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ON BOARD SOFTWARE FOR SCIENTIFIC PAYLOADS ON NANOSATELLITES

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Introduction

Nanosatellites are being used to carry out missions originally designed for large satellites due to advances in computing and nanotechnology. In this context, INPE is interested in migrating some scientific experiments that were originally planned for microsatellites into platforms based on nanossatélites and allowing *in-situ* measurements. This work aims at providing a on-board computing solution to support prospective payloads from CEA-INPE (Coordination of Space Sciences). Therefore, an integrated hardware and software development methodology is proposed, typically applied to embedded systems, using directives from Systems Engineering and TDD (Test-Driven Development). A scheme employing incremental models was adopted starting from emulation, prototyping and porting for a final flight processor and its communication with a Langmuir probe, used as payload in a case study. An I2C-based on-board protocol was defined and exercised. The software libraries, based on the Mbed framework, have been written and tested so that the on-board computer (OBC-P) can manage useful scientific loads. Instances of this system were generated with applications for the NanoSatBr2 nanosatellite as well as to a prospective educational-scientific nanosatellite named Alpha-CTEE from PG-ETE.

Development

Methodology adopted for Board Computing
1. Survey of General OBC Requirements in Space Applications
2. Choice of Microcontrollers => STM32
3. Choosing a Development Platform => ARM
4. Choice of an RTOS => Mbed
5. Adoption for Testing => Test Driven (TDD) and ...
6. Test Mapping to IDE => TDD in Mbed
7. Aspects of Systems Engineering - Feasibility in Envelopes of Engineering Systems (size, performance, etc.) - Development by incremental models (Emulation, Prototyping in HW / SW and porting to target)

General Requirements for OBC in Space Applications
a) The OBC in a spacecraft, must have numerical performance for the purpose of the mission, such as data processing, control, payload data management and other functions,
b) OBC must be mechanically robust to support the launch;
c) In orbit, the OBC must operate under adverse electromagnetic conditions (van Allen belt);
d) OBC must be capable of withstanding aggressive chemical substances, for example, in low orbits, the presence of atomic oxygen
e)The OBC consumption must be limited by constraints due to the power generation system,
f) The OBC must have defined criteria against failure and redundancy.

Minimum Hardware System
- The minimum hardware system (Figure 1) consists basically of commercial electronic components and boards in order to initiate project development and prototyping •
- Serves as a baseline and consists of two development boards with the STM32F407VET microcontroller low cost.
- One board emulates the OBC on-board computer and the other emulates a payload Langmuir probe.

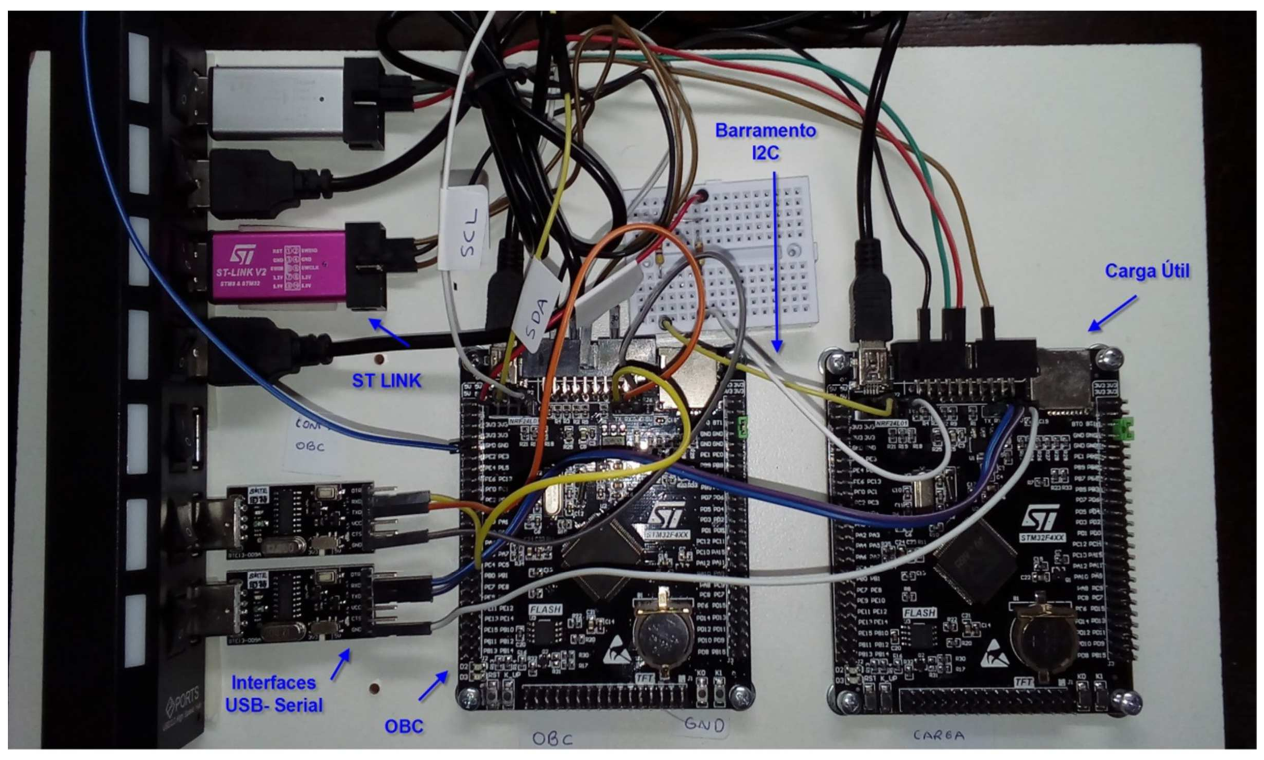

Figure 1 – Minimum Hardware System

Porting Mbed for different platforms (Figure 2)

Deployment process for other targets is deployed in the following basic steps:
- Step 1 - The code in C ++ is built using the Mbed framework
- Step 2 - Within the Mbed environment a target is defined
- Step 3 - A process Is there a way to do this.

Figure 2 – Porting Mbed to different platforms

Conclusions

Work focused on the integrated development of HW / SW for onboard computing solutions with scientific payloads at nanosatellite. - Increasing interest in nanossatellites embarking several missions originally from larger satellites. - INPE's Master Plan predicts in the short term the migration of microsatellite experiments to nanosatellite, eg the Langmuir probe of the CEA as a case study.- There is demand in several research groups of the CEA for instruments with in-situ measurements Nanossatellites allow as well as the verification and testing of new concepts for eventual use in larger satellites.

Limitations Found and Lessons Learned

iOBC -ISIS presented some interface problems at the protocol level during the integration phase of the payloads (SLP) and SDATF. • Cost-plus development for AT91SAM9G20MDK9G20-EK, MCU-ZONE • Non-existence of ICD documents for payloads of Radio Hiding and the Electron Detector • Development of payload controllers must: (a) test with the same processor used in the OBC or near, if possible and (b) use same HW and same SW libraries - An OBC using MCU-ZONE module similar to iOBC, will allow to develop and test interfaces with usable loads in near-flying environment.