Applied Research Laboratories

The University of Texas at Austin

The GPSTk: GLONASS, RINEX 3.00 and More

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Overview

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- Fundamentals of the GPSTk
- Web presence
- Functionality
- Getting Started
- RINEX 3.00 branch
- Clock tools

GPSTk Fundamentals

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- Ultimate goal: free researchers and developers from GNSS algorithm development
- Design and implementation
  - Core library + Applications
  - Object oriented, ISO standard C++, platform independent → *portable*
  - Version 1.6 contains 158,000 handwritten lines of code[1]
    - Estimated value of $6 million (COCOMO model)
    - Ver 1.1: 70,000 lines of code (handwritten)
- Released under Lesser GNU Public License, or LGPL
  - You have the right to use, modify and redistribute this code
  - LGPL license is not *viral*, unless
    - You modify the GPSTk to make your derivative work AND
    - You are externally distributing that work
  - The license file in the distribution contains the full license

[1]Metrics generated using David A. Wheeler's SLOCCount utility

Project Web Presence

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- Website at **http://www.gpstk.org/**
  - Site is a *wiki* : Users can modify/reprogram the site
  - Features include
    - Equations in LaTeX
    - Revision history
    - Powerful searching
    - Question and answer application
    - Tagging
  - Daily snapshot of library documentation
  - Growing user manual
- SourceForge services provide
  - Download of source or binaries
  - Code repository
  - Access to the developer mailing list
- IRC channel `#gpstk` at `freenode.net` for developers interaction in real time

Library Capabilities

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- RINEX manipulation
- Time conversion, manipulation and storage
- Matrix computation
- Basic transforms of time and location
- Precise ephemeris processing
- Range prediction and error modeling
- Reference frame computations
- Statistics
- Troposphere delay models
- Earth orientation transforms
- Expression evaluation
- FIC processing
- Almanac processing
- Low level BINEX input and output
- Broadcast ephemeris processing
- Clock models
- Code generation
- Cycle slip and discontinuity correction
- Numerical integration
- Combinations and difference computations
- Data structures
- Navigation solution
- Astronomical functions

Getting Started

- You can download the stable packages
  - Binary packages for Windows 32 bit, Mac OSX, Linux x386, Linux x86_64, Solaris
  - Source
- You can also get the latest code using Subversion, an open source revision control system
  - To anonymously check out the code base
    `svn checkout https://gpstk.svn.sourceforge.net/svnroot/gpstk`
  - To update your code base: **`svn update`**
- To build the project
  - Requires the **`jam`** utility, which automates compiling and linking
  - Change to the gpstk dev directory and type **`jam`**.
  - Grab some coffee...
  - **`make`** can be used as well. Check the website for details.
- To build the library documentation
  - Requires Doxygen, a utility that generates documentation from code and Graphviz, a package for graphs and visualizations
  - Change to the gpstk dev directory and type **`doxygen`**
  - Go check your email...

Data Structures

- GNSS Data Structures (GDS) are a feature of the procframe library
  - Data structures can be chained to processing objects and vice versa
  - Processing objects can provide smoothing, differences, transformations
  - Successive operations add, modify or remove information to the stream
  - Connection is made using C++ streaming operator **>>**
- Now GDS supports precise point positioning (PPP).
- Examples:

```
gRin >> myFilter >> model >> solver;

gRin >> myFilter >> model >> baseChange >> solverNEU;

gRin >> getPC >> getLC >> getLI >> getMW >> markCSLI >>
markCSMW >> smoothPC >> pcFilter >> modelPC >> mopsW >>
baseChange >> solverWMS;
```

Why RINEX 3.00 Support?

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- Anticipating Galileo
- Revival of GLONASS
- Multi-GNSS receivers
  - Cost dropping
  - Availability is growing
- Applications (e.g. PPP) will benefit
  - Increased robustness
  - Increase signals in obstructed views
- RINEX 3.00 standard is available

Issues in Growing the GPSTk beyond GPS

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- Time system
  - Originally GPSTk assumed a single unifying time system – GPS time
- Coordinate system
  - GPSTk computations all done in WGS84 (G1150)
- Data storage and access
  - Storage and access optimized for GPS data
- Navigation Data
  - Broadcast and precise GPS ephemeris only
- Observation Data
  - GPS only (small support for GLONASS via RINEX 2.11)

Issues in Growing the GPSTk

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- Time system
  - Originally GPSTk assumed a single unifying time system – GPS time
  - Each GNSS will have its own unique time system
- Coordinate system
  - GPSTk computations all done in WGS84 (G1150)
  - Assume each system will have a unique realization of ITRF
- Data storage and access
  - Storage and access optimized for GPS data
  - Data structures must now reflect the different forms of data from each system
  - But, we still would like a unifying design for all...
- Navigation Data
  - Broadcast and precise GPS ephemeris only
  - Must handle multiple forms of broadcast nav data
- Observation Data
  - GPS only (small support for GLONASS via RINEX 2.11)
  - Full RINEX 3 support

Design

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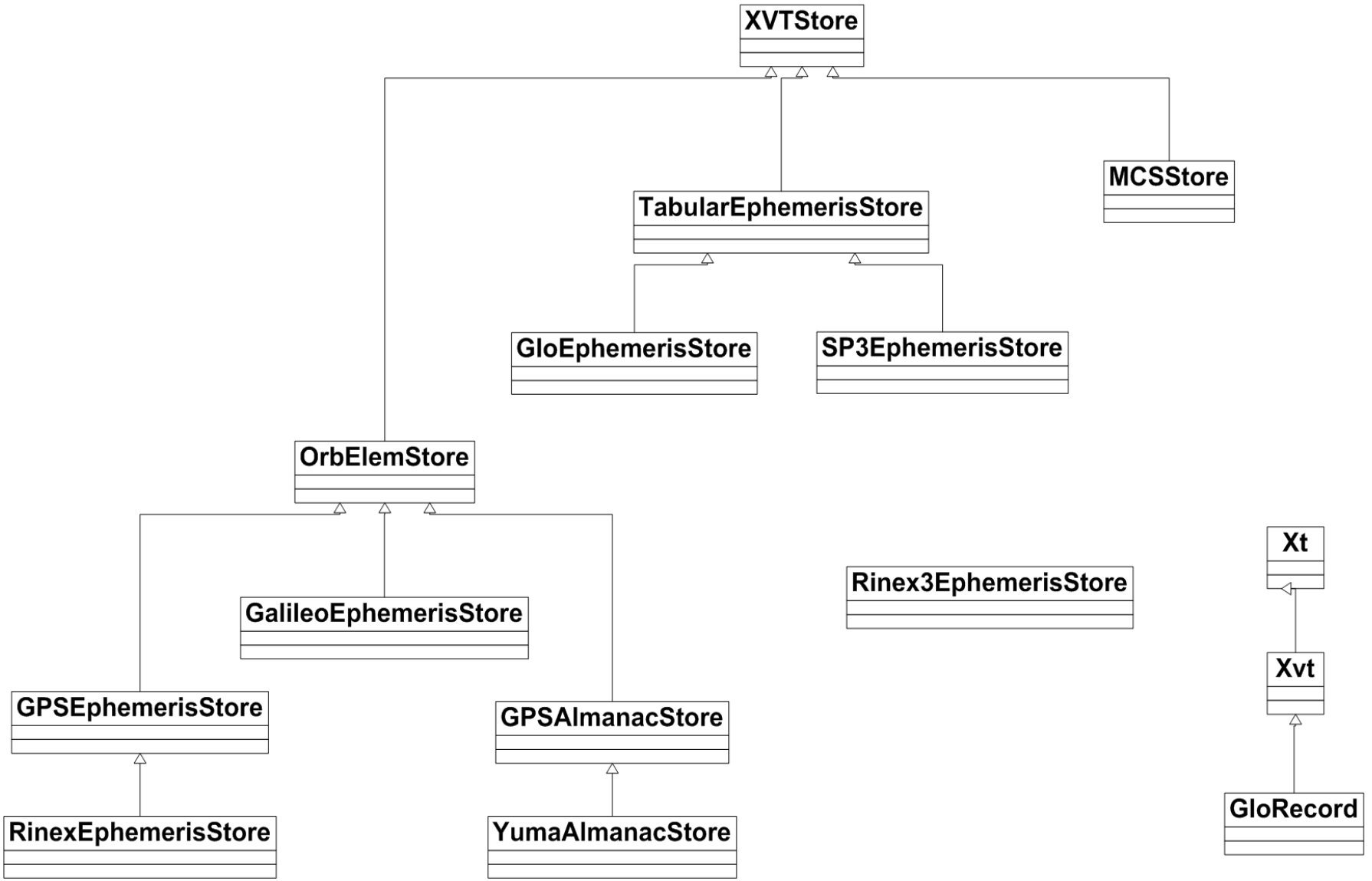

Current Status of RINEX 3.00 and GLONASS

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- Working SVN branch established
  - All changed publicly available
- RINEX 3.00 support added to core library:
  - Different time systems and handling has been incorporated
  - Different reference frames handling is present
  - General design is present that should be expandable
    - Specific implementations are in place for GPS, GLONASS
    - Placeholders for Galileo
  - Observation, navigation file handling for RINEX3
  - Utitlites/classes for RINEX 2.x seamless conversion to RINEX3 complete
- What remains?
  - Integrating to main branch
  - Port existing applications to RINEX 3

Clock Tools

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- Tools to measure the stability of a receiver attached to a clock, or just the stability of a given clock

- Stability metrics implemented include:
  - Allan Deviation (nallandev)
  - Overlapping Allan Deviation (oallandev)
  - Modified Allan Deviation (mallandev)
  - Total Deviation (tallandev)
  - Overlapping Hadamard Deviation (ohadamarddev)
  - Dynamic Allan Deviation (dallandev) – undergoing revision

- Clock tools and Stable 32 yield similar results

Example of Stability Analysis

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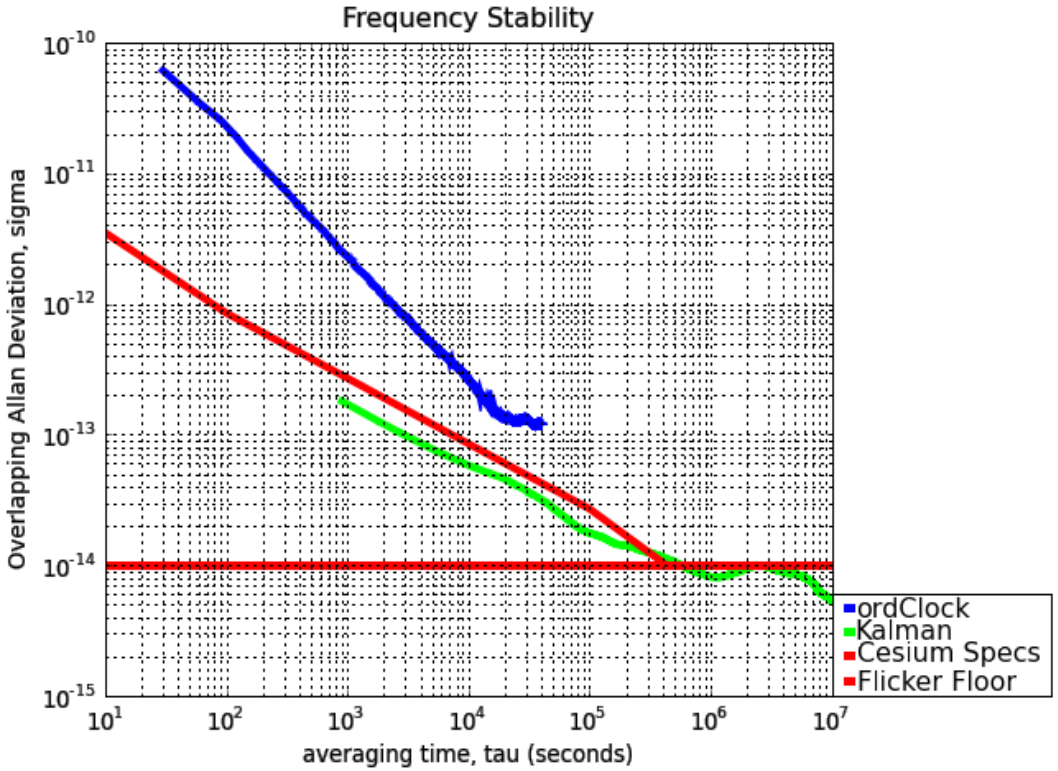


```
ordGen –o s141220a.08o –e s141220a.08n –w 414_220a.08m |
ordClock | ORDPhaseParser | rmoutlier | oallandev >
ordClockout

cat 2007.85414 | rmoutlier | oallandev > Kalmanout

allanplot ordClockout Kalmanout –c –l
```

Example of GPS Clock Stabilities

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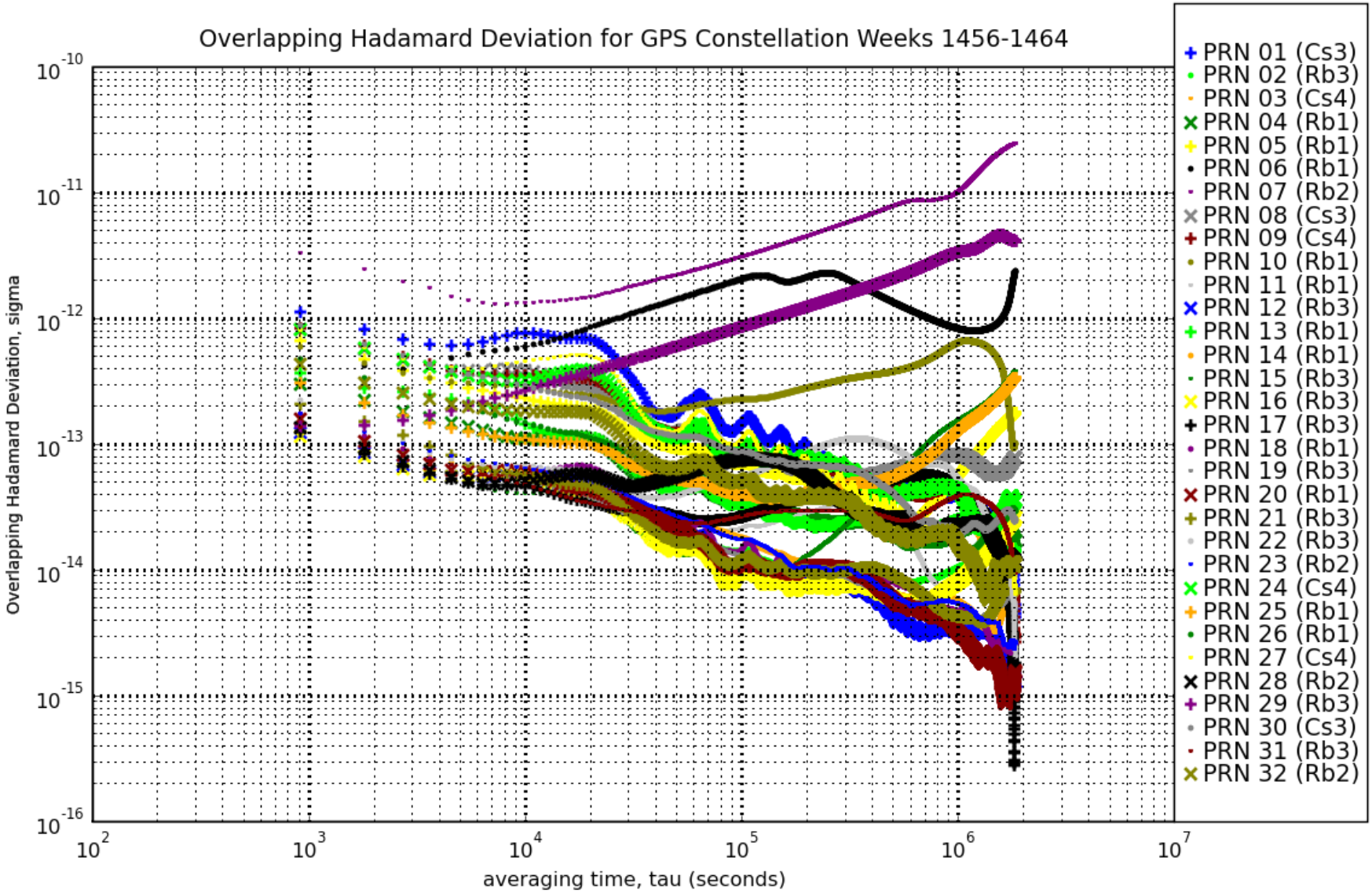

Questions? Comments?

http://www.gpstk.org/

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