

# How to Connect a machine via Heidenhain DNC interface

by David Schmeding

## Prerequisites

This lesson assumes that you want to integrate a Heidenhain controller using the DNC interface protocol with the Cybus Connectware. To understand the basic concepts of the Connectware, please check out the [Technical Overview](#) lesson. To follow along with the example, you will also need a running instance of the Connectware. If you don't have that, learn [How to install the Connectware](#). Additionally, it is not required, but will be useful to be familiar with the [User Management Basics](#) as well as the lesson [How To Connect an MQTT Client](#).

## Introduction

This article will teach you the integration of Heidenhain controllers. In more detail, the following topics are covered:

- Setup of the Cybus Heidenhain Agent
- Selecting the methods
- Creating the commissioning file
- Installing the service
- Verifying data in the Connectware Explorer

The commissioning files used in this lesson are made available in the [Example Files Repository](#) on GitHub.

## About Heidenhain DNC

Heidenhain is a manufacturer of measurement and control technology which is widely used for CNC machines. Their controllers provide the Heidenhain DNC interface, also referred to as "option 18", which enables vertical integration of devices and allows users to access data and functions of a system. The DNC protocol is based on Remote Procedure Calls (RPC), which means it carries out operations by calling methods on the target device. You can find a list of the available methods in the [Cybus Docs](#).

## Cybus Heidenhain Agent

Utilizing Heidenhain DNC with the Connectware requires the Cybus Heidenhain Agent running on a Windows machine or server on your network. This agent uses the Heidenhain RemoTools SDK to connect to one or

more Heidenhain controllers and communicates to the Connectware via MQTT. The Heidenhain Agent and required dependencies are provided to you by our [Support Team](#).

### Prerequisites

The host of the Cybus Heidenhain Agent must meet the following requirements:

- Windows 10 or Windows Server 2019
- Installed Heidenhain SDK
- Windows host must be able to reach machines (or emulators) via network
- Windows host must be able to reach Connectware instance via network

### Installation

- Start the Cybus Heidenhain Agent installer and follow the installation instructions
- Input Connectware host IP address

After successful installation, a windows system service with name "Cybus Heidenhain Agent" is up and running. It is already configured to automatically start on windows restart and to restart in case of crash. You can always inspect the status under "Windows Services".

### Post-installation Steps

Go to the Connectware Admin User Interface (Admin UI) (e.g. <https://myConnectware-IP>) and log in.

### Agent Role (once)

The agent needs to be able to communicate with the Connectware, thus we need to grant this permission. Permissions are bundled within Connectware roles (see [User Management Basics](#)). Create the following role:

- Name: heidenhain-agent
- Data permission: edge.cybus/# (readWrite)

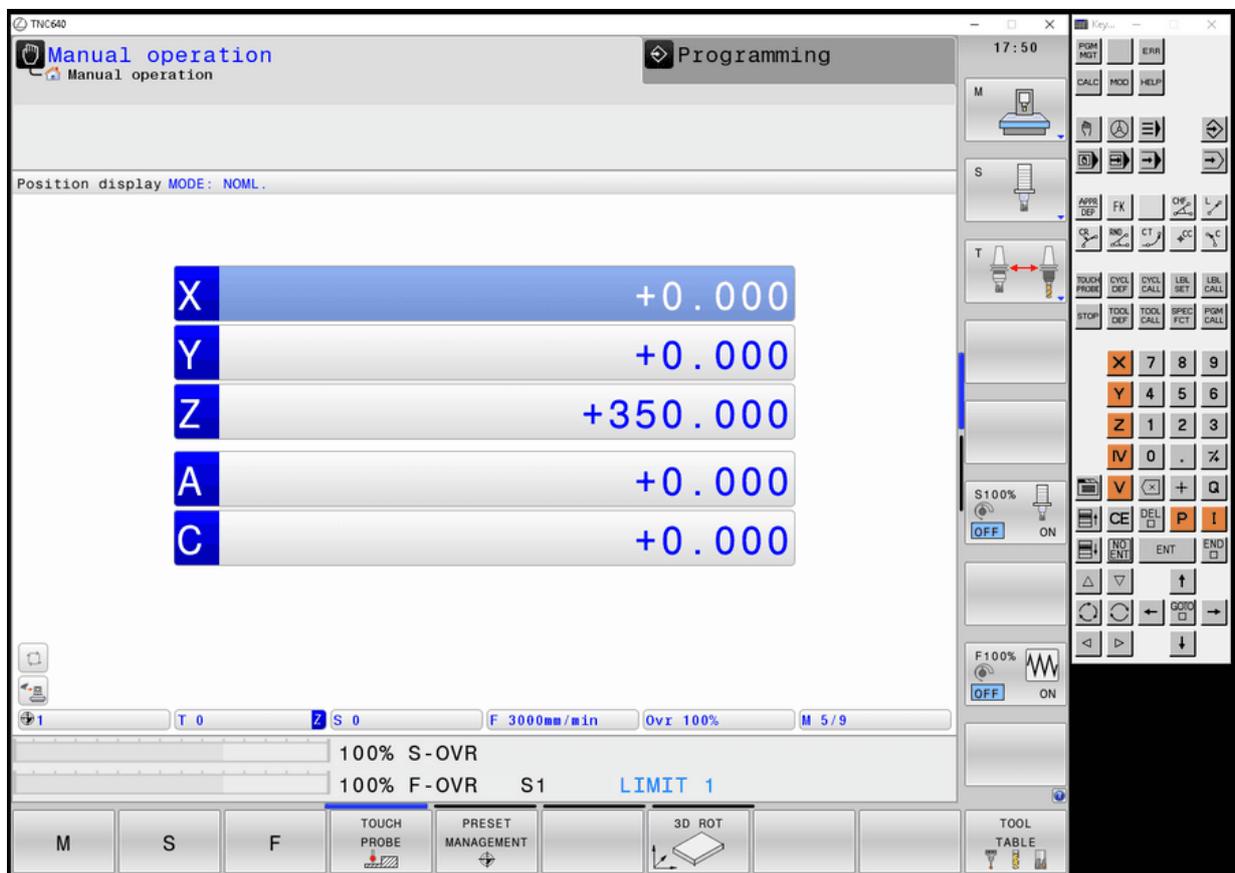
### Agent Onboarding (per Agent)

- Use the Client Registry (*User Management > Client Registry*) to onboard the agent (for details see [How To Connect an MQTT Client](#))
  - Enable self registration
  - Wait for agent to appear
  - Check if agent is correct

- Grant access to agent
- Go to *User Management > Users*
  - Click on Heidenhain agent user
  - Give the user the heidenhain-agent role
  - Save

## Installing and Starting the Heidenhain Emulator

For this lesson we do not have a machine with a TNC 640 controller available so we will utilize the TNC 640 emulator running on a Windows machine.



Download the latest version of *TNC 640 Programming Station* from [heidenhain.com](http://heidenhain.com) and install it to the same machine as the agent or another Windows machine of known IP address in the same network. After the installation you can start the program with the desktop shortcut *TNC 640*. Once the program is started and you see the tab *Power interrupted* you can press the CE button on the Keypad to enter the manual mode. The emulator should now also be available on your network.

## Selecting the methods

The most essential information we need to specify the commissioning file for our Heidenhain DNC application is the set of methods of the controller we want to make available with our Connectware. We could just take the whole list from the [Cybus Docs](#) and integrate all of the functions to be available on the Connectware but to not lose focus in this lesson we will pick a small set of them for demonstration purposes.

We will integrate the following methods:

- `getState`
- `getPlcData`
- `getToolTableRow`
- `transmitFile`
- `onToolTableChanged`

## Writing the Commissioning File

The *Commissioning File* is a set of parameters which describes the resources that are necessary to collect and provide all the data for our application. It contains information about all connections, data endpoints and mappings and is read by the Connectware. To understand the file's anatomy in detail, please consult the [Cybus Docs](#).

To get started, open a text editor and create a new file, e.g. `heidenhain-example-commissioning-file.yml`. The commissioning file is in the YAML format, perfectly readable for human and machine! We will now go through the process of defining the required sections for this example:

- Description
- Metadata
- Parameters
- Resources

### Description and Metadata

These sections contain more general information about the commissioning file. You can give a short description and add a stack of metadata. Regarding the metadata, only the name is required while the rest is optional. We will just use the following set of information for this lesson:

```
description: >

Heidenhain DNC Example Commissioning File
Cybus Learn - How to connect a machine via Heidenhain DNC interface
https://learn.cybus.io/lessons/how-to-connect-heidenhain-dnc/

metadata:

name: Heidenhain DNC Example
version: 1.0.0
icon:
https://www.cybus.io/wp-content/uploads/2019/03/Cybus-logo-Claim-lang.svg
provider: Cybus GmbH
homepage: https://www.cybus.io
```

## Parameters

Parameters allow the user to prepare commissioning files for multiple use cases by referring to them from within the commissioning file. Every time a commissioning file is applied or a service reconfigured in the Connectware, the user is asked to enter custom values for the parameters or to confirm the default values.

```
parameters:
  agentId:
    type: string
    description: Agent Identification (Cybus Heidenhain Agent)
    default: <yourAgentId>
  machineIP:
    type: string
    description: IP Address of the machine
    default: <yourMachineAddress>
  cncType:
    type: string
    default: tnc640
    description: >-
      Type of the machine control (DNC Type). Allowed values: tnc640, itnc530,
      itnc426.
    allowedValues:
```

- tnc640
- itnc530
- tnc426

The parameters we define here could vary from setup to setup, so it is just good to make them configurable. The `agentId` is the name of the agent's user in the Connectware, which was defined during client registration. The `machineIP` in our example is the address of the Windows machine running the TNC 640 emulator or would be the address of the machine tool you want to connect to. As parameter `cncType` we define the type of controller we use and additionally we define the currently supported controller types as `allowedValues` for this parameter.

## Resources

In the resources section we declare every resource that is needed for our application. For details about the different resource types and available protocols, please consult the [Cybus Docs](#).

## Connection

The first resource we need is a connection to the Heidenhain controller. The connection is defined by its `type` and its type-specific `properties`. In case of `Cybus::Connection` we declare which `protocol` and connection parameters we want to use. For the definition of our connection we reference the earlier declared parameters `agentId`, `machineIP` and `cncType` by using `!ref`.

```
resources:
  heidenhainConnection:
    type: 'Cybus::Connection'
    properties:
      protocol: Heidenhain
    connection:
      agent: !ref agentId
      ipAddress: !ref machineIP
      cncType: !ref cncType
      plcPassword: <password>
      usrPassword: <password>
      tablePassword: <password>
      sysPassword: <password>
```

The access to your *TNC 640 controller* is restricted by four preconfigured passwords. If you need help to find out the necessary passwords, feel free to contact our [Support Team](#). For *ITNC 530* and *TNC 426* no password is required.

## Endpoints

The next resources needed are the endpoints which will provide or accept data. All endpoints have some properties in common, namely the `protocol` defined as `Heidenhain`, the `connection` which is referenced to the previously defined connection resource using `!ref` and the optional `topic` defining on which MQTT topic the result will be published. In the default case the full endpoint topic will expand to `services/<serviceId>/<topic>`. For more information on that, please consult the [Cybus Docs](#).

The endpoints will make use of the methods we selected earlier. Those methods are all a bit different so let's take a look at each of the endpoint definitions.

```
getStatePolling:
  type: 'Cybus::Endpoint'
  properties:
    protocol: Heidenhain
    connection: !ref heidenhainConnection
    topic: getState
  subscribe:
    method: getState
    type: poll
    pollInterval: 5000
    params: []
```

The first endpoint makes use of the `method: getState`, which requests the current machine state. The result should be published on the `topic: getState`. This endpoint is defined with the property `subscribe`, which in the context of a Heidenhain connection means, that it will request the state in frequency of the defined `pollInterval`. This is also known as *polling* and brings us to the definition of the `type` which therefore is `poll`.

```
getState:
  type: 'Cybus::Endpoint'
  properties:
    protocol: Heidenhain
    connection: !ref heidenhainConnection
```

```
topic: getState
read:
  method: getState
```

But we could also make use of the method `getState` by requesting the state only once when it is called. The definition of this endpoint differs from the previous in the property `read` instead of `subscribe`. To utilize this endpoint and call the method, you need to publish an MQTT message to the topic `services/<serviceId>/<topic>/req`. The result of the method will be published on the topic `services/<serviceId>/<topic>/res`. `<topic>` has to be replaced with the `topic` we defined for this endpoint, namely `getState`. The `serviceId` will be defined during the installation of the service and can be taken from the services list in the Connectware Admin UI.

```
getToolTableRow:
  type: 'Cybus::Endpoint'
  properties:
    protocol: Heidenhain
    connection: !ref heidenhainConnection
    topic: getToolTableRow
  read:
    method: getToolTableRow
```

The previously used method `getState` did not expect any arguments so we could just call it by issuing an empty message on the `req` topic. The method `getToolTableRow` is used to request a specific row of the tool table. To specify which row should be requested, we need to supply the `toolId`. We will look at an example of this method call in the last section of the article.

```
getPlcData:
  type: 'Cybus::Endpoint'
  properties:
    protocol: Heidenhain
    connection: !ref heidenhainConnection
    topic: getPlcData
  read:
    method: getPlcData
```

Using the method `getPlcData` allows us to request data stored on any memory address of the controller. The arguments that must be handed over are the `memoryType` and the `memoryAddress`.

```
transmitFile:
  type: 'Cybus::Endpoint'
  properties:
    protocol: Heidenhain
    connection: !ref heidenhainConnection
    topic: transmitFile
  read:
    method: transmitFile
```

The method `transmitFile` allows us to transmit a file in the form of a base64-encoded buffer to a destination path on the Heidenhain controller. It expects two arguments: the string `fileBuffer` and another string `destinationPath`.

```
onToolTableChanged:
  type: 'Cybus::Endpoint'
  properties:
    protocol: Heidenhain
    connection: !ref heidenhainConnection
    topic: notify/onToolTableChanged
  subscribe:
    type: notify
    method: onToolTableChanged
```

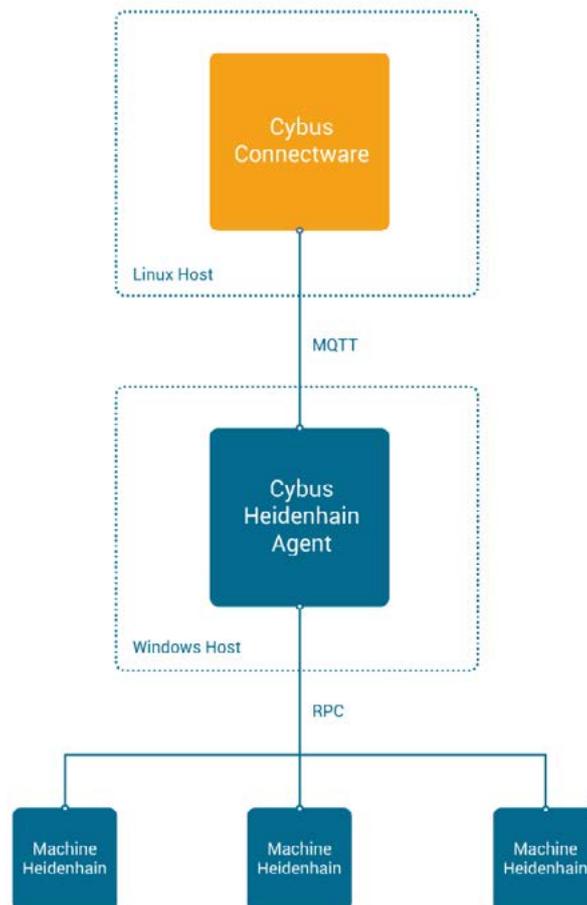
The last endpoint we define calls the method `onToolTableChanged`. This is an event method which will send a notification in case of a changed tool table. For this we have to use the property `subscribe` along with the `type notify`. This means that we are not polling the method in this context but subscribe to it and wait for a notification on the specified `topic`. We could trigger a notification by modifying the tool table in the TNC emulator.

## Installing the Commissioning File

You now have the commissioning file ready for installation. Head over to the Services tab in the Connectware Admin UI and hit the (+) button to select and upload the commissioning file. You will be asked to specify values for each member of the section `parameters` or confirm the default values. With a proper written commissioning file, the confirmation of this dialog will result in the installation of a service, which manages all the resources we just defined: The connection to the Heidenhain controller and the endpoints collecting data from the controller. After enabling this service you are good to go on and see if everything works out!

## How do all the components we installed and defined so far now work together?

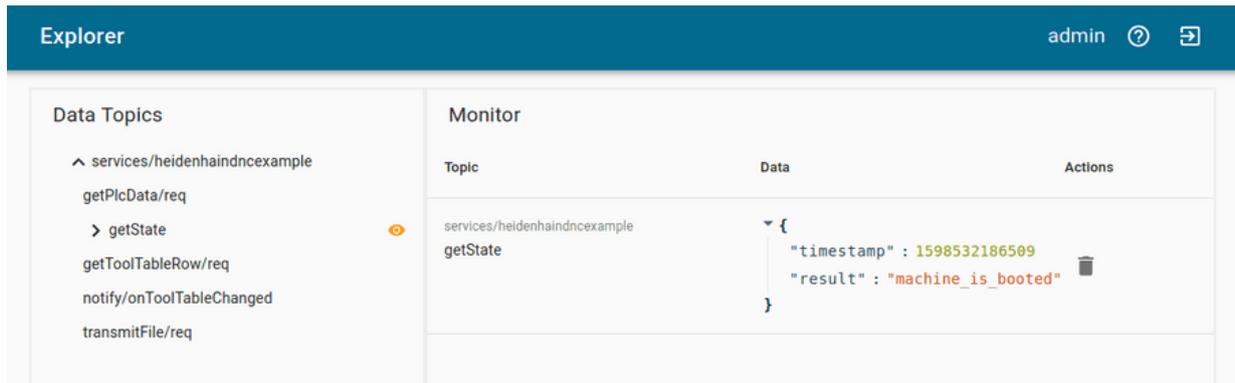
The Heidenhain agent running on the Windows machine tries to connect to the Connectware at the IP address, that was defined during its installation, as soon as it is started. We recognized these connection attempts when we opened the Connectware client registry and accepted the request of the Heidenhain agent with the name `heidenhain-<windows-pc-hostname>`. As a result a user with this name was created in the Connectware. We manually assigned this user the role `heidenhainagent` and through that granted the permission to access the MQTT topic for data exchange.



After the installation of the service in the Connectware it tries to establish the Heidenhain connection we declared in the resources section of the commissioning file. There we have defined the name of the Heidenhain agent and the IP address of the Heidenhain controller to connect to – or in our case of the emulator, which runs on the same machine as the agent. (Working with a real machine controller that would obviously not be the case.) As soon as the connection to the Heidenhain controller is established the service enables the endpoints which rely on the method calls issued by the agent to the Heidenhain controller via RPC. To address multiple Heidenhain controllers we could utilize the same agent but need to specify separate connection resources for each of them.

## Verifying the Connection

Now that we have a connection established between the Heidenhain controller and the Connectware, we can go to the Explorer tab of the Admin UI, where we see a tree structure of our newly created datapoints. Since we subscribed to the method `getState`, we should already see data being polled and published on this topic. Find the topic `getState` under `services/heidenhaindncexample`, hover it and click the eye icon on the right – this activates the live view and you should see data coming in.



On MQTT topics the data is provided in JSON format and applications consuming the data must take care of JSON parsing to pick the desired properties.

To utilize a method that expects arguments you would issue a request by publishing a message on the belonging `req` topic with the arguments as payload. For example to use the endpoint `getToolTableRow` you could publish the following message to request the tool information of tool table ID `42`:

```
{
  "id": "1",
  "params": [ "42" ]
}
```

The payload must be a valid JSON object and can contain two properties:

- `id`: (optional) User-defined correlation ID which can be used to identify the response. If this property was given, its value will be returned in the return message
- `params`: Array of parameters required for the used method. If the method requires no parameters, this property is optional, too.

The arguments required for each call are listed along with the methods in the [Cybus Docs](#).

The answer you would receive to this method call could look as follows:

```
{
  "timestamp":1598534586513,
  "result":
  {
    "CUR_TIME":"0",
    "DL":"+0",
    "DR":"+0",
    "DR2":"+0",
    "L":"+90",
    "NAME":"MILL_D24_FINISH",
    "PLC":"%00000000",
    "PTYP":"0",
    "R":"+12",
    "R2":"+0",
    "T":"32",
    "TIME1":"0",
    "TIME2":"0"
  },
  "id":"1"
}
```

To learn how you can easily test and interact with MQTT topics like in this example, check out the article [How to connect MQTT clients](#). Utilizing the Workbench you could simply hit *Import* from the menu in the upper right corner and paste the following JSON to add the test flow shown below. Add your MQTT credentials to the purple *subscribe* and *publish* nodes, then trigger requests.

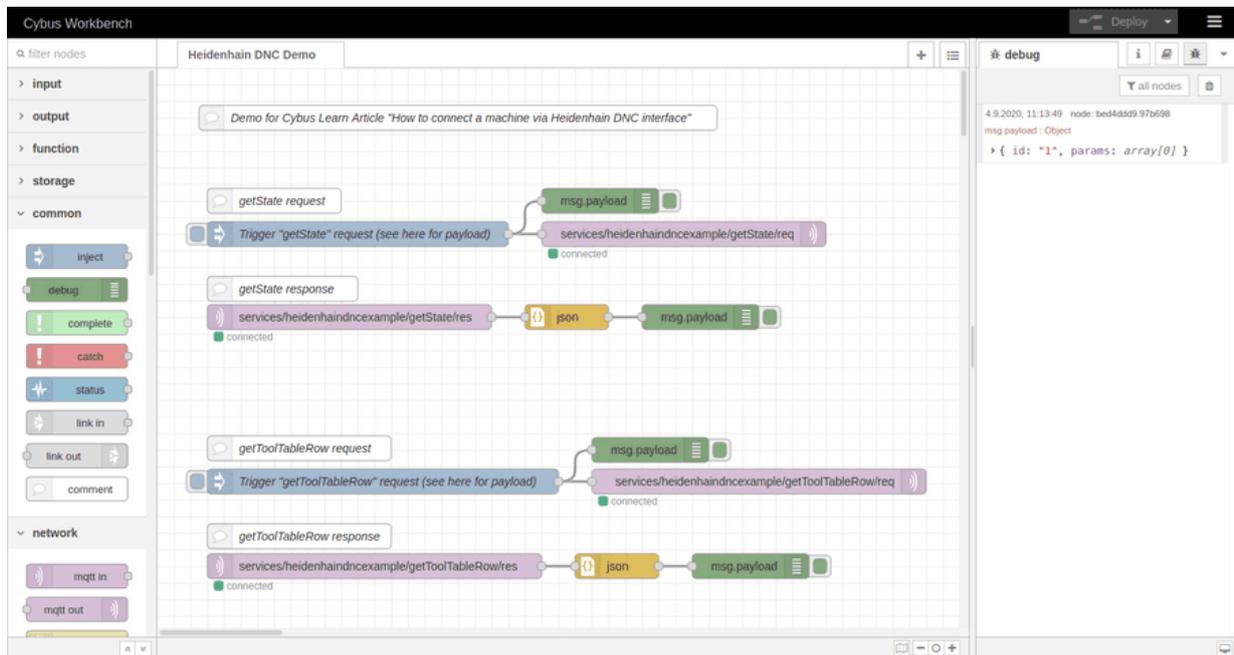
```
[{"id":"cba40915.308b38","type":"tab","label":"Heidenhain DNC Demo","disabled":false,"info":""}, {"id":"bc623e05.ae0f7","type":"inject","z":"cba40915.308b38","name":"Trigger \"getState\" request (see here for payload)","props":[{"p":"payload"}, {"p":"topic","vt":"str"}],"repeat":"","crontab":"","once":false,"onceDelay":0.1,"topic":"","payload":"{\\"id\\":\\"1\\",\\"params\\":[]}", "payloadType":"json","x":240,"y":200,"wires":[["aff3fdcf.d275d","9fd44184.a11d1"]]}, {"id":"f450d307.396ee","type":"comment","z":"cba40915.308b38","name":"Demo for Cybus Learn Article \"How to connect a machine via Heidenhain DNC interface\"", "info":"","x":360,"y":60,"wires":[]}, {"id":"aff3fdcf.d275d","type":"mqtt out","z":"cba40915.308b38","name":"","topic":"services/heidenhaindncexample/getState/req","qos":"0","retain":"false","broker":"b783
```

```

2f1d.e9d4e", "x":630, "y":200, "wires":[]}, {"id":"ddec5b0c.c0c418", "type":"mqtt
in", "z":"cba40915.308b38", "name":"","topic":"services/heidenhaindcexample/
getState/res", "qos":"0", "datatype":"auto", "broker":"b7832f1d.e9d4e", "x":23
0, "y":300, "wires":[["e1df9994.c3edc8"]]}, {"id":"21f886a8.ac3a2a", "type":"d
ebug", "z":"cba40915.308b38", "name":"","active":true, "tosidebar":true, "cons
ole":false, "tostatus":false, "complete":"false", "statusVal":"","statusType
":"auto", "x":650, "y":300, "wires":[]}, {"id":"dc2c1840.954bb8", "type":"comm
ent", "z":"cba40915.308b38", "name":"getState request", "info":"","x":140, "y
":160, "wires":[]}, {"id":"668e0f37.4f5", "type":"comment", "z":"cba40915.308
b38", "name":"getState response", "info":"","x":150, "y":266, "wires":[]}, {"i
d":"ec1150ad.7a23d", "type":"inject", "z":"cba40915.308b38", "name":"Trigger
\getToolTableRow\" request (see here for payload)", "props":[{"p":"payload"
}, {"p":"topic", "vt":"str"}], "repeat":"","crontab":"","once":false, "onceDela
y":0.1, "topic":"","payload":"{\id\": \"2\", \"params\": [\"42\"]}", "payloadTy
pe":"json", "x":270, "y":498, "wires":[["d317feb3.3eb0b", "4c3ab86e.f653b8"]]},
{"id":"d317feb3.3eb0b", "type":"mqtt out", "z":"cba40915.308b38", "name":"","t
opic":"services/heidenhaindcexample/getToolTableRow/req", "qos":"0", "retai
n":"false", "broker":"b7832f1d.e9d4e", "x":720, "y":498, "wires":[]}, {"id":"5a
2f9aca.f82724", "type":"mqtt in", "z":"cba40915.308b38", "name":"","topic":"s
ervices/heidenhaindcexample/getToolTableRow/res", "qos":"0", "datatype":"au
to", "broker":"b7832f1d.e9d4e", "x":260, "y":600, "wires":[["3ad07f7c.3bf85"]
]}, {"id":"b888e063.a8f84", "type":"debug", "z":"cba40915.308b38", "name":"","a
ctive":true, "tosidebar":true, "console":false, "tostatus":false, "complete":"
false", "statusVal":"","statusType":"auto", "x":710, "y":600, "wires":[]}, {"id
":"65db090f.922aa8", "type":"comment", "z":"cba40915.308b38", "name":"getTool
TableRow request", "info":"","x":170, "y":458, "wires":[]}, {"id":"23d593fd.e8
52ac", "type":"comment", "z":"cba40915.308b38", "name":"getToolTableRow respo
nse", "info":"","x":170, "y":564, "wires":[]}, {"id":"3ad07f7c.3bf85", "type":"
json", "z":"cba40915.308b38", "name":"","property":"payload", "action":"","pr
etty":false, "x":550, "y":600, "wires":[["b888e063.a8f84"]]}, {"id":"e1df9994.
c3edc8", "type":"json", "z":"cba40915.308b38", "name":"","property":"pay
load", "action":"","pretty":false, "x":490, "y":300, "wires":[["21f886a8.
ac3a2a"]]}, {"id":"9fd44184.a11d1", "type":"debug", "z":"cba40915.308b38", "nam
e":"","active":true, "tosidebar":true, "console":false, "tostatus":false, "comp
lete":"false", "statusVal":"","statusType":"auto", "x":530, "y":160, "wires":[
]}, {"id":"4c3ab86e.f653b8", "type":"debug", "z":"cba40915.308b38", "name":"","a
ctive":true, "tosidebar":true, "console":false, "tostatus":false, "complete":"f
alse", "statusVal":"","statusType":"auto", "x":590, "y":460, "wires":[]}, {"id":

```

```
"b7832f1d.e9d4e", "type": "mqtt-broker", "z": "", "name": "Connectware", "broker": "connectware", "port": "1883", "clientId": "", "usetls": false, "compatmode": false, "keepalive": "60", "cleansession": true, "birthTopic": "", "birthQos": "0", "birthPayload": "", "closeTopic": "", "closeQos": "0", "closePayload": "", "willTopic": "", "willQos": "0", "willPayload": ""}]
```



## Summary

In this article we went through the process of setting up a connection between a Heidenhain controller and the Cybus Connectware via the Heidenhain DNC interface. This required the Cybus Heidenhain agent to translate between the Connectware and Heidenhain DNC by making use of the RemoTools SDK. We wrote the commissioning file that set up the Connectware service which connected to an emulated instance of a *TNC 640* and requested and received information about the tool with ID 42. This or any other data from the Heidenhain DNC interface could now securely be vertically integrated along with data from any other interface through the unified API of the Connectware.

## Where to go from here

The Connectware offers powerful features to build and deploy applications for *gathering, filtering, forwarding, monitoring, displaying, buffering*, and all kinds of *processing* data... why not build a dashboard, for instance? For guides check out more of [Cybus Learn](#).

*Cybus is a specialist for secure IIoT Edge software, headquartered in Germany. Cybus Connectware serves smart factories as a universal Edge and DevOps hub. Machine builders and providers of IIoT services use the Cybus Connectware as a software-based gateway. As early as 2017, Cybus published the first secure industrial connector for machine data according to today's DIN SPEC 27070 standard. Industry analyst Gartner named Cybus a worldwide "Cool Vendor". Today, the company counts medium-sized and large companies from numerous industrial sectors such as mechanical engineering, automotive and aviation among its customers.*

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