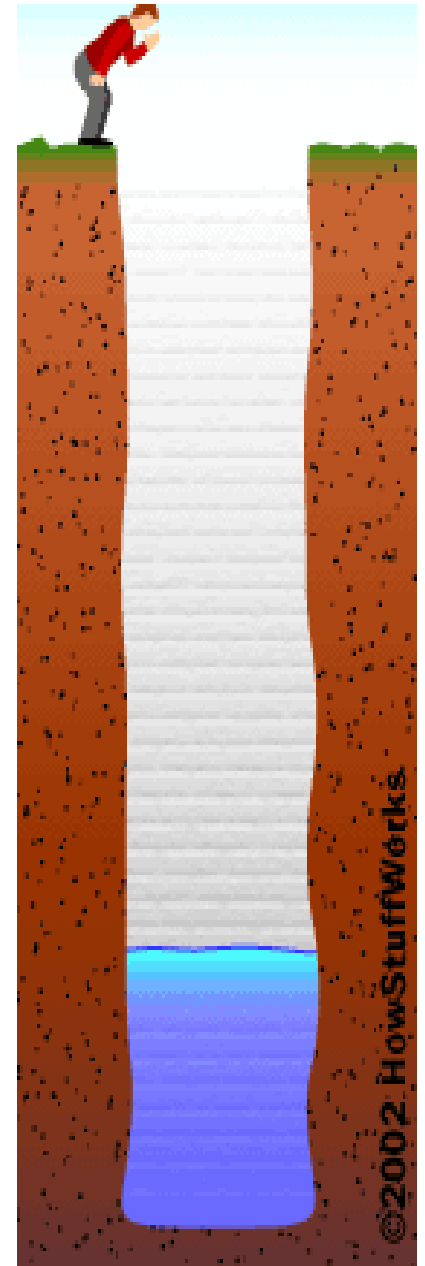


What is Echo?



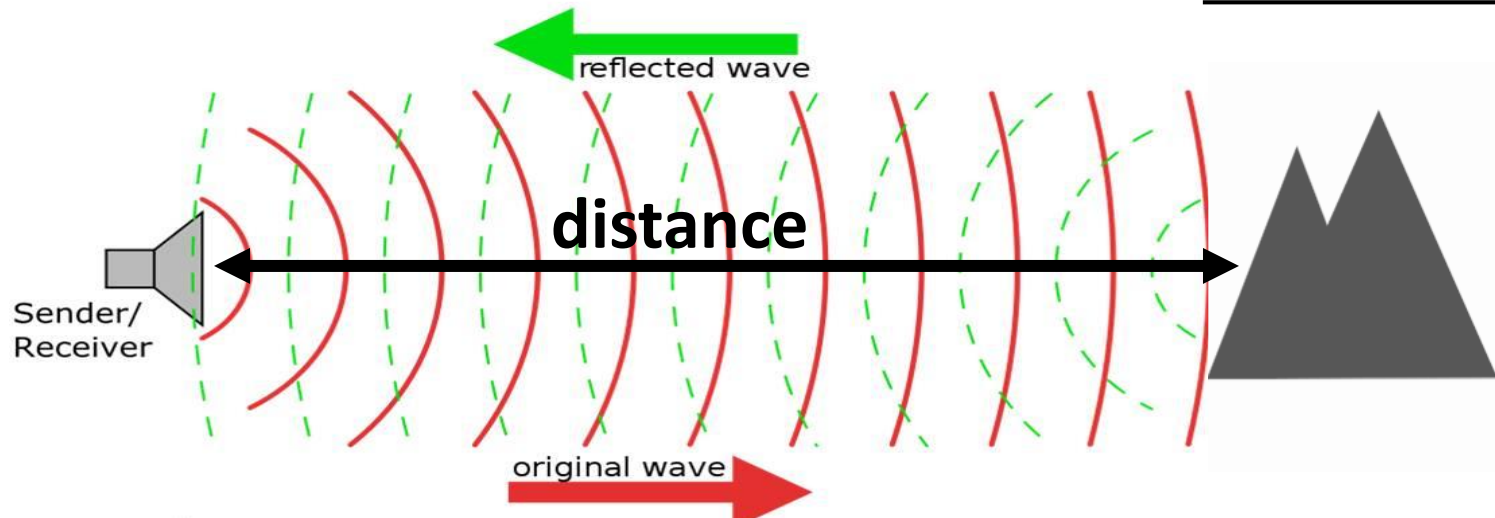
An echo is a reflected sound wave.

- For a human to hear the echo clearly, the delay in time between the original sound and reflected one must be at least 0.1 seconds (our ears can detect two separate sounds if they are at least this much apart).
- The **repeated reflection** (multiple overlapping echoes) of sound in closed quarters perceived as *persistence* of sound is called **reverberation**.



What is the minimal distance to an object that guarantees a clear echo?

- Let's consider AIR: sound travels at 343 m/s in air
- Time delay between the original sound and reflected one: minimum 0.1 s

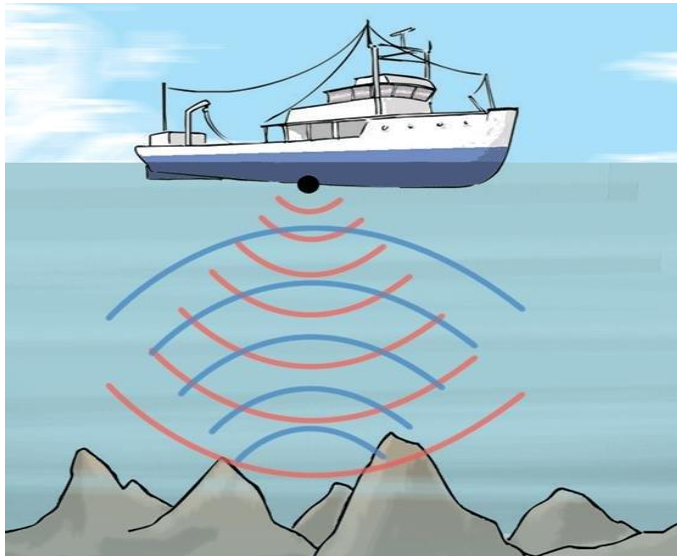
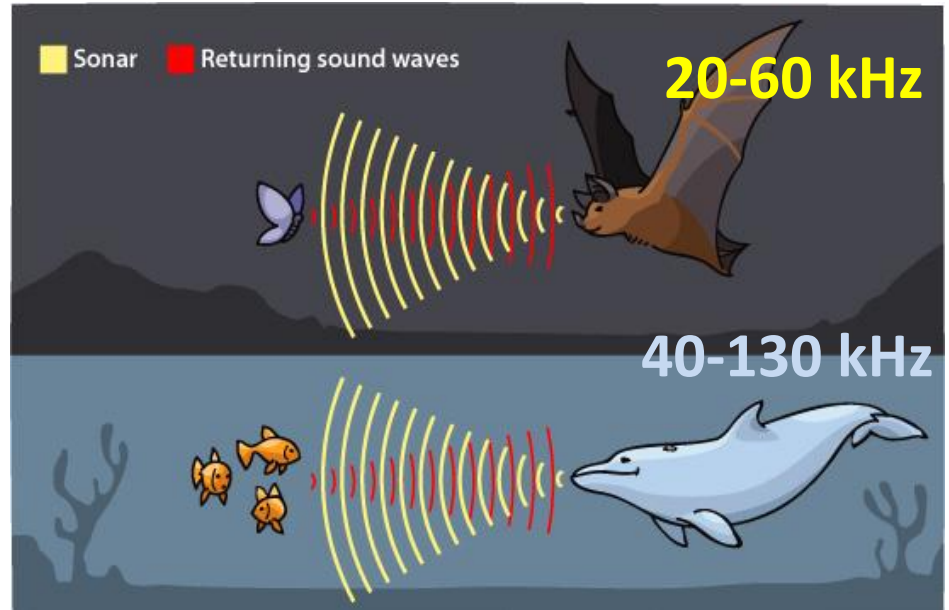


$$\text{DISTANCE} \cdot 2 = \text{SPEED} \cdot \text{TIME} = 343 \cdot 0.1 = 34.3 \text{ m}$$

Distance to an object must be **more than 17.2 m** (34.3 m back and forth) to produce a clear echo!

Echolocation and SONAR

- **Echolocation:** animals such as bats and dolphins send out **ultrasound** waves and use their echoes to identify the locations of objects they cannot see. Animals use echolocation to find prey and avoid running into objects in the dark.



- **SONAR (sound navigation ranging)** is a technique that uses sound to navigate, communicate with or detect objects on or under the surface of the water. Sonars use a wide range of frequencies from **infrasonic** (provides longer range) to **ultrasonic above a megahertz** (provides high detail).