Team AquaFu (Aperio)

Data Science on Water Data

Analysis of water quality problems - a challenge

- Water Quality sensors, Flow sensors
- Sensors of different types on different pipes.
- Unlabeled data.

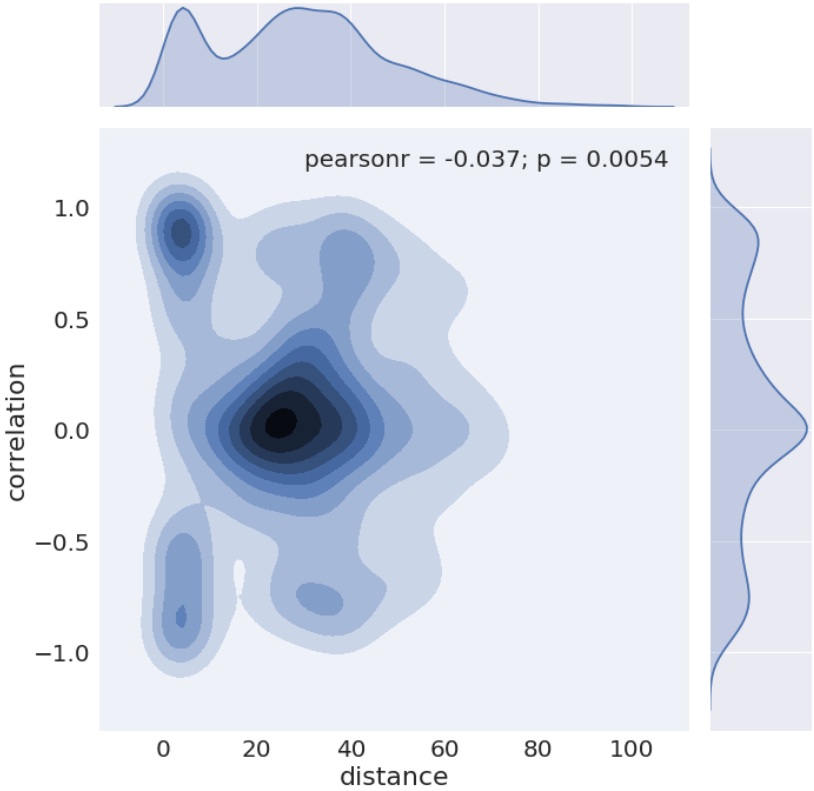
Tools

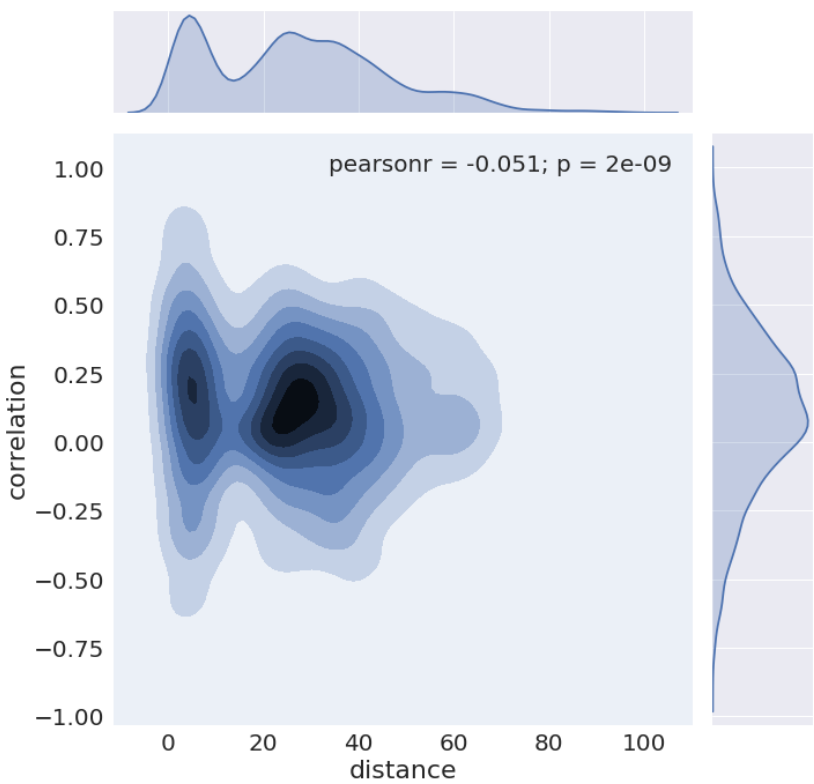
Python - Pandas, scikit-learn, jupyter notebook

Python - OSISOFT PI Web API library (written by Marcos Loeff)

Elasticsearch + Kibana. Python code written to Export PI to Elasticsearch

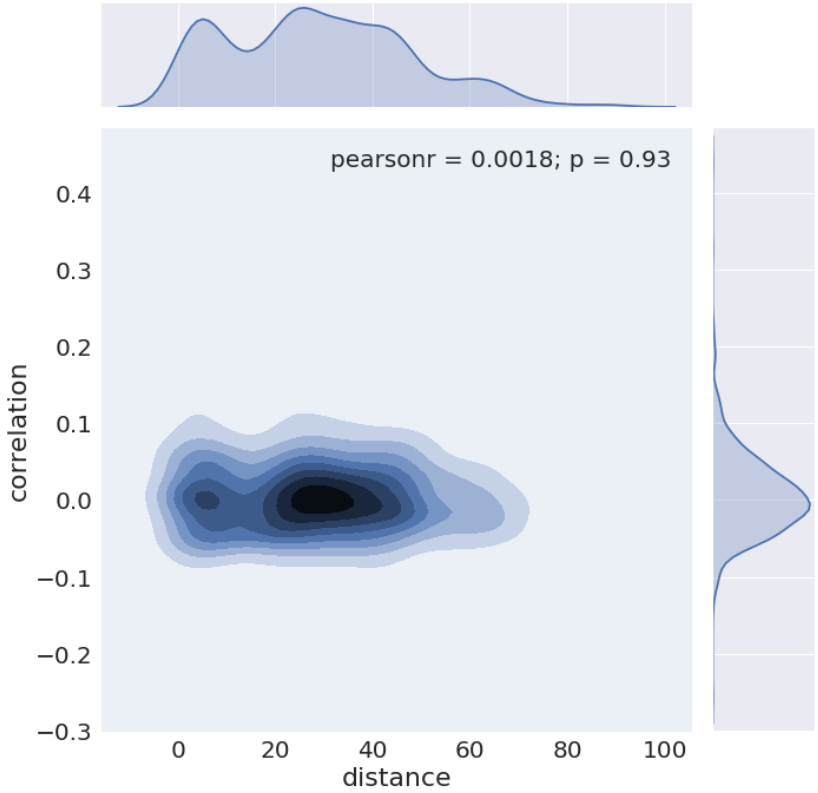
Correlate the Flow Rate & Temperature vs Dist (km)

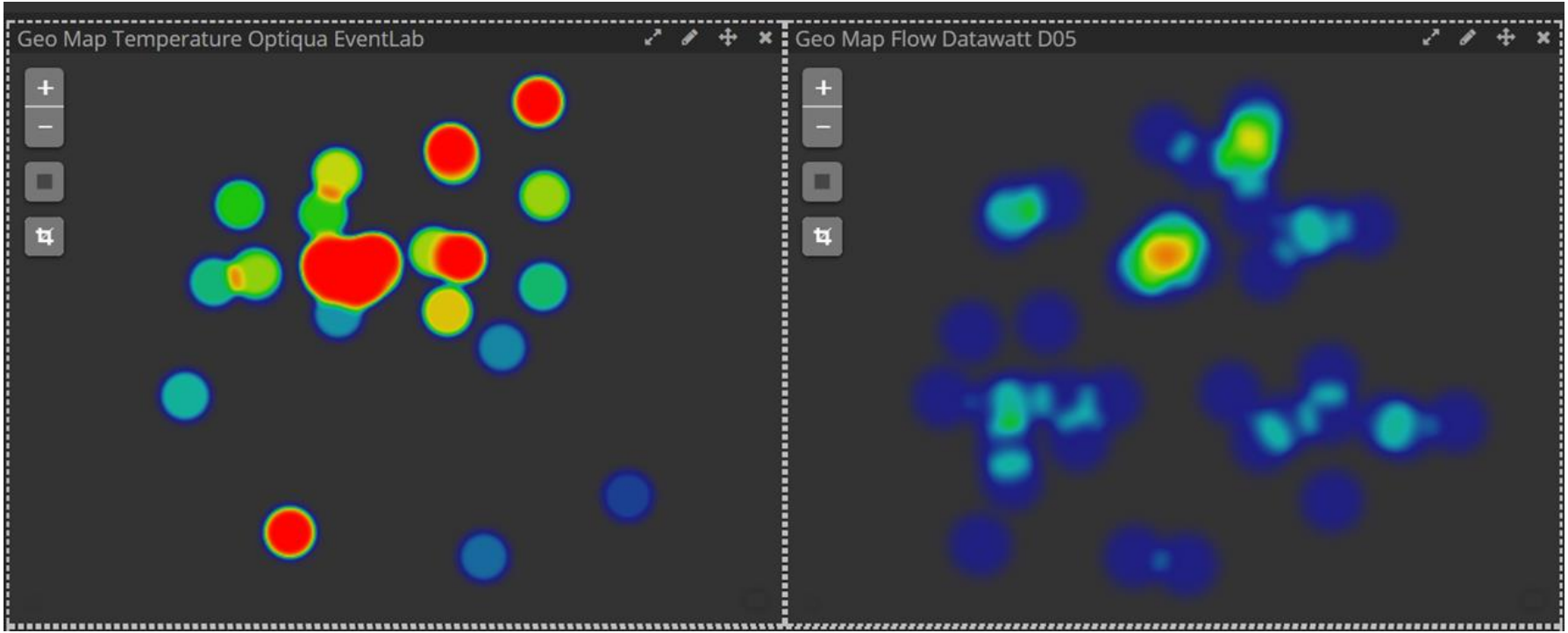




Correlate the Water Quality (Optical Refraction)

Distance - km




Geo Map Temperature Optiqua EventLab
Geo Map Flow Datawatt D05

Timestamp per 12 hours
DOCeq2 histogram
mg/L
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10
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Timestamp per 12 hours
Location FR-MSBA
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Location FR-MWIA
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Turb_EPA histogram
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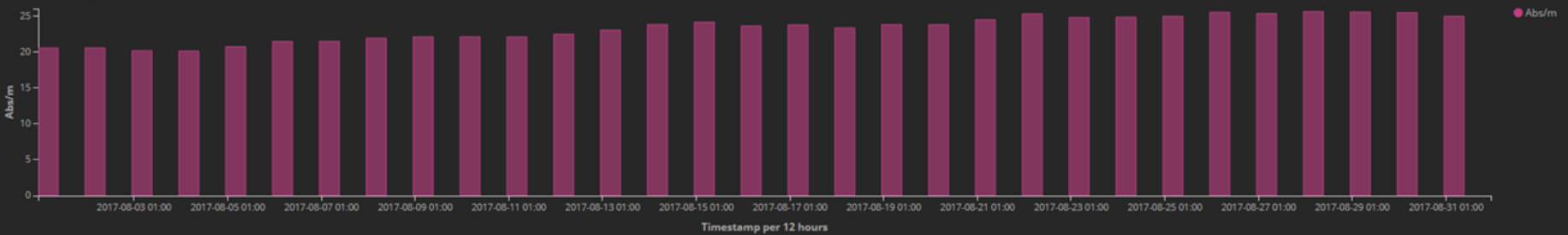
Timestamp per 12 hours
Location FR-MSBA
Location FR-MRSJ
Location FR-MRGR
Location FR-MRSH
Location FR-MWIA
Location FR-MFRI
Location FR-MNBU

Timestamp per 12 hours

ColorApp Histogram



Timestamp per 12 hours

Intellitect Intellisonde / ORP table

Site Name	Units	Min Value	Max Value	Average Value
Location FR-RLWG1	milliV	153	417	336.935
Location FR-RFNK1	milliV	227	362	329.871
Location FR-PNB_2	milliV	119	356	309.948
Location FR-PNB_1	milliV	178	349	302.258
Location FR-OWIR1	milliV	211	338	305.194

Intellitect Intellisonde / Conductivity table

Site Name	Units	Min Value	Max Value	Average Value
Location FR-RLWG1	uS/cm	528.545	549	537.792
Location FR-RFNK1	uS/cm	511	565	540.032
Location FR-PNB_2	uS/cm	547	658	602.911
Location FR-PNB_1	uS/cm	291	298.444	292.821
Location FR-OWIR1	uS/cm	525	561	542.001

Optiqua EventLab table

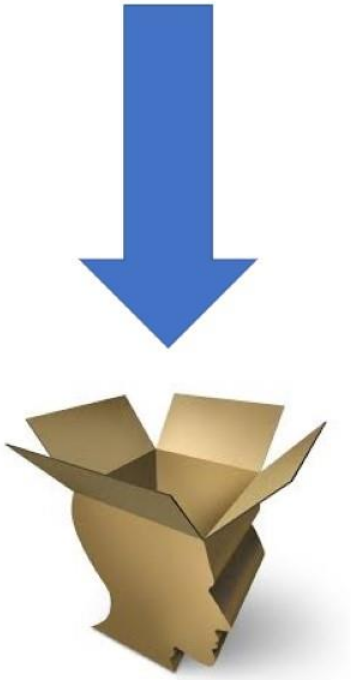
Site Name	Units	name	Max Value	Average Value
Location FR-MOZSI	rad/s	NOR3	0.023	0.005
Location FR-MOZSI	rad/s	NOR2	0.013	0.003
Location FR-MOZSI	rad/s	NOR1	0.038	0.01
Location FR-MOZBG	rad/s	NOR3	0.01	0.002
Location FR-MOZBG	rad/s	NOR2	0.01	0.002
Location FR-MOZBG	rad/s	NOR1	0.01	0.001
Location FR-MOZB2	rad/s	NOR3	0.086	0.014
Location FR-MOZB2	rad/s	NOR2	0.066	0.006

Thanks!

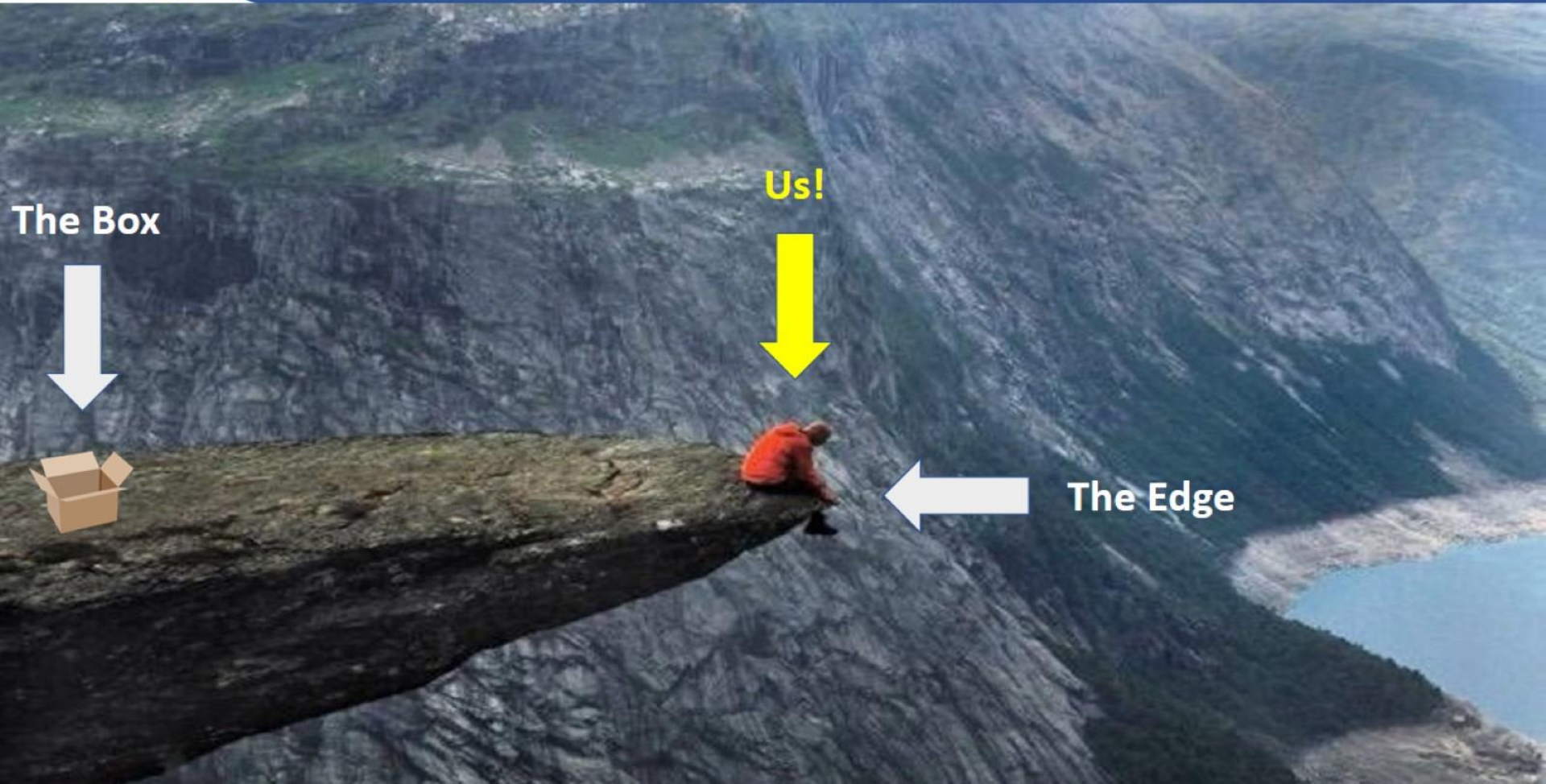
Life On The Edge

Background

A box



Our Thinking…

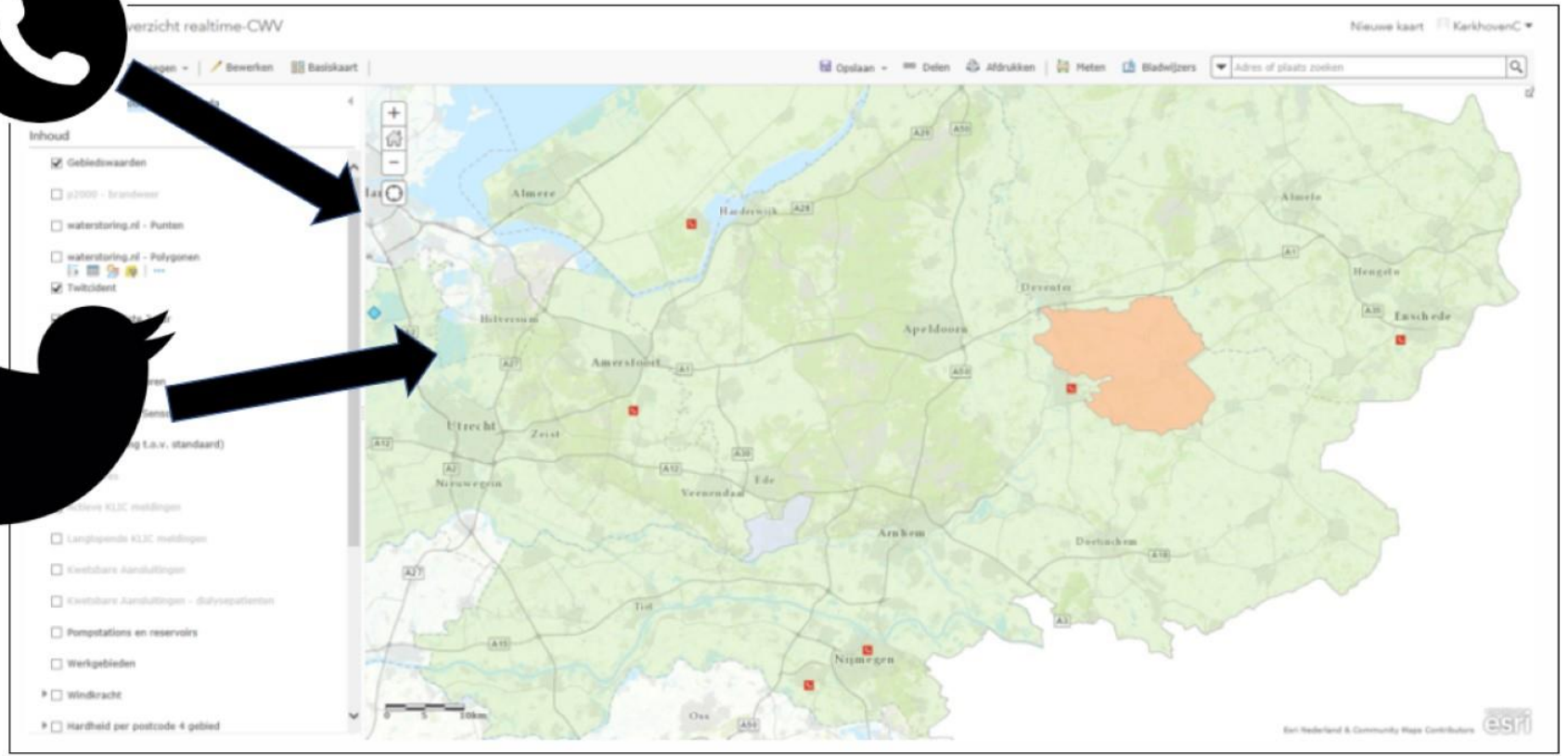

The Box
Us!
The Edge

Powered by the PI System

Water **E**nvironment for **S**mart **T**echnology

Our Inspiration - Existing “Real-Time” Map

https://sw4eu.com/vitens_real_time_map_production/



Our Inspiration – Amazon “Dash” (Dash Replenishment Service)

Our Inspiration – Amazon “Dash” (Dash Replenishment Service)

“Never forget a consumer’s telemetry again”

Open Edge Module Beta Program

- Open Source
- Built on Linux
- Micro Services

Come talk to us in the Networking Lounge!
2nd Floor Mezzanine Foyer, Day 1 - 3

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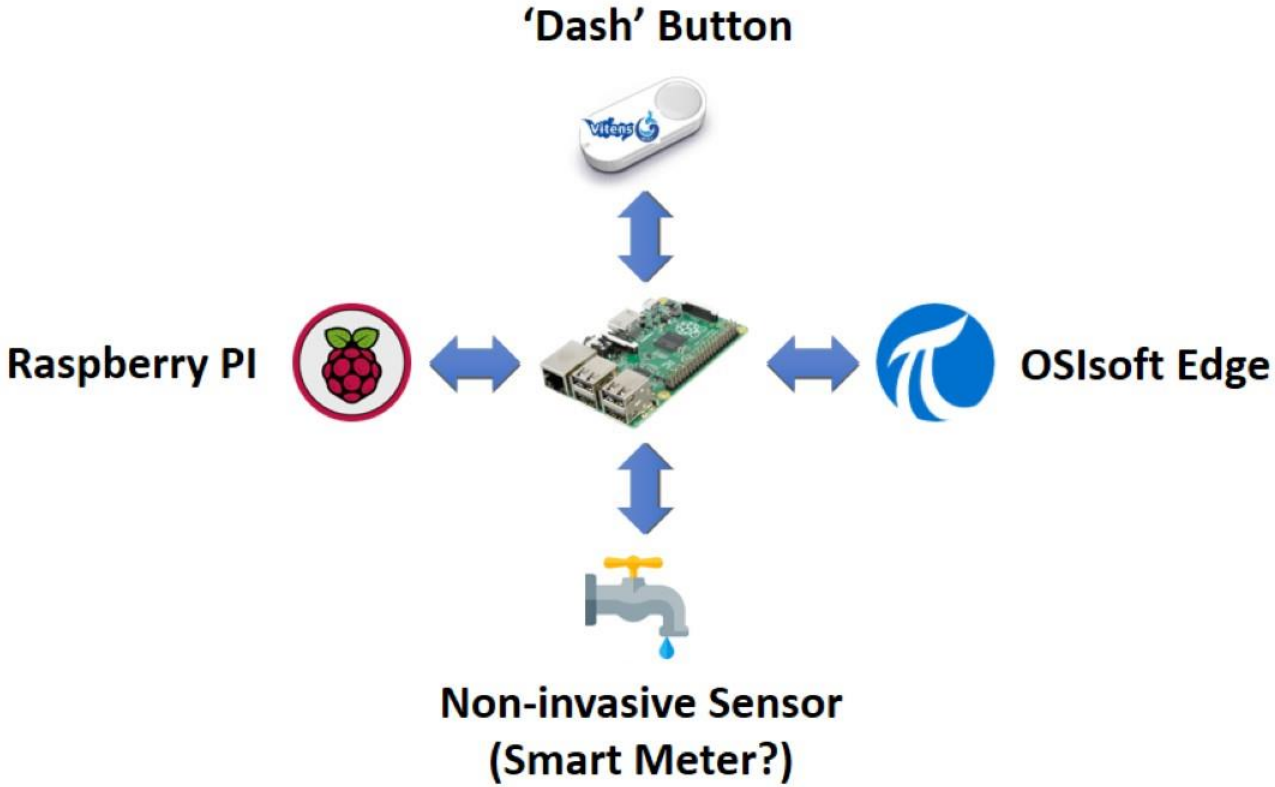
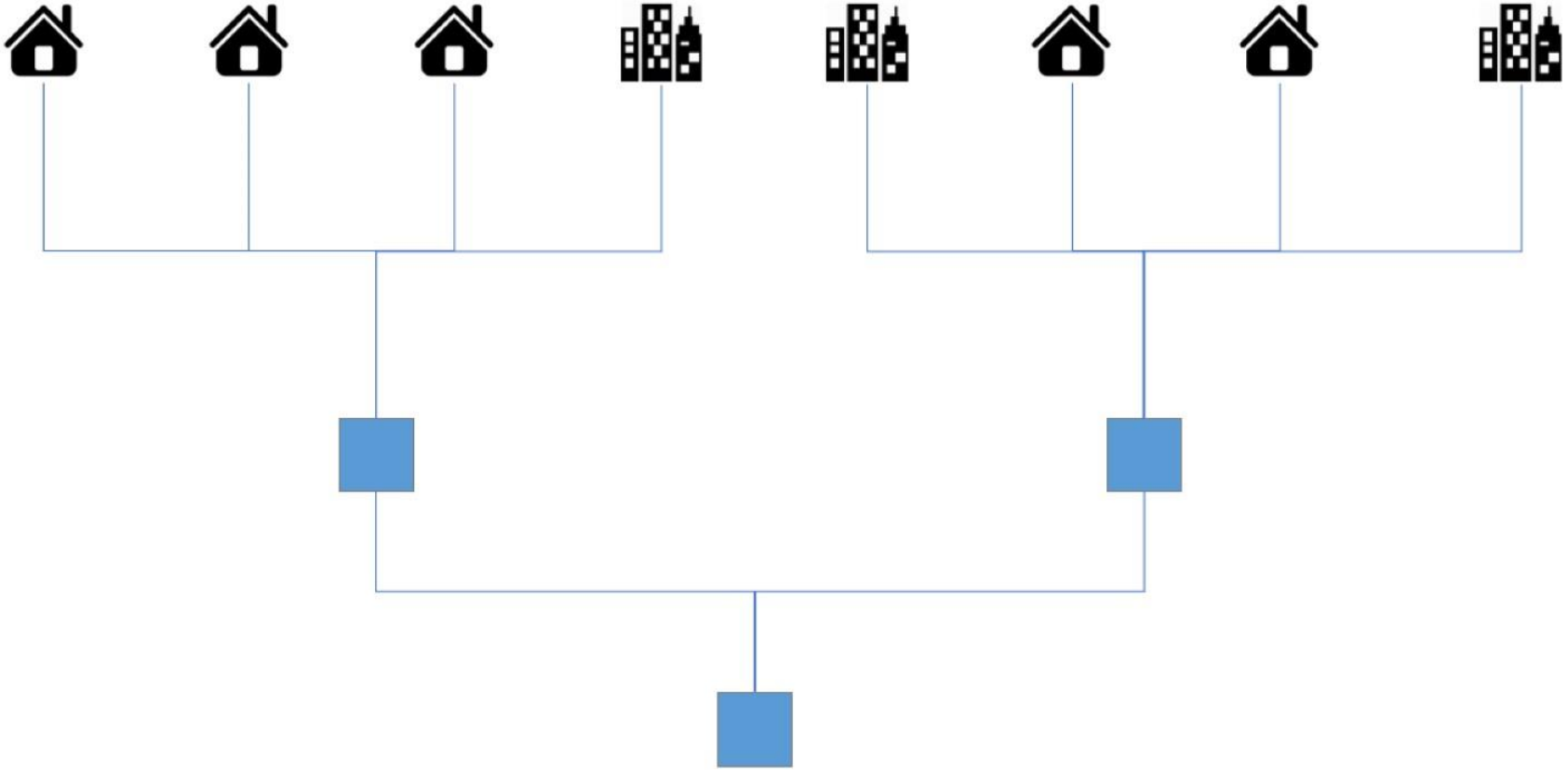
Conceptual Overview



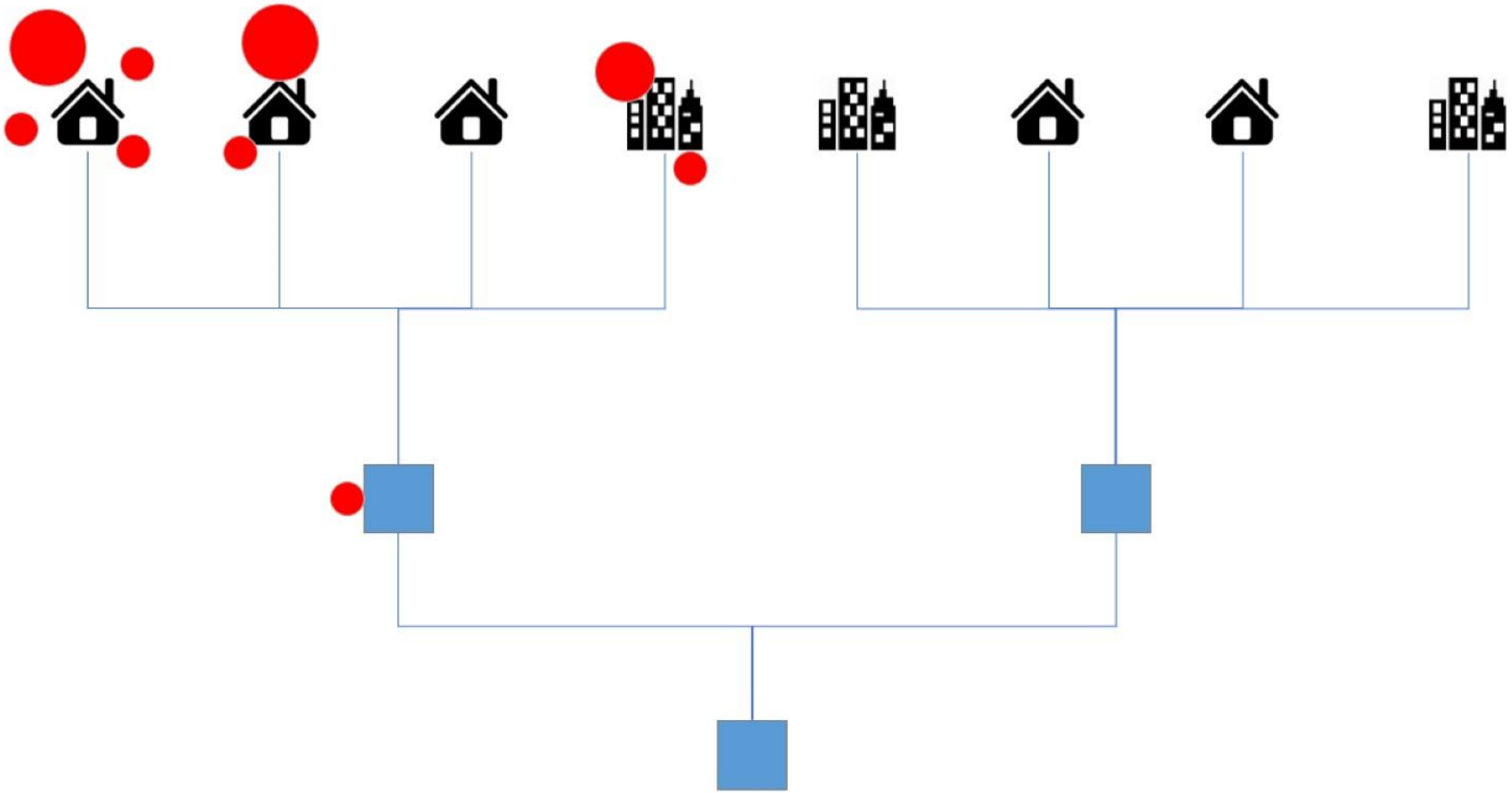
Conceptual Overview

Vitens
WEST

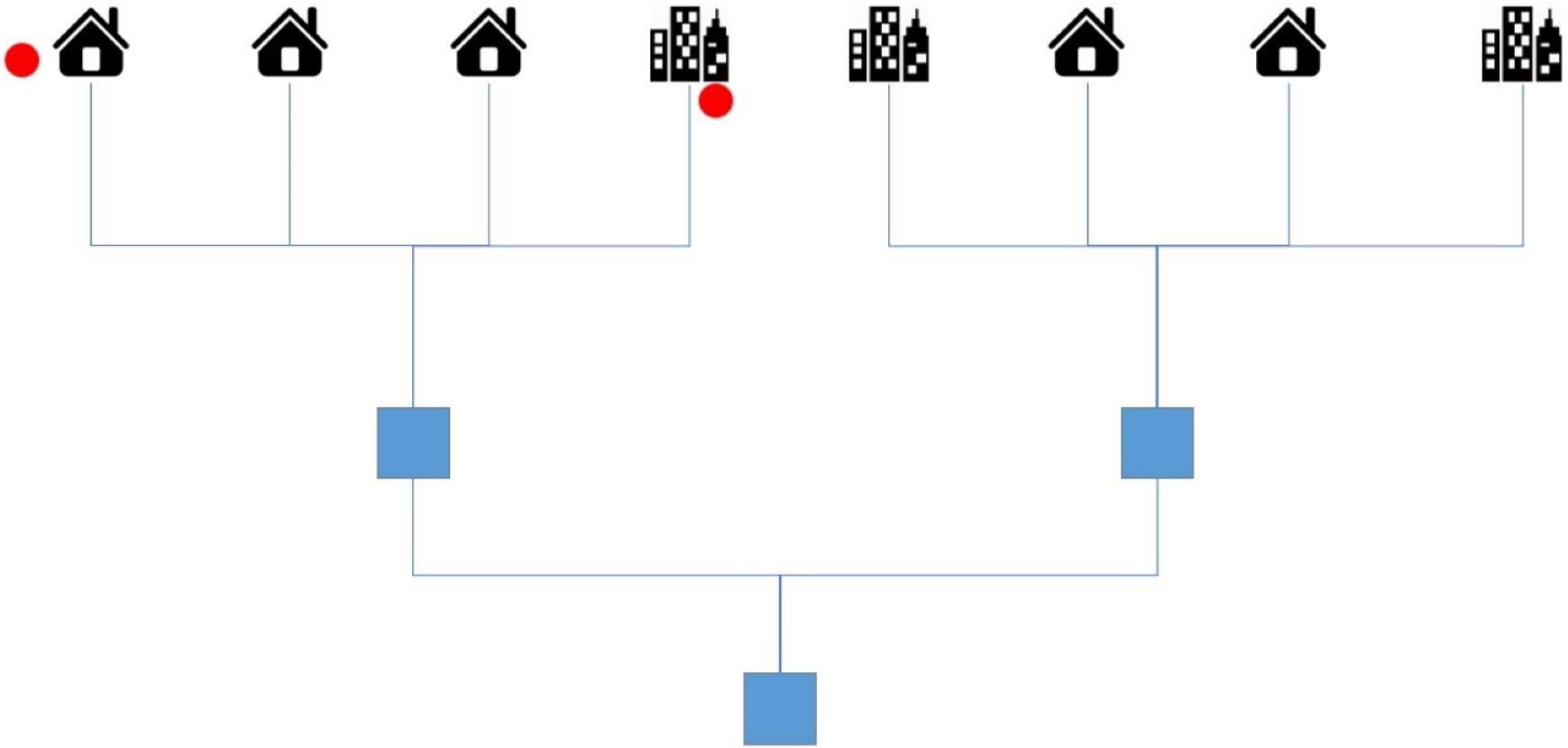
Conceptual Overview - Expanded



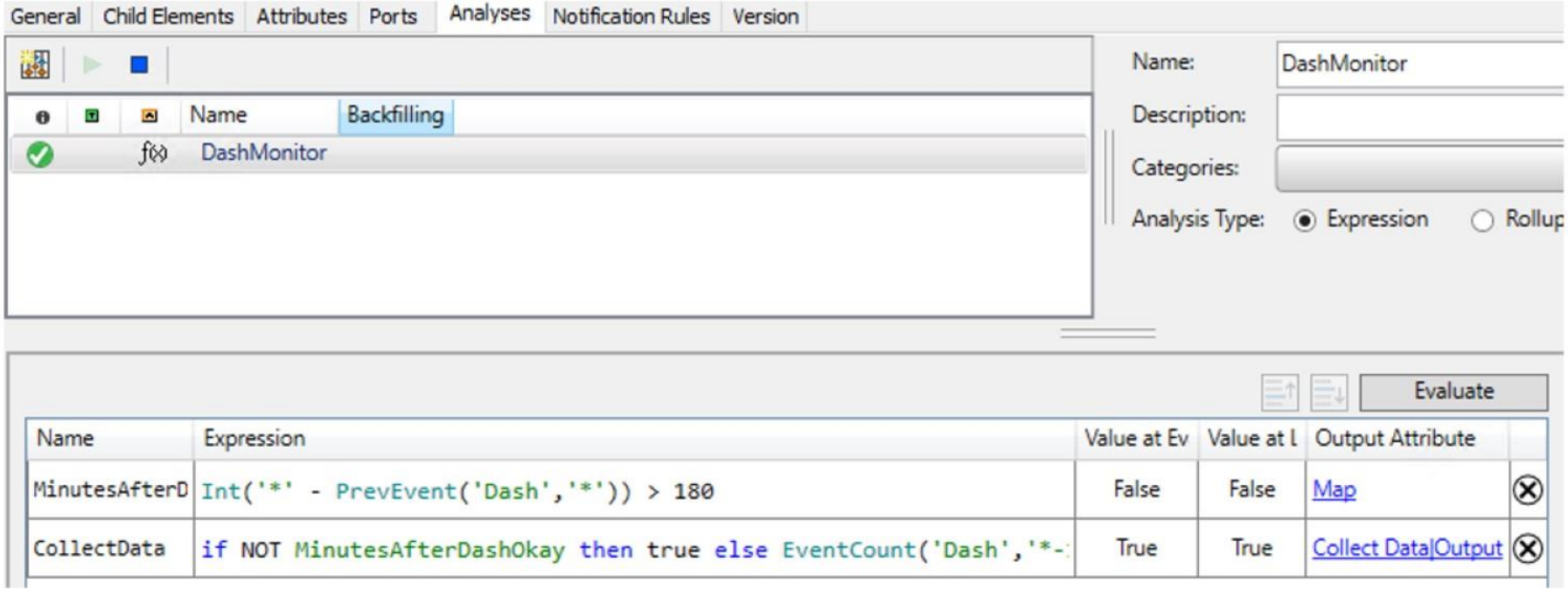
Conceptual Overview - Expanded



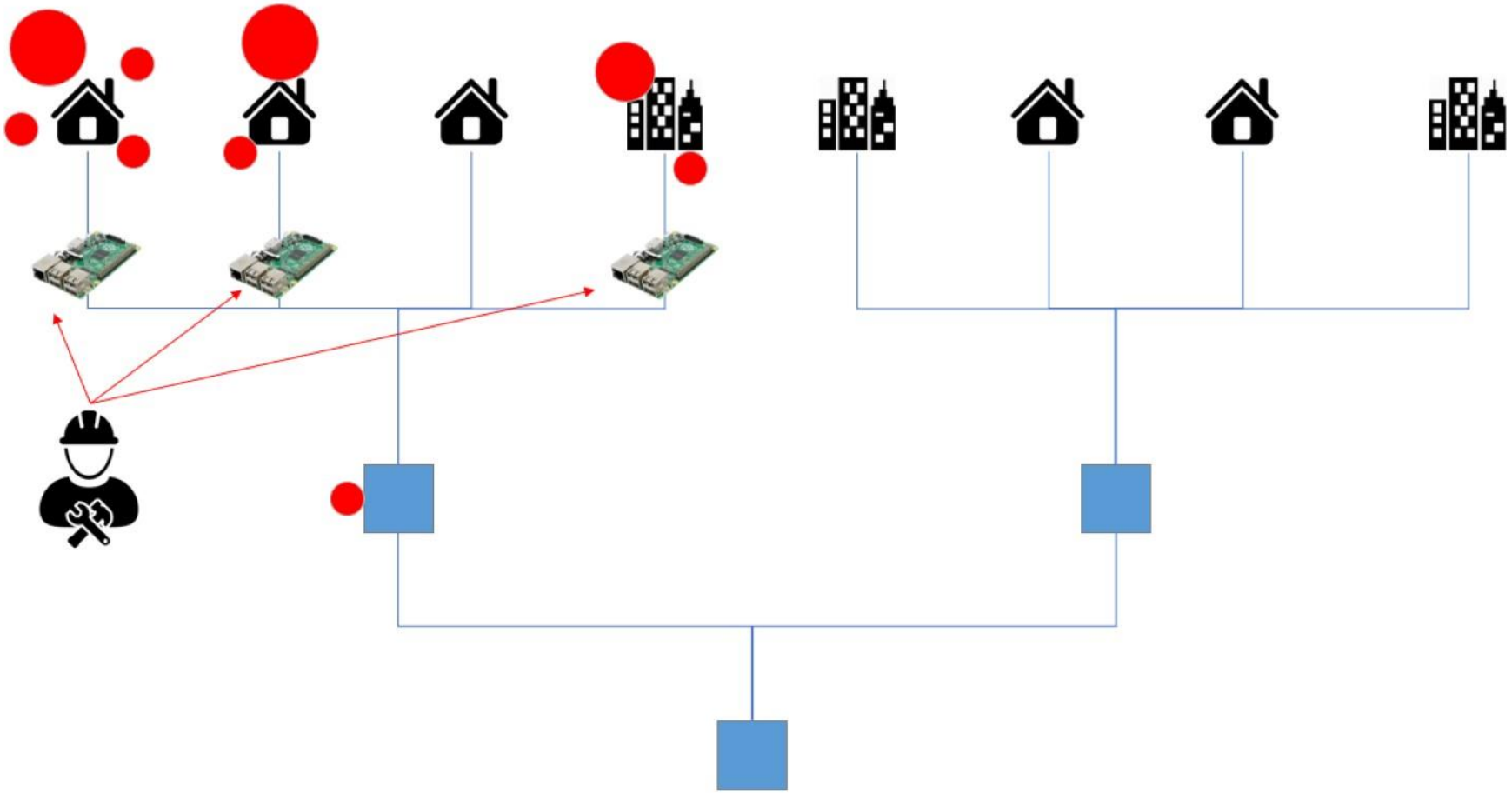
Conceptual Overview - Expanded



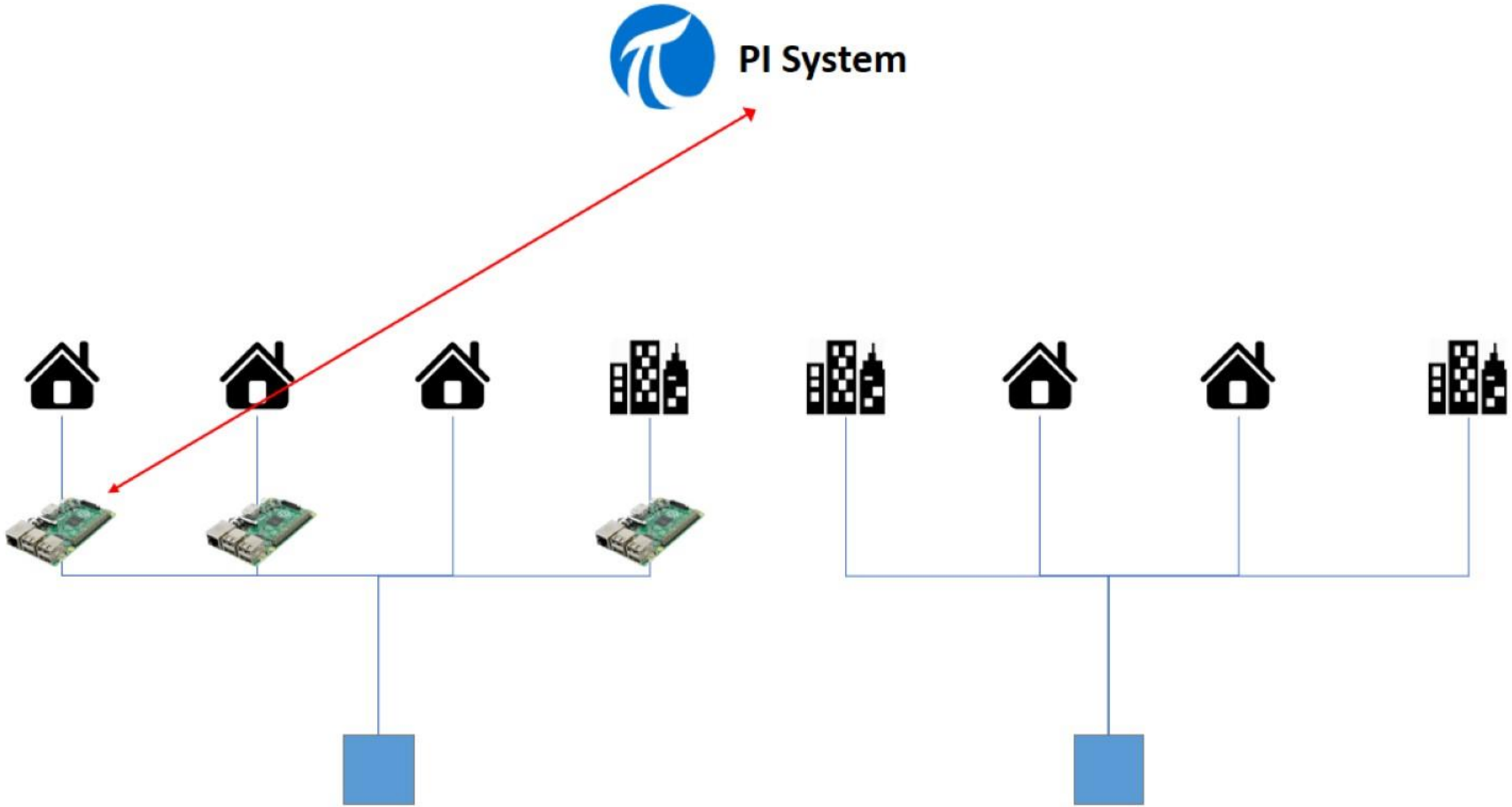
AF Analyses – Calculation output determines when to collect



Conceptual Overview - Expanded

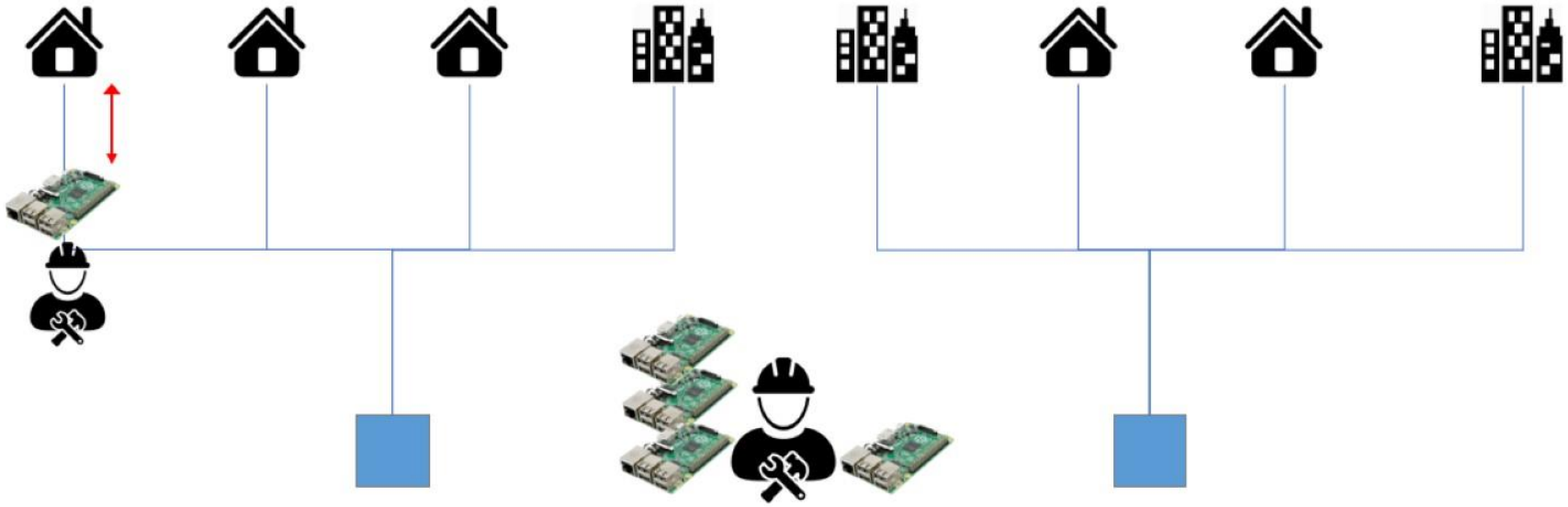


Conceptual Overview - Expanded

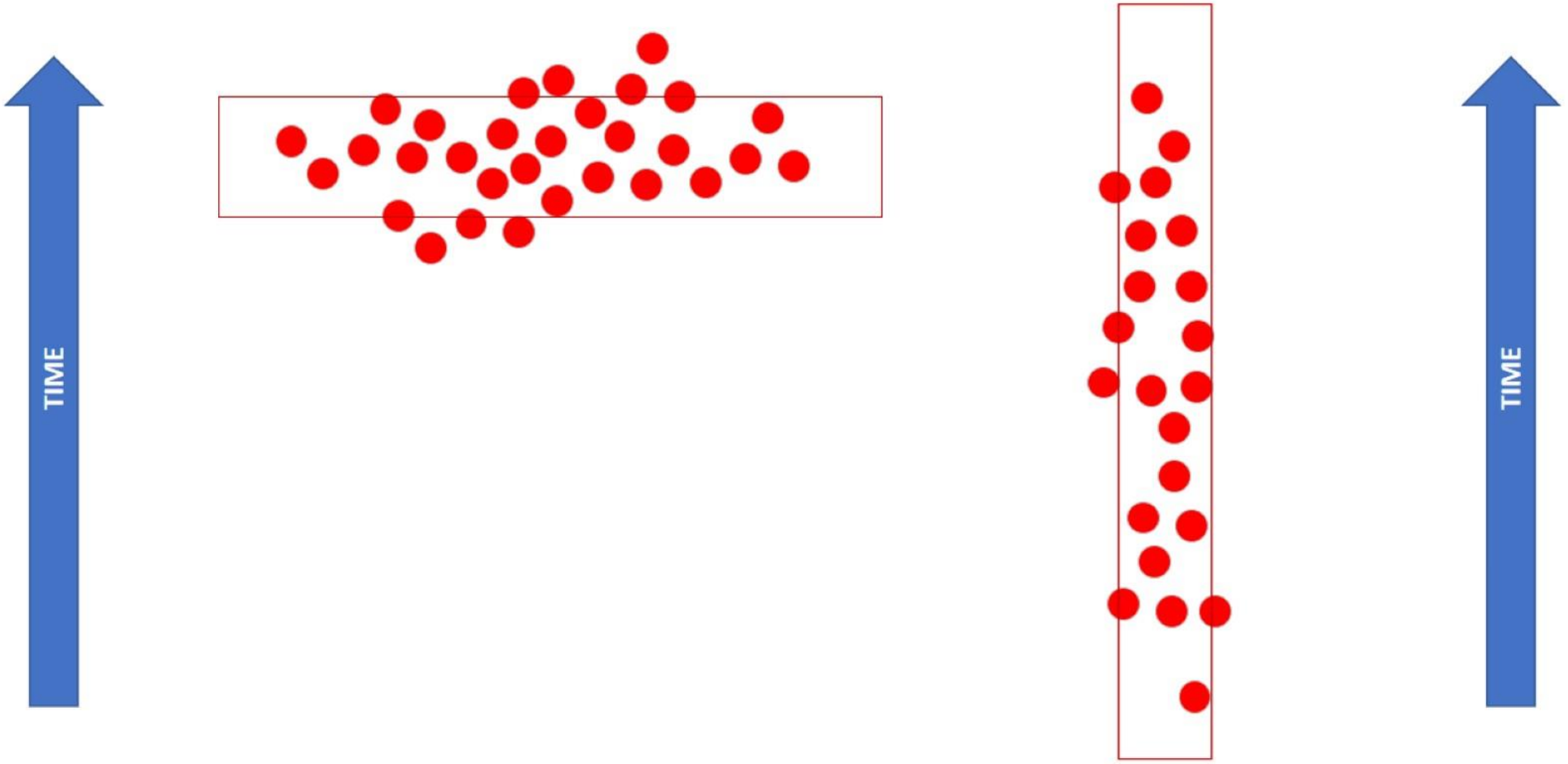


Conceptual Overview - Expanded

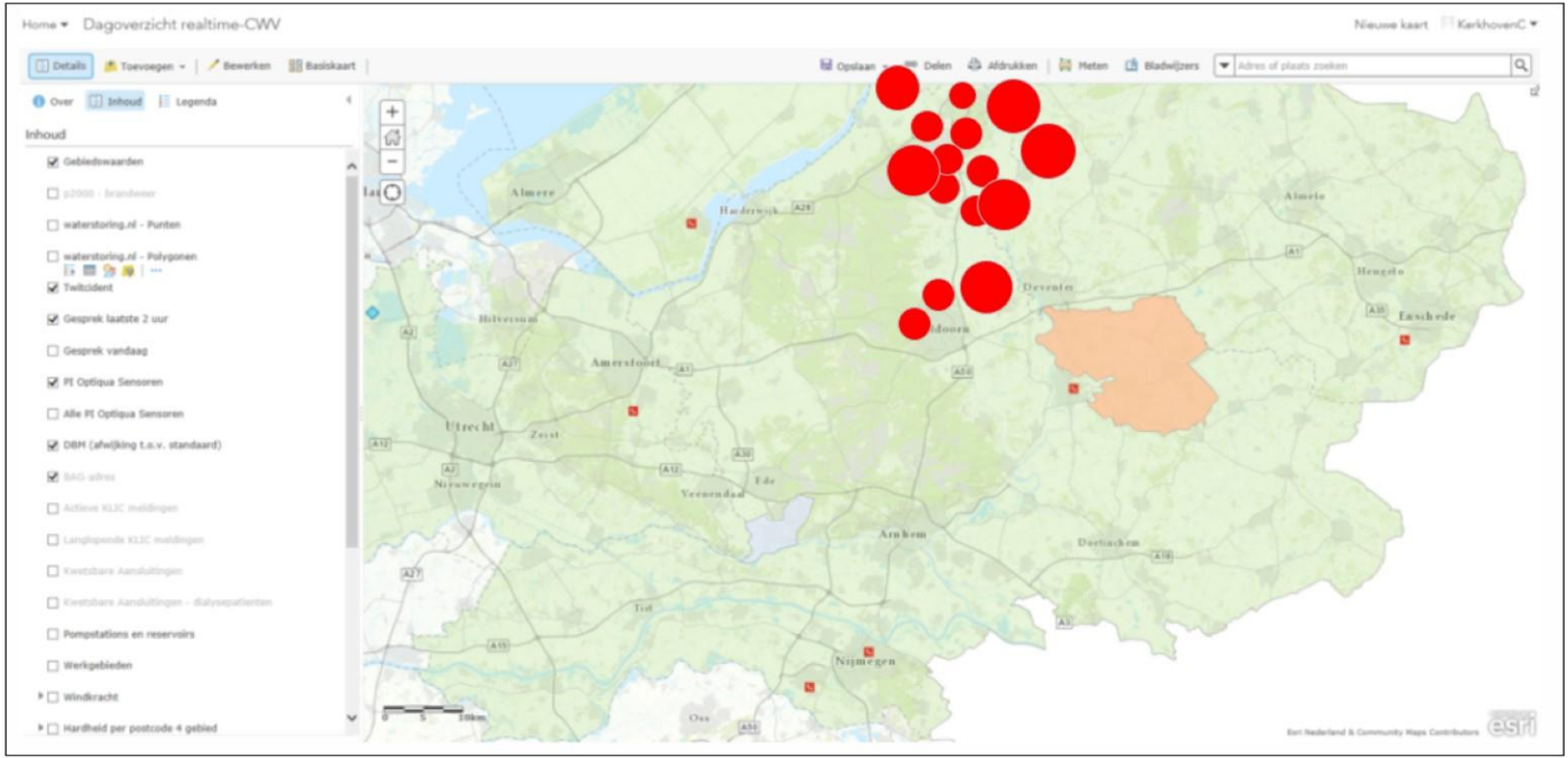
PI System



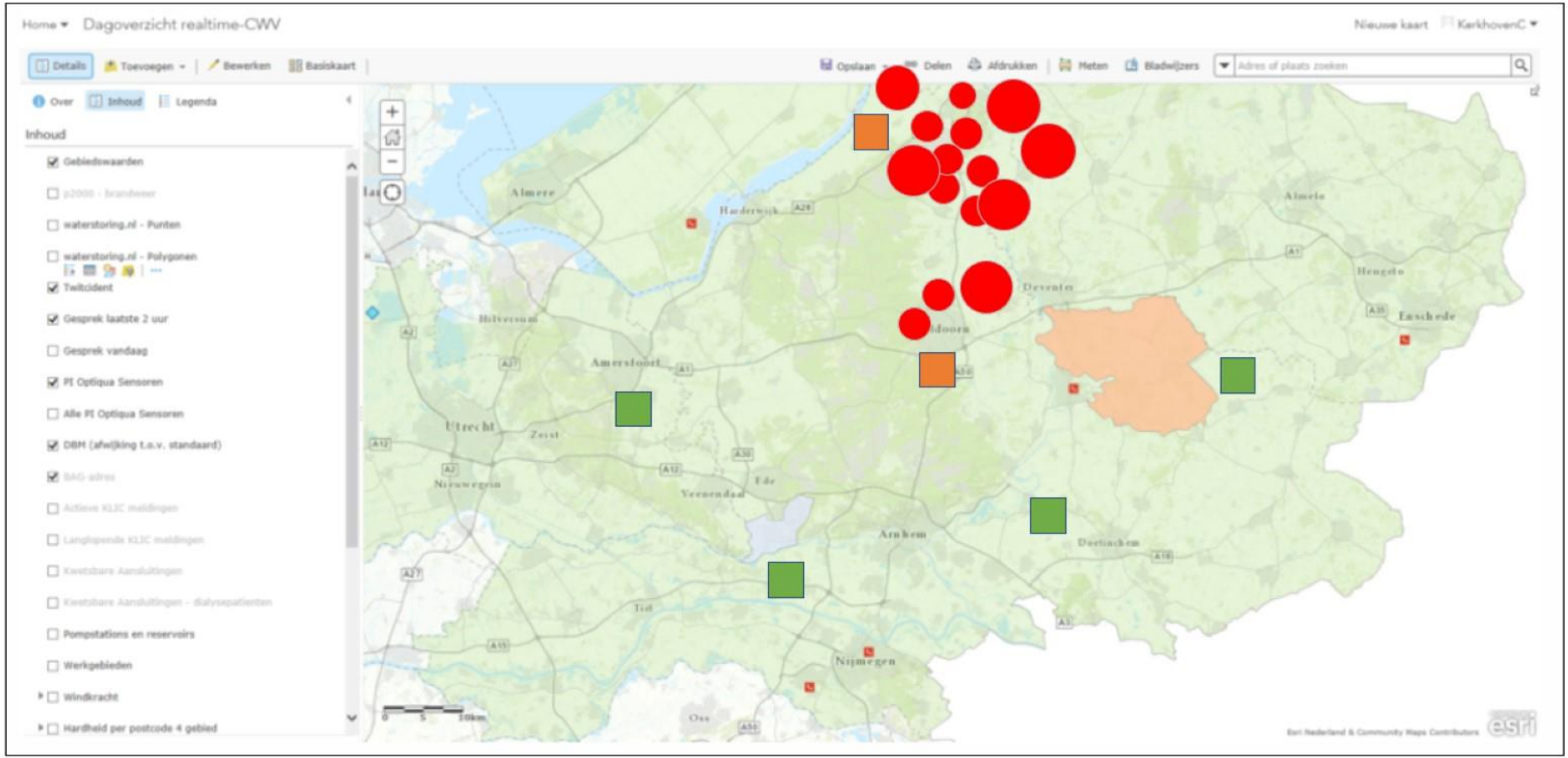
Acute vs Chronic Dashes



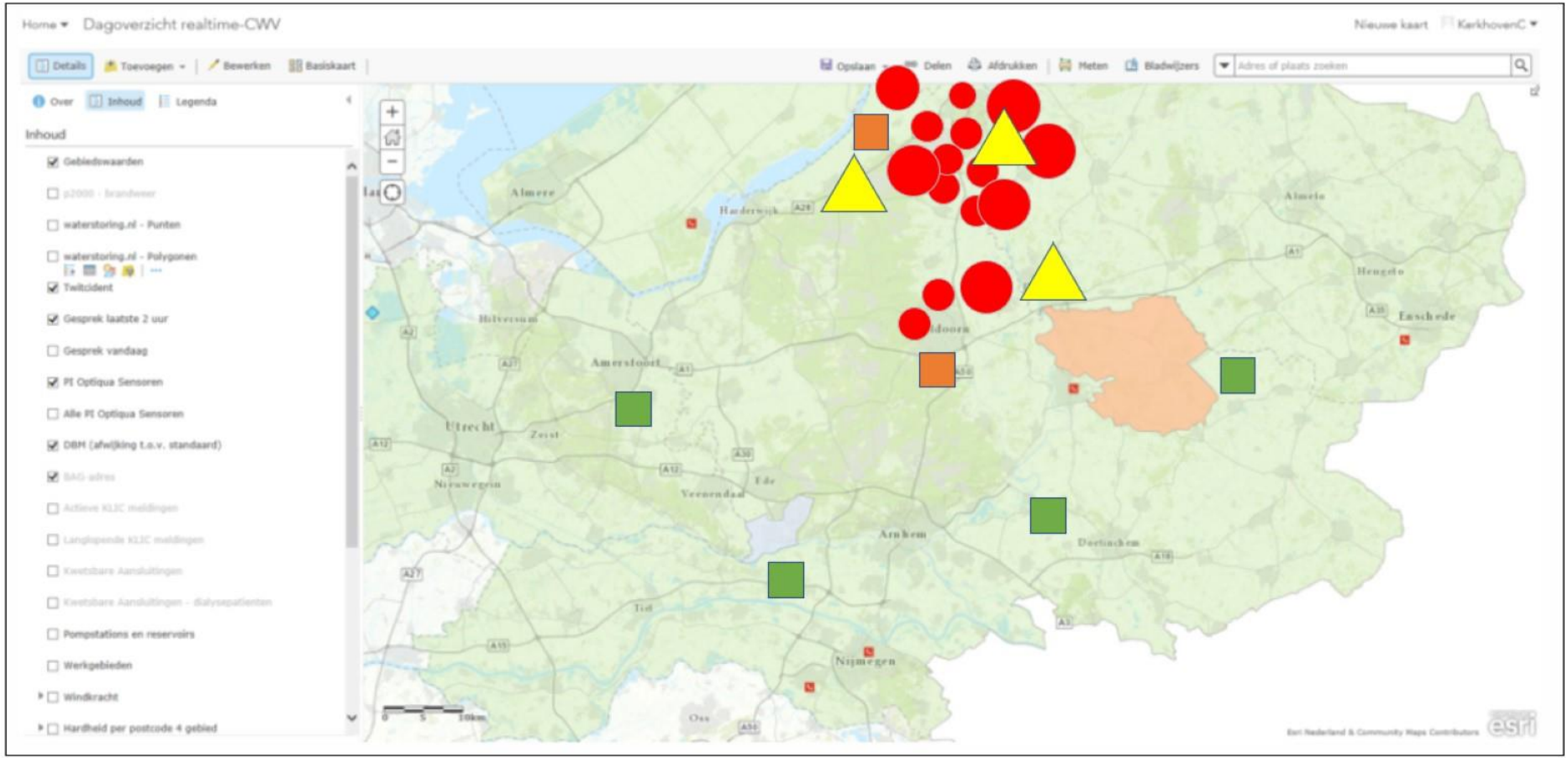
Overlay of “Dashes” on Water Network



Overlay of “Dashes” on Water Network

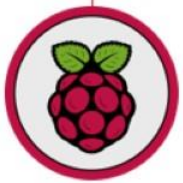


Overlay of “Dashes” on Water Network



Technology Stack

Hardware
Raspberry PI



Operating System
Win10 IoT Core

Data Historian
OSIsoft Edge

OSIsoft Edge

Connector
PI Web API Client
(.NET Core)

Data Access Technology
PI Web API

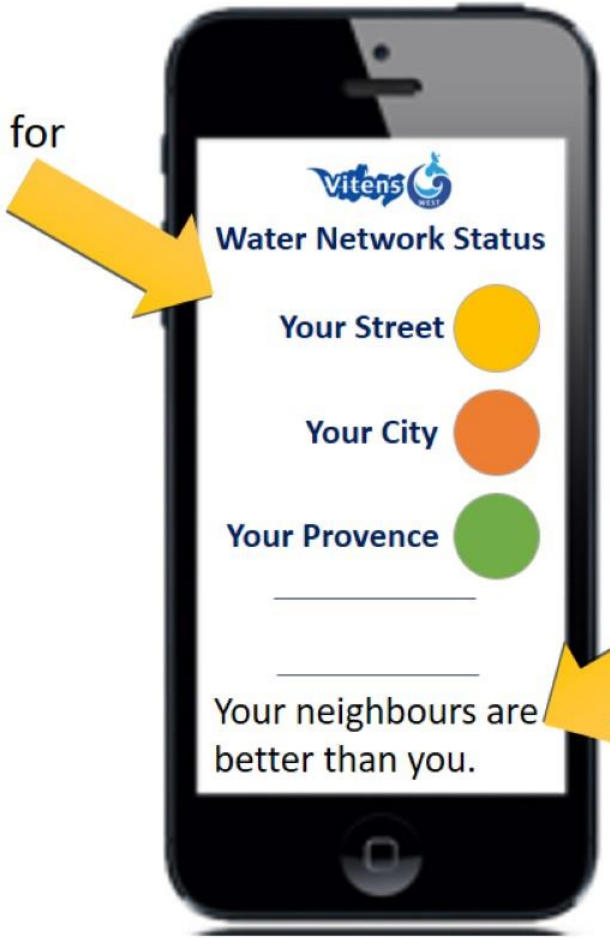
PI System

PI AF
AF Analyses
PI Vision

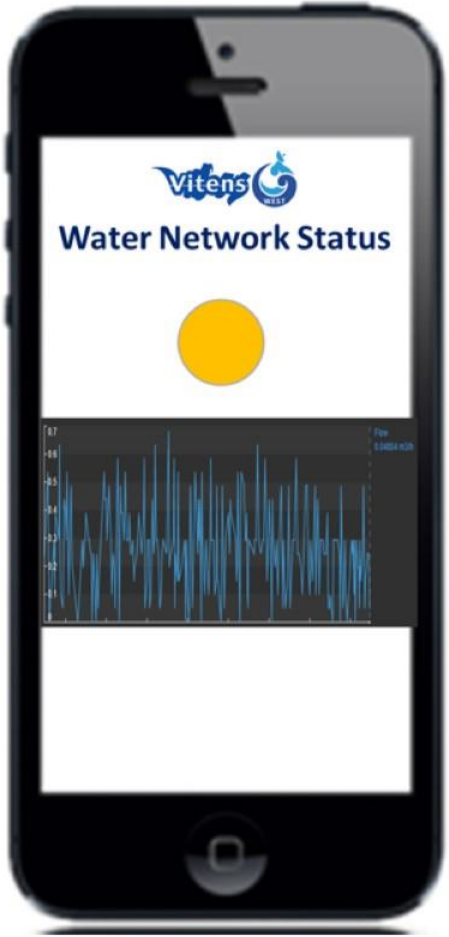
Edge → **Cloud**

Live Demonstration

Near Real-Time feedback for customer as a “reward”.



Behaviour based messaging.


Water Network Status

Water Network Status

Enrich existing data with a new source of consumer feedback and telemetry data.

Low cost and higher benefit to Vitens
- More rapid
- More consistent
- Less variable dataset

Modular and configurable based on where deployed in the water network.

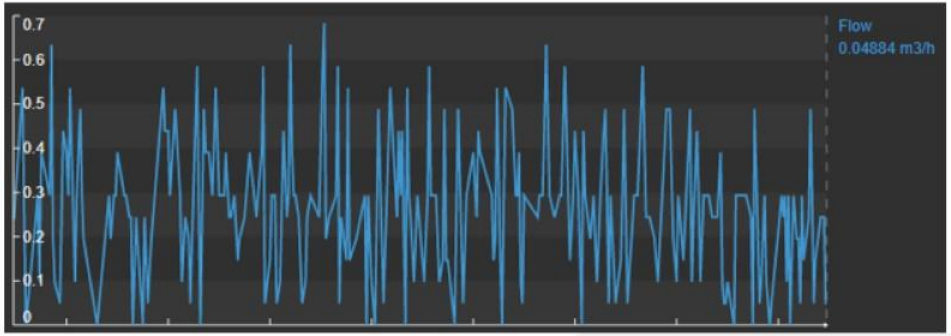
Mobile solution – can be deployed multiple times, moved around the water network.

Why Vitens should do this!

	Phone Call	Social Media	Dash Button
Customer Experience	Not easy. Time Consuming. Reluctance/inconvenient.	More attractive, easier than phone call. Some generations may struggle with this approach.	Simple, quick, easy. Convenient. Feels more connected. Physical presence.
Vitens	Staff for call centre. Flood or drought – in terms of calls. Variable/inconsistent feedback on issue.	Potential negative impact on Vitens – social trending of bad issues. Semi-automated feedback processing. Variable/inconsistent feedback on issue.	Instant feedback. Automated processing. Consistent telemetry data.

Why Vitens should do this!

"You are currently in a queue, please hold…
You are currently in a queue, please hold…
You are currently in a queue, please hold…
You are currently in a queue, please hold…"



Why Vitens should do this!

Convenient.

Instant.

Listened to.

Connected.

Engaged.

PyVision

Advanced Anomaly Detection for Water Quality Monitoring

What

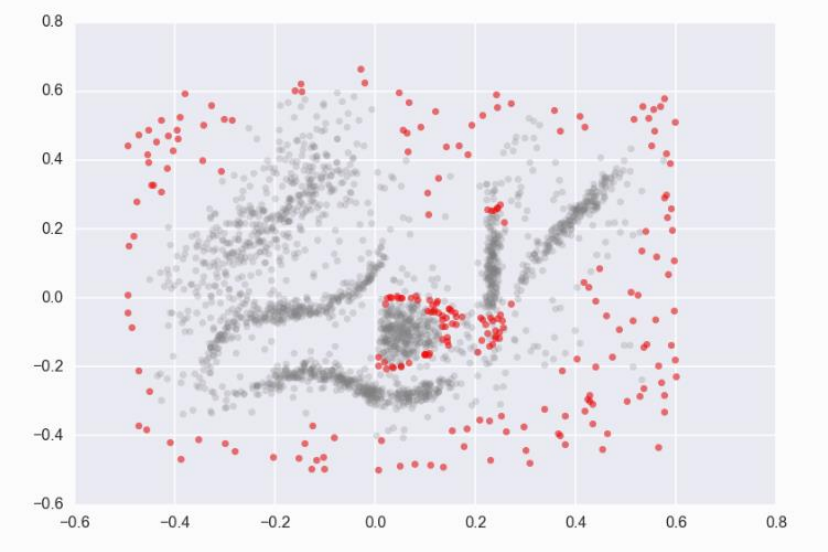
- Replace the monitor lizard
- Advanced Anomaly Detection at all locations
- Automatically create alarms & notifications

Why

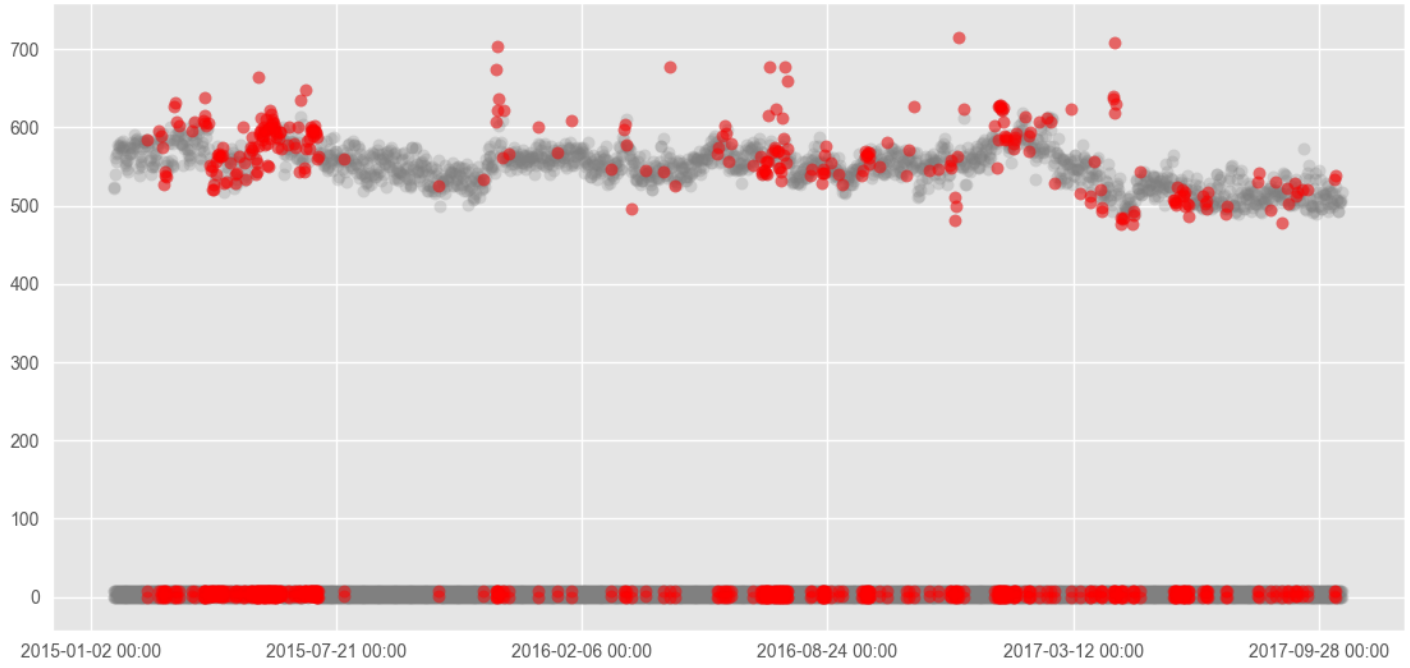
- Ensuring reliable service
- Enabling faster maintenance response
- Reduce likelihood of false alarms by combining multiple sensors

How

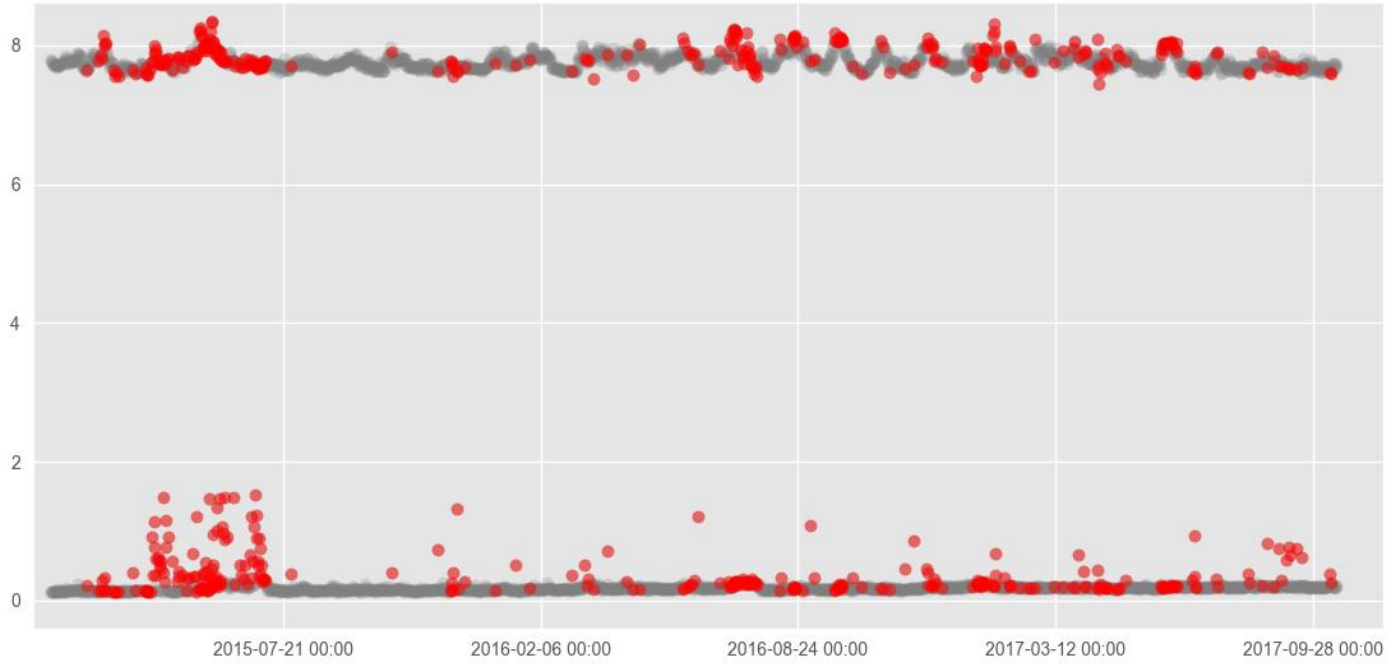
- HDBSCAN (hierarchical density-based spatial clustering w/ noise)
- Looking for spatial density-adaptive outliers in multiple dimensions



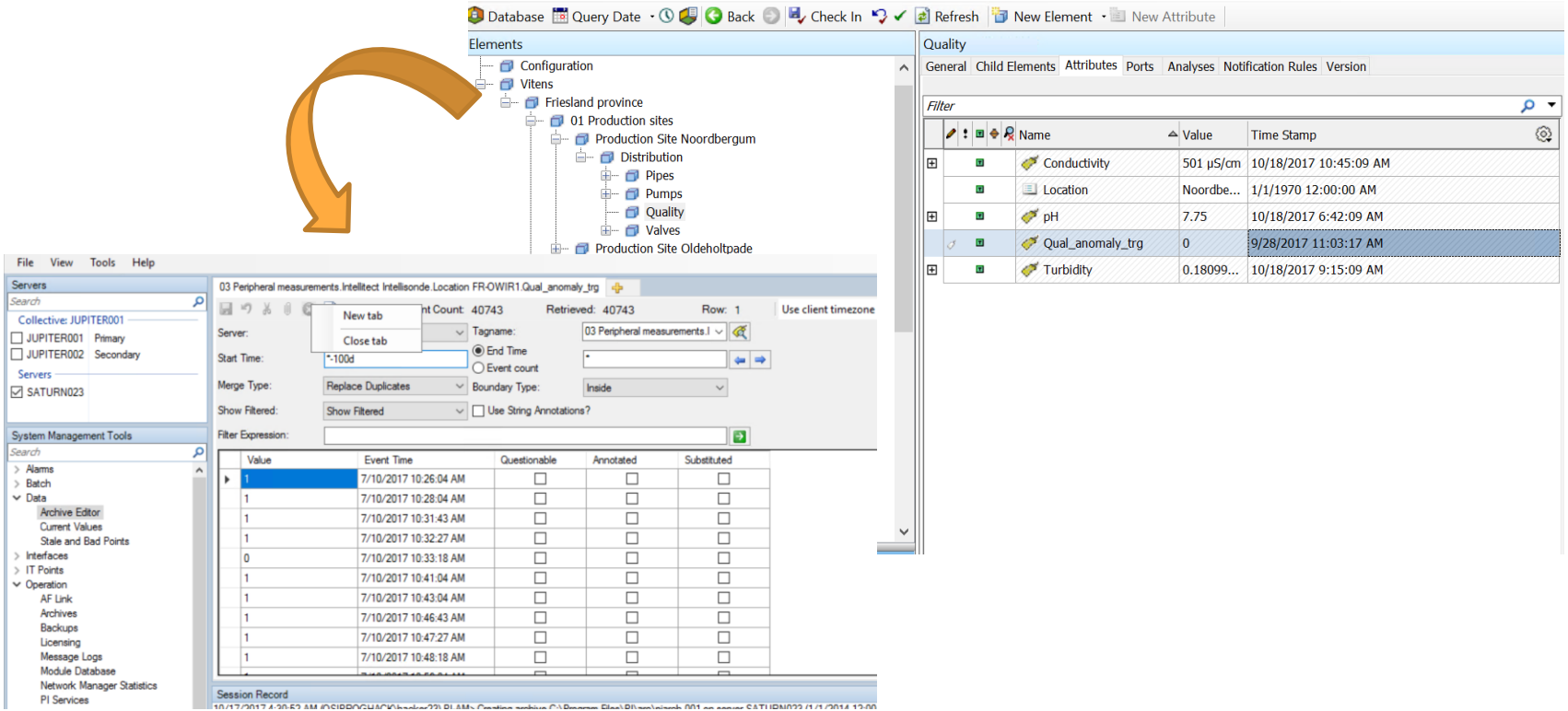
Production Site Noordbergum - conductivity



Production Site Noordbergum – pH & turbidity



PI AF


Database
Query Date
Back
Check In
Refresh
New Element
New Attribute
Elements
Configuration
Vitens
Friesland province
01 Production sites
Production Site Noordbergum
Distribution
Pipes
Pumps
Quality
Valves
Production Site Oldeholtpade
Quality
General
Child Elements
Attributes
Ports
Analyses
Notification Rules
Version
Filter
Name
Value
Time Stamp
Conductivity
501 µS/cm
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Location
Noordbe...
1/1/1970 12:00:00 AM
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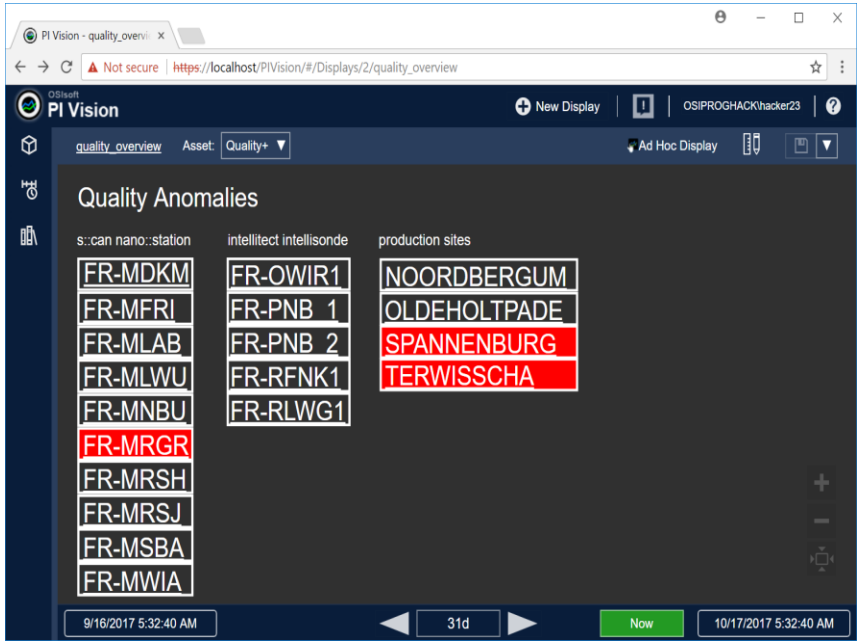
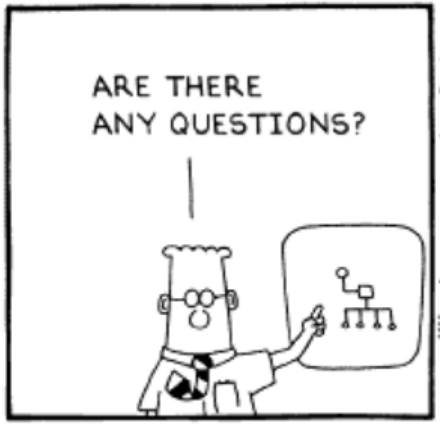
7.75
10/18/2017 6:42:09 AM
Qual_anomaly_trg
0
9/28/2017 11:03:17 AM
Turbidity
0.18099...
10/18/2017 9:15:09 AM
File
View
Tools
Help
Servers
Collective: JUPITER001
JUPITER001 Primary
JUPITER002 Secondary
SATURN023
System Management Tools
Alarms
Batch
Data
Archive Editor
Current Values
Stale and Bad Points
Interfaces
IT Points
Operation
AF Link
Archives
Backups
Licensing
Message Logs
Module Database
Network Manager Statistics
PI Services
03 Peripheral measurements.Intellitect Intellisonde.Location FR-OWIR1.Qual_anomaly_trg
New tab
Close tab
Server:
Tagname:
03 Peripheral measurements.I
Start Time:
*-100d
End Time
Event count
Merge Type:
Replace Duplicates
Boundary Type:
Inside
Show Filtered:
Show Filtered
Use String Annotations?
Filter Expression:
Value
Event Time
Questionable
Annotated
Substituted
1 7/10/2017 10:26:04 AM
1 7/10/2017 10:28:04 AM
1 7/10/2017 10:31:43 AM
1 7/10/2017 10:32:27 AM
0 7/10/2017 10:33:18 AM
1 7/10/2017 10:41:04 AM
1 7/10/2017 10:43:04 AM
1 7/10/2017 10:46:43 AM
1 7/10/2017 10:47:27 AM
1 7/10/2017 10:48:18 AM
Session Record

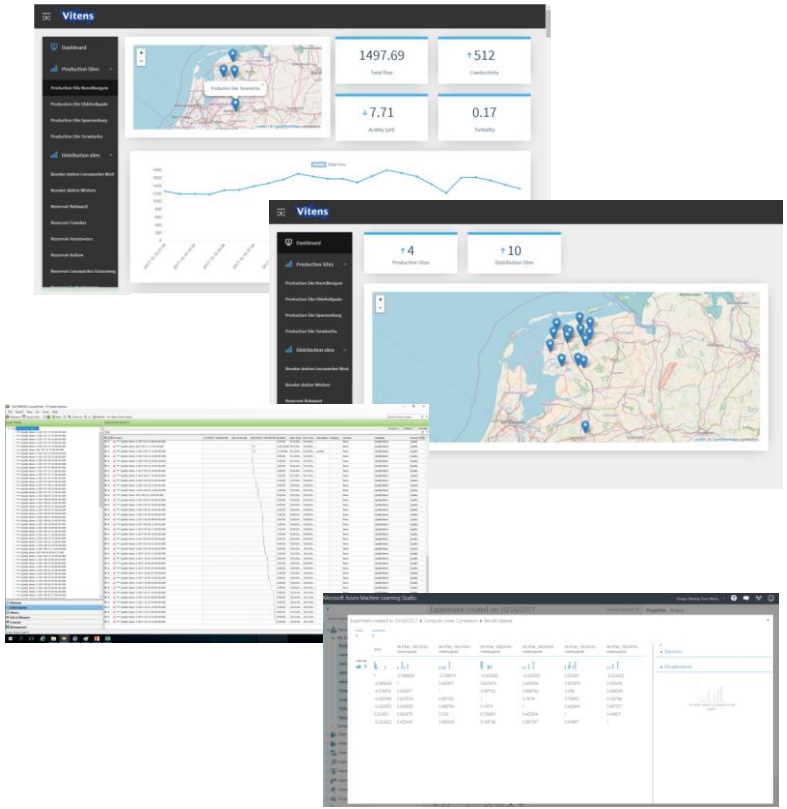
PI Vision Dashboard



Thank you!



OSIsoft EMEA 2017 Hackathon event



Voice Simulator

Hear how Alexa will speak a response entered in plain text or SSML. Learn more about supported SSML tags.

For example: Here is a word spelled out: <say-as interpret-as="spell-out">hello</say-as>.

What is the water pressure in Spannenburg Pipe TR21 | Listen

Service Simulator

Use Service Simulator to test your HTTPS endpoint: arn:aws:lambda:eu-west-1:141709047767:function:hackathonWaterQuality

Note: {0} does not currently support testing audio player directives, dialog model, customer permissions and customer account linking.

Text | JSON

Enter Utterance

What is the water pressure in Spannenburg Pipe TR21

Ask OSIsoft UC EMEA Hackathon 2017 | Reset

Service Request

```
{
  "session": {
    "new": false,
    "sessionId": "SessionId.302ad206-f04a-4d8d-8a
    "application": {
      "applicationId": "amzn1.ask.skill.5b2ce3f4-
    },
    "attributes": {
      "speechOutput": "The status of the pump at
    },
    "user": {
      "userId": "amzn1.ask.account.AFIWFV2RUWDUFG
    }
  },
  "request": {
```

Service Response

```
{
  "version": "1.0",
  "response": {
    "outputSpeech": {
      "ssml": "<speak> In the area noordbergum
      "type": "SSML"
    },
    "speechletResponse": {
      "outputSpeech": {
        "ssml": "<speak> In the area noordberg
      },
      "shouldEndSession": true
    }
```

Listen

Echo Show Render Response (beta)

Connect Point

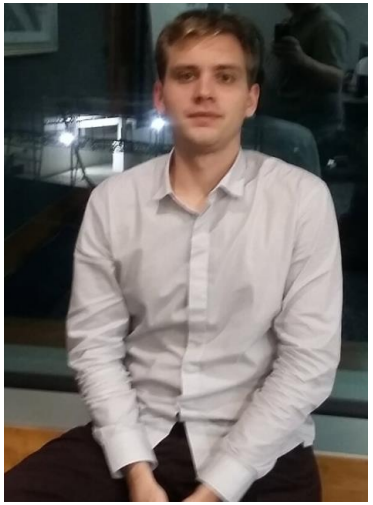
OSIsoft EMEA 2017 Hackathon event

„Objects on the presentation might look older than it appear“

Connect Point Connect Point Connect Point e·on Climate & Renewables

Who are we?

Marek
Data Plumber



Jakub
Coder

Alexa
„her“

alexa

Przemyslaw
Coder

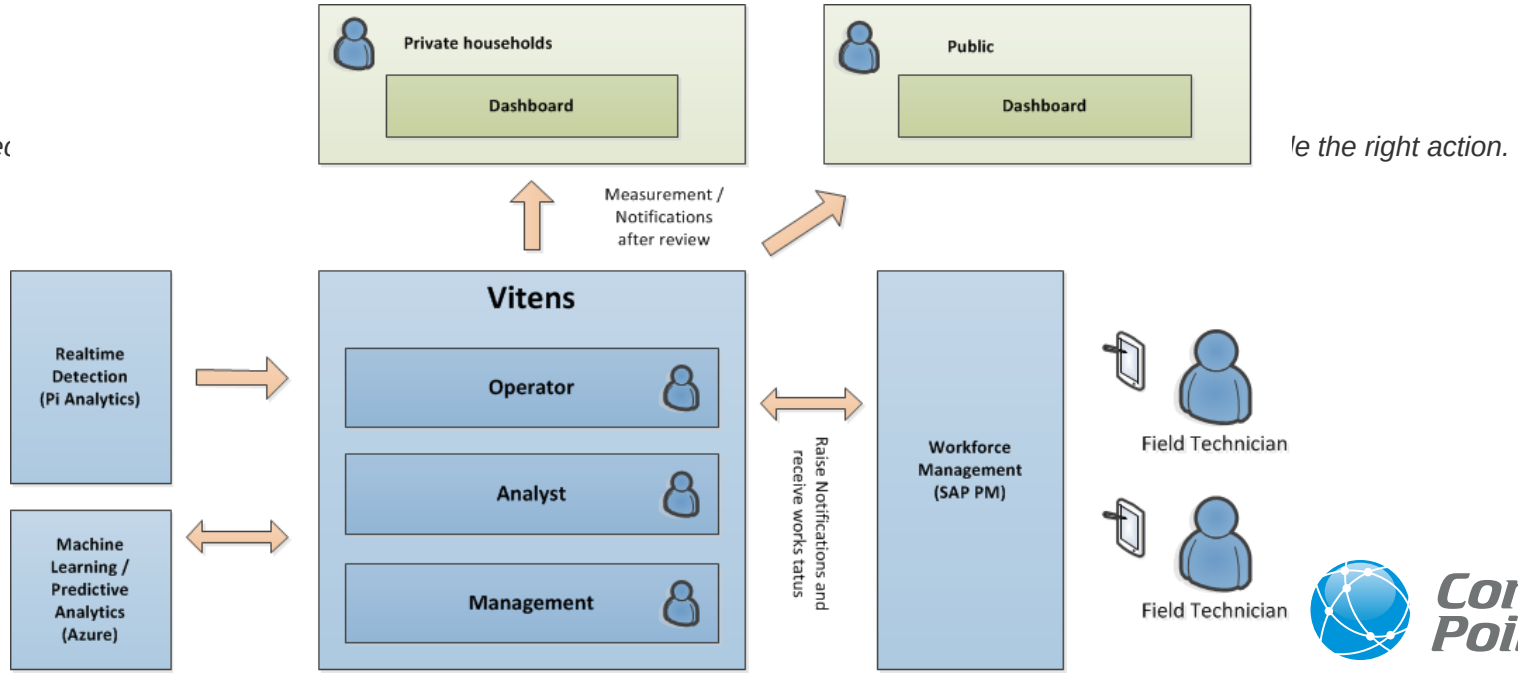
Gregor
The other

Connect Point

The challenge

Provide ***ur*** ***of thei.*** ***future***

A connec *le the right action.*



Provi Vitens our IDEA of their digital ure

When the data indicates an issue that can cause a problem, it is assigned to the right work force and affected parties are notified if required.

Interventions are performed to resolve the issue.

Solutions are recorded. Outage and incidents are prevented and private households dissatisfaction eliminated

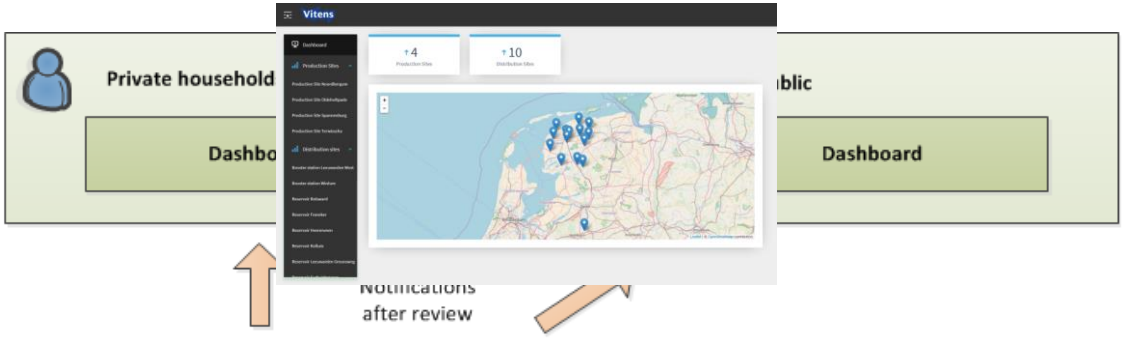
Data is acquired and transmitted to a central location

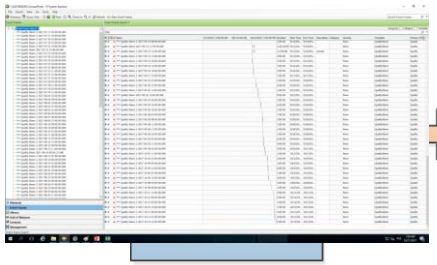
Analytics in real time identify anomalies. Machine learning analytics predicts by correlating signals and past experience

*Connected system **enabling learning cycles** where gained knowledge can be apply to future issue to **detect earlier** or **resolve faster***

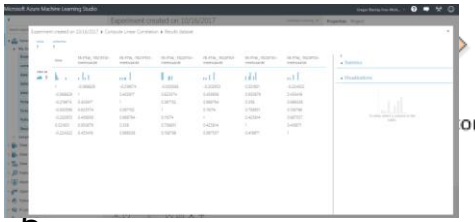
Connect Point

What we did


Vitens
Private household
Dashbo
Dashboard
Notifications
after review



Vitens
Vitens
Management



Field Technicia

Field Technician

Used technologies

PI AssetFramework

-Analysis

-EventFrames

Webtechnologies

-PI Web API

-Realtime data (channels/websockets)

-Batch queries

-EventFrames (fetch and acknowledge)

-Vue.js + Vuestic

Data Analytics

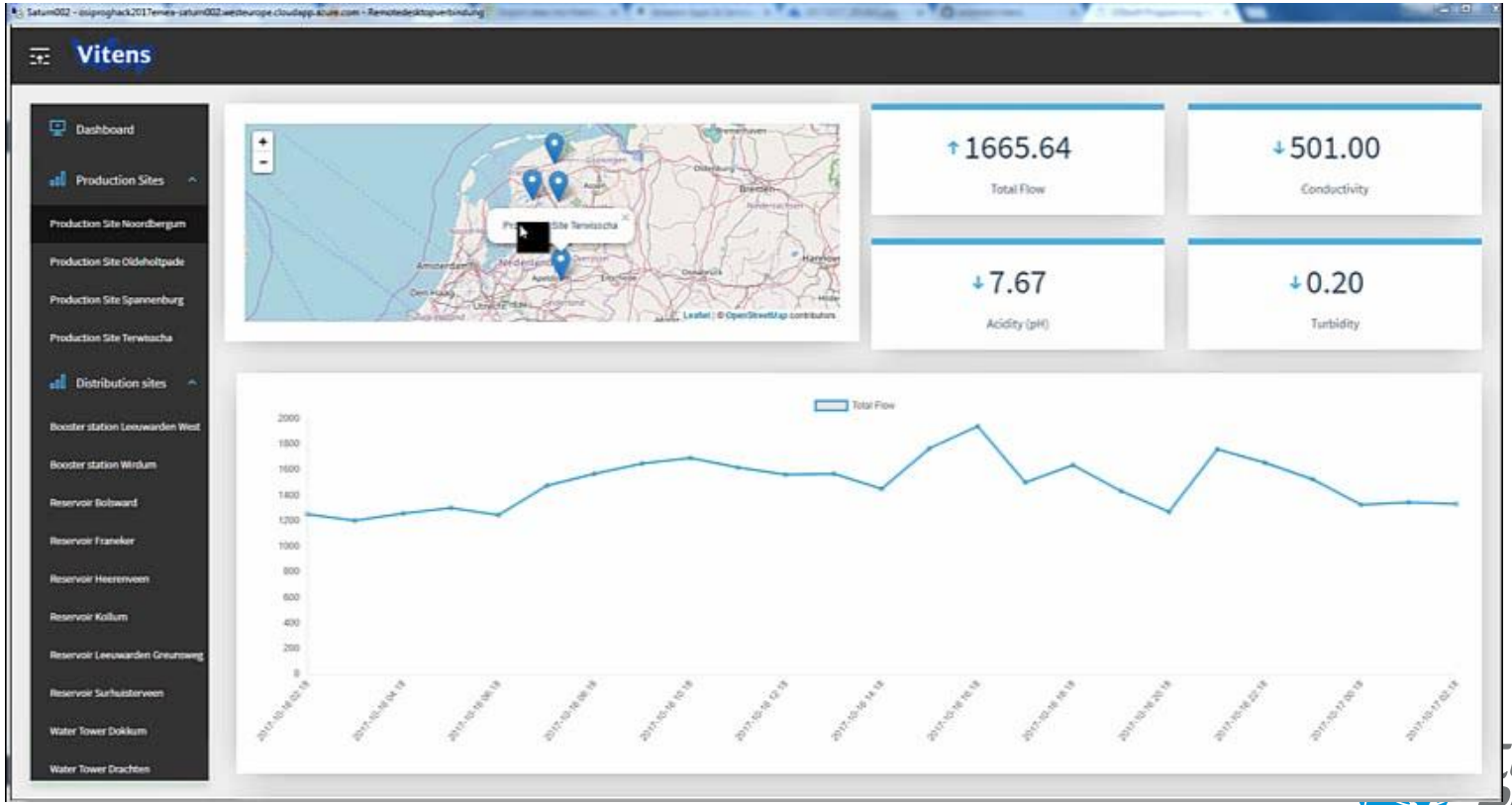
- Tableau Desktop
- Microsoft Azure Machine Learning Studio
- SQL
- PI OLEDB

Extended Userexperience

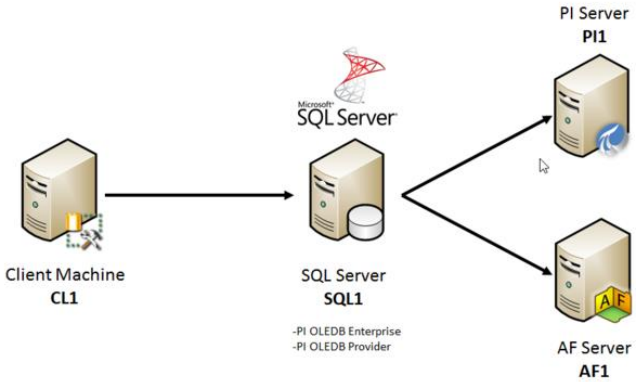
- Alexa
  - Alexa Skills Kit
  - AWS Lambda Function (Node.js)

Connect Point

Dashboard


Vitens
Dashboard
Production Sites
Production Site Noordbergum
Production Site Oldeholtpade
Production Site Spannenburg
Production Site Terwisscha
Distribution sites
Booster station Leeuwarden West
Booster station Wirdum
Reservoir Bolsward
Reservoir Franeker
Reservoir Heerenveen
Reservoir Kollum
Reservoir Leeuwarden Greunswg
Reservoir Surhuisterveen
Water Tower Dokkum
Water Tower Drachten
1665.64
Total Flow
501.00
Conductivity
7.67
Acidity (pH)
0.20
Turbidity
Total Flow

Data Analytics (Cloud)

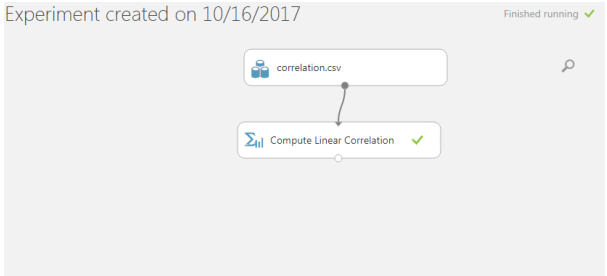


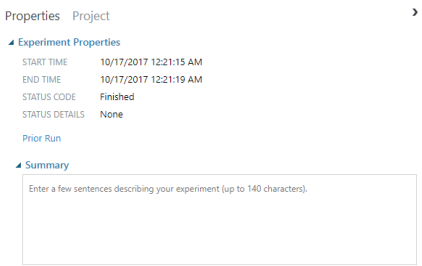
Using data extracts via PI OLEDB. Visualizing the data with Tableau or experimenting with Microsoft Azure Machine Learning Studio by apply existing algorithms.

Experiment created on 10/16/2017 › Compute Linear Correlation › Results dataset

rows 7 columns 7

time	FR-PTW_-TR21FT01-meetwaarde	FR-PTW_-TR21PT01-meetwaarde	FR-PTW_-TR22FT01-meetwaarde	FR-PTW_-TR22PT01-meetwaarde	FR-PTW_-TR23FT01-meetwaarde	FR-PTW_-TR23PT01-meetwaarde
1	-0.068829	-0.219674	-0.000566	-0.202953	0.021851	-0.224322
-0.068829	1	0.403917	0.623574	0.459956	0.950679	0.455418
-0.219674	0.403917	1	0.067152	0.989764	0.358	0.989336
-0.000566	0.623574	0.067152	1	0.11074	0.706651	0.108798
-0.202953	0.459956	0.989764	0.11074	1	0.425814	0.997557
0.021851	0.950679	0.358	0.706651	0.425814	1	0.418971
-0.224322	0.455418	0.989336	0.108798	0.997557	0.418971	1



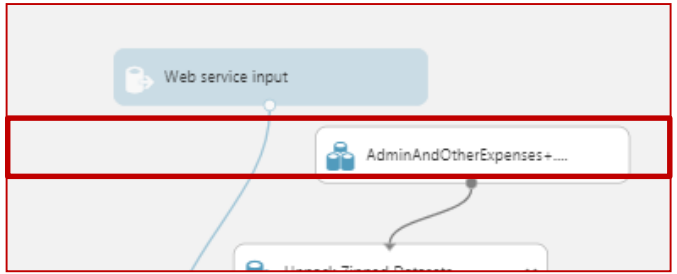


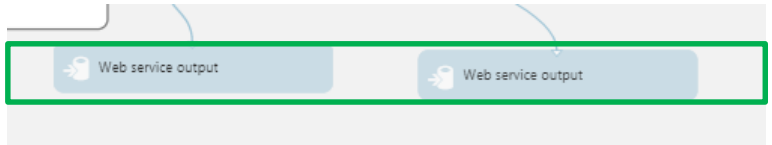
Connect Point

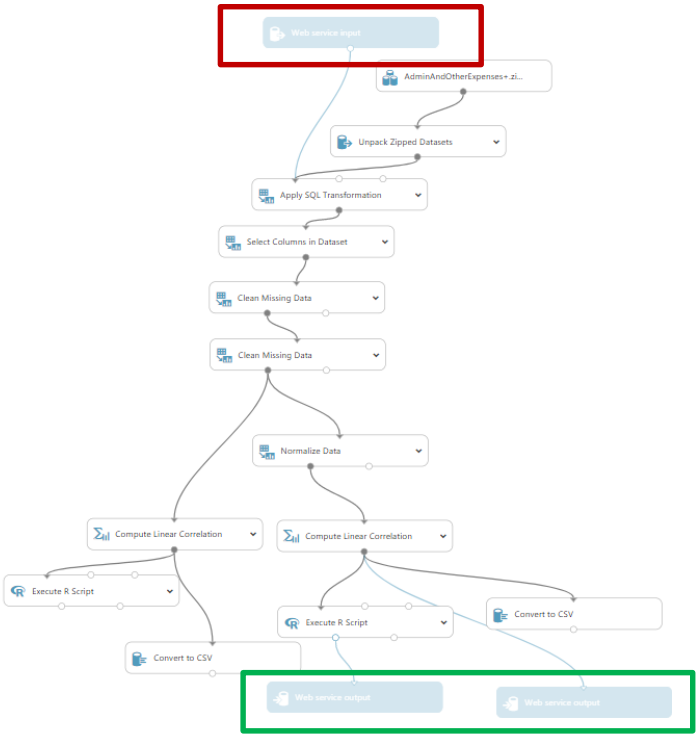
Data Analytics (Cloud-Integration)

MY EXPERIMENTS SAMPLES

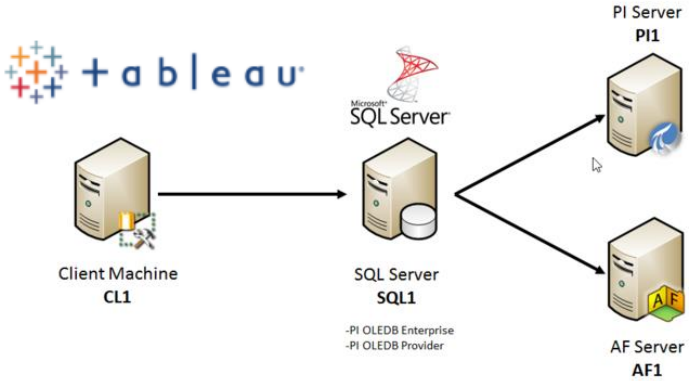
NAME	AUTHOR	STATUS	LAST EDITED	PROJECT
Linear correlation analysis	Ruslan Sementsov	Draft	10/18/2017 11:33:30 AM	*None*
Experiment created on 10/16/20...	gregor.biering	Finished	10/17/2017 1:21:12 AM	None
Correlation Matrix	Yilin Allan	Finished	10/17/2017 12:26:10 AM	None
Time Series Forecasting	gregor.biering	Finished	10/17/2017 12:18:53 AM	None
Time Series Forecasting	AzureML Team	Draft	10/16/2017 6:19:50 PM	None



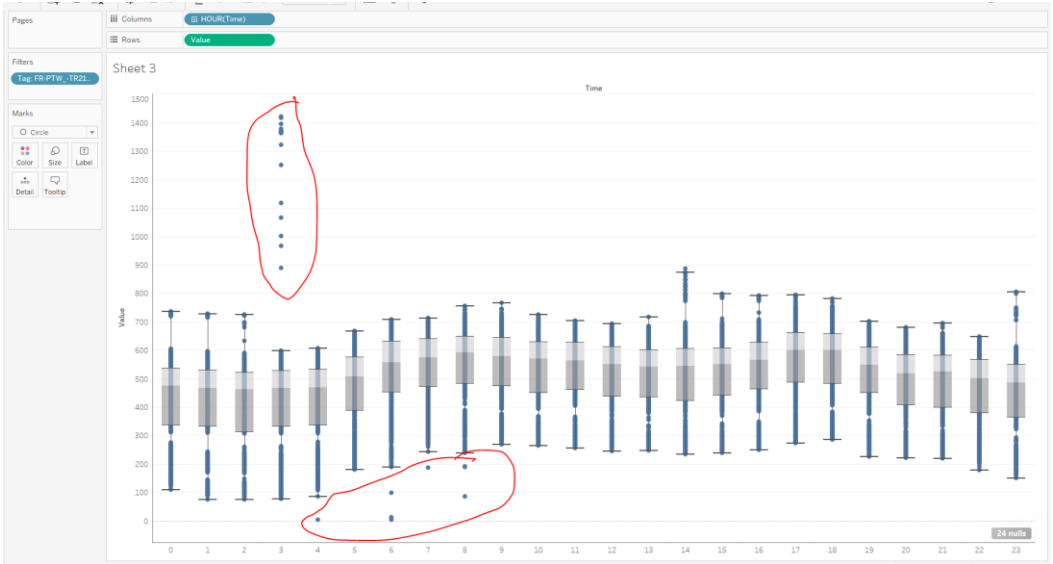




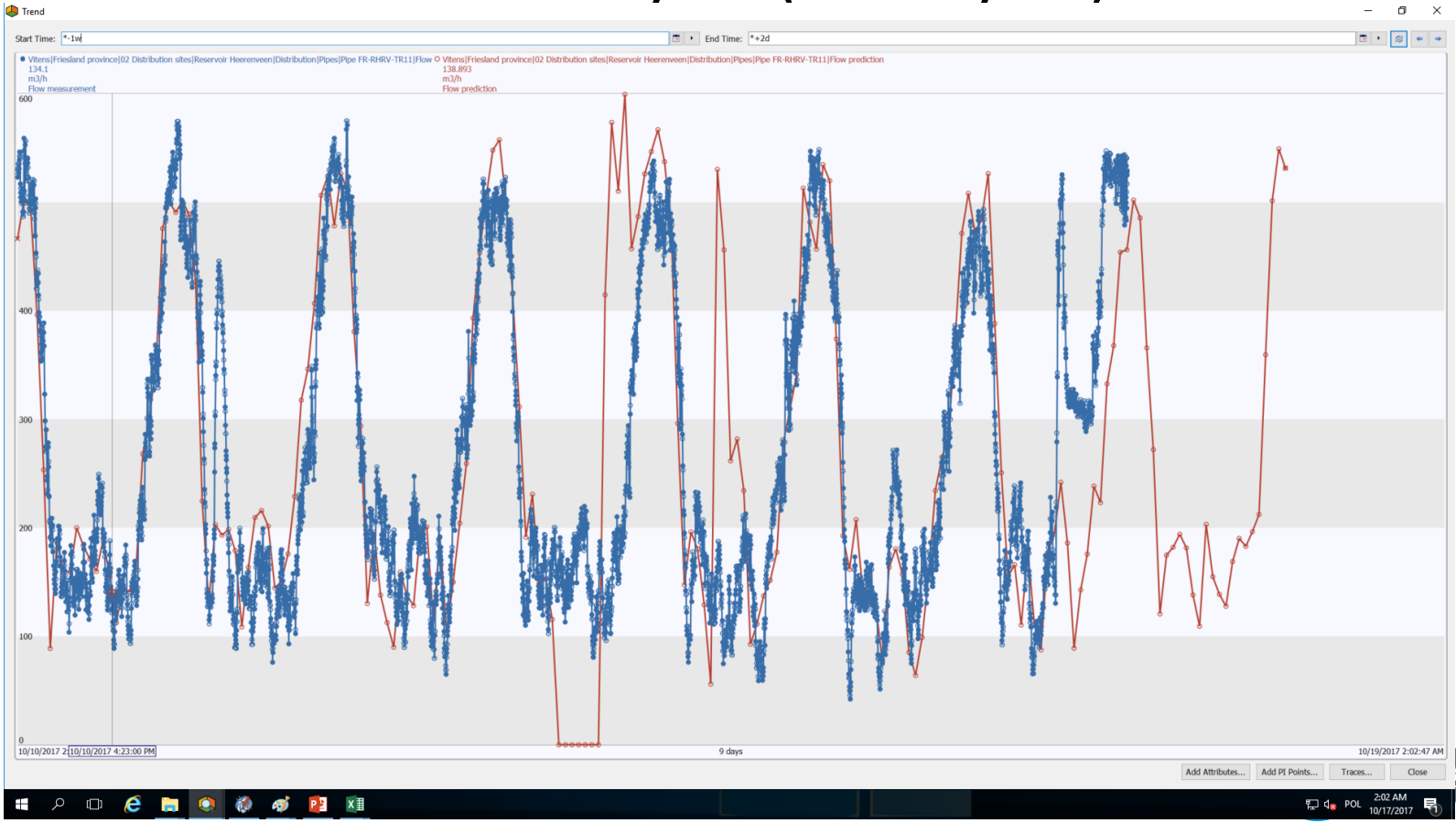
Data Analytics (Tableau)



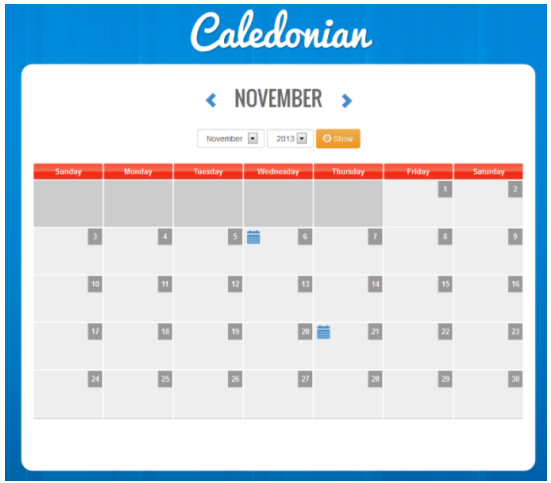
Using data extracts via PI OLEDB. Visualizing the data with Tableau or experimenting with Microsoft Azure Machine Learning Studio by apply existing algorithms.



Data Analytics (PI Analytics)



Consider all kind of data



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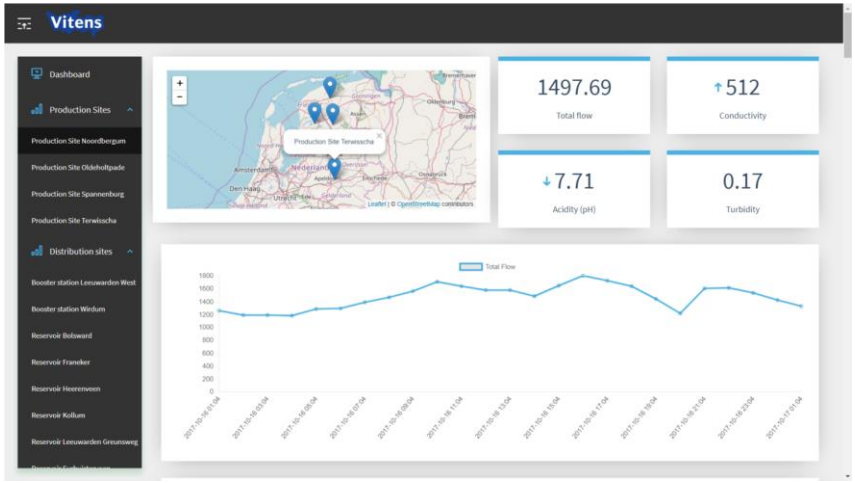

2017-08-18T11:00:00Z 2017-08-18T12:00:00Z Quality Alarm 2 2017-08-18 12:00:00.000 CATEGORIZE TO VERIFY ACCEPT

By categorizing issues / anomalies not just to operative events but public events too (e.g. football, vacation) is it possible to predict data anomalies by just checking the calendar?

How this will help

- A connected system provides a better overview and enables a seamless workflow by having systems integrated
- Using existing powerfull tools to prevent implementation of things that already exists (e.g. Cortana Intelligence Gallery)
- Enabling data exploration by using Tableau for vizualisation
- Interaction with the system in new way (Alexa)
- Saving costs predicting events faster and assigning field forces at the right time

Thanks

E.ON Climate & Renewables - ConnectPoint

E.ON is an international, privately-owned energy supplier focused on 3 areas:

- Renewables
- Energy networks
- Customer solutions

It operates in over 30 countries and serves over 33 million customers.

The Company employs above 50 000 people world-wide and annually achieves revenues above 100 billions Euro

E.ON Climate & Renewables (EC&R), headquartered in Essen, Germany, is responsible for E.ON's industrial-scale renewable energy activities.

EC&R develops, builds

ConnectPoint is a Software vendor and System Integrator specialized in Utilities & Industry sector

The company is present in Poland and Germany with the team of experienced professional in **IT/OT integration and SW development**

ConnectPoint started co-operation with E.ON Climate & Renewables in 2013 and since that time the company conducted above 20 projects in areas like

- Custom Software development
- System Integration in IT/OT area
- Business Intelligence applications development (e.g. OSIsoft PI)

Find out more.

If you would like to find out more about how ConnectPoint can help transform your utility service with intelligent network capability, get in touch with Gerald.Sierowski@connectpoint.pl