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ASR-2300 – Multichannel SDR Module for PNT and Mobile communications

GNU Radio Conference 2013
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Boston, Massachusetts

Dr. Michael B. Mathews
Loctronix, Corporation

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Loctronix Corporation Overview

Founded in 2006, Woodinville, WA

Loctronix provides position sensing solutions for GPS challenged environments

- Offering hybrid inertial, SoOp, GNSS positioning, navigation, and timing solutions
- Experts in Signals of Opportunity (SoOp) and alternative GNSS signal processing
- Targeting embedded applications in military, aerospace, commercial markets

Products / Solutions

Available Q4 2013

- **Advanced Software Radio™ (ASR)**
  SoOp / GNSS based navigation and simulation solutions for Military / Aerospace applications

Core Technologies

- **Spectral Compression Positioning™ (SCP)**
  SoOp / GNSS Signal Processing
- **Doppler Aided Inertial Navigation™ (DAIN)**
  RF/Inertial Sensor Fusion
- **SCP-GNSS Hybrid**
  High Performance GNSS

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Advance Software Radio™ (ASR)

Software Defined Radio (SDR) Products for SoOp / GNSS-Based Positioning, Navigation, and Timing Applications

Development

- **ASR-2300**, MIMO SDR Motion Sensing Module (Nov'13)
  OPEN SOURCE Hardware

open source™ MYRIAD RF

- **ASR-2300-Device Development Kit,** Embedded Applications (Q4'13)

SDR Waveforms (2014)

- **ASR-HGR**, Hybrid GPS Receiver
- **ASR-DAIN**, SoOp Doppler Aided Inertial Navigation™ (DAIN)
- **ASR-SAID**, GPS Signal Assurance and Interference Detection Receiver™
- **ASR-SIM**, Multiband SoOp/GNSS Signal Generator / Recorder

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ASR-2300 MIMO SDR / Motion Sensing Module

RF / Multi-Sensor Signal Processing

- 2 x 28 MHz Transceivers 300 MHz to 3.8 GHz Full Duplex
- 9 RF Paths: 6 RF inputs / 3 RF outputs (U.FL)
- Integrated L1 GPS and Wi-Fi Antennas
- Integrated 10 axis MEMS sensors
  (accelerometer/ gyroscope / compass / barometer)
- Expansion Port supports for MIMO / Data I/O

ASR -2300

Electrical Interface

- SuperSpeed USB 3.0 interface at 315 MB/s sustained data transfer
- Very Large Spartan-6 FPGA: 6,822 / 58 DSP slices
- 128 MiB RAM
- 5 Volts @ 1.2 A (6 W) at full utilization.
- 1.2 mbps UART
- Li-Ion Battery external connection w/charger function

ASR -2300 Housing Kit

Physical Specifications

- 9.90 x 6.61 x 0.95 cm
  (3.898 x 2.60 x 0.375 in)
- Weight ~ 48 grams (1.5 oz).

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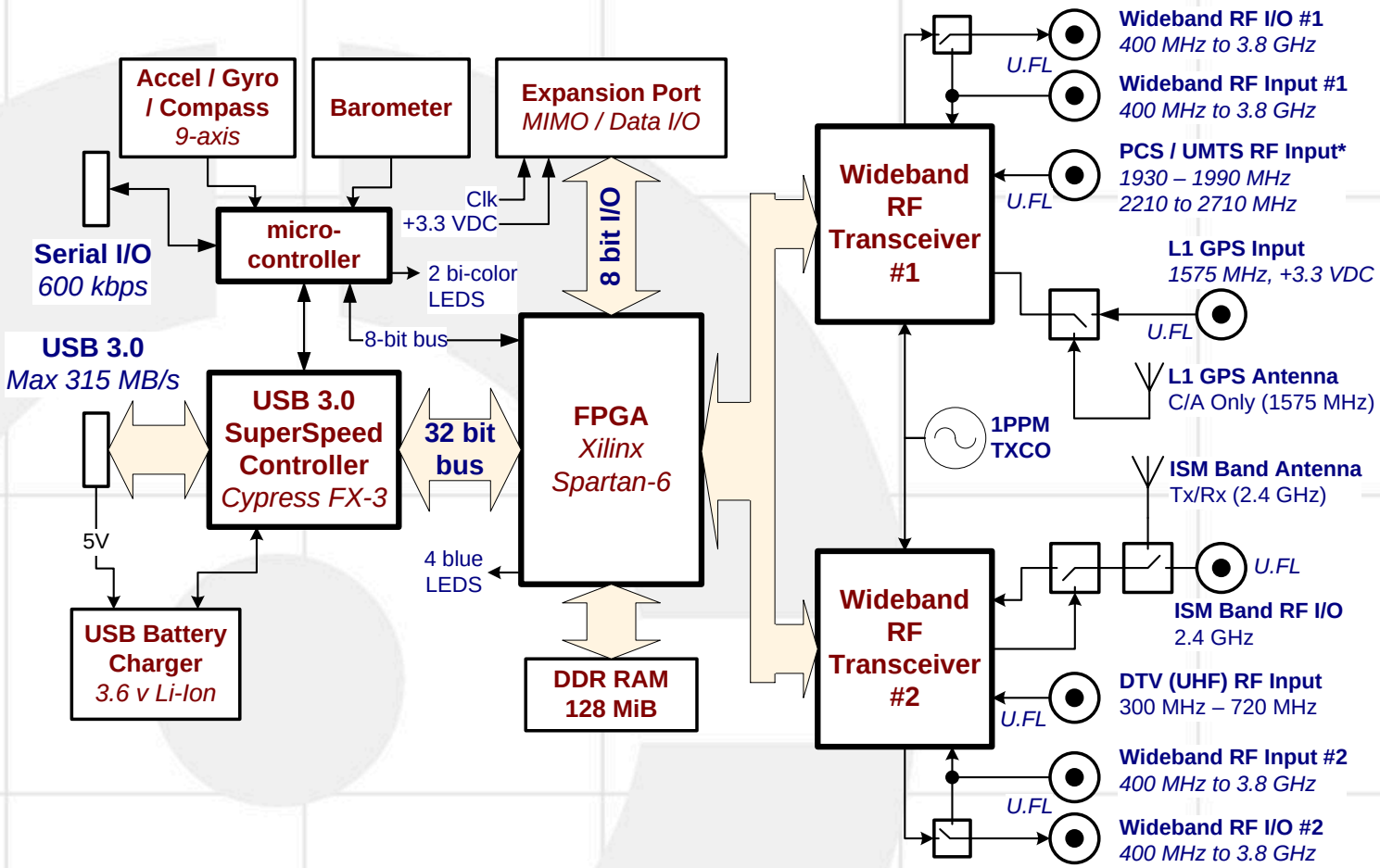
ASR-2300 Functional Blocks



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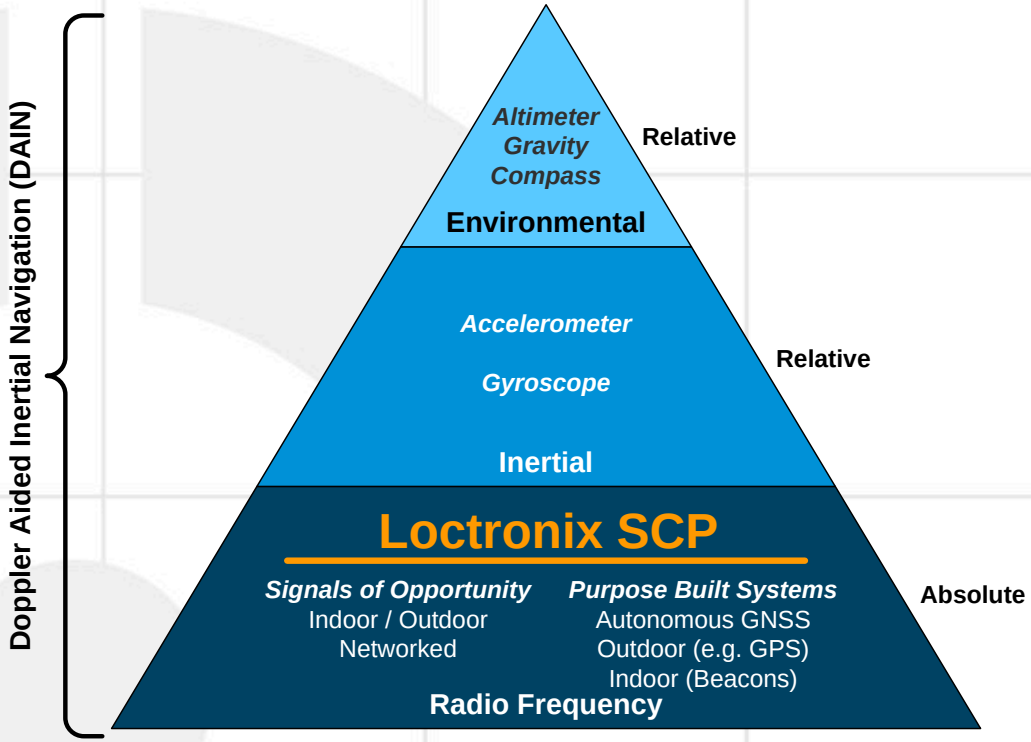
Loctronix Multi-Sensor Approach



The Universal Positioning Sensor Solution Set

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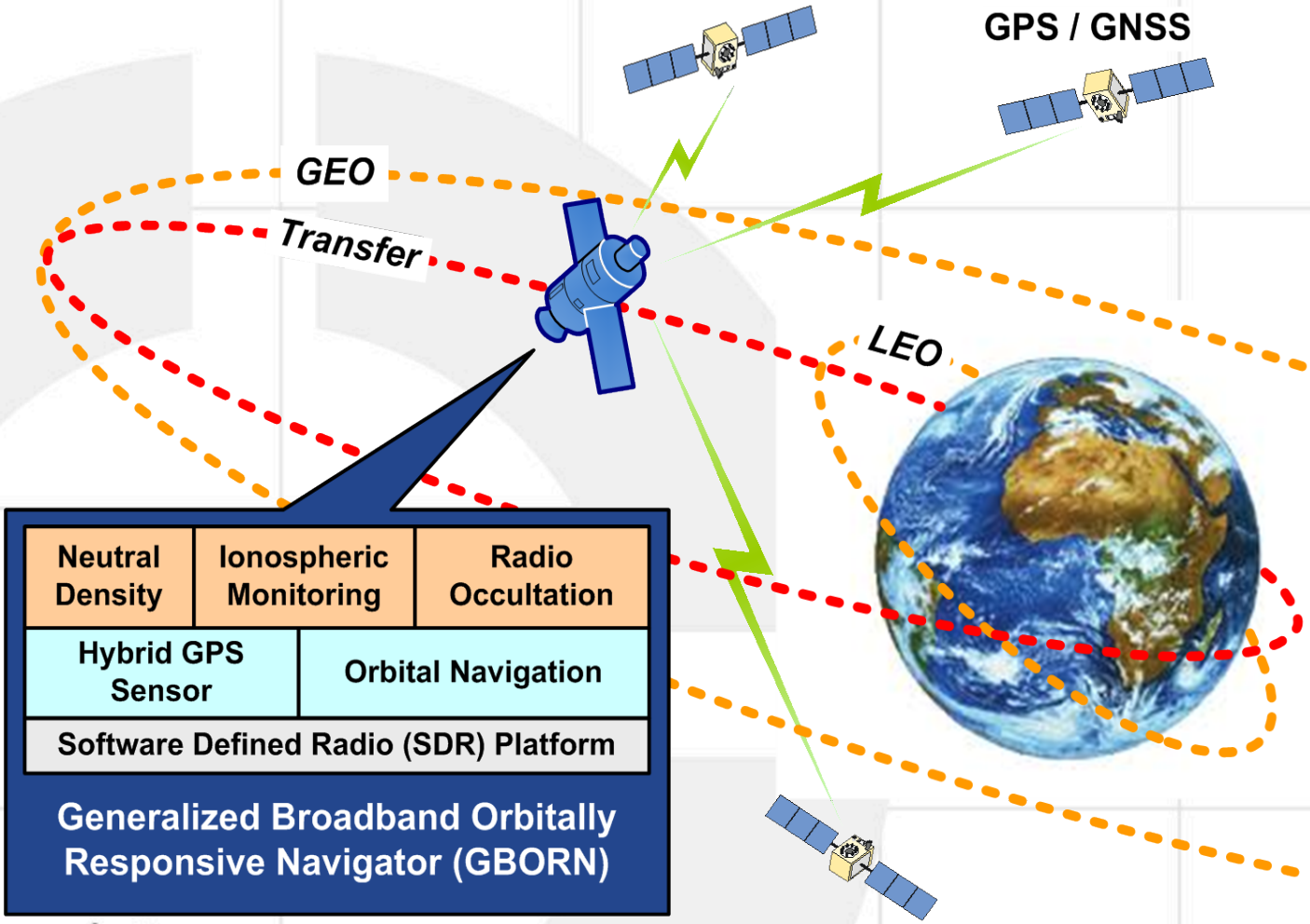
Orbital Navigation Using SDR



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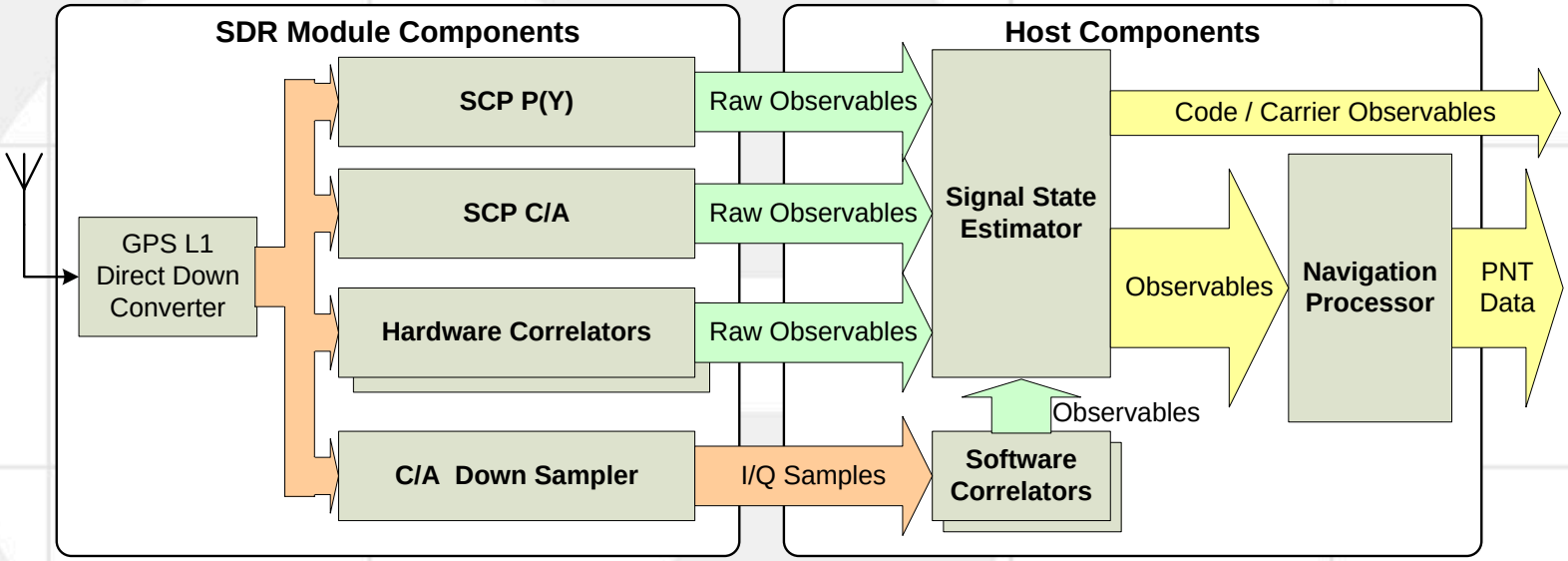
ASR-HGR Waveform Hybrid GPS

Combines SCP and traditional correlation technologies

Low SWaP high-performance L1/ L2 / L5, C/A / C, P(Y) channel observables

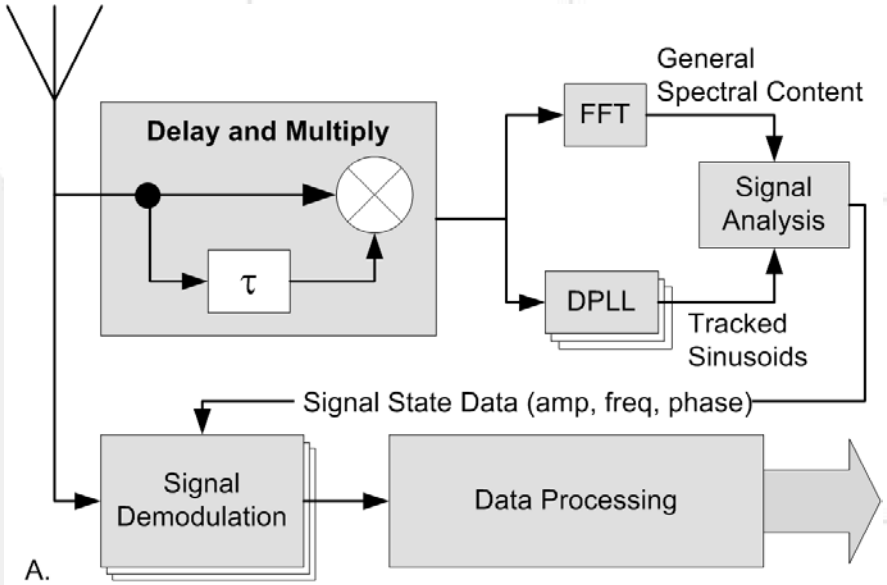


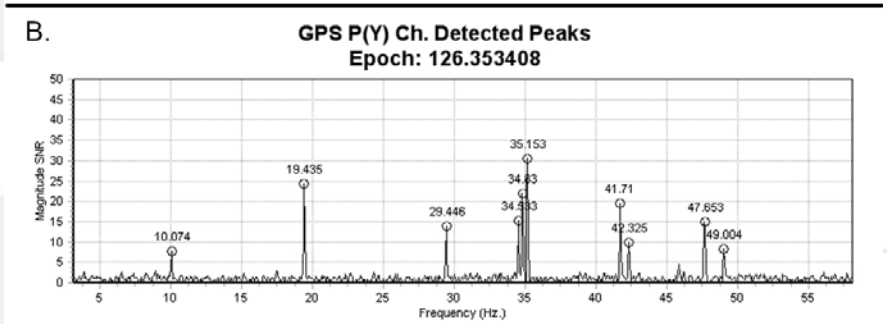
Spectral Compression Positioning™ (SCP)

A non-linear operation on a broadband signal that enables extraction of amplitude, frequency, and phase information

GPS example with Delay & Multiply

- Spectral compression applies a delay and multiply operation on P(Y) ranging signals.
- Fundamental chipping rate signals are extracted using an FFT on the Spectral Compressor output
- Each peak in the FFT (containing amplitude, frequency, and phase) represents a single GPS satellite
- Doppler frequency shift is used to uniquely identify the specific satellite given a GPS Almanac
- No complicated tracking loops or correlators are required





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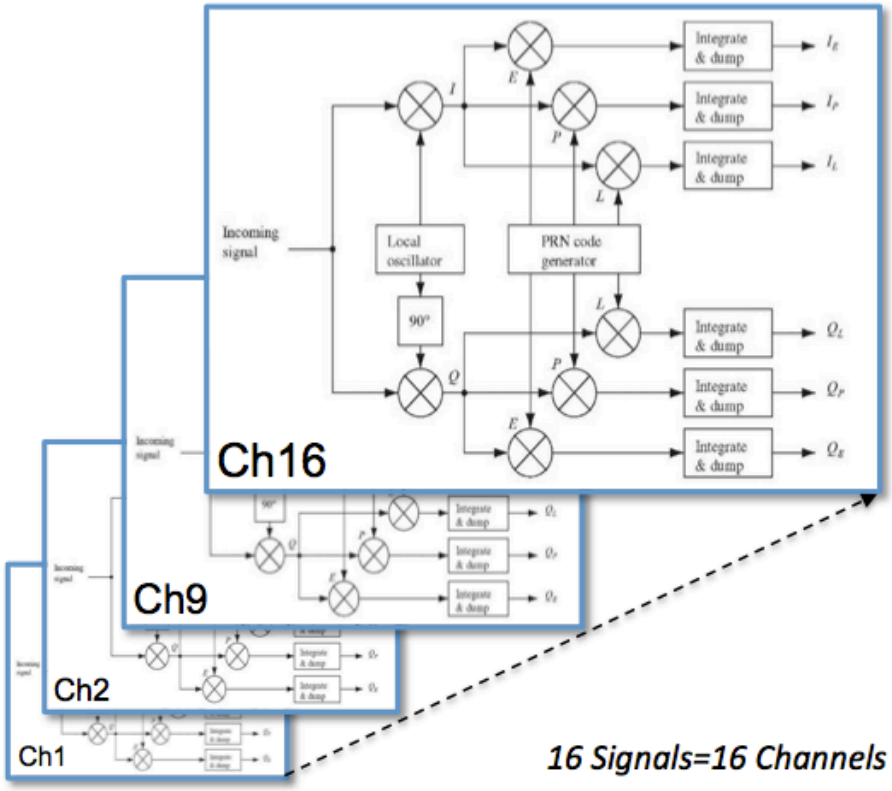
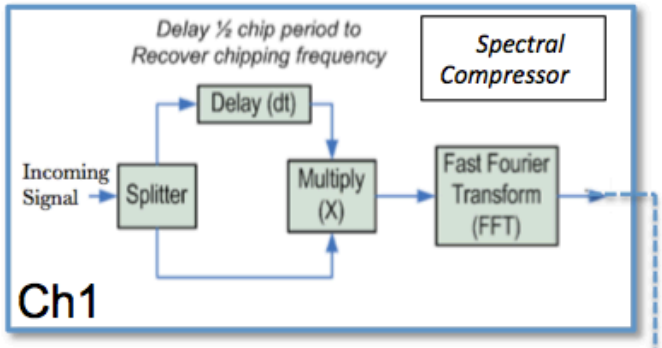
Spectral Compression Positioning (SCP) SWaP Advantages

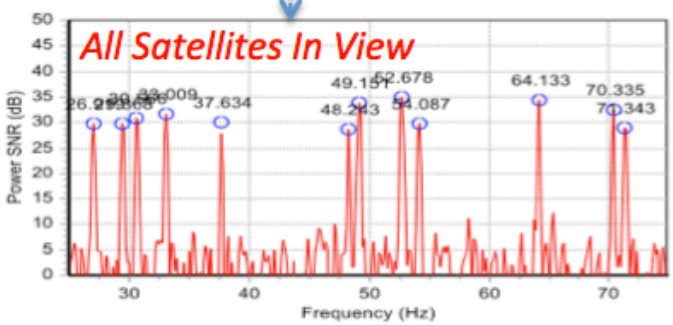
L1 C/A Code-Correlation Receiver (16 Channels)



16 Signals=16 Channels

L1 C/A Receiver Using SCP (1 Channel)





LEO Obs.

All-in-View = 1 SCP Channel

1 Channel of SCP signal processing is equivalent to 16 or more correlation channels

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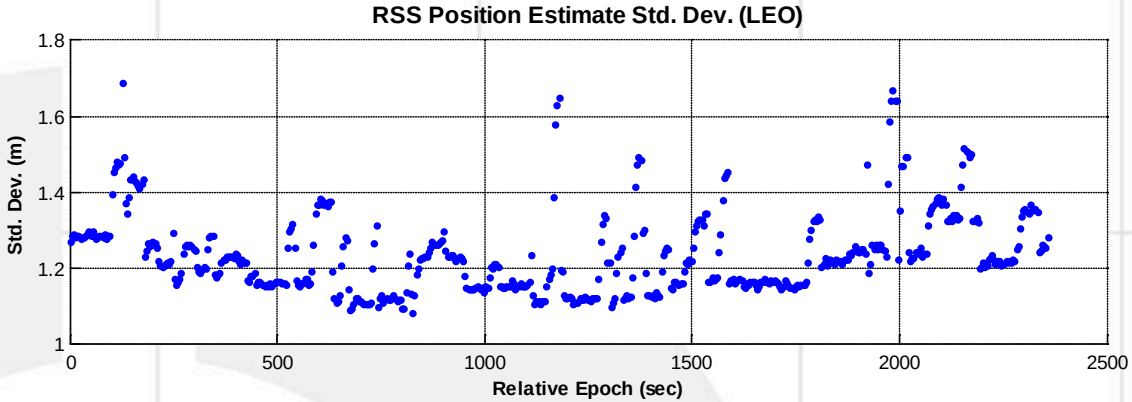
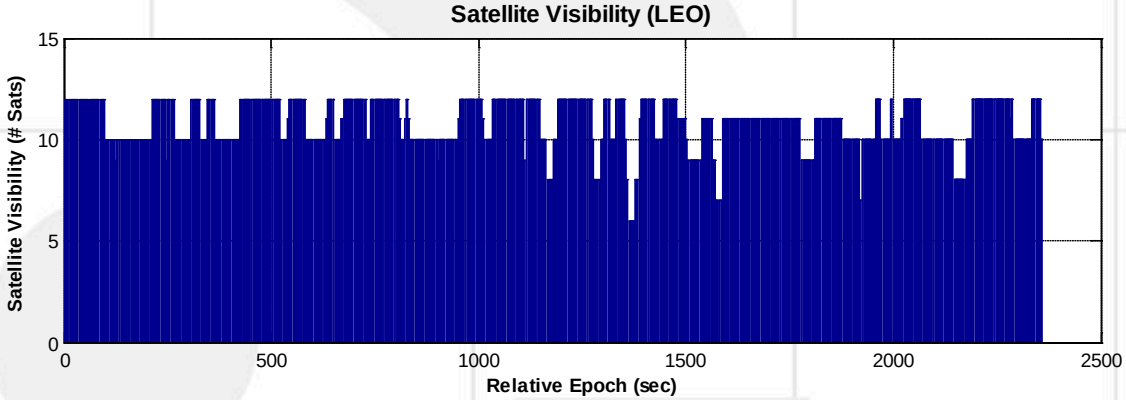
SCP C/A LEO Hardware Simulation (Spirent Simulator)





Ionosphere Free Point Positioning , Predicted Accuracy < 4 m, All satellites in view (Spirent limited to maximum of 12 satellites).

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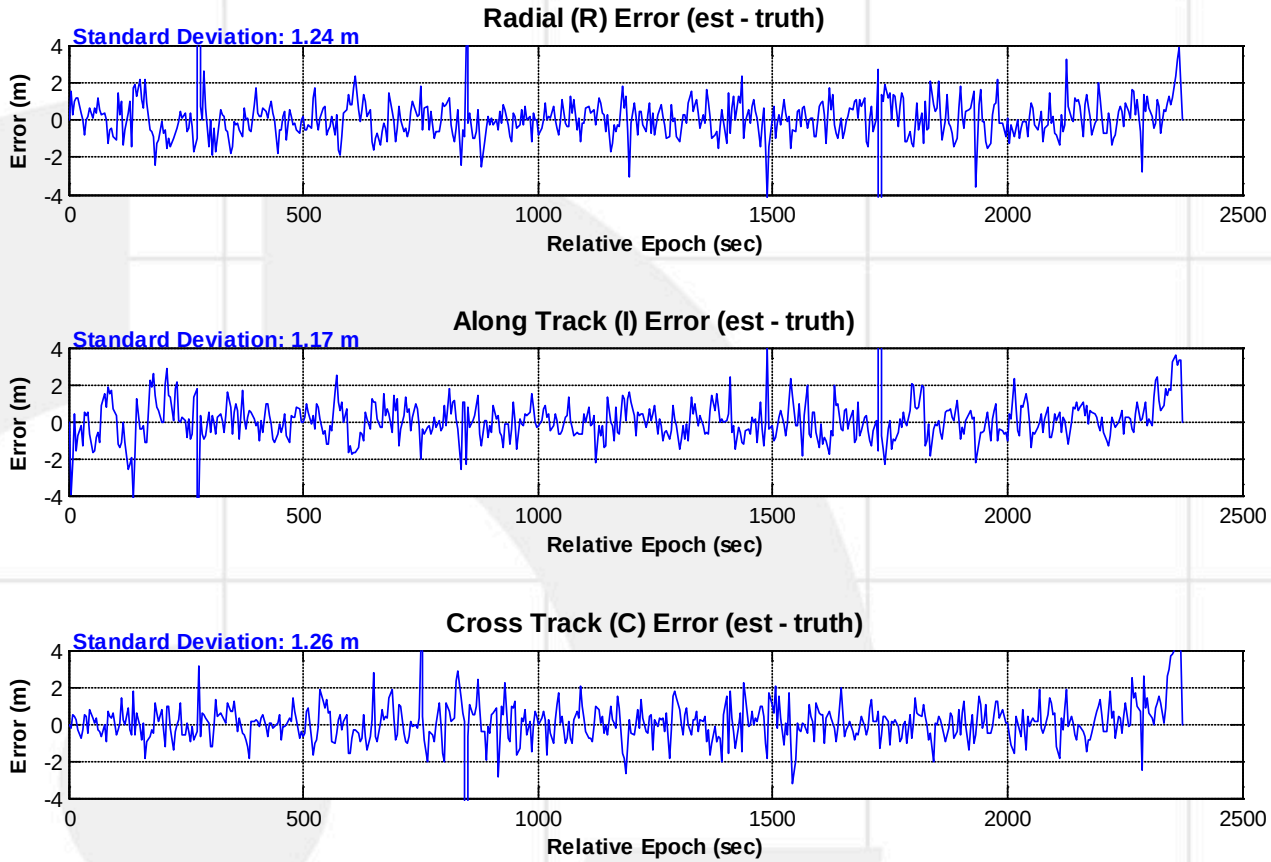
SCP C/A LEO Ionosphere Free RIC Error (Spirent Simulator)



Ionosphere Free Point Positioning Total Error < 4m (3 sigma)

- Systematic Biases Removed -

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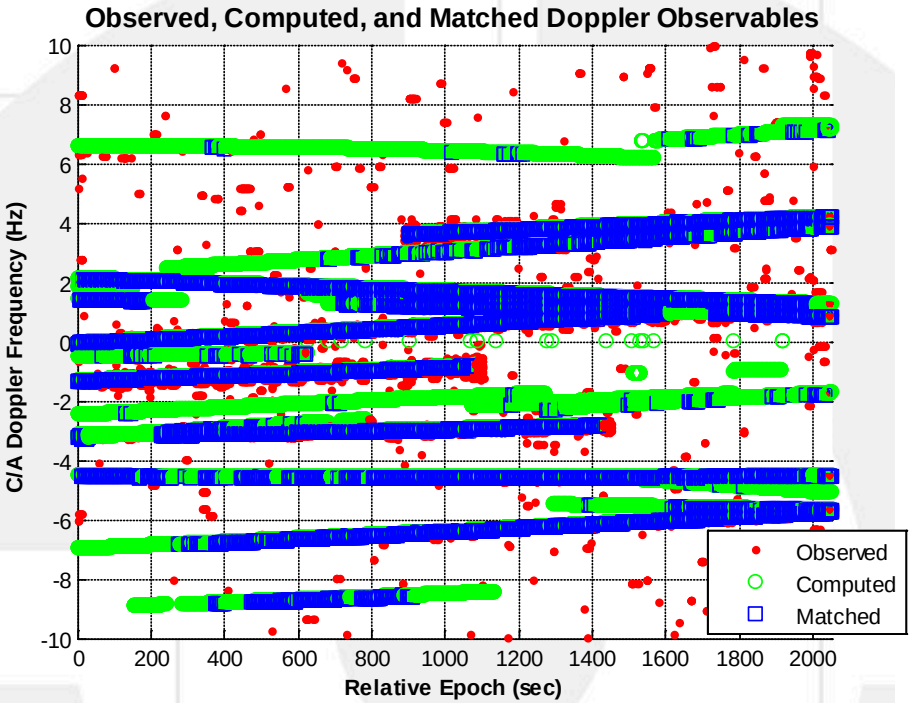
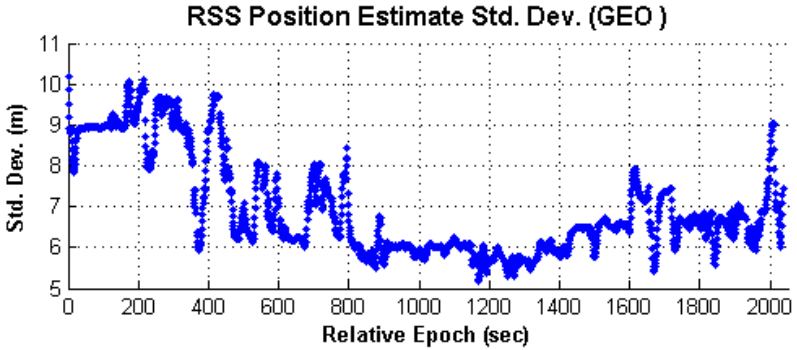
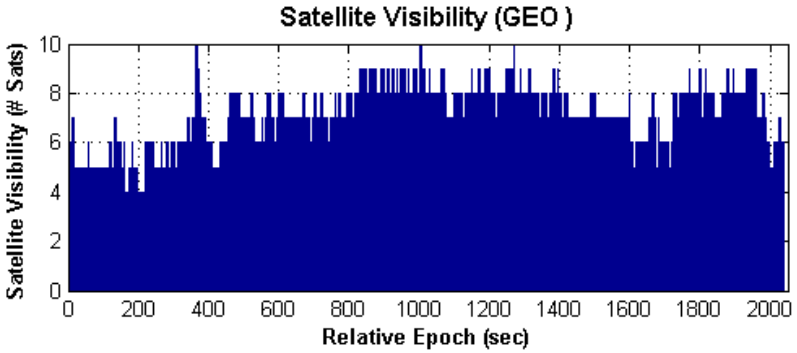
SCP GEO Hardware Simulation (Spirent Simulator)







C/A High Sensitivity: 32 seconds coherent integration

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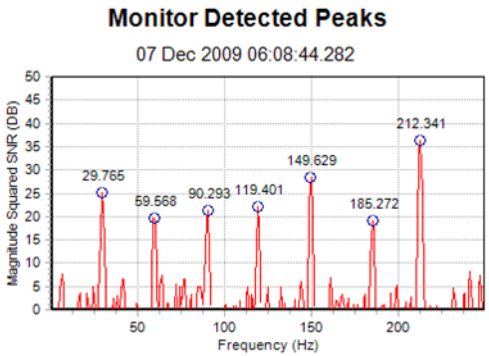
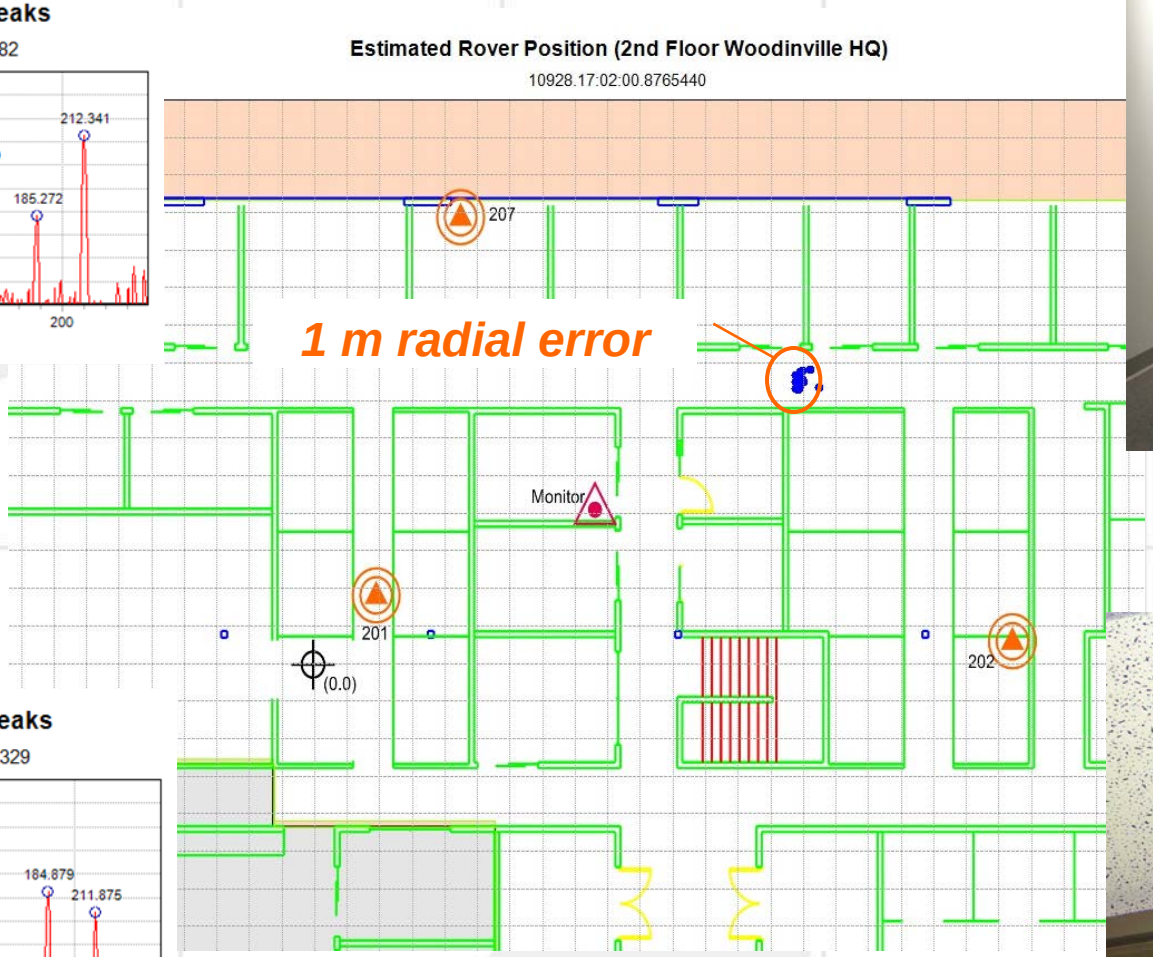
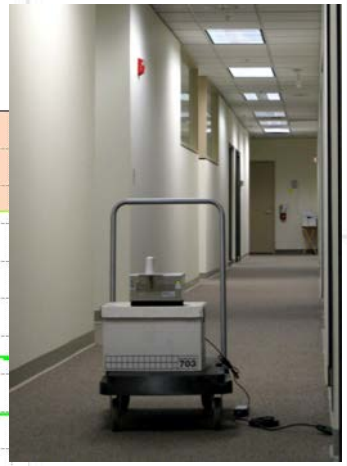
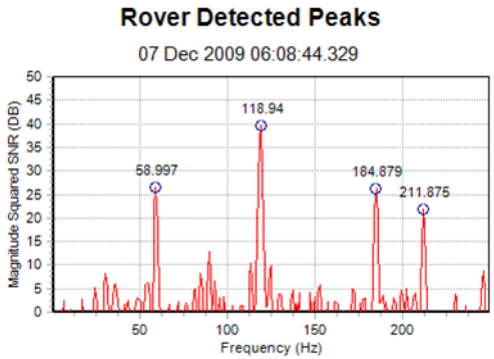
SCP Real Time Locating Systems (RTLS)









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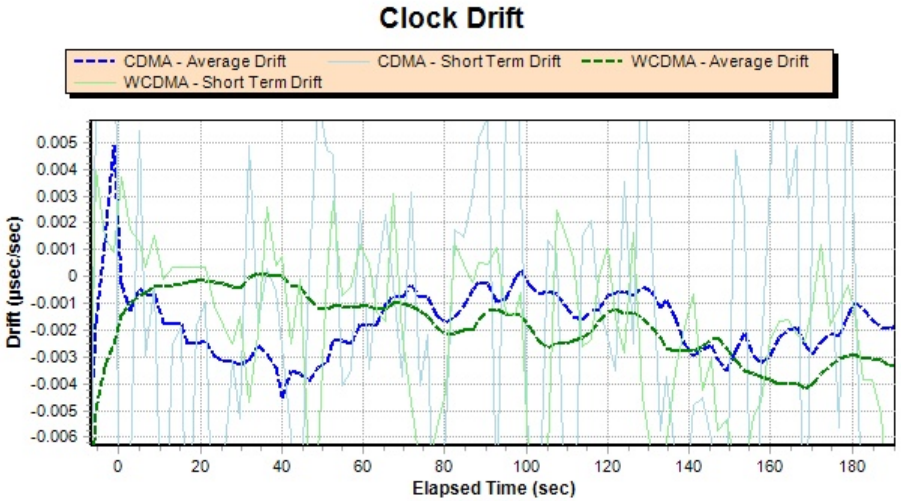
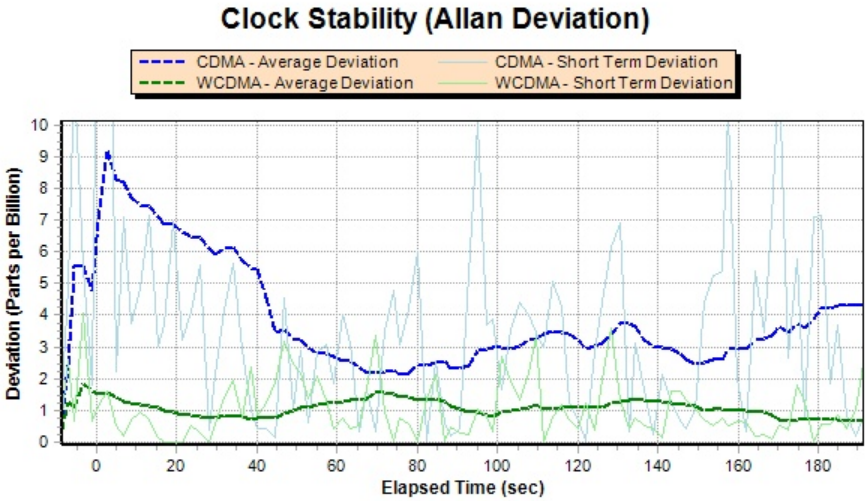
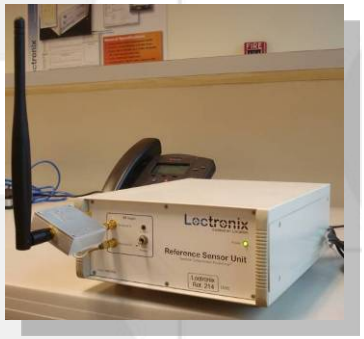
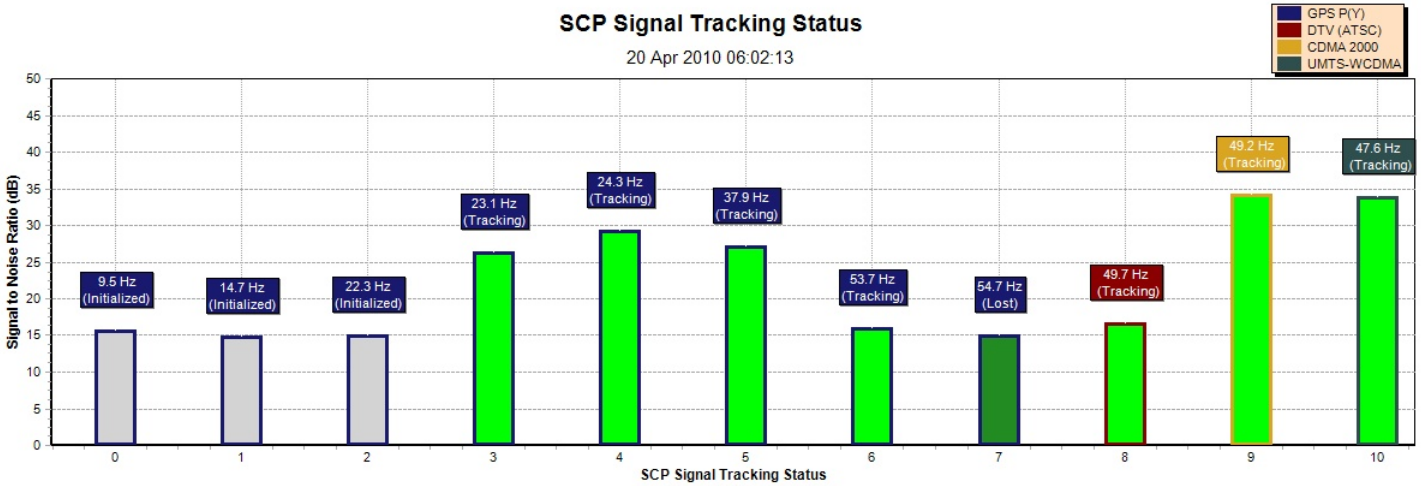
SCP Time and Frequency Synchronization
Fixed Wireless Applications (e.g. Femtocell)









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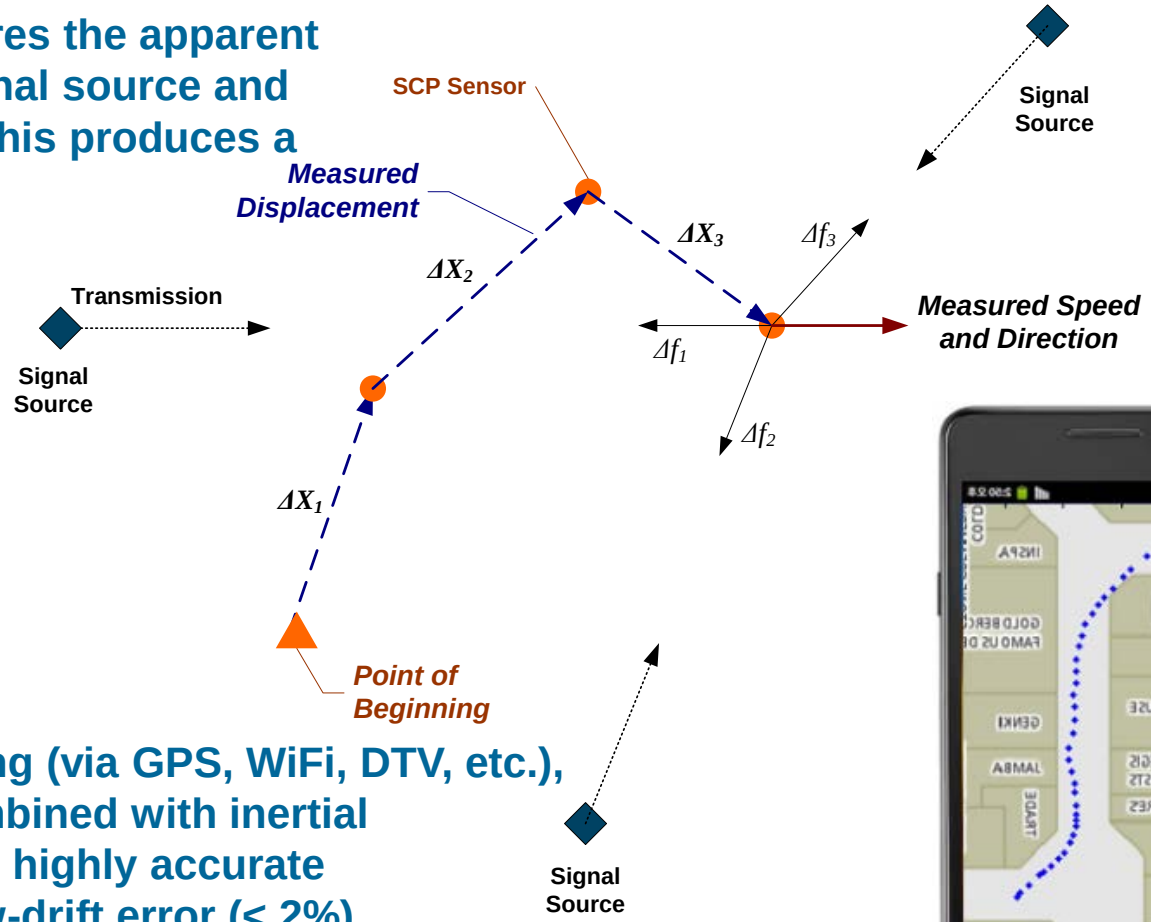
SCP Autonomous Positioning (DAIN)

Doppler Ranging measures the apparent velocity between the signal source and sensor. By integrating, this produces a displacement vector.



Given a point of beginning (via GPS, WiFi, DTV, etc.), this technique when combined with inertial measurements produces highly accurate positioning with very low-drift error (< 2%).

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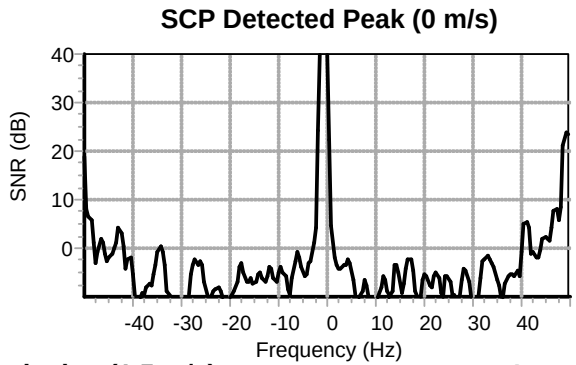
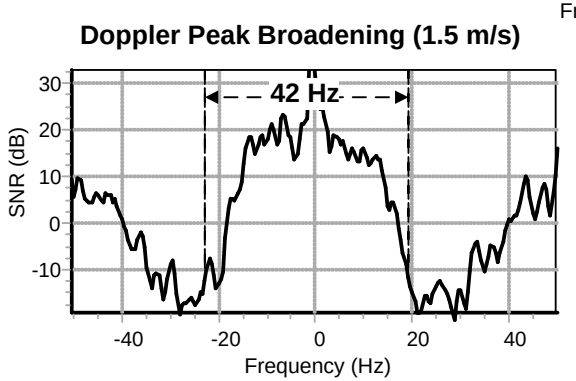
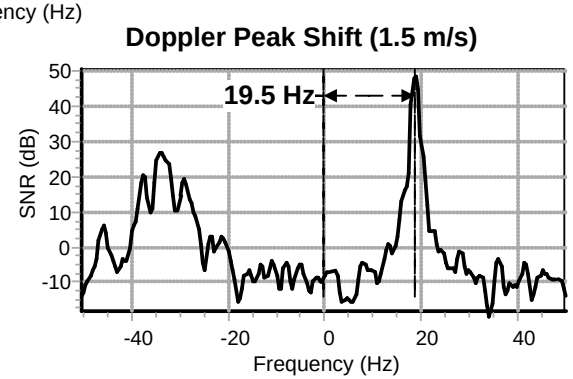
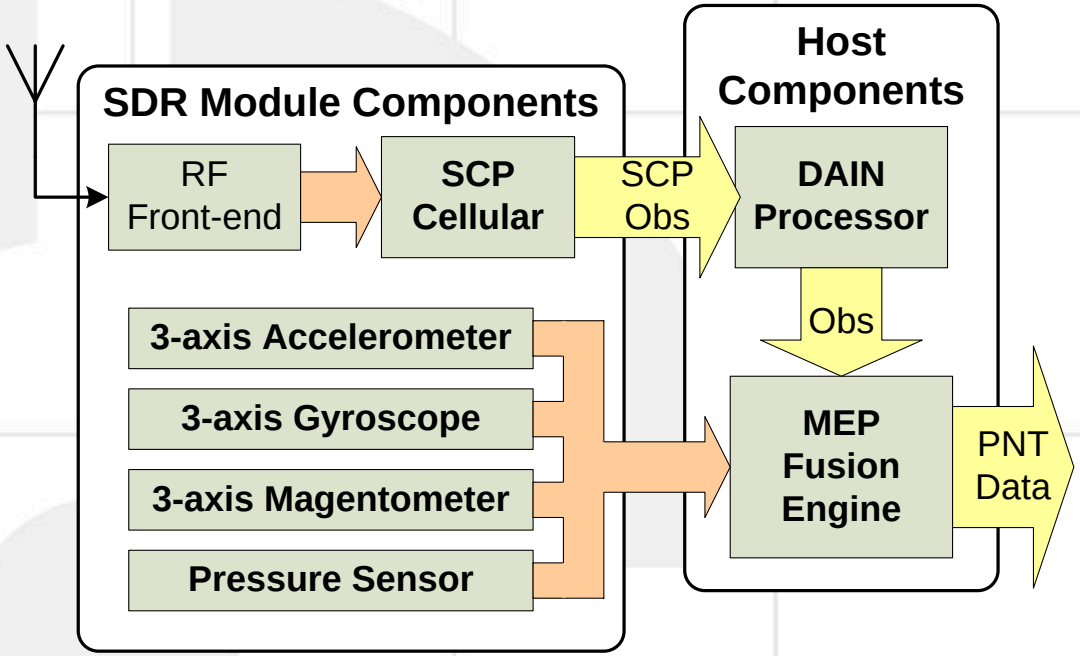
SCP Doppler Observables







ASR-DAIN Waveform Components



Application: Indoor Navigation using Signals of Opportunity

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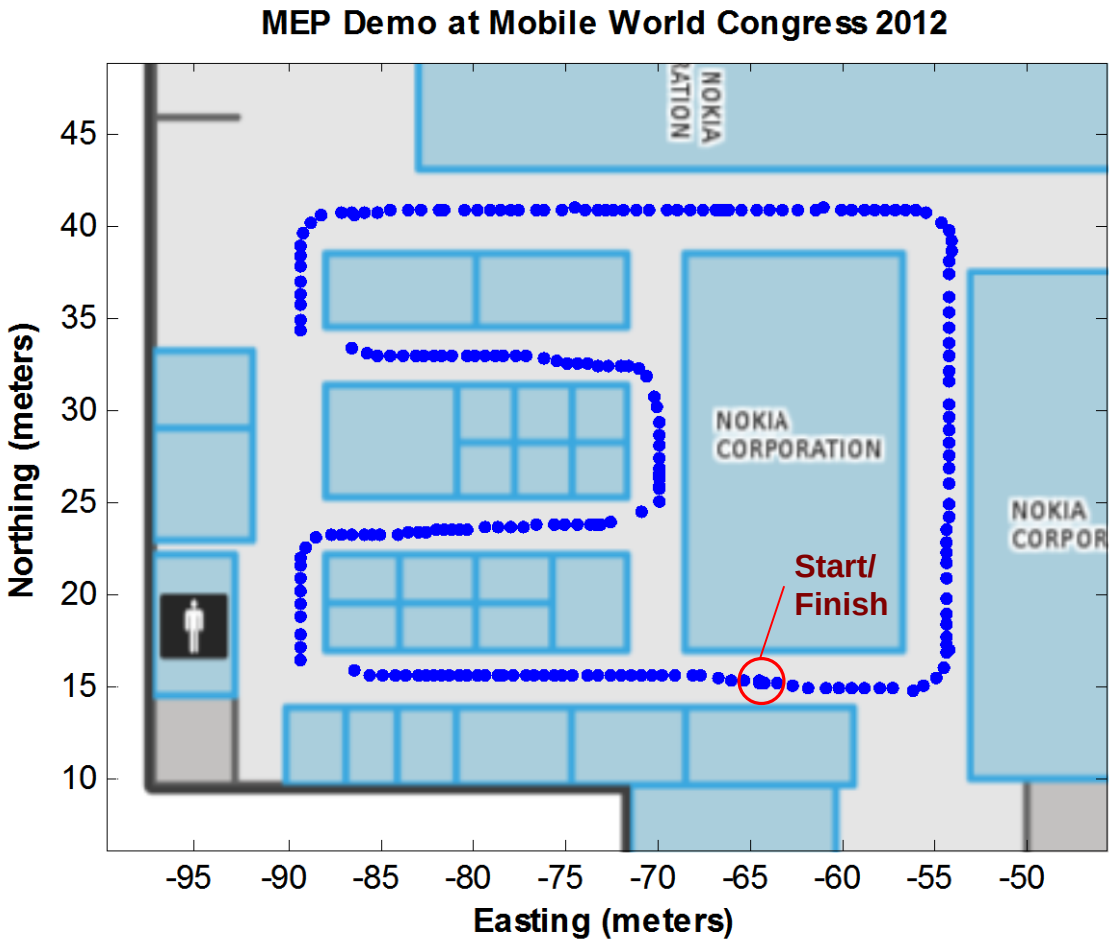
Indoor Navigation Demonstration

Video Demonstration (click here)



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