1. WHAT IS CHANNEL MODEL ?

A channel model is representation of physical layer in a communication simulation.It models the effects of the communication channel through mathematical assumptions and calculations.In underwater networks it represents the behavior of the acoustics wave carrying data through the water.

2. FACTORS THAT EFFECT COMMUNICATION

1. Absorption and spreading loss
2. Surface reflection
3. Surface duct
4. Bottom Bounce

ABSORPTION AND SPREADING LOSSES

The acoustic path loss depends on the signal frequency and distance. This dependence is a consequence of absorption (i.e., transfer of acoustic energy into heat). In addition, the signal experiences a spreading loss, which increases with distance. Spreading loss refers to the energy distributed over an increasingly larger area due to the regular weakening of a sound signal as it spreads outwards from the source. The overall transmission loss that occurs in UW channel over a transmission distance of l meters at a signal frequency f is given by :

$TL = k \cdot 10 \log l + l \cdot 10 \log a(f)$ (1)

where k is spreading factor (k = 2 for spherical spreading, k = 1 for cylindrical spreading, and k = 1 . 5 for the so-called practical spreading). In general, for shallow water channels, cylindrical spreading is assumed (k = 1) while for deep water channels spherical spreading is assumed(k = 2). Now 10loga(f) is the absorption coefficient expressed using Thorp's formula, which gives a(f) in dB/km for f in kHz as follows :

10 log a (f) = 0.11f 2f 2+44+ 2.75.10 − 4 f 2 + 0.003221 + f4100 + f(2)

The absorption coefficient increases rapidly with frequency and is a major factor that limits the maximal usable frequency for an acoustic link of a given distance. The transmission loss due to absorption and spreading (we refer this case as model 1) is shown in Figure 1 for k = 1.5 . The loss increases rapidly with frequency and distance, imposing a limit on the available acoustic bandwidth.

SURFACE REFLECTION

Surface reflection describes the reflection of sound from the sea surface and is affected by the roughness or smoothness of the sea. When the sea is rough, the transmission loss on reflection can be found using the Beckmann-Spizzichino surface reflection model

$$TL\_SR = 10\log\left(\frac{1+\left(f/f_1\right)2}{1+\left(f/f_2\right)^2}\right) - \left(1+\frac{(90-w)}{60}\right)\left(\frac{\theta}{30}\right)^2 \qquad (3)$$

where f1 = sqrt(10)f2 and f2 = sqrt(378)w^(−2), where w is the wind speed in knots, and θ is the angle of incidence to the horizontal measured in degrees. The total acoustic path loss is computed (we refer this case as model 2) using Eqn. (4) below and is shown in Figure 1 (w = 0 m/sec, θ = 50).

TL = k .10 log l + l .10 log a (f) + TL _ SR (4)

SURFACE DUCT

In a surface duct, sound propagates to long ranges by successive reflections from the sea surface along ray paths that are long arcs of circles and the corresponding transmission loss, including loss due to absorption and spreading is given as follows (we refer this case as model 3)
[2]:
TL = k .10 log l + l .(10 log a (f) + α L) (5)
where H is the layer depth in meters and.

$$\alpha_L = \frac{26.6 f (1.4)^S}{[(1452 + 3.5t)H]^{1/2}}.$$

Here S stands for the sea[(1452 + 3.5 t) H] 1/ 2state number, and t is the temperature. The resulting transmission loss is plotted in Figure 1(assumed parameters are S = 0, H = 91 meters, and t = 22 0 c).

BOTTOM BOUNCE

This corresponds to the reflection of sound from the sea floor. The reflection loss of sound incident at a grazing angle θ 1 to a plane boundary between two fluids of density ρ 1 and ρ 2 and of sound velocity c 1 and c 2 is given by the ratio of intensity of the reflected wave I r related to the intensity of the incident wave I i [2]:

$$TL\_bottom = 10\log\left[\frac{I_r}{I_i}\right] = 10\log\left(\left[\frac{m\sin\theta - (n^2 - \cos^2\theta)^{1/2}}{m\sin\theta + (n^2 - \cos^2\theta)^{1/2}}\right]^2\right) \tag{6}$$

where $m = \rho_2 / \rho_1$ and $n = c_1 / c_2$. The attenuation coefficient α_s due to the presence of sediments at the seafloor is $\alpha_s = \beta f^{\upsilon}$ where υ is an empirical constant (typically 1 for many measurements on sands and clays) and β (dB/m-kHz) depends upon porosity and isapproximately equal to 0.5. The total transmission loss is computed as

$$TL = (k \,.10 \log l) + (l \,.10 \log a(f)) + (\alpha_s \,. l) + |TL\_bottom| \tag{7}$$

The attenuation corresponding to this loss model is also shown in Figure 2 (parameters assumed are: $m = 1.95$, $n = 0.86$, $\theta = 35^0$, $\beta = 0.5$, and $\upsilon = 1$).

UNETSTACK

UnetStack is an agent-based underwater network stack that defines commonly needed agents with services, messages, capabilities and parameters. The stack is extensible, allowing agents to provide additional services that may be used by other agents for the development of optimized network protocols. Although the stack focuses on underwater networks, it allows wired and wireless radio links to be included as part of the network.

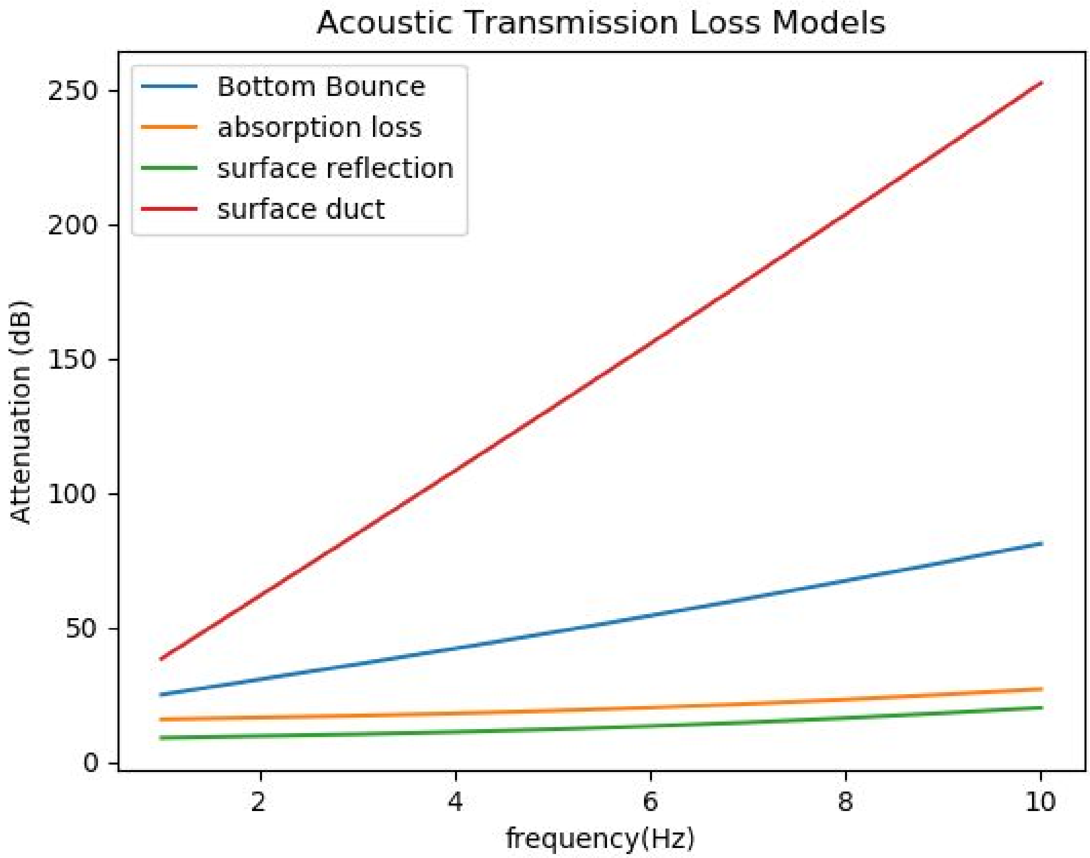
The UnetStack is implemented in Java and Groovy, and is based on the open-source fjåge lightweight agent framework. Although it is primarily designed for use on embedded devices, it can be run on desktops or clusters when simulating underwater networks. It provides a basic set of agents that allow an underwater network to be deployed. Designed for extensibility, UnetStack allows additional agents for optimized protocols to be rapidly developed, tested and deployed. The stack can easily be integrated with most underwater modems.

In the UnetStack, agents play the role that ‘layers’ play in traditional network stacks. However, as the agents are not organized in any enforced hierarchy, they are free to interact in any way suitable to meet application needs. This promotes low-overhead protocols and cross-layer information sharing. A driver agent offering a ‘Physical’ service usually provides access to the physical layer implementation in a modem. Multiple agents providing similar services may coexist in the modem (e.g. drivers for multiple modems, acoustic and RF links, etc.)

Internship Work

Implementation of the above Transmission loss models in unetstack.Transmission loss models are tested against different source frequencies and propagation distance.

The following are the graphs of frequency vs attenuation(figure 1) and distance vs attenuation (figure 2) for the different propagation loss models



Acoustic Transmission Loss Models
Bottom Bounce
absorption loss
surface reflection
surface duct
Attenuation (dB)
250
200
150
100
50
0
2
4
6
8
10
frequency(Hz)

Figure 1.

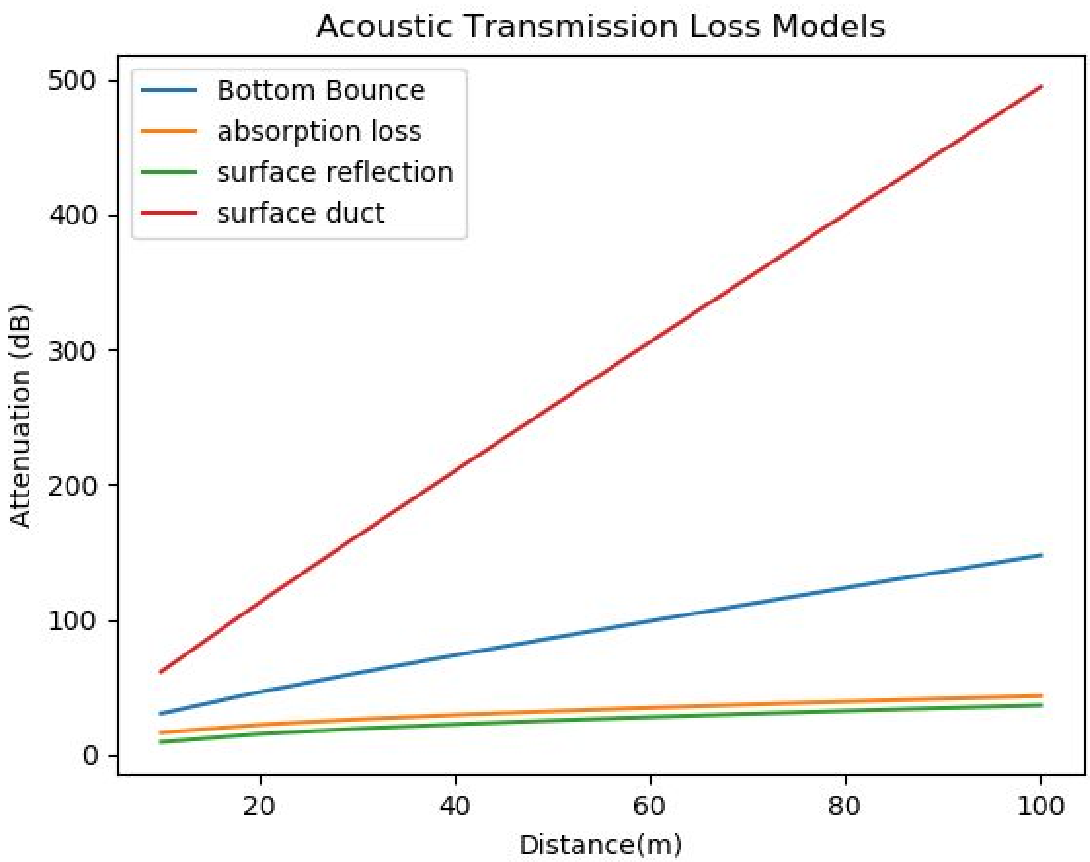


Figure 2.

ANALYSIS

Attenuation increases with increase in frequency and distance , the channel model was implemented on unetsack and the values were recorded and graph was plotted using python. Plotted graph and values were tested against the previous work and the result was satisfactory.

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