Windows Communication Foundation

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Software Modeling

Primary Code References

- www.ecs.syr.edu/faculty/Fawcett/handouts/CSE681-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 – Berkeley sockets released with BSD
- 1990 – CORBA 1.0
- 1991 – OLE
- Early ’90s – 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 privileges 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.

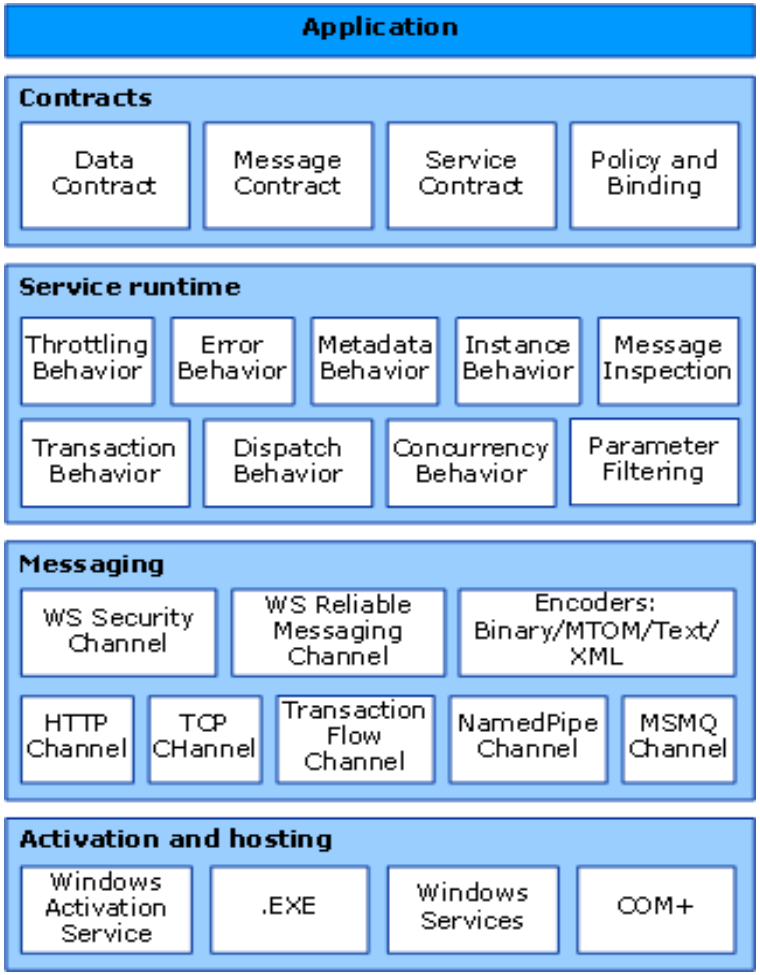
- BasicHTTP Service – Declarative
- BasicHTTP Service – Programmatic
- WSHttp Service – Declarative
- WSHttp Service – Programmatic

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://msdn.microsoft.com/en-us/library/ms733128(v=vs.110).aspx

ServiceModel Namespace

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

Principal Parts of a WCF Service

- Contract
  - An interface defining services rendered
  - Service, Data, Message
- Endpoints
  - Address: http://localhost/Calculator/service
  - 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>
      <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:
  - Handcraft 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

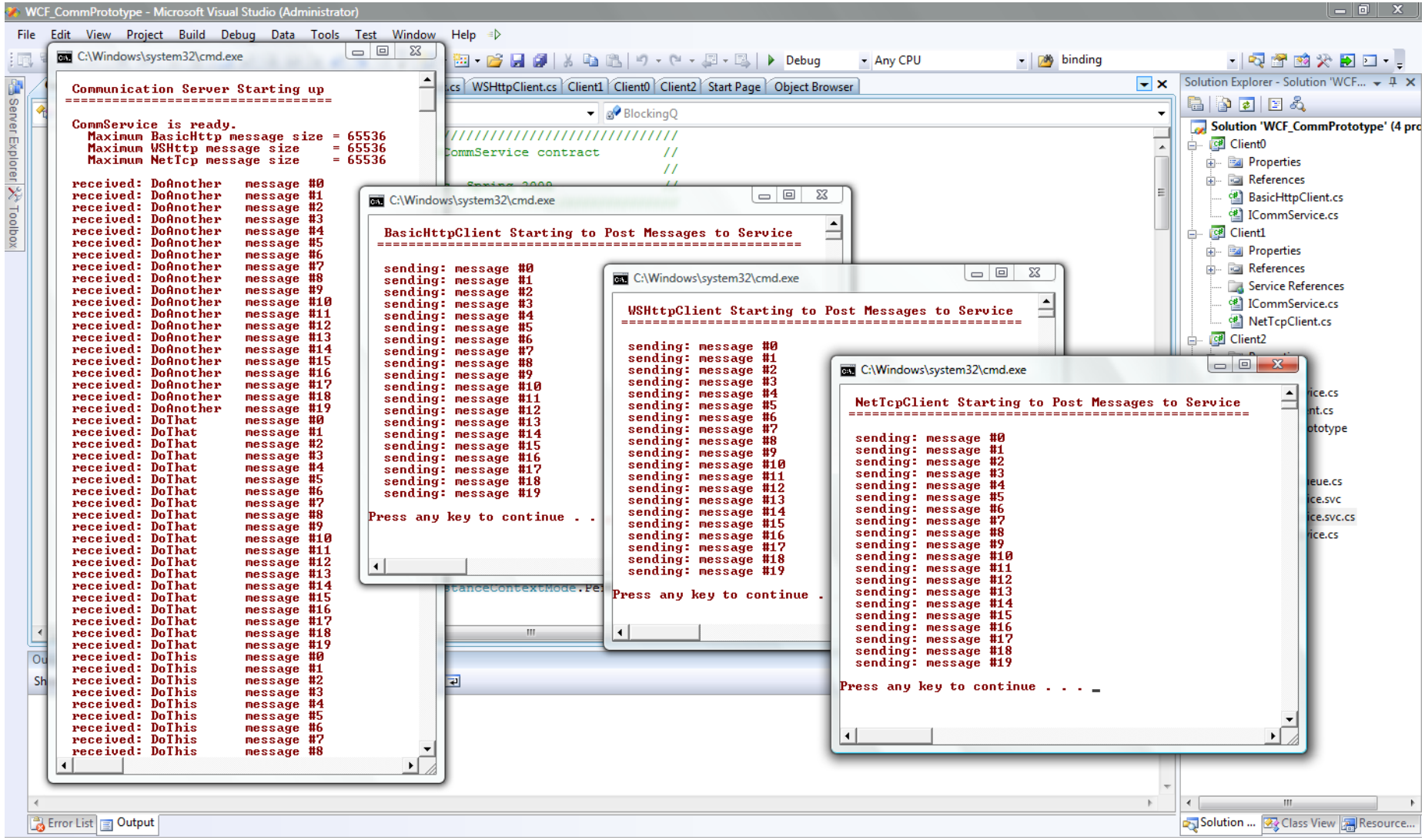
- Build proxy with svcutil
  - Visual Studio will do that if you add a service or web reference
  - Proxy code is in a subdirectory under the project
- Add proxy code to project
- Add “using System.ServiceModel” to client code
- Build and run

Generating Proxies

- SvcUtil.exe generates code:
  - From a mex endpoint:
    svcutil http://localhost/myService
  - 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);


WCF_CommPrototype - Microsoft Visual Studio (Administrator)
File Edit View Project Build Debug Data Tools Test Window Help
Debug
Any CPU
binding
C:\Windows\system32\cmd.exe
Communication Server Starting up
CommService is ready.
Maximum BasicHttp message size = 65536
Maximum WSHttp message size = 65536
Maximum NetTcp message size = 65536
received: DoAnother message #0
received: DoAnother message #1
received: DoAnother message #2
received: DoAnother message #3
received: DoAnother message #4
received: DoAnother message #5
received: DoAnother message #6
received: DoAnother message #7
received: DoAnother message #8
received: DoAnother message #9
received: DoAnother message #10
received: DoAnother message #11
received: DoAnother message #12
received: DoAnother message #13
received: DoAnother message #14
received: DoAnother message #15
received: DoAnother message #16
received: DoAnother message #17
received: DoAnother message #18
received: DoAnother message #19
received: DoThat message #0
received: DoThat message #1
received: DoThat message #2
received: DoThat message #3
received: DoThat message #4
received: DoThat message #5
received: DoThat message #6
received: DoThat message #7
received: DoThat message #8
received: DoThat message #9
received: DoThat message #10
received: DoThat message #11
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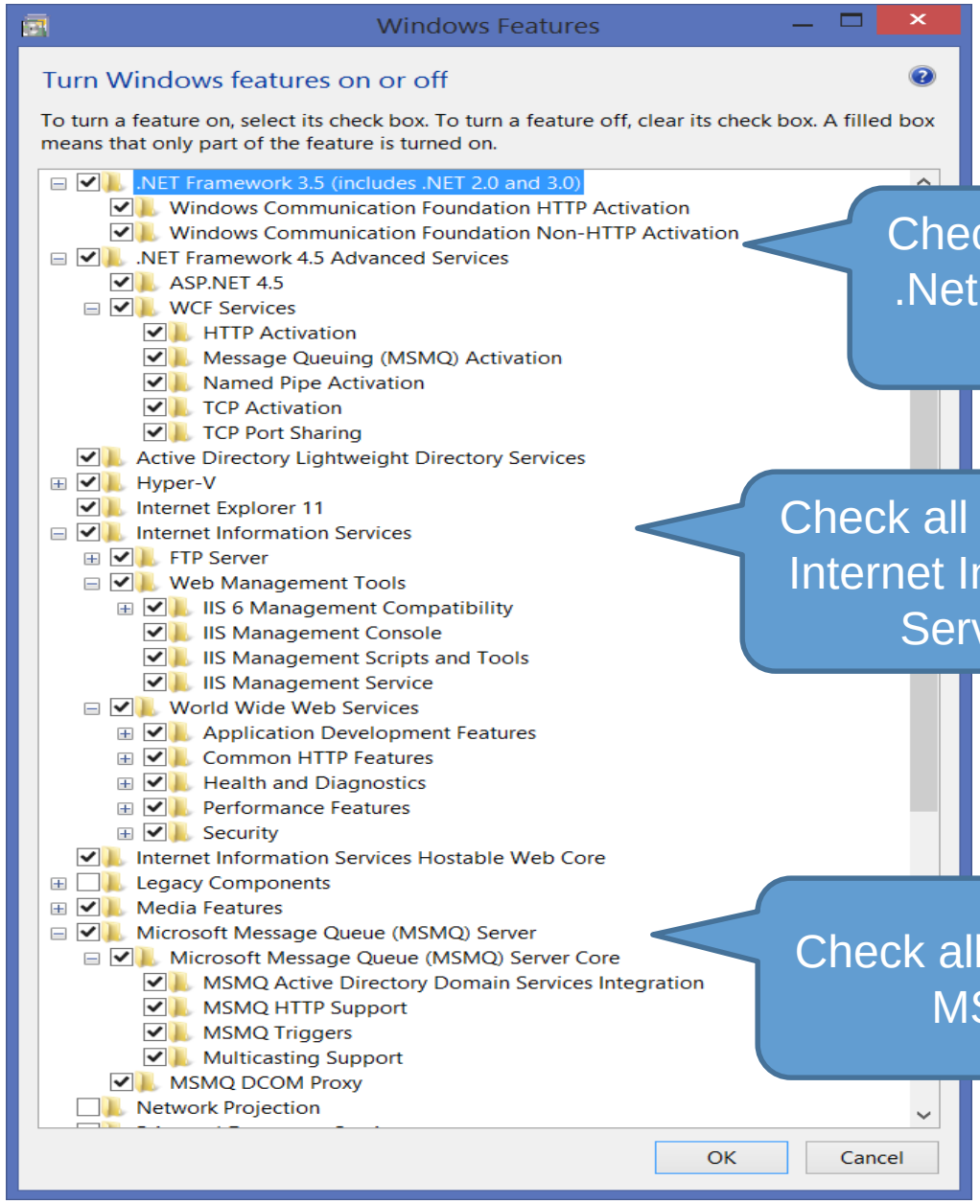
received: DoThat message #13
received: DoThat message #14
received: DoThat message #15
received: DoThat message #16
received: DoThat message #17
received: DoThat message #18
received: DoThat message #19
received: DoThis message #0
received: DoThis message #1
received: DoThis message #2
received: DoThis message #3
received: DoThis message #4
received: DoThis message #5
received: DoThis message #6
received: DoThis message #7
received: DoThis message #8
C:\Windows\system32\cmd.exe
BasicHttpClient Starting to Post Messages to Service
sending: message #0
sending: message #1
sending: message #2
sending: message #3
sending: message #4
sending: message #5
sending: message #6
sending: message #7
sending: message #8
sending: message #9
sending: message #10
sending: message #11
sending: message #12
sending: message #13
sending: message #14
sending: message #15
sending: message #16
sending: message #17
sending: message #18
sending: message #19
Press any key to continue . .
C:\Windows\system32\cmd.exe
WSHttpClient Starting to Post Messages to Service
sending: message #0
sending: message #1
sending: message #2
sending: message #3
sending: message #4
sending: message #5
sending: message #6
sending: message #7
sending: message #8
sending: message #9
sending: message #10
sending: message #11
sending: message #12
sending: message #13
sending: message #14
sending: message #15
sending: message #16
sending: message #17
sending: message #18
sending: message #19
Press any key to continue .
C:\Windows\system32\cmd.exe
NetTcpClient Starting to Post Messages to Service
sending: message #0
sending: message #1
sending: message #2
sending: message #3
sending: message #4
sending: message #5
sending: message #6
sending: message #7
sending: message #8
sending: message #9
sending: message #10
sending: message #11
sending: message #12
sending: message #13
sending: message #14
sending: message #15
sending: message #16
sending: message #17
sending: message #18
sending: message #19
Press any key to continue . . .
Solution 'WCF_CommPrototype' (4 pro
Client0
Properties
References
BasicHttpClient.cs
ICommService.cs
Client1
Properties
References
Service References
ICommService.cs
NetTcpClient.cs
Client2
Error List
Output
Solution ...
Class View
Resource...

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
  - One-Time Setup for WCF
  - 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.



Check all features in .Net Framework 3.5 and 4.5

Check all features in Internet Information Services

Check all features in MSMQ

Primary Book References

- *Pro C# 2010 and the .Net 4 Platform*, Andrew Troelsen, Apress, 2010
  - Excellent introduction
- *Programming WCF Services*, 2nd edition, Juval Lowy, O'Reilly, 2009
  - More up-to-date details than any 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
- Microsoft WCF Samples Setup
- Self-signed certificates, finding keys, ... Petar Vucetin blog
- Makecert - Certificate Creation Tool
- Distributed .NET Learn ABCs Of Programming WCF
- Service Station Serialization in Windows Communication Foundation
- Service Station WCF Messaging Fundamentals
- Windows Communication Foundation Glossary
- Windows Communication Foundation Tools
- Tutorials on WCF, WPF, and more
- A Performance Comparison
- Security in WCF

References—Activation and 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
- WCF Syndication HTTP Programming with WCF and the .NET Framework 3.5
- Creating WCF AJAX Services without ASP.NET
- Creating WCF Services for ASP.NET AJAX

References—Building Clients

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

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