Compensating Doppler effect for D-STAR satellite communications: on-board and on-ground solutions

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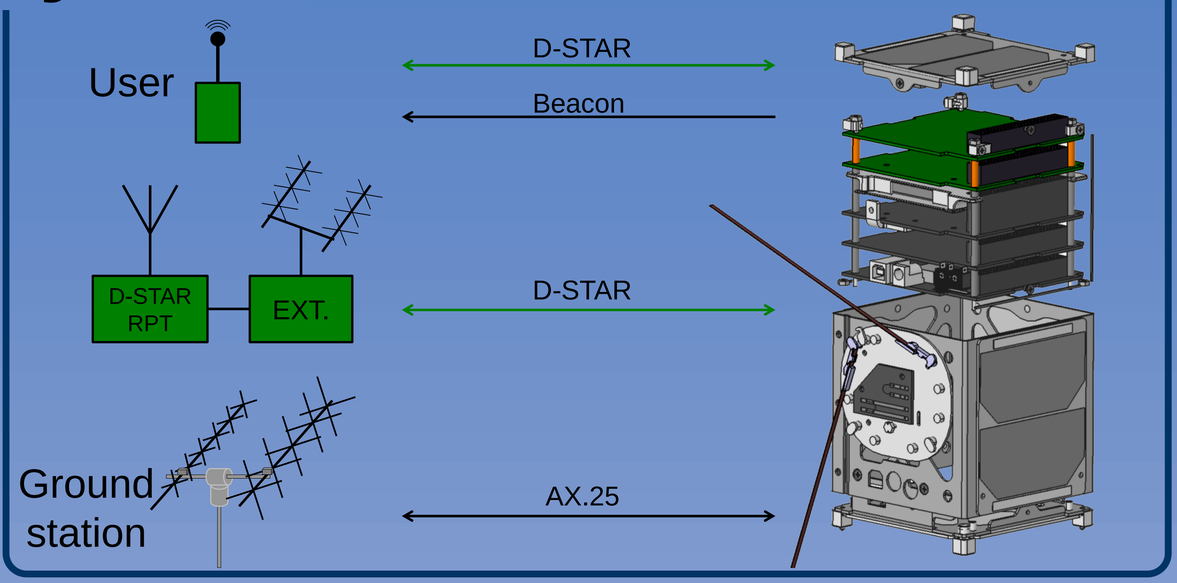
OUFTI - 1

Introduction

A major issue in the design of a D-STAR radiocommunication system for a satellite is the Doppler shift compensation. We describe the various constraints we faced, and the solutions we implemented on-board and on the ground for the OUFTI-1 nanosatellite system.

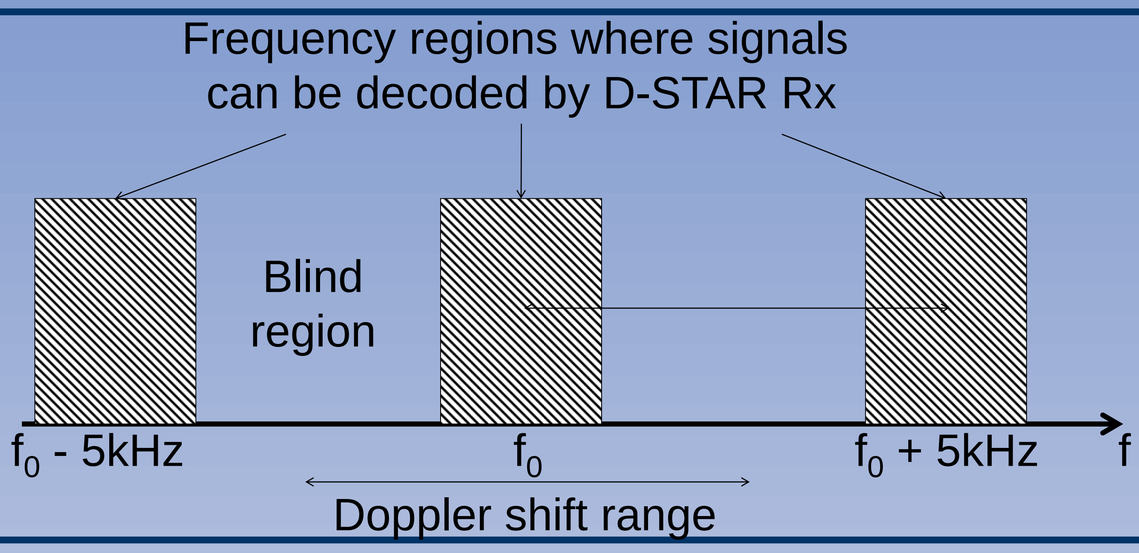
System



Constraints

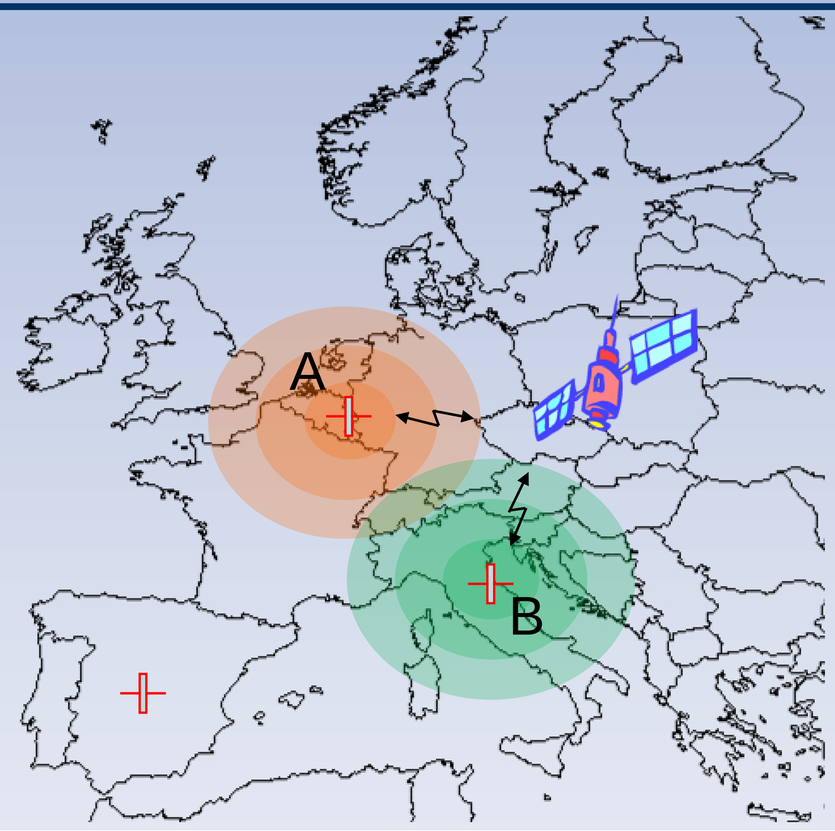
- Doppler shift ranges
  - -3 kHz to +3 kHz at 145 MHz (downlink)
  - -9 kHz to +9 kHz at 435 MHz (uplink)
- Commercial D-STAR transceivers
  - Tolerance of 1 kHz
  - Step of 5 kHz

→ Unable to compensate Doppler shift correctly.



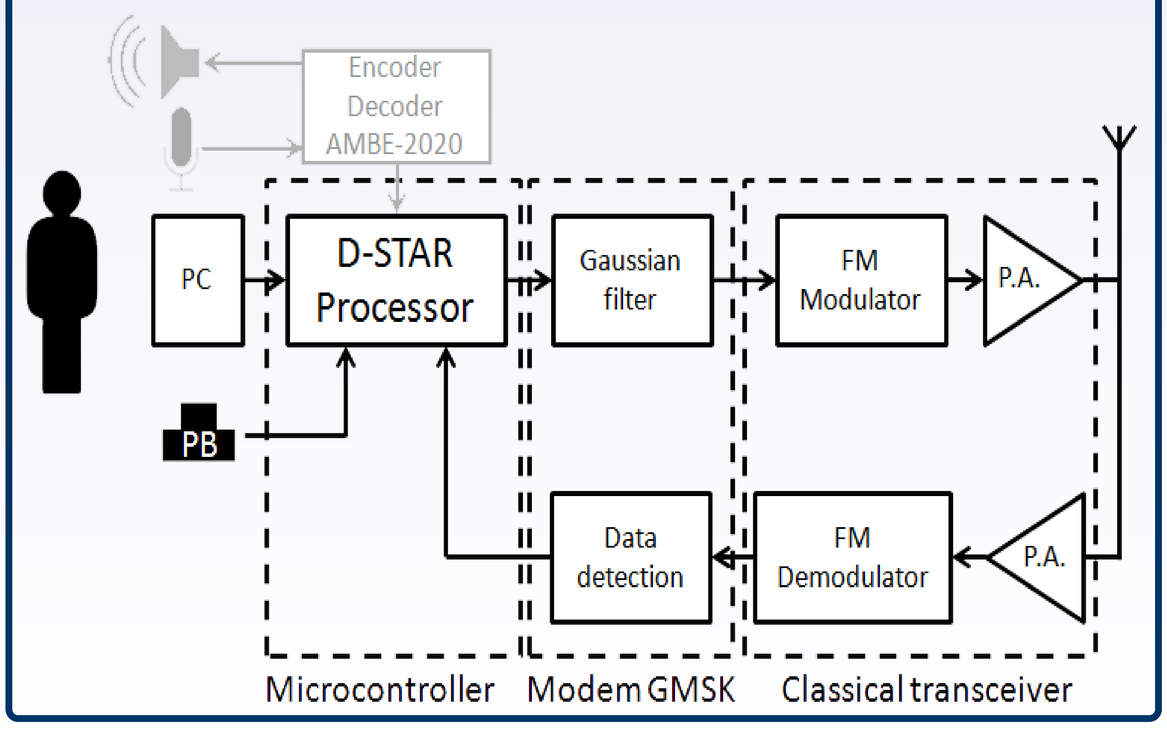
On-board strategy

- Compensate Doppler shift for two geographic regions (e.g.: Liège, Belgium, and Northern Italy)
- Possible D-STAR communications: A⇔A, A⇔B, B⇔B
- Regions pre-determined by Mission Control Center based on reservation by users
- Doppler shift compensations computed on ground, and transmitted to CubeSat by telecommands
- User located outside regions A and B (e.g.: Spain) can use D-STAR satellite transceiver by compensating Doppler shift compensation



User strategy

- Addition of an electronic system between (1) microphone, PC, … and (2) commercial (non-D-STAR) transceivers



Ground strategy

- Addition of an electronic system to interface dual-frequency satellite signals and single-frequency D-STAR signals