Critical manufacturing
an ASMPT company

Critical manufacturing 11.2

Installation Guide

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1 Installation Guide

The Critical Manufacturing MES installation guide provides you with detailed instructions on how to successfully deploy Critical Manufacturing MES. Critical Manufacturing MES is a high availability product that is optimized for transaction throughput with critical system requirements. For an overview of the system and its main components please refer to the System Architecture section.

Due to its demanding nature Critical Manufacturing MES requires careful planning and preparation. Before starting a new installation please follow the steps in the Preparation section very carefully as this is where you will find instructions that will help you prepare a new system to host Critical Manufacturing MES. This section provides a checklist of the system requirements and links to the detailed instructions on how to prepare each item in the checklist.

2 Introduction

This document is a guide for planning, installing and configuring the Critical Manufacturing application.

- Preparation - Instructions and recommendations about how to prepare an infrastructure for installing Critical Manufacturing MES. It's not intended to be an exhaustive document about infrastructure but instead a quick guide on proven solutions for successfully deploying the solution.
- Installation - A visual walk-through of the installation wizard and the settings that must be entered before initiating a deployment.
- Post Installation - Best practices that are required to double check the health status of the solution and advanced configuration options that can be made after installation.
- Upgrade - The steps necessary to upgrade an existing installation.
- Removal - How to remove Critical Manufacturing MES from your system.

Should you require further assistance, please open a support ticket in the Critical Manufacturing Customer Portal at https://portal.criticalmanufacturing.com

2.1 Target Audience

This Installation Guide is intended for application administrators and should be used to support the Critical Manufacturing installation process.

2.2 Definitions

The next table identifies some common terms used throughout the document:

Table 1: Definitions

Acronym	Definition
ACL	Access Control List
AD	Active Directory
CMF	Critical Manufacturing
COM	Component Object Mode
DACL	Discretionary Access Control List
DB	DataBase
DWH	Data Warehouse
EFC	Electronic Failure Catalogue
HPC	High Performance Cluster
HTTP	HyperText Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
IIS	Microsoft Internet Information Services
IP	Internet Protocol
MS-DTC	Microsoft Distributed Transaction Coordinator

Acronym	Definition
MSMQ	Microsoft Message Queue
NLB	Network Load Balancing
ODS	Operational Data Store
OLAP	Online Analytical Processing
OS	Operating System
SAN	Storage Area Network
SDDL	Security Descriptor Definition Language
SID	Security Identifier
SMTP	Simple Mail Transfer Protocol
URL	Uniform Resource Locator

2.3 Naming Conventions

The following conventions are applied throughout the document:

 Helpful hints to assist in particular situations.

 A note with important information.

 A warning or a word of caution.

These callouts carry important information can be very useful. However, in some situations, other smaller icons are visible and should be regarded as a visual identifier that a larger information callout of the same type can be found below. These icons include:

Table 2: Snippet visual conventions

Convention	Callout
:information_source:	Info
	Warning
	Note

Other visual indicators are used in the documentation to indicate information on specific actions or operations found in the MES GUI:

Table 3: Visual conventions

Convention	Description
	Described functionality is associated with the stated **security** feature
edit	Icon that symbolizes an **edit** action

Convention	Description
	Icon that symbolizes an **add** action
	Icon that symbolizes a **remove** action
	Icon that symbolizes a **move up** action
	Icon that symbolizes a **move down** action
	Icon that symbolizes the use of a **camera** or **scanner**
	Icon that symbolizes the use of a **keypad**
	Icon that symbolizes a browser modal window **view** action
	Icon that symbolizes a **download** action
	Icon that symbolizes a **copy** action
	Icon symbolizing PDF availability

2.4 Documentation Set

This Critical Manufacturing release comes with the following set of documents available online:

Table 4: Guides available online

Document	Target Audience	Description
User Guide	End Users	The standard application user interface manual (with a few exceptions which are covered in the Operations Guide and the Developer Guide/).
System Requirements	System Administrators	A description of the system requirements for Critical Manufacturing MES installation and operation.
Installation Guide	System Administrators	The application installation guide.
Operations Guide	System Administrators	A guide for maintaining, optimizing and troubleshooting the application.
Developer Portal	System Integrators	A guide to explain how to extend and customize the system.
Data Dictionary	System Administrators	A description of the database schema including the relationships of main objects.
Tutorials	End Users	Scenario creation and system operability for factory-floor and planning situations.

This Critical Manufacturing release also includes the following separate PDF documents:

Table 5: Included PDF documents

Document	File Name	Description
Installation Guide	InstallationGuide.p	The application installation guide.
Release Notes	ReleaseNotes.pdf	The release notes that includes a description of the new features as well as the description of any changes.
System Requirements	SystemRequiremer	A description of the system requirements for Critical Manufacturing installation and operation.

The PDF version of this document included in the Critical Manufacturing release is an exported version of the web-based guide.

2.5 Document History

This document was developed prior to the product release to manufacturing and as such, it cannot be guaranteed that all details included herein will be exactly as what is found in the shipping product. Critical Manufacturing cannot guarantee the accuracy of any information presented after the date of publication.

The date of the document changes whenever a new edition is released. However, it must be noticed that some product updates do not necessarily require document changes, and as such, versions of the product may be released without accompanying documentation and vice versa.

2.6 Licensing

The Critical Manufacturing base license includes the Core module. All other modules are licensed separately.

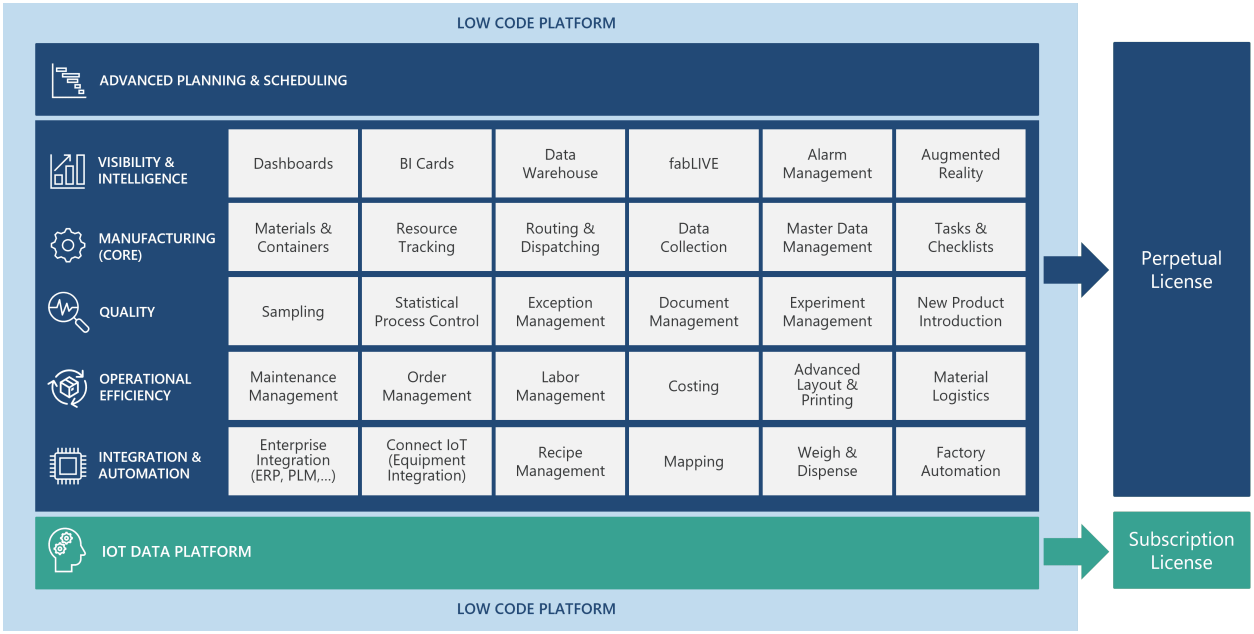


Figure 1: Application Modules

3 Preparation

Critical Manufacturing provides you with the following checklist that serves as a quick guide and helps determine the preliminary procedures and requirements for the installation to take place. Below you can see links to information resources to get started:

- [[operation-guide-container-stack-index|Container Stack Documentation]] section of the Operations Guide to know the components of the stack.
- DevOps Center Documentation in the Critical Manufacturing Customer Portal for installation instructions.
- [[system-requirements-application-layer-applicationlayercontainers|Software Requirements]] in the System Requirements.

3.1 Infrastructure

This section contains a list of the computer, server and client roles required to run Critical Manufacturing MES. Generically, we recommend that you deploy each of the application tiers on separate machines. For development environments, you can deploy all tiers on a single machine. If a machine is hosting several tiers, it must fulfill all the requirements of the current tier.

Table 6: Servers

Item	Description	Planning and installation guides	Checked
Hardware infrastruct	Plan the number of servers and the computing, storage and memory requirements for each one	[[system-requirements-application-layer-applicationlayercontainers]] [[system-requirements-application-layer-applicationlayeroptional]]	
Database Servers	The database servers will host Critical Manufacturing persistency layer components	[[installation-guide-database-servers-index	Planning and installing database servers]]
Applicatic Servers	The application servers will host Critical Manufacturing application layer components	[[installation-guide-planningapplicationservers	Planning and installing the application servers]]
Applicatic Clients	The application clients will run Critical Manufacturing presentation layer components in a browser	[[installation-guide-planningapplicationclients	Planning and preparing application clients]]

3.2 Storage and Network Shares

Information on file shares and volume configurations is available on the Customer Portal support website here.

3.3 Accounts, Permissions and Active Directory Objects

In this section, we summarize what must be prepared in terms of account configurations:

Table 7: Accounts, Permissions and Active Directory Objects

Item	Description	Planning and installation guide	Checked
Deployment Account	The account that will be used to deploy Critical Manufacturing	[[installation-guide-accountsandsecurity]]	
Critical Manufacturing Windows Services Account	The account that will be used to run the Critical Manufacturing Windows Service applications	[[installation-guide-accountsandsecurity]]	
Microsoft SQL Server User Account	The account that will be used to connect to the Microsoft SQL Server instance	[[installation-guide-accountsandsecurity]]	
Microsoft SQL Server Analysis Service User Account	The account that will be used to connect to the OLAP cubes created by Critical Manufacturing	[[installation-guide-accountsandsecurity]]	
Microsoft SQL Server Reporting Services User Account	The account that will be used in Reporting Services to host Critical Manufacturing reports	[[installation-guide-accountsandsecurity]]	
Active Directory Domain Services FQDN	The FQDN for the Active Directory domain services server	[[installation-guide-accountsandsecurity]]	
Active Directory Domain Name	The shorter domain name that is used to prefix user accounts	[[installation-guide-accountsandsecurity]]	
ClickHouse User Account Name	The account that will be used to connect to ClickHouse	[[installation-guide-accountsandsecurity]]	
Kafka User Account Name	The account that will be used to connect to Kafka	[[installation-guide-accountsandsecurity]]	
S3 User Account Name	The account that will be used to connect to S3	[[installation-guide-accountsandsecurity]]	

3.4 SAP Connection Setup

This section outlines the configuration required to support SAP integration when using the Theobald ERP Connector. If the integration is implemented via web services or other protocols, this setup is not required.

Table 8: SAP Connection Setup

Item	Description	Planning and installation guide	Checked
SAP Host	Critical Manufacturing will connect to this SAP instance to receive inbound messages and to send outbound messages	SAP Integration	
SAP System Number	The SAP system name to connect to	SAP Integration	
SAP Service	The SAP RFC gateway hostname	SAP Integration	
SAP Program Id	The name of the Remote Server Program that will be used for IDOC exchange	SAP Integration	
SAP User Name	The user name used to authenticate in SAP	SAP Integration	
SAP Password	The password used to authenticate in SAP	SAP Integration	
SAP Client	The SAP Client number	SAP Integration	
ERP Connector-License Key	The Theobald ERP Connect license required to communicate with SAP	SAP Integration	

3.5 Other infrastructure requirements

In this section, we summarize the configurations for the email infrastructure required for notifications:

Table 9: Other infrastructure requirements

Item	Description	Planning and installation guide	Checked
SMTP Server Address	Critical Manufacturing requires an email server to send notifications through email (SSL is both supported and recommended)	[[installation-guide-email]]	
SMTP Server User Name	The account used to authenticate at the email server	[[installation-guide-email]]	
SMTP Server Password	The password used to authenticate at the email server	[[installation-guide-email]]	
Support Email Address	Critical Manufacturing will send email messages to this destination	[[installation-guide-email]]	
Support Email From Name	Critical Manufacturing will send email messages using this text to identify the email sender	[[installation-guide-email]]	

4 Planning Guides

In this section you have step-by-step instructions on how to plan and prepare systems for deploying Critical Manufacturing MES. Refer to the Preparation article for an overview and checklist of the installation process requirements.

- Infrastructure
- AWS - Amazon Web Services
- Database Servers
- Additional Components
- Application Servers
- Application Clients
- File Shares
- Accounts and Security
- Email

5 Infrastructure

This guide contains step-by-step instructions on how to successfully plan and deploy an infrastructure for Critical Manufacturing MES. See the System Requirements sections below to find out more:

- Application Layer - Container Stack

5.1 Optional components

Some components of the application layer of Critical Manufacturing MES require traditional methods of installation, unlike the main stack of container-based installation:

- Application Layer - Optional Components

6 AWS - Amazon Web Services

This guide will walk you through the steps to configure the necessary resources to have an AWS infrastructure ready to host Critical Manufacturing MES. The configuration includes several components needed to run the MES, such as a Kubernetes cluster, database optionally running on AWS, shared storage solutions, network configurations for secure and reliable communication, and load balancers for traffic management.

The following architecture diagram shows how the Critical Manufacturing MES can be deployed on AWS cloud infrastructure, including, among others, the kubernetes cluster for the application servers, SQL Server database, and external services such as Rabbit MQ and ClickHouse.

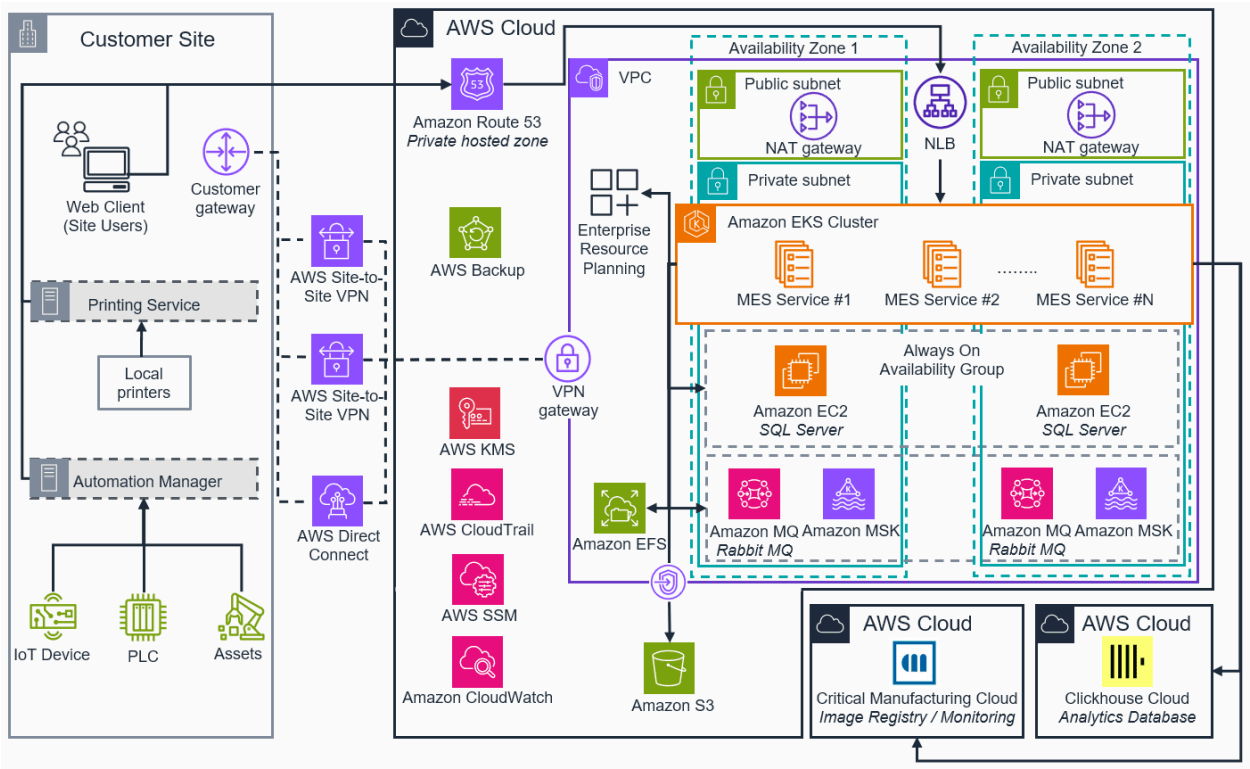


Figure 2: Infrastructure architecture and components

6.1 Time Estimate

This guide includes the creation of several infrastructure resources and may take up to an hour to complete.

6.2 Preconditions

6.2.1 Required Skills and Knowledge

It is assumed the user has basic knowledge of some AWS services, such as:

1. **AWS Services**: Understanding of Amazon Web Services (AWS), specifically VPC and networking, EKS, EC2, IAM, and Route 53.
2. **Kubernetes**: Familiarity with Kubernetes concepts such as clusters, nodes, pods, and services.
3. **EKS**: Experience with Amazon EKS and the deployment of Kubernetes clusters on AWS.

4. **Command Line Interface**: Ability to work with AWS CLI and `eksctl` for infrastructure management.
5. **IAM Roles and Policies**: Knowledge of AWS IAM, including the creation of policies and roles for managing service accounts and permissions.
6. **Storage Classes**: Familiarity with Amazon EFS, S3, and Storage Gateways, and their integration with Kubernetes.

6.2.2 Billable AWS Services

When deploying an EKS-based environment on AWS, there are several AWS services that will incur costs. Below is a list of the billable services and an indication of whether each is **mandatory** or **optional** for the deployment.

Service	Manda	Description	Pricing
Amazon VPC (Virtual Private Cloud)	:white_	Required to create the network environment. There are costs for NAT gateways, VPC endpoints, Load Balancers, and data transfer.	https://aws.amazon.com/vpc/pricing/
Amazon EKS (Elastic Kubernetes Service)	:white_	Required for running Kubernetes clusters. Costs include control plane fees and per-node pricing.	https://aws.amazon.com/eks/pricing/
Amazon EC2 (Elastic Compute Cloud)	:white_	Required for provisioning worker nodes. EC2 instance costs are based on the instance type, and pricing is pay-per-hour or reserved.	https://aws.amazon.com/ec2/pricing/
Amazon EFS (Elastic File System)	:octicon dash-16: (at least one of the stor-age solu-tions is require	Used for shared storage across the cluster. If persistent storage is needed, EFS may be necessary.	https://aws.amazon.com/efs/pricing/

Service	Manda	Description	Pricing
Amazon S3 (Simple Storage Service)	:octicon dash-16: (at least one of the storage solutions is require	Used for object storage. Costs include storage fees and data retrieval.	https://aws.amazon.com/s3/pricing/
AWS Storage Gateway (S3 File Storage Gateway)	:octicon dash-16: (at least one of the storage solutions is require	Depending on the chosen Volume Types, it may needed to create a Storage Gateway to share data in Amazon S3 and access it locally via file gateways.	https://aws.amazon.com/storagegateway/pricing/
Amazon Route 53	:octicon dash-16:	If domain name resolution and custom DNS are required for your deployment, Route 53 will be used for managing DNS.	https://aws.amazon.com/route53/pricing/

6.2.3 AWS Regions Support

Critical Manufacturing MES does not impose any AWS Region restriction by itself. For details on regional support for each required AWS service, please consult https://aws.amazon.com/about-aws/global-infrastructure/regional-product-services/.

6.2.4 AWS Service Limits

When deploying to Amazon EKS, you might encounter AWS service limits. These limits, also known as AWS Service Quotas, include constraints on the number of EC2 instances, EBS volumes, NAT gateways, and other resources that can be provisioned within an AWS account.

Before starting a deployment, it is recommended to check your current service limits to avoid interruptions during cluster creation and management. To view your limits:

1. Go to the Service Quotas Dashboard.

2. In the AWS Management Console, you can view your limits for different services such as EC2, VPC, and EKS.
3. If any limit is too low, submit a request to increase the limit by clicking **Request quota increase**.

6.2.5 Secrets Management

Critical Manufacturing does not require any specific service for managing secrets, as all the sensitive data is stored as Kubernetes Secrets. For more details, check https://portal.criticalmanufacturing.com/Help/devops-center/deployment-targets/kubernetes-section/kubernetes_sensitive_data/.

6.2.6 Publicly Available Components

Which components and services need to be publicly available to outside of the AWS infrastructure depends on your specific configuration and requirements. In a deployment following the suggested architecture, where all the components are deployed and running in the AWS Cloud, the only resource that needs to be publicly exposed and available to ingress traffic is the Load Balancer / DNS managing service.

6.2.7 Required Software

It is possible to create the cluster in three different ways:

- AWS Management Console Web GUI
- AWS CLI
- eksctl

In this guide, we will use `eksctl`, version 0.114.0, and AWS CLI, so these tools must be installed. More information on how to install this command can be found here.

6.3 Requirements

If the cluster will be used to deploy a Critical Manufacturing MES installation, the requirements must be taking into account. You can check the MES requirements in the [[system-requirements-application-layer-applicationlayercontainers]] page.

6.4 Configuration Sections

The following sections will cover:

-
-
-
-
-
-

Each section will focus on the key configurations and requirements to ensure the MES system operates efficiently on AWS infrastructure.

7 Network

This section describes how to create and configure the AWS Network components required to allow communication between the several application components, the database, storage, external components service, and incoming web traffic.

Critical Manufacturing MES requires a well-configured network to ensure secure, fast, and reliable communication between its components (Kubernetes pods, SQL Server database, and external services). The following configurations are essential for proper operation.

7.1 Key Components

- **VPC**: Create an isolated Virtual Private Cloud (VPC) for the MES system, ensuring that the EKS cluster, SQL Server, and other components are secure and have controlled access.
- **Subnets**: Use both public and private subnets:
  - **Public Subnets** for exposing load balancers and external services.
  - **Private Subnets** for keeping the MES containers and SQL Server secure from direct internet exposure.
- **Security Groups**: Define security groups to control traffic, such as allow ingress from the load balancers to the EKS services.
- **NAT Gateways**: Ensure private subnets have outbound internet access for software updates and external communication needs of MES pods.
- **Internet Gateways**: Allows resources in the public subnets, with a public IP, to access the internet, both inbound and outbound traffic.

This setup provides an isolated and secure network for the MES components while maintaining access to essential external services.

 More information: https://docs.aws.amazon.com/vpc/

7.2 Configuration Steps

=== "AWS Management Console"

```
1. Open the [AWS Management Console](https://console.aws.amazon.com/console/home)
1. Search for **VPC** and open
1. Click **Create VPC**
1. Choose **VPC and more**
1. If required, change the configuration according to your needs
1. ![Create VPC](images/vpc_create.png)
1. Click **Create VPC**
```

=== "AWS CLI"

```
Example steps for the creation of a VPC, with two Availability Zones, each one with a private subnet, a
    public subnet, and outbound Internet connection:

```bash
# Step 1: Create VPC
echo "Creating VPC..."
VPC_ID=$(aws ec2 create-vpc --cidr-block "10.0.0.0/16" --tag-specifications
    'ResourceType=vpc,Tags=[{Key=Name,Value=cm-vpc}]' --query 'Vpc.VpcId' --output text)
echo "VPC ID: $VPC_ID"
```
```

```
# Step 2: Modify VPC attributes (Enable DNS hostnames)
echo "Enabling DNS hostnames for the VPC..."
aws ec2 modify-vpc-attribute --vpc-id $VPC_ID --enable-dns-hostnames "{\"Value\":true}"

# Step 3: Create public subnets
echo "Creating public subnets..."
SUBNET_PUBLIC1=$(aws ec2 create-subnet --vpc-id $VPC_ID --cidr-block "10.0.0.0/20" --availability-zone
    "us-east-1a" --tag-specifications
    'ResourceType=subnet,Tags=[{Key=Name,Value=cm-subnet-public1-us-east-1a}]' --query
    'Subnet.SubnetId' --output text)
SUBNET_PUBLIC2=$(aws ec2 create-subnet --vpc-id $VPC_ID --cidr-block "10.0.16.0/20" --availability-zone
    "us-east-1b" --tag-specifications
    'ResourceType=subnet,Tags=[{Key=Name,Value=cm-subnet-public2-us-east-1b}]' --query
    'Subnet.SubnetId' --output text)
echo "Public Subnet 1 ID: $SUBNET_PUBLIC1"
echo "Public Subnet 2 ID: $SUBNET_PUBLIC2"

# Step 4: Create private subnets
echo "Creating private subnets..."
SUBNET_PRIVATE1=$(aws ec2 create-subnet --vpc-id $VPC_ID --cidr-block "10.0.128.0/20"
    --availability-zone "us-east-1a" --tag-specifications
    'ResourceType=subnet,Tags=[{Key=Name,Value=cm-subnet-private1-us-east-1a}]' --query
    'Subnet.SubnetId' --output text)
SUBNET_PRIVATE2=$(aws ec2 create-subnet --vpc-id $VPC_ID --cidr-block "10.0.144.0/20"
    --availability-zone "us-east-1b" --tag-specifications
    'ResourceType=subnet,Tags=[{Key=Name,Value=cm-subnet-private2-us-east-1b}]' --query
    'Subnet.SubnetId' --output text)
echo "Private Subnet 1 ID: $SUBNET_PRIVATE1"
echo "Private Subnet 2 ID: $SUBNET_PRIVATE2"

# Step 5: Create and attach an Internet Gateway
echo "Creating Internet Gateway..."
IGW_ID=$(aws ec2 create-internet-gateway --tag-specifications
    'ResourceType=internet-gateway,Tags=[{Key=Name,Value=cm-igw}]' --query
    'InternetGateway.InternetGatewayId' --output text)
echo "Attaching Internet Gateway to VPC..."
aws ec2 attach-internet-gateway --internet-gateway-id $IGW_ID --vpc-id $VPC_ID

# Step 6: Create a public route table and routes
echo "Creating public route table..."
RTB_PUBLIC=$(aws ec2 create-route-table --vpc-id $VPC_ID --tag-specifications
    'ResourceType=route-table,Tags=[{Key=Name,Value=cm-rtb-public}]' --query 'RouteTable.RouteTableId'
    --output text)
echo "Creating route for Internet access in the public route table..."
aws ec2 create-route --route-table-id $RTB_PUBLIC --destination-cidr-block "0.0.0.0/0" --gateway-id
    $IGW_ID

# Step 7: Associate public route table with public subnets
echo "Associating public route table with public subnets..."
aws ec2 associate-route-table --route-table-id $RTB_PUBLIC --subnet-id $SUBNET_PUBLIC1
aws ec2 associate-route-table --route-table-id $RTB_PUBLIC --subnet-id $SUBNET_PUBLIC2

# Step 8: Allocate an Elastic IP for NAT Gateway
```

```
echo "Allocating Elastic IP for NAT Gateway..."
EIP_ALLOC_ID=$(aws ec2 allocate-address --domain "vpc" --tag-specifications
    'ResourceType=elastic-ip,Tags=[{Key=Name,Value=cm-eip-us-east-1a}]' --query 'AllocationId'
    --output text)

# Step 9: Create a NAT Gateway in the public subnet
echo "Creating NAT Gateway..."
NAT_GW_ID=$(aws ec2 create-nat-gateway --subnet-id $SUBNET_PUBLIC1 --allocation-id $EIP_ALLOC_ID
    --tag-specifications 'ResourceType=natgateway,Tags=[{Key=Name,Value=cm-nat-public1-us-east-1a}]'
    --query 'NatGateway.NatGatewayId' --output text)
echo "NAT Gateway ID: $NAT_GW_ID"

# Step 10: Create private route tables and routes through NAT Gateway
echo "Creating private route table 1..."
RTB_PRIVATE1=$(aws ec2 create-route-table --vpc-id $VPC_ID --tag-specifications
    'ResourceType=route-table,Tags=[{Key=Name,Value=cm-rtb-private1-us-east-1a}]' --query
    'RouteTable.RouteTableId' --output text)
echo "Creating route in private route table 1 through NAT Gateway..."
aws ec2 create-route --route-table-id $RTB_PRIVATE1 --destination-cidr-block "0.0.0.0/0"
    --nat-gateway-id $NAT_GW_ID

echo "Creating private route table 2..."
RTB_PRIVATE2=$(aws ec2 create-route-table --vpc-id $VPC_ID --tag-specifications
    'ResourceType=route-table,Tags=[{Key=Name,Value=cm-rtb-private2-us-east-1b}]' --query
    'RouteTable.RouteTableId' --output text)
echo "Creating route in private route table 2 through NAT Gateway..."
aws ec2 create-route --route-table-id $RTB_PRIVATE2 --destination-cidr-block "0.0.0.0/0"
    --nat-gateway-id $NAT_GW_ID

# Step 11: Associate private route tables with private subnets
echo "Associating private route tables with private subnets..."
aws ec2 associate-route-table --route-table-id $RTB_PRIVATE1 --subnet-id $SUBNET_PRIVATE1
aws ec2 associate-route-table --route-table-id $RTB_PRIVATE2 --subnet-id $SUBNET_PRIVATE2

# Step 12: Verify Route Tables
echo "Verifying route tables..."
aws ec2 describe-route-tables --route-table-ids $RTB_PRIVATE1 $RTB_PRIVATE2
```

8 EKS - Elastic Kubernetes Service

This section describes how to create and configure the Kubernetes cluster that runs, manages, and orchestrates the several application containers.

After the creation of the basic network resources, we need to create the Kubernetes Cluster that will run and manage the several application containers of the Critical Manufacturing MES. To that end, we will use Amazon EKS.

8.1 Amazon Elastic Kubernetes Service

The Amazon Elastic Kubernetes Service (EKS) is AWS's managed Kubernetes cloud platform.

In the DevOps Center, you can remotely deploy a Customer Environment to an EKS cluster.

 More information: https://docs.aws.amazon.com/eks/

8.1.1 Cluster Nodes

Cluster Nodes are the actual machines that provide computational power to the cluster, it's where the pods and containers are deployed and run.

For EKS, Critical Manufacturing recommends the usage of **Managed nodes**. Managed nodes are EC2 instances that AWS automatically provisions, manages, and scales within a Kubernetes cluster. These nodes are part of EKS Managed Node Groups, which simplify node lifecycle management, including upgrades and security patches, while integrating with Kubernetes and EC2 features.

EKS Managed nodes have several key features, highlighting the following:

- **Automated Provisioning**
  - AWS automatically creates EC2 instances, registers them with the Kubernetes control plane, and configures them to run as worker nodes in the cluster.
- **Simplified Upgrades**
  - Managed node groups allow easy updates to the latest Amazon EKS-optimized AMI versions, which include the latest Kubernetes versions, security patches, and performance enhancements.
  - During updates, nodes are drained (pods are evicted), upgraded, and then brought back online with minimal disruption.
- **Auto-scaling**
  - Managed node groups integrate with EC2 Auto Scaling, enabling automatic scaling of nodes based on workload demands. If more compute capacity is needed, the node group scales out; when demand drops, it scales in to optimize resource usage and cost.
- **Integrated Security**
  - Managed nodes are launched with the latest EKS-optimized AMI, which includes built-in security configurations for enhanced protection.
  - IAM roles can be assigned to the nodes to control access to AWS resources.
  - Managed node groups can be configured with Security Groups to define network traffic rules.

 Currently, **Fargate nodes are not supported**. Critical Manufacturing recommends the usage of Managed nodes.

8.1.2 Network

The network in an EKS cluster is built using Amazon VPC (Virtual Private Cloud), and it leverages AWS networking services for scaling, security, and performance.

You can find more information on the subject in [installation-guide-aws-network].

8.1.3 High Availability

High availability in an EKS cluster ensures that workloads and applications remain accessible, even in the event of failures or disruptions. EKS, running on AWS, allows the building of highly available clusters with several built-in features.

- Multi-AZ (Availability Zone) Deployments
  - Node Groups: EKS enables the creation of worker node groups spread across multiple Availability Zones (AZs) within a region. By distributing nodes across AZs, the impact of an outage in a single zone is minimized.
  - Load Balancing: AWS Load Balancers can route traffic across nodes in multiple AZs to ensure consistent traffic handling even if some nodes go down.
- Managed Control Plane
  - Master Nodes: EKS provides a managed Kubernetes control plane (master nodes), which is distributed across multiple AZs within a region by default. AWS automatically maintains and ensures the high availability of the control without manual intervention.
  - Scaling: The EKS control plane scales horizontally and can handle disruptions due to hardware failure or updates, ensuring continuous availability.
- Auto Scaling
  - Cluster Autoscaler: Dynamically adjusts the number of worker nodes (EC2 Instances) in the cluster based on resource demand. It can automatically add new nodes when workloads require more capacity and remove them when demand decreases.

8.2 Cluster Configuration

To create the EKS cluster, it is assumed that a VPC has already been configured according to Network section.

=== "AWS Management Console"

```
1. On [AWS Management Console](https://console.aws.amazon.com/console/home) search for **EKS** and open
1. Click **Add cluster**, "Create"
   ![Create EKS cluster](images/eks_create.png)
1. Set a **Cluster Name** and a **Cluster IAM role**
1. On the **Networking** section, select the VPC, and the appropriate subnets
1. Proceed until the end of the wizard and create the EKS cluster
1. After a few minutes the cluster is created and ready.
```

=== "AWS CLI"

```
![note](images/note.png)
    The following command must be run on the same console window as the VPC creation; otherwise, the
        variables value must be set manually.
```

````
1. Create the required [IAM
    Roles](https://docs.aws.amazon.com/eks/latest/userguide/cluster-iam-role.html)

    ```bash
    # Create IAM Role for EKS Cluster
    echo "Creating IAM Role for EKS Cluster..."
    EKS_ROLE_NAME="eks-cluster-role"
    EKS_ROLE_ARN=$(aws iam create-role \
        --role-name $EKS_ROLE_NAME \
        --assume-role-policy-document '{
          "Version": "2012-10-17",
          "Statement": [
            {
              "Effect": "Allow",
              "Principal": {
                "Service": "eks.amazonaws.com"
              },
              "Action": "sts:AssumeRole"
            }
          ]
        }' \
        --query 'Role.Arn' --output text)
    echo "IAM Role ARN for EKS Cluster: $EKS_ROLE_ARN"

    # Attach necessary policies to the EKS role
    echo "Attaching AmazonEKSClusterPolicy to EKS Cluster Role..."
    aws iam attach-role-policy --role-name $EKS_ROLE_NAME --policy-arn arn![](images\.png){ width=20px
        }iam:![](images\.png){ width=20px }policy/AmazonEKSClusterPolicy
    aws iam attach-role-policy --role-name $EKS_ROLE_NAME --policy-arn arn![](images\.png){ width=20px
        }iam:![](images\.png){ width=20px }policy/AmazonEKSServicePolicy

    # Create IAM Role for EKS Node Group
    echo "Creating IAM Role for EKS Node Group..."
    NODE_ROLE_NAME="eks-nodegroup-role"
    NODE_ROLE_ARN=$(aws iam create-role \
        --role-name $NODE_ROLE_NAME \
        --assume-role-policy-document '{
          "Version": "2012-10-17",
          "Statement": [
            {
              "Effect": "Allow",
              "Principal": {
                "Service": "ec2.amazonaws.com"
              },
              "Action": "sts:AssumeRole"
            }
          ]
        }' \
        --query 'Role.Arn' --output text)
    echo "IAM Role ARN for EKS Node Group: $NODE_ROLE_ARN"

    # Attach necessary policies to the Node Group role
    echo "Attaching AmazonEKSWorkerNodePolicy and other policies to EKS Node Group Role..."
    aws iam attach-role-policy --role-name $NODE_ROLE_NAME --policy-arn arn![](images\.png){ width=20px
````
````

```
        }iam:![](images\.png){ width=20px }policy/AmazonEKSWorkerNodePolicy
    aws iam attach-role-policy --role-name $NODE_ROLE_NAME --policy-arn arn![](images\.png){ width=20px
        }iam:![](images\.png){ width=20px }policy/AmazonEC2ContainerRegistryReadOnly
    aws iam attach-role-policy --role-name $NODE_ROLE_NAME --policy-arn arn![](images\.png){ width=20px
        }iam:![](images\.png){ width=20px }policy/AmazonEKS_CNI_Policy
    ```

1. Create the EKS cluster

    ```bash
    # Ensure you have the necessary environment variables set up from the previous script:
    # VPC_ID, SUBNET_PUBLIC1, SUBNET_PUBLIC2, SUBNET_PRIVATE1, SUBNET_PRIVATE2, EKS_ROLE_ARN,
        NODE_ROLE_ARN

    # Create EKS Cluster (public and private cluster endpoint access)
    echo "Creating EKS Cluster 'cm-cluster'..."
    aws eks create-cluster \
        --name cm-cluster \
        --role-arn $EKS_ROLE_ARN \
        --resources-vpc-config subnetIds=$SUBNET_PUBLIC1,$SUBNET_PUBLIC2,$SUBNET_PRIVATE1,
            $SUBNET_PRIVATE2,endpointPublicAccess=true,endpointPrivateAccess=true \
        --kubernetes-version 1.31 \
        --region eu-east-1

    # Wait for the EKS Cluster to be active (this can take a few minutes)
    echo "Waiting for the EKS cluster to become ACTIVE..."
    aws eks wait cluster-active --name cm-cluster

    # Create Node Group (with 2 nodes of type m5.large)
    echo "Creating Node Group 'cm-nodegroup' with 2 m5.large instances..."
    aws eks create-nodegroup \
        --cluster-name cm-cluster \
        --nodegroup-name cm-nodegroup \
        --scaling-config minSize=2,maxSize=2,desiredSize=2 \
        --disk-size 20 \
        --subnets $SUBNET_PUBLIC1 $SUBNET_PUBLIC2 \
        --instance-types m5.large \
        --ami-type AL2_x86_64 \
        --node-role $NODE_ROLE_ARN \
        --region eu-east-1

    # Wait for the Node Group to be active
    echo "Waiting for the Node Group to become ACTIVE..."
    aws eks wait nodegroup-active --cluster-name cm-cluster --nodegroup-name cm-nodegroup

    echo "EKS Cluster and Node Group successfully created!"
    ```
```

=== "eksctl"

```
![note](images/note.png)
    The following command must be run on the same console window as the VPC creation; otherwise, the
        variables value must be set manually.

```bash
```

```
eksctl create cluster \
       --name cm-cluster \
       --region us-east-1 \
       --vpc-public-subnets $SUBNET_PUBLIC1,$SUBNET_PUBLIC2 \
       --vpc-private-subnets $SUBNET_PRIVATE1,$SUBNET_PRIVATE2 \
       --managed \
       --node-type m5.large \
       --nodes 2 \
       --node-private-networking
```

Cluster creation takes several minutes but some output lines can be seen. When all operations are done, the following line is shown:

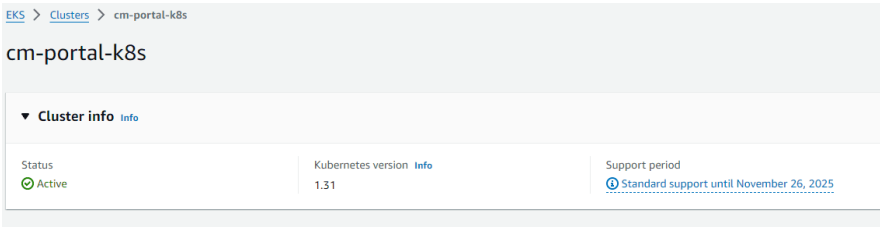
```
![Screenshot showing a configuration interface for creating a cluster.](images/cluster_creation.png)
```

After this, your EKS cluster is running and ready.

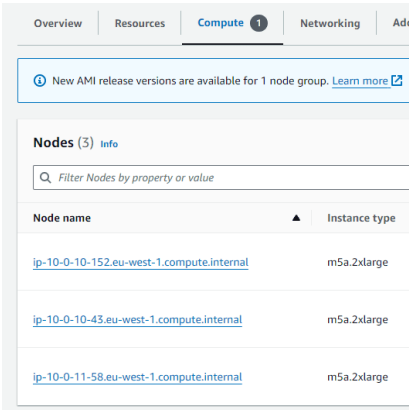
8.3 Troubleshooting

A user can follow several steps to troubleshoot issues with the cluster.

1. Verify the cluster status to ensure it is 'Active'.



2. On the Compute tab of the EKS Cluster page, check the node status to confirm they are 'Ready'. If a node is not 'Ready,' you can click on it to view its events at the bottom of the page.



9 Storage

This section describes how to configure storage to serve as backend for volumes or storage classes in your EKS cluster.

9.1 Cluster Storage

We will present two different options for the cluster storage, allowing you to choose the one that best fits your needs.

- **EFS** - Amazon Elastic File System
- **NFS File Share** (backed-up by an S3 File Gateway)


We recommend using EFS as it is a fully managed service and therefore does not require manual management or maintenance.

9.1.1 Option 1. EFS - Amazon Elastic File System


More information: https://docs.aws.amazon.com/eks/latest/userguide/efs-csi.html

- Before creating the storage class, verify that an Amazon EFS Container Storage Interface (CSI) Driver is deployed to the previously created Amazon EKS cluster. Also, verify that an AWS Identity and Access Management (IAM) OpenID Connect (OIDC) provider exists for the cluster. To check this topic, follow this link.

  - **Create an IAM policy and role**

    1. **Create an IAM policy**
       * Download the IAM policy that allows the CSI driver's service account to make calls to AWS APIs. This IAM policy is designed for the AWS EFS CSI (Container Storage Interface) driver, which allows Kubernetes to manage Amazon EFS (Elastic File System) volumes. This policy grants permissions needed for EFS operations from within a Kubernetes cluster.

```
curl -o iam-policy-example.json
    https://raw.githubusercontent.com/kubernetes-sigs/aws-efs-csi-driver/master/docs/iam-policy-exa
```

       * Create the policy based on the previously downloaded json.

```
aws iam create-policy  --policy-name AmazonEKS_EFS_CSI_Driver_Policy --policy-document
    file://iam-policy-example.json
```

    2. **Create an IAM role and attach the IAM policy to it.**
       * First, you need to find the cluster's OpenID Connect (OIDC) provider URL. This is possible through the following command:

```
aws eks describe-cluster --name my-cluster --query "cluster.identity.oidc.issuer" --output text
```

       The output must be as follows:
       `https://oidc.eks.region-code.amazonaws.com/id/EXAMPLED539D4633E53DE1B71EXAMPLE`
       * Create the IAM role, granting the Kubernetes service account the AssumeRoleWithWebIdentity action. This action allows the role to be assumed by an entity using a Web Identity Federation token (in this case, an OIDC token from Kubernetes).

* Copy the following contents to a file named trust-policy. Replace **111122223333** with your account ID. Replace `EXAMPLED539D4633E53DE1B71EXAMPLE` and `region-code` with the values returned in the previous step.

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Principal": {
                "Federated": "arn![](images\.png){ width=20px
                    }iam::111122223333:oidc-provider/oidc.eks.region-code.amazonaws.com/id/EXAM
            },
            "Action": "sts:AssumeRoleWithWebIdentity",
            "Condition": {
                "StringEquals": {
                    "oidc.eks.region-code.amazonaws.com/id/EXAMPLED539D4633E53DE1B71EXAMPLE:sub"
                        "system![](images\.png){ width=20px }kube-system:efs-csi-controller-sa"
                }
            }
        }
    ]
}
```

* Now, create the role.

```
aws iam create-role
--role-name AmazonEKS_EFS_CSI_DriverRole
--assume-role-policy-document file://"trust-policy.json"
```

* Attach the IAM policy to the role with the following command. Replace **111122223333** with your account ID.

```
aws iam attach-role-policy
--policy-arn arn![](images\.png){ width=20px }iam::111122223333:policy/AmazonEKS_EFS_CSI_Driver_Pol
--role-name AmazonEKS_EFS_CSI_DriverRole
```

* Create a Kubernetes service account that is annotated with the ARN of the IAM role that you created.
* Create a file with the following contents named efs-service-account.yaml and replace **111122223333** with your account ID.

```
---
apiVersion: v1
kind: ServiceAccount
metadata:
  labels:
    app.kubernetes.io/name: aws-efs-csi-driver
  name: efs-csi-controller-sa
  namespace: kube-system
  annotations:
    eks.amazonaws.com/role-arn: arn![](images\.png){ width=20px
        }iam::111122223333:role/AmazonEKS_EFS_CSI_DriverRole
```

* Run the following command to create the storage class. The Kubernetes service account named efs-csi-controller-sa is annotated with the IAM role that you created named AmazonEKS_EFS_CSI_DriverRole.

```
kubectl apply -f efs-service-account.yaml
```

– **Install the Amazon EFS driver**

* There are three ways to install the driver: Helm, Manifest (private registry), or Manifest (public registry). We used the last option.

1. Download the manifest through the following command:

```
kubectl kustomize
"github.com/kubernetes-sigs/aws-efs-csi-driver/deploy/kubernetes/overlays/stable/?ref=v1.4.0" >
    public-ecr-driver.yaml
```

2. Edit the file and remove the lines that are responsible for the creation of the storage class named efs-csi-controller-sa because it was created in the previous step. After that, apply the manifest:

```
kubectl apply -f public-ecr-driver.yaml
```

– **Create an Amazon EFS file system**

* The Amazon EFS CSI driver supports the Amazon EFS access points, which are application-specific entry points into an Amazon EFS file system that make it easier to share a file system between multiple points.
* Below are the different steps the you need to create an Amazon EFS file system for the previously created cluster.

1. Get the VPC (Virtual Private Cloud) ID where the cluster is in.

```
vpc_id=$(aws eks describe-cluster --name my-cluster --query "cluster.resourcesVpcConfig.vpcId"
    --output text)
```

2. Get the CIDR range for the cluster's VPC.

```
cidr_range=$(aws ec2 describe-vpcs --vpc-ids $vpc_id --query "Vpcs[].CidrBlock" --output text)
```

3. Create a security group with an inbound rule that allows inbound NFS traffic for the Amazon EFS mount points.
   · Create a security group.

```
security_group_id=$(aws ec2 create-security-group --group-name MyEfsSecurityGroup --descripti
    security group" --vpc-id $vpc_id --output text)
```

   · Create an inbound rule that allows inbound NFS traffic from the CIDR for the cluster's VPC.

```
aws ec2 authorize-security-group-ingress --group-id $security_group_id --protocol tcp --port
    --cidr $cidr_range
```

4. Create an Amazon EFS file system for the previously created cluster.
   · Create a file system.

```
file_system_id=$(aws efs create-file-system  --region region-code --performance-mode generalP
    --query 'FileSystemId' --output text)
```

   · Create mount targets. First you need to find the ip address of the cluster nodes. This can be done through the following command:

```
kubectl get nodes
```

   The output needs to be as follows:

```
NAME                                          STATUS   ROLES    AGE   VERSION
ip-192-168-56-0.region-code.compute.internal   Ready    <none>   19m   v1.19.6-eks-49a6c0
```

Figure 3: nodes_cluster_info

- After that, determine the ids of the subnets in the VPC and which Availability Zone the subnet is in.

```
aws ec2 describe-subnets
--filters "Name=vpc-id,Values=$vpc_id" --query 'Subnets[*].{SubnetId: SubnetId,AvailabilityZo
    AvailabilityZone,CidrBlock:CidrBlock}' --output table --region region-code
```

```
|                          DescribeSubnets                          |
+------------------+--------------------+----------------------------+
| AvailabilityZone |     CidrBlock      |         SubnetId           |
+------------------+--------------------+----------------------------+
|  region-codec    |  192.168.128.0/19  |  subnet-EXAMPLE6e421a0e97  |
|  region-codeb    |  192.168.96.0/19   |  subnet-EXAMPLEd0503db0ec  |
|  region-codec    |  192.168.32.0/19   |  subnet-EXAMPLEe2ba886490  |
|  region-codeb    |  192.168.0.0/19    |  subnet-EXAMPLE123c7c5182  |
|  region-codea    |  192.168.160.0/19  |  subnet-EXAMPLE0416ce588p  |
+------------------+--------------------+----------------------------+
```

Figure 4: cluster_subnets

- Finally, add mount targets for the subnets that the nodes are in. Through this link you can find out in which CidrBlock the node's ip address is in.

```
aws efs create-mount-target
--file-system-id $file_system_id
--subnet-id subnet-EXAMPLEe2ba886490
--security-groups $security_group_id --region region-code
```

- To ensure that everything was created correctly, you can deploy the sample application with dynamic provisioning presented at the end of this guide.
- After that, you can create a storage class. Take what follows as an example:

```
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: efs-sc
provisioner: efs.csi.aws.com
parameters:
  provisioningMode: efs-ap
  fileSystemId: fs-0e40f7a1635c2391d
  directoryPerms: "700"
```

Figure 5: storage_class_example

- Replace the fileSystemId value with the previously created file system.

9.1.2 Option 2. NFS

More information: https://docs.aws.amazon.com/filegateway/latest/files3/create-gateway-file.html and https://docs.aws.amazon.com/filegateway/latest/files3/create-nfs-file-share.html

1. **Create AWS Storage Gateway**

    1. Open the AWS Storage Gateway console and select **Create Gateway**.
    2. **Gateway Settings**
        - For **Gateway name**, enter a name for the gateway.
        - For **Gateway time zone**, select the local time zone for the part of the world where you want to deploy the gateway.
    3. **Gateway Options**
        - For **Gateway Type**, select **Amazon S3 File Gateway**.

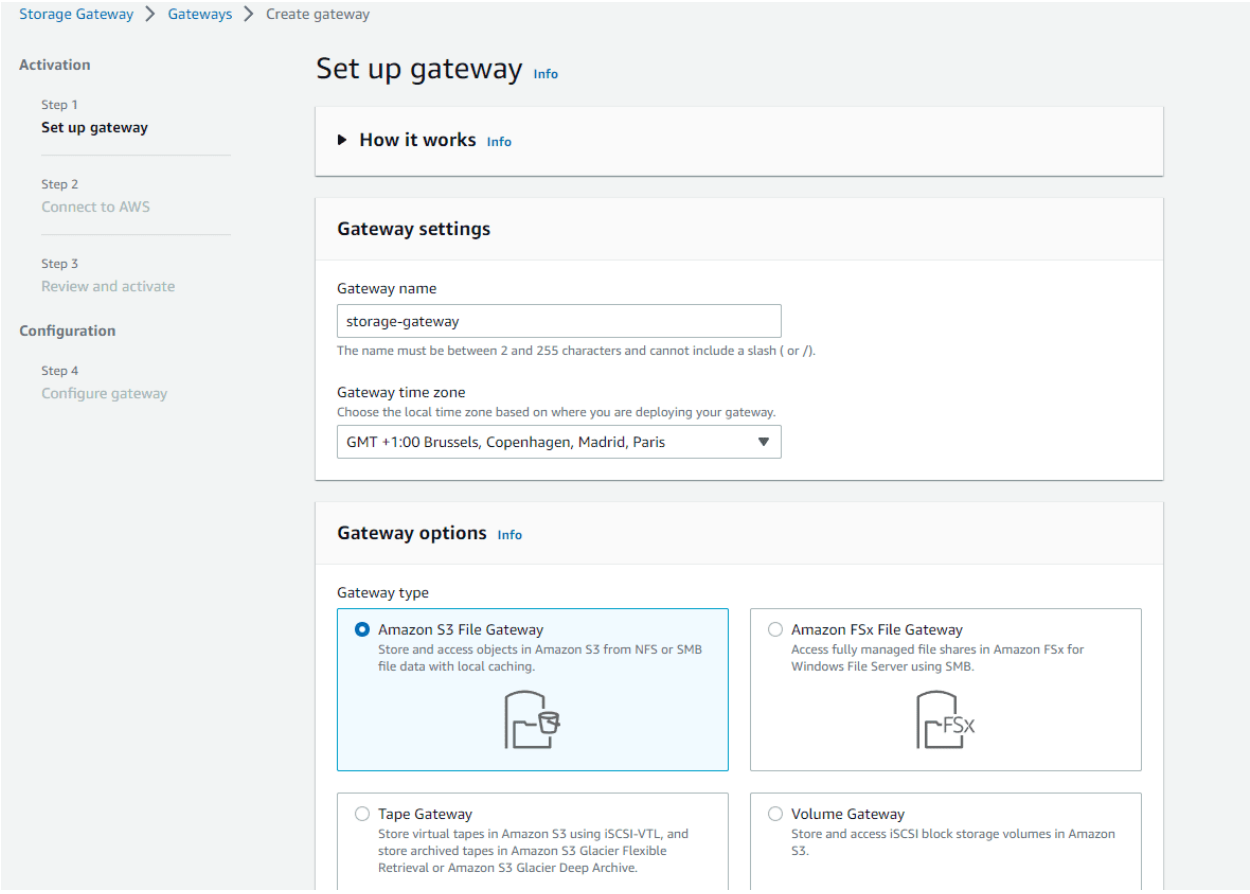


Figure 6: setup_gateway

4. **Platform Options**
    - For **Host platform**, select the platform on which the gateway is supposed to be deployed. On our side, we chose **Amazon EC2**. The gateway must be created in the same *Virtual private cloud (VPC)* as the cluster, and the selected *VPC subnet* can be one that is available in the VPC.
    - After filling out all the fields with the correct data, select **Launch Instance**. This step can take up to two minutes. Select **Next** when the previous task is completed.

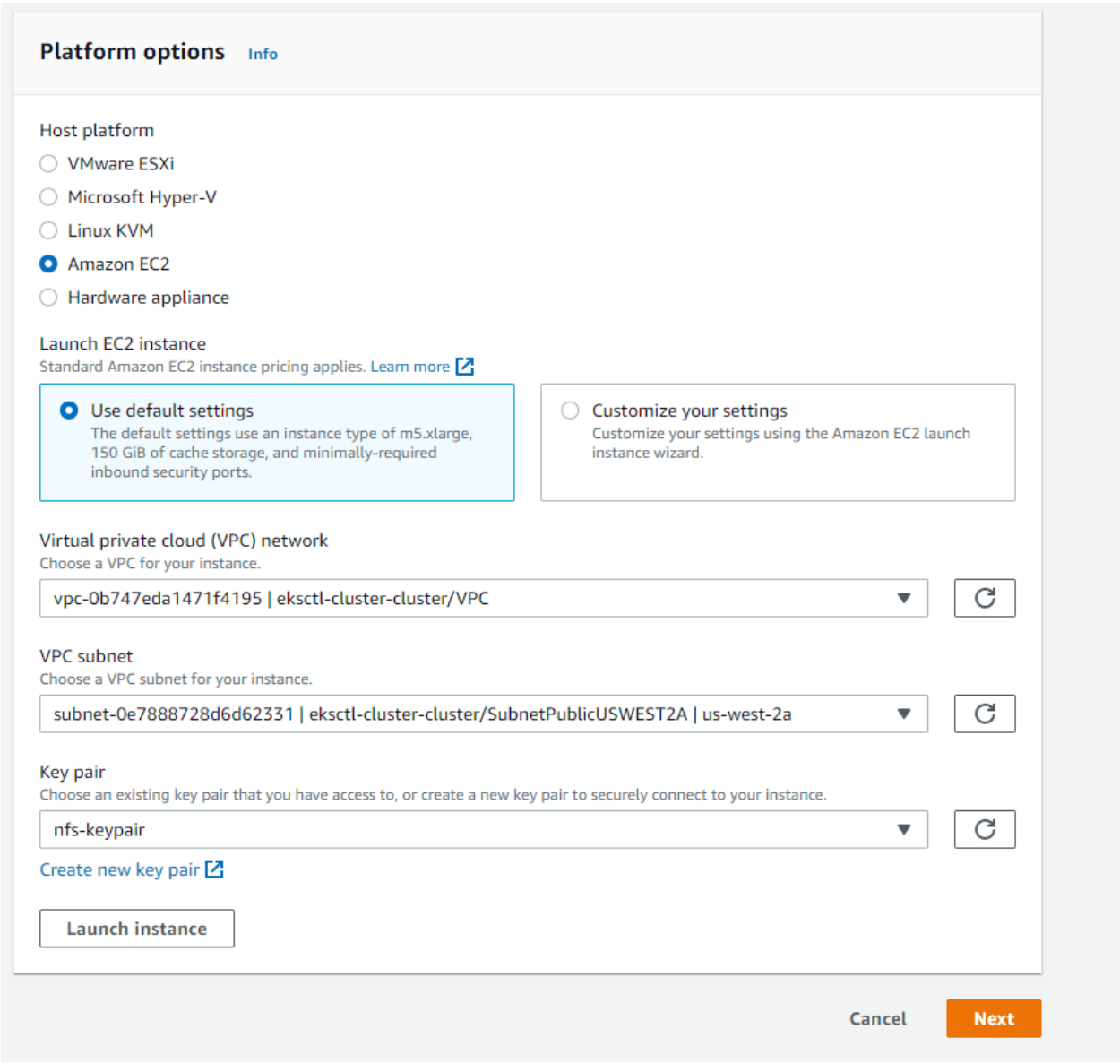


Figure 7: setup_gateway_platform_options

5. **Connect to AWS**

   - For **Endpoint options** you can select **VPC hosted**, but you must have created all the inherent resources in advance. Otherwise, continue with **Publicly accessible**.
   - For **Gateway connection options**, continue with the default options.

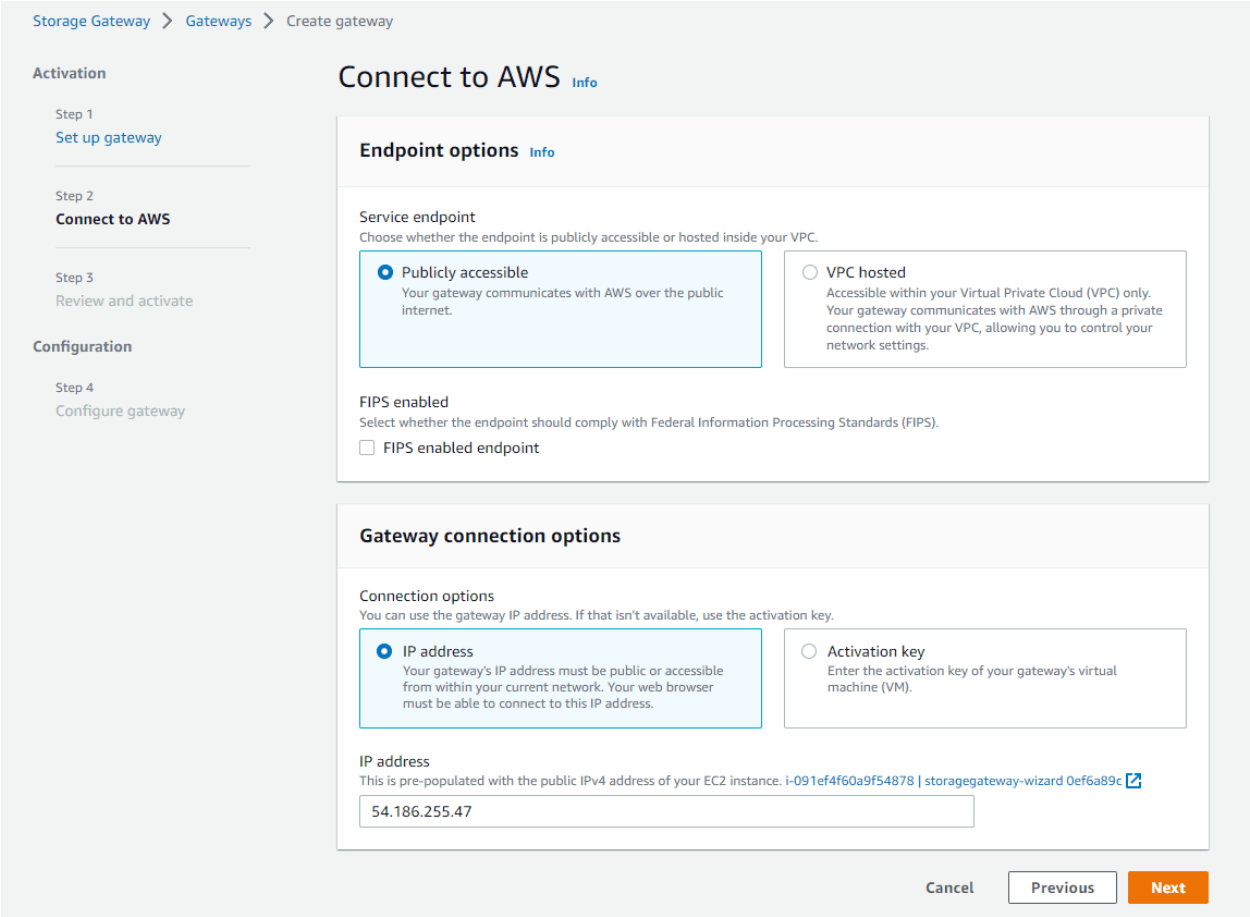


Figure 8: connect_to_aws

6. **Review and activate**
    - In this step, you can edit the prefilled settings. After proceeding, all data cannot be changed.
7. **Configure gateway**
    - This is the last step and all configurations can be left with the default values. Select **Next** to finish the gateway configuration.

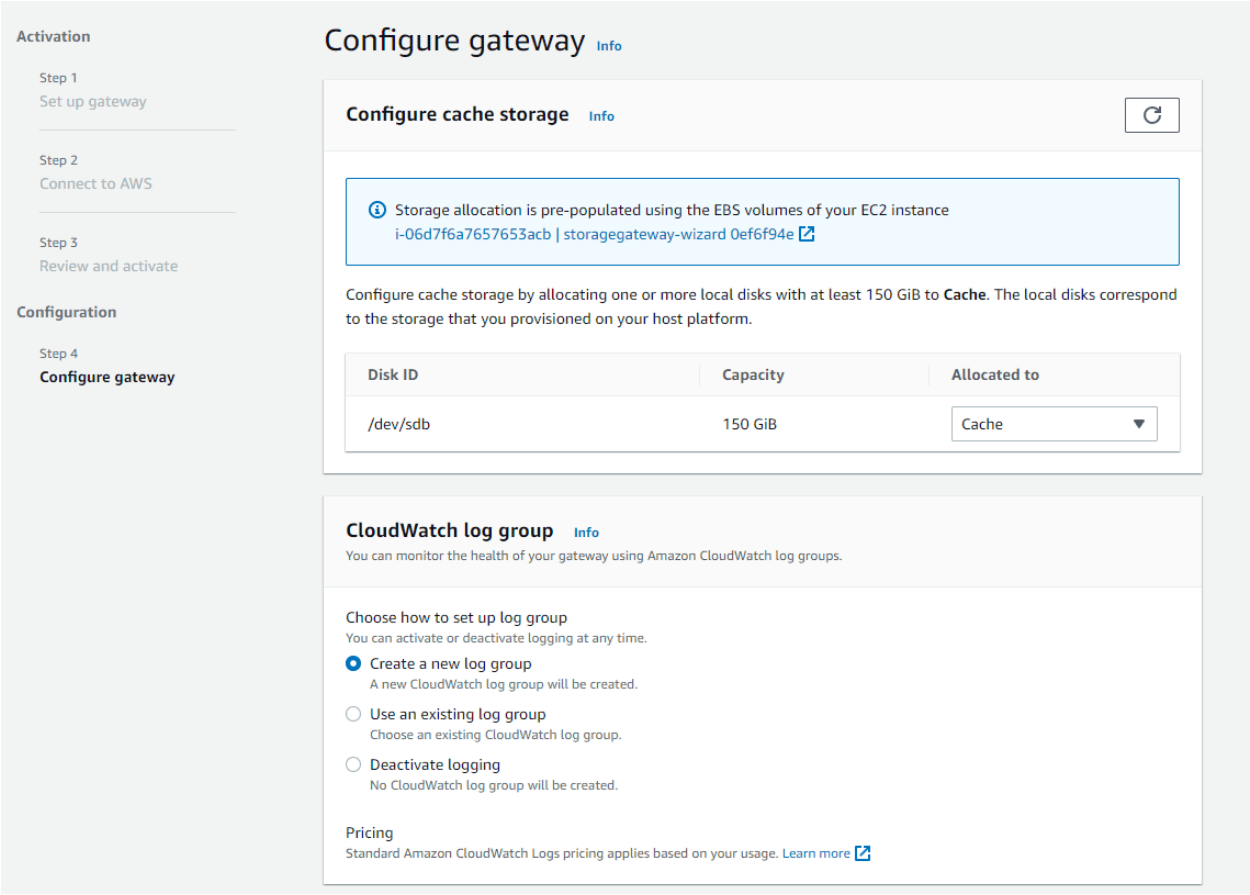


Figure 9: configure_gateway

8. Now, on the **Gateway overview dashboard**, the resource is available. You may need to wait a few minutes for the status to turn green. At this point, the gateway is ready to use.

   With the gateway ready, it is time to create the file shares. Besides having the gateway up and running, a S3 bucket resource needs to be created for each file share. Buckets are containers for data stored in S3.

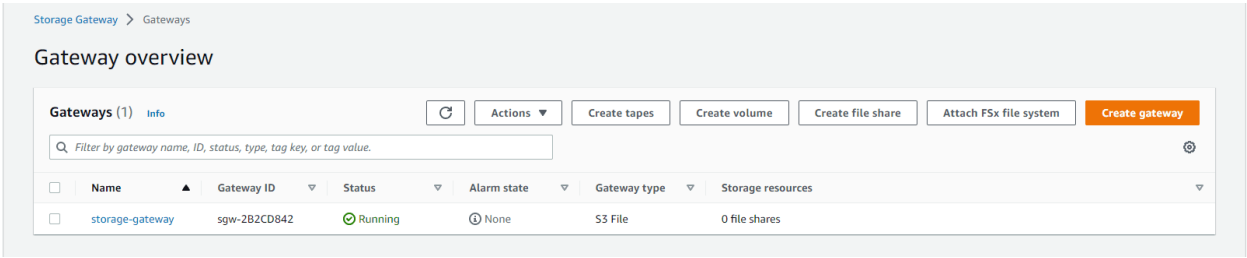


Figure 10: gateway_overview

2. **S3 bucket creation**

   1. To create this resource, go to this dashboard and select **Create bucket**. A page similar to the one below comes up. Fill out the **bucket name** and make sure that the AWS Region is the same as in the previous resources. All other configurations can be left with the default values.

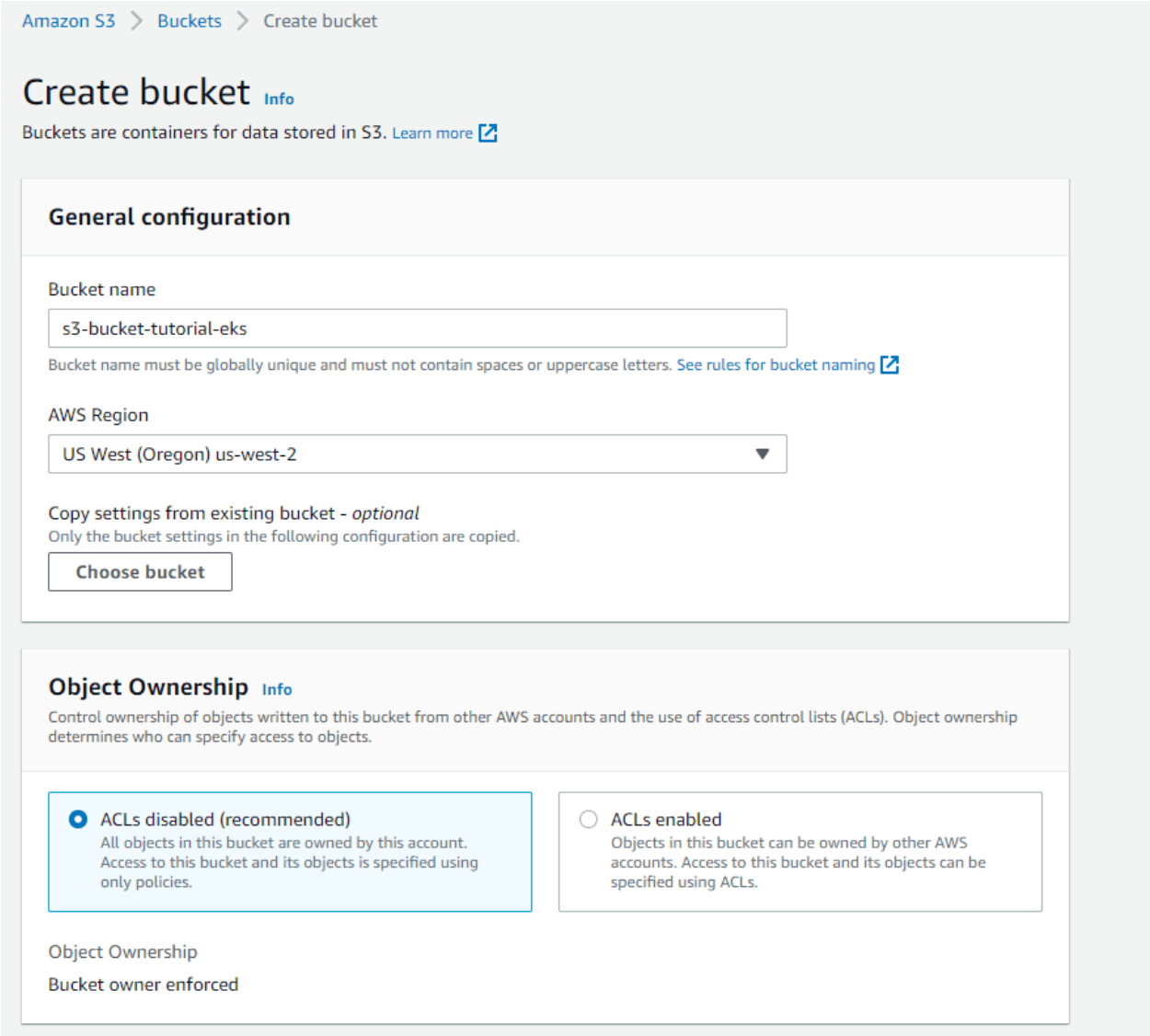


Figure 11: create_bucket

2. If all goes well, the bucket is created and ready to use.

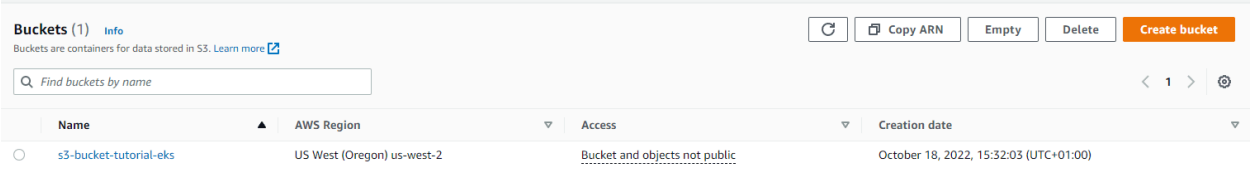


Figure 12: buckets_dashboard

3. **File share creation**

    1. **File share settings**

        - For **Gateway**, select the previously created gateway.
        - For **Amazon S3 location**, select **S3 bucket name** and fill out the corresponding field with its name.

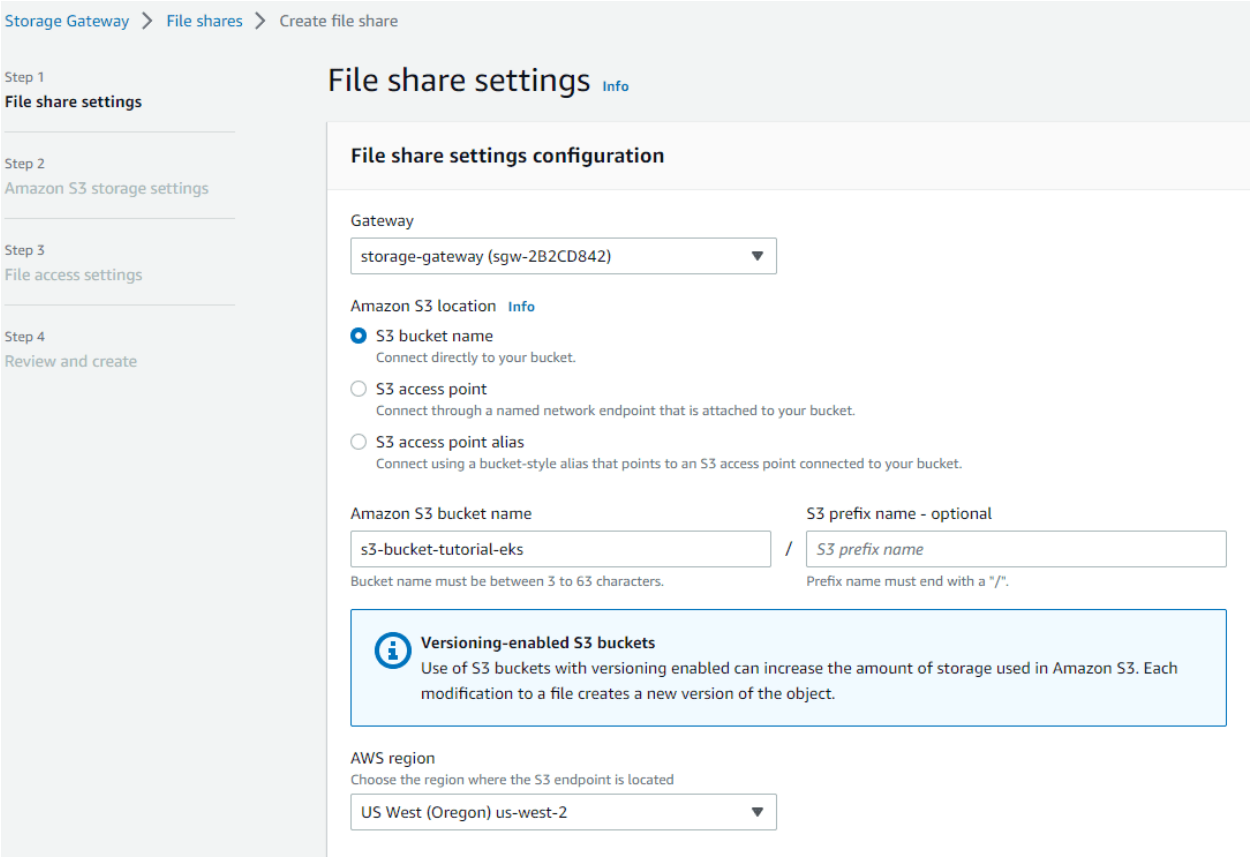


Figure 13: file_share_settings

- By default, the file share name is prefilled with the S3 bucket name, but it can be changed to a different one.
- For now, leave the other configurations with the default values and select **Next**.

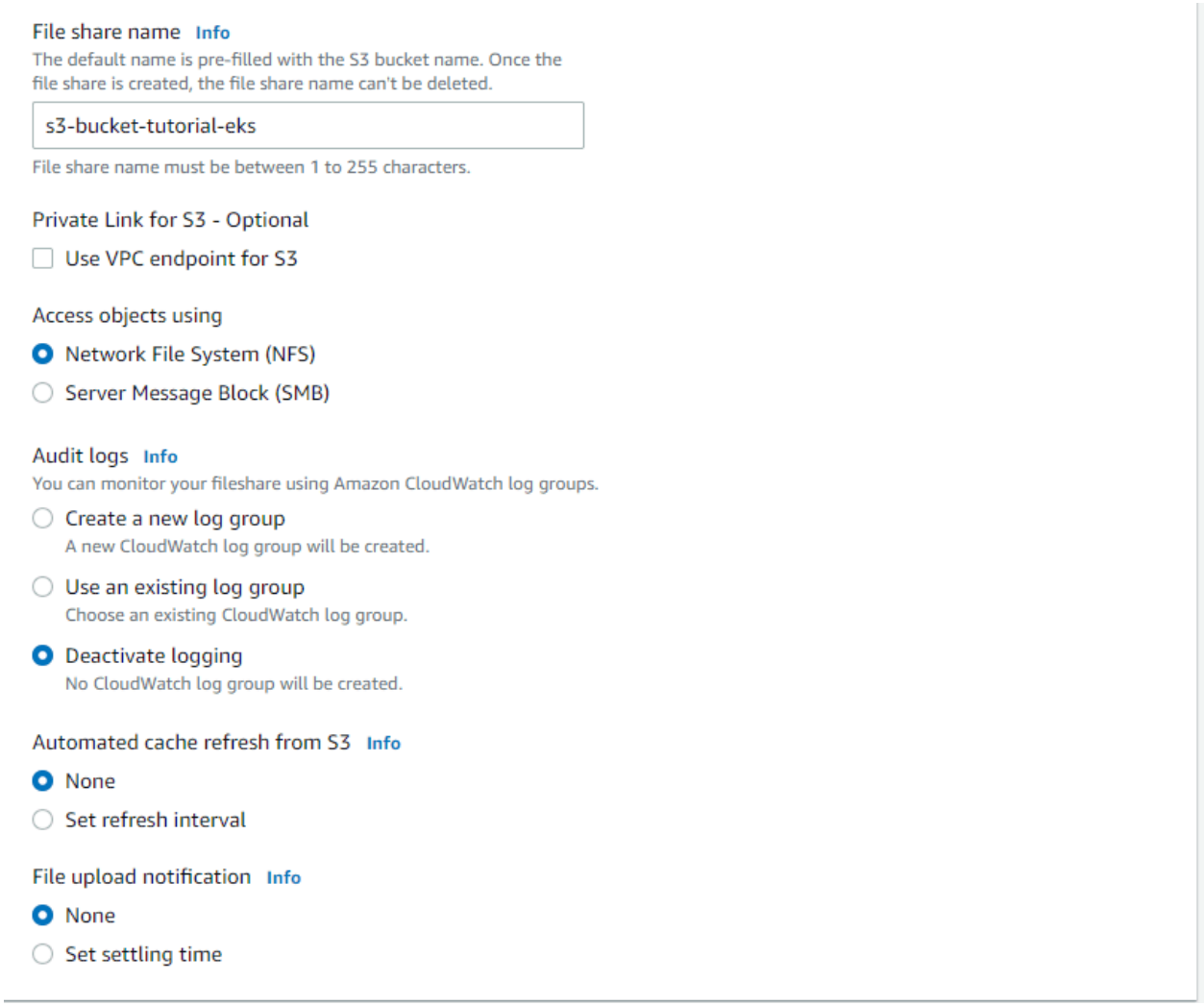


Figure 14: file_share_settings_2

2. **Amazon S3 storage settings**

    - Keep the configurations with the default values and proceed.

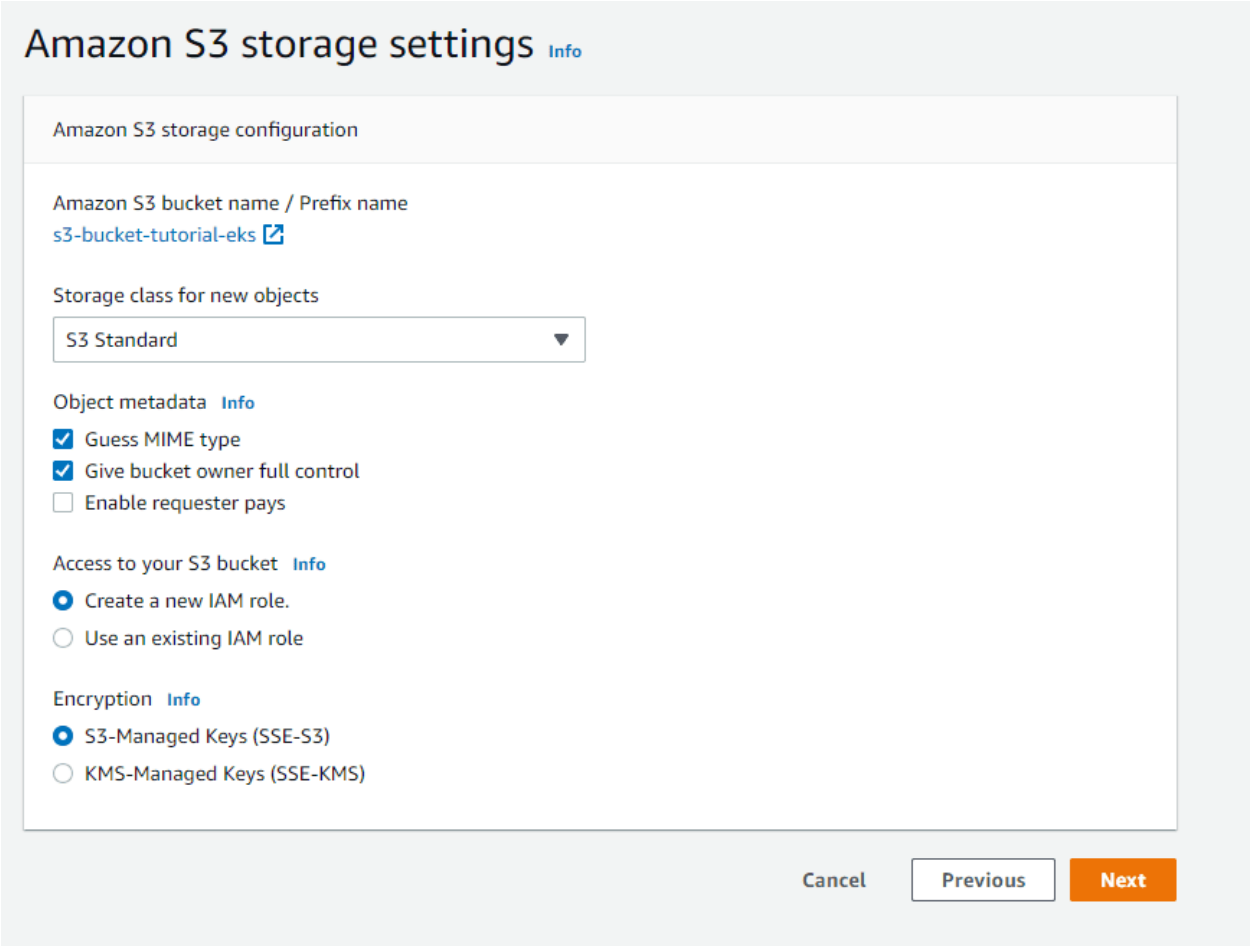


Figure 15: amazon_s3_storage_settings

3. **File access settings**
    - Keep the configurations with the default values and proceed.

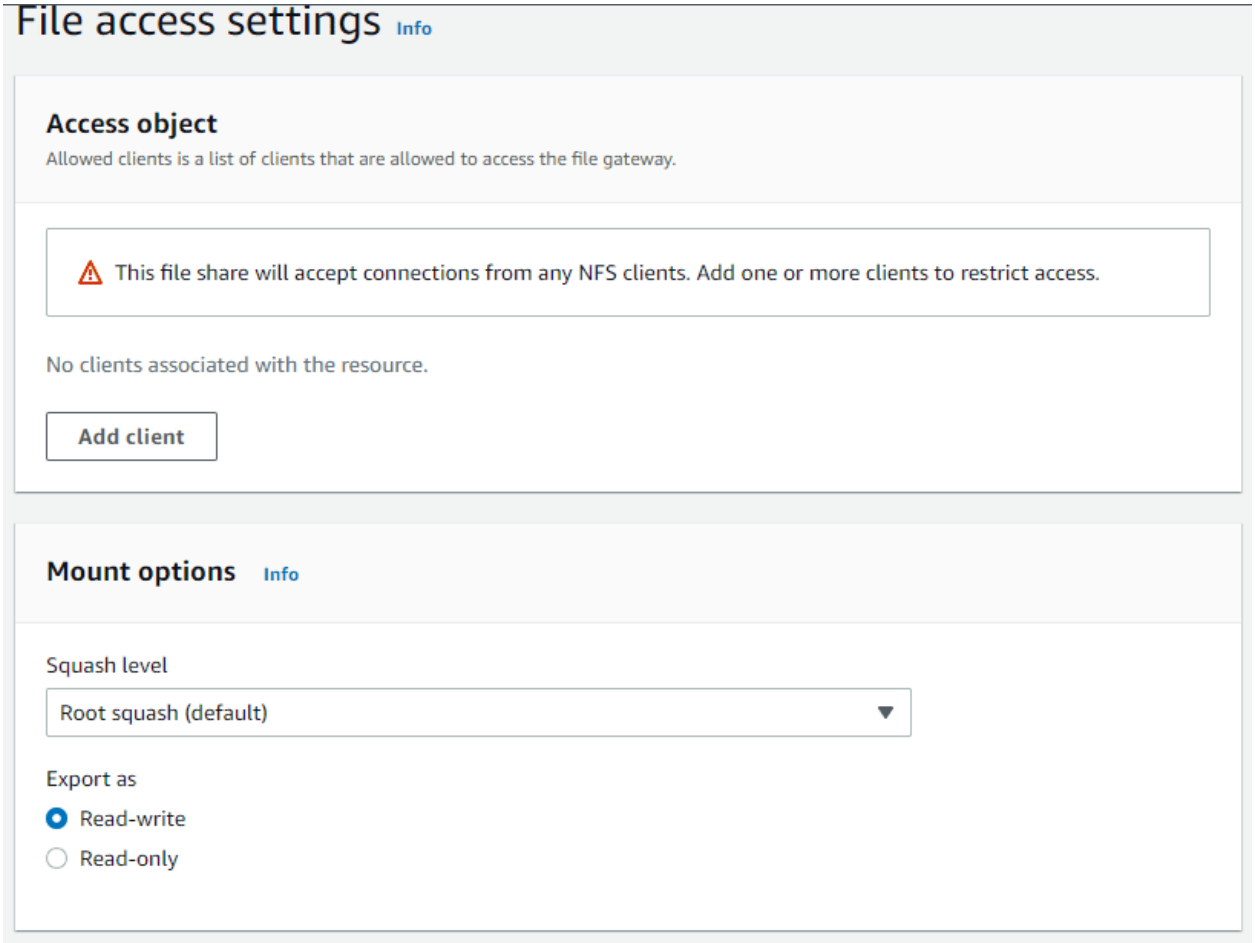


Figure 16: file_access_settings

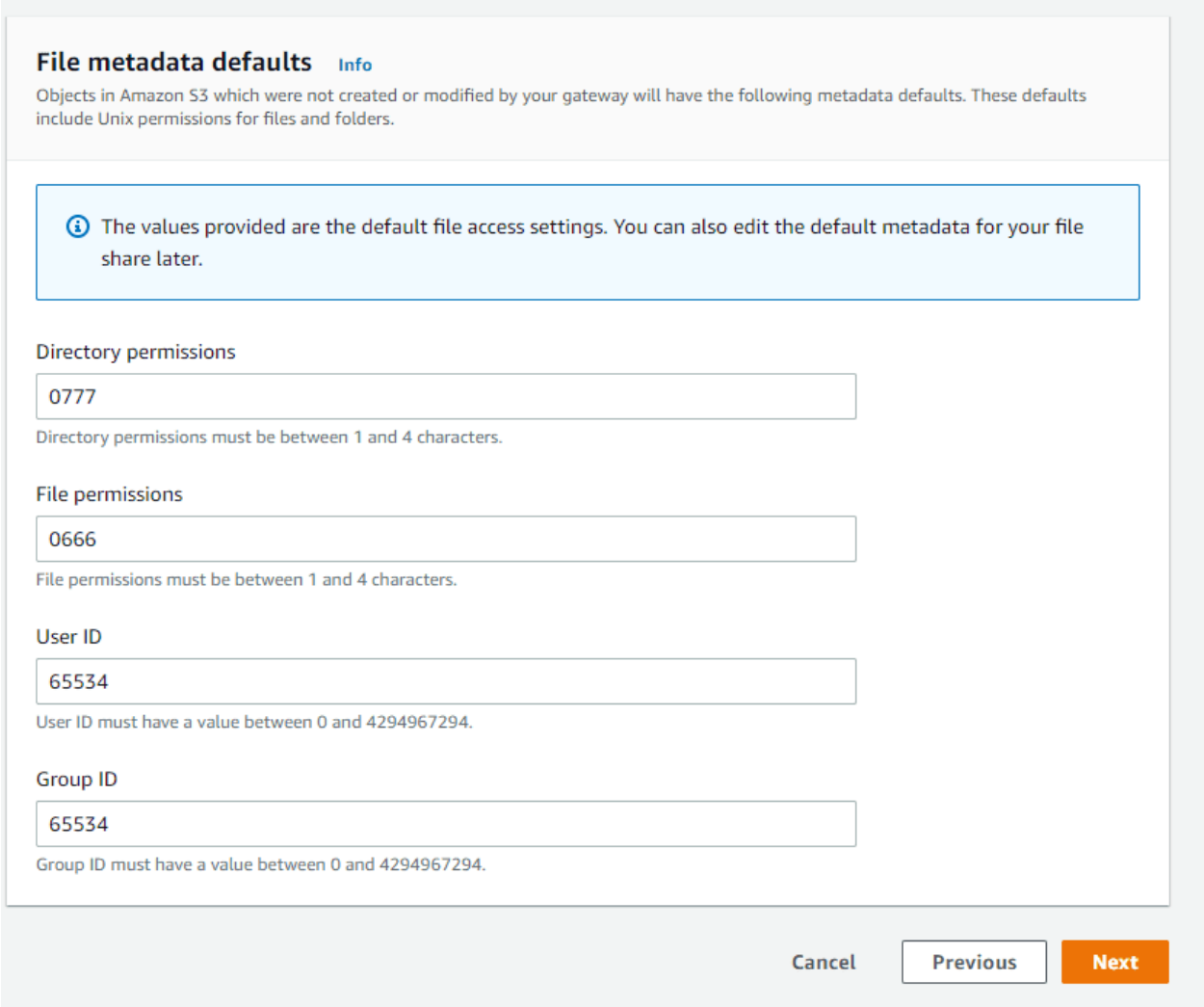


Figure 17: file_access_settings_2

4. **Review and create**
    - Check that all settings are correct and proceed with creating the file share.
5. File share is ready to use when its status changes to **Available**. It may take a few minutes between creation and this status update.

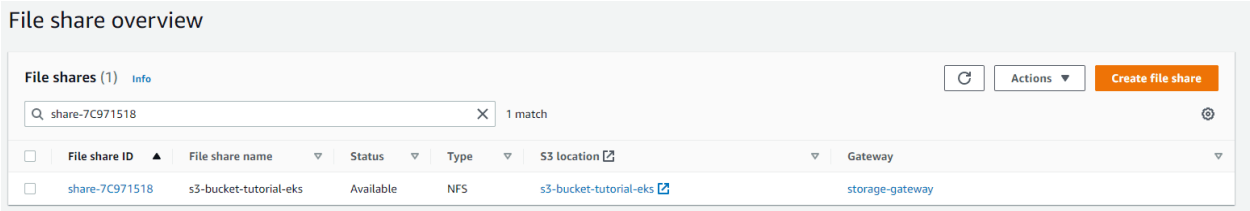


Figure 18: file_share_overview

9.2 EKS and Database Shared Storage

The EKS cluster and the SQL Server must have a shared storage space that allows both to read and write data, ensuring seamless access and interaction between them.

10 Ingress

This section describes how to manage the incoming ingress traffic onto the EKS cluster at the Ingress Controller level, including its exposure, TLS and how to route to different environments.

10.1 Ingress Controller

An Ingress Controller is responsible to handle traffic coming from outside the Kubernetes cluster, acting as a reverse proxy and routing the requests to the backend services as defined in Ingress specifications.

Critical Manufacturing MES includes a Traefik instance that acts as an internal reverse proxy, routing the traffic to the namespace services, and an Ingress definition to be consumed by the controller. These Ingresses define a single HTTPS rule that matches a particular host, indicating that all traffic that gets matched is to be delivered to the Traefik service which takes care of the rest.

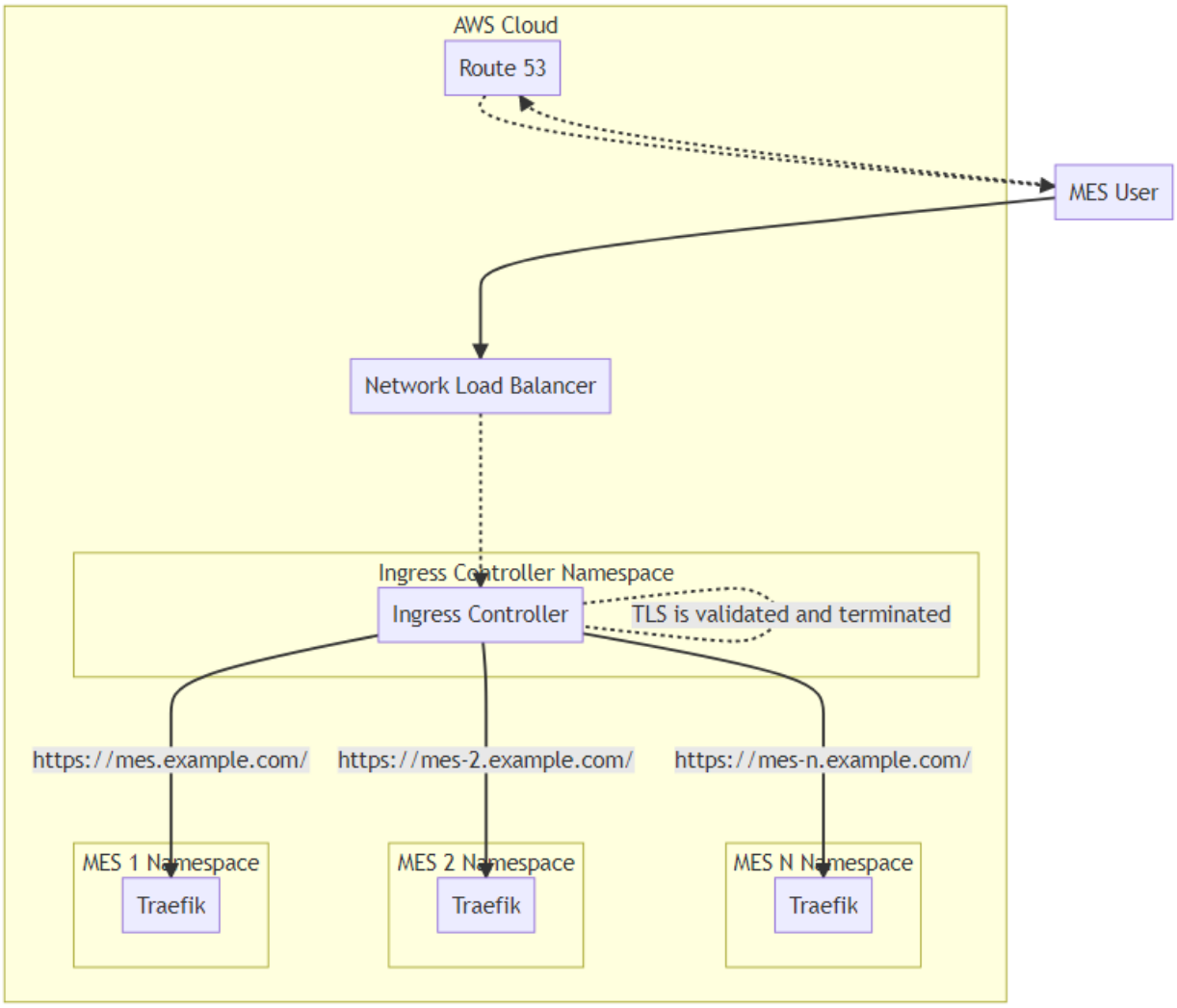
Having this in mind, the Ingress Controller must read Ingresses from different namespaces (in order to serve more than one MES environment), which requires a set of RBAC permissions (these vary depending on the Ingress Controller of choice). Currently, the Critical Manufacturing Infrastructure Agent includes a Traefik instance that is configured to run as the cluster's Ingress Controller with all the necessary requirements:

1. Two entrypoints for incoming traffic, HTTP and HTTPS (HTTP traffic is permanently redirected to the HTTPS entrypoint)
2. RBAC definitions allowing it to read and manage Ingresses from all namespaces
3. Matches all Ingresses with the label `app: traefik`
4. Only allows HTTPS and deals with TLS validation and termination

 "Deprecation warning" The **Infrastructure Agent's Traefik is deprecated** starting from Infrastructure Agent 11.1, and will be removed when MES 12.0 is released.

 If using a custom Ingress Controller, these requirements must be met.

The following diagram illustrates how the traffic is managed:



10.2 Ports

The Ingress Controller needs to expose two ports:

1. 80 - Handle HTTP traffic. Security-wise it should permanently redirect all traffic to the HTTPS entrypoint.
2. 443 - Handle HTTPS traffic.

10.3 TLS

All incoming traffic that hits the HTTPS entrypoint is validated and TLS is terminated before being forwarded to the backend service. As such, TLS configurations must be put into place:

- Using a TLS secret with a certificate that matches different subdomains through SANs or using a wildcard.
- Using external services to handle certificate management, such as Let's Encrypt with Route 53.

If using the Infrastructure Agent's Traefik, you'll have the possibility to reference the name of the secrets that contain the Certificate and Key, or include configures for external providers such as Route 53 through Let's Encrypt.

Defining different certificates at the Ingress level (per MES) is not supported.

10.4 Load Balancer

Having the ingress traffic reaching the Ingress Controller requires a Load Balancer that respects the Ports requirements. Since we are dealing with Layer 7 (Application) in the Ingress Controller, we require a Layer 4 (Transport) Load Balancer - a Network Load Balancer (NLB). As the AWS documentation refers, it is recommended to use the AWS Load Balancer Controller. This controller will automatically manage the NLB during its whole lifecycle, including the creation and destruction.

Having the AWS Load Balancer Controller, you should add the following annotations to the Load Balancer Kubernetes Service that exposes the Ingress Controller:

- `service.beta.kubernetes.io/aws-load-balancer-scheme` - The scheme of the Load Balancer. The value can be **internet-facing** or **internal**, depending if you want to route requests from over the internet or just with private IP addresses.
- `service.beta.kubernetes.io/aws-load-balancer-type` - Type of the Load Balancer which should be set to **external**. This will define, by default, that all traffic is routed to the port of the service.

After having these changes, AWS should automatically create an NLB for you with an A Record, similar to the following example:

The ARN, Zone, VPC, Region, Availability Zones and DNS name will vary.

The A Record resolves to the NLB which will, in turn, route all the traffic to the Ingress Controller. Now, since the latter operates at Layer 7, and to be able to support other domains, you should configure a DNS provider to resolve a particular DNS name to this A record. You can leverage Route53 by adding a CNAME record to your domain. Taking the *mes.example.com* as an example:

1. Go to Route53
2. Choose the Hosted Zone where your top domain (example.com) resides
3. Create a Record:
    - Name: the name of the subdomain (mes)
    - Type: A Record
    - Target: Alias to Network Load Balancer and choose your value

For more information, see https://docs.aws.amazon.com/Route53/latest/DeveloperGuide/routing-to-elb-load-balancer.html.

11 Encryption Data Configuration

Amazon EFS provides encryption for both data in transit and data at rest, ensuring that the data remains secure when stored and while being accessed. Amazon S3 Gateway can be used to mount volumes that map S3 buckets, while encryption is handled by S3 and through the network protocol.

 More information about the two above mentioned methods can be found here.

11.1 Encryption in transit

Protects the data while it is being moved from one place to another. This ensures that it can't be intercepted or read while it's being sent over a network.

11.1.1 Features

- It acts when the data is moved between two systems, such as a computer and a cloud service or between services within a cloud.
  - The data is encrypted during transmission using protocols like TLS, which ensures that no one can intercept and read the data while it's being sent over a network.
  - The main goal of this process is to protect data from being intercepted while it is moving across a network.
  - It is supported using TLS to ensure that the communication between the client (Kubernetes) and EFS is encrypted.

     To learn more about this topic, go to the Encrypting data in transit page in the Amazon Elastic File System User Guide.

11.1.2 Volumes

- When using S3 Gateway, the data in transit between the application and the gateway may not be encrypted by default over NFS.
- However, once the data is transferred from the gateway to Amazon S3, it is encrypted using HTTPS that ensures that data is secure during the process between the gateway and the S3 bucket.

11.2 Encryption at rest

Protects the data onces it reaches its destination and is stored on a disk, database, or in the cloud. This ensures that if someone gains unauthorized access to the physical storage, they won't be able to read the data without the decryption keys.

11.2.1 Features

- Amazon EFS encrypts the data at rest using AWS Key Management Service.
- The data and metadata are encrypted with the AES-256 encryption algorithm.
- It is possible to choose between AWS-managed key (default) or a customer-managed key in AWS KMS for greater control over the encryption.

- This method is enabled when the EFS file system is created, and after that, all data written to the file system will be encrypted.

 To learn more about this topic, go to the Encrypting data at rest page in the Amazon Elastic File System User Guide.

11.2.2 Volumes

- Data stored in Amazon S3 is encrypted at rest using Server-Side Encryption (SSE). There are three main options:
  - **SSE-S3** (Server-Side Encryption with S3-Managed Keys):
    * S3 automatically encrypts your data using AES-256 (Advanced Encryption Standard) without requiring user involvement.
    * AWS manages both the encryption and decryption processes seamlessly. Suitable for use cases where simplicity and minimal configuration are required.
  - **SSE-KMS** (Server-side Encryption with Customer-Provided Keys)
    * Data is encrypted using keys managed by AWS KMS.
    * The user can control and audit the usage of the encryption keys.
    * It provides additional security features like fine-grained permissions and key rotation.
  - **SSE-C** (Server-Side Encryption with Customer-Provided Keys):
    * The user provides the encryption keys for S3 to use when encrypting and decrypting data.
    * S3 does not store the encryption key, so it must be provided with each request.

12 External Services

This section contains information regarding services external to Critical Manufacturing MES that are dependencies and required for the MES system to run.

- [[installation-guide-aws-external-sqlserver]]
- [[installation-guide-aws-external-kafka]]
- [[installation-guide-aws-external-rabbitmq]]
- [[installation-guide-aws-external-s3]]
- [[installation-guide-aws-external-clickhouse]]

13 SQL Server

As described in [[system-requirements-persistency-layer-index]] and [[installation-guide-database-servers-index]], an SQL Server database is required for Critical Manufacturing to run.

Depending on your infrastructure configuration, the SQL Server database instances may or may not be part of the AWS deployment. There is no requirement on where the database servers are deployed and running, as long as there is connectivity with the EKS cluster.

The following sections give some guides on how to install SQL Server in AWS if you want to have the database running in the AWS infrastructure as well.

13.1 EC2 Instances

One way to install SQL Server in AWS is using EC2 instances. Amazon Elastic Compute Cloud is a service that allows to create and run virtual machines with resizable capacity.

Using EC2, you will create **Windows Server EC2** instances following the software and hardware requirements documented in [[system-requirements-persistency-layer-index]]. When the instances are running, SQL Server needs to be installed and configured on these instances according to the documentation that you can find in [[installation-guide-database-servers-index]].

Keep in mind that, similarly to local on-premises servers, these EC2 instances need to be managed, updated, and maintained manually.

13.2 AWS RDS Custom

An alternative way to have your databases running on AWS infrastructure is using AWS **RDS Custom for SQL Server**. Managed database services for applications that require operating system and database customization The idea behind RDS Custom is to allow the users to initially setup the machine where the database is running, giving access to the underlying EC2 instance to perform specific configurations or installing any required additional software. After this, RDS Custom service will monitor and manage the SQL Server database inside this EC2 instance.

For more information, see https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/rds-custom.html.

 Presently, Amazon RDS databases **are not supported** by Critical Manufacturing.

14 Kafka

Managing Kafka clusters manually can be complex, especially when considering factors like scalability, monitoring, and security. Fortunately, it is possible to access several managed Kafka solutions via AWS Marketplace. The two primary options are Amazon MSK and Confluent Cloud.

14.1 Amazon Managed Streaming for Apache Kafka - Amazon MSK

Amazon Managed Streaming for Apache Kafka (MSK) is a fully managed service that simplifies deploying, managing, and scaling Apache Kafka clusters on AWS. It allows to use Apache Kafka without handling the operational complexity of running it manually.

14.2 Confluent Cloud

Confluent Cloud is a managed Kafka service that extends the Apache Kafka with advanced features and tools. Built by the Kafka creators, it provides additional capabilities on top of Kafka that helps to build robust data streaming pipelines.

This solution can be subscribed through AWS Marketplace. With this, the setup is simplified, as the marketplace allows to subscribe and deploy the Kafka cluster in a easy way, it offers flexible pricing models, the integration is seamless with other AWS services.

15 RabbitMQ

RabbitMQ is a reliable and mature messaging and streaming broker, which is easy to deploy of cloud environments, on-premises, and on local machines.

15.1 Amazon MQ

AWS offers a solution for RabbitMQ called **Amazon MQ**. It is a managed message broker service that supports message brokers such as RabbitMQ and Apache ActiveMQ. It allows developers to use RabbitMQ's robust messaging features without worrying about the complexity of broker management, scaling, or infrastructure maintenance.

There are many key features of Amazon MQ. Below, some of them are highlighted:

- **Fully Managed** - it takes care of the operational overhead, including provisioning the message broker, ensuring high availability, patching, monitoring, and failure recovery.
- **High Availability** - it deploys RabbitMQ brokers across multiple availability zones (AZs) in a region, providing built-in redundancy and automatic failover for improved reliability.
- **Security** - it integrates with AWS Identity and Access Management (IAM) and supports encryption in transit and at rest using TLS and AWS Key Management Service, ensuring secure messaging.
- **Monitoring and Metrics** - Integrated with Amazon CloudWatch, it provides metrics and logs to monitor broker performance and health.
- **Cost-Effective** - *Pay-As-You-Go* approach.

It is possible to find more information about this topic and how to setup it in AWS here.

16 S3

16.1 Amazon S3

Amazon S3 is is a scalable object storage service offered by AWS (Amazon Web Services). It allows to store and retrieve large amounts of data at any time. S3 is designed for high durability, availability, and scalability, making it suitable for a variety of use cases, including data backups, content storage and distribution, big data analytics, and more.

It is widely used for both small applications and enterprise-level storage solutions due to its flexibility and ease of use.

17 ClickHouse

ClickHouse is a high-performance, column-oriented SQL database management system (DBMS) for online analytical processing (OLAP). OLAP scenarios require real-time responses on top of large datasets for complex analytical queries.

17.1 ClickHouse - AWS Marketplace

Through AWS Marketplace, it is possible to deploy ClickHouse as a fully managed service, eliminating the operational complexity of running and maintaining the ClickHouse clusters. Managed service providers handle tasks like infrastructure setup, scaling, backup, and security.

There are different benefits in subscribing ClickHouse through the Marketplace. Firstly, it is possible to get a fully managed ClickHouse deployment with automated maintenance, backups, and scaling, reducing operational overhead. Moreover, this makes it easier to integrate with other AWS Services like S3 storage. Finally, as other AWS Services, it has the *Pay-as-You-Go* pricing so the user only pays fot the resources used.

Thus, ClickHouse on AWS Marketplace is a robust solution for the users who need fast, scalable analytics without the overhead of managing their own infrastructure. It is possible to find more information about this topic here.

18 Accounts and Security

This guide will walk you through the process of planning and preparing the security objects required by Critical Manufacturing MES.

18.1 Critical Manufacturing Windows Services Account

All Critical Manufacturing services will be created to run under an account that is configured in deployment time in the installation wizard. To better understand Service User Accounts, please refer to this section on Microsoft documentation.

As a reminder, please make sure that your service user account:

- Has been granted the **Log on as service** permission in the host computer
- Has permissions to access the network shares and the deployment folder
- If Remote Shipping is able to read/write the queues created for Remote Shipping
- The password never expires or there is a company mechanism to renew it before it expires

18.2 SQL Server Accounts

If the database system was deployed in Always On on Availability Groups it is fundamental to run all instances of the same component (example: Database Engine) under the same account. Additionally, unless there is a critical security requirement forcing to do otherwise, it is recommend to use the same account for all the SQL Server Components:

- Microsoft SQL Server User Account
- Microsoft SQL Server Analysis Service User Account
- Microsoft SQL Server Reporting Services User Account

If the account hosting Reporting Services is not the same as the one hosting Critical Manufacturing services the Critical Manufacturing services user must be granted administration privileges in Reporting services.

18.3 ClickHouse

To communicate with ClickHouse, Critical Manufacturing MES uses traditional username and password authentication. To operate correctly, the user must have permissions to create and alter databases related to MES (including but not limited to the default ClickHouse database), which typically have the **SystemName** prefix, followed by a pertinent suffix (example: **SystemName**CDM). For more information, see Access Control Lists (ACLs).

For the backup and recovery procedures described in [[operation-guide-clickhouse-backupandrestoreoverview]], ClickHouse must have access to the S3 storage server used by the MES.

18.4 Kafka

To communicate with Kafka, Critical Manufacturing MES provides two forms of authentication:

- Mutual TLS (client certificates)
- SASL Plain (username and password)

In terms of access, the user must be granted the following permissions:

- Topic Permissions:
  - Alter
  - AlterConfigs
  - Create
  - Delete
  - Describe
  - DescribeConfigs
  - Read
  - Write
- Consumer Group Permissions:
  - Read
  - Delete
  - Describe
- Cluster Permissions:
  - AlterConfigs
  - Create
  - Describe
  - DescribeConfigs

 These permissions must be granted to resources with the prefix **SystemName** and **_SystemName**.

18.5 RabbitMQ

No additional account or security requirements are required for RabbitMQ installation.

18.6 S3

No additional account or security requirements are required for S3 installation.

19 Database Servers

This guide will walk you through the steps to successfully plan and install a database server to host Critical Manufacturing MES databases.

19.1 Planning for disaster recovery and high-availability

Critical Manufacturing recommends adopting the Always On for Availability Groups disaster recovery and high-availability solution for database systems hosting Critical Manufacturing databases. If you are not familiar with the process, the Always On Guide contains technical information on the subject. This guide is intended to serve as a summary and does not cover the technical details included in the above-mentioned guide.

An individual cluster for online, for ODS and for DWH to maximize the availability should be created, though the solution will also work if you decide to create a single cluster. In both cases, it is necessary to create an availability group for each of the product databases. This process is detailed below.

19.2 Database Server pre-requisites

The following software requirements must be met in all database nodes:

Table 11: Database Server pre-requisites

Name	Requisite	Supported Versions	Checked
Operating System	Microsoft Windows Server	2016 to 2022	
Microsoft Windows Server Roles and Features Configuration	Microsoft Distributed Transaction Coordinator Configuration Microsoft Advanced Firewall Configuration Windows Server Failover Clustering **1**		
Microsoft SQL Server	Microsoft SQL Server Database Engine Microsoft SQL Server Reporting Services Microsoft SQL Server Analysis Services	2019 to 2022	
Microsoft OLE DB Driver for SQL Server	Microsoft OLE DB Driver for SQL Server **2**		

1 Failover clustering is only necessary when building an Always On for Availability Groups solution.

2 Only required if the Analysis Services and SQL Server are installed on different machines. In that case, please make sure to install Microsoft OLE DB Driver for SQL Server on the Analysis Services machine. More information on the installation of Microsoft OLE DB Driver for SQL Server here: https://learn.microsoft.com/en-us/sql/connect/oledb/download-oledb-driver-for-sql-server?view=sql-server-ver16.

19.3 SQL Server Licensing

This section contains licensing information regarding SQL Server 2019 and SQL Server 2022.

SQL Server 2019 and SQL Server 2022 Standard editions are licensed in Core-Based and Server + CAL modes, whereas SQL Server 2019 and SQL Server 2022 Enterprise editions are licensed only in Core-Based mode.

When running Critical Manufacturing on SQL Server Standard edition, the following limitations apply:

- Database instance maximum hardware consists of 128 GB or the lesser of 4 CPUs or 24 Cores (SQL Server 2019 and SQL Server 2022).
- Mobile reports and KPIs are not available.
- Power BI Report Server is not available.

For more information about SQL Server licensing, see the URLs below:

- SQL Server 2019
- SQL Server 2022

19.4 Always On for Availability Groups pre-requisites

If you have decided to implement an high-available SQL Server solution using Always On for Availability Groups, these additional requirements and preparation steps must me met:

Table 12: Always On Availability Groups pre-requisites

Task	Notes	Checked
Define names for the Availability Groups	We **recommend** adopting the following naming convention to name the Availability Groups and to use the same names for the Availability Group Listeners. At this time, you should have chosen the name to give to this Critical Manufacturing installation, referred to as `SystemName` `AG<SystemName>` - the AG that will host the online database `AG<SystemName>ODS` - the AG that will host the **ODS** database `AG<SystemName>DWH` - the AG that will host the **DWH** database	
Install WSFC	The Failover Cluster role must be enabled in all database nodes	
Enable Always On for Availability Groups in SQL Server		

19.5 Preparing Windows Server Failover Cluster

To prepare the WSFC cluster, follow the instructions on this guide. Because we use Always On for Availability Groups, we do not require any kind of storage resource in the cluster. You can also choose the quorum solution that best fits your environment.

19.6 Microsoft Distributed Transaction Coordinator (MS-DTC) Configuration

This section describes how to install and configure Microsoft Distributed Coordinator (MS-DTC). MS-DTC is a component that is used to managed distributed transactions and the two-phase commit protocol. Microsoft Distributed Coordinator (MS-DTC) is installed as part of the operating system installation but it needs to be configured in order for Critical Manufacturing to work correctly.

Microsoft IIS needs to be installed in all Critical Manufacturing Application and Database servers.

The instructions for configuring Microsoft Distributed Coordinator (MS-DTC) according to Critical Manufacturing requirements are the same for Windows Server 2008 and for Windows Server 2012 and can be found in the URL: http://technet.microsoft.com/en-us/library/cc731495.aspx. For convenience, the configuration procedure is described in this section.

- Start the **Component Services** management console by typing **comexp.msc** in the start command and pressing **OK**.

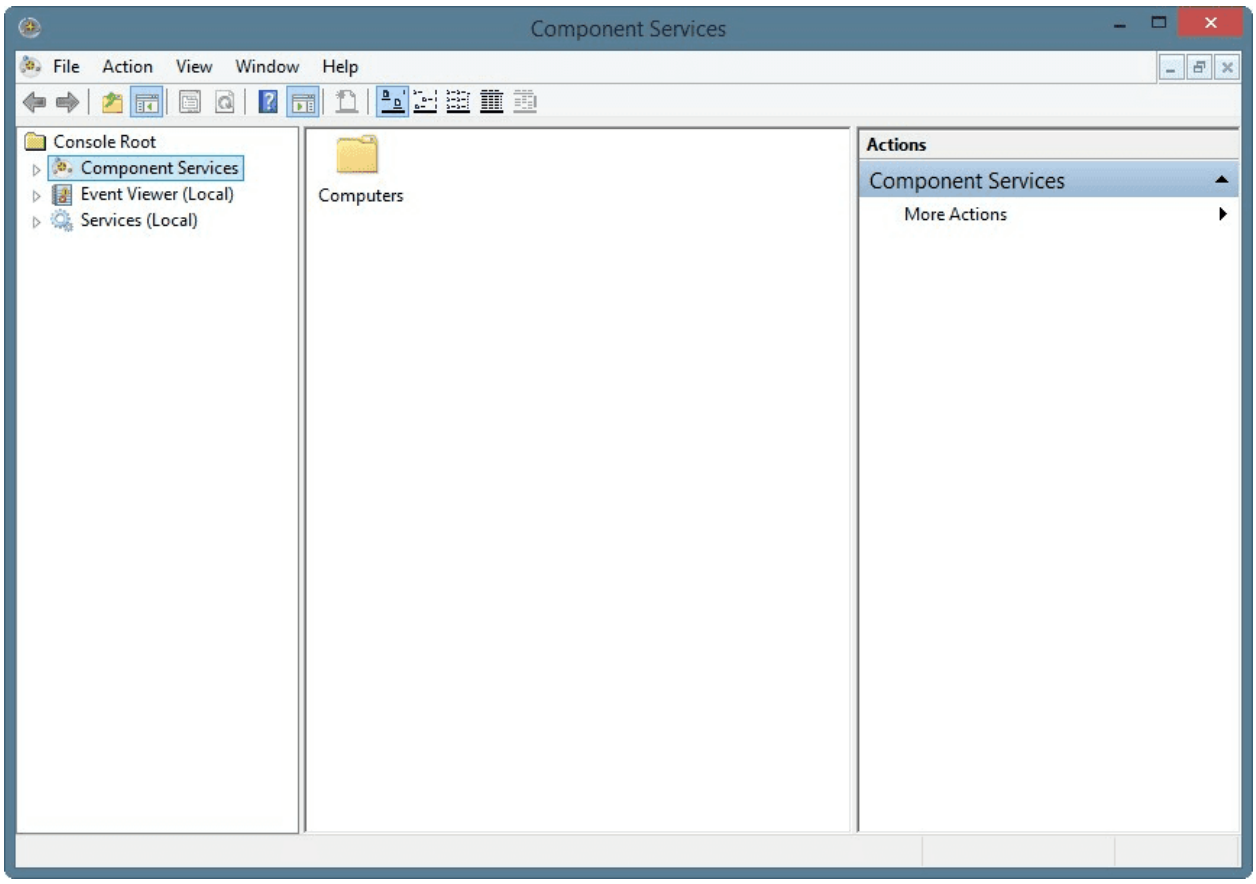


Figure 19: Component Services

- Drill-down by clicking on **Component Services** > **Computer** > **My Computer** > **Distributed Transaction Coordinator** > **Local PC**.
- Right-click on the **Local PC** under **Distributed Transaction Coordinator** and then select **Properties**.
- Click on the **Security** tab and then make sure that the following options are checked as shown in the picture below:
  - Network DTC Access
  - Allow Remote Clients
  - Allow Remote Administration
  - Allow Inbound

- Allow Outbound
- Enable XA Transactions
- Enable SNA LU 6.2 Transactions

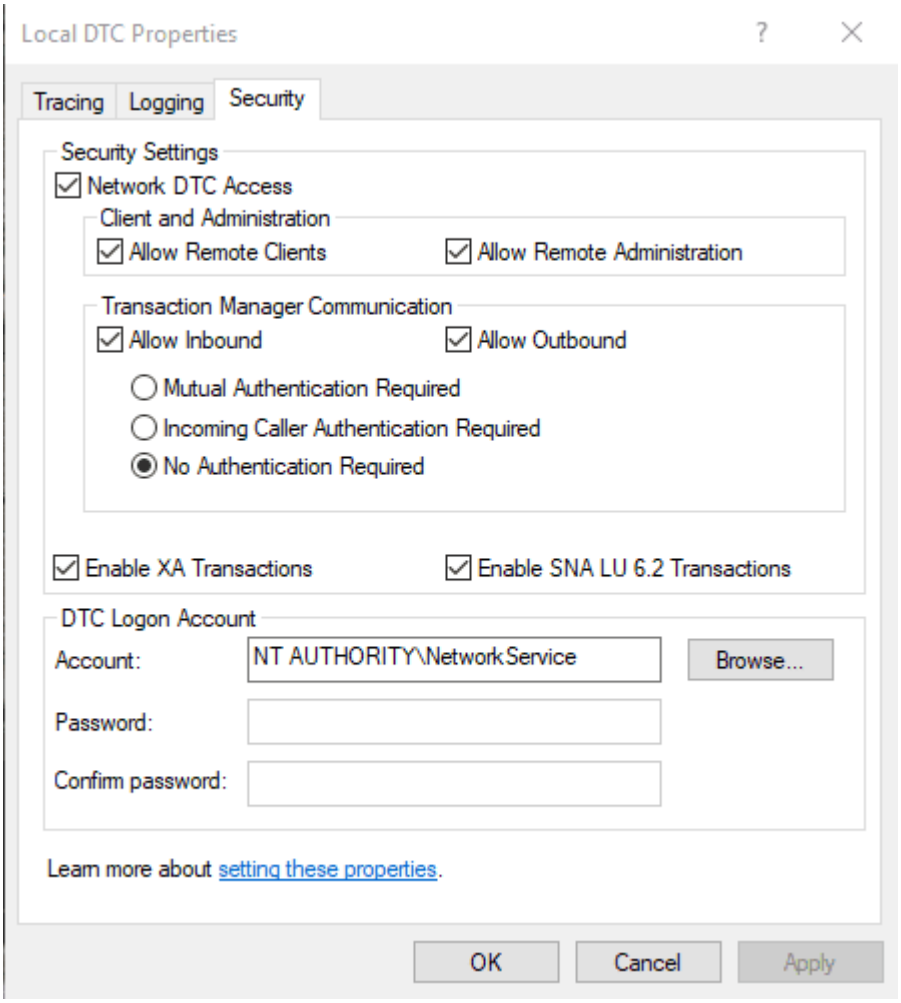


Figure 20: Local DTC Properties

19.7 SQL Server Installation

To implement Always On for Availability Groups, first you need to perform a **single node** installation of SQL Server on **each of the nodes** of the cluster. This procedure can also be used to setup a development environment where a high-availability solution is not required.

Table 13: SQL Server pre-requisites

Feature	Description	Remark
SQL Server Engine Services	The core SQL Server engine.	Mandatory for all database servers.
Analysis Services	The analysis services engine used by the data warehouse and necessary for data mining.	Mandatory for the Operational Data Store and Data Warehouse database servers.

Feature	Description	Remark
Reporting Services	The SQL Server engine used for reporting.	Mandatory for the Operational Data Store and Data Warehouse database servers.

Reporting Services must be installed separately from this installation.

The next picture shows the *Feature Selection* screen for **SQL Server**. It represents the features required by Critical Manufacturing.

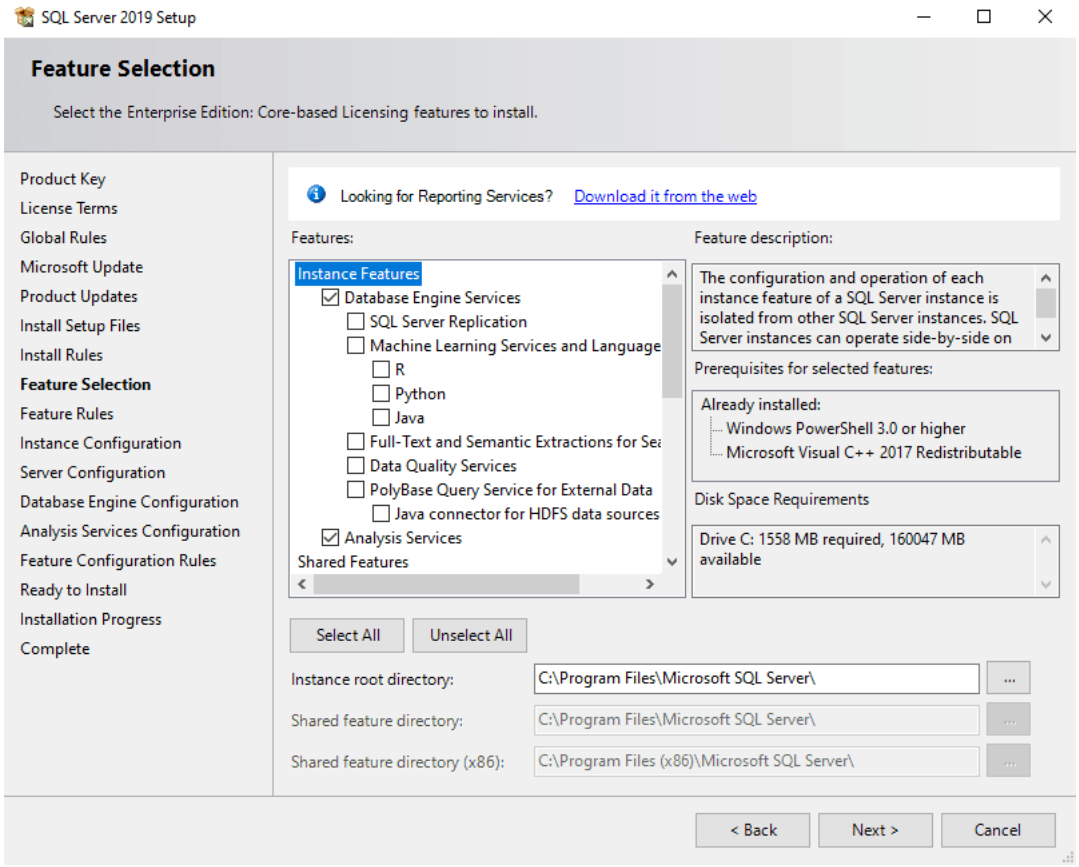


Figure 21: SQL Server Installation - Feature Selection

Next set the name of the instance to install. Critical Manufacturing recommends deploying three instances of SQL Server (Online, ODS and DWH) ideally on different physical machines. In that sense this procedure should be repeated for each of the instances.

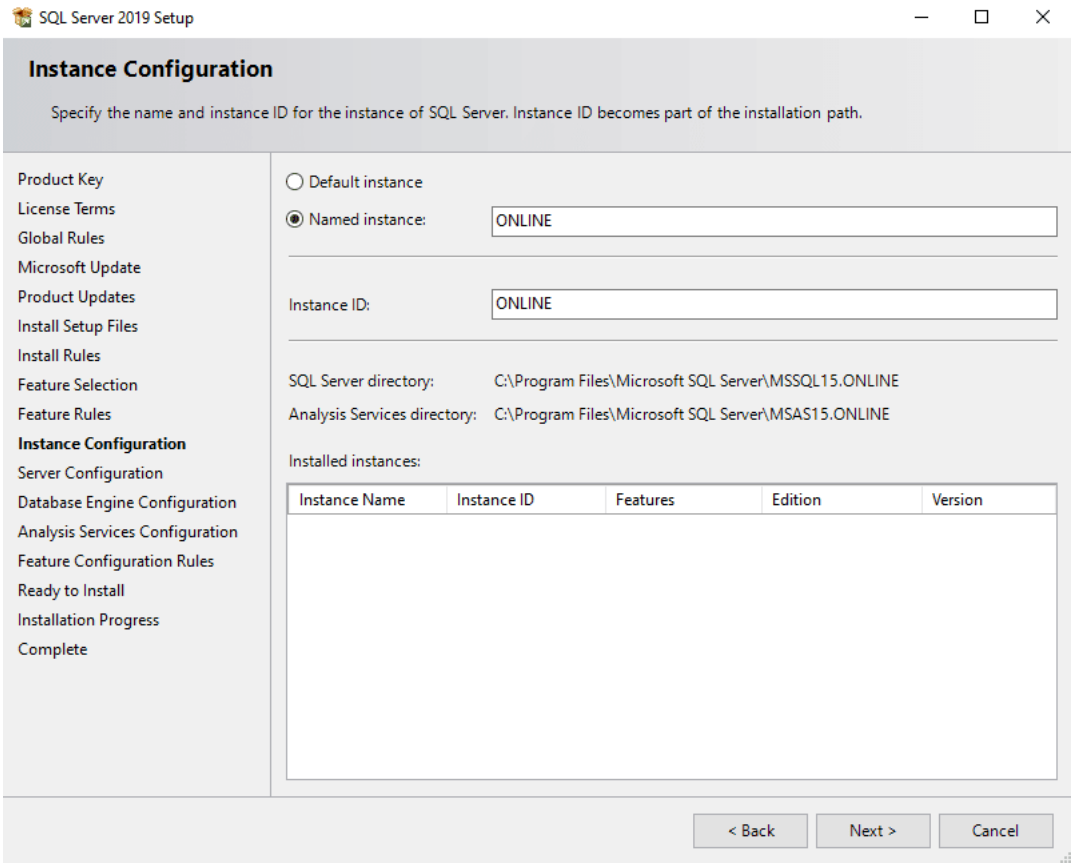


Figure 22: SQL Server Installation - Name

Next set the service account to run the engine service and the agent service. This account should be the domain account, which requires rights to access the file system.

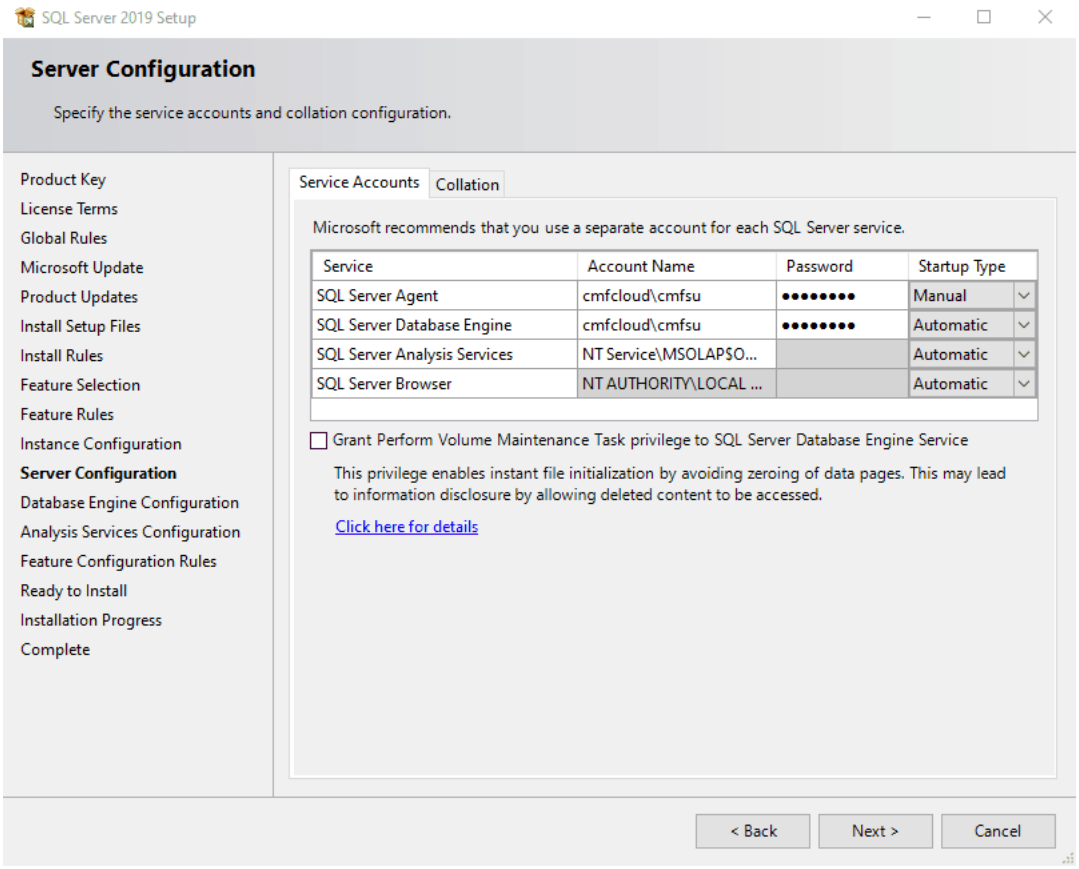


Figure 23: SQL Server Installation - Service Account

It is necessary to check that the collation is exactly **Latin1_General_CI_AS**. The deployment software will verify this setting and **will fail if it differs**.

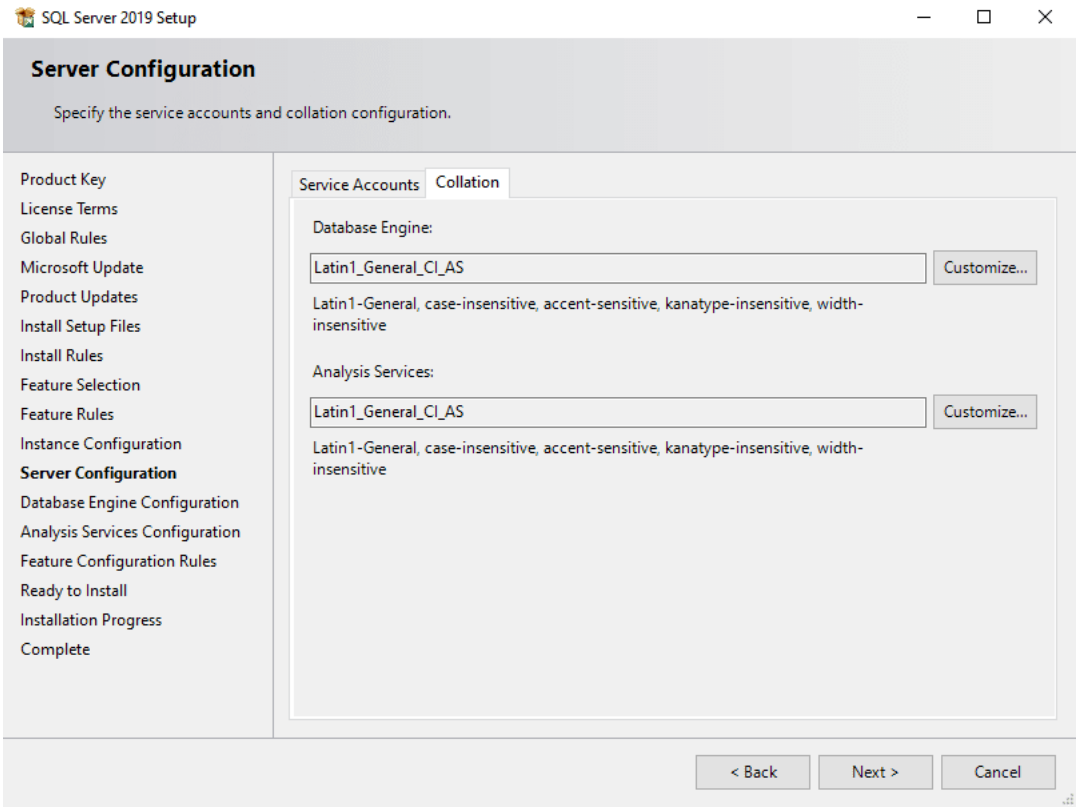


Figure 24: SQL Server Installation - Collation

If the values do not match choose the "Customize..." action and configure it as shown here:

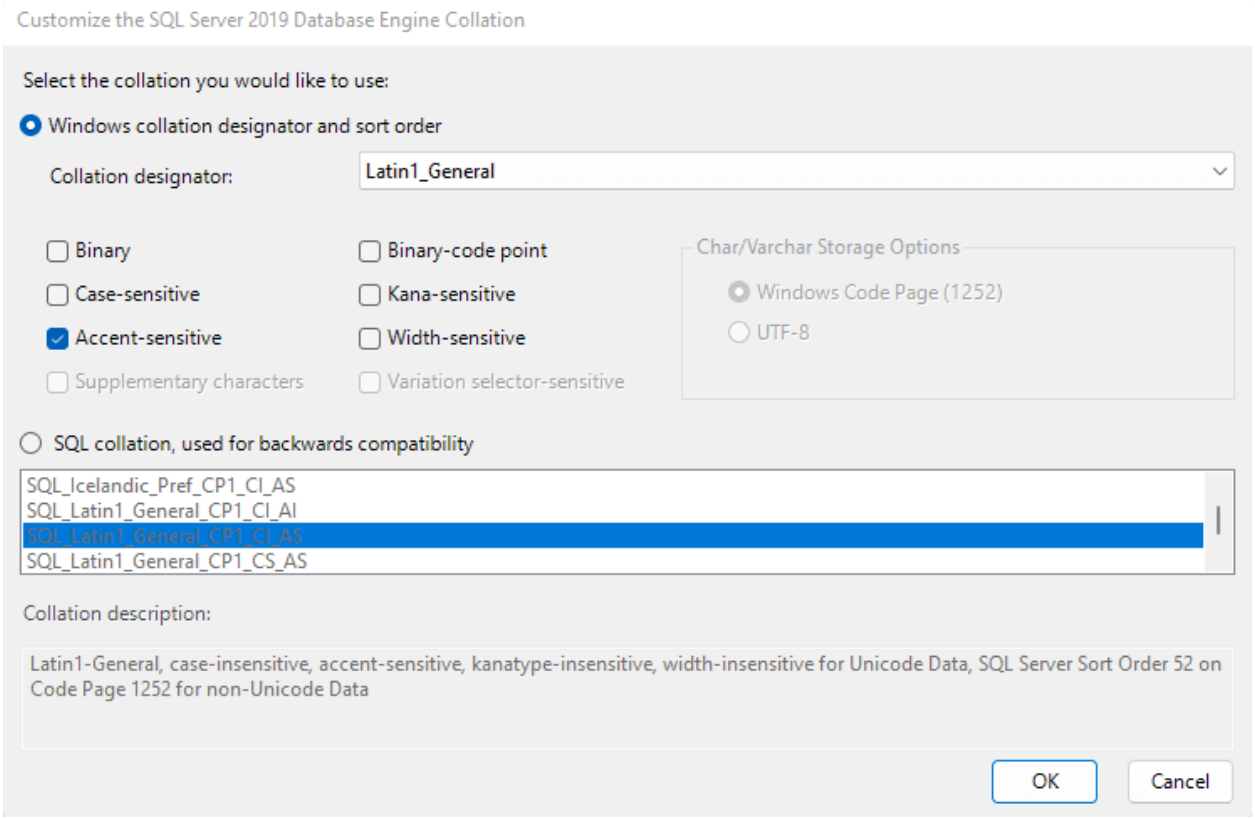


Figure 25: SQL Server Installation - Customization

Now configure the database engine. Set the authentication mode to "Mixed mode" and set the sa account password to a value of your choice.

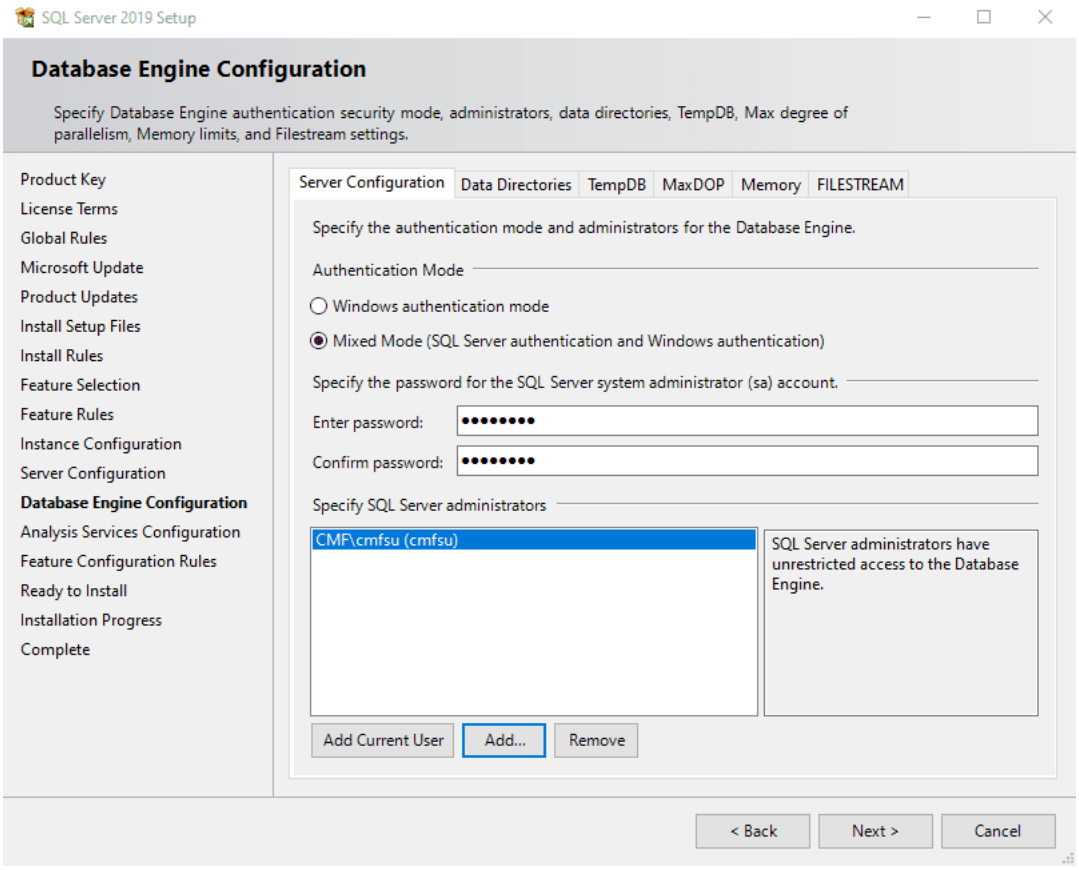


Figure 26: SQL Server Installation - Database Engine

Now configure the data directories. Critical Manufacturing recommends separating the data files and at this moment you should have already prepared the disk drives on all nodes.

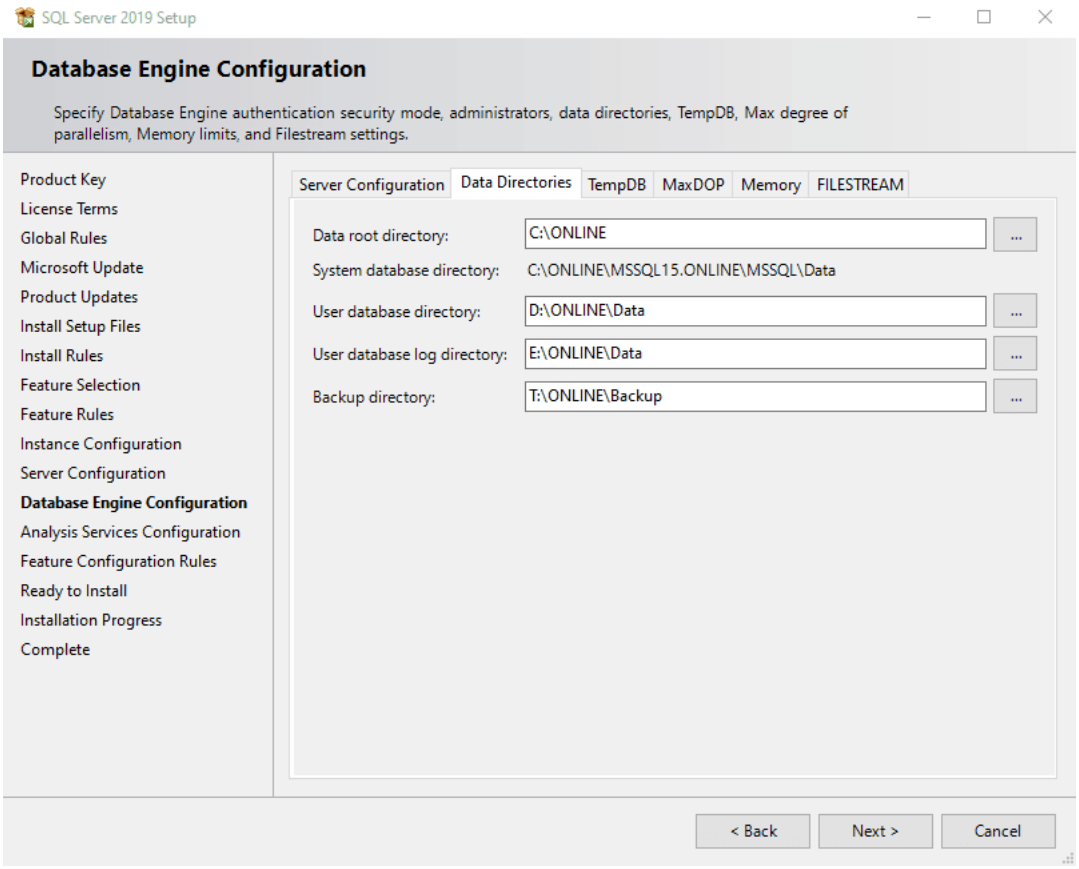


Figure 27: SQL Server Installation - Data Directories

The same recommendation is applicable to the TempDB database.

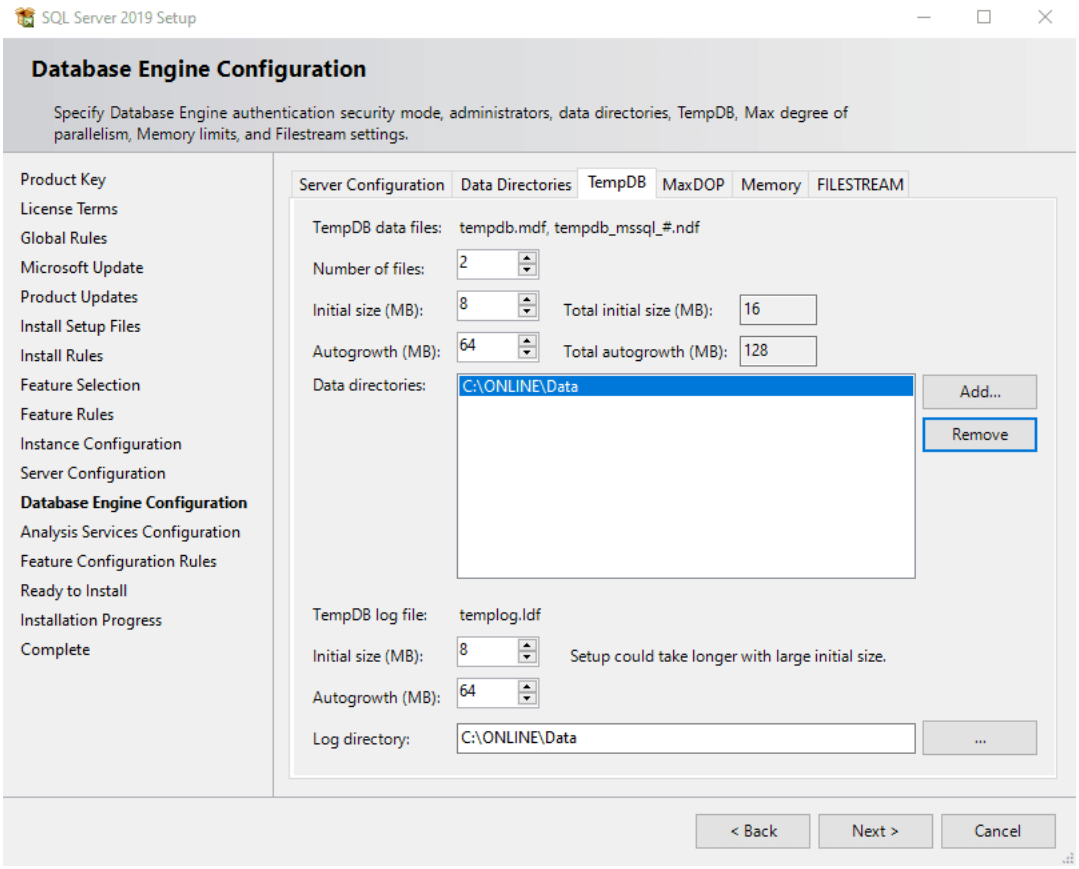


Figure 28: SQL Server Installation - TempDB

And also to the Analysis Services database files.

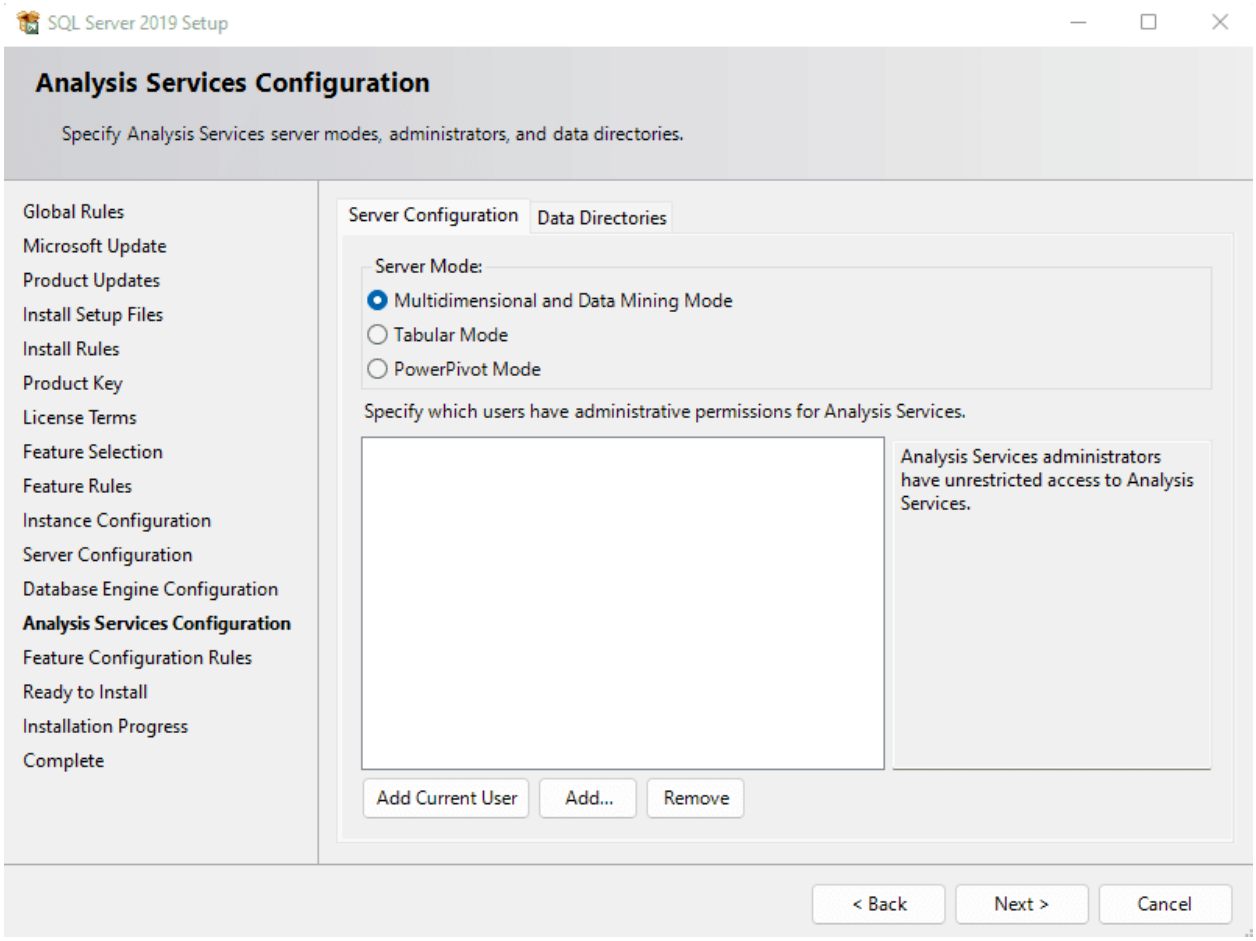


Figure 29: SQL Server Installation - Analysis Services

When installing SQL Server, the Analysis Services must be installed in **Multidimensional** mode.

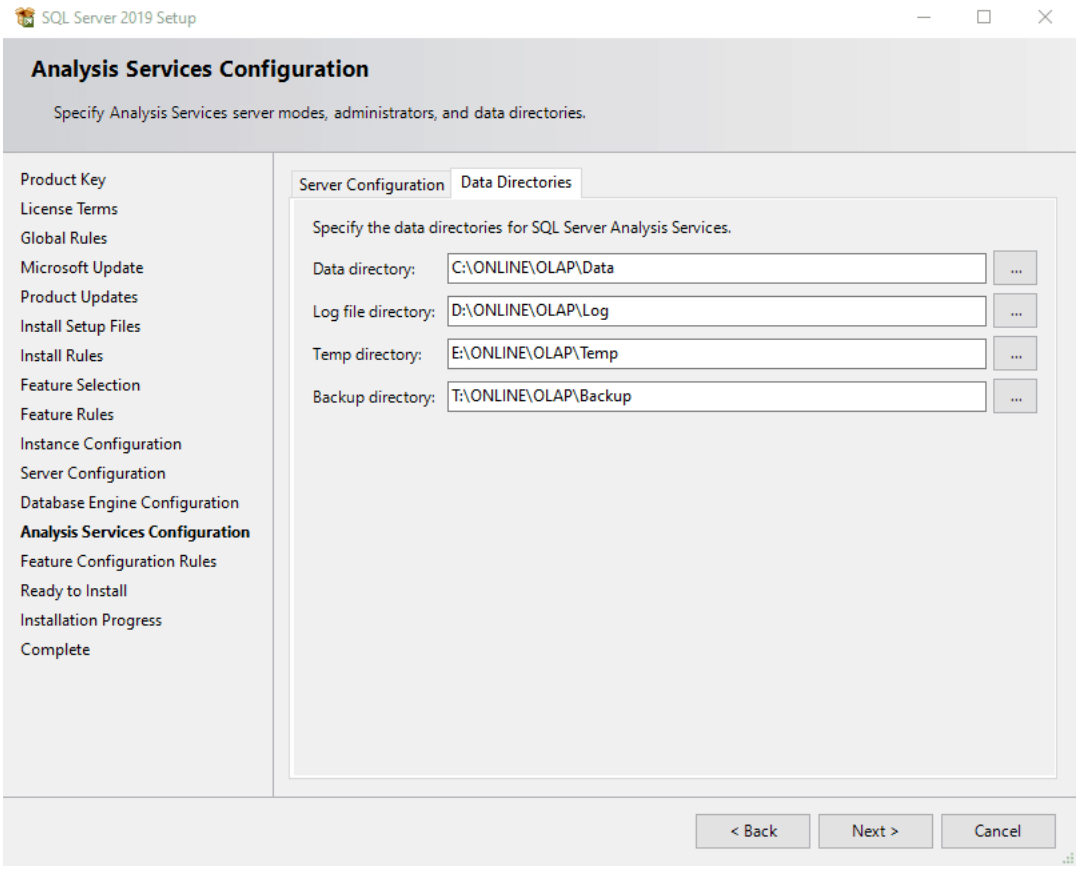


Figure 30: SQL Server Installation - Analysis Services

19.8 SQL Server Reporting Services

SQL Server Reporting Services server installation is performed outside the main SQL Server installation. This guide from Microsoft provides assistance to install this feature: https://docs.microsoft.com/en-us/sql/reporting-services/install-windows/install-reporting-services?view=sql-server-ver15.

19.8.1 Configuring Reporting Services for Critical Manufacturing

To configure reporting services for Critical Manufacturing in Always On on Availability Groups you need to create the database in its own availability group. Please refer to this Microsoft article for instructions on how to configure reporting server on that scenario.

The following changes should be performed on `ReportServer.Config`.

Reporting Services Authentication

Basic authentication is a requirement for container-based installations. For more information on how to enable basic authentication, visit https://docs.microsoft.com/en-us/sql/reporting-services/security/configure-basic-authentication-on-the-report-server?view=sql-server-ver16. The host is able to use basic authentication but it must be manually enabled. Otherwise, it should be configured in `ReportServer.Config`:

```
<AuthenticationTypes>
    <RSWindowsNTLM/>
```

```
    <RSWindowsBasic/>
</AuthenticationTypes>
```

Reporting Services Concurrent Connections

By default Microsoft Reporting Services have the maximum number of requests per user set to 20. Given the nature of our system we recommend this limit to be increased to maximum number of users seeing reports simultaneously. If in doubt, increase it to at least 500.

```
<Add Key="MaxActiveReqForOneUser" Value="500" />
```

19.9 Creating Availability Groups in SQL Server

Pre-conditions:

- All database servers have **WSFC** installed;
- All SQL Servers have the **Always On High Availability** for Availability Groups enabled.

The most universal way (in place since the initial versions of SQL Server that support Always On High Availability) to create an Availability Group is as follows.

Create a temporary database for each planned Availability Group. If you want to create an Availability Group for Online, ODS and DWH, you need to create 3 temporary databases.

Start by creating a temp, tempODS and tempDWH:

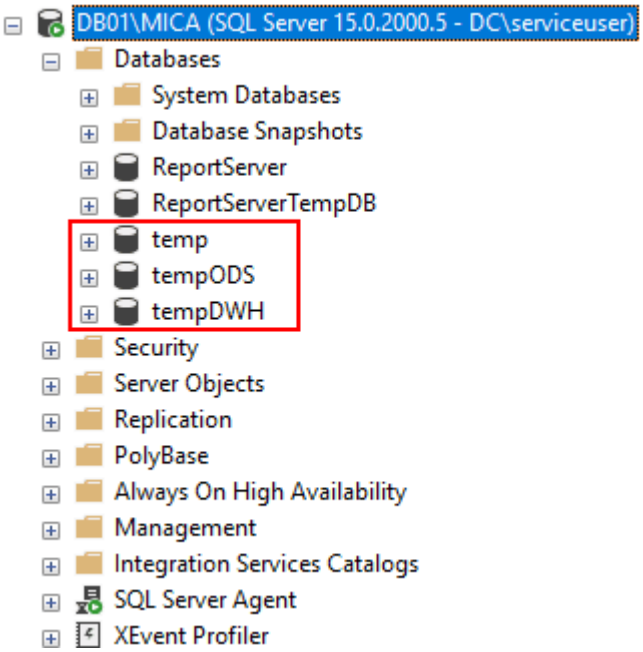


Figure 31: Screenshot showing SQL Server 2019 instance configuration with service account credentials.

Before creating the Availability Group, you need to perform a full backup of each database:

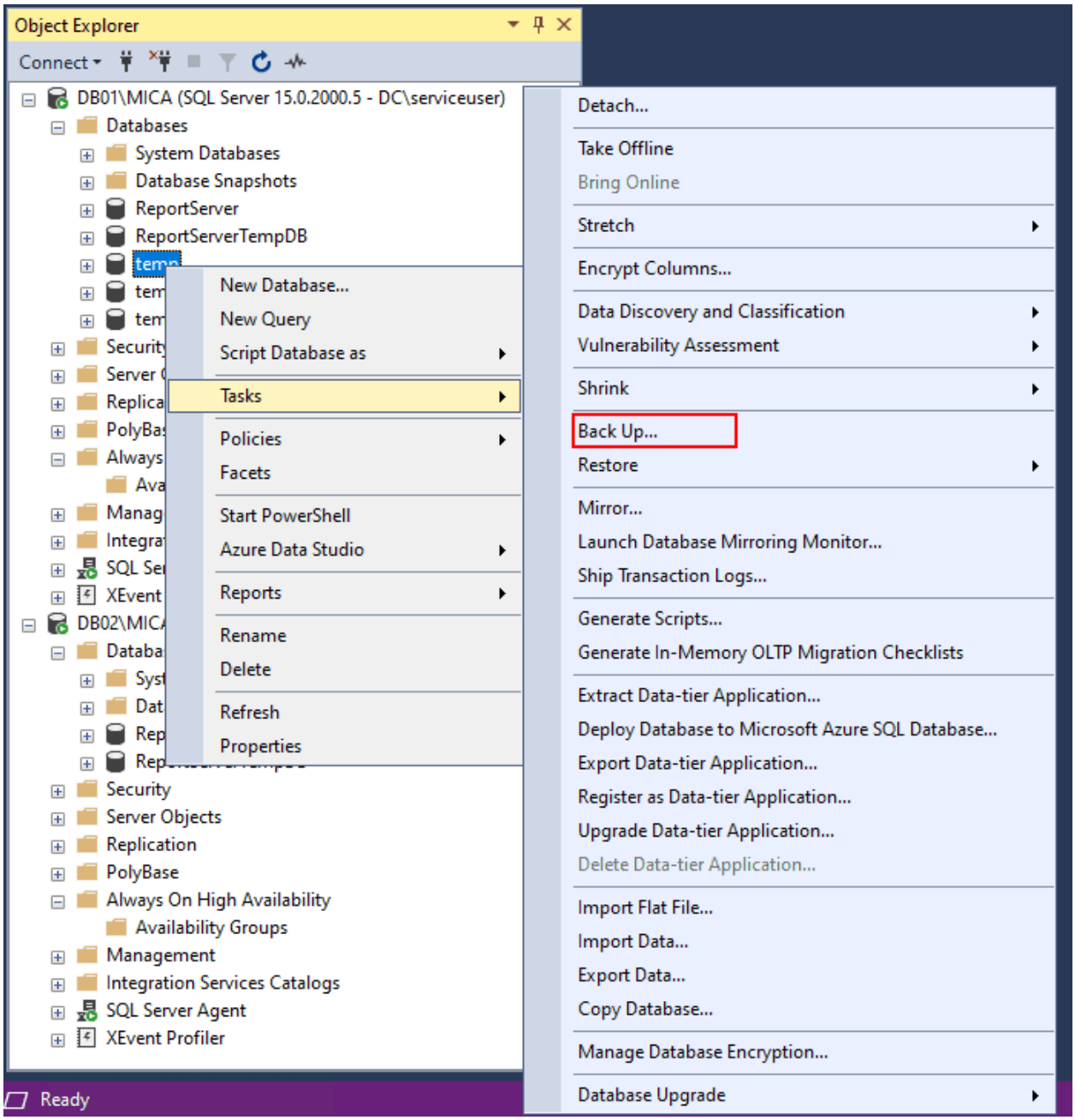


Figure 32: Screenshot showing Object Explorer in SQL Server Management Studio, connected to a database named "DBONMICA" on server "DC".

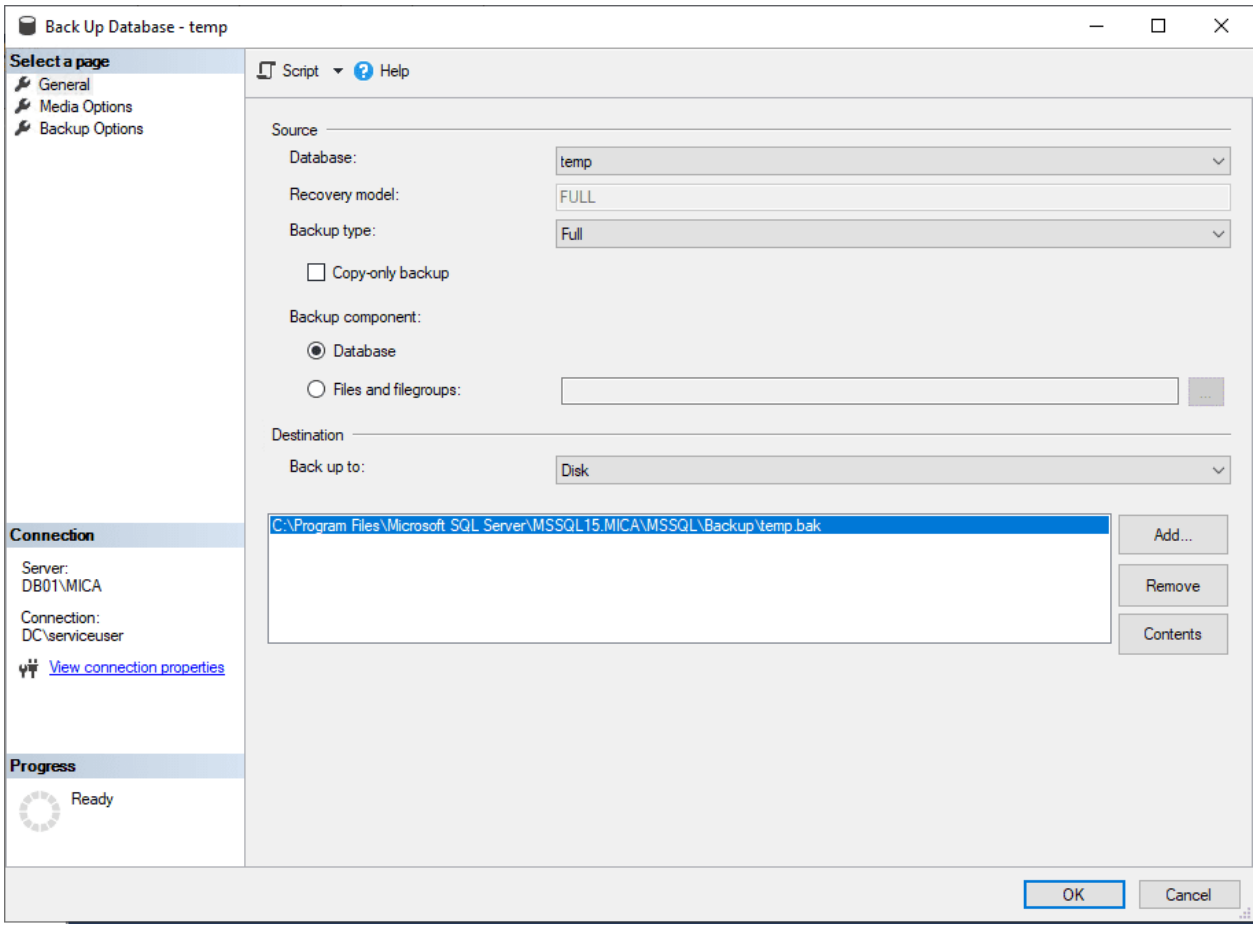


Figure 33: Screenshot showing a SQL Server backup options dialog with source database “temp” and recovery model settings.

Then, go to the Always On High Availability folder and right click on it to start the **New Availability Group Wizard**:

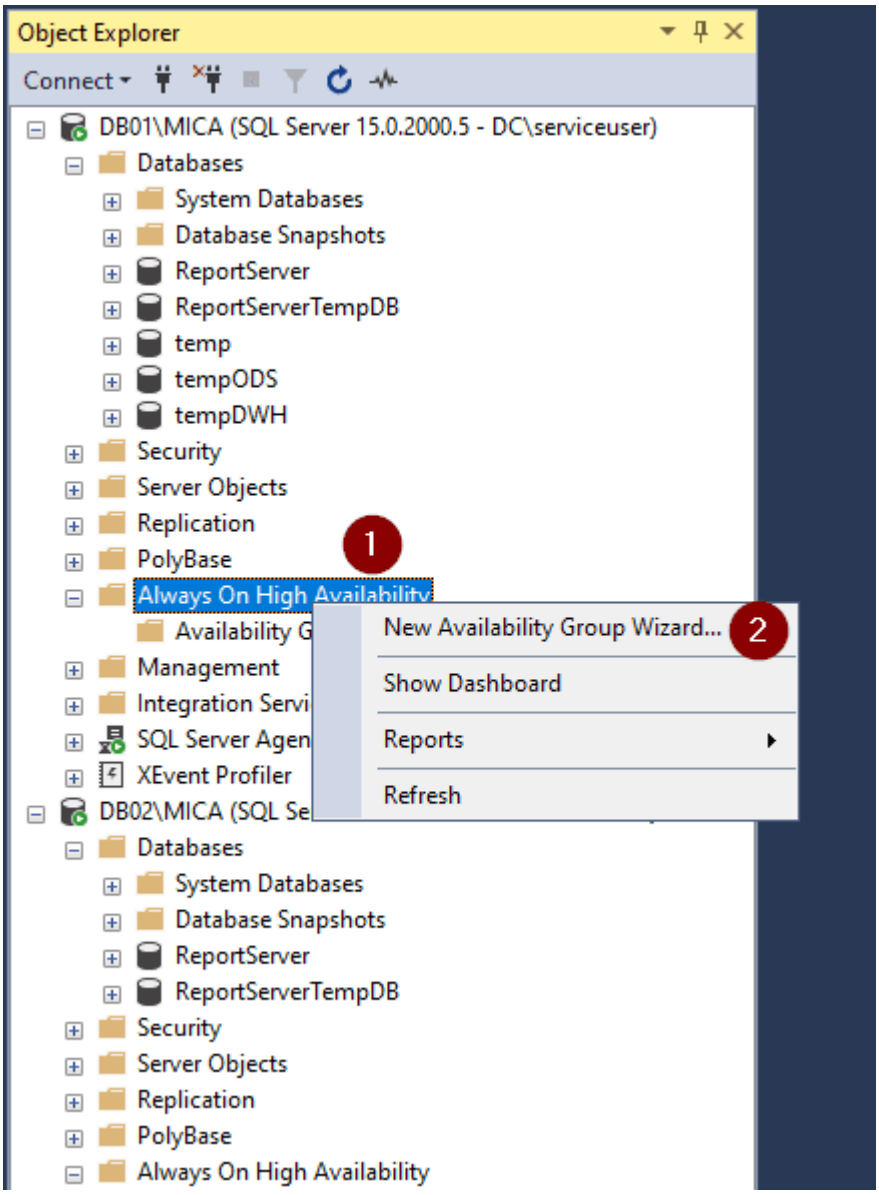


Figure 34: Screenshot showing the Object Explorer in SQL Server, with the Always On High Availability folder selected.

After this you must select the name of the Availability Group. In this case the system will be called `CMF` and three availability groups will be created (Online, ODS and DWH). According to the guidelines, the names will be `AGCMF`, `AGCMFODS` and `AGCMFDWH`:

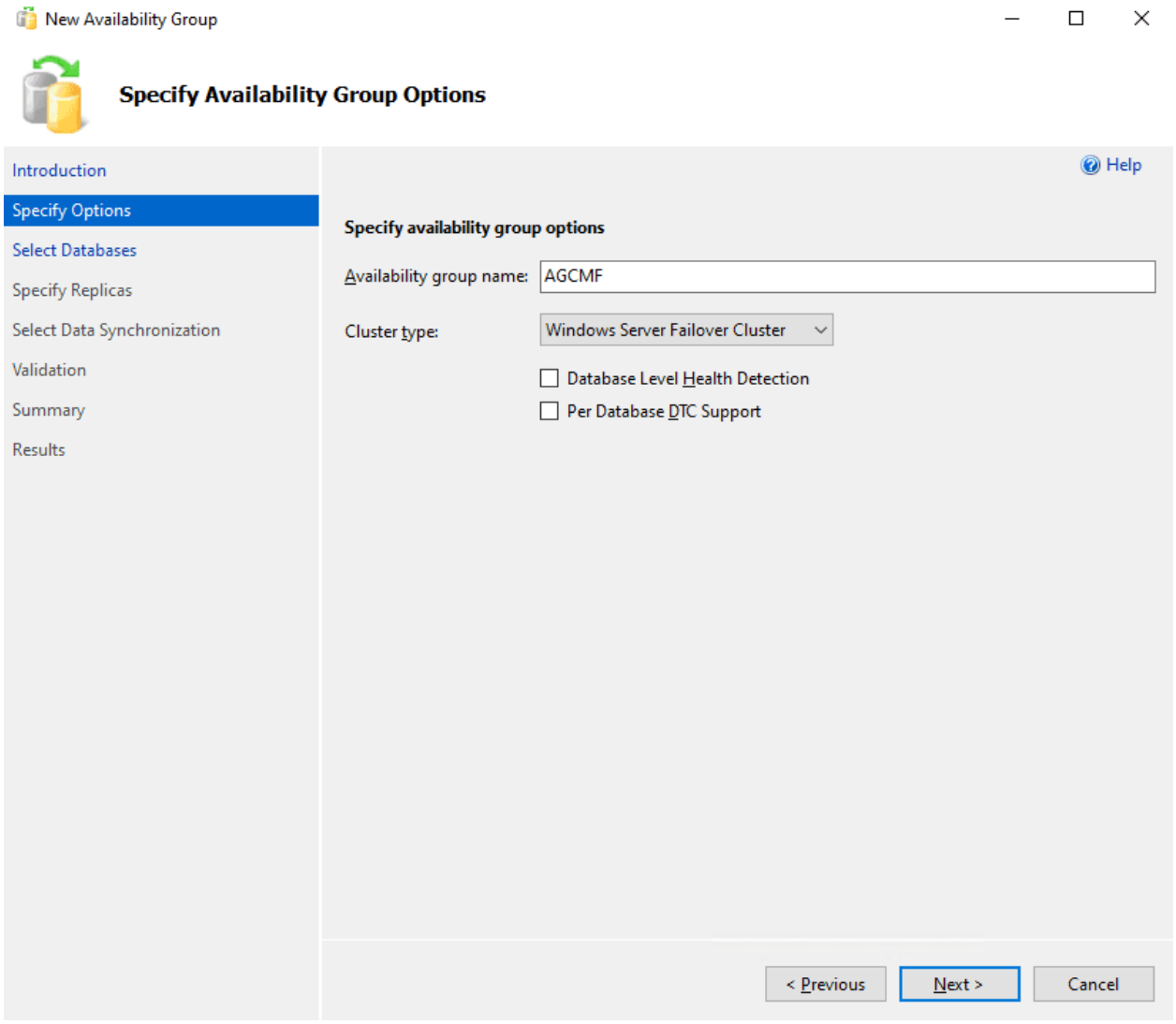


Figure 35: Screenshot showing the "Specify Availability Group Options" page in SQL Server.

Now select the database that will be associated to this Availability Group:

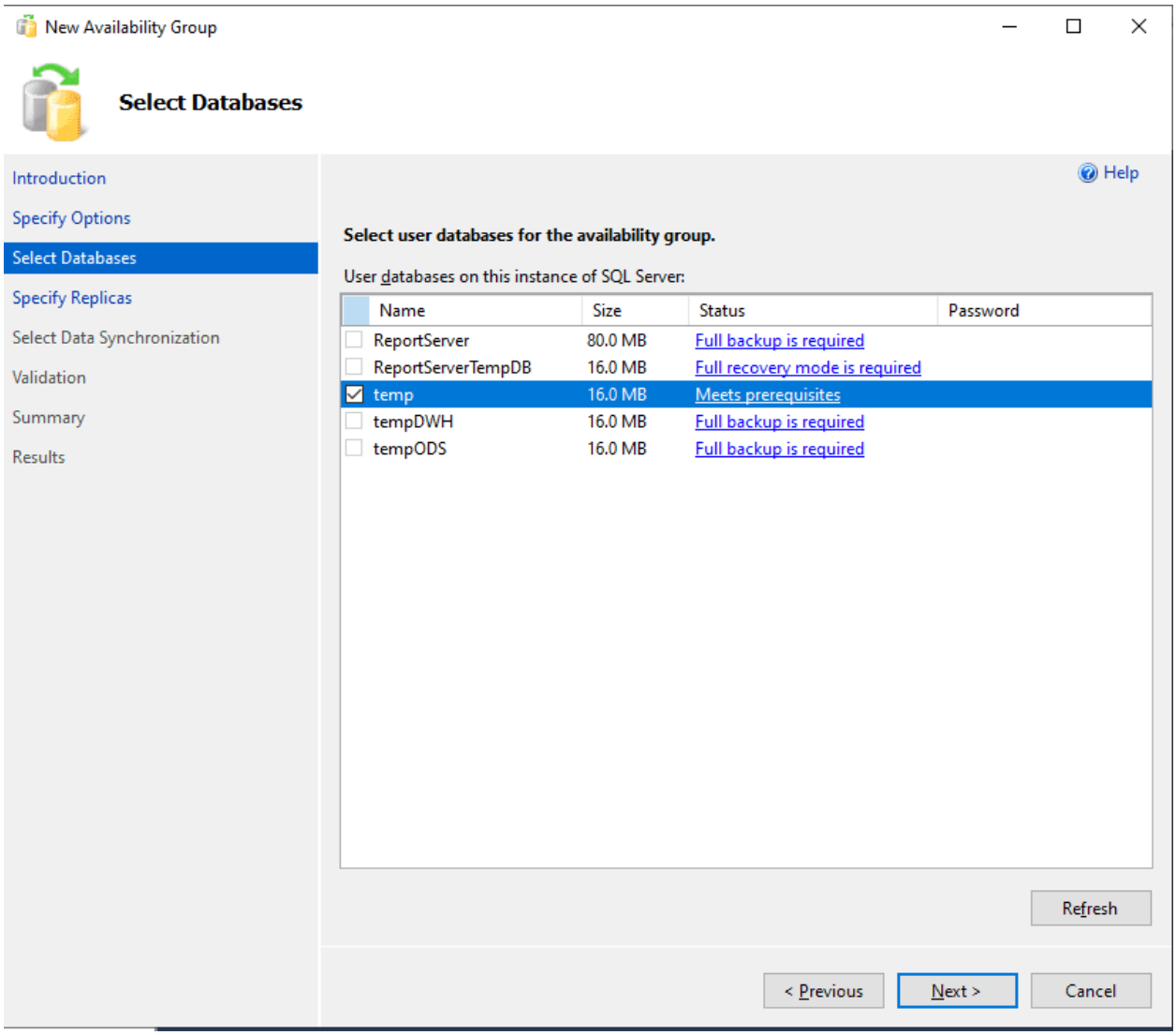


Figure 36: Screenshot showing a SQL Server dialog box with options to select databases for an Availability Group.

Next set the replicas that you need and set how you want the availability groups to work:

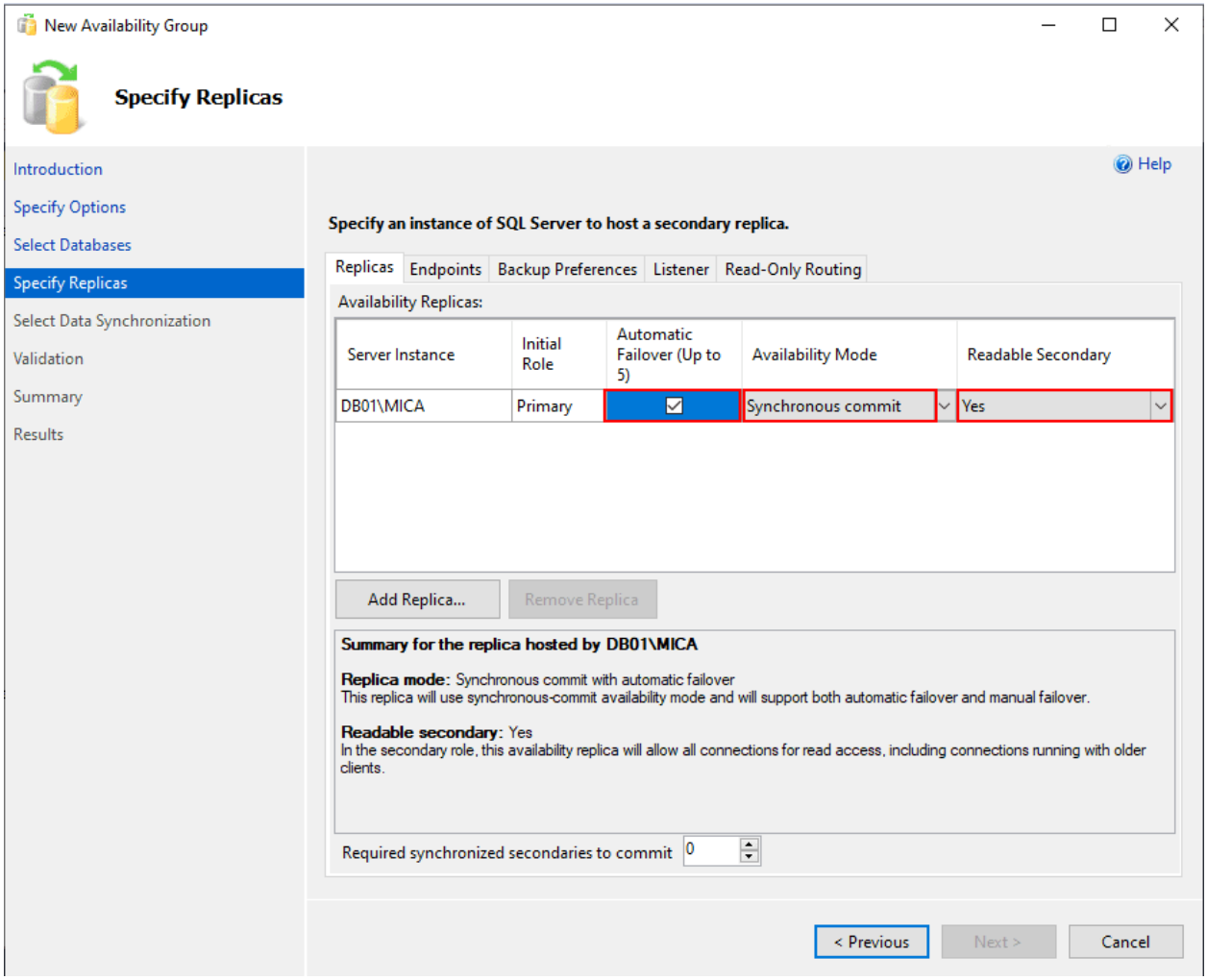


Figure 37: Screenshot showing a SQL Server dialog box with options for setting replicas and configuring an availability group.

Change the default settings of the original replica and then add a another replica:

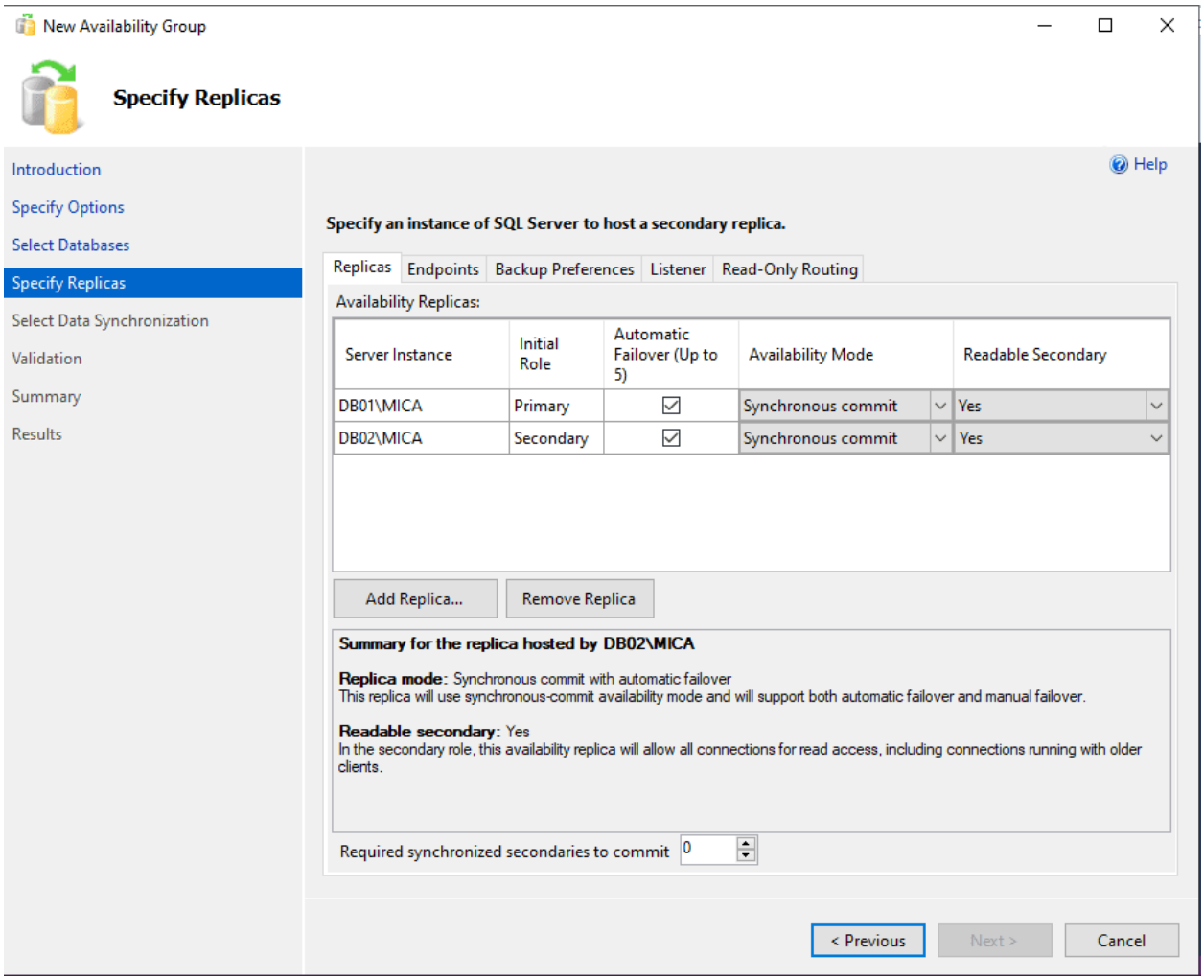


Figure 38: Screenshot showing the "Specify Replicas" page in SQL Server's Availability Groups configuration.

It is also possible to create the listeners for each Availability Group. Follow the guidelines and give the listener the same name as the Availability Group. Hence, the listener will be named `AGCMF`:

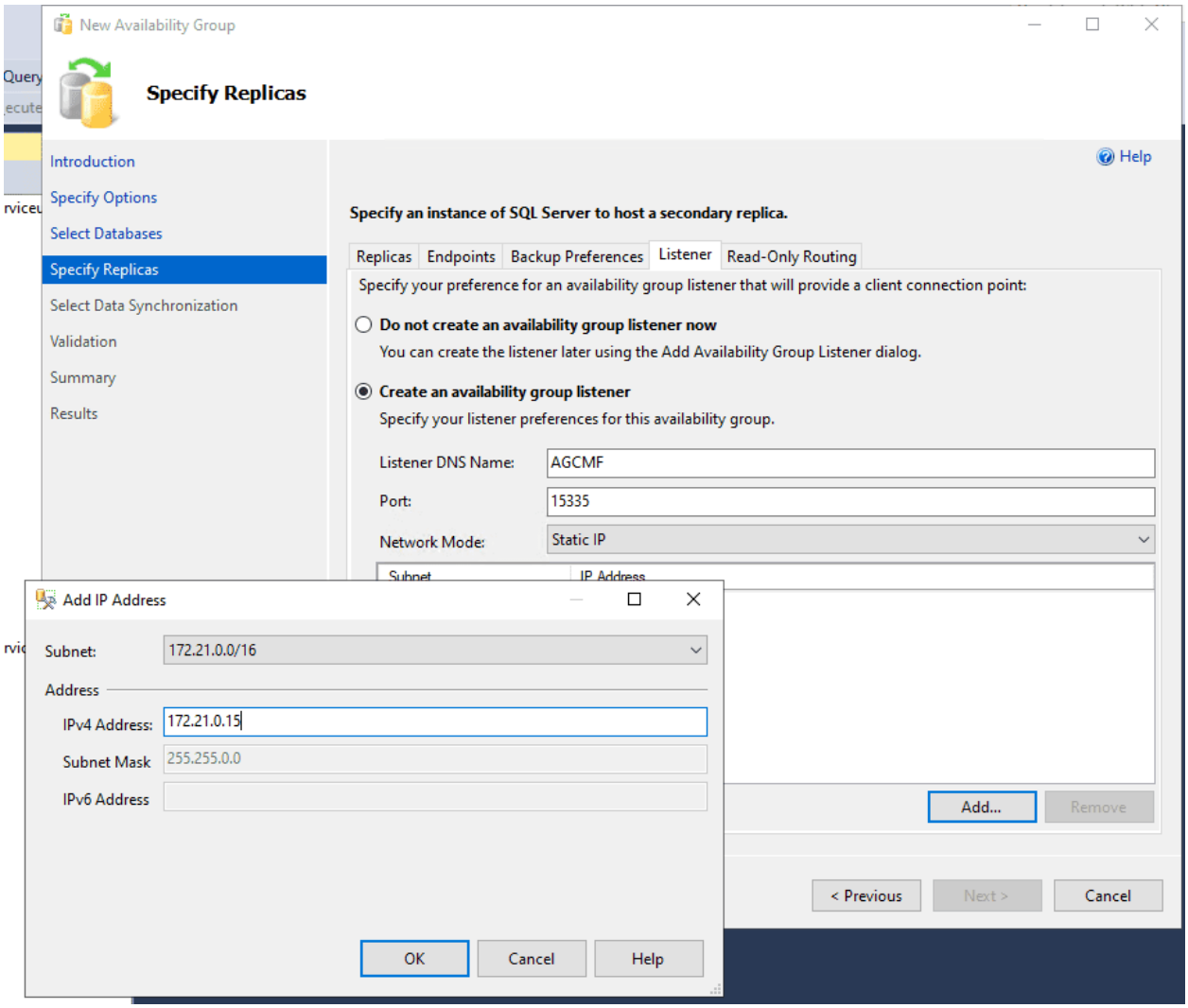


Figure 39: Screenshot showing the "Specify Replicas" page in SQL Server, where you can select an instance to host a secondary replica.

The port and IP Address must be selected according to the available values. Do not forget that the listener will be the **public address** of the Availability Group. Therefore, this will be the value that you will use when preparing the database server in the MES setup:

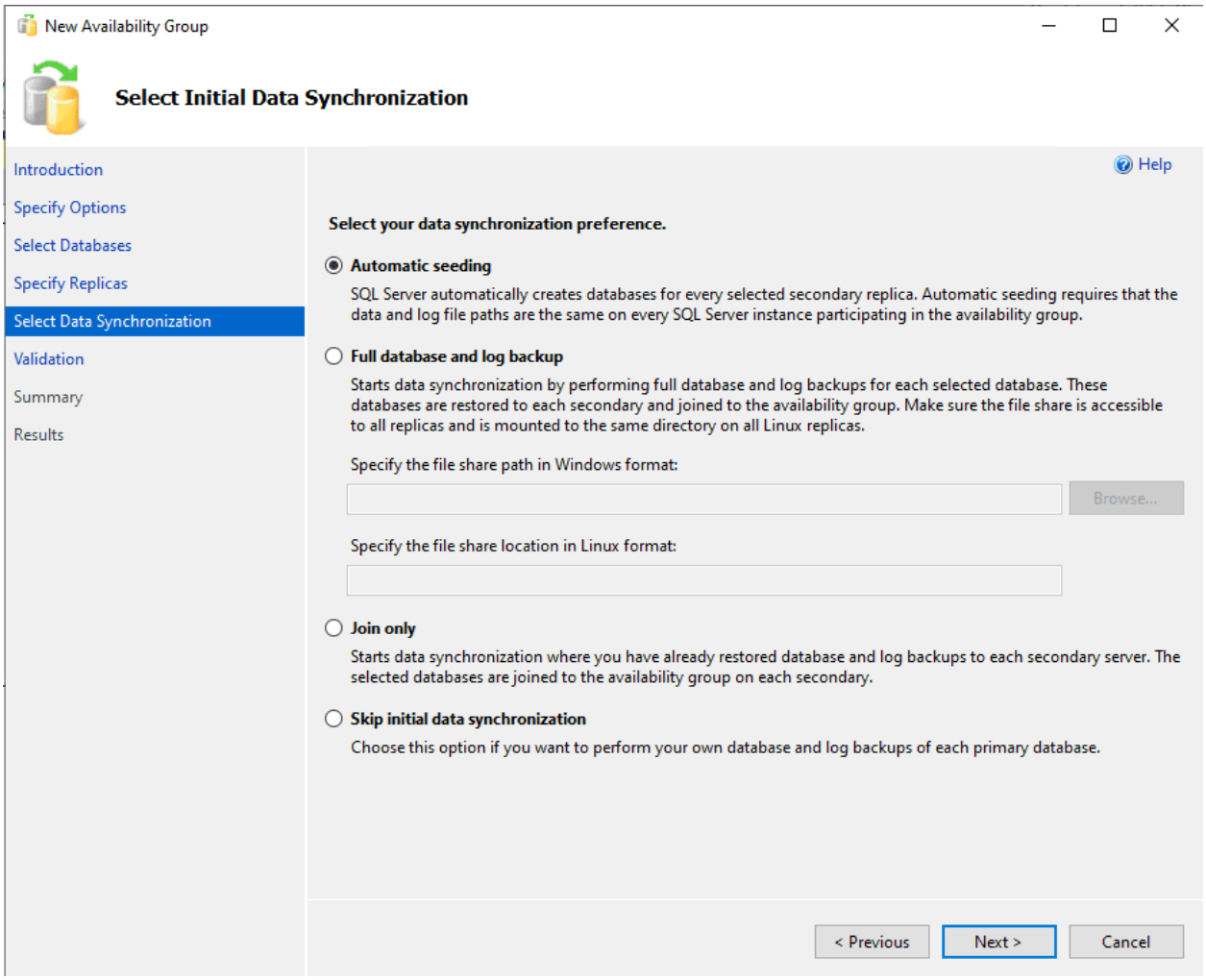


Figure 40: Screenshot showing the "New Availability Group" dialog with options for initial data synchronization.

Use **Automatic seeding** as your data synchronization preference because experience has proved it to be the most stable, and it is recommended that all the SQL Server machines directory structure be the same.

The validation step should have an all green result:

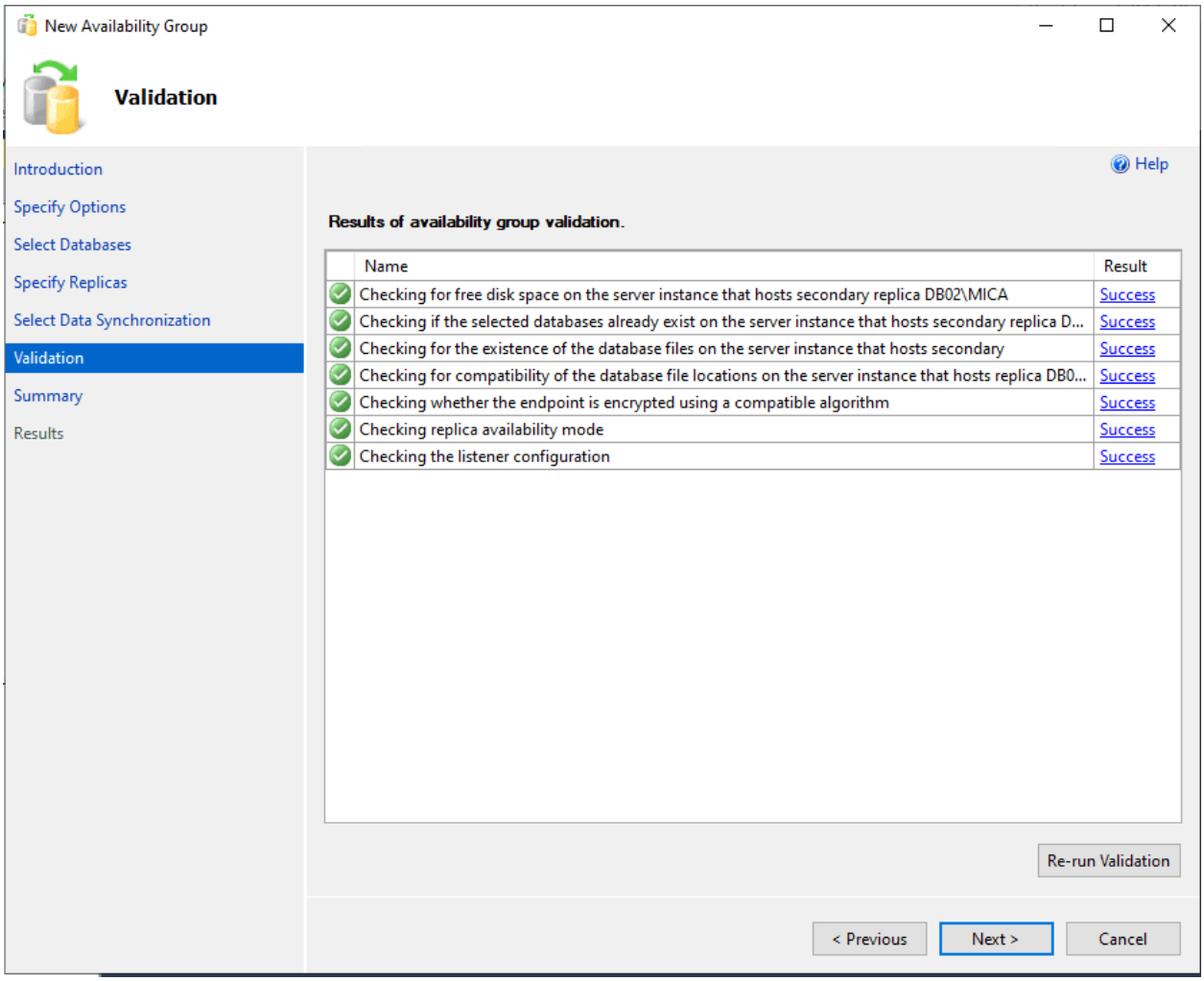


Figure 41: Screenshot showing a SQL Server dialog box with options for creating a new Availability Group.

Finally, select **Next** and wait for the creation of the Availability Group. If no problem is found, the successful result will be clear:

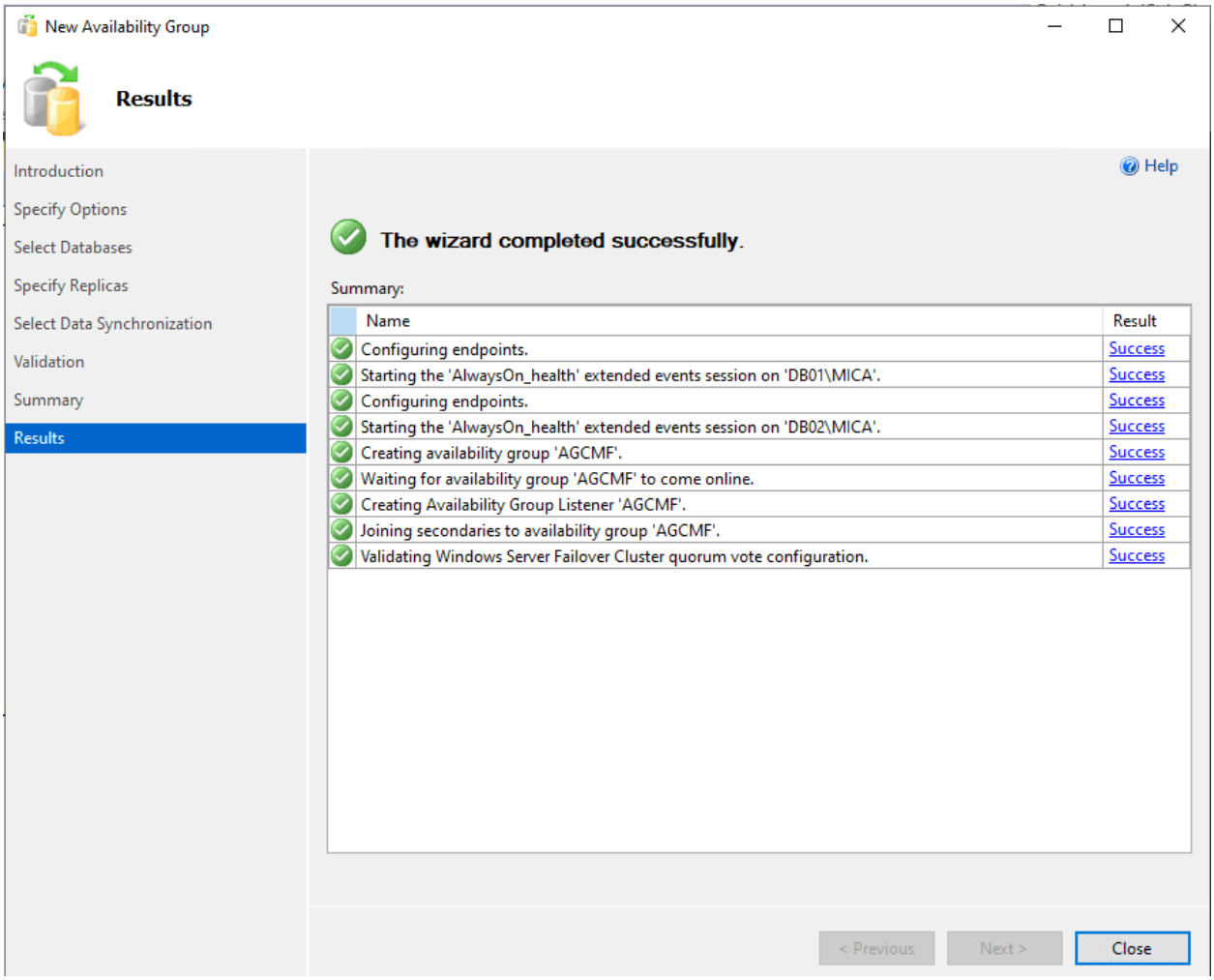


Figure 42: Screenshot showing a SQL Server dialog box with options for specifying settings during the creation of an Availability Group.

If you now go to the **Availability Groups** folder, you will see the new Availability Groups:

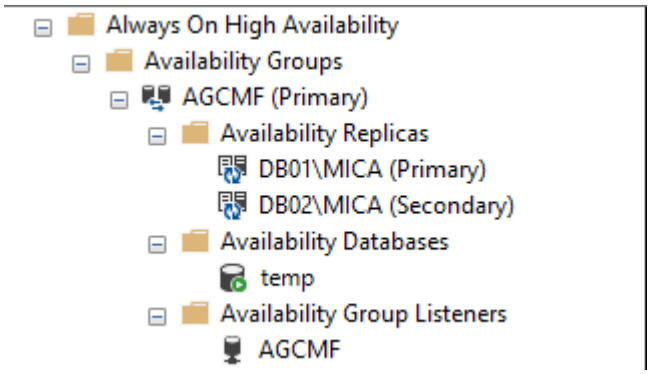


Figure 43: Screenshot showing the Always On High Availability page in SQL Server.

After creating the Availability Group, you can delete the temporary database. First remove the database from the Availability Group:

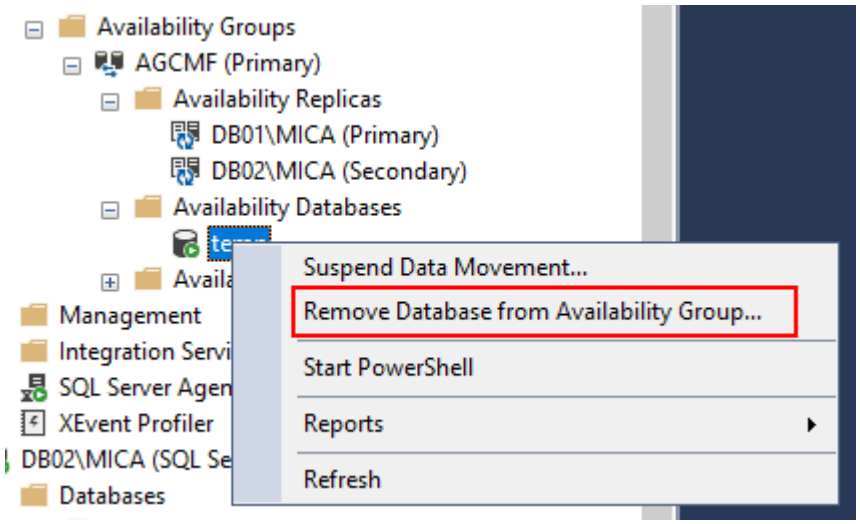


Figure 44: Screenshot showing a SQL Server UI with an Availability Group configuration, featuring "@RS AGCME" as the primary replica.

And then delete the database from all the nodes:

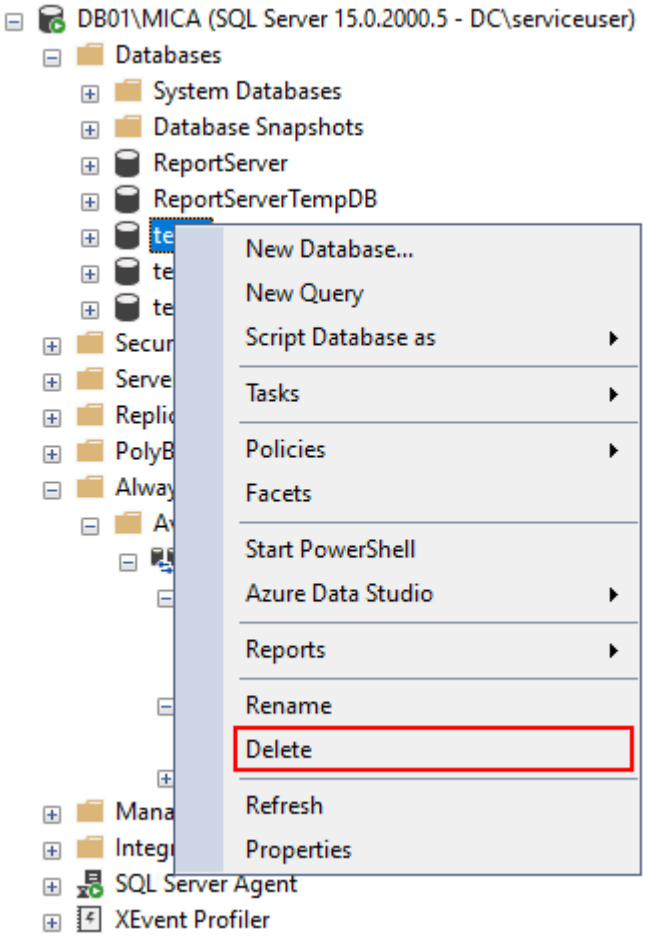


Figure 45: Screenshot showing a SQL Server Management Studio dialog box with database list, highlighting "ReportServer" and "RenartCerverTempnn".

The secondary database might be in a restoring state. This is not a problem as it is a temporary database:

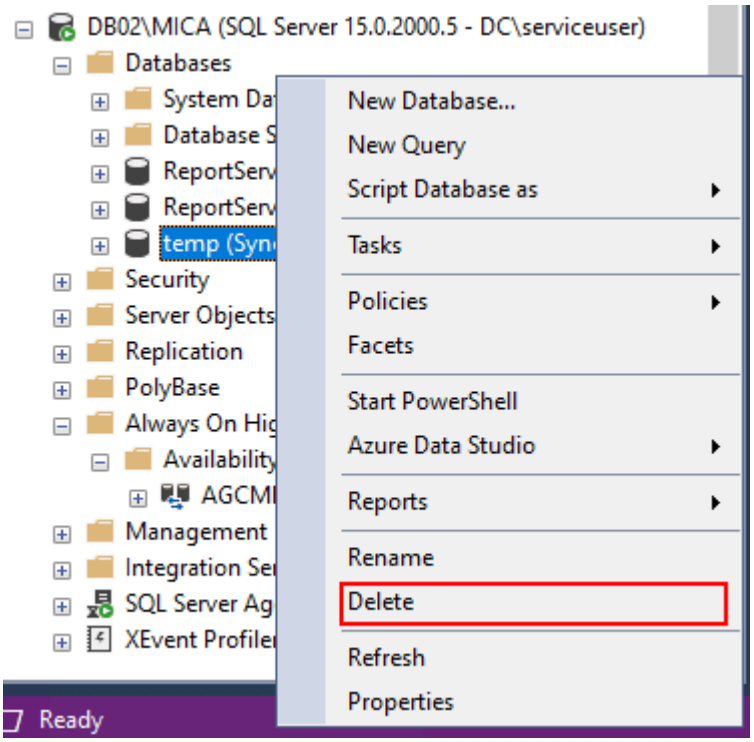


Figure 46: Screenshot showing a SQL Server Management Studio window with database objects, including “Databases” and “New Database”, in the Object Explorer.

You need to repeat these steps for the other two Availability Groups.

For more information about SQL Server Always On for Availability Groups please refer to SQL Server AlwaysOn Availability Groups

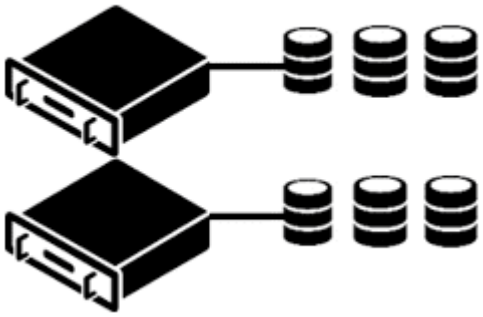


Figure 47: SQL Server Always On Availability Groups

19.10 Microsoft Advanced Firewall Configuration

The following inbound ports must be allowed in the database servers for proper operation:

Table 14: Advanced Firewall Configuration

Port Number	Purpose
1433	SQL Server Database Engine

19.11 SQL Server Installation Advanced Topics

In this section, we present some guidelines and considerations for optimizing SQL Server at the installation phase.

- Breaking Up SQL Server Databases into Multiple Files
- Database Filegroups and Data Files
- TempDB Database Configuration
- Storage and RAID Levels
- Recommendations for SQL Server Installation Options

19.12 Installing to an Azure managed instance

Critical Manufacturing can use an Azure SQL Managed Instance as the database. This will require having the files located in the actual instance, together with the proper configuration in the installation process.

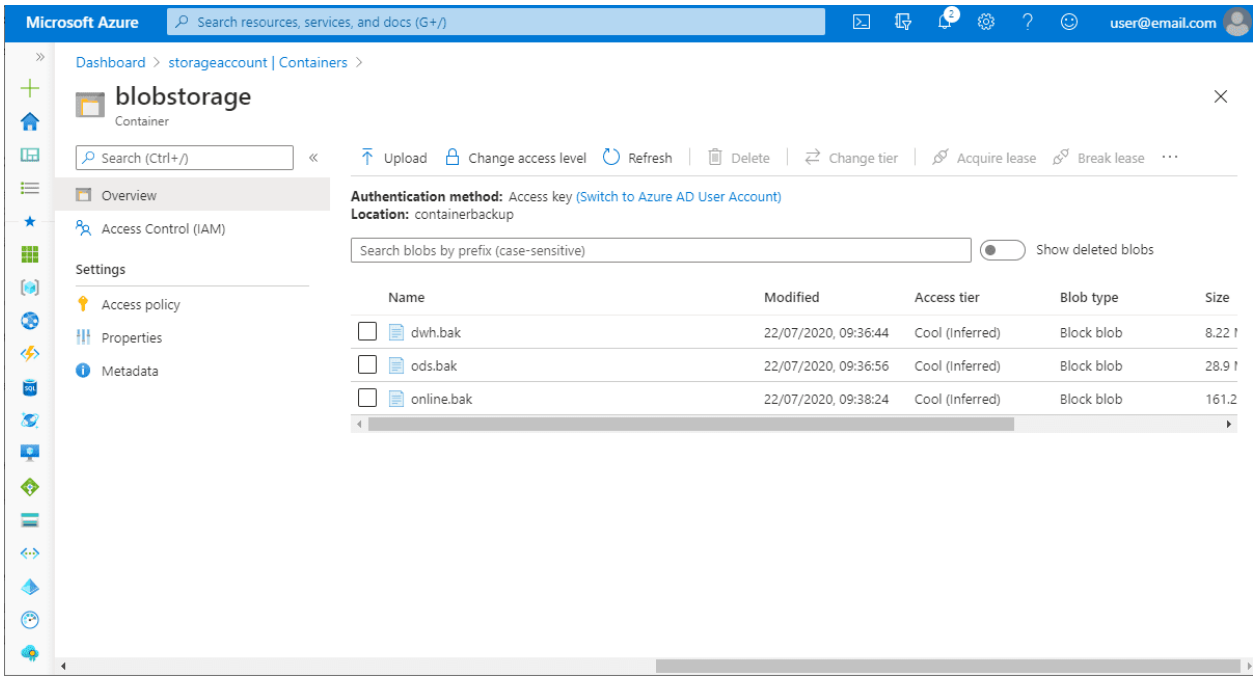


Figure 48: Screenshot showing a Microsoft Azure portal screenshot with details of installing to an Azure managed instance, specifically referencing Blob Storage.

20 Always On Availability Groups

The Always On Availability Groups feature is a high-availability and disaster-recovery solution that provides an enterprise-level alternative to database mirroring. Always On Availability Groups maximize the availability of a set of user databases for an enterprise. An availability group supports a failover environment for a discrete set of user databases, known as availability databases, that fail over together. An availability group supports a set of read-write primary databases and one to eight sets of corresponding secondary databases. Optionally, secondary databases can be made available for read-only access and/or some backup operations.

20.1 Always On on Availability Groups versus on Failover Cluster Instances

An availability group is composed by a primary availability replica and one to four secondary replicas that synchronize via log-based data movement for data protection without the need for shared storage. This reduces the overall cost of the solution.

An availability group listener on the primary node responds to connection requests to the virtual network name, and redirects each request to the appropriate SQL Server instance. In the event of a failover, the system does not transfer ownership of shared physical resources to another node. WSFC assists SQL Server in the reconfiguration of a secondary replica on another SQL Server instance to become the availability group's primary replica. The availability group virtual network name resource is moved to that instance to complete the failover process.

20.2 Always On Terms

Table 15: Always On Terms

Name	Definition
Availability group	A container for a set of databases, availability databases, that fail over together.
Availability database	A database that belongs to an availability group. For each availability database, the availability group maintains a single read-write copy (the primary database) and one to eight read-only copies (secondary databases).
Primary database	The read-write copy of an availability database.
Secondary database	A read-only copy of an availability database.
Availability replica	An instantiation of an availability group that is hosted by a specific instance of SQL Server and maintains a local copy of each availability database that belongs to the availability group. Two types of availability replicas exist: a single primary replica and one to eight secondary replicas.
Primary replica	The availability replica that makes the primary databases available for read-write connections from clients and also sends transaction log records for each primary database to every secondary replica.

Name	Definition
Secondary replica	An availability replica that maintains a secondary copy of each availability database and serves as a potential failover target for the availability group. Optionally, a secondary replica can support read-only access to secondary databases and can support creating backups on secondary databases.
Availability group listener	A server name to which clients can connect in order to access a database in a primary or secondary replica of an Always On availability group. Availability group listeners direct incoming connections to the primary replica or to a read-only secondary replica.

21 Breaking Up SQL Server Databases into Multiple Files

File access is fundamental and an essential consideration to an OLTP system. If your system is busy (it gets a high number of transactions), or you expect it to be in the future, put in a little planning to prevent waiting for the disk. The next topics will address file placement, as well as log files and adding data.

For additional information, please refer to the following links:

- Optimizing TempDB Performance
- Capacity Planning for TempDB
- Place Data and Log Files on Separate Drives
- How to Optimally Use SSDs Without Burning Them Out

22 Database Filegroups and Data Files

Every SQL Server database contains a data file (.MDF) and a transaction log file (.LDF); however, you can add additional files to the database. These files are called secondary files (.NDF) and will also be used to store data rows or indexes. The files are assigned to filegroups in the same way that files are assigned to folders in a file system. When assigning several files to the same filegroup, data is distributed evenly between all of them, in a round-robin way.

When Critical Manufacturing is installed, it creates six data files:

1. `Primary`
2. `MainTableDat\_1`
3. `MainTableIdx\_1`
4. `HstTableDat\_1`
5. `HstTableIdx\_1`
6. The transaction log file

Additionally, it creates the necessary TempDB data and log files.

For Critical Manufacturing database, we strongly recommend that you isolate the transaction log file(s) into a separate LUN. Ideally, this LUN will be completely separated from the data files - even at disk level (most SAN vendors provide a way to set aside a few disks and isolate them to provide a write-optimized, mirrored disk resource like a RAID 10 LUN). With SQL Server's synchronous, write-log first transaction log behavior, the transaction log write latency is a critical potential bottleneck. You can avoid this by using proper SAN and database data file architecture.

SQL Server writes each transaction to the log before writing it to the data file. If both data and log are on the same disk, this means a lot of jumping back and forth between the two files and extra time taken up. Nonetheless, if the log is on its own disk, it has a dedicated read/write head to write the transactions, uninterrupted by data file writes.

It is also important to keep your log files separated, from a disaster recovery perspective. In case the disk that houses your data files fails, you will be glad to have the transaction log accessible in another disk. As a result, you are able to back up the tail of the log and be able to recover to the point of failure.

By definition, Critical Manufacturing uses one data file per filegroup.

23 Recommendations for SQL Server Installation Options

This section describes recommendations based on best practices for a Critical Manufacturing typical installation and workload. Some parameters might have to be adjusted during the lifetime of the application or if this recommendation is updated.

23.1 Install Analysis Services in Multidimensional and Data Mining Mode

Analysis Services provides online analytical processing (OLAP) and data mining functionality for business intelligence applications. When installing SQL Server, the Analysis Services must be installed in *Multidimensional mode*. This is one of three server modes in which Analysis Services runs in.

23.2 Provision Storage For The Operating System and for SQL Server

The following setup is recommended for each SQL Server Instance:

- Critical Manufacturing databases data files - `G:`
- Critical Manufacturing databases log files (including tempdb Log) - `L:`
- Critical Manufacturing databases backup disk - `H:`
- SQL Server Instance tempdb data file(s) - `T:`

In addition:

- Transaction log files (`L:`) should not be in the same disks as data files (`G:`) due to their random vs sequential way of writing in log files and data files.
- Use **RAID 10** (better write performance and reliability). Always make sure write cache is enabled (if applicable).
- TempDB should ideally be in SSD disks. If not possible, make sure it is using different spindles rather than the database files.

23.3 Operating System Configuration

The following configurations are recommended:

- Configure the Windows page file - we typically create a 2GB size page file on the system drive. Page file size can be found in the system properties of Windows Server.
- Set anti-virus exclusions - You need to configure exclusions for all SQL Server files per Microsoft's guidelines: https://support.microsoft.com/en-us/kb/309422.
- If you have additional tools that restrict the creation/modification of files, exclusions should also be set.
- Make sure server "Power Options" are set to "High Performance".
- Format the drives with 64K allocation blocks.

This only applies to drives holding SQL Server database and log files (including tempdb). Your C drive / system drive should be separate and 4K block size is appropriate for that logical drive.

23.4 Service Accounts and Permission Granting

Make sure to grant the 'Perform Volume Maintenance Tasks' and 'Page locks in memory' rights to the account that will be used for the SQL Server service (the engine, not the agent). This will enable the instant file initialization (IFI). Please refer to the link https://msdn.microsoft.com/en-us/library/ms175935.aspx for more information.

23.5 SQL Server Installation and Configuration

The following configurations are recommended:

- Make sure the TCP/IP Protocol is enabled.
- Configure this in the SQL Server Configuration Manager under "SQL Server Network Configuration." Enabling the TCP/IP protocol will only take effect after the SQL Server instance is restarted.
- Test Instant File Initialization (IFI)
- Create an empty database. Grow the data file by 5GB. If it does not complete immediately, then IFI is not working (revisit the previous step where it was granted.) If you have verified IFI is working, go ahead and drop the empty database.

23.6 TempDB Configuration

By default, the TempDB files are placed on the same drive as the SQL Server binaries. Even if the user chooses a custom install, TempDB still goes on the same drive as the other data files, and that is not advisable. Alternatively, the TempDB data files should be on their own dedicated drive.

23.7 Move TempDB to its own drive

In this example, we put the data file on the T drive and the log file on the L drive. (Important: directory paths must exist beforehand).

```
use master;
GO
alter database tempdb modify file (name='tempdev', filename='T:\MSSQL\DATA\tempDB.mdf', size = 1MB);
GO
alter database tempdb modify file (name='templog', filename='L:\MSSQL\LOGS\templog.ldf', size = 1MB);
GO
```

After this code runs, restart the SQL Server. That will create the new TempDB file on the new drive. Manually delete the old TempDB file on the original drive, since SQL Server does not delete it itself.

Grow that file and add additional data files. Now that TempDB is on the right drive, expand it to the full size according to your preferences and then create additional TempDB files.

```
USE [master];
GO
alter database tempdb modify file (name='tempdev', size = 2GB, FILEGROWTH = 100MB);
GO
```

The current guidance from Microsoft in KB 2154845 is to use the same number of tempdb files as the number of logical processors up to 8 logical CPUs. Do not add more, unless you observe you have contention.

The code to create one additional TempDB data file can be seen below - you can modify this in order to have more files:

```
USE [master];
GO
ALTER DATABASE [tempdb] ADD FILE (NAME = N'tempdev2', FILENAME = N'T:\MSSQL\DATA\tempdev2.ndf' , SIZE =
    2GB , FILEGROWTH = 100MB)
GO
```

The data file creation should only take a couple of seconds - if it takes more than ten seconds, then instant file initialization is not configured correctly (Revisit the section where IFI is enabled). On a general note: Autogrowing files by at least 100MB for the transaction log is acceptable, but this value may need to be higher to provide enough space to avoid autogrowing again quickly. The best option is to avoid autogrowing in the first place, by correctly sizing the files.

23.8 Configuration of SQL Server Max Degree of Parallelism

Set this value to the number of physical cores in a single NUMA node (processor) socket on your hardware or less.

Example to set the Max Degree of Parallelism to 8:

```
USE [master];
GO
ALTER DATABASE [tempdb] ADD FILE (NAME = N'tempdev2', FILENAME = N'T:\MSSQL\DATA\tempdev2.ndf' , SIZE =
    2GB , FILEGROWTH = 100MB)
GO
```

23.9 Configuration of SQL Server Cost Threshold for Parallelism

```
USE CriticalManufacturing;
GO
EXEC sp_configure 'show advanced options', 1;
GO
RECONFIGURE WITH OVERRIDE;
GO
EXEC sp_configure 'max degree of parallelism', 8;
GO
RECONFIGURE WITH OVERRIDE;
GO
```

23.10 Configuration of SQL Server Max Memory

By default, SQL Server's maximum memory is 2147483647, i.e. no memory limit. A limit should be defined so that paging to disk is less likely. It is advisable to leave 4GB or 10% of total memory free (whichever is larger on your instance to begin with) and adjust as needed.

Example for a server with 32GB of memory:

```
EXEC sys.sp_configure 'max server memory (MB)', '29491';
GO
RECONFIGURE WITH OVERRIDE;
GO
```

To double-check if you are paging to disk, go to *Task Manager*, open the *Performance* tab, and look at the free memory metric for Windows 2008. If it is under 200, you are in danger of swapping to disk.

23.11 SQL Server Maintenance Setup

Configure and schedule regular maintenance for all of the following:

- Full (and possibly differential) backups;
- Log backups (every 15 mins);
- CheckDB;
- Index maintenance;

We recommend using free scripts from Ola Hallengren to create customized SQL Server Agent: http://ola.hallengren.com/.

23.12 Set Compatibility level

The compatibility level set by Critical Manufacturing MES to its databases is equal to the maximum compatibility level supported by the oldest version of Microsoft SQL Server supported on each version.

For version 11, the oldest supported SQL Server version is SQL Server 2019 Standard Edition. The maximum database compatibility level support by this version is **150**, thus the compatibility level used by Critical Manufacturing MES v11 databases is **150**.

For more information, see https://learn.microsoft.com/en-us/sql/t-sql/statements/alter-database-transact-sql-compatibility-level?view=sql-server-ver16.

23.13 Other SQL Server Settings (to check after Critical Manufacturing has been installed)

Enable the option *optimize for ad hoc workloads* at the instance level.

```
EXEC sys.sp_configure 'optimize for ad hoc workloads', 1
GO
RECONFIGURE WITH OVERRIDE;
GO
```

Enable *backup compression default*

```
EXEC sp_configure 'backup compression default', '1';
GO
RECONFIGURE WITH OVERRIDE;
GO
```

Enable *Page_Verify* for a high level data-file integrity in our databases.

```
/*This will script out the command for you, check it and execute the output
*/
SELECT 'ALTER DATABASE ' + QUOTENAME(s.name) + ' SET PAGE_VERIFY CHECKSUM WITH NO_WAIT;'
FROM sys.databases AS s
WHERE s.page_verify_option_desc <> 'CHECKSUM';
GO
```

This script just creates the TSQL for your change: you still need to copy it and execute it in another window. When you configure your full backups, use the *With Checksum* option to check the checksums each time a full backup is run.

23.14 Manually Enable Backup Jobs

The SQL Server installation creates the backup jobs but does not enable them by default. In order for the jobs to run, they must be enabled manually.

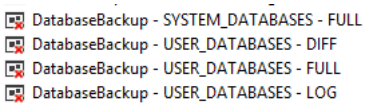


Figure 49: SQL Server Backup Jobs

For more information, see Database Backup and Restore section of the Operations Guide.

23.15 Optional Settings

Enable SQL Trace Flags. Trace flags are used to temporarily set specific server characteristics or to switch off a particular behavior. To find out more on how to enable SQL Trace flags on startup, visit https://msdn.microsoft.com/en-us/library/ms190737.aspx.

The trace flags indicated below are the most useful in this context:

- **1117** - Causes files in a filegroup to grow at the same time. Useful with tempdb.
- **1118** - Removes the use of mixed extents. Most often used to help with tempdb contention.
- **2371** - Statistics are recomputed less rarely as tables grow larger.
- **3226** - Stops logging all of your backup success entries to the error log.
- **4199** - To get new query optimizer hot fixes that produce different query plans.
- **8048** - Enables SOFT NUMA when SQL's NUMA-awareness code does not work on larger systems.

24 Storage and RAID Levels

The RAID levels have a big impact on both performance and availability. The most common RAID levels that you will encounter are:

- **RAID 0** (sometimes called *disk striping*). This RAID level spreads all the data across all the available disks. You often see this RAID level used in different database benchmarks. **RAID 0** provides good performance, but you should never use it on a production server because one disk failure will result in data loss.
- **RAID 1** (sometimes called *disk mirroring*). With **RAID 1**, data is mirrored on the disks. Read and write performance is good, but the overall disk capacity is cut in half. **RAID 1** is often used for SQL Server log files. It can sustain one disk failure.
- **RAID 5** (sometimes called *disk striping with parity*). **RAID 5** stripes data across multiple disks and uses a disk for data redundancy. It is often used for data files. This RAID level provides good read performance and can sustain the failure of one disk. However, it is known for slower write performance.
- **RAID 10** (sometimes called *disk mirroring with striping*). **RAID 10** combines the performance of striping with the protection of mirroring. **RAID 10** provides the highest levels of performance and availability out of the different RAID levels. **RAID 10** uses twice as many disks as **RAID 5**, but it can sustain multiple disk failures. A **RAID 10** array can sustain failures for as many as half of the disks in the set. **RAID 10** is good for both data and log files.

For Critical Manufacturing databases, we strongly recommend to use:

- **RAID 5** for the ODS and Data Warehouse databases.
- **RAID 10** or **RAID 5** for the Online database.
- Solid State Disks (SSD) or **RAID 10** for TempDB database.

25 TempDB Database Configuration

TempDB is critical to performance as it is used by several users and system actions such as cursors, temp tables, hash table for sorts, re-indexing, and so on. It is recommended that you handle TempDB before you separate your OLTP data and log files.

TempDB is typically one of the most active databases on a production SQL Server instance, so it is highly recommended that a separate LUN for the TempDB is used. The TempDB data and log files should be placed on different physical drives, apart from your production database data and log files. Because TempDB is so active, it is also a good idea to make sure the drives are protected with SSD or striped with RAID 10.

The Microsoft SQL Server Customer Advisory Team (SQLCAT) has recommended that TempDB should have one data file for each CPU core. However, this recommendation is best suited for very heavy workloads. It is more commonly recommended that TempDB have a 1:2 or 1:4 ratio of data files to CPU cores. As with most performance recommendations, this is a general guideline. The requirements for your system will vary. If you are unsure of how many data files to use for TempDB, a common recommendation is to start with four data files. Typically, one log file is enough for TempDB. (For more in-depth TempDB recommendations, see the resources listed in the *Breaking Up SQL Server Databases into Multiple Files* section.)

By default, TempDB files are placed on the same drive as the SQL Server binaries. Even if the user chooses a custom install, the TempDB is still placed in the same drive as the other data files. Instead, the TempDB data files should be stored on their own dedicated drive. This must be corrected by first moving the TempDB to its own separate drive. In the example below, we put the data file on the T: drive and the log file on the L: drive. Note that the directory paths must already exist before running the command.

```
USE [master]
GO
ALTER DATABASE [tempdb] MODIFY FILE (NAME='tempdev', FILENAME='T:\MSSQL\DATA\tempDB.mdf', SIZE = 1mb)
GO
ALTER DATABASE [tempdb] MODIFY FILE (NAME='templog', FILENAME='L:\MSSQL\LOGS\templog.LDF', SIZE = 1mb)
GO
```

In the example above, we only set a 1mb file size because SQL Server behaves uncommonly. Even though we are instructing it to use a different drive letter, it will look for this amount of free space on the current TempDB drive. If the SQL Server had been installed on the server's C: drive, for example, and we had tried to create a 10GB TempDB file on a T: drive, that SQL command would have failed if 10GB of free space were not on the C: drive.

After the command above is run successfully, it is necessary to restart the SQL Server instance. That will create the new TempDB file on the new drive. The old TempDB file will have to be manually deleted from the original drive, because SQL Server will not do it itself.

Now that TempDB is on the right drive, expand it to the full size according to your preferences and then create additional TempDB files using the rule explained above (related with the number of processor cores). If you have got a quad-socket, quad-core box, i.e. 16 cores, it is recommended to use 4 to 8 TempDB files.

To create one additional TempDB data file it is necessary to run the command below:

```
USE [master]
GO
ALTER DATABASE [tempdb] ADD FILE (NAME = 'tempdev2', FILENAME='T:\MSSQL\DATA\tempdev2.ndf', SIZE =
    10GB, FILEGROWTH = 0)
GO
```

It is important to highlight the fact that file growth has not been enabled. You should proactively create the TempDB files at their full sizes in order to avoid drive fragmentation. If you have a dual-cpu quad-core server (8 cores total) and an 80GB array for TempDB data, you should create eight 10GB files for TempDB. As a result, each file will be contiguous. If you create them as smaller files and let them grow automatically, then the disk will be fragmented because the files will be growing at random times. In addition, you could end up with differently sized TempDB files if one of them happened to grow faster than the rest. That is why we strongly recommend that all the TempDB files are pre-grown beforehand and then get them at exactly the right size.

26 Additional required components

In this section you have instructions on setup and configuration of the additional required components that must be running for a successful installation and operation of Critical Manufacturing MES.

- ClickHouse
- Kafka
- RabbitMQ
- S3

27 ClickHouse Connection Setup

In this section you can see information on specific settings that must be set in your system to allow connection and operation with ClickHouse:

Table 16: ClickHouse connection setup

Item	Description
ClickHouse Username	The ClickHouse User name
ClickHouse Password	The ClickHouse User password

See more information on [[installation-guide-accountsandsecurity]] for specific information on accounts and security settings for ClickHouse.

27.1 Deployment

Critical Manufacturing MES uses ClickHouse for data persistence. For the MES system to operate correctly, deploy `ClickHouse-Server` with the appropriate version matching the definitions listed in [[system-requirements-additionalcomponents]]. You can use the provided ClickHouse templates available here: ClickHouse Templates.

 These templates are available for guidance purposes only. Critical Manufacturing recommends consulting an expert for proper ClickHouse setup.

Furthermore, at least one user must exist with the permissions listed in [[installation-guide-accountsandsecurity]].

If you are using mTLS as the authentication method, a secret is required in the namespace where ClickHouse will be installed. This secret should contain the following key-value pairs:

Key	Value
`root.crt`	(Cluster Certificate Authority)
`client.crt`	(User Public Key)
`client.key`	(User Private Key)

The name of this secret should be passed to `values.yaml`.

 If you are using SASL Plain as the authentication method, it is necessary to pass the username and password to `values.yaml` instead of user certificates.

27.1.1 Fully managed ClickHouse service

It is also possible to use a fully managed ClickHouse service such as ClickHouse Cloud. If this is the setup you wish to deploy in your system, please contact ClickHouse on ClickHouse Support for detailed instructions on setting up ClickHouse and integrating with Confluent Cloud.

28 Kafka Connection Setup

In this section you can see information on what you must prepare to configure the connection to Kafka.

28.1 Authentication Methods

There are different required settings depending on the authentication method selected. Both are listed in the tables below:

28.1.1 Using Mutual TLS authentication

Table 18: Kafka connection setup using Mutual TLS authentication

Item	Description	Planning and installation guide	Checked
Cluster Certificate Authority	The Kafka cluster certificate authority	This will be used to connect to Kafka when using mutual TLS	[[installation-guide-accountsandsecurity]]
User public key	The kafka user public key	This will be used to connect to Kafka when using mutual TLS	[[installation-guide-accountsandsecurity]]
User private key	The kafka user private key	This will be used to connect to Kafka when using mutual TLS	[[installation-guide-accountsandsecurity]]

28.1.2 Using SASL SSL Plain

Table 19: Kafka connection setup using SASL SSL Plain

Item	Description	Planning and installation guide	Checked
Kafka Username	The Kafka User name	This will be used to connect to Kafka when using SASL SSL Plain	[[installation-guide-accountsandsecurity]]
Kafka Password	The Kafka User password	This will be used to connect to Kafka when using SASL SSL Plain	[[installation-guide-accountsandsecurity]]

28.2 Deployment

Critical Manufacturing MES uses Kafka for event streaming. Ensure that the Kafka deployment complies with the [[system-requirements-kafka#minimum-system-requirement|Minimum System Requirements]] defined for the platform.

As stated above, Critical Manufacturing MES provides two forms of authentication to communicate with Kafka:

- Mutual TLS (client certificates)
- SASL Plain (username and password).

For an adequate operation connection setup for Kafka under Critical Manufacturing MES, the user must have the permissions

described in [[installation-guide-accountsandsecurity]].

When running MES on OpenShift, we recommend using Red Hat Streams for Apache Kafka version 3.7.0 or higher. Please contact Red Hat at Red Hat Support for detailed instructions on setting up AMQ Streams.

It is also possible to use Confluent Cloud. Please contact Confluent at Confluent Support for detailed instructions on setting up Kafka.

29 RabbitMQ Connection Setup

In this section you can see information on specific settings that must be set in your system to allow connection and operation with RabbitMQ:

From the official RabbitMQ website:

> RabbitMQ is a reliable and mature messaging and streaming broker, which is easy to deploy on cloud environments, on-premises, and on your local machine. It is currently used by millions worldwide.

Table 20: RabbitMQ connection setup

Item	Description
Host	The fully qualified domain name of the machine where RabbitMQ will be running
Port	The port where RabbitMQ will be running
Use Client Certificates	Whether to use client-signed digital certificates for authenticated requests
RabbitMQ Username	The RabbitMQ User name
RabbitMQ Password	The RabbitMQ User password
Certificate PEM	Certificate containing the public key for authentication
Key PEM	Key used for authentication
CA PEM	Certificate authority in PEM (Privacy Enhanced Mail) format

30 S3 Connection Setup

In this section you can see information on specific settings that must be set in your system to allow connection and operation with Amazon Web Services Simple Storage Service (S3):

From the official Amazon S3 website:

> Amazon Simple Storage Service (Amazon S3) is an object storage service that offers industry-leading scalability, data availability, security, and performance. Customers of all sizes and industries can use Amazon S3 to store and protect any amount of data for a range of use cases, such as data lakes, websites, mobile applications, backup and restore, archive, enterprise applications, IoT devices, and big data analytics. Amazon S3 provides management features so that you can optimize, organize, and configure access to your data to meet your specific business, organizational, and compliance requirements.

Table 21: S3 connection setup

Item	Description
Address	The fully qualified domain name of the machine where S3 will be running (in `address:port` format)
Bucket name	Name of the bucket used for storage in S3
AccessKey Id	Access Key Id used to sign the requests sent to S3
Secret Access Key	Secret Access Key used to sign the requests sent to S3
Use Path Style	Whether to use virtual-hosted style or path-style requests to S3

31 Application Servers

This guide walks you through the steps to successfully plan and install an application server to host the optional components used by Critical Manufacturing MES.

31.1 Planning for disaster recovery and high-availability

Critical Manufacturing recommends adopting the Windows Server Failover Clustering solution to provide high-availability of the roles required for Critical Manufacturing normal operation, including a scenario where Connect IoT is present and requires high-availability.

31.2 Application Server pre-requisites

Table 22: Application Server pre-requisites

Name	Requisite	Supported Versions	Checked
Operating System	Microsoft Windows Server	2016 to 2022	
Command Line Shell	Microsoft PowerShell	>=5.1	
Other software requirements	.NET Framework .NET	4.8 8	

31.3 Frameworks Installation

This section details the installation process for the required .NET Framework and .NET versions.

31.3.1 .NET Framework 4.8

The .NET Framework 4.8 is essential to run the Critical Manufacturing MES setup executable and various legacy components. Follow the installation steps below.

1. **Download:** Obtain the .NET Framework 4.8 offline installer by downloading it from the official Microsoft website: https://dotnet.microsoft.com/download/dotnet-framework/net48.
2. **Install:** Locate the downloaded installer and run it with administrator privileges. Follow the on-screen prompts to complete the installation.

31.3.2 .NET 8.0 Runtime

.NET 8.0 is required for modern Critical Manufacturing MES components and services. Ensure you download the correct architecture (x64 for server deployments). Follow the installation instructions below.

1. **Download:** Download the .NET 8.0 **x64 Runtime** installer from the official Microsoft website: https://dotnet.microsoft.com/download/dotnet/8.0.

    Look for the `Runtime` section and select the `Windows x64` installer.

2. **Install:** Run the downloaded installer with administrator privileges. Follow the on-screen prompts.

32 Application Clients

See the System Requirements section to learn more about this topic.

- Client Devices

33 File Shares

Information on file shares and volume configurations is available on the Customer Portal support website here.

34 Email

This guide will walk you through the steps required to plan and prepare an email infrastructure to be used by Critical Manufacturing MES.

34.1 Email configuration

To configure the email infrastructure in Critical Manufacturing MES, the following information needs to be collected on the email service provider:

- SMTP Server Address
- SMTP Server User Name
- SMTP Server Password

 Critical Manufacturing also supports using transport security (SSL) when sending emails. In this case, besides providing the https address in this setting, you need to set EnableSSL to ON.

When sending an email, Critical Manufacturing MES will identify itself through the information in these settings:

- Support Email Address
- Support Email From Name

All these settings will be requested in the installation wizard.

35 Installation

Installing Critical Manufacturing MES is a streamlined process carried out directly through the Critical Manufacturing DevOps Center, available from the Critical Manufacturing Customer Portal. This environment provides a centralized, guided experience designed to help you deploy, configure, and maintain your MES landscape with confidence.

In the section below, you'll find a step-by-step overview of how to perform a full installation of the core MES platform. Additional details on optional modules and complementary components are also provided, allowing you to tailor your installation to the needs of your operation.

If you're looking for broader information on prerequisites, architecture, or infrastructure-related topics, be sure to explore the comprehensive DevOps Center documentation, which offers deeper insights into setup, best practices, and system administration.

In this guide you are going to create an MES Customer Environment in an existing Customer Infrastructure with an Infrastructure Agent already deployed and connected to the DevOps Center. Let's consider the Infrastructure Agent with version 11.2.0. This example is configured for an OpenShift v4.18 cluster.

35.1 Step 1: Create an Environment

1. Load the **Environments section** in the main page of the Customer Infrastructure and select **Create**. This opens a transaction wizard.

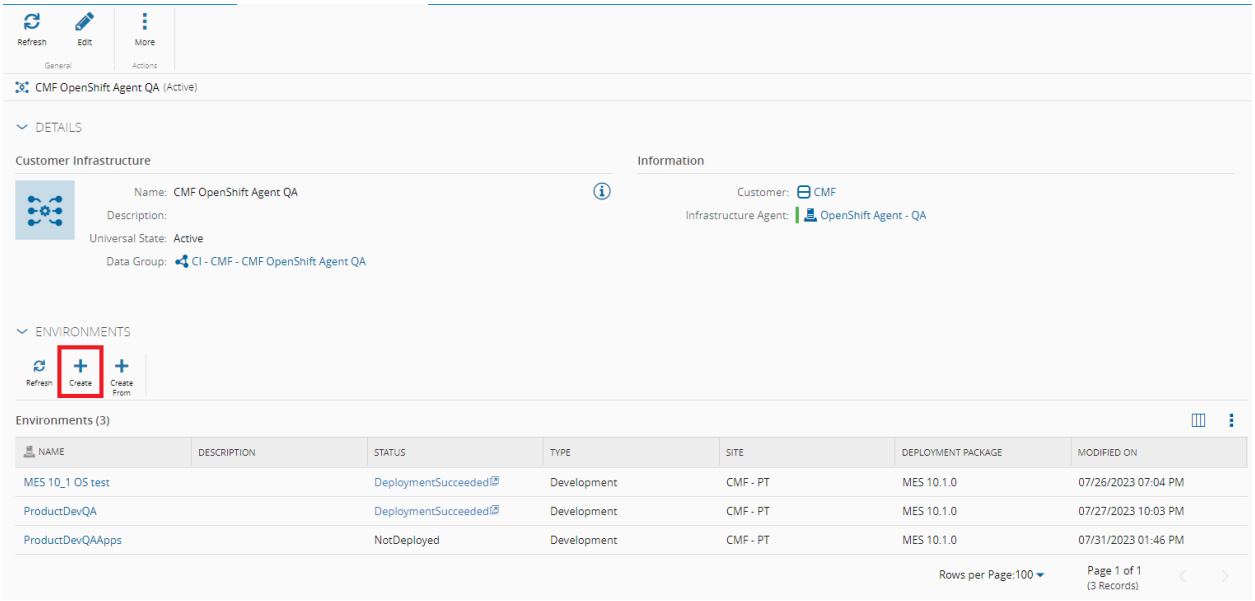


Figure 50: Screenshot showing the "Create" button on the Environments section of the Customer Infrastructure main page.

2. Set a **Name**, a **Type** and a **Site**. Select **Create**.

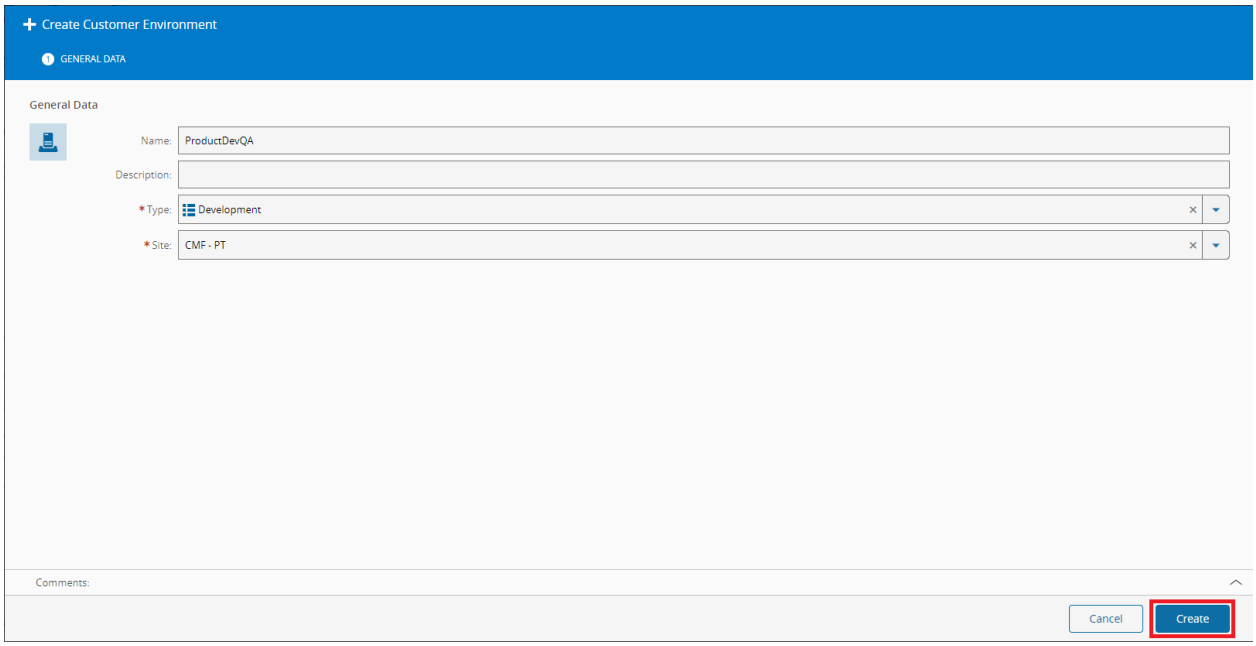


Figure 51: Screenshot showing an environment creation form with fields for “Name”, “Type”, and “Site”.

35.2 Step 2: Define the Target

The Customer Environment is now created in the system and ready to be used. The current page should now be its installation view where it is possible to start configuring. The first step group is named **Target** and is related with the configurations’ base package and version, opt-in features and the deployment target.

35.2.1 Package

In the first step, you can define the base package and version along with other metadata. Set the following values and select **Next**:

- **Deployment Package** - base package to be used. Since you are installing a Critical Manufacturing MES 11.2.0, set the value to `MES 11.2.0`.
- **Configuration Level** - different levels which will have an impact in how many configurations will be asked and are possible to configure. Set to `Advanced` so that you are able to configure everything that is currently possible.
- **License** - license for the Critical Manufacturing MES installation. Select an available license.

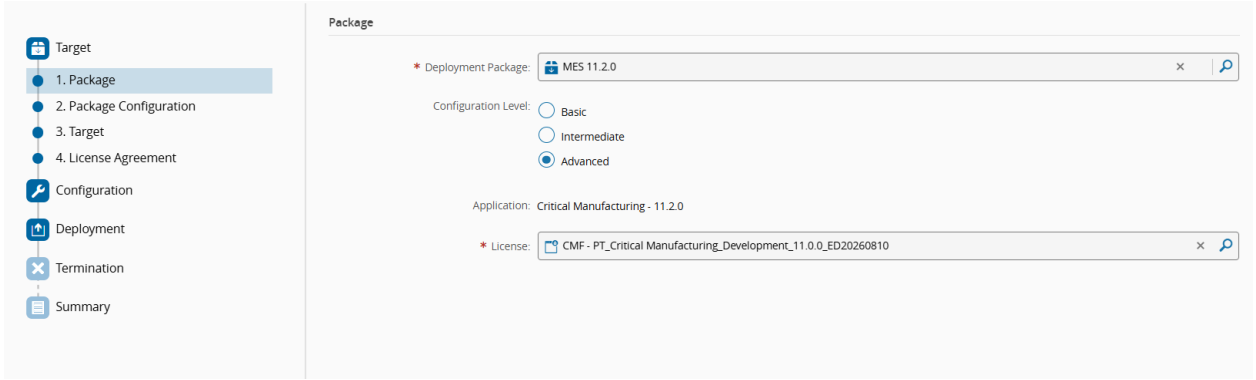


Figure 52: Screenshot showing a package selection interface with “License” nearby, illustrating the step to select an available license for the Critical Manufacturing MES installation.

35.2.2 Package Configuration

Now configure the base package with opt-in features. These can vary based on the license modules and on the base package and version. The available ones for a Critical Manufacturing MES 11.2.0 are the following:

- **External dependencies mode** - different modes for ClickHouse, Kafka, RabbitMQ, and S3. These may be:
  - **None** - ClickHouse, Kafka, RabbitMQ, and S3 are not installed within the MES stack. These components must be available externally to the MES stack.
  - **Broker and Storage** - ClickHouse and Kafka are not installed within the MES stack, but RabbitMQ and S3 are installed within MES stack (not recommended for Staging or Production environments).
  - **All** - ClickHouse, Kafka, RabbitMQ, and S3 are installed within the MES stack (not supported in Staging or Production environments).
- **Generative AI** - different modes for Generative AI. These may be:
  - **None** - the dependencies required to enhance the system with Generative AI capabilities will not be installed.
  - **Generative AI Infrastructure** - all dependencies required to enhance the system with Generative AI capabilities are installed along with the MES stack.
- **Database Mode** - different modes for the database installation. These may be:
  - **None** - base mode where only the Online database is installed in an external MSSQL Server.
  - **MES Analytics** - enhanced version of the previous mode where more features are available but an external MSSQL Server is still required. These features are: Operational Data Store (ODS), Data WareHouse (DWH), Reporting and Analysis Services.
  - **MSSQL Server** - similar to the None mode but instead of relying on an external MSSQL Server, a container is deployed along with the rest of the stack, which runs a containerized version of MSSQL Server.

   The Canonical Data Model (CDM) is only generated when the `MES Analytics` mode is selected. If the installation is performed using any other Database Mode option (without ODS and DWH), Data Platform components will not be deployed, and CDM and cube data will not be available.
- **Connect to a central Traefik** - configures the stack's Traefik reverse proxy to not be exposed and instead connect to the Traefik that is included in the Infrastructure Agent. This is very useful as many Customer Environments can be deployed and their only entrypoint is the Infrastructure Agent's Traefik reverse proxy, which means less open inbound ports and less networking configurations. When creating a Customer Environment in a Customer Infrastructure with an Infrastructure Agent, this option will be selected by default.

To exemplify the feature, keep the **Database mode** set to `MES Analytics`, the **External dependencies mode** set to `None` and the opt-in feature **Connect to a central Traefik** set to `true` since you have an Infrastructure Agent configured and running.

Set the values as shown in the example below and select **Next**.

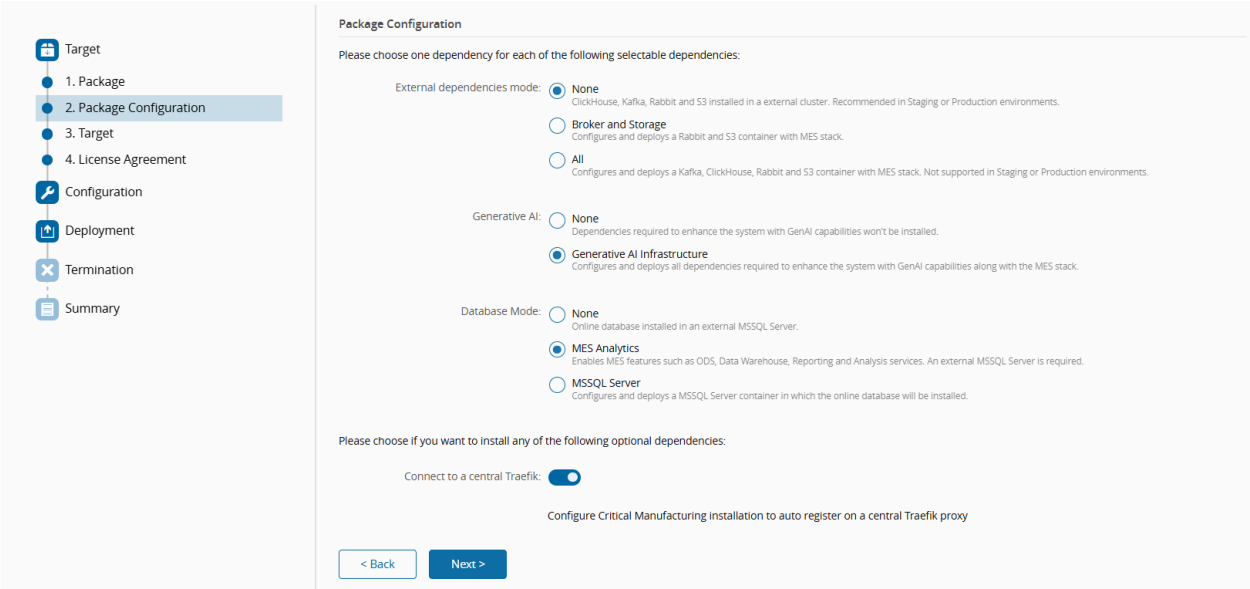


Figure 53: Screenshot showing a package configuration example with two packages listed, "Package Congueion" and "Package Conpraon".

35.2.3 Target

Set the Target to `OpenShift Remote` as you are using OpenShift as your remote Deployment Target. Select **Next**.

35.2.4 License

Read and Understand all the licenses that are displayed and select **Next**, which advances to the next step group, **Configuration**.

35.3 Step 3: Configuration

By now, the base application and its features are set. Before starting the deployment process, you need to configure the base application and features with the required data. The following steps address the available configurations for each different part of the system. Bear in mind that the Configuration Level and License have an impact on how many steps and parameters are shown along with the available Critical Manufacturing MES features.

For configuration purposes, the character double quotes (**"**) is not allowed to be inserted on input fields.

35.3.1 General Data

In this wizard, you should add the general information regarding the system, such as:

1. **Details**
    - **System Name** - name of the system. Also used to set the database(s) name(s).
    - **Tenant Name** - tenant name of the system. Must not contain blank spaces.
2. **Connect IoT**
    - **Storage Retention Time** - how long the raw IoT data is retained in storage before being automatically deleted.

3. **Access Information**

    - **Application Public HTTP Address** - public HTTP address to access the environment. Remember that when using Domain Name System (DNS) providers or Transport Layer Security (TLS) via certificates, such as in the case of an Infrastructure Agent, this field must comply to their specifications, for example, **if configuring a wildcard certificate** for `*.mydomain.com` or using a Cloudflare for that same domain, **this field must be set to** `<mysubdomain>.mydomain.com`. Do not specify the HTTP Port, since the Agent's Traefik already has the ports 80 and 433 configured and these are the ones that are going to be used. For OpenShift, we should use its native routing mechanism which generally follows the cluster's certificate and domain as well instead of relying on DNS and TLS validation at the Infrastructure Agent or another level.
    - **Application Public HTTP TLS Enabled** - set to `true` if this environment has TLS enabled. This is just for internal usage, the actual TLS configuration must be set via DNS providers or certificates.

4. **Install Information**

    - **Package to Install** - root package to be installed by the Environment Manager. If empty, it will use the default base package for the version. This can be set to override and install a different package, for example, a customization package.
    - **Installation Data Path** - the path that the MSSQL Server can use to access the Installation Data volume. When using an external MSSQL Server, this volume must be a shared location between it and the containers.
    - **Deployment Mode** - the deployment mode can be Transactional (if the installation fails, the database is guaranteed to be in a stable state and the installation can be retried) or it can be Non-Transactional (if the installation fails, the database is left in an intermediate state and it needs to be restored before retrying, **requiring downtime**. It is much faster than the Transactional mode).

5. **Add Package Source** - defines external sources for retrieving Installation Packages during MES setup. These sources are later referenced by the Environment Manager. The Environment Manager uses the configured package sources to download the necessary packages at runtime. If you select the **Add Package Source** button, you must fill in the following information:

    - **Type** - the type of package source (only NPM is supported).
    - **Address** - the URL to the NPM repository.
    - **Username** - the username for accessing the package source. *Applies if authentication is required.*
    - **Password** - the corresponding password or access token for authentication. *Applies if authentication is required.*

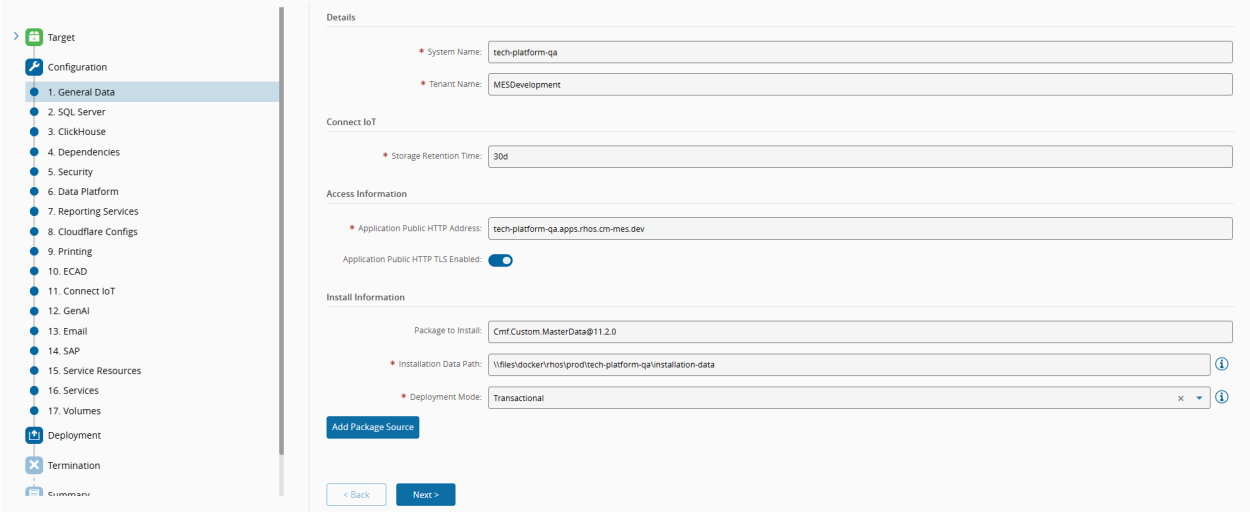


Figure 54: Screenshot showing a UI with unclear input fields, illustrating the step to configure general data.

35.3.2 SQL Server

Now, add the information regarding database(s) connection(s).

1. **Online** - online database information.
    - **Address** - database address. *Applies to Database Modes: None and MES Analytics*.
    - **Port** - database TCP port. *Applies to Database Modes: None and MES Analytics*. **Only set this if the database listens on a fixed non-default port. For named instances, this must be left empty as they use dynamic ports**.
    - **Username** - database SA user. *Applies to Database Modes: None and MES Analytics*.
    - **Password** - database SA user password. **Generated when in database mode MSSQL Server**. *Applies to Database Modes: None, MES Analytics and MSSQL Server*.
    - **File Location** - location where the database files will be persisted. *Applies to Database Modes: None and MES Analytics*.
    - **Log Location** - location for the Microsoft SQL online database log. *Applies to Database Modes: None and MES Analytics*.
    - **Encrypt** - encrypted communication with the database can be enforced (Mandatory) or negotiated if requested (Optional).
    - **Trust Server Certificate** - when disabled and Encrypt is Mandatory (or Optional but the server enforces encryption), the server name in the server's TLS certificate must exactly match the server name specified in the connection string.
    - **Database Always On Enabled** - whether to enabled Always On mode. *Applies to Database Modes: None and MES Analytics*. **Feature not available with MSSQL Server database mode**.
    - **External Port** - port to expose the database for remote access. *Applies to Database Modes: MSSQLServer*.
2. **Online Data Store (ODS)** - ODS database information. *Applies to Database Modes: MES Analytics*.
    - **Address** - database address. If left blank, it will default to the Online database value.
    - **Port** - database TCP port. If both this and the Address are left blank, it will default to the Online database value. **Only set this if the database listens on a fixed non-default port. For named instances, this must be left empty as they use dynamic ports**.
    - **Username** - database SA user. If left blank, it will default to the Online database value.
    - **Password** - database SA user password. If left blank, it will default to the Online database value.
    - **File Location** - location where database files will be persisted. If left blank, it will default to the Online database value.
    - **Log Location** - location for the Microsoft SQL online database log. *Applies to Database Modes: None and MES Analytics*.
    - **Encrypt** - encrypted communication with the database can be enforced (Mandatory) or negotiated if requested (Optional).
    - **Trust Server Certificate** - when disabled and Encrypt is Mandatory (or Optional but the server enforces encryption), the server name in the server's TLS certificate must exactly match the server name specified in the connection string.
3. **Data WareHouse (DWH)** - DWH database information. *Applies to Database Modes: MES Analytics*.
    - **Address** - database address. If left blank, it will default to the Online database value.
    - **Port** - database TCP port. If both this and the Address are left blank, it will default to the Online database value. **Only set this if the database listens on a fixed non-default port. For named instances, this must be left empty as they use dynamic ports**.
    - **Username** - database SA user. If left blank, it will default to the Online database value.
    - **Password** - database SA user password. If left blank, it will default to the Online database value.
    - **File Location** - location where database files will be persisted. If left blank, it will default to the Online database value.
    - **Log Location** - location for the Microsoft SQL online database log. *Applies to Database Modes: None and MES Analytics*.
    - **Encrypt** - encrypted communication with the database can be enforced (Mandatory) or negotiated if requested (Optional).
    - **Trust Server Certificate** - when disabled and Encrypt is Mandatory (or Optional but the server enforces encryption), the server name in the server's TLS certificate must exactly match the server name specified in the connection string.
4. **Analysis Services (AS)** - AS database information. *Applies to Database Modes: MES Analytics*.

- **Address** - database address.
- **Port** - database TCP port. **Only set this if the database listens on a fixed non-default port. For named instances, this must be left empty as they use dynamic ports**.
- **Username** - Windows authentication user.
- **Password** - Windows authentication user password.

Example:

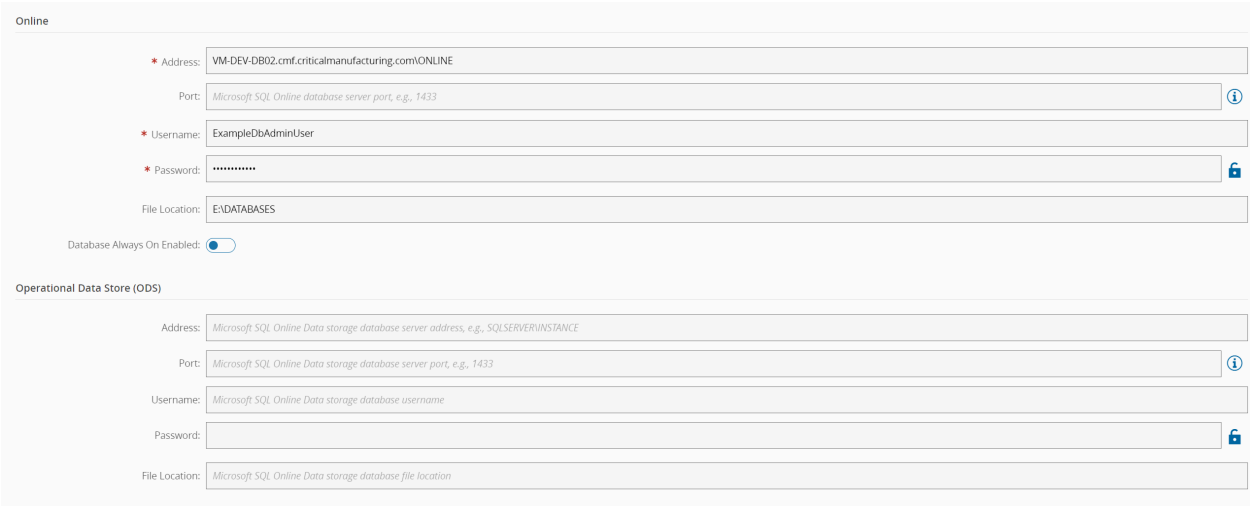


Figure 55: step configuration database 1

Figure 56: step configuration database 2

35.3.3 ClickHouse

Add ClickHouse information. *Applies to External dependencies mode: None/Broker and Storage.*

1. **General Data**

   - **Address** - the hostname or IP address of the ClickHouse server.
   - **TCP Port** - the TCP port used by ClickHouse.
   - **HTTP Port** - the HTTP port used by ClickHouse.
   - **Username** - the username for ClickHouse authentication.
   - **Password** - the password for ClickHouse authentication.

- **Encrypt** - if enabled, the application will wrap all the network traffic into TLS stream.

2. **Users**

   - **Automatically provision additional ClickHouse users** - if enabled, additional ClickHouse users are automatically created by the system. Advanced users can disable this setting and manage user creation themselves, providing the credentials shown below:

     - **MES (R/W) Username** - the username for accessing MES datasets with read and write permissions.
     - **MES (R/W) Password** - the password for the MES (R/W) user.
     - **Analytics (R) Username** - the username with read-only access to Analytics datasets.
     - **Analytics (R) Password** - the password for the Analytics (R) user.
     - **DWH (R) Username** - the username with read-only access to Data Warehouse (DWH) datasets.
     - **DWH (R) Password** - the password for the DWH (R) user.
     - **DWH Playground Username** - the Read-only username used to access DWH data via development tools like the ClickHouse Playground.
     - **DWH Playground Password** - the password for the DWH Playground user.
     - **Analytics (R/W) Username** - the username with read and write access to Analytics datasets.
     - **Analytics (R/W) Password** - the password for the Analytics (R/W) user.
     - **Analytics (R) / DWH (R/W) Username** - the user with read-only access to Analytics and read-write access to DWH datasets. Typically used by hybrid services that both consume and ingest data.
     - **Analytics (R) / DWH (R/W) Password** - the password for the combined Analytics/DWH user.

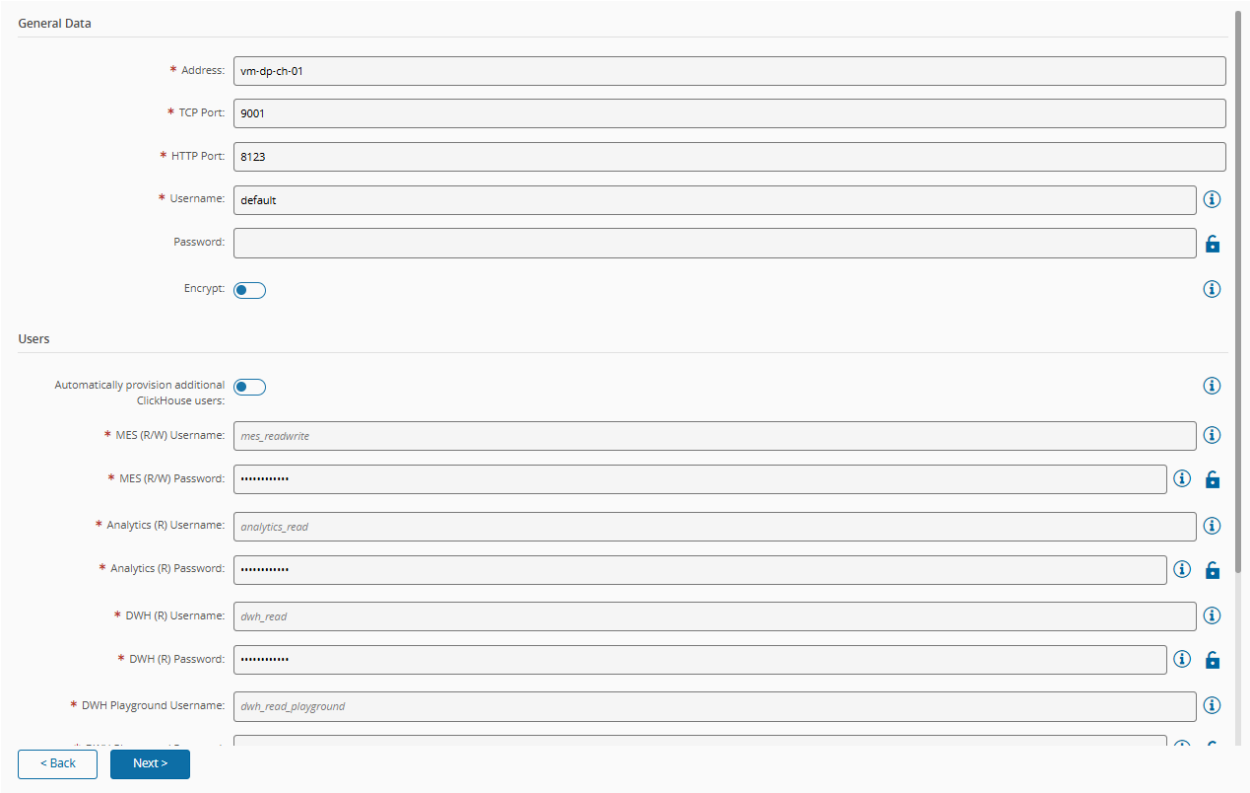


Figure 57: step configuration clickhouse

35.3.4 Dependencies

Add the information regarding external MES dependencies.

1. **Kafka** - Kafka information. *Applies to External dependencies mode: None/Broker and Storage.*
    - **Bootstrap Servers** - the Kafka bootstrap servers.
    - **Authentication Method** - the authentication method used by Kafka (None, mTLS, SASL_SSL Plain).
    - **Ssl Certificate Authority** - the certificate authority (CA) file for validating the Kafka server's certificate. *Applies to Authentication Method: mTLS and SASL_SSL Plain.*
    - **Ssl Certificate** - the public key certificate used for client authentication against Kafka. *Applies to Authentication Method: mTLS.*
    - **Ssl Key** - the private key certificate used for client authentication against Kafka. *Applies to Authentication Method: mTLS.*
    - **Validate certificates** - toggle to enable or disable server certificate validation. *Applies to Authentication Method: mTLS.*
    - **Kafka Username** - the username for Kafka authentication. *Applies to Authentication Method: SASL_SSL Plain.*
    - **Kafka Password** - the password for Kafka authentication. *Applies to Authentication Method: SASL_SSL Plain.*
2. **RabbitMQ** - RabbitMQ information. *Applies to External dependencies mode: None.*
    - **Host** - the hostname or IP address of the RabbitMQ server.
    - **Port** - the port used by RabbitMQ.
    - **Virtual Host** - the RabbitMQ virtual host name.
    - **Username** - the username for RabbitMQ authentication.
    - **Password** - the password for RabbitMQ authentication.
    - **Use TLS** - toggle to enable or disable TLS for RabbitMQ communication.
    - **Ssl Certificate** - the public key used for client authentication against RabbitMQ. *Applies to Use TLS: true.*
    - **Ssl Key** - the private key used for client authentication against RabbitMQ. *Applies to Use TLS: true.*
    - **Ssl Certificate Authority** - the certificate authority (CA) file for validating the RabbitMQ server's certificate. *Applies to Use TLS: true.*
    - **Validate Certificate(s)** - toggle to enable or disable server certificate validation. *Applies to Use TLS: true.*
3. **External Storage (S3-compatible)** - S3 information. *Applies to External dependencies mode: None.*
    - **Address** - the hostname or IP address of the S3-compatible storage service.
    - **Bucket Name** - the name of the S3 bucket to be used.
    - **AccessKey Id** - the access key ID for authenticating with the S3-compatible storage.
    - **Secret Access Key** - the secret access key for authenticating with the S3-compatible storage.
    - **Use Path Style** - toggle to enable or disable path-style access for S3-compatible storage.

Example:

Figure 58: Screenshot showing a toggle button labeled "Path Style" in an S3-compatible storage settings dialog.

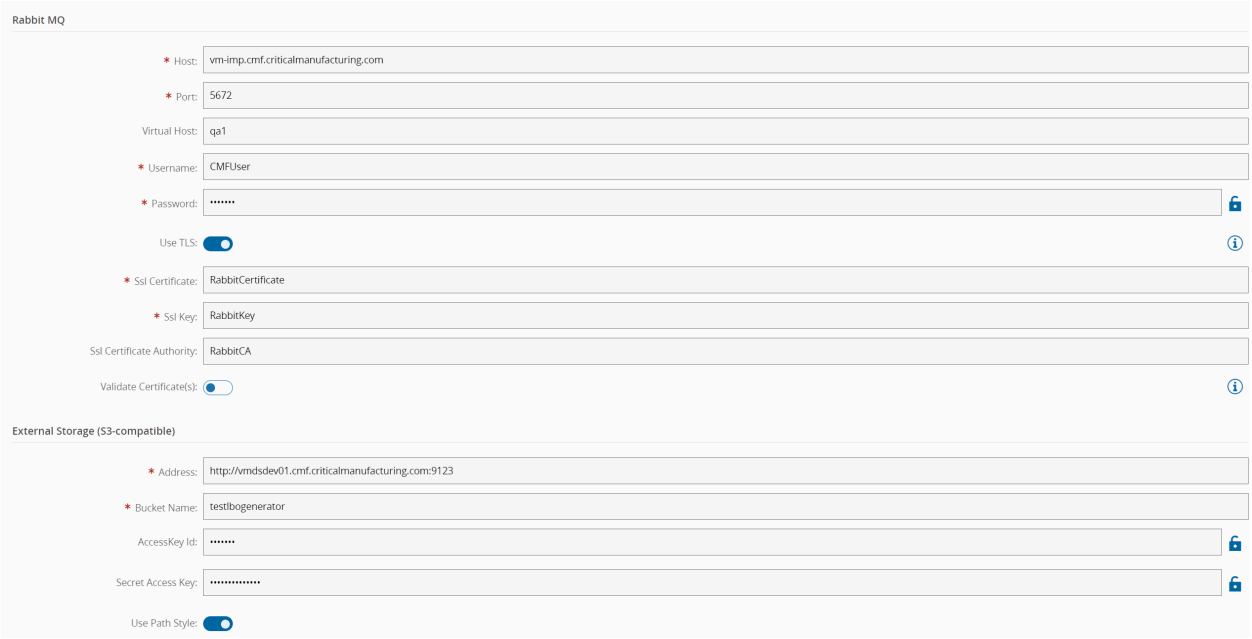


Figure 59: Screenshot showing a UI with options related to enabling or disabling path-style access for S3-compatible storage.

35.3.5 Security

Add the information regarding the Security Portal.

1. **Domain**

    - **Client Id** - System's Auth Client Id. Defaults to **MES** and cannot be changed.

2. **Active Directory**

    - **Enable** - whether to enable the Active Directory authentication strategy.
    - **Domain** - default domain where user information is stored. *Applies if Active Directory is enabled.*
    - **Address** - AD address to connect. *Applies if Active Directory is enabled.*
    - **Base DN Address** - base search query. *Applies if Active Directory is enabled.*
    - **Username** - user to use for searching. *Applies if Active Directory is enabled.*
    - **Password** - user password to use for searching. *Applies if Active Directory is enabled.*
    - **Use SSL** - whether to use SSL. *Applies if Active Directory is enabled.*
    - **Port** - AD port to connect. *Applies if Active Directory is enabled.*
    - **Validate Certificate** - whether to validate the SSL certificate when establishing a secure connection._Applies if Use SLL is enabled._

    Example:

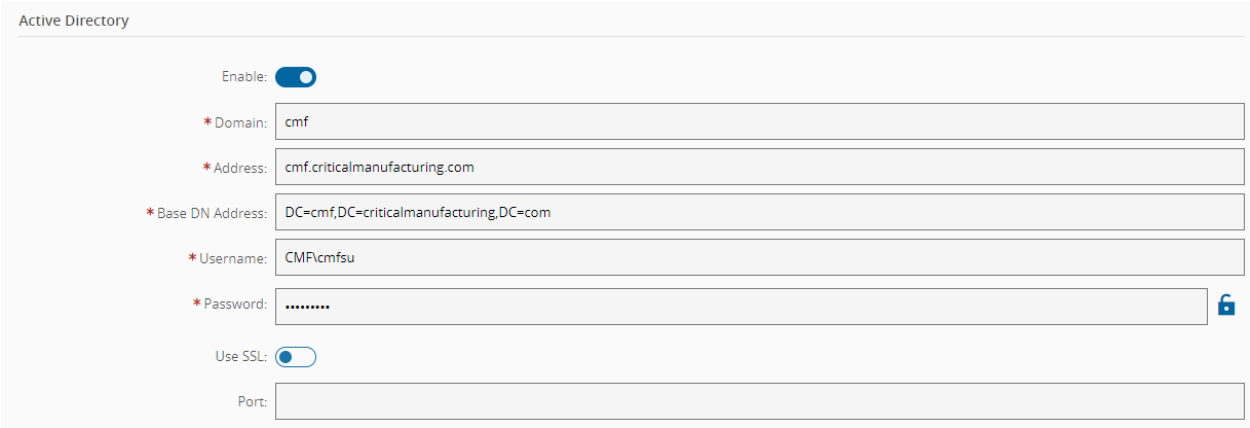


Figure 60: Screenshot showing an active directory with SSL validation settings.

3. **WebAuthn**
    - **Enable** - whether to enable the WebAuthn authentication strategy.
4. **Open ID Connect**
    - **Enable** - whether to enable the OpenID Connect authentication strategy.
    - **Display Name** - the display name of the strategy in the Security Portal. Defaults to **OpenID**. *Applies if Open ID Connect is enabled.*
    - **Client ID** - ID of an existing OpenID provider's auth client. *Applies if Open ID Connect is enabled.*
    - **Metadata URL** - URL of the OpenID provider metadata. *Applies if Open ID Connect is enabled.*
    - **Extra Scope** - add extra OpenID Connect scope if needed. If empty, the system will use the default scopes.
    - **Enable Enrollment** - enable or disable user self-enrollment.
5. **Session Options**
    - **Session Duration** - the duration while a session is still valid for authentication.
    - **Show Remain Signed In** - whether the option to remain signed in via a session strategy is shown to the user after a login.
6. **CORS (Cross-Origin Resources Sharing)**
    - **Allowed Origins** - when set, will configure some client containers, such as the UI, Help and Security Portal, with the domains specified here, effectively blocking cross-domain requests by the browser.

35.3.6 Data Platform

Configure the options for the Data Platform.


This option is only available if your license includes the Data Platform Core module.

1. **Light CDM Events**
    - **Enabled** - toggle to activate or deactivate Light CDM Events.
2. **UNS**
    - **Enabled** - toggle to enable or disable UNS integration.

- **MQTT Broker Address** - the hostname or IP address of the MQTT broker. *Applies if UNS is enabled.*
- **MQTT Broker Port** - the port number used to connect to the MQTT broker. *Applies if UNS is enabled.*
- **MQTT Broker Username** - the username used for MQTT broker authentication. *Applies if UNS is enabled.*
- **MQTT Broker Password** - the password used for MQTT broker authentication. *Applies if UNS is enabled.*

Figure 61: step configuration data platform

Enabling the Light CDM Events and the UNS options will trigger the deployment of the HouseKeeper CDM Builder Light and the Data Platform UNS Connector containers, respectively. If these containers are not visible in the Service Resources step, try refreshing your browser to update the list.

35.3.7 Reporting Services

Reporting Services access information. *Applies to Database Modes: None and MES Analytics*.

1. **Reporting Services**
    - **Web Portal URL** - URL of the MSSQL Reporting Services Web Portal.
    - **Web Service URL** - URL of the MSSQL Reporting Services Web Service.
    - **Username** - user with read and write access for the MSSQL Reporting Services.
    - **Password** - user password.

Figure 62: Screenshot showing a Reporting Services interface with a focus on password entry for user authentication.

35.3.8 Cloudflare Configs

Add the Cloudflare configuration to be used to create a subdomain for the current Customer Environment. Since we are not using Cloudflare to configure DNS, skip this step.

35.3.9 Printing

Access information of the printing component service or to use a CUPS server. Currently, the service only works in Windows and it is not deployed in a containerized stack.

 It must be installed using the Deployment Framework in a Windows machine.

- **Access Information**
  - **Use CUPS** - Set to true if using a CUPS server.
  - **Printing Service URL** - URL to a printing service running in a Windows server. *Available if Use CUPS is set to false*.
  - **CUPS URL** - URL of a CUPS server. *Available if Use CUPS is set to true*.

Figure 63: Screenshot showing the CUPS URL field, available when "Use CUPS" is enabled.

35.3.10 ECAD

Access information of the ECAD component service. Currently, this service only works in Windows and it is not deployed in a containerized stack.

 It must be installed using the Deployment Framework in a Windows machine.

- **Access Information**
  - **HTTP Address** - HTTP address to connect to the ECAD service (deprecated).
  - **HTTP Port** - HTTP port to connect to the ECAD service (deprecated).
  - **ECAD Service Endpoints** - Comma-separated list of ECAD service endpoints, example: `http://ecad-server1:5000,http://e`

 ECAD Service Endpoints are only available from v11.2.2 and above.

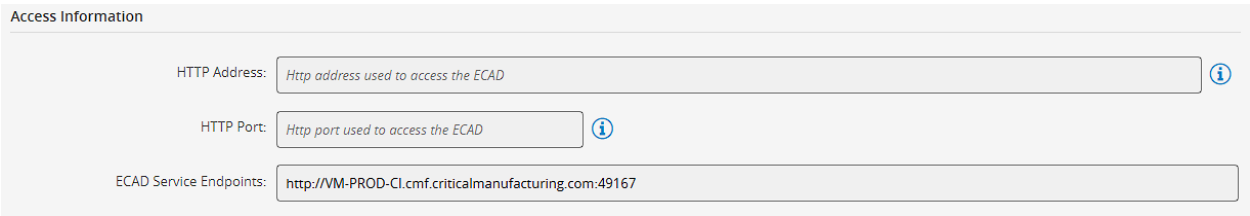


Figure 64: Screenshot showing a list of ECAD service endpoints.

35.3.11 Connect IoT

Add the configurations for the Connect Iot module.

- **Automation Manager Controller**

- **Worker Pool** - defines the pool from which the Automation Manager Controller reads. Only Automation Managers of type `Automatic Deploy` and assigned to this pool will be deployed by the controller.

Figure 65: Connect IoT configuration step in MES 11.2.0 environment wizard

35.3.12 GenAI

Configure the settings required to enable the Generative AI feature.

1. **Validate Certificates**
    - **Validate Certificates** - if enabled, it validates SSL certificates when making API requests to the selected provider.
2. **Provider**
    - **Generative AI Provider** - choose the desired provider for the Generative AI. The supported options are: Anthropic, AWS Bedrock, Azure OpenAI, Google, and OpenAI.

Depending on the selected Generative AI provider, you must configure the required authentication fields and model options, as detailed below.

=== "Anthropic"

```
* **API Key** - the Anthropic API key for authentication.
* **Models** - the Anthropic model to use. For more information, see [Anthropic
    models](https://docs.anthropic.com/en/docs/about-claude/models/overview).
```

=== "AWS Bedrock"

```
* **Default Region** - The AWS region where the Bedrock service is hosted.
* **API Key** - the AWS API key for authentication.
* **Models** - the AWS Bedrock model to use. For more information, see [AWS Bedrock
    models](https://docs.aws.amazon.com/bedrock/latest/userguide/models-supported.html).

![note](images/note.png)
    Certain AWS Bedrock models are available in specific Regions only through cross-Region inference.
        For more information, see the [AWS Bedrock User
        Guide](https://docs.aws.amazon.com/bedrock/latest/userguide/inference-profiles-use.html).
```

=== "Azure OpenAI"

```
* **Instance Name** - the name of your Azure OpenAI resource (not the full URL), example:
    `my-company-openai`.
* **API Key** - the Azure OpenAI API key for authentication.
* **API Version** - the specific API version to use (example: `2024-02-15-preview`).
* **Model** - the Azure OpenAI model to use. For more information, see [Azure OpenAI
    models](https://learn.microsoft.com/en-us/azure/ai-foundry/foundry-models).
* **Deployment Name** - the name of the deployment of the Azure OpenAI model. To simplify the
    configuration, use the name of the model as the deployment name.

![info](images/information.png) "Azure OpenAI Configuration"
    For step-by-step instructions on how to create Azure OpenAI resources, deploy models, and identify
        the correct values for each field, see [[user-guide-azure-openai]].
```

=== "Google"

```
* **API Key** - the Google API key for authentication.
* **Models** - the Google model to use. For more information, see [Google
    models](https://ai.google.dev/gemini-api/docs/models).
```

=== "OpenAI"

```
* **API Key** - the OpenAI API key for authentication.
* **Models** - the OpenAI model to use. For more information, see [OpenAI
    models](https://openai.com/open-models/).
```

35.3.13 Email

Add the email server information for the system used by several features.

- **Email Server**
  - **From** - email address to be used to send emails.
  - **Address** - email server address.
  - **Port** - email server port.
  - **TLS Enabled** - whether the email server is configured with TLS or not.
  - **Username** - email server user.
  - **Password** - password of the email server user.
  - **Support Email Address** - email address of the local support team to send emails to.

Figure 66: Screenshot showing a configuration email with server details and a support email address.

35.3.14 SAP

Add the ERP SAP connection information:

- **Access Information**
  - **Enabled** - whether the connection to a SAP system is enabled.
  - **Address** - address of the SAP host. *Applies if SAP is enabled.*
  - **System Number** - SAP system number. *Applies if SAP is enabled.*
  - **Service Name** - name of the gateway in SAP. *Applies if SAP is enabled.*
  - **Program ID** - SAP Program ID. *Applies if SAP is enabled.*
  - **Username** - user to connect to the SAP system. *Applies if SAP is enabled.*

- **Password** - user password to connect to the SAP system. *Applies if SAP is enabled.*
- **Client Number** - SAP Client Number. *Applies if SAP is enabled.*
- **Connect License** - Theobald ERPConnect license. *Applies if SAP is enabled.*

Example:

Figure 67: "Screenshot showing access information for SAP configuration."

35.3.15 Service Resources

Definition of resources used by stack. You can define the **memory** (GB/GBi) and **CPU** (number of virtual cores) needed to deploy the specific container and maximum available to it. Also, you can specify the number of **replicas** to be deployed. Note that, in the upper right corner, there is a button to restore these configurations to their default values, as defined in the deployment package manifest, depicted in the image below.

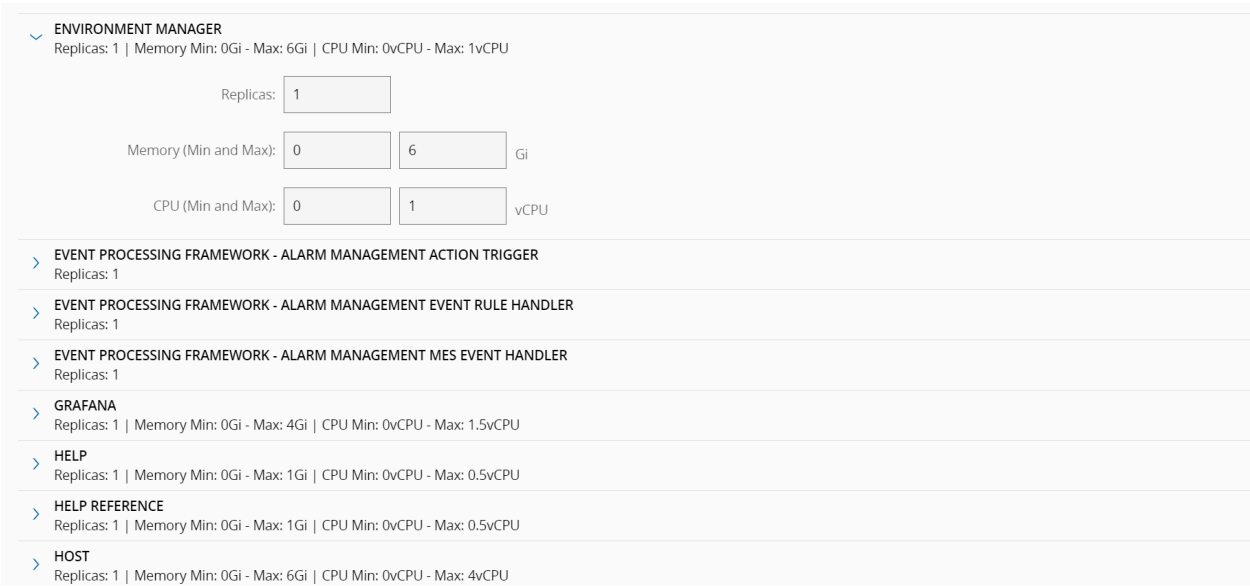


Figure 68: Screenshot showing a service resource configuration with details about replicas, memory, and CPU settings.

If you enabled the Light CDM Events and the UNS options in the Data Platform step, the HouseKeeper CDM Builder Light and Data Platform UNS Connector containers should be available in this step. If these containers are not visible, try refreshing your browser to update the list.

35.3.16 Services

Add the generic stack-wide configurations that vary depending on the base deployment package and deployment target.

1. **Environment Manager**
    - **Stop Installation on External Components Validation Failure** - stops installation if validation against external components fails.
2. **DNS** - allows to set custom DNS domains to use for resolving host names. **It's recommended to use Fully Qualified Domain Names (FQDN) everywhere** instead of short names and configuring this setting since it will impact the performance of hostname resolving and may even lead to unexpected issues.
3. **Container Image Registry Override** - this setting can be used to override the image registry used to pull container images from. Useful in the case that a private registry is preferred.
4. **Custom Certificates** - allows adding new certificates to the running containers. It is possible to add more than one certificate, and all of them will be injected into the containers that accept this feature. Before starting the deployment, a secret for each certificate must be created with the content of the certificate (same logic as external secrets). It is necessary to insert the name of the created secrets in this field. **If there are proxies performing SSL Inspection on the network traffic, the respective certificate should also be added through this feature.**

Figure 69: Screenshot showing a step configuration for services CACERTS.

35.3.17 Volumes

Add the configuration for each required volumes. The entries here depend on the deployment package, database mode and opt-in features.

1. **Cube** - repository for cube models. *Applies to Database Modes: MES Analytics.*
2. **Dagster** - repository for Dagster Data files. *Applies to Database Modes: MES Analytics.*
3. **ML Platform Agent** - repository to store the ML models binaries that are deployed and in use.
4. **ML Platform Training** - repository to store the ML models' configurations and other associated data such as CSV datasets, transformed data and binaries.
5. **Redis Data Folder** - repository for the Redis Data files. Recommended to be a local high-performance disk.
6. **MSSQL Server Data** - volume to persist the database files to. Currently, MSSQL Server does not support restoring a database when persisting the data to a Windows directory. Ensure that the environment is running on Linux. *Applies to Database Modes: MSSQL Server.* Recommended to be a local high-performance disk.
7. **Grafana Folder** - repository to persist the Grafana's data.
8. **Installation Data** - shared location between the MSSQL Server and the Environment Manager. **When using an external database, the shared path must point to the same location as the Installation Data Path setting**.
9. **Connect IoT Repository Share** - repository for Connect IoT compressed files.
10. **Rabbit Data Folder** - repository for RabbitMQ Data files. *Applies to External dependencies mode: All/Broker and Storage.*
11. **Rabbit Log Folder** - repository for RabbitMQ Log files. *Applies to External dependencies mode: All/Broker and Storage.*
12. **Storage Data Folder** - repository for Storage Data files. *Applies to External dependencies mode: All/Broker and Storage.*
13. **Kafka Data Folder** - repository for Kafka Data files. *Applies to External dependencies mode: All.* Recommended to be a local high-performance disk.
14. **ClickHouse Data Folder** - repository for ClickHouse Data files. *Applies to External dependencies mode: All.*

15. **ClickHouse Log Folder** - repository for ClickHouse Data files. *Applies to External dependencies mode: All.*
16. **Documents Folder** - location where the Critical Manufacturing MES documents and attachments are persisted to. Advised to be a shared location, so that when having more replicas of the Critical Manufacturing MES host, the containers maintain data consistency.
17. **Logs Folder** - location to persist logs as files. This is an optional volume, you can set this volume to the type *None* in order to not use it.

Each volume can be configured with a different volume type. These types are Deployment Package specific. For more information on each type and their configurations, see Kubernetes Volumes Configuration documentation. Also, check the requirements for each volume System Requirements.

For local volumes, it's recommended to use dynamic provisioning so that all local paths are handled by the cluster and not by you. For more information, see Local Volumes with dynamic provisioning.

35.4 Step 4: Deployment

Selecting **Next** will trigger the deployment process. It is automatic and you are provided with feedback to follow during the installation.

Figure 70: Screenshot showing a deployment process with steps 1, 2, and 3 connecting to an OpenShift cluster.

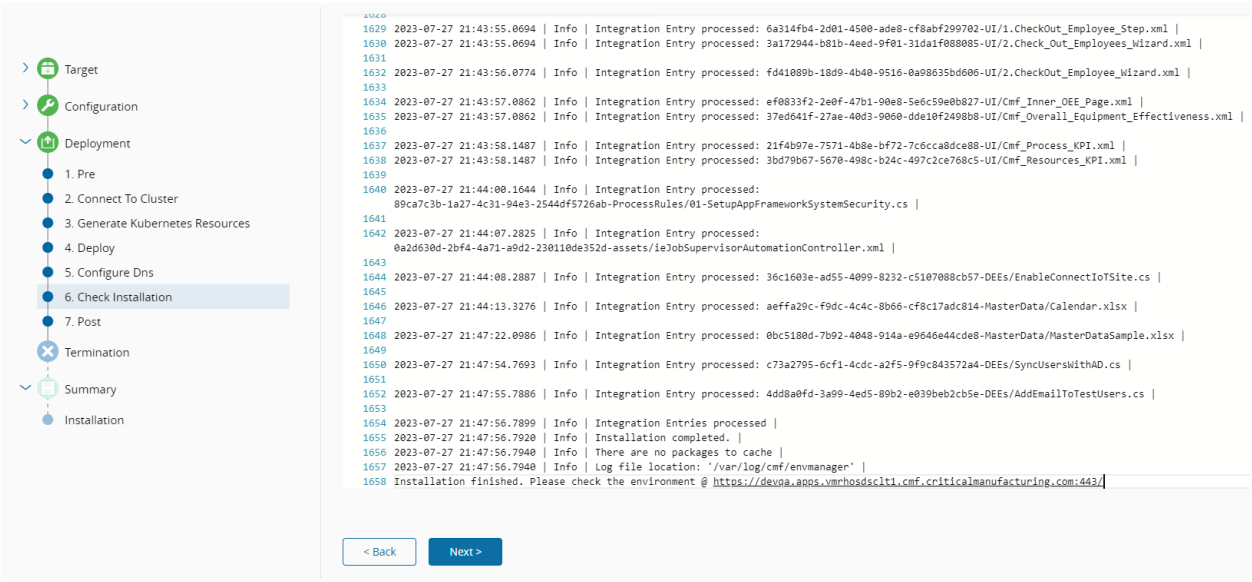


Figure 71: Screenshot showing deployment options.

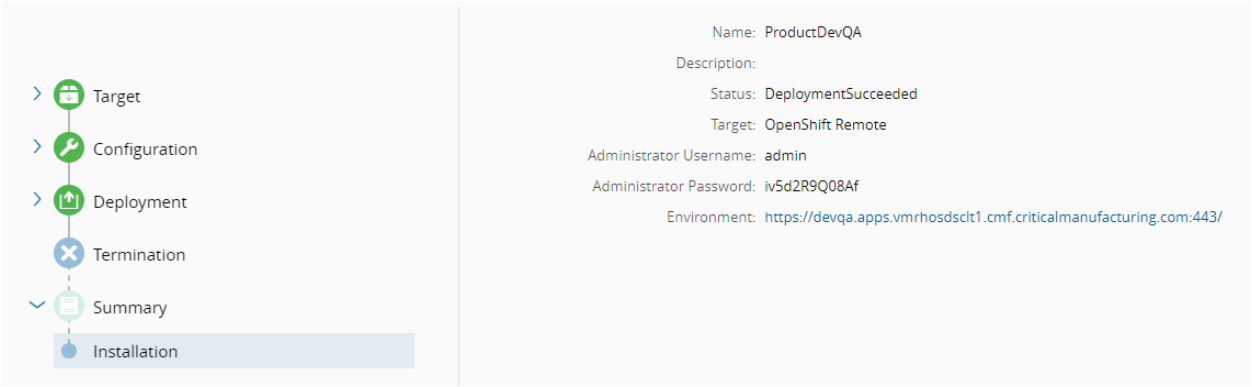


Figure 72: Screenshot showing the deployment settings.

35.5 Step 5: Termination

If, for some reason, you need to terminate the environment, you can do so in this step.

35.6 Step 6: Summary

If everything is correct, the last screen should present you with the deployment Summary, which includes information such as the outcome, admin credentials to use to access the environment, and the URL.

Accessing this URL should present the Critical Manufacturing MES to be used. In this case, you must log in and because this is the first login, the credentials in the Summary must be used to access the system and the password must be reset after logging in:

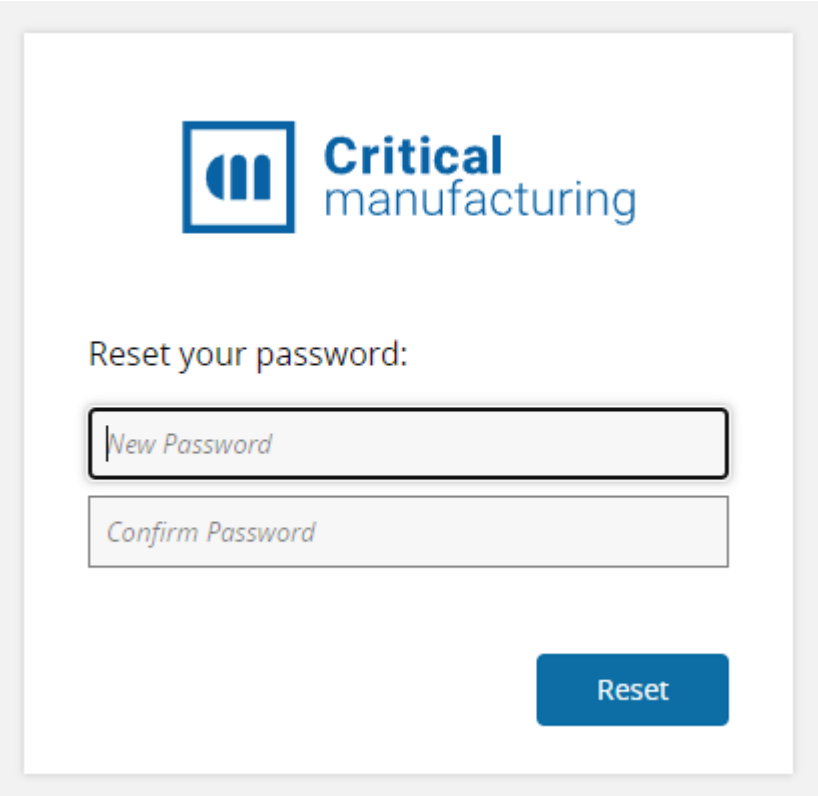


Figure 73: Screenshot showing a critical message.

After resetting the password, you'll be redirected to the Home Page which will show there are no Apps installed:

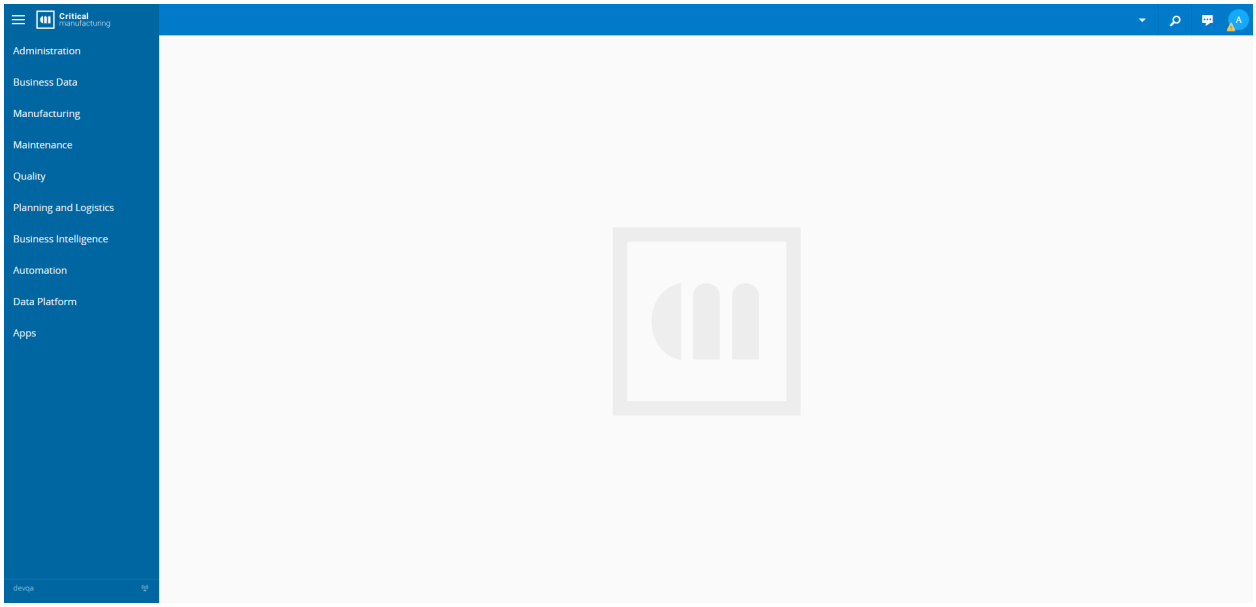


Figure 74: Screenshot showing a summary of key information on a home page.

At this stage, only Administrator users have access to the MES. To allow other users to access it, you need to assign them the MES **OAuth** Role in the security page:

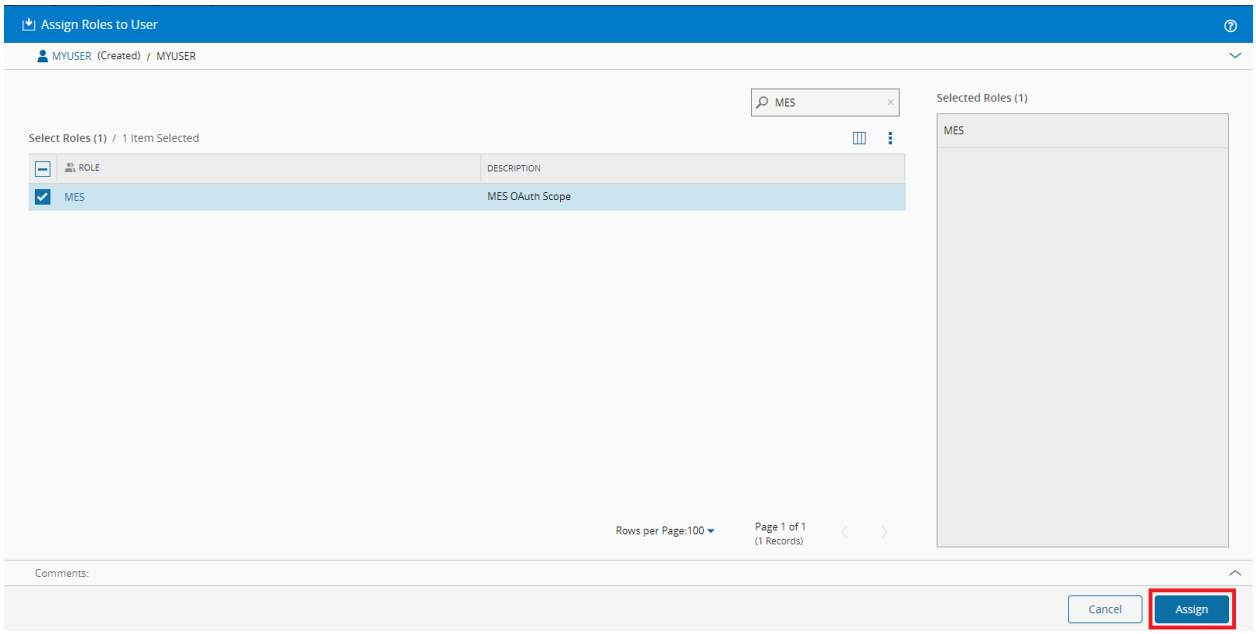


Figure 75: Screenshot showing a user's assigned OAuth roles.

35.7 Optional Component Installation

The Critical Manufacturing MES installation procedure is supported by an installation wizard that is described step-by-step in this section. Depending on whether the installation is performed with or without Internet access, and on the chosen installation package, the setup's interface may present changes. Therefore, you may notice slight differences between the screenshots included in this guide and the version being installed.

Random errors may occur during the Critical Manufacturing MES installation process if it is initialized using a blocked ISO file. This occurs when Windows Attachment Manager marks ISO files as blocked (more information here).

Before mounting and starting the installation, execute the following procedure to unblock your ISO file:

1. Open the folder containing the ISO file on Windows Explorer.
2. Right-click on the file and select the **Properties** option.
3. Select the **Unblock** option, if available.
4. Select the **Apply** button and then the **OK** button.

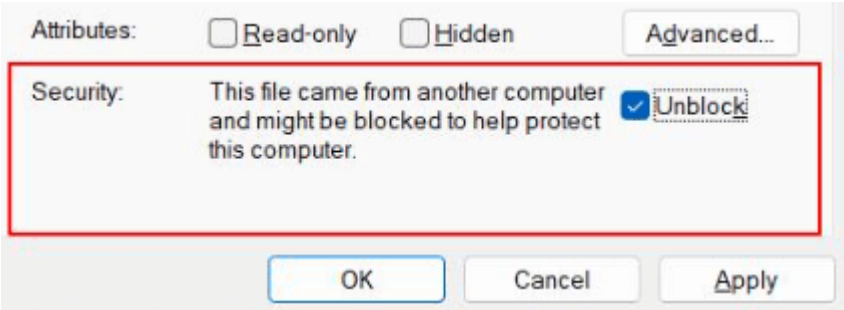


Figure 76: Screenshot showing a UI with read-only attributes, hidden advanced settings, and an "iso properties" filename hint.

The image below shows the first screen of the setup wizard:

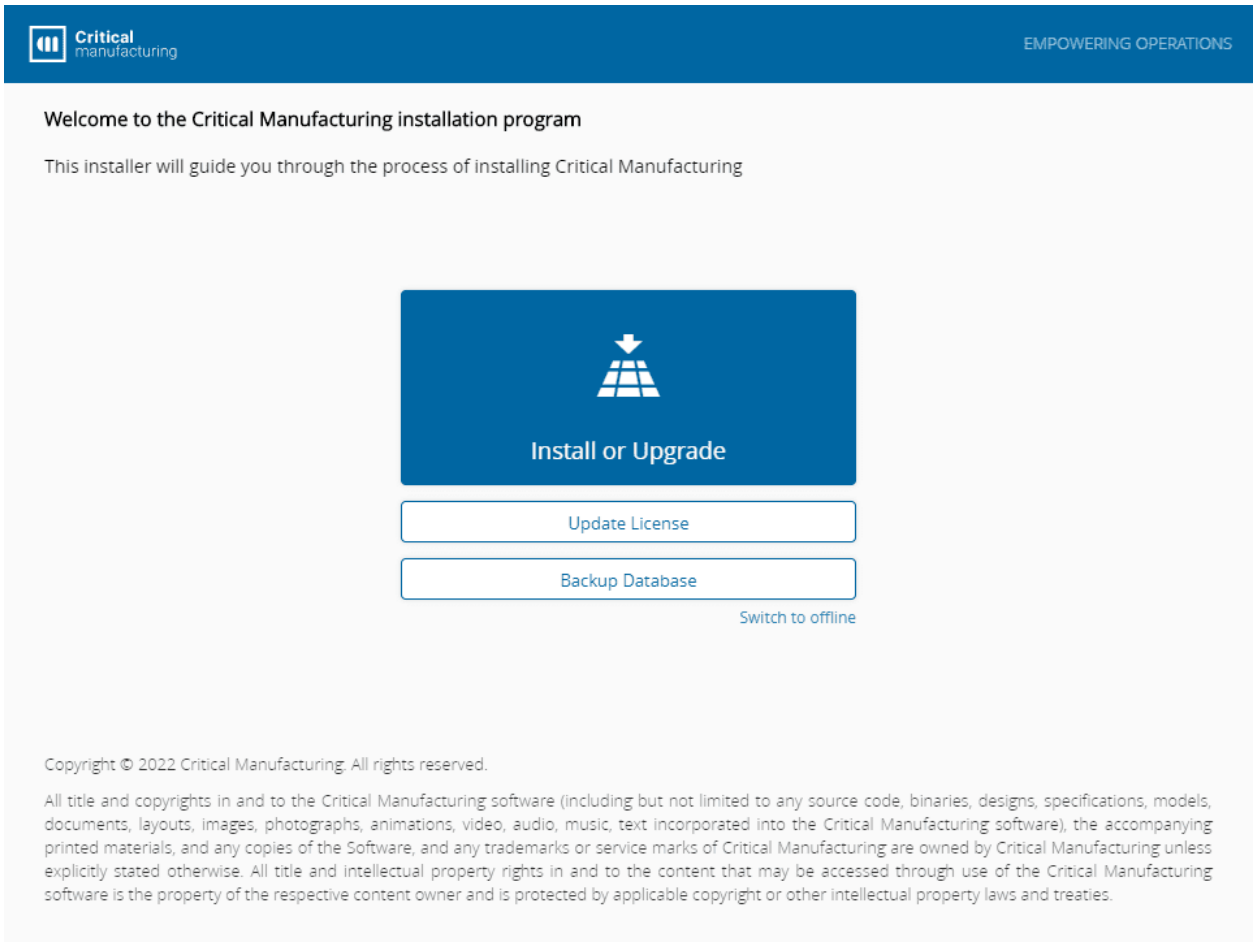


Figure 77: Installation - Welcome screen

All screens of the setup wizard are divided in three areas:

1. The top area displays all the steps of the installation, and the current step is highlighted. It also displays the name of the user who is logged in to the Customer Portal or **Offline**. If the setup process is launched in **Online** mode without previous valid user authentication for the current user in the Customer Portal, a separate browser tab window is automatically opened for proper user authentication.
2. The middle area shows the information setup step and the text boxes to be filled out with the required setup information.
3. The bottom area is the navigation area. In this navigation area, you can go to the next screen or return to the previous one. It is also possible to cancel the installation, thus aborting the setup. The **Install** button is only enabled when all the configurations are filled out, and the setup is then ready to start.

Completing the text boxes may be mandatory (flagged by { style="margin-top: 2px; color: #b83128;" }). Throughout the steps, the existing groups may have an associated **Validate** button which if selected, will check if the entered value is within the expected ranges.

See the example below:

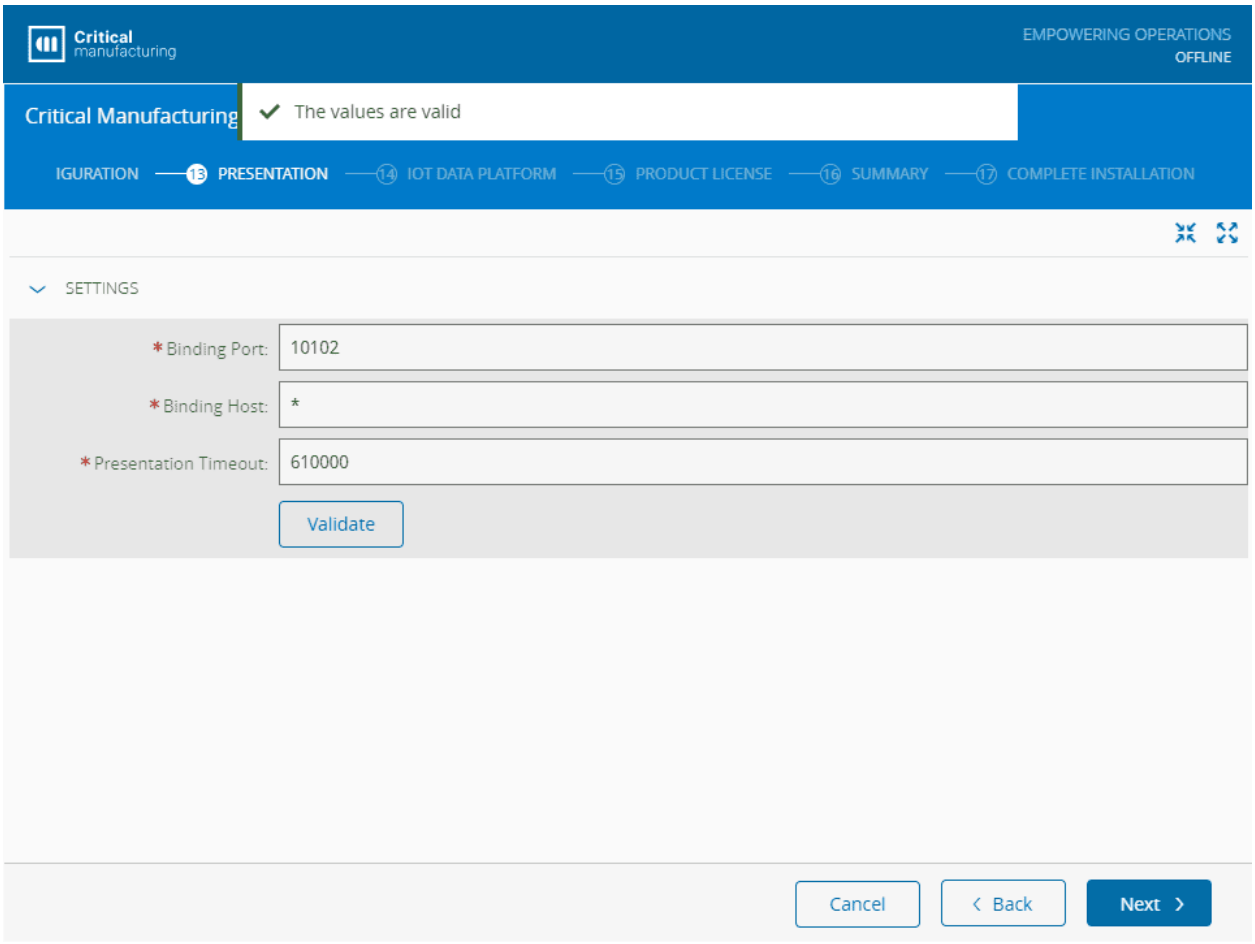


Figure 78: Installation - Field Validation

35.7.1 Main Installation Process

If you need to backup existing databases, visit Database Backup and Restore for a specific guide for this process.

The first step of the installation process is the **License Agreement**. Select **Install or Upgrade** to get started.

35.7.2 License Agreement

In this step, you need to read and agree to the Critical Manufacturing License Agreement.

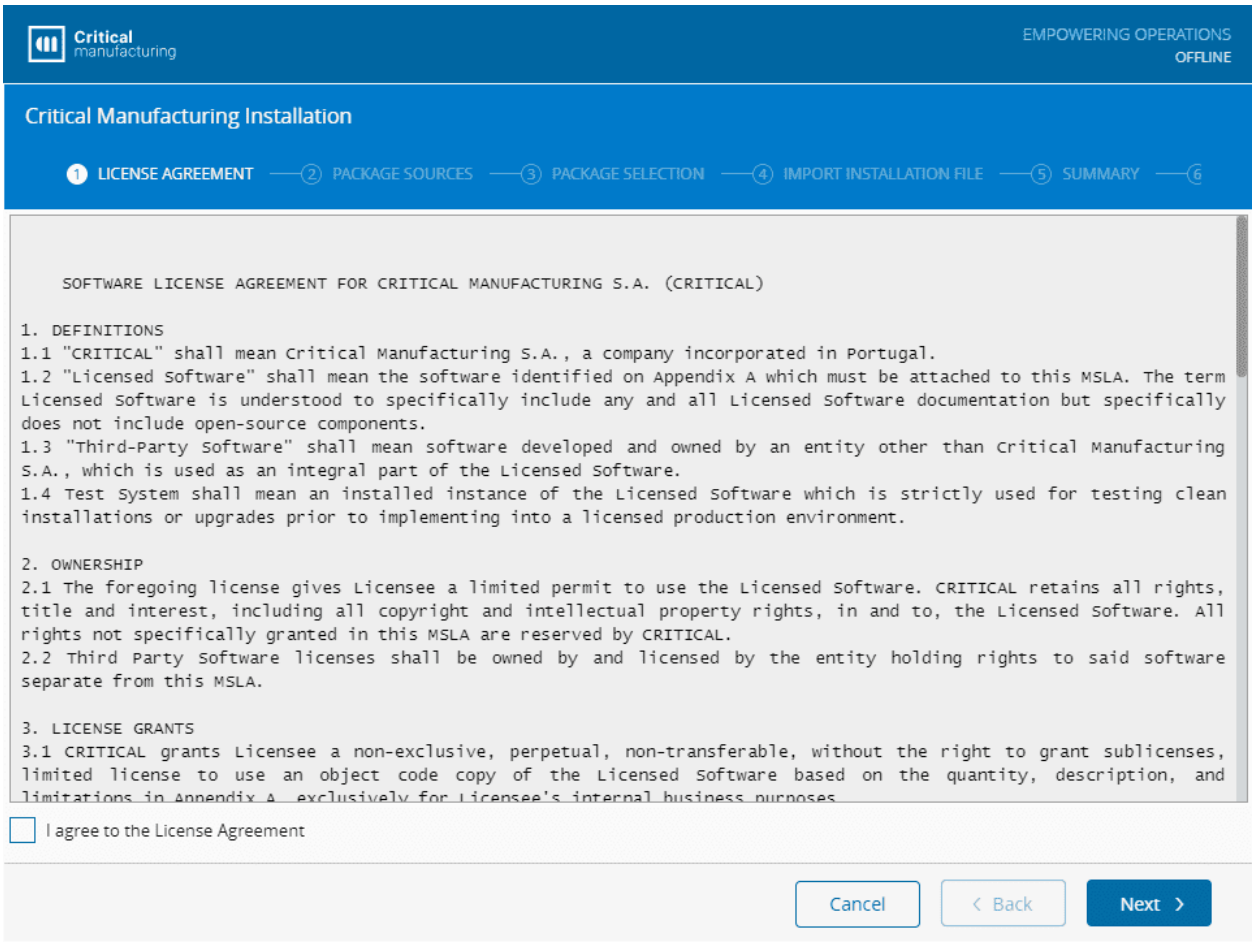


Figure 79: Installation - License Agreement review

It is necessary to accept the License Agreement to continue with the installation, otherwise the wizard will display an error message:

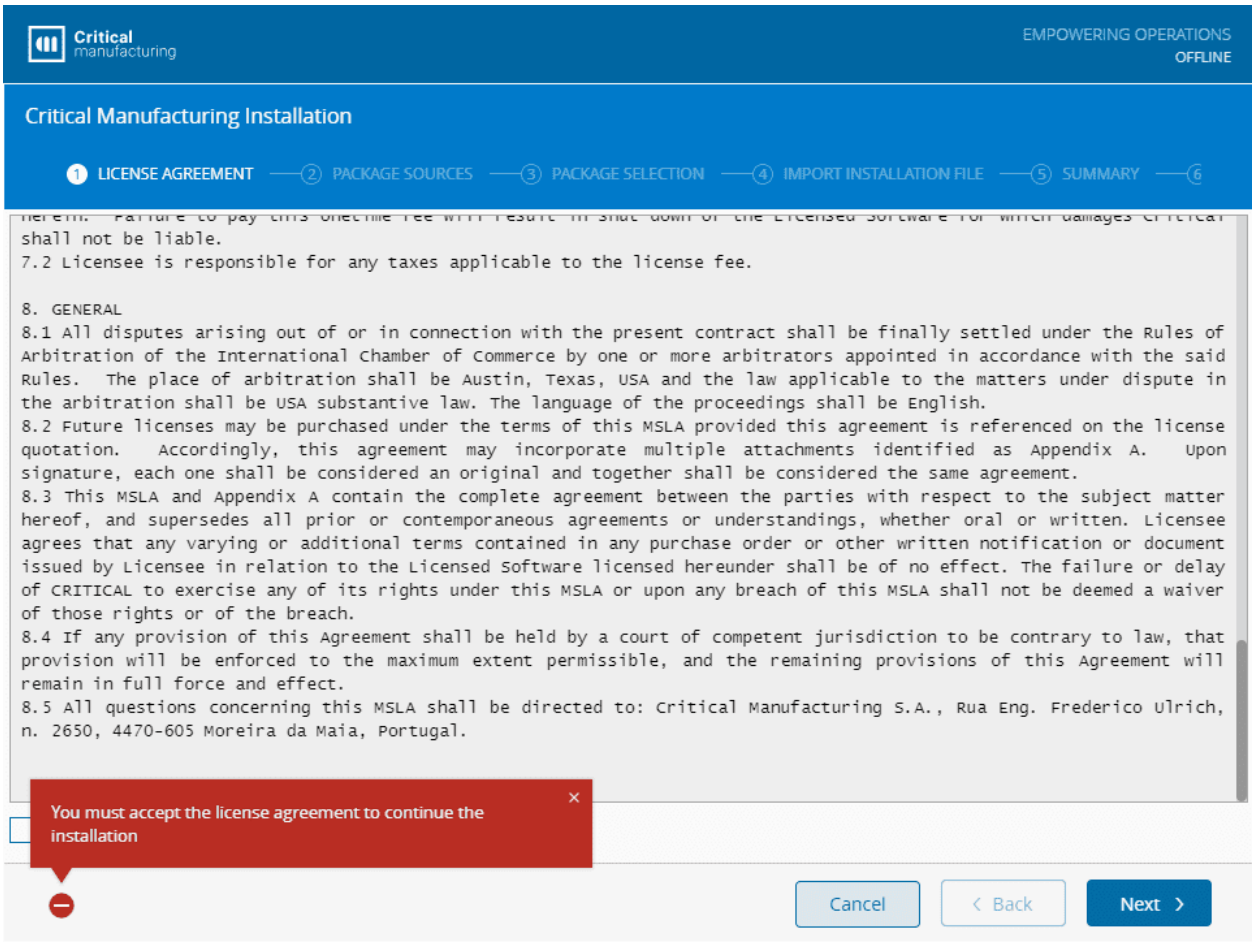


Figure 80: Installation - License Agreement acceptance

To accept the License Agreement select **I agree to the License Agreement**. Then, select **Next** to continue.

35.7.3 Package Sources

In the **Package Sources** step, you can add a location to search for installation packages. You can also add multiple package sources, and dependencies are resolved using the provided source order. If the setup is running in **Online** mode, the default process will add the local packages folder, and the server, to the list.

The package source can either be a `Server` or a `FileSystem`. The `Server` should be an NPM compatible endpoint. The `FileSystem` should be a folder accessible by the user running the setup, when the installation is started from the installation media, or the user running the master agent windows service is using a master only or master/slave configuration.

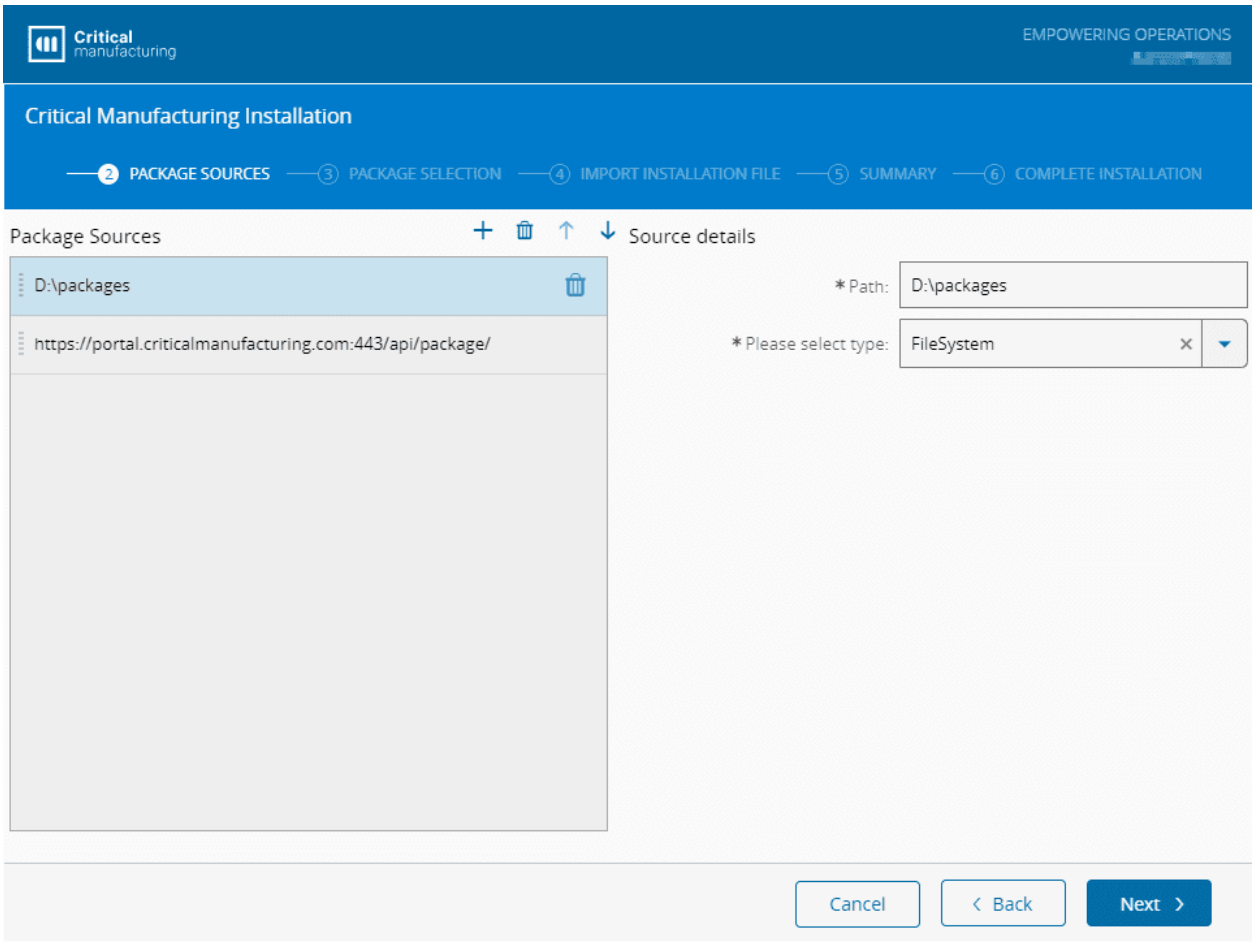


Figure 81: Installation - Package Sources

Select **Next** to continue.

35.7.4 Package Selection

In the **Package Selection** screen, you must select the product and the version to be installed. The available packages are:

- **Cmf.ConnectIoT.Packages**: Connect IoT packages to upload to a supported Package Repository.
- **Cmf.ECADService.Server**: Critical Manufacturing MES ECAD (Electronic Computer-Aided Design) server to run as a service.
- **Cmf.PrintingService.Server**: Critical Manufacturing MES Printing Service.

For Critical Manufacturing Connect IoT packages there is only one available option. The product names, versions, and installation options can vary according to the installation packages available on the installation media.

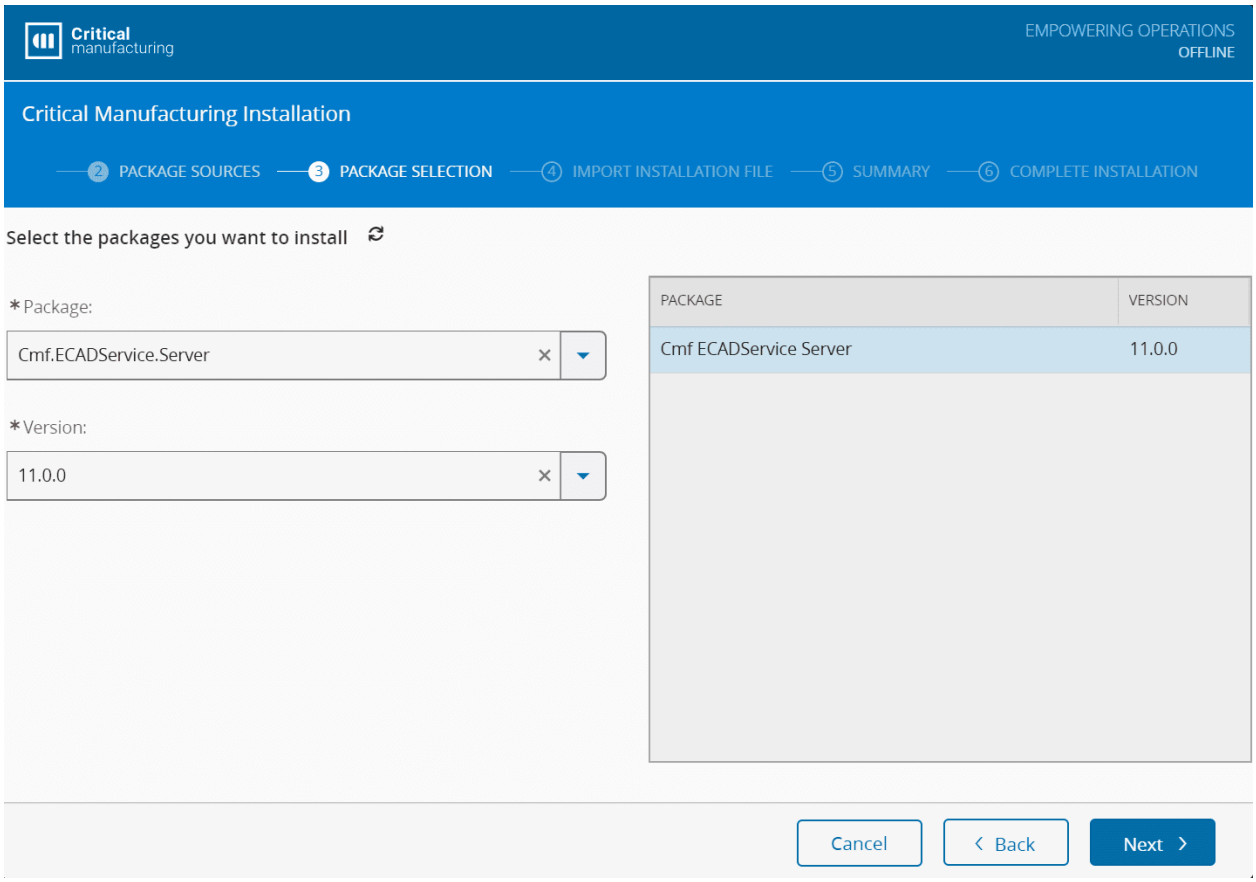


Figure 82: Installation - Package Selection

Choose the package you wish to install and select **Next** to continue.

ECAD Service

Before installing the **ECAD Service**, ensure that the Visual C++ Redistributable Packages for Visual Studio 2013 are installed. Afterwards, the **ECAD Service** can be installed using several different configurations, as shown in the image.

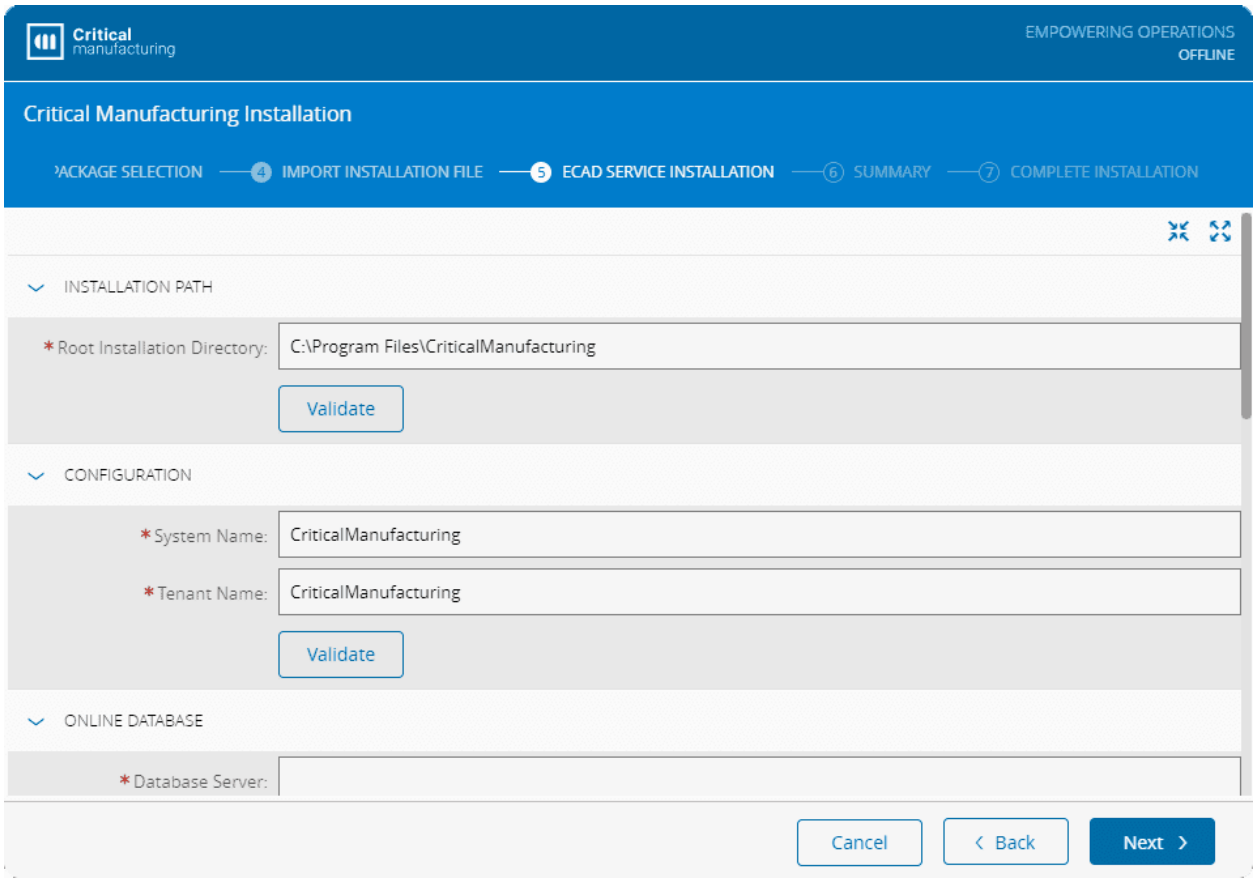


Figure 83: ECAD Configuration.1

The **Import Installation File** step allows you to load a file with the configuration of the installation. It will automatically fill out the information existing in the selected file.

Configure the **Online Database** and **Services User Account** settings:

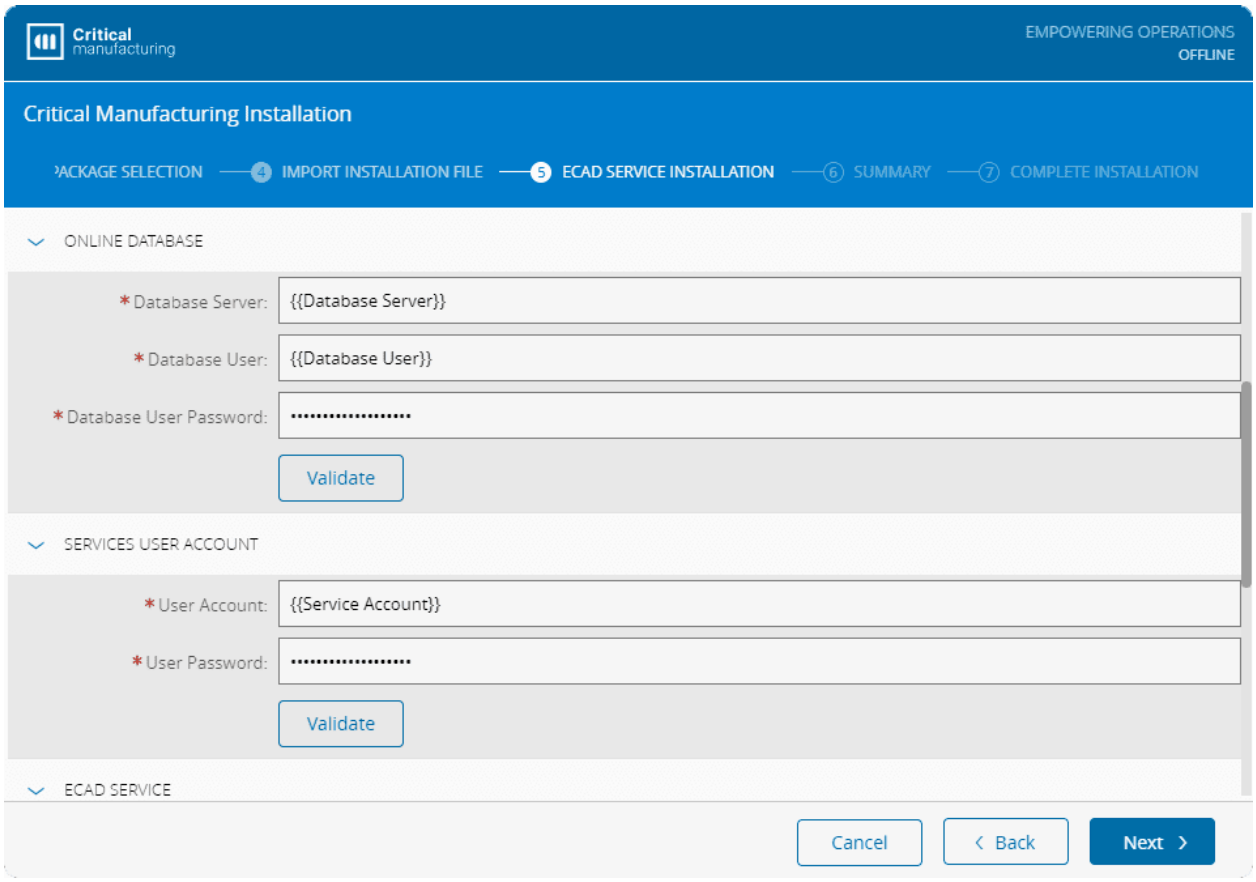


Figure 84: ECAD Configuration.2

Configure the settings for the **ECAD Service**. The **PCBI Floating Service Address** should use the default **IPv4** address and the **PCBI Floating Service Port** can use any available port.

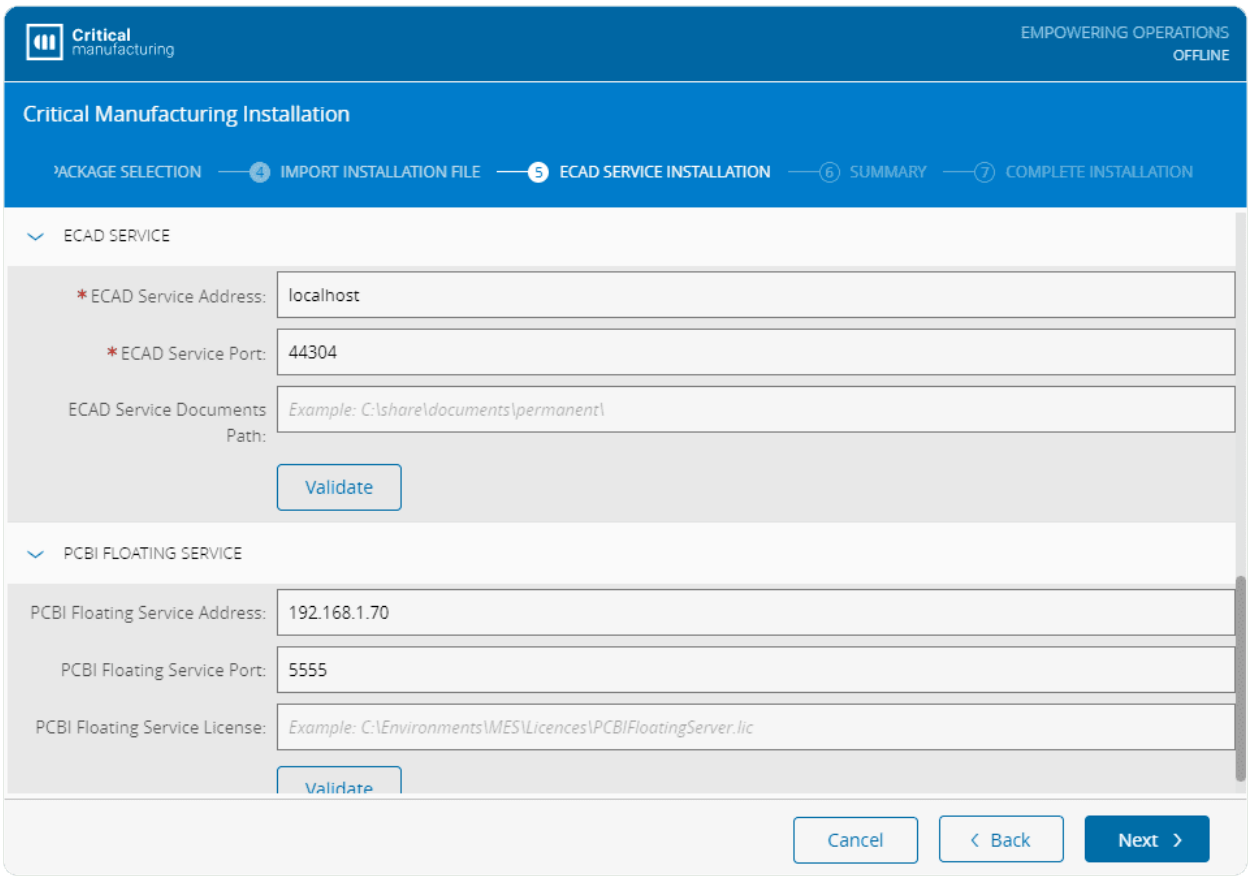


Figure 85: ECAD Configuration.3

The current way to get the **PCBI Floating Service License** is by requesting a license file using the **Server ID**.

If you do not have the **PCBI Floating Service License** you can keep this field empty and follow the manual steps below (after the setup finishes).

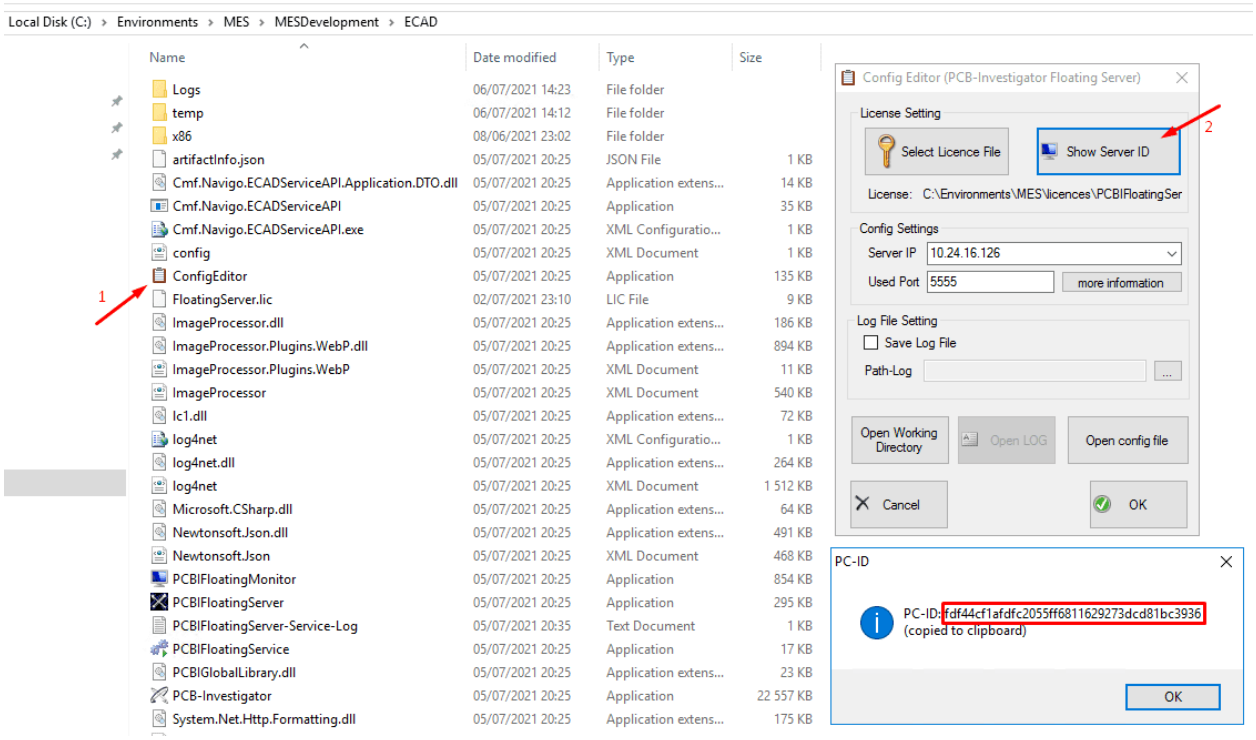
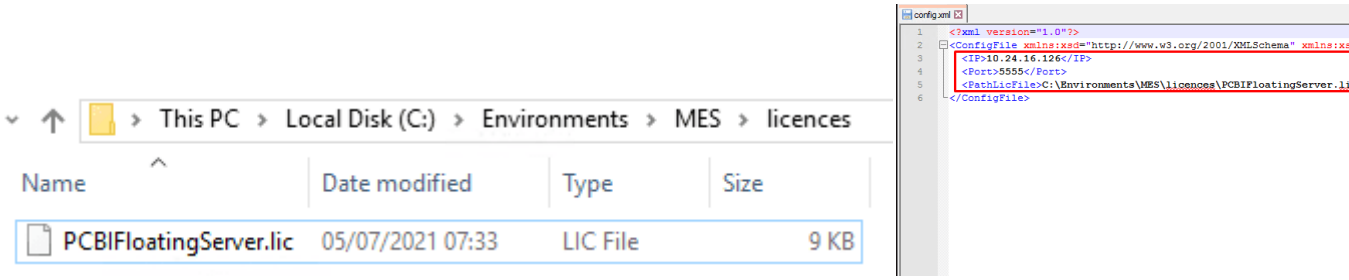


Figure 86: ECAD Configuration - PCBI Floating Service.2

Contact the System Administrator by sending the **Server ID** to generate the license.

When you get your license, place the file inside a folder and make sure that the configuration properties of **ECAD** are duly set. These configurations can be found inside the **ECAD** folder named `config.xml` and `Cmf.Navigo.ECADServiceAPI.exe.config`.



Restart the **PCBI Floating Server** and **Critical Manufacturing ECAD** services.

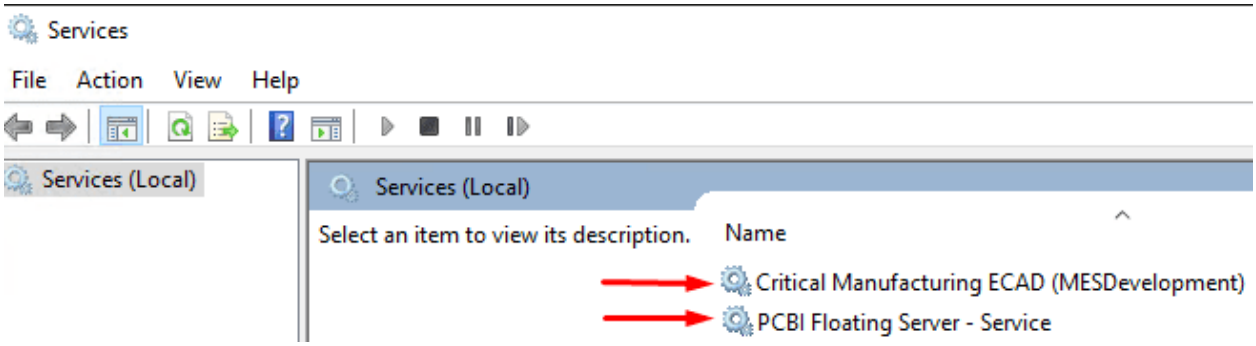


Figure 87: ECAD Configuration.6

If you have multiple environments in the same machine, all environments should point to the same **PCBI Floating Service**

and only one **PCBI Floating Service** can be started.

Confirm the settings and select **Next**, where you will be shown the summary of the component you are about ot install. You have the option to force a reinstallation if you have previously installed a version of this component in your system.

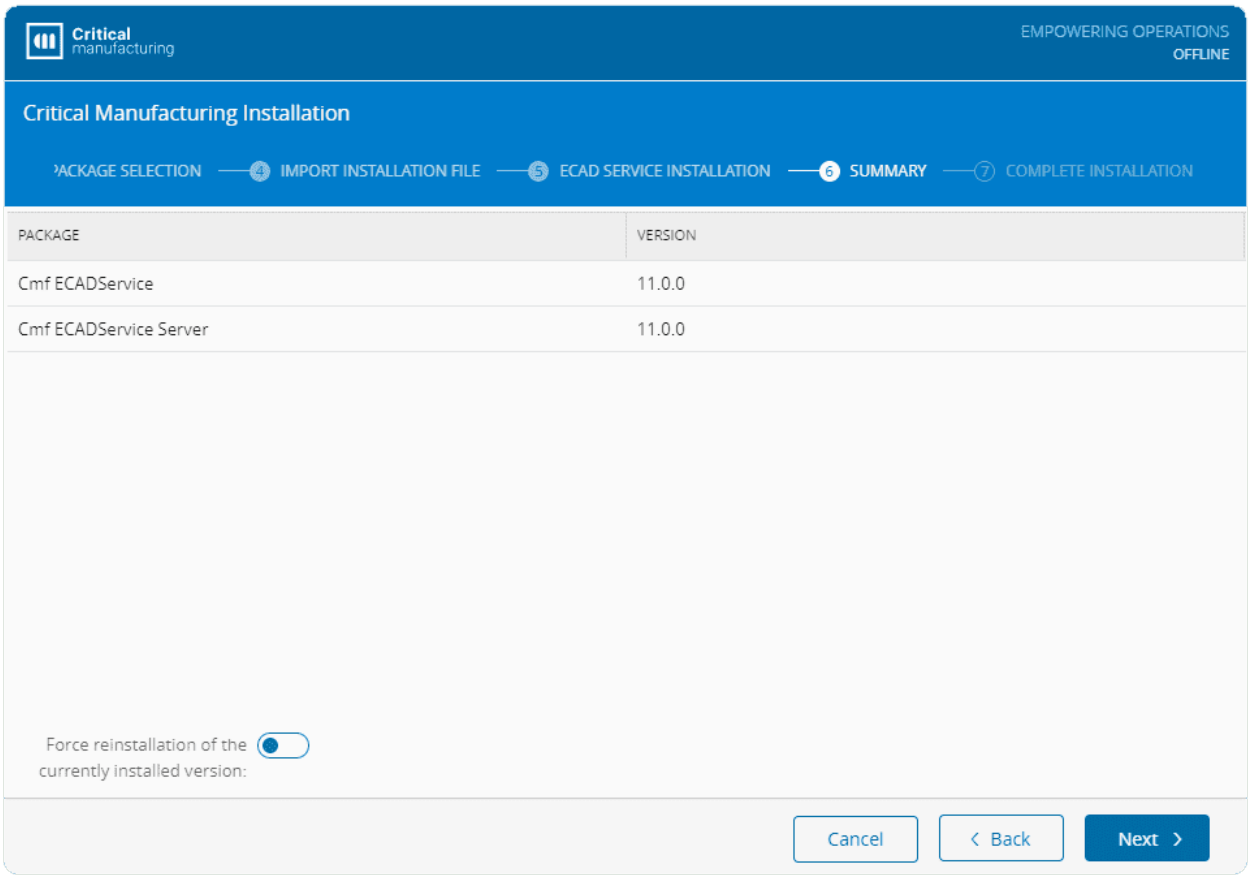


Figure 88: ECAD Configuration Summary

Select **Next** to complete the installation process configuration.

In the **Complete Installation** screen, you can export all the current installation configuration data (including licenses) to a file. To export the current configuration data, select **Export** and then choose a location and a file name.

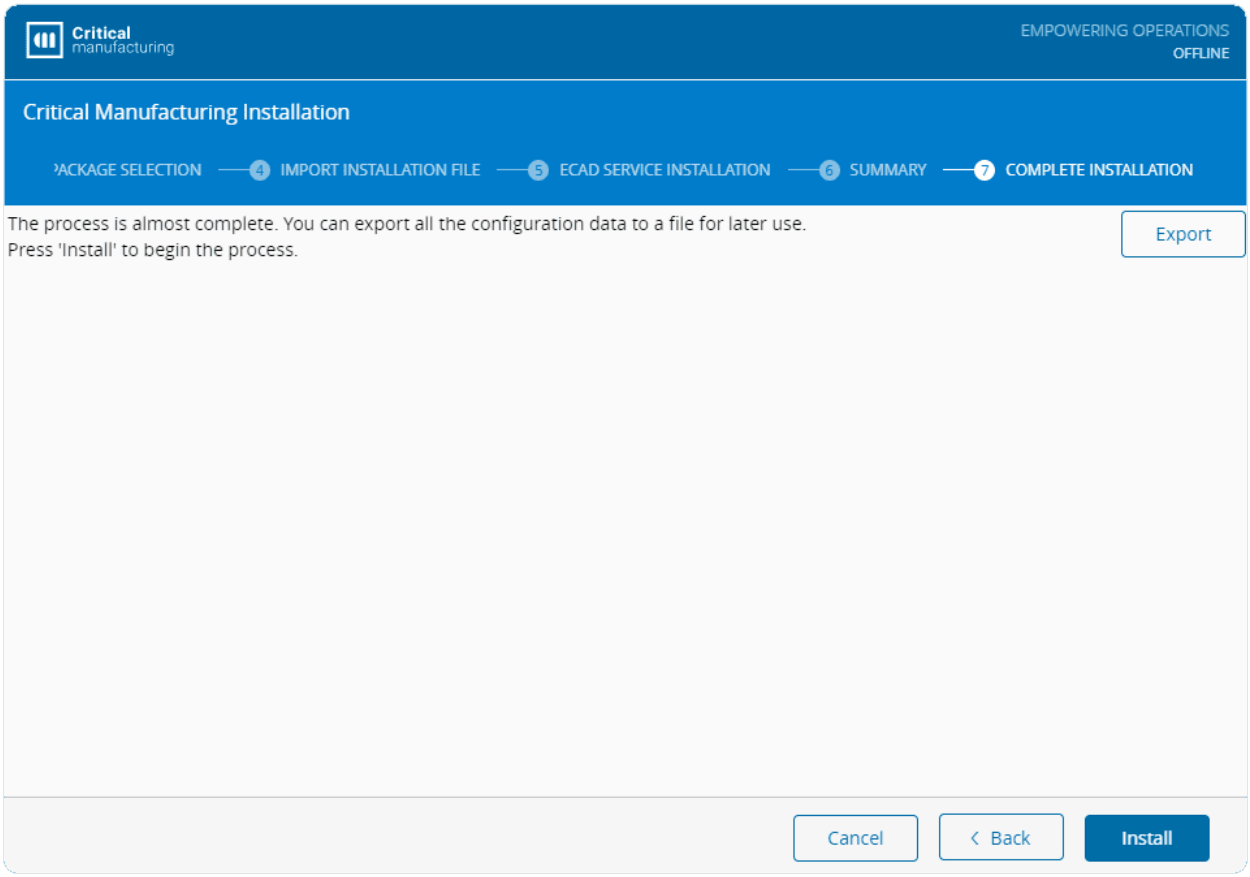


Figure 89: ECAD Installation Export

Select **Install** to start the installation process.

Printing Service

The Critical Manufacturing MES Printing Service is a standalone service that enables containerized environments to perform printing jobs using printers configured in a Windows machine.

To achieve this, the Printing Service must be installed in the Windows machine that has access to the printers (which may need permissions to be used by the user running the service). Additionally, when deploying the environment using DevOps Center, the user must select the option to use the external printing service and configure the URL to the Windows machine running the service.

This service is standalone and not coupled to a specific MES installation, which means that multiple MES installations can share the same Printing Service.

The Printing Service is installed using the same setup process as the traditional installation and selecting the **Cmf.PrintingService.Server** option in the Package Selection screen.

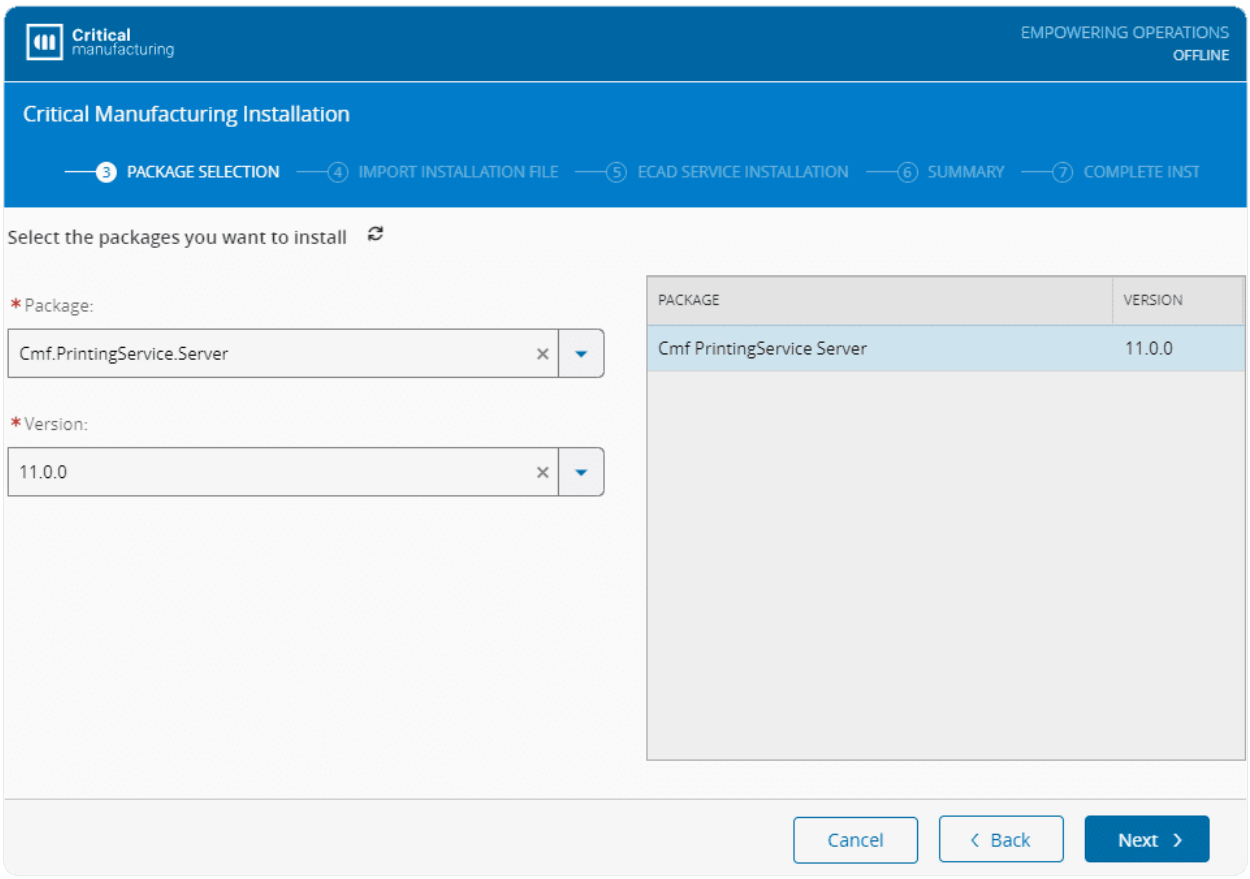


Figure 90: Printing Selection

The **Import Installation File** step allows you to load a file with the configuration of the installation. It will automatically fill out the information existing in the selected file.

After selecting the Printing Service package, the user must fill (or import from a parameters file) the following information:

- **Root Installation Directory** - The Directory where the Printing Service will be installed.
- **Services User Account** - The user account that will be used to run the service.
- **Port** - The port where the service will be exposed.

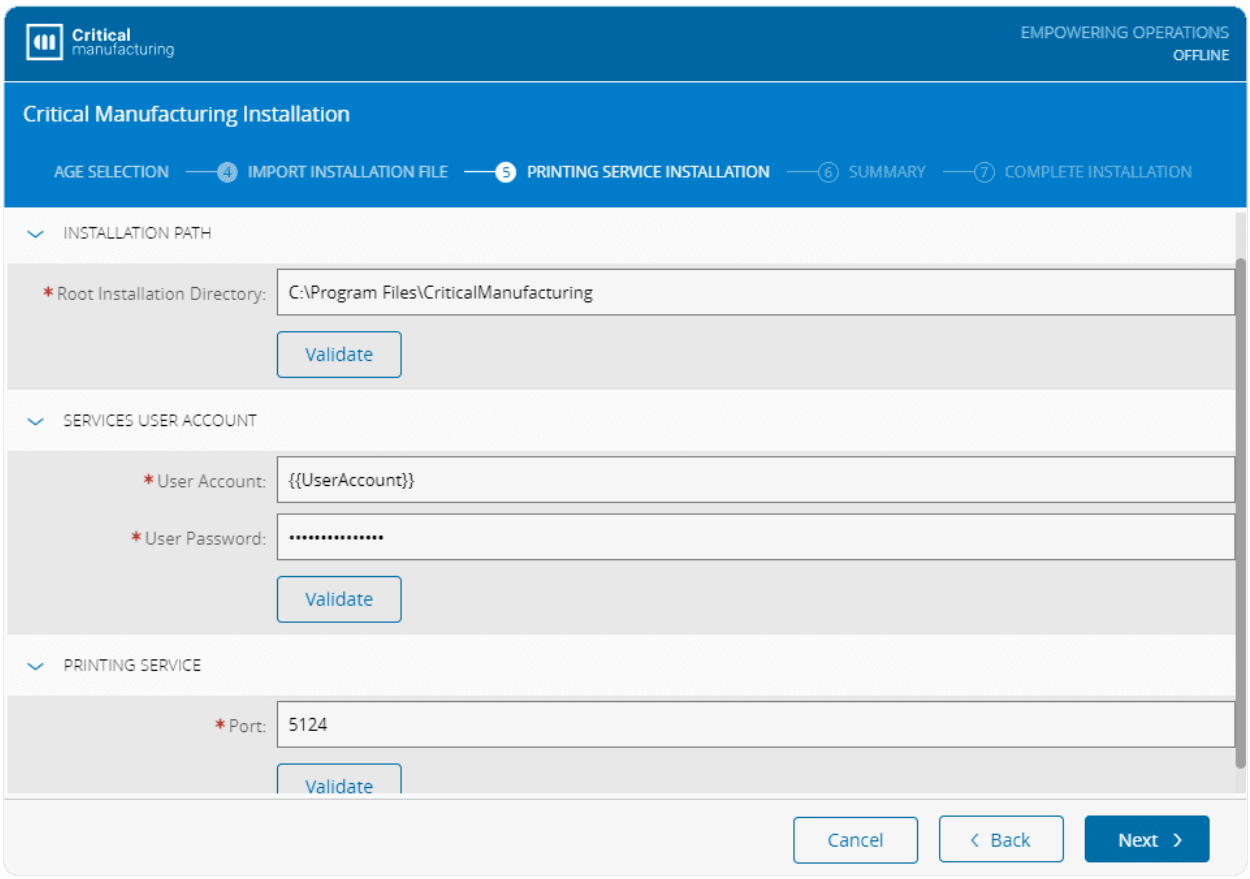


Figure 91: Printing Installation

Confirm the settings and select **Next**, where you will be shown the summary of the component you are about ot install. You have the option to force a reinstallation if you have previously installed a version of this component in your system.

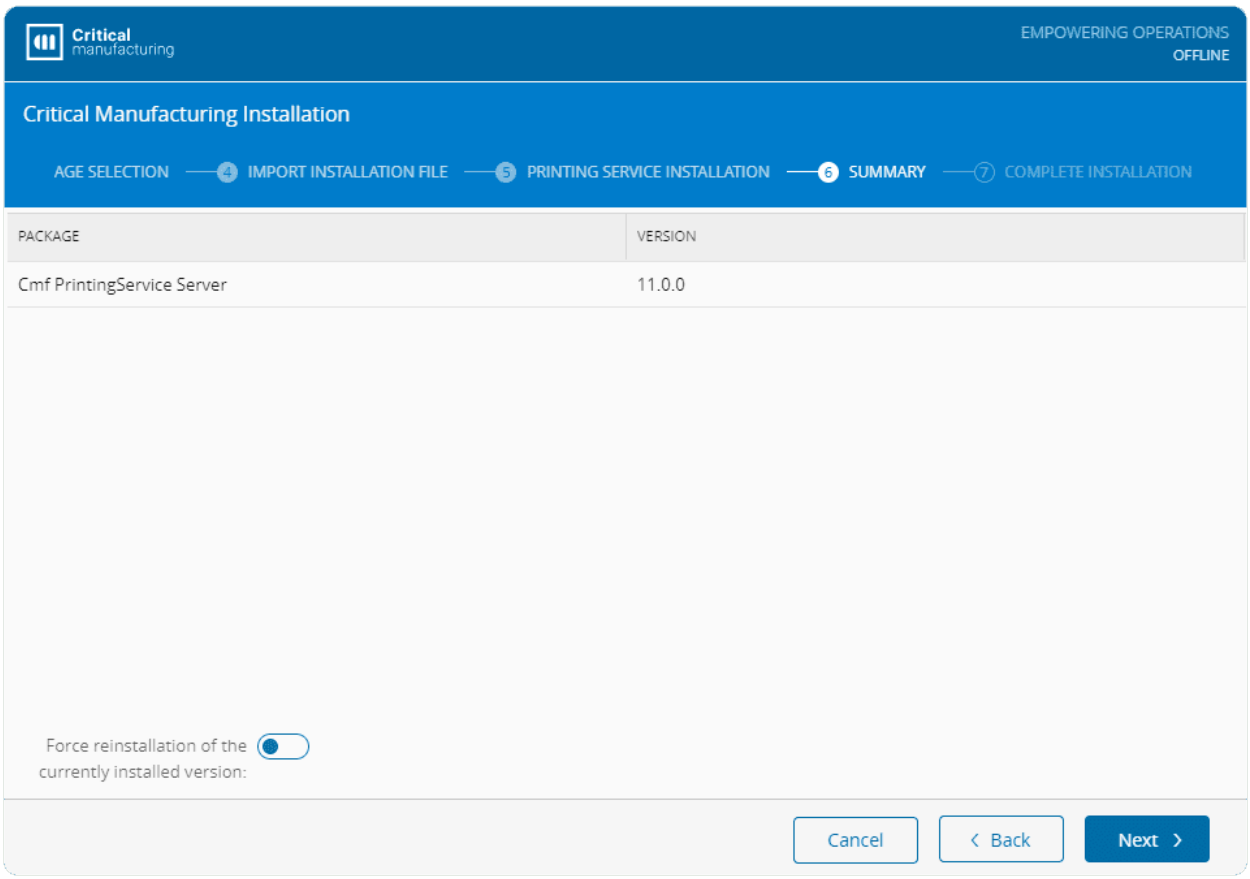


Figure 92: Printing Installation Summary

In the **Complete Installation** screen, you can export all the current installation configuration data (including licenses) to a file. To export the current configuration data, select **Export** and then choose a location and a file name.

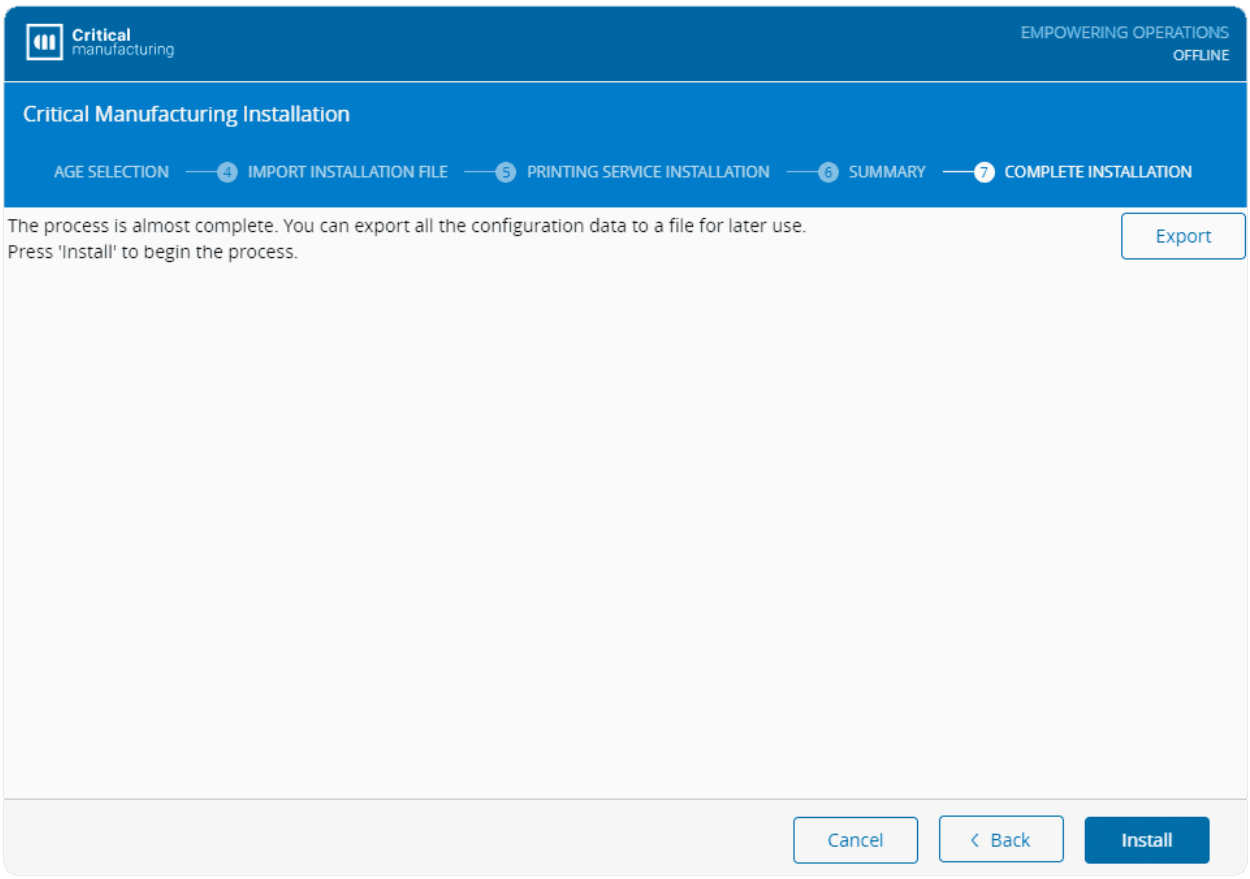


Figure 93: Printing Installation Export

Select **Install** to start the installation process.

35.7.5 Update Product License

The Product License can be updated using the Critical Manufacturing setup program in three ways:

- Setup - Online
- Setup - Offline
- Command Console

For the **Setup - Online**, follow the steps below:

1. Mount the Critical Manufacturing MES ISO.
2. Run the **Setup.exe**:

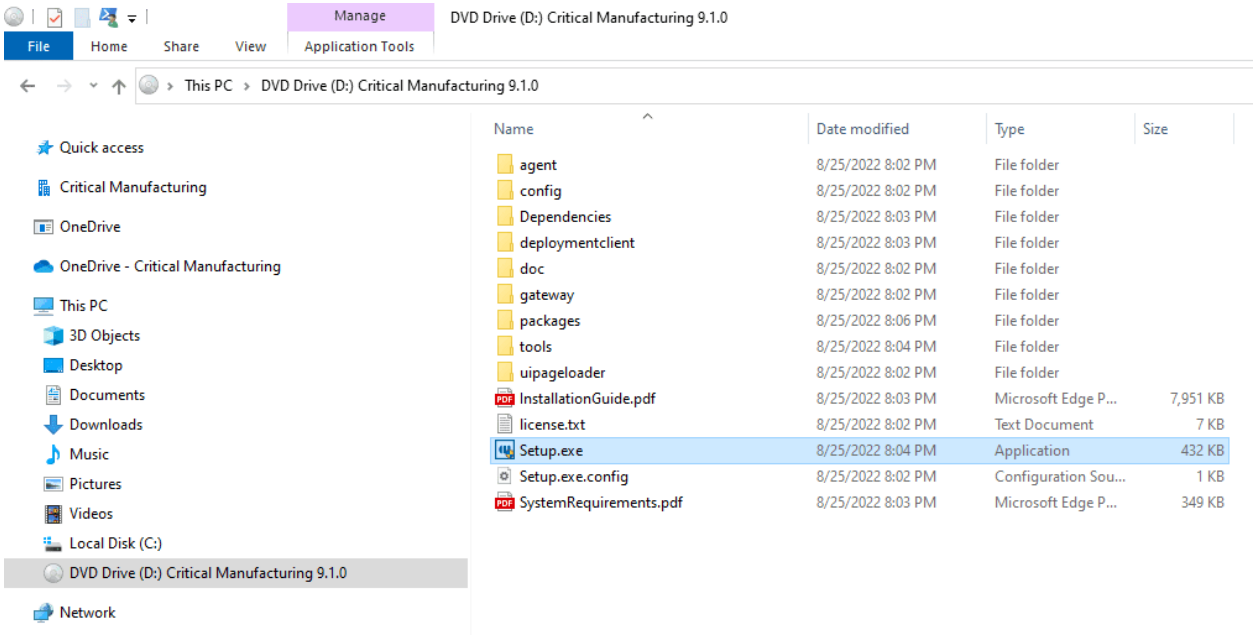


Figure 94: Screenshot showing the Setup.exe installation process for a product license update, with details on file size and date modified.

3. Select **Update License**:

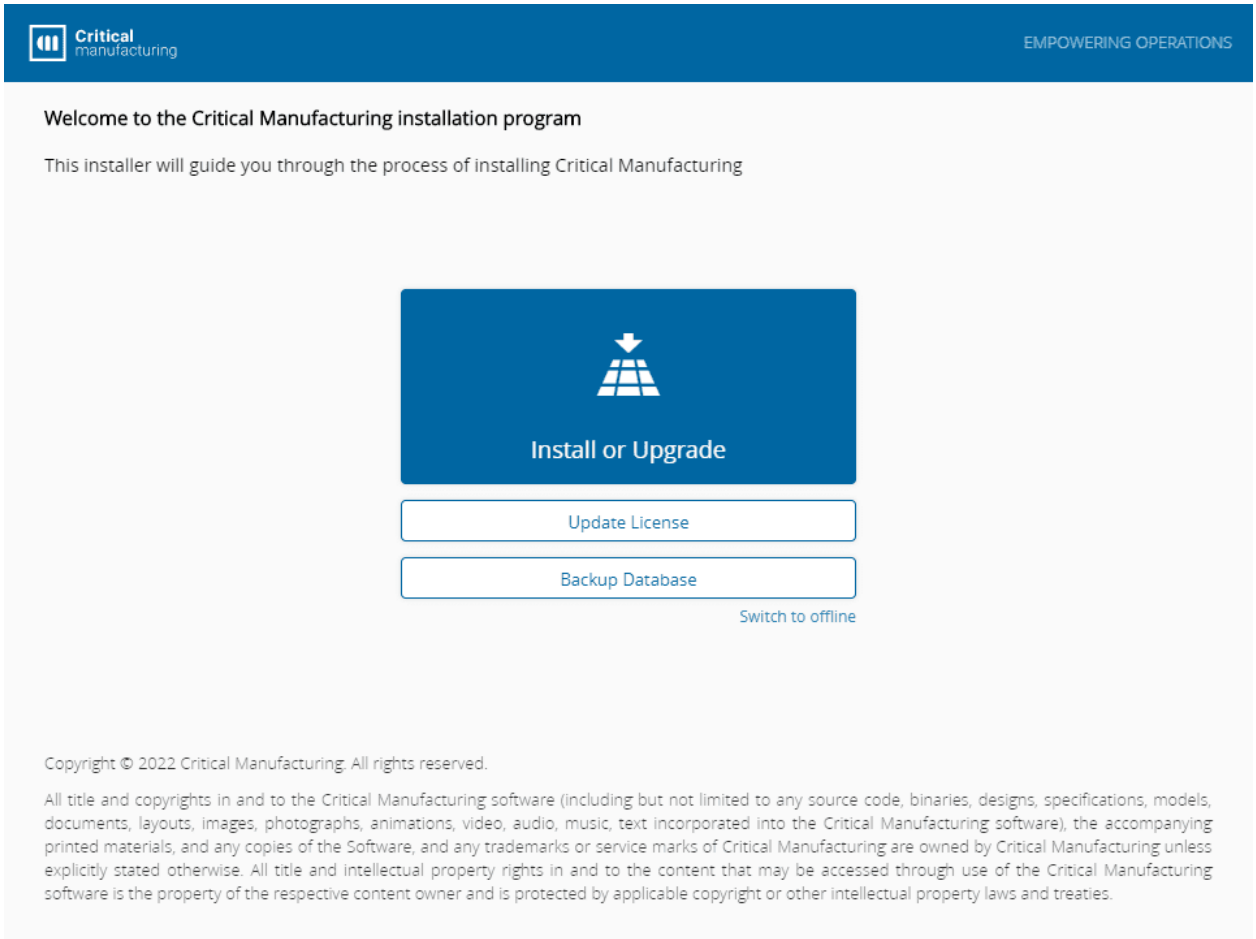


Figure 95: Screenshot showing the Update License selection step in the Critical Manufacturing installation program.

4. You will be redirected to the Critical Manufacturing Customer Portal and will need to log in with a User that has access to Critical Manufacturing Licenses:

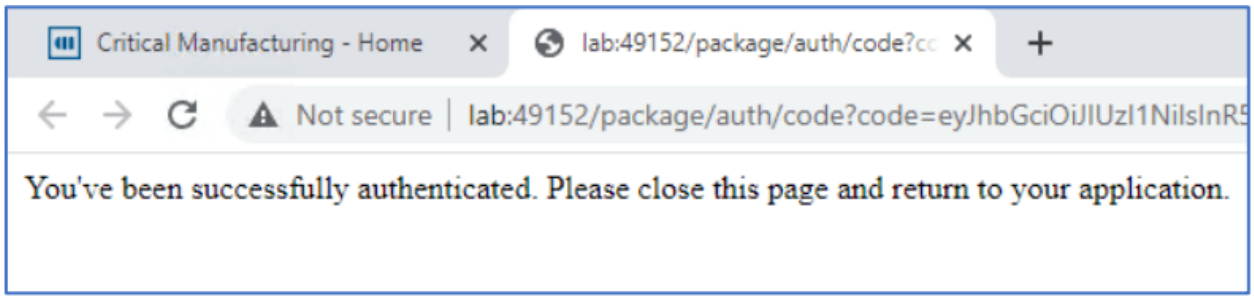


Figure 96: Screenshot showing the login page for the Critical Manufacturing Customer Portal.

5. Import the `.json` parameters file used with the original installation:

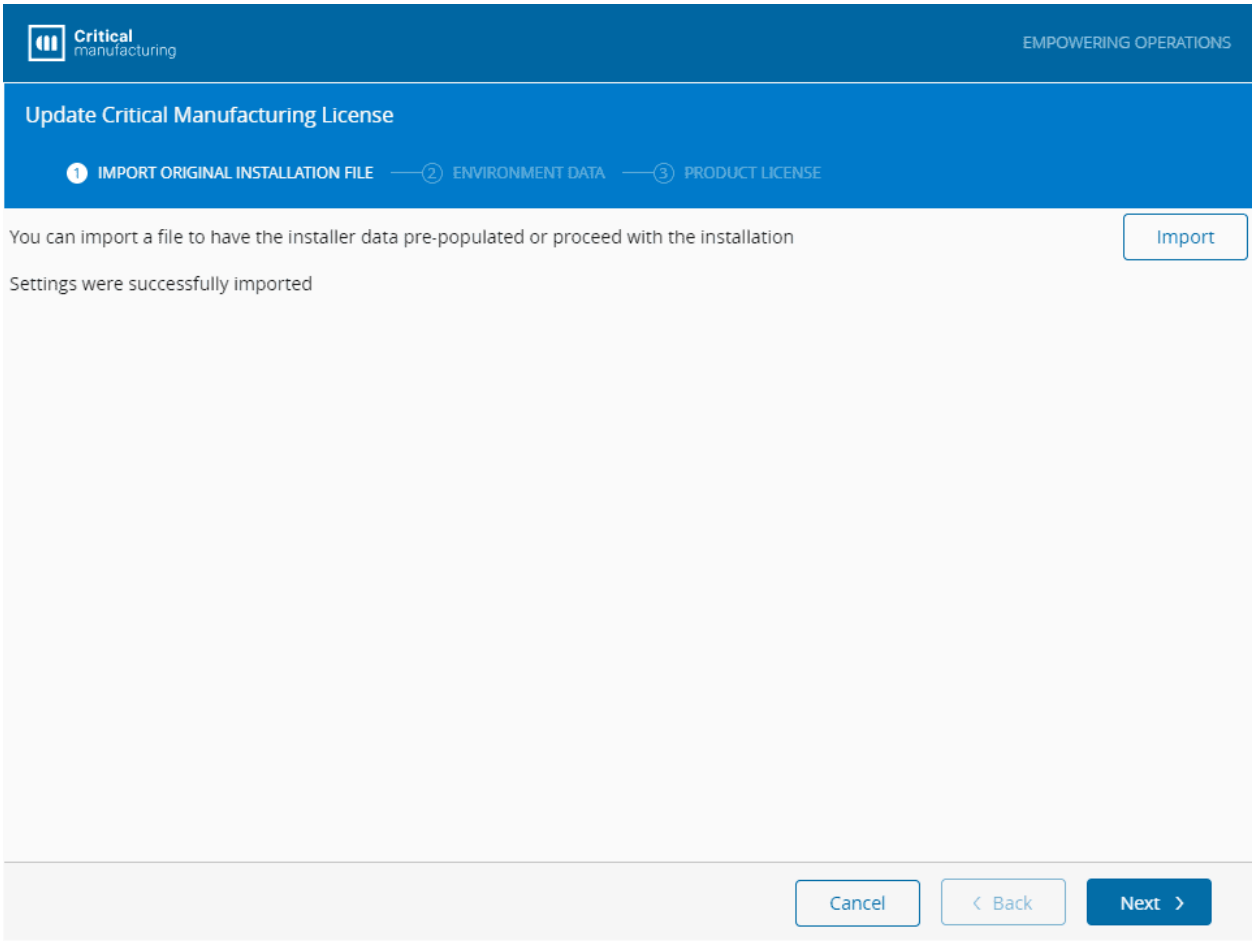


Figure 97: Screenshot showing the update product license screen, highlighting the critical manufacturing license details.

6. Select **Next** to continue.

7. The **Environment Data** screen will contain the **System Name** and the connection to the **Online DataBase**:

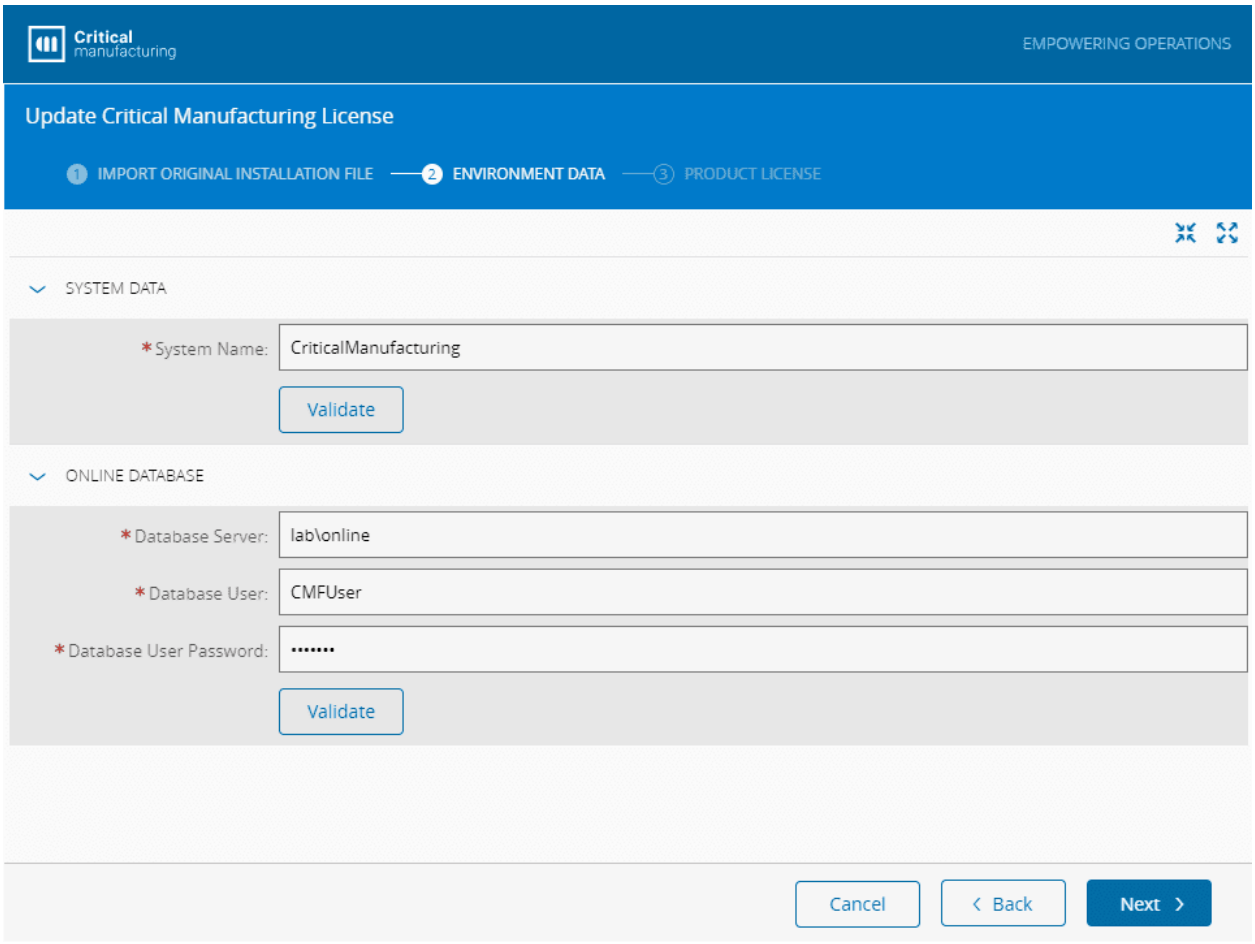


Figure 98: Screenshot showing the Update Product License page with system name and online database connection details.

You can also set the parameters manually if you know the settings.

8. Select **Next** to continue.

9. Select the license you want to use:

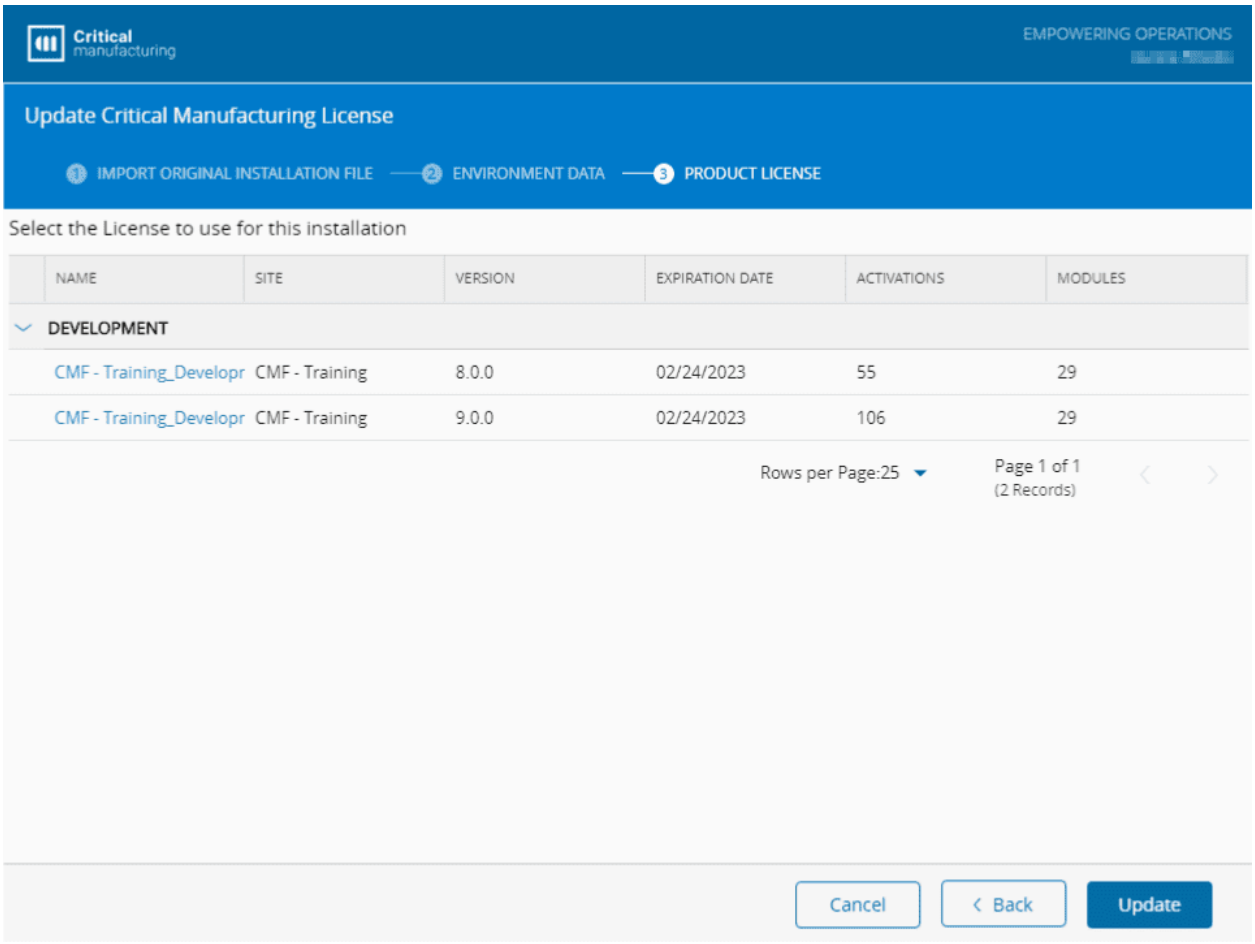


Figure 99: Screenshot showing a product license selection menu with options including "Update Critical Manufacturing License".

10. Proceed with the **Update**:

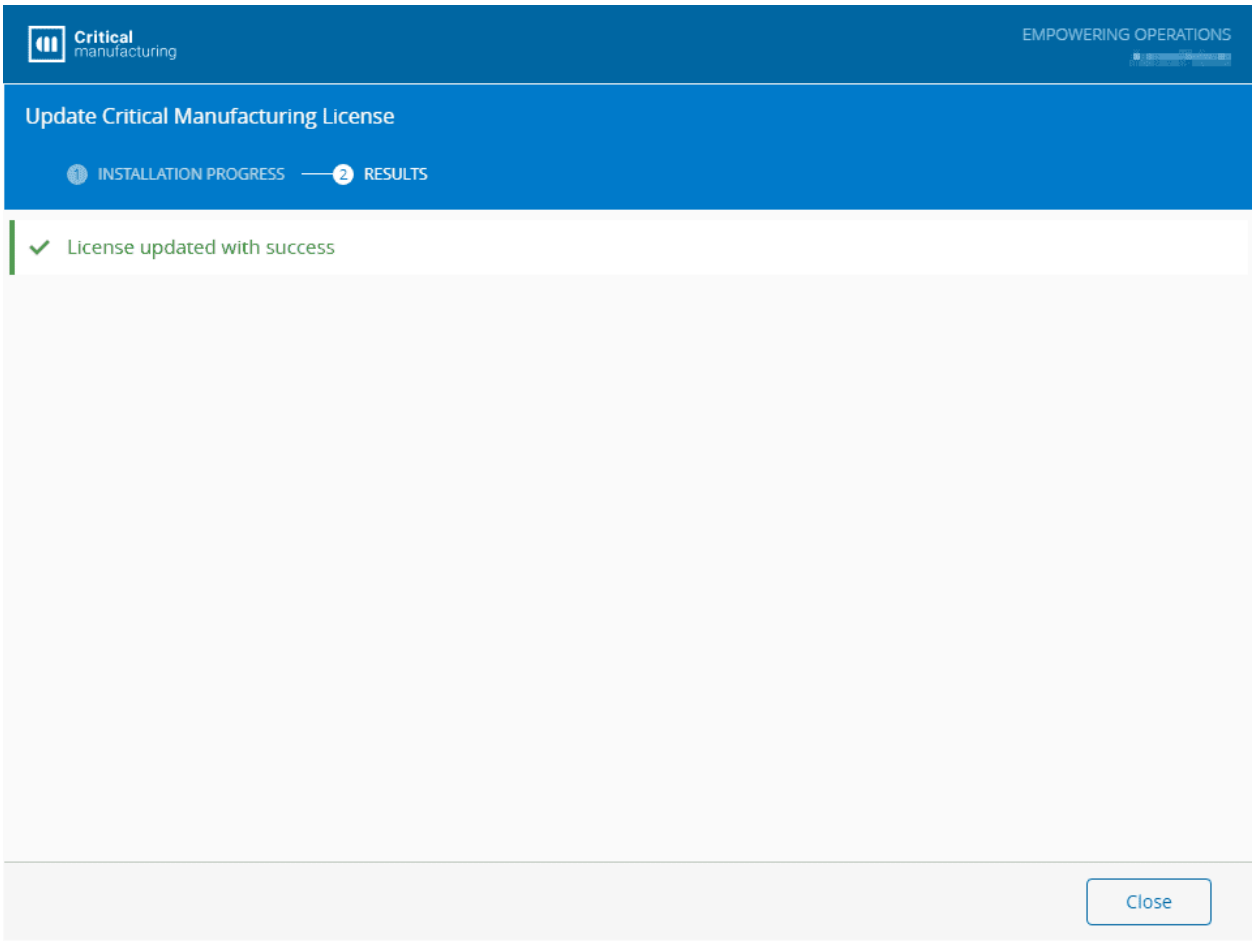


Figure 100: Screenshot showing the update progress for a manufacturing license during an installation process.

For the **Setup - Offline**, follow the steps below:

1. Before selecting **Update License**, select the **Switch to offline** option:

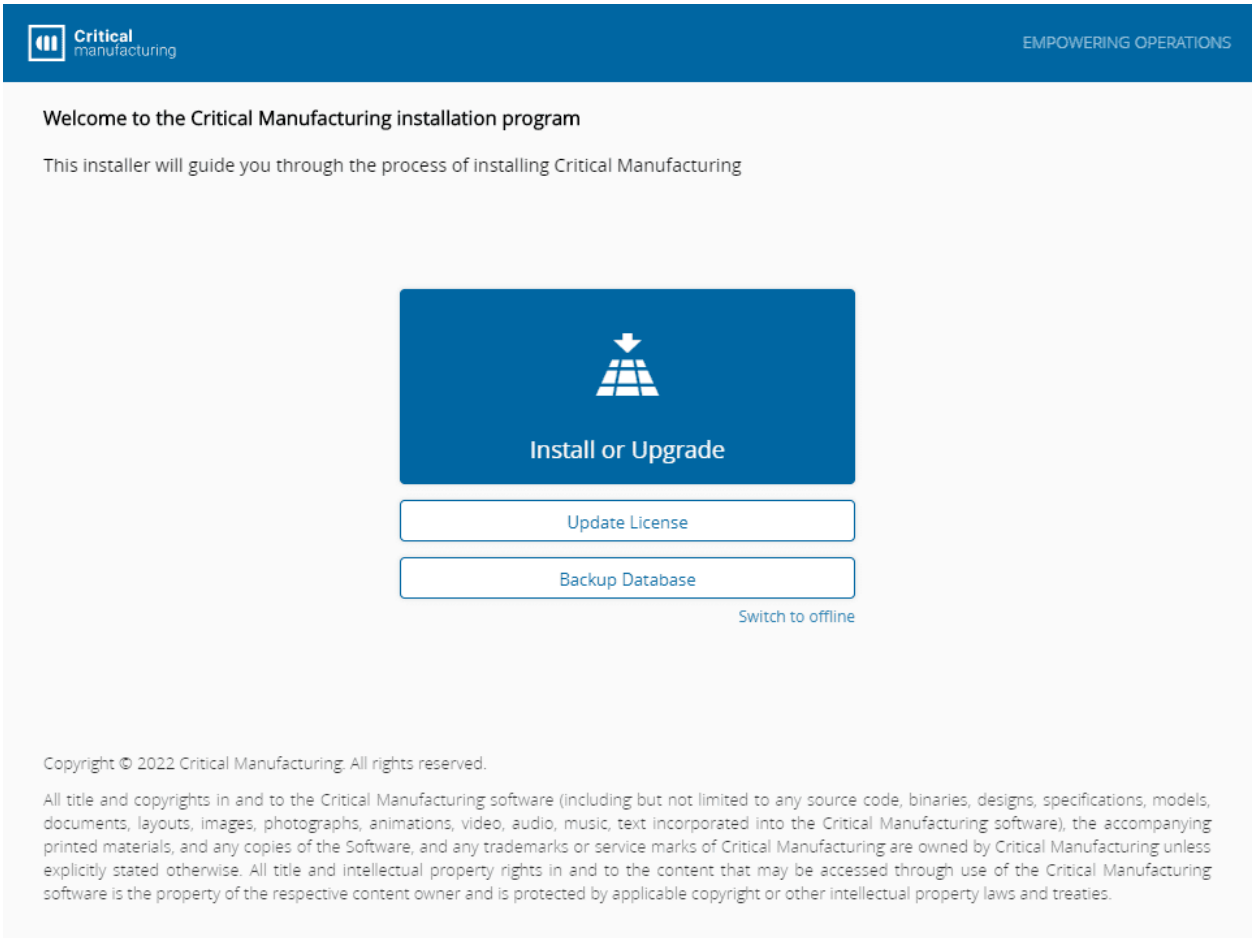


Figure 101: Installation - Welcome screen

2. After importing the `.json` parameters file used with the original installation or manually setting the **Environment Data**, an activation code is provided:

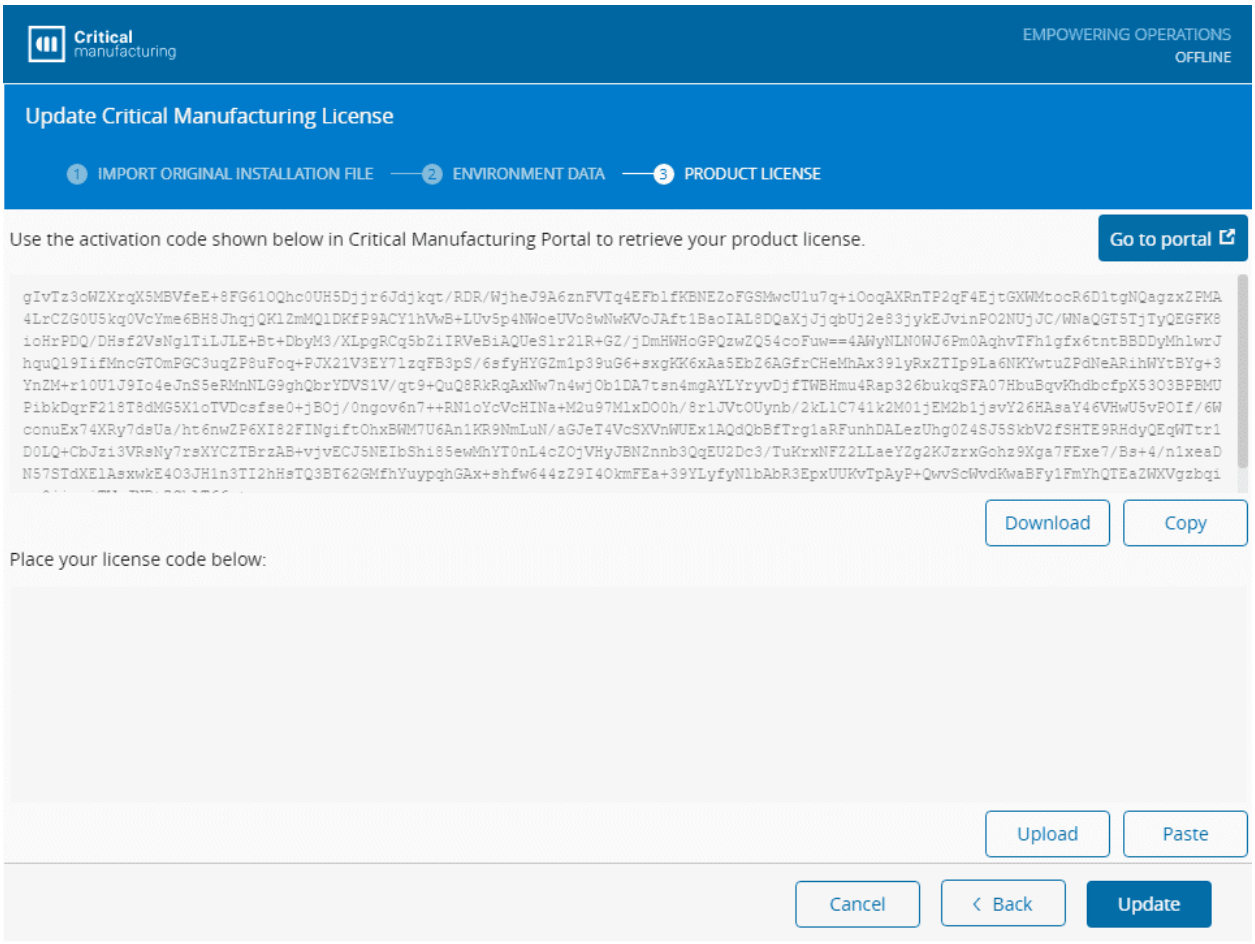


Figure 102: Screenshot showing an update license screen with a filename hint "installation activation code" and a heading "Update Product License".

3. Copy the activation code.
4. With a different device, log in to the Critical Manufacturing Customer Portal with a User that has access to the required license.
5. Open the **Licenses** menu and select **My Licenses**:

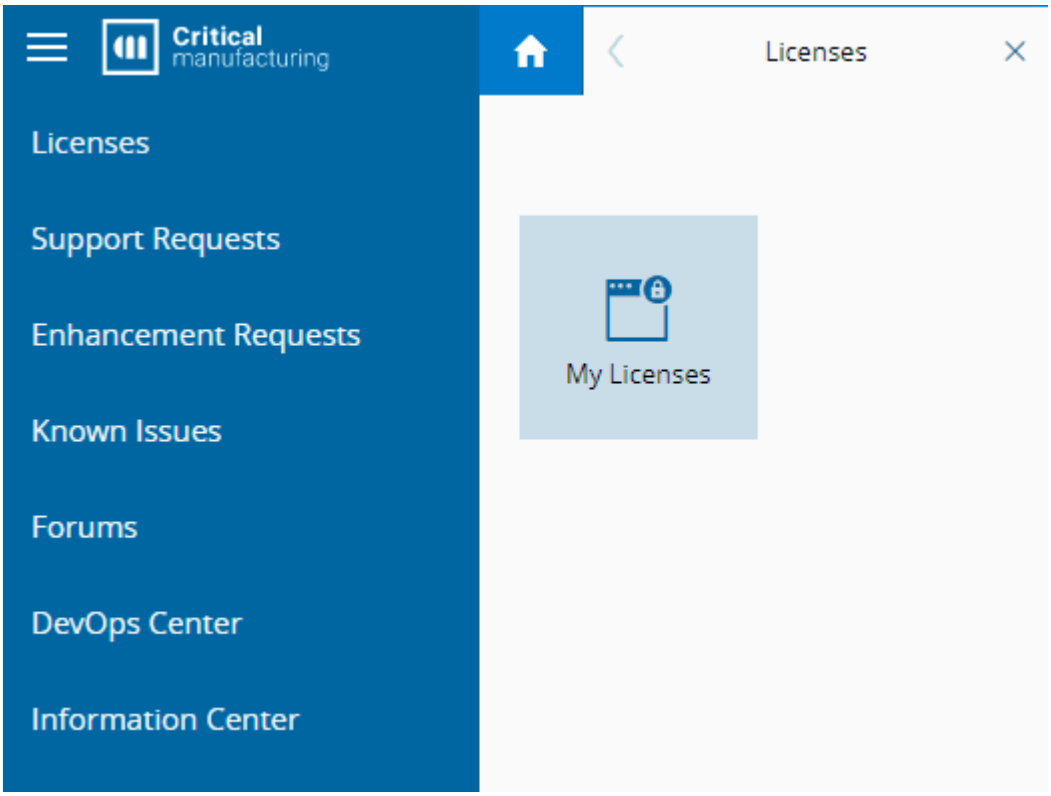


Figure 103: Installation - Activation - Step 2

6. From here you can:

   - Select the **Activate License** in the top ribbon:

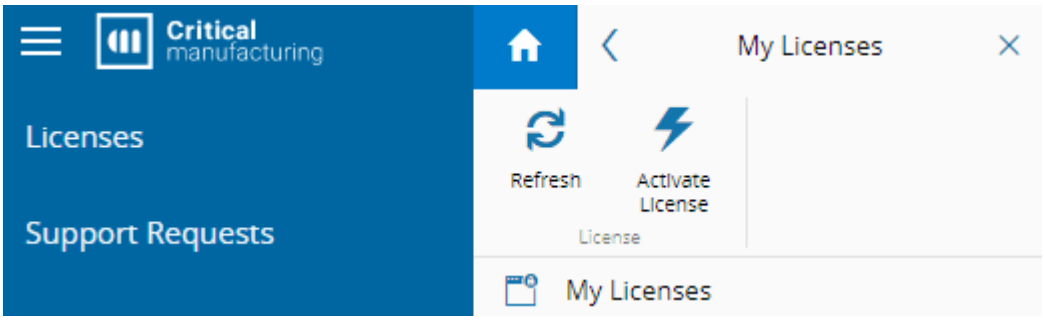


Figure 104: Installation - Activation - Step 3

   - Paste the **Activation Code** from the Setup - Offline update license operation:

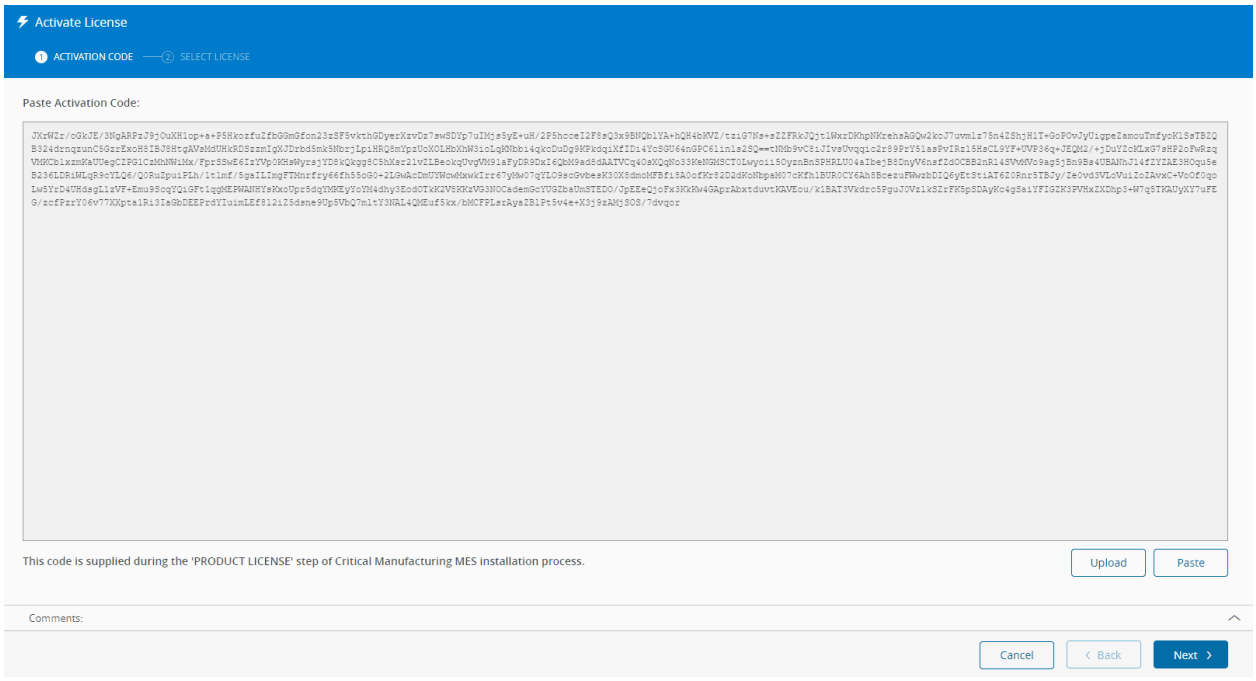


Figure 105: Installation - Activation - Step 4

- Then select the required Environment License and **Activate** it:

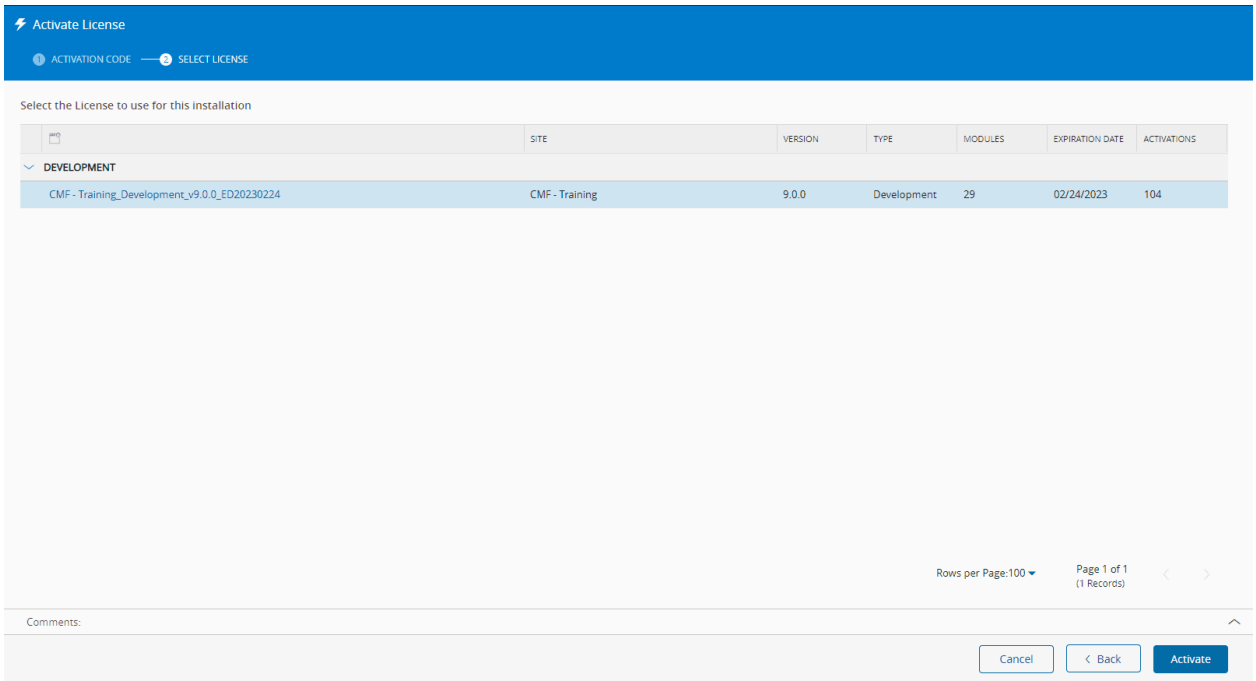


Figure 106: Installation - Activation - Step 5

7. A license code will be provided and you should **Download** or **Copy** it:

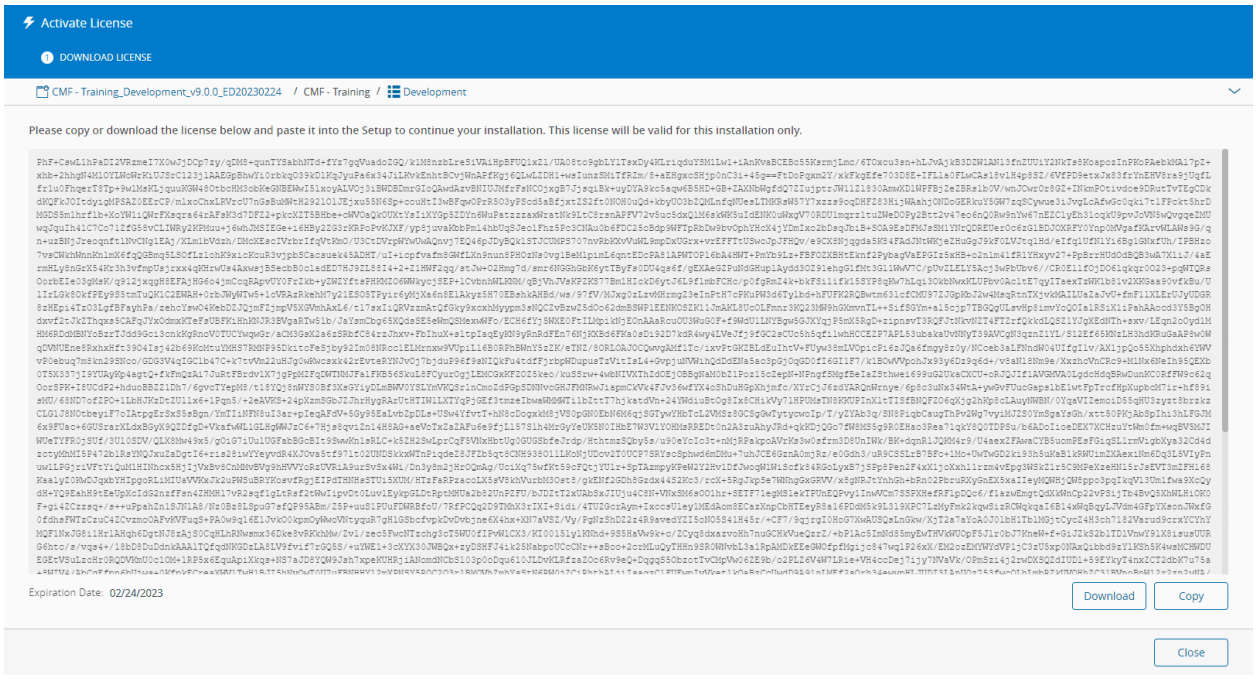


Figure 107: Installation - Activation - Step 6

8. Use the license code with the Setup - Offline installer, accordingly, and then select **Update**:

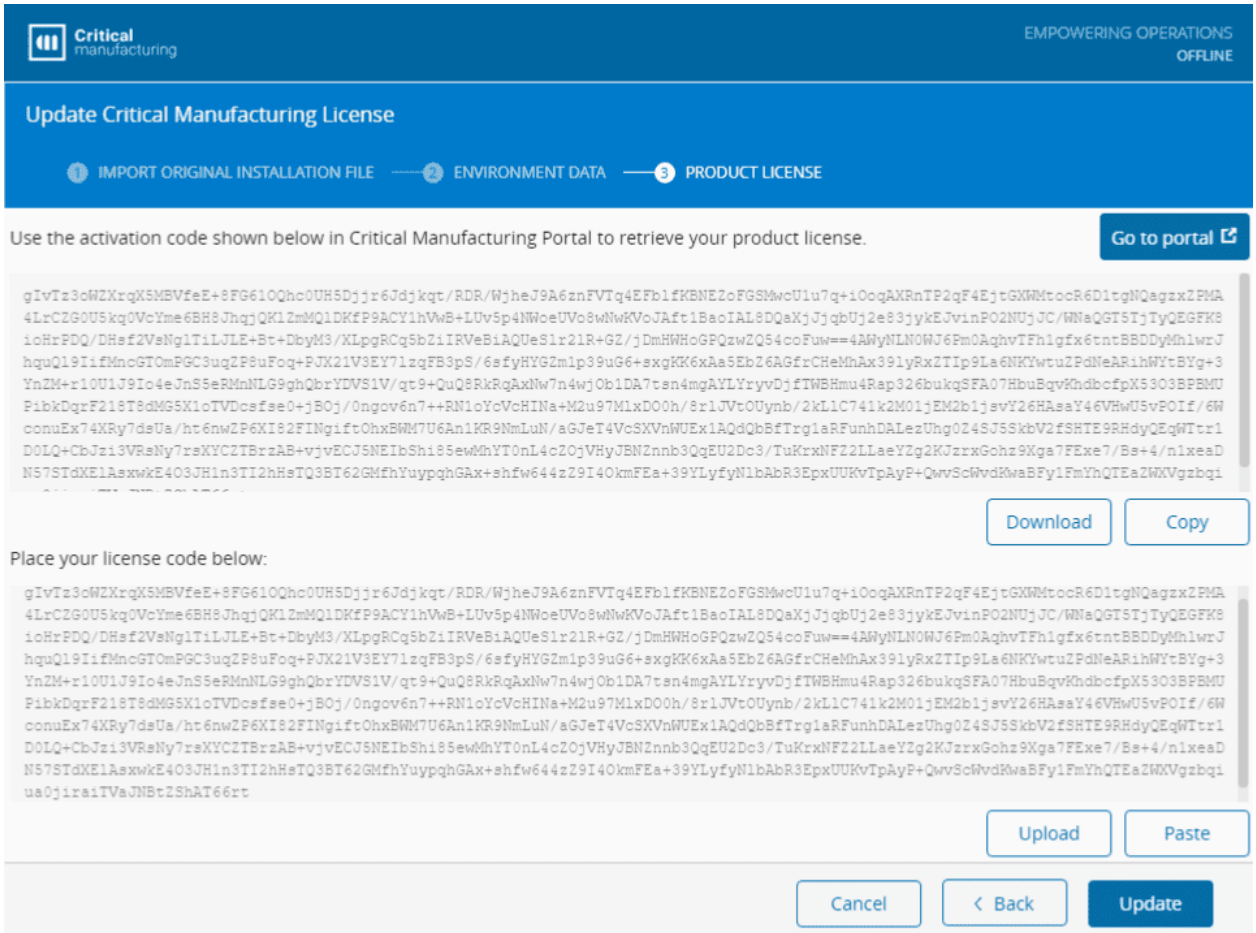


Figure 108: Screenshot showing a product license update screen with a highlighted “Update” button.

For the **Command Console**, follow the steps below:

This method requires that you know the **License Id** or the **License Name**. You also need to have a valid `json` file with the **Environment data** (original installation `json` file), and online access to the Critical Manufacturing Customer Portal.

1. Mount the Critical Manufacturing MES ISO.
2. Open a console at the mounted ISO root:

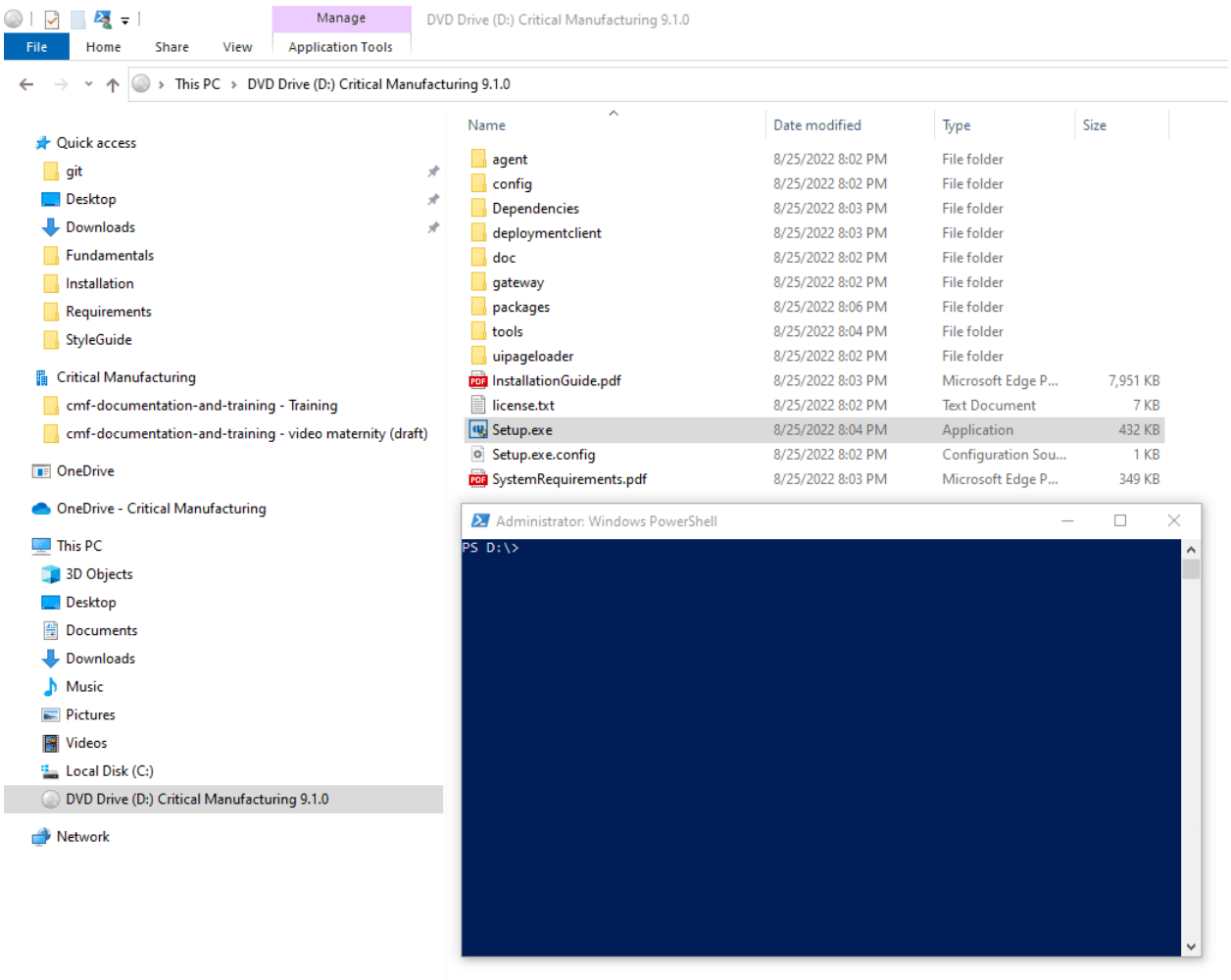


Figure 109: Screenshot showing a console window with a prompt indicating an update product license operation.

3. Run the **CmfDeploy.exe** and provide the `licenseId` and the `parameters`:
   - Command for reference: `.\\tools\\CmfDeploy.exe installlicense --licenseId="LicenseName" --parameters="OriginalInstallationJsonFilePath"`
   - Example for reference: `.\\tools\\CmfDeploy.exe installlicense --licenseId="CMF - CMFLAB\_Development\_v7 --parameters="C:\\Users\\Administrator\\Downloads\\installation 7.0.2.json"`
4. You will be redirected to the Customer Portal and will need to log in with a User that has access to the provided License. What follows is a successful output example for this operation:

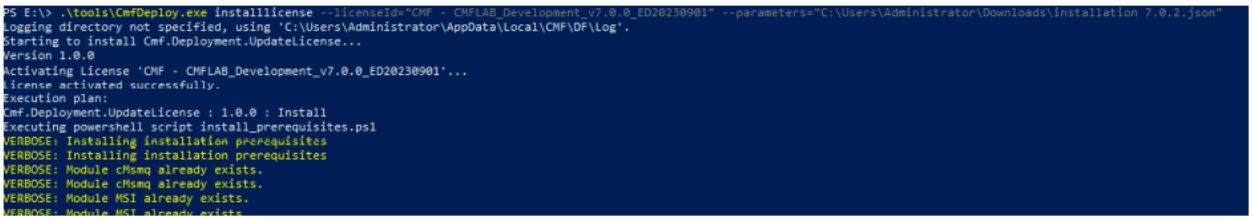


Figure 110: Screenshot showing an installation console displaying license update options.

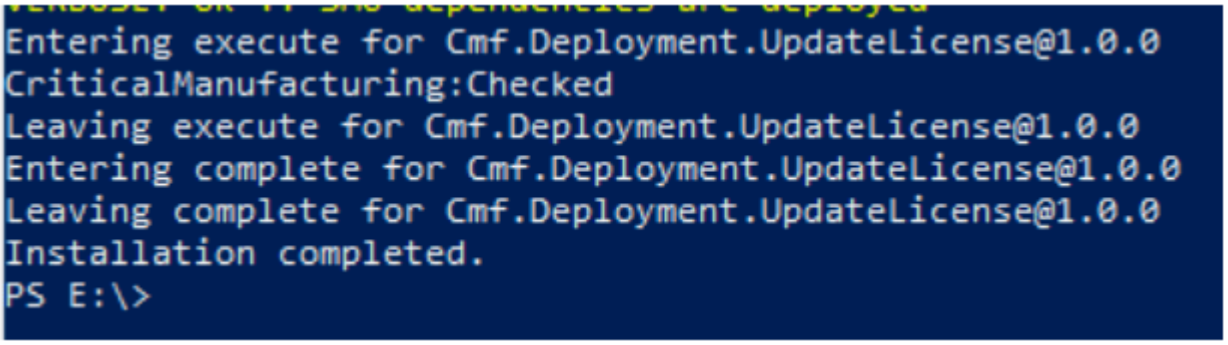


Figure 111: Screenshot showing an installation console with a command prompt displaying “Entering execute… update license…”

36 Post Installation

After installing Critical Manufacturing MES, it is necessary to perform the following steps:

{{ generate_simple_index() }}

37 Connect IoT

- Connect IoT Installation
- Automation Manager Configuration File

38 IoT Runtime Components Configuration

The configuration file is a JSON structured file and it will be used by all components (Manager, Monitor, Controller, Driver). It allows the use of some tokens to be inserted depending on the context, those tokens are explained in the following table:

Table 23: Connect IoT Configuration Tokens

Name	Type	Usage	Description
application	`Applicatio`	`$\{applicatio`	The name of the current application
pid	`Applicatio`	`$\{pid\}`	The process id of the current application
componen	`Applicatio`	`$\{componentI`	Name of the component running (`AutomationManager`, `AutomationMonitor`, `AutomationController`, `DriverCsv`, etc)
entityNam	`Applicatio`	`$\{entityName`	The name of the context entity for the current application
tmp	`OperatingS`	`$\{tmp\}`	User temporary directory
pwd	`OperatingS`	`$\{pwd\}`	Running script location
cwd	`OperatingS`	`$\{cwd\}`	Working directory (where the command is being executed)

38.1 Base Structure

Table 24: Connect IoT Base Structure

Name	Type	Default Value	Description
id	String		Identifier of the process
monitorHost	String	`"localhost"`	Address of the local monitor listener address
monitorPort	Integer	0	Port of local monitor listener. 0 for automatic port assignment
cache	String		Local path where the packages will be downloaded and executed
monitorApplicatior	String	`""$\{pwd\}\\monito`	Complete path of the Monitor process
repository	`Repository`		Repository regarding packages handling
system	`System`		System access settings
storage	`Storage`		Section to configure persistency location
logging	`Logging`		Logging mechanism settings
monitor	`monitor`		Monitor process specific settings
controller	`controller`		Controller(s) process(es) specific settings
driver	`driver`		Driver(s) process(es) specific settings

38.2 Repository Structure

The repository represents the way the Monitor process handles the location where the packages are located (remote) and stored (local).

Table 25: Connect IoT Repository Structure

Nam	Typ	Possible Values	Defau Value	Description

type	Stri	`Npm`
		`Directory`
		`System`
				Type of repository
				- `Npm` - uses an NPM server
				- `Directory` - uses a local directory with the packages and a json-based database descriptor
				- `System` - downloads the packages from MES (retrieves settings from the `system` structure detailed below)

setti	Ob			Repository settings (depending on the type)

38.2.1 Type `Npm` Settings

Table 26: Npm specific settings

Name	Type	Default Value	Description
url	String		URL where the NPM server is located (including port)
token	String		Optional Bearer token used for authentication

38.2.2 Type `Directory` Settings

Table 27: Directory specific settings

Nam	Type	Default Value	Description
path	String		Directory where the packages are located. Must be accessible by process and currently, UNCs are **not** supported

38.2.3 Directory Examples

```
"repository": {
    "type": "Npm",
    "settings": {
        "url": "YourNpmAddress",
        "token": "YourNpmToken"
    }
}
```

```
"repository": {
    "type": "Directory",
    "settings": {
        "path": "[UserSelectedDirectory]\\MyDirectoryRepository"
    }
}
```

38.3 Storage Structure

Table 28: Connect IoT Storage Structure

Name	Type	Possib Value:	Defau Value	Description
type	String	`Direc`	`Direc`	Type of persistency location
settings	Object			Storage type settings
settings	String			Base path where the persistency data will be stored. `OperatingSystem` tokens are supported
settings	`Integer` `string`		`"30d`	Number of seconds to store the data. `0` means forever. Supports string with a trailing token indicating the time unit: `s` - seconds `m` - minutes `h` - hours `d` - days `w` - weeks (7 days)
settings	`Integer`		`4096`	Maximum number of characters displayed in the console when storing a value in storage. If the value exceeds this limit, it will be truncated for readability.

38.3.1 Storage Structure Examples

```
"storage": {
    "type": "Directory",
    "settings": {
        "path": "[UserSelectedDirectory]/Persistency",
        "retentionTime": 3600,
        "logMaxLength": 4096
    }
}
```

```
"storage": {
    "type": "Directory",
    "settings": {
        "path": "[UserSelectedDirectory]/Persistency",
        "retentionTime": "10d",
        "logMaxLength": 0
    }
}
```

38.4 System Structure

Table 29: Connect IoT System Structure

Name	Type	Default Value	Description
tenantName	String		System Tenant name to use by the components
address	String	`"localhost"`	
port	Integer		
timeout	Integer		
useSsl	Boolean	`false`	
authentication	`Authentication`		Object

38.4.1 `Authentication` Structure

Table 30: Authentication structure

Name	Type	Possible Values	Default Value	Description
type	String	`SecurityPortal` `ClientCredentials`		Authentication type to use
settings	Object			Authentication settings (depending on the type)

38.4.2 Authentication type `SecurityPortal` settings

Table 31: Authentication type SecurityPortal structure

Name	Type	Default Value	Description
clientId	String		Id of the client accessing to (MES)
accessToken	String		Security Portal generated long term Access Token. To be set on non-interactive scenarios with Security Portal
openIdConfig	String		URL where the OpenId endpoint can be accessed. Example: `http://YourEnvironment/tenant/YourTenant/.well-known/openid-configuration`
applicationBa	String		Optional: In the case of apps, the Monitor will send requests to this address

38.4.3 Authentication type `ClientCredentials` settings

Table 32: Authentication type SecurityPortal structure

Name	Type	Default Value	Description
clientId	String		Id of the client accessing to (MES)
openIdConfig	String		URL where the OpenId endpoint can be accessed. Example: http://YourEnvironment/tenant/YourTenant/.well-known/openid-configuration
applicationBa	String		Optional: In the case of apps, the Monitor will send requests to this address
password	String		Optional: Password to login - Should not be used

38.4.4 Examples

```
"system": {
    "tenantName": "YourTenant",
    "address": "YourEnvironment",
    "port": 8093,
    "timeout": 60000,
    "useSsl": false,
    "authentication": {
        "type": "SecurityPortal",
        "settings": {
            "clientId": "MES",
            "accessToken": "user created access token",
            "openIdConfiguration":
                "http://YourEnvironment/tenant/YourTenant/.well-known/openid-configuration"
        }
    }
}
```

```
"system": {
    "tenantName": "YourTenant",
    "address": "YourEnvironment",
    "port": 8093,
    "timeout": 60000,
    "useSsl": false,
    "authentication": {
        "type": "ClientCredentials",
        "settings": {
            "clientId": "MES",
            "openIdConfiguration":
                "http://YourEnvironment/tenant/YourTenant/.well-known/openid-configuration"
        }
    }
}
```

38.5 Logging Structure

The logging configuration allows several different loggers to be configured at same time, meaning that for each type of logger, different options can be configured.

Table 33: Connect IoT Logging Structure

Nam	Type	Possible Values	Defa Valu	Description
id	String			Identifier of the logger, if none is configured, only one of the same type is allowed

type	String	`Console`
		`File`
		`Http`
		`OTLP`
				Type of the transport

opti	Objec			Transport options,different for each type of transport, see each transport information below

appl	Array of String	`AutomationMonitor`
		`AutomationController`
		`AutomationManager`
		`DriverSecsGem`
		`DriverOpcUA`
		`DriverMqtt`
		`DriverBle`
		`DriverCsvFile`
		`DriverRawFile`
		`DriverKeyboardWedge`
		`DriverOib`
		`DriverOpcDA`
		`DriverSerial`
		`DriverTcpIp`
				A wildcard can configure all or filter by name, example: '`Driver*`'

38.5.1 Common Transport Options

These options apply to all types:

Table 34: Connect IoT Common Transport Options

Name	Typ	Possible Values	Default Value	Description

level	Stri	`debug`
		`info`
		`warn`
		`error`
			`"info"`	Minimum level of messages that this transport should log. If `info`level is defined, all entries of level `info`, `warn` and `error` will be logged and `debug` entries will be ignored.

label	Stri		`"$\{applic`	Label to append in the beginning of the log entry (if used in the format)
forma	Stri		`"$\{log.ti`	Format of the line of the log

Name	Type	Possible Values	Default Value	Description
timest	Boo		`true`	Flag indicating if we should prepend output with timestamps. If function is specified, its return value will be used instead of timestamps
timest	Stri		`"YYYY-MM-D HH![](imag width=20px \}ss.SSS"`	Format of the timestamp in the log entry. Please refer to https://github.com/taylorhakes/fecha#formatting-tokens for full format information
maxL	Inte		0	Max length of the message entry to log (<=0 to ignore). If entry is larger than the value, will log (70% of the maxLength) of the start of the message and the last (30% of maxLength) characters. This setting is useful to keep huge communication logs in a more controllable state.
specif	Boo		`false`	Only log the specified verbosity level. With this setting set to `true` the levels greater than the `level` will be ignored.
isEnab	Boo		`true`	Is the Transport enabled

38.5.2 Console Transport Options

This transport log all the messages to the application console.

Table 35: Connect IoT Console Transport Options

Name	Type	Default Value	Description
colorize	Boolean	`true`	Flag indicating if we should colorize output.
colorizeMessage	Boolean	`true`	Is the colorization to apply to the full message or only the verbosity.

38.5.3 Example

```
{
    "type": "Console",
    "options": {
        "level": "debug",
        "prettyPrint": true,
        "colorizeMessage": true
    },
    "applications": [ "*" ]
}
```

38.5.4 File Transport Options

As the name states, this transport log all the messages to the file system.

Table 36: Connect IoT File Transport Options

Name	Type	Default Value	Description
frequ	Stri		A string representing the frequency of rotation. This is useful if you want to have timed rotations, as opposed to rotations that happen at specific moments in time. Valid values are `'\#m'` or `'\#h'` (e.g., '5m' or '3h'). Leaving this null relies on datePattern for the rotation times.
dateP	Stri	`"YYYY-MM-`	A string representing the moment.js date format to be used for rotating. The meta characters used in this string will dictate the frequency of the file rotation. For example, if your datePattern is simply `'HH'` you will end up with 24 log files that are picked up and appended to every day.
filena	Stri	`"LogFile\`	Filename to be used to log to. This filename can include the ${date} placeholder which will include the formatted datePattern at that point in the filename \| \| dirname \| String \| ""."" \| The directory name to save log files to \| \| maxSize \| String \| ""10m"" \| Maximum size of the file after which it will rotate. This can be a number of bytes, or units of kb, mb, and gb. If using the units, add 'k', 'm', or 'g' as the suffix. The units need to directly follow the number. \| \| maxFiles \| String \| ""30d"" \| Maximum number of logs to keep. If not set, no logs will be removed. This can be a number of files or number of days. If using days, add 'd' as the suffix \| \| option \| Object \| "{ flags: 'a', mode: 0o777 }" \| An object resembling <https://nodejs.org/api/fs.html#fs_fs_createwritestream_path_options> indicating additional options that should be passed to the file stream \| \| auditFile \| String \| "${dirname}/.-audit.json"

38.5.5 File Transport Options Example

```
{
    "id": "MyFileLogger01",
    "type": "File",
    "options": {
        "filename": "${applicationName}_${date}.log",
        "dirname": "${tmp}/YourManager01/Logs/${applicationName}",
        "level": "debug",
        "timestampFormat": "HH![](images\.png){ width=20px }ss.SSSSS",
        "maxSize": "10m",
        "maxFiles": 5,
        "maxLength": 5000,
        "specificLevelLock": false
    },
    "applications": [ "AutomationMonitor", "AutomationManager" ]
}
```

38.5.6 HTTP Transport Options

The HTTP transport is a generic way to log, query, and stream logs from an arbitrary HTTP endpoint, preferably `winstond`. It takes options that are passed to the node.js http or https request:

Table 37: Connect IoT HTTP Transport Options

Name	Type	Default Value	Description
host	String	`"localhost"`	Remote host of the HTTP logging endpoint.
port	Integer	80 or 443	Remote port of the HTTP logging endpoint.
path	String	`"/"`	Remote URI of the HTTP logging endpoint.
auth	Object	`None`	An object representing the username and password forHTTP Basic Auth.
ssl	Boolean	`false`	Value indicating if we should us HTTPS

38.5.7 HTTP Transport Options Example

```
{
    "id": "MyHttp01",
    "type": "Http",
    "options": {
        "host": "localhost",
        "port": "80",
        "path": "logger",
    },
    "applications": [ "AutomationController" ]
}
```

38.5.8 OTLP Transport Options

The OTLP transport is a transport to broadcast logs using the open telemetry standard. It requires the endpoint to be configured:

Table 38: Connect IoT OTLP Transport Options

Name	Type	Default Value	Description
isEnabl	Boole		Flag to enable the transport.
level	String		Logging Level.
isInterr	Boole	False	Flag only used if the automation manager is running in the same stack as the MES application.
endpoi	String		An external endpoint that receives and processes telemetry signals sent according to the OTLP (open telemetry protocol) format (i.e https://mytelemetrystack.com/telemetry/http).

38.5.9 OTLP Transport Options Example

```
{
    "type": "OTLP",
    "options": {
        "isEnabled": true,
        "level": "debug"
```

```
    },
    "applications": [ "*" ]
},
```

38.6 Monitor Structure

The optional monitor section is specifically for the monitor process and are not used by the other applications.

Table 39: Connect IoT Monitor Structure

Name	Type	Default Value	Description
notifyBeforeK	Boolea	`true`	Flag indicating if a notification to the processes before killing them (allowing them to properly cleanup any resources, disconnect from devices, etc), or simply kill them.
killNotificatior	Integer	`10000`	Number of milliseconds to wait for the "about to be killed" process reply that it has finished the cleanup an is ready to be killed.
retryAttempts	Integer	`30`	When calls protected by retry mechanism fail, number of executions before failing
sleepBetweer	integer	`1000`	When calls protected by retry mechanism fail, time to wait between retries
processComn	`SslCo`		Configuration to allow inter-process communications to be using SSL (monitor <-> controller(s) and monitor <-> driver(s))

38.6.1 Monitor Structure Example

```
"monitor": {
    "notifyBeforeKill": "true",
    "killNotificationTimeout": 30000,
    "retryAttempts": 45,
    "sleepBetweenAttempts": 1000,
    "processCommunication": {
        "useSsl": true,
        "privateKey": "YourCertificatesRepository\\key.pem",
        "certificate": "YourCertificatesRepository\\cert.pem",
        "certificateAuthority": "YourCertificatesRepository\\ca-cert.pem"
    }
}
```

38.7 Controller Structure

The optional controller section is specifically for the controller(s) process(es) and are not used by the other applications.

Table 40: Connect IoT Controller Structure

Name	Type	Default Value	Description
retryAttempts	Integer	30	When calls protected by retry mechanism fail, number of executions before failing
sleepBetweenAttempts	integer	1000	When calls protected by retry mechanism fail, time to wait between retries
profilerSessionsLocation	string		Location where the profiler sessions will be stored

38.7.1 Controller Structure Example

```
"controller": {
    "retryAttempts": 45,
    "sleepBetweenAttempts": 1000,
    "profilerSessionsLocation": "YourControllerRepository\\tempController"
}
```

38.8 Driver Structure

The optional driver section is specifically for the driver(s) process(es) and are not used by the other applications.

Table 41: Connect IoT Driver Structure

Name	Type	Default Value	Description
retryAttempts	Integer	30	When calls protected by retry mechanism fail, number of executions before failing
sleepBetweenAtte	integer	1000	When calls protected by retry mechanism fail, time to wait between retries
processCommuni	SslConfi		Configuration to allow inter-process communications to be using SSL (driver<-> controller)

38.8.1 Driver Structure Example

```
"driver": {
    "retryAttempts": 45,
    "sleepBetweenAttempts": 1000,
    "processCommunication": {
        "useSsl": true,
        "privateKey": "YourCertificatesRepository\\key.pem",
        "certificate": "YourCertificatesRepository\\cert.pem",
        "certificateAuthority": "YourCertificatesRepository\\ca-cert.pem"
    }
}
```

38.9 SslConfig structure

When communication between processes require SSL use these settings.

Table 42: Connect IoT SslConfig Structure

Name	Type	Default Value	Description
useSs	Boo	`fals`	Use SSL communication on component communication
reject	Boo	`fals`	If not false a server automatically reject clients with invalid certificates. Allows bypass of error: "Connection with monitor error: unable to verify the first certificate" on a completely unsecured way when set to false! also, if we want to ignore environment variable "NODE_TLS_REJECT_UNAUTHORIZED=" we may set rejectUnauthorized: true On self-signed certificates, we can pass the correct CA (certificate authority) certificate with certificateAuthority option
privat	stri		PEM encoded SSL private key Value or file full path containing the key value
certifi	stri		PEM encoded SSL certificate Value or file full path containing the certificate value
certifi	stri		PEM encoded SSL custom certificate authority (CA) Value or file full path containing the certificate value

38.9.1 SslConfig Structure Example

```
{
    "useSsl": true,
    "privateKey": "YourCertificatesRepository\\key.pem",
    "certificate": "YourCertificatesRepository\\cert.pem",
    "certificateAuthority": "YourCertificatesRepository\\ca-cert.pem"
}
```

38.10 SystemCertificate structure

When communication between processes require SSL use these settings.

Table 43: Connect IoT SystemCertificate Structure

Name	Type	Default Value	Description
rejectUnauth	Boole	`false`	If rejectUnauthorized is set to true, it will change the environment variable of the process 'NODE_TLS_REJECT_UNAUTHORIZED' to '1', if set to false or not set it default to '0'.
certificate	string		It will generate a temporary file and add the path to the environment variable of the process 'NODE_EXTRA_CA_CERTS'.
certificateAu	string		It will append to the certificate and generate a temporary file and add the path to the environment variable of the process 'NODE_EXTRA_CA_CERTS'. value

38.10.1 SystemCertificate Structure Example

```
{
  "id": "MyManager",
  "cache": "[MyCacheLocation]/Cache",
  "hostName": "localhost",
  "monitorApplication": "${pwd}/monitor.js",
  "repository": {
    "type": "System"
  },
  "system": {
    "tenantName": "MyTenant",
    "address": "MyAddress",
    "port": 80,
    "timeout": 120000,
    "useSsl": false,
    "isLoadBalancingEnabled": false,
    "authentication": {
      "type": "SecurityPortal",
      "settings": {
        "clientId": "MES",
        "accessToken": "user access token",
        "openIdConfiguration":
            "http://MyAddress/SecurityPortal/tenant/MyTenant/.well-known/openid-configuration"
      }
    }
  },
  "isMinimal": false,
  "storage": {
    "type": "Directory",
    "settings": {
      "path": "[MyPersistencyDirectory]/Persistency",
      "retentionTime": "30d"
    }
  },
  "logging": [
    {
      "type": "Console",
      "options": {
        "level": "debug",
        "prettyPrint": true,
        "colorizeMessage": true,
        "isEnabled": true
      },
      "applications": [
        "*"
      ]
    },
    {
      "type": "OTLP",
      "options": {
        "level": "info",
        "isEnabled": false
      },
```

```
    "applications": [
      "*"
    ]
  },
  {
    "id": "Controllers",
    "type": "File",
    "options": {
      "filename": "${applicationName}_${date}.log",
      "dirname": "[MyLogsDirectory]/Instances/${entityNameNormalized}/${componentId}",
      "level": "debug",
      "timestampFormat": "HH![](images\.png){ width=20px }ss.SSSSS",
      "maxSize": "10m",
      "maxFiles": "30d",
      "isEnabled": true
    },
    "applications": [
      "AutomationController"
    ]
  },
  {
    "id": "Drivers",
    "type": "File",
    "options": {
      "filename": "${applicationName}_${date}.log",
      "dirname": "[MyLogsDirectory]/Instances/${entityNameNormalized}/${componentId}",
      "level": "debug",
      "timestampFormat": "HH![](images\.png){ width=20px }ss.SSSSS",
      "maxSize": "10m",
      "maxFiles": "30d",
      "isEnabled": true
    },
    "applications": [
      "Driver*"
    ]
  },
  {
    "id": "ManagerAndMonitor",
    "type": "File",
    "options": {
      "filename": "${applicationName}_${date}.log",
      "dirname": "[MyLogsDirectory]/Instances/Manager/${applicationName}",
      "level": "info",
      "timestampFormat": "HH![](images\.png){ width=20px }ss.SSSSS",
      "maxSize": "10m",
      "maxFiles": "30d",
      "isEnabled": true
    },
    "applications": [
      "AutomationMonitor",
      "AutomationManager"
    ]
  },
  {
```

```
      "id": "Jobs",
      "type": "File",
      "options": {
        "filename": "Job_${jobId}_${date}.log",
        "dirname": "${temp}/ConnectIoT/Jobs",
        "auditFile": "${temp}/ConnectIoT/Jobs/.audit.json",
        "level": "info",
        "timestampFormat": "HH![](images\.png){ width=20px }ss.SSSSS",
        "maxSize": "10m",
        "maxFiles": "30d",
        "isEnabled": true
      },
      "applications": [
        "AutomationJob"
      ]
    }
  ]
}
```

39 Connect IoT Installation

The **Connect IoT Installation** requires post installation steps that are described in this document.

 While this method provides a direct installation method for Connect Iot, Critical Manufacturing recommends using the automatic deployment method, which you can read about in [[user-guide-automation-manager-configure-deployment]].

39.1 Package Repository

As described in the System Requirements, Connect IoT requires a Package Repository to store all binaries and respective versions.

Currently, two types of repositories are supported (`NPM` and `Directory`), each with their advantages and disadvantages.

Table 44: Package Repository types

Type	Advantages	Disadvantages
NPM	Authentication with roles Web-Server-Based Well defined Api Commercial solutions with support	Must install/configure/maintain server Commercial solutions/support is not free Internet connection may be required Updating packages requires unpublish + publish (development + hotfixes)
Director	Free Easy to prepare Easy to retrieve/change packages No internet/ports required	Must be available in all IoT computers (mount) Authentication based on ACL Anyone with permissions can simply delete everything

39.2 Deploy Connect IoT Packages

39.2.1 Package Selection

Run the setup wizard and select the package `Cmf.ConnectIoT.Packages` from the dropdown and select **Next**.

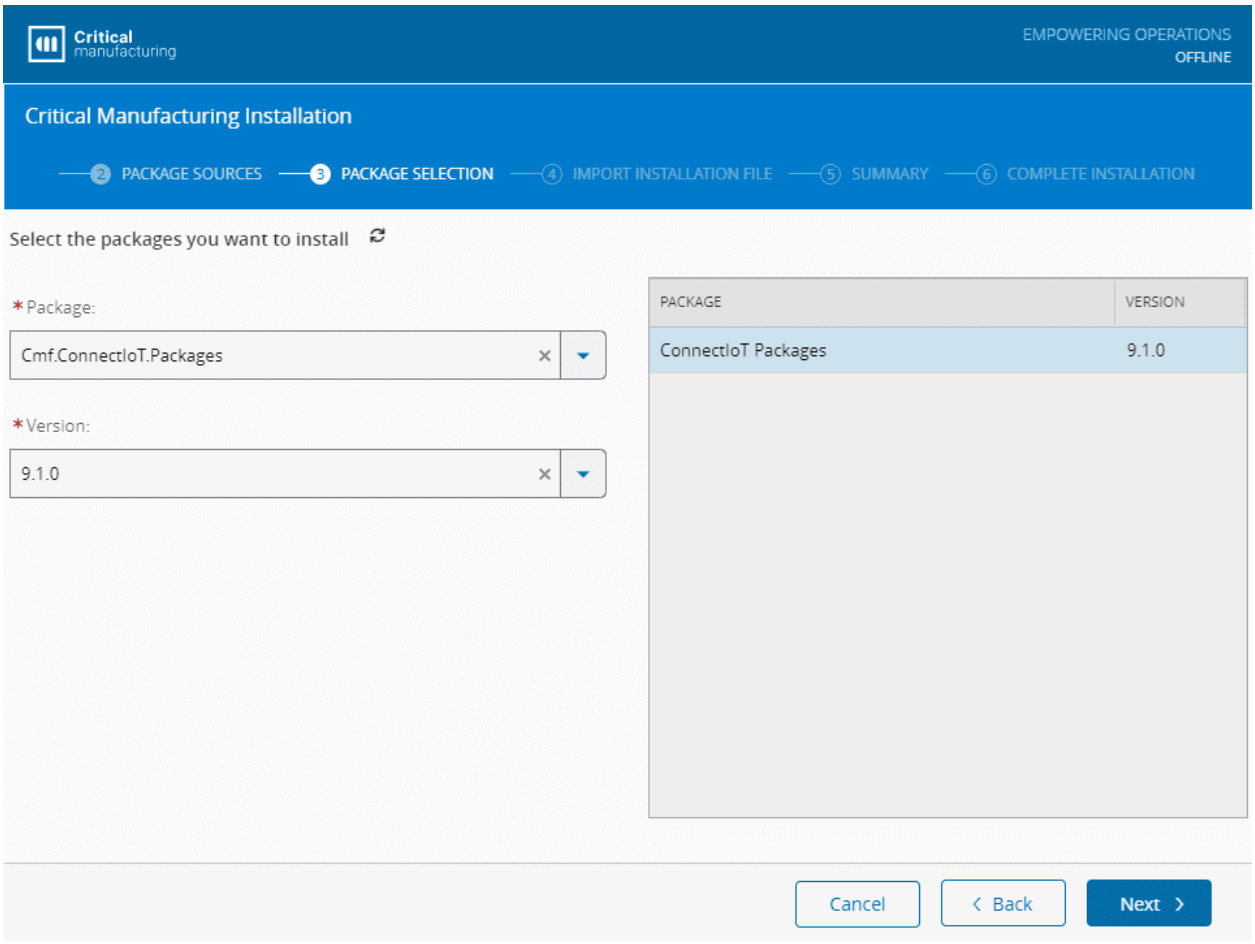


Figure 112: Deploy Connect IoT Packages - Package Selection

If you have any previously exported configuration file, you can import it. Nevertheless, continue to the **Next** step.

39.2.2 Connect IoT Configuration

In the **NPM Server Repository** group, fill out the fields as described below:

- **Is Enabled** - specify if the packages should be published to an NPM Repository.
- **Address** - full address (including port) of the server (must support NPM api).
- **Tag** - tag to mark the packages.
- **Registry User** - username with publish permissions.
- **Registry User Password** - password of the user indicated in the previous field.
- **Registry User Email** - email to associate to the user that will publish the packages.

In the **Directory Repository** group, define the following options:

- **Is Enabled** - specify if the packages should be published to a Directory Repository.
- **Location** - directory full path (if the directory does not exist, it will be created).

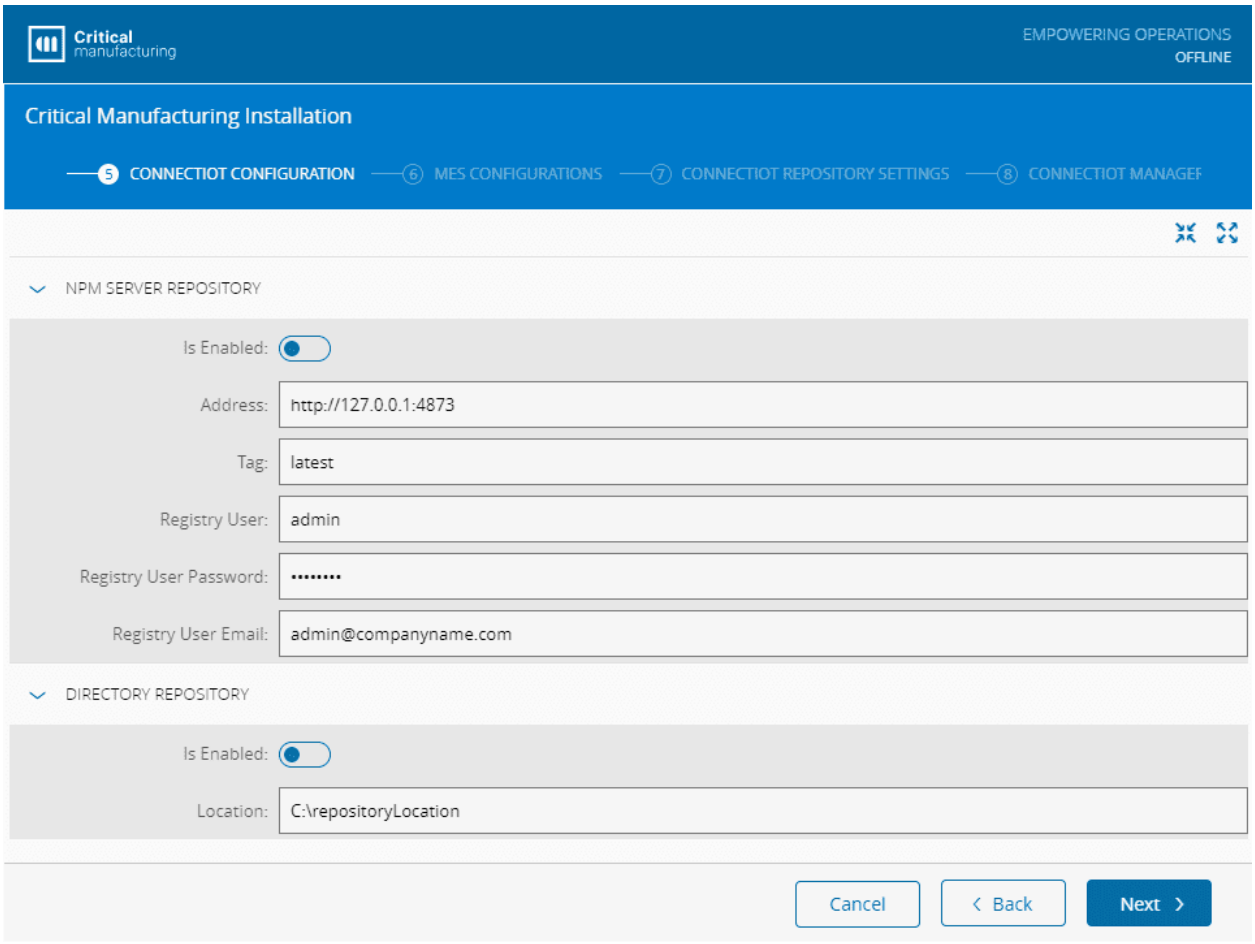


Figure 113: Deploy Connect IoT Packages - Connect IoT Configurations

39.2.3 MES Configurations

Define the configurations for the MES system:

- **Tenant Name** - tenant name used to connect to the MES system.
- **HostName or IP Address** - address where the MES system is installed.
- **Port** - port address for the MES system.
- **Use SSL** - whether SSL will be used.

In the **User Account** group, fill out the details for the user that will access the system:

- **User Account** - user account to access the MES system.
- **User Password** - user password to access the MES system.

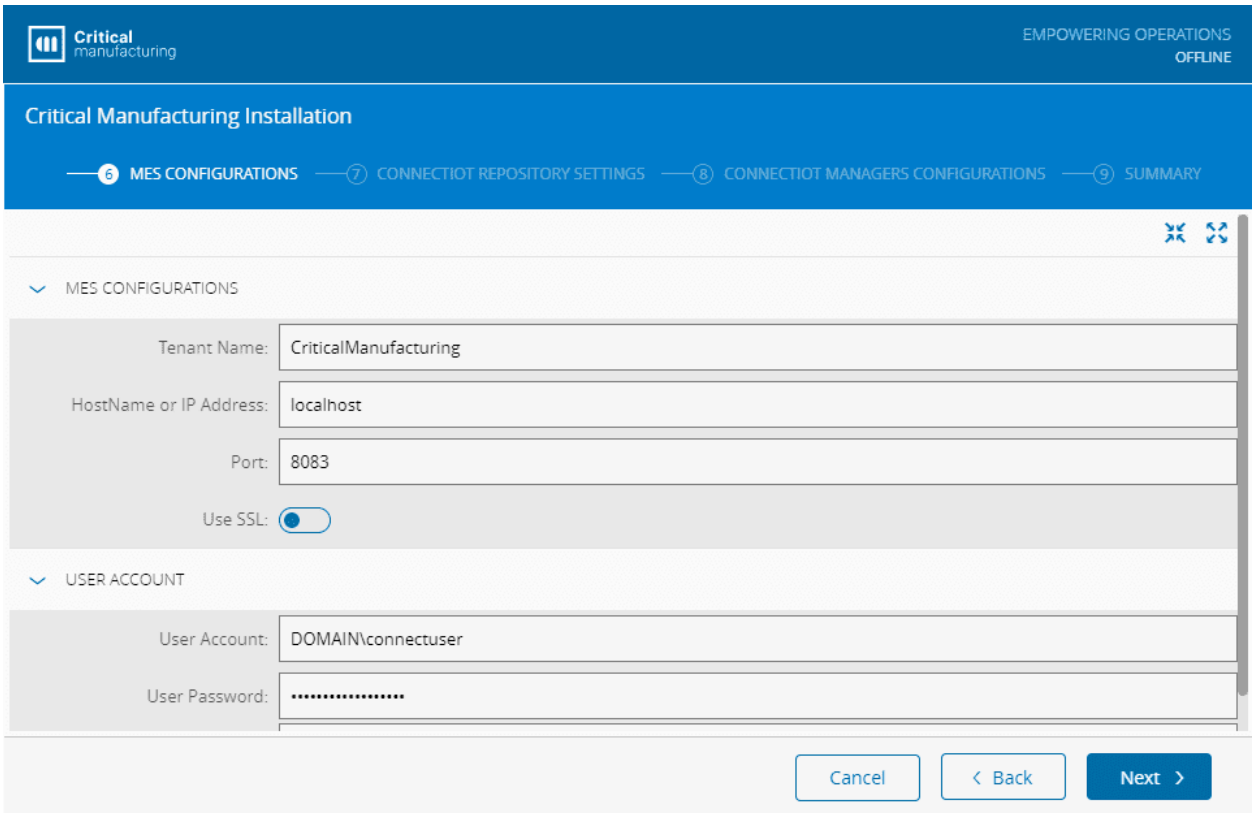


Figure 114: Deploy Connect IoT Packages - MES Configurations

Select **Next** to continue.

39.2.4 Connect IoT Repository Settings

In the **Repository Settings** group, define whether to use Configure Repository Settings, as well as the type of Repository to use:

- **Npm**
- **Directory**

In the **Temporary Files** group, select whether the temporary files should be removed.

Select **Next** to continue.

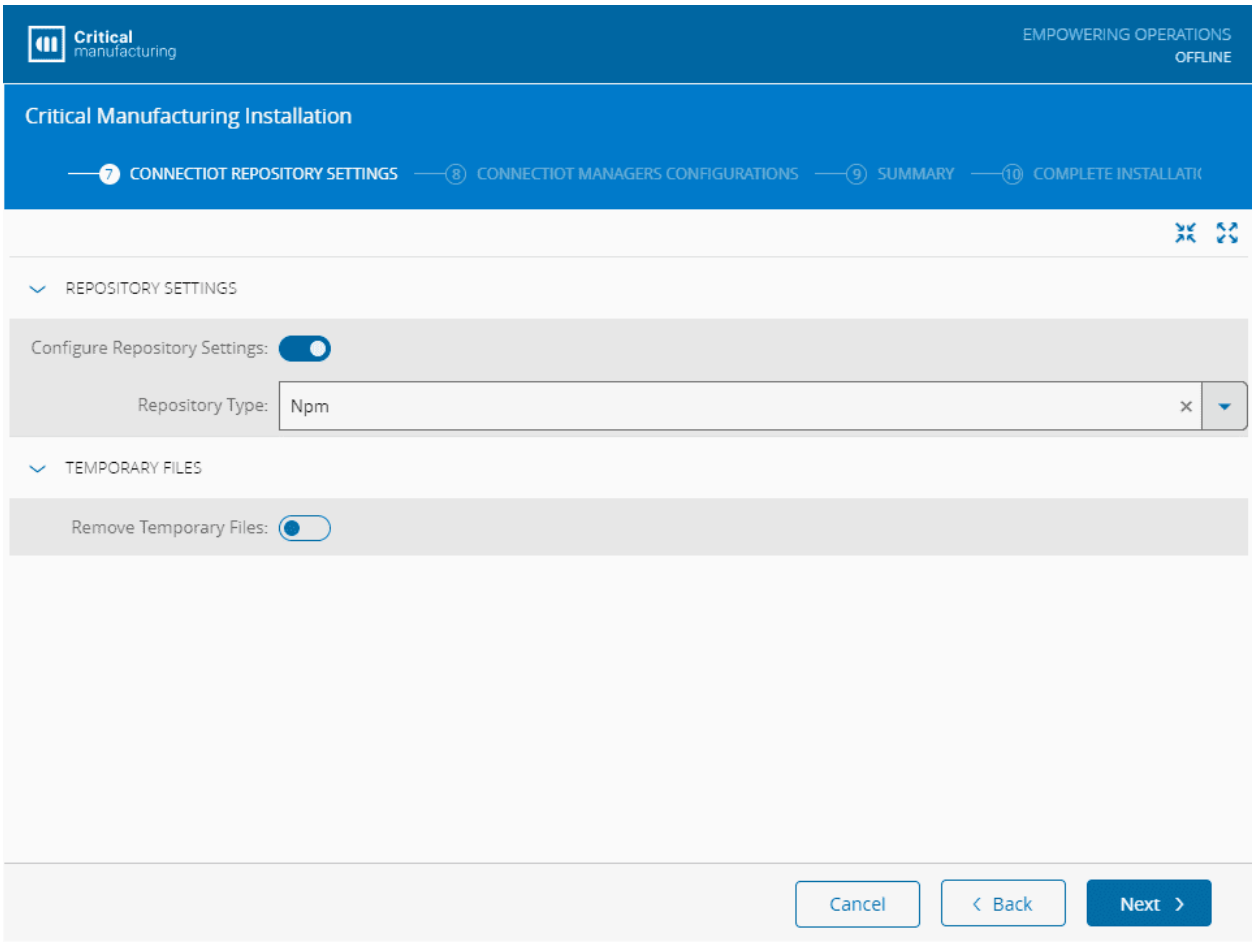


Figure 115: Deploy Connect IoT Packages - Connect IoT Repository Settings

39.2.5 Connect IoT Managers Configurations

In the **Manager Selection** group, insert the Automation Manager IDs (one entry per line), and define the base directory where the Managers will be running.

Finally, define whether the Manager should be installed as a service.

Below, in the **Automation Manager User Settings** group, define the user credentials (username and password) to be used to run the Automation Manager.

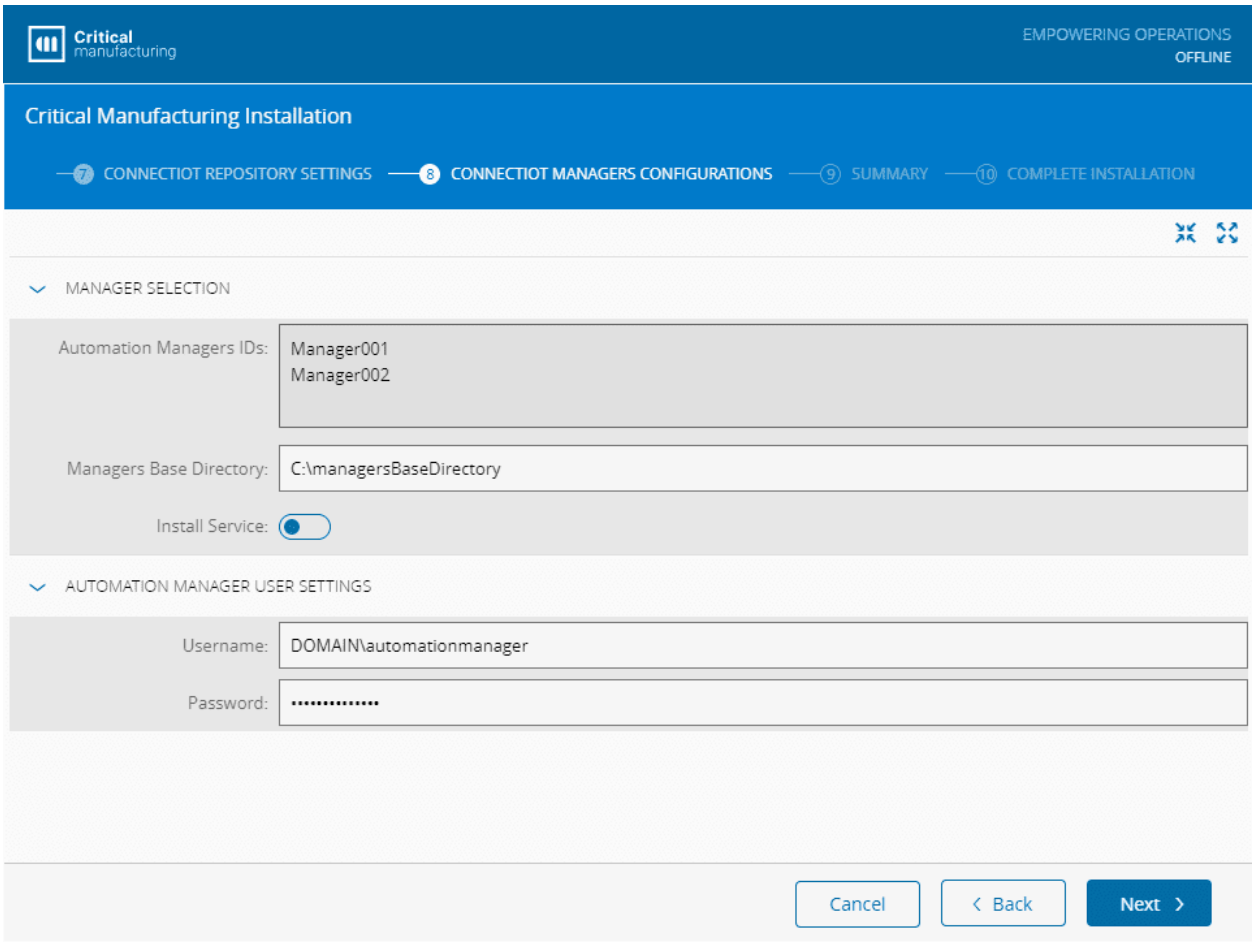


Figure 116: Deploy Connect IoT Packages - Connect IoT Managers Configurations

Select **Next** to review the installation summary, and then continue with the installation process until the end.

39.3 Manually Deploy Packages

Sometimes, there is the need to manually deploy packages - example: Customization packages, so it is important to understand how to accomplish this task.

39.3.1 Directory Repository

It is fairly simple to deploy a package or even a set of packages:

1. Copy the file(s) into the directory you are using as the Directory Repository (the one used in the installation of the previous section).
2. Execute the `.rebuildDatabase.ps1` PowerShell script that was created during the installation:

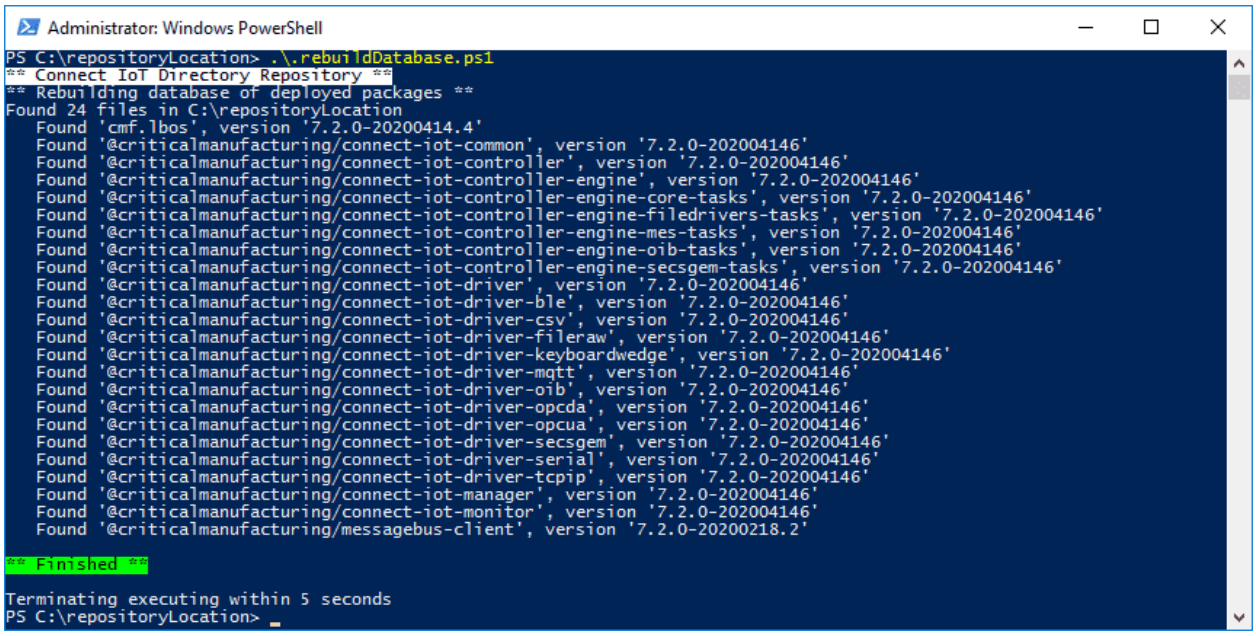


Figure 117: Rebuild database Powershell script

3. The database is now updated will all the available packages.

The script fully updates the content of the directory, so you can delete/add/update the packages and run the script.

39.3.2 NPM Repository

If the NPM server is configured with authentication roles for publishing, make sure you log in first:

```
npm login --registry=<url>
```

Then, and for each of the packages you intend to publish, run the command:

```
npm publish <package> --registry=<url> --tag=<tag>
```

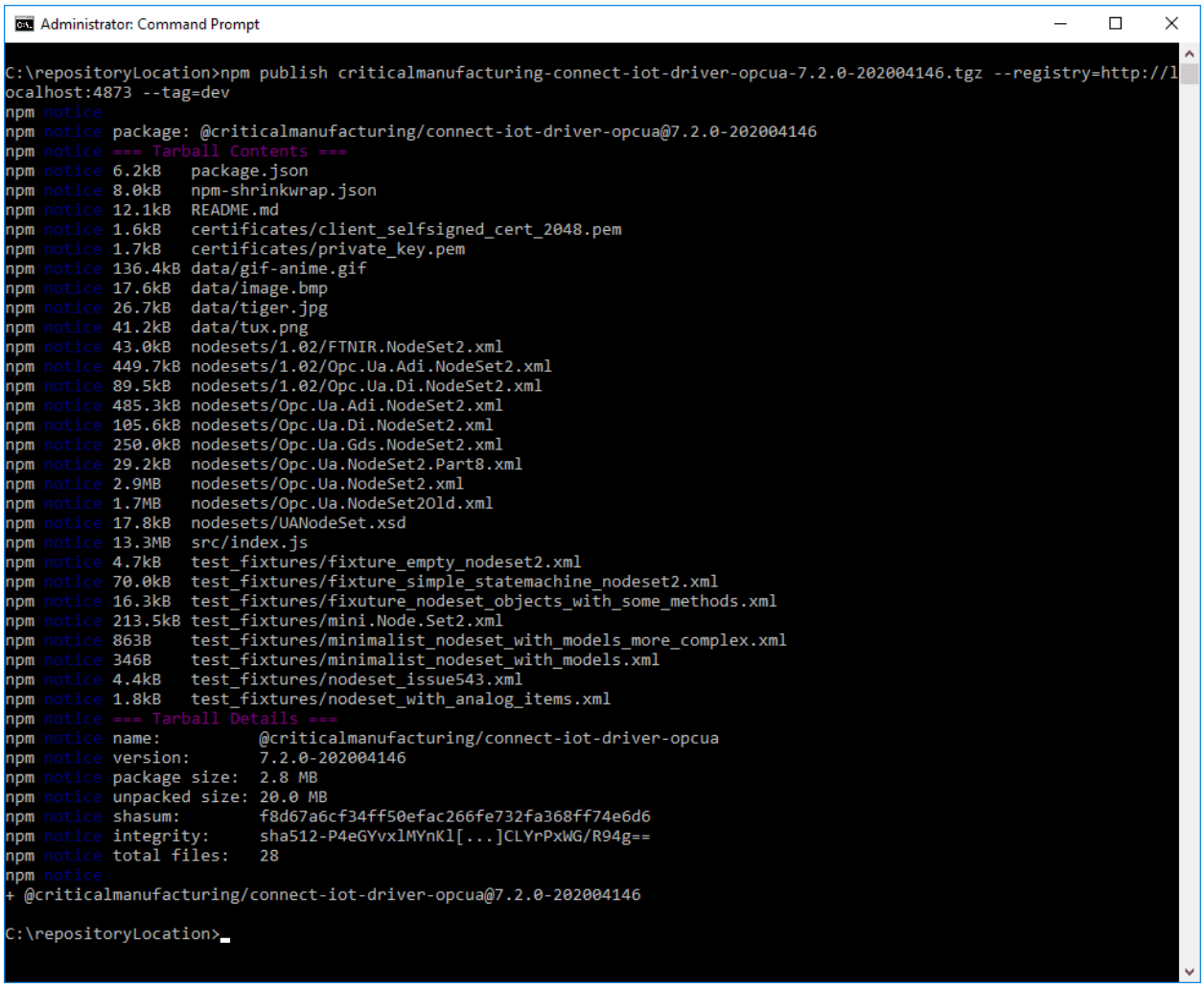


Figure 118: Running npm commands

39.4 Install Automation Manager

As of version 7.2, it is possible to download, from the `Automation Manager` entity page, a zip compressed file fully prepared to be used, so, installing the Automation Manager has never been easier.

After downloading the file using the respective wizard, simply extract all the contents into the destination directory.

The final step is to install the automation as a Windows Service. For this feature, execute the PowerShell script that is located in `scripts\\InstallService.ps1` as an administrator (requirement to create Windows Services), and answer the questions.

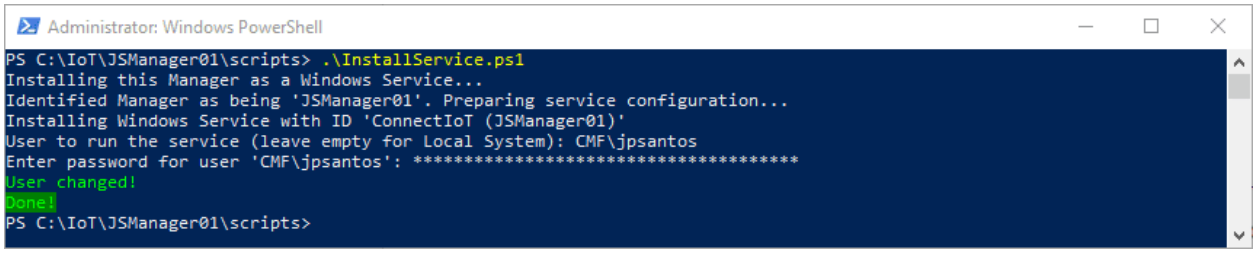


Figure 119: Install Automation Manager

.Net Framework 3.5 or higher is required for a correct installation of the Automation Manager.

39.5 Troubleshooting

39.5.1 "Unable to verify the first certificate"

39.5.2 "Unable to get local issuer certificate"

When you get any of these errors, this means you are connecting to an SSL enabled host and most likely, the server certificate was issued by a non trusted certificate authority.

To fix this issue, you need to create a text file will the entire chain of certificates (in `.pem` format), which is needed to allow the server certificate to be validated.

If you only have certificates in `.pfx` format, you can use OpenSSL to convert them:

```
openssl pkcs12 -in file.pfx -out file.pem -nodes
```

The structure of the final file is expected to be something like this:

```
-----BEGIN CERTIFICATE-----
bGUgQ28xEDAOBgNVBAsMB3RlY2hvcHMxCzAJBgNVBAMMAmNhMSAwHgYJKoZIhvcN
AQkBFhFjZXJ0cOBleGFtcGxlLmNvbTAeFw0xOTA1MTcxMDQ5NTRaFw0ONjEwMDEx
...
oEGp4U7q1UGmGfmXKiT/gsxJB6bbD6kO1SVdE+706WLg1vN4cLj1jvIr0OjhWt41
sJtjAyB64zRVeS5Ic7Vidv6UDMM=
-----END CERTIFICATE-----

-----BEGIN CERTIFICATE-----
MDQ5NTRaMIGBMQswCQYDVQQGEwJVUzELMAkGA1UECAwCTUExDzANBgNVBAcMBkJv
c3RvbjETMBEGA1UECgwKRXhhbXBsZSBDbzEQMA4GA1UECwwHdGVjaG9wczELMAkG
...
knyZpJnYVisd5NUVmjWNSlK/S6eA/Ka9LxFUhjRt0MMcXP91YHp6+rgsigZt5c3V
aBM3yGsn3YQnttUNp2dQwBgNpH9=
-----END CERTIFICATE-----

-----BEGIN CERTIFICATE-----
BwmQEGpD6ECCjPXZLH38KLCpSLzzQEqz0tulvDtRIGlEPLsdlWMLnwbQPG/TJ2M5
Gpezb90Lqfi6POObEIO3/3dAewgn4xhW6aZHf6yWgtM7gdQIJpRXK2T8ZGWv1LMz
...
KAjgC4ttj4DlJfljq61DlegE/0BbAtqNiQ3er9NB/wor3ET5eOO/12Ly1eotiHd5
/rkm+ENnvbNWk4w+LzHXfejtSAh=
-----END CERTIFICATE-----
```

Then, set the location of this file into the `NODE\_EXTRA\_CA\_CERTS` environment variable:

```
set NODE_EXTRA_CA_CERTS=c:\certificates\extra_ca_certificates.txt
```

As an alternative, you can disable the certificate integrity check. This will not disable security, but will use the certificate exactly as received. However, this option should **only** be used in a development environment.

```
set NODE_TLS_REJECT_UNAUTHORIZED=0
```


The environment variables should be defined as a persistent wide definition. The commands explained in this section are temporary and will only be valid during the session of the command window.

40 Theobald ERPConnect License

In addition, it is also necessary to license the Theobald ERPConnect component by obtaining a valid license key which must be encrypted using the tool *String Encrypter* available in the installation CD in the folder `packages\\Cmf.ERPLicenseEncrypter.6.1.0.zip`. The encrypted string must be set in the configuration file of each application server under the entry **ERPConnectorLic** in the **SapConnector** section of the `.config` file together with the remaining ERP configuration entries, as listed in the next section.

40.1 ERP Application Configuration Entry Files

The table below describes the ERP application configuration entries of the SapConnector section `.config` of the Critical Manufacturing application.

Table 45: ERP Application Configuration Entry Files

Key	Description	Example
ERPMgmtActive	Enable or disable ERP integration - this flag will determine if the Critical Manufacturing will be able to send and receive information from SAP (true, false)	`true`
ERPHost	The SAP server name	`/H/saprouter.mycompany.com/H/m2bsrv03`
ERPSystemNumb	The SAP system number	0
ERPService	The name of the gateway in SAP, which is usually a string that results from the concatenation of the constant `sapgw` with the system number (i.e: sapgw00)	`sapgw00`
ERPProgramID	The Registered Server Program name (this must match the Registered Server Program defined in SAP in transaction SM59)	`ZERPCONNECT`
ERPUser	The user name used to connect to the SAP system	`user001`
ERPPwd	The user password used to connect to the SAP system	12345678
ERPClient	The SAP client (usually a number)	800
ERPLanguage	A two letter string that defines the language to be used for the SAP integration (e.g.: EN for English or DE for German)	`EN`
ERPConnectorLic	ERP connector license string - this string must be encrypted from the original license string and using the tool Script Encrypter included in the `Software\\cmNavigo` Tools directory	`Encrypted license key text`

40.2 Configuring ERP Integration

Critical Manufacturing ships with a generic ERP Integration solution that is capable of working with different ERPs. This configuration is based on three tables listed below, filled with sample configuration data for illustration purposes:

40.2.1 IntegrationSystem (Lookup Table)

Used to define the different systems to be integrated.

Table 46: IntegrationSystem Lookup Table

Value	Description
MES	MES
ERP	ERP

40.2.2 IntegrationHandler (Generic Table)

Used to register the assembly to be used for the integration.

Table 47: IntegrationHandler Generic Table

Name	AssemblyQualifiedName
SapIntegrationHanc	Cmf.Foundation.Integration.SapConnector.SapIntegrationPackage, Cmf.Foundation.Integration.SapConnector, Version=4.2.0.0, Culture=neutral, PublicKeyToken=6bbf07329f6aa8df

40.2.3 IntegrationHandlerResolution (Smart Table)

Used to define the assembly to be used for a particular integration between two systems.

Table 48: IntegrationHandlerResolution Smart Table

FromSystem	ToSystem	MessageType	HandlerType
MES	**ERP**		SapIntegrationHandler
ERP	**MES**		SapIntegrationHandler

More information in the IntegrationHandlerResolution Smart Table.

41 Manually Set TRUSTWORTHY Database Property on Always On Systems

For customers installing Critical Manufacturing on Always On availability groups it is necessary to manually set the trustworthy flag on the secondary replicas. For the Online, ODS and DWH databases follow this procedure:

1. Failover to the node currently holding the secondary replica.
2. Run the following command statement in SQL Management Studio:

```
ALTER DATABASE <Database Name> SET TRUSTWORTHY ON;
```

42 Report Server Security

This section describes the SQL Server Reporting Services' security configuration from the point of view of SQL Reporting Services' server. Critical Manufacturing provides an integrated security management GUI which allows the security configuration to be managed from a central location.

To access reports from Critical Manufacturing, a domain group must be configured in the report server and the same domain group must be created as a role in Critical Manufacturing. All users that belong to that role will have access to the reports.

The user who is running the Critical Manufacturing Windows service must have administration privileges on the SQL Server Reporting Services server(s).

Due to security restrictions on application servers, it is advisable to open the Report Server Manager in a client computer and not on the server.

42.1 Accessing SQL Server Reporting Services

To configure the security settings for Critical Manufacturing's reports, it is necessary to access SQL Server Reporting Services™ by using the browser and providing an URL address in the form:

`http://[server\_name]/Reports\_[instance\_name]`

- The `[server\_name]` must be replaced by the name of the server where the SQL Server Reporting Services is installed.
- The `[instance\_name]` must be replaced by the name of the instance where the SQL Server Reporting Services is running.

In case that the server name is `dbserver` and the SQL Server Reporting Services instance name is `online`, the URL address to access the SQL Server Reporting Services is:

`http://dbserver/Reports\_ONLINE`

Due to security restrictions and browser configurations, adding the Report Server manager URL to the browser trusted sites' list, could be required.

42.2 Assigning or modifying a User/Group to a System Role

Follow the steps below to assign or modify a user/group to a system role:

1. Click on **Site Settings**, available in the top right corner.
2. In the left tab, click on **Security**. The roles for each user and group are displayed.
3. To add a new role, click on the **New Role Assignment**, and then enter the Group or User Name and specify the Roles to be assigned.
4. To edit one user or group role, click on the user or group **Edit** link.
5. To delete one or more roles, tick the checkbox and click on **Delete**.

42.3 Defining Role-based security for the Reports Homepage

Follow the steps below to define the roles for the home page:

1. In the homepage, click on the **Properties** tab.
2. To add a new role, click on the **New Role Assignment**, and then enter *Group* or *User Name* and specify the Roles to be assigned.
3. To edit one user or group role, click on the user or group **Edit** link.
4. To delete one or more roles, tick the checkbox and click on **Delete**.

42.4 Defining Security by Folder

By default, each folder inherits the security definitions from the parent folder. It is possible to change this configuration by following the steps described below:

1. Click on **Folder Settings**.
2. Click on **Edit Item Security** and perform the desired changes.

It is also possible to customize each folder with different security settings. In order to do that, follow the steps below:

1. Click on the folder to change the roles.
2. Click on the **Properties** tab.
3. Click on **Edit Item Security** and perform the desired changes.

 Click on **Revert to Parent Security** to inherit the father's folder roles again.

43 Critical Manufacturing Upgrade Procedure

The Critical Manufacturing Upgrade procedure is heavily dependent on the level of customization of the system and must always be validated and rehearsed in a staging system. When upgrading between major versions, it's expected that some downtime is required. When upgrading between minor versions of the system it might be possible to upgrade without downtime depending on the customer requirements. While the database is being upgraded incoming requests might block waiting for the upgrade to complete and this might have impact on the system normal operation. When applying an update, it's not expected any downtime.

Information on the upgrade procedure for the Critical Manufacturing MES is available on the Developer Portal.

43.1 Upgrade an MES Customer Environment

Upgrading a Customer Environment is a simple process in the DevOps Center. Having an existing Customer Environment, the process relies on creating a new version and changing what is necessary before deploying. What changes in an upgrade is completely your choice.

By creating a new version, changing configurations and finishing by deploying, a new stack will be created in the cluster with the newly applied changes.

To exemplify, you should continue from the [installation-guide-installation#step-1-create-an-environment|Create Environment] section of the Guide and upgrade that environment to a Critical Manufacturing MES v8.3.3. This will create a new environment and the actual system will also upgrade the database to v8.3.3 during the installation.

1. Start by selecting **New Version** in the main page of the Customer Environment.

   New Version button on the Customer Environment main page

2. In the wizard, nothing has to be done. However, it is possible to change the **Description** and opt-in to clear the parameters. Be careful as this last operation clears all configurations for the new version. Select **Create** and the new version is created in the system.

3. The next step is to change Critical Manufacturing MES from v8.3.2 to v8.3.3. In the installation page, change the **Deployment Package** to `MES 8.3.3`.

   Changing the Deployment Package to MES 8.3.3 in the installation page

4. The version is now changed from v8.3.2 to v8.3.3. This is enough for the upgrade to happen after triggering the deployment process. However, if using a customization package and if the upgrade also comprehends a change to that package, it is necessary to change it. In that case, update the value of **Package to Install** in the **General Data** step.

   Updating the Package to Install field in the General Data step

    If consuming local packages for Critical Manufacturing MES Environment Manager, such as a customization package, do not forget to add those to the location that the Boot Packages Folder points to.

5. In case the upgrade also comprehends changing any configuration or enabling a new feature, you can now do that. What you have to do is select **Next** and wait until the execution jumps to the Deployment step, and then wait until the deployment and installation finishes. You are advised to turn on Critical Manufacturing MES Maintenance Mode before upgrading to ensure that if the new version has integration entries to be processed, these are not handled by the old Critical Manufacturing MES that is still running as this could result in errors or data inconsistency.

   To turn on the Maintenance Mode, go to Critical Manufacturing MES, select **Administration** followed by **System Monitoring**. On that page, there is a button named **Set Maintenance Mode**. Select it.

   Set Maintenance Mode button in the System Monitoring page

Selecting **Active** will turn on the Maintenance Mode. A notification is then displayed in the bottom-left corner:

Notification confirming that Maintenance Mode is active

6. After starting the Deployment, the process is the same; it is automatic and feedback is presented.

   Deployment progress and status for the new MES version

   After a short time, the Deployment should finish with success (upgrades take longer than clean installs). This indicates that the new stack was successfully deployed and Critical Manufacturing MES was upgraded.

7. Lastly, you have to deactivate the Maintenance Mode. Once again, go to Critical Manufacturing MES, select **Administration** followed by **System Monitoring**. Select **Set Maintenance Mode** and then select **Deactivate**.

   Deactivate option for Maintenance Mode in System Monitoring

   After deactivation, you are presented with a notification regarding the new version that is available:

   Notification indicating that a new MES version is available after upgrade

   Selecting the new version will refresh Critical Manufacturing MES, which will load any new changes that came from the upgrade.

44 Uninstall

To uninstall the Critical Manufacturing software, follow the steps below:

1. Manually remove all the Windows-specific Services. To know specifically which services need to be removed, go to System Architecture, scroll down to the **Optional Components** and see each corresponding service.
2. Remove the databases
    - **Online**
    - **ODS**
    - **Data Warehouse**
    - **Analysis Services**
3. Remove the MES Reports from SQL Server Reporting Services.
4. Open the SQL Server Agent, go to **Jobs** and click on **Job Activity Monitor** to remove all related jobs.
5. Go to **Linked Servers** (in the instance, go to **Server Objects** and **Linked Servers**) and remove all related linked servers.
6. Follow the steps on the Customer Portal support website here to continue uninstalling the application.

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