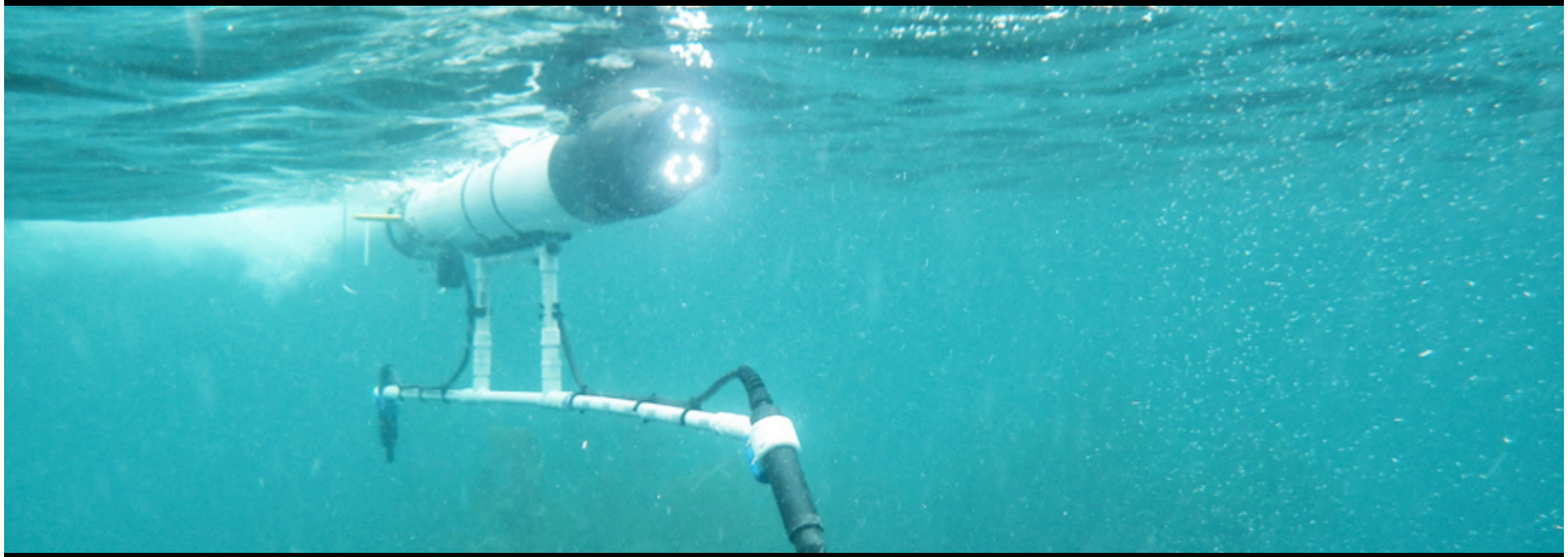
MRRSS

Marine Robotics Research Summer School

Underwater Robot Platforms



MRRSS – 2016

Christopher M. Clark

Underwater Robot Platforms

1. Characteristics
2. Components
3. Categories
4. Exercise A

Underwater Robot Platforms

1. Characteristics
2. Components
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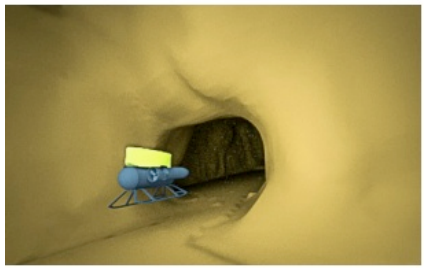
1. Characteristics

- Level of Autonomy
- Endurance
- Speed
- Depth Rating
- Modularity
- Open source software
- Controllability

Level of Autonomy

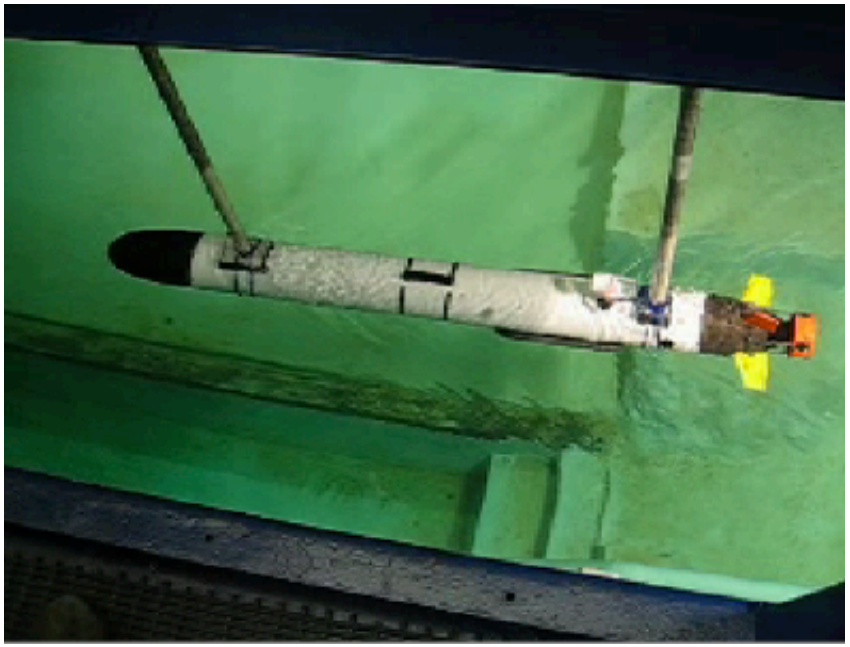
- Hardware
  - Power
  - Communication
  - Tethered?
- Software
  - Manual Control
  - Station Keeping & Waypoint Tracking
  - In situ decision making

Increasing autonomy



Endurance & Speed

- Hydrodynamics
- Propulsion
- Energy sources



Perl Lab, UM

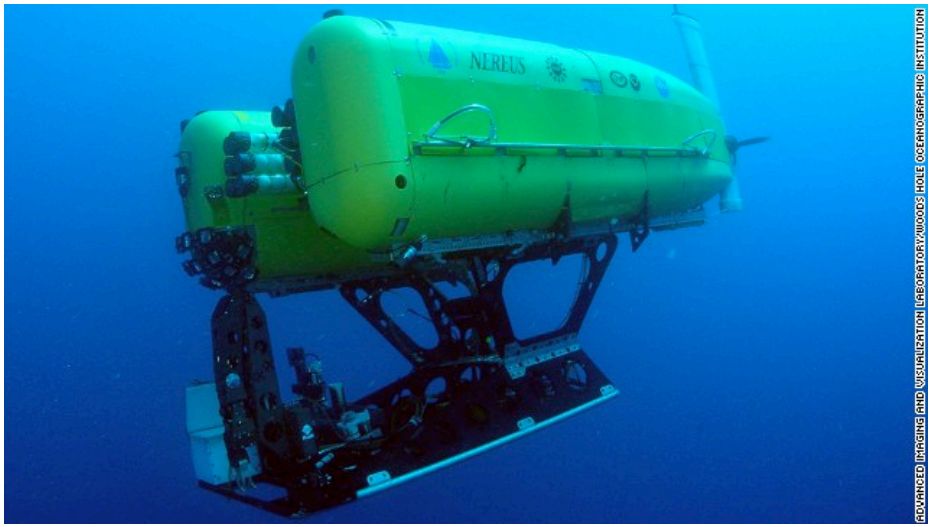
Controllability

- Dependent on the number and configuration of thrusters
- Often a trade-off between speed/ endurance & controllability

Stone Aerospace

Depth Rating

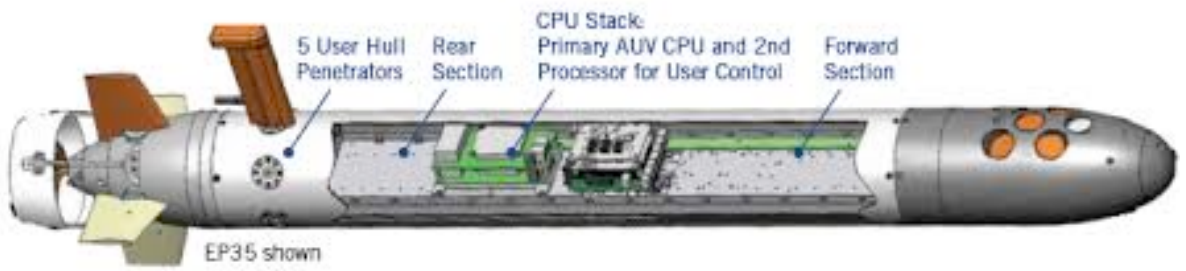
- Materials
- Shape
- Seals



WHOI – Nereus,
blog.geogarage

Open Source

- Not all AUVs are programmable
- Open source software exists for some
  - ROS
  - MOOS
  - C#



Modularity

- Trade-off with waterproofing complexity

Underwater Robot Platforms

1. Characteristics
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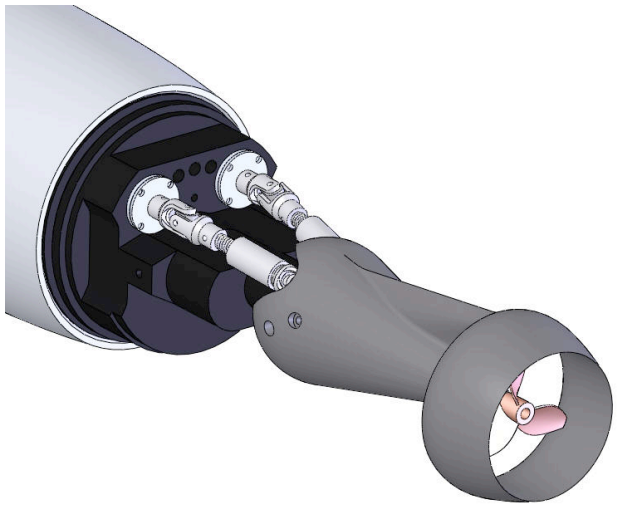
2. Components

- Computing
- Actuation
- Perception
- Communication
- Energy Generation & Storage
- Systems Integration Architecture

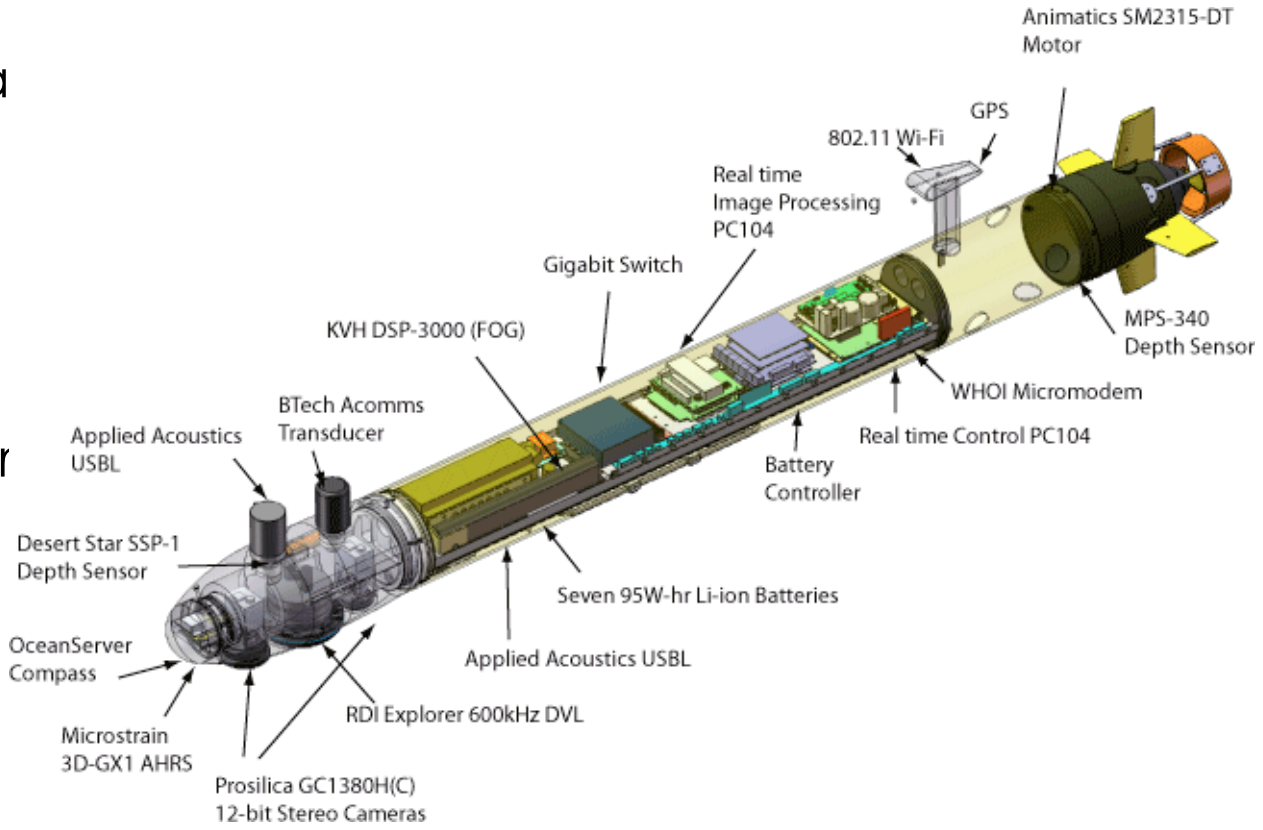
Actuation

- Needed for propulsion
- Motor Driven Propellers
- Control Surfaces
- Vector Thrust
- Buoyancy



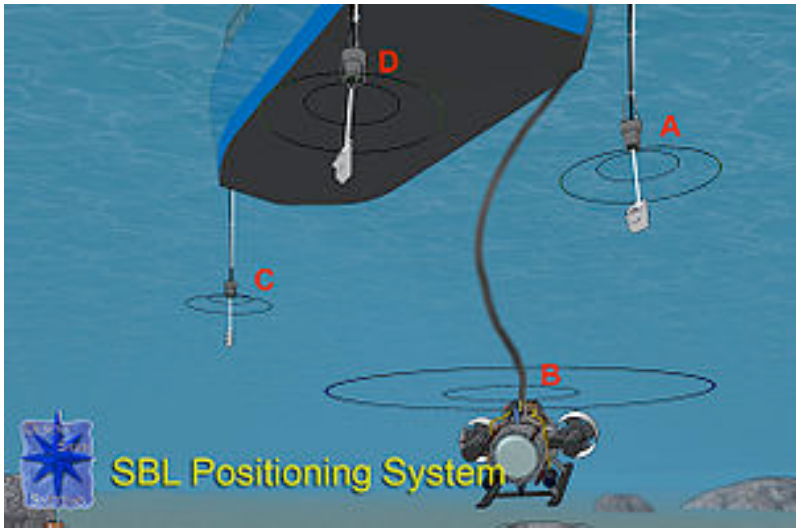
Perception

- Needed for na
- GPS
- Compass
- IMU
- DVL
- Pressure Sensor
- Camera



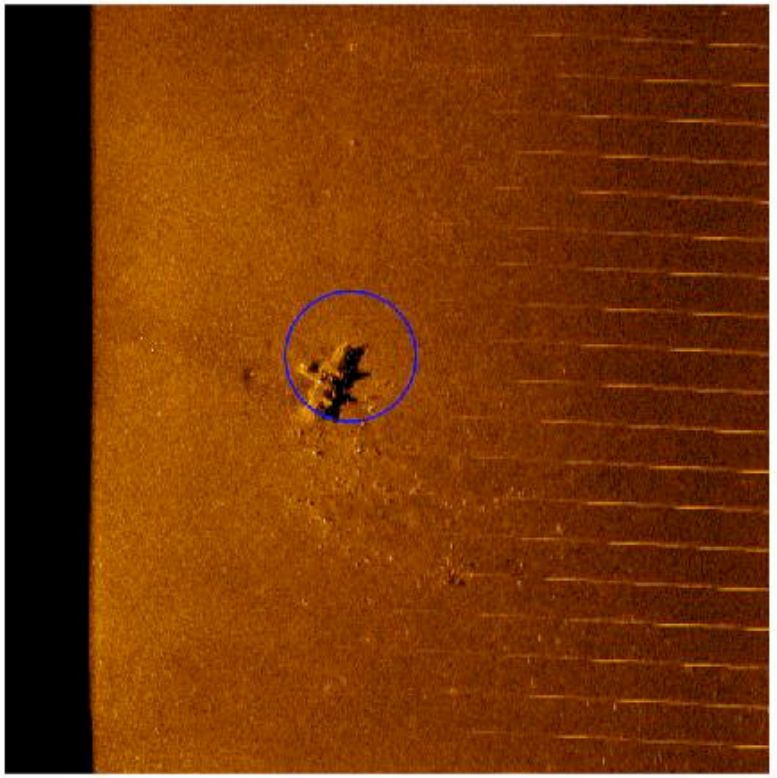
Perception

- Acoustics for Positioning
  - SBL – Short Base Line
  - LBL – Long Base Line
  - Homing Beacons



Perception

- Acoustics for Sensing
  - Side Scan sonar
  - Scanning sonar
  - Imaging sonar



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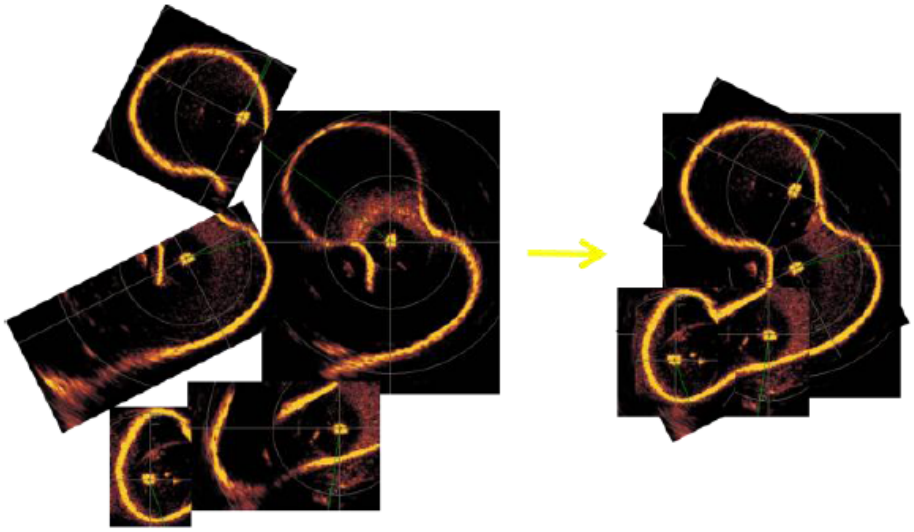

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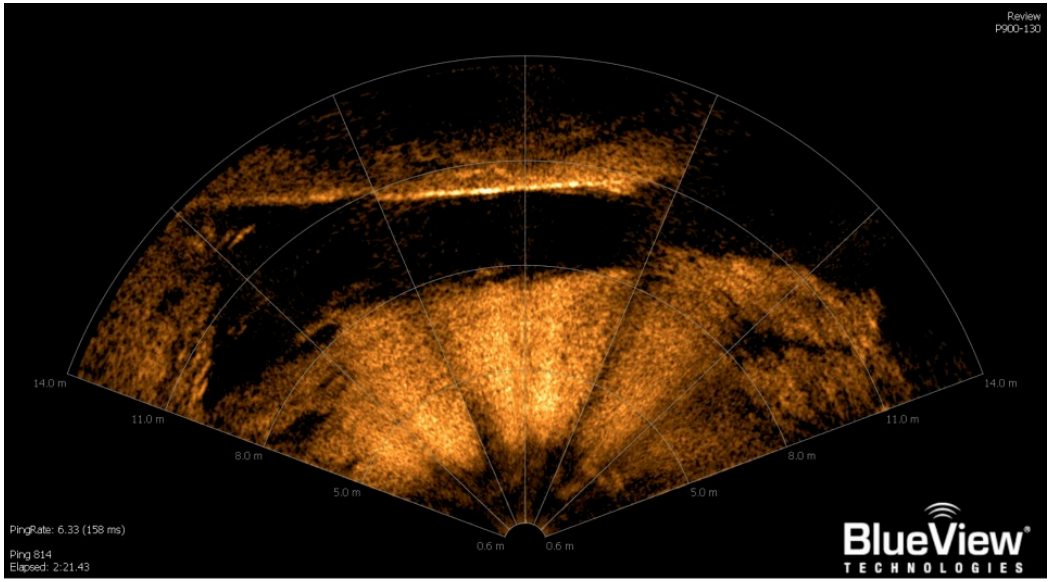
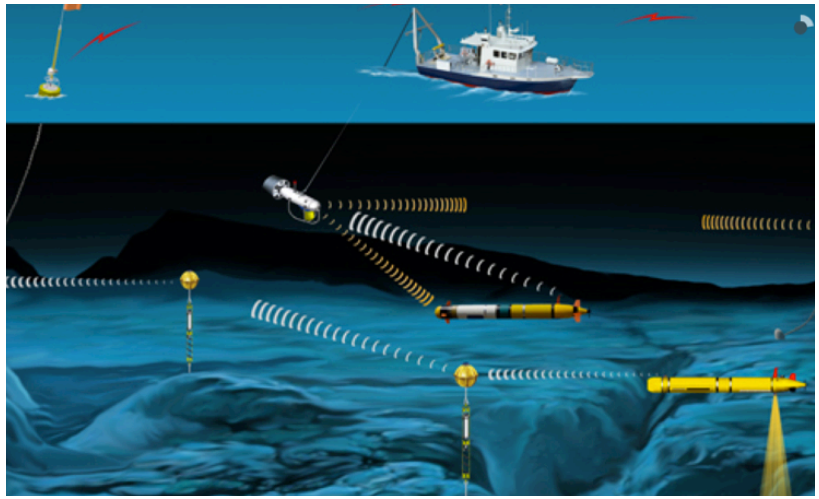


Communication

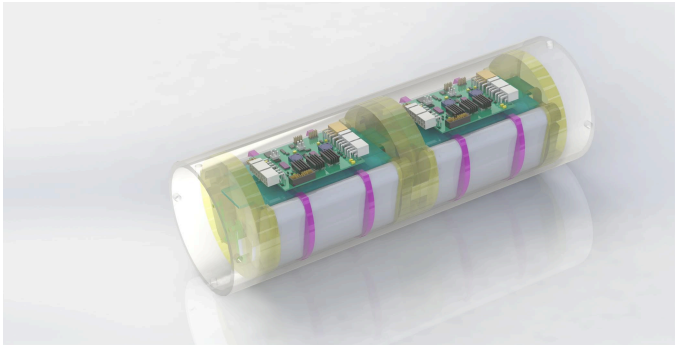
- Wifi
- Iridium Phone
- Acoustics
  - WHOI acoustic micromodem
  - 10-28 kHz
  - Packet length ~3s
  - Frame size 256 bytes
  - Code accessible
  - Dock and robot transceivers

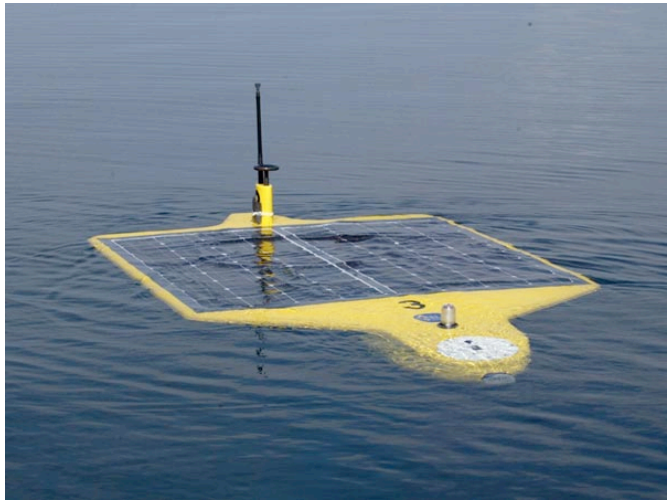


WHOI

Energy

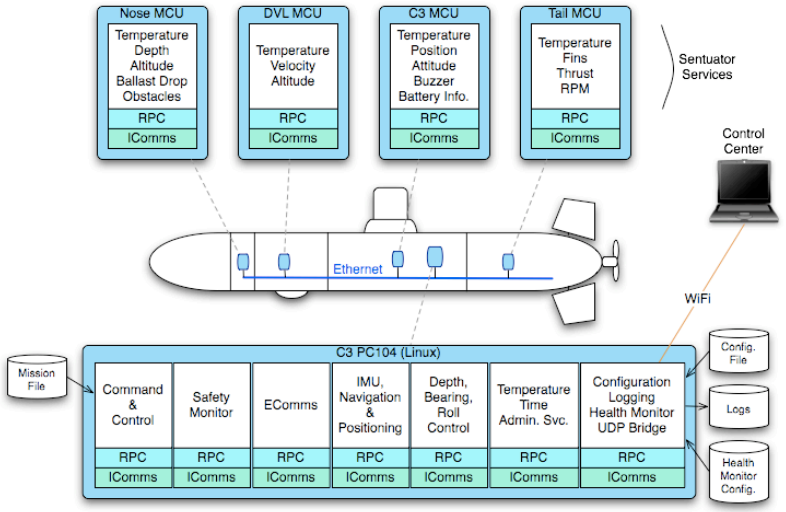
- Batteries (typically Li Ion)
- Diesal
- Wind
- Solar





Systems Integration

- Most AUVs use a backbone architecture to enable signals
- E.g. the iver2 uses a "backplane of mostly analog signals.



National University of Singabure (ARL)

Underwater Robot Platforms

1. Characteristics
2. Components
3. Categories
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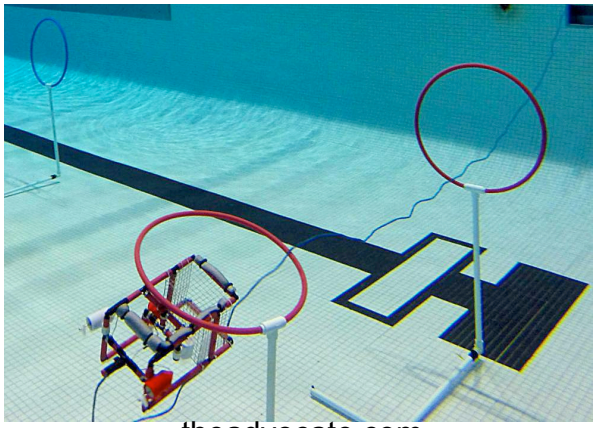
3. Categories

- ROVs
- AUVs
- Gliders
- ASVs
- Miscellaneous

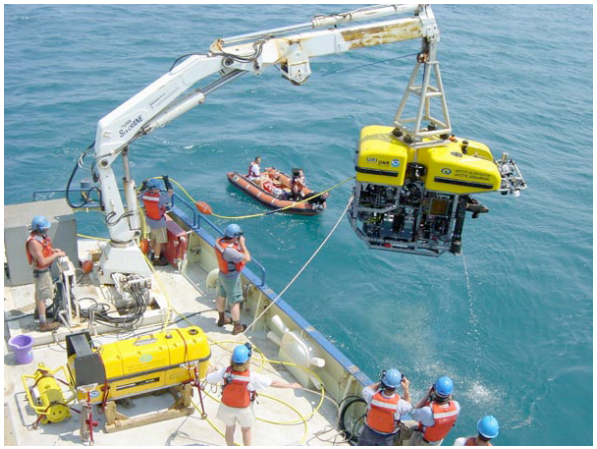
saab.com

ROVs

- Remotely Operated Vehicles
- Tethered
- Tele-operated
- Some have autonomous capabilities.
- Multiple classes (size/ depth rating dependent)



theadvocate.com



noaa.gov

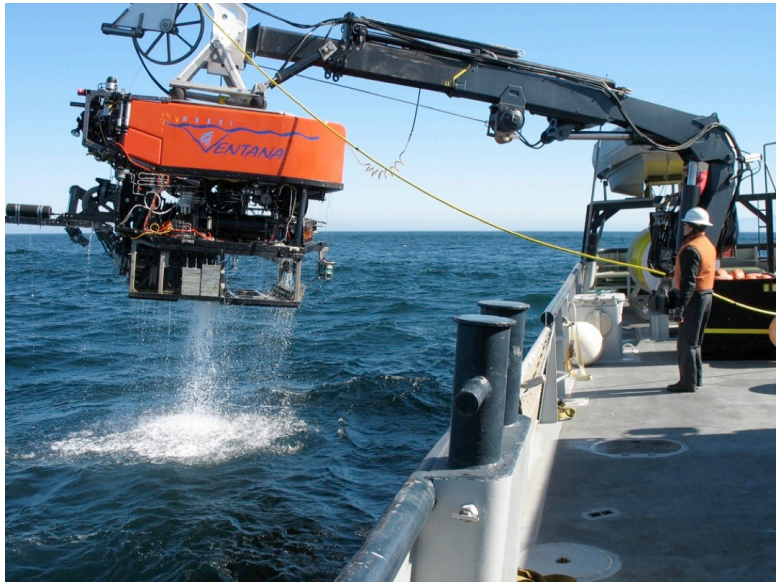
ROV Spotlight: VideoRay Pro 4

- **Dimensions** 38 x 29 x 22 cm
- **Dry Weight** 6.1 kg
- **Depth Rating** 305 m
- **Thrusters** 3
- **Manipulator** 1

videoRay.com

ROV Spotlight: Ventana

- **Dimensions** 10 x 7 x 6 ft
- **Dry weight** 2,567 kg
- **Power** 8 kW
  - Lighting: 3.4 kW
  - System: 1.1 kW
  - Science: 3.5 kW
- **Hydraulic power** 3000 psi
- **Thrusters** six
- **Manipulators** two
- **Max Depth** 1850 m



mbari.com

AUVs

- Autonomous Underwater Vehicles
- No tether (typically)
- Way point tracking
- Mission planning
- Additional computing/ control options

civil.ubc.edu

saab.com

AUV Spotlight: Remus 6000

- **Vehicle Diameter:** 0.71 m
- **Vehicle Length:** 3.84 m
- **Weight in Air:** 862 kg
- **Max Depth:** 6000 meters
- **Energy:** 11 kWh to 22 hrs
- **Propulsion:** DC brushless motor to propeller
- **Max Velocity:** 2.6 m/s
- **Control:** 2 coupled yaw and pitch fins; altitude, depth, yo-yo, and track-line

kongsberg.edu

http://www.whoi.edu/page.do?pid=38144&cid=120553&tid=7842

http://www.whoi.edu/page.do?pid=38144&cid=120513&tid=7842

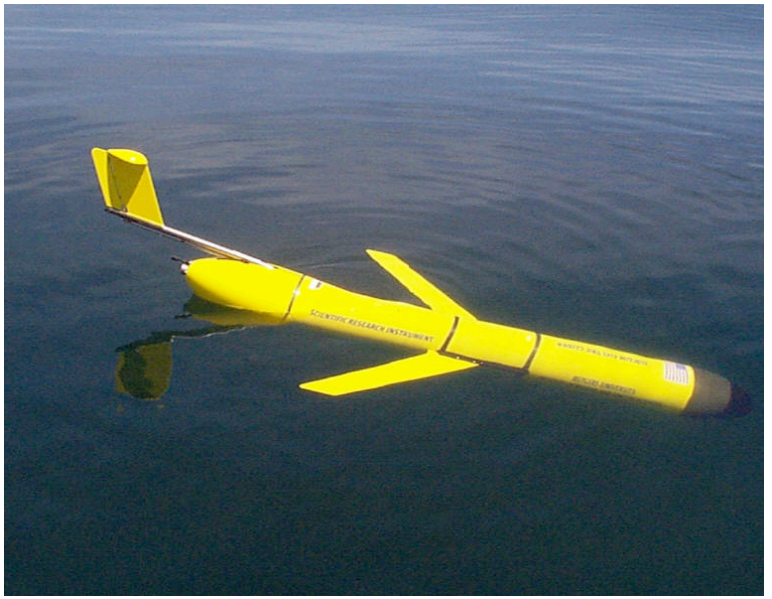
AUV Spotlight: Seabed AUV

- **Dimensions** 6.5 ft x 4 ft x 5 ft
- **Weight in air** 500-600lbs
- **Top Speed** 0.3 m/s
- **Max depth** 2000m
- **Duration** 6 hours
- **Application** map fish habitats

hawaii.edu

Glider Spotlight: Slocum

- **Size** 1.8 x 1 x 0.5 m
- **Body Size** 1.5 x 0.2 x 0.2 m
- **Weight** 52 kg
- **Max Depth** 1000 m
- **Dynamic Buoyancy** yes
- **Endurance (nominal)** 720 hrs
- **Nominal Speed** 0.35 m/s
- **Self-Righting** yes



auvac.org

ASVs

- Autonomous Surface Vehicles
- Have access to satellites (iridium phone and GPS)
- Have access to energy sources
- Easy to prototype

Clearpath.com

ASV Spotlight: C-Enduro

- **Dimensions** 4.2x2.4x2.8 m
- **Weight** 350kg
- **Propulsion** 2 x DC brushless motors
- **Speed** Up to 7 knots
- **Endurance** Up to 3 months
- **Control** semi-autonomous or autonomous control

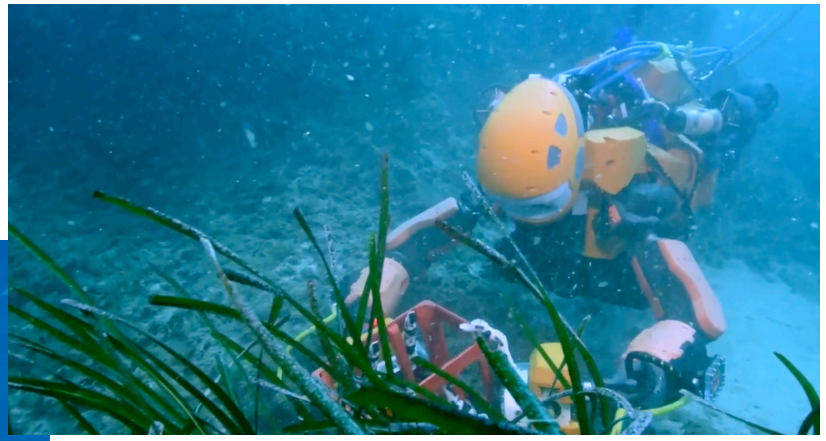
Asvglobal.com

ASV Spotlight: Wave Glider

- **Water Speed** 1kt to 3kts
- **Endurance** Up to 1 year
- **Operating Water Depth**
  > 15m
- **Station Keeping**: 40m radius
- **Tow Capability** Up to 500kg mass

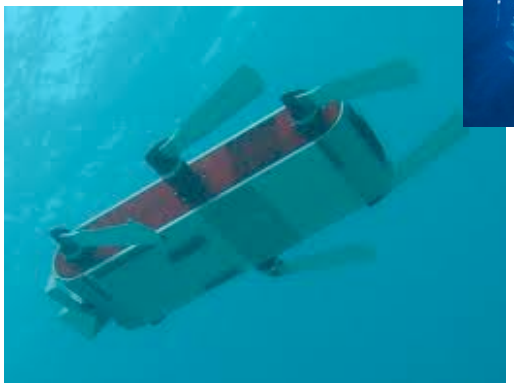
Miscellaneous

- All sorts…



Stanford.edu

VirginiaTech



McGill etc.

MRRSS

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4. Exercise A

- Find one underwater robot platform. Select based on novelty or research interest as desired.
- Determine the history, characteristics, and components of the platform.
- Present the platform in 1-3 slides.