Overview of Acoustic Communications for the Universal Gateway Workshop

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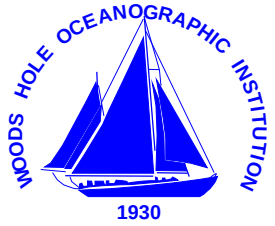
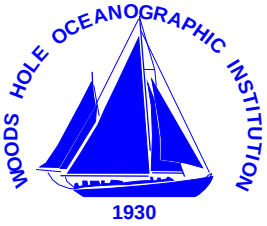


Outline

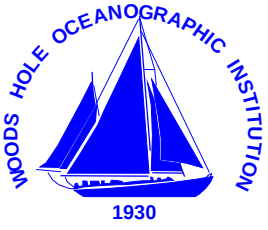
- Ocean acoustics overview.
- Modulation for acoustic communications.
- System-level performance issues.
- Performance estimates.



Ocean Acoustics and Undersea Communication

A Simple View - The Sonar Equations:

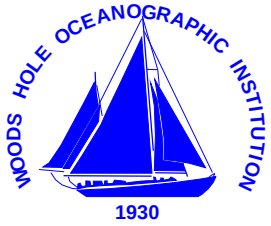
- Geometrical spreading $10log(R^2)$.
  (e.g. 1000 m = 60 dB)
- Absorption αR.
  (e.g. $\alpha = 0.5$ dB/km at 10 kHz)
- Frequency and location-dependent ambient noise.
  (e.g. 40-50 dB re μPa/Hz at 10 kHz)
- Man-made, own-ship and biological noise.
  (e.g. pile-driver, flow-noise, snapping shrimp)



Ocean Acoustics and Undersea Communication

Propagation Modeling for Ray Path Estimation:

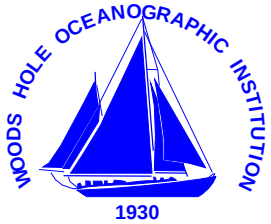
- Raytrace approximation.
- Range and depth-dependent sound-speed.
- Surface reflections.
- Bottom interaction.



Doppler and Undersea Communication

Frequency Shift and Spread:

- Doppler *shift* due to source-receiver motion.
- Doppler *spread* due to moving reflectors (e.g. surface waves).



Modulation for Undersea Communication

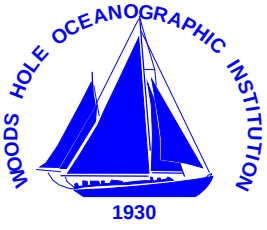
Phase-Coherent

- m-ary signaling provides high bandwidth efficiency.
- Receiver algorithms compensate for multipath and Doppler.

Incoherent

- Frequency-hopped, multi-frequency or FM.
- Receivers use coding, interleaving, diversity, etc.

Note: Code-Division (spread-spectrum) techniques are applicable to both, providing multiple-access and reduced signature.



System Issues and Performance (Range-Throughput)

Primary System Performance Drivers:

- Transmit and receive frequencies.
- Available receiver array aperature.
- Maximum source level.

Primary Channel Effects:

- Acoustic propagation (path strength, delay, rate of change, etc.)
- Source-receiver Doppler shift.
- Total noise at receiver.

Note: Performance estimation is very difficult, mostly due to uncertainties in the channel.