Networks Research Group
DT-Winet

PhD thesis
2024–2027

Digital Twins for Wireless (5G, IoT, IIoT) Networks

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

Keywords

Digital Twins ; Machine Learning ; Internet of Things ; self-calibration ; Wi-Fi ; 5G

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 the Cyber-Physical Systems (CPS) for e.g., predictive maintenance. More recently, they have been proven to be useful for 5G and 6G 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 ;

— Machine Learning and Deep Learning algorithms ;
— 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 ;
— the grades for 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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[3] Jan-Frederik Uhlenkamp, Jannicke Baalsrud Hauge, Eike Broda, Michael Lütjen, Michael Freitag, and Klaus-Dieter Thoben. Digital twins : A maturity model for their classification and evaluation. IEEE Access, 10 :69605–69635, 2022.

[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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[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.