Systems Center PACIFIC

Interoperable Open-Source Sensor-Net Frameworks With Sensor-Package Workbench Capabilities: Motivation and Exploratory Results

Jayson Durham

Advanced Information Operations (IO) Capabilities Branch

SPAWAR Systems Center - Pacific

Mehrube Mehrubeoglu

Dept. of Computing Sciences, Mechanical Engineering and Engineering Technology

Texas A&M University-Corpus Christi

Lifford McLauchlan

Dept. of Electrical Engineering and Computer Science

Texas A&M University-Kingsville

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Outline

- Background and Motivation
- Network Centric Warfare: Vision and Objectives
- Emerging Technologies
  - Rapidly Deployable Sensor Networks (e.g. MAVS)
  - Free Open Source Software (e.g. UAV Simulators)
- Mission-Driven Systems Engineering
  - Mission-Driven M&S Frameworks (e.g. NPS MOVES)
  - System of Systems Engineering (SOSE)
  - Sensor Packages for Supporting Tactical ISR
- Exploratory Results
- Summary and Conclusions
- Future Work

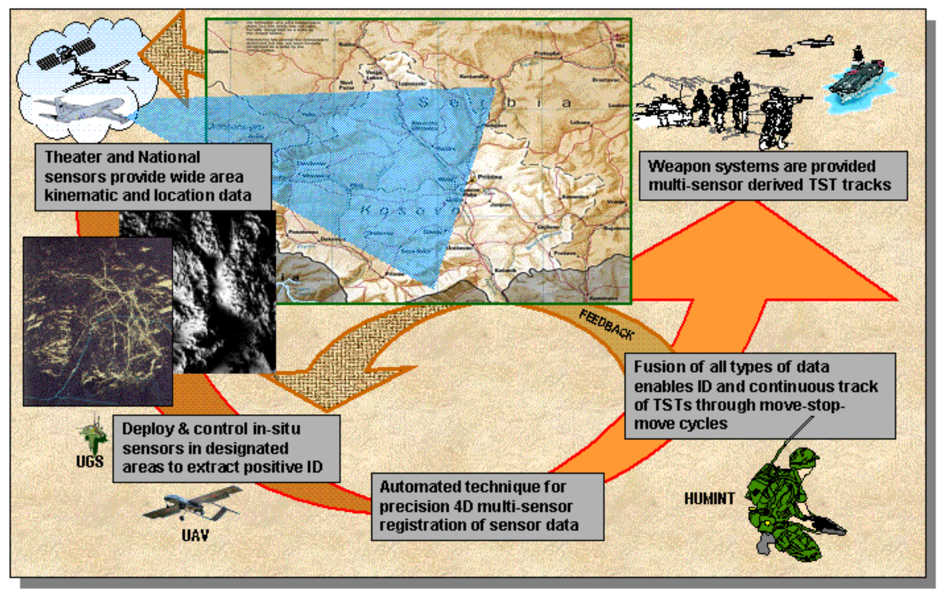
Network Centric Warfare (NCW)
Time-Sensitive Targeting (TST) Examples

Joint Fires - Network Centric Collaborative Targeting (JF-NCCT) Integration Study

DARPA IXO
Dynamic Tactical Targeting (DTT)

TST Goals and Objectives

- *Real-time collaboration*
- *Self-synchronization*
- *Machine-to-machine networking*
- *Dynamic sensor management*
- *Geographically dispersed sensing*



NCW Vision: "To-Be" Architecture

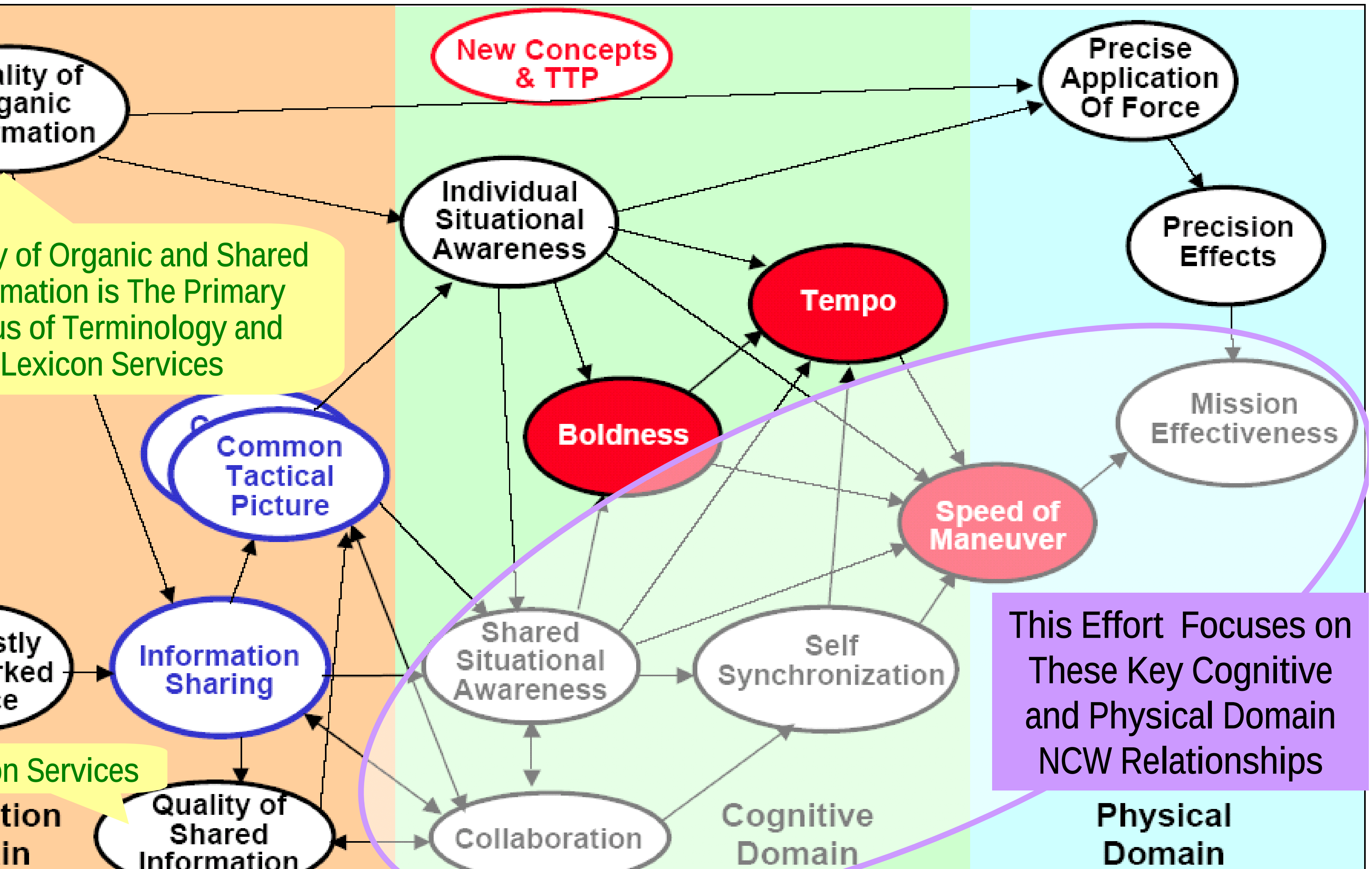
Core Enterprise Services and SOA Infrastructure

NCW – Network Centric Warfare; SOA – Service Oriented Architecture

Source:http://www.defenselink.mil/cio-nii/docs/GIGArchVision.pdf

NCW Vision: Tenets of NCW

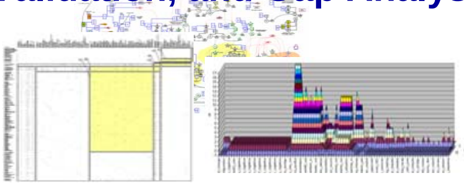
(Info Sharing, Shared SA, Collaboration, Self-Synchronization)



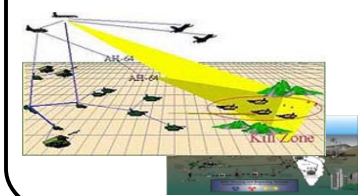
NCW Objective

Mission-Driven Systems Engineering

Capability Tracing, Assessment, Validation, and Gap Analysis



Threat Scenarios



Inter-Agency

Cross-Domain

Information-Sharing

Supply-Chain

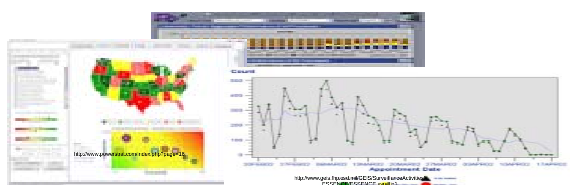
se

rk -

Rules, Metrics

es, Architectures, ...

Mission Architecture Dashboard (MACE Portal)



Operational

Mission-Threads

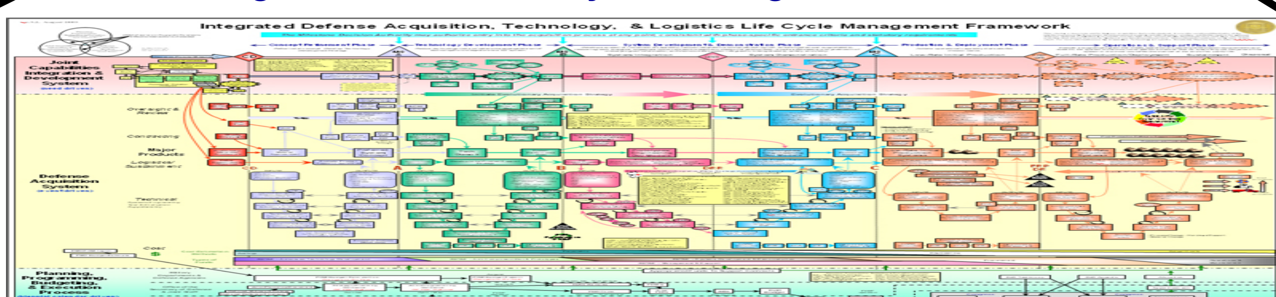
Operational Plans (OPlans)

Mission Operations

Systems

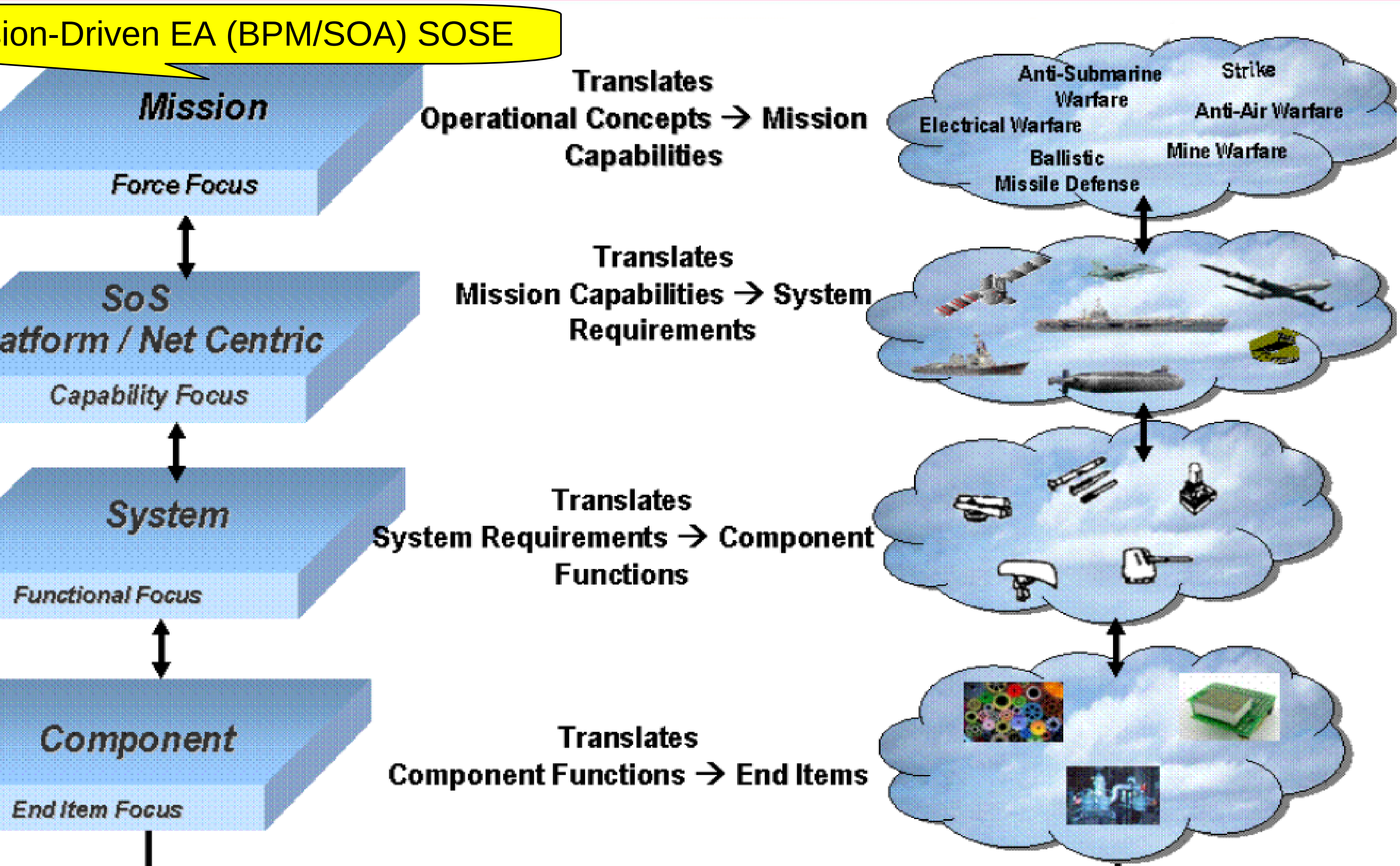
Devices

Integrated AT&L Life Cycle Management Framework

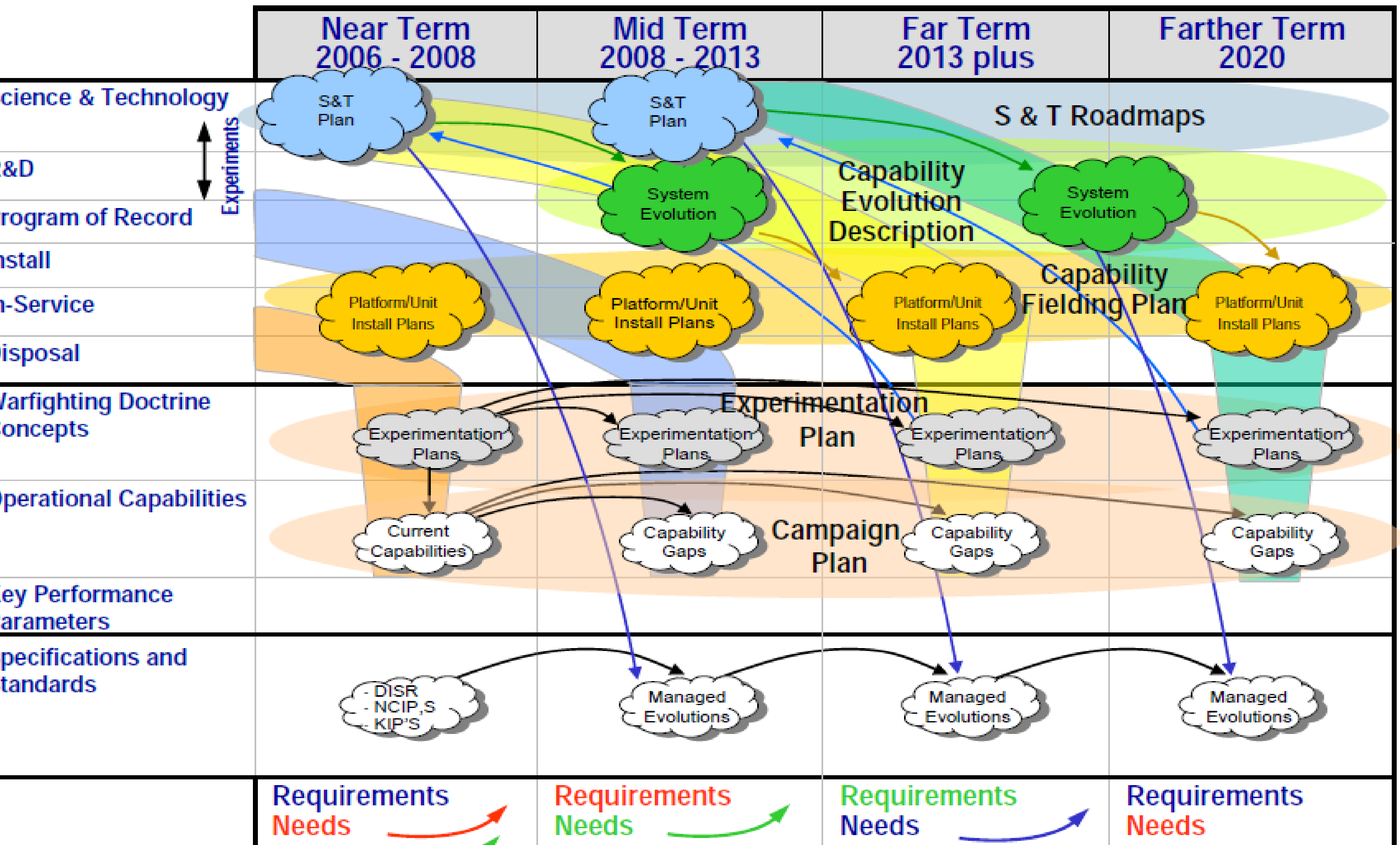


NCW Objective (continued)

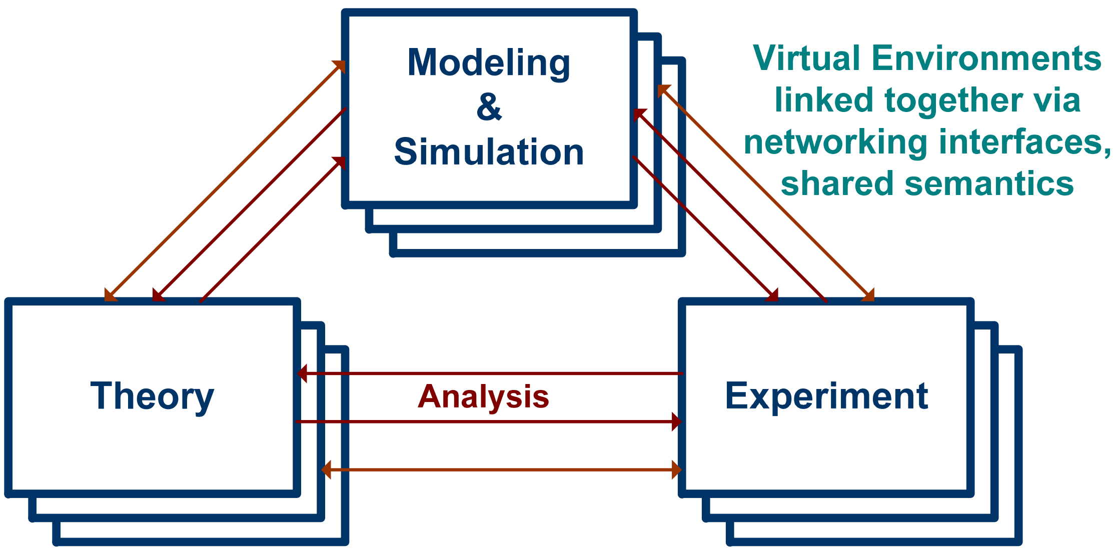
Navy (DON) System-of-System Engineering (SOSE)



NCW Objective: Systems-Support of NCW
Roadmapping Example (circa 2007)



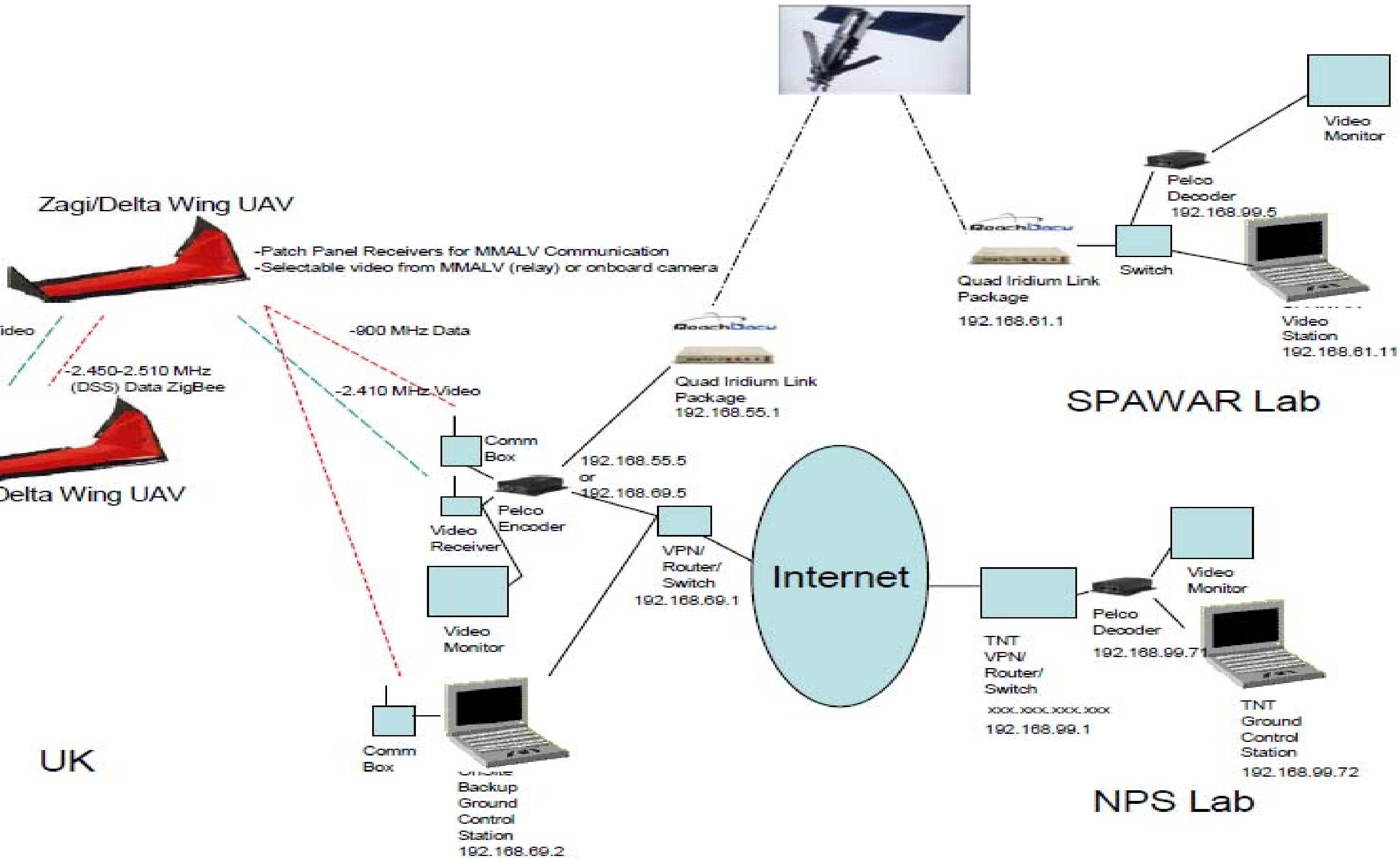
NCW Objective
Virtual Environments



Scientific method, emerging 21st century

Naval Postgraduate School (NPS) Autonomous Unmanned Vehicle (AUV) workbench (Brutzman 2007, Brutzman and Daly 2007, Weekley *et al.* 2004, NPS Autonomous Unmanned Vehicle (AUV) Workbench)

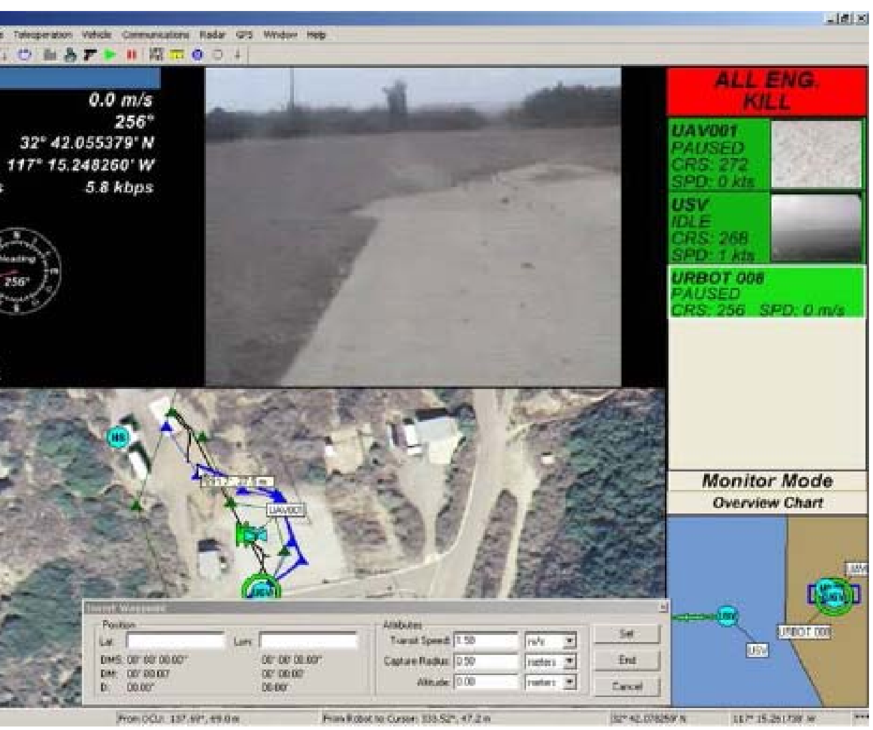
NCW Objective
Global Reachback (MAV Example)



Network Diagram of Global Reachback Experiment, D. Blakely, et al. 2007

NCW Objective
Rapid Mission-Driven Experimentation

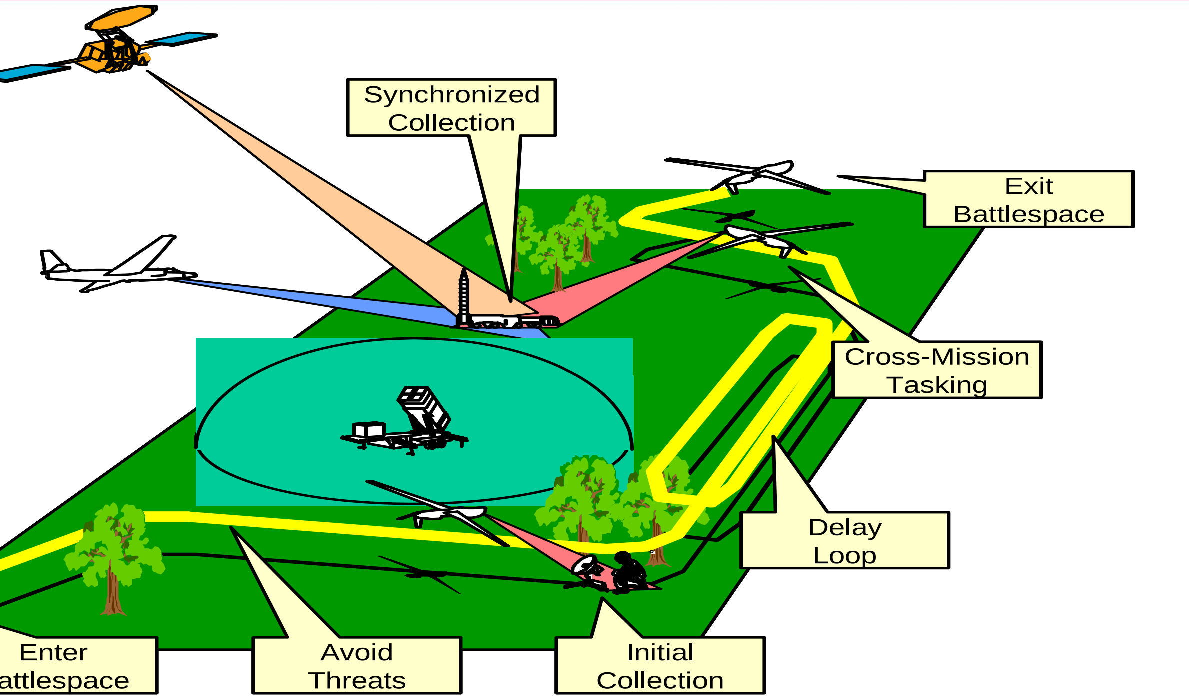
o Aerial Vehicles (MAVs) and larger anned Aerial Vehicles (UAVs) titute a powerful tool for the modern ighter and First Responder.



Screen-Shot of MOCU Configured as A Multi-Vehicle (UAV/USV/UGV) Controller with Video From A Manportable UGV. (Nguyen, et al. 2009)

Example Scenario: Tactical ISR

Mission-Driven Warfighter Support



Mosaicking

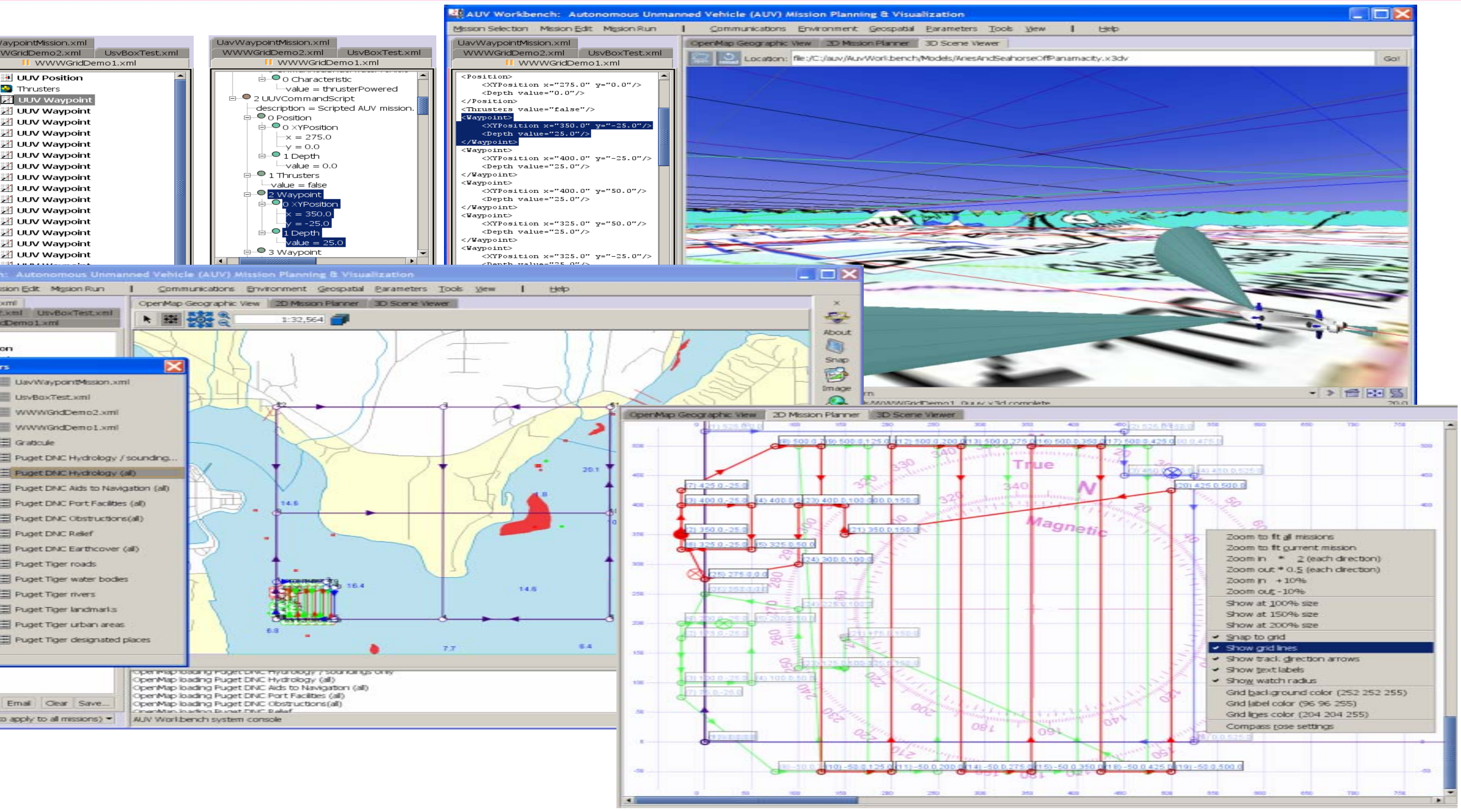
FlightGear: Open-source Flight Simulator

'S – a disruptive technology

'S could potentially replace larger-scale, more expensive
's in missions

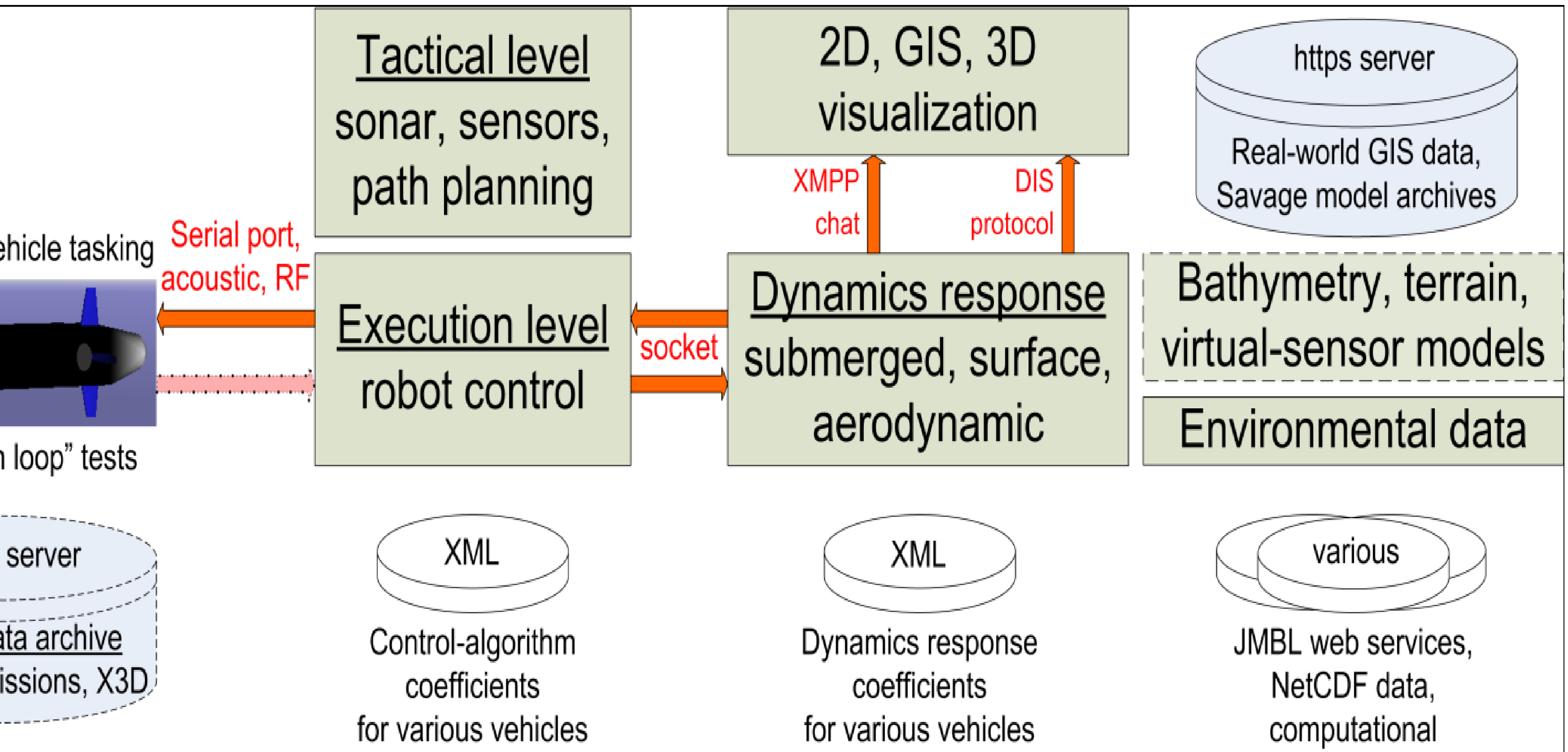
's' dynamics - drastically different from larger UAVs
MAV dynamics makes them more sensitive to
ronmental conditions (e.g., gusts of wind) which must be
pensated for during image processing, fusion and data

NPS AUV Workbench
Mission Planning and Rehearsal



Naval Postgraduate School (NPS)
Autonomous Unmanned Vehicle (AUV) Workbench

NPS AUV Workbench (cont.)
Integrated Engineering Framework



Naval Postgraduate School (NPS)
Autonomous Unmanned Vehicle (AUV) Workbench
(MOVES Institute, http://www.movesinstitute.org/)

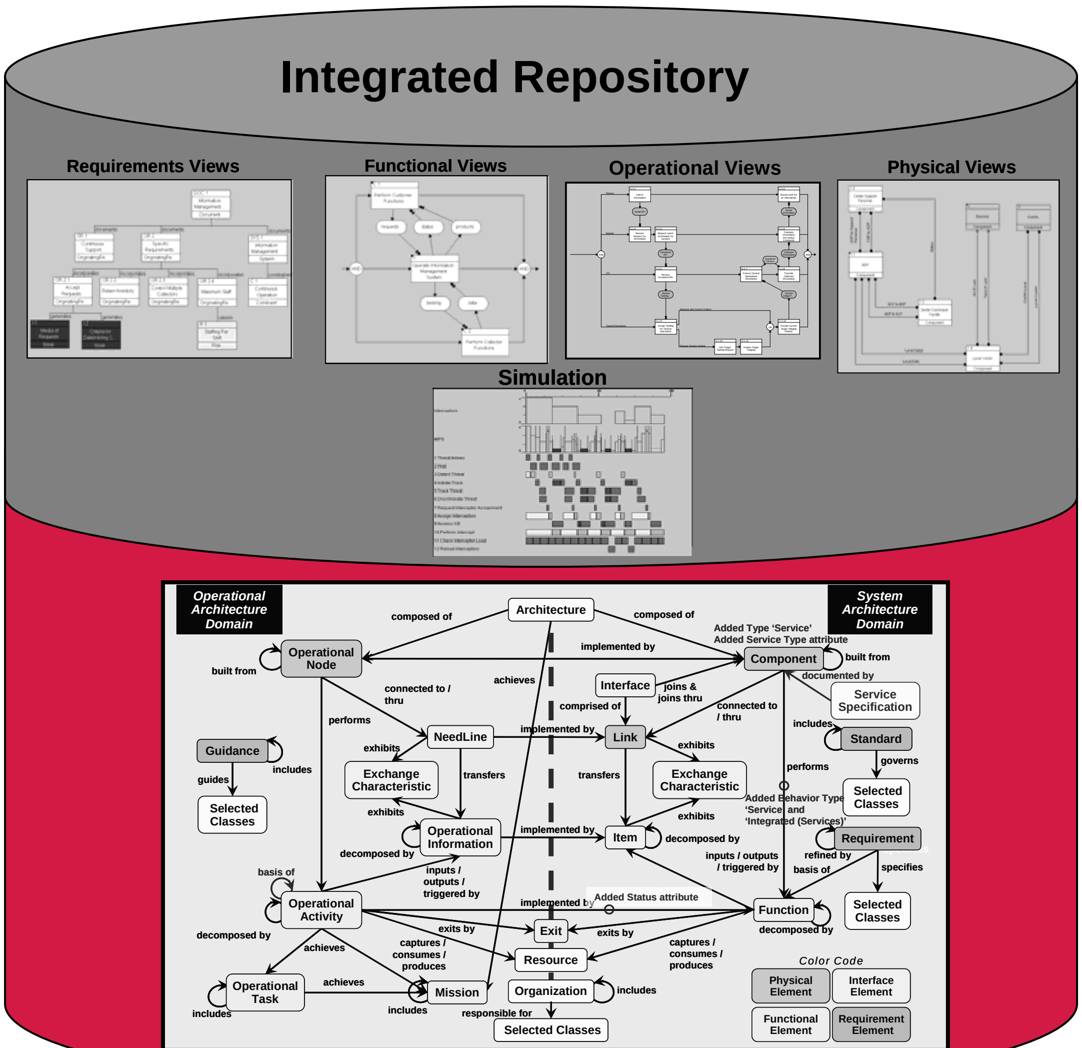
CORE Executable Architecture

System-of-Systems Engineering Framework

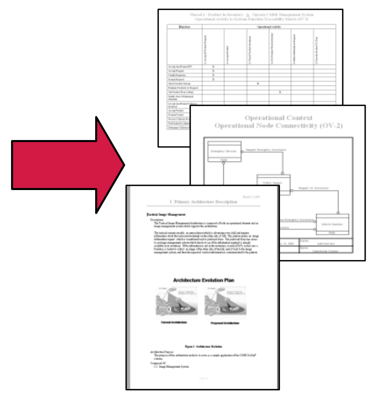
E Views

N AV-2
ERG)

Language

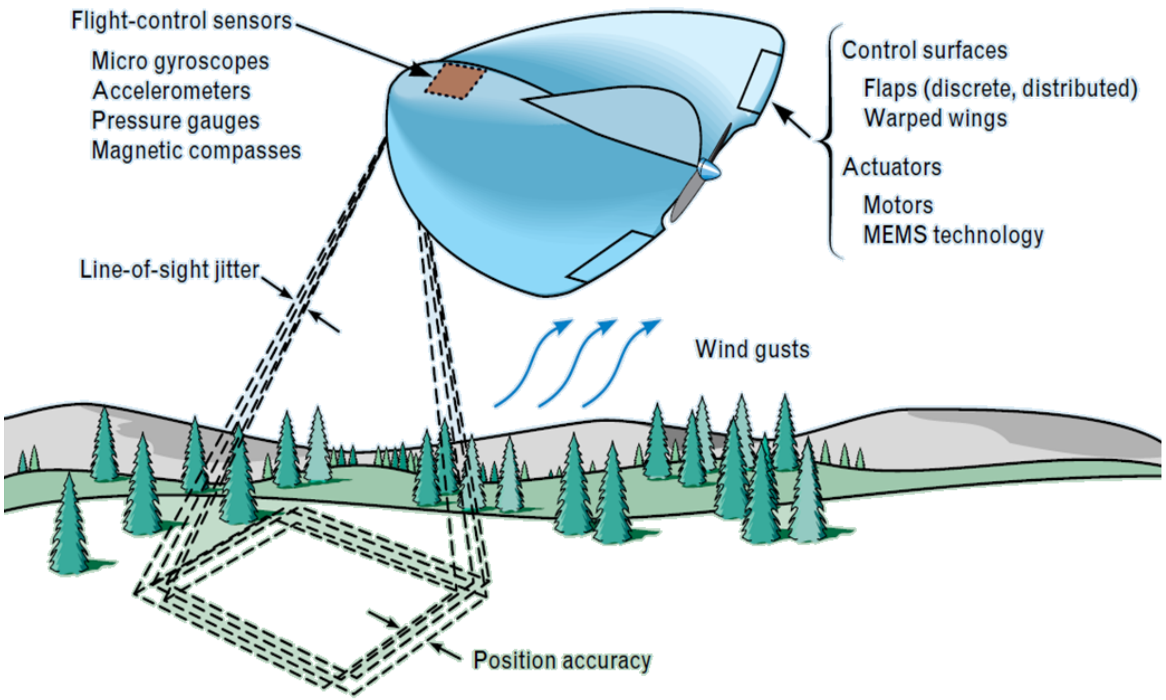


DoDAF Views
(OV/SV/TV/AV)



Sensor Package Analysis - Needs

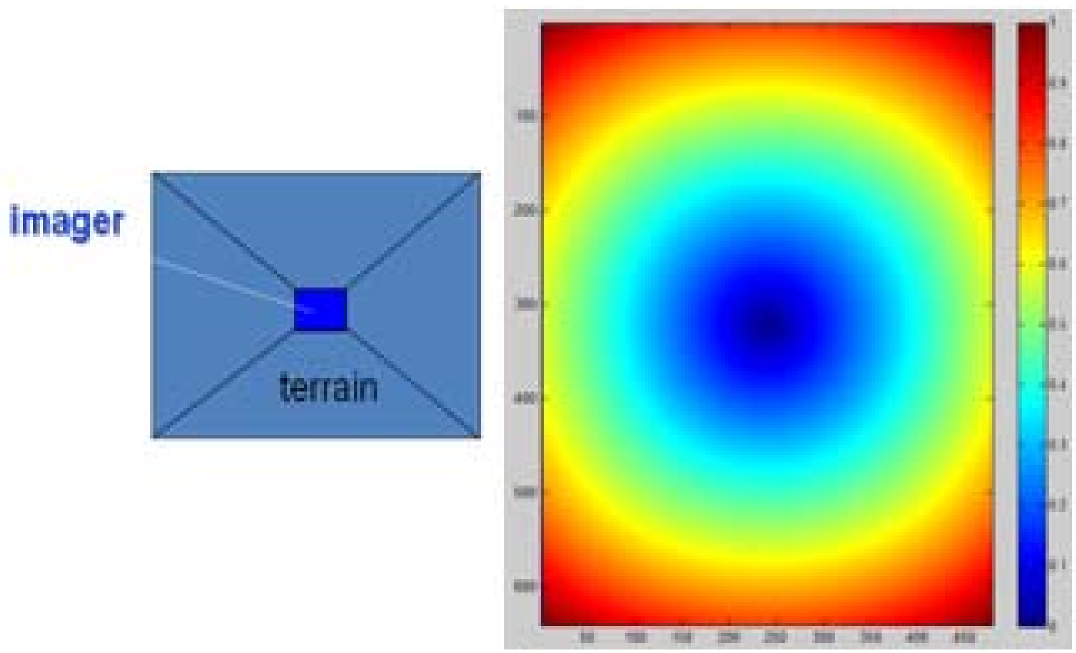
Factors Affecting Performance: MAV Dynamics



V flight-control system. Flight control requires sensors that measure motion (roll, :h, and yaw) of the MAV platform, and aerodynamic control inputs that stabilize l maneuver the MAV in wind gusts and turbulence.

liam R. Davis, Jr., Bernard B. Kosicki, Don M. Boroson, and Daniel F. Kostishack, e Lincoln Laboratory Journal 1996

Parameters Affecting MAV Mission Mosaicking and Georegistration



(Left) Camera imaging system parallel to the surface.
(Right) Relative distance represented by each pixel

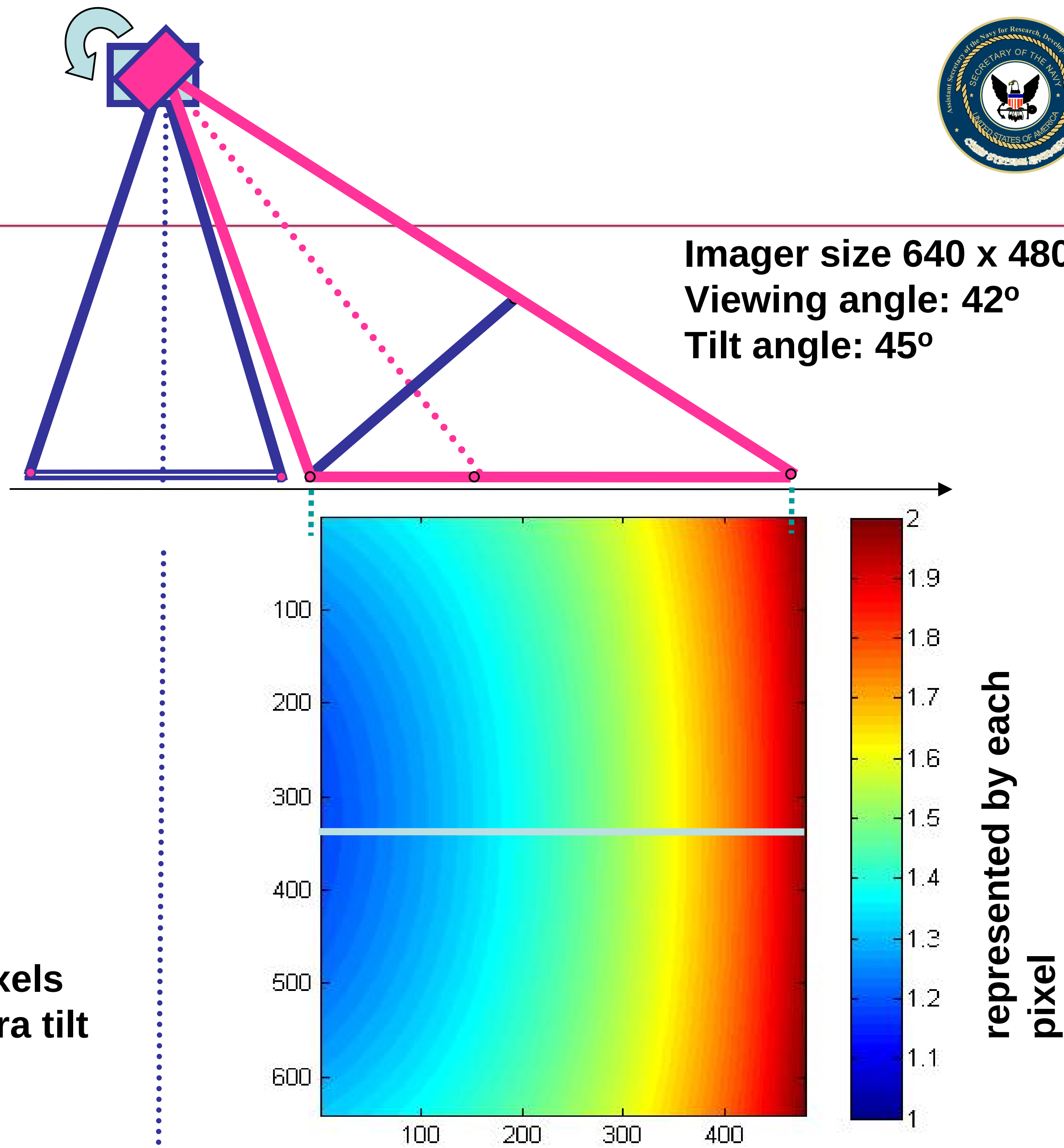
M. Mehrubeoglu and J. Durham, "AUV Sensor-Payload Workbench: Exploratory Pilot for Image/Video Processing," presentation, Enterprise Lexicon Services Workshop, Mitre, San Diego, CA July 21-23, 2009.

t of camera tilt along
lane on terrain area
sented by each pixel

ed flat terrain

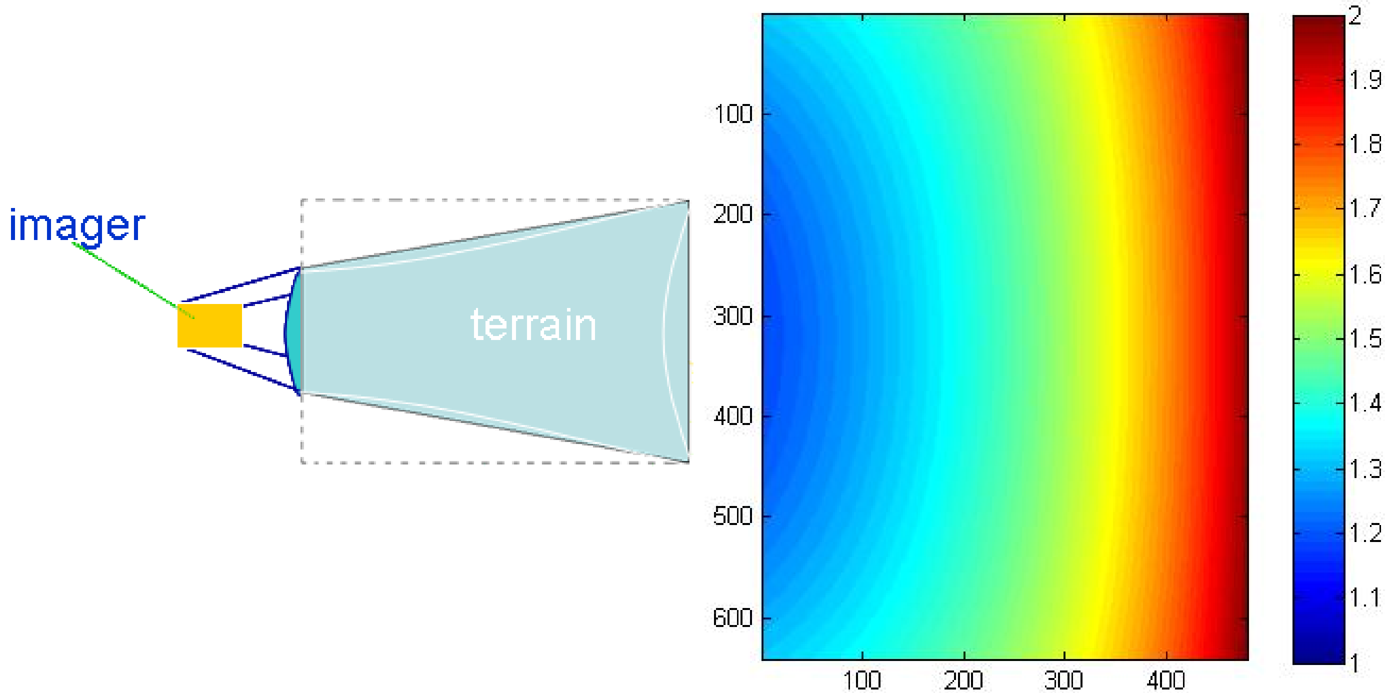
nce representation by pixels
pixel distance and camera tilt

Imager size 640 x 480
Viewing angle: 42º
Tilt angle: 45º



Area represented by each pixel based on tilt angle in X

Parameters Affecting MAV Mission Mosaicking and Georegistration (continued)



(Left) Flat Camera imaging system at angle to the surface.
(Right) Relative distance represented by each pixel.

Conclusions/Future Directions

- The pilot effort demonstrates the merits and immediate value of extending the MOVES AUV Workbench with a complementary Image/Video Processing Workbench

  - Model CONOP Provides Insights for MAV Sensor-Package Workbench

  - Initial Analysis Capability to be Integrated into NPS MOVES Unmanned Autonomous Vehicle (AUV) Workbench to Further Explore Development of a Complementary MOVES AUV Sensor-Payload Workbench Capability

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Questions, Comments, and Dialog

BACKUP SLIDES