20th, Feb. 2008


# Recent ASIC Developments by NEC

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NEC TOSHIBA Space Systems, Ltd.

# Space Cube Architecture
## - a mutual subset of T-Engine architecture (1)



❑ **from Palm-top size reference model through chip-size implementation**

**Space Cube**

**Space Cube 2**

**developed in 2005**

***Space Cube Architecture***

***- Joint development with JAXA/ISAS***

JAXA

**Space DICE**

**Space Cube MCM (Chip-size assembly)**

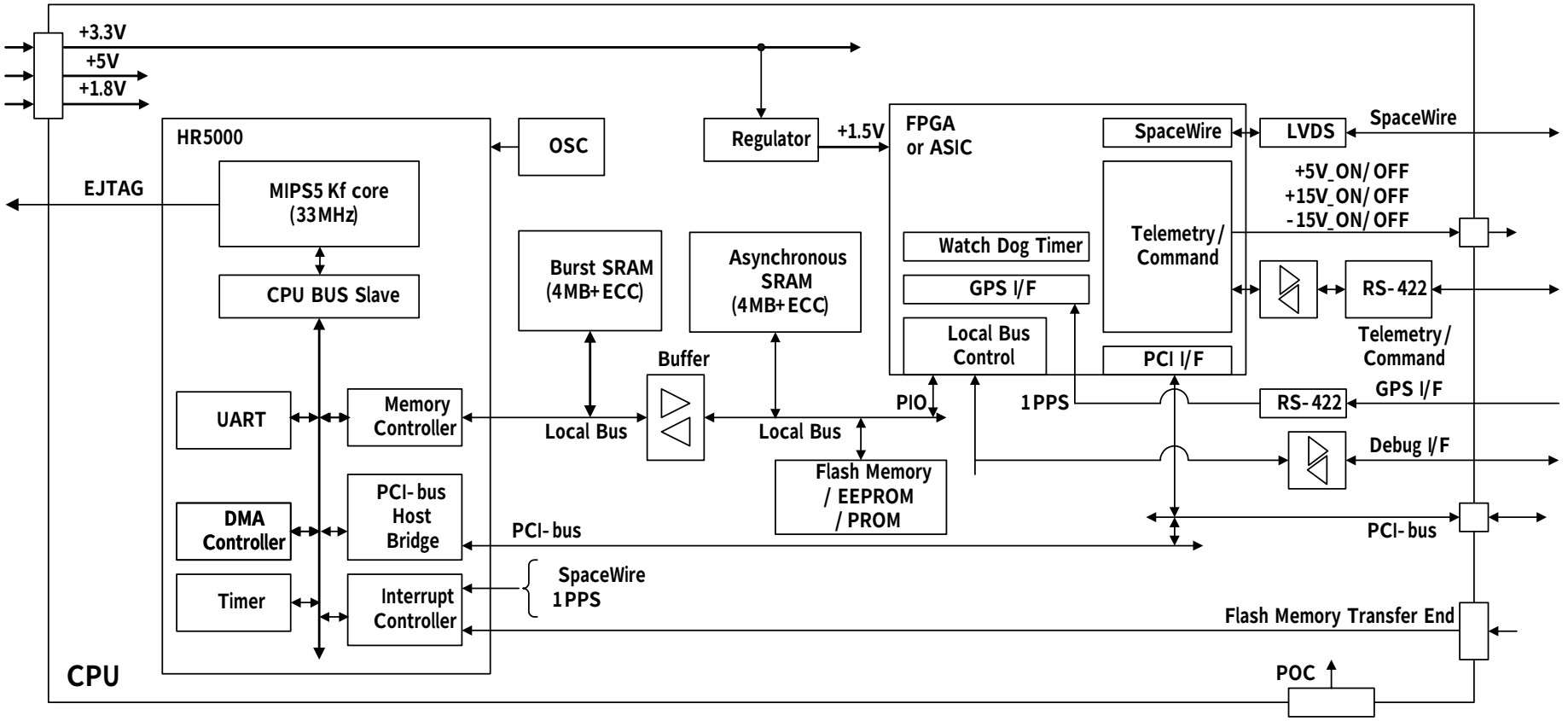
**under development**

**Space Cube Chip • • • Goal !**

# Space Cube Architecture
# - a mutual subset of T-Engine architecture (2)



## ❑ Basic CPU module for Space Cube 2



# Space Cube® 2
# - Technical Features



## ❑ Base Model

- SpaceWire interface: 3ch
  (additional ports are available)
- UART interface: 2ch @ RS422
- System Memory:
  - FLASH Memory (2MB) and/or PROM/EEPROM
  - Burst SRAM (4MB)
  - Asynchronous SRAM (4MB)
- Data Recorder Memory:
  - SDRAM (1GB)
  - Back-up FLASH Memory (1GB)
- Size (mm): 71(W) x 220.5(D) x 175.5(H)

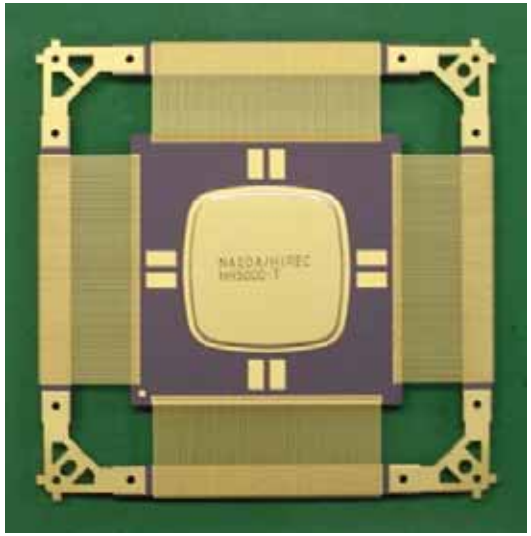
# Key ASICs for Space Cube 2
# 64bit MPU and Burst SRAM developed by JAXA

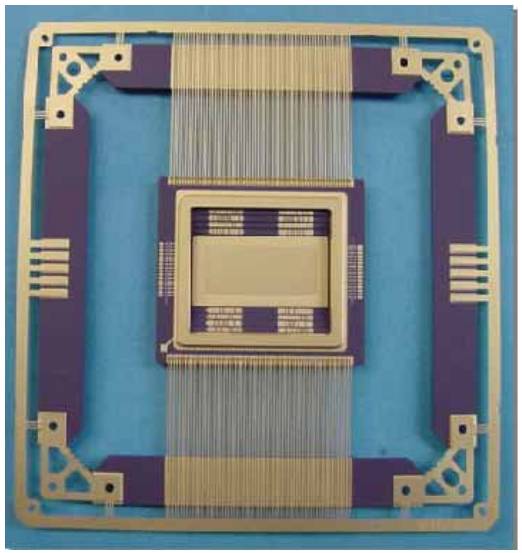
❑ **HR5000**

- 320MIPS 64bit micro-controller with integrated peripheral devices on one chip
- 0.18 μ process
- Peripherals
  - PCI Ver. 2.2
  - eight-bank memory controller with EDAC
  - 2ch UART
  - 2ch Timer
  - 2ch DMA controller
  - Interrupt controller

❑ **Burst SRAM**

- 36Mbit / chip





# Road Map Overview for SpaceWire in Japan

- Demonstration on orbit with SDS-1
- Standardization through small satellites

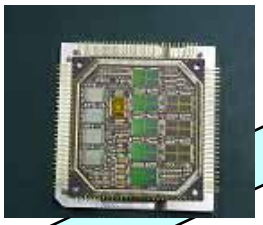
Space Cube 2





Monolithic Space Cube (Target)

Space Cube MCM



Commercial

NeXT advanced X-ray telescope

Collaboration with JAXA/ISAS
64bit MPU
Burst SRAM
SpaceWire FPGA
Real-time OS (T-Kernel)

JAXA “New Concept”
Chip size mounting of...
- 64bit MPU
- Burst SRAM
- FPGA / ASIC

SDS-1

Small Satellite series

Standardization

Demo

Demonstration

Next Generation Bus

2008

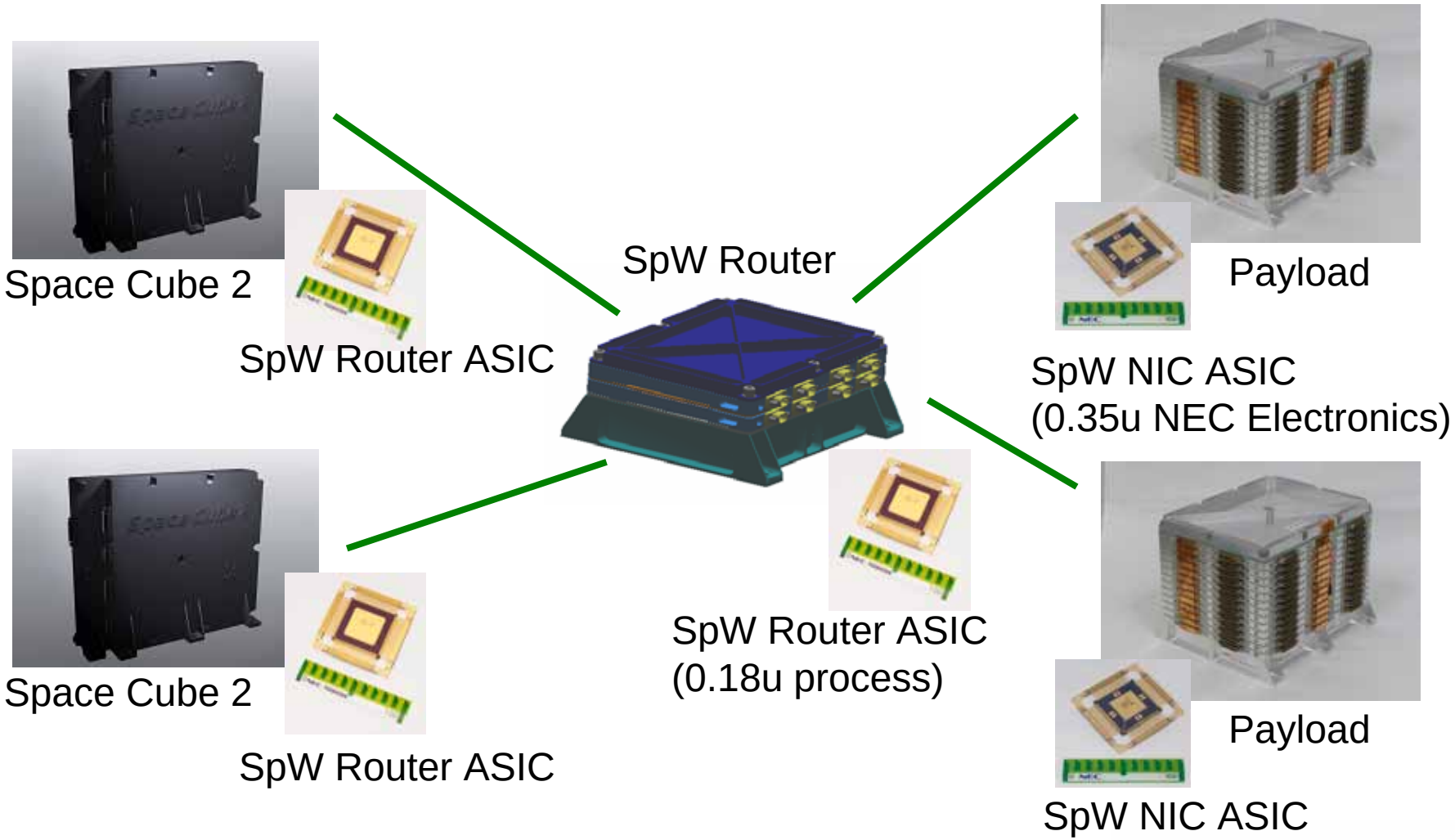
2010

2013～2015

# Satellite Assembly Kit with SpaceWire ASICs for standardized satellite bus



## ❑ Space Cube 2, Router ASIC, and NIC ASIC

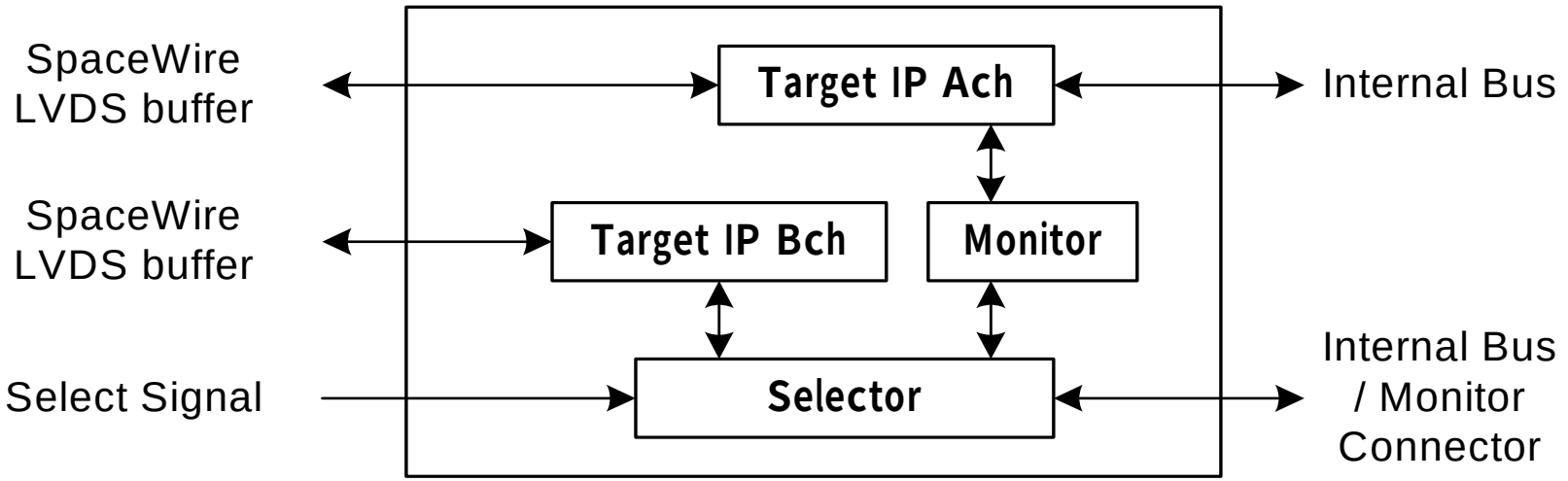


# User-side SpaceWire interface ASIC - SpaceWire-NIC07



## ❑ Common network interface chip for components

- Two SpaceWire ports
- Selectable Monitor Function



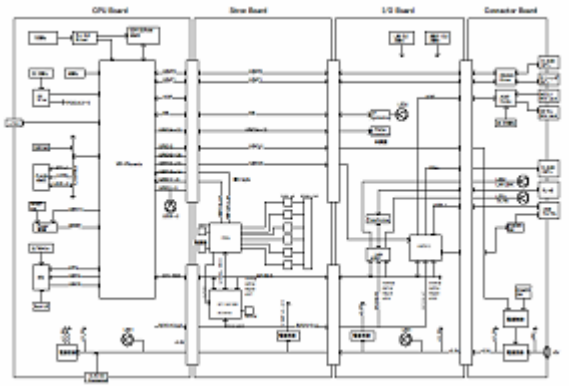
# Platform extension for exploiting SpaceWire ASICs



## ❑ Support system for development

**Interface Design Kit**

**Space Cube Architecture**

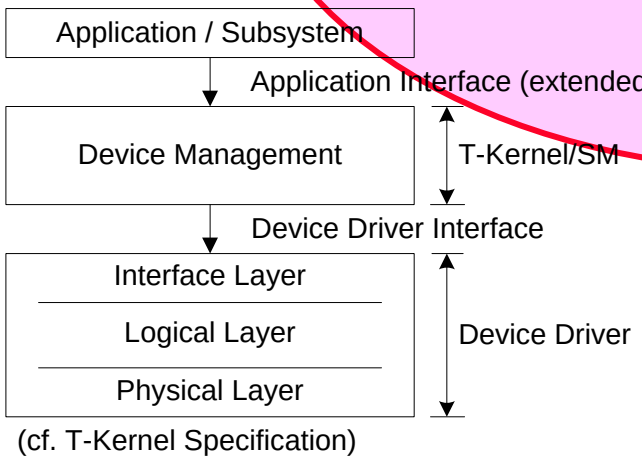


**High Reliability**
**Low Cost**
**Fast Delivery**

**Common Software API**

**Versatile Assembly and Test Equipments**

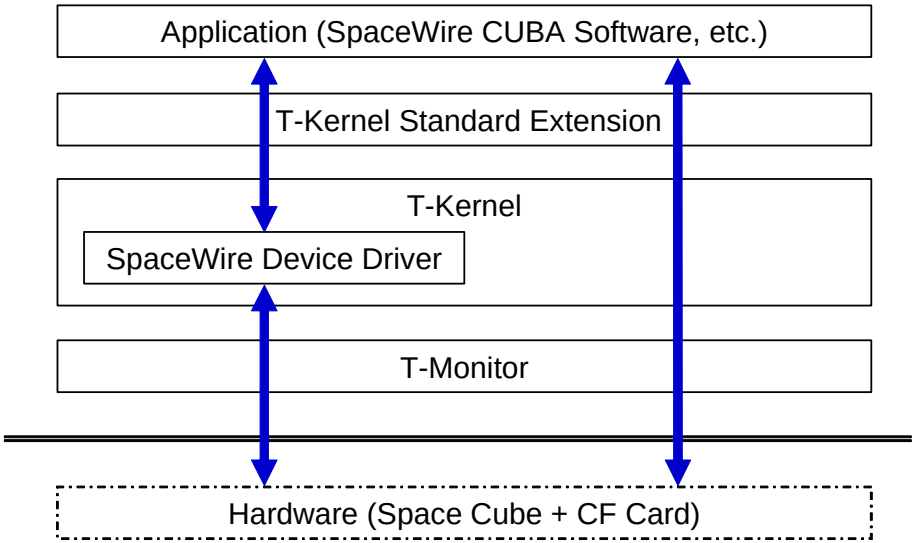
CRAFTSYSTEM




(cf. T-Kernel Specification)

# Common Software Interface for SpaceWire ASICs

- **Common API with UoD**
  - developed in joint development activity
- **T-Kernel**
  - State-of-the-Art real-time operating system
  - the successor of TRON operating system, developed in TRON project
  - standardized by Ubiquitous Networking Laboratory, Tokyo.




Reference Software Architecture on Space Cube

# Test equipments for developing components using SpaceWire ASICs



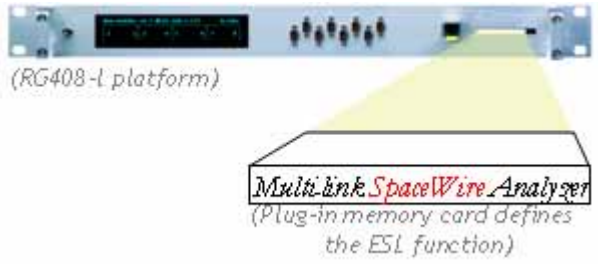
## ❑ SpaceWire test set with legacy interface support

SpW USB Brick

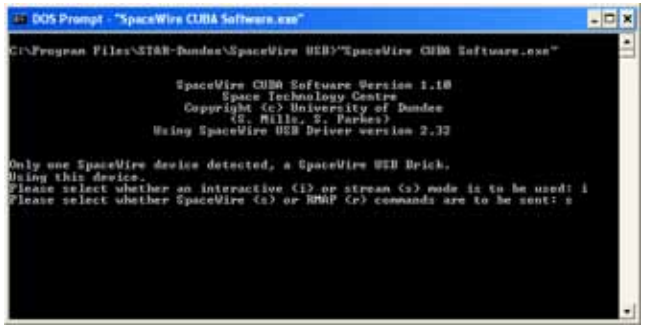
SpW Link Analyser

Conformance Tester

by STAR-Dundee




**Multi-Link SpW Analyzer by 4Links**




**SpW CUBA Software with Space Cube by UoD and NTSpace**

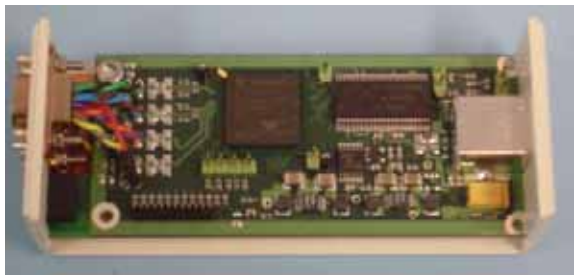

**Multi Protocol Tester with SpW and Legacy I/F by NEC/NTSpace**

# SpaceWire CUBA Software

- The same RMAP protocol analyzer software runs on both USB brick and Space Cube®

**Common API is established**


USB brick

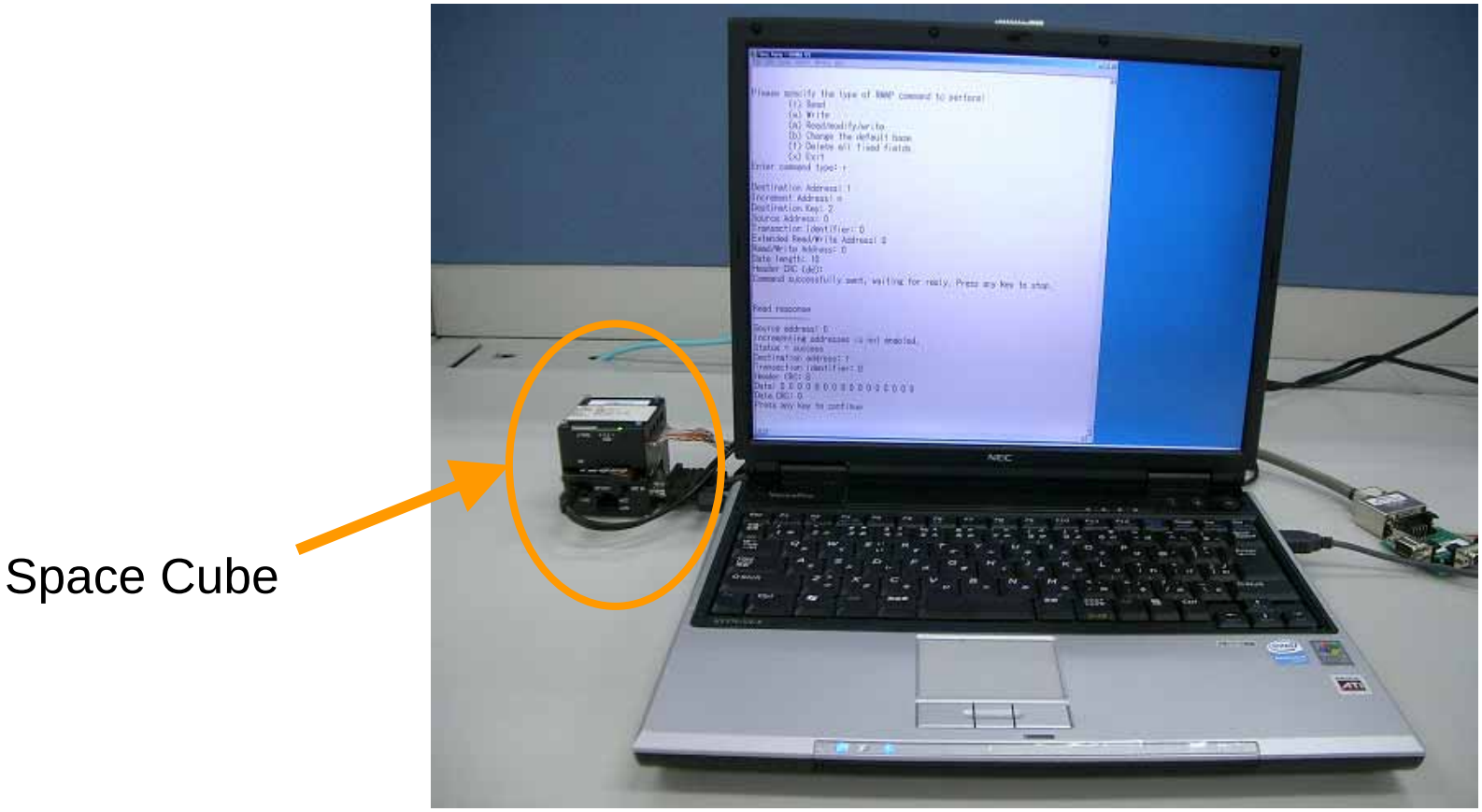



SpaceCube®

# Portable Test Set for SpaceWire / RMAP



## ❑ SpaceWire CUBA Software on Space Cube



# Onboard software development Platform using SpaceWire ASICs



## ❑ SOFTWARE DEVELOPMENT ENVIRONMENT

– Commercial level Space Cube®-mini
  • Engineering model with HR5000 micro-controller

– Palm top size model (original Space Cube®)
  • VR5701 (commercial 64bit micro-controller by NEC Electronics Corp.)

– JTAG ICE (In-circuit Emulator) by Yokogawa-Digital Corp.

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# SpaceWire User's Group, Japan
## -- User support community for SpW application

- **SpaceWire User's Group Constitution**
  - Chair
    - Prof. T. Takahashi (JAXA/ISAS)
    - Prof. M. Nomachi (Osaka University)
  - Founder Members
    - JAXA/ISAS
    - NEC TOSHIBA Space Systems, Ltd.
    - NEC Electronics Corp.
    - NEC Soft, Ltd.
    - Sumitomo Heavy Industries, Ltd.
    - Mitsubishi Heavy Industries, Ltd.
    - Meisei Electric Co., Ltd.
    - NIPPI Corp.

FAM Science