

# CNT 4714: Enterprise Computing Fall 2011

## Introduction To Servlet Technology – Part 1

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# Client-Server Relationship Revisited

- In a client-server relationship, the client requests that some action be performed and the server performs the action and responds to the client.
- This **request-response model** of communication is the foundation for the highest-level view of networking in Java – **servlets** and **JavaServer Pages (JSP)**.
- A **servlet** extends the functionality of a server, such as a Web server that serves Web pages to a user's browser using the HTTP protocol. A servlet can almost be thought of as an applet that runs on the server side--without a face. Java servlets make many Web applications possible.
- Packages `javax.servlet` and `javax.servlet.http` provide the classes and interfaces to define servlets. Packages `javax.servlet.jsp` and `javax.servlet.jsp.tagext` provide the classes and interfaces that extend the servlet capabilities for JSP.



# Client-Server Relationship Revisited (cont.)

- Using special syntax, JSP allows Web-page implementers to create pages that encapsulate Java functionality and even to write scriptlets of actual Java code directly into the page.
- A common implementation of the request-response model is between Web browsers and Web servers. When a user selects a Web site to browse through the browser (the client application), a request is sent to the appropriate Web server (the server application). The server normally responds to the client by sending the appropriate XHTML Web page.
- Servlets are effective for developing Web-based solutions that help provide secure access to a Web site, interact with databases on behalf of a client, dynamically generate custom XHTML documents to be displayed by browsers and maintain unique session information for each client.



# Static and Dynamic Web Content

- Consider how a web page is displayed by a browser.
  - Typically, the web page is created using XHTML and stored as a file on the web server. A user enters a URL for the file from a web browser. The browser contacts the web server and requests the file. The server finds the file and returns it to the browser. The browser then displays the file for the user.
- Static information is stored in XHTML files. The XHTML files can be updated, but at any given time, every request for the same file returns exactly the same content. The contents do not change regardless of who requested the file.



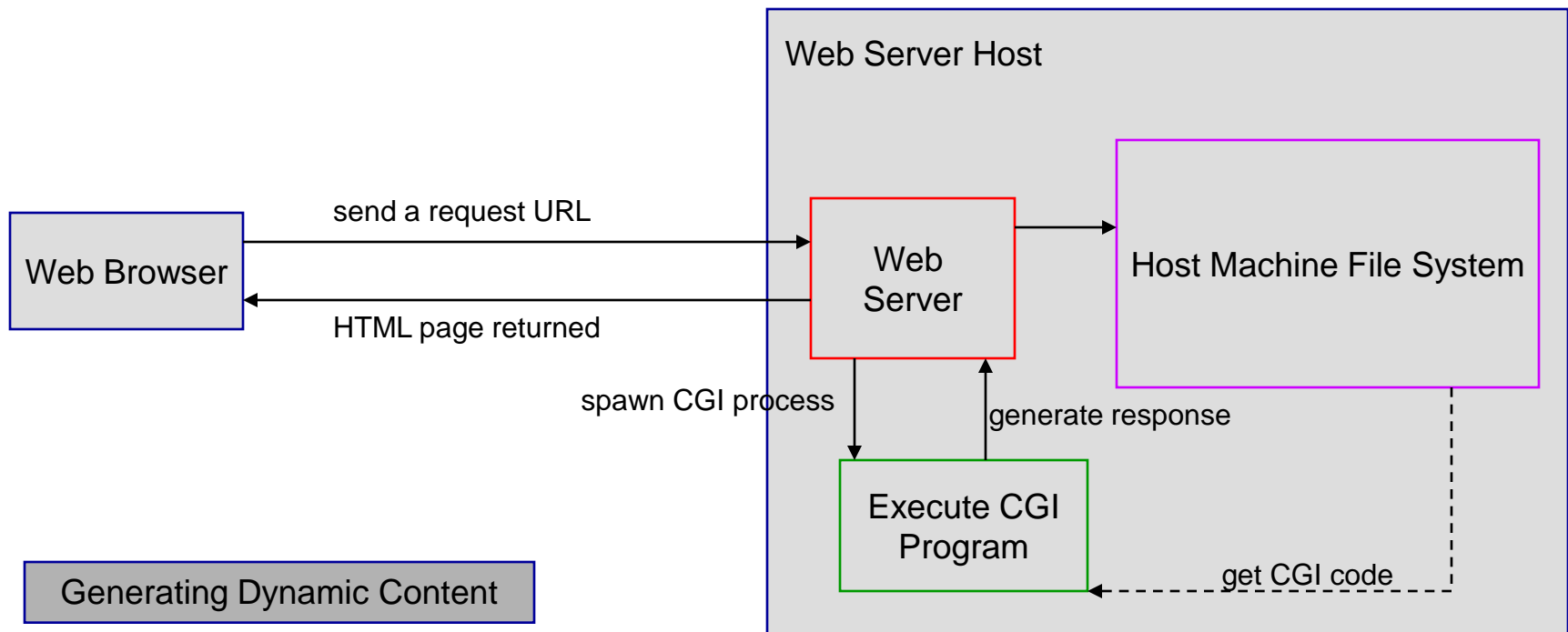
# Static and Dynamic Web Content (cont.)

- Not all information, however, is static in nature. Often XHTML pages need to generate information dynamically.
- Dynamic web pages are generated by web server. The web server will execute certain programs to process user requests from browsers in order to produce a customized response.
- The **Common Gateway Interface (CGI)** was proposed to generate dynamic web content. The interface provides a standard framework for web servers to interact with external program known as **CGI programs**.



# CGI Programming

- When a web server receives a request from a browser it passes it to the CGI program. The CGI program processes the request and generates a response at runtime. CGI programs can be written in any language, but Perl is the most popular choice.



# The GET and POST Methods

- The two most common HTTP requests, also known as methods, are GET and POST.
- The web browser issues a request using a URL or an XHTML form to trigger the web server to execute a CGI program. (We'll deal with forms later.) When issuing a CGI request directly from a URL, the GET method is used.
- This form of a URL is known as a **query string**. The URL query string consists of the location of the CGI program, parameters, and their values.
- When issuing a request from an XHTML form, either a GET or POST method can be used.



# The GET and POST Methods (cont.)

- The form explicitly specifies which of the two is used.
- If the GET method is used, the data in the form are appended to the request string as if they were submitted using a URL.
- If the POST method is used, the data in the form are packaged as part of the request file. The server program obtains the data by reading the file.

The GET and POST methods both send requests to the web server. The POST method always triggers the execution of the corresponding CGI program. The GET method may not cause the CGI program to be executed if the previous same request is cached in the web browser. Browsers often cache web pages so that the same request can be quickly responded to without contacting the web server. The browser checks the request sent through the GET method as a URL query string. If the results for the exact same URL are cached on a disk, then the previous web page for the URL may be displayed. To ensure that a new web page is always displayed, use the POST method.





# From CGI To Java Servlets

- CGI provides a relatively simple approach for creating dynamic web applications that accept a user request, process it on the server side, and return responses to the user's browser.
- However, CGI is extremely slow when handling a large number of requests simultaneously, because the web server must spawn a process for executing each CGI program.
- Java servlets were developed to remedy the performance problem of CGI programs. Java servlets are basically Java programs that behave like CGI programs.



# Java Servlets

- Java servlets are executed upon request from a web browser.
- All servlets execute inside a **servlet container**, also referred to as a **servlet server** or a **servlet engine**.
- A servlet container is a single process that runs a JVM (Java Virtual Machine). The JVM creates a thread to handle each servlet (recall that threads have considerably less overhead than full-blown processes). All the threads share the same memory allocated to the JVM. Since the JVM persists beyond the lifecycle of a single servlet execution, servlets can share objects already created in the JVM.
  - For example, if multiple servlets access the same database, they can share the connection object.



# Thin Clients

- Servlets are the ideal solution for database-intensive applications that communicate with **thin clients**.
  - **Thin clients** are applications that provide presentation but do not process data, thus requiring few computing resources.
- The server is responsible for database access. Clients connect to the server using standard protocols available on most client platforms. The presentation-logic code for generating dynamic content can be written once and reside on the server for access by clients, to allow programmers to create efficient thin clients.



# Apache Tomcat Server

- Sun Microsystems, through the Java Community Process is responsible for the development of the servlet and JSP specifications.
- To run Java servlets, you need a [servlet container](#). While many servlet containers are available, the reference implementation of both these standards developed by the Apache Software Foundation ([www.apache.org](http://www.apache.org)) is known as Tomcat.
- Tomcat was developed as part of the Jakarta Project. The Jakarta Project contains many subprojects designed to help commercial server-side developers.
- Tomcat became a top-level project at Apache in early October 2005.
- Tomcat is the official reference implementation of the JSP and servlet standards. Tomcat can be used standalone as a web server or plugged into a web server like Apache, IIS (Internet Information Services), etc.. The current stable implementation is Tomcat 7.0.21 (as of February 4, 2011).



# Servlet Overview and Architecture

- The Internet offers many protocols. The HTTP (Hypertext Transfer Protocol) that forms the basis of the WWW uses URLs (Uniform Resource Locators) to locate resources on the Internet.
- URLs can represent files or directories and can represent complex tasks such as database lookups and Internet searches.
- JSP technology, basically an extension of servlet technology, simplifies the process of creating pages by separating presentation from content.
- Typically, JSPs are used when most of the content sent to the client is static text and markup, and only a small portion of the content is generated dynamically with Java code.



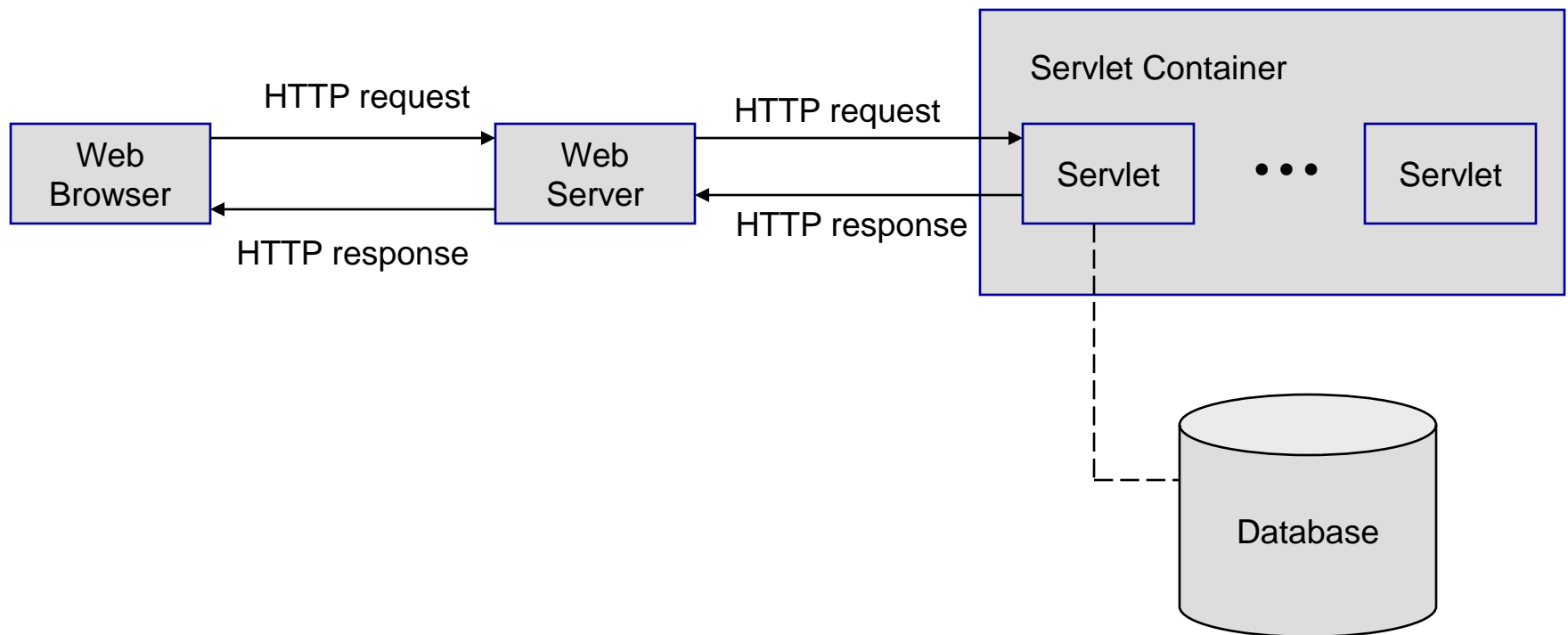
# Servlet Overview and Architecture (cont.)

- Servlets are more commonly used when a small portion of the content sent to the client is static text or markup. In fact, some servlets do not produce content. Rather, they perform a task on behalf of the client, then invoke other servlets or JSPs to provide a response.
- Note that in most cases servlet and JSP technologies are interchangeable.
- The server that executes a servlet is referred to as the  **servlet container**  or  **servlet engine** .
- Servlets and JSP have become so popular that they are now supported directly or with third-party plug-ins by most major Web servers and application servers (servers that execute applications to generate dynamic Web pages in response to requests).



# Servlet Overview and Architecture (cont.)

- We'll look at servlets that implement the request-response model between clients and servers using the HTTP protocol. This architecture is shown in the diagram below.



# Servlet Overview and Architecture (cont.)

## Explanation of the architecture diagram on previous page

- A client application sends an HTTP request to the server.
- The servlet container receives the request and directs it to be processed by the appropriate servlet.
- The servlet does its processing, which may include interacting with a database or other server-side components, such as other servlets or JSPs.
- The servlet returns its results to the client – normally in the form of an HTML, XHTML, or XML document to display in a browser.





# Interface Servlet and the Servlet Lifecycle

- Architecturally speaking, all servlets must implement the `Servlet` interface of package `javax.servlet`.
- The methods of interface `Servlet` are invoked by the servlet container. This interface declares five methods which deal with the execution of a servlet. These methods are shown on the next page. For the details see: [www.java.sun.com/j2ee/1.4/docs/api/javax/servlet/Servlet.html](http://www.java.sun.com/j2ee/1.4/docs/api/javax/servlet/Servlet.html)
- A servlet's life cycle begins when the servlet container loads it into memory – normally, in response to the first request for the servlet.
- Before the servlet can handle that request, the container invokes the servlet's `init` method.



# Methods of the Servlet Interface

Method	Description
<code>destroy( )</code>	Called by the servlet container to indicate to a servlet that the servlet is being taken out of service.
<code>getServletConfig( )</code>	Returns a <code>ServletConfig</code> object, which contains initialization and startup parameters for this servlet.
<code>getServletInfo( )</code>	Returns information about the servlet, such as author, version, and copyright.
<code>init( )</code>	Called by the servlet container to indicate to a servlet that the servlet is being placed into service.
<code>service( )</code>	Called by the servlet container to allow the servlet to respond to a request.



# The Servlet Lifecycle

- After `init` completes execution, the servlet can respond to its first request.
- All requests are handled by the a servlet's `service` method, which receives the request, processes it and sends a response to the client.
- During the servlet's lifecycle, the method `service` is invoked once per request. Each new request is typically handled in a separate thread of execution (managed by the servlet container) in which method `service` executes.
- When the servlet container terminates the servlet (whenever the servlet needs more memory or when it is shutdown), the servlet's `destroy` method is invoked to release servlet resources.



# Setting Up Tomcat

- Tomcat is a fully functional implementation of servlets and JSPs. It includes a Web server, so it can be used as a standalone test container for servlets and JSPs.
  - The current stable version is 7.0.22 available from [www.apache.org](http://www.apache.org). This version was declared stable on September 27, 2011.
1. Select the Tomcat page from the menu on the left-hand side of the screen (its way down the page). As shown on page 21.
  2. Once in the Tomcat project, select Download Tomcat 7.0.22 from the left-hand side of the screen as shown on page 22.
  3. Once in the download binaries screen, select the option of your choice. This is shown on page 24.



Welcome to The Apache Software Foundation! - Windows Internet Explorer

http://www.apache.org/ tomcat

File Edit View Favorites Tools Help

Google tomcat Search Share Sign In Convert Select

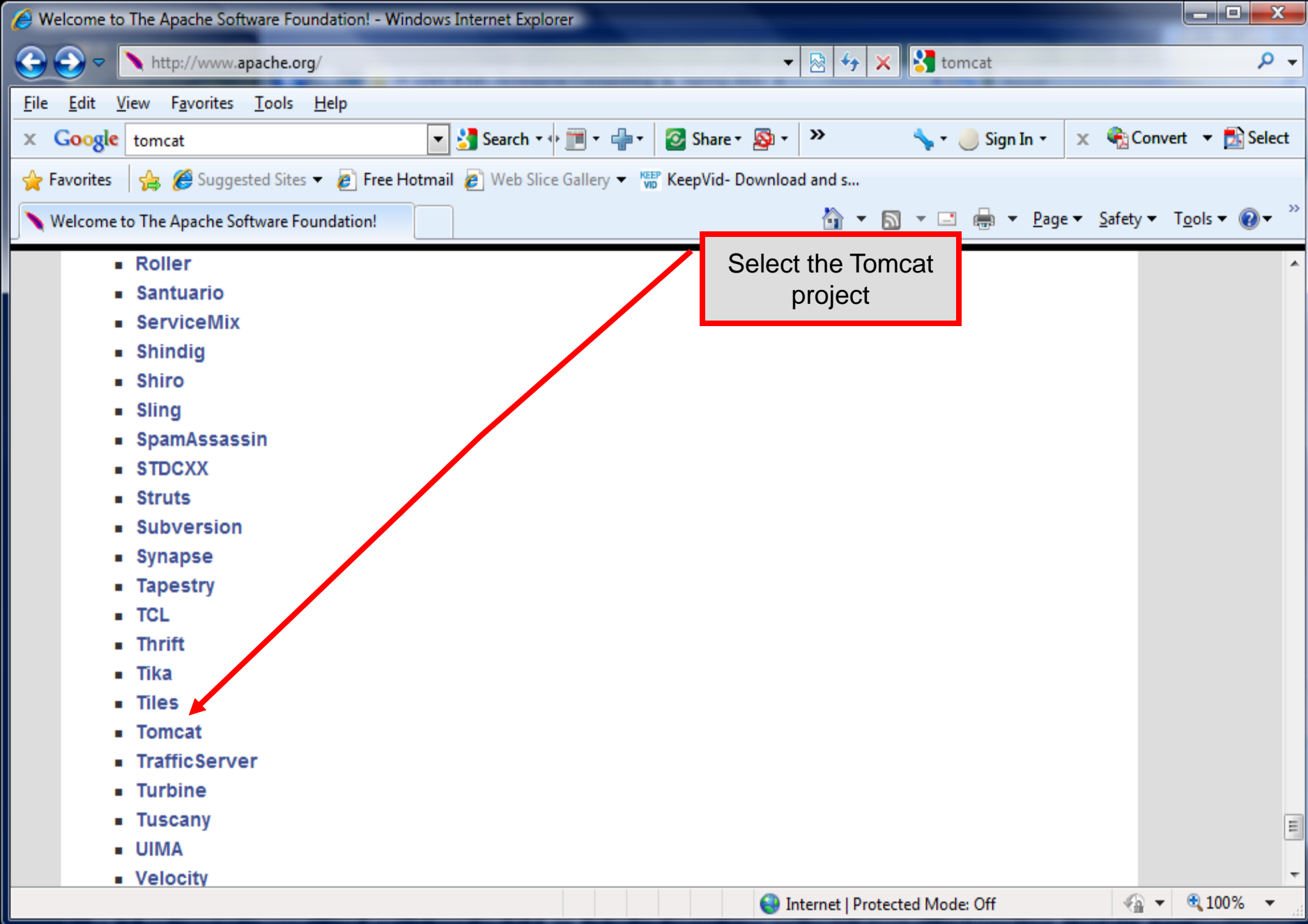
Favorites Suggested Sites Free Hotmail Web Slice Gallery KeepVid- Download and s...

Welcome to The Apache Software Foundation!

- Roller
- Santuario
- ServiceMix
- Shindig
- Shiro
- Sling
- SpamAssassin
- STDCXX
- Struts
- Subversion
- Synapse
- Tapestry
- TCL
- Thrift
- Tika
- Tiles
- Tomcat
- TrafficServer
- Turbine
- Tuscany
- UIMA
- Velocity

Select the Tomcat project

Internet | Protected Mode: Off 100%





http://tomcat.apache.org/

File Edit View Favorites Tools Help

Google tomcat Search Share Sign In Convert Select

Apache Tomcat - Welcome!


Apache Tomcat

The Apache Software Foundation  
http://www.apache.org/

Search the Site Search Site

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## Apache Tomcat

**Apache Tomcat**

- [Home](#)
- [Taglibs](#)

**Download**

- [Which version?](#)
- [Tomcat 7.0](#)
- [Tomcat 6.0](#)
- [Tomcat 5.5](#)
- [Tomcat Connectors](#)
- [Tomcat Native](#)
- [Archives](#)

Apache Tomcat is an open source software implementation of the Java Servlet and JavaServer Pages technologies. The Java Servlet and JavaServer Pages specifications are developed under the [Java Community Process](#).

Apache Tomcat is developed in an open and participatory environment and released under the [Apache License version 2](#). Apache Tomcat is intended to be a collaboration of the best-of-breed developers from around the world. We invite you to participate in this open development project. To learn more about getting involved, [click here](#).

Apache Tomcat powers numerous large-scale, mission-critical web applications across a diverse range of industries and organizations. Some of these users and their stories are listed on the [PoweredBy](#) wiki page.

Apache Tomcat, Tomcat, Apache, the Apache feather, and the Apache Tomcat project logo are trademarks

Internet | Protected Mode: Off 100%





Apache Tomcat

Apache Software Foundation  
http://www.apache.org/

Search the Site Search Site

Apache Tomcat Versions

Apache Tomcat

- [Home](#)
- [Taglibs](#)
- [Maven Plugin](#)

Apache Tomcat is an open source software implementation of the Java Servlet and JavaServer Pages technologies. Different versions of Apache Tomcat are available for different versions of the Servlet and JSP specifications. The mapping between the specifications and the respective Apache Tomcat versions is:

Download

- [Which version?](#)
- [Tomcat 7.0](#)
- [Tomcat 6.0](#)
- [Tomcat 5.5](#)
- [Tomcat Connectors](#)
- [Tomcat Native](#)
- [Archives](#)

Servlet/JSP Spec	Apache Tomcat version	Actual release revision	Minimum Java Version
3.0/2.2	7.0.x	7.0.22	1.6
2.5/2.1	6.0.x	6.0.33	1.5
2.4/2.0	5.5.x	5.5.34	1.4
2.3/1.2	4.1.x (archived)	4.1.40 (archived)	1.3
2.2/1.1	3.3.x (archived)	3.3.2 (archived)	1.1



• [IRC](#)

## 7.0.22

### Get Involved

- [Overview](#)
- [SVN Repositories](#)
- [Buildbot](#)
- [Reviewboard](#)

Please see the [README](#) file for package distribution contains.

Select the download version you need. Select Windows Executable for a Windows installer version.

## Binary Distributions

### Media

- [Blog](#)
- [Twitter](#)

### Misc

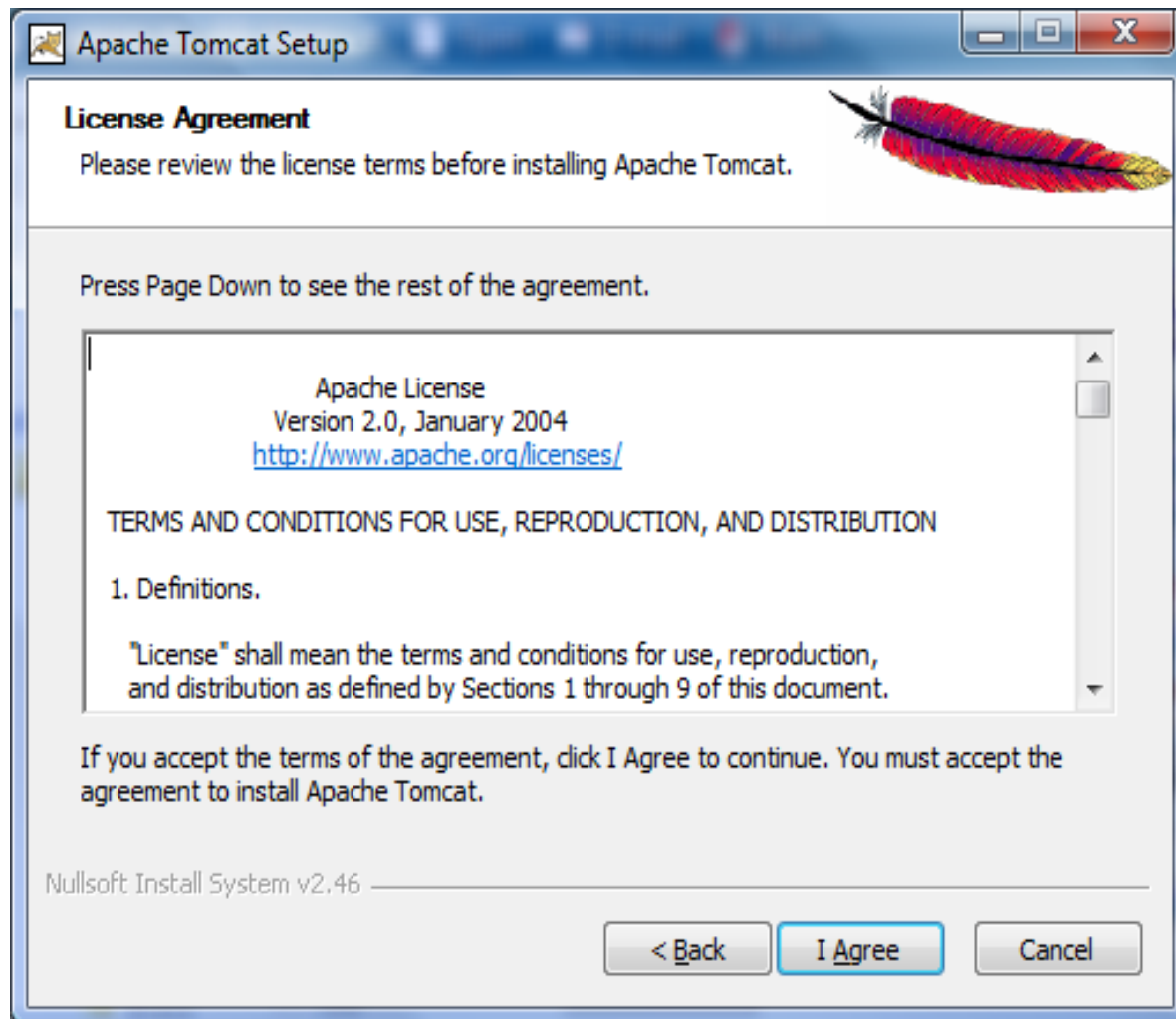
- [Who We Are](#)
- [Heritage](#)
- [Apache Home](#)
- [Resources](#)
- [Contact](#)
- [Legal](#)
- [Sponsorship](#)

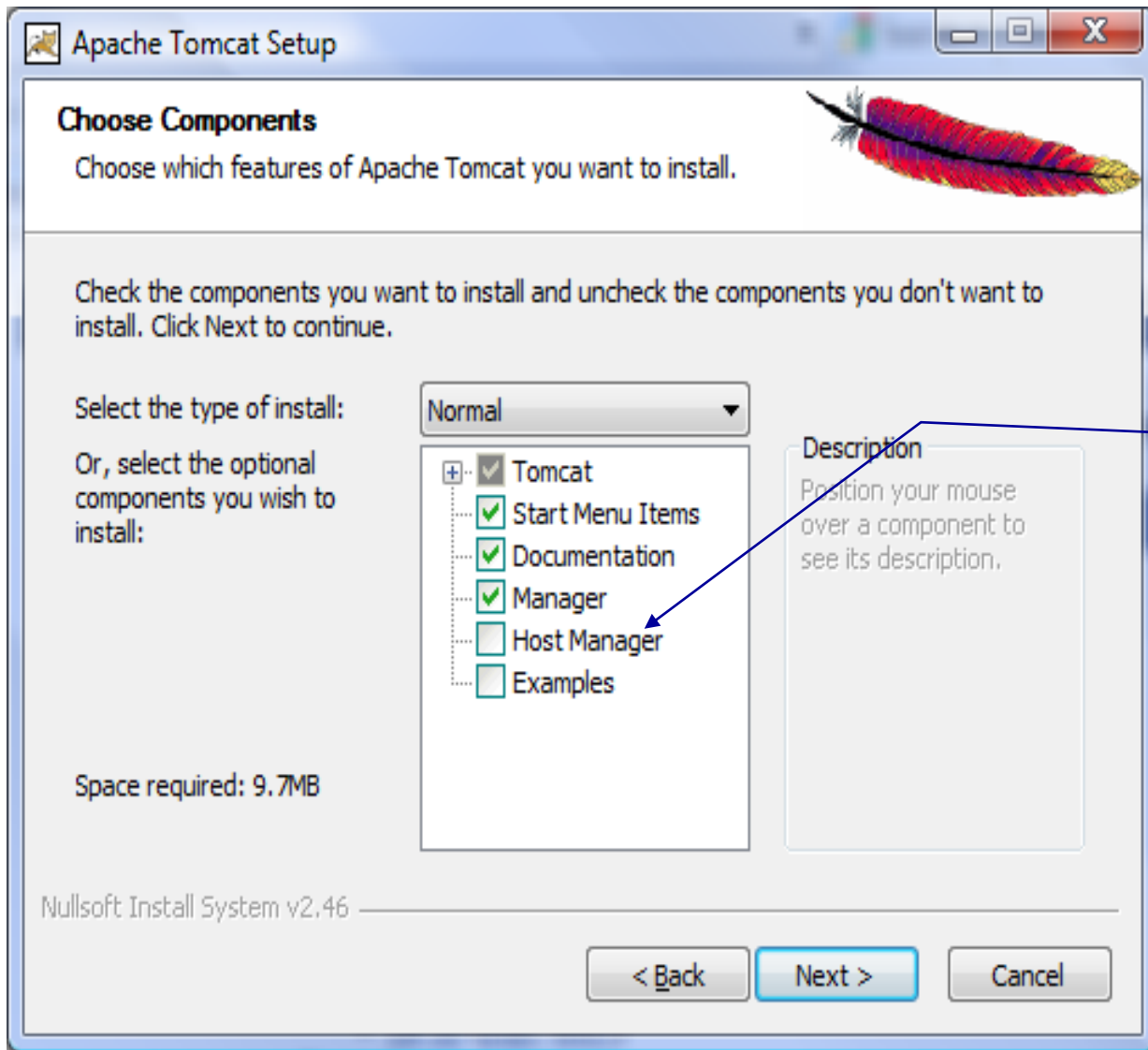
- Core:
  - [zip \(pgp, md5\)](#)
  - [tar.gz \(pgp, md5\)](#)
  - [32-bit Windows zip \(pgp, md5\)](#)
  - [64-bit Windows zip \(pgp, md5\)](#)
  - [64-bit Itanium Windows zip \(pgp, md5\)](#)
  - [32-bit/64-bit Windows Service Installer \(pgp, md5\)](#)
- Full documentation:
  - [tar.gz \(pgp, md5\)](#)
- Deployer:
  - [zip \(pgp, md5\)](#)
  - [tar.gz \(pgp, md5\)](#)
- Extras:
  - [JMX Remote jar \(pgp, md5\)](#)
  - [Web services jar \(pgp, md5\)](#)












The host manager will not be selected in the default setting. Be sure to check its box. You can decide whether or not to include the examples.



**Apache Tomcat Setup: Configuration Options**

**Configuration**  
Tomcat basic configuration.



Server Shutdown Port: 8005

HTTP/1.1 Connector Port: 8080

AJP/1.3 Connector Port: 8009

Windows Service Name: Tomcat7.0.22

Create shortcuts for all users:

Tomcat Administrator Login (optional)

User Name: admin

Password: ●●●●●

Roles: admin-gui,manager-gui

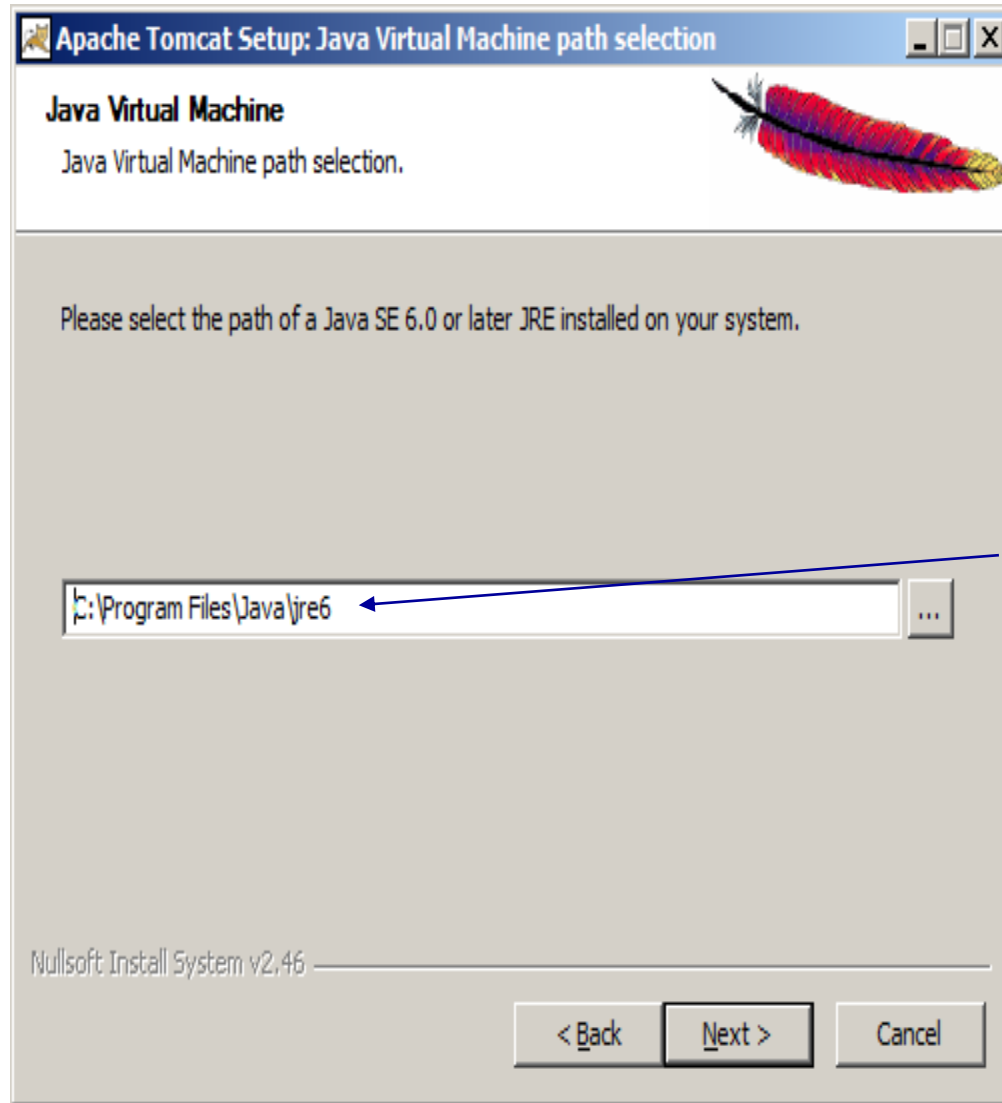
Nullsoft Install System v2.46

< Back   Next >   Cancel

Port 8080 is the default Tomcat connector port. Unless you have a conflict with this port, use this for Tomcat. When we setup Apache later, we'll put in on a different connector port so that both servers can be running simultaneously.

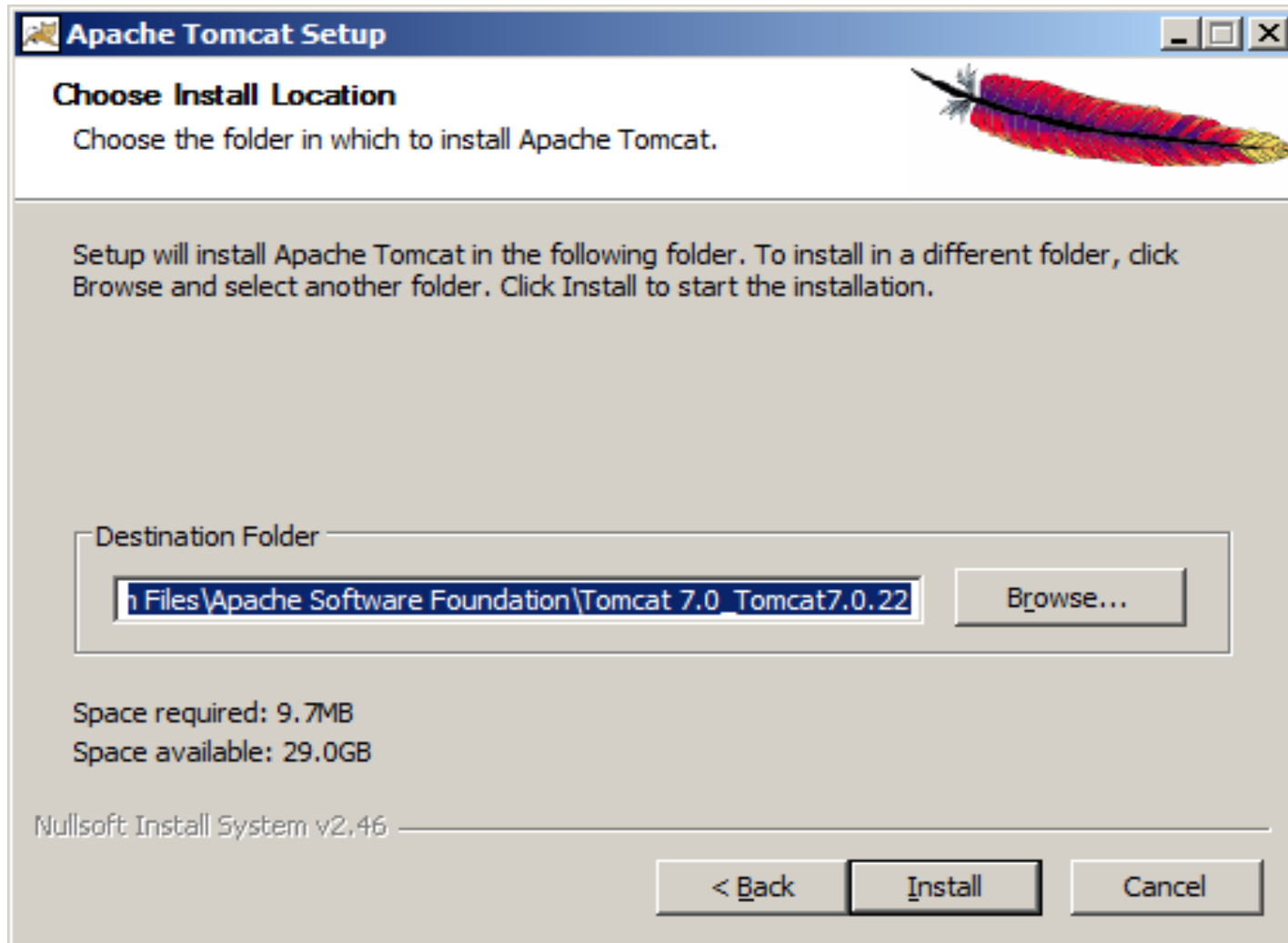
Set up a Tomcat Administrator login so that you can manage your Tomcat server more easily. This will be very important when you are deploying your servlets.

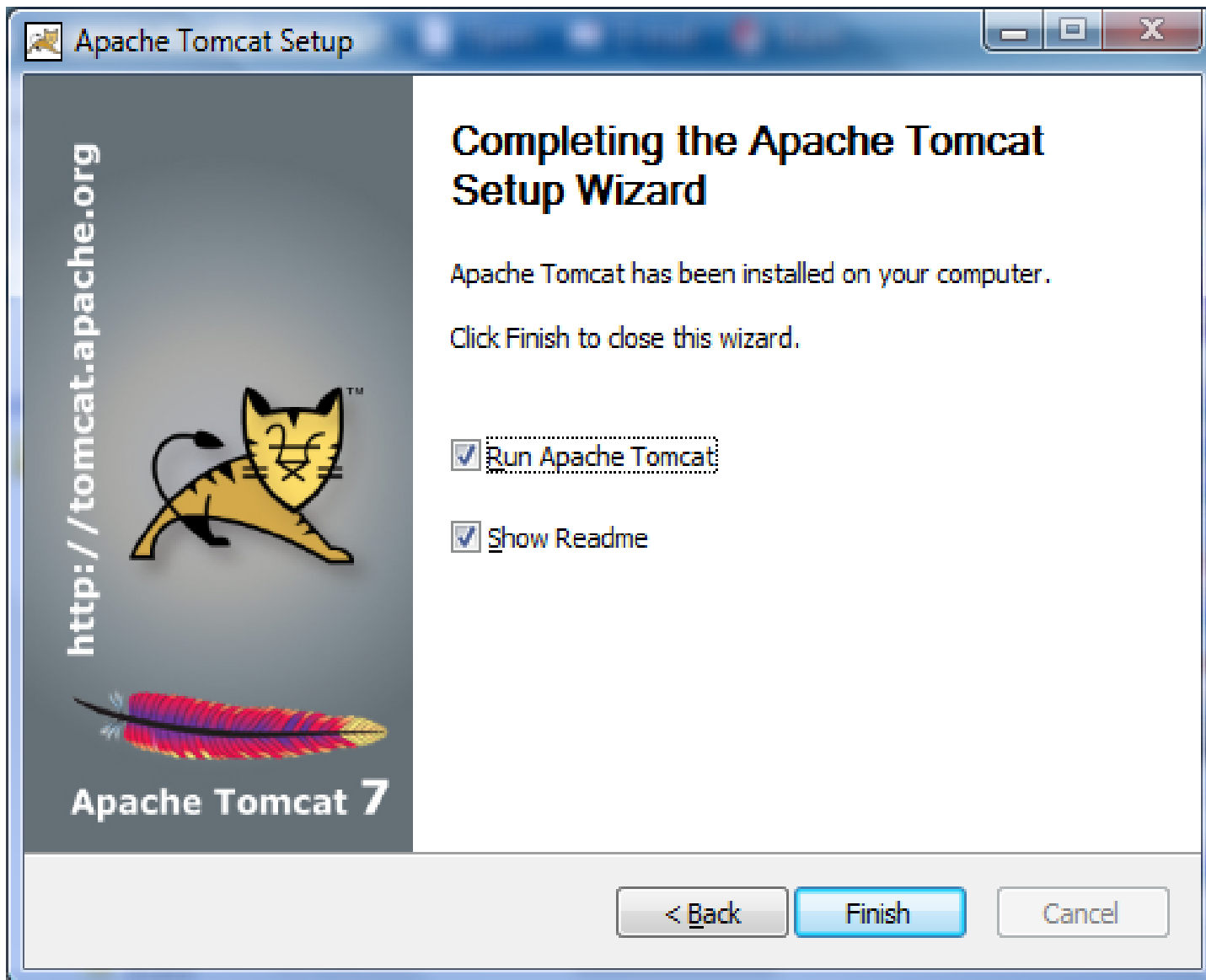




The installer should find the path to your Java jre. If you have more than one, be sure it is set to the one you want to use.







```
C:\Program Files\Apache Software Foundation\Tomcat 7.0_Tomcat7.0.21\webapps\ROOT\RELEASE-NOTES.txt - Notepad++
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?
license.txt RELEASE-NOTES.txt
1 =====
2 Licensed to the Apache Software Foundation (ASF) under one or more
3 contributor license agreements. See the NOTICE file distributed with
4 this work for additional information regarding copyright ownership.
5 The ASF licenses this file to You under the Apache License, Version 2.0
6 (the "License"); you may not use this file except in compliance with
7 the License. You may obtain a copy of the License at
8
9     http://www.apache.org/licenses/LICENSE-2.0
10
11 Unless required by applicable law or agreed to in writing, software
12 distributed under the License is distributed on an "AS IS" BASIS,
13 WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
14 See the License for the specific language governing permissions and
15 limitations under the License.
16 =====
17
18 $Id: RELEASE-NOTES 1157872 2011-08-15 15:03:57Z markt $
19
20
21     Apache Tomcat Version 7.0.21
22     Release Notes
23
24
Normal text file      length : 9060  lines : 229      Ln:19  Col:1  Sel:0      Dos\Windows  ANSI  INS
```





# Setting Up Tomcat

- Once you've downloaded and installed Tomcat you're ready to run a demonstration test that will tell you if you've got everything set-up properly.

**NOTE:** During the install, Tomcat will ask you which TCP port Tomcat should run on (See page 28). To avoid any conflict with standard Web servers which default to TCP port 80, Tomcat is set to default to TCP port 8080. If you have any other service running on this port change the port number at this time to one on which no conflict will occur.

In all subsequent examples, I'm running Tomcat on TCP port 8080.



# Starting Up Tomcat

- Once Tomcat is installed, you need to start it as a service. On Windows machines, the current versions of Tomcat are installed as a service that will start when Windows starts. On Unix/Linux a startup.sh file is included so you just type startup (assuming you are in the bin directory where you located Tomcat).
  1. Start Tomcat running.
  2. Start your Web browser.
  3. Enter URL: <http://localhost:8080>
  4. You should see the screen on the following page if everything is set up ok.




Apache Tomcat/7.0.22 - Windows Internet Explorer

http://localhost:8080/

Tomcat default homepage


Home Documentation Configuration Examples Wiki Mailing Lists Find Help

# Apache Tomcat/7.0.22



The Apache Software Foundation  
http://www.apache.org/

If you're seeing this, you've successfully installed Tomcat.  
Congratulations!



Recommended Reading:

- [Security Considerations HOW-TO](#)
- [Manager Application HOW-TO](#)
- [Clustering/Session Replication HOW-TO](#)

Server Status  
Manager App  
Host Manager

Developer Quick Start

- [Tomcat Setup](#)
- [First Web Application](#)

Servlet Specifications  
Tomcat Versions


Click the Server Status link and you'll see the screen on the next page.

Done Local intranet | Protected Mode: Off 100%



If you set up an administrator login when you click on the these items this window will pop-up to enter your administrator credentials.

**Connect to localhost**



The server localhost at Tomcat Manager Application requires a username and password.

Warning: This server is requesting that your username and password be sent in an insecure manner (basic authentication without a secure connection).

User name:

Password:

Remember my password

OK Cancel

ling Lists Find Help

**Software Foundation**  
//www.apache.org/

alled Tomcat.

Server Status

Manager App

Host Manager

Servlet Specifications

Tomcat Versions





## Server Status

### Manager

- [List Applications](#)
- [HTML Manager Help](#)
- [Manager Help](#)
- [Complete Server Status](#)

### Server Information

Tomcat Version	JVM Version	JVM Vendor	OS Name	OS Version	OS Architecture	Hostname	IP Address
Apache Tomcat/7.0.22	1.6.0_27-b07	Sun Microsystems Inc.	Windows Server 2008	6.0	x86	WIN-OGZ0HXCQGAX	192.168.9.128

### TVM



Tomcat Web App Manager will be a very useful tool for you when deploying and developing servlets. Get to know it now.



# Tomcat Web Application Manager

Message: OK

## Manager

[List Applications](#)   [HTML Manager Help](#)   [Manager Help](#)   [Server Status](#)

## Applications

Path	Version	Display Name	Running	Sessions	Commands
/	None	Welcome to Tomcat	true	0	<input type="button" value="Start"/> <input type="button" value="Stop"/> <input type="button" value="Reload"/> <input type="button" value="Undeploy"/>

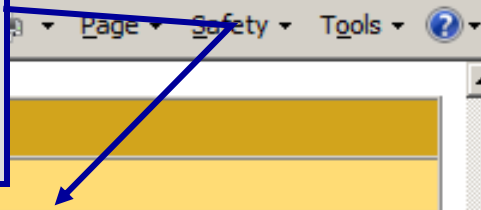


When the underlying code for a servlet is modified, you need to reload the servlet on the server in order for the clients to see the changes.

**CAUTION!** Undeploy removes all servlet files from the server!

### Applications

Path	Version	Display Name	Running	Sessions	Commands
/	None specified	Welcome to Tomcat	true	0	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/docs	None specified	Tomcat Documentation	true	0	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/host-manager	None specified	Tomcat Host Manager Application	true	0	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
/manager	None specified	Tomcat Manager Application	true	1	Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes



We won't be using the Tomcat Virtual Host Manager tool. This is a Tomcat tool that is useful when Tomcat is hosting several virtual server.



## Tomcat Virtual Host Manager

Message: OK

- [Host Manager](#)
- [List Virtual Hosts](#)
- [HTML Host Manager Help \(TODO\)](#)
- [Host Manager Help \(TODO\)](#)
- [Server Status](#)

Host name		
Host name	Host aliases	Commands
localhost		Host Manager installed - commands disabled

