SpaceWire Plug-And-Play:

Fault-Tolerant Network Management for Arbitrary Network Topologies

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SpaceWire Network Scenario

No Assumptions are made on the status of the network and possible upcoming events.

- The network topology is unknown and arbitrary.
- Arbitrary network topology changes can occur at any time due to failures or user intervention.
- Devices or subnets can be plugged and unplugged to/from any element of an existing network at any time. New devices plugged may not be in reset status. (they could have been previously configured for another network)
- Multiple devices with the same hardware configuration may be present in the same network. (there are no unique hardware IDs)

Worst case:

“We have in our lab children playing with SpW cables and devices”

Network Discovery Requirements

- It shall detect plug/unplug events of any SpaceWire link, device or subnet.

Using polling or notification method

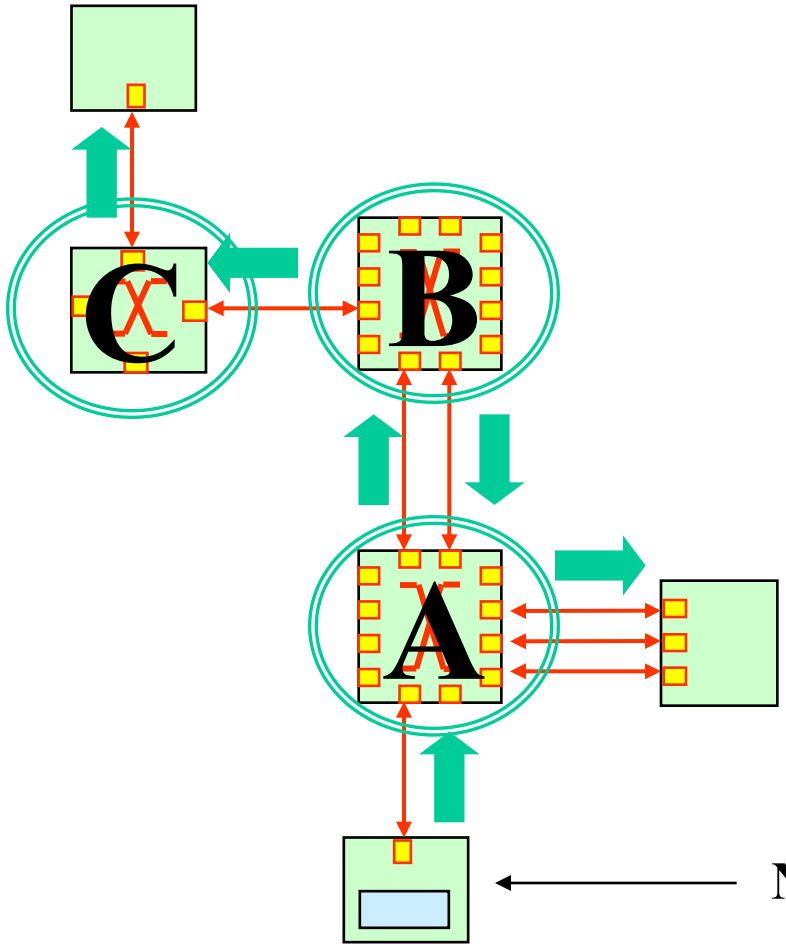
- It shall uniquely identify all devices in the network.

Writing/Reading a different identifier for each device

- It shall support redundancy or fault tolerance mechanisms

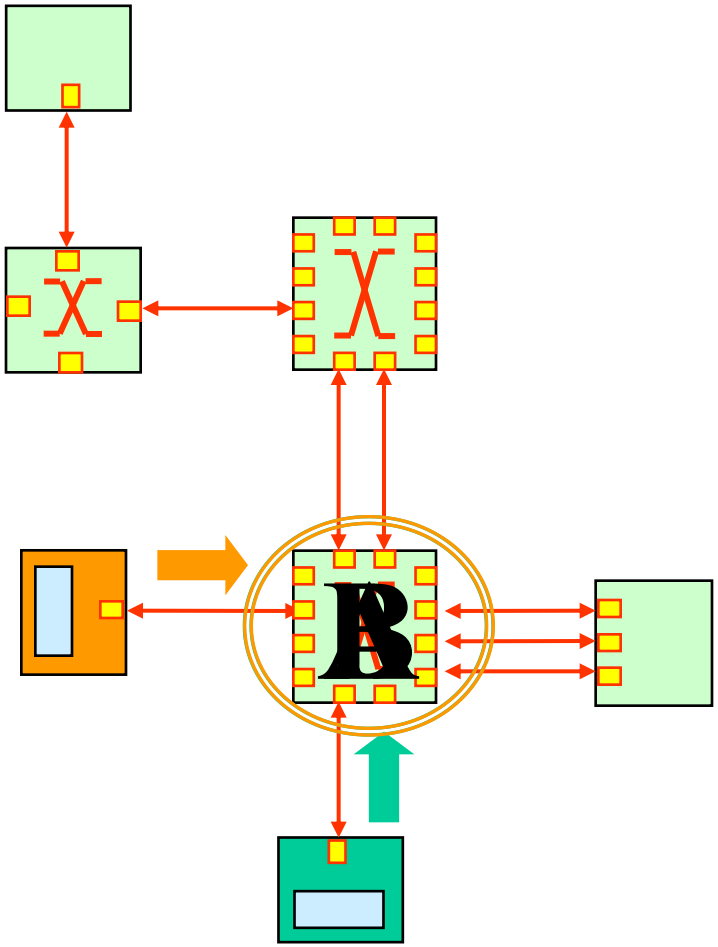
Multiple nodes may simultaneously discover the network

Basic Network Discovery Algorithm



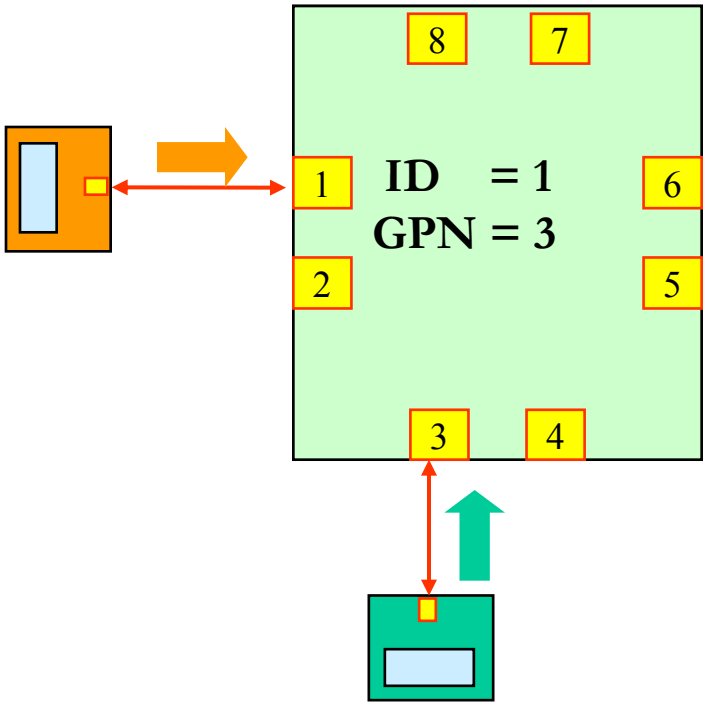
- NNM interrogates routers about the status of their ports or links in order to discover new devices (nodes or other routers).
- Unique device identifiers are writing to avoid identifying multiple times the same device when there are loops.

Basic Network Discovery Algorithm (2)



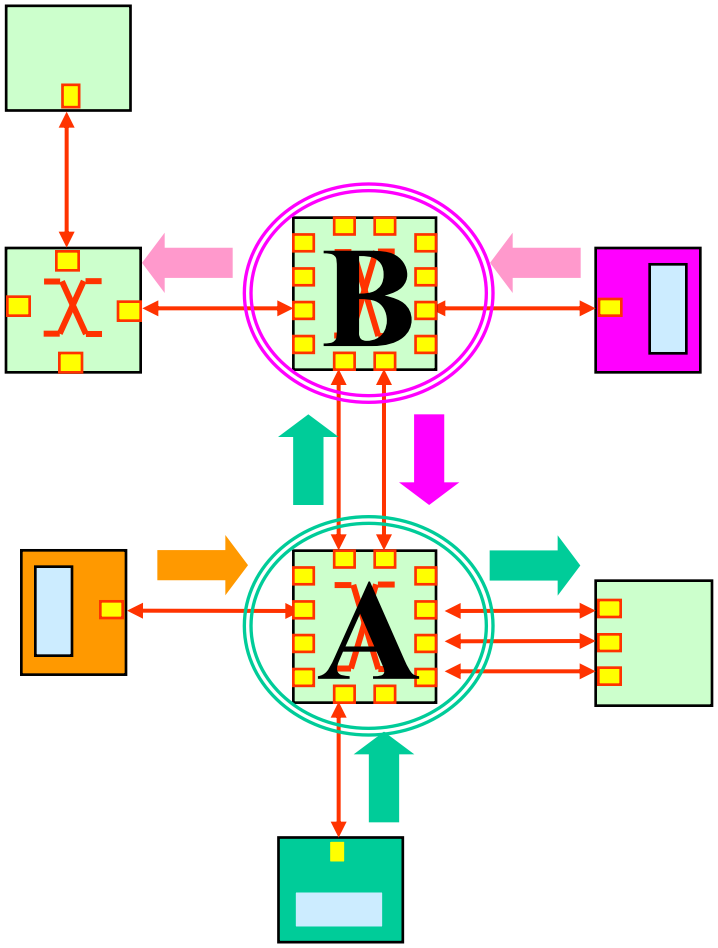
- Fault tolerance capability is implemented by using multiple NNMs
- Only one NNM, called Master NNM, should be active when the network is fully operative
- We need an arbitration mechanism to avoid race conditions!

Proposed Approach



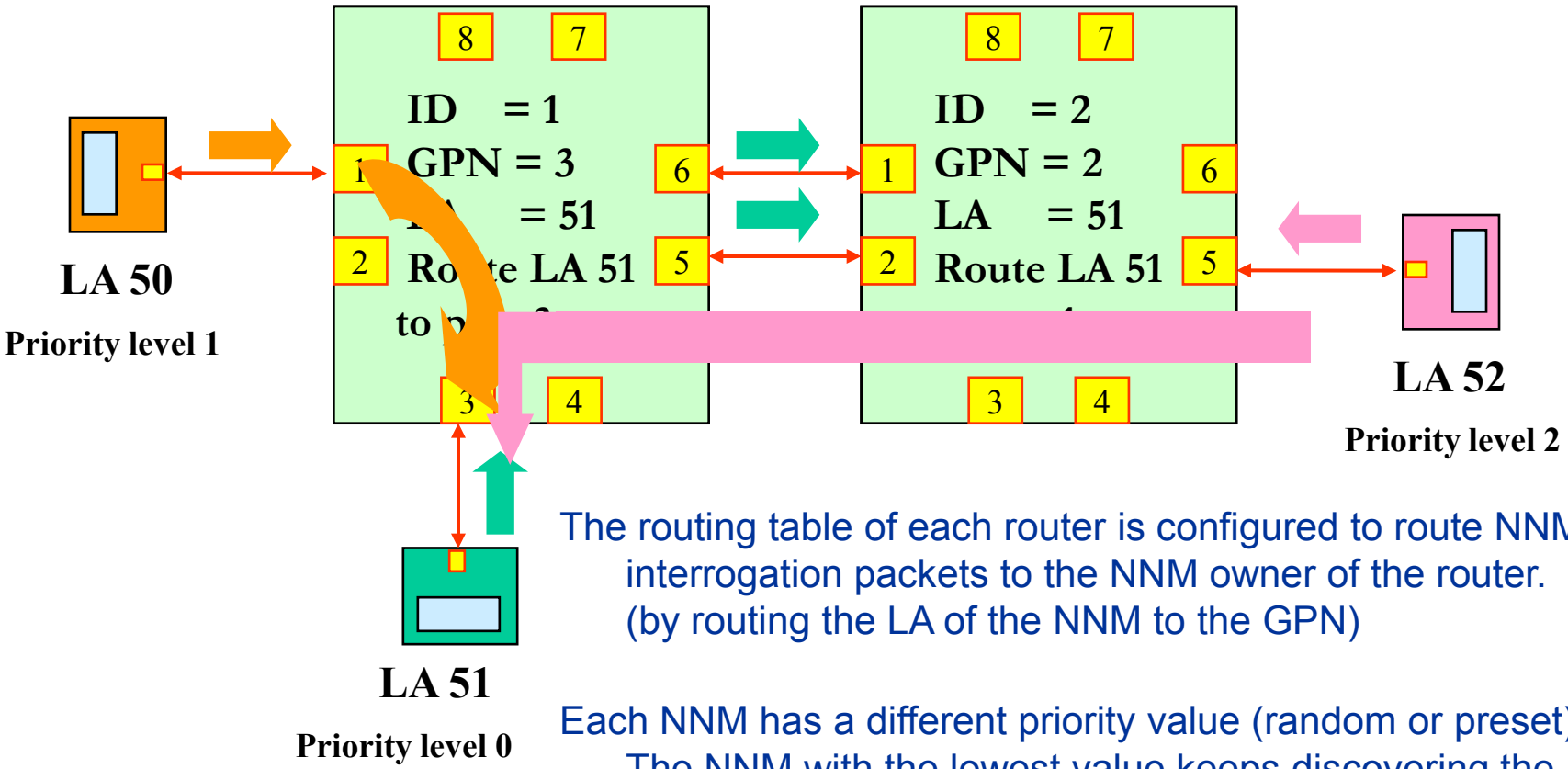
- Network Node Managers writes to a specific register, called GPN (Granted Port Number), the port number used to access to the router
- A NNM only immediately tries to change the configuration if the GPN = 0

Basic Network Discovery Algorithm (3)



- We need an arbitration mechanism between NNMs.
- It is necessary to store information in the router about the NNM that can configure it.

Proposed Approach (2)

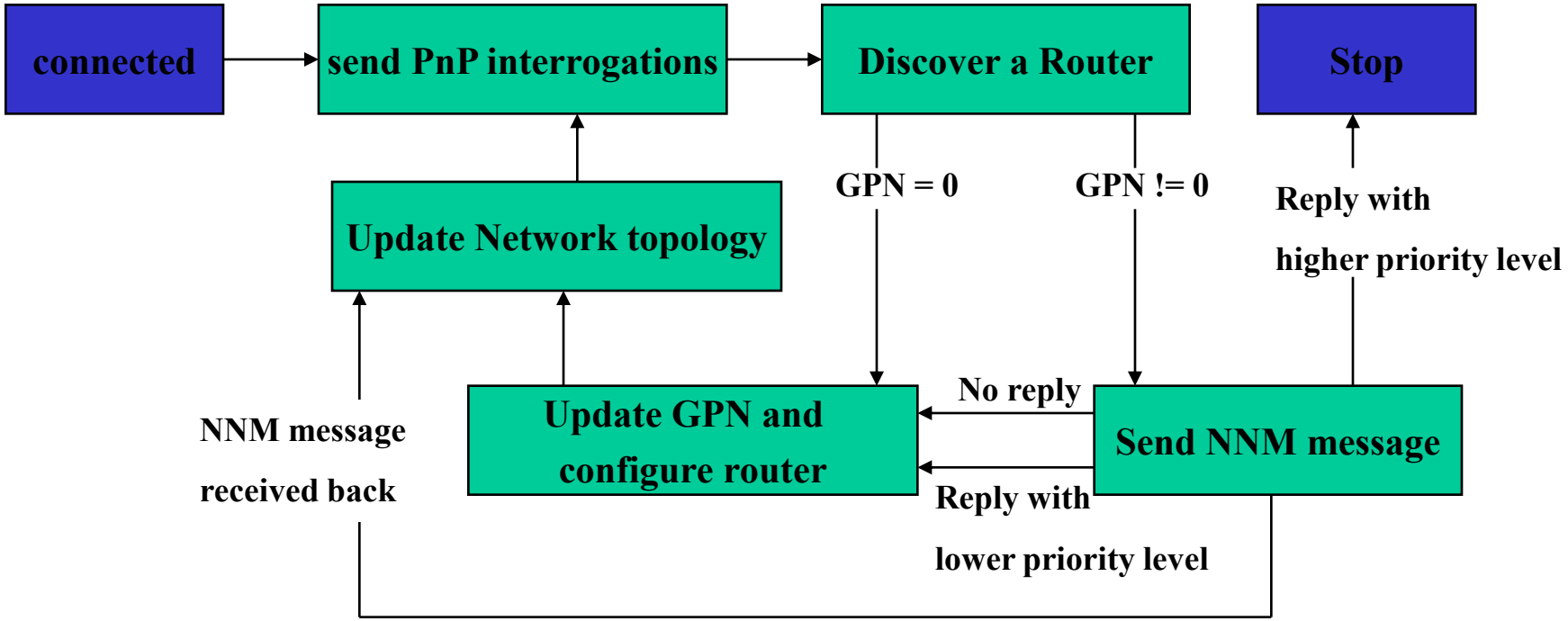


The routing table of each router is configured to route NNM interrogation packets to the NNM owner of the router. (by routing the LA of the NNM to the GPN)

Each NNM has a different priority value (random or preset). The NNM with the lowest value keeps discovering the network.

Proposed Approach (3)

Network Node Manager (NNM) flow diagram:



Conclusions

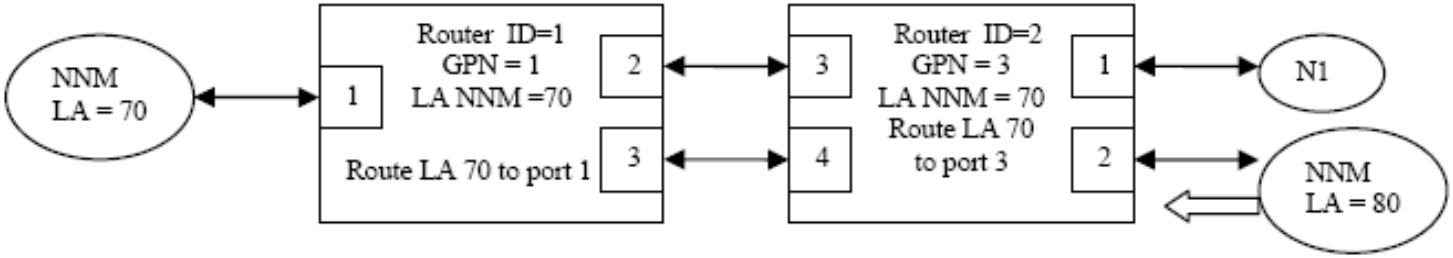
The proposed methodology for network discovery and network configuration defines:

- A Granted Port Number (GPN) register:
  - Force each router to be configured by only one device.
- A NNM Logical Address register:
  - Permits to interrogate the device that is allowed to configure each router.
- A Priority scheme:
  - Leads to a single Network Manager Node configure the Network with other devices acting as hot backups.

These definitions allows:

- Fault tolerant network management:
  - In case of failure another device can configure the network.
- Support for arbitrary networks and arbitrary link events.

Thank you for your attention!


NNM
LA = 70
1
Router ID=1
GPN = 1
LA NNM =70
Route LA 70 to port 1
2
3
3
4
Router ID=2
GPN = 3
LA NNM = 70
Route LA 70
to port 3
1
2
N1
NNM
LA = 80