TIMICO
Middleware and Communication Protocols for Dependable Systems
Data Distribution Service for Real-Time Systems

Practicalities

About:	This note covers a module. A module consists of two consecutive lecture days.
Lecturer:	Christian Fischer Pedersen, office E-311, cfp@eng.au.dk
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Subject

This module is about Data Distribution Service for Real-Time Systems (DDS). DDS is an Object Management Group (OMG) middleware standard that simplifies complex network programming. It implements a publish/subscribe model for sending and receiving data, events, and commands among the nodes in a distributed system. Publishers create *topics* (type of data) and publish *samples* (actual data) to them; subscribers on the other hand, receives the data by subscribing to topics. DDS handles network transfer chores, e.g. addressing, data (de)marshaling, delivery and flow control. Any node can be a publisher, subscriber, or both simultaneously.

Agenda

Day 1

- L1: Data Distribution Service
- L2: Data Distribution Service
- E1: Exercises
- E2: Exercises

Day 2

- E3: Exercises
- AP: Presentation of reading number 7

Readings

1. G. Pardo-Castellote, B. Farabaugh, R. Warren, "An introduction to DDS and data-centric communications", Real-Time Innovations, 2005, pp. 1–15
2. RTI, “Is DDS for You?”, RTI whitepaper, 2014, pp. 1–10
3. RTI, “RTI Connext – Your systems. Working as one”, RTI whitepaper, 2012, pp. 1–20
4. RTI, “DDS: The Right Middleware for the Industrial Internet of Things?”, RTI whitepaper, 2014, pp. 1–12
5. RTI, “RTI Connext: Core Libraries and Utilities. Getting Started Guide”, Version 5.0, 2012, pp. 1–87
    - Read chapter 1, "Welcome to RTI Connext!"
    - Read chapter 2, "Installing Connext"
    - Read chapter 3, "Getting Started with Connext"

6. RTI, “RTI Data Distribution Service. Core Libraries and Utilities. User’s Manual”, RTI manual, version 4.5, 2011, pp. 1–992
    - Read section 12.3: Only the introductory part before section 12.3.1
7. I. Calvo, F. Perez, I. Etxeberria-Agiriano, O.G. de Albeniz, “Designing High Performance Factory Automation Applications on Top of DDS”, International Journal of Advanced Robotic Systems, 2013, pp. 1–12
8. P.TH. Eugster, P.A. Felber, R. Guerraoui, AM. Kermarrec, “The Many Faces of Publish Subscribe”, ACM Computing Surveys, Vol. 35, No. 2, June 2003, pp. 114–131
9. A. Detti, P. Loreti, N. Blefari-Melazzi, F. Fedi, “Streaming H.264 Scalable Video over Data Distribution Service in a Wireless Environment”, IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks, 2010, pp. 1–3 (Optional reading)

Exercises

Data Distribution Service for Real-Time Systems (DDS)

1. Discuss the relationship between OMG, DDS, and RTI Connext
2. Discuss the role of middleware and DDS in particular in distributed real-time systems
3. Discuss DDS cf. the Automation Pyramid (heterogeneity of networks, HW and SW)
4. Discuss the Publish/Subscribe paradigm with focus on space, time, and flow decoupling
5. Discuss the role of the DDS component Data Local Reconstruction Layer (DLRL)
6. Discuss the role of the DDS component Data Centric Publish Subscribe (DCPS) and all of it’s sub-components, e.g. Subscriber and Reader, Publisher and Writer, and Topic
7. Discuss the role of Quality of Service (QoS) parameters in DDS. Single out a few QoS parameters and discuss them in depth
8. Discuss the role of the IDL (Interface Description Language) in DDS
9. Discuss the The Real-time Publish-Subscribe Protocol (RTPS) and how it relates to DCPS

Implementation

⋆1. Use RTI Connext to implement the offset and delay correction steps of the Precision Time Protocol. Let one domain participant be the slave clock and another participant the master clock. You can for instance introduce oscillation frequency variation in the slave clock by continuously adding a random number. To get started, see for instance the example in the end of chapter 3 in: Real-Time Innovations "RTI Connext: Core Libraries and Utilities. Getting Started Guide", RTI, 2012.

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.