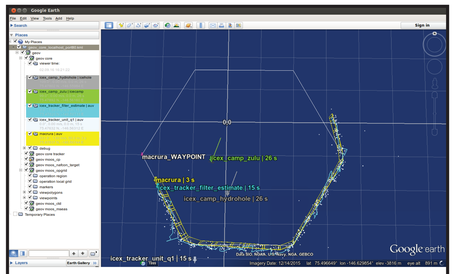
ICEX 2016 MIT Autonomous Underwater Vehicle: *Communications and Tracking*

gobysoft.org aquatic software

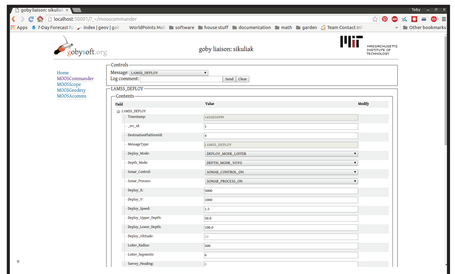
Massachusetts Institute of Technology

Unified Command and Control Topside

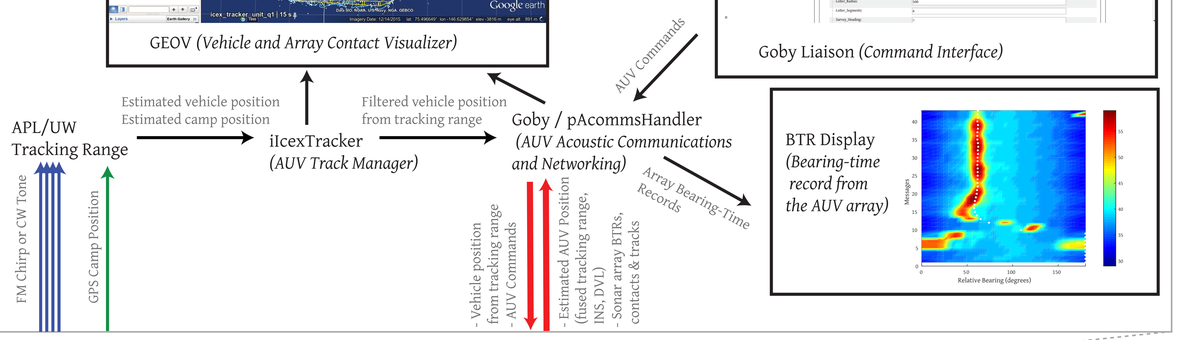
- ~ Goby Communications
  - ~ Dynamic Compact Control Language - flexible, unit-safe, type-safe language for marshalling data to be sent over slow links (e.g. acoustic, satellite)
  - ~ Time-sensitive priority queuing: data buffering that balances both overall value and time sensitivity of data to be sent over highly latent links (e.g. acoustic, store-and-forward networks)
  - ~ Generic Modem Driver for interfacing with many types of at-sea and simulation physical layers
    - ~ WHOI Micro-Modem Medium Frequency (MF) for Digital Acoustic Communications in collaboration with NUWC.
- ~ APL/UW Tracking Range for Ice Camp and Vehicle Locations
- ~ Google Earth interface for Ocean Vehicles (GEOV) Visualizer
- ~ Goby Liaison Operator Command Interface
- ~ BTR Display: near-realtime display of computed bearings from the AUV towed passive acoustic array

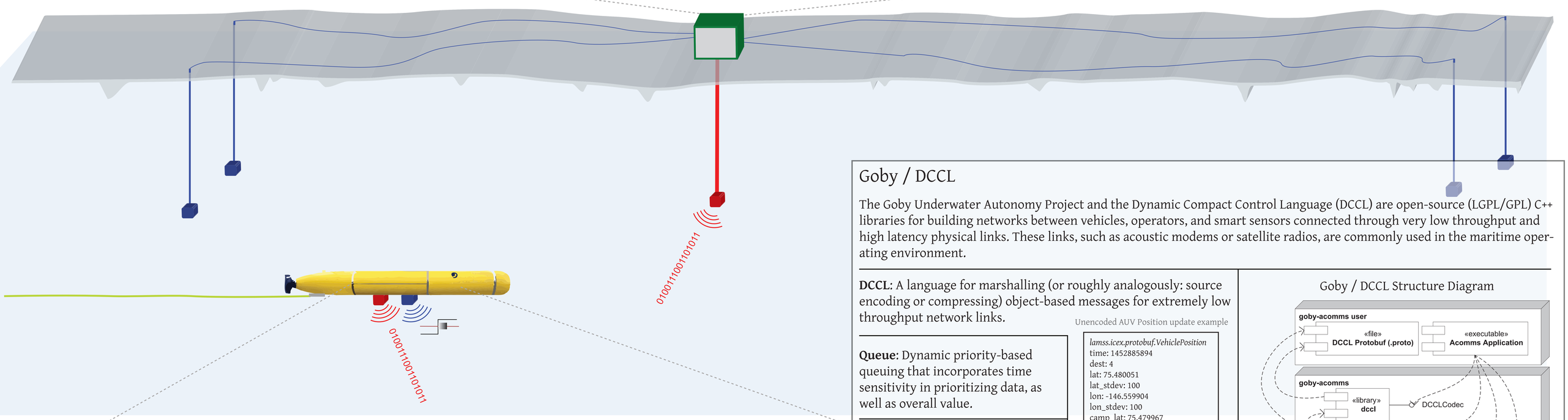


GEOV *(Vehicle and Array Contact Visualizer)*



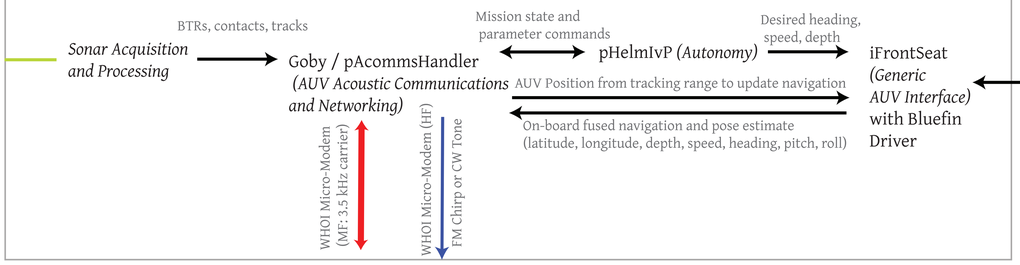
Goby Liaison *(Command Interface)*





Macrura AUV Payload

- ~ MOOS-IvP Autonomy
- ~ Goby Communications
  - ~ WHOI Micro-Modem High Frequency (HF) for Tracking Range Pings
  - ~ WHOI Micro-Modem Medium Frequency (MF) for Digital Acoustic Communications



Bluefin AUV Main Vehicle Computer

Bluefin Huxley Architecture

Goby / DCCL

The Goby Underwater Autonomy Project and the Dynamic Compact Control Language (DCCL) are open-source (LGPL/GPL) C++ libraries for building networks between vehicles, operators, and smart sensors connected through very low throughput and high latency physical links. These links, such as acoustic modems or satellite radios, are commonly used in the maritime operating environment.

DCCL: A language for marshalling (or roughly analogously: source encoding or compressing) object-based messages for extremely low throughput network links.

Unencoded AUV Position update example

lamss.icex.protobuf.VehiclePosition
time: 1452885894
dest: 4
lat: 75.480051
lat_stdev: 100
lon: -146.559904
lon_stdev: 100
camp_lat: 75.479967
camp_lon: -146.560049

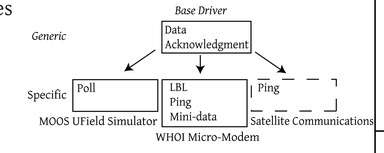
BygGEQnzNOzIwIL8A9knDbtnIP8A

Same message encoded (using DCCL) (shown as base64): 21 bytes total

Queue: Dynamic priority-based queuing that incorporates time sensitivity in prioritizing data, as well as overall value.

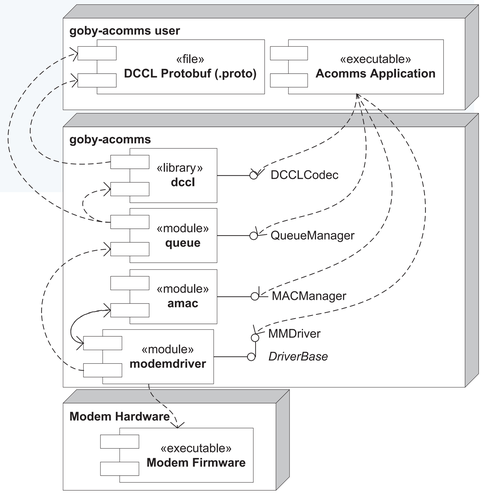
AMAC: Time division multiple-access (TDMA) medium access control (MAC) for multiple vehicles to share the same frequency band.

ModemDriver: A flexible interface that allows incompatibilities between different modems to be abstracted, while preserving unique functionality (e.g. long-baseline pings on an acoustic modem) when desired.



More information:
Goby: http://gobysoft.org/doc/2.0/
DCCL: http://libdccl.org

Goby / DCCL Structure Diagram



Partial list of other projects that have or are using Goby and/or DCCL:
- ~ DARPA Distributed Agile Submarine Hunting (DASH)
- ~ Bluefin Robotics TOPICS Communications Architecture
- ~ DARPA Robotics Challenge (DRC)
- ~ ONR Shallow Water Autonomous Mine Sensing Initiative (SWAMSI)
- ~ NATO Centre for Maritime Research and Experimentation AUVs