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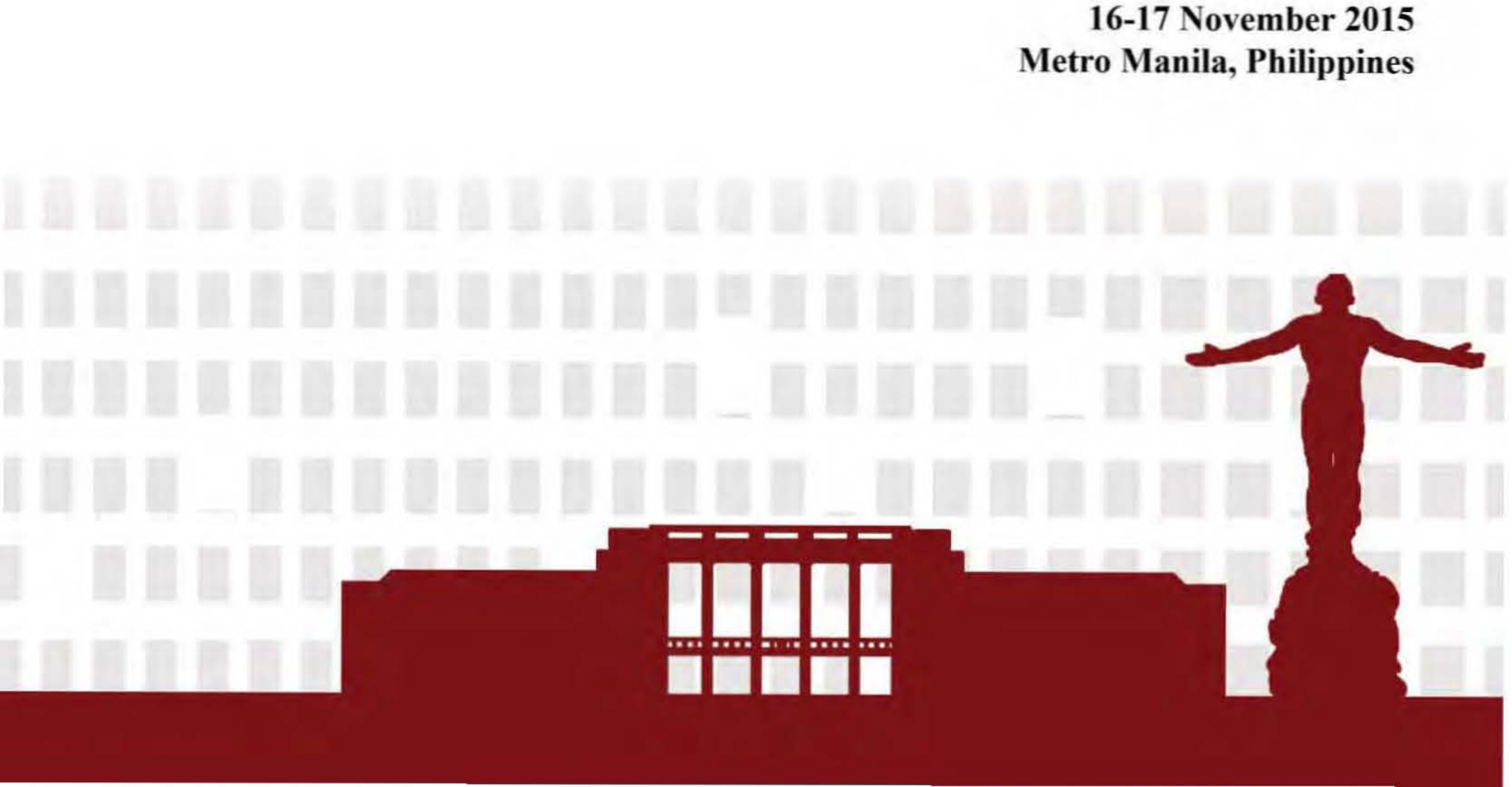
11th ERDT Conference

on Semiconductor and Electronics, Information and Communications Technology and Energy

16-17 November 2015
Metro Manila, Philippines



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Editors:
Dr. Joel Joseph S. Marciano Jr.
Dr. Jhoanna Rhodette I. Pedrasa
Dr. Rhandley D. Cajote

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PERFORMANCE ANALYSIS OF RPL UNDER AN AMBIENT ENERGY HARVESTING WIRELESS SENSOR NETWORK

Wilbert Jethro R. Limjoco* **and Nestor Michael C. Tiglao**

Ubiquitous Computing Laboratory, Electrical and Electronics Engineering Institute,
University of the Philippines Diliman, PHILIPPINES.
* E-mail: wrlimjoco@eee.upd.edu.ph

ABSTRACT

Wireless sensor networks (WSNs) with millions or billions of nodes deployed in areas such as forests and electricity grids cannot use battery-operated sensor nodes since it would be highly impractical to replace the batteries of a large number of sensors while maintaining continuous operation. Instead, we must use sensors that can harvest ambient energy from the environment. These nodes would be cheap, have smaller energy capacity, and must recharge often to ensure that the size of the sensors will be small to be deployable in large quantities. To make that possible, we can make use of coin-sized supercapacitors, such as commercial surface mount supercapacitors sold by [1].

The IPv6 Routing Protocol for Low Power and Lossy Networks (RPL) is currently the de facto standard routing protocol for low power and lossy WSNs as set by the Internet Engineering Task Force (IETF) [2]. Its performance has been comprehensively evaluated in multiple works [3][4] with good results in standard battery-operated WSNs. However, we need to determine how the standard RPL protocol will perform in a network of low energy capacity sensors that frequently recharge. Our results show that RPL performs poorly when run under an energy harvesting sensor network. Figure 1 shows that the number of lost packets of the harvester network is linearly increasing from the hundreds to the thousands, while the battery network has negligible loss. This results in the harvester network having a 40-45% lower throughput than the battery network. This poor performance is due to critical sensor nodes running out of energy all at the same time, thus creating a time period when the entire network is down, as seen in Figure 2. We can possibly improve the network performance by adding energy awareness with a smarter selection and switching of critical nodes via the use of cross-layer optimization techniques to incorporate energy measurement and packet caching. We propose to modify RPL's objective function to include a mechanism for parent switching based on the remaining energy of the sensor nodes.

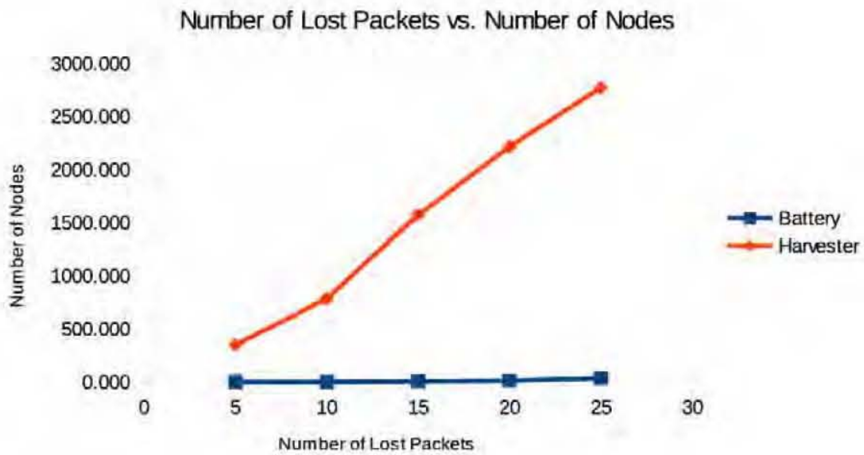

Figure 1. Loss comparison of battery-operated and energy harvesting sensor networks

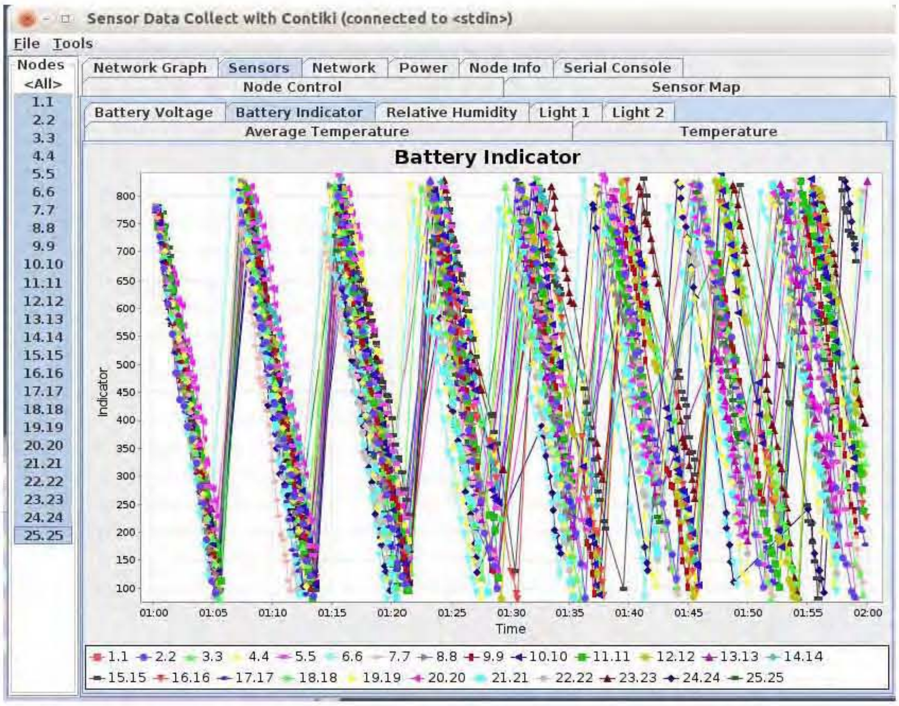

Figure 2. Charging behavior of the energy harvesting sensor network

Keywords: Energy, Harvesting, RPL, Supercapacitor

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