Stanford GPS/GNSS Matlab Platform

Integrated Research Platform with Unbounded Positioning Database

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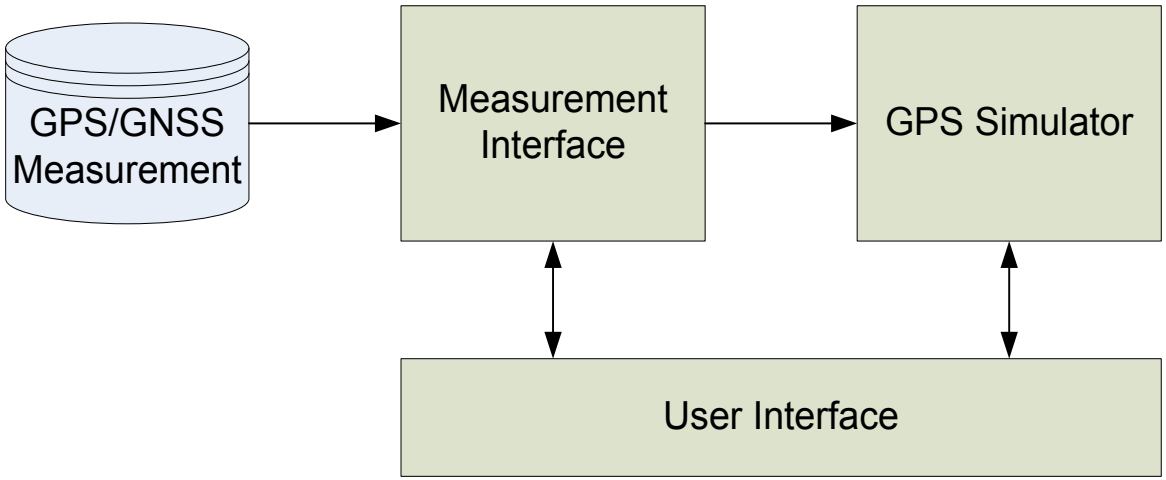
- Stanford GPS Matlab Platform (SGMP) is a platform that enables you to use GPS/GNSS measurements in various formats for your GPS research activity.



Key Aspects of SGMP

- **Everything Matlab**

  Matlab has been most popular for GPS/GNSS research. So let's move everything to the world of Matlab for seamless and uninterrupted research.

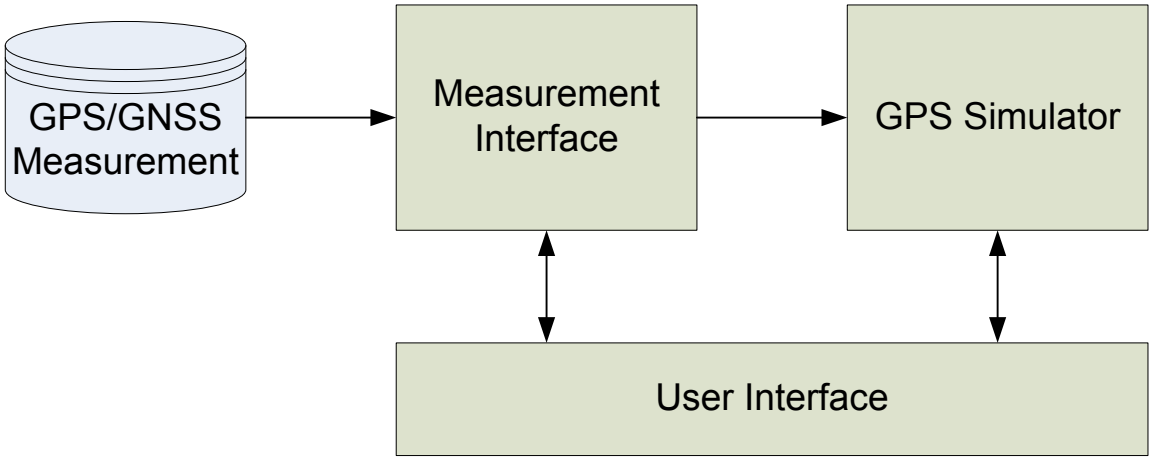
- **Access to Unbounded Database**

  Convert positioning database in various formats (NSTB, NMEA, RINEX…) to a single format in Matlab.

- **Integrated Platform**

  SGMP is a platform intended for GPS simulation as well as measurement interface. Any simulation based on SGMP format can operate under SGMP platform.

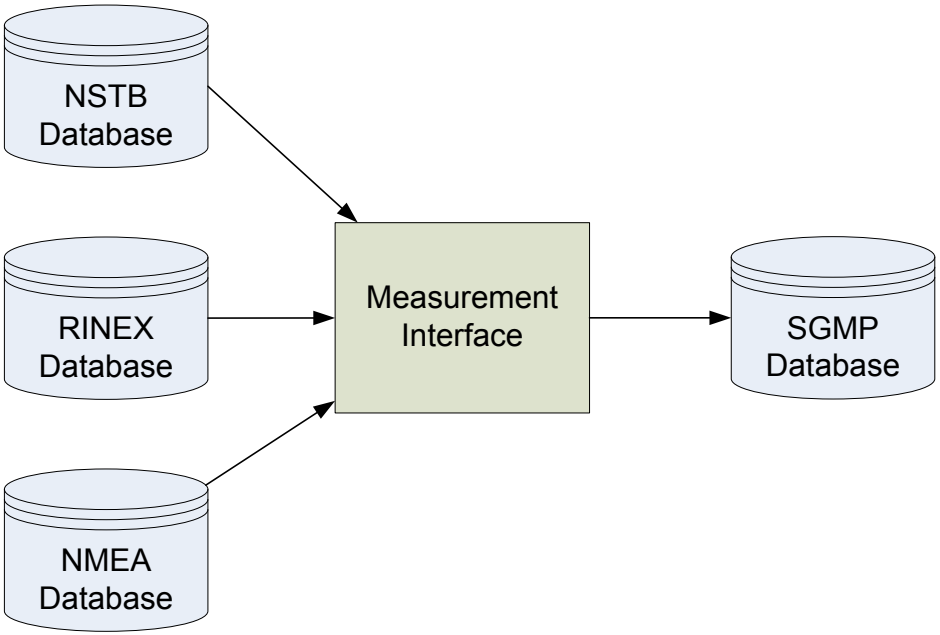
Components in SGMP



- ***Measurement Interface***
  Convert various formats to SGMP format.
- ***GPS Simulator***
  Position estimation, RAIM research…
- ***User Interface***
  Provides user control.

Measurement Interface

- *A*n interface to various formats of GPS intermediate measurements (psuedorange). All supported formats of measurements are converted to a Matlab format.



- Extension to other sensors (TV, WiFi, INS…)?

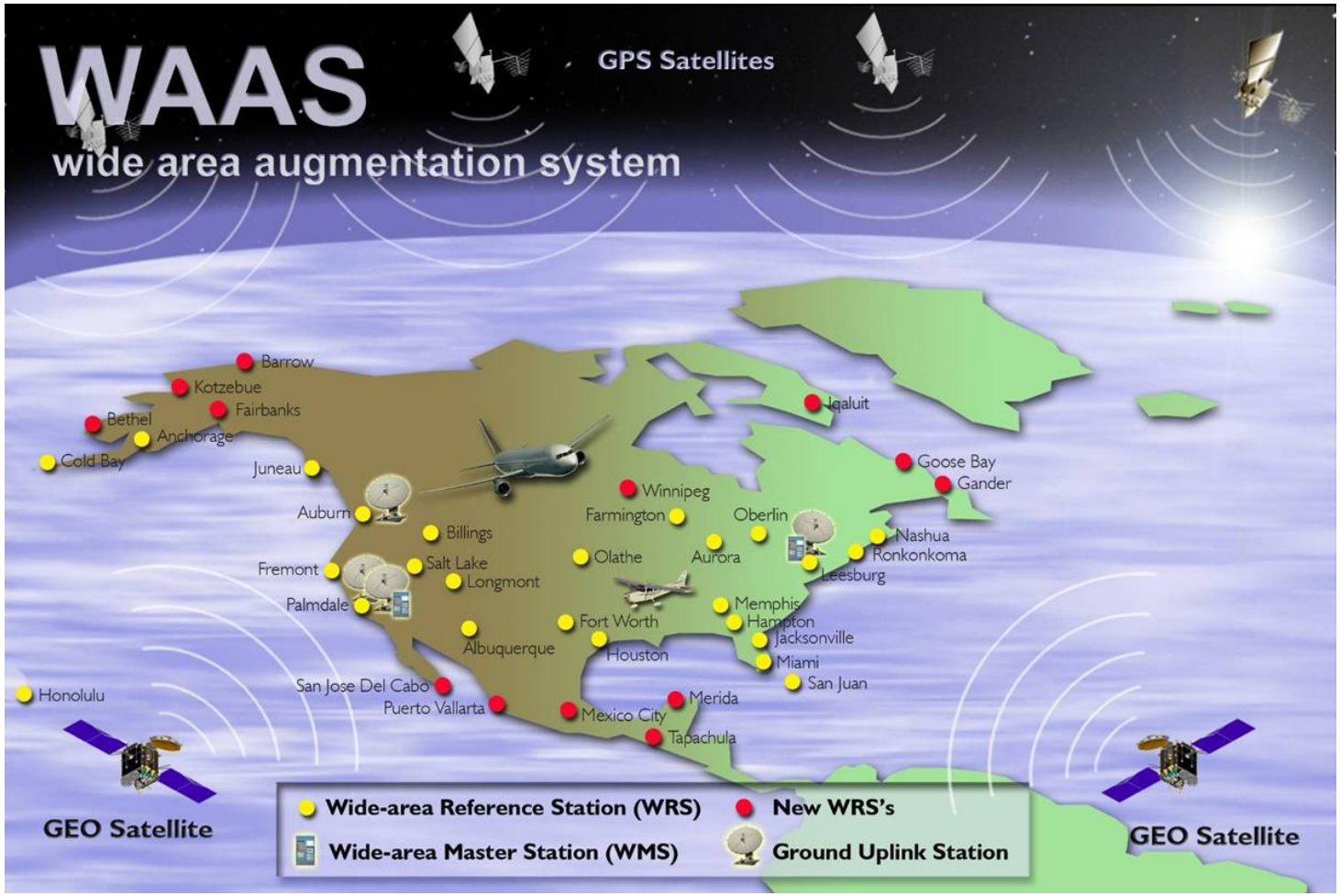
Input Formats: NSTB, …

- **National Satellite Test Bed (NSTB)**
  A data format for Test Bed Reference Station (TRS) and WAAS Reference Stations (WRS) data. The recorded data includes GPS measurements; ephemeris and almanac data; GEO measurement and WAAS broadcast data; as provided by the GPS receivers at the Reference sites.

- **Receiver Independent Exchange Format (RINEX)**
  A data interchange format for raw satellite navigation system data. This allows the user to post-process the received data (usually with other data unknown to the original receiver, such as better models of the atmospheric conditions at time of measurement) to produce a more accurate solution.

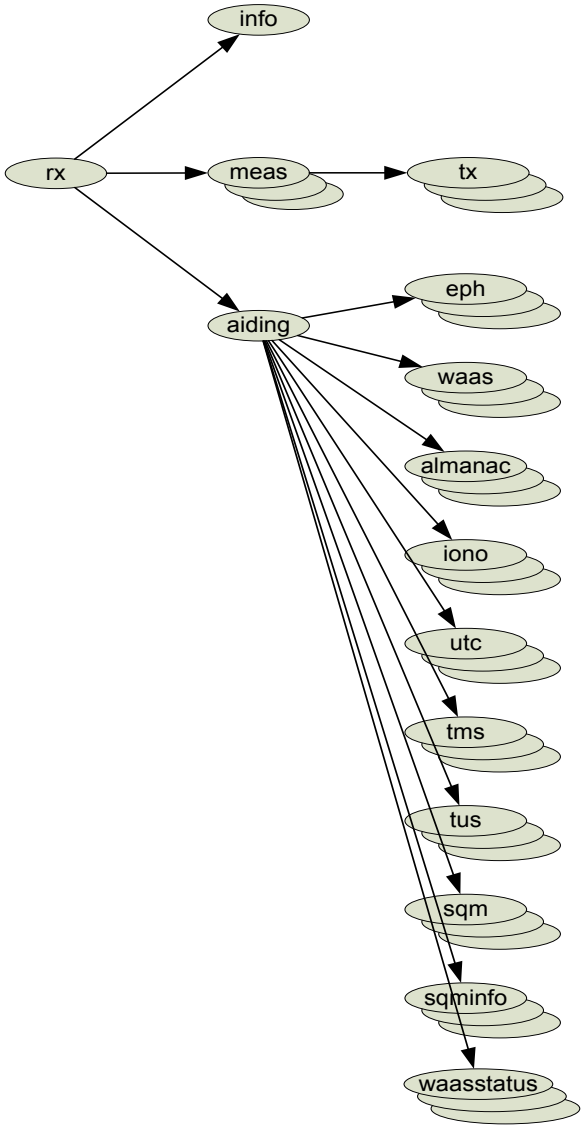
- **National Marine Electronics Association (NMEA)**
  NMEA 0183 (or NMEA for short) is a combined electrical and data specification for communication between marine electronic devices such as echo sounder, sonars, anemometer (wind speed and direction), gyrocompass, autopilot, GPS receivers and many other types of instruments. It has been defined by, and is controlled by, the U.S.-based National Marine Electronics Association.

NSTB Stations



Output Format: SGMP

- Structured data tree
- ***rx*** contains information and measurements by a receiver during a specific time frame.
- ***rx.info***, ***rx.meas***, and ***rx.aiding***.



Field	Description
info	receiver and data file information
meas	measurements by receiver
aiding	aiding information from external sources

rx.info

- ***rx.info*** contains receiver specific static information such as receiver type and the start and end time of overall data file.

Field	Description
id	User defined receiver identification number
sitename	receiver site name
type	receiver type
initpos	initial position of receiver in XYZ (meter) and equivalent to true position for stationary receiver
gpswk	reference time in gps week number
starttow	start time of reception in time of week (second)
endtow	end time of reception in time of week (second)

rx.meas.tx

- ***rx.meas.tx*** contains transmitter specific measurements for given reference measurement time.

Field	Description
prn	transmitter identification number. prn for GPS satellites
numch	number of channels for this transmitter
pr	pseudo-range (meter)
cr	carrier-range (meter)
dp	Doppler (meter/second)
snr	signal-to-noise ratio (dBHz)
slip	cyclic slip counter (0-7)

rx.aiding

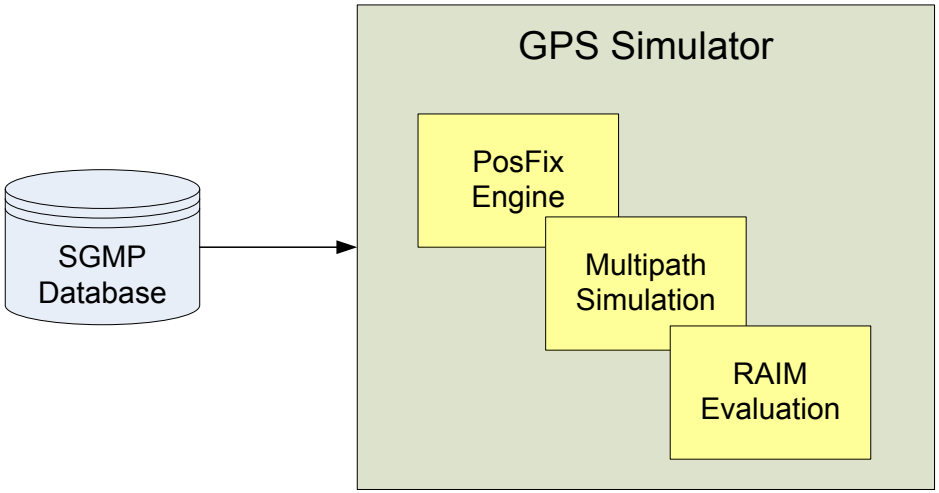
- ***rx.aiding*** contains aiding information provided by external sources such as GPS satellites and WAAS satellites. Includes *eph*, *waas*, *almanac*, *iono*, *utc*, *tms*, *tus*, *sqm*, *sqminfo*, and *waasstatus*.

Field	Description
eph	ephemeris and clock parameters from GPS navigation message
waas	WAAS broadcast message
almanac	almanac message
iono	ionosphere (Klobuchar) message
utc	UTC message
tms	TMS to TUS message
tus	TUS to TMS message
sqm	SQM message
sqminfo	SQM information message
waasstatus	WAAS subsystem status message

GPS Simulator

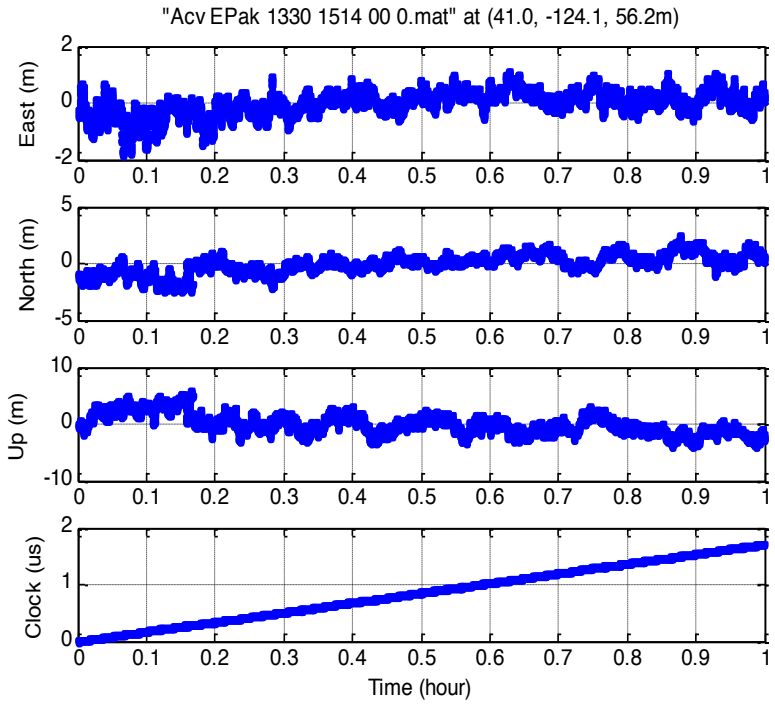
- **Now We're Ready to Rock!**

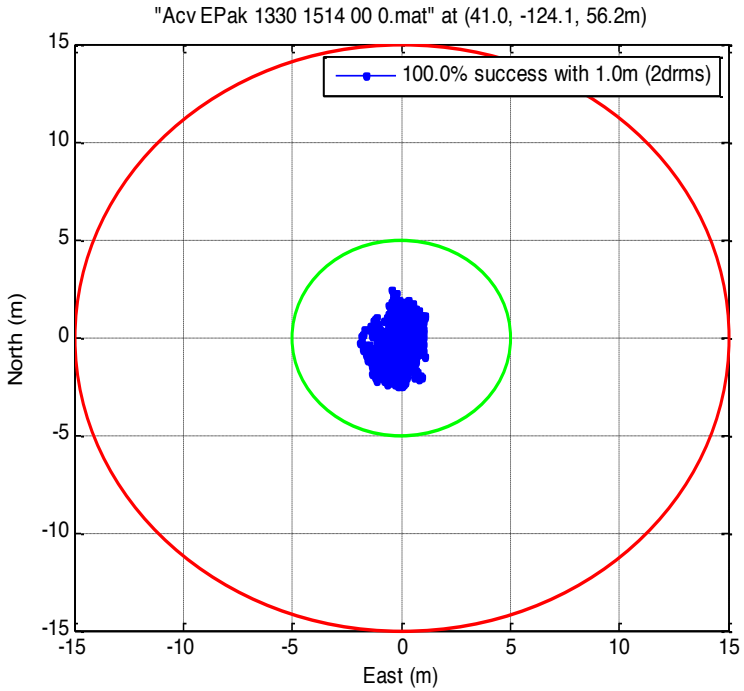
  GPS Simulator is a block allocated for signal processing functionalities based on data from *Measurement Interface*. A sample program is provided which can be modified according to user's needs.



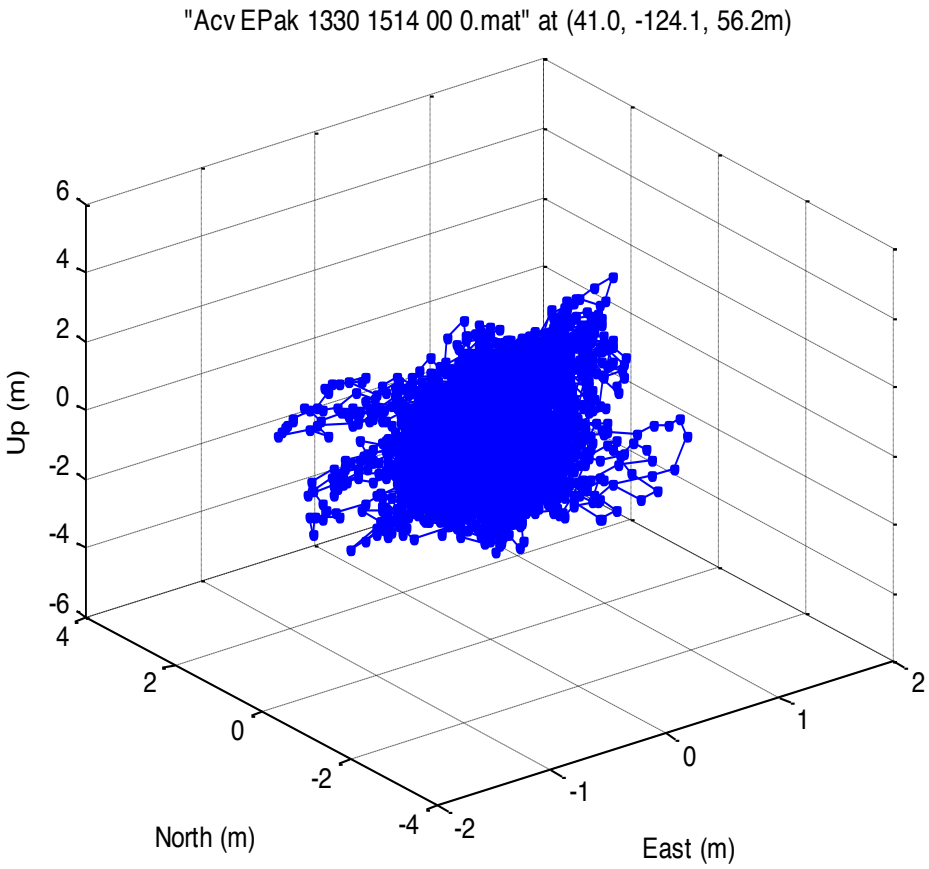
Example: Position Fixes

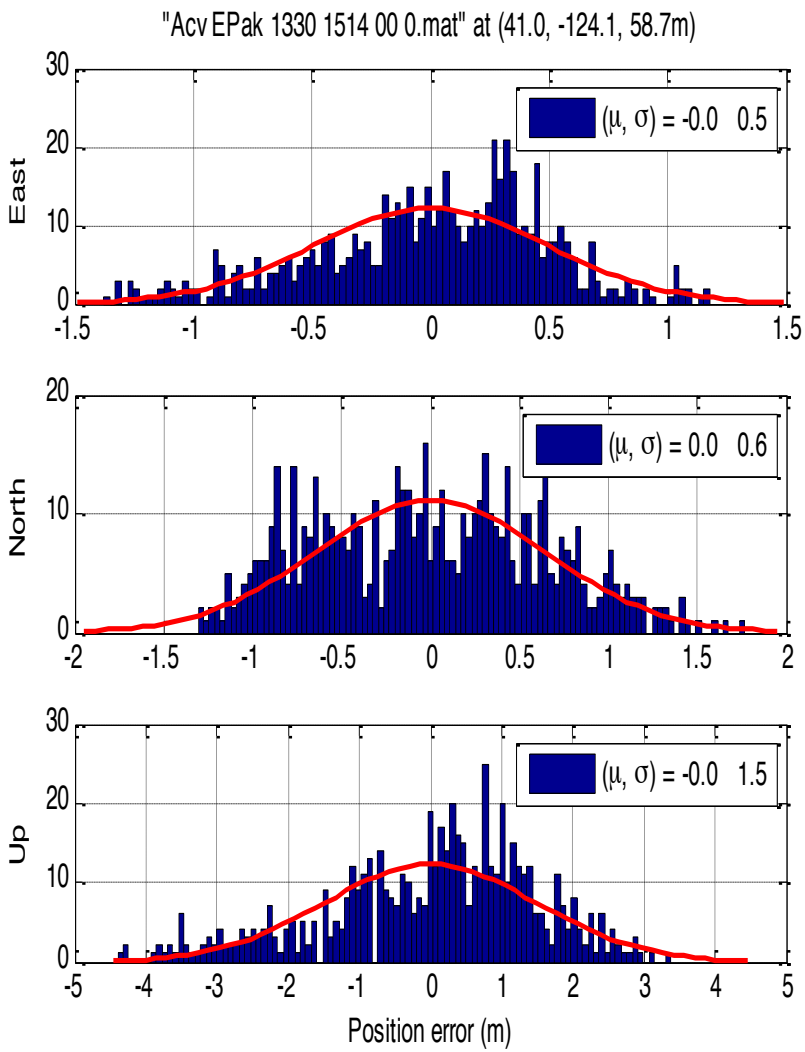
- **Position Estimation**





Example: Position Fixes (cont'd)





How it works: Setting Up

- **Go to waas.stanford.edu**
- **Download and unzip SGMP.zip**
- **You'll see following directories created under / SGMPrelease:**
  - /SGMPrelease/document
  - /SGMPrelease/measurement interface
  - /SGMPrelease/simulator
  - /SGMPrelease/user interface

How it works: Parsing

- **Getting NSTB Data**
  - Go to http://www.nstb.tc.faa.gov/DisplayNSTBDataDownload.htm
  - Download and unzip NSTB files
  - Move the unzipped NSTB files to /SGMPrelease/measurement interface/data/nstb

- **Parsing**
  - To parse all NSTB files, use /SGMPrelease/measurement interface/batchparseNSTB.m
  - To parse a NSTB file, use /SGMPrelease/measurement interface/ parseNSTB(filename, starthour, endhour, crccheck)

    ex) rx = parseNSTB('Acv_EPak_1330_1514_00', 1, 5, 0);

    %parse NSTB file from 1 hour to 5 hour without CRC checking

How it works: Positioning

- **Positioning**
  - After parsing NSTB files to SGMP files (located under /SGMPrelease/measurement interface/data/parsed), we are ready to rock!
  - Start Matlab and go to /SGMPrelease/simulator/
  - Execute batchPosfixSGMP.m
  - Alternatively, use posfixNSTB(filename)

- **Results**
  - Go to /SGMPrelease/simulator/result/posfix/
  - Check out *.mat, *.fig, or *.eps files for results

Summary

- SGMP (Stanfor GPS/GNSS Matlab Platform) is a Matlab based platform providing access to multi-format positioning database.
- SGMP enables you to tap into existing and ever-growing database regardless of formats.
- Standardized format (SGMP) opens door to research collaboration and connection b.t. generations of students.

What's next…

- **Measurement Interface**
  - Support for NMEA, RINEX, …
  - Extension to other sensors such as TV, WiFi,…
- **GPS simulator**
  - Add more blocks (RAIM simulation, differential positioning, …)
  - For example, NSTB provides dual frequency code and carrier measurements. Lots of possibilities.
- **User Interface**
  - Implement a "Per"-friendly GUI?

Reference

1. **NstbDataFormat1103.doc Description of NSTB format**

2. **www.nstb.tc.faa.gov/DisplayNSTBDataDownload.htm NSTB data files are provided.**

3. **www.mathworks.com/access/helpdesk/help/techdoc/ref/struct.html Matlab structure type is described.**

4. **SGMP.zip**

Thanks!

Thanks to Euiho and Grace for their earlier works for NSTB data.

Thanks to Todd, Juan and Per for their inputs to SGMP.

Thank you, everyone!