AIR

ARINC 653 Interface in RTEMS

The AMOBA and AIR Activities

Presented at ESA Workshop on Avionics Data, Control and Software Systems (ADCSS)

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Excerpt from the ESA ADCSS Abstract Book:

The AMOBA & AIR activities

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The ESA sponsored AMOBA activity aims to build a multi-platform POSIX compliant ARINC 653 OS. The AMOBA activity also aims to perform a first study on which changes or add-ons must be done over the ARINC 653 standard as for it to cope with the specific space needs. This study shall be WP1 of the AMOBA project and the conclusions achieved shall be included on the AMOBA simulator (WP2 and WP3). WP1 is planned to be over by September 2007 and as such we believe to be relevant to present a resume of the conclusions we have reached on the workshop.

Also on last May, Skysoft and FCUL have ended the AIR activity (also ESA sponsored), which aimed to study and do a proof of concept prototype on the adaptations required on the RTEMS OS to offer the application interface and the functionality required by the ARINC 653 standard. A paper (ARINC 653 Interface in RTEMS) was presented at the DASIA conference with the results of the activity. At this point Skysoft and FCUL continue to work on evaluating future evolutions of the results achieved on the scope of AIR. As such we propose to present the AIR activity achievements and the future work that Skysoft and FCUL aims to do on the scope of AIR-II.

[1] Skysoft Portugal SA.
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Skysoft and FCUL perspective over IMA on space:

The AIR & AMOBA Projects

ESA IMA on Space Workshop

- The IMA concept and the APEX ARINC 653 standard are strong candidates to became the *de facto* technology for software development on the aeronautics market.
- The foreseen advantages are:
  - Provide easier system integration and validation
  - Provide a standard development platform
  - Inter-operability of different systems
  - Physical advantages – less energy consumption/less weight/more free space
- We believe this are also applicable on the space market context.
- Next we present 2 projects relevant for the spin in of IMA/ARINC 653 for the space market.

AMOBA Project

Fundamental concepts

By: Skysoft Portugal SA

- AMOBA stands for: ARINC 653 Simulator for Modular Based Space Application
  - Sponsor: ESA under the 4th GSTP ITI program (50% funded)
  - Consortium: Skysoft Portugal SA
  - Time frame: January 2007 to January 2008

AMOBA objectives

- The AMOBA objectives are
  - To study which changes must be done to ARINC 653 standard as to make it compliant with on board space software needs
  - To build and ARINC 653 simulator which shall:
    - Enable developers to test their software on different architectures then the final target ones;
    - Enable system integrators to perform early integration testing and benchmarking of the ARINC 653 system;
  - Integrate proposed changes to ARINC 653 for space on the AMOBA simulator.
  - Market analysis of the AMOBA simulator.

AMOBA Simulator design

- The AMOBA Simulator aims to be:
  - multi-platform - this implies the simulator must be easily portable and as such:
    - Independent from hardware
    - Independent from the OS
      - Usage of well know and common standards as POSIX;
      - If not 100% possible then non OS independent components must be isolated and carefully identified as to make porting easier
  - Compatible:
    - Be 100% compatible with the APEX definition
    - Developed on ANSI C language using the POSIX library
  - Simulator shall be executed over the TSIM2, simulator of SPARC processors commonly used on space missions
  - Reflect the output of IMA/ARINC 653 space adaptation analysis;

AMOBA Status

- Expected conclusion: January 2008
- Study of ARINC 653 on space should be concluded on early November;
- AMOBA Simulator is planned to enter integration and assessment testing on early December

AIR – ARINC 653 Interface in RTEMS

AIR Project

Fundamental concepts

By: Skysoft Portugal SA and FCUL

AIR Summary

- The AIR (ARINC 653 in RTEMS) proof of concept project:
  - Sponsor: ESA under ITI program
  - Consortium: Skysoft Portugal SA and FCUL
  - Time frame: September 2006 to March 2007
  - Target Hardware Architectures
    - INTEL IA32/PC386 (prototyping basis)
    - Adaptation to SPARC architecture family namely the ERC32, LEON2 and LEON3

The RTEMS OS

- RTEMS – Real Time Executive for Multiprocessor Systems
  - Free, well-known, real-time multitasking kernel, with a modular architecture used for space applications.
- RTEMS implements some of the required ARINC 653 functionalities:
  - Real-Time priority-based pre-emptive task scheduling;
  - Set of inter-task communication and synchronization capabilities;
- RTEMS **does not implement** the fundamental mechanisms to secure all ARINC 653 functionalities:
  - Temporal segregation
  - Spatial segregation

AIR Objectives and Skills

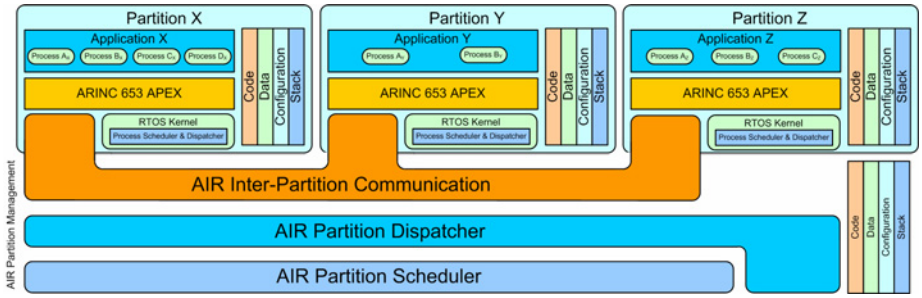
- AIR aimed to:
  - tailor the RTEMS OS to implement the ARINC 653 specification
    - Make available the ARINC 653 API to RTEMS developers
    - Implementing the partitioning concept over RTEMS
      - spatial segregation
      - temporal segregation
- Skysoft:
  - Use ARINC 653 know how to specify, design and implement a demonstrator of the ARINC 653 services over RTEMS
- FCUL:
  - Use knowledge of RTEMS as to tailor it to the ARINC 653 partition requirements

AIR Motivation and Results

- Initial motivation was:
  - Be the first iteration on the creation of a commercial ARINC 653 compliant RTOS aimed for the space market
  - Provide ESA evidences of the utility and usability of the ARINC 653 concept on space based applications
- But AIR went further and...
  - A general architecture for an ARINC 653 compliant RTOS was defined.

AIR Design Concepts – Multi-Executive Core

- one RTOS instance per-partition; one APEX per-partition
- different RTOS may be used at each partition



AIR Proof of Concept Demonstrator

AIR-II Rationale

- ARINC 653 in Space – Industrial Initiative
  - Skysoft Portugal SA, FCUL, Thales Alenia Space
- Design consolidation of main components:
  - RTOS independence (open-source, commercial)
  - Inter-partition communication and input/output
  - Spatial partition
- Overall Goals:
  - Compliance with space requirements
  - Deployment as an advanced prototype
  - Integration and testing with space-related applications

IMA Open Issues

- IMA concept for Space
  - Unmanned spacecrafts
  - Limited on-board maintenance
    - software updates deployment
- Impact on Spacecraft Avionics
  - Processor infrastructure with MMU facilities
- Impact on Real Time Operating System
  - AIR Architecture: minimal changes on native RTOS
- Business case for space:
  - IMA concept used in the aeronautic world
  - IMA concept based on open-source RTOS (e.g. AIR)
    - Opens room for a cost reduction opportunity