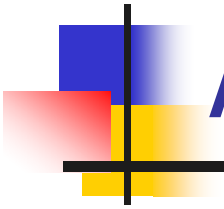
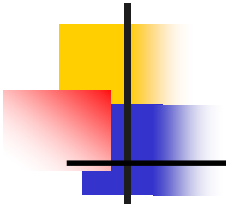
Programming Models for Service Oriented Architecture



Paul Fremantle

Senior Technical Staff Member

IBM Hursley Park

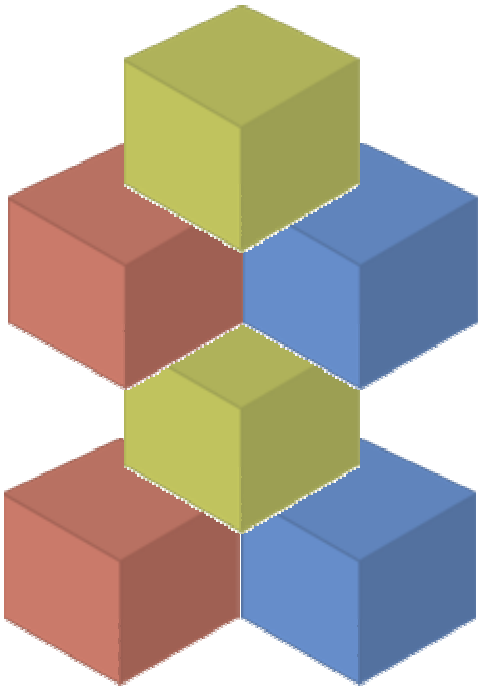


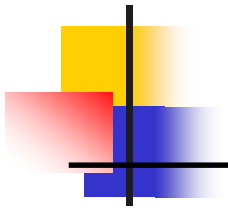
Who Am I?

- *pzf@uk.ibm.com*
- Lead development architect for
  - IBM's Web Services Gateway
  - C/C++ Web Services Toolkit
- Co-author of *Building Web Services with Java: Making Sense of XML, SOAP, WSDL, and UDDI (2nd Edition)* – an excellent book about WSinJ
- This session will discuss how to successfully program applications as part of a wider Service Oriented Architecture

What Is a Service Oriented Architecture?

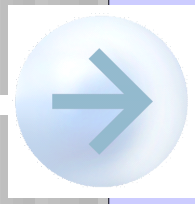
- An **approach** for **building** distributed systems that deliver application functionality as **services** to either end-user applications or other services
- It defines :
  - An architecture that leverages open standards to represent software assets as services.
  - Provides a standard way of representing and interacting with software assets
  - Individual software assets become building blocks that can be reused in developing other applications
  - Shifts focus to application assembly rather than implementation details
  - Used externally to integrate with applications outside of the enterprise





Shift to SOA

From	To
▪ Function oriented ▪ Build to last ▪ Prolonged development cycles	▪ Process oriented ▪ Build to change ▪ Incrementally built and deployed
▪ Application silos ▪ Tightly coupled ▪ Object oriented ▪ Known implementation	▪ Orchestrated solutions ▪ Loosely coupled ▪ Message oriented ▪ Abstraction



Business Level SOA

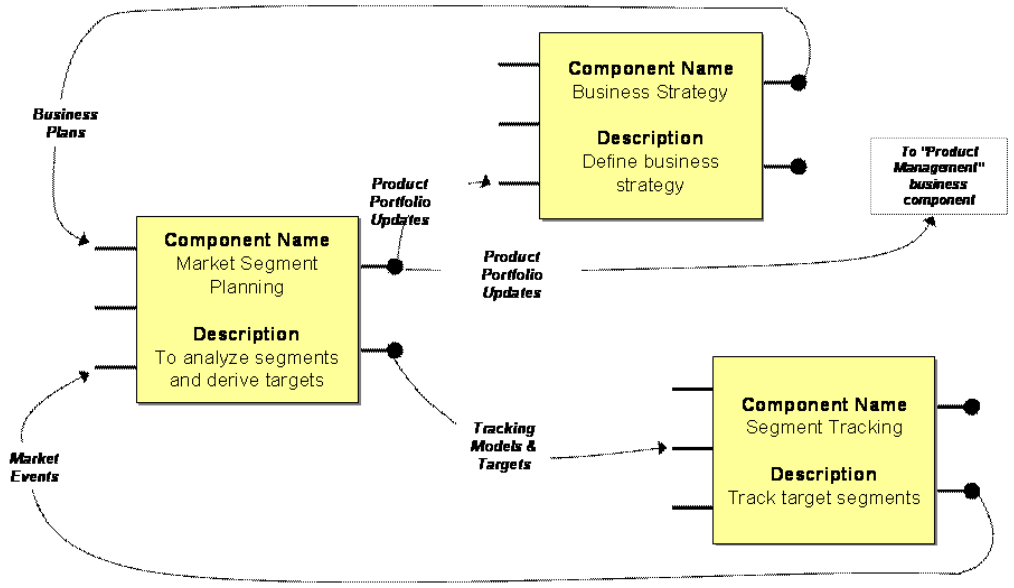
Component Name
Market Segment Planning

Description
To analyze markets and derive targets

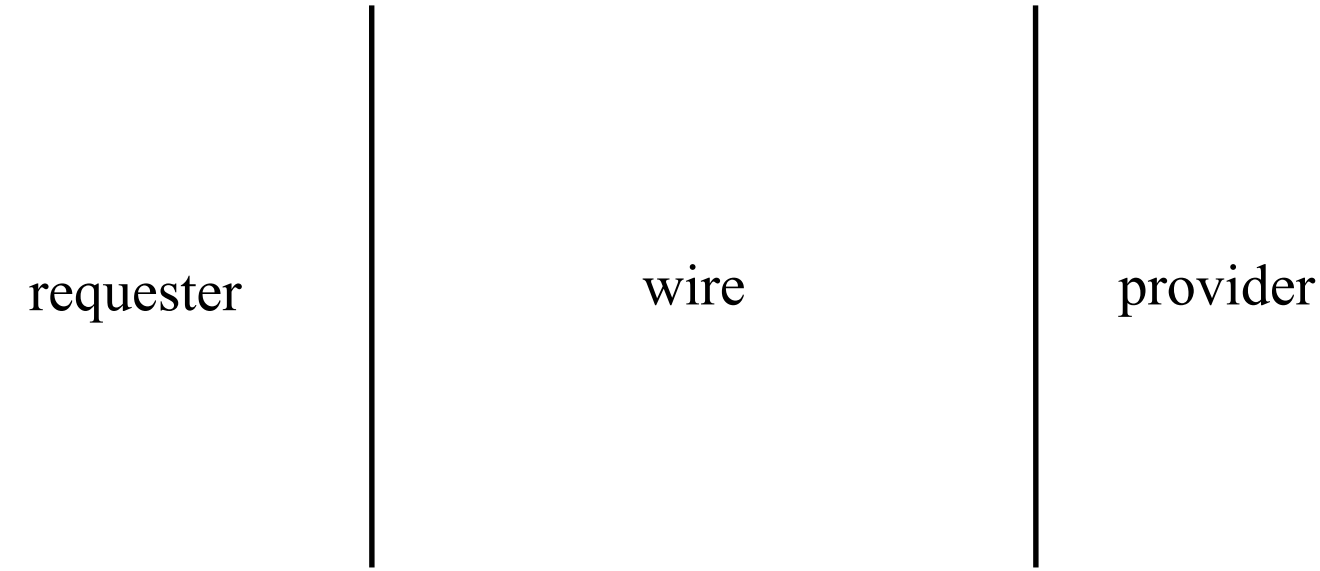
- **A Business Component**
  - Discrete boundaries
  - Includes the resources, people, technology
  - Is 'black box'
  - Provides logical 'cleave points'
  - Has Attributes

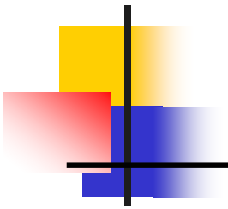
- **Business Services**
  - are goods or services that a business component offers to other business components and/or to external parties
  - are what's directly visible outside the component

A business process can be represented as collaboration among components.



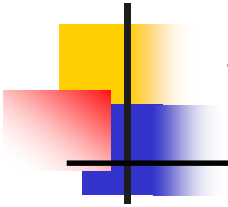
Current View of a Service Interaction





Programming Models and Web Services

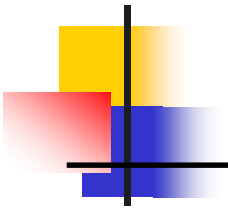
- Isn't Web Services just about what's on the wire?
  - Yes…. Today
  - But SOA is not just about the wire
    - Good boundaries between business logic
    - More efficient integration and re-use



What Is a Programming Model?

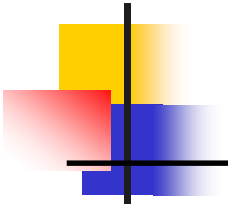
- The application programming interface (API)
- Service programming interfaces (SPI)
- Configuration and administration model
- Separation of concerns

- Differing views!
  - J2EE takes a prescriptive view (aiming for full portability)
  - Other people mean for example
    - Stub *vs* DII (Dynamic invocation interface)



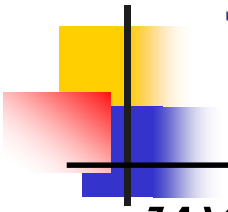
What Are the Programming Models That Exist So Far?

- Java:
  - Apache SOAP
  - Apache Axis
  - JAX-RPC, Enterprise Web Services (109), J2EE
  - Glue
- C
  - gSOAP, Axis C/C++
- .NET



Examples – Axis

```
AddressBookService abs = new
        AddressBookServiceLocator();
AddressBook ab1 = abs.getAddressBook();
Address mine = ab1.lookup("pzf");
```



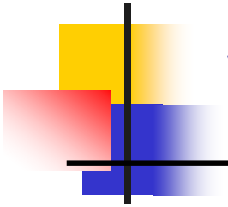
JAX-RPC and Enterprise Web Services (EWS)

- *JAX-RPC*

```
ServiceFactory serviceFactory = ServiceFactory.newInstance();
Service service = serviceFactory.createService("my.wsdl", qName);
AddressService myProxy = (AddressService)
                service.getPort(AddressService.class);
myProxy.updateAddress(addressBean, 75005);
```

- *Enterprise Web Services + JAX-RPC*

```
InitialContext ic = new InitialContext()
Service service = ic.lookup("java:comp/env/AddressService");
AddressService myProxy = (AddressService)
        service.getPort(AddressService.class);
myProxy.updateAddress(addressBean, 75005);
```

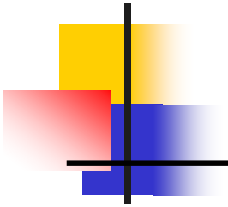


WSIF Dynamic Proxy

```
WSIFService sq = ServiceFactory.newInstance().
    getService("http://my.com/svcs/stockquote.wsdl");
QuoteService quote =
    (QuoteService)sq.getStub("soap", QuoteService.class);
Float value = quote.getQuote("IBM");
```

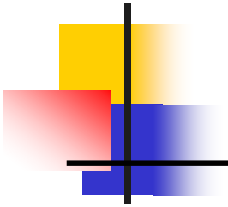
Web Services Invocation Framework (WSIF) DII

```
WSIFService sq = ServiceFactory.newInstance().
   getService("http://my.com/svcs/stockquote.wsdl")
WSIFPort defPort = sq.getPort();
WSIFOperation getQ =
        defPort.createOperation("getQuote");
WSIFMessage inMessage =
        getQ.createInputMessage();
inMessage.setStringPart("symbol", "IBM");
...
getQ.executeRequestResponse(inMessage, outMsg, fltMsg);
outMessage.getFloatPart("value");
```



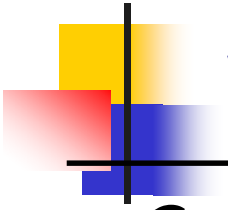
.NET

- IFoo proxy = ProxyFactory.CreateProxy<IFoo>("service URI");
- int n = proxy.Bar(3);



Lessons Learnt…

- Axis – simple practical, but very Axis specific
  - Little abstraction from implementation classes
  - Portability only by running Axis somewhere else!
- EWS/JAX-RPC
  - Good, but very focussed on "stub" model
  - Client-server model
  - No standard way to pass SOAP XML or Envelope
- WSIF DII + JROM
  - Excellent model of WSDL + XML
  - Perhaps a little too faithful!
- .NET
  - Easy to code
  - A little too much QoS in the code



What's Changing This?

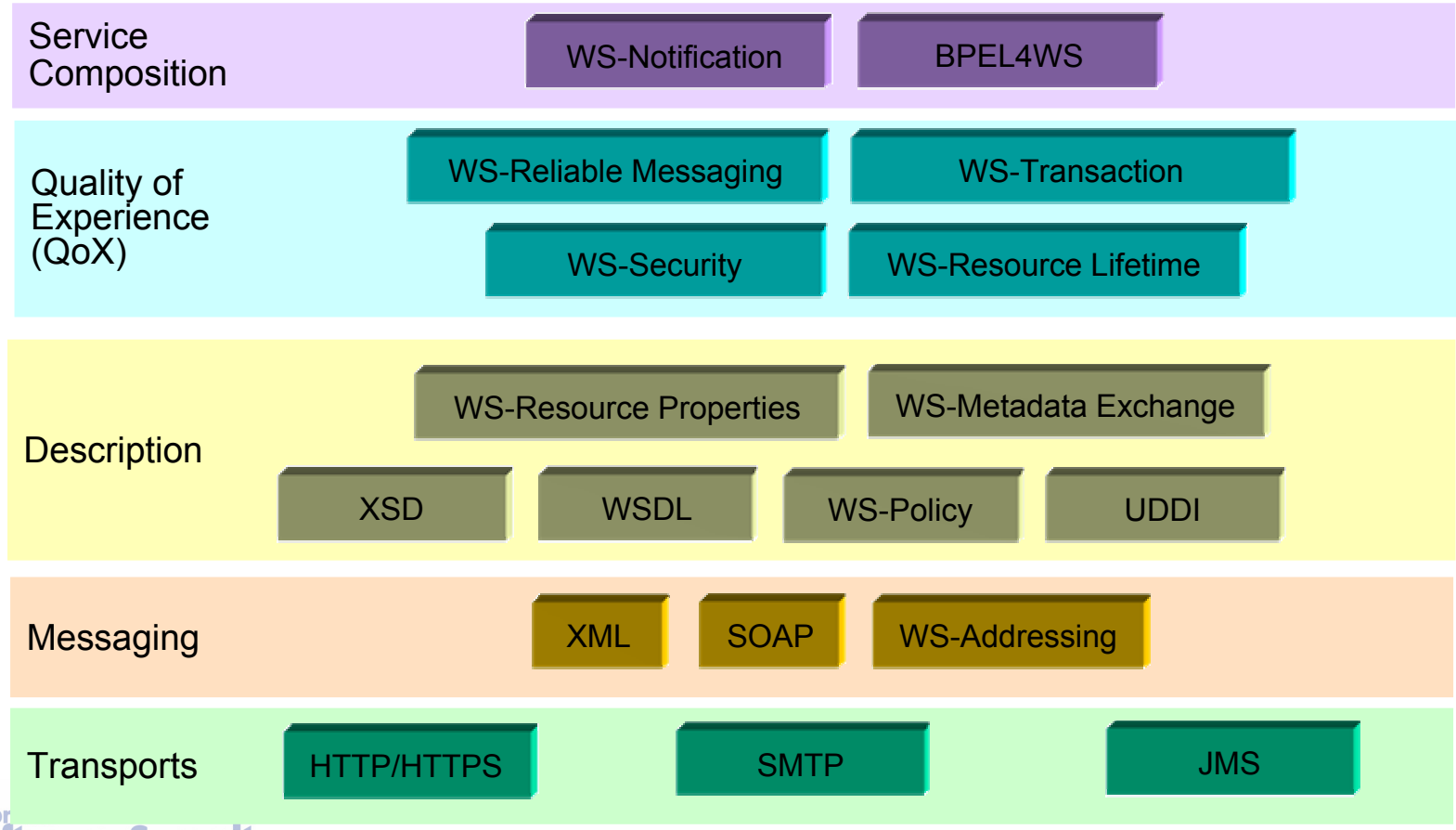
- *Composability*

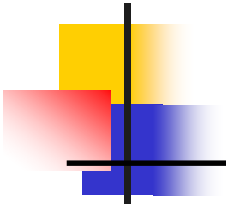
- Business Process Execution Language

- WS-Addressing
- WS-ReliableMessaging / WS-Reliability
- WS-AtomicTransaction, WS-BusinessActivity
- WS-Security

- WS-Policy
- WS-MetadataExchange

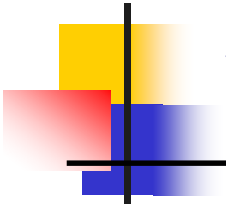
The Extended Web Services Platform





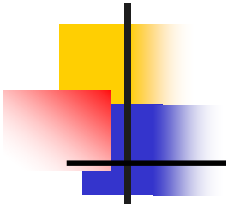
What's REALLY Changing This

- Enable "dynamic" e-business
  - In IBM-speak "On Demand Computing"
- Quickly host new business processes
- Incorporate new partners as needed
- Add the right quality of service
  - (reliable, transactional, secure)
  - As needed



Virtualisation

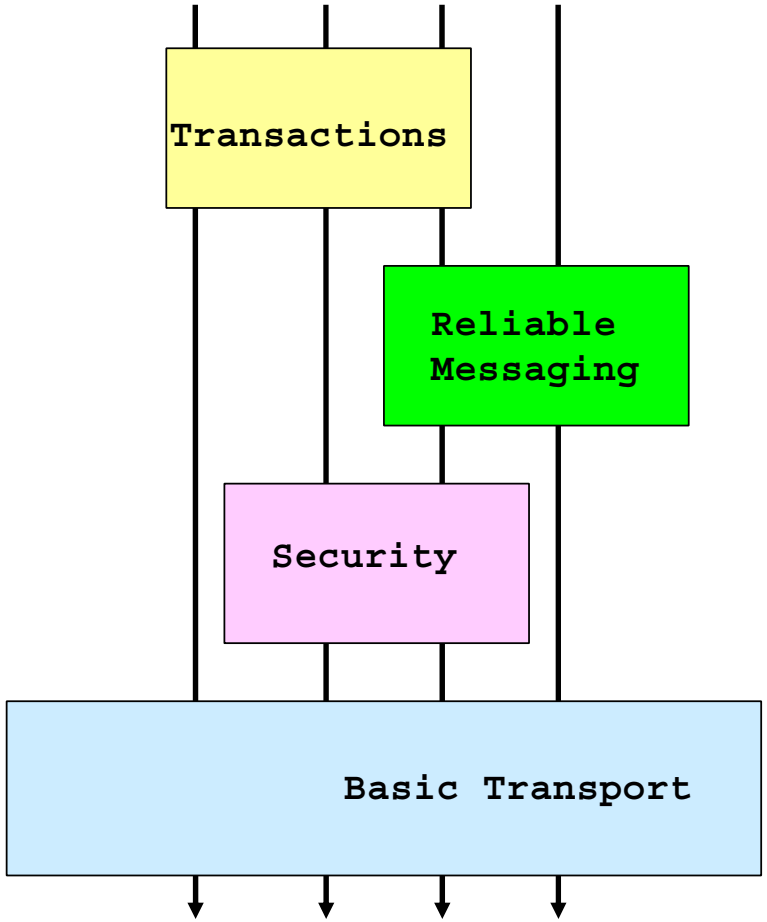
- The ability
  - to swap implementations as simply as possible
    - Change a constant in a program = NOT BAD
    - Redeploy a program with a new config = OK
    - Change a UDDI entry and restart = GOOD
    - Administer a change to take place at 00:01 on Weds morning – GREAT
  - to change quality of service
  - to use the same service in different business and technical contexts



How?

- Re-target an existing service or process to use new providers
  - Intermediaries and directories allow new service providers to be added
  - BPEL allows new partner links to be created dynamically
  - WS-MetadataExchange allows services to be queried for the WSDL and WS-Policy

Composability



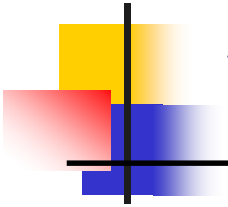
Composable Headers

Addressing

Security

Reliability

```
<S:Envelope … >
 <S:Header>
   <wsa:ReplyTo>
    <wsa:Address>http://business456.com/User12</wsa:Address>
   </wsa:ReplyTo>
   <wsa:To>http://fabrikam123.com/Traffic</wsa:To>
   <wsa:Action>http://fabrikam123.com/Traffic/Status</wsa:Action>
  <wssec:Security>
     <wssec:BinarySecurityToken
          ValueType="wssec:X509v3"
          EncodingType="wssec:Base64Binary">
      dWJzY3JpYmVyLVBlc…..eFw0wMTEwMTAwMD
     </wssec:BinarySecurityToken>
  </wssec:Security>
  <wsrm:Sequence>
     <wsu:Identifier>http://fabrikam123.com/seq1234</wsu:Identifier>
     <wsrm:MessageNumber>10</wsrm:MessageNumber>
  </wsrm:Sequence>
 </S:Header>
 <S:Body>
   <app:TrafficStatus
       xmlns:app="http://highwaymon.org/payloads">
     <road>520W</road><speed>3MPH</speed>
   </app:TrafficStatus>
 </S:Body>
</S:Envelope>
```

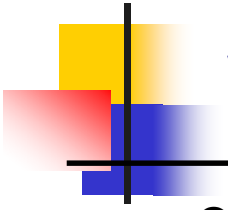


WS Policy

- Assertions
  - An individual capability, requirement etc
    - *e.g.* <wsse:SecurityToken TokenType=”wsse:Kerberosv5TGT” wsp:Usage="wsp:Required" wsp:Preference=”100”/>
  - Assertions are defined in “plug-in” languages
    - such as WS-SecurityPolicy
- Assertions are grouped into Statements

```
<wsp:ExactlyOne>
    <assertion1>
    <assertion2>
</wsp:ExactlyOne>
```

- Policy Attachment defines how to link from
  - A WSDL document or UDDI entry to a policy



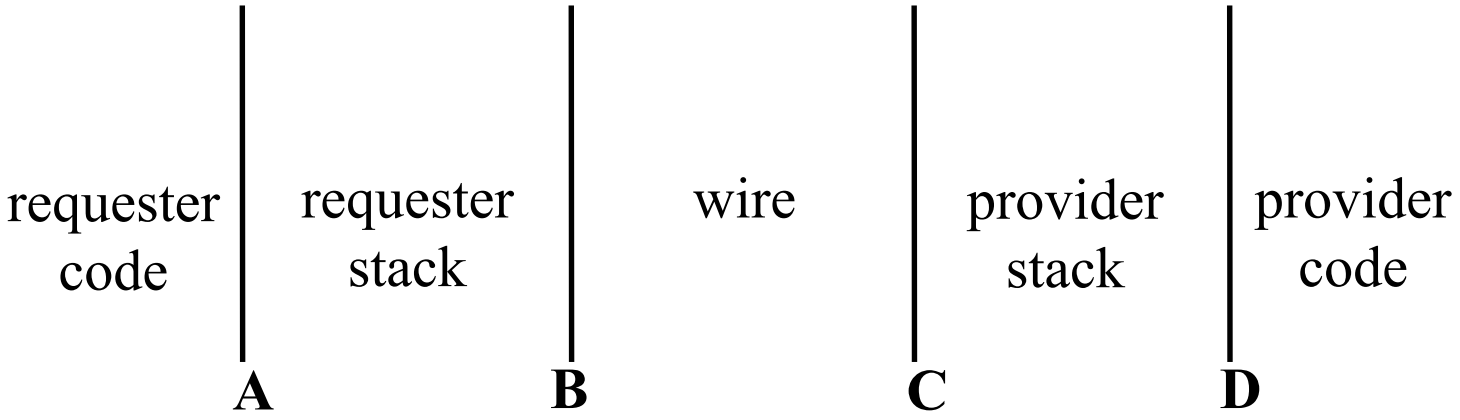
WS Policy *(Continued)*

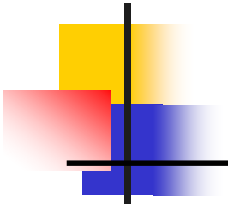
- Operators
  - ExactlyOne, OneOrMore, All
- For example

  *WS-CoffeePolicy™ – **in order to talk to me in the morning I require***
  - Double Cappuccino with an extra shot of espresso ☺☺
    - or
  - Double Cappuccino ☺
    - Or
  - Large Mocha Java
    - but not
  - Instant, Motel filter, Tea, Decaffeinated……

Lesson #1 – The Right Contracts Matter

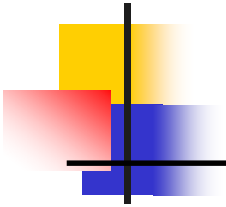
- Implementing flexible QoS means
  - separating the QoS code from the business logic





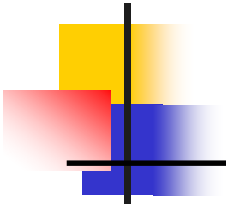
Lesson #2

- Two different models:
  - Java → WSDL type of people
    - Basically using a stub model to do distributed computing
    - Using Java / C / C++ / perl / CLR types
  - XML type of people
    - Using existing XML schemas or DTDs
      - ✓ *e.g.* OAGIS
    - Business process and integration focused



Lesson #2a

- Contract first
  - Start with WSDL and schema
  - Improves interoperability
    - (if you use a fairly simple subset of XSD)
    - See lesson #5!
  - Makes for better design
    - More re-usable
  - Can be a refactoring of code-first



Lesson #3 – Don't Hardcode URLs

- EWS

  Service s = ic.lookup("service-ref");

- UDDI lookup

  Stub.setProperty(
  ENDPOINT_ADDRESS_PROPERTY, myUDDIHelper.getURLforKey
  ("C6410450-9976-11D8-A122-000629DC0A53"))

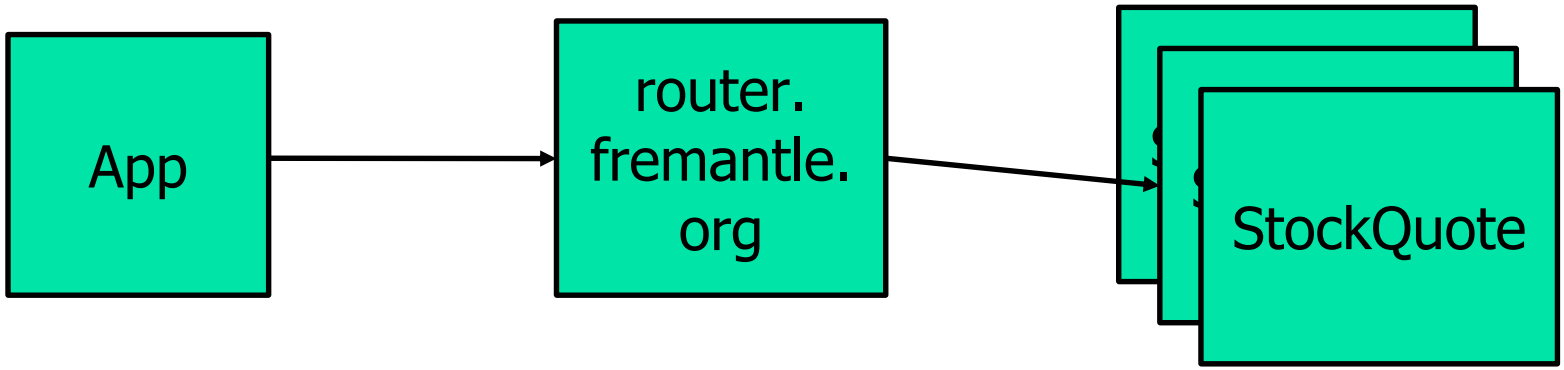
- Inversion of Control Pattern

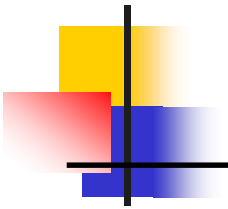
```
public interface businessService { … }
public class businessApp {
        private businessService = null;
        public void setBusinessService(businessService bs) {
                this.businessService = bs;
        }
        ….
}
```

Lesson #3a – Do hardcode URLs Sometimes

- Hardcode a "virtual URL"

```
Stub.setProperty(ENDPOINT_ADDRESS_PROPERTY,
  "http://router.fremantle.org/StockQuoteService");
```





Lesson #4 – Split Your Logic between Application and Handlers

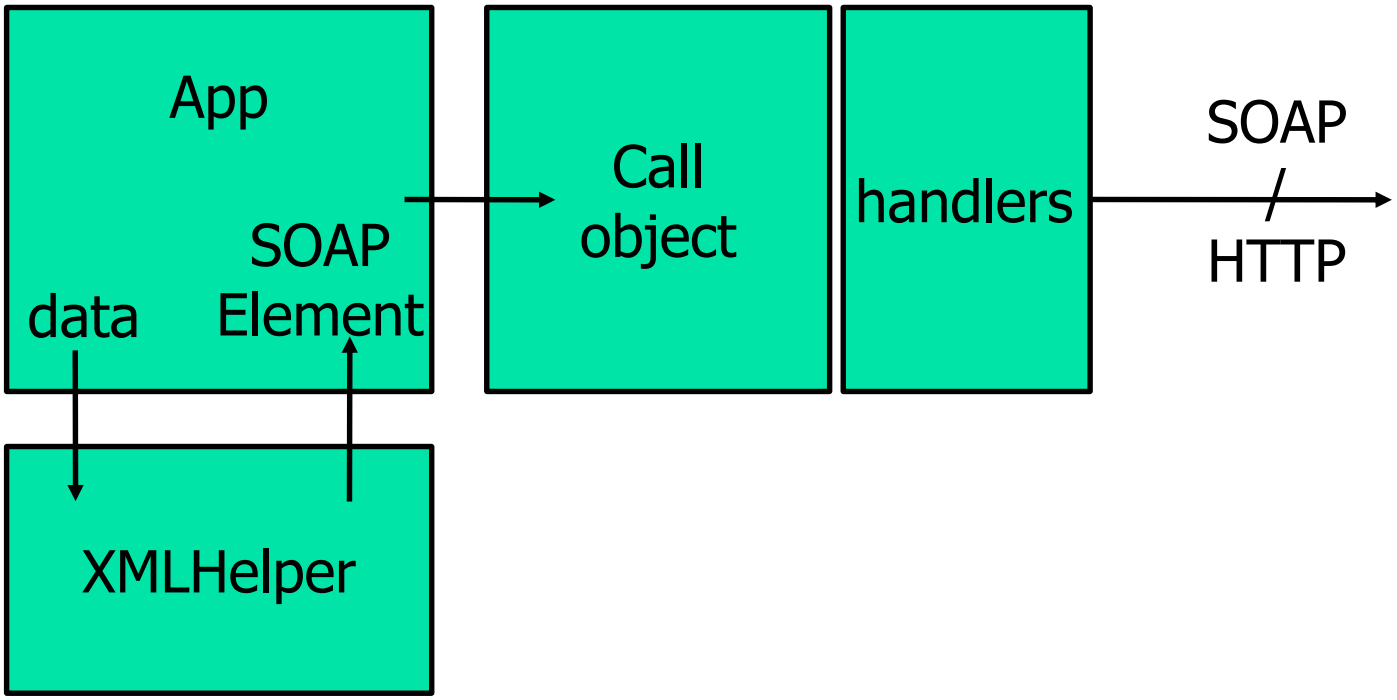
- The SOAP message maps directly into your logic:
  - <S:BODY> is the domain of your business logic
  - <S:HEADER> is the domain of the middleware – enhanced by handlers

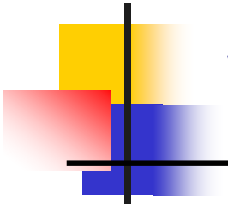
- What can you do in handlers?
  - Add/read/modify headers
  - Modify the target URL of the request (*e.g.* "target.url") in WebSphere
  - Log the message
  - Look at the SOAPMessage

Lesson #5 – If You Are Doing XML, Do XML

- Taking existing XML schemas and DTDs and trying to map them to Java types does NOT work!
  - Most stacks support a way of passing an XML object to the service invocation
    - See Axis Message example
    - WebSphere has a Call.invoke(SOAPEnvelope) – unsupported so far
    - WSIF can use DOM objects
    - Service Data Objects and XMLBeans offer nicer interfaces than SOAPElement / DOM
    - If you are really stuck you can do it in a handler

Using XML

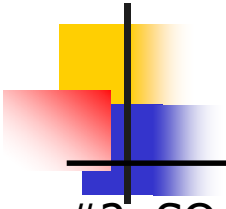




WS-Addressing

- There are two main aspects:
  - #1
  - Assertion that each service may have "instances", distinguished by EndpointReferences
  - For example, same WSDL but two URLs
    - http://my.com/StockQuote
    - http://fremantle.org/FreeStockQuote
  - An example EndpointReference

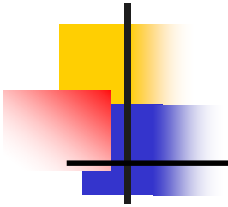
```
<wsa:EndpointReference>
  <wsa:Address>http://www.fremantle.org/FreeStockQuote
  </wsa:Address>
  <wsa:PortType>stock:StockQuoteInterface</wsa:PortType>
</wsa:EndpointReference>
```



WS-Addressing *(Continued)*

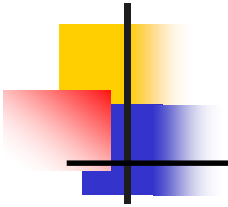
#2. SOAP messages may have more complex transport patterns than a single HTTP connection:

```
<S:Envelope>
   <S:Header>
     <wsa:MessageID>uuid:aabb-cc-dd-ee-fgf
     </wsa:MessageID>
     <wsa:ReplyTo>
              <wsa:Address>
                       http://requester.example/client1
              </wsa:Address>
     </wsa:ReplyTo>
     <wsa:To S:mustUnderstand="1">
              mailto:joe@fabrikam123.example
     </wsa:To>
     <wsa:Action>http://fremantle.org/Quote</wsa:Action>
   </S:Header>
   <S:Body>…</S:Body>
</S:Envelope>
```



Lesson #6 – Watch Out for Instances

- Beware instances!
  - What is the behaviour of the middleware?
  - At what point is the service instance selected?
    - Deployment
    - Lookup
    - Invocation
  - Affinity / Context
    - By the middleware – *e.g.* WebSphere Activity Service
    - Or with help from the programmer



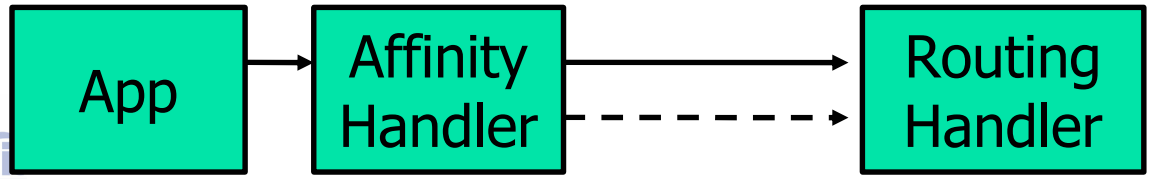
Lesson #7

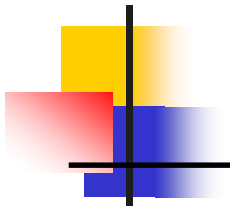
- Use intermediaries
  - Pass context as headers
  - Virtualize services *via* routers
  - Log, audit, filter, meter, monitor
  - Transform
  - Takes handler logic out of clients and servers
    - Making it easier to support .NET, Java, J2EE, Perl, *etc*.
  - Leaves running deployed applications untouched

Affinity and Context

- One way of ensuring affinity is to place a token into a header
  - Use the token to ensure affinity
  - stub.setProperty("com.my.affinityToken", UUIDGenerator.getUUID());
  - Affinity Handler grabs property and populates Header

    <my:Affinity>uuid:aa-bb-cc-dd-ee-fgf</my:Affinity>
  - Routing Handler may be in same stack or intermediary
    - Uses affinity header to ensure consistent routing



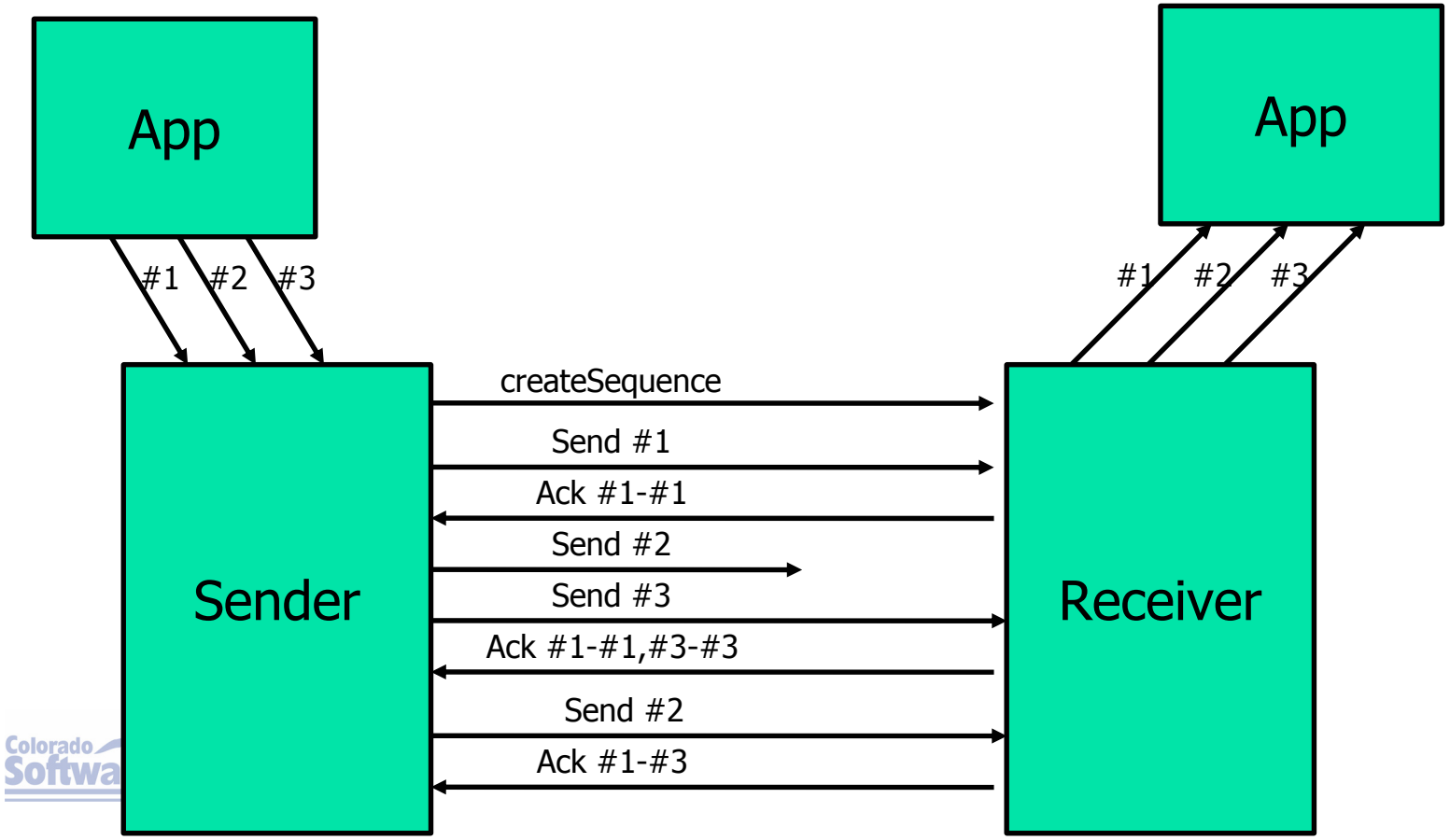


Reliable Messaging

- Three extra qualities of service
  - At most once
  - At least once
  - In order
- Plus – ExactlyOnce = AtMostOnce+AtLeastOnce
- Associated with the destination

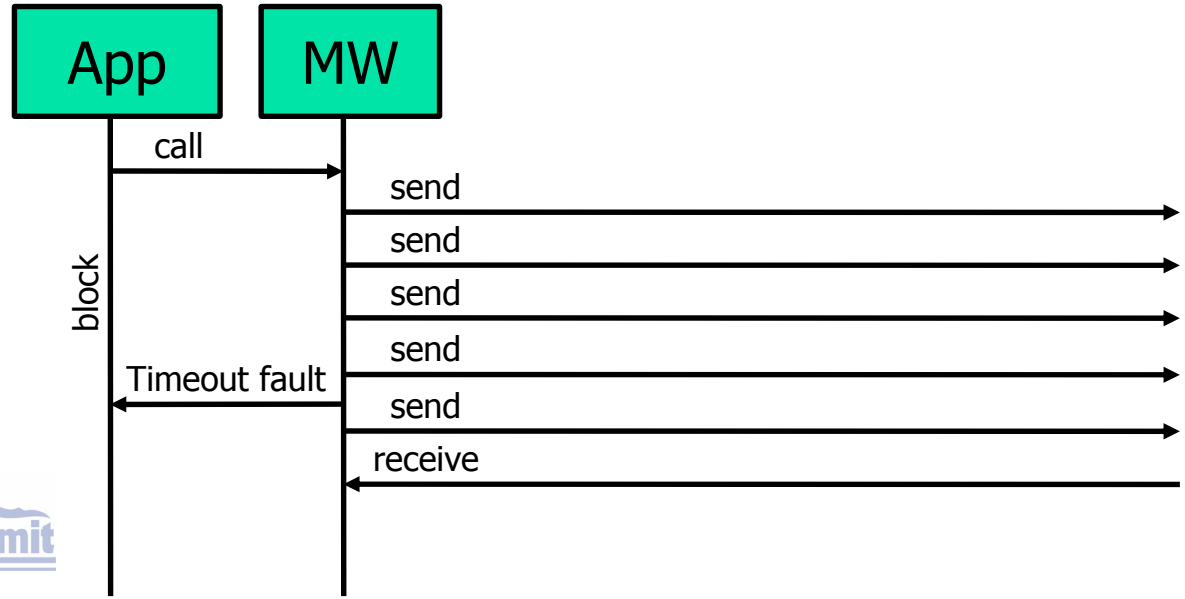
RM + One-way Messaging

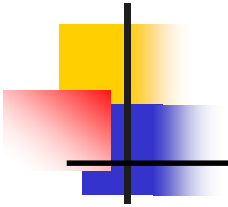
- Can be "composed" with existing application logic



RM + Request-Response

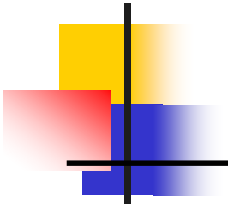
- Cannot be composed with existing middleware in general
- Either timeout = ∞ or a statistical improvement: greater chance of a message working





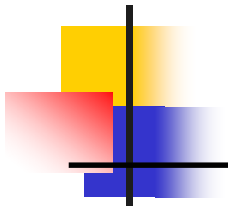
Lesson #8 – Be Prepared for Reliability

- Think business process, not stub
  - Until the stub programming models get better ☺
- Decompose request response into two messages:
  - With some correlation information
    - either in a header,
    - or in the body



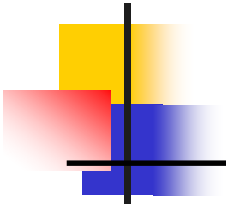
Decomposing Request Response

1. Create two WSDLs – each one way
2. Generate Java stubs and skeletons for each
3. Create handlers that can add / read the correlation information at each end



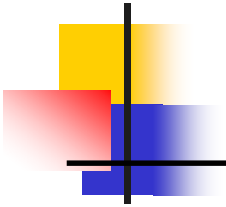
Client Request Handler

```
handleRequest(MessageContext mc) {
    if (mc instanceof SOAPMessageContext) {
        SOAPMessageContext smc = (SOAPMessageContext)mc;
        SOAPMessage m = smc.getMessage();
        SOAPHeader h = m.getSOAPPart().getEnvelope().getHeader();
        String messageID = smc.getProperty("message.id");
        h.addChildElement(WSA_URI,MESSAGEID_TAG)
                .addTextNode(messageID);
    }
}
```



Provider Request Handler

```
handleRequest(MessageContext mc) {
    if (mc instanceof SOAPMessageContext) {
        SOAPMessageContext smc = (SOAPMessageContext)mc;
        SOAPMessage m = smc.getMessage();
        SOAPHeader h = m.getSOAPPart().getEnvelope().getHeader();
        Iterator it = h.getChildElements();
        while (it.hasNext()) {
            SOAPElement thisEl = (SOAPElement)it.next();
            if
    (thisEl.getElementName.getLocalName().equals(MESSAGEID_TAG)
    &&thisEl.getElementName.getURI().equals(WSA_URI)) {
                smc.setProperty("message.id",thisEl.getValue());
            }
        }
    }
}
```

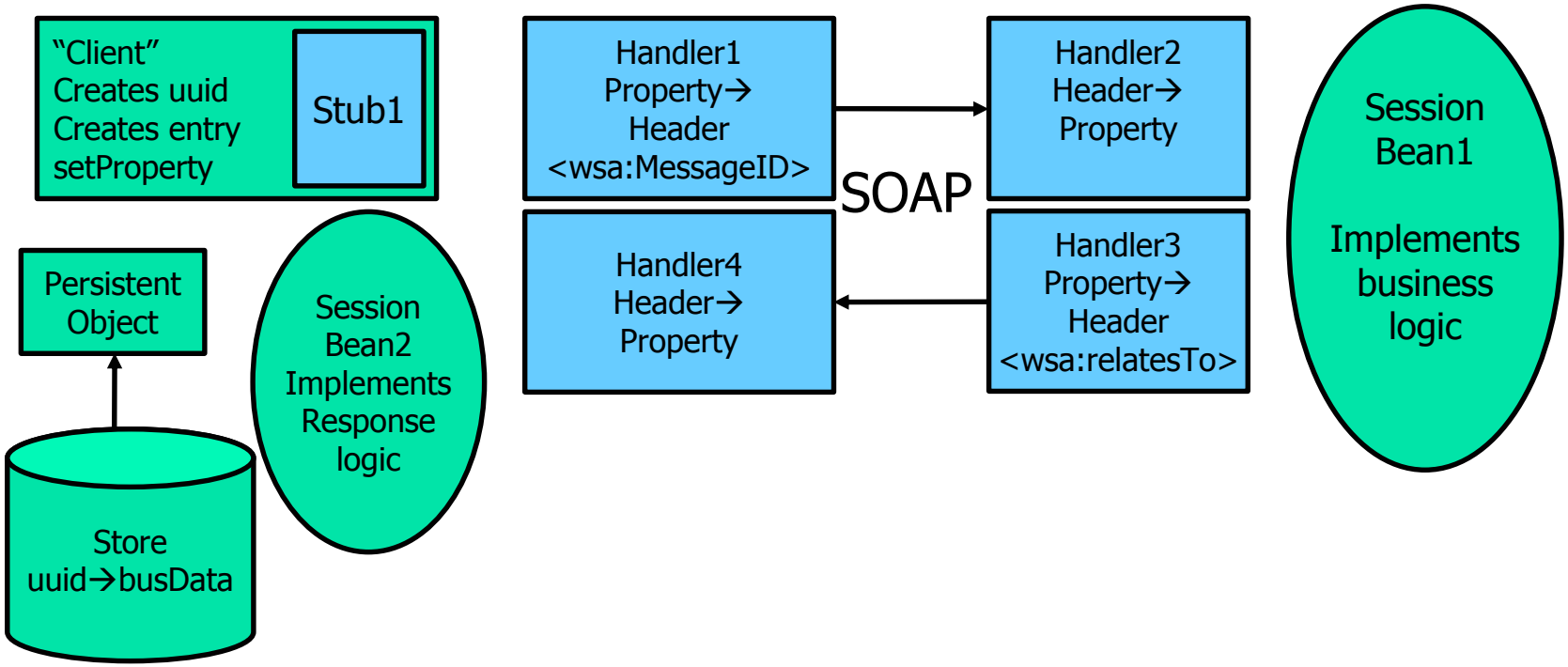


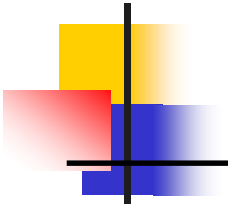
SessionEJB – provider1

- J2EE 1.4 adds
  - SessionContext.getMessageContext
  - Now… we can extract the message ID, and then add it onto the next invocation back
  - A third handler turns this into a header:

```
<wsa:RelatesTo
  RelationshipType="wsa:Reply">uuid:aa-bb-cc
</wsa:RelatesTo>
```

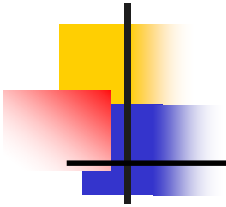
Overview of the Interaction





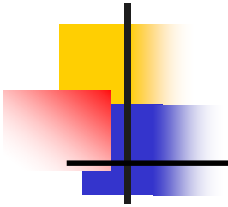
Lesson #8a – MEPs As Well

- Message Exchange Patterns
- http://www.w3.org/TR/wsdl20-extensions
  - In-Only
  - Robust In-Only
  - In-Out
  - In-Optional-Out
  - Out-Only
  - Robust Out-Only
  - Out-In
  - Out-Optional-In



Lesson #9

- Services are NOT objects
  - Coarse grained
  - Pass by value
  - Fundamentally data exchange
  - Sounds simple, but this one takes a while to sink in!



Lesson #10

- Learn your own lessons…
  - These are some lessons that have been learnt from real projects, and from exploring and implementing the standards
  - Getting the value out of SOA is more about architecture than <s:xml>
  - Don't be afraid to challenge existing programming practice to build more loosely coupled systems

Resources

- IBM developerWorks WebServices Zone
  - http://www.ibm.com/developerworks/webservices/
  - All the IBM / MS standards
- "The Hidden Impact of WS-Addressing"
  - http://www-106.ibm.com/developerworks/webservices/library/ws-address.html
- *Building Web Services with Java: Making Sense of XML, SOAP, WSDL, and UDDI (2nd Edition)*
  - **Publisher:** Pearson Education
  - **ISBN:** 0672326418