Open Source Software for Small Satellites

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Introduction

- Open source approaches are transforming the software development world

- This paper examines open source software for small satellites, including:
  - Benefits of using, releasing, and developing open source software
  - Current state of and future directions for small satellite-relevant open source software

What is Open Source Software?

- Open source software is software licensed to allow you to freely use, modify, and redistribute to others

- Many open source / free software licenses exist, with varying terms and conditions
  - See for example http://www.fsf.org/licensing/licenses and http://www.opensource.org/licenses

- Open source development tends to feature community involvement (including contributions) and broad-based software peer-review and testing

Note: We do not make a distinction between the "Free Software" (Free as in Freedom) and "Open Source" movements in this paper

Benefits of Open Source Software for Small Satellite Activities

- Existing source code offers the potential for decreased cost and faster availability by eliminating the need for substantial development and/or procurement of proprietary software

- Developing software in an open source manner leads to significantly greater feedback and contributions towards the functionality of the software than would otherwise be available
    - Tends to increase the quality of the software (in terms of both features and reliability) while decreasing the investment that must be made by the organization developing the software

- Releasing software in an open source manner can also increase interest in the project and provide an educational opportunity for those examining the software
    - Can be of benefit to small satellite projects in need of additional resources and/or whose objectives are educational in nature

- Characteristics that frequently accompany small satellite projects make them well suited to the use of open source software.
    - A tight budget leads to a desire to limit licensing fees
    - The need for new, innovative solutions creates a desire to be able to add functionality on-top of that of existing software
    - A rapid development schedule leads to a desire to have a code base to build-upon, rather than having to build everything from scratch
    - Having massively parallel, distributed peer-review of software can also lead to increased probability of mission success

- Many of these benefits come about as a result of a wide variety of people using and in so doing, testing the software

Examples

- Many open source packages exist of relevance to small satellite projects, ranging from general use software (Linux, Eclipse, MySQL, etc.) to space specific software
    - This software can be used both in the design and development of satellites as well as in their operation (including flight software)

- We highlight three example open source software packages that may be of interest to the community
    - Java Astrodynamics Toolkit (JAT)
    - Open-Source, Extensible Spacecraft Simulation And Modeling Environment (Open-SESSAME)
    - OpenFlightLinux

- A more comprehensive listing of open source engineering software related to space projects can be found at http://www.developspace.net/wiki/Open_Source_Engineering_Tools

JAT and Open-SESSAME

- Java Astrodynamics Toolkit (JAT, http://jat.sourceforge.net)
  - Cross-platform software library centered around astrodynamics
  - Enabling mission design and other spacecraft development simulations
  - Not a complete stand-alone environment, but similar in functionality to some aspects of the STK and FreeFlyer software applications
  - Provides flexibility to a mission designer as it can be tailored to specific needs
  - Released as free, open source software under the General Public License (GPL)

- Open-Source, Extensible Spacecraft Simulation And Modeling Environment (Open-SESSAME, http://spacecraft.sourceforge.net)
  - C++ software package aimed primarily at spacecraft dynamics and control
  - Developed originally by the Virginia Tech Space Systems Simulation Laboratory
  - This package and the related, lower-level code for their "Distributed Spacecraft Attitude Control System Simulator" are both also released under the GPL

FlightLinux

- FlightLinux was a NASA Goddard project from 1999-2002 to assess the technological readiness of an open source operating system for onboard spacecraft use
  - Many lessons were learned, and the advantages of this approach were delineated in the Project's final report
  - Export control issues emerged that hindered the unlimited release of spacecraft flight software

- Independent OpenFlightLinux project recently created, building on NASA's investment in FlightLinux
  - Provides customized operating system and applications builds
  - Can be customized as a development platform, a server, an embedded real-time system, an appliance, avionics, a cluster, even a desktop.
  - Team is developing and deploying open source tools to facilitate custom system builds and address dependency problems
  - Real-time, low latency embedded systems are also addressed
  - Free open source distributions available for x86 and PowerPC (targeted to the RAD-750 processor)

- Enables project-wide visibility and control of all of the software at the source code level
  - Having the same software platform across the spectrum of applications is also beneficial

- OpenFlightLinux is not restricted to space projects
  - Team is actively working on Medical-FlightLinux, a version that implements NASA-developed planetary imaging techniques for medical applications
  - Also developing Flight-Linux-FPGA, which allows configurable hardware as well as software

- OpenFlightLinux project website: http://www.openflightlinux.org

- Original NASA FlightLinux project website: http://flightlinux.gsfc.nasa.gov/

Building an Open Source Space Community

- Building a community around open source space software can broaden its adoption and encourage the developing of additional software

- NASA's CosmosCode project, is an effort by NASA Ames to catalyze open source space software development and encourage NASA participation in the open source software world
  – Will be creating an community infrastructure and will provide open source software project hosting

- DevelopSpace is a non-profit initiative aiming to enable a wide variety of individuals and groups to participate in the technical aspects of the exploration, development, and utilization of space
  – Applying open source principles to all aspects of space systems engineering, including software
  – Currently provides wiki functionality for reference material and specific projects; additional project hosting and community building infrastructure is being developed
- Interested in engaging with small satellite developers to provide functionality to their project hosting needs and foster an "open source" space community

Summary

- Open source software offers significant benefits in the conception, development, and operation of small satellites

  - Decreases cost

  - Decreasing development time

  - Increases reliability

- Open source software exists of relevance to the small satellite community, ranging from general purpose engineering, networking, and analysis software to software developed specifically for space-related purposes

  - Three examples highlighted, although many more exist

- Efforts to foster open source space software development are being developed

  - NASA's CosmosCode project, focused on space-related software

  - DevelopSpace, for open and collaborative space engineering in general

Selected Websites

- Open-Source, Extensible Spacecraft Simulation And Modeling Environment (Open-SESSAME) project website, http://spacecraft.sourceforge.net/

- Java Astrodynamics Toolkit (JAT) website, http://jat.sourceforge.net/

- OpenFlightLinux project website, http://www.openflightlinux.org

- NASA Ames Research Center Open Source Software, http://opensource.arc.nasa.gov/

- NASA Goddard Space Flight Center Open Source Software, http://opensource.gsfc.nasa.gov/

- NASA CosmosCode project website, http://www.cosmoscode.org/

- DevelopSpace website, http://www.developspace.net

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