Mobile and EC/EB Applications

Chapter 9: Mobile Application Servers -- the Mobile Computing Platforms

Chapter 10: e-Commerce Servers -- Platforms for C2B Trade

Chapter 11: B2B Servers -- Platforms and Standards for B2B Trade

Chapter 12: Platforms for Multimedia and Collaboration

Chapter 13: Application Servers State of the Practice, Market, and Art

MODULE (ARCHITECTURES): Architectures and Integration through Web Services

Chapter 14: Component-based Architectures and Web Services

Chapter 15: Enterprise Application Integration -- An Overview

MODULE (TUTORIALS): Tutorials and Detailed Discussions on Special Topics

Chapter 1: Network Technologies -- A Tutorial

Chapter 2: Object-Oriented, Java, and UML -- A Tutorial

Chapter 3: Database Technologies and SQL -- A Tutorial

Chapter 4: Web Engineering and XML Processing -- A Closer Look

Chapter 5: Distributed Object Technologies (CORBA and DCOM) -- A Closer Look

INDEX

OTHER RECENT BOOKS BY THE SAME AUTHOR

Mobile Computing and Wireless Communications

Applications, Networks, Platforms, Architectures, and Security

This book presents a comprehensive coverage of the technical as well as business/management aspects of mobile computing and wireless communications. Instead of one narrow topic, this classroom tested book covers the major building blocks (mobile applications, mobile computing platforms, wireless networks, architectures, security, and management) of mobile computing and wireless communications. Numerous real-life case studies and examples highlight the key points. The book starts with a discussion of m-business and m-government initiatives and examines mobile computing applications such as mobile messaging, m-commerce, M-CRM, M-portals, M-SCM, mobile agents, and sensor applications. The role of wireless Internet and Mobile IP is explained and the mobile computing platforms are analyzed with a discussion of wireless middleware, wireless gateways, mobile application servers, WAP, i-mode, J2ME, BREW, Mobile Internet Toolkit, and Mobile Web Services. The wireless networks are discussed at length with a review of wireless communication principles, wireless LANs with emphasis on 802.11 LANs, Bluetooth, wireless sensor networks, UWB (Ultra Wideband), cellular networks ranging from 1G to 5G, wireless local loops, FSO (Free Space Optics), satellites communications, and deep space networks. The book concludes with a review of the architectural, security, and management/support issues and their role in building, deploying and managing wireless systems in modern settings.

Information Security and Auditing in the Digital Age

A Managerial and Practical Perspective

This book integrates people, processes, and technologies to solve the current and future security problems in highly distributed and mobile enterprises. The focus is on recent issues such as Web Services security (e.g., SAML), wireless security, and integrated systems security. Additional topics include security management, policies and requirements, risk assessment and mitigation, cryptographic techniques, security packages (PKI and security auditing tools), a systematic methodology, network security, host security, web security, middleware, security, application security, and auditing in modern environments. Numerous case studies and examples are used throughout to illustrate the key points.

All books are available through Amazon.com and other book sellers.

Visit the author website (www.amjadumar.com) for additional details and instructor materials.

Dedicated to my best friend, Dolorese, who also happens to be my wife

Visit the Author Website (www.amjadumar.com) for:

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- Purchasing options and instructions
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- Free slides (PDF format) of all chapters of the book that summarize the chapter topics and can be used as lecture notes
- Information about other books by the same author
- Frequently asked questions
- Feedback and suggestions
- Contacting the author
- Author background

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PREFACE

Distributed computing has gone through several generations over the years. Our interest is in the Third Generation Distributed Computing Environments (3GDCEs) that provide a collection of powerful services to support the e-business and m-business initiatives of today and tomorrow. Specifically, 3GDCEs comprise a wide range of middleware services; Web Services that allow components to be published, discovered, selected, and invoked over the Web; and platforms that package many services to support mobile computing and EC/EB applications. This book gives a systematic analysis of 3GDCEs and shows how these environments can be used to architect and integrate modern applications.

The book contents are based on selected chapters of the "eBusiness and Distributed Systems Handbook" (see the handbook outline below). The selected chapters have been updated and edited to present a recent and relevant view. The modules of this handbook can be purchased individually and can be, and have been, used to offer different professional and academic courses. However, over the past few years, some "usage patterns" have emerged. This book was created for a popular usage pattern -- many instructors and practitioners have used these chapters repeatedly as a text for courses on modern client/server systems or distributed systems. In addition, this book serves as a second edition of the book "Object-Oriented Client/Server Internet Environments", A. Umar, Prentice Hall, 1997¹. The salient features of this classroom tested book are:

- Examination of modern applications (CRMs, ERP, SCMs, emarkets) that drive the enabling technologies.
- Updated discussion of modern middleware services with emphasis on Web, XML, Semantic Web, and Web Services.
- Analysis of mobile computing and EC/EB platforms that are becoming available to support special purpose applications.
- Approaches to architect solutions and integrate applications by using Web Services and components.
- Several case studies and examples to illustrate the key points.

e-Business and Distributed Handbook

From Strategies to Working Solutions

A, Umar, NGE Solutions, May 2003

Note: * indicates that an updated version (August 2004) of the chapter is included in this book.

MODULE (OVERVIEW): The Big Picture and Case Studies

*Chapter 1: e-Business and Distributed Systems – From Strategies to Working Solutions

*Chapter 2: Case Studies and Examples

E-BUSINESS APPLICATIONS, ARCHITECTURES, AND INTEGRATION

MODULE (APPLICATIONS): e-Business Strategies and Applications

Chapter 1: e-Business– From Strategies to Applications

*Chapter 2: e-Business Applications (CRMs, ERPs, eMarkets, SCM, ASPs, Portals)

Chapter 3: From Strategies to Solutions – A Planning Methodology

Chapter 4: IT Infrastructure – Overview of Enabling Technologies

Chapter 5: Applications State of the Practice, Market, and Art

¹ Although this is an old and outdated book, many instructors are still using it (I don't know why). I still receive emails about a new edition, so here it is.

MODULE (ARCHITECTURES): Solution Architectures Through Components

*Chapter 1: Solution Architecture Overview
Chapter 2: Enterprise Application Architectures - A Component-based Approach
Chapter 3: Enterprise Data Architectures in Web-XML Environments
Chapter 4: Architecture Implementation: Concepts and Examples
Chapter 5: Architectures State of the Practice, Market, and Art

MODULE (INTEGRATION): Enterprise Application Integration and Migration

*Chapter 1: Integration with Existing (Including Legacy) Applications -- An Overview
Chapter 2: Enterprise and Inter-Enterprise Application Integration (EAI/eAI)
Chapter 3: Data Warehouses and Data Mining for Integration
Chapter 4: Migration Strategies and Technologies
Chapter 5: Integration State of the Practice, Market, and Art

ENABLING IT INFRASTRUCTURE (NETWORKS AND MIDDLEWARE)

MODULE (NETWORKS): Network Services and Architectures in the Internet World

Chapter 1: Principles of Communication Networks
Chapter 2: Network Architectures and Interconnectivity
Chapter 3: Wireless and Broadband Networks -- Next Generation Networks:
Chapter 4: IP-based Networks and the Next Generation Internet
Chapter 5: Networks State of the Practice, Market, and Art

MODULE (MIDDLEWARE) : Application Interconnectivity Through Middleware

*Chapter 1: Middleware Principles and Basic Middleware Services
*Chapter 2: Web, XML, Semantic Web, and Web Services
*Chapter 3: Distributed Objects, CORBA, Web Services, J2EE, .NET, SOAP, and EJB
*Chapter 4: Enterprise Data and Transaction Management
*Chapter 5: Middleware State of the Practice, Market, and Art

MODULE (PLATFORMS): Application Servers for Mobile and EC/EB Applications

*Chapter 1: Mobile Application Servers
*Chapter 2: e-Commerce Platforms for C2B Trade -- The Commerce Servers
*Chapter 3: B2B Platforms and Standards -- The B2B Servers
*Chapter 4: Platforms for Multimedia and Collaboration
*Chapter 5: Application Servers State of the Practice, Market, and Art

MANAGEMENT AND SUPPORT

MODULE (MANAGEMENT): Management and Security

Chapter 1: e-Business Management in Practice
Chapter 2: Management Platforms for Network and Systems Management
Chapter 3: Security Management-- Approaches and Technologies
Chapter 4: Security Solutions -- Using Technologies to Secure Systems
Chapter 5: Management State of the Practice, Market, and Art

MODULE (TUTORIALS): Tutorials and Detailed Discussions on Special Topics

Chapter 1: Network Technologies -- A Tutorial
Chapter 2: Object-Orientation, Java, and UML -- A Tutorial
Chapter 3: Database Technologies and SQL -- A Tutorial
Chapter 4: Web Engineering and XML Processing -- A Closer Look
Chapter 5: CORBA -- A Closer Look

Conventions Used

We will use the following conventions in this book. *Highlighted italics* are used to indicate definitions of new terms, *italics* are used for emphasis and **bold letters** are used for subject headings.

Intended Audience and Recommended Usage

- IS Managers who want to understand what they are managing
- IS technical staff who want to understand why managers act as they do
- IS students who want to get through their programs with minimal damage to their body and soul
- Computer science students who want to link reality to their algorithm oriented courses in distributed systems

- All others who just want to read books written by good people

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I am greatly indebted to my wife, Dolorese, who keeps supporting me through this endless writing process. She also did a great deal of copy editing in good spirit, made valuable suggestions about the contents, and improved the overall look and feel of the manuscript. Her own background in computing (she worked at the University of Michigan and later at Bellcore/Telcordia Technologies in systems analysis and customer support) has been a valuable asset in this project. This work could never have been finished without her help and understanding.

Suggested Usage in a Course

I have developed and taught courses on distributed systems for more than a dozen years at different universities (University of Pennsylvania, University of Michigan, Rutgers University, and Fordham University) and professional settings (Society of Manufacturing Engineers, Frost and Sullivan, and telecommunications sector seminars). Although the courses have evolved over the years and the content varies with audience, a recent and generic course description and outline follows.

Course: Modern Distributed Systems

Other Possible Titles for the same course:

- Modern Client/server Environments
- Object-oriented Client/Server Internet Environments
- Middleware and the Web Technologies
- e-Business/e-Commerce Technologies

Course Description: This course introduces the main concepts of modern distributed systems with special emphasis on contemporary middleware, Web Services, platforms, and component-based architecture issues. The topics of this course continually evolve as new technologies and approaches emerge. The course starts with an overview of modern distributed systems and their role in supporting ebusiness initiatives and applications. The key middleware services and Web technologies (Web clients, Web proxies, Web servers, XML and its variants, web gateways, and cookies) are covered with emphasis on Next Generation Web (i.e., object orientation of Web). Emerging application servers and approaches to build Web applications (e.g., Web Services, .NET, J2EE) are examined to illustrate practical applications. The course concludes with a discussion of how the most recent technologies such as components and Web services can be used to architect and integrate the modern large scale distributed applications. Several case studies, examples, and commercially available products are reviewed.

Prerequisites:

Basic course in IS/IT with some background in databases, object-orientation, and networks.

Main Text:

Umar, A "Third Generation Distributed Computing Environments", NGE Solutions, Inc. July 2004.

Course Grade:

- Two Projects that include hands-on experimentation with several packages (200 points)
- One Examination (100 points)
- Total: 300 points

Course Outline

Session	Major Topic	Readings
1	Introduction and Overview	Chapter 1
2	Modern Distributed Applications (CRMs, ERPs, eMarkets, SCM, ASPs, Portals)	Chapter 2
3	Middleware Principles and Basic Middleware Services	Chapter 4
4	Web, XML, and Semantic Web	Chapter 5
5	Web Services, .NET and J2EE	Chapter 6
6	Enterprise Data and Transaction Management	Chapter 7
7	Exam or project	
8	Mobile Application Servers	Chapter 9
8	e-Commerce Servers	Chapter 10
10	B2B Platforms and Standards -- The B2B Servers	Chapter 11
11	Platforms for Multimedia and Collaboration	Chapter 12
12	Component-based Solution Architectures	Chapter 14
13	Enterprise Application Integration	Chapter 15
14, 15	Exam, special topics, or project presentations	

Discussion of case studies, examples, commercial products, and trends:

The course uses several case studies, examples, and commercial products at different points in the course. This material is extracted from the following chapters:

- Examples and Case Studies Chapter (Chapter 3)
- Middleware State of the Practice, Market, and Art (Chapter 8)
- Application Servers State of the Practice, Market, and Art (Chapter 13)

Acronyms and Glossary of Terms

ACL	Authorized control list
ACM	Association of Computing Machinery
ACSE	Association Control Service Elements
AI	Artificial Intelligence
AIA	Application Integration Architecture
API	Application Programming Interface
APPC	Advanced Program to Program Communications
ANSI	American National Standards Institute
ASN.1	Abstract Syntax Notation One
ASP	Application service provider
ASP	Active Server pages - A Microsoft technology for building server side code
ATM	Asynchronous Transfer Mode - a packet switching technology used typically in high data rate networks
ATM	Automatic Teller Machine - used in banking
ATMF	Asynchronous Transfer Mode Forum
BISDN	Broadband Integrated Services Digital Network
BSP	Business System Planning
B2B	Business to business
B2C	Business to consumer
B2E	Business to employee
B2G	Business to government
CAD	Computer Aided Design
CAM	Computer Aided Manufacture
CBX	Computerized Branch Exchange
CCITT	Comité Consultatif Internationale de Télégraphique et Téléphonique (The International Telegraph and Telephone Consultative Committee)
CGI	Common Gateway Interface - A Web gateway technology
CICS	Customer Information Control System - an IBM mainframe transaction manager
CIM	Computer Integrated Manufacturing
CIO	Chief Information Officer
CLNP	Connectionless Mode Network Protocol
CLNS	Connectionless Mode Network Service
CMIP	Common Management Information Protocol
CMIS	Common Management Information Service
CMISE	Common Management Information Service Element
CMOT	Common Management Information Services and Protocol Over TCP/IP
CORBA	Common Object Request Broker Architecture
COTS	Commercial off-the-Shelf
CPU	Central Processing Unit
CRM	Customer Relationship management
CSF	Critical success factors
CSMA/CD	Carrier Sense Multiple Access/Collision Detect
DAF/ODP	Distributed Application Framework/Open Distributed Processing
DAS	Distributed Application System
DBMS	Database Management System
DCP	Distributed Computing Platform
DCOM	Distributed Component Object Model
DCRM	Distributed Computing Reference Model
DCS	Distributed Computing System

DDBM	Distributed Database Manager
DDBMS	Distributed Database Management System
DDL	Data Definition Language - used in database management
DDTMS	Distributed Data and Transaction Management System
DFM	Distributed File Manager
DIS	Draft International Standard
DISOS	Distributed Operating System
DML	Data Manipulation Language
DNA	Digital Network Architecture
DOD	Department of Defense
DQDB	Distributed Queue Dual Bus
DRDA	Distributed Relational Database Architecture (from IBM)
DS	Directory Services
DSL	Digital subscriber loop
DTM	Distributed Transaction Manager
DTMS	Distributed Transaction Management System
EAI	Enterprise application integration
EB	Electronic Business
EC	Electronic commerce
EDI	Electronic Data Interchange
EJB	Enterprise Java Beans
ERP	Enterprise Resource Planning
ES-IS	End System to Intermediate System
ETSI	European Telecommunication Standards Institute
FAP	File Allocation Program (Procedure)
FDM	Frequency Division Multiplexing
FDDI	Fiber Distributed Data Interface
FEP	Front End Processor
FMS	Flexible Manufacturing System
FTAM	File Transfer, Access, and Management
FTP	File Transfer Protocol
GDMO	Guideline for Definition of Managed Objects
GUI	Graphical User Interface
IEEE	Institute for Electrical and Electronic Engineers
IDL	Interface Definition Language - used in CORBA and other distributed object middleware services
I/O	Input/Output
IMS	Information Management System - IBM DB/DC system on mainframes
IRM	Information resource management - a management methodology
IP	Internet protocol
IPC	Interprocess Communication
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
ISP	Internet service provider
IT	Information Technology
ITU	International Telecommunications Union
ITU-T	International Telecommunications Union - Telecommunications Services Sector
JDBC	Java Database Connectivity
J2EE	Java Version 2 Enterprise Edition
LAN	Local Area Network
LDBMS	Local Database Management System
LLC	Logical Link Control
LU	Logical Unit - an endpoint in the IBM SNA environment
MAN	Metropolitan Area Network
MAC	Medium Access Control

MAP	Manufacturing Automation Protocol
Mbps	Million bits per second
MHS	Message Handling Service
MIB	Management information base - used in network management
MIPS	Million Instructions Per Second
MMS	Manufacturing Messaging Specification
MOM	Message oriented middleware
MVS	Multiple Virtual System - operating system on IBM's mainframes
MUX	Multiplexor
NAS	Network Application Support - DEC's open architecture
NBS	National Bureau of Standards
NCP	Network Control Program - a component of IBM's SNA
NFS	Network File Services - SUN Microsystem's File System for Networks
NIST	National Institute of Standards and Technology
NLM	Network Loadable Module (A Novell Netware feature)
NM	Network Management
NMF	Network Management Forum
NML	Network Management Layer
NMS	Network Management System
NOS	Network Operating Systems - typically indicates a LAN operating system (e.g., Novell Netware)
NSP	Network service provider (e.g., UUNET)
OAG	Open Application Group - a standards organization
ODBC	Open Database Connectivity - a de-facto standard for remote SQL
ODIF	Office Document Interchange Format
OEM	Original equipment manufacturer
OMG	Object Management Group
OODBMS	Object-Oriented Database Management System
OOPL	Object-Oriented Programming Language
OS	Operating System
OSF	Open Software Foundation
OSF-DCE	OSF Distributed Computing Environment
OSF-DME	OSF Distributed Management Environment
OSI	Open System Interconnection
OSS	Operations support systems - for telecom network provisioning
QoS	Quality of Service
QMP	Queued Message Processing
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PGP	Pretty Good Privacy
PU	Physical Unit - used in IBM's SNA
RDA	Remote Database Access
RTS	Reliable Transfer Service
RPC	Remote Procedure Call
SAA	System Application Architecture - IBM's "Open" Environment
SCM	supply chain managemnt
SDLC	Synchronous Data Link Control - Layer 2 Protocol in IBM's SNA
SET	Secure Electronic Transaction - a security standard
SIF	Synchronous Optical Network (SONET) Interoperability Forum
SQL	Structured Query Language
SMDS	Switched Multi-megabit Data Service
SML	Service-management layer - used in telecom network

	services
SNA	System Network Architecture - IBM's Network Architecture
SNMP	Simple Network Management Protocol - TCP/IP Network management Protocol
SOAP	Simple Object Activation Protocol - part of Web Services
SONET	Synchronous Optical Network
SSL	Secure socket layer
TCP/IP	Transmission Control Protocol/Internet Protocol
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TMN	Telecommunications managed network
TOP	Technical and Office Protocol
UDDI	Universal Description, Discovery and Integration - a registry for Web Services
UDP	User Datagram Protocol - a protocol that runs on IP
VAN	Value-added Network
VPN	Virtual Private Network
VT	Virtual Terminal
VTAM	Virtual Telecommunications Access Method - a component of IBM's SNA
VXML	Voice eXtensible Markup Language
WAN	Wide Area Network
WAP	Wireless Application Protocol
WML	Wireless Markup Language
WS	Workstation
WSDL	Web Services Definition Language

Detailed Table of Contents

MODULE (OVERVIEW): The Big Picture and Case Studies

1 THE BIG PICTURE

1.1 INTRODUCTION

- 1.1.1 *What is Distributed Computing and how is it Related to e-Business?*
- 1.1.2 *Some Examples and Short Case Studies*
- 1.1.3 *Why This Book?*

1.2 E-BUSINESS AND DISTRIBUTED COMPUTING EVOLUTIONS

- 1.2.1 *e-Business Evolution*
- 1.2.2 *Next Generation Enterprises (NGEs) -- The Digital Real-time Corporations*
- 1.2.3 *Evolution of Distributed Computing Technologies*
- 1.2.4 *Synthesis of e-Business and Distributed Computing Evolutions*
- 1.2.5 *Case Study: GE Evolves into a Real-Time Digital Enterprise*

1.3 THE BOOK ROADMAP

- 1.3.1 *A Reference Model*
- 1.3.2 *Contents of this Book*

1.4 A CASE STUDY: INTRODUCING XYZCORP

1.5 CONCLUDING COMMENTS

1.6 REVIEW QUESTIONS AND EXERCISES

1.7 ADDITIONAL INFORMATION

2 MODERN DISTRIBUTED APPLICATIONS – (CRMS, ERPS, EMARKETS, SCMS, PORTALS, MOBILE APPLICATIONS)

2.1 INTRODUCTION

2.2 CASE STUDY -- XYZCORP IDENTIFIES E-BUSINESS APPLICATIONS

2.3 DISTRIBUTED APPLICATIONS – ANOTHER LOOK

2.4 PORTALS: FROM WEB SITES TO VIEW INTEGRATION

- 2.4.1 *Overview*
- 2.4.2 *Classes of Portals*
- 2.4.3 *Portal Architectures and Software*

2.5 CUSTOMER RELATIONSHIP MANAGEMENT (CRM) SYSTEMS: KEEPING CUSTOMER IN THE FOREFRONT

- 2.5.1 *What is Customer Relationship Management*
- 2.5.2 *Short Examples of CRM*
- 2.5.3 *Why CRMs?*
- 2.5.4 *Issues in Building CRM*
- 2.5.5 *CRM Technologies and Architectures*
- 2.5.6 *Extending CRM to Business Relationship Management*

2.6 ONLINE PURCHASING SYSTEMS: THE CORNERSTONE OF E-COMMERCE

- 2.6.1 *Overview*

- 2.6.2 *Example of Setting Up a Simple Online Purchasing System -- Bob's Bicycle Shop*
- 2.6.3 *Web Storefronts and Virtual Shops for Purchasing*
- 2.6.4 *Online Purchasing -- A Closer Look*
- 2.7 **EPROCUREMENT AND ELECTRONIC MARKETPLACES: THE PURCHASING NETWORKS**
 - 2.7.1 *Overview*
 - 2.7.2 *Electronic Marketplaces (EMarkets)*
 - 2.7.3 *Electronic Marketplaces -- A Closer Look*
 - 2.7.4 *Examples of eMarkets*
 - 2.7.5 *Analysis of eMarkets*
 - 2.7.6 *What is the Right eMarket Strategy?*
 - 2.7.7 *eMarket High Level Architectures*
 - 2.7.8 *eMarket Concluding Comments*
- 2.8 **ENTERPRISE RESOURCE PLANNING (ERP) SYSTEMS: THE BACKBONE OF CORPORATE E-BUSINESS**
 - 2.8.1 *Overview*
 - 2.8.2 *Classes of ERP Systems*
 - 2.8.3 *Requirements of ERP Systems*
 - 2.8.4 *Evaluation Criteria*
 - 2.8.5 *Future Trends in ERP*
- 2.9 **SUPPLY CHAIN MANAGEMENT SYSTEMS: THE BACKBONE OF B2B E-BUSINESS**
 - 2.9.1 *Overview*
 - 2.9.2 *Supply Chain Decisions and Models*
 - 2.9.3 *"Electronification" of Supply Chain Management ("eSCM")*
 - 2.9.4 *Illustrative Examples of Modern Supply Chains*
 - 2.9.5 *Selling Chain Management*
 - 2.9.6 *Trends in SCM*
- 2.10 **DATA WAREHOUSES, DATA MINING, AND BUSINESS INTELLIGENCE**
 - 2.10.1 *Overview*
 - 2.10.2 *Highlights of Data Warehouses*
 - 2.10.3 *Data Mining and Web Mining*
- 2.11 **OUTSOURCING THROUGH SERVICE PROVIDERS (NSPs, ISPs, ASPs)**
 - 2.11.1 *Overview*
 - 2.11.2 *Outsourcing Through Service Providers*
 - 2.11.3 *ASPs -- A Closer Look*
 - 2.11.4 *Classifications of ASPs*
 - 2.11.5 *Why are ASPs so Popular?*
 - 2.11.6 *ASP versus other SPs*
 - 2.11.7 *Why Use an ASP?*
 - 2.11.8 *Architectures of ASPs*
 - 2.11.9 *Issues and Trends in ASPs*
- 2.12 **MOBILITY AND MOBILE APPLICATIONS**
 - 2.12.1 *Mobile Enterprise Business Applications (MEBAs)*
 - 2.12.2 *Mobile Commerce (M-Commerce)*
 - 2.12.3 *Voice Commerce (V-Commerce), Positional Commerce (P-commerce), and TV Commerce (T-Commerce)*
 - 2.12.4 *Location-Sensitive Applications*
 - 2.12.5 *Wireless Sensor Network (WSN) Applications*
 - 2.12.6 *RFID Applications*
 - 2.12.7 *Mobile Agent Applications*
 - 2.12.8 *Architectures for Mobile Applications*
- 2.13 **HINTS ABOUT THE XYZCORP CASE STUDY**
- 2.14 **CHAPTER SUMMARY**
- 2.15 **ADDITIONAL INFORMATION**

3 CASE STUDIES AND EXAMPLES

- 3.1 **INTRODUCTION**

- 3.2 SHORT EXAMPLES OF E-BUSINESS STRATEGIES
 - 3.2.1 *Staples Gets into e-business*
 - 3.2.2 *Nestle Corporation*
 - 3.2.3 *Visteon*
 - 3.2.4 *Wired Wellington -- Wiring up New Zealand's Capital*
 - 3.2.5 *Stock Research Group (SRG)*
 - 3.2.6 *Auto-by-Tel*
 - 3.2.7 *Charles Schwab*
 - 3.2.8 *Dell Computers*
 - 3.2.9 *Miller Industries*
 - 3.2.10 *Northern Telecom*
 - 3.2.11 *Synchronized Supply Chains*
 - 3.2.12 *Review Questions*
- 3.3 E-COMMERCE/E-BUSINESS EXAMPLES
 - 3.3.1 *Xerox Document Processing Equipment*
 - 3.3.2 *Amazon.Com Site*
 - 3.3.3 *Amp Inc. Electronic Connectors*
 - 3.3.4 *W.W. Grainger -- Facilities Management Supplies*
 - 3.3.5 *Mitre Corporation -- The DISCUS Data Interchange System*
 - 3.3.6 *Cisco -- Data Communications Equipment*
 - 3.3.7 ***Web Security at Exostar***
- 3.4 E-COMMERCE -- ONLINE PURCHASING EXAMPLES
 - 3.4.1 *Getting Sam Started in e-commerce*
 - 3.4.2 *A Simple C2B Purchasing Example -- An Electronic Store Front*
 - 3.4.3 *A Simple B2B Purchase Example*
- 3.5 A FINANCIAL MARKETPLACE
 - 3.5.1 *Overview*
 - 3.5.2 *EMarket Transactions and Transaction Flows*
 - 3.5.3 *An Architectural View*
 - 3.5.4 *Review and Discussion Questions*
- 3.6 CITY OF SEATTLE PUBLIC UTILITIES GO WIRELESS
 - 3.6.1 *Introduction*
 - 3.6.2 *Choosing the Computing Platform and Wireless Network*
 - 3.6.3 *Application Architecture*
 - 3.6.4 *Software Approaches*
 - 3.6.5 *Review Questions*
- 3.7 INSURING OUTSOURCED ENTERPRISES IN E-COMMERCE -- A METHODOLOGY
 - 3.7.1 *Overview*
 - 3.7.2 *An Approach to Estimate Risks*
 - 3.7.3 *Review Questions*
- 3.8 AN INTEGRATED MANUFACTURING SYSTEM
 - 3.8.1 *Overview*
 - 3.8.2 *Review and Discussion Questions*
- 3.9 A CUSTOMER RELATIONSHIP MANAGEMENT PORTAL -- A TECHNICAL VIEW
 - 3.9.1 *Overview*
 - 3.9.2 *Usage Scenarios*
 - 3.9.3 *Detailed Design -- Solution Architecture*
 - 3.9.4 *Review Questions*
- 3.10 MIGRATION OF A PROJECT MANAGEMENT SYSTEM
 - 3.10.1 *Overview*
 - 3.10.2 *Step 1: Business Drivers and Requirement Definition*
 - 3.10.3 *Step 2: Development of a Solution Architecture*
 - 3.10.4 *Step 3: Detailed Design and Implementation*
 - 3.10.5 *Review Questions*
- 3.11 OLDER CASE STUDIES -- A FRESH LOOK
 - 3.11.1 *Hewlett Packard's Migration to Client/Server Architecture*

- 3.11.2 *Off-Shore Reengineering*
- 3.11.3 *University of Florida Reengineers via the World Wide Web*
- 3.11.4 *3Com's Data Warehouse*
- 3.11.5 *British Telecom's Data Warehouse*
- 3.12 REFERENCES

MODULE (MIDDLEWARE) : Application Interconnectivity Through Middleware

4 MIDDLEWARE PRINCIPLES AND BASIC MIDDLEWARE SERVICES

- 4.1 INTRODUCTION
- 4.2 CASE STUDY: XYZCORP CHOOSES AN INTERCONNECTIVITY ARCHITECTURE
 - 4.2.1 *Middleware for Interconnectivity Project*
- 4.3 APPLICATIONS IN DISTRIBUTED ENVIRONMENTS
- 4.4 MIDDLEWARE -- THE GLUE BETWEEN APPLICATIONS
 - 4.4.1 *What is Middleware?*
 - 4.4.2 *Functional View of Middleware*
- 4.5 MIDDLEWARE EXAMPLES AND A CLOSER LOOK
- 4.6 THE CLIENT/SERVER MODEL – A CLOSER LOOK
 - 4.6.1 *Overview of Client/Server Model*
 - 4.6.2 *Architectural Configurations of C/S Systems*
- 4.7 PUTTING THE PIECES TOGETHER
- 4.8 XYZCORP CASE STUDY: PARTIAL SOLUTION 1
 - 4.8.1 *High Level XYZCorp Application Interconnectivity Architecture*
 - 4.8.2 *Business Reporting System*
- 4.9 BASIC MIDDLEWARE -- A CLOSER LOOK
- 4.10 CONNECTING TO REMOTE PROGRAMS - REMOTE PROCEDURE CALL (RPC)
 - 4.10.1 *Overview*
 - 4.10.2 *The RPC Paradigm*
 - 4.10.3 *RPC Analysis*
 - 4.10.4 *Strengths and Weaknesses of RPC*
- 4.11 ACCESSING REMOTE DATABASES DIRECTLY - REMOTE DATA ACCESS (RDA)
 - 4.11.1 *Overview*
 - 4.11.2 *RDA Paradigm*
 - 4.11.3 *RDA Analysis*
 - 4.11.4 *Strengths and Weaknesses of RDA*
- 4.12 LOOSE COUPLING BETWEEN APPLICATIONS -- MESSAGE ORIENTED MIDDLEWARE (MOM)
 - 4.12.1 *Overview*
 - 4.12.2 *MOM with Message Queuing Paradigm*
 - 4.12.3 *QMP Analysis*
 - 4.12.4 *Strengths and Weaknesses*
- 4.13 PUSHING INFORMATION TO CONSUMERS -- PUBLISH-SUBSCRIBE MODEL
 - 4.13.1 *Overview*
 - 4.13.2 *Publish/Subscribe Model*
 - 4.13.3 *Publish-Subscribe Analysis*
 - 4.13.4 *Strengths and Weaknesses*
- 4.14 THE JMS STANDARD -- COMBINING MESSAGING INTO ONE
- 4.15 OTHER INTERACTION PARADIGMS
- 4.16 COMPARISON AND ANALYSIS

- 4.17 XYZCORP CASE STUDY: PARTIAL SOLUTION 2
- 4.18 STATE OF THE PRACTICE, MARKET, AND ART
- 4.19 SUMMARY
- 4.20 REVIEW QUESTIONS AND EXERCISES
- 4.21 ADDITIONAL INFORMATION

5 WEB, XML, SEMANTIC WEB, AND WEB SERVICES

- 5.1 INTRODUCTION
- 5.2 CASE STUDY: WEB PORTAL FOR XYZCORP
- 5.3 INTERNET AND INTRANETS: A QUICK REFRESHER
- 5.4 OVERVIEW OF WORLD WIDE WEB
 - 5.4.1 *Brief History*
 - 5.4.2 *World Wide Web Technologies – The First Generation*
 - 5.4.3 *A Simple Example*
 - 5.4.4 *Evolution of Web Technologies – The Next Generation Web*
- 5.5 HYPERTEXT MARKUP LANGUAGE (HTML)
- 5.6 WEB BROWSERS
 - 5.6.1 *Overview*
 - 5.6.2 *Highlights of Browser Capabilities*
 - 5.6.3 *Browsers as Web Clients*
- 5.7 WEB SITES AND WEB SERVERS
 - 5.7.1 *Overview*
 - 5.7.2 *Web Server Architectures*
 - 5.7.3 *Web Server Security*
- 5.8 WEB GATEWAYS: ACCESSING NON-WEB INFORMATION
 - 5.8.1 *Web Gateway Overview*
 - 5.8.2 *Common Gateway Interface (CGI)*
 - 5.8.3 *Servlets*
 - 5.8.4 *Java Server Pages (JSPs)*
 - 5.8.5 *Client-Side Mobile Code Gateways*
 - 5.8.6 *Other Gateways*
- 5.9 HYPERTEXT TRANSFER PROTOCOL (HTTP)
 - 5.9.1 *The Initial Model (HTTP 1.0)*
 - 5.9.2 *New Model – HTTP 1.1*
- 5.10 WEB COOKIES AND WEB PROXIES
 - 5.10.1 *Cookies*
 - 5.10.2 *Web Proxies*
- 5.11 XML (EXTENDED MARKUP LANGUAGE)
 - 5.11.1 *What is XML?*
 - 5.11.2 *A Few XML Details*
 - 5.11.3 *Why XML is So Popular*
 - 5.11.4 *Document Type Declarations (DTD)*
 - 5.11.5 *XSL ((XML Stylesheet Language)*
 - 5.11.6 *XML Schema*
 - 5.11.7 *Other XML Capabilities*
- 5.12 THE SEMANTIC WEB -- A LOOK AT THE NEXT GENERATION OF WEB
 - 5.12.1 *Overview and Motivation*
 - 5.12.2 *Web Metadata and PICS (Platform for Internet Content Selection)*
 - 5.12.3 *Resource Definition Framework (RDF)*
 - 5.12.4 *Document Object Model (DOM)*
- 5.13 WEB SERVICES – USING WEB TO BUILD GLOBAL APPLICATIONS
 - 5.13.1 *Overview*
 - 5.13.2 *A Quick Example*

- 5.13.3 *Why are XML Web Services Important? What are the Main Activities?*
- 5.14 XYZCORP CASE STUDY: HINTS AND SUGGESTED SOLUTION
- 5.15 SUMMARY
- 5.16 PROBLEMS AND EXERCISES
- 5.17 ADDITIONAL INFORMATION
- 5.18 ATTACHMENT A: JAVA AND JAVA APPLETS
 - 5.18.1 *What is Java and Why is it so Hot?*
 - 5.18.2 *What is a Java Applet?*

6 WEB SERVICES, DISTRIBUTED OBJECTS, .NET, AND J2EE

- 6.1 INTRODUCTION
- 6.2 FROM DISTRIBUTED OBJECTS TO WEB SERVICES
 - 6.2.1 *Object: The Basic Building Block*
 - 6.2.2 *Distributed Object Middleware (CORBA and DCOM) at a Glance*
 - 6.2.3 *Interface Definition Languages (IDLs) – The Main Capability*
 - 6.2.4 *Components, Business Objects, and Object Frameworks*
- 6.3 WEB SERVICES, J2EE, AND .NET -- AN OVERVIEW
 - 6.3.1 *XML Web Services - A Revisit*
 - 6.3.2 *Microsoft's Dot Net (.NET) -- An Overview*
 - 6.3.3 *Sun's J2EE (Java 2 Enterprise Edition) -- An Overview*
- 6.4 WEB SERVICES – A CLOSER LOOK
 - 6.4.1 *Web Services Example of an Inventory Service*
 - 6.4.2 *WSDL – A Closer Look*
 - 6.4.3 *UDDI -- A Closer Look*
 - 6.4.4 *SOAP – A Closer Look*
- 6.5 .NET – A CLOSER LOOK
 - 6.5.1 *.NET Clients and Windows Server System*
 - 6.5.2 *Microsoft .NET Framework*
 - 6.5.3 *XML Web Services in .NET*
 - 6.5.4 *Visual Studio .NET*
 - 6.5.5 *Programming Tools*
 - 6.5.6 *Building Web Applications by using .NET*
 - 6.5.7 *Short ASP.NET Coding Example*
 - 6.5.8 *.NET Documentation and Installation*
- 6.6 J2EE – A CLOSER LOOK
 - 6.6.1 *Revisiting J2EE*
 - 6.6.2 *Enterprise Components - The EJB (Enterprise Java Bean) Architectures*
 - 6.6.3 *EJB Containers and Servers*
 - 6.6.4 *An Example*
- 6.7 CONCLUSIONS AND SYNTHESIS
 - 6.7.1 *Combining XML Web Services with J2EE and .NET*
 - 6.7.2 *Comparison Between J2EE and .NET*
 - 6.7.3 *Next Steps in Web Services*
- 6.8 XYZCORP CASE STUDY: HINTS AND PARTIAL SOLUTIONS
- 6.9 SUMMARY
- 6.10 PROBLEMS AND EXERCISES
- 6.11 ADDITIONAL INFORMATION

7 ENTERPRISE DATA AND TRANSACTION MANAGEMENT

- 7.1 INTRODUCTION
- 7.2 CASE STUDY: XYZCORP ESTABLISHES A DATA AND TRANSACTION PROCESSING STRATEGY
- 7.3 DISTRIBUTED DATA AND TRANSACTION MANAGEMENT CONCEPTS

- 7.3.1 *Review of Basic Concepts*
- 7.3.2 *Role of Web and XML in Enterprise Data and Transaction Management*
- 7.3.3 *Distribution Data Access Management: What and Why?*
- 7.3.4 *Distributed Data and Transaction Management Overview*
- 7.4 DISTRIBUTED FILE PROCESSING
- 7.5 SINGLE-SITE REMOTE DATABASE ACCESS: THE SIMPLE SQL MIDDLEWARE
 - 7.5.1 *Overview*
 - 7.5.2 *SQL Clients*
 - 7.5.3 *SQL Servers*
 - 7.5.4 *Remote Data Standards: ODBC/JDBC and DRDA*
- 7.6 DISTRIBUTED QUERY PROCESSING AND DISTRIBUTED DATABASE SERVERS
 - 7.6.1 *Overview*
 - 7.6.2 *Distributed Database Servers*
 - 7.6.3 *Heterogeneous and Federated Databases in Network Environments*
- 7.7 WEB-BASED DATA ACCESS
 - 7.7.1 *Web Query Processing and XQL (XML Query Language) -- XML as a Database*
 - 7.7.2 *Web Access to Relational Databases - The Web Gateways*
- 7.8 XYZCORP CASE STUDY: PARTIAL SOLUTION 1
- 7.9 DISTRIBUTED TRANSACTION MANAGEMENT -- THE TP-HEAVY APPROACH
 - 7.9.1 *Overview of Transaction Management Concepts*
 - 7.9.2 *Distributed Transaction Processing Concepts*
 - 7.9.3 *Standards for Distributed Transaction Processing*
- 7.10 DATA REPLICATION SERVERS -- THE TP-LITE APPROACH
 - 7.10.1 *Overview*
 - 7.10.2 *Definitions and Technical Considerations*
 - 7.10.3 *General Architecture of Replication Servers*
- 7.11 TWO-PHASE COMMIT ("TP-HEAVY") VERSUS DATA REPLICATION SERVERS ("TP-LITE")
 - 7.11.1 *Two-Phase Commit*
 - 7.11.2 *Trade-offs Between Two Phase Commit and Replication Servers*
- 7.12 DISTRIBUTED TRANSACTION PROCESSING: TP-LESS, TP-LITE, TP-HEAVY
 - 7.12.1 *TP-Less*
 - 7.12.2 *TP-Lite*
 - 7.12.3 *TP-Heavy*
 - 7.12.4 *Trade-offs Between TP-Lite and TP-Heavy*
- 7.13 DISTRIBUTED DATA AND TRANSACTION MANAGEMENT: A CONSOLIDATION
 - 7.13.1 *Global Data Definition and Translation Challenges*
 - 7.13.2 *Global Directory Allocation (Name Services) Challenges*
 - 7.13.3 *Distributed File Processing Challenges*
 - 7.13.4 *Distributed Query Processing Challenges*
 - 7.13.5 *Distributed Transaction Processing Challenges*
- 7.14 A DISTRIBUTED DATA AND TRANSACTION MANAGEMENT EVALUATION FRAMEWORK
- 7.15 EXAMPLES OF DISTRIBUTED DATA AND TRANSACTION MANAGEMENT
- 7.16 STATE OF THE ART: OBJECT-ORIENTATION IN TRANSACTION MANAGEMENT
- 7.17 XYZCORP CASE STUDY: PARTIAL SOLUTION 2
- 7.18 PROBLEMS AND EXERCISES
- 7.19 ADDITIONAL INFORMATION

8 MIDDLEWARE STATE OF THE PRACTICE, MARKET, AND ART

- 8.1 INTRODUCTION
- 8.2 STATE OF THE PRACTICE: SHORT CASE STUDIES
 - 8.2.1 *Middleware State of the Practice -- General Observations*
 - 8.2.2 *J.D. Edwards Uses Messaging Services*
 - 8.2.3 *Web Technologies at Procter and Gamble*

- 8.2.4 *The Chemical Markup Language (CML) -- XML in the Chemical Industry*
- 8.2.5 *Dun & Bradstreet Use of XML -- A Case Study*
- 8.2.6 *Dollar Rent a Car and Trans World Entertainment Corp Use Web-XML*
- 8.2.7 *Distributed Objects Examples – Short “Snippets”*
- 8.2.8 *Bank Boston: Using Distributed Objects for Software Infrastructure*
- 8.2.9 *MITRE Corporation - The DISCUS Data Interchange System*
- 8.2.10 *XML Web Services at MSNBC.com to Reach New Markets*
- 8.2.11 *Expedia Uses .NET for Travelers*
- 8.2.12 *US Army Uses J2EE for Traffic Management*
- 8.2.13 *Distributed Data Management Examples*
- 8.2.14 *Distributed Transaction Management Examples*
- 8.3 STATE OF THE MARKET: PRODUCTS
 - 8.3.1 *Middleware State of the Market*
 - 8.3.2 *Basic Middleware State of the Market*
 - 8.3.3 *Web State of The Market*
 - 8.3.4 *XML Web Services State of the Market*
 - 8.3.5 *Distributed Objects State of the Market*
 - 8.3.6 *Distributed Data and Transaction Management State of the Market*
- 8.4 STATE OF THE ART: TRENDS
 - 8.4.1 *State of the Art: General Trends*
 - 8.4.2 *Middleware for Real-time Enterprises*
 - 8.4.3 *Middleware for Grid Computing*
 - 8.4.4 *The Next Generation Middleware -- Possible Research Directions*
- 8.5 EXERCISES
- 8.6 REFERENCES

MODULE (PLATFORMS): Application Servers for Mobile and EC/EB Applications

9 MOBILE APPLICATION SERVERS -- THE MOBILE COMPUTING PLATFORMS

- 9.1 INTRODUCTION
 - 9.1.1 *A Framework for Discussing Mobility*
- 9.2 MOBILE APPLICATIONS AND MOBILE COMMERCE -- OVERVIEW AND EXAMPLES
 - 9.2.1 *Mobile Enterprise Business Applications (MEBAs).*
 - 9.2.2 *Mobile Commerce (M-Commerce)*
 - 9.2.3 *Voice Commerce (V-Commerce), Positional Commerce (p-commerce) and TV-Commerce (T-Commerce)*
- 9.3 WIRELESS NETWORKS -- A QUICK OVERVIEW
 - 9.3.1 *Wireless Network Landscape*
 - 9.3.2 *Quick Comparison of Wireless Networks*
 - 9.3.3 *Wireless Versus Wired Networks*
- 9.4 CASE STUDIES AND EXAMPLES OF MOBILITY
 - 9.4.1 *Overview*
 - 9.4.2 *Airline Industries*
 - 9.4.3 *Financial Industry*
 - 9.4.4 *Car Rental Agencies*
 - 9.4.5 *Healthcare*
 - 9.4.6 *Retail Industries for Online Purchasing*
- 9.5 MOBILE APPLICATION SERVERS -- CONCEPTS AND EXAMPLES
 - 9.5.1 *Overview*
 - 9.5.2 *Conceptual Model of Mobile Application Servers*
 - 9.5.3 *Examples of Mobile Application Servers*

- 9.6 THE WIRELESS APPLICATION PROTOCOL (WAP)
 - 9.6.1 *Overview*
 - 9.6.2 *Why WAP is Needed?*
 - 9.6.3 *The New WAP -- WAP 2.0*
 - 9.6.4 *Wireless Application Environment (WAE)*
 - 9.6.5 *Wireless Markup Language (WML)*
 - 9.6.6 *WAP Microbrowsers*
 - 9.6.7 *WAP Gateway*
 - 9.6.8 *WAP Security*
 - 9.6.9 *WAP Applications*
 - 9.6.10 *Example of WAP and Bluetooth Together*
 - 9.6.11 *WAP Summary and Trends*
- 9.7 OTHER MIDDLEWARE FOR WIRELESS (I-MODE, WIRELESS JAVA, MMIT, BREW)
 - 9.7.1 *Overview*
 - 9.7.2 *i-Mode*
 - 9.7.3 *Wireless Java and J2ME (Java 2 Micro Edition)*
 - 9.7.4 *Microsoft Mobile Internet Toolkit (MMIT)*
 - 9.7.5 *QualComm's Binary Runtime Environment for Wireless (BREW)*
 - 9.7.6 *Message Oriented Middleware for Mobility*
- 9.8 VOICE COMMUNICATIONS -- VOICE BROWSERS AND VOICE XML
 - 9.8.1 *Overview*
 - 9.8.2 *Voice Browsers*
 - 9.8.3 *VOICE XML*
- 9.9 MOBILE AGENTS
 - 9.9.1 *Overview: What are Agents, Intelligent Agents, and Mobile Agents*
 - 9.9.2 *Mobile Agents Versus Client/Server Model*
 - 9.9.3 *Sample Applications of Mobile Agents in Ecommerce*
 - 9.9.4 *Mobile Agent Requirements*
 - 9.9.5 *Existing Mobile Agent Platforms and Architectures*
 - 9.9.6 *Mobile Agent Summary*
- 9.10 CHAPTER SUMMARY
- 9.11 CASE STUDY: XYZCORP INVESTIGATES PLATFORMS FOR MOBILITY AND EC/EB SERVICES
 - 9.11.1 *Mobile Application Server Project*
- 9.12 REVIEW QUESTIONS AND EXERCISES
- 9.13 ADDITIONAL INFORMATION

10 E-COMMERCE SERVERS – PLATFORMS FOR C2B TRADE

- 10.1 INTRODUCTION
- 10.2 INTERNET-BASED PURCHASING OVERVIEW
 - 10.2.1 *An Example -- Getting Sam Started in e-Commerce*
 - 10.2.2 *A Simple C2B Purchasing Example*
 - 10.2.3 *A Simple B2B Purchase Example*
- 10.3 C2B E-COMMERCE MIDDLEWARE
 - 10.3.1 *Extranets and Virtual Private Networks (VPNs) for ECommerce*
 - 10.3.2 *Shopping Carts*
 - 10.3.3 *Catalog Management systems*
 - 10.3.4 *XML for Ecommerce*
 - 10.3.5 *Sample XML Source and DTD for Purchase Order*
 - 10.3.6 *Ecommerce Transaction Processing*
 - 10.3.7 *Electronic Payment Systems -- An Example of Transaction Processing*
- 10.4 SECURITY FOR E-COMMERCE/E-BUSINESS
 - 10.4.1 *Overview*
 - 10.4.2 *Overview of Core Security Technologies*
 - 10.4.3 *Information Protection (Privacy and Integrity)*

- 10.4.4 *Authentication and PKI*
- 10.4.5 *Authorization and Access Control*
- 10.4.6 *Accountability and Assurance*
- 10.4.7 *A Security Example*
- 10.4.8 *Summary of Security*
- 10.5 ELECTRONIC COMMERCE PLATFORMS: PACKAGING EC MIDDLEWARE
 - 10.5.1 *IBM Net.Commerce Technologies and WebShpere*
 - 10.5.2 *Oracle E-Commerce Platform*
 - 10.5.3 *Microsoft Internet Commerce Strategy*
 - 10.5.4 *Netscape EC Servers and the Sun iPlanet Platform*
 - 10.5.5 *Open Market*
 - 10.5.6 *BroadVision*
 - 10.5.7 *Miva Merchant*
- 10.6 OUTSOURCING CONSIDERATIONS
 - 10.6.1 *Outsourcing the Web Server*
 - 10.6.2 *Outsourcing the Commerce Server*
 - 10.6.3 *Outsourcing the Payment Systems*
 - 10.6.4 *Outsourcing the Merchant Account*
 - 10.6.5 *Outsourcing the Payment Authorization and Processing*
 - 10.6.6 *Outsourcing the entire Ecommerce Operation (e-Store)*
- 10.7 CONCLUDING COMMENTS
- 10.8 CASE STUDY: ON-LINE PURCHASING FOR XYZCORP
- 10.9 REVIEW QUESTIONS AND EXERCISES
- 10.10 ADDITIONAL INFORMATION

11 B2B SERVERS -- PLATFORMS AND STANDARDS FOR B2B TRADE

- 11.1 INTRODUCTION
- 11.2 B2B DIRECT INTERACTIONS (SUPPLY CHAINS) -- ANOTHER LOOK
 - 11.2.1 *Overview*
 - 11.2.2 *Supply Chain Management (SCM) Middleware Services*
- 11.3 B2B THROUGH INTERMEDIARIES -- ANOTHER LOOK
 - 11.3.1 *Overview*
 - 11.3.2 *Middleware for eMarkets*
- 11.4 MIDDLEWARE TECHNOLOGIES TO SUPPORT B2B COMMERCE - A QUICK OVERVIEW
- 11.5 B2B MESSAGE EXCHANGES BETWEEN PARTNERS -- EDI AND XML
 - 11.5.1 *Electronic Data Interchange (EDI)*
 - 11.5.2 *XML for e-Commerce*
- 11.6 B2B MIDDLEWARE NEEDED TO SUPPORT EMARKETS
 - 11.6.1 *Mediators for eMarkets and the Role of XML*
 - 11.6.2 *Web Content Development ("Web Farming")*
 - 11.6.3 *Mediating Electronic Product Catalogs*
- 11.7 B2B EXCHANGES STANDARDS (EBXML, PIPs) -- EFFORTS TOWARDS INTEROPERABILITY
 - 11.7.1 *OASIS, ebXML and UBL*
 - 11.7.2 *ebXML -- A Closer Look*
 - 11.7.3 *RosettaNet*
 - 11.7.4 *CommerceOne and Marketsite.net*
 - 11.7.5 *BizTalk.org and XML.Org*
- 11.8 WORKFLOW MANAGEMENT
 - 11.8.1 *Workflow Concepts*
 - 11.8.2 *Workflow Management System—The Middleware to Support Workflow*
 - 11.8.3 *Business Process Modeling - Some Details*
 - 11.8.4 *The Evolution of Workflow Management Systems*
 - 11.8.5 *Workflow Management Products - State of the Market*

- 11.8.6 *IBM's MQSeries WorkFlow - Example of a Workflow Product*
- 11.9 ENTERPRISE APPLICATION INTEGRATION (EAI) PLATFORMS
 - 11.9.1 *Overview*
 - 11.9.2 *EAI Platform Concepts*
 - 11.9.3 *Application Connectivity - The Publish//Subscribe Model*
 - 11.9.4 *Information Transformation (Application Adapters and Data Translators)*
 - 11.9.5 *Process and Workflow Management*
 - 11.9.6 *Integration of B2B Applications Through Web Services*
 - 11.9.7 *EAI Platform State of the Market*
- 11.10 EXAMPLES OF B2B PLATFORMS – THE B2B SERVERS
 - 11.10.1 *Oracle Exchange eMarket Platform*
 - 11.10.2 *Hewlett Packard's e-speak*
 - 11.10.3 *Supply Chain Products from i2*
 - 11.10.4 *B2B Application Integration Platforms (EAI for B2B)*
 - 11.10.5 *MCC's CMI: Rapid Prototyping of BTB Applications using Dynamic Workflow*
- 11.11 CONCLUDING COMMENTS
- 11.12 CASE STUDY: XYZCORP B2B SERVICES AND PLATFORMS
- 11.13 REVIEW QUESTIONS AND EXERCISES
- 11.14 CHAPTER REFERENCES

12 PLATFORMS FOR MULTIMEDIA AND COLLABORATION

- 12.1 INTRODUCTION
- 12.2 PLATFORMS FOR DISTRIBUTED MULTIMEDIA APPLICATIONS
 - 12.2.1 *Overview*
 - 12.2.2 *Multimedia Over the Internet -- The Protocol Stack*
 - 12.2.3 *Lower Network Issues to Support Multimedia Applications*
 - 12.2.4 *Data Transport Protocols: RTP (Real-time Transport Protocol) and RTCP (Real-Time Control Protocol)*
 - 12.2.5 *Session Establishment: RTSP, SIP, and SAP*
 - 12.2.6 *Presentation Middleware For Distributed Multimedia Applications*
 - 12.2.7 *State of the Practice, Market and Art*
- 12.3 GROUPWARE AND COLLABORATION SERVERS
 - 12.3.1 *Overview*
 - 12.3.2 *Groupware: From Lotus Notes to Groove*
 - 12.3.3 *Collaborative Learning in Internet2*
 - 12.3.4 *State of the Practice, Market, and Art*
- 12.4 DISTRIBUTED OPERATING SYSTEMS
 - 12.4.1 *Principles of Distributed Operating Systems*
 - 12.4.2 *Distributed Operating System Versus a Network Operating System*
 - 12.4.3 *Design Issues in Distributed Operating Systems*
 - 12.4.4 *Examples of Distributed Operating Systems*
- 12.5 APPLICATION SERVERS -- EVOLUTION OF PACKAGING MIDDLEWARE SERVICES
- 12.6 THE NEXT GENERATION MIDDLEWARE
- 12.7 SUMMARY
- 12.8 CASE STUDY: XYZCORP INVESTIGATES EMERGING MIDDLEWARE SERVICES AND PLATFORMS
- 12.9 PROBLEMS AND EXERCISES
- 12.10 ADDITIONAL INFORMATION

13 APPLICATION SERVERS STATE OF THE PRACTICE, MARKET, AND ART

- 13.1 INTRODUCTION
- 13.2 APPLICATION SERVERS -- STATE OF THE PRACTICE CASE STUDIES
 - 13.2.1 *A General Approach for a Small Chain of Stores*

- 13.2.2 *AIRTIS Wireless Traffic and Weather Solution*
- 13.2.3 *Microsoft Application Server at Honeywell*
- 13.2.4 *Telekom Malaysia*
- 13.2.5 *Coca-Cola Integrates Business Processes with BizTalk Server 2000*
- 13.2.6 *A B2B Food Exchange*
- 13.2.7 *Fubon Uses WebSphere*
- 13.2.8 *Party Warehouse Uses Integrated Applications*
- 13.2.9 *Digex Uses MS Commerce Server for Hosted Application Services*
- 13.3 STATE OF THE MARKET -- COMMERCIAL APPLICATION SERVERS
 - 13.3.1 *Commercial Mobile Application Servers (MASs)*
 - 13.3.2 *Commercially Available e-Commerce Servers*
 - 13.3.3 *Commercially Available B2B Servers*
- 13.4 STATE OF THE ART -- APPLICATION SERVER EVOLUTION AND TRENDS
 - 13.4.1 *Overview*
 - 13.4.2 *Evolution of Application Servers*
 - 13.4.3 *Super Application Servers*
 - 13.4.4 *Examples of Super Application Servers*
 - 13.4.5 *Summary and Trends of Application Servers*
- 13.5 EXERCISES

MODULE (ARCHITECTURES): Architectures and Integration through Web Services

14 COMPONENT-BASED ARCHITECTURES AND WEB SERVICES

- 14.1 INTRODUCTION
- 14.2 ARCHITECTURE OVERVIEW
 - 14.2.1 *Basic Definitions*
 - 14.2.2 *Good versus Bad Architectures – Some Guidelines*
 - 14.2.3 *Solution Architectures -- A Closer Look*
 - 14.2.4 *Quick Example of a Solution Architecture*
- 14.3 WEB-BASED SOLUTION ARCHITECTURES -- FROM HTML TO COMPONENTS
 - 14.3.1 *Overview*
 - 14.3.2 *Simple Client-Side Applications*
 - 14.3.3 *Small and Medium Sized Applications*
 - 14.3.4 *Components (Java Beans and Enterprise Java Beans) and Distributed Objects*
- 14.4 COMPONENT-BASED SOFTWARE ARCHITECTURE CONCEPTS
 - 14.4.1 *What is a Component and Why Should You Care?*
 - 14.4.2 *Granularities of Components*
 - 14.4.3 *What is a Component-based Architecture?*
 - 14.4.4 *Component-based Architecture Platforms*
- 14.5 SERVICE ORIENTED ARCHITECTURES AND WEB SERVICES
 - 14.5.1 *Service Oriented Architectures*
 - 14.5.2 *Web Services and SOAs*
 - 14.5.3 *Quick Example of WS*
 - 14.5.4 *Online Purchasing Example -- A Closer Look*
 - 14.5.5 *The Evolving Role of Web Services in Enterprise Applications*
 - 14.5.6 *.NET and J2EE as Players in Service-Oriented Architectures*
 - 14.5.7 *Combining Web Services with J2EE and .NET for Service-Oriented Architectures*
- 14.6 EXAMPLE: WEB SERVICES AND ENTERPRISE APPLICATION ARCHITECTURES
- 14.7 EXAMPLE: WEB SERVICES AND COALITIONS
- 14.8 EXAMPLE: WEB SERVICES AND APPLICATION SERVICE PROVIDERS (ASPs)

- 14.8.1 *The Traditional ASPs*
- 14.8.2 *Web Services (WS) and Evolution of ASPs*
- 14.8.3 *Virtual ASPs and Service Brokers*
- 14.9 REALITY CHECK -- CHALLENGES AND APPROACHES
 - 14.9.1 *Security and Privacy Issues*
 - 14.9.2 *QoS and Reliability*
 - 14.9.3 *Service Taxonomies and Business Choreography*
 - 14.9.4 *Business Issues*
- 14.10 A PROCEDURE FOR BUILDING COMPONENT-BASED ARCHITECTURES - QUICK REVIEW
 - 14.10.1 *Overview*
 - 14.10.2 *Analysis -- Building a Technology Independent Model*
 - 14.10.3 *Architectures -- Building a Technology Specific Model*
 - 14.10.4 *Implementation*
 - 14.10.5 *Deployment and Support*
- 14.11 CONCLUDING COMMENTS
- 14.12 CASE STUDY: XYZCORP EMBARKS ON SOLUTION ARCHITECTURES
 - 14.12.1 *Overall Solution Architecture Project*
- 14.13 REVIEW QUESTIONS AND EXERCISES
- 14.14 ADDITIONAL INFORMATION

15 ENTERPRISE APPLICATION INTEGRATION -- AN OVERVIEW

- 15.1 INTRODUCTION
- 15.2 APPLICATION INTEGRATION: CONCEPTS AND DEFINITIONS
 - 15.2.1 *What is Application Integration?*
 - 15.2.2 *Why Integrate? Promises and Pitfalls*
 - 15.2.3 *Good versus Bad Integrations -- Some Guidelines*
 - 15.2.4 *Application Integration -- The Basic Models*
 - 15.2.5 *A Broader Framework for integration*
- 15.3 INTEGRATION OF ENTERPRISE APPLICATIONS -- GENERAL CONSIDERATIONS
 - 15.3.1 *Integration of Enterprise (Internal, Back-office) Applications*
 - 15.3.2 *Integration of B2B Applications*
 - 15.3.3 *Integration of Legacy Applications*
- 15.4 APPLICATION INTEGRATION ARCHITECTURES - A QUICK LOOK
 - 15.4.1 *Overview*
 - 15.4.2 *Application Integration Issues*
 - 15.4.3 *Integrated Architectures by Using EAI (Enterprise Application Integration) Platforms*
 - 15.4.4 *Web Services as EAI Platforms*
- 15.5 WEB SERVICES FOR ENTERPRISE APPLICATION INTEGRATION
 - 15.5.1 *The Role of Web Services in EAI*
 - 15.5.2 *Integration of Legacy Applications through Web Services*
 - 15.5.3 *Integration of B2B Applications through Web Services*
 - 15.5.4 *B2B Integrations for Coalitions and ASPs through Web Services*
- 15.6 INTEGRATING WITH LEGACY APPLICATIONS -- A CLOSER LOOK
 - 15.6.1 *Issues with Integrating Legacy Applications*
 - 15.6.2 *Categories of Legacy Applications*
 - 15.6.3 *Overview of Strategies to Integrate Legacy Applications*
 - 15.6.4 *Strategy 1: Ignore the Legacy Applications*
 - 15.6.5 *Strategy 2: Rewrite From Scratch (Cold Turkey)*
 - 15.6.6 *Strategy 3: Access/Integration in Place*
 - 15.6.7 *Strategy 4: Data Warehousing*
 - 15.6.8 *Strategy 5: Gradual Migration*
- 15.7 PLANNING FOR APPLICATION INTEGRATION
 - 15.7.1 *Overview*
 - 15.7.2 *Opportunity Analysis*

- 15.7.3 *Choose a Solution Architecture*
- 15.7.4 *Implementation Considerations*
- 15.7.5 *Cost/benefit Analysis*
- 15.7.6 *Justification and Scheduling*
- 15.8 STATE OF THE PRACTICE: CASE STUDIES
 - 15.8.1 *Short Examples of Application Integration*
 - 15.8.2 *Application Integration Success and Failures*
 - 15.8.3 *Off-Shore Reengineering of legacy Applications*
 - 15.8.4 *Hewlett Packard's Migration to Client/Server Architecture*
- 15.9 STATE OF THE MARKET: REENGINEERING TOOLS
- 15.10 STATE OF THE ART: RESEARCH NOTES
- 15.11 SUMMARY
- 15.12 CASE STUDY: XYZCORP EMBARKS ON APPLICATION INTEGRATION AND MIGRATION
 - 15.12.1 *Overall Integration Strategy Project*
 - 15.12.2 *Hints About The Case Study*
- 15.13 REVIEW QUESTIONS AND EXERCISES
- 15.14 ADDITIONAL INFORMATION

MODULE (TUTORIALS): Tutorials and Detailed Discussions on Special Topics

1 NETWORK TECHNOLOGIES – A SHORT TUTORIAL

- 1.1 INTRODUCTION
- 1.2 LOCAL AREA NETWORKS, WIDE AREA NETWORKS, AND METROPOLITAN AREA NETWORKS
 - 1.2.1 *Local Area Networks*
 - 1.2.2 *Wide Area Networks*
 - 1.2.3 *Metropolitan Area Networks*
- 1.3 ENTERPRISE NETWORKS AND NETWORK ARCHITECTURE
 - 1.3.1 *Overview*
 - 1.3.2 *The Open System Interconnection (OSI) Reference Model*
 - 1.3.3 *Network Interconnectivity*
- 1.4 BROADBAND AND WIRELESS NETWORKS
 - 1.4.1 *Overview*
 - 1.4.2 *Broadband Networks*
 - 1.4.3 *Wireless Networks*
- 1.5 OVERVIEW OF INTERNET
 - 1.5.1 *What is Internet?*
 - 1.5.2 *User View of Internet*
 - 1.5.3 *Next Generation Network and Internet*
- 1.6 CHAPTER SUMMARY
- 1.7 **ADDITIONAL SOURCES OF INFORMATION**

2 OBJECT ORIENTED CONCEPTS, JAVA, AND UML - A SHORT TUTORIAL

- 2.1 INTRODUCTION
- 2.2 BASIC OBJECT CONCEPTS
 - 2.2.1 *Object: The Basic Building Block*
 - 2.2.2 *Messages: Activating Objects*
 - 2.2.3 *Classes*
 - 2.2.4 *Inheritance*

- 2.3 OBJECT BASED VERSUS OBJECT ORIENTATION
 - 2.3.1 *Abstraction*
 - 2.3.2 *Encapsulation (Information Hiding)*
 - 2.3.3 *Polymorphism*
- 2.4 OBJECT ORIENTED USER INTERFACES
- 2.5 OBJECT ORIENTED DESIGN AND PROGRAMMING
- 2.6 OBJECT ORIENTED DATABASES
- 2.7 OBJECT-ORIENTED MODELING
 - 2.7.1 *Object Oriented Analysis -- Building The Object Model*
- 2.8 OBJECT MODELING BY USING UNIFIED MODELING LANGUAGE (UML)
 - 2.8.1 *What is UML*
 - 2.8.2 *Importance of UML*
 - 2.8.3 *Some important features of UML*
 - 2.8.4 *UML Summary*
- 2.9 A QUICK TOUR OF JAVA AND JAVA APPLET
 - 2.9.1 *Java Overview*
 - 2.9.2 *Java Applets Versus Java Applications*
 - 2.9.3 *Key Java Features*
 - 2.9.4 *Java Security Concerns*
- 2.10 JAVA PROGRAMMING AND DEVELOPMENT ENVIRONMENTS
 - 2.10.1 *Getting Started*
 - 2.10.2 *An Applet*
 - 2.10.3 *Example of a Java Application*
 - 2.10.4 *Java Development Tools and Environments*
- 2.11 JAVA IN WEB ENVIRONMENTS -- A CLOSER LOOK AT JAVA APPLET
 - 2.11.1 *Java-enabled Web Browsers*
 - 2.11.2 *A more significant Java Applet*
 - 2.11.3 *An Applet/Application combination*
 - 2.11.4 *More Complex Applets*
 - 2.11.5 *Java Servlets*
 - 2.11.6 *The Java Virtual Machine (JVM)*
 - 2.11.7 *Differences among JVM Implementations*
- 2.12 STATE OF THE PRACTICE: GENERAL OBSERVATIONS
- 2.13 SUMMARY
- 2.14 ADDITIONAL INFORMATION

3 - DATABASE TECHNOLOGIES AND SQL -- A SHORT TUTORIAL

- 3.1 INTRODUCTION
- 3.2 DATABASE MANAGEMENT CONCEPTS
 - 3.2.1 *Files and Databases*
 - 3.2.2 *Database Management System (DBMS)*
 - 3.2.3 *Data Models and Categories of DBMS.*
 - 3.2.4 *Data View Support*
 - 3.2.5 *Data Definition Facilities*
 - 3.2.6 *Data Manipulation Facilities*
 - 3.2.7 *Operational Facilities*
- 3.3 OVERVIEW OF RELATIONAL DATABASES
- 3.4 SQL -- A QUICK OVERVIEW
 - 3.4.1 *Data Definition*
 - 3.4.2 *Data Retrieval*
 - 3.4.3 *Data Modification*
 - 3.4.4 *View Support*
 - 3.4.5 *Administrative Facilities*
 - 3.4.6 *Embedded SQL*
 - 3.4.7 *Performance*

- 3.4.8 *SQL Products*
- 3.4.9 *Strengths and Weaknesses*
- 3.5 SQL -- A CLOSER LOOK
 - 3.5.1 *Data Definition*
 - 3.5.2 *Data Manipulation*
 - 3.5.3 *Data Administration*
 - 3.5.4 *References for Additional Information*
- 3.6 OBJECT-ORIENTED SYSTEMS AND DATABASES
 - 3.6.1 *Introduction*
 - 3.6.2 *Object-Oriented Databases*
 - 3.6.3 *Objectizing a RDBMS*
- 3.7 OVERVIEW OF DATABASE DESIGN
- 3.8 CHAPTER SUMMARY
- 3.9 CASE STUDY: DATABASES FOR XYZCORP
- 3.10 KEY REFERENCES

4 WEB ENGINEERING AND XML PROCESSING-- A CLOSER LOOK

- 4.1 INTRODUCTION
- 4.2 HTTP DESIGN -- A CLOSER LOOK
 - 4.2.1 *HTTP Server Design*
 - 4.2.2 *HTTP Methods and Headers*
 - 4.2.3 *HTTP 1.1 Highlights*
 - 4.2.4 *Current Activities in HTTP*
- 4.3 WEB PERFORMANCE AND WORKLOAD MEASUREMENT
 - 4.3.1 *A Simple Web Performance Model*
 - 4.3.2 *Performance Measurements*
 - 4.3.3 *Role of HTTP and TCP in Web Performance*
 - 4.3.4 *Workload Characterization*
- 4.4 TRANSMISSION CONTROL PROTOCOL (TCP) CONSIDERATIONS
- 4.5 APPLICATION LAYER PROTOCOLS IN TCP/IP
 - 4.5.1 *Overview*
 - 4.5.2 *An Example of Traditional Internet Applications*
 - 4.5.3 *Telnet (Remote Logon)*
 - 4.5.4 *The File Transfer Protocol (FTP)*
 - 4.5.5 *The SUN Network File System (NFS) Protocol*
 - 4.5.6 *TCP/IP Berkeley Sockets*
 - 4.5.7 *Miscellaneous Application Layer Protocols*
- 4.6 XML PROCESSING
 - 4.6.1 *Highlights of XML*
 - 4.6.2 *XML Versus Other Description Languages*
- 4.7 XML TECHNOLOGIES
 - 4.7.1 *DTDs and XML Schema*
 - 4.7.2 *XSL(eXtensible Style Language)*
 - 4.7.3 *XML Query Languages*
 - 4.7.4 *XLink, XPointer*
 - 4.7.5 *How XML Works: XML Data Validation*
- 4.8 CLIENT VERSUS SERVER SIDE XML PROCESSING AND XSL
 - 4.8.1 *Overview*
 - 4.8.2 *Client Side Processing:*
 - 4.8.3 *Server Side Processing*
- 4.9 HANDLING XML DATA BY USING DATABASES
 - 4.9.1 *Using Relational Databases -Mapping between XML and Relational Databases*
 - 4.9.2 *Data Storage in Native XML format*
 - 4.9.3 *General Comments*
- 4.10 SOURCES OF ADDITIONAL INFORMATION

5 DISTRIBUTED OBJECT TECHNOLOGIES (CORBA AND DCOM) -- [A CLOSER LOOK](#)

5.1 DISTRIBUTED OBJECT TECHNOLOGIES OVERVIEW

- 5.1.1 *Concepts*
- 5.1.2 *Distributed Objects: From CORBA/DCOM to Web Services and J2EE*
- 5.1.3 *Interface Definition Languages (IDLs)*
- 5.1.4 *Components, Business Objects, and Object Frameworks*

5.2 COMMON OBJECT REQUEST BROKER ARCHITECTURE (CORBA)

- 5.2.1 *Object Management Architecture*
- 5.2.2 *Basic CORBA Concepts*
- 5.2.3 *CORBA Facilities*
- 5.2.4 *Using CORBA – An Example*
- 5.2.5 *Combining CORBA with Web and XML*
- 5.2.6 *CORBA 3.0*
- 5.2.7 *CORBA Summary*

5.3 MICROSOFT'S DCOM (DISTRIBUTED COMPONENT OBJECT MODEL)

- 5.3.1 *Overview*
- 5.3.2 *DCOM (Distributed Component Object Model) as an ORB*
- 5.3.3 *Web Browsers as Containers of ActiveX Components*
- 5.3.4 *ActiveX Controls -- Building Downloadable Web-based Components*
- 5.3.5 *ActiveX Server*
- 5.3.6 *General Observations and Comments*

5.4 CORBA 3.0 -- THE LATEST CORBA

- 5.4.1 *Evolution of CORBA*
- 5.4.2 *Locating CORBA Objects – The IOR (Interoperable Object Reference)*
- 5.4.3 *Object Adapters and POA (Portable Object Adapters)*
- 5.4.4 *Objects by Value*
- 5.4.5 *CORBA Messaging - Asynchronous Messaging and Quality of Service Control*
- 5.4.6 *Minimum, Fault-Tolerant, and Real-Time CORBA – More Quality of service control*
- 5.4.7 *Event/Notification Services*
- 5.4.8 *Internet integration*
- 5.4.9 *Inter-ORB Architecture (GIOP and IIOP)*
- 5.4.10 *CORBAComponents Package*
- 5.4.11 *CORBA Scripting*
- 5.4.12 *CORBA 3.0: Conclusions*
- 5.4.13 *Other OMG Activities*

5.5 CORBA OPERABILITY (PERFORMANCE, SCALABILITY, FAULT TOLERANCE) AND SUMMARY

- 5.5.1 *CORBA Reality Check -- Operability (Performance, Scalability, Fault Tolerance) Issues*
- 5.5.2 *CORBA Summary*

5.6 A DETAILED CORBA EXAMPLE

- 5.6.1 *Overview*
- 5.6.2 *Create CORBA Definitions*
- 5.6.3 *Build the Server*
- 5.6.4 *Build Client (Static Invocation)*
- 5.6.5 *Building a Client (Dynamic Invocation)*

5.7 SUMMARY

INDEX