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

- The State of Korea Cubesats
- Background
- Purpose
- Proposed Flight SW Framework
- Development Env.
- Some Experience of Cubesat Software
- Cubesat Software Community in Korea
- Conclusion
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 innosphere and thermosphere.
- Yonsei Univ’s mission is develop and verify vision alignment technology.
- Korea Aerospace Univ. will observe thermal images of the Earth

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
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
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

Nano-Satellite Service Layer

Nano-Satellite Core Layer

Nano-Satellite Driver Layer

Operating System
  (freeRTOS, Salvo etc.)

H/W
  (I2C, SPI etc.)
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
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
Satellite Part-GomSpace OBC

OBC is NanoMind A712D and FSW use freeRTOS.
Satellite Part-Tyvak OBC (in the near future)

Tyvak OBC use linux as operating system.
- **Ground Station**
  - Use Attenuator for degrading TX power not to harm cubesat transceiver (ISIS TRUXV).
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.
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
Some Experience of Cubesat SWs (4/4)

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

![Diagram showing satellite communication setup]

- Satellite
- Beagle Analyser
- Advark Adapter
- ISIS Javademo
- USRP100
- Ground Station
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.

1st Meeting(‘14.3)  
2nd Meeting(‘14.4)  
5th Meeting(‘14.4)
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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