

Administration and Configuration of Communication SpaceWire Network

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Abstract

The configuration and administration of distributed systems are among the important tasks in the construction and exploitation of on-board distributed SpaceWire systems. When all nodes and routers are connected, it is necessary to configure them, i.e. map logical addresses to all nodes, to compare to all nodes logical addresses, to create routing tables and adaptive group routing tables and other parameters specified for this system. During the normal operation state of the distributed systems it's necessary to track and fix connections and disconnections of new devices (nodes and routers), modify routing tables, issue logical addresses to new nodes and provide information about the changes in system structure of other devices, i.e. administer the distributed system.

Index Terms: SpaceWire, administration, configuration, Plug'n'Play, RMAP

I. INTRODUCTION

The configuration and administration of distributed systems are among the important tasks in the construction and exploitation of on-board distributed SpaceWire systems. When all nodes and routers are connected, it is necessary to configure them, i.e. map logical addresses to all nodes, to compare to all nodes logical addresses, and to create routing tables and adaptive group routing tables and other parameters specified for this system.

Also it is necessary to have access to statistical information (errors, failures) that have occurred in the system. The choice of the method of configuration and administration depends on efficiency and convenience of working with the distributed systems.

The configuration of nodes and routers should be separated from each other.

Router configuration, the configuration of the communication network, provides the transmission of packets between nodes in a system.

Node configuration is the configuration of terminal devices, which can be sensors and computational nodes that compute information or that run user program. Therefore different methods should be used for the nodes and routers.

The main methods of administration and configuration are:

1. Local
2. Remote
3. The automated process of network configuration and administration (Plug'n'Play) [3]

II. MAIN PART

A. *SpaceWire*

SpaceWire technology is assigned to make communication networks for on-board systems. One of the main aims is the provision of compatibility with different types of equipment and the multifunctional usage of terminal devices and subsystems.

SpaceWire is assigned to transmit data and to control information for on-board systems. It is high-speed standard (2-400 Mbits per second).

SpaceWire is rapidly becoming a de facto communications standard within the space industry. SpaceWire represents a suitable point of convergence for data communication onboard spacecraft due to its simplicity, speed, low-power, and reliability, which provides the basis for interoperability between devices and components from different manufacturers and organizations.

SpaceWire network consists of 3 types of elements: node, link, and router. Nodes are connected through the router and admit to exchange data packets (messages) [4].

B. *Remote Memory Access Protocol (RMAP)*

The remote memory access protocol (RMAP) has been designed to support a wide range of SpaceWire applications. Its primary purpose, however, is to configure a SpaceWire network – it controls SpaceWire units and gathers data and status information from those units. RMAP may operate alongside other communication protocols running over SpaceWire. RMAP may be used to configure SpaceWire routing switches, setting their operating parameters and routing table information. It may also be used to monitor the status of those routing switches. RMAP may be used to configure and read the status of nodes on the SpaceWire network. For example, the operating data rate of a node may be set to 100 Mbits/s and the interface may be set to auto-start mode. For simple SpaceWire units without an embedded processor, RMAP may be used to set application configuration registers, to read status information and to read or write data into memory in the unit. For intelligent SpaceWire units RMAP can provide the basis for a wide range of communications services. Configuration, status gathering, and data transfer to and from memory or mailboxes can be supported [1].

RMAP operations divided on 3 types:

1. Read command

Read command reads one or more bytes of data from a specified memory location in the destination node. Requested data is returned in a reply packet.

2. Write command

Write command can be with or without acknowledgement, if a packet is received by destination node correctly. Example of this packet is shown on Fig.1.

3. Read-modify-write command

Read-modify-write commands reads register (or memory), returns its value, and afterwards writes new value, defined in a packet, to the register [2].

of selector being used. If necessary RMAP allows a CRC validation check for the data to be performed before writing the data, as well as a decision to send a confirmation.

For remote configuration the administration software creates a RMAP packet, which sends the packet to a connected router from the PC through COM-port (USB or PCI), which then forwards this packet to a network according to the specified path address in the packet. When the RMAP packet reaches the required router, the router performs command, if necessary creates and sends a reply RMAP packet. When this packet reaches the source router, it forwards it through COM-port to PC [3].

Consider the example on Figure 2. When the administration software is working in remote mode on the PC, you can configure remote routers 1 and 2 and others in the SpaceWire network. In this case, there is no need for a second PC – one PC is enough. It is connected through COM-port to a router to configure a second router and others.

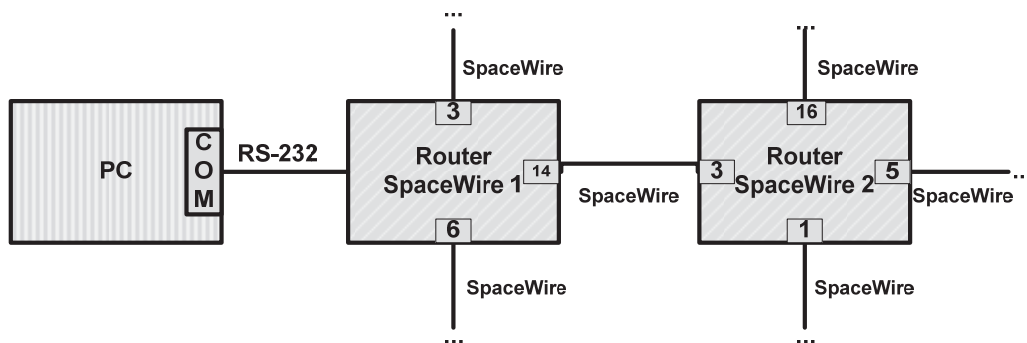


Fig. 2. Part of SpaceWire network

E. The automated process of network configuration and administration(Plug'n'Play)

Under the Plug'n'Play technology it is generally understood that when all devices are connected, the devices with special algorithms will discover and determine the topology of a distributed system – it will give nodes logical addresses and configure routing tables and other parameters. In this state working connections and disconnections of new devices are identified automatically.

All Plug'n'Play algorithms generally can be divided into 2 types:

1. *Centralized*. In this system there is only one device, which initiates and fully manages the Plug'n'Play process.
2. *Decentralized*. This system has several centers, which manage the Plug'n'Play process. On one hand, if one or more of these devices fail the system will still continue to work. On the other hand, it imposes optional requirements on networks and discovery centers. [3] When a node claims to have two centers, a solution to this problem must be found. If the node is set up in the first center and is reported by the second, the individual nodes must be set up and the network explored.

Figure 3 illustrates both cases. If the algorithm is centralized then the network has only one center (Network Manager 1), which discovers the network. If the algorithm is

decentralized, the network has two or more centers (Network Manager 1 and Network Manager 2).

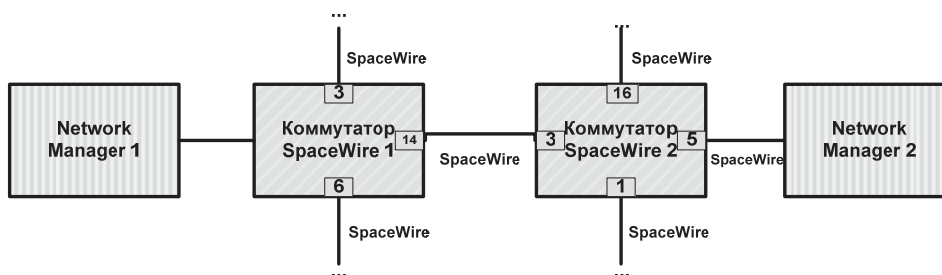


Fig. 3. Part of the SpaceWire network for the automated process network administration and configuration

The different levels of the Plug'n'Play algorithms complexity should also be noted. Several methods should be used for both structures and for a network of any topology. Some algorithms can be more complex and may incorporate many features of the network, like the consideration of the collected statistics during the working state.

Therefore, some algorithms may have limitations. The most common are: the algorithm cannot be applied for all network topologies, and the solution which provides a Plug'n'Play algorithm may not be optimal. It is necessary to consider the equipment which may have different set of parameters and functions, i.e. added restrictions or additional conditions to the application of the Plug'n'Play algorithm. The algorithm specifies a set of parameters and functions that are necessary for the full and correct functionality of the algorithm. The creation of a universal algorithm is an extremely difficult task.

One of the possible implementations of a Plug'n'Play algorithm is using a remote memory access protocol, but other options are possible. For example, creating a new data transfer protocol will bring some changes to the router and node software.

There are also requirements for the Plug'n'Play technology, among them are:

1. The algorithms must not result in undetermined results or deadlock. Plug'n'Play must allow the network to function as well as possible for as long as possible. The effect of failures should be minimized.
2. Operating with only two types of devices (a router and a node), we arbitrarily build a large structured network and algorithm. Plug'n'Play should work correctly on it.
3. Technology should provide for the future ability to add new devices. Thus, there shouldn't be any overload in the present.
4. This technology should be implemented with minimal cost; device equipment should take a small place on an integrated circuit and consume minimal amounts of energy [1].

There are different variations and modifications of the Plug'n'Play algorithm. Among them are the algorithms proposed by the University of Dundee and space agency NASA.

Plug'n'Play technology at this stage of development of the SpaceWire standard has not yet been standardized. There is a special joint project of NASA and other important partners that are working for the further development of SpaceWire-Plug'n'Play technology.

III. CONCLUSION

Local configuration allows for the configuring router to be connected via COM-port to the computer.

The remote configuration is implemented using remote memory access protocol (RMAP). By using this protocol there is no need to connect each router in network to a PC with running administration program on it. Only one computer with the administration program operating with RMAP is needed for all of the routers in the SpaceWire network to become available.

For local and remote router configuring created special software operating on PC. It allows writing or reading registers, monitoring or testing routers.

The automated configuration process (Plug'n'Play) doesn't required human intervention.

Plug'n'Play technology at this stage of development of the SpaceWire standard has not yet been standardized. There are different variations and modifications of the Plug'n'Play algorithm.

The most convenient way is a combination of last two methods. That is, after determining the network, allow the user to configure network devices, if necessary. Thus the user is able to compensate the possibility of a suboptimal network configuration in an automated way.

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