

Université Toulouse III - Paul Sabatier

INTEGRATION

REPORT

ON

**“Browser-based diagram editor for timed automata models and
coupling to an existing prototype bounded model checker”**



MASTER 1

RESEARCH INITIATION

COMPUTER SCIENCE FOR AEROSPACE

FACULTY OF SCIENCES AND ENGINEERING

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1. Abstract

Timed automata (TA) were introduced as a formal notation to model and analyze the behaviour of real-time systems, network protocols, etc. Bounded Model Checking (BMC) has proven to be a very efficient technique for the verification of these systems and protocols. It reduces model checking to propositional satisfiability (SAT). Many computer scientists, software engineers etc. use these verification tools for many purposes; therefore it is important to explore new ideas and methods to make them more efficient. The method ensures safety and liveness by checking whether a given set of states is reachable and detecting loops in a system's state transition graph. In this paper, we explicate a timed automata network model and ensure the coupling on the server-side with an existing prototype bounded model checker, capable of computing feasible execution traces. The prototype implementation relies on an MILP solver (Gurobi) and SAT solver (MathSAT). Bounded model checking for networks of timed automata is also explained.

2. Goals

1. Write the State of the Art
2. To develop the editor.
3. A secondary goal is the display of execution traces in a sequence diagram format to make it easier to read in detail every trace with the actions, actors and order of interaction all visible for analysis and verification on the browser side and implementing trace diagnostic functionality (filtering, etc.). The trace diagnostic functionality is in-built in order to analyze the performance and resource consumption of the prototype. The prototype implementation relies on a MILP solver ([Gurobi](#)) because MILP scales well with Mixed-Integer reasoning.

3. Research approach

The research approach we took was in two main stages: Data collection (qualitative and quantitative) and Data analysis (inductive and deductive). We read and re-read multiple articles, books, collections such as Revisiting bounded reachability analysis of timed automata based on MILP (https://link.springer.com/chapter/10.1007/978-3-030-00244-2_18) authored by Professor Iulian Ober and Symbolic Model checking without BDD's (https://link.springer.com/chapter/10.1007/3-540-49059-0_14) by Armin Biere, Alessandro Cimatti and company. At a point in time, we had to use the Intranet UPS, because it allows access to even paid articles and books. That made it easier for the group. Throughout the semester, we read, jotted down our basic ideas, created and modified the report on a constant basis. The subjects: Embedded systems and Advanced optimization gave us a strong footing in the theoretical concept of the research topic. Some of the tools we had to acquire and use are:

- Computers with python, HTML and JavaScript installed
- GitHub accounts (<https://github.com/iulianober/brat>) to push the coding progress
- The professor's website and research paper
- A quick-and-dirty version of python code that uses SMT solver.
- Many research papers using Intranet UPS
- Overleaf for State of Art and Zotero for References

4. Organization of Activities

Despite all of the group members being dynamic and eager to do everything, we split and divided the workload with each having to concentrate more on a part. The split is as follows:

ROLE	MEMBER
Group Head, Data Collection (quantitative), Review of report	Ehsan Elwan A.
Data Collection (qualitative), Poster design, Content provider	Monpara Radhika
Data analysis (Inductive and deductive), Poster design	Mukhtar Ibrahim K.

However, we interchanged when the need arises.

5. Identification of conferences, Journals, working groups related to the theme

At first we had three articles to review from our supervisor and then, we started figuring out other research papers by looking at the references similar to the theme of our topic at the end of each paper. We also looked for journals from the university libraries for more content and broader knowledge.

We read tips on avoiding predatory conferences and journals. Normally, we worked in groups of 3 at the school library and in the university sites on weekends. Our semester lectures helped us in refreshing our ideas related to the topic. We also did an exhaustive search on Google Scholar and got many related articles and journals. The annotated and filtered references, which we structured using Zotero allowed us to filter the unimportant papers from the most important ones.

6. Overview of acquired knowledge

We acquired so many forms of knowledge during this research mainly:

- Knowledge in Project management: Each person had a responsibility and this gave us a practical idea of what it means to manage a project and we had to explore the most effective ways to organize ourselves in order to achieve maximum co-operation and efficiency. We took a look into MyLeanMBA program and AGILE, which proved worthwhile.
- Teamwork: One of the most important knowledge acquired during this research is Teamwork. We are from different backgrounds and cultures and this helped us yield into the tune of each other.
- In-depth knowledge of the topic in question: Regarding the main topic, we were able to understand it so much so that we started proposing directions for the future.
- Improvement in communication and organization: Handling of communication between group members and supervisor can be very tricky, as all of you have to be free or be able to make out time. Even the manner in which you write your professor E-mails have to be learnt. The knowledge acquired from this is significant.
- Improvement in analysis of scientific papers: After analyzing tens of papers, we improved in our methods of analyzing scientific papers and learnt to write in “mathematical language”. The use of Overleaf and Zotero helped a lot.
- Security and Confidentiality: Attackers often have different attack intentions including data theft, destruction or modification. They may use a variety of techniques to achieve these objectives such as Malware and exploits. Malware is malicious code that typically damages an endpoint. They include viruses, worms, logic bombs (These are triggered by a specific condition, such as a given date or a particular user account being disabled) etc. Therefore, we took some security measures such as setting difficult passwords and protecting our account.

7. Conclusion

Overall, the knowledge gotten from this research was very useful. We have proposed some directions for the future and hopefully, we will go deeper into our research topic.