

CLD200

**Build a side-by-side extension on
SAP BTP**

**PARTICIPANT HANDBOOK
INSTRUCTOR-LED TRAINING**

Course Version: 21
Course Duration: 2 Day(s)
Material Number: 50160659

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Typographic Conventions

American English is the standard used in this handbook.

The following typographic conventions are also used.

This information is displayed in the instructor's presentation



Demonstration



Procedure



Warning or Caution



Hint



Related or Additional Information



Facilitated Discussion



User interface control

Example text

Window title

Example text

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Course Overview

TARGET AUDIENCE

This course is intended for the following audiences:

- Application Consultant
- Development Consultant
- Super / Key / Power User
- Business Process Architect
- Business Process Owner/Team Lead/Power User
- Developer
- Enterprise Architect
- Solution Architect

UNIT 1

Setting up the CAP-Project

Lesson 1

Getting Started

3

Lesson 2

Using APIs

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Lesson 3

Describing OData

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Explaining JSON/YAML

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UNIT OBJECTIVES

- Perform the setup necessary to build your extension project
- Use APIs to exchange information in a standardized way
- Describe the OData standard for web-based applications
- Explain JSON and YAML
- Create a CAP-based service

Getting Started



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Perform the setup necessary to build your extension project

Introduction

Business Case

Let's begin by considering the following scenario:

Your manufacturing company exports goods to foreign countries. Along this supply chain, day-to-day risks and exceptional risks that can significantly influence the export business are continuously identified and monitored. These risks are to be managed in a new application.

Your company manages all business processes via an SAP S/4HANA Cloud system. Customer extensions within the system itself, known as "in-app extensions", only meet individual requirements to a certain extent. For the required risk management application, the company decided to implement a "side-by-side extension" as they offer more flexibility than "in-app extensions". The "side-by-side extensions" are developed using different types of development tools and services on the SAP Business Technology Platform (SAP BTP).

The new risk management application should be developed using the SAP Business Application Studio (BAS) on SAP BTP. There are several options and runtime environments available:



- ABAP Environment
- Cloud Foundry Runtime
- Kyma Runtime

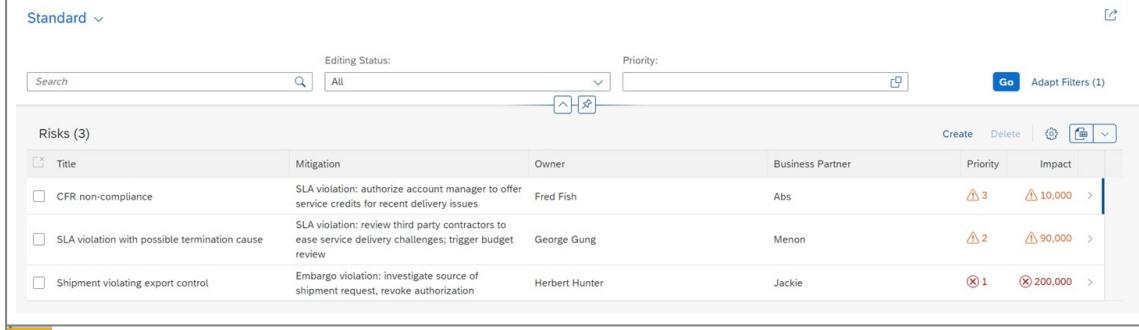
Before choosing a runtime, it is essential to familiarize yourself with the level of knowledge in your development department. If the developers only have ABAP knowledge, the decision for an extension written in ABAP, which in the end runs on the ABAP environment in the cloud, is obvious.

Let's presume your development team consists mainly of developers with Node.js knowledge. Therefore, the company decided to develop an extension with SAP's Node.js-based Cloud Application Programming Model (CAP). The deployment will take place on the [SAP BTP, Cloud Foundry Environment - SAP Help Portal](#).

As part of our development team, you will develop a CAP-based application for risk management.

Course Preview

First, you will deploy your application manually into the SAP BTP, Cloud Foundry Runtime. After that, you will add authorizations and make your application ready for continuous integration and delivery.



The screenshot shows a table titled "Risks (3)". The columns are: Title, Mitigation, Owner, Business Partner, Priority, and Impact. The data rows are:

Title	Mitigation	Owner	Business Partner	Priority	Impact
CFR non-compliance	SLA violation: authorize account manager to offer service credits for recent delivery issues	Fred Fish	Abs	⚠ 3	⚠ 10,000
SLA violation with possible termination cause	SLA violation: review third party contractors to ease service delivery challenges; trigger budget review	George Gung	Menon	⚠ 2	⚠ 90,000
Shipment violating export control	Embargo violation: investigate source of shipment request, revoke authorization	Herbert Hunter	Jackie	✗ 1	✗ 200,000

Figure 1: Risks List Page

Users of this application will then be able to create, edit, and delete risks from this list page. Each risk has the properties of `impact` and `priority` based on each risk's potential.

The risk manager can assign mitigations to the identified risks. Both, risks and mitigations, are stored in the extension's own database. Details like the name of the individual business partner that is authorized to make decisions will be retrieved from our S/4HANA Cloud system.

To view and edit a single risk, the user can select an item. This opens the object page:



The screenshot shows the object page for the risk "CFR non-compliance". The main section is labeled "Main". It displays the following details:

- Mitigation: SLA violation: authorize account manager to offer service credits for recent delivery issues
- Business Partner: Abs
- Priority: ⚠ 3
- Impact: ⚠ 10,000
- Owner: Fred Fish

Figure 2: Object Page

Caveat

Note that we cannot provide a complete SAP S/4HANA Cloud system for this course. Therefore, we have chosen to use the SAP API Business Hub SAP S/4HANA Sandbox, which provides the same OData API for business partners as a real S/4HANA Cloud system.

What's Next?

The following units will guide you through an end-to-end development process from development to automated deployment.

First Steps

To build your extension project, there are a few things you need to do first:

- Create a Full-Stack Cloud Application Dev Space Type for Business Applications in SAP Business Application Studio.

Reference links

For your convenience, this section contains the external references of this lesson in the following format:

- Reference number
- Section heading
- Context text fragment to identify the location in the section.
- Brief description of the linked content.
- Link to the content as link and in clear text

If links are used multiple times in a text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
2	Dev Space for Business Applications	Tutorial: Create a Dev Space for Business Applications	Create a dev space	https://developers.sap.com/tutorials/appstudio-devspace-create.html



LESSON SUMMARY

You should now be able to:

- Perform the setup necessary to build your extension project

Using APIs



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Use APIs to exchange information in a standardized way

What are APIs?

Business Scenario

Continuing the previous scenario, let's suppose your company is planning to develop an application that will use standard functionalities, such as creating and updating entities, that are provided by another company as Application Programming Interfaces (APIs). So, what are APIs and how can you use them?

Benefits of API

An API is a way to communicate with other software programs.

APIs specify how software programs can exchange information with each other, even if they are designed and run by different organizations. APIs facilitate interaction by selectively exposing functionality that allow different apps, websites, and devices to communicate effectively with each other. More importantly, APIs allow businesses to reach beyond regular business channels and share data, content, and services directly with both business to business (B2B) and business to consumer (B2C) clients, making UI development easy.

Business Scenario

Your company creates an application for customers to create and display maps. You create an API to enable customers to display your company's maps in their application.

The customer creates an application, such as a customer relationship management (CRM) application. Within this CRM application, the customer calls your API to add a map next to their customer's profile.

Your application receives the call and does something, such as access your proprietary map database. Your application can be as complicated as it needs to be, but the customer doesn't need to know exactly what you are doing behind the scenes.

When your application is ready, it sends a response. For example, a map for an address, entered by the customer.

To summarize, you create and expose an API and your customers could consume your API.

When your application is running and gets a request, it sends back a response - either a confirmation that you did something, or some information, requested by the customer.

The application behind your API performs some specific business logic and sends back a response that gives your customers the information they need for their own application.

Rules to Develop and Deploy APIs

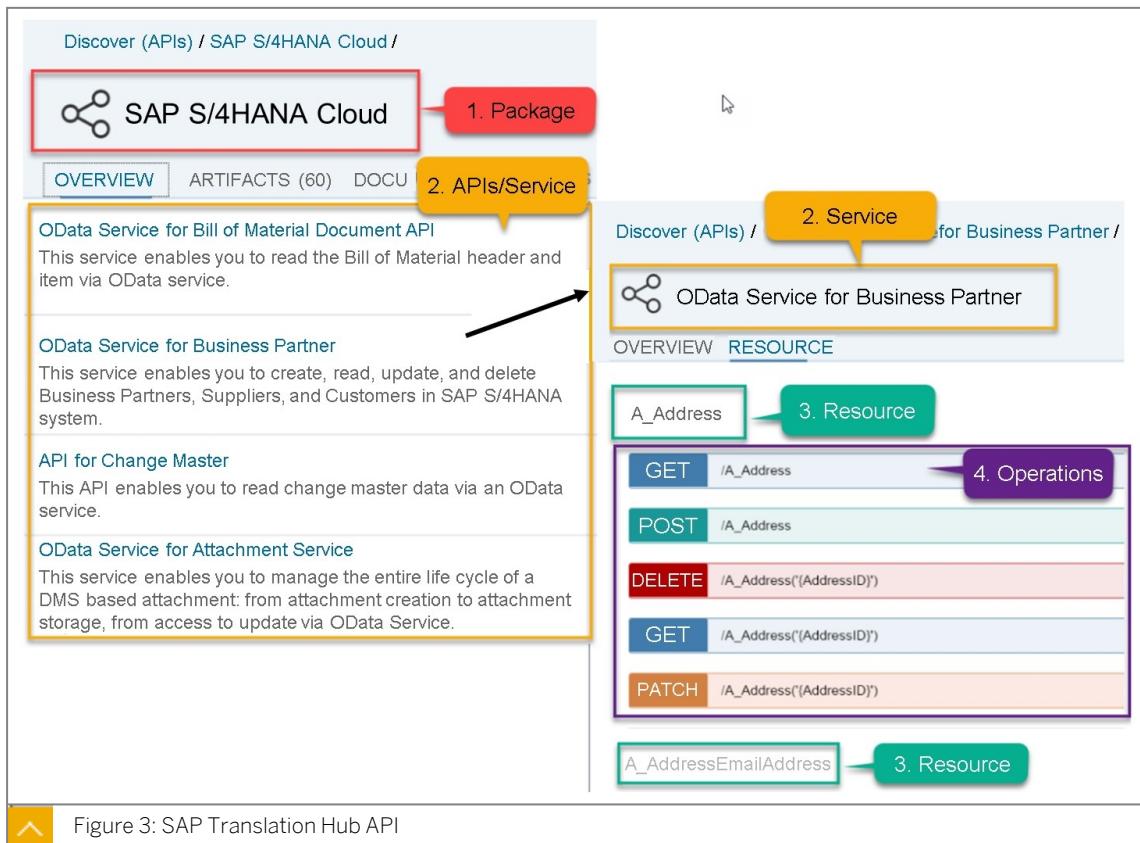
Since the developer of the API and the consumers usually do not know each other, it is useful to follow some rules.



- API documentation is a pillar of the developer experience. Good API documentation ensures that the developers fully understand the API, can use it, and don't get stuck.
- Customers and partners find it easier to adopt APIs with names that are meaningful, clear, and self-explanatory.
- Developer or service guides complement API references by describing how to use an API and related services, any SDKs, or the development platform in general.
- Rules dealing with the deprecation of APIs and the decommissioning of their deliverables.

APIs in the SAP API Business Hub

The [SAP API Business Hub](#) is a web application hosted by SAP to discover, explore, and test SAP and partner APIs that are required to build extensions or process integrations. In the SAP API Business Hub, the information about APIs is organized according to the following hierarchy as shown in the SAP Translation Hub API:



- **API Package:** An API Package is a collection of related APIs or services, belonging to one product or product area, packaged and delivered together.
- **API/service:** An API or service is a collection of related resources and operations available for each resource.

- Resource: A resource is a remote data entity, identified by a URI, on which operations are performed.
- Operation: An operation is a data operation, such as GET, POST, PUT, UPDATE, or DELETE, performed on a resource.

Summary

When we need software programs to exchange information in a standardized way, such as creating or modifying business partners (entities), these standard functions can be defined as APIs. This will also allow other organizations to develop and operate APIs. It is then important to follow some rules when developing and deploying APIs.

Further Reading

See: [What is an API?](#)



LESSON SUMMARY

You should now be able to:

- Use APIs to exchange information in a standardized way

Describing OData



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Describe the OData standard for web-based applications

What is OData?

Business Scenario

Your company is planning to develop a set of web-based applications. Open Data Protocol (OData) is intended to be used for data access as a standardized access protocol that meets the requirements of modern Web development.

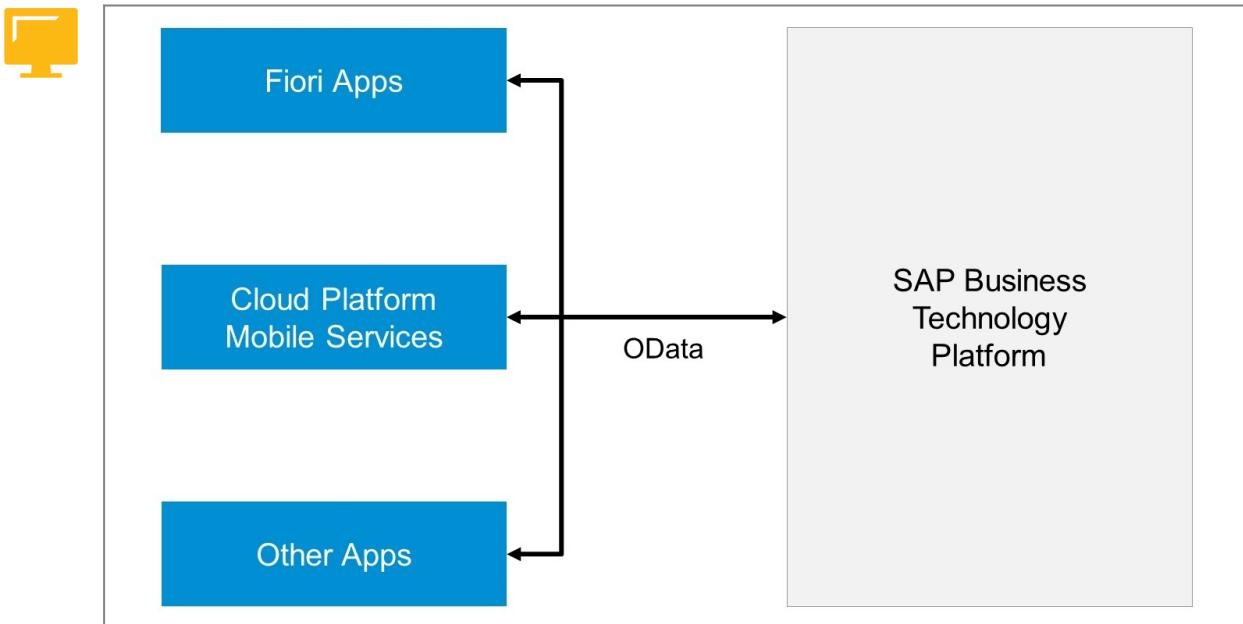
Overview

The OData is a data access protocol built on core protocols like HTTP and commonly accepted methodologies like REST (Representational State Transfer) for the web. Thus, as common practices of REST, OData builds on HTTP, AtomPub, and JSON using URIs to address and access data feed resources.

Key Challenges in Enterprise Computing for Business Consumers

The problem in the past was that for different consumers, a developer had to build a specific integration scenario that used its own protocol. However, one-off applications specific to each device or platform were not transferable. For example, a solution built for browser-based applications could not be used for an integration of enterprise software.

The solution is to use one protocol, the OData protocol.



OData Service

An **OData service** is a logical data model; it describes entities (resources) using associations and operations. The most important point is that the OData service forms a kind of contract between the UI and the back end system side, helping to bring together developers on both sides.

OData currently supports two formats for representing the resources it exposes:

- the XML-based AtomPub and
- the JSON formats

JSON has significantly less protocol overhead than the Atom Publishing protocol. JSON can easily be consumed with JavaScript and by SAPUI5.

Each OData service is represented by a URI, called the service root URI. A URI (Uniform Resource Identifier) is a uniform resource identifier, which is a string of characters used to identify a resource. More precisely, each resource can be accessed using a URL (Uniform Resource Locator), a uniform resource locator, describing how to access the resource. This type of identification enables interaction with representations of the resource across a network using specific protocols like OData.

Types of documents associated with each OData service

There are two types of documents associated with each OData service:



- The service document
- The service metadata document

The service document lists entity sets, functions, and singlenets that can be retrieved. Clients can use the service document to navigate the model in a hypermedia-driven fashion. The service document is available at `http://<host>:<port>/<service>/`.

The metadata document describes the types, sets, functions, and actions understood by the OData service. Clients can use the metadata document to understand how to query and interact with entities in the service. The service metadata document is available at `http://<`

<host>:<port>/<service>/\$metadata. The URL will return XML metadata of the service (Entity data model). The response of a service metadata document only supports XML.

CRUD Operations

CRUD stands for CREATE, READ, UPDATE, and DELETE. One of the main features of OData is that it uses the existing HTTP verbs GET, PUT, POST, and DELETE against addressable resources identified in the URI.

Conceptually, OData is a way of performing database-style create, read, update, and delete operations on resources by using HTTP verbs:



- **GET**: Get the resource (a collection of entities, a single entity, a structural property, and so on).
- **POST**: Create a new resource.
- **PUT**: Update an existing resource by replacing it with a complete instance.
- **PATCH**: Update an existing resource by replacing part of its properties with a partial instance.
- **DELETE**: Remove the resource.

OData API

An Application Programming Interface (API) allows you to access data, for example, monitoring data.

The [OData API](#) is implemented as a REST API and the technical protocol is OData. This means that you can use standard HTTP methods (for example, the GET method) to call the API.

Summary

You now have a more profound understanding of the OData protocol, and also you can explain why it is so useful in modern web development.

Further Reading

- [SAP Gateway – Building OData Services](#)
- [OData - the Best Way to REST](#)
- [Understand OData in 6 steps](#)



LESSON SUMMARY

You should now be able to:

- Describe the OData standard for web-based applications

Unit 1

Lesson 4

Explaining JSON/YAML



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Explain JSON and YAML

JSON and YAML

Business scenario

Continuing the previous scenario, let's assume that your company is interested in using standardized techniques for modern web development. This includes the use of JSON (JavaScript Object Notation) and YAML (originally meaning Yet Another Markup Language) for data exchange and configuration files, for example. You need to become more familiar with these open standard formats.

What are JSON and YAML?

JSON

JSON is an open standard file format and data interchange format that uses human-readable text to store and transmit data objects consisting of attribute: value pairs and arrays. It is a common data format with a diverse range of functionality in data interchange including communication of web applications with servers.

JSON is a lighter plain-text alternative to XML and based on JavaScript syntax but is independent of JavaScript and supported in other programming languages as well. JSON file names use the extension .json.

JSON is built on two structures:



- A collection of name: value pairs. In various languages, this is realized as an object.
- An ordered list of values. In most languages, this is realized as an array.

The following example shows a possible JSON representation describing a person.

```
{  
    "firstName": "John",  
    "lastName": "Smith",  
    "isAlive": true,  
    "age": 27,  
    "address": {  
        "streetAddress": "21 2nd Street",  
        "city": "New York",  
        "state": "NY", "postalCode": "10021-3100"  
    },  
    "phoneNumbers": [  
        {  
            "type": "home",  
            "number": "212 555-1234"  
        },  
        {  
            "type": "mobile",  
            "number": "312 555-1234"  
        }  
    ]  
}
```

```

    "type": "home",
    "number": "212 55-1234"
},
{
    "type": "office",
    "number": "646 555-4567"
}
],
"children": [],
"spouse": null
}

```

If you currently don't have an editor installed supporting JSON, here is what it looks like with syntax highlighting.



```

{
    "firstName": "John",
    "lastName": "Smith",
    "isAlive": true,
    "age": 27,
    "address": {
        "streetAddress": "21 2nd Street",
        "city": "New York",
        "state": "NY",
        "postalCode": "10021-3100"
    },
    "phoneNumbers": [
        {
            "type": "home",
            "number": "212 555-1234"
        },
        {
            "type": "office",
            "number": "646 555-4567"
        }
    ],
    "children": [],
    "spouse": null
}

```



Figure 4: JSON Representation Describing a Person

YAML

YAML is a human-friendly, cross language, Unicode based data serialization language designed around the common native data types of agile programming languages. It is broadly useful for programming needs ranging from configuration files to internet messaging to object persistence to data auditing.

YAML was specifically created to work well for common use cases such as: configuration files, log files, interprocess messaging, cross-language data sharing, object persistence, and debugging of complex data structures. When data is easy to view and understand, programming becomes a simpler task. YAML filenames use the extension `.yaml` or `.yml`.

YAML is a strict JSON superset and includes additional features such as the notion of tagging data types, support for non-hierarchical data structures, the option to structure data with indentation, and multiple forms of scalar data quoting. YAML is an open format.

The following example shows a possible YAML representation describing a family.

```

--- # The Smiths
- { name: John Smith, age: 33 }
- name: Mary Smith

```

```

age: 27
- [name, age]: [Rae Smith, 4] # sequences as keys are supported
--- # People, by gender
men: [John Smith, Bill Jones]
women:
  - Mary Smith
  - Susan Williams

```

If you currently don't have an editor installed supporting YAML, here is what it looks like with syntax highlighting.



```

--- # The Smiths
- {name: John Smith, age: 33}
- name: Mary Smith
  age: 27
  - [name, age]: [Rae Smith, 4] # sequences as keys are supported
  --- # People, by gender
  men: [John Smith, Bill Jones]
  women:
    - Mary Smith
    - Susan Williams

```

Figure 5: YAML Representation Describing a Family

Objects and lists are important components in YAML and can be mixed. The first example is a list of key-value objects, all people from the Smith family. The second lists them by gender; it is a key-value object containing two lists.

YAML in Relation to JSON

Both JSON and YAML aim to be human-readable data interchange formats. However, JSON and YAML have different priorities.

JSON's foremost design goal is simplicity and universality. Therefore, JSON is trivial to generate and parse, at the cost of reduced human readability. It also uses a lowest common denominator information model, ensuring any JSON data can be easily processed by every modern programming environment.

In contrast, YAML's foremost design goals are human readability and support for serializing arbitrary native data structures. Thus, YAML allows for extremely readable files, but is more complex to generate and parse. In addition, YAML ventures beyond the lowest common denominator data types, requiring more complex processing when crossing between different programming environments.

YAML can therefore be viewed as a natural superset of JSON, offering improved human readability and a more complete information model. This is also the case in practice; every JSON file is also a valid YAML file. This makes it easy to migrate from JSON to YAML if or when the additional features are required.

Summary

You now have a more profound understanding of JSON and YAML.

Further Reading

- [JSON - Wikipedia](#)
- [YAML - Wikipedia](#)



LESSON SUMMARY

You should now be able to:

- Explain JSON and YAML

Unit 1

Lesson 5

Creating a CAP-Based Service



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Create a CAP-based service

Reference Links: Creating a CAP-Based Service

For your convenience, this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref #	Section	Context text fragment	Brief description	Link
1	Add a Data Model to the Project	You are using the namespace riskmanagement.	Using namespaces	https://cap.cloud.sap/docs/guides/domain-models#using-namespaces
2	Add a Service to the Project	annotation enables edit sessions with draft states	Draft-based editing	https://cap.cloud.sap/docs/advanced/fiori#draft-support



LESSON SUMMARY

You should now be able to:

- Create a CAP-based service

Learning Assessment

1. What is the default IDE for SAP's multi-cloud environment?

Choose the correct answer.

- A Eclipse
- B Oxygen
- C SAP Business Application Studio
- D Microsoft Visual Code

2. Which dev space type should you select to extend SAP S/4HANA with a CAP project?

Choose the correct answer.

- A SAP Fiori
- B SAP HANA Native Application
- C Full Stack Cloud Application

3. What is an Application Programming Interface (API)?

Choose the correct answer.

- A A software development kit (SDK) for mobile applications
- B A way for applications to interact with other applications
- C A way for applications to remotely modify other applications

4. Where can you find APIs provided by SAP and SAP partners?

Choose the correct answer.

- A SAP Cloud Connector
- B SAP Business Application Studio
- C SAP API Business Hub

5. What is OData?

Choose the correct answer.

- A Standard to access data through RESTful APIs
- B Standard to create user interfaces (UI) for applications
- C Standard to share data under a creative commons license

6. Which of the following does OData use to address and access data feed resources?

Choose the correct answer.

- A URL
- B URN
- C URI

7. Which document types are associated with an OData service?

Choose the correct answers.

- A Service manifest document
- B Service document
- C Service description document
- D Service metadata document

8. JSON is based on which programming language?

Choose the correct answer.

- A Java
- B Julia
- C JCL
- D JavaScript

9. What are the two structures JSON is built on?

Choose the correct answers.

- A Collections of name/value pairs
- B Collections of value/value pairs
- C Unordered list of strings
- D Ordered list of values

10. What is the relationship between YAML and JSON?

Choose the correct answer.

- A YAML and JSON are unrelated.
- B JSON is a superset of YAML.
- C YAML is a superset of JSON.

11. Which of the following supports non-hierarchical data?

Choose the correct answer.

- A YAML
- B JSON
- C Neither YAML nor JSON

12. Which of the following statements are correct?

Choose the correct answers.

- A Each JSON file is a valid YAML file.
- B Each YAML file is a valid JSON file.
- C JSON's foremost design goal is support for serializing arbitrary native data structures.
- D YAML's foremost design goal is support for serializing arbitrary native data structures.

13. Which command do you use to install dependencies in your project?

Choose the correct answer.

A cds

B yum

C bash

D npm

14. In data models, are namespaces optional or mandatory?

Choose the correct answer.

A mandatory

B optional

15. What is the difference between entities and types?

Choose the correct answer.

A Types represent data elements, entities describe aspects of types.

B Entities represent data, types describe properties of entity elements.

Learning Assessment - Answers

1. What is the default IDE for SAP's multi-cloud environment?

Choose the correct answer.

- A Eclipse
- B Oxygen
- C SAP Business Application Studio
- D Microsoft Visual Code

Correct. The default IDE for SAP's multi-cloud environment is SAP Business Application Studio.

2. Which dev space type should you select to extend SAP S/4HANA with a CAP project?

Choose the correct answer.

- A SAP Fiori
- B SAP HANA Native Application
- C Full Stack Cloud Application

Correct. You should use the dev space: "Full Stack Cloud Application".

3. What is an Application Programming Interface (API)?

Choose the correct answer.

- A A software development kit (SDK) for mobile applications
- B A way for applications to interact with other applications
- C A way for applications to remotely modify other applications

Correct. An Application Programming Interface (API) is a way for applications to interact with other applications.

4. Where can you find APIs provided by SAP and SAP partners?

Choose the correct answer.

- A SAP Cloud Connector
- B SAP Business Application Studio
- C SAP API Business Hub

Correct. You can find APIs provided by SAP and SAP partners in the SAP API Business Hub.

5. What is OData?

Choose the correct answer.

- A A standard to access data through RESTful APIs
- B A standard to create user interfaces (UI) for applications
- C A standard to share data under a creative commons license

Correct. OData is a standard to access data through RESTful APIs.

6. Which of the following does OData use to address and access data feed resources?

Choose the correct answer.

- A URL
- B URN
- C URI

Correct. OData uses URI to address and access data feed resources.

7. Which document types are associated with an OData service?

Choose the correct answers.

- A Service manifest document
- B Service document
- C Service description document
- D Service metadata document

Correct. The following document types are associated with an OData service: "Service document" and "Service metadata document".

8. JSON is based on which programming language?

Choose the correct answer.

- A Java
- B Julia
- C JCL
- D JavaScript

Correct. JSON is based on JavaScript.

9. What are the two structures JSON is built on?

Choose the correct answers.

- A Collections of name/value pairs
- B Collections of value/value pairs
- C Unordered list of strings
- D Ordered list of values

Correct. The two structures JSON is built on are: collections of name/value pairs, and ordered list of values.

10. What is the relationship between YAML and JSON?

Choose the correct answer.

- A YAML and JSON are unrelated.
- B JSON is a superset of YAML.
- C YAML is a superset of JSON.

Correct. The relationship between YAML and JSON is: YAML is a superset of JSON.

11. Which of the following supports non-hierarchical data?

Choose the correct answer.

- A YAML
- B JSON
- C Neither YAML nor JSON

Correct. YAML supports non-hierarchical data.

12. Which of the following statements are correct?

Choose the correct answers.

- A Each JSON file is a valid YAML file.
- B Each YAML file is a valid JSON file.
- C JSON's foremost design goal is support for serializing arbitrary native data structures.
- D YAML's foremost design goal is support for serializing arbitrary native data structures.

Correct. The statements: "Each JSON file is a valid YAML file", and "YAML's foremost design goal is support for serializing arbitrary native data structures" are correct.

13. Which command do you use to install dependencies in your project?

Choose the correct answer.

- A cds
- B yum
- C bash
- D npm

Correct. To install dependencies in your project you use the command NPM.

14. In data models, are namespaces optional or mandatory?

Choose the correct answer.

- A mandatory
- B optional

Correct. In data models, namespaces are optional.

15. What is the difference between entities and types?

Choose the correct answer.

- A Types represent data elements, entities describe aspects of types.
- B Entities represent data, types describe properties of entity elements.

Correct. Entities represent data, types describe properties of entity elements.

UNIT 2

User Interface and Business Logic

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Lesson 6

Adding Custom Business Logic

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UNIT OBJECTIVES

- List the design principles and key benefits of SAP Fiori
- Evaluate the difference between SAP Fiori and SAP Fiori Elements
- Generate a User Interface (UI) using SAP Fiori Elements
- Evaluate when to use event handlers
- Explain error handling
- Add custom business logic

Unit 2

Lesson 1

Explaining UIs: SAP Fiori



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- List the design principles and key benefits of SAP Fiori

SAP Fiori

Usage Scenario

Your company is planning to develop a set of cloud-based applications. These applications are to be used on different types of devices such as mobile phones, tablets, and laptops. The appearance of these applications should be similar on these devices to reduce the learning time for the end-users. Therefore, you need an efficient method for designing and developing the user interface of these applications. SAP Fiori provides an efficient and consistent way to serve front ends to your business applications.

Overview



The figure displays three views of the SAP Fiori user interface. The top view is a desktop browser window showing a dashboard with various cards: Sales Fulfillment Team, US Profit Margin, Wind Power Monitoring, Cumulative Totals Expenses, Comparative Annual Tools By Region, My Appointments, and a notification for a new purchase order awaiting approval. The middle view is a tablet showing a similar dashboard with additional cards for Incoming Customer Complaints and Share of Votes Processed By Region. The bottom view is a smartphone showing a simplified version of the dashboard with a chart for Average Return Rate and a bar chart for Revenue Trend.

Figure 6: SAP Fiori Overview

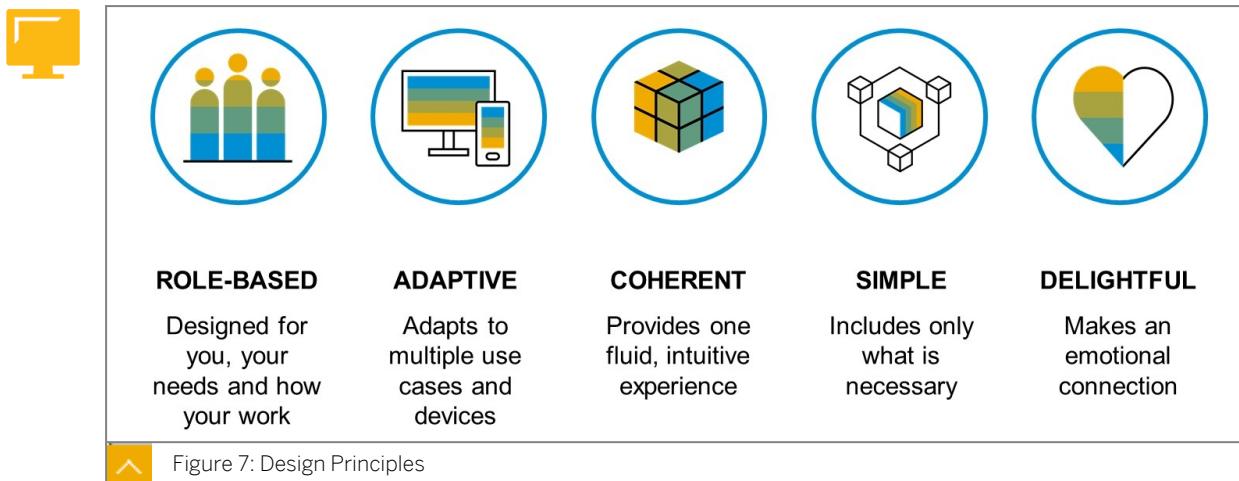
SAP Fiori is the design language that enables user experiences in enterprise applications. At the time of SAPPHIRE 2013, the first SAP Fiori apps were released for managers and employees with request and approval functions. Since then, the number of apps has grown massively. With the 2016 release of SAP S/4HANA, SAP Fiori 2.0 was introduced. Today, SAP Fiori 3 represents the current target design, which further develops the SAP Fiori design language for all SAP products to fully support the [Intelligent Suite](#).

In a nutshell, SAP Fiori defines a simple and role-based user experience (UX) that simplifies the way people work with SAP products.

The underlying technology, which is required for the design language, is [SAPUI5](#) as UI technology.

Design Principles

The underlying design philosophy of SAP Fiori is based on five core principles:



Further explanations:

ROLE-BASED

SAP Fiori is designed for your business, your needs, and the way you work. It is based on SAP's insights into the multiple roles of today's workforce. Providing the right information at the right time, SAP Fiori reflects the way people actually work.

ADAPTIVE

With SAP Fiori, you can work how and where you want, regardless of the device you're using. And it delivers relevant information that provides instant insight.

COHERENT

No matter whether you're running a sales order, checking your latest KPIs, or managing leave requests, SAP Fiori follows a consistent interaction and visual design language. Across the enterprise, you'll enjoy the same intuitive and consistent experience.

SIMPLE

SAP Fiori enables you to get your work done intuitively and quickly. With SAP Fiori, you can focus on what matters - essential functions are easy to use, and you can personalize the experience to focus on your relevant tasks and activities.

DELIGHTFUL

Beyond enabling you to work smarter, SAP Fiori also enriches your work experience by allowing you to easily get your work done.

Benefits of SAP Fiori

For businesses, the key benefits of using SAP Fiori are as follows:

- Simple and user-friendly operability
- Increased user satisfaction through modern user interfaces

- Reduced costs for in-house developments to optimize the user interface
- Optimized display on the desktop and most popular mobile devices
- Role-based permissions so that each user only sees the applications relevant to their area of responsibility

Summary

You are now familiar with the key principles and benefits of SAP Fiori. Using SAP Fiori reduces up to 80% of costs in the front end development process and ensures that all products and applications have a simple and consistent end-to-end user experience for their respective business users.

Further Reading

These resources might be helpful if you want to dive deeper into SAP Fiori.

- [SAP Fiori Product Page](#)
- [SAP Fiori @ SAP](#)
- [SAP Fiori Guidelines](#)
- [SAP Fiori Foundations ILT-Course](#)



LESSON SUMMARY

You should now be able to:

- List the design principles and key benefits of SAP Fiori

Explaining UIs: Elements Versus SAP Fiori



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Evaluate the difference between SAP Fiori and SAP Fiori Elements

SAP Fiori Elements

Usage Scenario

Your company is planning to develop a set of cloud-based applications. These applications should be accessible on all device types such as mobile phones, tablets, and laptops. The look and feel of these applications should be similar on these devices to reduce learning time for end-users. Therefore, you need an efficient way to design the UI of these applications. SAP Fiori Elements provides multiple generic templates to do so.

Advantages of Using SAP Fiori Elements

SAP Fiori itself represents the design philosophy behind SAP applications. This philosophy defines the core principles that should drive modern user interfaces. Based on these principles, SAP Fiori Elements provides a set of several common page types — comparable to several templates — that give developers a head start in developing applications that connect to data in SAP back-end systems. SAP Fiori builds on [SAPUI5](#), SAP's HTML5 development toolkit.

The main idea behind SAP Fiori elements is to generate an SAP Fiori app at runtime from an existing [OData](#) service. OData is the industry standard for exchanging business data via RESTful HTTPS APIs.

Each OData service comes with a metadata document that describes the service. The metadata document is also extendable by developers. SAP entities exposing the OData services can be enriched with additional metadata, called “annotations” to define new attributes and relationships of the data. Based on these annotations, SAP Fiori elements will dynamically generate the app at runtime.

In addition to the content of the pages, SAP Fiori elements manages the logic and behavior of the application. For example, there is no longer the need to write UI code to manage navigation between pages or apps, to apply a filter to the content of a table, or to edit and save an object. This means that standard apps require very little UI development, and occasionally no additional UI code at all.

When your app differs slightly from the standard page specification, it is possible to use annotations to achieve exactly the look or functionality you want. If you want a fully custom app, sometimes called a **freestyle app**, using your own designs, layouts or workflows, you can do this with SAPUI5, but **not** with SAP Fiori elements.

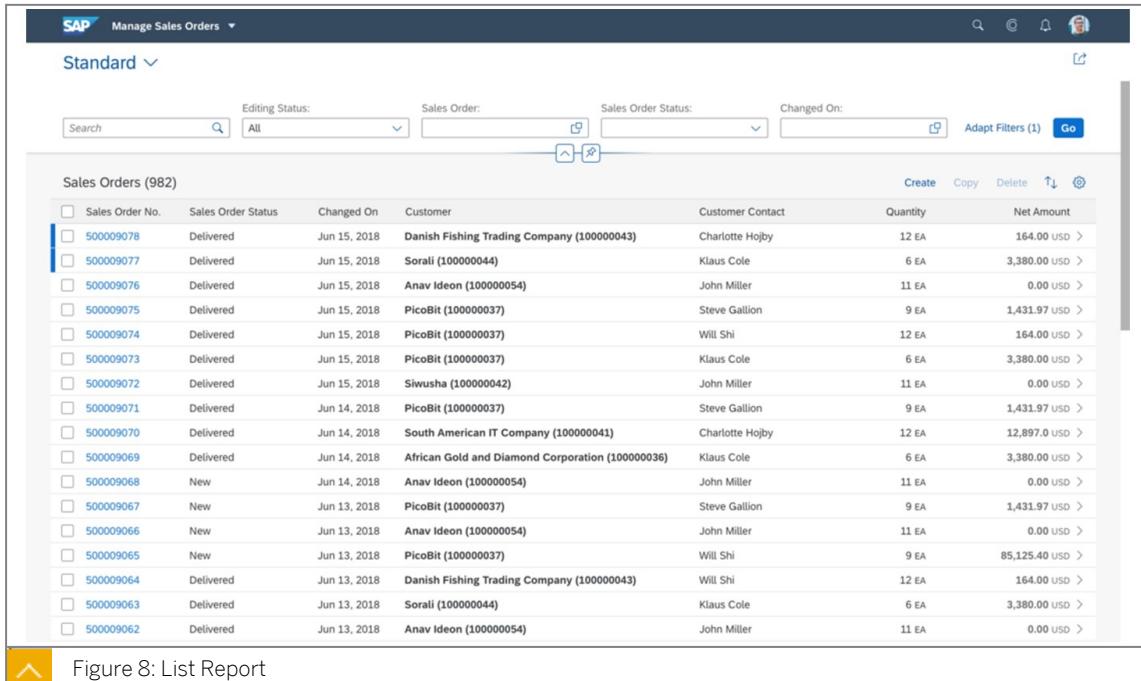
When to Use SAP Fiori Elements

When it comes to decision-making, you or your team can choose between two options:

1. Develop the application with SAP Fiori Elements.
2. Start with SAP UI5 freestyle development.

In case your business requires a working app as quickly as possible, and you want to do as little coding as possible, SAP Fiori elements might be the right choice for you. The different template wizards will guide you through the creation of the app. During the creation, you have to decide with which page type you want to work with. SAP Fiori elements offers the following page types or floorplans:

List Report: choose this when you need to work with a [large set of items](#).



Sales Orders (982)

Sales Order No.	Sales Order Status	Changed On	Customer	Customer Contact	Quantity	Net Amount
500009078	Delivered	Jun 15, 2018	Danish Fishing Trading Company (100000043)	Charlotte Højby	12 EA	164.00 USD >
500009077	Delivered	Jun 15, 2018	Sorali (100000044)	Klaus Cole	6 EA	3,380.00 USD >
500009076	Delivered	Jun 15, 2018	Anav Ideon (100000054)	John Miller	11 EA	0.00 USD >
500009075	Delivered	Jun 15, 2018	PicoBit (100000037)	Steve Gallion	9 EA	1,431.97 USD >
500009074	Delivered	Jun 15, 2018	PicoBit (100000037)	Will Shi	12 EA	164.00 USD >
500009073	Delivered	Jun 15, 2018	PicoBit (100000037)	Klaus Cole	6 EA	3,380.00 USD >
500009072	Delivered	Jun 15, 2018	Siwusha (100000042)	John Miller	11 EA	0.00 USD >
500009071	Delivered	Jun 14, 2018	PicoBit (100000037)	Steve Gallion	9 EA	1,431.97 USD >
500009070	Delivered	Jun 14, 2018	South American IT Company (100000041)	Charlotte Højby	12 EA	12,897.0 USD >
500009069	Delivered	Jun 14, 2018	African Gold and Diamond Corporation (100000036)	Klaus Cole	6 EA	3,380.00 USD >
500009068	New	Jun 14, 2018	Anav Ideon (100000054)	John Miller	11 EA	0.00 USD >
500009067	New	Jun 13, 2018	PicoBit (100000037)	Steve Gallion	9 EA	1,431.97 USD >
500009066	New	Jun 13, 2018	Anav Ideon (100000054)	John Miller	11 EA	0.00 USD >
500009065	New	Jun 13, 2018	PicoBit (100000037)	Will Shi	9 EA	85,125.40 USD >
500009064	Delivered	Jun 13, 2018	Danish Fishing Trading Company (100000043)	Will Shi	12 EA	164.00 USD >
500009063	Delivered	Jun 13, 2018	Sorali (100000044)	Klaus Cole	6 EA	3,380.00 USD >
500009062	Delivered	Jun 13, 2018	Anav Ideon (100000054)	John Miller	11 EA	0.00 USD >

Figure 8: List Report

Worklist: use this to take action on [work items](#).



SAP Resolve Billing Issues ▾

Billing Documents

Errors (23) Warnings (50) Success (50) Information (10)

Billing Documents with Errors (23)

Document Number	Company	Contact Person	Posting Date	Amount (Local Currency)
10223882001981	Jologa	Denise Smith	11/15/2019	12,897.00 EUR
10223882001982	DelBont Industries	Richard Wilson	11/15/2019	234,197.00 EUR
10223882001983	Jologa	Denise Smith	11/15/2019	11,865.99 EUR
10223882001984	DelBont Industries	Richard Wilson	11/15/2019	12,897.00 EUR
10223882001985	Jologa	Denise Smith	11/15/2019	12,897.00 EUR
10223882001986	DelBont Industries	Richard Wilson	11/15/2019	12,897.00 EUR
10223882001987	DelBont Industries	Richard Wilson	11/15/2019	234,197.00 EUR
10223882001988	Jologa	Denise Smith	11/15/2019	12,897.00 EUR
10223882001989	DelBont Industries	Richard Wilson	11/15/2019	12,897.00 EUR
10223882001990	DelBont Industries	Richard Wilson	11/15/2019	234,197.00 EUR
10223882001991	DelBont Industries	Richard Wilson	11/15/2019	234,197.00 EUR
10223882001992	DelBont Industries	Richard Wilson	11/15/2019	12,897.00 EUR
10223882001993	Jologa	Denise Smith	11/15/2019	11,865.99 EUR
10223882001994	Jologa	Denise Smith	11/15/2019	12,897.00 EUR
10223882001995	DelBont Industries	Richard Wilson	11/15/2019	234,197.00 EUR
10223882001996	Jologa	Denise Smith	11/15/2019	12,897.00 EUR
10223882001997	Jologa	Denise Smith	11/15/2019	12,897.00 EUR
10223882001998	DelBont Industries	Richard Wilson	11/15/2019	12,897.00 EUR
10223882001999	DelBont Industries	Richard Wilson	11/15/2019	234,197.00 EUR

Search Up Down Filter Reset

Figure 9: Worklist

Object page: use to display details about an [object](#).



SAP Product ▾

Robot Arm Series 9
PO-48865

General Information

Manufacturer: Robotech
Factory: Orlando, FL
Supplier: Robotech (234242343)

Status: **Delivery** Delivery Time: **12 days** Assembly Option: **To Be Selected** Monthly Leasing Instalment: **379.99 USD**

Order Details

Order ID:	Expected Delivery Date:	Model:	Leasing Instalment:
589946637	June 23, 2018	Robot Arm Series 9	379.99 USD per month
Contract: 10045876	Factory: Florida, OL	Color: White (default)	Axis: 6 Axis
Transaction Date: May 6, 2018	Supplier: Robotech	Socket: Default Socket 10	

Configuration Details

Show More

Assembly Options

Work Items with Errors (23)

Document Number	Company	Contact Person	Posting Date	Amount (Local Currency)
10223882001820	Jologa	Denise Smith	11/15/19	12,897.00 EUR
10223882001820	DelBont Industries	Richard Wilson	11/15/19	234,197.00 EUR
10223882001820	Jologa	Denise Smith	11/15/19	11,865.99 EUR
10223882001820	DelBont Industries	Richard Wilson	11/15/19	12,897.00 EUR
10223882001820	Jologa	Denise Smith	11/15/19	12,897.00 EUR
10223882001820	DelBont Industries	Richard Wilson	11/15/19	12,897.00 EUR

Search Up Down Filter Reset

Figure 10: Object Page

Overview page: to provide an [entry-level view of content](#).

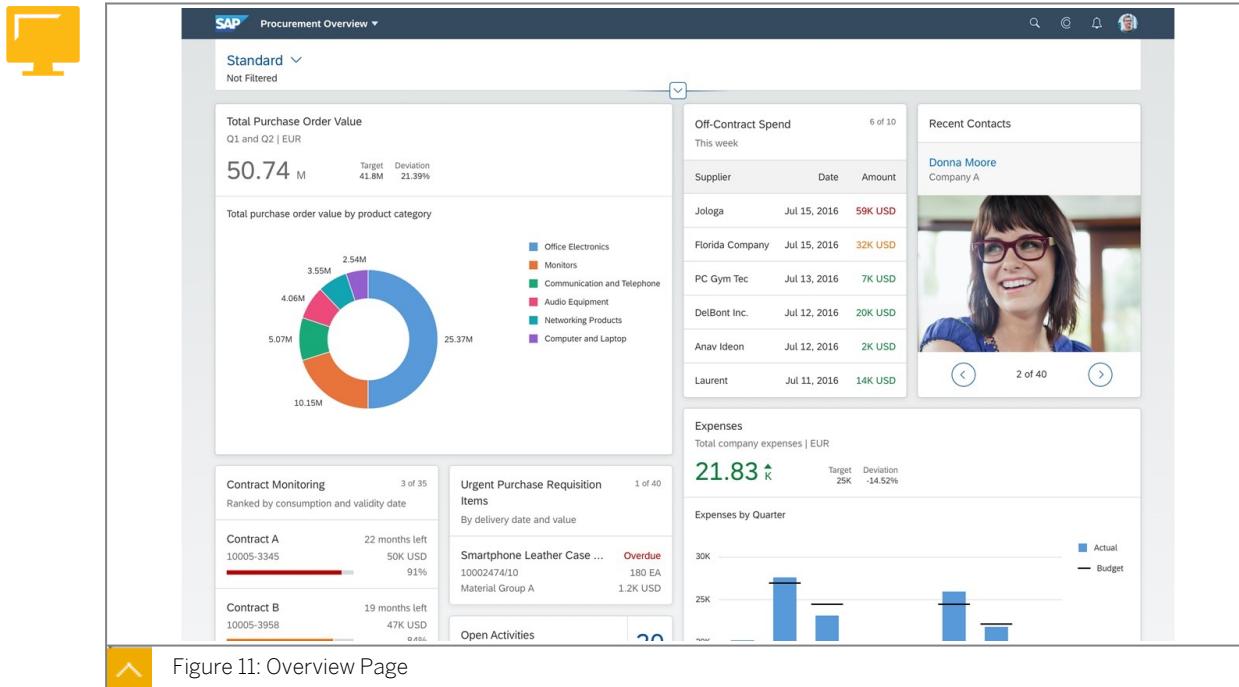


Figure 11: Overview Page

Analytical list page: provide multiple angles of data for [analyses](#).

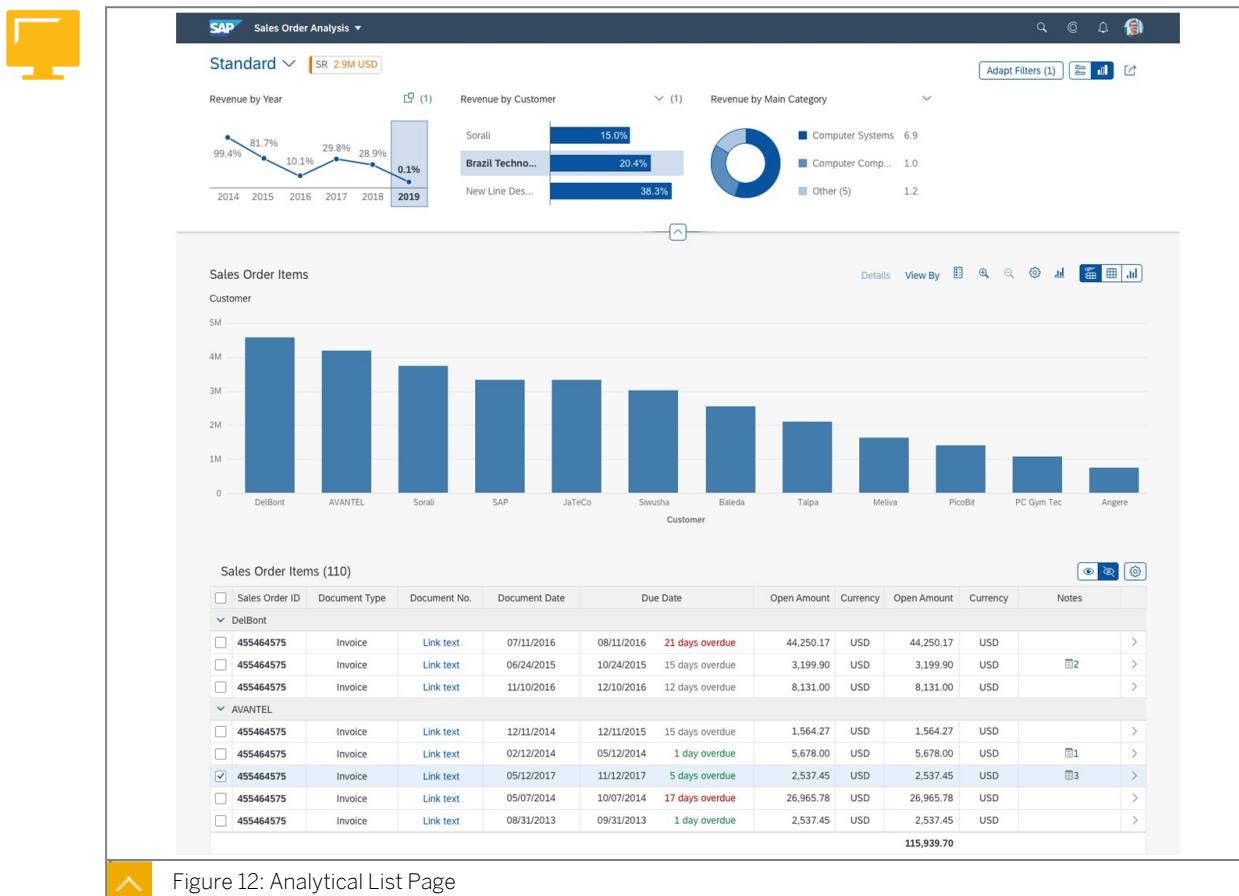


Figure 12: Analytical List Page

Summary

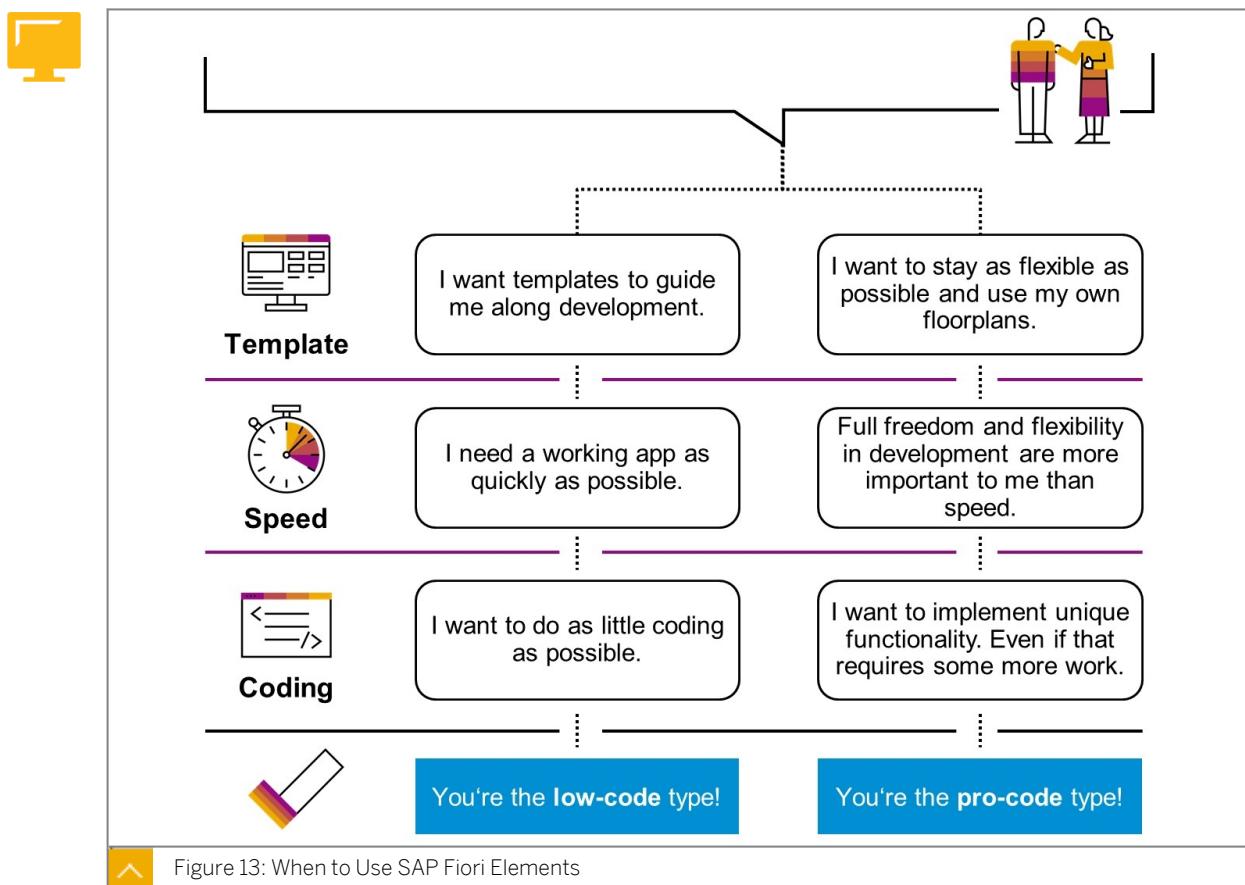


Figure 13: When to Use SAP Fiori Elements

You are now familiar with the fundamentals of SAP Fiori elements. You understand when to use SAP Fiori elements and when to start a SAPUI5 freestyle development project. If you want to dive deeper into this topic, consider the further reading section.

Further Reading

- [SAP Fiori Product Page](#)
- [SAP Fiori elements usage guide](#)
- [SAP Fiori @ SAP](#)
- [SAP Fiori Guidelines](#)
- [SAP Fiori Elements ILT-Course](#)



LESSON SUMMARY

You should now be able to:

- Evaluate the difference between SAP Fiori and SAP Fiori Elements

Generating a User interface



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Generate a User Interface (UI) using SAP Fiori Elements

Generate a User Interface Using SAP Fiori Elements, Code Snippets

In the following, you find the code blocks without page break.

```
using RiskService from '../../../../../srv/risk-service';

// Risk List Report Page
annotate RiskService.Risks with @UI : {
    HeaderInfo : {
        TypeName : 'Risk',
        TypeNamePlural : 'Risks',
        Title : {
            $Type : 'UI.DataField',
            Value : title
        },
        Description : {
            $Type : 'UI.DataField',
            Value : descr
        }
    },
    SelectionFields : [prio],
    Identification : [{Value : title}],
    // Define the table columns
    LineItem : [
        {Value : title},
        {Value : miti_ID},
        {Value : owner},
        {
            Value : prio,
            Criticality : criticality
        },
        {
            Value : impact,
            Criticality : criticality
        },
    ],
});
```

Reference Links: Generating a User Interface

For your convenience, this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
1	Task Flow	Build a user interface with SAP Fiori elements	SAP Fiori elements	https://experience.sap.com/fiori-design-web/smart-templates/



LESSON SUMMARY

You should now be able to:

- Generate a User Interface (UI) using SAP Fiori Elements

Unit 2

Lesson 4

Evaluating the Use of Event Handling



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Evaluate when to use event handlers

Event Handling - CAP Service SDK for Node.js

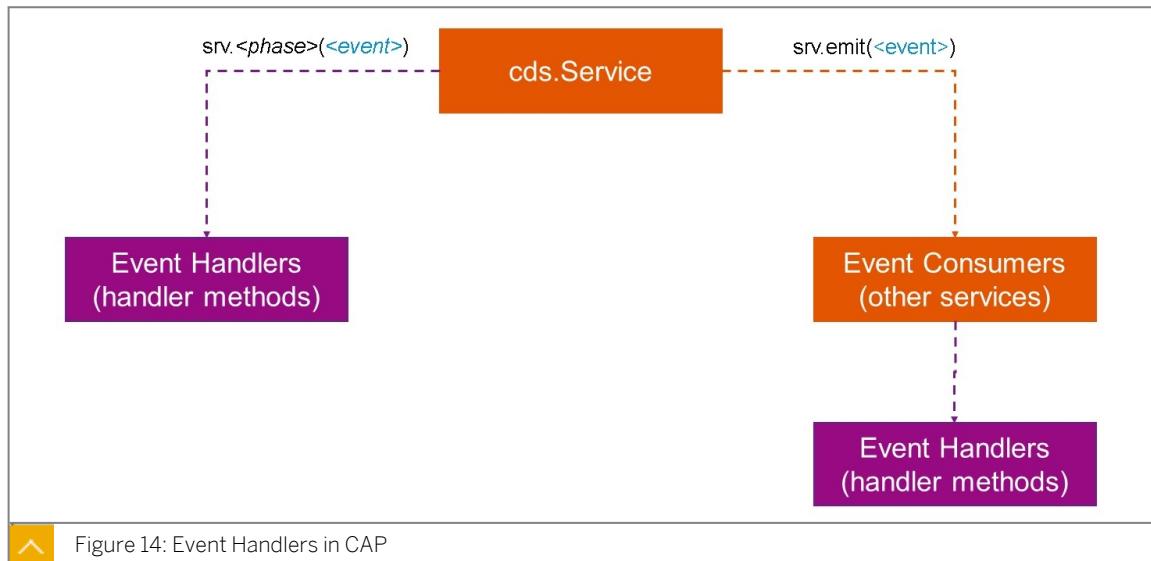
Usage Scenario

Your company is planning to build an extension application using the SAP Cloud Application Programming Model (CAP). The generic service handlers that the framework provides for standard CRUD operations (CREATE, READ, UPDATE, DELETE) do not fully satisfy the application's requirements. You want to implement custom business logic on top of the standard functionality. For that, you need to understand the concept of event handlers in CAP.

Event Handlers in CAP

Event Handlers in CAP

In CAP everything that happens at runtime is an event that is sent to a service. They are a powerful means to extend CAP. An event handler is simply a method, that is executed when something happens in the application.



If you need a specific service to react to a specific event, you register an event handler using `srv.<phase>(<event>)`, where:

- `srv` is the instance of the service that you are extending,
- `<phase>` is one of `on`, `before`, or `after` (see the following section **Event Phases**) and
- `<event>` is any kind of named event as a string (for example '`READ`').

Once a service has an event handler for a specific event, it becomes a consumer for that event. Using `srv.emit(<event>)`, a service can send arbitrary events. These events then get consumed by other services that have event handlers registered for the respective event.

An Example

Think of a simple application, that manages your company's IT inventory. For each asset category, there is an entity, for example `Notebooks`, `Phones`, `Tablets`. The entities are exposed via an `inventory` service. The service provides an OData API that enables you to interact with the entities. Let's say you want to see the current inventory of notebooks. You perform a `GET` request to the `inventory/Notebooks` service. Within CAP, a `READ` event is triggered for the `Notebooks` entity. There is a built-in event handler (also known as *Generic Provider*) that retrieves the requested data from the database on a `READ` event for the `Notebooks` entity.

Making use of Event Handlers

CAP handles all CRUD events (`CREATE`, `READ`, `UPDATE`, `DELETE`) out-of-the-box. You do not need to take any further steps after defining your entities and services. But often times, the standard functionality does not fulfill all of your requirements. You want to implement custom logic. In these cases, you can make use of the [handler registration API](#) of the CAP Service SDK for Node.js.

Extending the Example Above

Let's assume you are building a UI on top of your `inventory` service. It should display when a device is eligible for replacement. Whether a device is eligible for replacement depends on device type, date of acquisition, or country - thus there is no easy answer. Your service needs to uncover it. Within your entities there is a boolean field `eligible_for_replacement`, which is set to `false` by default.

Whenever there is a `READ` event for any of the entities in your `inventory` service, after the entities have been read, you want to have a custom event handler finding out, whether the individual devices are eligible for replacement or not. It could look like the following:

```
cds.serve('inventory-service') .with (function() {
    this.after('READ', '*', (devices)=>{
        for (let each of devices) {
            var deviceAge = calculateDeviceAgeYears(each)
            if (deviceAge >= 4) {
                each.eligible_for_replacement = true
            } else {
                each.eligible_for_replacement = false
            }
        }
    })
})
```

The code defines that after each `READ` of any (*) entity in your `inventory` service, the eligibility for replacement should be calculated. The method loops through each line of the data that was fetched by the generic service handler. Note that instead of registering the handler method for any entity (*), you could also register the event handler for a specific entity, for example `Notebooks`.

In this simple example, eligibility for replacement only depends on the age of the device, but you can grasp that almost anything is possible here.

Event Phases

Events are processed in three phases that are executed consecutively: `Before`, `On`, and `After`. When registering an event handler, the phase in which the event handler should be called, needs to be specified. In the previous example the handler method was specified for the `After` phase. It is possible to register multiple event handlers for each event phase.

Summary

You can now explain the concept of event handlers in CAP.

Also, you are able to evaluate whether a custom event handler is required, and you are able to perform basic implementation of custom event handlers.

Further Reading

See: [CAP Service SDK for Node.js](#)



LESSON SUMMARY

You should now be able to:

- Evaluate when to use event handlers

Explaining Error Handling



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Explain error handling

Error Handling - CAP Service SDK for Node.js

Why we need this?

Having good error handling is key to ensuring the robustness, correctness, and performance of the given application. Building robust applications requires you to throw and handle exceptions which occur during the runtime of the application. Thus, you will be introduced to the basic concepts of exception handling in Node.js as well as specific techniques for the CAP Service SDK for Node.js.

Error Handling and Error Types

Proper error handling is crucial for today's business applications. Before going into more detail, it is necessary to distinguish between two types of errors:

Programmer Errors

These occur as a result of programming errors (for example, `foo` cannot be read by `undefined`). They must be corrected.

Operational Errors

These occur during runtime (for example, when sending a request to a faulty remote system). They must be corrected.

Guidelines

"Let it crash" is a philosophy taken from the Erlang programming language (Joe Armstrong), which is also (partially) applicable to Node.js.

The key takeaways for programming errors are:

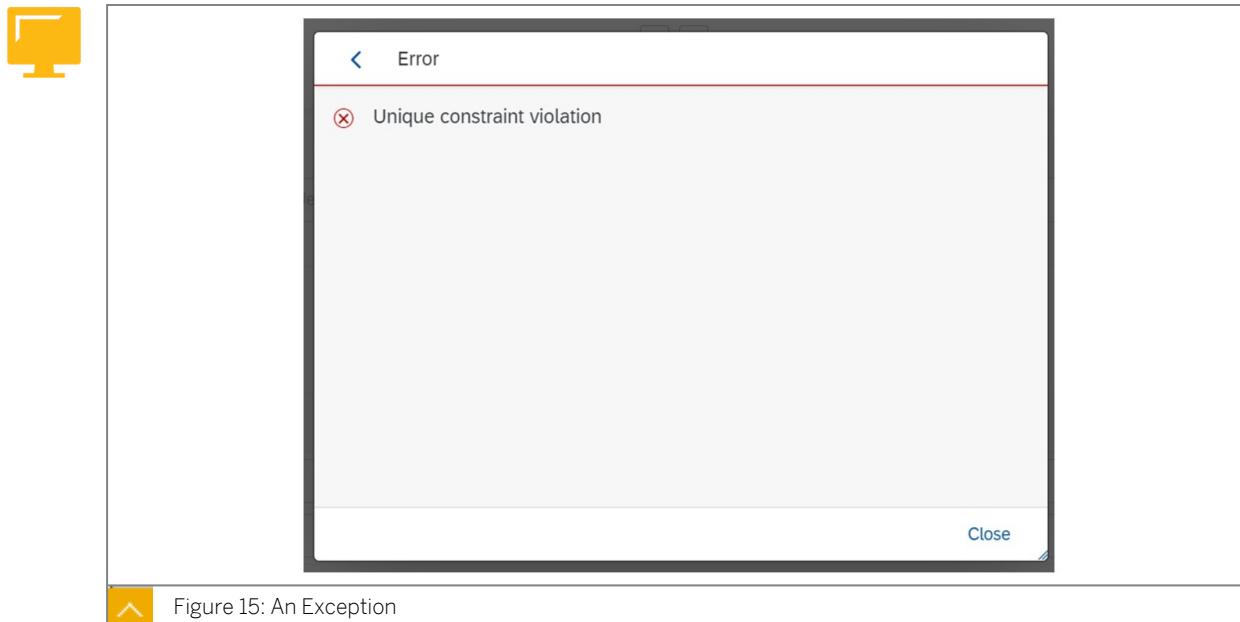
- **Fail loudly:** Do not hide errors and continue silently. Ensure to log unexpected errors correctly. Don't catch errors you can't handle.
- **Don't develop in a defensive fashion:** Focus on your business logic and only handle errors when you know they will occur. Use `try/catch` blocks only when necessary.

Never try to catch and handle unexpected errors, rejections of promises, and so on. If it is unexpected, you cannot handle it correctly. If you could, it would be expected (and should already be handled). Even if your apps should be stateless, you can never be 100% sure that a shared resource was not affected by the unexpected error. Therefore, you should never allow an app to continue running after such an event, especially for multi-tenant apps where there is a risk of information disclosure.

Following these guidelines will make your code shorter, clearer, and simpler.

Never Hide the Causes of Errors

When an error occurs, it should be possible to know the root cause. The CAP SDK for Node.js also throws exceptions, for example when a CRUD operation violates the foreign key constraints. In this case, the framework throws the exception `UNIQUE_CONSTRAINT_VIOLATION`. The problem in this case is that the end user will only see a cryptic error message:



It is therefore useful to provide a meaningful error message.

For this purpose, you can register an error handler in your service implementation, as exemplified in the editor below:



Figure 16: Example: Registering an Error Handler in an Service Implementation

Example code:

```
// Imports
const cds=require("@sap/cds");

/**
 * The service implementation with all service handlers
 */
module.exports=cds.service.impl(asyncfunction() {
    /**
     * Custom error handler
     *
     * throw a new error with: throw new Error('something bad happened');
     *
     */
    this.on("error", (err,req)=>{
        switch(err.message){
            case "UNIQUE_CONSTRAINT_VIOLATION":
                err.message="The entry already exists.";
                break;

            default:
                err.message=
                    "An error occurred. Please retry. Technical error message: "+
                    err.message;
                break;
        }
    });
});
```

This handler now steps in whenever this exception gets triggered and overrides it with an alternative error message:



Figure 17: Meaningful Error Message

Raising and Catching Exceptions

You will certainly add your implementations to your services. It is very likely, that you want to interrupt some operations before something crashes. In this case, you can throw a Node.js exception. Our recommendation is to look at the [Node.js documentation](#) for error handling.

Request Response

You can also use the `req.error()` method to collect messages or errors and return them to the caller in the request-response. Read more [here](#).

```
this.on("submitOrder", async(req)=>{
  const{ book, amount }=req.data;
  let{ stock }=awaitdb.read(Books,book, (b)=>b.stock);
  if(stock >= amount){
    awaitdb.update(Books,book).with({stock: (stock-=amount)});
    awaitthis.emit("OrderedBook",{ book, amount,buyer: req.user.id});
    returnreq.reply({ stock });// <-- Normal reply
  }else{
    // Reply with error code 409 and a custom error message
    returnreq.error(409,`${amount} exceeds stock for book #${book}`);
  }
});
```

Summary

The core error handling concepts in the CAP SDK for Node.js are now familiar to you. We strongly recommend incorporating these concepts to ensure the overall robustness of your CAP application.



LESSON SUMMARY

You should now be able to:

- Explain error handling

Unit 2

Lesson 6

Adding Custom Business Logic



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Add custom business logic

Reference Links: Adding Custom Business Logic

For your convenience, this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
1	Explanation of the Custom Code	CAP exposes several events	Handler registration API	https://cap.cloud.sap/docs/node.js/services#event-handlers
2	Explanation of the Custom Code	you have to use @impl:... notation.	Providing Custom Implementations	https://cap.cloud.sap/docs/guides/providing-services#service-impls
3	Explanation of the Custom Code	possible values of the Criticality annotation	Criticality types	https://github.com/SAP/odata-vocabularies/blob/main/vocabularies/UI.md#Criticality-Type
4	Explanation of the Custom Code	OData Annotation vocabularies for UI and Common	UI vocabulary	https://github.com/SAP/odata-vocabularies/blob/main/vocabularies/UI.md
5	Explanation of the Custom Code	OData Annotation vocabularies for UI and Common	Common vocabulary	https://github.com/SAP/odata-vocabularies/blob/main/vocabularies/Common.md



Note:
For GitHub, a registration is required.



LESSON SUMMARY

You should now be able to:

- Add custom business logic

Learning Assessment

1. What is SAP Fiori?

Choose the correct answer.

- A A collection of design guidelines.
- B An SDK to develop multi-target applications.
- C A design language.

2. What are some SAP Fiori Elements floorplans?

Choose the correct answers.

- A Analytical Worklist Page
- B List Report
- C Analytical List page
- D Analytical Dashboard Page

3. What is the main idea behind SAP Fiori elements?

Choose the correct answer.

- A Provide a showcase for the core principles of modern user interfaces (UI).
- B Generate SAP Fiori apps at runtime from an existing OData service.
- C Define a role-based user experience (UX).
- D Provide a framework and development tool kit for HTML 5.

4. What is SAP Fiori elements designed to do?

Choose the correct answers.

- A Speed up development.
- B Drive UX consistency.
- C Drive full flexibility of development.
- D Implement unique functionality.

5. You are asked to add a User Interface to your CAP project as quickly as possible and without any unique functionalities. Which option do you choose?

Choose the correct answer.

- A SAPUI5 Freestyle
- B SAP Fiori Elements
- C SAP UI5 Elements

6. What is a reason to add UI annotations to your project?

Choose the correct answer.

- A To add tooltips to the header fields of tables.
- B To allow users to annotate table cells.
- C To display columns and form fields.

7. Which pattern do you use to register an event handler?

Choose the correct answer.

- A event.()
- B phase.()
- C srv.()

8. In CAP, which keyword is used to send events?

Choose the correct answer.

- A throw
- B emit
- C actions
- D stream

9. How many event handlers can you register for one event phase?

Choose the correct answer.

- A Multiple
- B Exactly one
- C Exactly three

10. What can you do to provide meaningful error messages to users in your CAP application?

Choose the correct answer.

- A Catch exceptions.
- B Register an error handler.
- C Hide the cause of errors.
- D Register an event handler.

11. In Node.js, which statement do you use to create an exception?

Choose the correct answer.

- A throw
- B try
- C catch

12. Why does CAP set the file `risks-service.js` automatically as a handler file for the respective service?

Choose the correct answer.

- A Because the filename and the service definition filename are the same.
- B Because SAP Business Application Studio added a respective annotation.

13. Which criticality value is assigned to `Negative criticality`?

Choose the correct answer.

- A 1
- B 2
- C 3

Learning Assessment - Answers

1. What is SAP Fiori?

Choose the correct answer.

- A A collection of design guidelines.
- B An SDK to develop multi-target applications.
- C A design language.

Correct. SAP Fiori is a design language.

2. What are some SAP Fiori Elements floorplans?

Choose the correct answers.

- A Analytical Worklist Page
- B List Report
- C Analytical List page
- D Analytical Dashboard Page

Correct. Some SAP Fiori technology components are SAPUI5 and Analytics.

3. What is the main idea behind SAP Fiori elements?

Choose the correct answer.

- A Provide a showcase for the core principles of modern user interfaces (UI).
- B Generate SAP Fiori apps at runtime from an existing OData service.
- C Define a role-based user experience (UX).
- D Provide a framework and development tool kit for HTML 5.

Correct. The main idea behind SAP Fiori elements is to generate SAP Fiori apps at runtime from an existing OData service.

4. What is SAP Fiori elements designed to do?

Choose the correct answers.

- A Speed up development.
- B Drive UX consistency.
- C Drive full flexibility of development.
- D Implement unique functionality.

Correct. SAP Fiori elements is designed to speed up development and drive UX consistency.

5. You are asked to add a User Interface to your CAP project as quickly as possible and without any unique functionalities. Which option do you choose?

Choose the correct answer.

- A SAPUI5 Freestyle
- B SAP Fiori Elements
- C SAP UI5 Elements

Correct. You will use the option: "SAP Fiori Elements".

6. What is a reason to add UI annotations to your project?

Choose the correct answer.

- A To add tooltips to the header fields of tables.
- B To allow users to annotate table cells.
- C To display columns and form fields.

Correct. A reason to add UI annotations to your project is to display columns and form fields.

7. Which pattern do you use to register an event handler?

Choose the correct answer.

- A event.()
- B phase.()
- C srv.()

Correct. You use the pattern srv.() to register an event handler.

8. In CAP, which keyword is used to send events?

Choose the correct answer.

- A throw
- B emit
- C actions
- D stream

Correct. In CAP, you use the keyword emit to send events.

9. How many event handlers can you register for one event phase?

Choose the correct answer.

- A Multiple
- B Exactly one
- C Exactly three

Correct. You can register multiple event handlers for one event phase.

10. What can you do to provide meaningful error messages to users in your CAP application?

Choose the correct answer.

- A Catch exceptions.
- B Register an error handler.
- C Hide the cause of errors.
- D Register an event handler.

Correct. To provide meaningful error messages to users in your CAP application, you can register an error handler.

11. In Node.js, which statement do you use to create an exception?

Choose the correct answer.

- A throw
- B try
- C catch

Correct. In Node.js, you use the statement throw to create an exception.

12. Why does CAP set the file `risks-service.js` automatically as a handler file for the respective service?

Choose the correct answer.

- A Because the filename and the service definition filename are the same.
- B Because SAP Business Application Studio added a respective annotation.

Correct. CAP sets the file because the filename and the service definition filename are the same.

13. Which criticality value is assigned to Negative criticality?

Choose the correct answer.

- A 1
- B 2
- C 3

Correct. The criticality value 1 is assigned to Negative criticality.

Lesson 1

Adding an External Service

63

UNIT OBJECTIVES

- Add and consume an external service

Unit 3

Lesson 1

Adding an External Service



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Add and consume an external service

Reference Links: Add an External Service

For your convenience, this section contains the external references in this lesson.

If links are used multiple times in the text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
1	Task Flow	Add an EDMX file to your project.	EDMX OData standard	http://docs.oasis-open.org/odata/odata/v4.0/odata-v4.0-part3-csdl.html
2	Download the Business Partner EDMX File	Open the SAP API Business Hub page	SAP API Business Hub	https://api.sap.com/
3	Add the EDMX File to the Project	CSN is a compact representation of CDS	SAP Cloud Application Programming Model	https://cap.cloud.sap/docs/cds/csn
4	Add the Business Partner Field to the UI	...as it happened before in Create a CAP-Based Service..	SAP Cloud Application Programming Model	See exercise: Create a CAP-Based Service



LESSON SUMMARY

You should now be able to:

- Add and consume an external service

Learning Assessment

1. What do you need to connect a service to the Sandbox environment of the SAP API Business Hub for the Business Partner API that you want to use?

Choose the correct answer.

- A An API key
- B A personal token

2. What does the .env file provide?

Choose the correct answer.

- A Values into the runtime environment of a CAP service
- B Values for your version-management-system

Learning Assessment - Answers

1. What do you need to connect a service to the Sandbox environment of the SAP API Business Hub for the Business Partner API that you want to use?

Choose the correct answer.

A An API key

B A personal token

Correct. You need an API key to connect a service to the Sandbox environment of the SAP API Business Hub for the Business Partner API that you want to use.

2. What does the .env file provide?

Choose the correct answer.

A Values into the runtime environment of a CAP service

B Values for your version-management-system

Correct. The .env file provides values into the runtime environment of a CAP service.

Lesson 1

Using a BTP Management Tool: CF CLI

69

Lesson 2

Performing a Manual Deployment

71

UNIT OBJECTIVES

- Use the Cloud Foundry Command Line Interface (CF CLI)
- Perform a manual deployment

Using a BTP Management Tool: CF CLI



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Use the Cloud Foundry Command Line Interface (CF CLI)

The Cloud Foundry Command Line Interface

Usage Scenario

You have an account in the SAP Business Technology Platform and you enabled the runtime in your subaccount. To manage the environment using a command line interface, you need to get familiar with the Cloud Foundry Command Line Interface (CF CLI).

Manage the Cloud Foundry Runtime

The CF CLI enables you to work with the Cloud Foundry runtime to deploy and manage your applications. To manage the Cloud Foundry runtime, you can use both the BTP cockpit and the CF CLI. Many actions can only be performed via the CF CLI, for example, renaming a Cloud Foundry org.

To install the CLI, you can either grab the latest release on the [official release page](#) or use <https://tools.hana.ondemand.com/#cloud>.

In order to manage the SAP Cloud Foundry runtime, you need to provide the CF CLI with an API endpoint. The API endpoint depends on the region you chose for your account:

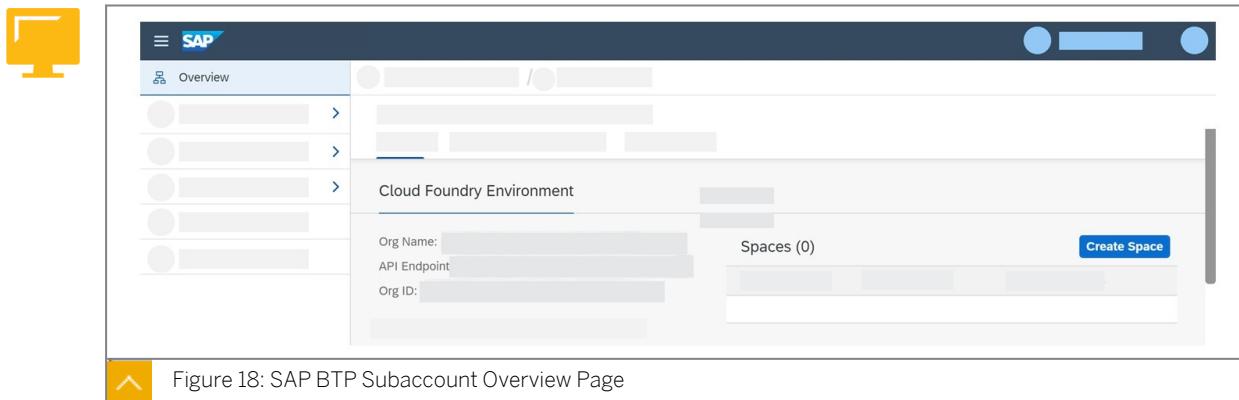
- For EU: <https://api.cf.eu10.hana.ondemand.com>
- For US EAST: <https://api.cf.us10.hana.ondemand.com>
- For US CENTRAL: <https://api.cf.us20.hana.ondemand.com>



Note:

The mentioned endpoints above are examples. Please always use the endpoint which you can find in the SAP BTP cockpit.

You can find your specific API endpoint of your Cloud Foundry organization on your SAP BTP subaccount overview page.



To try this out, you can open a command prompt and enter the following commands (in this case for the EU region):

```
cf api <your-api-endpoint>
cf login
```

Enter your credentials and try it out.

If you want to have an overview of all commands, enter the following command:

```
cf help -a
```

If you want to know the use of a special command, for example `rename-org` to rename an org, enter the following command:

```
cf help rename-org
```

CF CLI: Plug-ins

[CF CLI: Plug-ins](#) offers a list of additional commands that have been implemented as plug-ins to extend the base CF CLI client.

You can find examples of a CF CLI plug-in for performing operations on multi-target applications (MTAs) in Cloud Foundry, such as deploying, removing, viewing, and so on:

- [MTA-Plug-in for Cloud Application Programming](#)
- [Multi-Apps CF CLI Plug-in](#)

Summary

You now have a more profound understanding of the CF CLI to manage the Cloud Foundry environment.



LESSON SUMMARY

You should now be able to:

- Use the Cloud Foundry Command Line Interface (CF CLI)

Unit 4

Lesson 2

Performing a Manual Deployment



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Perform a manual deployment

Reference Links: Performing a Manual Deployment

For your convenience this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
1	Set Up SAP HANA Cloud Trial Instance	Open your SAP BTP Trial Account Cockpit	Open SAP BTP cockpit	https://cockpit.hana-trial.ondemand.com/trial/#/globalaccount
2	Manual Deployment Using a "Multi Target Application" (MTA) File	(MTA) file for deployment	SAP Help Portal, Create the MTA...	https://help.sap.com/viewer/4505d0bdaf4948449b7f7379d24d0f0d/2.0.05/en-US/ebb42efc880c4276a5f2294063fae0c3.html
3	Manual Deployment Using a "Multi Target Application" (MTA) File	it supports blue-green deployment.	SAP Help Portal, Blue-Green Deployment Strategy	https://help.sap.com/viewer/65de2977205c403bb107264b8eccf4b/Cloud/en-US/7c83810c31d842938cbc39c135a2d99f.html
4	Generate MTA Deployment Descriptor (mta.yaml)	MTA deployment is described in the MTA Deployment Descriptor	SAP Help Portal, MTA deployment	https://help.sap.com/viewer/4505d0bdaf4948449b7f7379d24d0f0d/2.0.03/en-US/33548a721e6548688605049792d55295.html



LESSON SUMMARY

You should now be able to:

- Perform a manual deployment

Learning Assessment

1. Which tools can you use to manage the SAP BTP, Cloud Foundry environment?

Choose the correct answers.

- A SAP Business Application Studio
- B Eclipse
- C CF CLI
- D SAP BTP cockpit

2. After you run the command `cds add hana`, which file is updated with the required configuration?

Choose the correct answer.

- A package.js
- B package.cds
- C package.json
- D package.mta

3. What are the advantages of using an MTA file for deployment? (Choose 2)

Choose the correct answers.

- A It supports red - green deployment.
- B It supports blue-green deployment.
- C It provides workflows.
- D It provides a build tool.

4. What are yaml files used for?

Choose the correct answer.

- A To describe documents
- B To describe data

5. Which statements about YAML files are correct? (Choose 2)

Choose the correct answers.

- A YAML uses whitespace indentation for structuring purposes.
- B YAML uses tab indentation for structuring purposes.
- C YAML uses hyphens: - for comments.
- D YAML uses hashes: # for comments.

Learning Assessment - Answers

1. Which tools can you use to manage the SAP BTP, Cloud Foundry environment?

Choose the correct answers.

- A SAP Business Application Studio
- B Eclipse
- C CF CLI
- D SAP BTP cockpit

Correct. You can use the following tools to manage the SAP BTP, Cloud Foundry environment: CF CLI and SAP BTP cockpit.

2. After you run the command `cds add hana`, which file is updated with the required configuration?

Choose the correct answer.

- A package.js
- B package.cds
- C package.json
- D package.mta

Correct. The package.json file is updated with the required configuration.

3. What are the advantages of using an MTA file for deployment? (Choose 2)

Choose the correct answers.

- A It supports red - green deployment.
- B It supports blue-green deployment.
- C It provides workflows.
- D It provides a build tool.

Correct. The advantages of using an MTA file for deployment are: "it supports blue-green deployment", and "it provides a build tool".

4. What are yaml files used for?

Choose the correct answer.

- A To describe documents
- B To describe data

Correct. Yaml files are used for describing data.

5. Which statements about YAML files are correct? (Choose 2)

Choose the correct answers.

- A YAML uses whitespace indentation for structuring purposes.
- B YAML uses tab indentation for structuring purposes.
- C YAML uses hyphens: - for comments.
- D YAML uses hashes: # for comments.

Correct. The following statements are correct: "YAML uses whitespace indentation for structuring purposes", and "YAML uses hashes: # for comments".

UNIT 5

Authorization and Trust Management

Lesson 1

Describing Authorization and Trust Management

79

Lesson 2

Defining CDS Restrictions and Roles

85

Lesson 3

Configuring Authorization and Trust Management for Production

87

Lesson 4

Assigning Role Collections

89

UNIT OBJECTIVES

- Describe the SAP Authorization and Trust Management service
- Define CDS Restrictions and Roles
- Add the UI and approuter module to the MTA
- Assign role collections

Describing Authorization and Trust Management



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Describe the SAP Authorization and Trust Management service

SAP Authorization and Trust Management Service

Business Case

Your company is developing a set of applications on the SAP Business Technology Platform, Cloud Foundry environment. As the applications are running in the cloud, you want to protect them from unauthorized access. The SAP Authorization and Trust Management service in conjunction with the Extended Services - User Account and Authentication (XSUAA) service provide all the required features.

Manage User Authorizations

The [SAP Authorization and Trust Management service](#) lets you manage user authorizations and trust to identity providers. Identity providers are the user base for applications. You can use an identity authentication tenant, an SAP on-premise system, or a custom corporate identity provider. User authorizations are managed using technical roles at the application level, which can be aggregated into business-level groups and role collections for large-scale cloud scenarios.

Platform Users Versus Business Users

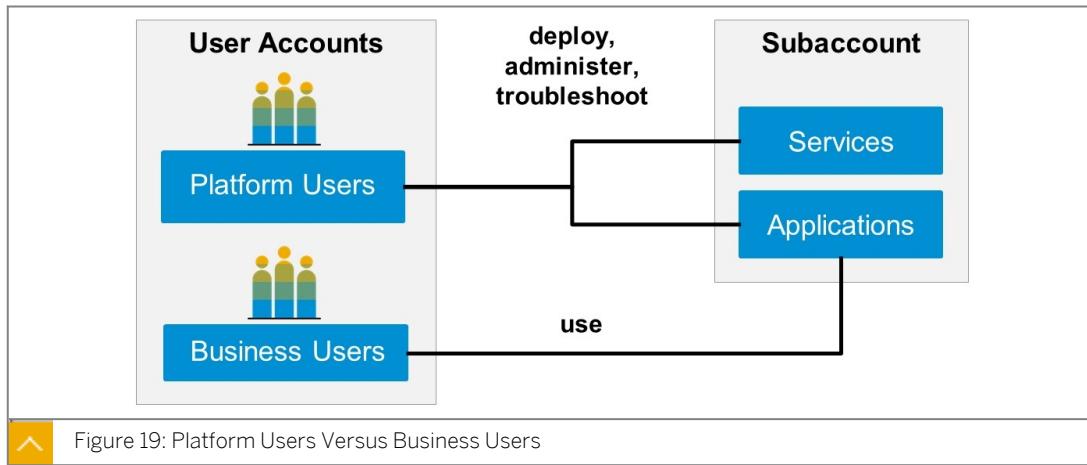
Platform Users

Platform users are usually developers, administrators, or operators who deploy, administer, and troubleshoot applications and services on SAP BTP.

For platform users, the default identity provider is SAP ID service.

Business Users

Business users use the applications that are deployed to SAP BTP. For example, the end users of your deployed application or users of subscribed apps or services, such as SAP Business Application Studio or SAP Web IDE, are business users.



Extended Services - User Account and Authentication (XSUAA) Service

The Extended Services - User Account and Authentication (XSUAA) service is one of the most important components to deal with when developing your own applications on Cloud Foundry. It authenticates and authorizes your users and assigns the right privileges to your user's session so your application can:

- Identify the user by Email, UserId, First and Lastname.
- Check its roles (scopes) to decide if a user is allowed to do something or prohibit its action.

The XSUAA is an internal development of SAP. SAP took the base of the [open source UAA OAuth2 Provider of Cloud Foundry](#) and extended it with SAP specific features to be used in SAP applications. One important thing is that the XSUAA does NOT store “real” users. This is why the XSUAA needs to trust an external Identity Provider (IdP).

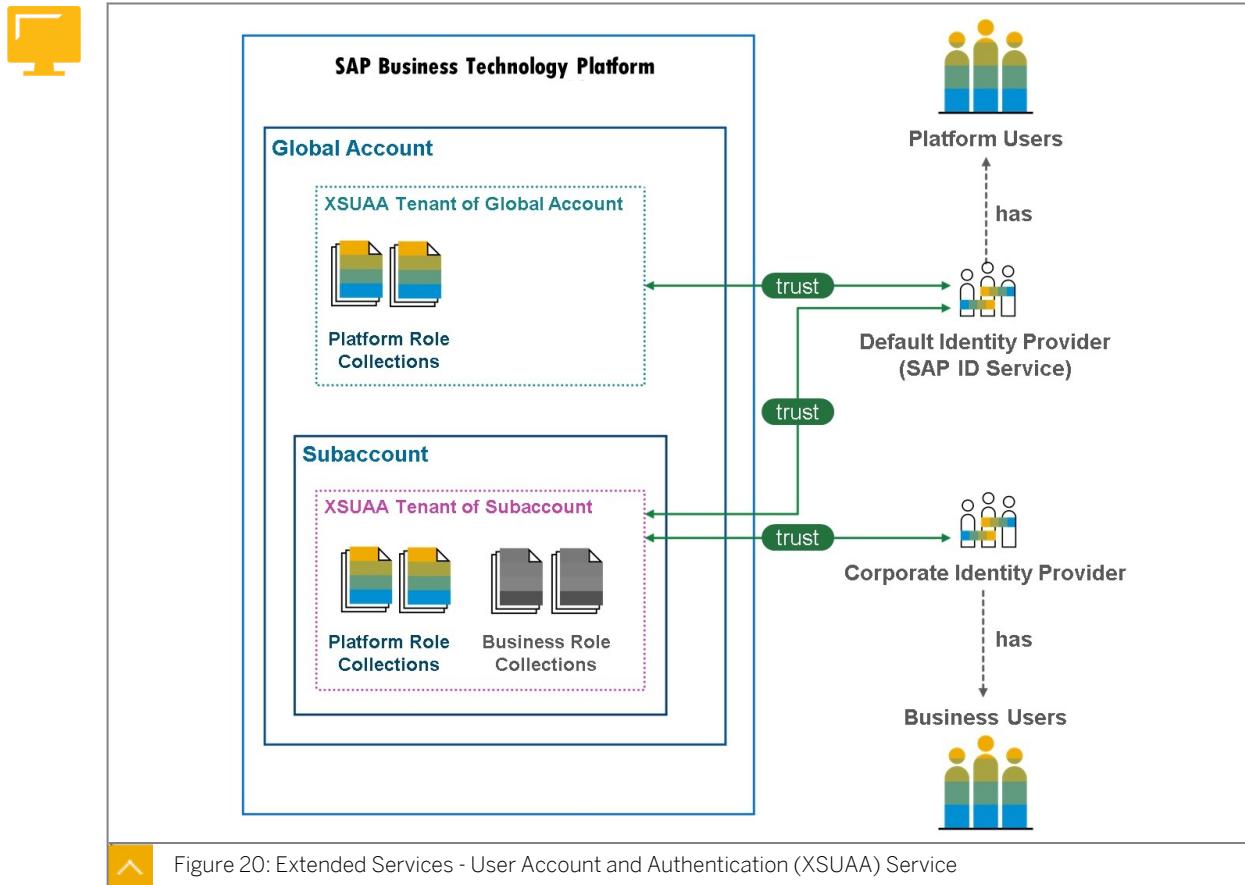


Figure 20: Extended Services - User Account and Authentication (XSUAA) Service

Note:

This graphic only applies to SAP Business Technology Platform cloud management tools Feature Set B. Check out [User and Member Management](#) in the SAP Help Portal pages to better understand the differences between Feature Set A and Feature Set B in regard to user management.

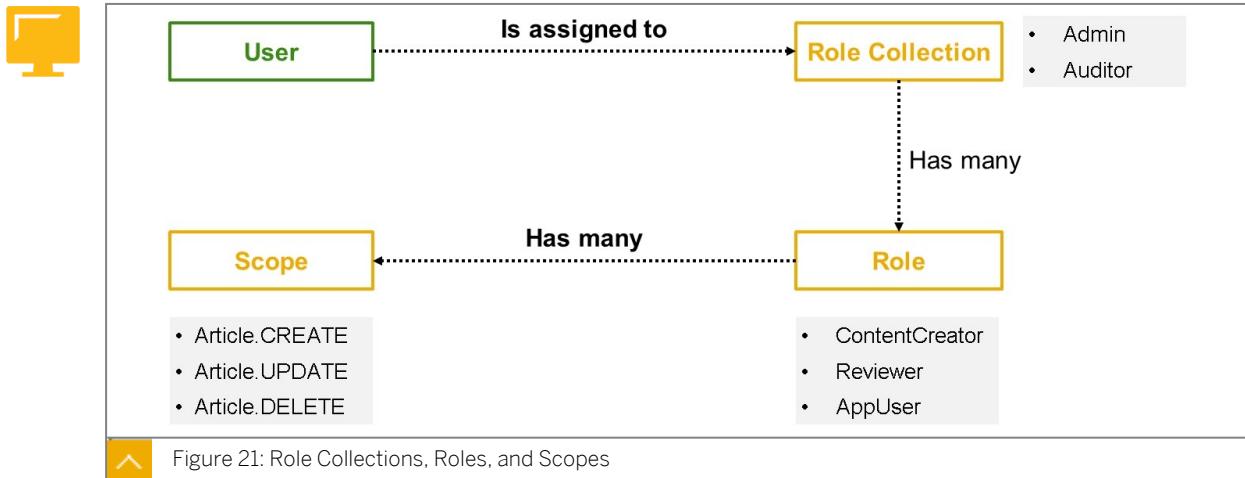
In Feature Set B, your SAP BTP global account has its own XSUAA tenant. This XSUAA tenant by default has a trust relationship to the SAP ID service. The SAP ID service manages a large base of users, that have created a [user account with SAP](#). You can add users that exist in the SAP ID service as members to your global account and subaccount. For these users to be able to perform administrative tasks, they need to be assigned with corresponding role collections. There is a set of default platform role collections, like `Global_Account_Administrator`, `Global_Account_Viewer`, `Subaccount_Administrator`, or `Cloud_Connector_Administrator` that you can use for the purpose of assigning SAP BTP account management authorizations. See this [SAP Help Portal page](#) for further information on the default role collections for account management.

Contrary to the platform users from the SAP ID service, your business users can also be provided via your own corporate identity provider. These are the users you want to provide access to your business applications. These might be SaaS applications provided by SAP, like SAP Business Application Studio or SAP Workflow Management, or your own applications that you develop on the SAP BTP. The business applications have their own role collections, like - for example - `Business_Application_Studio_Developer`, `WorkflowManagementAdmin`, or any custom role collection that you create for your application.

The following sections shed more light on the terms role collection, role, and scope, and their relationship to each other.

role collections, Roles, and Scopes

The following image shows the relationships between role collections, roles, and scopes.



Scopes

Scopes are arbitrary values that express authorizations / access rights in an application or service. Scopes need to be prefixed with an `xsappname` to make them uniquely identifiable.

Roles

Roles are entities that hold several scopes. Scopes can be put in multiple roles, so you are not limited to have scopes sitting in just one role.

Role Collections

Role collections contain one or more roles. A role can be used in multiple s. But it is totally fine to have, for example, a called `Admin` that only has an `admin` role.

Role collections are stored as an assignment in the XSUAA and are THE entity that can be assigned to a certain business user.

How Does it Work in Practice?

The following section is a short summary of the [official help page](#).

In the diagram, you can see that there are different personas. One is the developer working within a project and space. The other persona is an admin taking care of the CF account as a security admin.

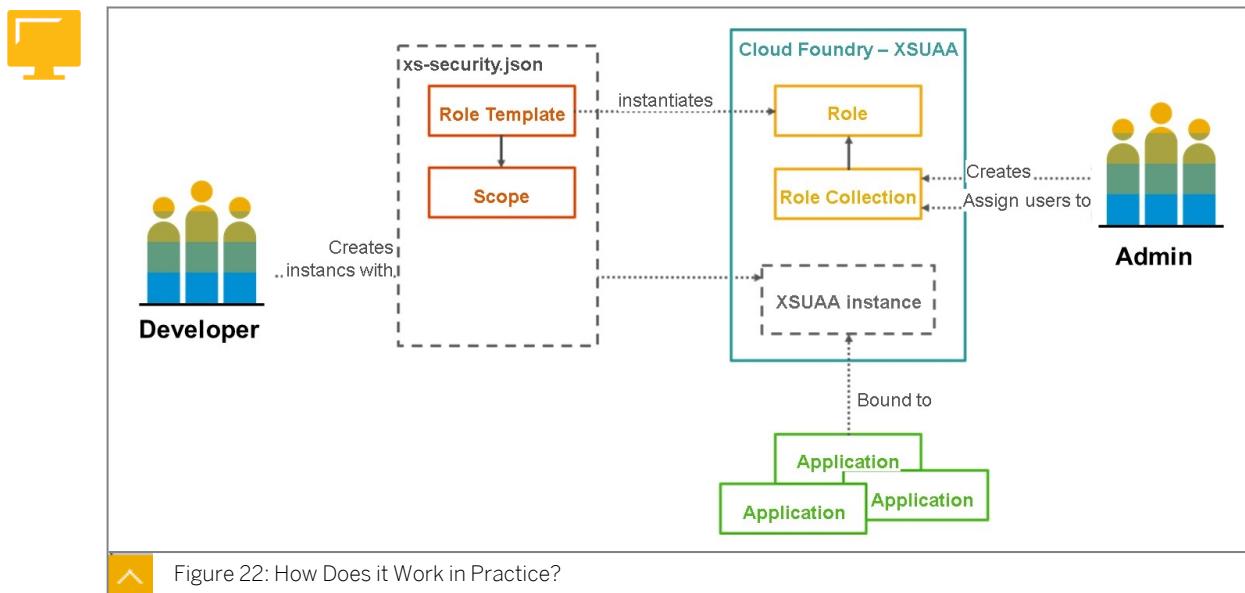


Figure 22: How Does it Work in Practice?

When you, as a developer, build a new business application, you define scopes and pre-bundle them in role-templates. You perform these definitions in the so called application security descriptor (`xs-security.json`) file. You use the `xs-security.json` file to create an instance of the XSUAA service, which is bound to the corresponding business application(s). The role-template definitions translate into roles. You, as an administrator, assemble these roles into sets and assign them to the business users of your application.

What is `xs-security.json`?

To simplify things, let's just call the `xs-security.json` the "declaration of your app's security". The following `xs-security.json` is an excerpt of the risk-management application being built in the SAP Extension Suite fundamentals course.

```
{
    "xsappname": "risk-management",
    "tenant-mode": "dedicated",
    "scopes": [
        {
            "name": "$XSAPPNAME.RiskViewer",
            "description": "RiskViewer"
        },
        {
            "name": "$XSAPPNAME.RiskManager",
            "description": "RiskManager"
        }
    ],
    "attributes": [],
    "role-templates": [
        {
            "name": "RiskViewer",
            "description": "generated",
            "scope-references": [
                "$XSAPPNAME.RiskViewer"
            ],
            "attribute-references": []
        },
        {
            "name": "RiskManager",
            "description": "generated",
            "scope-references": [
                "$XSAPPNAME.RiskManager"
            ],
            "attribute-references": []
        }
    ]
}
```

```
        ],
        "attribute-references": []
    }
}
```

You have to tell the XSUAA service how to call your application (`xsappname`) and further define your scopes and role-templates. This can also be defined in the `mta.yaml` file as well. The scopes are being used within the application to check concrete permissions whenever a user tries to perform a certain action.

Summary

You have now gained a general understanding of the SAP Authorization and Trust Management service, the relevance of the Extended Services - User Account and Authentication (XSUAA) service, and the basic concepts of user management and assignment. You know what the `xs-security.json` application security descriptor file is used for and how it relates to scopes, roles, and the XSUAA service. You also know where to look for additional information.

Further Reading

- Parts of the text and graphics were taken from the blog post [Demystifying XSUAA in SAP Cloud Foundry](#). Take a look at the blog for even more information. The explanations in regard to user management in the blog post refer to the SAP BTP cloud management tools, Feature Set A.
- [The Application Security Descriptor](#)



LESSON SUMMARY

You should now be able to:

- Describe the SAP Authorization and Trust Management service

Unit 5

Lesson 2

Defining CDS Restrictions and Roles



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Define CDS Restrictions and Roles

Reference Links: Defining CDS Restrictions and Roles

For your convenience, this section contains the external references of this lesson.

If links are used multiple times in a text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
1	Add Users for Local Testing	Learn more here.	CAP project configuration	https://cap.cloud.sap/docs/node.js/cds-env#project-settings
2	Summary	You enabled authentication using passport.js	Passport.js	http://www.passportjs.org/



LESSON SUMMARY

You should now be able to:

- Define CDS Restrictions and Roles

Configuring Authorization and Trust Management for Production



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Add the UI and approuter module to the MTA

Reference Links: Adding the UI and Approuter Module to the MTA

For your convenience, this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref#	Section			
1	Re-Build and Re-Deploy the .mtar File	Additional Documentation: How to build an MTA archive from the project sources	Build an MTA archive	https://sap.github.io/cloud-mta-build-tool/usage/#how-to-build-an-mta-archive-from-the-project-sources



LESSON SUMMARY

You should now be able to:

- Add the UI and approuter module to the MTA

Unit 5

Lesson 4

Assigning Role Collections



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Assign role collections

Reference Links: Assigning Role Collections

For your convenience, this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
1	Assign Role Collections	As the name implies, role collections	Role collections	https://help.sap.com/viewer/65de2977205c403bbc107264b8eccf4b/LATEST/en-US/0039cf082d3d43eba9200fe15647922a.html



LESSON SUMMARY

You should now be able to:

- Assign role collections

Learning Assessment

1. Which user types will work on and with SAP BTP?

Choose the correct answers.

- A Professional users
- B Platform users
- C Trial users
- D Business users

2. What is the default identity provider for SAP BTP platform users?

Choose the correct answer.

- A SAP Cloud Identity Services
- B SAP ID service
- C SAML 2.0
- D XSUAA

3. What does the Extended Services - User Account and Authentication (XSUAA) service enable your app to do?

Choose the correct answers.

- A Store "real" users.
- B Identify users by address and social security ID.
- C Identify users by e-mail, userId, first and last name.
- D Check users' roles to allow or prohibit actions.

4. Which file contains an app's "declaration of security"?

Choose the correct answer.

- A xs-sec.json
- B xs-app.json
- C xs-security.json

5. How do you add authorization and trust management to your CAP project?

Choose the correct answer.

- A cds add security
- B cds add uaa
- C cds add xsuaa

6. Which files do you modify to store project configurations?

Choose the correct answers.

- A .cdsrc.json
- B passport.js
- C package.json

7. What does the .env file provide?

Choose the correct answer.

- A Values for your version-management-system
- B Values into the runtime environment of a CAP service

8. Role collections of a subaccount are available in the global account.

Determine whether this statement is true or false.

- True
- False

9. Role collections of a global account are available in a subaccount of this global account?

Determine whether this statement is true or false.

- True
- False

10. In the SAP BTP cockpit, where can you assign role collections to users?

Choose the correct answer.

- A Security → Roles
- B Security → Users

Learning Assessment - Answers

1. Which user types will work on and with SAP BTP?

Choose the correct answers.

- A Professional users
- B Platform users
- C Trial users
- D Business users

Correct. Platform users and business users work on and with SAP BTP.

2. What is the default identity provider for SAP BTP platform users?

Choose the correct answer.

- A SAP Cloud Identity Services
- B SAP ID service
- C SAML 2.0
- D XSUAA

Correct. SAP ID service is the default identity provider for SAP BTP platform users.

3. What does the Extended Services - User Account and Authentication (XSUAA) service enable your app to do?

Choose the correct answers.

- A Store "real" users.
- B Identify users by address and social security ID.
- C Identify users by e-mail, userId, first and last name.
- D Check users' roles to allow or prohibit actions.

Correct. XSUAA enables your app to identify users by e-mail, userId, first and last name and check users' roles to allow or prohibit actions.

4. Which file contains an app's "declaration of security"?

Choose the correct answer.

- A xs-sec.json
- B xs-app.json
- C xs-security.json

Correct. The file xs-security.json contains an app's "declaration of security".

5. How do you add authorization and trust management to your CAP project?

Choose the correct answer.

- A cds add security
- B cds add uaa
- C cds add xsuaa

Correct. You can install Passport.js to add authentication to your CAP application.

6. Which files do you modify to store project configurations?

Choose the correct answers.

- A .cdsrc.json
- B passport.js
- C package.json

Correct. You modify .cdsrc.json and package.json files to store project configurations.

7. What does the .env file provide?

Choose the correct answer.

- A Values for your version-management-system
- B Values into the runtime environment of a CAP service

Correct. The .env file provides values into the runtime environment of a CAP service.

8. Role collections of a subaccount are available in the global account.

Determine whether this statement is true or false.

- True
- False

Correct. Role collections of a subaccount are not available in the global account.

9. Role collections of a global account are available in a subaccount of this global account?

Determine whether this statement is true or false.

True

False

Correct. Role collections of a global account are not available in a subaccount of this global account.

10. In the SAP BTP cockpit, where can you assign role collections to users?

Choose the correct answer.

A Security → Roles

B Security → Users

Correct. In the SAP BTP cockpit, you can assign role collections here: *Security → Users*.

UNIT 6

Automated Deployment

Lesson 1

Describing Continuous Integration and Delivery

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Creating and Connecting a GitHub Repository

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Enabling SAP Continuous Integration and Delivery

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Configuring a CI/CD Job

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Verifying the Build Success

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UNIT OBJECTIVES

- Describe the principles and benefits of continuous integration and delivery
- Create and connect a GitHub repository
- Enable SAP Continuous Integration and Delivery
- Configure a job in the SAP Continuous Integration and Delivery service
- Start monitoring a job in SAP Continuous Integration and Delivery

Describing Continuous Integration and Delivery



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Describe the principles and benefits of continuous integration and delivery

Continuous Integration and Continuous Delivery (CI/CD)

Usage Scenario

Your company develops a set of cloud applications in a dedicated development environment. Usually, this environment is the developer's computer or even a cloud-based Integrated Development Environment (IDE), such as the SAP Business Application Studio (BAS). Locally, you can run and test your application at any time. The manual build and deployment is often very tedious and not convenient at all. To automate these repetitive build and deployment steps, you can set up an automation. CI/CD pipelines are well suited for this.

What is a CI/CD Pipeline?



CI/CD-Pipeline

Continuous Integration Continuous Delivery Continuous Deployment

Figure 23: CI/CD Pipeline

The goal of CI/CD is to automate as many steps of software development as possible in order to minimize manual effort. There are a variety of ways to achieve this.

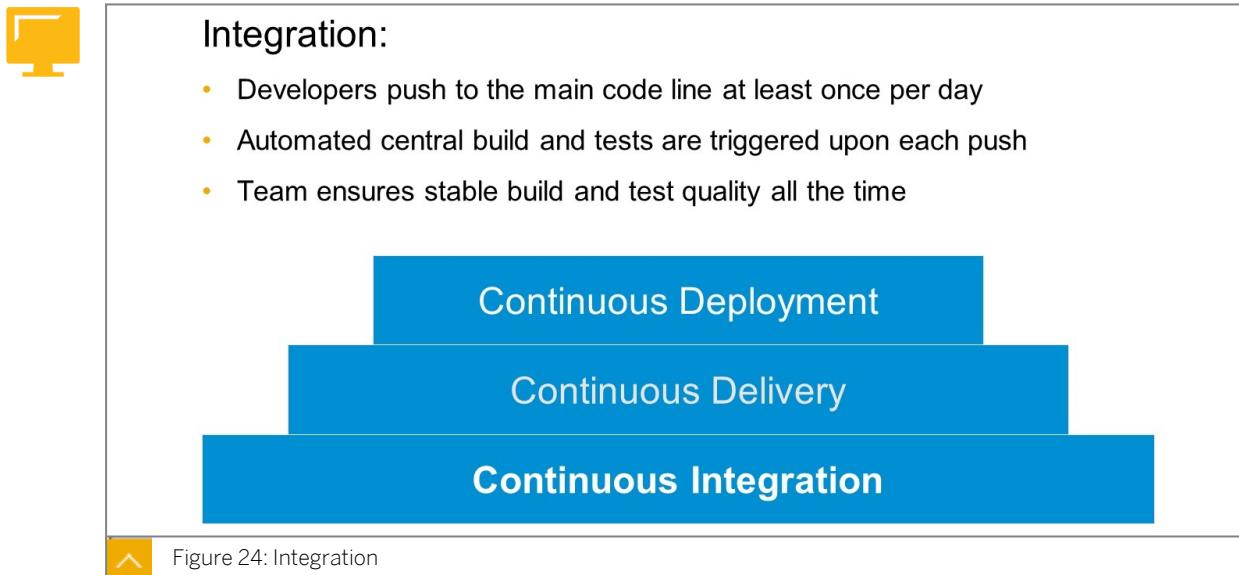
But before diving deeper, let's clarify the question: what is a pipeline?

Well, at its simplest, it is a series of activities that are carried out in a predefined order.

A CI/CD pipeline's goal is to automate as many steps of software development as possible to reduce manual effort.

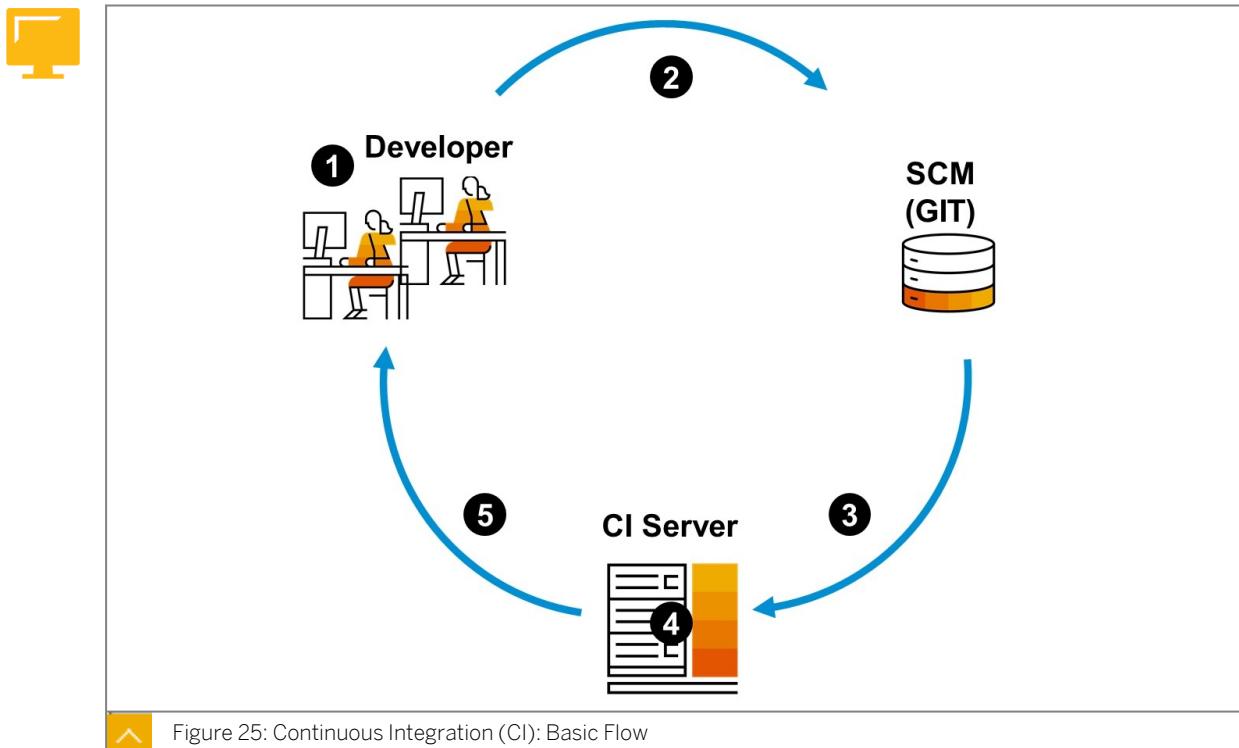
Now, there is some confusion around the acronym CI/CD. To clarify: "CI" stands for Continuous Integration, while the "CD" can stand for either Continuous Delivery or Continuous Deployment.

Continuous Integration



Each of the different **Continuous X** types do not stand isolated or side by side, instead they build upon each other. **Continuous Integration** is the foundation, which includes several principles. Ultimately, there is always a stable build available.

Continuous Integration (CI): Basic Flow



The picture above states the basic flow of a continuous integration. The developer writes code and pushes its code changes to a centralized and remote source code management system (SCM) like GitHub. The SCM then triggers the CI server. Usually, this is done via so-called [webhooks](#).

After sending the event to the CI server, the server itself then automatically starts the pre-configured build and unit tests. Finally, the CI server sends the feedback to the developer.

Continuous Delivery

On top of **Continuous Integration** is **Continuous Delivery**. While a stable build is always available with CI, Continuous Delivery defines the software in such a way that it is ready for deployment on the production system, whereby the trigger for the deployment is a human decision. Deployment must therefore be triggered manually, or automatically, for example, just by pressing a button.

Facts about Continuous Delivery:

- Software is ready for deployment to a productive system all the time.
- Deployment to a productive system is triggered **manually**.
- Feedback from a productive system gets quickly integrated into teams' backlogs.

Continuous Deployment

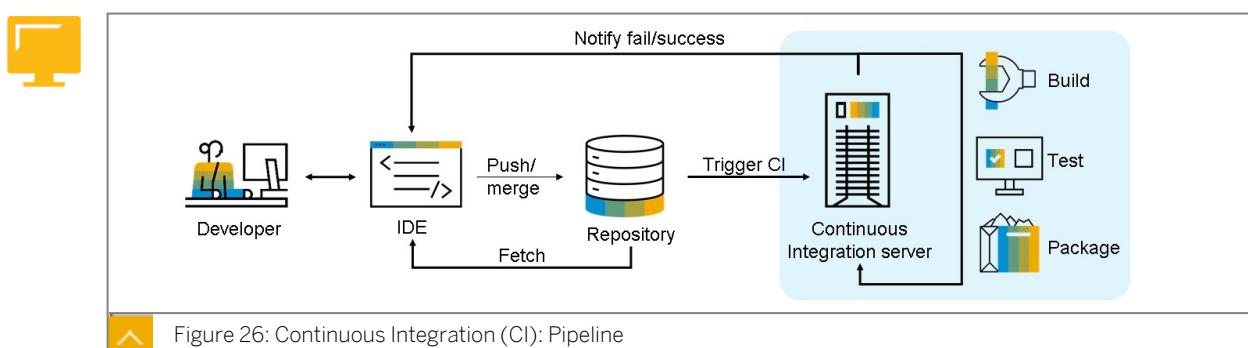
On top of the Continuous Delivery, **Continuous Deployment** means that the deployment to the productive system is triggered with each commit. It is important to be aware that Continuous Delivery and Continuous Deployment are sometimes not clearly separated, which means that some sources (like blogs, books, and so on) talk about Continuous Deployment while they mean Continuous Delivery! To avoid misunderstandings, you should always clarify these definitions when talking about CI/CD.

Facts about Continuous Deployment:

Deployment to a productive system is triggered automatically (instead of manual deployment as in Continuous Delivery).

The Pipeline

Putting all these pieces together, you can create a fully automated pipeline to build, test, and deploy your application.



Summary

By now, you have a more profound understanding of the core principles and benefits of a CI/CD pipeline. You should now be able to describe the principles and benefits of continuous integration and delivery.

In short, Continuous Integration (CI) is the adoption of agile principles while Continuous Delivery/Deployment (CD) is a combination of agile methodology techniques and a high-quality delivery process. The goal is to validate each change (commit), preferably in an automated way, so that it can potentially be delivered reliably.

Further Reading

These resources might be helpful if you want to dive deeper into CI/CD: [SAP Solutions for CI/CD](#).



LESSON SUMMARY

You should now be able to:

- Describe the principles and benefits of continuous integration and delivery

Unit 6

Lesson 2

Creating and Connecting a GitHub Repository



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Create and connect a GitHub repository

Reference Links: Creating and Connecting a GitHub Repository

For your convenience, this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Breif description	Link
1	Create and Connect a GitHub Repository	the steps described in Creating a personal access token	GitHub token	https://github.com/
2	Create a Personal Access Token for GitHub	you will create a public GitHub repository	Project GitHub	https://docs.github.com/en/github/authenticating-to-github/keeping-your-account-and-data-secure/creating-a-personal-access-token
3	Connect Your GitHub Repository with Your CAP Project	open your SAP BTP Trial	SAP BTP trial	https://cockpit.hana-trial.ondemand.com/
4	Summary	public GitHub repository using git commands	Git commands	https://git-scm.com/docs



LESSON SUMMARY

You should now be able to:

- Create and connect a GitHub repository

Unit 6

Lesson 3

Enabling SAP Continuous Integration and Delivery



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Enable SAP Continuous Integration and Delivery

Reference Links: Enabling SAP Continuous Integration and Delivery

For your convenience, this section contains the external references in this lesson.

If links are used multiple times within the text, only the first location is mentioned in the reference table.

Ref#	Section	Context text fragment	Brief description	Link
1	Scenario	Continuous Integration Principles	Continuous Integration principles	Continuous Integration Principles
2	Scenario	Continuous Integration and Continuous Delivery Guide	Overview of the continuous integration and delivery concepts	Continuous Integration and Continuous Delivery Guide
3	Continuous Delivery	SAP BTP Trial Account	SAP BTP Cockpit	SAP BTP trial account



Note:

In this exercise, you find a simulation and a list of all steps displayed in the simulation. Performing the steps below allows you to follow the simulation in your own trial account.



LESSON SUMMARY

You should now be able to:

- Enable SAP Continuous Integration and Delivery

Configuring a CI/CD Job



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Configure a job in the SAP Continuous Integration and Delivery service



LESSON SUMMARY

You should now be able to:

- Configure a job in the SAP Continuous Integration and Delivery service

Verifying the Build Success



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Start monitoring a job in SAP Continuous Integration and Delivery



LESSON SUMMARY

You should now be able to:

- Start monitoring a job in SAP Continuous Integration and Delivery

Learning Assessment

1. What does the source code management system use to trigger the CI server?

Choose the correct answer.

- A Webhooks
- B Web services
- C HTTP PUT requests

2. Which of the following statements apply to Continuous Delivery?

Choose the correct answers.

- A Software is ready for deployment to a productive system all the time.
- B The trigger for deployment to a productive system is a human decision.
- C Deployment to a productive system is triggered automatically.
- D Code changes are pushed to a remote source code management system.
- E Feedback from a productive system gets quickly integrated into teams' backlog.

3. Which of the following statements applies to Continuous Deployment?

Choose the correct answer.

- A Software is ready for deployment to a productive system all the time.
- B The trigger for deployment to a productive system is a human decision.
- C Feedback from a productive system gets quickly integrated into teams' backlog.
- D Deployment to a productive system is triggered automatically.
- E Code changes are pushed to a remote source code management system.

4. Which of the following statements about a GitHub Repository are correct?

Choose the correct answers.

- A Anyone on the internet can see a public repository.
- B Anyone on the internet can commit into a public repository.
- C You choose who can see your private repository.
- D You choose who can commit into your private repository.

5. After what period of time does GitHub remove unused personal access tokens?

Choose the correct answer.

- A 28 days
- B 100 days
- C 1 month
- D 1 year

6. What is the next step after you initialize a new local git repository (git init) and add files to it (git add)?

Choose the correct answer.

- A Commit
- B Fetch
- C Pull

7. Which of the following statements about SAP Continuous Integration and Delivery (CI/CD) is correct?

Choose the correct answer.

- A If you want to use SAP CI/CD in SAP BTP, you need to enable it with a service instance.
- B If you want to use SAP CI/CD in SAP BTP, you need to subscribe to a service plan of SAP CI/CD.

8. You can use the credentials created in the SAP CI/CD service to:

Choose the correct answers.

- A Connect to a private GitHub repository.
- B Access the service itself.
- C Deploy applications to the SAP BTP, Cloud Foundry environment.

9. What are some of the Continuous Integration principles?

Choose the correct answers.

- A Use version control.
- B Fix errors only when users complain.
- C Run tests in the build.
- D Run tests only in production.
- E Fix errors immediately.

10. What is a "main line" in a source control management system used for?

Choose the correct answer.

- A To automate deployment.
- B To enable a reporting line for the project manager.
- C To make developers' contributions transparent and avoid clashes.

11. A main line in a source control management system can contain feature branches.

Determine whether this statement is true or false.

- True
- False

12. What are the differences between continuous integration (CI) and continuous delivery (CD)?

Choose the correct answers.

- A CI allows team members to add their changes to a main line.
- B CD adds an aspect that changes have been tested successfully.
- C CI allows developers to integrate their contributions any time.
- D CD adds an aspect that changes are immediately ready for deployment.

13. What do you use to retrieve the information about a change on the repository?

Choose the correct answer.

- A A change document
- B A webhook
- C A PUT request to GitHub

14. What is the actual automation part of SAP CI/CD?

Choose the correct answer.

- A Configure a job.
- B Configure a branch in the GitHub repository.

15. What kind of request does the webhook send?

Choose the correct answer.

- A GET
- B PUT
- C POST

16. Within SAP CI/CD jobs you can:

Choose the correct answer.

- A Delete deployed applications directly from your Cloud Foundry environment space.
- B Monitor the successful creation of your builds.

17. In the Builds view of SAP Continuous Integration and Delivery, there is no new tile for your job. Which command do you run to trigger the job manually?

Choose the correct answer.

- A Trigger run
- B Trigger title
- C Trigger build
- D Trigger refresh

Learning Assessment - Answers

1. What does the source code management system use to trigger the CI server?

Choose the correct answer.

- A Webhooks
- B Web services
- C HTTP PUT requests

Correct. The source code management system uses Webhooks to trigger the CI server.

2. Which of the following statements apply to Continuous Delivery?

Choose the correct answers.

- A Software is ready for deployment to a productive system all the time.
- B The trigger for deployment to a productive system is a human decision.
- C Deployment to a productive system is triggered automatically.
- D Code changes are pushed to a remote source code management system.
- E Feedback from a productive system gets quickly integrated into teams' backlog.

Correct. Software is ready for deployment to a productive system all the time. The trigger for deployment to a productive system is a human decision.

3. Which of the following statements applies to Continuous Deployment?

Choose the correct answer.

- A Software is ready for deployment to a productive system all the time.
- B The trigger for deployment to a productive system is a human decision.
- C Feedback from a productive system gets quickly integrated into teams' backlog.
- D Deployment to a productive system is triggered automatically.
- E Code changes are pushed to a remote source code management system.

Correct. Deployment to a productive system is triggered automatically.

4. Which of the following statements about a GitHub Repository are correct?

Choose the correct answers.

- A Anyone on the internet can see a public repository.
- B Anyone on the internet can commit into a public repository.
- C You choose who can see your private repository.
- D You choose who can commit into your private repository.

Correct. Anyone on the internet can see a public repository. You choose who can see your private repository. You choose who can commit into your private repository.

5. After what period of time does GitHub remove unused personal access tokens?

Choose the correct answer.

- A 28 days
- B 100 days
- C 1 month
- D 1 year

Correct. GitHub remove unused personal access tokens after a period of 1 year.

6. What is the next step after you initialize a new local git repository (git init) and add files to it (git add)?

Choose the correct answer.

- A Commit
- B Fetch
- C Pull

Correct. The next step after you initialize a new local git repository (git init) and add files to it (git add) is Commit.

7. Which of the following statements about SAP Continuous Integration and Delivery (CI/CD) is correct?

Choose the correct answer.

- A If you want to use SAP CI/CD in SAP BTP, you need to enable it with a service instance.
- B If you want to use SAP CI/CD in SAP BTP, you need to subscribe to a service plan of SAP CI/CD.

Correct. The statement: "If you want to use SAP CI/CD in SAP BTP, you need to subscribe to a service plan of SAP CI/CD" is correct.

8. You can use the credentials created in the SAP CI/CD service to:

Choose the correct answers.

- A Connect to a private GitHub repository.
- B Access the service itself.
- C Deploy applications to the SAP BTP, Cloud Foundry environment.

Correct. You can use the credentials created in the SAP CI/CD service to connect to a private GitHub repository and deploy applications to the SAP BTP, Cloud Foundry environment.

9. What are some of the Continuous Integration principles?

Choose the correct answers.

- A Use version control.
- B Fix errors only when users complain.
- C Run tests in the build.
- D Run tests only in production.
- E Fix errors immediately.

Correct. Some of the Continuous Integration principles are: "Use version control", "Run tests in the build", and "Fix errors immediately".

10. What is a "main line" in a source control management system used for?

Choose the correct answer.

- A To automate deployment.
- B To enable a reporting line for the project manager.
- C To make developers' contributions transparent and avoid clashes.

Correct. A "main line" in a source control management system is used for making developers' contributions transparent and avoid clashes.

11. A main line in a source control management system can contain feature branches.

Determine whether this statement is true or false.

- True
- False

Correct. A main line in a source control management system can contain feature branches.

12. What are the differences between continuous integration (CI) and continuous delivery (CD)?

Choose the correct answers.

- A CI allows team members to add their changes to a main line.
- B CD adds an aspect that changes have been tested successfully.
- C CI allows developers to integrate their contributions any time.
- D CD adds an aspect that changes are immediately ready for deployment.

Correct. The differences are: "CI allows team members to add their changes to a main line", and "CD adds an aspect that changes have been tested successfully".

13. What do you use to retrieve the information about a change on the repository?

Choose the correct answer.

- A A change document
- B A webhook
- C A PUT request to GitHub

Correct. You use a webhook to retrieve the information about a change on the repository.

14. What is the actual automation part of SAP CI/CD?

Choose the correct answer.

- A Configure a job.
- B Configure a branch in the GitHub repository.

Correct. Configure a job is the actual automation part of SAP CI/CD.

15. What kind of request does the webhook send?

Choose the correct answer.

- A GET
- B PUT
- C POST

Correct. The webhook sends a POST request.

16. Within SAP CI/CD jobs you can:

Choose the correct answer.

- A Delete deployed applications directly from your Cloud Foundry environment space.
- B Monitor the successful creation of your builds.

Correct. Within SAP CI/CD jobs, you can monitor the successful creation of your builds.

17. In the Builds view of SAP Continuous Integration and Delivery, there is no new tile for your job. Which command do you run to trigger the job manually?

Choose the correct answer.

- A Trigger run
- B Trigger title
- C Trigger build
- D Trigger refresh

Correct. Trigger build is used to trigger the job manually in the Builds view of SAP Continuous Integration and Delivery.

Connection of an SAP S/ 4HANA Cloud System as an External Service for CAP

Lesson 1

DEMO: Connect a real SAP S/4HANA Cloud System

123

UNIT OBJECTIVES

- Connect your app to the productive Business Partner API of your SAP S/4HANA Cloud system

DEMO: Connect a real SAP S/4HANA Cloud System



LESSON OBJECTIVES

After completing this lesson, you will be able to:

- Connect your app to the productive Business Partner API of your SAP S/4HANA Cloud system

Business Partner API of an SAP S/4HANA Cloud System

In the exercise **Add an External Service**, you added an external Business Partner service to your application, and then connected it to the Sandbox environment of the API Business Hub. As a result, the Business Partner data in your application was provided by the Sandbox environment.

Now, you want to connect your app to the productive Business Partner API of your SAP S/4HANA Cloud system. Watch the following four demos to see how you can do this:

1. Connect SAP S/4HANA Cloud System with an SAP BTP Account.
2. Use a Business Partner on Server Side.
3. Use SAP S/4HANA Cloud Destination in CAP Project.
4. Deploy CAP Project using SAP Continuous Integration and Delivery Service.

Prerequisites

Make sure you already have the following:

- an SAP S/4HANA Cloud system with administrator access
- an SAP BTP Global account with administrator access
- successfully finished all the exercises of this course



LESSON SUMMARY

You should now be able to:

- Connect your app to the productive Business Partner API of your SAP S/4HANA Cloud system

Learning Assessment

1. What is required when registering an SAP S/4HANA Cloud system in your SAP BTP global account?

Choose the correct answer.

- A A token
- B A coin
- C A voucher
- D A developer

2. In which of the following apps can you manage connected SAP BTP accounts in an SAP S/4HANA system?

Choose the correct answer.

- A Maintain Integrations on SAP BTP
- B Maintain Extensions on SAP BTP
- C Manage Add-ons on SAP BTP

3. Which service plan of the SAP BTP S/4HANA Cloud Extensibility service do you choose when you want to use the Business Partner API of your SAP S/4HANA Cloud system?

Choose the correct answer.

- A Cloud Foundry
- B SAP_COM_0008
- C api-access

4. Which of the following identifiers of the communication scenario is used for accessing the Business Partner API in an SAP S/4HANA Cloud system?

Choose the correct answer.

- A SAP_COM_0009
- B SAP_COM_0213
- C SAP_COM_0008
- D SAP_COM_0109

Learning Assessment - Answers

1. What is required when registering an SAP S/4HANA Cloud system in your SAP BTP global account?

Choose the correct answer.

- A A token
- B A coin
- C A voucher
- D A developer

Correct. A token is required when registering an SAP S/4HANA Cloud system in your SAP BTP global account.

2. In which of the following apps can you manage connected SAP BTP accounts in an SAP S/4HANA system?

Choose the correct answer.

- A Maintain Integrations on SAP BTP
- B Maintain Extensions on SAP BTP
- C Manage Add-ons on SAP BTP

Correct. You can manage connected SAP BTP accounts in Maintain Extensions on SAP BTP.

3. Which service plan of the SAP BTP S/4HANA Cloud Extensibility service do you choose when you want to use the Business Partner API of your SAP S/4HANA Cloud system?

Choose the correct answer.

- A Cloud Foundry
- B SAP_COM_0008
- C api-access

Correct. You choose the api-access service plan of the SAP BTP S/4HANA Cloud Extensibility service to use the Business Partner API of your SAP S/4HANA Cloud system.

4. Which of the following identifiers of the communication scenario is used for accessing the Business Partner API in an SAP S/4HANA Cloud system?

Choose the correct answer.

- A SAP_COM_0009
- B SAP_COM_0213
- C SAP_COM_0008
- D SAP_COM_0109

Correct. The SAP_COM_0008 identifier is used for accessing the Business Partner API in an SAP S/4HANA Cloud system.