



Royal University of Bhutan



Unit II

Introduction to Java

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Learning Outcomes

In this session, you will learn about:

- What is Java?
- The creation of Java
- Characteristics of Java
- Java architecture
- Java architecture security
- Garbage collection in JVM

What is Java Programming?

- Java is a modern, high-level, OOP language that was designed to meet the need for a platform-independent language.
- Slogan: "*Write once, run anywhere.*"

The Creation of Java

- Conceived by **James Gosling**, Patrick Naughton, Chris Warth, Ed Frank, and Mike Sheridan at Sun Microsystems, Inc. in 1991.
- Initially called “Oak,” but was renamed “Java” in 1995.
- *Primary motivation*—Need for a portable, platform-independent language that could be used to produce code that would run on a variety of systems. (consumer electronic devices)
- Secondly, the Internet needed portable programs. The Internet consists of a diverse, distributed universe populated with various types of computers, operating systems, and CPUs.
- *The environmental change that prompted Java was the need for platform-independent programs destined for distribution on the Internet.*

The evolution of Java

- The following table describes the evolution of Java:

Year	Precedence
1990	Sun Microsystems developed software to manipulate electronic devices.
1991	A new language named Oak was introduced using the most popular object-oriented language C++.
1993	World Wide Web (WWW) appeared on the Internet that transformed the text-based Internet into graphical Internet.
1994	The Sun Microsystems team developed a Web browser called HotJava to locate and run applet programs on the Internet.
1995	Oak was renamed as Java.
1996	Java was established as an object-oriented programming language.

Java applications

A few types of Java applications are:

- *Applications that use CUI (Character user interface)*
- *Applications that use GUI (Graphical user interface)*
- *Applets*
- *Servlets*
- *Packages*

Characteristics of Java

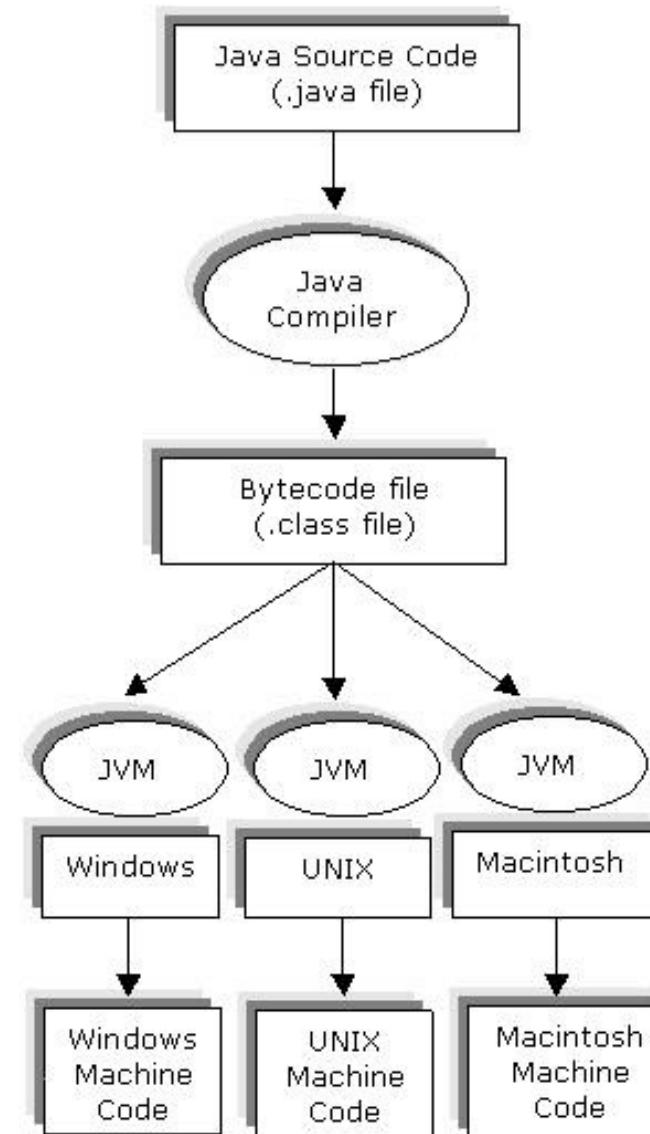
- Simple
- Secure
- Portable
- Object-oriented
- Interpreted
- Distributed

Characteristics of Java

- **Simple:** A Java programmer does not need to know the internal functioning of Java, such as how memory is allocated to data.
- **Object-oriented:** Java supports the object-oriented approach to develop programs.
- **Compiled and interpreted:** The Java programs are first compiled and then interpreted. After the program is compiled, it is converted to a bytecode. The Java Virtual Machine (JVM) then interprets this bytecode into the computer code and runs it.
- **Portable:** Refers to the ability of a program to run on any platform without changing the source code of a program

Compilation and Interpretation

- The following figure shows how the Java bytecode and the JVM together make Java programs portable on different platforms:



Characteristics of Java

- **Distributed:** Java is designed for the distributed environment of the Internet because it supports the various Internet protocols, such as Transmission Control Protocols and Internet Protocol (TCP/IP).
- **Secure:** Java has built-in security features that verify that the programs do not perform any destructive task, such as accessing the files on a remote system.

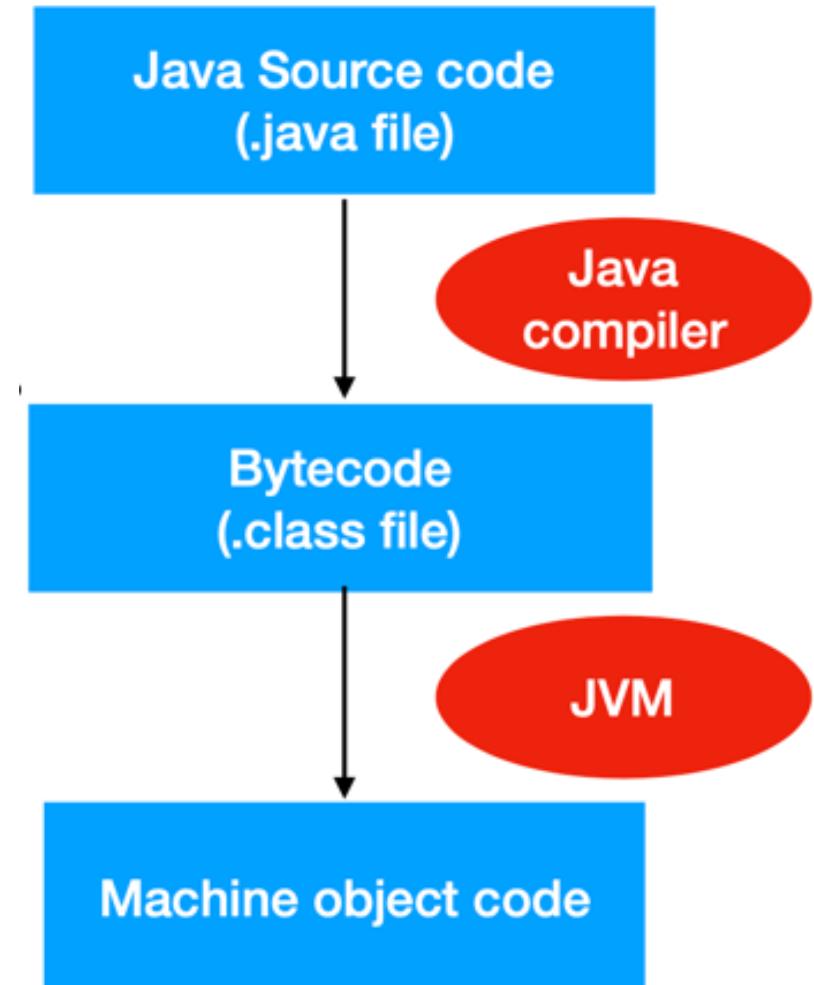
Java Architecture

The various components of the Java Architecture are:

1. Java Programming language and class file
2. Java Virtual Machine (JVM)
3. Java Application Programming Interface (API)

Java Programming language and class file

- Java programs saved with .java extension
- .java files are compiled to generate bytecode and saved as .class files
- JVM interprets the bytecode into machine code and runs it.
- The JVM needs to be implemented for each platform running on a different operating system.



2. JVM (Java Virtual Machine)

- JVM is the interpreter for the bytecode generated by the Java compiler.
- JVM is not platform independent.
- The execution of the bytecode by JVM is what makes Java portable as JVM is the only thing that needs to be implemented for each platform.

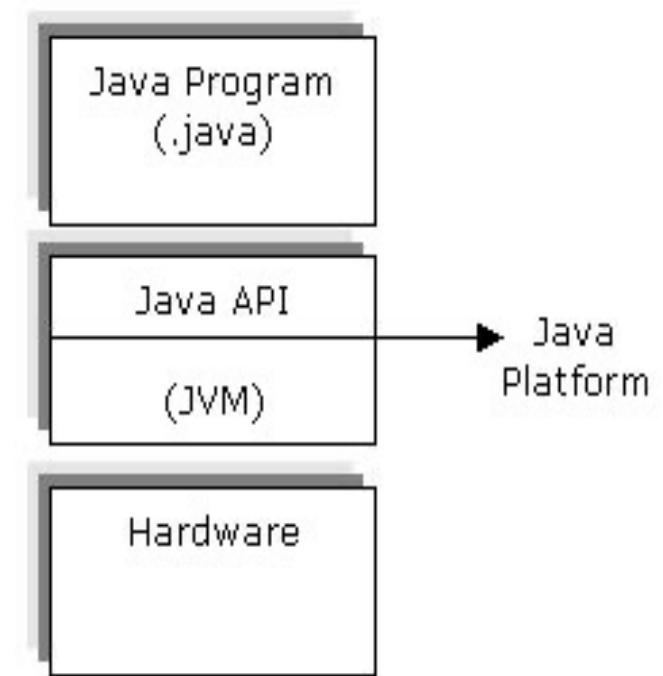
2. JVM (Java Virtual Machine)

The major components of JVM are:

- **Class loader:** Loads the class files dynamically when required by a running program.
- **Execution engine:** runs the bytecode line by line and converts it into machine object code and runs it.
- **Just In Time (JIT) compiler:** compiles a part of the bytecode into executable machine code which can be run directly by the JVM without interpreting it. (for very high performance)

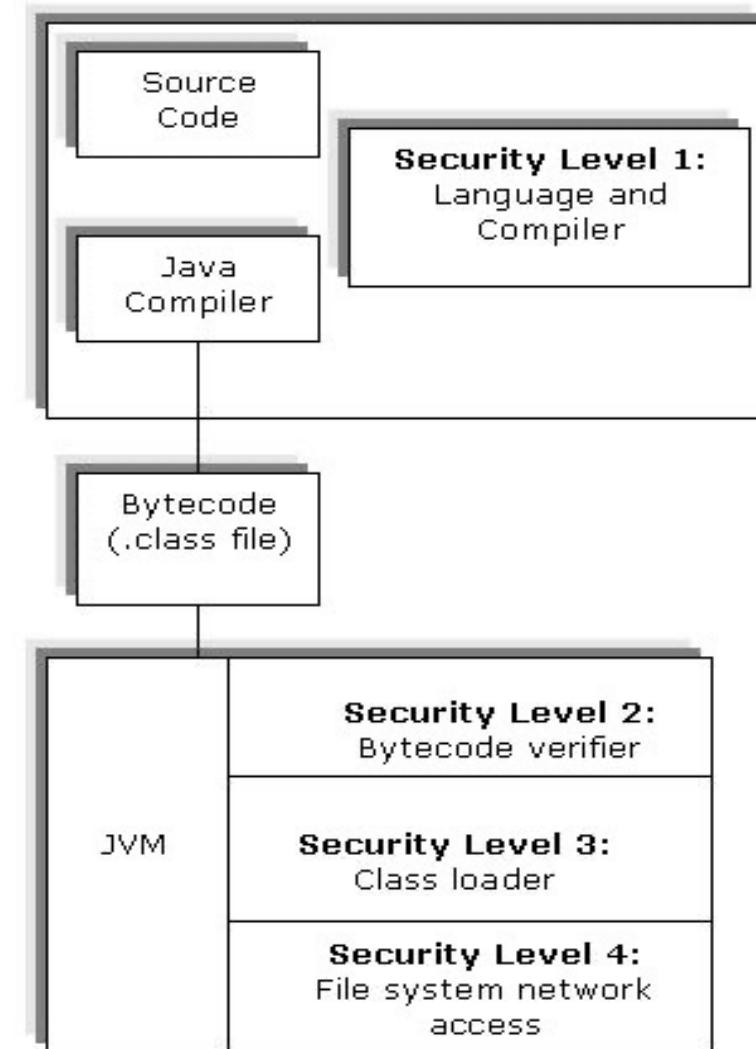
3. Java Application Programming Interface (API)

- Java API is a collection of software components that provide certain capabilities. Eg. GUI
- The related classes and interfaces of the Java API are grouped into packages.
- The figure shows how the Java API and the JVM forms the platform for the Java programs on top of the hardware.



Java Architecture Security

- The figure shows the various levels of security implemented on Java programs:



Java Architecture Security

The java architecture security features that makes Java a secure programming language:

1. **Compiler level security** : — Java doesn't support pointers therefore reduces compile-time errors generated due to improper memory management.
 - ✓ Typecasting ensures no data is lost as an output java code.
2. **Bytecode verifier** : checks the bytecode before it runs on a computer.
 - ✓ checks for the structure of the .class file
 - ✓ when the bytecode is run, it checks the validity of classes, variables, and methods.
3. **Class loader** : determines how and when an applet will use classes in a running Java environment.
4. **Sandbox model** : determines the resources accessible to the applets on the host computer and restricted on the local computer.

Garbage collection in JVM

- Each object within a program uses some amount of system resources during runtime, such as system memory.
- Garbage collection is **the process of automatically freeing the allocated memory of those objects which are no longer in use.**
- The space used by the object is released for use by another object.

Summary

- Java is both a language and a technology used to develop desktop and Internet-based applications known as Java applications and applets.
- The various characteristics of Java programming language
 - Simple
 - Object-oriented
 - Compiled and interpreted
 - Portable
 - Distributed
 - Robust
 - Secure

Summary

- The various components of the Java architecture are:
 - Java programming language
 - Java Class file
 - JVM
 - Java API
- The JVM converts the bytecode contained in the .class file to machine object code.

Thank you!