NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE | Graduate College

Joint PhD Program Description

The description for the Joint PhD program will be posted online as a sub-page to Joint/Dual PhD Programmes | Graduate College | NTU Singapore.

Name of Partner University	Linkoping University (LiU)
Country	Sweden
Year of JPP Establishment	2017
Program	☒ Joint Degree ☐ Joint Supervision
Description of the Program (150-250 words)	The Joint PhD programme is a 4-year programme with a minimum residency period of 12 months to a maximum of 24 months at the partnering university. Before spending the period of residency in the partnering university, the student would have to clear his or her qualification examination (QE).
Disciplines	EEE
PMC Names	NTU: Prof Shen Zexiang, Prof Chen Xiaodong LiU: Prof Daniel Aili, Prof Nicolette Lakemond
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Joint Projects

Home University	Nanyang Technological University	
Supervisors	**Home**	**Partner**
Name	Siek Liter	Atila Alvandpour
School	School of Electrical and Electronic Engineering (EEE), NTU	Department of Electrical Engineering (ISY), LiU
Email	elsiek@ntu.edu.sg	atila.alvandpour@liu.se
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Project Title	**Harvesting Energy from the environment for IoT**	
Project Description (200-300 words)	Internet of Things (IoT) is expected to grow from US$9.5 billion in 2014 to US$46 billion in 2024 according to Semiconductor Industry Association(SIA) technology roadmap. Fuelling this would be all the remote wireless sensor nodes (WSN) that are networked together. These WSN do not need maintenance if they are self-sufficiently powered by their environment through energy harvesting (EH) or scavenging. The harvested energy can come from numerous sources like radio frequency(RF) or electromagnetic(EM) wave, vibration, thermal, wind and solar (through Photovoltaic [PV] Cells). Upon harvesting these energies, they are then stored in rechargeable batteries or super-capacitors (supercap) so as to regulate the supply of the harvested energy across time when the sources may not be available like the solar energy from the Sun or from the indoor lighting. Although energy can be harvested from the environment, the power derived from these could be very low. The main challenge in harvesting energy is to charge the battery with the remaining energy after powering up the electronics that consumes part of the harvested energy. Take radio frequency (RF) or electromagnetic (EM) wave as a source of energy to be harvested, though it is available everywhere, depending on how close the source is transmitted from, the energy received by the battery could be very low. In this project, the electronics would probably consists of the antenna, receiving RF wave, a Maximum Power Point Tracker (MPPT) or a matching network to optimize the collection of the energy to charge the storage element (battery/supercap) and a DC-DC converter to boost and/or buck the voltage to the IoT load.	
Program/Center Website(s)	• Centre for Integrated Circuits and Systems (CICS, VIRTUS) https://www.ntu.edu.sg/cics# • Integrated Circuits and Systems (EKS) https://liu.se/en/organisation/liu/isy/eks	

Additional Information (e.g., files with project details)	NA