1. Overview

The extension library includes four types of REST services. You choose the type of REST service that meets your needs. This section introduces the different types of REST services. It also compares their capabilities to help you decide which type most applies to your needs.

The four types of REST services are as follows:

- The **Domino Data Service** is a built-in service that represents Domino data in JSON format. Once you install the extension library, you can begin using the data service without creating an XPage or adding any Java code to the Domino server.

- The **XPages REST Services Control** is a component you add to an XPage. Often you add other controls to the page that directly reference the REST Services control. For example, a Dojo Data Grid can reference a REST Services control on the same page. Once you save the page, the service also becomes available outside the page through a well-known URL. Depending on how you configure the control, the service represents data in JSON or XML format.

- A **Custom Database Servlet** is a Java class you add to a database design. The servlet handles incoming HTTP requests usually by delegating to one of the REST service classes in the extension library. This type of REST service requires detailed knowledge of the Java programming language, but you have complete control over the definition of the service.

- A **Custom Wink Service** is the most advanced type of REST service. You use the open source Apache Wink project to define your service. Your servlet is contained in a plug-in that is deployed directly to Domino’s OSGi framework. This means your service is not tied to a single database. It can access any data you choose and represent it in any format you choose.

See Table 1.1 for a side-by-side comparison of the four types of REST services. See sections 2 through 5 for detailed descriptions of each type.
## Table 1.1 Comparison of extension library REST services

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<td>Control</td>
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<td>Databases, views, documents, etc.</td>
<td></td>
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<tr>
<td>Custom Database</td>
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<tr>
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<td>Databases, views, documents, etc.</td>
<td></td>
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</tr>
<tr>
<td>Custom Wink Service</td>
<td>OSGi plug-in</td>
<td>OSGi framework</td>
<td>Any format you choose</td>
<td>You create the OSGi plug-in and add it to the Domino OSGi framework.</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
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</tbody>
</table>
2. Domino Data Service

The Domino Data Service is now included in the XPages Extension Library. It represents the Domino object model (databases, views, view entries and documents) in JSON format. The data service lets you send HTTP requests to:

- Read the list of databases on the server.
- Read the list of views and folders in a database.
- Read the design of a view or folder.
- Read the entries in a view or folder.
- Create, read, update and delete documents.

The data service requires Domino 8.5.3 (or greater). The data service is bundled with Domino 8.5.3 Upgrade Pack 1.

The following sections help you get started with the data service. For more information please see the Domino Data Service documentation included with the extension library.

NOTE: If you are using 8.5.3 Upgrade Pack 1, you can find the data service documentation here:


Also note there have been changes to the data service since 8.5.3 UP1. If you are using a recent version of the extension library from OpenNTF, you can find updated documentation here:

http://www.openntf.org/internal/home.nsf/documentation.xsp?databaseName=CN=Notes OSS2/O=NotesOSS!!projects\pmt.nsf&documentId=7F08DF36A6B3240386257AC6004C5B13&action=openDocument

2.1 Enabling the Data Service

2.1.1 Enabling the Data Service on a Server

After you install the extension library, the data service is loaded whenever the Domino HTTP task is started. However, an administrator typically doesn’t want the data service to handle requests on every Domino server. You need to deliberately enable the data service in the appropriate Internet Site document.

To enable the data service:

1. Use a Notes client to open the server’s public address book.
3. Open the Internet Site document for your server.
4. Click the Edit Web Site action.
5. Select the Configuration tab.
6. At the bottom of the form, look for a section labeled Domino Access Services.
7. In the Enabled services field, add the Data keyword:
8. Save your changes and restart the HTTP task.

NOTE: The above instructions assume you are using Internet Sites. If you are not using Internet Sites, you can enable the data service in the server document. See the Domino Data Service documentation for more information.

2.1.2 Enabling the Data Service for a Database

By default, the data service does not have access to each database. Just as you need to enable the data service for a server, you also need to deliberately enable the data service for a database.

To enable the data service for a database:

1. Use the Notes client to open the database.
3. Click on the Advanced tab.
4. At the bottom of the properties box, look for a field labeled “Allow Domino Data Service”. Change the field to “Views and documents”. See Figure 2.1.
5. Close the Database properties box.

![Database Properties Box](image)

**Figure 2.1** Database Properties Box

### 2.1.3 Enabling the Data Service for a View or Folder

By default, the data service does not have access to each view in a database. You need to deliberately enable the data service for a view or folder.

To enable the data service for a view or folder:

1. Use Domino Designer to open the database.
2. Open the view or folder.
3. Press Alt-Enter to display the View properties box.
4. Select the Advanced tab.
5. Look for the checkbox labeled “Allow Domino Data Service operations”. Check the box as shown in Figure 2.2.
6. Close the View properties box.

![View Properties Box](image)

**Figure 2.2 View Properties Box**

### 2.2 Database Collection Resource

To get the list of databases on a server you send an HTTP GET request to the database collection resource URI:

```
http://{host}/api/data
```

The data service returns a response in JSON format like this:

```
[
  {
    "@title": "Administration Requests",
    "@filepath": "Admin4.nsf",
    "@replicaid": "852573910361A2F4",
    "@template": "StdR4AdminRequests",
    "@href": "http:\/\/xyz.com:80\/admin4.nsf\/api\/data\/collections"
  },
  {
    "@title": "Java AgentRunner",
    "@filepath": "AgentRunner.nsf",
    "@replicaid": "8525671400725208",
    "@template": "",
    "@href": "http:\/\/xyz.com:80\/AgentRunner.nsf\/api\/data\/collections"
  },
  ...
]```
In other words, the response is an array of objects. Each object represents a database. For example:

- the @title property corresponds to the title of the database
- the @filepath property corresponds to the location of the database (relative to the Domino data directory)
- the @href property is the URI for the database’s view collection resource

2.3 View Collection Resource

To get the list of views and folders in a database, you send an HTTP GET request to the view collection resource URI:

http://{host}/{database}/api/data/collections

The data service returns a response in JSON format like this:

```json
[
  {
    "@title": "",
    "@folder": false,
    "@private": false,
    "@modified": "2011-04-29T13:02:19Z",
    "@unid": "45DF1A4D8B8C1027852578650065F565",
    "@href": "http:\/\/xyz.com:80\/xpagesext.nsf\/api\/data\/collections\/unid\/45DF1A4D8B8C1027852578650065F565"
  },
  {
    "@title": "TestCalendarOutline",
    "@folder": false,
    "@private": false,
    "@modified": "2011-04-29T13:02:20Z",
    "@unid": "F598C2D31E4E12F68525786500660B7E",
    "@href": "http:\/\/xyz.com:80\/xpagesext.nsf\/api\/data\/collections\/unid\/F598C2D31E4E12F68525786500660B7E"
  },
  ...
  {
    "@title": "AllContacts",
    "@folder": false,
    "@private": false,
    "@modified": "2011-04-29T13:02:20Z",
    "@unid": "CD40A953ABDE036A8525786500660C27",
    "@href": "http:\/\/xyz.com:80\/xpagesext.nsf\/api\/data\/collections\/unid\/CD40A953ABDE036A8525786500660C27"
  },
  {
    "@title": "Folder2",
    "@folder": true,
    "@private": false,
    "@modified": "2011-04-29T13:02:20Z",
    "@unid": "7B53FDDEE90C5E918525786500660E03",
    ...
]
```
The response is an array of objects. Each object represents either a view or a folder. For example:

- the @title property corresponds to the title of the view (or folder)
- the @folder property is true only for folders
- the @unid property correspond to the universal identifier for the view (or folder).

**NOTE:** The example above lists the views and folders in the XPages Extension Library sample database. This database is included with the extension library. The remaining examples are from the same database, but the data service works for other databases including mail files, team rooms, and so on.

### 2.4 View Design Resource

To read the design of a view or folder, you send an HTTP GET request to the view design resource URI:

```
http://{host}/{database}/api/data/collections/unid/{unid}/design
```

For example, the following URI corresponds to the AllContacts view in the extension library sample database:

```
http://xyz.com/xpagesext.nsf/api/data/collections/unid/CD40A953ABDE036A8525786500660C27/design
```

The data service returns a response in JSON format like this:

```
[
  {
    "@columnName":1,
    "@name":"$0",
    "@title":"#",
    "@width":4,
    "@alignment":0,
    "@hidden":false,
    "@response":false,
    "@twistie":false,
    "@field":false,
    "@category":false
  },
  {
    "@columnName":2,
    "@name":"Id",
    "@title":"Id",
    "@width":10,
    "@alignment":0,
    "@hidden":false,
  }
]
```
The response is an array of objects where each object represents a view column. For example:

- the @name property is the programmatic column name
- the @title property is the title displayed in the column header
- @width is the width of the column
- @field is true only if the column refers to a field on the corresponding document. It is false for computed values.

**NOTE**: This guide uses the UNID format of the view design resource URI. You may find it easier to use the name format instead. For example, you can send a GET request to:

http://xyz.com/xpagesext.nsf/api/data/collections/name/AllContacts/design

The response is the same as shown above.

### 2.5 View Entry Collection Resource

To get a list of entries in a view or folder, you send an HTTP GET request to the view entry collection resource URI:

http://{host}/{database}/api/data/collections/unid/{unid}

For example, the following URI corresponds to the AllContacts view in the extension library sample database:


The data service returns a response in JSON format like this:

```json
[
{
"@href":"http://xyz.com:80/xpagesext.nsf/api/data/collections/unid/CD40A953ABDE036A8525786500660C27/unid/AAE5C9A07AF9C1A7852578760048C0D6",
"@link":{
"rel":"document",

"href":"http://xyz.com:80/xpagesext.nsf/api/data/documents/unid/AAE5C9A07AF9C1A7852578760048C0D6"
},
"@entryid":"1-AAE5C9A07AF9C1A7852578760048C0D6",
```
The response is an array of objects where each object represents a view entry. For example:

- the `@href` property is the URI for this view entry
- the `@link` property represents the URI for the corresponding document
- the `@unid` property is the universal identifier for the document
- Id, FirstName, LastName, etc. correspond to column values. The exact set of properties will depend on the specific view design.

NOTE: This guide uses the UNID format of the view entry collection resource URI. You may find it easier to use the name format instead. For example, you can send a GET request to:

```plaintext
http://xyz.com/xpagesext.nsf/api/data/collections/name/AllContacts
```

The response is the same as shown above.

When you get view entries, the response also includes a Content-Range header indicating how many entries are included. For example:

```plaintext
Content-Range: items 0-9/201
```
This header indicates the data service returned entries 0 through 9 from a total of 201 entries. To get the next 10 entries, you send a GET request with additional URL parameters:


In this example, the ps parameter specifies the page size and the page parameter specifies which page to get. In this case, you want to get the second page (page numbers are zero-based). The data service returns the second page of data and a new Content-Range header like this:

Content-Range: items 10-19/201

2.6 Document Resource

2.6.1 Reading a Document

To read a single document, you send an HTTP GET request to the document resource URI:

http://{host}/{database}/api/data/documents/unid/{unid}

NOTE: You can get a document resource URI from a view entry collection resource (see section 2.5).

The data service returns a response in JSON format like this:

```
{
  '@href': 'http://xyz.com:80/xpagesext.nsf/api/data/documents/unid/AAE5C9A07AF9C1A7852578760048C0D6',
  '@unid': 'AAE5C9A07AF9C1A7852578760048C0D6',
  '@noteid': '9AA',
  '@modified': '2011-04-18T13:14:40Z',
  '@form': 'Contact',
  'Id': 'CN=Adela Rojas\O=renovations",
  'FirstName': 'Adela',
  'LastName': 'Rojas',
  'City': 'Paterson',
  'State': 'NJ',
  'EMail': 'adela_rojas@renovations.com'
}
```

The response is a single object representing the document. For example:

- @href is the document resource URI
- @unid is the universal identifier for the document
- @form is the name of the form used to create the document
- Id, FirstName, LastName, etc. correspond to items in the document. The exact set of items usually depends on the form used to create the document. Also, the set of items is usually different than the set of columns in a corresponding view entry.

2.6.2 Updating a Document

You can also use the data service to update a document. To do so, you send a PUT request to the document resource URI. When sending a PUT request, you must include a Content-Type header as shown below:
The above request changes Adela Rojas’s city from Paterson to Newark. If the data service completes the request without errors, it returns an HTTP status code of 200 without a response body.

NOTE: When sending a PUT request, you don’t need to include any “@ properties” like @unid and @href. These properties are considered metadata. The data service ignores any attempt to update metadata.

Usually when you update a document, you want to execute the business logic contained in a specific form. To do so, you send a PUT request with additional URL parameters:

http://xyz.com/xpagesext.nsf/api/data/documents/unid/AAE5C9A07AF9C1A7852578760048C0D6?form=Contact&computewithform=true

In this example, the form parameter specifies the Contact form and the computewithform parameter is true, instructing the data service to execute the Contact form’s business logic.

### 2.6.3 Deleting a Document

To delete a document, you send an HTTP DELETE request to the document resource URI. If the data service deletes the document without errors, it returns an HTTP status code of 200.

### 2.7 Document Collection Resource

To create a new document, you send an HTTP POST request to the document collection resource URI:

http://{host}/{database}/api/data/documents

When sending a POST request, you must include a Content-Type header as shown below:

```json
Content-Type: application/json
{
   "FirstName":"Bob",
   "LastName":"Dylan",
   "City":"Hibbing",
   "State":"MN",
   "EMail":"bdylan@renovations.com"
}
```

If the data service is able to create the document without errors, it returns an HTTP status code of 201. The response also includes a Location header identifying the URI of the new document resource:

```
Location: http://xyz.com/.../api/data/documents/unid/3249435909DCD22F852578A70063E8E5
```
Usually when you create a new document you want to execute the business logic contained in a specific form. To do so, you send a POST request with additional URL parameters. For example:


See section 2.6.2 for more information on the form and computewithform parameters.

Sometimes you want to create a document that is a response to another document. To do this, you send a POST request with a parentid parameter. For example:


If you POST a request to the above URI, the data service creates a response to the document with an UNID of 440FA99B2F0F839E852578760048C1AD.

2.8 Troubleshooting the Data Service

The following sections list some common error conditions you might encounter. To help you troubleshoot the problem, each error condition is accompanied by one or more possible causes.

2.8.1 Bad Request

You send a request to a resource and the data service responds with an HTTP status code of 400 (Bad Request). Usually this is caused by a bad URL parameter or, in the case of a POST or PUT, a poorly formatted request body. For example, consider a GET request to this URI:


The data service responds with a status code of 400 because page=x is invalid. Often the response body includes details about the error condition:

```json
{
    "code":400,
    "text":"Bad Request",
    "message":"Invalid parameter page: x",
    "type":"text",
    "data":"java.lang.Exception: Invalid parameter page: x ...
}
```

2.8.2 Unauthorized

You send a request to a resource and the data service returns an HTTP status code of 401 (Unauthorized). This usually occurs for one of two reasons:

1. You are sending an anonymous request (no user credentials) to a protected resource. In this case, you can correct the problem by supplying the appropriate user credentials with each request. The Domino server supports both basic authentication (HTTP Authorization header) and session authentication. See the appropriate Domino web server documentation for more about these authentication schemes.

2. The authenticated user has insufficient access to the resource. In this case, you can correct the problem by changing the access control list (ACL) for the database.
A response body in HTML format usually accompanies an HTTP status code of 401. The response body may help you troubleshoot the error:

```html
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">
<html>
<head>
<title>Error</title></head>
<body text="#000000">
<h1>Error 401</h1>You are not authorized to perform this operation</body>
</html>
```

### 2.8.3 Forbidden
You send a request to a resource and the data service returns an HTTP status code of 403 (Forbidden). There can be many causes for this error:

- The data service could be disabled for this server. See section 2.1.1 for instructions for enabling the data service on a server.
- The data service could be disabled for this database. See section 2.1.2 for instructions for enabling the data service for a database.
- The data service could be disabled for this view (or folder). See section 2.1.3 for instructions for enabling the data service for a view.

### 2.8.4 Resource Not Found
You send a request to a resource and the data service returns an HTTP status code of 404 (Not Found). This can be caused by an improperly formatted URI. For example, the following two URIs are incorrect:

- `http://xyz.com/xpagesext.nsf/api/data/collection/name/AllContacts`
- `http://xyz.com/xpagesext.nsf/api/data/collections/unid/AllContacts`

The first URI is wrong because the collection path element should be plural (collections). The second URI is wrong because AllContacts is not a valid UNID.

Often, the data service will include additional details in the response body. For example, this response indicates the data service cannot find the specified view:

```json
{
"code":404,
"text":"Not Found",
"message":"The URI must refer to an existing view."
}
```

If you have checked the URI syntax and the Domino web engine is still returning an HTTP status code of 404, you should verify the data service plug-ins are active in the OSGI runtime of the Domino server. From the Domino server console, type the following command

```
> tell http osgi ss
```

The response will be a list of OSGI plug-ins and their status. Verify that the following plug-ins are included:

- `com.ibm.domino.das_8.5.3.yyyymmdd-hHmm.jar`
- `com.ibm.domino.services_8.5.3.yyyymmdd-hHmm.jar`
com.ibm.wink_8.5.3.yyyymmdd-hhmm.jar

If these plug-ins are not included, the data service has not been installed correctly on the Domino server. Please see the extension library installation procedure.

**2.8.5 Could Not Connect**

You send a request to a resource and the message "Error: Could not connect to server" is returned. Confirm the HTTP task is running on the Domino server. From the Domino server console enter the command:

```
> show tasks
```

Confirm the following line appears:

```
HTTP Server       Listen for connect requests on TCP Port:80
```

Please see the Domino Web Server documentation for additional information about troubleshooting HTTP connection problems.

**2.8.6 Internal Server Error**

You send a request to a resource and the data service returns an HTTP status code of 500 (Internal Server Error). This should happen very rarely, if at all. As described in the previous sections, the data service is designed to respond with status codes that help you pinpoint the cause of the problem. An HTTP status code of 500 could be caused by a software defect. Please report these errors to IBM.
3. XPages REST Services Control

3.1 Accessing Domino Data Service from XPages REST Services Control.

As stated previously, all the Domino Data Services resources can be accessed from the XPages REST Services Control. The data is exposed using the `pathinfo` property of the REST services control. From the REST Services Control you can select one of many services including the following data services:

- `xe:databaseCollectionJsonService` - Read the list of databases on the server.
- `xe:viewCollectionJsonService` - Read the list of views and folders in a database.
- `xe: viewJsonService` - Read the design of a view or folder.
- `xe: viewJsonService` - Read the entries in a view or folder.
- `xe:documentJsonService` - Create, read, update and delete documents.

![ViewJsonService Parameters](image)

**Figure 3.1.1 ViewJsonService Parameters**
Depending on the REST Services Control you select you will receive additional properties that map to the parameters supported by the service as documented in Section 2. For example, the Form field can be set as a URL parameter **form** or a property **formName** (see Figure 3.1.1). In most cases the name of the service property matches the parameter.

### 3.2 Tutorial

In this section we will walk through the steps on how to build and reference an XPage that uses the REST Services Control to access the Domino Data Services. In this tutorial we will access the same resource described in Section 2.2 Database Collection Resource.

1. Use Domino Designer to open a database or create a new database.
2. From the menu in Domino Designer select Create > Design > XPage.
3. In the New XPage dialog enter “MyXPage” for the Name field as shown in Figure 3.2.1.

![New XPage](image)

**Figure 3.2.1**

4. From the menu in Domino Designer select Create > Extension Library > Rest Services
5. Select the Rest Services control as shown in Figure 3.2.2.

![REST](image)

**Figure 3.2.2**
6. From the Properties tab select All Properties and enter “myPathInfo” for the pathInfo property as shown in Figure 3.2.3.

![Figure 3.2.3](image)

7. From the Properties tab select All Properties and select “xe:databaseCollectionJsonService” for the service property as shown in Figure 3.2.4.

![Figure 3.2.4](image)

8. From the menu in Domino Designer select File > Save (Ctrl+S).
9. (Optional) You can now view the source code in the XPage.
10. From a browser enter the URL:  

11. The response in JSON will look similar to the response described in Section 2.2 Database Collection Resource.

### 3.3 Domino Data Service from XPages Samples and Additional Documentation

Another good resource is the sample database “XPagesExt.nsf“ that is included with the XPages Extension Library. This sample application called XPages Extension Library Demo includes a REST tab that has several samples that demonstrate the REST Data Service.
3.3.1 Data Services Sample Page

This page contains an example that demonstrates all the Domino Data REST Services. A button is used to launch a URL that references each REST Services control as shown in Figure 3.3.2.

3.3.2 Dojo Grid Sample Page

This page contains an example that demonstrates a Dojo Data Grid referencing a REST Services control on the same page as shown in Figure 3.3.3. The REST Services control uses xe:viewJsonService to access the “AllContacts” view. The data in the grid can be updated and then saved back to the database.
Figure 3.3.3 Dojo Grid Sample Page

3.3.3 XPages REST Control Design Pattern

You can find additional information on the design pattern in section “Separating UI and data using complex types” in XPages Extension Library Documentation.
4. Custom Database Servlet

A custom database servlet is a set of Java classes you add to a Notes database. These classes handle HTTP requests for a URL in the following format:

http://{host}/{database}/xsp/services/{servicepath}

You can add more than one logical service to a single custom servlet. Each service class has a unique URL because each class is bound to a different {servicepath} segment.

You have complete control over how your custom servlet handles HTTP requests. However, the easiest way to get started is to delegate HTTP requests to one of the REST service classes included in the extension library. These are the same classes used by the REST services control described in section 3. For example, you can use RestViewJsonService to quickly build a service that handles RESTful requests for a particular view. Unlike the REST services control, you don’t have to create an XPage to build a service, but you do need to understand Java.

4.1 Adding a Custom Servlet to a Database

Let’s assume you have an existing application you would like to access via a REST service. You could enable the Domino Data Service (section 2), but you want to customize some of the responses. The REST services control (section 3) is a more customizable option, but you don’t necessarily want to create an XPage just to create a REST service. If you are already familiar with Java, a custom database servlet is probably the best fit.

This section includes the steps required to add a custom servlet to an existing database. The example is an application called Store.nsf. The database includes a Products view that lists all of the products in the store. You want to access the Products view with a custom REST service.

1. Open the database in Domino Designer.
2. In the navigator on the left, find the Application Properties element for the database. Double click to open Application Properties.
3. In the XPage Libraries section of the Advanced Properties tab, enable com.ibm.xsp.extlib.library as shown below:

4. Save the Application Properties design element.
5. Open the Eclipse package explorer (Window – Show Eclipse Views – Package Explorer). You should see your database’s design elements in the package explorer like this:
6. Create a new Java source folder. For example, right click on the database and select New – Other – Java – Source Folder. In the New Source Folder dialog, add “Java” to the Folder name box and click Finish.
7. Add a new package to the Java source folder. For example, right click on the Java folder and select New – Other – Java – Package. In the New Java Package dialog, enter a package name and click Finish.
8. Add a ServletFactory class to the new package. For example, right click on the package and select New – Other – Java – Class. In the New Java Class dialog, enter the following in the Name box:

ServletFactory

Enter the following in the Superclass box:

com.ibm.extlib.services.servlet.DefaultServletFactory

Then click Finish.

9. Replace the contents of ServletFactory.java with the code from Source Listing 4.1. We’ll explain the Java code later. For now, just note the following line assumes your database includes a view called Products:

```java
p.setPageName("Products");
```

If you would like to use a different view, change the code accordingly.

10. Register the servlet factory with XPages. To do this, add a file named com.ibm.xsp.adapter.ServletFactory to a folder named META-INF\services. The
contents of the file should be as shown in Source Listing 4.2. When you are done the project should look like this:

```
[
  {
    "@entryid": "1-F73088139B943195852578B20066F538",
    "@unid": "F73088139B943195852578B20066F538",
    "@noteid": "8FA",
    "@position": "1",
    "@read": true,
    "@siblings": 3,
    "@form": "Product",
    "ProductName": "GT-2160",
    "Company": "Asics",
    "ProductPrice": "$89.99"
  },
  {
```

At this point you can test your servlet. The easiest way to do this is to use a browser to send an HTTP GET request to the servlet URL. Type the following URL into your browser’s address bar:

```
http://{host}/Store.nsf/xsp/services/Products
```

Your service should return a response like this:

```
[
  {
    "@entryid": "1-F73088139B943195852578B20066F538",
    "@unid": "F73088139B943195852578B20066F538",
    "@noteid": "8FA",
    "@position": "1",
    "@read": true,
    "@siblings": 3,
    "@form": "Product",
    "ProductName": "GT-2160",
    "Company": "Asics",
    "ProductPrice": "$89.99"
```
Of course the exact response depends on the design and contents of the Products view in your database.
Source Listing 4.1. ServletFactory.java

```java
package com.sample.service;

import javax.servlet.ServletException;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import com.ibm.domino.services.ServiceEngine;
import com.ibm.domino.services.rest.das.view.RestViewJsonService;
import com.ibm.domino.services.rest.das.view.impl.DefaultViewParameters;
import com.ibm.xsp.extlib.services.servlet.DefaultServiceFactory;
import com.ibm.xsp.extlib.services.servlet.ServiceFactory;

public class ServletFactory extends DefaultServletFactory {

    private static ServiceFactory createFactory() {
        DefaultServiceFactory factory = new DefaultServiceFactory();
        factory.addFactory("Products", new ServiceFactory() {
            public ServiceEngine createEngine(HttpServletRequest httpRequest,
                HttpServletResponse httpResponse) throws ServletException {
                DefaultViewParameters p = new DefaultViewParameters();
                p.setViewName("Products");
                p.setGlobalValues(DefaultViewParameters.GLOBAL_ALL);
                p.setSystemColumns(DefaultViewParameters.SYSCOL_ALL);
                p.setDefaultColumns(true);
                // Set the default parameters
                p.setStart(0);
                p.setCount(4);
                return new RestViewJsonService(httpRequest, httpResponse, p);
            }
        });
        return factory;
    }

    public ServletFactory() {
        super("services","Extension Library Services Servlet",createFactory());
    }
}
```

Source Listing 4.2. com.ibm.xsp.adapter.servletFactory

```java
com.sample.service.ServletFactory
```

4.2 Explanation of Sample Code

As shown in the preceding sample code (listings 4.1 and 4.2), a custom database servlet requires multiple Java classes. It requires a servlet factory, usually a subclass of com.ibm.xsp.extlib.services.servlet.DefaultServletFactory. It requires a service factory, in this case an instance of com.ibm.xsp.extlib.services.servlet.DefaultServiceFactory, and it requires an instance of com.ibm.domino.services.ServiceEngine. Each of these classes has a distinct purpose and lifecycle.

You register your servlet factory by adding a line to the com.ibm.xsp.adapter.servletFactory file as shown in listing 4.2. Your servlet factory is created just once for multiple HTTP requests. In
our example, the servlet factory constructor calls the createFactory method to create and initialize an instance of DefaultServiceFactory. The servlet factory passes the service factory to its super constructor.

Take a closer look at the createFactory method in listing 4.1. After creating an instance of DefaultServiceFactory, it calls the addFactory method to add an anonymous instance of ServiceFactory. This anonymous class must override the createEngine method, which is called every time the extension library receives an HTTP request for your servlet. In our example, the createEngine method simply delegates to RestViewJsonService. In other words, all HTTP requests are handled by RestViewJsonService.

Now let’s imagine you want to access another view— for example, a view named Vendors— with the same servlet. To do this you can change createFactory to call addFactory a second time. The following code would add a Vendors service to the same servlet:

```java
factory.addFactory("Vendors", new ServiceFactory() {
  public ServiceEngine createEngine(HttpServletRequest httpRequest,
  HttpServletResponse httpResponse) throws ServletException {
    DefaultViewParameters p = new DefaultViewParameters();
    p.setViewName("Vendors");
    p.setGlobalValues(DefaultViewParameters.GLOBAL_ALL);
    p.setSystemColumns(DefaultViewParameters.SYSCOL_ALL);
    p.setDefaultColumns(true);
    // Set the default parameters
    p.setStart(0);
    p.setCount(4);
    return new RestViewJsonService(httpRequest, httpResponse, p);
  }
});
```

In other words, you can create one custom servlet that contains more than one logical service. Each service has its own path as defined by the first parameter of the addFactory method.

### 4.3 Customizing the Service

Until now our custom database servlet just uses RestViewJsonService to handle HTTP requests. When you send a GET request to the service URL, the response is determined completely by the implementation of RestViewJsonService. This section provides some examples of how you can customize a service. The examples all use RestViewJsonService, but the same principles apply to other subclasses of RestServiceEngine including:

- RestDatabaseCollectionJsonService
- RestDocumentJsonService
- RestViewCollectionJsonService

The simplest way to customize RestViewJsonService is to modify the parameters used to initialize the service. For example, listing 4.1 includes this line:

```java
p.setSystemColumns(_DefaultViewParameters.SYSCOL_ALL);
```

This tells the service to emit all system columns including UNID, note ID, position, read mark, etc. for each entry in the view. An example of an entry with all system columns is as follows:

```json
{
  "@entryid":"1-F73088139B943195852578B20066F538",
  "@unid":"F73088139B943195852578B20066F538",
  "@noteid":"8FA",
```
You can reduce the number of system columns, by changing the input to setSystemColumns().
For example, the following line tells the service to just include UNID and position:

```java
p.setSystemColumns(DefaultViewParameters.SYSCOL_UNID |
                    DefaultViewParameters.SYSCOL_POSITION);
```

After making this change to the code in listing 4.1, your service formats each entry like this:

```json
{
   "@entryid":"1-F73088139B43195852578B200666F538",
   "@unid":"F73088139B43195852578B200666F538",
   "@position":"1",
   "ProductName":"GT-2160",
   "Company":"Asics",
   "ProductPrice":"$89.99"
}
```

Another way to customize your view service is to add one or more columns to each entry. Let’s say all products from one manufacturer are on sale. You want to indicate which products are on sale in the service response. To do this, you create a list of RestViewColumn objects (in this case there is just one object in the list). Then you use DefaultViewParameters.setColumns() to add the column list to the service.

The following changes to createFactory are an example:

```java
private static ServiceFactory createFactory() {
    DefaultServiceFactory factory = new DefaultServiceFactory();

    final List<RestViewColumn> customColumns = Arrays.asList(new DefaultViewColumn("onsale") {  
        @Override
        public Object evaluate(RestViewService service, RestViewEntry entry) throws ServiceException {
            String company = entry.getColumnValue("Company").toString();
            Boolean v = null;
            if ("Asics".equals(company)) {
                v = new Boolean(true);
            } else {
                v = new Boolean(false);
            }
            return v;
        }
    });

    factory.addFactory("Products", new ServiceFactory() {
        public ServiceEngine createEngine(HttpServletRequest httpRequest, HttpServletResponse httpResponse) throws ServletException {
            DefaultViewParameters p = new DefaultViewParameters();
            p.setViewName("Products");
            p.setGlobalValues(DefaultViewParameters.GLOBAL_ALL);
            p.setSystemColumns(DefaultViewParameters.SYSCOL_UNID | 
                                DefaultViewParameters.SYSCOL_POSITION);
            p.setColumns(true);
            p.setColumns(customColumns);
    });
```
The above changes produce the following response. Notice the new onsale property for each view entry:

```
[
  {
    "@entryid":"1-F73088139B943195852578B20066F538",
    "@unid":"F73088139B943195852578B20066F538",
    "@position":"1",
    "ProductName":"GT-2160",
    "Company":"Asics",
    "ProductPrice":"$89.99",
    "onsale":true
  },
  {
    "@entryid":"2-95D7A6F090DF96F7852578B2006DB6E2",
    "@unid":"95D7A6F090DF96F7852578B2006DB6E2",
    "@position":"2",
    "ProductName":"ProGrid Ride",
    "Company":"Saucony",
    "ProductPrice":"$89.99",
    "onsale":false
  },
  {
    "@entryid":"3-95B3CA2BDEE839FF852578B2006E92D",
    "@unid":"95B3CA2BDEE839FF852578B2006E92D",
    "@position":"3",
    "ProductName":"Wave Rider",
    "Company":"Mizuno",
    "ProductPrice":"$89.99",
    "onsale":false
  }
]
```

The most advanced way to customize your service is to subclass one of the JSON content classes included with the extension library. To do this you must first understand that each of the REST service classes delegates some of its work to a JSON content class. For example:

- `RestViewJsonService` delegates to `JsonViewEntryCollectionContent`.
- `RestDatabaseCollectionJsonService` delegates to `JsonDatabaseCollectionContent`.
- `RestDocumentJsonService` delegates to `JsonDocumentContent`.

Therefore you can customize your service by subclassing one of the JSON content classes and overriding one or more methods. As a trivial example you can make all JSON property names lower case by subclassing `JsonViewEntryCollectionContent`. Source listing 4.3 shows a class that extends `JsonViewEntryCollectionContent`. To use this class you make the following change to `createFactory`:
//return new RestViewJsonService(httpRequest, httpResponse, p);
return new RestViewJsonService(httpRequest, httpResponse, p, new JsonContentFactory(){
    public JsonViewEntryCollectionContent createViewEntryCollectionContent(
        View view, RestViewService service) {
            return new CustomViewEntryCollectionContent(view, service);
        }
    });

In other words instead of using the three-parameter constructor for RestViewJsonService, you use the four-parameter constructor. The fourth parameter is an instance of JsonContentFactory that knows how to create an instance of CustomViewEntryCollectionContent.

After these changes, your service produces the following response. Notice the JSON properties are now all lower case:

```
[
  {
    "@entryid": "1-F73088139B943195852578B20066F538",
    "@unid": "F73088139B943195852578B20066F538",
    "@position": "1",
    "productname": "GT-2160",
    "company": "Asics",
    "productprice": "$89.99",
    "onsale": true
  },
  {
    "@entryid": "2-95D7A6F090DF96F7852578B2006DB6E2",
    "@unid": "95D7A6F090DF96F7852578B2006DB6E2",
    "@position": "2",
    "productname": "ProGrid Ride",
    "company": "Saucony",
    "productprice": "$89.99",
    "onsale": false
  },
  {
    "@entryid": "3-95B3CA2BDEE839FF852578B20066E92D",
    "@unid": "95B3CA2BDEE839FF852578B20066E92D",
    "@position": "3",
    "productname": "Wave Rider",
    "company": "Mizuno",
    "productprice": "$89.99",
    "onsale": false
  }
]
```

Throughout this section we have made changes to the ServletFactory class shown in listing 4.1. See listing 4.2 for the final version of ServletFactory.java.
Source Listing 4.3. CustomViewEntryCollectionContent.java

```java
package com.sample.service;
import java.io.IOException;
import lotus.domino.View;
import com.ibm.domino.services.ServiceException;
import com.ibm.domino.services.content.JsonViewEntryCollectionContent;
import com.ibm.domino.services.rest.das.view.RestViewNavigator;
import com.ibm.domino.services.rest.das.view.RestViewService;
import com.ibm.domino.services.util.JsonWriter;
public class CustomViewEntryCollectionContent extends JsonViewEntryCollectionContent {
    public CustomViewEntryCollectionContent(View view, RestViewService service) {
        super(view, service);
    }
    protected void writeColumn(JsonWriter jsonWriter, RestViewNavigator navigator,
                              int colIdx, String colName, Object colValue)
        throws IOException, ServiceException {
        super.writeColumn(jsonWriter, navigator, colIdx,
                          colName.toLowerCase(), colValue);
    }
}
```

Source Listing 4.4. ServletFactory.java (final version)

```java
package com.sample.service;
import java.util.Arrays;
import java.util.List;
import javax.servlet.ServletException;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import lotus.domino.View;
import com.ibm.domino.services.ServiceEngine;
import com.ibm.domino.services.ServiceException;
import com.ibm.domino.services.content.JsonContentFactory;
import com.ibm.domino.services.content.JsonViewEntryCollectionContent;
import com.ibm.domino.services.rest.das.view.RestViewColumn;
import com.ibm.domino.services.rest.das.view.RestViewEntry;
import com.ibm.domino.services.rest.das.view.RestViewJsonService;
import com.ibm.domino.services.rest.das.view.RestViewService;
import com.ibm.xsp.extlib.services.servlet.DefaultViewColumn;
import com.ibm.xsp.extlib.services.servlet.DefaultServletFactory;
import com.ibm.xsp.extlib.services.servlet.ServiceFactory;
public class ServletFactory extends DefaultServletFactory {
    private static ServiceFactory createFactory() {
        DefaultServiceFactory factory = new DefaultServiceFactory();
        final List<RestViewColumn> customColumns = Arrays.asList((RestViewColumn) new DefaultViewColumn("OnSale") {
            @Override
            public Object evaluate(RestViewService service, RestViewEntry entry) throws ServiceException {
                // Implementation
                return null;
            }
        });
        factory.addCustomColumns(customColumns);
        return factory;
    }
    public ServletFactory() {
        super();
    }
    public ServletFactory(ServiceEngine serviceEngine) {
        super(serviceEngine);
    }
}
```
String company = entry.getColumnValue("Company")
    .toString();
  Boolean v = null;
  if ("Asics".equals(company)) {
    v = new Boolean(true);
  } else {
    v = new Boolean(false);
  }
  return v;
});

factory.addFactory("Products", new ServiceFactory() {
  public ServiceEngine createEngine(HttpServletRequest httpRequest,
         HttpServletResponse httpResponse) throws ServletException {
    DefaultViewParameters p = new DefaultViewParameters();
    p.setViewName("Products");
    p.setGlobalValues(DefaultViewParameters.GLOBAL_ALL);
    p.setSystemColumns(DefaultViewParameters.SYSCOL_UNID
      | DefaultViewParameters.SYSCOL_POSITION);
    p.setDefaultColumns(true);
    p.setColumns(customColumns);
    // Set the default parameters
    p.setStart(0);
    p.setCount(4);
    // return new RestViewJsonService(httpRequest, httpResponse, p);
    return new RestViewJsonService(httpRequest, httpResponse, p,
      new JsonContentFactory() {
          public JsonViewEntryCollectionContent
            createViewEntryCollectionContent(
                  View view, RestViewService service) {
                return new CustomViewEntryCollectionContent{
                    view, service);
            }
        });
      }
   });
  return factory;
});

public ServletFactory() {
  super("services", "Extension Library Services Servlet", createFactory());
}
5. Custom Wink Service

A custom Wink service is implemented in Java and deployed as an OSGi plug-in on the Domino server. It handles HTTP requests to a URL in one of the following formats:

- \( \text{http://host/api/servicepath/resource} \)
- \( \text{http://host/database/api/servicepath/resource} \)

Unlike a custom database servlet (see Section 4), a custom Wink service is not tied to a specific Notes database. When handling a URL of the second form above, with a \{database\} segment, the service can use the specified database context, but it could refer to any database on the server.

A custom Wink service is defined with the Apache Wink framework. Apache Wink is itself an implementation of the JAX-RS specification. Both Apache Wink and JAX-RS are now included with the extension library, but this document does not discuss either one in great detail. To learn more about Apache Wink and JAX-RS, please find the relevant documentation on the web.

A custom Wink service uses the \text{com.ibm.domino.das.service} extension point to define its \{servicepath\} segment. This effectively adds the service to the list of REST services running on the Domino server. The \text{com.ibm.domino.das.service} extension point is not part of Apache Wink. It is unique to the extension library. To learn more about the extension point, see Section 5.2.

A custom Wink service usually consists of multiple resources. For example, a directory service might contain four types of resources: 1) a contact list, 2) a contact, 3) a group list, and 4) a group. By convention, the directory service would include a separate Java class for each resource type. Each resource class can handle one or more HTTP methods. For example, the \text{contact} class might support GET, PUT and DELETE, while the \text{contact list} class might support only GET and POST. You use JAX-RS annotations to define resource classes and the methods they support.

5.1 Sample Wink Service

The extension library includes a sample Wink service called \text{com.ibm.domino.services.sample}. The sample service plug-in is in a separate update site called \text{updateSiteOpenNTFSamples.zip}. You can install the sample service on your Domino server by unzipping the contents of this update site into the \text{workspace\applications\eclipse} folder of your Domino data directory. Alternatively, you can use NSF-based update site deployment. See section 5.3 for more details.

The sample service defines two resources. The “root resource” handles a GET request to the following URL:

- \( \text{http://host/api/sample} \)

This returns a response in JSON format like this:

```json
{
  "links":[
    {
      "rel":"contacts",
      "href":"http:\{host\}\xpagesext.nsf\api\sample\contacts"
    }
  
```
In other words, the response includes a link to the contacts resource — a list of contacts in the xpagesext.nsf database. If the service defined other resource types, the response would include more elements in the links array.

The contacts resource handles a GET request to the following URL:

http://{host}/xpagesext.nsf/api/sample/contacts

This returns a response in JSON format like this:

```
[
  {
    "firstName": "Addie",
    "lastName": "Pate",
    "emailAddress": "addie_pate@renovations.com",
    "city": "Dayton",
    "state": "OH",
    "href": "http://{host}/xpagesext.nsf/api/sample/contacts/F89EC6B0B37686A5852578FC005E4061"
  },
  {
    "firstName": "Adrienne",
    "lastName": "Middleton",
    "emailAddress": "adrienne_middleton@renovations.com",
    "city": "Palm Bay",
    "state": "DL",
    "href": "http://{host}/xpagesext.nsf/api/sample/contacts/C27592F4FEDA5929852578FC005E3FBC"
  },
  {
    "firstName": "Albert",
    "lastName": "Wiley",
    "emailAddress": "albert_wiley@renovations.com",
    "city": "Lafayette",
    "state": "LA",
    "href": "http://{host}/api/sample/contacts/C2E3338C09947B3E852578FC005E4042"
  }
]
```

In other words, the response includes summary information about each contact in the AllContacts view. Each contact object has properties for first name, last name, email address, etc.

Obviously, the sample service is not complete. For example, a real service would include the ability to create new contacts. A real service would let you read, update and delete existing contacts. A real service might also include more resource types. However, the sample service does demonstrate the minimum work required to create your own custom Wink service. The following sections describe how to develop, deploy and manage a custom Wink service. As you read these sections, please refer to the sample service code. See srcOpenNTFSamples.zip.

NOTE: Before you can use the sample service on your own Domino server, you need to enable the service. See Section 5.4 for more on enabling custom Wink services.
5.2 Developing a Wink Service

A custom Wink service is implemented as an OSGi plug-in. The plug-in includes one or more JAX-RS resources and implements an extension that causes the resources to be registered with the Domino Access Services (DAS) servlet.

The DAS servlet listens for HTTP requests to any URL starting with either of the following:

http://{host}/api
http://{host}/{database}/api

When you implement a DAS extension, you effectively add a unique {servicepath} segment to the DAS servlet:

http://{host}/api/{servicepath}
http://{host}/{database}/api/{servicepath}

All of your service resources have a unique URL, but each will have the same {servicepath} in common.

NOTE: You can also create a Wink service in a separate OSGi servlet. Such a service would not be an extension to DAS and its URLs would not include /api in the path. This document does not describe how to build your on servlet, but you could use com.ibm.domino.das as a guide. It is much easier to build a service that extends DAS.

The following sections describe more details on developing a custom Wink service.

5.2.1 Defining Service Resources

Your custom Wink service must include one or more resource classes. A resource class is usually tied to a particular URL path, as indicated by the @Path annotation. Each resource class should have at least one method annotated with @GET, @POST, @PUT or @DELETE. As an example, consider this excerpt from com.ibm.domino.services.sample.resources.RootResource:

```java
@Path("sample")
public class RootResource {

    ...

    @GET
    public Response getLinks(@Context UriInfo uriInfo) {
        SAMPLE_SERVICE_LOGGER.traceEntry(this, "getLinks");
        String jsonEntity = null;
        try {
            jsonEntity = getResponseEntity(uriInfo.getAbsolutePath().toString());
        } catch (IOException e) {
            throw new WebApplicationException(SampleService.createErrorResponse(e));
        } catch (JsonException e) {
            throw new WebApplicationException(SampleService.createErrorResponse(e));
        }
        ResponseBuilder builder = Response.ok();
        builder.type(MediaType.APPLICATION_JSON_TYPE).entity(jsonEntity);
        Response response = builder.build();
        SAMPLE_SERVICE_LOGGER.traceExit(this, "getLinks", response);
    }
```
This class defines a resource that handles GET requests to http://{host}/api/sample. Usually, a service contains many resource classes including some that handle multiple HTTP request methods. For more information on JAX-RS resource classes and annotations, please find the relevant documentation on the web.

5.2.2 Creating a Subclass of WinkApplication

Now that your plug-in contains resource classes, you need to create a subclass of WinkApplication. For example, consider this excerpt from com.ibm.domino.services.sample.SampleService:

```java
public class SampleService extends WinkApplication {

   public Set<Class<?>> getClasses() {
      Set<Class<?>> classes = new HashSet<Class<?>>();
      SAMPLE_SERVICE_LOGGER.getLogger().fine("Adding sample service resources.");
      classes.add(RootResource.class);
      classes.add(ContactsListResource.class);
      return classes;
   }
}
```

Your subclass must override the getClasses method, which returns a set of all the resource classes in your service.

NOTE: As you enhance your service, you will probably add new resource classes. When you do so, remember: You also have to modify the getClasses method. The set returned by getClasses must include all your resource classes.

5.2.3 Implementing the com.ibm.domino.das.service Extension

When the DAS servlet loads, it looks for all extensions of the com.ibm.domino.das.service extension point. Each extension registers its WinkApplication subclass among other properties. For example, consider the sample service's plugin.xml:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<?eclipse version="3.2"?>
<plugin>
   <extension point="com.ibm.domino.das.service">
      <serviceResources>
         class="com.ibm.domino.services.sample.service.SampleService"
         name="com.ibm.domino.services.sample" path="sample"
         version="0.0.1">
      </serviceResources>
   </extension>
</plugin>
```
It defines the name of the WinkApplication subclass
(com.ibm.domino.services.sample.service.SampleService), the name of the service itself
(com.ibm.domino.services.sample), the service path, and the version.

You can use the above template as a guide for your own Wink service. Once you have
implemented your own extension, the DAS servlet will call your implementation of
WinkApplication.getClasses() whenever the servlet loads. Each of your resources will then be
registered with the Wink runtime.

5.3 Deploying a Wink Service

The easiest way to deploy a custom Wink service is to copy your plug-in files to the Domino
OSGi framework. The OSGi framework is distributed across multiple folders in the Domino
program and data directories. The recommend location for your plug-in is the
workspace\applications\eclipse\plugins folder in the Domino data directory.

Alternatively, you can add your plug-in to an NSF-based update site. For more information on
NSF-based update sites, see:


Once you have deployed your plug-in files, you must restart the Domino HTTP task. This
causes the OSGi framework to restart and load the new plug-in.

5.4 Enabling a Wink Service

After you install a custom Wink service, the service is loaded whenever the Domino HTTP task
is started. However, it cannot handle requests until you enable it. You need to deliberately
enable the service in the appropriate Internet Site document.

To enable the service:

1. Use a Notes client to open the server’s public address book.
3. Open the Internet Site document for your server.
4. Click the Edit Web Site action.
5. Select the Configuration tab.
6. At the bottom of the form, look for a section labeled Domino Access Services.
7. In the Enabled services field, add the name of your service. For example, the following shows two services enabled – the data service and the sample service:

```
Domino Access Services

The following setting is a placeholder for services provided by an external plug-in. See the Lotus Notes and Domino wiki for more information.

Enabled services: Data, com.ibm.domino.services.sample

```

8. Save your changes and restart the HTTP task.

**NOTE:** The above instructions assume you are using Internet Sites. If you are not using Internet Sites, you can enable the service in the server document.