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NANO-SATELLITE SYSTEMS LLC

Open-source Software for CubeSat Satellites

CubeSat Summer Workshop 2012

Logan, UT

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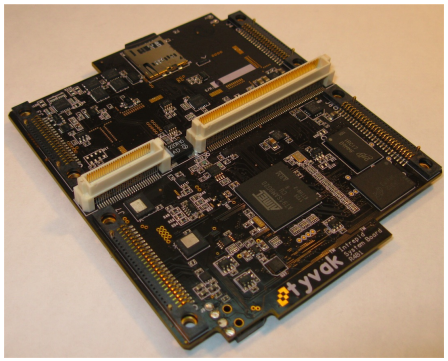
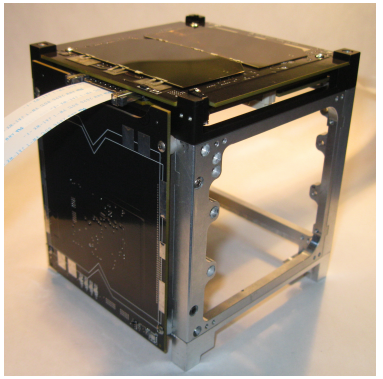




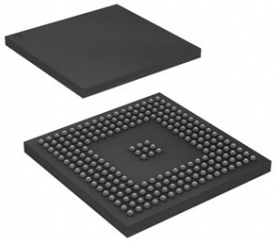
Presentation Goals

- **Provide open-source development knowledge**
  - Can you develop using open-source based software?
- **Applicability to overall CubeSat design**
  - How does it generally apply to your CubeSat or spacecraft?
- **Benefits and Disadvantages**

Open-source Development Introduction

- **Publicly available source code**
  - Typically distributed online and / or through repositories
  - Commercial or free options available

- **Developed under open source license**
  - GPL and LGPL common
  - Multiple extensions, such as v2, v3
  - In general, this provides every user with the freedom to use, change, and share software



- **Multiple collaborators and contributors**
  - Any interested developer can contribute to open source projects
  - Developers can even start their own projects

Applicability to CubeSats

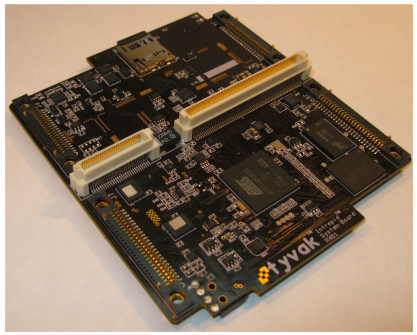
- **Ease of development**
  - In general, smoother development is extremely beneficial
  - Software developers have access to online support groups and forums
    - This is extremely common for open source development
  - Environment may already be familiar to multiple developers
- **Variety of development tools**
  - Typically available at no cost
  - Development environments, toolchains, troubleshooting tools or debuggers to support peoples' needs
    - Multiple development language support
- **Continuously improved software design**
  - Active projects have developers continuously contributing
  - Forms robust and reliable software design implementations, which is a big plus

Intrepid System Overview

- **Linux as primary OS**
  - Vanilla kernel without unnecessary modules or dependencies
    - I.e., video output support, standard Desktop environment removed
  - Time sharing system designed for fair scheduling

Credit L. Ewing

- **Open source benefits**
  - Utilizes a variety of pre-existing robust modules tested for other embedded applications
    - Linux network stack and supporting utilities
    - File system support
  - Support from others, even other CubeSat developers



- **RTOS compatibility**
  - Multiple extensions or skins available for improved real-time support
  - Hasn't been necessary for any current Intrepid-based missions

Other Open Source OS Options

- **RTOS**
  - FreeRTOS
    - Source is freely available and supported on a number of architectures
    - Standard support for task, message passing, interrupt, and shared-resource mechanisms
  - RTLinux
    - Variant of Linux where the OS is ran as a preemptive process to support real-time behavior
  - eCos
    - RTOS intended for embedded applications
- **Other Embedded**
  - TinyOS
  - Extensions or additions to Linux, such as Android

Other Awareness

- **Bring-up Time**
  - Committing time to form a stable development environment
  - Setup time is essentially removed after environment is formed
    - Begin development!
- **Learning Curve**
  - Inevitable for any new or unfamiliar material
  - Might not be necessary based on desired development
    - Linux-based systems taught at several universities
  - Initial hurdle may require several months of time
- **Hardware Support**
  - Desired architecture may not be supported and require change
  - Design for custom hardware may require other knowledge and time

Questions

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