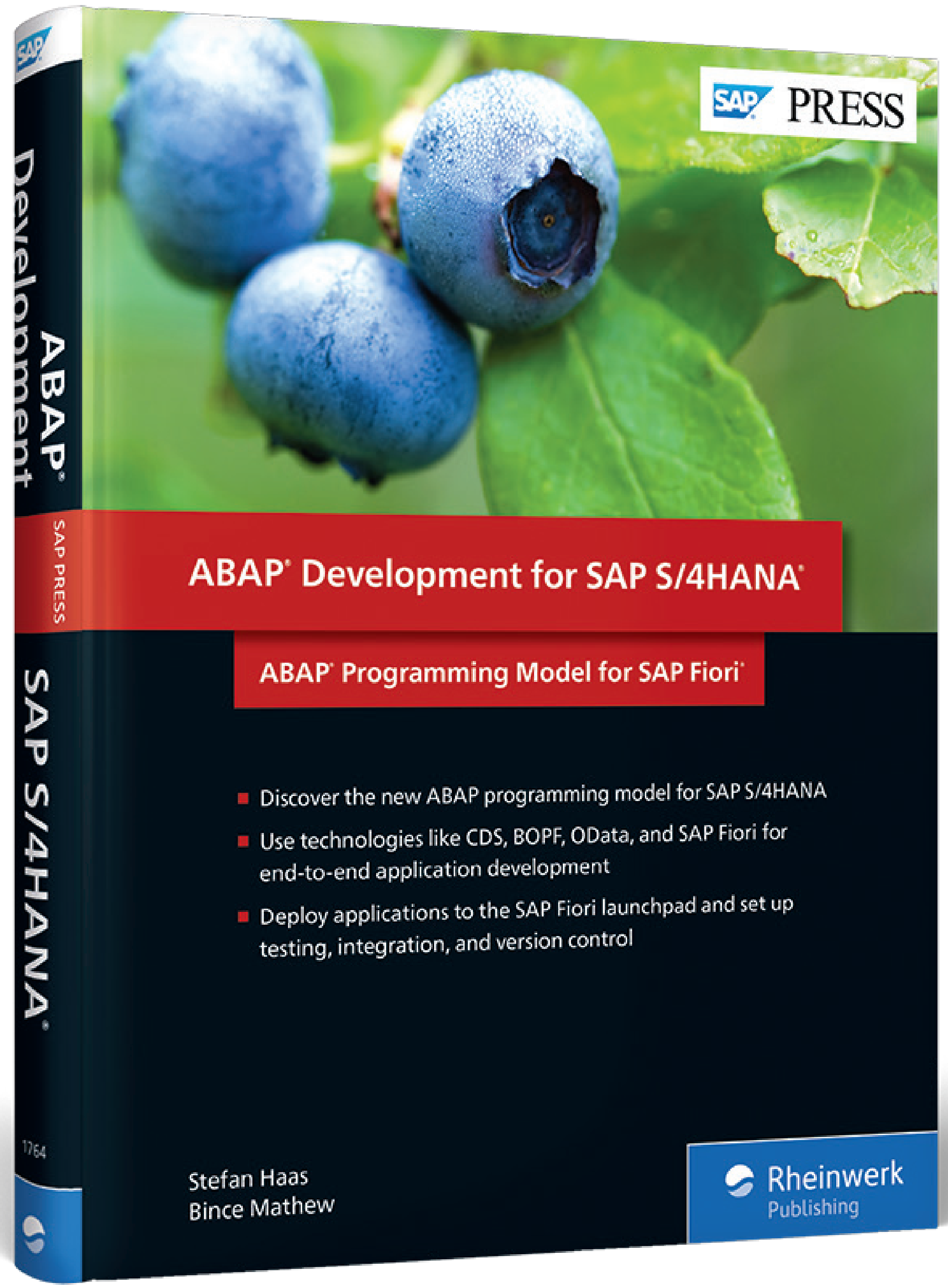
SAP PRESS First-hand knowledge.

Rheinwerk Publishing


SAP PRESS
ABAP® Development for SAP S/4HANA®
ABAP® Programming Model for SAP Fiori®
Discover the new ABAP programming model for SAP S/4HANA
Use technologies like CDS, BOPF, OData, and SAP Fiori for end-to-end application development
Deploy applications to the SAP Fiori launchpad and set up testing, integration, and version control
Stefan Haas
Bince Mathew
Rheinwerk Publishing
ABAP® Development for SAP S/4HANA®
1764

Browse the Book

In this chapter, you'll learn about SAP S/4HANA's application programing model and its associated technologies.

- "ABAP Programing Model for SAP Fiori"
- Table of Contents
- Index
- The Authors

Stefan Haas, Bince Mathew

ABAP Development for SAP S/4HANA: ABAP Programming Model for SAP Fiori

461 Pages, 2018, $79.95
ISBN 978-1-4932-1764-9

www.sap-press.com/4766

Chapter 3
ABAP Programing Model for SAP Fiori

This chapter introduces the ABAP programing model for SAP Fiori, which has been available since SAP S/4HANA 1610, SPS 03, or SAP NetWeaver Application Server for ABAP 7.52, SP 02. It's the standard development model for new SAP S/4HANA applications and reflects the SAP S/4HANA core architecture described in Chapter 1.

In general, the model supports the development of SAP HANA optimized OData services for SAP Fiori applications based on Core Data Services (CDS) views and covers analytical, transactional, and search application scenarios. Two main scenarios can be distinguished when developing applications using the programing model: read-only applications and transactional applications. Read-only applications only require an underlying CDS data model and application-specific analytics or search annotations. The CDS data model and its annotations are then exposed as an OData service using the Service Adaptation Description Language (SADL) technology.

Transactional applications, in addition to read-only applications, require the generation of a Business Object Processing Framework (BOPF) business object for handling create, update, and delete operations as well as additional business logic implemented via BOPF actions, validations, and determinations. In the following, we'll go through the different technologies associated with the ABAP programing model.

3.1 Core Data Services

Core Data Services (CDS) are the foundation of all SAP S/4HANA application types. They are deployed on top of legacy or new SAP ERP tables and enable the development of semantically rich data models that foster code pushdown to the SAP HANA database. They are developed on the ABAP stack and therefore use the standard lifecycle management of ABAP development objects; for instance, they are transported between systems using the standard ABAP Change and Transport System (CTS).

On activation of a CDS view, two artifacts are generated: a corresponding Data Dictionary (DDIC) view in the ABAP Dictionary (`@AbapCatalog.sqlViewName`) and a SAP HANA view on the database. Only the CDS view definition is transported and has the object repository entry `R3TR DDLS <CDS_DEFINITION_VIEW_NAME>`.

To cover different application scenarios, CDS views, which are defined using the data definition language (DDL) of CDS, can be enhanced using different types of annotations.

- **Analytical annotations**
  To use a CDS view as a data cube or query within analytical application scenarios via the Analytical Engine, it must be annotated using `@Analytics` annotations.
- **UI annotations**
  CDS views can be annotated with user interface (UI) annotations (`@UI`) to define where certain entities, fields, and data will be placed within a SAP Fiori elements template application, which reduces the required JavaScript SAPUI5 frontend code drastically. UI annotations can be moved to a metadata extension file with object repository type `R3TR DDLX` in order not to clutter the core CDS view with loads of UI annotations.
- **Search annotations**
  CDS views can be configured for search scenarios using `@Search` annotations, for instance, as an Enterprise Search (ESH) model for the SAP Fiori launchpad search or for SAP Fiori in-app search by defining the SAP HANA text search scope and fuzziness.
- **Transactional annotations**
  To enable transactional processing capabilities (create, write, delete) in addition to analytical or search capabilities, a BOPF object can be generated for a CDS entity by providing transactional `@ObjectModel` annotations.

Figure 3.1 shows an overview of the ABAP programming model development flow and involved artifacts. As you can see, CDS is in the center of the development flow and, for instance, the basis of the OData service, which is, in turn, consumed by the SAP Fiori app or the BOPF business object for transactional processing.

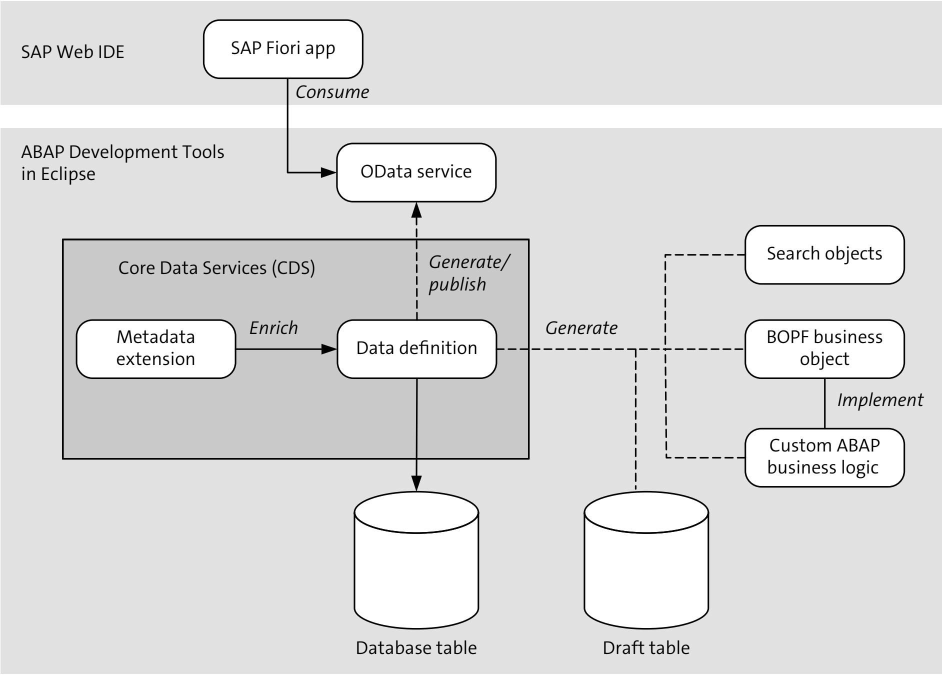


Figure 3.1 Overview of the ABAP Programming Model Development Flow and Its Artifacts

3.2 SAP Gateway

SAP Gateway plays a crucial role in providing an easy-to-use non-ABAP-based access to business data stored in backend SAP NetWeaver systems. Access to business data is granted via REST-based OData services using HTTP as the underlying data transfer protocol.

As of SAP NetWeaver version 7.40, the software component `SAP_GWFND` is installed as part of the SAP NetWeaver standard and includes the full scope of functionality required for hub and backend enablement. In general, from an architectural perspective, there are two deployment approaches: embedded deployment or hub deployment. The hub deployment can be further split up into development on the hub or development in the backend system. The usual setup for an SAP S/4HANA on-premise system is shown in Figure 3.2. Usually, development takes place in the ABAP backend system, and a hub system will be introduced to handle the additional load of client OData requests to the SAP Gateway component. This setup requires an additional SAP NetWeaver system functioning as the SAP Gateway hub system or frontend server and a trusted remote function call (RFC) connection between the hub and backend system to forward requests from the frontend to the backend system, which contains the business logic and the data. The RFC-enabled function module passing data from the frontend to the backend is /IWBEP/FM_MGW_HANDLE_REQUEST.

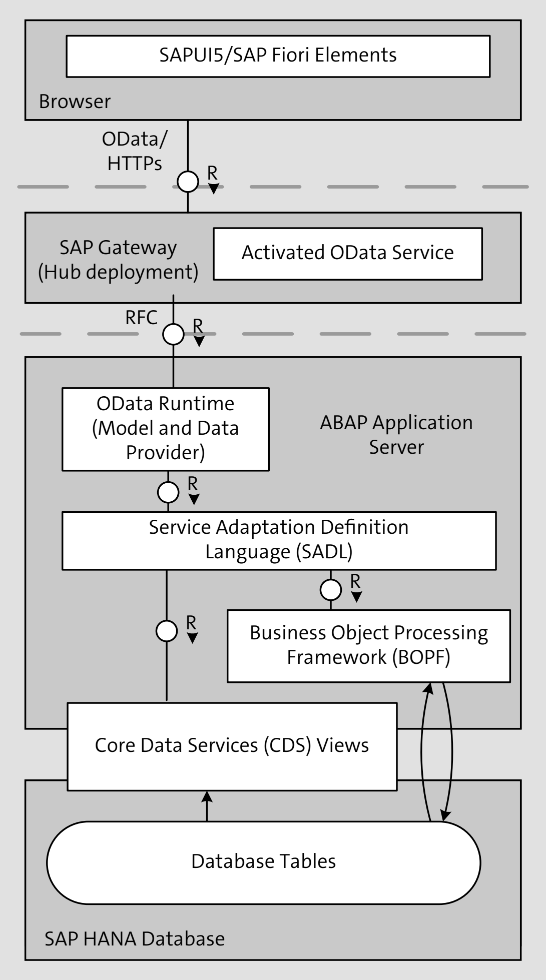


Figure 3.2 High-Level Overview of a Typical SAP S/4HANA System Setup with SAP Gateway Provided as a Separate Hub System

The SAP Fiori app running in the browser sends OData HTTP GET, POST, DELETE, or PUT requests to the SAP Gateway system, which exposes all registered and activated OData services. The SAP Gateway passes the incoming OData requests to the backend via a trusted RFC connection. The OData runtime in the backend then delegates the actual data selection to the SADL framework layer. If the request is a read-only GET request, SADL will delegate the request to its query engine, which will generate an SQL SELECT statement to select the requested OData entity's data from the database tables via its corresponding CDS view. In case of a write access, for instance, POST for create or PUT for update, the request will be delegated to the transactional BOPF runtime, which will handle the database updates according to the provided transactional annotations specified in the CDS view.

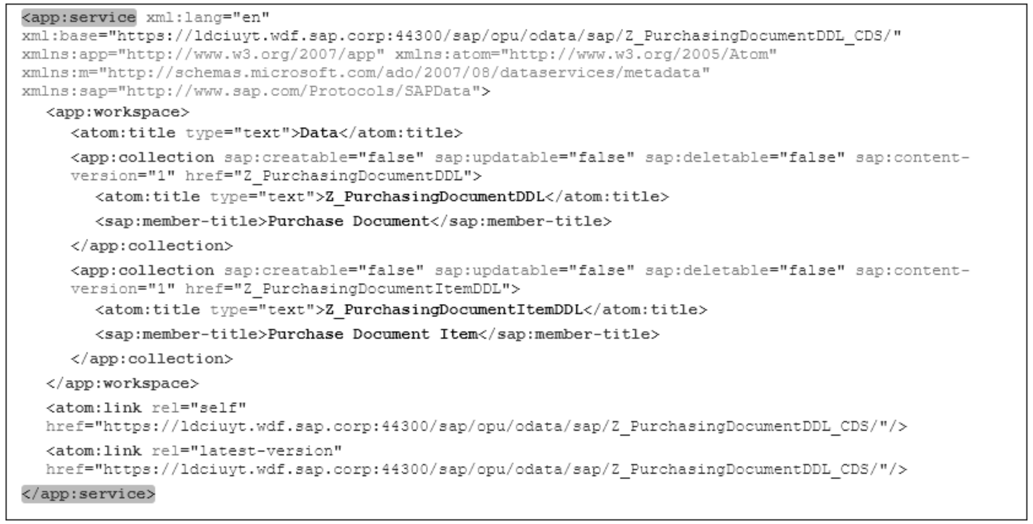
3.3 OData

OData is a REST-based data protocol used for transferring business data as well as metadata between the ABAP backend system and client applications via the SAP Gateway hub system. In SAP S/4HANA, client applications of OData services usually are SAP Fiori SAPUI5 applications running in the local browsers of end-user devices such as desktop PCs or tablets. Together with the SAP Gateway, OData provides access to the SAP backend business data in an easy-to-understand and well-defined way using HTTP as its data transfer protocol.

3.3.1 Overview

An OData service organizes data in the form of entities that have a set of properties interconnected via associations. These elements resemble the elements of CDS data models, so CDS data models are the perfect candidates for exposure as OData services.

The structure of an OData service can be explored by looking at its service document and its service metadata document. The service document contains a list of entities or resources that can be accessed using this service and can be requested via /sap/opu/odata/sap/<OData_service_name>/. Additionally, you can see whether the service allows creating, changing, or deleting entities by looking at the sap:creatable, sap:updatable, and sap:deletable attributes of the <app:collection> tag, which also contains a relative reference to the entity set via its href attribute (see Figure 3.3).



```
<app:service xml:lang="en"
xml:base="https://ldciuyt.wdf.sap.corp:44300/sap/opu/odata/sap/Z_PurchasingDocumentDDL_CDS/"
xmlns:app="http://www.w3.org/2007/app" xmlns:atom="http://www.w3.org/2005/Atom"
xmlns:m="http://schemas.microsoft.com/ado/2007/08/dataservices/metadata"
xmlns:sap="http://www.sap.com/Protocols/SAPData">
  <app:workspace>
    <atom:title type="text">Data</atom:title>
    <app:collection sap:creatable="false" sap:updatable="false" sap:deletable="false" sap:content-
    version="1" href="Z_PurchasingDocumentDDL">
      <atom:title type="text">Z_PurchasingDocumentDDL</atom:title>
      <sap:member-title>Purchase Document</sap:member-title>
    </app:collection>
    <app:collection sap:creatable="false" sap:updatable="false" sap:deletable="false" sap:content-
    version="1" href="Z_PurchasingDocumentItemDDL">
      <atom:title type="text">Z_PurchasingDocumentItemDDL</atom:title>
      <sap:member-title>Purchase Document Item</sap:member-title>
    </app:collection>
  </app:workspace>
  <atom:link rel="self"
  href="https://ldciuyt.wdf.sap.corp:44300/sap/opu/odata/sap/Z_PurchasingDocumentDDL_CDS/"/>
  <atom:link rel="latest-version"
  href="https://ldciuyt.wdf.sap.corp:44300/sap/opu/odata/sap/Z_PurchasingDocumentDDL_CDS/"/>
</app:service>
```

Figure 3.3 Service Document of a Simple Purchase Document and Purchase Document Item OData Service

The service metadata document is a lot more detailed than the service document and shows all metadata of the service. It can be requested using the `$metadata` option: `/sap/opu/odata/sap/<OData_service_name>/$metadata`. It displays all entities of the service, including their properties and associations.

OData uses the REST HTTP commands `POST`, `GET`, `PUT`, and `DELETE` for creating, reading, updating, and deleting (CRUD) entities. Additionally, OData defines a simple but powerful query language for restricting the result set provided by the SAP Gateway. Table 3.1 lists the most common OData query options.

Operation	Query Option
Filtering	`$filter`, e.g., `$filter = PurchaseDocument eq ‘0005’`
Projecting or selecting properties	`$select`, e.g., `$select = PurchaseDocument, PurchasingOrganization,…`
Sorting	`$orderby`, e.g., `$orderby = CreationDate desc`
Client-side paging	`$top` and `$skip`, e.g., `$top = 10&$skip = 0`
Counting	`$count`
Formatting	`$format`, e.g., `$format = JSON`

Table 3.1 Most Important OData Query Options

Table 3.1 Most Important OData Query Options (Cont.)

3.3.2 OData Service Creation

As you already know, you can directly select data from a CDS view using Open SQL in ABAP, as you would select data from a conventional database table. However, SAP Fiori apps require the exposure of data as an OData service using HTTP as the data transfer protocol.

Currently, a CDS data model can be exposed as an OData service in three different ways: Auto-Exposure, Reference Data Source (RDS), or Mapped Data Source (MDS).

Auto-Exposure

The simplest, but also the most restricted, way of exposing a CDS model as an OData service is by using the `@OData.publish:true` header annotation (Listing 3.1).

```
@AbapCatalog.sqlViewName: ‘SQL_VIEW_NAME’
…
@OData.publish: true
define view CDS_VIEW_NAME as select from …
```

Listing 3.1 @OData.publish:true Header Annotation to Expose a Simple Coherent CDS Data Model as an OData Service

When activating the view in the ABAP development tools in Eclipse, several artifacts will be generated in the system (Figure 3.4):

- The actual SAP Gateway Business Suite Enablement - Service object named `<CDS_VIEW_NAME>_CDS` (object type: `R3TR IWSV`)
- An SAP Gateway model named `<CDS_VIEW_NAME>_MDL` (object type: `R3TR IWMO`)
- An annotation model named `<CDS_VIEW_NAME>_CDS_VAN` (object type: `R3TR IWVB`)

By default, the generated OData service won't be activated. This must be done manually by accessing Transaction /IWFND/MAINT_SERVICE on the SAP Gateway hub system.

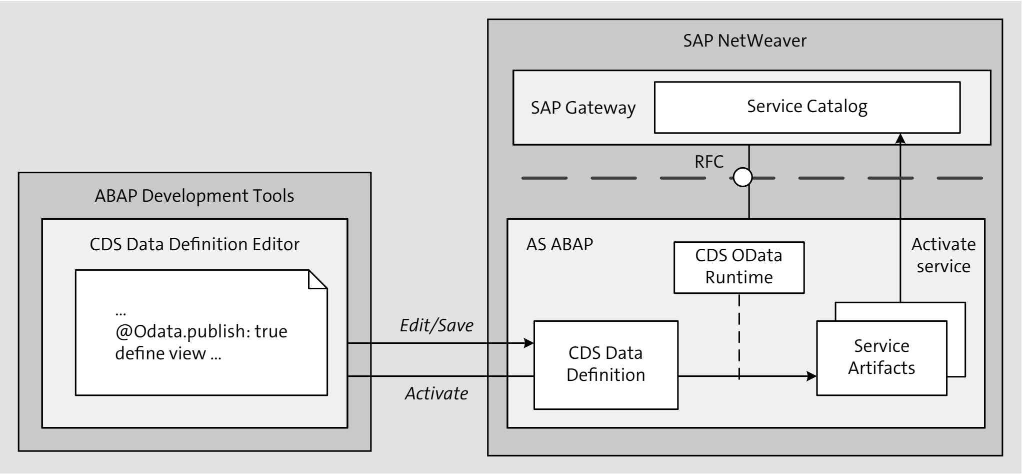


Figure 3.4 Components and Activities Involved When Exposing a CDS Data Model as an OData Service Using the Auto-Exposure Method

The Auto-Exposure OData service creation method can only be used for simple coherent CDS models that consist of a root node and first-level-associated views. It's not possible to add additional non-first-level-associated or unrelated CDS views as OData entities to the service; for instance, if you have a coherent model of a purchase document root view that has an association to a purchase document item child view, and the item view in turn has an association to a material view, the material entity can't be part of the service because it's not a first-level association of the root node (Figure 3.5). If this is required, one of the other approaches must be used.

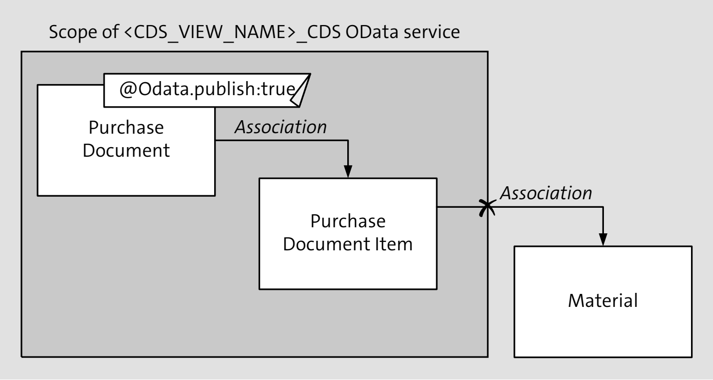


Figure 3.5 Scope of the OData Auto-Exposure Service Creation

Referenced Data Source

For complex CDS view models that need to be exposed as OData entities within a common OData service, the Reference Data Source (RDS) approach is the right choice. A CDS model can be considered as complex in this case when it has several levels of associations or unrelated root views. The RDS approach, however, requires the creation of an SAP Gateway Service Builder project. This can be done by carrying out the following steps:

1. Open Transaction SEGW.
2. Choose the **Create Project** button in the toolbar (Figure 3.6).

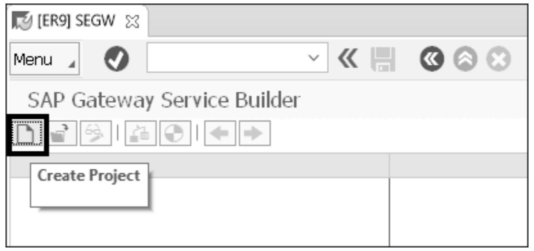
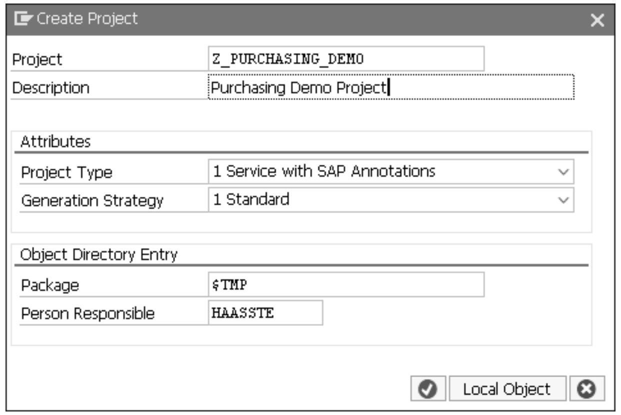


Figure 3.6 Creating a New SAP Gateway Service Builder Project

3. In the **Create Project** dialog that appears (Figure 3.7), provide a description and name for the SAP Gateway project that will become a transportable ABAP repository entry (`R3TR IWPR Z_PURCHASING_DEMO`). In this entry, `IWPR` stands for *Gateway Business Enablement – Service Builder Project*. Choose **Continue**.



Create Project

Project	Z_PURCHASING_DEMO
Description	Purchasing Demo Project

Attributes

Project Type	1 Service with SAP Annotations
Generation Strategy	1 Standard

Object Directory Entry

Package	$TMP
Person Responsible	HAASSTE

Figure 3.7 SAP Gateway Service Builder: Create Project Dialog

After the project has been created, you can start creating the actual OData service. First, you must create a data model. For the RDS scenario, we'll create a data model by referencing a CDS model. Therefore, choose **Reference • Data Source** from the context menu of the **Data Model** folder (Figure 3.8).

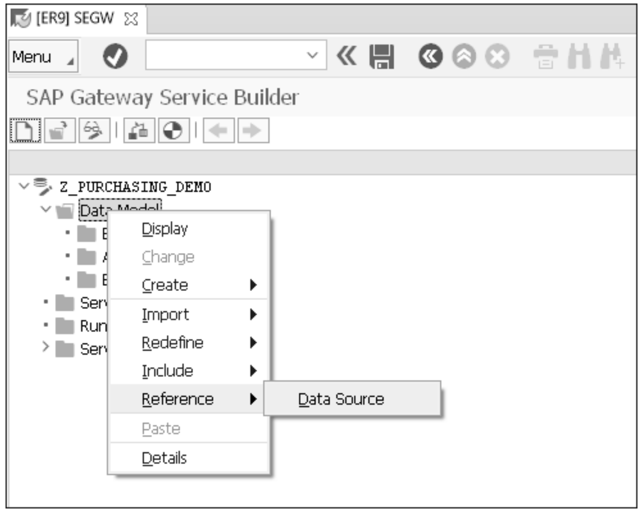
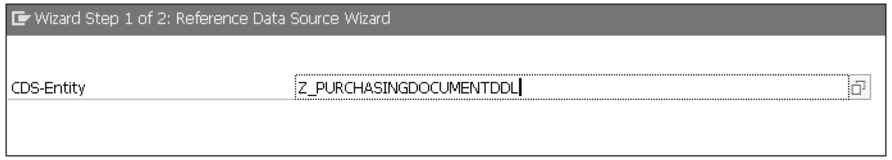


Figure 3.8 Creating a Data Model by Referencing a CDS Data Source

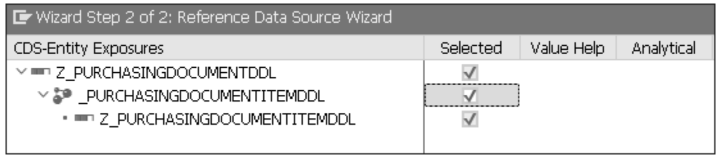
This will trigger the **Reference Data Source Wizard** (Figure 3.9). You must enter a CDS view you want to expose as an OData entity within your OData service, usually the root view or one of the root views of your CDS model.


Wizard Step 1 of 2: Reference Data Source Wizard

CDS-Entity Z_PURCHASINGDOCUMENTDDL

Figure 3.9 Entering the CDS Root View of the Referenced CDS Model

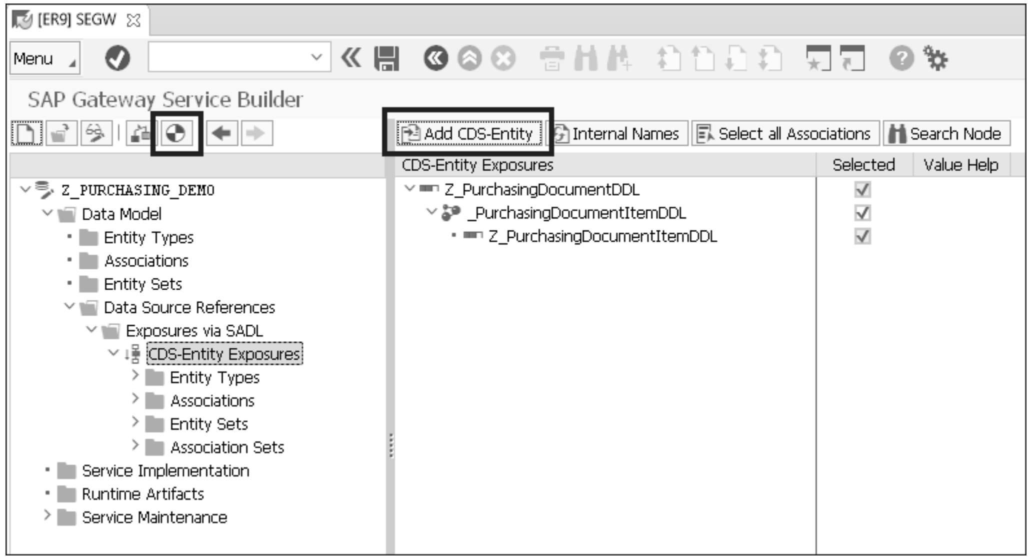
In the next step of the wizard (Figure 3.10), you can select the associated views of the previously selected CDS view and make them part of your OData service model definition.


Wizard Step 2 of 2: Reference Data Source Wizard

CDS-Entity Exposures	Selected	Value Help	Analytical
Z_PURCHASINGDOCUMENTDDL	✓		
_PURCHASINGDOCUMENTITEMDDL	✓		
Z_PURCHASINGDOCUMENTITEMDDL	✓		

Figure 3.10 Selecting Associations of the CDS Root View

When you finish the wizard, you'll see a new folder called **Data Source References Folder**. If you open its subfolder, **Exposures via SADL** and select the **CDS-Entity Exposures** node, you'll see the previously selected CDS entities that will be exposed as OData entities (Figure 3.11).

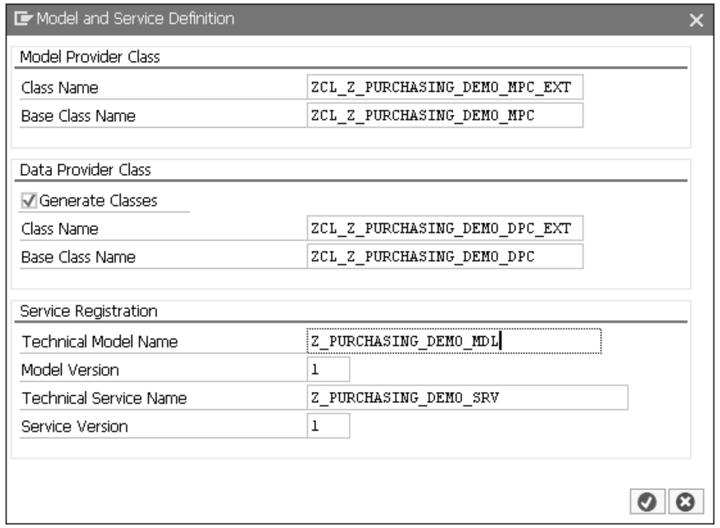


CDS-Entity Exposures	Selected	Value Help
Z_PurchasingDocumentDDL	✓	
_PurchasingDocumentItemDDL	✓	
Z_PurchasingDocumentItemDDL	✓	

Figure 3.11 The Exposed CDS Entities of the Service Builder Project

You can also add any additional CDS entities using the **Add CDS-Entity** button, which makes the RDS scenario a lot more flexible than Auto-Exposure. Finally, the OData service can be generated using the **Generate Runtime Objects** toolbar button, which will generate the runtime artifacts of the service and register them in the backend system.

The first time the service is generated, the **Model And Service Definition** dialog will appear so you can edit the default names of the objects to be created (Figure 3.12). As you can see, the RDS scenario will also generate a model provider class (MPC) and a data provider class (DPC), including the respective extension subclasses with the suffixes `MPC_EXT` and `DPC_EXT`. The MPC provides the runtime representation of our referenced CDS data model in the form of the service metadata document. The DPC provides the actual entity data by delegating the incoming requests to the generic SADL engine, which will transparently select data from CDS views and map them to OData entities.



Class Name	ZCL_Z_PURCHASING_DEMO_MPC_EXT
Base Class Name	ZCL_Z_PURCHASING_DEMO_MPC
☑ Generate Classes	
Class Name	ZCL_Z_PURCHASING_DEMO_DPC_EXT
Base Class Name	ZCL_Z_PURCHASING_DEMO_DPC
Technical Model Name	Z_PURCHASING_DEMO_MDL
Model Version	1
Technical Service Name	Z_PURCHASING_DEMO_SRV
Service Version	1

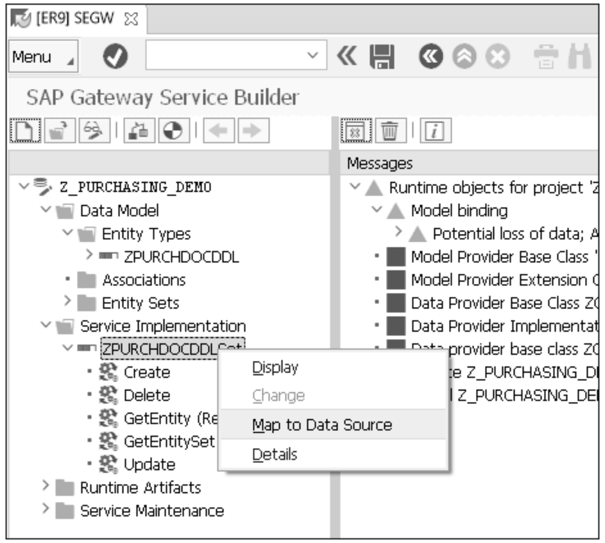
Figure 3.12 Model and Service Definition Dialog

With the RDS scenario, you have a lot of flexibility over the service creation process and implementation. You can even extend the `MPC_EXT` class to provide additional annotations or implement additional logic in the `DPC_EXT` class. However, adding non-CDS entities to the service isn't recommended.

Mapped Data Source

The Mapped Data Source (MDS) scenario is only used if one of the previous scenarios isn't applicable, for instance, if the service will contain non-CDS OData entities. Creating an OData service using the MDS scenario requires more manual work than the RDS and Auto-Exposure approaches. As with the RDS approach, you must first create a SAP Gateway Service Builder project using Transaction SEGW. Then, you must define a data model either manually or, in the case of CDS views, by importing the

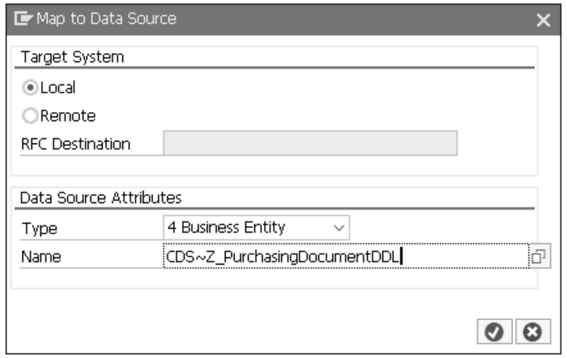
ABAP SQL view name of the CDS view as a DDIC structure. You can do this by choosing **Import • DDIC Structure** from the context menu of the **Data Model** folder (Figure 3.13). Then, under the **Service Implementation** folder, select the entity, and choose **Map to Data Source**.



Runtime objects for project 'Z
Model binding
Potential loss of data; A
Model Provider Base Class '
Model Provider Extension C
Data Provider Base Class ZC
Data Provider Implementat
Data provider base class ZC
e Z_PURCHASING_D
Z_PURCHASING_DE

Figure 3.13 Mapping the OData Entity to a Data Source

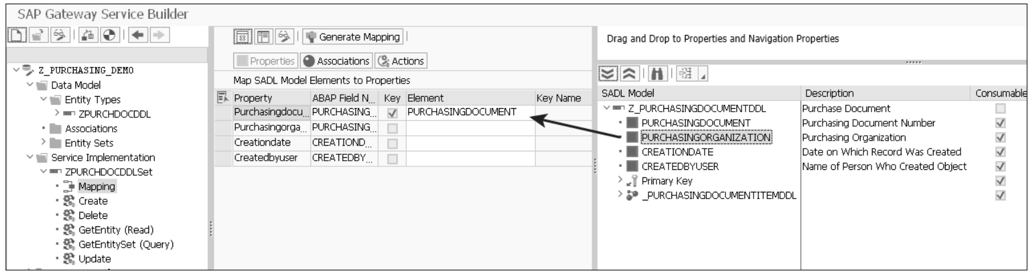
Select a CDS view to which you want to map the OData entity (Figure 3.14). This mapping will enable model-based data selection via the SADL engine, and you don't have to code the OData entity CRUD methods manually.



● Local	
○ Remote	
RFC Destination	
Type	4 Business Entity
Name	CDS~Z_PurchasingDocumentDDL

Figure 3.14 Mapping an OData Entity to a CDS Business Entity

Finally, you must manually map the fields of the OData entity to the fields of the CDS entity by dragging fields from the **SADL Model** pane on the right side of the screen to the mapping table in the middle (Figure 3.15).



Map SADL Model Elements to Properties

Property	ABAP Field N...	Key	Element	Key Name
Purchasingdocu...	PURCHASING...	☑	PURCHASINGDOCUMENT	
Purchasingorga...	PURCHASING...	□		
Creationdate	CREATIOND...	□		
Createdbyuser	CREATEDBY...	□		

SADL Model	Description	Consumable
Z_PURCHASINGDOCUMENTDDL	Purchase Document	□
PURCHASINGDOCUMENT	Purchasing Document Number	☑
PURCHASINGORGANIZATION	Purchasing Organization	☑
CREATIONDATE	Date on Which Record Was Created	☑
CREATEDBYUSER	Name of Person Who Created Object	☑
Primary Key		☑
_PURCHASINGDOCUMENTITEMDDL		☑

Figure 3.15 Mapping Fields of the CDS Entity to Fields of the OData Entity

In addition to the mapped data source entities, you can also manually create entities and implement their CRUD methods in the `DPC_EXT` class generated on the first generation of the service. As you can see, the MDS approach requires a bit more manual work than the previous options but provides you with full flexibility over the service creation. It supports generic data access to SADL CDS models as well as the manual ABAP-based implementation of OData entities.

Activating a Service on the SAP Gateway Hub System

One step we omitted for all three scenarios was the activation of the service in the Service Catalog of the SAP Gateway hub system, which we'll show now. Transaction /IWFND/MAINT_SERVICE is used to maintain all registered services, as well as to register and activate new services. It's the central entry point for dealing with OData services. To add a new service, you must click the **Add Service** button (Figure 3.16 ❶). This will lead you to another application for adding not yet registered backend services to the Service Catalog of the SAP Gateway system ❷. To find a certain service in a backend system, you must provide the system alias of the backend system in which the service has been created as well as the technical service name; for instance, in the Auto-Exposure case, this is `<CDS_VIEW_NAME>_CDS`. Finally, you can add the service to the Service Catalog by selecting the corresponding line and clicking the **Add Selected Services** button ❸.

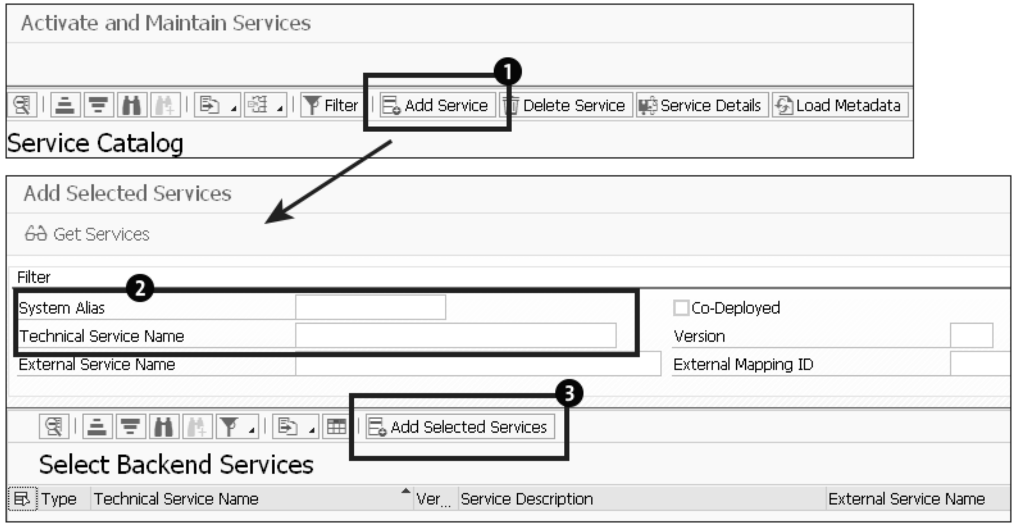


Figure 3.16 Adding a New OData Service to the Service Catalog

3.4 Service Adaptation Description Language

One of the core technologies enabling the ABAP programing model for SAP Fiori is the Service Adaptation Description Language (SADL). It provides two main functionalities in this context:

- *At design time*, SADL supports the model-based creation of an OData service based on a CDS data model.
- *At runtime*, the OData runtime delegates incoming requests for OData entities to the SADL adapter, which dynamically generates SQL `SELECT` statements to select the business data via CDS views or further delegates the requests to the transactional BOPF runtime if write access is required.

With this, SADL supports two of the three phases required for developing an OData service:

- Data model definition (supported by SADL)
- Service implementation (supported by SADL)
- Service maintenance

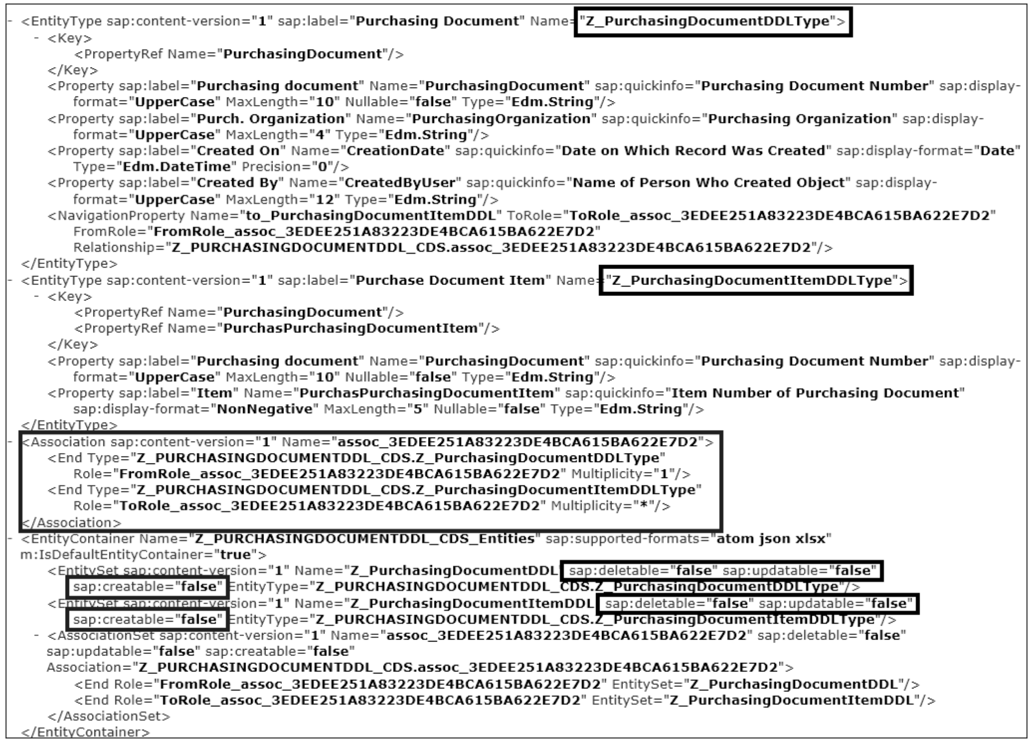
3.4.1 Data Model Definition Phase

The aim of this OData service development phase is to provide potential clients of the service with information about the service's shape, for instance, the structure of its entities, their relationships, and the supported operations. This information is provided in the form of a service metadata document in Extensible Markup Language (XML). In the data model definition phase, SADL creates a mapping of CDS entities to an OData Entity Data Model (EDM) and populates the MPC of the OData implementation with information derived from the CDS model structure. Additionally, CDS view field data types are mapped to EDM primitive data types; for instance, the ABAP dictionary built-in type `DATS` is mapped to the `EDM.DateTime` data type. Moreover, if transactional processing is enabled for CDS entities via the creation of a BOPF business object, BOPF actions will appear as OData function imports in the service metadata document. Table 3.2 provides an overview of the mappings from CDS concepts to OData concepts performed by SADL.

CDS	OData
CDS view (DDL)	EDM entity
CDS associations	EDM association
CDS view field data type	EDM primitive data type
BOPF actions	Function import

Table 3.2 Mappings between CDS Data Model Concepts and OData EDM Concepts

Figure 3.17 shows how the service metadata document will look for the simple scenario introduced in Chapter 1. As you remember, the purchase document CDS view (`Z_PurchasingDocumentDDL`) had an association to the purchase document items view (`Z_PurchasingDocumentItemDDL`). Both views now appear as OData entity types in the OData service's metadata document, including the information about the association between the two entities and their cardinalities. Which operations an entity supports is indicated by the `sap:creatable`, `sap:updatable`, and `sap:deletable` attributes of the `EntitySet` element. In the following example, you can see that the service doesn't support any write access at all, as we haven't enabled the transactional runtime for our CDS model by generating a BOPF business object. Thus, the service only supports read access via HTTP `GET` entity requests. As already mentioned, the metadata file of an OData service can be requested using the `$metadata` path, `/sap/opu/odata/sap/<OData_service_name>/$metadata`.



```
- <EntityType sap:content-version="1" sap:label="Purchasing Document" Name="Z_PurchasingDocumentDDLType">
  - <Key>
       <PropertyRef Name="PurchasingDocument"/>
    </Key>
    <Property sap:label="Purchasing document" Name="PurchasingDocument" sap:quickinfo="Purchasing Document Number" sap:display-
       format="UpperCase" MaxLength="10" Nullable="false" Type="Edm.String"/>
    <Property sap:label="Purch. Organization" Name="PurchasingOrganization" sap:quickinfo="Purchasing Organization" sap:display-
       format="UpperCase" MaxLength="4" Type="Edm.String"/>
    <Property sap:label="Created On" Name="CreationDate" sap:quickinfo="Date on Which Record Was Created" sap:display-format="Date"
       Type="Edm.DateTime" Precision="0"/>
    <Property sap:label="Created By" Name="CreatedByUser" sap:quickinfo="Name of Person Who Created Object" sap:display-
       format="UpperCase" MaxLength="12" Type="Edm.String"/>
    <NavigationProperty Name="to_PurchasingDocumentItemDDL" ToRole="ToRole_assoc_3EDEE251A83223DE4BCA615BA622E7D2"
       FromRole="FromRole_assoc_3EDEE251A83223DE4BCA615BA622E7D2"
       Relationship="Z_PURCHASINGDOCUMENTDDL_CDS.assoc_3EDEE251A83223DE4BCA615BA622E7D2"/>
 </EntityType>
- <EntityType sap:content-version="1" sap:label="Purchase Document Item" Name="Z_PurchasingDocumentItemDDLType">
  - <Key>
       <PropertyRef Name="PurchasingDocument"/>
       <PropertyRef Name="PurchasPurchasingDocumentItem"/>
    </Key>
    <Property sap:label="Purchasing document" Name="PurchasingDocument" sap:quickinfo="Purchasing Document Number" sap:display-
       format="UpperCase" MaxLength="10" Nullable="false" Type="Edm.String"/>
    <Property sap:label="Item" Name="PurchasPurchasingDocumentItem" sap:quickinfo="Item Number of Purchasing Document"
       sap:display-format="NonNegative" MaxLength="5" Nullable="false" Type="Edm.String"/>
 </EntityType>
- <Association sap:content-version="1" Name="assoc_3EDEE251A83223DE4BCA615BA622E7D2">
    <End Type="Z_PURCHASINGDOCUMENTDDL_CDS.Z_PurchasingDocumentDDLType"
       Role="FromRole_assoc_3EDEE251A83223DE4BCA615BA622E7D2" Multiplicity="1"/>
    <End Type="Z_PURCHASINGDOCUMENTDDL_CDS.Z_PurchasingDocumentItemDDLType"
       Role="ToRole_assoc_3EDEE251A83223DE4BCA615BA622E7D2" Multiplicity="*"/>
 </Association>
- <EntityContainer Name="Z_PURCHASINGDOCUMENTDDL_CDS_Entities" sap:supported-formats="atom json xlsx"
 m:IsDefaultEntityContainer="true">
    <EntitySet sap:content-version="1" Name="Z_PurchasingDocumentDDL" sap:deletable="false" sap:updatable="false"
       sap:creatable="false" EntityType="Z_PURCHASINGDOCUMENTDDL_CDS.Z_PurchasingDocumentDDLType"/>
    <EntitySet sap:content-version="1" Name="Z_PurchasingDocumentItemDDL" sap:deletable="false" sap:updatable="false"
       sap:creatable="false" EntityType="Z_PURCHASINGDOCUMENTDDL_CDS.Z_PurchasingDocumentItemDDLType"/>
  - <AssociationSet sap:content-version="1" Name="assoc_3EDEE251A83223DE4BCA615BA622E7D2" sap:deletable="false"
    sap:updatable="false" sap:creatable="false"
    Association="Z_PURCHASINGDOCUMENTDDL_CDS.assoc_3EDEE251A83223DE4BCA615BA622E7D2">
       <End Role="FromRole_assoc_3EDEE251A83223DE4BCA615BA622E7D2" EntitySet="Z_PurchasingDocumentDDL"/>
       <End Role="ToRole_assoc_3EDEE251A83223DE4BCA615BA622E7D2" EntitySet="Z_PurchasingDocumentItemDDL"/>
    </AssociationSet>
 </EntityContainer>
```

Figure 3.17 XML Service Metadata Document of the Simple CDS Scenario from Chapter 1 Exposed as an OData Service

3.4.2 Service Implementation Phase

In the previous data model definition phase, SADL maps the CDS data model to an OData EDM and creates a static service definition. At runtime, SADL also takes care of processing the OData requests performed by clients. The OData runtime delegates OData requests to the generic SADL query engine, which generates SQL `SELECTS` on CDS views based on the request parameters (`$select`, `$top`, `$filter`, etc.) and the requested OData entity.

An incoming OData request for the standard purchase order basic view entity might look like Listing 3.2.

```
GET I_PurchaseOrderEntity?$select=
PurchaseOrder,PurchaseOrderType,PurchasingOrganization,PurchasingGroup,Purchas
eOrderDate&$top=10&$orderby=PurchaseOrderDate asc&$filter=
( PurchaseOrderDate ge datetime'2018-01-
01T00:00:00' and PurchaseOrderDate le datetime'2018-12-31T00:00:00')
```

Listing 3.2 OData GET Request for the I_PurchaseOrderEntity OData Entity

The SADL framework will then transparently transform this request into an SQL `SELECT` statement on the `I_PurchaseOrder` CDS view (Listing 3.3).

```
SELECT
PurchaseOrder,
PurchaseOrderType,
PurchasingOrganization,
PurchasingGroup,
PurchaseOrderDate
FROM
I_PurchaseOrder
WHERE
PurchaseOrderDate GE '20180601'
    AND PurchaseOrderDate LE '20180601'
ORDERBY
    PurchaseOrderDate ASCENDING
UP TO 10 ROWS
```

Listing 3.3 Generated SQL SELECT for the OData GET Request

When you compare the OData request and the generated SQL statement, you can see that OData queries can easily be pushed down to a relational database as OData already resembles SQL, and all OData parameters can be mapped to a certain part of the SQL `SELECT` statement. This property makes OData the perfect candidate for exposing business entities over HTTP because easy transformation of HTTP requests to SQL `SELECT` statements promotes the Code-to-Data paradigm of SAP HANA and prevents unnecessary data processing on the ABAP server. Table 3.3 shows the mappings between OData parameters and SQL query parts.

OData Parameter	SQL
`$select`	`SELECT`
`$top`	`UP TO n ROWS`
`$orderby`	`ORDERBY`
`$filter`	`WHERE`

Table 3.3 Mapping between OData Parameters and Corresponding Parts of an SQL SELECT Statement

Table 3.3 Mapping between OData Parameters and Corresponding Parts of an SQL SELECT Statement (Cont.)

3.5 Business Object Processing Framework

The Business Object Processing Framework (BOPF) is an ABAP framework that constitutes the transactional runtime of an application in the ABAP Programming Model for SAP Fiori. As soon as an application requires write actions such as CUD, a BOPF business object must be generated from the CDS data model, which will take over the transactional part of the app. Currently, four transactional scenarios are supported, as discussed in the following subsections.

3.5.1 Read-Only Application with Quick Actions

In this case, you don't want to enable full create, write, and delete access but only enable a quick action, for instance, for changing the status of the business object. A BOPF business object for this scenario can be generated by annotating the root view of the CDS model with annotations on the header level as shown in Listing 3.4.

```
@ObjectModel: {
    transactionalProcessingEnabled: true,
    compositionRoot:                true,
    writeActivePersistence:         '<SQL View>',
    createEnabled:   false,
    updateEnabled:   false,
    deleteEnabled:   false
}
```

Listing 3.4 Required Annotations for Generating a BOPF Business Object to Implement Quick Actions

(Re)activation of the view will lead to the generation of a BOPF business object, and Quick Actions can be implemented in ABAP for the respective BOPF node. We also must provide an active persistence using the writeActivePersistence annotation. However, in this case, because we don't allow standard (CUD) access, it will only be used for field mappings between CDS and BOPF.

Note

When exposing a CDS view as an OData service using Auto-Exposure or the RDS scenario, SADL takes the createEnabled, updateEnabled, and deleteEnabled CDS annotations into account and maps them to OData entity set attributes. For instance, if the CDS view doesn't enable write access or doesn't have a linked BOPF business object at all, the respective OData entity set will have the attributes sap:creatable=”false”, sap:updatable=”false”, and sap:deletable=”false”.

3.5.2 New Application without Draft

If we also want to enable standard generic CUD access for our application, we must set the createEnabled, updateEnabled, and deleteEnabled annotations to true (Listing 3.5). Furthermore, we must provide the database table in which the data must be persisted in using the writeActivePersistence annotation.

```
@ObjectModel: {
transactionalProcessingEnabled: true,
compositionRoot:                true,
        writeActivePersistence: '<ActivePersistenceName>',
        createEnabled:          true,
        updateEnabled:          true,
        deleteEnabled:          true
}
```

Listing 3.5 Required Annotations for Full CUD BOPF Support

In this case, BOPF will generically handle CUD operations. If we want to enhance the standard generic transaction logic, we can provide BOPF actions, validations, or determinations for the respective node of the BOPF business object. However, if we want to reuse existing legacy ABAP CUD implementations containing complex business logic, the next scenario is better suited.

3.5.3 Draft-Enabled Application

In this scenario, data isn't immediately written to the standard active database tables but is stored in a draft table. This scenario is very well suited for legacy applications that already consist of database tables and ABAP CUD code, including complex business logic. We can enable the old database tables for SAP HANA optimized read access by providing CDS views on top of the legacy database tables and still reuse the legacy ABAP code when activating a draft. Activating in this context means transferring the data from the intermediary draft table to the actual table. To do this, the BOPF business object root node will provide an adapter (/bobf/if_frw_draft~copy_draft_to_active_entity) that must be implemented by the developer and maps the draft representation of the data to the legacy signature of the ABAP code to write the data into the legacy database tables. The required annotations for generating the draft infrastructure are shown in Listing 3.6.

```
@ObjectModel: {
    transactionalProcessingEnabled: true,
    compositionRoot:                true,
    draftEnabled:                   true;
    writeDraftPersistence: '<DraftPersistenceName>',
    createEnabled:   true,
    updateEnabled:   true,
    deleteEnabled:   true
}
```

Listing 3.6 Required Annotations for Generating the BOPF Draft Infrastructure for a Legacy Application with an Existing Persistence

3.5.4 New Application with Draft

In this scenario, we provide new tables for draft and active entities (Listing 3.7). As in the previous scenario, data will be stored in intermediary draft tables and only written to the active persistence on explicit activation of the entity. However, in this scenario, BOPF will completely take over the transactional processing. We can only enhance the data processing by adding BOPF actions, validations, or determinations to the respective nodes of the BOPF object. This scenario is only suited for new applications. If legacy tables and ABAP CUD code will be reused, this scenario isn't the right choice.

```
@ObjectModel: {
    transactionalProcessingEnabled: true,
    compositionRoot:                true,
    draftEnabled:                   true;
    writeDraftPersistence:  '<DraftPersistenceName>',
    writeActivePersistence: '<ActivePersistenceName>'
    createEnabled:   true,
    updateEnabled:   true,
    deleteEnabled:   true
}
```

Listing 3.7 Required Annotations for Generating the BOPF Draft Infrastructure for a New Application

3.6 SAP Fiori

The open access to backend business data via OData and SAP Gateway enables the use of modern non-ABAP UI technologies for displaying and interacting with business data. The UI of applications developed using the ABAP programming model for SAP Fiori is therefore completely based on the SAPUI5 framework, which implements the SAP Fiori design. The UI part of applications is usually implemented using the cloud-based SAP Web IDE and is either based on SAP Fiori elements applications or freestyle applications. SAP Fiori elements applications, for instance, the list report and object page templates or floorplans, adapt their layouts based on the OData service's metadata and UI annotations defined in CDS views or their respective metadata extensions. Therefore, SAP Fiori elements templates significantly reduce the necessary frontend SAPUI5 JavaScript code to a minimum and increase developer productivity significantly by still providing flexibility using predefined extension points in the frontend.

Additionally, transparent to the developer, the SAP Fiori elements applications implement the necessary CRUD request handling for read-only, draft-enabled, and non-draft-enabled applications, depending on which BOPF scenario has been annotated, generated, and implemented in the backend. Freestyle applications, in contrast to SAP Fiori elements, provide the frontend developer with full flexibility over the UI design and logic but require a lot of effort in the development phase. The UI layout and its controls must be declared manually by the developer, and the necessary SAPUI5 JavaScript logic must be implemented. Therefore, it's not recommended to use complex draft-enabled BOPF scenarios with freestyle applications because the orchestration of the necessary requests might become too complicated. Moreover, another risk when developing freestyle applications is the violation of SAP Fiori design guidelines. Consequently, only use freestyle applications when the required UI design isn't realizable using one of the SAP Fiori elements floorplans.

3.7 Summary

In this chapter, we gave you an overview of the ABAP programing model for SAP Fiori and its associated technologies. We started with CDS, which are at the center of any application development for SAP S/4HANA. They are the foundation for all application types and can be configured for different application types using domain-specific UIs, analytics, search annotations, or transactional annotations. Next, we looked at SAP Gateway and OData as the technologies enabling easy network-based access to business data stored in SAP NetWeaver backend systems. Then we explored SADL and how it supports providing model-based read and transactional access to CDS entities via OData. The BOPF constitutes the transactional runtime of the ABAP programming model for SAP Fiori and enables ABAP-based CUD operations for data models based on CDS views. It provides several scenarios for different application requirements, which we briefly listed and described.

Contents

2 SAP Fiori and the Design-Led Development Process 49

3 ABAP Programing Model for SAP Fiori 95

PART II Developing Applications for SAP S/4HANA

4 Developing an SAP Fiori Elements List Report and Object Page 121

8 Deploying Applications to the SAP Fiori Launchpad 297

PART III Operating Applications

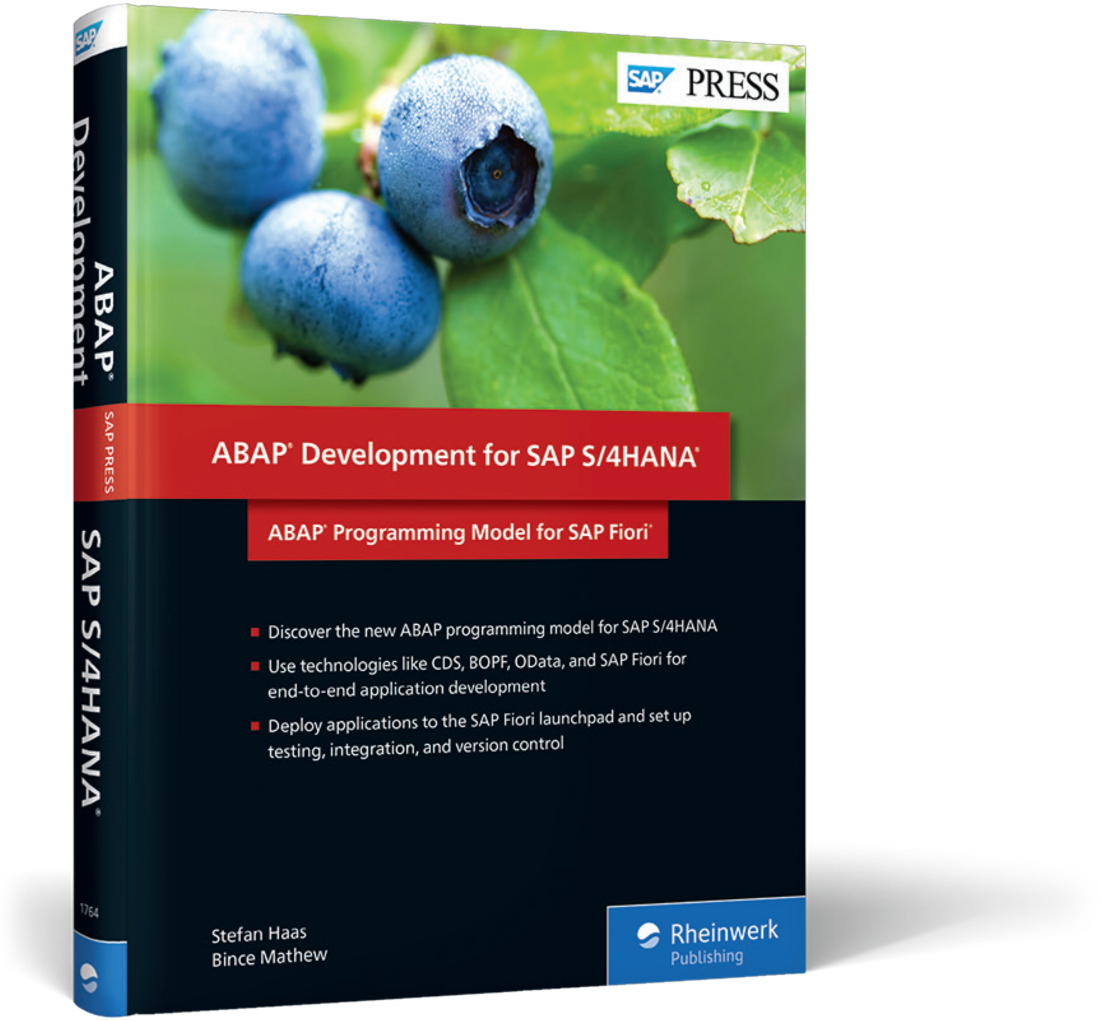
9 Version Control in SAP Web IDE Using Git 335

10 Automated Testing 361

11 Continuous Integration 393

Appendices 423

Index



Stefan Haas, Bince Mathew

ABAP Development for SAP S/4HANA: ABAP Programming Model for SAP Fiori

461 Pages, 2018, $79.95
ISBN 978-1-4932-1764-9

Stefan Haas is a senior developer at SAP working on Enterprise Asset Management applications for SAP S/4HANA within the Digital Supply Chain and Manufacturing lines of business. He is an experienced full stack developer on all layers of SAP S/4HANA ranging from SAP HANA, core data services (CDS), and ABAP over OData and SAP Gateway to SAP Fiori, SAPUI5, and JavaScript. Additionally, he was a fellow at the Machine Learning Engine team of SAP's Predictive Maintenance and Service cloud solution. He holds a master's degree in computer science, with a minor in business, from Ludwig Maximilian University of Munich and is a certified Cloud Foundry developer.

Bince Mathew is a senior developer at SAP with more than nine years of experience in providing solutions on various SAP mobility platforms. He is an expert in areas such as SAP Fiori, SAP S/4HANA, SAP Syclo, SAP Mobile Platform (formerly Sybase Unwired Platform), SAP Afaria, and the Internet of Things. He has worked with industry verticals such as Manufacturing and Retail. He is an SAP Certified Technology Associate for SAP Fiori and a published author with a focus on SAP Fiori developments. He was also given the best speaker award for SAP Fiori at the SAP Inside Track event held by SAP. He is active in the SAP Community Network (SCN) on topics related to SAP mobility.