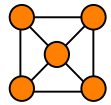
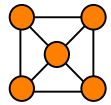


Spacewire related activities in JAXA & science community ~Summary~

Y. Kasaba, T. Takashima (ISAS/JAXA)
JAXA/BepiColombo Project Office
T. Takahashi, M. Ozaki (ISAS/JAXA)
M. Nomachi (Osaka Univ.)
NeXT mission WG

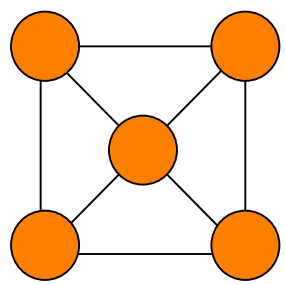
Backbone: Data Handling Group for Scientific Satellites (JAXA & science community members)

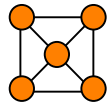


Backbone: Data Handling Group

covers key scientists & engineers
in space/non-space communities and industries
for laboratory & balloon experiments
and multi-scale scientific missions

- T. Hashimoto (ISAS/JAXA)
- H. Hayakawa (ISAS/JAXA)
- H. Hihara (NTSpace)
- S. Ishii (MHI)
- Y. Kasaba (ISAS/JAXA)
- H. Kataza (ISAS/JAXA)
- M. Kokubun (U. Tokyo)
- Y. Kuroda (MHI)
- K. Matsuzaki (ISAS/JAXA)
- E. Miyata (Osaka U.)
- T. Nakazawa (ISAS/JAXA)
- Nishiyama (ISAS/JAXA)
- M. Nomachi (Osaka U.)
- M. Ozaki (ISAS/JAXA)
- Y. Saito (ISAS/JAXA)
- S. Sakai (ISAS/JAXA)
- K. Sakamura (U. Tokyo)
- **T. Takahashi (ISAS/JAXA) [delegate]**
- T. Takashima (ISAS/JAXA)
- Y. Terada (ISAS/JAXA)
- Y. Tsuda (ISAS/JAXA)
- H. Yamakawa (ISAS/JAXA)
- T. Yamada (ISAS/JAXA)





Status

2003

Chip: SpW Protocol FPGA (Osaka U. & MHI)
Application: Balloon Experiment (JAXA, Osaka U., Yamagata U.)

2004

Multi I/F Extension: including Spacewire (NTS and others)
SpaceCube: "PC" with SpW (JAXA, Osaka U., Shimafuji Co.)
Application: Readout system for Compton Telescope

2005

Start of Space Application

[Technology]
- Establishment of common "Chip" & "Middleware"

[BepiColombo/MMO]
- Design fix of Electronics, including SpW I/F
- Development of "EGSE for Sensor", including SpW I/F
  (common development with NeXT)

SpW Missions in JAXA

• BepiColombo / MMO (2012)

Phase-B from 2005FY

First SpW-applied mission

Balloons

Ground experiments
(incl. fields in other sciences)

Rovers

Multi-scale future missions

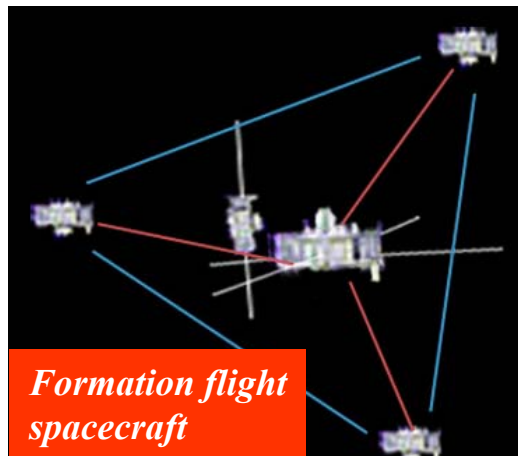
Piggy-bag class satellites

• NeXT (X-ray)

• Solar Sail (Engineering)

(approved as “High Priority Mission”)

Selection: Fall 2005



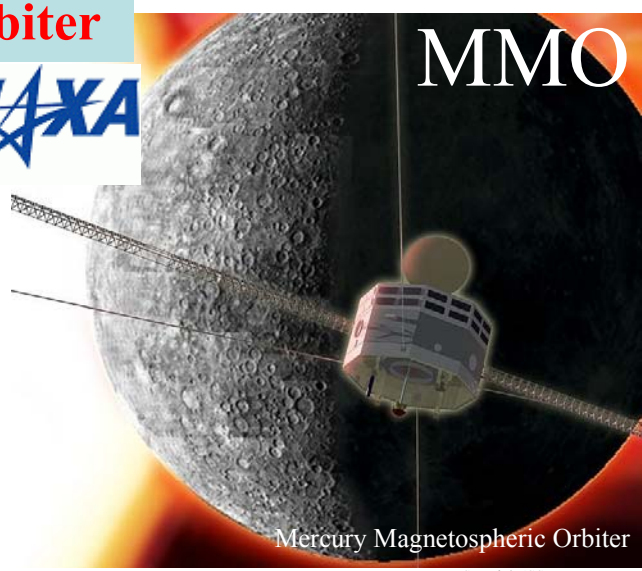
Formation flight spacecraft

BepiColombo: ESA-JAXA joint mission

Phase-B: 2005~
Phase-C/D: 2007~
Launch: 2012

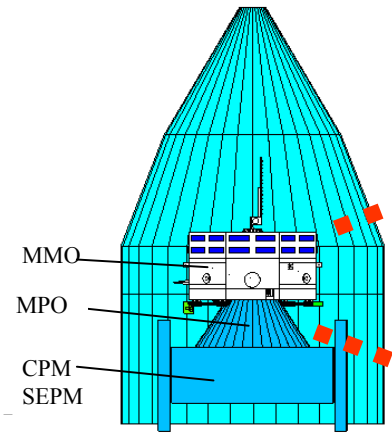
Mercury Magnetospheric Orbiter

NTSpace: System
MHI: MDP & some Payloads

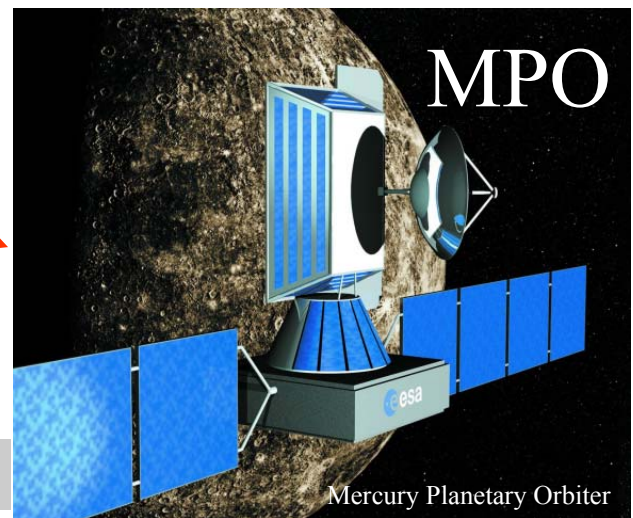


C. Noshi/RASC, Kyoto Univ.

Soyuz Fregat 2B:
MPO+MMO



Single Launch
Separation: after MOI



Mercury Planetary Orbiter

Launch: mid 2012

MMO: Data Processing Unit (DPU)

- Control unit	CPU, incl. HK monitor
- MEM unit	Large memory storage
- PI interface	LVDS [Spacewire router]
- Bus interface	LVDS [PIM or Spacewire]

(or MPO[ESA])

Command

Telemetry (<64kbps)

DMC

DR

Bus (SpW?)

Command

Telemetry

Mission Data Processor [MDP-1]
DPU

LVDS I/F [FPGA]

MEM [Memory]

Control [CPU]

RAM

SpW Router [FPGA] 8+1ch

2 routers

Mission Data Processor [MDP-2]
DPU

LVDS I/F [FPGA]

MEM [Memory]

Control [CPU]

RAM

SpW Router [FPGA] 8+1ch

SpW Sensor Electronics

SpW Sensor Electronics

SpW Sensor Electronics

8 clients

Sensor Electronics

Sensor Electronics

Sensor Electronics

8 clients

A/I-1: Usage within Power restriction

Concept is fixed.

[MDP ⇒ each Sensor]

- Non-real to each: CMD (low rate)
- Real to all: Spin pulse (~0.25Hz) [~0.1msec res.]
  (by "time code") + Spacecraft Time [32bit, ~10msec res.]
- Real (not incl. in SpW): Sync between some instruments [0.1msec ~ 0.1usec]

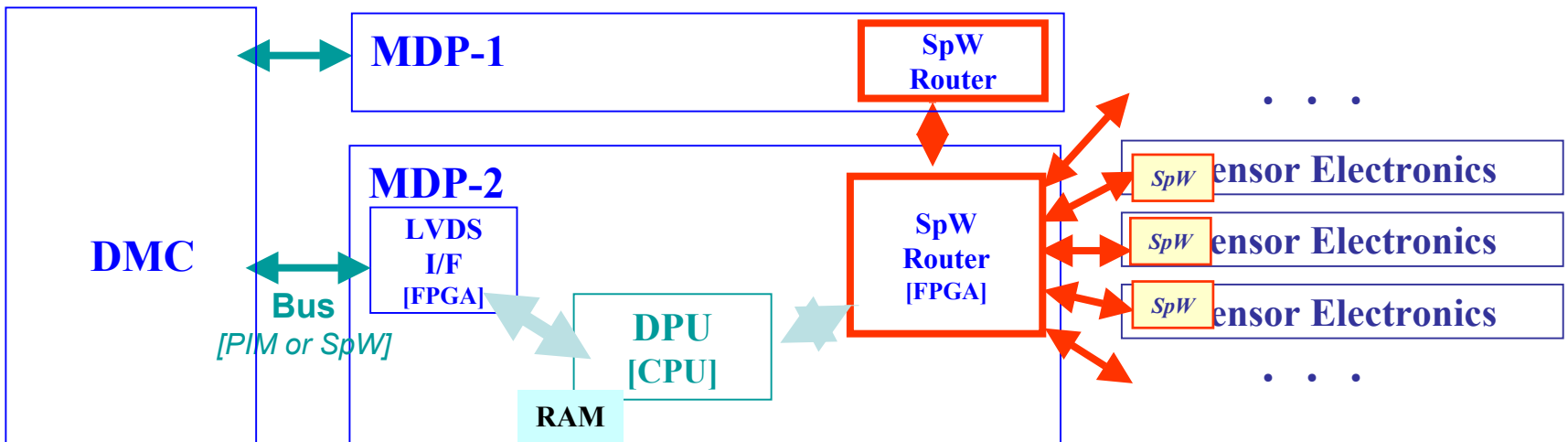
[each Sensor ⇒ MDP]

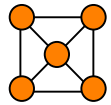
- Non-real to MDP: "Continuous & Fixed" data stream (< 2Mbps)
  - *Clock:* *minimized, for low power consumption*
  - *Flow control:* *by MDP (read: "pull" from MDP [by RMAP?])*
- Semi-Real to MDP: Ack. / HK / Status info. [option]

[Redundancy for Contingency]

Routing table change in "emergency of Bus I/F or DPU"

ex) S/C-system ⇦[⇨ MDP1 ⇦]⇨ MDP2 ⇦⇨ Sensor group





A/I-2: Procurement for MMO

Concept is fixed.

Procurement & Compatibility of "ASIC/VHDL" for Client in Japan & Europe

For MMO & MPO, potentially, Japanese instruments	with JAXA ASIC/VHDL *(with ESA ASIC/VHDL)*
European instruments	with ESA ASIC/VHDL *(with JAXA ASIC/VHDL)*

In order to reduce the size & power, procurement of **FPGA VHDL IP** is expected from Payload teams in both sides.

Standard procurement & support scheme for those demands is ready, including the applications out of space activities.

A/I-3: E-GSE as common emulator & prototype

GSE (PC with Spacewire I/F): "PC" with "SpW I/F" + "Common OS"

for sensor tests: "MDP/DPU emulator" from MDP team

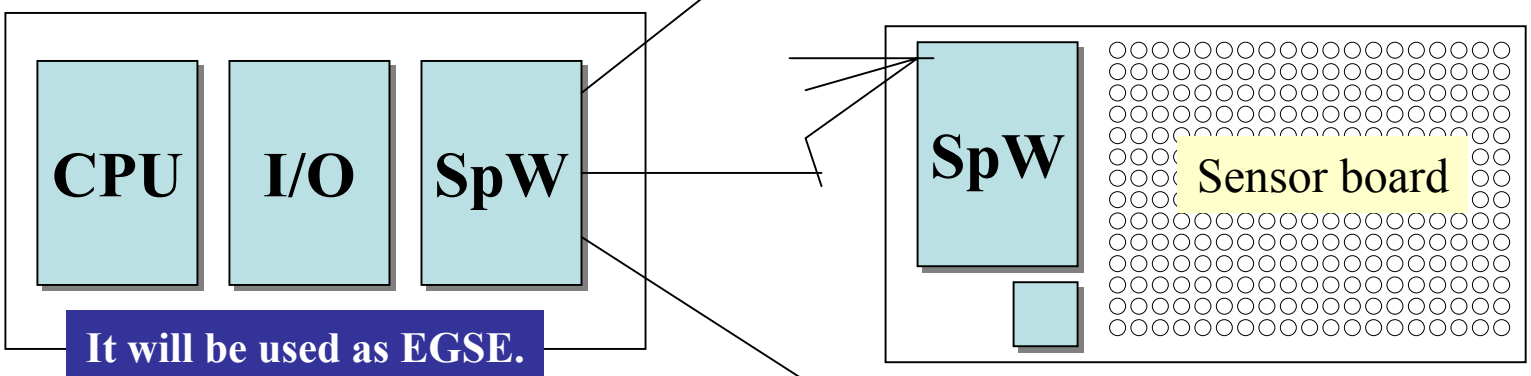
for MDP tests: "Sensor emulator" from Sensor team

Concept is fixed.

- Real Computer
  - Linux
  - TRON / T-Engine (Real Time Kernel)
- CPU: 200-300 MHz (MIPS arch.)
- Memory: 64MB SDRAM
- I/F: PCI / USB / Ethernet / Serial etc.
  + 3-port SpW link

Space Cube

Enhanced version of "T-Cube"
(on "T-Engine Project")



It will be used as EGSE.

A/I-3: SpaceCube-II ~ Test development

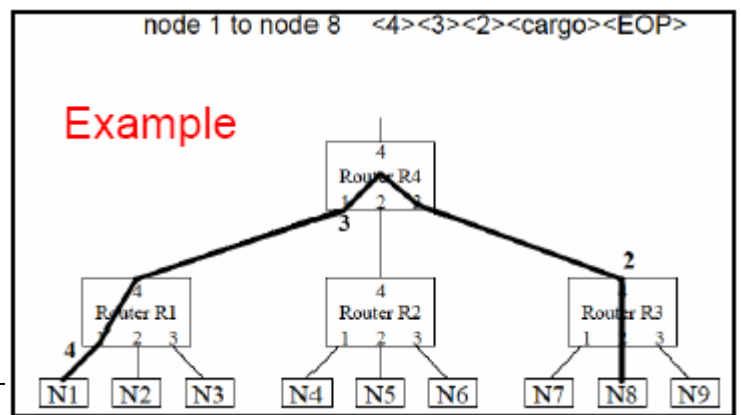
in design

Objective: Keep "full compatibility"
in ground-use & space-use
by common H/W & S/W architecture
→ *direct application in wide-range:*
"not only in ground-use,
but also in space"

Based on T-Engine platform

CPU: HIREC/JAXA MIPS
*200MIPS class
*Radiation-hard for space-use
Commercial for ground-use

H/W I/F: Spacewire
*enhanced "IEEE-1394"
*Speed: >2Mbps
*with Network & RMAP



OS & S/W I/F: TRON
*common OS for
commercial
embedded systems

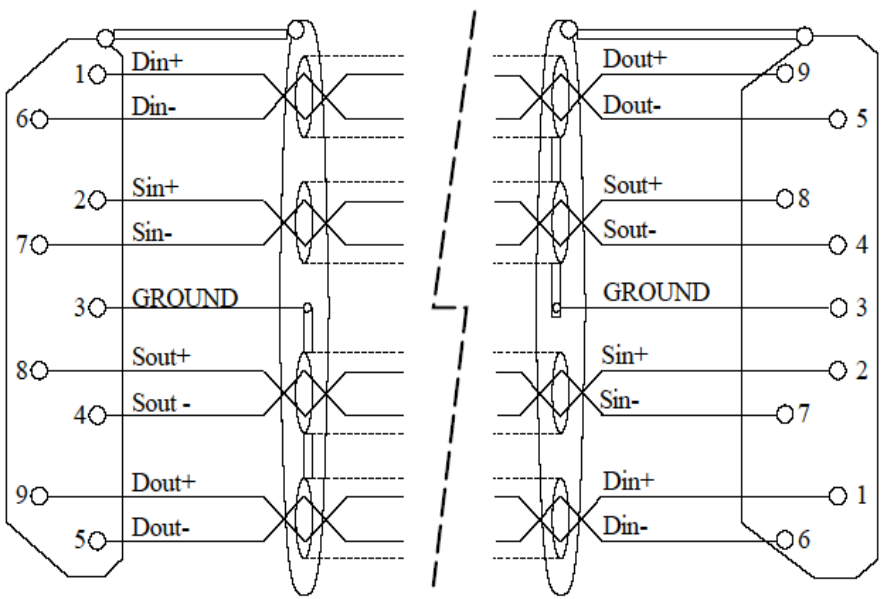
www.tron.org

T-Engine Forum

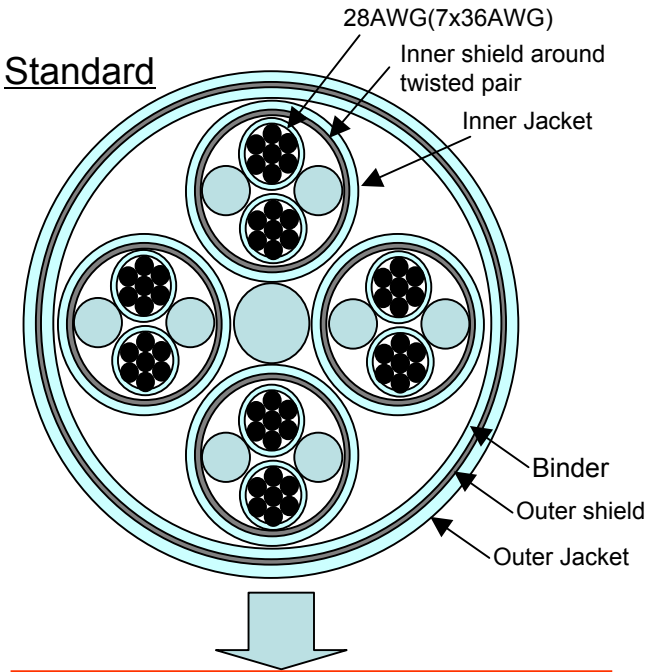
A/I-4: Light physical I/F for small satellites

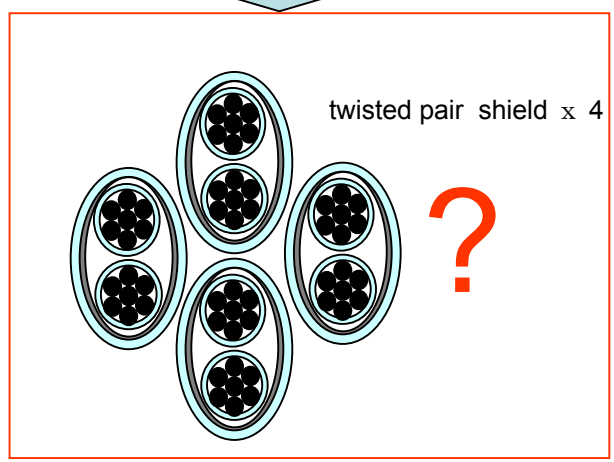
Problem of standard harness for "small-sized & mass-restricted" spacecraft:

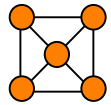
* *less flexibility for installation into small system*
* *larger mass for the small system*



Standard







[One candidate]
80g/m(28AWG) → 27g/m(26AWG) ~ 64g/m(22AWG) ???

in design > test

Tensolite

High-Performance Cable

NETflight™

Aerospace Grade 100BASE-T Ethernet Cables

P/N:	NF26Q100	NF24Q100	NF22Q100	NF24P100	NF22P100
Conductor AWG Size(19 Strand):	26	24	22	24	22
Conductor Material:	SCCA	SCCA	SCC	SCCA	SCC
Nom Conductor Diameter(in):	0.0189	0.0233	0.0295	0.0233	0.0295
Insulation Material:	ePTFE/PTFE	ePTFE/PTFE	ePTFE/PTFE	ePTFE/PTFE	ePTFE/PTFE
Nom Insulation Diameter(in):	0.038	0.045	0.055	0.063	0.070
Nom Cable Diameter(in):	0.137	0.163	0.190	0.175 x 0.270	0.195 x 0.290
Nom Cable Weight(lbs/1000 ft):	18.0	24.5	34.0	35.0	43.0
Impedance ± 10%(Ω):	100	100	100	100	100
Nom Capacitance(pF/ft):	13	13	13	13	13
Nom Velocity of Propagation:	79%	79%	79%	79%	79%
Max Delay Skew(ps/ft):	137	137	137	137	137
	10 MHz 100MHz	10 MHz 100MHz	10 MHz 100MHz	10 MHz 100MHz	10 MHz 100MHz
Nom/Max Attenuation(dB/100 ft):	2.8/3.2 9.6/11.0	2.3/2.7 8.0/9.2	1.8/2.2 6.4/7.3	1.8/2.1 6.0/7.1	1.6/2.0 5.6/6.7
Min NEXT(dB):	50 35	47 32	50 35	53 38	53 38
Min SRL(dB):	23 16	23 16	23 16	23 16	23 16
Cable Budget Length to meet CAT5 Requirements:	200 ft (60m)	240 ft (73m)	300 ft (91m)	310 ft (94m)	330 ft (100m)

Shielding consists of inner TCC flat braids and outer TCC round braids. The jackets are extruded FEP.
The cables are rated for maximum service at 150°C (200°C rated cables available upon request).

Flammability meets or exceeds FAR25.869 requirements.
Smoke and toxicity meet or exceed Boeing and Airbus requirements.

SCC - Silver Coated Copper
SCCA - Silver Coated Copper Alloy
TCC - Tin Coated Copper

A CARLISLE Company

100 Tensolite Drive, St. Augustine, FL 32092 (800) 458-9960

Subject to change without notice - April 2002

SpW Missions in JAXA

• BepiColombo / MMO (2012)

Phase-B from 2005FY

First SpW-applied mission

Balloons

Ground experiments
(incl. fields in other sciences)

Rovers

Multi-scale future missions

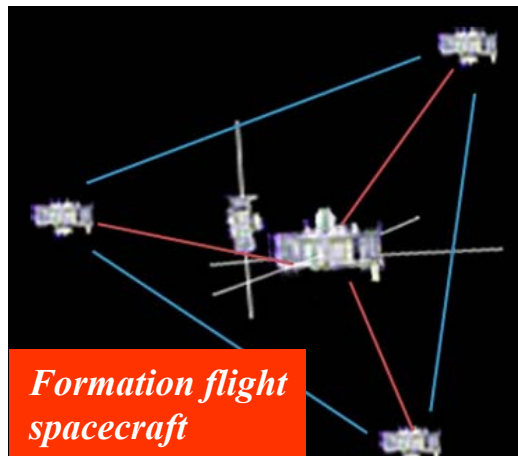
Piggy-bag class satellites

• NeXT (X-ray)

• Solar Sail (Engineering)

(approved as “High Priority Mission”)

Selection: Fall 2005



Formation flight spacecraft

Plans for "New Frame Work"

Establishment of "Modular Structure"

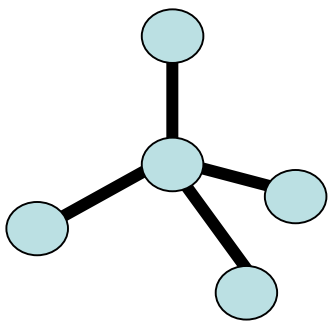
Standard architecture for
- Laboratories (GSE)
- Balloons / Sounding rockets
- Piggy-bag satellites
- Large-scale satellites
- Formation flights

…based on "Standard Interface" between multiple onboard computers

⇒ Hardware: ***"Spacewire"*** Software: ***"TRON"*** *(popular real-time OS)*

Step by Step approach toward the next missions

Define
- Function
- Link/Connection



From Big Satellite

To distributed satellites