Chapter 4
Embedded Networks Design and Simulation

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ABSTRACT

This chapter presents an approach for the design and simulation of embedded networks for spacecraft. The chapter provides an analysis of existing simulation tools for the on-board and local area networks. The authors overview the main abilities of the existing software and then propose the computer-aided design system for SpaceWire onboard networks design and simulation. This CAD system supports the full on-board network design and simulation flow, which begins from the network topology automated generation and finishes with getting the network structure, configuration and parameters setting, simulation results, and statistics – SpaceWire Automated Network Design and Simulation (SANDS). The authors describe formal theories, algorithms, methods, and approaches, which are used to solve general issues that appear in developing of onboard networks. The chapter covers topics of fault-tolerance in onboard networks, discusses routing problems, and approaches to organize deadlock-free routing. The authors propose schedule creation algorithms for STP ISS protocol and consider network simulation issues.

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INTRODUCTION

Embedded systems became a big part of a modern life; you can face with them everywhere, in every area of human activities. Onboard networks for the spacecraft and aircraft is the area, where embedding and networking technologies are very popular. That is why the current chapter provides a good example for building of a software system for design and simulation of onboard networks. Described algorithms and methods could be applied to other embedded systems prototyping and implementation procedures.

Evolution of microelectronics has led to the growth of the on-board networks and systems sizes. Modern on-board networks consist of a huge number of computers, telemetry, radio transmitting and data transmitting devices, scientific instruments and sensors and devices for electricity, heating control, orientation and stabilization of a spacecraft. Interconnection of these systems is done via the on-board network with numerous devices that work at different frequencies and data transmission speeds, transmit different types of data with different intensity. Each data flow has different Quality of Service (QoS) requirements. If there are some errors in a channel, or a device is corrupted, important scientific information could be lost. All these situations need to be simulated and tested by networking models before the assembling and launching of a spacecraft.

NETWORK SIMULATION TOOLS OVERVIEW

Network simulators allow researchers to test the scenarios that are difficult or expensive to imitate in real world. It is particularly useful to test new communication protocols or to change the existing protocols in a controlled and reproducible environment. Simulators can be used to design different network topologies using various types of nodes. There are different types of network simulators and they can be compared based on the following features:

- **Range:** From very simple to very complex;
- Ability to specify nodes and links between those nodes and the traffic between the nodes;
- Ability to specify everything about protocols used to handle traffic in a network;
- **Graphical User Interface:** Allows users to easily visualize operation of their simulated environment;
- **Text-Based Applications:** Permit more advanced forms of customization;
- **Programming-Oriented Tools:** Providing a programming framework that customizes to create an application that simulates the networking environment to be tested (Siraj, Gupta, & Rinku-Badgujar, 2012).

Some of network simulators are commercial, which means that the source code of the software or the affiliated packages is not provided to users. All users have to pay to get a license to use this software or pay to order specific packages for their own specific usage requirements. On the other hand, open source network simulators and their interfaces are completely open for the developers.

Currently there is a number of tools and models that give an ability to simulate the operation of communication networks, but mostly these tools are intended for the Ethernet and Wi-Fi networks. Most popular network simulators are overviewed in the current chapter.

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