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# *Mission Reconfigurable UUV (MRUUV) Industry Brief*

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# *MRUUV Industry Day Agenda*

- **UUV Program Brief**
  - Purpose & Goals**
  - UUV Vision & Master Plan**
  - Previous UUV Acquisition Programs**
  - Evolutionary Development to Achieve Vision**
  - SUBTECH & FNC**
  - MRUUV Concept**
  - Critical Tasks and Capabilities**
  - Industry Opportunities**
- **Autonomous Operations Future Naval Capability (AOFNC)**
- **JHU/APL Submarine Contested Area Study Brief**



# *MRUUV Industry Day*

- **PURPOSE**

- Communicate Government MRUUV planning information to industry
- Level playing field for all industry interested in UUV development
- Convey a level of government interest in this new market area
- Enable industry partners to make wise IRAD investments

- **GOALS**

- Partner with industry to produce quality proposals to future MRUUV solicitations
  - Performance goals
  - Technology challenges
- Leverage government investment and facilities
  - Minimize duplicate government/industry investment in same technologies
  - Facilitate G2B and B2B partnering to achieve performance goals



## *Wouldn't It Be Nice If UUVs Could...*

*(attack today's littoral coverage problem and tomorrow's advanced threat)*

1. Deploy or Retrieve Devices, Anyplace, Anytime

3. Engage Any Target: Bottom, Volume, Surface or Air

4. Without Risk or Burden to US Forces...Low Cost and Self Sustaining

2. Gather, Transmit, or Act on  
All Types of Information, From  
Anywhere to Anyone

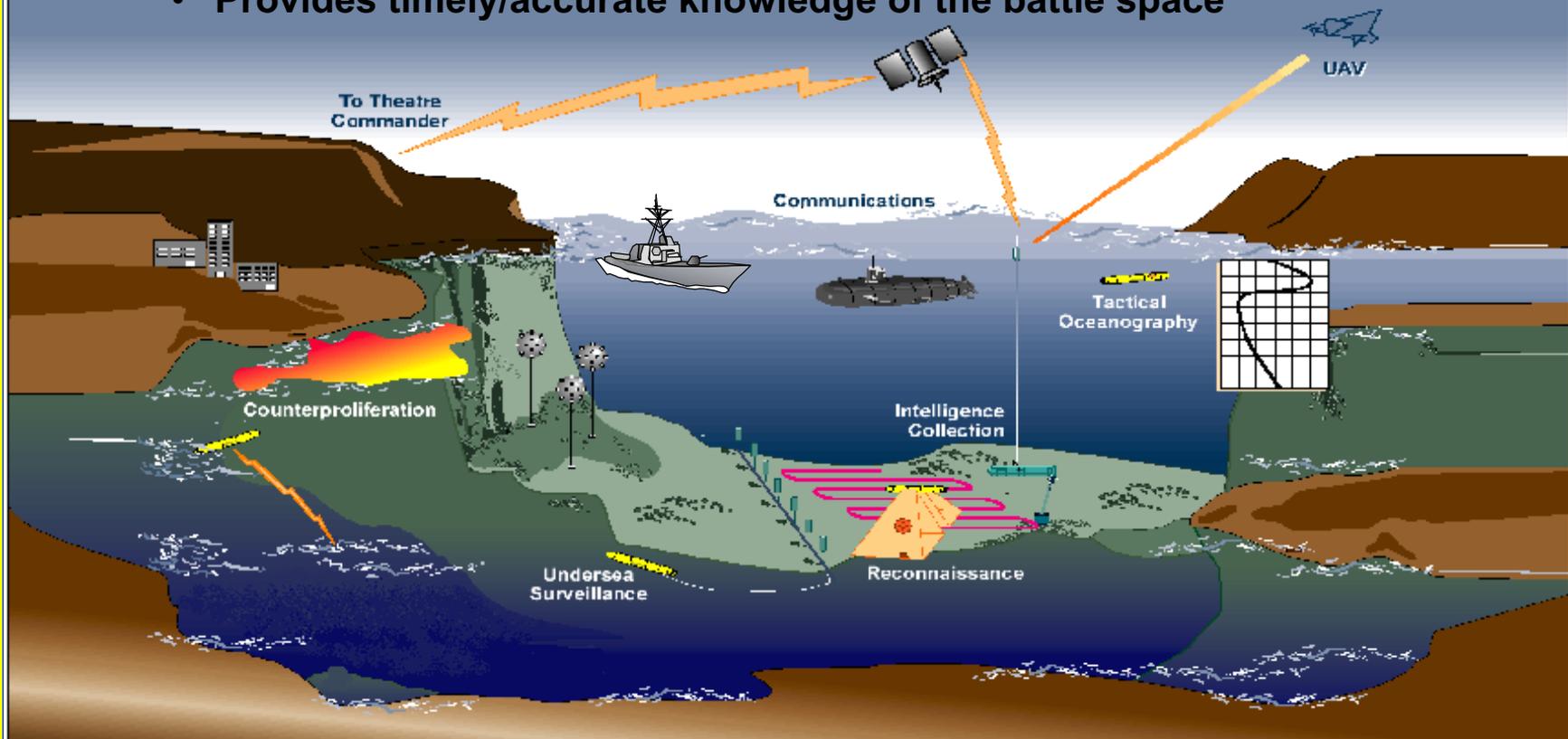
**It can happen, it  
will happen we  
have begun**

- Broad area denial is a real threat given technology trends (GPS, Missiles, Satellites, etc)
  - Both for advanced and not so advanced threats
- Undersea systems (manned and unmanned) may be the only (undenied) force (early)

# UUV Vision

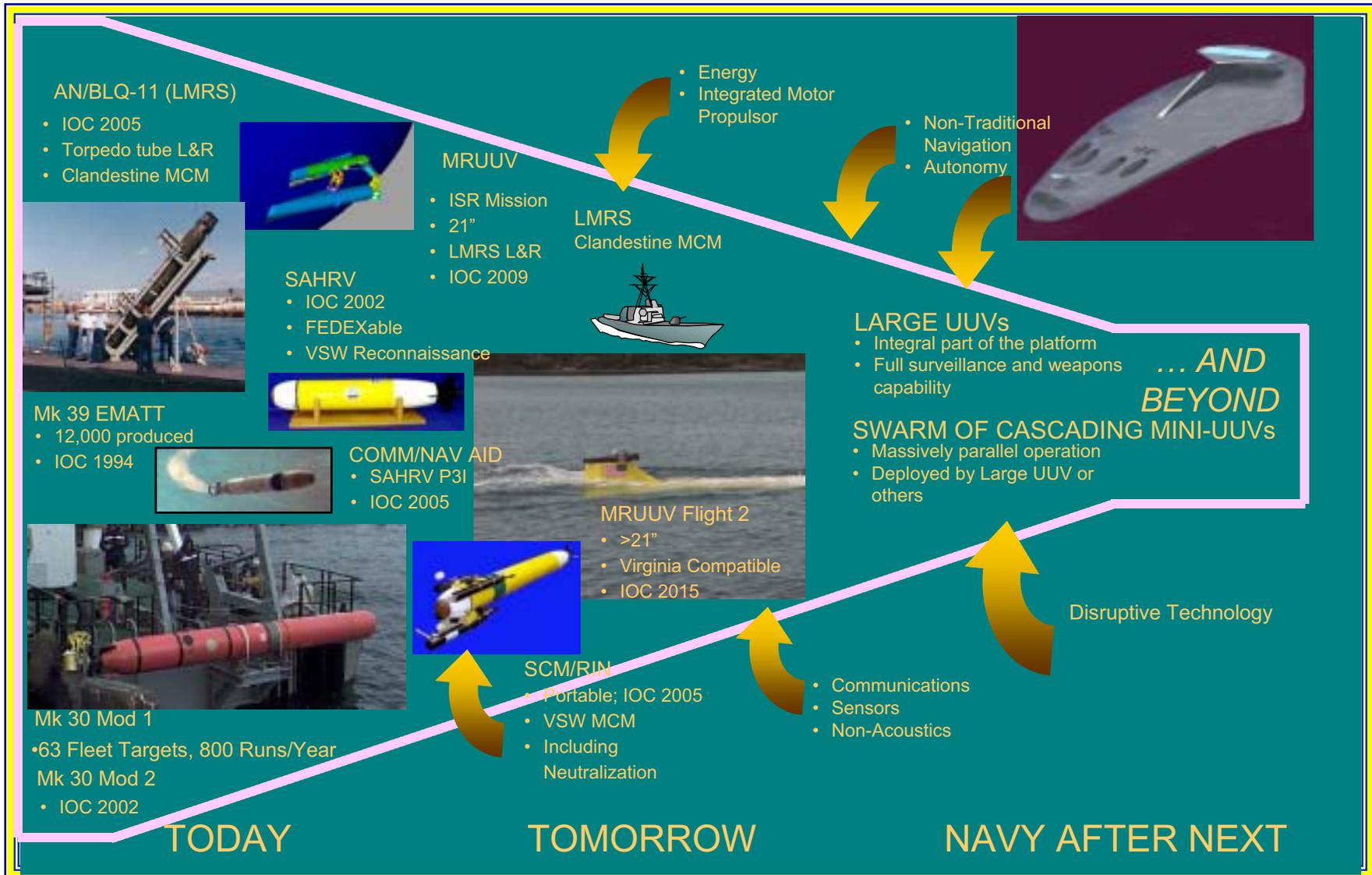
## A cost-effective, clandestine force multiplier

- Extends the Covert sensor range of the submarine
- Allows for presence in high risk or inaccessible areas
- Provides timely/accurate knowledge of the battle space





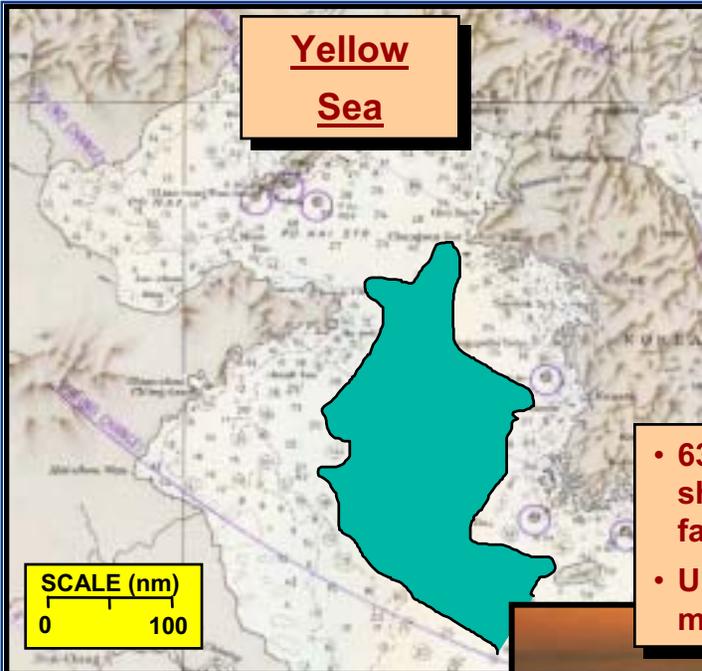
# UUVs: Extend Reach, Eliminate Water Depth Restrictions, Provide Force Multiplication, Reduce Risk





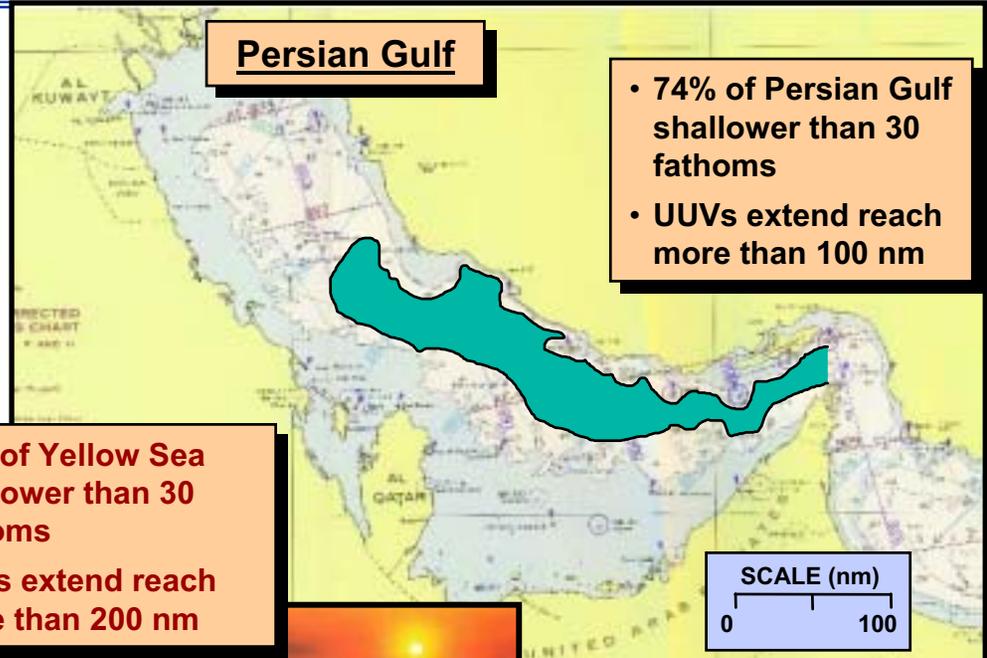
# Clandestine Battlespace Knowledge

## Yellow Sea



- 63% of Yellow Sea shallower than 30 fathoms
- UUVs extend reach more than 200 nm

## Persian Gulf



- 74% of Persian Gulf shallower than 30 fathoms
- UUVs extend reach more than 100 nm

***UUVs Eliminate SSN Water Depth Restriction... Extending Sensor Reach to Denied Areas***



***Submarine UUVs Will Provide A Key MCM, WMD and ISR Capability In The Future***

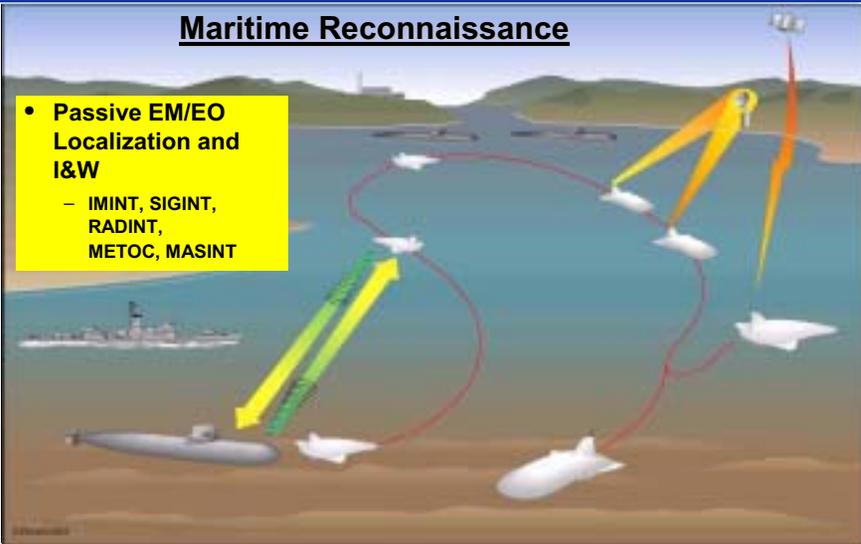


# UUV Master Plan

## Maritime Reconnaissance

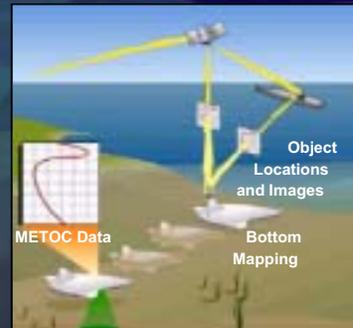
- **Passive EM/EO Localization and I&W**

- IMINT, SIGINT, RADINT, METOC, MASINT



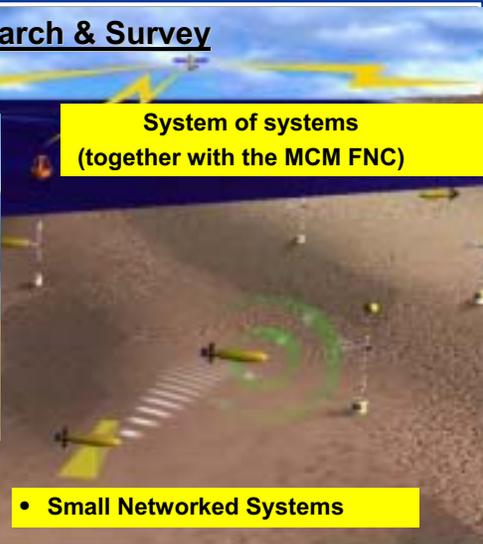
## Undersea Search & Survey

- **System of systems (together with the MCM FNC)**

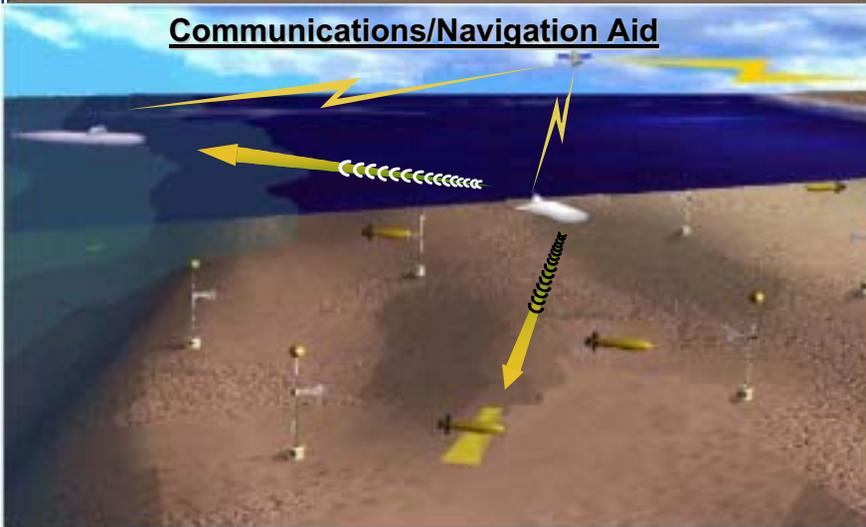


- **Large Long-Range Systems**

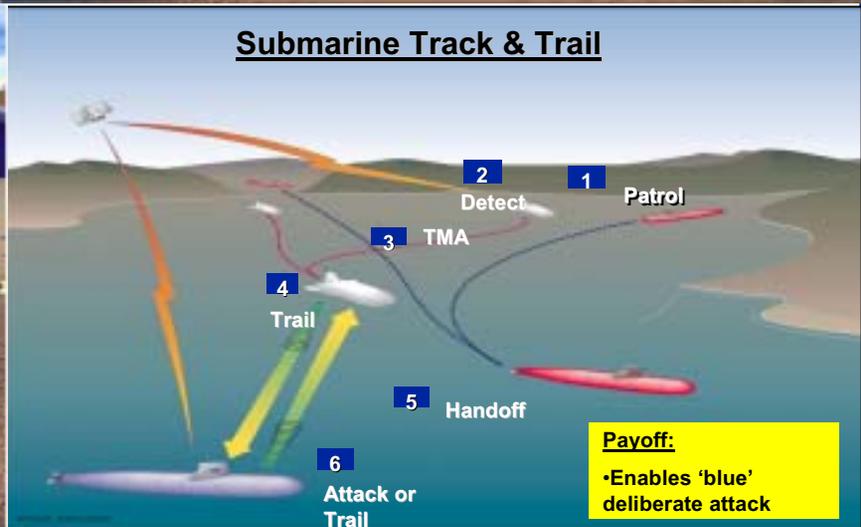
- **Small Networked Systems**



## Communications/Navigation Aid



## Submarine Track & Trail



**Payoff:**  
 •Enables 'blue' deliberate attack



# Near-Term Mine Reconnaissance System (NMRS)

## Requirements / Goals/ Capabilities

- Mission: NMRS provides the theater commander with a limited capability for conducting clandestine minefield reconnaissance from a submarine
- Special features
  - One operational prototype system
  - Semi-autonomous/Tethered UUVs
- Short operational life intended as a stop-gap measure until LMRS (AN/BLQ-11) IOC in FY05

## Technology

- Rapid development, extensive use of COTS / NDI
- Fiber optic micro cable tether

## Schedule

- One operational prototype system provided to the fleet-October 1999



## AN/BLQ-11 (LMRS)

### Torpedo Tube L&R



2 Autonomous UUVs

RF and Acoustic Communications

Single Sortie Reach 75-120 nm

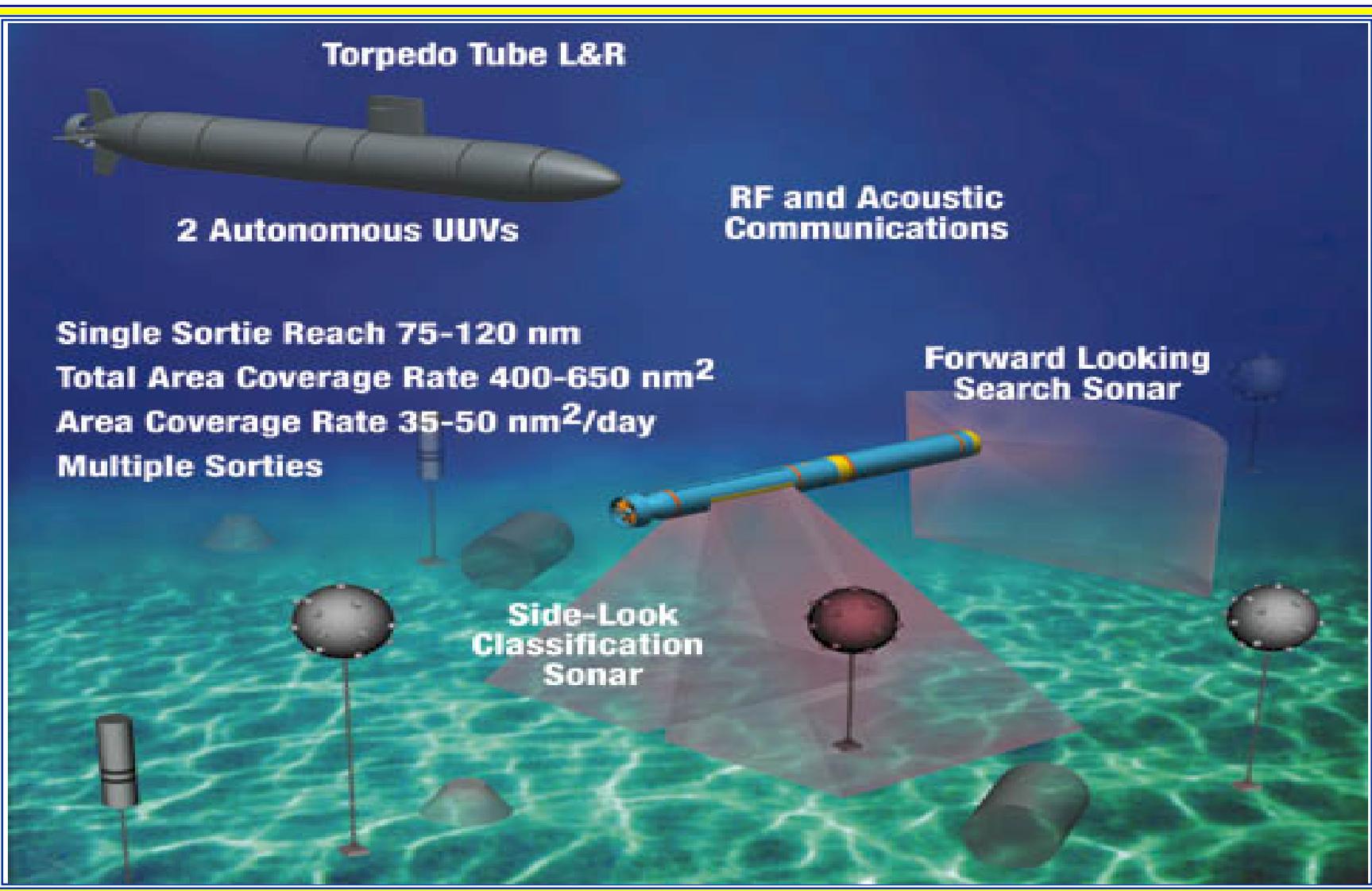
Total Area Coverage Rate 400-650 nm<sup>2</sup>

Area Coverage Rate 35-50 nm<sup>2</sup>/day

Multiple Sorties

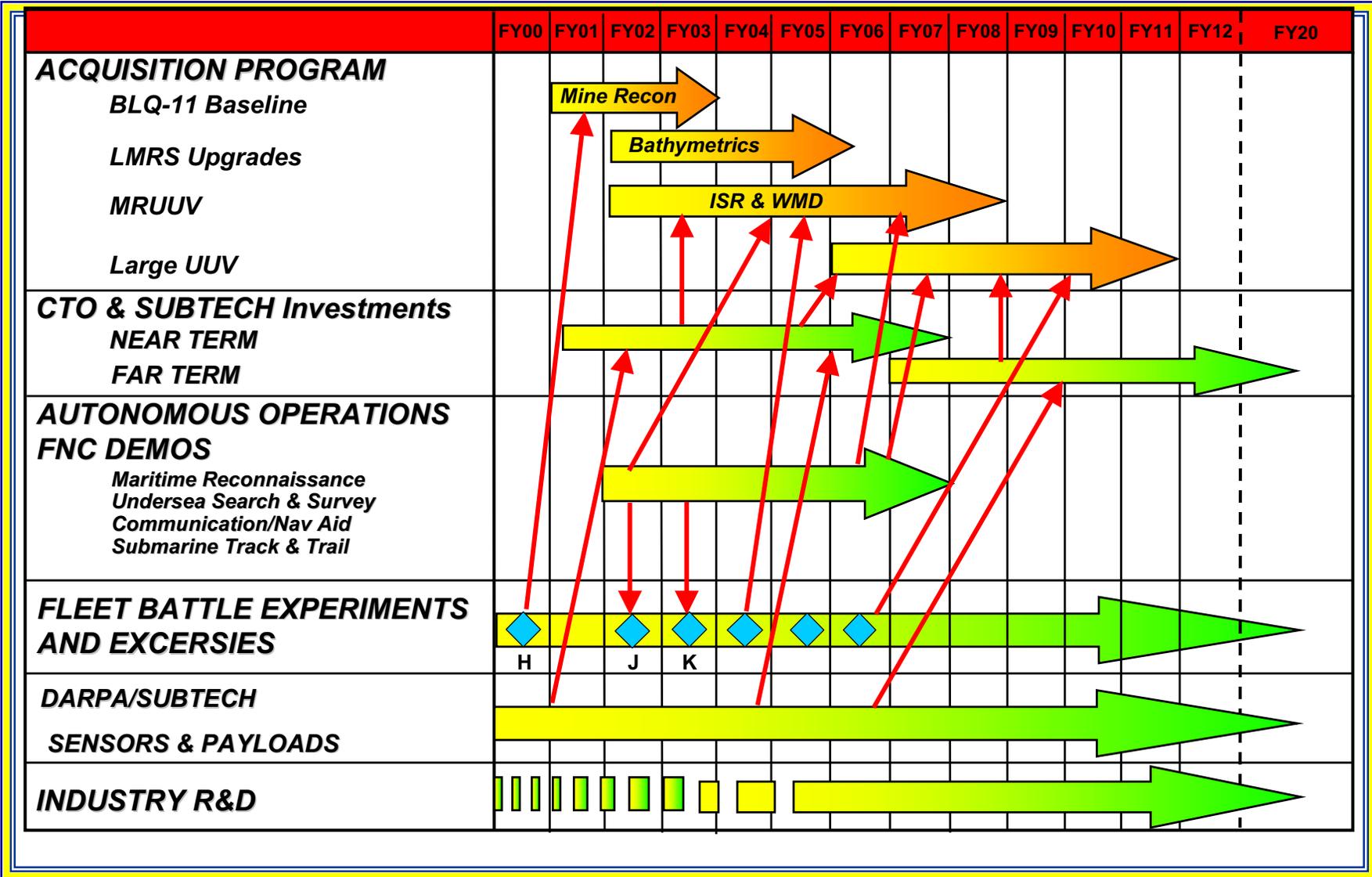
Forward Looking Search Sonar

Side-Look Classification Sonar





# Executing the UUV Master Plan



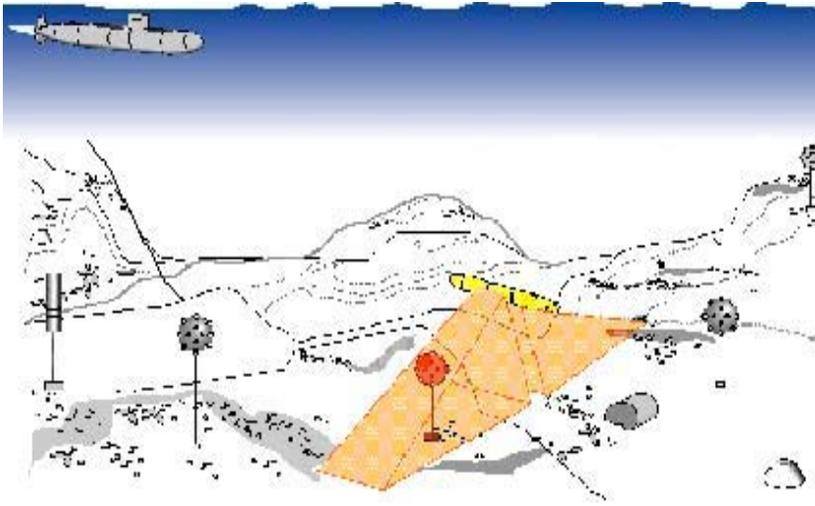


## *Evolutionary Acquisition*

- **Planned Technology Development & Transition**
- **Reduce Cycle Time of Technology to Fleet**
- **SUBTECH maps technology to Capabilities**
- **CTO Investment to Rapidly Insert new technology**
- **LMRS Block Upgrades incorporate demonstrated technologies**
- **War fighter Experiments & Exercises assess technology readiness**
- **Final End State (Realizing the Master plan)**
  - **Mission Reconfigurable UUVs (MRUUV)**
  - **Conformal/Larger Diameter UUVs**



# Synthetic Aperture Sonar (SAS)



## Top Level Schedule

Fiscal Year Quarter	FY01				FY02				FY03				FY04				FY05			
	I	II	III	IV																
System CDR	▼																			
SAS DEMO					▽															
Post Processing and Report					▽															
Fabrication & Integration	▼				▽															
Developmental Engineering (R&D)					▽				→				→				▽			
LMRS/SAS EDM Development Integration									▽				→				▽			
FOT&E																				▽
IOC																				▽

### Major Accomplishments

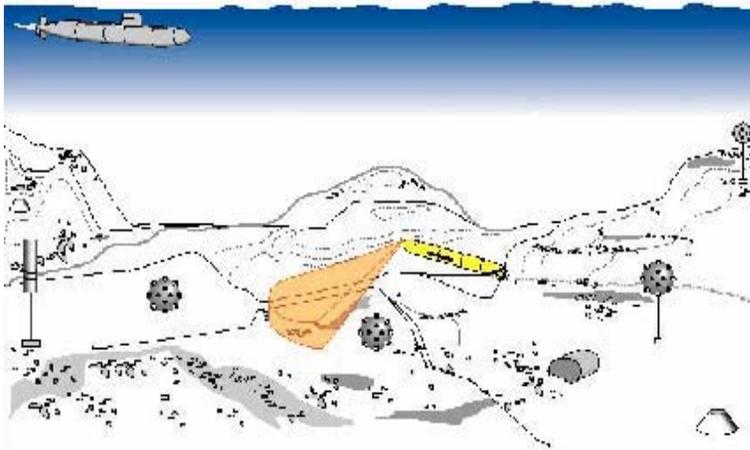
- Obtained ASN/CTO Authorization (Dec 00)
- BAA Posted (Dec 00)
- Completed Source Selection (Feb 01)
- Awarded Tasks and Contract (Mar 01)
- Kickoff Meeting (Mar 01)
- Completed CDR (Jun 01)

### Technical challenges

- Achieve 1" X1" resolution at 500yds
- Minimize Power Consumption
- Rapid Low Cost Vehicle Integration



# L-PUMA



## Top Level Schedule

Fiscal Year Quarter	FY02	FY03	FY04	FY05	FY06	FY07
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
PUMA Engineering(R&D)	▽	—	—	—	—	▽
Prototype Hardware/Software Development		▽	—	—	—	▽
L-PUMA System Integration with UUV				▽	—	▽
EMD Complete						▽
FOT&E						▽
IOC						→

### Technology

- Leverage submarine HF PUMA H/W & S/W development (ARCI Phase IV)
- Provides LMRS Improved Shallow Water Mine Reconnaissance Performance

### Approach

- Develop technology and prototypes for demo and FOT&E
- Negotiate additional funding from CTO to accelerate L-PUMA development and minimize backfit costs

### Requirements / Goals/ Capabilities

- Provide precision bottom mapping capability to LMRS
- Improve FLS capabilities in high clutter environment
- Improve Probability of Detection ( $P_d$ ) and Probability of Correct Dismissal ( $P_{cd}$ )
- Extends Submarine Battlespace Preparation Capability
- Scaling PUMA Technology to 21" UUV



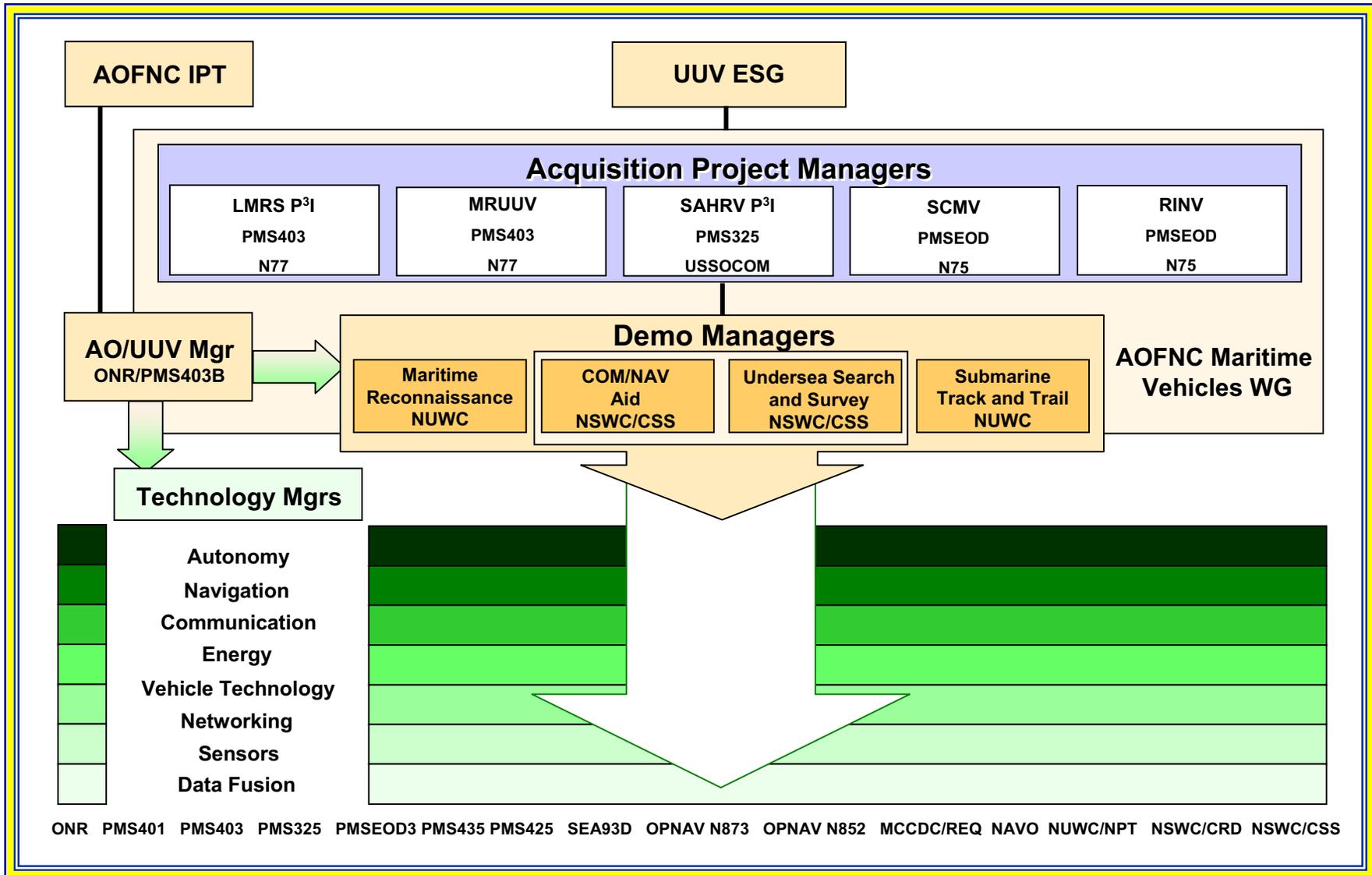
# SUBTECH Strategic Concept Task Mapping

## Strategic Concept IPT Task Mapping

Gain & Sustain Battleforce Access	Develop & Share Knowledge	Power Projection	Deter & Counter WMD
Mine Recon	Clandestine ISRT	SOF Ops	Strategic Deterrence
Littoral ASUW	Environmental Knowledge/ Awareness	Attack Hard Targets	Counter Proliferation Support
Theater ASW	Info Ops	Time Critical Targets	Theater Ballistic Missile Defense
Forward Presence	Tactical Recon & Targeting	Suppression of Coastal Defenses	Interdiction Ops
Extended Mobility Ops	Combat Situational Awareness	Attack Against Nodal Targets	
Covert Neutralization of Mines	Theater Network Reconstitution		
Artic Ops	Engagement		



# AOFNC Execution Management Structure





# Risk vs. Technology vs. Capability

	Maritime Reconnaissance		Undersea Search & Survey								Navigation/ Communication Aid			Submarine Track and Trail				
			Object Sensing & Intervention					Oceanography										
	Pass.	Active	Detect (SLS)	Class (SAS)	ID	Neut	Interv.	Bottom Char	Bathy	Volume Meas.	Comm.	Nav.	Data Ex.	Detect	Class	TMA	Trail	Hand-off
Communications	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Yellow
Navigation	Green	Green	Y-G	Y-G	Y-G	Y-G	Green	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green
Energy	Y-G	Y-G	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Red	Green
Propulsion	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Green
Mission Equip.	Green	Green	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Sensors	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Yellow	Green
Data Processing	Green	Green	Green	Yellow	Yellow	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Autonomy	Yellow	Yellow	Green	Green	Yellow	Green	Red	Green	Green	Green	Green	Green	Yellow	Yellow	Red	Yellow	Red	Yellow

- **Definitions:**

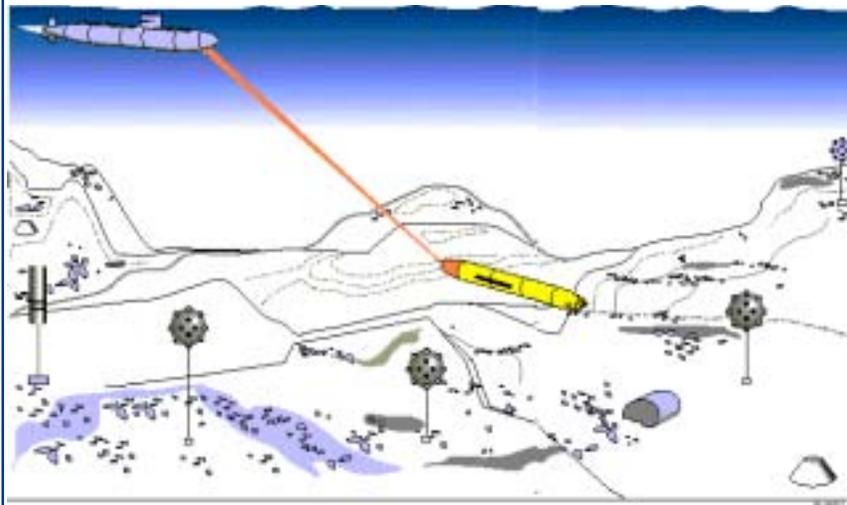
- **Mission Equipment:** Specific HW items associated with the Mission, not on-board sensors, but includes deployed equipment
- **Sensors:** UUV Installed Sensors Specific to accomplish the mission function
- **Data Processing:** Data processing and management specific to the mission requirements
- **Autonomy:** Software / artificial intelligence and decision making associated with performing the mission without human guidance

- **Ratings:**

- **Green:** Ready for 2002 or sooner
- **Yellow:** Technology Development Needed, could be ready in 2007 or sooner
- **Red:** Technology Development Needed, potentially ready in 2012



# UUV ACOMMS



## Requirements / Goals/ Capabilities

- Establish secure bi-directional acoustic link with no impact on platform signature
- Download mission data and re-program vehicle tasking
- Improve data rates and reliability

## Technology

- Leverage ONR S&T efforts
  - Shallow water MCM
- Leverage DARPA S&T efforts
- Leverage Industry IRAD

## Schedule

FY 99-01	ACOMMS ATD
FY 02	UUV Design
FY 04	Integrate with LMRS SAS EDM

# MRUUV

- **Concept**
- **Tasks and Capabilities**
- **Industry Opportunities**



## *MRUUV Acquisition Concept*

- **Spiral (evolutionary) development of LMRS (BLQ-11X)**
- **Reconfigurable payloads**
  - Developed separate from vehicles and support systems
  - Leverage ONI and AO FNC investments
- **Modified LMRS vehicle and support systems**
  - All payloads meet vehicle interface control drawing specs
- **Anticipated missions**
  - Clandestine ISRT
  - WMD
  - Covert Mine Neutralization
- **Joint N77/N2 requirements document**
- **Cooperative ISRT sensor development (PMS403/PMS435/ONI)**
- **Analysis of Alternatives funded in PB02**
  - JHU/APL Contested Area Study
  - Industry Day on 23 August



# *“Reconfigurable” Why ?? .. And What is it ??...*

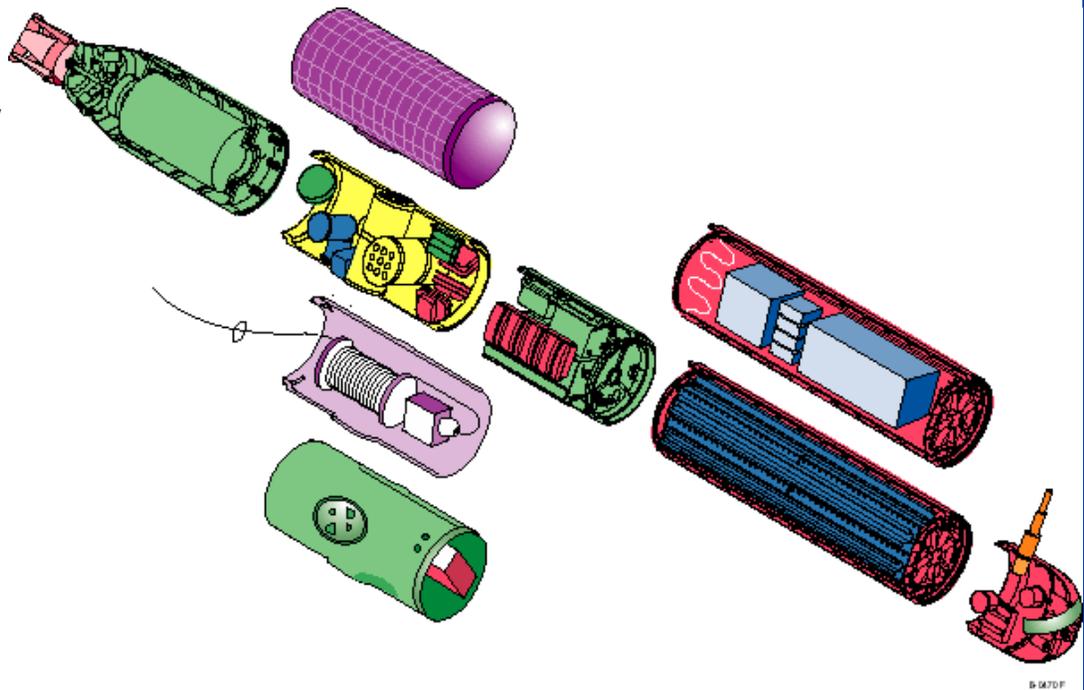
- **Why Reconfigurable ??**
  - **Number of SSN Weapon Room Stows are too few to carry separate dedicated 21” UUVs to support multiple missions**
    - But specific mission payloads may be swapped out...
  - **Many UUV subsystems can be common across multiple missions**
    - Energy & Propulsion, Vehicle Control, Ballast & Trim
    - Navigation & Obstacle Avoidance, Communications
- **What is Reconfigurable ??**
  - **Tactical Reconfigurability: Reconfigure Payload on-board the Platform**
    - Make the UUV the “Truck” to deliver specific payload packages
    - Provide Common Interfaces for payloads (ONI Classified Payloads, Tactical Payloads, etc)
    - Other Payloads to meet mission requirements (TBD)

## ***And/Or ....***

- **Shore Activity Reconfigurability: Reconfigure for missions @ Shore Facility**
  - Configure for specific mission(s)
  - Large UUV may have multiple payloads

# Commonality

- **Commonality and reconfigurability enable cost effective performance of UUV missions**
  - Intelligence Collection
  - Surveillance
  - WMD
  - Tactical Oceanography
- **Leverages significant Industry/Lab IRAD and anticipated or past ONR/DARPA investment**
- **21” and larger (Shape/size TBD)**





## How Big Do We Make MRUUV ???

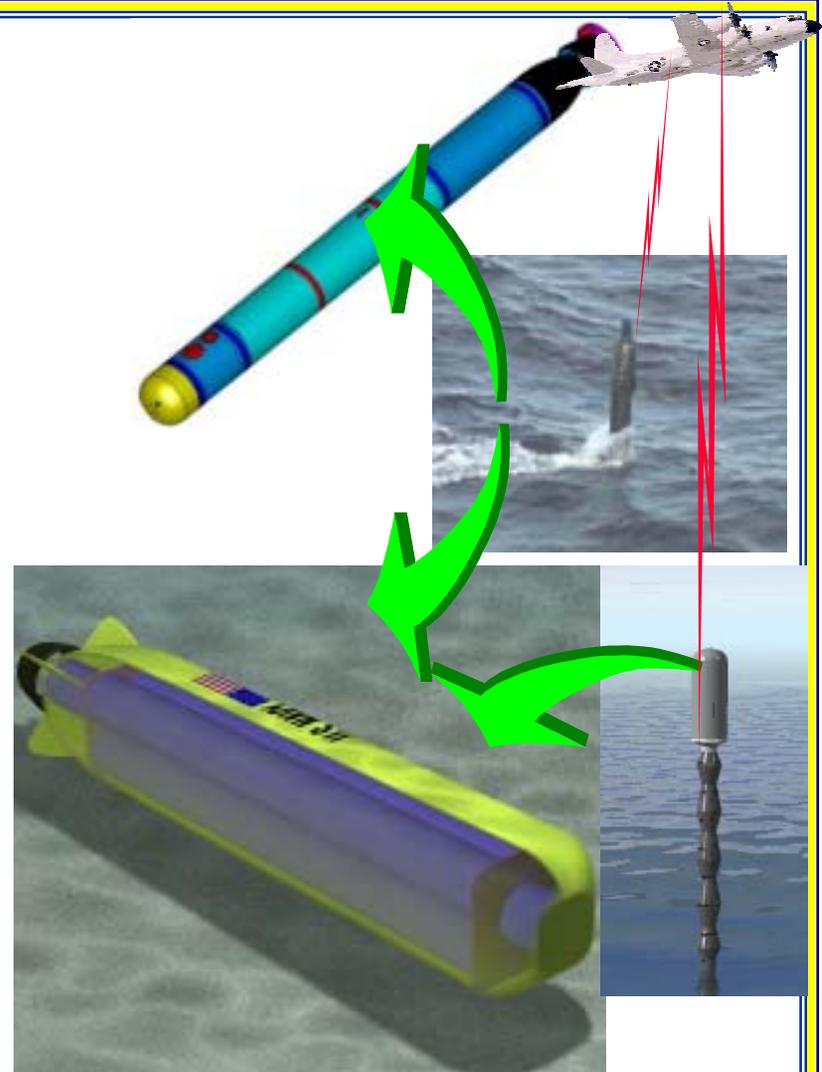
- **Plan for Two Sizes:**

- **21" Diameter, ~2800 lb displacement in Near Term (Flight 1)**

- Initial ISR UUV Capability for the Fleet (incl counter-WMD)
    - Utilize existing SSN and AN/BLQ-11 Infrastructure
    - Primary Transition target for AO FNC Maritime Reconnaissance Demo

- **Large UUV... 5,000 to 20,000+ lb displacement in outyears (Flight 2)**

- SSN and Surface Ship Operations
    - VA Class Bundle 2 and SSGN
    - Provide Robust ISR Capability
    - Provide Submarine Track & Trail / ASW Capability
    - Provide METOC and Tactical Scene Description
    - Deploy smaller UUVs or fixed sensors



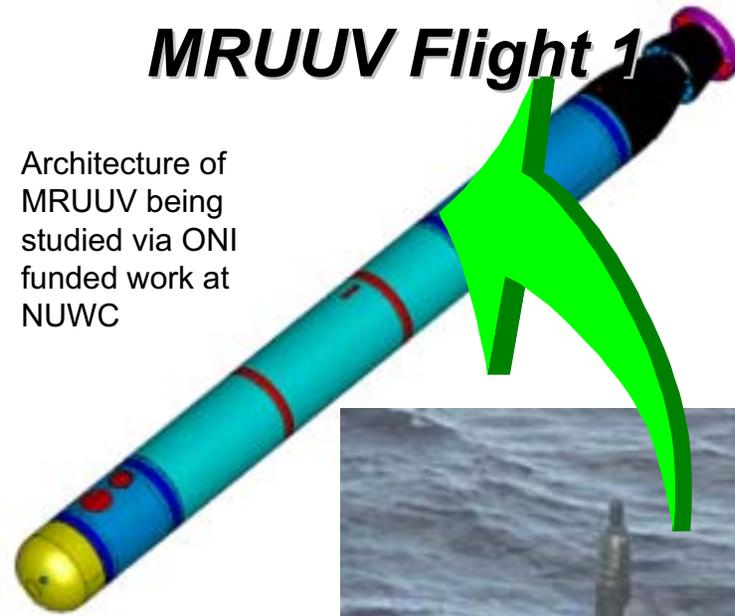


# Mission Reconfigurable UUV (MRUUV)

- **MNS: UUV Master Plan.** Draft ORD to be generated with Analysis of Alternatives
- **IOC: ~ 2007; Funding: POM-02, ~\$70M RDTE**
- **Stakeholders: PMS403, PEO(MUW), N773 (Resource), ONI (Mission), NUWC (TDA)**
- **Description: Torpedo tube launched and recovered UUV System.** Capable of extended autonomous operations, as well as ACOMMS, RF FLTSATCOM, and LOS High Data Rate RF updates (to UAV/Aircraft).
- **TEMPALT System.**
  - Everything (UUVs, Spare Energy, Displays, L&R Gear) is in the Torpedo Room.
  - Integrated into SSN/SSGN CCS
- **Warfighting Capabilities:** 1) ISR & WMD. Submarine reach is extended to water depths as shallow as 20 feet (100+ nm). Platform risk during collection is reduced. Force multiplication provided. Compatible with SSN 688 and Virginia. 2) Other capability as defined.
- **CONOPS:** To be developed by DEVRON 5 and ONI. Master Plan concept includes autonomous launch and transit to collection area, autonomous repositioning in collection area to get better data and avoid threats. Ability to re-task via long range communications will exist.
- **Metrics: Sensor parameters classified. Rough performance metrics:**
  - Vehicle Sortie Reach (VSR) of 50-75 nm
  - Time on Station of 50-100 hours
  - Payload capabilities consistent with 100 lb. payload, 10 lb. maximum of which is on a 30" mast.

## MRUUV Flight 1

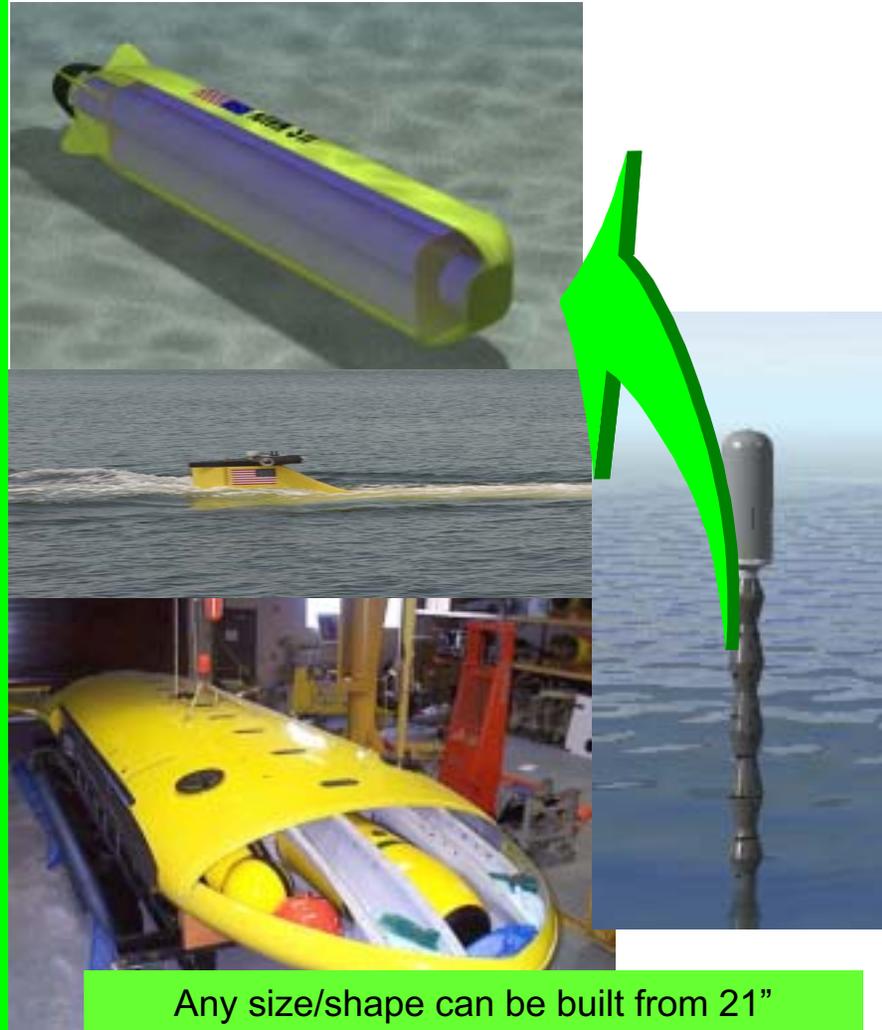
Architecture of MRUUV being studied via ONI funded work at NUWC





## MRUUV Flight 2: ISR

- **MNS: UUV Master Plan.** Draft ORD to be generated with Analysis of Alternatives
- **IOC: < 2014; Funding: Planned start FY08, ~\$200M RDTE**
- **Stakeholders: PMS403, PEO(MUW), N773 (Resource), ONI (Mission), NUWC (TDA)**
- **Description: Conformal or D5 tube launched and recovered UUV System.** Capable of extended autonomous operations, as well as ACOMMS, RF FLTSATCOM, and LOS High Data Rate RF updates (to UAV/Aircraft).
- **Warfighting Multi-mission capability: ISR, WMD, Covert Mine Neutralization, ASW**
- **CONOPS: To be developed by DEVRON 5 and ONI.** Master Plan concept includes autonomous launch and transit to collection area, autonomous repositioning in collection area to get better data and avoid threats. Ability to re-task via long range communications will exist.
- **Metrics: Sensor parameters classified.** The large vehicle will provide the same collection capability as the SSN.  
**Rough performance metrics:**
  - Vehicle Sortie Reach (VSR) of 100-150 nm
  - Time on Station of 200+ hours
  - Payload capabilities consistent with a submarine sized mast.



Any size/shape can be built from 21" modules. MTV is just one example.

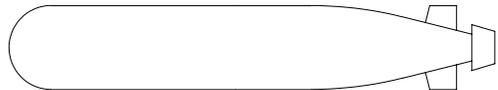


# Both Large and Small UUVs Can be Cost Effectively Produced Using Small Low Cost Modules

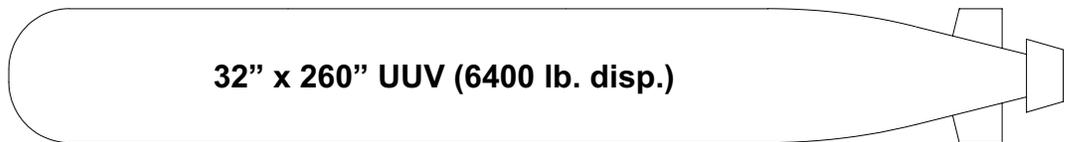
## Modules and Modular UUVs

 9" x 55" UUV (100 lb. disp.)

 9" x 97" UUV (200 lb. displ.)

 21"x120" UUV (1250 lb. disp.)

 21" x 240" UUV (2800 lb. disp.)

 32" x 260" UUV (6400 lb. disp.)

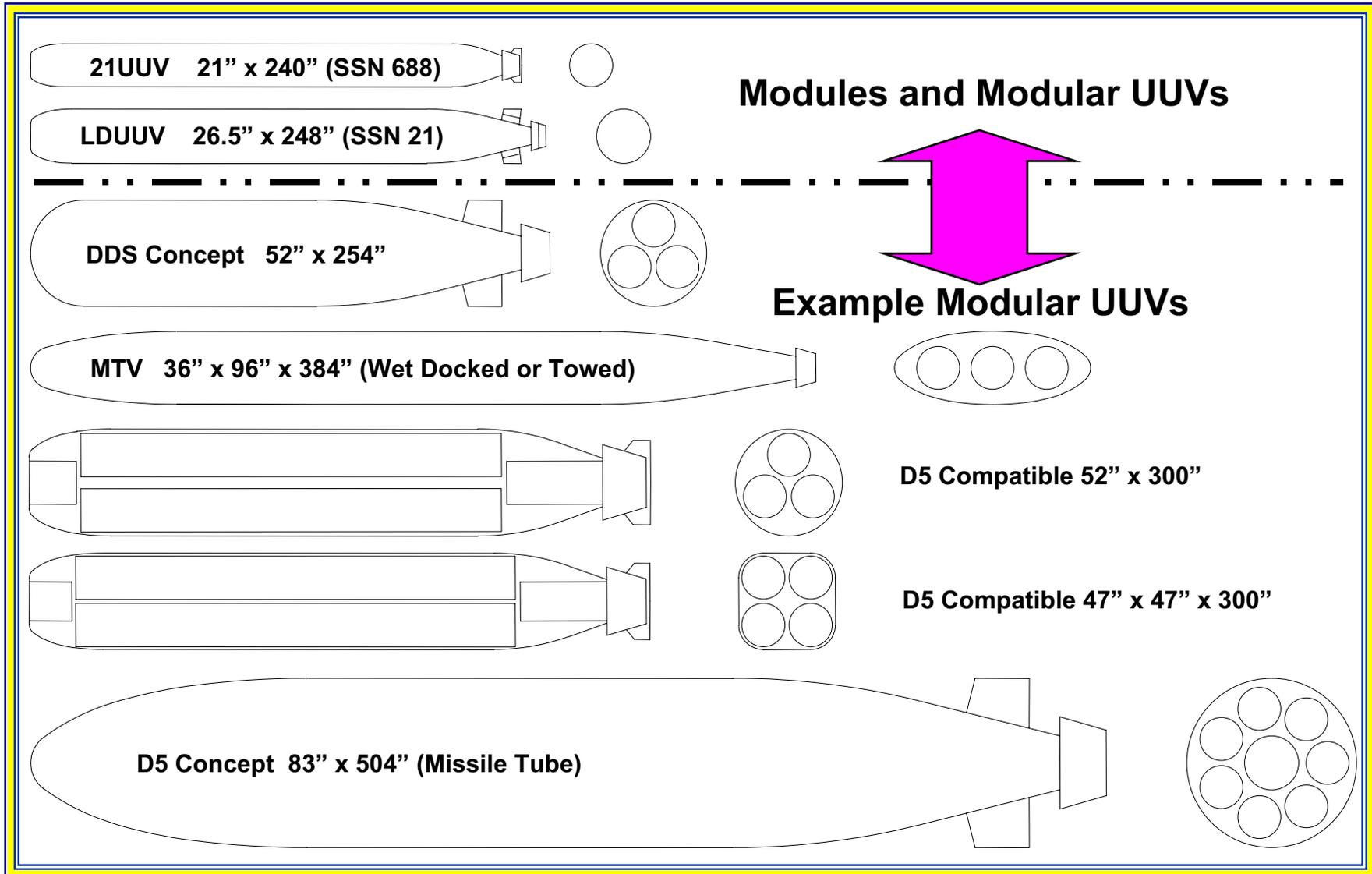
 32" x 360" UUV (9400 lb. disp.)

## Example Modular UUVs

*Large UUVs are not necessarily built from large modules...  
Component performance / cost trades will drive module selection*

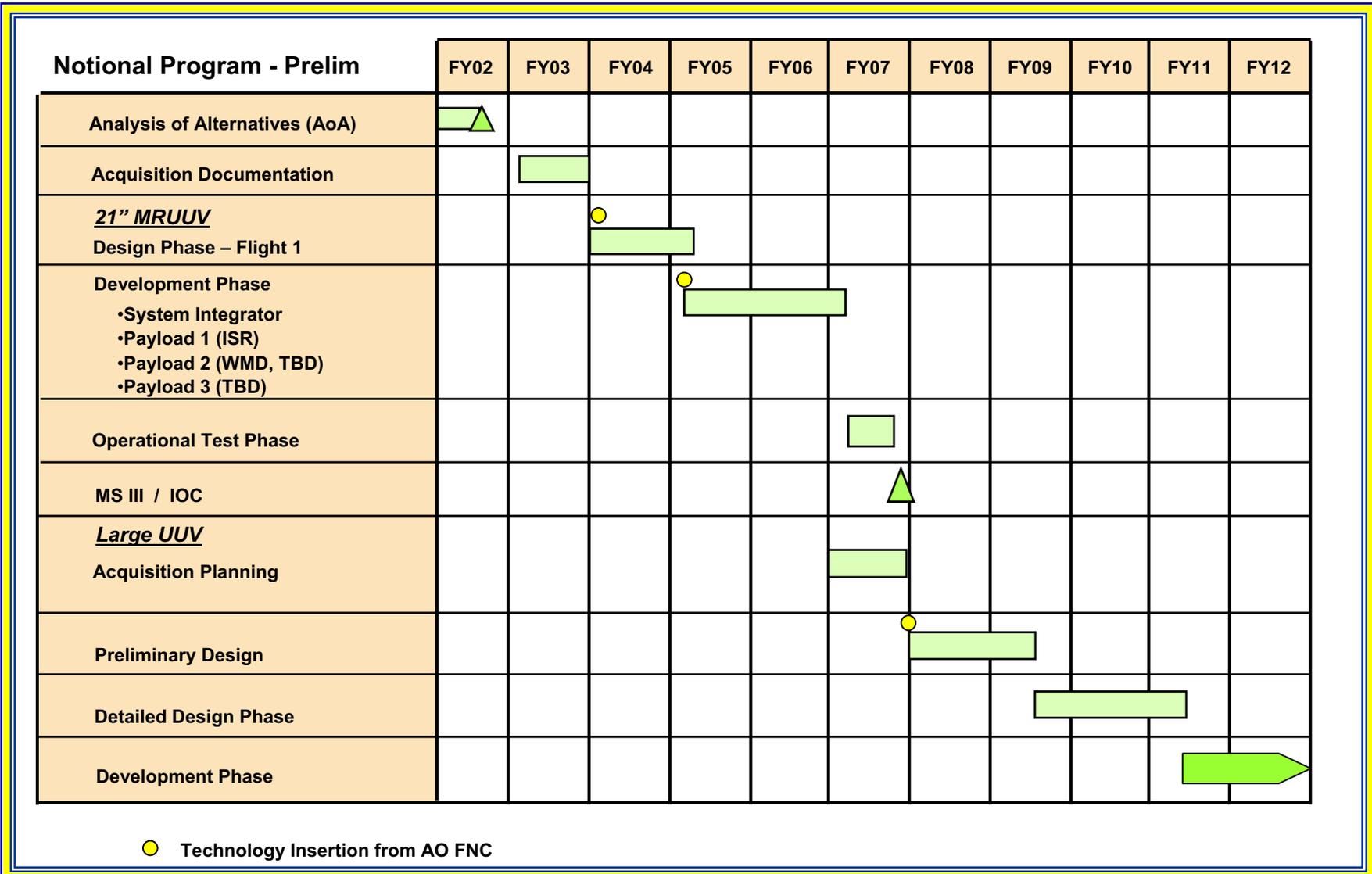


# Larger High Performance Modules Can Also Be Used to Yield Cost Effective, High Performance Systems





# When ??? - Notional MRUUV Schedule





Boeing

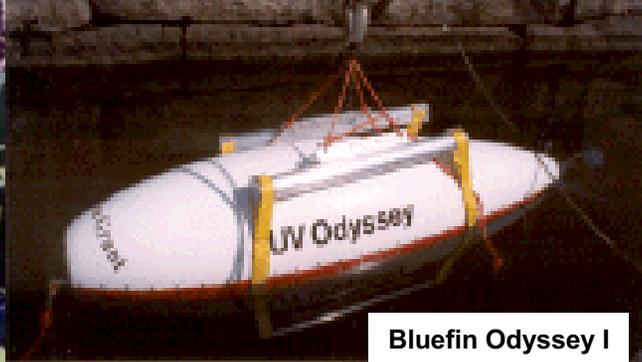


Kongsberg-Simrad

# Commercial UUVs



Maridan



Bluefin Odyssey I



Bluefin Seasquirt



## *Dual Use for UUV's Outside DOD*

- **Commercial activity ensures a US expertise in AUVs that is current and cost effective**
  - Government will not bear the sole responsibility of maintaining the industrial base
- **Government can benefit from more frequent technology refresh of commercial market place**
  - Upgrades in electronics, battery chemistries and sensors can be ported to government applications at reduced cost
  - Government can benefit from reduced development and life cycle cost, COTS AUV technology
- **Increase in AUV utilization will result in faster discovery of software defects**



## *The Challenge*

- **Government and Industry play as ONE TEAM**
- **Industry Competitors Work Together in a non hostile environment**
- **S & T efforts link to and transition to Navy needs**
- **Co-operative behavior between ALL Navy UUV Efforts**