# agrirouter Connectivity-Platform

## Integration Guide (Part 2)

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| | Title:<br>agrirouter Connectivity-Platform Integration Guide Part 2<br><br>Author:<br>DKE-Data GmbH & Co. KG | |
| Identification: agrirouter Integration Guide Part 2 | | Confidence: internal |
| Status: final | Version: 1.3 | September 4, 2018 |

author(s): DKE-Data GmbH & Co. KG
last modification: 9/4/2018 2:10:00 PM~~9/4/2018 2:08:00 PM~~
filename: DKE_agrirouter_Integration_Guide_Part_2_v1.3.DOCX
version: 1.3

# Content

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## *Document history*

| version | date | author | Description |
|---|---|---|---|
| 1.0 | 11.07.2018 | DKE-Data GmbH & Co. KG | First release |
| 1.2 | 25.07.2018 | DKE-Data GmbH & Co. KG | Added Remark on sending frequency<br>Fixed Error in documentation of Results from the outbox (Single message instead of array)<br>Link zum agrirouter toolset |
| 1.3 | 04.09.2018 | DKE-Data GmbH & Co. KG | Correction of Parameter id in onboarding (was Id)<br>Fixed Error: Requests to Outbox are done using GET, not POST<br>Added Definition for TeamsetContextID<br>Added TypeURLs<br>Added List of Message Types<br>Added clarification on VirtualCUs<br>Added external ID to endpoint list |
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## *Review*

| version | name | Department/Company | Location |
|---|---|---|---|
| 1.0 | 13.07.2017 | DKE-Data GmbH & Co. KG | |
| 1.3 | 03.09.2018 | DKE-Data GmbH & Co. KG | |
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# 1. Purpose

## 1.1. Purpose of this document

The purpose of this document is to create deep knowledge about the thirdparty integration into the agrirouter solution. This document shall include all information necessary to develop an integration with the agrirouter interface in an application. If you experience any problems with missing information in this document, please send an email to support@my-agrirouter.com mentioning “Integration Guide Part2” in the topic.

## 1.2. Purpose of further documents

This document is a follow up on the document “Integration Guide Part 1”. If you are not yet familiar with the agrirouter topic, please read this document first. It can be found here: https://my-agrirouter.com/support/

There are several documents including further information on agrirouter and the used message formarts. Please check the list of additional resources at the end of this document.

# 2. Epilog

Digitization in agriculture makes good progress. One unsolved problem so far are the different and customized developments that are used for the data exchange, for instance between machine and software products of different manufacturers. DKE-Data GmbH & Co. KG has a solution for this.

The company DKE-Data GmbH & Co. KG (DKE is the German abbreviation for digital communication and development) is currently developing a cross-manufacturer agrirouter Solution that is far more than merely hardware and software. Customers are making use of a service: safe and cross-product data transport.

The agrirouter Solution allows farmers to transfer data between farming machinery from several manufacturers and several farming applications from different application providers. Users can configure data transfer permissions centrally on agrirouter Solution, to control what data can be exchanged between which endpoint. Data can be published on the agrirouter Solution and routed to interested and allowed endpoints.

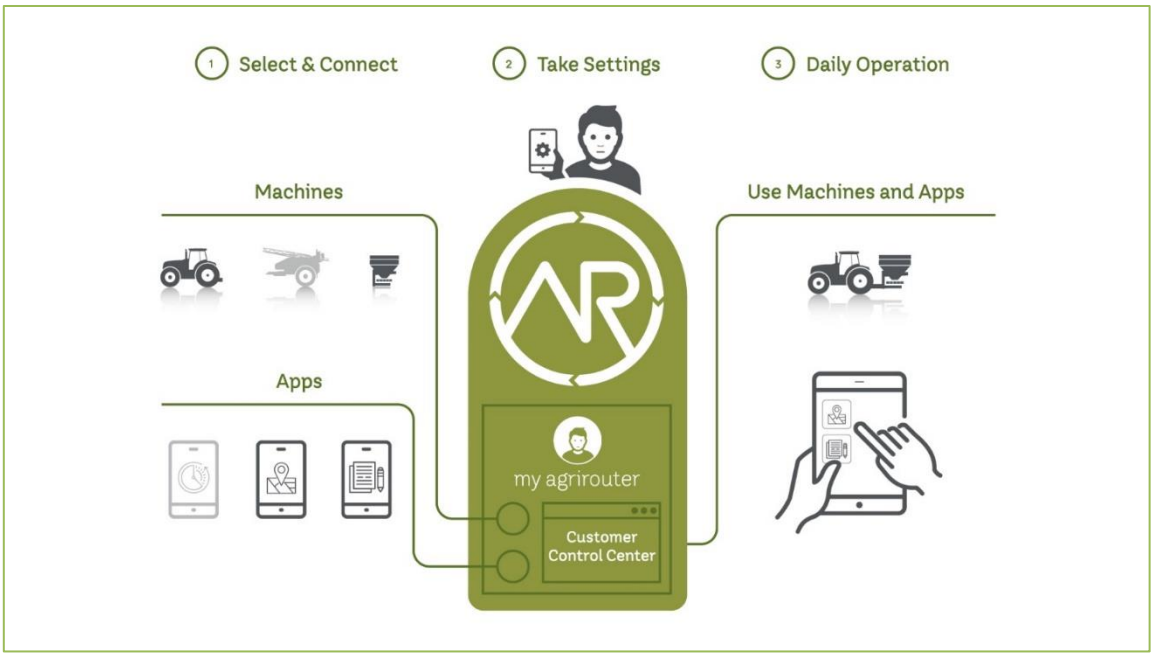



**Figure 1 agrirouter Solution**

With central maintenance of data routing between endpoints, there is no need to configure network connections between all data sources and targets on each machine/ or in each application.

The agrirouter Solution provides a common cross-vendor data exchange mechanism, based on a common message format, which can be implemented by different machine manufacturers and application providers.

The transmission and evaluation of live telemetry data is getting more and more important. With the agrirouter Solution, machines can send telemetry data to the agrirouter, where data is automatically distributed to several applications, based on permissions and configuration. For live telemetry data, the agrirouter filters the content of the messages according to the user-defined permissions.

This way it can be achieved that one application gets only application rate data, for example, while another one gets only machine-related data such as fuel consumption.

Technically, the agrirouter Solution is a cloud system, which provides the messaging service and a web site with self-services for the different user types.

When the recipient of a message is offline, the message is buffered on the agrirouter until the recipient is online again. However, the message is not buffered forever. After a maximum buffer time, the buffered messages are removed from the buffer even if they are not yet delivered.

The agrirouter Solution also stores additional data needed for rights management and message processing. This includes the list of endpoints attached to agrirouter account, and the technical device description of the connected agricultural machines. This information is needed for message routing and filtering and for automatic adjustment of message content by manufacturer-specific adapters. In addition, the agrirouter stores usage statistics data needed for billing and for ensuring a smooth and efficient function.

# 3. How to use this document – an advice on development and more

This chapter shall describe a possible way of handling the integration with the agrirouter. It is not the only way of doing it, of course. For a valid and well communicated agrirouter integration, you should follow a mixure of business and development decisions:

1. **Get basic knowledge:** First, read the basic concepts of agrirouter architecture and ecosystem; described in part 1 of this guide.

2. **Decide, what you want to implement:**
    a. **Read** the several non-agrirouter-relevant technical message types (e.g. TaskData, Images, Telemetry) as a general overview of possible capabilities.
    b. **Decide, which messages are relevant** for you and which information you could consume or provide. This way, you could e.g. forward the requirement for a TaskController Integration or a Camera attachment possibility at a CU to the relevant departments and it's more common that it will be there in time.
    c. **Synchronize your plans:** Dependend on your role in the company make sure, management, marketing, sales and developers have the same idea of the upcoming product

3. **Decide, how to implement:** Once you made these decisions, let's not care about the messages for a while and work out a possible architecture:
    a. **Read** about the onion principle of communication and the command flow.
    b. **Check** the general concepts around agrirouter like Protobuf, MQTT, REST and EFDI
    c. **Check** for libraries and frameworks e.g. at the DKE GitHub.
    d. **Decide**, how to build your architecture to make your system compatible for agrirouter or to build an interface service.

4. **Create an application in agrirouter,** to receive applicationID and CertificationID

5. **Start Development:**
    a. **Build** your application and read about the several messages in detail to implement them

6. **Do prerelease work**
    a. **PreCreate market place entry:** Even though your app is not yet tested, prepare the marked place form for the release of your product. Should be done by a sales or management person
    b. **Check the markedplace entry:** Should be done by a developer: Read the marked place entry and make sure, you support all the described functionality as described in the marked place entry and in the integration guide or linked documents.

7. **Test your app:** agrirouter provides the possibility to select test users for a not yet certified app. Select some customers or your internal staff to check, if your app runs smooth with agrirouter and perhaps with common other endpoints. For a farming software, a corresponding Communication Unit could be such an endpoint

8. **Certify your app:** Select your desired test institute and let your app be certified for public release.

9. **Release to public:** Activate your market place entry and let people know, that your app is up and running.

# 4. General conventions

## 4.1. Numbering convention

Within the agrirouter interface, there are several IDs or counters, that are of type int64. Due to difference between the protobuf implementation of C++ vs. e.g. Java, the ID “0” cannot be used.

Therefore:
**All numberings begin with 1**

## 4.2. String Identifiers convention

For **globally unique** instance ID we suggest using Uniform Resource Name (URN) according to RFC5141. Basically, this enabled an identification to be of any kind that is defined by the official IANA registered URN namespaces (https://www.iana.org/assignments/urn-namespaces/urn-namespaces.xhtml).

For example this could be a UUID if the CU is an App on a consumer device with a generated identity: urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6

Also this could identify an OEMs device with a Product Identification Information: urn:iso:std:iso:11783:-12:2013:ed-2:tech:pii:1234567890ABC*Brand Name*Product Name*.

## 4.3. TimeStamp conventions

If there is nothing different mentioned in the relevant chapter, all timestamps in messaging, onboarding etc. shall be in UTC. The common format for timestamps is ISO; e.g. “2018-06-14T14:53:28.123Z”.

## 4.4. Time Synchronisation

As agrirouter exchanges data between different applications in different environments, it is very important to have a common current time. Therefore, you should match the result timestamp of an agrirouter command with your local time and compensate too big differences (>1 minute), when setting the timestamp of your agrirouter commands.
The best practice here is to request the endpoint list on a regular basis and take the timestamp of the result.
If your application has access to the GPS time, this should be enough to keep the same time as the agrirouter.

**Please note:**
The agrirouter support team also suggests using this compensation time in your TaskController- and DataLogger- Data. Even though, this is not relevant for a proper communication with the agrirouter, it will avoid timing problems in the analysis of data with applications, that receive your data.

**Example:**
If multiple machines with multiple CUs work on a field, you’ll never be able to match their EFDI data, if you have different times

# 5. Environments

agrirouter currently supports 2 environments of the whole agrirouter connectivity platform.

## 5.1. Quality assurance

The quality assurance environment (“QA”) is used to develop and test applications in a save and uncritical eco system. Please note, that the quality assurance environment shall not be used by productive customers.

## 5.2. Productive

The productive environment is used by your endcustomers with tested and certified apps. This environment is very scalable and made for a huge number of users.

## 5.3. Areas

Currently, there is only one Area: EU1. Every app instance is onboarded to environments in this area. With upcoming availability of the agrirouter in more and more countries, there might be additional areas created. This could happen for performance reasons or legal requirements of different countries. If new areas become required, this document will be updated, providing all the required information.

# 6. Development tools

## 6.1. REST using Postman

Postman is a tool to send http requests and analyze results, usable for full test chains for online APIs. You can download postman here: https://www.getpostman.com/

With this integration guide, a postman collection is delivered, including the endpoint definitions and abstractions for the different environments.

### 6.1.1. Check onboarding

To do an onboarding request, open the Agrirouter: Application Registration/OnBoard/Onboarding Request
Open the Pre-Request-Script and fill the variable field names

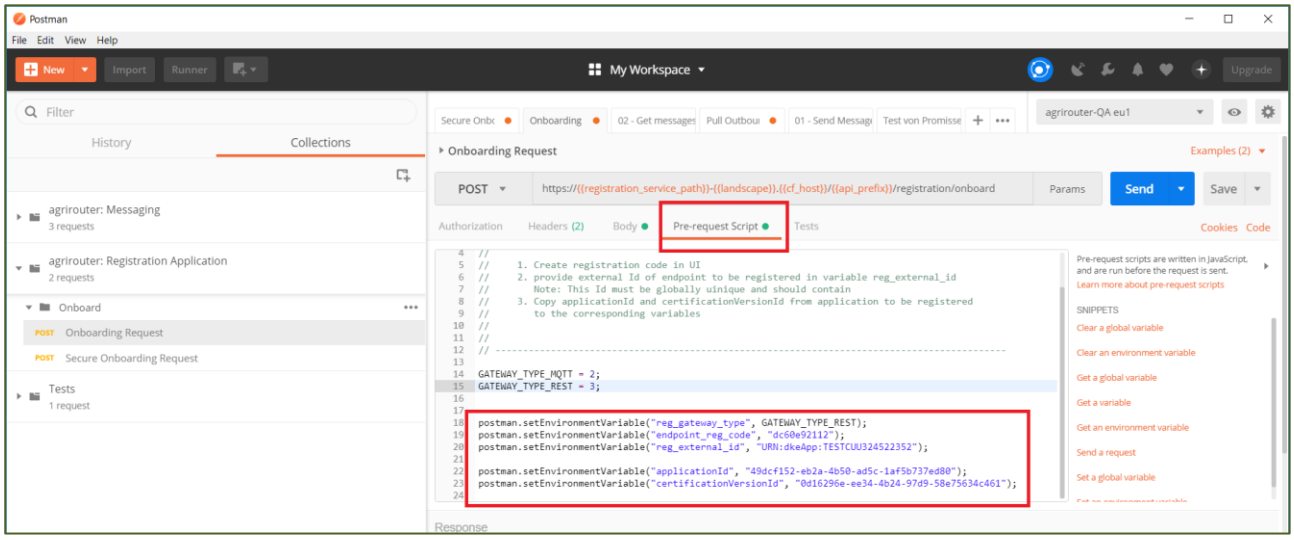



**Figure 2 Using Postman for onBoarding**

### 6.1.2. Adding a Certificate

For an SSL Secured communication, add the certificate delivered with the onboarding request:

Copy&paste ENCRYPTED PRIVATE KEY section to new file

Replace all \n with new lines.

Save both sections (ENCRYPTED PRIVATE KEY and CERTIFICATE) in separate files (e. g. DEVICE_MYEXTERNALID.key, DEVICE_MYEXTERNALID.crt)

Provide both in Postman Settings / Certificates, including the passphrase provided in the onboarding response.

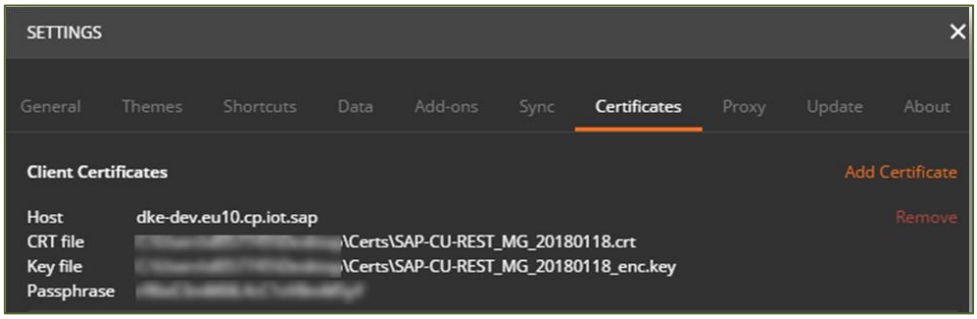



**Figure 3 Adding the certificate in Postman**

## 6.2. MQTT using Paho

Paho is an Eclipse tool fo connect to an MQTT Broker.

First, read the getting Started Guide: https://help.sap.com/viewer/e765b2a5b99540ce84da397c20cc1993/Cloud/en-US/4954c48d016f40eeb5fcaf1cd596b909.html

Secondly, download and install Paho: https://help.sap.com/viewer/e765b2a5b99540ce84da397c20cc1993/Cloud/en-US/53ad3e974dba4d49970113e0fd80ab07.html

### 6.2.1. Format Certificate for Paho

The certificate needs to be formatted to work with PAHO:

Copy the whole certificate field, replace the \n with new Lines (\r+\n) and save it in an *.pem file

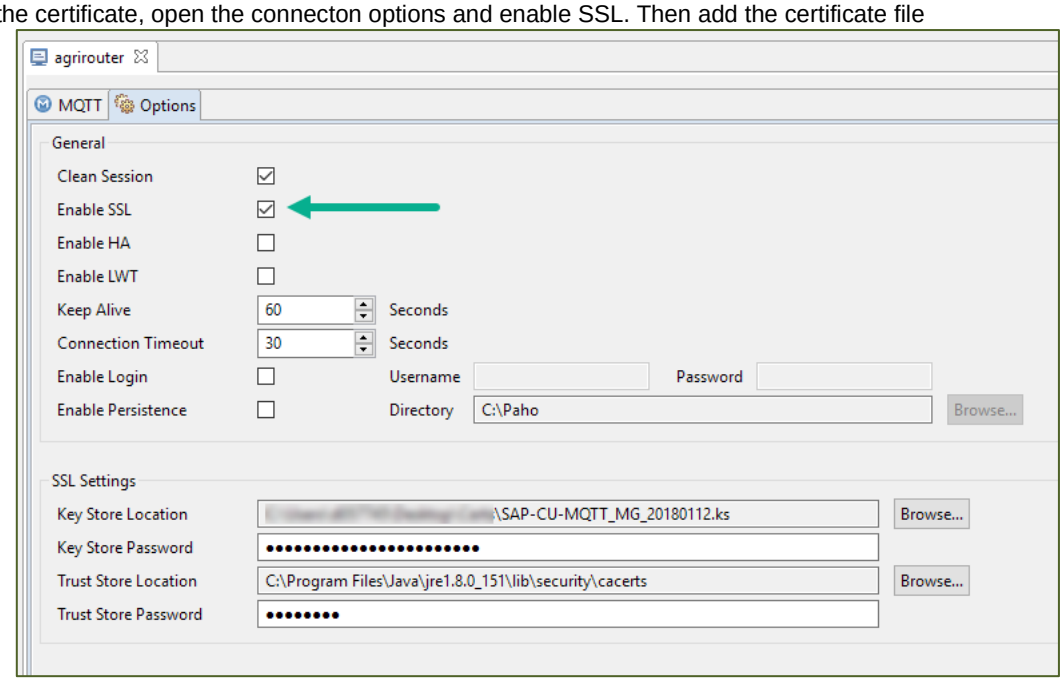
Install openssl.

Format the certificate:

```
$ openssl pkcs12 -export -in SAP-CU-MQTT_MG_2018012.pem -inkey SAP-CU-MQTT_MG_2018012.pem -out mqtt_client.ks
Enter pass phrase for SAP-CU-MQTT_MG_2018012.pem:
Enter Export Password:
Verifying - Enter Export Password:
```

### 6.2.2. Setup Paho Certificate

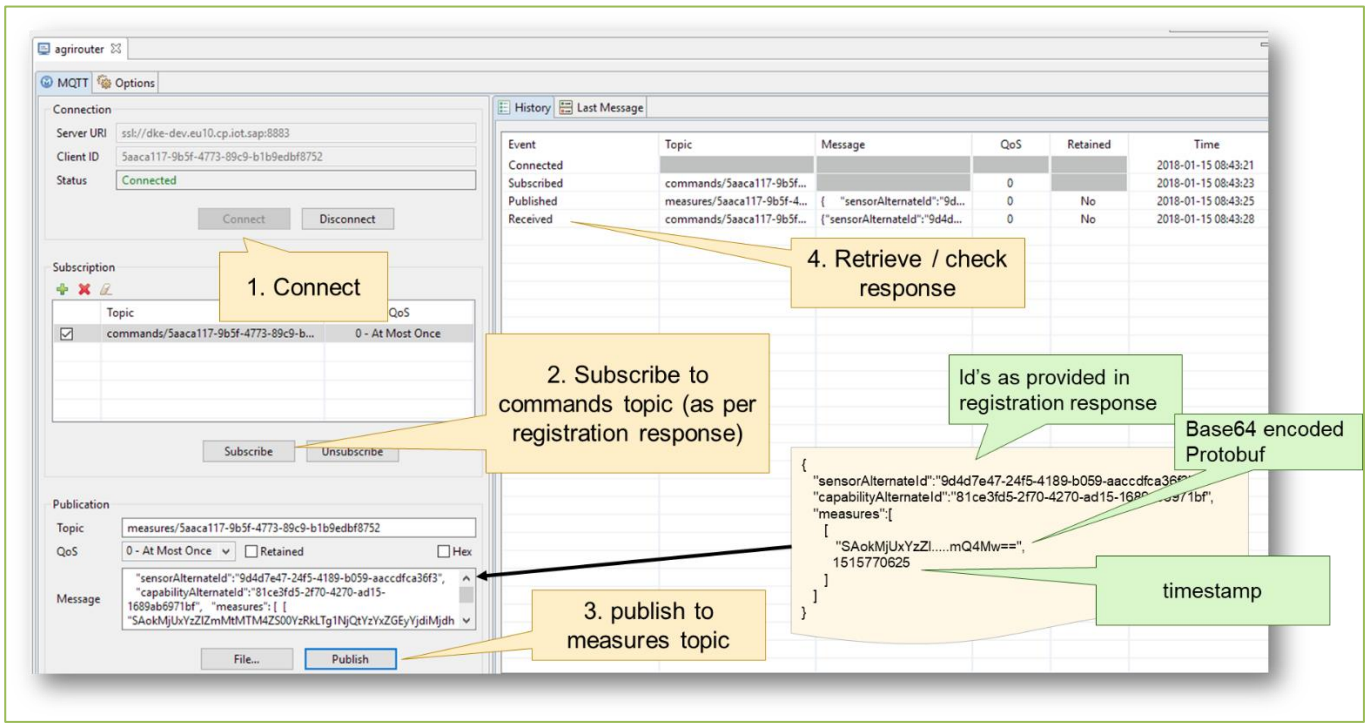
To setup the certificate, open the connecton options and enable SSL. Then add the certificate file




Further information: https://help.sap.com/viewer/e765b2a5b99540ce84da397c20cc1993/Cloud/en-US/711642e551f4477c882c5561853ee7c7.html

### 6.2.3. Setup the connection criteria of Paho:


### 6.2.4. Basic functions



## 6.3. agrirouter protobuf toolset

The agrirouter protobuf toolset (“ARTS”) is a Java Project to check or create several parameters for the agrirouter communication. It can for example decode received Base64 Strings to their Protobuf representation.
The tool includes a command line as well as a user interface.
The project can be found here: https://github.com/saschadoemer/agrirouter-protobuf-toolset

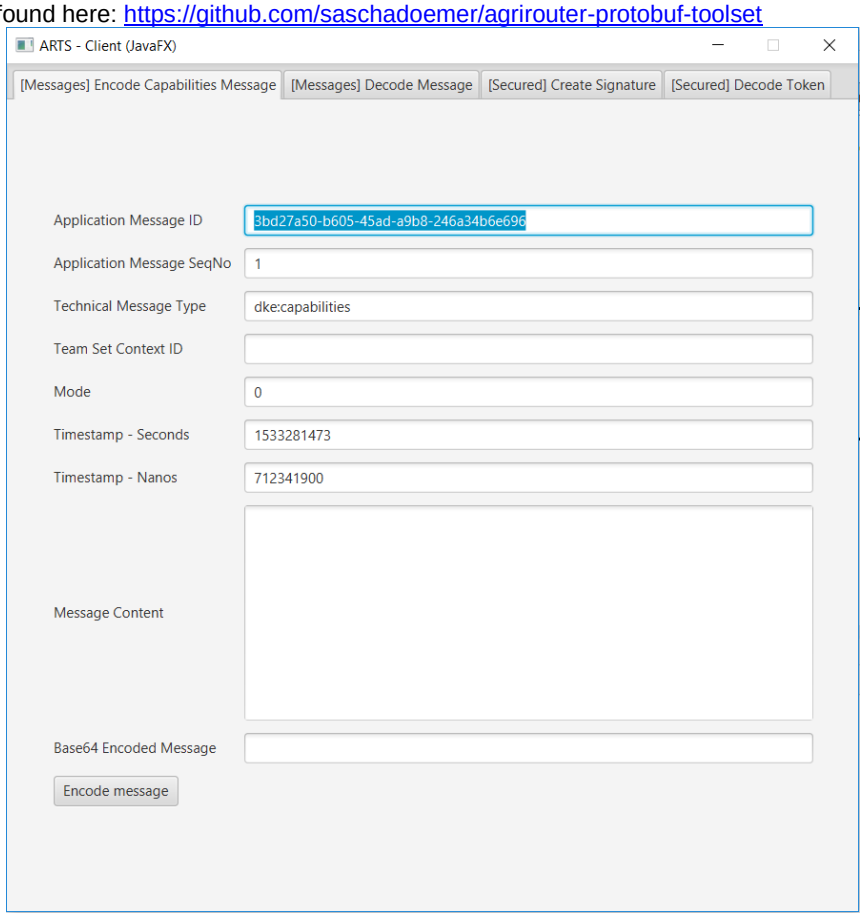



**Figure 4 ARTS User Interface**

**Remark**
The ARTS-Project is an open source project, feel free to participate and extend its functionality.

**Please note:**
This tool is not an official part of the agrirouter eco system and DKE-Data is not liable for it.

# 7. Authentication Process

The authentication process was designed to give application providers of consuming applications (e.g. farming software, but in general every application that consumes data) the chance to make sure, they know, which account is assigned to which agrirouter account. Otherwise, fake accounts could consume data on their costs.

**Remark:** As the authentication process – in difference to the rest of the communication – provides a request to your agrirouter integration and not the response to a request from your agrirouter integration, the documentation of the parameters is done in a little different way and there is no description for a HTTP Response code, because we don't get one.

## 7.1. Authentication of farming software

As application providers of farming software have to pay for the receiving of raw data, the application provider should make sure, that only such agrirouter accounts can onboard one of his applications, that he can assign to one of his users.

**Remark:** As the user has to log on to agrirouter, the authentication process requires a browser UI!

### 7.1.1. Preparation

To provide authentication, the developer first has to setup the application.

In the developers UI, he has to:

- Copy the application ID (1)
- Call Edit (2)
- Provide a redirect URL, to which agrirouter shall deliver the authentication result using HTTP 301 Browser redirect.(3)
- Provide a public key for his encryption or create a key pair on the agrirouter frontend

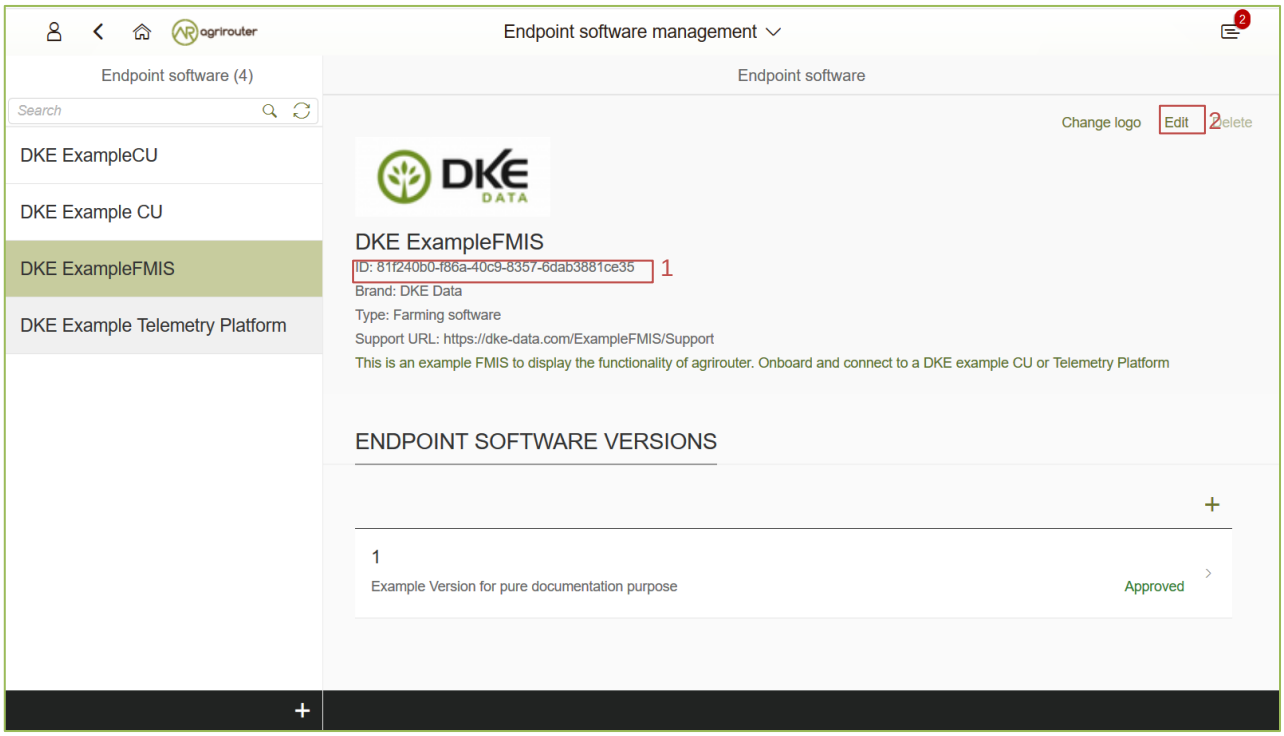



**Figure 5 Application overview**

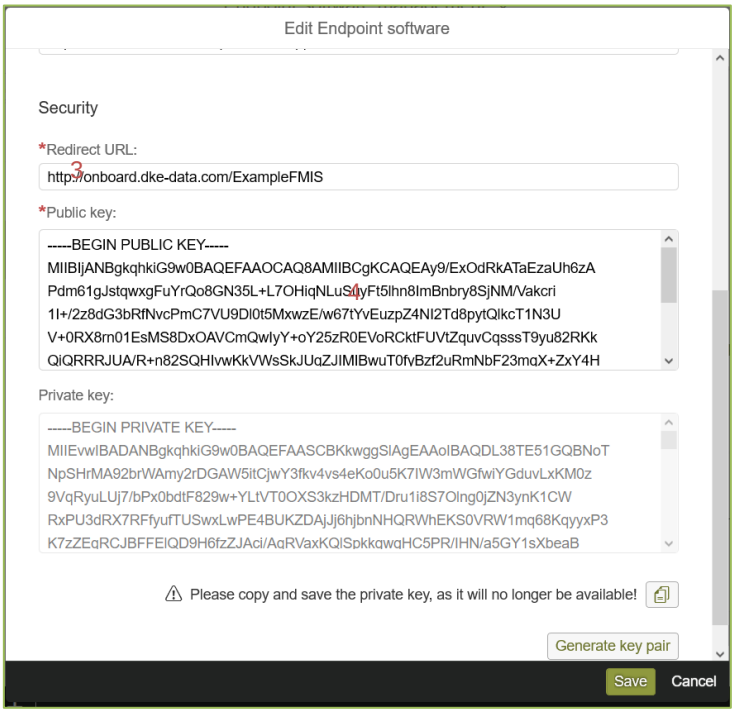



**Figure 6 Application settings**

**Remark**
If you do not have an official domain, where your application is reachable online, you can use http://fuf.me. This URL is a synonym for localhost or 127.0.0.1, but it meets the requirements of the agrirouter UI for redirect URLs.
Simply check Tracert/TraceRoute:

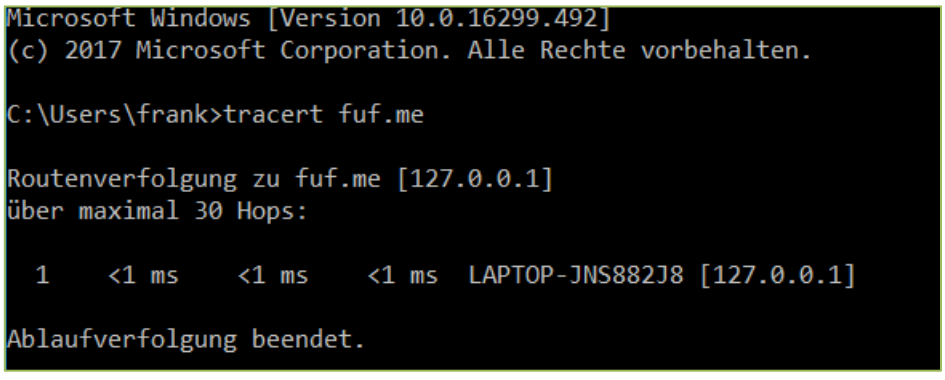



**Figure 7 fuf.me is an alias for localhost**

### 7.1.2. Authentication Process Overview

The authentication process works as follows:

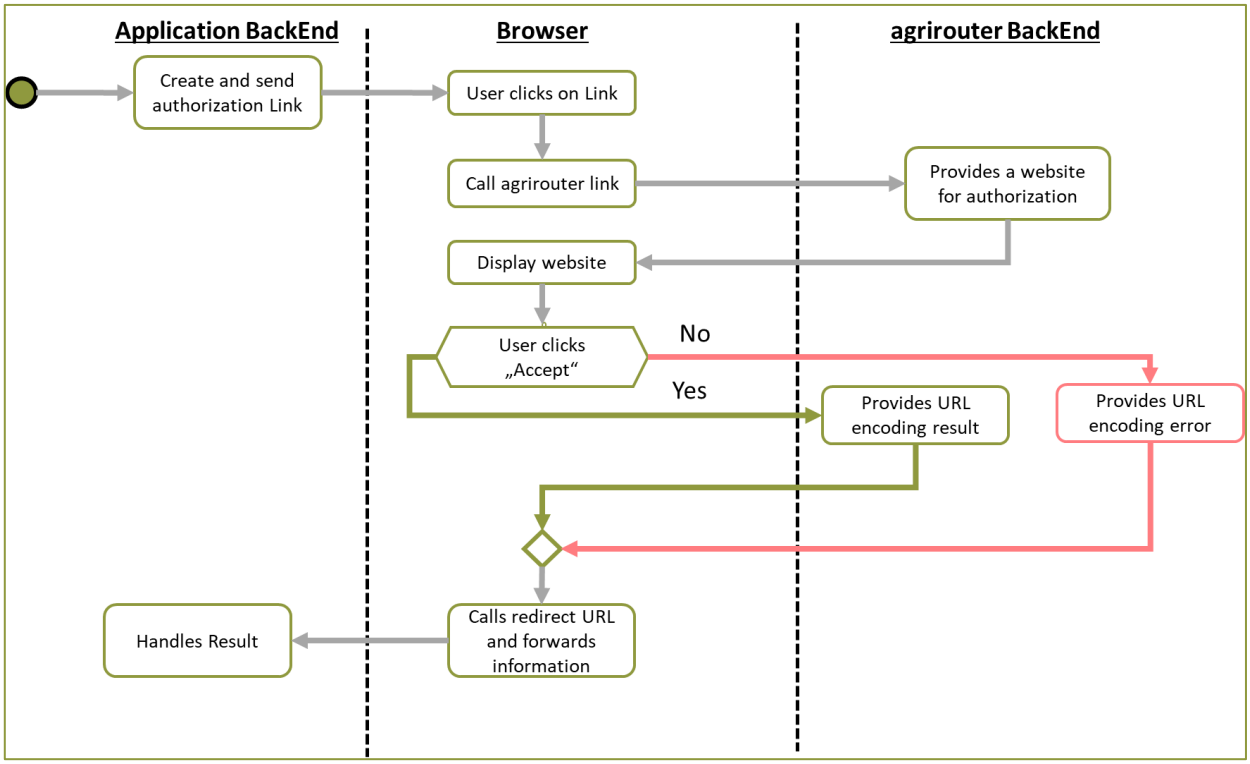



**Figure 8 Authentication Workflow**

To better understand, what happens here, try the following:

1. Call https://httpbin.org/get in your browser. You'll get a JSON view of the get request

2. Call https://httpbin.org/get?Param1=Value1&Param2=Value2 in your browser. You'll get a view of the get request
   ⇨ https://httpbin.org simply echoes the request that is send to the page. That's important to understand

**Remark**
For testing purpose, you can just enter the url https://httpbin.org/get in your applications redirect URL (see below) to see the result of authentication.

**Remark**
The step "user clicks on Link" might not be needed, applications could handle that different.
For example the application could send a redirect (HTTP Status 300) to directly redirect the user to the agrirouter Connection Website. The description "user clicks on Link" is simply the most understandable description we could come up with.

### 7.1.3. Generating an authentication URL

| Area | Environment | URL |
|---|---|---|
| **EU1** | Quality Assurance | https://agrirouter-qa.cfapps.eu1.hana.ondemand.com/ |
| **EU1** | Productive | https://goto.my-agrirouter.com/ |

The authentication Link is a HTTP GET Request that has to be called from a browser.

| Method | Address |
|---|---|
| **GET** | /application/{{applicationID}}/authorize |

To provide a link for authentication, create a link like this:

**{{agrirouter-url}}/application/{{applicationID}}/authorize?{{response_type}}&{{state}}&{{redirectURL}}**

| Parameter | Example Value | Remark |
|---|---|---|
| {{agrirouter-url}} | see above | Differentiates between QA and Live system |
| {{applicationID}} | Noted from the agrirouter UI | |
| {{response_type}} | response_type=onboard | Possible values:<br>verify: only verify the user,<br>onboard: verify user and create a Registration Code (Token) |
| {{state}} | state=w4st556dr543d4wr4s4 | A number to identify the request result on server side. The provided Number should be:<br>• Unique<br>• Not guessable |
| {{ redirect_uri}} | | Could extend your entered redirect URL |

**Caution:**
Calling this link will deliver a website to log in to agrirouter, therefore, this link has to be called through a browser!

**Remark**
The response type onboard can be used to onboard farming applications without having to create a Registration Code in the agrirouter UI.

### 7.1.4. Perform authentication

When the user clicks on the link, the agrirouter website is called. If the user is currently not logged in, he has to log in. After logging in, he is delivered a website to authorize the connection between agrirouter and the application provider:

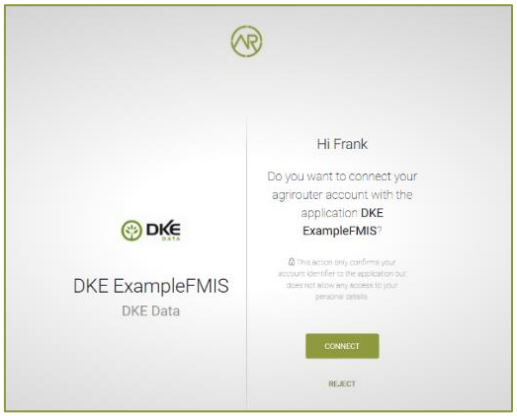



**Figure 9 Application authentication screen**

### 7.1.5. Analyse result

agrirouter sends an HTTP 301 redirect to the browser, encoding the authentication result in a get queue attached to the Redirect URL entered in the developers' application settings.

The browser reacts in requesting this redirect URL which performs a GET request at the endpoint of the address.
The following parameters will be delivered in the GET-Queue:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | signature | String | A signature to verify, that the source of the message is the agrirouter |
| **2** | state | String | The value that was passed to the agrirouter in parameter State |
| **3** | token | String | A base64 encoded JSON Object as Result |
| **(3)** | error | String | If error is delivered, user declined connection! |


```
{
  - args: {
        signature:
        "H45ZxgsWJZzYZgyBCrxnUAKpdDKuJy0BwXYztenNZI73+Rxb/pFhtc6x7YUAgMAQE1qXV0mM9hrXpXwEhdqr2l+NRAEY9
        state: "b862103e-7689-4a7a-9cab-f60c98448215",
        token: "eyJhY2NvdW50IjoiNTA5ZTY1YWEtODRkZi00YzRkLWJmOTgtYzMyOGYwODQ2NGM1IiwicmVnY29kZSI6ImQ2ND
    },
  - headers: {
        Accept: "text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8
        Accept-Encoding: "gzip, deflate",
        Accept-Language: "en,de-DE;q=0.9,de;q=0.8,en-US;q=0.7",
        Cache-Control: "max-age=0",
        Connection: "close",
        Host: "httpbin.org",
        Upgrade-Insecure-Requests: "1",
        User-Agent: "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko)
    },
    origin: "88.130.2.214",
    url: "http://httpbin.org/get?state=b862103e-7689-4a7a-9cab-
    f60c98448215&token=eyJhY2NvdW50IjoiNTA5ZTY1YWEtODRkZi00YzRkLWJmOTgtYzMyOGYwODQ2NGM1IiwicmVnY29kZSI
}
```


**Figure 10 Example of an authentication result**

#### 7.1.5.1. Checking for errors

If the result includes a parameter **error**, the request was declined. Possible values:

| Value | Description |
|---|---|
| **request_declined** | The user clicked on "decline" |

#### 7.1.5.2. Checking authenticity

Before analyzing the result, which is encoded in the **token**, it should be made sure, that the result (provided to the browser and from there to the application providers server) is really provided by the agrirouter.
Steps:

- concatenate ***state*** and ***token*** from the query
- create the SHA256 hash of the concatenated string
- verify the authenticity of the ***signature*** with the agrirouter public key and generated hash

**Remark**
The public keys can be found at Certificates and keys

#### 7.1.5.3. Analyse the result in token

The result token is a base64 encoded JSON object including the following parameters:

| Name | Type | Description |
|---|---|---|
| **account** | String | The unique id of the user account on agrirouter , that will be provided to you in the metrics exports for billing |
| **regcode** | String | If response-type=onboard, this regcode will deliver a Registration Code equal to clicking the generate TAN-Button in the agrirouter ui |
| **expires** | DataTime | The date and time (in UTC), when the regcode becomes invalid |

Example:

```
{
"account": "31c83d5d-c307-42f9-80b1-6fc9324823b8",
"regcode": "f75bfbd41b",
"expires": "2018-02-27T10:49:04.901Z"
}
```

## 7.2. Authentication for CUs and non-cloud-software

To perform authentication for software, that is not provided as a cloud solution, a small cloud onboarding service could be created to handle the onboarding communication:

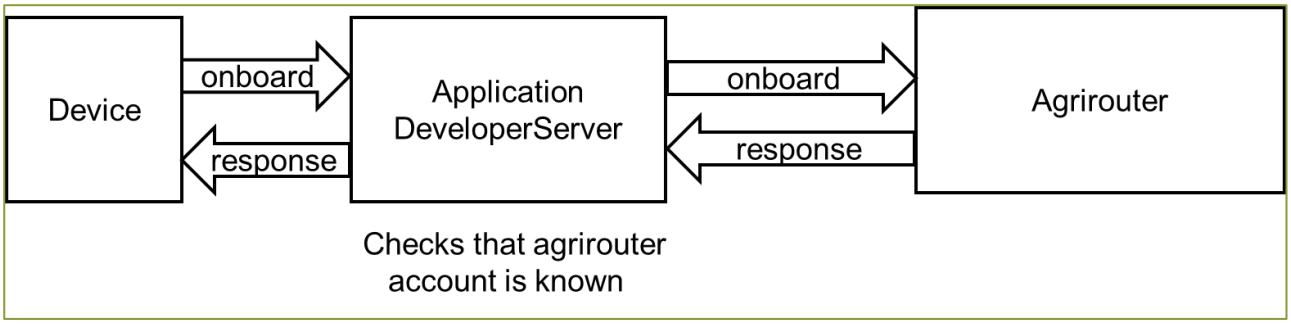



**Figure 11 Authentication for non-cloud-applications**

# 8. Onboarding App Instances

## 8.1. General Overview

The onboarding workflow is needed to onboard app instances and create endpoints in the agrirouter. The result of the onboarding process has to be stored.

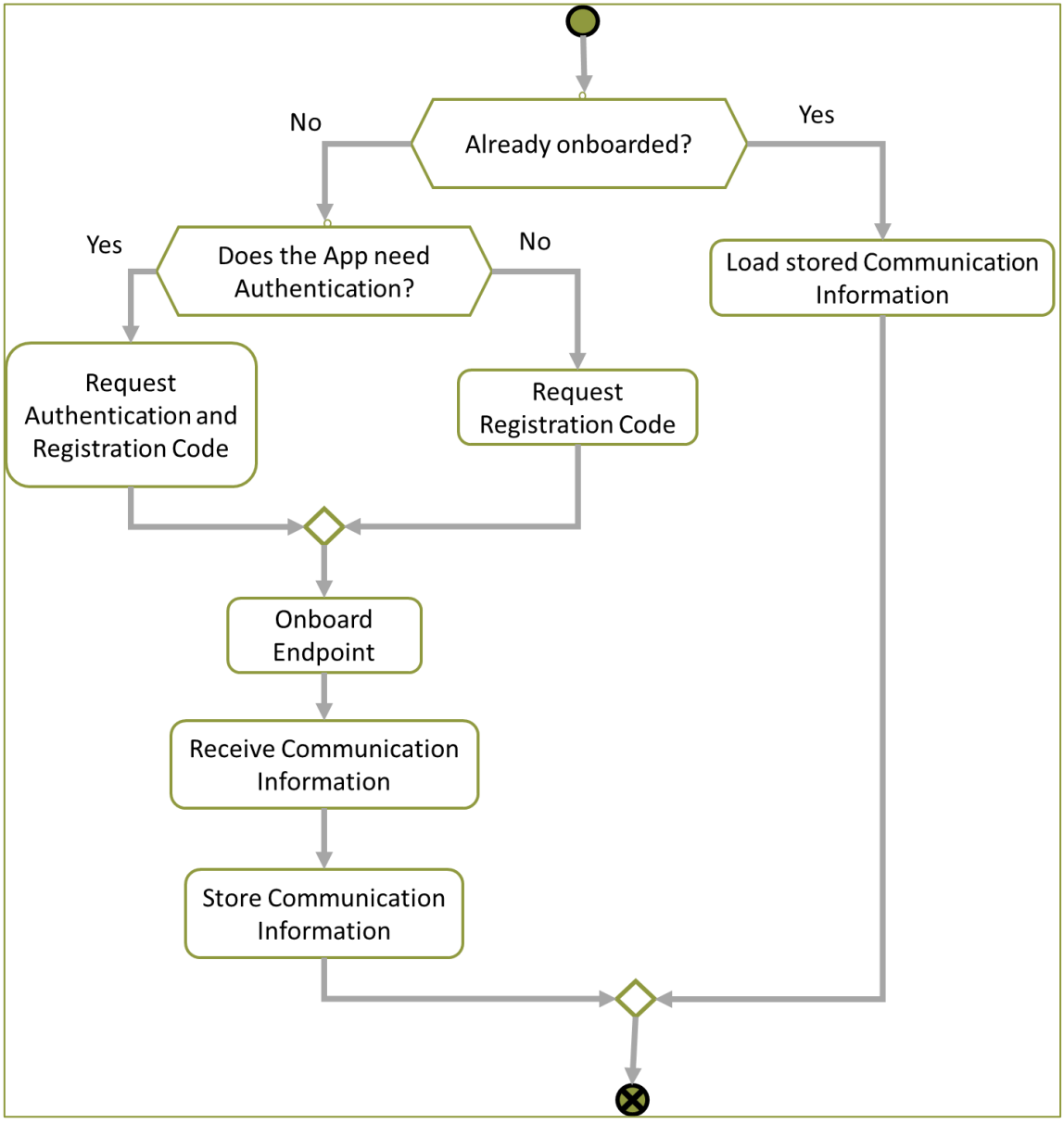



**Figure 12 General onboarding workflow**

## 8.2. Workflow for Farming Software and Telemetry Systems

Telemetry systems and Farming Software need to assign their own userID to the accountID of the user at the agrirouter. Therefore, a verification should be performed before onboarding.

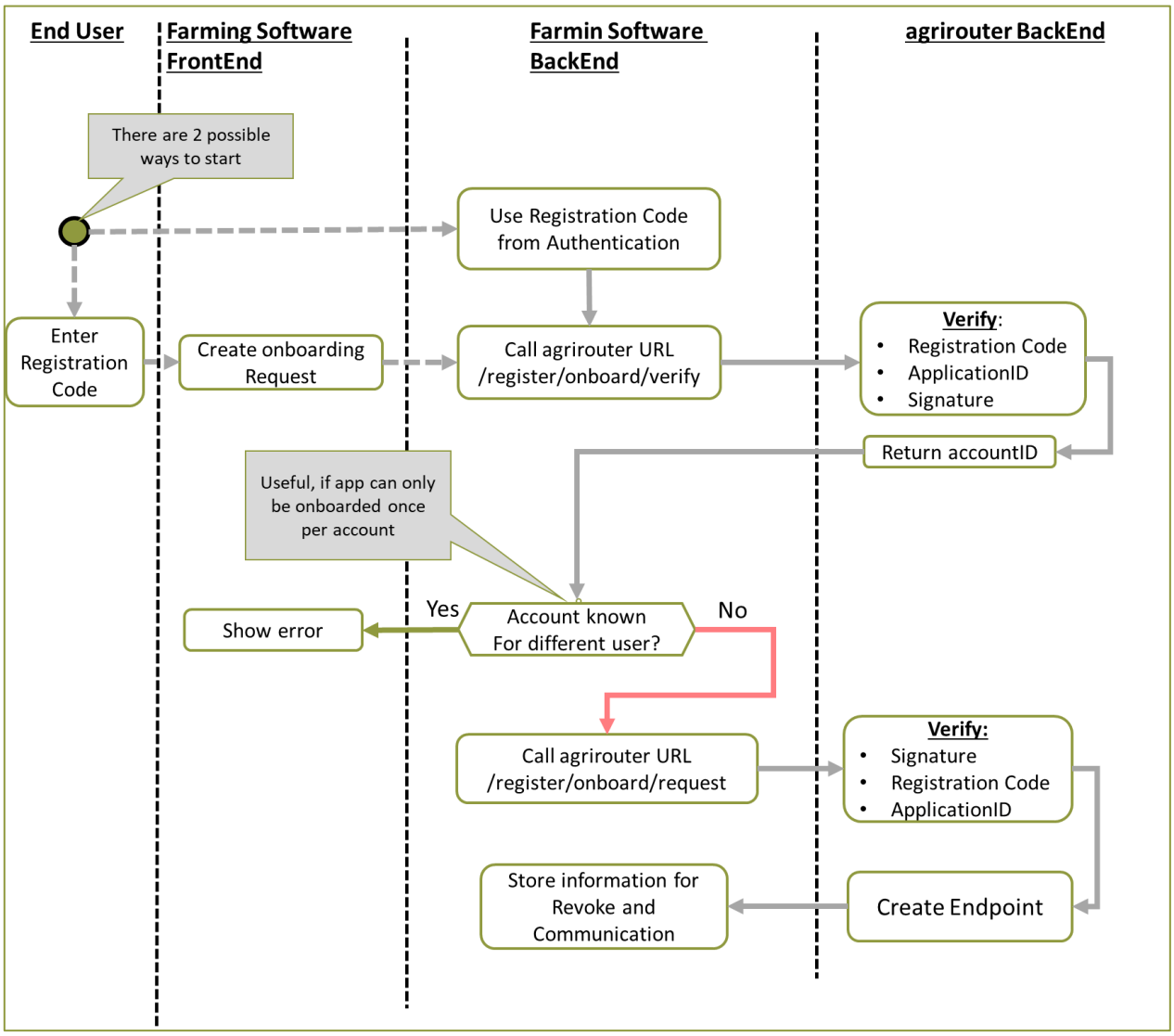



**Figure 13 onboarding Workflow for a farming software or telemetry platform**

## 8.3. Workflow for CUs

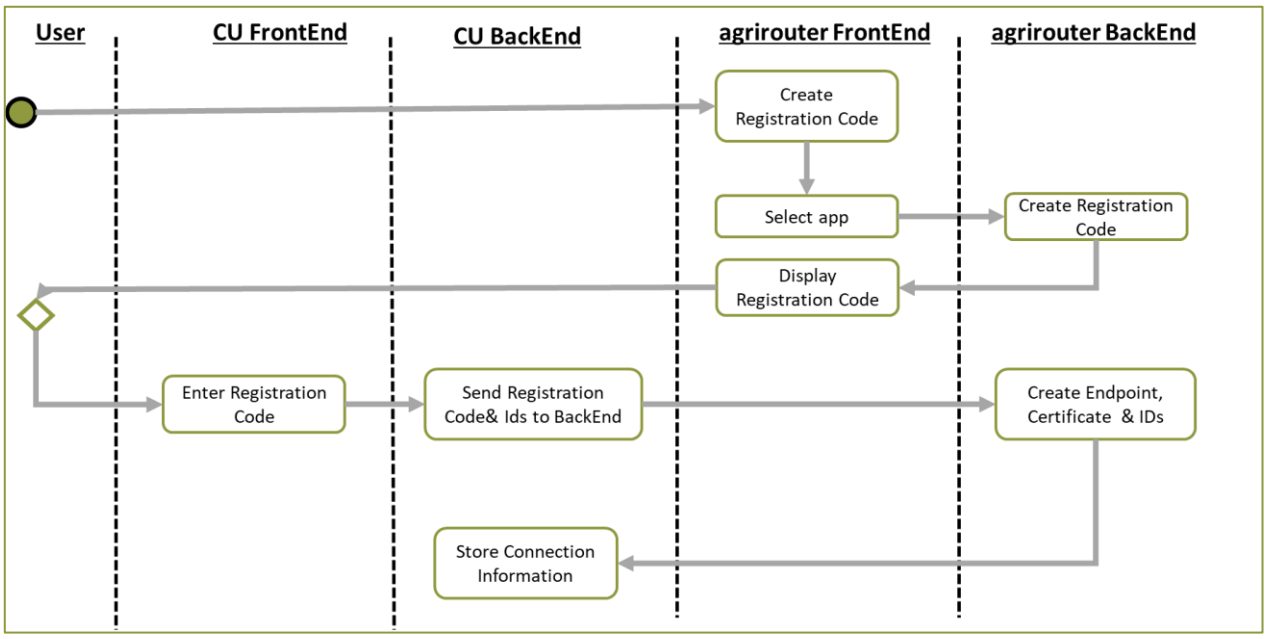



**Figure 14 Agrirouter onboarding process for a CU**

**Remark**
The CU onboarding mechanism needs less steps than the Farming Software and Telemetry software, as it is only required for those applications consuming data to know which user is assigned to which account.

The following parts of onboarding are **not** required for CU onboarding:

- Authentication
  - Entering certificates in the agrirouter UI
  - Adding a redirect URL in the agrirouter UI
- Verification
- onboarding with a Signed request

## 8.4. Workflow for Virtual CUs

Onboarding virtual CUs through a telemetry platform is done using a command. This will in particular be described later. See 16.5 Commands for telemetry platforms

From the end user's perspective, it is mostly dependend on the telemetry platform, if there is any selection mechanism or if it is done automatically.

## 8.5. Creating a Registration Code

### 8.5.1. Using the agrirouter UI

The Registration code for a new CU can be created by the end user clicking “Generate TAN”(1) in agrirouters’ control center. He has to select the desired CU (2) and gets a 10-digit code consisting of letters and numbers (3). A CU needs an interface to input this registration code.

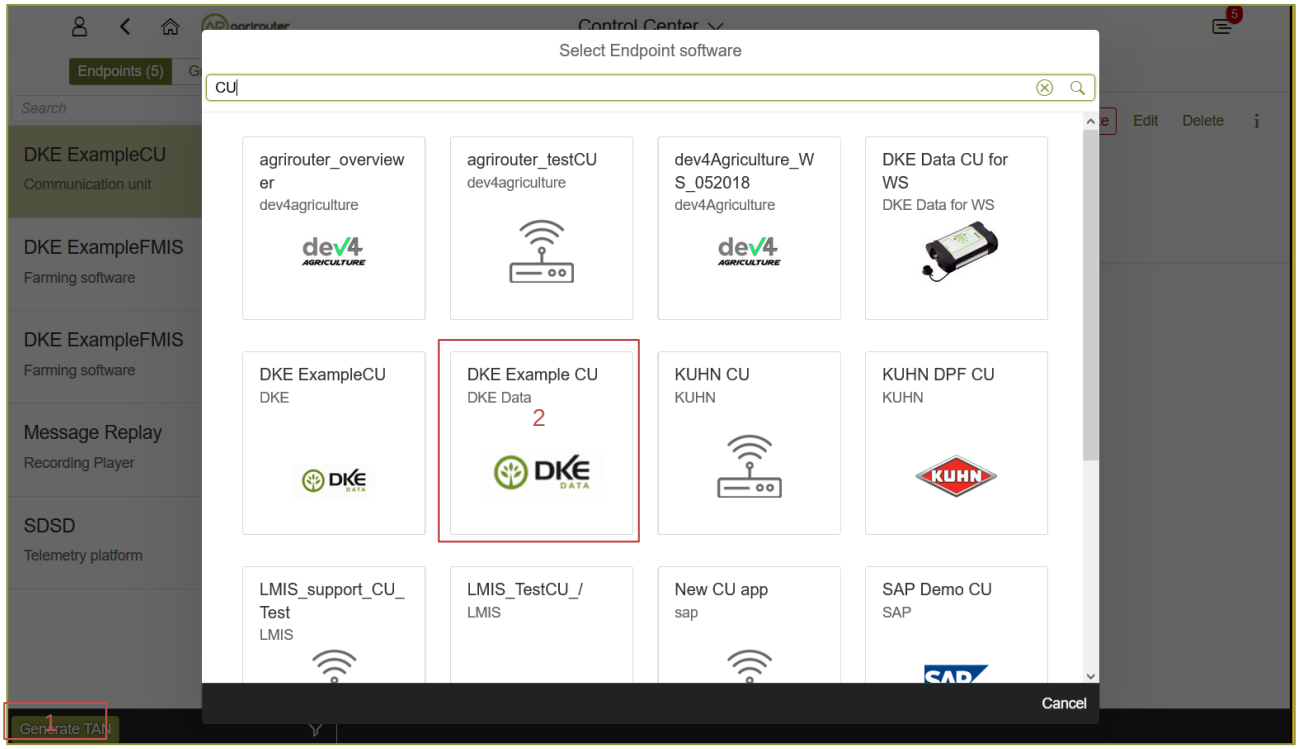



**Figure 15 Requesting a registration code in agrirouter UI**

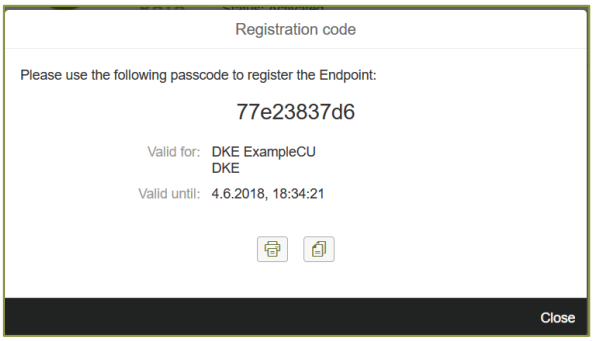



**Figure 16 Registration code for a CU**

### 8.5.2. As result of the authentication

If the authentication prozess is done using parameter *response_type=onboard*, the result will include a regcode. This regcode is a TAN.

### 8.5.3. Telemetry Platforms

A telemetry platform has to be onboarded using the authentication process. Once it is onboarded, it can onboard virtual CUs by itself. Therefore, it can use a special command. as Commands are described in a later chapter, please refer to 16.5.1 Onboarding a Virtual CU.

## 8.6. Collecting and setting up relevant information

The onboarding request requires several different information:

### 8.6.1. ApplicationID and X-Agrirouter-ApplicationID

Both IDs are the same, they can be found in the agrirouter software endpoint UI of the developers account:

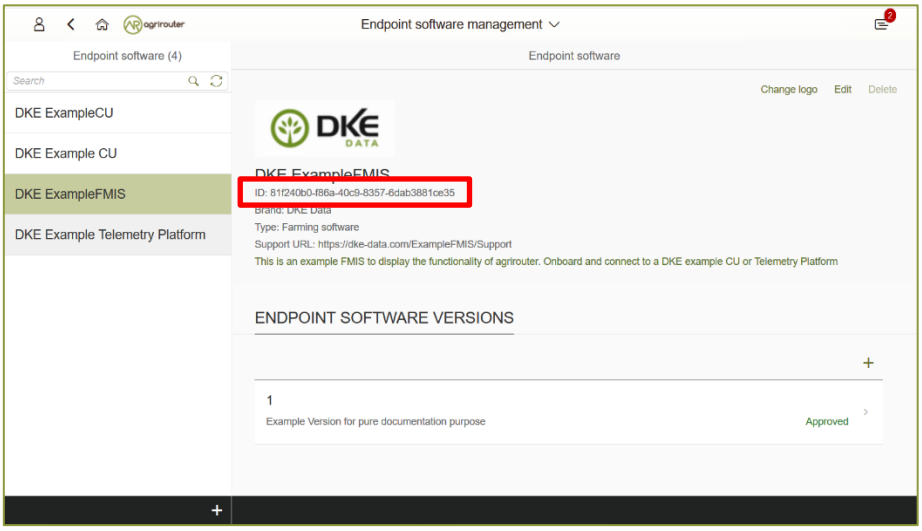



**Figure 17 Finding the applicationID**

### 8.6.2. CertificationVersionID

The CertificationVersionID is the ID unique to this specific app certification process. It can be found when clicking on the required Endpoint Software Version:

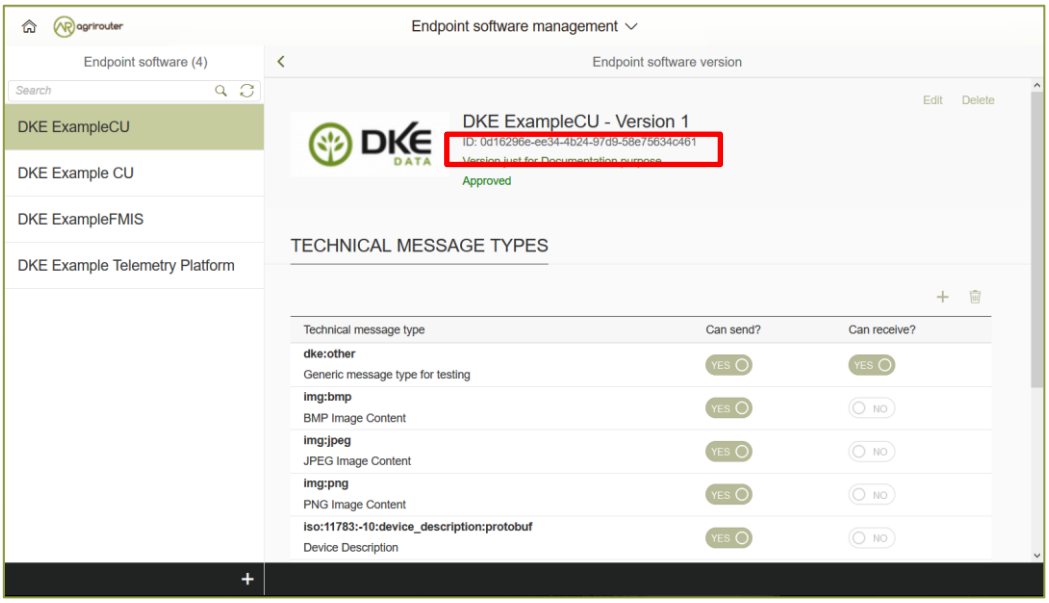



**Figure 18 Finding the certificationVersionID**

### 8.6.3. Setting up private and public key

**Remark**
This step is not required for CUs

As the requests need to be signed (see 8.8Signing requests), the public key has to be stored within the agrirouter. This can be done, calling “Edit” on the Endpoint Softwre Management Screen (see Figure 17 Finding the applicationID~~Figure 17 Finding the applicationID~~ ). The agrirouter UI offers the possibility to create a key pair, you can however create your own one and just store the public key on agrirouter.

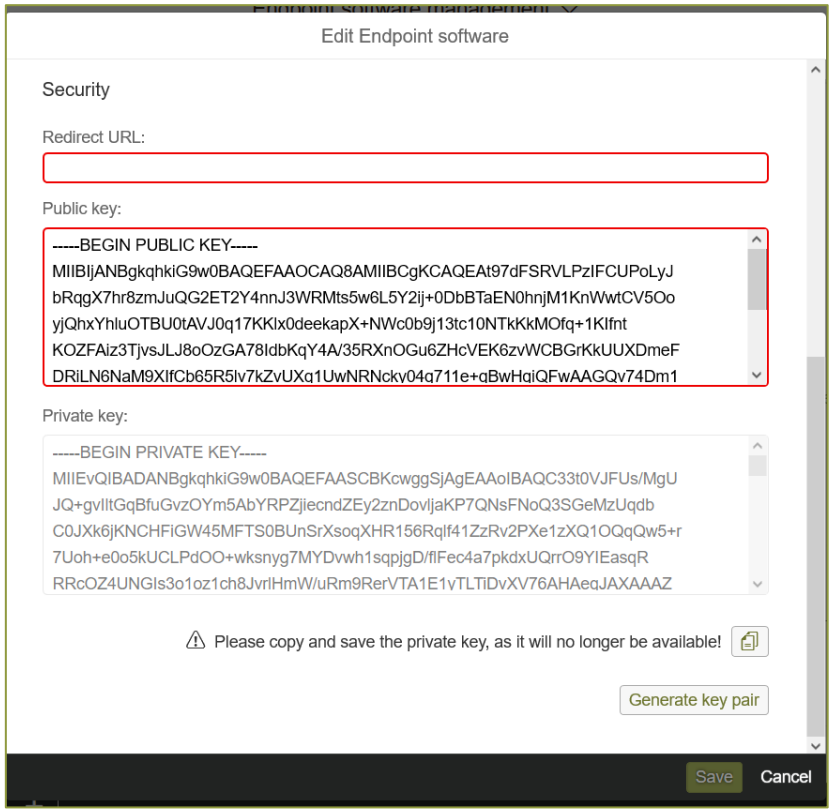



**Figure 19 Generating Private and Public Key in the agrirouter UI**

## 8.7. onboarding Endpoint URLs

The endpoint URL differs, depending on your desired geolocation and the Quality Assurance or Productive Environment. The request must be a HTTP Post request to

| Environment | Area | URL |
|---|---|---|
| **Quality Assurance** | EU1 | https://agrirouter-registration-service-hubqa-eu1.cfapps.eu1.hana.ondemand.com |
| **Production** | EU1 | https://agrirouter-registration-service.cfapps.eu1.hana.ondemand.com |

**Remark**
Like every URL in this document, these URLs might change in the future or there might be additional ones for new Areas.

## 8.8. Signing requests

For onboarding, the agrirouter must be sure, that the requests actually come from an instance of the app specified in the request. Therefore, the payload must be signed with the applications private key. The corresponding public key must be maintained by the developer in agrirouter per application, see Setting up private and public key.
A Payload encryption is not needed since all communication is encrypted with TLS

All signatures used for the onboarding and revocation process shall be created by:

- hashing the request body (SHA256)
- then using the private key to create an RSA signature of the hash
- Create HEX representation of this hash
- Add the hex string as “X-Agrirouter-Signature” to the header of the HTTP call

Agrirouter will look up the public key for the app id specified and verify the signature.

## 8.9. Sending a Verification Request

The verification request is used to actually check, if the endpoint is for the desired application and account before actually onboarding it.

### 8.9.1. General

The address for the verification request is as follows:

| Method | Adress |
|---|---|
| **POST** | api/v1.0/registration/onboard/verify |

### 8.9.2. Request Information

The app instance has to send a HTTP Post request.

#### 8.9.2.1. Header Information

##### *8.9.2.1.1. For CU onBoarding*

For CUs, this is not required or available

##### *8.9.2.1.2. For FarmingSoftware and Telemetry Platform onBoarding*

The Request shall include the following header information:

| Name | Type | Description |
|---|---|---|
| **Authorization** | String | "Bearer "+ the TAN |
| **Content-Type** | String | application/json |
| **X-Agrirouter-ApplicationId** | String | [Application Id] |
| **X-Agrirouter-Signature** | [Signature] | see 8.8 Signing requests |

#### 8.9.2.2. Body Information

The request body includes the same parameters as the onboarding requests body:
The request body is a JSON object including the following Parameters and is equal for any type of onboarding:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | id | String | The unique ID of the endpoint; we advice to create a URN |
| **2** | applicationId | String | The application ID for the application, provided in the agrirouter developer UI |
| **3** | certificationId | String | The ID of the certification software version provided in the agrirouter developer UI |
| **4** | gatewayId | String | The desired communication protocol after onboarding<br>2: MQTT<br>3: REST<br>Example: "2" |
| **5** | certificationType | String | Type of the desired certificate;<br>Possible values: PEM,P12 |
| **6** | UTCTimestamp | String | A Timestamp like this: *2018-06-20T07:29:23.457Z* |
| **7** | timeZone | String | A TimeZone like this: "+03:00" |

Example:

```
{
  "id": "urn:myapp:snr00003234",
  "applicationId": "e0eb00ff-e2ef-4429-85f5-2559aceedd6d",
  "certificationVersionId": "e0eb00ff-e2ef-4429-85f5-2559aceedd6d",
  "gatewayId": "3",
  "UTCTimestamp": "2018-06-04T12:00:03.000Z",
  "timeZone": "+02:00"
}
```

### 8.9.3. Verification Result

The result is a HTTP response code with a JSON object in the Body

#### 8.9.3.1. Result codes

There are different result HTTP Status codes indicating the result

| Code | Describtion |
|---|---|
| **200** | The validation was successful |
| **400** | There was an error in the request |
| **401** | The request was unauthorized; the provided registration code was unknown |

#### 8.9.3.2. Body Information

##### *8.9.3.2.1. Success*

For a successful result, the body will include a JSON object like this:

```
{
  "accountId": "4823443c-fd0d-44a7-81a6-06104455945a"
}
```

It includes the accountId, so that an app provider can check, if this accountId might already be known. For apps, that can be onboarded only once (like an FMIS, where it doesn't make any sense to have 2 of the same kind), this would mean, that onboarding is not needed.

##### *8.9.3.2.2. Failure*

In case of Failure, an error message is provided.

## 8.10. Sending Onboarding Request

To onboard a new endpoint, the endpoint has to send an onboarding request providing the registration code to agrirouter. The request is a HTTP POST request.

**Remark:** There is no MQTT onboarding mechanism, so onboarding always has to be done using REST.

### 8.10.1. Request information for signed onboarding

**Remark**
This is the onboarding request for Farming Software and Telemetry platforms, not for CUs.

#### 8.10.1.1. General

The address for the onboarding request is as follows:

| Method | Adress |
|---|---|
| **POST** | api/v1.0/registration/onboard/request |

#### 8.10.1.2. Header Information

##### *8.10.1.2.1. For FarmingSoftware and Telemetry Platform onBoarding*

The Request shall include the following header information:

| Name | Type | Description |
|---|---|---|
| **Authorization** | String | "Bearer "+ the registration code *Remark: There is a space between bearer and registration code!* |
| **Content-Type** | String | application/json |
| **X-Agrirouter-ApplicationId** | String | [Application Id] |
| **X-Agrirouter-Signature** | [Signature] | see 8.8 8.8 |

#### 8.10.1.3. Body Information

The request body is a JSON object including the following Parameters and is equal for any type of onboarding:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | id | String | The unique ID of the endpoint; we advice to create a URN |
| **2** | applicationId | String | The application ID for the application, provided in the agrirouter developer UI |
| **3** | certificationVersionId | String | The ID of the certification software version provided in the agrirouter developer UI |
| **4** | gatewayId | String | The desired communication protocol after onboarding<br>2: MQTT<br>3: REST<br>Example: "2" |
| **5** | certificateType | String | Type of the desired certificate;<br>Possible values: PEM,P12 |
| **6** | UTCTimestamp | String | A Timestamp like this: *2018-06-20T07:29:23.457Z* |
| **7** | timeZone | String | A TimeZone like this: "+03:00" |

Example:

```
{
  "id": "mydeviceid",
  "applicationId": "e0eb00ff-e2ef-4429-85f5-2559aceedd6d",
  "certificationVersionId": "e0eb00ff-e2ef-4429-85f5-2559aceedd6d",
  "gatewayId": "3",
  “UTCTimestamp”: “2018-06-04T12:00:03.000Z”,
  “timeZone”: “+02:00”
}
```

## 8.10.2. Request information for CU onboarding

**Remark**
This is the onboarding request for CUs.

### 8.10.2.1. General

The address for the onboarding request is as follows:

| Method | Adress |
|---|---|
| **POST** | api/v1.0/registration/onboard |

### 8.10.2.2. Header Information

The Request shall include the following header information:

| Name | Type | Description |
|---|---|---|
| **Authorization** | String | "Bearer "+ the TAN |
| **Content-Type** | String | application/json |

### 8.10.2.3. Body Information

The request body is a JSON object including the following Parameters and is equal for any type of onboarding:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | id | String | The unique ID of the endpoint; we advice to create a URN |
| **2** | applicationId | String | The application ID for the application, provided in the agrirouter developer UI |
| **3** | certificationId | String | The ID of the certification software version provided in the agrirouter developer UI |
| **4** | gatewayId | String | The desired communication protocol after onboarding<br>2: MQTT<br>3: REST |
| **5** | certificationType | String | Type of the desired certificate;<br>Possible values: PEM,P12 |

Example:

```
{
  "id": "mydeviceid",
  "applicationId": "e0eb00ff-e2ef-4429-85f5-2559aceedd6d",
  "certificationVersionId": "e0eb00ff-e2ef-4429-85f5-2559aceedd6d",
  "gatewayId": "3",
}
```

## 8.10.3. Response

### 8.10.3.1. Response code

The request has several possible response codes indicating Success or Failure:

| Code | Possible problem |
|---|---|
| **201** | Success; Analyze onboarding result to get started |
| **400** | The Request was invalid |
| **401** | Unauthorized; meaning, that one of the given header parameters is wrong. Refer to the error message |

### 8.10.3.2. Success

On success, the HTTP response code will be 201.

The result is a json object including the information required for onboarding.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | authentication | Object | Includes all Authetication information |
| **1.1** | certificate | String | The certificate required for communication; Public AND Private Key |
| **1.2** | secret | String | The passkey for the certificate |
| **1.3** | type | String | Type of Certificate; PEM or PK12 |
| **2** | capabilityAlternateId | String | A value that just has to be saved and sent in several scenarios |
| **3** | connectionCriteria | Object | Includes all information required for further communication |
| **3.1** | gatewayId | String | Assigned gateway; 2= MQTT, 3=REST |
| **3.2** | host | String | Only for MQTT: The broker address |
| **3.3** | port | String | Only for MQTT: The broker port |
| **3.4** | measures | String | Endpoint URL of the inbox or Topic, when using MQTT |
| **3.5** | commands | String | Endpoint URL of the outbox or Topic, when using MQTT |
| **3.6** | client | String | MQTT only: The ClientID of the endpoint |
| **4** | deviceAlternateId | String | The device ID used to mark the source of a message from this device |
| **5** | sensorAlternateId | String | The deviceID used to mark the source of the communication from this device |

Example:


```
{
    "authentication": {
        "certificate": "-----BEGIN ENCRYPTED PRIVATE KEY-----\n...\n-----END
ENCRYPTED PRIVATE KEY-----\n-----BEGIN CERTIFICATE-----\n...\n-----END
CERTIFICATE-----\n",
        "secret": "77R8cjOGi9yTCBt2",
        "type": "PEM"
    },
    "capabilityAlternateId": "7bc8ab05-a0de-40db-a259-7deefb1265e9",
    "connectionCriteria": {
        "gatewayId": "3",
        "measures": "https://dke-
qa.eu1.cp.iot.sap/iot/gateway/rest/measures/c067272a-d3a7-4dcf-ab58-
5c45ba66ad60",
        "commands": "https://dke-
qa.eu1.cp.iot.sap/iot/gateway/rest/commands/c067272a-d3a7-4dcf-ab58-
5c45ba66ad60"
    },
    "deviceAlternateId": "c067272a-d3a7-4dcf-ab58-5c45ba66ad60",
    "sensorAlternateId": "5564ce96-385f-448a-9502-9ea3c940a259",
```

```
}
```

**Remark**
Save all those information, you'll need them for communication with the agrirouter.

### 8.10.3.3. Failure

On Failure, a JSON object including an error message is received, e.g.:

```
{
    "error": {
        "code": "0110",
        "message": "Signing header is invalid, the request has timedout, or
UTCTimestamp is not provided",
        "target": "",
        "details": []
    }
}
```

Possible Error codes

| ErrorCode | Error Text | Comment |
|---|---|---|
| | | |
| **0010** | The account is inactive | |
| **0011** | Unknown account. | |
| **0020** | The account is not Approved for use with this application | |
| **0021** | The provided application certification is unknown | |
| **0022** | The provided application certification is not in the proper status. | |
| **0023** | The endpoint was previously onboarded and is blocked for use. | |
| **0024** | The provided application certification is not accepted for this request. | |
| **0100** | Invalid payload. | |
| **0101** | The certification Id provided is not valid for this request. | |
| **0102** | The gateway Id provided is not valid | |
| **0103** | The certificated type provided is not valid | |
| **0104** | The gateway id provided is not valid for this device. The gateway Id can not be changed when reonboarding an existent device in account | |
| **0105** | The application id provided is not valid. | |
| **0105** | You\'ve made too many requests in a short period of time. | |
| **0106** | Missing ${constants.Validation.SIGNATURE.APPLICATION_ID_HEADER_FIELD} or $ | |
| **0107** | Invalid signature | |
| **0108** | Application cannot be validated as application header is not the same as the application associated with the given registration code. | |
| **0109** | Application header is not the same as the application associated with the given endpoints or multiple applications found for the given enpoints. | |

#### *8.10.3.3.1. Handling Signature Issues*

If you experience problems with an invalid signature, (Code 107), try the following:

- make sure, you encoded the whole body
- compare the signature with the result of the node server tool delivered with the postman collection
- check the timestamp. If your local time is ahead of or too far behind agrirouter servers time, it will not recognize the signature as valid. The agrirouter HTTP answer includes a timestamp reporting agrirouters server time.

## 8.11. Reonboarding

### 8.11.1. What is re-onboarding?

Re-onboarding allows an endpoint to get new client certificates and updates on URLs / topics for measures and commands Internally, the endpoint gets the same identification (deviceAlternateId, sensorAlternateId and capabilityAlternateId remain the same), thus all rules, filters and buffered messages remain valid and do not get lost

### 8.11.2. Why should an endpoint be re-onboarded?

If an app instance loses parts of its onboarding information, it can be reonboarded using the onboarding process. Additionally, the endpoint URLs might change. Even though, this is currently not planned, it could be a result of scaling.

### 8.11.3. How does re-onboarding work?

The client needs to send the same onboarding request as for ist first onboarding, including a new registration code provided by the end-user.

**Remark**

The external Id **must be the same** as for the initial onboarding, as this is used to map the endpoint to the existing

Capabilities may be sent, but do not have to (these are stored within the agrirouter from initial onboarding)

Reonboarding has to be done, when an app is updated in a way, that its certification version id changes.

# 9. Revoking Accounts

If the contract with a customer ends, app providers should revoke their connection with the customers account. This can be done using a similar process

## 9.1. Process of Revoking

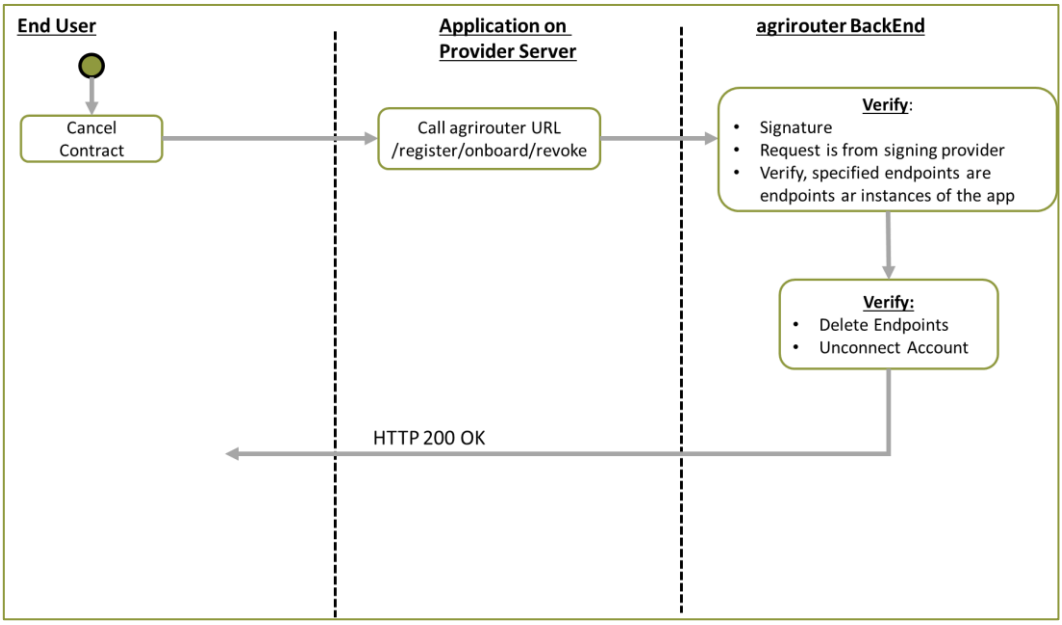



**Figure 20 Revoke Process**

### 9.1.1. Creating Revoke Command

#### 9.1.1.1. General

Deleting a CU is done through a DELETE-Request to the following endpoint:

| Method | Adress |
|---|---|
| **DELETE** | /registration/onboard/revoke |

**Remark**
Deleting virtual CUs is done using a command. See 16.5.2 Removing a Virtual Cu

### 9.1.2. Header

The Request shall include the following header information:

| Name | Type | Description |
|---|---|---|
| **Content-Type** | String | application/json |
| **X-Agrirouter-ApplicationId** | String | [Application Id] |
| **X-Agrirouter-Signature** | [Signature] | see 8.8 Signing requests |

### 9.1.3. Body

The body includes a JSON object:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | accountId | String | The ID of the users account |
| **2** | endpointId | Array of String | An Array of endpointIDs, that shall be deleted. |
| **3** | UTCTimestamp | String | A timestamp like this: *2018-06-20T07:29:23.457Z* |
| **4** | timeZone | String | A time zone like this: *"+03:00"* |

Example:

```
{
  "accountId": "4823443c-fd0d-44a7-81a6-06104455945a",
  "endpointIds": [
    "3823443c-ed0d-44a7-81a6-06104455945a",
    "7873443c-fd0d-44a7-81a6-06104455945a"
  ],
"UTCTimestamp": "2018-06-25T18:08:17.661890Z",
"timeZone": "+00:00",
}
```

### 9.1.4. Response

The response is an empty message using a HTTP Return code to indicate the result:

| Code | Description |
|---|---|
| **204** | Revoke was successful |
| **400** | A validation failure occured |
| **401** | The Request was unauthorized |

# 10. Architecture of an endpoint

## 10.1. General Overview

The endpoint can be seen as the interface between agrirouter and an App Instance. It receives messages from the app instance and can deliver messages to this app instance.

On the other side, it is part of the agrirouter and forwards messages to routing and addressing, receives addressed messages and can handle the subscribtions.

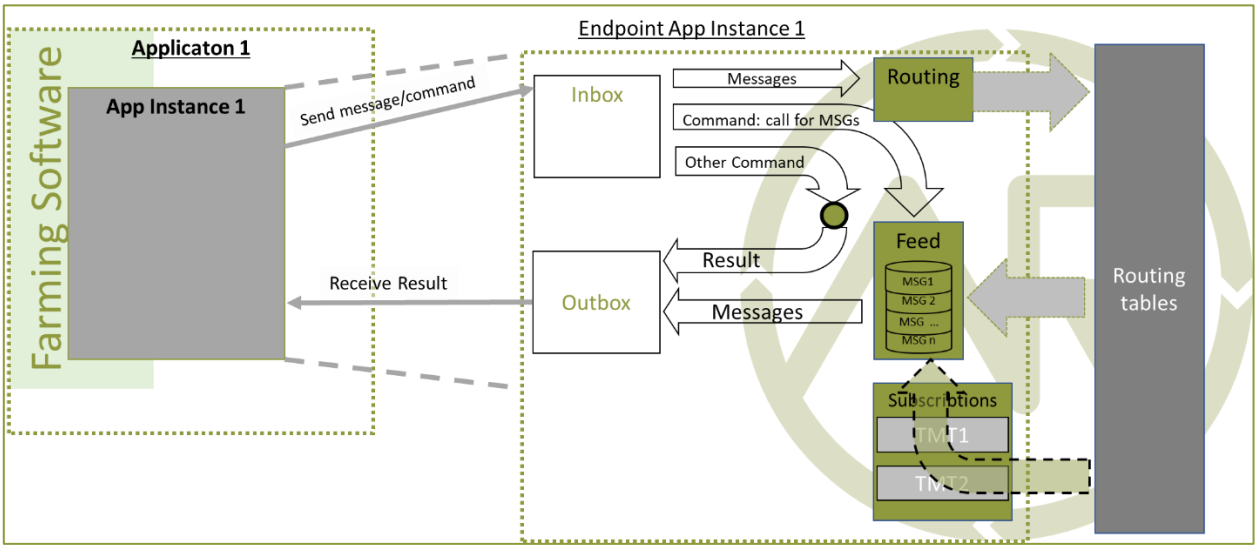



**Figure 21 Architecture of an endpoint**

**Remark**
The terms “subscription” and “subscribing” are well known by MQTT addicted developers. In this document however, subscribtions describe a technique of the agrirouter endpoint. It works like an MQTT subscription, it’s however important to notice, that MQTT is mostly not the context of these words in the document except for the relevant chapter 8.6.2!

## 10.2. Inbox

The inbox is used to receive messages or commands from an app instance.
The address of this inbox is delivered with the Response of the onboarding request as “measures”.

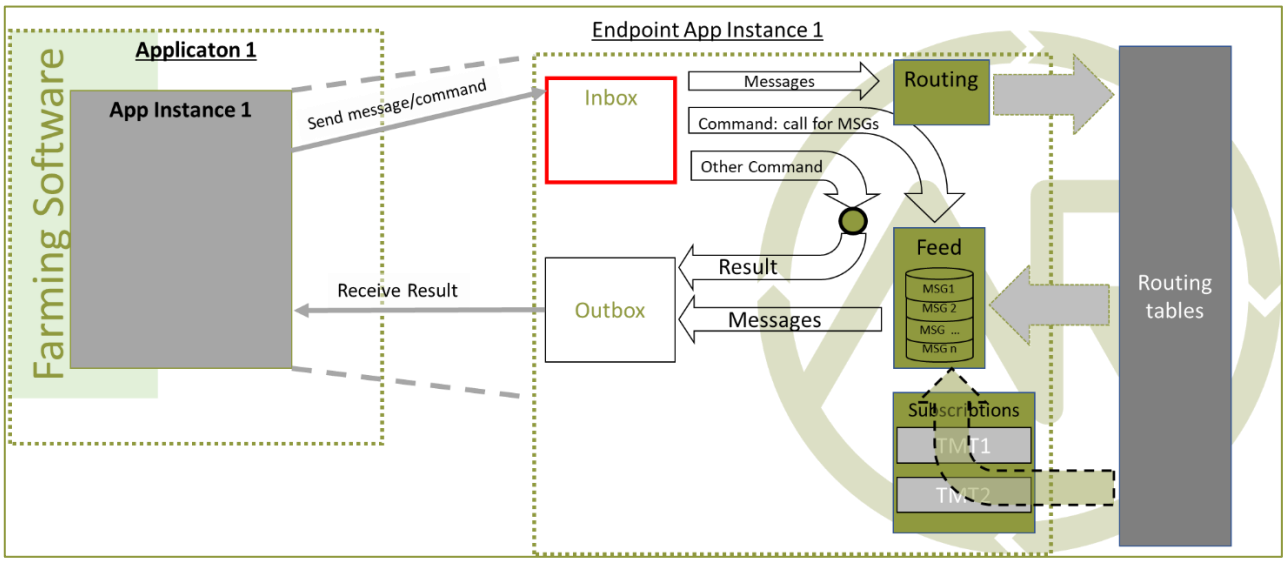



**Figure 22 Inbox within an agrirouter endpoint**

**Remark**
In terms of agrirouter onboarding result, the inbox is called measures due to the used standardized gateway. In this integration guide, we call it inbox as this is, what it really is in terms of agrirouter

## 10.3. Outbox

The outbox is used to deliver messages to an app instance.
The address of this outbox is delivered with the Response of the onboarding request as “commands”.

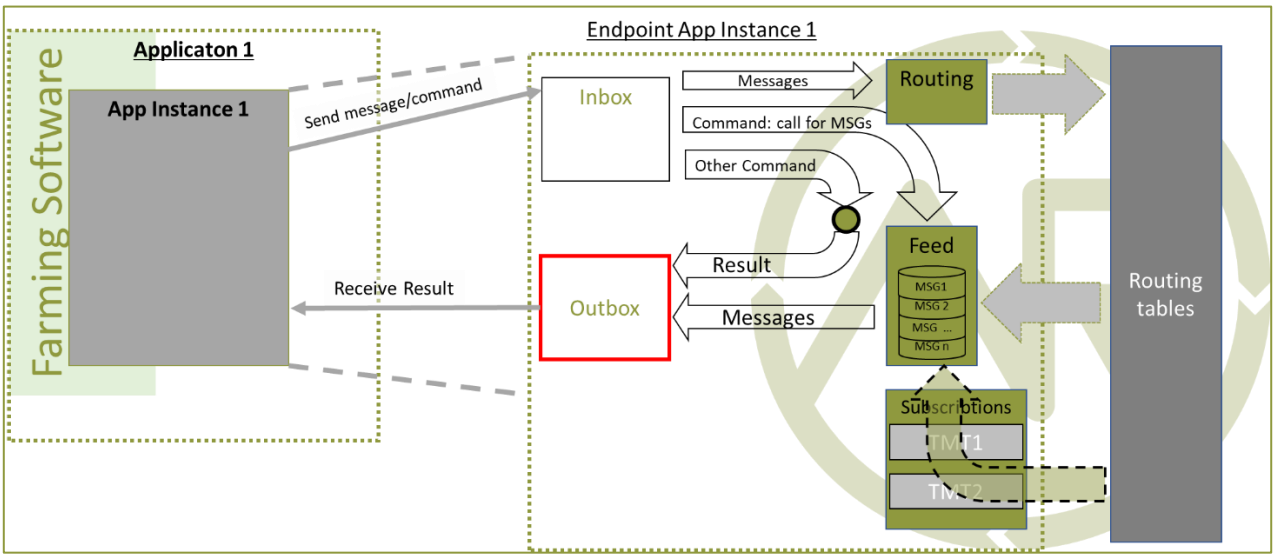



**Figure 23 Outbox within an agrirouter endpoint**

**Remark**
In terms of agrirouter onboarding result, the outbox is called comands due to the used standardized gateway. In this integration guide, we call it outbox as this is, what it really is in terms of agrirouter

## 10.4. Feed

The feed receives all messages from the agrirouter due to addressing of messages and subscribtions of the endpoint, given there is a routing for that. Messages in the feed are stored for a maximum of 4 weeks, before the are deleted. The user will get informant about that, if there are messages, that were not delivered for 3 weeks or more. An app instance can either request the messages to be forwarded to its outbox or request to delete the messages. If it requests the forwarding to the outbox, the messages are only deleted from the feed, when the app instance confirms having received those messages.

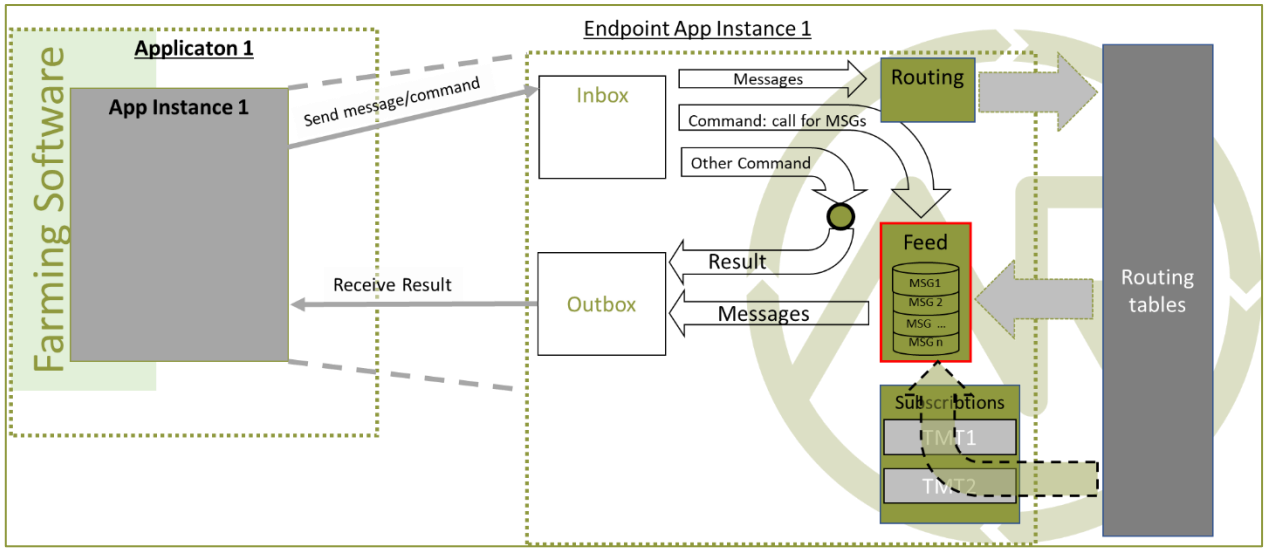



**Figure 24 The feed within an agrirouter endpoint**

## 10.5. Subscription List

The subscription list includes a list of all Message Types and DDIs, the endpoint is subscribed for. Whenever a message is published on the agrirouter account, this will lead to putting a copy of this message into the feed, given, there is a route for that.

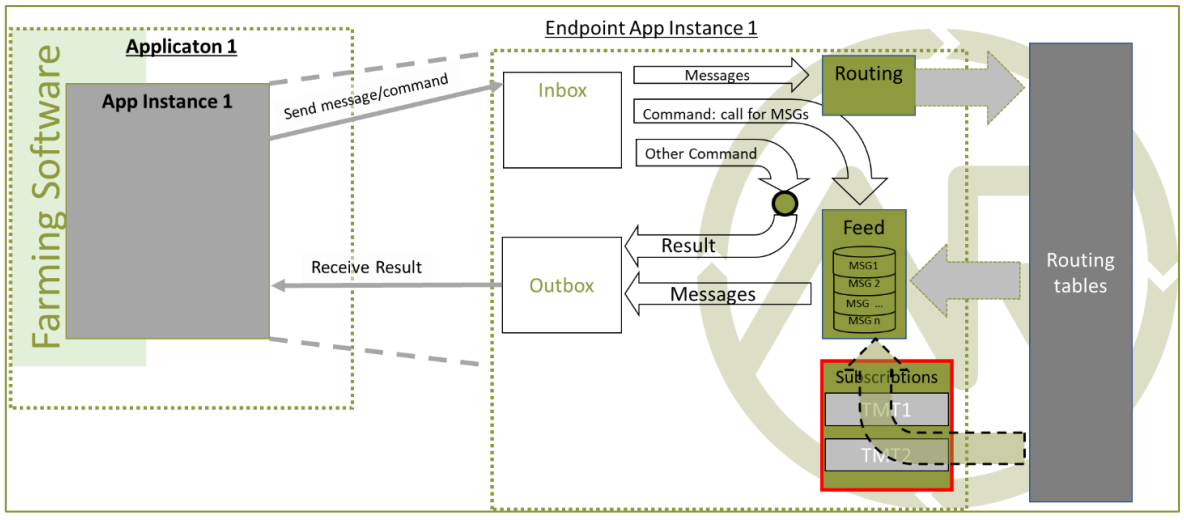



**Figure 25 Subscribtion List within an agrirouter endpoint**

# 11. Basics of communication

## 11.1. General communication convention

Communication with the agrirouter includes communication with inbox AND outbox, unimportant, if an app only sends messages or only consumes messages. Every message or command is sent to the inbox, results are always delivered through the outbox.

## 11.2. Prequisits for communication

Every communication is introduced by the App Instance. The agrirouter endpoint will never contact the app instance.

After application registration, the communication is secured using the SSL certificate retrieved during the onboarding process. The agrirouter provides PK12 certificates as well as PEM certificates which can be set within the SSL context of the request to ensure authenticated communication with the agrirouter.

Once after the validation has happened, the agrirouter provides all necessary security informations to establish a messaging connection. The developer is obliged to store this certificate, or the tokens secured and encrypted within the application. Receiving the certificate is described in 8 Onboarding .

## 11.3. Different layers, “The onion principle”

agrirouter is a platform, that is mostly used to transport messages **through** it and not towards it.
Therefore:
the content is encapsulated in
messages and commands, which are encapsulated into
the request to and the result from the agrirouter, which are encapsulated into
the protocol layer of REST using Request and Response or MQTT using Publish and Subscribe.

With except to the EFDI telemetry messages (DeviceDescription and live data), agrirouter doesn’t analyse the messages inside the agrirouter request. It just checks the technical message type and the addressing to determine the receipants based on the routings and subscribtions.

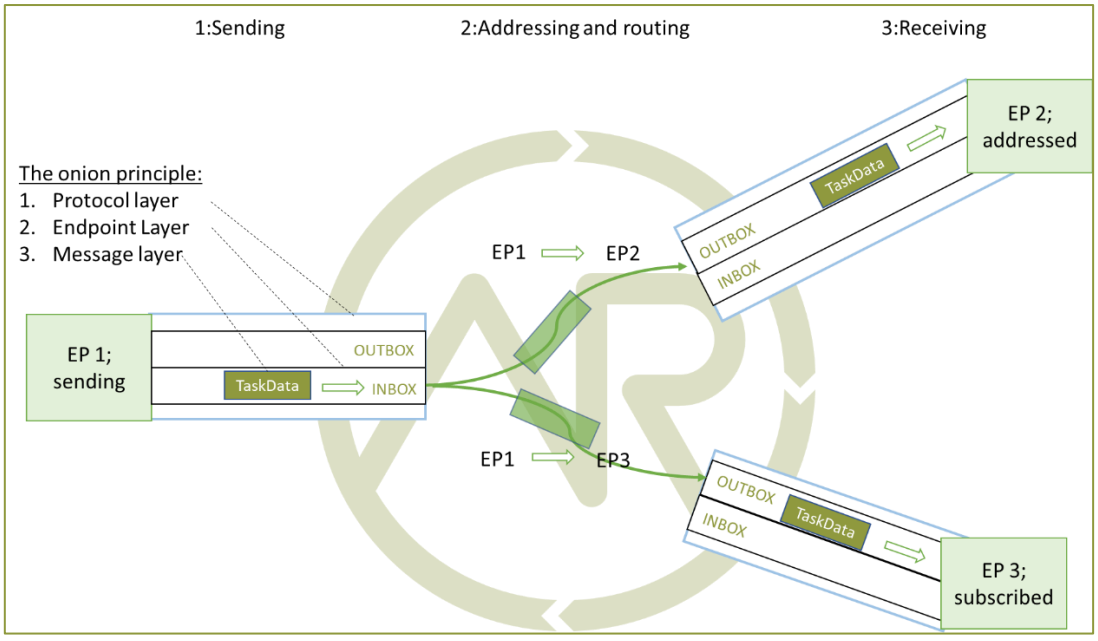



**Figure 26 The onion principal for a non-telemetry message**

An exception is the EFDI telemetry messages.
The device descriptions are needed by the agrirouter to

- determine the relevant CU when sending a Message directly to a machine
- filter for DDIs that are allowed to be sent to specific endpoints

The life telemetry data is analysed, so that a filtering for value categories like fuel consumption is possible.

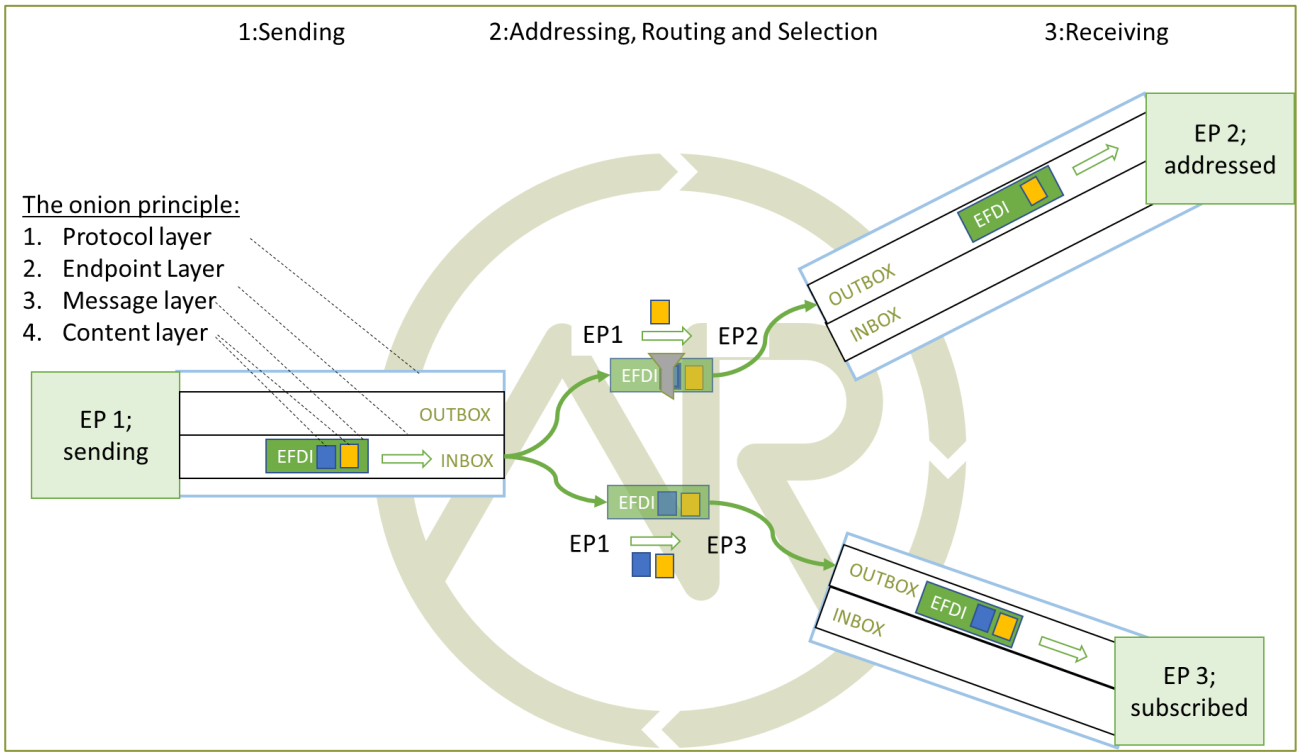



**Figure 27 The onion principle for a telemetry message**

## 11.4. The protocol layer

The protocol layer describes the basic communicaton layer. All agrirouter communicaton is based on a TCP-IP communication. When onboarding an endpoint, the developer can choose between REST and MQTT

### 11.4.1. REST

REST is a wellknown principle for online apis. For more information on REST, please see following recources:

- https://en.wikipedia.org/wiki/Representational_state_transfer
- https://code.tutsplus.com/tutorials/a-beginners-guide-to-http-and-rest--net-16340

REST uses HTTP requests, that result in an HTTP Response.
To avoid request timeouts, agrirouter will return an HTTP Status Code 201(Processing) and the app instance will have to poll for a request confirmation.

**Remark:**
REST is based on single, request only methods, therefore, the agrirouter cannot contact any endpoint. This means, that the endpoint for example has to poll for new messages in the outbox.

#### 11.4.1.1. Communication Workflow with the Inbox

Using REST, an app instance just receives a HTTP 200 “OK” Response. The App Instance sends a HTTP Post request over an SSL secured Connection.

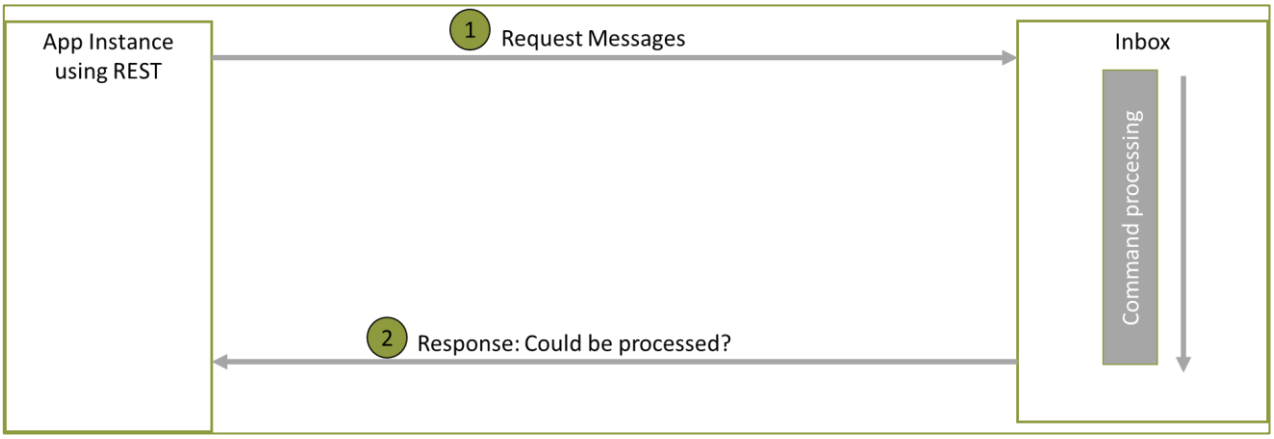



**Figure 28 Request and Response in HTTP**

#### 11.4.1.2. Communication with the Outbox

Using REST, the communication with the Outbox requires polling:

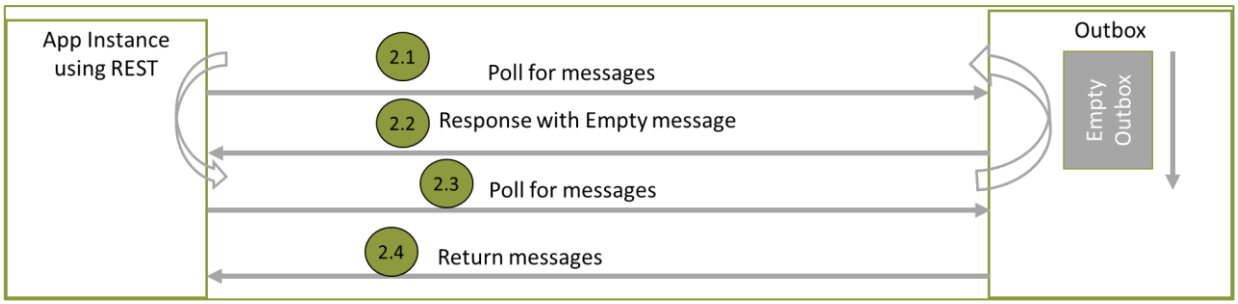



**Figure 29 REST Communication with the outbox**

### 11.4.2. MQTT

MQTT is a subscription based protocol. Therefore, the client can be informed by agrirouter, that new messages are available. For further information, please refer to one of the following recources:

- https://mqtt.org/

The agrirouter provides an MQTT Broker serverside, so, an app instance has to connect to this server with its client. agrirouter provides one MQTT Server per Endpoint, so there is no danger or chance to subscribe for messages of another endpoint

#### 11.4.2.1. Communication with the Inbox

Using MQTT, the app instance will publish the request and after a while, the agrirouter will publish the response. Polling is not required.


**Figure 30 Request and Response using MQTT**

#### 11.4.2.2. Communication with the Outbox

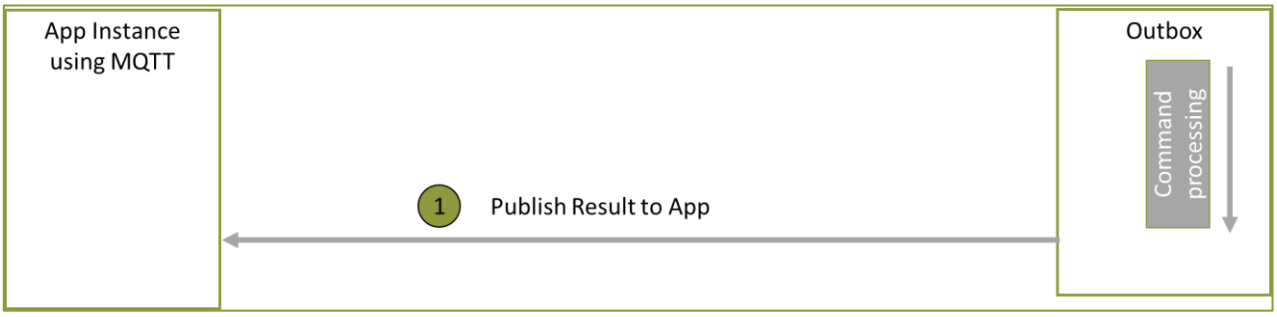



**Figure 31 Receiving Result from the outbox in MQTT**

If there are messages available in the outbox, agrirouter will simply publish them to the MQTT App Instance.

### 11.4.3. Comparison of protocols

Both protocols have several advantages and disadvantages. To select the right protocol for your needs, check the following table

| Topic | MQTT | REST |
|---|---|---|
| **Can be used for onboarding** | | X |
| **Can send JSON** | X | X |
| **Can send raw protobuf** | | X |
| **Needs no polling** | X | |
| **Steps for Call and Result** | 3 | min. 4; polling |

## 11.5. Abstraction of communication workflows

To avoid graphs with too many arrows, we simplifiy the upcoming requests, abstracting MQTT and REST. Whatever protocol you use, a Request and Response in this document will look like this:

#### 11.5.1.1. Abstraction of Calls to the Inbox

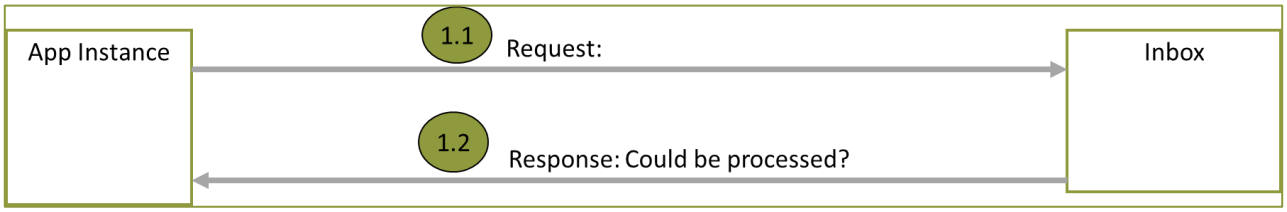



**Figure 32 Abstraction of a Call or Message Sending to the Inbox**

#### 11.5.1.2. Abstraction of Results from Outbox

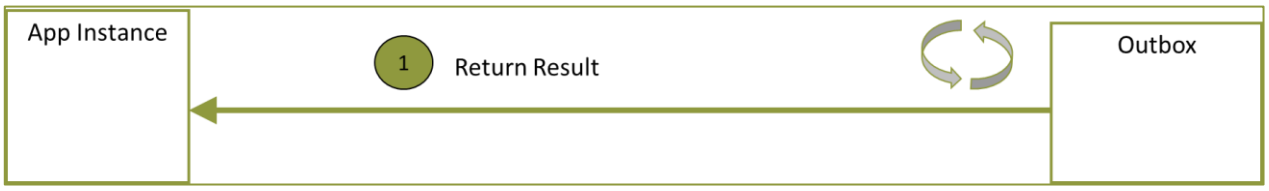



**Figure 33 Abstraction of a result from the outbox**

# 12. Communication of App Instance and Endpoint

## 12.1. Endpoint Adresses

The endpoint addresses of the inbox and outbox are delivered with the onboarding request. Please refere to 8.6.3

~~Sending Onboarding Request~~

## 12.2. Assigning a result to a request

The assignment between messages sent to the Inbox and their corresponding message in the outbox is done by comparing the application_message_id provided by the app.

**Exception:**
If a message is not correctly encoded, so that the agrirouter cannot decode it, there will be no application_message_id in the result.

## 12.3. Flow for sending messages

Sending messages to the agrirouter creates an ACK-Message in the outbox of the agrirouter

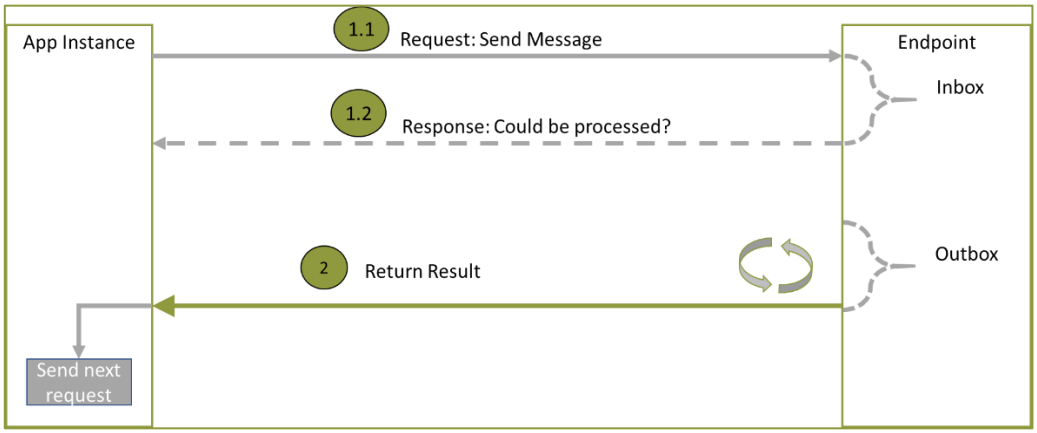



**Figure 34 Send Message or Command to agrirouter**

## 12.4. Flow of commands

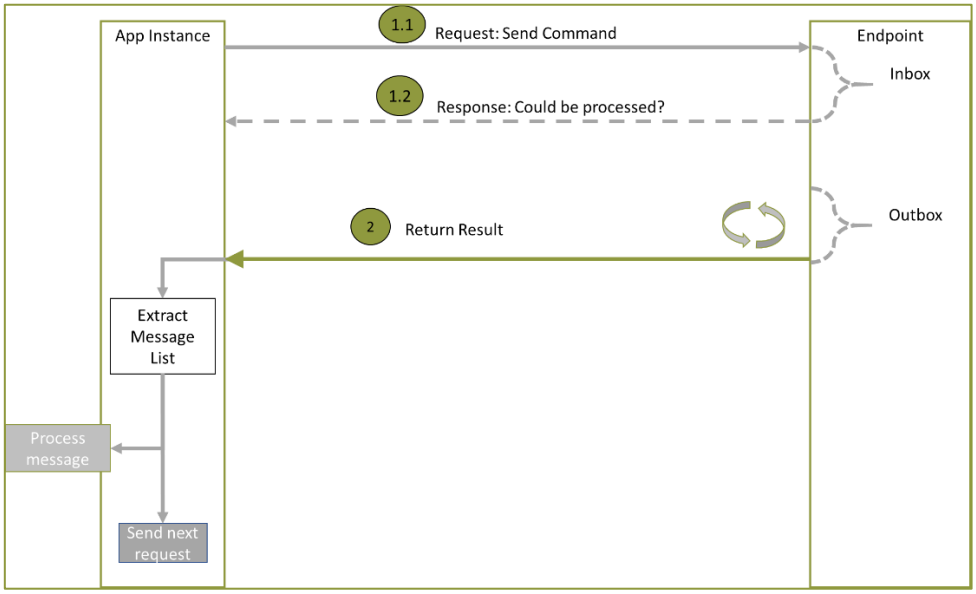



**Figure 35 Command Flow**

## 12.5. Flow of requesting messages from the feed

If the command is a feed command requesting messages from the feed, the app instance has to confirm the receival of the message, so that it is deleted from the feed.

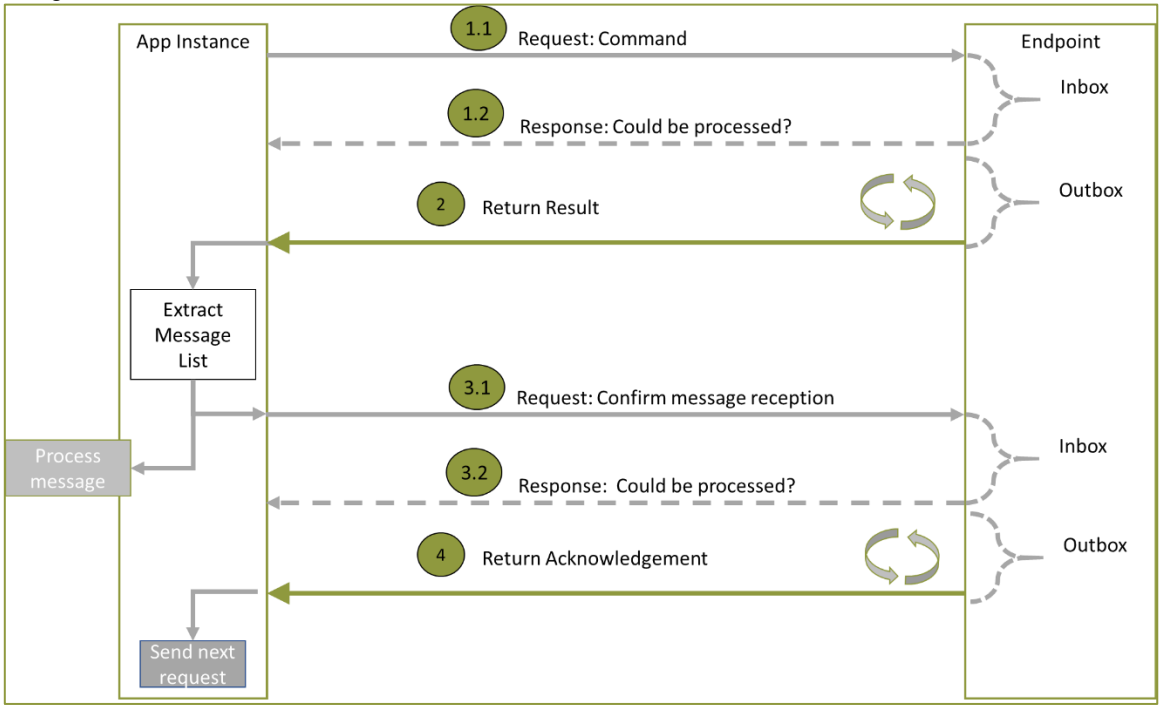



**Figure 36 Command flow for reading the feed**

## 12.6. Terms

A command-process consists of a call (1.1) to the inbox. This call consists of the request and a processing status response. Agrirouter will return a result through the outbox. When the app instance receives this result successfully, it has to call for confirmation at the inbox to clear the outbox. If a message list was delivered, this will also delete the received messages from the feed.

# 13. Building Messages and Commands

## 13.1. General

Creating a message includes several steps. This can be seen in the graph below:

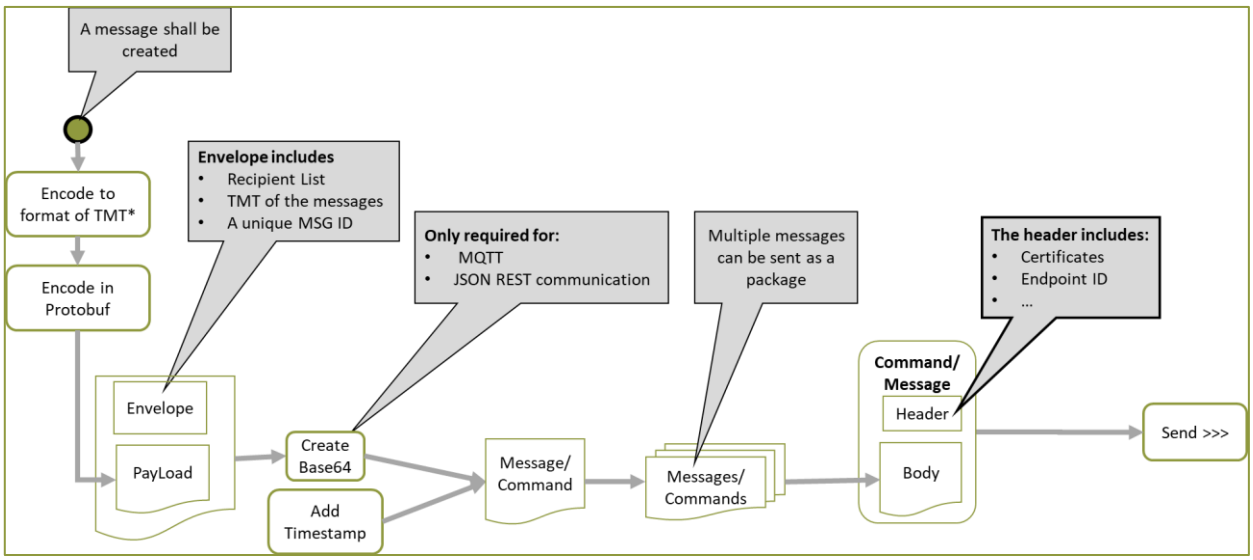



**Figure 37 Workflow of creating a message**

## 13.2. Chunking big messages

Exchanging data using a mobile connection can be very critical, as a stable internet connection is not always given. To avoid waisting data volume and time, agrirouter offers a possibility to cut messages into multiple smaller parts and send them one by another. If the internet connection breaks down inbetween, only one small package is not delivered and has to be send again.

**Remark**
agrirouter messages can have a maximum size of 1 MB each. If a message is too large, agrirouter will respond with a HTTP code 413 “Request too large”. Please note, that the relevant size value is the size of the protobuf format, which might increase with conversion to Base64.

**Remark**
EFDI telemetry messages cannot be chunked, as they are analyzed for the routing of telemetry data on agrirouter.

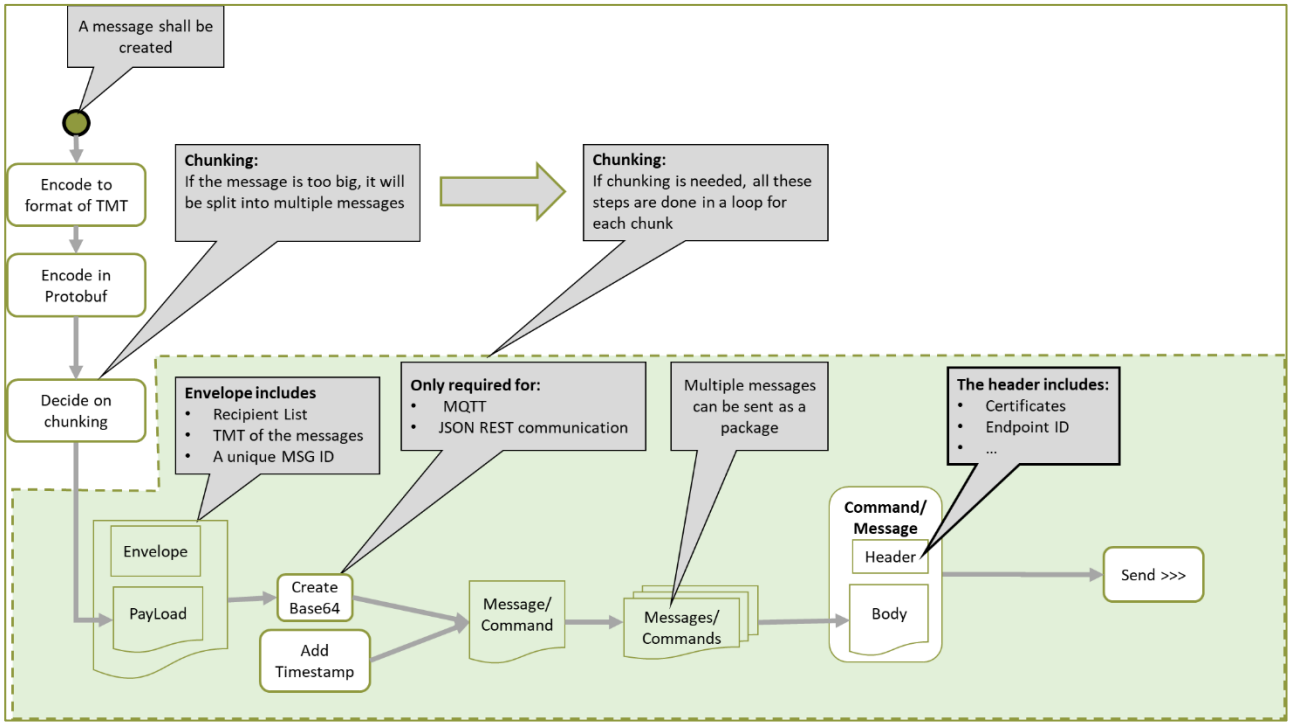



**Figure 38 Workflow of creating a chunked message**

**Remark:**
Sending multiple messages in one Request is only possible, if the overall size of all messages payloads is beyond the chunking maximum size value.

The overall body of the message to the inbox shall not include more payload than allowed without chunking. So, when a message is too big for one request and needs to be chunked, these chunks have to be sent in multiple messages, they can not be added as multiple chunks to one message.

## 13.3. Encode content to its Technical Message Type

Encoding a message in its required technical message type depends on the message type. The message types for agrirouter Commands are described further in 16 Overview of agrirouter commands.

## 13.4. Encode content in Protobuf

agrirouter messages and commands use protobuf 3 to encode content. Please refer to https://developers.google.com/protocol-buffers/ for a full documentation of the format and a lot of development resources.

The agrirouter uses the node.js lib: https://github.com/dcodeIO/protobuf.js

**Remark**
As the payload of a message is defined as an any message, the TypeURL has to be set to the corresponding message type. Otherwise, agrirouter will not be able to forward or process the message.

### 13.4.1. Getting the agrirouter protobuf files

Protobuff definitions are part of the integration guides attachments, they are delivered as .proto files.
They can also be found at the github: https://github.com/DKE-Data/agrirouter-api-protobuf-definitions

The repository delivers all protobuf files, that are owned by the DKE. It might be, that you need additional protocol buffers like the EFDI telemetry messages definitions, that cannot be delivered in this github account due to intellectual property rights. You will however find instructions, how to get those protobuf definition files.

### 13.4.2. Reading Protobuf definitions

Basically, you can think of a protobuf as a C Struct or a JSON object. It includes data of several data types with the possibility of default values or optional parameters and lists.

An example of a protobuf with several descriptions

```
message MyProtobuf{ //The main class of this element
  enum Direction {  // An enumeration of values
    SEND = 0;
    RECEIVE = 1;
    SEND_RECEIVE = 2;
  }
  message subBuffer{
     int64 x=1;
     int64 y=2;
  }
  string name=1; // Field 1 of the structure is a string called "name"
  int64 age=2;
  Direction direction=3; //A field of type direction, that describes an enum
  repeated string hobbies=4; //A list with 0 to n elements possible
  repeated subBuffer positions=5;
}
```

### 13.4.3. Including Protobuf in your project

Protobuf is available for multiple programming languages such as Java, C++, Java Script, Python, etc. etc.
The protobuf compiler creates sourcecodes for your desired language. Please refer to https://github.com/google/protobuf for a list of implementations

## 13.5. Chunking Messages

**Important note:**

The segmentation of message does not apply to the telemetry related data as it is described in EFDI telemetry messages. A maximum number of chunks (max. size for binaries) will be defined in the project

The max chunk size is capped at 1MB. This size might be decreased during the project for performance reasons.

### 13.5.1. Chunking parameters

The protobuf ChunkComponent can be found in commons/chunk.proto.

| Name | Type | Description |
|---|---|---|
| **context_id** | String | A unique ID for this chunk. The number shall be equal for each part of the chunk and help the receiving endpoint to Identify the chunk |
| **current** | int64 | The current index of this chunk within the whole chunk starting with 1 |
| **total** | int64 | The total number of chunks, this message consists of |
| **total_size** | int64 | The total size of the whole chunk in bytes. |

### 13.5.2. Preparing and creating chunked messages

If it is recognized, that a message needs to be split into multiple chunks, starting from here, the single message is sent to agrirouter by splitting the message body and creating multiple requests to the agrirouter, each including a new chunk element.

**Remark**
agrirouter does neither check nor inform about Chunks, that have not yet been delivered to agrirouter. It will forward the single parts and the receiving endpoint(s) will have to take care of realigning the parts.

## 13.6. Building the Envelope

The envelope is a protobuf structure of type agrirouter.request.RequestEnvelope.

The parameters as overview:

| Parameter | Type | Description |
|---|---|---|
| **application_message_id** | String | A unique ID for this message. UUID required |
| **application_message_seq_no** | int64 | An indicator, in which order the client sent the message. The smallest Sequence number must be >0. |
| **technical_message_type** | string | The TMT; see 17 Technical Message |
| **team_set_context_id** | string | The relevant teamset for this message; just in case, it changes |
| **mode** | mode | DIRECT, PUBLISH or PUBLISH_WITH_DIRECT |
| **recipients** | string(repeated) | A list of endpoint IDs to forward the message to |
| **chunk_info** | ChunkComponent | The chunking information for split messages |
| **timestamp** | timestamp | The timestamp, when the message was created |

For the timestamp format definition, please refer to:
https://github.com/google/protobuf/blob/master/src/google/protobuf/timestamp.proto

**Remark:**
The application_message_sequence_no shall not be 0, as this might lead to misbehavior in any C++ Implementation of the agrirouter interface. To be consistent with every endpoint, it shall also not be done in other languages, even though they do not have a problem with that on their side of the agrirouter.

## 13.7. Building the payload

The structure of the payload depends on the technical message type. Its always some kind of protobuf structure, please refer to the chapters on technical message types for further information.

## 13.8. Connecting envelope and PayLoad

Envelope and content are packaged into one container by using the technique of “Delimited Messages”. Please note, that this is **not** simply copying both memory buffers into one buffer. Please refer to https://developers.google.com/protocol-buffers/docs/techniques#streaming

**Remark**
Note that this concept is not supported in all protobuf libraries (in Java and node.js it is, in C++ it is not)
If building streaming is required for the language and libraries, you use, Note, that Delemited messages are attached to each other like this: Length1,Content1,Length2,Content2,…. The variable size of Length is the length of a varint; see https://developers.google.com/protocol-buffers/docs/encoding#varints.

A solution for C++ can be found here: https://stackoverflow.com/questions/2340730/are-there-c-equivalents-for-the-protocol-buffers-delimited-i-o-functions-in-ja/

## 13.9. Message container

The message needs to be packaged into a message container, that includes the message itself and a timestamp. Going forward from this step, the encoding can either be in protobuf or JSON. For MQTT, it has to be JSON, for REST, it can be both.

### 13.9.1. Encode in Base64

This step is only required, if your app instance communicates with its endpoint using MQTT or JSON based REST.

Encode the serialized binary protobuf stream into a base64 string. All further steps will be done in JSON from now on.

### 13.9.2. Go on in Protobuf

agrirouter REST endpoints are also capable of exchanging Protobuf.

When using Protobuf, the whole message including the upcoming steps will be encoded In Protobuf. The container is an element of type any in the message; see further steps.

## 13.10. Adding the Timestamp

The Timestamp and the message now have to be packaged into one JSON or Protobuf object with the timestamp of the message sending time. This timestamp shall use UTC.

**Remark:**
The timestamp is the time of recording the message, not the timestamp of sending it.

## 13.11. Add Message to List of Messages

The object can now be added to the list of messages, that shall be sent to the endpoint at once. It's important to know, that all these messages have the same recipient list.

### 13.11.1. JSON

The message List is a JSON array of Message containers and called measures in the following:

```
[message,timestamp]
```

### 13.11.2. Protobuf

The protobuf container can be found here:
It looks as follows:

```
message Measure {

  repeated google.protobuf.Any values = 1;

}
```

**Remark**
Please note, that this definition is part of the message definition below (when it comes to definition of the whole message).

## 13.12. Build message

To have a fully compatible message, we now need to take the list if messages and add a header describing the sending endpoint.

Parameters List:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | sensorAlternateId | String | The source of this message, e.g. the CU or a device |
| **2** | capabilitesAlternateId | String | An internal value |
| **3** | measures | Array | An Array of messages and Timepoints |
| **3.1** | message | Base64/Protobuf | A base64 encoded message |
| **3.2** | timestamp | Timestamp | The timestamp of recording |

### 13.12.1. JSON setup

The JSON setup looks like this:

```
{
      "sensorAlternateId": "{{sensorAlternateId}}",
      "capabilityAlternateId": "{{capabilityAlternateId}}",
      "measures": [["{{encoded_request}}", "{{$timestamp}}"]]
}
```

### 13.12.2. Protobuf setup

The protobuf message can be found here: https://help.sap.com/viewer/643f531cbf50462c8cc45139ba2dd051/Cloud/en-US/e97b63e35f9a4bdbab72075e7bd37ccf.html
It looks as follows:

```
syntax = "proto3";
import "google/protobuf/any.proto";
package gateway;

option java_package = "com.sap.iotservices.common.protobuf.gateway";
option java_outer_classname = "MeasureProtos";

message MeasureRequest {
  string capabilityAlternateId = 1;
  string sensorAlternateId = 2;
  string sensorTypeAlternateId = 3;
  int64 timestamp = 4;
  repeated Measure measures = 5;

  message Measure {
    repeated google.protobuf.Any values = 1;
```

```
    }
}
```

**Remark**
Note, that there is a repeated Element (=Array) in a repeated element (also Array). This inner array shall always consist of 2 Elements; First is the message, second is the timestamp.

# 14. Sending a Request

The message or command is sent to the agrirouter using a protocol dependent request to its agrirouter inbox.

## 14.1. General Prequesits

### 14.1.1. Routings available

To send a message to another endpoint, there is an existing routing required. This also applies to published messages

**Remark**
New routings might take a few seconds to minutes to be activated.

### 14.1.2. Publishing only with available subscriptions

If you publish a message, it will only reach an endpoint, if there is at least one subscribed endpoint.

## 14.2. Using MQTT

The endpoint address of the MQTT broker is delivered as host+port in the onboarding request. The inbox is the topic delivered with the “measures” attribute of the onboarding request.

To send a message, publish it.

In general, the hosts should be as follows:

| Area | Environment | URL |
|---|---|---|
| **EU1** | Quality Assurance | https://dke-qa.eu1.cp.iot.sap/ |
| **EU1** | Productive | https://dke.eu1.cp.iot.sap/ |

## 14.3. Using REST

Using REST, the message is sent as a single HTTP call using HTTPs and the endpoint certificates delivered with the onboarding Request.

### 14.3.1. Address

To send messages to the agrirouter, the app has to perform a POST request sending a message included in a Request.

Messages and commands are sent to the inbox. The address of the inbox is returned with the onboarding request (“measures”) and should look like this:

| Method | Adress |
|---|---|
| **POST** | /iot/gateway/rest/measures/{{deviceAlternateId}} |

### 14.3.2. Header

As the communication works via https, the SSL Certificate information delivered with the onboarding Result is needed.
In most communication libraries, the developer just has to provide

- the certificate, which is the public key,
- the SSLKey, which is the private key
- the KeyPassword for the private key

Most libraries are than able to handle the communication.

For further information see the curl documentation on the parameters used for a communication. For curl_easy_setopt(:

- CURLOPT_SSLKEY
- CURLOPT_KEYPASSWD
- CURLOPT_SSLCERT

The header of the HTTP Request for the REST implementation also requires

```
Content-Type: "application/json"
```

or

```
Content-Type: "application/x-protobuf"
```

### 14.3.3. Body

The body consists of the message package, that was created in the previous paragraphs.Receiving a Response
HTTP Messages always get confirmed by the agrirouter. For the HTTP REST Gateway, the agrirouter will simply send a HTTP Status 200 OK. For MQTT, there will not be any response.

## 14.4. Header

The Header has a HTTP Status 200

## 14.5. Body

The Body of the response is empty.

**Remark**
The result code of this simply informs you, if the endpoint was reachable and if the inbox was able to forward the message

# 15. Receiving Results

## 15.1. General

Results for commands and messages from calls for messages are returned to the outbox. An application instance receives them from the outbox and can than decode the data.

The address of the outbox is returned with the onboarding request (“commands”) and should look like this:

| Method | Adress |
|---|---|
| **GET** | /iot/gateway/rest/commands/{{deviceAlternateId}} |

**Remark**
**Any feed query message has to be confirmed to be deleted from the feed. If you do not confirm a feed message, you will receive it over and over again, until you confirm it.**

## 15.2. MQTT

The endpoint address of the MQTT broker is delivered as host+port in the onboarding request. The outbox is the topic delivered with the “commands” attribute of the onboarding request. The app instance has to subscribe for this topic.

The addresses can be found in chapter 14.2Using MQTT.

## 15.3. REST

The REST endpoint address of the outbox is delivered with the “command” attribute of the onboarding request.
An application Instance has to perform a GET request to this endpoint to receive all messages from the outbox.

## 15.4. Format of received messages

Agrirouter returns a message, so, there can be multiple responses in one response package.
The result format depends on the setting of the the Accept-Header in the GET Request to the Outbox:

| Accept Header | Will Receive |
|---|---|
| application/json | JSON |
| application/x-protobuf | Native Protobuf |

### 15.4.1. JSON Result

```
[
      {
      “sensorAlternateId”: “49dcf152-eb2a-4b50-ad5c-1af5b737ed80”,
      “capabilityAlternateId”: “49dcf152-eb2a-4b50-ad5c-1af5b737ed80”,
      “command”: {
            “message”:
“fskjlaflasdfkjlasdfkjfalkefnFSDLKDFJL33221sdldgkjglfdkjldkgjDFAFKJLKJSFDSFEE
SXFRRDGDGRDGDGRSDDGRddrrrg354grdgIODIO35445DGDGLKKJWE3333425H1SJK==”
                  }
      }
]
```

### 15.4.2. Protobuf Result

```
syntax = "proto3";

import "google/protobuf/any.proto";

package gateway;

option java_package = "com.sap.iotservices.common.protobuf.gateway";
option java_outer_classname = "CommandResponseProtos";

message CommandResponse {
  string capabilityAlternateId = 1;
  string sensorAlternateId = 2;
  Command command = 3;

  message Command {
    repeated google.protobuf.Any values = 1;
  }
}

syntax = "proto3";

import "CommandResponse.proto";

package gateway;

option java_package = "com.sap.iotservices.common.protobuf.gateway";
option java_outer_classname = "CommandResponseListProtos";

message CommandResponseList {
 repeated CommandResponse commands = 1;
}
```

### 15.4.3. ParameterList

The result of a request to the outbox is an **array** of messages each including the following parameters:

| Name | Type | Description |
|---|---|---|
| **capabilityAlternateId** | String | Equals value from onboarding |
| **sensorAlternateId** | String | Source of the message |
| **command** | String | The Base64 encoded message or a protobuf object, if agrirouter sent a protobuf object. |

As this Array can include multiple messages, all further steps need to be done in a loop.

## 15.5. Decoding Base64

In case, a JSON Object was received, the String inside the Command is a Base64 encoded protobuf object. The app instance has to decode the message into a protobuf object then.

The Base64 string should be convertible to a byte stream, that includes a ResponseEnvelope and a ResponsePayLoadWrapper.

## 15.6. *Delimiting Envelope and Payload*

Envelope and payload of each message are packaged into one delimited message. Seperating those parts requires the delimiting functionality of protobuf. To know the format for the payload, the envelope has to be decoded first

## 15.7. Envelope

The envelope is a protobuf object, that can be found in message agrirouter.response.ResponseEnvelope

Parameters are:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | response_code | int64 | A HTTP-like response code indicating the result |
| **2** | type | ResponseBodyType | An indicator of the correct decoding protobuf description |
| **3** | application_message_id | String | the corresponding message, that this answer is assigned to. |
| **4** | message_id | String | The agrirouter internal message ID used to be written to the agrirouter log and for confirmation. |
| **5** | timestamp | TimeStamp | The timestamp of the Result creation |

### *15.7.1. response_code*

The response code indicates success or failure of a request.

| HTTP Response Code | Description |
|---|---|
| **200** | request processed/received successfully. |
| **201** | request processed/received and data created (this would be valid in cases for response to subscriptions, capabilities, teamset context messages, etc) |
| **400** | validation of request failed, messages in the body specifies the type of request failure |
| **413** | request too large |
| **503** | request cannot be processed at the moment, probably due to temporary overload |

### 15.7.2. type

The type is required to determine the correct schema for the body:

The following List shows the corresponding Protobuf schemata for each ResponseType

| ResponseBodyType | Schema (.proto) | Comment |
|---|---|---|
| MESSAGES | agrirouter.feed.response. MessageQueryResponse | A list of messages as result of a request for messages |
| ACK | There is no Schema for this, the payload will just have a size of 0 bytes | An acknowledgement of a message |
| ACK_WITH_MESSAGES | agrirouter.commons.Messages | An acknowledgement with messages; e.g. warnings. |
| ACK_WITH_FAILURE | agrirouter.commons.Messages | Represents a failure response in correlation to a message sent to the agrirouter |
| ACK_FOR_FEED_HEADER_LIST | agrirouter.feed.response.HeaderQueryResponse | Used for acknowledgements for feed envelope requests |
| ACK_FOR_FEED_MESSAGE | agrirouter.feed.response.MessageQueryResponse | Used for acknowledgements for feed payload requests. |
| ACK_FOR_FEED_FAILED_MESSAGE | agrirouter.feed.response.FailedMessageQueryResponse | Response for failed requests to feed queries |
| ENDPOINTS_LISTING | agrirouter.response.payload.account.ListEndpointsResponse | Used for a response which contains the endpoint listing |
| CLOUD_REGISTRATIONS | agrirouter.cloud.registration.OnboardingResponse | The result of a Virtual CU registration |

Analysing the results is described in the specific chapters of process description for several

### 15.7.3. application_message_id

Indicates to which request this response is to be mapped (app message id is provided by sending application)

### 15.7.4. message_id

The message_id is a unique ID of this message on the agrirouter. Use this id for the confirmation or delition request.

### 15.7.5. timestamp

Time point, when this message was created by the sender.

## 15.8. Payload

There are several possible payload protobuf formats. Specific messages will be described in the following chapter, in this chapter we will only describe general payload answers.

### 15.8.1. Messages

The agrirouter.commons.messages element includes a message as result of a command.

```
syntax = "proto3";

package agrirouter.commons;


message Message {

    string message = 1;                                 // Message text in
English Only

    string message_code = 2;                            // Globally defined
message code

    map<string, string> args = 3;                       // List of argument
names and values which would be inserted into the message text

}


message Messages {

    repeated Message messages = 1;                      // Collection of the
Message object listed above used in scenario's when there are multiple
messages in a response

}
```

It includes an array of Message:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | message | string | A human readable description of the message including wildcard fields |
| **2** | message_code | string | A standardized code to analyse by a program |
| **3** | args | map<string,string> | A map of field+value pairs to add specific information to a standardized message |

To display the message, replace all fields in the message with the corresponding values from the map.
The possible codes can be found in the attached file ErrorCodes.xlsx, specific values will be described in more detail within the corresponding Commands chapter.

# 16. Overview of agrirouter commands

This chapter shall give you an overview of all the commands, that are relevant to control the agrirouter communication

Following a list of all commands; specific definitions follow in the next subchapters.

| MessageType | Schema (.proto) | Comment |
|---|---|---|
| dke:capabilities | agrirouter.request.payload.endpoint.CapabilitySpecification | Endpoint to announce ist capabilities in terms of technical message types that can be sent / received |
| dke:subscription | agrirouter.request.payload.endpoint.Subscription | Endpoint to subscribe for a certain technical message type, so that it receives published messages of this type |
| dke:feed_header_query | agrirouter.feed.request.MessageQuery | Endpoint to query for metadata of messages in its message feed (type, size, sender, time sent etc.) |
| dke:feed_message_query | agrirouter.feed.request.MessageQuery | Endpoint to query for messages in its message feed |
| dke:feed_confirm | agrirouter.feed.request.MessageConfirm | Endpoint to confirm that it has received a certain message (or set of messages) |
| dke:feed_delete | agrirouter.feed.request.MessageDelete | Endpoint to delete messages from its message feed |
| dke:list_endpoints | agrirouter.request.payload.account.ListEndpointsQuery | Endpoint to get a list of endpoints to which messages of a certain type can be sent (considering routing rules in place) |
| dke:list_endpoints_unfiltered | agrirouter.request.payload.account.ListEndpointsQuery | Endpoint to get a list of endpoints to which messages of a certain type can be sent (not considering routing rules) |
| dke:cloud_onboard_endpoints | agrirouter.cloud.registration.OnboardingRequest | A cloud system to create virtual CU endpoints in a paired agrirouter account |
| dke:cloud_offboard_endpoints | agrirouter.cloud.registration.OffboardingRequest | A cloud system to delete (offboard) virtual CU endpoints in a paired agrirouter account |
| iso:11783:-10:device_description:protobuf | efdi.ISO11783_TaskData | Communication Unit to send a device description message including a teamset Context ID |
| iso:11783:-10:time_log:protobuf | efdi.TimeLog | Live telemetry data according to ISO11783 TimeLog specification, encoded in protobuf |

**Remark**

Those are the commands, that have the agrirouter as destination. Messages have other endpoints as destination. They are sent to the agrirouter like commands, but the agrirouter recognizes, that he only has to route and perhaps filter them.

## 16.1. Describing the endpoint

This chapter will list all messages to tell the agrirouter, what the endpoint is capable of, who it is and what it wants to receive.

### 16.1.1. Capabilities Command

#### 16.1.1.1. Definition

Every endpoint has to report his capabilities of sending and receiving messages after onboarding and when the capabilities change ( e.g. an application functionality is extended by a new module). This is required from agrirouter to know, if specific messages can be routed to an endpoint and to show the correct choosable Information Types in the User Interface for routing.
**Remark:**
agrirouter specific commands are not part of the Capabilities, each application just has to support all of them.

**Remark:**
For the certification process it is required to send the capabilities message multiple times. Therefore, it must either be sent on manual request (request must be performable by the test processing person) or on reconnection/restart of the application.

The list of technical message types can include any TechnicalMessageFormat mentioned in 17 Technical Message types.

#### 16.1.1.2. Command

| | |
|---|---|
| **Command** | dke:capabilities |
| **Protobuf Schema** | agrirouter.request.payload.endpoint.CapabilitySpecification |
| **TypeURL** | types.agrirouter/agrirouter.request.payload.endpoint.CapabilitySpecification |

Parameters are an Array of elements of the following:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | capabilities | Array of capabilities | The list of capabilities of this endpoint |
| **2** | app_certification_id | String | The application ID assigned by agrirouter |
| **3** | app_certification_version_id | String | The ID of the apps certification version |

The technical message type can be a technical message type of DKE or a proprietary message type.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | technical_message_type | String | The name of the capability |
| **2** | direction | Direction | The message direction, that is part of the capabilities |

Direction can be one of those values:

| Value | Direction |
|---|---|
| **0** | Send |
| **1** | Receive |
| **2** | Send & Receive |

Those are the values of an Enumeration, see protobuf files.

#### 16.1.1.3. Result

| | |
|---|---|
| **ResultCode** | ACK |
| **Protobuf Schema** | agrirouter.response.payload.endpoint.CapabilityResponse |

| typeURL | types.agrirouter/agrirouter.response.payload.endpoint.CapabilityResponse |
|---|---|

The result is a list of endpoints, each with a list of the capabilities, it can receive. Therefore, the capabilities messages can be used to get an overview of all endpoints available to send messages to.

CapabilityResponse.

| Position | Name | Type | Description |
|---|---|---|---|
| 1 | application_message_id | String | The ID assigned with the request |
| 2 | recipients | Recipient (repeated) | A list of endpoints and their capabilites |

Recipient is a subelement, describing an endpoint

| Position | Name | Type | Description |
|---|---|---|---|
| 1 | id | String | The ID of the endpoint (devicealternateID) |
| 2 | technical_message_type | String (repeated) | A list of capabilities, this endpoint supports |

#### 16.1.1.4. Errors

If the message was malformed, an ACK_WITH_FAILURE will be returned. If the same capabilities message is sent twice, an ACK_WiTH_MESSAGES will be returned with a message indicating, that the capabilities did not change.

#### 16.1.1.5. Example


```
{
    "capabilities": [
        {
            "technicalMessageType": "iso:11783:-10:device_description:protobuf",
            "direction": 0
        },
        {
            "technicalMessageType": "iso:11783:-10:time_log:protobuf",
            "direction": 0
        },
        {
            "technicalMessageType": "dke:other",
            "direction": 1
        },
        {
            "technicalMessageType": "img:jpeg",
            "direction": 1
        },
        {
            "technicalMessageType": "iso:11783:-10:taskdata:zip",
            "direction": 2
        }
    ],
    "appCertificationId": "a94764fc-6704-47c2-aa39-9ca2490e0eb8",
    "appCertificationVersionId": "6776445b-09a0-49f9-9df0-f17ebe73e595"
}
```


### 16.1.2. Subscribtion Command

#### 16.1.2.1. Definition

The subscription command is used to subscribe for a list of technical message types. Being subscribed for a technical message type means, that your endpoint will receive a message of such TMT, whenever any other endpoint sends such a TMT to "publish" and a routing between the sender and your applications endpoint is given.

**Remark**

- Subscriptions can be defined for a specific message type, not for a specific sender.
- Each new subscription list sent by an endpoint deletes old subscriptions
- ⇨ Always send all required subscribtions in one Command.
- Sending a new capabilities message will delete all subscriptions
- ⇨ Always send all capabilities in one capabilities message

**Remark**
An app instance has to remember its subscription list on it own, there is no way to request this list.

**Best Practice**
To avoid mismatches between publishing applications and applications only receiving addressed messages, it is adviced to subscribe for any technical message type and DDI, your application shall handle, if there are no specific reasons not to do so.

**Remark:**
For the certification process it is required to send the subscribtions message multiple times. Therefore, it must either be sent on manual request (request must be performable by the test processing person) or on reconnection/restart of the application.

The list of technical message types can include any TechnicalMessageFormat mentioned in 17 Technical Message types.

### 16.1.2.2. Command

| | |
|---|---|
| **Command** | dke:subscription |
| **Protobuf Schema** | agrirouter.request.payload.endpoint.Subscription |
| **TypeURL** | types.agrirouter/agrirouter.request.payload.endpoint.Subscription |

.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | technical_message_type | Subscribtion (Repeated) | A list of subscribtions |

It is an array, each entry is of type agrirouter.request.payload.endpoint.MessageTypeSubscriptionItem

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | technical_message_type | String | The technical message type |
| **2** | ddis | uint32(repeated) | A list of ddis, only relevant for the EFDI telemetry message type |
| **3** | position | bool | Shall the GPS position be delivered? Only relevant for EFDI telemetry message type |

The DDIs field is only required, if the subscription is used for a subscription of Telemetry values. Same applies to Position.

### 16.1.2.3. Result

| | |
|---|---|
| **ResultCode** | ACK |
| **Protobuf Schema** | None; Simply 0 bytes of answer |
| **typeURL** | "" |

In case of success, an Acknowledgement is received.
In case of failure, an Acknowledgement with Message or an Acknowledgement with Failure is received. In both cases, the protobuf format will be agrirouter.commons.messages. See 15.8.1 Messages.

#### 16.1.2.4. Errors

Errors will be reported using ACK_WITH_FAILURE. For a list of possible errors, see the error list.

#### 16.1.2.5. Example

```
{
    "technicalMessageTypes": [{
            "technicalMessageType": "iso:11783:-10:time_log:protobuf",
            "ddi": [17, 23, 24],
            "positions": false
        },
        {
            "technicalMessageType": "img:jpeg",
            "ddi": [],
            "positions": false
        }
    ]
}
```

### 16.1.3. Sending a teamset using device Descriptions

#### 16.1.3.1. Definition

The teamset describes a list of devices attached to the communication unit. The most common devices are agricultural machines connected to the CU as ISO11783-10 TaskControllers. For more information on ISO11783-10, please refer to https://aef-online.org

**Remark:**
For the certification process it is required to send the device description message multiple times. Therefore, it must either be sent on manual request (request must be performable by the test processing person) or on reconnection/restart of the application.

For the format, please refer to 0

iso:11783:-10:device_description:protobuf - Teamset/EFDI Device Description

~~iso:11783:-10:device_description:protobuf - Teamset/EFDI Device Description~~

## 16.2. Reading the feed

These commands are used to control the delivery of messages from the feed to the app instance through the outbox.

### 16.2.1. Paging

Due to the huge number of messages, that could be delivered with a single call for messages, it would be a bad idea, to deliver all those message headers in one big package. Therefore, a paging mechanism was introduced to split the whole list of messages or message headers. into several pages, each including a maximum number of messages or a maximum overall size of the Result.

All pages will be the result of one single GET Request, if all messages are delivered to the outbox, when the endpoint requests them. If not all messages have been delivered from feed to the outbox at this point in time, the endpoint will have to poll for the messages. In MQTT, all Pages are delivered one after each other.

**Remark**
If an app instance misses one package, it should first request the messages of the headers, it already received to shorten the list of headers delivered when requesting again. This only works for self containing message, it is critical, if the missed package includes parts of a chunked message.

### 16.2.2. Message Query and Filtering

Reading the messages, the message headers from the feed or deleting messages from the feed can be done using a message filter including the following parameters:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | message_ids | String(repeated) | A list of agrirouter message IDs |
| **2** | senders | String(repeated) | A list of message senders |
| **3** | validity_period | Validity Period | A time span, that the messages were sent in |

The validity Period has following parameters.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | sentFrom | Timestamp | Begin of the time span |
| **2** | sentTo | Timestamp | End of the time span |

A message with id, source and timestamp fits the filter, if

- (id is part of messageIDs or messageIDs is empty) AND
- (source is part of senders or senders is empty) AND
- (timestamp is within validity_period or validity_period is empty)

**Remark:**
Make sure, that you never request a validity period with a sentFrom older than 4 Weeks (28 days); agrirouter will return an error message instead of the header list for that. In case, you request a period within those 28 days and receive an error anyway, compare your local time with the agrirouter answer to avoid a time difference.

### 16.2.3. Call for Message Header List

#### 16.2.3.1. Definition

To receive the Message ids of all available messages or a specific filtered list of available message IDs, an App Instance can call for the message headers available in the feed to be delivered to the Outbox

#### 16.2.3.2. Command

| | |
|---|---|
| **Command** | dke:feed_header_query |
| **Protobuf Schema** | agrirouter.feed.request.MessageQuery |
| **TypeURL** | types.agrirouter/agrirouter.feed.request.MessageQuery |

See 16.2.2 Message Query and Filtering.

#### 16.2.3.3. Result

| | |
|---|---|
| **ResultCode** | ACK_FOR_FEED_HEADER_LIST |
| **Protobuf Schema** | agrirouter.feed.response.HeaderQueryResponse |
| **typeURL** | types.agrirouter/agrirouter.feed.response.HeaderQueryResponse |

The Result is a list of message headers (“envelopes”) without the message payload.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | queryMetrics | QueryMetrics | A summarize of the response |
| **2** | page | Page | The current page of the message |
| **3** | chunk_contexts | ChunkComponent (repeated) | A list of all chunk contexts |
| **4** | feed | Feed (repeated) | A message from the feed |

The Query metrics informs about several result parameters:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | total_messages_in_query | int32 | The total number of all messages headers in the response |
| **2** | max_count_restriction | int32 | The maximum count of messages per page |

The Paging information is included in the page parameter:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | number | int32 | The index of the current page |
| **2** | total | int32 | The total number of pages |

The chunk context is an Array of available chunk contexts within this messages. If there are multiple of them, this means, that there are multiple chunked messages to be realigned.
The chunk context is described in 13.2 Chunking big messages

The feed includes an array of message headers

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | sender | string | Endpoint ID of the sender |
| **2** | receiver | string | Endpoint ID of the receiver |
| **3** | header | Header (repeated) | An array of message headers |

**Remark:**
As a telemetry platform can receive messages for multipla Virtual CUs, the receiver field is used to determine the correct virtual CU.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | message_id | string | The message ID to request, delete or confirm the message |
| **2** | technical_message_type | string | The technical message type of the message |
| **3** | team_set_context_id | string | The teamset ID to assign the message to the correct context. |
| **4** | chunk_contextID | string | The chunk context corresponding to the chunk list |
| **5** | payload_size | int64 | The size of the payload |
| **6** | sent_timestamp | timestamp | The timestamp, that was provided by the sender. It should be the recording time point |

| | | | |
|---|---|---|---|
| **7** | sequence_number | int64 | The sequence number to determine the correct order for messages, that were recorded at the same time point |

**Remark:**
The result is sorted ascellading by the senderID.
Within the sender-reciever package, the messages are sorted primary by the timestamp and secondary by the sequence number.

The header is a list of Sender+Receiver-Touples with a sublist of message headers. This sublist is sorted by the timestamp and – if multiple messages with the same timestamp exist – the Message Sequence Number.

#### 16.2.3.4. Errors

If the message was incorrect, an ACK_WITH_FAILURE will be reported. For specific error messages, see the error list.
.

## 16.2.4. Call for specific messages

### 16.2.4.1. Definition

Every app Instance can request a single or a list of messages to be forwarded from the feed to the outbox by its message ids

### 16.2.4.2. Command

| | |
|---|---|
| **Command** | dke:feed_message_query |
| **Protobuf Schema** | agrirouter.feed.request.MessageQuery |
| **typeURL** | types.agrirouter/agrirouter.feed.request.MessageQuery |

See 16.2.2Message Query and Filtering.

### 16.2.4.3. Result

| | |
|---|---|
| **ResultCode** | ACK_FOR_FEED_MESSAGE |
| **Protobuf Schema** | types.agrirouter/agrirouter.feed.response.MessageQueryResponse |

The Result is a list of message headers (“envelopes”) without the message payload.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | queryMetrics | QueryMetrics | A summarize of the response |
| **2** | page | Page | The current page of the message |
| **3** | messages | FeedMessage (repeated) | A message from the feed |

The Query metrics informs about several result parameters:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | total_messages_in_query | int32 | The total number of all messages headers in the response |
| **2** | max_count_restriction | int32 | The maximum number of messages per page |

The Paging information is included in the page parameter:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | number | int32 | The index of the current page |
| **2** | total | int32 | The total number of pages |

The messages include an array of messages

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | header | Header | The header of the message |
| **2** | content | any | The payload in the corresponding protobuf format |

The header includes the whole envelope of a message

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | receiver_id | string | The receiver; might be a secondary endpoint like a virtual CU behind a telemetry platform |
| **2** | technical_message_type | string | The technical message type of the message |
| **3** | team_set_context_id | string | The teamset ID to assign the message to the correct context. |
| **4** | chunk_contextID | string | The chunk context corresponding to the chunk list |
| **5** | payload_size | int64 | The size of the payload |

| | | | |
|---|---|---|---|
| **6** | sent_timestamp | timestamp | The timestamp, that was provided by the sender. It should be the recording time point |
| **7** | sequence_number | int64 | The sequence number to determine the correct order for messages, that were recorded at the same time point |
| **8** | sender_id | string | The endpoint ID of the sender |
| **9** | created_at | Timestamp | The timestamp, when this message was added to the receiving endpoints feed |

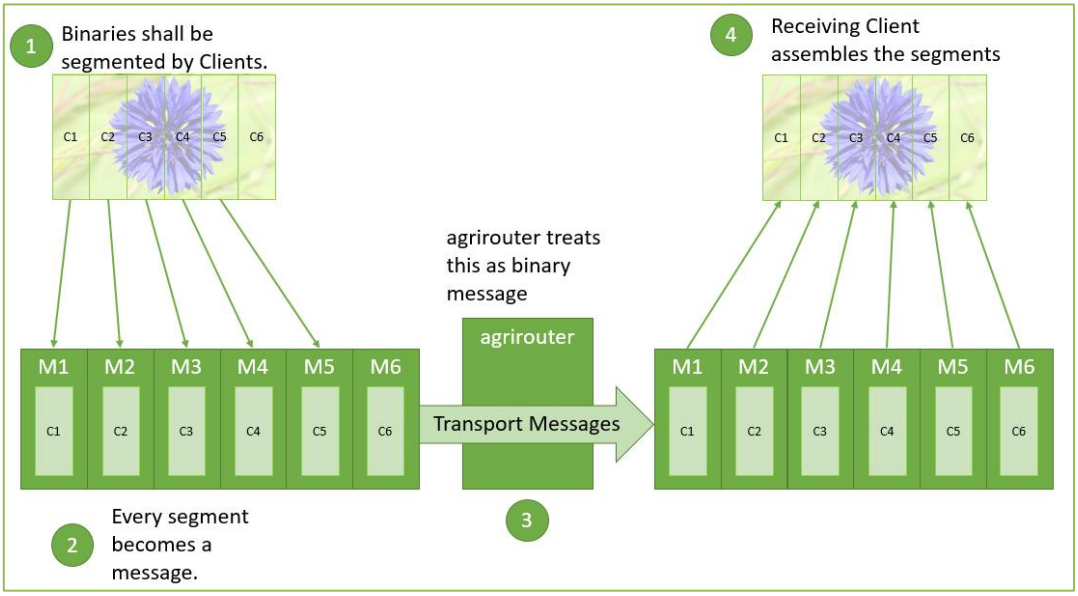
**Remark:**
The result is sorted ascending by the senderID.
Within the sender-reciever package, the messages are sorted primary by the timestamp and secondary by the sequence number.

#### 16.2.4.4. Errors

If the message was incorrect, an ACK_WITH_FAILURE will be reported. For specific error messages, see the error list.
.

#### 16.2.4.5. **Chunked messages**

Messages sent to the agrirouter can be split into multiple chunks, if the message format is not EFDI.




Only those message, that were not created by the agrirouter and that are not of type EFDI can be chunked.

##### *16.2.4.5.1. Recognizing chunked messages in the feed*

To recognize chunked messages, request the message header query and see, if you find different chunk contexts.

##### *16.2.4.5.2. Pulling chunked messages from the feed*

Chunked messages can be pulled like any other message type. make sure to request all chunks at once, so that you can make sure, that the message can be rebuild successfully before confirming chunks, which would delete them from the feed.

### 16.2.5. Call for message deletion

#### 16.2.5.1. Definition

An app instance can delete message from its feed, if it does not want to consume them. Therefore, it sends a list of message IDs or a validity period or a list of senders to the inbox.

#### 16.2.5.2. Command

| | |
|---|---|
| **Command** | dke:feed_delete |
| **Protobuf Schema** | agrirouter.feed.request.MessageQuery |
| **typeURL** | types.agrirouter/agrirouter.feed.request.MessageQuery |

See 16.2.2Message Query and Filtering.

#### 16.2.5.3. Result

| | |
|---|---|
| **ResultCode** | ACK |
| **Protobuf Schema** | None, simply 0 bytes |
| **typeURL** | “” |

#### 16.2.5.4. Errors

If the message was incorrect, an ACK_WITH_FAILURE will be reported. For specific error messages, see the error list.
.

## 16.3. Controlling the outbox

To make sure, that no message gets lost due to e.g. a loss of internet connection while delivering a message, the app instance has to confirm the receival of every message.

### 16.3.1. Call for message list confirmation

#### 16.3.1.1. Definition

Once a message was downloaded from the outbox, the Client has to confirm, that it properly received this message/those messages.

**Remark:**
As long as the receival of a message is not confirmed, it will be delivered again and again by agrirouter, whenever the client tries to download messages, it called for. When a message is confirmed, it will be deleted from the feed.

#### 16.3.1.2. Command

| | |
|---|---|
| **Command** | dke:feed_confirm |
| **Protobuf Schema** | agrirouter.feed.request.MessageConfirm |
| **typeURL** | types.agrirouter/agrirouter.feed.request.MessageConfirm |

MessageConfirm is simply an array of message IDs.

#### 16.3.1.3. Result

| | |
|---|---|
| **ResultCode** | ACK |
| **Protobuf Schema** | None, simply 0 bytes |
| **typeURL** | “” |

#### 16.3.1.4. Errors

If the message was incorrect, an ACK_WITH_FAILURE will be reported. For specific error messages, see the error list.
.

## 16.4. Read the eco system

To communicate with all the other endpoints in the eco system of the specific agrirouter account, it is required to read,

- which endpoints are available
- which TMT they can send
- which TMT they can receive
- which TMT they are subscribed for

### 16.4.1. Call for endpoints, that support a technical message type

#### 16.4.1.1. Definition

Every App Instance can call for a list of endpoints, that are capable of receiving or sending specific messages. This request does not filter for available routings.

#### 16.4.1.2. Command

| | |
|---|---|
| **Command** | dke:list_endpoints_unfiltered |
| **Protobuf Schema** | agrirouter.request.payload.account.ListEndpointsQuery |
| **typeURL** | types.agrirouter/agrirouter.request.payload.account.ListEndpointsQuery |

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | technical_message_type | String | The technical message type that should be part of the routing |
| **2** | direction | Direction | The direction, the routing shall support |

The direction describes, if messages shall be sendable or receivable:

| Nr | Direction |
|---|---|
| **0** | Send |
| **1** | Receive |
| **2** | Send and Receive |

#### 16.4.1.3. Result

| | |
|---|---|
| **ResultCode** | ENDPOINTS_LISTING |
| **Protobuf Schema** | agrirouter.response.payload.account.ListEndpointsResponse |
| **typeURL** | types.agrirouter/agrirouter.response.payload.account.ListEndpointsResponse |

The endpoint response includes a list of available endpoints:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | endpoint_id | String | The endpoint ID to address a message to |
| **2** | endpoint_name | String | The name of the endpoint as displayed in the agrirouter UI |
| **3** | endpoint_type | String | The type of Endpoint, see below |
| **4** | status | String | The current activity status of the endpoint |
| **5** | message_types | MessageTypes | See below |
| **6** | external_id | String | The id provided as “id” in the onboarding request |

The endpoint Type can be one of the following Values:

| Code | Description | Comment |
|---|---|---|
| **application** | Software Application | Software Application |

| | | |
|---|---|---|
| **foreignMachine** | External Machine | Machine shared by a paired agrirouter account |
| **machine** | Machine | Agricultural machine |
| **messageRecordingReplay** | Recording Player | Can replay recorded messages |
| **pairedAccount** | Paired Account | Repesents a paired Agri-Router account with which you can exchange messages |
| **endpointGroup** | Group | A group of other assets (applications, machines) with common rules |
| **virtualCU** | Telemetry Platform | Connection via Telemetry Platform |

The status can be one of the following values:

| |
|---|
| active |
| inactive |

The Message object describes technical message type and direction.

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | technical_message_type | String | The technical message type that should be part of the routing |
| **2** | direction | Direction | The direction, the routing shall support |

The direction describes, if messages shall be sendable or receivable:

| Nr | Direction |
|---|---|
| **0** | Send |
| **1** | Receive |
| **2** | Send and Receive |

**Remark:**
The endpoint requesting the endpoint list is also part of this answer.

**Remark:**
The concept of groups is only used to give a little more comfort to the end user when setting rules. It is currently not possible to address a message to the group.

#### 16.4.1.4. Errors

If the message was incorrect, an ACK_WITH_FAILURE will be reported. For specific error messages, see the error list.

## 16.4.2. Call for filtered list of endpoints, that support a specific message type

### 16.4.2.1. Definition

This request is used for request a list of endpoints, that support a technical message type and has corresponding routings to the requesting endpoint.

### 16.4.2.2. Command

| | |
|---|---|
| **Command** | dke:list_endpoints |
| **Protobuf Schema** | agrirouter.request.payload.account.ListEndpointsQuery |
| **typeURL** | types.agrirouter/agrirouter.request.payload.account.ListEndpointsQuery |

For further information, see 16.4.1.2Command

### 16.4.2.3. Result

| | |
|---|---|
| **ResultCode** | ENDPOINTS_LISTING |
| **Protobuf Schema** | agrirouter.response.payload.account.ListEndpointsResponse |
| **typeURL** | types.agrirouter/agrirouter.response.payload.account.ListEndpointsResponse |

For further information, see 16.4.1.3

### 16.4.2.4. Errors

If the message was incorrect, an ACK_WITH_FAILURE will be reported. For specific error messages, see the error list.

## 16.5. Commands for telemetry platforms

Telemetry platforms on- and offboard virtual CUs, this requires 2 commands.

**Remark**
If a telemetry platform does not provide any functionality of a farming software, those are the only 2 messages exchanged with the agrirouter by the Telemetry platform as any other communication will be done by the virtual CUs.

### 16.5.1. Onboarding a Virtual CU

#### 16.5.1.1. Definition

A telemetry platform can onboard its own CUs, which will show up in the agrirouter UI as own endpoints. These virtual CUs communicate

#### 16.5.1.2. Command

| | |
|---|---|
| **Command** | dke:cloud_onboard_endpoints |
| **Protobuf Schema** | agrirouter.cloud.registration.OnboardingRequest |
| **typeURL** | types.agrirouter/agrirouter.cloud.registration.OnboardingRequest |

The onboarding Request includes an Array of EndpointRegistrationDetails

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | id | String | The unique ID of the Virtual CU |
| **2** | Name | String | The name, that shall be displayed in the agrirouter UI |

For the ID, please respect the Naming convention in 4.2String Identifiers convention

#### 16.5.1.3. Result

| | |
|---|---|
| **ResultCode** | CLOUD_REGISTRATIONS |
| **Protobuf Schema** | agrirouter.cloud.registration.OnboardingResponse |

The Result is an Array of EndpointRegistrationDetails and Failure Notifications

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | onBoardedEndpoints | EndpointRegistrationDetails (Repeated) | The onboarding information for the endpoints |
| **2** | failures | Failures(Repeated) | A list of failed onboardings |

For all successfully registered Endpoints, following information will be delivered:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | id | String | The ID external ID provided with the onboarding Request as id |
| **2** | deviceAlternateID | String | The ID used to mark messages sent to agrirouter as coming from this Cloud account |
| **3** | sensorAlternateID | String | The ID used to mark messages sent to agrirouter as coming from this virtual CU |
| **4** | capabilityAlternateID | String | An internal value needed to be delivered with any message |
| **5** | endpointID | String | The endpointID to address this Virtual CU |

The **deviceAlternateId** is equalfor the telemetry platform and each of its virtual CUs. This means, that the messages for all virtual CUs are received through one feed and one outbox. The effected CU however is marked by its **sensorAlternateId**.

The **endpointId** is used to offboard a CU.

#### 16.5.1.4. Errors

Errors of a partly successful request are delivered with the Response.
If any of the onboarding Requests failed, failures includes a list of failed requests:

| Position | Name | Type | Description |
|---|---|---|---|
| **1** | id | String | The ID external ID provided with the onboarding Request as id |
| **2** | message | Message | The error message |

For the message format, refer to 15.8.1 Messages

### 16.5.2. Removing a Virtual Cu

#### 16.5.2.1. Definition

This command removes a virtual CU from the endpoint list of the users account.

**Attention**
Removing the endpoint leads to a dump of all data in the in- or outbox, subscription list and feed of this endpoint.
**Your customers data will be lost!**
Do not remove an endpoint, just because it is currently offline!

#### 16.5.2.2. Command

| | |
|---|---|
| **Command** | dke:cloud_offboard_endpoints |
| **Protobuf Schema** | agrirouter.cloud.registration.OffboardingRequest |
| **typeURL** | types.agrirouter/agrirouter.cloud.registration.OffboardingRequest |

#### 16.5.2.3. Result

| | |
|---|---|
| **ResultCode** | ACK |
| **Protobuf Schema** | None, simply 0 bytes |
| **typeURL** | „“ |

#### 16.5.2.4. Errors

See list of error codes.

# 17. Technical Message types

## 17.1. General

Technical message types are several standardized formats, that agrirouter apps should be capable of reading and creating. These technical message types are packaged into information types for the end user to make it easier for him to create the routings based on the type of data and not on the format of it.

The possible technical message types can be found in the agrirouter UI when creating a new application:

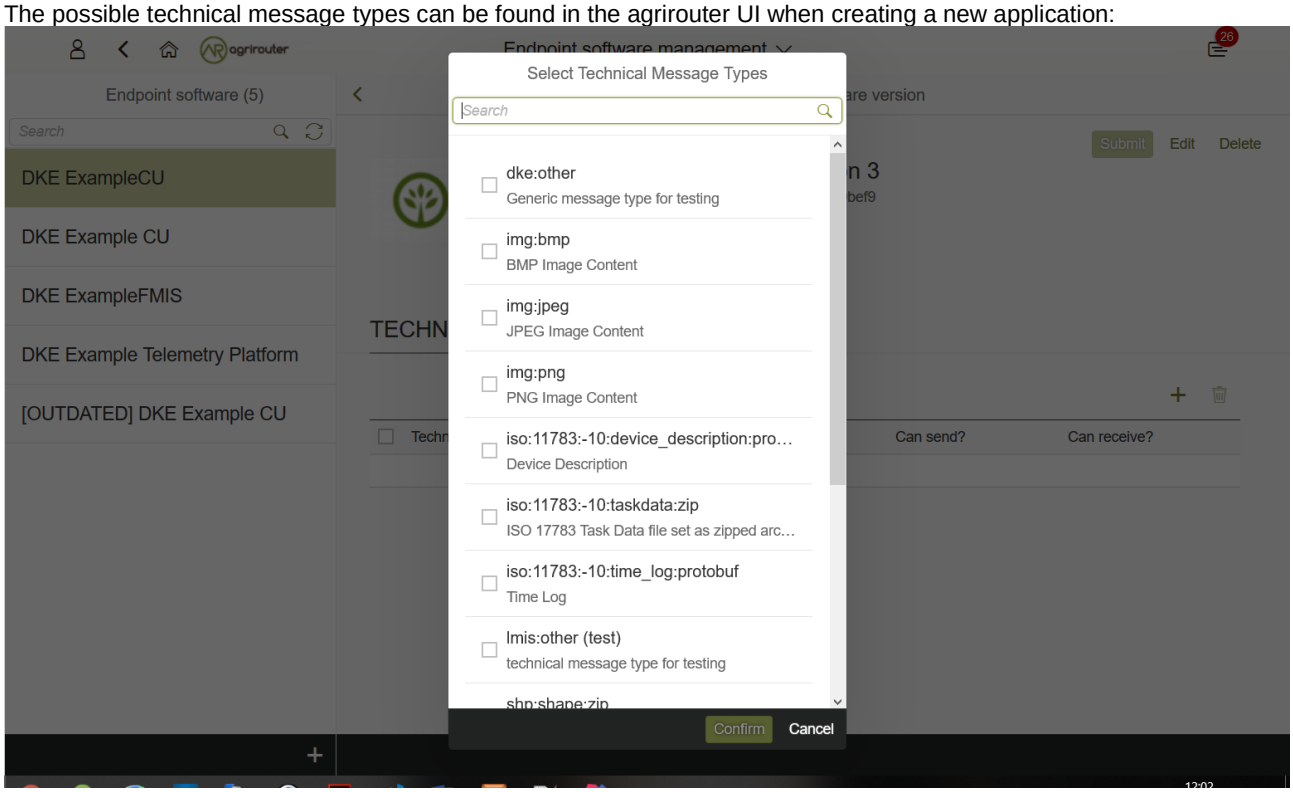



**Figure 39 Selecting Technical Message Types in the agrirouter UI**

It can be any of these formats:

| Technical Message Type | Information Type | Description |
|---|---|---|
| iso:11783:-10:taskdata:zip | TaskData | A zipfile including a TaskData Set |
| iso:11783:-10:device_description:protobuf | Telemetry | A set of device descriptions connected to a CU. Also called “TeamSet” |
| iso:11783:-10:time_log:protobuf | Telemetry | Life telemetry data based on the devicedescription |
| img:bmp | Image | A Bitmap File |
| img:jpeg | Image | A JPEG File |
| img:png | Image | A Portable Network Graphics File |
| shp:shape:zip | Shape | A zip file including a Shape dataset |
| vid:avi | Video | An AVI Video |
| vid:mp4 | Video | A MPEG4 Video |
| vid:wmv | Video | A wmv Video |

## 17.2. iso:11783:-10:device_description:protobuf - Teamset/EFDI Device Description

### 17.2.1. Definition

This format is used to report devices, that are attached to a CU to the agrirouter. These devices including the CU are known as a teamset, having their own teamsetID.

### 17.2.2. Command

| | |
|---|---|
| **Command** | iso:11783:-10:device_description:protobuf |
| **Protobuf Schema** | EFDI; available at AEF Repository |
| **TypeURL** | iso:11783:-10:device_description:protobuf |

The teamset message is part of EFDI and therefore currently not available here. It will be available by AEF.

### 17.2.3. Result

The result indicates, if the teamset could be forwarded to an addressed endpoint or – if it was published – if there was a subscribed endpoint, who received the message. If no endpoint received the message, there will be an ACK_WITH_FAILURE

**Remark:**

If a CU sends a teamset, applications are able to address messages directly to the devices. These messages are then delivered to the CU.

## 17.3. iso:11783:-10:time_log:protobuf - EFDI TimeLog

The EFDI timelog is comparable to IOSOXML Binary Log data. the format with all its parameters can be received from the AEF repository.

### 17.3.1. Command

| | |
|---|---|
| **Command** | iso:11783:-10:time_log:protobuf |
| **Protobuf Schema** | EFDI; available at AEF Repository |
| **TypeURL** | iso:11783:-10:time_log:protobuf |

## 17.4. iso:11783:-10:taskdata:zip - TaskData

### 17.4.1. Definition

This format is used to exchange a TaskData.zip Files. It can forward the binary Zip-File-Content, but currently no file name or other meta data.

### 17.4.2. Command

| | |
|---|---|
| **Command** | iso:11783:-10:taskdata:zip |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.4.3. Format

The zip file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

## 17.5. shp:shape:zip - Shape

### 17.5.1. Definition

This format is used to exchange application maps as a zip file.

### 17.5.2. Command

| | |
|---|---|
| **Command** | shp:shape:zip |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.5.3. Format

The zip file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

The zip file must at least include the following files:

- SHP: The main file including the geometry
- SHX: The index file indexing the geometry features
- DBF: The dBASE Table, including the attribute information of the features

## 17.6. img:bmp - Bitmap Image

### 17.6.1. Definition

This format is used to exchange a bitmap file. It can forward the binary bmp-Content, but currently no file name or other meta data.

### 17.6.2. Command

| | |
|---|---|
| **Command** | img:bmp |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.6.3. Format

The bmp file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

## 17.7. img:jpg – JPEG Image

### 17.7.1. Definition

This format is used to exchange a bitmap file. It can forward the binary jpeg-Content, but currently no file name or other meta data.

### 17.7.2. Command

| | |
|---|---|
| **Command** | img:jpg |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.7.3. Format

The bmp file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

## 17.8. img:png – PNG Image

### 17.8.1. Definition

This format is used to exchange a bitmap file. It can forward the binary png-Content, but currently no file name or other meta data.

### 17.8.2. Command

| | |
|---|---|
| **Command** | img:png |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.8.3. Format

The bmp file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

## 17.9. vid:avi – AVI Video Files

### 17.9.1. Definition

This format is used to exchange an avi video file. It can forward the binary avi-Content, but currently no file name or other meta data.

### 17.9.2. Command

| | |
|---|---|
| **Command** | vid:avi |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.9.3. Format

The bmp file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

## 17.10. vid:wmv – WMV Video Files

### 17.10.1. Definition

This format is used to exchange an wmv video file. It can forward the binary wmv-Content, but currently no file name or other meta data.

### 17.10.2. Command

| | |
|---|---|
| **Command** | vid:wmv |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.10.3. Format

The bmp file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

## 17.11. vid:mp4 – MPEG4 Video Files

### 17.11.1. Definition

This format is used to exchange an MPEG4 video file. It can forward the binary mp4-Content, but currently no file name or other meta data.

### 17.11.2. Command

| | |
|---|---|
| **Command** | vid:mp4 |
| **Protobuf Schema** | - |
| **TypeURL** | “” |

### 17.11.3. Format

The bmp file has to be formatted to a Base64-encoding of its binary data. It must be sent as a string.

# 18. Session workflow

## 18.1. General Overview

Every application instance communicates to the agrirouter in sessions. The first message can be sent after onboarding is done. It shall report the capabilities.

These capabilities must match those stated in the application version certification or a subset of them.
If the endpoint wants to 'listen' to certain messages, it must subscribe to the appropriate technical message types, so that published messages get routed to this endpoint. Messages however will only get routed, if there is a routing for that

Every request sent to the agrirouter inbox will be acknowledged by the agrirouter, indicating whether the request could be processed successfully, with warning or it could not be processed because of errors; in that case, an error code and an error message in English are returned. Communication Layers.

After that, the teamset is reported and a communication workflow can begin. The Workflow is as follows:

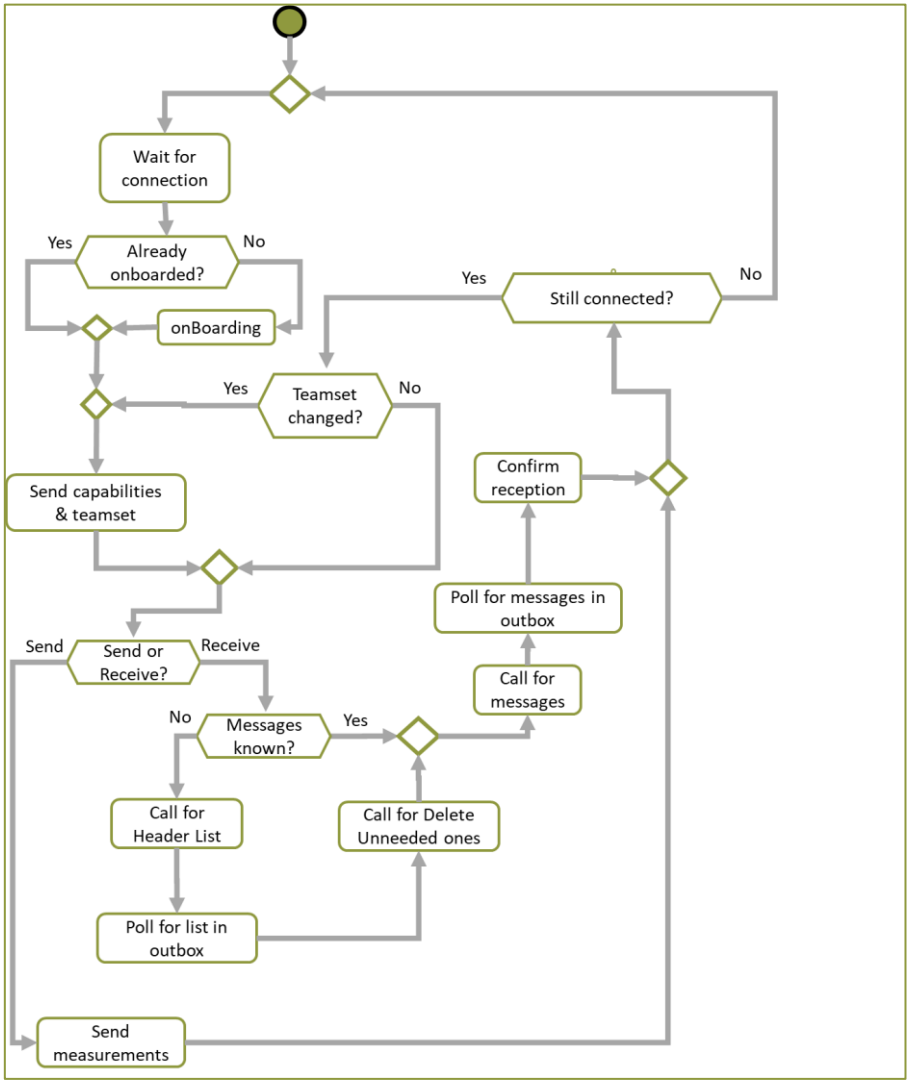



**Figure 40 General messaging workflow**

**Remark:**
The displayed workflow is just one possible solution. It is up to the app provider or his developer to find the most practical workflow of requesting, which messages are available and requesting or deleting those messages.

## 18.2. Request sending Frequency

agrirouter needs some time to process commands and forward messages, that are received through one of the endpoints. To avoid mixing up communication and reguesting the next message before receiving the result of the last command, the agrirouter support team advices, to have a minimum time lapse between sending of 2 requests to the agrirouter:

| Einvironment | Adviced time between 2 requests |
|---|---|
| **Quality assurance** | 10 s |
| **Production** | 5 s |

**Remark**
EFDI Log Telemetry messages can be collected over several seconds and than be sent in one request to the agrirouter.

# 19. IDs, IDs, IDs – Which is which?

## 19.1. Overview

The agrirouter api uses several IDs, which can be a little confusing. But don't worry, here is a short description, which ID is used for what:

| Name | Description |
|---|---|
| **accountId** | A UUID describing the account of an end user. In one account, there can be multiple endpoints. One account however has one set of login credentials for the agrirouter |
| **applicationId** | A UUID identifying an application regardless of the software version |
| **capabilityAlternateId** | This is an Id that is delivered with the onboarding Request and has to be delivered with any message |
| **certificationVersionId** | A UUID representing a Certification for one app. an app has to be certified every time, a new version with changed capabilities against agrirouter are implemented. |
| **deviceAlternateId** | The Id of the sender of a message |
| **endpointId** | The endpointId is the unique address of an Application Instance on the agrirouter. It's used to address the outbox and inbox and to directly address an endpoint from a different endpoint |
| **gatewayId** | This is a simple enumeration to determine the protocol type of the communication. It's either 2=MQTT or 3=REST |
| **sensorAlternateId** | The Id of the recorder or the final receiver of a message |

## 19.2. Ids in different Environments

It is important to keep in mind, that all Ids including applicationId or certificationVersionId might differ between QA and Productive environments.

## 19.3. Practical differentiation between SensorAlternateId and DeviceAlternateId

sensorAlternateID and deviceAlternateId seem to be pretty equal, but the context differs. Here are some practical examples

### 19.3.1. An App sends a TaskData

For apps, the solution is pretty easy:
**sensorAlternateId = deviceAlternateId =** The endpoint representing the users account within the app.

### 19.3.2. A CU sends a TaskData

Assume, a CU wants to send a taskdata.zip. Even though, it could include machine data - perhaps of multiple machines, the source of this taskdata is the CU. Therefore:

**sensorAlternateId = deviceAlternateId =** The CU

### 19.3.3. A telemetry Platform sends a TaskData from a virtual CU

The virtual CU as well as the telemetry platform are endpoints in the agrirouter. The platform wants to mark the virtual CU as source of the taskdataset.

**deviceAlternateId:** The telemetry platform is source of the message
**sensorAlternateId:** The virtual CU is source of the content of the message

## 19.4. accountId

### 19.4.1. Description

The Unique Identifier for an endusers or developers account. Relevant for billing.
A UUID describing the account of an end user. In one account, there can be multiple endpoints. One account however has one set of login credentials for the agrirouter UI.

### 19.4.2. Where to find

#### 19.4.2.1. As API/As Developer

The value is delivered with the authentication request. The value is also part of the billing metrics

#### 19.4.2.2. As End User

The value can be found in the agrirouter UI endpoint Information.

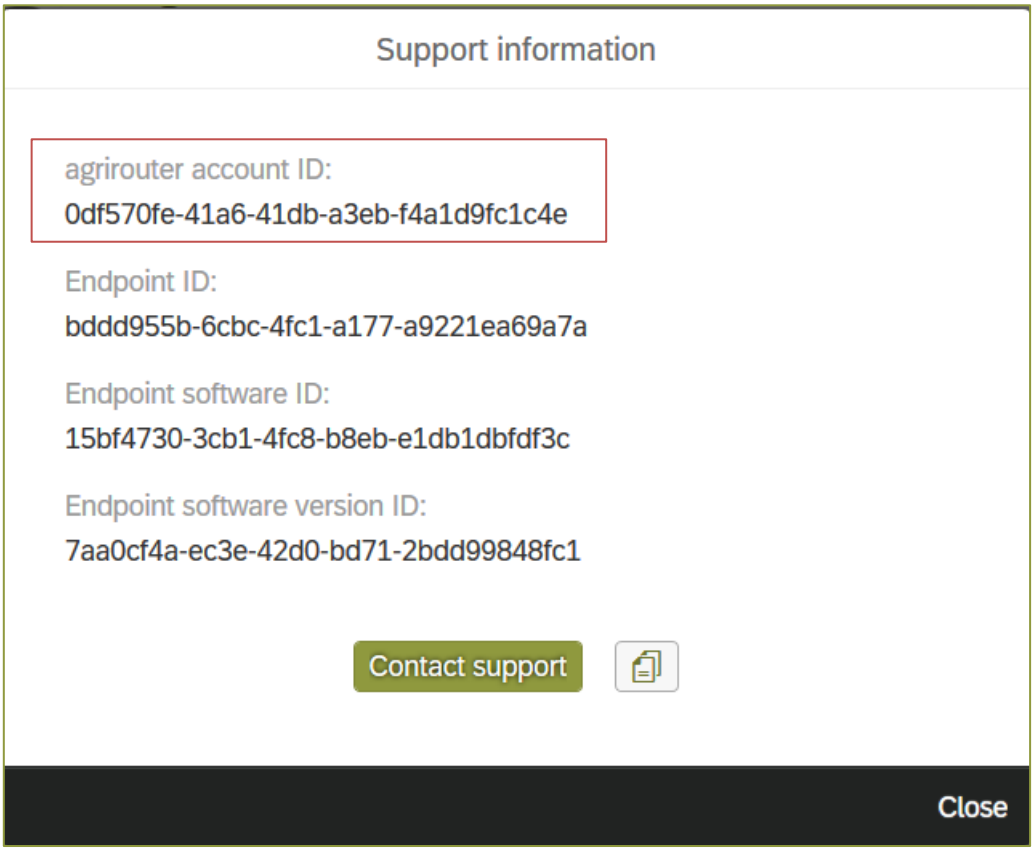



**Figure 41 agrirouter account ID**

## 19.5. applicationId

### 19.5.1. Description

A UUID identifying an application regardless of the software version.

### 19.5.2. Where to find

#### 19.5.2.1. As API

The value cannot be found by the api, it has to be entered by the developer.
The developer can find the ID in his developer account:

#### 19.5.2.2. As End User

The value can be found in the agrirouter UI endpoint Information

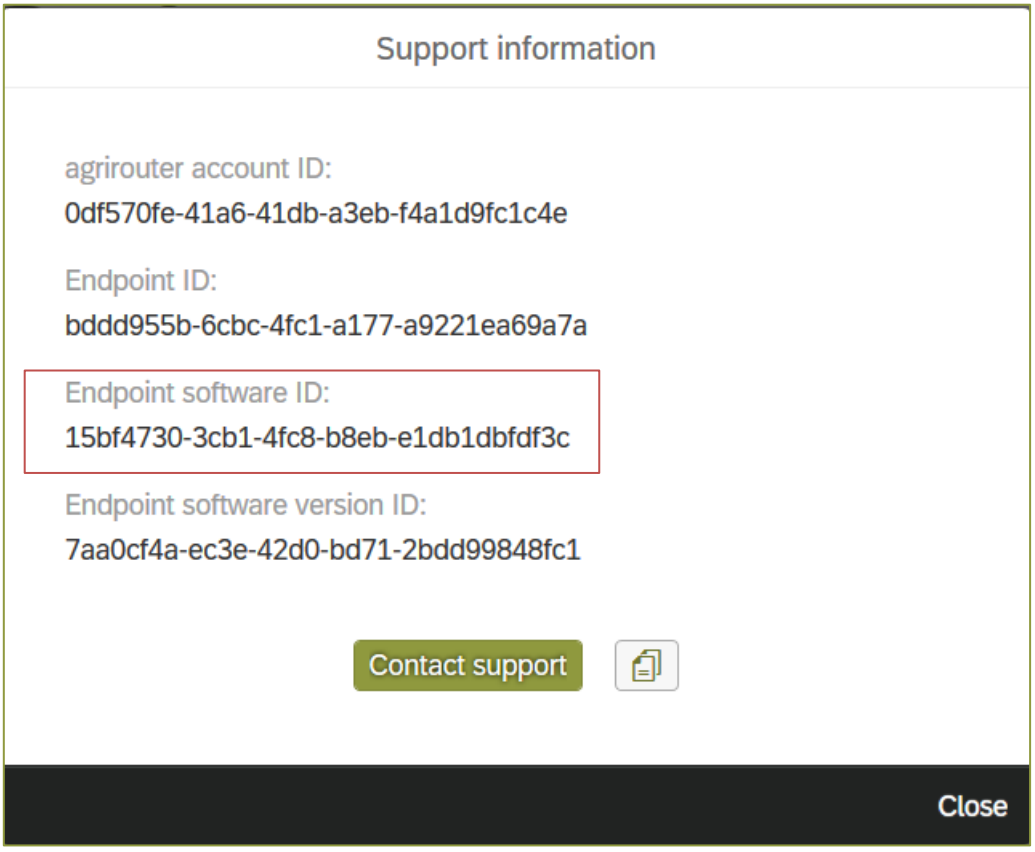



**Figure 42 agrirouter endpoint software ID**

## 19.6. capabilityAlternateId

### 19.6.1. Description

This is a value required by the IoT Gateway of the agrirouter. It has no further meaning for the endpoint or app instance and shall just be delivered with requests.

### 19.6.2. Where to find

#### 19.6.2.1. As API

The value is delivered with the onboarding request

#### 19.6.2.2. As End User

The value cannot be found by an end user and has no meaning for him.

## 19.7. certificationVersionId

### 19.7.1. Description

A UUID representing a certification for one app. an app has to be certified every time, a new version with changed capabilities against agrirouter are implemented.

### 19.7.2. Where to find

#### 19.7.2.1. As API

The value cannot be found by the API. It has to be entered by the developer.
The developer can find the certificationVersionID in his endpoint software overview:

#### 19.7.2.2. As End User

The value can be found in the agrirouter UI endpoint Information

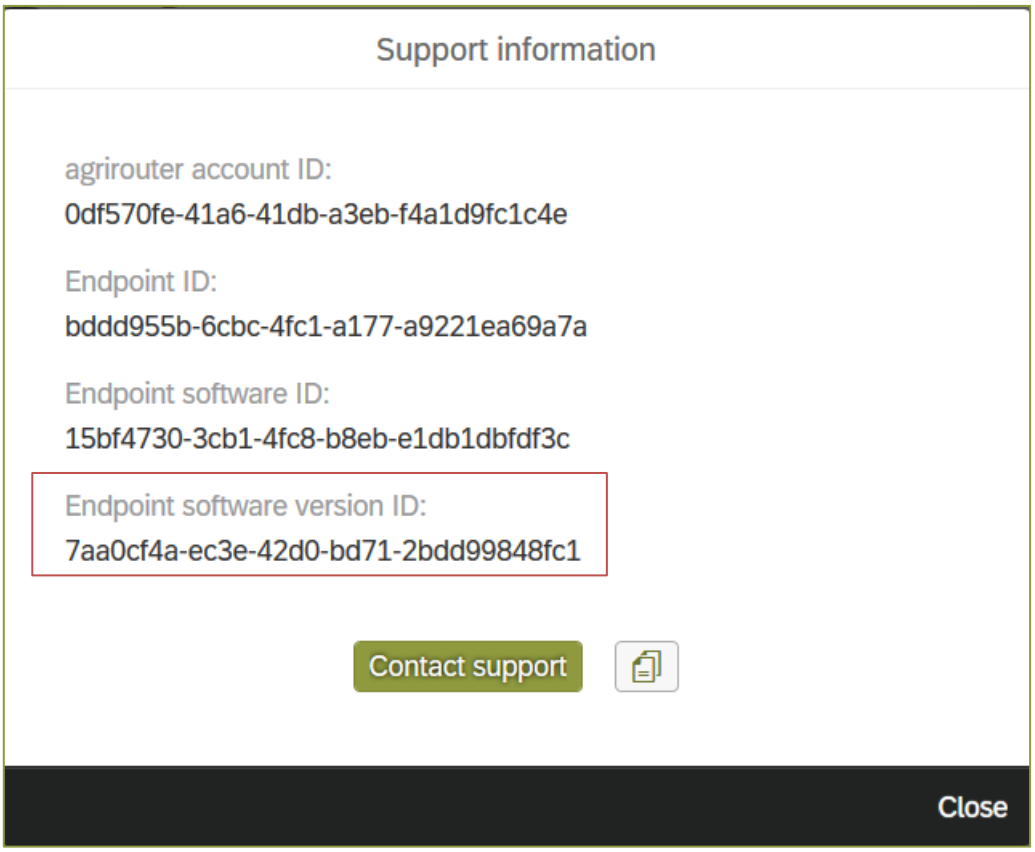



**Figure 43 agrirouter endpoint software version ID**

## 19.8. deviceAlternateId

### 19.8.1. Description

The deviceAlternateID represents the source of an agrirouter command, but not necessarily the source of the message itself. E.g. a telemetry platform would mark itself as deviceAlternateId and the virtual CU as source of message (content)

### 19.8.2. Where to find

#### 19.8.2.1. As API

The value is delivered with any agrirouter message. To create message, take the context relevant endpointId. Context is the command, e.g. an onboarding request.

#### 19.8.2.2. As End User

This ID cannot be found in the UI by the end user

## 19.9. endpointId

### 19.9.1. Description

The endpointID is the unique address of an Application Instance on the agrirouter. It's used to address the outbox and inbox and to directly address an endpoint from a different endpoint.
An endpoint can be an Application, a CU, a Virtual CU, a machine or a Telemetry platform.

### 19.9.2. Where to find

#### 19.9.2.1. As API

The value is delivered with the onboarding request.

#### 19.9.2.2. As End User

The value can be found in the agrirouter UI endpoint Information

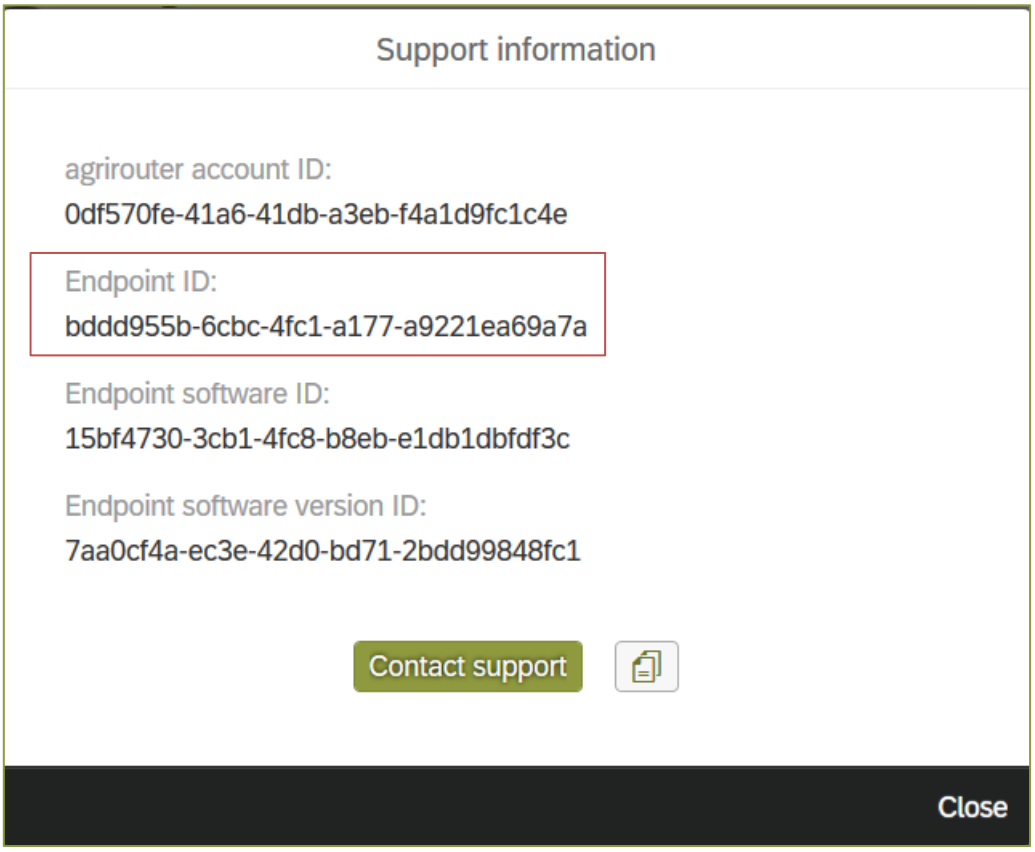



**Figure 44 agrirouter endpoint ID**

## 19.10. gatewayId

### 19.10.1. Description

The gatewayId is an enumeration to determine the used protocol for all communication after the onboarding:
2= MQTT
3=HTTP

### 19.10.2. Where to find

#### 19.10.2.1. As API

see above

#### 19.10.2.2. As End User

see above

## 19.11. sensorAlternateId

### 19.11.1. Description

The sensorAlternateID is an endpointID representing the parent telemetry platform for a Virtual CU.
It can be used to on- and offboard new virtual CUs.

### 19.11.2. Where to find

#### 19.11.2.1. As API

The value is delivered with any agrirouter message. To create message, take the context relevant endpointID. Context is the “source” of a message, e.g. a machine.

#### 19.11.2.2. As End User

The id is an endpointID and can be found like the endpoint Id

# 19.12. TeamsetContextId

## 19.12.1. Description

The TeamsetContextId is used to describe a unique combination of different machines and CUs attached to a CU or Virtual CU. It must be defined by the CU creating a URN:

```
urn:hash::algoritm:value
```

The agrirouter team advices to use a hashing algorithm of either md5 or sha256.

Examples (the key is the hash of “Hello World”):
MD5:

```
urn:hash::md5:b10a8db164e0754105b7a99be72e3fe5
```

Sha256:

```
urn:
hash::sha256:a591a6d40bf420404a011733cfb7b190d62c65bf0bcda32b57b277d9ad9f146e
```

## 19.12.2. Where to find

### 19.12.2.1. As API

The TeamsetContextId is sent in the envelope of every message. This information is forwarded through agrirouter so that it can be received by an app instance receiving this message.

### 19.12.2.2. As End User

An end user cannot see this value.

# 20. Certificates and keys

## 20.1. Definitions

Within this document, there are several public or private keys mentioned, that are relevant for the agrirouter. The following table shall giv e an overview of the different Keys/Certificates and their usage:

| Name | Describtion | Usage |
|---|---|---|
| **agrirouter public key** | A certificate to proofe the identity of the agrirouter. Only the public key is available to developers | Verify the signature in the authentication process |
| **Application Key Pair** | The key pair, that can be provided to or created by the agrirouter when creating a new software. | Create the signature for the onboarding Process |
| **Endpoint Certificate** | The certificate of an endpoint, used for the encrypted communication with the agrirouter | Standard communication in REST or MQTT; “Everything after onboarding” |

## 20.2. Agrirouter public keys

These are the public keys used by the agrirouter.

| Environment | Public Key |
|---|---|
| **EU1 QA** | -----BEGIN PUBLIC KEY-----<br>MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAy8xF9661acn+iS+QS+9Y<br>3HvTfUVcismzbuvxHgHA7YeoOUFxyj3lkaTnXm7hzQe4wDEDgwpJSGAzxIIYSUXe<br>8EsWLorg5O0tRexx5SP3+kj1i83DATBJCXP7k+bAF4u2FVJphC1m2BfLxelGLjzx<br>VAS/v6+EwvYaT1AI9FFqW/a2o92IsVPOh9oM9eds3lBOAbH/8XrmVIeHofw+XbTH<br>1/7MLD6IE2+HbEeY0F96nioXArdQWXcjUQsTch+p0p9eqh23Ak4ef5oGcZhNd4yp<br>Y8M6ppvIMiXkgWSPJevCJjhxRJRmndY+ajYGx7CLePx7wNvxXWtkng3yh+7WiZ/Y<br>qwIDAQAB<br>-----END PUBLIC KEY----- |
| **EU1 Production** | -----BEGIN PUBLIC KEY-----<br>MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAwCxD31sYtzH9NTfZ6n8H<br>+H/QgOaoTL9GAakplAsdwYSLjBpgYMZOHIgkdM9ksRP8WsITChtZtxrCnBjR8bap<br>ekPT/pM9zPZlNEPxUlylJNwwTWjzTJP03+Yr07Q8v8fTJ5VWzAHlHtGQ/sI7yXA8<br>pzruTNre1MzxO3lkljt2Q2e7CVXAp1b53BghgysppL9Bl7NK1R+vdWSs0B1Db/Gj<br>alOkWUnhivTjRMX61RGDCQSVSEaX12EvJX7FooAsW3NFeZCgeZGWEa5ZMALIiBL4<br>GNASOOHju7ewlYjkyGIRxxAoc3C0w5dg1qlLiAFWToYwgDOcUpLRjU/7bzGiGvp8<br>RwIDAQAB<br>-----END PUBLIC KEY----- |

## 20.3. Application keys

The keys of the application can be found at the endpoint software overview when selecting an application and clicking on edit.

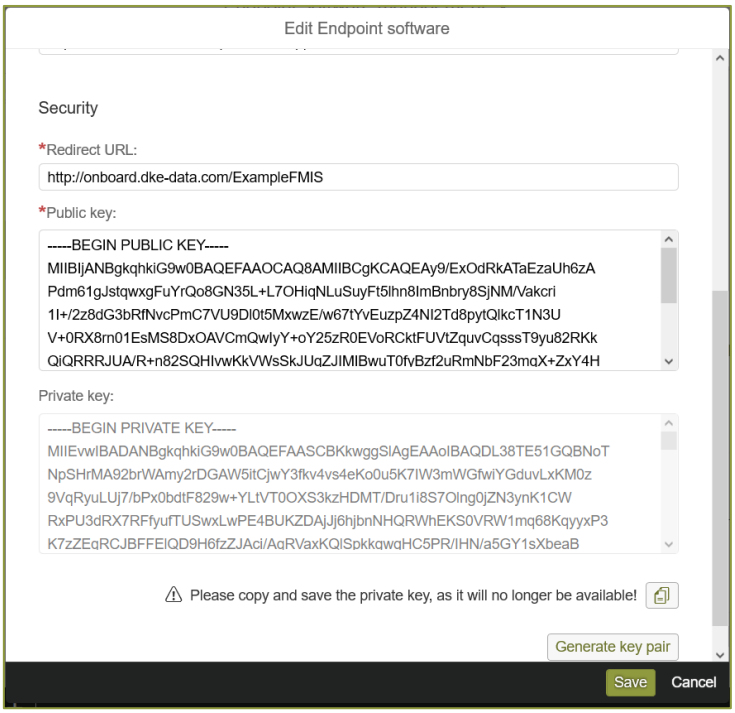



**Figure 45 Private and public key of an application in agrirouter**

Only the public key will be stored in the agrirouter, the private key has to be stored by your app in a secure way.

## 20.4. Endpoint certificate

The endpoint certificate is used to encrypt the communication with the agrirouter. It is delivered with the onboarding request.


```
{
    "deviceAlternateId": "6f1d952b-538e-4269-94b7-02bf51e83413",
    "capabilityAlternateId": "81ce3fd5-2f70-4270-ad15-1689ab6971bf",
    "sensorAlternateId": "aed40673-8e32-4f10-8cc8-3db2b58ed1bd",
    "connectionCriteria": {
        "gatewayId": "3",
        "measures": "https://dke-
qa.eu1.cp.iot.sap/iot/gateway/rest/measures/6f1d952b-538e-4269-94b7-
02bf51e83413",
        "commands": "https://dke-
qa.eu1.cp.iot.sap/iot/gateway/rest/commands/6f1d952b-538e-4269-94b7-
02bf51e83413"
    },
    "authentication": {
        "type": "PEM",
        "secret": "yY2uU1vV8aA1yY8uU1vV1cC",
        "certificate": "-----BEGIN ENCRYPTED PRIVATE KEY-----
\nMIIE6zAdBgoqhkiG9w0BDA\nVD8E3qSEsvWS1Z93XPji\n-----END ENCRYPTED PRIVATE
KEY-----\n-----BEGIN CERTIFICATE-----
\nMIIEPzCCAyegAwIBAgIOAIjM.....sV4DpbNKJlHut6OOOkzGCI+gsE=\n-----END
CERTIFICATE-----\n"
    }
}
```

# 21. Usage Metrics

agrirouter collects and measures all information (event types) regarding data exchange in real time.
For each message transported through agrirouter, it includes the following parameters:

| column | type | Comment |
|---|---|---|
| **id** | UUID | The ID of the message |
| **dh_message_id** | UUID | The agrirouter internal ID of this message |
| **account_id** | UUID | The agrirouter account id, in which this message was sent |
| **endpoint_id** | UUID | The endpoint ID of the endpoint, for which the event happened |
| **tech_msg_type_id** | String | The technical message type of this message |
| **event_type** | Enum | The current status of the message; see below |
| **volume** | Integer | The total volume of the encoded message |
| **buffer_duration** | Integater | How long did the message persist in the feed, until it was delivered or deleted |
| **month** | Integer | |
| **day** | Integer | |
| **hour** | Integer | |
| **year** | Integer | |
| **created_on** | TimeStamp | When was this message delivered to the feed? |

The event type is one of the following:

| Event | Description |
|---|---|
| **SENT** | Message was sent by specified endpoint |
| **ERROR** | Message was returned because of an error (e. g. missing team context ID) |
| **DELIVERED** | Message was delivered to specified endpoint (but not yet confirmed) |
| **CONFIRMED** | Message was confirmed by specified endpoint |
| **DELETED** | Message was deleted by specified endpoint |
| **OFFBOARDED** | Message was deleted, because the specified endpoint was deleted / offboarded |
| **TIMEOUT** | Message was deleted because of a timeout (4 weeks rule) |

Sent and Error mark events of the inbox, all the other events are events of feed or outbox.

The aggregated result will have the following structure:

| column | type | Comment |
|---|---|---|
| **app_provider_id** | uuid | derived from the endpoint ID |
| **app_id** | uuid | derived from endpoint ID; this is the field over which the aggregate will be calculated |
| **account_id** | uuid | taken directly from raw data |
| **endpoint_id** | uuid | taken directly from raw data |
| **event_type** | character varying(15) | taken directly from raw data; second field over which the aggregate will be calculated |
| **total_messages** | integer | number of messages in aggregate |

| | | |
|---|---|---|
| **total_volume** | integer | total data volume in aggregate |
| **average_duration** | integer | average buffer time of aggregate |
| **month** | integer | |
| **day** | integer | third key field over which the aggregate will be calculated |
| **hour** | integer | |
| **year** | integer | |
| **created_on** | timestamp with time zone | |

In any agrirouter developer account (account management -> export metrics), these usage statistics can be exported for your applications.

Currently, all messages delivered to an endpoints feed are relevant for billing; unimportant, if those were delivered or deleted. This might change in the future, all relevant information to change the billing mechanism are collected.
As changing the billing mechanism will impact app providers costs, this would be communicated and discussed in advance.

# 22. General Certification process

## 22.1. General

Every Application needs to be certified to be onboardable to the agrirouter. The certification makes sure, that the communication protocol of the agrirouter was successfully implemented and the application is able to communicate with the agrirouter.
A certification is needed any time, the app changes its capabilities.

## 22.2. Out of focus

The certification will not check, if an application “understands” the data sent over agrirouter, it will only check, if the application can send and receive data marked as such Technical message types, that were selected in the Certification Version.

## 22.3. Certification institutes

DKE and the agrirouter support team will release a list of certified partners, that are able and allowed to do the certification process. Please refer to https://my-agrirouter.com/support/

## 22.4. Tests

### 22.4.1. For Farming Software and Telemetry platforms

The test for farming software and telemetry platforms will check the following workflows:

- onboarding of a Farming Software or Telemetry Platform
- sending messages
- receiving messages

### 22.4.2. For Communication Units

The test for communication units will check the following workflows:

- Onboarding
- Capabilities
- Receive data
  - Respecting capabilities
- Send data
  - Respecting capabilities
- Reconnection: If a CU looses its connection t the agrirouter, it will be tested, that the communication will be reestablished, once the connection to the agrirouter is reestablished.

# 23. Annex A (Glossary)

| # | Concept | Description |
|---|---|---|
| 1. | Application | In the agrirouter context, an application is a product which can connect to the agrirouter. The applications are not running on the agrirouter, but they connect to the agrirouter over the network. |
| 2. | Application Instance | An application instance is the communication partner for an endpoint in an agrirouter account. An application instance represents a single software product or user account in a cloud software. |
| 3. | Communication Unit (CU) | An application acts as a communication unit when<br>• Its main purpose is to provide data collected by sensor systems like GPS or machine sensors<br>• It manages the agrirouter communication for these machines. It sends machine data to agrirouter, and receives and processes messages addressed to machines |
| 4. | agrirouter Account | An agrirouter account is a logical space on the agrirouter, that is used by one person or company. (e.g. a farm or contractor) |
| 5. | agrirouter Message Format | An agrirouter command consist of a agrirouter command header (also called envelope) and the content (sometimes also called payload). The header contains fields such as the sender ID, the list of recipients, and the technical message type. |
| 6. | agrirouter routings | agrirouter users can maintain routings to specify what data may go from which sender/source to which recipient. Without a corresponding routing, no data is transferred. |
| 7. | Capabilities | Capabilities are a list of technical message types, an app instance supports to send or receive |
| 8. | Command | A command is sent to the agrirouter from any endpoint. It consists of a header and an agrirouter control message (e.g. a teamset Message). The most common type of command includes a message of a specific message type, that shall be forwarded to one or more endpoints |
| 9. | Directly Connected Endpoints | A directly connected endpoint is any application, that communicates with its own endpoint at the agrirouter. |
| 10. | EFDI | EFDI (Extended FMIS Data Interchange) is the working title of an upcoming standard of the Agricultural Industry Electronics Foundation (AEF).<br><br>It defines message formats for network communication between machines and FMIS as well as between different FMIS, including the transfer of live telemetry data from machines.<br><br>The information that are transferred is based on ISOBUS concepts. It uses, for example, ISOBUS DDIs, and even the message structures are based on ISOXML elements. As the technical serialization format, EFDI does not use XML, but Google protocol buffers.<br><br>The agrirouter uses EFDI messages as the payload format for some message types, for example for live telemetry data and device descriptions.<br><br>At the time of this writing, EFDI is still in an early stage. The working group is just finalizing the internal definition of the first message types (live telemetry data, device descriptions). |
| 11. | Endpoint | In the agrirouter context, an endpoint is an addressable entity in an agrirouter account, which is the communication entry point for a single app instance or machine. |
| 12. | Endpoint Descriptions | The endpoint description contains detail information about an endpoint. Important part of this information is the list of the technical message types, the endpoint supports. |
| 13. | Farm Management Information System (FMIS) | An application providing farm management functionality. An FMIS may, for example receive data from machines, send settings and tasks to machines, and exchange data with other applications. |
| 14. | Information Type | A summarize of different Technical message types |

| | | |
|---|---|---|
| 15. | ISOBUS, ISO 11783, taskdata | Wikipedia: “ISO 11783, known as Tractors and machinery for agriculture and forestry -- Serial control and communications data network (commonly referred to as "ISO Bus" or "ISOBUS") is a communication protocol for the agriculture industry based on the SAE J1939 protocol (which includes CANbus) .” (source: https://en.wikipedia.org/wiki/ISO_11783 )<br><br>ISO 11783-10 describes the file-based and batch-oriented interchange format between machines and FMIS, using XML (ISOMXL) and binaries with XML header data. This is called a taskdata file set, even though it can contain many other data (fields, products, crop, worker, and many more) and need not even contain a task.<br><br>The ISOBUS standard specifies only the data but not how it is transferred between machines and FMIS. |
| 16. | ISOBUS DDI | A DDI (literally: Data Dictionary Identifier) represents a device or process parameter in the ISOBUS norm. Over 500 DDIs are defined in ISO 11783-11, see http://dictionary.isobus.net/isobus/ .<br><br>DDIs are used, for example, in device descriptions to describe properties, the supported settings, and the provided data of a machine.<br><br>DDIs are also used to identify the data records in telemetry messages.<br><br>agrirouter users can filter telemetry data for DDI Categories, that abstract all DDIs into 10 categories. A list of DDIs and their Category assignment can be found here:<br><br>A filtering for specific DDIs could not be provided, as this would have been too complex for the end user. |
| 17. | Live Telemetry Messages | A live telemetry message contains data points with data from the machines in one teamset. Each data point at least contains the time when it was logged. Additionally, each data point can have a geo-position. Each data point may contain many log entries. Each log entry contains the value of a specific parameter (DDI) of a specific component or function (device element) of one of the machines in the teamset.<br><br>The user-defined agrirouter routings define which parameters of which machine may go to which recipient. In addition, recipients can subscribe for certain parameters they want to get (sender-independent). Recipients will receive those data, when they are sent to the public address.<br><br>The agrirouter uses the routings and the subscriptions to determine the recipients, and the information each of them gets. To each recipient it delivers a filtered version of the messages, which contains only the allowed and subscribed parameters of the allowed machines. |
| 18. | Machines | Machines are agricultural machinery, in the sense of a ISO11783 device.<br><br>Machines are tractors, implements such as sprayers, or self-propelled machines like combine harvesters. A machine is described with machine description, which is conceptually based on ISO11783-10 device description.<br><br>Machines are the sources of the data records in live telemetry messages which applications send via agrirouter.<br><br>From an abstract view, machines are just sensor networks providing sensor data. |

| | | |
|---|---|---|
| 19. | Machine Endpoint | A machine endpoint represents one real-world machine in the context of an agrirouter account. The same real-world machine can have endpoints in several agrirouter accounts, but not more than one in the same account.<br><br>A message can be addressed to a machine as the recipient. This tells the agrirouter to deliver the message to that CU, to which the machine is connected. If the addressed machine is currently not connected, the agrirouter puts the message in the machine's feed and delivers it as soon as some CU reports that the machine is now connected. Since machines can be attached to different CUs at different times (connected to different tractor, for example), it is not known in advance which CU that will be.<br>The message itself will be received and processed by the CU, but addressing it to the machine makes sure that it goes to the right one. |
| 20. | Message | A message is an information or perhaps a request, that is sent from an endpoint to any other endpoint. A message is a possible payload of a command |
| 21. | teamset | A teamset is a set of connected machines which work and move together and are connected to the same communication unit |
| 22. | Virtual Communication Units | A virtual communication unit is the equivalent of a communication unit for situations where the teamsets are not directly connected to the agrirouter. Instead they are connected to an external telemetry-enabled cloud service, which itself is connected to the agrirouter. Such a telemetry-enabled cloud application has its own mechanisms for connecting farming machines.<br><br>For each farm, many machines are connected to the external cloud service, grouped in many teamsets. The cloud application, which makes these machines known on the agrirouter, also reports one virtual communication unit for each teamset. |

# 24. Annex B (Shortings)

As agrirouter uses multiple, sometimes quite long special terms, these terms are shortened in some of the graphics. Following a list of shorting's and the corresponding full term

| Shorting | Full Term |
|---|---|
| [] | Shorting for a list |
| … | additional steps; not shown here |
| App | Application |
| ar | agrirouter |
| CAP | Capabilities |
| CU | Communication Unit |
| DDI | Data Dictionary Identifier; see ISOBUS DDI |
| DVC | Device Description/ Device |
| EP | Endpoint |
| IT | Information Type |
| MSG | Message |
| TMT | Technical Message Type |
| VCU | Virtual CU; Virtual Communication Unit |

# 25. Annex C (Message Codes and Handling)

The error and message codes are delivered in the github repository, see https://github.com/DKE-Data/agrirouter-interface-documentation/blob/develop//docs/SystemMessageCodes.adoc .