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TIMICO
Middleware and Communication Protocols for Dependable Systems
Precision Time Protocol

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Practicalities

About: This note covers a module. A module consists of two consecutive lecture days.
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Subject

This module is introduced by some definitions and formalisms associated with real-time system technologies such as the middleware and communication protocols covered in this course. After the introduction, we will review the Precision Time Protocol that is used to synchronize clocks in nodes on a computer network. The protocol was originally defined in 2002 in the IEEE 1588-2002 standard entitled "Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems". A revised standard, IEEE 1588-2008, was released in 2008.

Agenda

Day 1

- L1: Dependable real-time systems
- L2: Automata
- L3: Precision Time Protocol
- E1: Exercises

Day 2

- E2: Exercises
- AP: Presentation of reading number 5

Readings

1. M. Sipser, "Introduction to the Theory of Computation", 2nd Ed., Thomson, 2006, pp. 31–63

2. M.T.B. Waez, J. Dingel, K. Rudie, "A survey of timed automata for the development of real-time systems", Elsevier Computer Science Review no. 9, 2013, pp. 1–26 (Read sections 0, 1, and 2; browse the rest.)

3. D.S. Mohl, "IEEE 1588 - Precise Time Synchronization as the Basis for Real Time Applications in Automation", White Paper, Industrial Networking Solutions, 2003, pp. 1–8

4. H. Weibel, "Technology Update on IEEE 1588: The Second Edition of the High Precision Clock Synchronization Protocol", Zurich University of Applied Sciences, 2009, pp. 1–8

5. T. Pearson and K. Shenoi, "A Case for Assisted Partial Timing Support Using Precision Timing Protocol Packet Synchronization for LTE-A", IEEE Communications Magazine, August 2014, pp. 136–143 (Student presentation paper.)

6. IEEE Instrumentation and Measurement Society, "IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems", IEEE New York, 2008, pp. 1–289 (This reading is only for reference.)

Exercises

Determinism and real-time

1. Discuss how deterministic finite automata (DFA) define determinism

2. Discuss how non-deterministic finite automata (NFA) define non-determinism

3. Discuss the definition you have been presented with of timed finite automata (TFA)

4. Discuss whether the TFA definition allows for non-determinism

5. Discuss why TFA can be used to model distributed real-time systems

6. Discuss the relationship between (non)determinism and dead-line guarantees in real-time systems

Precision Time Protocol

1. Discuss whether the Precision Time Protocol (PTP) is deterministic

2. Discuss what a packet-switched network is

3. Discuss to what extent the PTP is tailored for packet-switched networks only

4. Discuss whether the PTP works on Ethernet only

5. Discuss how the PTP can support real-time operations on Ethernet

6. Discuss the offset correction and delay correction in the PTP

7. Discuss whether it is fair to assume a symmetric line delay in the delay correction

8. Discuss how the PTP can play a role in Long Term Evolution (LTE) and LTE Advanced

9. Sketch and discuss a DFA, NFA or TFA that models the PTP

Note on exercises

I will mark with a star those exercises I consider to be most important; if none are marked, they are all equally important. The exercises are to help you fully understand the contents of the course, and master the theories, methods, and techniques presented in the lectures. Also, doing the exercises helps you gain a self confidence that most often shines positively through in an exam situation. When you have done all exercises it is good idea to think critically about the course material covered. Spend a few moments to think about the following:

- Summarize the main topics of this module and reconsider what you learned

- How did you succeed in your learning, and can you improve your learning process?

- How can the teaching-learning process be improved?

Of course, I will be happy to discuss the exercises and the course contents with you; however, before coming to me, it is very important that you engage in a discussion with your fellow students. Most often, the challenges you encounter are also challenges for others. Discussing with your fellow students is a good and social way of learning.