FlyingFish

Unmanned Aircraft System (UAS)

for

Ocean Science Missions

Overview

22 February 2010

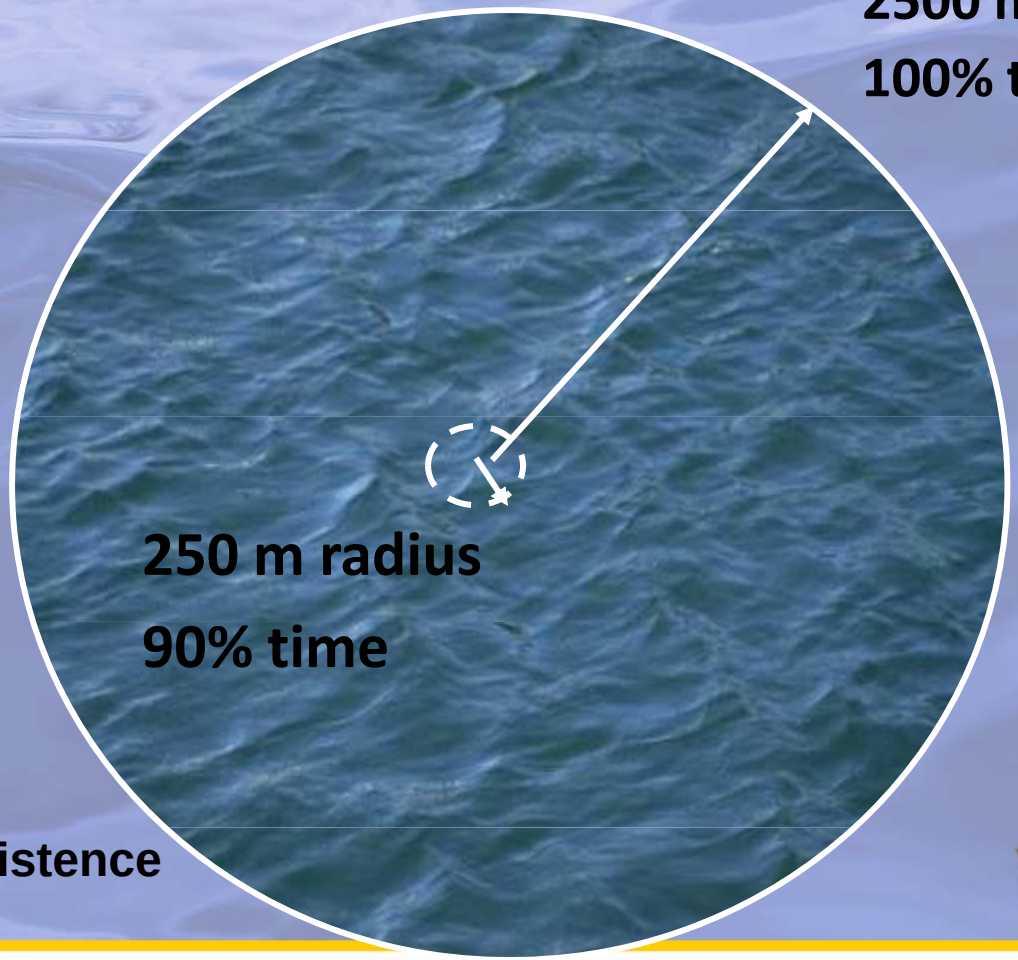
Prepared for

NSF Ocean Sciences

MichiganEngineering

Unattended - Ocean Persistence

Electric Powered Vehicle – Solar Recharge



2 kt current

27 kt winds

7 - 10 ft waves

Up to 1 Month
Unattended Persistence

History and Near-term Goals

- **History: very successful Phase I effort**
  - **Two "sea trials" off Monterey, CA with up to 2 m wave heights**
  - **Demonstrated first fully autonomous self-initiated flights from open ocean surface (22 times for DARPA in first trial alone)**
  - **Collected high quality flight and environmental data**
- **Phase II aircraft harvests solar energy**
  - **Initial flight tests conducted in Fall 2009**
- **Phase II goals (demo in May-Jun 2010)**
  - **Demonstrate balanced energy budget**
  - **Unattended watch circle maintenance**

Flying Fish Phase I (auto-takeoff

Flying Fish Phase II (initial flight)

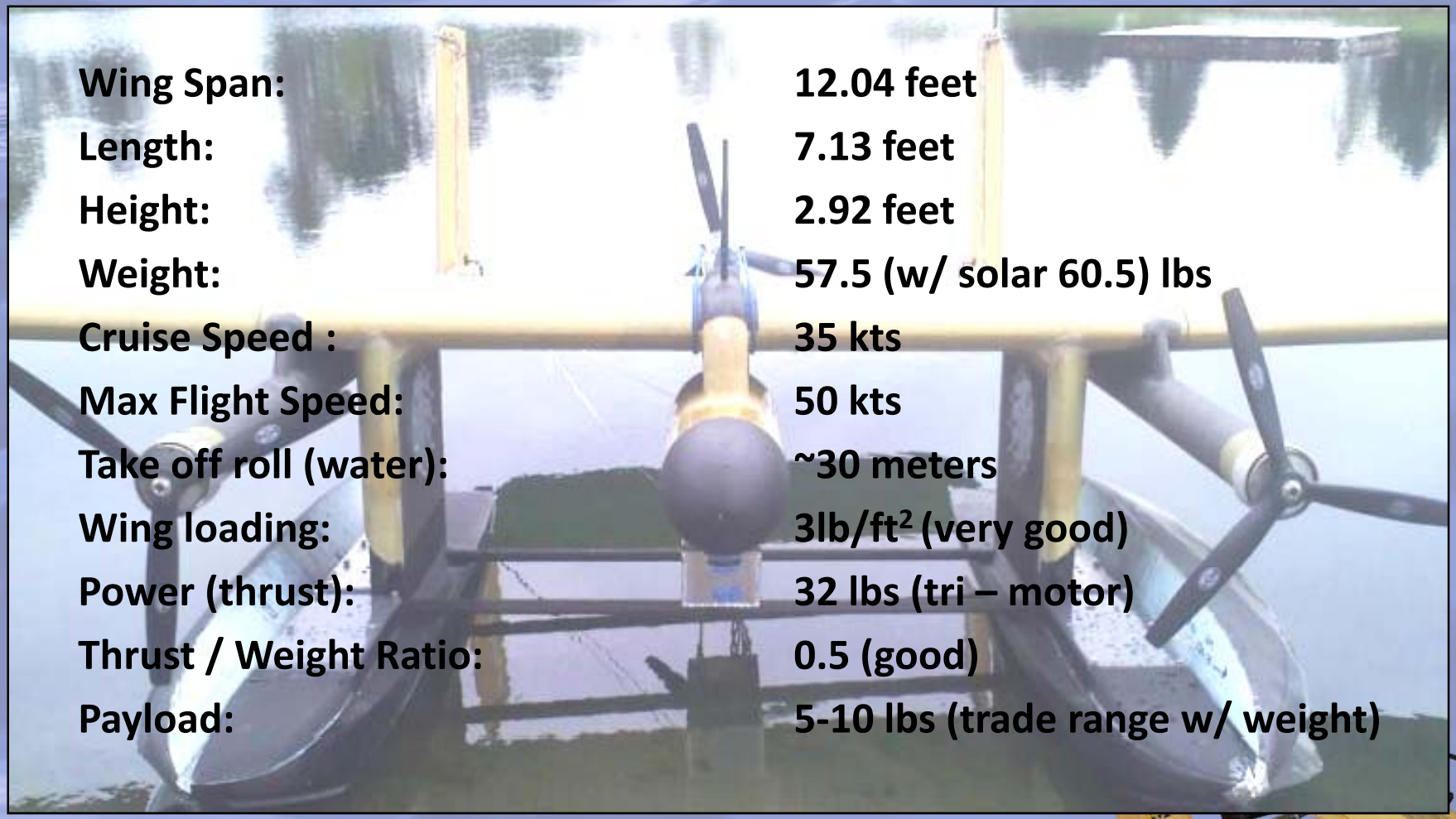
Sea Trials
Monterey Bay

Phase I

Phase II

Phase II Vehicle - Overview

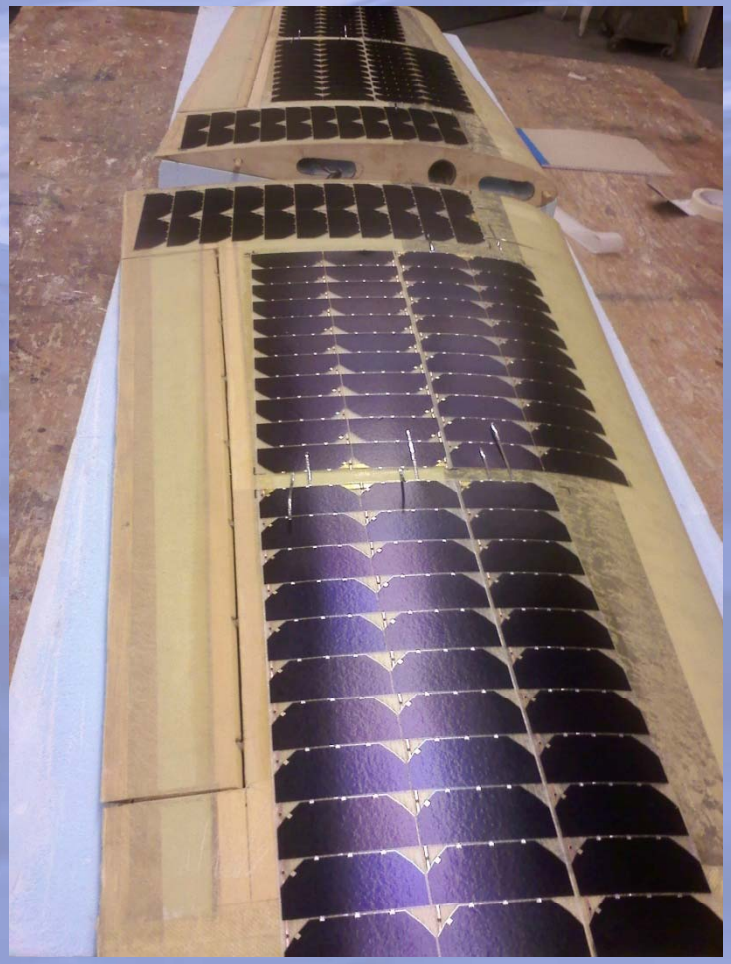
- **Electric Powered – Solar Recharged**



Wing Span:	**12.04 feet**
Length:	**7.13 feet**
Height:	**2.92 feet**
Weight:	**57.5 (w/ solar 60.5) lbs**
Cruise Speed :	**35 kts**
Max Flight Speed:	**50 kts**
Take off roll (water):	**~30 meters**
Wing loading:	**3lb/ft^2 (very good)**
Power (thrust):	**32 lbs (tri – motor)**
Thrust / Weight Ratio:	**0.5 (good)**
Payload:	**5-10 lbs (trade range w/ weight)**

Solar Array

(1 square meter @ 31% efficient)



Ocean Science Mission Descriptions

Persistent Ocean Surveillance Mission

Harmful Algal Bloom Mission

Oil Spill or Frontal Boundary Tracking

Possible Collaborative Mission With High Flying UAS

AUV Baby Sitting

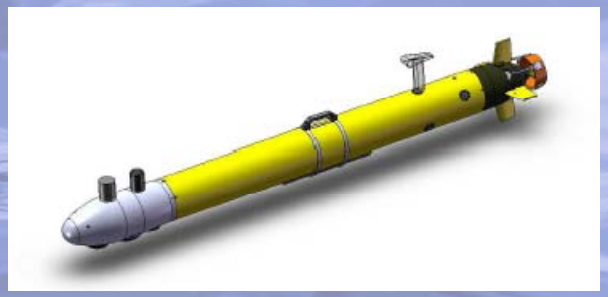
Science Missions: Harmful Algal Blooms / Oil Spill / Frontal Boundary

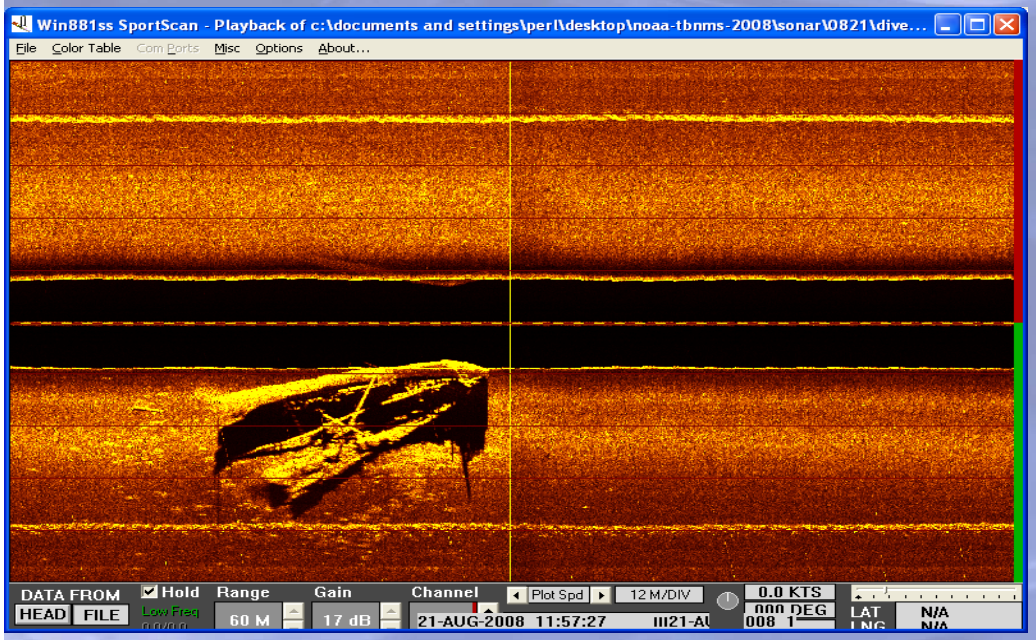
- Unattended persistent deployment
- Long-term direct observation of growth and tracking
- Low-level remote sensing
- Water surface measurements and sample collection
- Plug and Play payloads
  - Detachable waterproof payload canister with power & data conduits

Possible Collaborative Missions

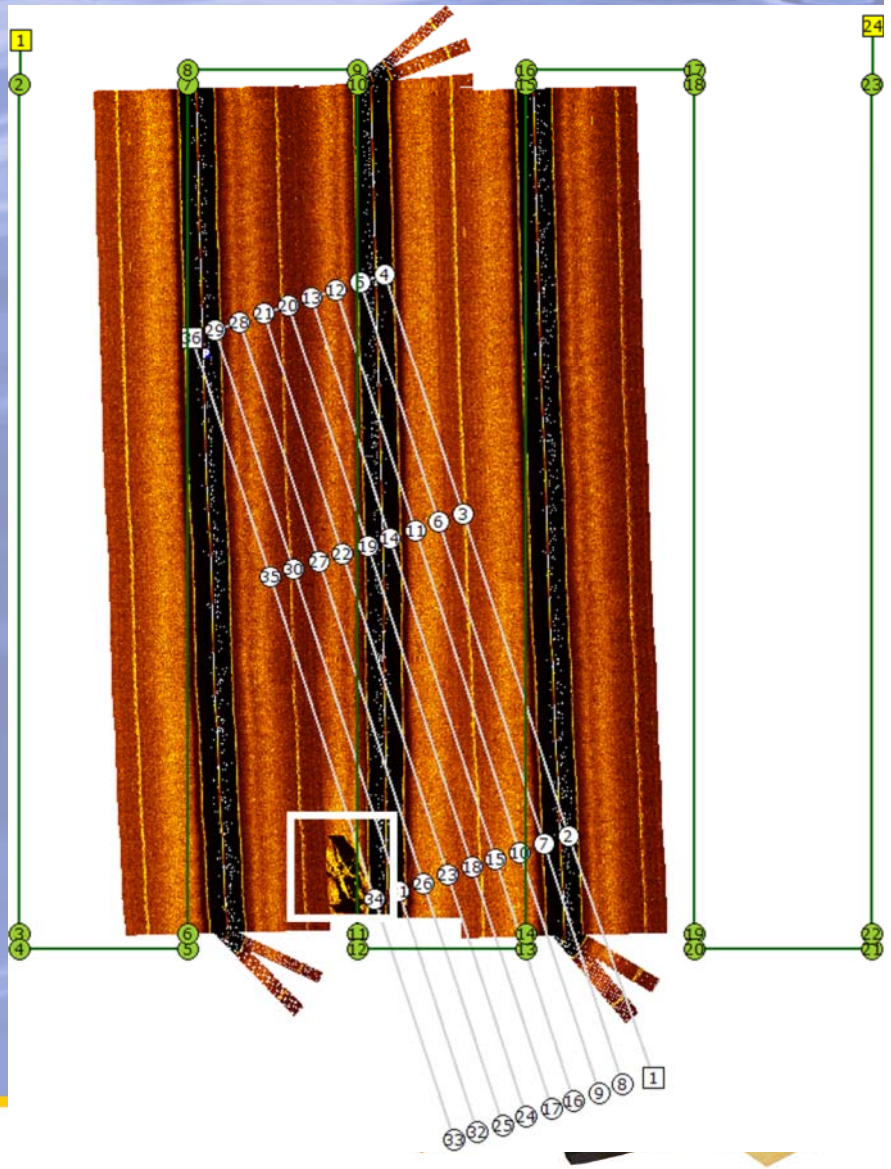
- Dynamically-configured sensor web
  - Multiple vehicles negotiate flight operations to provide continuous subsurface and/or aerial sensor coverage
  - Leapfrog operations used to chase targets, maintain a watch area with minimum number of flights, and balance energy across the team
- Augment traditional ocean science assets
  - Support science by providing alternative low-altitude air support, self-mobility, and long-term deployment options

Possible AUV Missions





(Shipwreck in Thunder Bay, MI, 2008)



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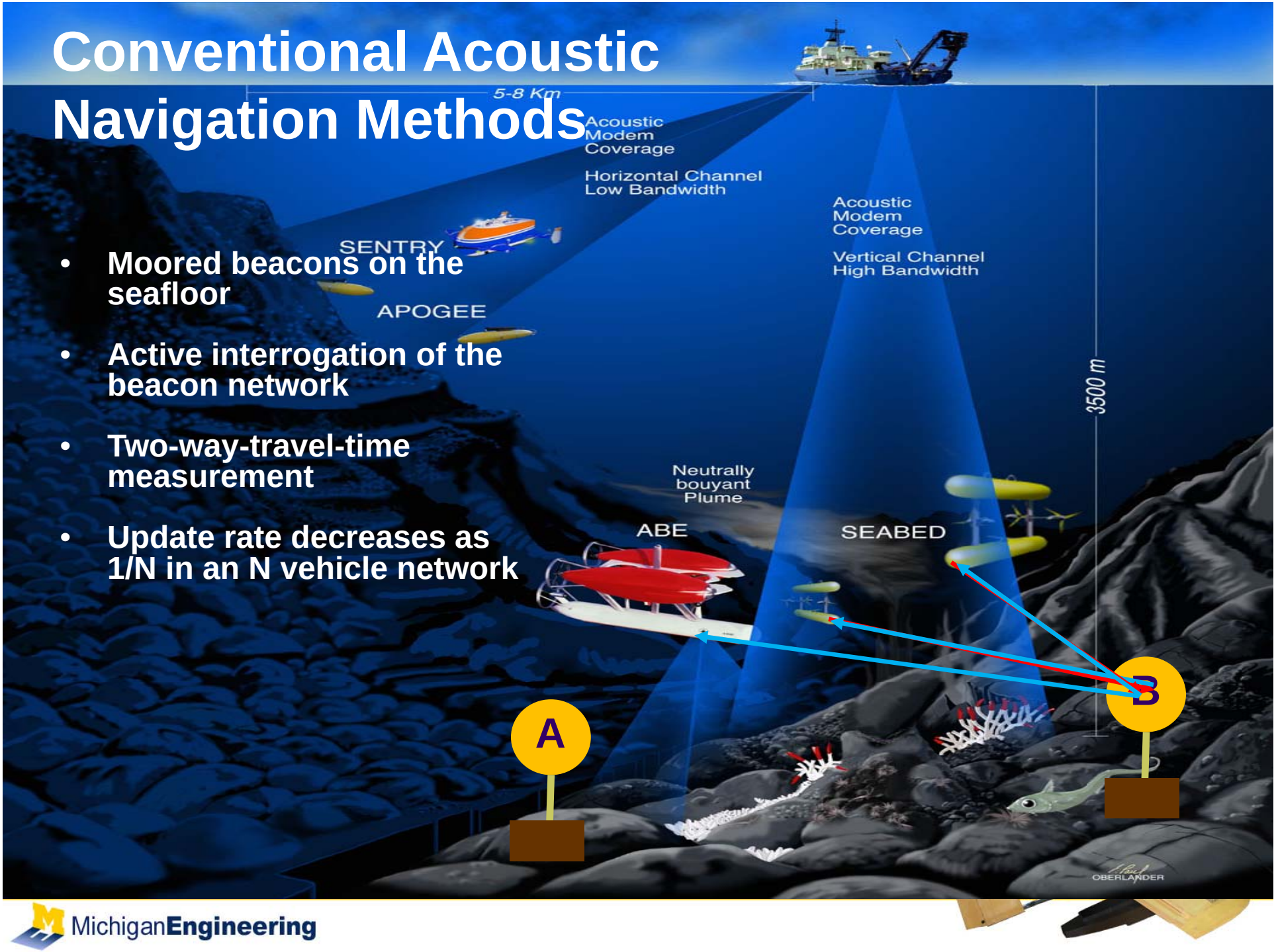
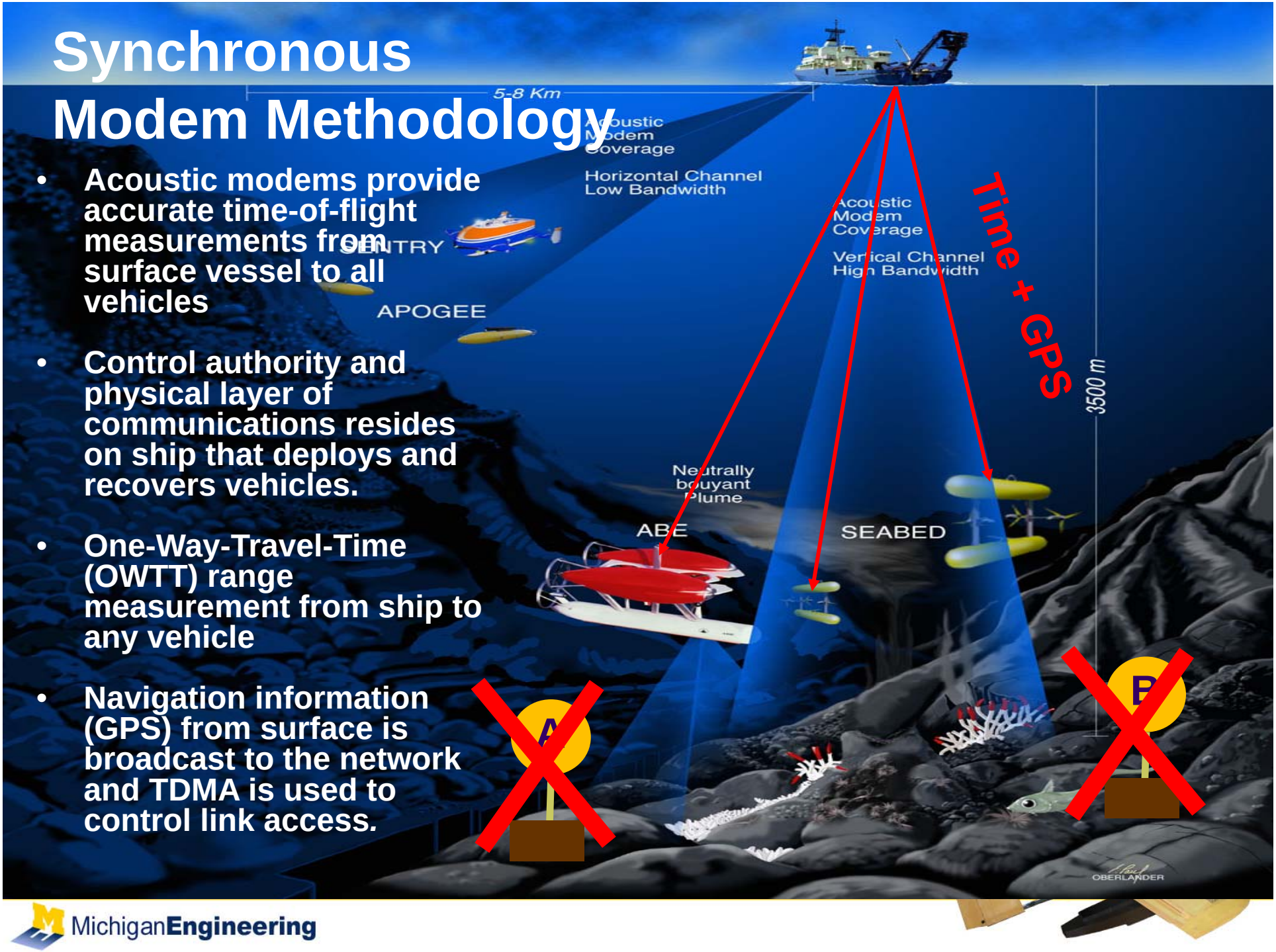
Conventional Acoustic Navigation Methods

- Moored beacons on the seafloor
- Active interrogation of the beacon network
- Two-way-travel-time measurement
- Update rate decreases as 1/N in an N vehicle network



Synchronous Modem Methodology

- Acoustic modems provide accurate time-of-flight measurements from surface vessel to all vehicles
- Control authority and physical layer of communications resides on ship that deploys and recovers vehicles.
- One-Way-Travel-Time (OWTT) range measurement from ship to any vehicle
- Navigation information (GPS) from surface is broadcast to the network and TDMA is used to control link access.



Flying Fish Phase I & II
A work in Progress……not an operational vehicle

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Discussion & Questions

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