The industrial Internet of Things: deterministic networking

IMT Atlantique

NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	IMT Atlantique
Name of the host laboratory / research team	IRISA / OCIF
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Internship offer

Topic of the internship (title)	The industrial Internet of Things: deterministic networking			
Proposed dates of the internship	**Start:**	2020-09-01	**End**	2021-02-26

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

Context

Wireless deployments are becoming broadly used and provide users (or things) with internet access service almost everywhere, due to the advance of technology that now provides not only smartphones and tablet PCs, but also small and uniquely identifiable devices. Therefore, during the last years we have experienced the emergence of a new paradigm called Internet of Things (IoT) in which smart and connected objects cooperatively construct a (wireless) network of things. Those things can be deployed or embedded nearly everywhere, at homes, universities, cities, agricultural fields, in the sea, even in the human body or any other natural or man-made object. Applications like e-health (wearable sensors), cargos containers, automotive industry and airport logistics all share the aspect of also including very low latency and high network reliability. Therefore, the current standards and technologies must consider the best effort traffic within the functionality of the network.

Approach and Technical Background

In 2016 the IEEE 802.15.4-2015 standard was published to offer a certain quality of service for deterministic industrial-type applications. Among the operating modes defined in this standard, TSCH is a medium access scheme for lower-power and reliable networking solutions in Low-Power Lossy Networks (LLNs). Given the robust performance of TSCH, coupled with the economic benefit of wire-free operation and the practical advantage of being able to place wireless sensors in locations where mains power is not available, industrial-oriented standardisation organisations have adopted TSCH technology for wireless communication, such as WirelessHART and ISA100.11a. As as result, TSCH has become the de-facto Medium Access Control (MAC) scheme for industrial applications. Objectives Radio transmissions are way lossier than wider transmission, and are usually associated with some form of Automatic Repeat-reQuest (ARQ), in other word a retransmission mechanism. The trouble with such mechanism is that it causes delays in best effort traffic, and requires timeslots scheduled for retries on a TSCH MAC, which is globally paid in energy budget and latency boundaries. Ideally, the loss that is incurred in radio transmission would be balanced by mechanisms that are also based on radio properties and produce additional redundancy. An example of this is discussed below with a promiscuous listening technique that allows 2 parallel paths to protect one another. In this model, the controller computes 2 parallel paths for a single track, such that the nodes on one path may promiscuously overhear transmissions along the other path. A listen-only schedule is added to the normal forwarding schedule to get an additional chance to receive a frame. Thus, in this project, the students will perform a thorough performance evaluation campaign of a proposed model (i.e., Leapfrog Collaboration) to demonstrate its behaviour under various topology and link quality conditions.

Name of industrial partner	Cisco
Role of the industrial partner in the internship project	The industrial partner is working together with us for many years, and is a co-author of several publications / standards that we wrote. We are pushing for a new working group at the IETF to standardize the protocols we define in this project.
Main contact at the French industrial partner	Pascal Thubert
Email	pthubert@cisco.com
Name of the Australian partner institution	University of Technology Sydney
Name of lab/department/team involved in the Collaboration at the Australian partner institution	School of Electrical and Data Engineering, FEIT
Main contact in the Australian partner institution	Ren Ping Liu
Function	Director of Cybersecurity Lab & Head of Discipline, Network and Cybersecurity
Email	RenPing.Liu@uts.edu.au
Outside of this ongoing collaboration, will applications coming from students of other eligible Australian universities be considered by the hosting institution in France?	Yes

Expected profile of applicant

Level of study	Undergraduate, postgraduate or Master
Discipline	Telecommunication, Networking, Electrical Engineering, Electronic

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Required qualities, knowledge and skills	Self-motivated open-mind Skills: TCP/IP network principle, electronics, programming