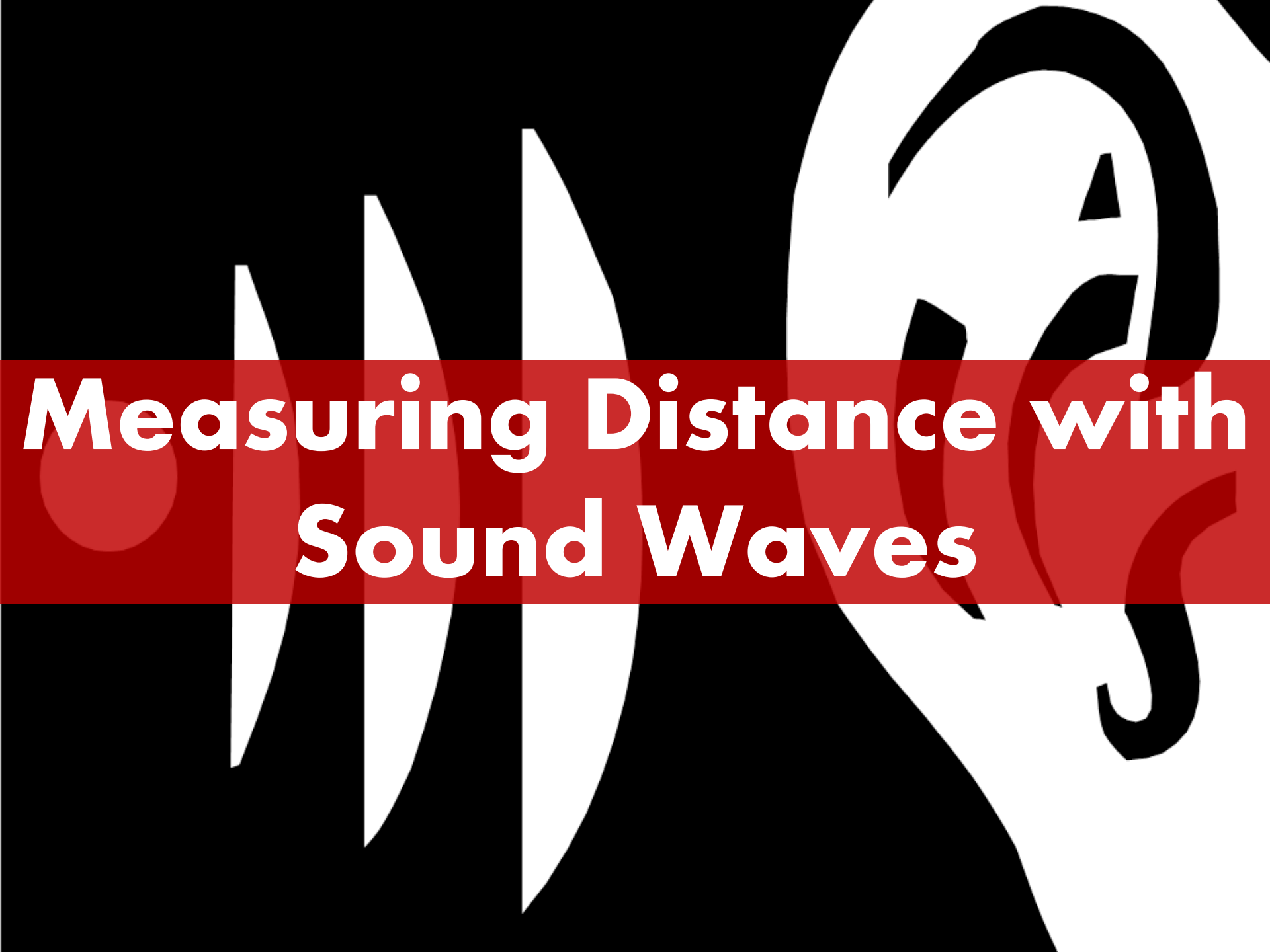


Measuring Distance with Sound Waves

To Do Now…

You are driving and need to determine the distance between your car and the car in front of you.

Come up with a way to determine the distance between vehicles without you leaving your car. *Note: you cannot use a ruler or a tape measure.*

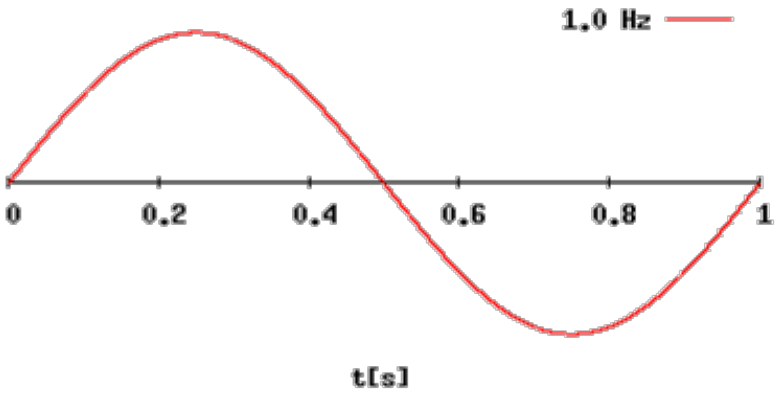
What is Frequency?

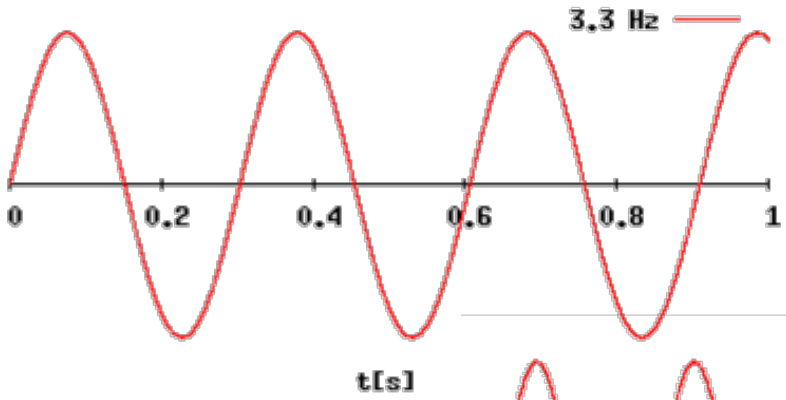
The frequency of a wave is defined as number of cycles the wave completes in a second.

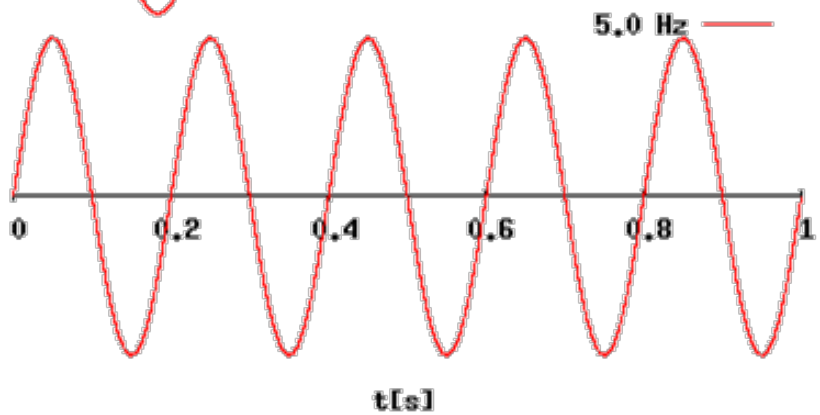
Hz (hertz) — is a SI unit of frequency
— defined as cycles per second

$$1\ Hz = 1/s$$

Frequency of a Sine Wave

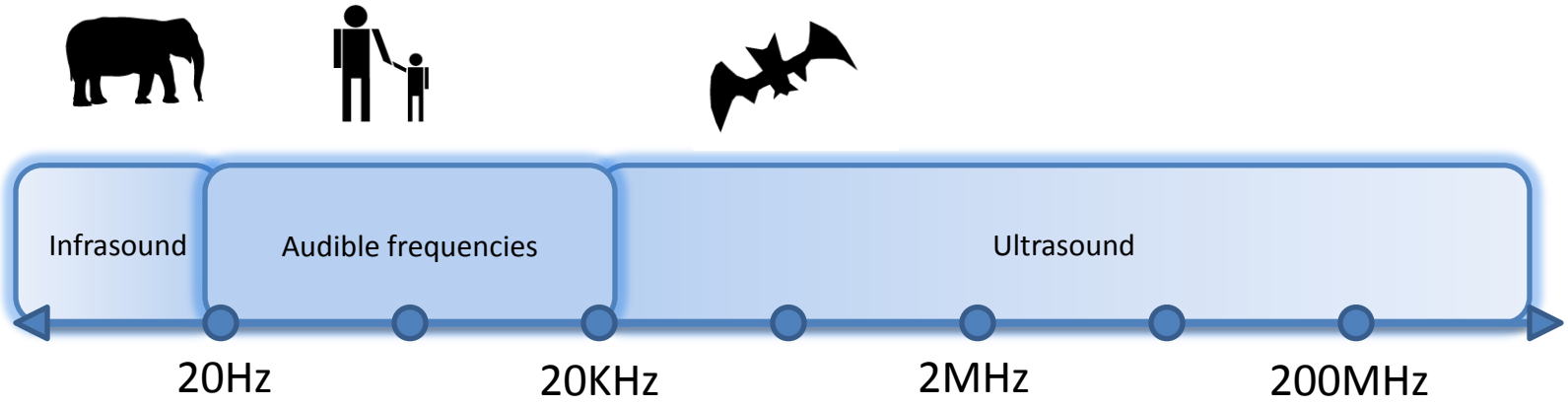






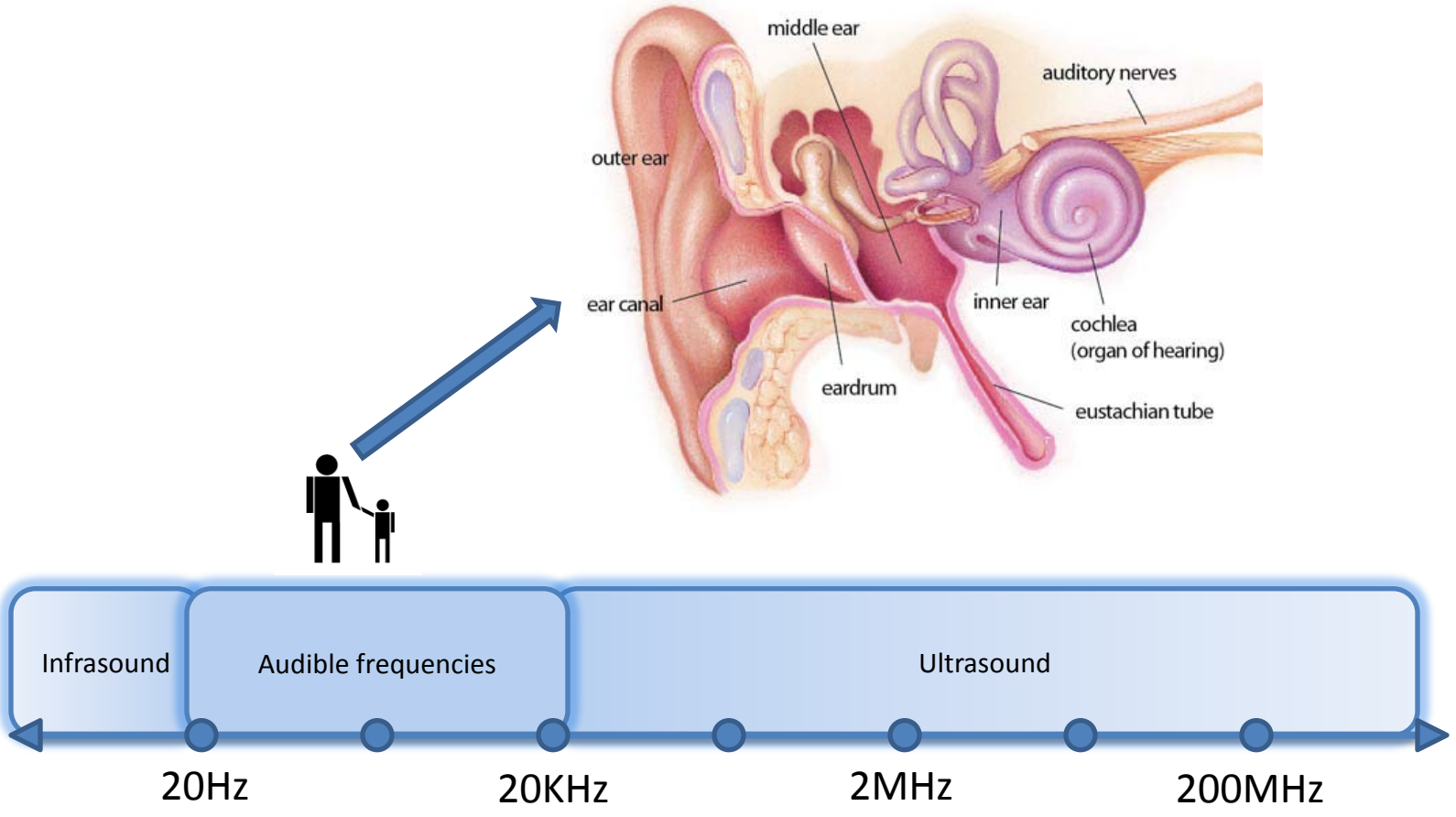
Sound comes in many frequencies

Can humans hear *all* types of sounds?



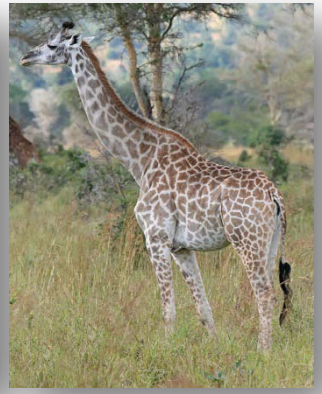
No, audible frequencies are what we can detect.

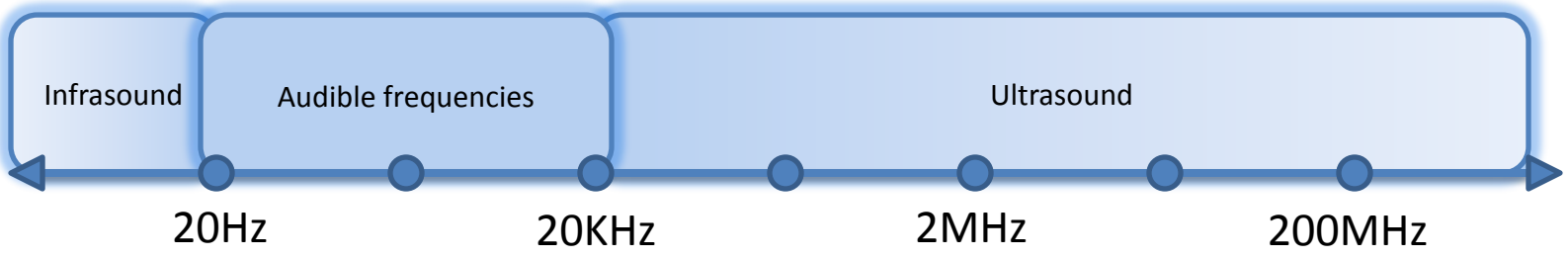
Because of our ear's construction, we can generally only hear a limited range of sounds.



Infrasound

Elephants and whales, along with other animals use infrasound to communicate.



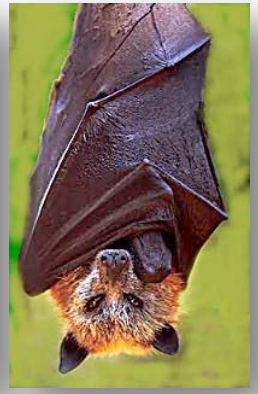
Impact of Nature on Infrasound

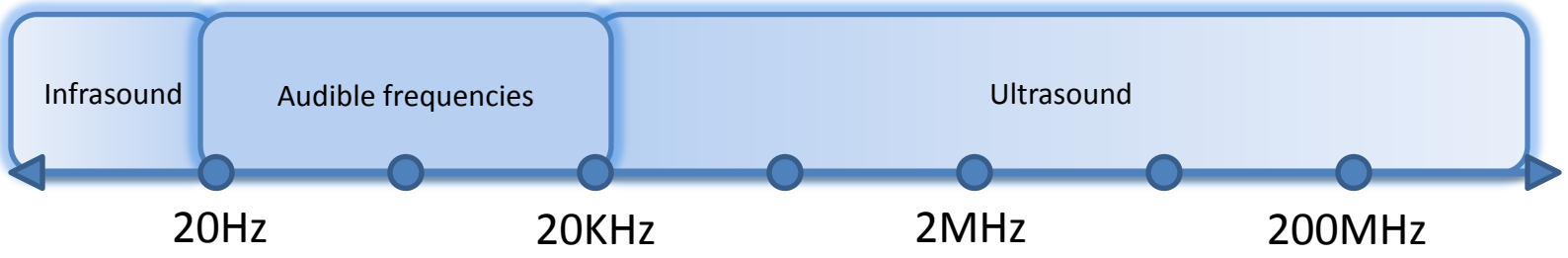
Infrasound can be generated by many of our Earth's natural events.

- Thunder
- Wind
- Volcanic activity
- Large waterfalls
- Ocean wave impact
- Earthquakes

Ultrasound

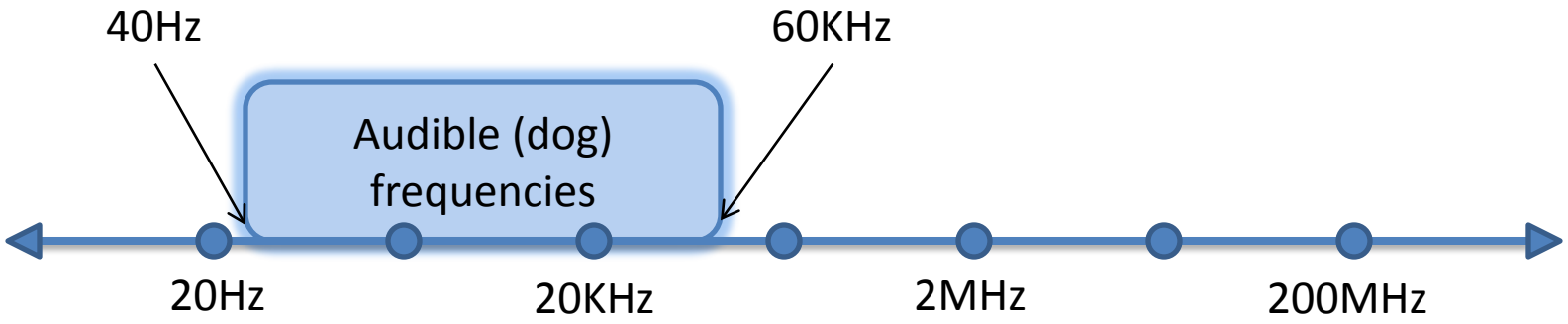
Many other small animals (cats, dogs, dolphins, bats and mice) can hear ultrasound.



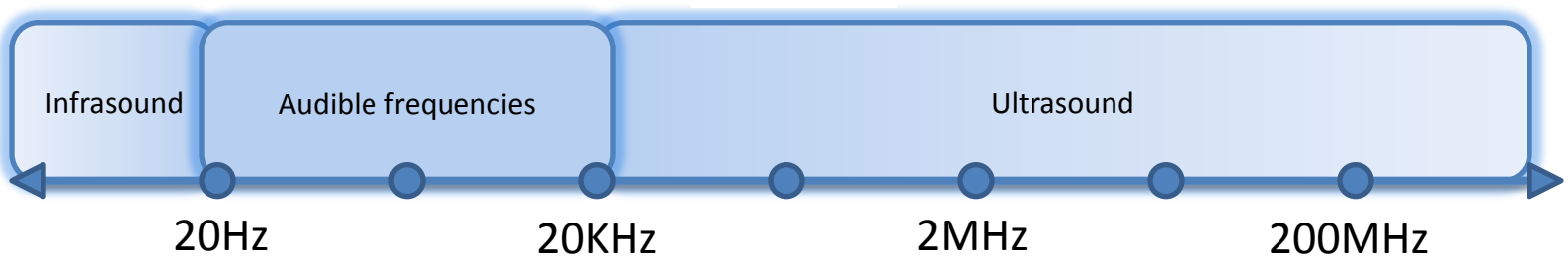
A dog's range of hearing...

Dogs can hear more ultrasound frequencies than humans, and humans can hear more infrasound than dogs.



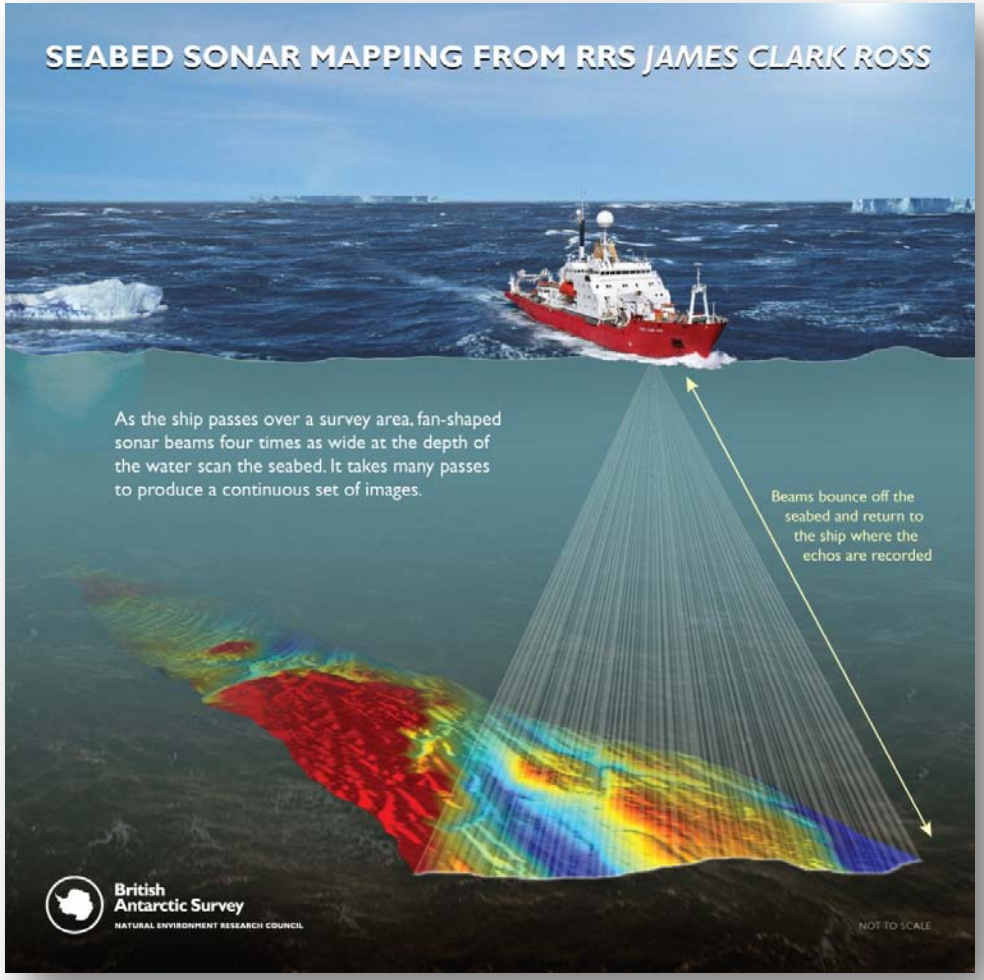
Ultrasonic Applications

Sonography



Ultrasonic Applications (cont'd)

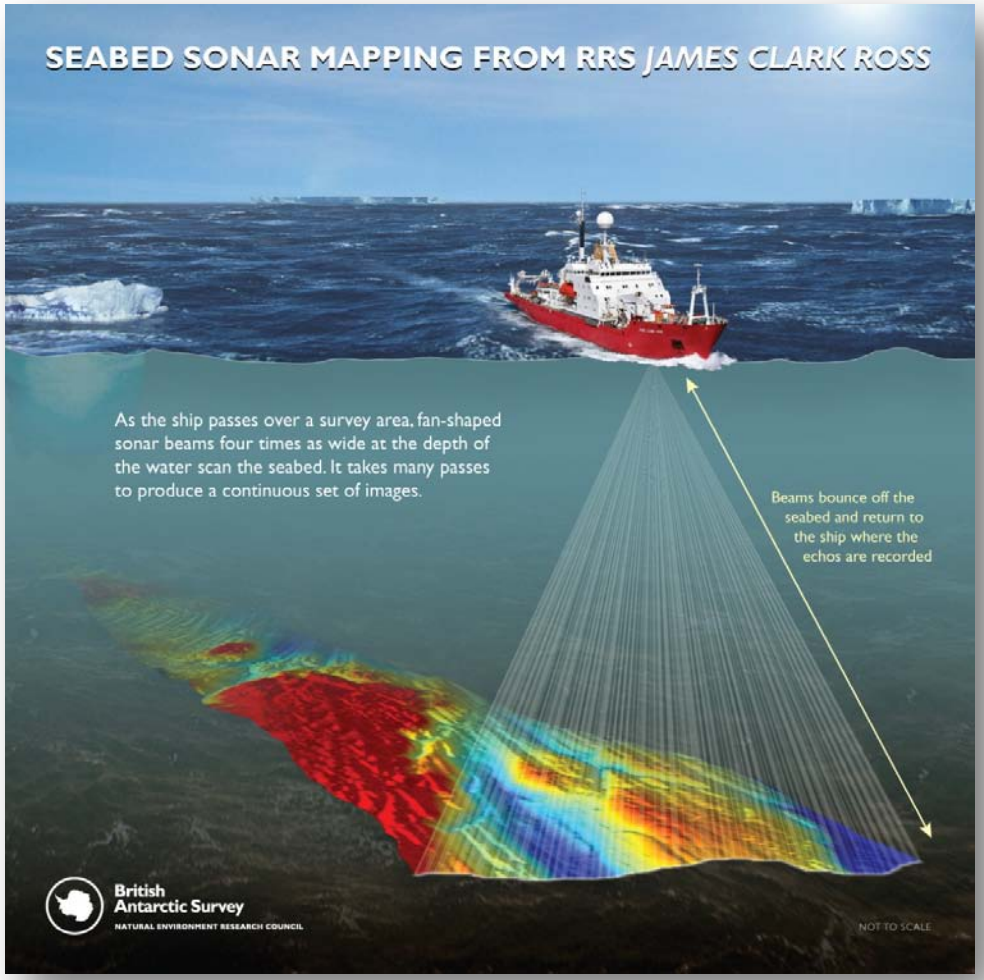
SONAR (SOund Navigation And Ranging)



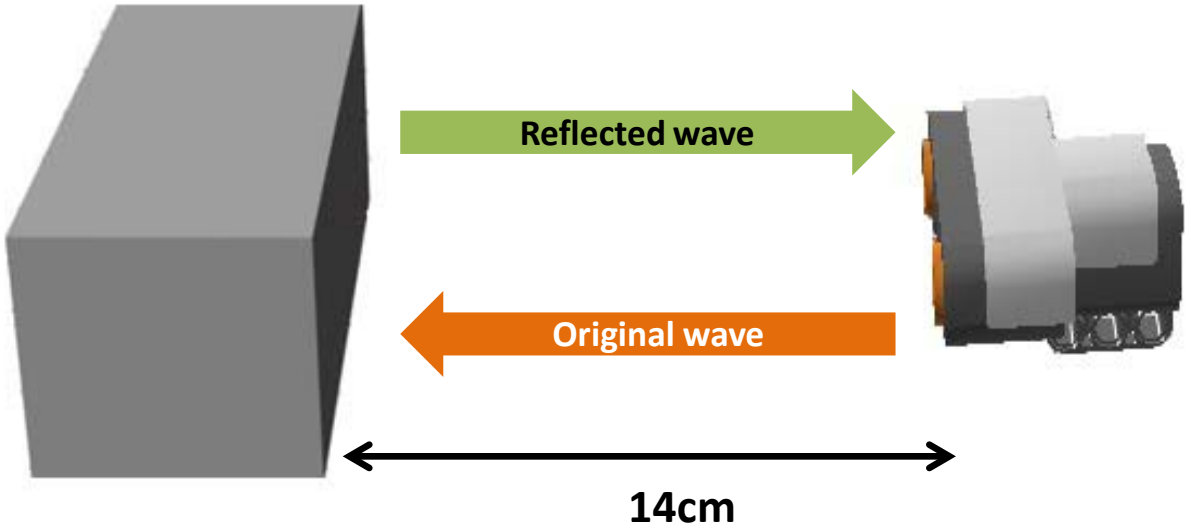
What kind of sensor measures distance using ultrasound waves?

Sender **Receiver**

PING)) Ultrasonic Sensor

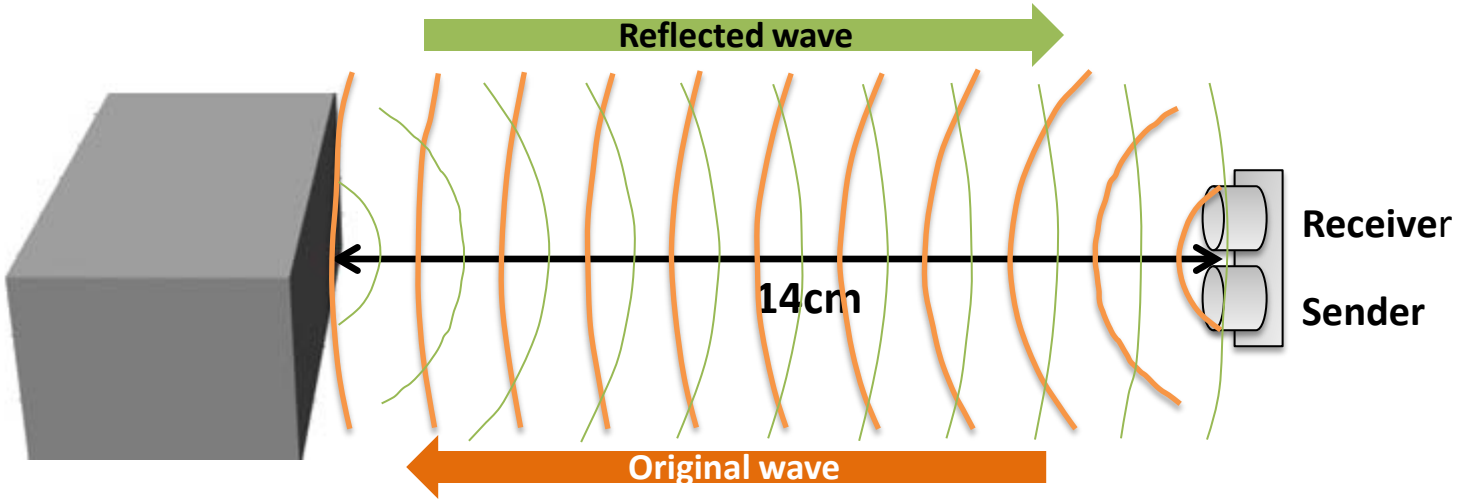


How Do Ultrasound Sensors Work?



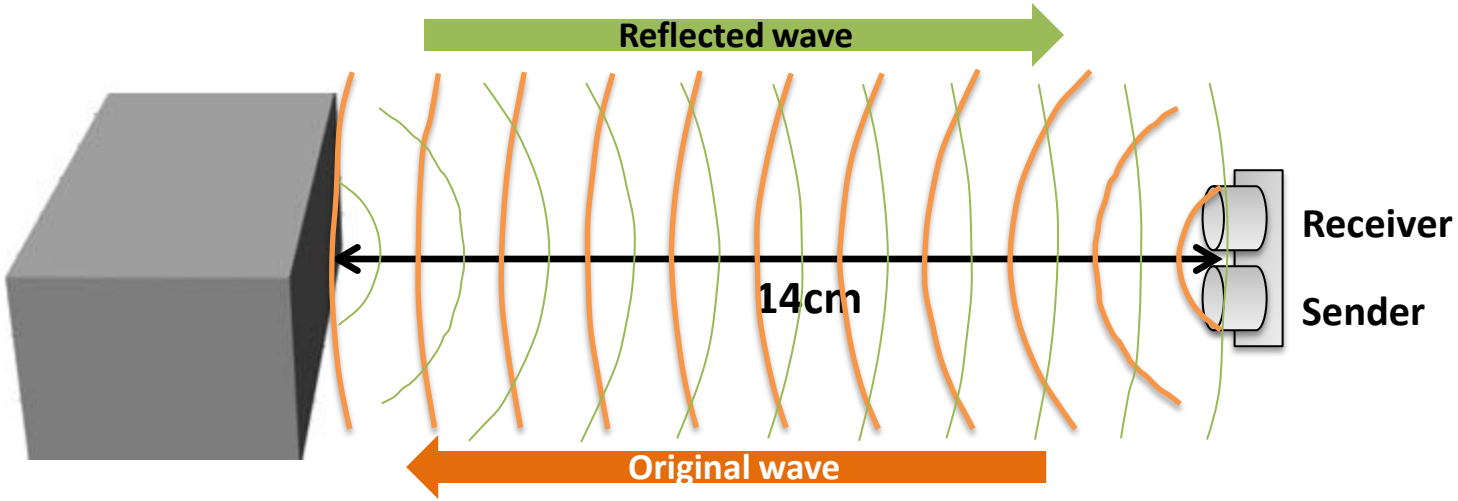
- The sensor emits high-frequency ultrasound ping, which bounces off objects and is read back by the sensor.
- The sensor has a clock that measures the time it takes for the ultrasound ping to come back.

The Distance of Sound



Distance that sound travels	=	Speed of sound in air	*	Time that sound travels
0.14 (m) + 0.14 (m)	=	343.6 (m/s)	*	Time that sound travels
0.14 (m) + 0.14 (m)	=	343.6 (m/s)	*	0.0008 (s)

Distance Between Sensor and Object



Distance to the object = 0.5 * Distance that sound travels

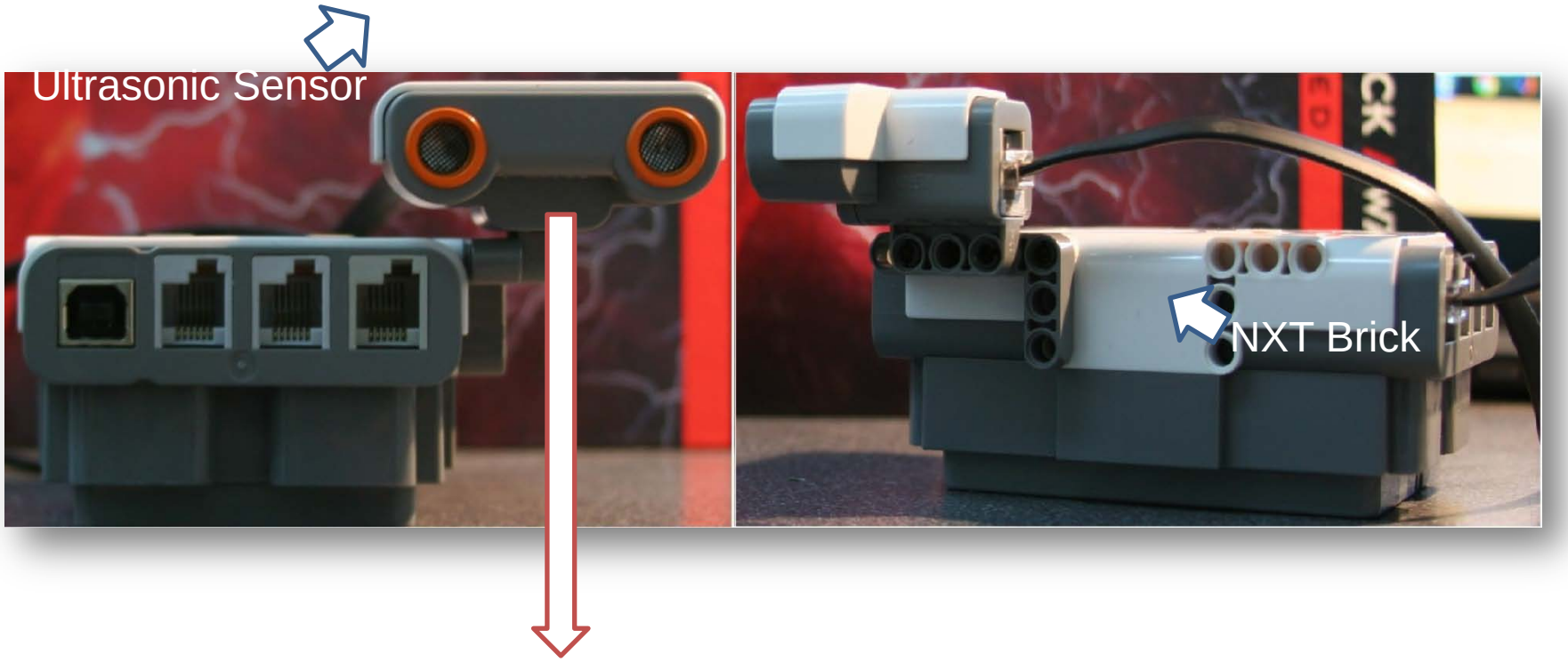
Time for sound to travel to the object = 0.5 * Time that sound travels

Speed of sound in air = Constant

0.14 (m) + 0.14 (m) = 343.6 (m/s) * 0.0008 (s)

0.14 (m) = 343.6 (m/s) * 0.0004 (s)

LEGO® MINDSTORMS® Ultrasonic Sensor – Limitations



0 (in cm) < outputs an integer (in cm) < 255±3 (in cm)

Using LEGO® MINDSTORMS® Ultrasonic Sensor to Measure Distance

Use the following steps to obtain ultrasonic measurements using inbuilt NXT function.

Browse menu using arrows.

Look for the 'View' option. Select with orrange button.

Browse for 'Ultrasonic cm' option.

Sepecify the Port on NXT that is connected to the sensor.

Have fun with your digital ruler!

Step 1 → Step 2 → Step 3 → Step 4 → Step 5

Activity: Look around and choose an object that you can measure the distance to using the LEGO® MINDSTORMS® Ultrasonic Sensor

Be creative and use your imagination!

Have fun!