Software GPS Signal Simulator

Modern GPS receivers adopt a digital architecture. RF signal is converted to digital data and DSP is used to extract satellite data. This serves the important purposes of reprogrammability and flexibility. In this context a software GPS signal simulator which generates digital GPS waveform is an important tool for research and performance analysis of GPS receiver algorithms.

The GPS Signal Simulator developed by NeST is a highly flexible and modular software tool based on MATLAB. It provides "true to life" multi channel GPS L1 band signal under conditions defined and completely controlled by the user. Output is available as a binary file which can be used as offline input for software receivers.

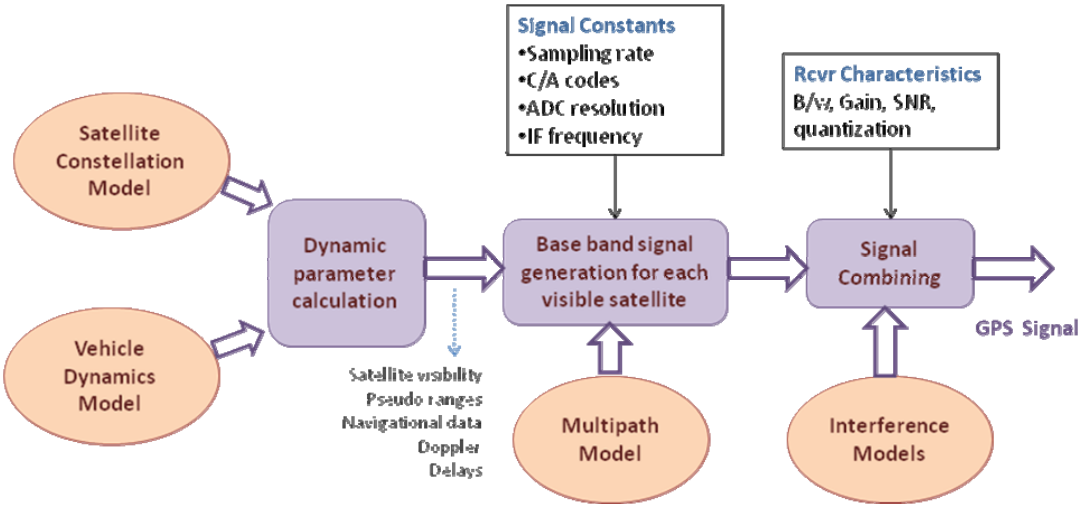

Figure 1 GPS Signal Simulator

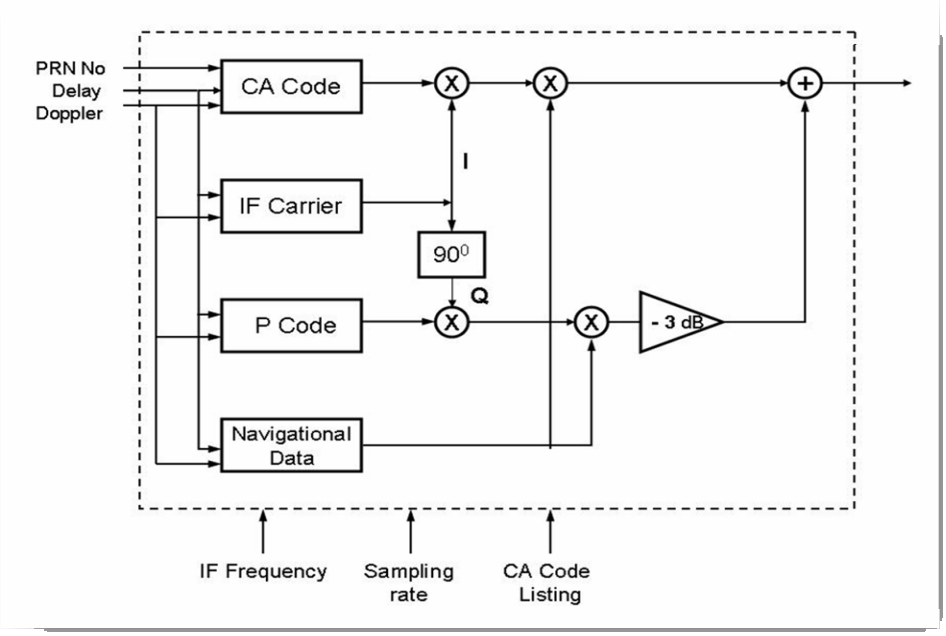

Figure 2 Signal generation scheme for one satellite

Salient Features

- Accurate and "real life" modeling of GPS satellite constellation. The resulting GPS waveforms can serve as truth reference for analyzing positioning accuracy of receivers.
- For specified spatial position and time, visible satellites are identified
- Vehicle dynamics modeling
- User control over almost all receiver parameters
    - IF frequency, Sampling rate, ADC resolution, Signal Power and Noise Power etc.
- User control over multipath conditions for each channel
- Simulation possible in two modes
    - Real mode - Real life satellite constellation is modeled
    - User mode - User can arbitrarily set the satellite parameters
- Reprogrammability – can easily integrate complex interference models and specialized environments

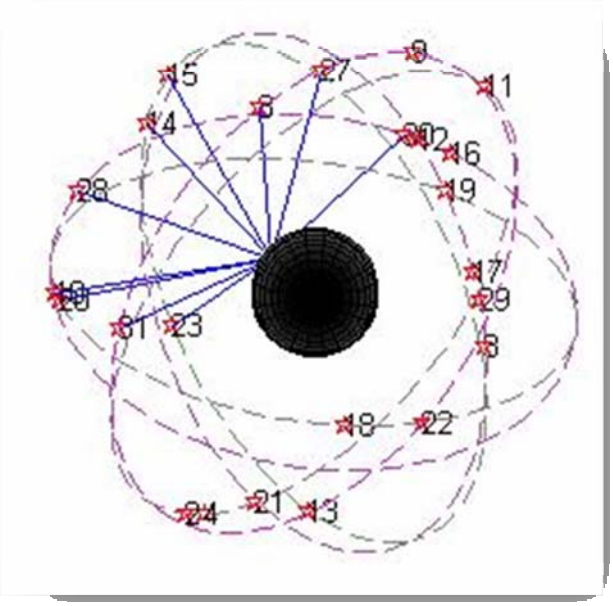

Figure 3 *Satellite Constellation Snapshot*

(Each satellite is labeled with its PRN number. Blue radial lines indicate visible satellites for given spatial coordinates and time)

Applications

- Test and performance evaluation of advanced GPS receiver algorithms
- Detailed analysis under controlled and repeatable GPS signal environments
- Applications where it is almost impossible to get comprehensive real data. Eg.
    - Complex multipath conditions
    - Space applications
- Can be used as a framework for receiver testing for futuristic GPS signal structures (new frequencies, code modulations and data formats)

Roadmap

- Introduction of complex interference models
    - Tropospheric, Ionospheric, Jamming
- Complete set of test and analysis tools
- Simulation of L2 and L5 bands
- Simulator for new generation GPS signal structures

Software GPS Receiver

Software GPS Receiver assumes digitized GPS waveform as its input. Rest of the processing (satellite acquisition, DLL and PLL of the Tracking Loop, positioning and post filtering) are achieved in software. The flexibility and reprogrammability provided by a software realization are crucial as the GPS scenario is changing rapidly. The current software prototype is a MATLAB implementation, which allows for very quick adaptation of new receiver algorithms.

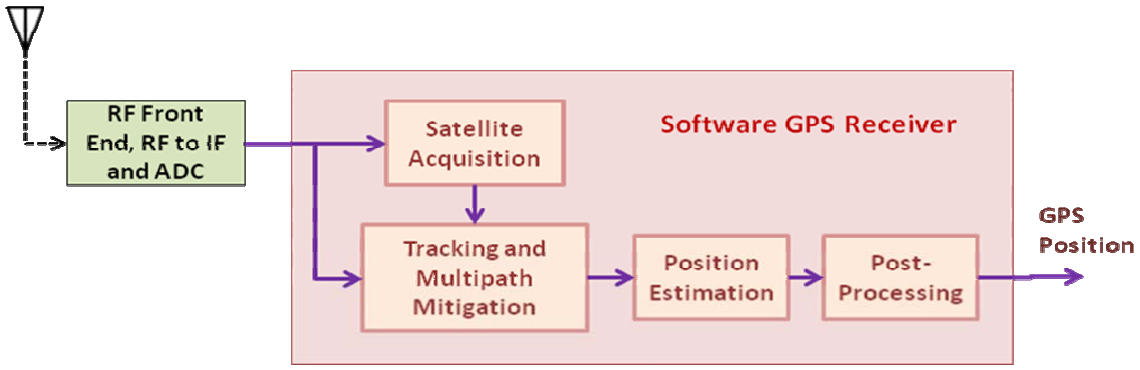

Figure 4 GPS Software Receiver

Salient Features

- Implemented with high modularity, so that every module can be independently replaced with an alternative algorithm
- Availability of intermediate waveforms and data for visualization - helpful for developing low level insights
- Example implementations of multipath mitigation algorithms integrated with the tracking loop
- Accompanying software for statistical error performance analysis

Applications

- Intended as a research tool in GPS receiver design.
- Provides a platform for evaluating novel algorithms for
    - Search strategies in acquisition
    - Multipath mitigation
    - Jamming and other interference management
    - FPGA implementation
- Together with the GPS Signal Simulator, it allows the user to simulate GPS test scenarios otherwise impossible to set up

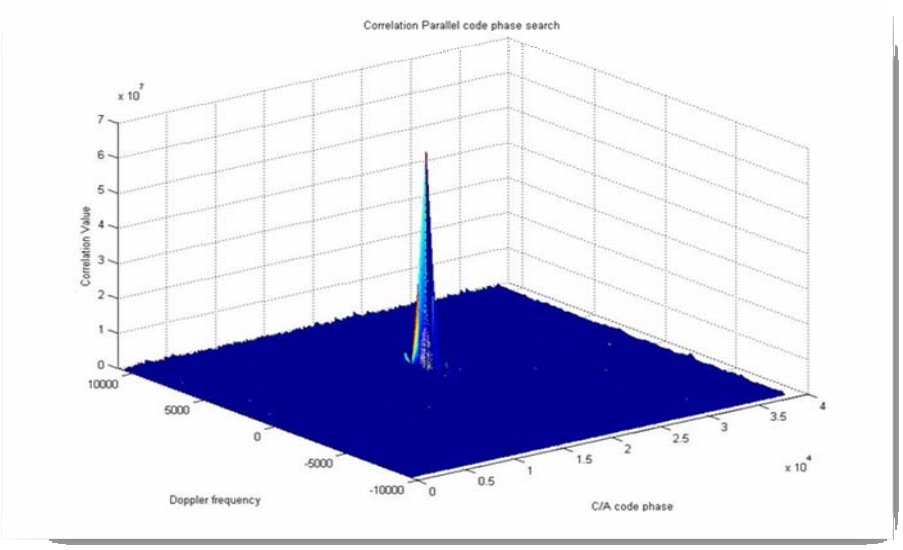

Figure 5 Satellite Acquisition

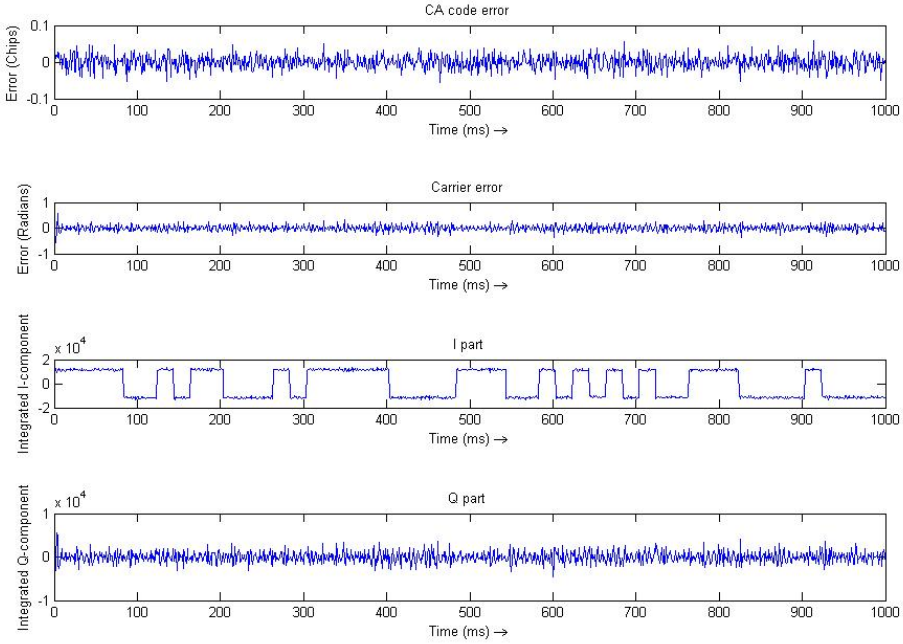

Figure 6 *Tracking Waveforms*

(The decoded navigational data bits can be seen in in-phase component shown in the third row)

Roadmap

- Development of sophisticated post filtering algorithms
- Development of novel multipath mitigation algorithms
- Adaptation of receiver algorithms for FPGA implementation
- Development of statistical tools for evaluating receiver performance trade offs