Networking Group

NSF Workshop on

Underwater Wireless Communications and Networking

Architectures

- Affordable devices
  - Enabling Large Deployments, supporting new applications
- Reconfigurable, information (or content) centric, mobility-aware architectures (Network Layer)
  - Software-defined networking
  - Support Robustness/Reliability
- Reprogrammable, self-organizing, self-healing, self-optimized (MAC/PHY Layer)
  - Software-defined Nodes not only way to enable reconfiguration
  - Reconfigurable Hardware (reprogrammable FPGA)

Architectures, IoUT Scenario/Application

- Mobility
  - Nodes joining/leaving the network
  - Full support to AUVs (more pervasive as costs go down)
  - Use opportunistically mobility (intentionally or unintentional/drifting?)
  - Move AUVs to guarantee networking/coverage or use opportunistically their mobility

- What is required to realize IoUT?
  - Multi-tier networks (accommodate low-end devices/Things/sensors)
  - Things can be Humans
  - Interoperability with current Internet networks
    - Network Layer?
    - PHY Layer? – JANUS is one step towards (is it enough?)

Routing

- More efficient routing algorithms required for smaller networks (e.g., 20 nodes)
- No grand challenges when network scale is small, new requirements/solutions though in IoUT
  - Geocasting/multicasting solutions that are underwater specific
  - Proactive vs reacting, pros and cons, new hybrid solutions
- Support for multi-modal and multi-medium networks
  - Different links and speeds
  - Transport layer awareness
- Distance-based/application-specific use of different modals/interfaces
  - i.e. optical, acoustic, magnetic induction
- Topology discovery
  - Efficient, low overhead
  - Limit the exposure (Covert communications/discovery) – application specific

Security

- Need for a well-defined problem statement
- Guidelines and requirements from the applications
- Cross-layer/All-layer solutions or Layer-specific solutions
  - Pros and Cons
  - Ex., use of Chaotic codes in CDMA at the Phy/MAC (distributed solution)
- Take advantage of the heterogeneity due to different modems/nodes, deployments of various generation of hardware
  - Change the computation burden based on the resources available (outsourcing/outbursting)
- Defining subset of attacks for different applications specific to underwater medium
- Application, user, and content specific adaptive security mechanisms

Authentication

- Bandwidth efficient
- Distributed or Localized, but likely no central entity (does not scale)
- No third party?
- Application specific solutions?

What do we need from others?

- Applications
  - Classes of applications and their requirements
    - To provide the right architecture
    - For example, 4 classes: loss tolerant/non tolerant, delay sensitive or insensitive
    - Core services
      - e.g. Geo-casting, multicasting
    - Security requirements
  - Novel applications
- PHY
  - Outage analysis (link/node)
  - Models to run simulations? Measures of temporal/spatial correlation of “links” (location/time specific)
- Implementation
  - Implementing some standardized tests (measuring some benchmark/pre-defined metrics)
  - Open Architecture Nodes – Community Testbed
  - Web Interface to run experiments remotely

Bridging the Gap between Simulation and Experiments

- SEAWEB provides models (e.g. shadow zones)
  - Deployment and architecture
- SNR BER formulas from RF are far from being true, upper limit
- Bellhop
  - missing Doppler effect and boundary conditions
  - Not time-variant
- Time-varying topology model
- Use past measurements
- Empirical dataset for link status (PHY layer)
  - Leveraged to design MAC/Routing design

Evaluation

- Benchmark, standardized conditions
- Theoretical framework to get upper bounds for network and mac protocols
  - To go beyond what is done now, i.e., comparing only with other competing solutions (under which conditions?)