

WIRELESS COMMUNICATIONS FOR MARINE SENSOR NETWORKS

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Abstract – Current marine wireless communication systems used for monitoring applications based on buoys suffer from lots of weakness. Our research project concerns the design and development of new technological applications to improve marine communications. Particularly, a novel wireless sensor network based on WiMAX standard operating at the 5.8 GHz band (license-exempt band) is proposed. As an initial task, a propagation channel measurement campaign in maritime environments was carried out to investigate the impact of the wireless channel in different situations. This work provides radio measurements over sea around urban environments. In particular, a radio link between a buoy and a ship at 5.8 GHz is studied. LOS (Line-Of-Sight) and NLOS (Non-Line-Of-Sight) paths are investigated. The designed measurement system is described and the experimental measurements are shown. This investigation is useful, among others, for planning Worldwide Interoperability for Microwave Access (WiMAX) networks offshore around these challenge environments.

Keywords - propagation channel measurements, WiMAX, maritime environment, wireless sensor networks.

EXTENDED ABSTRACT.

Recently, many studies have identified an emerging demand for telecommunication services in several applications over sea. Some of them are getting great interest for the scientific community, e.g. those related to real-time monitoring through sensing multiple physical parameters from the sea. Although the number and kind of parameters depend on the specific application, monitoring systems are quite similar. Basically, these systems are based on a set of buoys and each one is equipped with two main subsystems. Firstly, a subsystem including a lot of sensor devices that measure locally the data. Secondly, a radio system which is in charge of transmitting them to a central base station for processing and monitoring purposes. The base station could be installed on shore or aboard a ship. This last case is particularly interesting for some applications, e.g. those related to oceanography campaigns.

Current wireless technologies used in this kind of applications are mainly based on VHF, cellular mobile telecommunication systems (GSM, UMTS, etc.) and satellite communications systems (INMARSAT, VSAT, etc.). However, these systems suffer from lots of weakness [1], like low bandwidth or capacity (GSM, Satellite and VHF systems), short range (cellular mobile telecommunication systems), high cost for certain applications (satellite and cellular mobile telecommunica-

tion systems) and the large size and weight of antennas and hardware transceivers (VHF systems). These limitations have motivated a new research activity. The general goal is to design and develop a novel broadband wireless communication system to perform applications like the one mentioned above.

A wireless sensor network based on WiMAX standard ([2], [3]) could be a good candidate to accomplish this task. WiMAX is an evolving technology that is optimized for operating on land environments where its good performance has been extensively demonstrated. Several frequency bands can be used for deploying this system. The license-exempt 5 GHz band is of interest to WiMAX because this is generally available worldwide and it is free for anyone to use, i.e. it could enable deployments in underserved markets, like the maritime one. In particular it is the upper 5.725 GHz-5.850 GHz band that is most attractive due to the fact that many countries allow higher power output compared to other bands. This facilitates less costly deployments. Regarding range and peak data rates, field tests on land have shown tens of kilometers and Mbps, respectively. These potential characteristics overcome the weakness described above. However, the performance of WiMAX networks in marine environments is not optimum due to the different radio propagation conditions. The main goal of a research project between the universities of Cadiz and Abdelmalek Essaâdi is to optimize the WiMAX standard for maritime applications.

An initial and crucial task for the optimization of this standard over sea is to study the radio propagation channel in these scenarios in the 5 GHz band. Particularly, buoy-to-ship propagation measurements were performed over sea. Fig. 1 shows the routes where the measurements were carried out.

Propagation models and measurements for land, both large-scale path loss and small scale multipath, have been discussed extensively. Further works in this field have been done in urban and suburban environments. Besides, although some works present experimental measurements of propagation characteristics for maritime radio links, they do not apply to conditions covered by our study. To the best of the authors' knowledge, buoy-to-ship links characteristics over sea at 5.8 GHz have not been investigated. In this work, we focus on LOS (Line-Of-Sight) and NLOS (Non-Line-Of-Sight) paths. We discuss them analyzing the measurements performed in a real marine scenario. This work is helpful, among others, to deploy WiMAX systems in these challenges scenarios.

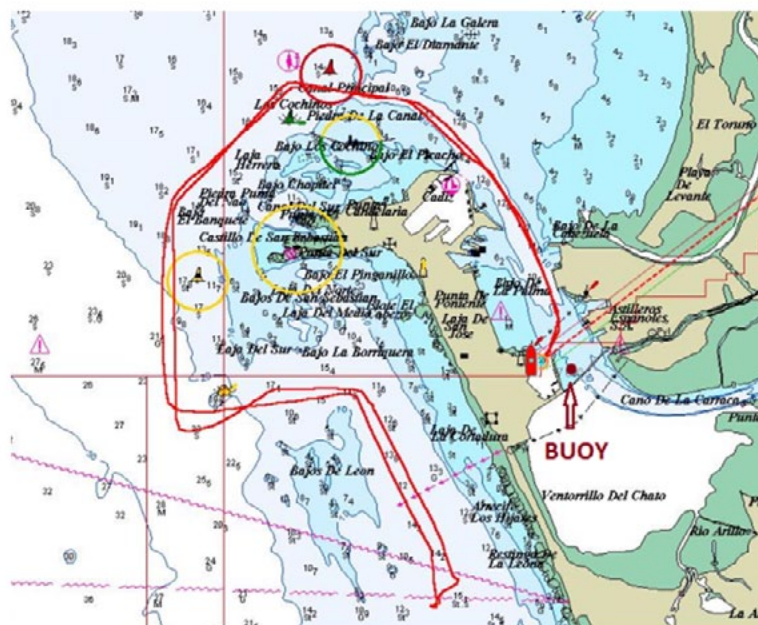


Fig. 1. Route followed by the ship (red) and fixed location of the buoy.