Systems Analysis and Design With UML 2.0

An Object-Oriented Approach, Second Edition

Chapter 13: Physical Architecture Layer Design

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Physical Architecture Layer Design

Chapter 13

Objectives

- Understand the different physical architecture components.
- Understand server-based, client-based, and client server physical architectures.
- Be familiar with distributed objects computing.
- Be able to create a network model using a deployment diagram.
- Understand how operational, performance, security, cultural, and political requirements affect the design of the physical architecture layer.
- Be familiar with how to create a hardware and software specification.

Physical Architecture

- Software Components
  - Data Storage
  - Data Access Logic
  - Application logic
  - Presentation logic
- Hardware Components
  - Client computers
  - Servers
  - Connecting network

Server Based Architecture

- Client is a terminal
- Server has functions of
  - Presentation logic
  - Application logic
  - Data access logic
  - Data storage

Server Based Architecture

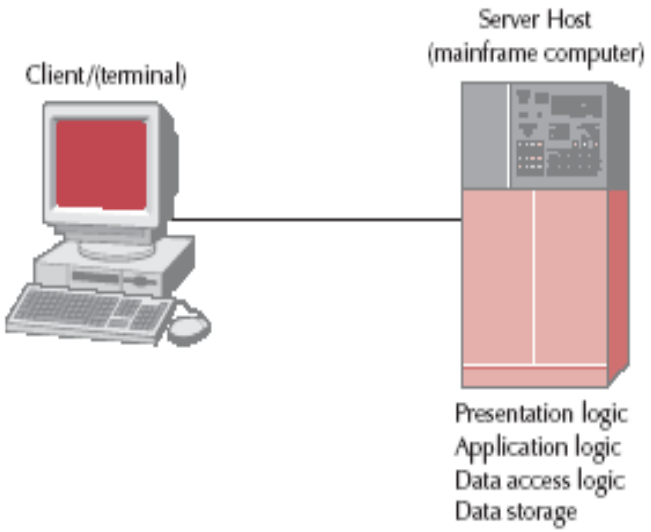

FIGURE 13-1
Server-Based
Architecture

Client-Server Architectures

- Thin Client/Fat Server
  - Client is little more than a terminal
  - Server handles all processing
- Fat Client/Thin Server
  - Client does all processing
  - Server may just store data

Thick Client

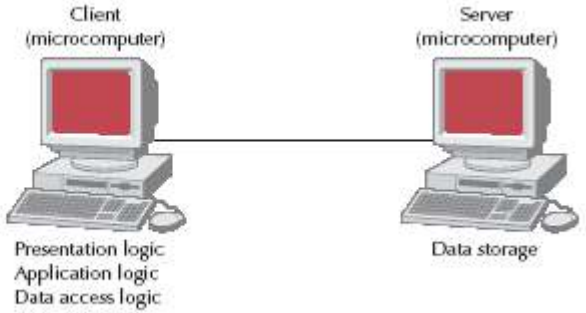

FIGURE 13-2
Client-based Architectures

Server has Data

2-Tiered Architecture

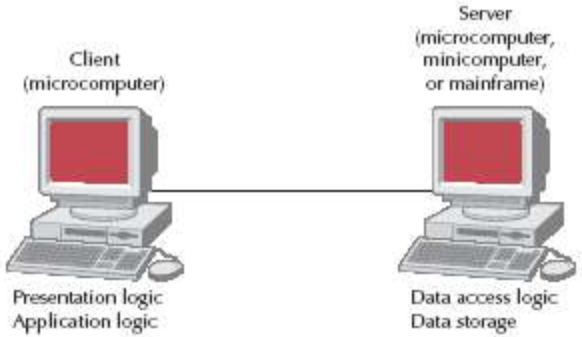

FIGURE 13-3
Client-Server Architecture

Client has Presentation Logic

3-tiered Architecture

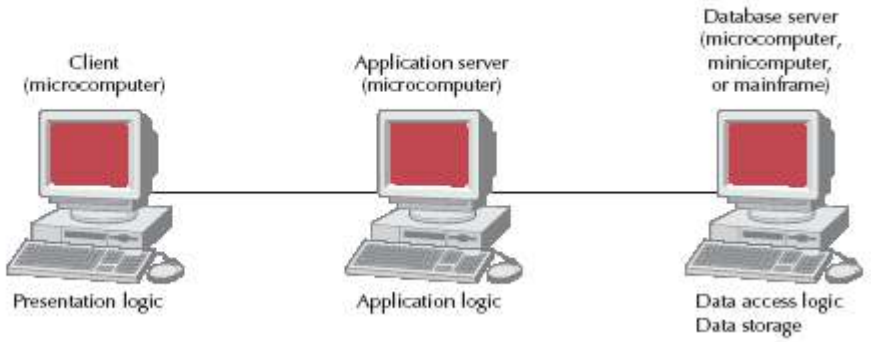

FIGURE 13-4
A Three-Tier Client-Server Architecture

N-tiered Architecture

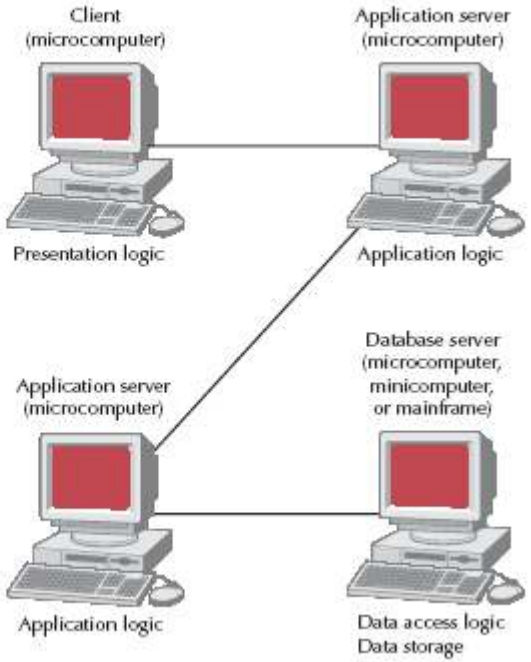

FIGURE 13-5
A Four-Tier Client–Server Architecture

Client-Server Benefits

- Scalable
- Support multiple clients and servers
- Using Internet Standards Presentation logic can be separated
- Multiple servers make for a generally more reliable network

Middleware

- *Middleware* is a type of system software designed to translate between different vendors' software.
- Middleware is installed on both the client computer and the server computer.
- The client software communicates with the middleware that can reformat the message into a standard language that can be understood by the middleware that assists the server software

Client-Server Limitations

- Complexity
- Updating the network computers is more complex

Distributed Objects Computing

- This is commonly called middleware
- DOC allows the developer to simply concentrate on the users, objects, and methods of an application instead of worrying about which
- server contains which set of objects. The client object simply requests the “network” to locate and execute the server object’s method.

Competing Approaches

- Object Management Group
  - *Common Object Request Broker Architecture (CORBA)*
- Sun
  - *Enterprise JavaBeans (EJB)*
  - *Java 2 Enterprise Edition (J2EE)*
- Microsoft
  - *Distributed Component Object Model (DCOM)*
  - *.net* initiative

Selecting a Physical Architecture

- Cost of Infrastructure
- Cost of Development
- Ease of Development
- Interface Capabilities
- Control and Security
- Scalability

Characteristics

FIGURE 13-6
Characteristics of Computing Architectures

	Server-Based	Client-Based	Client–Server
Cost of infrastructure	Very high	Medium	Low
Cost of development	Medium	Low	High
Ease of development	Low	High	Low–medium
Interface capabilities	Low	High	High
Control and security	High	Low	Medium
Scalability	Low	Medium	High

Deployment Diagram Components

- Nodes
  - Any piece of hardware in the model
- Artifacts
  - Piece of the information system such as software component, database table, …
- Communication paths
  - Links between nodes of the network

Deployment Diagram

A Node: ■ Is a computational resource, e.g., a client computer, server, separate network, or individual network device ■ Is labeled by its name ■ May contain a stereotype to specifically label the type of node being represented, e.g., device, client workstation, application server, mobile device, etc.	
An Artifact: ■ Is a specification of a piece of software or database, e.g., a database or a table or view of a database, a software component or layer ■ Is labeled by its name ■ May contain a stereotype to specifically label the type of artifact, e.g., source file, database table, executable file, etc.	

Deployment Diagram (cont.)

A Node with a Deployed Artifact: ■ Portrays an artifact being placed on a physical node ■ Supports modeling the distribution of the software over a network	
A Communication Path: ■ Represents an association between two nodes ■ Allows nodes to exchange messages ■ May contain a stereotype to specifically label the type of communication path being represented, e.g., lan, Internet, serial, parallel, etc.	

Diagram Examples

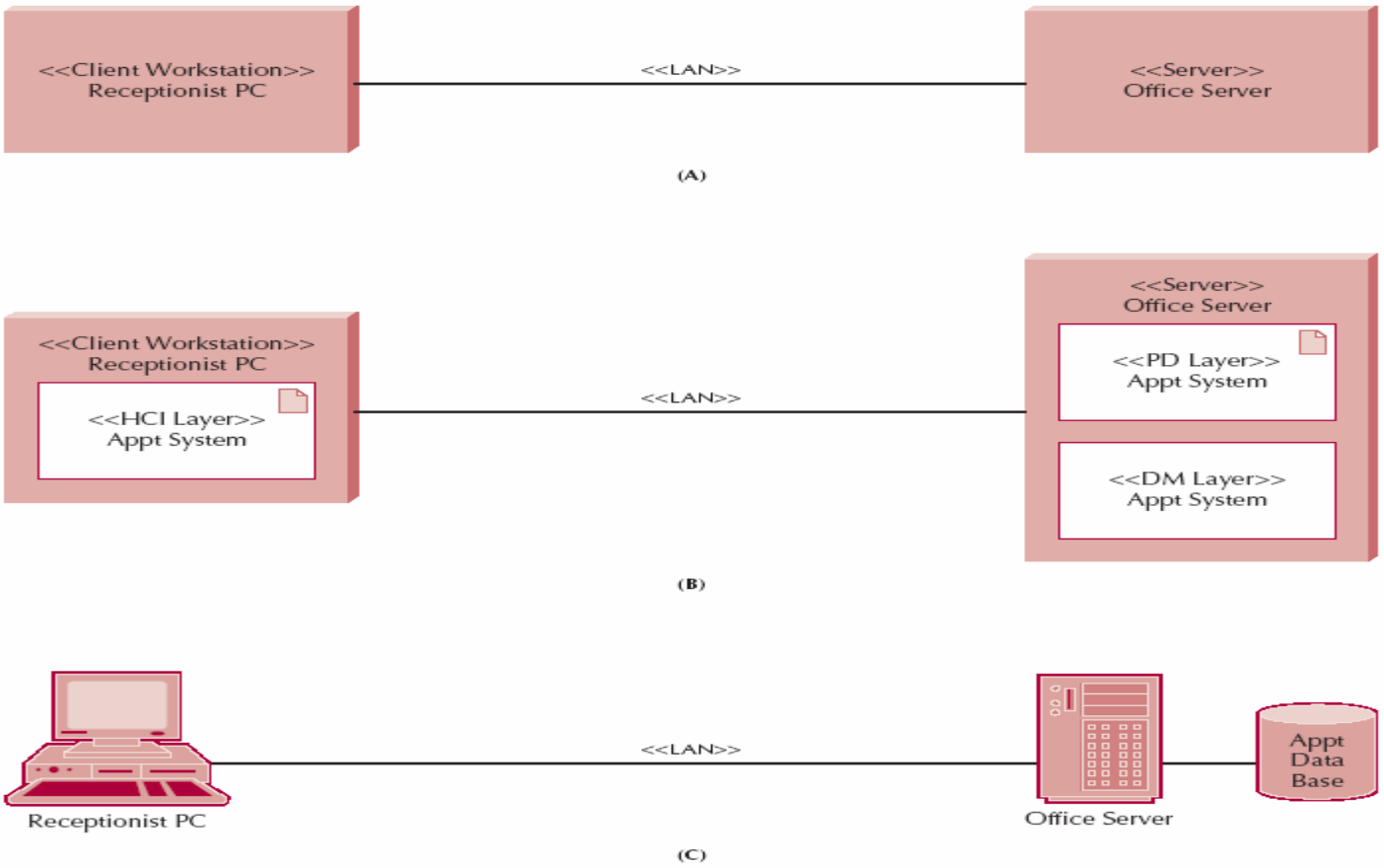

FIGURE 13-9 Three Versions of Appointment System Deployment Diagram

The Network Model

- The *network model* is a diagram that shows the major components of the information system (e.g., servers, communication lines, networks) and their geographic locations throughout the organization.

Network Model Example

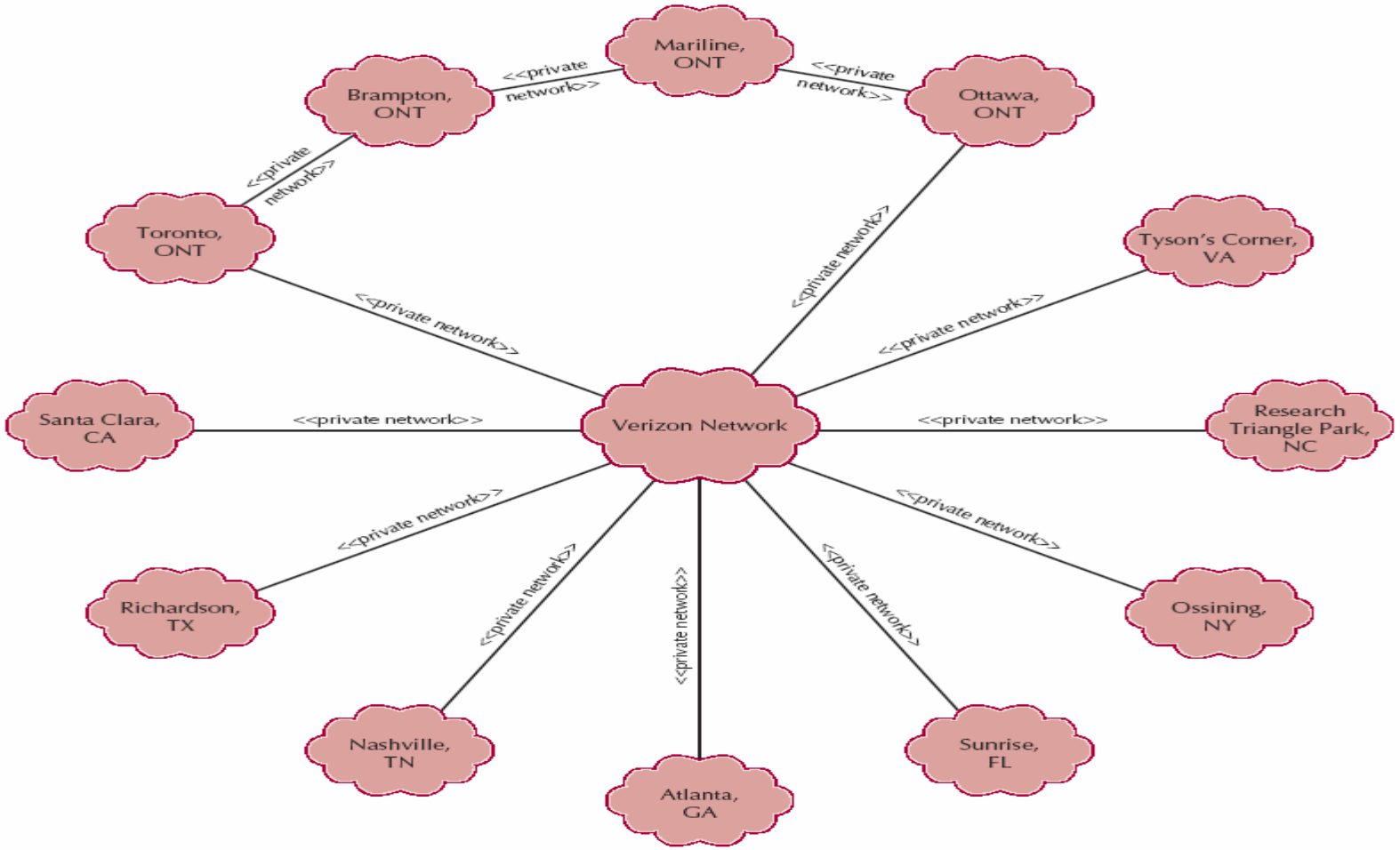

FIGURE 13-10 Deployment Diagram Representation of a Top-Level Network Model

NonFunctional Requirements

- Operational
  - Specify the operating environment
- Technical Environment
  - Type of hardware and software
- System Integration
  - Interaction with other systems
- Portability
  - Response to changing environments
- Maintainability
  - Expected business requirement changes

Performance Requirements

- Speed
  - Response time of the system
  - Transaction update time
- Capacity
  - Number of users
  - Volume of data
- Availability and Reliability
  - Specify available times
  - Permissible failure rate
- Security
  - Protect from disruption and data loss

Security

Type of Requirement	Definition	Examples
System Value Estimates	Estimated business value of the system and its data	• The system is not mission critical but a system outage is estimated to cost $50,000 per hour in lost revenue. • A complete loss of all system data is estimated to cost $20 million.
Access Control Requirements	Limitations on who can access what data	• Only department managers will be able to change inventory items within their own department. • Telephone operators will be able to read and create items in the customer file, but cannot change or delete items.
Encryption and Authentication Requirements	Defines what data will be encrypted where and whether authentication will be needed for user access	• Data will be encrypted from the user's computer to the Web site to provide secure ordering. • Users logging in from outside the office will be required to authenticate.
Virus Control Requirements	Requirements to control the spread of viruses	• All uploaded files will be checked for viruses before being saved in the system.

FIGURE 13-14 Security Requirements

Cultural and Political

- Multilingual
- Customization
- Making unstated norms explicit
- Legal requirements

Cultural and Political Rqrts.

Type of Requirement	Definition	Examples
Multilingual Requirements	The language in which the system will need to operate	• The system will operate in English, French, and Spanish.
Customization Requirements	Specification of what aspects of the system can be changed by local users	• Country managers will be able to define new fields in the product database to capture country-specific information. • Country managers will be able to change the format of the telephone number field in the customer database.
Making Unstated Norms Explicit	Explicitly stating assumptions that differ from country to country	• All date fields will be explicitly identified as using the month-day-year format. • All weight fields will be explicitly identified as being stated in kilograms.
Legal Requirements	The laws and regulations that impose requirements on the system	• Personal information about customers cannot be transferred out of European Union countries into the United States. • It is against U.S. federal law to divulge information on who rented what videotape, so access to a customer's rental history is permitted only to regional managers.

FIGURE 13-15 Cultural and Political Requirements

Synopsis

Requirements	Server-Based	Client-Based	Thin Client–Server	Thick Client–Server
Operational Requirements				
System Integration Requirements	✓		✓	✓
Portability Requirements			✓	
Maintainability Requirements	✓		✓	
Performance Requirements				
Speed Requirements			✓	✓
Capacity Requirements			✓	✓
Availability/Reliability Requirements	✓		✓	✓
Security Requirements				
High System Value	✓		✓	
Access Control Requirements	✓			
Encryption/Authentication Requirements			✓	✓
Virus Control Requirements	✓			
Cultural/Political Requirements				
Multilingual Requirements			✓	
Customization Requirements			✓	
Making Unstated Norms Explicit			✓	
Legal Requirements	✓		✓	✓

FIGURE 13-16
Nonfunctional Requirements and Their Implications for Architecture Design

Sample Specifications

	Standard Client	Standard Web Server	Standard Application Server	Standard Database Server
Operating System	• Windows • Netscape	• Linux	• Linux	• Linux
Special Software	• Adobe Acrobat Reader • Read Audio	• Apache	• Java	• Oracle
Hardware	• 40 gig disk drive • Pentium • 17 inch Monitor	• 80 gig disk drive • Pentium	• 80 gig disk drive • Pentium	• 200 gig disk drive • RAID • Quad Pentium
Network	• Always-on Broadband preferred • Dial-up at 56Kbps possible with some performance loss	• Dual 100 Mbps Ethernet	• Dual 100 Mbps Ethernet	• Dual 100 Mbps Ethernet

FIGURE 13-17 Sample Hardware and Software Specification

CD System –Op. Rqrts.

1. Operational Requirements		
Technical Environment	1.1	The system will work over the Web environment with Netscape and real audio.
	1.2	Customers will only need Netscape and RA on their desktops.
System Integration	1.3	The Internet sales system will read information from the main CD information database, which contains basic information about the CD (e.g., title, artist, id number, price, quantity in inventory). The Internet order system will not write information to the main CD information database.
	1.4	The Internet sales system will transmit orders for new CDs in the special order system, and will rely on the special order system to complete the special orders generated.
	1.5	The Internet sales system will read and write to the main inventory database.
	1.6	A new module for the In-store system will be written to manage the "holds" generated by the Internet system. The requirements for this new module will be documented as part of the Internet sales system because they are necessary for the Internet sales system to function.
	1.7	A new module will be written to handle the mail order sales. The requirements for this new module will be documented as part of the Internet sales system because they are necessary for the Internet sales system to function.
Portability	1.8	The system will need to remain current with evolving Web standards, especially those pertaining to music formats.
Maintainability	1.9	No special maintainability requirements are anticipated.

CD Systems - Performance

2. Performance Requirements

Speed	2.1	Response times must be less than 7 seconds.
	2.2	The inventory database must be updated in real time.
	2.3	In-store holds must be sent to the store within 5 minutes.
Capacity	2.4	There will be a maximum of 20–50 simultaneous users at peak use times.
	2.5	The system will support streaming audio to up to forty simultaneous users.
	2.6	The system will send up to 5K of data to each store daily.
	2.7	The in-store hold database will require 10–20K of disk space per store.
Availability and Reliability	2.8	The system should be available 24/7.
	2.9	The system shall have 99 percent uptime performance.

CD Systems – Security/Cultural

3. Security Requirements		
System Value	3.1	No special system value requirements are anticipated.
Access Control	3.2	Only store managers will be able to override In-Store Holds.
Encryption/Authentication	3.3	No special encryption/authentication requirements are anticipated.
Virus Control	3.4	No special virus control requirements are anticipated.
4. Cultural and Political Requirements		
Multilingual	4.1	No special multilingual requirements are anticipated.
Customization	4.2	No special customization requirements are anticipated.
Unstated Norms	4.3	No special unstated norms requirements are anticipated.
Legal	4.4	No special legal requirements are anticipated.

Summary

- Physical Architecture Layer
  - Choose server vs. client-server
  - Middleware
  - Assess strengths and weaknesses
- Infrastructure design
  - Various clients
  - Network equipment
- Nonfunctional Requirements
  - Operational
  - Performance
  - Security
- Hardware and software specification