
Prototype Development of Cubesat Flight Software Framework Supporting Multi-Operating Systems

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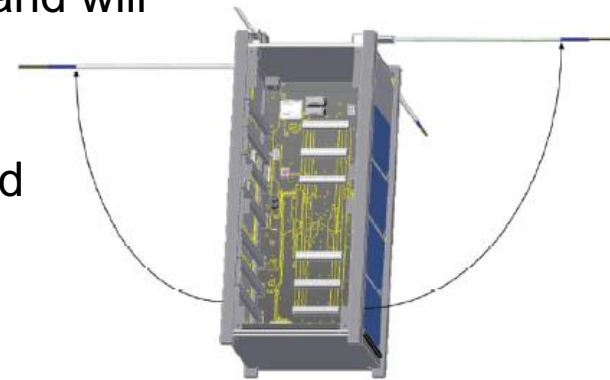
The State of Korea Cubesats(1/2)

- ❑ **In Korea, cubesat contest program has been started from 2012 by KARI and Gov.(MSIP)**
 - ※ MSIP, Ministry of Science, ICT and Future Planning
- ❑ **From now, two (2012, 2013) cubesat contest was hosted and total 6 teams were selected by mission and design contest.**
- ❑ **Korea Cubesat Contest support about 150,000\$ for developing cubesat and launch service to each team.**
- ❑ **Now,**
 - ▶▶▶ 2012 teams finished their CDR in 2013 Dec. and doing Space Environment test
 - ▶▶▶ 2013 teams finished their CDR in 2014 July, just two weeks ago
 - ▶▶▶ We are planning to launch 5 of 6 in 2015 Q3, 1 of 6 in 2016 Q2

The State of Korea Cubesats(2/2)

2012 Teams

- ▶▶▶ KAIST participate in QB50 program and will measure low ionosphere and thermosphere.
- ▶▶▶ Yonsei Univ 's mission is develop and verify vision alignment technology.
- ▶▶▶ Korea Aerospace Univ. will observe thermal images of the Earth

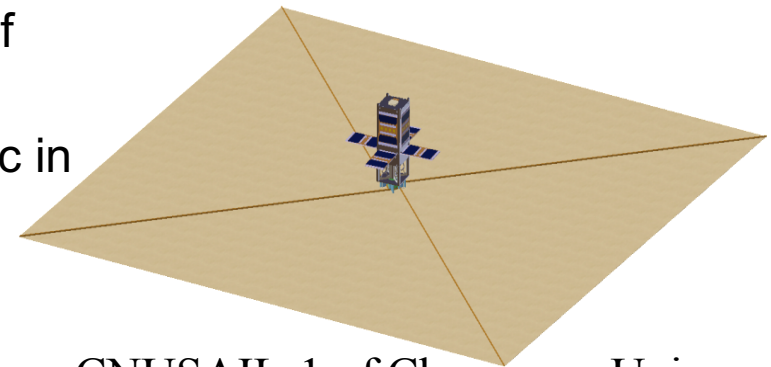


LINK of KAIST



2013 Teams

- ▶▶▶ Kyung hee niv. will measure radiation of Earth.
- ▶▶▶ Chosun Univ. will test mems thruster etc in space.
- ▶▶▶ Chungnam Univ. will test solar-sail deployer



CNUSAIL-1 of Chungnam Univ.

Background

❑ **Be Various Operating Environment of cubesats**

- need Software framework supporting various operating environments
- OS : freeRTOS, Salvo, uCOS etc.

❑ **Develop flight Software technologies with nano-satellites features**

- support AX.25 protocol, I2C data communication
- need replacement technology that is H/W functions to Software for developing small and light weight satellite

❑ **Use framework as common core Software for development productivity such as reusability and cost reduction**

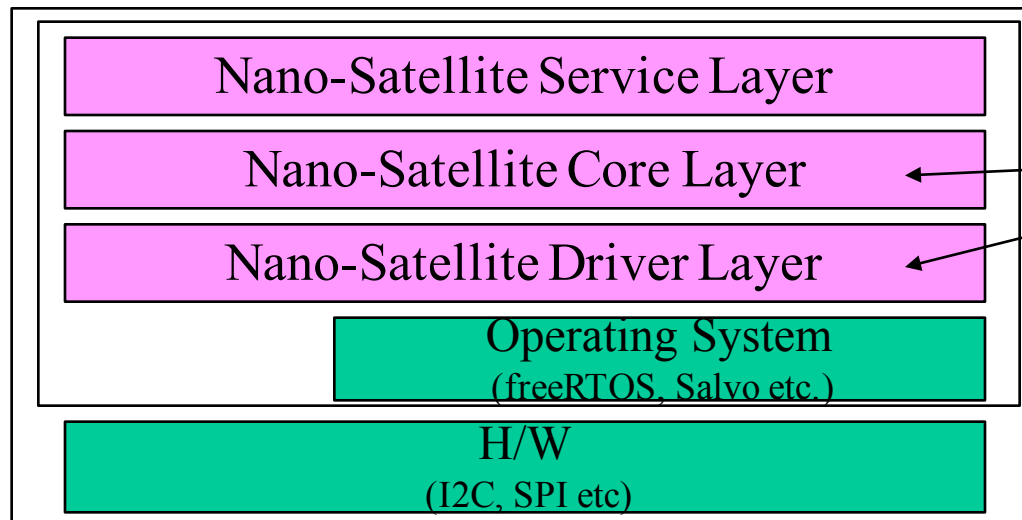
- In IT technology, Linux, Android, Struts etc. are very popular as operating system or development framework
- In nano-satellites, we need common software development framework

Cubesat Flight Software Framework (1/2)

□ Conceptual Design

➤ Basic Principal

- Use component based development way
- 3 of core layer applying Layered architecture for abstraction
 - Each layer is accessed by only API
- Have platform independent and open source software



In progress



Cubesat Flight Software Framework(2/2)

❑ Conceptual Design

➤ Nano-Satellite Service

- Service Management : Service Add, Update, Delete, Execute
- Message Service : Get housekeeping or mission information from subsystems

➤ Nano-Satellite Core

- TM&TC : TM&TC parsing, analyze, execute
- Data Processing : Data format, Data index etc.
- Scheduling : Real-time service scheduling

➤ Nano-Satellite Driver

- Core Driver : I2C, SPI, CAN, UART Data Bus Driver

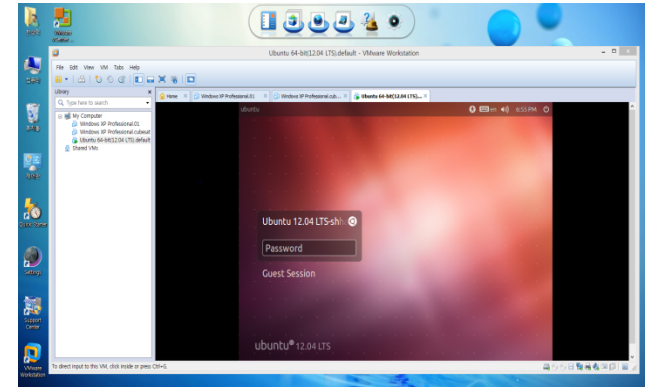
Development Env.(1/4)

❑ Satellite Part-Pumpkin OBC

- ▶▶▶ Pumpkin cubesat for MSP 430 and ISIS TRXUV communication board for H/W
- ▶▶▶ Development Computer, Compiler(Crossworks and Salvo etc)
- ▶▶▶ Windows XP and Ubuntu 12.4 UTS for development OS



<Fig 1> CubeSat and SubSystem

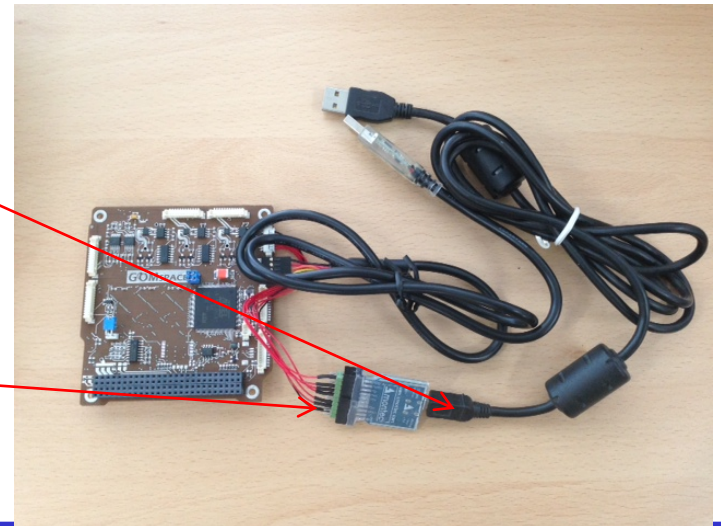
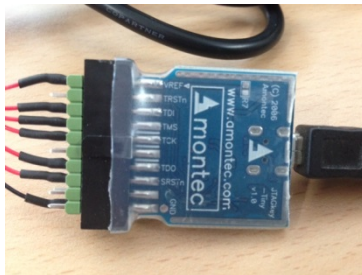
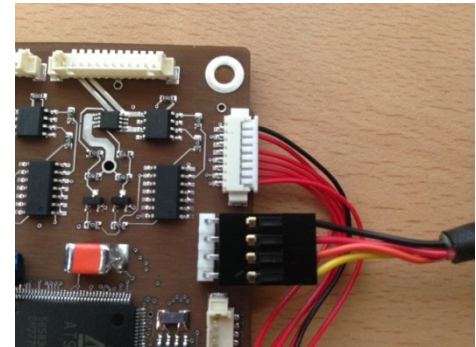
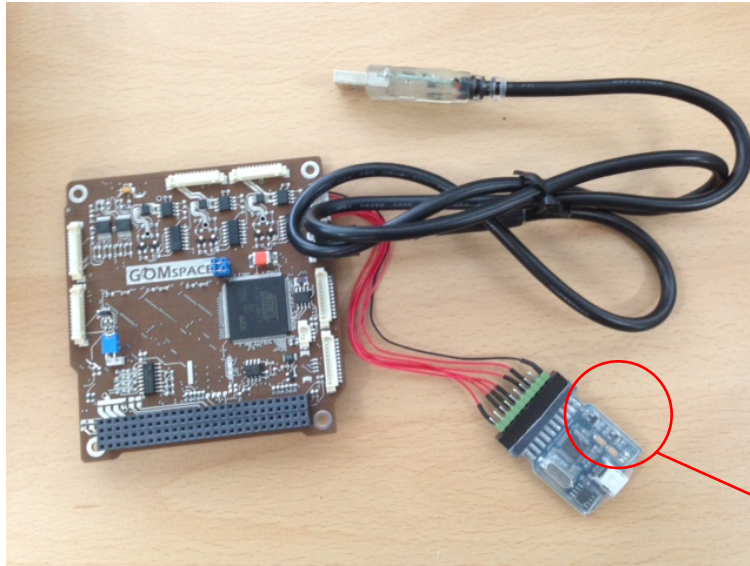


<Fig 2> Development Env.

Development Env.(2/4)

❑ Satellite Part-GomSpace OBC

➡ OBC is NanoMind A712D and FSW use freeRTOS.



Development Env.(3/4)

❑ Satellite Part-Tyvak OBC (in the near future)

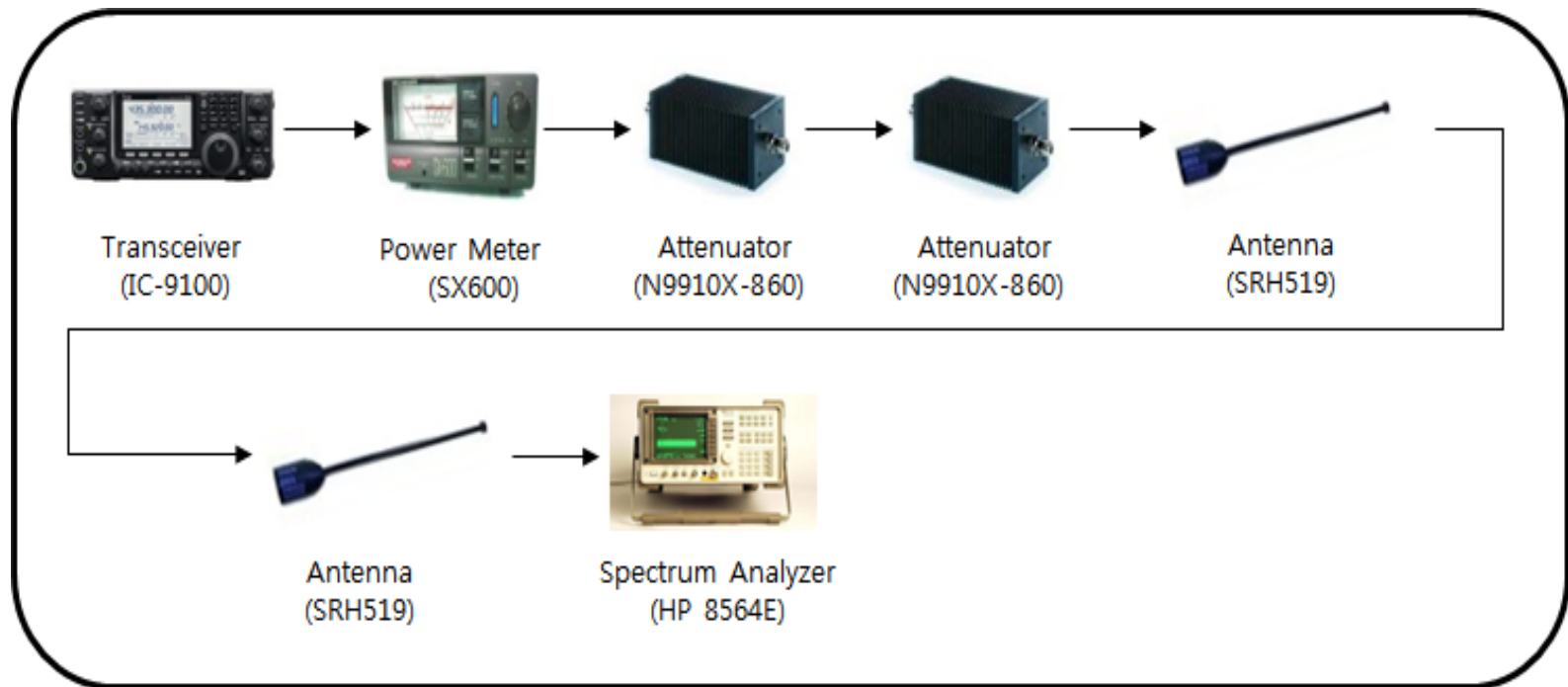
➡ Tyvak OBC use linux as operating system.



Development Env.(4/4)

□ Ground Station

- ▶ Use Attenuator for degrading TX power not to harm cubesat transceiver(ISIS TRUXV).



Some Experience of Cubesat SWs(1/4)

❑ I2C driver development on PUMPKIN OBC(1/2)

- In early, with lack of satellite system experience, it was very difficult and time consuming to solve problems.
- Some of the time consuming problems,
 - PUMPKIN MCU configuration for ISIS TRUVX
 - Understanding and configuration of I2C protocol
 - ISIS TRUVX need to be charged for operating
 - I think PC104 on Pumpkin will charge normal volt in first.
 - Difficult to know flow of I2C data
- Solving the problems step by step
 - Prepare I2C monitor and Host adapter : Beagle I2C analyser and Advark host adapter is good and easy to use.
 - Discussing and Questioning with cubesat members
 - First, test with RTC(Real Time Clock) on Pumpkin OBC and then test with ISIS TRUXV.

Some Experience of Cubesat SWs(2/4)

❑ I2C driver development on PUMPKIN OBC(2/2)

- ➡ '13.10.23 First communication from COM of OBC to Base Station : CW data, OBC <-> COM : I2C



Some Experience of Cubesat SWs(3/4)

❑ AX.25 data communication from OBC to GS(1/2)

- After sending CW data from OBC to GS, I thought AX.25 data communication can be easily done, but not.
- Some of Issues,
 - Lack of data communication knowledge, especially Data Modulation.
 - ISIS TRUVX use BPSK as data modulation.
 - In early, I thought any TNC(Terminal Node Controller) can do this work. But not
- Solving the problem
 - Study data communication from Satellite Transceiver to GS
 - Use SDR tool for receiving data

❑ AX.25 data communication from OBC to GS(2/2)



Cubesat Software Community in Korea

- ❑ For sharing information and developing cubesat software effectively
- ❑ We made CSCK(Cubesat Software Community in Korea) at '14.3, and monthly have offline meeting.
- ❑ We solved many problems and discussed many issues through CSCK
 - ▶▶▶ Experience sharing is very good education for beginners.



Conclusion

- ❑ **Openness and Sharing make it better and better**
- ❑ **SW will be more important in nano-satellite**
 - For making more elegant function easily and fast
- ❑ **The answer is framework based development for supporting multi-os**

Thank You!!

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