CNT 4714: Enterprise Computing Spring 2012

Introduction To Servlet Technology – Part 1

Instructor : Dr. Mark Llewellyn
markl@cs.ucf.edu
HEC 236, 4078-823-2790
http://www.cs.ucf.edu/courses/cnt4714/spr2012

Department of Electrical Engineering and Computer Science
Computer Science Division
University of Central Florida

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 scriplets 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

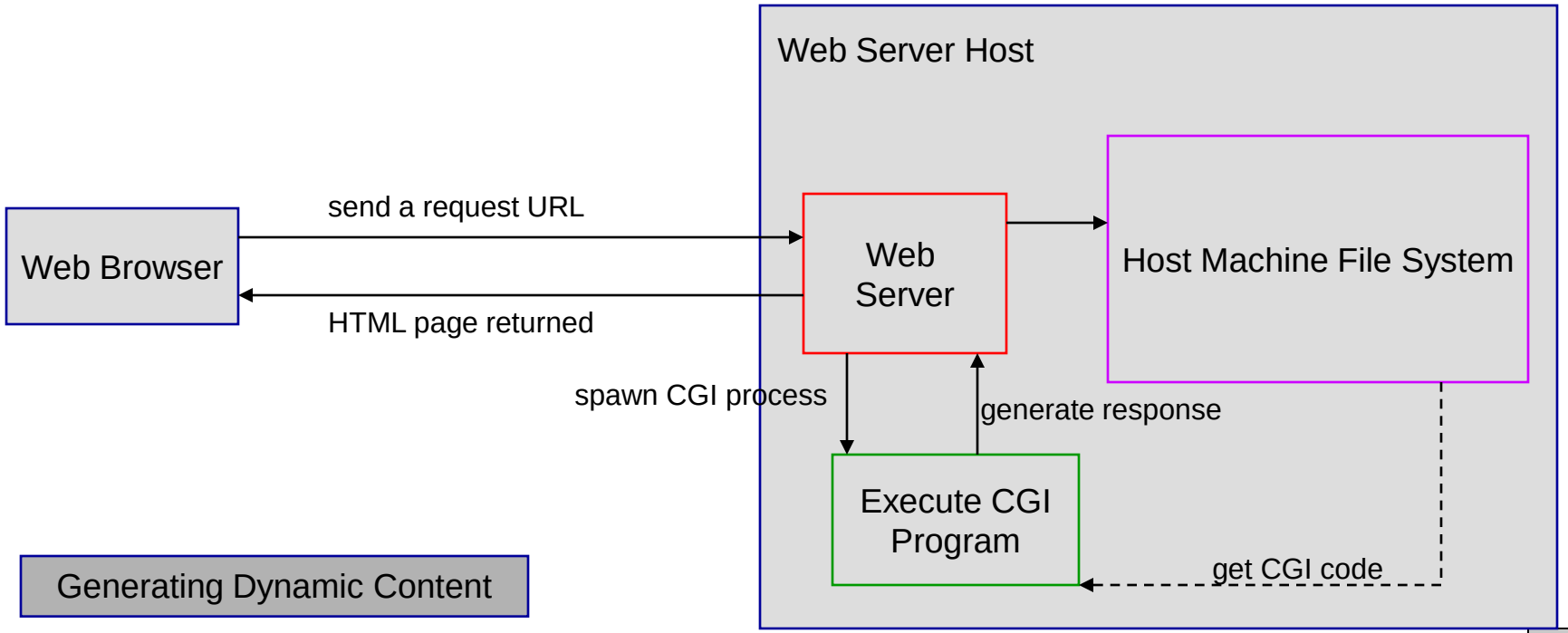
- Consider how a web page is displayed by a browser.
  - Typically, the web page is created using XHTML and stored as a file on the web server. A user enters a URL for the file from a web browser. The browser contacts the web server and requests the file. The server finds the file and returns it to the 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) 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 7.0.25 (as of January 21, 2012).

Servlet Overview and Architecture

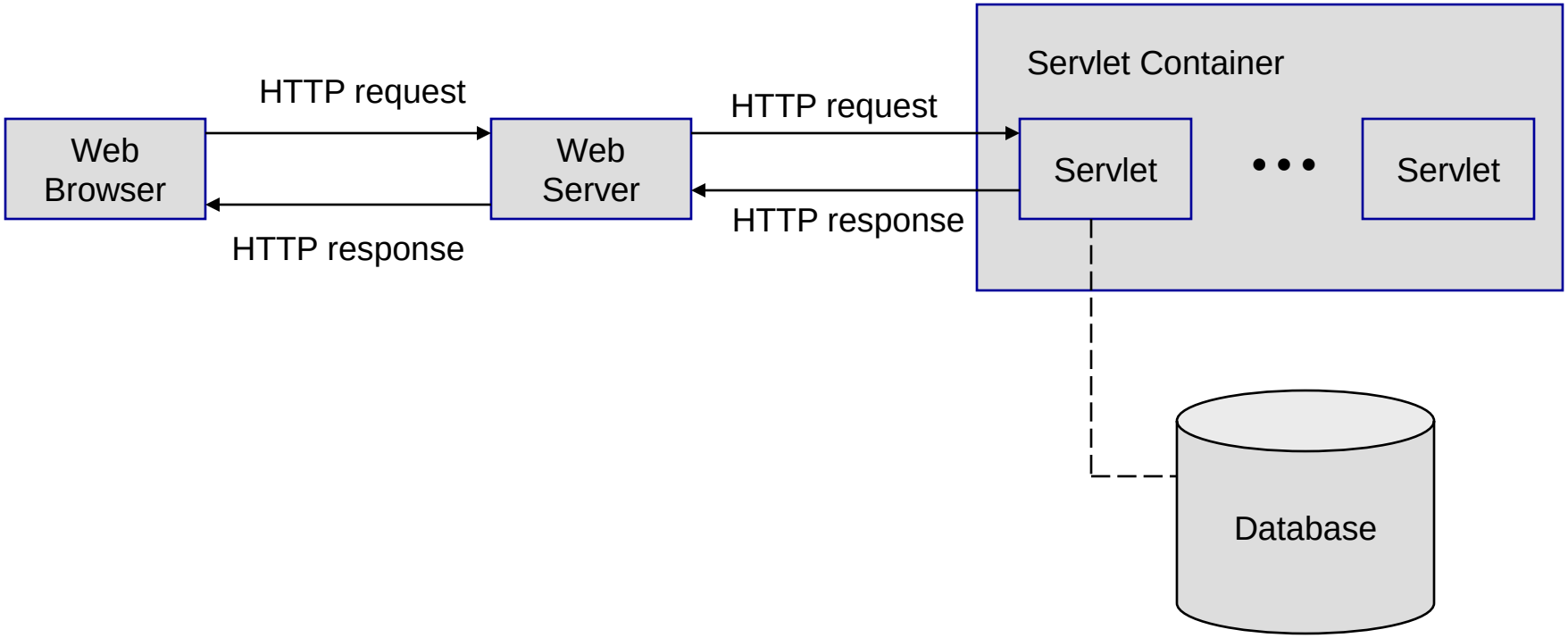
- The Internet offers many protocols. The HTTP (Hypertext Transfer Protocol) that forms the basis of the WWW uses URLs (Uniform Resource Locators) to locate resources on the Internet.
- URLs can represent files or directories and can represent complex tasks such as database lookups and Internet searches.
- 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
- 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
destroy( )	Called by the servlet container to indicate to a servlet that the servlet is being taken out of service.
getServletConfig( )	Returns a ServletConfig object, which contains initialization and startup parameters for this servlet.
getServletInfo( )	Returns information about the servlet, such as author, version, and copyright.
init( )	Called by the servlet container to indicate to a servlet that the servlet is being placed into service.
service( )	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

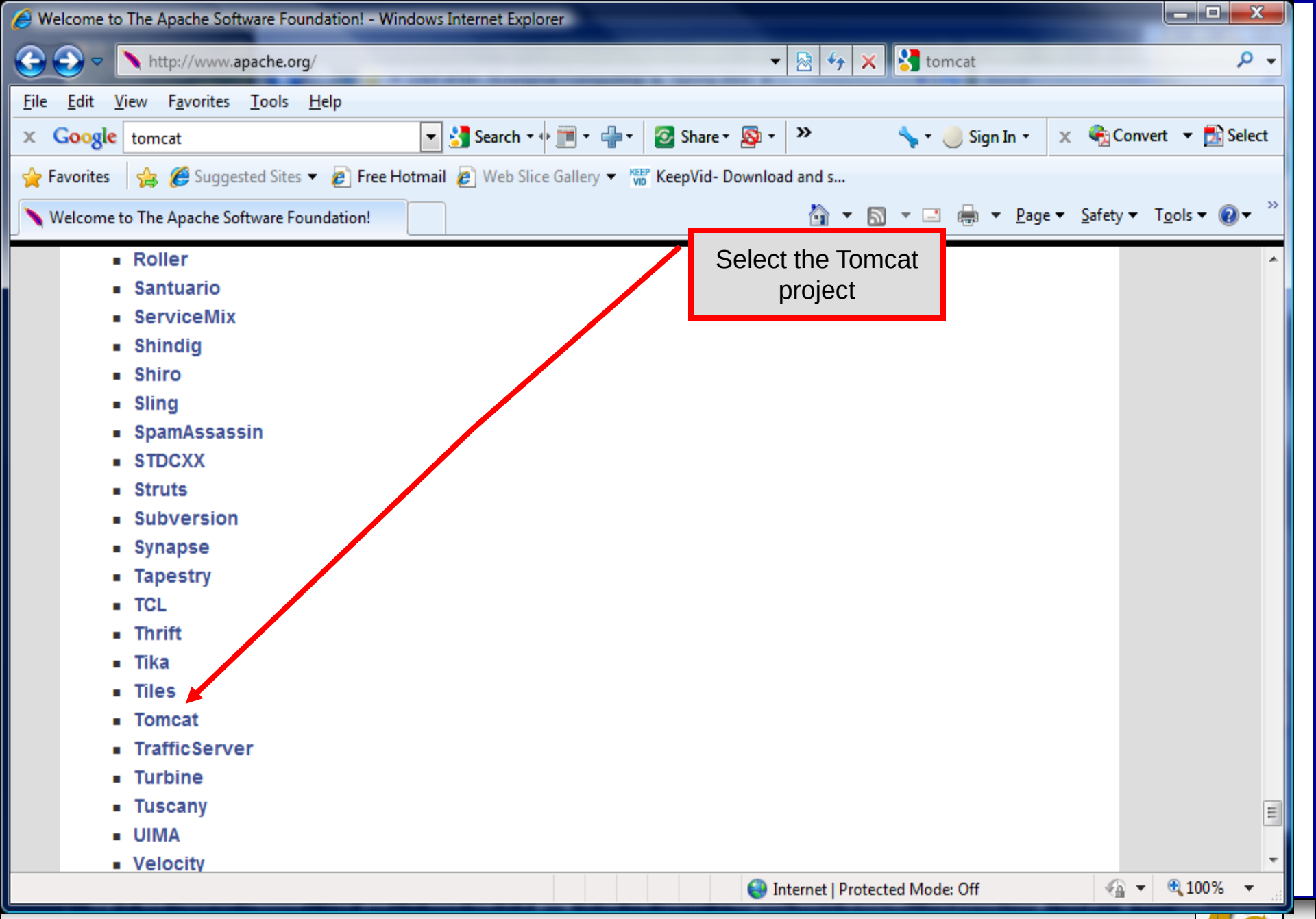
- Tomcat is a fully functional implementation of servlets and JSPs. It includes a Web server, so it can be used as a standalone test container for servlets and JSPs.

- The current stable version is 7.0.25 available from www.apache.org. This version was declared stable on January 21, 2012.

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 7.0.25 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.



Select the Tomcat project


Apache Tomcat - Welcome! - Windows Internet Explorer
Type to search the web (Ctrl+E)
http://tomcat.apache.org/
Google
File Edit View Favorites Tools Help
Convert Select
Search More
Sign In
Favorites
Suggested Sites
Free Hotmail
Web Slice Gallery
KeepVid- Download and s...
Apache Tomcat - Welcome!
Page Safety Tools
Apache Tomcat
The Apache Software Foundation
http://www.apache.org/
Search the Site
Search Site
Apache Tomcat
Home
Taglibs
Maven Plugin
Download
Which version?
Tomcat 7.0
Tomcat 6.0
Tomcat 5.5
Tomcat Connectors
Apache Tomcat
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
http://www.apache.org/
Internet | Protected Mode: Off
100%

Apache Tomcat - Which Version Do I Want? - Windows Internet Explorer

http://tomcat.apache.org/whichversion.html

Live Search

File Edit View Favorites Tools Help

Favorites Suggested Sites Web Slice Gallery

Apache Tomcat - Which Version Do I Want?

Page Safety Tools

Search the Site Search Site

Apache Tomcat

- Home
- Taglibs
- Maven Plugin

Download

- Which version?
- Tomcat 7.0
- Tomcat 6.0
- Tomcat 5.5
- Tomcat Connectors
- Tomcat Native
- Archives

Documentation

- Tomcat 7.0

Apache Tomcat Versions

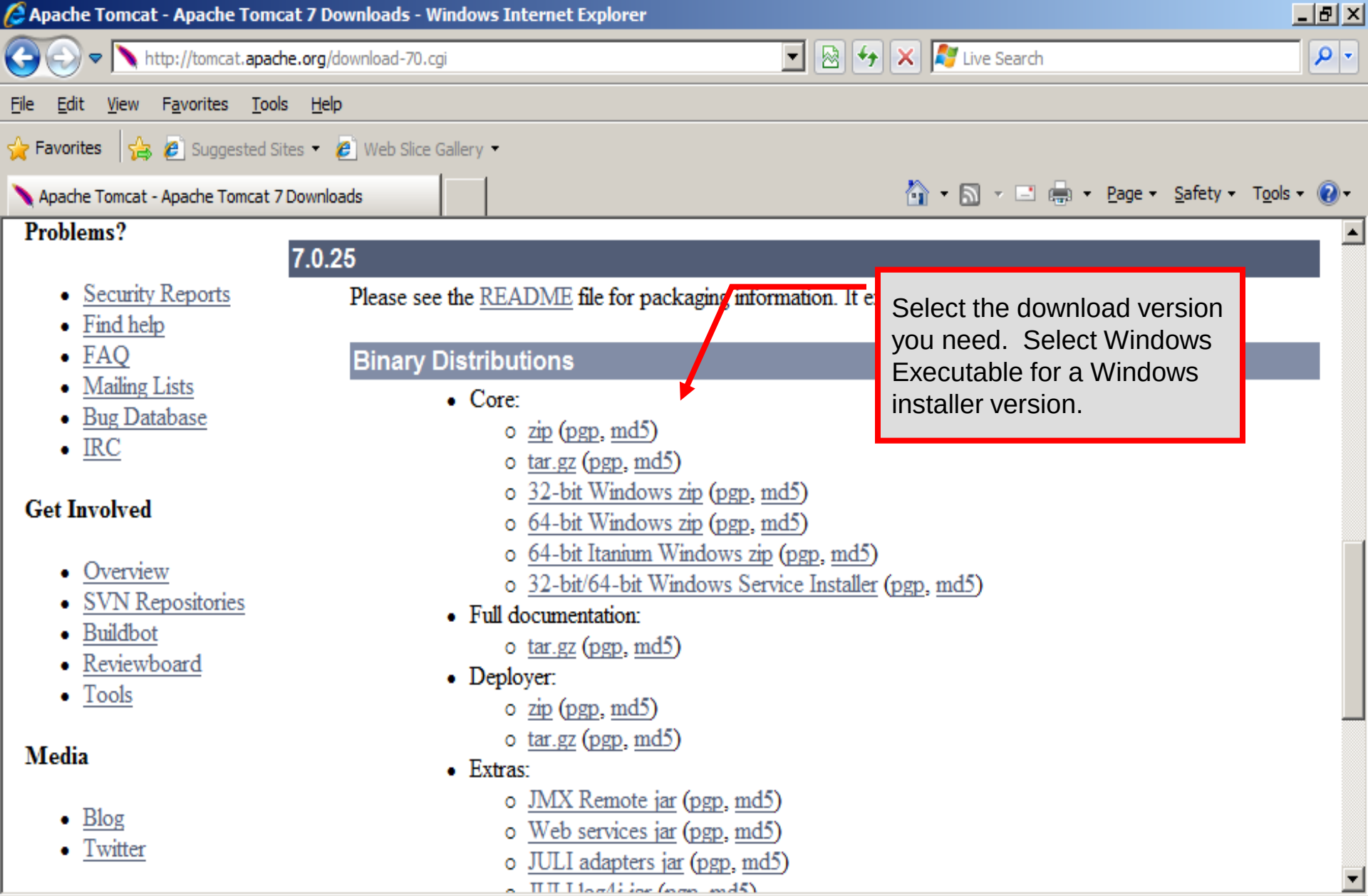
Apache Tomcat is an open source software implementation of the Java Servlet and JavaServer Pages technologies. Different versions of Apache Tomcat are available for different versions of the Servlet and JSP specifications. The mapping between the specifications and the respective Apache Tomcat versions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

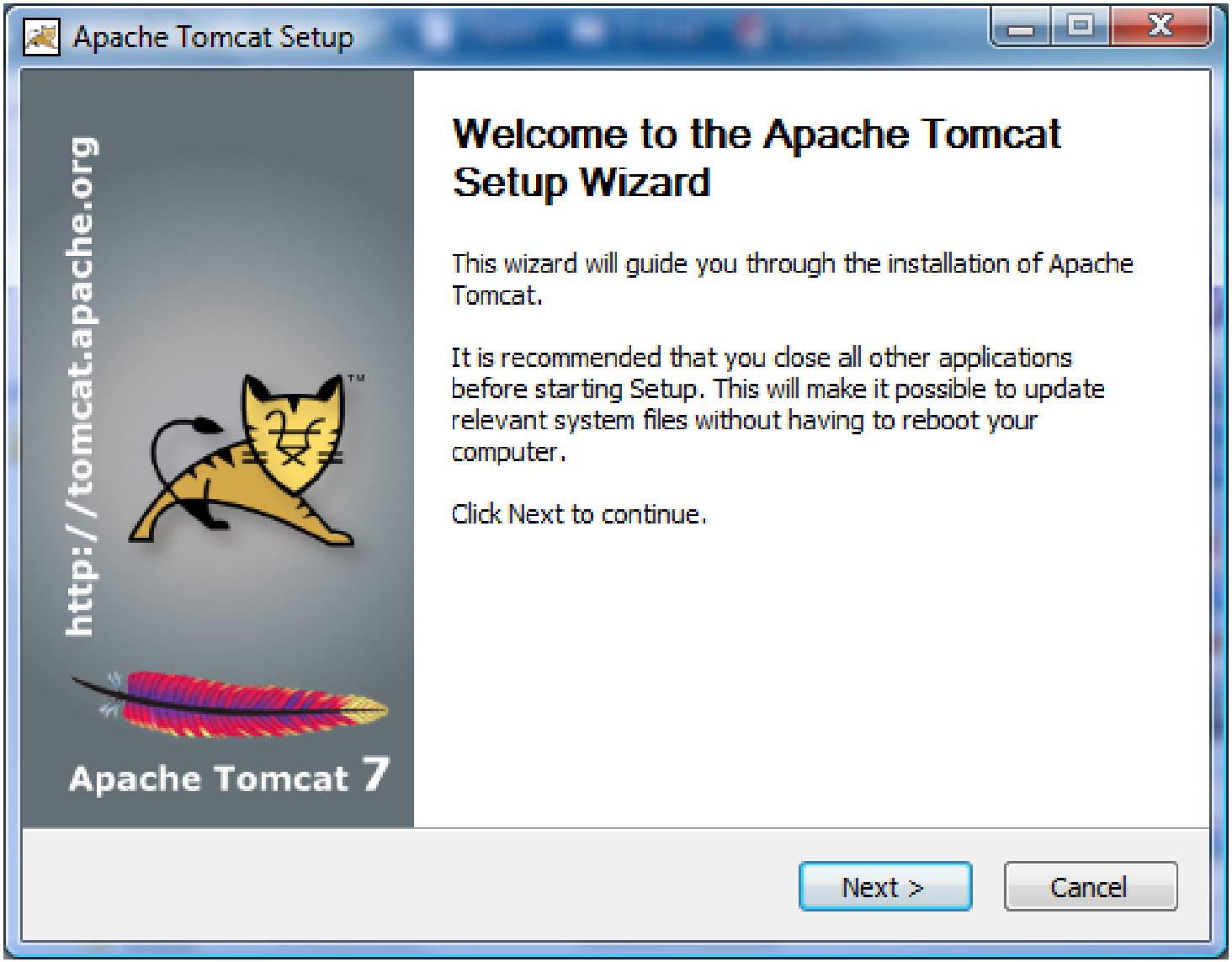
Servlet/JSP Spec	Apache Tomcat version	Actual release revision	Minimum Java Version
3.0/2.2	7.0.x	7.0.25	1.6
2.5/2.1	6.0.x	6.0.35	1.5
2.4/2.0	5.5.x	5.5.35	1.4
2.3/1.2	4.1.x (archived)	4.1.40 (archived)	1.3
2.2/1.1	3.3.x (archived)	3.3.2 (archived)	1.1

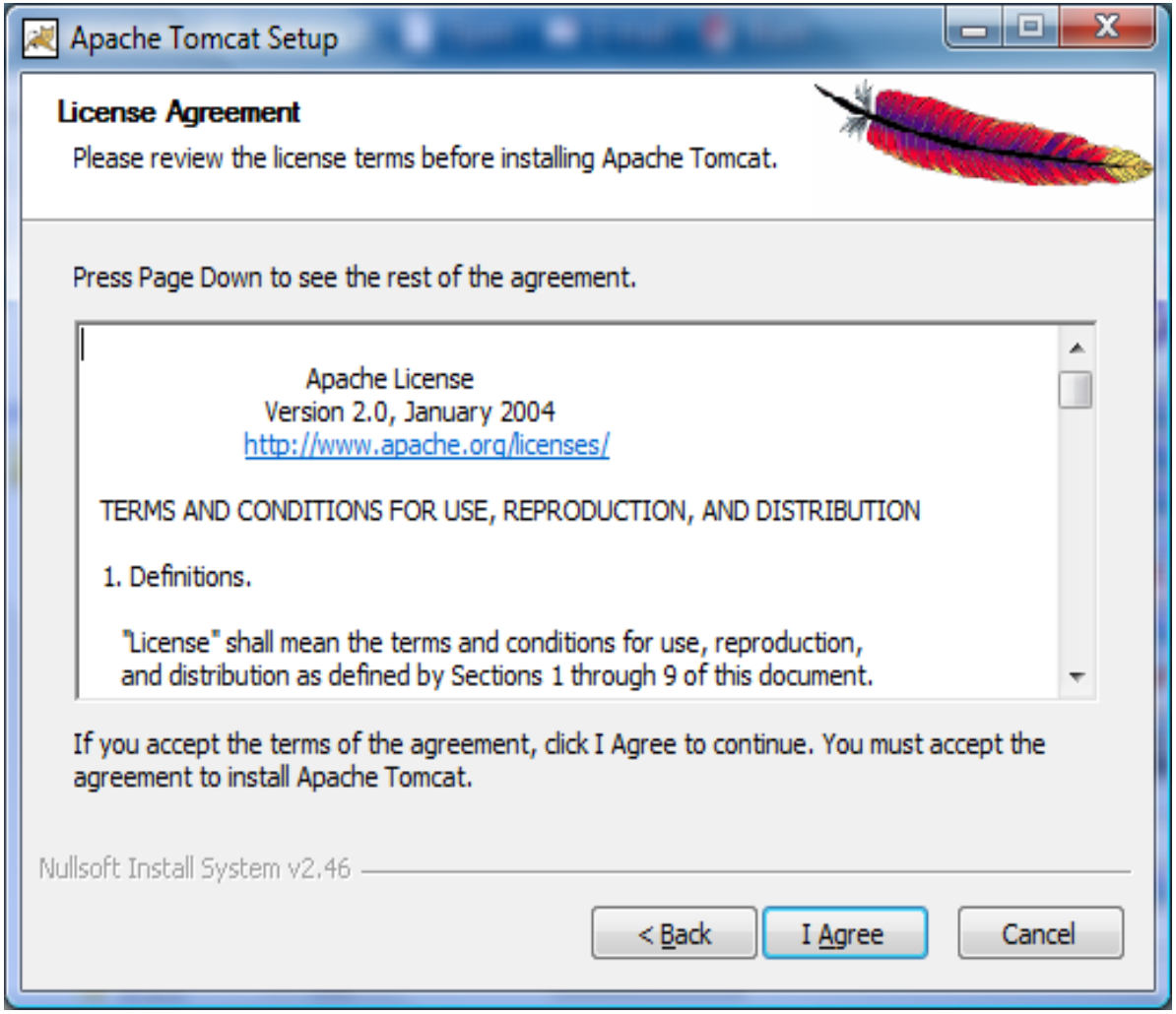
The releases are described in more detail below to help you determine which one is right for you. More details about each release can be found in the associated release notes.

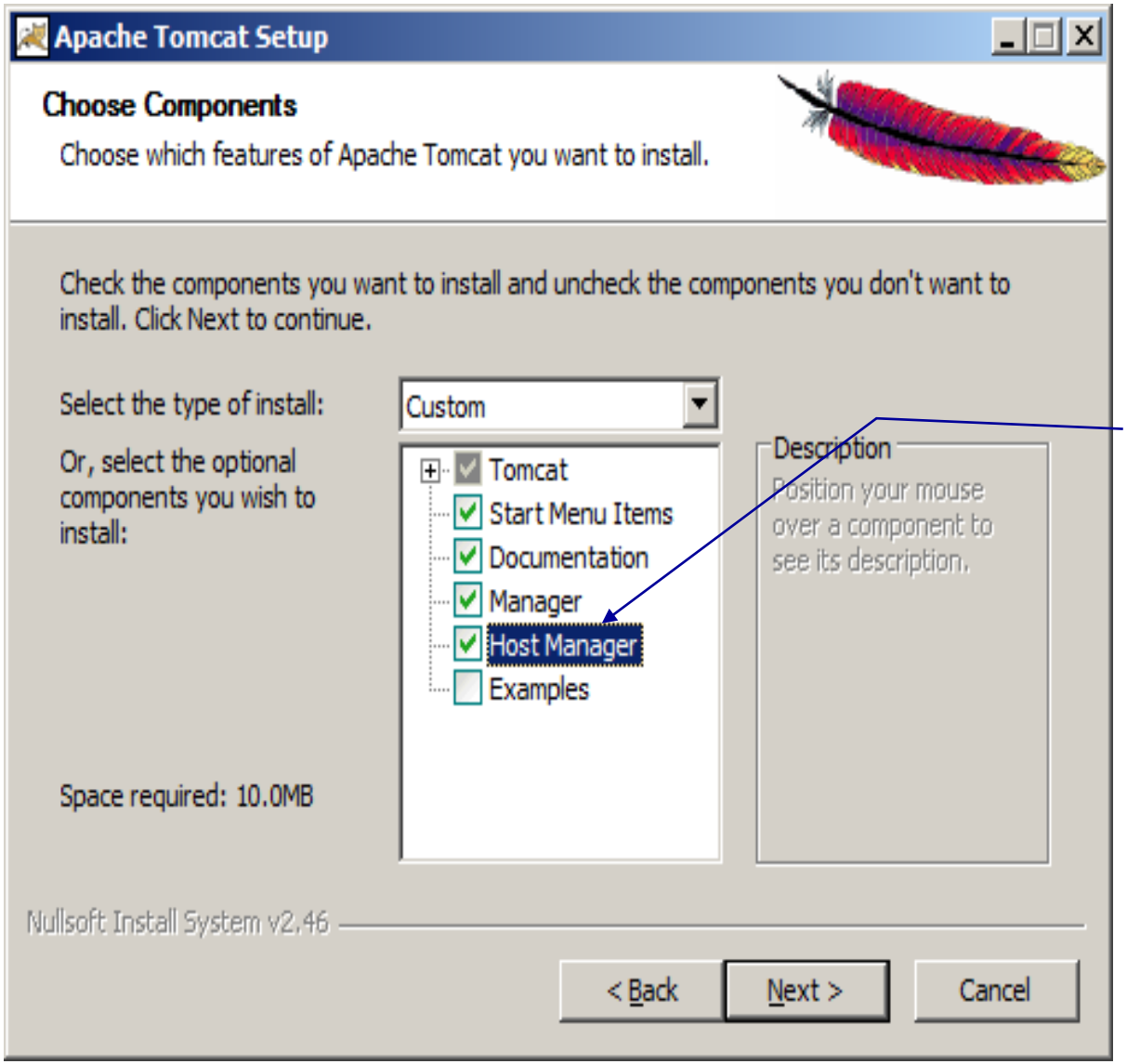
Please note that although we offer downloads and documentation of older releases, such as Apache Tomcat 4.x, we strongly encourage users to use the latest stable version of Apache Tomcat whenever

Done Internet | Protected Mode: Off 100%

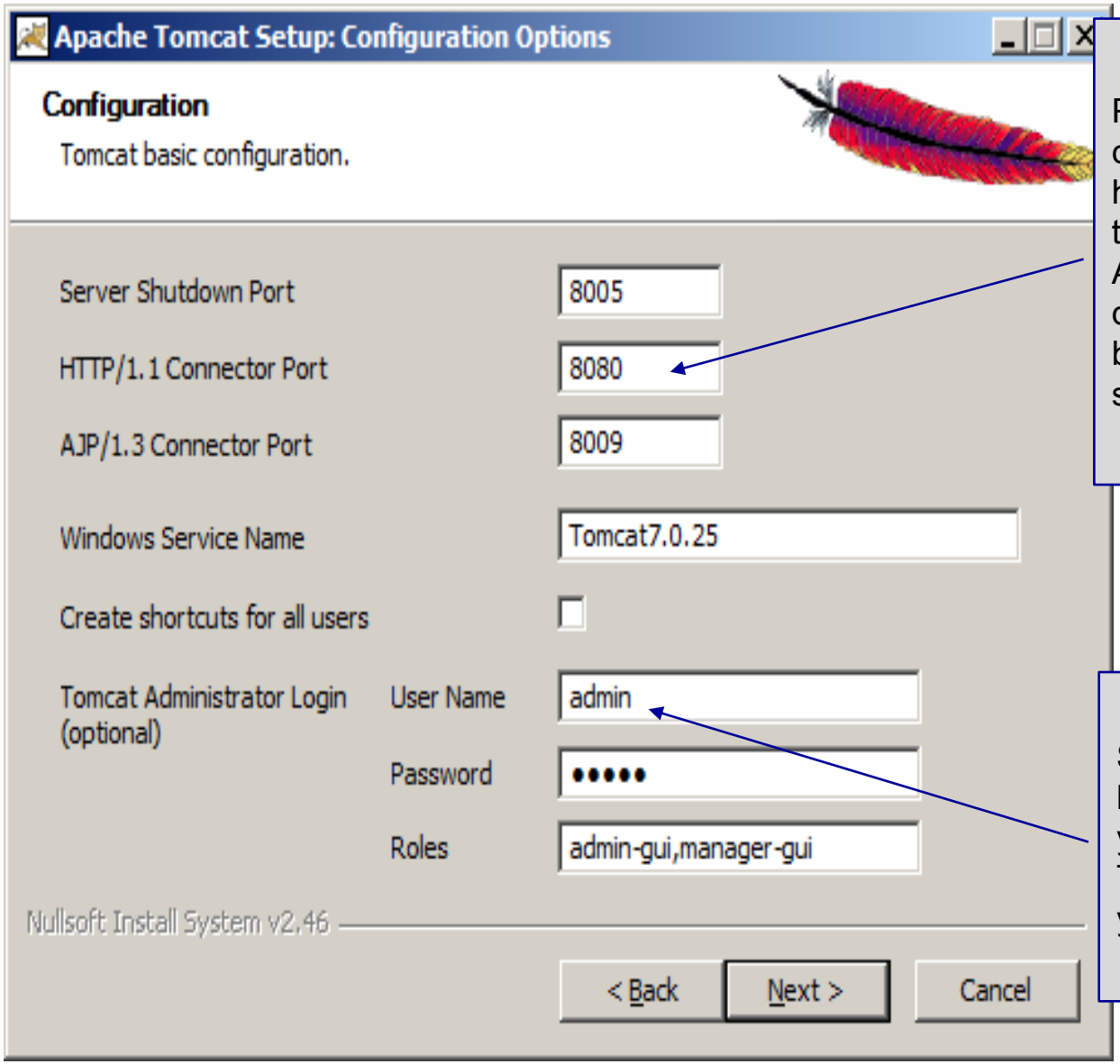

Apache Tomcat - Apache Tomcat 7 Downloads - Windows Internet Explorer
http://tomcat.apache.org/download-70.cgi
Live Search
File Edit View Favorites Tools Help
Favorites
Suggested Sites
Web Slice Gallery
Apache Tomcat - Apache Tomcat 7 Downloads
Page Safety Tools
Problems?
Security Reports
Find help
FAQ
Mailing Lists
Bug Database
IRC
Get Involved
Overview
SVN Repositories
Buildbot
Reviewboard
Tools
Media
Blog
Twitter
7.0.25
Please see the README file for packaging information. It e
Binary Distributions
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)
JULI adapters jar (pgp, md5)
Select the download version you need. Select Windows Executable for a Windows installer version.
Done
Internet | Protected Mode: Off
100%


Apache Tomcat Setup
http://tomcat.apache.org
Apache Tomcat 7
Welcome to the Apache Tomcat Setup Wizard
This wizard will guide you through the installation of Apache Tomcat.
It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.
Click Next to continue.
Next >
Cancel


Apache Tomcat Setup
License Agreement
Please review the license terms before installing Apache Tomcat.
Press Page Down to see the rest of the agreement.
Apache License
Version 2.0, January 2004
http://www.apache.org/licenses/
TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND DISTRIBUTION
1. Definitions.
"License" shall mean the terms and conditions for use, reproduction,
and distribution as defined by Sections 1 through 9 of this document.
If you accept the terms of the agreement, click I Agree to continue. You must accept the agreement to install Apache Tomcat.
Nullsoft Install System v2.46
< Back
I Agree
Cancel

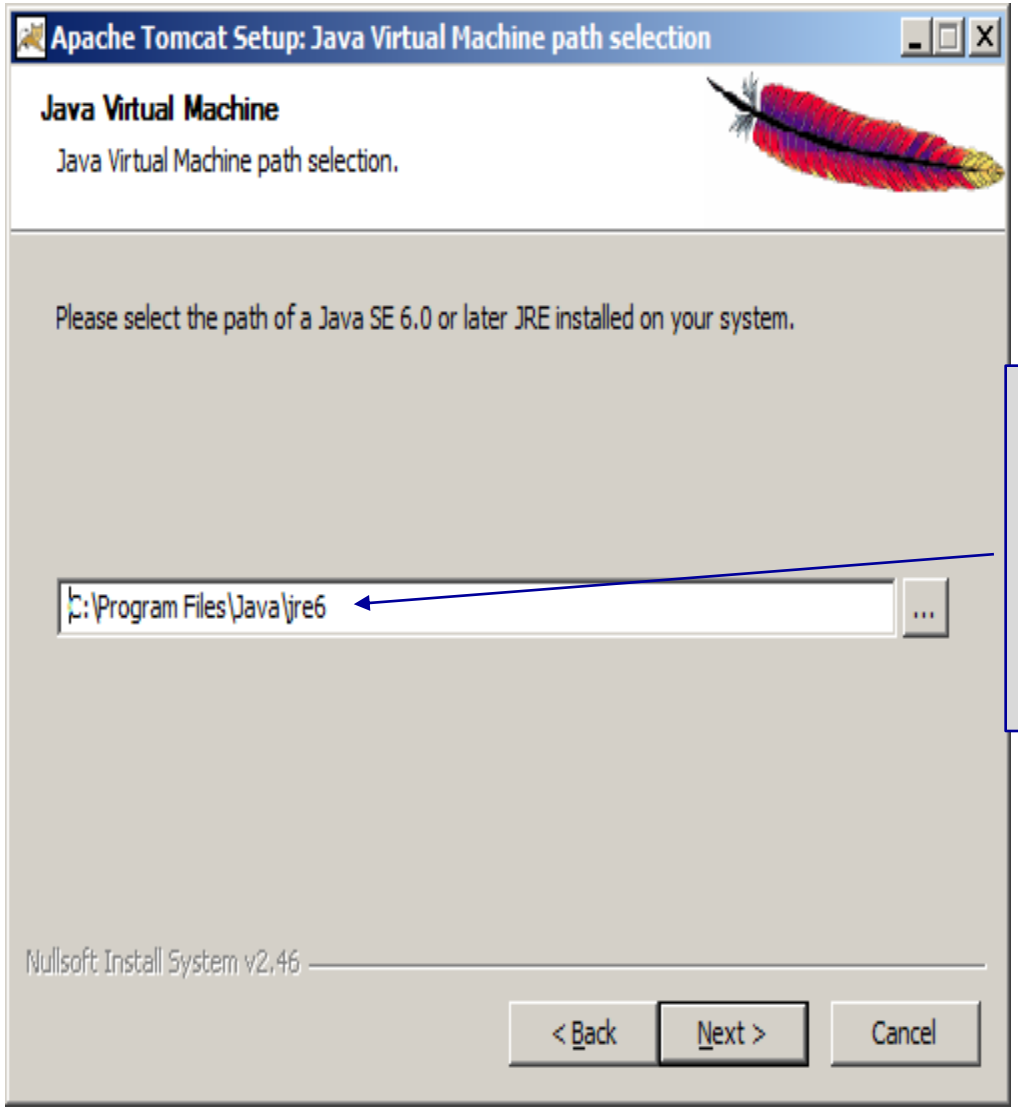


The host manager will not be selected in the default setting. Be sure to check its box. You can decide whether or not to include the examples.

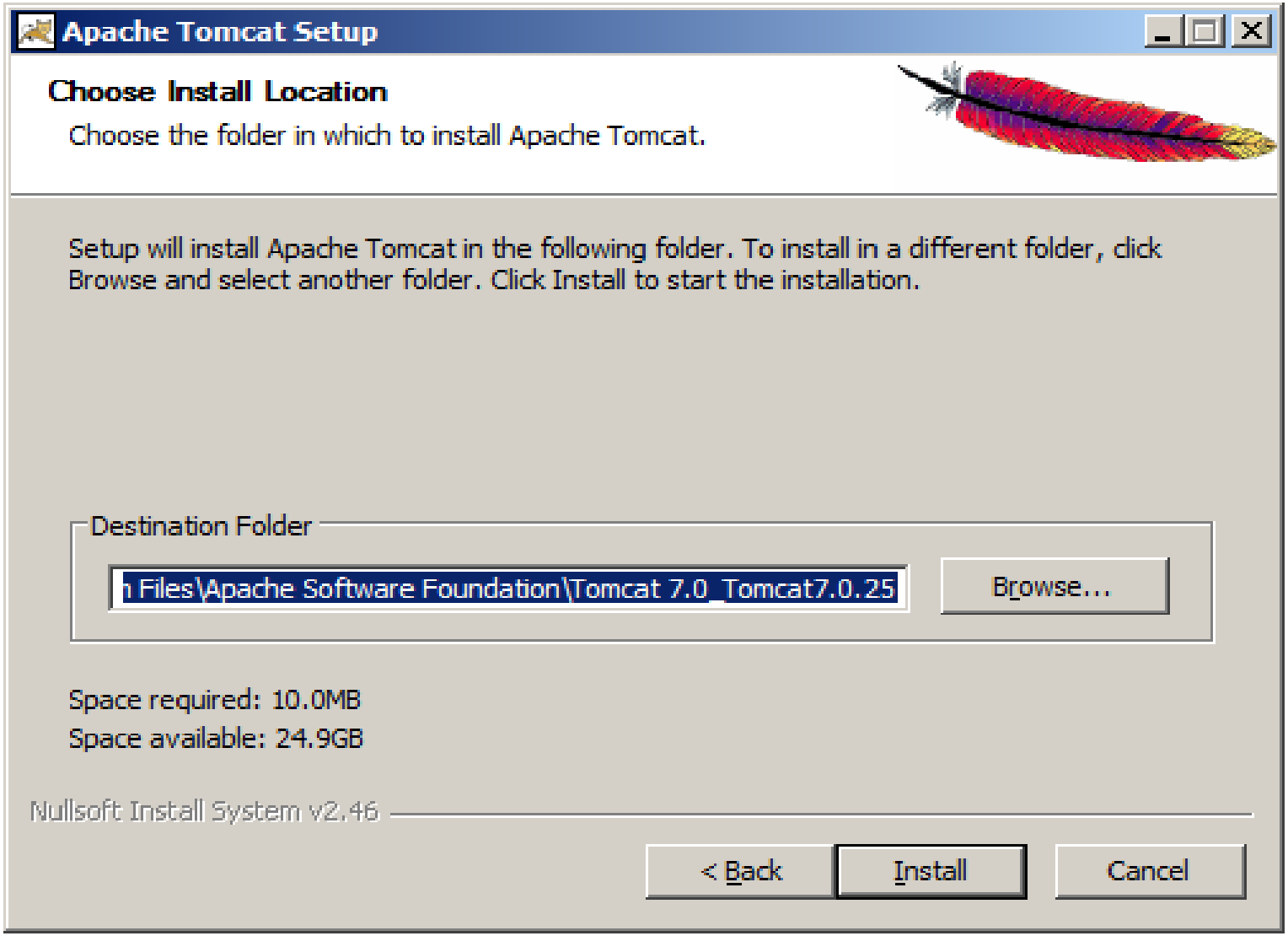


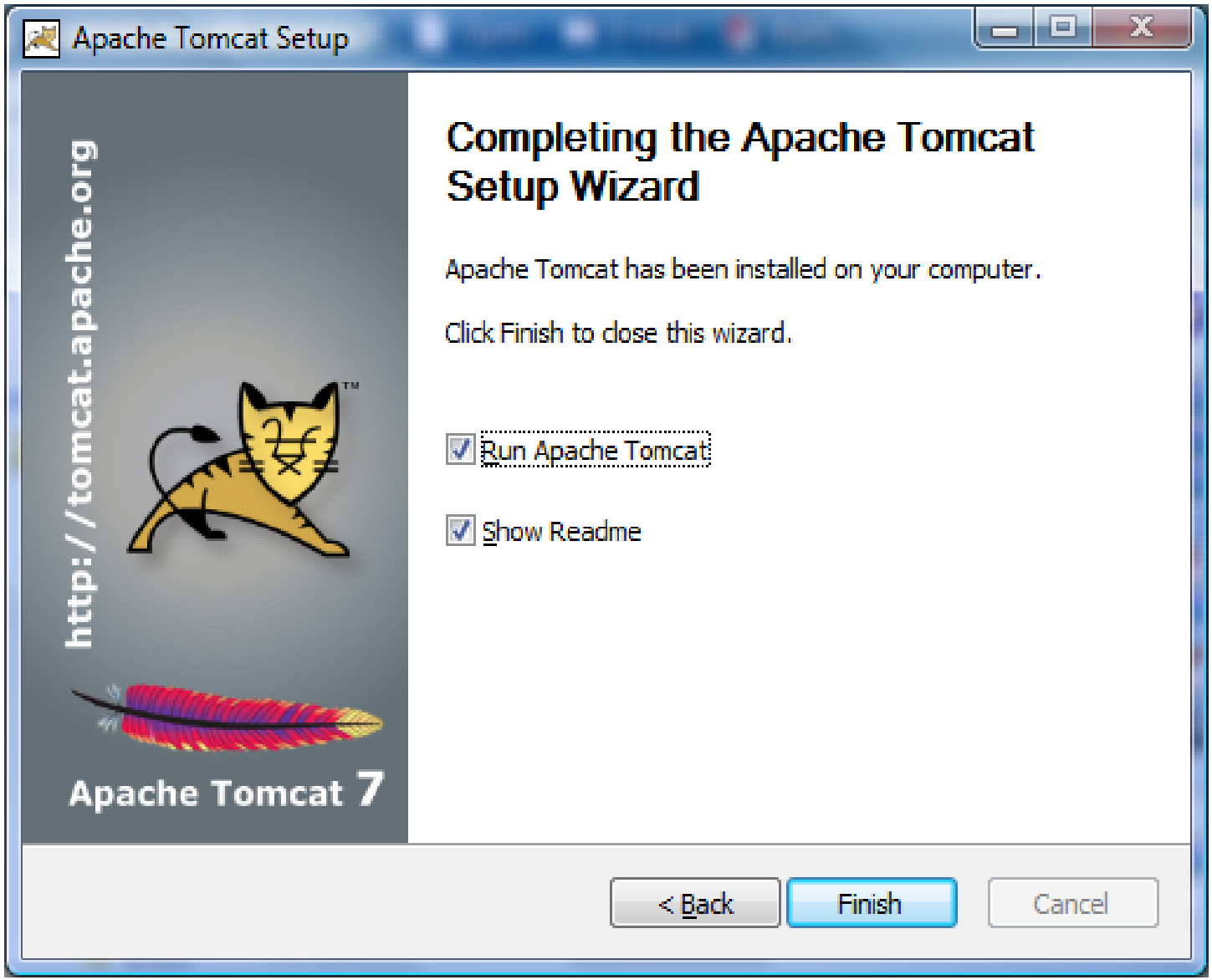
Port 8080 is the default Tomcat connector port. Unless you have a conflict with this port, use this for Tomcat. When we setup Apache later, we'll put in on a different connector port so that both servers can be running simultaneously.

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.


Apache Tomcat Setup
Choose Install Location
Choose the folder in which to install Apache Tomcat.
Setup will install Apache Tomcat in the following folder. To install in a different folder, click Browse and select another folder. Click Install to start the installation.
Destination Folder
n Files\Apache Software Foundation\Tomcat 7.0_Tomcat7.0.25
Browse...
Space required: 10.0MB
Space available: 24.9GB
Nullsoft Install System v2.46
< Back
Install
Cancel


Apache Tomcat Setup
http://tomcat.apache.org
Apache Tomcat 7
Completing the Apache Tomcat Setup Wizard
Apache Tomcat has been installed on your computer.
Click Finish to close this wizard.
Run Apache Tomcat
Show Readme
< Back
Finish
Cancel

RELEASE-NOTES - Notepad

File Edit Format View Help

```
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================================================================================

$Id: RELEASE-NOTES 1189163 2011-10-26 12:19:26Z kkolinko $


                    Apache Tomcat Version 7.0.25
                           Release Notes


=========
CONTENTS:
=========

* Dependency Changes
```


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/7.0.25 - Windows Internet Explorer

http://localhost:8080/

Live Search

File Edit View Favorites Tools Help

Favorites Suggested Sites Web Slice Gallery

Apache Tomcat - Which Vers... Apache Tomcat/7.0.25

Page Safety Tools

Home Documentation Configuration Examples Wiki Mailing Lists Find Help

Apache Tomcat/7.0.25

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

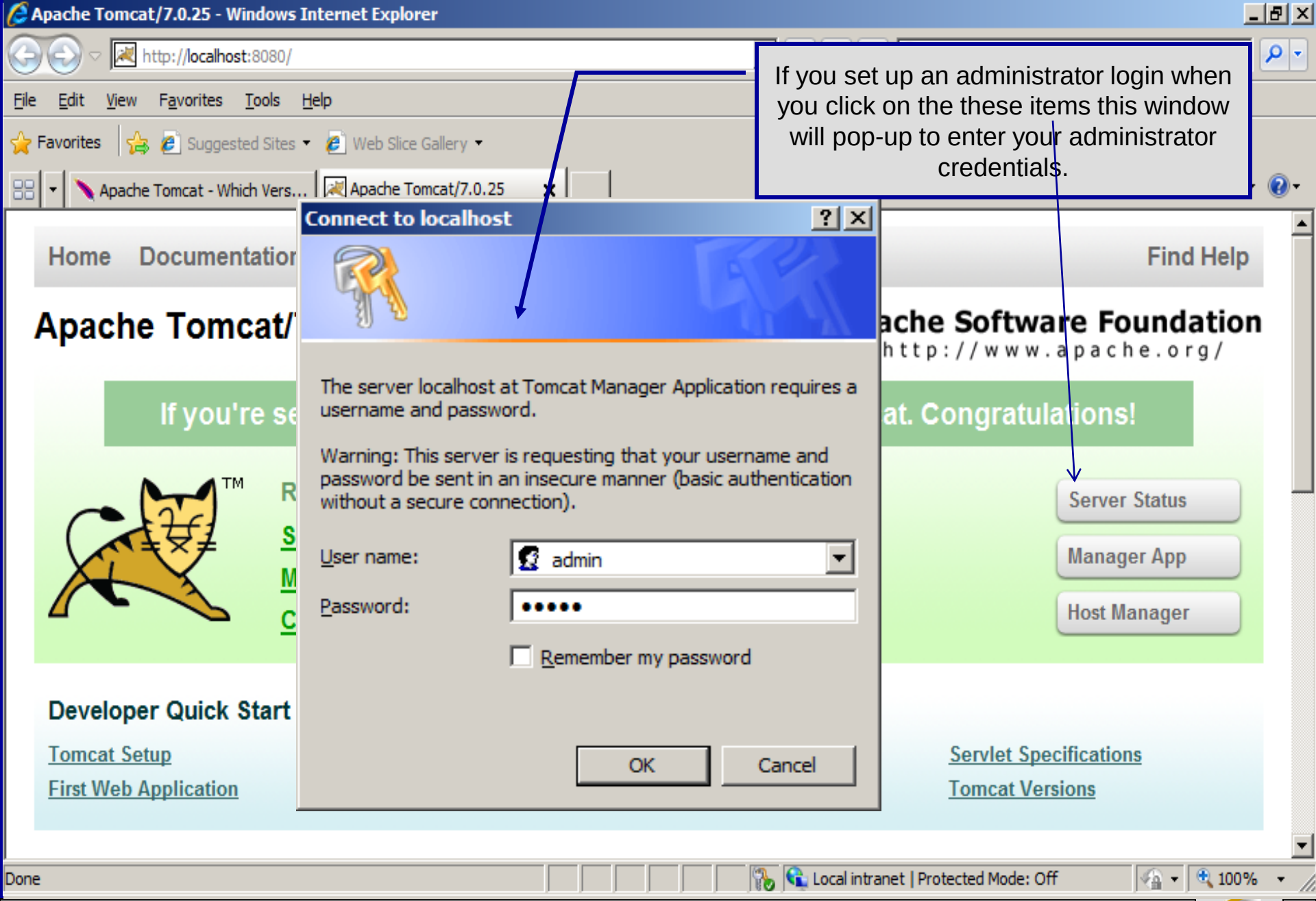
Host Manager

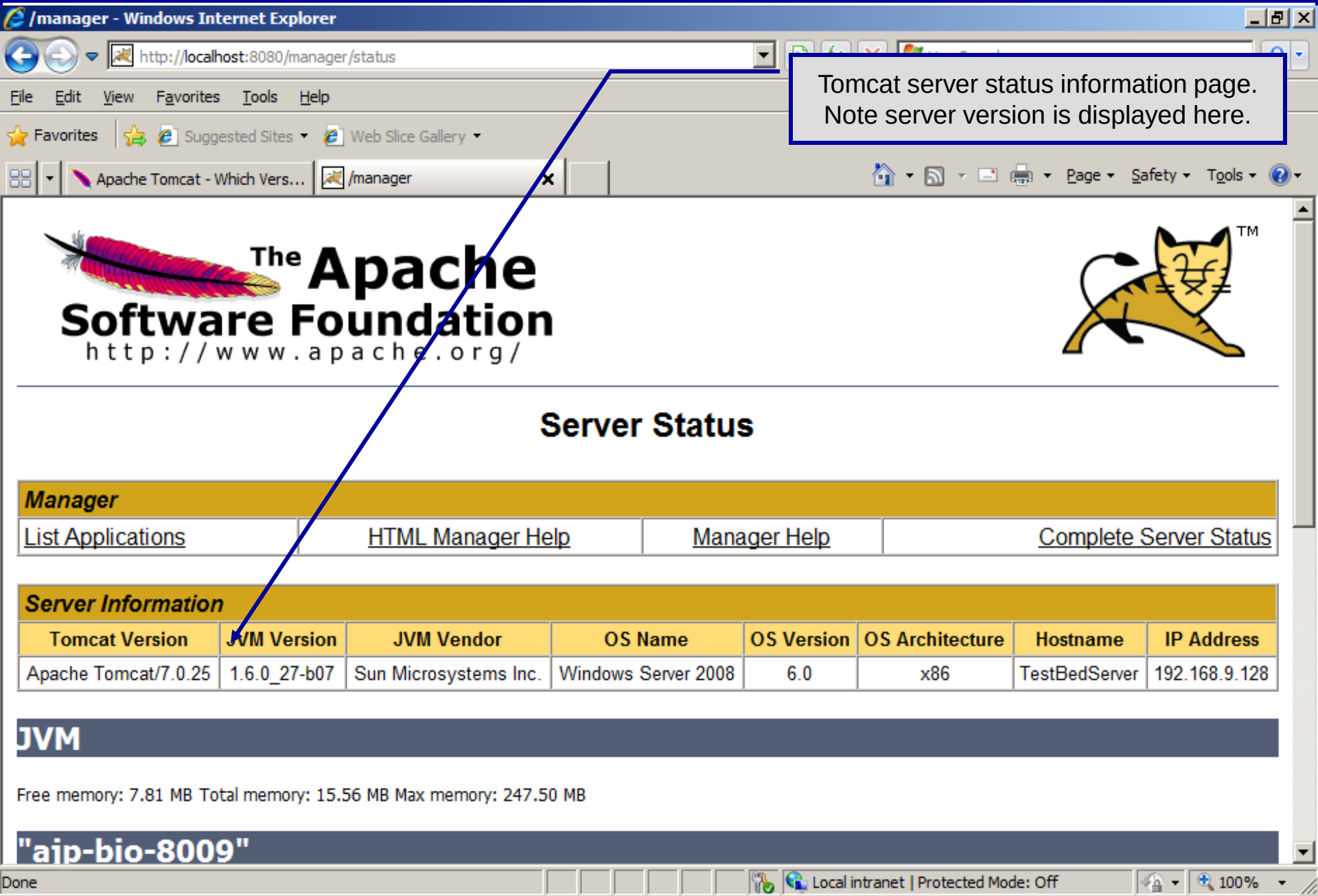
Developer Quick Start

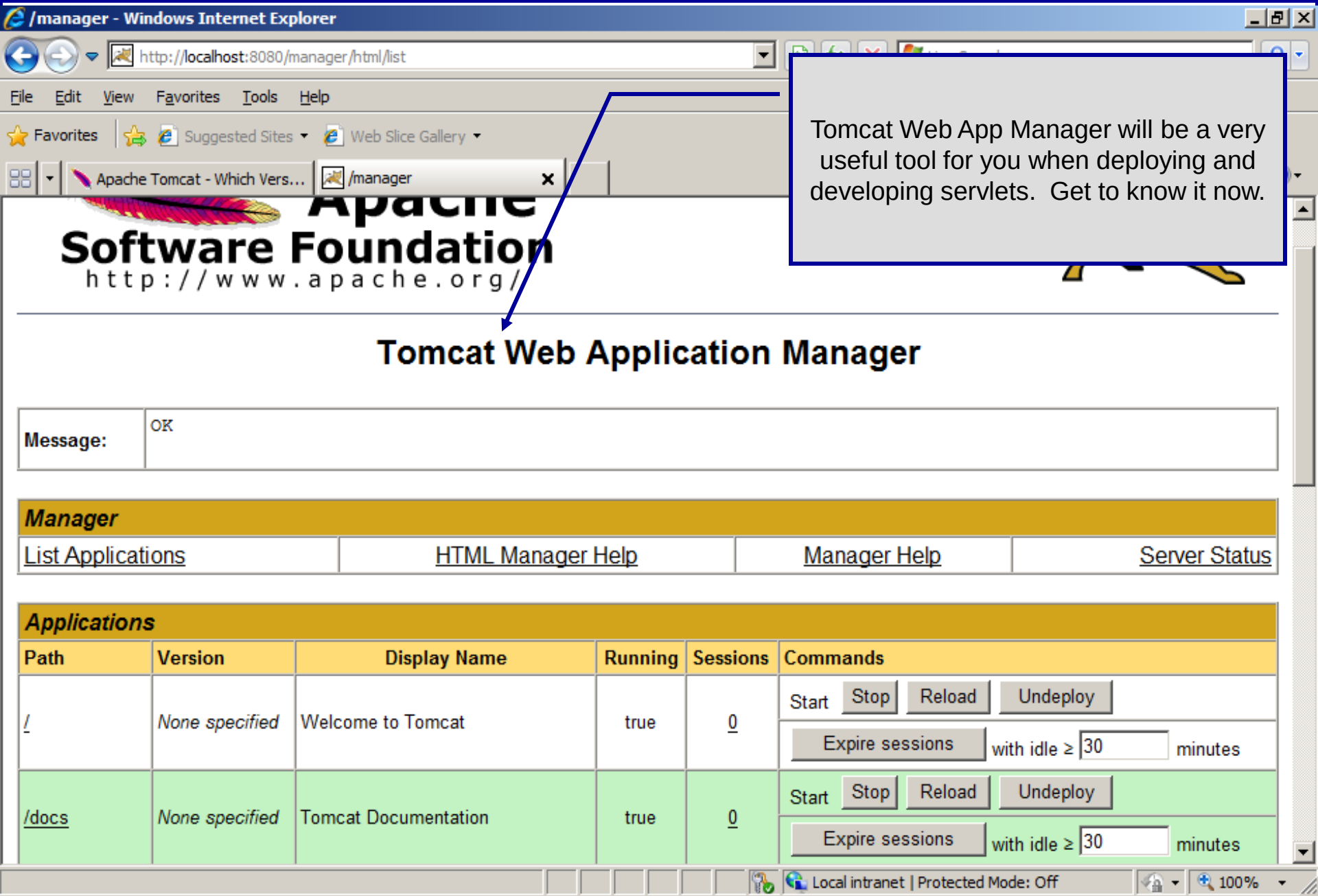
Tomcat Setup | Realms & AAA | Servlet Examples | Servlet Specifications

First Web Application | JDBC DataSources | JSP Examples | Tomcat Versions

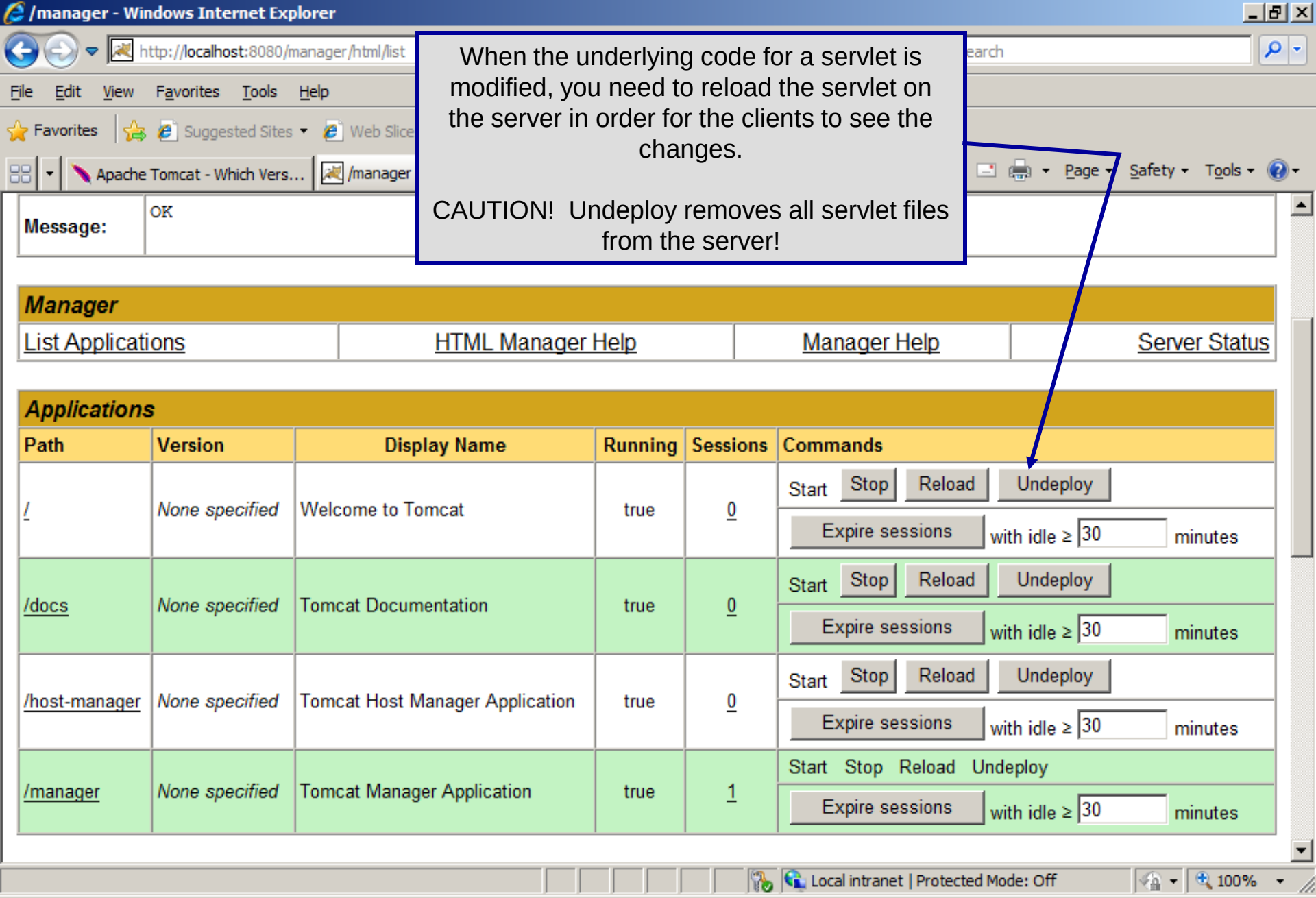
Done Local intranet | Protected Mode: Off 100%

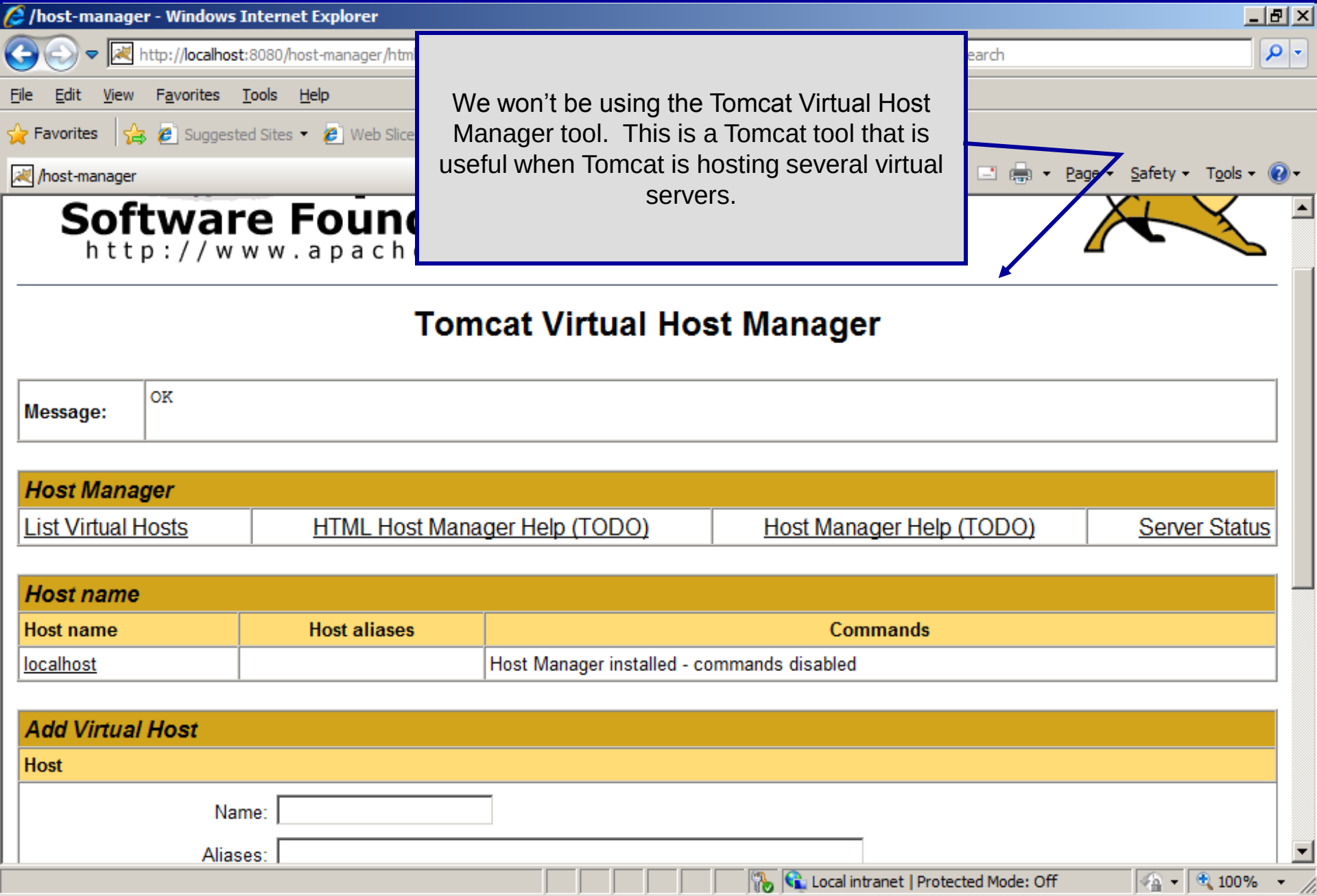

Apache Tomcat/7.0.25 - Windows Internet Explorer
http://localhost:8080/
File Edit View Favorites Tools Help
Favorites
Suggested Sites
Web Slice Gallery
Apache Tomcat - Which Vers...
Apache Tomcat/7.0.25
If you set up an administrator login when you click on the these items this window will pop-up to 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:
admin
Password:
Remember my password
OK
Cancel
Home
Documentation
Find Help
Apache Tomcat/
ache Software Foundation
http://www.apache.org/
If you're se
at. Congratulations!
Server Status
Manager App
Host Manager
Developer Quick Start
Tomcat Setup
First Web Application
Servlet Specifications
Tomcat Versions
Done
Local intranet | Protected Mode: Off
100%


/manager - Windows Internet Explorer
http://localhost:8080/manager/status
File Edit View Favorites Tools Help
Favorites
Suggested Sites
Web Slice Gallery
Apache Tomcat - Which Vers...
/manager
Page
Safety
Tools
Tomcat server status information page.
Note server version is displayed here.
The Apache Software Foundation
http://www.apache.org/
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/7.0.25
1.6.0_27-b07
Sun Microsystems Inc.
Windows Server 2008
6.0
x86
TestBedServer
192.168.9.128
JVM
Free memory: 7.81 MB Total memory: 15.56 MB Max memory: 247.50 MB
"ajp-bio-8009"
Done
Local intranet | Protected Mode: Off
100%



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

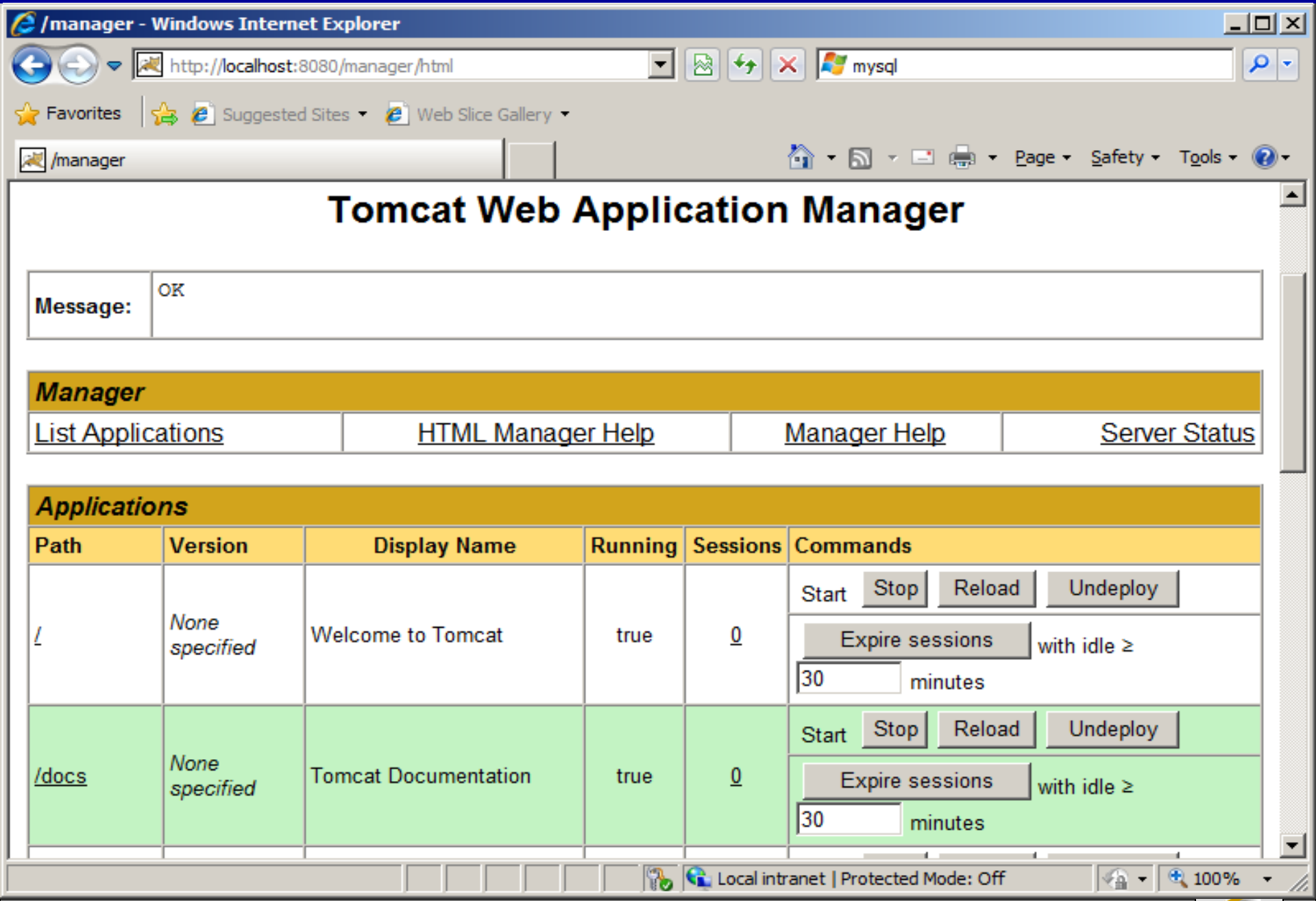

/manager - Windows Internet Explorer
http://localhost:8080/manager/html/list
File Edit View Favorites Tools Help
Favorites
Suggested Sites
Web Slice
Apache Tomcat - Which Vers...
/manager
Page
Safety
Tools
When the underlying code for a servlet is modified, you need to reload the servlet on the server in order for the clients to see the changes.
CAUTION! Undeploy removes all servlet files from the server!
Message:
OK
Manager
List Applications
HTML Manager Help
Manager Help
Server Status
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
/host-manager
None specified
Tomcat Host Manager Application
true
0
/manager
None specified
Tomcat Manager Application
true
1
Local intranet | Protected Mode: Off
100%

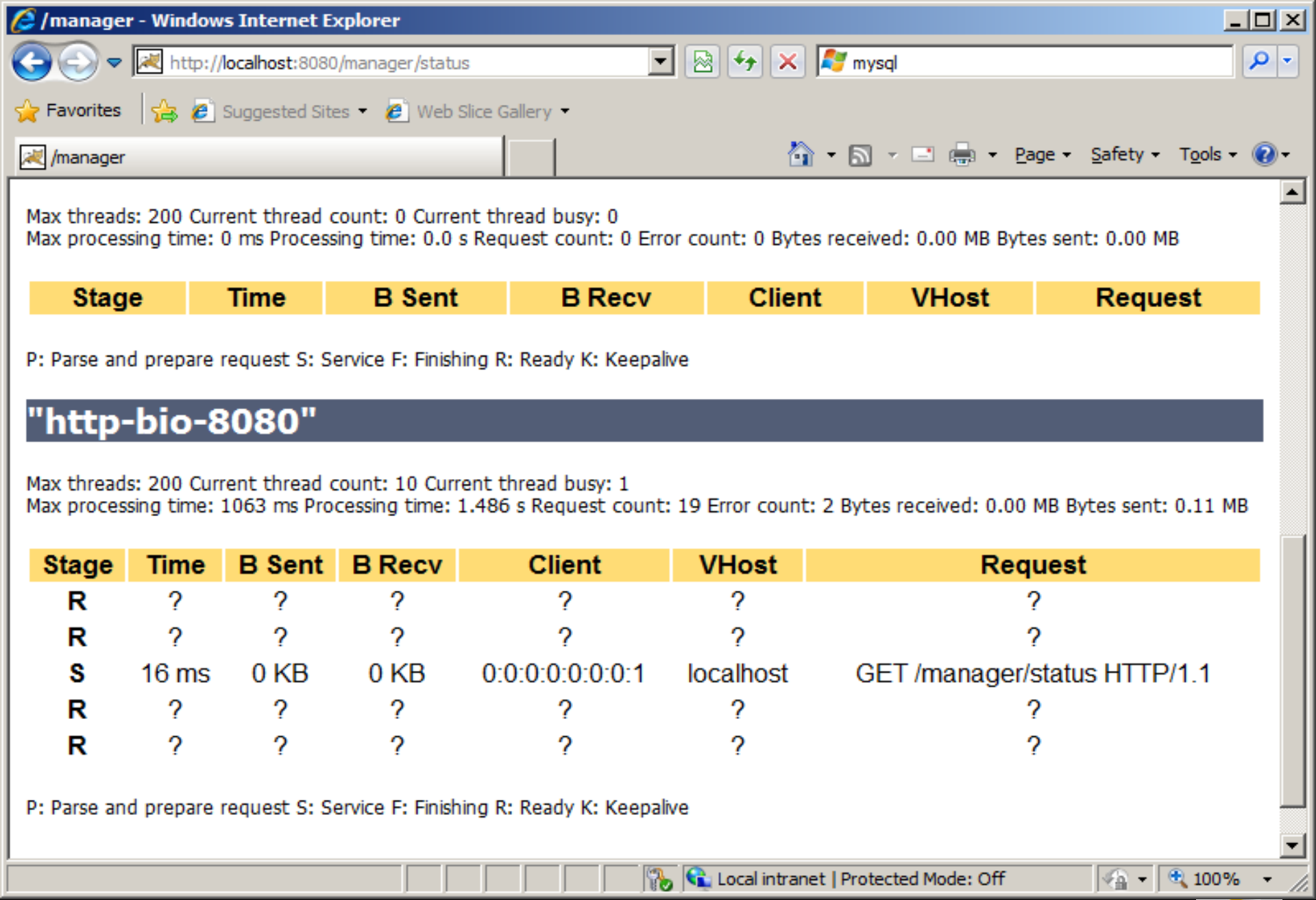


We won't be using the Tomcat Virtual Host Manager tool. This is a Tomcat tool that is useful when Tomcat is hosting several virtual servers.

More Tomcat Details

- If your system does not recognize "localhost", enter http://127.0.0.1:8080 instead of http://localhost:8080. Address 127.0.0.1 basically means "this machine" which is the same as localhost.
- From the Tomcat homepage you can also act as the server administrator and manager. You will need to do things on the administrator side (you must have set the host manager application during the installation process, (see page 28 of Servlets Part 1)), it is interesting to go into the manager side of things and look at the server from the server's point of view. It may also be necessary to reload applications occasionally (more on this later), which can be done from the manager application. See page 3 for an example.
- Checking the status of the server can also be accomplished from the Tomcat homepage. See page 4 for a sample.


/manager - Windows Internet Explorer
http://localhost:8080/manager/html
mysql
Favorites
Suggested Sites
Web Slice Gallery
/manager
Page
Safety
Tools
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 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
Local intranet | Protected Mode: Off
100%


/manager - Windows Internet Explorer
http://localhost:8080/manager/status
mysql
Favorites
Suggested Sites
Web Slice Gallery
/manager
Page
Safety
Tools
Max threads: 200 Current thread count: 0 Current thread busy: 0
Max processing time: 0 ms Processing time: 0.0 s Request count: 0 Error count: 0 Bytes received: 0.00 MB Bytes sent: 0.00 MB
Stage
Time
B Sent
B Recv
Client
VHost
Request
P: Parse and prepare request S: Service F: Finishing R: Ready K: Keepalive
"http-bio-8080"
Max threads: 200 Current thread count: 10 Current thread busy: 1
Max processing time: 1063 ms Processing time: 1.486 s Request count: 19 Error count: 2 Bytes received: 0.00 MB Bytes sent: 0.11 MB
Stage
Time
B Sent
B Recv
Client
VHost
Request
R ? ? ? ? ? ?
R ? ? ? ? ? ?
S 16 ms 0 KB 0 KB 0:0:0:0:0:0:0:1 localhost GET /manager/status HTTP/1.1
R ? ? ? ? ? ?
R ? ? ? ? ? ?
P: Parse and prepare request S: Service F: Finishing R: Ready K: Keepalive
Local intranet | Protected Mode: Off
100%

A Tour of Tomcat

- Before we look into creating our own servlets, we need to look more closely at Tomcat. This will help you better understand how web applications are developed and deployed.
- The directory structure within Tomcat looks like the one shown on the next page. It contains, among other things, seven directories named, `bin`, `conf`, `lib`, `logs`, `temp`, `webapps`, and `work`.

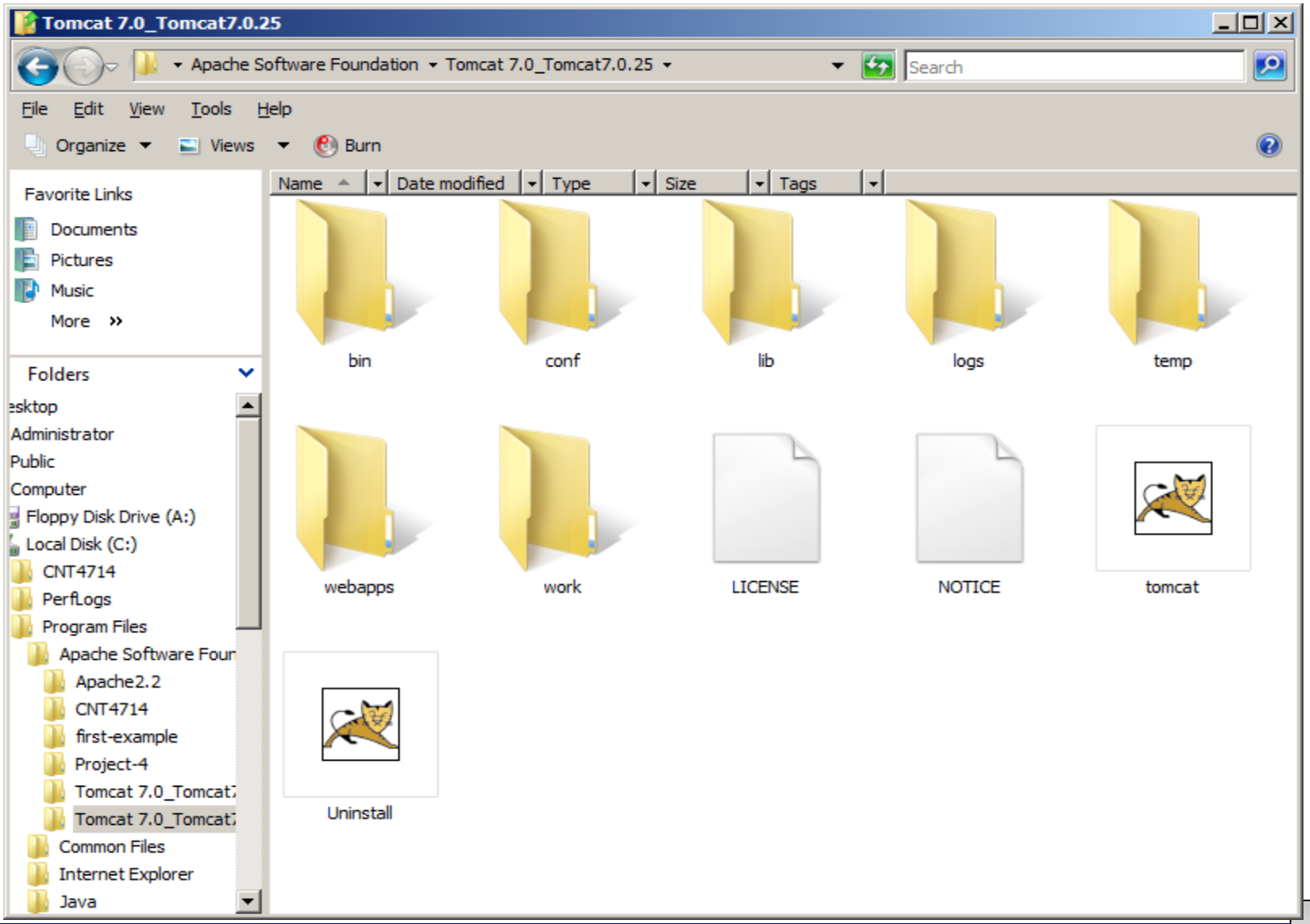
`bin`

- Directory `bin` contains scripts for starting and stopping Tomcat as well as some additional tools.

`conf`

- Directory `conf` contains files used to configure Tomcat at the global level, although it is possible for each web application to override many of the values provided in this directory.

Tomcat Directory Structure



A Tour of Tomcat (cont.)

- The most important file inside the `conf` directory is `server.xml`, which tells Tomcat the set of services to run when it starts up as well as what port to listen to. This file also specifies the set of resources to make available to applications and a number of security parameters. A portion of this file (the part illustrating the non-SSL HTTP port) is shown on page 47.
- There is also a `web.xml` file in this directory, which establishes default values that may be overridden by values in each applications `web.xml` file. A portion of this file is shown on page 48.
- The file `jk2.properties` defines a set of properties that are used when Tomcat is installed as an application server in conjunction with an external web server such as Apache or IIS. In these notes we will assume that Tomcat is running in stand-alone mode, where it operates as both a web server and application server.

C:\Program Files\Apache Software Foundation\Tomcat 7.0_Tomcat7.0.25\conf\server.xml - Notepad++

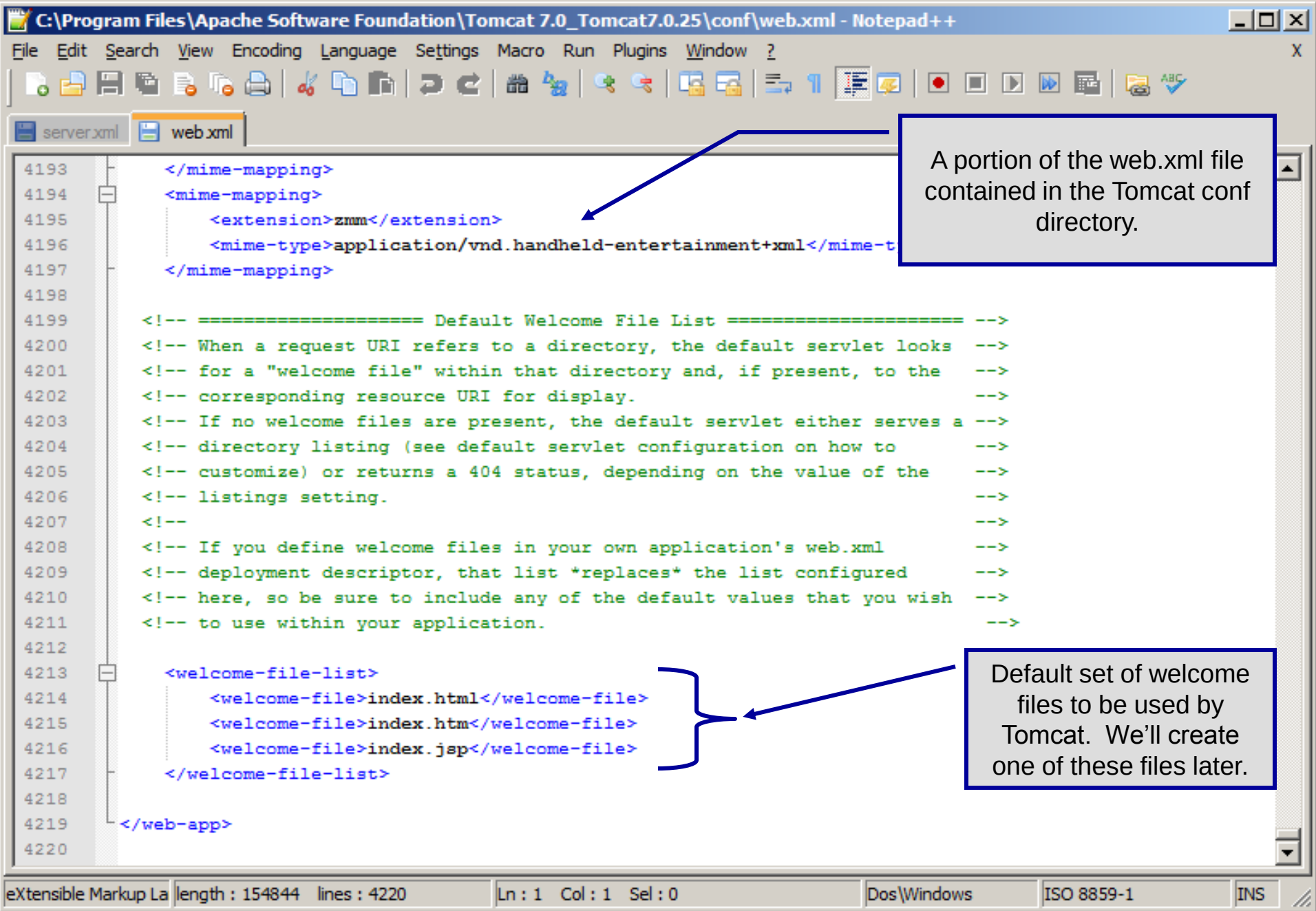
File Edit Search View Encoding Language Settings Macro Run Plugins Window ?

big form example - frontend.html | formvalidation.php | userdefinedvalidation.php | server.xml

```
56      <!--The connectors can use a shared executor, you can define one or more named thread pools-->
57      <!--
58      <Executor name="tomcatThreadPool" namePrefix="catalina-exec-"
59          maxThreads="150" minSpareThreads="4"/>
60      -->
61
62
63      <!-- A "Connector" represents an endpoint by which requests are received
64           and responses are returned. Documentation at :
65           Java HTTP Connector: /docs/config/http.html (blocking & non-blocking)
66           Java AJP  Connector: /docs/config/ajp.html
67           APR (HTTP/AJP) Connector: /docs/apr.html
68           Define a non-SSL HTTP/1.1 Connector on port 8080
69      -->
70      <Connector port="8080" protocol="HTTP/1.1"
71                 connectionTimeout="20000"
72                 redirectPort="8443" />
73      <!-- A "Connector" using the shared thread pool-->
74      <!--
75      <Connector executor="tomcatThreadPool"
76                 port="8080" protocol="HTTP/1.1"
77                 connectionTimeout="20000"
78                 redirectPort="8443" />
79      -->
80      <!-- Define a SSL HTTP/1.1 Connector on port 8443
81           This connector uses the JSSE configuration, when using APR, the
82           connector should be using the OpenSSL style configuration
83           described in the APR documentation -->
```

eXtensible Markup La | length : 6577 lines : 143 | Ln : 1 Col : 1 Sel : 0 | Dos\Windows | ANSI | INS

A portion of the server.xml file illustrating the connection port for Tomcat.



A portion of the web.xml file contained in the Tomcat conf directory.

Default set of welcome files to be used by Tomcat. We'll create one of these files later.

A Tour of Tomcat (cont.)

logs

- The logs directory contains a n umber of log files created by Tomcat. The file `catalina.out` contains anything written to `System.out` and `System.err`, as well as information relevant to the server as a whole.

lib

- In previous versions of Tomcat, this directory was named `common` and contained three subdirectories – classes, lib, and endorsed – which contain code used by Tomcat. The newer versions of Tomcat, beginning with version 6.0.29, have condensed these into a single directory named `lib`. Any custom `.jar` files that may be needed throughout Tomcat, such as a JDBC driver, are placed in this directory.

A Tour of Tomcat (cont.)

webapps

- This directory contains all the web applications Tomcat is configured to run, one web application per subdirectory. We will be placing the web applications that we develop into subdirectories in this directory. We'll look in more detail at the structure of these subdirectories a bit later.

work

- This directory is used by Tomcat to hold servlets that are built from JSP pages. Users will typically not need anything in this directory.

temp

- This directory is used internally by Tomcat and can be ignored.

Servlet Interface

- The servlet packages define two abstract classes that implement interface `Servlet` – class `GenericServlet` (from the package `javax.servlet`) and class `HttpServlet` (from the package `javax.servlet.http`).
- These classes provide default implementations of some `Servlet` methods.
- Most servlets extend either `GenericServlet` or `HttpServlet` and override some or all of their methods.
- The `GenericServlet` is a protocol-independent servlet, while the `HttpServlet` uses the HTTP protocol to exchange information between the client and server.
- We're going to focus exclusively on the `HttpServlet` used on the Web.

Servlet Interface (cont.)

- `HttpServlet` defines enhanced processing capabilities for services that extend a Web server's functionality.
- The key method in every servlet is `service`, which accepts both a `ServletRequest` object and a `ServletResponse` object. These object provide access to input and output streams that allow the servlet to read data from and send data to the client.
- If a problem occurs during the execution of a servlet, either `ServletExceptions` or `IOExceptions` are thrown to indicate the problem.

HTTPServlet Class

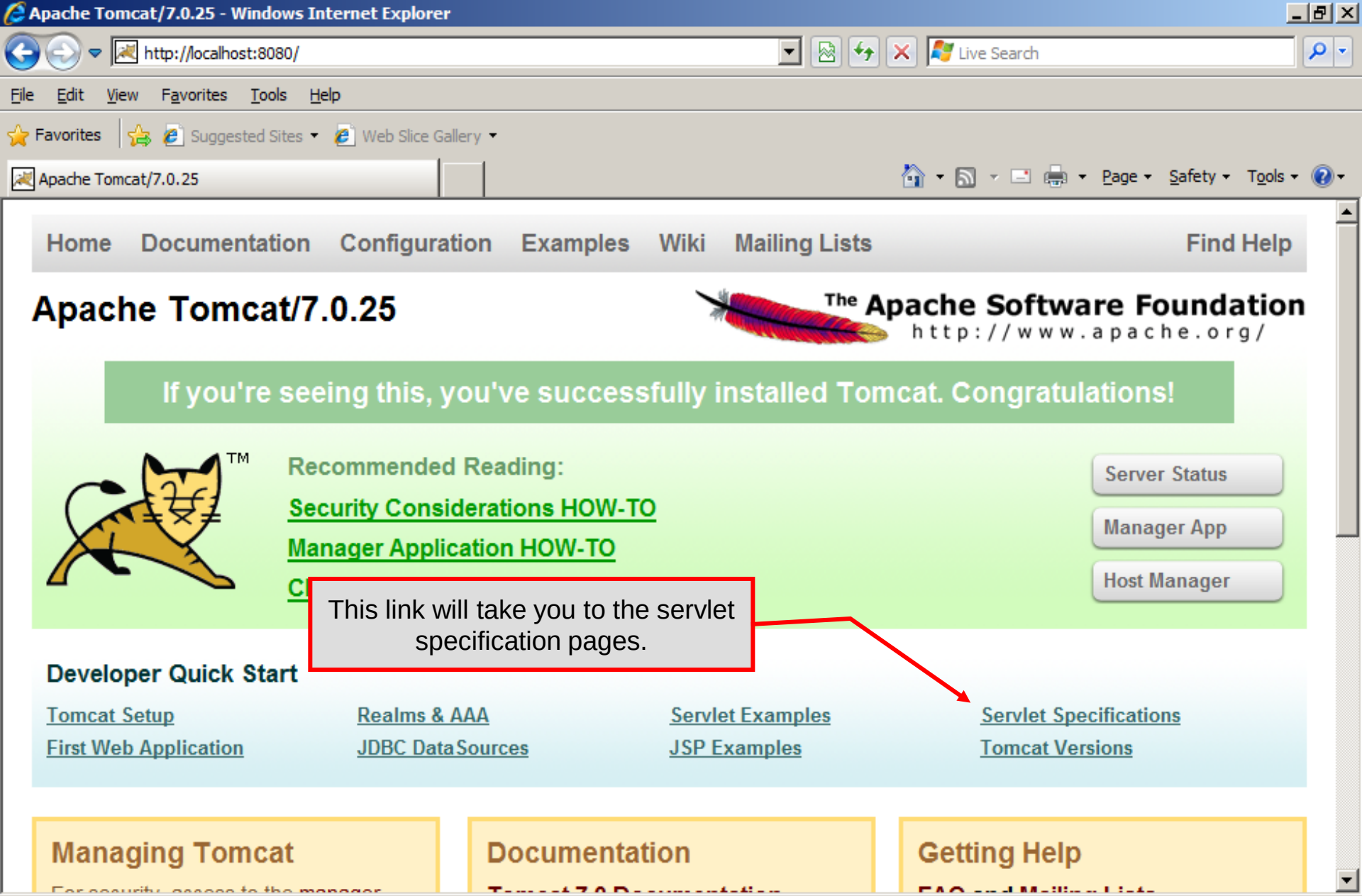
- Servlets typically extend class `HttpServlet`, which overrides method `service` to distinguish between the various requests received from a client web browser.
- The two most common HTTP request types (also known as request methods) are `get` and `post`. (See also Servlets – Part 1 notes.)
  - A get request retrieves information from a server. Typically, an HTML document or image.
  - A post request sends data to a server. Typically, post requests are used to pass user input to a data-handling process, store or update data on a server, or post a message to a news group or discussion forum.
- Class `HttpServlet` defines methods `doGet` and `doPost` to respond to get and post requests from a client.

HTTPServlet Class (cont.)

- Methods `doGet` and `doPost` are invoked by method `service`, which is invoked by the servlet container when a request arrives at the server.
- Method service first determines the request type, the invokes the appropriate method for handling such a request.
- In addition to methods `doGet` and `doPost`, the following methods are defined in class `HttpServlet`:
  - `doDelete` (typically deletes a file from the server)
  - `doHead` (client wants only response headers no entire body)
  - `doOptions` (returns HTTP options supported by server)
  - `doPut` (typically stores a file on the server)
  - `doTrace` (for debugging purposes)

HTTPServletRequest Interface

- Every invocation of `doGet` or `doPost` for an `HttpServlet` receives an object that implements interface `HttpServletRequest`.
- The servlet container creates an `HttpServletRequest` object and passes it to the servlet's `service` method, which in turn, passes it to `doGet` or `doPost`.
- This object contains the clients' request and provides methods that enable the servlet to process the request.
- The full list of HttpServletRequest methods is available at: www.java.sun.com/j2ee/1.4/docs/api/index.html, however, a few of the more common ones are shown on page 19. (Note: you can also get to them from Tomcat, see next page.)


Apache Tomcat/7.0.25 - Windows Internet Explorer
http://localhost:8080/
Live Search
File Edit View Favorites Tools Help
Favorites
Suggested Sites
Web Slice Gallery
Apache Tomcat/7.0.25
Page Safety Tools
Home Documentation Configuration Examples Wiki Mailing Lists Find Help
Apache Tomcat/7.0.25
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
Server Status
Manager App
Host Manager
This link will take you to the servlet specification pages.
Developer Quick Start
Tomcat Setup
First Web Application
Realms & AAA
JDBC DataSources
Servlet Examples
JSP Examples
Servlet Specifications
Tomcat Versions
Managing Tomcat
Documentation
Getting Help
Done
Local intranet | Protected Mode: Off
100%

HTTPServletRequest Methods

- `Cookie[] getCookies()` – returns an array of Cookie objects stored on the client by the server. Cookies are used to uniquely identify clients to the server.
- `String getLocalName()` – gets the host name on which the request was received.
- `String getLocalAddr()` – gets the IP address on which the request was received.
- `int getLocalPort()` – gets the IP port number on which the request was received.
- `String getParameter( String name)` – gets the value of a parameter set to the servlet as part of a `get` or `post` request.

HTTPServletResponse Interface

- Every invocation of `doGet` or `doPost` for an `HttpServlet` receives an object that implements interface `HttpServletResponse`.
- The servlet container creates an `HttpServletResponse` object and passes it to the servlet's `service` method, which in turn, passes it to `doGet` or `doPost`.
- This object provides methods that enable the servlet to formulate the response to the client.
- The full list of HttpServletRequest methods is available at: www.java.sun.com/j2ee/1.4/docs/api/index.html, however, a few of the more common ones are shown on the next page. (Also accessible from Tomcat.)

HTTPServletResponse Methods

- `void addCookie (Cookie cookie)` – adds a Cookie to the header of the response to the client.
- `ServletOutputStream getOutputStream()` – gets a byte-based output stream for sending binary data to the client.
- `PrintWriter getWriter()` – gets a character-based output stream for sending text data (typically HTML formatted text) to the client.
- `void SetContentType (String type)` – specifies the content type of the response to the browser to assist in displaying the data.
- `void getContentType()` – gets the content type of the response.

Handling HTTP `get` Requests

- The primary purpose of an HTTP `get` request is to retrieve the contents of a specified URL, which is typically an HTML or XHTML document.
- Before we look at a complete implementation of a servlet execution, let's examine the Java code that is required for a basic servlet.
- Shown on the next page is a servlet that responds to an HTTP `get` request. This is a simple welcome servlet and is about as simple a servlet as is possible.
- Note: Tomcat will look for an `index.html`, or `welcome.html` files to run as a default "home page". At this point we haven't set one up so the initial screen for our web application will not be too pretty.

```
// A simple servlet to process get requests.
import javax.servlet.*;
import javax.servlet.http.*;
import java.io.*;

public class WelcomeServlet extends HttpServlet {
   // process "get" requests from clients
   protected void doGet( HttpServletRequest request,
      HttpServletResponse response ) throws ServletException, IOException  {
      response.setContentType( "text/html" );
      PrintWriter out = response.getWriter();
      // send XHTML page to client

      // start XHTML document
      out.println( "<?xml version = \"1.0\"?>" );
      out.println( "<!DOCTYPE html PUBLIC \"-//W3C//DTD " +
         "XHTML 1.0 Strict//EN\" \"http://www.w3.org" +
         "/TR/xhtml1/DTD/xhtml1-strict.dtd\">" );
      out.println("<html xmlns = \"http://www.w3.org/1999/xhtml\">" );

      // head section of document
      out.println( "<head>" );
      out.println( "<title>Welcome to Servlets!</title>" );
      out.println( "<style type='text/css'>");
      out.println( "<!--  body{background-color:blue; color:white;} -->");
      out.println( "</style>");
      out.println( "</head>" );

      // body section of document
      out.println( "<body>" );
      out.println( "<h1>Hello!!</h1>");
      out.println( "<h1>Welcome To The Exciting World Of Servlet Technology!</h1>" );
      out.println( "</body>" );
      // end XHTML document
      out.println( "</html>" );
      out.close();  // close stream to complete the page
   }
```

Class name WelcomeServlet

doGet handles the HTTP get request – override method

Set MIME content type

XHTML document returned to the client

End the XHTML document generated by the servlet.

Handling HTTP `get` Requests (cont.)

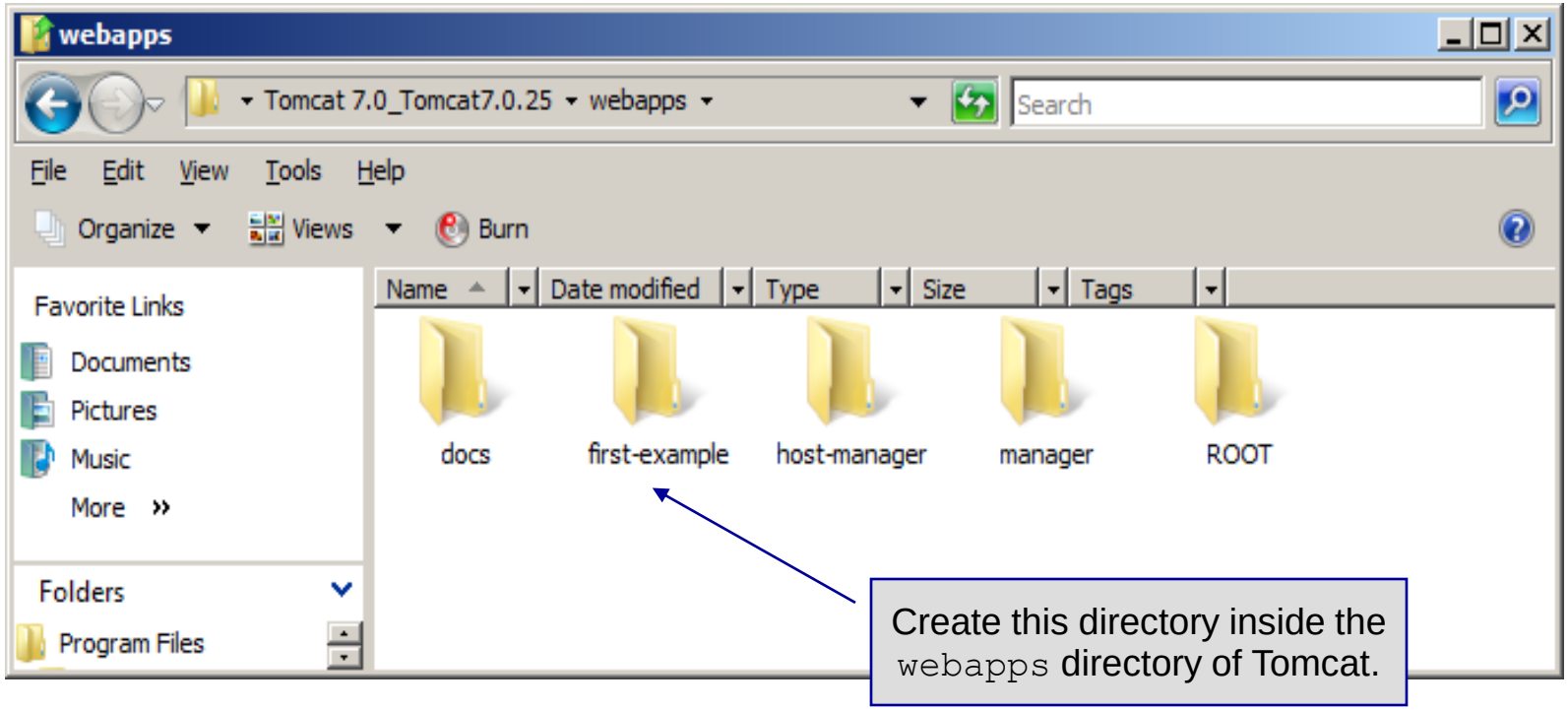
- The servlet creates an XHTML document containing the text "Hello! Welcome to the Exciting World of Servlet Technology!"
- This text is the response to the client and is sent through the `PrintWriter` object obtained from the `HttpServletRepsonse` object.
- The response object's `setContentType` method is used to specify the type of data to be sent as the response to the client. In this case it is defined as text/html, we'll look at other types later. In this case the browser knows that it must read the XHTML tags and format the document accordingly.
- The content type is also known as the MIME (Multipurpose Internet Mail Extension) type of the data.

Creating a Web Application

- One of the fundamental ideas behind Tomcat is that of a web application.
- A web application is a collection of pages, code, and configurations that is treated as a unit.
- Normally a web application will map to a particular URL, so URLs such as http://somesite.com/app1 and http://somesite.com/app2 will invoke different web applications called `app1` and `app2` respectively.
- Tomcat can contain an arbitrary number of web applications simultaneously.
- While web applications can be extremely complex, we'll start out with a minimal web application and build from there.

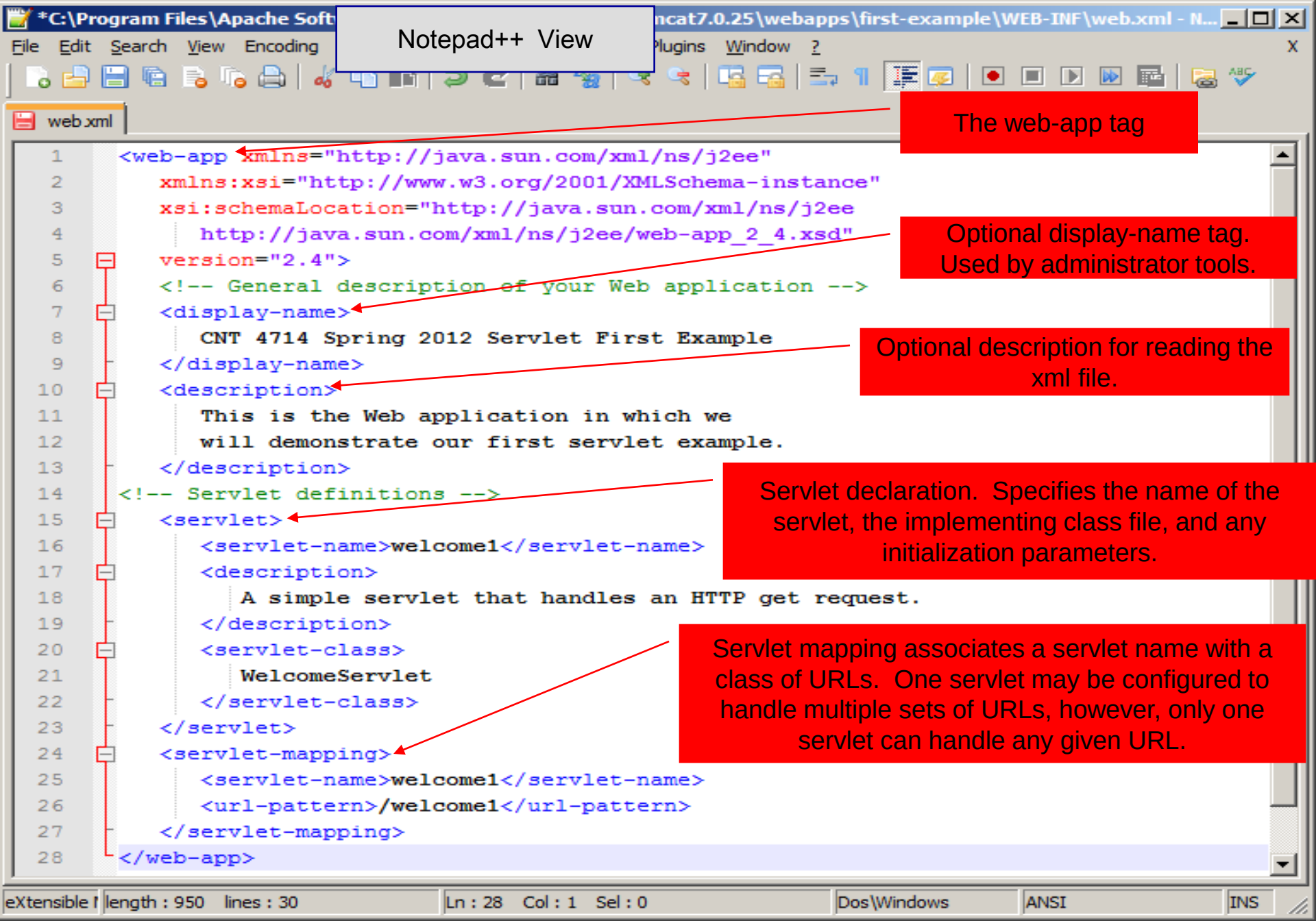
Creating a Web Application (cont.)

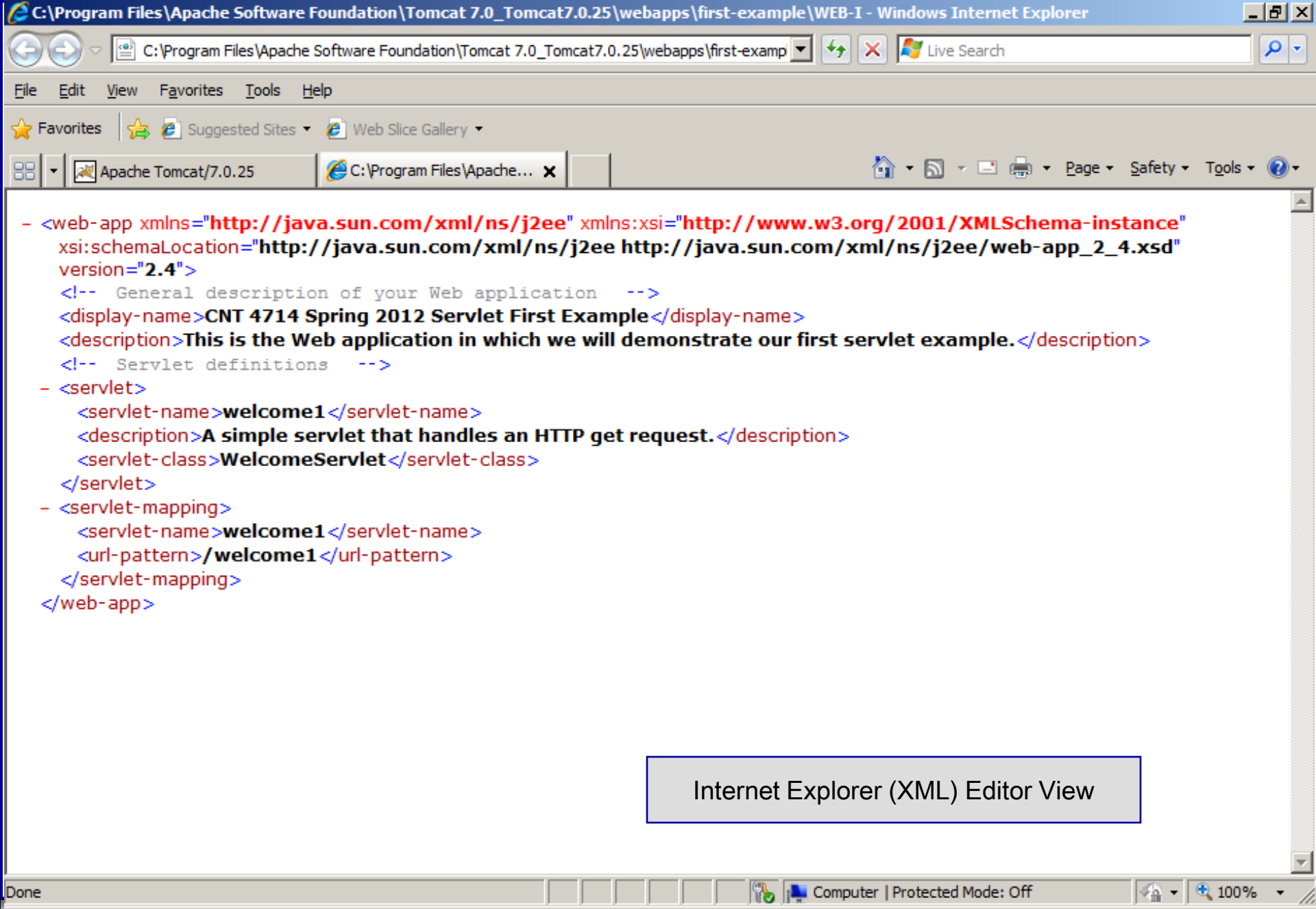
- The most basic web application in Tomcat will require the creation of a directory inside the `webapps` directory to hold the web application. For this first example, we'll create a subdirectory called `first-example`.



Creating a Web Application (cont.)

- Within the `first-example` directory we need to create a directory that will hold the configuration and all of the resources for the web application. This directory must be called `WEB-INF`.
- The most important and only required element in `WEB-INF` is the file `web.xml`. The `web.xml` file controls everything specific to the current web application. We'll look at this file in more detail later as we add to it, but for now we'll look only at the components of this file that are essential for a very simple web application.
- The next page illustrates our initial `web.xml` file.

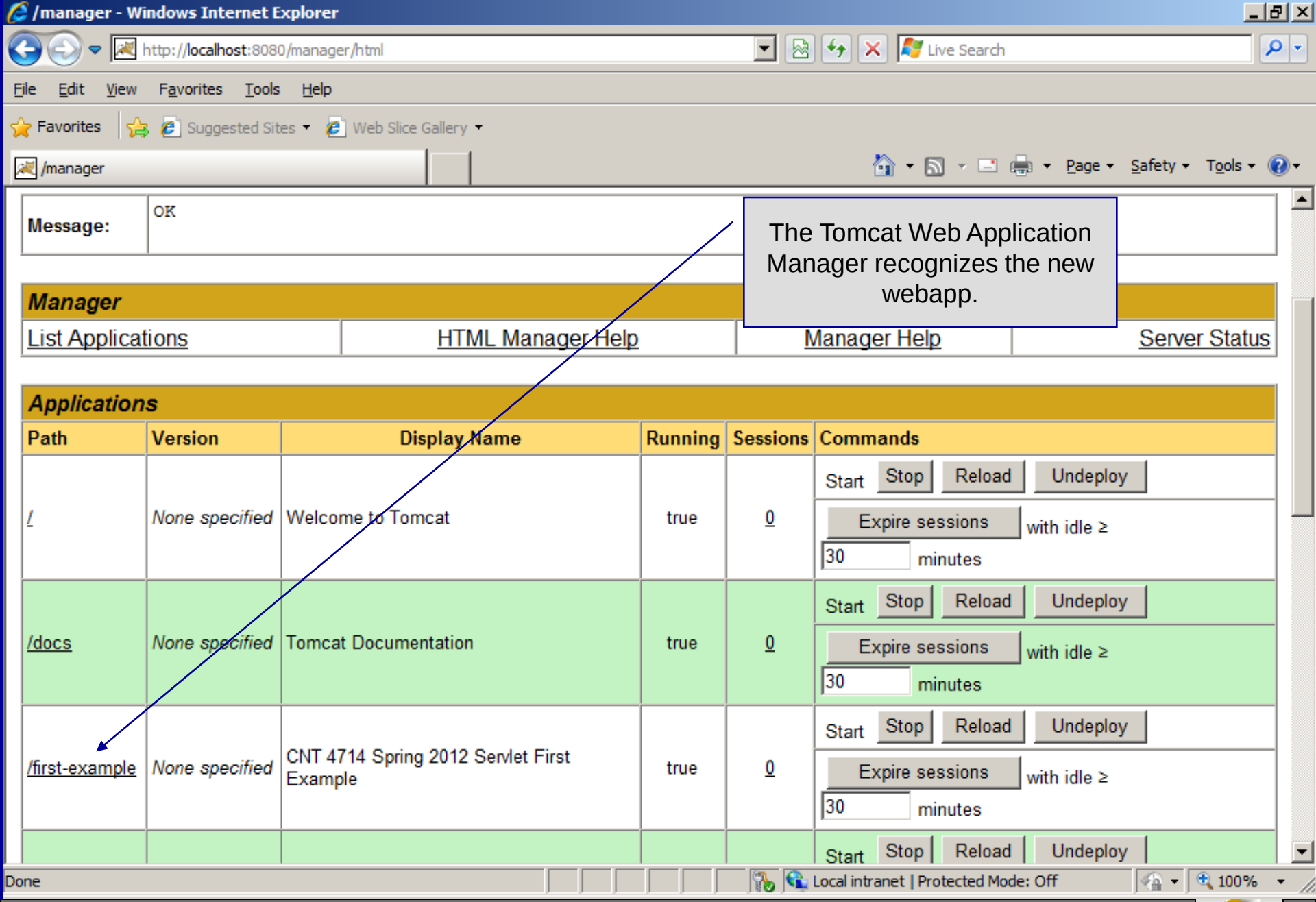

Notepad++ View
The web-app tag
Optional display-name tag. Used by administrator tools.
Optional description for reading the xml file.
Servlet declaration. Specifies the name of the servlet, the implementing class file, and any initialization parameters.
Servlet mapping associates a servlet name with a class of URLs. One servlet may be configured to handle multiple sets of URLs, however, only one servlet can handle any given URL.
web.xml
1 <web-app xmlns="http://java.sun.com/xml/ns/j2ee"
2 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
3 xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
4 http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd"
5 version="2.4">
6 <!-- General description of your Web application -->
7 <display-name>
8 CNT 4714 Spring 2012 Servlet First Example
9 </display-name>
10 <description>
11 This is the Web application in which we
12 will demonstrate our first servlet example.
13 </description>
14 <!-- Servlet definitions -->
15 <servlet>
16 <servlet-name>welcome1</servlet-name>
17 <description>
18 A simple servlet that handles an HTTP get request.
19 </description>
20 <servlet-class>
21 WelcomeServlet
22 </servlet-class>
23 </servlet>
24 <servlet-mapping>
25 <servlet-name>welcome1</servlet-name>
26 <url-pattern>/welcome1</url-pattern>
27 </servlet-mapping>
28 </web-app>
length : 950 lines : 30
Ln : 28 Col : 1 Sel : 0
Dos\Windows
ANSI
INS



Internet Explorer (XML) Editor View

Creating a Web Application (cont.)

- With these directories and files in place, Tomcat will be able to respond to a request for the page from a client at http://localhost:8080/first-example/WelcomeServlet.html.
- Other HTML and JSP pages can be added at will, along with images, MP3 files, and just about anything else.
- Although what we have just seen is all that is required to create a minimal web application, much more is possible with a knowledge of how web applications are arranged and we will see this as we progress through this technology.
- The next few slides illustrate the execution of our simple web application (a welcome servlet).

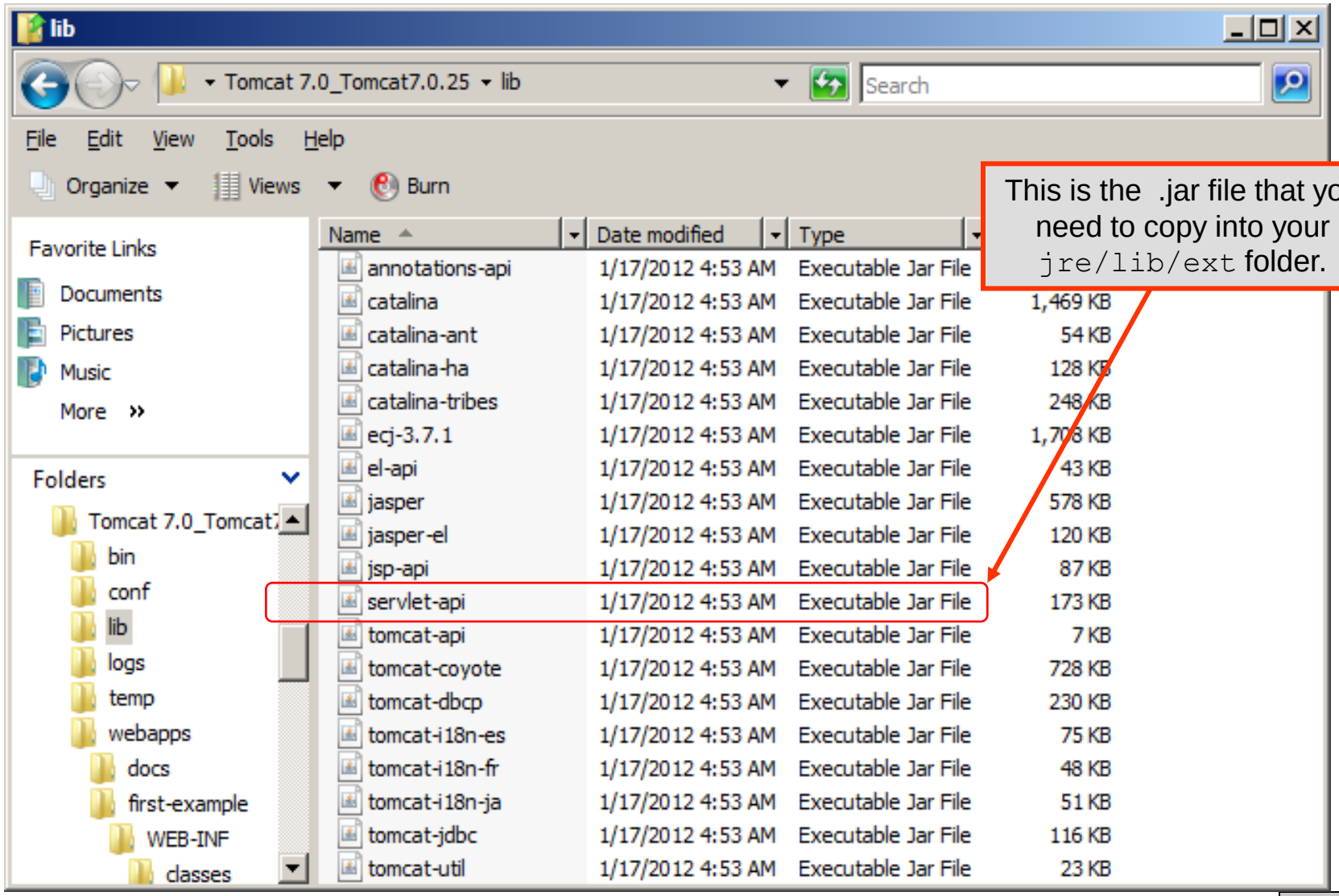

/manager - Windows Internet Explorer
http://localhost:8080/manager/html
Live Search
File Edit View Favorites Tools Help
Favorites Suggested Sites Web Slice Gallery
/manager
Page Safety Tools
Message: OK
The Tomcat Web Application Manager recognizes the new webapp.
Manager
List Applications HTML Manager Help Manager Help Server Status
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
/first-example None specified CNT 4714 Spring 2012 Servlet First Example true 0 Start Stop Reload Undeploy Expire sessions with idle ≥ 30 minutes
Start Stop Reload Undeploy
Done
Local intranet | Protected Mode: Off
100%

Tomcat/Java Configuration - The Servlet API

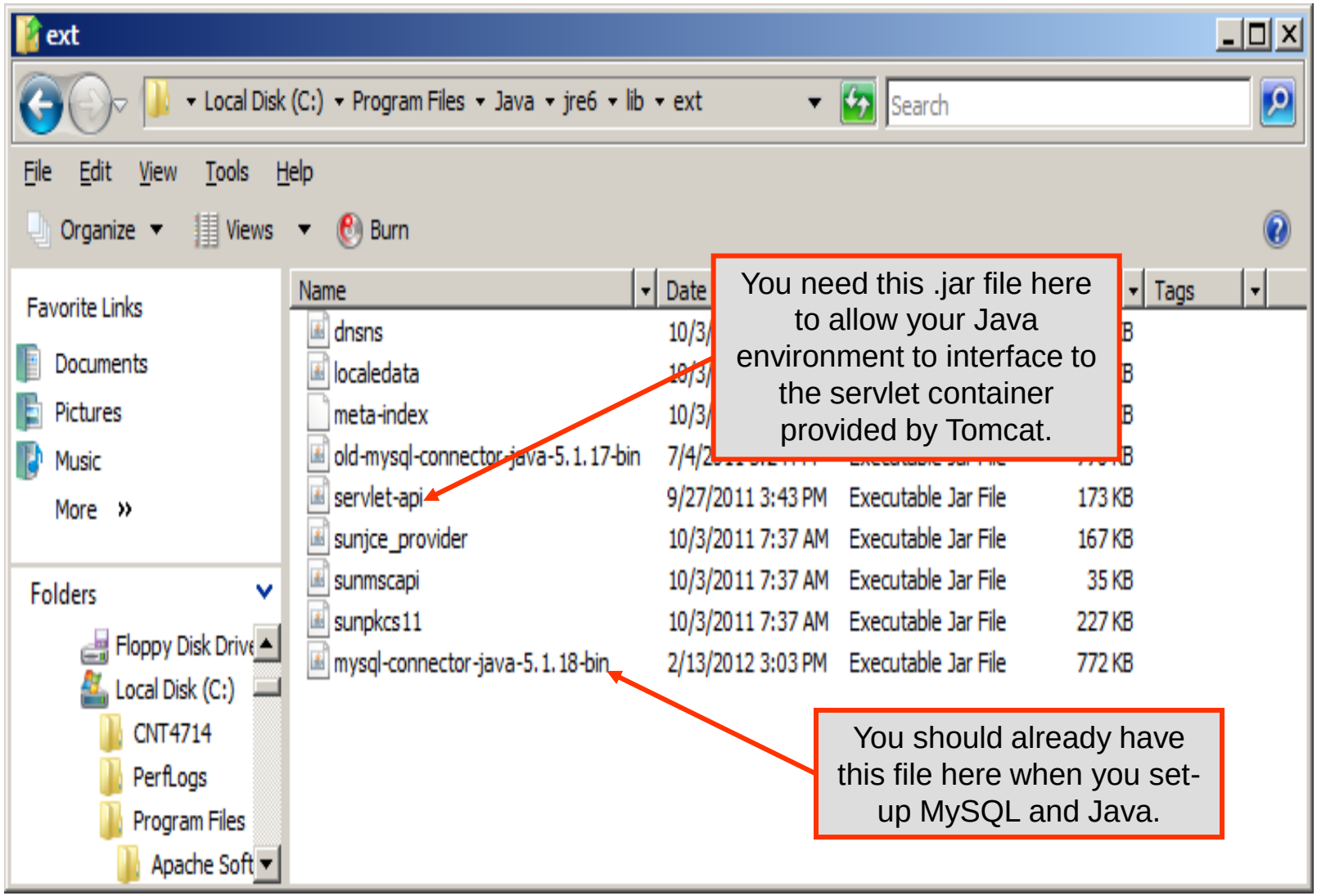
IMPORTANT ! !

- Your Tomcat installation includes the `servlet-api.jar` file. This file can be found in the `lib` folder in Tomcat. Copy this file into your `jdk/jre/lib/ext` folder to allow the java compiler access to the `javax.servlet` package.
- Note that your Java set-up may already have this installed depending on several things, so check your `jdk/jre/lib/ext` folder first.

Tomcat/Java Configuration - The Servlet API



Tomcat/Java Configuration - The Servlet API



C:\Program Files\Apache Software Foundation\Tomcat 7.0_Tomcat7.0.25\webapps\first-example\WelcomeServlet.html ...

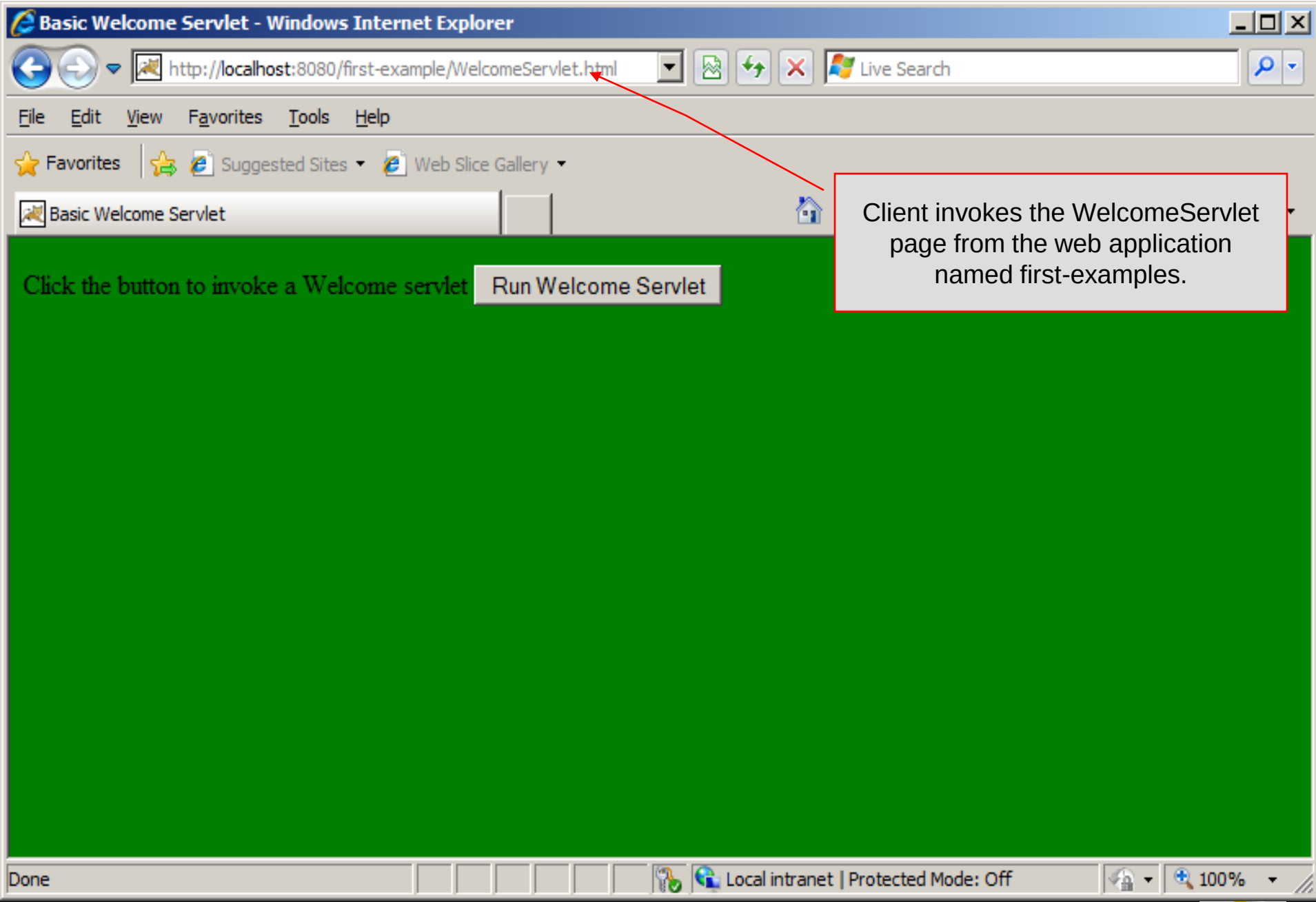
File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X

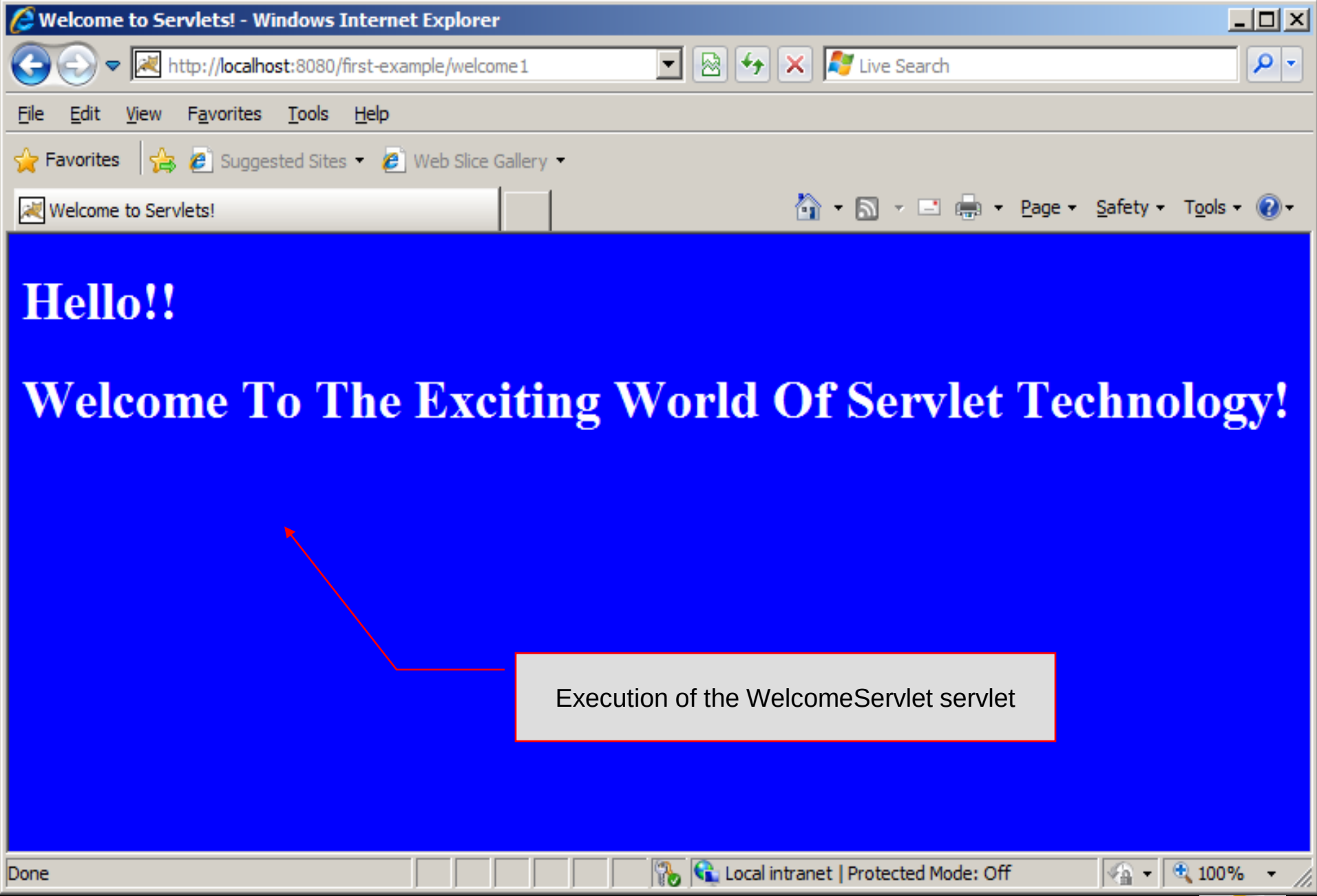
web.xml | WelcomeServlet.html

```
1  <?xml version = "1.0" encoding="UTF-8" standalone="no" ?>
2  <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
3     "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
4  <!-- WelcomeServlet.html -->
5  <html xmlns = "http://www.w3.org/1999/xhtml">
6  <head>
7     <title>Basic Welcome Servlet</title>
8     <style type="text/css">
9      <!--
10        body{background-color: green;}
11     -->
12     </style>
13 </head>
14 <body>
15    <form action = "/first-example/welcome1" method = "get">
16    <p>
17       <label>Click the button to invoke a Welcome servlet
18          <input type = "submit" value = "Run Welcome Servlet" />
19       </label>
20    </p>
21    </form>
22 </body>
23 </html>
```

This is the XHTML file that generates the output shown above which informs the client how to invoke the servlet.

Hyper Text | length : 656 lines : 23 | Ln : 1 Col : 1 Sel : 0 | Dos\Windows | ANSI | INS


Basic Welcome Servlet - Windows Internet Explorer
http://localhost:8080/first-example/WelcomeServlet.html
Live Search
File Edit View Favorites Tools Help
Favorites
Suggested Sites
Web Slice Gallery
Basic Welcome Servlet
Click the button to invoke a Welcome servlet
Run Welcome Servlet
Client invokes the WelcomeServlet page from the web application named first-examples.
Done
Local intranet | Protected Mode: Off
100%


Welcome to Servlets! - Windows Internet Explorer
http://localhost:8080/first-example/welcome1
Live Search
File Edit View Favorites Tools Help
Favorites
Suggested Sites
Web Slice Gallery
Welcome to Servlets!
Page Safety Tools
Hello!!
Welcome To The Exciting World Of Servlet Technology!
Execution of the WelcomeServlet servlet
Done
Local intranet | Protected Mode: Off
100%

An XHTML Document

- The XHTML document shown on page 73 provides a `form` that invokes the servlet defined on page 61.
- The form's `action` attribute (/first-example/welcome1) specifies the URL path that invokes the servlet.
- The form's method attribute indicates that the browser sends a get request to the server, which results in a call to the servlet's `doGet` method.
  - We'll look at how to set-up the URL's and deployment structure in the next set of notes.

Set-Up For First Web Application

- The exact set-up you need to use for setting up your web application in Tomcat is summarized on the next couple of pages.

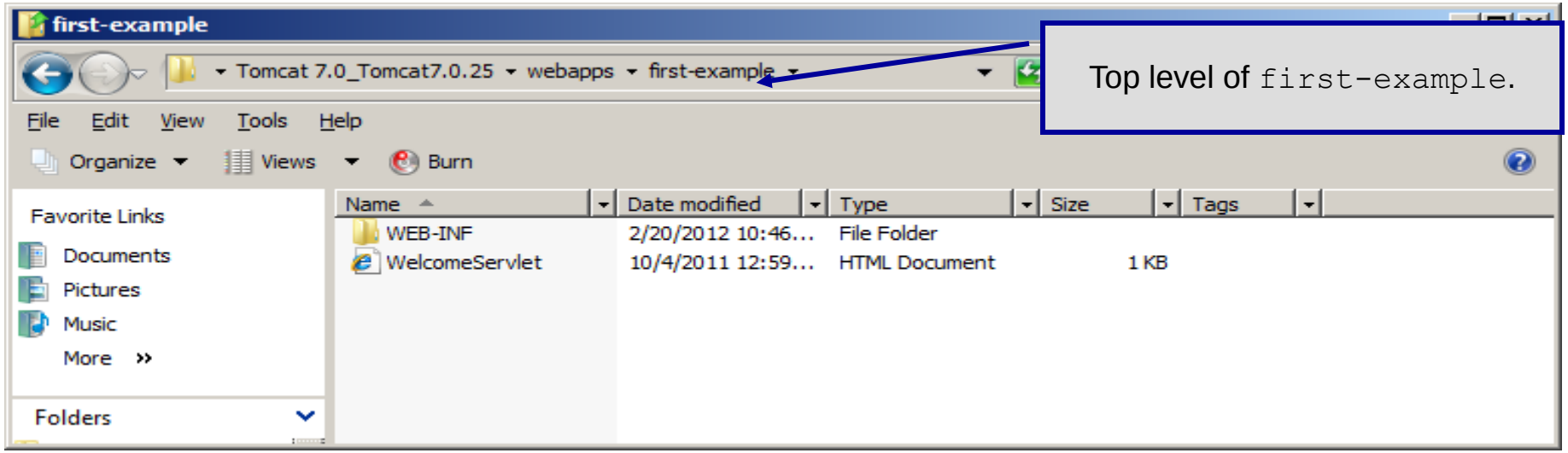
1. In the Tomcat `webapps` folder create a directory named `first-example`.

2. In the top level of `first-example` copy the `WelcomeServlet.html` file from the course code page.

3. In the top level of `first-example` create a directory named `WEB-INF`.

4. When steps 2 and 3 are complete the top level of first-examples should look like the picture at the top of the next page.

Set-Up For First Web Application (cont.)

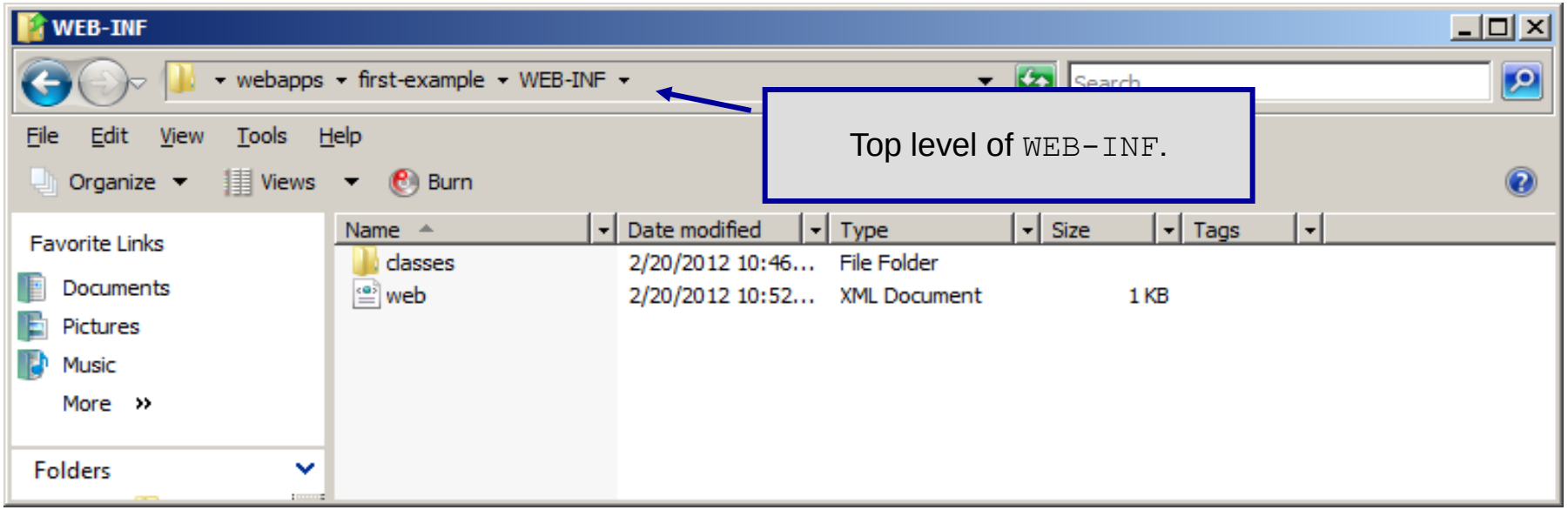


5. Copy the `web.xml` configuration file from the course code page into the `WEB-INF` directory.

6. At the top level of the `WEB-INF` directory create a directory named `classes`.

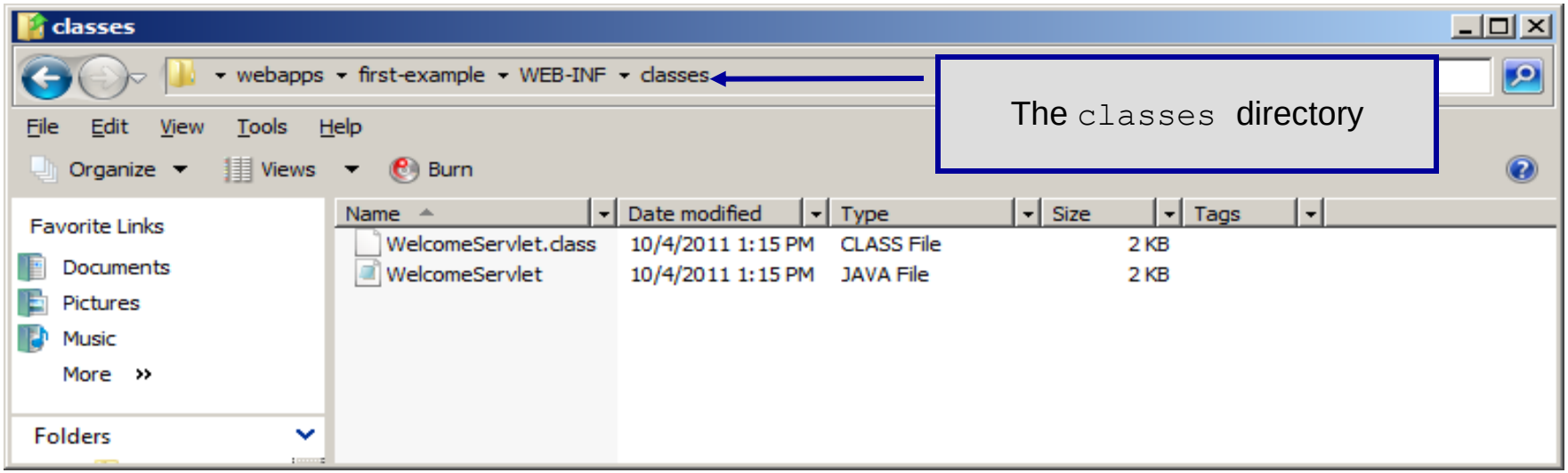
7. When steps 5 and 6 are complete, the WEB-INF directory should look like the picture on the top of the next page.

Set-Up For First Web Application (cont.)



8. Copy the `WelcomeServlet.java` file from the course code page into the `classes` directory and compile it to produce the `WelcomeServlet.class` file which should also reside in the classes directory. (The `.java` file does not need to reside in this directory for a servlet, but it is handy to keep the source in the same place.)

Set-Up For First Web Application (cont.)



9. Once the `classes` directory looks like the one shown above. You are ready to invoke the servlet from a web browser. Start Tomcat and enter the URL http://localhost:8080/WelcomeServlet.html. Tomcat and the servlet will do the rest. If all goes well you should see the output that was shown on pages 74-75.