Luplink : Link Budget Calculation UI

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Link Budget & Context

Link Budget & Context

Link Budget ?

$$P_{received}(dB) = P_{transmitted}(dB) + G_{dB} - L_{dB}$$

Losses : FSL, antenna depointing, polarization, edge of coverage, technological, rain attenuation, ...

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Losses : FSL, antenna depointing, polarization, edge of coverage, technological, rain attenuation, ...

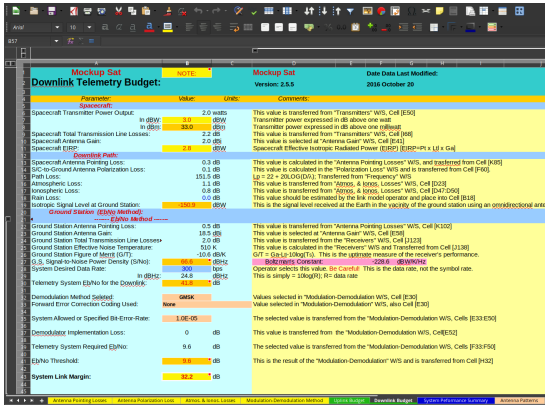


Figure 1: AMSAT.xls

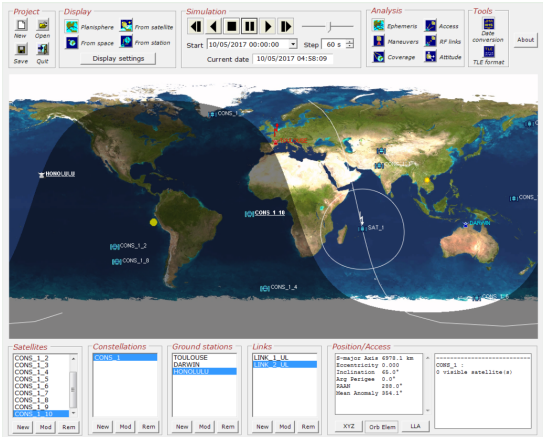


Figure 2: SatOrb

Python libraries :

- linkpredict
- luplink
- ...

The Project : JSatOrb & Luplink

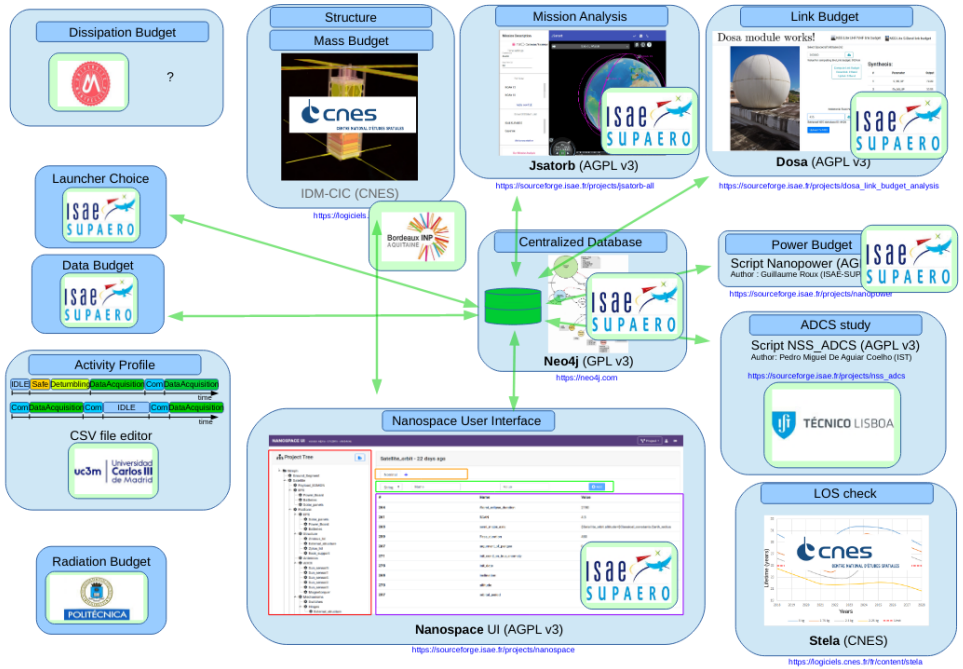


Figure 3: Nanospace Software Suite (NSS)

Luplink: Open-source tool integrated inside JSatOrb.

Requirements :

- Usable within NSS
- Suitable for teaching
- Modular
- Unit-tested

Luplink Diagram Simple Link Budget Full Link Budget Untitled_Link_Budget Compute

GEOMETRY UPLINK DOWNLINK RESULT

Welcome

LINK BUDGET

Geometry

Uplink

Carrier & Environment

Transmitter

Receiver

Downlink

Carrier & Environment

Transmitter

Receiver

Results

v0.2.0

Uplink Carrier

Frequency: 146 MHz

Bandwidth: 3 Hz

Bit Rate: 1200 bps

Eb/N0 Threshold: 23.2 dB

Implementation Loss: -1 dB

System Margin: 10 dB

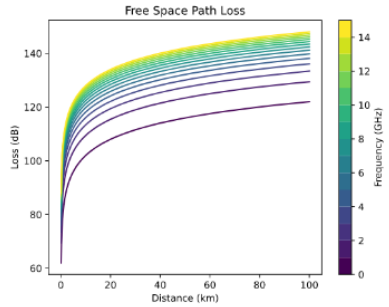
Atmosphere

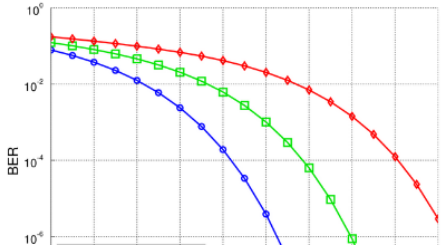
Depointing Loss: -0.9 dB

Documentation

Carrier & Environment

Here we can define the carrier used for the uplink. The Free Space Path Loss (FSPL) and atmospheric losses depend on frequency but also polarization of the carrier. This graph shows the losses in dB due to propagation in free space as a function of distance between antennas and frequency of the carrier



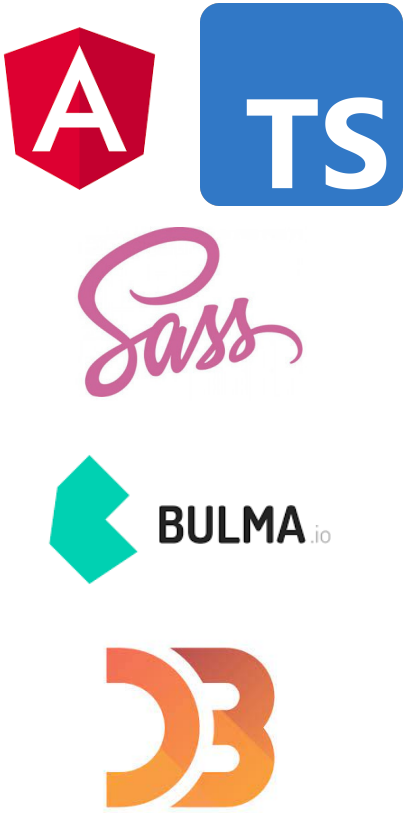


Uplink Downlink

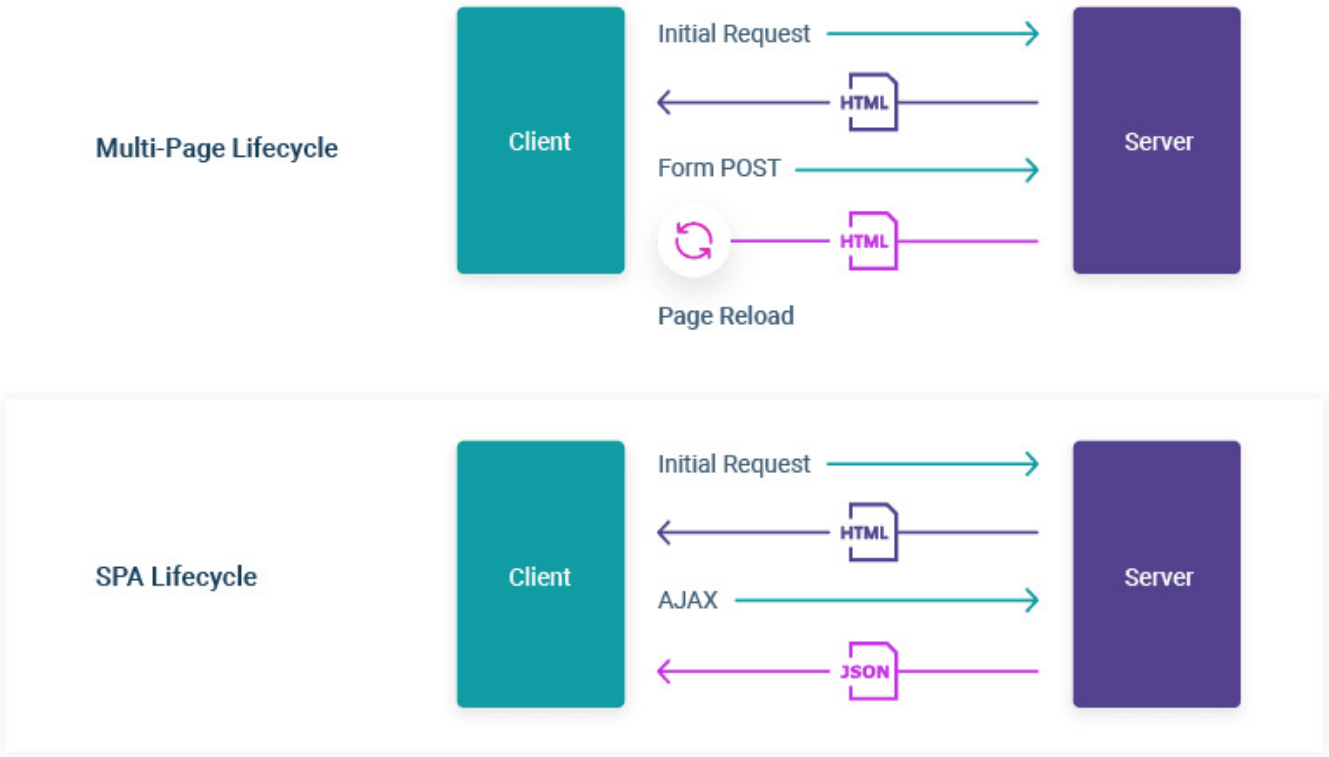
Transmitter	
Amplifier power	0.0
Circuit Loss	0.0
Antenna Gain	0.0
EIRP	0.0
Path	
Slant Range	0.0
Depointing Angle	0.0
FSL	0.0
Medium Losses	0.0
Total Path Loss	0.0
Receiver	
Isotropic power received	0.0
Pointing Losses	0.0
Antenna Gain	0.0
Circuit Loss	0.0
Noise Temperature	0.0
G/T Figure of Merit	0.0

Technologies used

- Angular / TypeScript,
- Node.js
- SCSS/SASS,
- Bulma,
- D3.js
- ...



Single Page Applications (SPA)



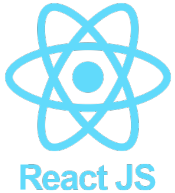
- No reload while navigating: faster load times
- Components are reusable

Framework choice

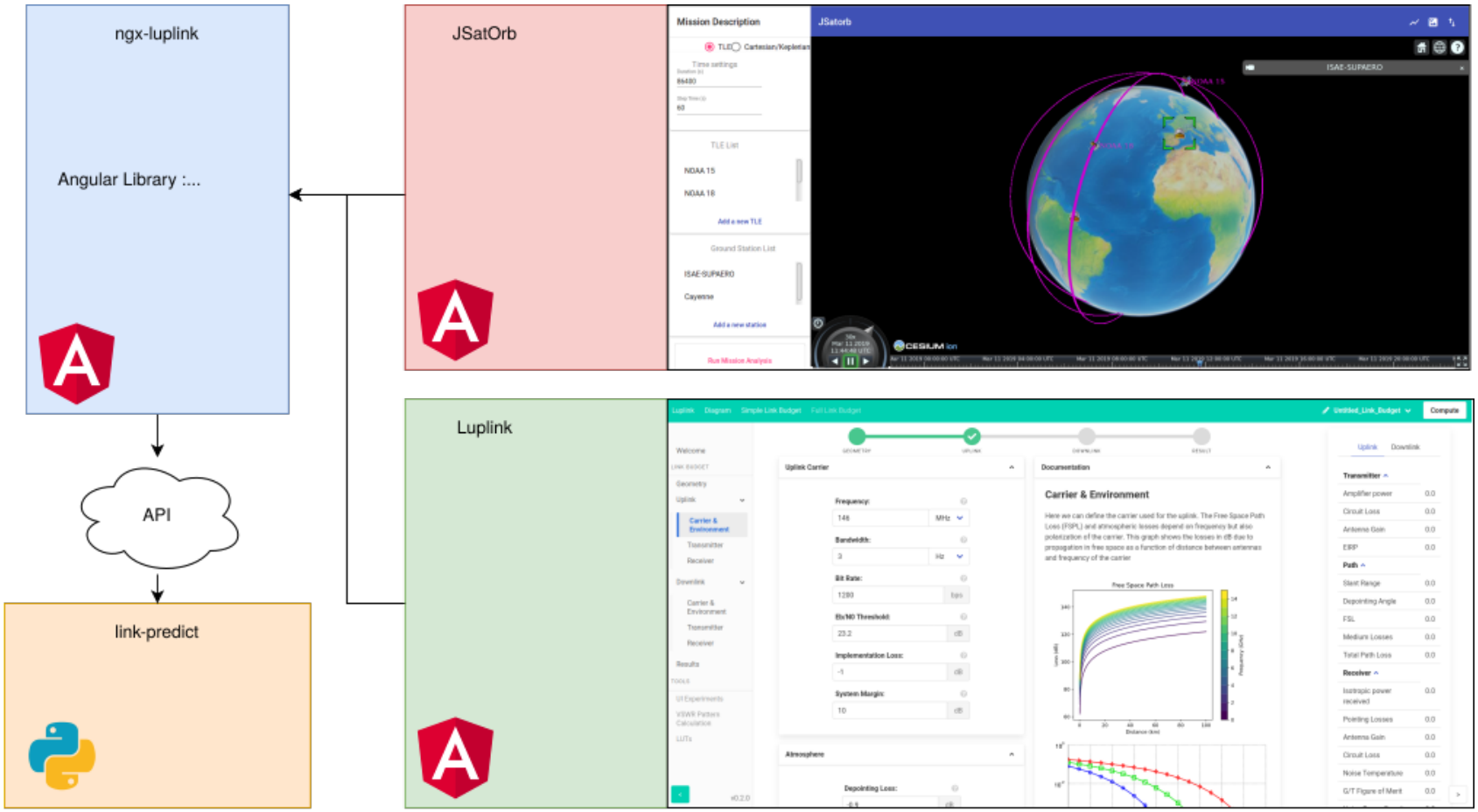
Angular framework :

- Components,
- Typescript,
- Good testing capabilities
- Used by JSatOrb (better integration)

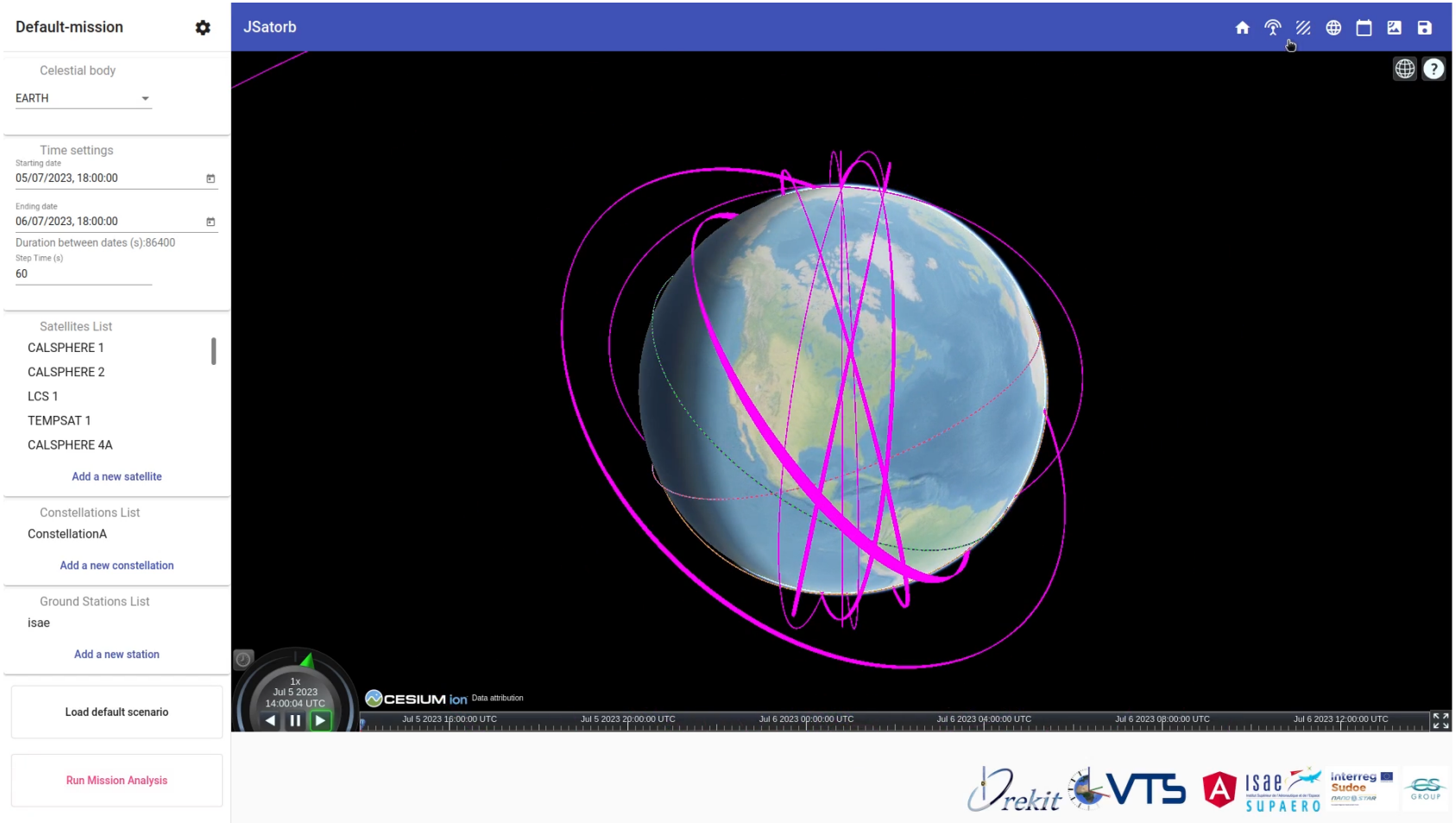
Alternatives:



Project Architecture



Usage


Default-mission
Celestial body
EARTH
Time settings
Starting date
05/07/2023, 18:00:00
Ending date
06/07/2023, 18:00:00
Duration between dates (s):86400
Step Time (s)
60
Satellites List
CALSPHERE 1
CALSPHERE 2
LCS 1
TEMPSAT 1
CALSPHERE 4A
Add a new satellite
Constellations List
ConstellationA
Add a new constellation
Ground Stations List
isae
Add a new station
Load default scenario
Run Mission Analysis
JSatorb
1x
Jul 5 2023
14:00:04 UTC
CESIUM ion
Data attribution
Jul 5 2023 18:00:00 UTC
Jul 5 2023 20:00:00 UTC
Jul 6 2023 00:00:00 UTC
Jul 6 2023 04:00:00 UTC
Jul 6 2023 08:00:00 UTC
Jul 6 2023 12:00:00 UTC

Luplink Diagram Simple Link Budget

Go back to JSatOrb | Default-mission | Compute

GEOMETRY — UPLINK — DOWNLINK — RESULT

- Welcome
- LINK BUDGET
- Geometry
- Uplink
  - Carrier & Environment
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- Results
- About

Import from JSatOrb

Satellite: CALSPHERE 2

Station: isae

Load

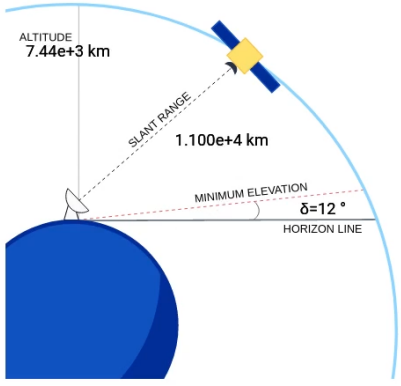
Geometry

Altitude: 7441.994990997203 km

Elevation Angle: 12 °

Slant Range: 11004 km

Documentation



δ is the minimum acceptable elevation angle. It is used for the calculation of the maximum slant range to the spacecraft. This range is then used to compute path losses. The slant range is calculated using the following formula :

$$S = R_e(\sqrt{[\frac{r}{R_e}]^2 - \cos^2\delta} - \sin\delta)$$

with:

S, the slant range in km
r, the distance of satellite from center of Earth in km ($r = R_e + h$)
R_e, the Earth's radius (in km)
δ, the minimum acceptable elevation angle

Uplink | Downlink

Transmitter	
Amplifier power	0.0
Circuit Loss	0.0
Antenna Gain	0.0
EIRP	0.0
Path	
Slant Range	0.0
Depointing Angle	0.0
FSL	0.0
Medium Losses	0.0
Total Path Loss	0.0
Receiver	
Isotropic power received	0.0
Pointing Losses	0.0
Antenna Gain	0.0
Circuit Loss	0.0
Noise Temperature	0.0
G/T Figure of Merit	0.0
Noise Power Density	0.0
C/N0 ratio	0.0
Bit Rate	0.0
Eb/N0 ratio	0.0

importing data

Luplink Diagram Simple Link Budget

Go back to JSatOrb | Default-mission | Compute

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Bandwidth: 3 Hz

Bit Rate: 1200 bps

Eb/N0 Threshold: 23.2 dB

Implementation Loss: -1 dB

System Margin: 10 dB

Atmosphere

Depointing Loss: -0.9 dB

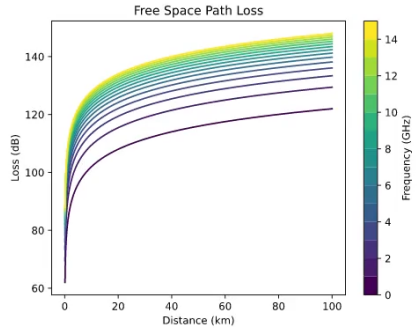
Cross Polarization: -3 dB

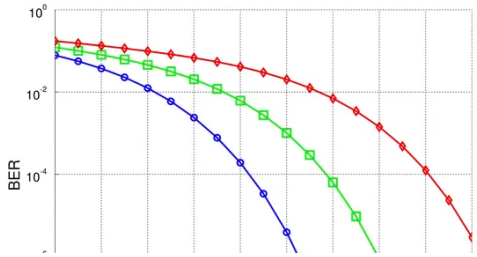
Atmosphere Gases:

Documentation

Carrier & Environment

Here we can define the carrier used for the uplink. The Free Space Path Loss (FSPL) and atmospheric losses depend on frequency but also polarization of the carrier. This graph shows the losses in dB due to propagation in free space as a function of distance between antennas and frequency of the carrier





Uplink | Downlink

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Medium Losses	0.0
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Receiver	
Isotropic power received	0.0
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Noise Power Density	0.0
C/N0 ratio	0.0
Bit Rate	0.0
Eb/N0 ratio	0.0

Luplink Diagram Simple Link Budget Go back to JSatOrb Default-mission* Compute

Export results as .md Export results as .json

Welcome

LINK BUDGET

Geometry

Uplink

Carrier & Environment

Transmitter

Receiver

Downlink

Carrier & Environment

Transmitter

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Results

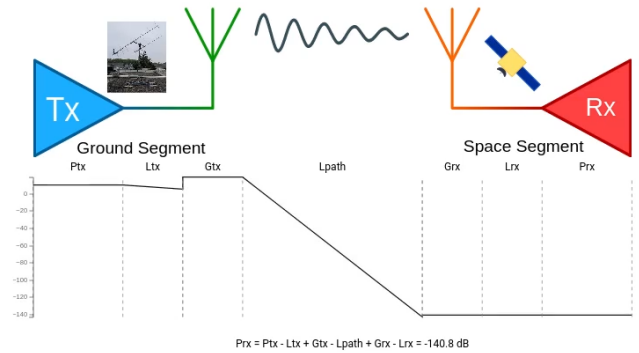
About

Uplink

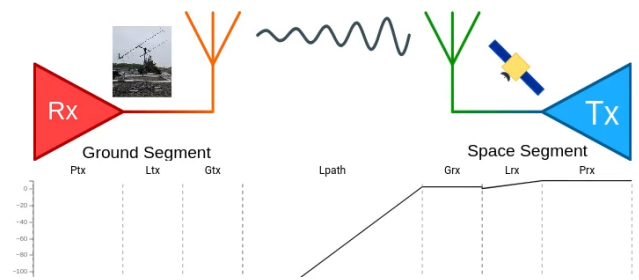
This link closes
Eb/N0 margin = 9.03 dB > 5 dB = System Margin

Transmitter	
Amplifier power	10.0 dBW
Circuit Loss	4.99 dB
Antenna Gain	14.0 dBi
EIRP	19.01 dBW
Depointing Angle	0.0 deg
Path	
Slant Range	11,004,000.0 m
FSL	156.57 dB
Medium Losses	5.4 dB
Total Path Loss	161.97 dB
Receiver	
Isotropic power received	-142.96 dB
Depointing Angle	0.0 deg
Antenna Gain	2.15 dBi
Circuit Loss	0.0 dB
Noise Temperature	299.93 K
G/T Figure of Merit	-22.62 dB/K

Synthesis Uplink



Synthesis Downlink



Downlink

This link closes with a low margin
Eb/N0 margin = 4.56 dB < 10 dB = System Margin

Transmitter	
Amplifier power	10.0 dBW
Circuit Loss	9.5 dB
Antenna Gain	2.15 dBi
EIRP	2.65 dBW
Depointing Angle	0.0 deg
Path	
Slant Range	11,004,000.0 m
FSL	156.57 dB
Medium Losses	5.4 dB
Total Path Loss	161.97 dB
Receiver	
Isotropic power received	-159.32 dB
Depointing Angle	0.0 deg
Antenna Gain	14.0 dBi
Circuit Loss	0.0 dB
Noise Temperature	297.18 K
G/T Figure of Merit	-10.73 dB/K

localhost:34355/luplink/results

Thank you for your attention!