



March 28, 2006

# Acoustic Communication and Localization

Shengli Zhou

Wireless Communications  
Research Laboratory (**WCRL**)  
Dept. of ECE  
Univ. of Connecticut



## Acoustic Communication

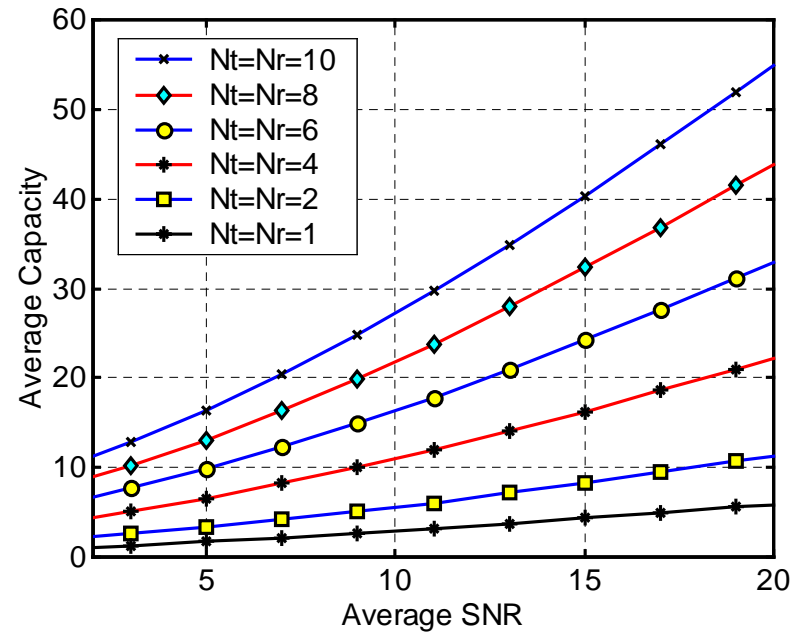
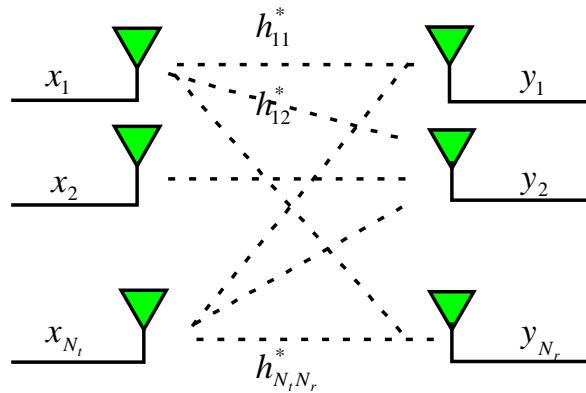
- Why acoustic? Radio does not propagate well in water
- Limitations and challenges for underwater communication
  - ✦ extremely low bandwidth, on the order of 10kHz
  - ✦ slow propagation speed → long multipath channels
  - ✦ high time variation
- Compared to radio, the development of underwater acoustic communication has been very slow
  - ✦ milestone 1: digital modulation by FSK (80's)
  - ✦ milestone 2: phase coherent modulation by PSK (90's)

## Paradigm Shift: From Single-Carrier to Multi-Carrier

- Existing approach: single carrier transmission with decision feedback equalization (DFE) [Stojanovic-Etal'94]
- Multicarrier modulation: very effective for long multipath channels
- Orthogonal frequency division multiplexing (OFDM)
- OFDM: the ``workhorse'' for wireless LAN (IEEE 802.11a/g/n)
- Can we replicate the success of OFDM in underwater?
- Currently work with M. Stojanovic on offline OFDM demodulation (Graduate student: Baosheng Li)

## The MIMO Promise

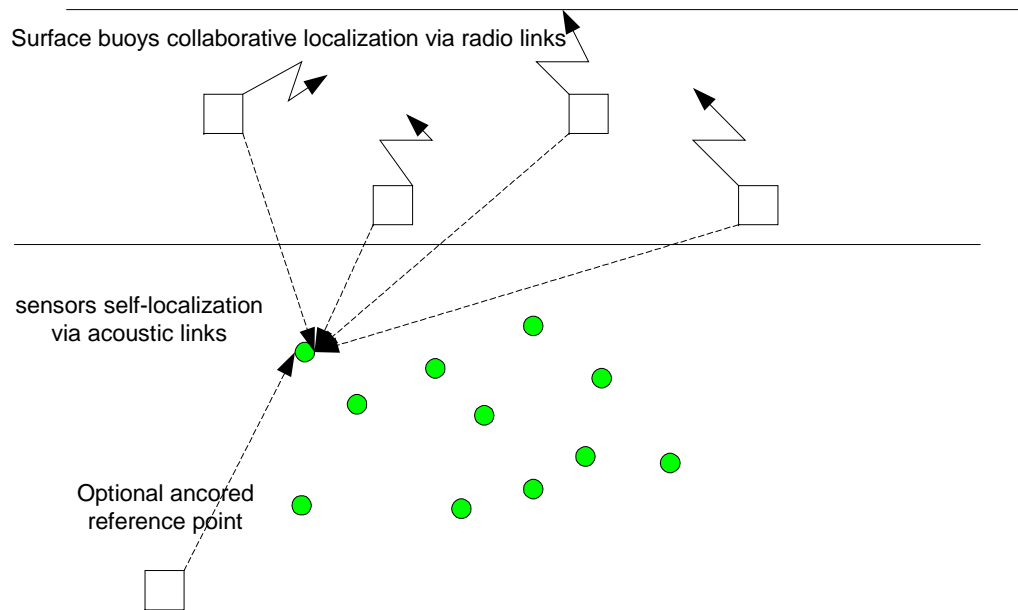
- Multi-Input Multi-Output via multiple antenna elements



- How to realize the MIMO benefits in underwater?
- Milestone 3: high-rate high-performance MIMO-OFDM

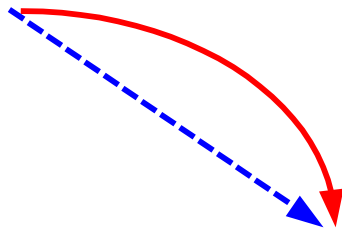
## Localization

- High-precision localization is a must for 4D environmental sampling
- Current approach: UAV interrogate fixed reference nodes (0.5m)
- Architecture for estuary monitoring: underwater GPS



## Approaches for High-Precision Localization

- Target high precision (around 10cm)
- Wideband waveform design: localization accuracy depends on signal strength and bandwidth (FH-OFDMA)
- Advanced tracking algorithm: incorporate kinematic models; high accuracy can be obtained via more frequency broadcasting
- Stratification effect compensation (ray tracing or other methods)

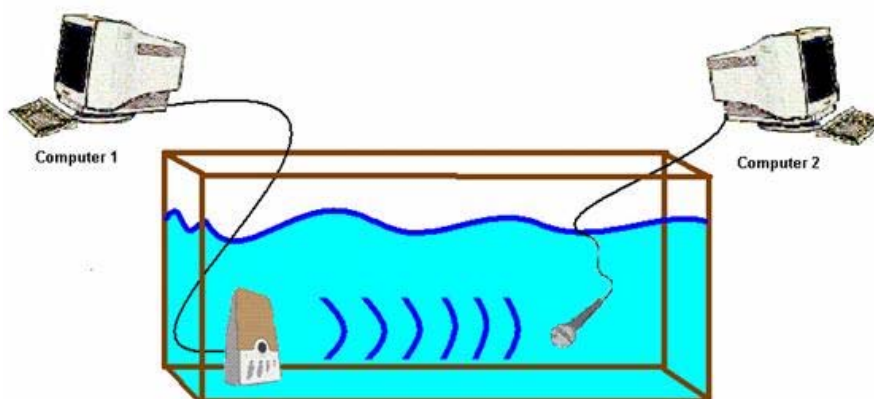


(Graduate student: Christian Berger)

## Senior Design Project

- Underwater Acoustic Modem

Sean Mason (EE), Nicoletti Anicette (EE), Robert Anstett (CE)



- Baosheng Li: OFDM modulation and demodulation
- Christian R. Berger: Timing/Synchronization
- Incorporate ``research'' into ``fun projects''