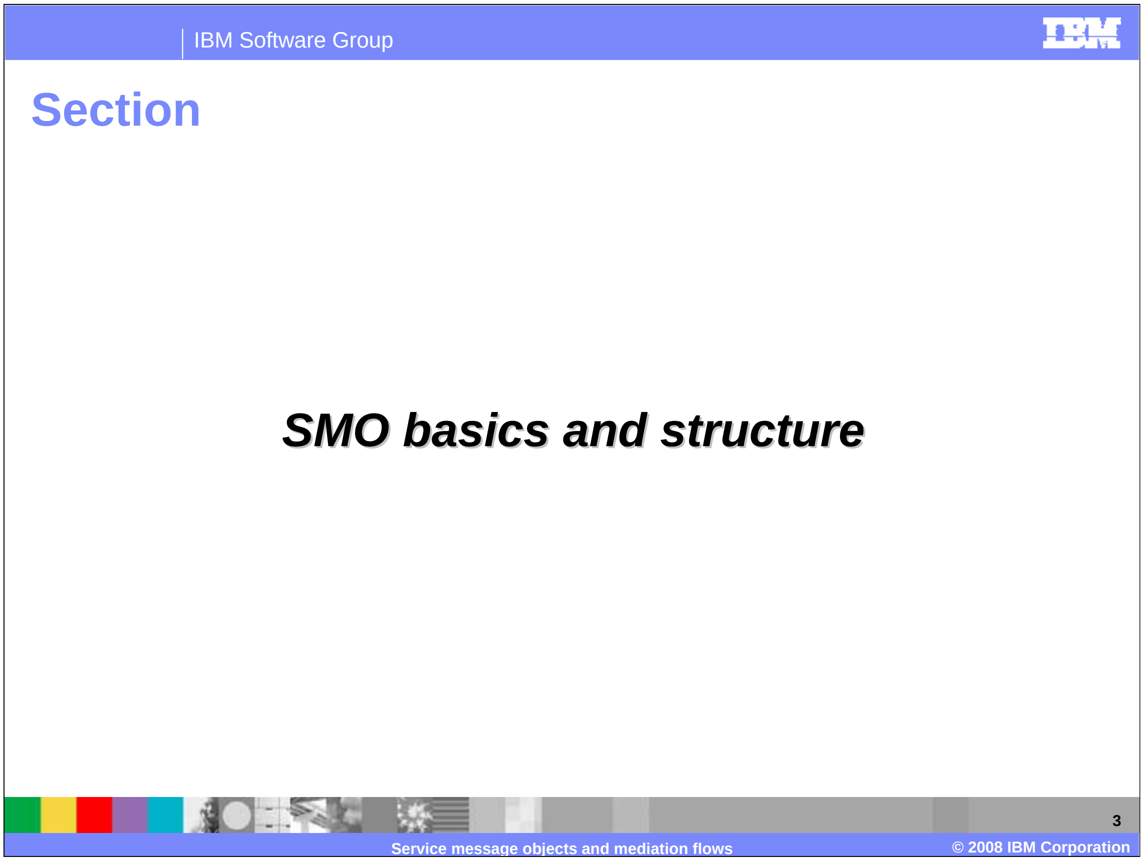
This presentation describes Service Message Objects and how they relate to Mediation Flows.

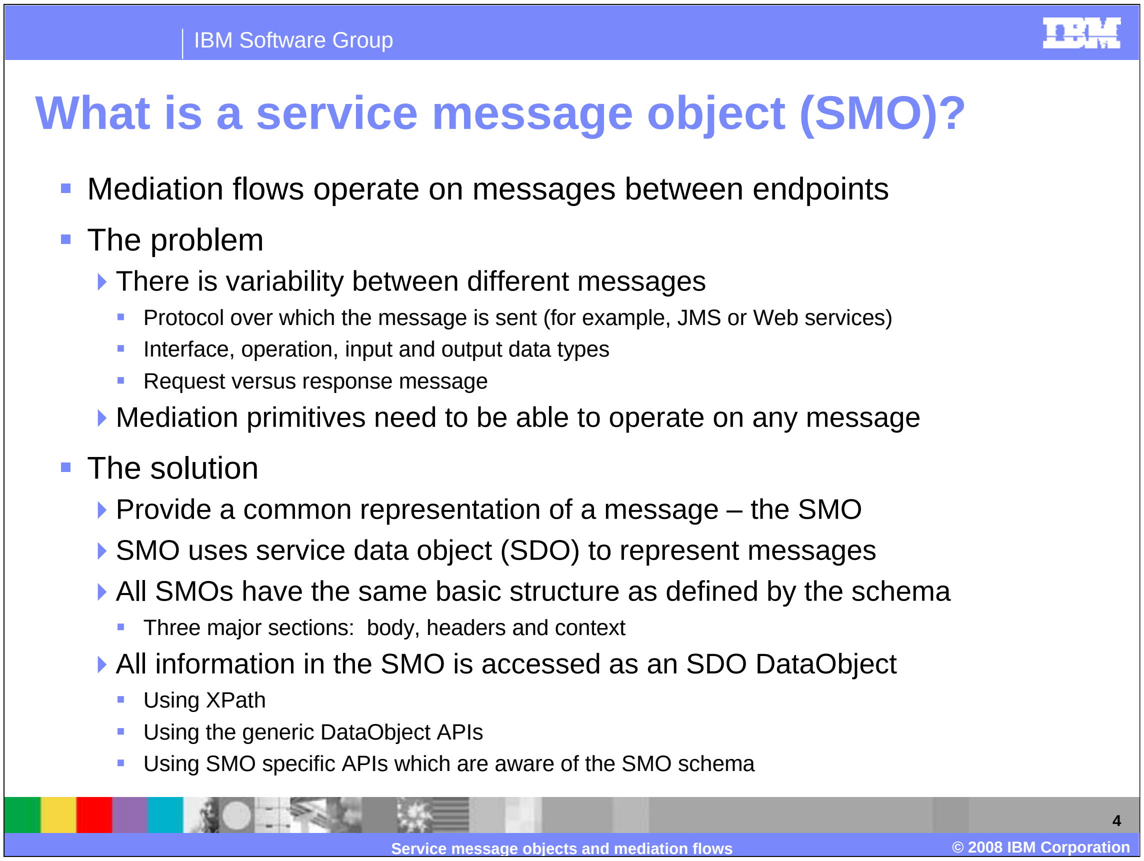
Goals

- Understand data representation in mediation flows
  - Describe the service message object (SMO)
    - Basics of the SMO
    - SMO structure
  - Message types and relationship to the mediation flow

The goal is to provide an understanding of how data is represented in a mediation flow. The data in a flow is described using a Service Message Object (SMO) and this presentation explains some basic characteristics of an SMO and then describes its overall structure. The structure of the application portion of the SMO, referred to as the body or payload, defines a message type. Message types are an important element when considering the logic and flow of a mediation. This presentation describes the relationship between message types and mediation flows.



This section considers the basic characteristics and structure of an SMO.



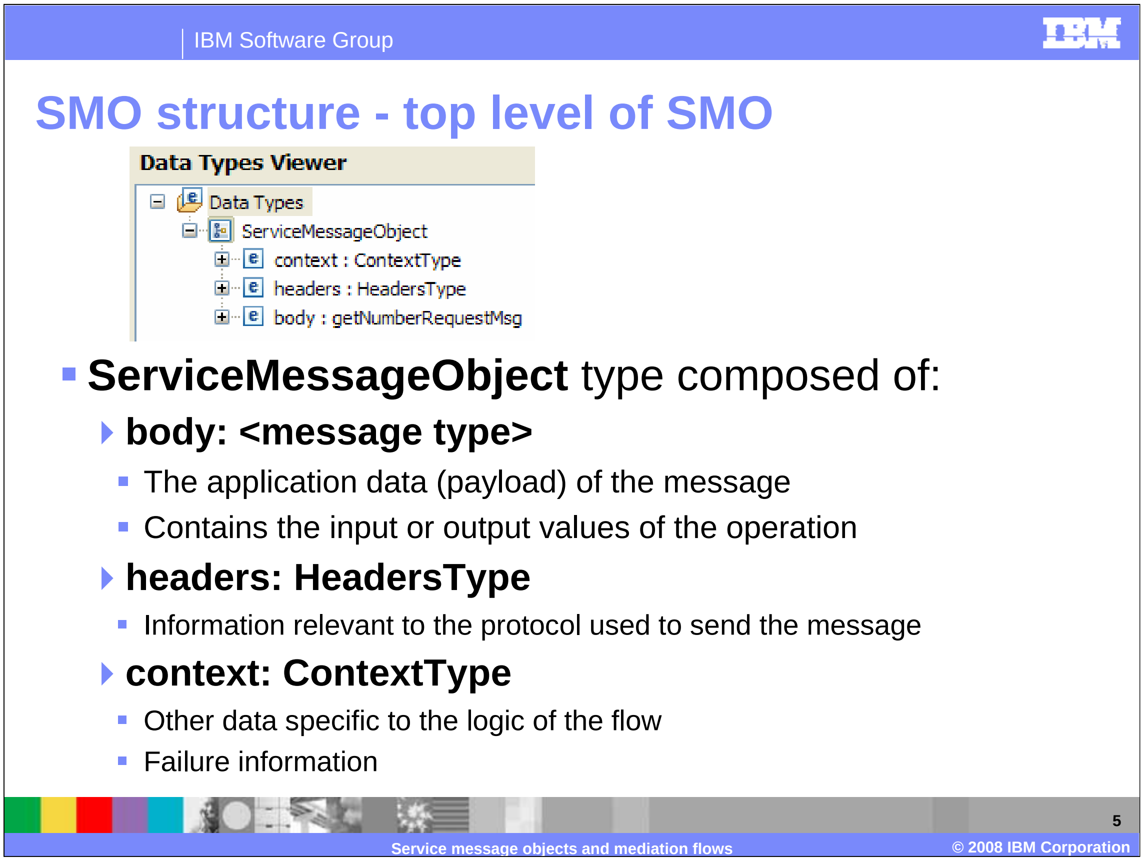
In order to understand what a Service Message Object is, you must first understand some characteristics of a mediation flow. The primary function of a mediation flow is to operate on a message between endpoints, where a service requestor and a service provider are those endpoints. However, this presents a problem.

The first point is that a message can take on many different forms, because the protocol used to send a message, whether JMS or Web services, can vary. Also, each message is different depending upon the interface and operation associated with the message and whether this is the request side or response side of the interaction between the requestor and provider.

The next point to understand is that within the mediation flow, mediation primitives are used to operate on the message. Mediation primitives examine and update the message contents and therefore must understand what is contained in the message. The solution is to provide mediation primitives with some kind of a common representation of a message, and that is what a Service Message Object does. SMOs provide a common representation of a message that accounts for differing protocols and differing interfaces, operations and parameters that the message represents.

SMOs are built using Service Data Object (SDO) technology. SDO uses a schema that describes the basic structure of an SMO which is composed of three major sections. The body of the message represents the specific interface, operation and parameters relevant to this message. The headers section of the message represents information about the protocol over which the message was sent. The context section represents data that is important to the internal logic of the flow itself. Each of these major sections of the SMO is examined in more detail in subsequent slides.

The data within an SMO is accessed using SDO, specifically the SDO DataObject, which enables access using XPath, the generic DataObject APIs, and some SMO specific APIs that are aware of the SMO schema.



Shown here is an illustration of the three major sections of an SMO. The screen capture at the top is from the data types viewer of the XPath expression builder tool, which is used to drill down into the structure of the SMO. The top level of the SMO is defined by the type ServiceMessageObject which contains three elements, the body, the headers and the context.

The body of the SMO contains the application data, sometimes referred to as the payload. This is the data that is relevant to the endpoints, the inbound coming from the service requestor and the outbound going to the service provider. The body describes the operation being performed and the inputs or outputs of that operation.

The headers of the SMO contain protocol specific information associated with the protocol over which the message is being sent.

The context of the SMO contains data required by the logic of the flow. This data exists within the flow itself but is not passed to or from the requestor or provider. Under certain conditions, error information is also added to the context.

Each of these sections of the SMO is examined more closely in the subsequent slides.

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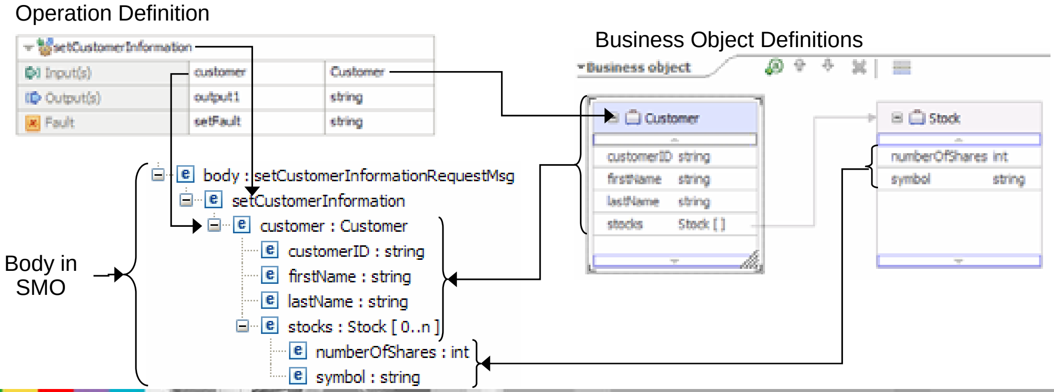
SMO structure - body

- The **body** contains the payload of the message
  - Payload is the application data flowing in the message
  - It identifies the operation and either its inputs, outputs or faults
- The operation is defined in WSDL using the Interface editor
- Inputs/outputs/faults can be simple types or XSD defined types
  - XSD defined types are created using the business object editor



6

Service message objects and mediation flows

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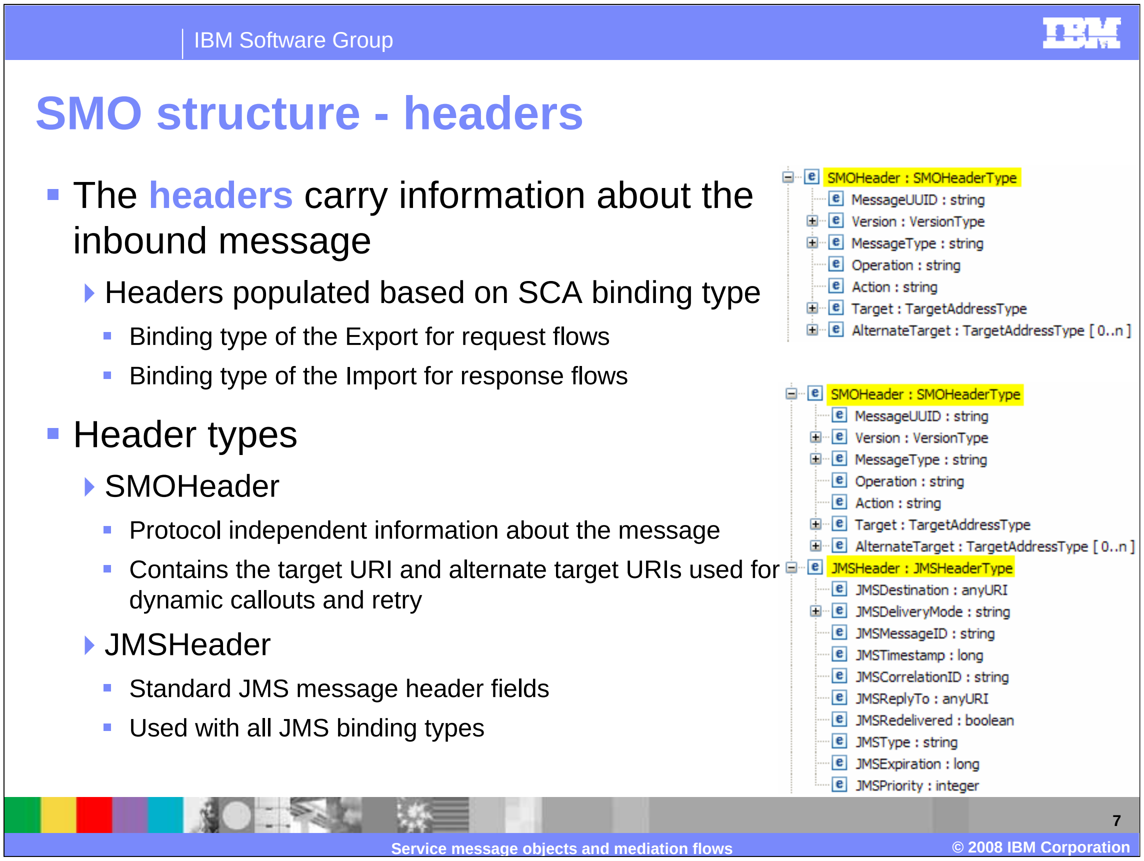
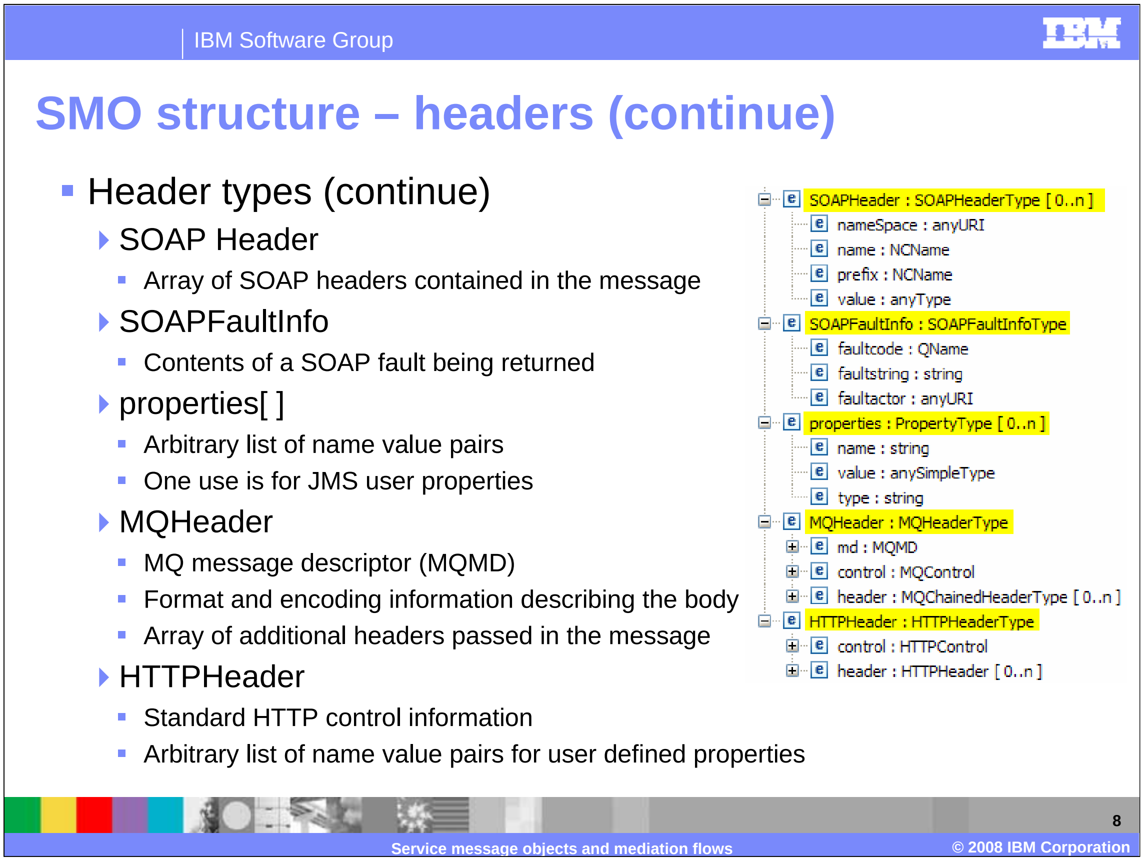
The body of the SMO contains the payload, which is the application data that flows between a service requestor and service provider. The body represents a specific operation on a specific interface. The data associated with that operation is also contained in the body and will be either the inputs, the outputs or the faults defined for the operation. The interface is a WSDL defined interface, and the Interface Editor in WebSphere® Integration Developer can be used to define it. The inputs, outputs and faults can be simple types or they can be XSD defined types. The Business Object Editor in WebSphere Integration Developer can be used to define these types. The illustration at the bottom of this slide shows the relationship between an interface defined in the Interface Editor, a business object defined in the Business Object Editor and the contents of the body of an SMO. In the lower left section is an SMO body expanded to show the individual elements. Starting at the upper left in the Interface Editor, is an operation definition for an operation called setCustomerInformation. The body contains a section called setCustomerInformation as its top level. This operation has an input called customer, defined by a Customer Business Object. Since this SMO body represents the request flow, it contains the inputs. Within the SMO, the setCustomerInformation section contains a customer section. To understand what is contained in the customer section, look at the Business Object Editor in the upper right where the Customer business object is defined. It is composed of four fields, a customerID, firstName and lastName, which are all strings, and a stocks field, which is an array of Stock business objects. A Stock business object is composed of two fields, numberOfShares, which is an int, and symbol, which is a string. The SMO body contains the same elements as the Customer business object defined in the Business Object Editor. The body of the SMO truly is a representation of an operation and the data associated with that operation.



The headers section of the SMO contains information associated with the protocol over which the inbound message is received. The binding type of the SCA export or import determines which of these header types are populated. The headers on a request flow are determined by the binding type of the export and the headers on the response flow are determined by the binding type of the import.

The first of the header types, the **SMOHeader**, contains protocol independent information that defines the message, including elements such as a unique message ID and the version number of the SMO schema. It also contains a target element and alternate target array, which can contain the URIs used for dynamic callouts and service call retry. The SMO header is always present in a service message object.

The **JMSHeader** type contains the standard JMS message header properties, which are sent with all JMS messages. This header applies to all of the JMS binding types.



The **SOAPHeader** type contains an array of the SOAP headers from the SOAP message.

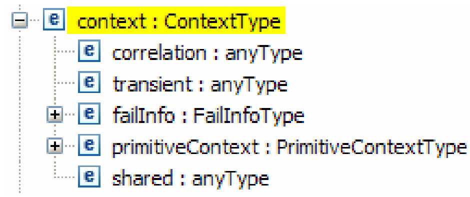
The **SOAPFaultInfo** type contains information about SOAP faults that are being returned.

The **properties** type provides the ability to include an arbitrary list of name/value pairs that can be used to represent any information. When JMS and HTTP protocols are being used, this array contains the user defined properties associated with the JMS or HTTP message.

The **MQHeader** type contains header information from an MQ message. It contains the MQ message descriptor, format and encoding information associated with the body of the message and an array of additional headers that were passed with the message. The structure of the MQ headers in the SMO is slightly simplified from the structure contained in the actual MQ message, eliminating the need to walk a chain of format and encoding information when traversing the headers.

The **HTTPHeader** type contains the standard HTTP control information, such as method, encodings and status code. There is also a list of name value pairs used to pass HTTP defined properties.

SMO structure - context



- The **context** contains flow specific data
  - Used to pass data between mediation primitives in a flow
  - Fundamental to enabling flow logic
- There are five parts to the context
  - primitiveContext
    - Contains data elements with a defined usage for selected mediation primitives
  - correlation, transient and shared
    - Each contains data elements that you defined
    - Each has a unique scope over which it applies
  - failInfo
    - Contains failure information for unmodeled faults occurring in the flow

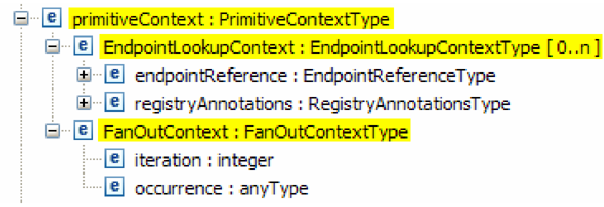
The context section of the SMO is used for passing data that is required internally by the mediation flow logic. Mediation primitives can place data into the context so that it can be accessed by subsequent mediation primitives in the flow. The context is divided into five sections.

The **primitiveContext** contains data whose definition and usage is specific to particular types of mediation primitives.

The **correlation**, **transient** and **shared** contexts contain data that is defined by you to meet specific requirements in your flow logic. The scope over which each of these contexts is used is different, addressing different needs in passing data between primitives.

The **failInfo** context is used to carry failure information when an unmodeled fault occurs during the flow.

SMO structure - primitiveContext



- The context includes the primitiveContext
  - Mediation primitive type specific elements
  - EndpointLookupContext
    - Resulting array of values returned from call to registry
    - Contains endpoint references and registry annotations
  - FanOutContext
    - Used with a fan out context in iteration mode
    - Contains current element being iterated over and its index
    - Occurrence field will reflect type of array elements being iterated over

The primitiveContext is used in those cases where the function delivered by a primitive needs to provide data for your use with other primitives in the flow. There are two primitives that fit into this category, the endpoint lookup primitive and fan out primitive.

The **EndpointLookupContext** is used to store the information returned from a query made to the WebSphere Service Registry and Repository. It contains an array of endpoint references and registry annotations for all the service endpoints that satisfied the query. You can then make use of this information when your flow logic is trying to determine which endpoint should be used for a service call.

The **FanOutContext** is used when a fan out primitive has been configured in iterate mode. The current array element and its index are stored in this context, allowing your flow logic to know which element is being worked on during this iteration of the flow. You can see that the occurrence element shows as an anyType in this screen capture. However, in a flow containing a fan out, it is defined as the specific element type of the array elements.

SMO structure – correlation, transient and shared contexts

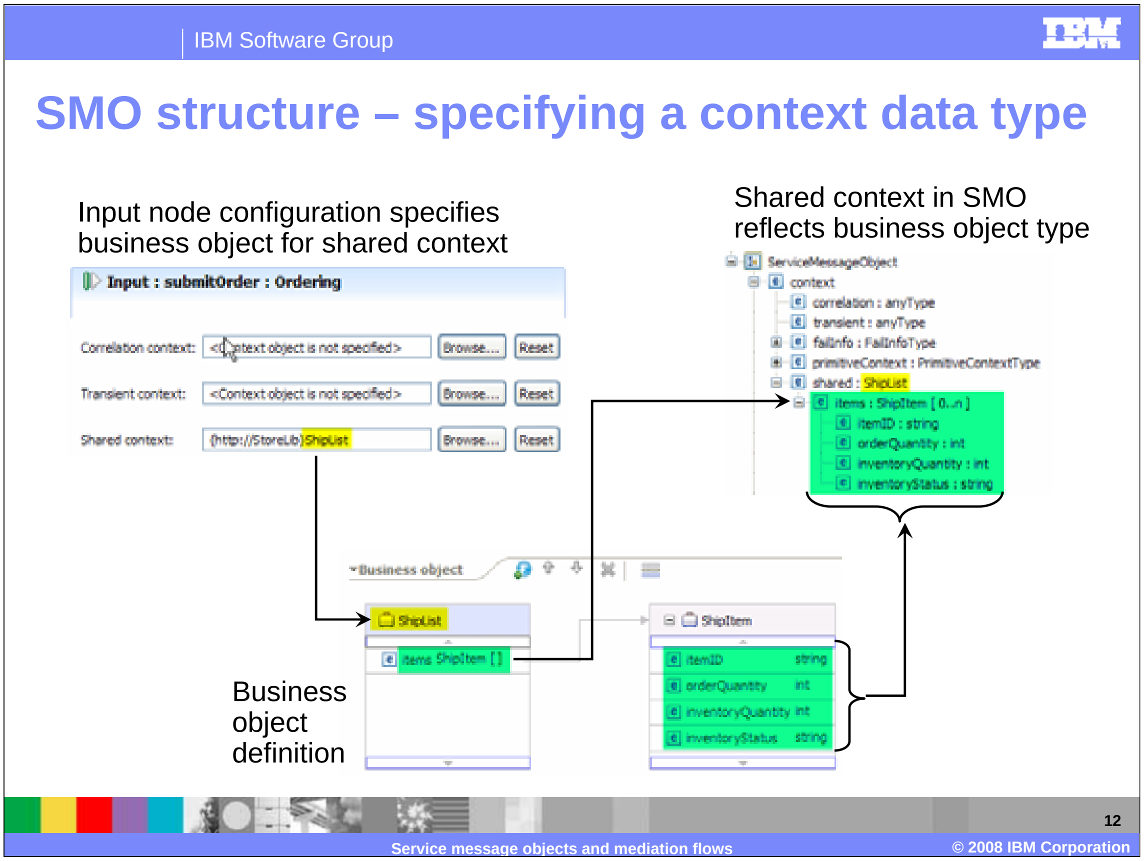
- The context includes the correlation, transient and shared contexts
  - Defined by an XSD data object (defined with business object editor)
  - You specify which business object defines each
- Correlation
  - Maintains data across a request/response flow
- Transient
  - Maintains data only during one direction (request or response)
  - One data object definition used for both the request and response
- Shared
  - Single memory area shared by all SMO instances
  - Aggregate results of processing between the fan out and fan in

The context section of an SMO contains the correlation, transient and shared contexts, which have several things in common. For instance, they are each used to pass flow specific information between mediation primitives. An XSD defined data object, such as one you created using the business object editor, is used to define the elements of a correlation, transient or shared context. You associate these with a flow by specifying the appropriate business object on the input node of the mediation flow. Correlation, transient and shared contexts differ, however, in the scope over which they maintain data.

A **correlation** context retains data across a request/response flow and therefore can be used to pass data from a mediation primitive on the request flow side to a mediation primitive on the response flow side.

A **transient** context can be used during either the request or response flow but does not retain the data set in the request for access by the response. Only one business object is used to define the transient context. Therefore, if you want to use it on both the request and response flows, the business object definition must contain the fields required for both sides of the flow. This is true even though the values set in the request flow are not available for the response flow.

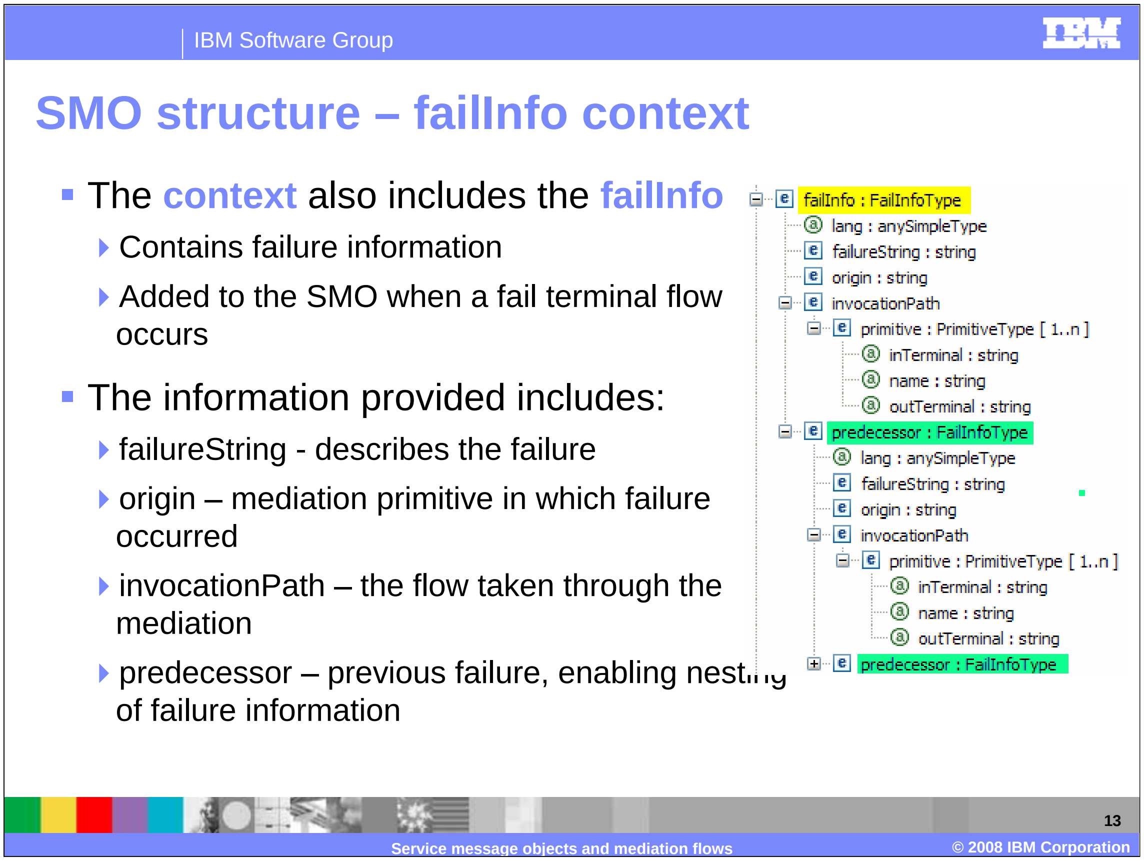
A **shared** context provides a single memory area shared by all SMO instances. This is needed when doing a splitting and aggregating scenario using the fan out and fan in primitives. The SMO is cloned at the start of each iteration between the fan out and fan in. Therefore, the shared context is needed to provided a location where the aggregated information can be built up during the iterative processing.



This slide illustrates the specification of a business object for the shared context and the resulting affect on the definition of the SMO.

Starting on the upper left side you can see the properties panel for the input node of a flow. The shared context has been configured to be defined by a business object type called ShipList. On the lower part of the slide you can see the business object editor showing that ShipList is an array of ShipItem, where a ShipItem is composed of the fields itemID, orderQuantity, inventoryQuantity and inventoryStatus. Looking at the upper right of the slide you can see that the SMO definition for the shared context reflects the definition of the ShipList business object.

Notice that in this illustration the transient and correlation contexts are not configured and therefore show as anyType in the SMO definition. Either or both of these might also be configured to a business object type with similar results on the SMO definition.

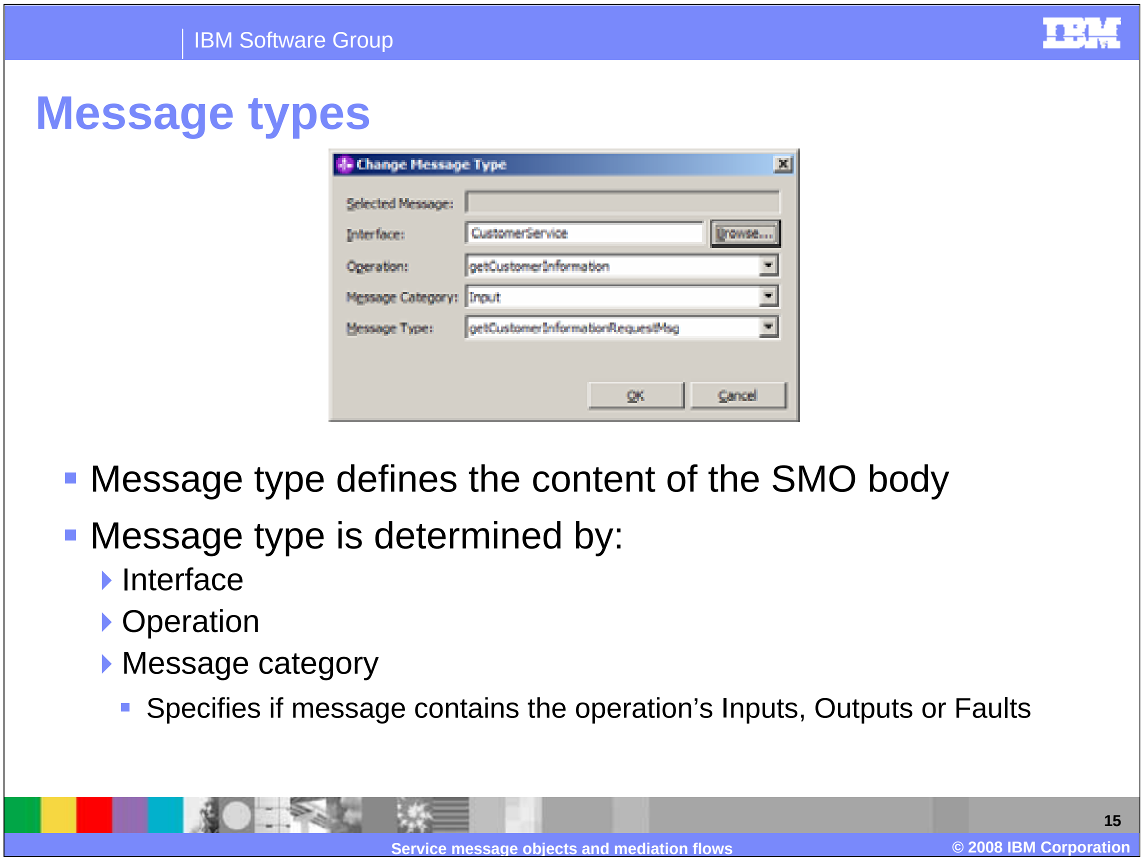


Shown on the right is an expanded view of the failInfo portion of the context section, which is used to contain information about a failure that occurred during the flow. It is only populated when a failure occurs in a mediation primitive and the mediation primitive has its fail terminal wired to another primitive or node. This allows a mediation flow to examine a failure and determine how the failure should be handled. The failInfo contains a string that describes the failure, the name of the mediation primitive in which the failure occurred and information about the path taken through the flow before the failure. In the event that a second failure occurs while processing the first failure, the predecessor section is used to retain the information about the original failure. Therefore, you are provided with a nesting of failure information when multiple failures occur in the flow.

Section

Mediation flows and the service message object

This section describes the relationship between SMOs and mediation flows, in particular how message type plays a major role when defining a mediation flow.



A message type defines what the structure of an SMO body will be and is defined by the interface and the operation associated with the message and the message category. The message category indicates if the message contains the operation’s inputs, outputs or faults. The screen capture in this slide shows the Change Message Type dialog, which is used by first browsing for and selecting an interface. Once that is done, the Operation dropdown box is used to select an operation from the list all of the operations defined on that interface. Finally the Message Category is set indicating if it is the operation’s inputs, outputs or faults that will be included. From these three settings, the Message Type field will be set to some specific type.

Message types (continue)

- Message type is a key factor in Mediation Flows
- Terminals on nodes and primitives
  - Are associated with a specific message type
  - Can only be wired together with terminals of like message type
- Naming convention applied to message types:
  - Input <operation_name>RequestMsg
  - Output <operation_name>ResponseMsg
  - Fault <operation_name>_<fault_name><?>Msg
    - <?> - additional qualifier sometimes generated
- Message type is fully qualified, including namespace
  - Example:
    - http://CustomerBackend/CustomerService}getCustomerInformationRequestMsg

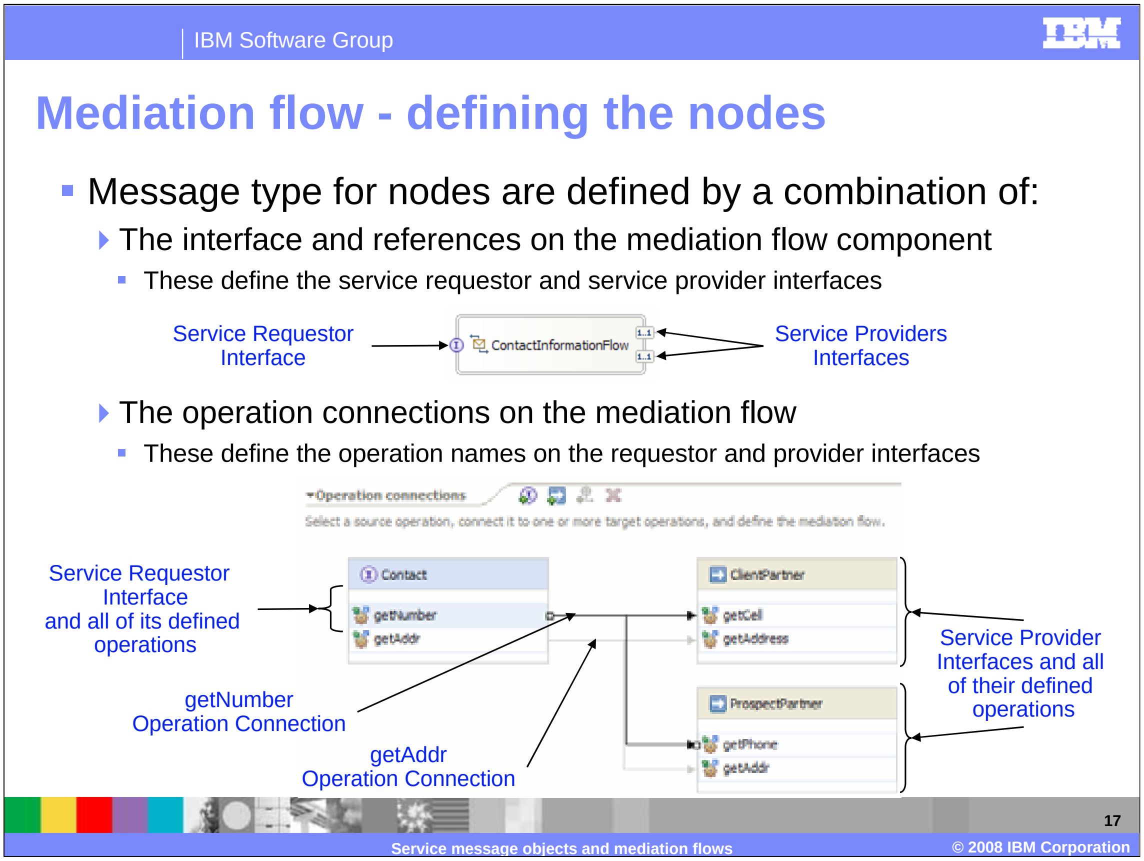
Message types are a key factor when defining a mediation flow. In a mediation flow the nodes and mediation primitives have terminals and each terminal is associated with a specific message type. When wiring a flow, only terminals of like message type can be wired together. There is a naming convention that is used for the definition of message types.

For an input message the convention is: *operation name*, RequestMsg.

For an output message the convention is: *operation name*, ResponseMsg.

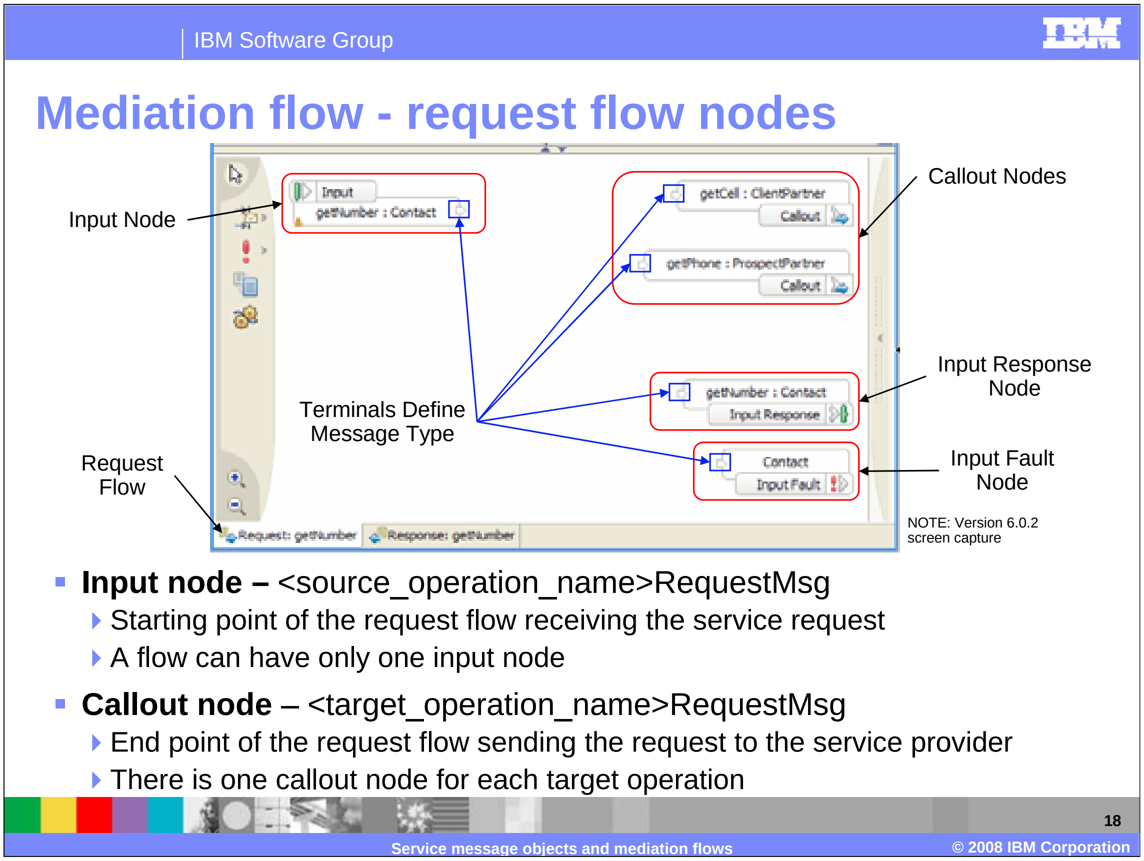
The convention for a fault is: *operation name*, *_faultname*Msg. In this case, there sometimes is also a generated qualifier placed in between fault name and Msg. When a qualifier is generated. It can have one or more characters.

These naming conventions are actually the shortened form of the message type that appears in the mediation flow editor, whereas the real message type appears in the properties view. The real message type is a fully qualified name and includes both the namespace and interface as shown in the example above. This example shows a namespace of http://CustomerBackend, an interface of CustomerService, an operation of getCustomerInformation and it ends in RequestMsg to indicate this is for a request flow and contains the inputs.



The next several slides are used to show how a mediation flow is defined. The specific focus is on the message types associated with the terminals of the nodes and mediation primitives that make up the flow. Every mediation flow has nodes that represent the entry and exit points for the flow and the nodes have terminals that have fixed message types. The interfaces and operations associated with the flow determine which nodes are present in the flow and the message types associated with their terminals. It starts with the definition of the Mediation Flow Component in the assembly diagram as shown in the top of this slide. The Mediation Flow Component contains an interface that is used by a requestor and it also has references defining the interfaces used for calling providers. In the lower portion of the slide, the Operation Connections panel of the Mediation Flow Editor shows all of the operations associated with the defined interfaces. Using this panel the operations on the input interface are connected to operations on the interfaces used to call providers.

Doing this provides sufficient information for any input operation to define the nodes for the flow, including the message types associated with the terminals for the nodes. This will be examined in detail on subsequent slides.



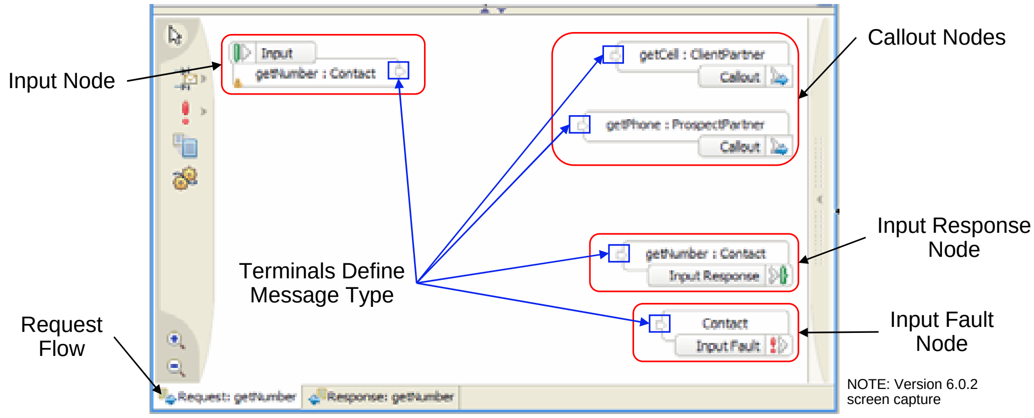
On this slide, and several of the next slides, there are screen captures taken from the mediation flow editor using WebSphere Integration Developer version 6.0.2. You might notice some differences between these screen captures and visual appearance when using version 6.1, but all the technical information is the same between the two versions.

This slide shows the canvas of the mediation flow editor for the request flow before the addition of any mediation primitives. Shown at the upper left of the canvas is the Input Node, which is the starting point for the request flow. There is only one input node for a mediation request flow and it has an output terminal with a message type of: source operation name, RequestMsg.

On the right side of the canvas, the top two nodes are the Callout Nodes. These are the end points for the request flow where a call is made to a service provider. There is one callout node for every target operation defined in the Operations Connections panel. The callout nodes each have an input terminal with a message type of: target operation name, RequestMsg.

The remaining nodes are described on the next slide.

Mediation flow - request flow nodes

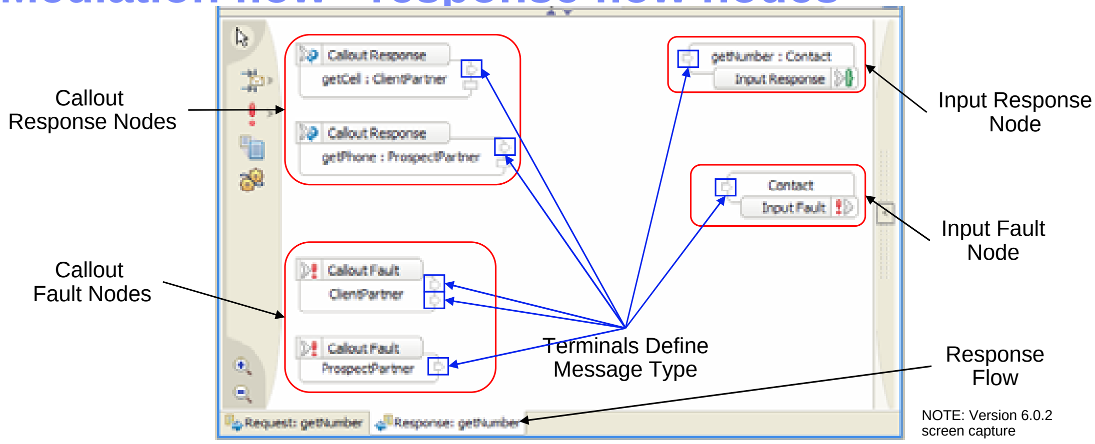


- **Input response node –** <source_operation_name>ResponseMsg
  - Enables mediation flow to reply to requestor without calling a service provider
- **Input fault node –** <source_operation_name>_<fault_name><?>Msg
  - Enables mediation flow to return a WSDL fault message to the requestor without calling a service provider
  - Each fault defined for the source operation has its own terminal on this node

The third node on the lower right side is the Input Response Node. The Input Response Node enables the mediation flow to return directly to the requestor without calling a service provider and can be used where the mediation flow can satisfy the request. The input response node has an input terminal with a message type of: source operation name, ResponseMsg.

The bottom node on the right is the Input Fault Node, which enables the mediation flow to return a WSDL fault to the requestor and can be used when some error has been detected within the mediation flow. This node can have multiple input terminals, one for each of the faults defined on the source operation. The message type associated with each terminal is: source operation name, underbar, fault name, optional qualifier, Msg. If there are no faults defined for the source operation, the input fault node will not be present on the canvas.

Mediation flow - response flow nodes



- **Callout response node –** <target_operation_name>ResponseMsg
  - Starting point of the response flow receiving the response from the service provider
  - There is one callout response node for each target operation
- **Callout fault node** – <target_operation_name>_<fault_name><?>Msg
  - Starting point of the response flow receiving a WSDL fault message from the provider
  - Each fault defined for the target operation has its own terminal on this node

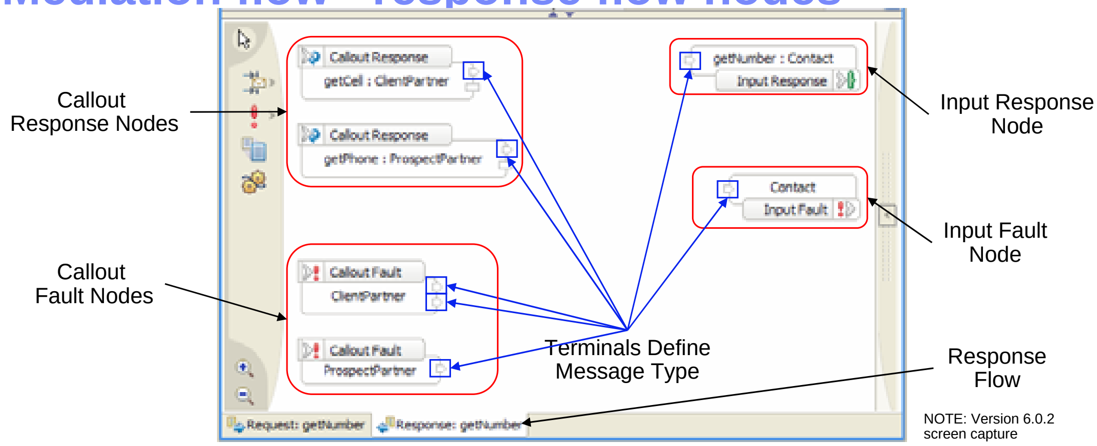
This slide shows the canvas of the mediation flow editor for the response flow before the addition of any mediation primitives.

Starting at the upper left of the canvas, there are two Callout Response Nodes, which are the starting points for the response flow where the return from the service provider is received. There is one callout response node for every target operation defined in the Operations Connections panel and they each have one output terminal with a message type of: target operation name, ResponseMsg. A Callout Response Node has another terminal which is used for unmodeled fault handling, the terminal type of which is beyond the scope of this discussion.

The lower two nodes on the left side are the Callout Fault Nodes, which are the starting points for the response flow when a service provider returns a fault. There is one callout fault node for every target operation that has one or more faults defined. These nodes may have multiple output terminals, one for each defined fault on the target operation. The message type for the terminals is: target operation name, underbar, fault name, optional qualifier, Msg.

The remaining nodes are described on the next slide.

Mediation flow - response flow nodes

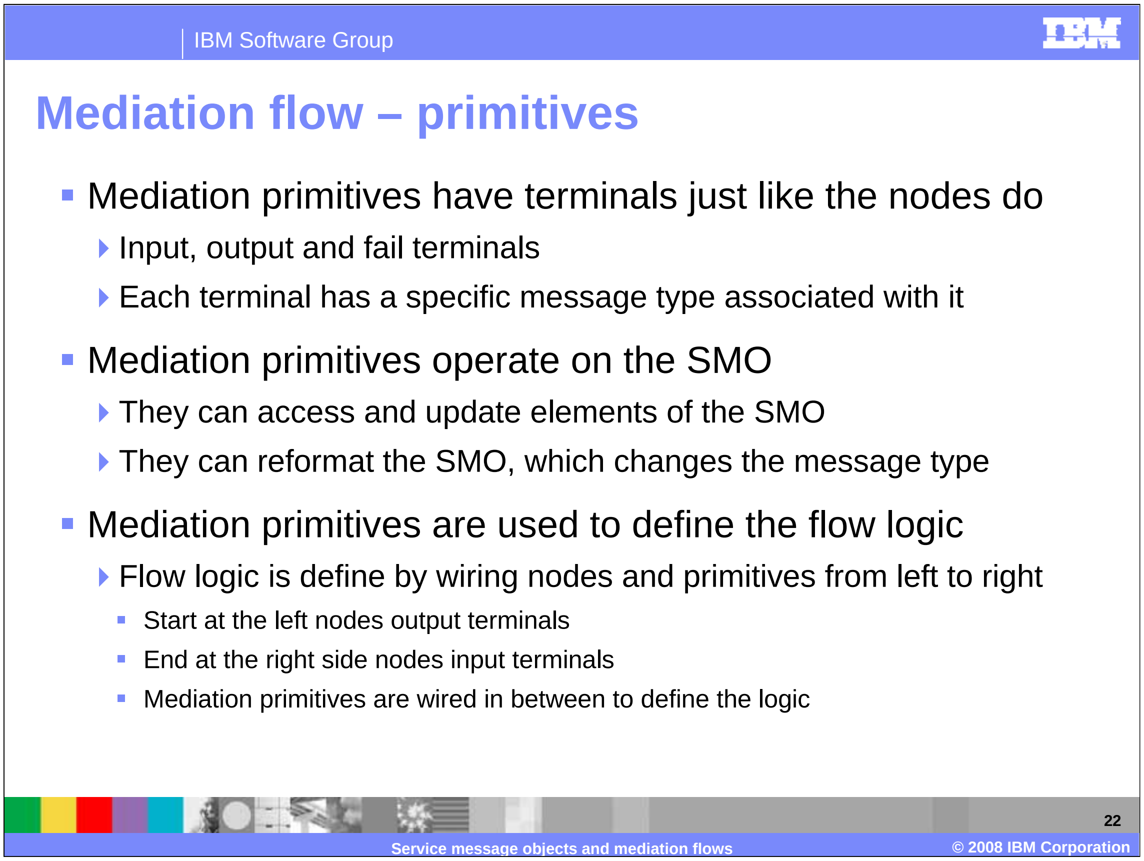


- **Input response node –** <source_operation_name>ResponseMsg
  - End point of the response flow returning a response to the original requestor
  - A flow can have only one input response node
- **Input fault node –** <source_operation_name>_<fault_name><?>Msg
  - End point of the response flow returning a WSDL fault message to the original requestor
  - Each fault defined for the source operation has its own terminal on this node

On the right side of the canvas, the top node is the Input Response Node, the end point for the response flow, which returns to the original service requestor. There will be only one input response node in a response flow and the input terminal of this node has a message type of: source operation name, ResponseMsg.

The bottom node on the right is the Input Fault Node, which is used to return a WSDL fault to the original service requestor. There can be multiple input terminals on this node, one for each of the faults defined on the source operation. The message type associated with each terminal is: source operation name, underbar, fault name, optional qualifier, Msg. If there are no faults defined for the source operation, the input fault node will not be present on the canvas.

This completes an examination of the nodes, their terminals and associated message types.

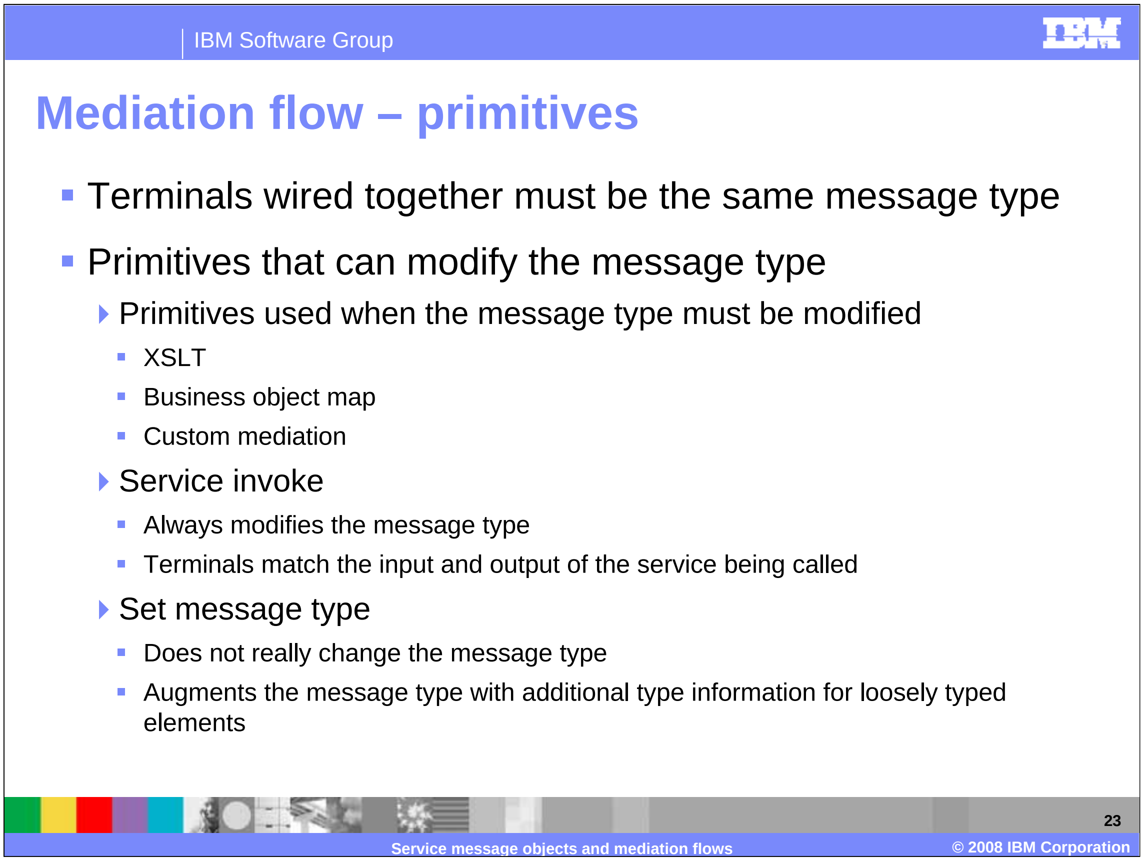


Now that nodes have been covered, including their terminals and associated message types it is time to consider mediation primitives and how they are used to define the logic of a mediation flow.

Similar to nodes, the mediation primitives also have terminals. An SMO is passed to a mediation primitive through the input terminal and is passed out of the primitive through an output or fail terminal. Each of these terminals has a specific message type associated with it.

The mediation primitives operate on the SMO. Some primitives can only access element values from the SMO, others can access and update values and some can also reformat the SMO. Reformatting of the SMO changes the message type.

The flow logic of the mediation is defined by adding mediation primitives to the canvas between the nodes and then wiring the nodes and mediation primitives together. The flow is defined from left to right, starting with the left side nodes, wiring through some combination of mediation primitives and ending with the right side nodes.



When wiring together the terminals for the nodes and primitives, any terminals that are wired together must be for the same message type. This is because the format of the SMO as it flows out of one terminal is unchanged as it flows into the terminal it is wired to.

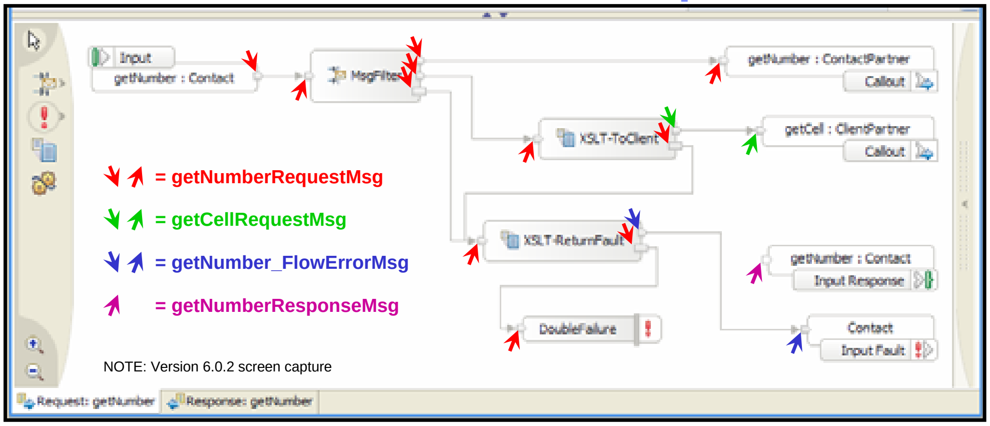
When there is a need to connect nodes or primitives having terminals with differing message types, the XSLT, business object map or custom mediation primitive must be used between them. This allows the SMO to be reformatted to the other message type based on a mapping you define.

Another primitive that modifies the message type is the service invoke. The input terminal for the service invoke is the request message type for the operation being invoked on the service, and the output terminal is the is the response message type.

Finally, there is the set message type primitive. The name of this primitive is somewhat misleading in that it does not really change the message type of the SMO that flows through this primitive at runtime. It is used to declare a more specific type for a loosely typed field in the SMO, such as an anyType. This allows development time tools to understand the more specific type, making it easier for you to use the XPath expression builder and the mapping tools in WebSphere Integration Developer. A good analogy for this functionality is a cast operation in a programming language. This message type augmentation does affect the wiring capabilities, which is explained in detail in the presentation for this primitive.

The next slide will provide an example mediation flow and explain the various terminal message types.

Mediation flow definition - example



- Two possible providers, one with a different interface than the requestor
- Errors in the flow result in a fault being returned to the requestor
- XSLT primitives used to modify message type when required
- Message types of terminal identified with color coded arrows

This slide contains a realistic example of a mediation flow, illustrating the wiring of nodes and mediation primitives together, while taking into account the constraint of only being able to wire terminals of like message type. This example shows two possible target service providers, one of which has a different interface than the service requestor. The flow also handles errors and returns a fault to the requestor if there is a failure in the flow. The flow in the upper left shows that the Input node is for the getNumber operation of the Contact interface. Therefore, it has an output terminal with a message type of getNumberRequestMsg. Looking at the flow in the upper right, the top Callout node is for the same interface and operation as the Input node and therefore has an input terminal of the same message type. The other Callout node is for the getCell operation of the Client interface and it therefore has an input terminal with a message type of getCellRequestMsg. Continuing down the right side, the Input Response node's input terminal will be for message type getNumberResponseMsg. Finally, on the lower right is an Input Fault node with an input terminal for message type getNumber_FlowErrorMsg, corresponding to the FlowError fault defined in the getNumber operation of the requestor. Before examining the flow, notice that each terminal in the flow is marked with an arrow of a different color, with each color representing the message type of the terminal it is pointing to. In the flow, the Input Node is wired to a Message Filter mediation primitive. This primitive contains some logic that differentiates between requests that should be passed to the provider with the Contact interface versus requests that should be passed to the provider with the Client interface. As you can see, all terminal message types for this primitive are for the getNumberRequestMsg. In the case where the request goes to the provider with the Contact interface, the wire can go directly to the Callout node. In the case where the request goes to the provider with the Client interface, the message type must be changed from a getNumberRequestMsg to a getCellRequestMsg. This is done using the XSLT primitive that is labeled XSLT-ToClient and which is then wired to the Callout. The description of the non-error paths through the flow is now complete and the error paths can now be examined. Coming out of the Message Filter and XSLT primitives are Fail terminals which are used when the primitive raises some kind of an error. Fail terminals always have the same message type as the input terminal, so both of these have a type of getNumberRequestMsg. The flow logic is designed to return a fault to the requestor when either of these primitives fails. In order to do this, both Fail terminals are wired to the primitive labeled XSLT-ReturnFault, which changes the message type from a getNumberRequestMsg to a getNumber_FlowErrorMsg. It is then wired to the Input Fault node which returns the fault to the requestor. Finally, there is a possibility that the XSLT used to modify the SMO to a fault message can fail. In this case, the Fail terminal of the XSLT-ReturnFault primitive is wired to a Fail primitive. This results in the mediation flow ending in an exception with no response returned to the requestor.

Summary

- Examined service message objects
  - Described the service message object (SMO)
    - Basics of the SMO
    - SMO structure
  - Discussed message types
    - Looked at how message types relate to the mediation flow

In summary, this presentation examined the use of Service Message Objects by first describing what an SMO is and how it is structured. The concept of message types was explained and a detailed description of how message types affect the construction of a mediation flow was given. Finally, an example of a mediation flow was provided, illustrating how the message type affects the wiring of the flow.

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