

### **UNDERWATER SOLUTIONS WORLDWIDE**

#### Payload Autonomy on the Phoenix International Artemis AUV

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# Outline

- Brief Company overview
- Our Path to Autonomy
- Horizon
- Artemis AUV
- Payload Design
- Future Developments



#### **Phoenix International**



**Company Overview** 



- Engineering Services: Robotics & Underwater Systems Design/Build, Operations Support, R&D
- Deep Ocean Search & Recovery: NAVSEA Undersea Ops Prime <u>since 2001</u>
- Submarine Rescue Operations & Support: NAVSEA Submarine Rescue Prime <u>since 2006</u>
- **Commercial Diving & Subsea Operations:** Offshore Oil & Gas, Ocean Science, Seafloor Minerals, Surveys and Search & Recovery
- Underwater Welding & Ship Repair: NAVSEA Diving Services Prime <u>since 1997</u>

#### **Phoenix International**























# Internal Research & Development

COMPANY PROPRIETARY FOR GOVERNMENT EVALUATION ONLY

Pressure Tolerant Electronics
 × Bot
 Liston Pochargophic Battorios

Li-Ion Rechargeable Batteries

- Supercapacitor UUV
   Contactless Charging
   Visible Light Data Communications
- Diver Operated xBot
- Payload Autonomy



### **Engineering Development**

# Horizon



- Multi-mission Fiber Optic Tethered UUV/ROV
  - Auto-Heading and Depth/Altitude Control for Semi-Autonomous Flight
  - Operator Control for Precision Maneuvering and Docking
- Submarine TDU launch
- Passive and Active Homing
- Segmented Vehicle with Multiple Payloads
  - Docking/Mating/Data Transfer to Subsea Fiber Connection
  - Subsea Fiber Connection
    > 360° Inspection

### **Engineering Capabilities**







# **ARTEMIS** AUV

#### Modular Payload for Changing Mission Requirements Free Flooded Architecture, Removable-Air Shippable Batteries



#### **General Specifications**

- Depth: 5000 m
- Diameter: 21 in, Length: 17.2 ft
- Weight in Air: 1600 lbs
- Speed: 2-4.5 knts
- Endurance: 20 hrs @ 3 knts
- Navigation Accuracy: 0.1% of distance traveled

### **Operational Resources**

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#### **Onboard Systems**

- Reson 7125 Multibeam
- EdgeTech 2200-M Side Scan Sonar
- EdgeTech DW2-16 Sub-Bottom Profiler
- Kearfott Custom KN-6053 INS
- Sonardyne AvTrak 2/Ranger 2 Gyro USBL
- Prosilica GX 1920 Digital Camera 1936 x 1456 pixels



# AUV Continuing Development

- Payload Autonomy → Payload Computer Commands Vehicle Computer Based on Sensor Input
  - >Uses Open Source Middleware MOOS
  - Using Autonomous Kayaks as Development Platforms
- Collaborating with MIT
- Developing Payloads for Customers
  - ➢Oil and Gas
  - ➤ Subsea Mining
- Potential Payloads Include
  - Pinger Locator
  - Synthetic Aperture Sonar
  - Electric Field Sensors
  - > Magnetometer, etc.

### **Engineering Development**







- Purpose
   > AUV-based leak detection system for subsea infrastructure inspection
- Backseat driver installation
   > Upgrade carried out by Bluefin
- Payload Sensors
   2 x HF sonar's and a mass spectrometer
- Payload Integration and Test
   Carried out at BHC on the Scarlett Isabella
- Test plan

Search for and acquire a simulated leak source

• Offshore test

Test the backseat driver and the system detection limits

• Results

Artemis detected the leak source, handed control over to the backseat driver and homed in on the target.

### **Engineering Development**

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## First Payload Integration





# **Seafloor Mining Payload**

- Mission Requirements
   Detect and map SMS (Seafloor Massive Sulfide) deposits at depths up to 3000m
- Sensor Selection
   Magnetometer, Electric Field Sensors, Conductivity Temperature and Depth sensor
- Payload Design
   Pressure housing specs
   Underwater connectors
   Low power
   Low magnetic signature
- Hardware design
   Payload computer selection
   Sensor interface circuitry
   Solid state Hard Disk capacity
   Low noise power supplies
   Underwater connector selection

### **Engineering Development**

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Prototype Payload Hardware



Gumstix OVERO computer and Tobi expansion board



- Software design
   Sensor data collection and logging in the client specified format
- Bench Testing
   Verify all sensors confirm timestamp and navigation data are logged in the client specified format
- Payload build
   >Bench test actual payload and sensors
- Payload Integration and Test
   Test actual payload and sensors while connected to the AUV, 8 hour tank test

Offshore test

Confirm payload can acquire a simulated targetConfirm that the logged data is of high quality

### **Engineering Development**

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Payload chassis topside

Payload chassis underside

# **Sensor Data Quality**

- The challenge was that the Electric and Magnetic fields of the AUV have not been characterized
- AUV Magnetic Field

To reduce the effects of the vehicles magnetic field the magnetometer was mounted in the nose.
 Additional magnetic shielding using mu-metal

• AUV Electric Field

➤ To reduce the effects of the vehicles electric field, the SP Ag-AgCl cells were positioned in the nose and 1.5m forward of the thruster motor.



Electric Field sensor spacing

### **Engineering Development**

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Silver-Silver Chloride cell



# **Offshore Testing**

- Mobilization in the Gulf of Mexico
- Dockside system and vehicle buoyancy checks
- Offshore tests
  - Calibration of the magnetometer
  - Record vehicle magnetic and electric field levels
  - Place test fixture on the seabed
  - Search for test fixture
  - ➢ Post Process data recorded during dive



### **Engineering Development**



## Payload Development Platforms

- Autonomous Kayaks (Elanor and Dee)
- Manuals and Schematics
- New Batteries
- New steering servos
- Updated software
- Function checked
- Wet test before the end of August
- Pinger Locator Payload using backseat driver





#### **Engineering Development** Underwater Solutions Worldwide



# Summary

- Who Phoenix is
   >We are primarily a deep water operations company with a strong background in, engineering and design of underwater vehicles
- How we engineer
   Our Engineers have offshore experience, they use this knowledge to design equipment that can operate reliably in the offshore environment
- What we engineer
   ➤Solutions to underwater problems from the surface to 6000 m
- What we are doing with Artemis
   Exploring opportunities in the O&G, Underwater mining, Science and Defense fields
- What we intend to do with Artemis
   Continue to develop new intelligent payloads in support of Defense and Commercial customer needs

#### **Phoenix International**





### **UNDERWATER SOLUTIONS WORLDWIDE**

### **QUESTIONS**

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