UNIVERSITY OF WESTMINSTER

Weak Signal and Multipath Analysis Using GNSScope: A Toolbox for End-to-End Modelling, Simulation and Analysis of GNSS

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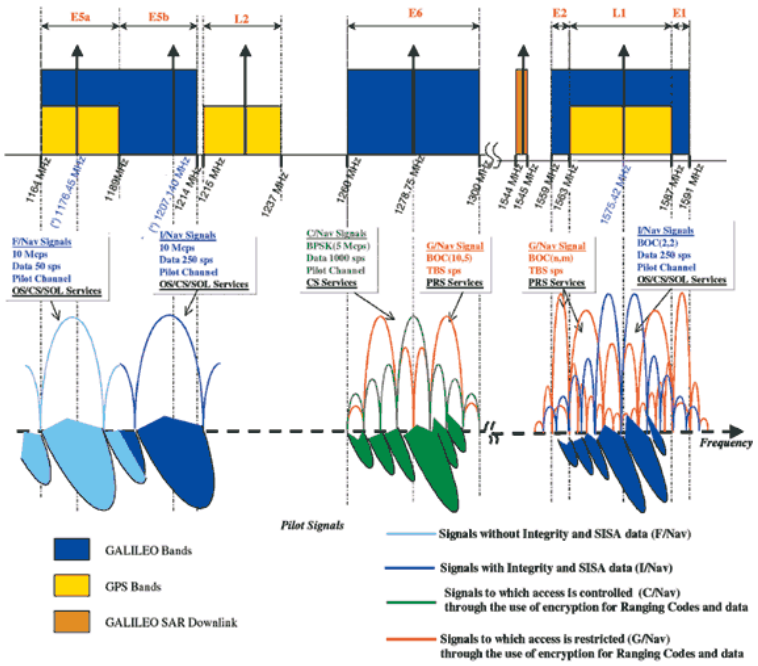
Outline

- Introduction
- Multiple Access Interference in GNSS
- Cross-Correlation Interference Mitigation
  - Serial Interference Cancellation
  - Parallel Interference Cancellation
  - Other methods...
- Motivation

Outline

- Signal Generation in GNSScope
- Simulation Case Studies & Analyses
- Concluding Remarks
  - Future Work...

Introduction



[2]

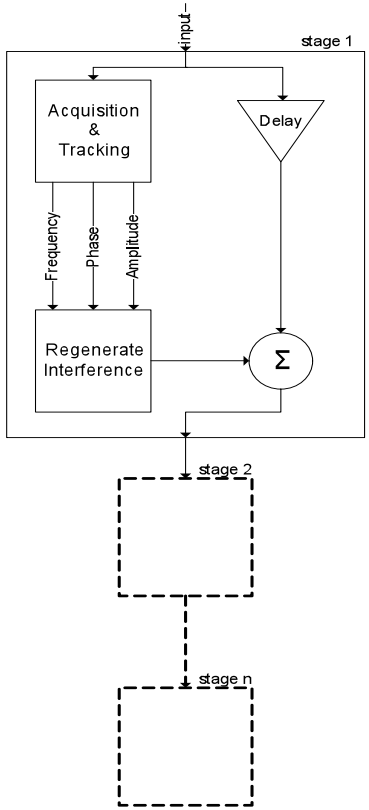
- Future civilian navigation signals:
  - Multiple bands
  - Multiple navigation systems
- Requiring:
  - Multi-mode
  - Wideband

Multiple Access Interference In GNSS

- Finite length spreading codes in GNSS
  - ⇒ limited dynamic range
- Random travel times
  - ⇒ PRN codes not orthogonal
- Signal paths different
  - ⇒ varying received signal levels

Cross-Correlation Interference Mitigation

- Serial Interference Cancellation *(SIC)*
  - ☺ *Reduced MAI in subsequent stages*
  - ☹ *Computationally intensive*
  - ☹ *Potential for significantly increased processing times*



Cross-Correlation Interference Mitigation

- Parallel Interference Cancellation *(PIC)*
  - ☺ *Interferers removed in parallel*
  - ☹ *Increased hardware complexity*
  - ☹ *Potentially, similar processing time problems could arise*

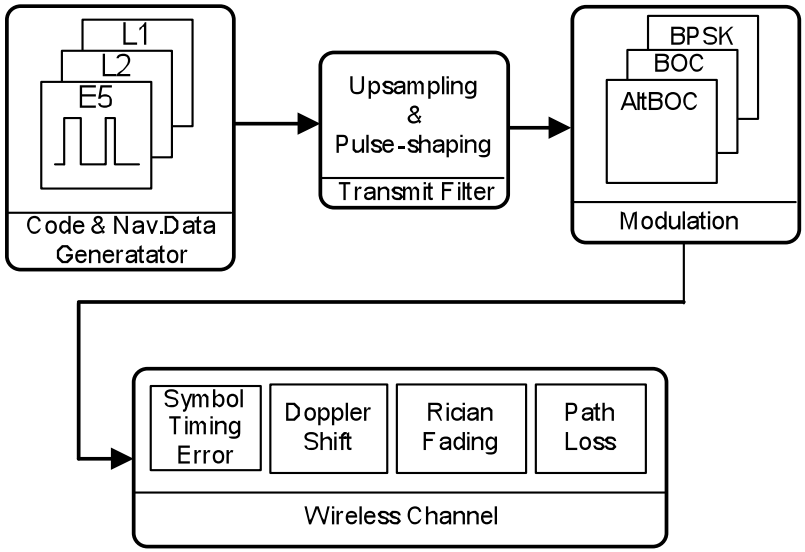
Cross-Correlation Interference Mitigation

- Other methods...
  - Delayed Parallel Interference Cancellation [8]
  - *sinc(Δf)* Signal Cancellation [9]
  - In-house methods

Motivation

- Enable rapid prototyping and testing of designs targeting multi-platform multi-frequency global navigation systems
- Undertake signal environment and condition emulation and analysis
  - Multipath, Weak Signal and Interference Mitigation
  - Signal Obstruction and Shadowing
  - Atmospheric Effects and Fading

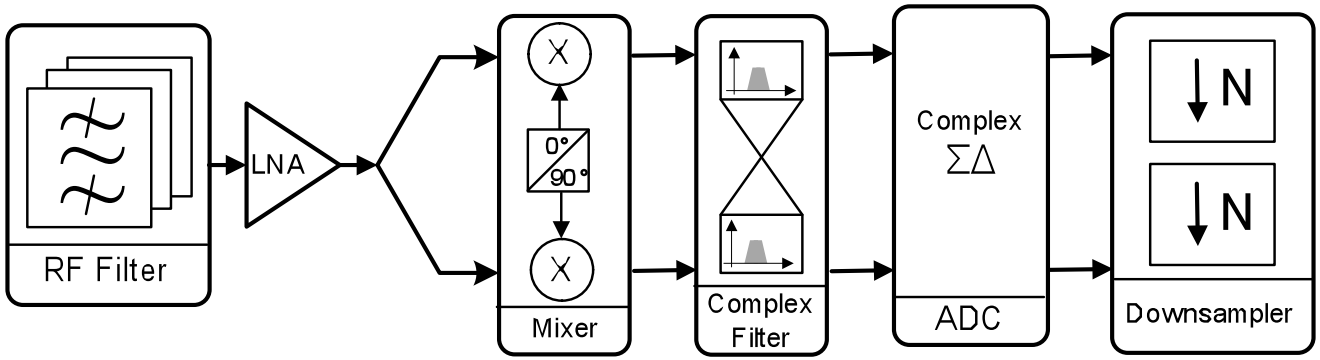
Signal Generation in GNSScope



GPS L1/L2C and Galileo L1/E5 Tx Model Implemented in Simulink

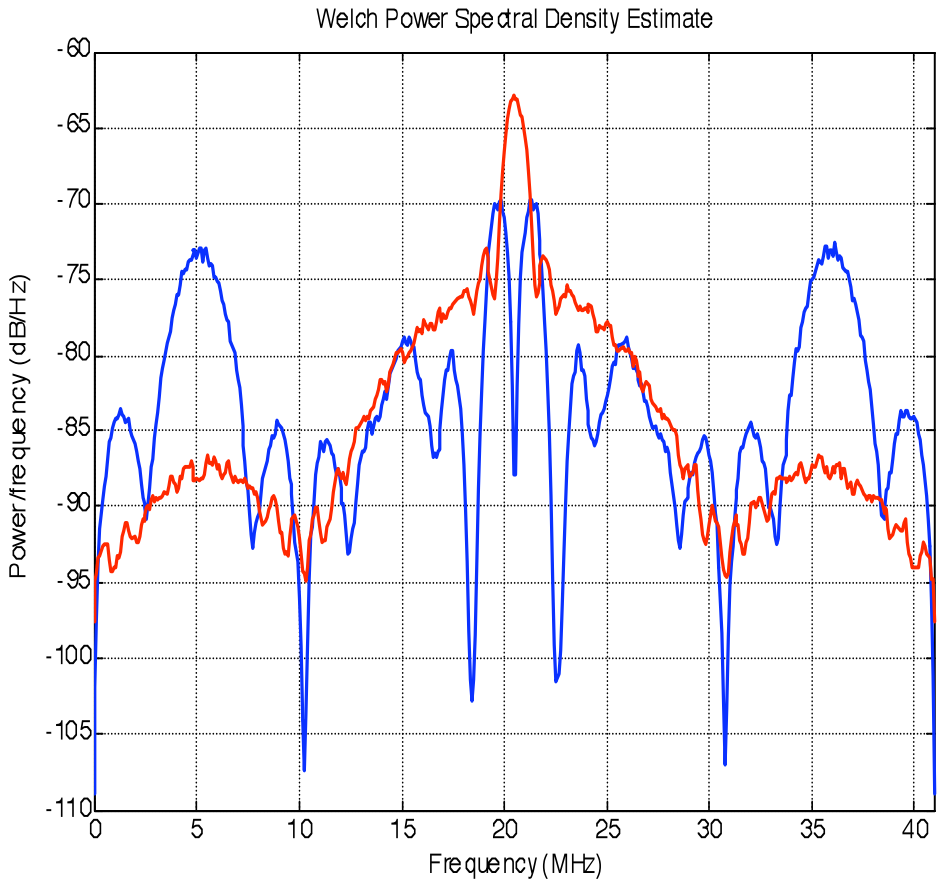
- Modulation Scheme
- Sampling Rate
- Roll-off Factor
- Group Delay
- Symbol Error Rate
- Rx Velocity (Doppler)
- Delay Factor (Multipath)
- K-Factor (Multipath)
- Path Loss

Signal Generation in GNSScope



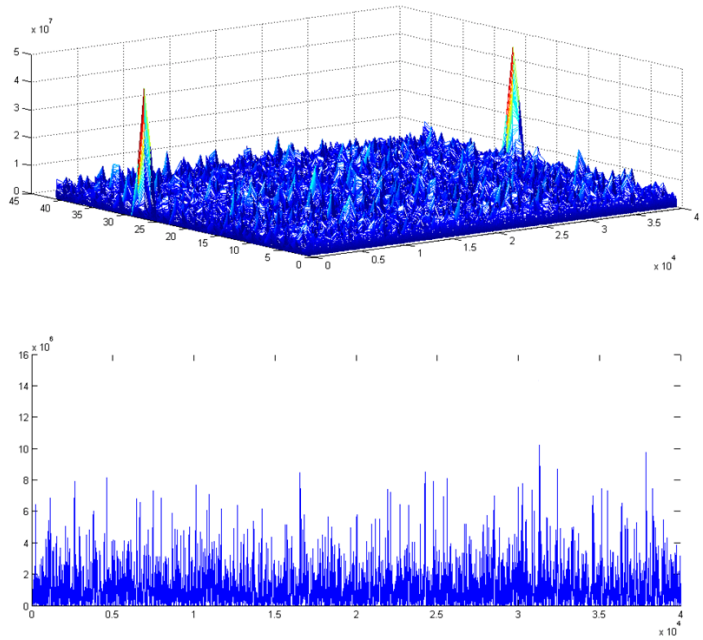
- RF Filter: Band Selection (L1/L2C/E5), Q-Factor
- LNA: Gain, IIP2, IIP3, 1dB Compression Point, Noise Figure
- Mixer: IF, Gain and Phase Error
- Complex Filter: BW, Mismatch Factors
- Complex Band-pass ADC: Mismatch Factors
- Decimator: DS Factor, Group Delay, Roll-off Factor

Signal Generation in GNSScope



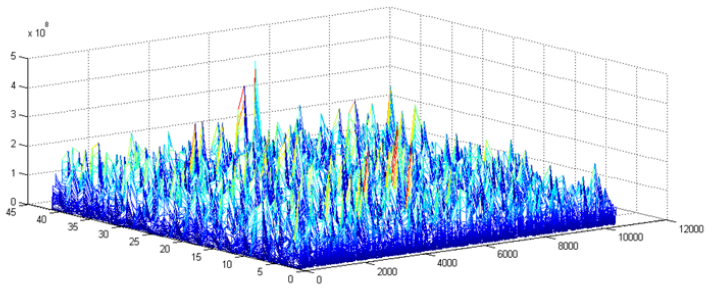
Simulation Case Studies & Analyses

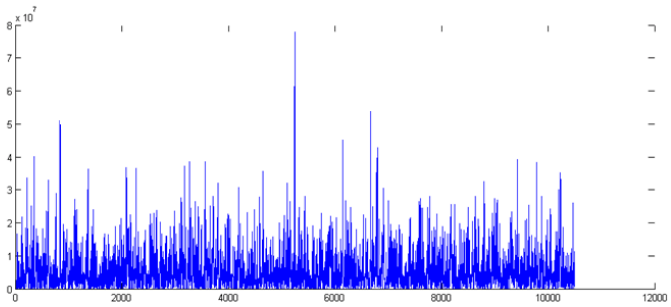
- Case A – Weak Signal Acquisition
  - 2 Strong SVs
  - 1 Weak SV
  - Normalised plots



Simulation Case Studies & Analyses

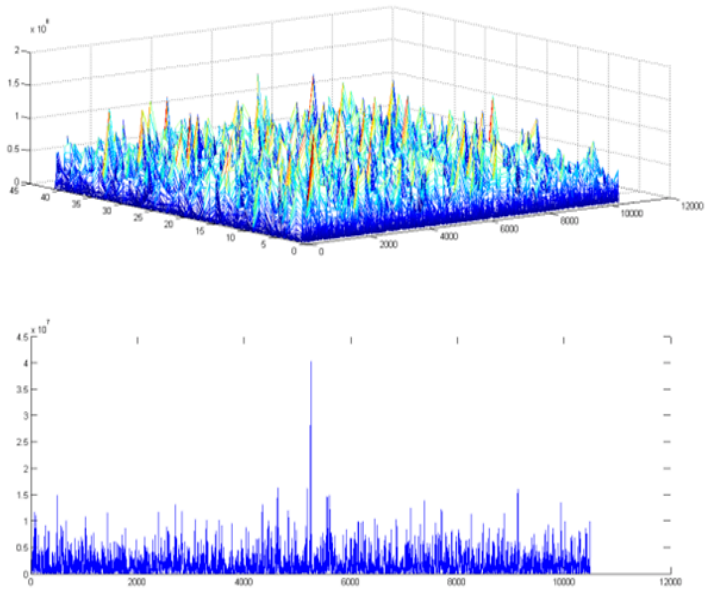
- Case A – Weak Signal Acquisition
  - pre-MAI
  - post-MAI
  - SIC method
  - no PDI





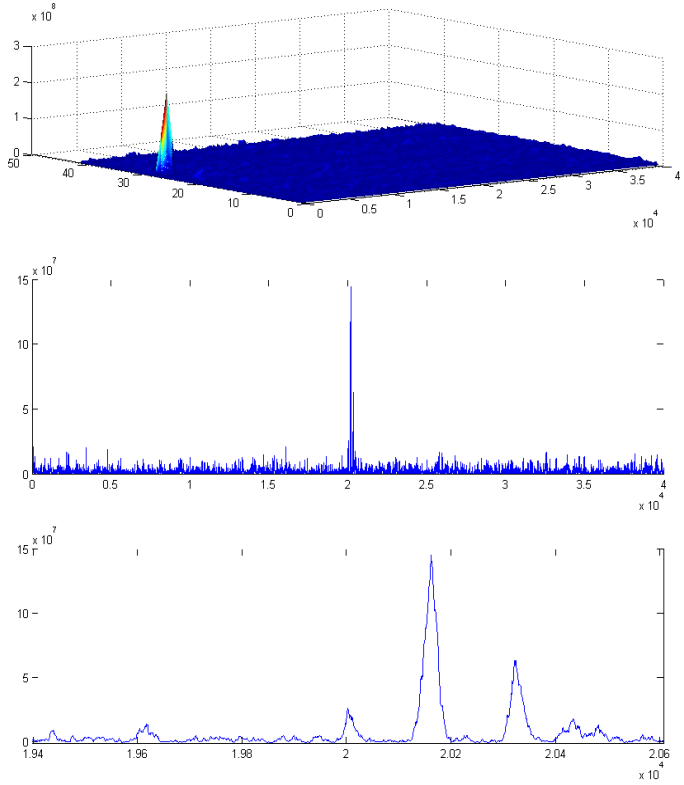
Simulation Case Studies & Analyses

- Case A – Weak Signal Acquisition
  - pre-MAI
  - post-MAI
  - PIC method
  - PDI



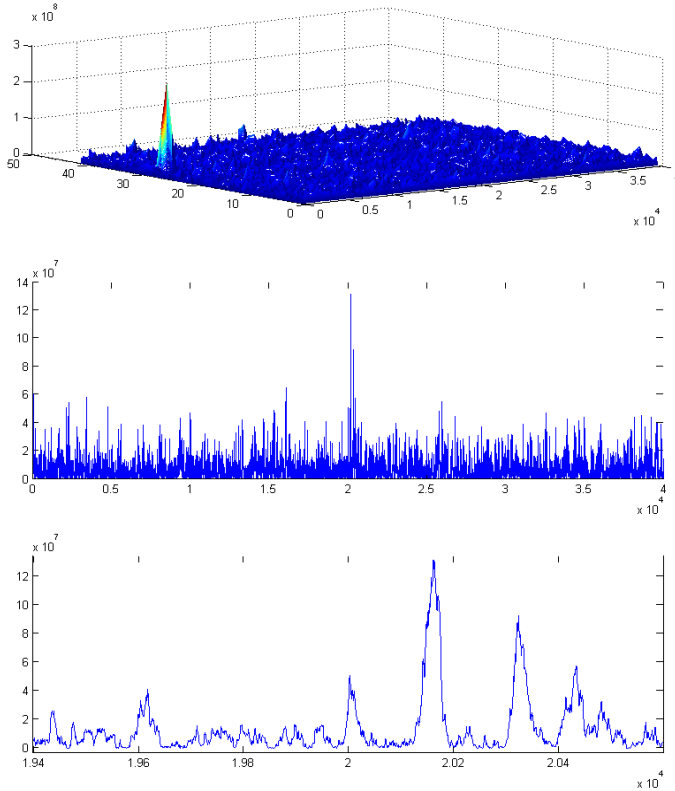
Simulation Case Studies & Analyses

- Case B – Multipath Recovery
  - -20dB SNR
  - 1 LoS Signal
  - 3 Multipath Signals
  - In-house method



Simulation Case Studies & Analyses

- Case B – Multipath Recovery
  - -30dB SNR
  - 1 LoS Signal
  - 3 Multipath Signals
  - In-house method



Concluding Remarks

- End-to-End modelling environment
- Complete control over every stage of the signal path
- Controlled weak signal and multipath condition emulation

Thank You!

For further information

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