Proposition de recherche doctorale

Just-Right Consistency

Mots clés :

- Directeur de thèse : Marc Shapiro
- Co-encadrant(s) :
- Unité de recherche : Laboratoire d'informatique de Paris 6
- Ecole doctorale : Ecole Doctorale Informatique, Télécommunications, Électronique de Paris
- Domaine scientifique principal : Divers

Résumé du projet de recherche (Langue 1)

In a distributed system, data is distributed and replicated, in order to ensure availability and persistence despite high latencies and (unavoidable) failures. This creates the issue of consistency: the famous "CAP" impossibility result shows there is an inherent trade-off between fault tolerance, performance, and programmability. Strong consistency is very safe but is slow, expensive, and unavailable when network connections break; eventual consistency is fast and cheap but exposes programmers to bug-prone anomalies. Intermediate models exist but they are hard to understand. No single consistency model is appropriate for all uses. We propose to develop a novel “Just-Right Consistency” (JRC) approach. As consistency aims to guarantee application invariants, we propose to tailor the distributed synchronisation mechanisms precisely to the needs of the specific application. It aims to provide the highest degree of availability that is compatible with the application requirements, and just enough consistency to ensure its invariants. The JRC approach rests on advanced techniques from the distributed algorithms area and from application analysis and verification. It deconstructs the traditional consistency algorithms into fine-grain, efficiently composable orthogonal primitives. Based on an static and dynamic analysis of the application, the approach identifies the application's requirements in terms of synchronisation and data access. This analysis identifies any consistency anomalies or availability/performance bottlenecks, and accordingly proposes either to weaken a specific requirement or to strengthen a specific action.

Résumé du projet de recherche (Langue 2)

The proposed research includes the following components: * Analyse application requirements. Identify and classify common classes of invariants; for each class, describe appropriate synchronisation protocol. * Design a tool or language for expressing invariants at a high level, and for helping application programmers to identify all important invariants of their application. * Extend our existing CISE static analysis tool for detecting concurrent transactions that are unsafe with respect to the above invariants, and for thus identifying points where the developer should insert synchronisation to ensure safety. * Taking into account the dynamic behaviour of the application, design and implement a dynamic analysis tool to analyse synchronisation performance, and to optimise by comparing alternative synchronisation placements. * Apply this research to our geo-replicated cloud database Antidote http://antidoteDB.eu/. Transactions will be asynchronous by default, but optionally may specify synchronisation for its reads, its writes, or both. The challenge is ensuring that synchronous operations do not slow down the asynchronous ones, and designing compact and uniform metadata for both types of operations. * Validate experimentally with applications running above Antidote.

Informations complémentaires (Langue 1)

The student will participate in EU project LightKone https://lightkone.eu/. Where today's cloud computing platforms are centralised and monopolistic, LightKone aims to locate data and computation at the edge, near the users and under their control. With massive numbers of replicas, edge computing makes the the CAP tension between consistency and availability extremely acute and relevant. An international internship during the PhD is strongly encouraged.

Informations complémentaires (Langue 2)

Required skills and background (optional): (training, specialities, knowledge ...): * Masters’ in Computer Science / Informatics or related field. * Excellent academic record. * Highly motivated by research in distributed systems and/or programming languages and verification. * Excellent implementation and experimentation skills. Please provide a CV, the list of your Masters or PhD courses and your marks, an essay relevant to the topic (1 to 4 pages), and at least two references (whom we will contact ourselves for a recommendation). Contact: Marc Shapiro http://lip6.fr/Marc.Shapiro/