2018-00903 - Doctorant / Sécurisation de traitement orientés données à base d'environnement d'exécution de confiance

Level of qualifications required: Graduate degree or equivalent
Fonction : PhD Position

About the research centre or Inria department

Located at the heart of the main national research and higher education cluster, member of the Université Paris Saclay, a major actor in the French Investments for the Future Programme (Idex, Labex, IRT, Epipes) and one of the main establishments present on the plateau, the centre is particularly active in three major areas: data and knowledge; safety, security and reliability; modelling, simulation and optimisation (with priority given to energy).

The 450 researchers and engineers from Inria and its partners who work in the research centre's 31 teams, the 100 research support staff members, the high-level equipment at their disposal (image walls, high-performance computing clusters, sensor networks), and the privileged relationships with prestigious industrial partners, all make Inria Saclay Île-de-France a key research centre in the local landscape and one that is oriented towards Europe and the world.

Context

The Personal Cloud paradigm holds the promise of a Privacy-by-Design storage and computing platform, where each individual can gather her complete digital environment in one place and perform advanced data oriented computations on her data with stringent privacy and security guarantees. However, this paradigm leaves the privacy and security issues in user's hands, which leads to a paradox if we consider the weaknesses of individual environment in terms of computer security. The challenge is however paramount in a society where emerging economic models are all based - directly or indirectly - on exploiting personal data.

On the other hand, trusted execution environments (TEE), like Intel SGX, are now embedded in end-users’ personal computers and in cloud servers. From a security point of view, it offers the capabilities to run code in isolation and provide remote attestations, which allow to prove required properties of the code running to third parties. Additionally, TEEs provide mechanisms for managing the information flow from code running in the TEE to the outside world, secure external storage thanks to encryption, and manage the communications between different processes running in a TEE. Typically, Intel SGX integrates cryptographic primitives in hardware, with an impact on the performance of data oriented tasks which remains to analyze.

While many research works tackle the organization of the user's workspace, the semantic unification of personal information, the personal data analytics problems, the objective of the PETRUS team is to tackle the privacy and security challenges from an architectural point of view. This PhD will investigate the design of database structures and algorithms in trusted execution environments for the personal cloud context.

Assignment

The goal of the PhD are (i) to identify the specific constraints of trusted execution environments (e.g., Intel SDK) with respect to personal database management tasks and understand how side channel attacks on trusted execution environments (timing, memory access patterns) affect classical data processing; and (ii) to propose appropriate design rules for data structures, algorithms and counter measures, for efficient, scalable and secure personal data management using secure enclaves.

Main activities

The Intel SGX technology is embedded in all recent Intel CPUs present in personal computers and cloud servers. From a security point of view, it provides a trusted execution environment (TEE), called enclave in the SGX context. More precisely, it offers the capabilities to run code in isolation and provide remote attestations, which allows to prove required properties of the code running to third parties. Additionally, TEEs provide mechanisms for managing the information flow from code running in the TEE to the outside world, secure external storage thanks to encryption, and manage the communications between different processes running in a TEE. Intel SGX therefore integrates cryptographic primitives in hardware, with an impact on the performance of data oriented tasks which remains to analyze.

In the PETRUS team, we use Intel SGX to secure data computations performed in a personal cloud context. More precisely, our goal is to process data under the control of the user either on the user's SGX enabled machine or in an untrusted cloud context using the SGX attestation mechanism. In this context, SGX provides an invaluable building block as it allows to isolate tasks from the – potentially compromised – user OS, or the untrusted cloud owner infrastructure, thus allowing for strong security guarantees against a realistic adversary that might compromise the user machine through malware, and compromise security of a cloud provider (either through an insider attack or a large scale compromise as seen recently). The aim of this internship is to identify tradeoffs between efficiency and security that have to be made when securing data processing tasks using SGX. This is an essential issue as the security and computation model of SGX are rather far from the well studied case of an dedicated processing server.

Two different issues have to be considered here. The first one is how the specific memory architecture of SGX affects the data management tasks. Indeed, SGX has two important limitations: first, the amount of protected memory is rather limited (roughly 100 Mo) compared to modern unprotected systems; second, while access to CPU cache from an enclave is similar to an unprotected context, because of data protection mechanisms, access to RAM is much more expensive. This leads to the first objective of this internship, namely benchmarking data processing tasks in the context of SGX in order to understand which algorithms are well suited for data processing in this context. The second issue is understanding how side channel attacks on SGX (timing, memory access patterns) affects classical data processing algorithms. The second objective of this internship is to evaluate the impact of these attacks on data processing tasks protected in enclaves and devising counter measures to protect against these attacks.

Skills

- Impact of these attacks on data processing tasks protected in enclaves and devising counter measures, for efficient, scalable and secure personal data management using secure enclaves.
- Knowledge of SGX architecture and its implications on data management tasks.
- Proficiency in computer science, with a focus on data processing and security.

Conditions for application

Defence Security : This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorization to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy : As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.
The successful applicant will have a masters (or any equivalent degree) in computer science. He will have a strong background both in computer security and databases. A knowledge of cryptography and/or formal methods would be a plus.

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
1st and 2nd year gross salary: 1,982 euros/month
3rd year gross salary: 2,085 euros/month