

# ARIS - Localization of a Sounding Rocket via GPS

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Simon Herzog

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Interim Presentation Bachelor Thesis

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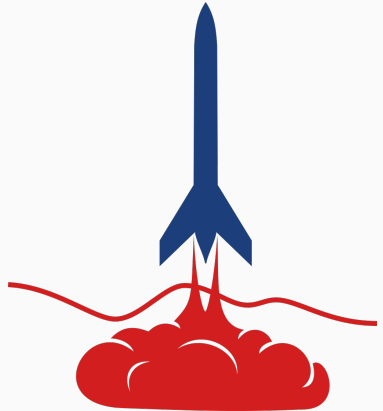
# Definition of Task

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# Framework



Akademische Raumfahrt  
Initiative Schweiz



Source: [spaceportamericacup.com](http://spaceportamericacup.com)  
Spaceport America Cup

# Task

- Evaluate GPS positioning for a sounding rocket
- Determine external and internal disturbances
- Find error mitigation methods
- Demonstrate feasibility of one method

# Requirements

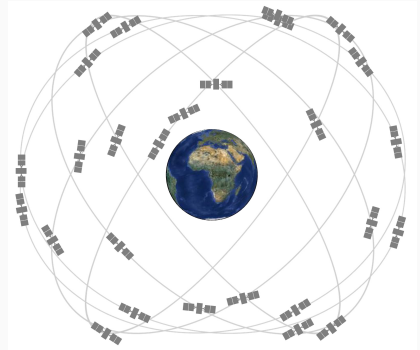
- Positioning Standard Deviation( $1\sigma$ ): 1m
- Min. Update Interval: 60s
- Max. TTFF after Burnout: 2s
- Max. Uplink Datarate: 2kbit/s

# GPS Concept

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# GPS Overview

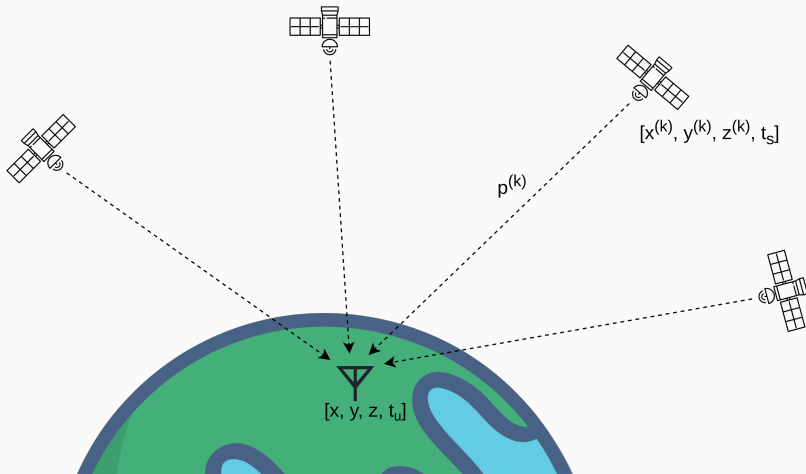
- Space Segment
  - 31 Satellites (min. 24) in  
Medium Earth Orbit
- Control Segment
  - Monitoring and Maintenance  
Stations
- User Segment
  - Civil and Military Receivers



Source: [gps.gov](https://www.gps.gov)



# Position Estimation

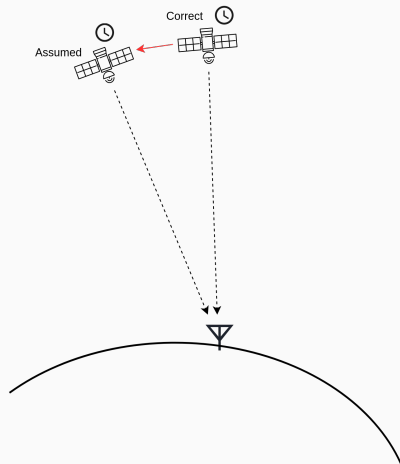


# Errors Sources

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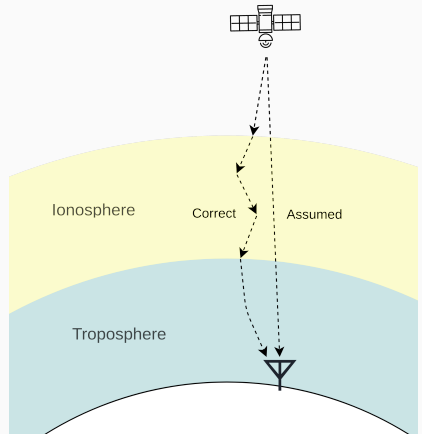
# Satellite Errors

- Clock Error
- Ephemeris Error



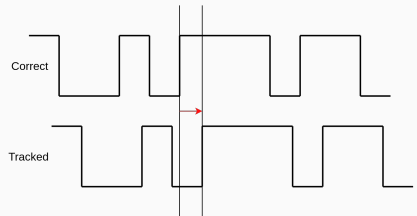
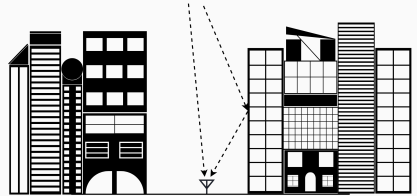
# Atmospheric Errors

- Ionospheric Delay
- Tropospheric Delay



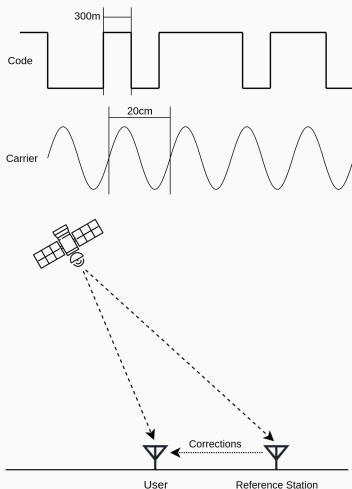
# Receiver Errors

- Multipath
- Receiver Noise



# Error Mitigation

- Carrier-Phase Measurements
- Differential GPS
- Real Time Kinematic

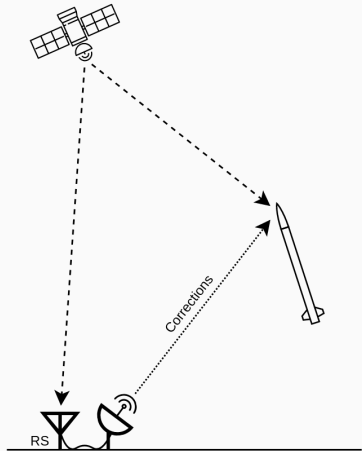


# DGPS Concept for a Sounding Rocket

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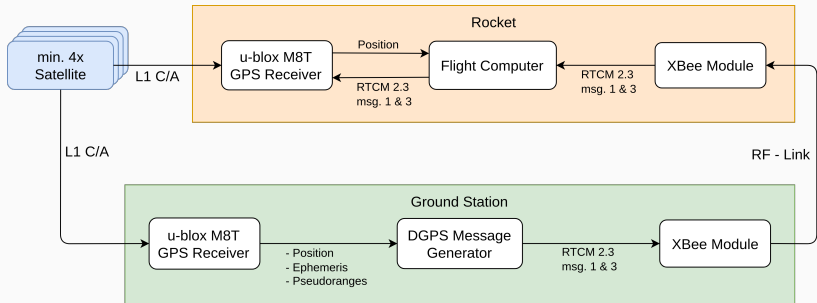
# Concept

- Position of RS is known
- RS receives satellite ephemeris data
- Pseudorange between RS and satellite is measured
- Distance between RS and satellite is calculated
- Range error of every visible satellite is sent to rocket
- Receiver on rocket includes corrections in position estimation



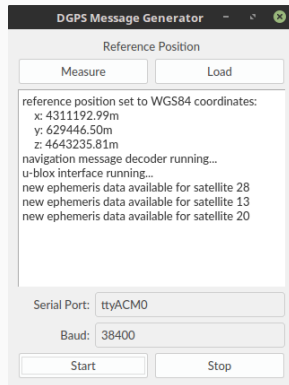


# System Overview

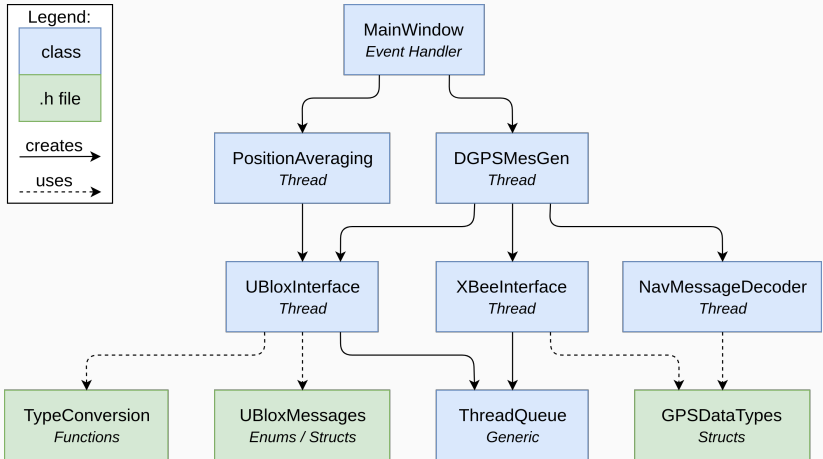


# DGPS Message Generator

- Receive UBX messages
- Set reference position
- Decode ephemeris data
- Calculate satellite position
- Calculate pseudorange error
- Encode RTCM messages
- Send RTCM messages



# Software Architecture



# Tests

- Static Accuracy
- Mobile Accuracy
- Rover / Reference Station Distance
- Height Difference
- Antenna Rotation
- Correction Message Interruption
- Rocket Launch

Questions?