FORCE EDGE CONNECT

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Product Description

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Product Description

FORCE EDGE CONNECT (hereafter simply referred to as EDGE CONNECT) offers manufacturing companies a solution for digitally connecting their heterogeneous machinery. Almost all machines can be digitized with EDGE CONNECT, 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).

EDGE CONNECT 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. EDGE CONNECT 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. It is important, for example, to interpret when a machine is actually in production or at stoppage.
EDGE CONNECT 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.

The modern and also cleanly structured menu navigation of EDGE CONNECT makes it possible to digitally connect machines in a quick and efficient way 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.

EDGE CONNECT 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.

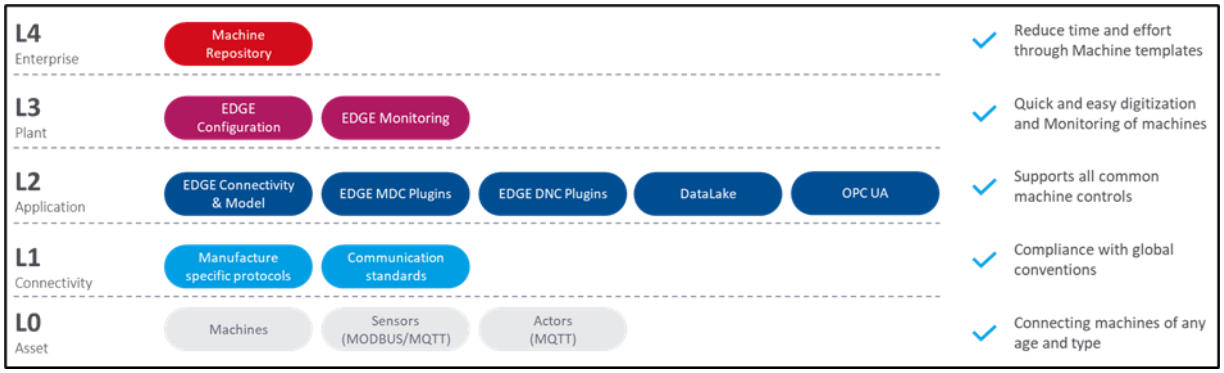

Fig. 1: Location of the EDGE CONNECT solution components

The following figure shows the reference architecture of the Open Industry 4.0 Alliance, which is also the basis of the EDGE CONNECT 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 EDGE CONNECT stand out.

System components

This chapter describes the individual EDGE CONNECT components and their functions.

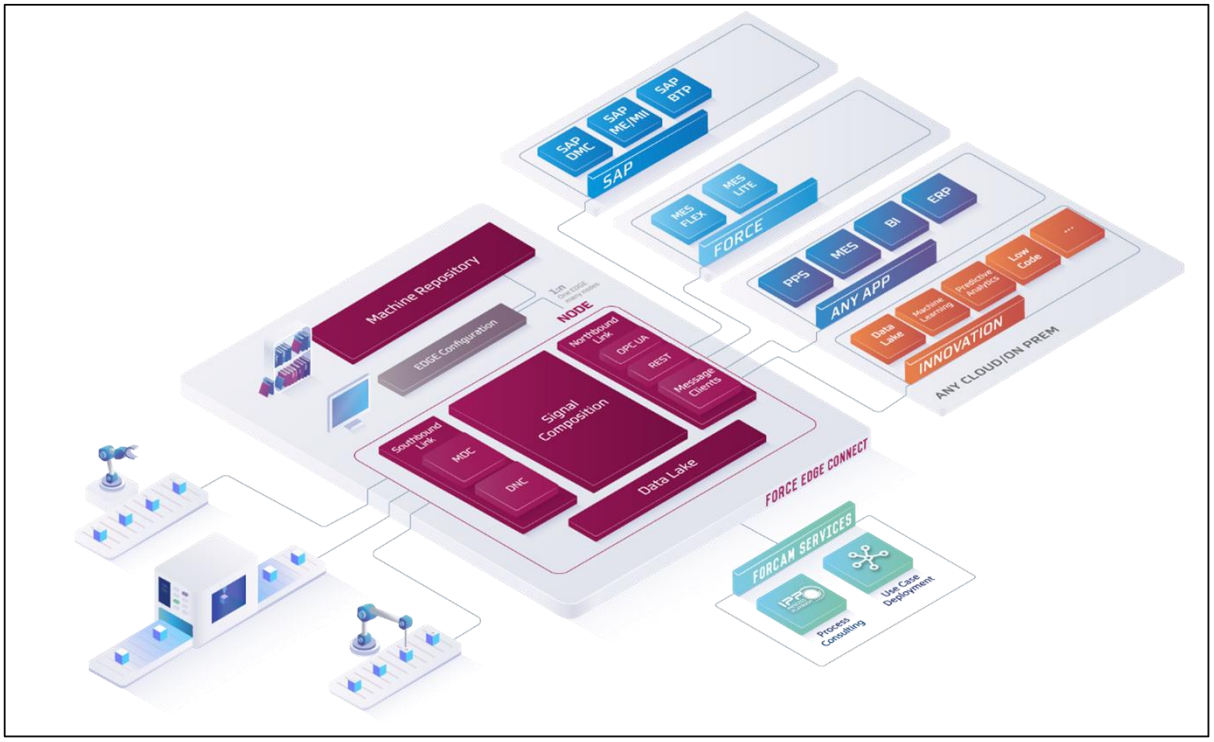

Fig. 2: Schematic structure of EDGE CONNECT

EDGE Node

The EDGE node is the central element of EDGE CONNECT when it comes to connecting assets. It consists of the following subcomponents:

Southbound Link

The Southbound Link component is responsible for the communication between EDGE CONNECT and the asset. In terms of infrastructure, EDGE CONNECT is located above the asset level (shopfloor). This is why we refer to the communication between assets and EDGE CONNECT as “southbound” communication.
The following three components manage the communication:

Plugins

The plugins used in the EDGE CONNECT establish communication links with specific machine controllers. They also standardize the data, thus making evaluations more comparable.
They allow direct communication with various machine controllers, but also cover modern communication protocols such as MQTT, UPC UA and many more. The plugin concept of EDGE CONNECT is extensible, 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 EDGE CONNECT by default. An overview of the current FORCAM plugins is listed in the **FORCE EDGE CONNECT manual**.

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 asset control, the configuration of the machine master data, the setting of the network connection and the definition of the asset signals. In addition, the EDGE MDC Layer forwards asset 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 asset control, the configuration of the asset master data, the setting of the network connection and the configuration of the DNC supply.

⚠ EDGE CONNECT is not intended to be used for providing, editing, or managing NC programs.

Signal Composition

The EDGE Signal Composition Layer is used to derive logical asset states. Either a script language or a graphical solution can be used to derive standardized events from signal combinations. For this purpose, the Composition Layer unifies the reporting capabilities. In addition, individual events are made possible. The composition also makes it possible to react to events and to write values to the control unit of the asset, as far as this is supported by control unit and protocol. Such a composition can be implemented in EDGE CONNECT either via a script or using a graphical solution. The latter provides an easy introduction into the world of signal composition.

Northbound Link

⚠ The Northbound Link component is responsible for the communication between EDGE CONNECT and any 3rd party system. In terms of infrastructure, the 3rd party system is located above EDGE CONNECT. This is why we refer to the communication between EDGE CONNECT and 3rd party systems as “northbound” communication.

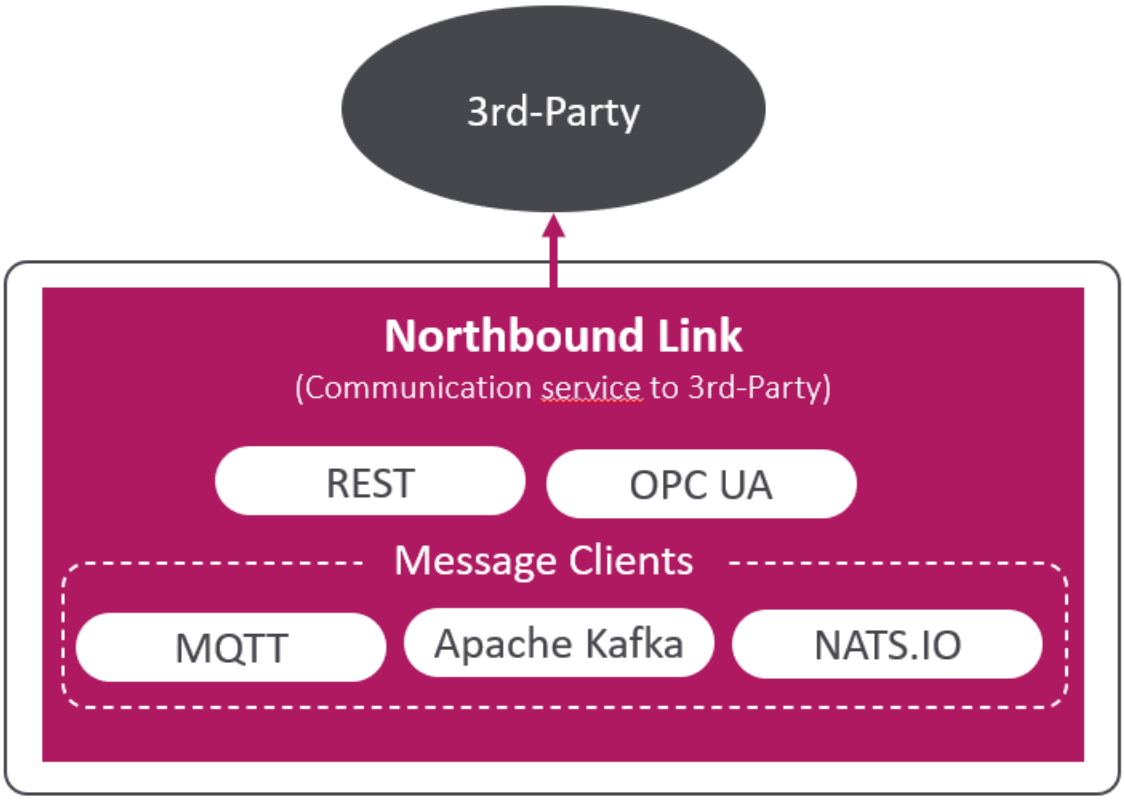

Fig. 3: Northbound Link

The Northbound Link component is used to forward asset data to superordinate systems (3rd party systems) in the form of standardized events. The following options are available for connecting superordinate systems:

- HTTP/REST
- MQTT
- Apache Kafka
- OPC UA
- NATS.io

The message content can be configured individually for each connection and event. If MQTT, NATS.io or Apache Kafka are used, a broker is required 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.
The middleware must be provided and configured separately. It is not part of the EDGE CONNECT.

Data Lake

To obtain a digital twin of an asset or control unit, it is not only important to establish the connection to the asset, interpret the signals and pass them on to other applications, but also to store the data. With the Data Lake component, all data is stored at the signal level, the interpretation level and the event level, including configuration changes, write operations and transferred NC files. Data is made available via the Data Lake API. This allows the latest AI algorithms, visualization tools, but also audit requirements to benefit.

EDGE Configuration

EDGE Configuration is the management interface for EDGE CONNECT. It can be used to manage multiple EDGE nodes. An EDGE node is the bundling of signal collection from several assets. 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 Repository allows templates to be generated from existing asset connections or for new ones. These templates can be used to connect assets of the same type and the same usage type in a standardized manner. The template contains all configuration elements that are not machine-specific. Asset-specific/asset connection-specific configuration elements are, for example, IP address, serial number, equipment number, etc. By using an existing template, the time required to connect an asset is significantly reduced. In addition, templates lead to a standardized and unified asset configuration, which makes data more comparable when it comes to evaluation.

Configuration

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

EDGE node

EDGE CONNECT 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 efficiently.

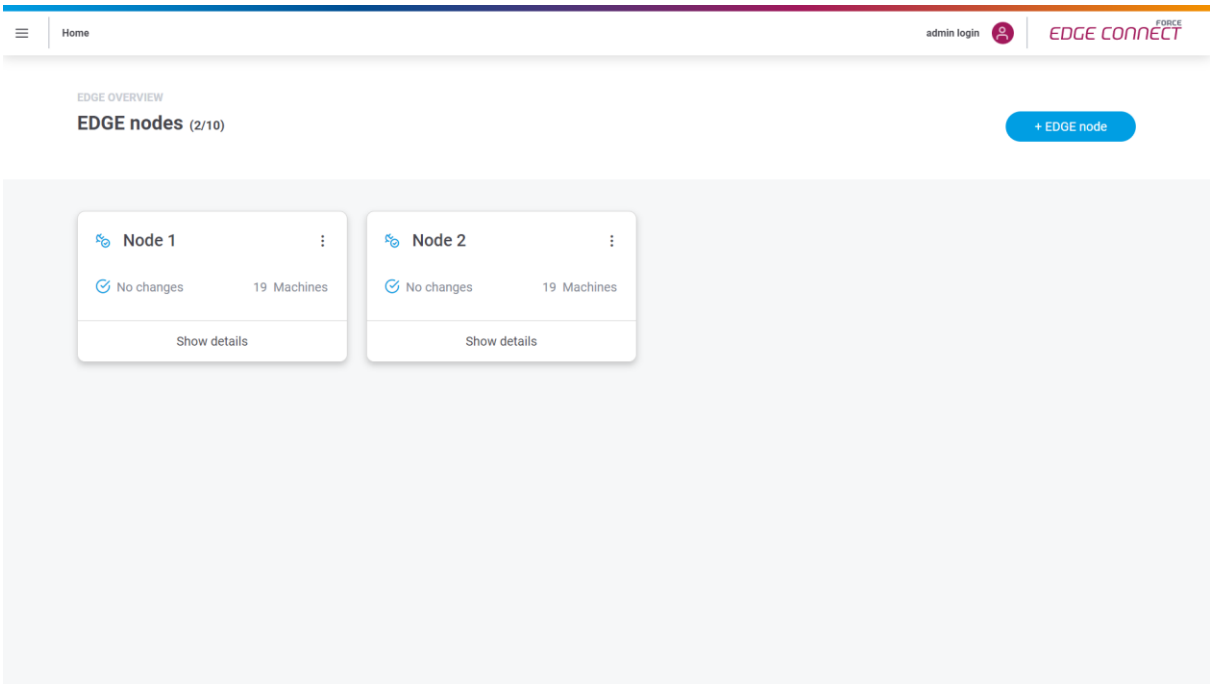

Fig. 4: EDGE CONNECT entry and overview page

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

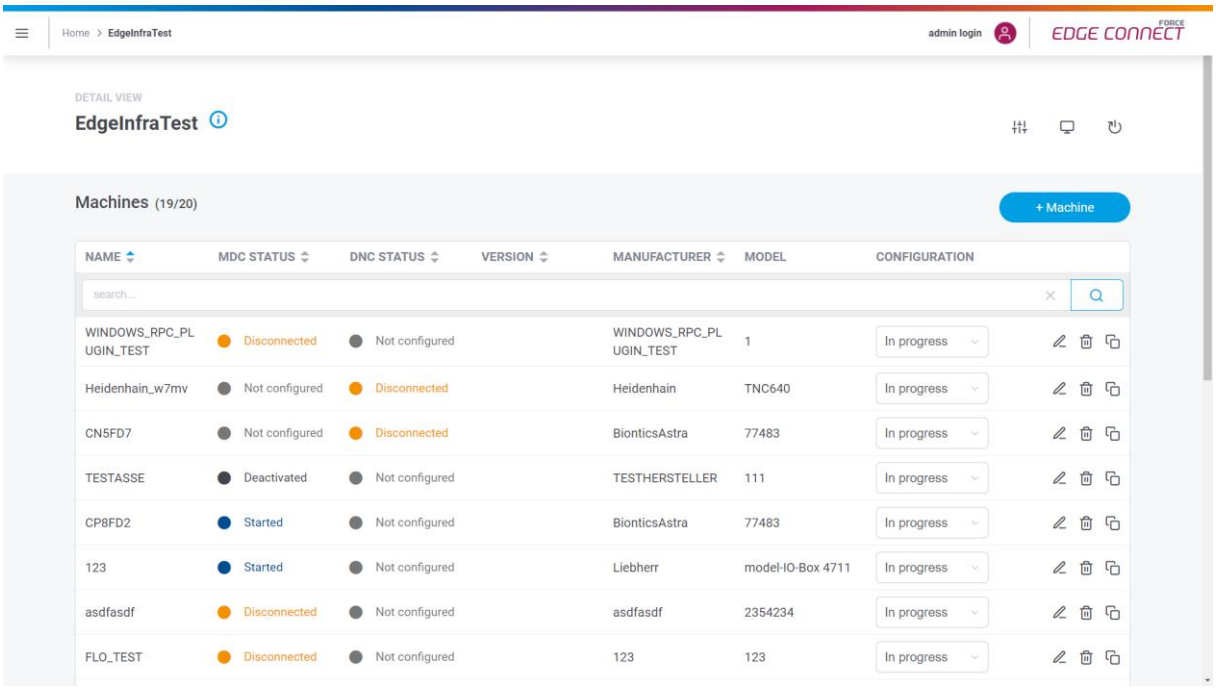

Fig. 5: Machine overview as next page after clicking on "Show details"

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.

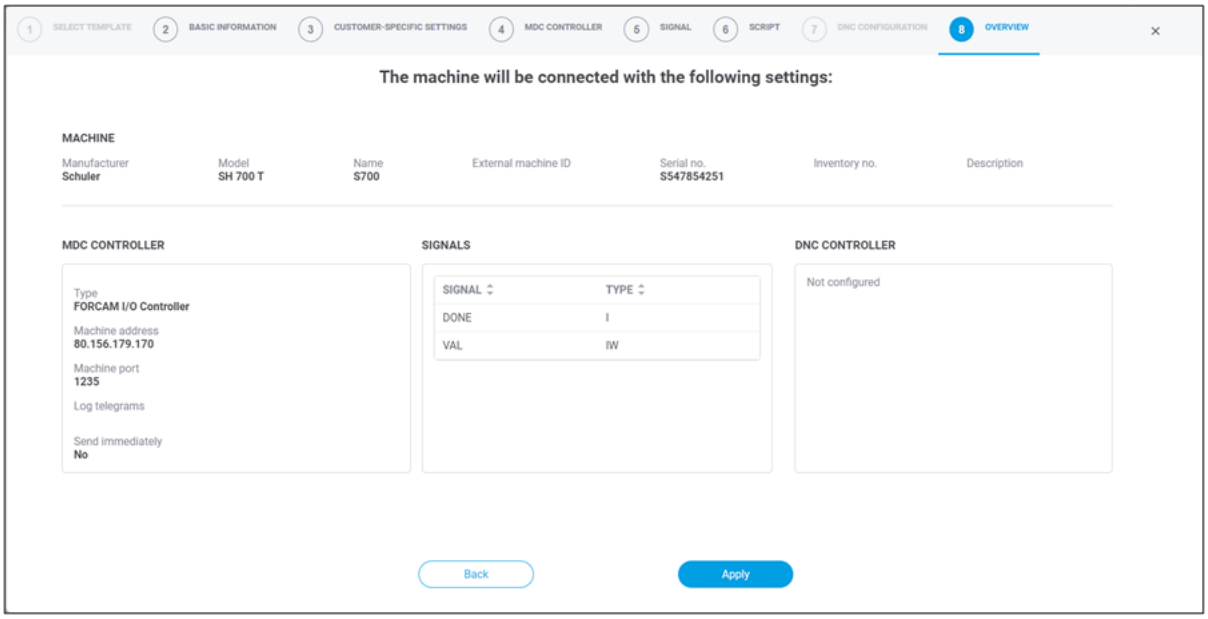

Fig. 6: Dialog for configuring a machine in EDGE CONNECT

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.

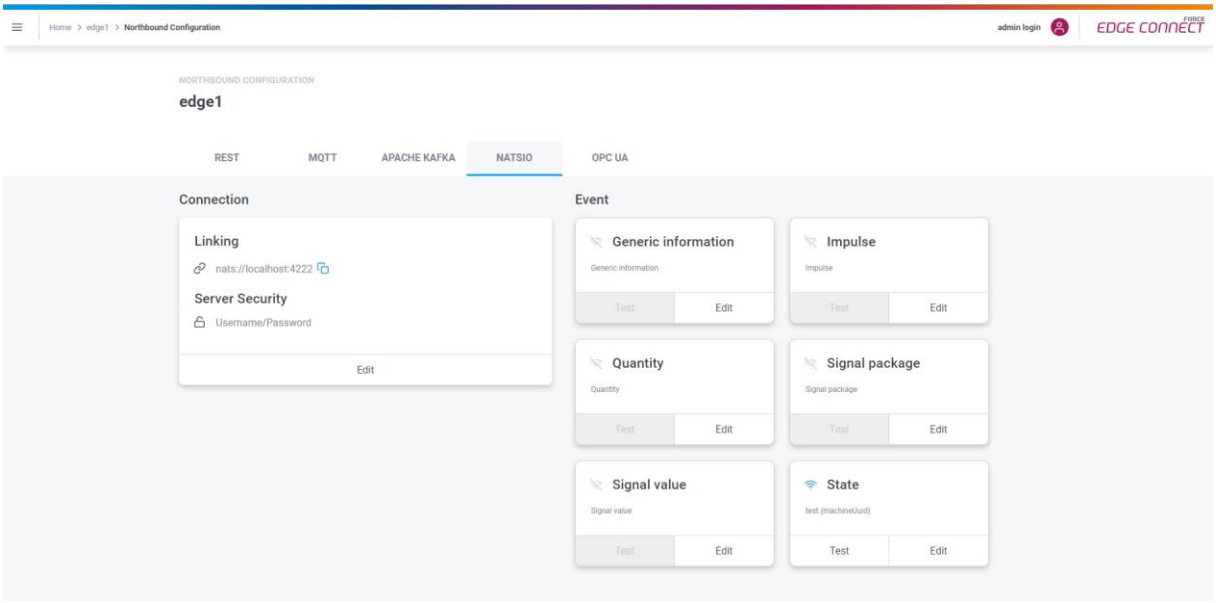

Fig. 7: Event configuration in EDGE CONNECT

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 transfer different types of information. This can be used, for example, to get the machine ID or the time stamp formatted in UTC.

Monitoring

EDGE CONNECT provides the option to monitor individual components and extensions via the monitoring page. The page indicates whether a component is running without errors or if there are any malfunctions. Error messages and logs can be retrieved specifically for each component.

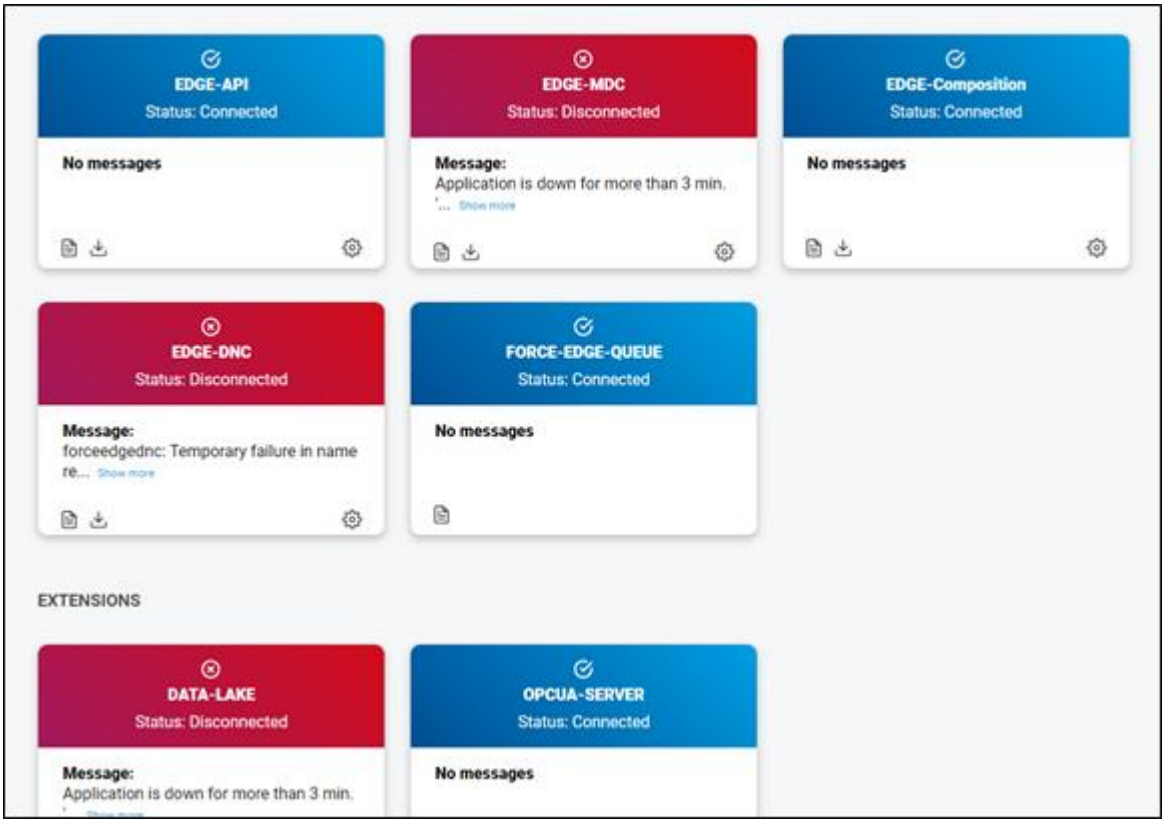

Fig. 8: Monitoring in EDGE CONNECT

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 connection
- Flexible use of EDGE CONNECT 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 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
- Four technical options to supply signals and events from an EDGE-node to a third-party application:
  - HTTP/REST
    Any REST endpoint can be served. The HTTP-methods POST and PUT are supported.
  - MQTT messaging
    Any MQTT broker can be served, if provided by the customer or partner.
  - OPC UA
    FORCAM provides an OPC UA server with “Data Access” functionality. This extension makes various machine data available via the defined OPC UA interface. The information models are prepared dynamically based on the existing configured machines in the EDGE node.
    You connect to the server via the specified URL to retrieve the desired data. We assume that the client required for data retrieval already exists.
  - Apache Kafka
    Any Apache Kafka broker can be served, if provided by the customer or partner.
  - NATS.io
    Any NATS.io server can be served, if the infrastructure is provided by the customer. Messaging can be implemented using Core NATS or JetStream.

Plugins

- Innovative plugin concept
  - Direct communication with different machine controls
  - All common machine manufacturer-specific protocols supported
    (e.g., HEIDENHAIN, Siemens S7, FANUC, etc.)
  - All common communication standards supported
    (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 is extensible, FORCAM is continuously expanding the number of supported plugins.

EDGE API

- Fetching machine master data and configuring machine connections via RESTful API
- Forwarding machine data to superordinate systems in the form of standardized events using the EDGE API event service
- Connecting superordinate systems via HTTP/REST, MQTT, Apache Kafka OPC UA or NATS.io
- Transmitting events via HTTP in JSON format
  (optionally: MQTT broker as middleware)
- Communication with the MES or ERP level through preconfigured standard events in the EDGE API

Data Lake

- Retrieval and storage of signal and event data, configuration changes, writing operations and transmitted NC files

Machine Repository

- Easy to create and use machine templates via the Machine Repository component
  - Definition of templates for machine connection
  - Deriving templates from existing connections to be applied to the same types of machines
  - Significant reduction of the individual effort for connecting a machine
  - Standardized connection of identical machines, which enables the comparison of machines of the same type

Monitoring

- Monitoring individual components via the monitoring option
- Real-time information about the respective component with status indication
- Retrieving error messages and downloading 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/
Siemens LOGO	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