Consistency and availability of data in dynamic distributed systems

Open PhD positions at Télécom Paris

Research directions

Maintaining consistency and availability of data in a dynamic distributed system subject to hardware failures and security attacks is one of the most important problems in computing. The plethora of recently proposed blockchains implementing public, totally-ordered "ledgers of transactions" address this problem in a system where multiple mutually distrusting users share data and exchange assets, and some users may cheat and collude. The service, however, must be consistent and available to the honest users.

Our PhD positions assume, but are not restricted to, the following directions:

- Light-weight transaction ordering. A few recent results indicate cryptocurrencies, the main application of blockchain systems, do not require totally-ordered ledgers to be implemented. Instead, we can resort to "light-weght" ordering that may only require small subsets of users to reach agreement on the order of their operations. For example, consider the supply chain composing a tree of pairwise contracts. What are the minimal system requirements under which this contracts can be implemented?

- Energy-aware distributed computing. Quality of service and fault-tolerance come with the need for replication: multiple redundant copies of data must be distributed across the globe. Maintaining consistency of these replicas incurs costs: time, space and, most importantly, energy. Can we prioritize energy-efficiency in large-scale synchronization protocols?

- Access control and replication. Shared data in a supply chain can be decomposed into the states of peer-to-peer contracts. It is desirable to allow a party to only access the "relevant" parts of the state, e.g., the contracts it is involved in. Moreover, we may want to allow an external party (e.g., an auditor or a market analytic firm) to aggregate information from the ledger and, possibly, perform some operations on it, without being able to see all the data. Can we achieve this without sacrificing consistency and security of the original solution?

- Multi-chain systems. A plausible scenario of future computing systems is multiple systems maintaining cross-chain interactions. An immediate challenge here is time, i.e., the synchrony assumption that enable solutions to the problem. All solutions proposed so far assume a synchronous network in which a form of "time-lock" can be implemented. Are there less demanding and, potentially, more efficient, solutions that involve asynchronous interactions? Can we determine the weakest synchrony assumptions for it?

- Decentralized trust. In large-scale systems, the classical assumption that large fractions of the system users can be trusted becomes unrealistic. Instead, multiple recent proposals consider

"local trust" models where a user only trusts its peers. Given the structure of distributed local (also called "federated") trust assumptions, can we determine levels of data consistency that can be achieved? What are the benefits and limitations of federated trust assumptions?

Location

Télécom Paris is (also known as ENST or École nationale supérieure des télécommunications) is one of France's top five graduate engineering schools, considered the leading French school in Information and Communication Technology (ICT). Located in the Paris area, it is a founding member of Institut Polytechnique Paris (https://www.ip-paris.fr/en/home-en/). In collaboration with EPFL, it has established Institut Eurécom at Sophia-Antipolis.

Eligibility and formalities

The PhD positions are open for three years starting in 2020 and 2021.

The positions are offered to both foreign and French students who hold a Master degree in computer science. Basic knowledge of distributed algorithms (with a focus on state-machine replication, Byzantine Fault-Tolerance, storage systems), basic concurrent programming skills, curiosity and persistence are expected.

Application process

To apply, please send the following documents:

- Curriculum Vitae
- Transcripts of undergraduate university grades
- Motivation letter from the applicant

to Petr Kuznetsov (`petr.kuznetsov@telecom-paris.fr`)

Contact

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