

Chapter 8. Architecture Design



- Elements of an architecture design.
- Creating an architecture design.
- Hardware and software specification.

- **Architecture design**
 - Plans for how the system will be distributed across multiple computers and what hardware, operating system software, and application software will be used for each computer.
- Key factors in architecture design
 - Nonfunctional requirements developed early in the analysis phase play a key role in architecture design.
- **Hardware and software specification**
 - Defines what hardware and software are needed for the new system.

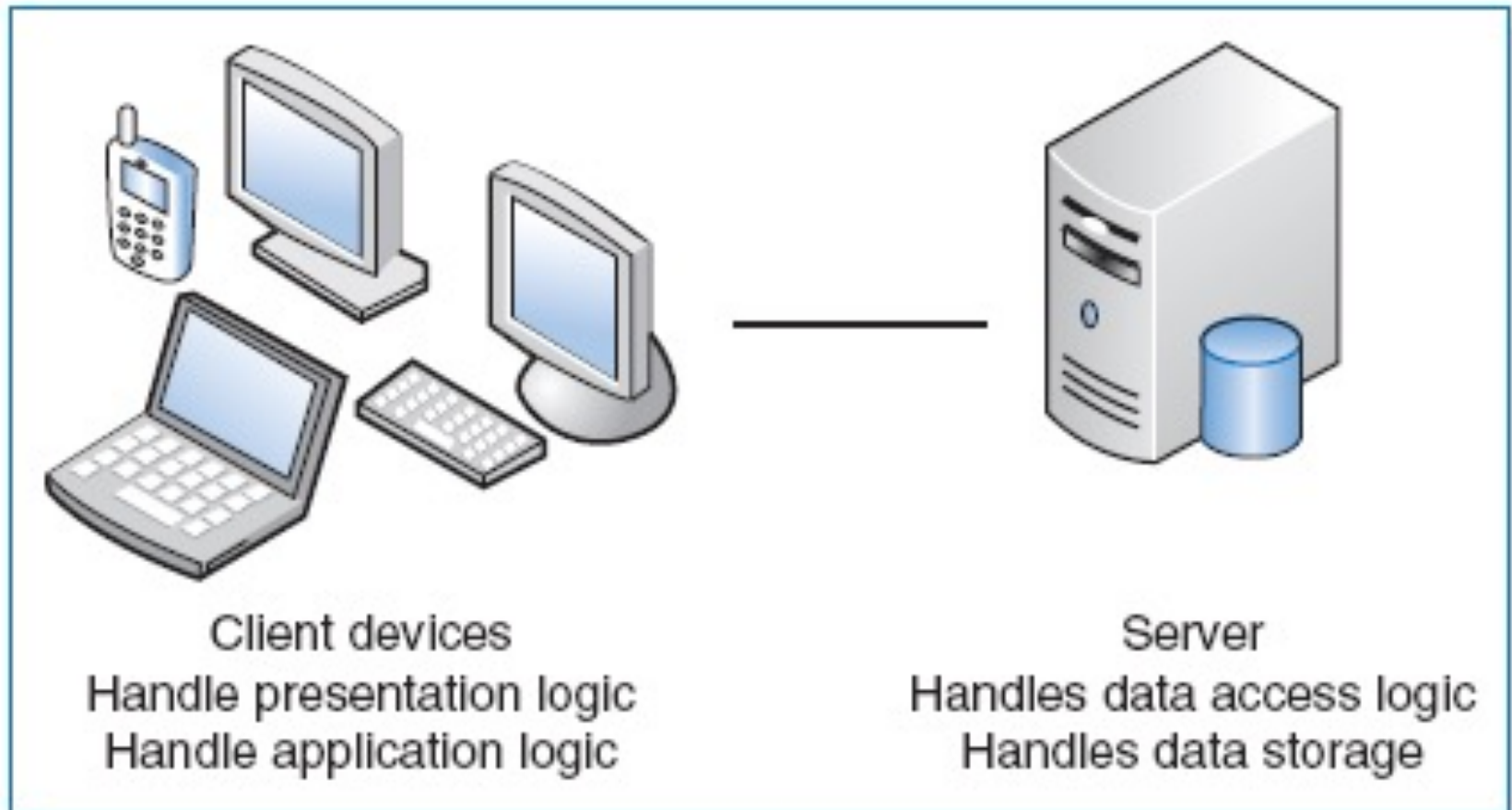
ELEMENTS OF AN ARCHITECTURE DESIGN

- The objective of **architecture design** is to determine how the software components of the information system will be assigned to the hardware devices of the system.

- The major **architectural components** of any system are the software and the hardware.
- All software systems can be divided into four basic **functions**:
 - *Data storage*.
 - *Data access logic*: the processing required to access stored data.
 - *Application logic*: the logic documented in the DFDs, use cases, and functional requirements.
 - *Presentation logic*: the display of information to the user and the acceptance of the user's commands.

- The three primary hardware components:
 - ***Client computers***: Input-output devices employed by users (e.g., PCs, laptops, handheld devices, smart phones)
 - ***Servers***: Larger multi-user computers used to store software and data.
 - The ***network***: Connects the computers.

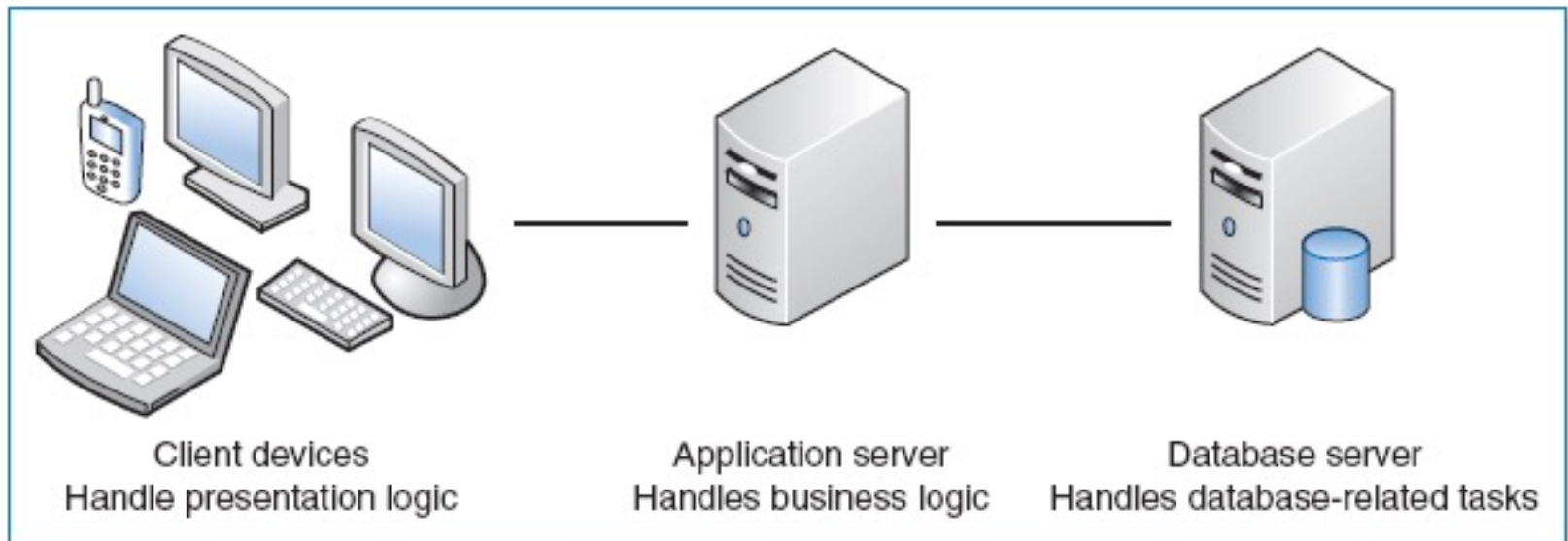
- ***Client-server architectures*** balance the processing between client devices and one or more server devices.
- The client is responsible for the presentation logic, whereas the server is responsible for the data access logic and data storage.
- A ***thick*** or ***fat client*** contains all or most of application logic; whereas a ***thin client*** contains a small portion of the application logic.



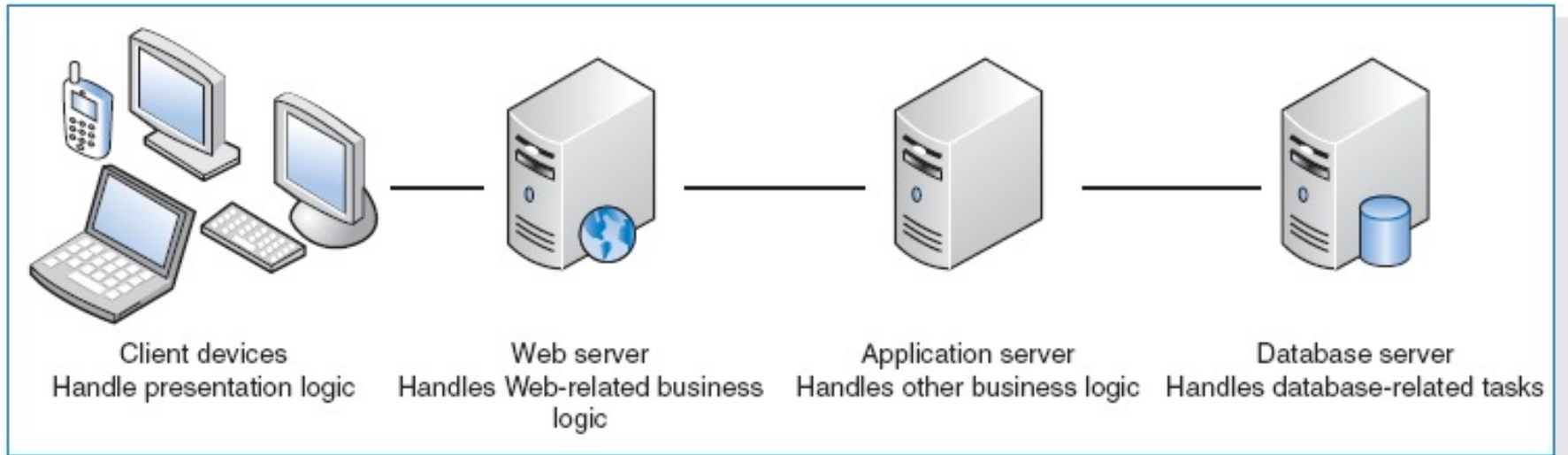
- Client-server architectures have four important benefits.
 - **Scalable**
 - Can support different types of clients and servers through **middleware**.
 - The presentation logic, the application logic, and the data processing logic can be independent.
 - If a server fails, only the applications requiring that server are affected.
- The major limitation of client-server architectures is their complexity.

- There are many ways in which the application logic can be partitioned between the client and the server.
- The arrangement in Figure 8-1 is called ***two-tiered*** architecture.

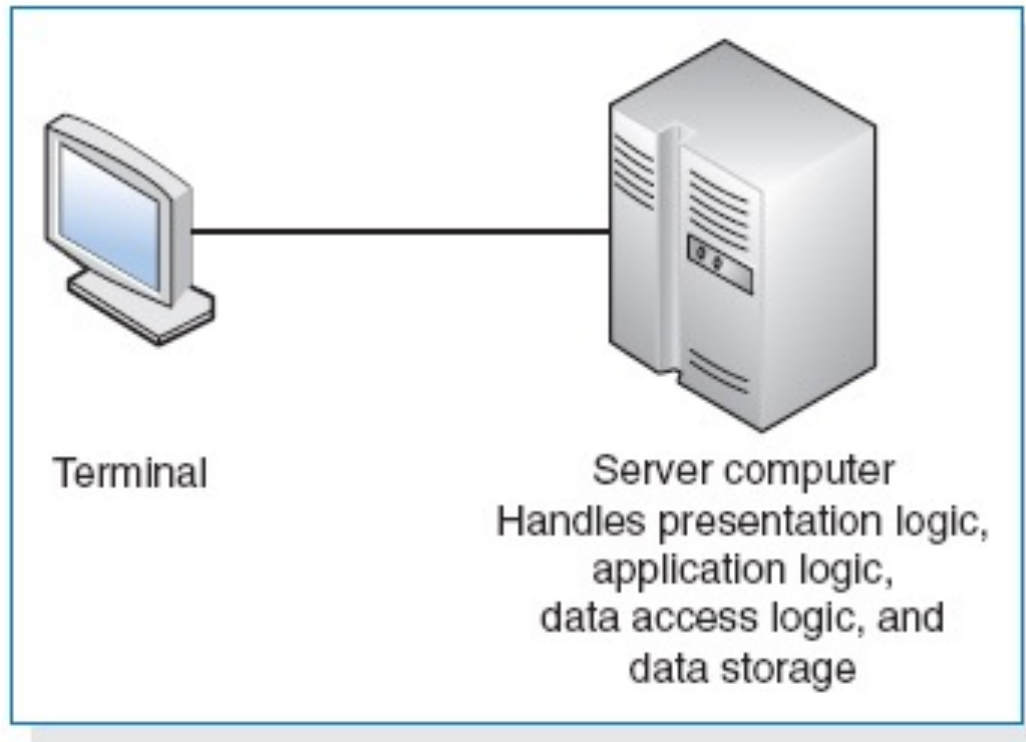
- ***Three-tiered architecture***



- ***n-tiered architecture***



Server-Based Architectures



Client-Based Architectures



Client computer
Handles presentation logic,
application logic, and
data access logic



Server computer
Handles data
storage

- Advances in hardware, software, and networking have given rise to a number of new architecture options.
 - ***Virtualization.***
 - ***Cloud computing.***

- ***Virtualization*** refers to a creation of a virtual device or resource, such as a server or storage device.
- ***Server virtualization*** involves partitioning a physical server into smaller virtual servers.
- ***Storage virtualization*** involves combining multiple network storage devices into what appears to be single storage unit.

- **Cloud computing** – everything from computing power to computing infrastructure, applications, business processes to personal collaboration can be delivered as a service wherever and whenever needed.
- The “**cloud**” can be defined as the set of hardware, networks, storages, devices, and interfaces that combine to deliver aspects of computing as a service.

- Cloud computing can be implemented in three ways:
 - private cloud,
 - public cloud, and
 - hybrid cloud.
- At this time, cloud computing is in its early stage of development.

- Advantages of cloud computing
 1. The resources allocated can be increased or decreased based on demand.
 2. Cloud customers can obtain cloud resources in a straightforward fashion.
 3. Cloud services typically have standardized ***APIs (application program interfaces)***.
 4. The cloud computing model enables customers to be billed for resources as they are used.

Comparing Architecture Options

- Most systems are built to use the existing infrastructure in the organization, so often the current infrastructure restricts the choice of architecture.
- Each of the architectures discussed has its strengths and weaknesses.
- Client-server architectures are strongly favored on the basis of the cost of infrastructure.

- Creating an architecture design begins with the nonfunctional requirements.
- Refine the nonfunctional requirements into more detailed requirements for the selection of architecture.
- The nonfunctional requirements and the architecture design are used to develop the hardware and software specification.

Operational Requirements

Type of Requirement	Definition	Examples
Technical Environment Requirements	Special hardware, software, and network requirements imposed by business requirements	<ul style="list-style-type: none"> The system will work over the Web environment with Internet Explorer. All office locations will have an always-on network connection to enable real-time database updates. A version of the system will be provided for customers connecting over the Internet via a small-screen smartphone.
System Integration Requirements	The extent to which the system will operate with other systems	<ul style="list-style-type: none"> The system must be able to import and export Excel spreadsheets. The system will read and write to the main inventory database in the inventory system.
Portability Requirements	The extent to which the system will need to operate in other environments	<ul style="list-style-type: none"> The system must be able to work with different operating systems (i.e., Linux; Windows 7). The system may need to operate with handheld devices such as an iPad.
Maintainability Requirements	Expected business changes to which the system should be able to adapt	<ul style="list-style-type: none"> The system will be able to support more than one manufacturing plant upon six months advance notice. New versions of the system will be released every six months.

FIGURE 8-6
Operational Requirements

Performance Requirements

Type of Requirement	Definition	Examples
Speed Requirements	The time within which the system must perform its functions	<ul style="list-style-type: none"> • Response time must be less than 7 seconds for any transaction over the network. • The inventory database must be updated in real time. • Orders will be transmitted to the factory floor every 30 minutes.
Capacity Requirements	The total and peak number of users and the volume of data expected	<ul style="list-style-type: none"> • There will be a maximum of 200 simultaneous users at peak use times. • A typical transaction will require the transmission of 10K of data. • The system will store data on approximately 5,000 customers for a total of about 2 MB of data.
Availability and Reliability Requirements	The extent to which the system will be available to the users and the permissible failure rate due to errors.	<ul style="list-style-type: none"> • The system should be available 24 x 7, with the exception of scheduled maintenance. • Scheduled maintenance shall not exceed one 6-hour period each month. • The system will have 99% uptime performance.

Security Requirements

Type of Requirement	Definition	Examples
System Value Estimates	Estimated business value of the system and its data	<ul style="list-style-type: none"> The system is not mission critical, but a system outage is estimated to cost \$150,000 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	<ul style="list-style-type: none"> Only department managers will be able to change inventory items within their own department. Customer Service personnel 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	<ul style="list-style-type: none"> 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	Controls the spread of viruses	<ul style="list-style-type: none"> All uploaded files will be checked for viruses before being saved in the system.

FIGURE 8-8
Security Requirements

Cultural and Political Requirements

Type of Requirement	Definition	Examples
Multilingual Requirements	The language in which the system will need to operate	<ul style="list-style-type: none"> • The system will operate in English, French, and Spanish.
Customization Requirements	Specification of what aspects of the system can be changed by local users	<ul style="list-style-type: none"> • Country managers will be able to define new fields in the product database in order 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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.

- In many cases, the technical environment requirements as driven by the business requirements define the application architecture.
- If the technical environment requirements do not require the choice of a specific architecture, then other nonfunctional requirements become important for designing the architecture.

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	✓		✓	✓

HARDWARE AND SOFTWARE SPECIFICATION

- The design phase is also the time to begin selecting and acquiring the hardware and software that will be needed for the future system.
- The ***hardware and software specification*** is a document that describes what hardware and software are needed to support the application.

• Sample hardware and software specification

	Standard Client	Standard Web Server	Standard Application Server	Standard Database Server
Operating System	<ul style="list-style-type: none"> • Windows • Mozilla 	<ul style="list-style-type: none"> • Linux 	<ul style="list-style-type: none"> • Linux 	<ul style="list-style-type: none"> • Linux
Special Software	<ul style="list-style-type: none"> • Real Audio • Adobe Acrobat Reader 	<ul style="list-style-type: none"> • Apache 	<ul style="list-style-type: none"> • Java 	<ul style="list-style-type: none"> • Oracle
Hardware	<ul style="list-style-type: none"> • 250-GB disk drive • Intel®Core™ i3-2100 dual core processor • 19-inch LCD Monitor 	<ul style="list-style-type: none"> • 500-GB disk drive • Dual-core Xeon 	<ul style="list-style-type: none"> • 160-GB disk drive • Quad-core Xeon 	<ul style="list-style-type: none"> • 1-TB disk drive • RAID
Network	<ul style="list-style-type: none"> • Always-on Broadband, preferred • Dial-up at 56 Kbps, possible with some performance loss 	<ul style="list-style-type: none"> • Dual 100 Mbps Ethernet 	<ul style="list-style-type: none"> • Dual 100 Mbps Ethernet 	<ul style="list-style-type: none"> • Quad core Xeon • Dual 100 Mbps Ethernet

FIGURE 8-11

Sample Hardware and Software Specification

- First, you define software
 - Define the operating system and any special purpose software
 - Consider additional costs such as training, warranty, maintenance, licensing agreements.
- Next, you create a list of the hardware needed
 - Database servers, network servers, peripheral devices, clients, backup devices, storage components, and others.
- Finally, you describe the minimum requirements for each piece of hardware.

- Factors in hardware and software

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1. **Functions and Features** What specific functions and features are needed (e.g., size of monitor, software features)
2. **Performance** How fast the hardware and software operates (e.g., processor, number of database writes per second)
3. **Legacy Databases and Systems** How well the hardware and software interacts with legacy systems (e.g., can it write to this database)
4. **Hardware and OS Strategy** What are the future migration plans (e.g., the goal is to have all of one vendor's equipment)
5. **Cost of Ownership** What are the costs beyond purchase (e.g., incremental license costs, annual maintenance, training costs, salary costs)
6. **Political Preferences** People are creatures of habit and are resistant to change, so changes should be minimized
7. **Vendor Performance** Some vendors have reputations or future prospects that are different from those of a specific hardware or software system they currently sell

- Application architecture.
 - Client-server architecture.
 - Advances in architecture configurations: virtualization and cloud computing.
- Architecture Design.
 - Nonfunctional requirements.
- Hardware and software specification.
 - A document that describes what hardware and software are needed to support the application.