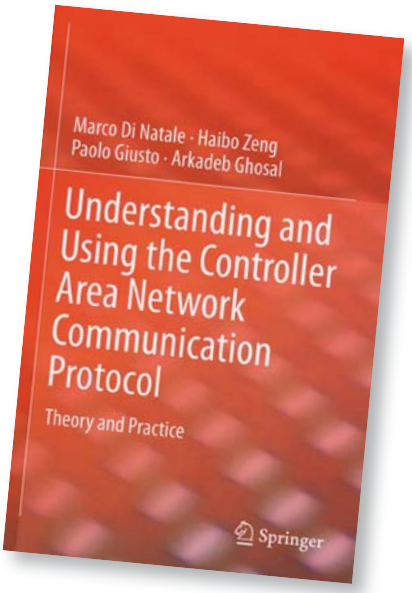
Understanding and using the CAN protocol



The book

Marco Di Natale, Haibo Zeng, Paolo Giusto, Arkadeb Ghosal: Understanding and Using the Controller Area Network Communication Protocol – Theory and Practice. Springer Science + Business Media, 2012 (ISBN 978-1-4614-0314-2).

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Contents

Chapter 1 contains a short summary of the CAN standard. Chapter 2 describes hardware controllers and software layers in CAN communication architectures. Chapter 3 focuses on the worst-case time analysis. Chapter 4 and 5 present the stochastic and statistical timing analyses. Chapter 6 addresses reliability issues. Chapter 7 deals with the analysis of message traces. Chapter 8 describes commercial tools, and chapter 9 contains a summary of higher-layer protocols.

Other books

The CAN Newsletter Online (www.can-newsletter.org) comprises a list of other English CAN books. For CAN books written in other languages you may contact CiA office (headquarters@can-cia.org).

The first chapter of the 223-pages book describes several CAN physical layer options and the CAN data link layer protocol. The four authors combine theoretical background knowledge and practical experiences. Paolo Giusto works with General Motors (USA) and Arkadeb Ghosal is an employee of National Instruments (USA). Marco Di Natale from the Retis Laboratory (Italy) and Haibo Zeng from the McGill University (Canada) are responsible for the more theoretical content. After the brief introduction of the CAN basics, the following chapters focus on interaction layers, worst-case time, stochastic and statistical as well as reliability analysis. This is the first book that describes these topics in such details. Of course, some of the details have been published in academic papers, but not combined in one publication. The hard-covered book is more than a collection of conference papers. It contains some practical hints and kinks as well.

The last chapter deals with some higher-layer protocols such as J1939, CANopen, CCP (CAN Calibration Protocol), and TTCAN. This part of the book provides just a very brief overview. A deeper understanding of them is unfortunately not provided. And there is no relation to the chapters before. An additional chapter describes "commercial tools for configuring, analyzing, and calibrating a CAN communication system". The book also contains a list of symbols and a list of 65 references, which are followed by an index.

The most unique and interesting parts of the book are those, which analyze in depth the response times, the communication reliabil-

Chapter 6.7: Babbling idiot faults and bus guardians

"Besides physical failures, what is probably the most serious concern in a CAN network is the event of a node behaving as a babbling idiot. In this case, a node may (permanently or sporadically) erroneously transmit a message stream (possibly with a low identifier) with a higher rate than its design specification, or maybe simply produce messages earlier than expected. In this case, nothing prevents a (faulty) flow of high priority messages from disturbing the communication of other nodes, to the point of possibly bringing them to starvation. The standard CAN protocol has no solution to this problem, which needs of course an appropriate treatment in safety-critical systems. The solution should consist in the detection of nodes that are misbehaving and their isolation from the network. Of course, the detecting device must be external to the transmitting node and capable of disconnecting it from the network. Such device is conventionally called a Bus guardian.

Bus guardians for CAN have been discussed and proposed in scientific literature, both as devices working in pair with the transmitting nodes, and as devices integrated in a start concentrator for star topologies. Commercial bus guardians are however not available today, quite possibly because the reliability of simple CAN networks has been in practice quite sufficient for handling today's applications and the use of CAN for high-reliability, high-integrity systems is till not quite seen as a near-future option."

(Reading probe from "Understanding and Using the CAN communication protocol" by Marco Di Natela, Haibo Zeng, Paolo Giusto, and Arkadeb Ghosal)

ity, and topics such as priority inversion, lost of messages, etc. The authors have long-time experiences in using CAN. You can see this already in the headline of the first chapter: “The CAN 2.0b Standard”. This CAN protocol, introduced in 1993, is standardized in ISO 11898, and has been split in 2003 to ISO 11898-1 (data link layer) and ISO 11898-2 (high-speed physical layer). In the preface, they reference the ISO 11519-2 low-speed physical layer, which has been withdrawn about ten years ago. Also in other parts of the book, terminology is not always up-to-date or close to laboratory slang.

The more than 140 figures and the 35 tables are very helpful to understand some of the complex topics. In particular, the response-time analysis is sometimes very theoretical and hard to read without graphics and examples. Figures tell more than words. “After worst-case analysis and stochastic analysis, another alternative for the timing evaluation of CAN systems is the use of statistical analysis, possibly in conjunction with simulation, or leveraging data from traces and simulations.” The authors present regression formulas to predict the probability of message latencies in a CAN system for which only limited information is available, “for example, when a hypothetical architecture option is analyzed”. This is not only interesting for automotive system designers but also for industrial and other CAN users. It would be interesting to extend those analyses specifically for higher-layer protocols such as CANopen.

The sixth chapter analyses in some details the reliability of CAN communication. The authors provide first some theoretical background information. Reliability is for them “the ability of a system to perform its specified function for a prescribed time under stipulated environment conditions”. It is, “along with availability, safety, and other metrics, part of the more general concept of dependability”. The authors discuss error rates in CAN, deviation points in the CAN protocol such as incorrect values in the data length code (DLC), fault confinement and transition of bus-off state, inconsistent omissions or duplicate messages, and protocol vulnerability. This book comes late, due to the fact that CAN technology has been introduced more than 25 years ago. Nevertheless, for newcomers it is very helpful, and even CAN experts may appreciate to dig deeper into the theoretical background and to get some practical hints – rules of thumb, so-to-say.

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