



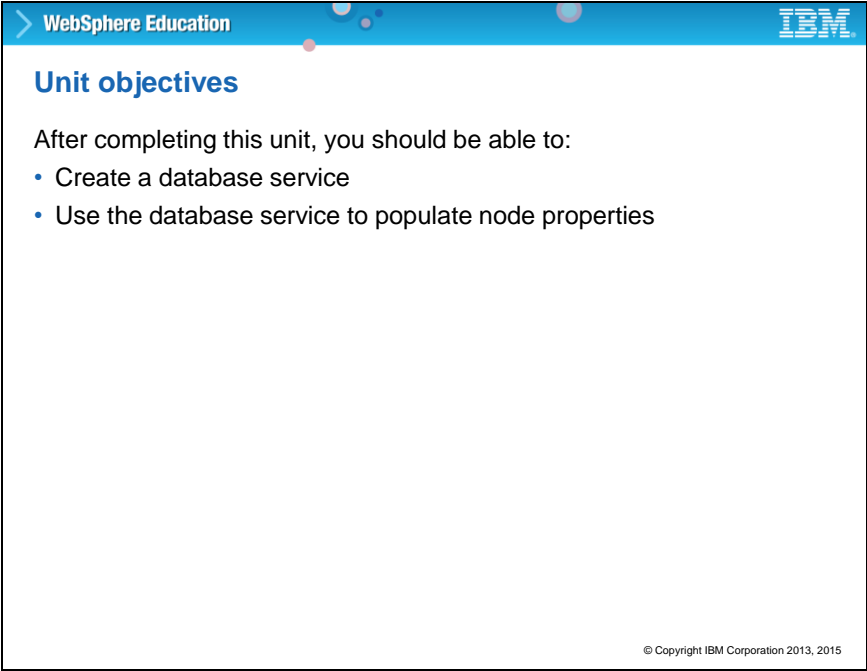
Slide 1

> WebSphere Education 


Connecting a database by using a discovered service



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The slide features a blue header bar with the text 'WebSphere Education' on the left and the IBM logo on the right. Below the header, the title 'Unit objectives' is displayed in blue. The main content area contains a paragraph followed by a bulleted list. The footer of the slide contains a small copyright notice.

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Unit objectives

After completing this unit, you should be able to:

- Create a database service
- Use the database service to populate node properties

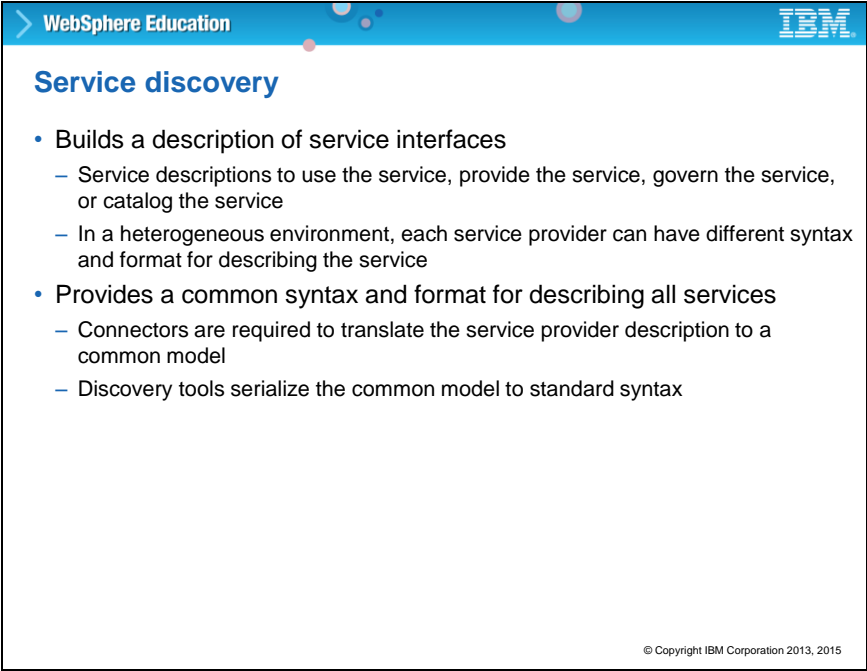
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Unit objectives

An IBM Integration Bus database service defines the interaction between Integration Bus and a database, and can be used with a message flow node to automatically configure connectivity to that database. In this unit, you learn how to define and implement a database service.

After completing this unit, you should be able to:

- Create a database service
- Use the database service to populate node properties



The slide is titled "Service discovery" and is part of a "WebSphere Education" presentation. It features a blue header with the IBM logo. The content is organized into a bulleted list. The first main bullet point is "Builds a description of service interfaces", which has two sub-bullets: "Service descriptions to use the service, provide the service, govern the service, or catalog the service" and "In a heterogeneous environment, each service provider can have different syntax and format for describing the service". The second main bullet point is "Provides a common syntax and format for describing all services", which has two sub-bullets: "Connectors are required to translate the service provider description to a common model" and "Discovery tools serialize the common model to standard syntax". A copyright notice "© Copyright IBM Corporation 2013, 2015" is located at the bottom right of the slide.

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Service discovery

- Builds a description of service interfaces
 - Service descriptions to use the service, provide the service, govern the service, or catalog the service
 - In a heterogeneous environment, each service provider can have different syntax and format for describing the service
- Provides a common syntax and format for describing all services
 - Connectors are required to translate the service provider description to a common model
 - Discovery tools serialize the common model to standard syntax

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Service discovery

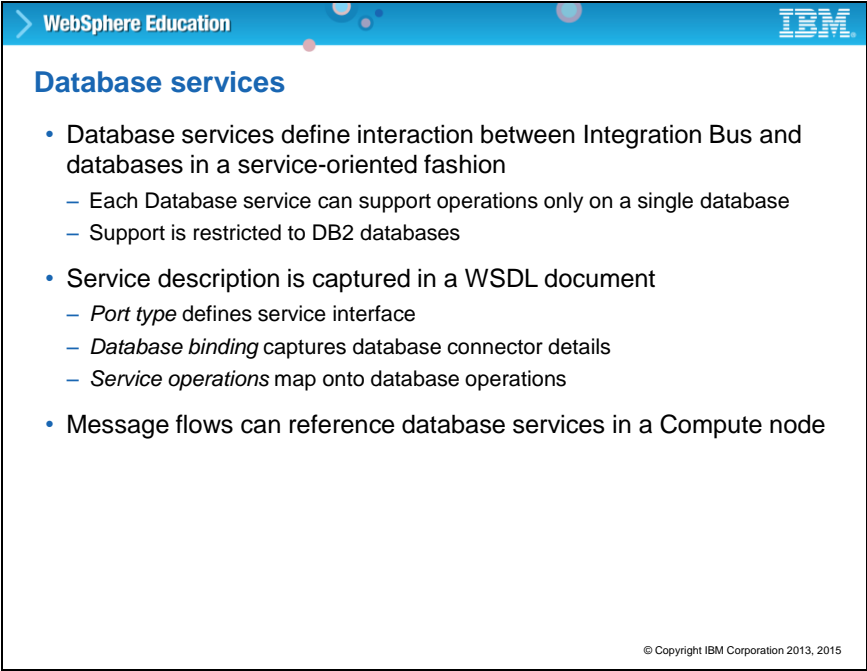
In a heterogeneous environment, each external application has a different syntax and format for describing their service. Integration Bus needs a description of these interfaces to use, provide, govern, or catalog the service. Service discovery in Integration Bus provides you with a common experience for describing service interfaces.

In Integration Bus, a discovered service is a representation of the external application with which your message flow interacts. Currently, Integration Bus supports service discovery for DB2 databases and MQ queues.

You can use a database service to make database operations accessible both within a message flow, and to external applications that call a message flow.

You can use an MQ service to discover artifacts from MQ queue managers. You can then use these artifacts in a message flow to configure the properties of an MQ node. You can reuse an MQ service across multiple nodes, which simplifies the MQ connectivity within your message flows.

This unit concentrates on database services. MQ services are described in Unit 10.



The slide is titled "Database services" and is part of a "WebSphere Education" presentation. It contains a bulleted list of information about database services in a service-oriented fashion. The list includes details about service descriptions in WSDL documents, the types of databases supported (DB2), and how message flows can reference these services. The IBM logo is visible in the top right corner of the slide.

- Database services define interaction between Integration Bus and databases in a service-oriented fashion
 - Each Database service can support operations only on a single database
 - Support is restricted to DB2 databases
- Service description is captured in a WSDL document
 - *Port type* defines service interface
 - *Database binding* captures database connector details
 - *Service operations* map onto database operations
- Message flows can reference database services in a Compute node

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Database services

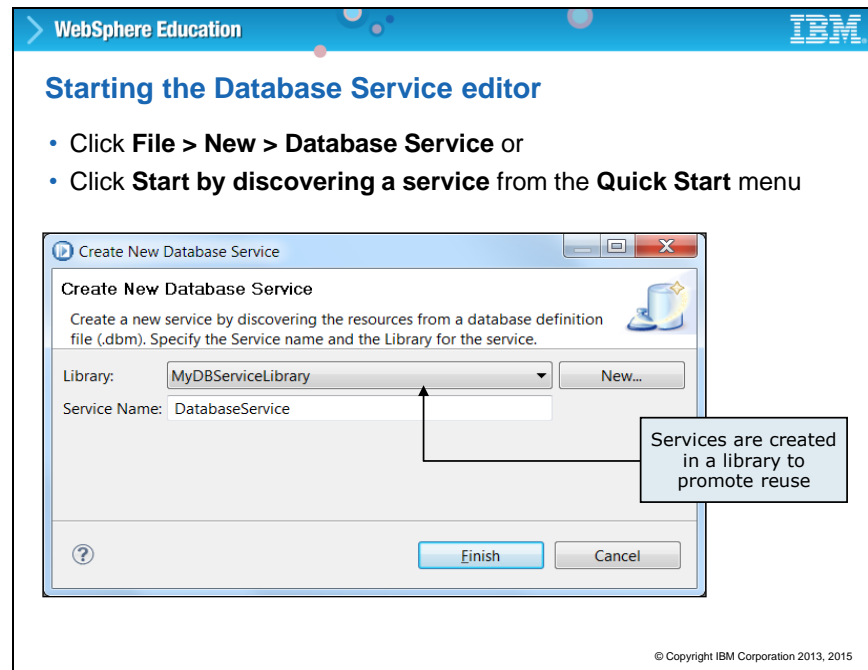
You can create a database service in the Integration Toolkit Database Service editor by combining metadata that is discovered from the database, with information supplied by the flow developer about the required database interaction.

The service description generates a WSDL file that contains:

- Operation-oriented interface definitions about the database interaction
- A database connection binding that captures the semantics of the operations on the database
- XML schema files that describe the inputs and outputs of the database operations

Currently, a database service has the following limitations:

- It can interact only with a DB2 database.
- It can be used only with a Compute node in a message flow.
- Each database service can support operations only on a single table in your database.



Starting the Database Service editor

The service discovery workflow consists of the following steps:

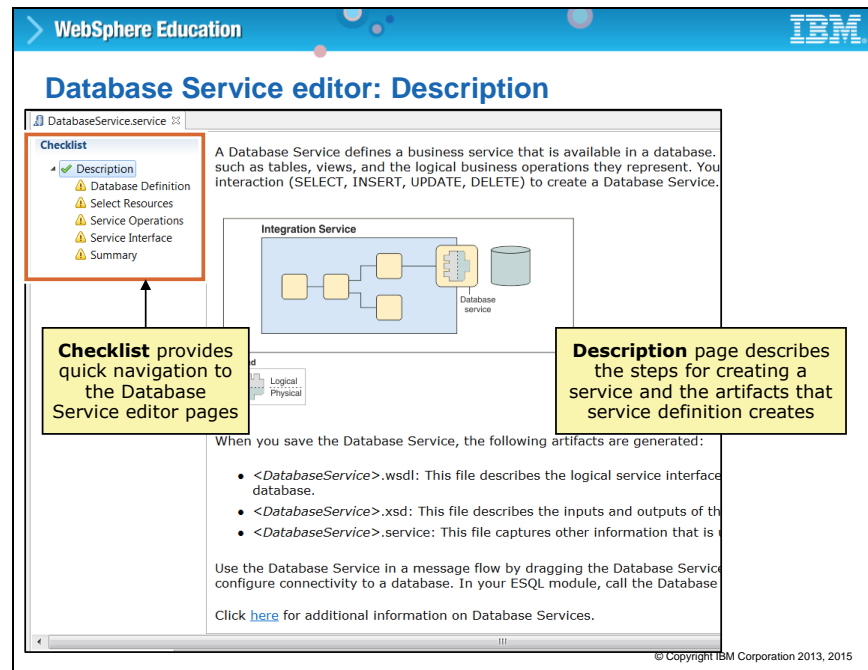
1. The developer enters connection details in the Database Service editor.
2. The Database Service editor discovers the technical assets based on the connection details.
3. The developer selects the required technical assets for elaboration.
4. The editor creates a service definition, and stores it in a catalog for later use.

You start the Database Service editor by using one of the following methods:

- Click **File > New > Database Service**.
- In the **Application Development** view, click **New > Database Service**.
- Right-click the white space of the **Application Development** view, and then click **New > Database Service**.
- Click **Start by discovering a service** from the **Quick Start** menu.

In the workspace, services are stored in a library for reuse. Be sure to provide a descriptive name for your service.

Slide 6

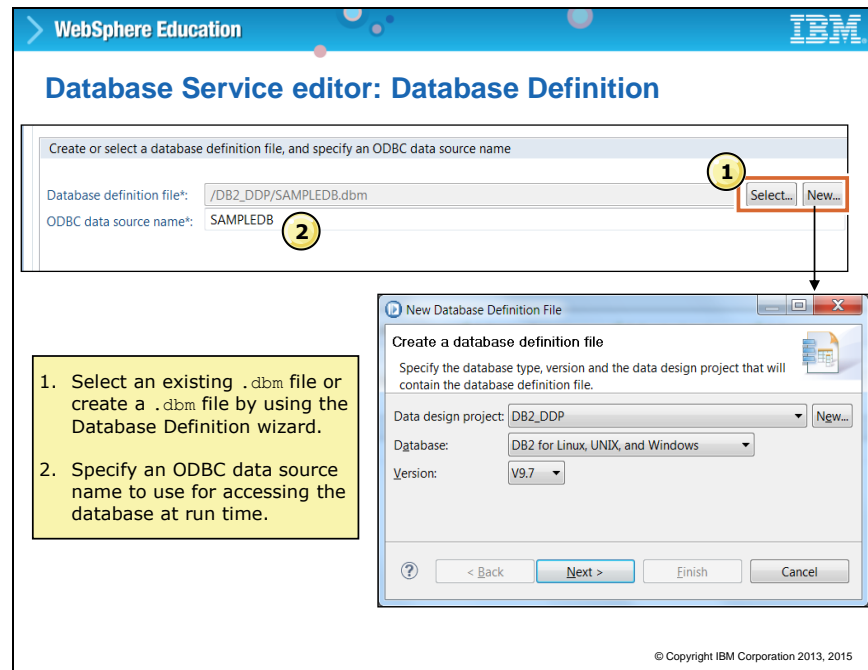


Database Service editor: Description

The Database Service editor in the Integration Toolkit has five main panels that guide you through the service definition. You click the option in the **Checklist** in the Database Service editor to go directly to a specific panel.

The Database Service editor opens on the **Description** panel. The **Description** panel contains the steps for defining a database service and a description of the artifacts that the Database Service editor generates.

To start defining the database service, click **Database Definition** in the **Checklist**.



Database Service editor: Database Definition

The Database Service editor uses a database definition file (.dbm file) for the database connection information. In addition to the database connection information, the database connection file also contains information about the database contents such as the database schemas, tables, and stored procedures.

When you create a database definition file, you must also specify the ODBC data source name. The database definition step assumes that an ODBC data source is already created for the database.

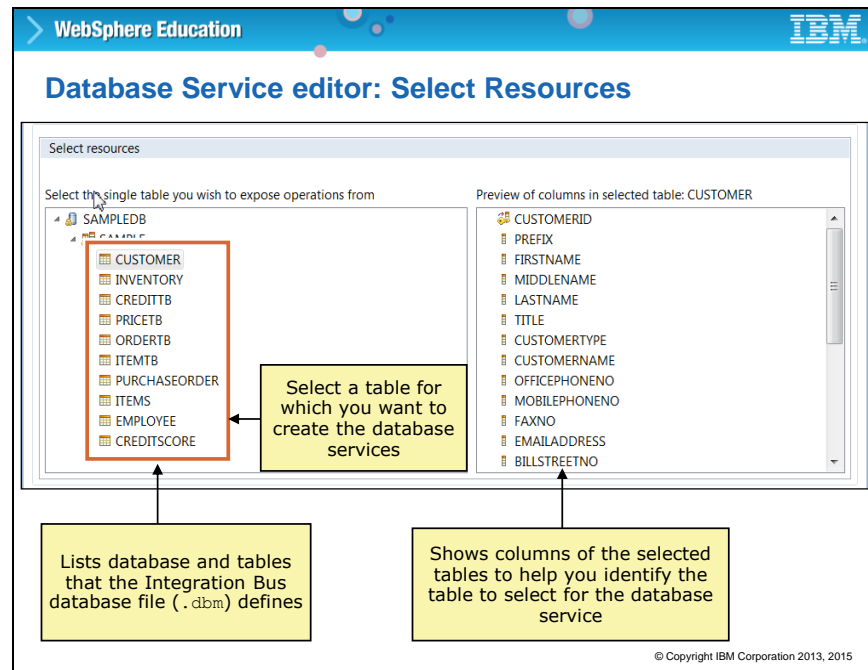
You learned about database definition files and ODBC in the prerequisite course *IBM Integration Bus V10 Application Development I*.

On the **Database Definition** panel, you discover the database definition by using one of the following methods:

- Specify the name of an existing database definition file (.dbm file).
- Click **New** to create a database definition file for the database.

Be sure to test the connection in the database definition file to ensure that the Integration Toolkit can connect to the database.

The next step is to select the database resources on the **Select Resources** panel.

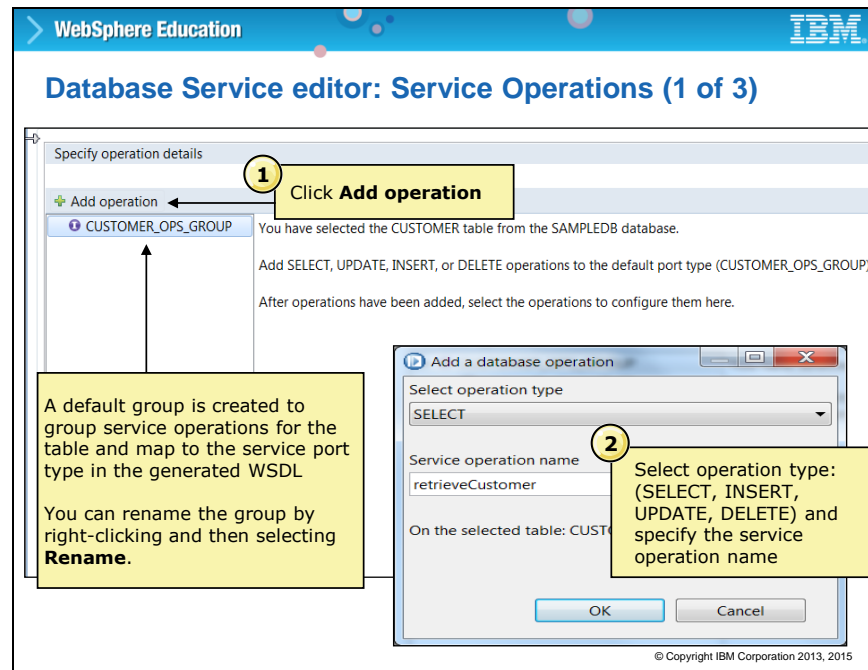


Database Service editor: Select Resources

On the **Select Resources** panel, you select the table for which you want to provide operations. Currently, each database service can support operations on a single table only.

When you select a table, the table columns are shown in the preview pane to help you to determine the table to select.

The next step is to define the database service operations on the **Service Operations** panel.



Database Service editor: Service Operations (1 of 3)

On the **Service Operations** panel, add the required SELECT, UPDATE, INSERT, or DELETE service operations. You can define several service operations, but they can relate to the one database table only.

A default group is created to group the service operations for the table. By default, the group is named <table_name>_OPS_GROUP. In the example, the group is named CUSTOMER_OPS_GROUP because the CUSTOMER table was selected on the **Select Resources** panel. This group maps to the service port type in the WSDL that the Database Service editor generates. You can rename the group by right-clicking the group name and then clicking **Rename**.

To add an operation:

1. Click **Add operation**.
2. Select the operation type and then enter a descriptive service operation name.

You create a SELECT operation in the lab exercise for this unit.

The next step is to identify the table columns for the service operation.

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Database Service editor: Service Operations (2 of 3)

Specify operation details

1 Operation Type: SELECT -- Selected columns from the table will be output parameters of the operation. In the Output Columns tab set the sort preferences for the columns. In the Conditions tab set which rows will be returned.

+ Add operation

CUSTOMER_OPS_GROUP
retrieveCustomerByID
retrieveCustomersByLastName
retrieveCustomersInToronto
createCustomer
updateCustomer
deleteCustomer

4

Select columns from the table and their sort order

Selected columns are output parameters of the service operation

CUSTOMER
CUSTOMERID
PREFIX
FIRSTNAME
MIDDLENAME
LASTNAME
TITLE
CUSTOMERTYPE

3

Select an operation to configure a corresponding database query

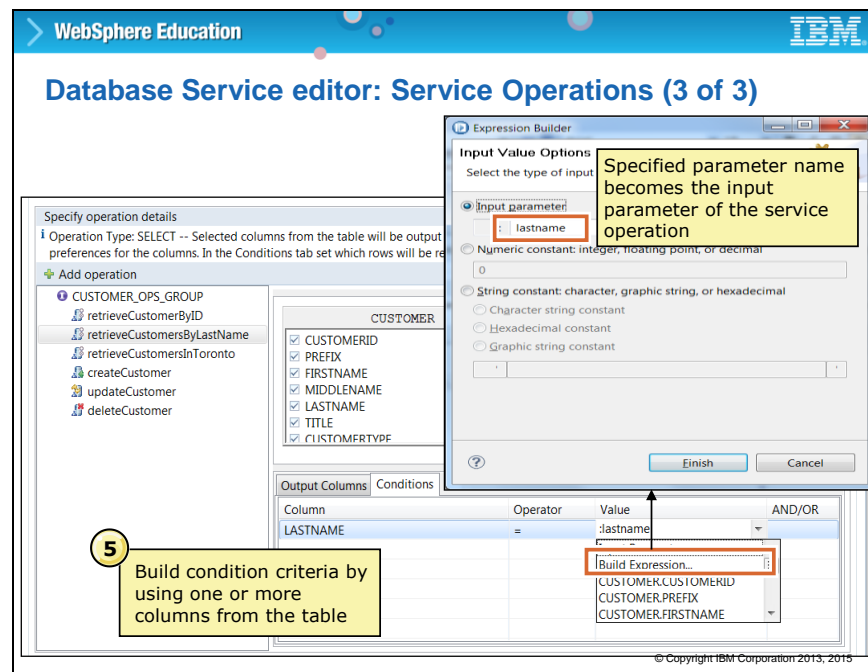
Columns	Sort Type	Sort Order
CUSTOMER.CUSTOMERID		
CUSTOMER.PREFIX		
CUSTOMER.FIRSTNAME	Ascending	2
CUSTOMER.MIDDLENAME		
CUSTOMER.LASTNAME	Ascending	1
CUSTOMER.TITLE		

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Database Service editor: Service Operations (2 of 3)

The next steps on the Service Operations panel are:

3. Select the operation.
4. Select the table columns that the service operation uses.




Database Service editor: Service Operations (3 of 3)

The next step is to define the operation conditions on the **Conditions** tab. For example, if the operation type is SELECT, specify the query condition to create a complete SELECT statement.

The value that you specify in the **Value** column becomes the input parameter of the service operation. When you click in the **Value** column, you have the option of selecting a column or starting the Expression Builder to help you build an expression.

You get practice defining a condition in lab exercise 5.

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Database query details

Specify operation details

Operation Type: SELECT -- Selected columns from the table will be output parameters of the operation preferences for the columns. In the Conditions tab set which rows will be returned.

Add operation

- CUSTOMER_OPS.GROUP
 - retrieveCustomerByID
 - retrieveCustomersByLastName
 - retrieveCustomersInToronto
 - createCustomer
 - updateCustomer
 - deleteCustomer

Expand, collapse, or resize any panes

```
SELECT CUSTOMERID, PREFIX, FIRSTNAME, MIDDLENAME, LASTNAME, TITLE,
CUSTOMERTYPE, OFFICEPHONENO, MOBILEPHONENO
FROM SAMPLE.CUSTOMER
WHERE LASTNAME = :lastname
ORDER BY LASTNAME ASC, FIRSTNAME ASC
```

SQL view

SQL view contains read-only view of the SQL that is generated based on selection of **Output Columns** and **Conditions**

By default, this view is collapsed

CUSTOMER

- ☒ CUSTOMERID
- ☒ PREFIX
- ☒ FIRSTNAME
- ☒ MIDDLENAME
- ☒ LASTNAME

Table view

Column	Operator	Value
LASTNAME	=	:lastname

Column selection and conditions

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Database query details

When you define an operation, you can open an SQL view pane that shows the SQL statement that this service operation sends to the database.

You cannot change the statement in the SQL view. If the statement is not correct, verify the columns that you selected and the conditions you included.

The next step for defining a database service is to define the service interface on the **Service Interface** panel.

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Database Service editor: Service Interface

Review the logical interfaces and operations created in this service

Interface

Name	CUSTOMER_OPS_GROUP
Namespace	http://MyDBService

Service port type name is identical to the operations group name
Service **Namespace** is derived from service name

Operations

Operation	Message
retrieveCustomerByID	
Input	retrieveCustomerByID
Output	retrieveCustomerByIDResponse
retrieveCustomersByLastName	
Input	retrieveCustomersByLastName
Output	retrieveCustomersByLastNameResponse
retrieveCustomersInToronto	
Input	retrieveCustomersInToronto

Click **Open file** to open the XSD schema file and review contents of request/response types for the operation

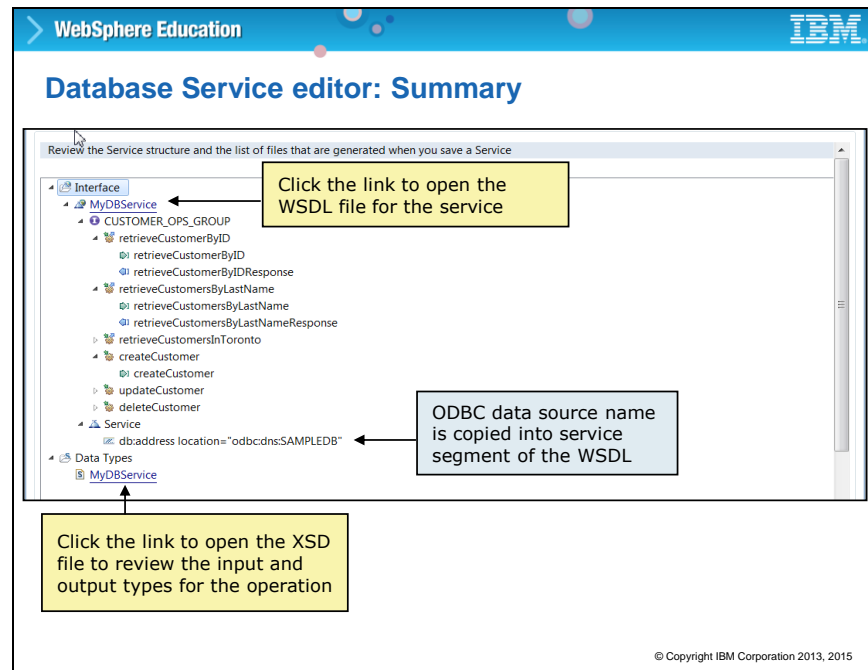
Database Service editor: Service Interface

The **Service Interface** panel contains two sections: **Interface** and **Operations**.

The **Interface** section contains the group name and the namespace. The service port type name in the WSDL is the same as the interface name. The namespace is derived from the service name.

The **Operations** section contains an entry for each operation that you create on the **Service Operations** panel. For any interface, you can click the **Open file** link to open the XML schema for the operation. If the database service is not saved, clicking **Open file** prompts you to save the service file, which generates the WSDL and XSD files for service.

The final panel in the Database Service editor contains a summary of the database service.




Database Service editor: Summary

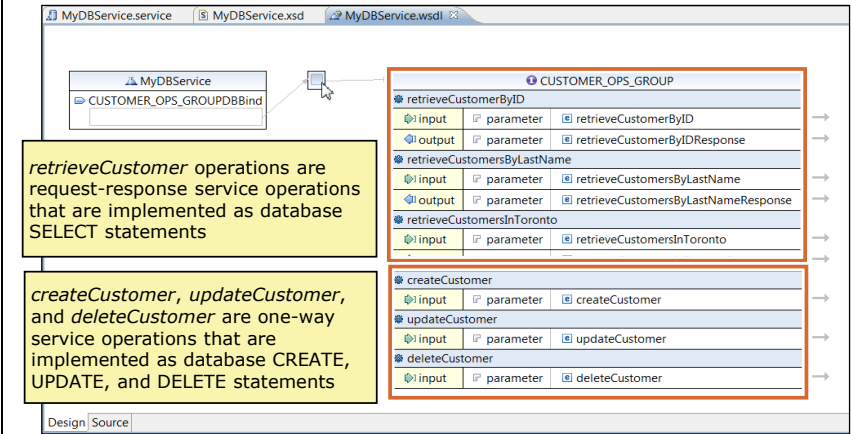
On the Database Service editor **Summary** page, you can review the service interface, which includes the operations and input and output message types.

You can click the service link to open the WSDL for the service. You can also click the link under the **Data Types** folder to open the XML schema file to review the input and output types for the operation.

The next slide contains an example of a database service WSDL file.

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Generated WSDL



retrieveCustomer operations are request-response service operations that are implemented as database SELECT statements

createCustomer, *updateCustomer*, and *deleteCustomer* are one-way service operations that are implemented as database CREATE, UPDATE, and DELETE statements

Design Source

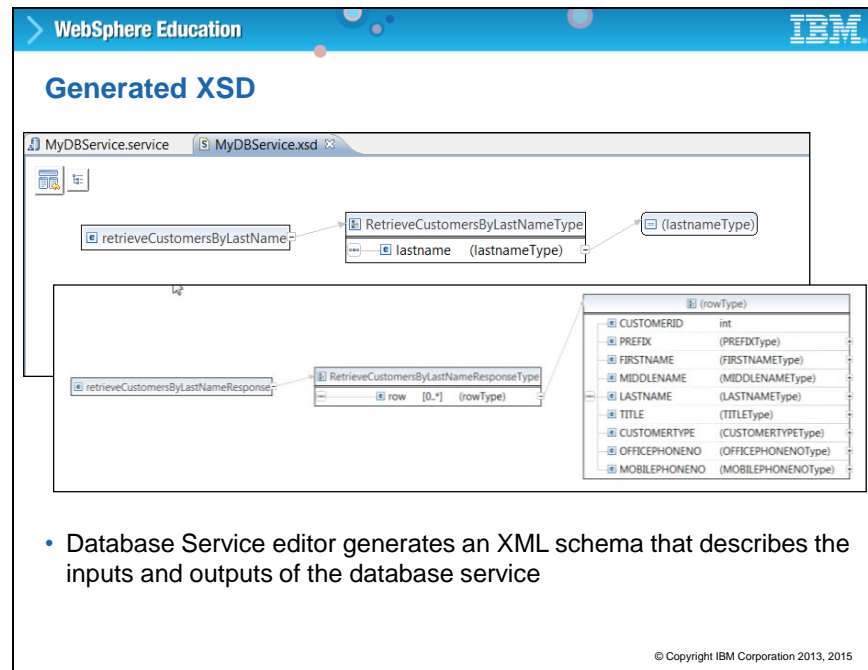
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Generated WSDL

You can view the WSDL in the Integration Toolkit.

The database service WSDL in this example contains six operations:

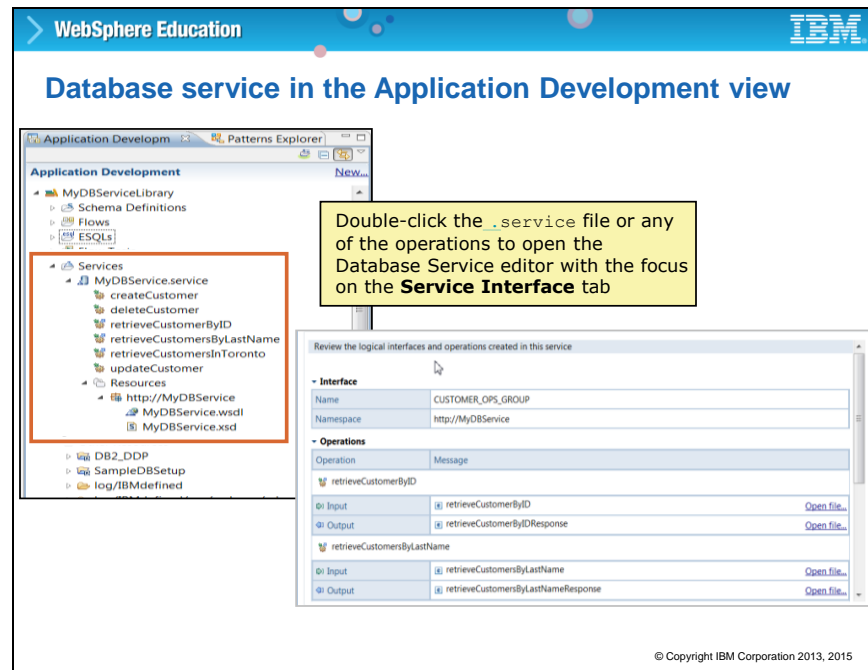
- **retrieveCustomerByID**, **retrieveCustomersByLastName**, and **retrieveCustomersInToronto** are request-response service operations that are implemented as database SELECTs.
- **createCustomer** is a one-way service operation that is implemented as a database CREATE.
- **updateCustomer** is a one-way service operation that is implemented as a database UPDATE.
- **deleteCustomer** is a one-way service operation that is implemented as a database DELETE.



Generated XSD

The Database Service editor also generates an XML schema that describes the inputs and outputs of the database service. You can open the schema file in the Toolkit by double-clicking the file in the **Application Development** view to review the input and output types for the operation. You can also click the link under the **Data Types** folder on the Database Service editor **Summary** panel to open the XML schema file.

This example shows the inputs and outputs for the **retrieveCustomerByLastName** and the **retrieveCustomersByLastNameResponse** operations.



Database service in the Application Development view

When you save the database service, the database service artifacts are added to the **Application Development** view.

A service file with a **.service** extension captures metadata that is used during the discovery process. The Integration Toolkit uses this file to store state information from the Database Service editor, and iteratively discovers previously discovered artifacts.

The service artifacts are added to the Application Development view under the **.service** file. The service artifacts include the operations, the WSDL that describes the service, and the XML schema definition file that describes the inputs and outputs of the database service.

You can open the Database Service editor and modify the service by double-clicking the **.service** file in the **Application Development** view.

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Calling a database service from a Compute node (1 of 2)

1 Drag database service from navigator to a Compute node

2 Select database operation for Compute node to call

- Adds PATH statement in the ESQL file for the Compute module
 - Makes the service operation visible
 - Enables content assist on the operation
- Generates ESQL implementation code for the service operation in the `<DBService>.ESQL` file in the library under the ESQL package `<DBService>.<PortType>`

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Calling a database service from a Compute node (1 of 2)

After you create the database service, you can use it to create the ESQL for a Compute node in a message flow.

1. Drag the database service (.service file) from the **Application Development** view onto the Compute node in the Message Flow editor. The Message Flow editor also supports a menu on the Compute node for selecting a database service.
2. Select the operation from the list of operations that are defined in the database service.

A compute module that is named `<DatabaseServiceName>.esql` is generated in the broker schema that is derived from the namespace of the service and port type of the database binding. This file is in the library that contains the .service file, and contains an ESQL procedure definition for each database operation selected.

The generated Compute module contains a PATH statement so that the database service can be called.

Next, is an example of the ESQL that the database service generates.

The diagram illustrates the process of calling a database service from a Compute node. It features a code snippet with three annotations:

- PATH statement:** Points to the line `PATH MyDBService.CUSTOMER_OPS_GROUP;`.
- Call database service operation as an ESQL function:** Points to the line `CALL retrieveCustomersByLastName(LASTNAME, dbResultSetRef);`.
- Output parameter:** Points to the line `dbResultSetRef REFERENCE TO dbResultSet;` with the text: "dbResultSetRef points to the first occurrence of the row of the result set returned from the database service operation".

The code snippet is as follows:

```

PATH MyDBService.CUSTOMER_OPS_GROUP;

DECLARE ns NAMESPACE 'http://MyDBService';

CREATE COMPUTE MODULE myFlow_GetCustomerInfo
CREATE FUNCTION Main() RETURNS BOOLEAN
BEGIN
    CALL CopyMessageHeaders();
    -- CALL CopyEntireMessage();

    DECLARE LASTNAME CHAR;
    SET LASTNAME = InputRoot.XMLNSC.ns:retrieveCustomersByLastName.LASTNAME;

    -- Call the database service operation retrieveCustomer in port type CUSTOMERGroup
    CALL retrieveCustomersByLastName(LASTNAME, dbResultSetRef);

    SET OutputRoot.XMLNSC.ns:retrieveCustomersByLastNameResponse = dbResultSetRef;

    RETURN TRUE;
END;

```

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Calling a database service from a Compute node (2 of 2)

The ESQL in this example calls the database service.

The PATH statement at the top of the ESQL module identifies the database service.

The CALL statement calls the database service operation. In this example, the operation is `retrieveCustomersByLastName`. The CALL statement includes an input parameter (LASTNAME), and an output parameter (dbResultSetRef).

The output parameter, dbResultSetRef, points to the first occurrence of the row of the result set that is returned from the database service operation.

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Generated ESQL code for service operation

```

myflow.msgflow  myflow_GetCustomerInfo.esql  *MyDBService.esql

/*****
 * Database Service operation retrieveCustomersByLastName:
 *
 * Data is returned through elements named 'row', created under INOUT parameter dbResultSetRef
 * of ESQL type ROW, containing:
 *   INTEGER CUSTOMERID
 *   VARCHAR PREFIX
 *   VARCHAR FIRSTNAME
 *   VARCHAR MIDDLENAME
 *   VARCHAR LASTNAME
 *   VARCHAR TITLE
 *   VARCHAR CUSTOMERTYPE
 *   VARCHAR OFFICEPHONENO
 *   VARCHAR MOBILEPHONENO
 *
 * Below is an example showing how to invoke the procedure for database service:
 *
 * -- Declare a location to hold the data returned from the database service call
 * DECLARE dbResultSet ROW;
 * DECLARE dbResultSetRef REFERENCE TO dbResultSet;
 *
 * -- Call the database service operation
 * CALL retrieveCustomersByLastName(lastname, dbResultSetRef);
 *
 * -- Get the result set data returned from database service call from rowRef
 * DECLARE rowRef REFERENCE TO dbResultSetRef.row;
 *****/

CREATE PROCEDURE retrieveCustomersByLastName(IN lastname CHARACTER, INOUT dbResultSetRef REFERENCE)
BEGIN
  SET dbResultSetRef.row[] = PASSTHRU (
    'SELECT CUSTOMERID, PREFIX, FIRSTNAME, MIDDLENAME, LASTNAME, TITLE, CUSTOMERTYPE,
     OFFICEPHONENO, MOBILEPHONENO FROM SAMPLE.CUSTOMER
     WHERE SAMPLE.CUSTOMER.LASTNAME = ?
     ORDER BY SAMPLE.CUSTOMER.LASTNAME ASC, SAMPLE.CUSTOMER.FIRSTNAME ASC'
    TO Database.SAMPLEDB VALUES (lastname));
END;

```

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Generated ESQL code for service operation

The ESQL code also contains an ESQL procedure that is based on the operation that you select when you drop the service onto the Compute node in the message flow.

The procedure that is shown in the example is the procedure that the ESQL in the previous slide calls. In the example, an ESQL procedure is created for a service operation that is named `retrieveCustomersByLastName`. The service operation determines the input and output parameters for the operation.

In this example, the generated ESQL uses the ESQL `PASSTHRU` for the `SELECT` statement because it contains `ORDER BY` clause, which ESQL does not support.

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Database service operation error handling

- Error handling is identical to standard practice for working with databases that use ESQL on Compute node
- Throw exception on database error** property
 - Errors from calling database service are raised as ESQL exceptions
 - Enabled by default
 - If not selected, then after calling the database service function, check for errors by using SQLCODE, SQLSTATE, SQLERRORTXT, and SQLNATIVEERROR

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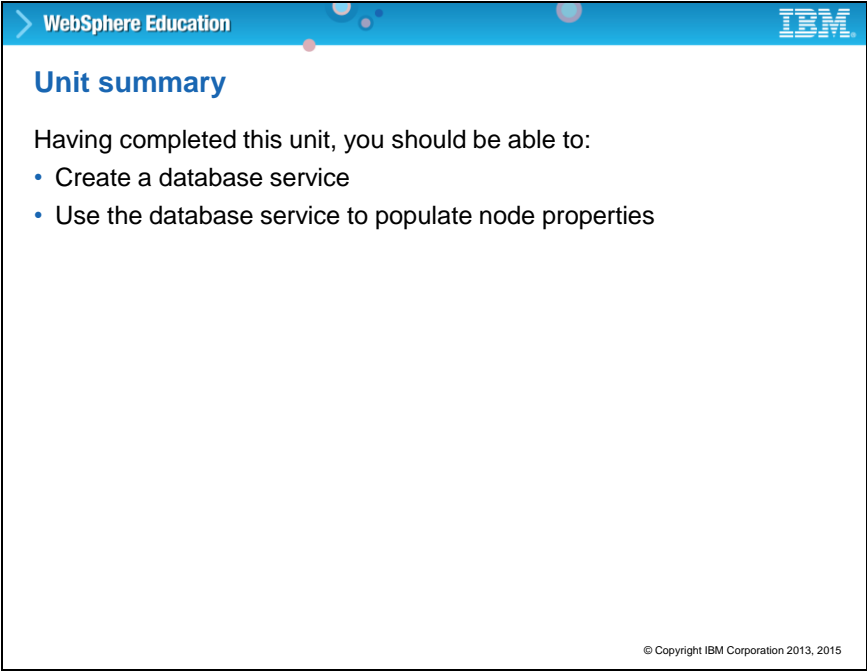
Database service operation error handling

Error handling for the database service is the same as when calling a database from any other node in a message flow.


One option is to add ESQL code to handle database errors that might occur when you call the generated procedure.

Another option is to use the option to **Throw exception on database error** on the Compute node properties, which is enabled by default.

Database error handling is described in detail in the prerequisite course *IBM Integration Bus V10 Application Development I*.



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Unit summary

Having completed this unit, you should be able to:

- Create a database service
- Use the database service to populate node properties

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Unit summary

An IBM Integration Bus database service defines the interaction between Integration Bus and a database, and can be used with a message flow node to automatically configure connectivity to that database. In this unit, you learned how to define and implement a database service.

Having completed this unit, you should be able to:

- Create a database service
- Use the database service to populate node properties