Implementing SpaceWire PnP in the Aeroflex Gaisler Router IP core

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Introduction

Aeroflex Gaisler has a wide variety of SpaceWire IP cores and products. The latest addition is the SpaceWire router IP core which has been developed during this year.

Due to the parallel development of the SpaceWire PnP protocol it was natural to use this core for prototyping this protocol.

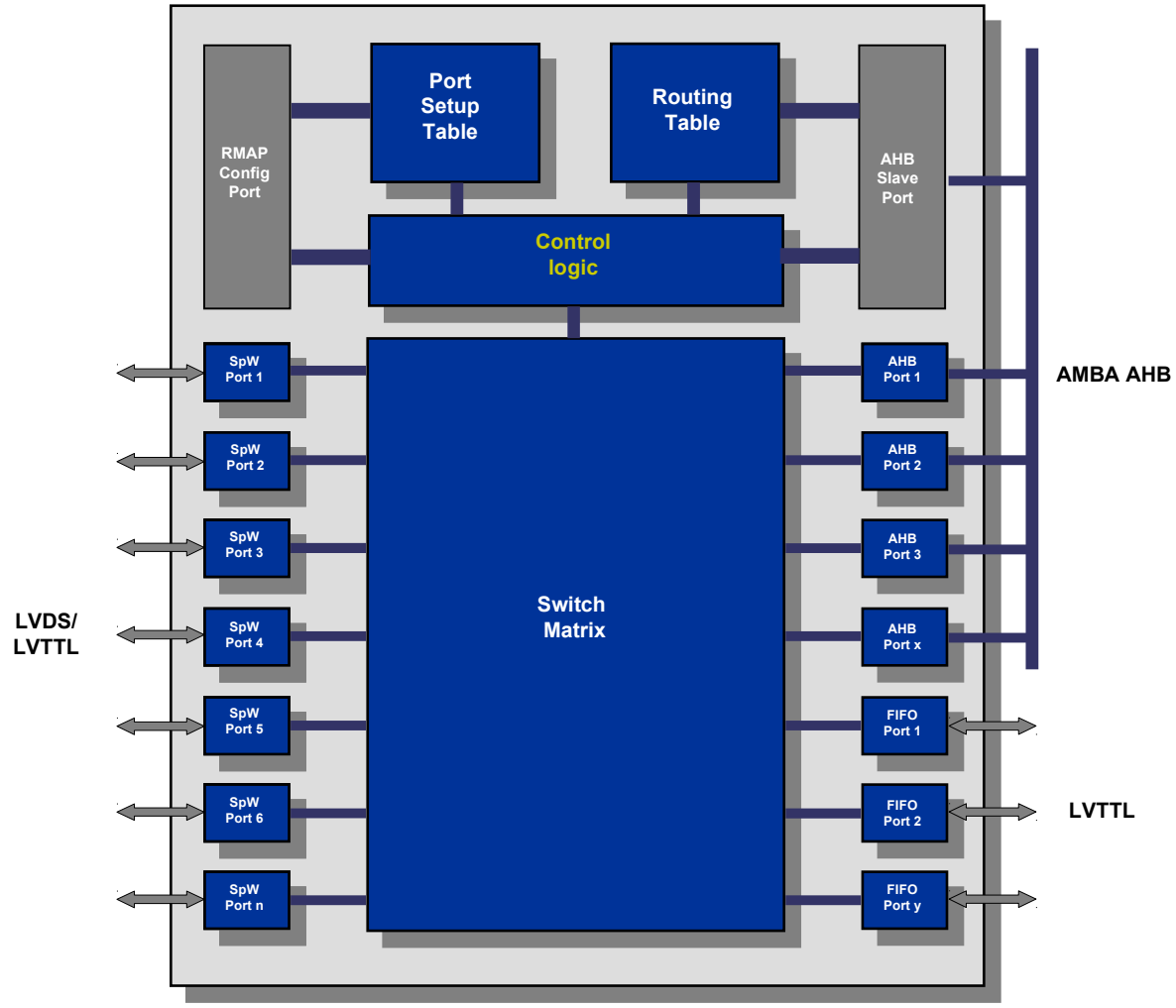
Aeroflex Gaisler also has long experience of developing hardware and software for other buses using PnP such as USB and PCI. Comparisons will therefore be made between SpW PnP and USB.

Coverage

Only the parts of PnP affecting passive nodes have been analyzed.

The difference between the two implementation levels is minor for passive nodes and has therefore not been taken into consideration.

SpaceWire Router block diagram



Router features

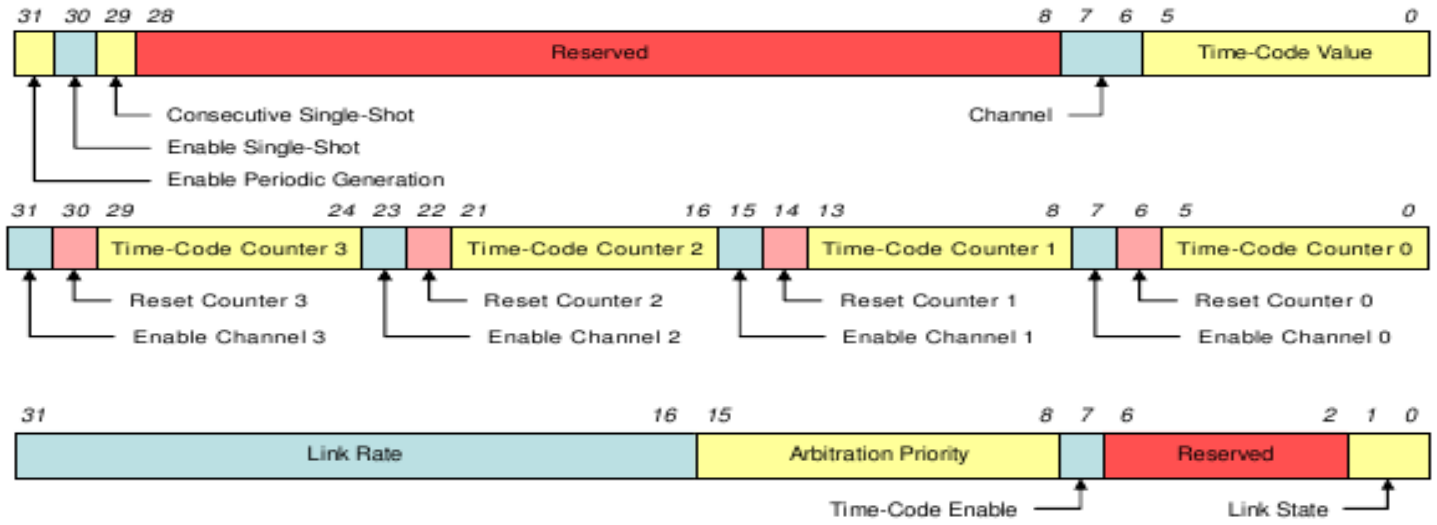
- 2 – 31 ports in addition to the configuration port.
- Three different port types: SpW Links, AMBA AHB, FIFO
- Group Adaptive Routing from 1 to up to all ports.
- Packet distribution to 1 up to all ports.
- Timers on ports to prevent packet locking.
- System time-distribution.
- Two-level round-robin arbitration.
- Bridging capability through the FIFO port without glue logic.
- AMBA AHB slave access to routing table
- RMAP configuration port

The support for router features in the SpW PnP specification

- All features required for routers as specified in the SpW standard are supported by various PnP services.
- In addition some features not in the standard that have been determined as very useful have been included in PnP. They are optional.
- Both above categories of services suffer from one main problem: the way and to what extent they are implemented is not dictated by a standard.
- Thus there will always be a potential problem with some parts of a feature being covered by PnP but still requiring a custom control protocol for full utilisation.

Example: System time-distribution

- Current fields in the PnP specification
- The Time-Code enable field is link specific and enables transmission. The AG router currently has a bit affecting both reception and transmission. It also has additional features such as control flag filtering.
- A custom way to access these would be needed e.g. the custom RMAP configuration protocol.



Example 2: Routing timers

- From the specification: “The Watchdog Timeout field shall contain the current value of the non-blocking protection watchdog timer. This shall be a 32-bit value (where bit 0 is the least significant). A value of zero shall indicate immediate timeout; a value of 0xFFFFFFFF shall indicate an infinite timeout (watchdog timeout disabled). All other values shall indicate the period of the watchdog timeout in microseconds.
- The AG router has a global prescaler which generates ticks used by individual counters for each port. This can clearly not be controlled completely through the current PnP services again requiring another means of control.

Table 5-21: Router Control Parameter Fields

ID	Name	Summary
0	Watchdog Timeout	Sets the non-blocking protection watchdog timer
1	Arbitration Mode	Permits configuration of the routing arbitration mechanism
2	Time-Code Counters	Permits control of up to 4 time-code counters
3-31	*Reserved*	*Reserved for future use*

Use of standard software libraries

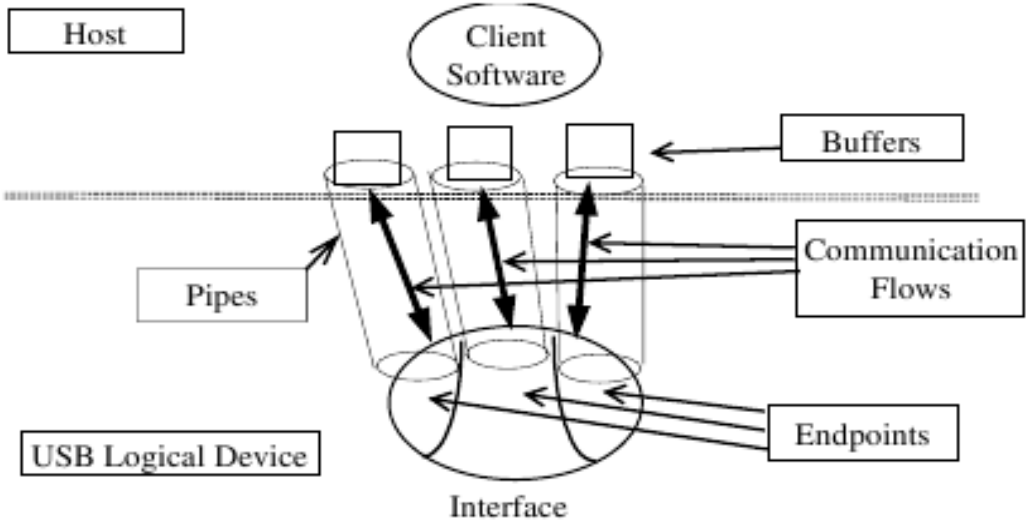
The issue discussed relates to the intention of providing standard software libraries.

If the issue of dividing control of features cannot be solved then there is little use of this approach. Most users of SpaceWire equipment will probably need to have access to all features thus requiring a driver.

A minimalistic approach would be to only have device and network discovery and load a driver for each device type found. All device features would be accessed through the driver.

The USB implementation of PnP

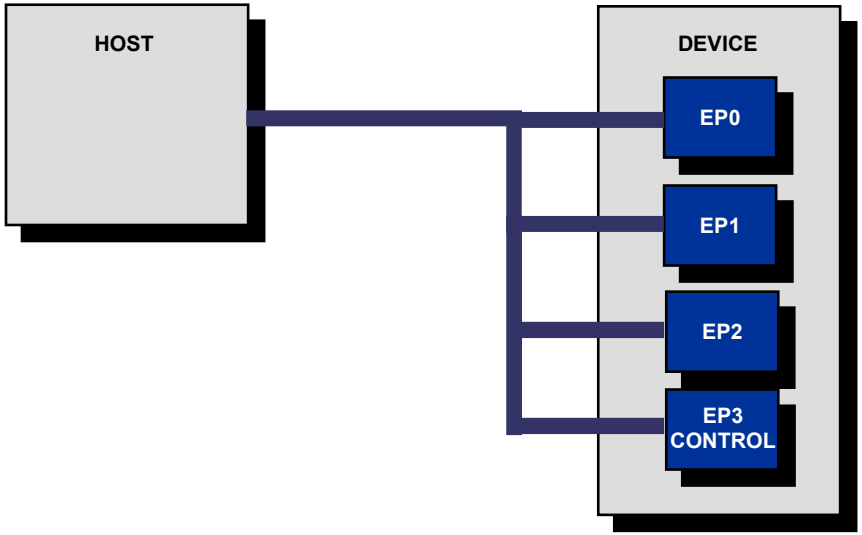
- All devices initially addressed with address 0.
- All communication done through endpoints.
- Endpoint 0 is always a control endpoint through which the other endpoints are controlled. Endpoint 0 provides descriptors with information on what endpoints the device supports and of what type the device is.
- If additional control flows are needed they would be done through additional control endpoints configured through endpoint 0. These control endpoints never affect anything configured through EP0.



The USB implementation of PnP (2)

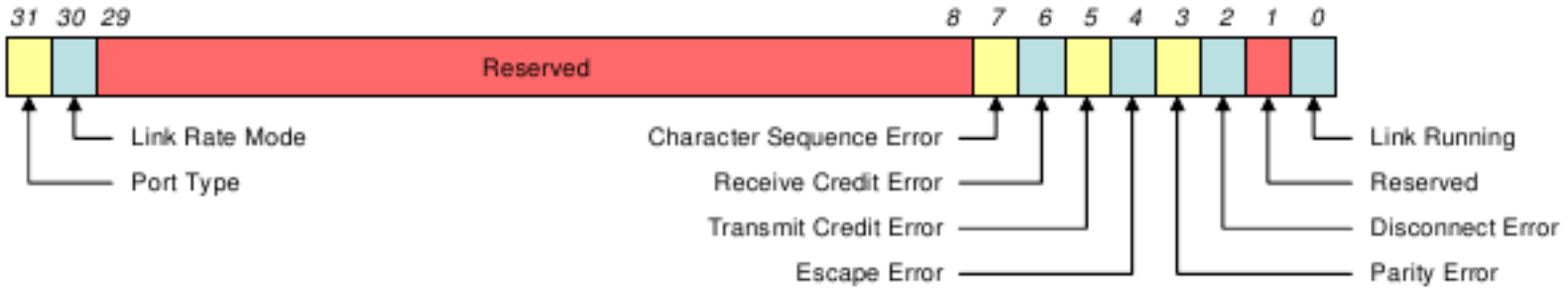
USB device at startup:

USB (example) device after startup. Endpoint configuration can only be affected through EP0:



Keep the PnP fields identical to the ones in the standard

The standard specifies credit errors while in PnP there are both receive credit error and transmit credit error bits. If a core does not distinguish between them there should be a separate credit error bit. Mapping it to either of the existing ones can potentially be problematic.



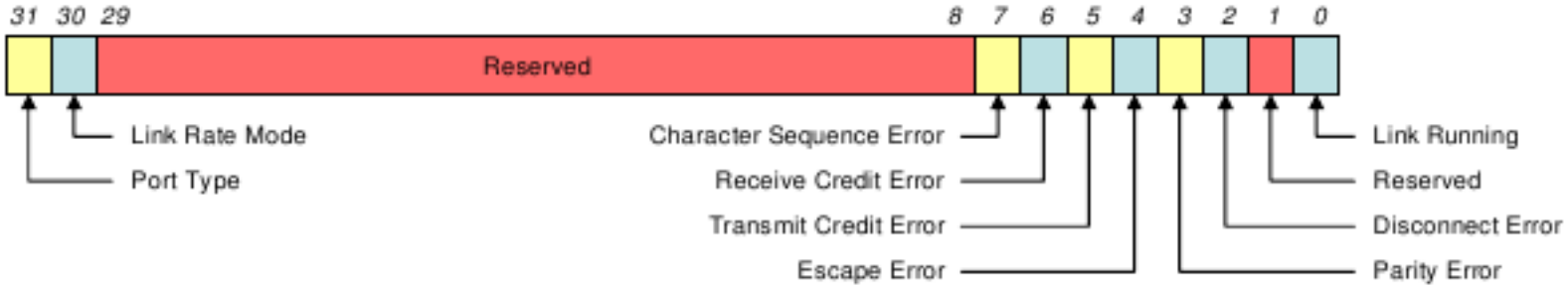
Keep the PnP fields identical to the ones in the standard (2)

The standard specifies linkdisabled, autostart, and linkstart. PnP specifies an encoding of different states which will be mapped to these three bits. It would be easier to just have these three bits available directly.

Table 5-17: Link State Encoding		
Bit 1	**Bit 0**	**State**
0	0	Idle
0	1	Started
1	0	Autostart
1	1	Disabled

Port types

- The AG router has three different port types as shown in the feature list.
- The Atmel/Dundee 10x has two.
- PnP distinguish between SpaceWire links and external ports using one bit mainly to show whether link configuration features are available.
- There can potentially be more port types in new routers.
- One approach is to have one bit determine whether that port should be followed for network discovery and one bit for determining if the SpaceWire link configuration service can be used for it. If configuration is needed for the other port types separate drivers would be needed.



AMBA ports

The AMBA ports in the router is an example of the potential diffuse area between routers and nodes that has been discussed.

Since they are inherently coupled to an AMBA bus a host system would reside on-chip with the router. Another scenario is that the AMBA bus provides bridging to another type of external interface.

This type of port should probably not be followed for network discovery thus requiring a bit indicating this in the PnP port description.

Summary

The main thing still left to solve for PnP from the device perspective is to figure a sufficiently good model for the services to avoid mixing it with custom configuration protocols.

Other smaller issues have been highlighted but are small in comparison and easy to fix.