Loria
Laboratoire lorrain de recherche
en informatique et ses applications

Postdoctoral Researcher Position Offer:
Reducing the Computational Effort in Large-Dimension MILP applied to the Routing under Latency Constraints in Large-Scale Time-Sensitive Networks

Institution/Employer: CNRS
Research Team: SIMBIOT at LORIA
Advisors: Ludovic Thomas (ludovic.thomas@cnrs.fr) and Bernardetta Addis
Start of the contract: negotiable around March 2026 – October 2026
Duration of the contract: 18 months
Applications submitted by January, 15th, 2026 will receive full consideration. If a suitable candidate is not identified, the position will remain open and subsequent applications will be reviewed until the role is filled.

Background:

Time-sensitive networks are used for safety-critical cyber-physical systems (CPSs) in vehicles, planes, satellites or power plants. Their significance has been increasing over the years and they are now used in many more applications, ranging from autonomous cars, automated manufactures (industry 4.0) to 5G backbone networks. While traditional public networks aim at improving the mean service performances (mean round trip time, mean throughput), time-sensitive networks provide guarantees for the worst case (e.g. guarantee of a maximal latency, guarantee of no loss, ...). Time-sensitive networks use specific layer-2 technologies such as IEEE TSN [TSN] for providing deterministic latency. Most of the time, certification authorities require formal proofs of the network timing behavior [LeBoudec01]. Network calculus is a commonly used theory for providing such formal proofs. Over the recent years, open-source tools based on network calculus have been published and provide timing upper bounds for a given network configuration (ex: for a given allocation of routes and priorities to flows).

However, time-sensitive networks control increasingly large and dynamic systems (smart-grid systems, unmanned air traffic management, public transportation systems). To choose a routing and configuration (ex: what paths and priorities to allocate to flows, depending on their deadlines and traffic profile ?) for these new types of networks, enumerating all possible configurations, analyzing them all using network-calculus tools to retain only those that meet the flows' requirements becomes impractical. The RÉCITAL research project proposes to start from the flow latency constraints to generate a routing of flows and a network configuration that respect these constraints and minimize the network usage and/or maximize the monetary value of the service.

Project description:

The idea in RÉCITAL's research project is to describe the routing-and-configuration problem as a Mixed Integer Linear Program (MILP) to leverage the performance of MILP solvers. We expect that this approach can provide better results than the ones based on gradient descent [Geyer22]. However, the obtained MILP models can be of very high dimension in large networks.

In this Postdoctoral Research Position, we aim at identifying, testing and selecting approaches for reducing the computational effort of the MILP models. You will work with the PhD and permanent members that create the MILP models to identify with them the opportunities of proposing and comparing different reformulations, valid inequalities and decomposition techniques. For the largest problems, we aim to identify promising heuristics providing a good coverage/accuracy/computational effort trade-off, etc.

Profile:

- PhD in operational research with contributions in integer linear programming (modeling, decomposition, math-heuristics).
- Previous work on network optimization is a plus.
- Knowledge in computer networks and/or time-sensitive systems is a plus.

Working Environment:

The employer for the position is **CNRS** (French National Centre for Scientific Research), France's largest public research organization and one of the world's leading institutions in scientific research. With over 33,000 employees and a presence across all scientific disciplines, CNRS conducts both fundamental and applied research to address major societal challenges. Renowned for its excellence, its expertise spans humanities and social sciences, life sciences, physics, chemistry, mathematics, engineering, and more. CNRS is committed to innovation, knowledge sharing, and research-based education, collaborating with universities, industries, and international partners.

The research will be conducted at **LORIA** (Lorraine Research Laboratory in Computer Science and its Applications), a research unit, common to CNRS, the University of Lorraine, CentraleSupélec and Inria. This unit was officially created in 1997. Loria focuses on fundamental and applied research in computer sciences. Bolstered by the 500 people working in the lab, its scientific work is conducted in 28 teams including 14 common teams with Inria. Loria is today one of the biggest research labs in the Grand Est Region.

The position is located in **Nancy, France**. Nancy is a vibrant city that beautifully blends historical heritage with innovation. As the former capital of the Dukes of Lorraine, it is a

UNESCO World Heritage site, celebrated for its 18th-century masterpiece, the Place Stanislas. A lively student city with a rich cultural scene, Nancy is home to prestigious institutions such as the University of Lorraine, top engineering schools, and leading research centers, fostering a thriving environment for scientific excellence and collaboration. With its high quality of life, renowned cuisine, and central location in Europe, Nancy is an attractive place to live and work.

References:

[TSN] "Time-Sensitive Networking (TSN) Task Group |." Accessed: Nov. 06, 2022. Available: https://1.ieee802.org/tsn/

[LeBoudec01] J.-Y. Le Boudec and P. Thiran, Network Calculus, vol. 2050. in Lecture Notes in Computer Science, vol. 2050. Berlin, Heidelberg: Springer, 2001. doi: 10.1007/3-540-45318-0.

[Geyer22] F. Geyer and S. Bondorf, "Network Synthesis under Delay Constraints: The Power of Network Calculus Differentiability," in IEEE INFOCOM 2022 - IEEE Conference on Computer Communications, May 2022, pp. 1539–1548. doi: 10.1109/INFOCOM48880.2022.9796777.