Attacking WCF Web Services

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Attacking WCF Web Services

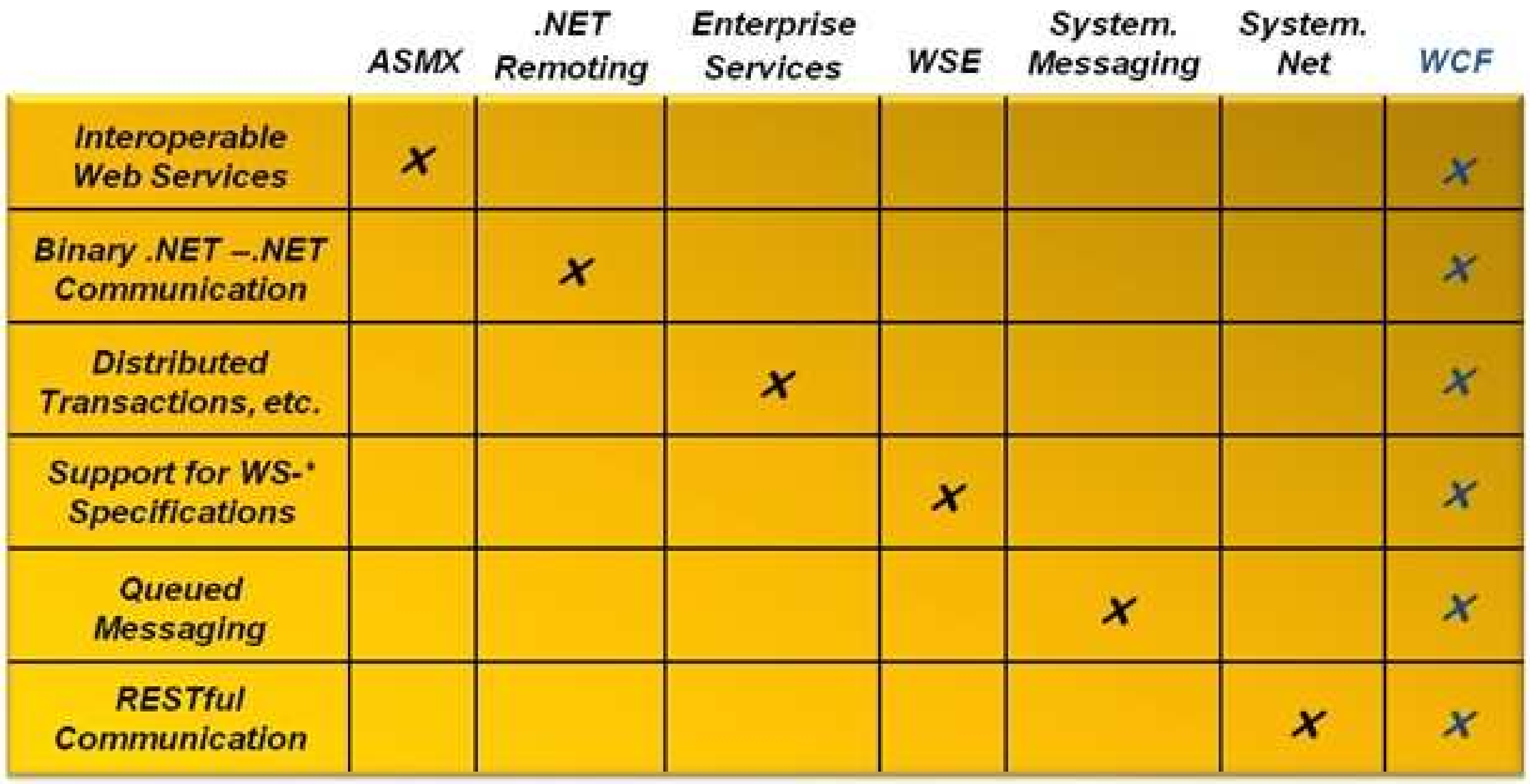
- Session Objectives
  - Introduction to WCF
  - Tools & Techniques for Pen-testing WCF Services

- Session Outline
  - WCF Overview
  - Silverlight WCF Web Services
  - WCF and WS-Security
  - Duplex Services

WTF is WCF?

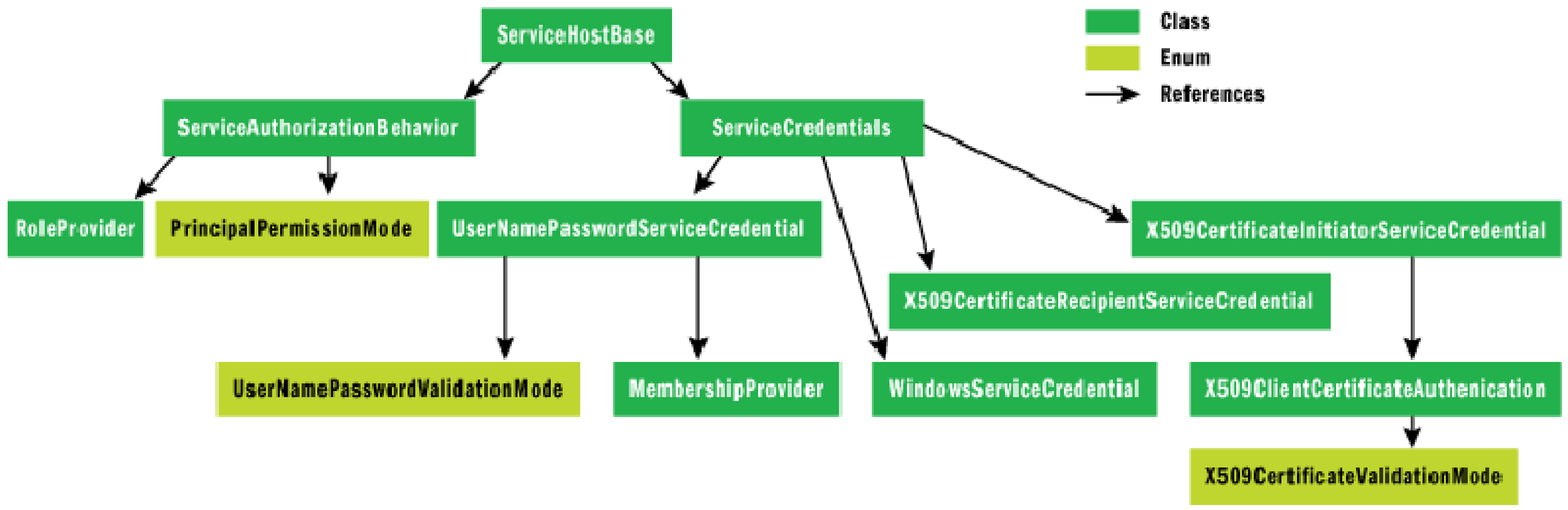
- Core Communications Framework for .NET Applications and Services
  - Introduced in .NET 3.0, enhanced in .NET 3.5
  - Supports various protocol bindings and message formats
  - Includes backwards compatible for legacy services

What's new with WCF?



	ASMX	.NET Remoting	Enterprise Services	WSE	System. Messaging	System. Net	WCF
Interoperable Web Services	X						X
Binary .NET –.NET Communication		X					X
Distributed Transactions, etc.			X				X
Support for WS-* Specifications				X			X
Queued Messaging					X		X
RESTful Communication						X	X

Security Properties of ServiceHostBase


ServiceHostBase
ServiceAuthorizationBehavior
ServiceCredentials
RoleProvider
PrincipalPermissionMode
UserNamePasswordServiceCredential
X509CertificateInitiatorServiceCredential
X509CertificateRecipientServiceCredential
UserNamePasswordValidationMode
MembershipProvider
WindowsServiceCredential
X509ClientCertificateAuthenication
X509CertificateValidationMode
Class
Enum
References

“Security is by far the most intricate area of the WCF”

-- Juval Lowy, Programming WCF Services (O’Reilly)

ABCs of WCF Endpoints

- WCF Services are exposed through **Endpoints**
- Each Endpoint has three required elements, commonly referred to as the A-B-C's
  - Address
  - Binding
  - Contract

WCF Addresses

"Where can I find this service?"

- Every WCF Service has a Unique Address
  - Transport Protocol
  - Location
  - Often use .svc file extension when hosted in IIS

[transport]://[machine or domain][:optional port]/[optional uri]

WCF Bindings

"What protocol can I use to talk to this service?"

- Bindings specify how a service communicates
  - Transport Protocol
  - Encoding (Message Format)

- Several out-of-the-box bindings, or can be customized

WCF Bindings

- WCF Transport Protocols
  - NET.TCP
  - HTTP/HTTPS
  - Named Pipes (IPC)
  - Peer to Peer (P2P)
  - Message Queuing (MSMQ)

- WCF Encoding Formats
  - Text
    - SOAP, XML, JavaScript
  - Binary
  - MTOM

WCF Contracts

"What can I do with this service?"

- WCF Contracts specify what is communicated to the outside world
- Four types of Contracts
  - Service: Operations the client can perform
  - Data: Define the data types passed by the service
  - Fault: Error handling and propagation
  - Message: Allows direct interaction with messages

WCF Contracts: Opt-In Approach

- Nothing is part of a service contract by default
  - Developer must explicitly use ServiceContract and OperationContract attributes to indicates methods exposed by the endpoint
  - DataContract and DataMember attributes can also be used to specify whether all or part of a complex type is exposed to clients

Attacking WCF Services

- Example 1: Silverlight 3 Client Service
- Example 2: WS-Security & Message Encryption
- Example 3: WCF Duplex Services

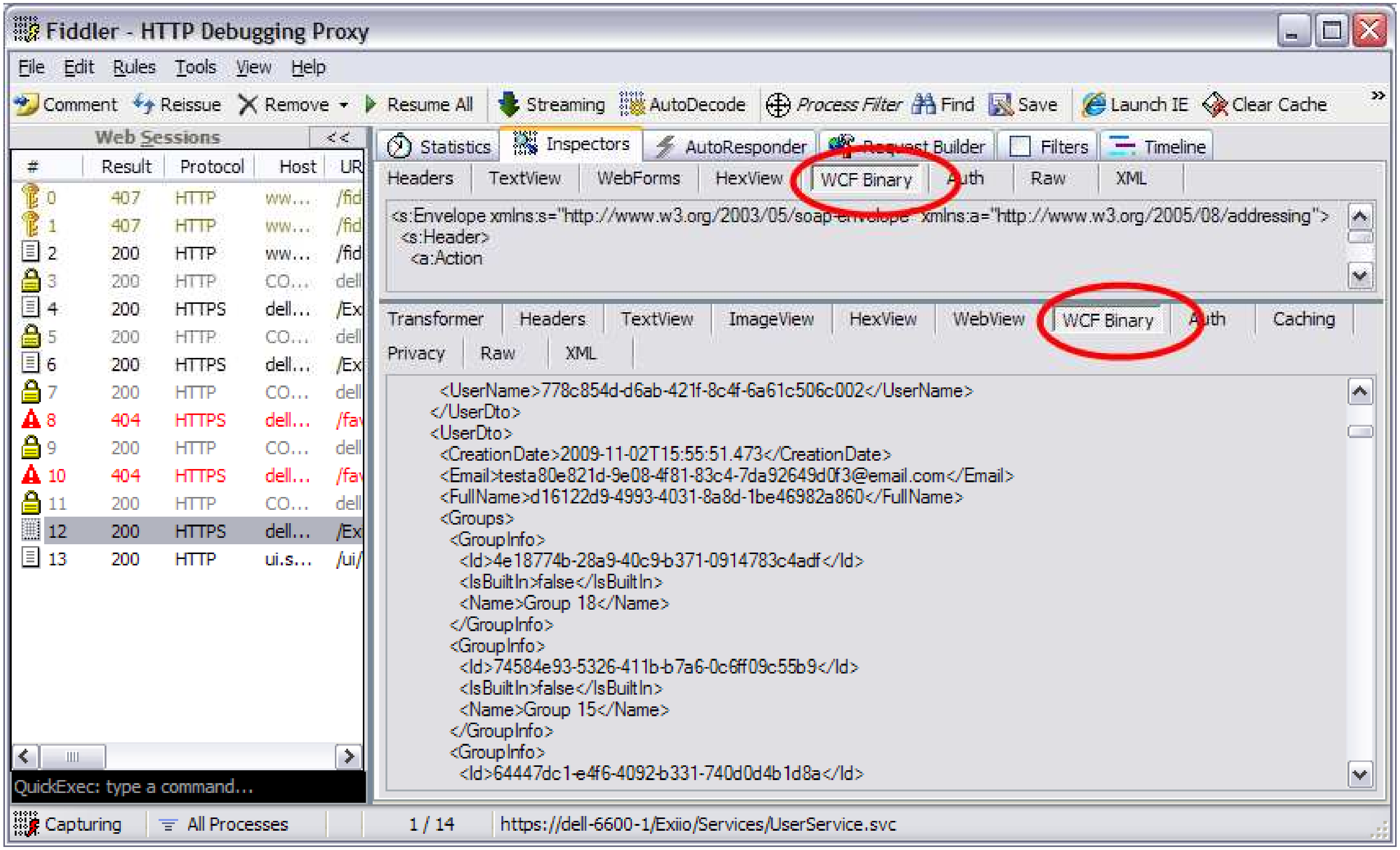
Example 1: Silverlight Client Service

- WCF is commonly consumed by Silverlight for browser-based services
  - Broad Support for WCF in Silverlight 3+
  - By default, uses .NET Binary SOAP Messages
    - Smaller message sizes
    - Better messaging performance
    - Content-Type: application/soap+msbin1
    - MC-NBFS Protocol Specification
      - http://msdn.microsoft.com/en-us/library/cc219175(PROT.10).aspx

HTTP/S Proxies and MC-NBFS

- Limited (if any) support for MC-NBFS/MSBin1 in most common proxy tools
  - Fiddler: Binary XML Inspector (Richard Berg)
    - http://tfstoys.codeplex.com/
    - Read Only inspection of Binary XML Messages

Fiddler: Binary XML Inspector



Fiddler - HTTP Debugging Proxy
File Edit Rules Tools View Help
Comment Reissue Remove Resume All Streaming AutoDecode Process Filter Find Save Launch IE Clear Cache
Web Sessions
Statistics Inspectors AutoResponder Request Builder Filters Timeline
Headers TextView WebForms HexView WCF Binary Auth Raw XML
Transformer Headers TextView ImageView HexView WebView WCF Binary Auth Caching
Privacy Raw XML
QuickExec: type a command...
Capturing All Processes 1 / 14

#	Result	Protocol	Host	UR
0	407	HTTP	ww...	/fid
1	407	HTTP	ww...	/fid
2	200	HTTP	ww...	/fid
3	200	HTTP	CO...	dell
4	200	HTTPS	dell...	/Ex
5	200	HTTP	CO...	dell
6	200	HTTPS	dell...	/Ex
7	200	HTTP	CO...	dell
8	404	HTTPS	dell...	/fa
9	200	HTTP	CO...	dell
10	404	HTTPS	dell...	/fa
11	200	HTTP	CO...	dell
12	200	HTTPS	dell...	/Ex
13	200	HTTP	ui.s...	/ui/

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope" xmlns:a="http://www.w3.org/2005/08/addressing">
  <s:Header>
    <a:Action
```

```
      <UserName>778c854d-d6ab-421f-8c4f-6a61c506c002</UserName>
    </UserDto>
    <UserDto>
      <CreationDate>2009-11-02T15:55:51.473</CreationDate>
      <Email>testa80e821d-9e08-4f81-83c4-7da92649d0f3@email.com</Email>
      <FullName>d16122d9-4993-4031-8a8d-1be46982a860</FullName>
      <Groups>
        <GroupInfo>
          <Id>4e18774b-28a9-40c9-b371-0914783c4adf</Id>
          <IsBuiltIn>false</IsBuiltIn>
          <Name>Group 18</Name>
        </GroupInfo>
        <GroupInfo>
          <Id>74584e93-5326-411b-b7a6-0c6ff09c55b9</Id>
          <IsBuiltIn>false</IsBuiltIn>
          <Name>Group 15</Name>
        </GroupInfo>
        <GroupInfo>
          <Id>64447dc1-e4f6-4092-b331-740d0d4b1d8a</Id>
```

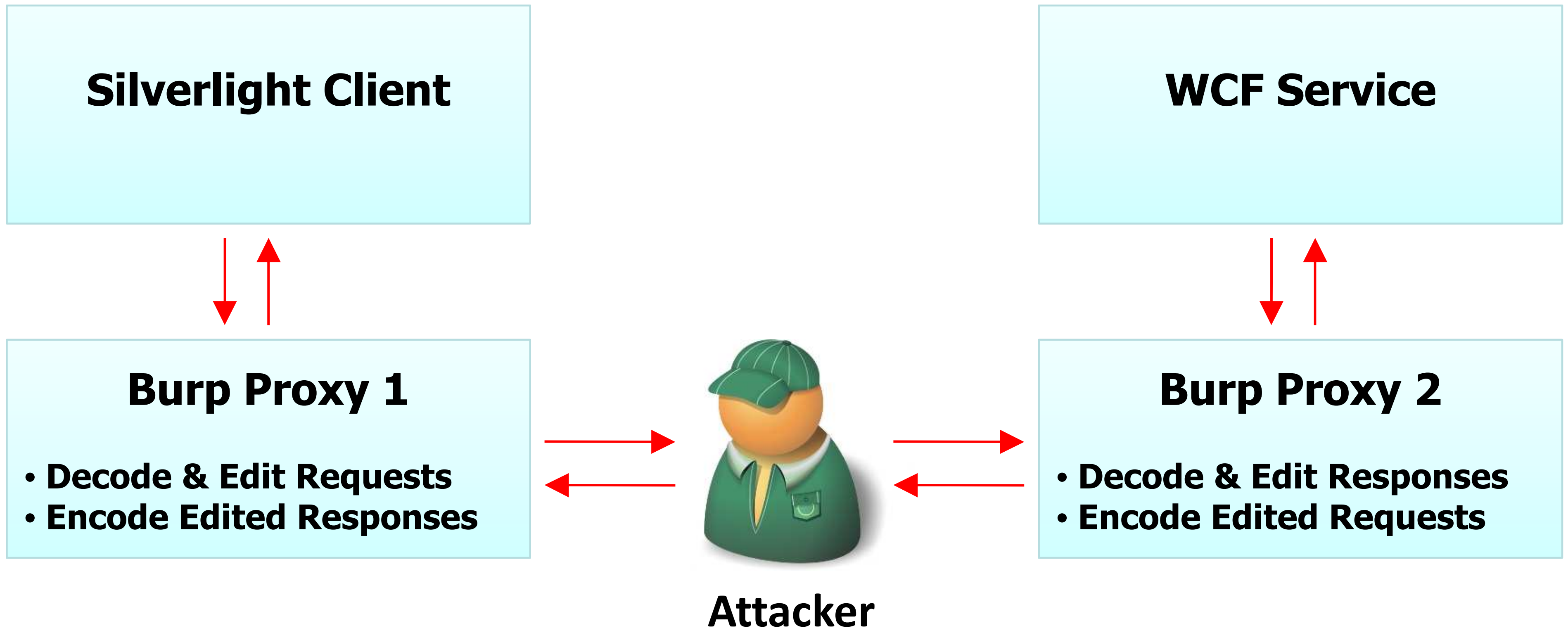
https://dell-6600-1/Exiio/Services/UserService.svc

MSBin1 Burp Proxy Plug-In

- Plug-In for Burp Suite Free Edition
  - Burp: MSBin1 Plug-In (Gotham Digital Science)
    - Leverages Richard Berg's XML Encoder/Decoder
    - Allows full edit/update of Binary XML Messages
  - Implements processProxyMessage method of BurpExtender interface
    - Requires two chained proxy instances to perform encoding and decoding of intercepted requests
    - Sets "X-WCF-Proxy: must-encode" header to notify downstream Burp proxy

MSBin1 Burp Proxy Plug-In

- Workaround for Burp Extender Limitation



MSBin1 Burp Proxy Plug-In

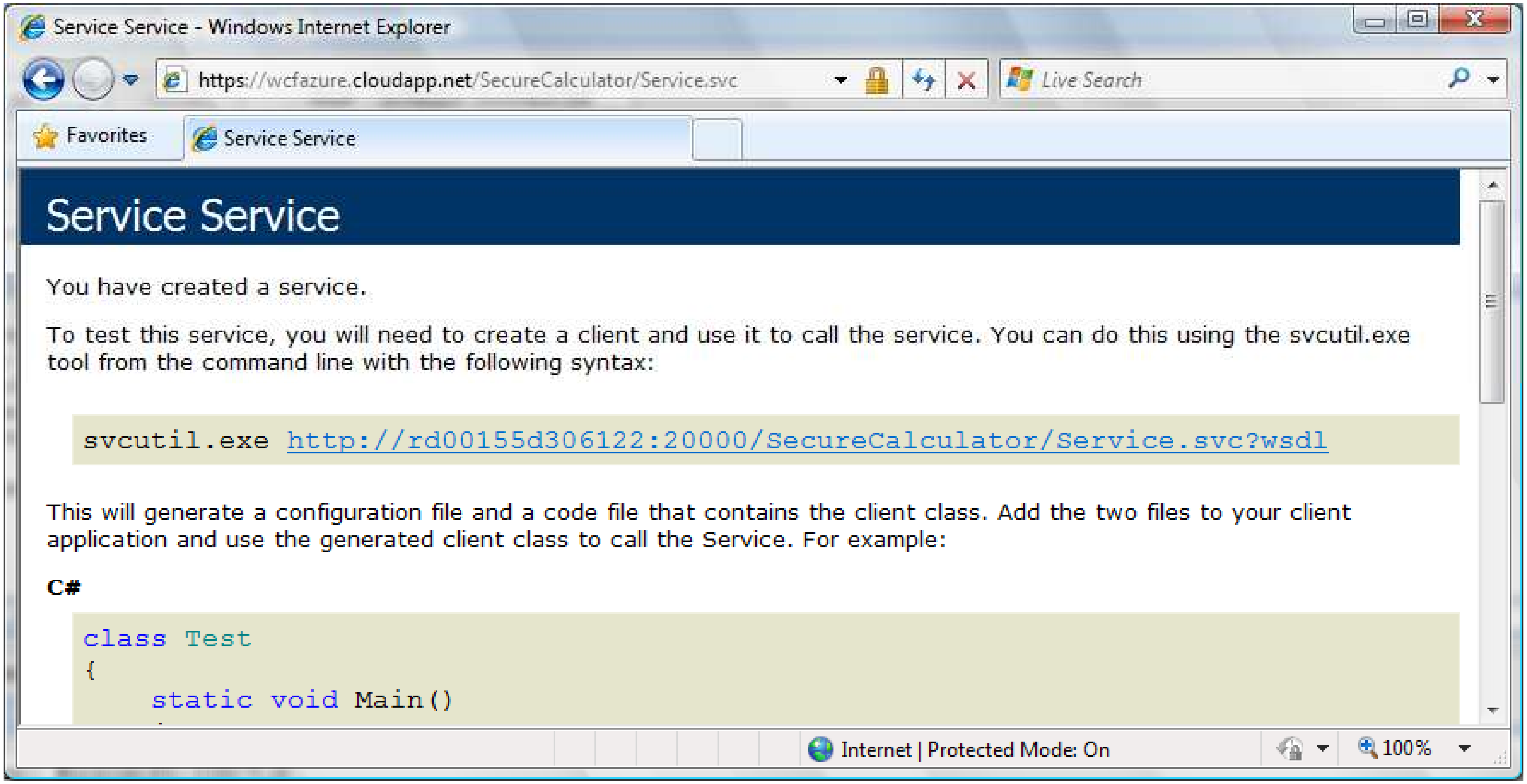
- Plug-In for Burp Suite Professional Edition
  - Implements processProxyMessage and processHttpMessage methods of BurpExtender
    - These methods will be included in Free v1.3
  - Still requires 2nd chained proxy to edit responses
    - Above methods both invoked before response edit, not after
  - Both plug-ins available for free on GDS website (after this talk)

Obtaining MetaData from a WCF Endpoint

- HTTP-GET
  - Same as legacy ASMX
  - Retrieved by appending “?wsdl” to the address

- Metadata Exchange (MEX) Binding
  - Based on WS-MetadataExchange Standard
  - W3C Working Draft 25 June 2009

MetaData Helper Page


Service Service - Windows Internet Explorer
https://wcfazure.cloudapp.net/SecureCalculator/Service.svc
Live Search
Favorites
Service Service
Internet | Protected Mode: On
100%

Service Service

You have created a service.

To test this service, you will need to create a client and use it to call the service. You can do this using the svcutil.exe tool from the command line with the following syntax:

```
svcutil.exe http://rd00155d306122:20000/SecureCalculator/Service.svc?wsdl
```

This will generate a configuration file and a code file that contains the client class. Add the two files to your client application and use the generated client class to call the Service. For example:

C#

```
class Test
{
    static void Main()
```

Obtaining MetaData from a WCF Endpoint

- By default, WCF services do not publish metadata
  - Both WSDL and MEX are enabled by default when generating WCF configuration in Visual Studio

```
[snip]
<endpoint address="mex" binding="mexHttpBinding"
   contract="IMetadataExchange"/>
[…]
<!-- To avoid disclosing metadata information, set the value
below to false and remove the metadata endpoint above before
deployment -->

<serviceMetadata httpGetEnabled="true"/>
[snip]
```

Basic MEX Request Structure

```
POST /MyService.svc/mex HTTP/1.1
Content-Type: application/soap+xml; charset=utf-8
Host: wcf.example.com
Content-Length: 565
```

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-
envelope" xmlns:a="http://www.w3.org/2005/08/addressing">
  <s:Header>
    <a:Action>
      http://schemas.xmlsoap.org/ws/2004/09/transfer/Get
    </a:Action>
    <a:To>
      http://wcf.example.com/MyService.svc/mex
    </a:To>
  </s:Header>
  <s:Body/>
</s:Envelope>
```

Manual Testing Utilities

- Leveraging MetaData for Manual Testing
  - WcfTestClient
    - Ships with Visual Studio 2008+
    - Automatically Parses WSDL or MEX
    - http://weblogs.asp.net/blogs/guillermo/Code/WcfTestClient.zip
  - WCF Storm
    - Supports most WCF bindings, including MC-NBFS over HTTP
    - Free Lite Version available
    - http://www.wcfstorm.com/wcf/download-wcfstorm-lite.aspx

Obtaining MetaData from a Silverlight XAP

- Silverlight client can be decompiled to obtain service metadata from the XAP file
  - Service Endpoints
  - Methods & Data Types

- Download, Unzip, Decompile
  - .NET Reflector
  - FileGenerator Plug-In

Example 2: Secure WCF Bindings

- Secure bindings support Message Security based on WS-Security standards
  - NetTCPBinding
    - Binary XML Message Format
  - wsHttpBinding
    - SOAP/XML over HTTP/S
  - many more…

- Multiple credentials options
  - Windows, Certificate, Username, Anonymous, IssuedToken

Determining WCF Security Settings

- Analyze Binding Security Settings
  - Primarily Driven off “Mode”
    - Transport
      - clientCredentialType
    - Message
      - clientCredentialType
    - TransportWithMessage
      - Refer to both Transport and Message settings
    - None

WCF Message Security

- Message security uses the WS-Security specification to secure messages
  - Alternative to TLS/SSL
  - Supports message signing, encryption, or both

- Message security supports negotiation by default
  - Service is dynamically asked for the correct token before any messages are exchanged
    - Can be anonymous or require credentials
    - Negotiation requires at least one certificate

WS-S Anonymous Message Encryption

SOAP security negotiation with 'http://target/service.svc' for target 'http://targetservice.svc' failed.

- Requires a valid server certificate
  - Signed by trusted CA or in “Trusted People” store
  - Can be disabled via client endpoint behaviorConfiguration
- Certificate may be provided within meta data
  - Client -> Endpoint -> Identity -> Certificate

Writing a Custom WCF Test Client

- Much easier than it sounds
  - Usually requires less than 10 lines of custom code!!
- Use **svcutil** to generate the following artifacts using WSDL or MEX medatata:
  - [Service Name].cs – Client class with accessible web methods and complex data types
  - output.config – Configuration file with endpoint information (address, bindings, contract)

Writing a Custom WCF Test Client

- Custom WCF client in less than 10 lines of code

```
public class MyClient
{
    public static void Main()
    {
        try
        {
            CalculatorClient client = new CalculatorClient();
            double sum = client.Add(1, 1);
            Console.WriteLine("1 + 1 = " + sum);
        }
        catch (Exception e)
        {
            Console.WriteLine(e.Message);
        }
    }
}
```

Writing a Custom WCF Test Client

- Quick and Dirty Test Client
  - Step 1: Generate [class].cs and App.config
    - svcutil <metadataPath> /out:MyClient.cs /config:MyClient.exe.config
  - Step 2: Add console processing logic
    - using System;
    - main()
  - Step 3: Compile MyClient.cs file with csc.exe

Writing a Custom WCF Test Client

- Disabling certificate verification

```
<behaviors>
  <endpointBehaviors>
      <behavior name="NoCertValidation">
          <clientCredentials>
              <serviceCertificate>
                  <authentication certificateValidationMode="None"
                     revocationMode="NoCheck" />
              </serviceCertificate>
          </clientCredentials>
      </behavior>
  </endpointBehaviors>
</behaviors>
```

WS-S Username Credentials

- Username & Password credentials passed with each message
  - WCF does not allow this mechanism over un-encrypted transport
  - Passed in SOAP Header as defined by standards

```
<o:Security s:mustUnderstand="1" xmlns:o="http://docs.oasis-
open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd">
    <o:UsernameToken>
        <o:Username>wcftest</o:Username>
        <o:Password>3mb3dd3d!</o:Password>
    </o:UsernameToken>
</o:Security>
```

WS-S Username Credentials

- NOTE: MetaData not always published over SSL

Default Visual Studio Template includes:

```
<serviceMetadata httpGetEnabled="true"/>
```

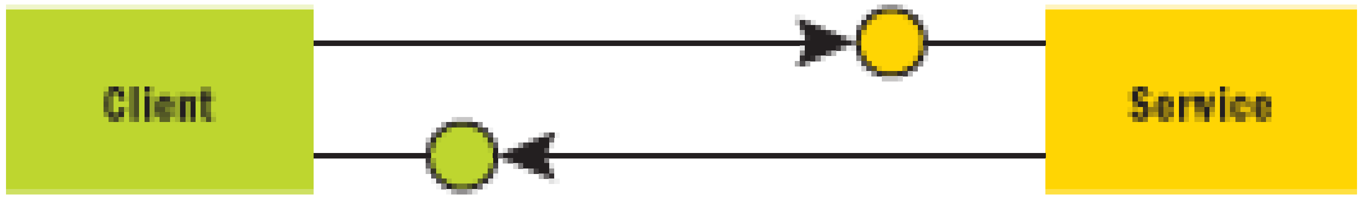
but NOT:

```
<serviceMetadata httpsGetEnabled="true"/>
```

$\uparrow$

Example 3: WCF Duplex Services

- WCF also supports "Duplex" communication
  - Opens "callback" channel for each client
    - WSDualHttpBinding
    - NetTcpBinding
    - NetPeerTcpBinding
  - Ideal for "push" notification
  - Callback endpoint is a listening port on the client host



WSDualHttpBinding

- WSDualHttpBinding designed for HTTP Duplex
  - Dedicated port on client machine to accept callbacks
  - Uses Microsoft-HTTPAPI/2.0
- Client informs WCF of callback address during initial request
  - WCF server will issue an acknowledgement response to callback address

Abusing WSDualHttpBinding

- Port scanning via WSDualHttpBinding callback

```
<s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"
  xmlns:a="http://www.w3.org/2005/08/addressing">
    <s:Header>
        <a:Action s:mustUnderstand="1">
          http://schemas.xmlsoap.org/ws/2005/02/rm/CreateSequence
        </a:Action>
        <a:MessageID>urn:uuid:foobar</a:MessageID>
        <a:ReplyTo>
            <a:Address>http://holyfield-pc:135/test</a:Address>
        </a:ReplyTo>
        <a:To s:mustUnderstand="1">
           http://gotham-vista:88/Service.svc
        </a:To>
    </s:Header>
    <s:Body>
        <CreateSequence xmlns="http://schemas.xmlsoap.org/ws/2005/02/rm">
        </CreateSequence>
    </s:Body>
</s:Envelope>
```

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