Efficient (re)naming in Conflict-free Replicated Data types (CRDTs)

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March 23, 2018

In order to design large scale distributed systems, the literature and companies increasingly adopt the optimistic replication model known as eventual consistency to replicate data among nodes. This consistency model allows replicas to temporarily diverge to be able to ensure high availability. Each node owning a copy of the data can edit it without any kind of coordination with other nodes, before propagating the changes to others. A conflict resolution mechanism is however required to handle updates generated in parallel by different replicas.

An approach which gains in popularity since a few years proposes to define Conflict-free Replicated Data types (CRDTs)[2]. These data structures behave as traditional ones, like the *Set* or the *Sequence* data structures, but are designed for a distributed usage. Their specification ensures that concurrent changes are resolved deterministically and that replicas eventually converge after observing all updates. Several promising ongoing works rely on this approach to design distributed datastores *TODO: insert reference to Riak or Antidote*, collaborative editing tools [1] *TODO: insert reference to teletype* and even programming languages for designing distributed application *TODO: insert reference to LASP*.

To achieve convergence, CRDTs proposed in the literature mostly rely on identifiers to reference updated elements. To be globally unique, element identifiers often include the identifier of the node which generates them. But, since node identifiers grow as new nodes join the system, element identifiers have to grow proportionally. Furthermore, element identifiers have to comply to additional constraints according to the CRDT, which may result in the acceleration of their growth.

Hence, since the size of identifiers is not bounded, the size of metadata attached to each element increases over time. It thus exceeds more and more the size of data itself. This impedes the adoption of CRDTs since nodes have to broadcast and store metadata, causing the application's performances and efficiency to decrease over time.

The goal of this PhD is to address this issue by 1. proposing more efficient specifications of identifiers according to their set of constraints, 2. proposing mechanisms to rename identifiers to reduce their size.

References

[1] Matthieu Nicolas, Victorien Elvinger, Gérald Oster, Claudia-Lavinia Ignat, and François Charoy. MUTE: A Peer-to-Peer Web-based Real-time Collaborative Editor. In *ECSCW 2017 - 15th European Conference on Computer-Supported Cooperative Work*, volume 1 of *Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Panels, Posters and Demos*, pages 1–4, Sheffield, United Kingdom, August 2017. EUSSET.

[2] Marc Shapiro, Nuno Preguiça, Carlos Baquero, and Marek Zawirski. A comprehensive study of Convergent and Commutative Replicated Data Types. Research Report RR-7506, Inria – Centre Paris-Rocquencourt, January 2011.