How Java works

- The java compiler takes a .java file and generates a .class file
  - ➢ The .class file contains Java bytecodes, the assembler language for Java programs
  - ➢ Bytecodes are executed in a JVM (java virtual machine), the valid bytecodes are specified by Sun
    - What if third parties create platform/OS specific codes?

- The JVM interprets the bytecodes
  - ➢ JVM is platform/OS specific, must ultimately run the code
  - ➢ Different JVMs will have different performance, JITs are part of the overall JDK/Java performance

JIT, Just In Time Compiler

- **JVM ultimately translates bytecode into native code, each time the same bytecodes are processed, the translation into native code must be made**
  - **If we can cache translated code we can avoid re-translating the same bytecode sequence**
  - **Why not just translate the entire .java program into native code?**

- **Still need the JVM, the JIT works in conjunction with the JVM, not in place of it**

- **How are classes loaded into the JVM? Can this be thwarted?**

Loading .class files

- The bytecode verifier “proves theorems” about the bytecodes being loaded into the JVM
  - ➤ These bytecodes may come from a non-Java source, e.g., compile Ada into bytecodes (why?)
- This verification is a *static* analysis of properties such as:
  - ➤ .class file format (including magic number 0xCAFEBABE)
  - ➤ Methods/instances used properly, parameters correct
  - ➤ Stack doesn’t underflow/overflow
  - ➤ …
- Verification is done by the JVM, not changeable as is, for example, the ClassLoader

http://securingjava.com

http://java.sun.com/sfaq/verifier.html

The ClassLoader

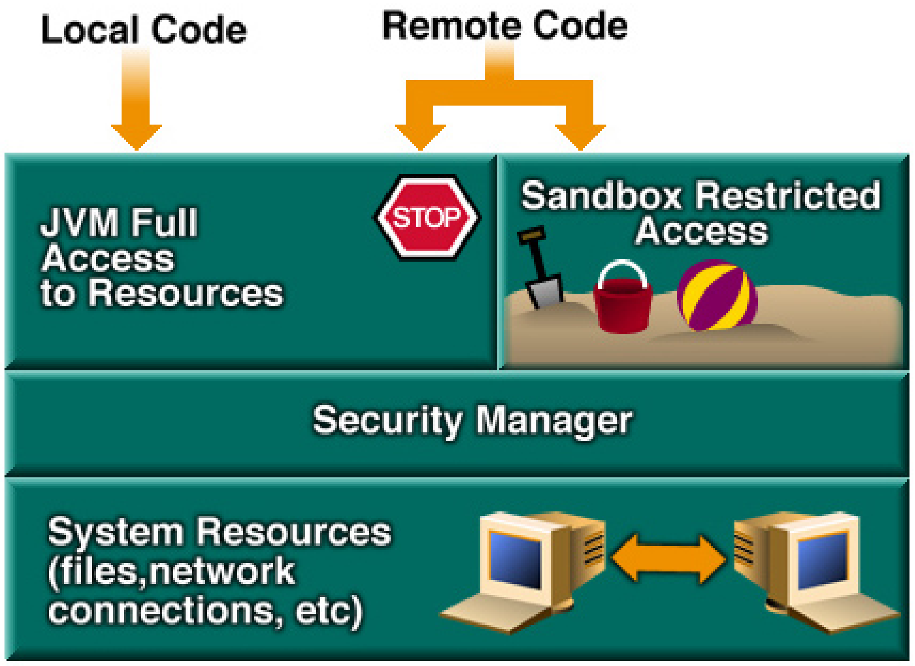
- The "Primordial" loader is built-in to the JVM
  - ➤ Sometimes called the "default" loader, but it's not extensible or customizable the way other loaders are
  - ➤ Loads classes from the platform on which the JVM runs (what are loader and JVM written in?)

- Applet class loader, RMI class loader, user loaders
  - ➤ Load .class files from URLs, from other areas of platform on which JVM runs
  - ➤ What's the order of sources consulted for loading, does this make a difference?
- Why implement a custom loader?
  - ➤ Work at Duke with JOIE

The Java ClassLoader

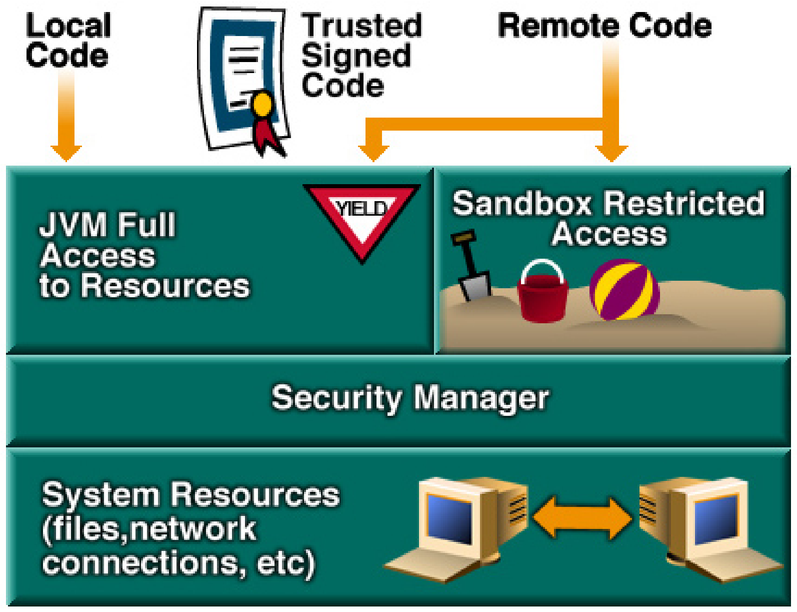
Security Manager

- Applets use a SecurityManager
  - ➤ Query for permissions
  - ➤ Supported by browsers by convention (would you use an “untrusted” browser)
- The picture shows JDK 1.0 model, “sandbox” restrictions supported by SecurityManager
  - ➤ Untrusted code restricted to the sandbox
  - ➤ All downloaded/applets are untrusted
  - ➤ Severely limits what a downloaded program can do


Local Code
Remote Code
JVM Full Access to Resources
STOP
Sandbox Restricted Access
Security Manager
System Resources (files,network connections, etc)

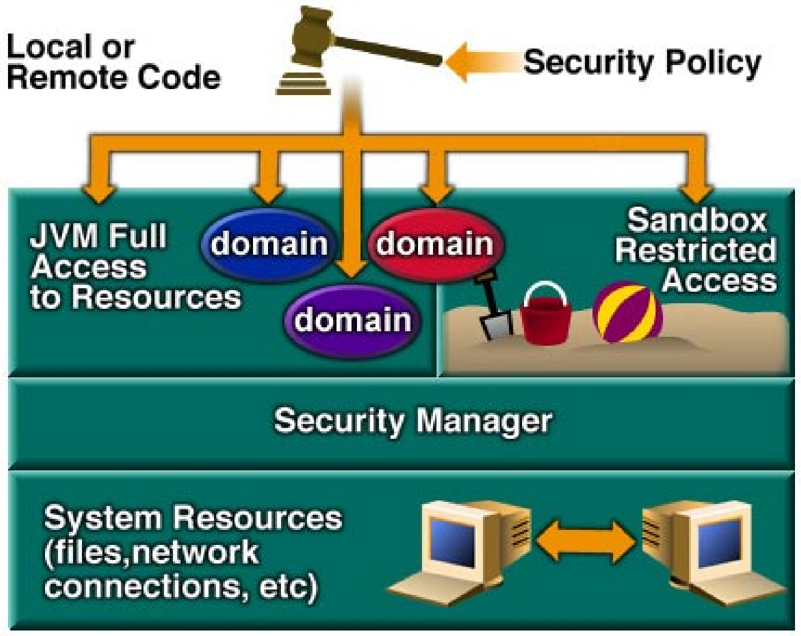
SecurityManager changes in JDK 1.1

- Applets support signing using digital signatures
  - Signature stored with code in JAR file that's downloaded
  - Clients support open/full access to "trusted" applets, some signatures ok
- Still "all-or-nothing", an applet is untrusted or completely trusted
  - What might be preferable?


Local Code
Trusted Signed Code
Remote Code
YIELD
JVM Full Access to Resources
Sandbox Restricted Access
Security Manager
System Resources (files,network connections, etc)

SecurityManager changes in JDK 1.2

- Policies are now supported
  - Allow more fine-grained control of access, permission
  - Based on location (URL) and/or digital signatures
  - Uses public/private key, applets don't need to be signed, can be from a trusted location
- Set policies on a systemwide basis using `policytool`
  - What about user-level permissions?


Local or Remote Code
Security Policy
JVM Full Access to Resources
domain
domain
domain
Sandbox Restricted Access
Security Manager
System Resources (files,network connections, etc)