Ocean-TUNE: A Community Ocean Testbed for Underwater Wireless NEtworks

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Motivations

- Simulations have limitations
  - No commonly accepted acoustic channel model
  - Unique features of the practical systems

- No common platform to validate research work in real world scenarios

- No real experiment data repository and advanced configurable acoustic modems
Objectives

- Explore practical issues such as communication/network dynamics and cross-layer optimization
- Encourage a rapid growth of the UWN community
- Facilitate the research of the community
- Move the whole field to the next milestone
Broader Impacts

• Societal Impacts
  • Enable a wide range of research within the community:
    • Communication
    • Networking
    • Engineering
    • Marine science
  • Promoting unprecedented progress towards practical solutions in diverse aquatic applications

• Educational Impacts
  • Afford a unique hands-on learning environment for undergraduate and graduate students
  • Serve as a powerful means for engaging K-12 students and teachers
Broader Impacts (Cont.)

- Industrial Impacts
  - Demonstrate the capacity of underwater wireless networks
  - Encourage commercial applications:
    - Surveillance
    - Health
    - Climatology
    - Meteorology
    - Oceanography
    - etc.
Ocean-TUNE Overview (1)

- **Ocean Testbed for Underwater Networks**

- An open testbed “suite” accessible to the public

- Collective efforts from four universities
  - University of Connecticut (UConn)
  - University of Washington (UW)
  - University of California Los Angeles (UCLA)
  - Texas A&M University (TAMU)

- Diverse Coverage of the US coast
Ocean-TUNE Overview (2)

- **Key features**
  - Ubiquity
  - Economy
  - Flexibility
  - Openness
  - Configurability
  - User-friendliness

- **Supported by NSF CRI**
  - UConn (lead), UW, UCLA, TAMU
  - $2,635,000 for 3 years

- **URL:** [http://www.oceantune.org/](http://www.oceantune.org/)
Sea Testbed with 4 sites:
- Long Island Sound
- Santa Monica Bay
- Galveston Bay
- Hood Canal

<table>
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<tr>
<th>Site</th>
<th>Location</th>
<th>Surface Nodes</th>
<th>Bottom Nodes</th>
<th>Mobile Nodes</th>
<th>Reconf. Modems</th>
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<td>3</td>
<td>5</td>
<td>2 Slocum Gliders</td>
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<td>Galveston Bay</td>
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Research Activities

- Tempo-Spatial Multi-level Dynamics (UConn)
  - Robust Channel Solutions
  - Reliable Link Solutions
  - Resilient Network Solutions

- Adaptive Physical and MAC Layers (UW)
  - Adaptive physical layer modulation and modem signal processing based on OFDM modulation
  - Adaptive cognizant MAC protocols that effectively support broadcast functionalities

- Efficient Localization Schemes (UCLA)
  - Dive‘N’Rise (DNR) Positioning
  - Network-based Localization

- Software-Defined Acoustic MIMO-OFDM (TAMU)
  - Space, time, frequency, power, and code
Ocean-TUNE Hardware (1)

• Acoustic Modems
  • Benthos ATM-885
    • Handle multipath up to 25ms at 600bps
    • High speed mode up to 15,360 bps
  • AquaSeNT modem
    • Handle multipath up to 150ms at 6,300bps
    • High speed mode up to 9,000 bps
Ocean-TUNE Hardware (2)

- System Board (UConn Version)
  - RF modem
  - Power Distribution Board
  - Micro-controller
  - Battery Pack
Ocean-TUNE Hardware (3)

- Surface Nodes (UConn Version)
  - Solar panels
  - A radar reflector and flasher
  - A surface wireless communication system
  - A splash-proof compartment
  - Acoustic modems
  - A GPS unit
  - An anchor
Ocean-TUNE Hardware (4)

- **Bottom Nodes (UConn Version)**
  - A bottom A-frame
  - A waterproof compartment
  - An acoustic releases
  - An Acoustic modem
  - A small floatation device

- **Underwater Glider**
  - Slocum Gliders (from Webb Research)
Ocean-TUNE Software (1)

- Networking Development Kit
  - A comprehensive, reliable, and configurable underwater acoustic network solution
- Each kit includes:
  - A network development framework
  - Customized acoustic modem driver(s)
  - A set of sample networking protocols
Ocean-TUNE Software (2)

- Web-based Graphic User Interface (GUI)
  - Easy access
  - Remote control
  - Online monitoring
  - Experiment management
  - Access control
  - Experiment reservation
Ocean-TUNE Software (3)

• Acoustic Remote Control
  • Necessity
    • Enable remote control and monitoring for underwater nodes
  • Responsibilities
    • Remote control
    • Online monitoring
    • Node reprogramming
    • Real-time data collection
  • Practical Issues
    • Security
    • Reliability
    • Multi-hop networks
    • Overheads: bandwidth, energy, efficiency, etc.
UConn Testbed Vista

- **Location:**
  - Long Island Sound
- **Water depth:**
  - 20~80 meters
- **Facilities**
  - 3 surface nodes
  - 5 underwater nodes
  - 3 underwater gliders
Long Island Sound Deployment

- Initial testbed deployment
- Location:
  - Near Avery Point Campus
- Experiment date:
  - Aug 14~27, 2012
- Number of nodes:
  - 4 surface buoys
Conclusions

- Ocean-TUNE is a community testbed that opens to public
- It consists of four test beds in the US
- Diverse coverage in terms of geography and weather
- Major properties
  - Ubiquity
  - Economy
  - Flexibility
  - Openness
  - Configurability
  - User-friendliness
THANKS!

Questions & Comments?