


The SpaceWire-PnP Protocol: UoD Document Version 2.1

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Agenda

- Requirements and aims
- RMAP usage
- SpaceWire-PnP services
  - Device Identification
  - Network Management
  - Link Configuration
  - Router Configuration
- Extensibility and capabilities
- Applying SpaceWire-PnP
- Known issues and discussion points
- How to use the UoD document

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SpaceWire-PnP Aims

- Protocol aims
  - Interoperability and reuse
  - Standard mechanisms for standard features
  - Support device/network discovery as required by SOIS
- Document aims
  - A complete solution
  - A starting point for discussion

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Perspective

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

  } Devices
- No topology restrictions
- 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

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Levels of Support

- Managed Networks — Level 1
  - Important role for system designer
  - Competition during discovery process removed by design
  - Competition for configuration of devices removed by design
  - Simplest case
- Open Networks — Level 2
  - Network handles all competition issues
  - Deals with networks where design is **not** known *a priori*
  - More flexible but more complicated

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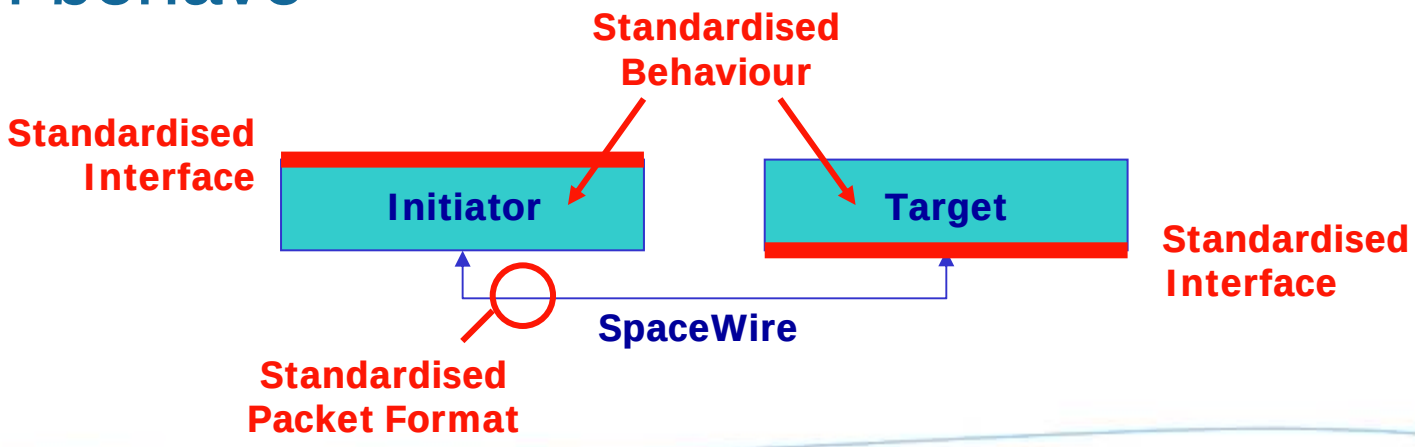
What is Standardised?

- A set of parameters on the target
  - This is a standardised RMAP address space
- An interface of primitives at the initiator
  - Satisfying the requirements for SOIS
- A description of how the initiator and target will both behave



RMAP Utilisation

- Semantics required for plug-and-play closely match RMAP
- Use a well-defined implementation of RMAP
  - 32-bit wide addressing and alignment
  - Big endian
  - Incrementing addressing
  - Acknowledged, verified writes
  - Pre-defined key
  - RMW implementation (optional) is a conditional write
- Use a different protocol ID
  - To distinguish from generic RMAP traffic
  - E.g. Mass memory device

So is SpaceWire-PnP a Protocol?

- Probably not…
  - A specific implementation of RMAP
  - Standardised address space
  - Standardised primitives
  - Standard semantics of use
  - Identified with a protocol ID
- Does that make it a protocol?

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Target Parameters

- Follow a regular form
- Parameters are made up of 32-bit *fields*
- Optionally, a parameter may have multiple *entries*
  - This is to permit tables, such as routing tables
  - The *root entry* has one set of fields
  - Every other *non-root entry* has a different but identical set of fields
- For example, the link configuration parameter
  - Root entry has one field giving the number of links
  - Has a non-root entry for each link, each of which has the same fields

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Core Services

- Four core services defined
  - Device Identification — **Basic discovery**
    - Read-only, constant fields — **Satisfies SOIS**
    - A few, mirrored, read-only dynamic fields
  - Network Management
  - Link Configuration — **Necessary for SpaceWire-specific configuration**
    - All devices
  - Router Configuration
    - Routers only
- Optionally, there is also a time-code source

Device Identification Service

- Permits the gathering of device information
  - Including type of device
- Parameters:
  - Device Information
  - Vendor String (Optional)
  - Product String (Optional)
  - Device Status
  - Capability List

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Device Information and Status

- Identifies the device
  - Vendor ID and Product ID (like PCI, USB etc.)
  - Type (node/router)
  - Number of ports
  - Optional static device ID
  - Vendor and Product string lengths
- Provides current status
  - Active ports
  - Device ID (non-static)
  - Return port

Read-Only and Constant (PROM)

Read-Only and Dynamic, Mirrored

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Example Parameter Fields

Table 5-3: Device Information Parameter Fields		
ID	**Name**	**Summary**
0	Vendor ID/ Product ID	Contains 16-bit vendor and product IDs
1	Region/Number of Ports	Indicates preferred device region gives port count
2	Static Device ID High	High 32 bits of the 64-bit static device ID (if present)
3	Static Device ID Low	Low 32 bits of the 64-bit static device ID (if present)
4	Version/Instance ID	Version and System instance of this device type
5	Operation/String Lengths	Length of the vendor and product strings (can be zero)
6-31	*Reserved*	*Reserved for future use*

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DIDS Primitives

- DIDS_READ_INFO.request
- DIDS_READ_INFO.indication
- DIDS_READ_VENDOR_STRING.request
- DIDS_READ_VENDOR_STRING.indication
- DIDS_READ_PRODUCT_STRING.request
- DIDS_READ_PRODUCT_STRING.indication
- DIDS_READ_STATUS.request
- DIDS_READ_STATUS.indication
- DIDS_READ_CAPABILITY_LIST.request
- DIDS_READ_CAPABILITY_LIST.indication

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DIDS Example Initiator Primitive

- DIDS_READ_INFO.request
  - RMAP_Parameters
- DIDS_READ_INFO.indication
  - Result
  - Vendor_ID
  - Product_ID
  - Preferred_Region
  - Router_Node
  - Support_Level
  - Port_Count
  - Device_ID
  - Version
  - Instance_ID

Network Management Service

- Permits the unique identification of devices
- Enables network discovery
- Parameters:
  - Read-write network ID (just a 32-bit register)
  - Logical address (for nodes only, and optional)

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NMS Primitives

- NMS_READ_NETWORK_ID.request
- NMS_READ_NETWORK_ID.indication
- NMS_WRITE_NETWORK_ID.request
- NMS_WRITE_NETWORK_ID.indication
- NMS_READ_DEVICE_LA.request
- NMS_READ_DEVICE_LA.indication
- NMS_WRITE_DEVICE_LA.request
- NMS_WRITE_DEVICE_LA.indication
- NMS_DISCOVER_NETWORK.request
- NMS_DISCOVER_NETWORK.indication

Optional

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Link Configuration Service

- Determine number and status of links
- Configure links
- Parameters:
  - Link activity, as a bit field
  - Reference transmit rate
  - Configuration for each link
    - Link type and status/errors (read-only)
    - Transmit rate
    - Link state

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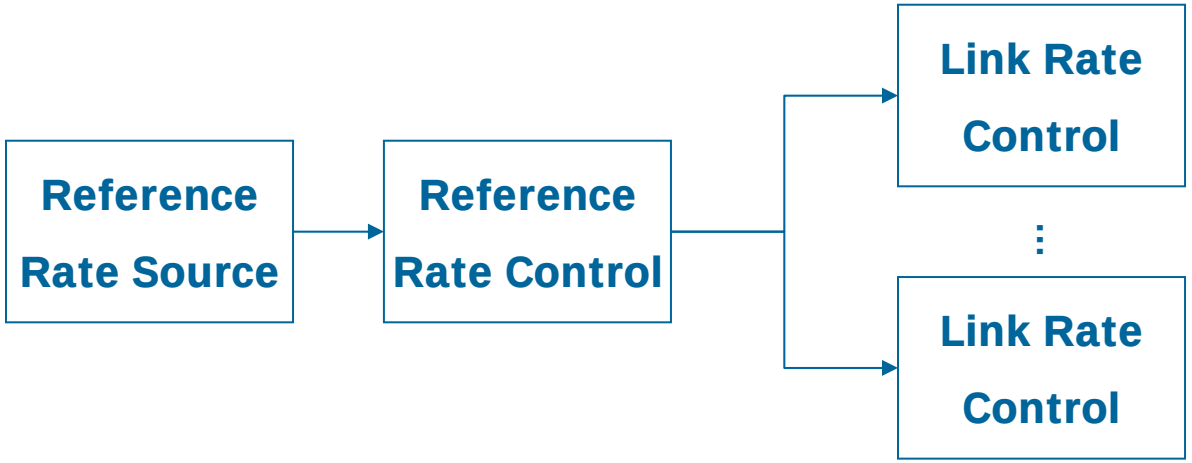
Transmit Rate Abstraction

- Designed to be simple and flexible
  - And reflect current practice
- Control of **reference rate** for all links
- Control of **link rates** individually
- Each rate can be controlled either as a numeric rate, or as a divider



LCS Primitives

- LCS_READ_PORT_ACTIVITY.request
- LCS_READ_PORT_ACTIVITY.indication
- LCS_READ_REFERENCE_RATE.request
- LCS_READ_REFERENCE_RATE.indication
- LCS_WRITE_REFERENCE_RATE.request
- LCS_WRITE_REFERENCE_RATE.indication
- LCS_READ_LINK_CONTROL.request
- LCS_READ_LINK_CONTROL.indication
- LCS_WRITE_LINK_RATE.request
- LCS_WRITE_LINK_RATE.indication
- LCS_WRITE_LINK_PRIORITY.request
- LCS_WRITE_LINK_PRIORITY.indication
- LCS_WRITE_LINK_STATE.request
- LCS_WRITE_LINK_STATE.indication

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Router Configuration Service

- Only for routers (obviously)
- Router configuration and status
- Parameters
  - Router configuration
    - Watchdog timeout (optional)
    - Arbitration mode
    - Time-code counter control
  - Routing table
    - Port association
    - Mechanism and arbitration control
    - Partial implementations permissible

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RCS Primitives

- RCS_READ_WATCHDOG_TIMEOUT.request
- RCS_READ_WATCHDOG_TIMEOUT.indication
- RCS_WRITE_WATCHDOG_TIMEOUT.request
- RCS_WRITE_WATCHDOG_TIMEOUT.indication
- RCS_READ_ARBITRATION_MODE.request
- RCS_READ_ARBITRATION_MODE.request
- RCS_WRITE_ARBITRATION_MODE.request
- RCS_WRITE_ARBITRATION_MODE.request
- RCS_READ_TIME_COUTER.request
- RCS_READ_TIME_COUTER.indication
- RCS_RESET_TIME_COUTER.request
- RCS_RESET_TIME_COUTER.indication
- RCS_ENABLE_TIME_COUNTER.request
- RCS_ENABLE_TIME_COUNTER.indication
- RCS_READ_LA_COUNT.request
- RCS_READ_LA_COUNT.indication
- RCS_READ_ROUTING_TABLE_ENTRY.request
- RCS_READ_ROUTING_TABLE_ENTRY.indication
- RCS_WRITE_ROUTING_TABLE_ENTRY.request
- RCS_WRITE_ROUTING_TABLE_ENTRY.indication

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Summary So Far

- Have presented
  - Principles of SpaceWire-PnP
  - Which bits are standardised
    - RMAP usage
    - RMAP address space (parameters)
    - Primitives
  - Functions logically grouped into services
    - Device Identification Service
    - Network Management Service
    - Link Configuration Service
    - Router Configuration Service

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SpaceWire-PnP Extensibility

- SpaceWire-PnP is a convenient mechanism for detecting and configuring
- Can it be used as a “gateway” to more functionality?
- Devices can define their **capabilities**
  - Identifiable feature set
  - Supported by a SpaceWire-PnP service
    - Parameters
    - Primitives
    - Permits identification and configuration of the capability

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Capabilities

- Device can provide a list of *capabilities*
- Capabilities based on protocol ID
  - A protocol which is supported
  - Optionally “transported” over another protocol
  - Supports nesting of “transports”
- Examples
  - CPTP over SpaceWire-(R)T
  - A standardised address space “transported” over RMAP

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Describing RMAP Address Spaces

- SpaceWire-PnP document proposes a method for describing RMAP address spaces
- Capability services allow the description of:
  - Memory regions which exist to receive data: **data sinks** (e.g. actuators)
  - Memory regions which permit access to generated data: **data sources** (e.g. sensors)
- Also permits non-trivial access mechanisms
  - Delayed response reads and writes
  - Initiated reads and writes

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Using SpaceWire-PnP (1): SOIS

- Supports services necessary for SOIS
- Device information, network ID and link activity together permit network and device discovery
- Minimal implementation requirements:
  - 12 words of read-only constant registers
  - 1 read-only dynamic register
  - 1 read-write register
- Minimal set of primitives
  - 5 pairs (request/indication)

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Using SpW-PnP (2): Datasheets

- Can use data source capability service to describe an RMAP region to read a datasheet from
  - E.g. direct interface to a PROM
- Data source type identifies format of datasheet
  - E.g. xTEDS
- Minimal implementation (in addition to previous)
  - 8 read-only words
  - 2 primitive pairs
- Uses the same RMAP core as for SpaceWire-PnP

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Using SpW-PnP (3): RMAP Spaces

- Can use data source/sink capability services to describe an existing RMAP address space
  - E.g. JAXA standardised memory map
- Same resource requirements as datasheet example for read-only
  - Add 8 read-only words and 4 primitive pairs for read-write
  - This adds a data sink

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Using SpW-PnP (4): Notification

- Ability for routers (or any device) to automatically inform a network manager when status changes
  - E.g. link connect/disconnect
- Uses a simple data source
- Additional requirements (from datasheet case):
  - 1 read-write field for a target source
  - 12 read-write fields for an initiator source
- Features to support multiple, uncoordinated network managers are documented

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Using SpW-PnP (5): SpW-(R)T, SpW-D

- Capability services could easily be added to support the configuration of mechanisms such as SpaceWire-(R)T and SpaceWire-D
  - No changes to SpaceWire-PnP necessary
- Standard SpaceWire-PnP device configuration easily fits within time slots
  - Works well with SpaceWire-D
  - Could be transported over SpaceWire-(R)T
- Level 2 support needs documenting further

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Using SpW-PnP (6): GenFAS

- The MARC hardware, built by SEA, has simplified SpW-10X compatible address spaces on each node and router
- SpaceWire-PnP defines 10X compatibility
- SciSys has implemented the full set of core SpaceWire-PnP primitives in the GenFAS software (executing on MARC)
  - Was a valuable learning experience
  - Fairly trivial (~2k LOC, heavily commented)
  - Works well!

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Known Issues/Discussion Points (1)

- Possibly confusing terminology: link and port used almost interchangeably
  - Haven't got around to fixing this
- Couple of minor changes necessary for full SOIS support
  - Haven't got around to updating document
- Deliberate mirroring of fields to support consolidated reads
  - Might not want this

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Known Issues / Discussion Points (2)

- Time-code handling is just one possible way
- Interrupts not in current document version
- Capabilities support full range of (extended) PIDs
  - Probably unnecessary: simplifications possible?
  - There may be a better way to identify capabilities than by protocol ID
  - However, the concept of capabilities is useful
- And more...

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How to Use the SpW-PnP Document

- This is a **discussion document**

- It is:
  - A complete proposal
  - The product of experience and research
  - The result of inputs from many people
- It is **not**:
  - Expected to become a standard as it is!

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A Guide to the Document

- The document is long, but don't be scared
- There is a detailed introduction
- Level 2 support is documented
  - In a self-contained section
  - Can safely be ignored unless you are interested
- Compatibility with the 10X is documented
- Document is repetitive in structure
  - Each parameter, entry, field, primitive and parameter is documented in detail

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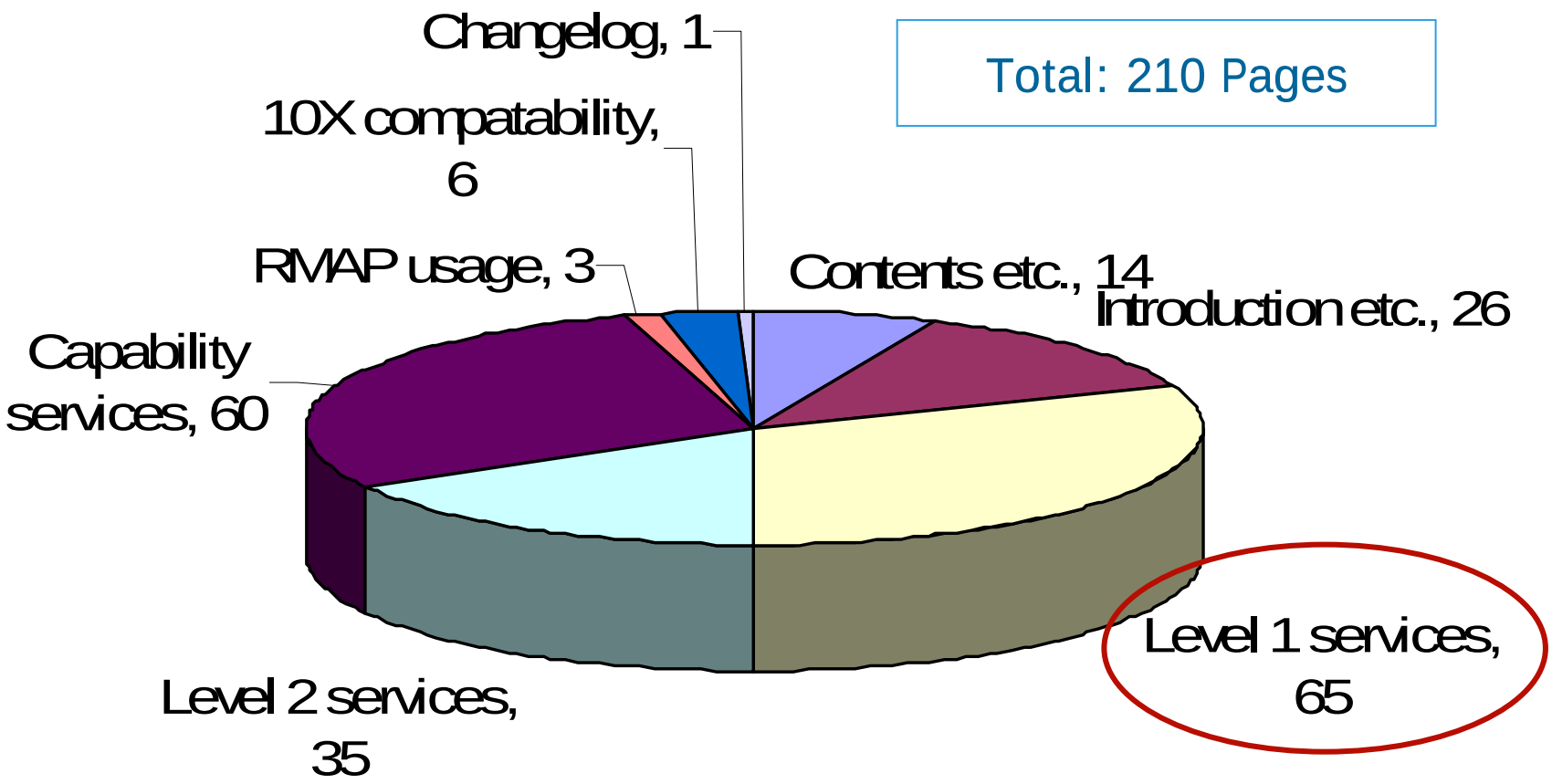
Page Breakdown: Whole Document



Total: 210 Pages

Page Breakdown: Level 1 Services

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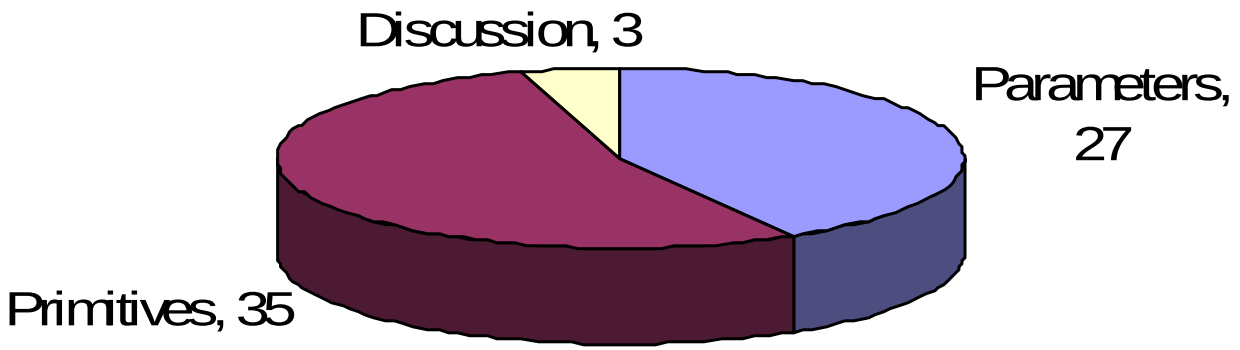

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Summarising SpaceWire-PnP

- Protocol utilising RMAP
- UoD document available: SpaceWire-PnP v2.1
- Defines
  - Target parameters
  - Initiator primitives (service interface)
  - Behaviours (algorithms) where necessary
- Simple
- Does not require extra feature support
- Flexible and extensible
  - Can use capability services to extend support

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Questions?
Discussion?

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