PhD Position in Data Management for Multi-stakeholders and Inter-domain Knowledge Sharing

Laboratoire Ville Mobilite Transport
Ecole nationale des ponts et chaussees, Institut Polytechnique de Paris

We invite application for a contract-based PhD position in data management for multi-stakeholders and inter-domain knowledge sharing applied to the domain of logistics data, in the Laboratoire Ville Mobilite Transport at Ecole nationale des ponts et chaussees, Institut Polytechnique de Paris, Champs-sur-Marnes, Paris region, France.

The position is part of the *Multimodal Collaborative Eco-friendly Logistics (ACME)* project funded by the PEPR Data Technology for Mobility in the Territories under the France 2023 framework. The PhD project will contribute to the work area focusing on designing a collaborative platform for exchanging, managing and analysing logistics data from multiple sources.

Context and objective

The supply chain operations of large corporations traditionally involve producing, collecting and processing a lot of different types of data, from the precise knowledge of existing transportation infrastructures and services such as road and train networks, locations of stations and warehouses, to information pertaining to the fleets of delivery vehicles with their availabilities and prices, as well as of local rules and regulations. This data must be gathered, analysed and turned into transportation orders, either executed in-house or transmitted to a third-party carrier. Consolidating knowledge across the multiple stakeholders that participate in the supply chain operations and that often belong to different domains, is essential to support collaboration and joint decision-making.

The consolidation efforts are today strongly hampered by the variety and incoherence of data management practices. Actors in the supply chain ecosystem tend to manage their own data, often manually, using ad-hoc formats (like Excel spreadsheets or relational databases) and without formal specification or automated pipelines. This makes the sharing of knowledge across stakeholders highly inefficient.

Multi-stakeholder knowledge sharing is however a key ingredient to support joint delivery planning or transfer between modes of transportation that can contribute to reducing the environmental footprint of logistics activities.

Position

The role of the PhD project is to investigate how to design, implement and operate a collaborative platform that can facilitate the exchange, management and processing of data in environments that are inter-domain and multi-stakeholders. The project will focus on the use case of data sharing for multimodal, collaborative logistics [1,2].

In particular, the PhD will address four main challenges.

1. The first challenge is to explore the development of configurable, knowledge-based models to represent and characterise modes of interactions between heterogeneous stakeholders in a set

environment. The project will work towards reviewing existing approaches that build on hierarchical abstraction models [3] and the principles of *knowledge-as-a* [4], in particular. The project will propose a solution that is adapted to the characteristics of interactions induced by data exchanges in the context of multimodal, collaborative logistics, *e.g.,* exchange dynamic requirements, type and information granularity, types of collaboration (mesh, star-based, sequential, *etc.*)

2. The second challenge will be to investigate knowledge-graph technologies as support of the implementation of a common repository of heterogeneous data in multi-stakeholders and inter-domain environments [5,9]. The project will focus on comparing different technologies for the implementation of the graph, *i.e.,* based on the RDF standard [6] or building on labelled property graphs [7]. It will also investigate how to integrate the proposed graph with ontology models that are currently being developed to standardise the description of resources (stakeholders, types of actions, data, infrastructure, relations) in the logistics domain, *e.g.,* [8].

3. The third challenge will be to design and implement the prototype of a collaborative platform tailored to the requirements of the multimodal, collaborative logistics scenario. This will include to develop the functionality of the platform (to search for information, to add/remove/modify data, to identify conflict, [10] *etc.*) and its architecture in terms of interfaces (*e.g.,* client/server, publish/subscribe, data streaming), data formats (*e.g.,* XML, JSON, CSV) and exchange protocols (*e.g.,* CoAP, MQTT, WebSocket). The project will devise test scenarios to assess the performance and suitability of the platform in terms of flexibility, overhead and interoperability guarantees.

4. The fourth challenge will be to develop a demo to illustrate the functionality and feasibility of the platform based on the optimisation use cases tackled by the ACME program of research. The PhD researcher will interact with the members of consortium, including other PhD researchers, postdoc researchers, as well as academics, to collect their requirements and inputs. The PhD researcher may also be invited to participate in standardisation activities as part of the demo development process.

About the position and the PhD project

The position is full-time for **36 months** starting **October 2025**.

The PhD project will be supervised by Dr Daphne Tuncer (PhD, HDR). More information about the profile of the supervisor can be found at http://dtuncer.com/index.html

The project will be held at Laboratoire Ville Mobilite Transport, Ecole nationale des ponts et chaussees, Institut Polytechnique de Paris, Greater Paris, France.

The PhD candidate will be registered at the Doctoral School of Institut Polytechnique de Paris (https://www.ip-paris.fr/en/education/phd-programs/ip-paris-doctoral-school). The PhD project will fall under the Computing, Data and Artificial Intelligence domain (https://www.ip-paris.fr/en/education/phd-programs/ip-paris-doctoral-school/phd-computing-data-and-artificial-intelligence). The PhD candidate and their project will be subject to the rules and conditions of the Doctoral School of Institut Polytechnique de Paris.

The salary is fixed and set in accordance to the standards applied at Ecole nationale des ponts et chaussees, Institut Polytechnique de Paris.

Required skills and experience

- A postgraduate degree in Computer Science, ICT Engineering, Applied Mathematics, or any relevant fields is required
- A first experience working in a research environment either through a 6-months (minimum) research placement or in a research assistant position
- Working knowledge and implementation experience in any of the following areas: data engineering, software engineering, system engineering
- Proficiency in at least one programming language
- A demonstrated ability to read and understand scientific reports
- A demonstrated ability to write research documents
- Strong interpersonal skills and teamwork ability
- An appetence for hands-on research
- An appetence for multi-disciplinary research settings
- General knowledge of the mobility domain is an asset but is not required
- A working knowledge of English is required for this position

How to apply

To apply, please send the following to Dr Daphne Tuncer at daphne dot tuncer at enpc dot fr:
1. A CV (including the list of publications if applicable)
2. A cover letter describing how the skills of the candidate match the requirements of the PhD project
3. The transcripts of the last year of the undergraduate degree and of the master degree
4. A sample course report or article written in English (if any) for which the candidate is the first author

For more information, prospective candidates are strongly encouraged to directly contact Dr Daphne Tuncer.

Incomplete applications will be automatically rejected.

References

[1] DISCO, "Data-driven, Integrated, Synchromodal, Collaborative and Optimised urban freight meta model for a new generation of urban logistics and planning with data sharing at European Living Labs,".

[2] T. Debicki, and C. Guzman, "Challenges in Future Data Interchange in Transport and Logistics Sector," Integration of Information Flow for Greening Supply Chain Management, 93-107, 2020.

[3] J. Rasmussen, L.P. Goodstein, "Decision support in supervisory control of high-risk industrial systems," *Automatica*, *23*(5), 663-671, 1987.

[4] M. Charalambides, D. Tuncer, N. Wang, and G. Pavlou, "KCN: Knowledge Centric Networking," arXiv, 2006.02107, cs.NI, June, 2020.

[5] Q. Wang, Z. Mao, B. Wang, and L. Guo, "Knowledge graph embedding: A survey of approaches and applications," IEEE transactions on knowledge and data engineering, 29(12), 2724-2743, 2017.

[6] M. Wylot, M. Hauswirth, P. Cudré-Mauroux, and S. Sakr, "RDF data storage and query processing schemes: A survey," ACM Computing Surveys (CSUR), 51(4), 1-36, 2018.

[7] J.J. Miller, "Graph database applications and concepts with Neo4j," In Proceedings of the southern association for information systems conference, Atlanta, GA, USA (Vol. 2324, No. 36, pp. 141-147), 2013.

[8] T. Grubic, and I. S. Fan, "Supply chain ontology: Review, analysis and synthesis," *Computers in Industry*, *61*(8), 776-786, 2010.

[9] J. Greenberg, "Understanding metadata and metadata schemes," In Metadata (pp. 17-36). Routledge, 2012.

[10] P. Almasan, *et al.*, *"*Digital twin network: Opportunities and challenges," arXiv preprint arXiv:2201.01144, 2022.