‘Make in India‘ Paradigm –
Roadmap for a Future Ready Naval Force

Organized by FICCI in association with Indian Navy

18-19 April 2016

Autonomous Underwater Vehicles

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AUV VISION

Taking 'Man Out of Water' from all dangerous and monotonous activities under water

- *Sense, track, identify, target and destroy an enemy*
- *Condition monitoring of underwater assets*
- *Pave way for sustainable ocean resource exploration*
- *Ocean environment monitoring*

– all autonomously

- "Eyes and Ears" for the fleet away from fleet **(ISR)**
- Force multiplier – ASW, Combat support & **Combat** Engagement
- Represent u/w in the **network centric data compilation & assessment** process

Requirements of AUVs

- Claiming, holding, utilizing the ocean
  - Explore, exploit and protect maritime resources
- Security : Detecting, Deterring and Defeating
  - Coastal, littoral and blue water
- Condition monitoring of u/w assets

- **India's coastline: 7517 km**
- **Territorial waters = 12 nm**
- **Exclusive Economic Zone = 200 nm**
- **Area coverage ,EEZ= 23 lakhs sqkm**

Naval Capability Requirements

- Unseen but on scene (Stealth)
- Present when and where least expected
- ISR
- Oceanographic bathymetric surveys
- Battle space awareness and preparation
- Surface warfare
- Mine warfare
- Anti Submarine Warfare (ASW)
- Special Operations & Strike support
- Low Intensity Conflicts

The Solution – Autonomous Sea Vehicles

OPERATIONAL DEPTH

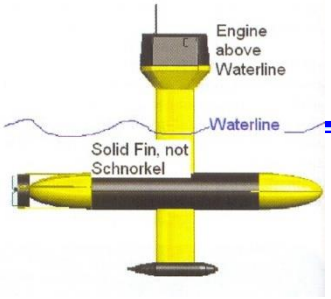
INTELLIGENCE

Ships are Manned !

WIG

ASSV

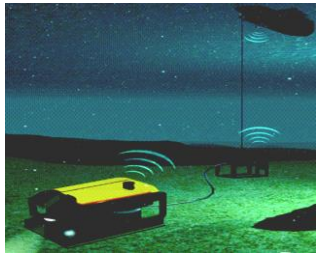
Semi Submersibles



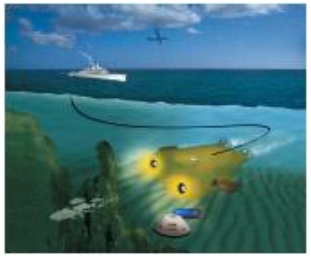
Towed Vehicles

Bottom Crawling Vehicles

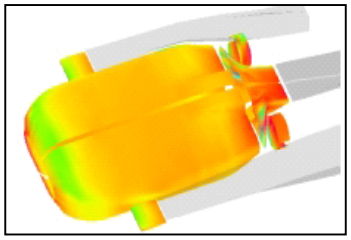
Remotely Operated Vehicles



ROV Convertible AUV



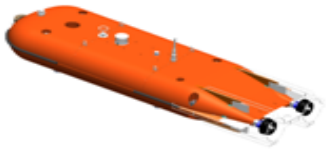
Autonomous Underwater Vehicles



World Scenario





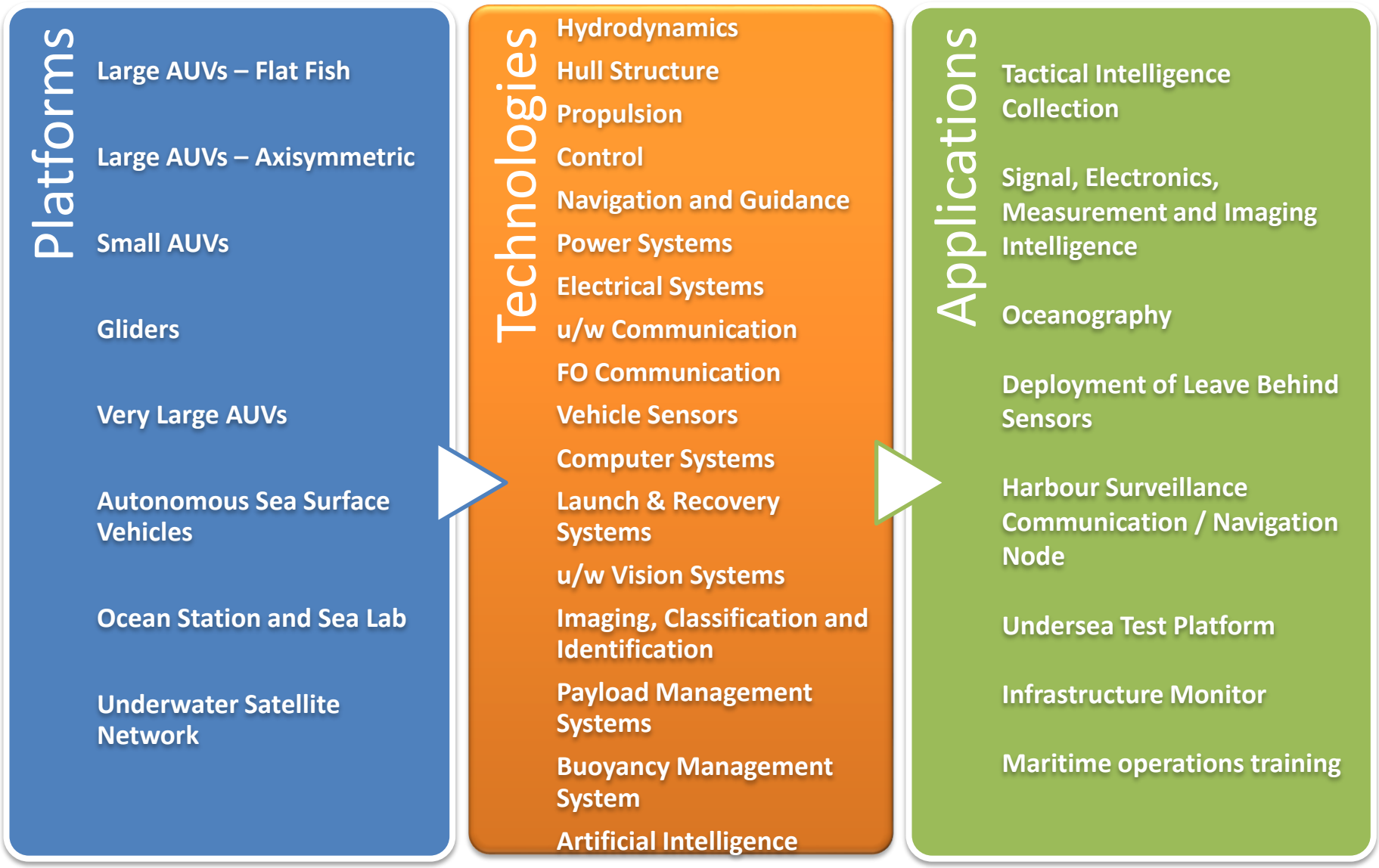




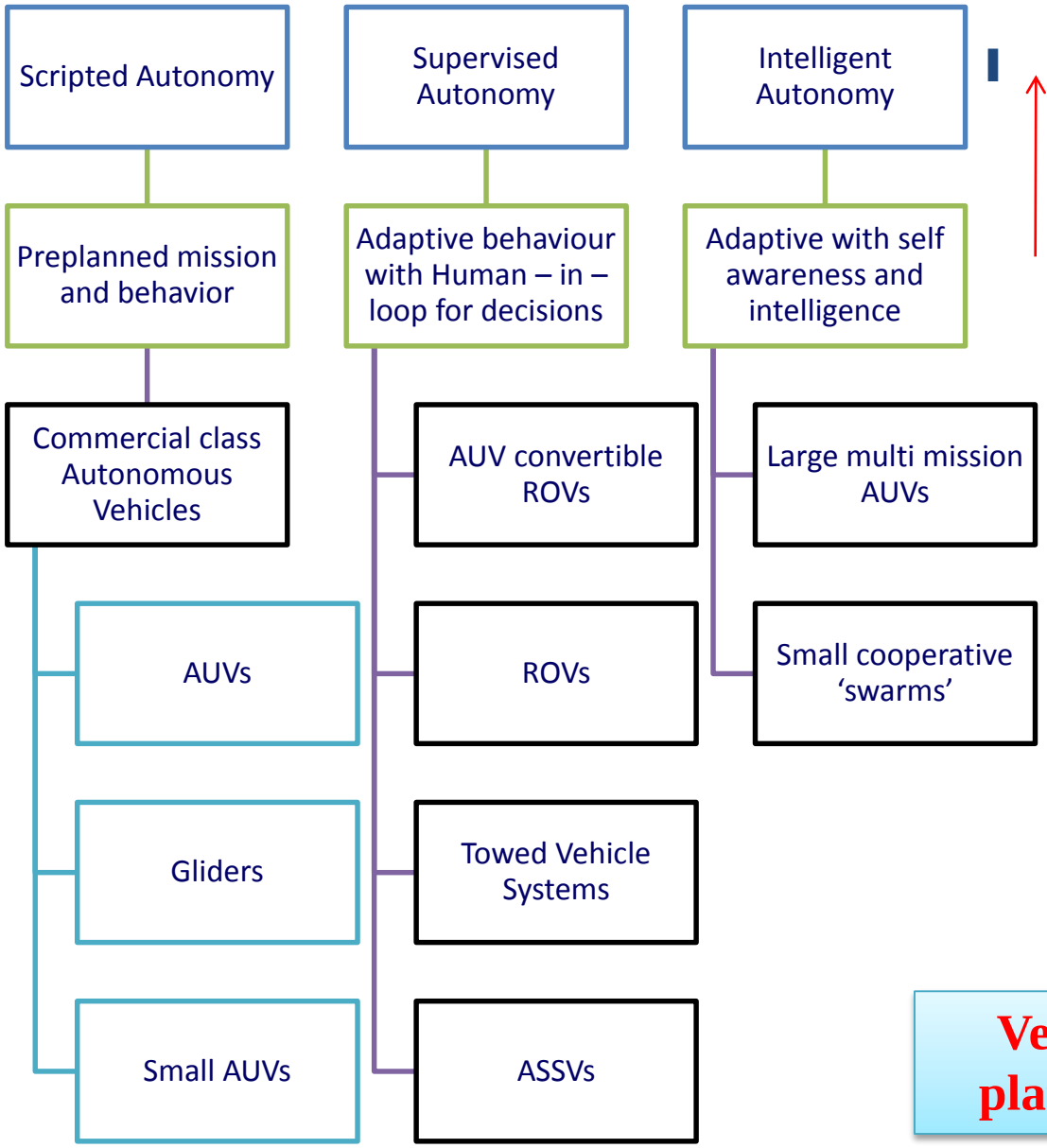


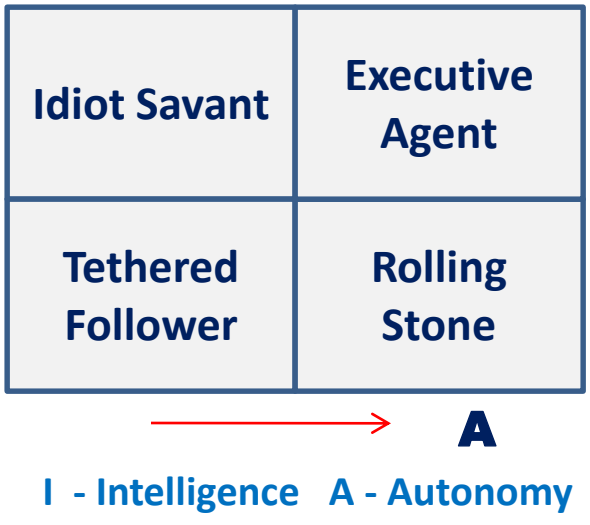



Platforms – Technologies - Applications

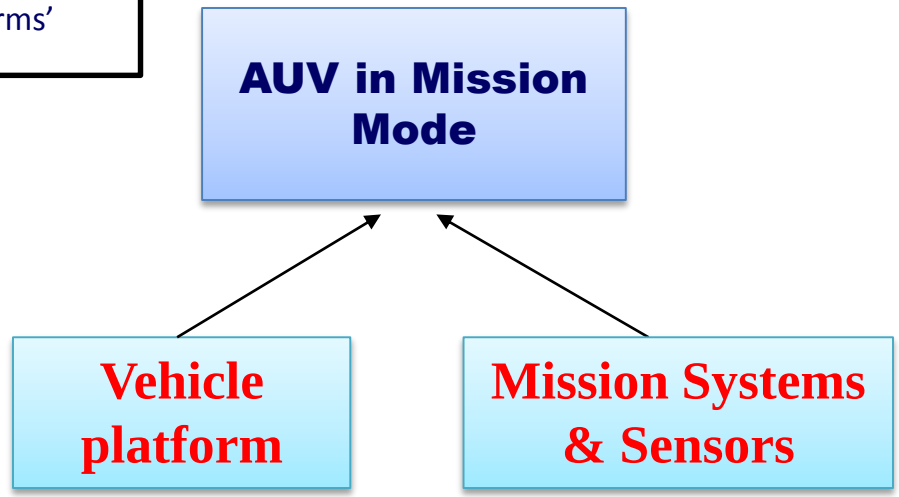


Autonomous Systems : Capabilities



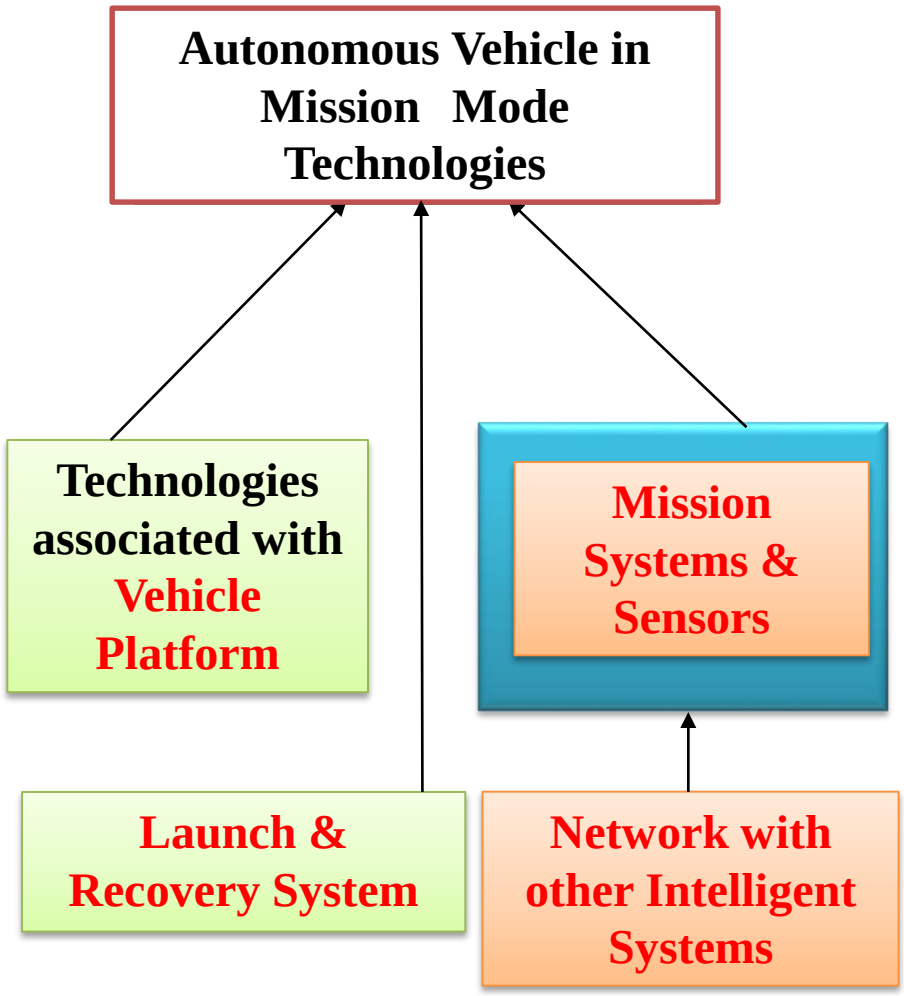


Courtesy : ONR & NUWC



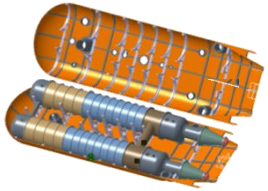
SPECTRUM OF TECHNOLOGIES DEVELOPED

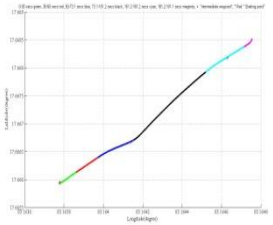
- ✓ Vehicle Architecture & Hydrodynamics
- ✓ Propulsion
- ✓ Hull Structure
- ✓ Power
- ✓ Control, Navigation & Guidance
- ✓ Communication
- ✓ Mission-critical Sensors
- ✓ Data , Signal & Image Processing
- ✓ Overall Autonomy
- ✓ Launch & Recovery
- ✓ U/W Manipulator (for Work Class)

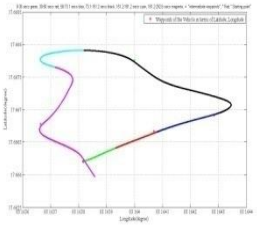


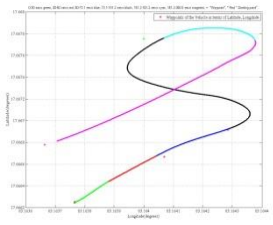
AUV development at NSTL

AUV Sea trials









Click to play video

TDV: Key features & capabilities

- Flat fish shaped, free flooding, re-configurable
- Size: 4.6 m x1.6 m x 0.7 m, Disp. : 1.5 Cum.
- Payload : 500 kg, positively buoyant with hovering
- OAS and INS, GPS & DVL aided navigation
- Underwater and surface comm. , U/W Camera and lights
- Normal and emergency recovery aids

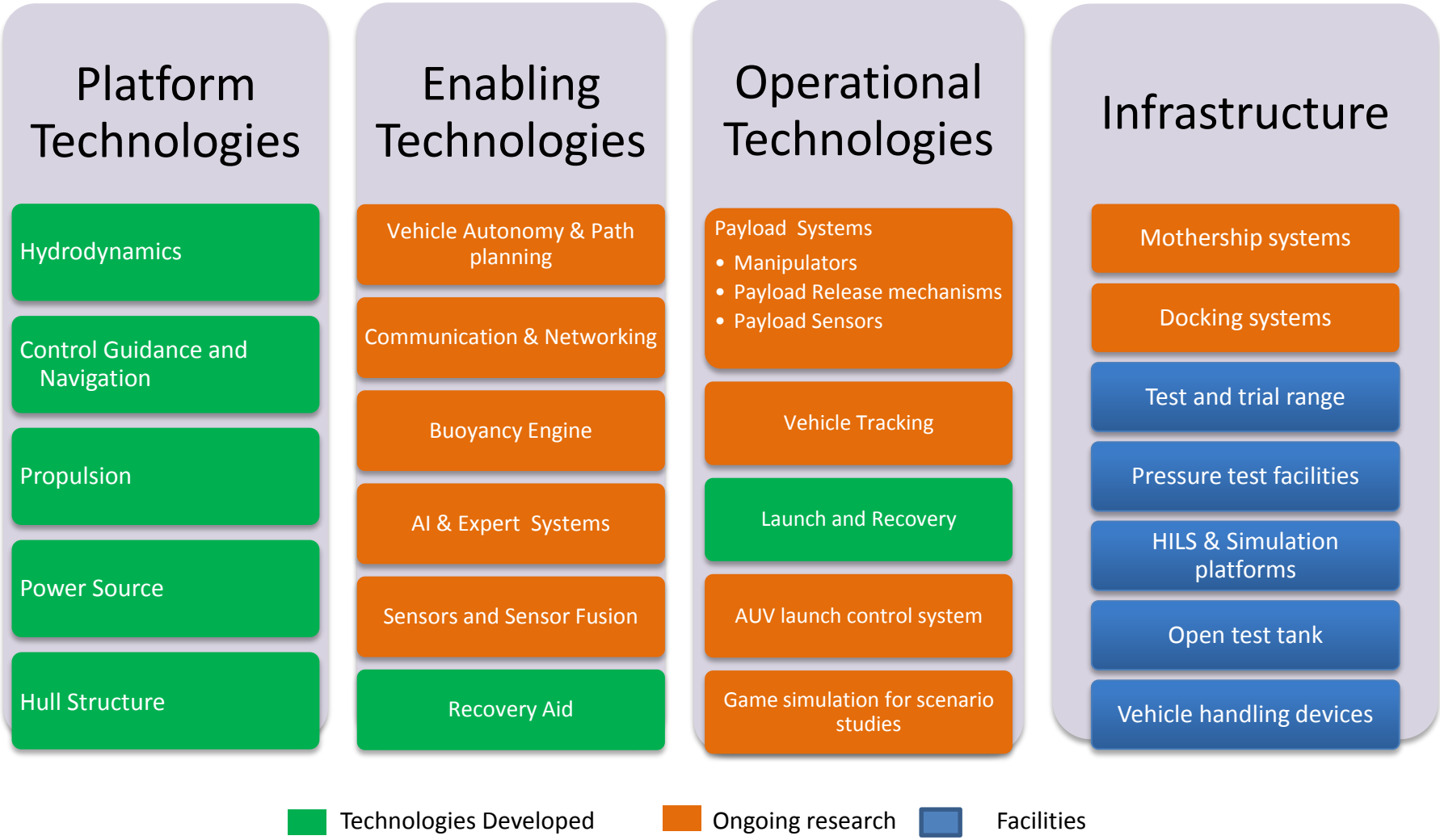
Achievements

- HSTT trials , Field trials and sea trials
- LARS and AUV release mechanism
- AUV center established
- ECIL as concurrent engineering partner

Applications

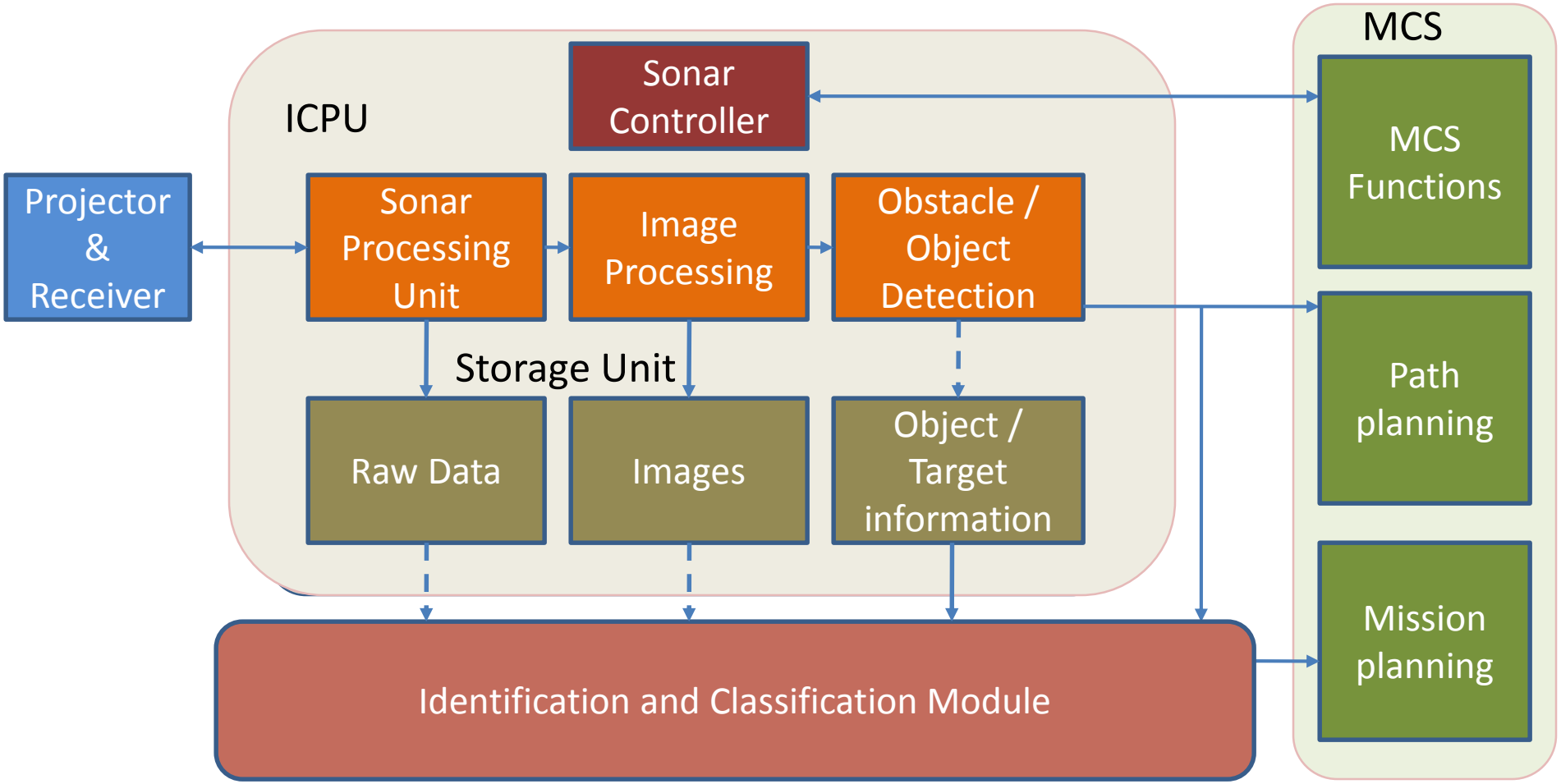
- Target for u/w exercises & deployment of leave behind sensors
- For surveillance & Oceanographic surveys

Technologies Developed & ongoing research for AUV at NSTL



Decision making

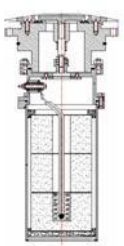
-Obstacle Avoidance Sonar
-Identification and Classification



RECOVERY AIDS

Smoke Marker

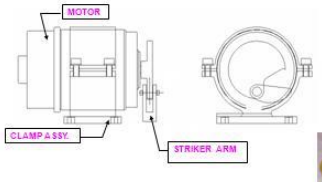
- Electrical signal fed to squib through IIRS
- Ignites and burns the smoke pellets
- Generates thick orange Colour smoke



Voltage : 28 volts
Current : 0.2 Amps
No of items in AUV : 1No
Time of operation: 90 Sec.
Weight : 3.5 Kg
Vehicle position : 2 m depth in water

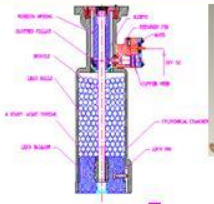
Noise Maker

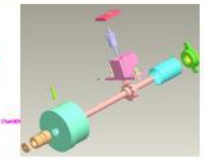
Noise maker produce the noise continuously on run termination

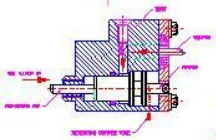


DC Rattler Motor
Voltage : 28 volts
Current : 3 Amps
No of items in AUV : 1No
Running time ≥ 24 hours
Weight : 1.3 Kg

Lead Dump Mechanism







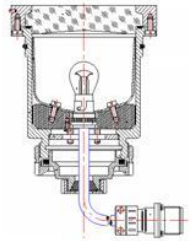
MASD ASSY

Lead dump mechanism (LDM) is a recovery aid incorporated in the AUV to develop additional positive buoyancy on emergency

Design consideration : Total 80 Kg for 4 LDM

Lead block weight : 5Kg Lead balls weight :15 Kg

Flasher



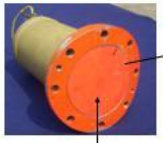
- Flasher is used for identification of the AUV at the end of the run after surfacing
- In the case of recovery of AUV at night by emitting the beam of light.

Voltage : 28 volts
Current : 3 Amps
No of items in AUV : 1No
Emitting time : 24 hours
Weight : 2.6 Kg

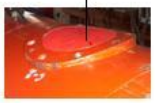
Sunken AUV Recovery Mechanism

Rope from Recovery drum

Buoy with 2 mm dia. rope With triggering mechanism



Movable mechanism with Kevlar rope

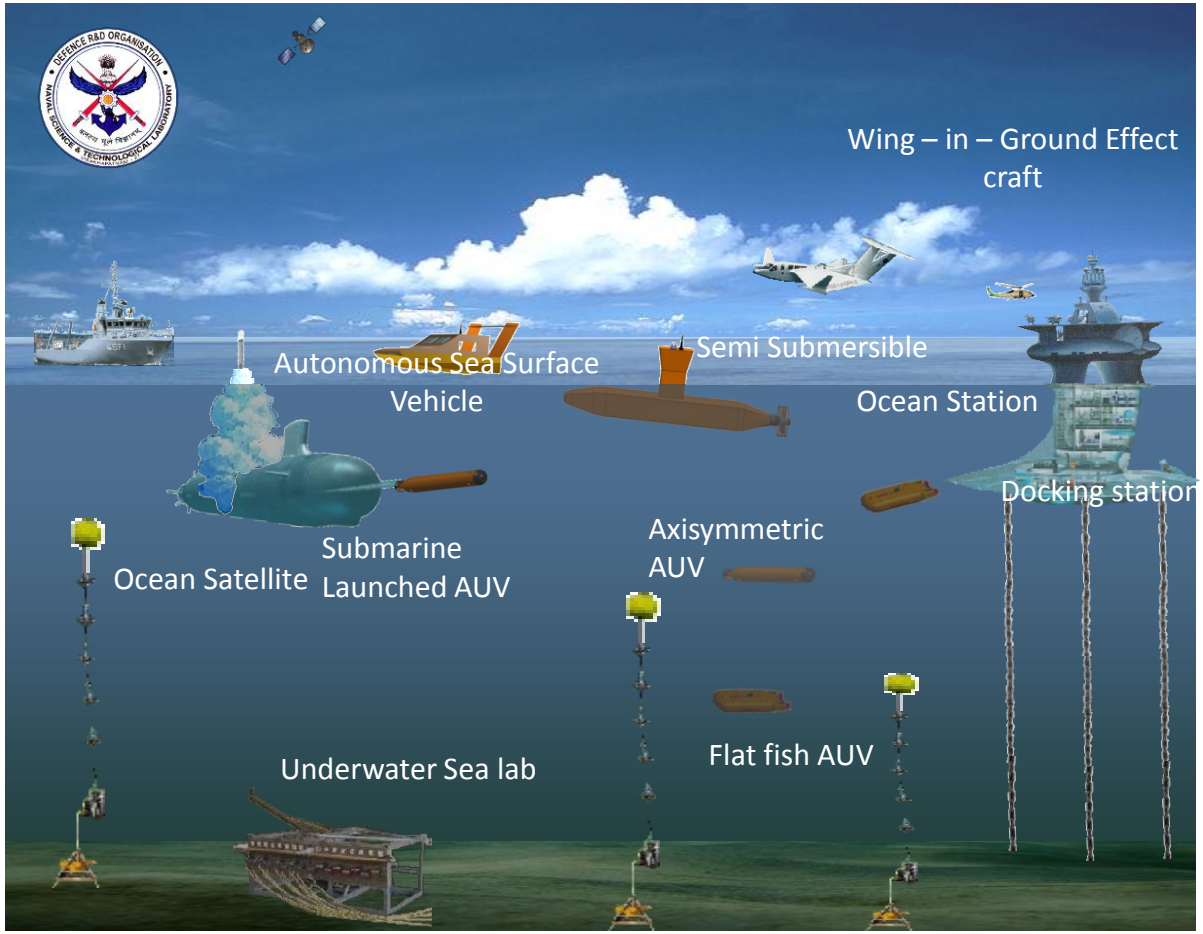


AUV

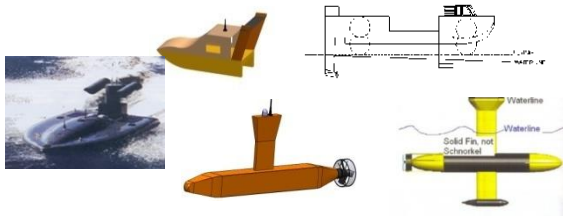
Voltage : 28 volts
Current : 3 Amps
No of items in AUV : 1No
Running time: 24 hours
Weight : 3.5 Kg

Network class AUVs and systems

- Surface Layer AUV
- Interior Layer AUV
- Bottom Layer systems



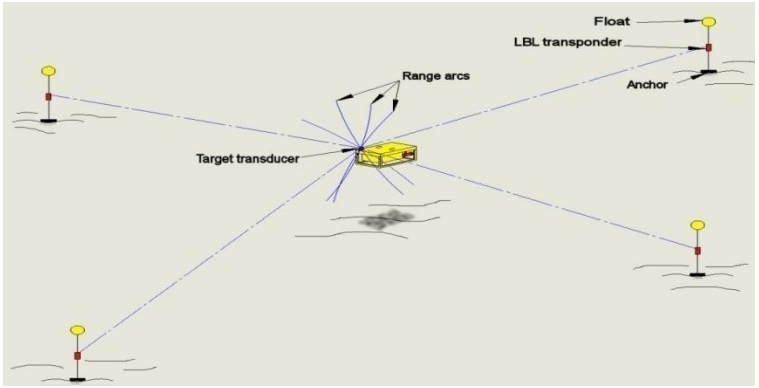
Surface Layer AUV



Interior Layer AUV

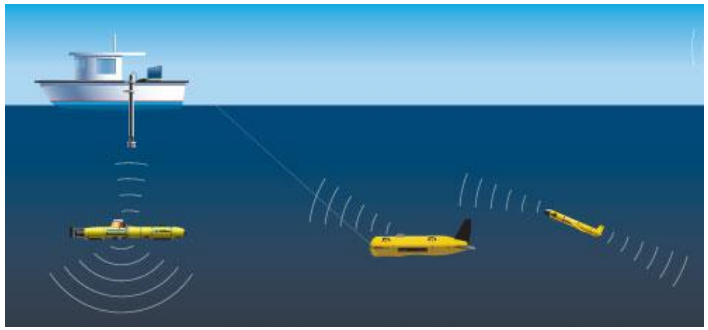
Bottom Layer systems

Technologies for networked operation of AUVs



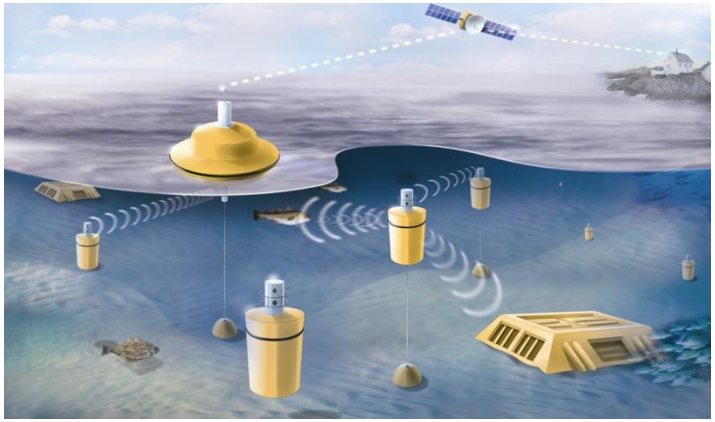
LBL system

- Fixed / moored transponder arrays placed at regular intervals at known global coordinates
- Transducers placed at vehicle
- Vehicle position localization



USBL system

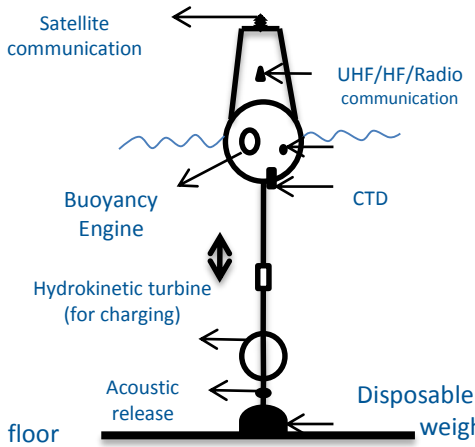
- USBL system deployed from a ship or stationary vessel
- Transponders placed at vehicles
- Vehicle location through triangulation and localization



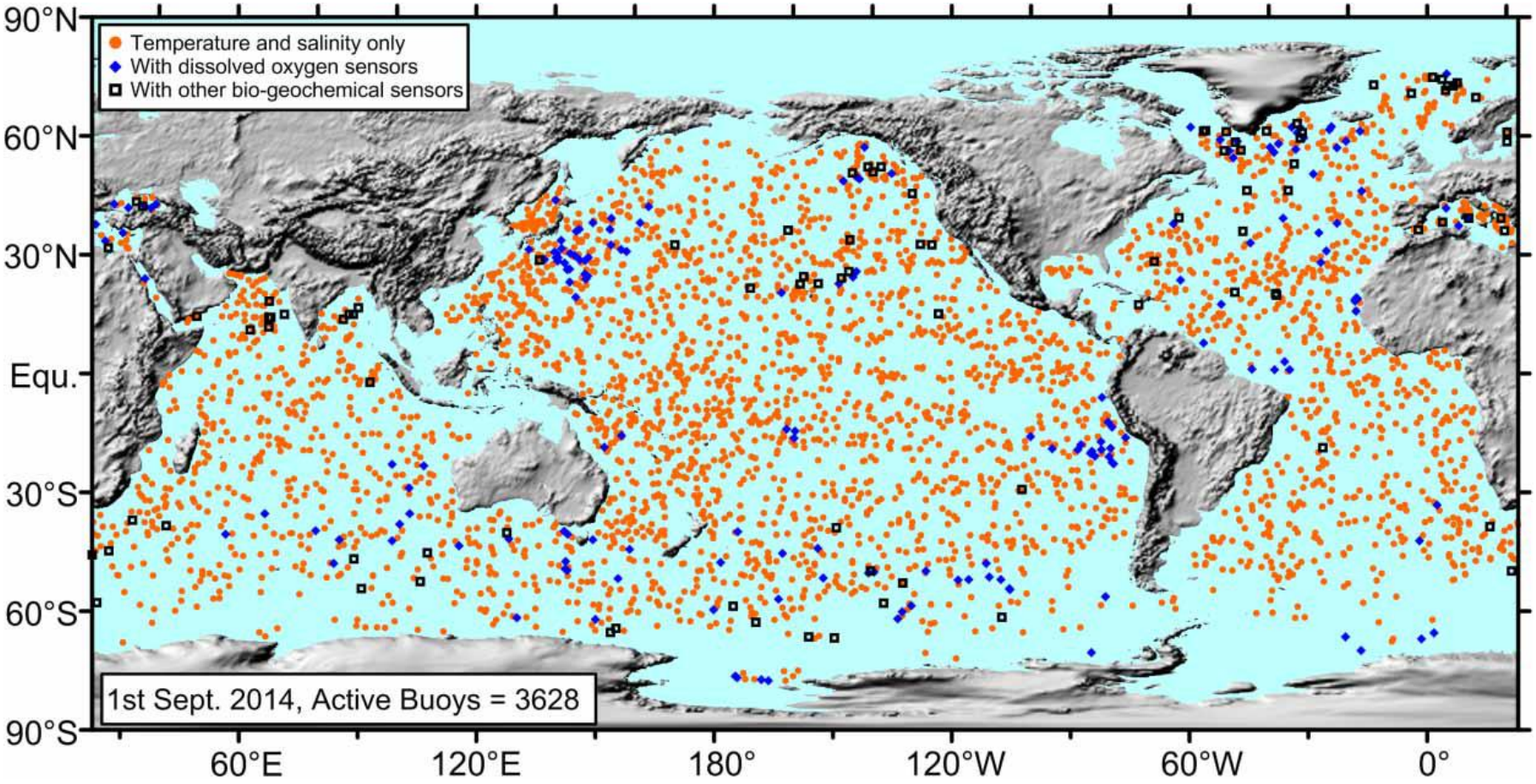
DP buoys

- Stationed on the sea surface
- Receives information from underwater sensors acoustically and transmits to satellite / ground station / mothership

Underwater satellites



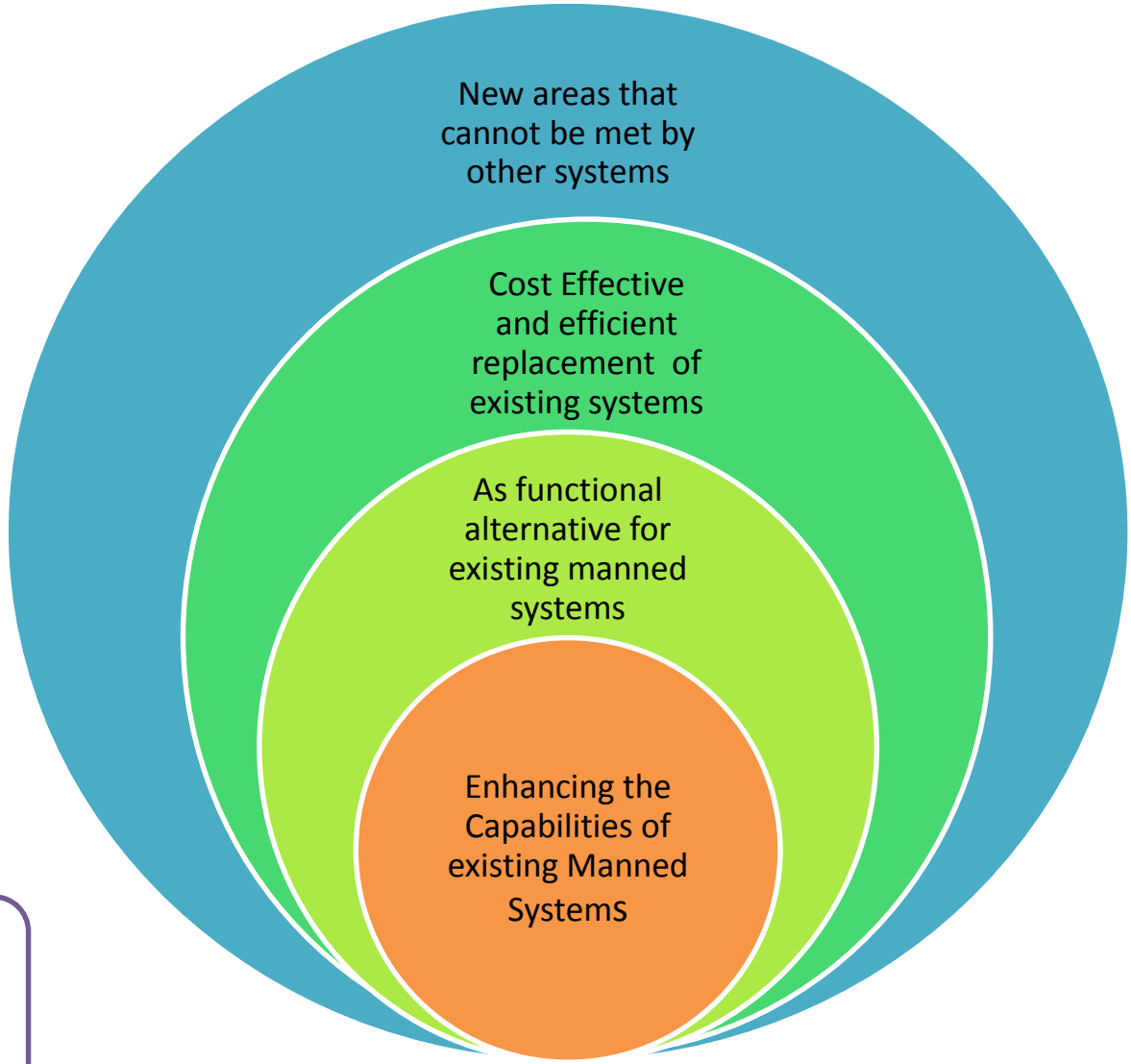
Ocean Information Grid

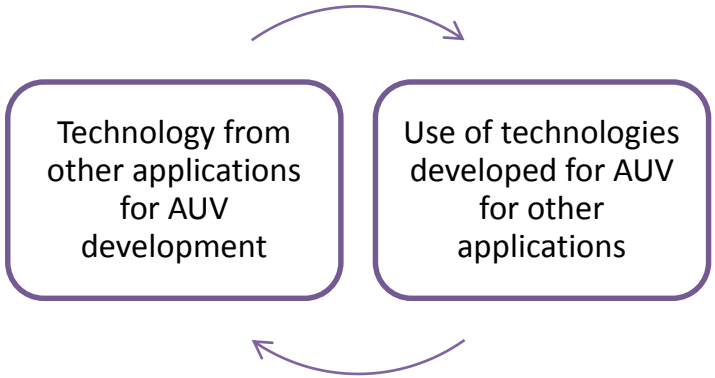


Various ocean sensors and buoys deployed globally

Source: Journal of Operational Oceanography

Strategy for deployment of unmanned sea systems

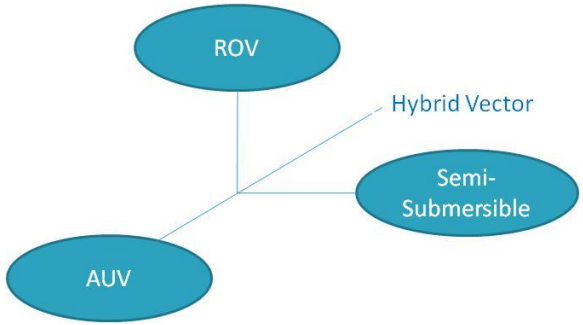




System trends

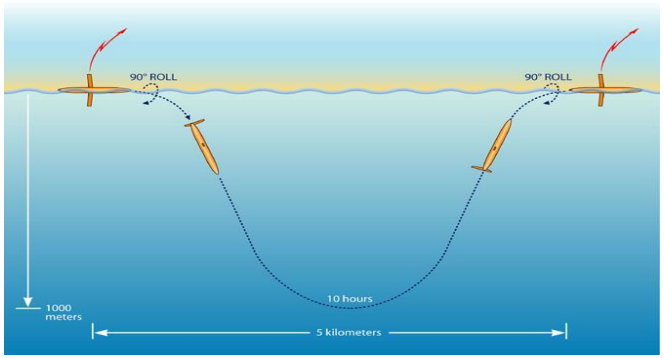
- Platforms
  - Large multi role capable AUVs
  - Small AUV with cooperative navigation operating in ‘swarms’
- Low drag designs and miniaturization
- Autonomy: Increased level of AI with self learning capabilities and sensor fusion
- Biologically inspired propulsion
- U/w Gliders (24 X 7)
- Trends in propulsion & power
  - Energy efficient power sources
  - Renewable energy sources
  - Digestive systems
  - Biologically inspired propulsion
- Self deployed and recovered AUVs
- Reusable / Disposable system

- Trends in modes of operation
  - ROV
  - AUV & ASSV
  - Hybrid

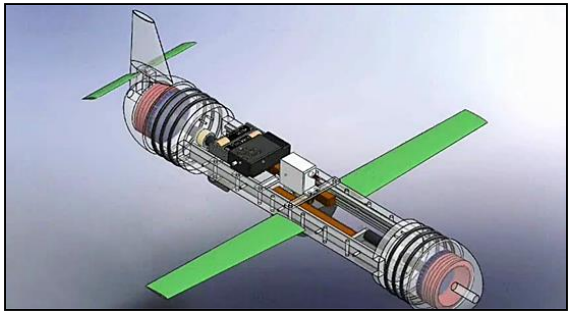


Underwater gliders

- U/w Gliders are
  - Small Size (1 – 2 meter)
  - Long Endurance (upto 6 months)
  - Low Speed (about 1m/s)
  - Low cost.
  - Minimum power consumption (1 watt on Avg.)



- Buoyancy driven gliders can follow a saw-tooth pattern patter across ocean depth, periodically they transmit the data collected by onboard sensors to mother ship or shore by satellite communication. Gliders are extremely stealthy. They are quite, with very low self-noise, small acoustic cross section and leave a practically invisible wake.



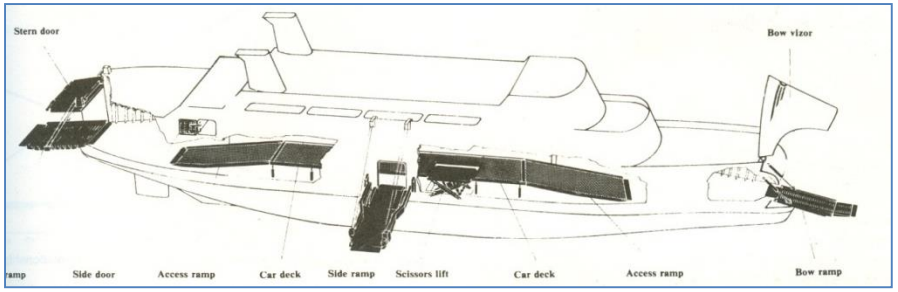
Amphibian vehicles

Courtesy: NRB

VIDEO

Way ahead

- AUV carriers (like aircraft carriers) that can fly in and fly out AUVs to and from the theater of operation



- AUVs that can fly in and out of mother ship to the sea
- Amphibians (land, air, sea surface and U/W)
- Networked systems with Ocean satellites, ocean Stations and sea lab

Conclusion

- Robust, mature COTS, ROV, AUV and Semi-Sumersible Autonomous Vehicles and boats have arrived.
- Robotic Vehicles can be moved to theatres of operation by air.
- They carry sensor suites with the same capabilities as ships.
- They provide standoff.
- They are relatively low cost and keep personal out of harm's way.
- They can be linked via shore, air, satellite or vessels of opportunity.

THANK YOU