The **N**avigation and **O**ccultation e**X**periment (NOX) onboard TET-1

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Overview

- Introduction and Motivation
- NOX Concept and Payload Design
- Past Activities
- Present Status
- Next Steps
- Summary and Conclusions

Introduction - GPS in Orbit

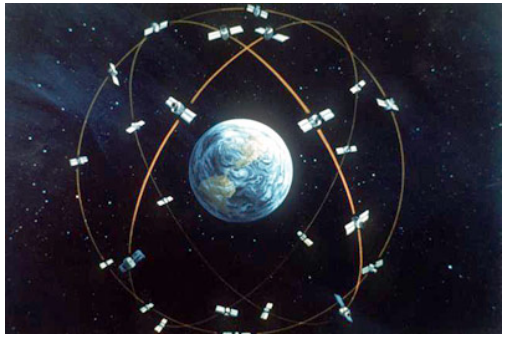
- Over the past 15 years GPS has evolved into a well established tracking system for space vehicles
- Global coverage (LEO) and high accuracy at competitive system costs
- Onboard availability (higher degree of autonomy)
- Key applications:

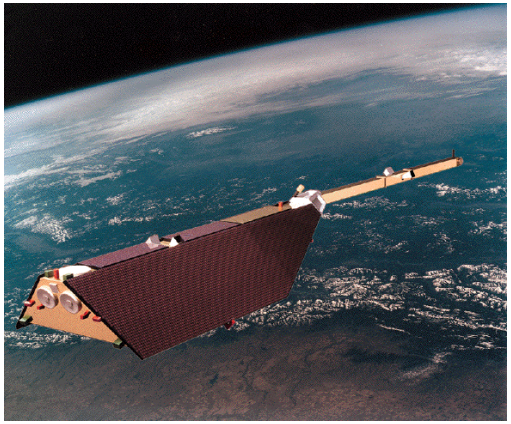
  Navigation oriented:

  - Orbit Determination (real-time & offline)
  - Relative Navigation (formation flying)
  - Geocoding and time synchronization
  - Attitude Determination (?)

  Science oriented:

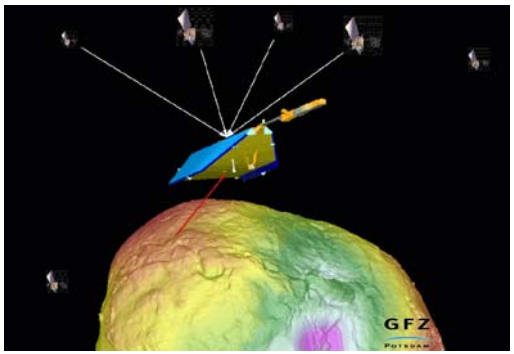
  - Gravity Field Determination
  - Occultation
  - Sea Surface Reflections





Another Spaceborne GPS Experiment – Why?

- Navigation requirements of most (current) missions can be met with single-frequency GPS
- However, science investigations and high precision orbit determination require use of second frequency
- In view of tight quality assurance requirements and a small market segment, the costs of space-qualified dual-frequency GPS receivers (IGOR, Lagrange, GRAS) range from 0.5 - 2 M€



⇒ **Use of COTS GPS technology**

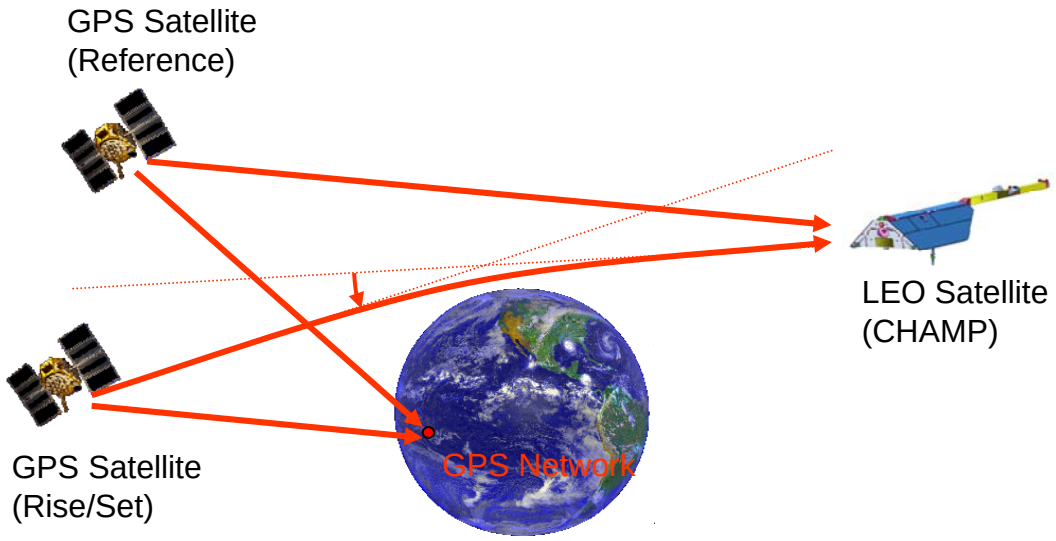
(Requires dedicated test and qualification program!!)

NOX Concept and Payload Design - Objectives

- Acronym stands for **N**avigation and **O**ccultation e**X**periment
- Primary objective is COTS GPS technology validation for use in space projects
- Secondary objective is to collect scientific data for the following two applications:
  a) *Precise Orbit Determination (POD)*
  b) *Occultation Measurements*

Occultations

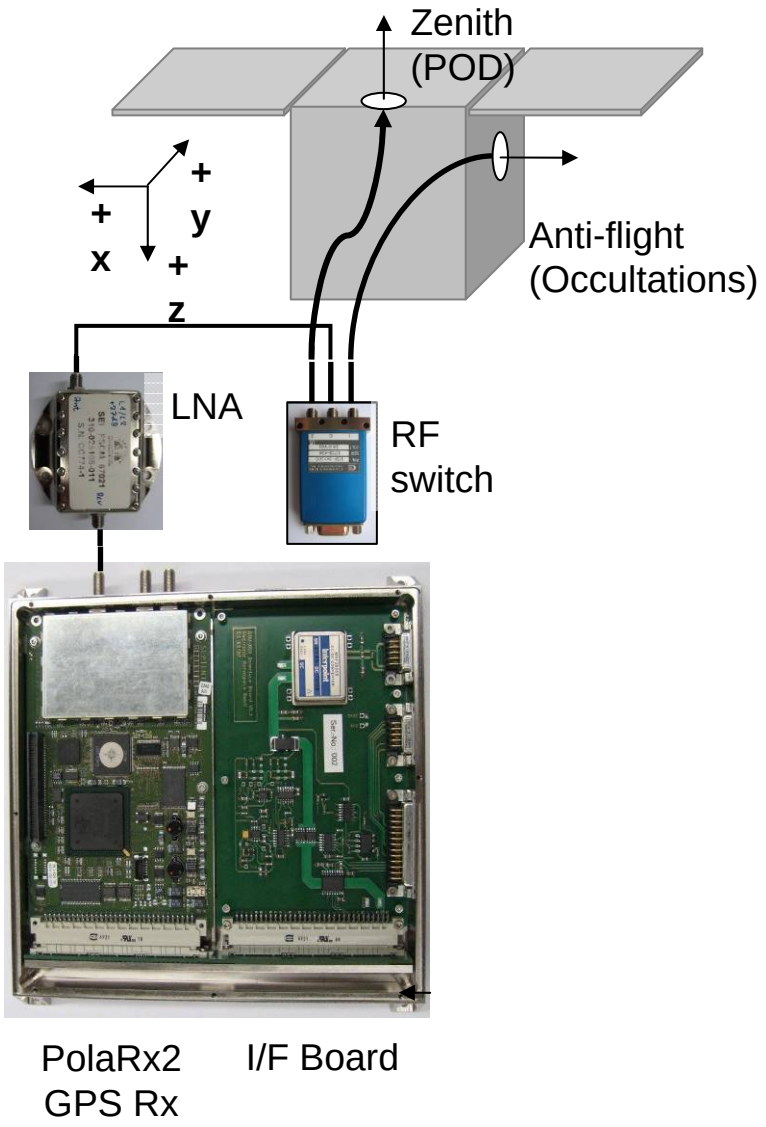
- Measurement of path/phase change of the GPS signals during transition through the atmosphere (rising/setting)
- Dual-frequency measurements (L1/L2)
- Position and velocity of the receiver available from GPS satellites at higher elevations
- Reconstruction of the refractivity as a function of altitude assuming spherical symmetry
- Variation of pressure, temperature, water vapor, electron density



NOX Payload Design

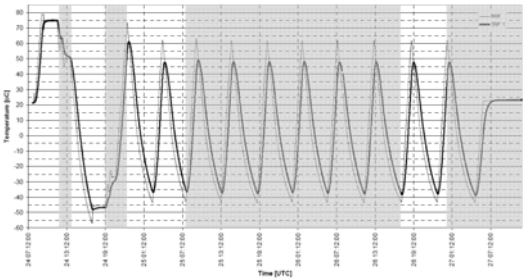
The NOX payload comprises:

- PolaRx2 GPS receiver
  - Geodetic-grade dual-frequency GPS receiver for terrestrial applications designed by Septentrio (Belgium)
  - 48 channels for tracking of C/A, P1 and P2 code and carrier phase for up to 16 satellites
- Dedicated I/F Board (power, latch-up protection, line drivers…)
- Two identical GPS antennas
- R/F relay for antenna selection
- LNA for required signal amplification



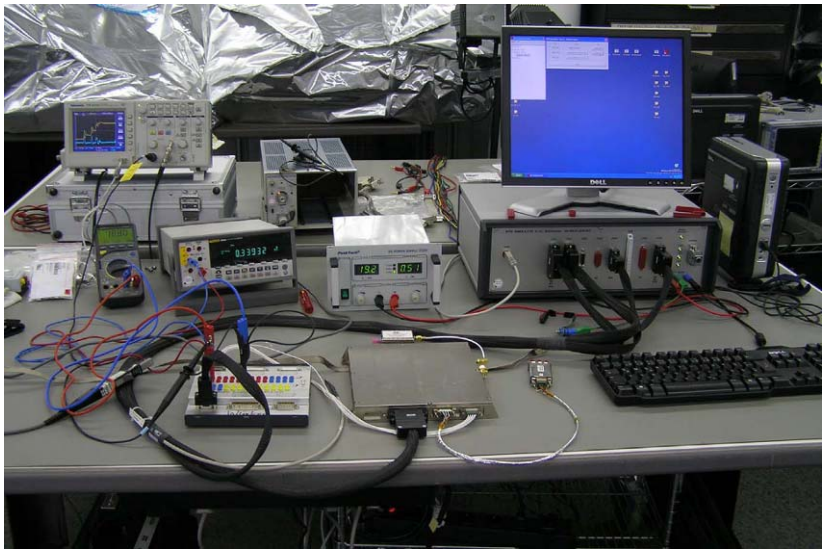
Past Activities

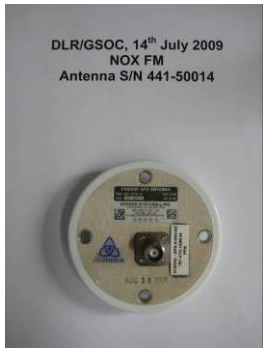
- Conceptual and Architectural Design
- Prototyping and Proof-of-Concept
- Procurement of required components and manufacturing of EM, QM and FM units
- Tracking and navigation performance assessment in signal simulator environment
- Environmental Testing
  - Thermal-Vacuum: *11 cycles; non-op. -45°C..+75°C & op. -35°C..+50°C*
  - Total Ionization Dose: *nominal operation up to accumulated dose of ~10 krad*
  - Vibration and shock tests (passed)
  - EMC tests (passed)



Present Status

- Manufacturing and testing completed
- Successful EM & FM handover to Kayser-Threde
- I/F and acceptance tests passed
- EIDP submitted and accepted





Next Steps

- Integrated system tests (planned for week 29)
- Development of an operations concept and corresponding flight procedures
- Definition and build-up of an “Experiment Control Center”

- Launch!!

Summary and Conclusion

- The PolaRx2 receiver has been selected for a flight experiment onboard the TET-1 technology demonstration satellite.
- The experiment will assess the feasibility and limitations of spaceborne GPS tracking using COTS-based dual-frequency receivers.
- Extensive ground tests have been conducted to obtain adequate confidence in the proper function and performance of the PolaRx2 receiver in low Earth orbit.
- The NOX FM and EIDP have been delivered to the project.
- Integrated system tests are currently under preparation