Vietnam National University of HCMC

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Web Application Development (IT093IU)

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Lecture 4: J2EE Framework

- Date: March 07th, 2024
- Content: Introduction to J2EE Framework
- Refer:
  - Java EE Web Application Primer - Building Bullhorn - A Messaging App with JSP, Servlets, JavaScript, Bootstrap and Oracle 2017
  - Prem Kumar Karunakaran - Introducing Play Framework - Java Web Application Development 2020
  - https://www.oracle.com/java/technologies/jee-tutorials.html

Objectives

- Understanding the value propositions of J2EE
- Getting a big picture of J2EE architecture and platform
- Getting high-level exposure of APIs and Technologies that constitute J2EE
  - No need to understand all the details
- Understanding why J2EE can be used for as a platform for development and deployment of web services

Agenda

- Introduction to J2EE
- J2EE Framework
- Support to J2EE of big software vendors
- Software Architectures
- Features and Concepts in J2EE
- Sample J2EE Architectures
- Extend to other frameworks: PHP, .Net, NodeJS, etc.

Enterprise Computing

Challenges

Portability

Diverse Environments

Time-to-market

Core Competence

Assembly

Integration

Key Technologies

J2SE™

J2EE™

- JMS
- Servlet
- JSP
- Connector

XML

- Data Binding
- XSLT

Products

App Servers

Web Servers

Components

Databases

Object to DB tools

Legacy Systems

Databases

TP Monitors

EIS Systems

J2SE: Java Second Standard Edition

JMS: Java Messages Service

TP Monitors: Transaction Processing Monitors

EIS: Execute Information System

XSLT: Extensible Stylesheet Languages Transformations

What Is J2EE?

- Say simply: Java 2 Platform Enterprise Edition (J2EE) is:
  - a suite of *specifications* for application programming interfaces
  - a distributed computing architecture
  - definitions for packaging of distributable components for deployment.
- It's a collection of standardized **components, containers**, and **services** for creating and deploying distributed applications within a well-defined distributed computing architecture.

What Is J2EE?

- Open and standard based platform for
  - developing, deploying and managing
  - n-tier, Web-enabled, server-centric, and component-based enterprise applications

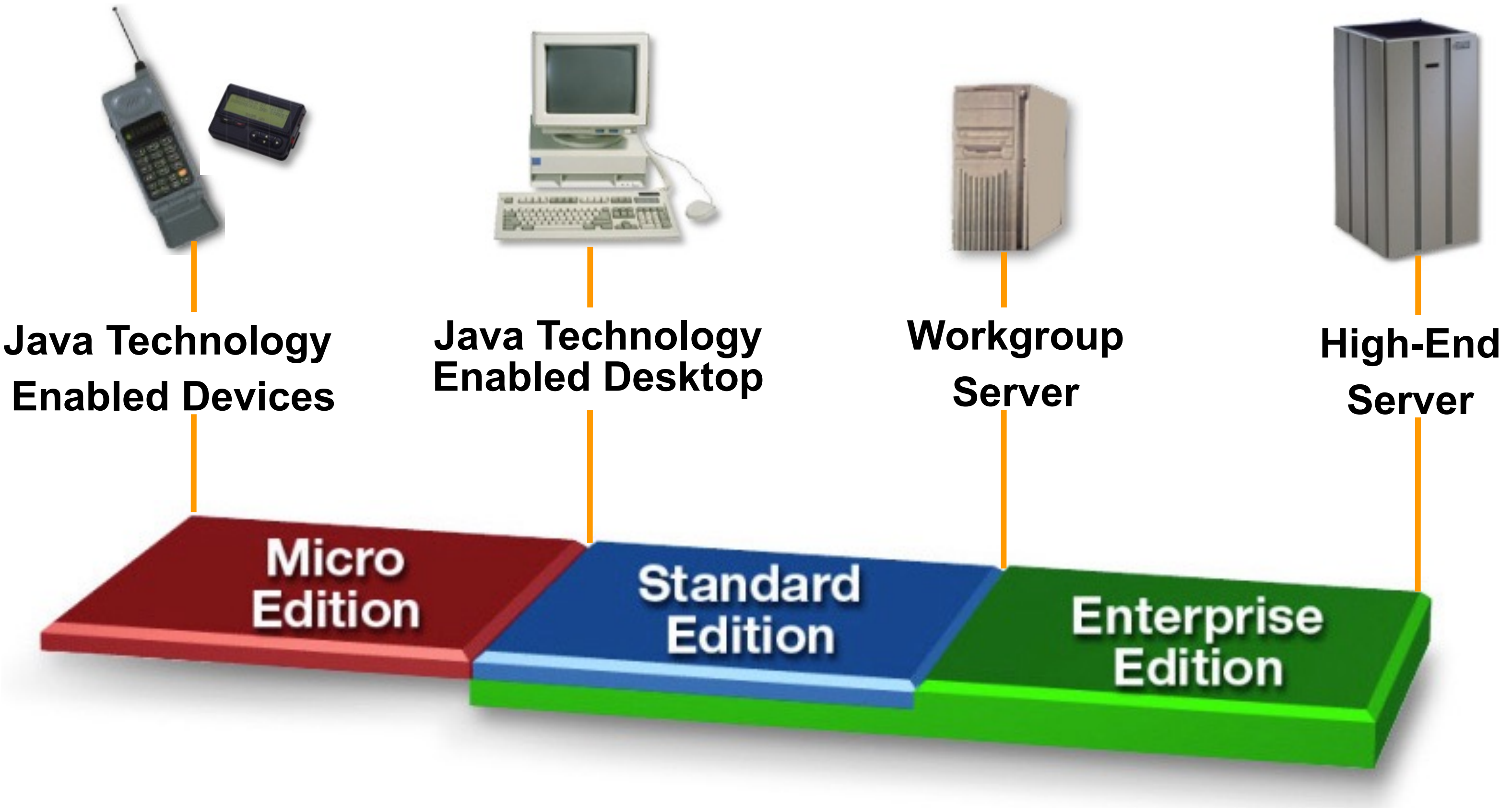
In short:

J2EE is an open, standard-based, development and deployment platform for building n-tier, web-based and server-centric, and component-based enterprise applications.

What does J2EE comprise?

- Java Servlets
- Java Server Pages (JSP)
- Enterprise JavaBeans (EJB)
- Java Message Service (JMS)
- Java Naming and Directory Interface (JNDI)
- Java Database Connectivity (JDBC)
- Java Mail
- Java Transaction Service (JTS)
- Java Transaction API (JTA)
- J2EE Connector Architecture (J2EE-CA, or JCA)

The Java™ Platform



Java Technology Enabled Devices

Java Technology Enabled Desktop

Workgroup Server

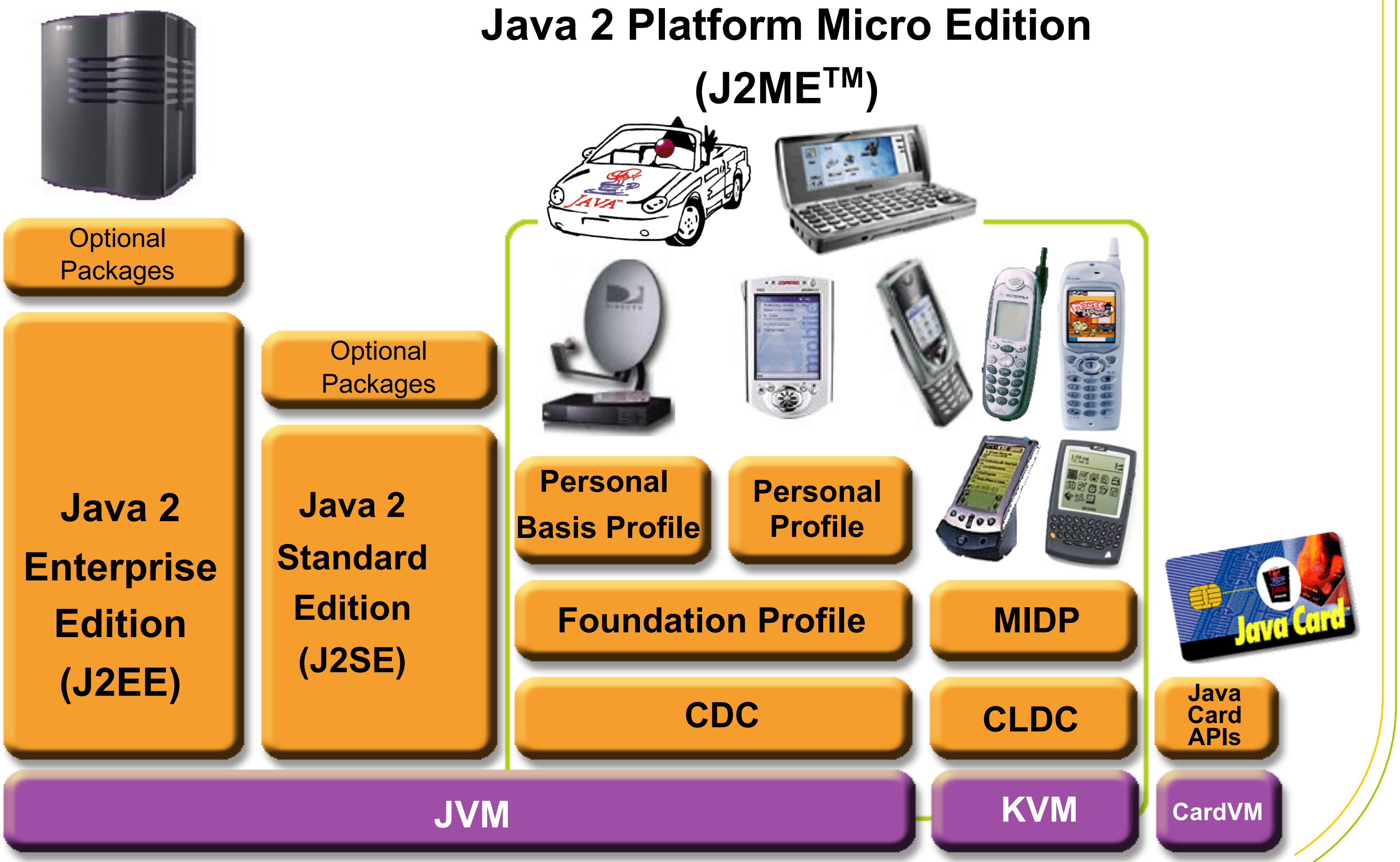
High-End Server

Micro Edition

Standard Edition

Enterprise Edition

The Java™ Platform



Java 2 Platform Micro Edition (J2ME™)

Optional Packages

Java 2 Enterprise Edition (J2EE)

Optional Packages

Java 2 Standard Edition (J2SE)

Personal Basis Profile

Personal Profile

Foundation Profile

MIDP

CDC

CLDC

Java Card APIs

JVM

KVM

CardVM

What Makes Up J2EE?

- API and Technology specifications
- Development and Deployment Platform
- Standard and production-quality implementation
- Compatibility Test Suite (CTS)
- J2EE brand
- J2EE Blueprints
- Sample codes

Open and Standard Solution

- Use “component and container” model in which container provides system services in a well-defined and as industry standard

- J2EE is the standard that also provides portability of code because it is based on Java technology and standard-based Java programming APIs

When using J2EE?

- J2EE targets at **large-scale** business systems
- The software in the J2EE framework needs to be partitioned into functional pieces and deployed on the appropriate hardware platforms to provide the necessary computing power
- J2EE provides:
  - a collection of standardized components that facilitate software deployment
  - standard interfaces that define how the various software modules interconnect
  - standard services that define how the different software modules communicate.

Relate to J2SE

- J2SE (Java 2 Standard Edition) is the **core** upon which J2EE is based
- Use J2SE components and APIs in conjunction with the J2EE components and APIs to build your applications

Why using J2EE?

J2EE:

- Define a number of essential services to develop enterprise-class applications
- Provide infrastructure required to write enterprise-class applications: there are a bunch of different system-level capabilities to write distributed applications that are scalable, robust, secure, and maintainable
- Define a set of containers, connectors, and components that can run on any number of J2EE-compliant implementations

Platform Value to Developers

- Can use ***any J2EE implementation*** for development and deployment
  - Use production-quality standard implementation which is free for development/deployment
  - Use high-end commercial J2EE products for scalability and fault-tolerance
- Vast amount of J2EE ***community resources***
  - Many J2EE related books, articles, tutorials, quality code you can use, best practice guidelines, design patterns etc.
- Can use off-the-shelf 3rd-party business components

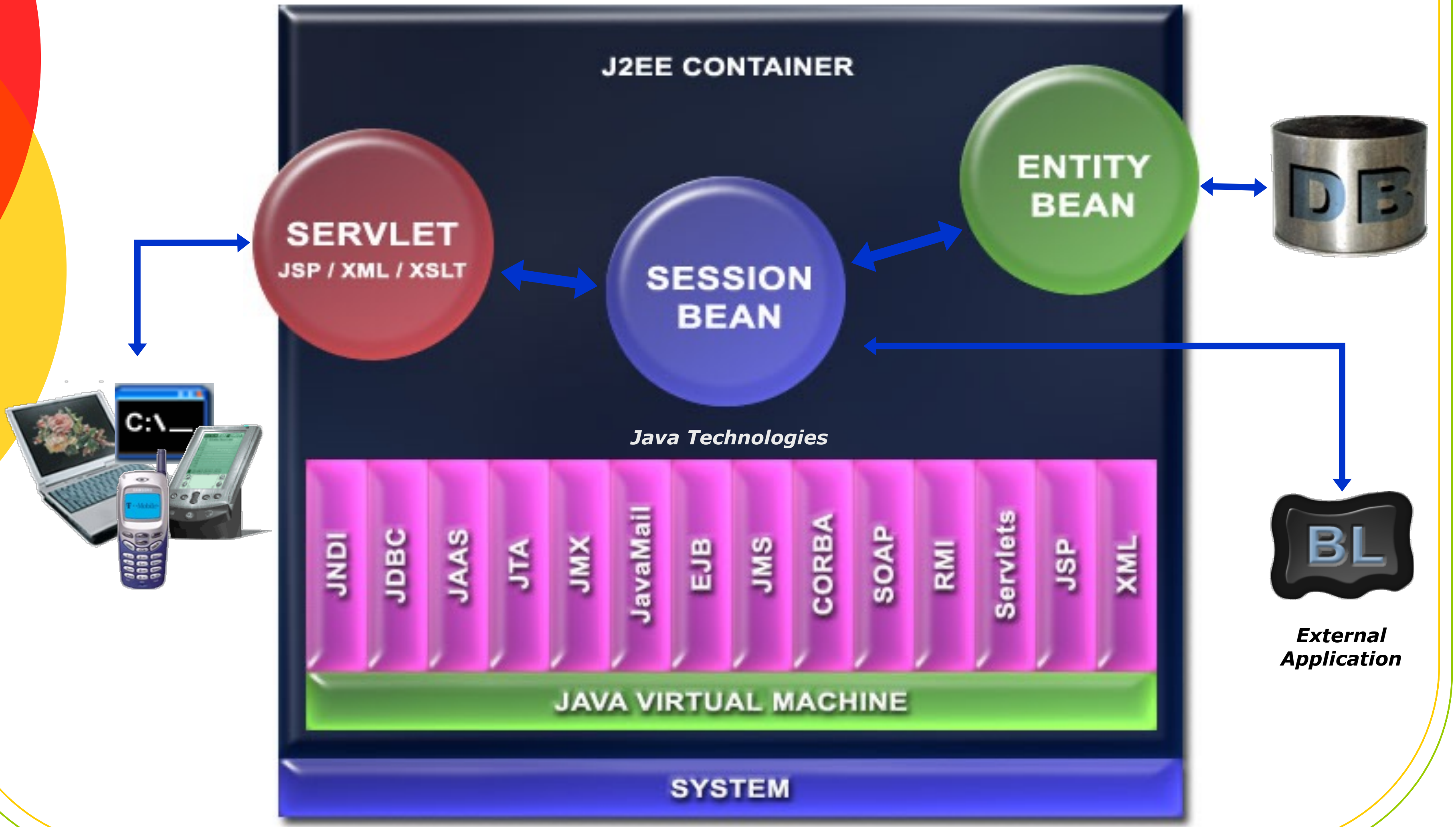
Platform Value to Vendors

- Vendors work together on specifications and then compete in implementations
  - In the areas of Scalability, Performance, Reliability, Availability, Management and development tools, and so on
- Freedom to innovate while maintaining the portability of applications
- ***Do not have create/maintain their own proprietary APIs***

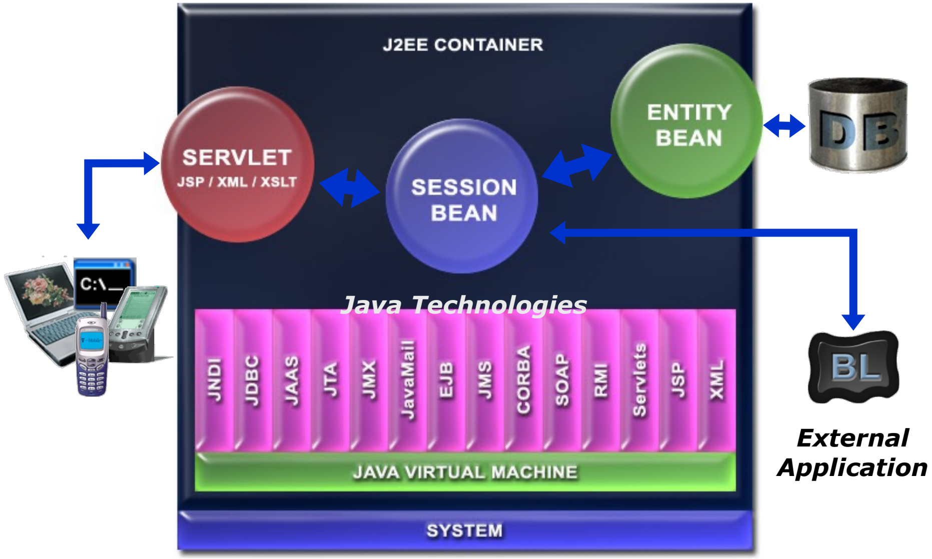
Platform Value to Business Customers

- ***Application portability***
- Many implementation choices are possible based on various requirements
  - Price (free to high-end), scalability (single CPU to clustered model), reliability, performance, tools, and more
  - Best of breed of applications and platforms
- Large developer pool

J2EE Framework



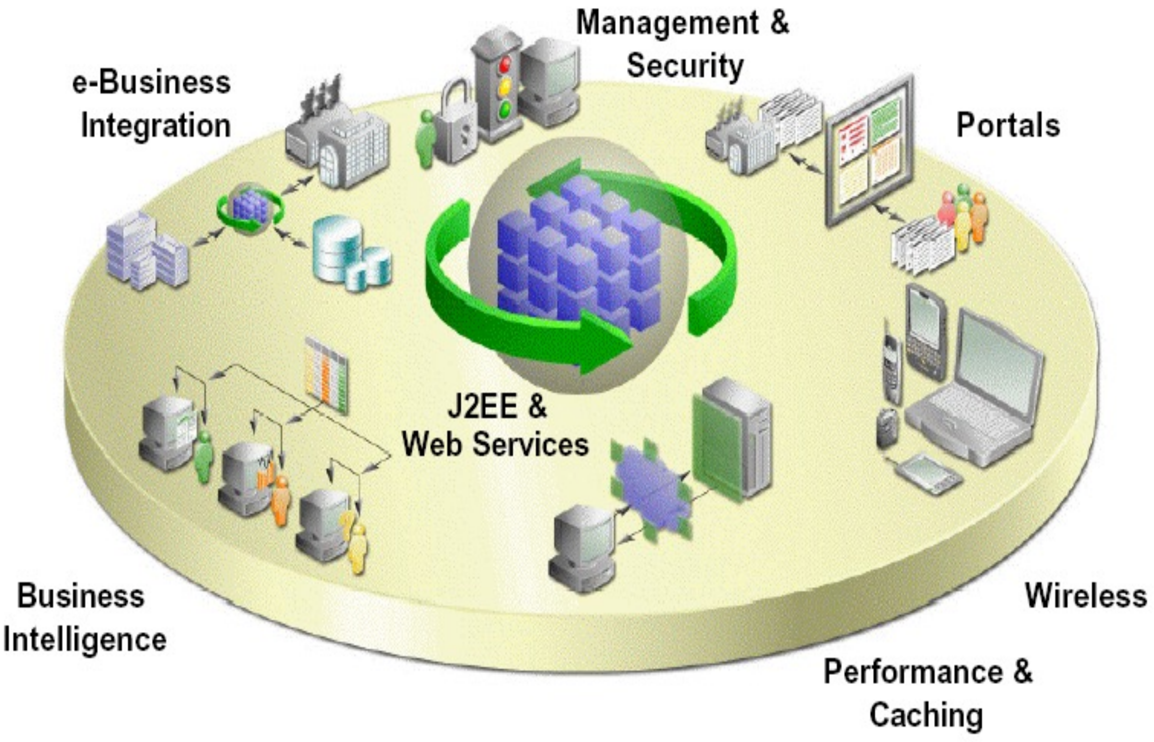
J2EE Frameworks



- JNDI: Java Naming and Directory Interface
- JAAS: Java Authentication and Authorization Service
- JTA: Java Transaction APIs
- JMX: Java Management Extension
- JMS: Java Message Service
- CORBA: Common Object Request Broker Architecture (: is a standard defined by the Object Management Group (OMG) designed to facilitate the communication of systems that are deployed on diverse platforms)

ORACLE

- Oracle 9*i*AS Internet Application Server Enterprise Edition used by SCT for Banner
- 100% compliant J2EE server

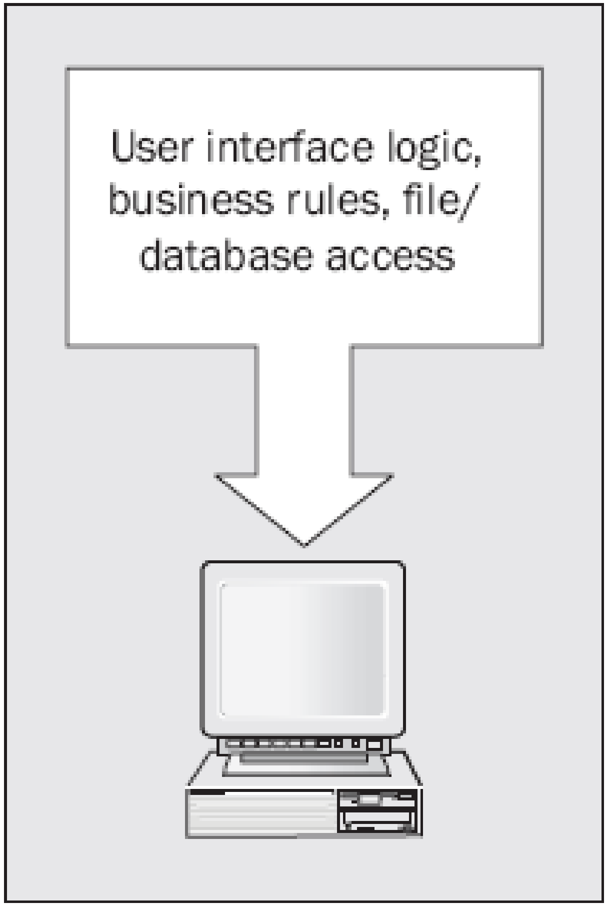


Oracle9i Application Server

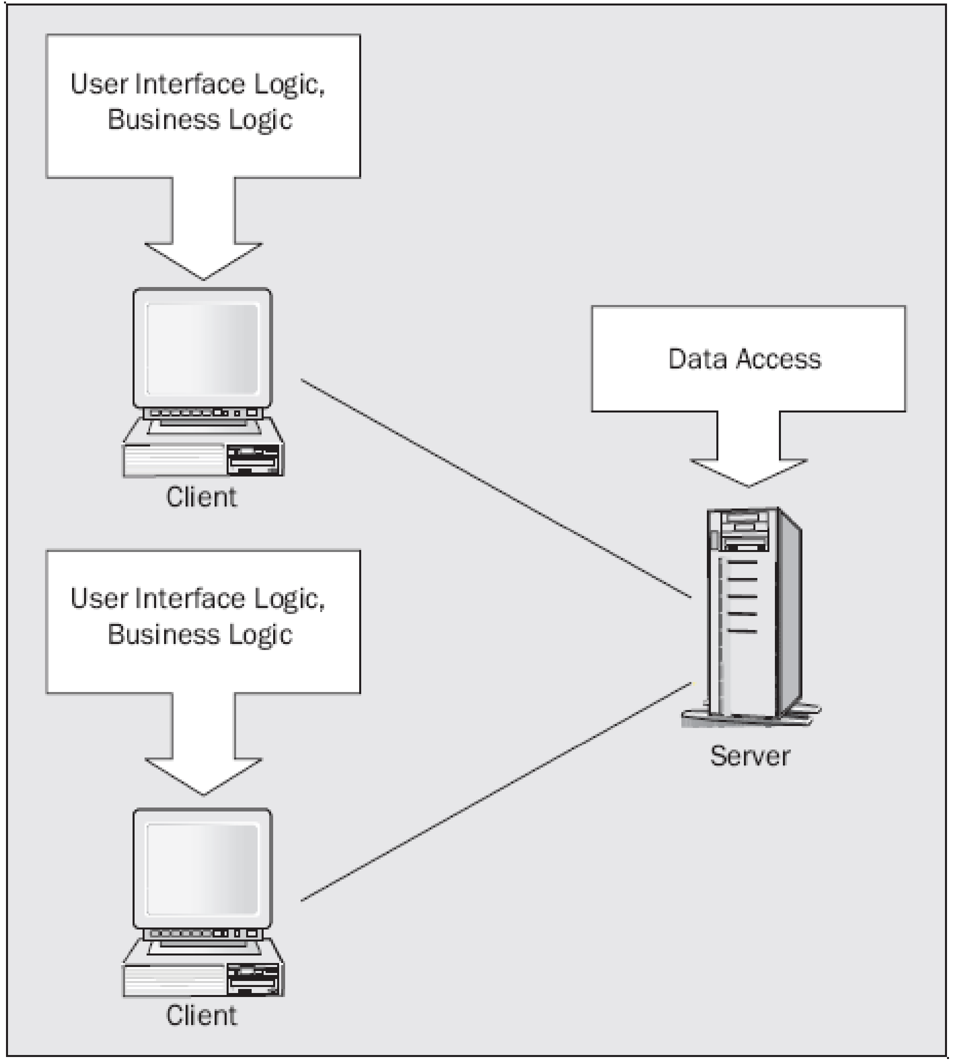
http://www.oracle.com/ip/deploy/ias

- “WebSphere continues the evolution to a single Web services-enabled, Java™ 2 Enterprise Edition (J2EE) application server and development environment that addresses the essential elements needed for an on demand operating environment.”
  - *https://www.ibm.com/cloud/websphere-application-platform/*
- IBM & Globus Project developing grid computing with JBoss and IBM WebSphere
  - https://www.ibm.com/docs/en/warehouse-management/9.4.0?topic=SS73R8_9.4.0/com.ibm.help.vm.implement.doc/c_VM_IntroductionToJ2EEWebApplications.html

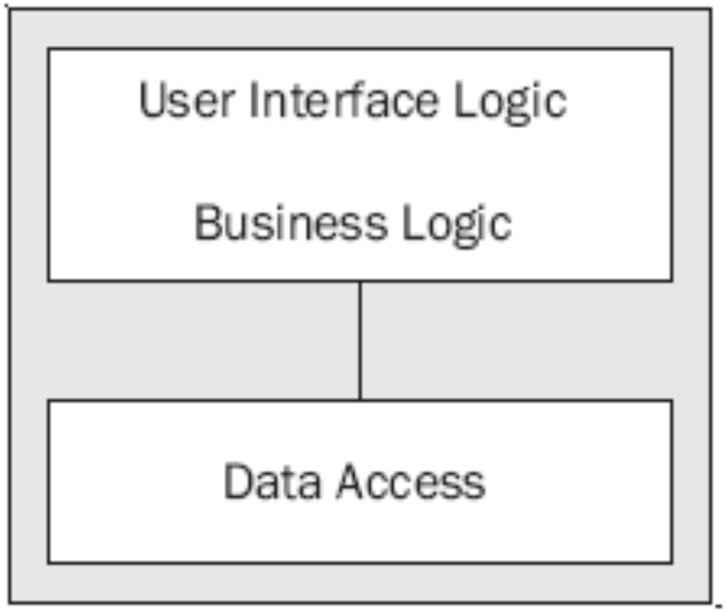
Single Tier Applications



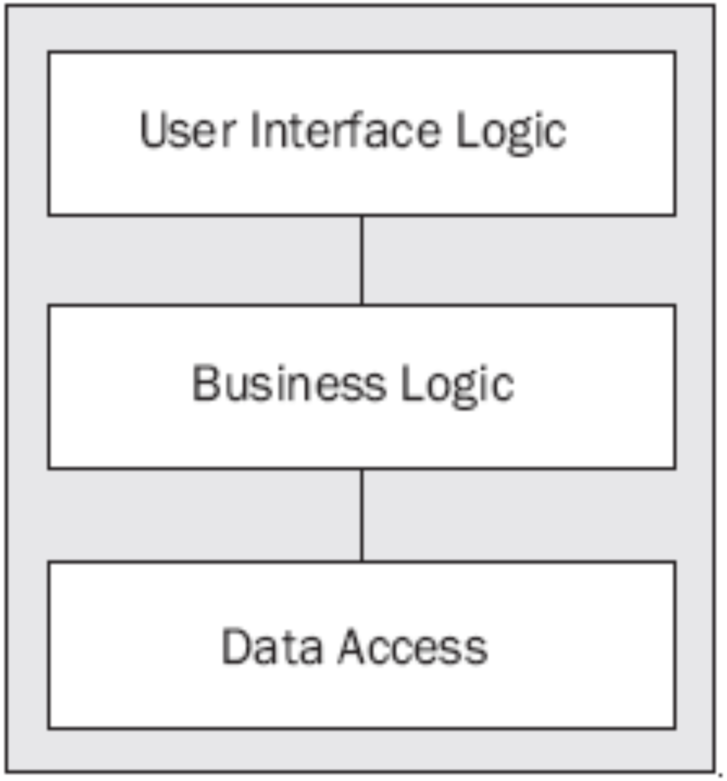
Client-Server Applications


User Interface Logic, Business Logic
Client
Data Access
Server
User Interface Logic, Business Logic
Client

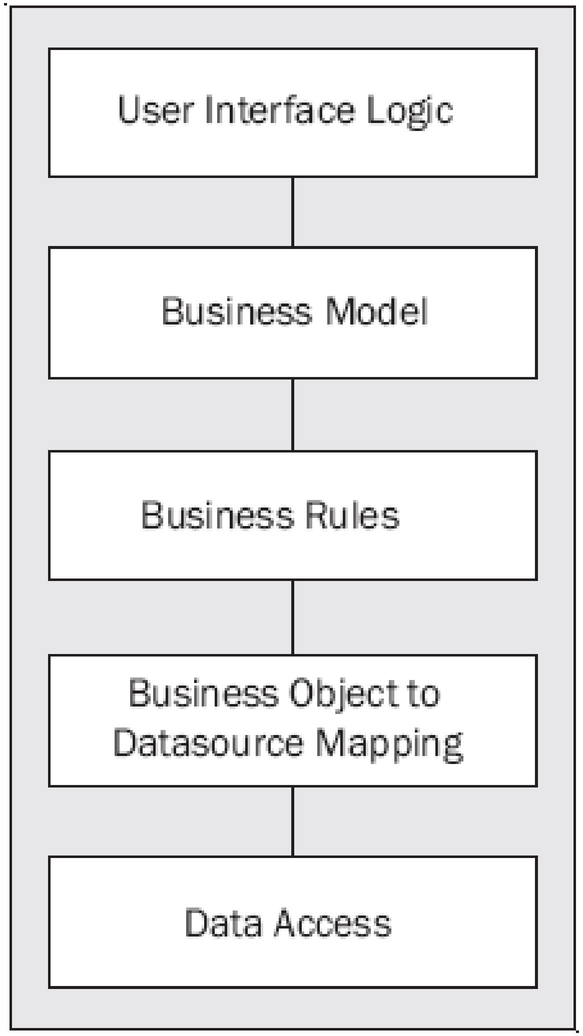
Two-Tier Architecture



Three-Tier Architecture



Multi-Tier Architecture



Vendor Independence

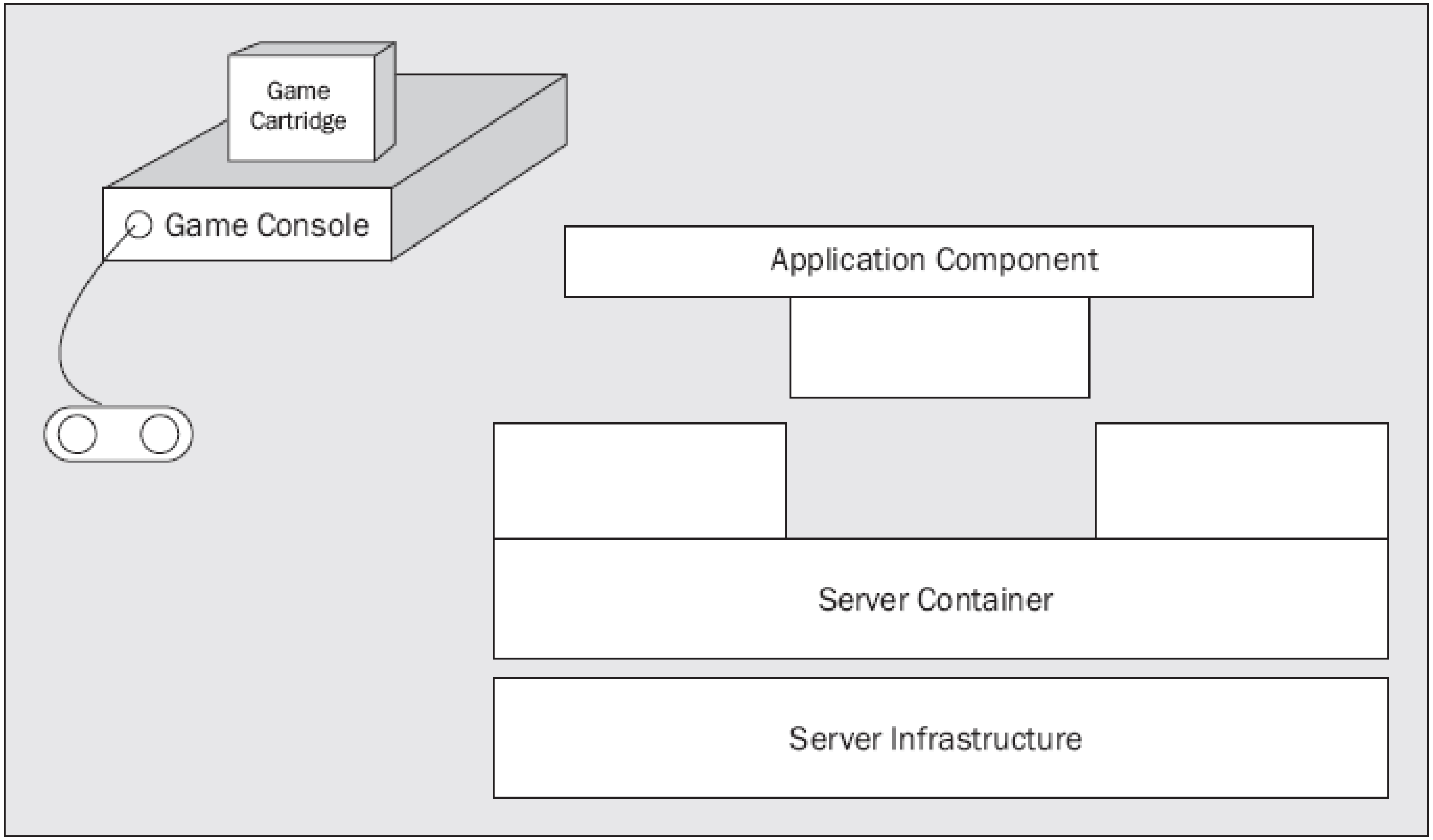
- Java (including J2EE) is designed to run on all platforms (platform-independence)
- The architects of J2EE has an open specification that can be implemented by vendors

Scalability

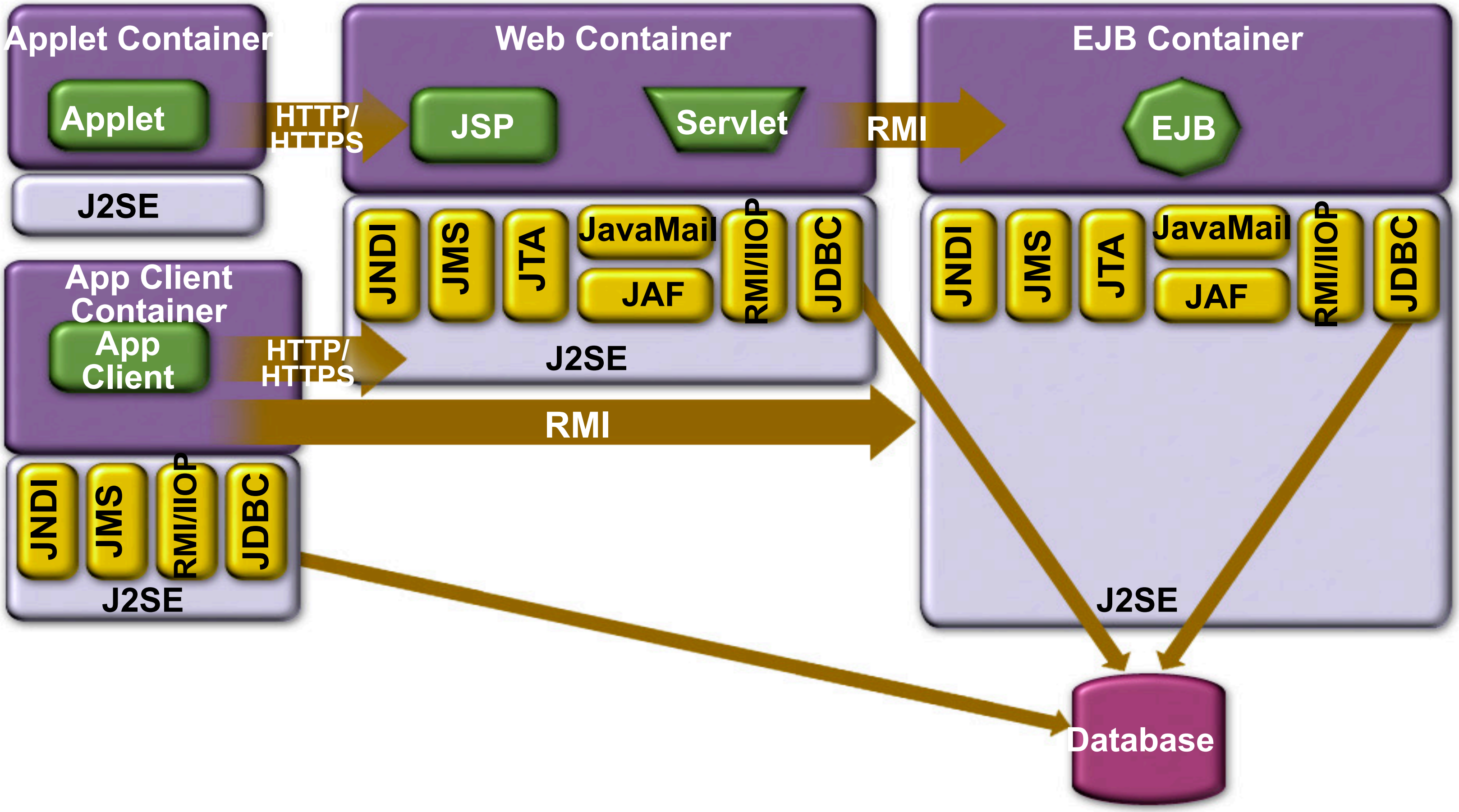
- Changes in requirements → changes have to be made in software
- The J2EE architecture provides much flexibility to accommodate changes as the requirements for throughput, performance, and capacity change
- J2EE also supports clustering, connection pooling, and failover

Containers

- A central theme in the J2EE architecture



J2EE Containers & Components



Containers Handle

- Concurrency
- Security
- Availability
- Scalability
- Persistence
- Transaction
- Life-cycle management
- Management

Components Handle

- Presentation
- Business Logic

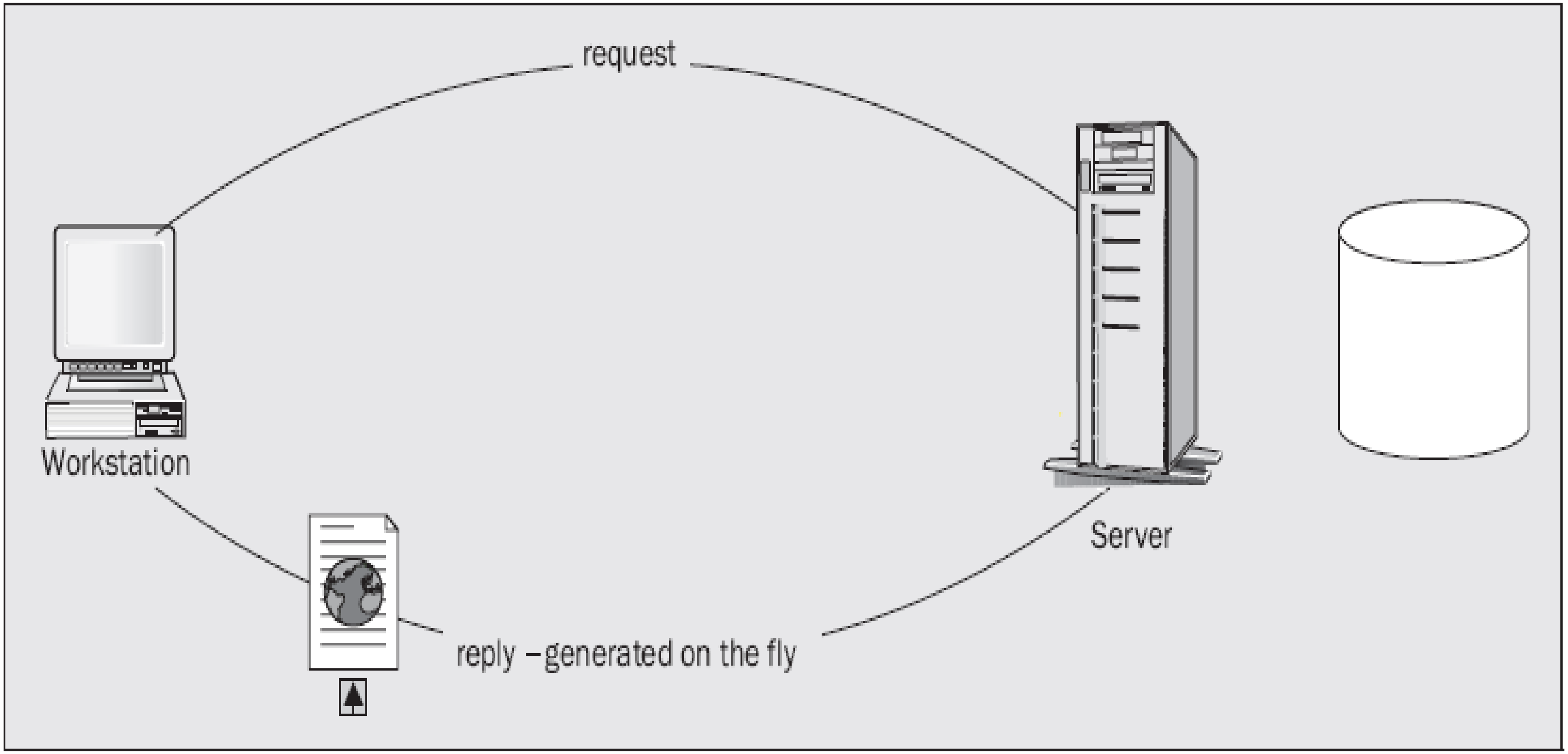
Containers & Components

- Containers do their work invisibly
  - No complicated APIs
  - They control by interposition
- Containers implement J2EE
  - Look the same to components
  - Vendors making the containers have great freedom to innovate

What is a Servlet?

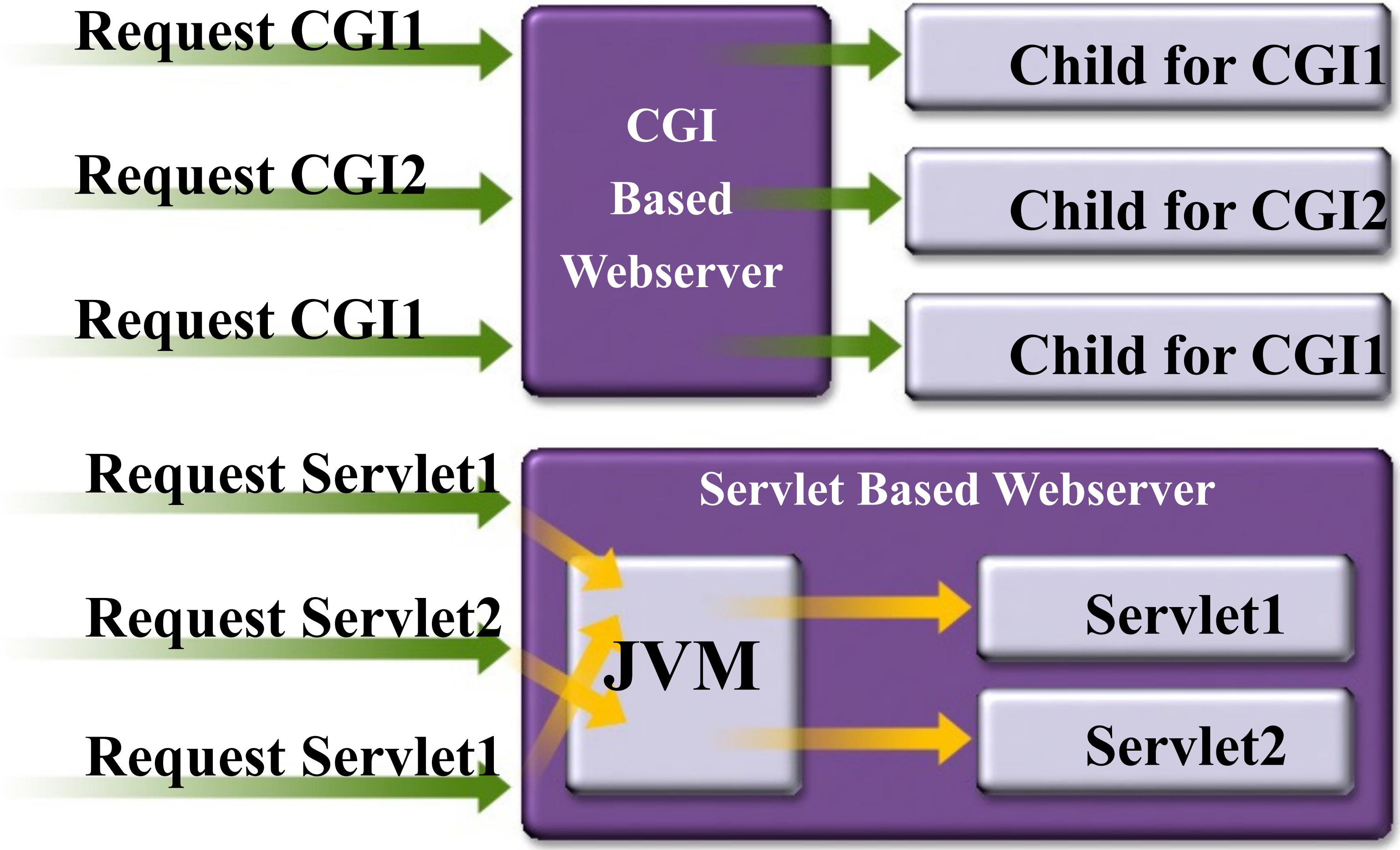
- Java™ objects which extend the functionality of a HTTP server by providing the capability of dynamic contents generation
- Better alternative to CGI, NSAPI, ISAPI, etc.
  - Efficient
  - Platform and server independent
  - Session management
  - Java-based

Java Servlets



- Provide for dynamically generated content

Servlet vs. CGI



Request CGI1

Request CGI2

Request CGI1

CGI Based Webserver

Child for CGI1

Child for CGI2

Child for CGI1

Request Servlet1

Request Servlet2

Request Servlet1

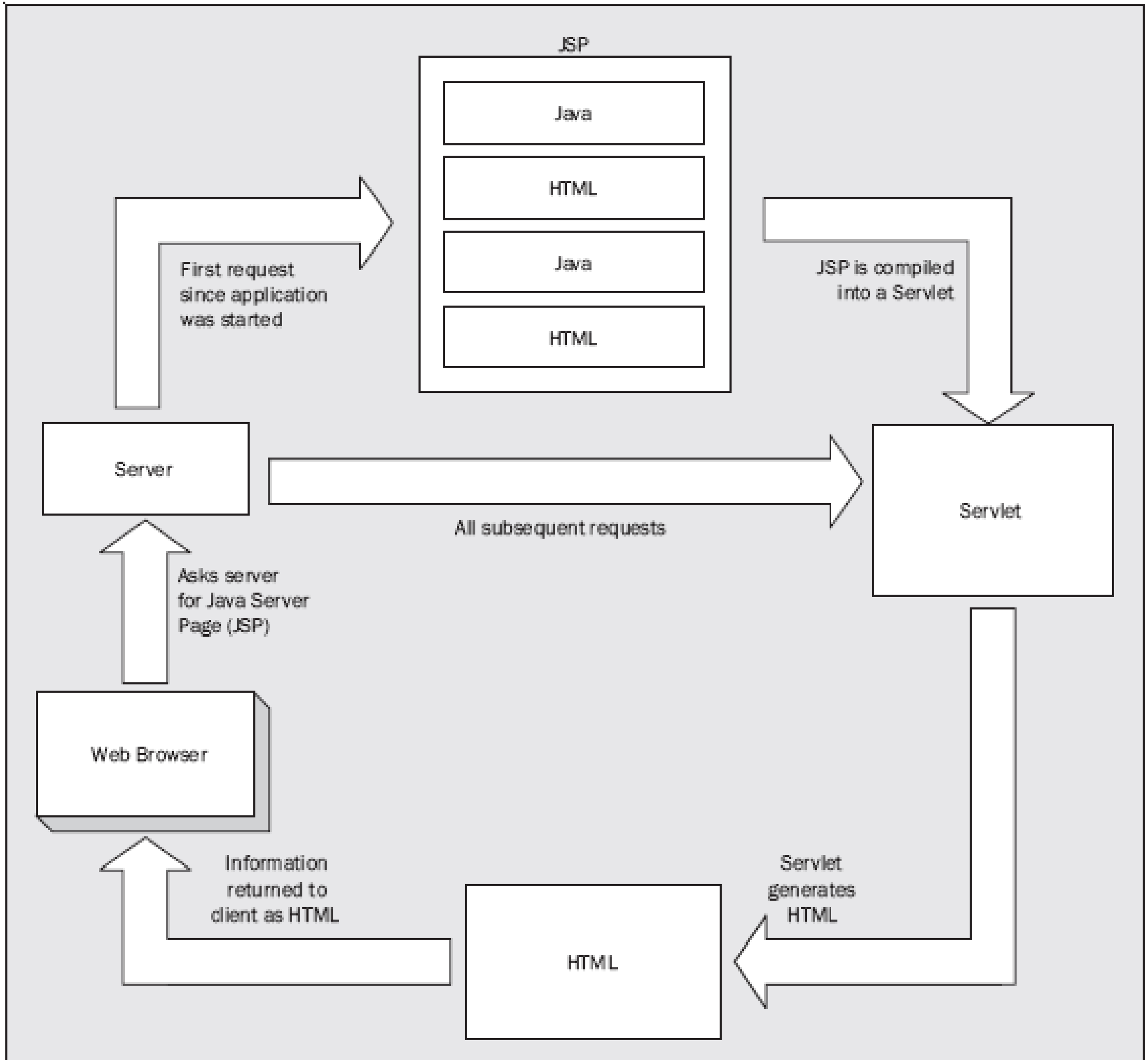
Servlet Based Webserver

JVM

Servlet1

Servlet2

JavaServer Pages


JSP
Java
HTML
Java
HTML
First request since application was started
JSP is compiled into a Servlet
Server
All subsequent requests
Servlet
Asks server for Java Server Page (JSP)
Web Browser
Information returned to client as HTML
Servlet generates HTML
HTML

Enterprise JavaBean (EJB)

- Developed based on Remote Method Invocation (RMI)
- EJBs are Java components that implement business logic. This allows the business logic of an application kept separate from the front-end applications that use that business logic
- The J2EE architecture includes a server that is a container for EJBs
- 3 types:
  - Session bean: maintain the state of sessions
  - Entity bean: represent business objects
  - Message bean: a component model for services that listen to Message Service messages

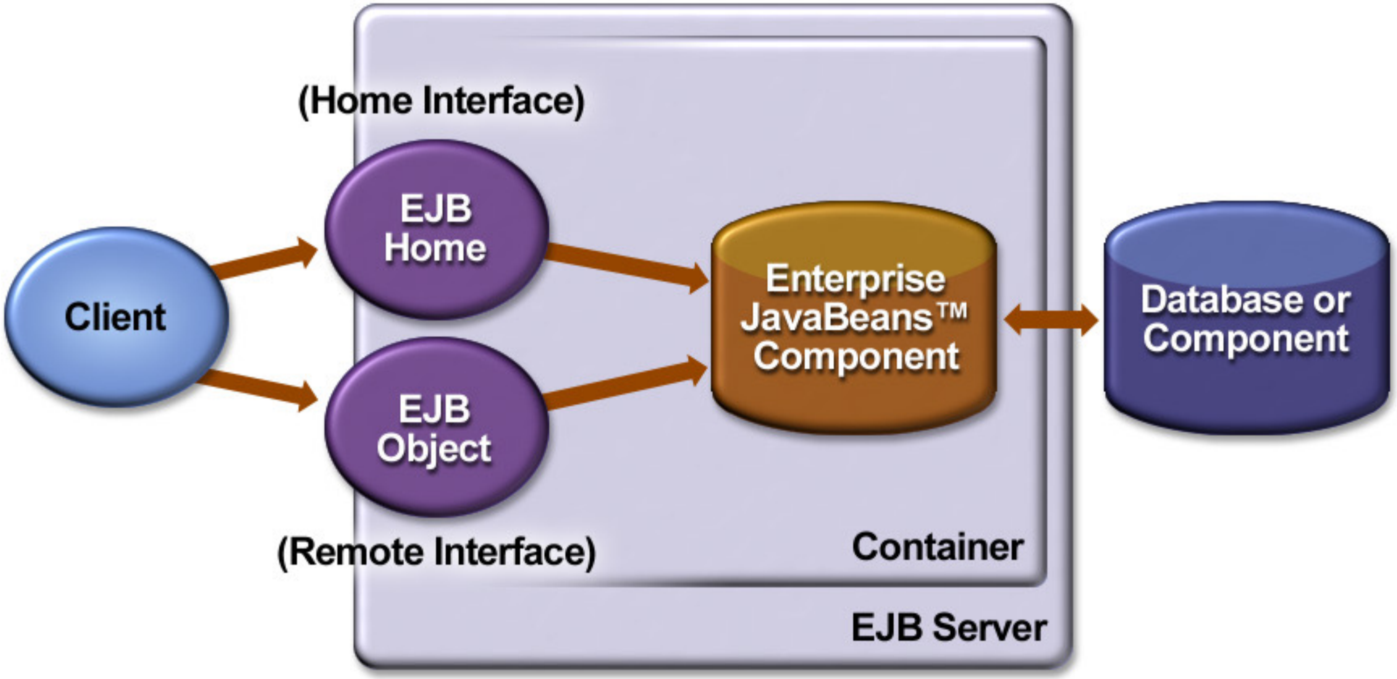
What is EJB Technology?

- A server-side component technology
- Easy development and deployment of Java technology-based application that are:
  - Transactional, distributed, multi-tier, portable, scalable, secure, …

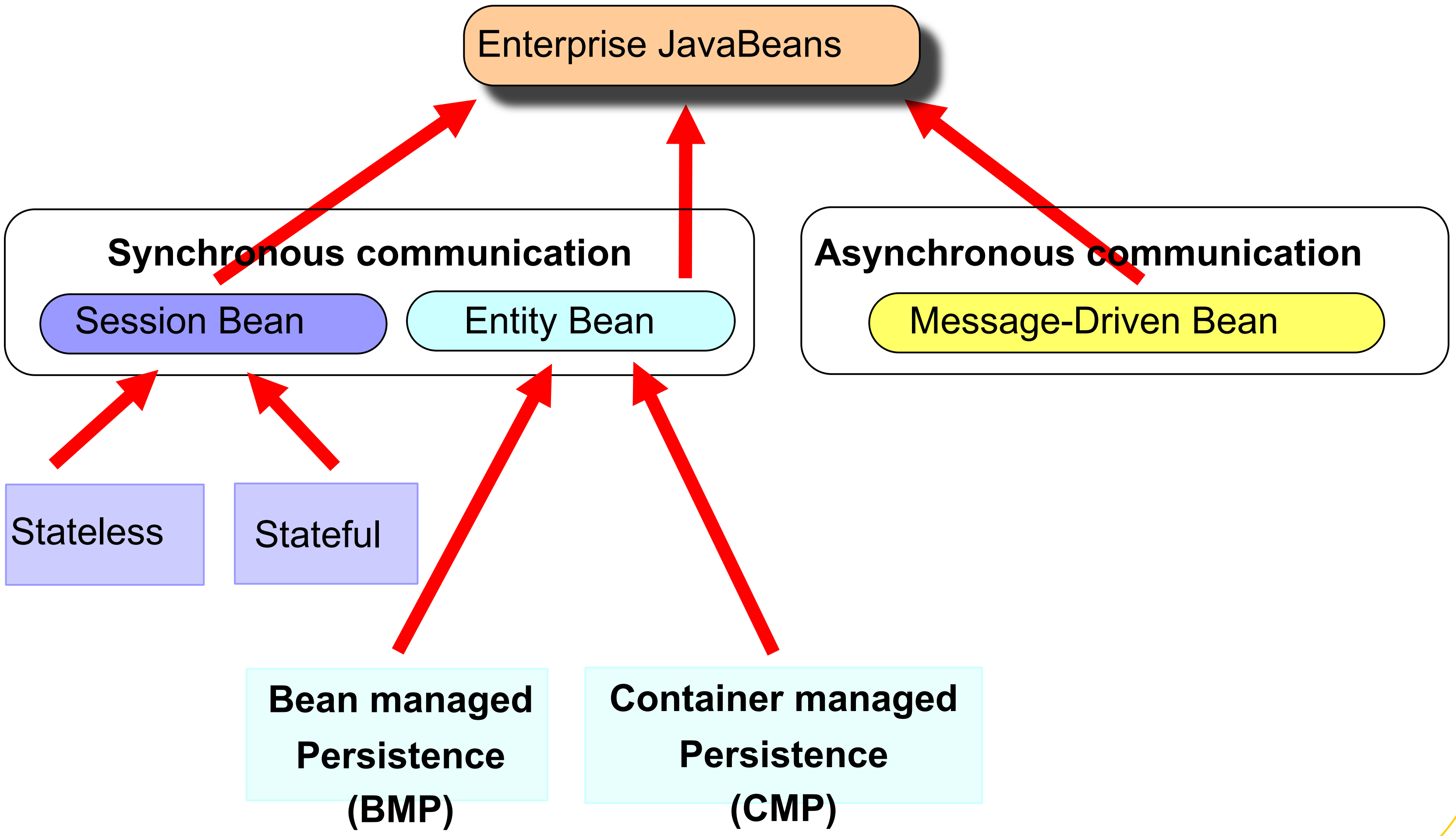
Why EJB Technology?

- Leverages the benefits of component-model on the server side
- Separates business logic from system code
  - Container provides system services
- Provides framework for portable components
  - Over different J2EE-compliant servers
  - Over different operational environments
- Enables deployment-time configuration
  - Deployment descriptor

EJB Architecture



Enterprise JavaBeans


Enterprise JavaBeans
Synchronous communication
Session Bean
Entity Bean
Asynchronous communication
Message-Driven Bean
Stateless
Stateful
Bean managed Persistence (BMP)
Container managed Persistence (CMP)

XML Support

- Extensible Markup Language (XML) is a significant cornerstone for several core techniques in J2EE
- Two APIs to process XML:
  - Document Object Model (DOM): a tree-oriented model
  - SAX (Simple API for XML): a stream-based event-driven processing model
- Java API for XML Binding (JAXB): mapping XML to and from Java classes

Web Services

- A web service is a software function that:
  - Its interface is public
  - Can be called by other services or programs
- A business service is often designed and implemented by a web service
- Web services become a new method to develop software
- Service-Oriented Architecture (SOA): a software architecture that is based on web services

Web service is background of cloud computing, grid computing nowadays

Transaction Support

- J2EE and EJB in particular provides substantial transaction support.
- The EJB container provides built-in support for managing transactions and allows the developer to specify and modify transaction boundaries without changing code.
- Where more complex transaction control is required, the EJB can take over the transaction control from the container and perform fine-grained or highly customized transaction handling.

Security

- J2EE provides strong built-in security mechanisms
- Authorization in J2EE is based on roles of users of applications

JNDI

- Java Naming and Directory Interface
- Utilized by J2EE applications to locate resources and objects in portable fashion
  - Applications use symbolic names to find object references to resources via JNDI
  - The symbolic names and object references have to be configured by system administrator when the application is deployed.
- JNDI provides methods for performing standard directory operations, such as associating attributes with objects and searching for objects using their attributes.

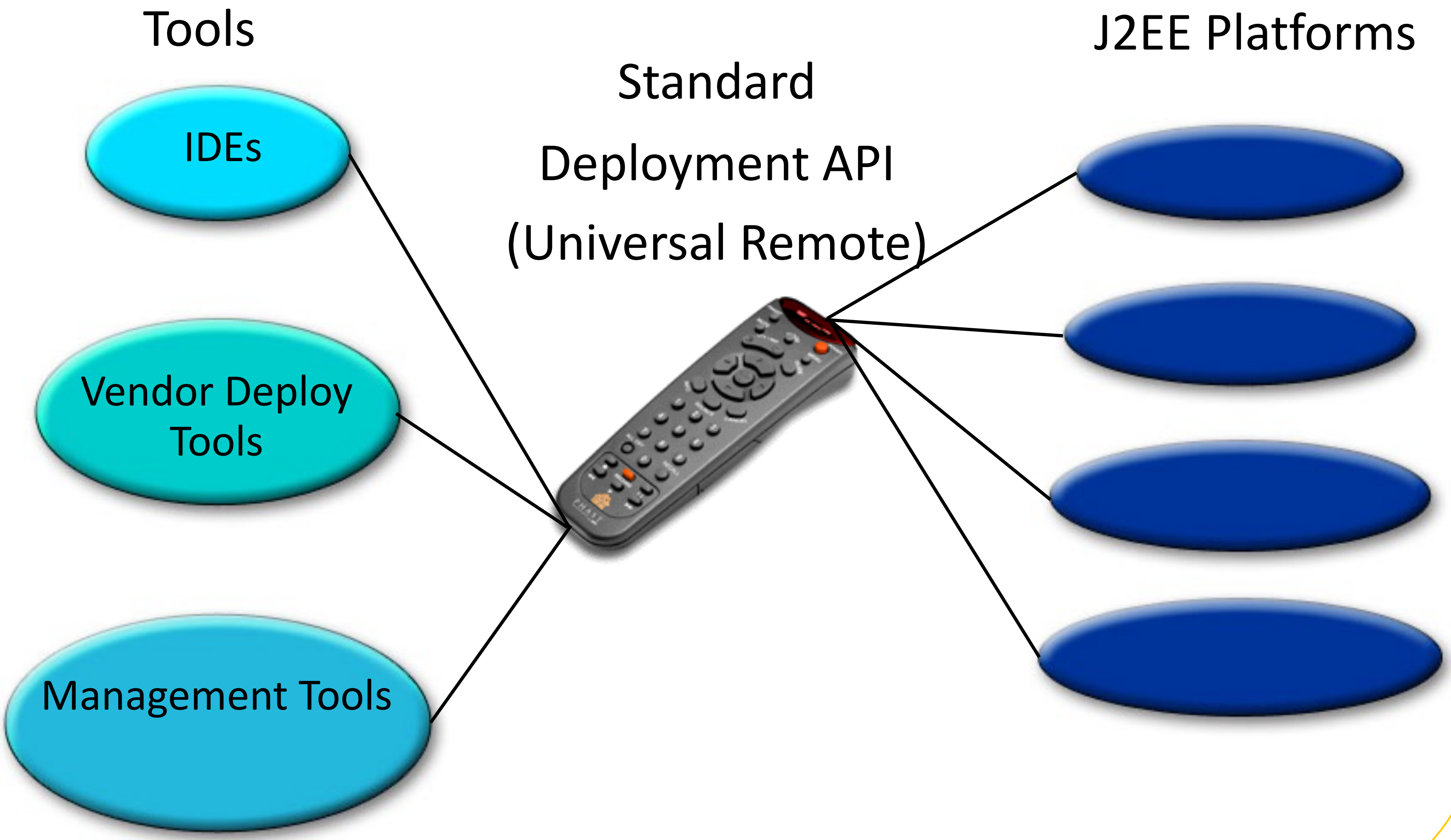
JDBC

- Provides standard Java programming API to relational database
  - Uses SQL
- Vendors provide JDBC compliant driver which can be invoked via standard Java programming API

J2EE Management (JSR-77)

- Management applications should be able to discover and interpret the managed data of any J2EE platform
- Single management platform can manage multiple J2EE servers from different vendors
- Management protocol specifications ensure a uniform view by SNMP and WBEM management stations
- Leverages JMX

J2EE Deployment (JSR-88)



Tools

J2EE Platforms

Standard

Deployment API

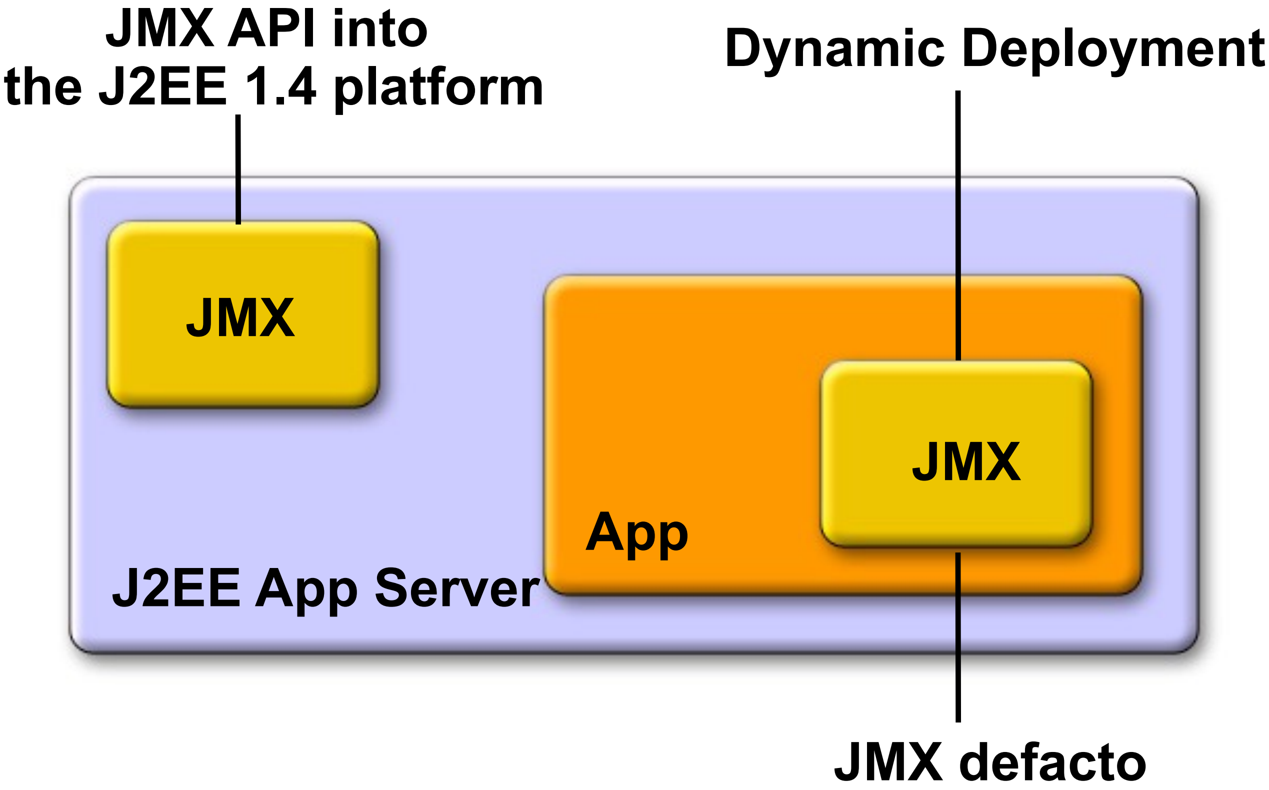
(Universal Remote)

IDEs

Vendor Deploy Tools

Management Tools

JMX

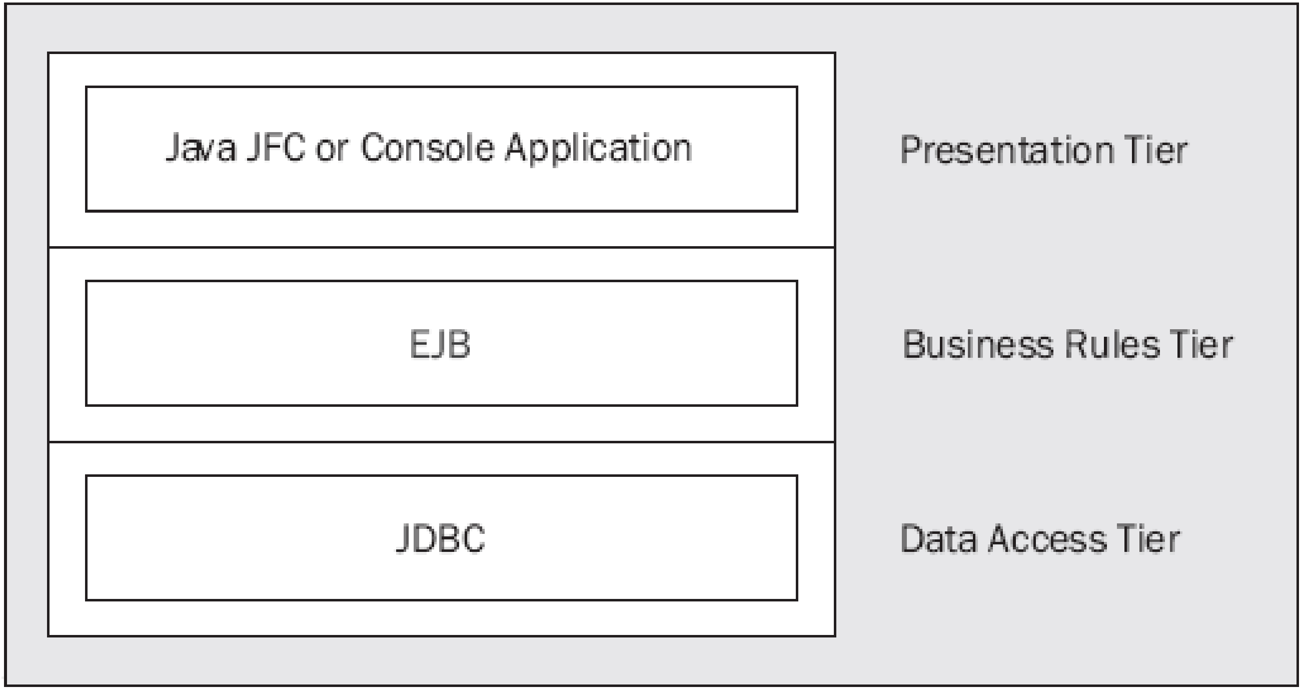


A single technology for the J2EE platform

Sample J2EE Architectures

- Several different architectures for different types of applications, but some commons
- n-Tier Architecture is intended to solve:
  - High cost of maintenance when business rules change
  - Inconsistent business rule implementation between applications
  - Inability to share data or business rules between applications
  - Inability to provide web-based front ends to line-of-business applications
  - Poor performance and inability to scale applications to meet increased user load
  - Inadequate or inconsistent security across applications

Application Client with EJB



Java JFC or Console Application

Presentation Tier

EJB

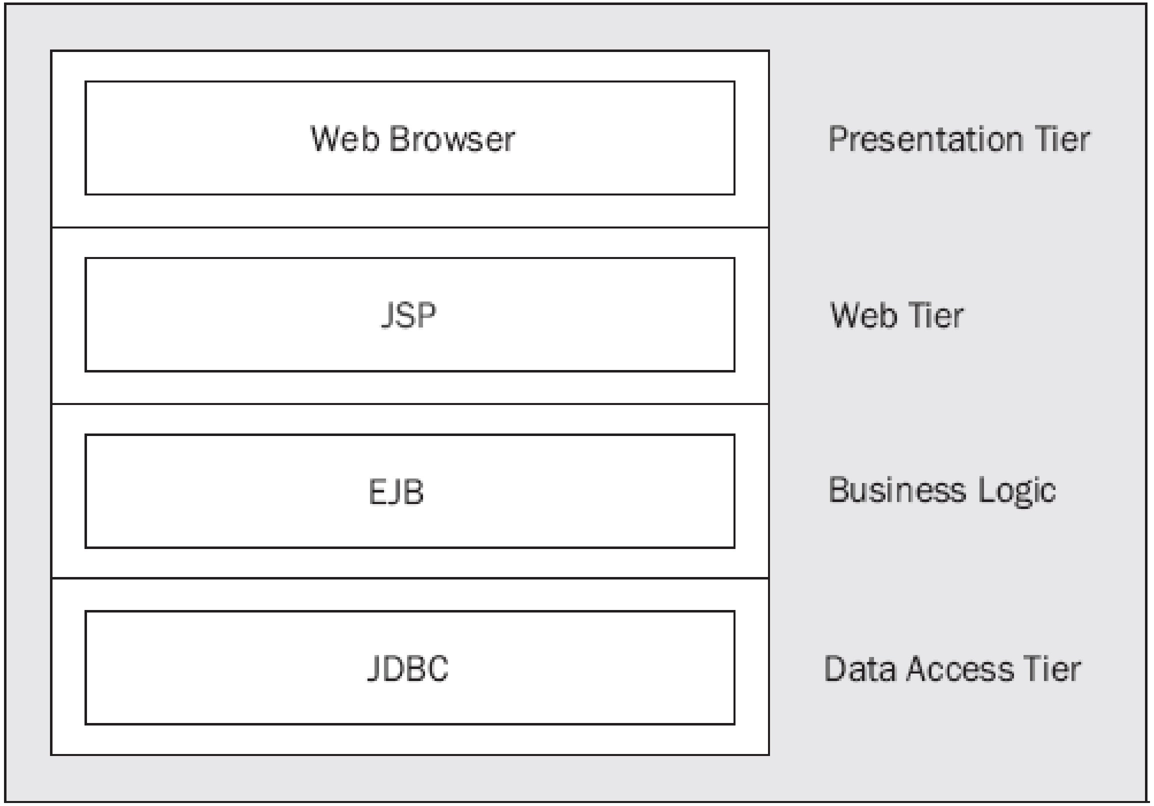
Business Rules Tier

JDBC

Data Access Tier

- The client application is built as a stand-alone (JFC/Swing or console) application.
- The application relies on business rules implemented as EJBs running on a separate machine.

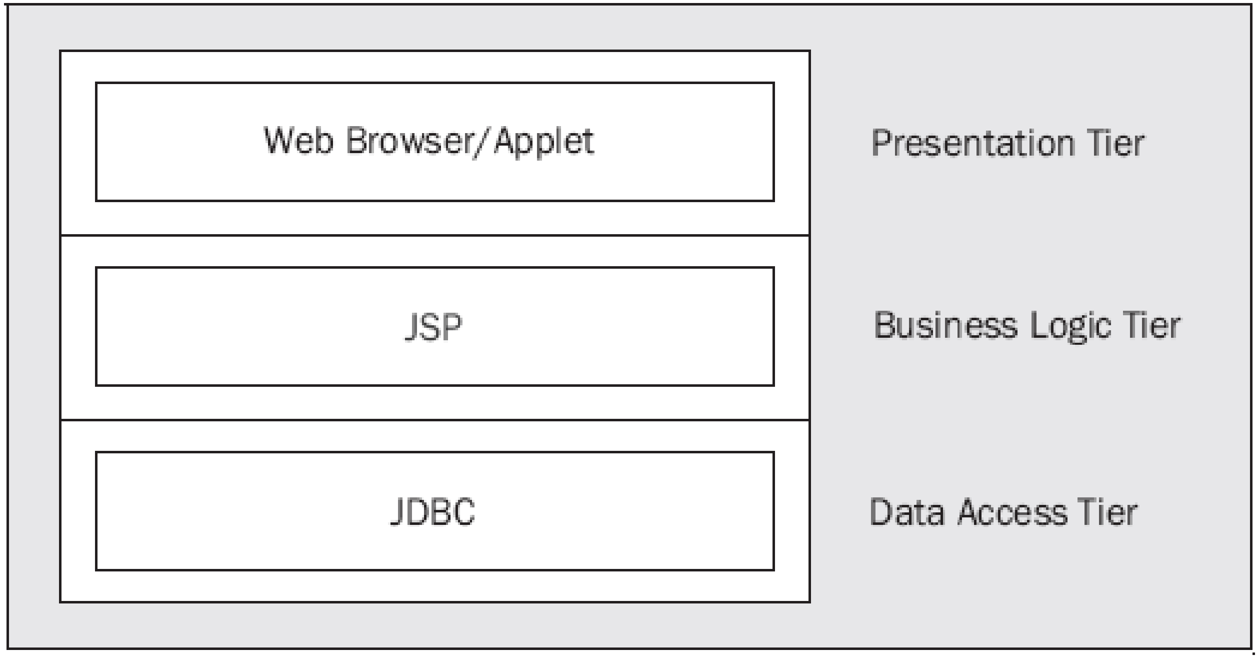
JSP Client with EJB



Web Browser	Presentation Tier
JSP	Web Tier
EJB	Business Logic
JDBC	Data Access Tier

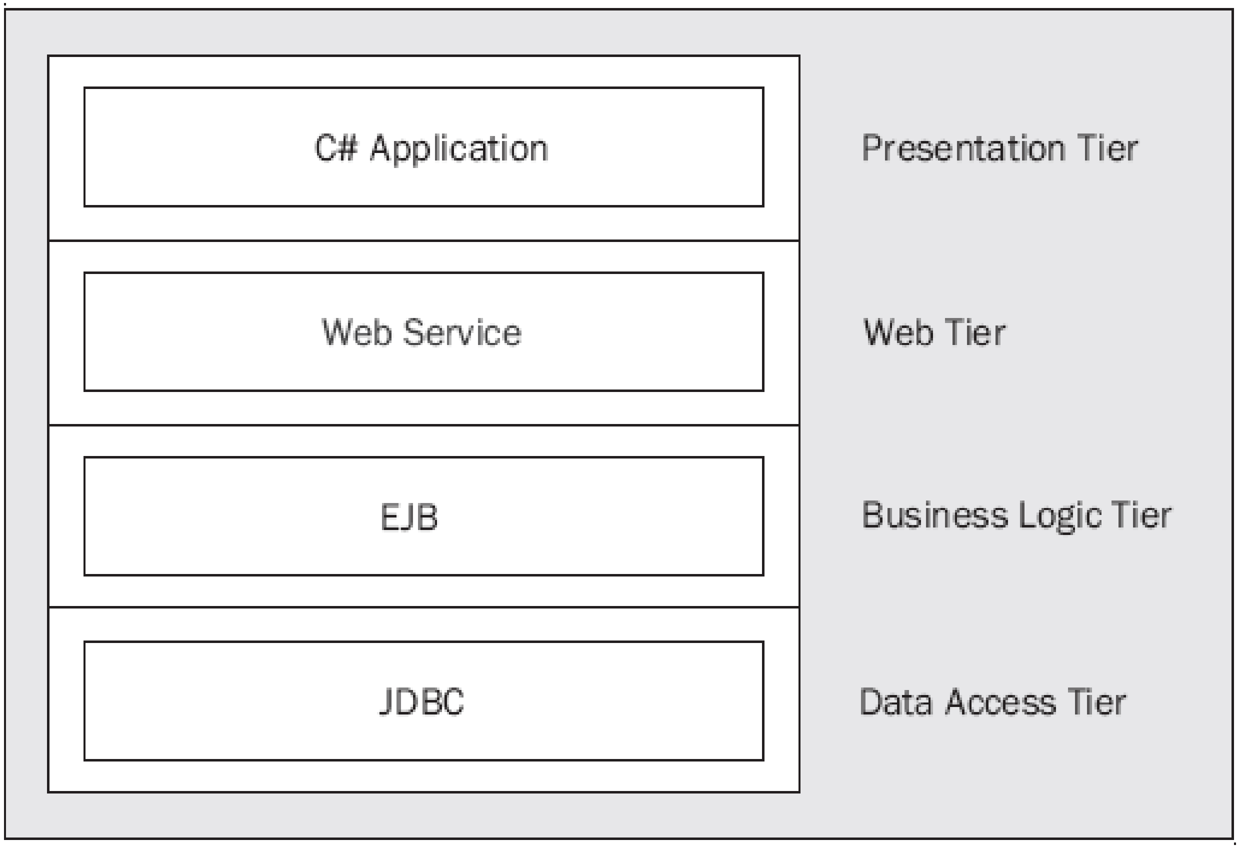
- The client in this architecture is a web browser.
- JavaServer Pages access business rules and generate content for the browser.

Applet Client with JSP and Database



- The client application is a web browser, but in this case a Java applet is used within a web page to provide a more interactive, dynamic user interface for the user. That applet accesses additional content from JSPs.
- Data is accessed from the JSP via the JDBC API.

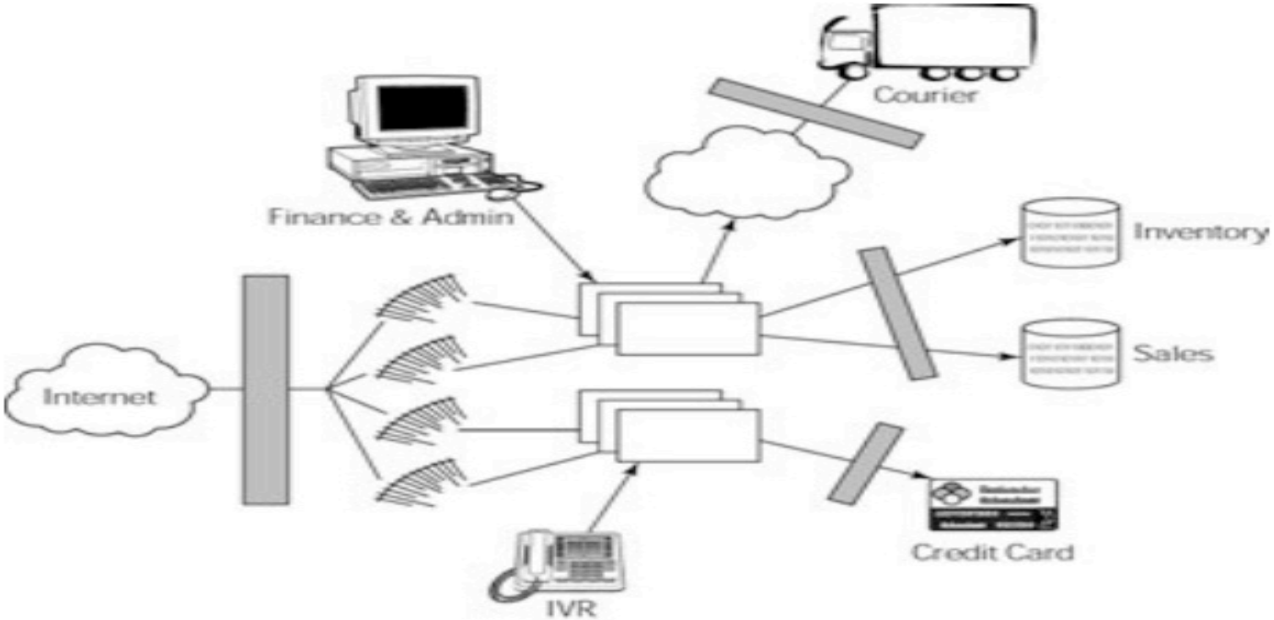
Using Web Services for Application Integration



C# Application	Presentation Tier
Web Service	Web Tier
EJB	Business Logic Tier
JDBC	Data Access Tier

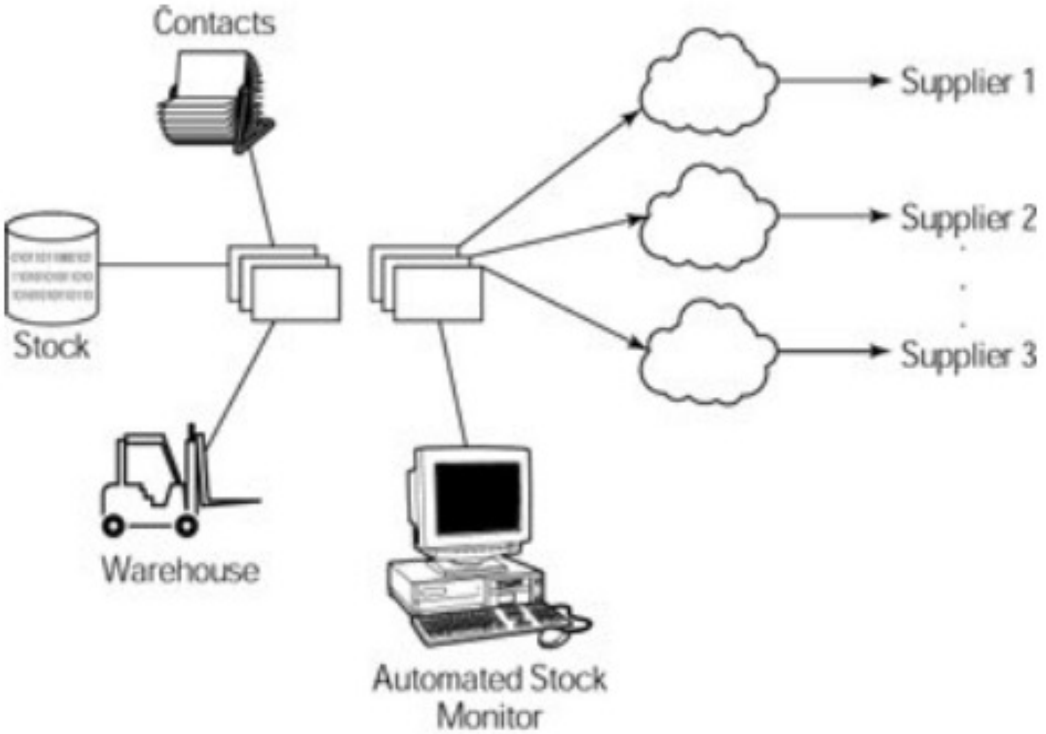
- A client application implemented in C# accesses data from a web service implemented in Java.

Sample J2EE Application 1
B2C E–commerce Website



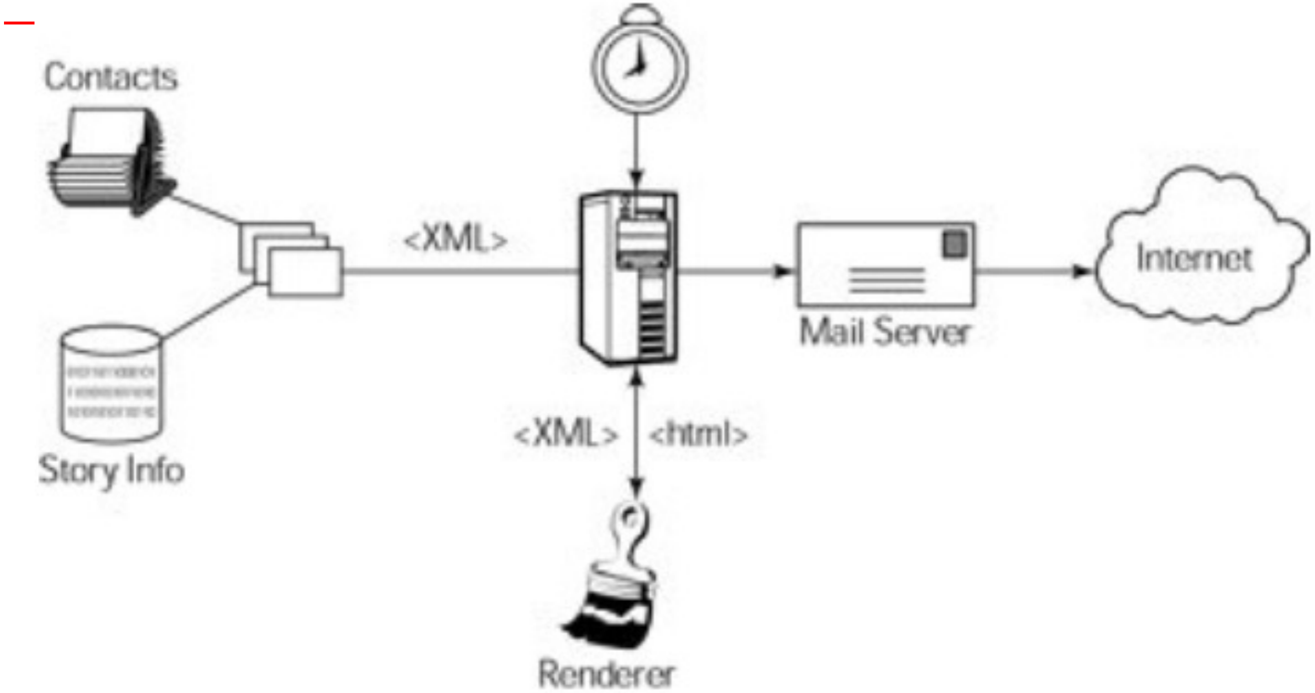
Web−Page Generation	Middleware	Database Server	Operating System
ASP	COM/DCOM	Usually SQLServer, but could be Oracle/Informix/Sybase	Microsoft
Servlet/JSP	EJB or CORBA	Oracle/Informix/Sybase	UNIX/Microsoft
CGI	CORBA	Oracle/Informix/Sybase	UNIX

Sample J2EE Application 2
An Inventory System in B2B Ecommerce



API	Use
EJB	Abstraction of business logic.
XML	Exchange of parts information and orders.
JNDI	Customer and supplier directory handling.

Sample J2EE Application 3 Monthly electronic newsletter



API	Use
JavaMail	Interface to e−mail system.
XML	Stores formatted message information.
JDBC	Extracts address information directly from the database.

Homework

- Explore J2EE on the internet (IBM and Oracle)
- Research J2EE Architecture
- How to apply J2EE in a web application
- Extend yourself: name.php and name.aspx

https://www.w3schools.com/php/default.asp

https://www.w3schools.com/cs/cs_intro.asp

https://www.oracle.com/tools/technologies/building-j2ee-web-applications.html

https://www.ejbtutorial.com/j2ee/basic-introduction-to-java-2-enterprise-edition-j2ee