# Windows Communication Foundation

Jim Fawcett CSE681 – Software Modeling and Analysis Fall 2017

#### **Primary Code References**

- www.ecs.syr.edu/faculty/Fawcett/handouts/C SE681-OnLine/code/WCF\_Examples
- Start with these references and use object browser and MSDN docs via F1 key

#### **Tutorials**

- Tutorials on WCF, WPF, and more
- Getting Started MSDN

### **Distributed Computer Communication**

- 1964 Dartmouth Time Sharing System
- 1969 First link of ARPANET installed
- 1974 First TCP specification
- 1978 TCP/IP specification
- 1980 Ethernet
- 1983 Berkely sockets released with BSD
- 1990 CORBA 1.0
- 1991 OLE
- Early 90's DCE/RPC
- 1993 COM
- 1994 CORBA 2.0
- 1996 ActiveX, DCOM
- 1997 Java RMI (Sun jdk 1.1, Java 2.0)
- 2002 .Net Remoting
- 2006 WCF (.Net 3.0)

#### What is WCF?

- Provides software Services on machines, networks, and across the internet
- Unified programming model for all of these
- Supported natively on Windows 8, 7 and Vista
  - Requires installation on XP
- Not available on other platforms
  - Mono?
  - DotGnu?
  - Mac OSX ?

#### **Integration into .Net Facilities**

- One model for distributed systems decomposes into presentation layer, application logic layer, and data layer, all bound together with communication.
- Presentation: WPF
- Data: LINQ retrieves data
- Communic: WCF local, network, internet
- Applic Logic: Custom designs

#### **WCF Design Principles**

- Boundaries are explicit
  - No attempt to hide communication
- Services are intended to be autonomous
  - Deployed, managed, and versioned independently
- Services share contracts and schemas, not types
  - Contracts define behavior, schemas define data
  - Client needs a reference to contract not to service implementation
- Compatibility is policy-based
  - Policy supports separation of behavior from access constraints

#### **Essential Pieces of WCF**

- Contracts for **services**, **data**, and **messages** 
  - A contract is simply an interface declaration
- Service, Data, and Message definitions
  - Class implementations of the contracts
- Configurations defined programmatically or declaratively
  - Net class instances versus config files.
- A host process (can be self hosted)
  - IIS, Windows Executable, Windows Service, or WAS
- .Net Framework Classes provide support for all of the above.

#### Examples

- All code samples for WCF must be run in Visual Studio with administrator privileges. That's because Windows requires administrative priviledges to start and stop services.
- You can do that in at least two different ways:
  - 1. Create a link to Visual Studio (devenv.exe) and right-click, selecting run as administrator.
  - 2. Search on Visual Studio and right-click on the desktop app and select run as administrator.
- If you forget to do that you will get a crash dialog with lots of text.

#### Examples

These examples are important. They show you how to build services and proxies that can be self-hosted. The WCF wizard (there is only one) builds an IIS hosted service and that is not what we need for projects.

- BasicHTTP Service Declarative
- BasicHTTP Service Programmatic
- WSHttp Service Declarative
- WSHttp Service Programmatic

You will find these in the code folder in WCF Examples.

#### Look and Feel of WCF

- Convergence of programming models
  - Just like web services
  - Similar to .Net Remoting
  - Sockets on steriods
  - Hosting for local, network, and web
- Communication models
  - Remote Procedure Call (RPC) with optional data models
  - Message passing
  - One way, request and (callback) reply, synchronous call (wait for return)

#### WCF Architecture

#### https://docs.microsoft.com/en-us/dotnet/framework/wcf/architecture

Application							
Contracts							
Data Contract	Messa Contr		Service Contract		P	olicy and Binding	
Service runtime							
	Error Meta Behavior Beha		data vior	Instance Behavior		Message Inspection	
Transaction Behavior				arameter Filtering			
Messaging							
WS Security Channel WS Reliable Encoders: Binary/MTOM/Text/ Channel XML				)M/Text/			
	opel	ransac Flow Chann		NamedP Channe		MSMQ Channel	
Activation and hosting							
Windows Activation Service	.EXE		Windows Services		∞M+		

#### ServiceModel Namespace

- Bindings, Channels, Endpoints, Messages, Serialization
- Activation, Concurrency, Hosting, Security, Sessions
- Queuing, Transactions
- Exceptions

#### **Principle Parts of a WCF Service**

- Contract
  - An interface defining services rendered
  - Service, Data, Message
- Endpoints
  - Address: <u>http://localhost/Calculator/service</u>
  - Binding: WSHttpBinding
  - Contract: ICalculator
- Implementation
  - One or more classes that implement the contract interfaces. May also include hosting code.

#### **WCF Service Files**

- IService.cs
  - Interface(s) that define a service, data, or message contract
- Service.cs
  - Implement the service's functionality
- Service.svc
  - Markup file (with one line) used for services hosted in IIS
- Configuration files that declare service attributes, endpoints, and policy
  - App.config (self hosted) contains service model markup
  - Web.config (hosted in IIS) has web server policy markup plus service model markup, as in App.config

#### Service serviceModel Markup

```
<system.serviceModel>
 <services>
   <service name="mySvcName" behaviorConfiguration="...">
     <endpoint address="" binding="wsHttpBinding"
        contract="myNamespace.myInterface" />
    <!-- can expose additional endpoints here -->
     <endpoint address="mex" binding="mexHttpBinding"
        contract="IMetadataExchange" />
   </service>
 </services>
 <behaviors>
   <serviceBehaviors>
     <br/><br/>behavior name="myNamespace.mySvcNameBehavior">
      <serviceMetaData httpGetEnabled="true" />
      <serviceDebug includeExceptionDetailInFaults="false" />
     </behavior>
   </serviceBehaviors>
 </behaviors>
</system.serviceModel>
```

#### Channels

- Channels are the vehicles that transport messages. They provide:
  - Transport protocols via bindings
    - Http, WSHttp, Tcp, MSMQ, named pipes
  - Encoding and Encryption
  - Reliable sessions
  - Communication modes
    - Simplex, duplex, send and wait
  - Security modes

## WCF Bindings

Binding	Interoperability	Mode of Security (Default)	Session (Default)	Transactions	Duplex
BasicHttpBinding	Basic Profile 1.1	(None), Transport, Message, Mixed	None, (None)	(None)	n/a
WSHttpBinding	ws	None, Transport, (Message), Mixed	(None), Transport, Reliable Session	(None), Yes	n/a
WS2007HttpBinding	WS-Security, WS-Trust, WS-SecureConversation, WS-SecurityPolicy	None, Transport, (Message), Mixed	(None), Transport, Reliable Session	(None), Yes	n/a
WSDualHttpBinding	WS	None, (Message)	(Reliable Session)	(None), Yes	Yes
WSFederationHttpBinding	WS-Federation	None, (Message), Mixed	(None), Reliable Session	(None), Yes	No
WS2007FederationHttpBinding	WS-Federation	None, (Message), Mixed	(None), Reliable Session	(None), Yes	No
NetTcpBinding	.NET	None, (Transport), Message, Mixed	Reliable Session, (Transport)	(None), Yes	Yes
NetNamedPipeBinding	.NET	None, (Transport)	None, (Transport)	(None), Yes	Yes
NetMsmqBinding	.NET	None, Message, (Transport), Both	(None)	(None), Yes	No
NetPeerTcpBinding	Peer	None, Message, (Transport), Mixed	(None)	(None)	Yes
MsmqIntegrationBinding	MSMQ	None, (Transport)	(None)	(None), Yes	n/a

#### Interoperability

- Channel protocols determine interoperability with other platforms:
  - − BasicHttpBinding → universal interoperability
  - − WSHttpBinding → platforms that use ws extensions
  - − NetTcpBinding → .Net on both ends
  - − MSMQ → WCF to pre WCF windows platforms

#### **Service Behaviors**

- Instancing:
  - Singleton: one instance for all clients
  - Per call: one instance per service call
  - Private session: one instance per client session
  - Shared session: one instance per session shared between clients
- Concurrency models for instances:
  - Single: one thread at a time accesses instance
  - Multiple: more than one thread may enter instance
  - Reentrant: threads make recursive calls without deadlock

#### **Other Service Behaviors**

- Throttling:
  - Limits on number of messages, instances, and threads a service can process simultaneously
- Error handling:
  - Options to handle, let framework handle, and report to client
- Metadata:
  - Services can be self-describing, providing MEX endpoints
- Lifetime:
  - Can specify session duration, service operations to initiate sessions and others to terminate sessions
- Security:
  - Can specify message confidentiality, integrity, authentication, authorization, auditing, and replay detection.

#### **Structuring Service Code**

Service	Class	Attribute
Service contract	interface	[ServiceContract]
Service operation	method	[OperationContract]
Implementation	class	[ServiceBehavior] Derive from contract interface
Implementation	method	[OperationBehavior]
Data Contract	class	[DataContract] class [DataMember] member
Message Contract interface		[MessageContract] interface [MessageHeader] member [MessageBody] member

#### **Building Clients**

- There are three ways to build a client's proxy:
  - Hand craft a proxy using ClientBase<ServiceType> as we did in BasicService-Declarative
  - Create a proxy programmatically with the ChannelFactory<ServiceContract>, as we did in SelfHosted\_StringsService
  - Create a proxy with SrvcUtil. It also uses
     ClientBase<ServiceType> but adds a lot of other stuff as well.

### **Building Clients**

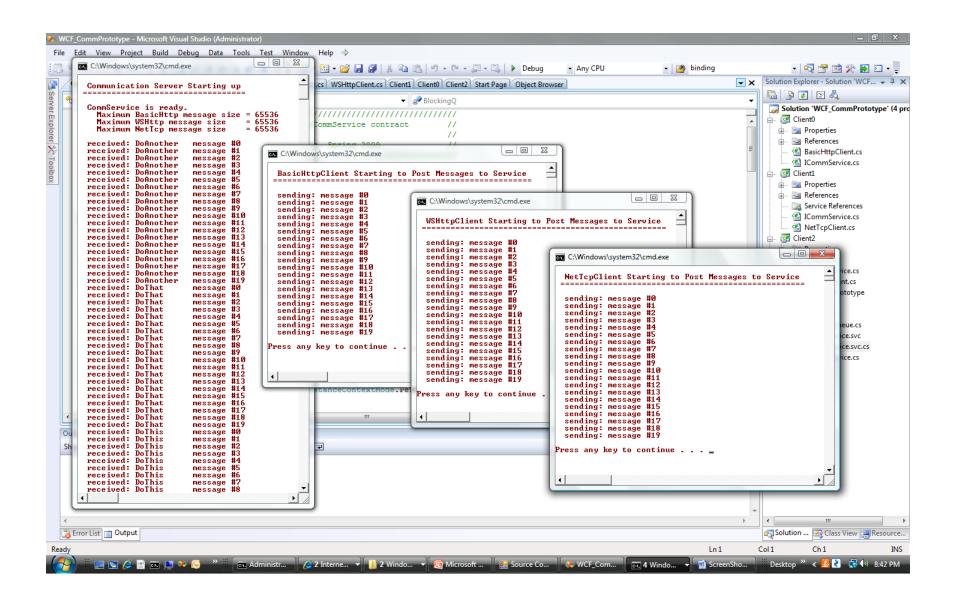
- Build proxy with svcutil
  - Visual Studio will do that if you add a service or web reference
  - Proxy code is in a subdirectory under the project.
- Add proxy code to project
- Add "using System.ServiceModel" to client code
- Build and run

#### **Generating Proxies**

- SvcUtil.exe generates code:
  - from a mex endpoint: svcutil <u>http://localhost/myService</u>
  - from WSDL or XSD files:
     svcutil myService.wsdl
- SvcUtil.exe generates WSDL and XSD files from a service library:
  - svcutil myService.dll

#### **Building Proxy Programmatically**

- WSHttpBinding binding = new WSHttpBinding();
- Uri address = http://Odysseus:4040/ICommService;
- ICommService proxy = ChannelFactory<IContract>.CreateChannel(binding, address);
- Message msg = new Message();
- msg.text = "a message";
- proxy.PostMessage(msg);

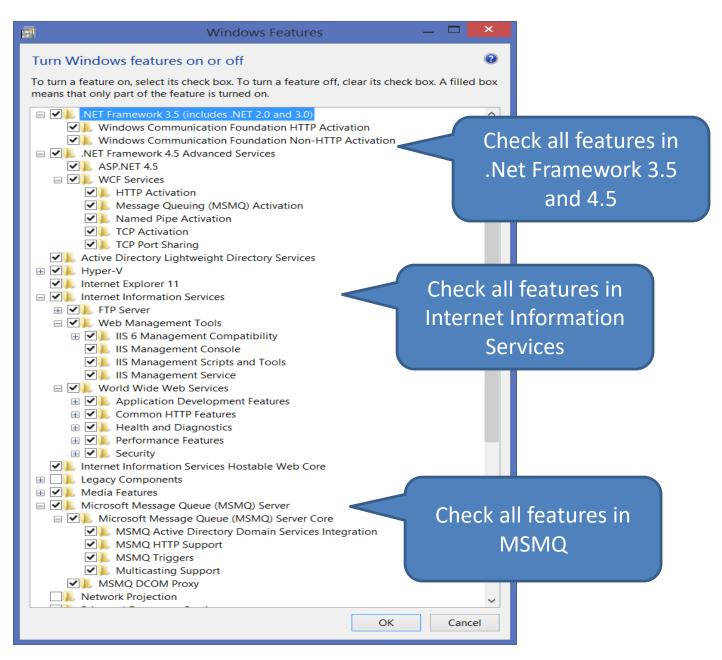


#### References

- Setting up Reference Code
- Web References
- Tutorials

#### Microsoft WCF Samples are useful, but NOTE !!!

- WCF Samples won't run unless you:
  - Install a digital certificate (can be self-signed), part of setup
  - Run Visual Studio as Administrator (in Win8, Win7, Vista)
- Setup steps
  - <u>One-Time Setup for WCF</u>
  - IIS7 doesn't include a folder of scripts used by setup so you have to add IIS6 compatibility which creates the script folder
  - There are a number of Windows features you need to turn on to make the samples work – see next slide.



#### **Primary Book References**

- Pro C# 6.0 and the .Net 4.6 Platform, Andrew Troelsen, Apress,
  - Excellent introduction
- Programming WCF Services, 2<sup>nd</sup> Edition, Juval Lowy, O'Reilly, 2009
  - More up-to-date details than many of the others
- Inside Windows Communication Foundation, Justin Smith, Microsoft Press, 2007
  - Covers some of the plumbing, e.g., messaging and service host details
- Microsoft Windows Communication Foundation, Step by Step, John Sharp, Microsoft Press, 2007
  - Practical discussion with examples for securing communication

#### **Primary Web References**

- MSDN WCF Root Page
- WCF Feature Details
- MSDN WCF Architecture Overview
- <u>Microsoft WCF Samples Setup</u>
- <u>Self-signed certificates, finding keys, ... Petar Vucetin blog</u>
- Makecert Certificate Creation Tool
- Distributed .NET Learn ABCs Of Programming WCF
- <u>Service Station Serialization in Windows Communication Foundation</u>
- <u>Service Station WCF Messaging Fundamentals</u>
- <u>Windows Communication Foundation Glossary</u>
- <u>Windows Communication Foundation Tools</u>
- <u>Tutorials on WCF, WPF, and more</u>
- <u>A Performance Comparison</u>
- Security in WCF

### **References – Activation & Channels**

- How to Access WCF Services with One-Way and Request-Reply Contracts
- How to Access Services with a Duplex Contract
- Sessions, Instancing, and Concurrency
- WCF Essentials Instance Management
- WCF Essentials One-Way Calls, Callbacks, Events

#### **References – Web Model**

- How to Create a Basic Web-Style Service
- WCF Web Programming Model Overview
- Web Programming Model
- WCF Web Programming Object Model
- <u>WCF Syndication HTTP Programming with WCF and the .NET Framework</u> <u>3.5</u>
- <u>Creating WCF AJAX Services without ASP.NET</u>
- Creating WCF Services for ASP.NET AJAX

#### **References – Building Clients**

- <u>Accessing Services Using a Client</u>
- <u>Clients</u>
- <u>Client Architecture</u>
- <u>Client Configuration</u>
- <u>Call WCF Service Operations Asynchronously</u>
- <u>A Performance Comparison</u>
- <u>Security in WCF</u>
- File-streaming with a few comments about file chunking

## **End of Presentation**