Underwater Distributed Systems

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Physical Layer Communication

- **Acoustic**
  - typical choice for communication
  - 100s of meters
  - slow propagation

- **Radio**
  - effective at very short ranges
  - not often used

- **Optical**
  - line of sight communication
  - over a few meters
Acoustic Communication

- Signal to noise ratio
  - Attenuation rates, longer distance means lower frequency
- Doppler Effect
  - Motion of nodes high as 0.1% of medium
- High speed is tens of kbps
- Interference
Access Control

- FDMA/TDMA very common
- Contention resolution
  - ALOHA - transmit when you have something to say
  - CSMA/CA - listen to medium before transmitting
  - DACAP & T-Lohi - designed specifically for acoustics
Transmit Example
Other network layers

- TCP/IP stack not suitable
  - Limit retransmission
  - Medium latencies are too high
- Not as well studied, formalized
  - Systems deployed with custom solutions, not shared
Challenges

● Expensive to deploy
  ○ Modeling very common
  ○ Nodes cost in $1000s range
  ○ Even testing in pool can be pricey

● Conditions harsh, hard to fix problems

● Battery power!
Converges quickly
Discussion

- AquaNodes
  - 60 MHz processor, algorithm in Matlab?
- Depth vs Surface Distance
- Power usage!
  - Avoiding 'hills'
- Determining points of interest