Aqua-Net: An Underwater Sensor Network Architecture
Design, Implementation and Initial Testing

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Outline

- Motivations
- Aqua-Net
  - Features
  - Architecture
  - Components
- Case Study
  - UW-Aloha
- Conclusions
Motivations

- System architecture is application specific
- New implementation is time consuming
- Difficult to re-use existing code
- Hard to compare and evaluate performance
What is Aqua-Net

- A framework for Underwater sensor networks (UWSN)
- A set of standard interfaces for developers
- Make it easier to implement
  - Protocols
  - Applications
- Design philosophy
  - Lowering the “Narrow Waist”
  - Cross-layer design
  - User-friendly
Aqua-Net Features

- Easy to
  - Modify an existing protocol
  - Add a new protocol
- Developer friendly
  - Socket style (TCP/IP)
  - Implemented in user space
- High
  - Reusability
  - Portability
System Components

- Hardware platform
  - Acoustic modem
    - Micro-modem, Benthos modem, OFDM modem, etc.
  - Micro-controller
    - Gumstix

- Software platform
  - Operating system
    - Embedded linux
  - Network protocol stack
  - Interfaces and protocols
Protocol Stack

Aqua-Net

Micro-Modem
Benthos Modem
OFDM Modem

Physical Devices

Physical Layer Wrapper
NMEA Serial Comm.

USP

ALOHA
SDRT
FAMA

Link Layer Abstract
Link Layer Protocols
Network Layer Protocols

Pseudo BSD Socket Interface

Cross Layer Interface
System Database

User Applications

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Next: Hardware
# Hardware Platform

- **Gumstix**

- **Processor:** XScale™
- **Speed:** up to 600MHz
- **Memory:** up to 128MB RAM
  - up to 32MB Flash
- **Features:**
  - Serial port
  - USB support
  - Audio support
  - LCD support
  - CCD camera signals
- **Operating system:** Embedded Linux, etc.
- **Size:** 80mm x 20mm
Operating System

- Embedded Linux
  - Designed and optimized for embedded system
  - Well supported by open source community
    - Linux kernel
    - Applications
    - Development tools
- Widely used in commercial products
  - Mobile phones
  - Game consoles
  - Video cameras
Case Study: UW-Aloha

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UW-Aloha

- Traditional Aloha
  - Doesn’t work in UWSN

- Underwater Aloha (UW-Aloha)
  - Effective back-off scheme
  - Automatic repeat-request (ARQ)

- UW-Aloha work flow
UW-Aloha Back-off Schemes

- Binary exponential back-off
  \[ T_{bk} = (2^i - 1) \times t_o \]
  - \( i \): number of retransmissions
  - \( t_o \): minimal frame time

- Poisson back-off
  \[ T_{bk} = \frac{-1}{\lambda} \ln U \]
  - \( \lambda \): traffic load
  - \( U \): random variable, uniform on (0,1)
Lab Test Setup

- **Topology:**
  - One hop network
  - Multiple sources
  - Single sink

- **Testing environment**
  - Aqua-Lab
    - a. Micro-Modem
    - b. Sound mixer
    - c. Water tank
    - d. Hydrophone
    - e. Underwater speaker
Lab Test Setup (cont.)

- **Parameters:**
  - Sending rate: 80 bps
  - Frame size: 32 bytes

- **Testing scenarios**
  - Increasing total traffic by increasing sending nodes
Performance

![Graph showing performance](graph.png)

Next: Analysis vs. Tests
Theoretical vs Lab Testing Results

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Next: Conclusions
Conclusions

- **Aqua-Net**
  - Developer/User friendly
  - Robust & Reliable
  - Extendable & Configurable
  - Cross-layer design possible
  - Tested in many field trials

- **Future work**
  - Include more protocols
  - Support new techniques
Thanks!

Questions & Comments?