The GPS Toolkit
An Open Source GPS Software Project

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For most engineers, scientists and students, research and development related to GPS is a software-intensive endeavor. A number of proprietary software packages are available to provide basic analytic functions. But in order to implement a new product, to validate a new idea, or to vary a standard algorithm, frequently researchers must create new software. What is missing from the current GPS research landscape is a software development suite that is open source. To meet this need, Applied Research Laboratories at The University of Texas at Austin (ARL:UT) has established an open source project called the GPS Toolkit, or GPSTk.

The GPSTk distribution consists of a core library, plus a collection of applications, released under the terms of the Lesser GNU Public License (LGPL). Some of the applications are stand-alone utilities. Others exist to provide programming examples. A variety of test programs are provided that exercise the library and may be used for validation testing on a new platform. The source code for the GPSTk is highly portable C++, and platform-independent. It has been installed and tested under Linux, Solaris, and Windows, using Visual Studio and Cygwin compilers. Support for Mac OS X is expected in the near term.

This paper presents an introduction to the GPSTk, including a summary of its capabilities. The suite of applications provided by the GPSTk distribution will be described in detail. The paper will conclude with a description of how the project is expected to mature.

What are the benefits of providing such an open source GPS library? There are a number of benefits that can accrue to all involved. First, a readily available library speeds the development of research applications by eliminating the need to develop base level functions. Second, all users benefit from the increased robustness of the source code as users contribute bug reports and fixes. Third, by providing the source code, users are allowed insight into the provided algorithms. This allows the user to make an informed decision as to the appropriateness of processing a particular dataset with a given software utility or library function. Fourth, users have the option to fix software defects on the fly, rather than awaiting a bug fix. Finally, users have the option to experiment with or to tailor standard algorithms. In summary, by providing the user with an open source library, the user can begin doing research sooner.
The GPSTk supports a broad range of functionality including reading and writing observations to standard formats such as RINEX; algorithms defined in the ICD-GPS-200; navigation solutions such as receiver-autonomous integrity monitoring (RAIM); atmospheric delay models; and P-code generation.

In addition to this support library, there are stand-alone utilities built upon it. These utilities provide stand-alone, application specific functionality such as the following: position estimation and plotting; RINEX editing; cycleslip correction; and total electron content (TEC) estimation.

The GPSTk distribution is expected to be available for download on SourceForge at [http://gpstk.sourceforge.com/](http://gpstk.sourceforge.com/) as of June 1, 2004. Both source code and platform-specific binaries will be available. In addition to a download page, the website will provide a bug reporting and tracking facility, and a feature request list. Through the website, extensive documentation will be provided. There is a guide for new users, as well as a guide for developers and contributors. The project creates a detailed design document generated directly from the source code using the doxygen package. Any user with the doxygen package can regenerate the detailed design document.

Although the GPSTk is a new project, it draws from a rich history of satellite navigation software development. ARL:UT has been involved with satellite navigation since its involvement with the Transit constellation in the 1960's. Since that time, ARL:UT has developed a significant body of software source code related to processing satellite navigation data for both pure and applied research. GPSTk is derived from that body of source code and benefits from ARL:UT's experience with source code development.

While the origins of the GPSTk are in software development at ARL:UT, the goal is for the GPSTk to become an excellent, community-wide resource for all users of GPS and GNSS technology. ARL:UT welcomes participation in the GPSTk. All forms of input are encouraged: bug reports, new algorithms, suggestions for improvement, and contributions of additional applications. Suggestions or contributions which would broaden the range of applicability of the project are welcome as well.

The GPSTk is actively growing and improving. New capabilities, which are expected to become part of the applications section of the distribution in the very near future, include bindings for interpreted languages such as MATLAB and Octave; more RINEX utilities; positioning and navigation algorithms; satellite visibility tools; receiver-dependent raw data-to-RINEX conversions; time transfer algorithms; and more. As the user base grows, the GPSTk will benefit from contributed features and bug fixes. ARL:UT is dedicated to ensuring that the GPSTk is extended and maintained throughout the lifetime of this project. Through community involvement and collaboration, ARL:UT hopes to ensure that the GPSTk provides a freely available, best-of-class suite of software tools to every GPS researcher.