SpaceWire Back Plane for Ground system

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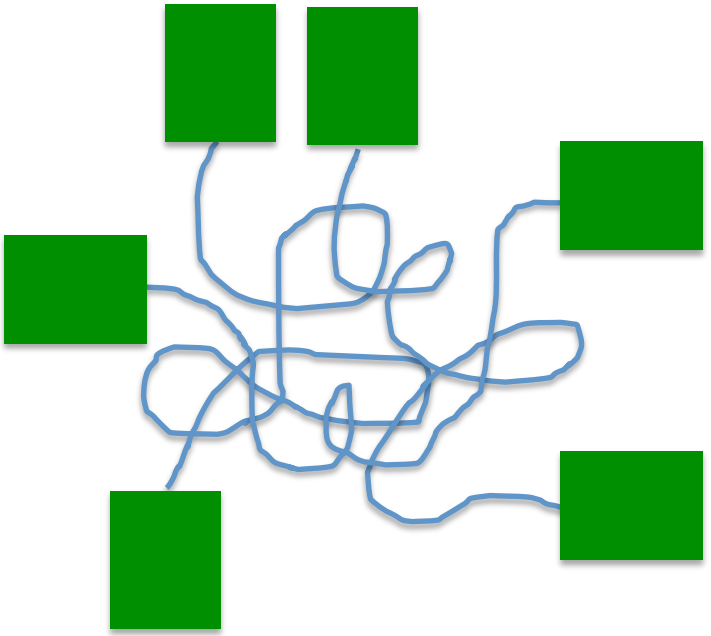
SpW backplane for GSE

- Need several modules for testing.



- Need power/grounding

SpW backplane for GSE

- Need several modules for testing.
- Rugged mechanical support.
- Good power supply and grounding.
- Good cooling.
- Commercial availability.
- 100 Ω transmission line for SpaceWire.

- µTCA system + AMC modules

PICMG® Open Modular Computing Specifications

AdvancedMC™

AMC follows past Mezzanine card standards

CMC = common mezzanine card
PMC = PCI mezzanine card
AMC = Advanced mezzanine card

PICMG (PCI Industrial Computer Manufacturers Group)

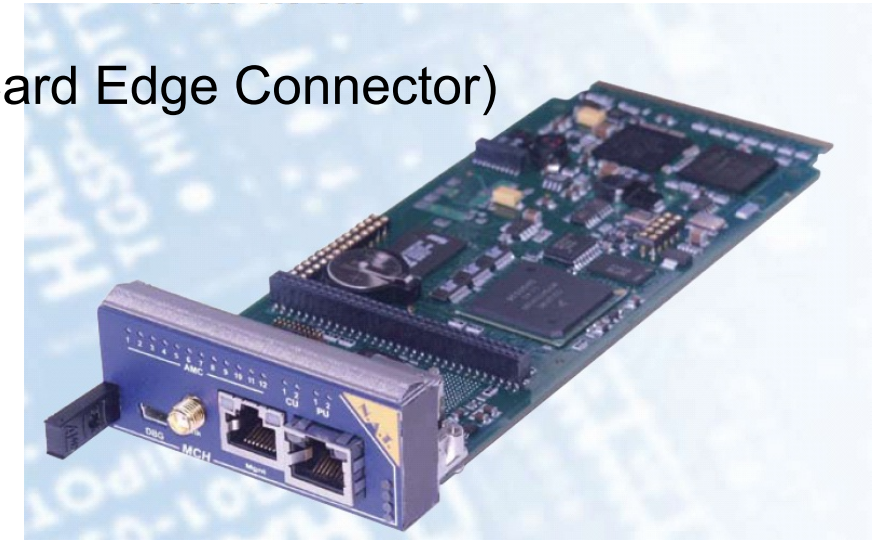
What's new

Serial data link

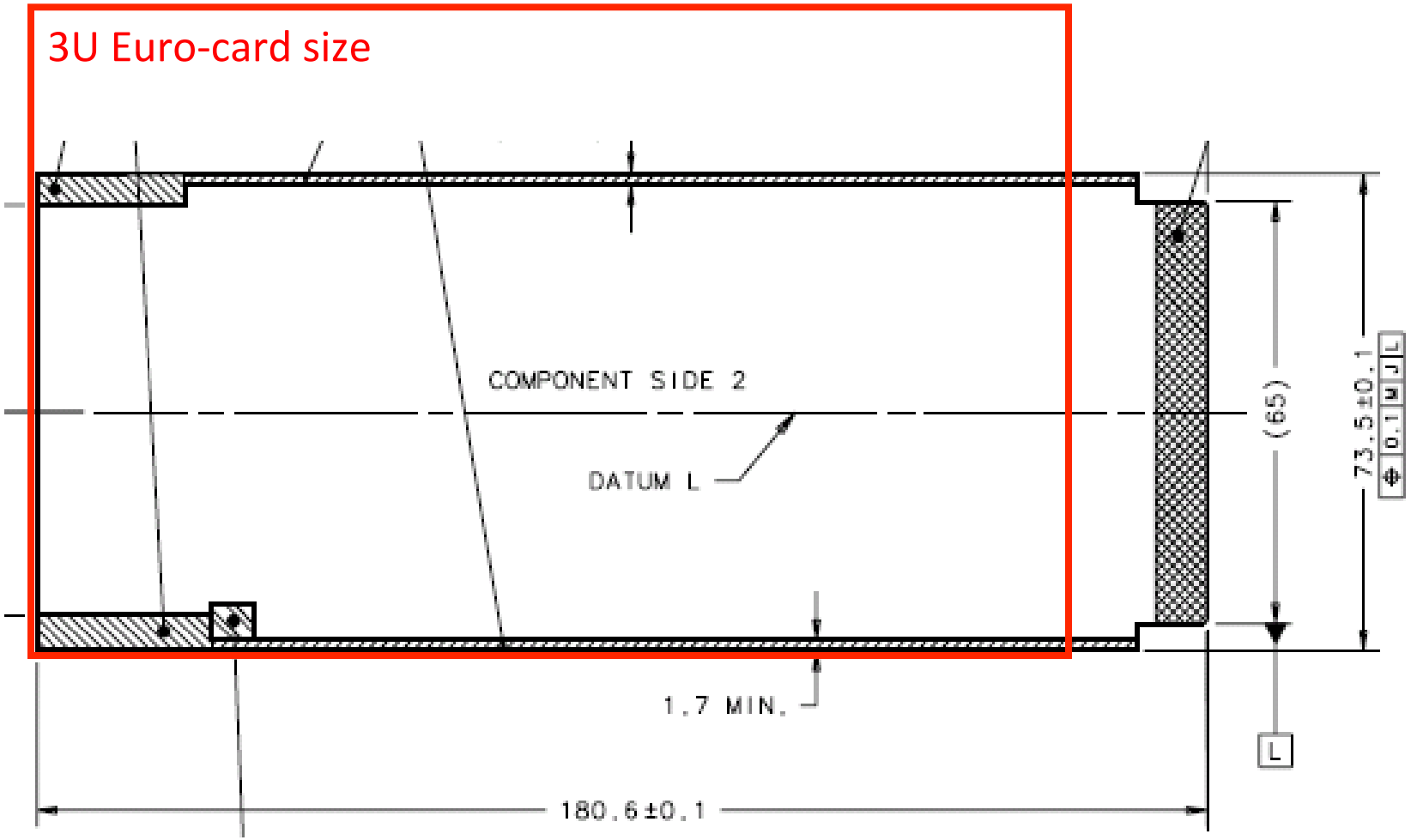
Any protocol with LVDS

Hot Swap

Insertion from the front (Card Edge Connector)



AMC board size



Double size is allowed

Table 6-1 AMC Module Card-edge Interface contact assignments

Basic Side (Component Side 1)					Extended Side (Component Side 2)				
Pin No.	Signal	Driven by	Mating	Pin Function on the AMC	Pin No.	Signal	Driven by	Mating	Pin Function on the AMC
84	PWR	Carrier	First	Payload Power	87	Rx8-	Carrier	Third	Port 8 Receiver -
83	PS0#	Carrier	Last	Presence 0	88	Rx8+		Third	Port 8 Receiver +
81	FCLKA-	FCLKA	Third	Fabric Clock A -	90	Tx8-	AMC	Third	Port 8 Transmitter -
80	FCLKA+	driver	Third	Fabric Clock A +	91	Tx8+		Third	Port 8 Transmitter +
78	TCLKB-	TCLKB	Third	Telecom Clock B -	93	Rx9-		Third	Port 9 Receiver -
77	TCLKB+	driver	Third	Telecom Clock B +	94	Rx9+	Carrier	Third	Port 9 Receiver +
75	TCLKA-	TCLKA	Third	Telecom Clock A -	96	Tx9-	AMC	Third	Port 9 Transmitter -
74	TCLKA+	driver	Third	Telecom Clock A +	97	Tx9+		Third	Port 9 Transmitter +
72	PWR	Carrier	First	Payload Power	99	Rx10-	Carrier	Third	Port 10 Receiver -
71	SDA_L	IPMI Agent	Second	IPMB-L Data	100	Rx10+		Third	Port 10 Receiver +
69	Rx7-	Carrier	Third	Port 7 Receiver -	102	Tx10-	AMC	Third	Port 10 Transmitter -
68	Rx7+	Carrier	Third	Port 7 Receiver +	103	Tx10+		Third	Port 10 Transmitter +
66	Tx7-	AMC	Third	Port 7 Transmitter -	105	Rx11-	Carrier	Third	Port 11 Receiver -
65	Tx7+		Third	Port 7 Transmitter +	106	Rx11+		Third	Port 11 Receiver +
63	Rx6-	Carrier	Third	Port 6 Receiver -	108	Tx11-	AMC	Third	Port 11 Transmitter -
62	Rx6+		Third	Port 6 Receiver +	109	Tx11+		Third	Port 11 Transmitter +
60	Tx6-	AMC	Third	Port 6 Transmitter -	111	Rx12-	Carrier	Third	Port 12 Receiver -
59	Tx6+		Third	Port 6 Transmitter +	112	Rx12+		Third	Port 12 Receiver +
57	PWR	Carrier	First	Payload Power	114	Tx12-	AMC	Third	Port 12 Transmitter -
56	SCL_L	IPMI Agent	Second	IPMB-L Clock	115	Tx12+		Third	Port 12 Transmitter +
54	Rx5-	Carrier	Third	Port 5 Receiver -	117	Rx13-	Carrier	Third	Port 13 Receiver -
53	Rx5+		Third	Port 5 Receiver +	118	Rx13+		Third	Port 13 Receiver +
51	Tx5-	AMC	Third	Port 5 Transmitter -	120	Tx13-	AMC	Third	Port 13 Transmitter -
50	Tx5+		Third	Port 5 Transmitter +	121	Tx13+		Third	Port 13 Transmitter +
48	Rx4-	Carrier	Third	Port 4 Receiver -	123	Rx14-	Carrier	Third	Port 14 Receiver -
47	Rx4+		Third	Port 4 Receiver +	124	Rx14+		Third	Port 14 Receiver +
45	Tx4-	AMC	Third	Port 4 Transmitter -	126	Tx14-	AMC	Third	Port 14 Transmitter -
44	Tx4+		Third	Port 4 Transmitter +	127	Tx14+		Third	Port 14 Transmitter +
42	PWR	Carrier	First	Payload Power	129	Rx15-	Carrier	Third	Port 15 Receiver -
41	ENABLE#	Carrier	Second	AMC Enable	130	Rx15+		Third	Port 15 Receiver +
39	Rx3-	Carrier	Third	Port 3 Receiver -	132	Tx15-	AMC	Third	Port 15 Transmitter -
38	Rx3+		Third	Port 3 Receiver +	133	Tx15+		Third	Port 15 Transmitter +
36	Tx3-	AMC	Third	Port 3 Transmitter -	135	TCLKC-	TCLKC	Third	Telecom Clock C -
35	Tx3+		Third	Port 3 Transmitter +	136	TCLKC+	Driver	Third	Telecom Clock C +
33	Rx2-	Carrier	Third	Port 2 Receiver -	138	TCLKD-	TCLKD	Third	Telecom Clock D -
32	Rx2+		Third	Port 2 Receiver +	139	TCLKD+	Driver	Third	Telecom Clock D +
30	Tx2-	AMC	Third	Port 2 Transmitter -	141	Rx17-	Carrier	Third	Port 17 Receiver -
29	Tx2+		Third	Port 2 Transmitter +	142	Rx17+		Third	Port 17 Receiver +
27	PWR	Carrier	First	Payload Power	144	Tx17-	AMC	Third	Port 17 Transmitter -
26	GA2	Carrier	Second	Geographic Addr. 2	145	Tx17+		Third	Port 17 Transmitter +
24	Rx1-	Carrier	Third	Port 1 Receiver -	147	Rx18-	Carrier	Third	Port 18 Receiver -
23	Rx1+		Third	Port 1 Receiver +	148	Rx18+		Third	Port 18 Receiver +
21	Tx1-	AMC	Third	Port 1 Transmitter -	150	Tx18-	AMC	Third	Port 18 Transmitter -
20	Tx1+		Third	Port 1 Transmitter +	151	Tx18+		Third	Port 18 Transmitter +
18	PWR	Carrier	First	Payload Power	153	Rx19-	Carrier	Third	Port 19 Receiver -
17	GA1	Carrier	Second	Geographic Addr. 1	154	Rx19+		Third	Port 19 Receiver +
15	Rx0-	Carrier	Third	Port 0 Receiver -	156	Tx19-	AMC	Third	Port 19 Transmitter -
14	Rx0+		Third	Port 0 Receiver +	157	Tx19+		Third	Port 19 Transmitter +
12	Tx0-	AMC	Third	Port 0 Transmitter -	159	Rx20-	Carrier	Third	Port 20 Receiver -
11	Tx0+		Third	Port 0 Transmitter +	160	Rx20+		Third	Port 20 Receiver +
9	PWR	Carrier	First	Payload Power	162	Tx20-	AMC	Third	Port 20 Transmitter -
8	RSRVD8		Second	Reserved, not connected	163	Tx20+		Third	Port 20 Transmitter +
6	RSRVD6		Second	Reserved, not connected	165	TCK	Carrier	Second	JTAG Test Clock Input
5	GA0	Carrier	Second	Geographic Addr. 0	166	TMS	Carrier	Second	JTAG Test Mode Select In
4	MP	Carrier	First	Management Power	167	TRST#	Carrier	Second	JTAG Test Reset Input
3	PS1#	AMC	Last	Presence 1	168	TDO	AMC	Second	JTAG Test Data Output
2	PWR	Carrier	First	Payload Power	169	TDI	Carrier	Second	JTAG Test Data Input

Legend to the colors used in the signal mapping tables

PWR	12V Payload Power		Fabric Interface differential signal
MP	3.3V Managemnent Power		Clock Interface differential signal

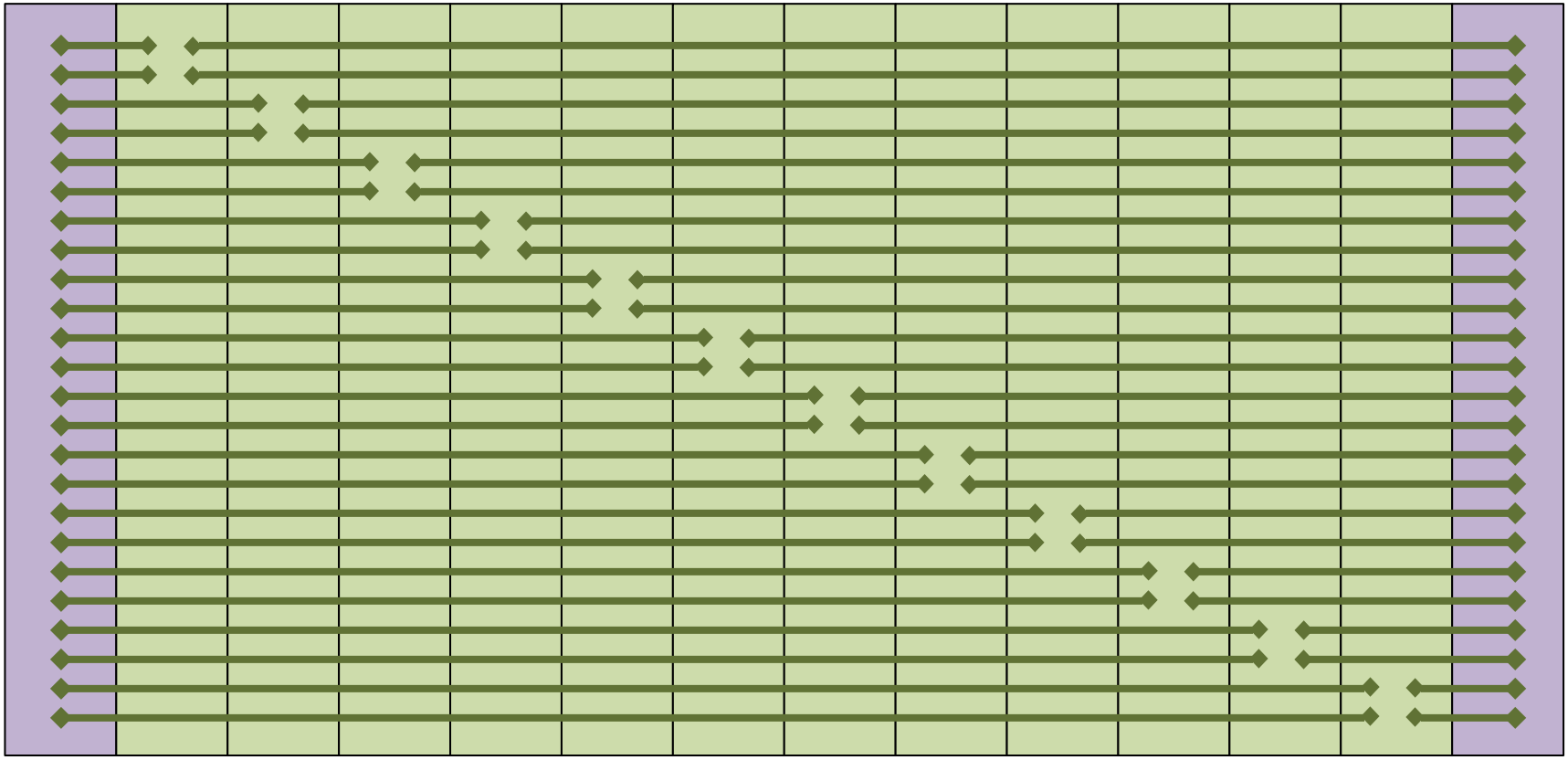
Figure 6-13 AdvancedMC region mapping

Connector Region		AMC Port #	Signal Conventions	Non-redundant MCH Fabric #	Redundant MCH # / Fabric #
Basic Side	Common Options	0	AMC.2 1000BASE-BX	A	1 / A
		1	AMC.2 1000BASE-BX		2 / A
		2	AMC.3 SATA/SAS	B	1 / B
		3	AMC.3 SATA/SAS	C	2 / B
	Fat Pipe	4	SpaceWire	D	1 / D
		5		E	1 / E
		6	SpaceWire	F	1 / F
		7		G	1 / G
Extended Side	Extended Fat Pipe	8	SpaceWire		2 / D
		9			2 / E
		10	SpaceWire		2 / F
		11			2 / G
	Extended Options	12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
		20			

One port = Tx＋Rx,
One SpW = two ports. Even port =“D”,Odd port = “S”
Max 4 SpaceWire in one AMC module

Backplane connection

Extended FAT pipe (port 8~11 == MCH2 DE(1~12),FG(1~12))



FAT pipe (port 4~7 == MCH1 DE(1~12),FG(1~12))

MCH =
SpaceWire router.

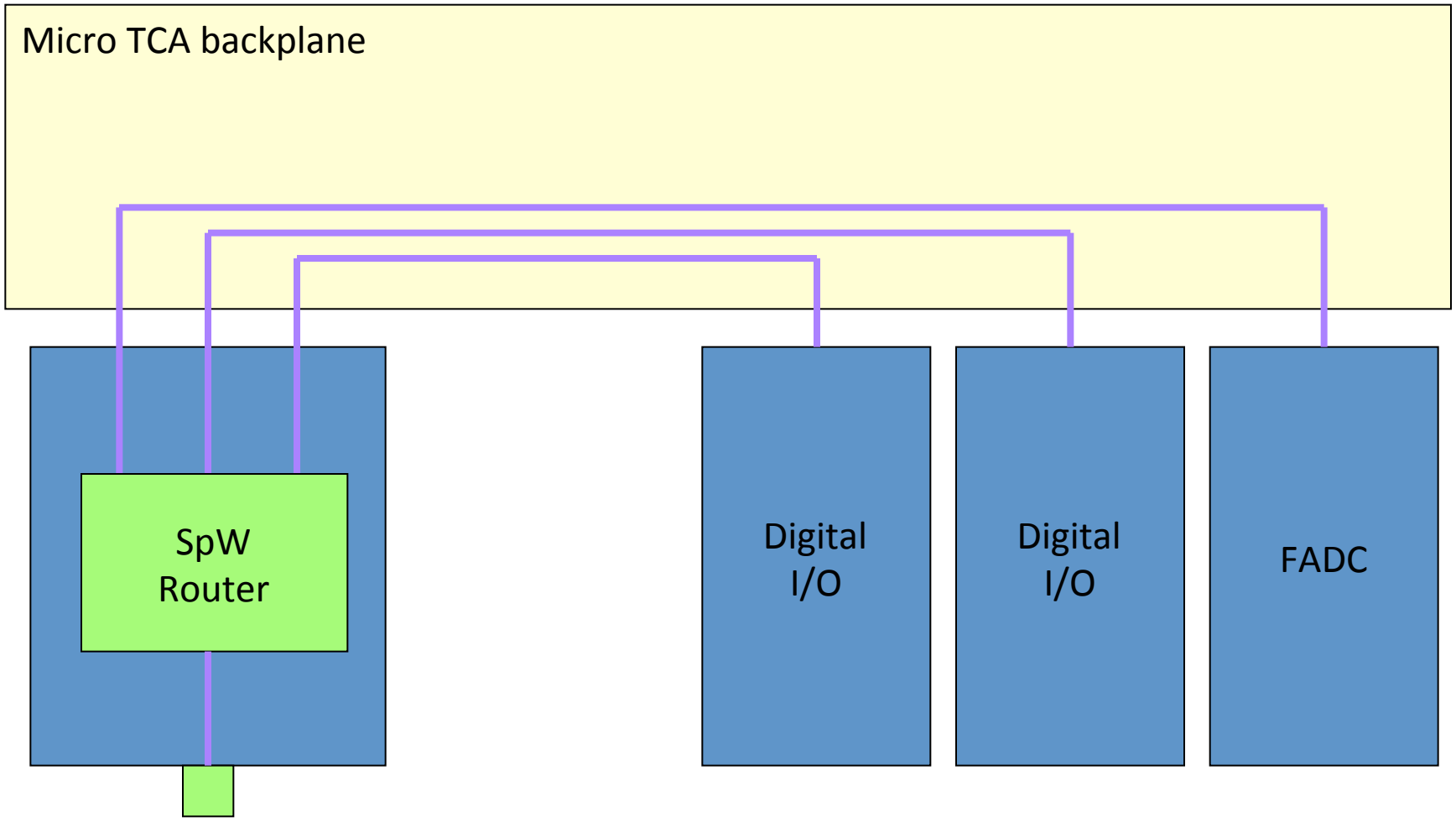
Up to 12 module
4 SpaceWire / module

MCH =
SpaceWire router.

Full slot (12 slot) µTCA

- Front slots conform to MicroTCA specification PICMG MicroTCA.0 R1.0
  - 2 x MCH slots Single/Double Full-size
  - 12 x AMC slots Single/Double Mid-size
  - 4 x PM slots Single/Double Full size
- Rear slots according to PICMG Physics WG1 (MTCA.4)
  - 12 x RTM slots Double Mid-size
- Two redundant hot-swap fan trays with EMMC for AMC and uRTM cooling in push-pull configuration.
- Air Flow: bottom front air intake, top rear air exhaust
- Chassis dimensions:
  - Width: 19” Rack mount
  - Height: 9U
  - Depth: 373.30 mm

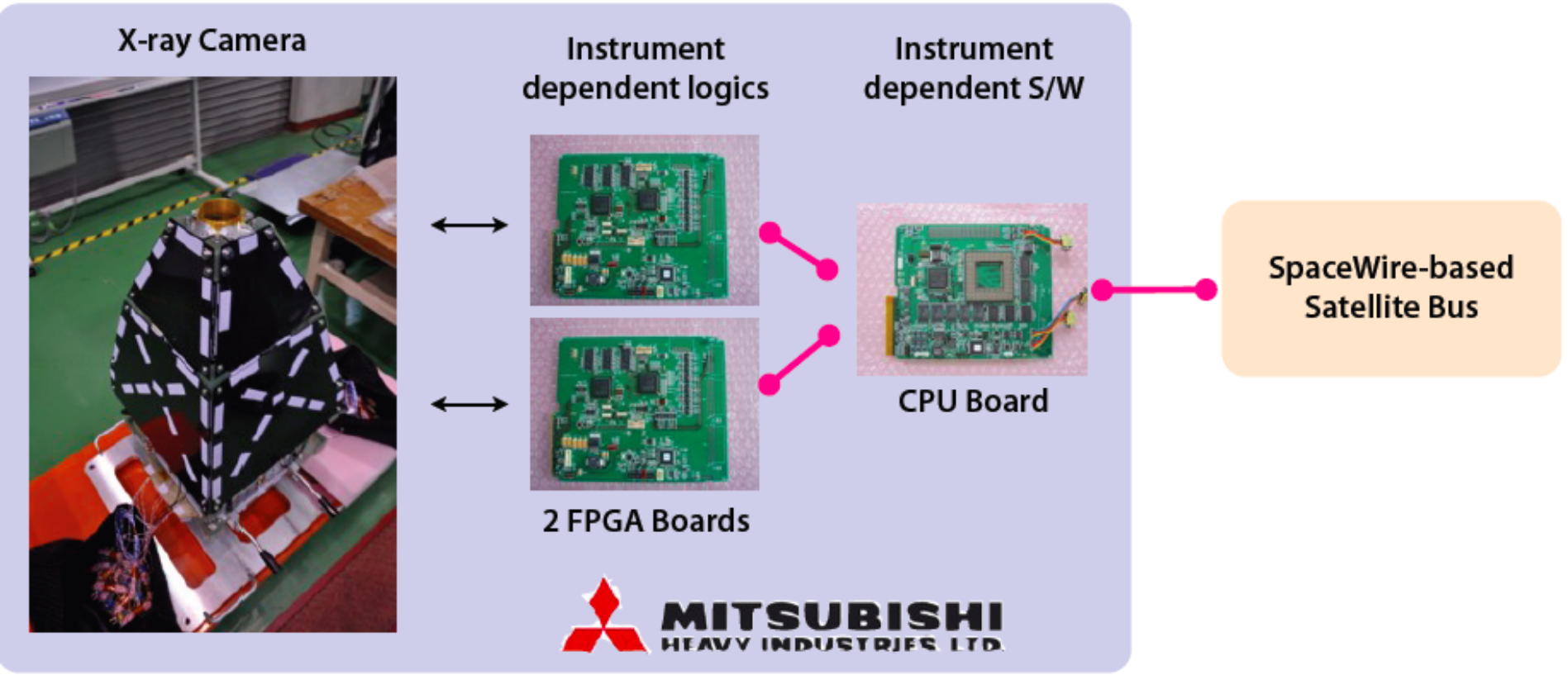
Example



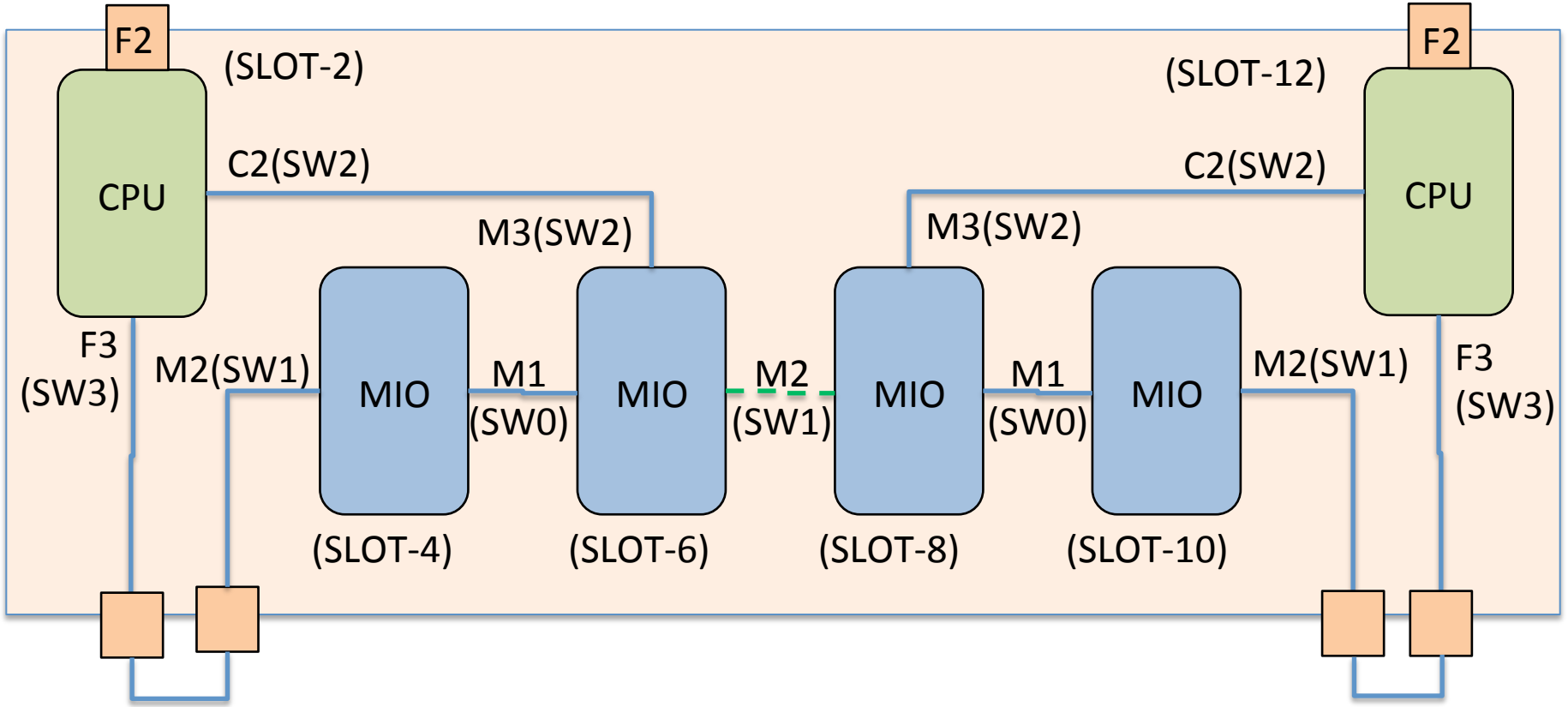
MCH
Router module

Mission instrument development using SpW

- For reducing the cost and the complexity, 4 types of X-ray telescopes are developed using the same standardized computer board and FPGA signal processing board developed by MHI.
- Instrument dependent hardware logics and software are implemented on the CPU and the FPGA boards.
- # of CPUs and # of FPGAs can be tailored based on requirements.



SGD @ full slot µTCA

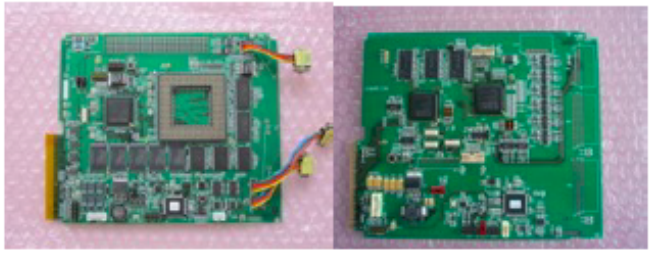


Passive Router module (Cable dispatcher module) is provided

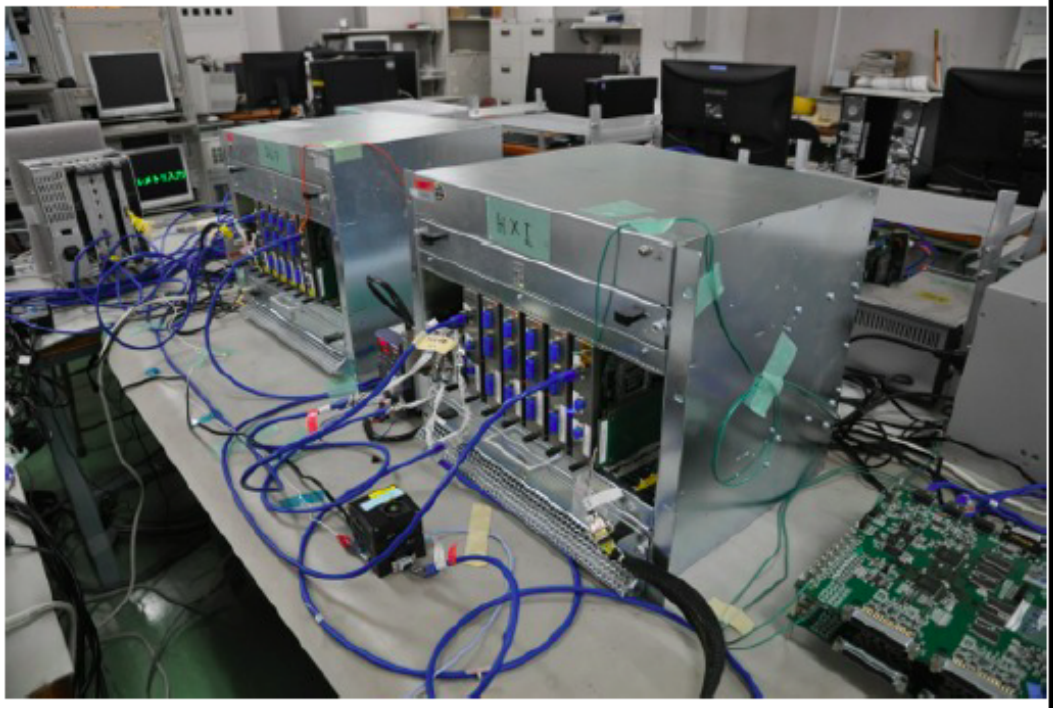
SpaceWire network test (Jun-Jul & Oct-Nov, 2011)

- Bus and Mission components joined.
- uTCA SpaceWire backplane system was used in mission instruments.
- Network design was tested: command distribution and telemetry collection under the time-slicing. No unexpected congestion.
- Malfunctioning node was connected to cause artificial congestion.
  → Watch-dog timers of routers prevented the whole network from completely blocked.

CPU Board FPGA Board



uTCA SpW Backplane for ground use



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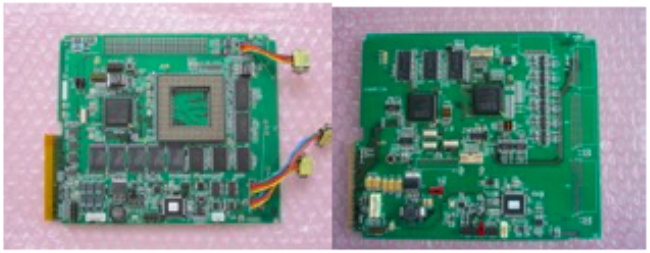
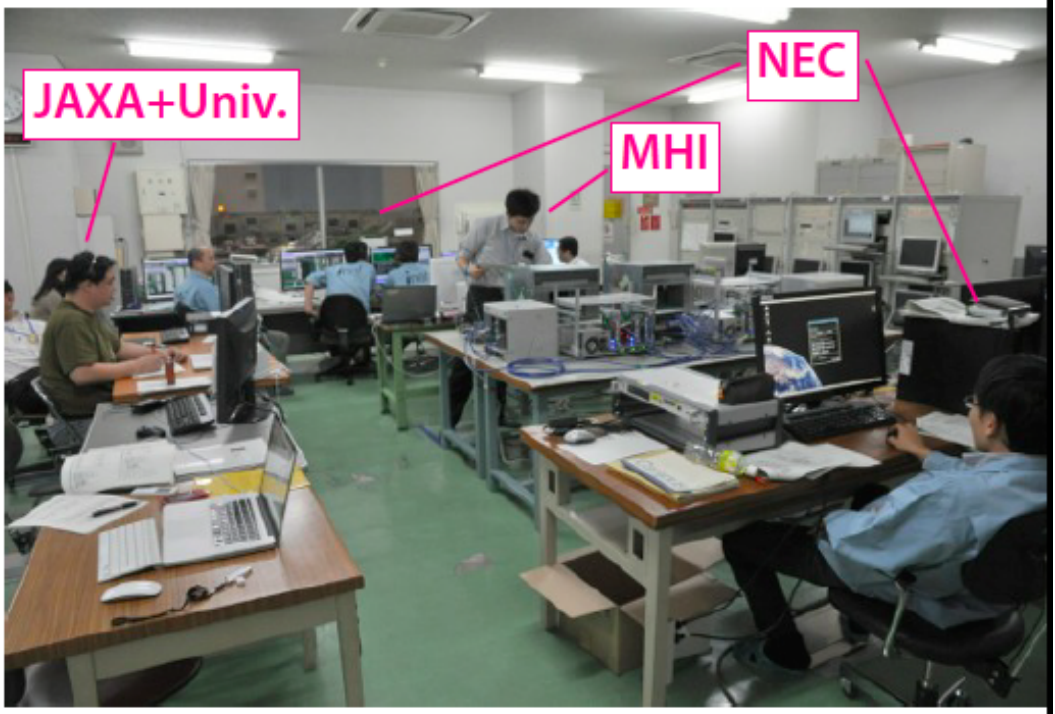
CPU Board

FPGA Board



uTCA SpW Backplane for ground use

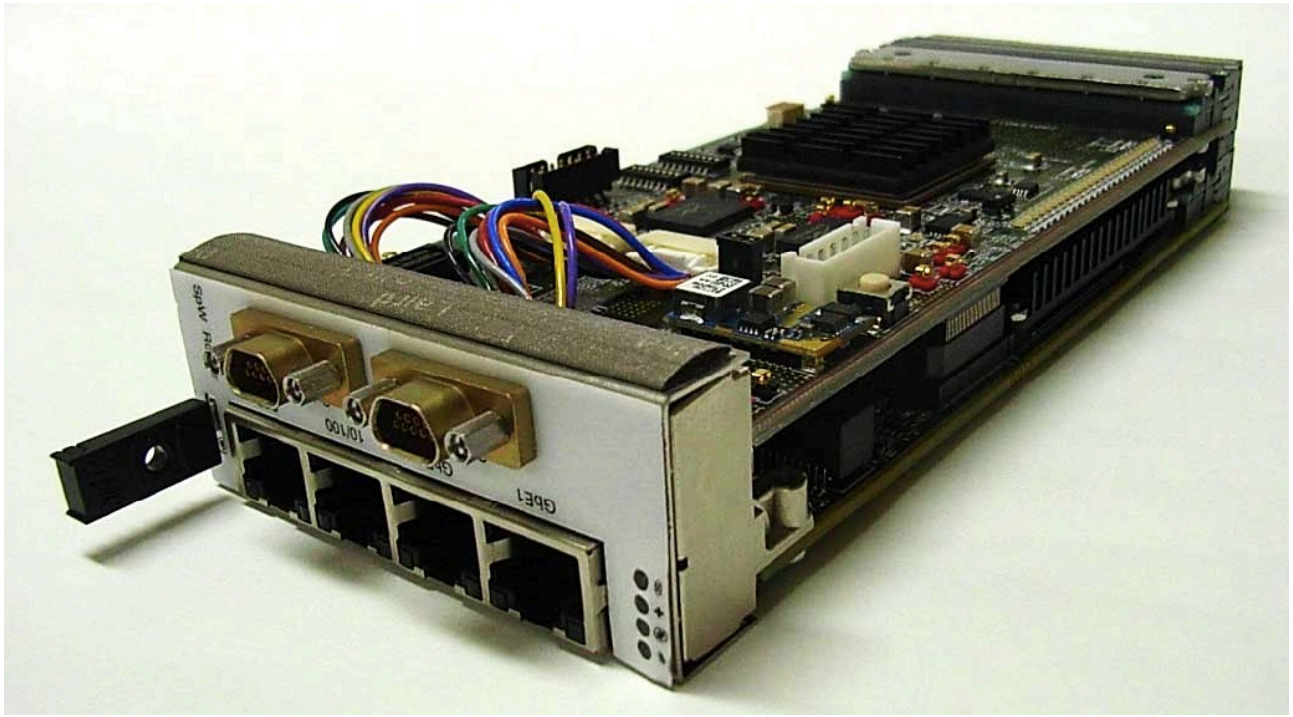


SpaceWire MCH

(Micro-TCA Carrier Hub)

SHIMAFUJI

- 26 SpaceWire connections (24 to back plane, 2 to external ports)
- max 200 Mbps on Xilinx FPGA

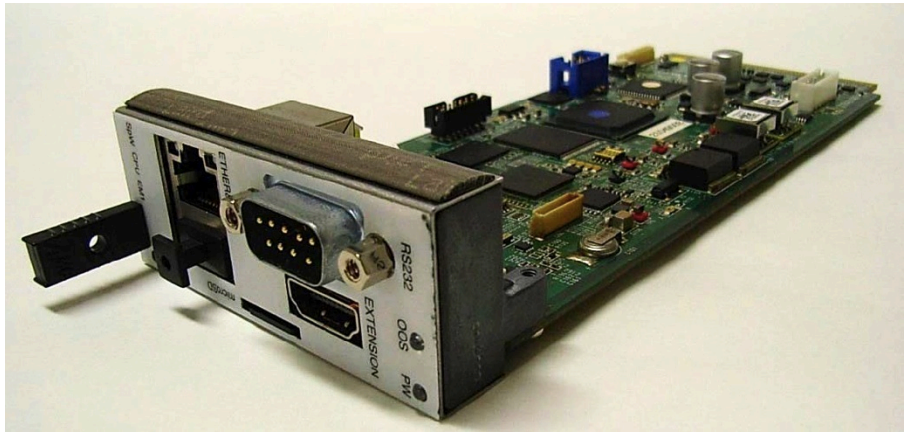


SHIMAFUJI

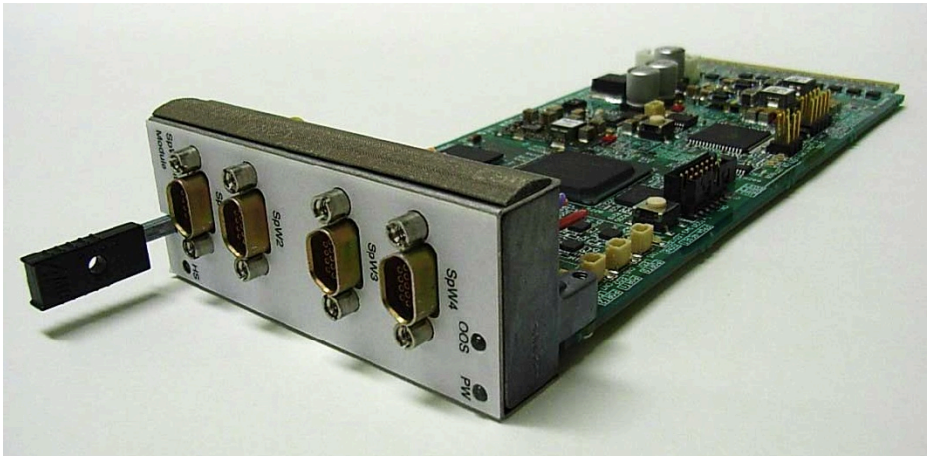
JAXA

USEF

SpaceWire-to-GigabitEther



CPU with SpaceWire interface



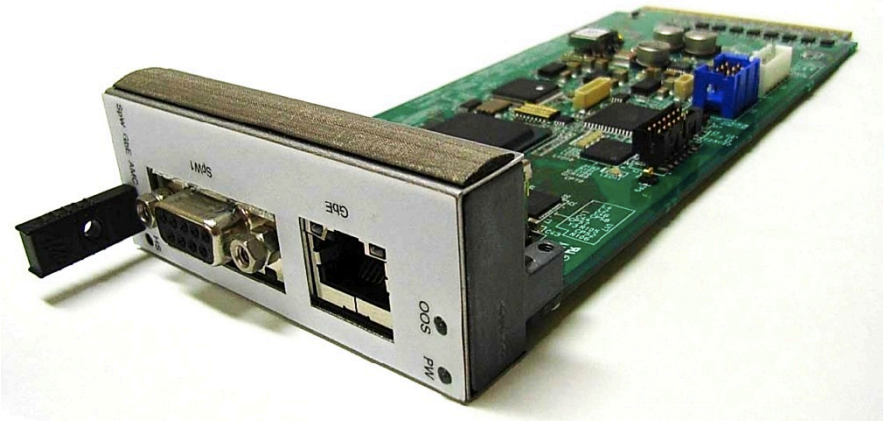
SpaceWire interface

SpaceWire traffic generator

SpaceWire-to-GigabitEther (JAXA/Shimafuji/USEF)

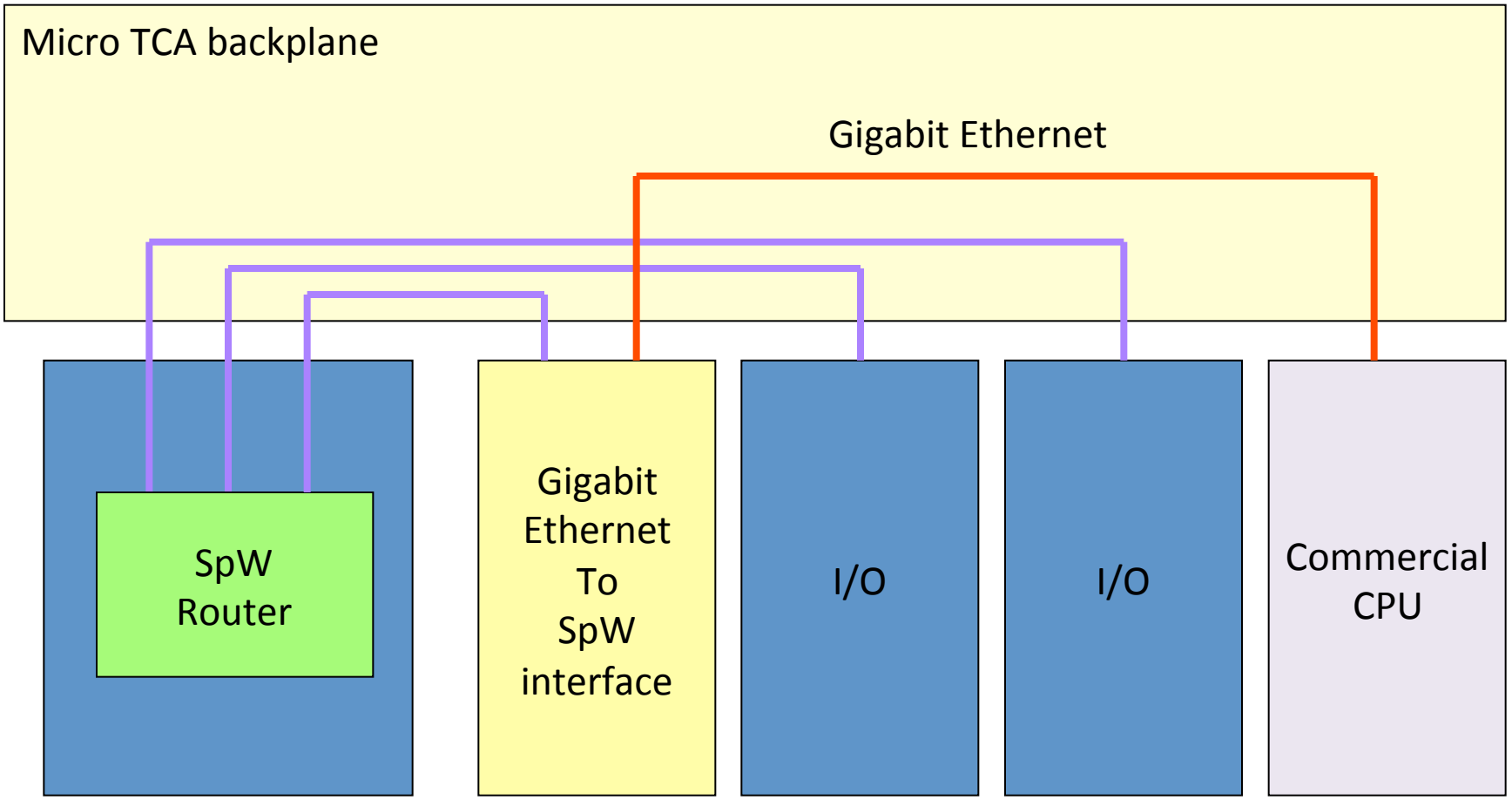
- Used in mission instrument developments for rapid tests.
  More than 10 institutes and companies have been using this.
- TCP/IP implementation in hardware logic (high throughput).
- Internal router.
- SpaceWire IP by Japan SpaceWire User Group.
- Open-source version and product version are both available.
- The open-source C++ SpaceWire/RMAP Library as API.

SHIMAFUJI

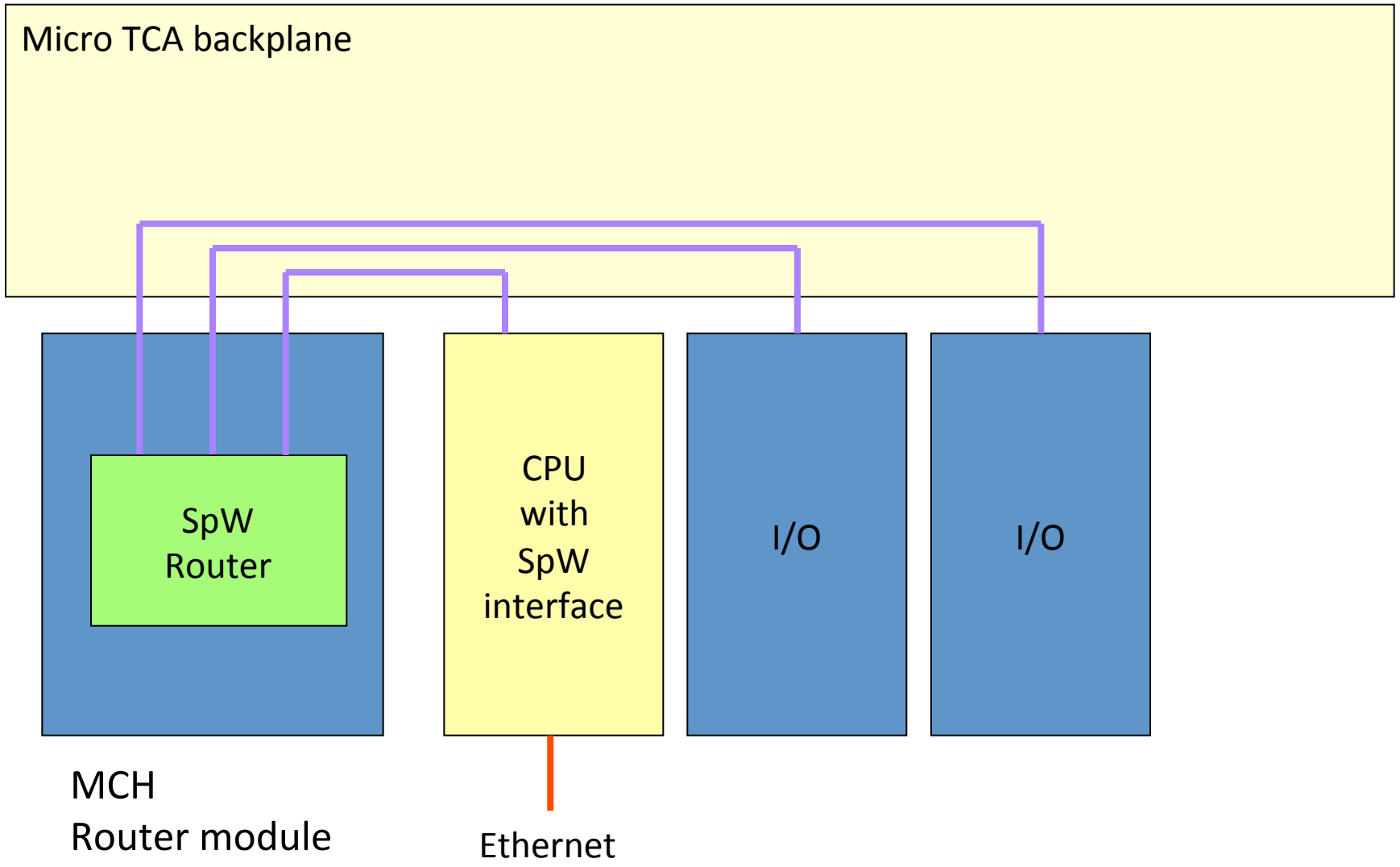


< 3K Euro + shipping

*MDM 4port version is also available.



MCH
Router module


Micro TCA backplane
SpW
Router
CPU
with
SpW
interface
I/O
I/O
MCH
Router module
Ethernet

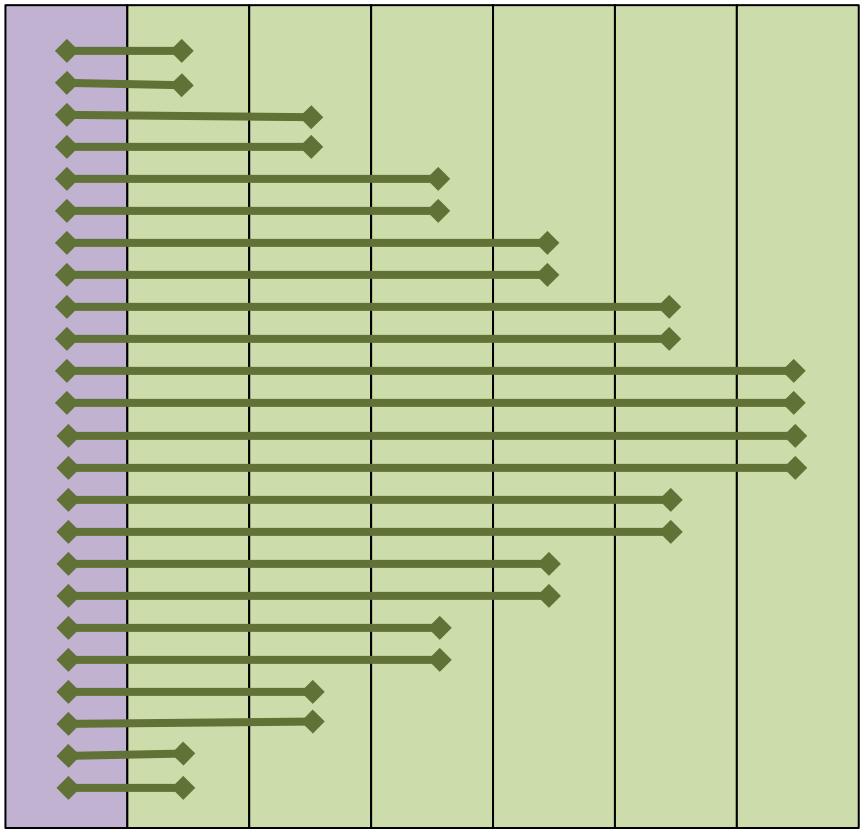
Traffic generator system

- Stress test for SpaceWire Router
- CPU with 4 SpaceWire connections on the back plane
- Gigabit Ethernet to 4 SpaceWire connections on the back plane
- Programmable traffic generator/receiver for the test

SHIMAFUJI

- Not only for the test system but Emulator system

Modified Backplane connection



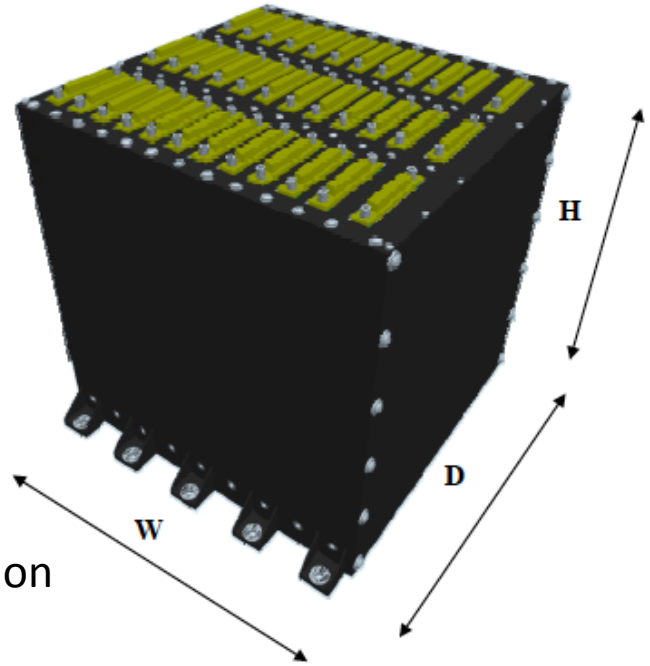
FAT pipe
(port 4~7 == MCH1 DE(1~6),FG(1~6)

Extended FAT pipe
(port 8~11 == MCH1 DE(12~8),FG(12~8)

MCH =
SpaceWire router.

Up to 6 module
4 SpaceWire / module

Into Space

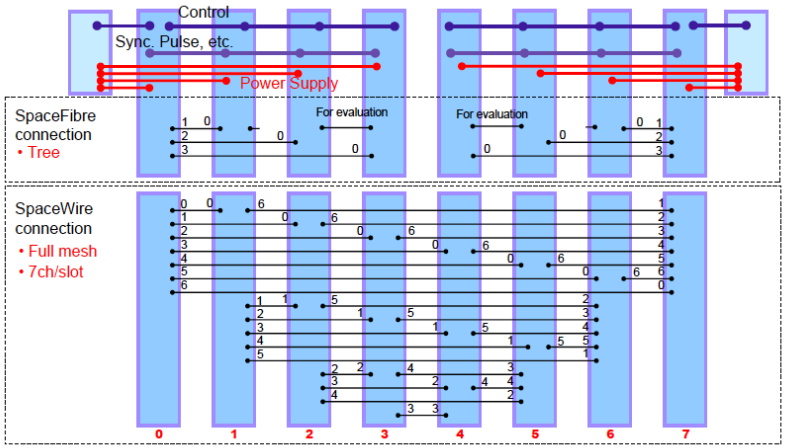


Adapter module
Allows seamless transition

Prototype module

+ COTS module
(Commercial Off The Shelf Module)

•Size: 290 x 253 x 264 [mm]



Summary

- μ TCA system provides rugged and reliable system for housing several SpaceWire modules.
- It also provide good POWER/GROUNDING.
- Sub-Rack system with power supply/cooling is commercially available.