

# Remote Communications and Cloud Processing for Environmental Data Sets

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STREAM

Outline

Background

IT Infrastructure

Consumers/Applications

Aggregation Layer

Storage Layer

Collection Layer

Sensor Layer

Current Deployment

Conclusion & Thanks

# Background

- ▶ Website at [www.marinestream.eu](http://www.marinestream.eu)
- ▶ ERDF Funded project until the Ireland Wales Programme 2014-2020
- ▶ Total Budget of 5.4 Million with a Duration of 4.5 Years
- ▶ Partners included:
  - ▶ South East Technological University
    - ▶ The Pharmaceutical and Molecular Biotechnology Research Centre
    - ▶ The Walton Institute

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    - ▶ Centre for Sustainable Aquatic Research

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    - ▶ The Welsh Centre for Printing and Coating (WCPC)
    - ▶ Centre for Sustainable Aquatic Research
  - ▶ Munster Technological University
    - ▶ Mass Spectroscopy Group
    - ▶ Halpin Center for Research and Innovation at the National Maritime College of Ireland

# Background

- ▶ Three phases to the project
  - ▶ Phase 1 - Deploy state of the art sensors

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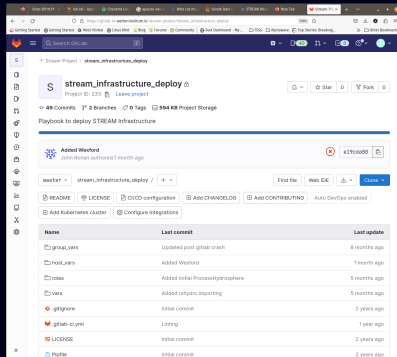
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- ▶ Three phases to the project
  - ▶ Phase 1 - Deploy state of the art sensors
  - ▶ Phase 2 - Deploy *consumer grade* sensors & weather stations
  - ▶ Phase 3 - Deploy novel sensors (MEMS Spectroscopy and electronic printed sensor probes)



# IT Infrastructure - Orchestration



The screenshot shows a GitHub repository page for 'stream\_infrastructure\_deploy'. The repository has 49 commits, 2 branches, 0 tags, and 584 KB of project storage. The main branch is 'stream\_infrastructure\_deploy / master'. A commit by John Roman is highlighted, with a commit hash of #371c080. Below the commit information, there is a table of files in the repository.

Name	Last commit	Last update
group_vars	Updated post gitlab crash	8 months ago
host_vars	Added Workflow	1 month ago
roles	Added Initial Proxmox/Proxmox	5 months ago
vars	Added relayto importing	5 months ago
gitignore	Initial commit	2 years ago
gitlab-ci.yml	Linking	1 year ago
LICENSE	Initial commit	2 years ago
Playfile	Initial commit	2 years ago

Everything is version controlled, 60 code repositories and counting. All servers, applications and weather stations are *mostly* configured by Ansible, which is a commonly used orchestration tool.

# IT Infrastructure - Monitoring

Host group **STREAM**  
Monitor -> Group -> Host group: STREAM

Commands Host group Hosts Export Display Help

Acknowledge problems Schedule downtimes Filter Show checkboxes

### Local site walton

Host	Icons	OK	Wa	Un	Cr	Pd
UP dashboard.marlinstream.eu	📶	19	0	0	0	0
UP data1.marlinstream.eu	📶	20	0	0	0	0
UP data2.marlinstream.eu	📶	17	0	0	0	0
UP data.marlinstream.eu	📶	1	0	0	0	0
UP grafana.marlinstream.eu	📶	30	0	0	0	0
UP import.marlinstream.eu	📶	20	0	0	0	0
UP influx1.marlinstream.eu	📶	32	0	0	0	0
UP influx2.marlinstream.eu	📶	22	0	0	0	0
UP mon.marlinstream.eu	📶	19	0	0	0	0
UP nc.stream.ksg.org	📶	30	0	0	0	0
UP www.marlinstream.eu	📶	32	0	0	0	0

Services of Host **grafana.marlinstream.eu**  
Monitor -> Host -> grafana.marlinstream.eu

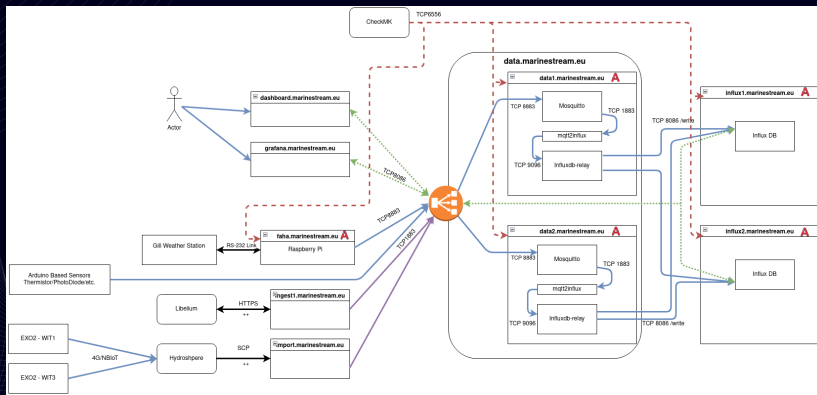
Commands Host Services Export Display Help

Acknowledge problems Schedule downtimes Filter Show checkboxes grafana.marlinstream.eu

Service	Icons	OK	Warn	Down	Cr	Pd
grafana-middleware	📶	3	0	0	0	0
grafana-frontend	📶	6	0	0	0	0
grafana-backend	📶	6	0	0	0	0
grafana-provisioner	📶	0	0	0	0	0
grafana-panels	📶	0	0	0	0	0
grafana-panels-1	📶	0	0	0	0	0
grafana-panels-2	📶	0	0	0	0	0
grafana-panels-3	📶	0	0	0	0	0
grafana-panels-4	📶	0	0	0	0	0
grafana-panels-5	📶	0	0	0	0	0
grafana-panels-6	📶	0	0	0	0	0
grafana-panels-7	📶	0	0	0	0	0
grafana-panels-8	📶	0	0	0	0	0
grafana-panels-9	📶	0	0	0	0	0
grafana-panels-10	📶	0	0	0	0	0
grafana-panels-11	📶	0	0	0	0	0
grafana-panels-12	📶	0	0	0	0	0
grafana-panels-13	📶	0	0	0	0	0
grafana-panels-14	📶	0	0	0	0	0
grafana-panels-15	📶	0	0	0	0	0
grafana-panels-16	📶	0	0	0	0	0
grafana-panels-17	📶	0	0	0	0	0
grafana-panels-18	📶	0	0	0	0	0
grafana-panels-19	📶	0	0	0	0	0
grafana-panels-20	📶	0	0	0	0	0
grafana-panels-21	📶	0	0	0	0	0
grafana-panels-22	📶	0	0	0	0	0

12 Active Hosts at the moment, 230 services

# IT Infrastructure - Overall Architecture



Monitor hardware, virtual machines and also data gathering processes

# Consumers/Applications

- ▶ Manufacturer Specific
  - ▶ Xylem & TRIOS - Hydrosphere
  - ▶ In-SitU - HydroVu

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- ▶ STREAM
  - ▶ MQTT
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  - ▶ CSV

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- ▶ STREAM
  - ▶ MQTT
  - ▶ Grafana
  - ▶ CSV
- ▶ Third Parties
  - ▶ WOW - Met Éireann
  - ▶ CWOP - Citizens Weather Observation Program
  - ▶ PWS Weather
  - ▶ WindGuru

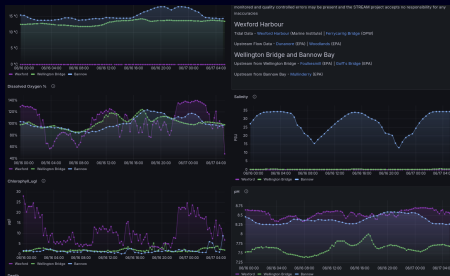
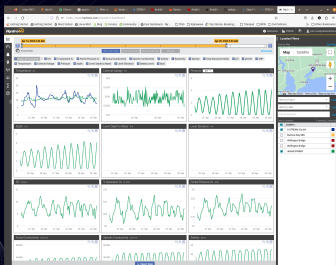
# Consumers - Manufacturers

## Hydrosphere - Xylem EXO2 Multiparameter Sonde



# Consumers - Manufacturers

## Hydrovu - AquaTROLL from In-Situ





# Consumers - MQTT

## MQTT

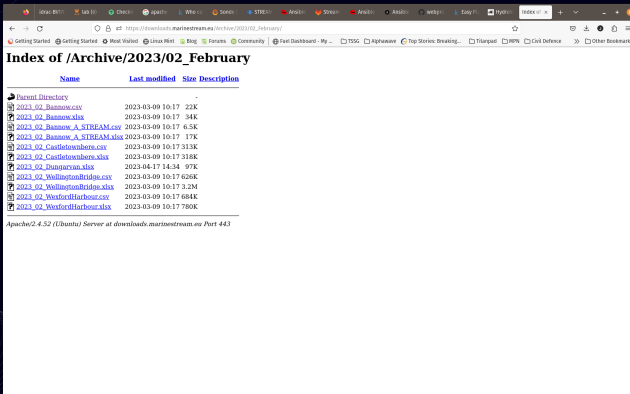
```
mosquitto_sub -h data1.marinestream.eu -p 1884 -t RSHydro/# -u USER -P PASSWORD -v
```

```
sysadmin@data2:~$ mosquitto_sub -h data2.marinestream.eu -p 1884 -t RSHydro/# -u transec -P fA6u0coHdjT6ud -i testb -v
RSHydro/status Running
RSHydro/op55219/data {"Datestring": "2023-04-26T12:24:48+00:00", "Battery": NaN, "Cable Power": NaN,
"CDOM TempCorr.": NaN, "Chlorophyll-A": NaN, "Counter 1": NaN, "DOC": NaN, "External Volts": NaN,
"HDO ": NaN, "mAh Adjusted": NaN, "pH": NaN, "pH mV": NaN, "Proteus S/N 12215244": NaN,
"Proteus S/N 12215244.1": NaN, "Signal": 26, "Spare node": NaN, "Spare node.1": NaN, "SpCond.": NaN,
"Temperature": NaN, "TOC": NaN, "Turbidity": NaN, "location": "360 Aquaculture",
"latitude": "51.610889", "longitude": "-3.915065"}
RSHydro/status Sleeping
RSHydro/status/uptime 22 days, 3:46:37.591255
RSHydro/status/loop 8567
```

Near Real time feed from MQTT

# Consumers - CSV and Excel

## CSV and XLS Archives



Index of /Archive/2023/02\_February

Name	Last modified	Size	Description
<a href="#">Parent Directory</a>	-	-	-
<a href="#">2023_02_Basnow.csv</a>	2023-03-09 10:17	22K	
<a href="#">2023_02_Basnow.xls</a>	2023-03-09 10:17	34K	
<a href="#">2023_02_Basnow_A_STREAM.csv</a>	2023-03-09 10:17	6.5K	
<a href="#">2023_02_Basnow_A_STREAM.xls</a>	2023-03-09 10:17	17K	
<a href="#">2023_02_Castletownbere.csv</a>	2023-03-09 10:17	313K	
<a href="#">2023_02_Castletownbere.xls</a>	2023-03-09 10:17	318K	
<a href="#">2023_02_Dungaryan.xls</a>	2023-04-17 14:34	97K	
<a href="#">2023_02_Wellingtonbridge.csv</a>	2023-03-09 10:17	626K	
<a href="#">2023_02_Wellingtonbridge.xls</a>	2023-03-09 10:17	3.2M	
<a href="#">2023_02_WestfortHarbour.csv</a>	2023-03-09 10:17	684K	
<a href="#">2023_02_WestfortHarbour.xls</a>	2023-03-09 10:17	780K	

Apache/2.4.52 (Ubuntu) Server at downloads.marinestream.eu Port 443

Available from [grafana.marinestream.eu](https://grafana.marinestream.eu) -> Sonde Data (Ireland) ->

# Consumers - Third Parties

## Met Éireann

The screenshot shows the WOW-IE (Weather Observations Website of Ireland) interface. At the top, there's a navigation bar with the WOW-IE logo and 'MET ÉIREANN' branding. Below the navigation, a text box states: "WOW-IE is the Weather Observations Website of Met Éireann and is part of the global WOW network of crowdsourced weather observations." The main content area features a map of Ireland with several weather stations marked by colored circles (11, 12, 13, 14, 15, 16). A search overlay is active on the right side of the map, titled "Weather Station Search". It includes a search bar with the text "Search Station Name / Site", a "Period" dropdown set to "27/04/2023, 11:00 to 11:59", an "Element" dropdown set to "Temperature", and a "Station Type" dropdown set to "2 selected". A "Print Map" button is located at the bottom of the search overlay. Below the map, there is a color-coded temperature scale legend ranging from -20 to 38 degrees Celsius. At the bottom of the page, a disclaimer reads: "WOW-IE displays weather observations from various sources in real-time. Met Éireann does not correct or review WOW data, hence incorrect values or missing data may occur, even from official stations. See: WOW Disclaimer. For weather forecasts, warnings and for download of quality controlled data".

# Aggregation Layer - Software Components

- ▶ Haproxy/Keepalived
  - ▶ High Availability/Redundancy
- ▶ Apache
  - ▶ Websockets - convert to MQTT

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  - ▶ Direct to Influx
    - ▶ Met Éireann
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- ▶ MQTT
  - ▶ Raspberry Pi based Weather Stations
    - ▶ WeeWX
  - ▶ Arduinos
    - ▶ Nutrient Sensors, Thermistor Strings

# Storage Layer

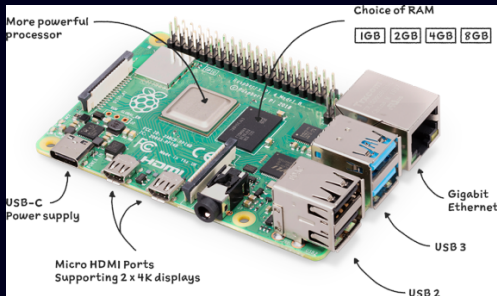


- ▶ Influxdb
  - ▶ Open Source Time Series Database
- ▶ Influxdb-relay
  - ▶ Buffers writes and adds resiliency to actual influxdb

How much data? Approximately 2.1 million rows of data from STREAM deployed devices using approximately 620MB of HD Space per server

# Collection Layer

## Raspberry Pi

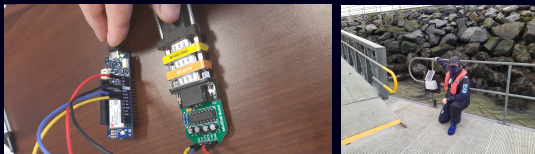


- ▶ Powered over USB, 2.5A @5Volts (12 watts approx.)
- ▶ Fully functional general purpose computer
- ▶ Pi4 Starter Kit now €76 from Radionics
  - ▶ Built in Ethernet and WiFi



# Collection Layer

## Arduino



- ▶ Powered over USB or Dedicated Pins, 190mA @3.3Volts (approximately 1 Watt)
- ▶ Microcontroller. NOT General purpose
  - ▶ Has to be specifically programmed for each task
  - ▶ In STREAM we programmed them for specific purposes
    - ▶ i.e. Temperature/Nitrite/Nitrate/Ammonia/Ph
- ▶ Now €81.5 from Radionics
  - ▶ Needs PSU, Antenna and SIM Card to operate

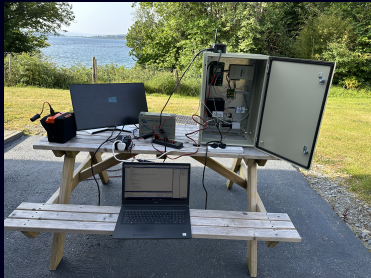
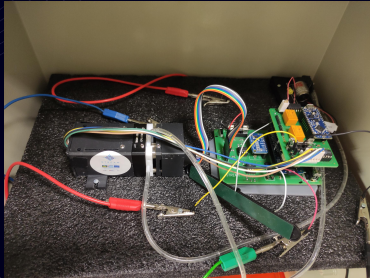
# Sensor Layer

## Weather Stations



# Sensor Layer

## STREAM Sensors



## Locations as of June 2024

- ▶ Wexford Quay - Weather Station, EXO2 and Opus
- ▶ Wellington Bridge - EXO2 and Opus, STREAM - Nitrate and CDOM
- ▶ Dungarvan Harbour - Weather Station (Faha)
- ▶ Bannow Bay - Aquatroll
- ▶ 360 Aquaculture, Swansea Bay - RSHydro
- ▶ Tawe Lock, Swansea - RSHydro
- ▶ Tramore, Castletownbere & Kilmore Quay - Weather Station
- ▶ Future locations under review for EXO2, STREAM Nitrate, CDOM and Weather Station

 <p>EU Funds: Ireland Wales Programme 2014-2020</p>	 <p>Tionól Réigiúnach an Deiscirt Southern Regional Assembly</p>  <p>Cláir Chistí Eorpacha Struchtúrtha agus Infheistíochta na hÉireann 2014-2020</p> <p>Cómhaoiníthe ag Rialtas na hÉireann agus ag an Aontas Eorpach</p>	 <p>UNDES EWROPEAIDD EUROPEAN UNION</p>  <p>Llywodraeth Cymru Welsh Government</p> <p><b>Cronfa Datblygu Rhanbarthol Ewrop European Regional Development Fund</b></p>
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Thank You!  
Any questions?