



Networks Research Group
DT-Winet

PhD thesis
2024–2027

Digital Twins for Energy Efficient Wireless Networks

Location	Network research group – ICube (UMR CNRS 7357), University of Strasbourg (France)
Supervision	Dr. Fabrice THÉOLEYRE (fabrice.theoleyre@cnrs.fr)

Keywords

Digital Twins ; Internet of Things ; self-calibration ; Wi-Fi ; 5G ; Energy efficiency

Context

Most applications now use wireless communications, even critical applications can operate over a wireless infrastructure. We are already involved in the RAW working group at the IETF to design the new protocols for these real-time networks. We have defined scenarios [1] and management features [2] for this type of networks. The achievements of the PhD student are expected to fit in the RAW working group at the IETF (<https://datatracker.ietf.org/wg/raw>).

Scientific Objectives

Digital twins are a popular concept for Industry 4.0 [3]. They model real processes in manufacturing systems to enable predictive maintenance and continuous optimization. More recently, they have been proven to be useful for networks [4]. Indeed, modern network architectures exploit the Software Defined Networking (SDN) paradigm [5], where a collection of controllers orchestrate the network. To our mind, a digital twin represents a key building block for this SDN architecture.

We will explore how digital twins could improve the efficiency of a wireless network infrastructure. Unfortunately, wireless environments are known to be lossy, with time-variant characteristics. While many models exist for the link quality [6], radio propagation [7]. However, a tradeoff between accuracy and computational complexity exists, and a unified framework has to be proposed. Finally, the PhD candidate will also explore how measurements [8] to feed the DT can be implemented in a wireless network to be energy-efficient.

Skills

The expected skills are :

- Excellent programming skills in C, and embedding programming ;
- Distributed algorithms ;



- Statistics and Measurements ;
- Wireless networks (protocols and radio propagation), energy efficiency ;
- 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), or Electrical and Computer Engineering (ECE) is mandatory.

Application

The Ph.D. is expected to start on October 1st, 2024. Please send an email to fabrice.theoleyre@cnrs.fr comprising :

- a detailed CV ;
- your possible list of publications if applicable ;
- your transcripts of the last three years, with your position after the final exams ;
- a cover letter.

Deadline : March 30, 2024.

Références

- [1] G. Mirsky et al. Raw use cases. RFC 9450, IETF, <https://datatracker.ietf.org/doc/html/rfc9450>, 2023.
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- [4] Hamed Ahmadi, Avishek Nag, Zaheer Khar, Kamran Sayrafian, and Susanto Rahardja. Networked twins and twins of networks : An overview on the relationship between digital twins and 6g. IEEE Communications Standards Magazine, 5(4) :154–160, 2021.
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- [6] Gregor Cerar, Halil Yetgin, Mihael Mohorčič, and Carolina Fortuna. Machine learning for wireless link quality estimation : A survey. IEEE Communications Surveys & Tutorials, 23(2) :696–728, 2021.
- [7] Aristeidis Seretis and Costas D. Sarris. An overview of machine learning techniques for radiowave propagation modeling. IEEE Transactions on Antennas and Propagation, 70(6) :3970–3985, 2022.
- [8] Grigorios Kakkavas, Adamantia Stamou, Vasileios Karyotis, and Symeon Papavassiliou. Network tomography for efficient monitoring in sdn-enabled 5g networks and beyond : Challenges and opportunities. IEEE Communications Magazine, 59(3) :70–76, 2021.