

**HAQT**  
**Implementation and testing of**  
**interfaces for HAQT**  
**instrument network linked to**  
**CITYZER (D2-2):**  
**Test Report**

	Function	Name	Company	Signature	Date
Prepared by	WP1 leader	Walter Schmidt	FMI		12.08.2019

## Document Change Record

Issue	Date	Description of Change
1.0	05.03.2019	Initial Version
1.1	03.05.2019	Reference documents added
1.2	15.05.2019	Section 6 details added
2.0	12.08.2019	Modified to final test report

---

## Table of Contents

<b>1. APPLICABLE DOCUMENTS .....</b>	<b>4</b>
<b>2. SCOPE OF DOCUMENT .....</b>	<b>4</b>
<b>3. PRE-REQUISITES .....</b>	<b>6</b>
<b>4. DOCUMENTATION REQUIRED.....</b>	<b>6</b>
<b>5. TEST OPERATIONS .....</b>	<b>7</b>
5.1 TEST PREPARATION .....	7
5.2 MODULE INTERCONNECTIONS .....	7
5.3 TEST OPERATION PHILOSOPHY .....	7
<b>6. STEP-BY-STEP PROCEDURE.....</b>	<b>9</b>
6.1 PREPARATIVE TASKS .....	9
6.2 STARTUP .....	11
6.3 STANDARD OPERATION: DATA INPUT TO FILE SERVER WITH ENFUSER INPUT AND OUTPUT, NOWCASTING INPUT AND OUTPUT .....	12
6.4 APPLICATION ACCESS AND FUNCTIONALITY.....	13

## 1. Applicable documents

Identifier	Date	Doc. No	Issue	Name
AD1	15.11.2015	CITYZER_FINAL_Submission	2.0	
AD2	21.06.2017	HAQT-PL-001	1.0	Sensor tests plan Vaisala
AD3	20.09.2016	CITYZER-TN-002	1.0	Interface Implementation
AD4	25.09.2018	CITYZER-D2-6	1.1	Cityzer detailed design and implementation plan
AD5	11.06.2018			Operational FMI-ENFUSER documentation A- architecture and installation
AD6	10.07.2017			Cityzer_run_control_draft_doc
AD7				Description of the Rolling Storage File System
AD8	10.04.2017		1.6	PegasorAQ Urban Air Quality Monitor Operating Manual
AD9	07.05.2018		1.3	AQU-Modbus
AD10	26.07.2016	<a href="http://docs.opengeospatial.org/is/15-078r6/15-078r6.html">http://docs.opengeospatial.org/is/15-078r6/15-078r6.html</a>		OGC SensorThings API
AD11	01.12.2018	M211690EN-P	P	NM10 User Guide
AD12	01.12.2018	M212019EN-E	E	NM10 Configuration And Maintenance Manual
AD13	2019	B211581EN-G	G	AQT400 Series data sheet
AD14	22.11.2016	PI216526-F	F	NM10 WFS Interface Configuration Procedure Instruction
AD15	24.05.2019	CITYZER-D5-5	2.2	Test Procedure Specifications

## 2. Scope of document

This document represents the verification test report for the Helsinki metropolitan Air Quality Testbed (HAQT) implementation according to [AD4], adapted to HAQT. The test demonstrates the full functionality of the HAQT system with all its basic building blocks and their interfaces from a sensor data repository up to a user application including the central data storage system with associated database, modeling software and security aspects of the external access of an application to the stored data.

The full functionality with different deployed sensor networks, public data sources and different applications according to use cases identified inside the project were tested.

Figure 2.1 , adapted from [AD15] shows the general system structure.

## CZ HAQT Deployment Architecture 2.4

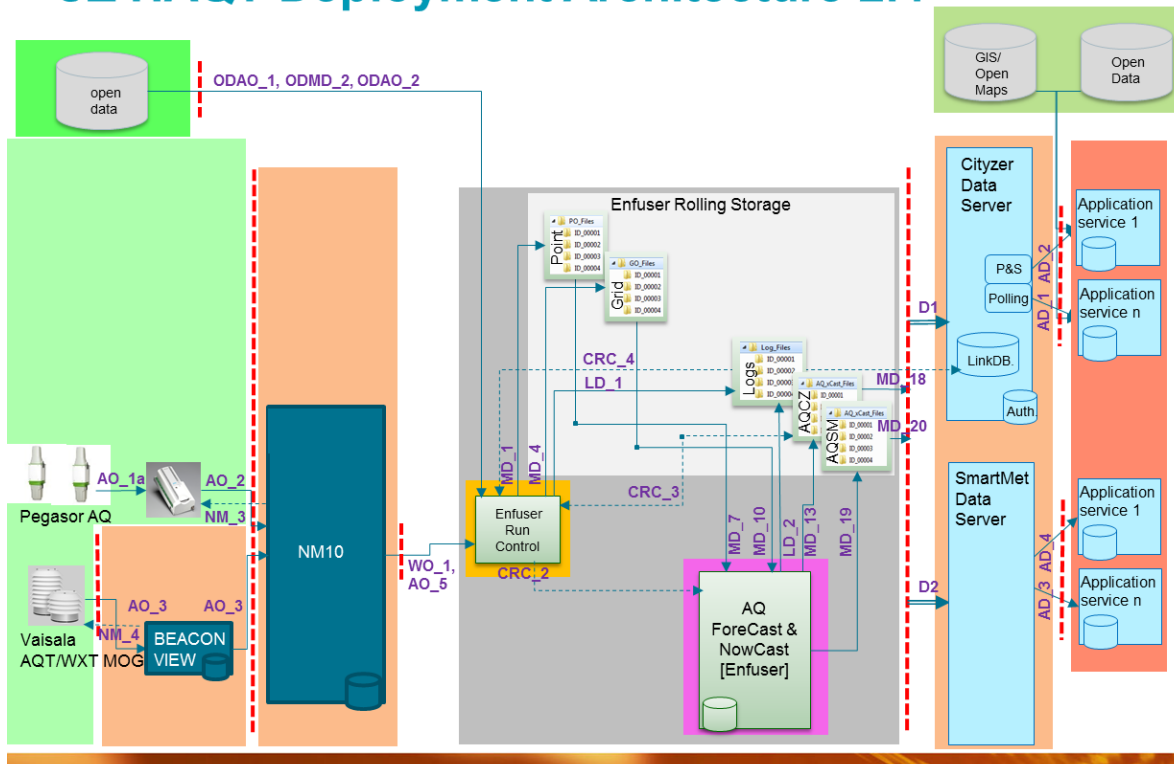


Figure 2.1 HAQT Deployment Architecture

The different data paths and their formats, indicated by codes in the figure, are explained in detail in the following list.

- ODAO\_1, open data air quality observations (DEXTR\_FMI\_OD)
- ODAO\_2, open AVAA/SMEARIII air quality observations (DEXTR\_FMI\_OD)
- ODMD\_2, open model data (NWP/regional AQ Fcast) (DEXTR\_SILAM/HIRLAM/GFS/CMAQ)
- AO\_1a, air quality observations from Pegasor AQ to Vaisala QML logger
- AO\_2, air quality observations from Vaisala QML logger to Vaisala NM10
- AO\_3, air quality and surface weather observations from Vaisala AQT/WXT to NM10/Beacon
- AO\_5, air quality observations via WFS (DEXTR\_NM10)
- WO\_1, surface weather observations via WFS (DEXTR\_NM10)
- NM\_3, network management interface to Vaisala QML/CL
- NM\_4, network management interface to Vaisala MOG/Beacon
- MD\_1, air quality and surface weather observation data to RainNC+Enfuser storage (DWR\_NM10/FMI\_OD)
- MD\_4, NWP and regional AQ forecast data to RainNC+Enfuser storage (DWR\_SILAM/HIRLAM/GFS)
- MD\_7, air quality observation data to FMI AQ fore & nowcasting engine (DREAD\_FMI\_OD)
- MD\_10, regional and model data to FMI Enfuser (DREAD\_SILAM/HIRLAM)
- MD\_13, air quality now and forecast data to FMI Enfuser CZ\_OUT storage (OCS\_1)

- MD\_18, air quality now and forecast data to Sasken cz data server (AQCZ)
- MD\_19, air quality now and forecast data to SmartMet storage (AQSM)
- MD\_20, air quality now and forecast data to SmartMet data server
- LD\_1, Logging output from Enfuser Run Control DataMiner (LOG\_DM)
- LD\_2, Logging output for FMI Enfuser runs (LOG\_ENF)
- AD\_1, application data polling from Sasken cz data server
- AD\_2, application data as publish & subscribe from Sasken cz data server to applications
- AD\_3, application data polling from SmartMet data server
- AD\_4, application data as publish & subscribe from SmartMet data server to applications
- CRC\_2, Enfuser control file interface for model run parameters
- CRC\_3, Enfuser Run Control check if new run air quality forecast data is available
- CRC\_4, Enfuser Run Control update Sasken cz data server linkDB with 'new data available' information
- D1, observation, now and forecast data to Sasken cz data server
- D2, observation, now and forecast data to SmartMet data server

### 3. Pre-requisites

All elements of the HAQT infrastructure as given in Figure 2.1 have to be present and functional during the test:

- Enfuser Rolling Storage with correct file structure, see [AD2]
- Functional AQ sensor networks with connectivity to Vaisala's Network Manager
- Linux-based computing environment at FMI with the following properties:
  - Network access to the AQ data repository
  - Network access to the AQ-sensor data via Vaisala's Network Manager NM10
  - Data access (read and write) between the file system and the *enfuser* AQ-modelling software
  - Control software / scripts taking care of AQ-input data fetch, enfuser software activation, and data base update control
  - Monitor workstation
- Workstation or virtual computer with *enfuser* program connected to the data server
- Cityzer Data Server with data base containing information of available data and search interface
- SmartMet Data Server with data base containing information of available data and search interface
- Applications to display some aspects of the AQ data

### 4. Documentation required

All documents referred to below should be available in the "Working Documents" – folder of the Cityzer intranet before the start of the tests.

- Datasheets / manuals with information about the available AQ sensors and input data to be included in the test [AD8], [AD9], [A13]
- Datasheet / manual with information about the applications, the intended parameter(s) and meta-data to be displayed [AD3].
- Description of the Rolling Storage File System [AD7]
- Functional description of the Run Control System [AD6]
- Functional description of the ENFUSER model software [AD5]

## 5. Test operations

### 5.1 Test preparation

Before beginning the test go through the complete procedure and enter the expected values like port numbers, addresses, response times etc into the 2<sup>nd</sup> column of the step-by-step procedure. In the first phase of the test verify that all sensors, connections and other functional modules listed in this test procedure specifications in section 5.2 are available, interconnected and functional.

### 5.2 Module interconnections

- Configuration of input data access ports and data paths
- Configuration of the NM10 system to work with the sensors and *enfuser*
- Configuration of the sensors and communication channels towards the NM10 system
- Configuration of file system to receive AQ input data and *enfuser* output data
- Configuration of control software to generate detailed logging information of each activity
- Configuration of *enfuser* software to generate detailed logging information
- Configuration of *enfuser* software to access updated AQ input data
- Configuration of *enfuser* software to write to correct output directories
- Configuration of control software to generate detailed logging information of each activity
- Configuration of data base system to link to correct filesystems
- Configuration of application server to accept application authorization
- Configuration of application to generate correct authentication exchange
- Configuration of SmartMet system

### 5.3 Test operation philosophy

Once all interconnections have been completed, checked and logged in the test report, the test operation is started by activating the control software in the data server. Thereafter the operation should be automatic and autonomous. Any operator interaction needed to keep the operation running has to be logged as exception with as many details as possible describing the scenario under which the autonomous operation had stopped.

Once the data fetch /storage / modelling system is running the application has to be activated and stopped according to the test plan, its selection and display details changed.

In case any operation aspect stops or fails, the test has to be interrupted and the status of each module and interface analysed and logged as detailed as possible including snapshots of the file system structure at that moment and the contents of the file(s) being processed at the moment of failure. If

possible the remainder of the test procedure should be executed and any possible additional failures logged as outlined above. Once all detected failures have been corrected the complete test procedure including generation of a detailed test report has to be started from the beginning.



## 6. Step-by-step procedure

Add detailed comments to the end of the procedure table of any sub-section, preceded by the step reference to which they relate. In case one or more log files are generated at a test step, their full filenames should be logged also. Abbreviations in the table refer to Figure 2.1

Short remarks can be written into the “Remarks” column at each step. If the result is as expected, add a “P” into the pass/fail column, else an “F”.

For section 6.1 the expected access details should be defined in the corresponding documentation. Please add the exact reference document name and section or page number where this can be found for each sub-step. Deviations not invalidating the test intentions should be noted in the section “Notes” below this table

### 6.1 Preparative tasks

Step	Activity description	Required result	Actual result	Remarks	Pass/Fail
0	Check availability of documents	Done	available	HAQT/CITYZER intranet, propriety information only in drop box	P
1A.	Configure input data paths ODxxx	Done			
1	Access details ODAO_1		verified	cronfetch_aq_pointdata.tesh	P
2	Access details ODAO_2		verified	cronfetch_aq_pointdata.tesh	P
4	Access details ODMD_2		verified	cronfetch_model_data.tesh	P
1B.	Configure input data path WO_1	Done			
1	Access details WO_1			cronfetch_aq_pointdata.tesh	P
1D.	Configure input data path AO_5	Done			
1	Access details AO_5		verified	according to [AD11]	P
2	Access details AO_1a		verified	LoRA SensorThings API [AD10]	P
3	Access details AO_2		verified	according to [AD9]	P
4	Access details AO_3		verified	according to [AD13]	P
1E.	Configure file system for input data	Done			
1	Point		verified	[AD6] checked according to [AD7]	P
2	Grid		verified	[AD6] checked according to [AD7]	P
3	Logs		verified	[AD6] checked according to [AD7]	P
1F.	Configure control software to correct file system details	Done	verified	[AD6] checked according to [AD7]	P
1G.	Configure <i>enfuser</i> operation	Done			
1	Access details CRC_2		verified	verified according to [AD5]	P
1H.	Configure control software to control <i>nowcasting</i>	Done			
1	Access details CRC_3, MD_18		verified	verified according to [AD4]	P
1J.	Configure control software to provide maximum logging information	Done			P
1K.	Configure <i>enfuser</i> to act on control software information	Done		See [AD5], section 2 / ERFC config.	P
1L.	Configure <i>enfuser</i> to access correct input data	Done		See [AD5], section 2.1.1	
1	Access details MD_7		verified	See [AD5], section 4	P
2	Access details MD_10		verified	See [AD5], section 4	P
3	Access details MD_12		verified	See [AD5], section 3	P
1M.	Configure <i>enfuser</i> to write to correct output file system	Done		See [AD5], section 3	
1	Access details MD_13, LD_2		verified		P
2	Access details LD_1		verified		P

## Implementation and testing of interfaces for HAQT

1R.	Configure the data base to react on control SW triggers	Done			P
1	Access details MD_18		verified		P
2	Access details MD_19		verified		P
3	Access details MD_20		verified		P
1S.	Configure the data base to accept correct authentication	Done			P
1	Access details AD_1		verified		P
2	Access details AD_2		verified		P
1T.	Configure the applicatione to generatet correct authentication	Done	verified		P
1U.	Configure the applicatione to access R/W the DB	Done	verified		P
1V.	Configure the SmartMet system	Done	verified	Via SmartMet applications	P

### Notes:

Please enter in the remarks column a short description of how to execute this step. If more complicated please give the reference document name and section/page number where to find the details. Collect log files where possible and give the log file name in the Notes section

### 6.2 Startup

Step	Activity description	Required result	Actual result	Remarks	Pass/Fail
2A.	Start data base system	Confirmation	verified		P
2B.	Start control software	Log processes	verified	Check with crontab -l, see [AD6]	P
2C.	Observe <i>enfuser</i> start	Confirmation	verified	Check process statistics, log	P
2D.	Start application part for authentication	Authentication successful	verified		P
2E.	Check database status	Initialized	verified		P
2F.	Check control software status with system command ps, record ID	process should be active	verified	Check according to crontab list in [AD6]	P
2G.	Check NM10 active	Confirmation	verified	Login to <a href="https://hel-nm10-blue.vaisala.com/nm10/login">https://hel-nm10-blue.vaisala.com/nm10/login</a> and check that the time is correctly displayed at the top bar of the application, [AD12]	P
2H.	Check that AQ sensors are active	Done			P
1	Etteplan, LoRa	Confirmation	verified	See [AD8], [AD9] and [AD10]	P
2	Pegasor AQ	Confirmation	verified	See [AD8]	P
3	AQT/WXT	Confirmation	verified	go to NM10 list view and check the column 'last data received' [AD13]	P
4	BEACON VIEW	Confirmation	verified	Check via <a href="https://beacon.vaisala.com/">https://beacon.vaisala.com/</a>	P

**Notes:**

Please enter in the remarks column a short description of how to execute this step. If more complicated please give the reference document name and section/page number where to find the details. Collect log files where possible and give the log file name in the Notes section

### 6.3 Standard operation: data input to file server with enfuser input and output, nowcasting input and output

Step	Activity description	Required result	Actual result	Remarks	Pass/Fail
3A.	<i>enfuser</i> starts operations	Done	verified	Check process statistics, log [AD5], section 5.1	P
3B.	<i>enfuser</i> modelling procedes, logging of operations	logfile increases	verified	See [AD5], section 5	P
3C.	<i>enfuser</i> writes output	new file generated	verified		P
3D.	New file is in correct directory with correct name	Correct	verified	Check that netCDF files are generated	P
3E.	Data base is updated with new <i>enfuser</i> file	DB update	verified		P
3F.	DB-update check	Correct	verified		P
3G.	Make new input data available	Control software fetches new data	verified		P
3H.	Control software triggers data base	DB update	verified		P
3I.	<i>enfuser</i> uses new data set	Done	verified		P
3J.	<i>enfuser</i> writes new data set, new file is in correct directory with correct name	Done	verified		P
1	File format is correct		verified		P
2	Data are reasonable		verified		P
3K.	Control software triggers DB	Done	verified		P
3L.	Control software triggers data base	DB update	verified		P
3M.	<i>enfuser</i> uses new data set	Done	verified		P
3N.	<i>enfuser</i> writes new data set, new file is in correct directory with correct name	Done	verified	<i>according to file list, see document p.23</i>	P
3O.	Control software triggers DB	Done	verified	<i>Make DB dump (partial)</i>	P
3P.	Removal of 1 AQ sensor		verified	<i>Done during separate field tests</i>	P
1	NM10 records change	Confirmation	verified	go to NM10 list view and check the column 'last data received'	P
2	<i>enfuser</i> reacts on change	Confirmation	verified	Continues operation	P

#### Notes:

Sensor addition, removal and re-configuration via NM10 control was done in separate tests  
The end-to-end system has been running for several months.

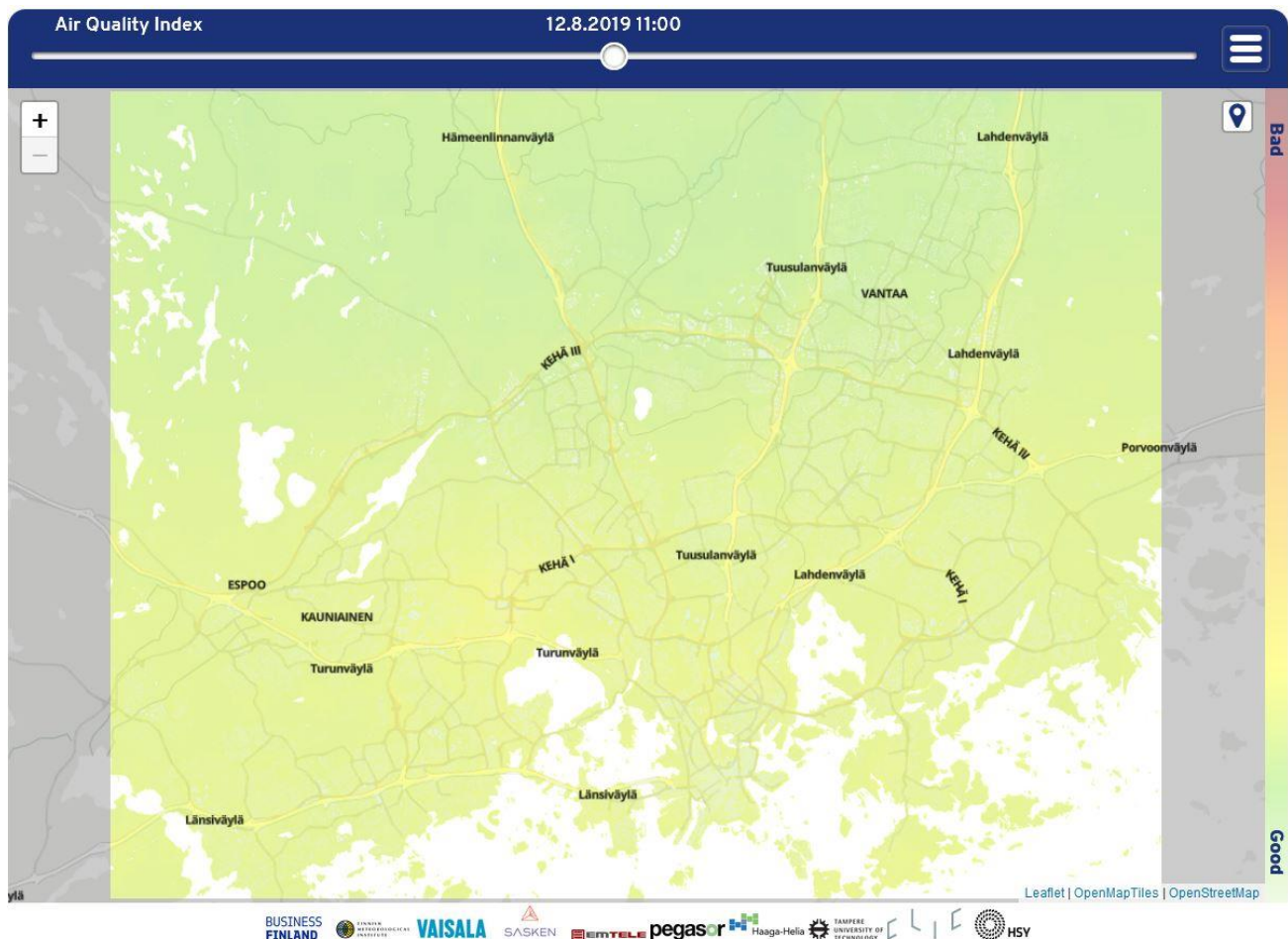
Please enter in the remarks column a short description of how to execute this step. If more complicated please give the reference document name and section/page number where to find the details. Collect log files where possible and give the log file name in the Notes section

## 6.4 Application access and functionality

Step	Activity description	Required result	Actual result	Remarks	Pass/Fail
5A.	Disconnect and re-connect	Connection			P
5B.	Default display	As defined		<i>Snapshot</i>	P
5C.	Change display area	Display changes		<i>Snapshot</i>	P
5D.	Updated <i>enfuser</i> data	Display updates		<i>Snapshot</i>	P
5E.	Update of input data (if used by application)	Display updates		<i>Snapshot</i>	P

### Notes:

Screenshot of air quality map mobile application for the Helsinki area (5B.):



Zoomed in snapshot with updated data (5C., 5D., 5E.):

