System Requirements Specification

for

DinBox RTU Q7

Secondary Smart Cabine Energy Measurement

Version 0.1

Revision History

Date	Name	Ver	Reason for change
15/01/2018	Markian Yskout	0.1	Initial version
20/02/2018	Filip Lavaerts	0.1	Initial version

1 Introduction

1.1 List of Abbreviations

ASW	Application Software
BSW	Bootloader Software
BL	Bootloader
DRQ7	DinBox RTU Q7
DMSW	DRQ7 Management Software
DSO	Distribution System Operator
ESW	Embedded Software
IEC104	Standard IEC60870-5-104
IoT	Internet of Things
OOB	Out of box
OS	Operating System

1.2 Applicable Documents

AD1	DRQ7 Software Design Description
AD2	MQTT Specification - http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.html
AD3	IPv4 RFC - https://tools.ietf.org/html/rfc791
AD4	IPv6 RFC - https://tools.ietf.org/html/rfc8200

1.3 Scope

This document describes the system requirements for the Bausch **DinBox RTU Q7** or DRQ7. This RTU is the successor of the existing **DinBox RTU SL** and **DinBox RTU M4**.
The software components of the DRQ7, as well as the supporting ‘DRQ7 Management Software’ (DMSW) are described in this specification.
The DRQ7 and DMSW are new products representing the next step in the evolution of the Bausch Datacom RTU product line. They are intended to make part of the DSO network and aim at provide a flexible and highly integrated product.

This document provides an overview of the system's technical properties intended for development & maintenance engineers, customers, and project managers.

2 Overall Description

2.1 Product Perspective

The preceding **DinBox RTU**s which are deployed as IP endpoints provide their telemetry data over IP via integrated metering circuits or via third party devices attached by a serial connection (RS232, RS485). The **DinBox RTU Q7** extends this functionality with IP forwarding/routing capabilities, and therefore can serve as a gateway for third party devices which can be attached through different I/O interfaces (DI, DO, RS-232, RS-485 and 2x Ethernet).

The DRQ7 comprises the embedded system containing the application SW including e.g. communication protocols, libraries, and lifecycle management logic as well as its bootloader and tools for development, debugging and deployment. The following functions are performed by the DRQ7:

- Collect and forward data from integrated periphery (DI, PT100 input, serial, …)
- Serve as an IP gateway (WAN/LAN, LAN/LAN, …)
- Encapsulate data from serial interfaces (RS-232, RS-485, …)

The DMSW is the system which is intended to live in the DSO's home network and is responsible for the following functions which are interfaced with and the DRQ7 itself in the field:

- Monitoring
- Configuring
- Managing the lifecycle

2.2 Software Components

The relevant software components for the DRQ7 are:

- Embedded Software, including OS and application
- Bootloader
- Flasher tool
- Production tool

For the DMSW these are:

- Device Management Endpoint
- Device Management Database
- Device Management Front-end

The following software components are not in scope of this document and are listed here for clarity:

- Telemetry back-end, i.e. SCADA system
- PQ database <TBD>
- Advanced Device Management front-end, i.e. mobile/web app

2.3 Operating Environment

2.3.1 Environment

The DRQ7 shall be deployed dispersed over the operating area of the DSO, whereas the DMSW shall operate in a central location. The DRQ7 shall communicate with the DSO network by using GSM WAN (for example LTE Cat-M1 with 2G GPRS fall back) connectivity and shall be designed to be permanently connected. The typical use case of the DRQ7 is to serve as an IEC104 slave in a SCADA system, where the SCADA server initiates a TCP connection to the RTU. Figure 1 depicts a conceptual overview of the DRQ7 operating environment, of which the individual components will be described further in this document.

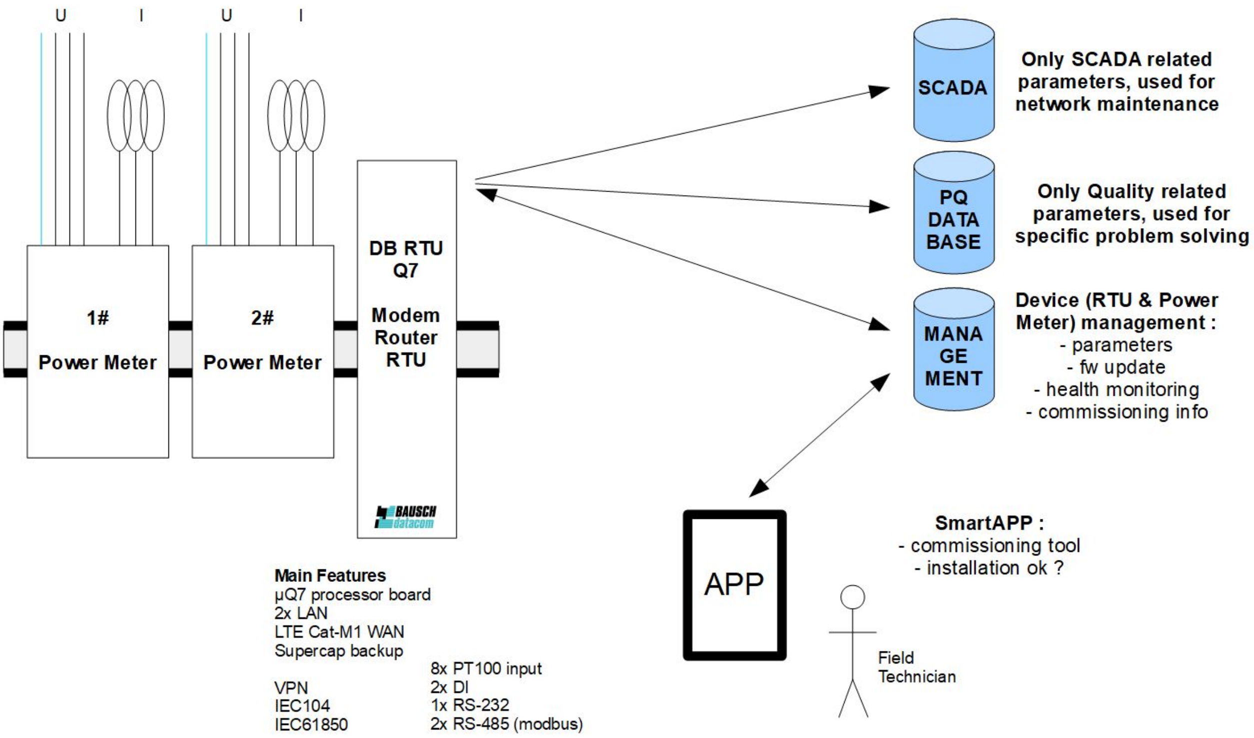


Figure 1: Conceptual illustration of the operating environment

2.3.2 Hardware & System Software

The DRQ7 shall operate stand-alone in the field and run on hardware as described in Appendix 1, and shall leverage on open source software combined with custom designed system & application software.

The DMSW shall run on standard commercially available x86-64 server hardware with TBD (depending on the specific deployment) minimum requirements and a recent Linux distribution as operating system, and shall make use of open source software components with custom application software.

2.3.3 Device Commissioning Flow

The remote devices commissioning flow describes the process which is intended to minimize manual intervention as much as possible during deployment of new field equipment. The main goal of the commissioning is provisioning the newly deployed devices with their predetermined configuration and in addition the metadata provided by the field technician who installs the product. To achieve this the prerequisites are the following.

- The inventory stock database of the deployable devices is available
- Each device carries an identifiable token (e.g. bar/QR code, serial #)
- Each device is capable of connecting to the (private) WAN in OOB mode
- The device is pre-configured OOB so that it connects to a specified server
- The field technician has the means to input metadata (e.g. geolocation, calibration parameters) to a centralized server (e.g. direct access via network or indirect file transfer).

There are 2 important roles in the commissioning process for new RTU deployment, as illustrated in figure 2, which are:

- The commissioning engineer who prepares the configuration to be provisioned to the newly deployed device, e.g. by managing and linking an inventory database.
- The field technician who deploys the RTU and identifies it in the system and attaches the relevant metadata to it.

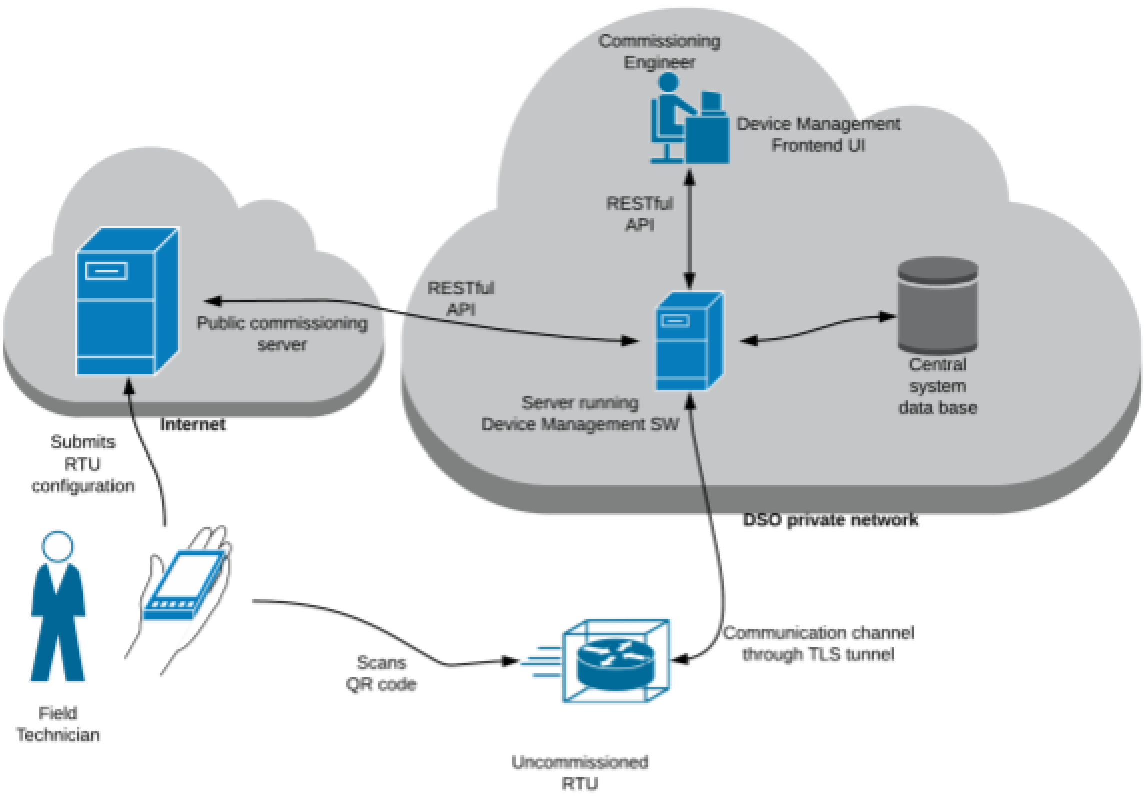


Figure 2: Commissioning Flow depicted in a scenario where the field technician uses the public WAN

In terms of chronological order, these are the steps performed in the process:

1. The commissioning engineer feeds the device management database with the inventory of RTUs ready for deployment.
2. The field technician installs the RTU at its designated location in the field
3. The RTU connects to the DSO's private network
4. The field technician identifies the deployed RTU in the commissioning tool (i.e. mobile app, web app) by scanning the attached barcode.
5. The field technician provides the relevant metadata in the commissioning tool.
6. The commissioning application in the RTU connects to the device management server and polls for available provisioning data.
7. The commissioning engineer monitors deployed devices and verifies correct operation.

DRQ7s instances in the Device Manager will exist in the central database having different statuses:

1) Added to the database (status = created)
The process to add a device to the database can be performed e.g. by putting a file (e.g. in JSON format) in a specific location on the server running the DMSW. The DMSW will automatically detect the file and process it. This file can be created and imported into the system as soon as the device has been produced in the factory or when it has been delivered to the DSO. The contents of the file will contain information according to the device's target default configuration. The DMSW will however not be able to contact the device before it has been deployed. Ideally this process is automated by batch importing data from a database.

2) Commissioned (status = commissioned)
Then the field technician performing the installation creates the commissioning information in the DSO's network. The DMSW will process this information automatically, and set the status of the device to "commissioned", and correlate all relevant (e.g. geolocation, calibration) parameters present in the commissioning file with the correct device in the database.

3) Activated in the Device Manager (status = activated)
From the moment the device is in the status 'commissioned' it is usable by the DMSW, meaning it can be remotely configured and updated. The DMSW will monitor devices in the status 'commissioned' and report whether they come online. As described before, the DRQ7 will connect and update its configuration with both the commissioning data and the designated default configuration. Once the configuration has been retrieved the status will evolve to 'activated'. It will then be possible to further remotely configure, update and monitor the device using the Device Manager. In case of problems connecting to the device (both in status commissioned and active), an alert will be shown in the DMSW.

4) Confirmed operational by the SCADA System (status = operational)
When the DRQ7 is activated it shall have the correct configuration for it's IEC104 slave. The SCADA system shall then be configured to connect the IEC104 master to DRQ7 slave via a method TBD not in scope of this specification. After confirming successful IEC104 connection to the SCADA system the activated DRQ7 shall be marked with status 'operational'.

2.3.4 Software Update Flow

The DMSW shall provide a repository where DRQ7 software artifacts can be uploaded. These software artifacts are assumed to contain metadata which can be used to identify the software and correlate it to configuration management processes used during SW development. The DSO shall be able to attach their own metadata to the software artifacts.

When a target software is available in the DMSW the technician shall be able to select a (group of) DRQ7 devices and configure them for software update. The system will then schedule software updates according to a configurable limit of simultaneous updates.
The SW update flow shall adhere to the security requirements defined in clause 5.2.

2.3.5 Monitoring and Control

Next to initial commissioning and periodically recurring firmware updates, the DMSW system shall be used to monitor the deployed devices in the field. It shall be possible to provide engineers with an overview of health and status information telemetry. This shall include but not be limited to:

- WAN Status information
  - Network operator (AT+COPS)
  - RSSI or Received Signal Strength Indication (AT+CSQ)
  - Network band selection (AT+KBND)
- General system status
  - Uptime, reset count
  - Firmware version
- I/O status
  - Connected devices
  - RS-485/Modbus stats
  - Ethernet stats
  - IEC104 / IEC61850 stats

The DMSW system shall provide the means for engineers to configure system parameters remotely via a telecommand implementation. The attributes of the system that shal be remotely configurable shall include but not be limited to:

- Modem parameters
  - WAN GSM configuration (e.g. SIM PIN, APN, APNun, APNpw, ...)
- Router settings
  - IP filtering
  - VPN configuration
  - LAN Network settings
- RTU parameters
  - IEC104 settings
  - RS-485 / Modbus configuration
  - MODBUS - IEC104 mapping configuration
  - Event monitoring timing parameters

2.4 Assumptions and Dependencies

This specification makes abstraction of the DSO network infrastructure as much as possible. The system is designed such that it can accomodate to the most common infrastructures DSOs typically deploy, and effort to customize is limited. The detailed implementation design shall be further clarified and documented when the exact setup and customer requirements are known.

3 Interface Requirements

3.1 User Interfaces

The users interacting with the system are the field technician, the device management engineer and the commissioning engineer. The latter two users basically perform the same role but in a different context: commissioning is a specific case of device management.

The field technician uses the commissioning app, of which the design itself is not in scope of this document. The same is valid for the front end UI to the DMSW. However the DMSW shall provide a RESTful API with which a custom UI can be built in a flexible way, e.g. either a native Android/iOS (normally only the case for the commissioning tool) or a HTML based web app. A basic implementation of the front end UI shall be provided to demonstrate the functioning of the RESTful API as an example for custom SW development. Figure 3 illustrates an example of what the front-end can look like, displaying status information about an RTU in the field.

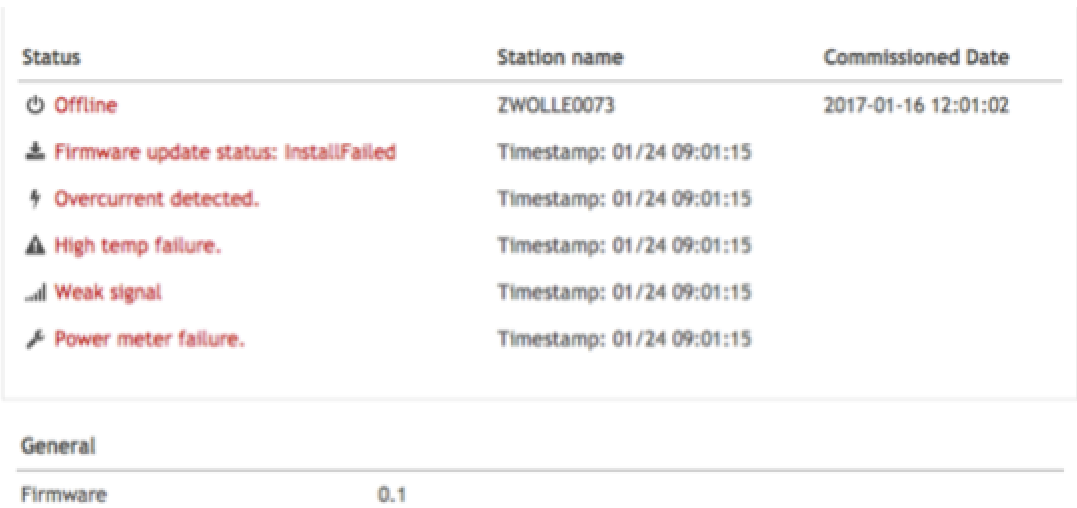


Figure 3: status view of a deployed RTU

3.2 Hardware Interfaces

The DRQ7 SW shall support interfacing with the hardware components described in Appendix 1. Figure 4 depicts a high level overview of the DRQ7 hardware components.

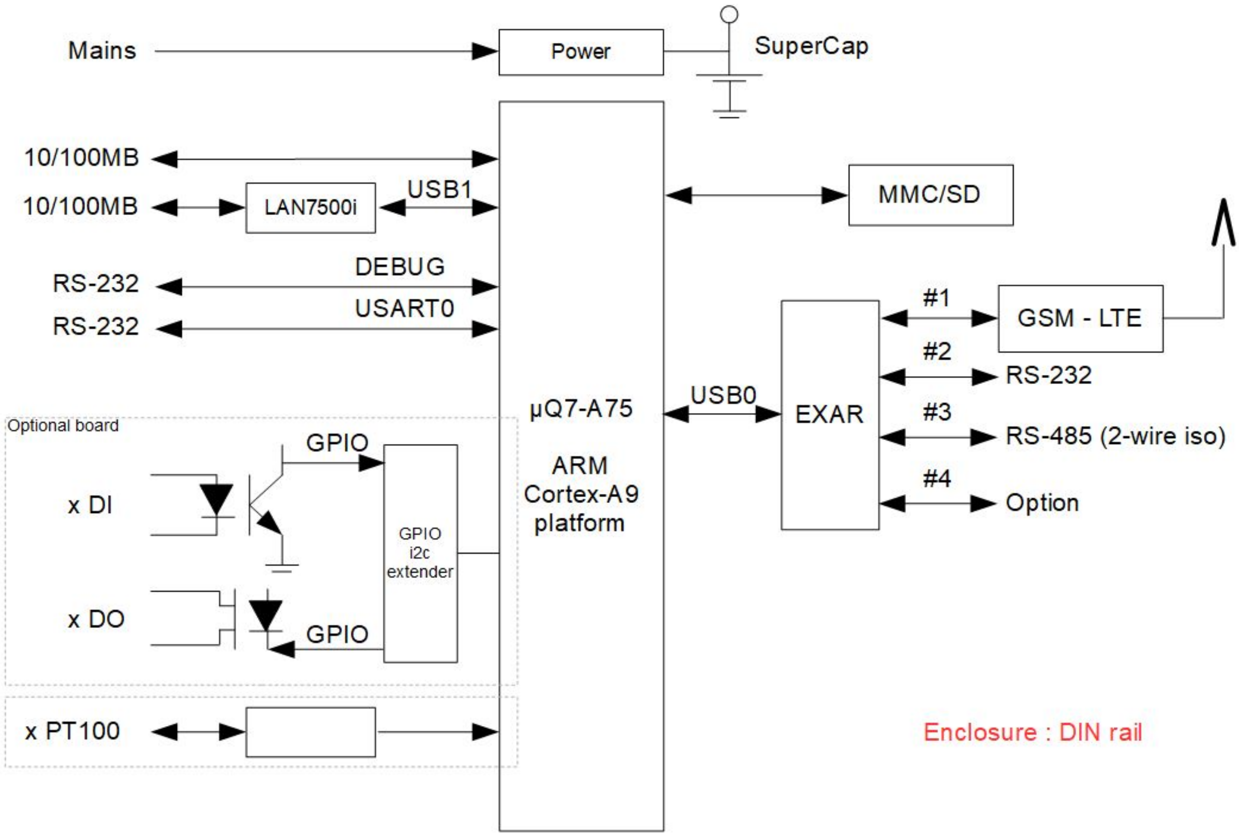


Figure 4: DRQ7 Hardware components

In the use case where the geolocation needs to be stored as metadata for the DRQ7 during the commissioning process, the hardware used by the field technician should contain a GPS receiver and provide the means to interface with the commissioning tool.

3.3 Software Interfaces

To allow flexible customization of the product the front end UI of the DMSW shall interface with the back end by using a RESTful API, which shall be documented in AD1.

The DMSW shall make use of a database, which is provided by a separate SW component. The SW shall interface with the DB via network sockets to ensure scalability.

To allow for a flexible product a NoSQL database (e.g. MongoDB) as DBMS could be used to store the configuration of the DRQ7 devices. NoSQL databases permit storage of objects without defining a schema, thus allowing different sets of devices with other properties to be added to the system. When using relational database (e.g. MySQL) each table change results in a database migration.

3.4 Communications Interfaces

This clause specifies the high level requirements for the communication architecture between the system components, and in particular between the DRQ7 and the DMSW.

3.4.1 General considerations

The implemented software components shall be maximally isolated from the protocol used provide communication between the DRQ7 and the DMSW, to ensure that other protocols can be integrated by only redesigning the software components directly related to the communication protocols.

3.4.2 Reference implementation

Figure 5 shows a reference implementation using the MQTT protocol (AD2). The Message Queuing Telemetry Transport protocol is a popular IoT protocol and is known for being lightweight and low-bandwidth, therefore well suited for resource constrained networks. The protocol implements the publish/subscribe paradigm.

The DRQ7 and DMSW shall both implement MQTT clients and shall have a MQTT broker exchange their messages. The DRQ7 shall publish its events and alarms for which the DMSW shall subscribe. To allow configuration the DRQ7 shall subscribe to an RPC channel meant for the DMSW to publish configuration changes. Because MQTT doesn't implement a request/response message out of the box exchange this pattern needs to be implemented, i.e. the DRQ7 shall listen to a 'request' channel and publish its responses to a 'response' channel.

The MQTT client on the DMSW side shall implement the 'glue logic' with the database. This means that it shall monitor changes in the database, e.g. invoked by a maintenance engineer who changes the device configuration. When a change has been detected by the database listener it will trigger the MQTT client to publish changes in the DRQ7 configuration to the correct device via the broker.

Using a MQTT broker bridging setup, as depicted in figure 5, can be considered and has the advantage of offering scalability & reliability. Clients can connect to different edge brokers and therefore balance the network load across multiple hosts. Furthermore when the central broker is down then messages are buffered by the edge brokers.

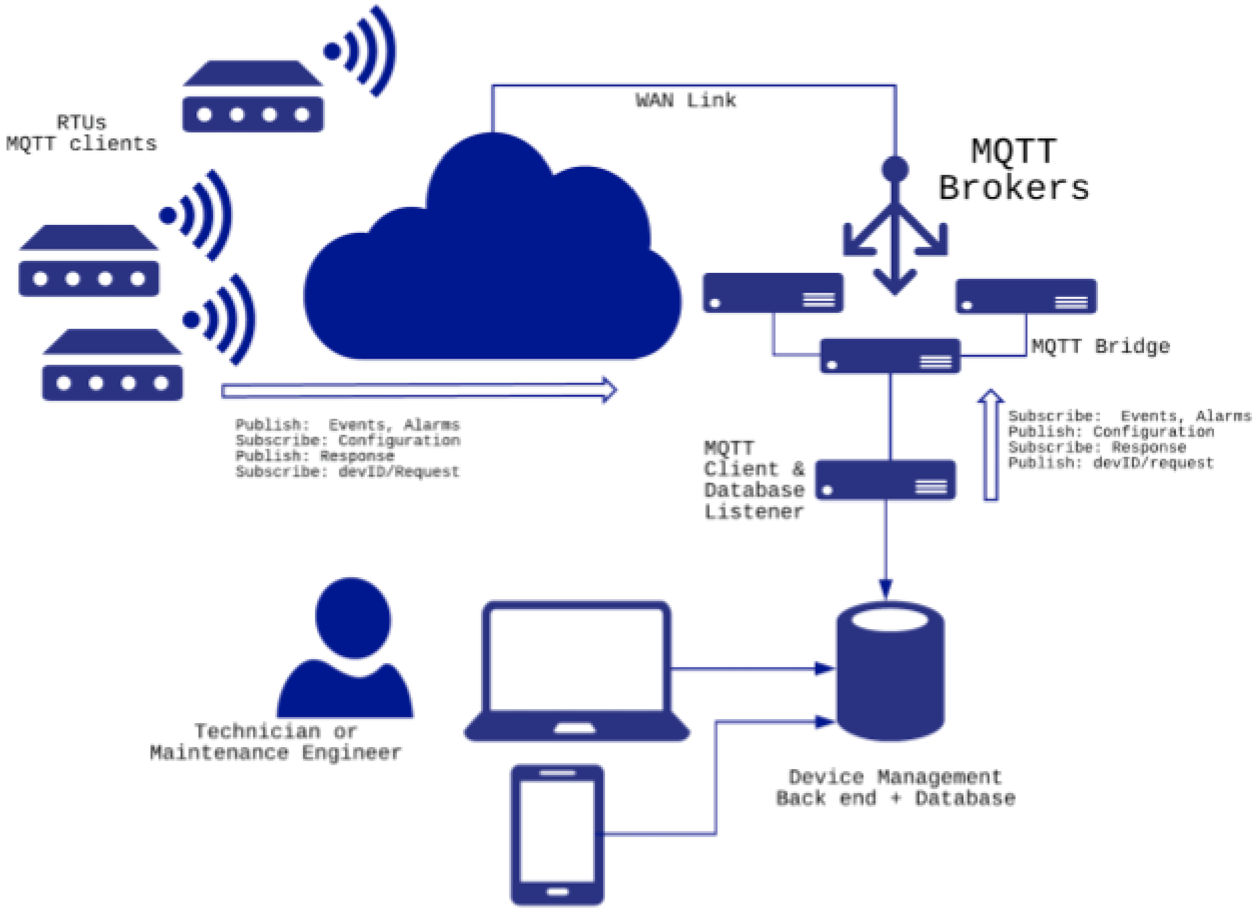


Figure 5: Reference implementation based on MQTT

4 System Requirements

4.1 DinBox RTU Q7 ESW

ID	Subsystem	Requirement Specification
DRQ7-1	Bootloader	The BSW shall perform integrity and authenticity check of the firmware image before booting.
DRQ7-2	Bootloader	The BSW shall support storage and retrieval of a secret key which can be used for integrity/authenticity verification.
DRQ7-3	Bootloader	The BSW shall fall back to a recovery system upon boot failure.
DRQ7-4	Device management	The ASW shall automatically attempt to connect to a preconfigured DMSW server upon boot.
DRQ7-5	Device management	The ASW shall be capable of transmitting alarms, events and telemetry data to the DMSW in near-real time.
DRQ7-6	Device management	The ASW shall implement a telecommand interface to allow management by the DMSW.
DRQ7-7	Device management	The DRQ7 must support remote secure shell using SSH
DRQ7-8	Device management	The DRQ7 must support remote software updates and be able to retain its configuration.
DRQ7-9	System	The ASW must support retrieval of system logs.
DRQ7-10	System	The ASW shall implement NTP (or IEC104) time synchronization with a configurable NTP server.
DRQ7-11	System	The ASW shall interface with a Real Time Clock with battery (Supercap) backup.
DRQ7-12	System	The ASW shall support logging of statistics of its network interfaces.
DRQ7-13	Telemetry	The ASW shall record a timestamp for all samples acquired by its measurement inputs.
DRQ7-14	Telemetry	The ASW shall support the IEC104 protocol and provide protocol statistics as telemetry data
DRQ7-15	Telemetry	The ASW shall provide the following System attribute variables as telemetry data: ● System uptime ● Power cycle count

		● Firmware version ● I/O status ● Device Identification
DRQ7-16	Telemetry	The ASW shall connect to the DMSW system automatically upon boot and shall remain connected permanently
DRQ7-17	Networking	The ASW shall keep the Ethernet LAN interface disabled in OOB mode.
DRQ7-18	Networking	The ASW shall implement watchdog functionality to detect loss of WAN signal and recover.
DRQ7-19	Networking	The DRQ7 shall be compliant with the TCP/IP, IPv4 (AD3) and IPv6 RFCs (AD4).
DRQ7-20	Networking	The DRQ7 shall initiate IPsec tunnel connections upon boot.
DRQ7-21	Networking	The ASW shall filter IP-traffic on the WAN interface.
DRQ7-22	Networking	The ASW shall implement a VPN authenticator based on IPsec.
DRQ7-23	Networking	The ASW shall be compliant with the IKEv2 RFC (RFC7296).
DRQ7-24	Networking	The ASW shall allow remote configuration for the following networking parameters: ● LAN IP configuration ● DHCP server state and IP pool ● VPN configuration ● IP forwarding enable/disable
DRQ7-25	Networking	The ASW shall provide the following networking attribute variables as telemetry data: ● Connected LAN hosts ● Interface statistics
DRQ7-26	Networking	The ASW shall allow remote configuration for the following WAN parameters: ● APN parameters ● SIM PIN ● Connection timeout
DRQ7-27	Networking	The ASW shall provide the following WAN attribute variables as telemetry data: ● Connection uptime ● Network operator (AT+COPS) ● RSSI or Received Signal Strength Indication (AT+CSQ) ● Network band selection (AT+KBND)
DRQ7-28	I/O	The ASW shall disable all debugging interfaces in OOB mode.
DRQ7-29	I/O	The ASW shall implement an IEC61850 master for EID communication and provide statistics as telemetry data
DRQ7-30	I/O	The ASW shall allow to configure data/object mapping between all

		modbus slaves & EID's & SCADA protocols.
DRQ7-31	I/O	The ASW shall support a Modbus RTU master interface, based on: - Minimum speed of 9.600 Baud 8N1 - 2-wire RS-485 (DE delay timing configurable) - Polling frequency of ≥ 0.1 Hz - To be polled registers of Modbus-IED's can be remotely configured
DRQ7-32	I/O	The ASW shall support reading from/writing to an RS232 interface
DRQ7-33	I/O	The ASW shall support reading from/writing to GPIOs
DRQ7-34	FDIR	The ASW shall support SuperCap backup functionality.

4.2 Device Management Software

ID	Subsystem	Requirement Specification
DRQ7-35	DMSW	The DMSW shall implement a RESTful API to present a UI to the device management engineer.
DRQ7-36	DMSW	The DMSW shall provide the means to acquire, store, and change the configurable attributes of the DRQ7 (and/or connected devices).
DRQ7-37	DMSW	The DMSW shall allow software artifacts to be uploaded, assigned and deployed to groups of deployed DRQ7 devices.
DRQ7-38	DMSW	The DMSW shall support commissioning flow as described in clause 2.3.3
DRQ7-39	DMSW	The DMSW shall protect impactful actions for accidental change.

5 Nonfunctional Requirements

5.1 Performance Requirements

ID	Subsystem	Requirement Specification
DRQ7-40	DMSW	The DMSW system shall be designed to accomodate for a volume at least 50 000 deployed RTU devices.
DRQ7-42	DMSW	To achieve scalability the DMSW software components must be capable of running distributed among different machines while retaining a single source of truth.

5.2 Security Requirements.

ID	Subsystem	Requirement Specification
DRQ7-42	Security	No system component shall ever store passwords in plain text.
DRQ7-43	Security	All communication channels outside the DSO network shall make use of methods to provide authenticated, secured and integrity protected communication, e.g. TLS.
DRQ7-44	Security	The DRQ7 shall support remote updates of all cryptographic keys within an authenticated and secure channel.
DRQ7-45	Security	All unneeded services and applications shall be removed from the DRQ7 SW.
DRQ7-46	Security	The DRQ7 shall implement a random number generator function.
DRQ7-47	Security	The DRQ7 and/or the DMSW shall restrict access to the configuration and firmware update functionality by using an authentication method.
DRQ7-48	Security	The DRQ7 shall not have a root account available for remote connections.
DRQ7-49	Security	All communication sockets using TLS shall implement OCSP certificate verification.
DRQ7-50	Security	TLS version v1.2 or higher shall be used.
DRQ7-51	Security	The production SW shall have its local debugging interfaces disabled by default.

5.3 Quality Requirements

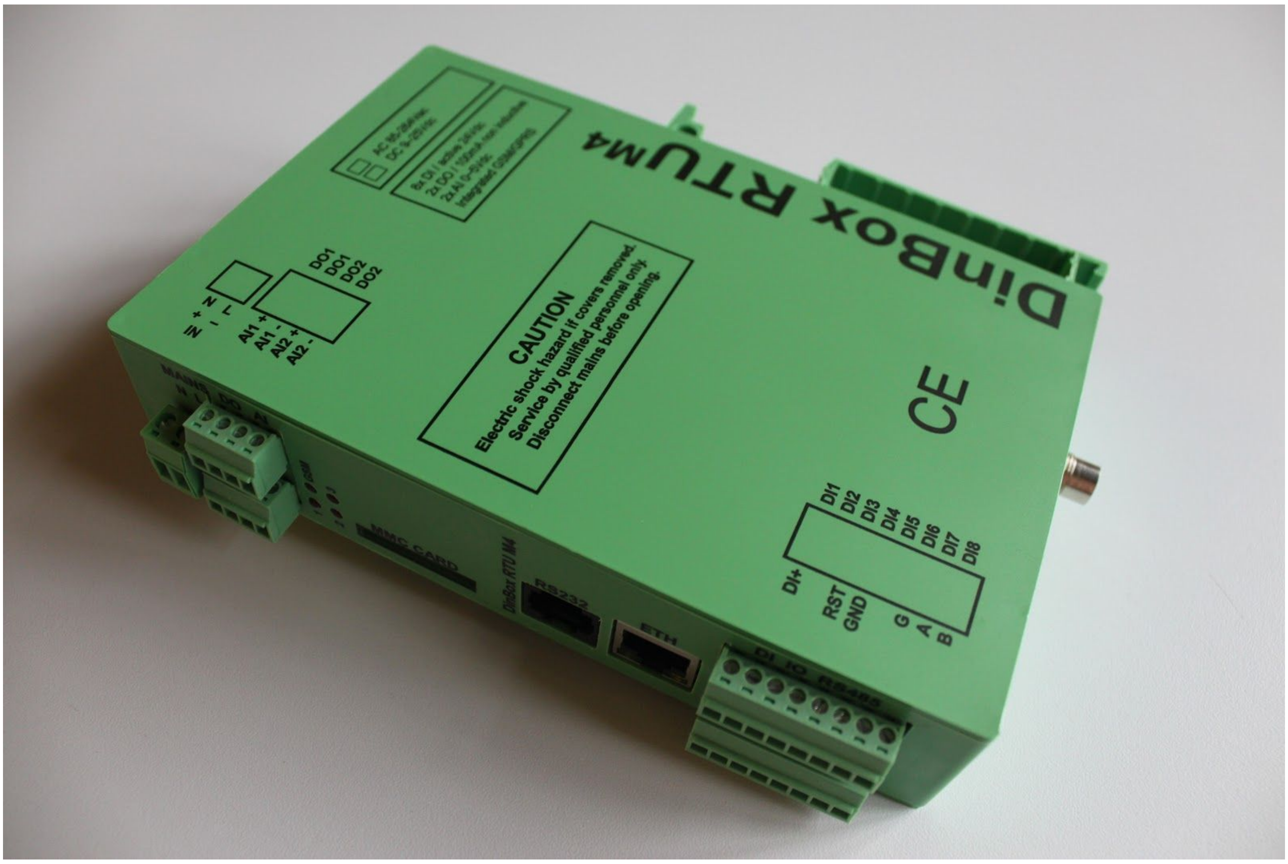
ID	Subsystem	Requirement Specification
DRQ7-52	Quality	The DRQ7 shall be demonstrated to operate for at least 48 hours without interruption while connected to the DMSW.
DRQ7-53	Quality	Static analysis shall be performed on all source code of custom designed software and no compiler warnings shall be present.
DRQ7-54	Quality	Parts critical for the operation of the system (TBD) shall be validated by unit testing.
DRQ7-55	Quality	Both integrated and in-house developed source code shall be kept under revision control with a SCM system .

DRQ7-56	Quality	Software components shall be maximally isolated from the protocol used to provide communication between the DRQ7 and the DMSW, to allow for efficient integration of IoT protocols

6 Appendix 1 : DRQ7 Hardware Description

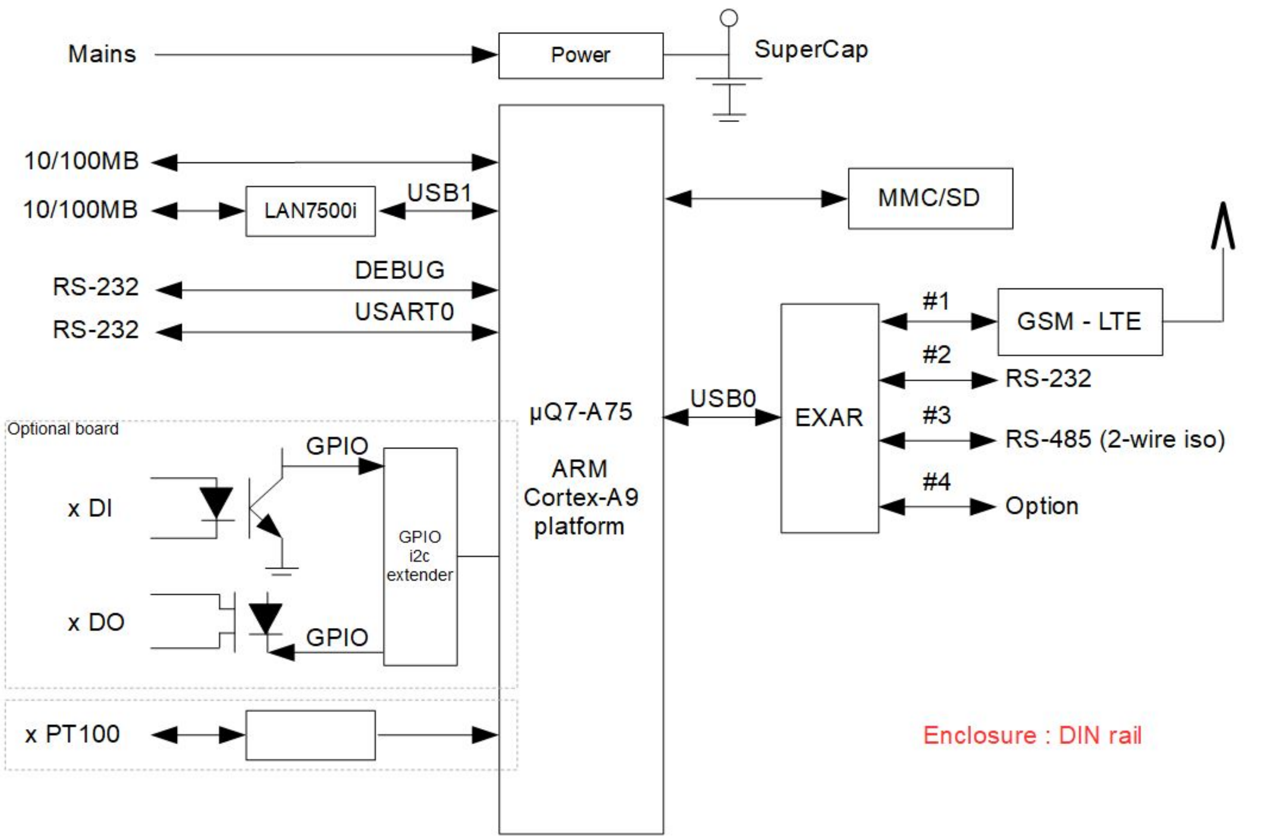
The **DRQ7** RTU is the successor of the **DinBox RTU SL** and **DinBox RTU M4**. This new RTU is housed in the same DIN-rail mountable enclosure and uses a powerful Cortex-A9 *processor board* instead of a Cortex-M4 *processor*. Thanks to this board the ESW of the DRQ7 can run on a Linux or Yocto OS.

Photo (DinBox RTU M4) :



The DRQ7 will have the same type of connectors as shown in the photo above.

Block Diagram :



By default the DRQ7 will have the following connections :

- Mains
- Vin (for SuperCap connection)
- LAN #1 RJ45
- LAN #2 RJ45
- RS-232 (for EID connection or configuration)
- FME antenna connector
- 24-pin connector

The DRQ7 will have the possibility to fit an optional board for other I/O connections. This optional board is connected to a 24-pin connector on front of the DRQ7. Depending on customer specifications the following I/O can be provided on an optional board :

- DI
- DO
- AI
- PT-100
- ...

The WAN SIM card and optional SD card will only be accessible from the inside of the DRQ7. Two LEDs will give some basic status information.

7 Appendix 2: Power Meter Modbus Mappings

Average value measurements are taken over a period of 15 minutes, maximum and minimum are measured within this period. The measurement period is configurable (by default 15 minutes).

3 Phased 400V - max 1250 A

Parameter	Description
V1N	gemiddelde fasespanning 1-N [V]
V2N	gemiddelde fasespanning 2-N [V]
V3N	gemiddelde fasespanning 3-N [V]
V1N, min	minimum fasespanning 1-N [V]
V2N, min	minimum fasespanning 2-N [V]
V3N, min	minimum fasespanning 3-N [V]
V1N, max	maximum fasespanning 1-N [V]
V2N, max	maximum fasespanning 2-N [V]
V3N, max	maximum fasespanning 3-N [V]
V12	gemiddelde gekoppelde spanning 1-2 [V]
V13	gemiddelde gekoppelde spanning 1-3 [V]
V23	gemiddelde gekoppelde spanning 2-3 [V]
I1	gemiddelde stroom in fase 1 [A]
I2	gemiddelde stroom in fase 2 [A]
I3	gemiddelde stroom in fase 3 [A]
IN	gemiddelde stroom in neutrale (indien gemeten) [A]
I1, min	minimum stroom in fase 1 [A]
I2, min	minimum stroom in fase 2 [A]
I3, min	minimum stroom in fase 3 [A]
IN, min	minimum stroom in neutrale (indien gemeten) [A]
I1, max	maximum stroom in fase 1 [A]
I2, max	maximum stroom in fase 2 [A]
I3, max	maximum stroom in fase 3 [A]

IN, max	maximum stroom in neutrale (indien gemeten) [A]
Ptot	gemiddeld totaal actief vermogen door alle fasen [kW]
Qtot	gemiddeld totaal reactief vermogen door alle fasen [kW]
Stot	gemiddeld totaal schijnbaar vermogen door alle fasen [kW]
P1	gemiddeld actief vermogen door fase 1 [kW]
P2	gemiddeld actief vermogen door fase 2 [kW]
P3	gemiddeld actief vermogen door fase 3 [kW]
Q1	gemiddeld reactief vermogen door fase 1 [kW]
Q2	gemiddeld reactief vermogen door fase 2 [kW]
Q3	gemiddeld reactief vermogen door fase 3 [kW]
Cos(j)	cosinus phi – totale arbeidsfactor [-]
THD V1	totale harmonische spanningsdistortie fase 1-N [%]
THD V2	totale harmonische spanningsdistortie fase 2-N [%]
THD V3	totale harmonische spanningsdistortie fase 3-N [%]
THD V	totale harmonische spanningsdistortie [%]
H5V1	percentage vijfde harmonische in fase 1 [%]
H5V2	percentage vijfde harmonische in fase 2 [%]
H5V3	percentage vijfde harmonische in fase 3 [%]
f	netfrequentie (Hz)

3 Phased 230V - max 1250 A

Parameter	**Description**
V12	gemiddelde gekoppelde spanning 1-2 [V]
V13	gemiddelde gekoppelde spanning 1-3 [V]
V23	gemiddelde gekoppelde spanning 2-3 [V]
V12, min	minimum fasespanning 1-2 [V]
V13, min	minimum fasespanning 1-3 [V]
V23, min	minimum fasespanning 2-3 [V]
V12, max	maximum fasespanning 1-2 [V]

V13, max	maximum fasespanning 1-3 [V]
V23, max	maximum fasespanning 2-3 [V]
I1	gemiddelde stroom in fase 1 [A]
I2	gemiddelde stroom in fase 2 [A]
I3	gemiddelde stroom in fase 3 [A]
IN	gemiddelde stroom in neutrale (indien gemeten) [A]
I1, min	minimum stroom in fase 1 [A]
I2, min	minimum stroom in fase 2 [A]
I3, min	minimum stroom in fase 3 [A]
IN, min	minimum stroom in neutrale (indien gemeten) [A]
I1, max	maximum stroom in fase 1 [A]
I2, max	maximum stroom in fase 2 [A]
I3, max	maximum stroom in fase 3 [A]
IN, max	maximum stroom in neutrale (indien gemeten) [A]
Ptot	gemiddeld totaal actief vermogen door alle fasen [kW]
Qtot	gemiddeld totaal reactief vermogen door alle fasen [kW]
Stot	gemiddeld totaal schijnbaar vermogen door alle fasen [kW]
P1	gemiddeld actief vermogen door fase 1 [kW]
P2	gemiddeld actief vermogen door fase 2 [kW]
P3	gemiddeld actief vermogen door fase 3 [kW]
Q1	gemiddeld reactief vermogen door fase 1 [kW]
Q2	gemiddeld reactief vermogen door fase 2 [kW]
Q3	gemiddeld reactief vermogen door fase 3 [kW]
Cos(j)	cosinus phi – totale arbeidsfactor [-]
THD V1	totale harmonische spanningsdistortie fase 1-N [%]
THD V2	totale harmonische spanningsdistortie fase 2-N [%]
THD V3	totale harmonische spanningsdistortie fase 3-N [%]
THD V	totale harmonische spanningsdistortie [%]
H5V1	percentage vijfde harmonische in fase 1 [%]

H5V2	percentage vijfde harmonische in fase 2 [%]
H5V3	percentage vijfde harmonische in fase 3 [%]
f	netfrequentie (Hz)