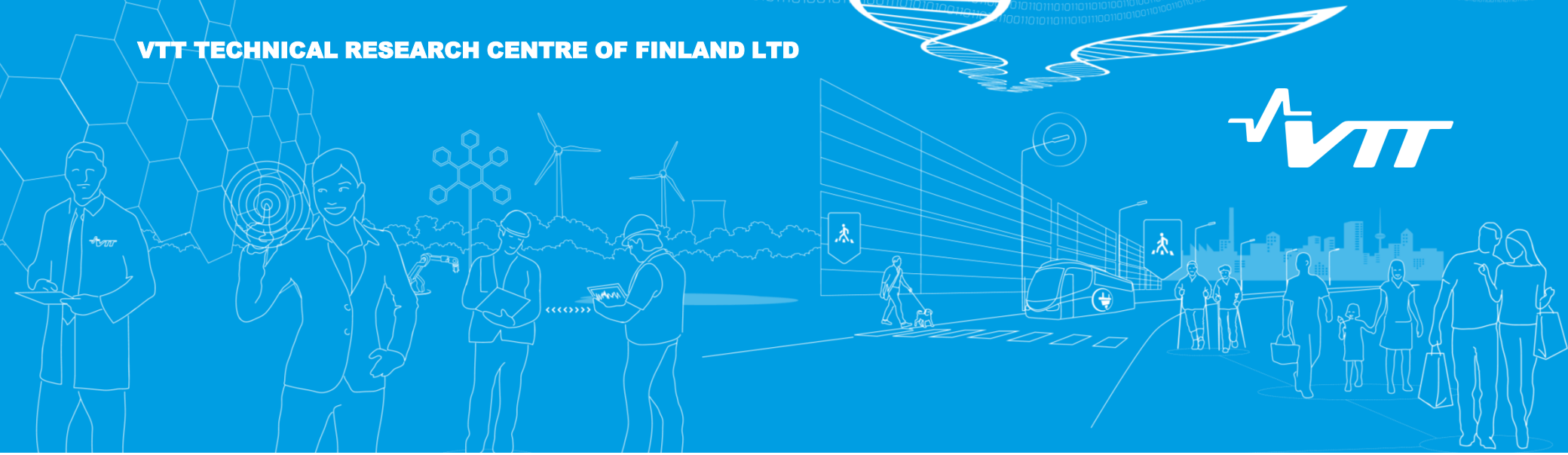


W-band communication test mission

Finnish Satellite Workshop 17.1. 2018

Jussi Säily, Mikko Kantanen, Jukka Kiviniemi, and Pertti Järvensivu

Outline

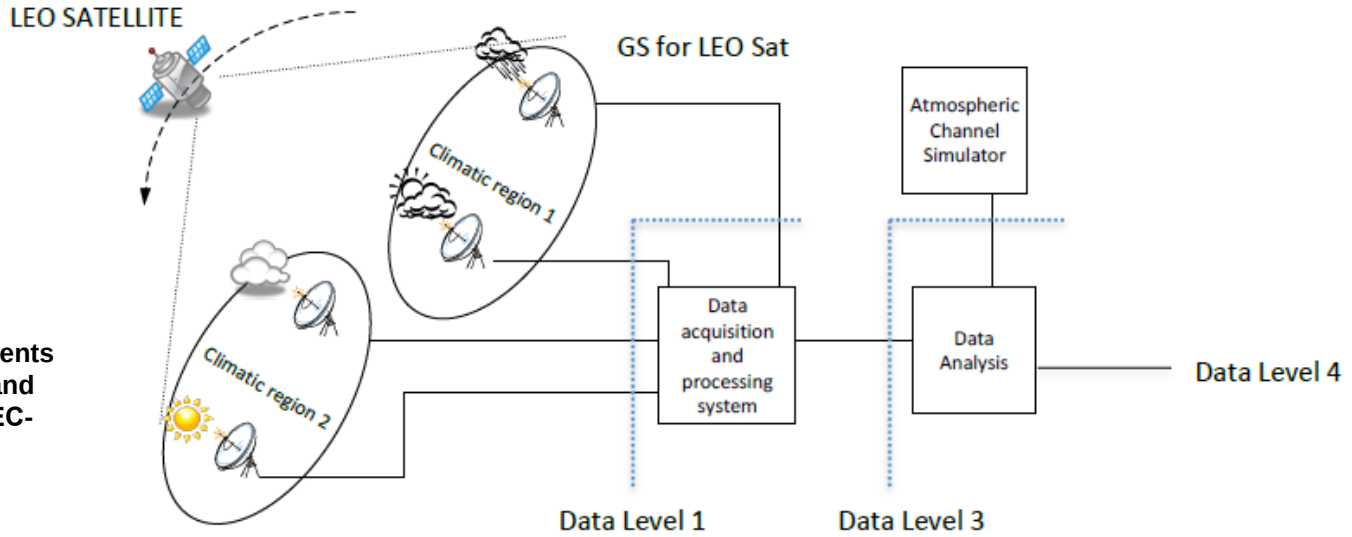
- Mission definition
- Satellite platform
- RF payload
- Antenna technology
- Conclusions

Mission definition

- Ka-band (27-40 GHz) is in commercial satellite phase
  - Growing interference from ground systems like 5G
- Q/V-bands (33-50/40-75 GHz) are being evaluated (ongoing Alphasat Aldo Paraboni mission)
- W-band (75-110 GHz)
  - Wide available bandwidth, small antenna size for high gain, low interference from ground, rapid RF electronics development
  - High atmospheric losses especially with low elevation angles in non-GEO missions
  - Accurate modelling of propagation effects is needed for designing SatCom services at W-band

Mission definition

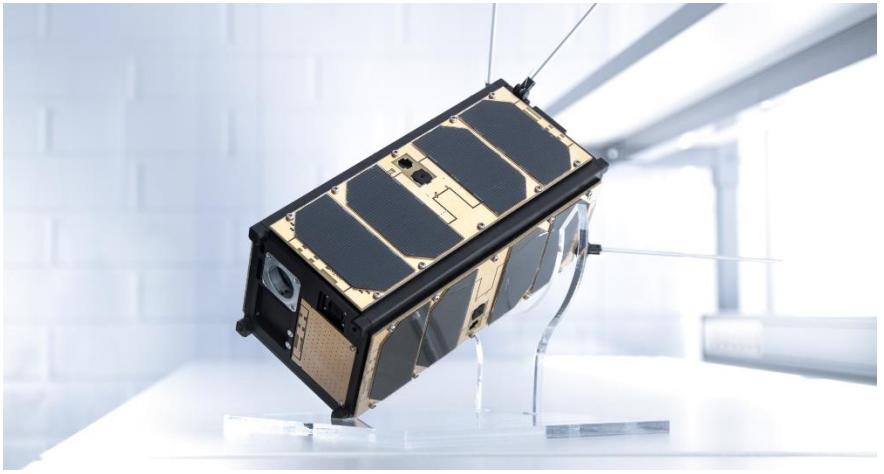
- Cubesat W-band mission is attractive due to low cost
  - Dynamic atmospheric variations can be measured
  - Duration and reliability are limited
  - 2-4 years mission duration is planned
- Purpose is to collect propagation data as long as possible and input to numerical atmospherical simulator to create atmospheric models
  - One or more ground stations equipped with weather stations
  - Compare with existing Ka/Q/V-band models
- Two frequencies for satellite beacon: 75 and 37.5 GHz

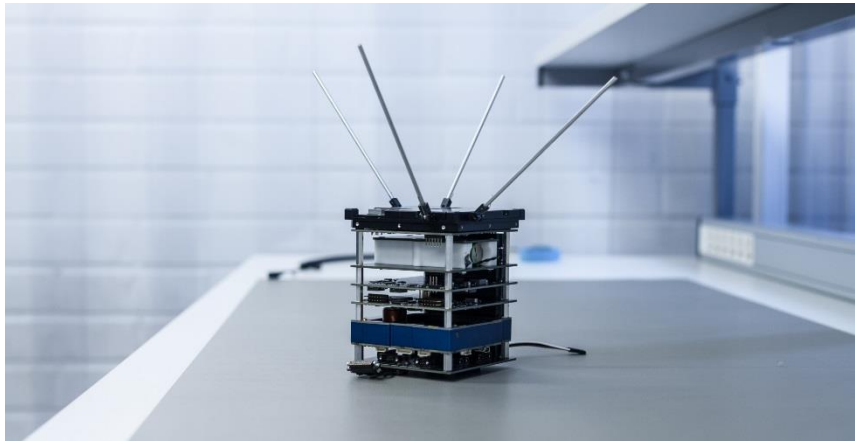


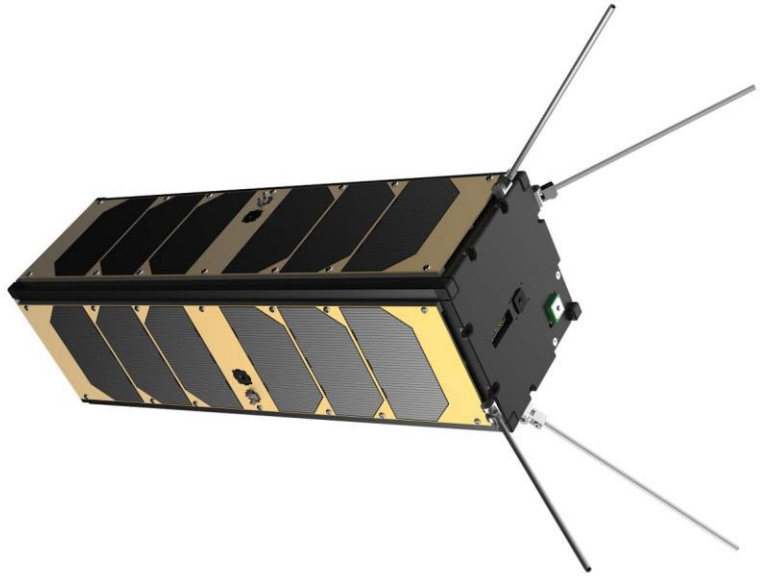
A. Martellucci and E. Re, "Analysis of requirements for propagation experiments with an in-orbit demonstrator for W band SatCom services," ESA Memo, Ref /TEC-EEP/2015.135, 20 December 2015.

Satellite platform

- Reaktor Hello World satellite platform is used in 3U configuration
- Spacecraft subsystems fit in 1U
- 2U available for payload unless a larger battery is fitted

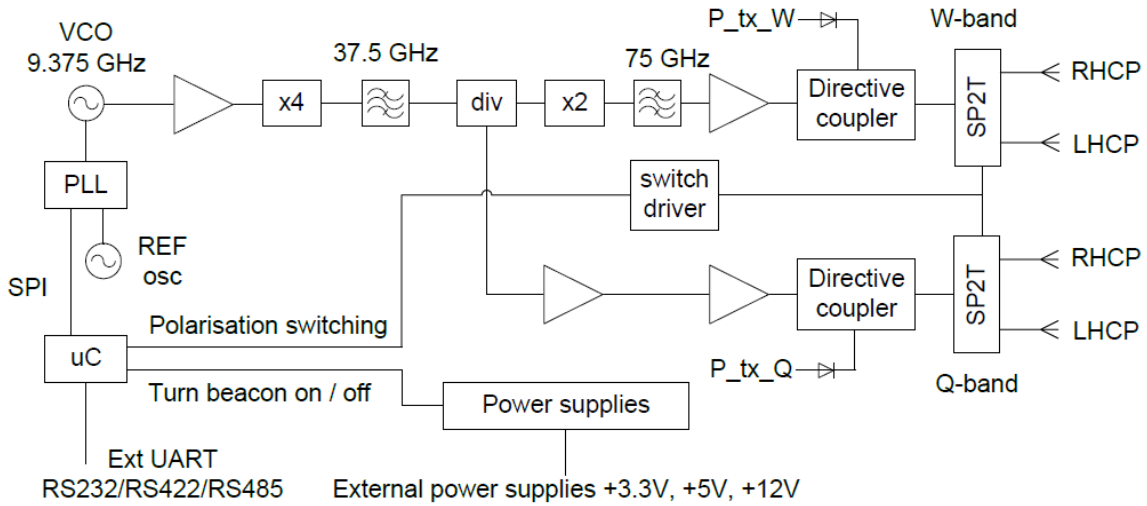






RF payload

- Q- and W-band beacon transmitters
  - Both on at the same time
  - Switched between RHCP/LHCP polarizations
  - Mostly COTS components
- Switched on during fly-over of ground stations
- <10 W power available to RF payload during fly-over



Antenna technology

- Isoflux type radiation pattern for wide Earth coverage
  - The desired antenna pattern must equalize attenuation in the field of view
  - For a 800 km orbit the EOC (edge of coverage) angle is 61 degs
- Dual circular polarizations
  - LHCP / RHCP
  - Beacon transmitter switched between polarizations
- Separate Q/W-band antennas

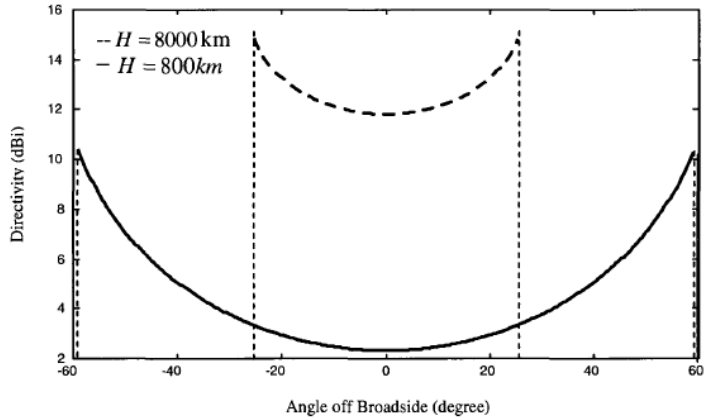


Fig. 1.1-3 Profile of Desired Rotationally Symmetric Directivity Patterns for Satellite Altitudes of (a) 8000km and (b) 800km, $\phi_0 = 15^\circ$

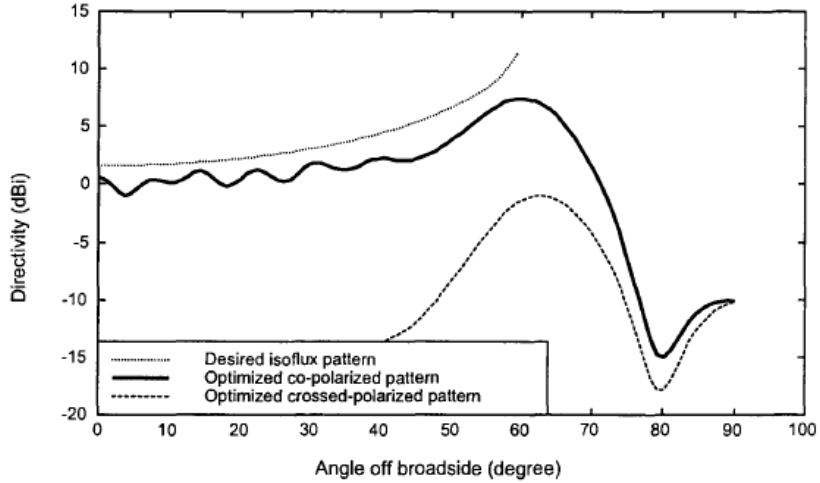


Fig.5.3-6 Directivity Pattern of the RLSA with Radius of 4.15 λ and EOC Angle of 60°

Xiangjun Meng, "*A Synthesis Technique for Radial Line Slot Array Antennas with Isoflux Radiation Patterns*", PhD Thesis, University of Ottawa, 2009.

Conclusions

- Dual band (Q/W-band) Cubesat mission is being planned for atmospheric modelling during 2-4 years
- Challenges
  - Small satellite size for complex payload (3U)
  - Tight payload power budget (<10 W)
  - Dual-polarized dual-band antennas required
  - Reliability for 2 years minimum with no redundancy
  - Tight development schedule (satellite will fly in 2019)
- Project consortium includes VTT/MilliLab and Reaktor Space Lab (Finland) as sub-contractors, prime contractor and other sub-contractors will be announced later when contracts have been signed

MilliLab Reaktor Space Lab RSL


TECHNOLOGY FOR BUSINESS