

An Indian-Australian research partnership

**Project Title:** **Deterministic Wireless Mesh Systems**

**Project Number** **IMURA0482**



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## Research Academy Themes:

**Highlight which of the Academy's Theme(s) this project will address? #1, #2, #3 and #4**  
(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

There is critical need to bring determinism in wireless systems for various applications. Two scenarios are considered here. First one deals with "802.15.4 based systems for IoT" and second deals with "WLAN Mesh for real-time applications".

"802.15.4 Mesh Systems for IoT": Internet of Things (IoT) is the next technology transition where IoT systems will allow us to sense and control the physical world. IoT devices may support various types of connectivity mechanisms such as IEEE802.15.4, WiFi, 3GPP, PLC, Ethernet, Bluetooth and Serial interfaces. These networks need to support diverse performance requirements in terms of reliability, delay, jitter, scalability, low convergence time, security and low power operation for industrial and non-industrial applications. Support for video surveillance applications over some of these networks can also be quite demanding. IEEE 802.15.4e incorporates various mechanisms such as Time Slotted Channel Hopping

(TSCH), Deterministic and Synchronous Multichannel Extensions (DSME) and Low Latency Deterministic Networks (LLDN) to support diverse performance requirements. IEEE802.15.4k supports mechanisms for Low Energy Critical Infrastructure Monitoring (LECIM). There is considerable amount of standardization and research work going on for higher layer components such as distributed and centralized resource management, IPv6 over TSCH (6TiSCH), Routing for Low Power Lossy Networks (RPL), Constrained Application Protocol (CoAP) and efficient security mechanisms.

“WLAN Mesh for Various Applications”: WLAN can be used in mesh mode for different types of real-time applications. For example, WLAN mesh may be deployed for video streaming or for smart city surveillance. There are many challenges in supporting real-time applications over large scale WLAN mesh networks.

This work deals with support of real-time applications over WLAN Mesh or dual mode (i.e. WLAN and 802.15.4) wireless systems. Research problems proposed are as follows:

- Consider wireless networks that use “WLAN mesh only” or “WLAN and IEEE802.15.4 mesh” technologies. Carry out performance characterization of existing mechanisms for supporting real-time applications over these systems. Study factors like scalability, convergence time, reliability, delay / jitter, power consumption etc. Identify areas for improvement.
- Propose and analyze methods to improve performance. Example of some problems that can be addressed: How to keep a consistent mesh in high mobility scenario? How to reduce convergence time in a wireless mesh network? How to manage resources efficiently? How to reduce overhead in these networks? How to make these networks more deterministic for industrial and other applications?

## Project aims

*Define the aims of the project*

First aim of this project is to characterize performance of some methods that exist in standard bodies (or are available in research literature) for wireless mesh networks. Second aim is to propose and analyse methods to improve performance to support requirements of different types of industrial and non-industrial IoT applications. Overall goal is to have set of mechanisms that enable efficient support of real-time applications over wireless mesh networks.

## Expected outcomes

*Highlight the expected outcomes of the project*

- Performance characterization of Layer 2 -- Layer 7 mechanisms that are used to support real-time applications over wireless mesh networks. (Note: In addition to theoretical work, a network simulator such as ns-3 or Matlab or some other package may also need to be enhanced for this purpose)
- Methods to improve performance indicators (such as convergence time, delay / jitter, power consumption, network overhead etc.). Proof of concept via theoretical and simulation results.

## 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.*

- This research work is related to ongoing work in the areas of “Advanced computational engineering, simulation and manufacture”, “Infrastructure Engineering”, “Clean Energy” and “Water Resource Management”. Efficient methods to support real-time applications over wireless networks can potentially enable more efficient design of the associated systems.

## 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.

- EECS type of background
- Background in communication networks, protocols, algorithms, performance modelling and simulations
- Good to have interest in standardization work as well.

## For Industry Partners:: Potential Collaborators

Please visit the IITB website [www.iitb.ac.in](http://www.iitb.ac.in) and 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.

IITB Professors (EE): Abhay Karandikar, D. Manjunath  
 IITB Professors (CSE): Anirudha Sahoo, Purushottam Kulkarni, Varsha Apte, Kameswari Chebrolu  
 Monash Professors: Someone with interests in the areas of sensor networks or wireless networks in general

## Major Milestones:

Please add major intended milestones for the project

#	Milestone	Deliverable	Timeline	Responsible
A	• Survey of existing and ongoing work in this area	A summary report highlighting key results	Timeline to depend on whether or not student is doing course work along with this research work. This can be discussed.	Student with inputs from IITB / Monash Professors and Cisco contact for this work (Dr. Mukesh Taneja)
B	• Performance characterization of key methods studies during Phase A	Performance results of existing methods. Identify areas of improvement such as convergence time etc. Should also result in some papers.		
C	• Propose and analyse new methods to improve performance	New methods along with performance results.		
D	• Publish	Papers and standard contributions for new results		
E	•			
F	•			