Wi-Fi-based network systems design over freshwater: Experimental evaluation using COTS devices



CISTER – Research Centre in Real-Time & Embedded Computing Systems **Miguel Gutiérrez Gaitán^{*}, Pedro M. Santos**⁽²⁾, **Luis R. Pinto[†] and Luis Almeida**^{*} ^{*}CISTER/FEUP, Universidade do Porto, Portugal; ⁽²⁾ CISTER/ISEP, Politécnico do Porto, Portugal [†]IPFN, Instituto Superior Técnico, Lisboa, Portugal {mjggt,pss}@isep.ipp.pt, lpinto@ipfn.tecnico.ulisboa.pt, Ida@fe.up.pt

Motivation

- In the design of **shore-to-shore** and **shore-to-vessel** links, the impact of the signal reflections on the surface is often neglected.
- When choosing an antenna height for an inshore node, a typical decision is to use the **largest possible height**; but, this approach can lead to signal degradation.

Objective: To experimentally assess the impact of surface reflection on the received signal strength of a set of short-and-medium-range shore-to-shore links (<200 m) that use antennas installed at two heights, at a few meters above surface (<3 m).

Two-ray model

- The **two-ray** is the most fundamental path loss model to account for the influence of signal reflections on the received power [1].
- This condition gets further aggravated at near-shore areas as **tides** impose a variation of the reflection geometry over time [2].



Testbed



The experimental setup showing: (a) a representative node deployment at the actual location, and (b) the set of links and nodes positions evaluated.

Experimental Results



Two-ray model at two different time instants

$$P_r \!=\! \frac{\lambda^2}{(4\pi d)^2} \! \left[2 \! \sin \! \left(\frac{2\pi h_t h_r}{\lambda d} \right) \right]^2 \! P_t G_t G_r$$

Simulation results

 In the set of link distances and antenna heights that we explore, the two-ray model predicts the occurrence of strong path loss attenuation (due to the reflected ray) at well-defined distances.



Two-ray model (dotted) vs. RSSI measurements at different link distances and antenna heights (boxplot); with median points connected (solid).

Conclusion & Future work

- We observed **considerable consistency** between packet-based measurements of RSSI and the two-ray model estimates.
- These results provide strength to the claim that both the two-ray model and antenna height adjustment are key building blocks for effective design of over-water links in coastal environments.

References

[1] T. Rappaport, Wireless Communications: Principles and Practice. USA: Prentice Hall PTR, 2nd ed., 2002.

[2] M. Gutiérrez Gaitán, L. Pinto, P. M. Santos, and L. Almeida, "On the two-ray model analysis for overwater links with tidal variations," in 2019 Proceedings of the 11th National Symposium on Informatics (INForum), 2019.

Co-financed by UIDB/04234/2020 (CISTER) and project PTDC/CCI-COM/30142/2017 (AQUAMON)

FCT

CISTER Research Centre ISEP, Polytechnic Institute of Porto Rua Dr. Ant^o Bernardino de Almeida, 431 4249-015 Porto, Portugal

+351 228 340 502

f

www.cister-labs.pt

facebook.com/cisterlabspt



