HSR and PRP Redundancy on RT Linux

Part 3: Redundancy and Linux
Which Operating System on the host for HSR/PRP?

Application

Publisher/Subscriber

Transport Layer

Network Layer

Host

LRE

Ports

Create Duplicate

Duplicate Discard

Duplicate Discard

Duplicate Discard

TX A RX

TX B RX

Texas Instruments
Which Operating System on the host for HSR/PRP?
Linux is recognized with networking

• Since these applications are networking based, Linux seems like a natural choice
  – Allows scale across products and platforms
  – Reuse common networking stack, applications, tools, scripts, etc.
• Some packet deadlines may require RT Linux
• TI-RTOS solutions are also available
Linux architecture

User Space

Linux Kernel

Network Hardware
## Focus on application in User Space

<table>
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<th>User Space</th>
<th>IEC61850 Application</th>
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### Linux Kernel

### Network Hardware
Existing Linux network stack – No redundancy

User Space

Linux Kernel

Network Hardware

IEC61850
Application

eth2

Network Stack

Ethernet Driver

port0
Adding a second port for redundancy

User Space
IEC61850 Application

Linux Kernel
Network Stack

Network Hardware
Ethernet Driver

port0
port1

eth2
eth3
Need LRE to handle duplicates

User Space
- IEC61850 Application
- LRE

Linux Kernel
- Network Stack
  - eth2
  - eth3

Network Hardware
- Ethernet Driver
  - port0
  - port1

Texas INSTRUMENTS
Should we duplicate the LRE?
Move the LRE lower in the stack

User Space
- IEC61850 Application
- LRE
- IEC61850 Application

Linux Kernel
- Network Stack
  - Ethernet Driver
    - eth-slave-0
    - eth-slave-1
- slave-0
- slave-1

Network Hardware
Adding a HSR driver to implement protocols

User Space
- IEC61850 Application

Linux Kernel
- Network Stack
- HSR
- LRE
- Ethernet Driver

Network Hardware
- eth-slave-0
- eth-slave-1
- slave-0
- slave-1
Adding capability to create a HSR connection

User Space

- IEC61850 Application
- iproute2 ip command

Linux Kernel

- Network Stack
- hsr0
- Ethernet Driver
- eth-slave-0
- eth-slave-1

Network Hardware

- slave-0
- slave-1
Adding packet forward and LRE

User Space
- IEC61850 Application
- iproute2 ip command

Linux Kernel
- Network Stack
- Packet Forward
- HSR
- LRE
- Redundancy Management
- Sequence Number
- netlink socket
- Ethernet Driver
- eth-slave-0
- eth-slave-1

Network Hardware
- slave-0
- slave-1

Texas Instruments
Creating supervisory packets

User Space

- IEC61850 Application
- iproute2 ip command

Linux Kernel

- Network Stack
  - hsr0
- Packet Forward
- HSR
  - LRE
    - Redundancy Management
    - Sequence Number
- Network Supervision (announcement/check)

Network Hardware

- Ethernet Driver
  - eth-slave-0
  - eth-slave-1
- slave-0
- slave-1

Texas Instruments
Existing HSR Driver

User Space

Linux Kernel

Network Stack

HSR

Packet Forward

LRE

Redundancy Management

Sequence Number

Ethernet Driver

Network Hardware

IEC61850 Application

iproute2 ip command

netlink socket

Ethernet Driver

eth-slave-0

eth-slave-1

Network Supervision (announcement/check)

Network Hardware

slave-0

slave-1
Modifying the HSR driver

User Space
- Net-SNMP agent (snmpd)
  - IEC-62439 module
- iproute2 ip command
- netlink socket

Linux Kernel
- Network Stack
  - hsr0
- IEC-62439 MIB
- Packet Forward
  - LRE
  - Redundancy Management
  - Sequence Number
- Ethernet Driver
  - eth-slave-0
  - eth-slave-1
- slave-0
- slave-1

Network Hardware

Color code:
- Exists
- Missing
Adding PRP to the driver

User Space
- Net-SNMP agent (snmpd)
- IEC-62439 module
- iproute2 ip command

Linux Kernel
- Network Stack
  - IEC-62439 MIB
  - Packet Forward
  - Redundancy Management
  - Sequence Number
- HSR
  - eth-slave-0
  - eth-slave-1

Network Hardware
- slave-0
- slave-1

Color code
- Exists
- Missing

Network Hardware
- Ethernet Driver
  - prp0
  - netlink socket
Adding PRP to the driver

User Space
- Net-SNMP agent (snmpd)
- IEC-62439 module
- iproute2 ip command

Linux Kernel
- Net-Stack
- prp0
- Packet Forward
- IEC-62439 MIB
- Network Supervision (announcement/check)
- Redundancy Management
- LRE
- Sequence Number
- eth-slave-0
- eth-slave-1
- slave-0
- slave-1

Network Hardware

Network Supervision
- Announcement/check

Color code
- Exists
- Missing

LRE
- Sequence Number
- Redundancy Management
- Network Supervision (announcement/check)

Ethernet Driver

IEC-62439 module

Net-SNMP agent (snmpd)

iproute2 ip command

netlink socket
Minimal changes for PRP

User Space

- Net-SNMP agent (snmpd)
- IEC-62439 module

Linux Kernel

- iproute2 ip command
- netlink socket

Network Stack

- Network Supervision (announcement/check)
- Packet Forward
- Redundancy Management
- Sequence Number
- prp0

IEC-62439 MIB

HSR

Ethernet Driver

- eth-slave-0
- eth-slave-1

Network Hardware

- slave-0
- slave-1

Color code
- Exists
- Missing
Why RT Linux?

- More deterministic latency to meet requirements
Section summary

• Given the focus on networking, Linux is a good OS choice
• Redundancy requires at least two ports
• HSR implementation abstracts two ports to one HSR port implemented lower in the stack
• PRP implementation is very similar
• With either implementation, upper software layers (i.e. applications) are abstracted from details
• RT Linux provides more deterministic latencies to meet requirements
For more information

- Sitara Processors Product Overview: http://www.ti.com/sitara
- AM571x Industrial Development Kit (IDK): http://www.ti.com/tool/tmdxidk5718
- AM572x Industrial Development Kit (IDK): http://www.ti.com/tool/tmdxidk5728
- Processor SDK Software Developer Guides:
- For questions regarding topics covered in this training, visit the Sitara Processors support forum at the TI E2E Community website: https://e2e.ti.com/support/arm/sitara_arm/f/791