Offre n°2022-05223

PhD Position F/M Reliable and cost-efficient data placement and repair in P2P storage over immutable data

Le descriptif de l'offre ci-dessous est en Anglais

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Inria Rennes - Bretagne Atlantique Centre is one of Inria's eight centres and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute, etc.

Contexte et atouts du poste

This PhD thesis will be in the context of a collaboration between HIVE and Myriads and Coast Inria teams. The Ph.D student will be located at Inria Center of the University of Rennes and will be visiting team Coast at Inria Nancy-Grand Est and the Hive offices in Cannes.

About Hive:

Hive intends to play the role of a next generation cloud provider in the context of Web 3.0. Hive aims to exploit the unused capacity of computers to offer the general public a greener and more sovereign alternative to the existing clouds where the true power lies in the hands of the users. It relies both on distributed peer-to-peer networks, on the encryption of end-to-end data and on blockchain technology.

About Inria Center of the University of Rennes:

The Inria Center of the University of Rennes is one of Inria's eight centers and has more than thirty research teams. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institutes, etc.

About Inria Nancy - Grand Est:

The Inria Nancy - Grand Est center is one of Inria's eight centers and has twenty project teams, located in Nancy, Strasbourg and Saarbrücken. Its activities occupy over 400 people, scientists and research and innovation support staff, including 45 different nationalities. The Inria Center is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative PMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institutes, etc.

Mission confiée

Recently, there is a growing trend toward highly distributed storage solutions by storing and sharing data across geo-distributed connected devices from the edge of the network to large scale data centres. An appealing solution – which we are exploring within the Inria-Hive collaborative framework – is utilizing the available storage and compute resources of connected devices (mobile/desktops) across the world to form a P2P storage system that provides data storage and sharing in a cost-efficient way. However, this requires to deal with several issues including node failures, node availabilities (churns), how to guarantee data availability and avoid data loss, etc.

Erasure coding (EC) has been progressively used in storage systems to provide high data availability with

relatively less storage and energy cost compared to replication. For example, EC has been deployed in data analytic systems [1, 2, 3, 4] and in-memory storage systems on cached (hot) data [5]. EC can be an ideal candidate for large scale peer-to-peer storage systems (exploits parallel read and write of data, involves large number of nodes in storing and repairing data). However, unlike previous efforts where EC is mainly used for achieved data in P2P system [6, 7], performing EC on the critical path of data access (which is the case in this project) in large scale P2P storage system (to store hot and frequently accessed data) poses many research challenges on how to ensure high data availability and meet data and node dynamicity, and on how to provide cost-effective and heterogeneity-aware data repair.

This PhD thesis will address the problem of how to provide cost-efficient yet reliable data management when deploying erasure codes (EC) in large scale trusted peer-to-peer cloud storage systems.

References:

[1] H. Chen, H. Zhang, M. Dong, Z. Wang, Y. Xia, H. Guan, and B. Zang. “Efficient and available in- memory KV-store with hybrid erasure coding and replication”. In: ACM Transactions on Storage (TOS) 13.3 (2017), pp. 1–30. doi: 10.1145/3129900.

[2] J. Darrous and S. Ibrahim. “Understanding the performance of erasure codes in hadoop distributed file system”. In: CHEOPS@EuroSys 2022: Proceedings of the Workshop on Challenges and Opportunities of Efficient and Performant Storage Systems, Rennes, France, 5 April 2022. Ed. by M. Kuhn, K. Duwe, J. Acquaviva, K. Chasapis, and J. Boukhobza. ACM, 2022, pp. 24–32. doi: 10.1145/3503646.3524296.

[3] J. Darrous, S. Ibrahim, and C. Pe□rez. “Is it Time to Revisit Erasure Coding in Data-Intensive Clusters?” In: 27th IEEE International Symposium on Modeling, Analysis, and Simulation of Computer and Telecommunication Systems, MASCOTS 2019, Rennes, France, October 21-25, 2019. IEEE Computer Society, 2019, pp. 165–178. doi: 10.1109/MASCOTS.2019.00026.

[4] Z. Zhang, A. Deshpande, X. Ma, E. Thereska, and D. Narayanan. Does erasure coding have a role to play in my data center? Tech. rep. MSR-TR-2010-52. May 2010.

[5] K. V. Rashmi, M. Chowdhury, J. Kosaian, I. Stoica, and K. Ramchandran. “EC-Cache: Load-Balanced, Low-Latency Cluster Caching with Online Erasure Coding”. In: 12th USENIX Symposium on Operating Systems Design and Implementation, OSDI 2016, Savannah, GA, USA, November 2-4, 2016. Ed. by K. Keeton and T. Roscoe. USENIX Association, 2016, pp. 401–417.

[6] J. Kubiatowicz, D. Bindel, Y. Chen, S. Czerwinski, P. Eaton, D. Geels, R. Gummadi, S. Rhea, H. Weatherspoon, W. Weimer, C. Wells, and B. Zhao. “OceanStore: An Architecture for Global- Scale Persistent Storage”. In: SIGPLAN Not. 35.11 (Nov. 2000), pp. 190–201. issn: 0362-1340. doi: 10.1145/356989.357007.

[7] R. Rodrigues and B. Liskov. “High Availability in DHTs: Erasure Coding vs. Replication”. In: Peer-to-Peer Systems IV, 4th International Workshop, IPTPS 2005, Ithaca, NY, USA, February 24-25, 2005, Revised Selected Papers. Ed. by M. Castro and R. van Renesse. Vol. 3640. Lecture Notes in Computer Science. Springer, 2005, pp. 226–239. doi: 10.1007/11558989_21.

Principales activités

- As a first step, we will investigate new data placement strategies that can ensure high data availability under frequent failures and node unavailabilities. We will start by exploring how to initially place the data while considering the performance of data retrieval (location-aware, upload bandwidth of storage nodes) and the availability of data (fast data repair to avoid data loss in case of multiple failures and node unavailabilities “churns”).

- Data comes with different format and has different access patterns (write once read many, periodically read, hot and cold, etc). In addition, P2P systems are highly dynamic (nodes availabilities, churns, the contributed storage and bandwidth of the nodes vary with time, etc). Therefore, data should be re-encoded (e.g., using wide-strip for cold data) and re-placed considering the dynamicity of both data and participating nodes. To facilitate that, we will make use of machine learning and probabilistic models to predicate node availabilities and study how to use the role of nodes, the contributed resources of the nodes and the incentive and awarding mechanisms which are used in the system to classify and estimate the performance of storage nodes.

- To cope with the high number of repair jobs due to lost or temporarily unavailable data, we will design data repairs orchestrator (centralized/decentralized scheduling framework) that ensures cost-effective and efficient data repair jobs by considering the location of data, availabilities of nodes, heterogeneity of the network bandwidth, etc.

Compétences

- Engineering and/or Master 2 degree in Computer science / Applied mathematics with an experience in computer networks.

- Theoretical expertise: distributed systems, P2P networks

- Good collaborative and networking skills, excellent written and oral communication in English
- Good programming skills
- Strong analytical skills

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking (90 days per year) and flexible organization of working hours
- partial payment of insurance costs

Rémunération

Monthly gross salary amounting to :

- 1982 euros for the first and second years and
- 2085 euros for the third year

Informations générales

- **Thème/Domaine :** Systèmes distribués et intergiciels
  Système & réseaux (BAP E)
- **Ville :** Rennes
- **Centre Inria :** Centre Inria de l'Université de Rennes
- **Date de prise de fonction souhaitée :** 2023-10-01
- **Durée de contrat :** 3 ans
- **Date limite pour postuler :** 2023-09-16

Contacts

- **Équipe Inria :** MYRIADS
- **Directeur de thèse :**
  Ibrahim Shadi / Shadi.Ibrahim@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

Please submit online : your resume, cover letter and letters of recommendation eventually

For more information, please contact shadi.ibrahim@inria.fr

Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :
Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.