SpaceWire-PnP: Progress Update

Peter Mendham, Albert Ferrer Florit, Steve Parkes

University of Dundee

Space Technology Centre
University of Dundee

SpaceWire-PnP in Detail

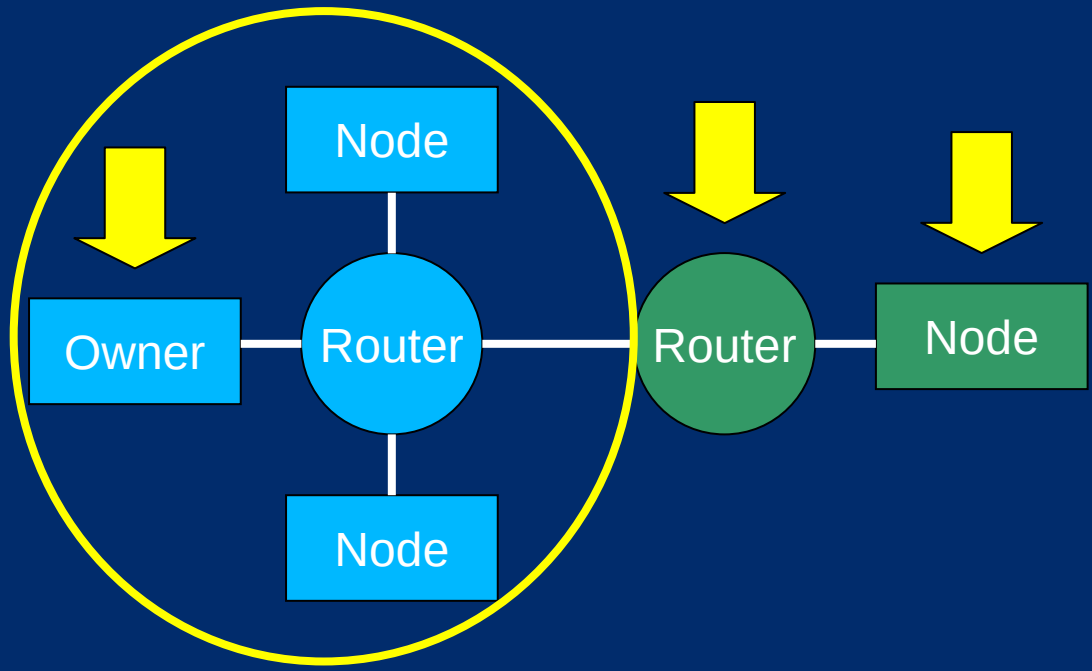
- Significant progress in shaping a protocol
- Analysis and prototyping work has been done
- Structure of services presented in Nara
- Concentrate on depth rather than breadth…
- Focus on two services:
  - Device Ownership
  - Owner Proxy
- All other services build on these

Device Ownership

- Every device has an owner
- Owner is responsible for device configuration
- *Only* owner may configure device
  - By convention
- Ownership of device must be contiguous

Space Technology Centre
University of Dundee

Contiguous Ownership



- “Owner” owns all devices in blue
- If “Owner” wishes to own green node it must first own green router

Ownership Issues

- How to identify owner of device to those discovering the network?
  - Owner Location
  - Also necessary to determine if owner is still valid
- How to ensure that device is uniquely identified to owner?
  - Device Disambiguation

Owner Location

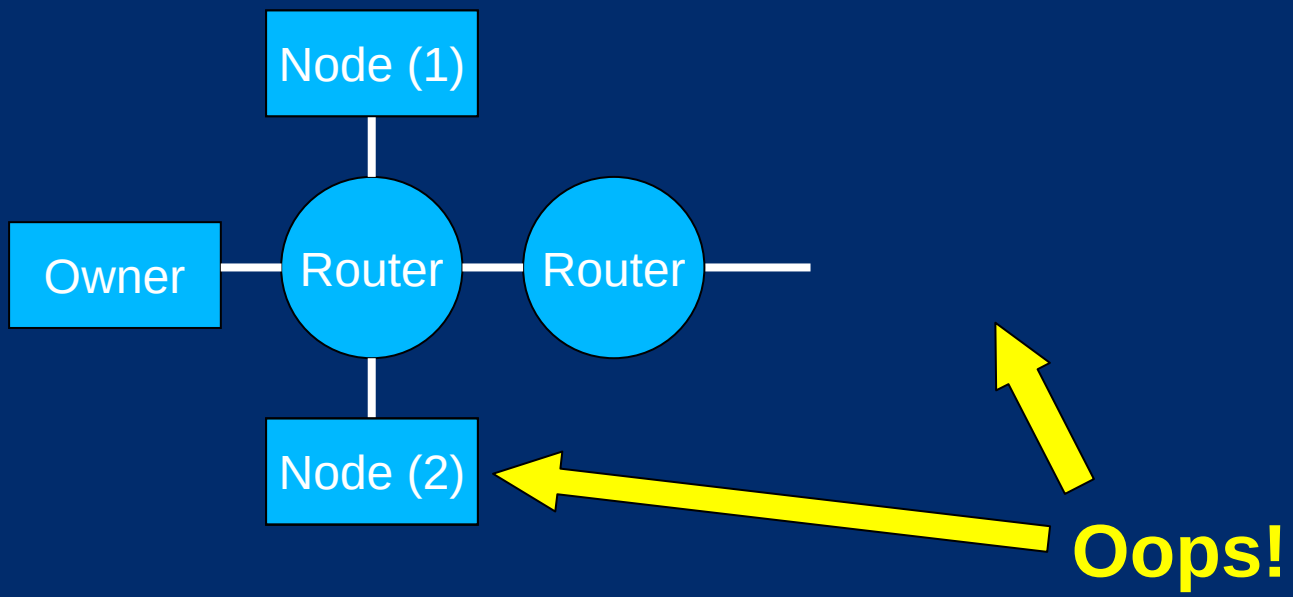
How to identify owner of device to those discovering the network?

- Owner can be located by logical address or by path address
- Ownership is contiguous, so logical addressing is OK
  - Router is configured before node is claimed

Device Disambiguation

How to ensure that device is uniquely identified to owner?

- Owner gives device an identifier
- On a closed network (devices known *a priori*) ID can be assigned deterministically
- On an open network this is not the case



- Assign identifier *randomly*

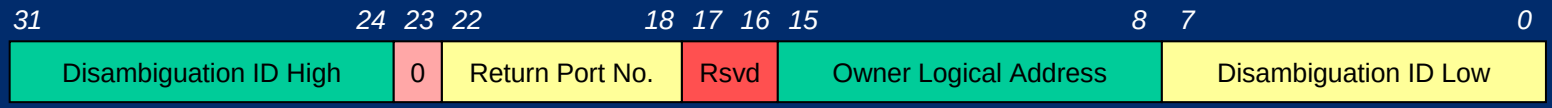
Atomicity

- Only works if:
  - Owner location
  - Device disambiguation identifier

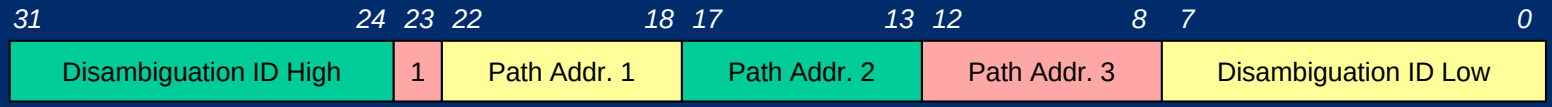
  are written atomically
- Use a conditional write implementation of RMAP Read-Modify-Write
- Limited to 32-bits
  - Logical/path address selection (1 bit)
  - Logical address + return port number (13 bits)
  - Path address, 3 ‘hops’ (15 bits)
  - Device disambiguation identifier (16 bits)
- When this is written on a router, routing table is configured automatically

Device Owner Field

Logical Addressing:



Path Addressing:



- If the path between a device is more than three ‘hops’
  - Follow three hops to find another router
  - Check router to find the next hops
  - Continue as long as is necessary
- “Disambiguation ID” is split up for good reason
  - Come back to that later (this is a simplification)

“Disambiguation ID”

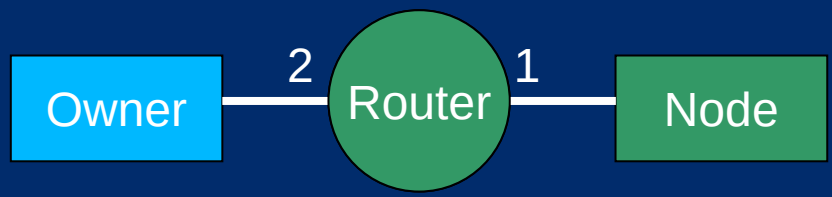
- Randomly assigned
- 16-bits
- On a network of 32 devices chance of clash is 0.75%

- Based on the “Birthday Paradox”
  - In a room of 23 people there is a 50% chance that two people will share a birthday
  - For example, with a 1-byte ID, chance of clash on a network of 32 devices is > 85%

Space Technology Centre
University of Dundee

Competition Resolution

- There may be competition for device ownership
- Resolved using priorities pre-assigned to potential owners
- If priorities are equal or not assigned the port number being used to access the device is used
- Lowest port number wins



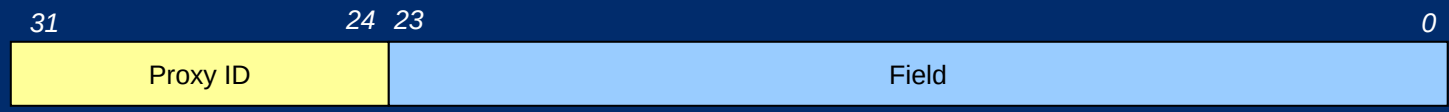
Configuring Un-Owned Devices

- If you don't own a device, how do you configure it?
  - E.g. routing table entries in a router
- Must request the owner to make the change
- How should a request to the owner be formatted?
- Exactly the same as if the request was for the device, but specifying the "disambiguation ID"

Space Technology Centre
University of Dundee

Owner Proxy

- SpaceWire-PnP operates on fields
  - Field identifier forms an RMAP address

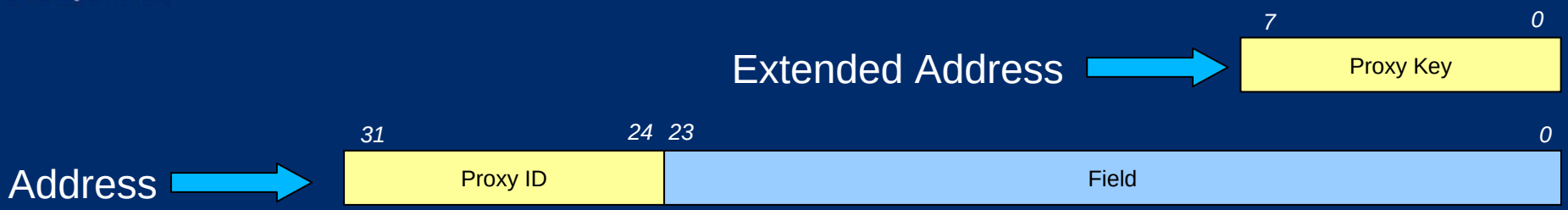


- On owners this is combined with Proxy ID
  - This is the “Disambiguation ID”
- If Proxy ID is zero operation is on the owner
- If Proxy ID is non zero operation is a request to alter the device with that Proxy ID
- Owner has the chance to vet the operation and then carry it out on the device if permitted

Space Technology Centre
University of Dundee

Owner Proxies

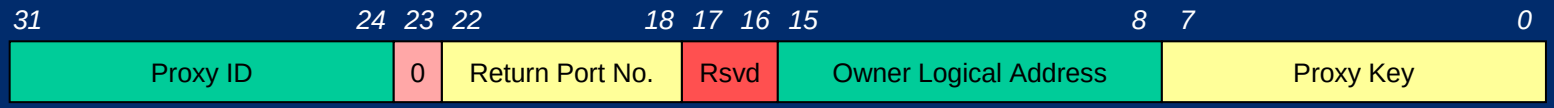
- Each owner can proxy 255 devices
- Proxy ID = lowest byte of “Disambiguation ID”
- Proxy Key is used purely for disambiguation
- Makes up the 16-bit “Disambiguation ID”



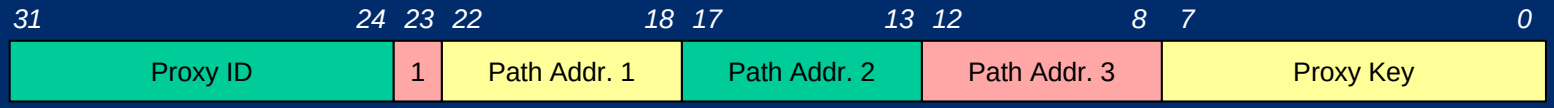
- To clarify:
  - “Disambiguation ID” split into two 8-bit fields
  - Lowest 8-bit specifies Proxy
  - Highest 8-bits is purely for disambiguation (called Proxy Key)
  - Combined with field indexing – form 40-bit address

Device Owner Field

Logical Addressing:



Path Addressing:



- These are the actual device owner fields
- Proxy ID/Key fields allow device to be configured
  - Via owner proxy
  - Using owner location
- Also used for disambiguation

Space Technology Centre
University of Dundee

Summary

- Significant effort has gone into SpaceWire-PnP
- Goals have been presented multiple times
  - Interoperability
  - Compatibility (e.g. with SpaceWire Standard, RMAP, SpaceWire-RT, SpW-10X)
  - Flexibility
  - Extensibility
  - Simplicity
- Presented details of two services here:
  - Device Ownership
  - Owner Proxy
- These are key to other services
  - For example, the Network Discovery service

Backup Slides

Principles

- Interoperability
  - Promote hardware and software reuse
  - Create more potential for off-the-shelf components
  - Permit network discovery and verification
- Services for SpaceWire networks
  - Discovery
  - Identification
  - Configuration
- Provide support for features defined in the SpaceWire standard
- If it is optional in the SpaceWire standard it should be optional in plug-and-play

Perspective

- PnP views the network like the SpaceWire standard
  - Links
  - Nodes
  - Routers

  } Devices
- Both nodes and routers have links
  - Nodes have 1 or more links
  - Routers have 2 or more links
- Every device on the network has a port zero
  - This is the target for PnP transactions
- In a running system, every device can have one owner node which is responsible for that device

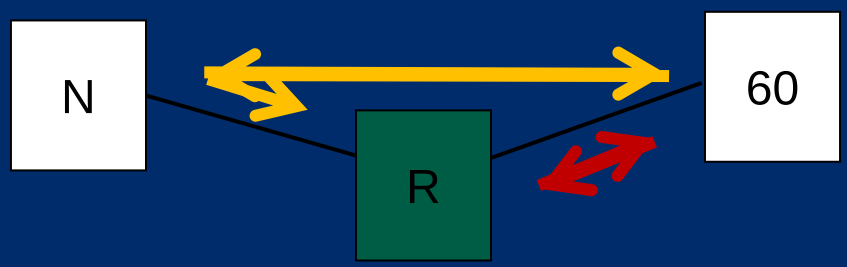
SpaceWire-PnP Services

- Device Identification
- Device Ownership
- Owner Proxy
- Network Discovery
- Link configuration
- Router configuration
- Time-code source
- Generic data sources
- Generic data sinks
- SpaceWire-RT

Owner Proxy Service

- Device owners offer access to the devices they own via *proxy address spaces*
- An owner may provide up to 255 proxies
- A device identifies its owner and the proxy space ID
- All access to that device go via the proxy space on the owner
- A proxy address space is a standard PnP address space
- Allows full control of all requests in a standardised manner with owner intervention

Owner Proxy Example



Owner responds to original request
with Proxy ID = 1010

Access real router

Space
Technology
Centre
University of Dundee

End