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Unmanned Systems and Robotics, The Next Technology Revolution

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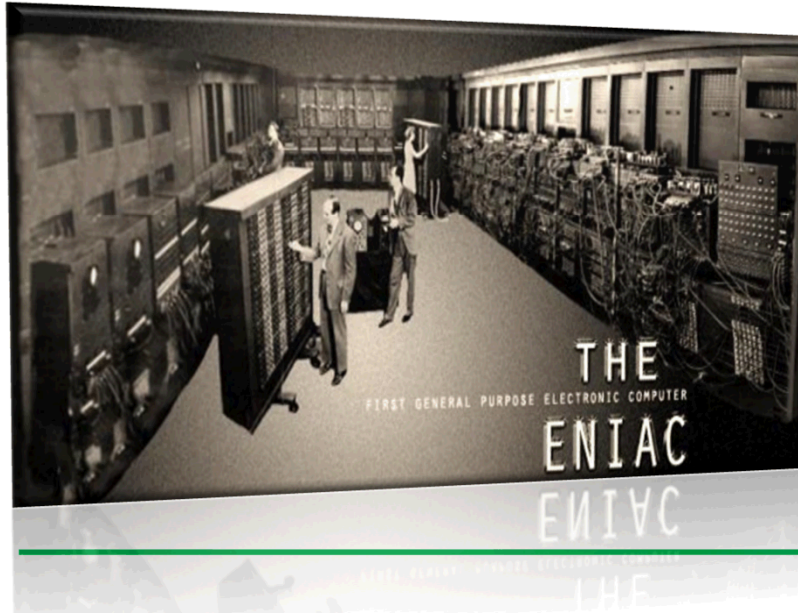
Intelligent Systems, Robotics, and Cybernetics

Sandia National Laboratories

U.S. DEPARTMENT OF
ENERGY

The Evolution of Computing Technology

First General Purpose Electronic Computer, 1946

Red Storm Supercomputer
Sandia National Laboratories

Time

Major Differences Between Computing and Robotics:

Computing:

- There is no known lower limit on energy to compute

- Computing advances at the rate of Moore's Law

- Most computer advances happen in a virtual world (adapt to technology)

Robotics:

- Moving mass requires power and material strength

- Material capabilities advance more slowly

- Robotics must face the complexity of real world (technology must adapt to the world)

Changes in Perspective: Looking to the Future

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Current Perspective

Few High Value Robots

"Everything Must Work Perfectly"

Future Perspective

- Many Low Value Robots
- Okay to have a few fail

Inherit Manned Approach

"High rate of action, must bring sufficient energy"

- Free of manned requirements
- Variable rates of action
- Harvest energy from environment

The Next Arms Race may be a Control Algorithm Race

Majority of discriminating technology can transfer and remove Pilot induced limitations

However, pilot Training, Tactics and Procedures (TTPs) are key discriminators

X-45C UCAS

F35 – Manned Fighter   Source: U.S. Air Force

For an Autonomous UAV, Tactics and Procedures are Control Algorithms
(training is trivial)

Hierarchy of Control Algorithms

Government Domain

Strategic

Asset allocation and establishment of tactical objectives

Tactical

Objective completion, multi-unit coordination
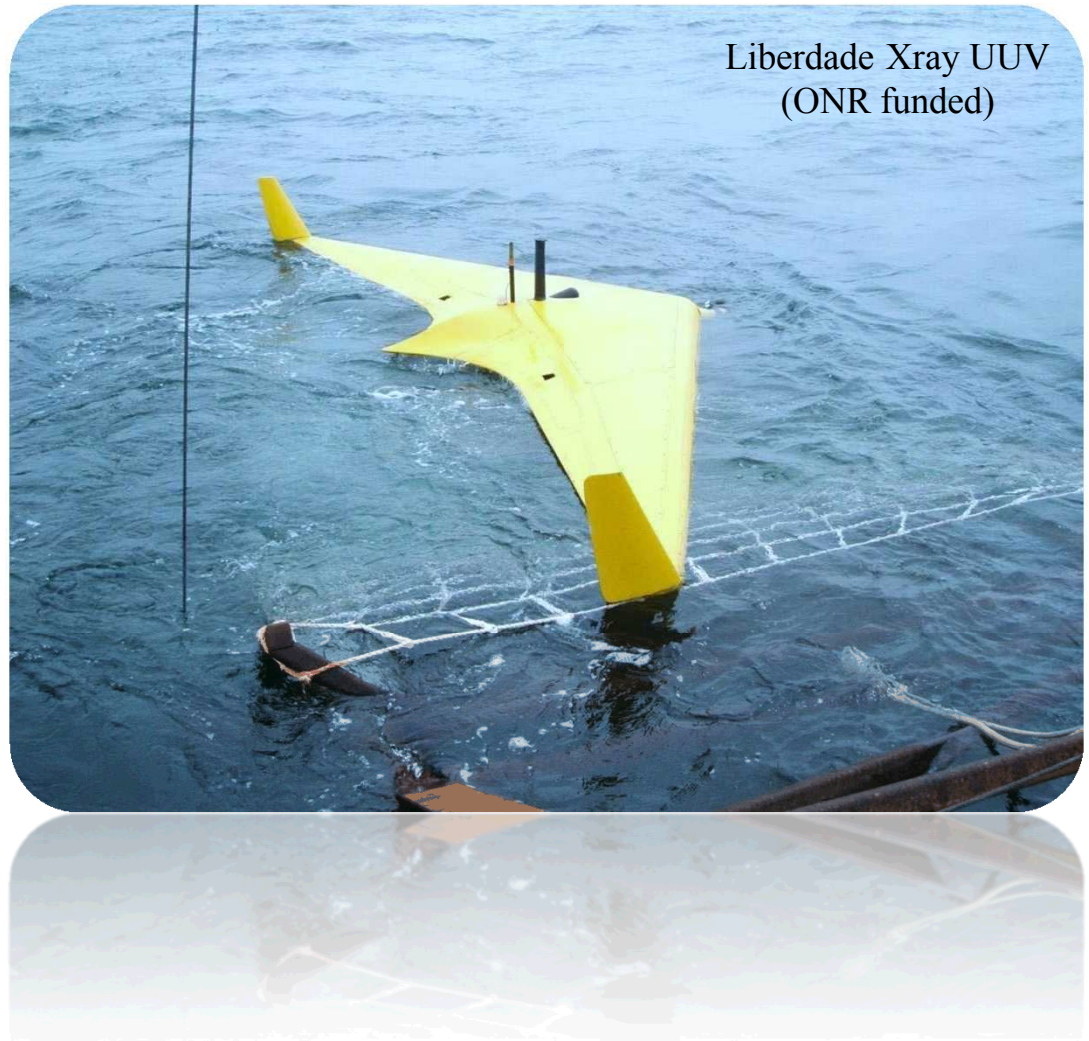
Industry and Academia Domain

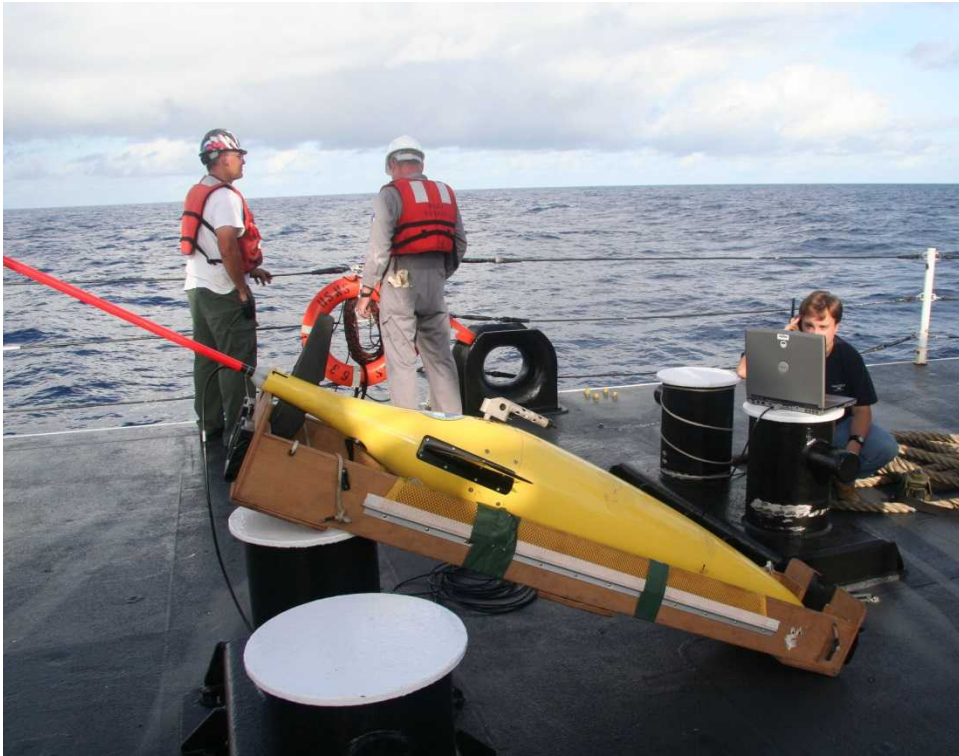**Behavioral**

Transit, avoid net, hide,.....

Autonomic

Basic functions: dive, communicate, …

Internal Functional (low-level)

Control thruster motor speed
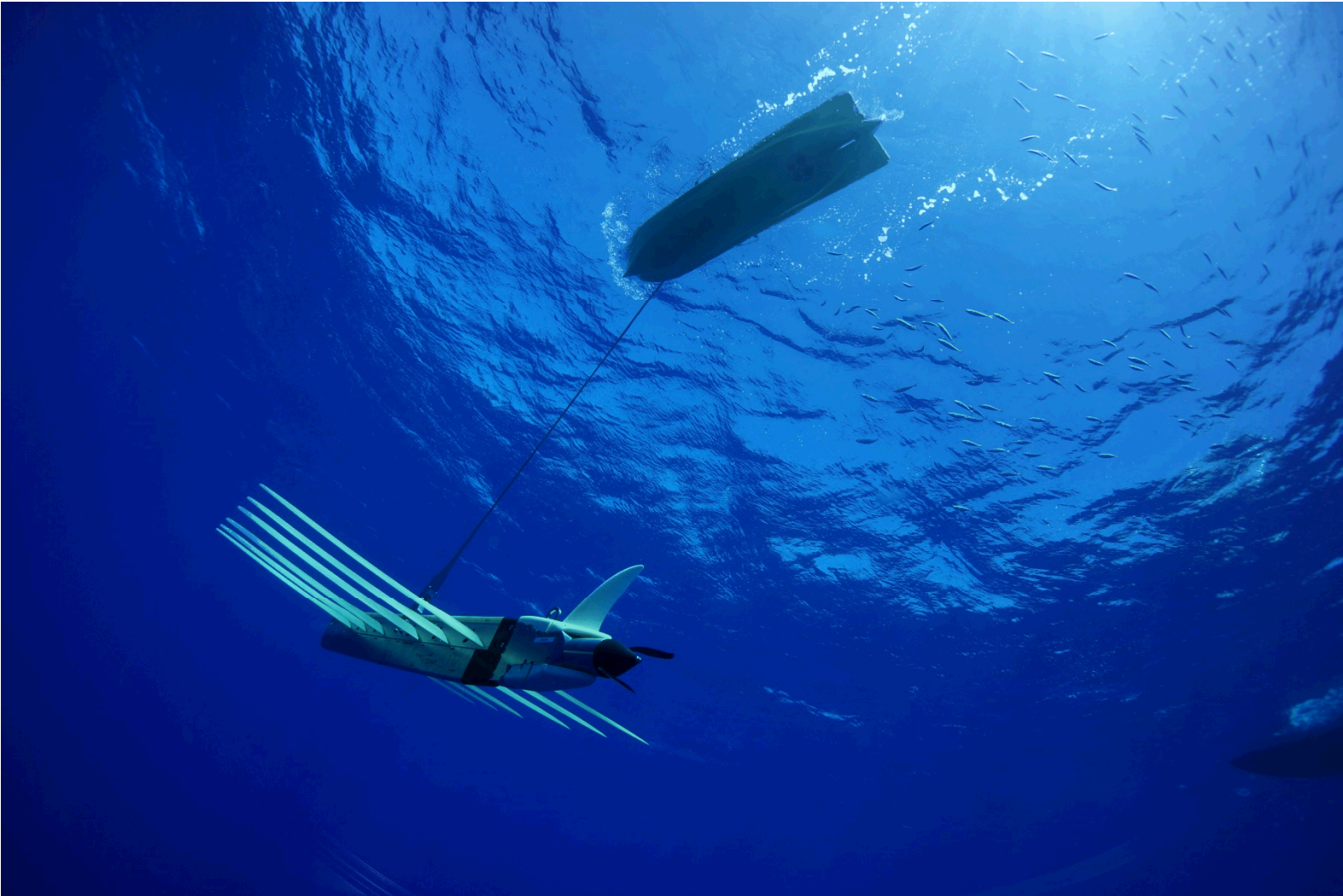

Liberdade Xray UUV
(ONR funded)

Slocum (Thermal Glider)

- <u>Named after Joshua Slocum</u>: The first man to sail a small sailing vessel singlehanded around the world.
- <u>Around the world race</u> Hawaii↔Hawaii, between US-Australian-French entries
  - French won in 708 days
- <u>World Ocean Observing System (WOOS)</u>
  - Operate a fleet ~1000 Slocum's for oceanographic purposes
  - Routinely patrol the ocean 50° S↔50° N
  - Slocums can be in continuous service for 5-10 years
  - Broach 6 times a day to communicate

Slocums which have ranges of 1000's of miles and missions durations of years were developed in the early 1980's for ocean surveillance.

Wave Glider

Source: Liquid Robotics

A New Force Projection Paradigm?

Diplomacy --- Unmanned Systems --- Prompt War
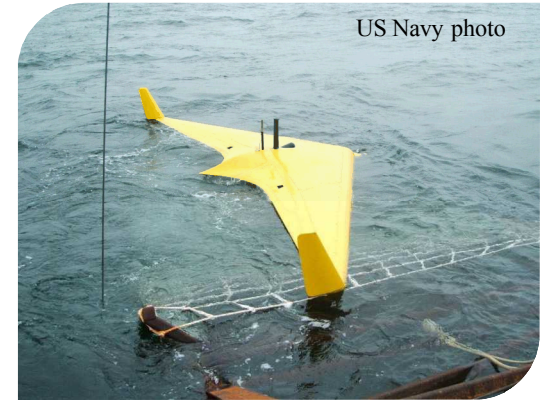

Architect of the Capitol Photo

US Navy photo

US Navy photo

Long Duration Sustainable Indirect Destruction

Shorter Duration Direct Destruction

Slow Persistent War

A Branch of Cyber?

DOE photo

US Navy photo

Virtual Space   Fixed Assets   Mobile Assets

Spectrum of Cyber Effects

Questions?

Major Shift In Thinking:

Historical:

Necessary Features

- Highly Reliable Components

- Power Supply

- Low Cost

- Miniaturization

Surprises:

- Disposability

- High Complexity

- Rapid Evolution

- Standards as Key Enabler

Future:

Robotic Applications

- No Need for "Perfect", Robust: Few Platforms, Integrated Components

- Advanced Power Sources, Harvest Energy

- Simple Hardware, Robust, Tap broad customer markets

- Miniaturize all Possible Functionality, Adopt & Deploy True Standards