Challenges and Approaches for Real-Time Data Quality Evaluation

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Presented by..... John B. Copp, Ph.D.

Overview

- Brief Introduction to Primodal
- Primodal Monitoring Stations/Networks
- Real-Time Data Quality Evaluation
- Discussion for the Future

Introducing Primodal

Primodal Inc.

- Based in Hamilton, ON.
- Dedicated WWTP modelling firm
- Primary consulting firm
- Projects around the world including:
  - Locally as well as US, UK, Greece, Hungary, Isreal

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- Wastewater Treatment Expertise
  - Process Engineering & Modelling
    - from development to application,
    - as clients and modellers,
    - as academics, and consultants

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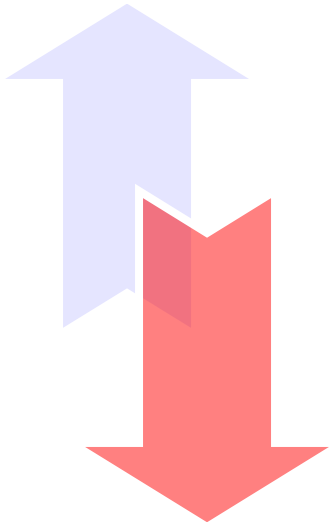
    - COMMON THEME → Data Evaluation
      - the need for accurate and representative data

Process Understanding & Modelling

The Potential

- User-friendly software
- Limitless applications
- Whole-system modelling



The Pitfalls

- Model Prediction Accuracy
- Communication
- Expertise
- Model Maintenance
- Data Quality

Primodal Systems
Data Acquisition

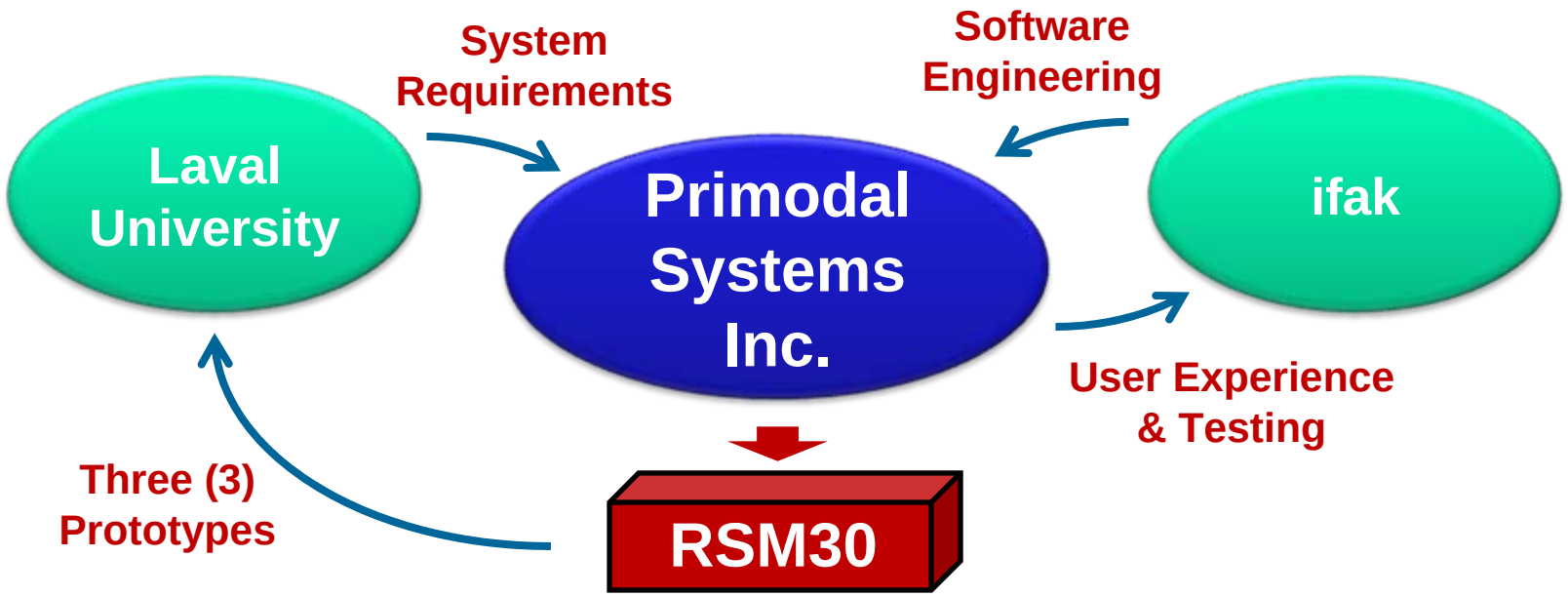
Identified Needs In Water Monitoring

➢ Identified Issues: Continuous Monitoring

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling
- information available to field technician at water's edge
- advancements with digital sensor technology
- portability of system

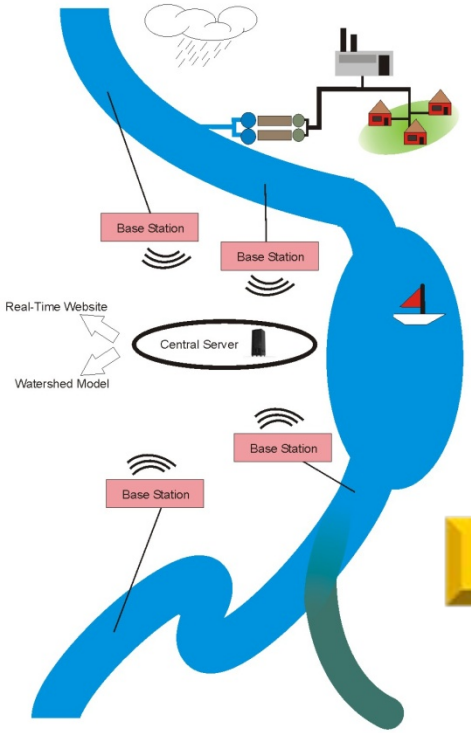
Monitoring Station Development (RSM30)

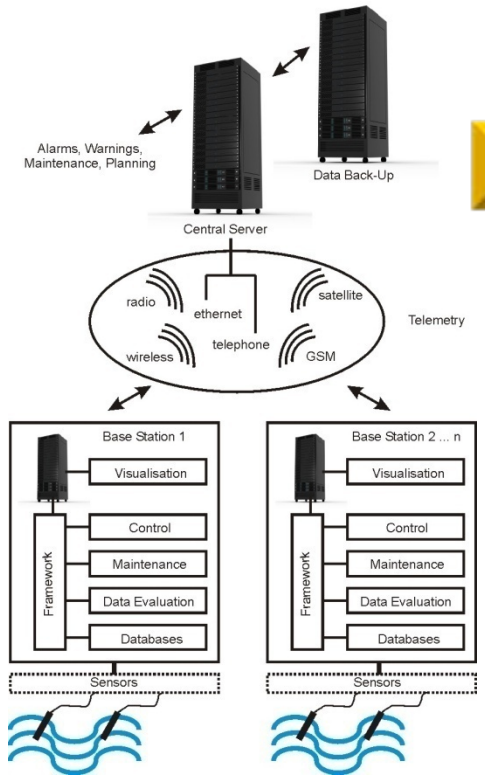
- 2-year RSM30 Development Effort
  - private company / university collaborative effort
  - custom software development
  - sensor manufacturer independent



Monitoring Network Design

RIVER → OFFICE → PUBLIC



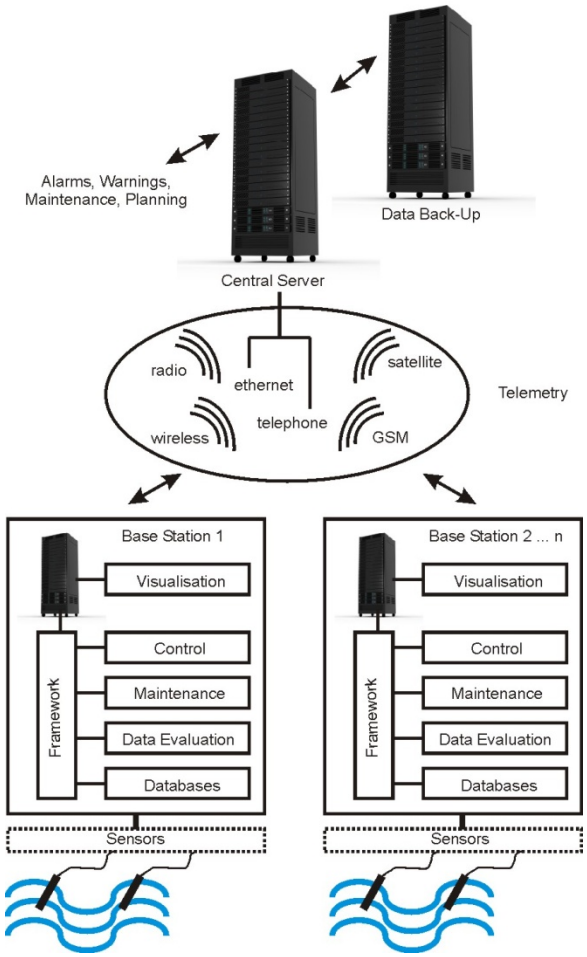


- Real-Time Data Websites
- 'Clean' Data
- Watershed Models

Primodal Monitoring Networks

Network Features

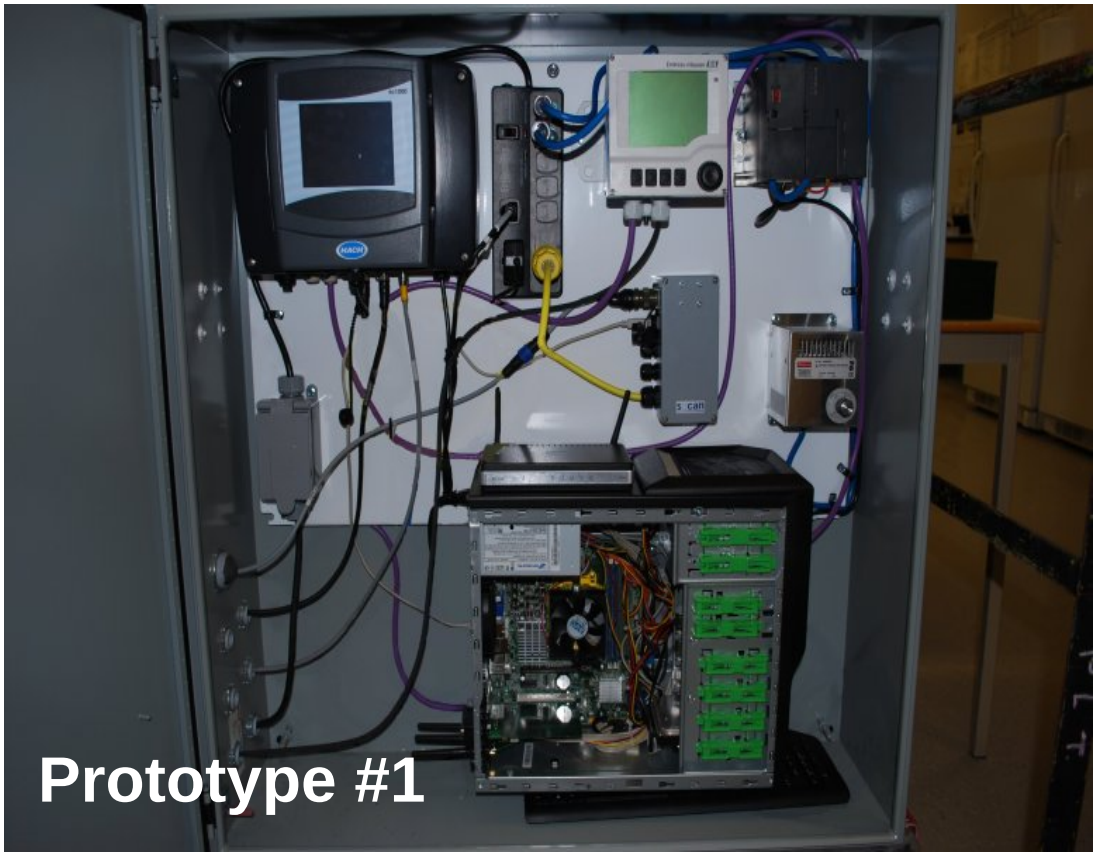
- BaseStation
  - Fieldbus configured
  - Local data storage and data analysis
  - Local RAID data protection
  - Real-time data analysis
- Central Server
  - Connection to multiple stations
  - Supervisory control
- Remote communication
  - TCP/IP – based
  - Wireless, ethernet, GSM,…



Primodal Monitoring Stations

- Std Configuration

  - std AC power
  - multiple sensors
  - industrial computer
  - fieldbus
  - logger
  - climate control



Primodal Monitoring Stations

- Installed at Quebec City WWTP

  – measuring primary effluent

Primodal Monitoring Stations

- Installed at Water's Edge St. Charles River

  – measuring river quality parameters

Primodal Monitoring Stations

- Installed at Water's Edge St. Charles River

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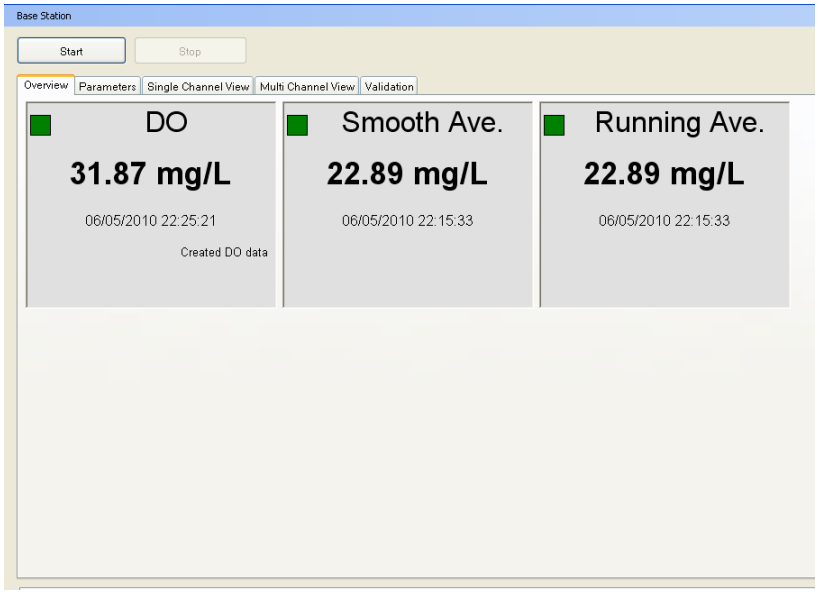
Primodal Monitoring Stations

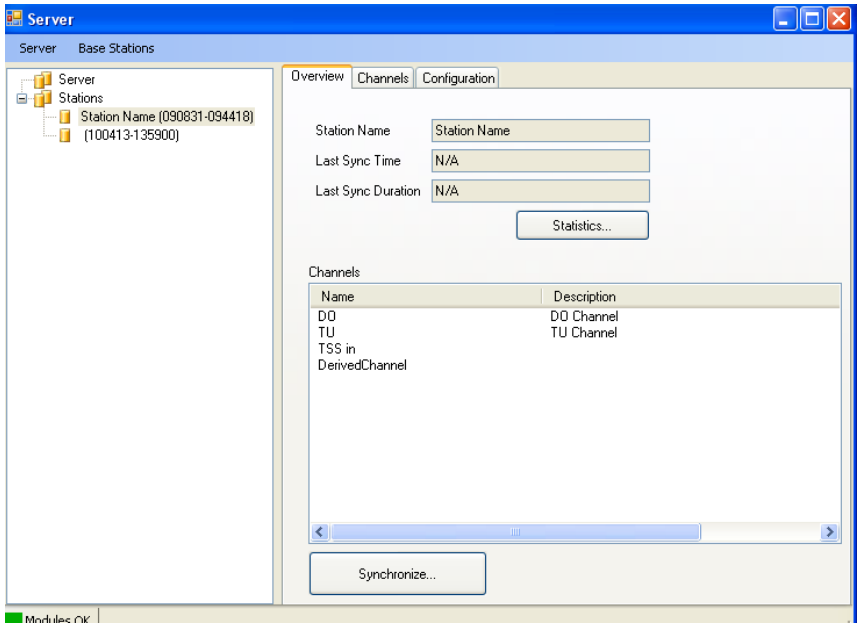
- PrecisionNow:
  Two Stage Approach

  - **BaseStation**
    - water's edge



Primodal Monitoring Stations

- PrecisionNow:
  Two Stage Approach



  - **BaseStation**
    - water's edge

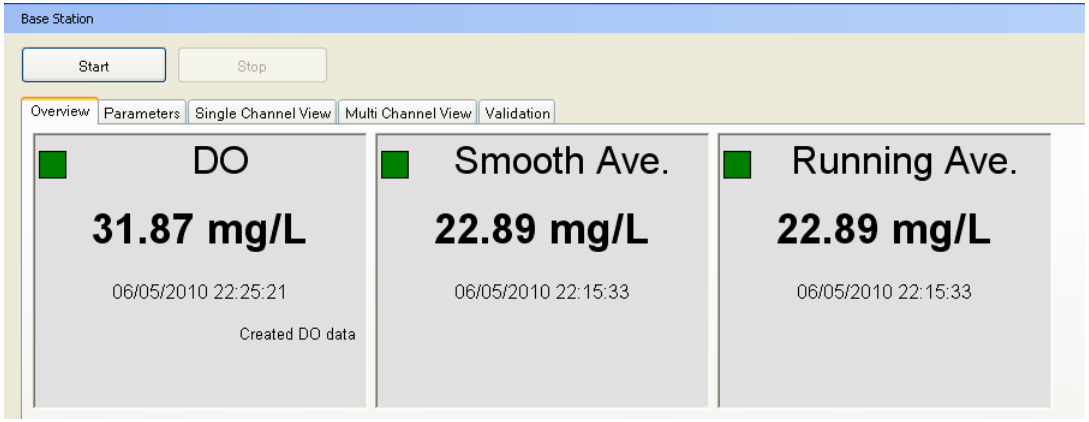
  - **Central Server**
    - office location
    - advanced data analysis
    - connection to multiple BaseStations

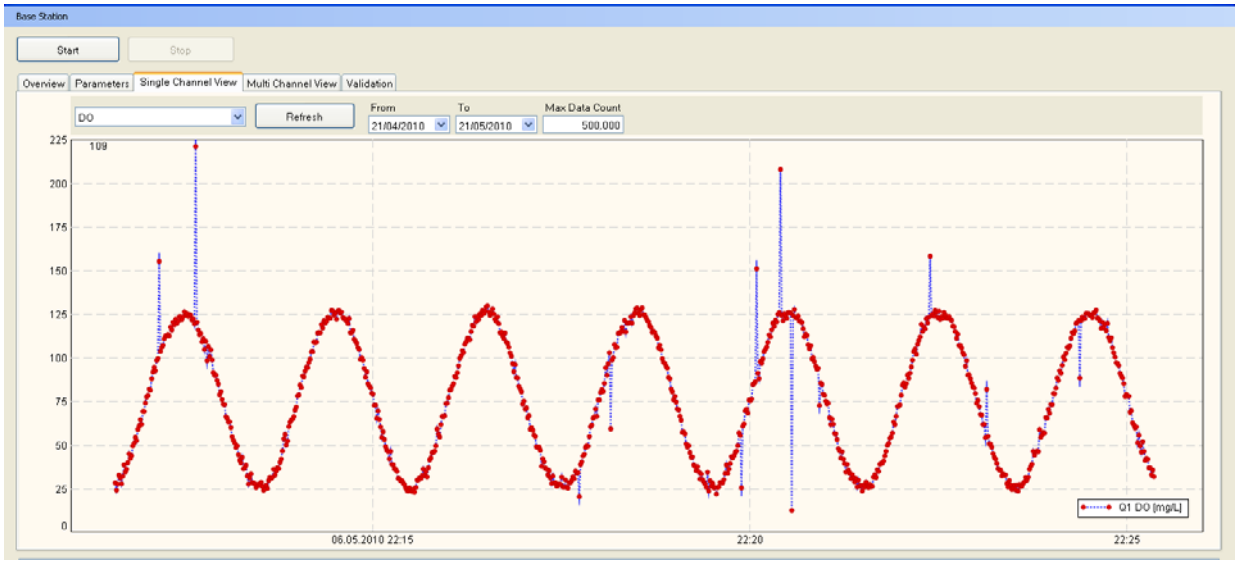
Primodal Monitoring Stations

- BaseStation

  - measurement channels

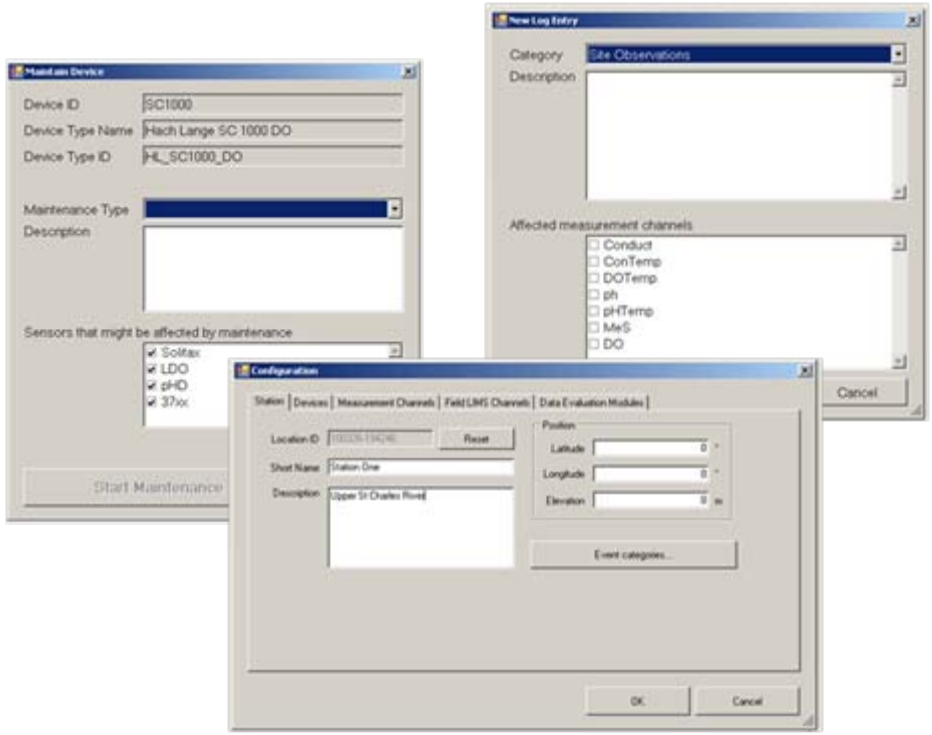
  - visualisation





Primodal Monitoring Stations

- BaseStation
  - measurement channels
  - visualisation
  - meta-data storage ….



user-input qualitative information (i.e. recalibration, event logs, weather, sensor faults…)

Primodal Monitoring Stations

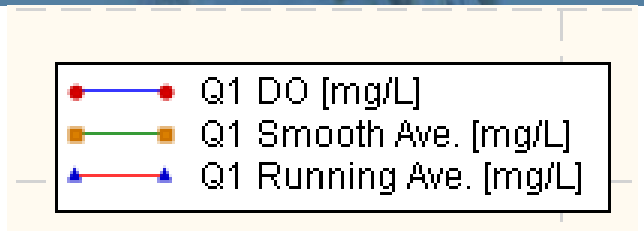
- BaseStation

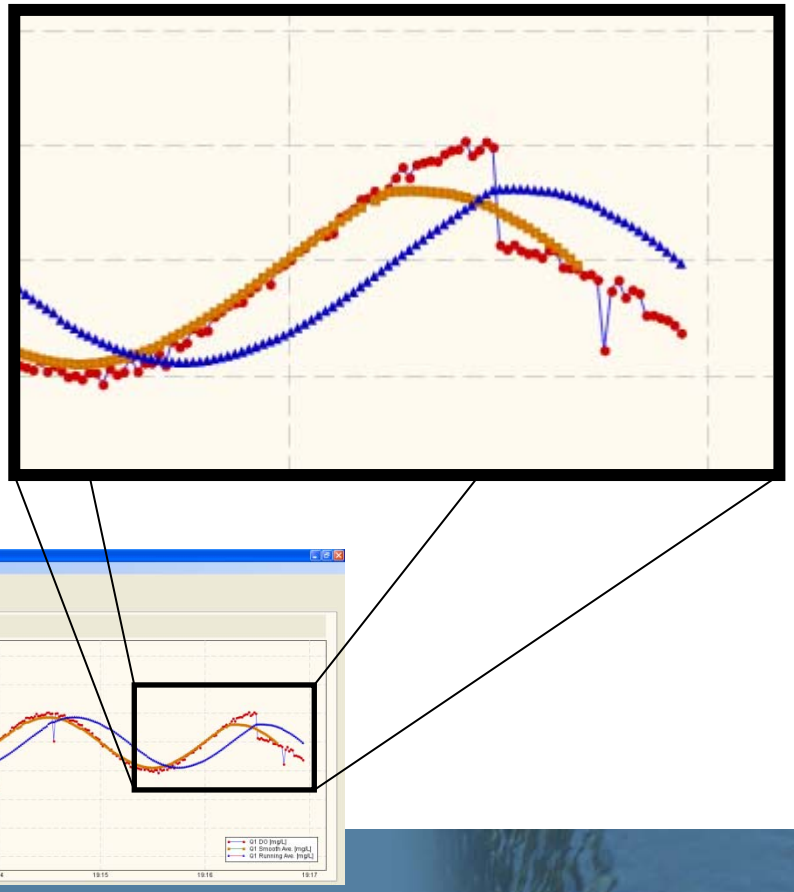
  - measurement channels

  - visualisation

  - meta-data storage ….

  - customisable, user-definable data modules



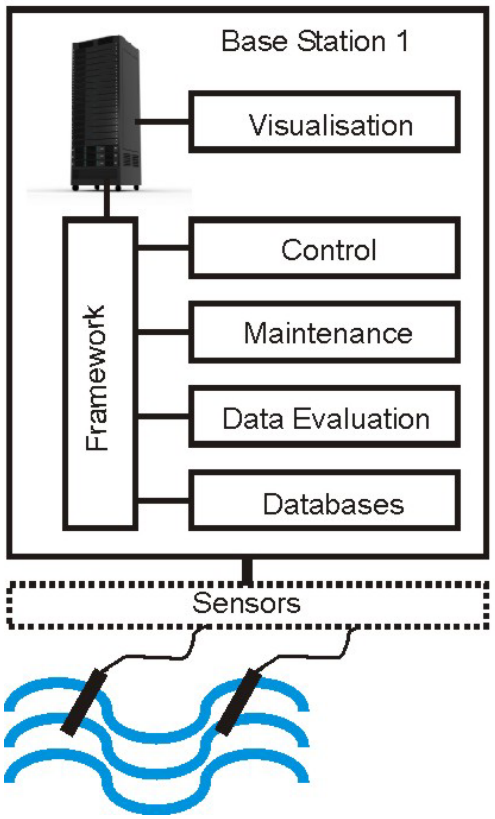


Primodal Monitoring Stations

RSM30 at the Water's Edge

- PrecisionNow software
- raw data logger
- intelligence at the water's edge
  - storage of meta data
  - storage of log data
  - real-time data quality analysis
  - error identification, alarm triggering
  - signaling (events)
  - storage of analysis data
  - storage of primary data

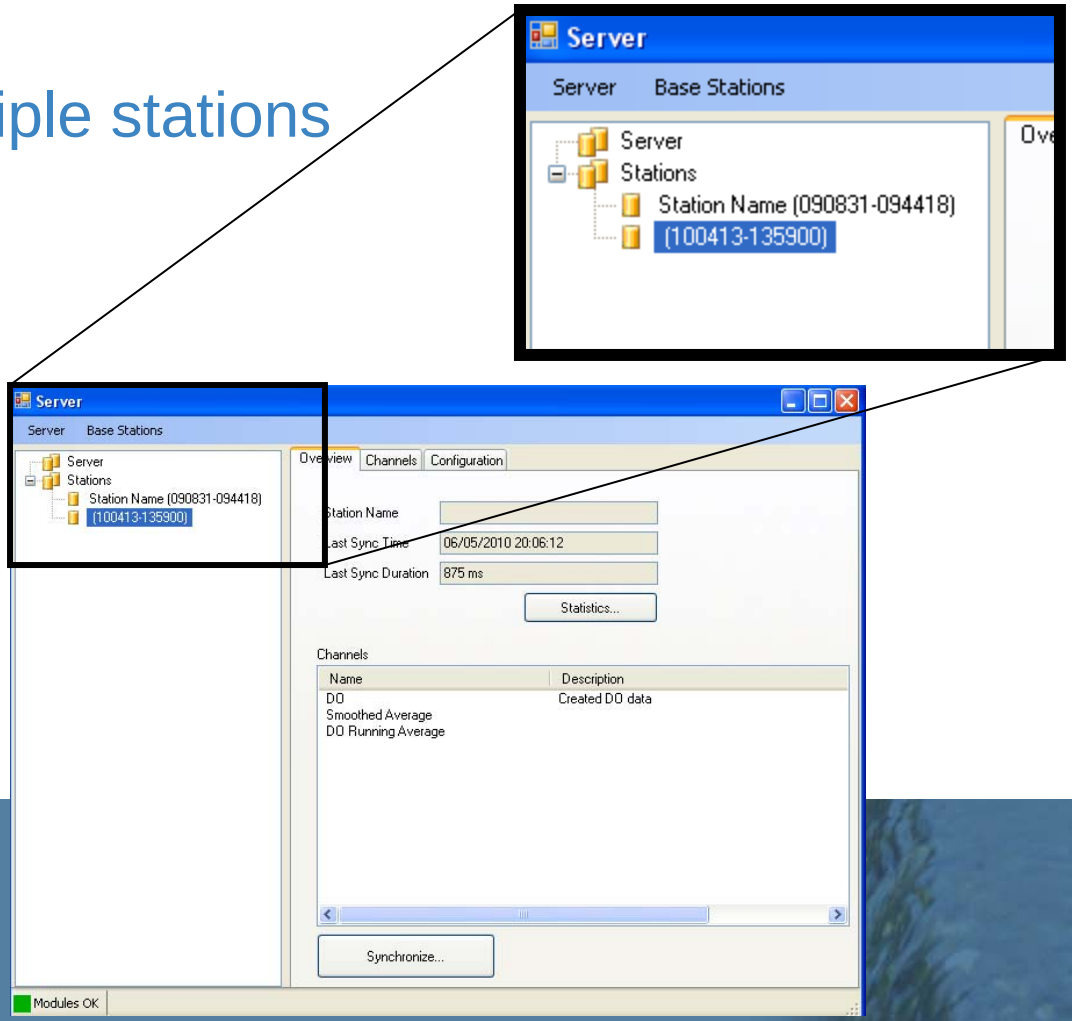
RSM30



Primodal Central Server Features

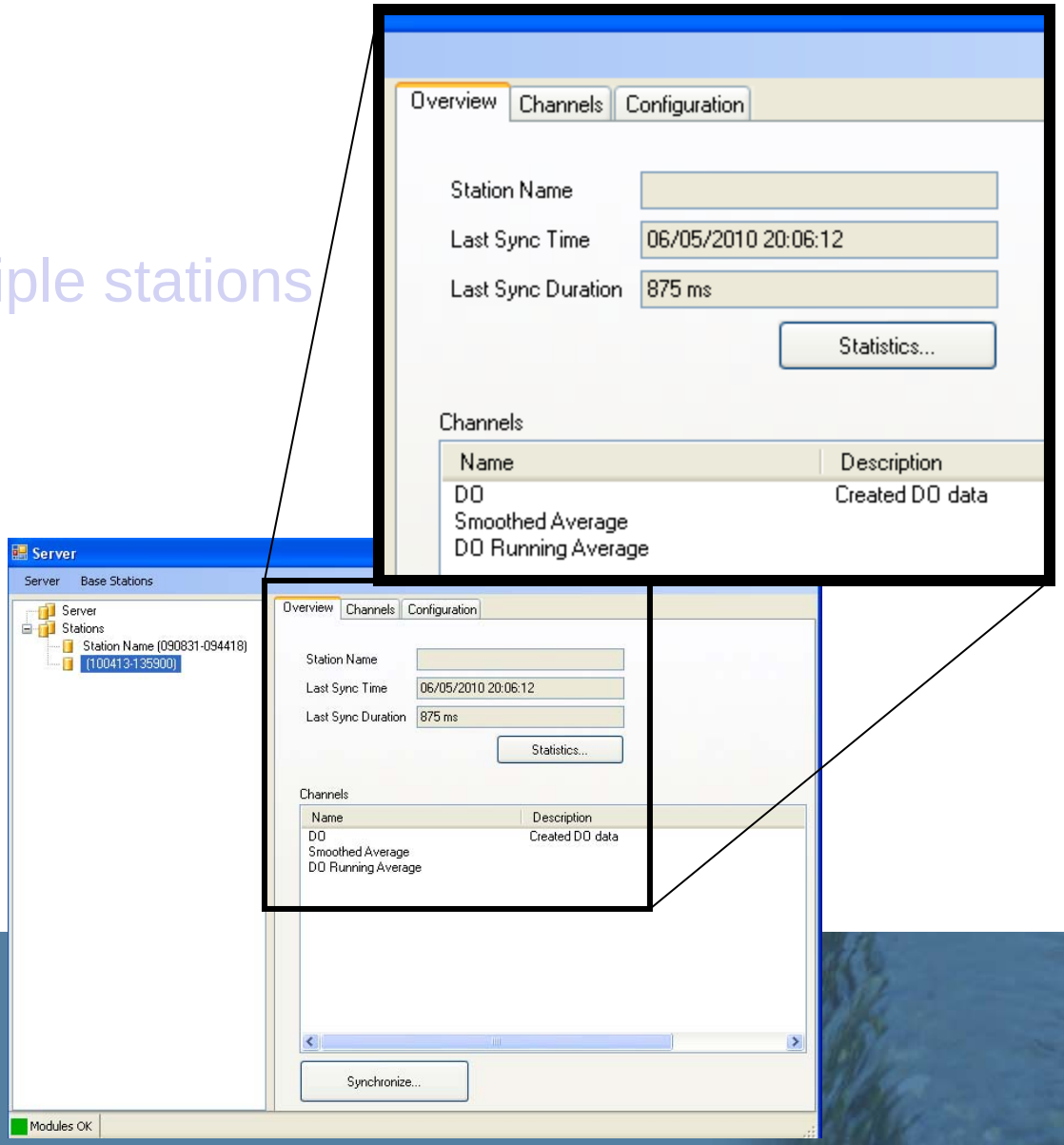
- Central Server

  - connection to multiple stations



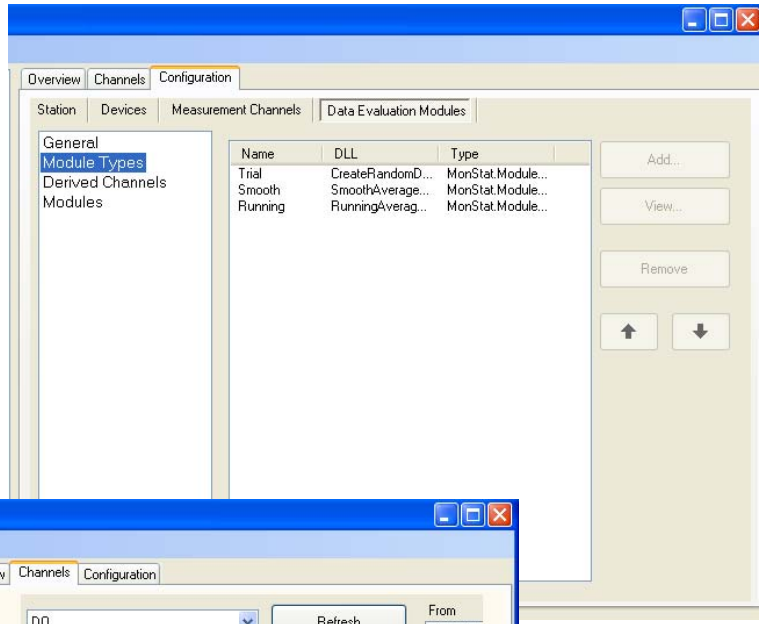
Primodal Central Server Features

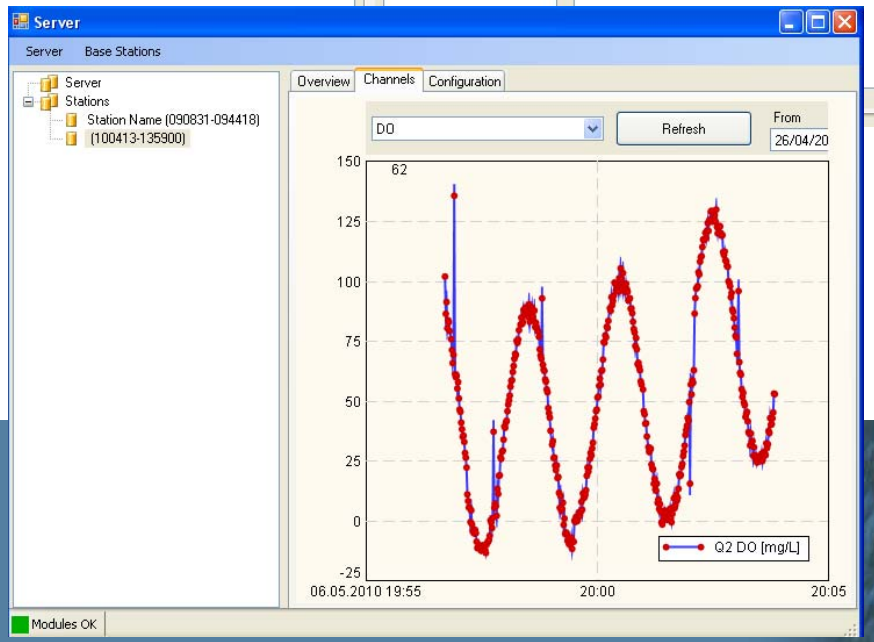
- Central Server
  - connection to multiple stations
  - station details



Primodal Central Server Features

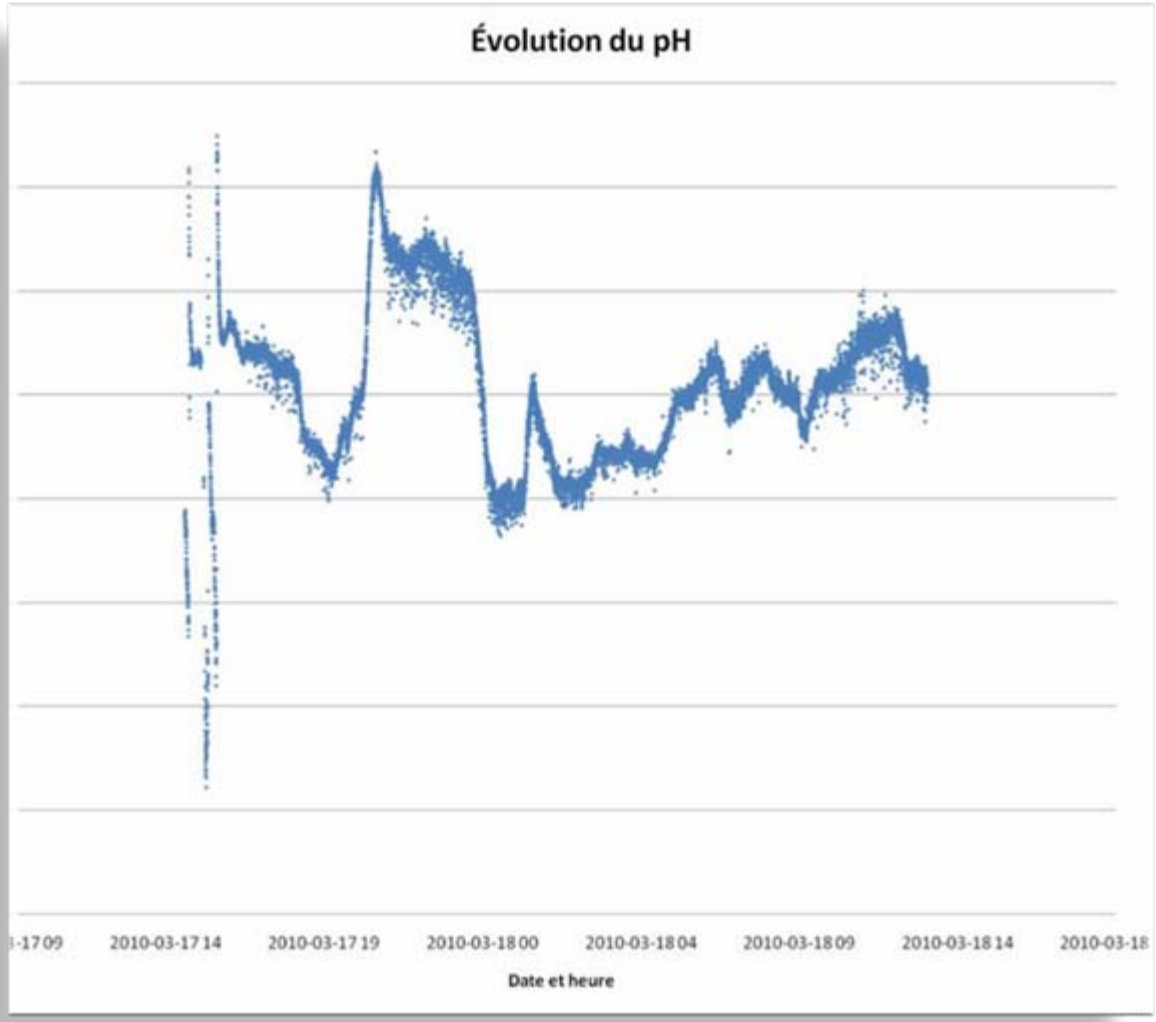
- Central Server
  - connection to multiple stations
  - station details
  - visualisation & data modules





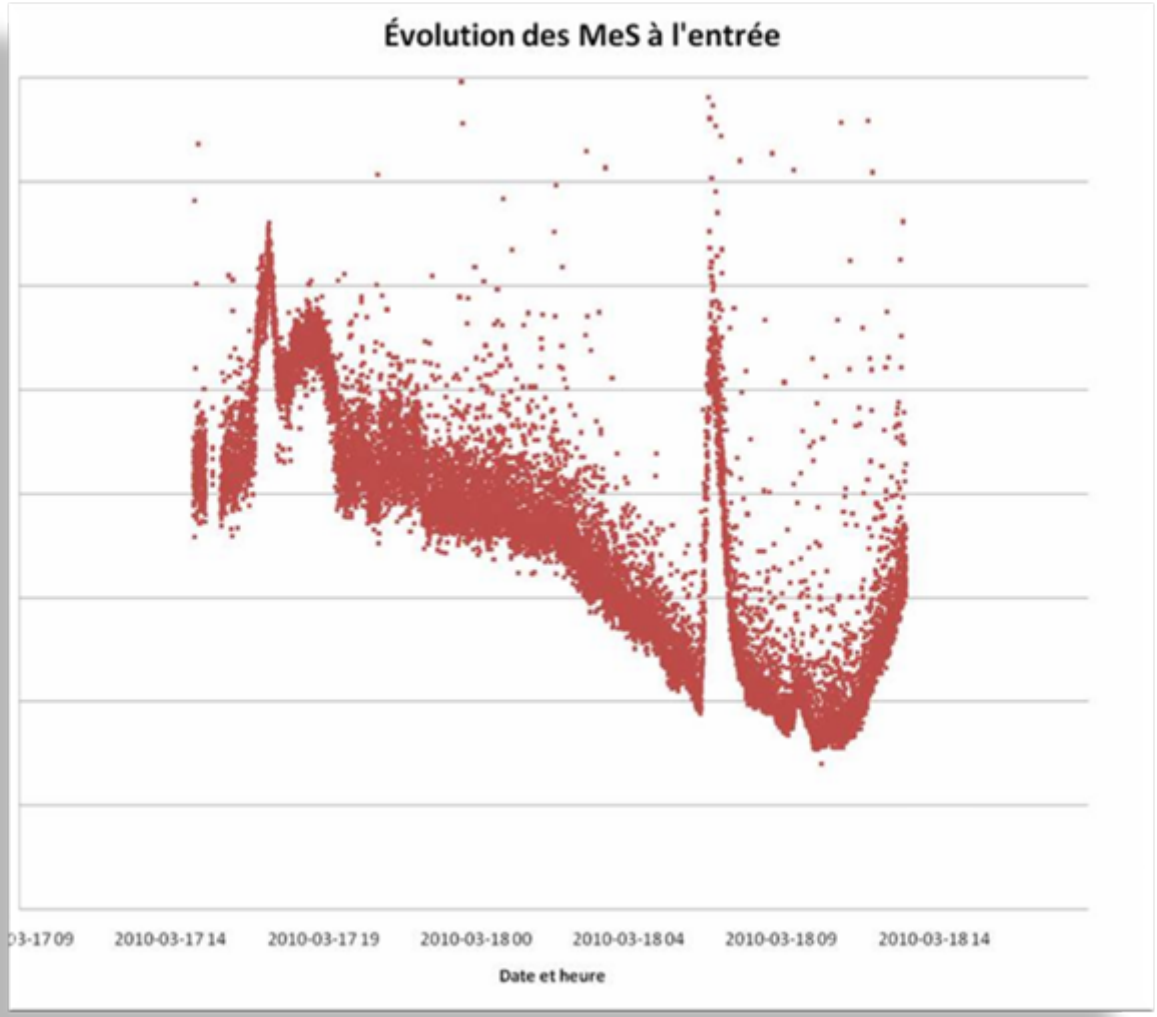
Primodal Monitoring Station Data Modules

- Data from Quebec City WWTP
  - Hach Lange (pH)



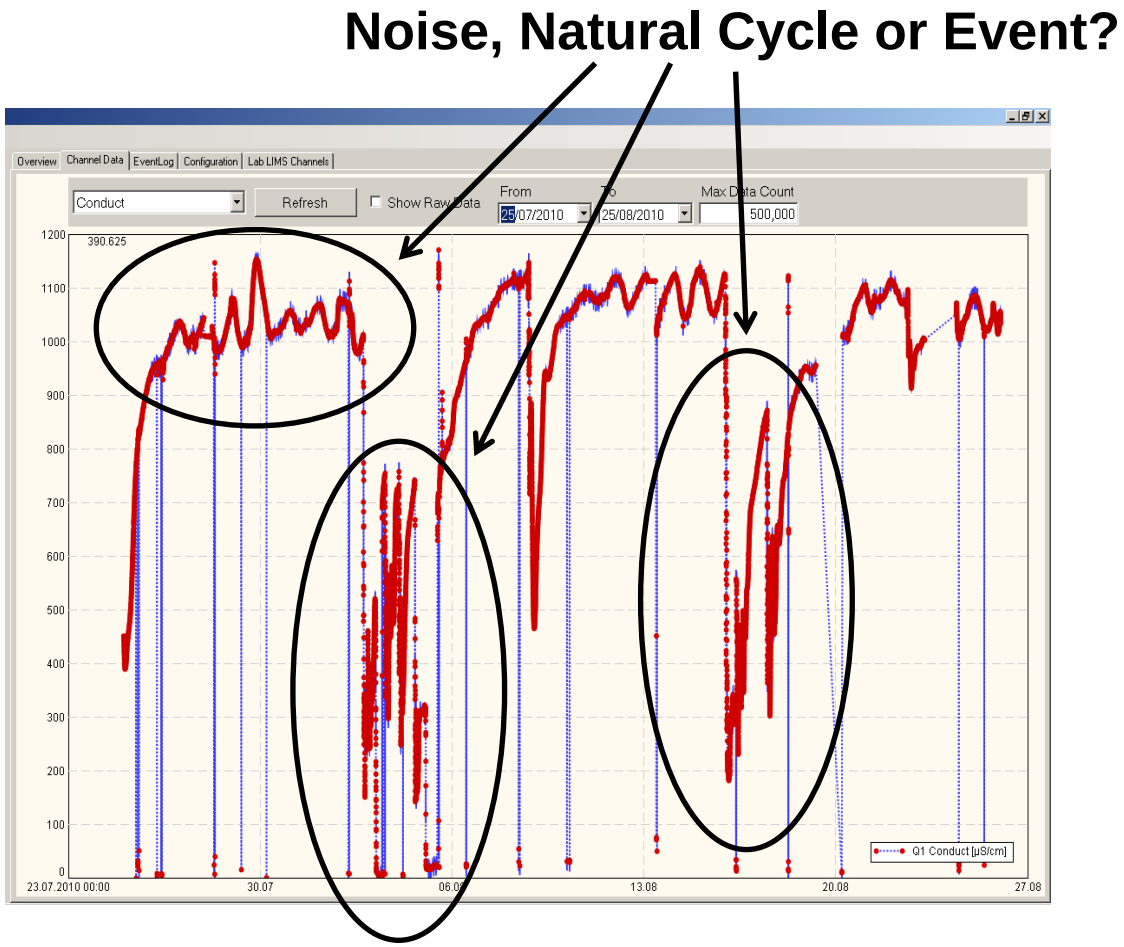
Primodal Monitoring Station Data Modules

- Data from Quebec City WWTP
  - Hach Lange (TSS)



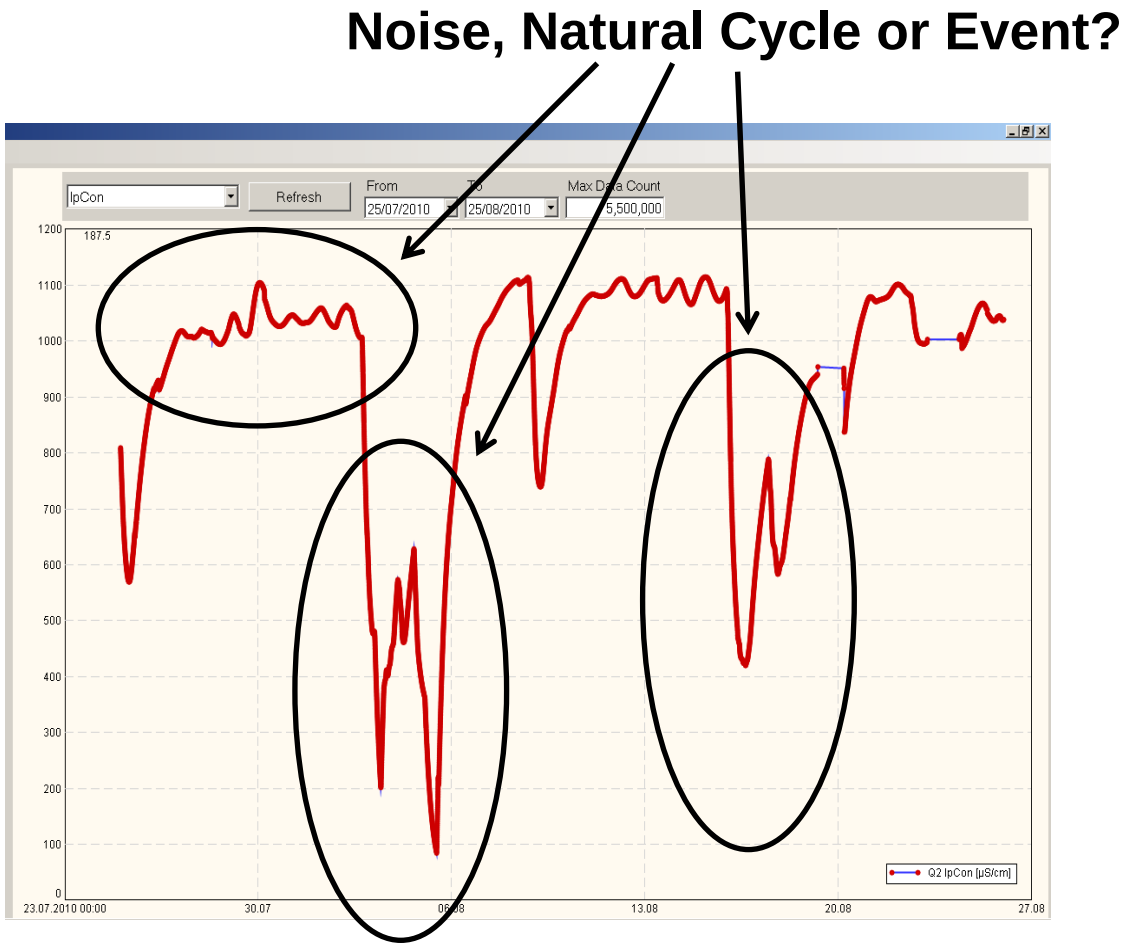
Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River
  - Conductivity raw data



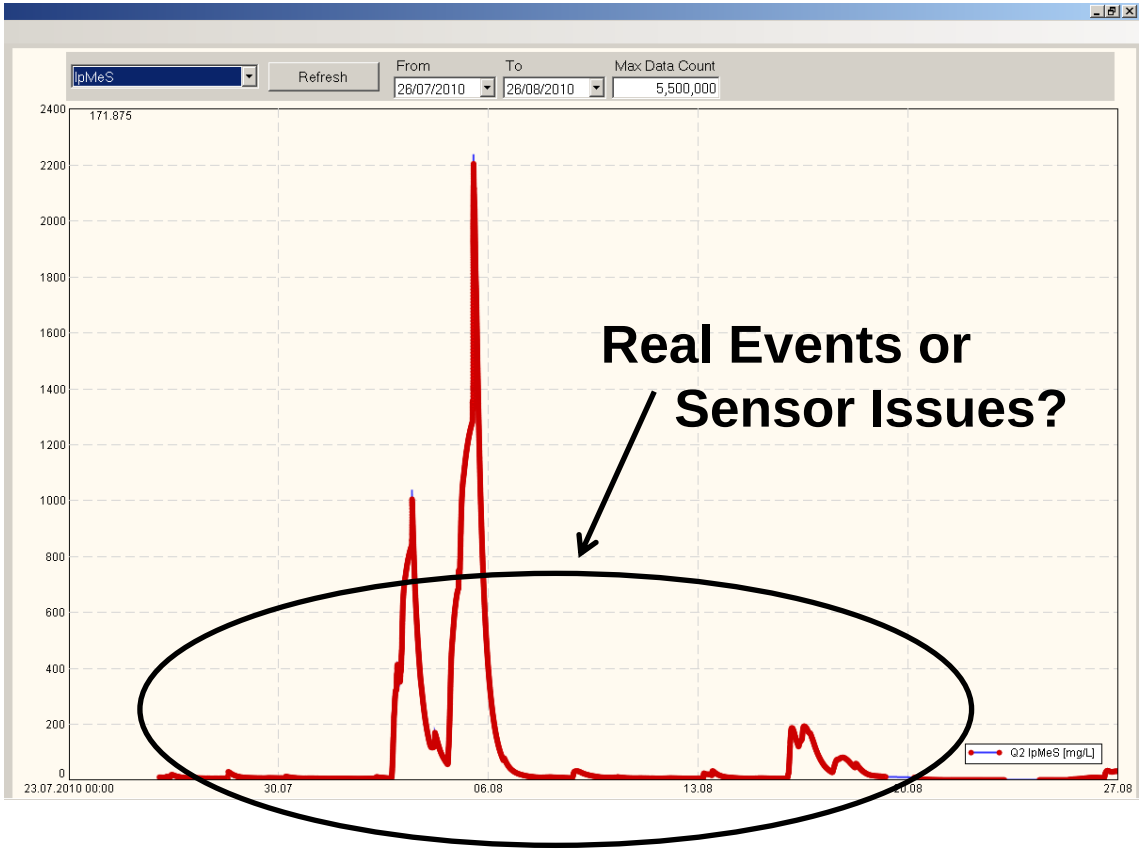
Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River
  - Conductivity data after LowPass Filter



Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River
  - MeS probe: TSS data after LowPass Filter

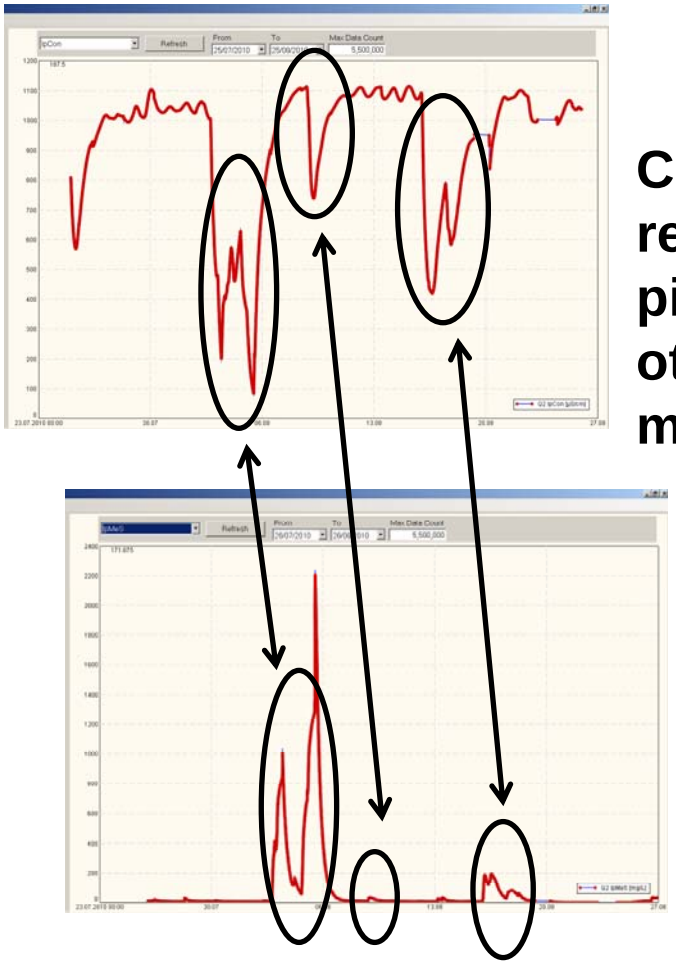


Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River

  – Conductivity vs MeS (data after LowPass Filter)

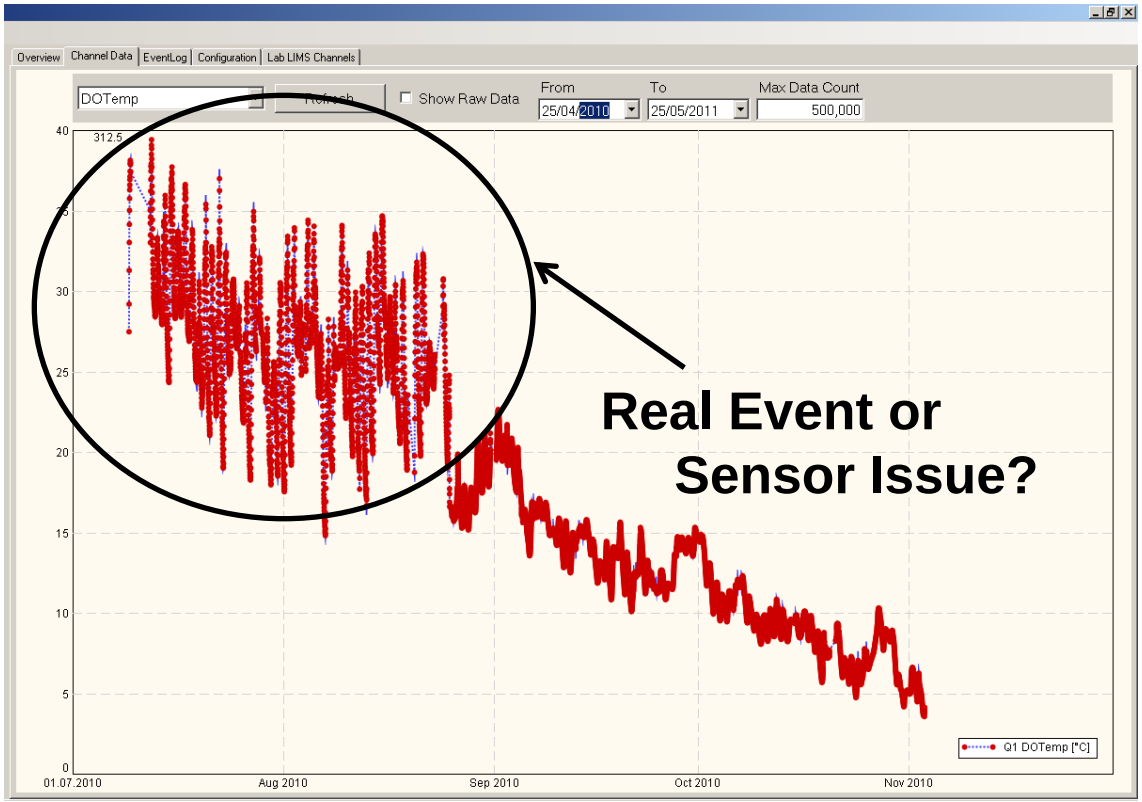
  - no alarm



Confirmation of real events as picked up by other measurements

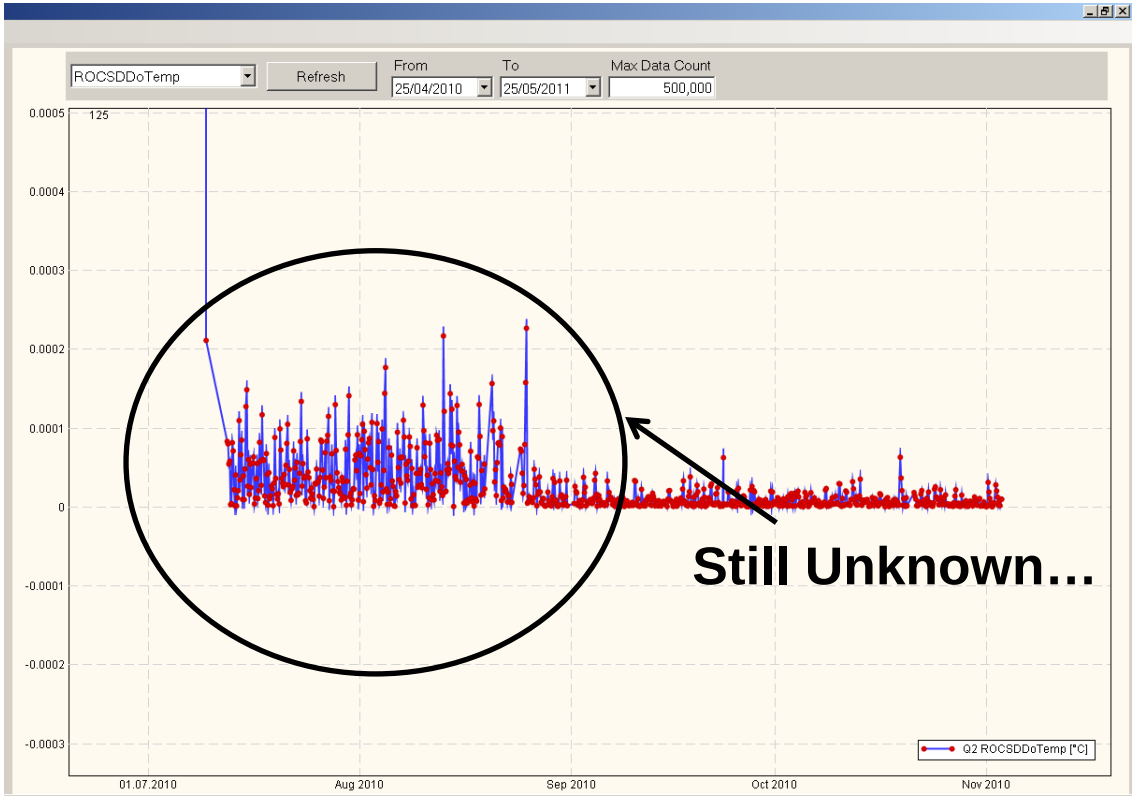
Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River
  - DO probe: Temperature



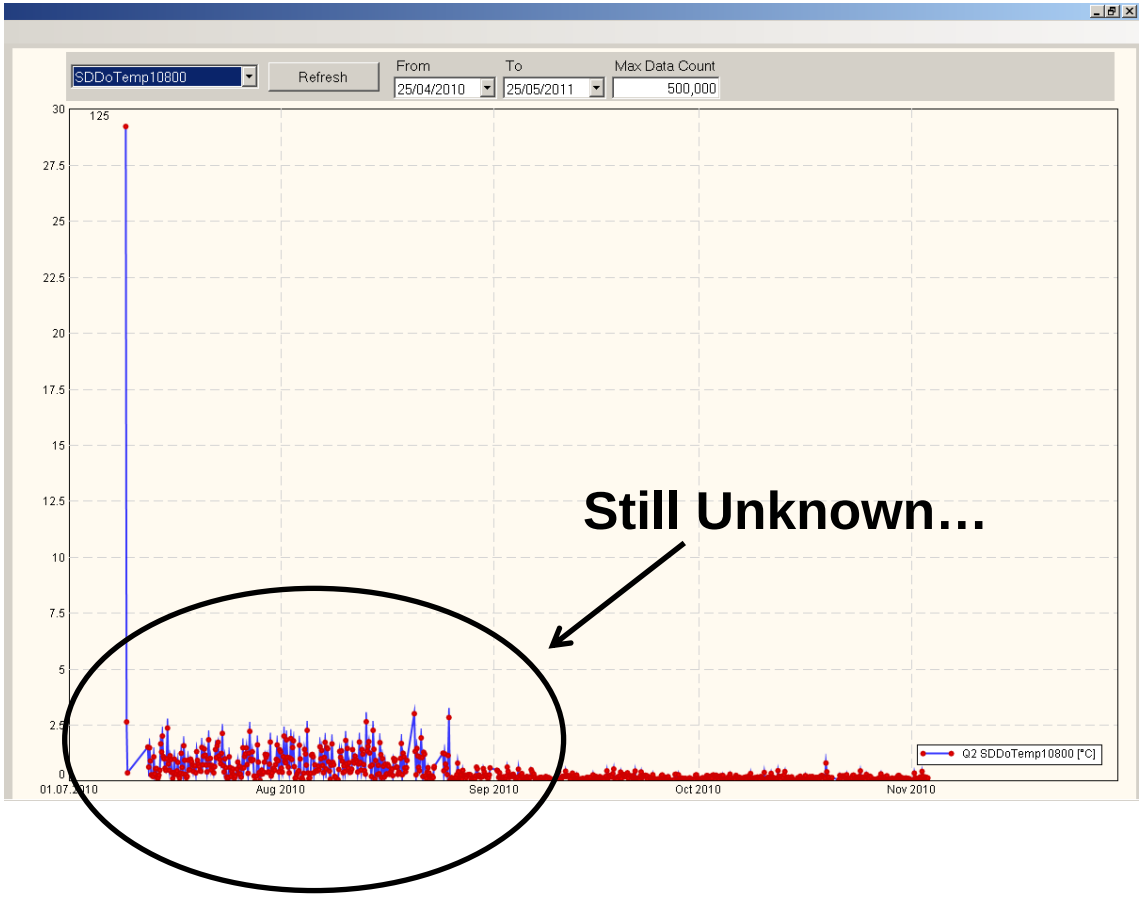
Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River
  - DO probe: Temperature, Rate of Change



Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River
  - DO probe: Temperature, Standard Deviation

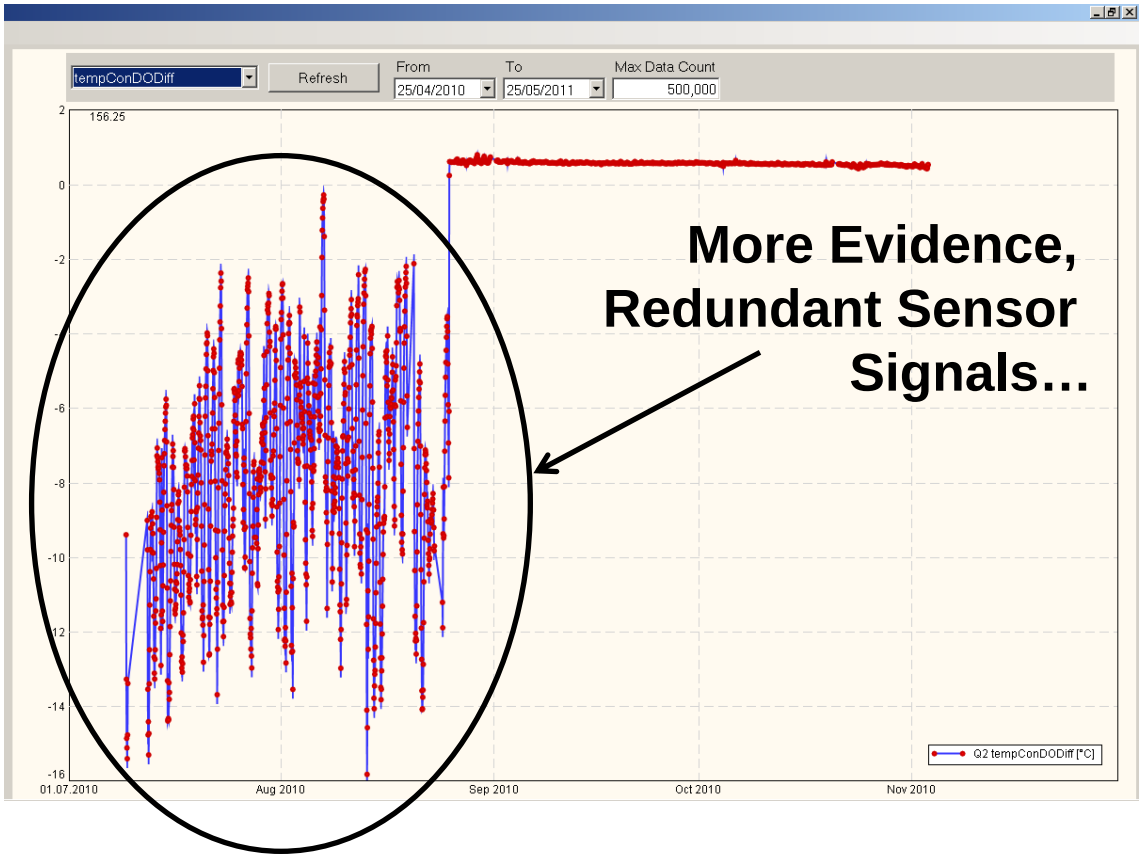


Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River

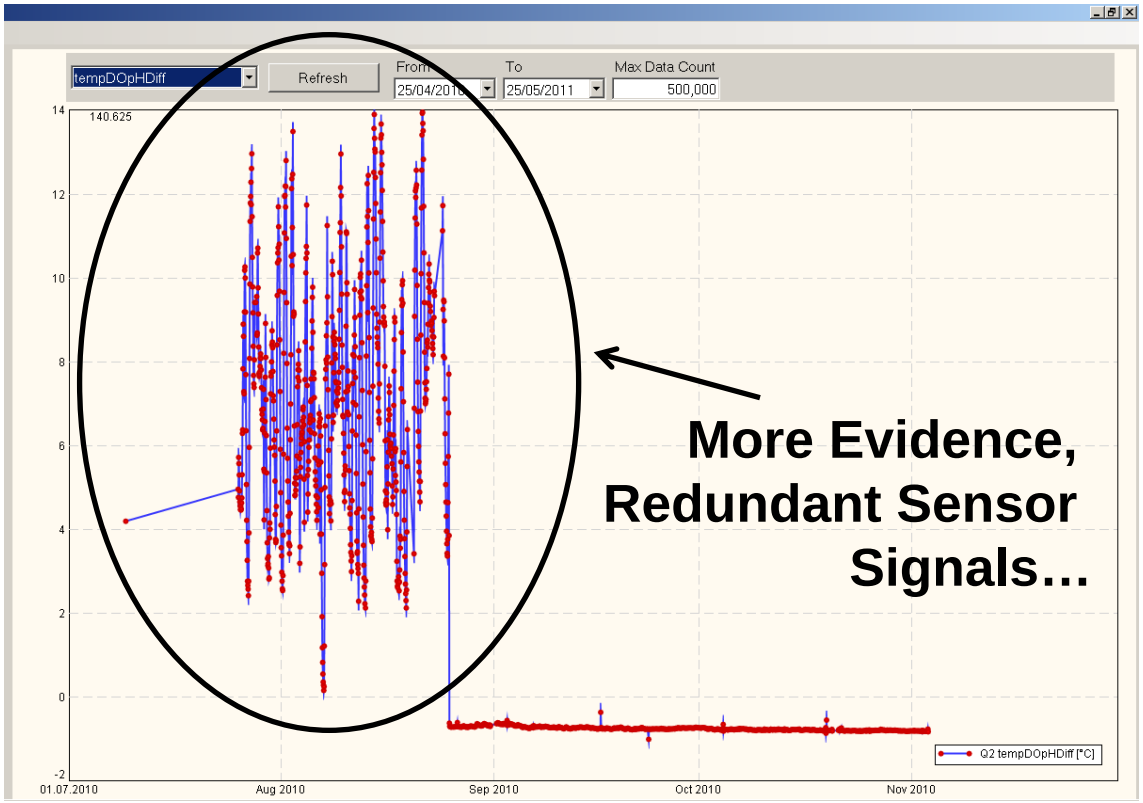
  – Comparison of Temperature Signals

  - DO vs Conductivity Probes



Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River
  - – Comparison of Temperature Signals
  - - DO vs pH Probes



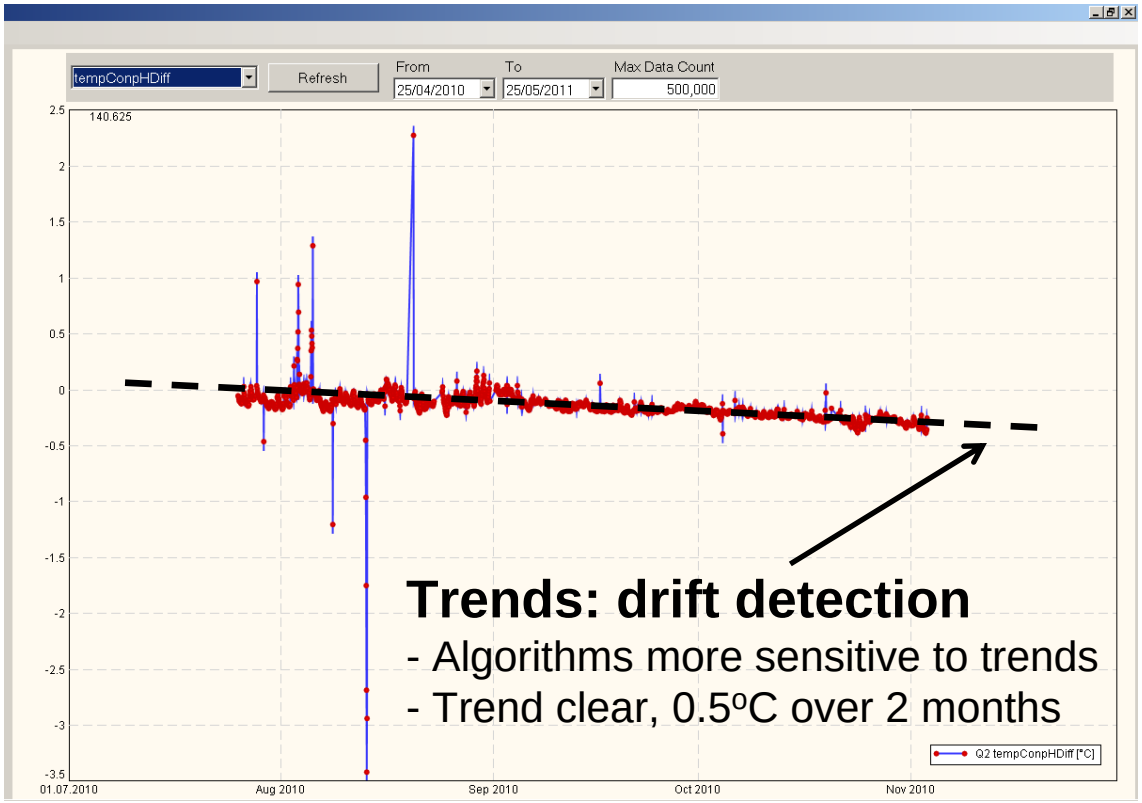
Primodal Monitoring Station Data Modules

- Data from Quebec City: St Charles River

  – Comparison of Temperature Signals

  - Conductivity vs pH Probes

  - alarm triggered



Summary

- Identified Issues: RSM30 Solutions
  - volume of data → data stored, simplified, filtered

Summary

➢ Identified Issues: RSM30 Solutions

- volume of data
- data graveyards → real-time analysis to identify and trigger alarm situations, generate datasets of ‘clean’ data

Summary

➢ Identified Issues: RSM30 Solutions

- volume of data
- data graveyards
- post-processing effort → automated data analysis for initial sanity check and to minimise calibration problems, identify trends, offsets …. as the data is stored

Summary

➢ Identified Issues: RSM30 Solutions

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling → trend, problem analysis to identify sensor problems and enable timely dispatch of technicians when problems present themselves

Summary

➢ Identified Issues: RSM30 Solutions

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling
- information available to field technician at water's edge

  → data storage and visualisation included in the station itself, giving technicians access to historical, log, measurement data to better maintain sensors and stations

Summary

➢ Identified Issues: RSM30 Solutions

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling
- information available to field technician at water's edge
- advancements with digital sensor technology
  - → profibus based sensor connections allow two-way communication with digital sensors and use of advanced sensor features

Summary

- Identified Issues: RSM30 Solutions

  - volume of data
  - creation of data graveyards
  - post-processing effort
  - maintenance scheduling
  - information available to field technician at water's edge
  - advancements with digital sensor technology
  - portability of system → small, light form factor allows station to be moved, new sensors configured, new analyses incorporated…

Discussion

- Moving Forward
  - More field deployments
  - More system design feedback
  - Integrate user feedback into interface
  - More remote communication options
  - Data module development
    - out-of-bounds → multi-variant regression analysis
    - SNR → more advanced time-series analysis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Thank-you