



# A Portable SpaceWire/RMAP Class Library for Scientific Detector Read Out Systems

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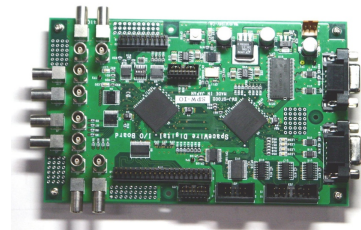
*JAXA/ISAS*

# Context

- Developing satellite-onboard scientific instruments.
- Developing SpaceWire/RMAP-based data acquisition system (DAQ).
  - From the beginning of R&D or Bread Board Model phases.
  - Expect smooth transition to Flight Model developments.
  - Hardwares for ground-based experiments were developed by JAXA, Universities and Enterprises.
  - Odaka et al. and Yuasa et al. (ISC2007) for practical applications.
- Upgraded SpaceWire/RMAP class library used in read-out programs (user programs) on SpaceCube computers.
  - Emphasis on Modularity, Portability and Documentation.
  - Based on experience in SDS-I/SWIM development (poster by Kokuyama et al. in this conference).



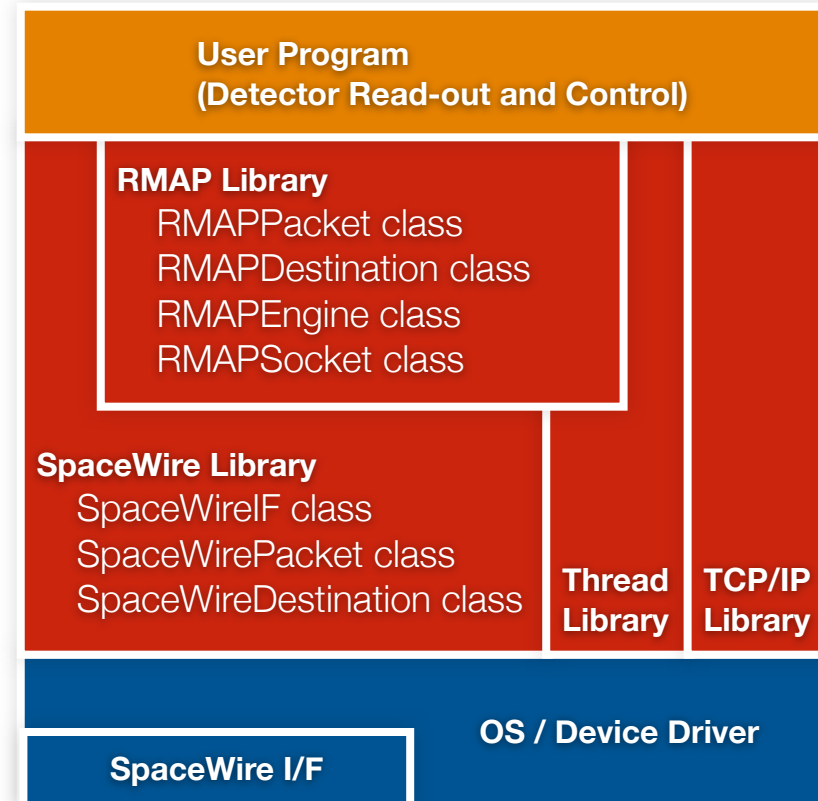
**SpaceCube Computer**



**Front-end SpW I/F Boards**

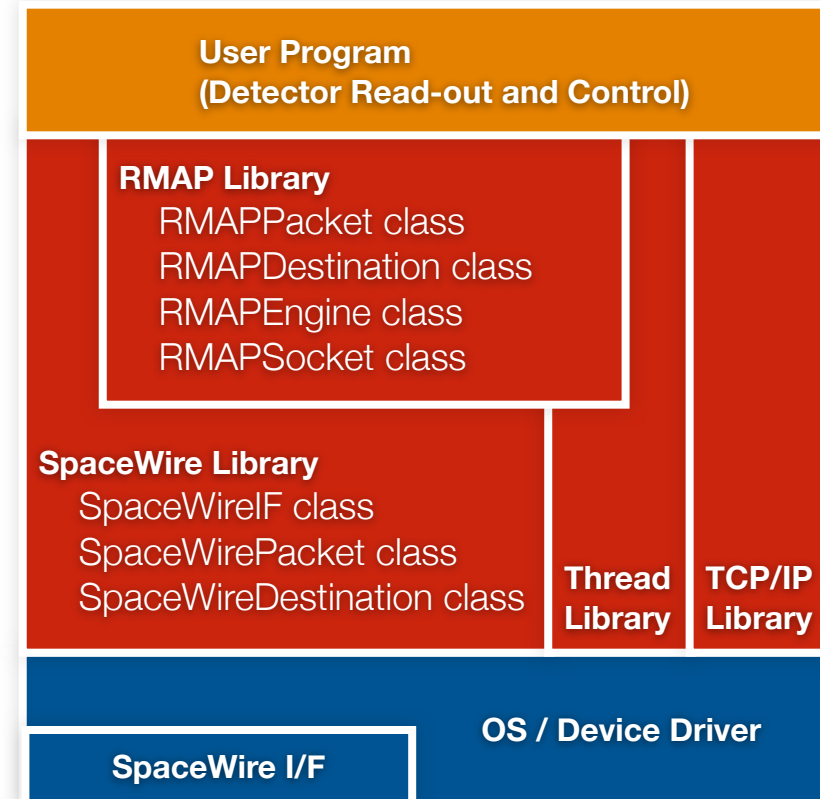
# SpaceWire/RMAP Library : Concept and Structure

- ❑ Modular and Layered structure.
- ❑ Encapsulation of OS-dependent and hardware-dependent functions.
  - SpaceWire I/F hardware and driver
  - Thread (or Task in RTOS)
  - TCP/IP socket
- ❑ RMAP Software Interpreter.
  - RMAPEngine and RMAPSocket classes
  - Abstract expression of RMAP Destinations and RMAP Packets
  - Multiple- and concurrent-RMAP transactions from multithreads



# SpaceWire/RMAP Library : Implementation

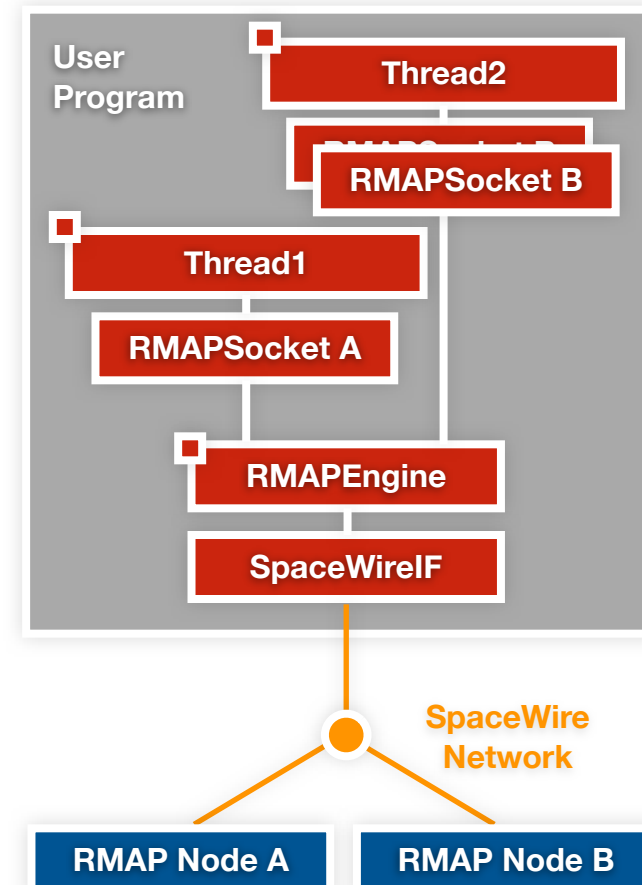
- Fully written in C++.
  - ~30,000 lines including Doxygen-style in-source documentations.
  - No dependency on external libraries except for STL (almost always available).
  - API Reference (English), and Tutorial (Japanese) are also available.
- SpaceWireIF wrapper class for
  - SpW I/F by NEC Soft, Ltd.
  - SpW I/F by Shimafuji Electric Inc.
- Thread and TCP/IP Libraries for
  - POSIX (ordinary Linux, Mac OSX)
  - T-Kernel (RTOS)



# SpaceWire/RMAP Library : Usage

## Example of Simple RMAP Read/Write

1. Create a SpaceWireIF instance.
2. Create an RMAPEngine instance.
3. Set an RMAPDestination instance.
  - Logical/Path Addresses of Destination and Source.
  - Destination Key, etc.
4. Open an RMAPSocket instance.
  - Giving the RMAPDestination instance.
  - Multiple instances can be opened from single thread.
5. Invoke RMAPSocket::read() or write() methods.
  - Data are passed as vector class
  - Errors could be thrown as exception class instances.

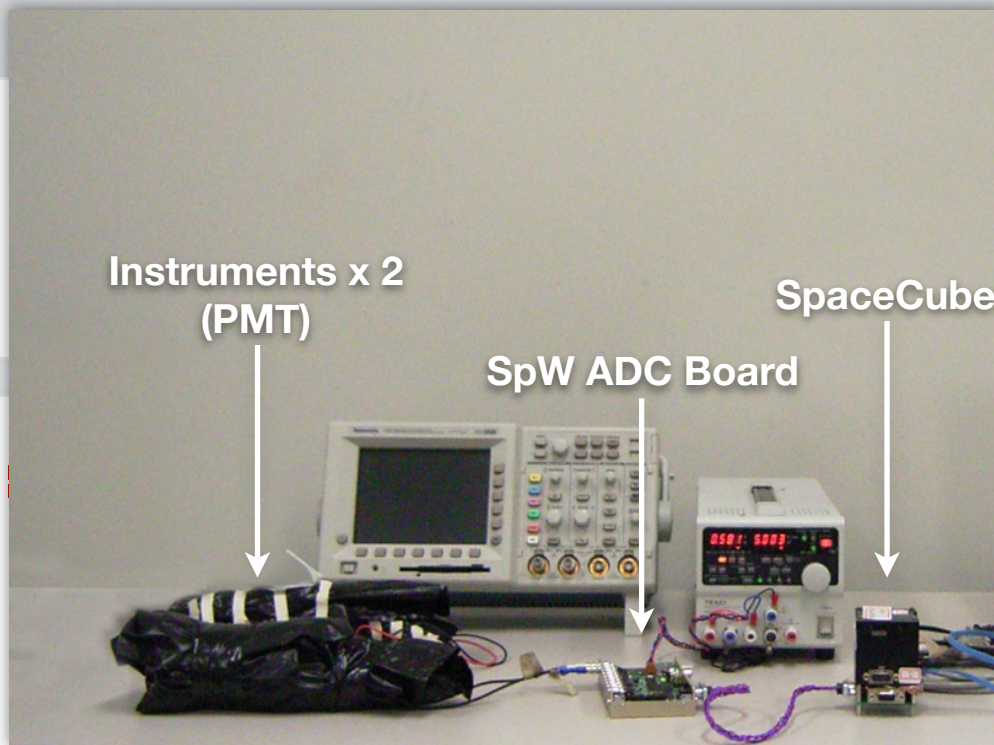




# SpaceWire/RMAP Library : Portability

- The portability enables user programs to run on various environments; SpC, PC and Mac.
  - Easily ported from a BBM development environment to another one.
- We performed an instrument read-out experiment.
  - First executed on SpaceCube computer, successfully acquired data.

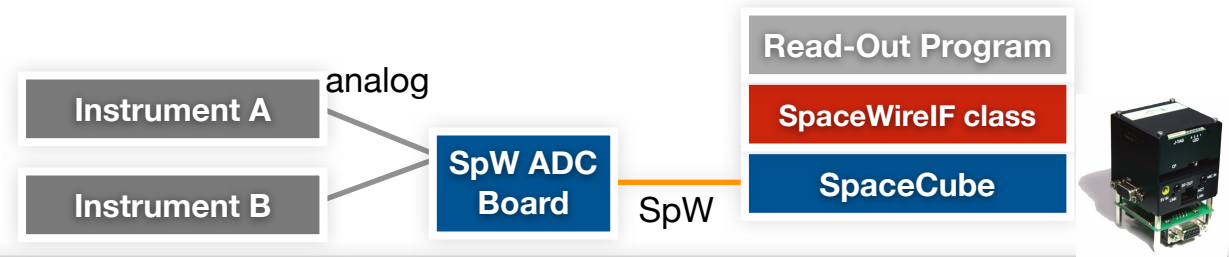


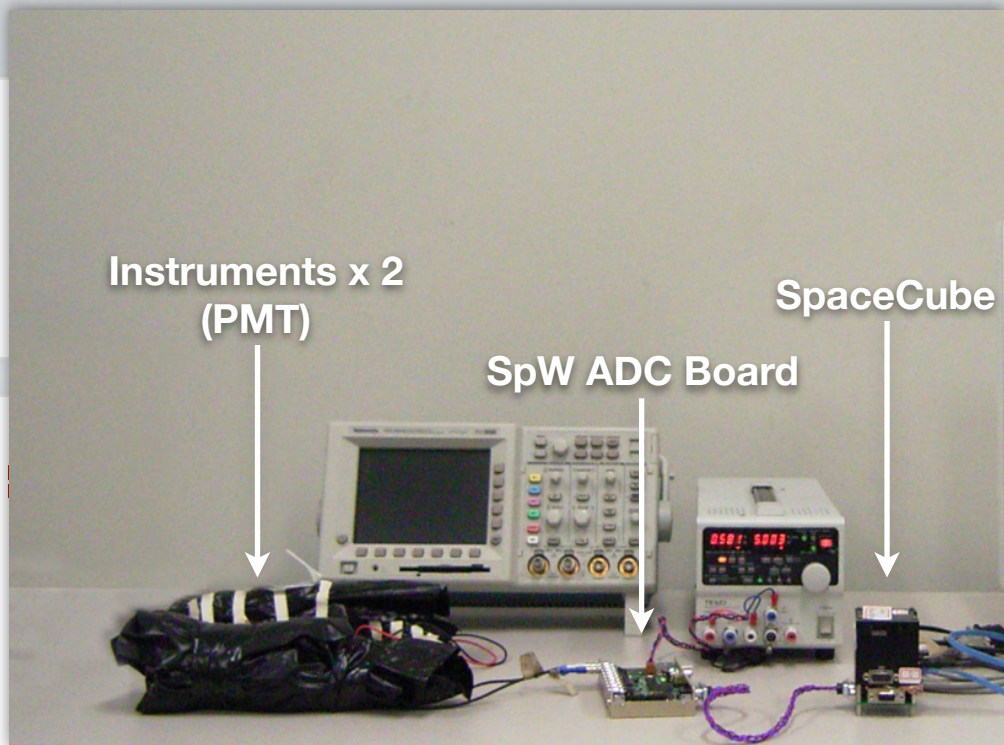


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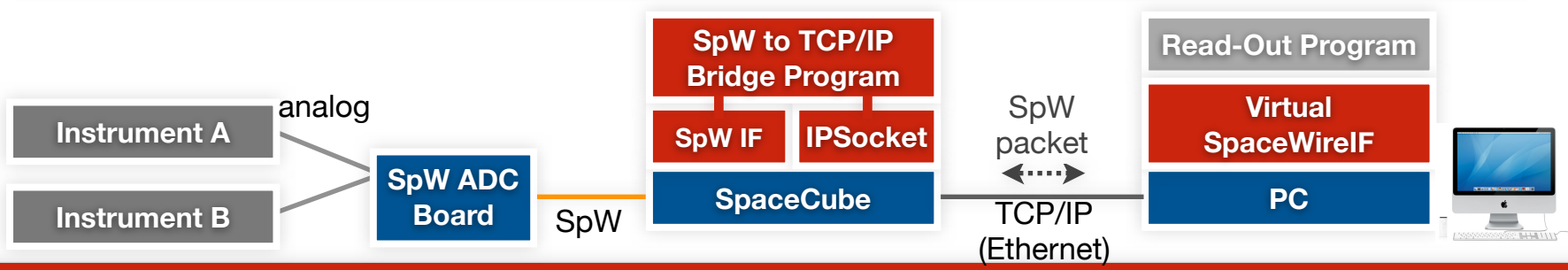




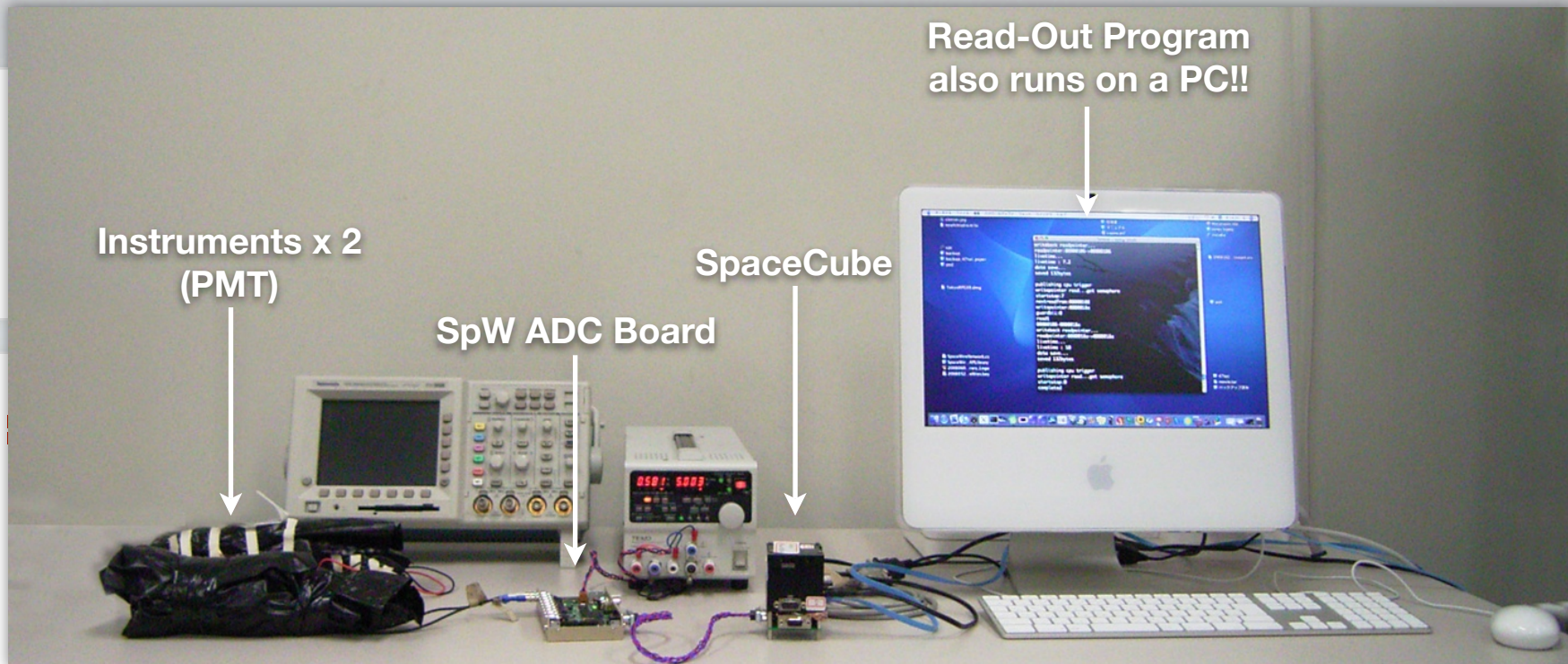
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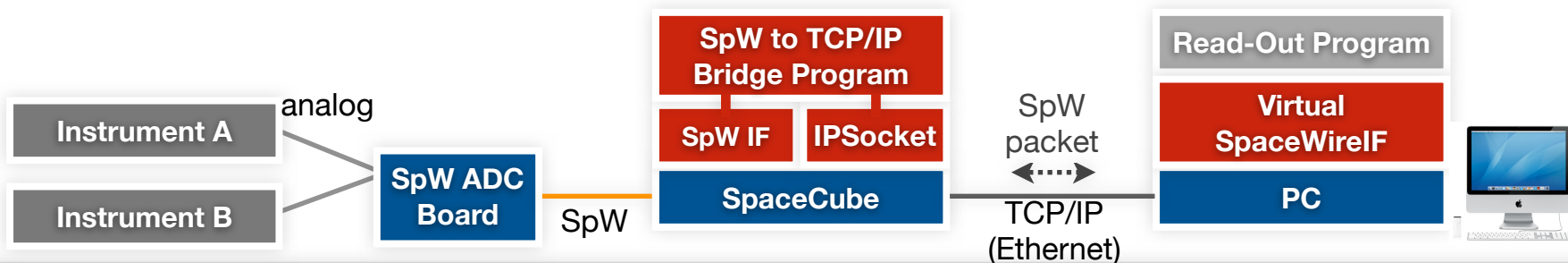
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- We performed an instrument read-out experiment.
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  - Then, the same program (same code) was also successfully compiled and executed on a PC (SpaceWireIF of SpaceCube computer was used via TCP/IP bridge).



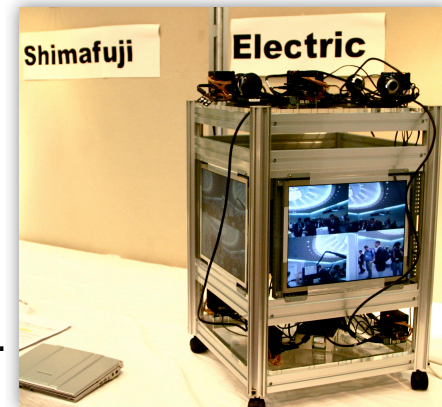
# Performance and Applications

## Transfer Speed

- Using SpaceWire I/F IP Core by Shimafuji Electric Inc. (link speed 100MHz) on SpaceCube (CPU 200MHz).
- SpaceWire layer ~ **32Mbps** (without RMAP packet interpretation or data copy to user memory space)
- RMAP layer ~ **3Mbps** (with RMAP packet interpretation, CRC calculation, data copy to user memory space)

## Applications

- In the X-ray CCD and the X-ray micro-calorimeter experiments.  
=> For next Japanese X-ray astrophysical mission ASTRO-H.
- **“SpaceCube Cube”** demo displayed in Exhibition Room  
also uses SpaceWire/RMAP Library.  
=> Example of error handling and network topology description.





# Summary

- We developed SpaceWire/RMAP Library in C++ language improving portability and modularity. We showed the validity of the portability in a practical instrument read-out experiments.
- Using Shimafuji Electric SpaceWire I/F on SpaceCube, we obtained transfer speeds of 32Mbps (SpaceWire layer) and 3Mbps (RMAP layer).
- The library has been used in developments of some scientific instruments.