



# Buying and MOOSifying Two USVs in 2008/2009

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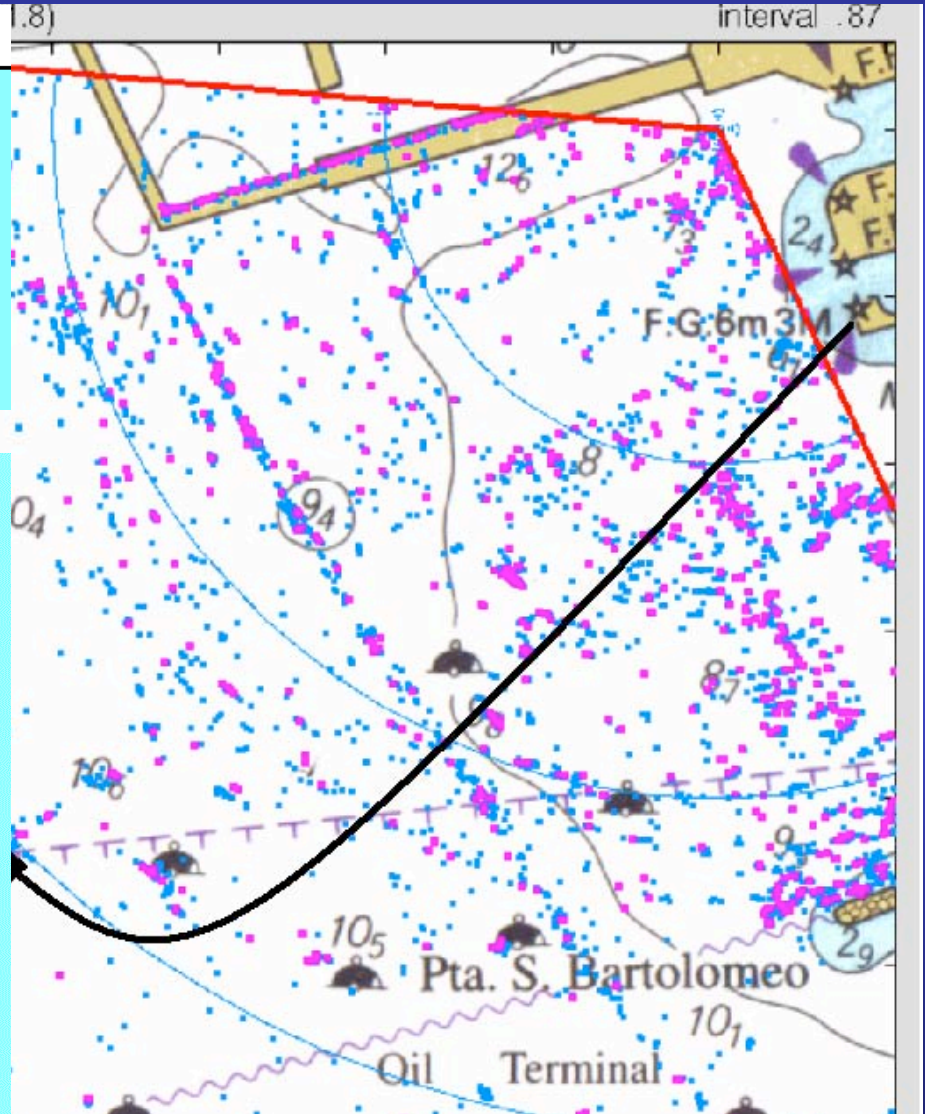
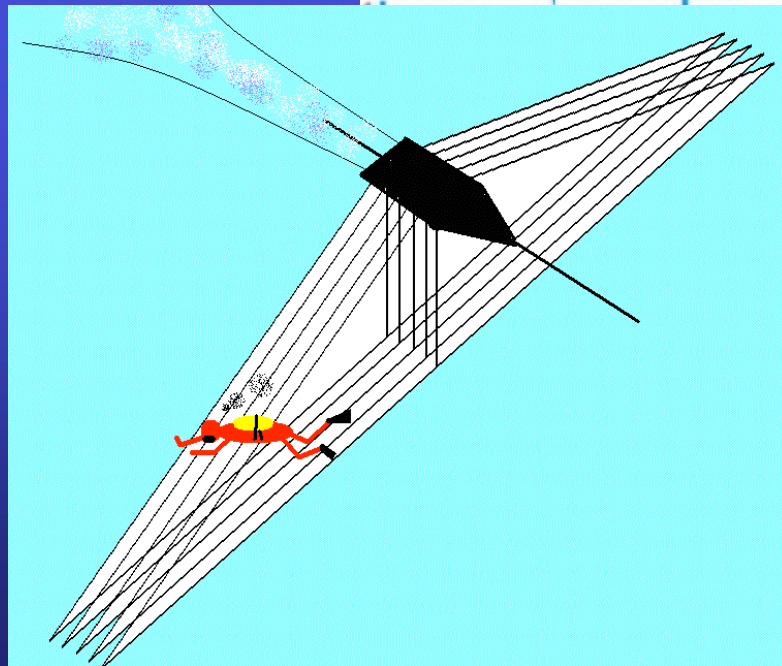
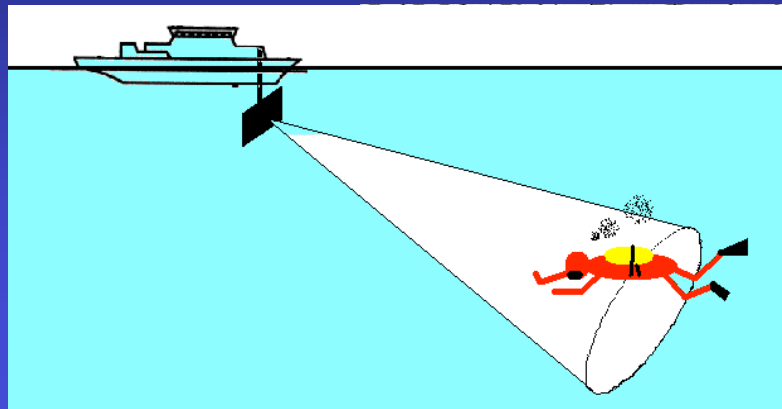
26 August 2010



## Primary Objective (2008)

- Re-acquisition of divers using USV
- Vessel is autonomously driven
- Once in position operator can
  - Classify
  - Warn
  - Closely observe

# Diver Response





# Performance Specifications



- Shallow draft
- Smallish and quiet
- Good low-speed handling



## Secondary Objectives (2009)



- Surface missions
  - Surface contact intercept/escort
  - Inspection of surface objects
- Cooperative behaviours
- Avoidance and coexistence in harbour

# Performance Specifications

	accept threshold	desireable
<b>Max Speed</b>	6 knots	up to 20 kts
<b>Idle Speed</b>	1 knot	zero
<b>Reverse Speed</b>	NR	up to 6 kts
<b>Weight</b>	600 kg	less is better
<b>Length</b>	5.5 meters	shorter is better
<b>Draft</b>	1 meter	shallower is better
<b>Payload Weight</b>	40 kg	up to 100 kg
<b>Payload Volume</b>	40 liters	up to 100 liters
<b>Endurance</b>	2 hours @ 4 kts	8 hours @ 4 kts



# Performance Specifications



- Required
  - Control and Telemetry
  - Video camera
- Desired
  - Advanced Control and Telemetry
  - “Scalable and Hierarchical” autonomy
  - Better control/telemetry link
    - Longer range
    - Higher data rate





NATO  
+  
OTAN

# Unmanned Surface Vehicles



H-Scientific  
RHIB



Mandarina

SeaRobotics  
catamaran



Gemellina



# Performance Specifications

	accept threshold	Mandarina
<b>Max Speed</b>	6 knots	up to 8 kts
<b>Idle Speed</b>	1 knot	0.5 knot
<b>Reverse Speed</b>	NR	burst few knots
<b>Weight</b>	600 kg	460 kg
<b>Length</b>	5.5 meters	4.6 meters
<b>Draft</b>	1 meter	~ 50 cm
<b>Payload Weight</b>	40 kg	> 100 kg
<b>Payload Volume</b>	40 liters	> 100 liters
<b>Endurance</b>	2 hours @ 4 kts	> 8 hours @ 4 kts

# Performance Specifications

	accept threshold	Gemellina
<b>Max Speed</b>	6 knots	up to 10 kts
<b>Idle Speed</b>	1 knot	zero
<b>Reverse Speed</b>	NR	up to 4 kts
<b>Weight</b>	600 kg	125 kg
<b>Length</b>	5.5 meters	4 meters
<b>Draft</b>	1 meter	< 50 cm
<b>Payload Weight</b>	40 kg	100 kg
<b>Payload Volume</b>	40 liters	100 liters
<b>Endurance</b>	2 hours @ 4 kts	~ 8 hours @ 4 kts

## Details on Autonomy...

### Mandarina:

- SPECTRE, dedicated processor as front-seat
- NMEA interface
- Custom extensions to NMEA
- NURC added second processor

### Gemellina:

- dedicated processor as front-seat
- NMEA interface
- Custom extensions to NMEA
- Second TS7800 ARM available as backseat

# Mandarina's Autonomy

- SPECTRE housed in steering console
- backseat processor with necessary interfaces easily added

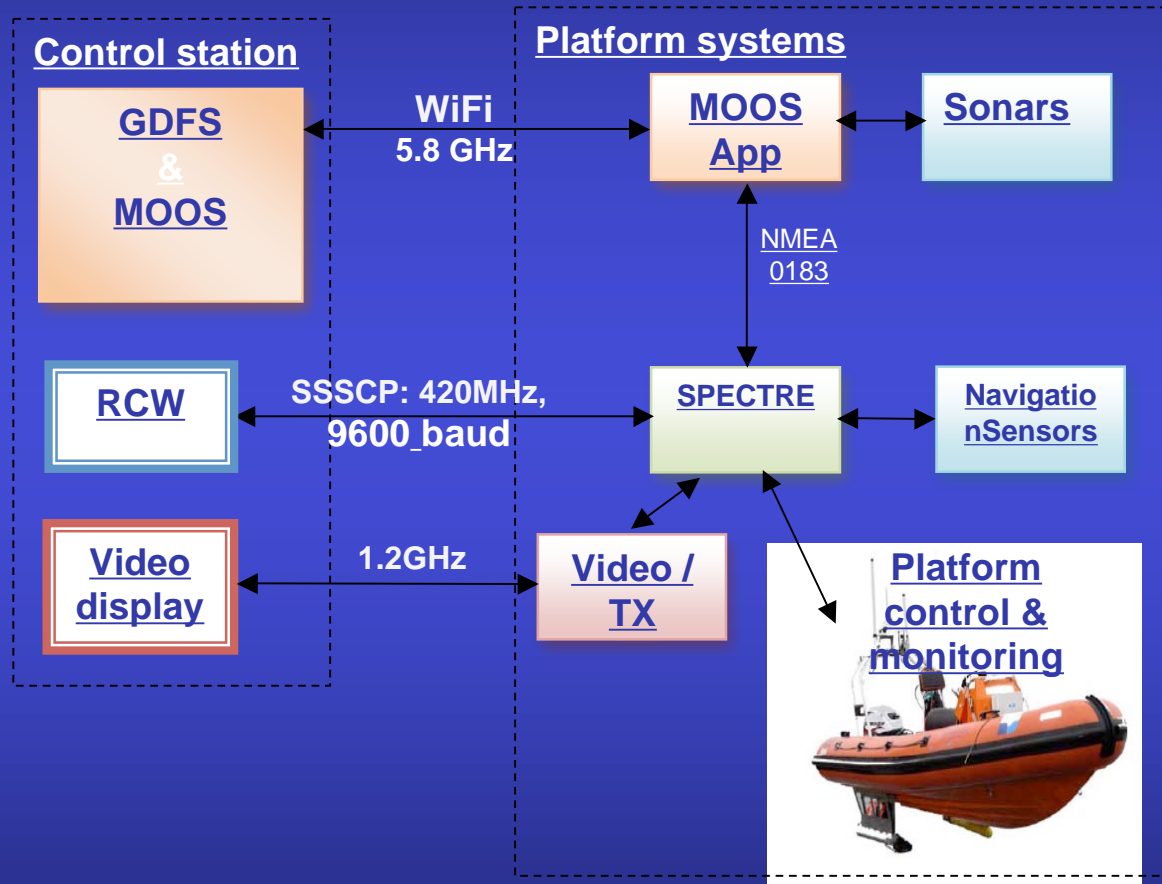


Figure supplied by H-Scientific Ltd

# Gemellina's Autonomy

- BCU built around TS7800 ARM
- Second TS7800 supplied, became backseat processor

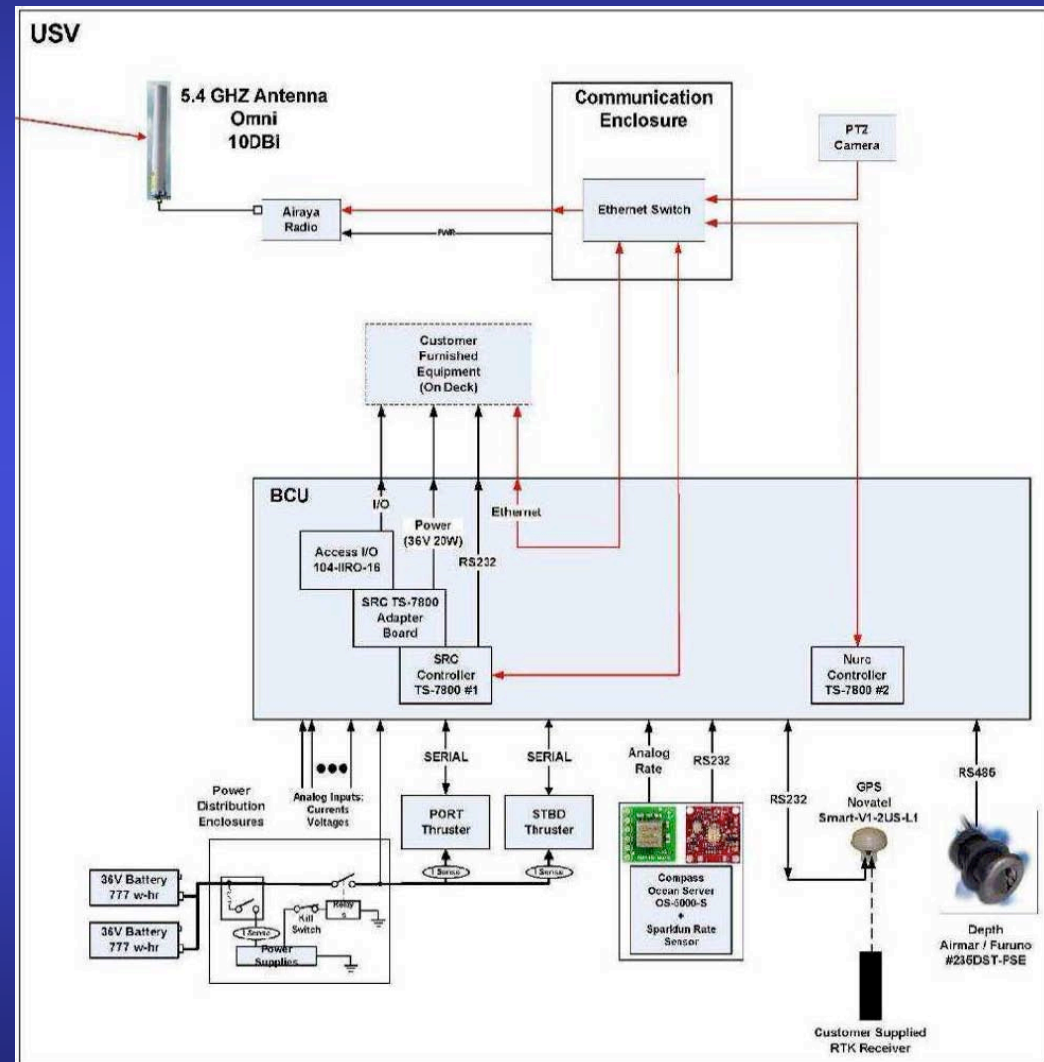


Figure supplied by SeaRobotics Corp





## Details on Autonomy...

- Decision to run MOOS on TS-7800 ARM
- Kept Gemellina
  - Light
  - Simple
  - Power-efficient
- Porting software presented some challenges...



# Running MOOS on TS-7800



- zlib, gsl, boost, libxml2, libxslt
  - Downloaded source and cross-compiled
- boost libraries
  - Cross-compiled using BoostJam
- MOOS, IvP, parts of moos-ivp-local and nurclocal
  - Cmake as normal with additional flags related to choice of compiler



# RCW sample screen



The image displays a screenshot of the RCW (Remote Control Workstation) software interface. The window title is "RCW - [settings (S).rcw]". The menu bar includes: File, View, Config, Machinery, Autopilots, Comms, Joystick, Data Monitor, Help.

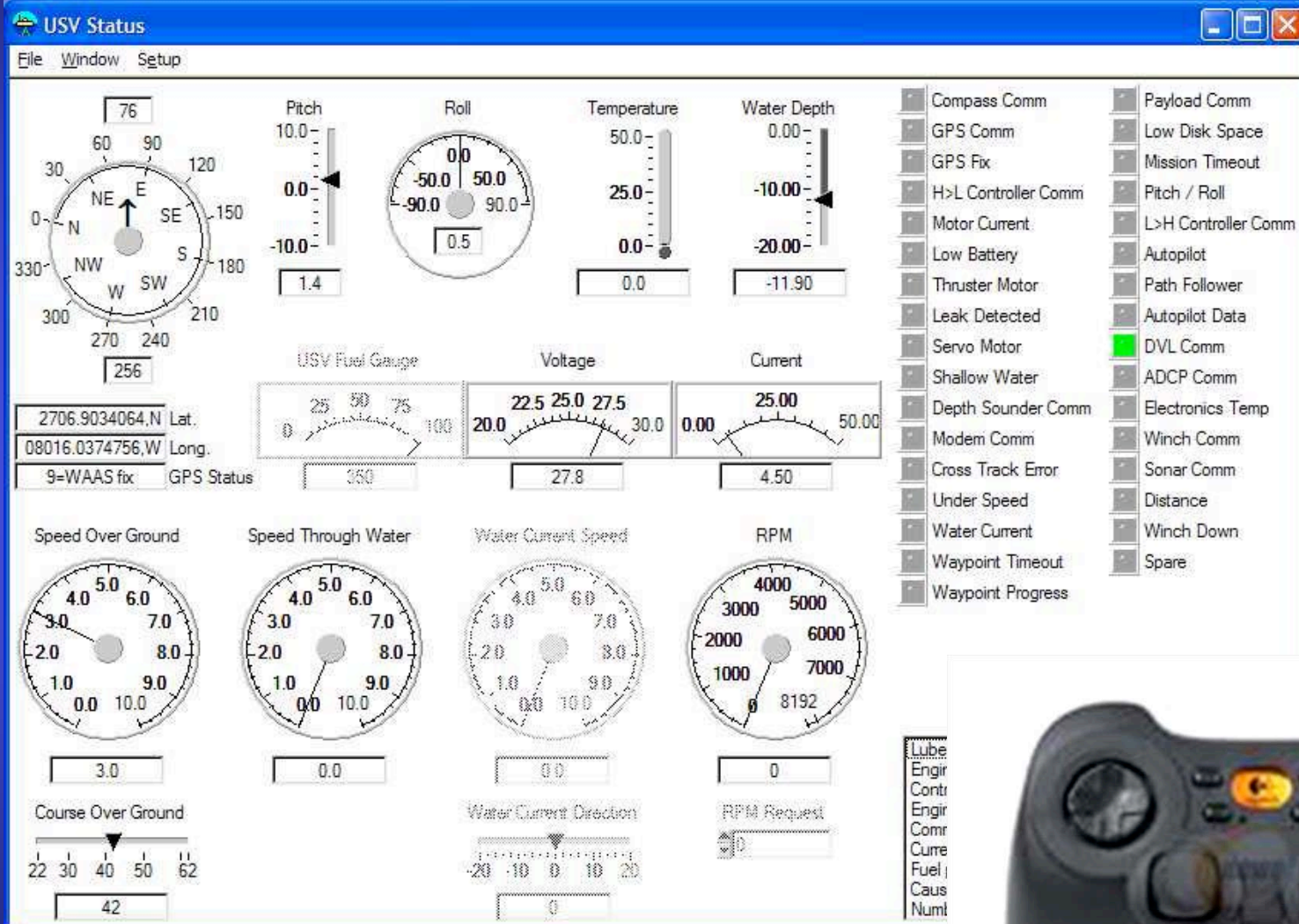
The interface is divided into several sections:

- Top Left:** A heading scale from 30 to 180, with "355 N 5 1" displayed above it.
- Top Center:** A "DATALINK" button.
- Top Right:** A large circular radar display with a scale from 0 to 40. It shows a yellow diamond target and two yellow arrows pointing towards the center.
- Middle Left:** A heading gauge labeled "HEADING" with a scale from -270 to 360. Below it are two vertical levers labeled "Prop" and "Trim", both set to 0.0.
- Middle Center:** A speed gauge labeled "0.0 Kts". Below it are two smaller gauges for "RPM" and "FUEL".
- Middle Right:** A "Video" section with "OFF" and "ON" buttons, and "DUAL NMEA" and "ONLY NMEA" options.
- Bottom Left:** A "Warning" section with "STOP" and "RUN" buttons, and a "START" button. Below it is a "Strg AUTO" section with a "Reset" button and an "Auto" button.
- Bottom Center:** A "Batt" gauge labeled "0.0 Batt". Below it is a "Yaw" gauge labeled "0.0 Yaw".
- Bottom Right:** A "Steering" gauge labeled "0.0". Below it are "Set WS" and "Set GS" buttons.

The right side of the interface is a large blue grid area, likely a radar or map display. A yellow triangle is positioned at approximately (0, 10) on the grid, with a white line extending from the origin to it. The grid has x-axis labels from -15 to 15 and y-axis labels from 0 to 15. At the bottom right of the grid area, there is a "<> Plan View" button.

The "h-scientific remote control systems" logo is visible in the bottom left corner of the interface. The word "Operator" is displayed at the bottom center.

# SeaRobotics Controller



Lube  
Engin  
Contr  
Engin  
Comm  
Curre  
Fuel  
Caus  
Numt

## Control

Who's in charge?

Tele-operation

MOOS

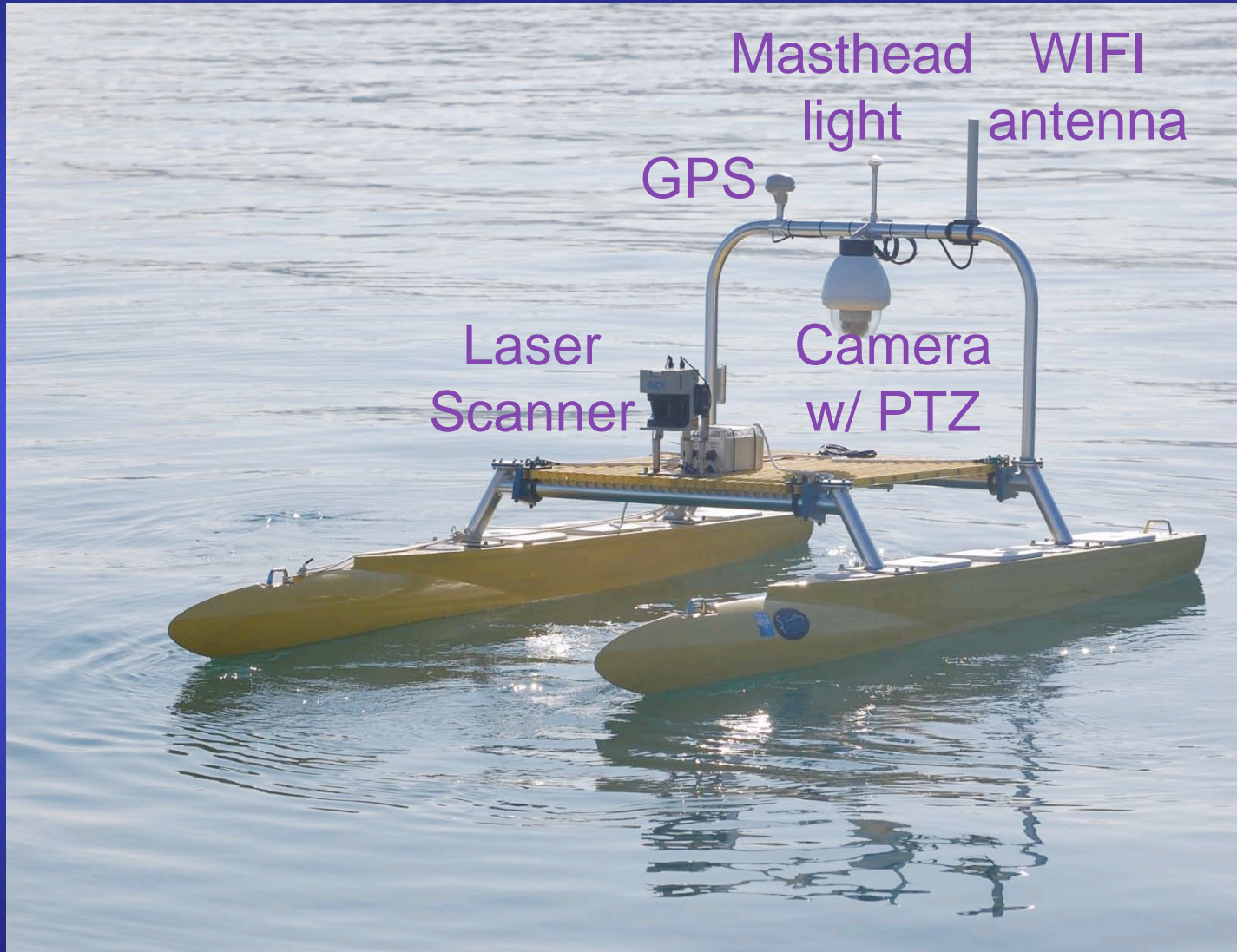
Driver aboard  
(mandarina only)

Handover of control  
must be well  
rehearsed,  
procedurally exact





# Gemellina Sensor Suite



# Mandarina Sensor Suite







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# Gemellina 2010 Configuration

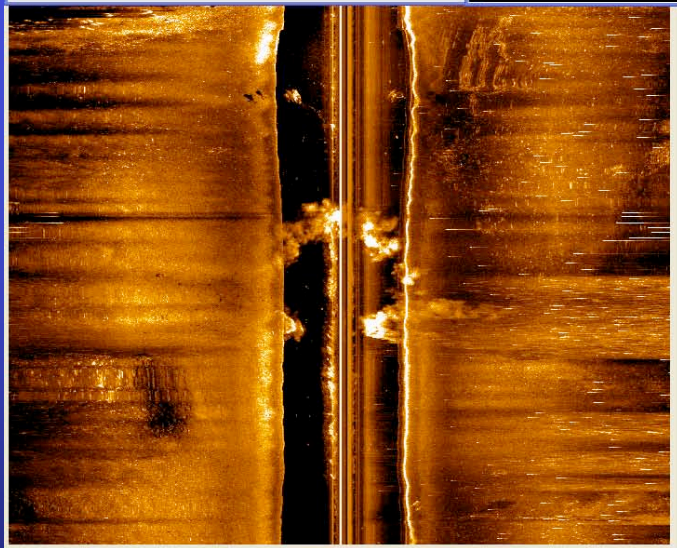
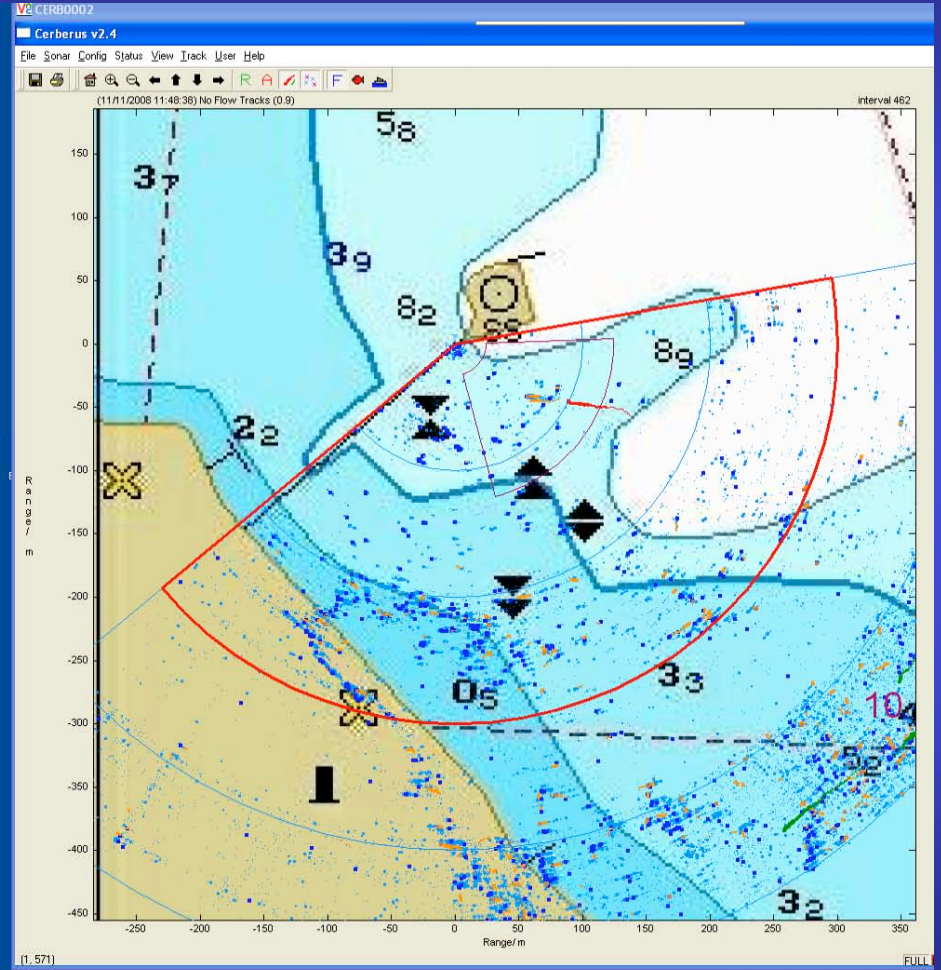
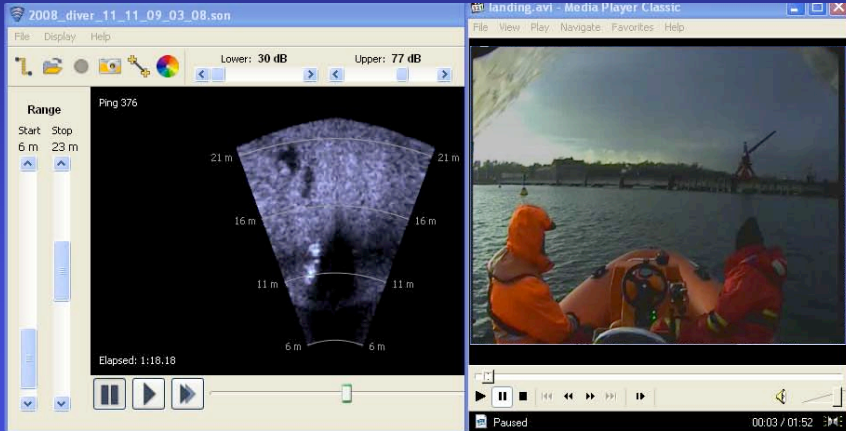


# Sensor Interfaces

- OEM sensor software used in most cases
- Laser scanner OEM provided an interface to which an application was written
- Radar “integration” has not yet been possible

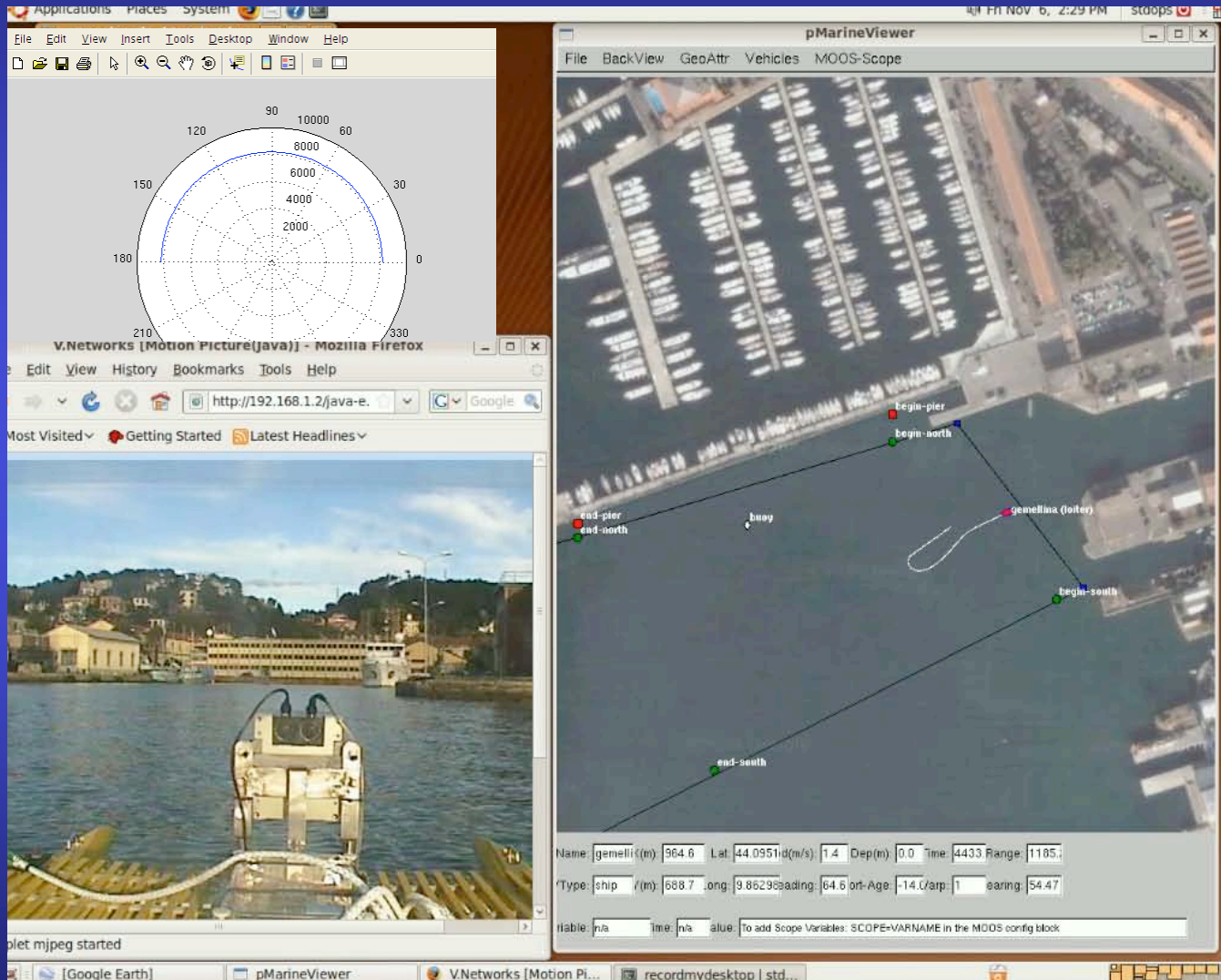


# Sensor Data as seen ashore





# Sensor Data as seen ashore



The screenshot displays a desktop environment with three main windows:

- V.Networks [Motion Picture(java)] - Mozilla Firefox:** Shows a circular plot with concentric rings representing range (0 to 10000) and radial lines representing bearing (0 to 330 degrees).
- Browser Window:** Displays a video feed of a sensor mounted on a boat, with a coastal town in the background.
- pMarineViewer:** Shows an aerial satellite view of a harbor area. A track is plotted with points labeled 'begin-pier', 'begin-north', 'gemellina (outer)', 'begin-south', and 'end-south'. A data panel at the bottom provides details for the 'gemellina (outer)' point:
 

Name:	gemellina (m)	964.6	Lat:	44.0951	d(m/s):	1.4	Dep(m):	0.0	Time:	4433	Range:	1185.	
Type:	ship	(m)	688.7	Long:	9.8629	Heading:	64.6	ort-Age:	-14.0	arp:	1	earing:	54.47
riable:	na		Time:	na		Value:	To add Scope Variables: SCOPE=VARNAME in the MOOS config block						



# Summary



## Competitive Bidding Process + MOOS

- Good for NURC
- Good for MOOS community
- Good for winning bidders