A Software Model for GPS Receiver Signal Processing Blocks Used in Educational Environment

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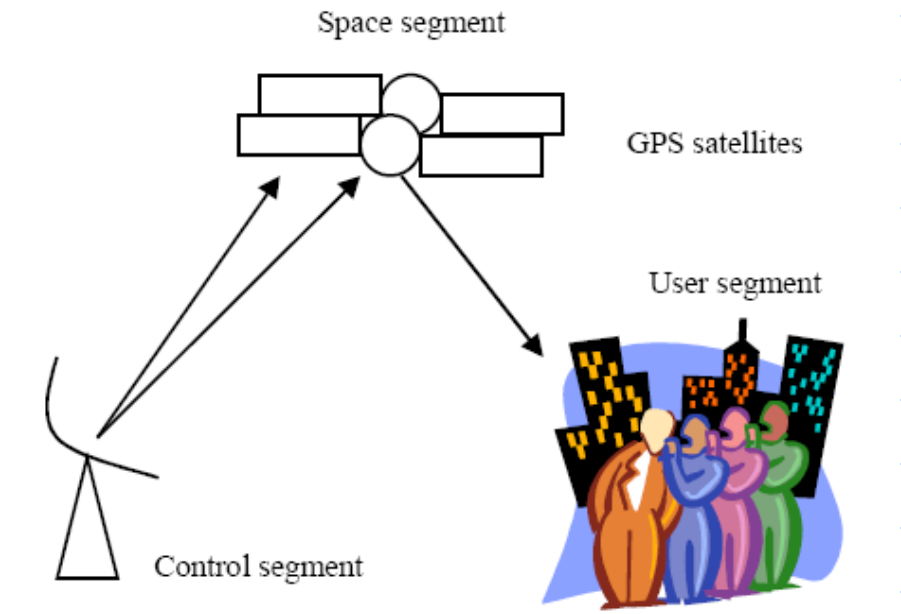
Overview

- Introduction in GPS
- GPS receiver
- Simulation of GPS DSP processing
- Results using Matlab
- Compatibility under Octave
- Future work
- Conclusions

Introduction in GPS

- Well known acronym (Global Positioning System)
- Coordinate calculation using a set of satellites (theoretically minimum 4)
- Three segments : space segment, control segment, user segment



Introduction in GPS

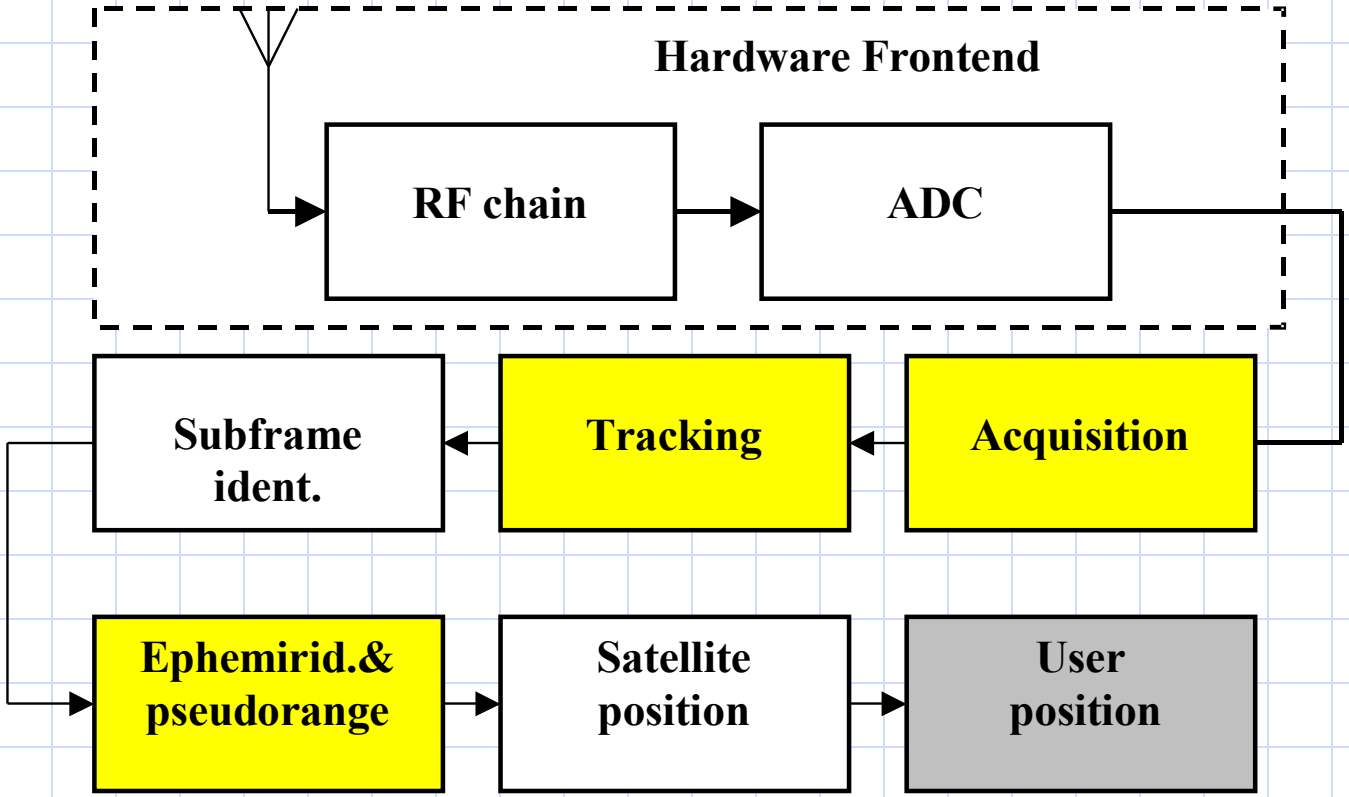
- Space segment:
  - Satellites in orbit – 26600 km altitude
  - Transmitting 2 signals – L1, L2
  - L1 at 1575.42MHz with a QPSK modulation modulated by a known Gold code of length 1023 the C/A code, with a rate of 1.023MHz (civilian code).
  - L2 at 1227.6MHz, with a BPSK modulation of the carrier by the P(Y) code (military)

Introduction in GPS

- Control segment
  - 5 surveillance stations around the globe, 1 main control station called the Master Control Station
- User segment
  - authorized users (military)
  - non-authorized users (normally civilians).

GPS receiver

Block schematic

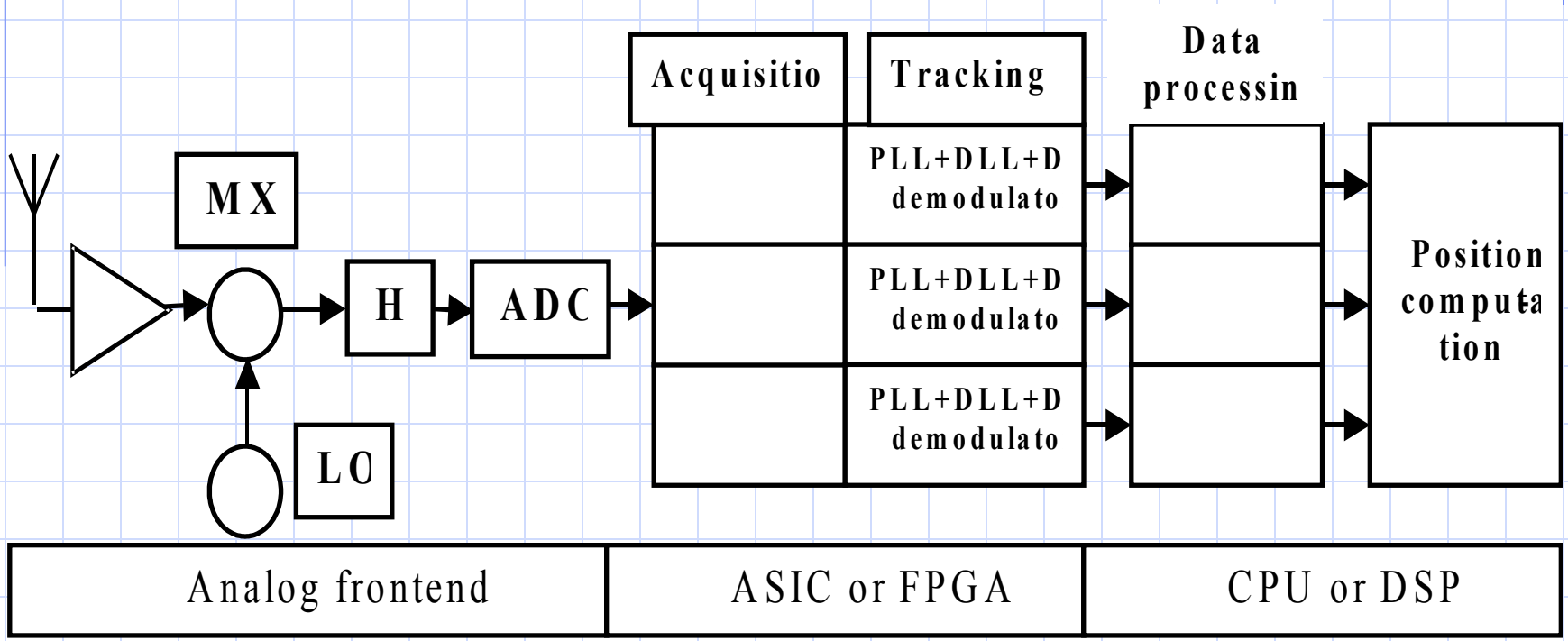


GPS receiver

- Processing
  - Real time implementation
    - Programmed logic : DSP, RISC Processors
    - FPGA
  - Simulation
    - Used to test new architectures or algorithms
    - Test benches – performance evaluation of hardware architectures
    - Educational purposes (our goal)

GPS receiver

- Hardware implementation -FPGA



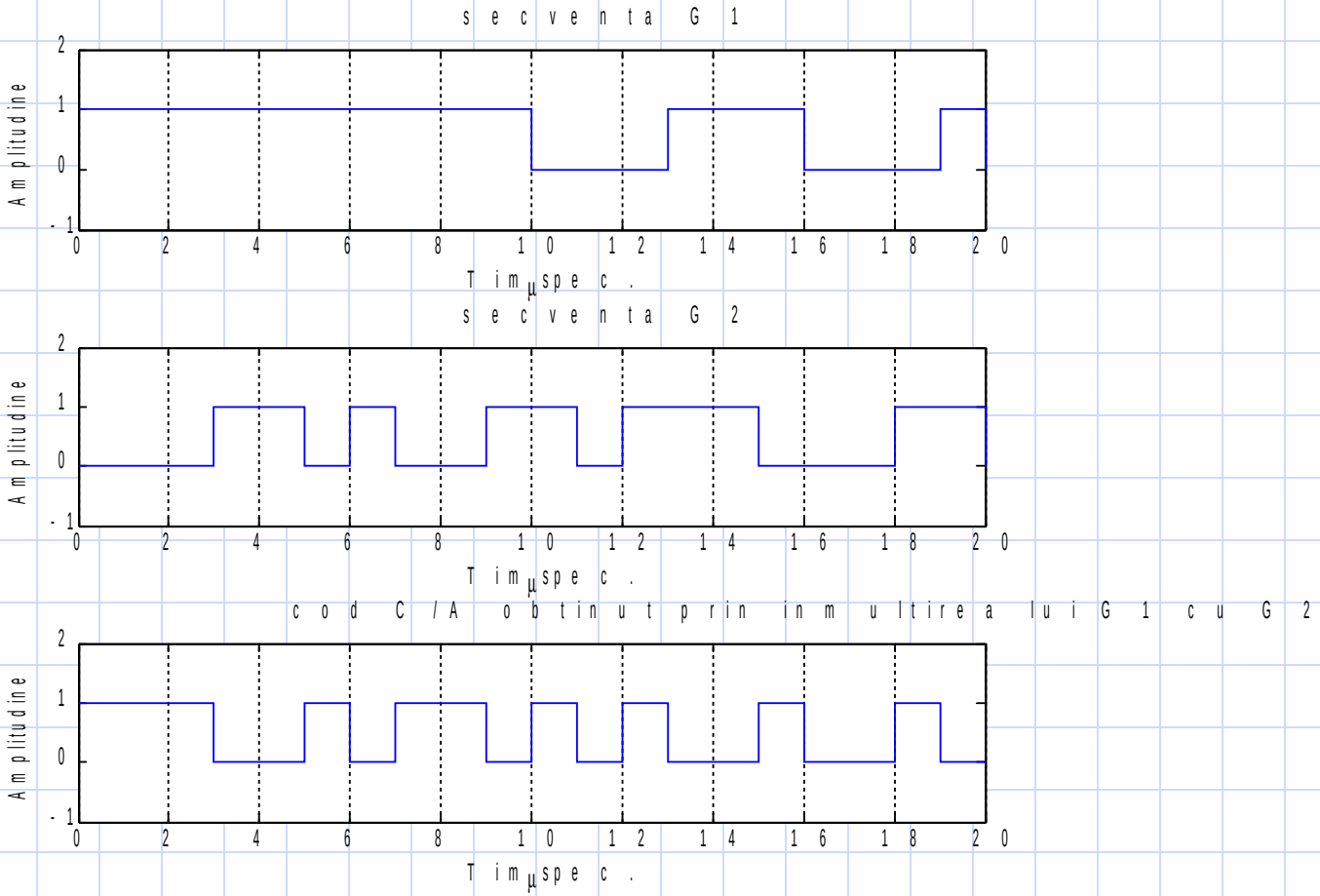
Simulation of GPS DSP processing

- Based on programming environment
  - Matlab-Simulink (eventually Octave)
  - C Environment
- Important issue: chosen Model
- Our case : GPS code (Kai Borre [6])
- Input data: open data sets like in RINEX (Reciver INdependent EXchange Format) family.

Results- simulation under Matlab

- Reference code optimized for Matlab
- Compatibility “guaranteed”
- Blocks already implemented:
  - Random code generation for different satellites
  - Observation files
  - Navigation files

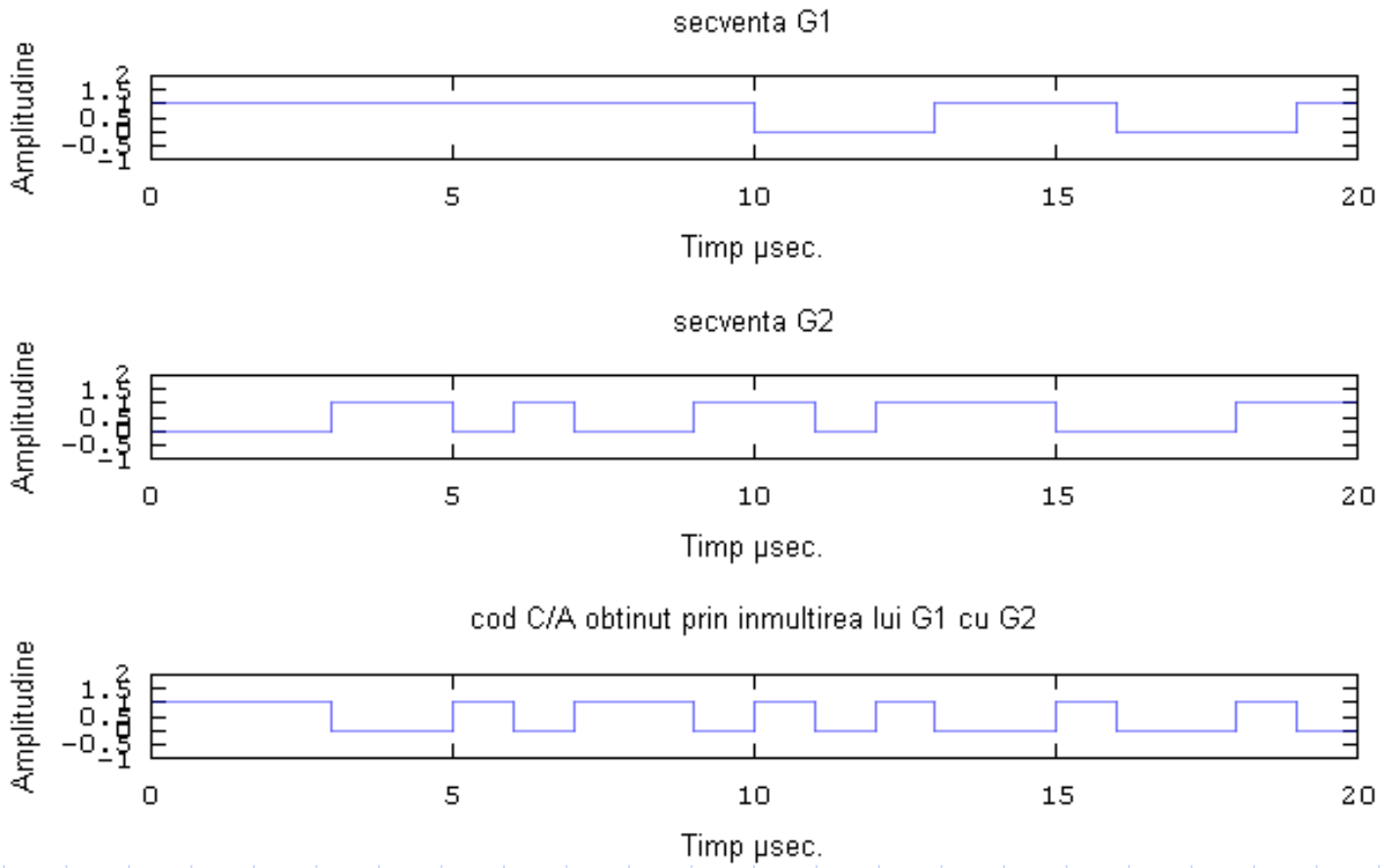
C/A code generation



Compatibility under Octave

- Octave [7] – free replacement of Matlab
- Some compatibility issues
- A specific goal for our work - verfication of compatibility for the GPS code
- The same modules implemented also under Octave
- Our goal – to have all modules full functional under Octave

C/A code – Octave version



Future work

- Transforming the "stop and go" work in an "ongoing" work
- Implementation of all modules
- test the modules under Matlab and Octave
- Add a RF frontend for real signal capture
- Going to a Rapid prototyping solution using DSP or FPGA (see the new versions of Matlab) – Real–time workshop

Conclusions

- GPS – a well-known technology with complex digital signal processing
- Most implementations are concentrated on efficiency and cost, ignoring the transparency of the technology
- Our implementation - educational aspects
- Useful in the future to support the work in promising future projects like Galileo