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America's Navy, A Global Force For Good

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Bringing Interoperability to Warfighters

Intelligent Unmanned Systems: Air, Land, and Sea

30 OCT 2012

Captain Joe Beel

Commanding Officer

SPAWAR Systems Center Pacific

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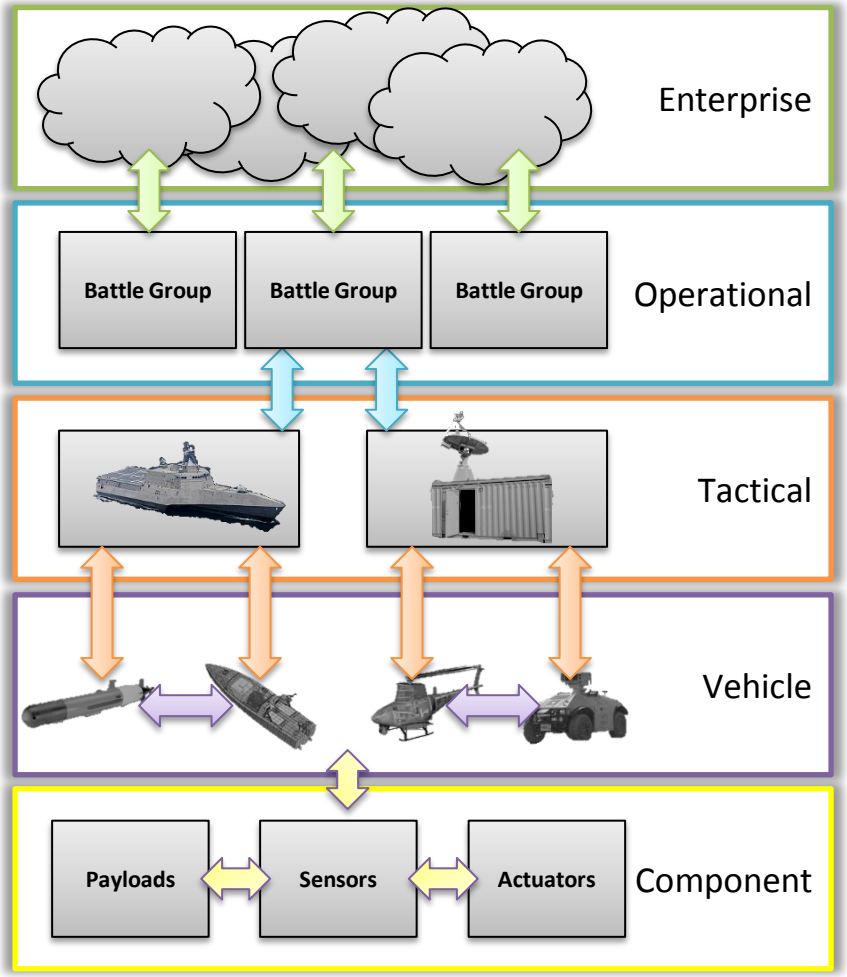
The Full Spectrum of Interoperability

- **Enterprise Level** – Global data repository and interchange
- **Operational Level** – Coordination within area of responsibility (AOR)
- **Tactical Level** – Operator control of single- and cross-domain missions
- **Vehicle Level** – Interactive unmanned-vehicle collaboration
- **Component Level** – Modular design for rapid vehicle/payload adaptation to evolving threats



Why Interoperability is Important

- **Key enabler for Maritime Forces**
  - Meet requirements across all geographic AORs
  - Rapidly build up combat power as situations change
  - Meet escalating technology threats
  - Support evolving Homeland Defense missions
- Links current and future systems
- Links manned and unmanned systems

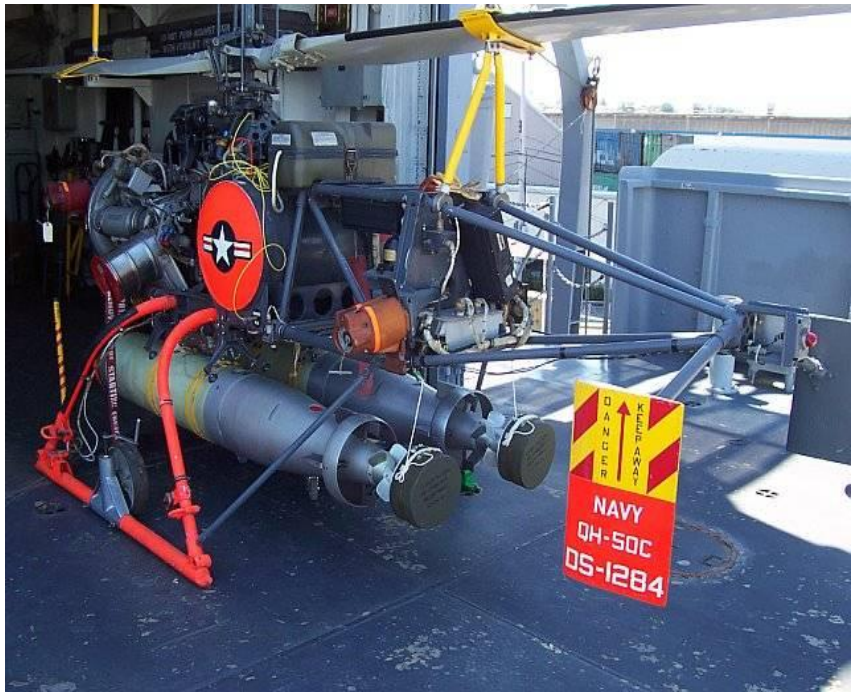
Ultimate objective: *ensure UxSs have ability to mutually interact, obtain C2 from any service or coalition partner, upload relevant intelligence to the appropriate users in a timely fashion*

Where we were with UAVs… 60 years ago

QH-50 Drone Anti-Submarine Helicopter (DASH)

- Mid-1950s response to rapidly expanding Soviet submarine threat
- Gyrodyne *QH-50* deployed on destroyers in 1962 - 1969
- Could deliver *MK-17* nuclear depth charge or *MK-44* torpedoes

- ASW mission turned over to manned *UH-2 Seasprite* helicopters under *Light Airborne Multi-Purpose System (LAMPS)* program in 1970



QH-50C onboard *USS Joseph P. Kennedy (DD-850)*

Multi-Domain UxV Operations… 76 years ago

- 1946 - **Operation Crossroads**
  multiple UAVs and USVs assessed effects of atomic blasts at Bikini Atoll
- 1948 - **Operation Sandstone**
  Army tanks collected soil samples radio controlled from Navy helicopters

Post-mission decontamination of Navy *Apex* drone boats

Navy *F6F-3K* drones prepare to embark upon *USS Shangri-La (CV-38)*

Army *B-17G* drone overflies control station

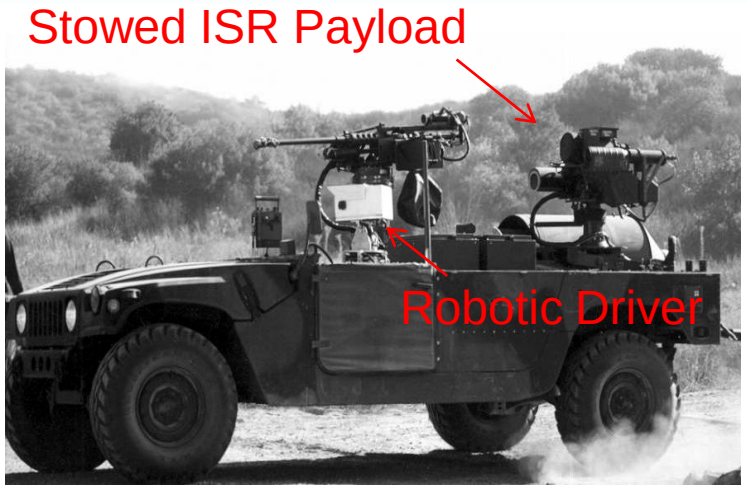
Army drone tank collects soil samples

Towards Interoperability

GATERS Teleoperated Vehicle (TOV) Demo 1989

- SPAWAR *Unmanned Systems Branch* demonstrated pair of teleoperated *HMMWV* UGVs
- One provided ISR and laser designation, other launched *Hellfire* missiles
- Driver consoles collocated in same control van
- More coordinated target acquisition/engagement

- … not true interoperability



Teleoperated *HMMWV*

VTOL UAV

Control console

Foundation of Interoperability

Mobile Detection Assessment Response System (MDARS)

- 1990s - SPAWAR developed *Multiple Robot Host Architecture (MRHA)* command-and-control (C2) architecture robotic-security
  - C2 architecture to oversee multiple UGVs
  - Government-owned C2 architecture
  - Control of UGVs of different types (indoor and outdoor)
  - Modular, distributed, scalable
- The genesis of things to come…

MDARS Exterior robot

MDARS Interior robot

Expanded Interoperability

Multi-robot Operator Control Unit (MOCU)

- 2001, SPAWAR delivered controller level interoperability to USVs in tactical environments
- More modular, scalable, and flexible user interface
- Accommodates a wide range of vehicles and sensors in varying mission domains
- Easily extendable for new sensors, payloads and next-generation vehicles

Navy EOD robot *MOCU* display

Unmanned surface vehicle *MOCU* display

Interoperability across UxV domains

2005 Interoperability Demo

- Interoperability across UGV/USV/UAS/UUV
- Simulated littoral security breach
- *MRHA* dispatched *MDARS* security robots to intercept intruders
- *MOCU* controlled man-portable UGV, UAV, USV and UUV

Intruders detected by unattended sensors

UAV provided overwatch

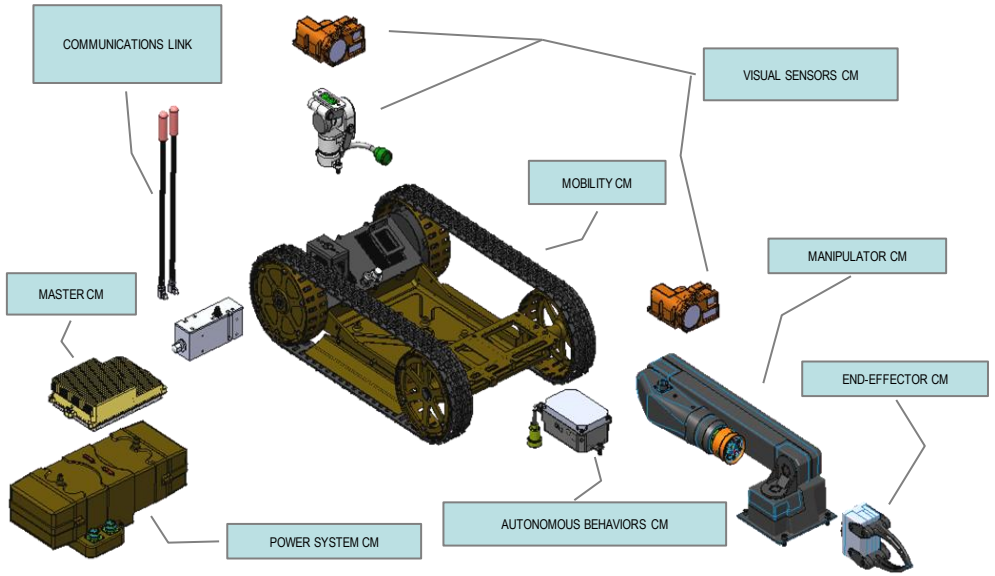
USV blocked escape route

CETUS UUV

Component Interoperability
Autonomous Capabilities Suite (ACS) (2007)

- Component architecture parallel to *MOCU* command and control architecture
- Provides interoperability at the device, behavior, and communication levels
- Both ACS and MOCU used on Navy PoR providing Joint-Force EOD capability for UXO, C-IED and WMD missions
- Onboard vehicle intelligence/autonomy:
  - Improves effectiveness
  - Facilitates interoperability
  - Reduces control burden
  - Reduces communication bandwidth requirements

Increment 1 pre-Production Representative Model (pPRM)

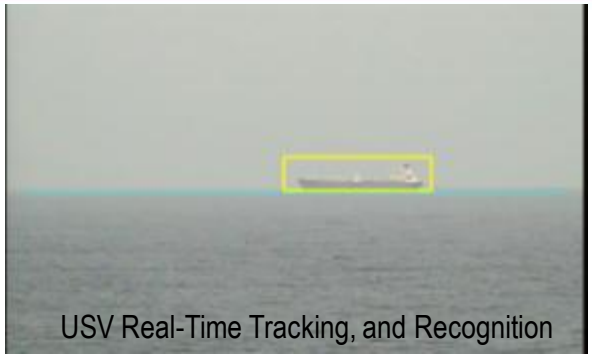


(CM = Capability Module)

Vehicle Interoperability

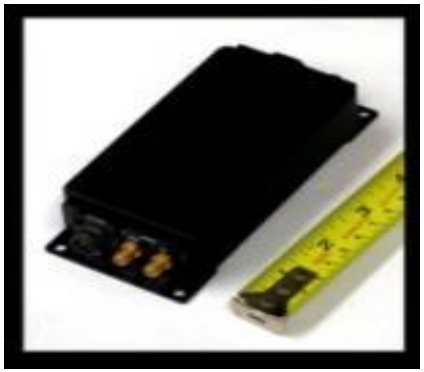
Automated Image Processing for UxSs

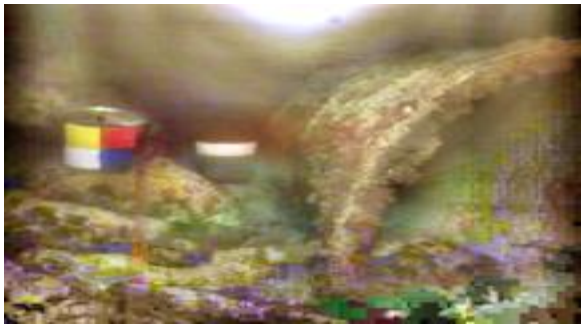
UAV Real-Time Tracking, and Recognition



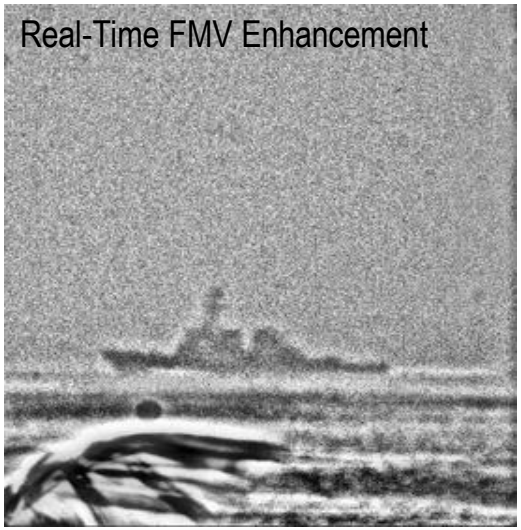
USV Real-Time Tracking, and Recognition

Real-Time Enhancement Algorithm
Hardware Implementation





UUV Detection and Recognition
(Mine Test Range)



It's time to put advanced processing on the UxS platforms

Vehicle Interoperability

Joint Collaborative Technology Experiment (JCTE) 2009

- *MOCU* controlled collaborative behaviors in multiple domains
- Autonomous launch, recovery, refuel, and re-launch of a UAV from an unmanned *HMMWV*
  - Direct vehicle-vehicle versus operator-operator collaboration
  - Direct communication between unmanned systems reduces operator workload while promoting interoperability

Surrogate helicopter UAV and HMWWV UGV

iSTAR ducted-fan UAS and *MDARS Exterior* vehicle

Vehicle Interoperability

Mk18 Swordfish/Kingfish

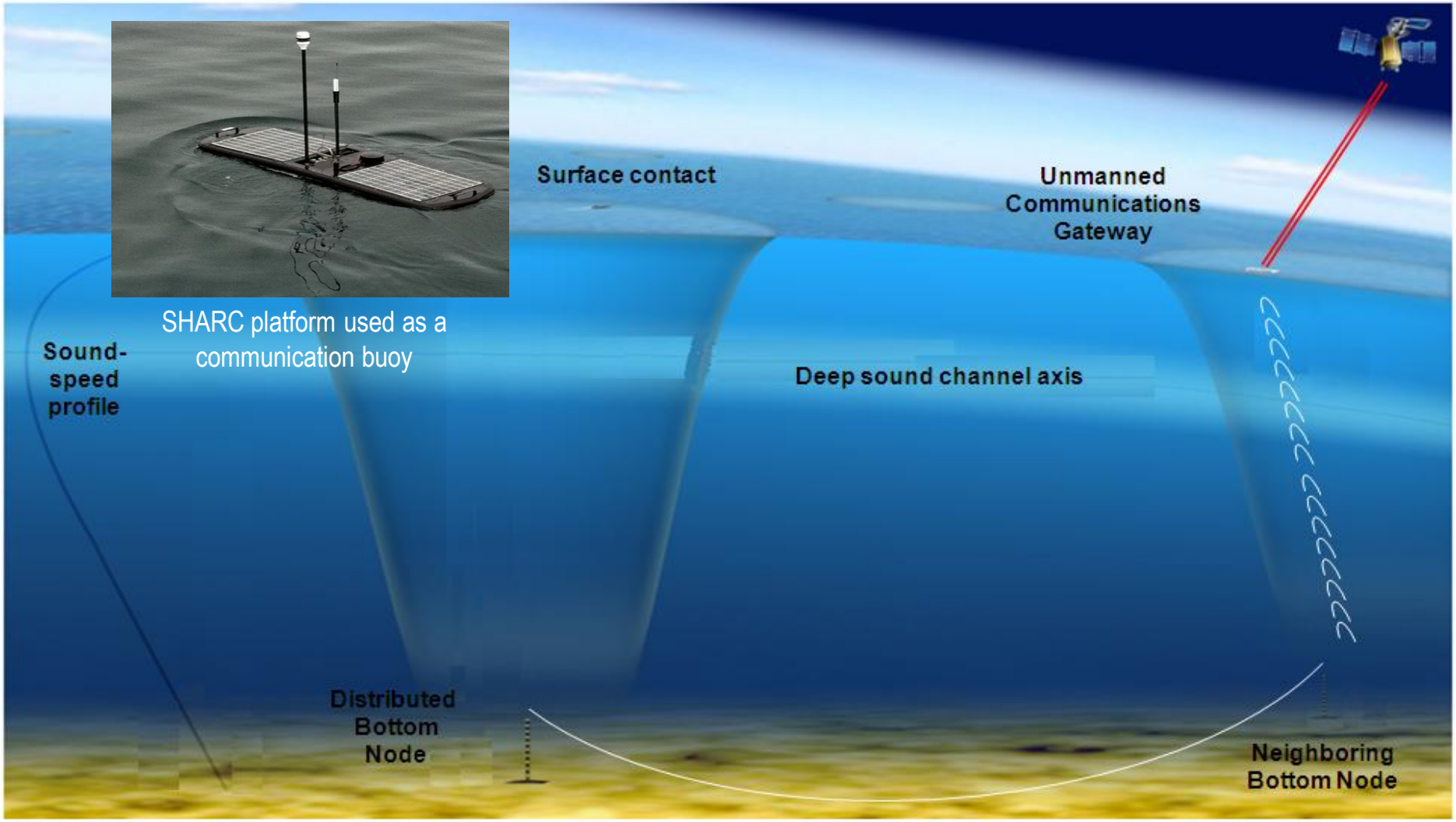
- Search, identify and classify mines
- Mature, faster, more effective and efficient search capability
- Saves lives, time, and money

"We've demonstrated the ability to employ more modern unmanned systems, including autonomous underwater vehicles deployed from the ships to hunt for and detect mines and some advanced capabilities."

Vice Admiral John W. Miller, Commander, U S Naval Forces Central Command, United States Fifth Fleet, Combined Maritime Forces following 30-nation International Mine Countermeasures Exercise, SEP 2012

Vehicle Interoperability

Unmanned Sensor/Vehicle Communication Networks

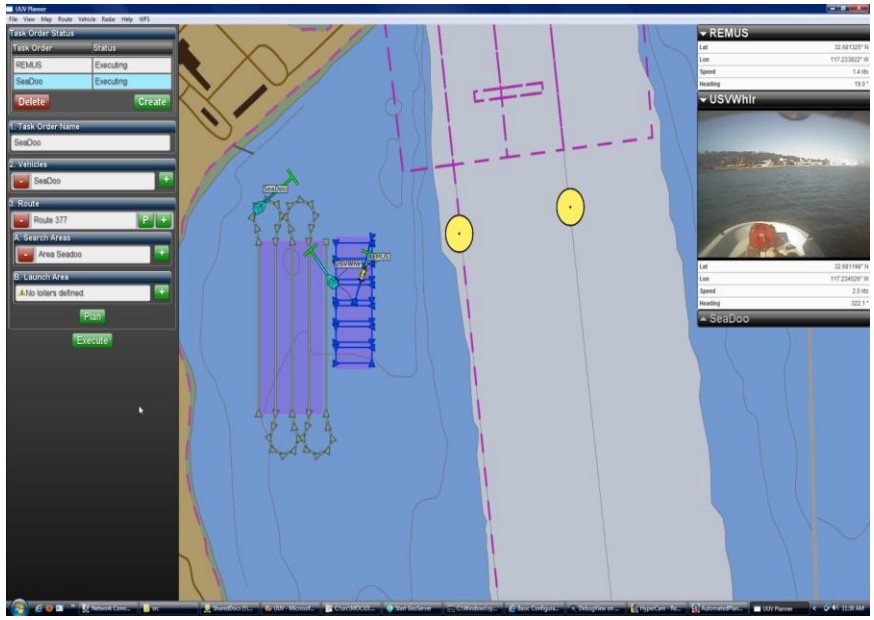


SHARC platform used as a communication buoy

Vehicle and Tactical-Level Interoperability

Collaborative USV/UUV Command and Control

- *MOCU* used to control SPAWAR developed USV and *REMUS* UUV
- Mission planned and downloaded to both unmanned vehicles
- *REMUS* launched from the USV
- USV used hydrophone to capture *REMUS* position status and report to *MOCU*
- *MOCU uplinked to Composeable Forcenet (CFn)*



MOCU display showing UUV and USV positions

Tactical Interoperability

Raven UAS Integration into *MOCU*

- Extended *MOCU's* C2 umbrella over operational UAS
- More intuitive user interface
- Reduced initial/recurrent training requirements
- More realistic flight simulation/training environment
- *Used Google Earth*

Old operator interface

More intuitive operator interface

Tactical Level Interoperability

Intelligence Carry on Program (ICOP)

First ever multi-intelligence ISR capability supporting afloat and expeditionary operations… interoperable with wide range of UAS and manned A/C sensor feeds, shipboard cameras, DCGS-N systems and C5F MOC

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Future Direction

Adaptive Naval Force of 2020

- **Distributed Forces Globally** - unmanned systems collect data to know the region, the people, and identify the patterns
- **Distributed Geographically** - unmanned systems, with their long persistence, help fill in the seams between units allowing the Navy to aggregate effects without aggregating mass
- **Disaggregated Combat Functionality**
  - Current 'multi-mission unit of issue' (i.e., the ship) that 'owns' all of its resources and data
  - Future view is that sensors, deciders, and effectors are resources to share across the battlespace – not just one ship
  - Networked and state-based

Conclusion

- Fittingly, key **DON Objective for FY-12**:
  5. ***Dominate in Unmanned Systems***
     a) *Integrate Unmanned Systems into the DON Culture*
     b) *Develop Unmanned Systems in the Air*
     c) *Deploy, establish Unmanned Systems On/Under the Sea*
     d) *Field Unmanned Systems on the Ground*
- The **key to effective domination is effective interoperability**
- Future progress facilitated by **Government-owned, modular, open architectures**
- Much work still to be done

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