Architectural Challenges in Underwater Wireless Sensor Networks

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Building UWSN requires interdisciplinary collaborations

- Design challenges in UWSNs
  - Communications
  - Networking algorithms/protocols
- Architectural issues in UWSNs
  - Workload characterization
  - Energy-efficient design and resource management
  - Lifetime estimation
System design of UWSNs

- Environmental constraints
- Application requirements

UWSN design
- Sensor node design
- Resource management
- Other design components

Energy consumption model

Lifetime estimation model

UWSN system parameters
Typical structure of a sensor node

- Sensor probes
  - Interface circuitry
- Controller (processors)
- Trans-receiver
  - Acoustic modem
- Storage
- Battery
- Triggerable air-bladder

Different from land-based sensors:
- Larger and more expensive
- More power hungry
- Prone to failures
Goals of underwater sensor nodes

- Easy to customize for different applications: workload characterization
  - Satisfying performance
    - Computing capacity
  - Storage
  - Bandwidth
- Long operation time: low power
  - Energy becomes more critical
    - Acoustic communications, memory, air-bladder, etc., more power-hungry
    - Energy harvesting difficult: solar and wind energy are not available
- Reliable operations
  - Fault tolerant
  - Secure
- Low cost: allows deployment of large amounts of nodes
  - Decomposable or retrievable
Energy-efficient design at the node level

- Design choices: ASIC, ASIP, FPGA, microcontroller
- Power-efficient design of individual components
  - Acoustic communication modules
  - Flexible packet relaying circuit
    - Only wake up the microcontroller when needed
- Proper task assignments and scheduling
  - Sampling, processing, storing, transmitting, receiving, and forwarding
- Exploiting opportunities in the underwater environment
  - Long and frequent sleep mode due to the long delay of acoustic channels
In the near future, …

- Prototype node built with off-the-shelf parts
  - PDA
  - Acoustic modem
  - Sensor
  - Interface board

- Investigating simulators for workload characterization
  - Data types and traffic patterns of specific applications
  - Routing and localization algorithms
  - Processors
    - Performance, power, etc.