Équipe Networks Research Group
Sujet RAW

PhD thesis
2020–2022

Software Defined Industrial Internet of Things

Location	Network research group – ICube (UMR CNRS 7357), Strasbourg (France)
Supervision	Dr. Fabrice Théoleyre (theoleyre@unistra.fr) Dr. Julien Montavont (montavont@unistra.fr)

Principal Topics

- Industrial Internet of Things: protocols and algorithms;
- Software Defined Networking;
- Mobility;

Context

Critical applications now commonly use industrial networks to connect a large set of electronic devices to digitalize the production line. In particular, the detnet IETF working group aims at defining how to support real-time flows in the network [1]. Resources are reserved to cope with the worst case (e.g. latest time of arrival).

However, the Industry now aims to go further in this direction, by using wireless transmissions. This way, a large collection of wireless sensors and actuators may be disseminated in our environment to create a Cyber Physical System (CPS). In particular, the IoT is a key enabler for the Industry 4.0 [2] to make the production lines reactive. However, the radio infrastructure is very time-dependent, and lossy, jeopardizing the reliability. Thus, we need to define how to provide a robust wireless infrastructure, able to predict the future, and to provision the resources accordingly.

We have to support multiple (more or less critical) applications executed on top of the same wireless infrastructure. Besides, some of the devices may be mobile (e.g. robots or human operators).

Scientific Objectives

We have currently many concurrent wireless technologies, with very different characteristics. While LoRa [3] targets long-range networks with a small set of gateways, Bluetooth[4] is rather designed for short range communications. WirelessHART or TSCH are scheduled networks [5], tailored for short-range topologies, with critical applications. WiFi is very popular and provides a very high bitrate, but is not designed for energy-constrained devices. Thus, we have now to define a common way to exploit all these wireless technologies, to construct a wireless infrastructure able to support both real-time and best-effort flows.

Software Defined Networking [6] seems a promising way to reduce the cost on the end-devices, that must support real-time features with a very constrained environment. Besides, we have to explore the tradeoff between centralization and reactiveness.

We will also explore how to support mobile devices, that use a wireless infrastructure for time-critical applications [7]. Resources have to be provisioned accurately along the path of the device. We expect to exploit the periodic mobility pattern, common for many industrial scenarios, to predict the amount of resources to provision.

The PhD student will contribute to the novel RAW working group [8] at the IETF. We have already started to define scenarios [9] and management feature [10] that must be supported by real-time wireless networks. We have now to define how to support multiple wireless heterogeneity, and the algorithms to make it robust.

Skills

The expected skills are:

- Excellent programming skills in C, and embedding programming;
- Distributed algorithms;
- Wireless networks (protocols and radio propagation), energy efficiency;
- SDN would be a plus;
- Applicants should possess good verbal and written English skills. French is not a requirement;
- Holding an MSc in Computer Science (CS) or Electrical and Computer Engineering (ECE) is mandatory.

Supervision

The Ph.D. student will be jointly supervised by:

- Dr. Fabrice Théoleyre (CNRS / Univ. of Strasbourg, France)
- Dr. Julien Montavont (Univ. of Strasbourg, France)

Application

The candidate has to submit an application package including:

- a curriculum vitae;
- a cover letter closely related to the research topics (your skills, your experience, your possible ideas, etc.);
- the grades for the last three years, with your position after each final exam;
- a list of references that we shall contact.

References

[1] IETF. Deterministic networking (detnet). https://datatracker.ietf.org/wg/detnet/.

[2] M. Wollschlaeger, T. Sauter, and J. Jasperneite. The Future of Industrial Communication: Automation Networks in the Era of the Internet of Things and Industry 4.0. IEEE Industrial Electronics Magazine, 11(1):17–27, March 2017.

[3] B. Vejlgaard, M. Lauridsen, H. Nguyen, I. Z. Kovacs, P. Mogensen, and M. Sorensen. Coverage and capacity analysis of sigfox, lora, gprs, and nb-iot. In 85th Vehicular Technology Conference (VTC Spring). IEEE, June 2017.

[4] K. Chang. Bluetooth: a viable solution for iot? [industry perspectives]. IEEE Wireless Communications, 21(6):6–7, December 2014.

[5] Rodrigo Teles Hermeto, Antoine Gallais, and Fabrice Theoleyre. Scheduling for ieee802.15.4-tsch and slow channel hopping mac in low power industrial wireless networks: A survey. Computer Communications, 114:84 – 105, 2017.

[6] S. Bera, S. Misra, and A. V. Vasilakos. Software-defined networking for internet of things: A survey. IEEE Internet of Things Journal, 4(6):1994–2008, Dec 2017.

[7] Marina Indri, Antoni Grau, and Michael Ruderman. Guest editorial special section on recent trends and developments in industry 4.0 motivated robotic solutions. IEEE Transactions on Industrial Informatics, 14:1677–1680, 04 2018.

[8] IETF. Reliable and available wireless (raw). https://datatracker.ietf.org/wg/raw/.

[9] G. Papadopoulos, P. Thuber, F. Theoleyre, and CJ. Bernardos. Raw use cases. draft bernardos-raw-use-cases-01, IETF, https://tools.ietf.org/html/draft-bernardos-raw-use-cases-01, 2019.

[10] F. Theoleyre and G. Z. Papadopoulos. Operations, administration and maintenance (oam) features for raw. draft theoleyre-raw-oam-support-01, IETF, https://tools.ietf.org/html/draft-theoleyre-raw-oam-support-01, 2019.