

An Indian-Australian research partnership

**Project Title:** **Communication Schemes for Next-Generation Wireless Networks Powered by Wireless Power Transfer**

**Project Number** IMURA0657

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Department of Electrical Engineering

## Research Academy Themes:

**Highlight which of the Academy's Theme(s) this project will address?**

*(Feel free to nominate more than one. For more information, see [www.iitbmonash.org](http://www.iitbmonash.org))*

1. **Advanced computational engineering, simulation and manufacture**
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

## The research problem

*Define the problem*

Future wireless communication devices are expected to become truly wireless without the need to be connected with wires at any time. In particular, future wireless devices are expected to be powered by harvesting the freely available ambient energy, such as solar, thermal, and electro-magnetic, and/or by harvesting radio frequency (RF) energy transmitted from dedicated wireless power transmitters. Since energy harvesting (EH) from natural resources is usually climate dependent, it may not be suitable for small and mobile wireless devices. In these cases, wireless power transfer (WPT) of RF energy to the wireless communication devices is an appealing solution for providing a perpetual power supply. WPT is relatively an old idea, dating back to Nikola Tesla a century ago, and recent developments of WPT technology are making this idea into a reality. For example, using current WPT technology, RF EH circuits embedded in wireless sensors are capable of harvesting microwatt to milliwatt of power over the range of several meters for a transmit power of 1 Watt and a carrier frequency of less than 1 GHz.

Although WPT is a very useful technology, it is limited by the high path loss attenuation which severely attenuates the RF energy received at an RF EH receiver. In fact, for large distances between a wireless power-beacon and a RF EH receiver, the RF energy received at the RF EH receiver is not sufficient for

enabling wireless communications. As a result, wireless devices powered by WPT are constrained to communicate over short distances and with low data rates. An obvious solution for increasing the communication distance and the data rate of wireless communication devices powered by WPT, is adding additional functionalities to the wireless power-beacons. In particular, the wireless power-beacons can also be used as 1) access points through which the wireless device can connect to a backhaul communication network (i.e., the internet), or as 2) relays which can relay the information received from the wireless communication device to an intended destination (i.e., an access point). Thereby, the wireless power-beacons can play a dual role. Namely, they can power the wireless devices by WPT and they can function as access-points or as relays. In this project we propose to investigate the fundamentals limits of these two types of channels using information theoretic analysis.

## Project aims

*Define the aims of the project*

The aim of this project is to study the fundamentals limits of information flow of two types of wireless networks power by WPT and to design communication schemes which can achieve these limits. In particular, we will investigate the following two types of wireless networks:

1. One-hop wireless networks comprised of a source of information that is powered wirelessly by a power-beacon, which also acts as an access point.
2. Two-hop wireless networks comprised of source of information that is powered wirelessly by a power-beacon, which also acts as a relay that relays the received information to an access point.

## Expected outcomes

*Highlight the expected outcomes of the project*

Successful completion of the project will result in developing novel communication schemes for next generation wireless networks, which in part will be powered by RF EH.

## How will the project address the Goals of the above Themes?

*Describe how the project will address the goals of one or more of the 6 Themes listed above.*

The proposed project is important in developing future generation wireless communication networks, which in contrast to today's wireless networks that are powered by the electrical grid, will be powered in part by RF EH.

## Capabilities and Degrees Required

*List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.*

The preferred candidate should have a master's degree in electrical engineering with specialization in wireless communications. Moreover, good understanding of information theory is also a requirement.

## Potential Collaborators

*Please visit the IITB website [www.iitb.ac.in](http://www.iitb.ac.in) OR Monash Website [www.monash.edu](http://www.monash.edu) to highlight some potential collaborators that would be best suited for the area of research you are intending to float.*

A potential collaborator at Monash University could be Prof. Emanuele Viterbo,  
[Emanuele.Viterbo@monash.edu](mailto:Emanuele.Viterbo@monash.edu)

Please provide a few key words relating to this project to make it easier for the students to apply.

**Wireless communications, Information theory, Energy harvesting, Simultaneous wireless information and power transfer**