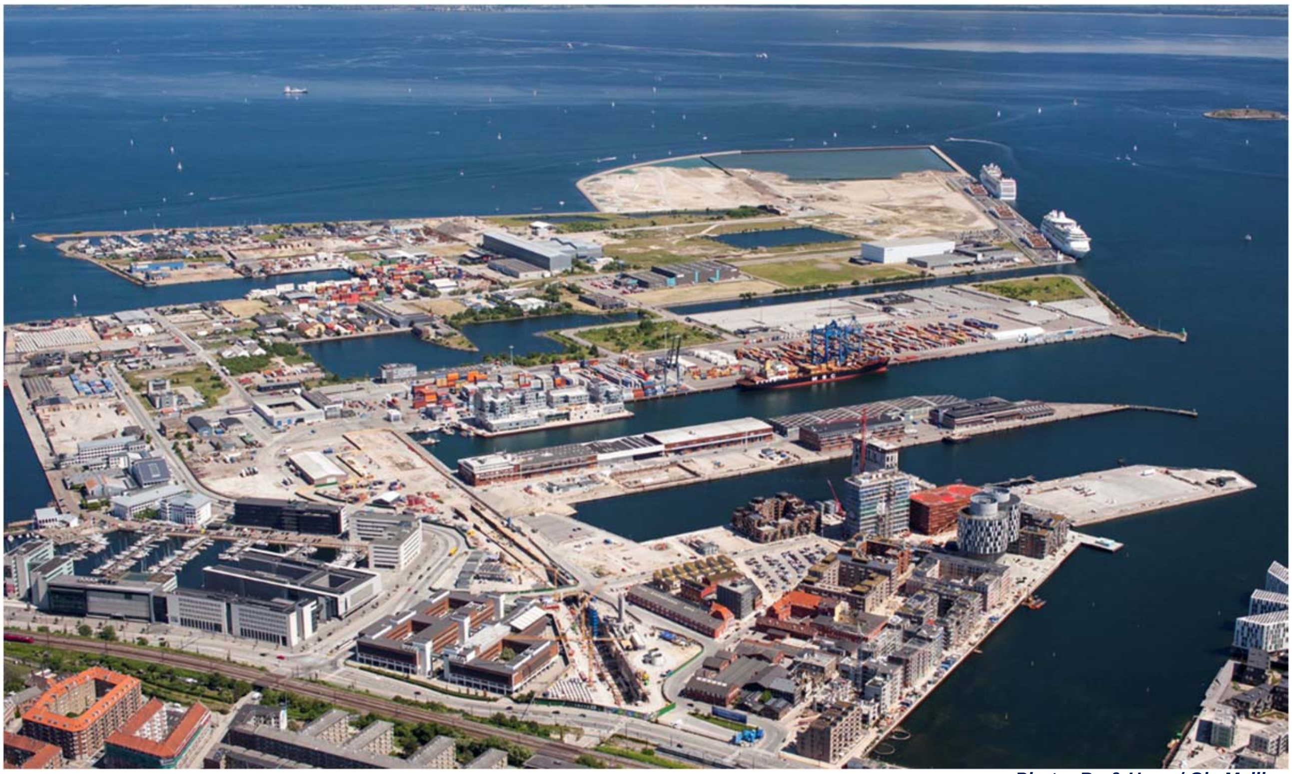
Delivery no.: D2.7a
MTBF or similar system stability analysis report



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DTU
Author, Anders Laage Kragh
Date 30-02-2019

Public deliverable ☒
Confidential deliverable ☐

Preface

EnergyLab Nordhavn – New Urban Energy Infrastructures is an exciting project which will continue until the year of 2019. The project will use Copenhagen's Nordhavn as a full-scale smart city energy lab, which main purpose is to do research and to develop and demonstrate future energy solutions of renewable energy.

The goal is to identify the most cost-effective smart energy system, which can contribute to the major climate challenges the world are facing.

Budget: The project has a total budget of DKK 143 m (€ 19 m), of this DKK84 m (€ 11 m) funded in two rounds by the Danish Energy Technology Development and Demonstration Programme (EUDP).

Forord

EnergyLab Nordhavn er et spændende projekt der løber til og med 2019. Projektet vil foregå i Københavns Nordhavn, og vil fungere som et fuldskala storbylaboratorium, der skal undersøge, udvikle og demonstrerer løsninger for fremtidens energisystem.

Målet er at finde fremtidens mest omkostningseffektive energisystem, der desuden kan bidrage til en løsning på de store klimaudfordringer verden står overfor nu og i fremtiden.

Budget: Projektets totale budget er DKK 143 mio. (EUR 19 mio.), hvoraf DKK 84 mio. (EUR 11 mio.) er blevet finansieret af Energiteknologisk Udviklings- og Demonstrationsprogram, EUDP.

Disclaimer

None

Project Information

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Task Leader: Benny Stougaard Hansen
WP Leader: Benny Stougaard Hansen
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Table of Contents

Resumé

In this deliverable the monitoring of the data warehouse solution is presented and data for the availability is shared.
Recommendation for improvements are presented in the conclusion.

Version Control

Version	Date	Author	Description of Changes
1.0	07-03-2019	Anders Laage Kragh	
1.1	08-03-2019	Benny Stougaard Hansen	First review
1.2	08-03-2019	Anders Laage Kragh	
1.3	08-03-2019	Benny Stougaard Hansen	Second review

Quality Assurance

Author	Reviewer	Approver
Anders Laage Kragh	Benny Stougaard Hansen	WPL group

Status of deliverable		
Action	**By**	**Date/Initials**
Sent for review	Anders Laage Kragh	**07-03-2019**
Reviewed	Benny Stougaard Hansen	**08-03-2019**
Verified	Benny Stougaard Hansen	**08-03-2019**
Approved	WPL group	**25-03-2019**

1. Introduction

In this document the observed stability of the data warehouse is reported. The data warehouse has been in operation since Q2 2018 and during this period 13 different data providers have been integrated into the data warehouse with more than 10.000 unique data sets. Further logged data from a temporary data store has been imported into the system. In the same period, the system has been further developed and improving the functionality. When evaluate the stability of the DMS system this has to be kept in mind.

2. Architecture and monitoring

The architecture of the system is described in delivery D2.1b Measurement system specification and in D2.6a: Specification of data collection system. An overview of the system is shown in Figure 1

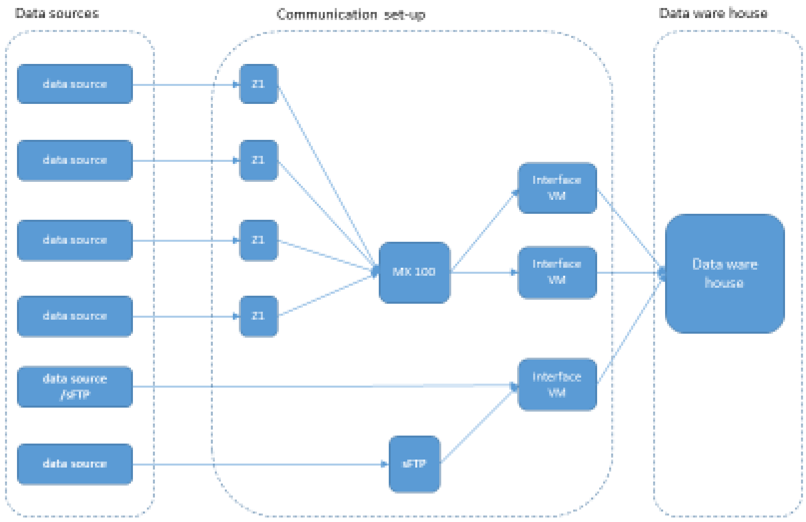

Figure 1 Data collection overview

A more detailed picture of the data ware house can be found in Figure 2

Figure 2 Core servers of energydata.dk

2.1 Monitoring by Prometheus

Monitoring of Energydata.dk is based on the Prometheus monitoring and alerting system. This system works by letting the components you wish to monitor expose a simple HTTP endpoint, which returns a collection of metrics in a simple text based format. A central Prometheus server scrape all exposed endpoints regular and in the Nordhavn solution every 15. second and store all the metrics as time series data.

The time series data is queried, and alert rules are configured to raise alarms for queries, which return values outside acceptable thresholds. Alerts will trigger the Prometheus alert manager and forward the alarm to the correct recipients through a variety of data media.

The metrics are made available in a dashboard created by the Grafana tool and are accessible via a web browser. From the dashboard the performance and health of the system is supervised. Examples from the dashboard are shown in Figure 3, Figure 4 and Figure 5.

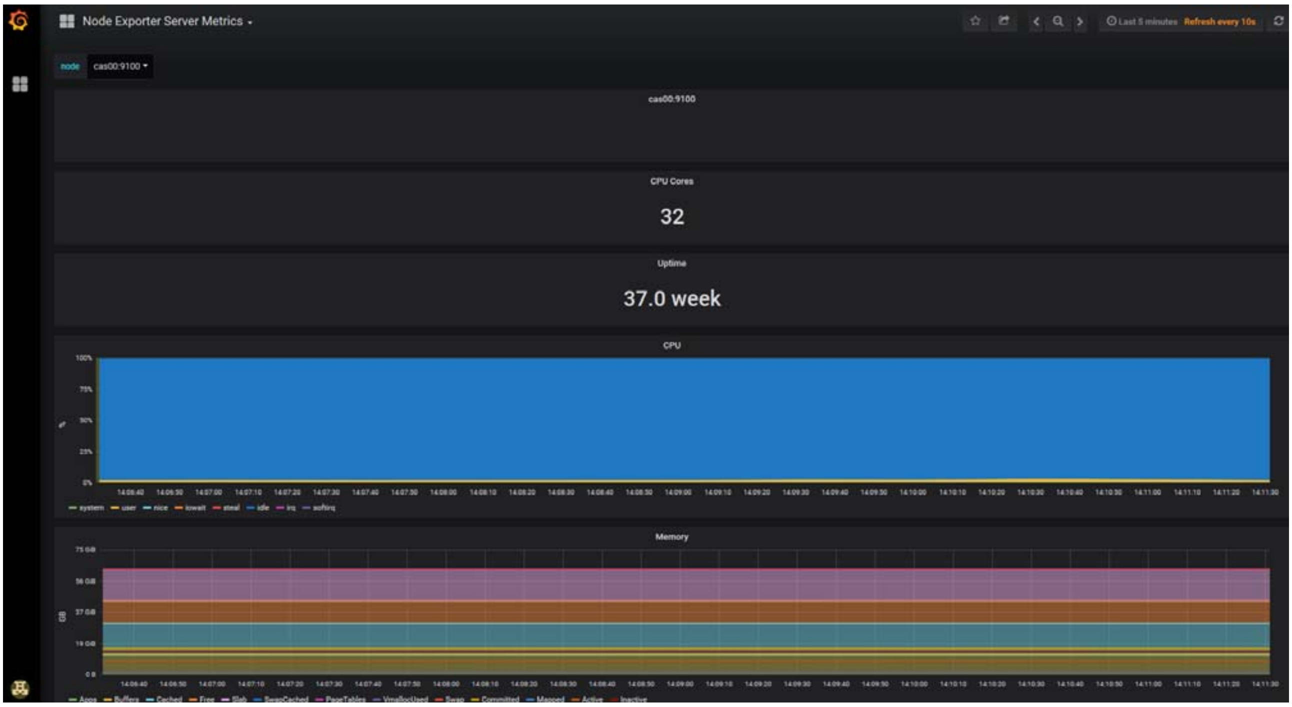

Figure 3 Uptime and CPU load

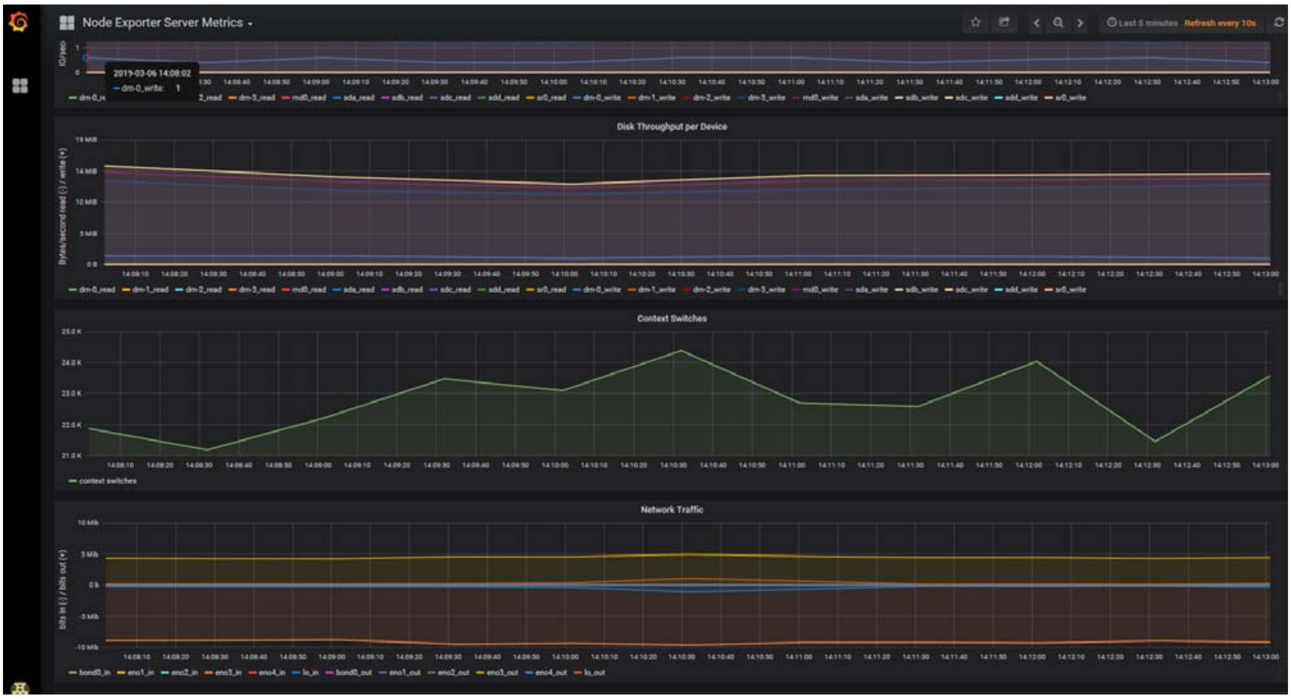

Figure 4 Disk and network performance

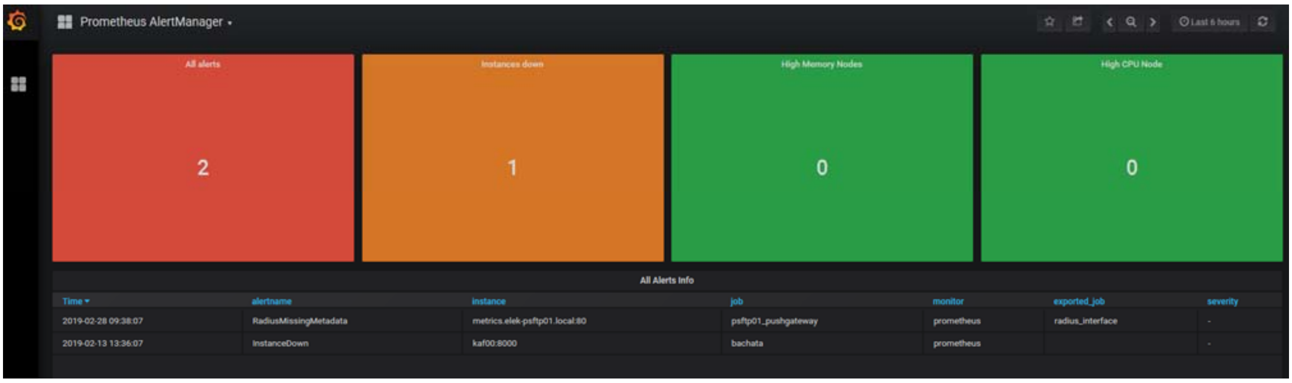

Figure 5 Alarm overview

All 8 servers making up the core of energydata.dk (see Figure 2) and the interface VM, see Figure 1 are supervised by Prometheus. Further these major key software components are supervised:

- VerneMQ – the MQTT broker for the system, receiving and sending MQTT telegrams
- Kafka – handling the MQTT streams from VerneMQ and enrich these data stream (telegrams) with relevant metadata before forward to the Cassandra database
- Bachata – own developed component for the Kafka process, required for Kafka

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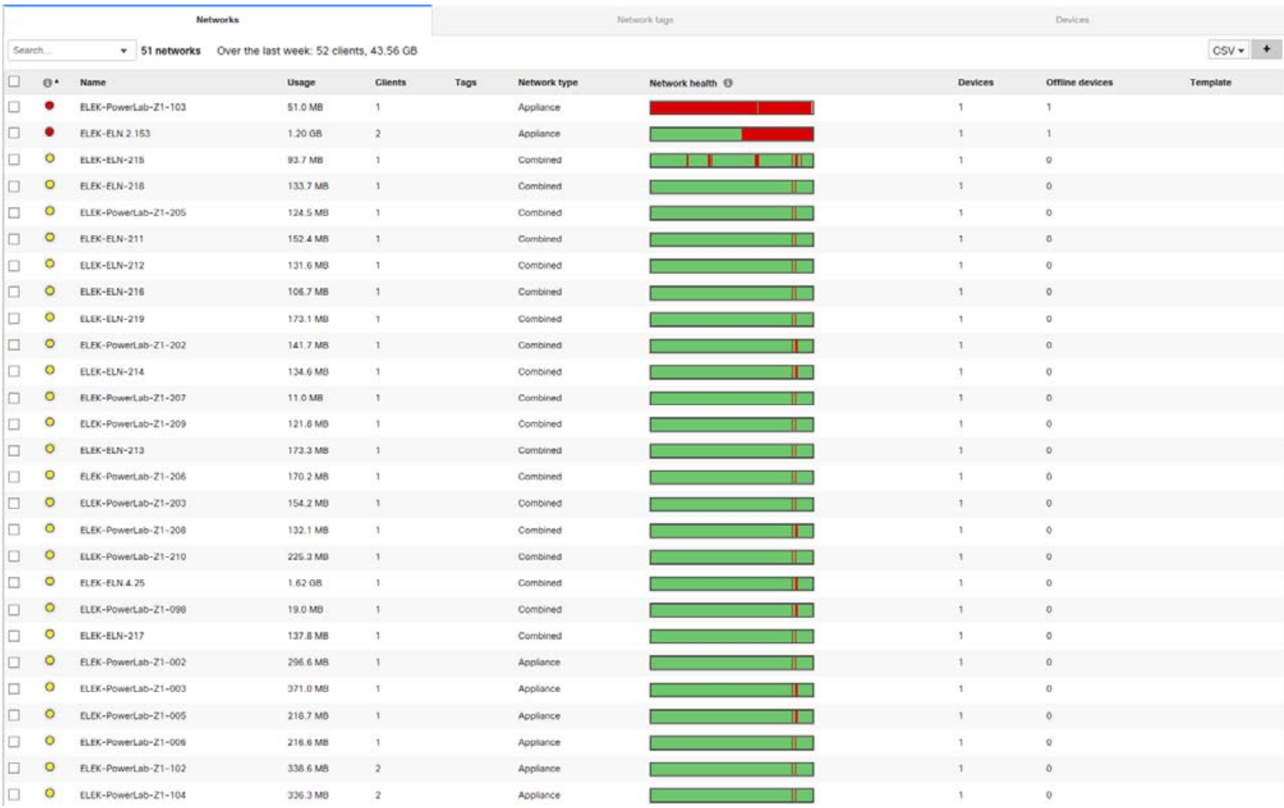
2.2 Monitoring be Meraki Dashboard

The communication between the datawarehouse and the installations in Nordhavn is monitored by the Meraki Dashbord. In Figure 6 the overview is presented showing the availability the last week.



Networks | Network tags | Devices

Search... ▾ 51 networks Over the last week: 52 clients, 43.56 GB CSV ▾

Name	Usage	Clients	Tags	Network type	Network health	Devices	Offline devices	Template
ELEK-PowerLab-Z1-103	51.0 MB	1		Appliance		1	1	
ELEK-ELN.2.153	1.20 GB	2		Appliance		1	1	
ELEK-ELN-215	93.7 MB	1		Combined		1	0	
ELEK-ELN-218	133.7 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-205	124.5 MB	1		Combined		1	0	
ELEK-ELN-211	152.4 MB	1		Combined		1	0	
ELEK-ELN-212	131.6 MB	1		Combined		1	0	
ELEK-ELN-216	106.7 MB	1		Combined		1	0	
ELEK-ELN-219	173.1 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-202	141.7 MB	1		Combined		1	0	
ELEK-ELN-214	134.6 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-207	11.0 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-209	121.8 MB	1		Combined		1	0	
ELEK-ELN-213	173.3 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-206	170.2 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-203	154.2 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-208	132.1 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-210	225.3 MB	1		Combined		1	0	
ELEK-ELN.4.25	1.62 GB	1		Combined		1	0	
ELEK-PowerLab-Z1-098	19.0 MB	1		Combined		1	0	
ELEK-ELN-217	137.8 MB	1		Combined		1	0	
ELEK-PowerLab-Z1-002	296.6 MB	1		Appliance		1	0	
ELEK-PowerLab-Z1-003	371.0 MB	1		Appliance		1	0	
ELEK-PowerLab-Z1-005	218.7 MB	1		Appliance		1	0	
ELEK-PowerLab-Z1-006	216.6 MB	1		Appliance		1	0	
ELEK-PowerLab-Z1-102	338.6 MB	2		Appliance		1	0	
ELEK-PowerLab-Z1-104	336.3 MB	2		Appliance		1	0	

Figure 6 Meraki Dashboard, overview

As it can be seen in Figure 6 most networks are available but all have an incident at the same time, as seen as the tiny red line. This is due to an incident at the central router which can be seen Figure 7.

Figure 7 Status for central Meraki router

As shown in Figure 6 device ELN-215 has some “hick ups” which is seen as the red blocks. A more detailed look into ELN-215 is presented in Figure 8.

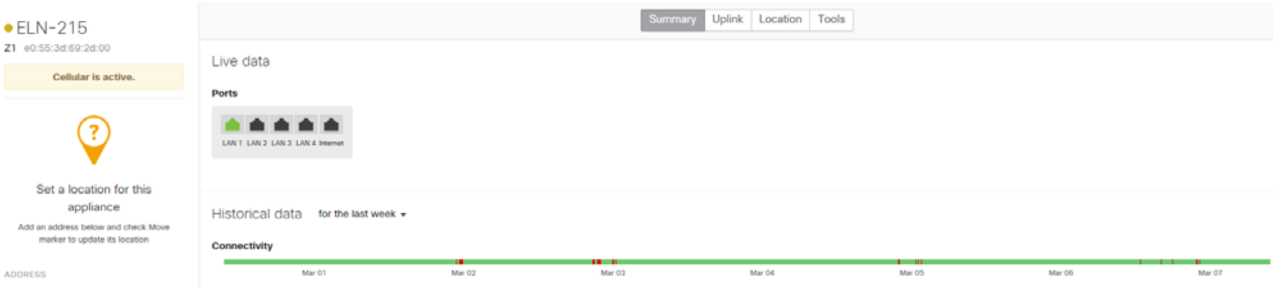


Figure 8 ELN-215 availability for 1 week

A more detailed analysis is needed if the root cause for the un-availability is required as it could be caused by many issues, e.g. the cellular network.

In Figure 9 the live traffic for ELN-215 is shown.

Figure 9 Live traffic from ELN-215

By using the Meraki Dashboard the network status is supervised and further the dashboard can be used for trouble shooting.

3. System stability

The system stability can be evaluated by looking at the server availability and the flow of “measurement” / “data telegrams” in the system.

As per March 2019 the uptime for the system can be found in Table 1

Server	Uptime (hours)
Cas-0	6216
Cas-1	6216

Cas-2	4822
Kaf-0	4754
Kaf-1	4754
Zoo-0	6888
Zoo-1	6888
Zoo-2	6888

Table 1 Server uptime

The flow of ”data telegrams” is presented both as the accumulated (over a period) and as “data telegrams” per seconds. In Figure 10 the data telegrams per second is shown. It must be noted that “VerneMQ” receives data telegrams from the interface applications and forward them to “Kafka” which handle the insertion into the Cassandra database. Therefore “VerneMQ” has both a received and sent metric.

Figure 10 Data telegrams per second

An example of the accumulated number of telegrams is shown in Figure 11. As it can be seen, there was an incident on the system from 15-02-2019 to 18-02-2019 (over a week-end) where no data telegrams were processed. This is seen as the horizontal line and the “dip”. However, as data telegrams are logged at the interface applications as backup, these data could later be processed and stored in the database.

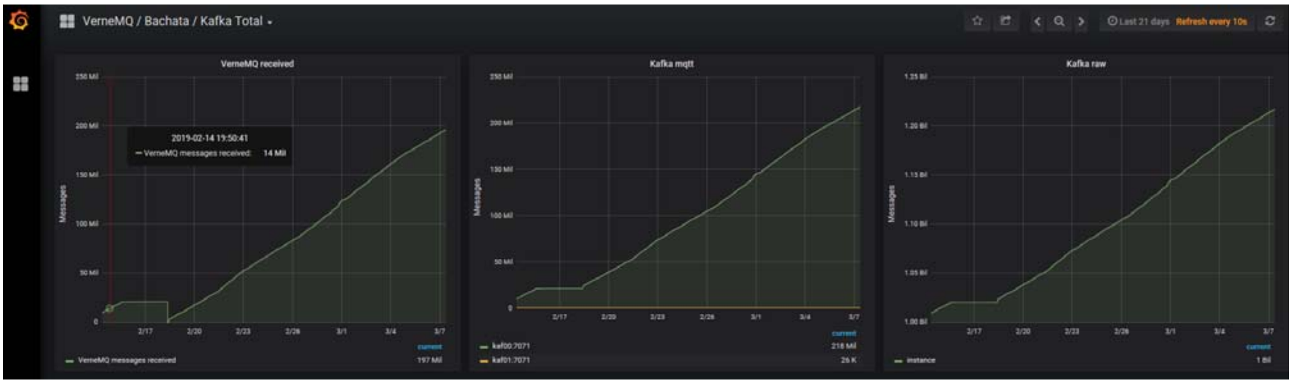


Figure 11 Accumulated telegrams for a 2 week period

The communication network(s) availability is supervised by the Meraki Dashboard and availability is presented for all networks, as shown in Figure 6 and per network (device) as shown in Figure 8.

4. Conclusion

Given that the data warehouse and communication network is:

- still under development
- new functionality and new data sources have been and are added to the system
- it is an experimental system
- the system has not been handed over to a "Operation and Maintenance" team

the stability and availability of the solution is deemed to be acceptable. Experience as shown that the "weak link" is the locally deployed equipment (Meraki router, KNX gateway, Kamstrup meters) because incident at these devices often require on-site trouble shooting which however very often is as simple as turning on the device again if it accidentally has been turned off. These incidents are however locally and does not affect the complete system availability. To improve system availability the following is recommended:

- Create a "operation and maintenance team" and hand over the operation of the system to this team, to separate the development and operation of the system
- Improve the robustness of local deployed equipment from being turned off or locally operated