SPACEWIRE NETWORK FUNCTIONAL MODEL

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Short Paper

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ABSTRACT

The complex of simulation programs for building models of SpaceWire distributed systems and investigation of their characteristics is presented. It includes a specification of basic SpaceWire network elements: a node, a routing switch and a link, allows to assemble a SpaceWire interconnection system of required structure, implements wormhole routing, time flow and distributed interrupts mechanisms, generation and transmission of data packets. This configurable tool enables to estimate an efficiency of SpaceWire based interconnections.

1 INTRODUCTION

An important task for devices design, network protocols development and distributed systems building is their simulation. For this purpose the configurable software simulation tool programs was developed. It implements SpaceWire network functional model (SpWNM). To input distributed system structure (topology) and their parameters the MS Visio based GUI is used. Software system model tool is written in SystemC. It could be used in different modeling environment where SystemC is supported, for example, in IUS(5.1–5.7) environment (Cadence Design Systems), under Linux Red Hat. Each type of network elements is implemented as an independent module, so a network of required topology could be composed from these modules without changing their programs. It is easy to learn this tool because of its interactive documentation.

2 SPWNM DESCRIPTION

The SpWNM package implements:

- data packets generation, receiving and transmission;
- generation, receiving, transmission and handling of control-codes (Interrupt-codes, Interrupt_Acknowledge-codes, Time-codes), NULL and FCT;
- Wormhole routing and symbol flow priority according to SpaceWire standard;
- Path, logic and regional-logic addressing;

- Adaptive group routing;
- Data packet blocking in switch where output port is unavailable (busy) or has buffer overflow;
- Timeout mechanism in switches and nodes;
- Error modeling at the channel level and credit errors.

SpWNM composes a SpaceWire network model according to a special input file generated by MS Visio. For this purpose the application in VBA was made. It allows users to compose distributed system model, their structure and parameters in a graphical way, using drag and drop and dialog windows. The generated by application system structure is saved in a file to be used by the systemC application. Thus user doesn't write a systemC model. All devices interconnections and their parameters settings are done automatically according to the input file. So complex distributed systems with big number of devices and links could be composed easily. To compose such a system as SystemC application by hand would be quite difficult.

SpWNM's structure and parameters which are set in Visio wholly describe SpaceWire network devices. A user can set types of generated distributed interrupts and parameters of their generation, types of distributed interrupts and parameters of their handling, signals transmission rate for every channel, parameters of time-codes' generation, timeouts values for switches and nodes, routing tables and adaptive group routing, packets' generation parameters in the nodes, parameters of channels error imitation. Setting of these properties is convenient for the user and are separately applied for each device.

Before simulation started the SpWNM can be configured for specific devices implementation that are used in it. Particularly, user can set a lot of time intervals required by the device to perform different actions – to process a signal which is received from input port, to write some value to the device's internal buffer, to read a value from this buffer, addressing to the application which is used by this device, etc. Besides times, the buffers size and numbers of input and output ports are configured for the every device separately. So there can be several devices of the same type but with different parameters and different numbers of ports in the system. It provides flexibility in models' building.

The SpWNM provides the user with ability to for writing a special program for each application. This program will receive and process data packets which are got by application over simulated SpaceWire network and return generated result. Each application is linked with a node in the network.

3 SPWNM SIMULATION RESULTS

The result of modeling is statistics that is stored during the system simulation. It consists of several files. Some files describe the history of system's simulation in special tables. Each table's row contains the time, the device ID, its action and additional information about it. These tables can be parsed, for example, using filters in Excel. Other files contain statistical data such as channels' workload by symbols of different types, average time of channels' blocking inside switches, time from sending

concrete type of distributed interrupt to receiving of this interrupt, time from sending answer for distributed interrupt to receiving of this answer, full time of each type of distributed interrupt handling used in the system. There is also information about average time from sending data packet which is sent by concrete node from its concrete port to receiving this packet. Information about data transmission errors in channels is also stored (these errors are imitated by the program, parameters of their generation is configured too). Diagrams can be built for all these results.

Automatic analysis of system simulation is performed by the special application. It reads generated xml-files (they are simultaneously generated with html tables), takes from them statistics and also detects errors which occurred in system simulation. The system simulation validity is checked according to all types of addressing and routing used in SpaceWire. Errors of receiving a control code that is not registered in the system are also detected – these errors can occur because of imitation of noises in channels.

4 SpWNM objectives

The SpWNM provides means to estimate a wide range of characteristics for different research. Many characteristics are set for every distributed system element so it is possible to find various dependences of estimated time characteristics from input parameters that could be important for a distributed system and a task set. Simulation could be used for different research, for example, to select a distributed system topology, to define parameters (distributed interrupts, time-codes, routing table, timeout values and so on) in a way, that required system characteristics correspond to requirements specification; to research load of every router, node and link caused by data flow and control-codes flow with different intensity; to validate a SpaceWire network analytical model.

In networks with wormhole routing a deadlock is possible. To solve this problem a correct routing table and timeout mechanism are used. These parameters strongly effects network capacity and data packet latency so it is useful to use simulation to select them.

The SpaceWire simulator can reflect some details of hardware implementation of real devices so it is possible to use simulation results during devices design. For example, we can investigate different output port arbitration schemes in data packet switch, or different buffer size, and so on.

5 Conclusion

The SpWNM provides an efficient tool for users to compose distributed system from ready made configurable modules and set their parameters in a simple way. As a result of simulation it is possible to estimate a wide range of characteristics that that are useful for research during building distributed systems, to define their parameters. The results can be used also to validate analytical models and devices in design.