TransForm: Theoretical Foundations of Transactional Memory

TransForm is an EU-funded research project targeted at building the theoretical underpinning for the design and analysis of efficient Transactional Memory (TM) systems. Transactional Memory is a new programming paradigm which is considered very promising by many researchers.

Parallel programming comes once more en vogue as major chip manufacturers shift their focus from trying to speed up individual processors into putting several processors on the same chip. The constructors are now calling for a new software revolution: the concurrency revolution. This might look at first glance surprising, for concurrency is almost as old as computing and a big number of concurrent programming models and languages were invented. However, the current parallel programming approaches are considered to be too difficult for any but a few experts. Thus, what the the revolution is about is way more than concurrency alone: it is about concurrency for the masses.

Deep understanding of the capabilities and the properties of TM systems is highly desirable, albeit not an easy task, since many difficulties are encountered: several, sometimes contradictory, performance parameters must be taken into consideration, and different trade-offs should be identified. Many of these difficulties come from the lack of commonly accepted, precise definitions and rules to describe and govern such systems.

To understand properly TM systems, as well as be able to assess them and improve them, a rigorous theoretical study of the approach, its challenges and its benefits is needed. This project aspires to be a highly successful endeavor in this direction.

More specifically, the main objectives of the project are the following:

a) the provisioning of a common framework that will allow the unification of all current state-of-the-art TM architectures and will facilitate the design, analysis and verification of new TM systems;
b) the deep understanding and precise formulation of the correctness and progress semantics of TM systems;
c) the exploration of valuable complexity measures and performance metrics that will facilitate the comparison of the currently available and the newly designed TM implementations;
d) the formalization of abstractions for main problems encountered when designing TM systems;
e) the study of important trade-offs of TM design, and the proof of lower bounds and impossibility results, thus identifying where designers should not put the effort in trying to solve a problem, allowing them to decide if implementations are optimal, helping them understand the difficulties, and possibly suggesting novel approaches to achieve better performance;
f) the study of efficient TM implementations, which could be based on the design of more sophisticated mechanisms that may rely on the semantics of data structures and applications to determine synchronization in order to yield significant performance gains.

In addition, TransForm aims at improving the career perspectives of Early-Stage Researchers (ESR) by offering structured training in the challenging research area of Transactional Memory, as well as providing complementary skills and exposing the researchers to other sectors including private companies, with the goal to create a group of experts in this research area.

The partners of TransForm are:

– École Polytechnique Fédérale de Lausanne (EPFL) – Switzerland,

- Foundation for Research and Technology - Hellas (FORTH),
- Technische Universität Berlin - Germany,
- Technion – Israel, and
- University of Rennes 1 - France.

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The project is supported and co-supervised by a board of industrial partners:

- Deutsche Telekom – Germany,
- Microsoft Research, Cambridge – UK,
- Oracle Labs, Massachusetts – USA,
- IBM T.J. Watson Research Center – USA.

The Foundation of Research and Technology participates in the project via its Institute of Computer Science (ICS). Its participation is twofold: Not only is FORTH the coordinator of the project, but it also contributes to two of the main research objectives, objectives a) and b). FORTH is responsible of overseeing the organization of events, the preparation of deliverables and the cooperation among partners. In terms of research, FORTH has to lay the groundwork of determining the framework for the project, as well as to investigate the basic aspects of safety and liveness. FORTH will collaborate with the rest of the partners for contributing to the other research objectives.

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