STAR-LAUNCH AND NETWORK DISCOVERY

Session: SpaceWire Networks and Protocols

Long Paper

Stuart Mills, Chris McClements

STAR-Dundee, c/o School of Computing, University of Dundee, Dundee, Scotland, UK

Steve Parkes

University of Dundee, School of Computing, Dundee, Scotland, UK

E-mail: stuart@star-dundee.com, chris@star-dundee.com, sparkes@computing.dundee.ac.uk

ABSTRACT

STAR-Launch is a new software tool that can be used to launch applications and modules to interact with STAR-Dundee SpaceWire devices. It will provide the ability to discover devices on a SpaceWire network and display these graphically. The software will then allow applications and modules to be launched to perform operations specific to the devices discovered.

This paper describes the features that are currently provided by the STAR-Launch software, and the new features which are to be added. The updated software will provide many of the features described in the draft SpaceWire-PnP Protocol Definition. The services in the draft PnP definition that will be implemented in STAR-Launch are described in this paper, along with details of our experience of implementing these services.

1 INTRODUCTION

STAR-Dundee has been working on an updated API for accessing SpaceWire devices. The new API provides a common interface for accessing all STAR-Dundee SpaceWire devices [1], regardless of whether they are routers or interfaces, and whether they are connected by USB, PCI, or some other mechanism. It also provides a number of components for implementing common functionality, such as RMAP [2] initiators and targets. Components are also included to create virtual devices and links, which allow virtual representations of SpaceWire networks to be built in software [3].

To allow users to access the new features provided by the updated API, new applications such as STAR-Launch have been developed. The main purpose of STAR-Launch is to display the SpaceWire devices connected to a PC, and allow applications to be launched to access these devices. It can display both physical devices as well as virtual devices, which can be created using the application.

STAR-Launch is being extended to allow the SpaceWire network to which the local physical devices are connected to be discovered. This will make use of the Plug and Play (PnP) functionality described in the latest draft of the SpaceWire-PnP Protocol Definition [4]. STAR-Dundee devices will be modified to support the SpaceWire-PnP Protocol, while software modules will be added to the STAR-Dundee Application Programming Interface (API) to provide PnP support in both applications and virtual devices.

This paper describes the features of STAR-Launch and the services from the SpaceWire-PnP Protocol Definition which will be implemented. Comments on the Protocol Definition and details of the experience of implementing the services are also provided.

2 STAR-LAUNCH FEATURES

The current release of STAR-Launch automatically detects all STAR-Dundee SpaceWire devices connected to the PC on which it is running and displays an icon for each device. The user can run the default software application for a device by double-clicking on its graphical representation, or bring up a menu showing all available software for the device by right-clicking on it. An example screenshot is shown in Figure 1.

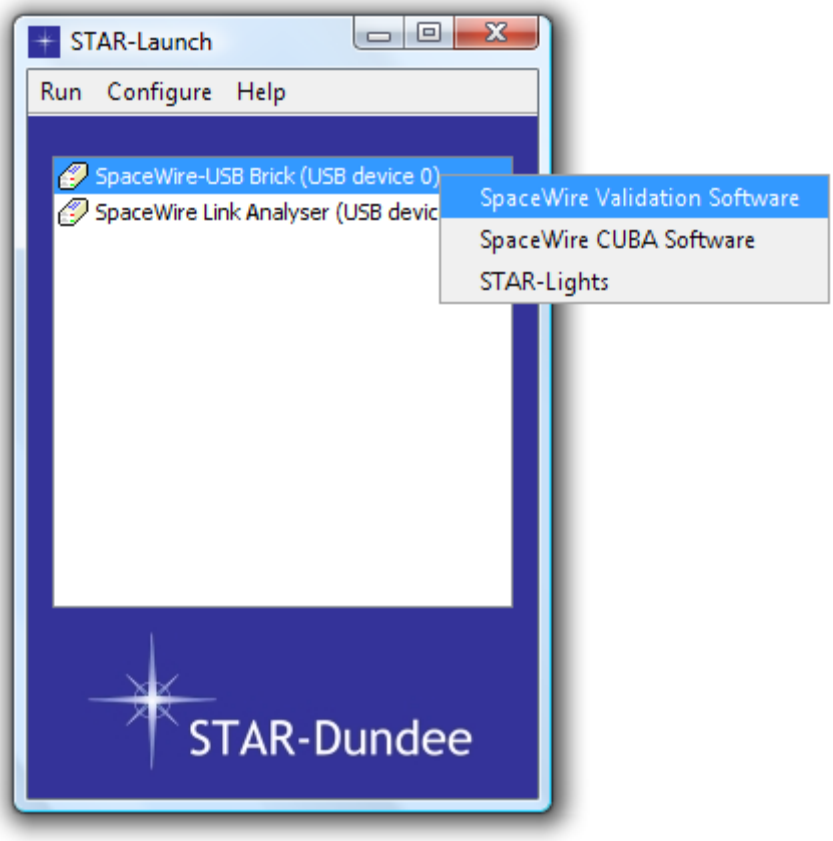

Figure 1: STAR-Launch Screenshot

The applications provided for each device type, and the default application for a device type, are all configurable by the user. For example, double-clicking on the

icon for a SpaceWire Link Analyser would normally run the Link Analyser software for that device. Double-clicking on a SpaceWire-USB Brick icon could bring up a window in which the Brick can be configured. Right-clicking on the icon will bring up a list of software which can be run for the SpaceWire-USB Brick, which could include the Validation Software, CUBA Software and the default option to configure the device. If a user has written some software which uses the SpaceWire-USB Brick, they can add this to the Brick's menu, and possibly set it as the default option.

2.1 VIRTUAL DEVICES

Following the addition of virtual devices and links to the STAR-Dundee API, STAR-Launch was updated to display all virtual devices and to allow new virtual devices to be added and existing virtual devices to be deleted. Some method to establish virtual links between virtual and physical devices, and remove these links when no longer required was also required. STAR-Launch is the ideal application for these purposes, so was extended to provide these features. Rather than just displaying a list of devices, STAR-Launch now displays the topology of a PC's virtual SpaceWire network, showing the links between applications, virtual devices and physical devices.

Virtual devices are treated in a similar manner to physical devices in both the STAR-Dundee API and STAR-Launch. STAR-Launch allows applications to be run for virtual devices and virtual devices to be configured, just as it does for physical devices. STAR-Launch also allows Virtual Link Analysers to be attached to virtual links, so that traffic crossing over a virtual link can be monitored and recorded. This is a powerful debugging tool and can be used not only in virtual SpaceWire networks, but also to view the traffic passing between a physical device and an application, for example.

2.2 NETWORK TOPOLOGY

As STAR-Launch provides the ability to interact with both physical and virtual networks, and also displays the local virtual network, it was decided to expand this functionality to display the physical SpaceWire network or networks connected to a PC. This would allow the user to see the topology of the physical SpaceWire network, configure remote devices, send packets or commands to these devices, etc.

In order to display an arbitrary physical and/or virtual network, a method to discover the network is required. The University of Dundee and STAR-Dundee have researched methods to discover networks, and the draft SpaceWire-PnP Protocol Definition includes the results of some of this research. As this protocol definition aims to standardise network discovery, device configuration, etc. the PnP Protocol is the obvious choice to provide this functionality in STAR-Launch.

3 SPACEWIRE-PNP SERVICES

The STAR-Launch application is being updated to include support for the SpaceWire-PnP Protocol. The first stage of this process is to add support for the protocol to the STAR-Dundee API. The API already provides RMAP target and initiator components, which can be used to implement RMAP support in software. This functionality is being extended to provide PnP initiator and target components in the API. This will allow applications to discover networks and configure devices, and

will allow virtual devices and applications to be implemented which can be discovered and configured using PnP.

The STAR-Dundee API will provide all the services outlined for both levels defined by the SpaceWire-PnP Protocol Definition, Level 1 and Level 2, and will allow both active and passive nodes to be developed. Active nodes are those nodes which may act as the initiators of PnP commands, such as the nodes which request the properties of other devices on the network. Passive nodes are those that only act as a target for PnP commands.

The services for both Level 1 and Level 2 that are being implemented in the API are similar, the difference being that Level 2 services must be able to cope with multiple active nodes. An example of when Level 2 services are required is when there are multiple nodes trying to discover the network at the same time. The services to be provided are described briefly below.

Device Identification: This service allows a device to identify itself and to describe its characteristics.

Network Management: This service provides methods to discover and manage a network.

Link Configuration: This service can be used to query and configure the properties of the links on a device.

Router Configuration: This service is provided by routing devices to allow properties specific to a router to be queried and configured.

Time-Code Source: This service is optional and can be used to enable and configure a time-code source.

There are currently two SpaceWire-PnP Capability Services defined by the PnP Protocol Definition. These Capability Services are protocols that a node supports for transporting data. The STAR-Dundee API will provide support for both of these services, which are described below. As with the other PnP services, these are being built on top of the RMAP target and initiator components already provided by the API.

RMAP Data Sources: A target which supports this service can produce data in response to RMAP read commands, while an initiator can produce data using RMAP write commands.

RMAP Data Sinks: A target which supports this service can consume data in RMAP write commands, while an initiator can consume data by initiating RMAP read commands.

4 Network Discovery and Device Configuration

Once the PnP services have been added to the STAR-Dundee API, they will be incorporated into example virtual devices provided with the API. It will then be possible to discover these virtual devices if they are connected in a virtual network. If the virtual network is also connected to a physical SpaceWire network, it will be

possible to detect the virtual network from any point on the physical SpaceWire network. The virtual network will appear as just another section of the SpaceWire network, and the active node discovering the network will treat the virtual devices in the same way as the physical devices.

The updated STAR-Launch application with support for the PnP services will allow the SpaceWire network to be discovered and configured. It will be possible to discover and configure existing virtual devices on other PCs connected to a SpaceWire network. This will allow individual PCs to be used to represent different subsystems, for example, and each can be configured from a single location.

In order to enable discovery and configuration of physical SpaceWire devices using the SpaceWire-PnP Protocol, these devices must support the PnP Protocol. STAR-Dundee's routing devices, the SpaceWire Router-USB and SpaceWire-USB Brick will be updated to include support for PnP. It is already possible to configure links routing tables, etc., of these devices over a SpaceWire network using RMAP, but they will be updated to use the register mappings defined for SpaceWire-PnP and to use the SpaceWire-PnP Protocol ID [5].

The SpaceWire-PnP software components added to the API can be used to provide a PnP service for devices. To support SpaceWire-PnP in SpaceWire interface devices, such as the STAR-Dundee SpaceWire PCI device, no modification is required to the hardware, as shown in Figure 2. This diagram illustrates how configuration port traffic received by the PCI device (packets with a first byte of 0) could be routed to a protocol dispatcher by a virtual router. PnP traffic could then be routed to the PnP service by the protocol dispatcher, while RMAP traffic could be routed to an RMAP implementation of a configuration port. Meanwhile, packets with a logical address of 70, for example, could be routed from the PCI device to a mass memory unit application.

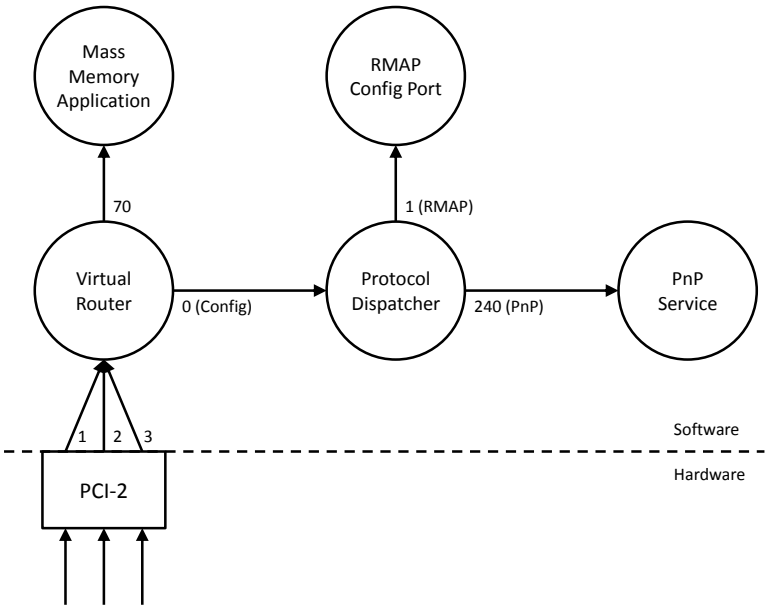

Figure 2: SpaceWire PCI Interface Device Supporting PnP

This diagram could be simplified by removing the protocol dispatcher and RMAP configuration port. The PnP service would then deal with all packets sent to the configuration port, ignoring any with an incorrect protocol ID.

Alternatively, if there is a virtual SpaceWire network connected to an interface device, it may be required that the device does not respond to PnP requests. It then becomes a pass-through device which is not visible to the active nodes which detect the network. The instance of STAR-Launch running on the local PC will have knowledge of the virtual network, and will display it in its network topology display, as shown in Figure 3, which shows three applications connected to each of the links of a PCI device. STAR-Launch instances running on other PCs will have no knowledge of the PCI device's existence, and will just see three nodes connected to each of the links, if these applications respond to PnP requests.

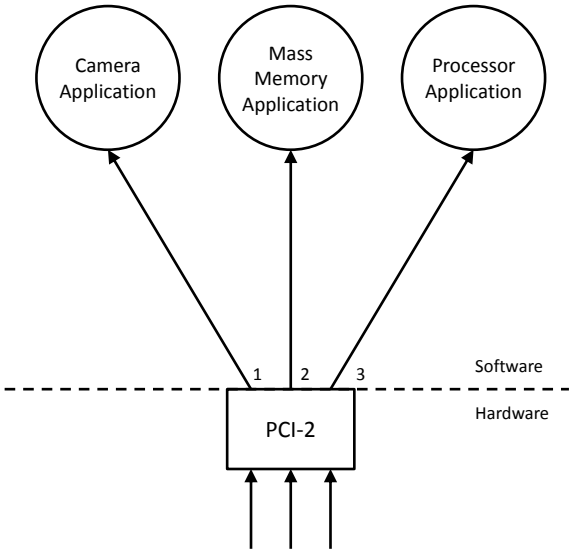

Figure 3: SpaceWire PCI Interface Device Acting As a Pass-Through Device

5 DEVELOPMENT EXPERIENCE

The implementation of the SpaceWire-PnP features in the API, the improvements to STAR-Launch to support these features, and the addition of PnP support to STAR-Dundee devices, are ongoing. The experiences of the developers working on these features can be of use to others working on SpaceWire-PnP developments.

The developers found that it is quite simple to implement the protocol using existing RMAP components, as SpaceWire-PnP is built on top of RMAP. STAR-Dundee hardware was already designed to allow properties to be read and configured using RMAP reads and writes, so software and hardware RMAP implementations were already present.

The SpaceWire-PnP Protocol Definition is very long (211 pages), and this gave the impression that the PnP Protocol was very complicated. However, after some initial reading it became clear that there are only around 20 pages that everyone working with SpaceWire-PnP must read: sections 3 and 4. The sections which follow this,

sections 5, 6, 7 and 8, provide all the technical information to implement a service, and are useful reference points for the developers.

The protocol definition is not yet at a stage where it can be considered complete. In addition to the prototyping and technical verification required before SpaceWire-PnP can be considered a suitable solution, there are still a number of typographical improvements that need to be made to the document. It does however appear to provide a capable solution to provide Plug and Play support over SpaceWire.

6 SUMMARY

This paper has described the features of STAR-Launch, the features of SpaceWire-PnP, and how these two are being combined. The experience of the developers working on the implementation has shown that the SpaceWire-PnP Protocol Definition, while not yet perfect, seems to provide a comprehensive set of services to allow networks to be discovered and devices to be configured.

7 REFERENCES

1. STAR-Dundee, http://star-dundee.com/products.php, STAR-Dundee SpaceWire Products, STAR-Dundee Website.

2. ECSS, "SpaceWire – Remote Memory Access Protocol", Standard ECSS-E-ST-50-52C, Issue 1, European Cooperation for Space Standardization, February 2010.

3. S. Mills, A. Mason, S.M. Parkes, "STAR-Dundee Virtual Devices and System Simulation", International SpaceWire Conference 2010, St Petersburg, Russia, 22–24 June 2010.

4. P. Mendham, A. Ferrer Florit, S.M. Parkes, "SpaceWire-PnP Protocol Definition", Issue 2.1, University of Dundee, September 2009.

5. ECSS, "SpaceWire Protocol Identification", Standard ECSS-E-ST-50-51C, Issue 1, European Cooperation for Space Standardization, February 2010.