



# FORCAM FORCE EDGE

Version 211221

## *Product Description*



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## Product Description

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.

A diverse range of information is obtained from the machine connections. This includes information about the current status of the connected machines or their sensor readings such as temperatures, pressures or energy consumption. Especially in the Brownfield environment, it is important not only to read the signals and pass them on, but also to interpret them for utilization. This is done by the EDGE Composition Layer. It is important, for example, to interpret when a machine is actually in production or at stoppage.

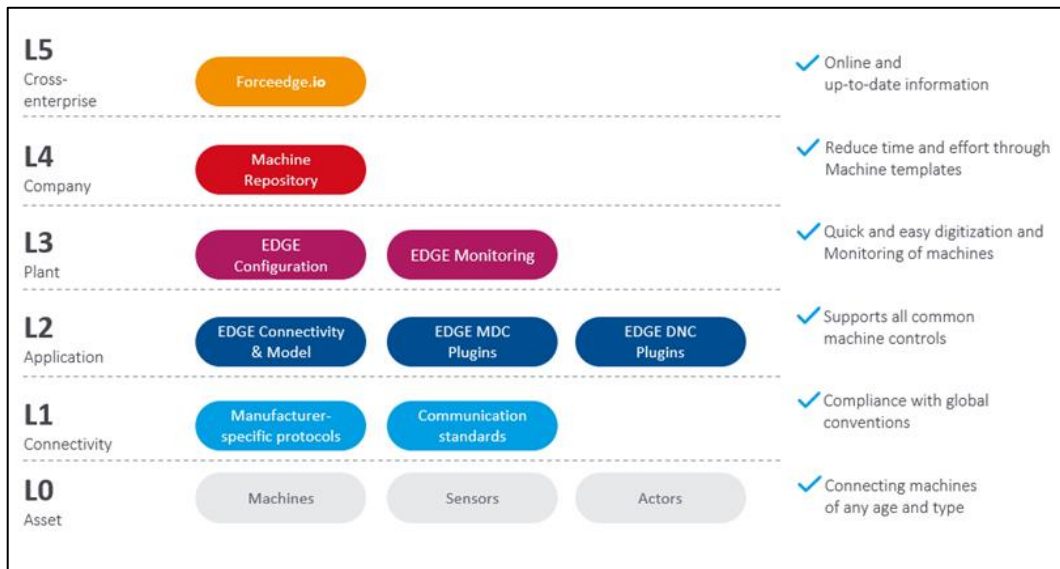
FORCAM FORCE EDGE is not only able to read or write machine signals. Another essential part of the solution is the handling of NC programs and the possibility to transfer them to and from the machine.

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.

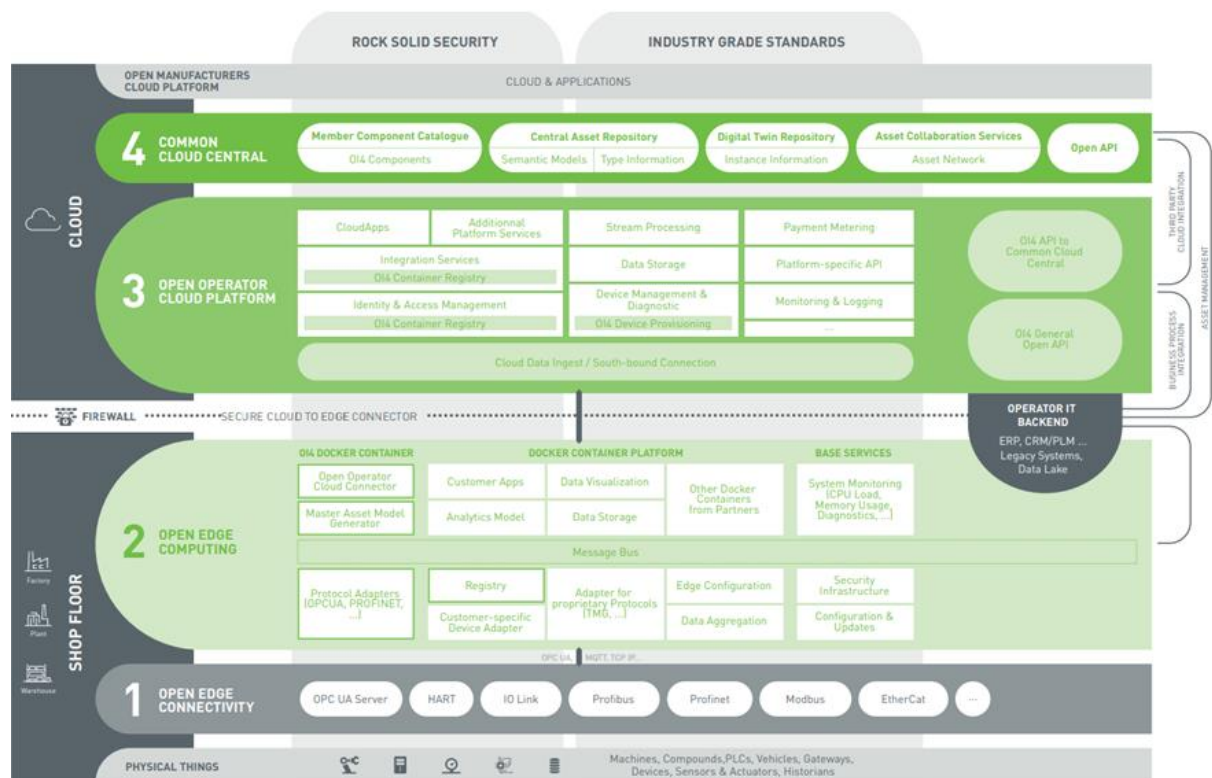
FORCAM provides standard templates for common machines.

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 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.

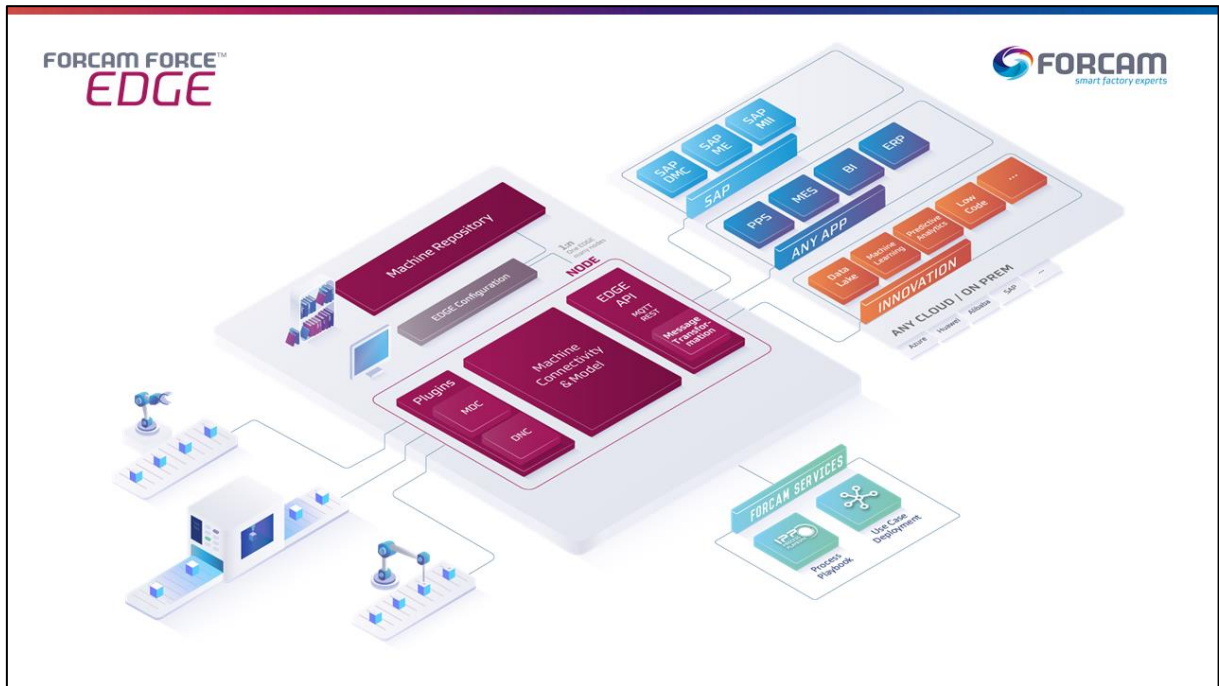


**Fig. 2: Reference architecture of the Open Industry 4.0 Alliance**

## System Components

FORCAM FORCE EDGE includes the following components, which are described in more detail as follows:

- Machine Connectivity & Model
- Plugins
- Data Lake
- EDGE API
- EDGE components



**Fig. 3: Schematic structure of FORCAM FORCE EDGE**

### Machine Connectivity & Model

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

#### EDGE MDC Layer

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.

#### EDGE DNC 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.

## 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 the annex.

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

## Data Lake

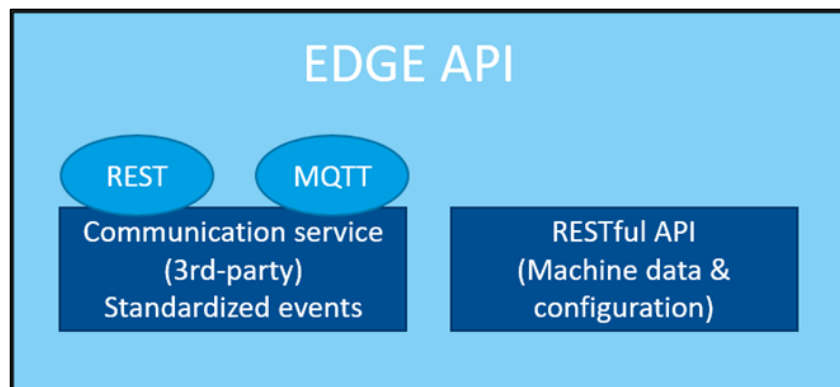
To obtain a digital twin of a machine or control system, it is not only important to establish connectivity to the machine, interpret the signals and pass them on to other applications, but also to store the data. With Data Lake, all data is stored on signal level, interpretation level, and event level,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

The data is made available through our 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.

## 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 or MQTT. The events are transmitted via HTTP in JSON format. Optionally, an MQTT broker can be used 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**

## EDGE Components

### 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.

### Machine Repository

The Machine 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. Machine and machine connection-specific configuration elements 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.

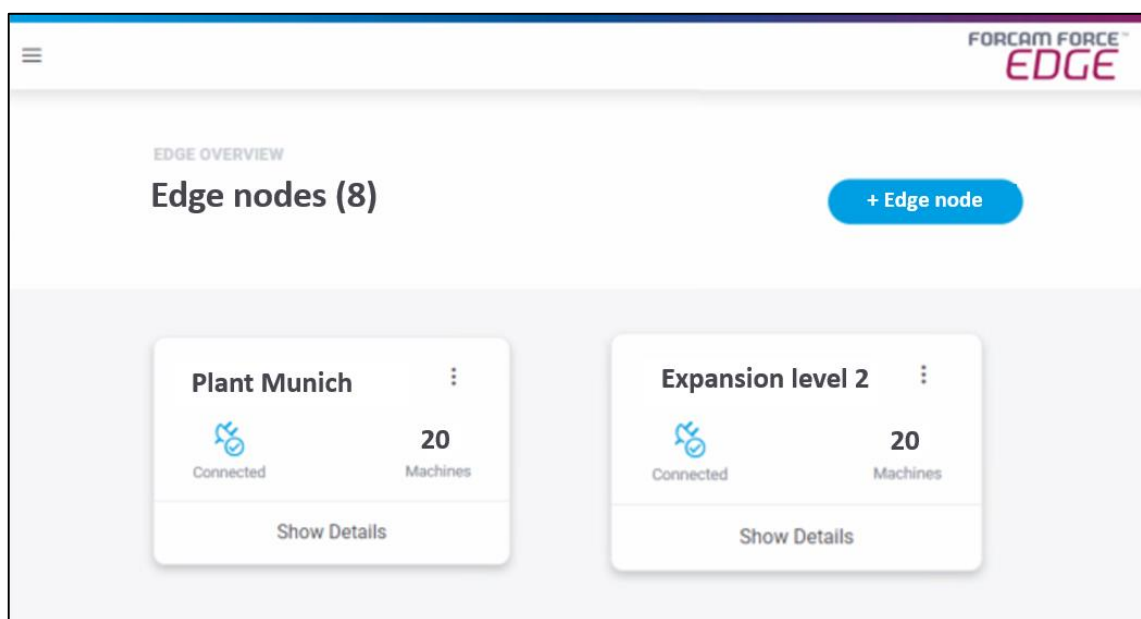


## Configuration

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.

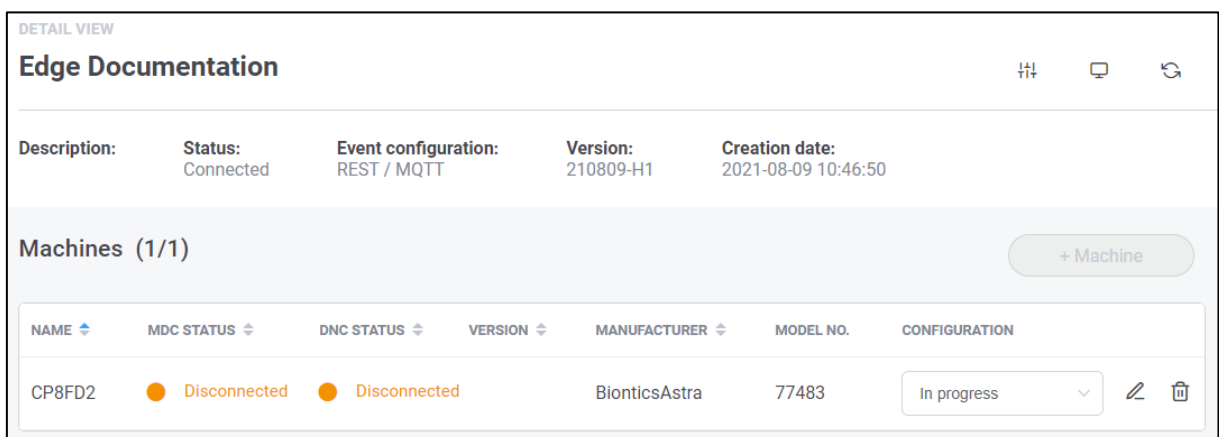
### EDGE Node

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.



**Fig. 5: FORCAM FORCE EDGE entry and overview page**

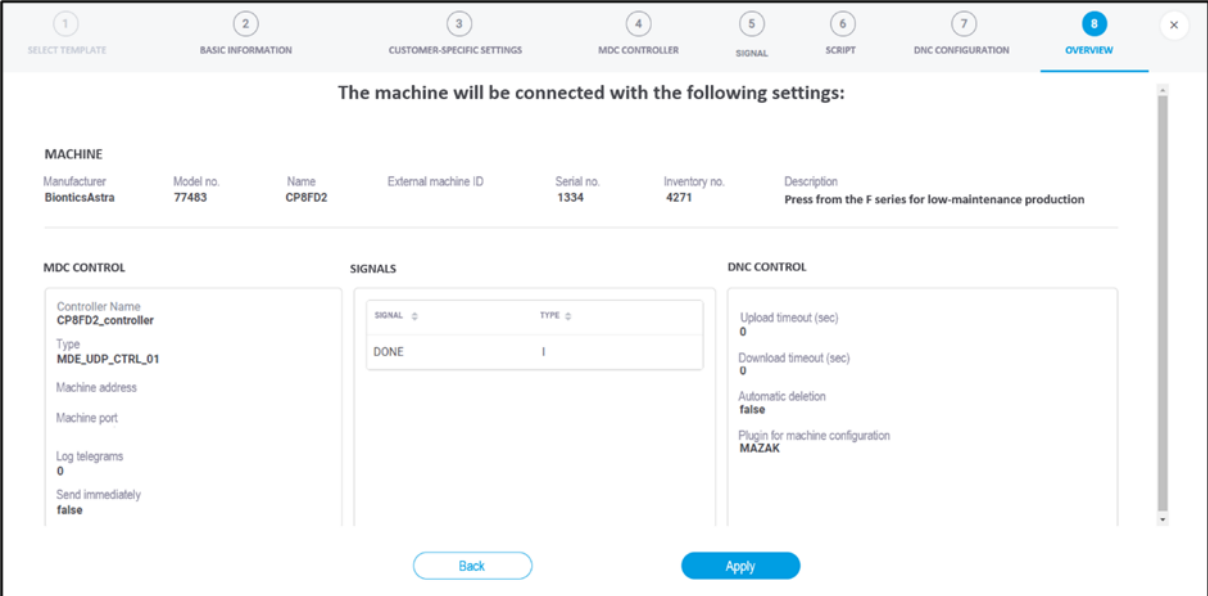
The machine overview gives a description of the plant and indicates the status of each connected machine.



**Fig. 6: Machine overview as next page after clicking on "Show details".**

## Machines

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.



**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	SIGNALS	DNC CONTROL
<p>Controller Name CP8FD2_controller</p> <p>Type MDE_UDP_CTRL_01</p> <p>Machine address</p> <p>Machine port</p> <p>Log telegrams 0</p> <p>Send immediately false</p>	<p>SIGNAL: DONE    TYPE: I</p>	<p>Upload timeout (sec) 0</p> <p>Download timeout (sec) 0</p> <p>Automatic deletion false</p> <p>Plugin for machine configuration MAZAK</p>

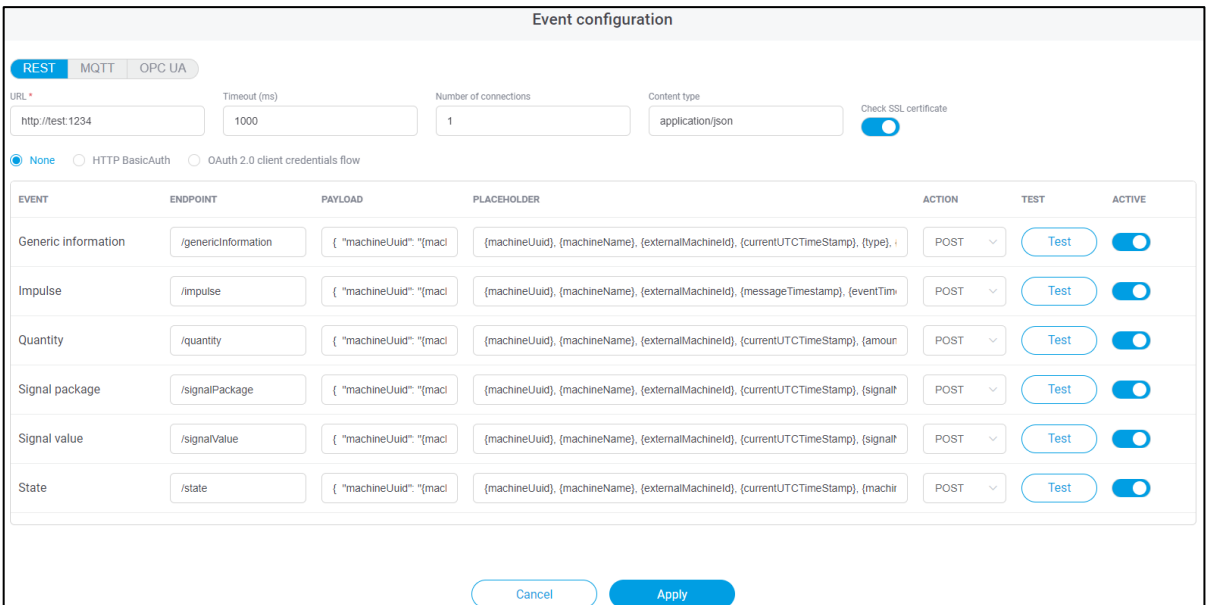
Buttons: Back, Apply

**Fig. 7: Dialog for configuring a machine in FORCAM FORCE EDGE**

## Events

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.

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 configuration**

REST | MQTT | OPC UA

URL: http://test.1234    Timeout (ms): 1000    Number of connections: 1    Content type: application/json    Check SSL certificate: ☒

☒ None    ☐ HTTP BasicAuth    ☐ OAuth 2.0 client credentials flow

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}, {signal#	POST	Test	<input checked="" type="checkbox"/>
Signal value	/signalValue	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {currentUTCTimeStamp}, {signal#	POST	Test	<input checked="" type="checkbox"/>
State	/state	{ "machineUuid": "{maci"	{machineUuid}, {machineName}, {externalMachineId}, {currentUTCTimeStamp}, {machir	POST	Test	<input checked="" type="checkbox"/>

Buttons: Cancel, Apply

**Fig. 8: Event configuration in FORCAM FORCE EDGE**

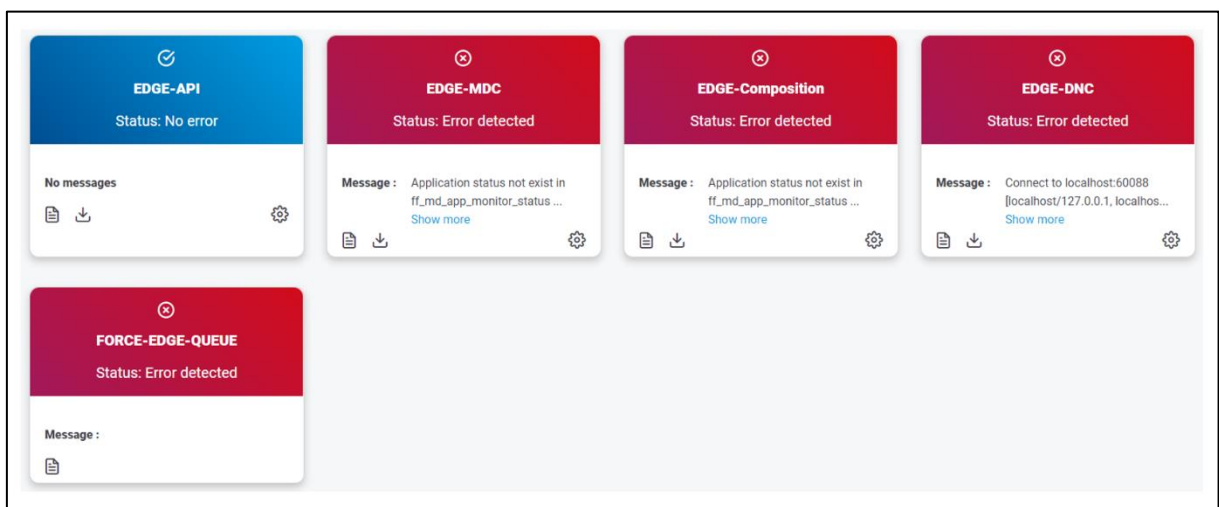


For each type of event there is a standardized **Event**. For example, the **Quantity** event type sends the quantity produced by the machine.

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.

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



**Fig. 9: Monitoring in FORCAM FORCE EDGE**

## Scope of functions

### General

- Simple, digital connection of a heterogeneous machine park without great effort
- Almost all machines can be digitized, regardless of age or type
- Configuration of EDGE nodes and machines via modern menu navigation
- Clearly structured and user-friendly dialogs for easy machine connections
- Flexible use of FORCAM FORCE EDGE for any manufacturing company
- Substantial contribution to the Open Industry 4.0 Alliance and thus to digitization in the manufacturing industry with a focus on customer benefits

### Machine signals

- Transmission of standardized events to superordinate ME or MOM systems such as SAP DMC/ME or MII
- Reading machine signals to interpret when, for example, a machine is in production or at stoppage
  - Writing machine signals
  - Obtaining a wide variety of information from the machine such as current status or sensor readings such as temperatures, pressures or energy consumption
- Three technical methods for supplying signals and events from an Edge node to a 3rd party application:
  - HTTP/REST
    - Any REST endpoint can be used.
    - It supports the HTTP POST and PUT methods.
  - MQTT Messaging
    - Any MQTT broker can be used, if it is supplied by customers or partners.
  - 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.
    - Using the specified URL, the user connects to the server to retrieve the desired data. The necessary client for the retrieval is prerequisite.

## Plugins

- Innovative plugin concept
  - Direct communication with different machine controls
  - Support of all common machine manufacturer-specific protocols (For example HEIDENHAIN, Siemens S7, FANUC etc.)
  - Support of all common communication standards (e.g. MTConnect, OPC UA, MQTT etc.)
  - FORCAM I/O Controller as separate hardware for digitally connecting non-networked machines
- Transfer of NC programs from and to the machine
- The plugin concept of FORCAM FORCE EDGE is extensible and is continuously expanded

## EDGE API

- Fetching machine master data and configuring machine connections via RESTful API
- The EDGE API event service is used to forward machine data in the form of standardized events to superordinate systems
- Superordinate systems can be connected either via HTTP/REST or MQTT
- The events are transmitted via HTTP in JSON format (optionally: MQTT broker as middleware)
- The EDGE API is delivered with preconfigured standard events for communication with the MES or ERP level

## Data Lake

- Capture and storage of all data, configuration changes, write operations and transferred NC files

## Machine Repository

- Easy to create and use machine templates via the Machine Repository component
  - Definition of templates for machine connections
  - Deriving templates from existing connections to be applied to the same types of machines
  - Significant reduction of the individual effort for connecting a machine
  - 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

## Monitoring

- Monitoring individual components via the monitoring option
- Realtime information about the respective component with status indication
- Fetches error messages and downloads logs

## Annex

### MDC Plugins

Table 1: 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/

Name	Read	Write	Transmission type Polling/Event based
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 2: 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)		