



FORCAM FORCE EDGE

Version 220404

Manual



Document: Manual - FORCAM FORCE
EDGE 220404.docx



Release date: 2022-04-25



Document version: 1



Author: AEgilmez, STernes

Content

1	Concept	4
2	System Components	6
2.1	Machine Connectivity & Model	6
2.2	Plugins.....	7
2.3	Data Lake	7
2.4	EDGE API	8
2.5	EDGE Configuration	8
2.6	Machine Repository	8
3	System Architecture.....	9
4	Deployment.....	11
5	Basic settings	12
5.1	User management	13
5.2	Licensing	15
5.3	Download area	16
5.4	Monitoring	16
5.5	Sorting of table entries	17
6	EDGE Configuration.....	18
6.1	Add EDGE node	20
6.2	Add machine	21
6.2.1	① Select template	22
6.2.2	② Basic information	23
6.2.3	③ Customer-specific settings	24
6.2.4	④ MDC controller	25
6.2.5	⑤ Signal	26
6.2.6	⑥ Script.....	27
6.2.7	⑦ DNC configuration.....	28
6.2.8	⑧ Overview	29
6.3	Event configuration	30
6.3.1	Signals & events from EDGE to superordinate system	32
6.3.2	Data & documents from superordinate system to EDGE	35
6.3.3	Configure an event.....	35

7	Monitoring	36
8	Annex	38
8.1	Table of changes.....	38
8.2	Document conventions.....	39
8.3	Abbreviations and terms	40
8.4	List of supported plugins	41
8.5	Standardized events	43
8.6	Script examples	44
8.6.1	Machine status and temperature	44
8.6.2	Temperature and humidity.....	45
8.6.3	Crane control	46
8.6.4	Signal package.....	48
8.7	Script functions	51
8.8	Table of figures.....	56

1 Concept*

FORCAM FORCE EDGE offers manufacturing companies a solution for digitally connecting their heterogeneous machinery. Almost all machines can be digitized with FORCAM FORCE EDGE, regardless of age or technical status. Thus, FORCAM supports the digital transformation of a manufacturing plant in the Brownfield environment.

FORCAM therefore delivers a product that solves the main requirement of Industry 4.0 by extracting digital information from the production machinery. This makes a significant contribution to the digital transformation by closing the gap between IT (information technology) and OT (operational technology).

FORCAM FORCE EDGE interconnects the various machine connections and signals and delivers them as standardized events to superordinate systems. These can be ME or MOM systems such as SAP DMC/ME or MII, among others. FORCAM can thus reduce the time and effort required for digitization and create a standardized interface to the machine park. The machines are connected via an innovative plugin concept for easier future expansion. All common machine manufacturer-specific (proprietary) protocols are presently supported (such as HEIDENHAIN, Siemens S7 or FANUC & Co.) as well as all common communication standards (such as MTConnect, OPC-UA or MQTT). The FORCAM I/O Controller is available as separate hardware for digitizing the machine if the machine is not network-capable. FORCAM FORCE EDGE is continually expanded with plugins in order to meet the challenge of digitally mapping every type of machine via the EDGE solution.

The machine connections are used to obtain a wide variety of information. This includes information about the current status of the connected machines or their sensor readings, such as temperatures, pressures or energy consumption. Particularly in the Brownfield environment, it is important not only to pick up the signals and transmit them, but also to interpret them for use. This task is performed by the EDGE Composition Layer. For instance, the interpretation of when a machine is actually in production or at stoppage is fundamentally important. FORCAM FORCE EDGE is not only able to read or write machine signals. Another essential part of the solution is the handling of NC programs and the ability to transfer them to and from the machine.

FORCAM FORCE EDGE's modern, cleanly structured menu navigation makes it quick and efficient to digitally connect machines using the available control and signal information.

The Machine Repository component makes it easy to create and use machine templates. This means that templates can be defined for machine connections or derived from existing connections and used for the connection of the same machine types. This further reduces the individual effort required to connect a machine, which saves time and resources for the digitization project. The template structure ensures a standardized connection of identical machines, thus enabling the comparison of machines of the same type.

FORCAM provides standard templates for common machines.

* For better readability, we are using the generic masculine form in the text. These formulations, however, encompass all genders and address everyone equally.

Concept*

FORCAM FORCE EDGE is flexible and can be applied to any manufacturing company. The individual components of the solution can be located in different areas and levels and provide benefits at each level.

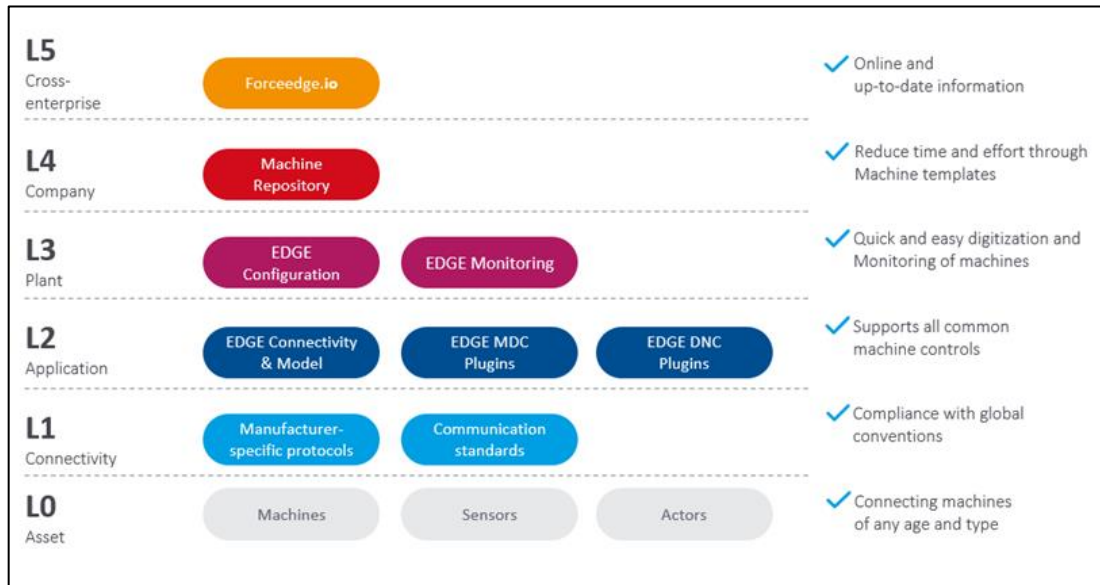


Fig. 1: Location of the FORCAM FORCE EDGE solution components

The following figure shows the reference architecture of the Open Industry 4.0 Alliance, which is also the basis of the FORCAM FORCE EDGE architecture. FORCAM contributes significantly to digitalization in industry and focuses on customer benefits. The connectivity of hardware through intuitive and user-friendly software is what makes FORCAM FORCE EDGE stand out.

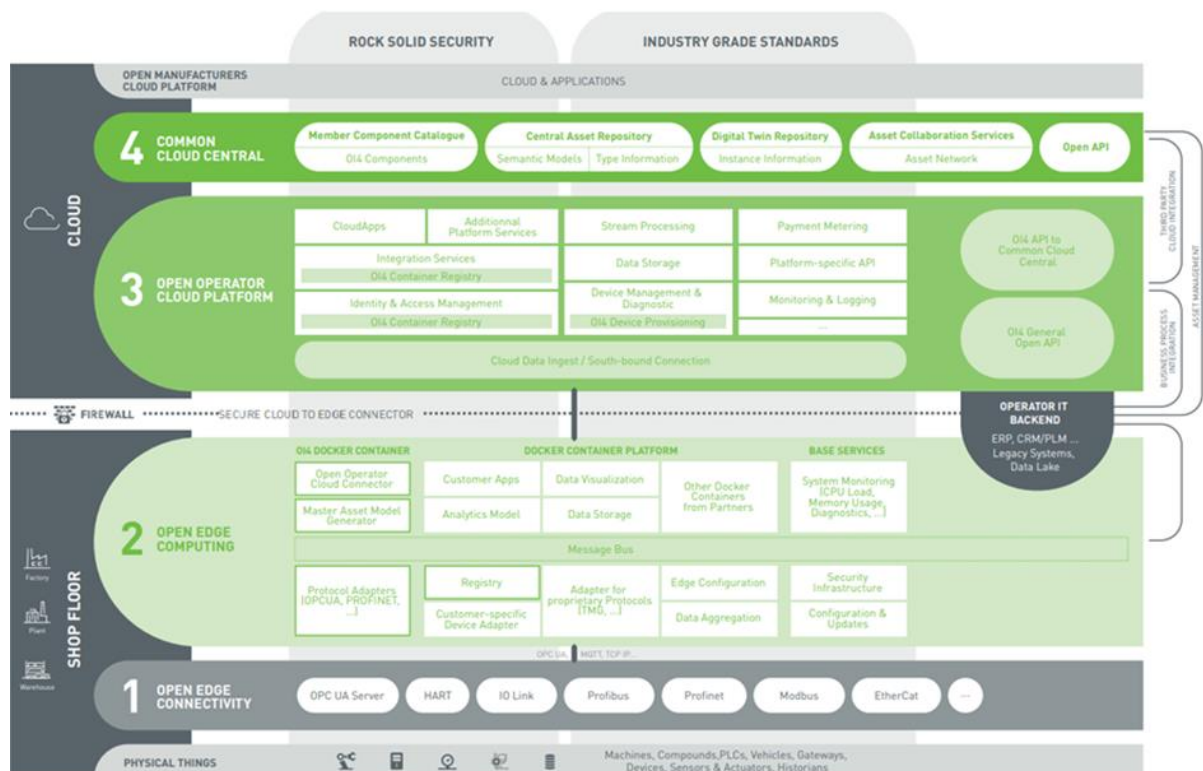


Fig. 2: Reference architecture of the Open Industry 4.0 Alliance

This chapter explains the individual components of FORCAM FORCE EDGE and their functions.

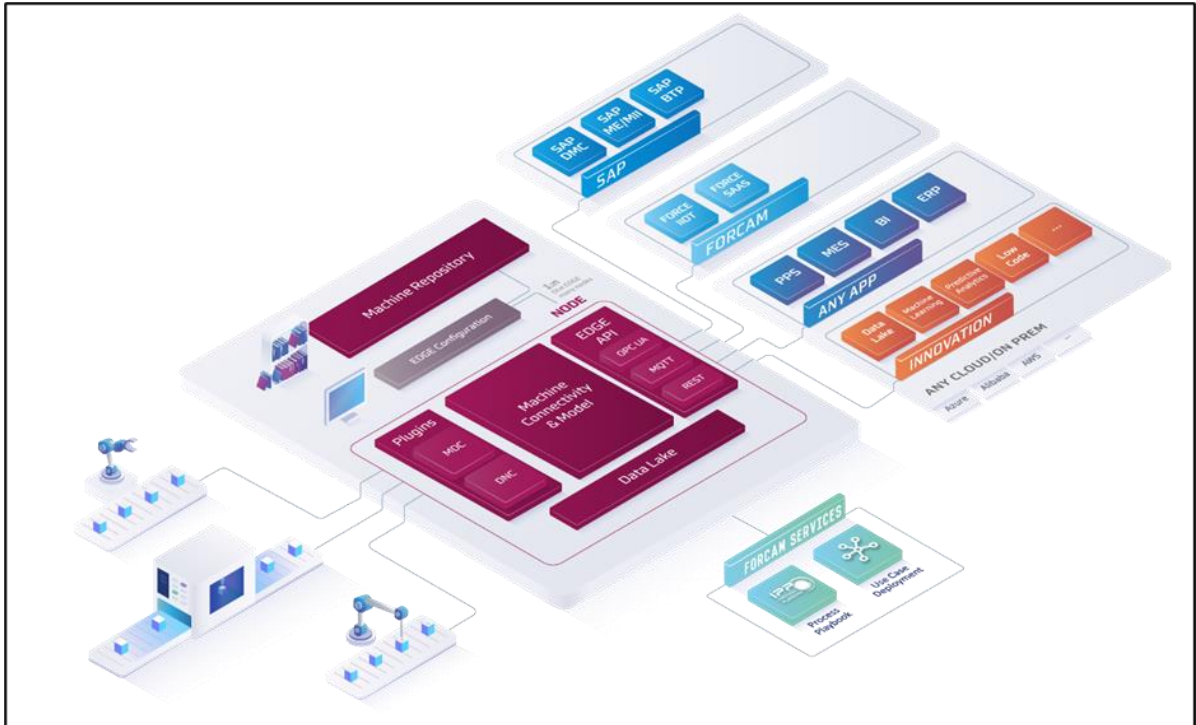


Fig. 3: Schematic structure of FORCAM FORCE EDGE

FORCAM FORCE EDGE's central system component **Machine Connectivity & Model** is the core element of machine connectivity and contains the following relevant subcomponents:

The EDGE MDC layer manages the actual connection of the machines. The essential elements are the selection of the suitable plugin for the communication with the machine control, the configuration of the machine master data, the setting of the network connection and the definition of the machine signals. In addition, the EDGE MDC Layer forwards machine signals to the EDGE Composition Layer.

The EDGE DNC Layer manages the actual connection of machines with an NC supply. The essential elements here are the selection of the suitable plugin for communication with the machine control, the configuration of the machine master data, the setting of the network connection and the configuration of the DNC supply.

EDGE Composition Layer

The EDGE Composition Layer enables deriving logical machine states. Using a simple script language, status events can be derived from signal combinations. This is an important factor for success in the Brownfield environment, since older machines can be operated, which would otherwise not provide any usable information. For this purpose, the standardization of the report capability is ensured by the composition layer. This is done via a scripting language. In addition, options for individual events are also provided. The scripts also make it possible to react to events and write values to the machine's control unit.

2.2 Plugins

Plugins in the FORCAM FORCE EDGE environment are used to establish communication links with specific machine controllers. They allow direct communication with various machine controllers, but also cover modern communication protocols such as MQTT, OPC UA and many more. The plugin concept of FORCAM FORCE EDGE is extendible, FORCAM is continuously expanding the number of supported plugins.

The plugins are divided into those for Machine Data Collection (MDC) and for Distributed Numerical Control (DNC).

MDC plugins include those designed for unidirectional readout of machine signals as well as for bidirectional signal transmission, i.e. for reading out and writing back signals.

DNC plugins are used for transferring and reading NC files. They are used for transferring NC programs to the machine's file system or to query the program active on the machine.

For the most common control types, a set of plugins is included in FORCAM FORCE EDGE by default. An overview of the current FORCAM plugins is listed in section 8.4.

 Providing, editing or managing NC programs is not a function of FORCAM FORCE EDGE

2.3 Data Lake

To obtain a digital twin of a machine or control system, it is not only important to establish connectivity to the machine, interpret the signals and pass them on to other applications, but also to store the data. With Data Lake, all data is stored on signal level, interpretation level, and event level, this includes configuration changes, write operations and transmitted NC files.

The data is made available through the EDGE API. This allows the latest AI algorithms, visualization tools but also audit requirements to benefit from it. This is the foundation for Data-Driven Manufacturing.

2.4 EDGE API

The EDGE API as RESTful API is used to retrieve machine master data and for configuring the machine connections. The EDGE API event service is used to forward machine data in the form of standardized events to superordinate systems (3rd party). Superordinate systems can be connected either via HTTP/REST, MQTT, or OPC UA. The events are transmitted via HTTP in JSON format. When using MQTT, a broker is necessary as middleware.

The EDGE API is delivered with preconfigured standard events for communication with the MES or ERP level. If necessary, these can be further individualized.

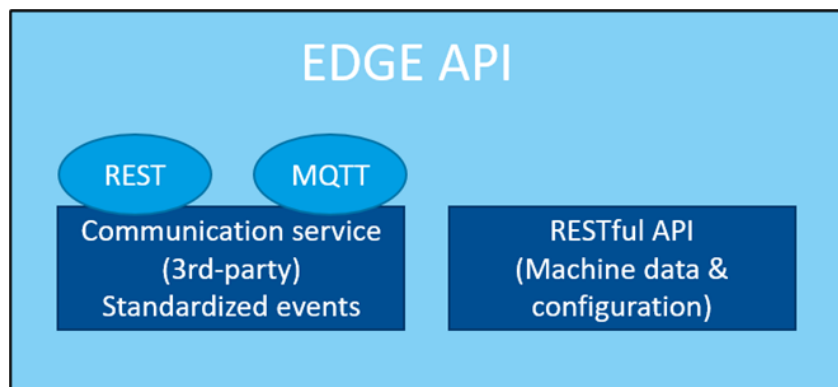


Fig. 4: The EDGE API structure

2.5 EDGE Configuration

EDGE Configuration is the management interface for FORCAM FORCE EDGE. It can be used to manage multiple EDGE nodes. An EDGE node is the bundling of signal collection from several machines. Depending on the amount of data, one or more EDGE nodes are used per plant. The management of the nodes is done centrally.

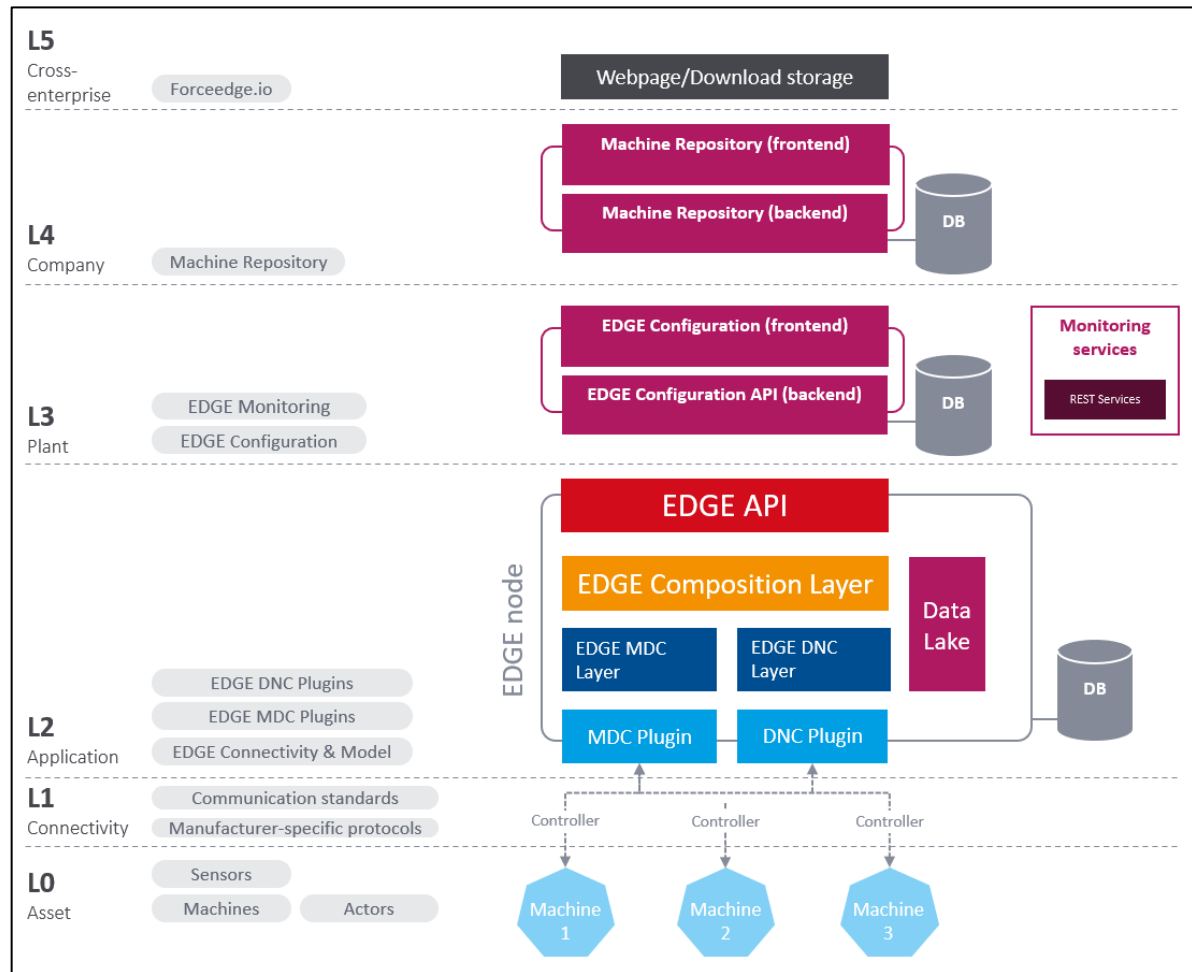
2.6 Machine Repository

The Machine Repository lets you generate templates from existing machine connections or for new ones. These templates can be used to connect machines of the same type and the same usage type in a standardized manner. The template contains all configuration elements that are not machine-specific. Individual configuration elements of machines and connections are, for example, IP address, machine name, equipment number, etc.

By using an existing template, the time required to connect a machine is significantly reduced.

3 System Architecture

FORCAM FORCE EDGE is architecturally divided into levels (layers). These are based on the business use case, which enables a high scalability of the individual components. For example, multiple EDGE nodes can be hosted to divide the machines logically, but also based on performance.



Level 0 - Asset

The lowest layer is where the machines, sensors and actuators are connected. In this respect, the value added pledge is to support every machine in terms of type and age.

Level 1 - Connectivity

The growing selection of plugins facilitates the connection of a wide variety of controllers with their different communication standards such as OPC UA or MT Connect, as well as manufacturer-specific protocols.

System Architecture

Level 2 - Application

The number of possible edge nodes is not limited. A node encompasses several layers or tasks:

- **EDGE MDC Layer** controls the connection of the machine via **Plugins** and forwards the signals to **EDGE Composition Layer**. Similarly, DNC capable machines are connected via **EDGE DNC Layer**.
- **EDGE Composition Layer** is responsible for signal interpretation and for creating the standardized events.
- **EDGE API** is the programming interface through which machines, event management and notification of third party systems can be configured and done "northbound".
- **Data Lake** keeps all data, configuration changes as well as write operations or transferred NC files. The data can then be accessed via the EDGE API.
- **DB** holds all configurations related to machine connectivity and works autonomously as a node.

Level 3 - Plant

The configuration component can serve 1 to n EDGE nodes. This can be provided per plant, as well as per production line.

Each component is standalone and can run without a connection (for example, if temporarily down). This enables a wide variety of deployment. For example, EDGE Configuration does not necessarily have to be hosted in FORCAM FORCE EDGE itself, but simply a connection to the respective API has to be established.

All components communicate via standardized interfaces (HTTP/REST).

Level 4 - Company

The Machine Repository is a FORCAM FORCE EDGE component that lets you create and manage machine connection templates.

Level 5 - Cross-enterprise

FORCAM FORCE EDGE provides a collection of machine configuration templates freely available via forceedge.io. These can be downloaded via forceedge.io and then imported into your own machine repository.

4 Deployment

FORCAM FORCE EDGE can be purchased and installed on premise or directly as Software as a Service (SaaS).

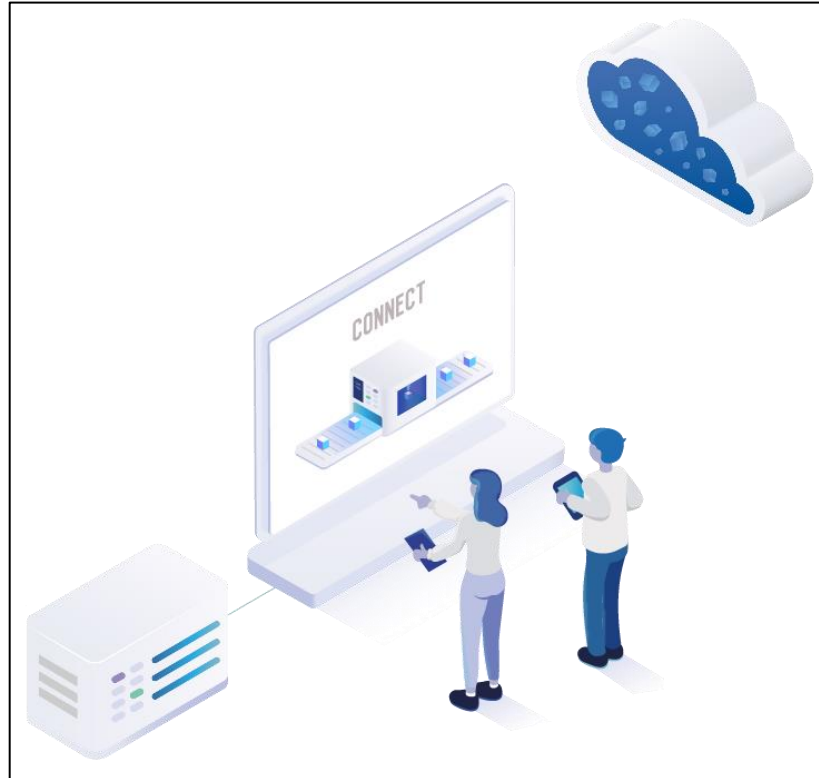


Fig. 5: Options for installing FORCAM FORCE EDGE

On premise

Two installers are provided for an on premise installation: **ForceEdgeUI** and **ForceEdgeNode**. These are installed by the customer themselves, or by a FORCAM service provider.

ForceEdgeUI contains the entire user interface including all functions and is installed first.

ForceEdgeNode contains the Edge node and can be installed as often as needed, since the number of nodes in FORCAM FORCE EDGE is not limited, it only depends on the subscription model purchased. This defines how many nodes can be created and how many controllers can be connected per node.

SAP BTP (SaaS)

FORCAM FORCE EDGE can be purchased as a solution extension of **SAP Digital Manufacturing Cloud** (SAP DMC) on the SAP Business Technology Platform (SAP BTP).

If purchased as SaaS, FORCAM provides the hardware on which FORCAM FORCE EDGE is run. A Microsoft Azure Stack Edge (ASE) is used for this purpose, which is preconfigured by FORCAM. To do so, FORCAM requires specific IP addresses, which must be entered manually by the customer or communicated to FORCAM's service providers. The customer is responsible for integrating the ASE into the existing hardware environment. FORCAM guarantees the function and availability of the ASE and the software components.

5 Basic settings

General settings for FORCAM FORCE EDGE are possible in the **Home** section.

In addition to the user administration and permissions, current documents can also be downloaded here. This chapter covers **User Management**, **Licensing**, the **Download Area** and **Monitoring**, and then explains how table entries are sorted.

- ❗ The settings made for language and dark mode in the profile are saved in the user profile and apply only to this user.

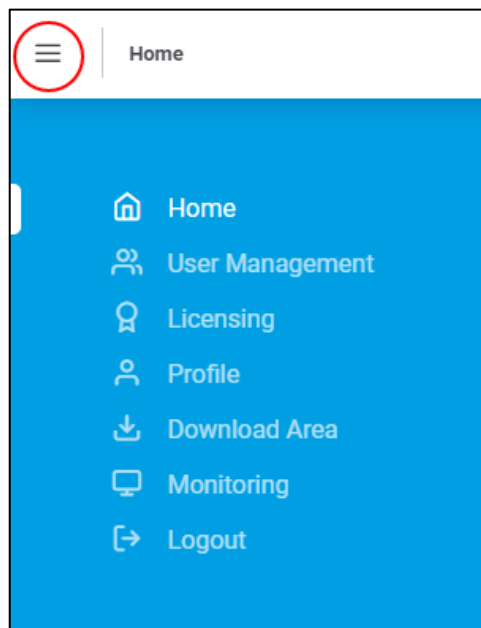


Fig. 6: Calling up the Home section

5.1 User management

Users are created for FORCAM FORCE EDGE in the user management. Each user can be assigned permissions containing only the functions appropriate or intended for that user (e.g. configure machine, restart node, etc.). Existing user accounts can also be edited subsequently.

- i** Once the permissions of a logged-in user have been changed, they take effect immediately after a new login. However, it may take up to 30 minutes for the change to take effect if the user does not log in again.

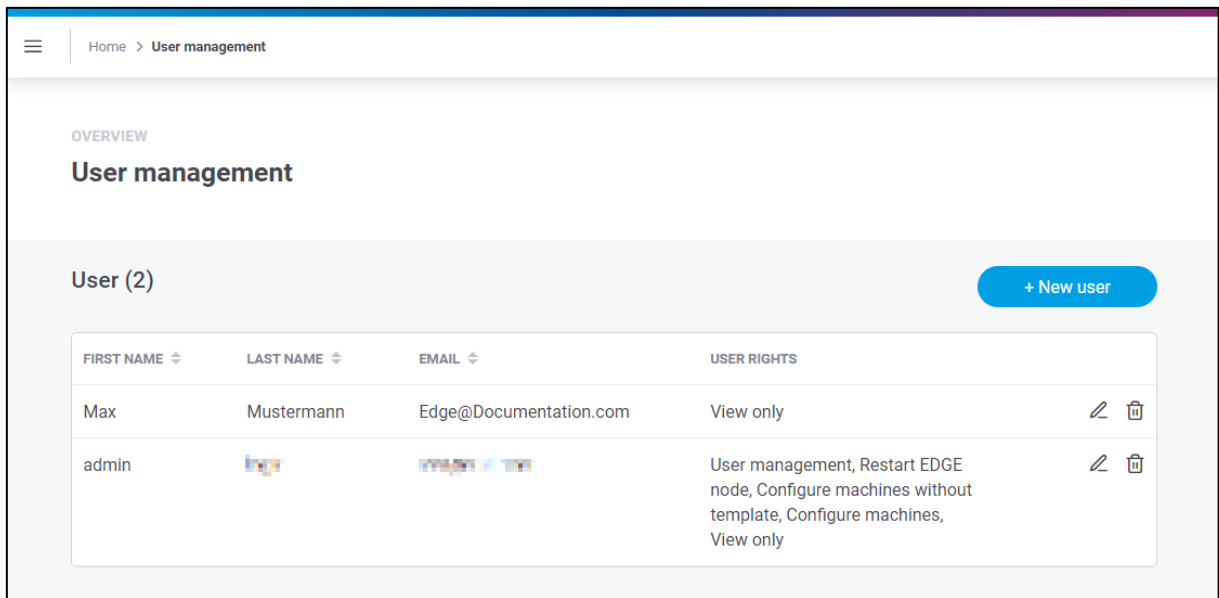


Fig. 7: FORCAM FORCE EDGE user management with 2 users

To create a new user:

1. Click on **+ New user**.
2. Enter an email address, first and last name in the subsequent dialog.
3. Set the desired password.
This must be at least 8 characters long, consist of upper and lower case letters and contain at least one number and one special character.
The following special characters are permitted:
! " # \$ % & ' () * + , - . / : ; < = > ? @ [\] ^ _ ` { | } ~
4. Assign user permissions (see below).
5. Save.

- i** A user with the same data cannot be created a second time.

Table 1: User permissions in FORCAM FORCE EDGE

User permission	Description
User management	The user can call-up the user management, create new users and assign/remove permissions.
Restart Edge node	The user can restart an Edge node.
Configure machines without template	The user can create machines without the use of MR templates.
Change template-based machine values	The user can change those data that have been adopted from the template for the asset.
Configure machines	The user can create machines only by means of MR templates. Changes cannot be made.
View	The user is only able to view the Edge node. Changes cannot be made.

Create new user

Email *

john.doe@forcam.com

First name *

John

Last name *

Doe

New password *

Confirm password *

User rights:

User Management

Monitoring Page

Restart EDGE node

Configure machines without template

Change template-based machine values

Configure machines

Configure nodes

View

Cancel

Save

Fig. 8: Dialog for creating a new user

5.2 Licensing

Licenses can be imported and viewed under **Licensing**.

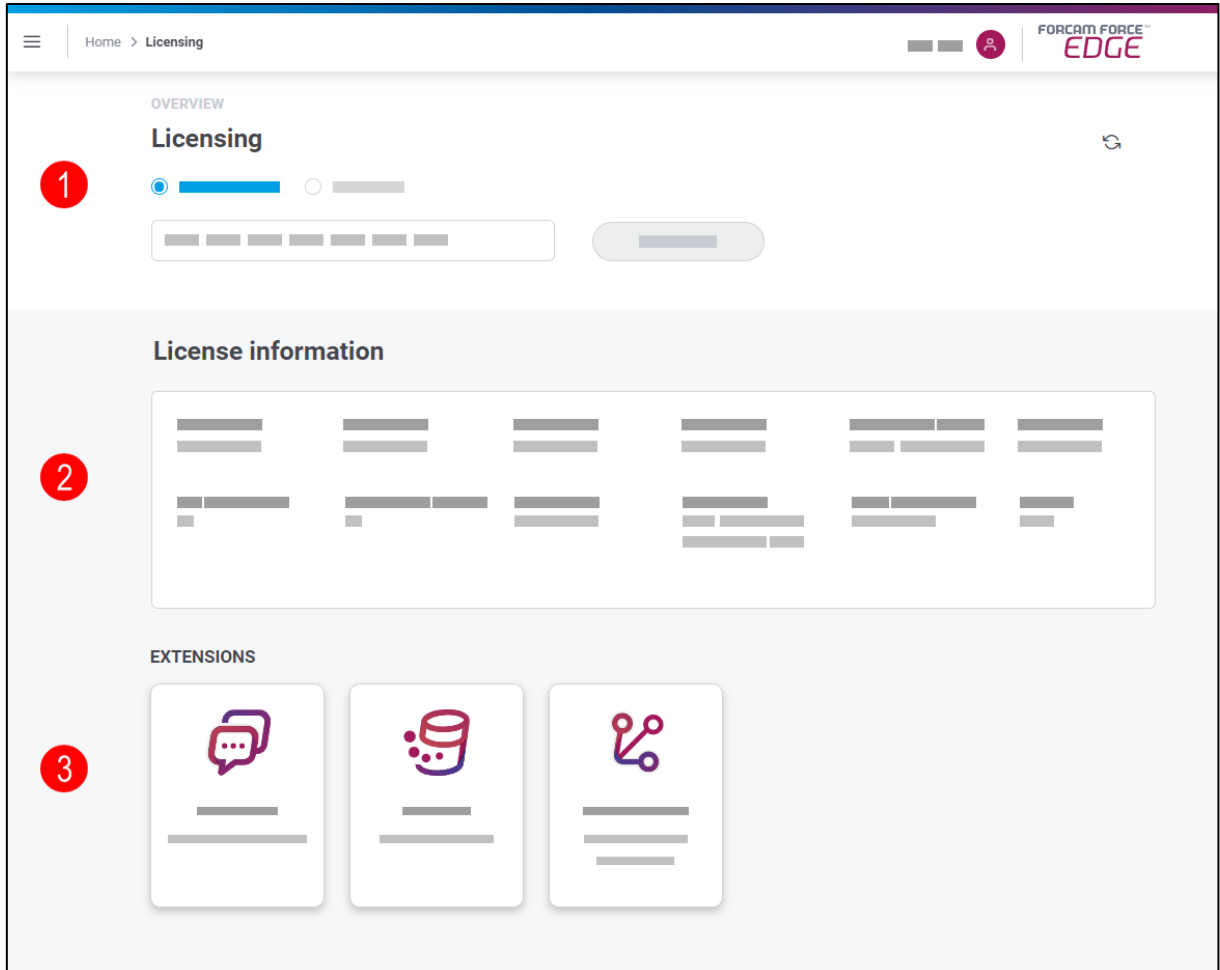


Fig. 9: Licensing and overview

- (1) A new license can be uploaded as a file or entered directly as a key.
- (2) License information consists of type and status of the license, number of licensed nodes and machines, maintenance, validity and other data.
- (3) All booked add-ons are listed here.
Clicking on an extension tile provides more information, such as the URLs provided

5.3 Download area

The current FORCAM FORCE EDGE documentation can be downloaded in several languages via the **General** tab. The manual and a product description are available. The manual is this document with detailed configuration instructions. The product description is a shorter document describing only the function and benefits of the application and a listing of the scope of performance functions.

FORCAM provides a custom application in the tabs **MDC Plugins** and **DNC Plugins**. This application is needed to communicate with a machine via the corresponding plugin. It is located between the EDGE MDC layer and the machine and enables the bi-directional communication.

5.4 Monitoring

The Monitoring of the Home menu is used to monitor the Edge configuration. The monitoring of the Edge components is displayed on a separate page and is described in chapter 7. The structure of the Monitoring tiles is, however, the same.

The following tile monitors the status of template transmissions via the API. It indicates all the information that is logged in the process.

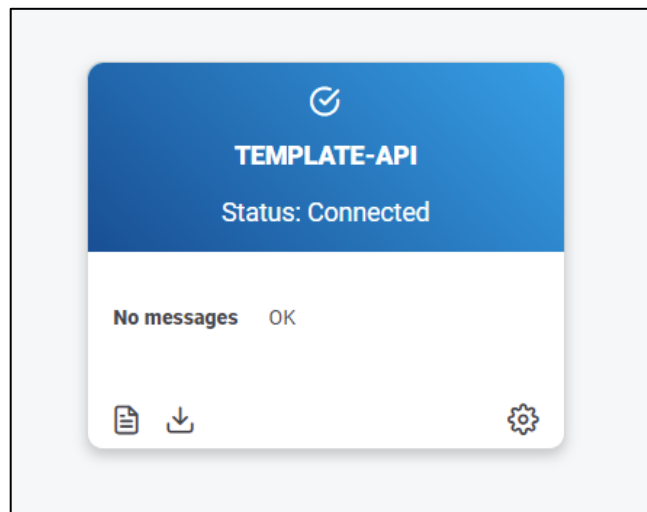


Fig. 10: Monitoring of template transmissions via the API

5.5 Sorting of table entries

Most pages in FORCAM FORCE EDGE display the data as tables. To offer the usability that is familiar from other table tools, the sorting function of columns has also been used here: The columns can be sorted alphabetically in ascending or descending order.

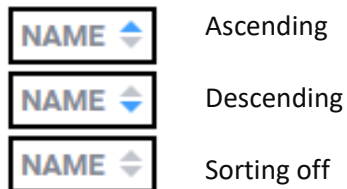


Fig. 11: Alphabetical sorting of columns

Columns that specifically involve DNC and MDC indicate a status instead of a string. Sorting maps the statuses alphabetically and additionally groups them by content.

NAME ▾	MDC STATUS ▾
S7Test	● Started
T	● Started
WINDOWS_RPC_PL UGIN_TEST	● Started
S700	● Error

Fig. 12: Alphabetical sorting and grouping by content

6 EDGE Configuration

The configuration of an edge node as well as a machine is done completely in the EDGE Configuration of FORCAM FORCE EDGE. The user-friendly interface will guide you through all relevant settings and shows all nodes and the statuses in the overview.

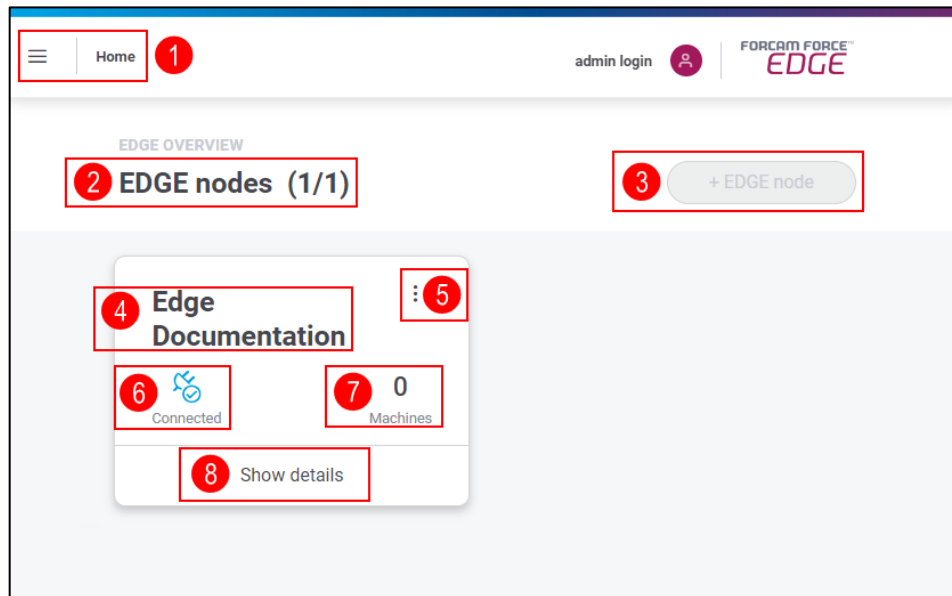



Fig. 13: FORCAM FORCE EDGE entry and overview page

- (1) FORCAM FORCE EDGE settings menu
 - Licensing
 - User management
 - Language
- (2) Shows how many edge nodes are configured (first number) and how many nodes can be configured in accordance with the license (second number)
- (3) Adds a new EDGE node
- (4) Node name
- (5) Node settings menu:
 - Edit
 - Event configuration
 - Delete
- (6) Status of the connected machines
- (7) Number of connected machines
- (8) More detailed node information:
 - List of all connected machines and their status
 - Option to add a new machine
 - Monitoring connected machines

 Changes to user management regarding user rights can take up to 30 minutes to take effect throughout the system.

EDGE Configuration

DETAIL VIEW

BB_Node_1

Description:

new desc

Status:

Connected

Event configuration:

REST / MQTT

Version:

220406-NR

Creation date:

2022-04-06 02:04:31

Machines (8/20)

+ Machine

NAME	MDC STATUS	DNC STATUS	VERSION	MANUFACTURER	MODEL	CONFIGURATION
Presse	<div><div></div>Deactivated</div>	<div><div></div>Not configured</div>	1 (2 Available)	Schuler	SH 500 T	<div>In progress</div> <div><div></div><div></div><div></div></div>

Fig. 14: Machine overview as next page after clicking on "Show details"

TEMPLATE VERSION shows the current implementation (see section 4.2.1).

CONFIGURATION lets you manually determine which status the configuration should have, for example to give employees an overview or to call them in:

- In progress:
The configuration is not yet complete and is to be continued at another time.
- In validation:
The configuration of the machine is to be checked for errors and consistency.
- Completed:
The configuration is completely finished. This is the only status in which the MR learning cycle can take place to generate a template from the configuration.

6.1 Add EDGE node

FORCAM FORCE EDGE lets you add nodes in just a few steps. An edge node corresponds to an instance of a connection variant. There can be several nodes per plant. They are logically bundled so that the machine workload is distributed practically.

- i** If a configured edge node is removed from the interface, its configuration is preserved. If the node is recreated under the same data, it automatically adopts the previously configured data.

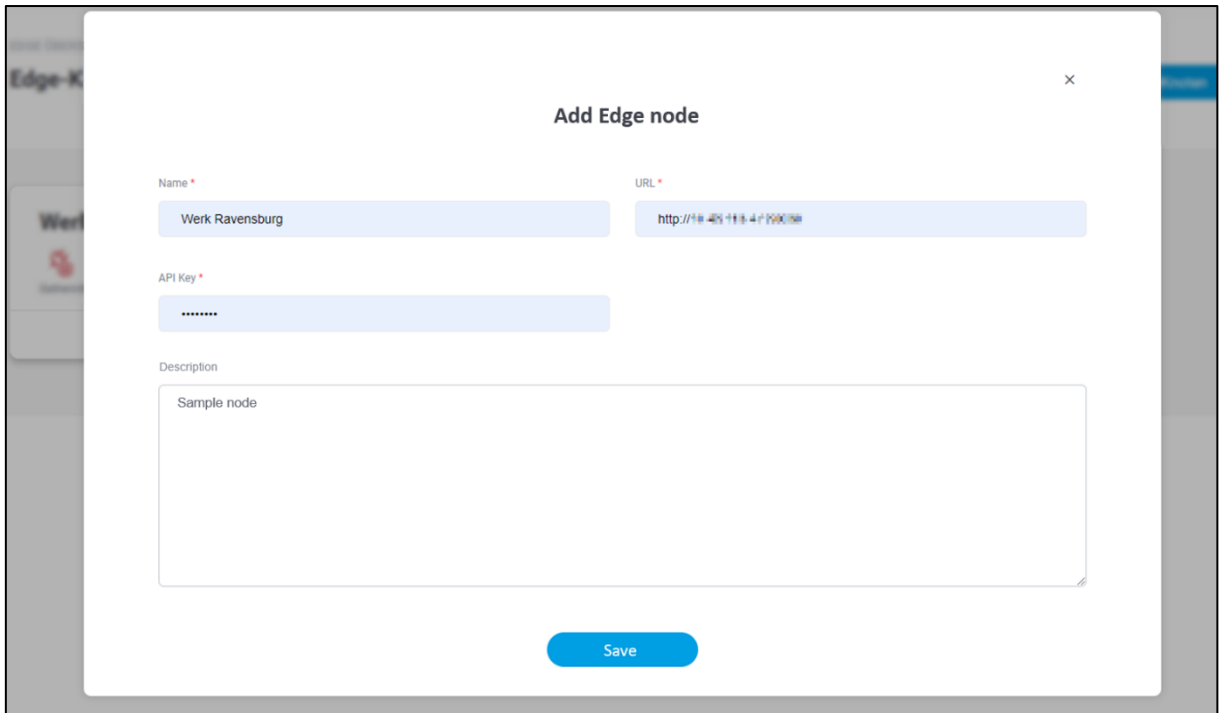




Fig. 15: Dialog for adding a new node

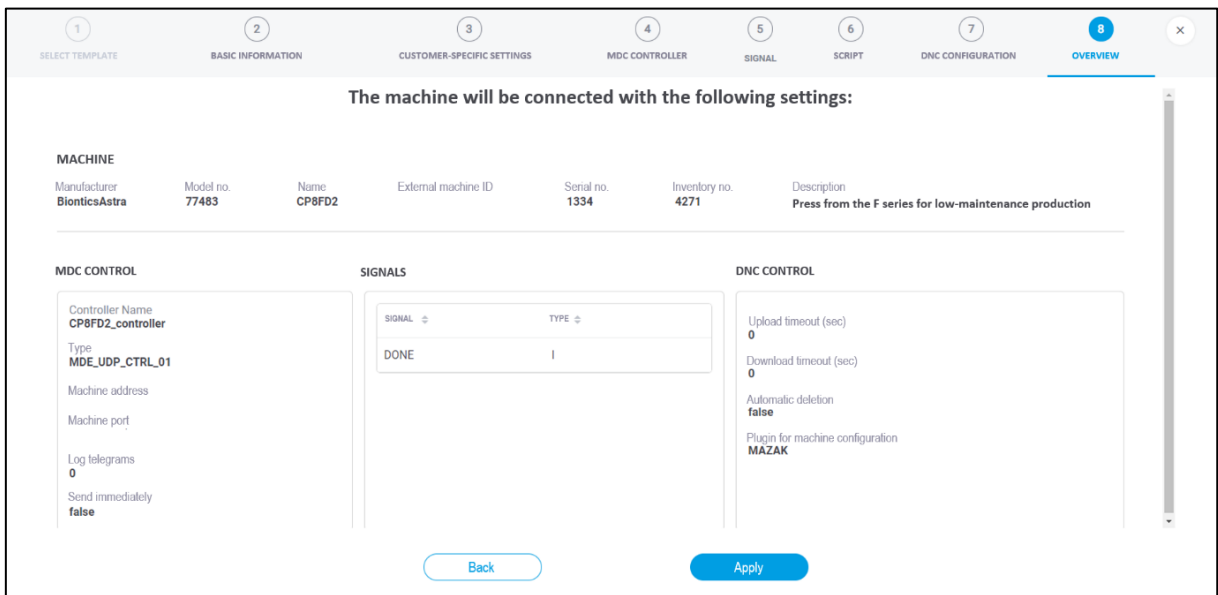
To add a new EDGE node:

1. Click on **+ EDGE node**.
2. Fill in all mandatory fields in the next dialog:
 - Name:
Appears in the node overview as the node title
 - URL:
Consists of http + IP address + host. Only one edge node can be created per URL.
 - API key:
Password that was assigned during the initial node installation
3. Optional: add description.
4. Save.

6.2 Add machine

The dialog for adding a machine guides you through eight steps necessary for a connection. This is where MDC/DNC controls are configured and machine signals are defined, among other things.

-  Negative values are not permitted in the machine configuration.
-  When a step is completed, it is highlighted in blue in the top bar.
To return to a completed step, click on it.
Each configuration page can be selected and called-up directly when editing a machine that has already been configured.



The machine will be connected with the following settings:

MACHINE							
Manufacturer	Model no.	Name	External machine ID	Serial no.	Inventory no.	Description	
BionicsAstra	77483	CP8FD2		1334	4271	Press from the F series for low-maintenance production	

MDC CONTROL

Controller Name
CP8FD2_controller

Type
MDE_UDP_CTRL_01

Machine address

Machine port

Log telegrams
0

Send immediately
false

SIGNALS

SIGNAL	TYPE
DONE	I

DNC CONTROL

Upload timeout (sec)
0

Download timeout (sec)
0

Automatic deletion
false

Plugin for machine configuration
MAZAK

[Back](#) [Apply](#)

Fig. 16: Dialog for configuring a machine in FORCAM FORCE EDGE

To add a machine:

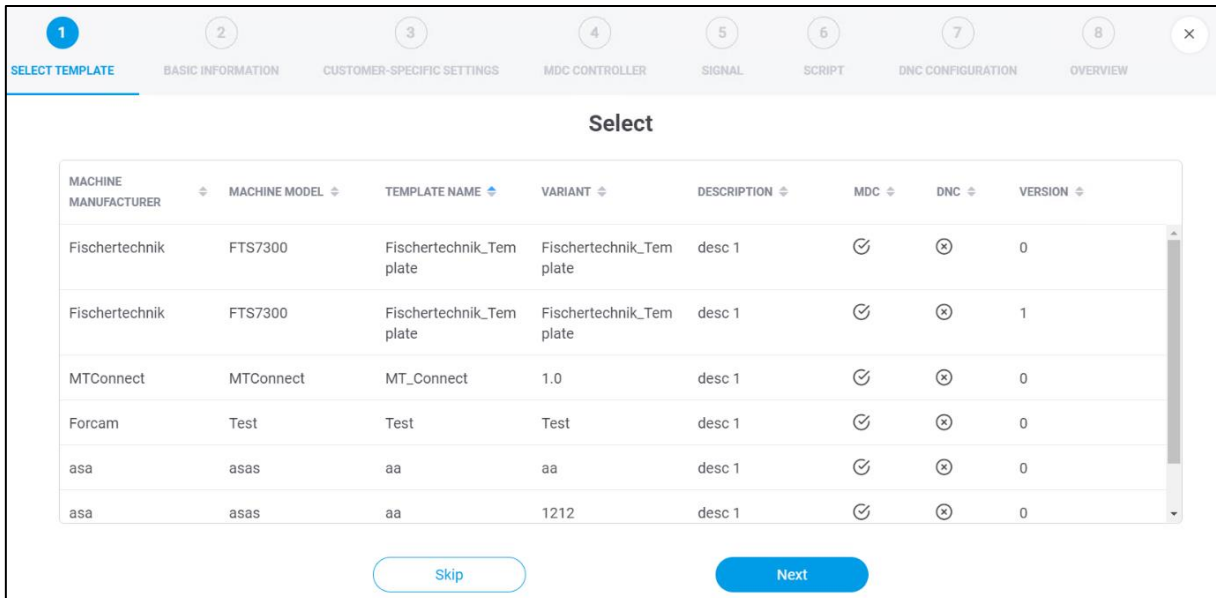
1. Click **Show details** at the desired node in the EDGE overview.
 2. Click on **+ Machine** on the next page.
- ➔ The next dialog guides you through the following eight steps to configure a machine.

6.2.1 ① Select template

In FORCAM FORCE EDGE, multiple machines of the same type do not have to be completely reconfigured every time: Once a machine has been configured, it can be entered as a template in the Machine Repository and will then be offered for the next machine connection in this mask. If the template is selected at this point, all settings are automatically used for this machine and all configuration fields that are not machine-specific are pre-filled. Only machine-specific (e.g. serial number) and information specific to the connection (e.g. IP address or port of the machine or controller) must still be edited.

The template **VERSION** shows which version it is in. If a template is revised, the version number is automatically incremented, and the earlier version is overwritten. Version 0 means that no script is configured in the corresponding template.

- ❗ This step is only available if the MR component is used. If no template is configured or MR is not in use, the machine connection will start with step ②.

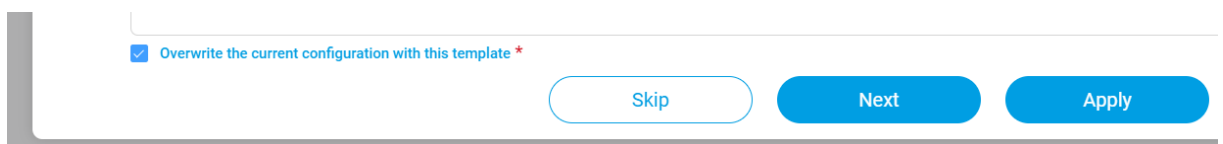


MACHINE MANUFACTURER	MACHINE MODEL	TEMPLATE NAME	VARIANT	DESCRIPTION	MDC	DNC	VERSION
Fischertechnik	FTS7300	Fischertechnik_Template	Fischertechnik_Template	desc 1	✓	✗	0
Fischertechnik	FTS7300	Fischertechnik_Template	Fischertechnik_Template	desc 1	✓	✗	1
MTConnect	MTConnect	MT_Connect	1.0	desc 1	✓	✗	0
Forcam	Test	Test	Test	desc 1	✓	✗	0
asa	asas	aa	aa	desc 1	✓	✗	0
asa	asas	aa	1212	desc 1	✓	✗	0

Fig. 17: Add machine - select template

1. Select the desired machine connection from the list.
2. Click on **Next**.

- ❗ If a template is selected during subsequent editing of a previously configured machine, it will overwrite the existing configuration after clicking **Next**. This is why the template must be confirmed by the checkbox at the bottom. The checkbox will only be visible if a template has been selected.



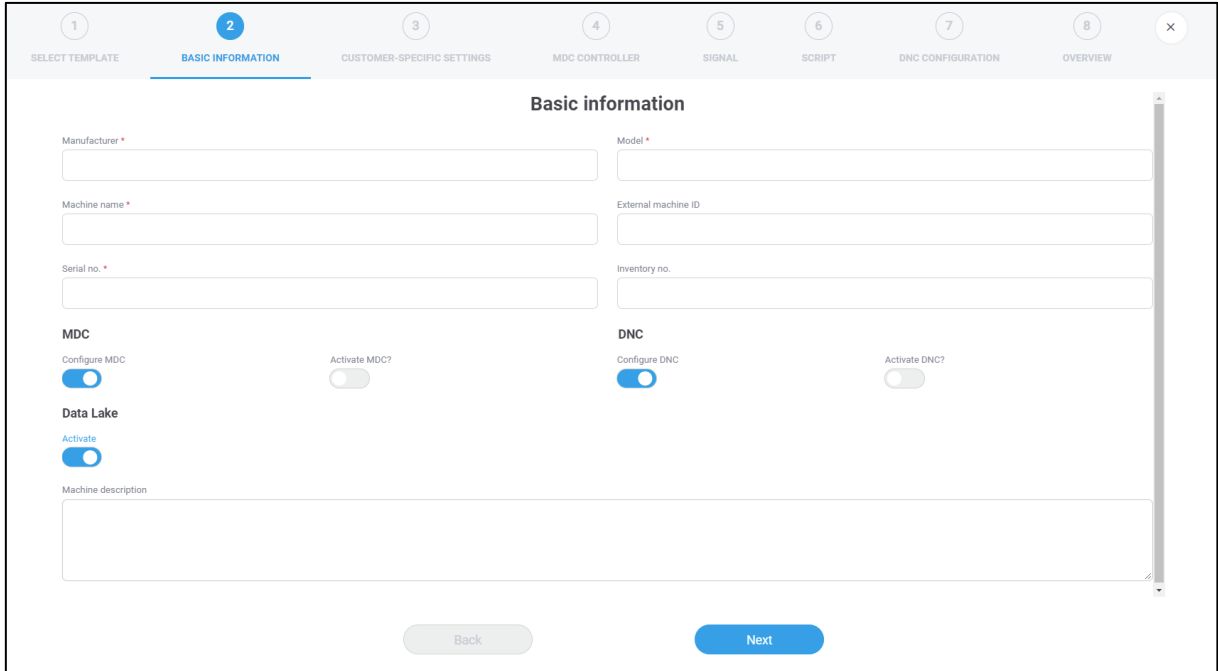
☒ Overwrite the current configuration with this template *

Skip Next Apply

Fig. 18: Confirming the overwriting of the configuration with a template

6.2.2 ② Basic information

This is where basic information of the machine to be configured, such as name or serial number is entered. This is also where you determine whether an MDC and/or a DNC control is to be configured. With the MDC controller, signals are collected from the machine and transmitted or written to it. NC files are transferred to the machine via the DNC controller.



The screenshot displays the 'Basic information' configuration screen. At the top, a navigation bar shows eight steps: 1. SELECT TEMPLATE, 2. BASIC INFORMATION (active), 3. CUSTOMER-SPECIFIC SETTINGS, 4. MDC CONTROLLER, 5. SIGNAL, 6. SCRIPT, 7. DNC CONFIGURATION, and 8. OVERVIEW. The main content area is titled 'Basic information' and contains the following fields and controls:

- Manufacturer ***: Text input field.
- Model ***: Text input field.
- Machine name ***: Text input field.
- External machine ID**: Text input field.
- Serial no. ***: Text input field.
- Inventory no.**: Text input field.
- MDC**:
 - Configure MDC**: Toggle switch (ON).
 - Activate MDC?**: Toggle switch (OFF).
- DNC**:
 - Configure DNC**: Toggle switch (ON).
 - Activate DNC?**: Toggle switch (OFF).
- Data Lake**:
 - Activate**: Toggle switch (ON).
- Machine description**: Large text area for description.

At the bottom, there are two buttons: 'Back' (disabled) and 'Next' (active).

Fig. 19: Add machine - basic information

1. Enter **manufacturer, model, machine name** and **serial no.**
2. Optional: Add further information if necessary.
3. Activate **Configure MDC** and/or **Configure DNC**.
4. Optional: Specify if MDC or DNC is to be activated initially.
5. Optional: Activate Data Lake.
6. Click on **Next**.

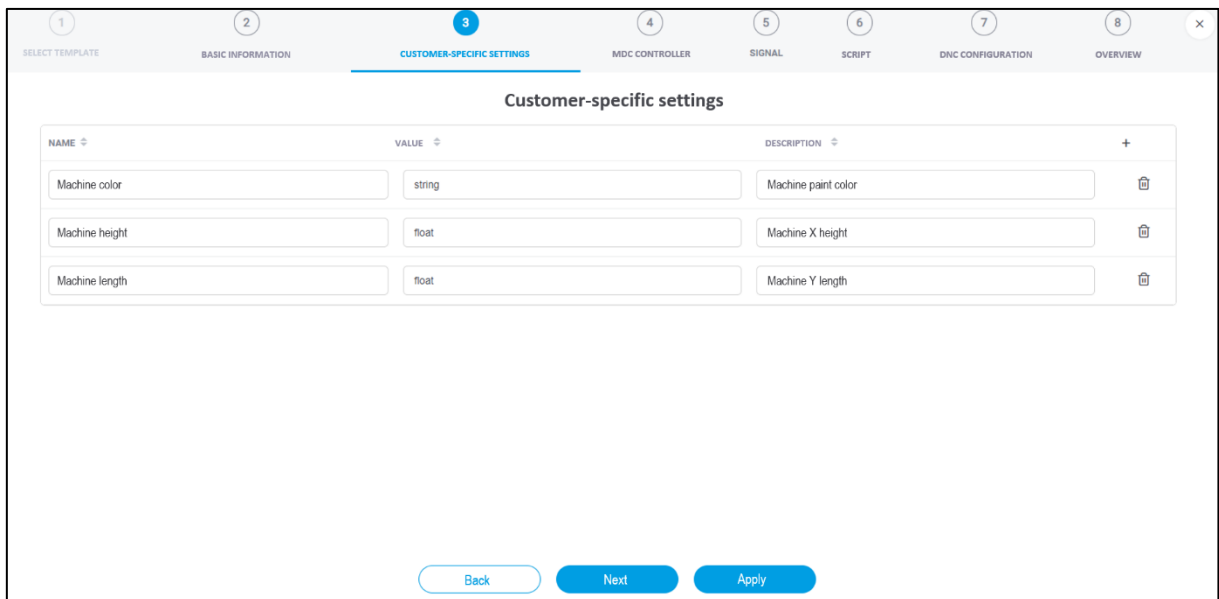
6.2.3 ③ Customer-specific settings

This enables individual, plant-specific information to be added to a machine to further supplement the machine's data. This data can later be retrieved from the API to provide more information to a third-party system.

Example: Name = location, value = hall 2.

This is where an additional locational aspect is added to the machine data to help accurately locate the machine in the event of a malfunction.

 This step is optional.



NAME	VALUE	DESCRIPTION	
Machine color	string	Machine paint color	
Machine height	float	Machine X height	
Machine length	float	Machine Y length	

Back Next Apply

Fig. 20: Add machine – Customer-specific settings

1. Click on the + icon.
2. Enter the desired parameters.
3. Click on **Next**.

6.2.4 ④ MDC controller

Option to configure an MDC controller. Specifies the type and method of connection to the machine. FORCAM supports all common controllers on the market and continuously strives to expand their availability. An overview of the current FORCAM plugins is listed in section 8.4.

The bus type is a specific communication protocol of the controller type. Many controllers have only one protocol and therefore only one bus type to choose from (e.g. bus type **FORCAM I/O Controller connection** for controller **FORCAM I/O Controller**). For the Siemens S7 controller, for example, several protocols are possible, which is why there are several bus types available.

i This step is only available if ② **Configure MDC** was selected in step .

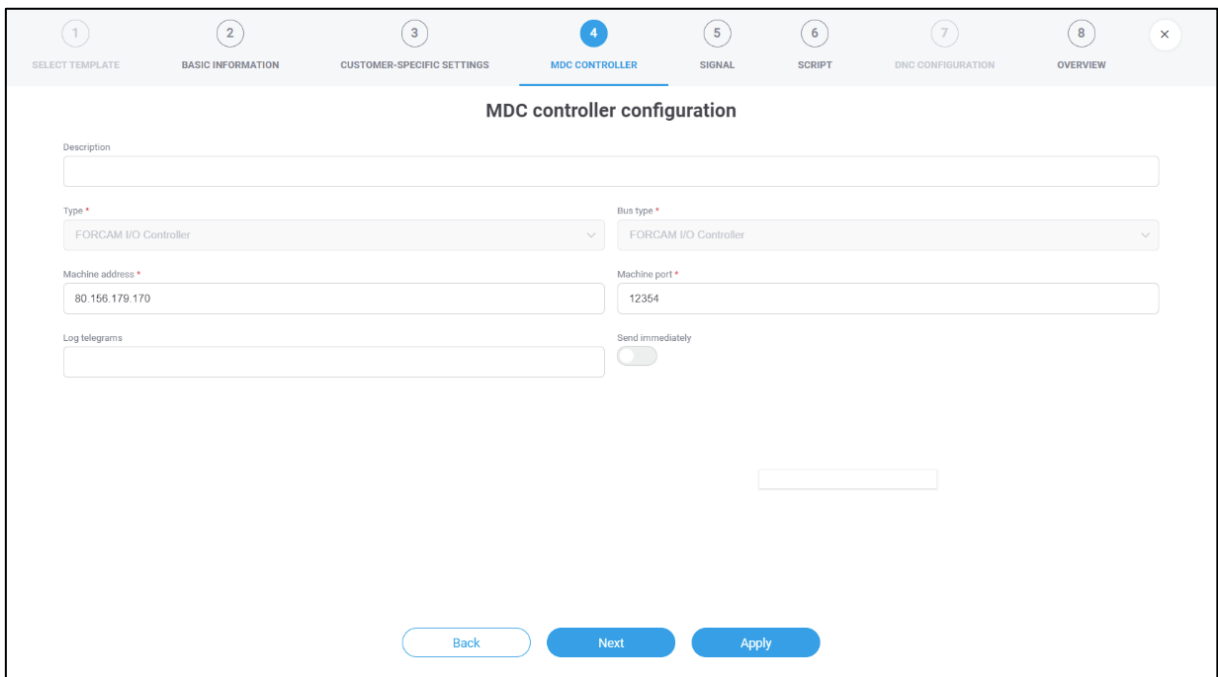


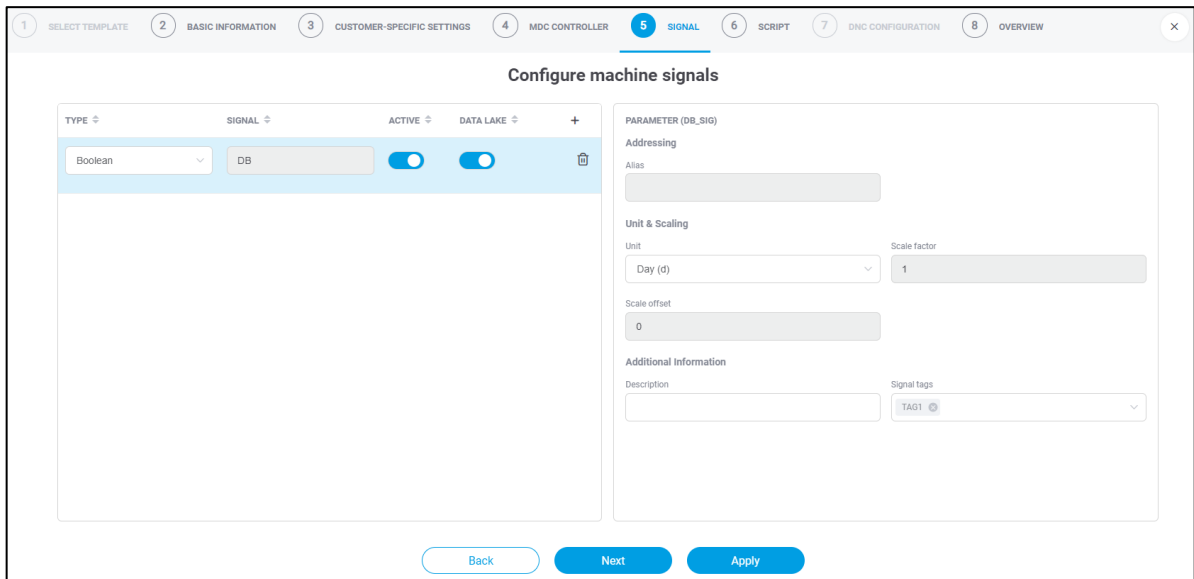
Fig. 21: Add machine - MDC controller

1. Optional: Enter the description of the control.
2. Select the control type.
- ➔ Additional configuration parameters appear depending on the selected type.
3. Select bus type.
The possible selection depends on what type of control was previously selected.
4. Adjust the configuration according to the controller.
5. Click on **Next**.

i The **Log telegrams** function is used to log out of the UDP telegrams in the DCU log. The number of characters for logging out of each telegram is specified in the input field.

6.2.5 ⑤ Signal

Defines which signals are read from the controller. For example, a binary signal can be configured to allow the interpretation "Machine running" or "Machine not running". If 1 is reported, the machine is in production, and if it is 0, it is at a stoppage. In this example, the signal is called "DONE". Additionally, different data types can be used to map various signals such as temperature. Signals can also be defined that can be written to the controller, e.g. an order number or default times. With Data Lake all data is captured and stored. The Data Lake storage can be switched on & off per signal. Units can be recorded on individual signals (e.g. degrees Celsius or liters per minute), and scaling factors can also be configured.



The screenshot displays the 'Configure machine signals' window. At the top, there is a navigation bar with tabs: 1 SELECT TEMPLATE, 2 BASIC INFORMATION, 3 CUSTOMER-SPECIFIC SETTINGS, 4 MDC CONTROLLER, 5 SIGNAL (active), 6 SCRIPT, 7 DNC CONFIGURATION, and 8 OVERVIEW. Below the navigation bar, the title 'Configure machine signals' is centered. The interface is divided into two main sections. The left section contains a table with columns: TYPE (dropdown menu showing 'Boolean'), SIGNAL (input field showing 'DB'), ACTIVE (toggle switch), and DATA LAKE (toggle switch). There is a '+' icon to the right of the table. The right section contains configuration options for the selected signal. It includes a 'PARAMETER (DB_SIG)' section with an 'Addressing' field (input field) and an 'Alias' field (input field). Below this is a 'Unit & Scaling' section with a 'Unit' dropdown menu (showing 'Day (d)'), a 'Scale factor' input field (showing '1'), and a 'Scale offset' input field (showing '0'). At the bottom of the right section is an 'Additional Information' section with a 'Description' input field and a 'Signal tags' dropdown menu (showing 'TAG1'). At the bottom of the window, there are three buttons: 'Back', 'Next', and 'Apply'.

Fig. 22: Add machine - Signal

1. Click on the + icon.
2. **Enter Name, type and description.**
3. Expand the drop-down menu on the left.
The name is prefilled according to the selected type.
4. Enter the desired value.
5. At the right, enter the various desired parameter specifications and values for each signal.
6. Click on **Next**.

6.2.6 ⑥ Script

Defines how the machine signals are to be interpreted.

Different signals can be read out via a script depending on the control, e.g. "Production in partial automatic state" or "Stoppage due to mechanical error".

All signals configured in step ⑤ are listed in the left part of the mask.

The area in the center is the input field for a script, where the actual machine logic is defined.

- ① See the **Scripting Language** manual for a listing of formula elements and operators in scripts.
- ⌕ The script window can be maximized via the icon in the upper right corner.

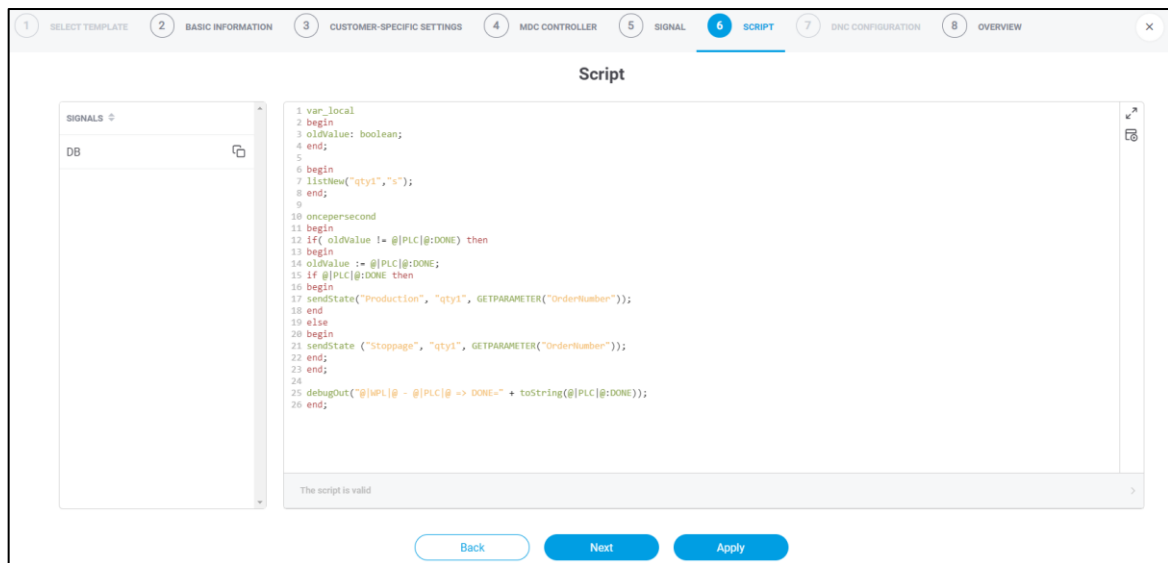


Fig. 23: Add machine - Script

In order to follow the example from the "DONE" signal in step ⑤, the script in Fig. 23 is as follows: If bit 1 for "DONE" comes from the machine, an event **sendStateProduction** is sent, thus eventually corresponding to the status **Production**. If no bit flag is set to 1, **sendStateStoppage** is sent, thus **stoppage**. More script examples are available in section 8.6.

```

10 oncepersecond
11 begin
12 if( oldValue != @|PLC|@:DONE) then
13 begin
14 oldValue := @|PLC|@:DONE;
15 if @|PLC|@:DONE then
16 begin
17 sendState("Production", "qty1", GETPARAMETER("OrderNumber"));
18 end
19 else
20 begin
21 sendState ("Stoppage", "qty1", GETPARAMETER("OrderNumber"));
22 end;
23 end;
24
25 debugOut("@|WPL|@ - @|PLC|@ => DONE=" + toString(@|PLC|@:DONE));
26 end;
27

```

Fig. 24: Excerpt from the script sample for the "DONE" signal

EDGE Configuration

To configure a script:

1. In the left-hand area, select the signal that is to be added to the script.
2. Enter the desired script in the central input field.
3. Optional: Use the play icon in the upper right corner to run the script and check the validity.
4. Click on **Next**.

6.2.7 ⑦ DNC configuration

Option to configure a DNC control. Determines the way in which an NC file is to be transferred to the machine.

FORCAM supports all common controllers on the market and continuously strives to expand their availability. An overview of the current FORCAM plugins is listed in section 8.4.

i This step is only available if **Configure DNC** was selected in step ②.

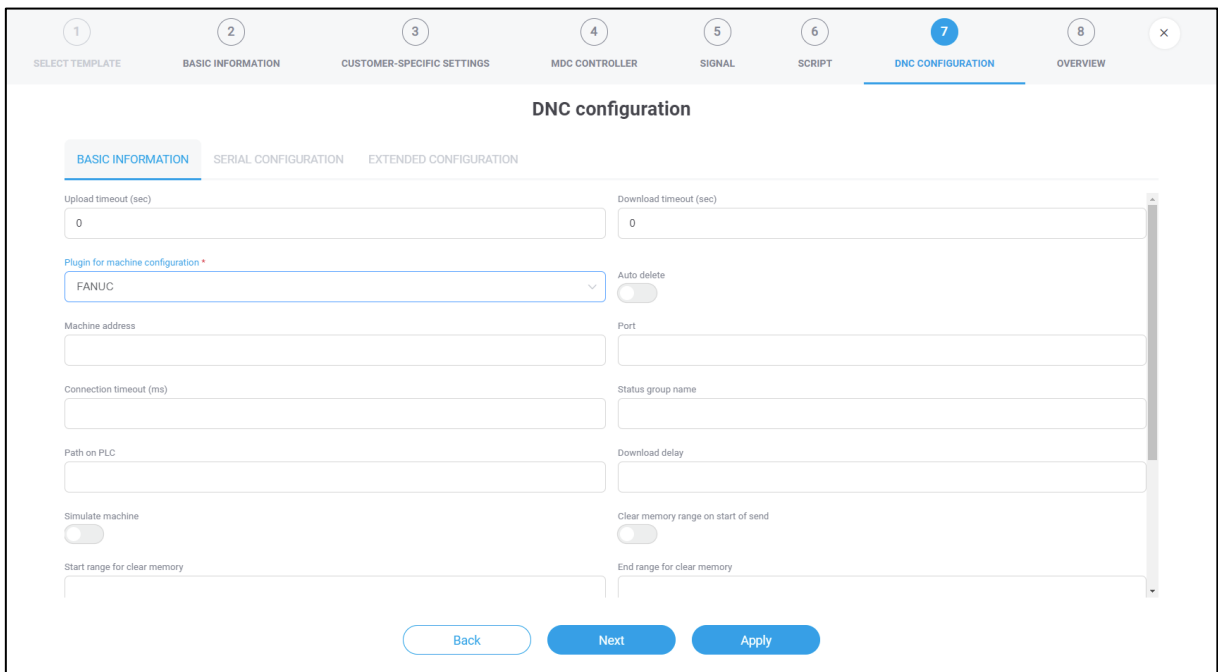


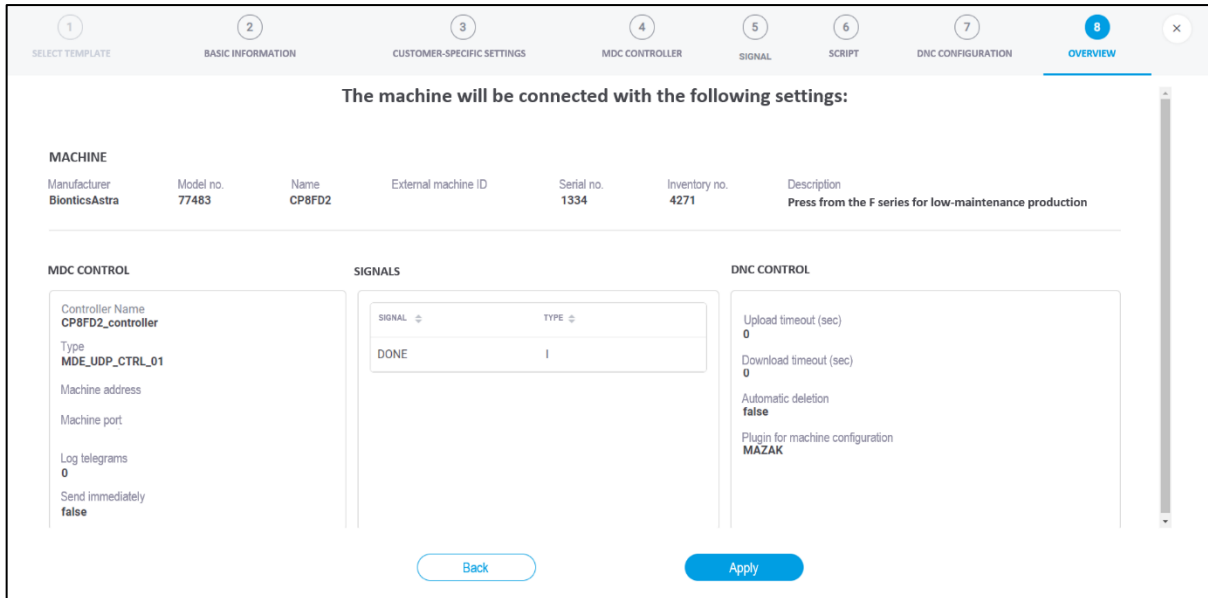
Fig. 25: Add machine - DNC configuration

1. Optional: Enter the **Upload** and **Download** timeout.
2. Select **plugin for machine configuration**.
 - ➔ Additional configuration parameters may appear in further tabs depending on the selected plugin.
3. Optional: Set automatic deletion.
If enabled, the NC file is automatically deleted from the machine after it has been read.
4. Enter additional configuration parameters depending on the selected plugin in the remaining tabs.
5. Click on **Next**.

EDGE Configuration

6.2.8 ⑧ Overview

A summary of the previous configuration from all steps and a list of all defined signals. After confirming, the machine is mapped with the specified configuration and is therefore digitized. The configured machine appears under the specified name in the overview (see Fig. 14).



The machine will be connected with the following settings:

MACHINE						
Manufacturer	Model no.	Name	External machine ID	Serial no.	Inventory no.	Description
BionticsAstra	77483	CP8FD2		1334	4271	Press from the F series for low-maintenance production

MDC CONTROL

Controller Name
CP8FD2_controller

Type
MDE_UDP_CTRL_01

Machine address

Machine port

Log telegrams
0

Send immediately
false

SIGNALS

SIGNAL	TYPE
DONE	I

DNC CONTROL

Upload timeout (sec)
0

Download timeout (sec)
0

Automatic deletion
false

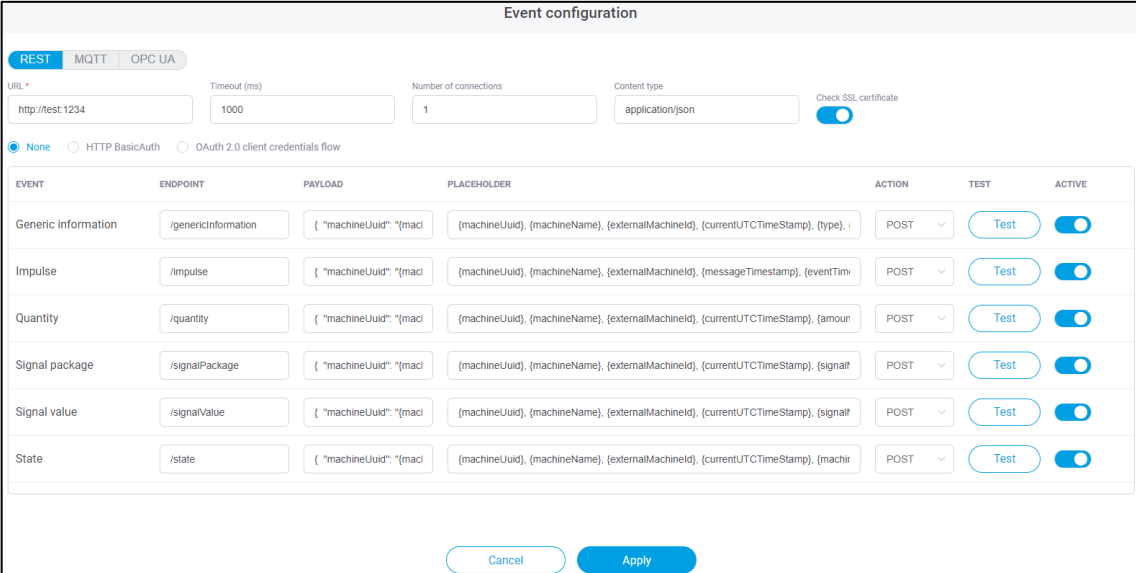
Plugin for machine configuration
MAZAK

Back Apply

Fig. 26: Add machine - Overview

6.3 Event configuration

The event configuration specifies how the signals are sent to a superordinate system. Payload and endpoint are predefined by default, but they can be customized.



EVENT	ENDPOINT	PAYLOAD	PLACEHOLDER	ACTION	TEST	ACTIVE
Generic information	/genericInformation	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {currentUTCTimeStamp}, {type}, {	POST	Test	<input checked="" type="checkbox"/>
Impulse	/impulse	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {messageTimeStamp}, {eventTim	POST	Test	<input checked="" type="checkbox"/>
Quantity	/quantity	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {currentUTCTimeStamp}, {amoun	POST	Test	<input checked="" type="checkbox"/>
Signal package	/signalPackage	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {currentUTCTimeStamp}, {signall	POST	Test	<input checked="" type="checkbox"/>
Signal value	/signalValue	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {currentUTCTimeStamp}, {signall	POST	Test	<input checked="" type="checkbox"/>
State	/state	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {currentUTCTimeStamp}, {machir	POST	Test	<input checked="" type="checkbox"/>

Fig. 27: Event configuration in FORCAM FORCE EDGE

Events are used in a script to trigger outgoing events. For this, there are script functions available that generate a corresponding event depending on the type.

In the sample from section 6.2.6, for example, the script function **sendStateProduction** was used, which sends the state **Production** as an event to a third-party system.

For each type of event there is a standardized **Event**. For example, the **Quantity** event type sends the quantity produced by the machine. All available events are listed in section 6.3.

EDGE Configuration

Under **PAYLOAD** the JSON body defines what the message to the superordinate system should look like. Finally, the placeholders (wildcards) are replaced by the corresponding existing signals. Example of an event structure:

```
{
  machineId: $machineId$
  machineName: $machineName$
  externalMachineId: $externalMachineId$
  reference: $reference$
  timeStamp: $currentUTCTimeStamp$
  signalName: $signalName$
  value: $value$
  unit: $unit$
}
```

Script functions allow events to use **placeholders** (wildcards) which can be used to transmit different information. This can be used, for example, to get the machine ID or the timestamp formatted in UTC. Section 8.7 lists and explains all available script functions.

If **ACTIVE** is enabled, the corresponding event will be sent. Events that are not enabled will not be sent.

An enabled event can also be tested by clicking **TEST**. In the subsequent dialog, values such as **machineID** (machine ID) or **Value** can be entered to generate and execute the signal as an example without influencing the actual machine connection. This allows events to be tested in advance without having to execute them in the live environment.

6.3.1 Signals & events from EDGE to superordinate system

There are three technical options for supplying signals and events from an EDGE node to a third-party application.

- ❶ The supply can be configured in the EDGE node itself.

HTTP/REST

To supply the external system, any REST endpoint provided there can be used. The HTTP methods POST and PUT are supported.

The following standards are implemented as HTTP authentication methods:

- Basic authentication: Authentication according to RFC 2617 by entering the username and password (see <https://datatracker.ietf.org/doc/html/rfc2617>).
- Client credential flow: Authentication according to OAuth 2.0 RFC 6749 via client ID and client secret known to the system (see <https://auth0.com/docs/flows/client-credentials-flow>). This type of authentication is performed without user intervention, i.e. in the background.

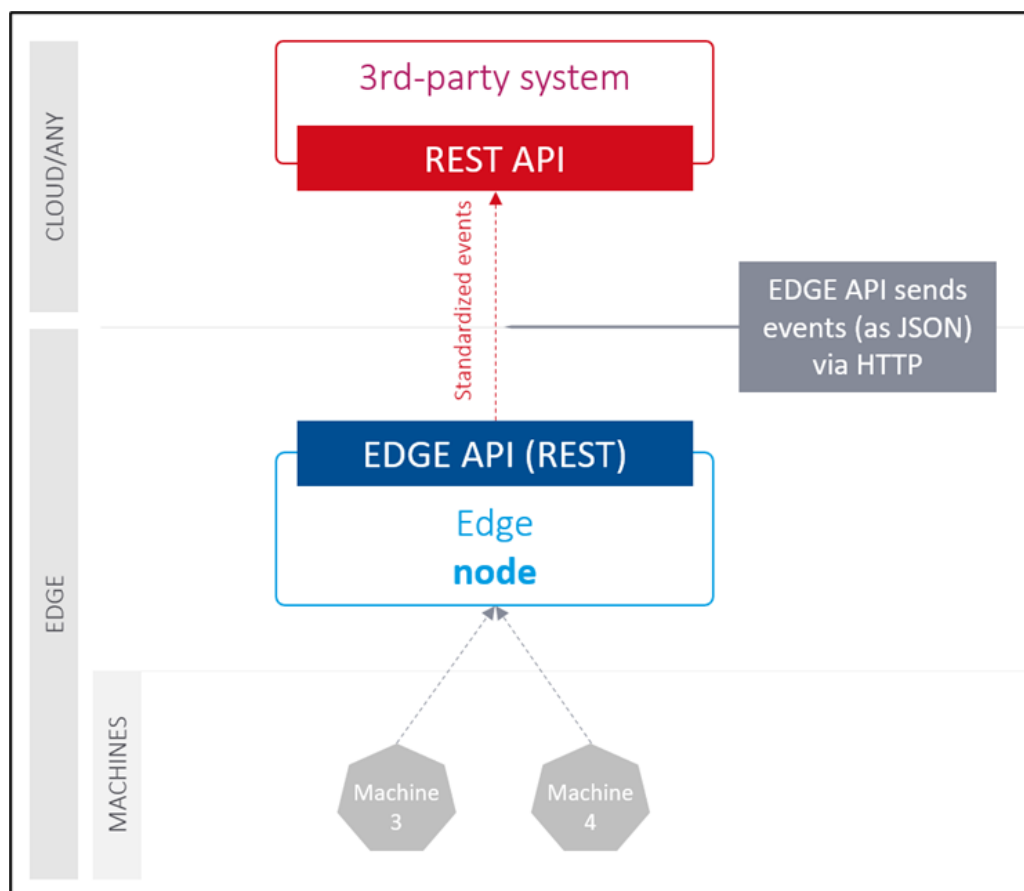


Fig. 28: Communication with superordinate systems via HTTP/REST

EDGE Configuration

MQTT messaging

Any MQTT broker can also be used to supply the data, if provided by customers or partners.

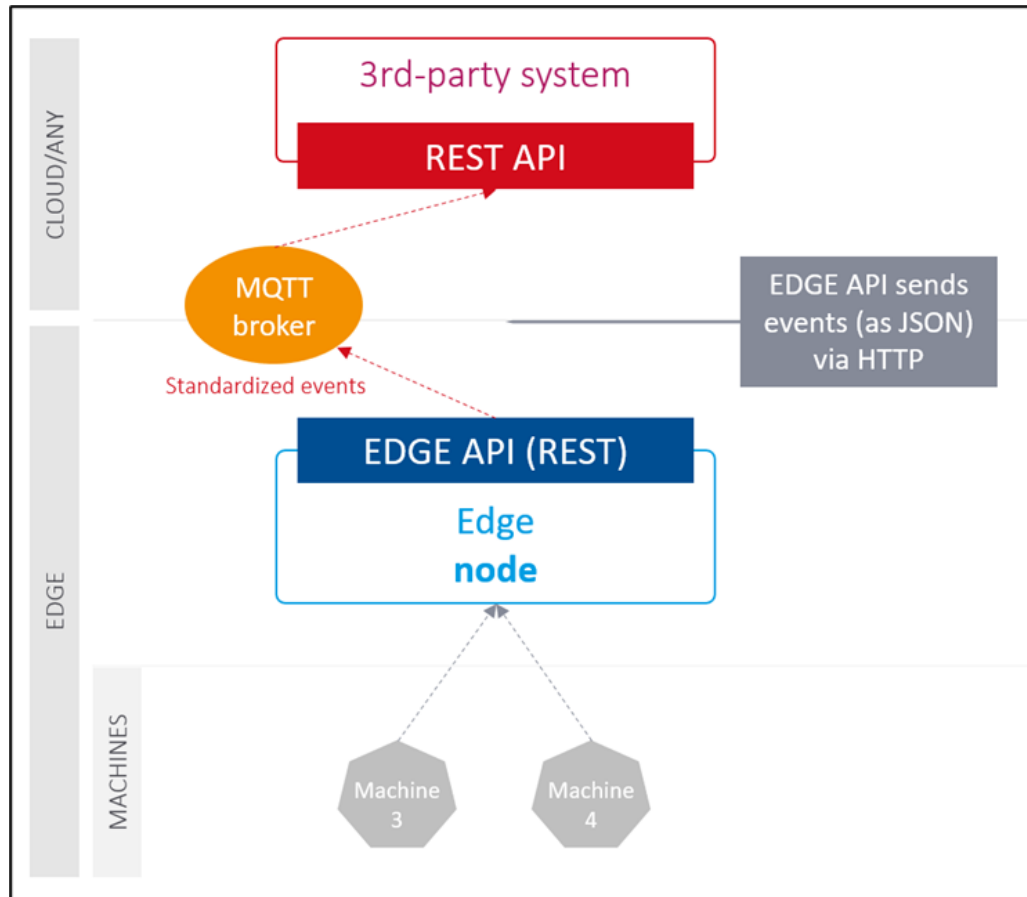


Fig. 29: Communication with superordinate systems via MQTT broker

OPC UA

FORCAM provides an OPC UA Server with "Data Access" functionality. This extension provides various machine data via the defined OPC UA interface. The information models are dynamically generated based on the existing configured machines in the Edge node.

By using the specified URL, the user connects to the server to retrieve the desired data. The necessary client for retrieval is prerequisite.

It is not only possible to query the current values of an event or signal, but also the development. In order to process these historical datasets, FORCAM FORCE EDGE supports the **Historian** functionality of OPC UA. The Historian acts as a data logger with SQL databases. It logs historical data and can also be used as a gateway to access realtime data from all underlying OPA UP servers.

In FORCAM FORCE EDGE, the user has the options to assign login credentials. This data must then be entered correctly when connecting to the server via the client.

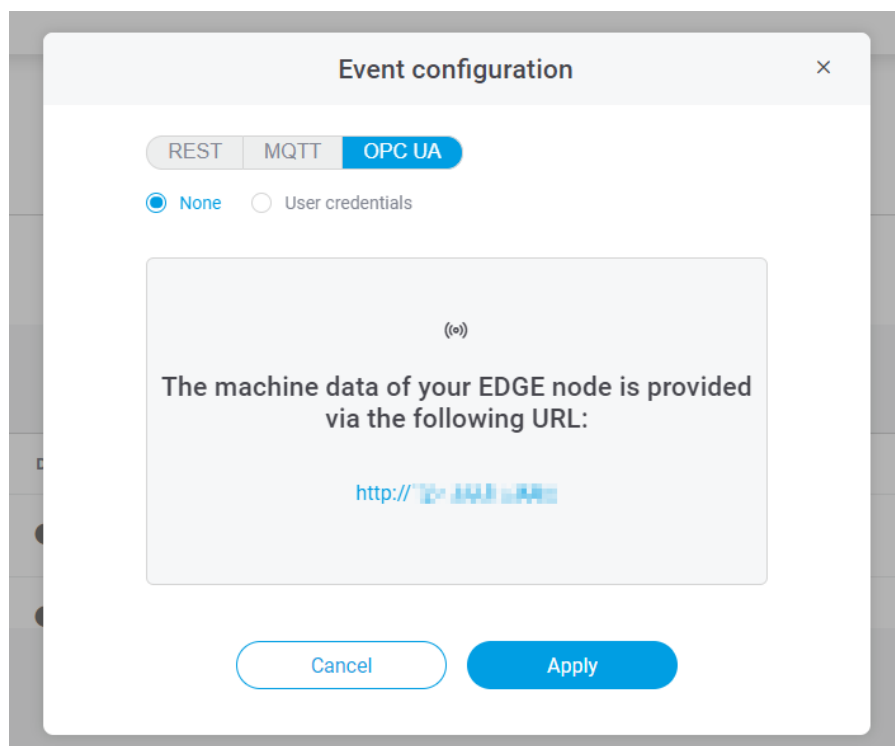


Fig. 30: Event configuration via OPC UA

6.3.2 Data & documents from superordinate system to EDGE

The EDGE API can be used to supply FORCAM FORCE EDGE with data and documents. Technically, this is only possible via **HTTP/REST**.

The following interfaces are provided:

Table 2: Interfaces for transferring data and documents

Interface	Description
Transfer of process and reference parameters	These business parameters can be used in the EDGE Composition Layer to supplement standardized events (e.g. order number or cycle time).
Transfer of signal parameters	Parameter values for specific signals can be transferred. These are written directly to the machine control.
Transfer of documents	NC programs can be transferred, which are also transferred to the machine control.

6.3.3 Configure an event

1. Click on the event configuration icon in the upper right-hand part of the detailed view of a configured machine (see Fig. 14).
2. In the subsequent dialog determine if **REST** or **MQTT** should be used.
3. In the upper bar, enter **URL** and optionally other details such as timeout, etc. Specifies where the events should be sent.
4. Set SSL certificate validation.
If the switch **Check SSL certificate** is active, FORCAM FORCE EDGE can also be connected via REST to an application that does not have a valid or unsigned security certificate.
5. Select desired authentication and enter login data.
6. Configure events as desired.
7. Save.

7 Monitoring

FORCAM FORCE EDGE has the option to monitor individual components via the monitoring page. The page indicates if a component is running without errors or if there are any malfunctions. The monitoring can be called up via the icon in the upper right area in the machine overview (see Fig. 14).

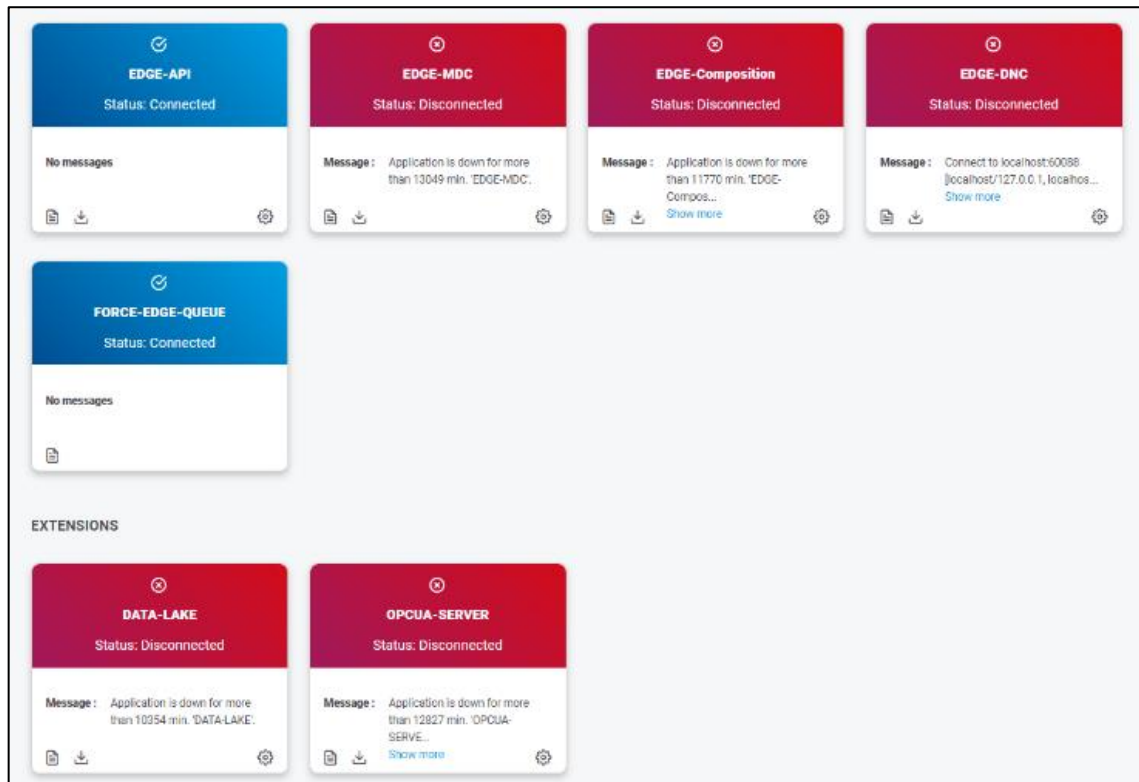


Fig. 31: Monitoring in FORCAM FORCE EDGE

Monitoring

Error messages and logs can be retrieved specifically for each component.

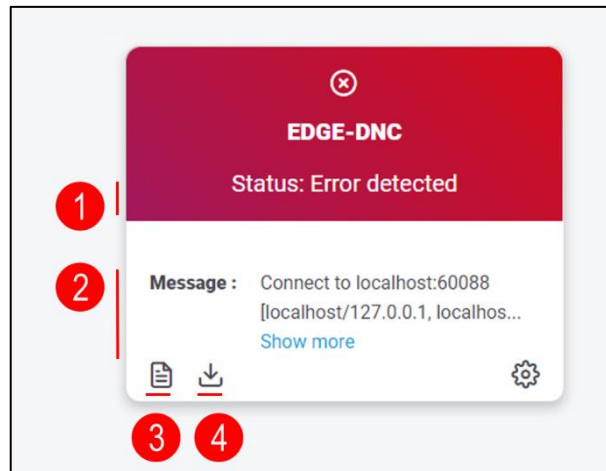


Fig. 32: „EDGE DNC“ component in the Monitoring page

- (1) Current status of the component
- (2) Message in the event of an error.
Clicking **Show more** displays the full error message in a pop-up window.
- (3) Displays the last warning and error message of the component for each case
- (4) Enables downloading a log file from a specific day

8 Annex

8.1 Table of changes

Table 3: Changes in release version 220404

Datum	Edge version	Doc. version	Change
2022-04-08	220404	1	Gender reference moved to footer of chapter 1
2022-04-08	220404	1	Replaced screenshots to reflect the current UI
2022-04-08	220404	1	Extended 2.4 with OPC UA
2022-04-08	220404	1	Removed heading „Edge Components “ (formerly 2.5)
2022-04-08	220404	1	Simplified explanatory text to Machine Repository in 2.6
2022-04-08	220404	1	Updated diagram for system architecture in 3
2022-04-08	220404	1	Changed license model to on premise as well as SAP DMC in the subheading to SAP MTP in 4
2022-04-08	220404	1	Extended options for special characters in 5.1
2022-04-08	220404	1	Corrected description to „Change template-based machine values“ in 5.1
2022-04-08	220404	1	Extended legend point (3) in 5.2
2022-04-08	220404	1	Added chapters 5.4 and 0
2022-04-08	220404	1	Updated step 2 in 6.2.2
2022-04-08	220404	1	Corrected step 1 in 6.2.6
2022-04-08	220404	1	Updated step 7 in 6.2.7
2022-04-08	220404	1	Updated section OPC UA with Historian in 6.3.1
2022-04-08	220404	1	Updated Monitoring in chapter 7
2022-04-08	220404	1	Added „Asset“ and „DB“ to terms in 8.3
2022-04-08	220404	1	Added Siemens LOGO plugin in 8.4
2022-04-08	220404	1	Removed the following script functions in : <ul style="list-style-type: none"> — CONTROLLERERROR1/2 — OFFLINESTRING — S5TIMETONUMBER(args) — NUMBERTOS5TIME(args)

8.2 Document conventions

Table 4: Fonts, formatting and characters used

Conventions	Description
Boldface	Buttons and options names are written in boldface.
Italics	Highlighted words are in italics.
Icons	For a function that is represented by an icon, the icon is referenced as the object.
Action result	Action results are indicated by ➔.
Prerequisites	Prerequisites are indicated by ✓.
Warnings	Warnings are indicated by ⚠.
Notes	Notes are indicated by ⓘ.
Tips	Tips are indicated by ⓘ.

8.3 Abbreviations and terms

Table 5: Abbreviations and terms used

Abbreviations	Explanation
Asset	General term for all objects that FORCAM FORCE EDGE can connect to (e.g. machines, sensors, databases, IT systems, etc.)
Brownfield	An existing factory or manufacturing facility that has already been built and in operation for some time. The Brownfield approach in the context of Industry 4.0 means the digital transformation of an existing manufacturing plant.
CP	Communication processor
DB	Database
DNC	Distributed Numerical Control: NC systems that are connected to a computer. The individual systems can be centrally supplied with NC programs and then coordinated.
IT	Information technology
Machine	In FORCAM FORCE EDGE, the machine is a partial plant according to ISA 95. If there are no other partial plants (i.e. additional physical controls), we refer to it as a plant.
MDC	Machine data connection (machine data collection)
MQTT	Message Queuing Telemetry Transport: Open network protocol for machine-to-machine (M2M) communication that enables transmitting telemetry data in the form of messages between devices, despite high delays or network limitations.
MR	Machine Repository
Northbound	A northbound interface communicates with a higher level element in a particular network component.
OPC UA	Open Platform Communications Unified Architecture (the standard for data exchange in a platform-independent, service-oriented architecture)
OT	Operational technology
POST	POST is a method which is supported by HTTP and means that a web server accepts the data contained in the body of the message requested.
PUT	The PUT method is used to update a resource available on the server. Typically, it replaces everything existing at the target URL with something else.
REST	Programming paradigm for distributed systems (collection) of independent computers that present themselves to the user as a single system.)
RESTful API	API for data exchange based on HTTP requests via GET, PUT, POST and DELETE, which is subject to the requirements or restrictions of the REST architecture.
Signal	Values read from the machine control, such as temperature, pressure or certain statuses.
Southbound	An equivalent to the northbound interface, a southbound interface communicates with lower level components.
SPS	Programmable Logical Control
UTC	Coordinated Universal Time
Wildcard	Placeholder for other characters.

8.4 List of supported plugins

MDC Plugins

Table 6: List of all supported machine connection variants

Name	Read	Write	Transmission type Polling/Event based
AUDI SPS	X	X	X/
CSV file exchange	X		X/
Euromap 63	X		X/
Euromap 77 (via OPC UA)	X	X	/X
FANUC	X	X	X/
FORCAM I/O Controller	X	X	/X
FORCAM I/O Controller (hardware)	X		
Heidenhain	X	X	X/
MAKINO Pro 3/Pro 6	X		
Mazak	X		
MCIS RPC (SINUMERIK 810D/840D/840D)	X		X/X
Modbus	X		
MQTT	X	X	/X
MT Connect	X		X/
Node-RED	X	X	/X
OKUMA	X		
Omron	X		
OPC Classic	X	X	X/
OPC UA	X	X	/X
OPC XML	X		X/
Rockwell/Allen Bradley	X	X	X/

Annex

Name	Read	Write	Transmission type Polling/Event based
Siemens LOGO	X	X	X/
Siemens S5 with CP	X		
Siemens S5 without CP	X		
Siemens S7 with CP	X	X	X/
Siemens S7 without CP	X	X	X/
SQL database exchange	X		X/
Weihenstephan	X		X/
Wiesemann & Theis (WUT)	X		X/

DNC plugins

Table 7: List of all supported NC machine connection variants

Name	Read	Write
COM	X	X
Heidenhain	X	X
Mazak DNC	X	X
RPC Plugin	X	X
FTP Plugin	X	X
FANUC	X	X
File Handler (File Copy)	X	X
File Handler Server	X	X
MOXA-Box	X	X
Wiesemann & Theis (WUT)		

8.5 Standardized events

Table 8: Events and their function in FORCAM FORCE EDGE

Event type	Values	Function
General Information	<ul style="list-style-type: none"> Machine ID Machine name External machine ID Reference (any) Timestamp Type (any) Value (any) 	Any information
Impulse	<ul style="list-style-type: none"> Machine ID Machine name External machine ID Reference (any) Timestamp Count 	For example: hit, shot etc.
Quantity	<ul style="list-style-type: none"> Machine ID Machine name External machine ID Reference (any) Timestamp Amount Unit (optional) QualityDetail (optional) 	Produced quantity
Signal package	<ul style="list-style-type: none"> Machine ID Machine name External machine ID Reference (any) Timestamp ARRAY [SignalName, Value, TimeStampUTC, Unit (optional)] 	Collection of signals (e.g. serial number, pressure and temperature)
Signal value	<ul style="list-style-type: none"> Machine ID Machine name External machine ID Reference (any) Timestamp SignalName Value Unit (optional) 	Temperature, pressure, etc.

Event type	Values	Function
State	<ul style="list-style-type: none"> Machine ID Machine name External machine ID Reference (any) Timestamp State (production or downtime) Statuscodes (optional list of statuses) 	Machine state (production, or stoppage)

8.6 Script examples

8.6.1 Machine status and temperature

The following script sends the status of the machine (production or stoppage). In addition, the temperature is also indicated. As soon as the temperature changes, the updated temperature is sent.

```
var_local
begin
    oldState: boolean;
    oldTemperature: string;
end;

oncepersecond
begin
    if( oldState!= @|PLC|@:DONE) then
        begin
            oldState := @|PLC|@:DONE;
            if @|PLC|@:DONE then
                begin
                    sendStateProduction()
                end
            else
                begin
                    sendStateStoppage();
                end;
            end;
        end;

        if( oldTemperature != toString(@|PLC|@:TEMP)) then
            begin
                oldTemperature := toString(@|PLC|@:TEMP);
                sendSignalValue("TEMPERATURE", toString(@|PLC|@:TEMP), "Degrees");
            end;
        end;
    end;
```

8.6.2 Temperature and humidity

The following script sends the current temperature and humidity. This occurs in intervals of 30 seconds, and as soon as a change of these values takes place.

```
var_local
begin
    oldTemperature : string;
    oldHumidity : string;
    seconds: number;
end;

oncepersecond
begin
    seconds := seconds + 1;

    if (seconds > 30) then
    begin
        seconds := 0;
        oldTemperature := "";
        oldHumidity := "";
    end;

    if (oldTemperature != @|PLC|@:TEMP ) then
    begin
        oldTemperature := @|PLC|@:TEMP;
        sendSignalValue("TEMP", toString(@|PLC|@:TEMP), "Degree");
    end;

    if (oldHumidity != @|PLC|@:HUMIDITY ) then
    begin
        oldHumidity := @|PLC|@:HUMIDITY;
        sendSignalValue("HUMIDITY", toString(@|PLC|@:HUMIDITY), "Degree");
    end;
end;
```


8.6.3 Crane control

This script collects a crane control with the black, green and red buttons.

- The black button turns the machine on and off
- The red button triggers an emergency
- The green button sends a pulse for piece counts then counts this number up

```
var_local
begin
    // GENERAL LOGIC VARIABLES
    seconds: number;
    // MACHINE STATE
    state: number;
    stateOld: number;
    // MACHINE STATUS REASON
    status_reason: string;
    status_reasonOld: string;
    // PIECE COUNT VARIABLES
    counter: number;
    counterOld: number;
    counterSend: number;
end;

begin
    //DEFINE LISTS START
    ListNew("STATUSCODES", "S");
    //DEFINE LISTS END
end;

begin
    // INITIALIZE SCRIPT VARIABLES START
    if not initialized and not offline(@|PLC|@) then
        begin
            status_reason := " ";
            status_reasonOld := " ";
            counter := @|PLC|@:Good_count;
            counterOld:= counter;
            ListClear("STATUSCODES");
            // Set initialized to perform initializing once
            initialized := true;
        end
    else if initialized then
        begin
            counter := @|PLC|@:Good_count;
            ListClear("STATUSCODES");
        end;
    // INITIALIZE SCRIPT VARIABLES END

    // ACTIONS ONCE PER SECOND START
    oncePerSecond
    begin
        seconds := seconds + 1;
    end;
    // ACTIONS ONCE PER SECOND END

    // DEFINITION STATE / STATUS_REASON START
    if offline(@|PLC|@) then
        begin
            state := "1";
            status_reason := 'NOT_CONNECTED';
            seconds := 0;
        end
    else if not @|PLC|@:Emergency_ON then
        begin
            state := "1";
            status_reason := 'EMERGENCY_ON';
            seconds := 0;
        end
    else if not @|PLC|@:Machine_ON then
```

Annex

```

begin
    state := "2";
    status_reason := 'PRODUCTION'
    seconds := 0;
end
else
begin
    if seconds > waiting period then
    begin
        state := "1";
        status_reason := 'UNDEFINED_STOPPAGE'
        seconds := 0;
    end
end;
// DEFINITION state END

// DEFINITION COUNTER START
if counter >= counterOld then                // Part counter on PLC is incremented
begin
    counterSend := counter - counterOld;
    counterOld := counter;
end
else if counter < counterOld then            // Part counter on PLC changes to negative
begin
    counterSend := 32768 - counterOld;
    counterOld := counter;
end;
// DEFINITION COUNTER END

// SEND state status_reason START
if state <> stateOld or status_reason <> status_reasonOld then
begin
    if state == 2 then
    begin
        ListAdd("STATUSCODES", status_reason);
        sendStateProduction("STATUSCODES");
    end
    else
    begin
        if == 1 then
        begin
            ListAdd("STATUSCODES", status_reason);
            sendStateStoppage("STATUSCODES");
        end
    end;
    debugOut("@|PLC|@" + "Send state: " + state);
    stateOld := state;
    status_reasonOld := status_reason;
end;
// SEND state status_reason END

// SEND STROKES / QUANTITY START
if counterSend > 0 and packetNo <> packetNoOld then
begin
    debugOut("@|PLC|@" + "Send quantity: " + toString(counterSend));
    SendQuantity(counterSend);
    counterSend := 0;
end;
// SEND STROKES / QUANTITY END

// LOGGING SIGNALS WHEN CHANGED START
logstring := "@|PLC|@ Signals: " + " offline: "          + toString(offline(@|PLC|@))
                                     + " State: "          + toString(state)
                                     + " status Reason: "   + toString(status_reason)
                                     + " Machine_ON: "      + toString(@|PLC|@:Machine_ON)
                                     + " Emergency_ON: "    + toString(@|PLC|@:Emergency_ON )
                                     + " COUNTER: "         + toString(@|PLC|@:Good_count)
                                     + " seconds: "         + toString(seconds);

if logString <> logstringOld then
begin
    debugOut(logString);
end

```

```

        logstringOld := logString;
    end;
    // LOGGING SIGNALS WHEN CHANGED END
end;

```

8.6.4 Signal package

The following script is an example of signal packages:

```

//
// Task: Send machine state / status_reason / quantities to runtime
// Created: 2021-05-12
// Version: 1.0
// Author: FORCAM MDC
//
// -----
//
// Incoming signals
// Reg1 = holding register 1
//
//
// Outgoing information
// //state      = machine state
// //STATUSCODES = Status reason
// Reg1SEND    = just display holding register
////-----

// VARIABLES
var_local
begin
// GENERAL VARIABLES
    seconds: number;
    logstring: string;
    logstringOld: string;
// SIGNAL VARIABLES
    H10ld: number;
    H20ld: number;
    H30ld: number;
    H40ld: number;
    H50ld: number;
    H60ld: number;
    H70ld: number;
    H80ld: number;
    H90ld: number;
    H100ld: number;
// SCRIPT INIZIALIZING VARIABLES
    initialized: boolean;
end;

begin
    if not initialized and not offline(@|PLC|@) then
        begin
            //DEFINE LISTS START (S=strin B=boolean N=number)
            ListNew("Signals", "S");
            ListNew("Values", "S");
            ListNew("Timestamps", "S");
            //DEFINE LISTS END
        end;

// INITIALIZE SCRIPT & VARIABLES START
        if not initialized and not offline(@|PLC|@) then
            begin
                H10ld := 0;
                H20ld := 0;
                H30ld := 0;
                H40ld := 0;
                H50ld := 0;
                H60ld := 0;
                H70ld := 0;
            end;
        end;
    end;
end;

```

Annex

```

      H80ld := 0;
      H90ld := 0;
      H100ld := 0;
      ListClear("Signals");
      ListClear("Values");
    //      ListClear("Timestamps");
    //      set initialized to perform initializing once
    initialized := true;
  end
  else if initialized then

// ACTIONS ONCE PER SECOND START
  oncePerSecond
  begin
    seconds:= seconds + 1;

// ACTIONS ONCE PER SECOND END
// send one package for all 10 holding registers  for now always
// Reg1Content Start
    if( H10ld <> @|PLC|@:H1 ) then
      begin
//fill lists
        H10ld := @|PLC|@:H1;
        ListAdd("Signals", "H1");
        ListAdd("Values", toString(@|PLC|@:H1));
        H20ld := @|PLC|@:H2;
        ListAdd("Signals", "H2");
        ListAdd("Values", toString(@|PLC|@:H2));
        H30ld := @|PLC|@:H3;
        ListAdd("Signals", "H3");
        ListAdd("Values", toString(@|PLC|@:H3));
        H40ld := @|PLC|@:H4;
        ListAdd("Signals", "H4");
        ListAdd("Values", toString(@|PLC|@:H4));
        //      H50ld := @|PLC|@:H5;
        //      ListAdd("Signals", "H5");
        //      ListAdd("Values", toString(@|PLC|@:H5));
        //      H60ld := @|PLC|@:Reg6;
        //      ListAdd("Signals", "H6");
        //      ListAdd("Values", toString(@|PLC|@:H6));
        //      H70ld := @|PLC|@:H7;
        //      ListAdd("Signals", "H7");
        //      ListAdd("Values", toString(@|PLC|@:H7));
        //      H80ld := @|PLC|@:H8;
        //      ListAdd("Signals", "H8");
        //      ListAdd("Values", toString(@|PLC|@:Reg8));
        //      H90ld := @|PLC|@:H9;
        //      ListAdd("Signals", "H9");
        //      ListAdd("Values", toString(@|PLC|@:Reg9));
        //      H100ld := @|PLC|@:H10;
        //      ListAdd("Signals", "H10");
        //      ListAdd("Values", toString(@|PLC|@:H10));
        //      sendSignalValue("HoldingReg1", toString(@|PLC|@:H1));
        //      sendSignalValue("HoldingReg2", toString(@|PLC|@:H2));
        //      sendSignalValue("HoldingReg3", toString(@|PLC|@:H3));
        //      sendSignalValue("HoldingReg4", toString(@|PLC|@:H4));
        //      sendSignalValue("HoldingReg10", toString(@|PLC|@:H10));
        // send Signal Package with lists
        SendSignalPackage("Signals", "Values")

        //initialize list
        begin
          ListClear("Signals");
          ListClear("Values");
        end;

// SENDING Holding Register  END

// LOGGING SIGNALS WHEN CHANGED START
    logstring := "@|PLC|@ Signals: "
      + " Reg 1: " + toString(@|PLC|@:H1)
      + " Reg 2: " + toString(@|PLC|@:H2)

```

Annex

```

//
//
//
//
//
//
+ " Reg 3: "
+ " Reg 4: "
+ " Reg 5: "
+ " Reg 6: "
+ " Reg 7: "
+ " Reg 8: "
+ " Reg 9: "
+ " Reg 10: "

+ toString(@|PLC|@:H3)
+ toString(@|PLC|@:H4)
+ toString(@|PLC|@:H5)
+ toString(@|PLC|@:H6)
+ toString(@|PLC|@:H7)
+ toString(@|PLC|@:H8)
+ toString(@|PLC|@:H9)
+ toString(@|PLC|@:H10)
;

if logString <> logstringOld then
begin
  debugOut(logString);
  logstringOld := logString;
end;
// LOGGING SIGNALS WHEN CHANGED END
end;
end;
end;
```

8.7 Script functions

Application	Script function Parameters in [...] are optional	Description	Output event
Default	SendImpulse(ImpulseCount, [Reference])	Sends impulses.	Impulses
Default	SendQuantity(Quantity, [Unit], [QualityDetail], [Reference])	Sends quantity.	Quantity
Custom	SendState(State, [StatusCodesListName], [Reference])	Sends status.	State
Default	SendStateProduction([StatusCodesListName], [Reference])	Sends production status.	State
Default	SendStateStoppage([StatusCodesListName], [Reference])	Sends the stop state.	State
Default	SendSignalValue(SignalName, Value, [Unit], [Reference], [CustomerSpecificSetting], [Timestamp])	Sends the value of a signal. Data type "Long" (L) must be used for the timestamp list.	SignalValue
Default	SendSignalPackage(SignalNamesListName, ValuesListName, [UnitsListName], [Reference], [CustomerSpecificSetting], [TimestampsListName])	Sends signal values as a package. Data type "Long" (L) must be used for the timestamp list.	SignalPackage
Custom	SendGenericInformation(ParamName, ParamValue, [Reference])	Sends generic information.	GenericInformation
Helper	ListNew(ListName, DataType)	Creates a new list with the name ListName and list elements of the data type DataType (S for string, B for boolean, N for number).	-
Helper	ListAdd(ListName, Value)	Adds an element to the list.	-

Application	Script function Parameters in [...] are optional	Description	Output event
Helper	ListClear(ListName)	Empties the list.	-
Helper	ListDelete(ListName)	Deletes the list.	-
Helper	GetMachineStatus()	Indicates the machine status.	-
Helper	GetMachineData(ParameterName)	Indicates machine data for the specified parameter.	-
Helper	SetParameter(ParameterName, ParameterValue)	Sets a new value for the specified parameter.	-
Helper	GetParameter(ParameterName)	Fetches the value for the specified parameter.	-
Helper	DeleteParameter(ParameterName)	Deletes the parameter.	-
Helper	DeleteAllParameters()	Deletes all parameters.	-
Helper	OFFLINE	Indicator whether the controller is offline or not.	-
Helper	IPADDRESS	The IP address of the DACQ.	-
Helper	HOSTNAME	Hostname of the DACQ.	-
Helper	SQRT(args)	Root function MATH.	-
Helper	SIN(args)	Sine function MATH.	-
Helper	COS(args)	Cosine function MATH.	-

Application	Script function Parameters in [...] are optional	Description	Output event
Helper	TAN(args)	Tangent function MATH	-
Helper	RISINGEDGE(args)	Checks if the last inspected value was false and if it is true.	-
Helper	FALLINGEDGE(args)	Checks if the last inspected value was true and if it is false.	-
Helper	SUBSTRING(str, startIndex[, endIndex])	Substring of the specified string.	-
Helper	TONUMBER(str)	String to number (double), replaces comma to period in string.	-
Helper	TOSTRING(str or number[, formatSpecifier])	Specifies the format of the form width. The default formatting is used for empty strings. Width is the minimum length of the result string. Precision is the number of decimal places. If not specified, 0 is used. If the format specification starts with 0, the result string is prefixed with filled zeros. If the format specification ends with X, the number is converted to hexadecimal, using upper or lower case letters with upper or lower case x. In this case, the decimal places are always cut off.	-
Helper	LENGTH(obj)	The length of an object as a string value.	-

Application	Script function Parameters in [...] are optional	Description	Output event
Helper	FORMATTIME(timeformatStr, timeOffset, [, timeunit])	<p>Formats the current time with the time unit as one of the following:</p> <p>MILLISECOND SECOND MINUTE HOUR TAG MONTH YEAR MSABSOLUTE (current time)</p> <p>"R" at Format is specified as a number in milliseconds, otherwise the format is used and the offset and time unit are used to calculate the time.</p>	-
Helper	STDLOG(ignored, logLevel, suffixNumber, logText)	<p>The first parameter is ignored. The log level should be W = warning, C or F = error and everything else for the debug level. The suffix number, if not 0, is added to the end of the log text as "<SuffixNumber>" with script loggers.</p>	-
Helper	FILELOG(filepath, textToAppend)	Creates or appends a file with a file path ('/' used as separator) with a specified text to be appended.	-
Helper	SENDTOFORCAM(str1[, str2]) / SENDTOCLIENT (str1[, str2])	If a string already exists, "clientsend" or "forcamsend" is used as the first argument, otherwise the first string is used as the first argument to send the data of the second string to the TCP connections configured in Javis.INI..	-
Helper	DEBUGOUT(text)	Logs the text at debug log level with parser logger.	-

Annex

Application	Script function Parameters in [...] are optional	Description	Output event
Helper	COPYFILE(inFile, outFile)	Copies data from in-file to out-file. Arguments can be file paths. If successful, the last modified out-file is also updated as in-file.	-
Helper	COPYREPLACE(inFile, outFile, searchStr, replaceStr)	Copies from in-file to out-file as with function COPYFILE, replacing all incidences of search-string with replace-string.	-
Helper	ATTIME(seconds, obj)	Calculates the object every day at specified times in seconds (seconds represents time fraction of the current day in seconds).	-
Helper	FROMASCII(num)	Returns a string that has the numeric value specified as num.	-
Helper	SLEEP(ms)	Pauses the current thread for a specified time in milliseconds (ms).	-

8.8 Table of figures

<i>Fig. 1: Location of the FORCAM FORCE EDGE solution components</i>	5
<i>Fig. 2: Reference architecture of the Open Industry 4.0 Alliance</i>	5
<i>Fig. 3: Schematic structure of FORCAM FORCE EDGE</i>	6
<i>Fig. 4: The EDGE API structure</i>	8
<i>Fig. 5: Options for installing FORCAM FORCE EDGE</i>	11
<i>Fig. 6: Calling up the Home section</i>	12
<i>Fig. 7: FORCAM FORCE EDGE user management with 2 users</i>	13
<i>Fig. 8: Dialog for creating a new user</i>	14
<i>Fig. 9: Licensing and overview</i>	15
<i>Fig. 10: Monitoring of template transmissions via the API</i>	16
<i>Fig. 11: Alphabetical sorting of columns</i>	17
<i>Fig. 12: Alphabetical sorting and grouping by content</i>	17
<i>Fig. 13: FORCAM FORCE EDGE entry and overview page</i>	18
<i>Fig. 14: Machine overview as next page after clicking on "Show details"</i>	19
<i>Fig. 15: Dialog for adding a new node</i>	20
<i>Fig. 16: Dialog for configuring a machine in FORCAM FORCE EDGE</i>	21
<i>Fig. 17: Add machine - select template</i>	22
<i>Fig. 18: Confirming the overwriting of the configuration with a template</i>	22
<i>Fig. 19: Add machine - basic information</i>	23
<i>Fig. 20: Add machine – Customer-specific settings</i>	24
<i>Fig. 21: Add machine - MDC controller</i>	25
<i>Fig. 22: Add machine - Signal</i>	26
<i>Fig. 23: Add machine - Script</i>	27
<i>Fig. 24: Excerpt from the script sample for the "DONE" signal</i>	27
<i>Fig. 25: Add machine - DNC configuration</i>	28
<i>Fig. 26: Add machine - Overview</i>	29
<i>Fig. 27: Event configuration in FORCAM FORCE EDGE</i>	30
<i>Fig. 28: Communication with superordinate systems via HTTP/REST</i>	32
<i>Fig. 29: Communication with superordinate systems via MQTT broker</i>	33
<i>Fig. 30: Event configuration via OPC UA</i>	34
<i>Fig. 31: Monitoring in FORCAM FORCE EDGE</i>	36
<i>Fig. 32: „EDGE DNC“ component in the Monitoring page</i>	37