



## Overview of the PAMBuoy system

Cormac Booth

Doug Gillespie

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27th September 2012



# Introduction to PAMBuoy™

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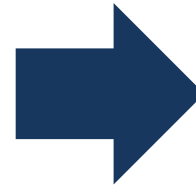
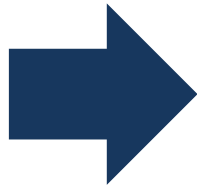
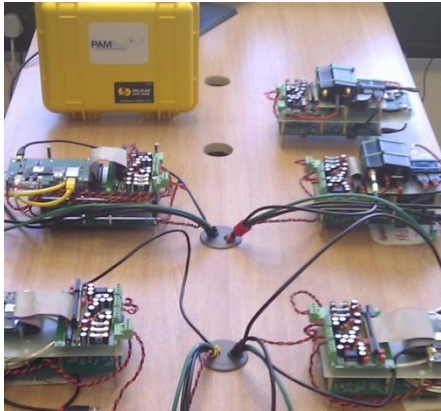
- SMRU Ltd has an extensive marine mammal background
- SMRU Ltd identified a gap in PAM ability, based on many years experience of current PAM tools
  - CPODs, static PAM systems, etc
    - Most remote systems require retrieval;
    - Cabled systems usually not an option;
- Opted to build a system to address these issues, the main objective being

**Wireless data recovery to enable real time detection**

A reconfigurable **software acoustic signal processing(ASP) platform**,  
utilising advanced detection and classification algorithms  
to reduce data volumes  
which enables **low power, real-time data transmission**

Enabling mammal detections to reach your desktop in **seconds**

# What does a PAMBuoy™ look like?



# PAMBuoy™ applications



## Monitoring sites of industrial activities

- Long term baseline and impact monitoring
  - Distribution in time and space



## Mitigation during industrial activities

- Detecting animals in the vicinity of pile driving, seismic exploration, explosives



## Cumulative impact & noise monitoring

- Finding animals for visual study
- Population studies
- Behavioural studies

# How can you deploy PAMBuoy™?



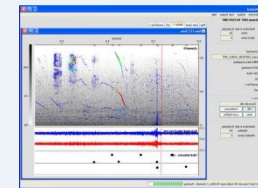
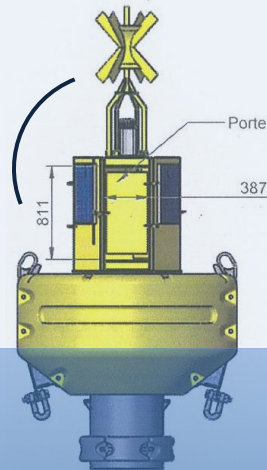
**Data interpretation:**  
Detection data analysis on shore



**Data transmission:**  
Processed data transmitted  
by 3G mobile network



**Remote control:**  
Unit is set-up and  
maintained wirelessly

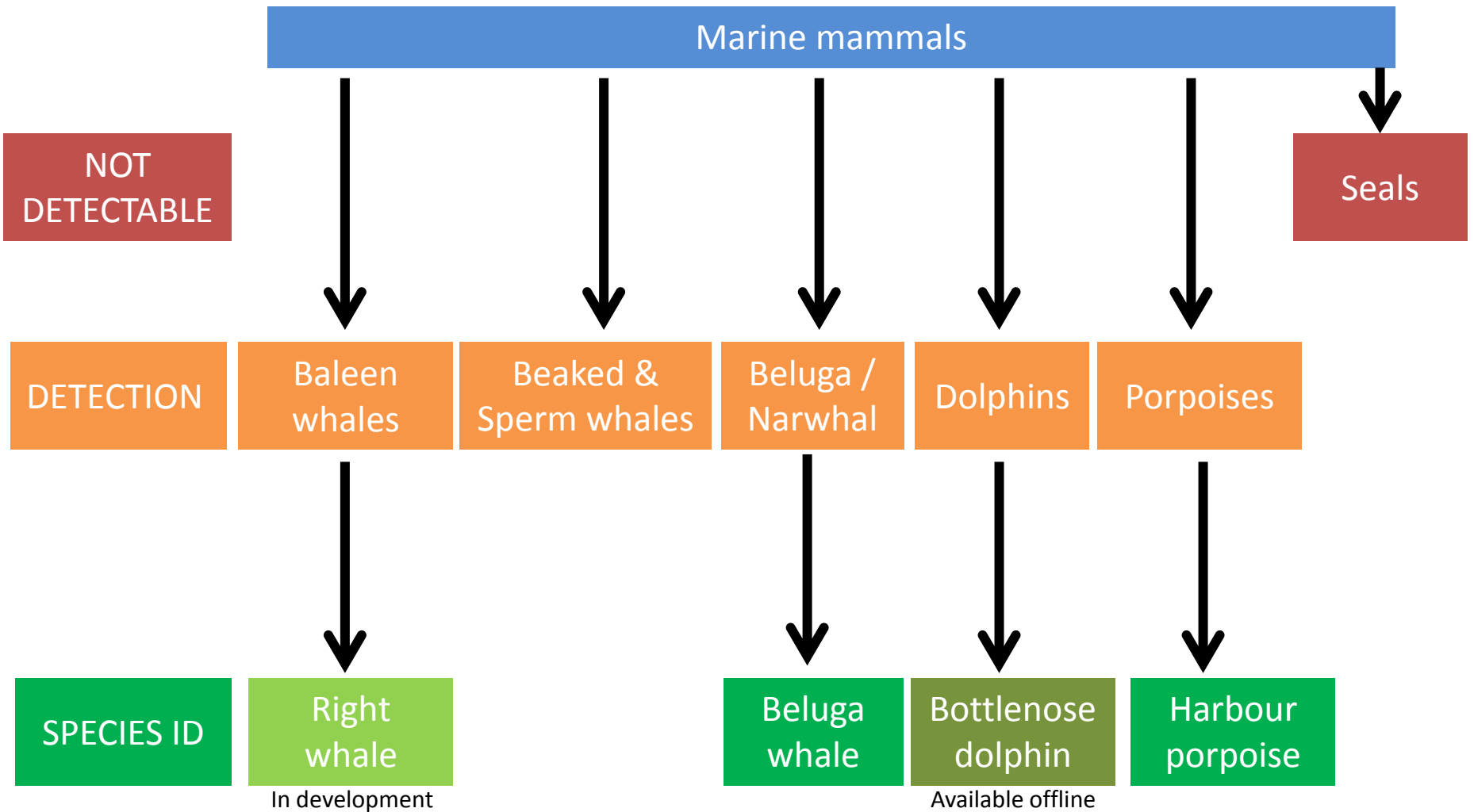


**Data processing:**  
Detection algorithms

**Data acquisition:**  
High sampling rate (500kHz)



# PAMBuoy™ detection and classification





# Benefits of real-time PAM

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1. Having your data on a regular basis;

- **Minimising data loss**

2. Wireless and remote control – **saves time and money:**

- Upload new detectors or sampling regimes;

**3. Performance information**

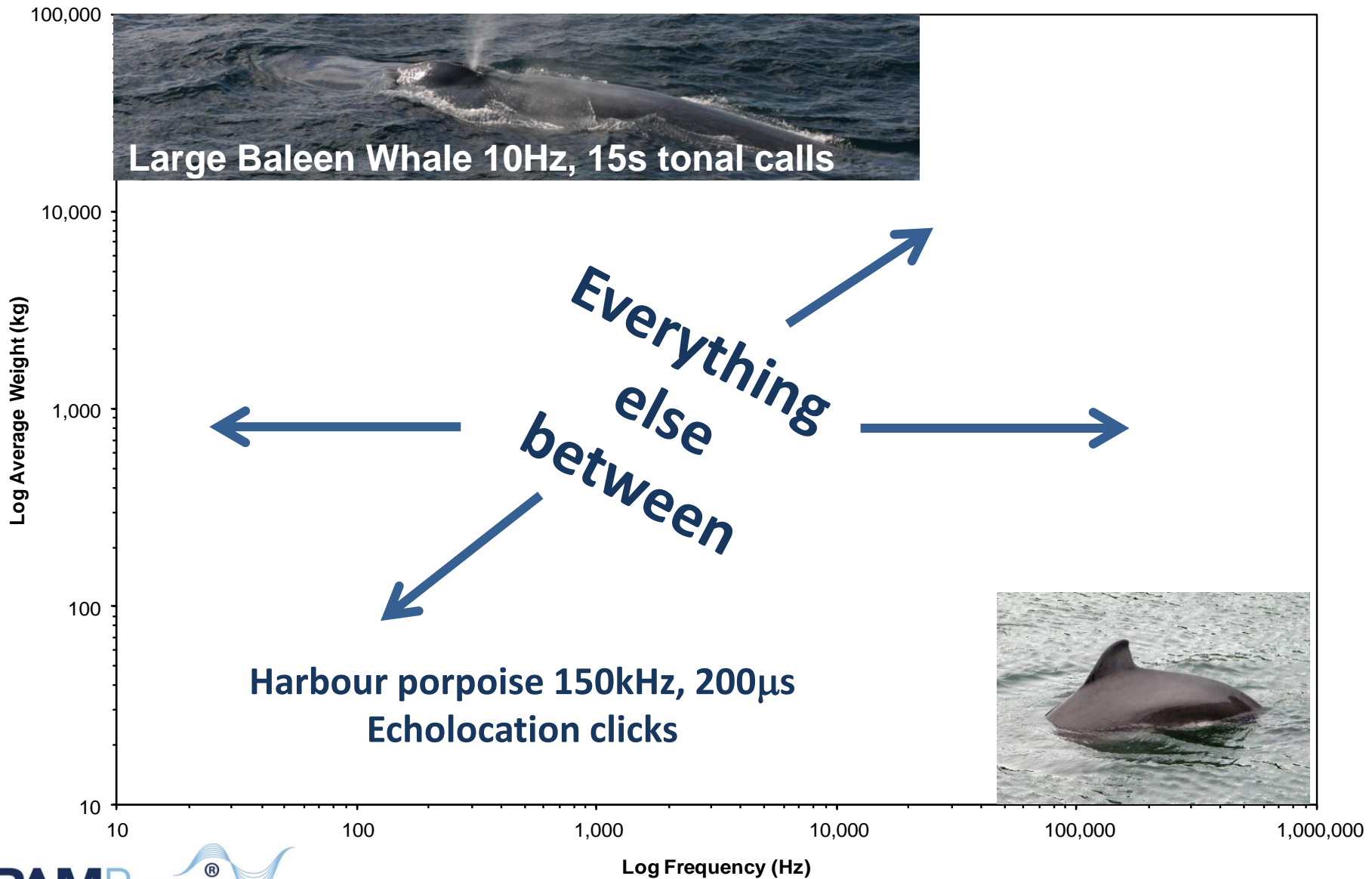
- Quick to find out if there's a issue with the system;



PAMBuoy™ software  
Doug Gillespie

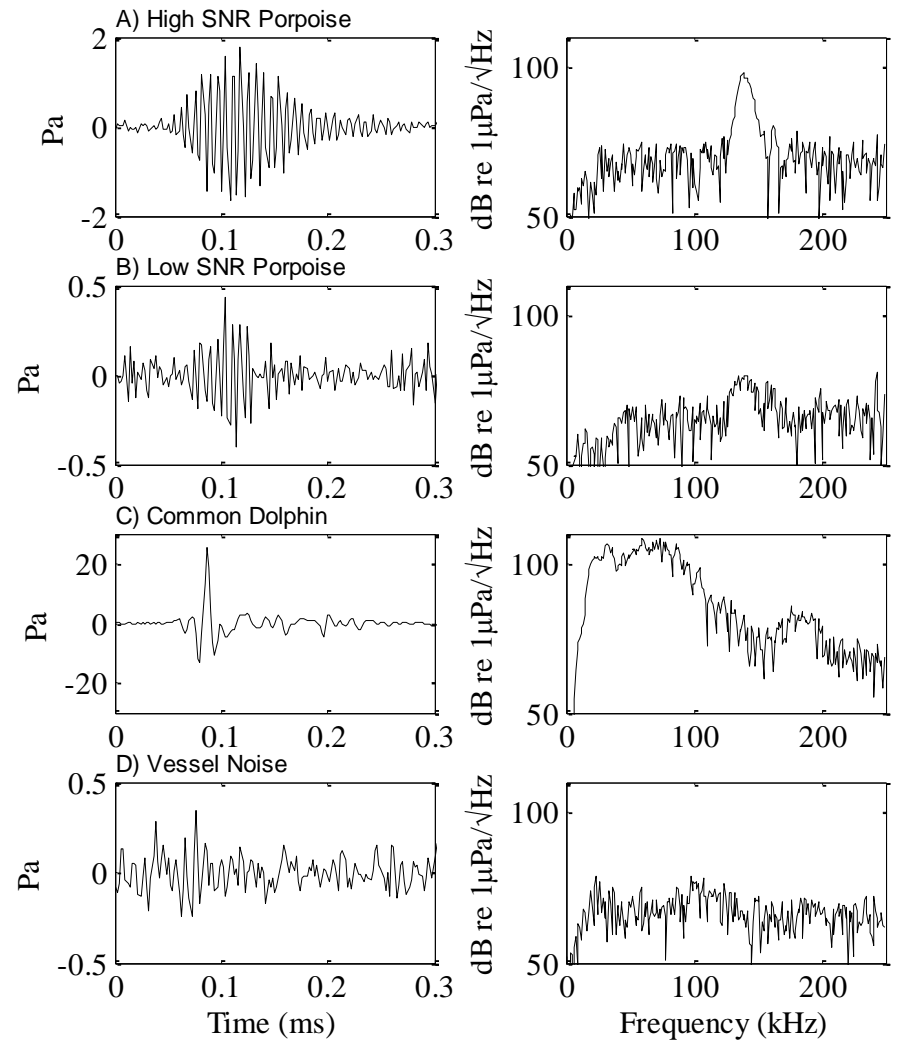


# Summary of cetacean vocalisation frequency



# Porpoise Echolocation

- 100 – 150kHz narrow band signal.
- Easily distinguished
- Requires sampling at very high sample rates (typ' 500kHz).
- Lots of samples:
  - Lots of number crunching
  - Lots of storage

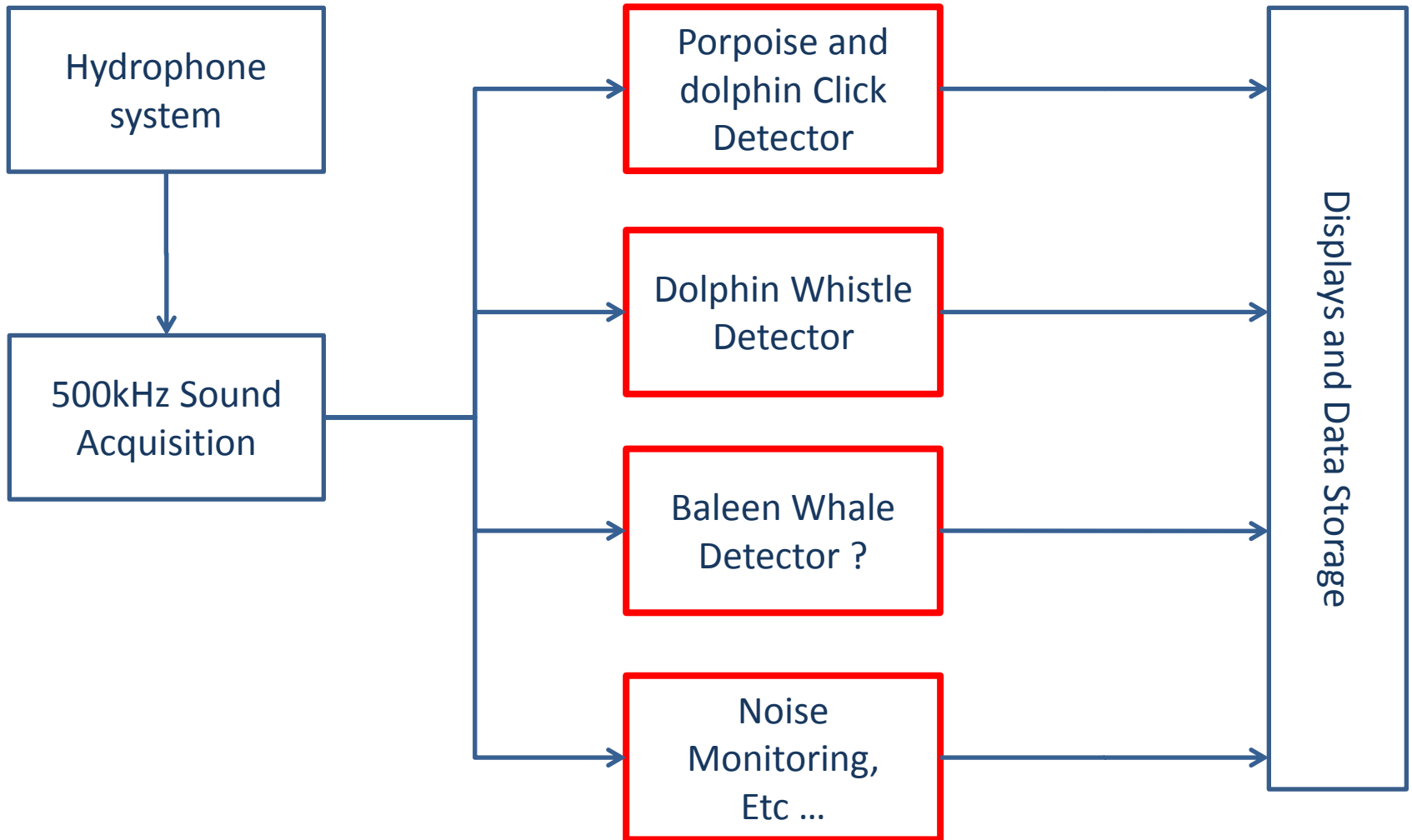


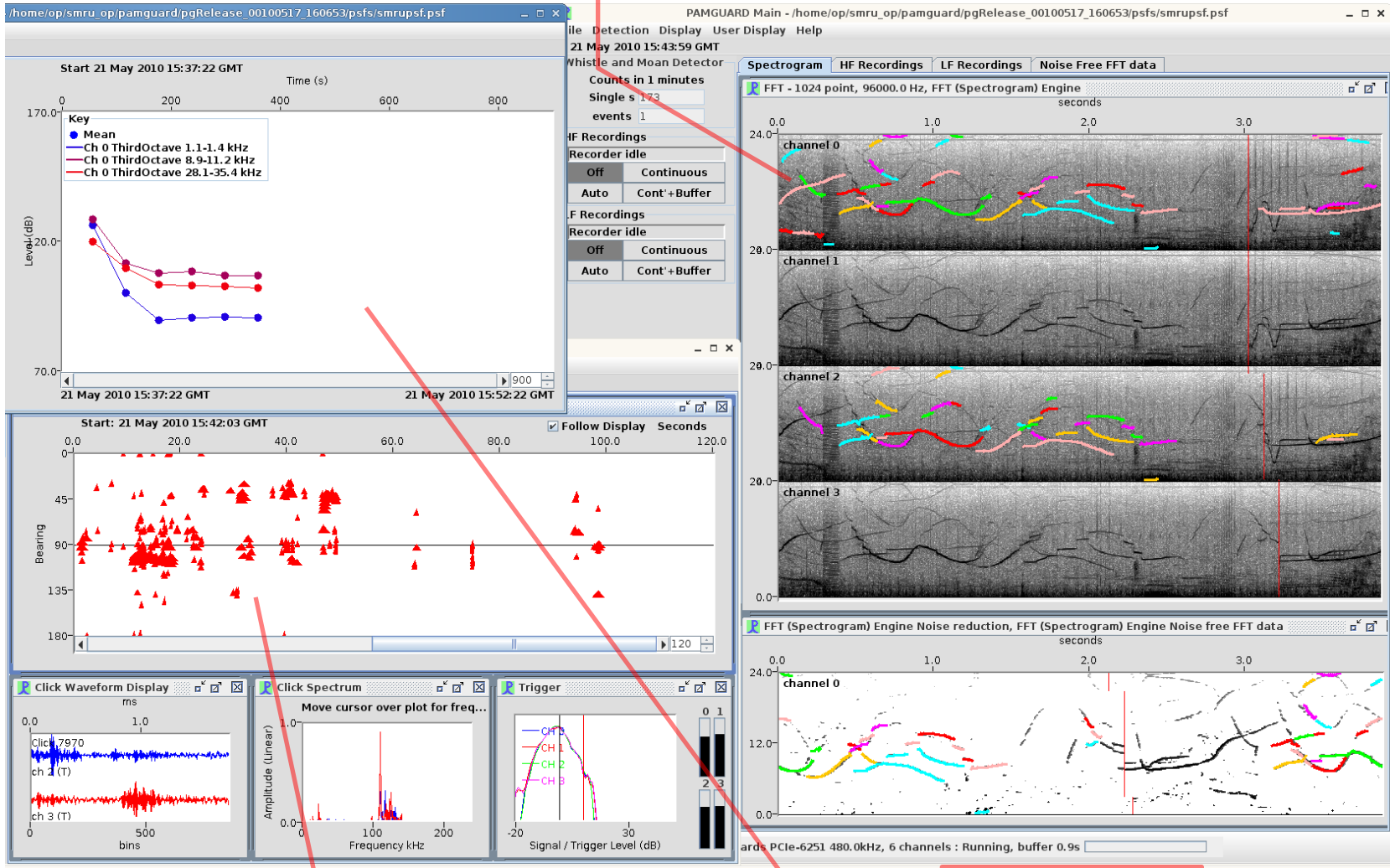
# Its all about data reduction

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- Sampling for porpoise clicks at 500kHz
  - 1 Megabyte of data / second
  - 3.4 Gigabytes / hour
  - 80 Gigabytes / day
  - 29 Terrabytes / year
- By detecting online, we are reducing this to ~1 or 2 Megabytes per day.
  - Data reduction of 40,000:1 or 0.002%

# UK PAM system requirement

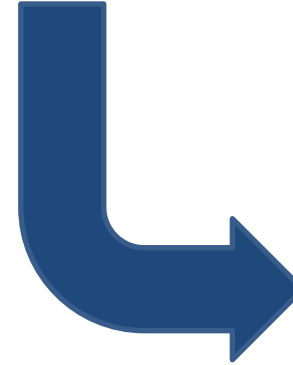




Porpoise click detections

Noise level measurements

- PAMGUARD is
  - ✓ Free, open source
  - ✓ PC Based
  - ✗ High Power
  - ✗ Need operator
- We have something
  - ✓ Small
  - ✓ Low Power
  - ✓ Fully autonomous





# The PAMBuoy™ ASP Software

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**Custom** ground up **C++** codebase

Designed to **share** processing between a **DSP** and an **ARM**

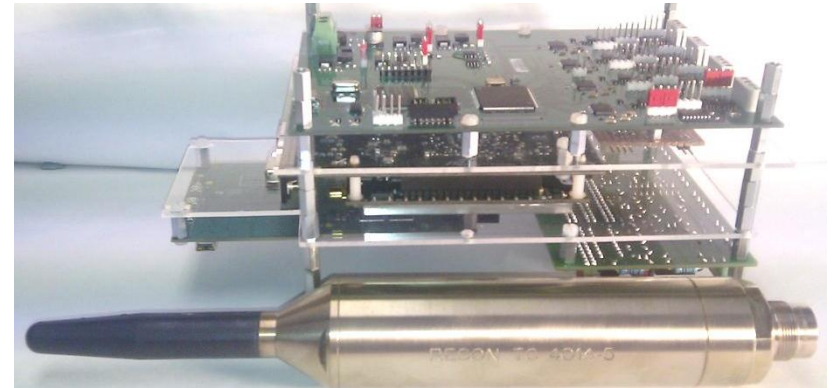
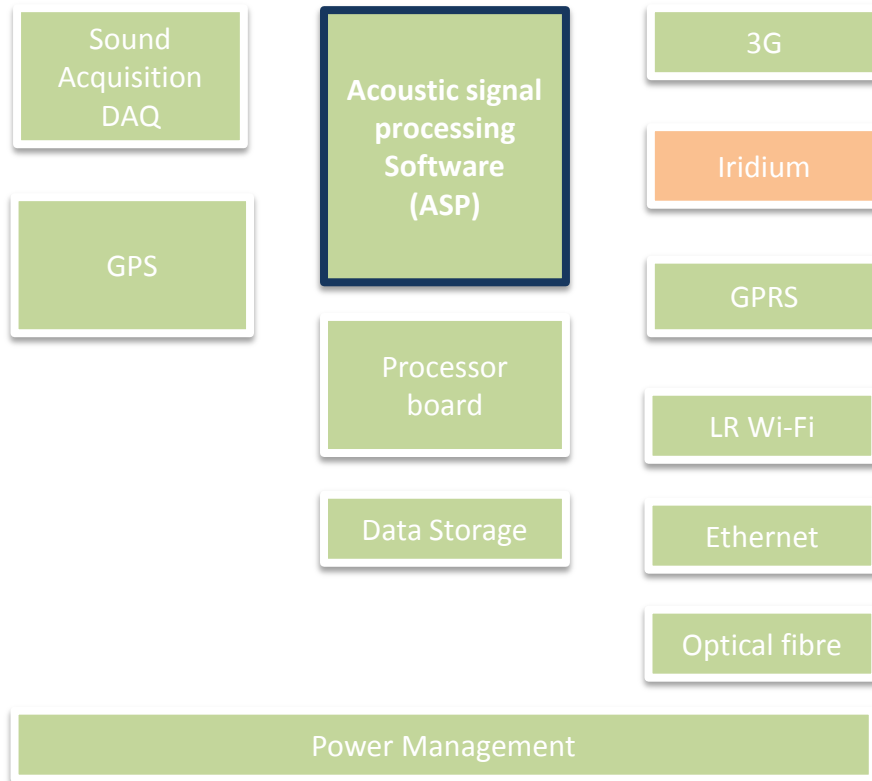
Flexible **modular** structure for fast **detector/classifier** development



Algorithms match that of PAMGuard

Data output formats are compatible with PAMGuard/Matlab

# What's in the electronics box?

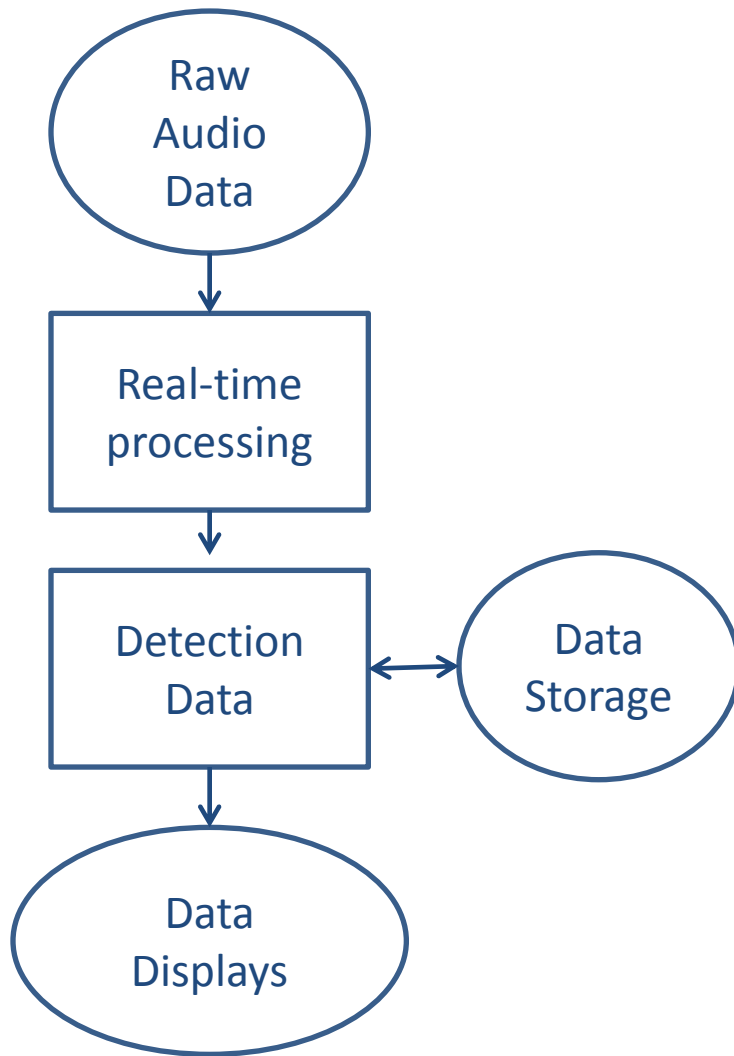
Acquisition → Processing ↔ Transmission



-  Current function
-  In development

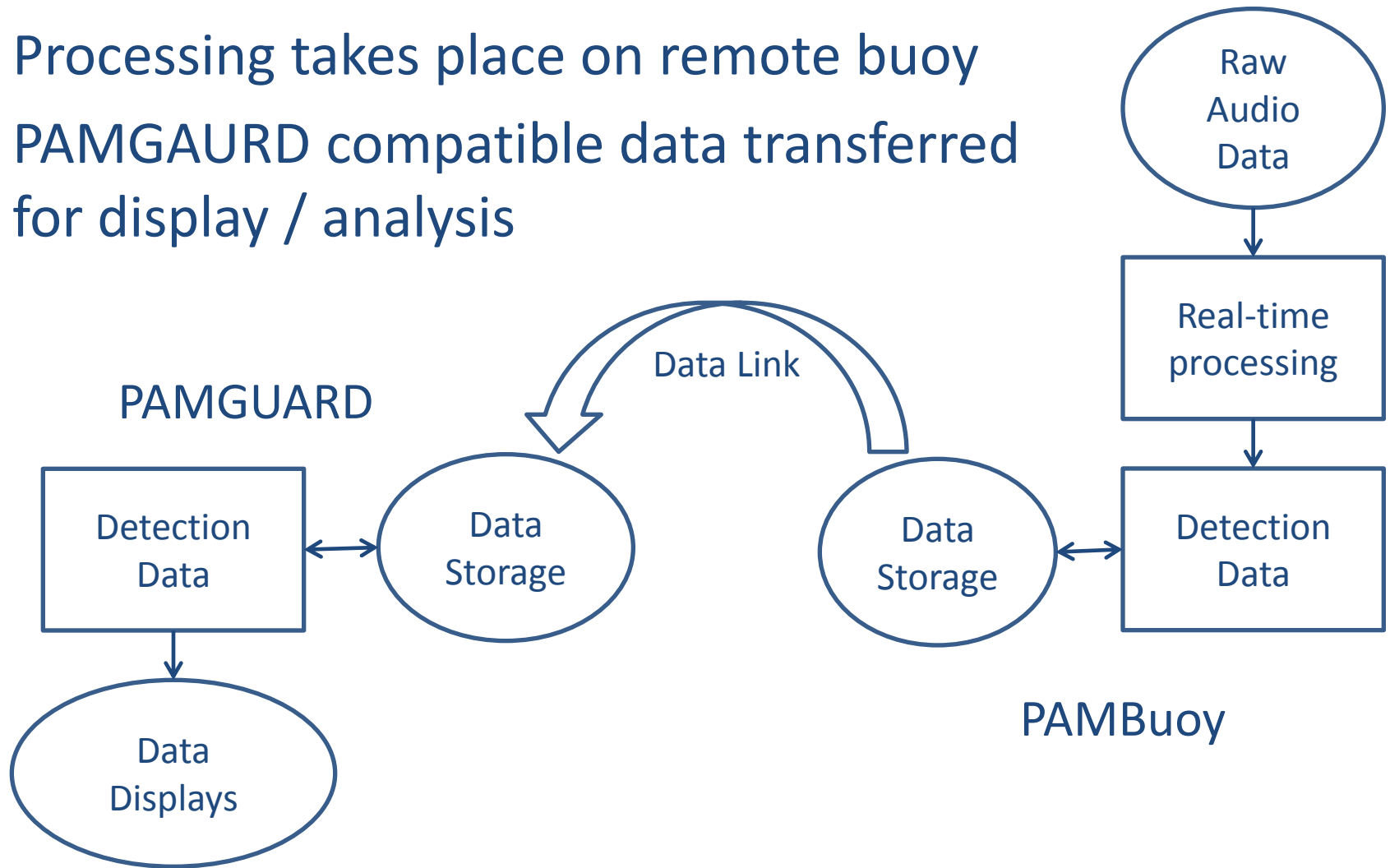
# PAMGuard Operation

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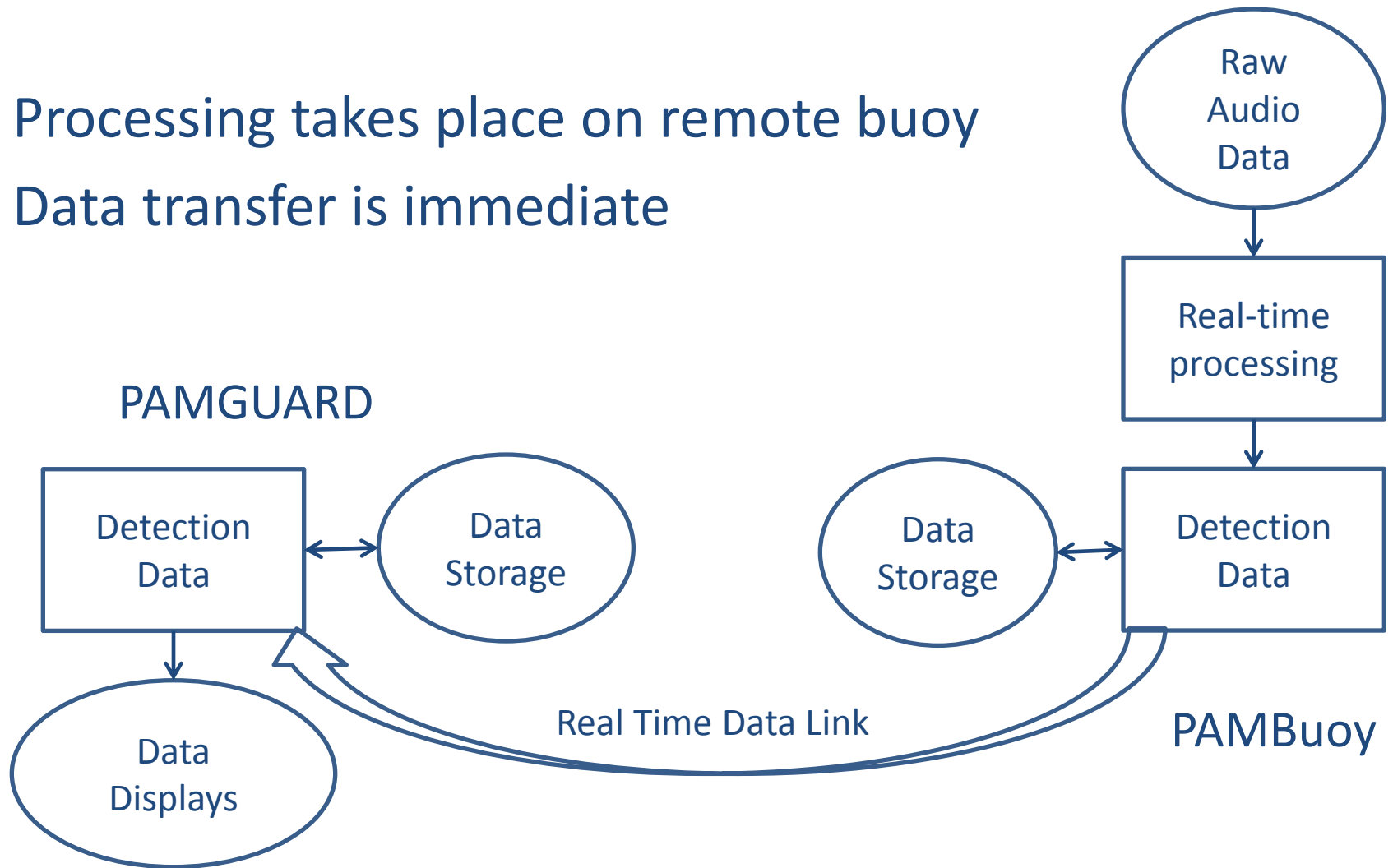
# Operating modes: baseline

- Processing takes place on remote buoy
- PAMGAURD compatible data transferred for display / analysis

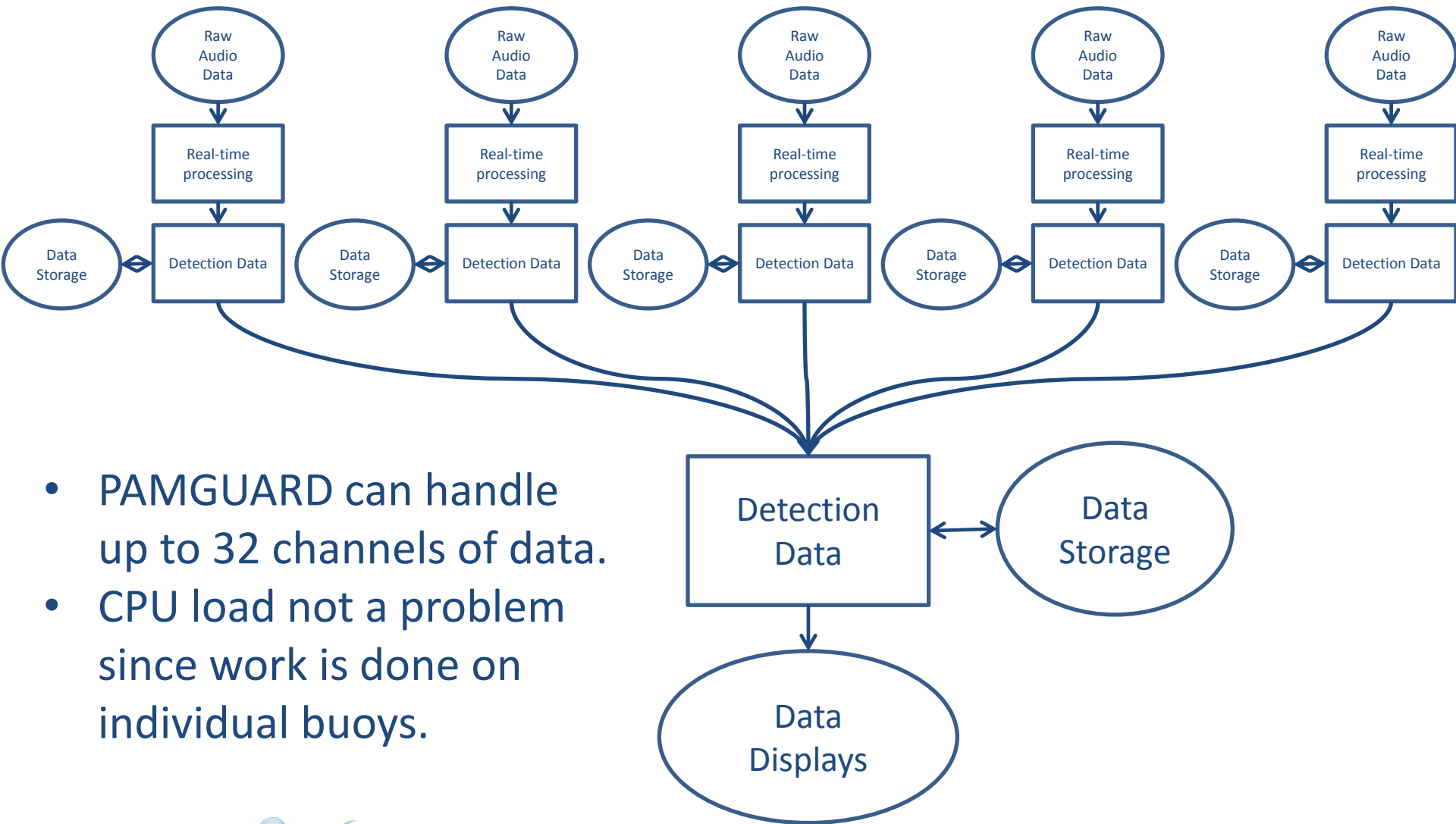


# Operating modes: mitigation

- Processing takes place on remote buoy
- Data transfer is immediate

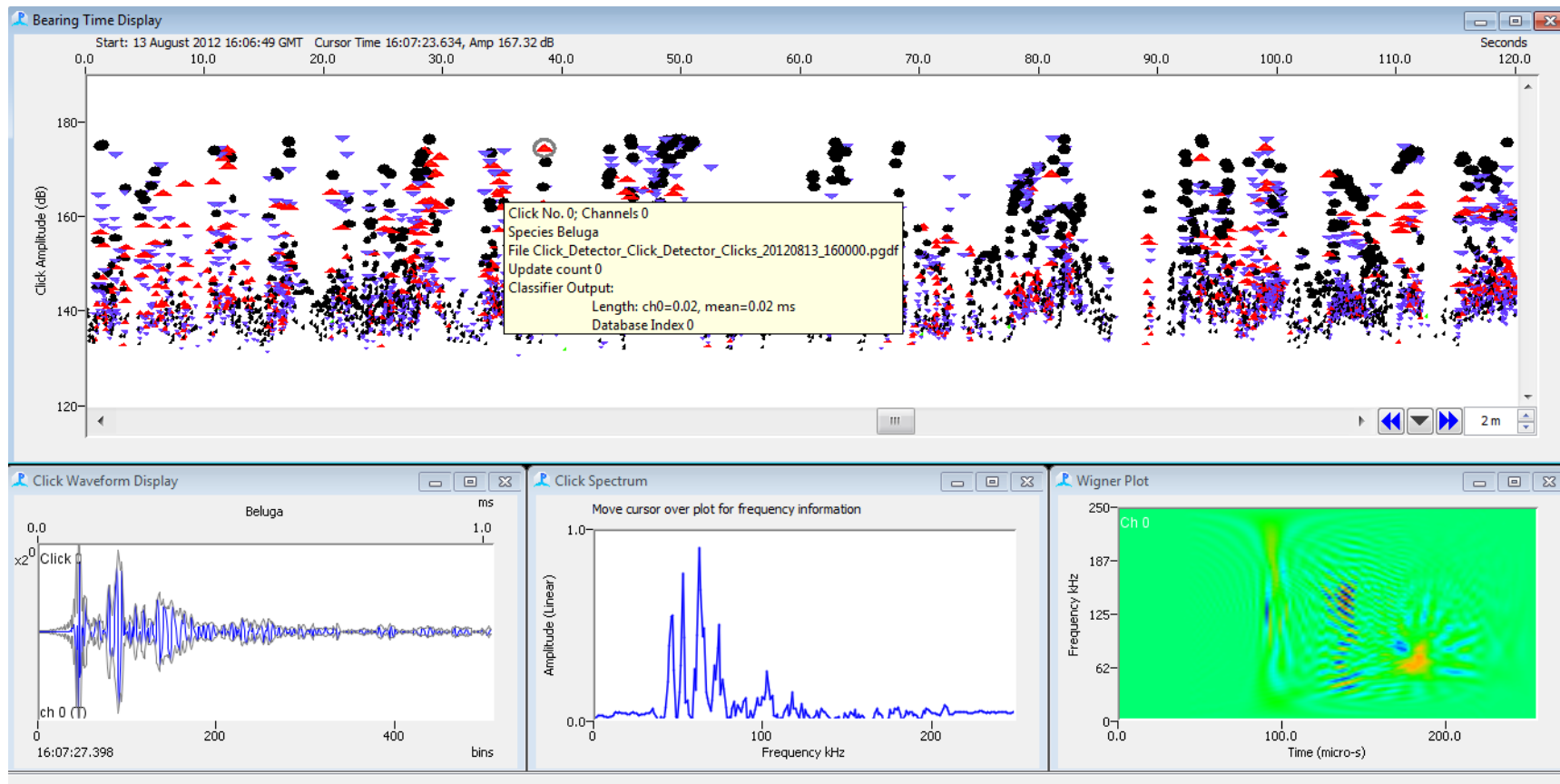


# Operating modes: mitigate

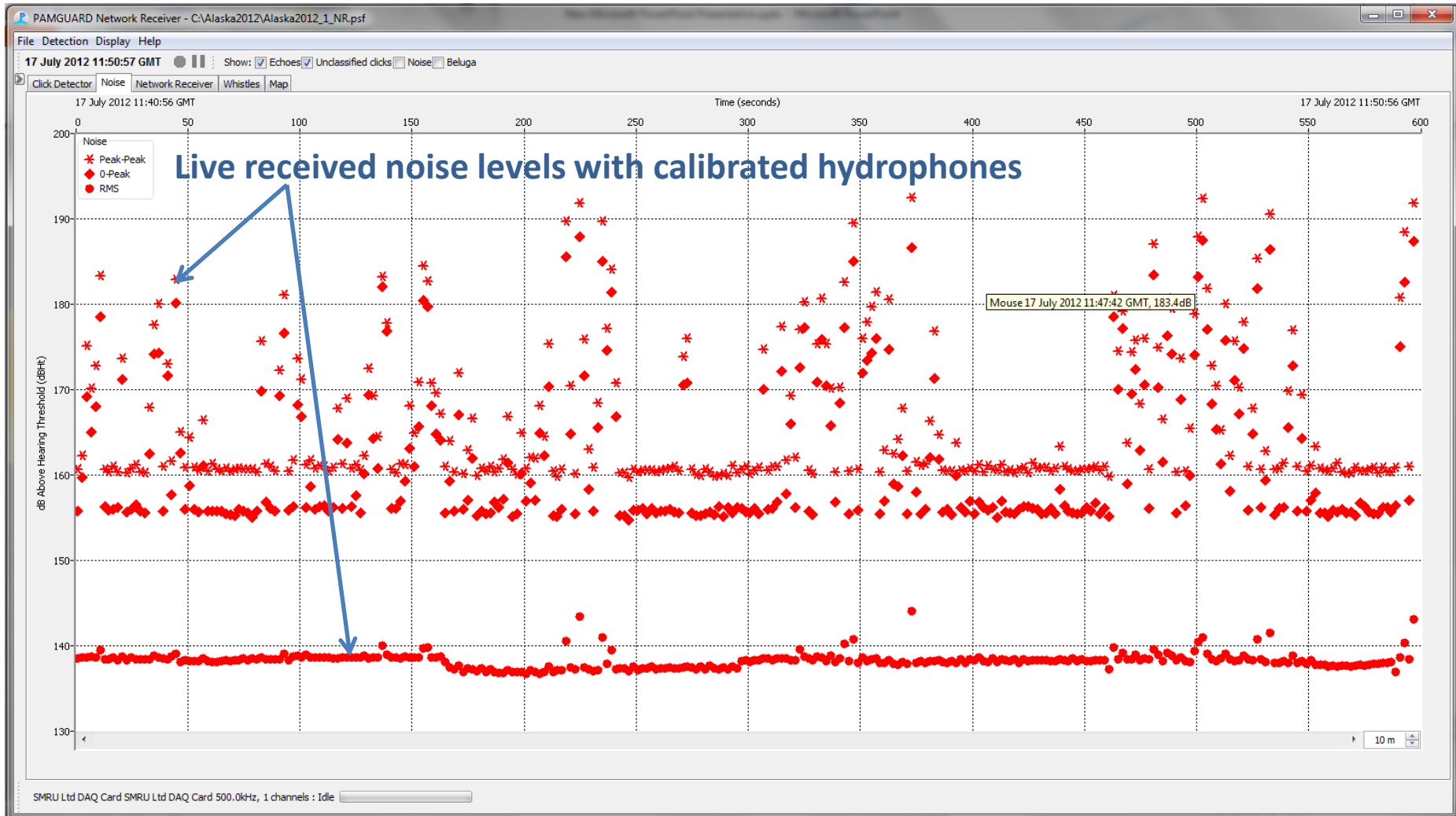


- PAMGUARD can handle up to 32 channels of data.
- CPU load not a problem since work is done on individual buoys.

# PAMGuard used as real time mitigate viewer

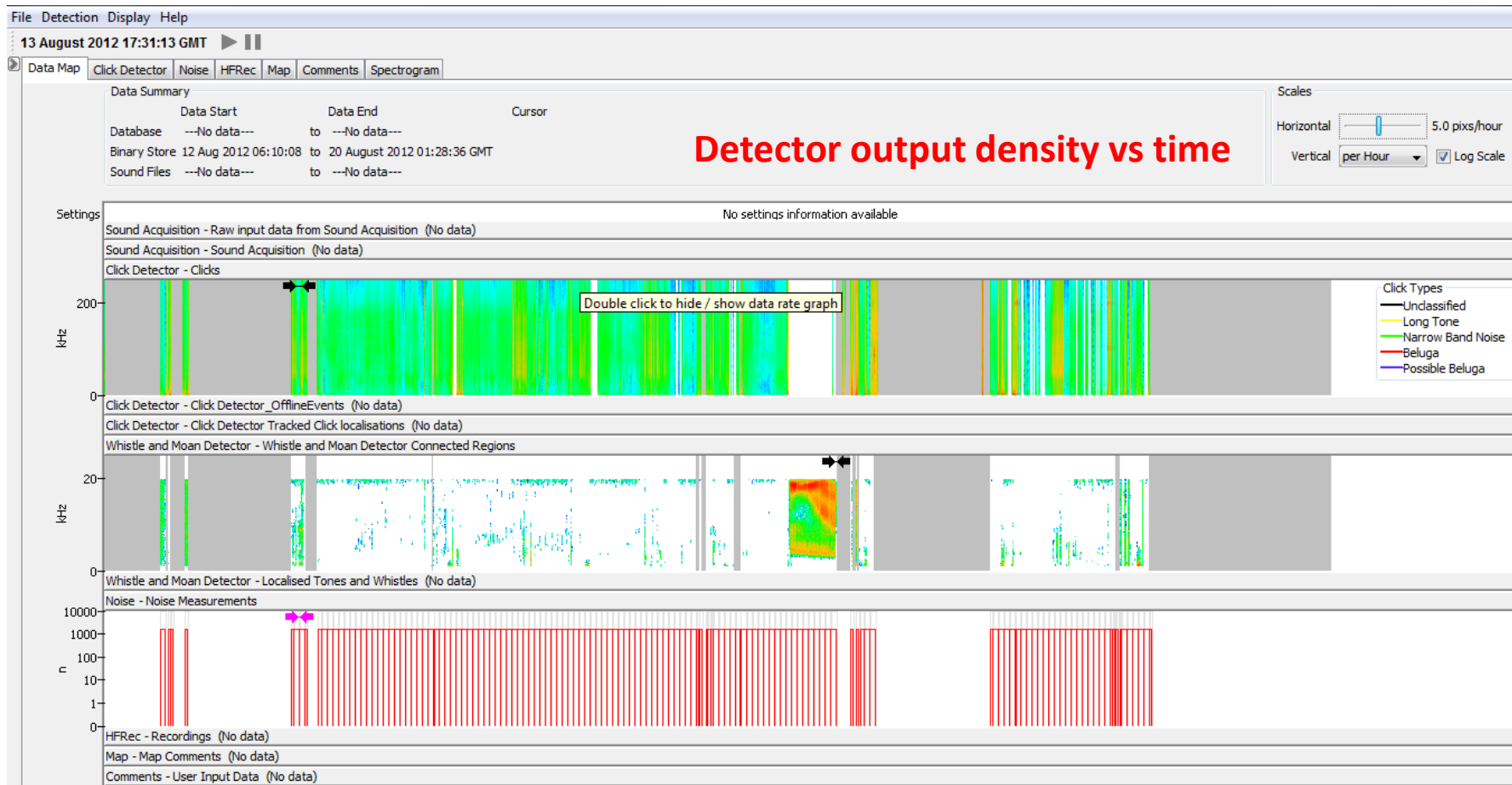


# Noise monitor output, in mitigation mode





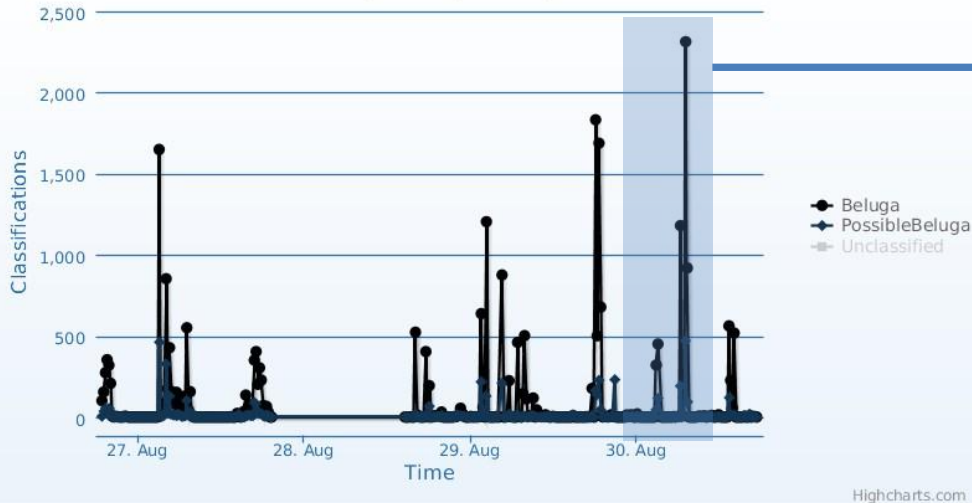
# PAMGuard viewer used for offline analysis



# Online real-time detection/status graphs

Click Detector, Beluga Classification

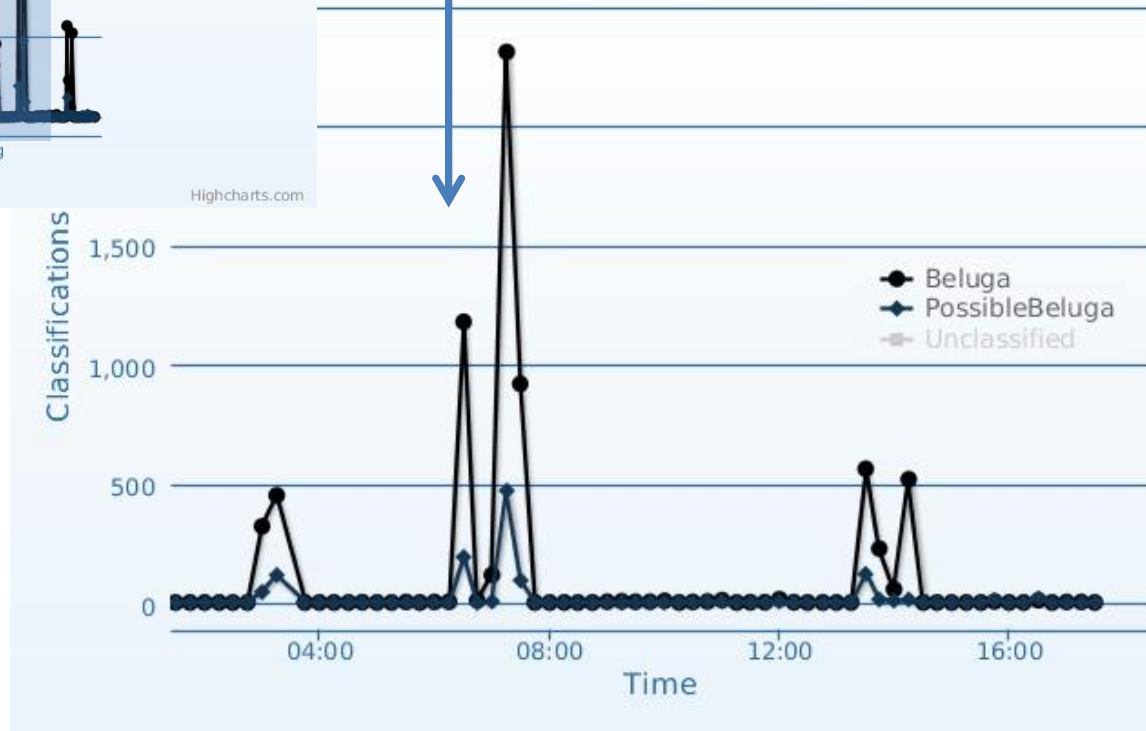
Data provided by PAMBuoy.com



Select region and zoom

Click Detector, Beluga Classification

Data provided by PAMBuoy.com



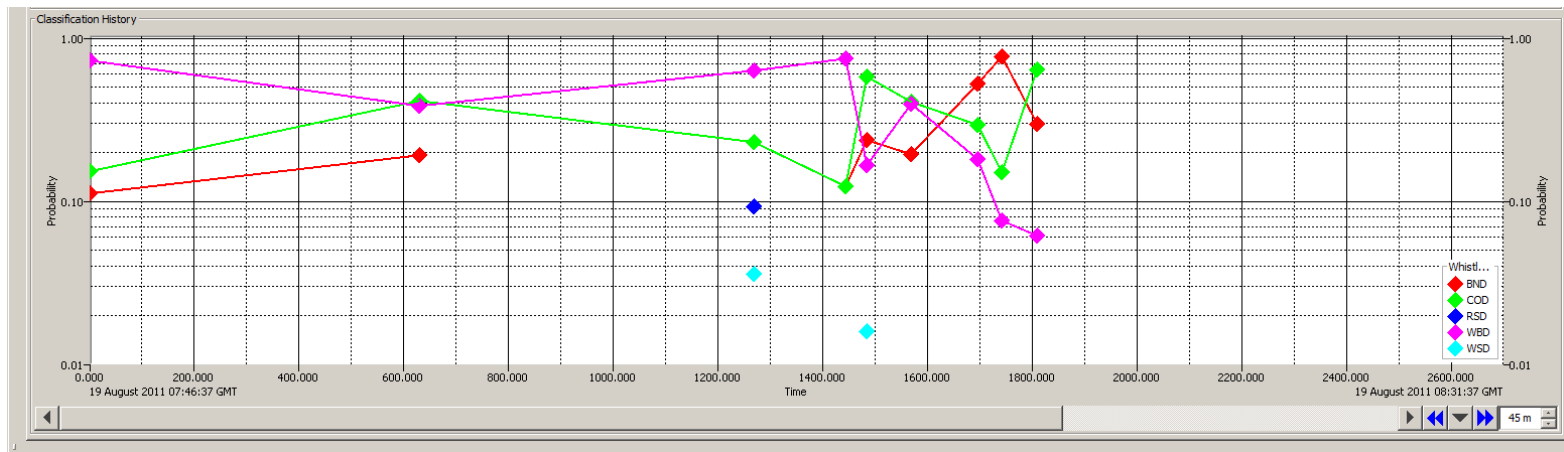
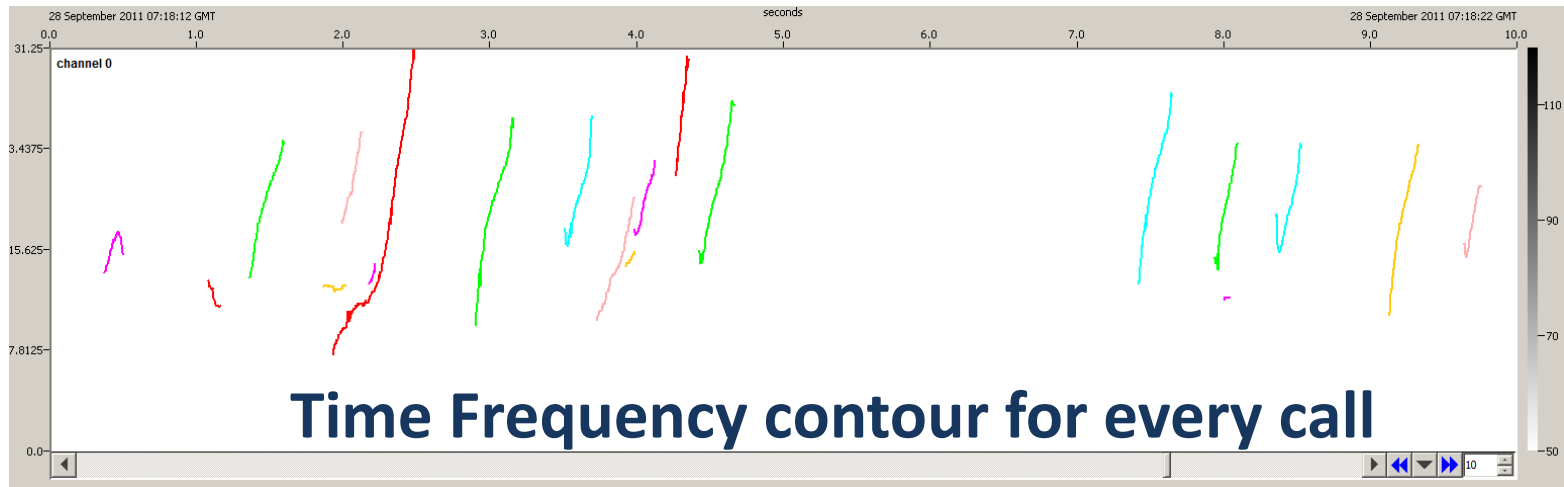
# Available PAMBuoy™ software modules

- **Sound Processing**
  - Sound Acquisition
  - FFT / Spectrogram
  - Decimator
  - FIR Filters
- **Detectors**
  - Click Detector / Classifier
  - Tonal Detector
- **Other**
  - Sound Recorder
  - Noise Measurement
  - Long Term Spectral Average

## PAMGuard Offline

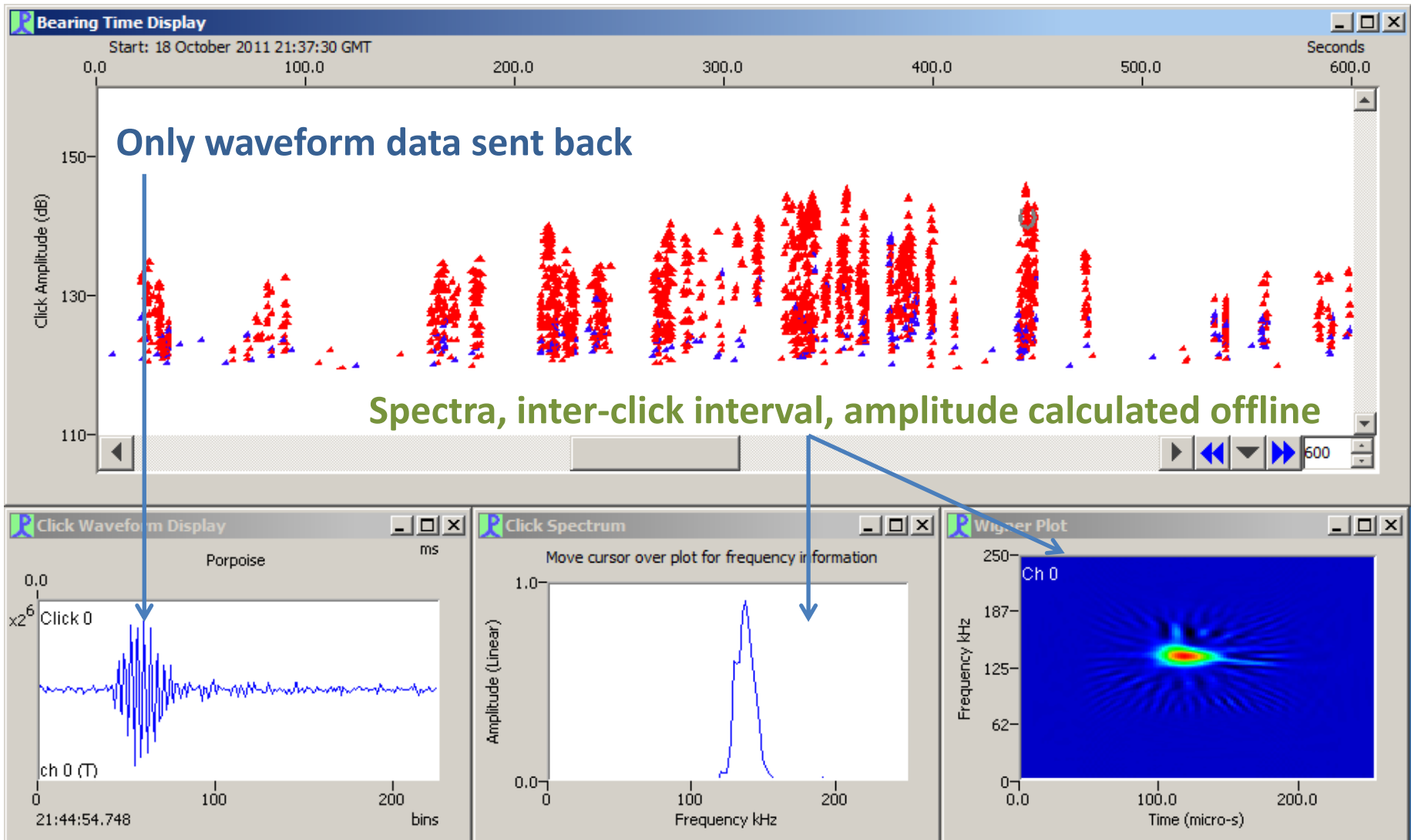
- Data Display
- Whistle Classification
- Reporting





Run classifier offline to assign to species

# Click Data - porpoise





PAMBuoy™ deployment and  
communications

Dick Baggaley



# PAMBuoy™ deployment options

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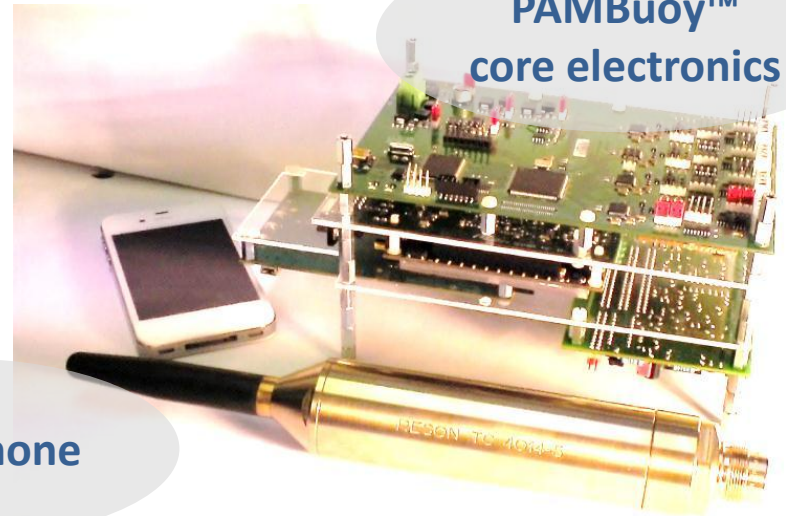
- Bespoke IP65 boxed option for OEMs
- Adaption to Datawell Waverider System
- Peli/Storm Case system and for various deployment and locations
- Integrated into Liquid Robotics Wave Glider Payload Bay
- Bespoke Solutions and applications for Acoustic Detection

# IP 68/65 boxed versions

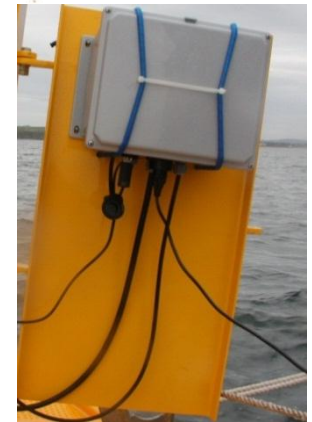
Core electronics **lunch box** size

Hydrophone

PAMBuoy™  
core electronics



Fit the device to **your** needs

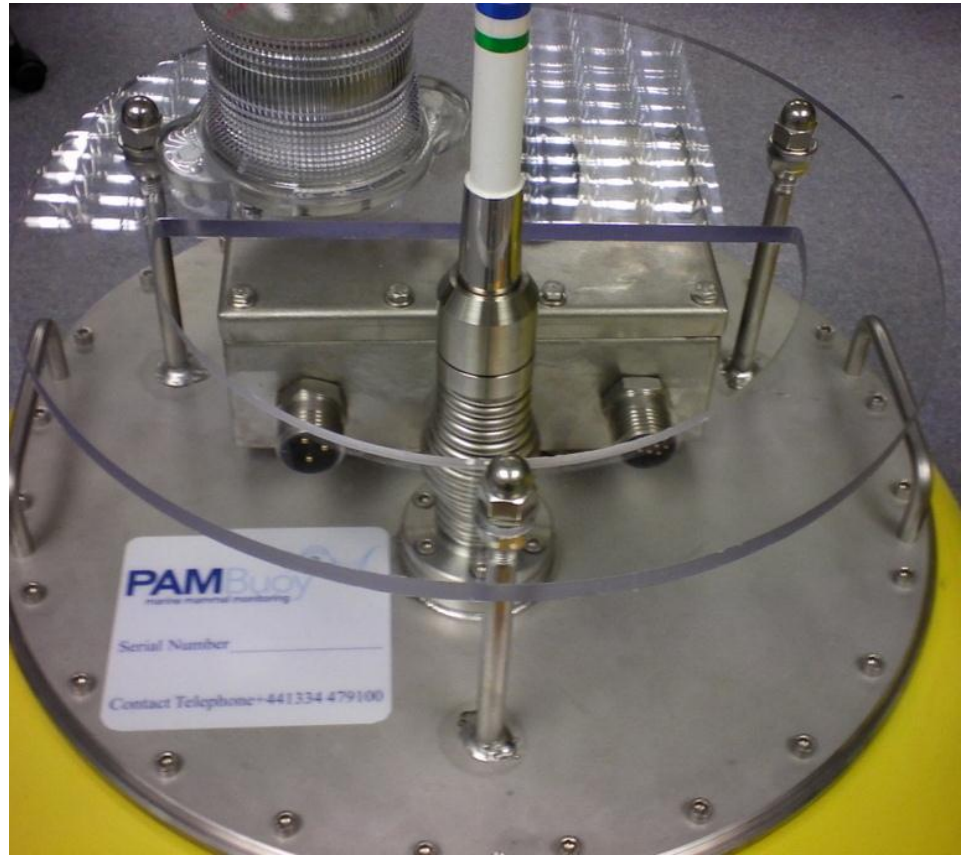




# Datawell Waverider Option

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Ideal as an easily deployable mitigation platform



# Peli/Storm case system

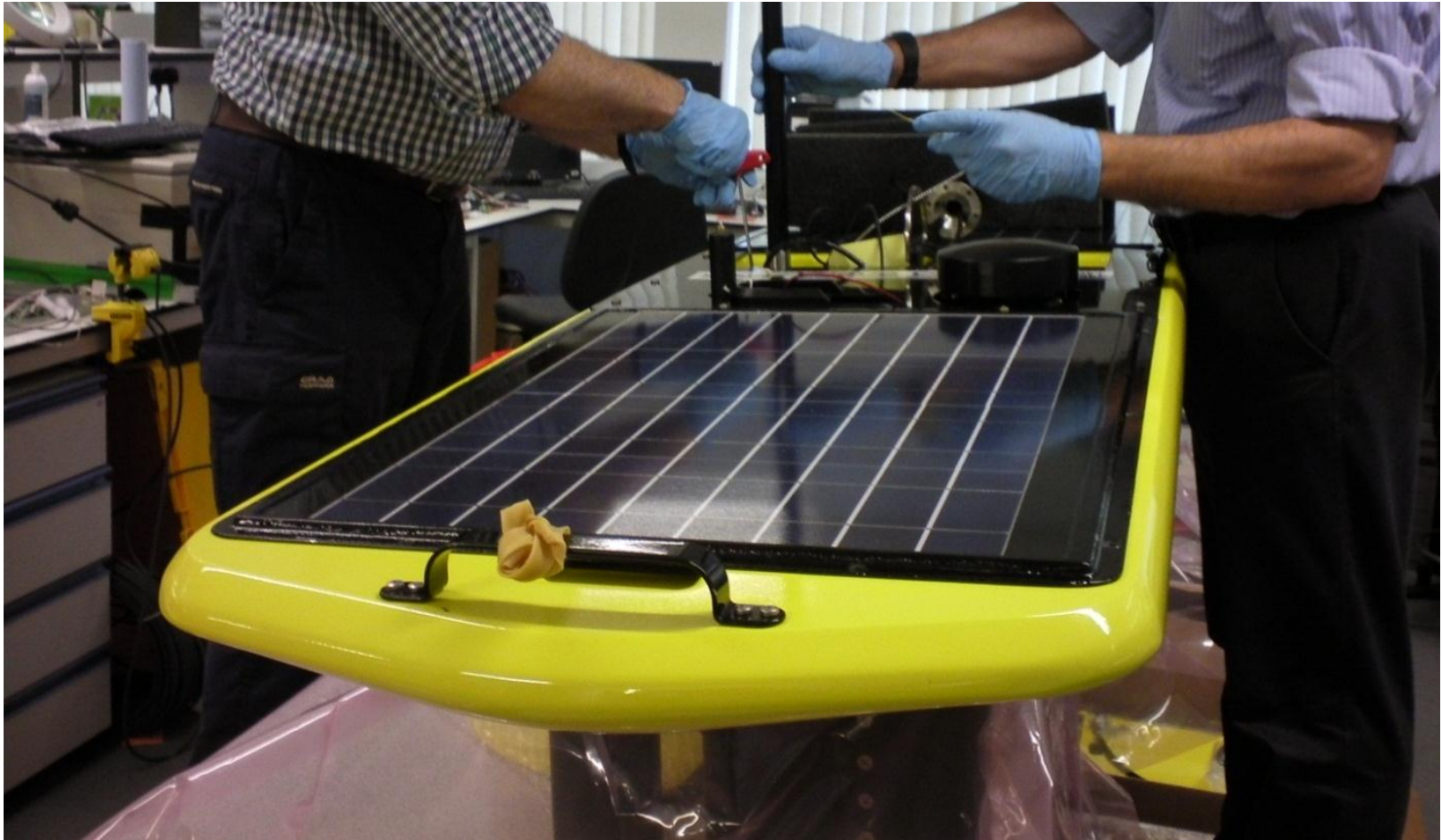
Suitable for large buoy, ship or land based deployment



# Liquid Robotics payload option

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Configurable in mitigation or baseline modes



# Bespoke solutions

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If it makes a **sound**, we can help YOU



# Current communications options

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- Majority of PAMBuoy™ communications are IP based
  - Allows a flexible comms architecture
- Ethernet and optical fibre
- Long range wireless, 2.4GHz, 900Mhz
- 3G/GPRS
- Satellite Data Links,
  - Iridium, under development
  - Inmarsat, a future option
- Bespoke Solutions



## Please view the examples

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- Please ask one of the presenters for more information on
  - Technical Details
  - Case Studies
  - Bespoke Solutions for You

# Thank you

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[www.pambuoy.com](http://www.pambuoy.com)

PAMBuoy®: A revolution in marine mammal monitoring

