Evaluation of Antenna Performance for Use in Wide Band Wireless Protocols

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Abstract— **Wideband transmission improves the ability of a device to communicate in different scenarios and with a range of devices. Wideband transmission protocols can also make use of multiple bands to implement parallelism and thereby improve throughput. Such transmissions require hardware that is capable of handling wideband signals for both, transmission and reception. The study undertaken in this paper looks at some popular antennae and their performance in wideband scenarios. It is usually noticed that high-frequency signals (mobile phones, WiFi, 3G, etc.) show very high attenuation in foliage. However, it is also noticed that lower frequencies (TV signals, FM radio, CB Radio, etc.) can penetrate the same environments quite well. Hence a wideband protocol that can adaptively use the available frequency band is needed. This paper presents the comparison of antennae that may be beneficial for use with such a protocol, in an attempt to identify a low-cost and effective antenna that will sufficiently satisfy the communication requirements for radio signals from 100 MHz to 2.4 GHz. Some available popular antennae, namely, 2.4 GHz Yagi Antenna, Whip Antenna and the retractable telescopic antenna, was considered for this study since the cost was an important criterion.**

Keywords— Antenna propagation; wideband protocol antenna; low-frequency protocols; low-cost antenna comparison

I. INTRODUCTION

The common practice in wireless communication establishes the signal frequency while the transceiver is designed and the devices are tuned to operate in the designated frequency band only. In this, the radio signal frequency is hardware defined, and the protocols do not have much to do. However, in many scenarios, it is beneficial to move the decision of which frequency to use to the software protocols, giving much more flexibility to the devices. However, for this to be possible, the underlying radio module should be capable of handling wideband signals. One of the key components for this design to be effective is to identify or design a good antenna capable of handling wideband signals.

Research is also advancing in an attempt to bring network communication to rural environments [1]. These environments ususally have thick foliage. The current protocols that make use of the high-frequency signals, namely GSM (900-1800MHz), Wifi, Bluetooth, etc. (2.4 GHz) show very high attenuation, whereas lower frequency signals such as FM radio (~100 MHz) or TV signals (~ 400 MHz) demonstrate better penetration in such environemnts. It is also obvious that as the frequency is lower, the maximum data-rate that can be supported will also be lower. The rural environments are not static and changes widely with seasons. Rainy seasons may have much thicker foliage compared to a dry season or the thick mist on a rainy day may offer higher interference than on a clear day. So, if the optimal frequency for the environment conditions at hand can be selected as needed, to adapt to the dynamic changes in the environment, it can improve efficiency. As the variations in the environments are random and unpredictable, it will be challenging to set up a system to cater to each specific case to extract the best efficiency. Hence, a protocol using Artificial Intelligence (AI) with Software Defined Radio (SDR) is called for, allowing the system to be self-configuring and self-adapting.

Any system capable of wideband communication also needs adequate hardware. A key component in this consideration is the antenna. The rural environments most often work on a limited budget. Therefore, it is desirable for the hardware to offer low cost and complexity. This is a preliminary study in this direction, in an attempt to identify the ideal low-cost antenna that will support wideband transmissions ranging from 100 MHz to 2.4 GHz. After the antenna is identified, then the protocol to make use of AI defined SDR for wideband can be designed.

This paper is organised as the following sections. The "Literature review" section looks at related works in the area, followed by "The Protocol Challenge" section, outlining challenges faced by the current protocol signals. "The Antenna Evaluation" section compares some popular low-cost antenna to identify the best candidate for the wideband networking protocol envisaged. The "Proposed Wideband Protocol Adaptations" section introduces the Antenna identified as the candidate for the new wideband protocol followed by the "Conclusion and Future Work" section.

II. LITERATURE REVIEW

The review of related works noticed is organised as follows. We start with discussing the 2.4 GHz frequency in environments with thick foliage, followed by some studies of wideband signals in seemingly related environments. The approach of technology giants, namely, Google, Microsoft and Facebook in this direction is also noticed. A brief study of software defined radios (SRD) was done to notice the progress in the wideband areas. AI in networking protocols would enable the SRD to be intelligent, and therefore some relevant AI techniques are noticed.

978-1-5090-0676-2/16/$31.00 ©2016 IEEE