PhD Position
Reconfigurable intelligent surfaces for millimeter wave communications in metros

Scientific domain: Digital communications

Keywords: multi-antennas ; millimeter-wave communications ; channel propagation model ; baseband precoding design ; channel estimation ; baseband receiver design

DESCRIPTION

Context

The increased use of rail transport, especially metro, as well as the improvement of the experience of the users of this transport, requires a better quality of service obtained by increasing the frequency of passage, reducing technical incidents, and finally improving the fluidity of the traffic. This objective can be achieved by automating trains through the implementation of wireless communication systems that transfer control functions from the human driver to computers, subject to strict performance constraints (throughput, robustness, reliability, latency). However, the current transmission bands (900 MHz, 1900 MHz and 5.9 GHz) are not sufficient, and the millimeter wave range (30-100 GHz) is being explored.

Due to the extremely difficult propagation environment in railway tunnels, current systems require many base stations, or relay systems, to achieve the necessary network coverage, which is not always possible due to cost and space limitations. In addition, these systems require constant access to a power supply.

Objectives

Our focus is therefore on a very recent technology identified as key for 6G systems: reconfigurable intelligent surfaces (RIS). This involves transforming the nature, by definition random, of the propagation channel into a partially deterministic and programmable radio environment. These surfaces are quasi-passive since power consumption is only required to configure the switches and receive the configuration control signals. Thus, once the configuration is done, the surfaces become passive, and no power is required. Recent studies claim that sufficiently large RIS, relative to wavelength, can outperform relay systems in terms of data throughput and energy efficiency, while reducing implementation complexity.

Our ambition is therefore to study whether it is possible to drastically improve the energy efficiency of millimeter-wave wireless transmission systems in tunnels using RIS, compared to relaying techniques, while maintaining the quality of service required for train automation. This thesis project will be carried out in 3 steps: 1) development of a reference system based on a channel model adapted to the environment (millimeter, tunnel, multi-antenna) and relaying elements, 2) study of a channel model that integrates RIS in the same environment, 3) proposal of a multi-antenna transmission system (transmitter and receiver) that takes advantage of RIS.

PHD ENVIRONMENT

The research work will be realized in the MEE (Mathematical and Electrical Engineering) department of IMT Atlantique, Brest, France. The department has recognized expertise in the area of telecommunications, signal processing, error-correction codes, and machine learning. Therefore, you will have the opportunity to interact with researchers, PhD students and postdocs working on those fields in the department.

The PhD project will be carried out in the context of the MILLIRIS (Reconfigurable intelligent surfaces for millimeter wave communications in metros) project. This French project, funded by the Brittany Region, will involve researchers from Université Gustave Eiffel in the domain of wireless transmission systems in the railway domain, and, in particular, in the modeling of the propagation environment. Interactions with researchers in the domain of modeling and design of metamaterials for different applications such as antennas for communication systems, metasurfaces for electromagnetic energy recovery are also expected.

APPLICANT PROFILE

The candidate should have earned an MSc degree, or equivalent, in one of the following fields: telecommunications, information theory, applied mathematics, signal processing.

HOW TO APPLY?

Applicants should send their complete application package by email to the contacts provided. This includes:

- Full CV with a list of projects and courses related to the subject of the PhD,
- Complete academic record (from bachelor to MSc),
- 1 or 2 reference contacts (former or current internship advisor, teacher, etc.).