STAR-DUNDEE VIRTUAL DEVICES AND SYSTEM SIMULATION

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Short Paper

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ABSTRACT

STAR-Dundee's latest software API and applications allow users to build virtual SpaceWire networks on their PCs. Users can create their own virtual devices to represent hardware that may not yet be available, or to prototype features that aren't implemented in existing hardware. Virtual SpaceWire networks can then be constructed using these virtual devices. The virtual networks can also be integrated with one or more physical SpaceWire networks for testing, or can be tested in an entirely virtual environment.

This paper describes the functionality provided to allow users to create virtual devices, and the mechanisms used to integrate these virtual devices with one another and with physical SpaceWire networks. The advantages and potential limitations of this concept of virtual integration are identified and discussed.

1 INTRODUCTION

STAR-Dundee supplies a number of SpaceWire devices for test and development which can be connected to a PC [1]. Software is provided with these devices to allow users to send and receive traffic on a SpaceWire network, to configure and monitor devices on a SpaceWire network, and to perform many other tasks.

Users of STAR-Dundee equipment can also write their own applications to communicate with the SpaceWire devices and the SpaceWire network. An Application Programming Interface (API) is provided which allows software to be developed in C, C++, Java and many other languages.

Recently this API has been substantially improved, with new functions to make the development procedure much easier and to simplify common tasks. The new API also provides a number of additional features. The same API can be used to communicate with all STAR-Dundee devices, regardless of whether they are routers or interfaces, and whether they are connected by USB, PCI, or some other mechanism.

The focus of this paper, however, is the API's support for virtual devices. Virtual devices are virtual representations of physical devices, created onboard the PC. These virtual devices can be routers or interfaces and are treated exactly like physical devices by the API.

2 USING VIRTUAL DEVICES

Virtual devices can be created using the API or through the STAR-Launch [2] software provided. STAR-Launch is a graphical tool which can be used for many purposes. As with normal devices, virtual devices can be configured using the API or STAR-Launch, and traffic can be sent to them or received from them.

Virtual devices can be connected together using virtual SpaceWire links, and applications and physical devices can also be connected together using the same virtual links. This allows a virtual SpaceWire network to be constructed inside a PC, with no physical hardware required. Alternatively virtual and physical devices can be combined in a single network. This allows a subsystem to be replaced with a virtual implementation, which may be useful in projects where subsystems are developed in different locations and/or organisations.

Using virtual devices also allows for additional debugging and status information to be made available. A virtual device can provide information to the user, which may not be possible with the physical implementation. Virtual devices can display error information on screen, or record statistics to file. This may not be possible in the physical implementation of these devices.

The use of virtual links also makes it much easier to analyse the traffic crossing a link. Virtual Link Analysers allow the traffic crossing a virtual SpaceWire link to be monitored. In a physical system, analysing a link is likely to involve replacing a cable with two cables and a SpaceWire Link Analyser [3]. In a virtual system, a Link Analyser can be added to a virtual link with the click of a button.

A planned improvement is the addition of the SpaceWire IP Tunnel [3], a tool for virtual spacecraft integration [4, 5], which allows subsystems to be connected virtually over the Internet. This would allow virtual subsystems to be integrated virtually, and would mean that a group working on one subsystem could debug problems with their subsystem, while connecting remotely to the other subsystems. These subsystems could in turn be monitored and debugged by their developers.

3 VIRTUAL ROUTING

A SpaceWire network is made up of links, nodes and routers [6]. To connect together the nodes in a large virtual network, in addition to the virtual links, virtual routers are required.

The STAR-Dundee API includes a Virtual SpaceWire Router, which can be used for a number of purposes, including the basic task of routing traffic around a virtual network. The Virtual SpaceWire Router can be used to test different router configurations, e.g. different timeouts, different routing tables, etc. It can also be set to act as a time-code master, in order to test the behaviour of a network or device when time-codes are distributed across the network.

Virtual routers can also be useful in systems which aren't obviously using virtual components. For example, a PC might have two applications running, each of which wishes to receive packets sent to a device connected to the PC. The first application may wish to receive packets sent to logical address 251. The second application may wish to receive packets sent to logical address 252. To achieve this, a virtual router can be connected to the device, with packets with logical address 251 routed to the first application and packets with logical address 252 routed to the second application. The two applications can now share the same physical connection to a SpaceWire device, and receive only the packets they are interested in.

Applications or services may also wish to receive packets based on their protocol ID, which should be the second byte in an appropriately formatted packet. The virtual router can also be configured to act as a protocol dispatcher, routing packets based on the second byte. This allows RMAP packets to be passed to a service which deals with RMAP requests and replies, for example, while CCSDS packets are passed to a different service.

4 BENEFITS AND LIMITATIONS

It's not always possible to exactly simulate a physical device in software, and there may be timing differences between a physical device and its virtual implementation. It may also take some time to write a virtual device, although the STAR-Dundee API is designed to simplify this development and provides a number of re-usable components for this purpose.

As long as any testing is also performed on physical hardware at some stage, the use of virtual devices can provide huge benefits during initial testing and integration, for example.

Virtual devices can be used to prototype a device or new features in an existing device. They can be used to replace a device which is not available or has a fault, or to try out a new device being considered for use. Virtual networks allow different network architectures to be tested without the time consuming task of connecting devices and SpaceWire cables.

The additional debugging information that can be provided in a virtual device could be invaluable in identifying problems. Similarly the monitoring and analysis that can be performed on a virtual link can provide information which might not be obtainable in a physical network.

5 SUMMARY

For equipment developers virtual devices provide a simple method of prototyping features before implementing these features in hardware. For equipment suppliers virtual devices can allow users to test virtual implementations of hardware prior to purchase, or to begin development while waiting on delivery. For network designers virtual networks can be constructed to rapidly prototype and test potential network architectures, without needing to connect SpaceWire cables to devices.

The ability to integrate devices and subsystems into a network without requiring the physical hardware to be present means that devices or subsystems developed at separate geographical locations can be virtually integrated at an earlier stage of development. With the additional debugging and analysis capabilities available in a virtual network, potential problems in a system can be discovered at this stage, rather than towards the end of the project when the components are physically integrated and correcting errors is more costly.

6 REFERENCES

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