OCEANOGRAPHIC DECISION SUPPORT SYSTEM (ODSS)

A TOOL TO IMPROVE EFFICIENCY OF BIOLOGICAL OCEAN STUDY

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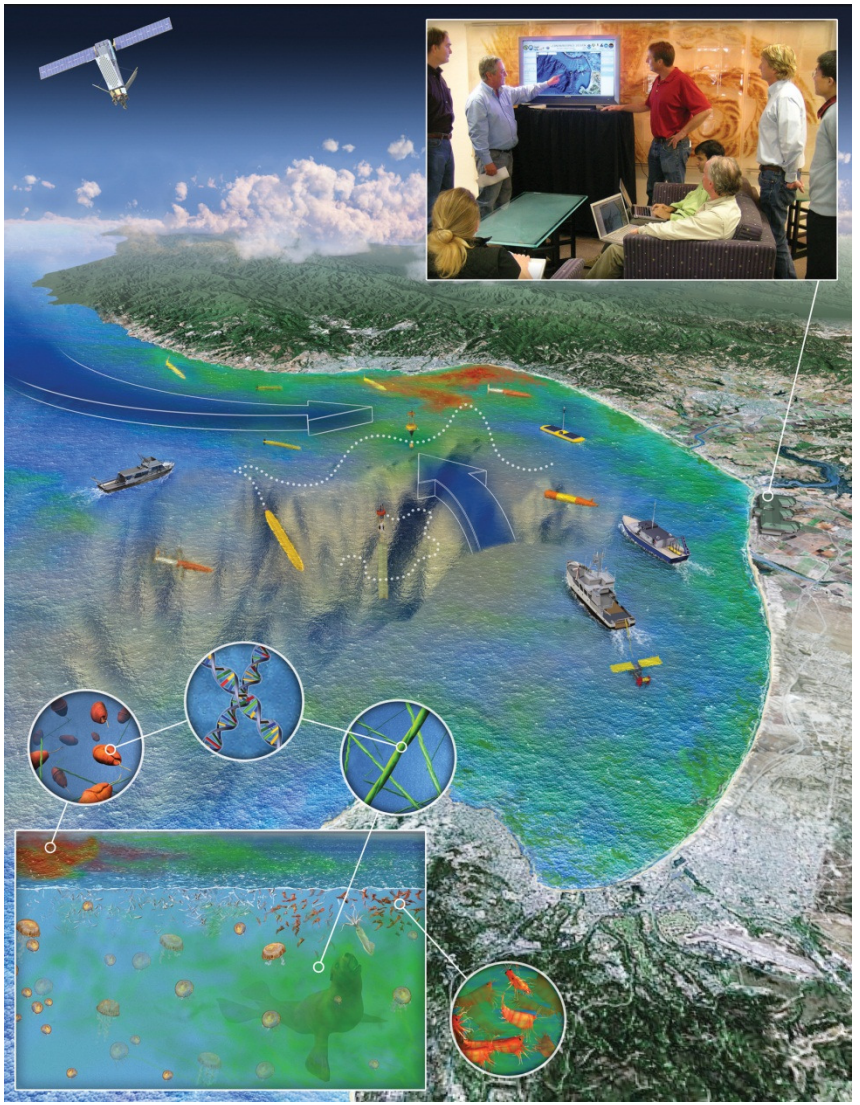
MBARI “CANON” Initiative

Controlled Agile Novel Observation Network

CANON Science

- Persistent ocean presence reveals ecosystem dynamics
- Four science research themes in CANON.
  - Coastal phytoplankton blooms
  - Zooplankton dynamics
  - Oxygen minimum zones and ocean acidification
  - Open ocean eddies and global primary production.

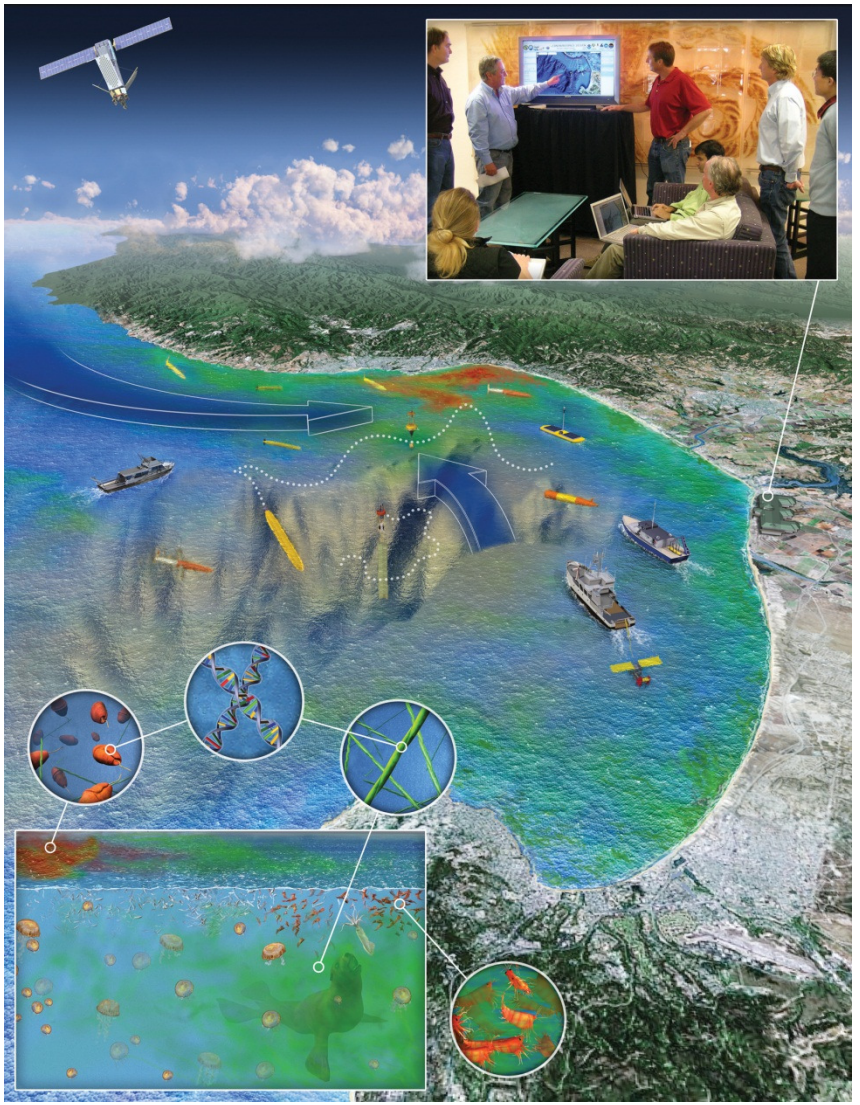


MBARI "CANON" Initiative

Controlled Agile Novel Observation Network

CANON Technology

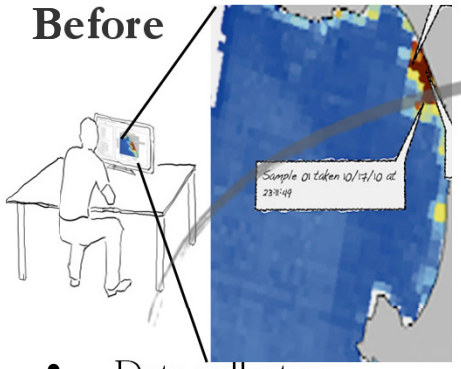
- Each CANON science theme involves:
  - Process driven, ecologically oriented field experiments
  - Multi-platform, multi-sensor, multi-disciplinary, multi-scale
    - AUV, LRAUV, Gliders, Drifters, Ships, …
  - 'Patch Tracking' - Map, Tag, Track and Sample.
- Technology themes in CANON
  - Sampling
  - Experiment and Data Management
- Need technology support for:
  - Experiment planning,
  - Collaboration and communication
  - Visibility on 'what is happening' in real time
  - Autonomous asset control
  - Logistic agility for platform planning
  - Centralized data access for analysis, data and results sharing
  - Experiment logging – why, what, where, when
  - Dissemination



Oceanographic Decision Support System (ODSS)

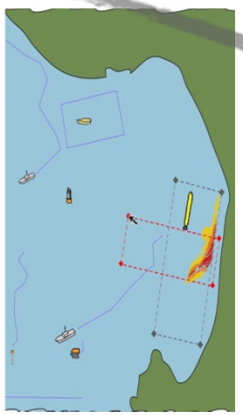
CANON Workflow

Before



- Data collection
  - recent events
  - historical
- Analysis
- Planning
- Simulation experiments (VPE)
- Populating database(s)

During a Field Experiment



- Situational awareness
- Planning
- Collaboration
- Annotation, Tagging
- Logistics

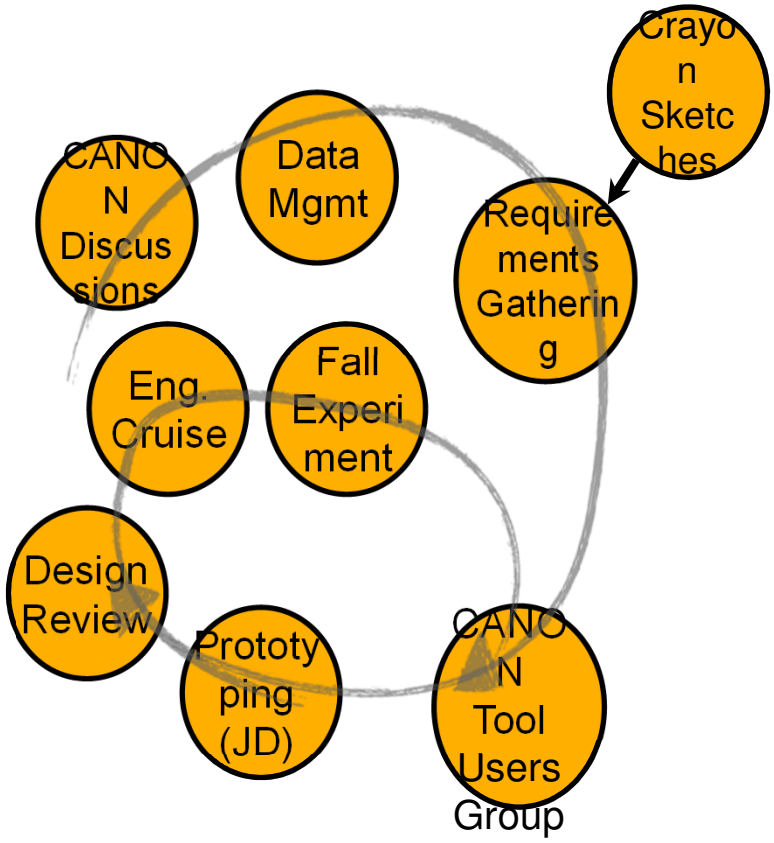
After

- Replay
- Analysis
- Archival use
- Dissemination
- Outreach
- Water Sample processing

Software Development Approach

Spiral Development

- Feasibility study started in 2010 by the MBARI Autonomy group in collaboration with the AOSN team.
- CANON experiment workflow analysis
- Prototyping and ‘agile’ software development
- User requirements gathering:
  - Pencil sketches of feature ideas to aid the conversation with scientists



Click through examples of

PENCIL SKETCHES

CANON Decision Support System

Data

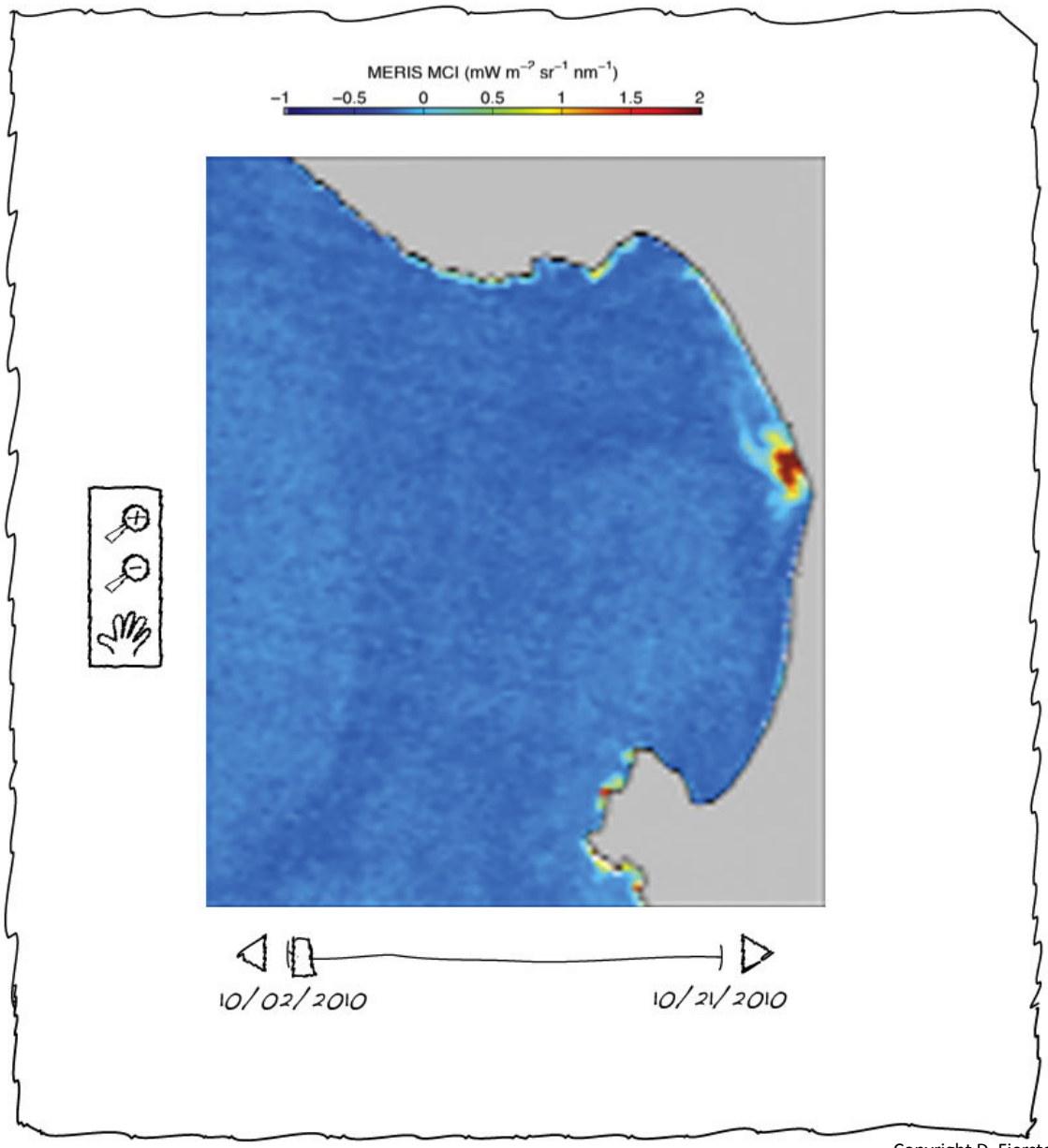
Data | Planning | Logistics

- Data Sources
  - [x] MODIS
  - [ ] HF Radar
  - [ ] MERIS
  - [ ] Chlorophyll
  - [ ] Current
  - [ ] Provenance
  - [ ] [redacted]
  - [ ] [redacted]
  - [ ] [redacted]
  - [ ] [redacted]
  - [ ] [redacted]
- Live Data
  - + [ ] DSS Plan Data
    - [ ] [redacted]
    - [ ] [redacted]
- Forecast
  - [ ] 4D Bio-Physical Model
  - [ ] [redacted]
  - [ ] [redacted]

Event Notification

[redacted]

Visualization



CANON Decision Support System

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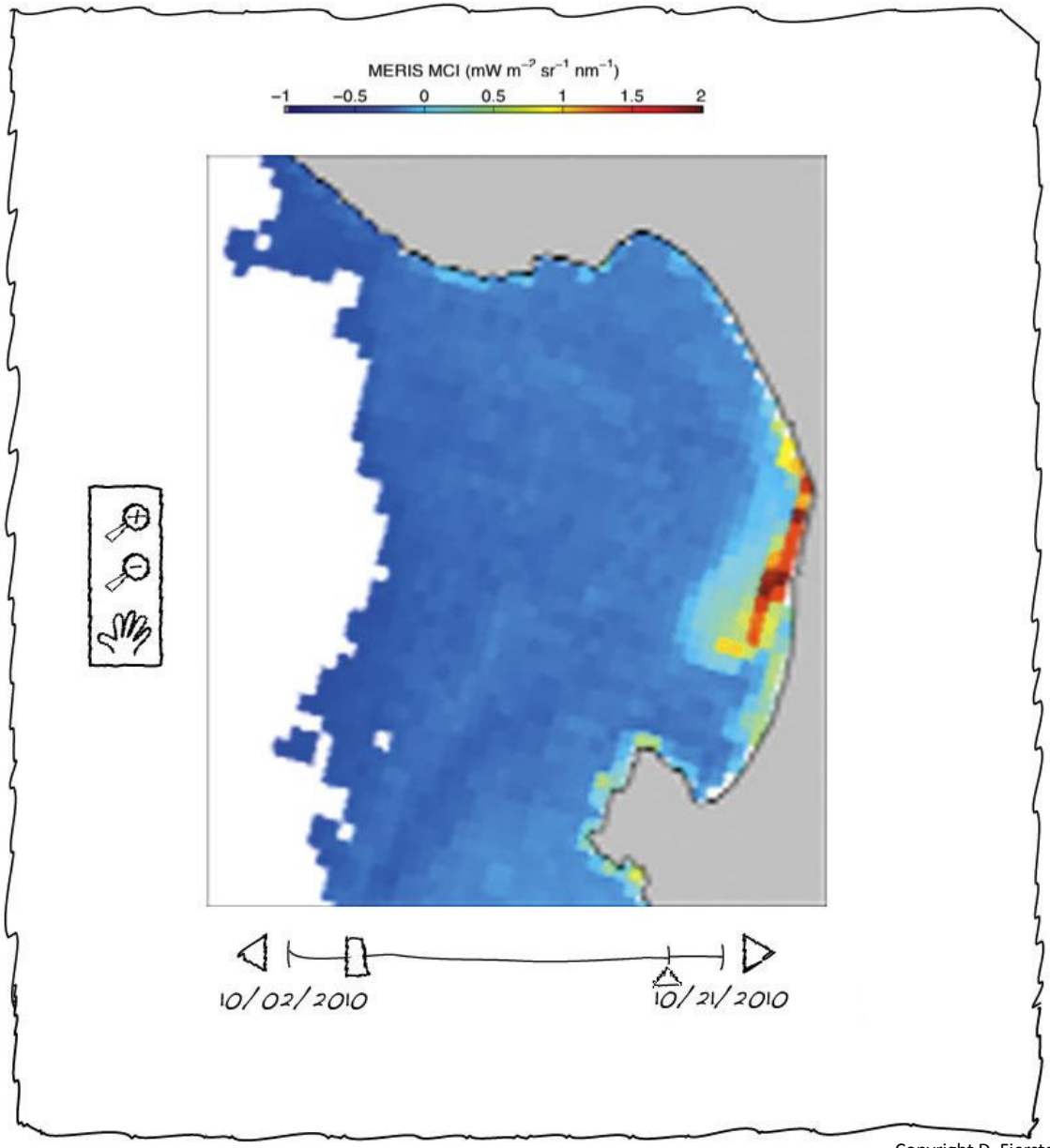
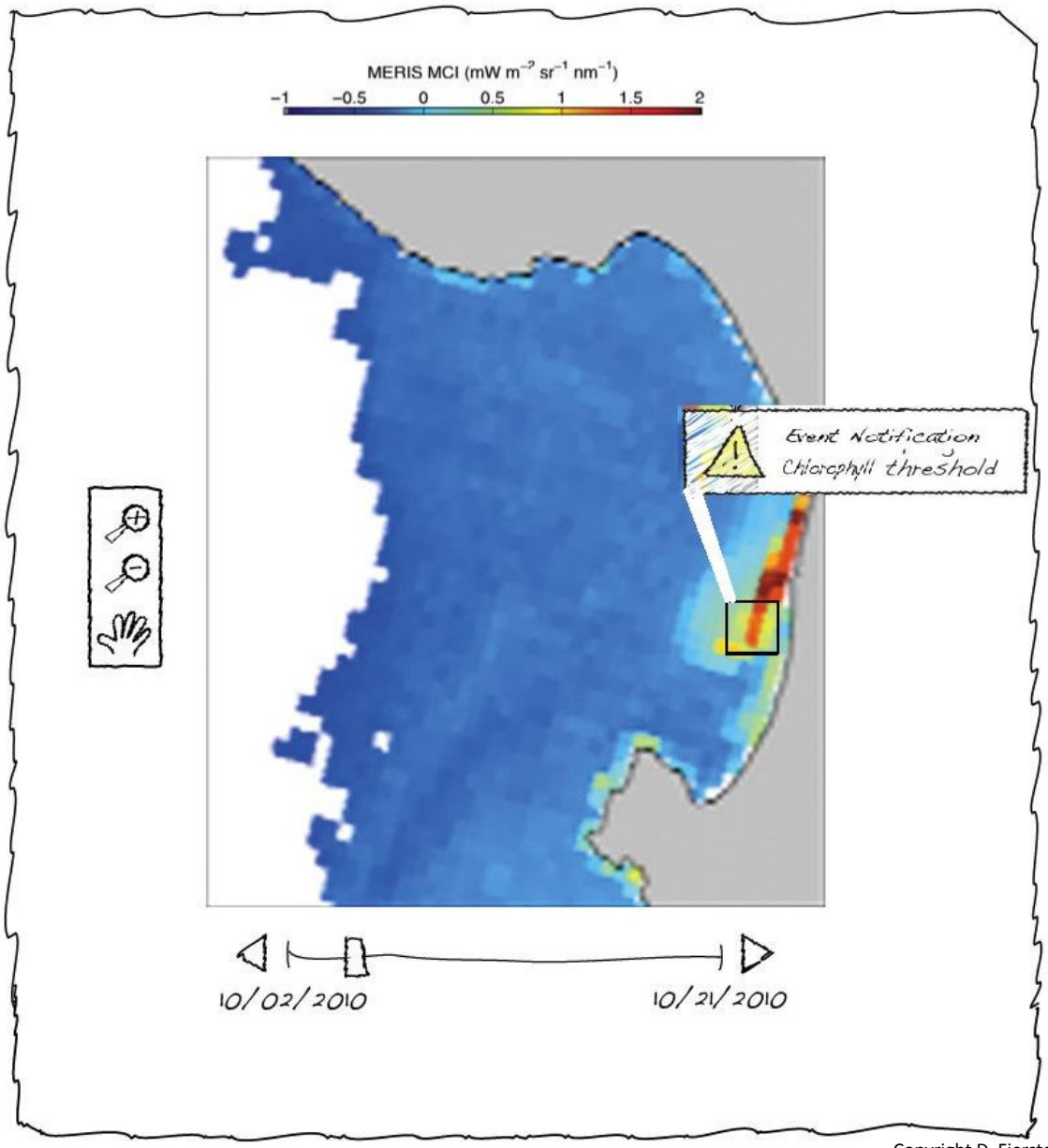
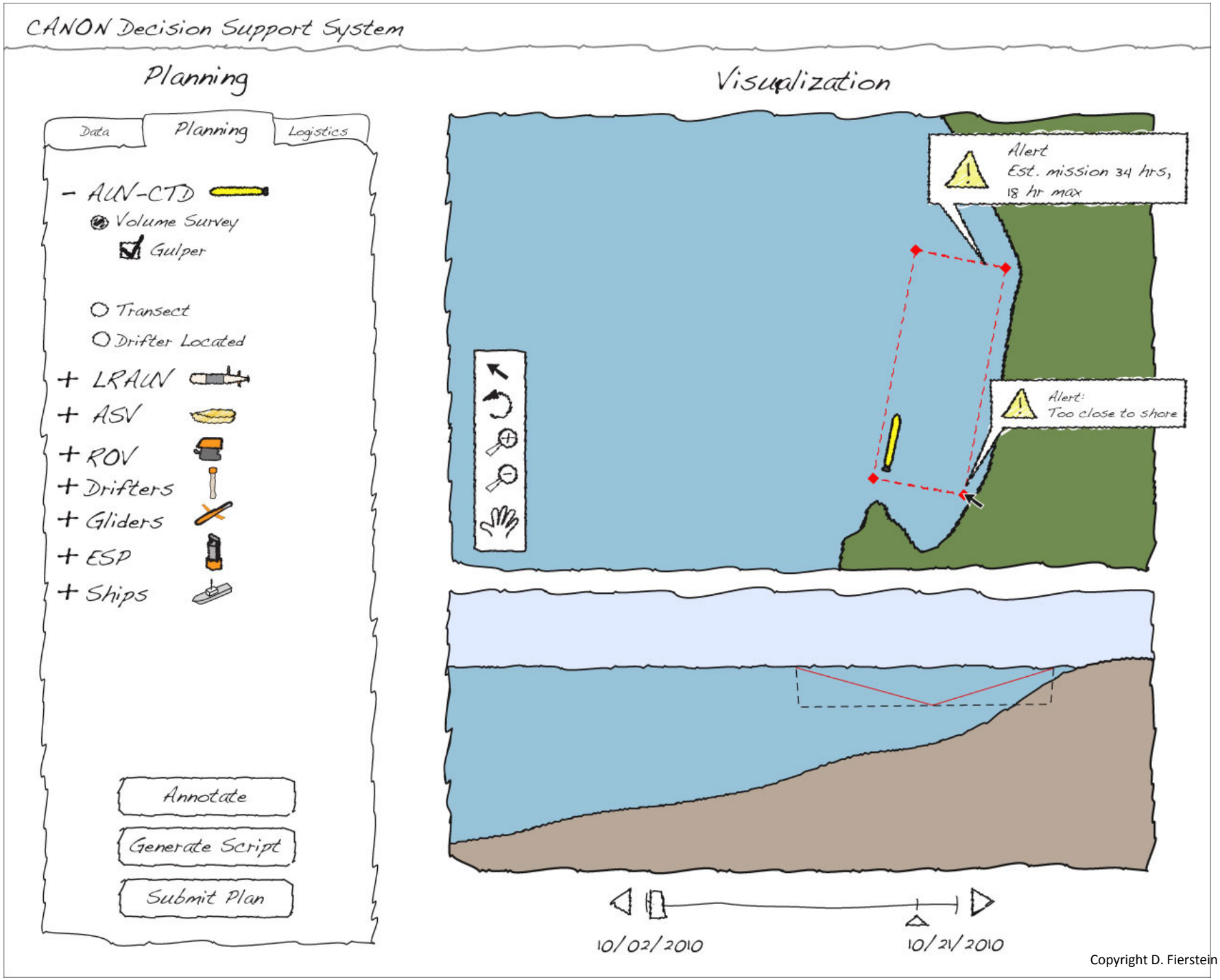


CANON Decision Support System

Data

Visualization





CANON Decision Support System

Planning

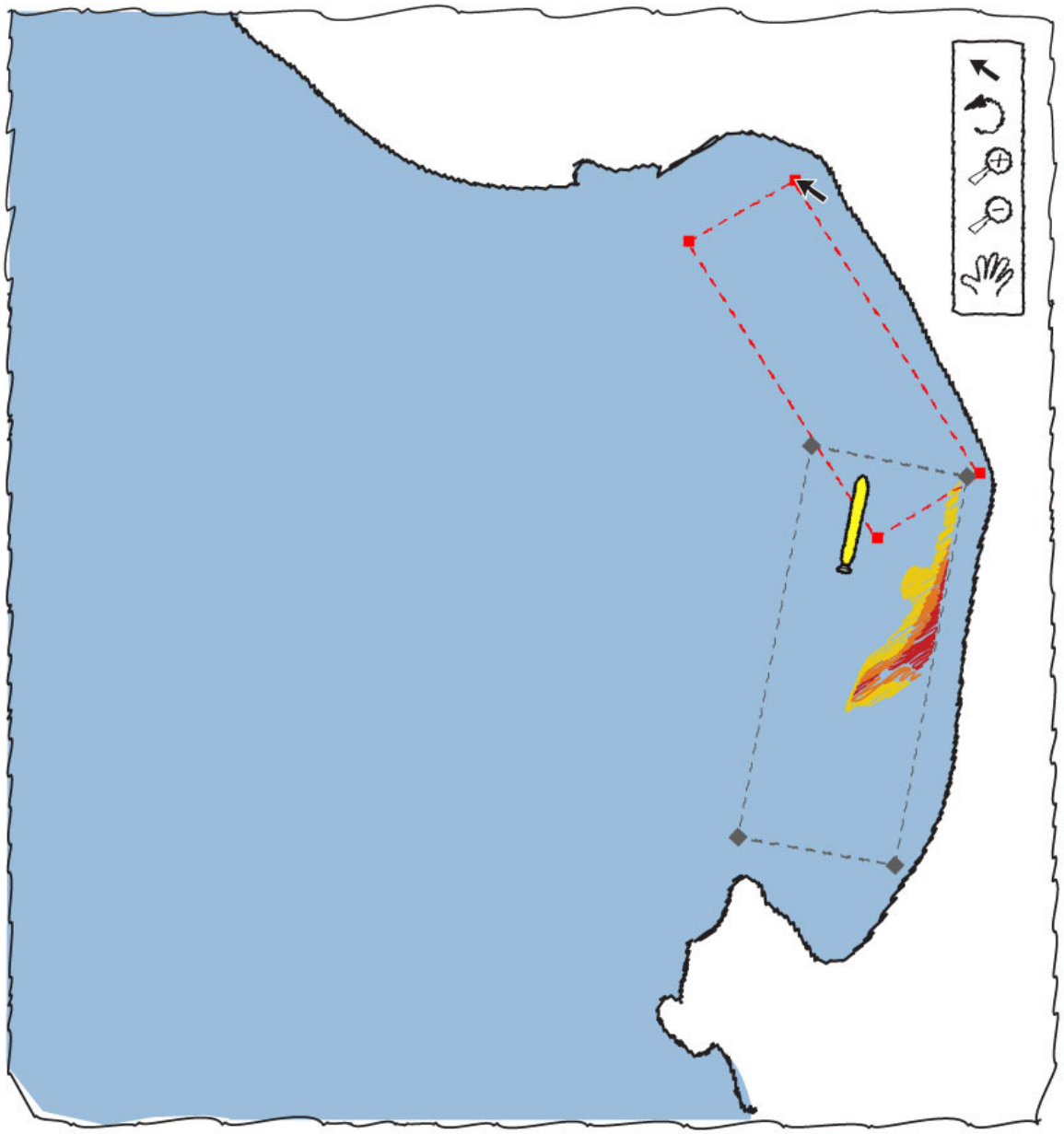
Data | Planning | Logistics

- AUN-CTD
  - Configure Transect pattern
  - Configure Sampling
  - Configure AUN Automation
- LRAUN
- ASV
- ROV
- Drifters
- Gliders
- ESP
- Ships

Generate Script

Submit Plan

Visualization



CANON Decision Support System

Planning

Visualization

CANON Decision Support System

Planning

Data | Planning | Logistics

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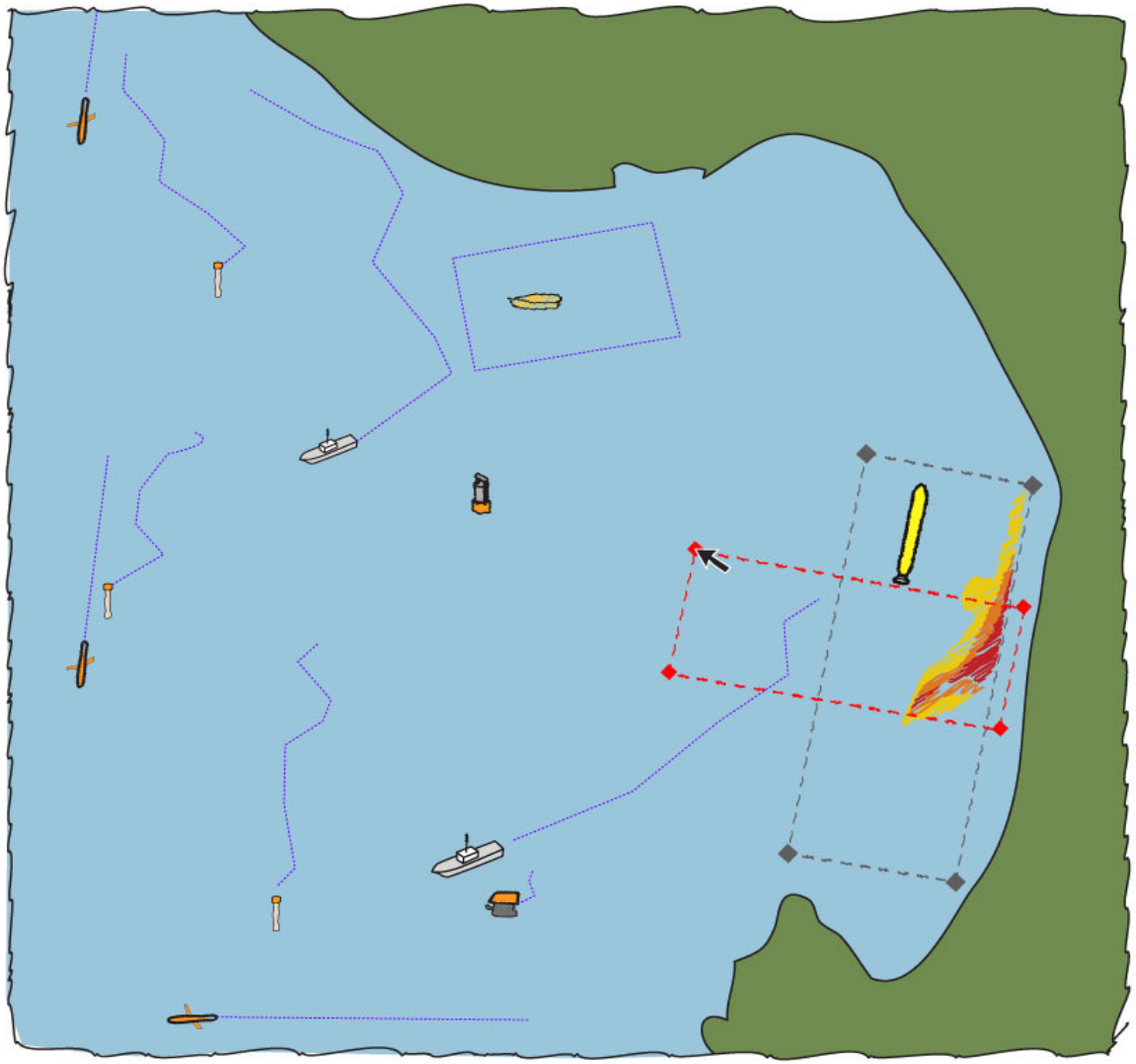
Annotate

Generate Script

Submit Plan

Visualization



CANON Decision Support System

Planning

Data | Planning | Logistics

- AUV-CTD
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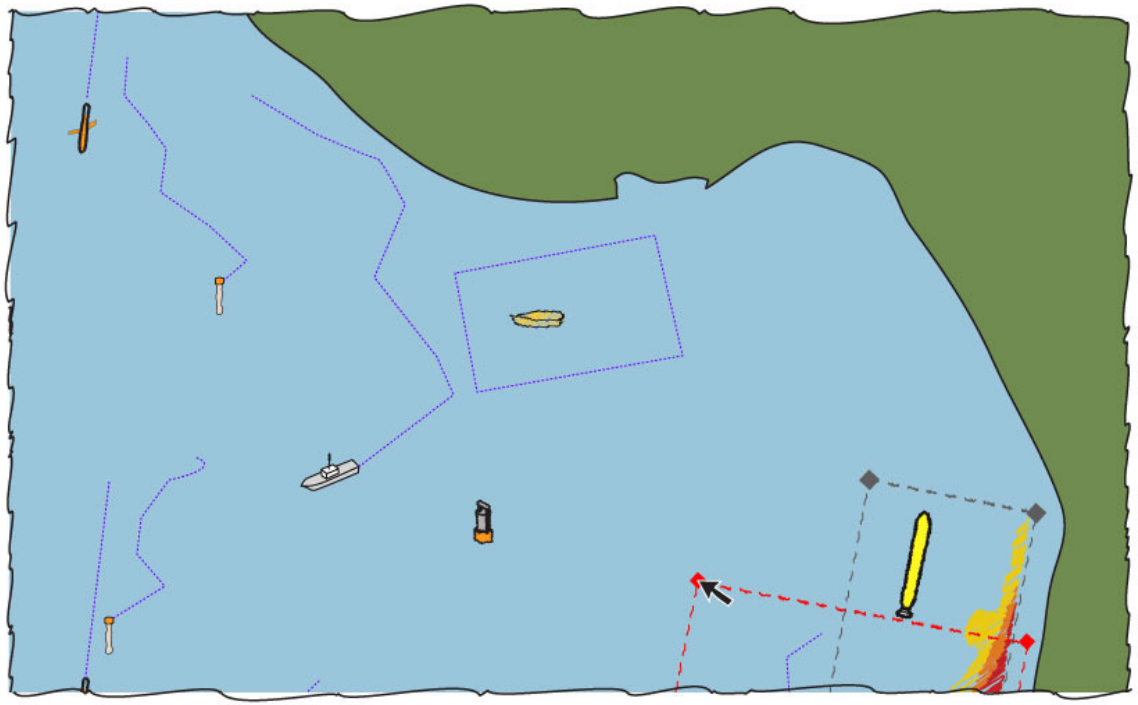
  - Configure Sampling
  - Configure AUV Automation
- LRAUV
- ASV
- ROV
- Drifters
- Gliders
- ESP
- Ships

Annotate

Generate Script

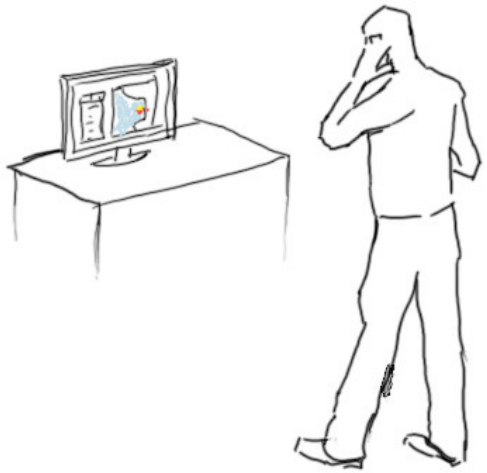
Submit Plan

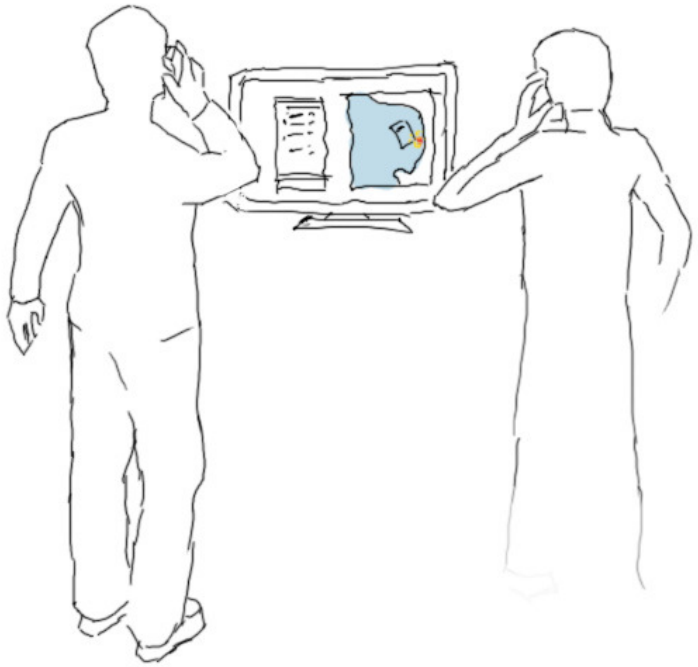
Visualization



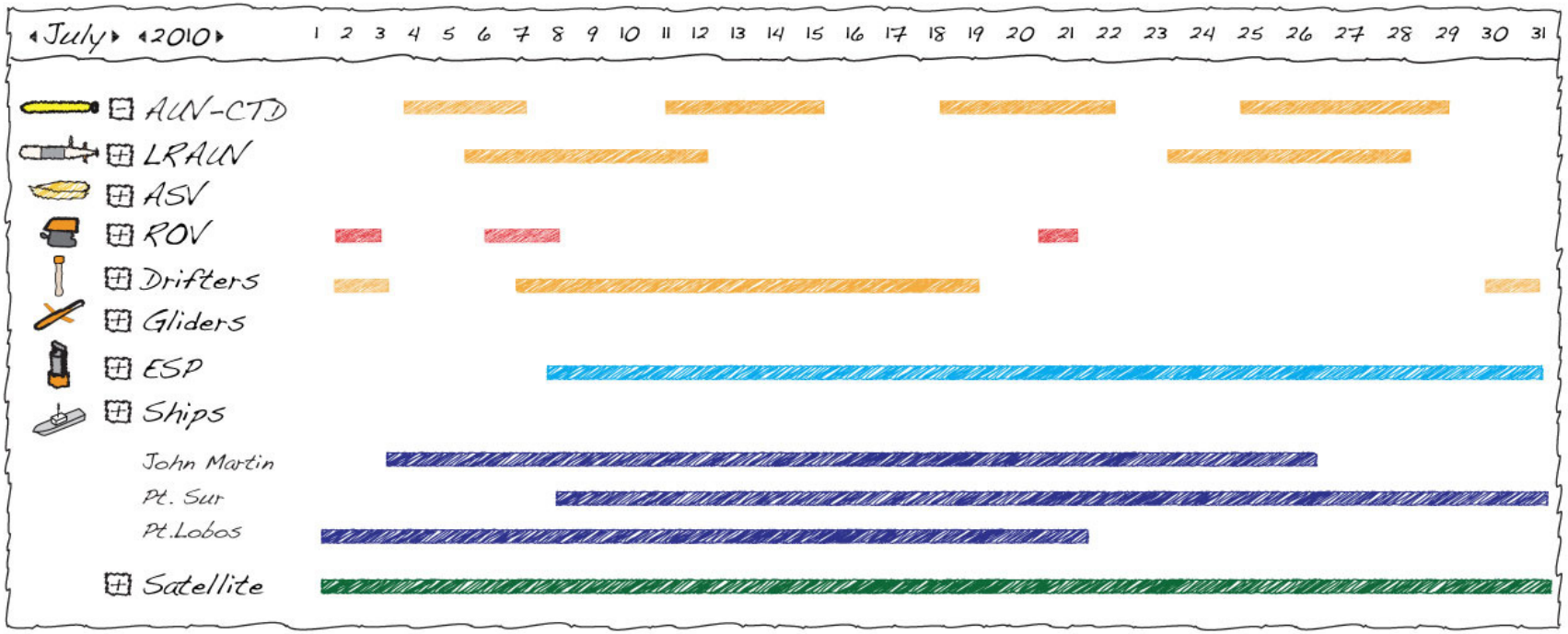
AUV plan submitted for review ----------

Control Scripts Generated ----------

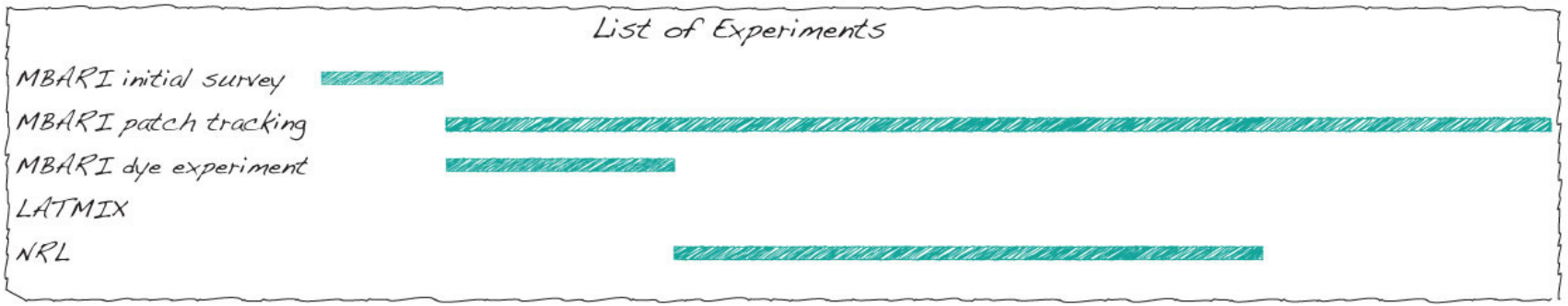




Asset Timeline



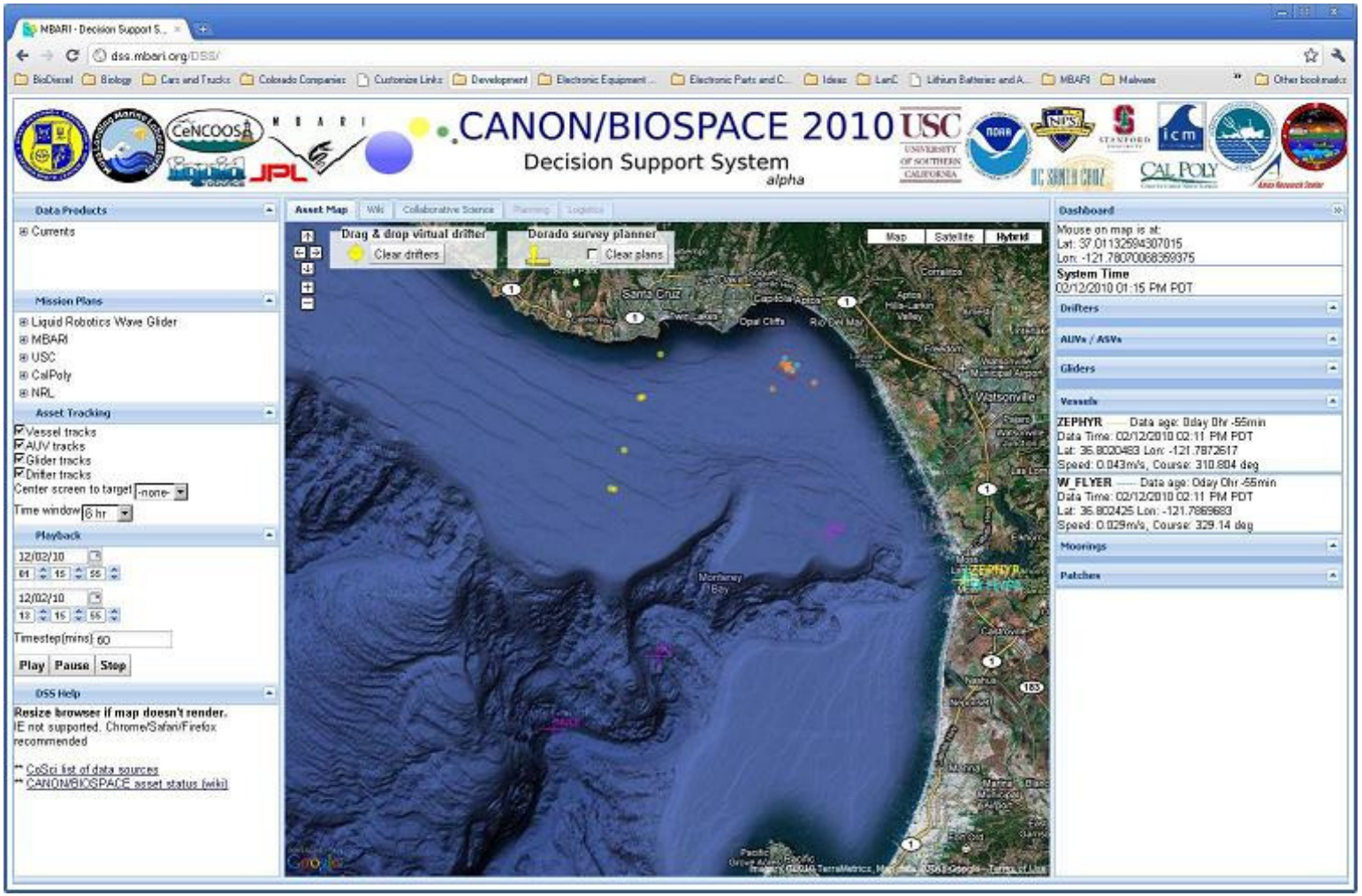
List of Experiments



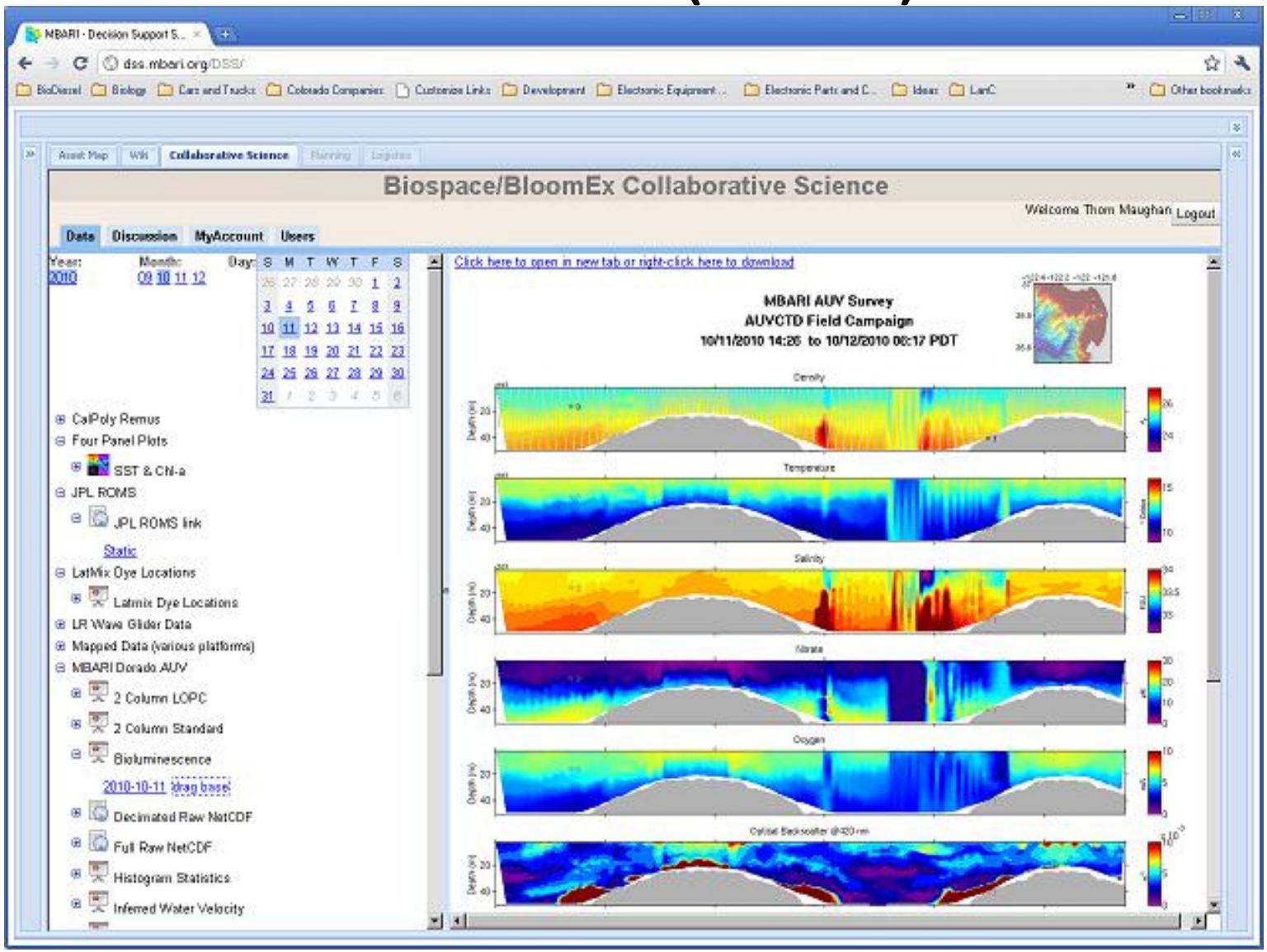
First Prototype ODSS

- Sep 2010, J. Das, a grad student from USC 'volunteered' to do a quick prototype from the pencil sketches.
- Feature focus
  - Situational Awareness
    - Data products, vehicle tracks, sensor tracks, playback, drifter projection
  - Integration of collaborative science tools developed in ONR funded MBARI program called AOSN
- Data sharing: Experiment context provided through archive of discussion behind daily experiment planning

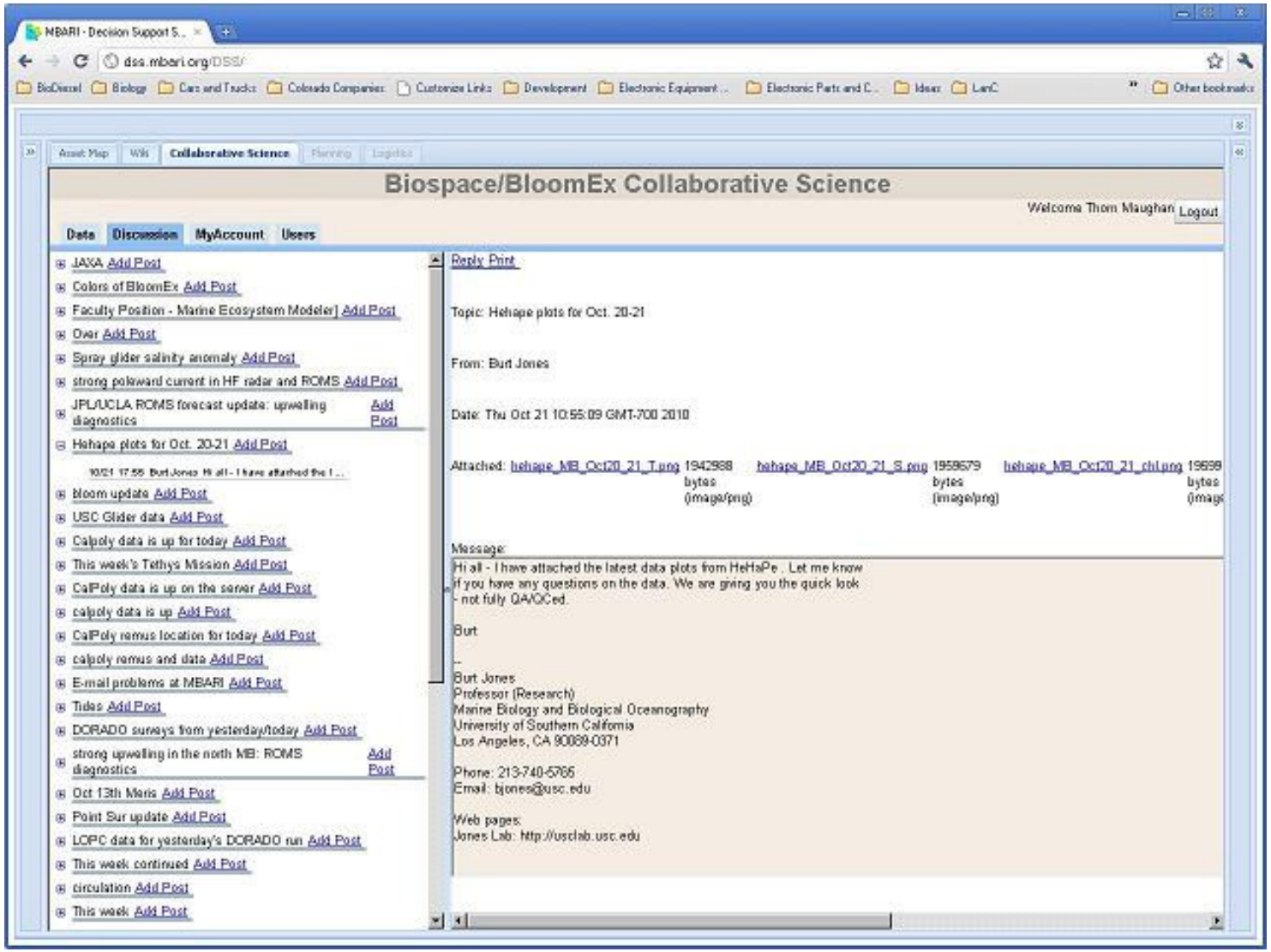
ODSS First Prototype
Situational Awareness



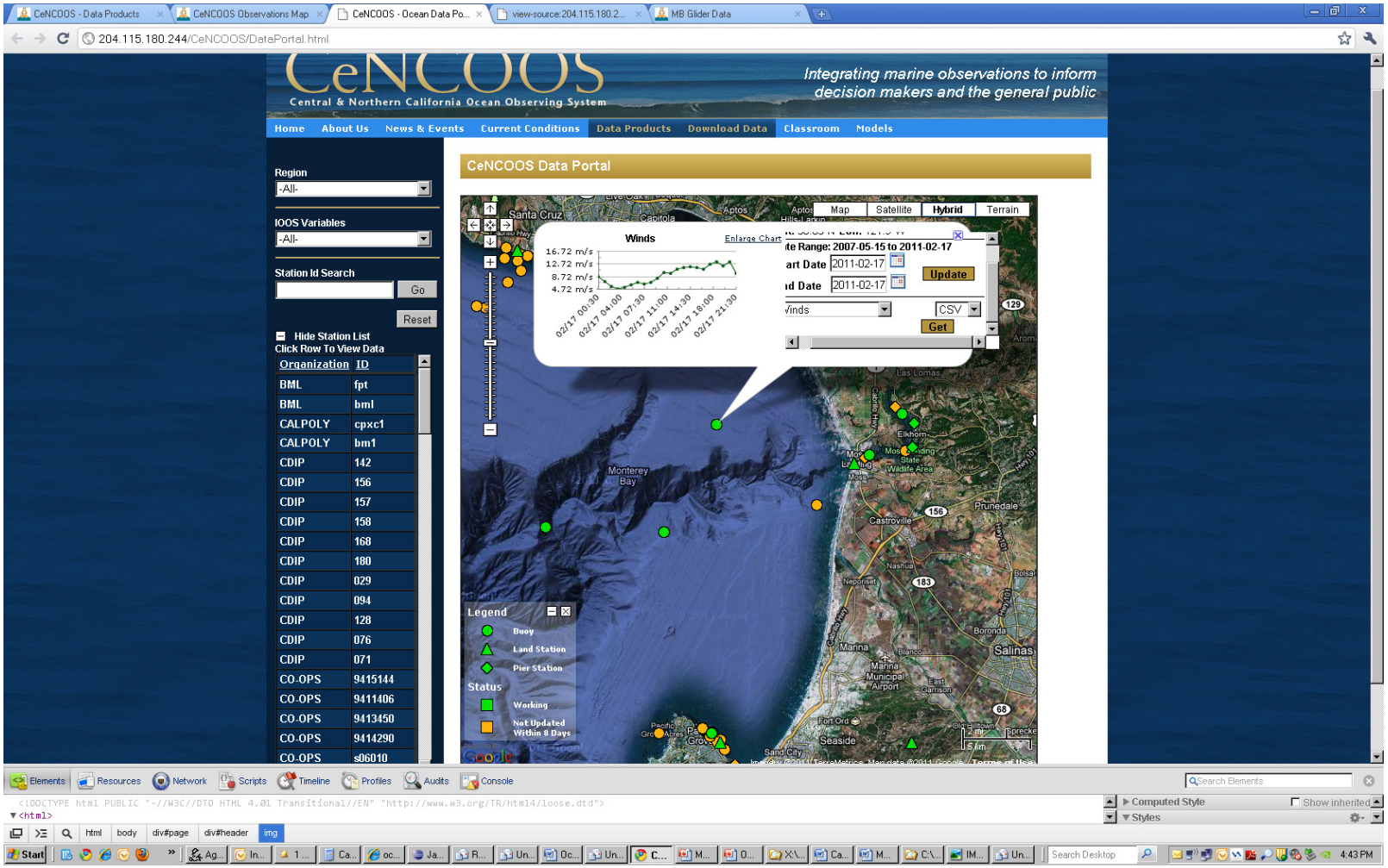
ODSS First Prototype
Collaborative Science (CoSci) Data Tools



ODSS First Prototype
CoSci Threaded Discussion Tool



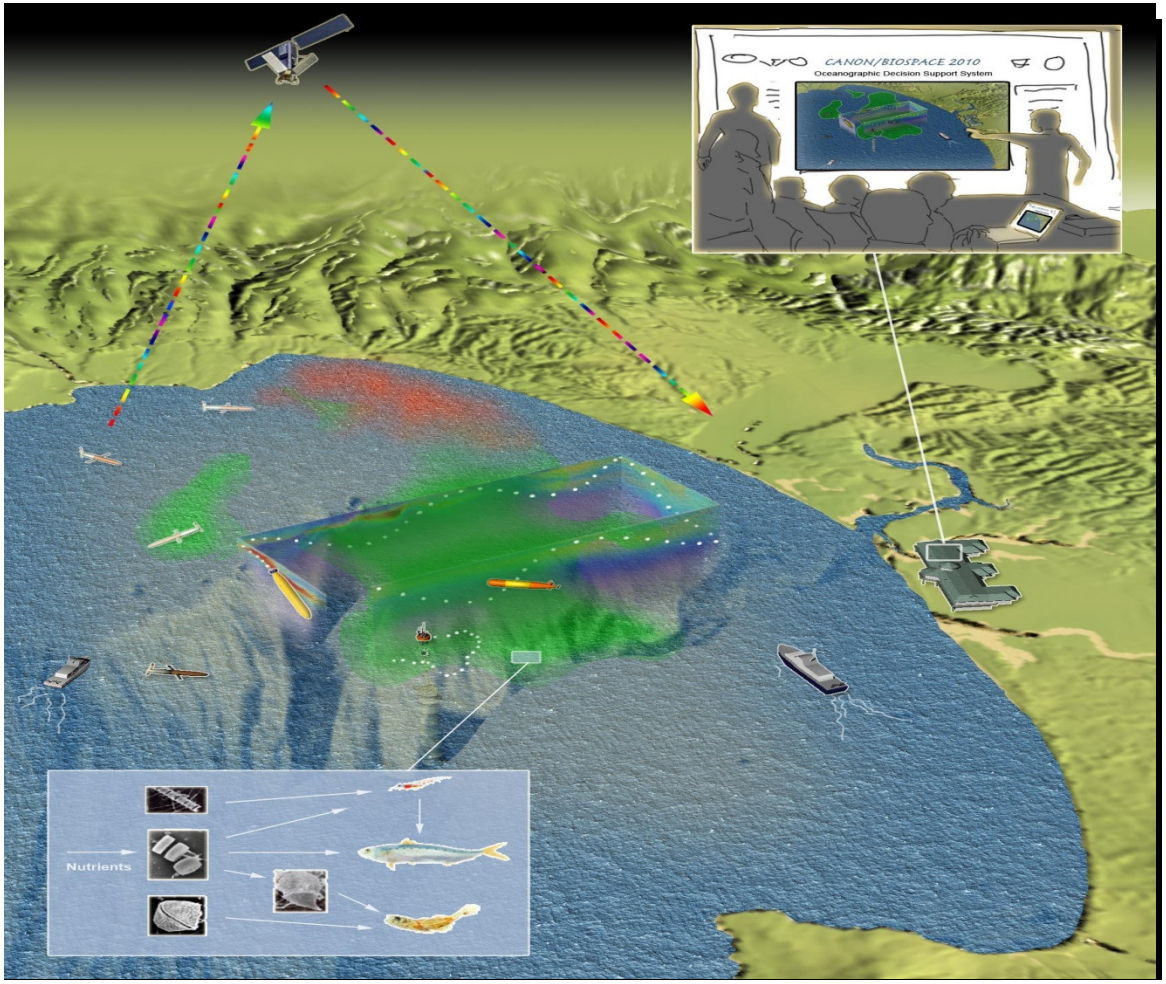
Data collaboration with CENCOOS



http://www.cencoos.org/sections/news/MontBay_HAB_experiment_2010.shtml

ODSS used in Oct. 2010 BloomEx / BioSpace

R/V Pt. Sur
R/V John Martin
R/V Zephyr
R/V Shanna Rae
Dorado Gulper
LRAUV
Remus 100's
Remus 600
Drifters
Moorings
Two Airplanes
Spray Gliders
UCSC Glider
Web Glider
Model ROMS
Model COAMPS
NASA Aqua
ESA MERIS
SeaWiFS
HF Radar



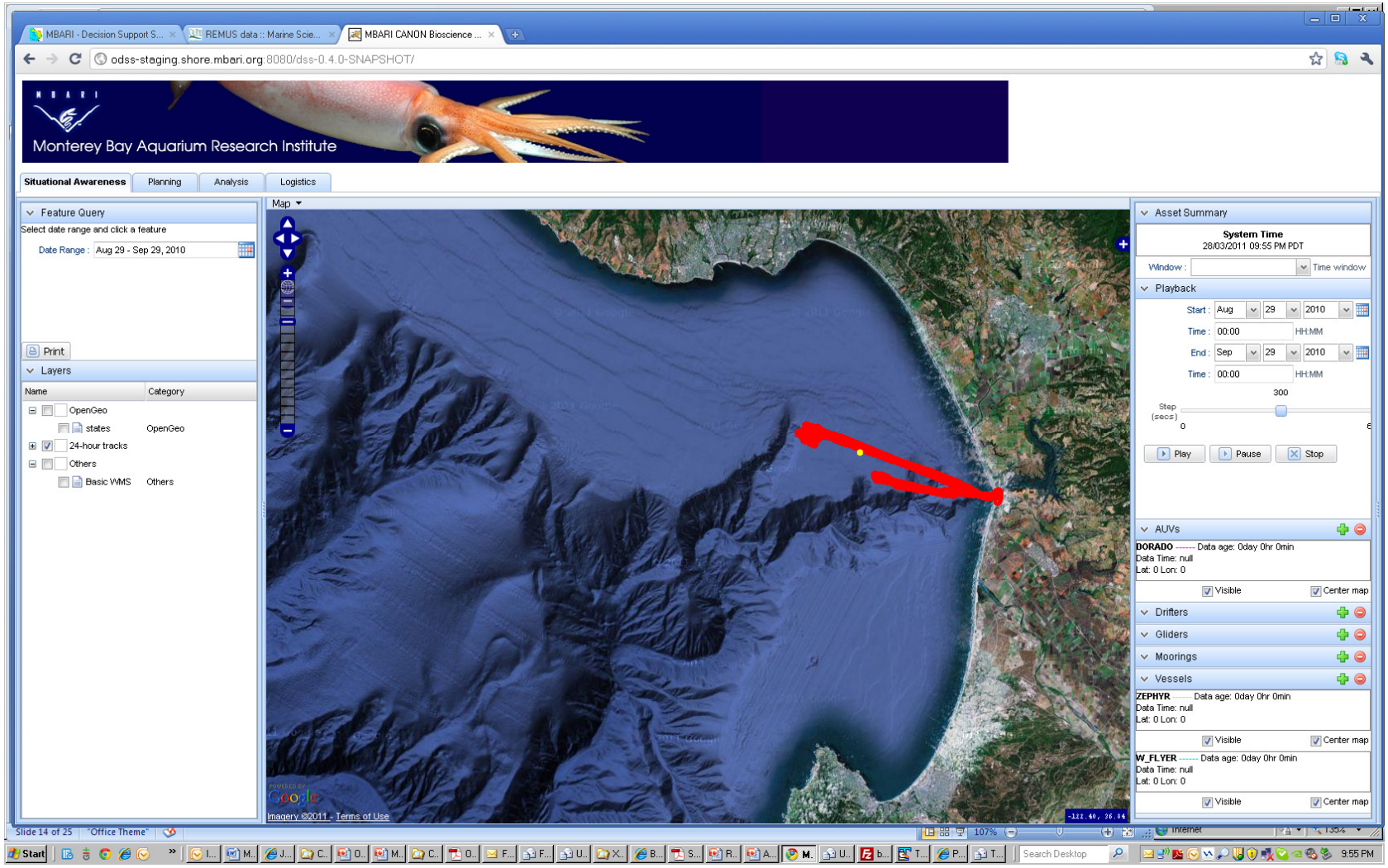
MBARI
NRL SSC
NRL DS
NPS
USC
UCSC
Cal Poly
Liquid Robotics
CenCOOS
Stanford
U of H
UCB

Logistics, Planning, Operations, Communications, and the data…
Can we get that in 4D, near real time?

2011 Activities

- MBARI engineering resources added
- Lessons learned from 2010
- Strong data management system foundation, integrate LRAUV platform.
- Standards based web services architecture
- Robust messaging and communications infrastructure
- Integrate ‘shore-side’ autonomy capability – “robot ballet”
- Explore web app software technologies
- Three field campaigns in 2011 – April, June, September

ODSS Web Application 2011



2012 Activities and Next Steps

- Lessons learned from 2011
  - Bug fixes and replace SmartGWT, etc. web components used in Situational Awareness
- Start work on “Data Analysis” capability
  - Define requirements for data access system
    - Access privileges for sensitive data
  - Automate the execution of ‘select’ data analysis
- Implement visual planning capability
- May and September field experiments

Thank-you and Acknowledgements

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- Special thanks to Jim Bellingham and Mike Godin for the ONR funded AOSN program and contributions on collaboration tools. Also for the concepts on data management and visualization contributed from the LRAUV program. Thanks to Yanwu Zhang for his work on sampling algorithms.
- Thanks to Jnaneshwar Das of USC and NSF for his funding, also his advisor Gaurav Sukhatame of USC.
- Thanks to MBARI engineering (co-authors), science and marine operations
- And a most importan thanks to CANON Principal Investigators: Francisco Chavez, Jim Bellingham, Kanna Rajan, John Ryan, Chris Scholin, Ken Smith, Bob Vrijenhoek, Alex Worden, Steve Haddock.

Links

- CANON: http://www.mbari.org/canon/
- AOSN: http://www.mbari.org/aosn/
- Autonomy: http://www.mbari.org/autonomy/
  - AUV Curtain plots: http://www.mbari.org/autonomy/TREX/Sep_2011.htm
- CENCOOS: http://www.cencoos.org/
- ODSS: http://www.mbari.org/canon/DSS.htm

Backup slides

Abstract: AN OCEANOGRAPHIC DECISION SUPPORT SYSTEM (ODSS) , A SOFTWARE TOOL TO IMPROVE EFFICIENCY OF BIOLOGICAL OCEAN STUDY

- The Controlled, Agile, and Novel Observing Network (CANON) team at MBARI is creating new ways to remotely assess biological ocean conditions and collect samples of microorganisms. In addition to science, the CANON program has an engineering component.
- The coordination of multiple science objectives and multiple mobile platforms provides a rich problem domain for engineering.
- MBARI engineering studied the workflow of the CANON science campaigns created requirements for an Oceanographic Decision Support System (ODSS).
  - The tool provides a set of perspectives that map to the workflow of the experiment. The high level functionality provided in the tool: 1) Situational Awareness: platform trajectory and real time data 2) Logistics and planning of asset deployment. 3) Collaborative discussion workspace 4) Real-time mobile platform control and coordination 5) Data access and analysis.
  - The engineering team is following an iterative development process and is hosting the software as an open source project. The presentation will cover the high level requirements, architecture, implementation overview and lessons learned in the CANON experiments.
- The team has fielded various iterations of the ODSS software tool in several CANON experiments. The ODSS has successfully facilitated scientists in their efforts to adaptively follow, sense and sample the changing conditions of upwelling driven algal bloom.