2024-07-30-Cable-Diameter-And-Frequency
Project: 902401 - Geo-Sense (2024)
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Rev (2024-07-30): Initial Release
Related documents: "2024-07-17-Notes-Solifos-MBARI-Zoom-Meeting.PDF"

DAS Cable Diameter and Frequency Range

Issue: In what case the location of the DAS fiber in the cable stack is important? Refer to **Fig 1**, copied from a relevant discussion with Patrick Weissinger (Solifos) on 7/17/2024

Approach: Here is a quick estimate for Geo-Sense meeting discussion on 07/30/2024 on the topic of frequency cut-off where location of the DAS fiber in the cable stack become important.

- If the wavelength of the sound wave is larger than the object size, the internal structure of the object from the point of view of distribution of material density (rubber, steel, etc). is likely to be insignificant, as the wave is not going to interfere with objects smaller then it's period; so, the interaction between the wave and the object could be estimated by the average density of the cable.
- The speed of sound in the water is ~1500 m/s (https://oceanexplorer.noaa.gov/explorations/sound01/background/acoustics/acoustics.html)
- For the cable of 15 mm diameter, the frequency of the sound wave with the wavelength equal to the cable diameter, can be calculated as:
    - F [Hz] = V [m/s] / D [m] = 1500 m/s / 0.015 m = **100 kHz**

So, for the range of the acoustic frequencies we are more interested in (up to 100s Hz I assume), that is closer to vibration range or infra-sound range, in the water environment, the location of the DAS fiber in the cable stack, should be largely unimportant.

Now, Patrick's argument of importance of locating the DAS fiber outside of the cable stack would likely to be important for higher acoustic frequencies, especially in the air:

- In the air, for the 15 mm cable, the frequency of the sound wave with the wavelength equal to the cable diameter, is going to be F [Hz] = V [m/s] / D [m] = 343 m/s / 0.015 m = **22.866 kHz**
- This frequency is much closer to human hearing frequency range, and located within hearing range of many animals (**Fig 2**, copied from https://en.wikipedia.org/wiki/Hearing_range)
- For this case of higher frequencies and operating acoustic antenna in the air, location of DAS fiber is likely to be important.

Conclusion: for sensing the frequency range up to of hundreds of Hz, location of the DAS fiber within the cable stack deployed in the water, should be unimportant, and the Winchster cable with the DAS fiber(s) located in the K-tube in the center of the cable, should be adequate.

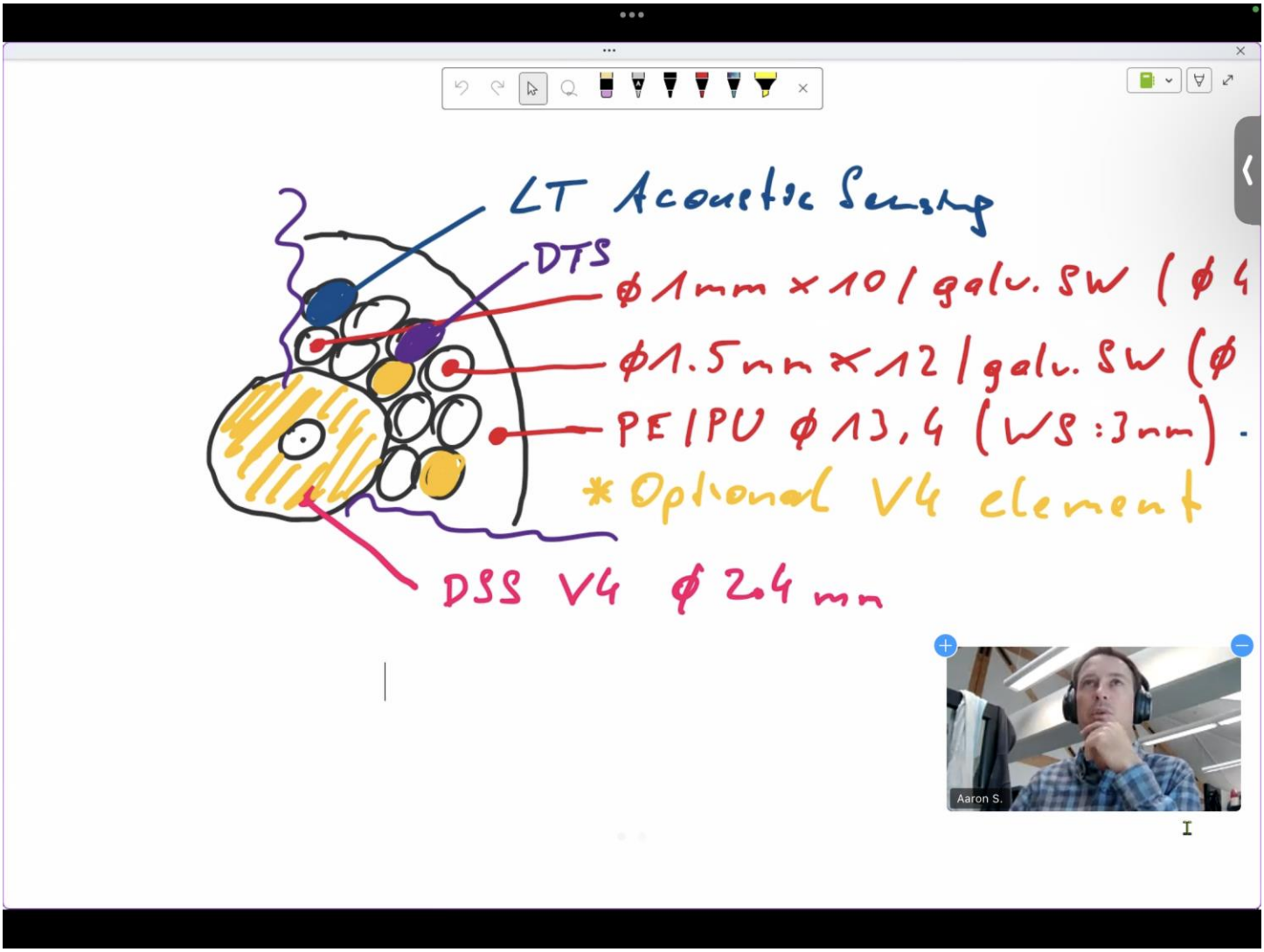

Fig 1. Proposed location of DAS fiber as well as other sensing elements during 2024-07-17 discussion with Patrick Weissinger (Solifos)

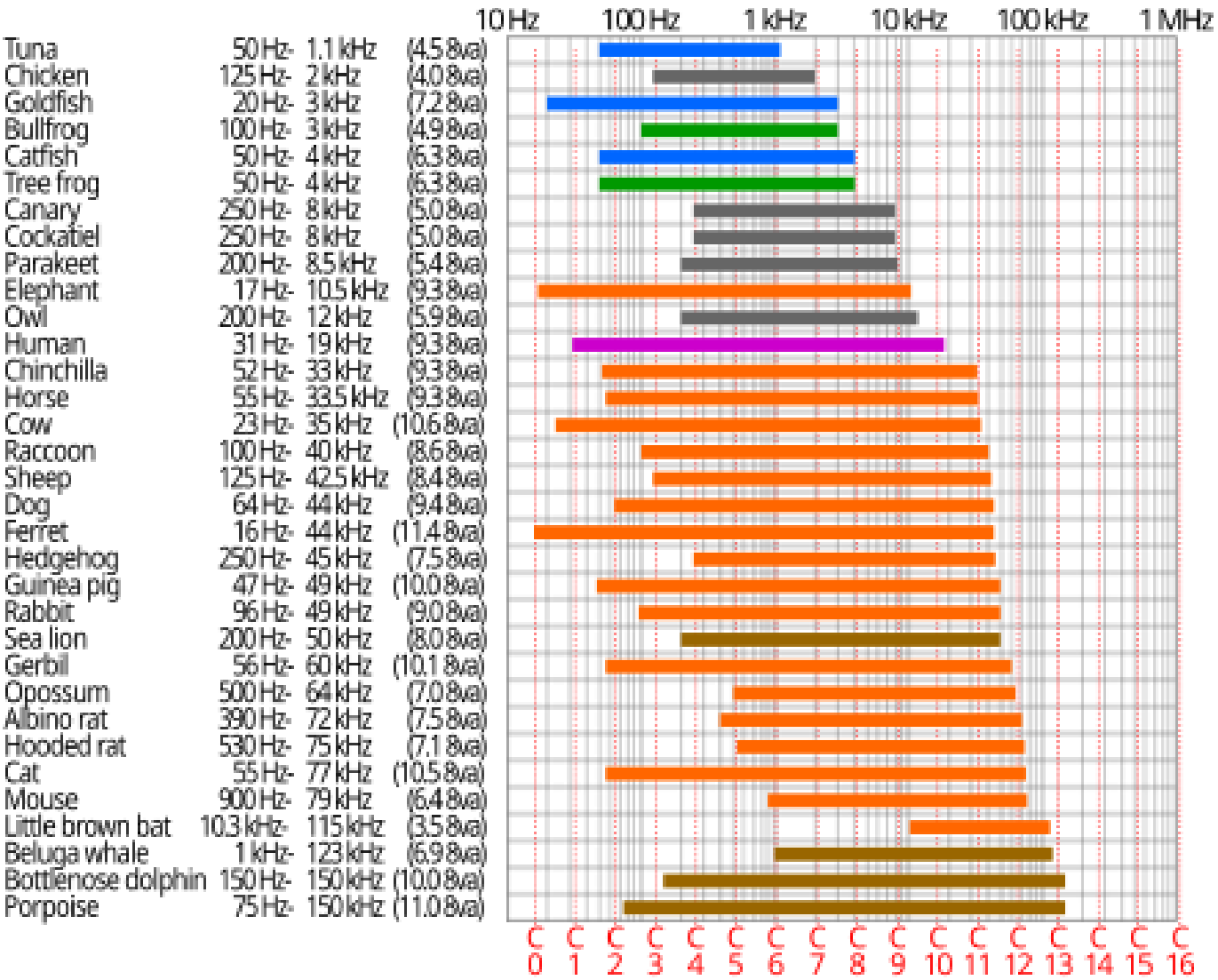

Fig 2. Logarithmic chart of the hearing ranges of some animals (from https://en.wikipedia.org/wiki/Hearing_range)