



OPAL-RT
TECHNOLOGIES

OPAL-RT Multi-System Expansion link

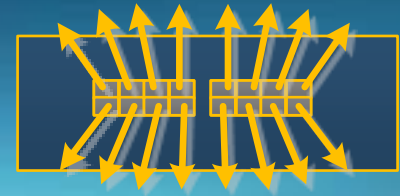
User Guide

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FROM IMAGINATION... TO REAL-TIME

What is the Multi-System Expansion Link ?



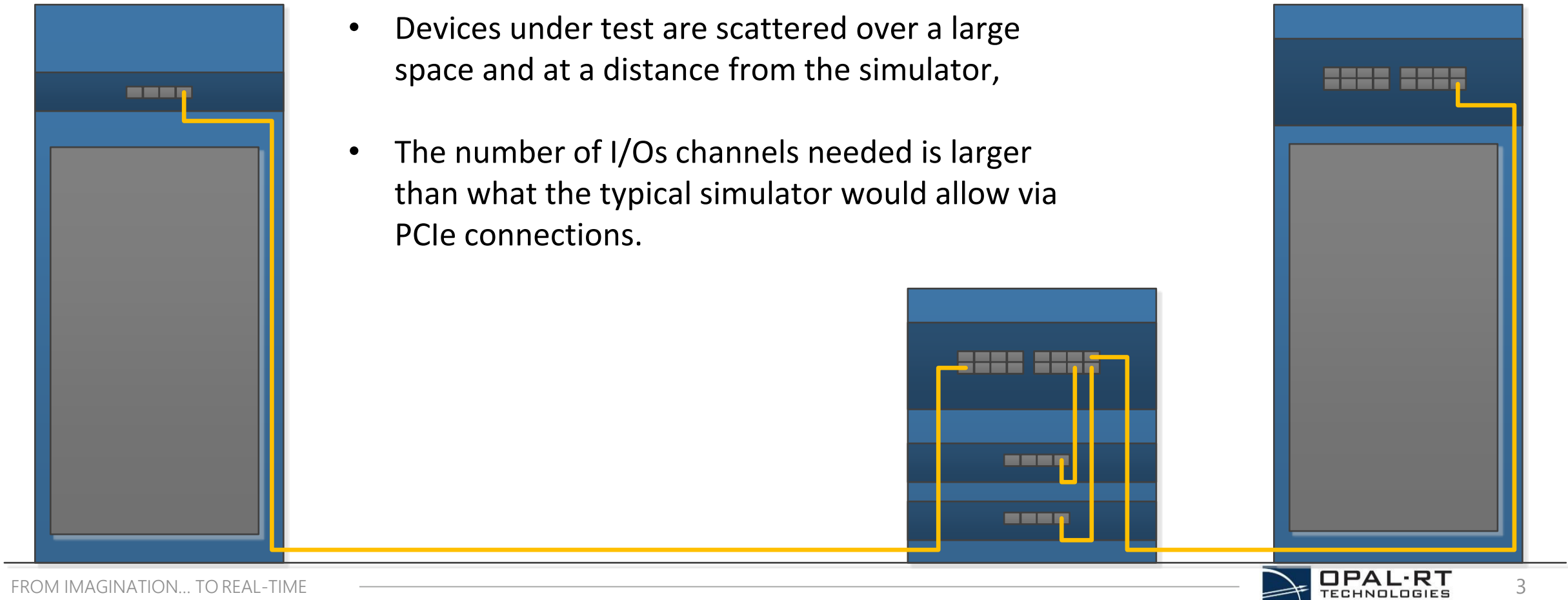
- OPAL-RT **Multi-System Expansion link** (MuSE)¹ is a fully integrated feature of OPAL-RT Software and FPGA solutions that facilitates management of a large number of I/O channels.
- The MuSE link expands the I/O capability of the real-time simulators by enabling connection of multiple FPGA-based I/O expansion boxes to the simulator.
- Based on **standard multi-mode optical fibers** and **small form-factor pluggable (SFP) 5Gbps transceivers**, this innovative feature allows you to manage **up to 4096 I/O channels** from your simulation model.

¹ This link is also referred to as High Speed Link (HSL)

Who should use the MUSE link ?

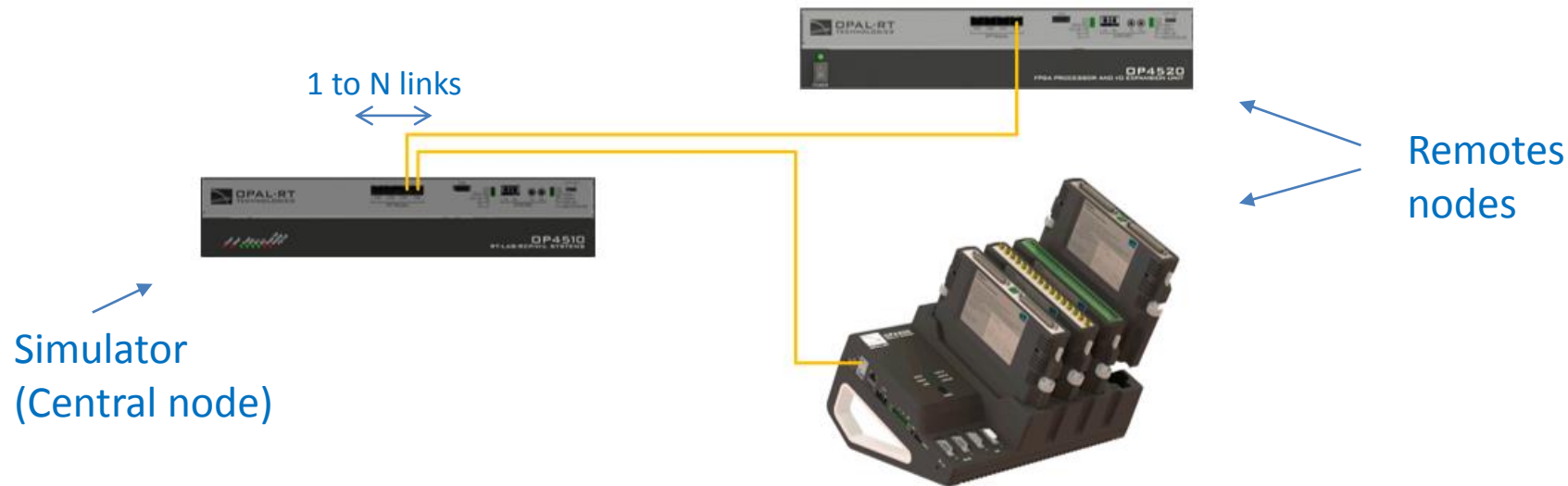
The MuSE link is the solution when:

- Devices under test are scattered over a large space and at a distance from the simulator,
- The number of I/Os channels needed is larger than what the typical simulator would allow via PCIe connections.



MuSE link architecture

- The typical topology is a star configuration with one simulator as the **central** node, connected to up to 16 **remote** boxes,
- The number of chassis is limited only by the number of available SFP sockets on the simulator



- The network of remote chassis is easily set up using the existing SFP sockets of the simulator, standard multi-mode optical fibers and small form-factor pluggable (SFP) transceivers, and does not require additional PCIe inter-connection hardware.

Hardware support

- The MuSE link is supported on most OPAL-RT platforms:

Central nodes



OP5707



OP4510

OP5607 and OP4520 can also be programmed as central nodes if connected to an OP5030 industrial target

Remote I/Os



OP4200



OP4520



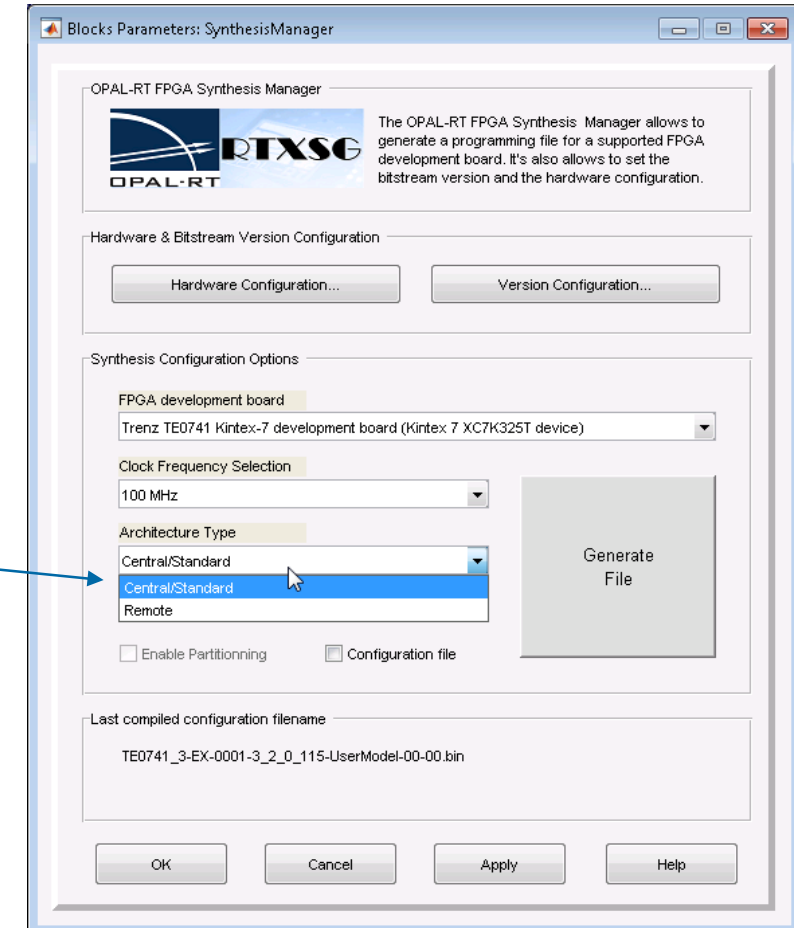
OP5607

FPGA configuration

- The configuration of the FPGA for the MuSE link does not require advanced knowledge of high-speed communication programming :

The MuSE link capability is automatically integrated into the FPGA programming file during its generation with OPAL-RT's RT-XSG tool after the User has selected the **Architecture type** (**Central** or **Remote**) option

- Existing chassis can be upgraded to support the new link simply by updating the FPGA programming file.



Software support

Configuration and management of remote I/Os is done via the RT-LAB or HYPERSIM User

RT-LAB v11.2.3.113

File Edit Navigate Search Simulation Tools Window Help

Project Explorer

- Targets
 - RTServer
 - localhost
- iosfp
 - Models
 - I/Os
 - OPAL-RT Board -> SM_Master
 - Panels
 - Configuration (Default)
 - File system
 - Create a new project...

OPAL-RT Board Configuration

Associated subsystem: OP4510_dma_loopback/SM_Master

I/O are available for connection in the Configuration panel.

Folders

- General
 - Slot 1A - Digital in
 - Channels 0 - 7
 - Channels 8 - 15
 - Channels 16 - 23
 - Channels 24 - 31
 - Slot 1B - Digital out
 - Channels 0 - 7
 - Channels 8 - 15
 - Channels 16 - 23
 - Channels 24 - 31
 - Slot 2A - Analog in
 - Channels 0 - 7
 - Channels 8 - 15
 - Slot 2B - Analog out
 - Channels 0 - 7
 - Channels 8 - 15
 - Remote Boards Configuration (2)
 - Remote_1
 - Remote_2

General

Parameter	Value
Board type	TE0741 3
Board ID	0
Use external synchronization source	<input type="checkbox"/>
Type of generated synchronization signal	Optical
Bitstream configuration file path	... OpalBitstreams\Examples\TE0741 3 central_Serie100.opal
Show advanced configuration	<input type="checkbox"/>

I/O Configuration

- Slot 1A - Digital in
- Slot 1B - Digital out
- Slot 2A - Analog in
- Slot 2B - Analog out

General / Remote Boards Configuration / Remote_1

Parameter	Value
Board type	OP4200
MAC address	
Use external synchronization source	<input checked="" type="checkbox"/>
Type of expected synchronization signal	Optical
Bitstream configuration file path	... models\OP4510_dma_loopback\MEZX5_AXR-0001-3_1_8_80-
Show advanced configuration	<input checked="" type="checkbox"/>
Time step factor	1

Progress

No operations to display at this time.

Example configuration for OP4510 Central + OP4200 Remote

Software features

- Detection and initialization of the systems connected to the central unit are handled automatically at model load time
- Remote programming of the FPGA bitstreams of the remote units is supported ¹
- Central units programmed with a MuSE-link-compatible bitstream can run legacy models using Simulink I/O blocks when the remote units are not in use.
- The real-time synchronization signal is propagated to all units. ²

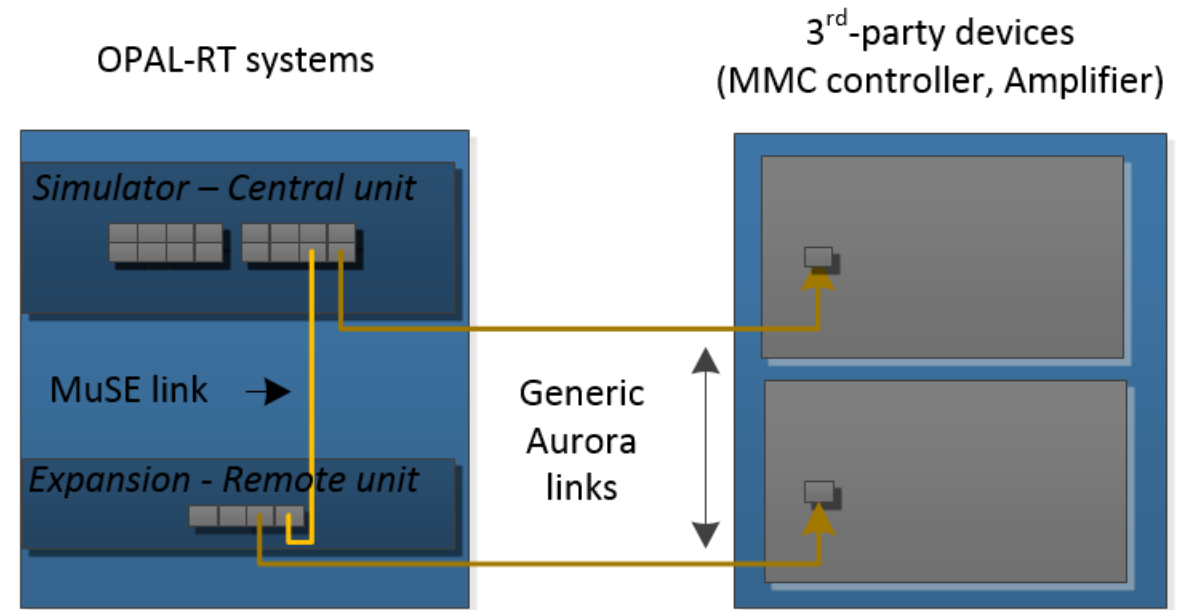
¹ Early versions of the link require JTAG programming

² Early versions of the link require the legacy daisy-chain plastic optical fiber or copper cable

Applications

RT-XSG Legacy Generic Aurora blockset and the MuSE link can coexist in the same system

- Simulators can connect simultaneously to expansion chassis via MuSE link and to 3rd-party devices via the Generic Aurora link
- Expansions chassis can connect simultaneously to a simulator via MuSE link and to 3rd-party devices via the Generic Aurora link
- Upgrading existing systems to make them compatible with the MuSE link only requires regenerating the bitstream.



Specifications

Platforms

Platform	OP4200	OP4510	OP4520	OP5607	OP5707
Physical links	2 (*)	4	4 (*)	16 (*)	16
Supported mode	Remote	Central	Remote (**)	Remote (**)	Central

(*) Only one link is used for the MuSE link in remote mode

(**) Central mode also supported if chassis is connected via PCIe to an OP5030 target

Link specifications

Communication protocol	Aurora 8b10b
Link Speed	5Gbps
SFP transceivers	Avago AFBR-57R5APZ 850nm
Optical fiber	Duplex Multi-Mode 50/125μm or 62/125μm, LC-LC
Cable length	Up to 150m, depending on fiber type



The background image shows several pieces of electronic equipment, likely test or simulation hardware. On the left, a unit is labeled 'DP4520' and 'RTIO EXPANSION UNIT'. In the center, a unit is labeled 'OPAL-RT TECHNOLOGIES'. To the right, another unit is labeled 'DP4510' and 'RTIO EXPANSION UNIT'. Various orange and yellow cables are connected to the units. The text is overlaid on this image.

**Interested in expanding your
simulator using the MuSE link?**

**Contact your sales representative
for more details.**