16TH INTERNATIONAL WORKSHOP ON REAL-TIME NETWORKS

RTN 2018

This year's edition of the International Workshop on Real-Time Networks congregated over 20 academic and industrial researchers on an intense day full of discussions and good sense of collaboration. In this edition 6 papers were presented in two regular sessions followed by a new collaborative session including the presentation of two poster and one demo, resulting in one of the most participative and interactive sessions of the day.

The main focus of this edition was given to the new IEEE standardization activities and protocol stacks within the 802.1 Time Sensitive Networking task group (TSN). Dr. Wilfried Steiner, from TTTech Austria, opened the workshop with a keynote covering the process of standardization and current research directions in TSN with potential value for industry.

KEYNOTE

Time-Sensitive Networking - Technical Overview and The Bigger Picture

***BIO**: Dr. Wilfried Steiner is Corporate Scientist at TTTech Computertechnik AG and Leader of the research team TTTech Labs. He holds a degree of Doctor of Technical Sciences from the Vienna University of Technology, Austria. His research is focused on dependable cyber-physical systems and he contributes in the domains of automotive, space, aerospace, as well as new energy and industrial automation. While the initial targets of Wilfried Steiner's research have been rather compact systems, such as automobiles and airplanes, Wilfried Steiner more recently also addresses research problems in the area of Internet of Things (IoT), like the Industrial IoT and Industry 4.0, as well as connected vehicles.*

During the keynote Dr. Steiner reviewed the history of time-triggered technologies from the early beginnings of the Time-Triggered Protocol (TTP) up to the current days with the ongoing standardization process of over 20 new standards and amendments carried out within the IEEE TSN task group. The

overview extended towards the configurability and inter-operativity standardization efforts directed by different industrial bodies and alliances like OPC UA, AvNu, and the Industrial Leaders Alliance. To this respect, it was highlighted that TSN covers a large umbrella of standards and it is often not easy to identify which of these are implemented in the first TSN-compliant components currently hitting the market. The interoperability of components from different vendors is, therefore, additionally subject to the compliance with those industrial initiatives, which narrow down some of the details left to interpretation by the standards.

Closing the keynote, Dr. Steiner walked the audience along those research directions currently representing a direct interest for industry, highlighting those contributions with potential to rise a higher appreciation and impulse the adoption of TSN networks within the automotive and industrial automation domains. Among them, it was acknowledged that the large number of parameters exposed by the sum of TSN standards represent a challenge by itself. Hence, the study of trade-offs within the configuration space and analysis of network configuration methods represents a direct interest for industry. Furthermore, mechanisms to dynamically request, deploy and orchestrate configurations are needed. The integration of TSN mechanisms in brown field deployments is as well a necessary step to allow the adoption of new technologies without jeopardizing the functionality of existing deployments. Further extension of TSN networks towards upper communication layers, as envisioned by Fog and Cloud computing services is an interesting line of research. Parallel to these directions, topics like security, scheduling, and network analysis remain as highly interesting topics.

As a lesson learned from the past in relation to the industry and academic collaboration, Dr. Steiner pointed out that industrial acceptance and potential market impact of novel technologies is not typically achieved by means of iteratively reinventing and refactoring existing solutions. Standardization times and efforts are extensive, and industry tends to take slow steps in their adoption. Examples of failed attempts were given by looking at the large number of real-time Ethernet variants developed in former years, out of which very few were adopted by industry. Instead, working on existing standards, like TSN, and exploring their appropriateness to domain specific problems is key to finding successful synergies between industry players.

SESSION 1

TSN Scheduling

The first workshop session of the workshop, chaired by Jean-Luc Scharbarg from the University of Toulouse, consisted of three papers covering core aspects of TSN scheduling and analysis. Papers presented in this session are listed below:

SIZE-BASED QUEUING: AN APPROACH TO IMPROVE BANDWIDTH UTILIZATION IN TSN NETWORKS
FLORIAN HEILMANN AND GERHARD FOHLER

HEURISTIC LIST SCHEDULER FOR TIME TRIGGERED TRAFFIC IN TIME SENSITIVE NETWORKS
MARYAM PAHLEVAN, NADRA TABASSAM AND ROMAN OBERMAISSER

PERFORMANCE ENHANCEMENT OF EXTENDED AFDX VIA BANDWIDTH RESERVATION FOR TSN/BLS SHAPERS
ANAIS FINZI, AHLEM MIFDAOUI, FABRICE FRANCES AND EMMANUEL LOCHIN

SESSION 2

Configuration and Flexibility Support

The second session of the workshop, chaired by Ahlem Mifdaoui from the University of Toulouse, consisted of three additional papers covering configuration and flexibility support in real-time networks, including but not exclusive TSN networks. Papers presented in this session are listed below:

SDN-BASED CONFIGURATION SOLUTION FOR IEEE 802.1 TIME SENSITIVE NETWORKING (TSN)
SIWAR BEN HADJ SAID, QUANG HUY TRUONG AND MICHAEL BOC

ΔELTA: DIFFERENTIAL ENERGY-EFFICIENCY, LATENCY, AND TIMING ANALYSIS FOR REAL-TIME NETWORKS
STEFAN REIF, ANDREAS SCHMIDT, TIMO HÖNIG, THORSTEN HERFET AND WOLFGANG SCHRÖDER-PREIKSCHAT

TOWARDS A SELF-RECONFIGURABLE INFRASTRUCTURE FOR CRITICAL ADAPTIVE DISTRIBUTED EMBEDDED SYSTEMS
ALBERTO BALLESTEROS, JULIÁN PROENZA, MANUEL BARRANCO, LUÍS ALMEIDA AND PERE PALMER

SESSION 3

Collaborative Session

The collaborative session started with the short presentations of two posters and one demo, listed below, which then where displayed in posters and a demo desk, respectively.

The topics presented included fault tolerance proofs and formal verification models, analysis of proactive redundancy mechanisms, and a demonstration of advance scheduling and analysis tools for a variety of TSN scheduling algorithms.

POSTER: FIRST STUDY OF THE PROACTIVE TRANSMISSION OF REPLICATED FRAMES MECHANISM OVER TSN
INES ALVAREZ, DRAGO CAVKA, JULIAN PROENZA AND MANUEL BARRANCO

POSTER: FORMAL VERIFICATION OF THE FTTRS MECHANISMS FOR THE CONSISTENT UPDATE OF THE TRAFFIC SCHEDULE
DANIEL BUJOSA, SERGI ARGUIMBAU, PATRICIA ARGUIMBAU, JULIÁN PROENZA AND MANUEL BARRANCO

DEMO: TTCONF - TOOLS FOR THE ANALYSIS AND CONFIGURATION OF TSN
PAUL POP, VOICA MARIA GAVRILUT, LUXI ZHAO AND BAHRAM ZARRIN

After the presentations authors had the time to engage in vivid and constructive discussions, which were later reported as highly valuable for their research. Unfortunately, some of the discussions had to be cut due to timing constraints but valuable synergies among different groups were discovered and will hopefully result in fruitful collaborations.

Wrapping up and Conclusions

This year's RTN workshop has been a success in attendance and participation. The newly introduced collaborative session has been greatly received and the participation during the presentation of the two posters and demo has shown a good spirit of collaboration between the different groups. It has been proposed to keep the idea of this collaborative session for the next editions of the workshop, with the possibility to even extend it with an "*industrial challenge*" at the level of the network.

With respect to the Keynote, the topics and messages presented by Dr. Steiner shown to be insightful during the wrapping up round in which participants related key aspects of the keynote while addressing the main lessons learned from the workshop. Particular value was given to the suggested research directions and the acknowledgement of TSN exposing a large number of parameters for which their configurability analysis remains an open challenge. It was further discussed how different work presented during the workshop addressing individual aspects of TSN had the potential to integrate as part of a complete end-to-end solution.

The relation and mapping of existing concepts to new technologies was also a topic of discussion. For example, well known trends like software defined networking (SDN) has the potential to map seamlessly in the mechanisms envisioned in TSN for the deployment and orchestration of TSN networks, as similarly, network analysis tools and methods, like those based on network calculus, provide the basis for latency analysis and interference required in the computation of latency bounds for the different traffic shaping policies in TSN.

Despite the main focus of interest in this occasion was given to TSN networks we maintained an inclusive program extending to other real-time networking domains, including critical adaptive distributed systems as well as energy and latency analysis tooling for soft real-time networks.

RTN 2018 was concluded with an acknowledgement to the reviewers for their good and qualitative work and the expectations put in next year venue.

We hope to meet you all again next year!

Mathieu Jan Ramon Serna Oliver