



Scientific-Research Institute for System Analysis
Russian Academy of Science

32-bit microprocessor with SpaceWire routing switch for space applications

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Outline

- introduction of SRISA RAS
- current space products
- description of the 32-bit uP with SW router
- conclusions

SRISA RAS in facts

- Was founded in 1986
- More than 700 scientists
- Located in Moscow
- www.niisi.ras.ru



SRISA main fields of research

- theoretical problems of the programming automation and data security
- HPC theoretical base
- system software: the RTOS, compilers, debuggers, ...
- microelectronics
 - R&D of high performance chips for HPC (uP, DSP, RapidIO switch, ...)
 - R&D of rad-tolerant and fault-tolerant CPUs and interface circuits for space applications

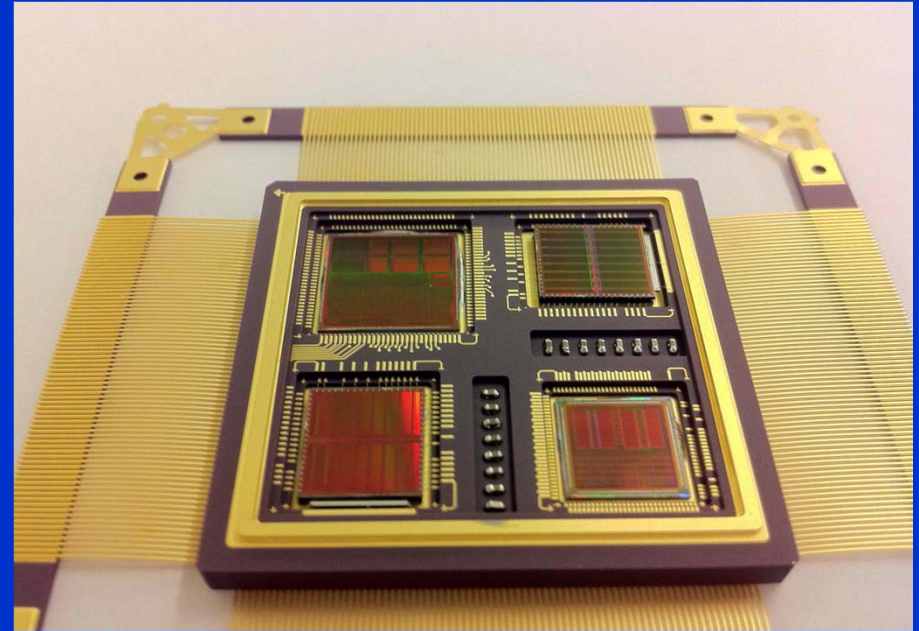
SRISA's Research Fab

- Up to 0.25 μm , 5 LM
- CMOS, CMOS SOI
- No volume production
- Located in Moscow



space products: MCM BT83_micro

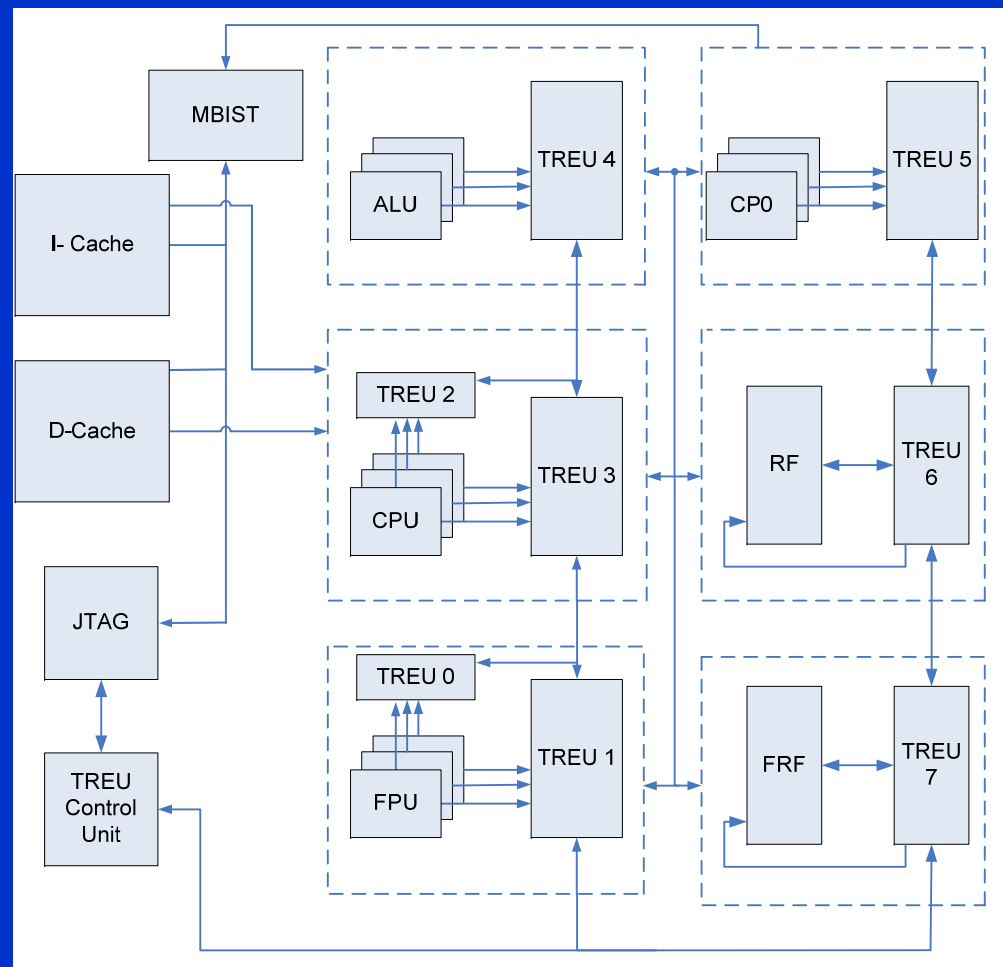
- 32-bit microprocessor
- 2xMIL1553B
- 4x128KByte SRAM
- PCI, RS232, GPIO, ...
- 0.5 μm CMOS SOI
- 33 MHz
- TID >200krad
- SEL immune



space products: K32-TMR

- 32-bit FT-microprocessor
- 0.35 um CMOS SOI
- 66 MHz
- on-chip TMR
- TID >200krad
- SEL immune
- SEU*, cm²/bit <2*10⁻¹²
- SEFI, cm²/chip <5*10⁻⁷

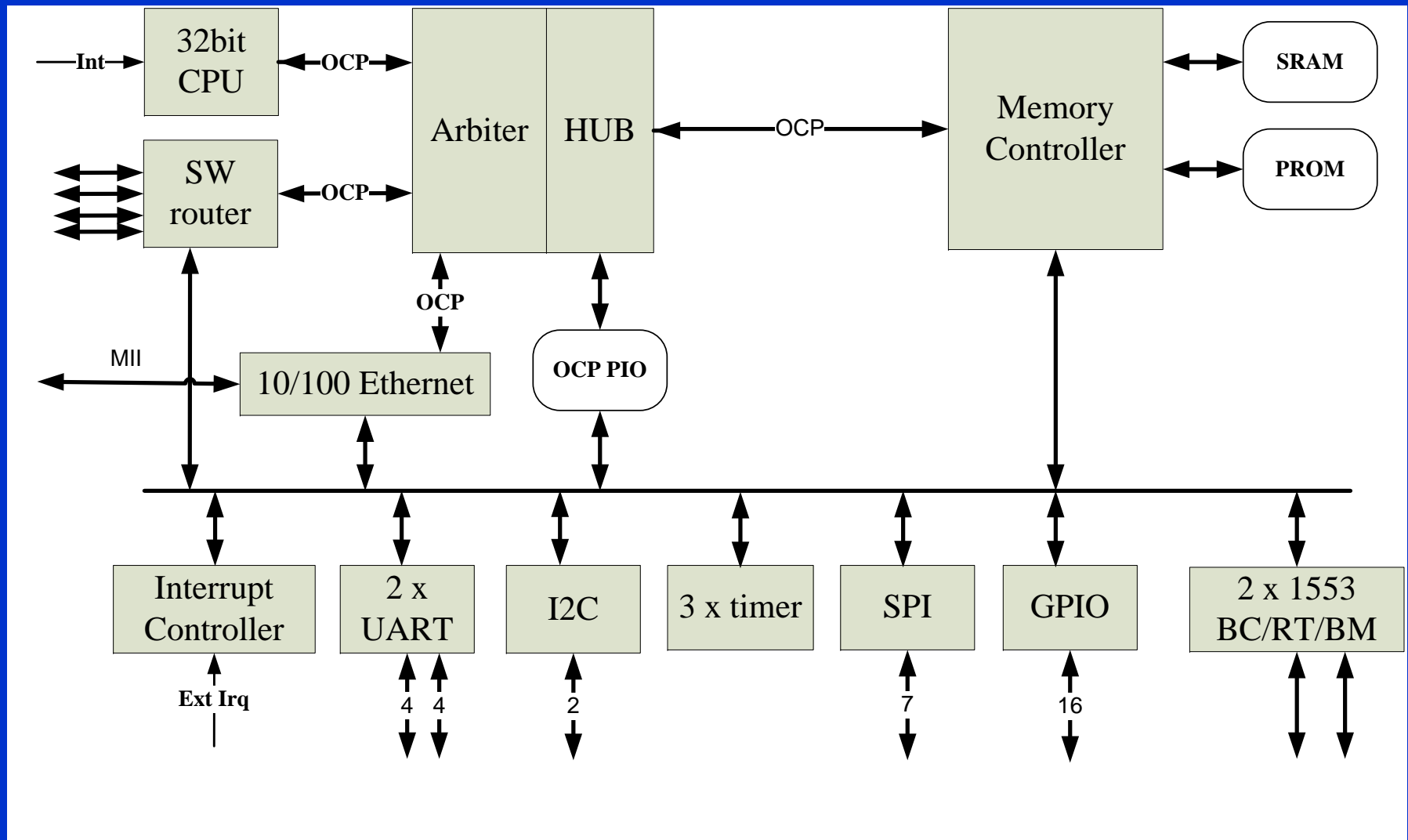
* - parity check disable



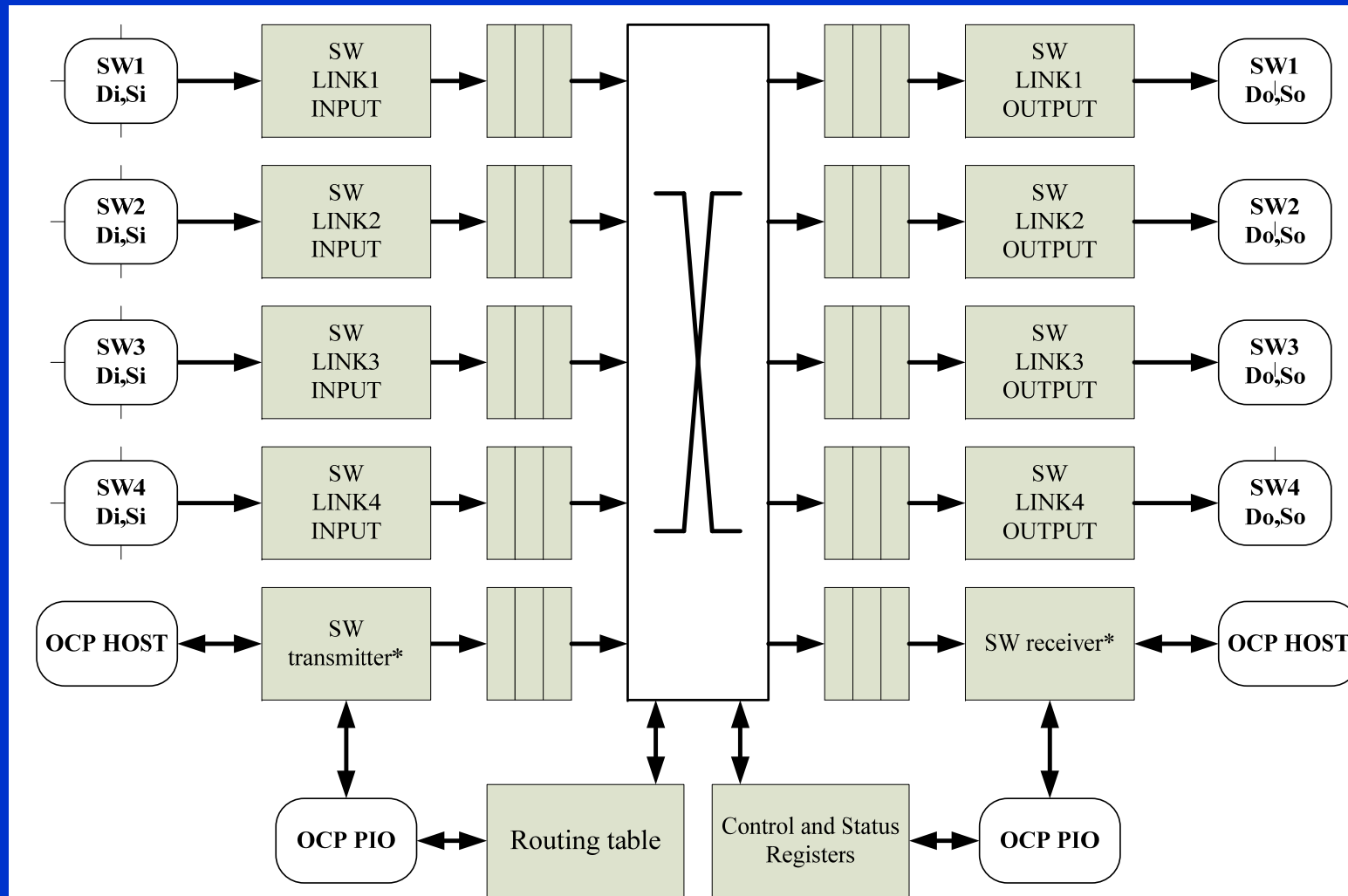
Current Space Applications

- SUBMICRON have developed computers for Russian space ships (SOUZ-TMA and PROGRESS) and satellites (RESURS-P) on the base of SRISA's chips.
- Several new on-board computers are being developed.

32-bit uP 'ORBITA' block diagram



5-port SW routing switch



*** with RMAP support**

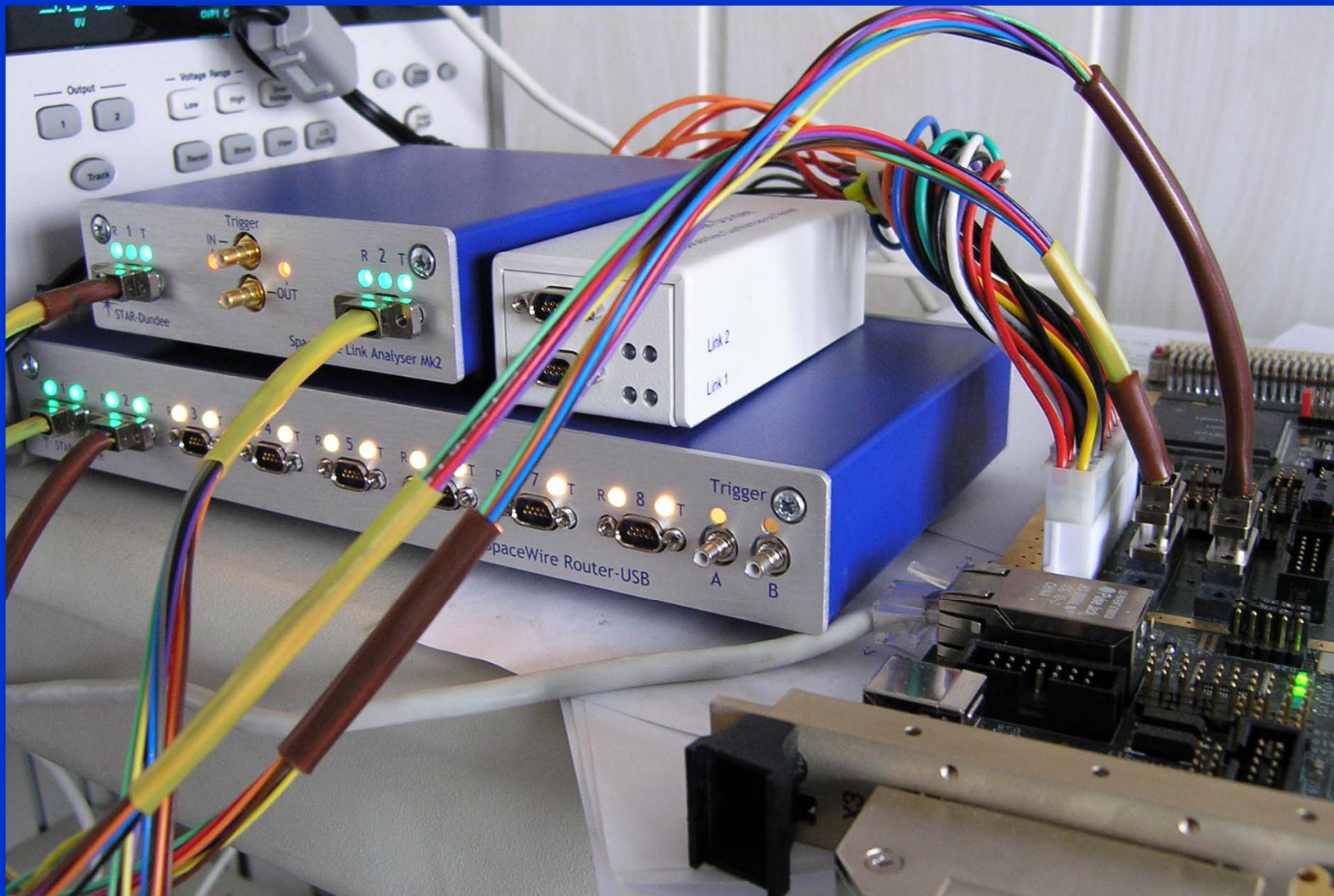
ORBITA main features

- >100 MHz MIPS32-like microprocessor
- 0.25 um CMOS SOI
- TID >200krad
- SEL immune
- Full set of software: OS2000 RTOS, gcc compiler, ...

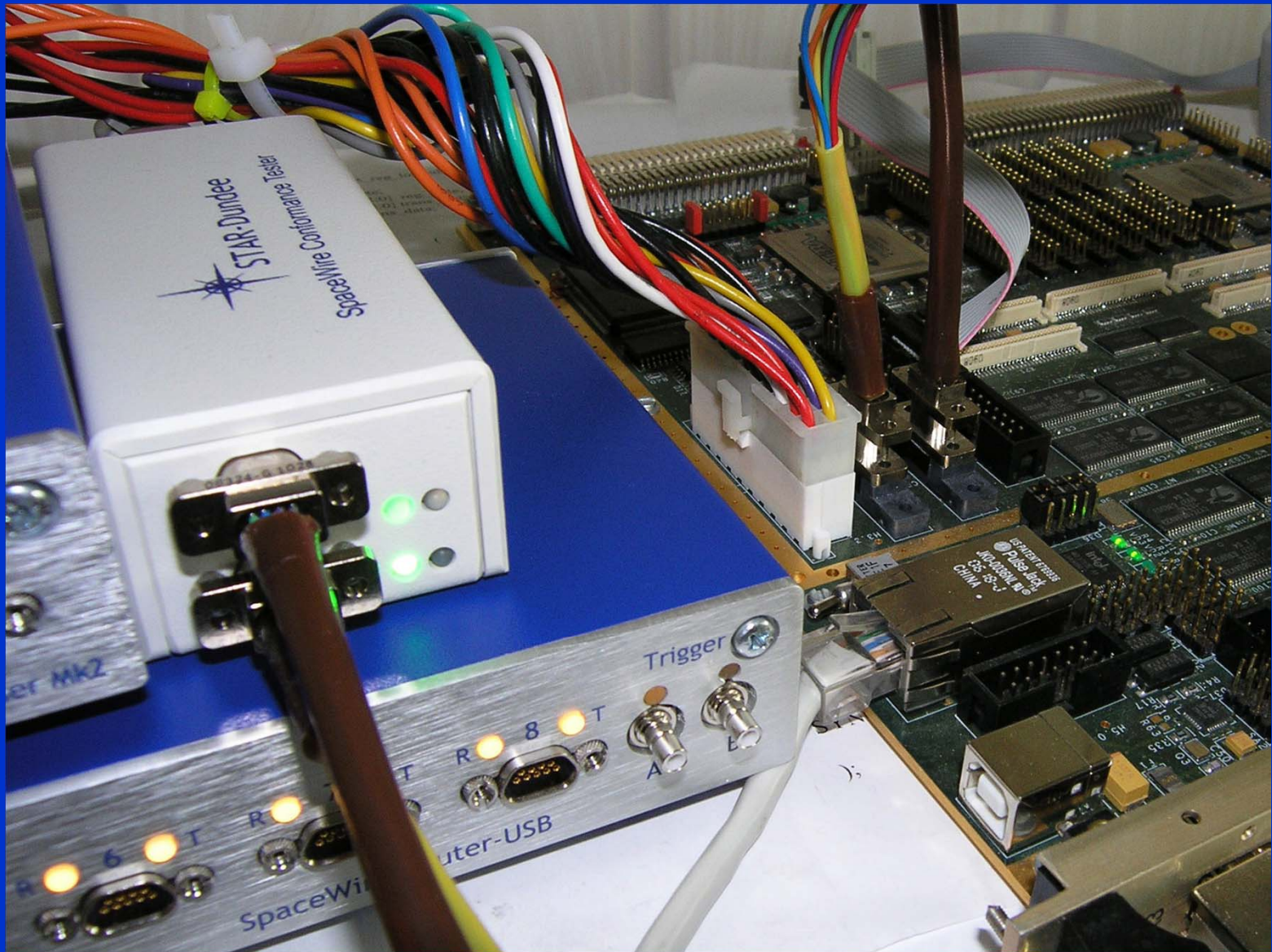
Current status

- FPGA prototype passed almost all tests of STUR-Dundee conformance tester
- First engineering samples are expected by the end of 2012 (CPGA602 package)

SpaceWire conformance testing stand



SpaceWire conformance testing stand (2/2)



SpaceWire testing results

SpaceWire Conformance Tester 1.10(18) (not saved)

File Edit Settings Tests Goto Debug Help

Cover Settings Bit-level Exchange EOP/EEP Timecode Credit Packet (1) Packet (2) Other Waveform

<input type="checkbox"/> Success	Run Test	Empty Packet (EOP)
<input type="checkbox"/> Success	Run Test	Empty Packet (EEP)
<input type="checkbox"/> Success	Run Test	Empty Packet Loop-back (EOP)
<input type="checkbox"/> Success	Run Test	Empty Packet Loop-back (EEP)

☐ Success Run Test Send Packet With EEP

Maximum test duration:

Packet bytes:

SpaceWire Conformance Tester 1.10(18) (not saved)

File Edit Settings Tests Goto Debug Help

Cover Settings Bit-level Exchange EOP/EEP Timecode Credit Packet (1) Packet (2) Other Waveform

<input checked="" type="checkbox"/> Success	Run Test	UUT is data loop-back
Header bytes: <input type="text" value="0x01"/>		
Packet size: <input type="text" value="4"/>		

<input checked="" type="checkbox"/> Success	Run Test	UUT is data sink
Header bytes: <input type="text" value="0x00"/>		
Packet bytes: <input type="text" value="X 65 0x20 0x17 0b00001101"/>		

<input checked="" type="checkbox"/> Success	Run Test	UUT is data source
Maximum number of packets: <input type="text" value="10"/>		
Maximum test duration: <input type="text" value="10"/>		

SpaceWire Conformance Tester 1.10(18) (not saved)

File Edit Settings Tests Goto Debug Help

Cover Settings Bit-level Exchange EOP/EEP Timecode Credit Packet (1) Packet (2) Other Waveform

<input checked="" type="checkbox"/> Success	Run Test	Investigate UUT timecode support
<input checked="" type="checkbox"/> Success	Run Test	Timecode/NCHAR confusion

<input checked="" type="checkbox"/> Success	Run Test	UUT receives valid timecodes
Timecode to send: <input type="text" value="42"/>		

<input checked="" type="checkbox"/> Success	Run Test	UUT ignores invalid timecodes
Timecode to send: <input type="text" value="21"/>		

<input checked="" type="checkbox"/> Success	Run Test	Measure timecode frequency
Test duration (seconds): <input type="text" value="10"/>		

Conclusions

- SRISA RAS is able to develop, manufacture and test RT and FT Systems-on-Chip, and we are open for cooperation
- It's rather difficult to develop SoC with SpaceWire nodes, when SW standard is not totally defined
- Now, a new interface SpaceFibre for high-speed communication is being developed
- May be, it is time to look once more at existing well-defined interfaces for speed >400 Mb/s? (Subset of RapidIO??)

Thank you!