

More than a Data Relay

Satellite TM/TC with EDRS and GlobeNet

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5. Nationale Konferenz "Satellitenkommunikation in Deutschland"
March 28, 2017

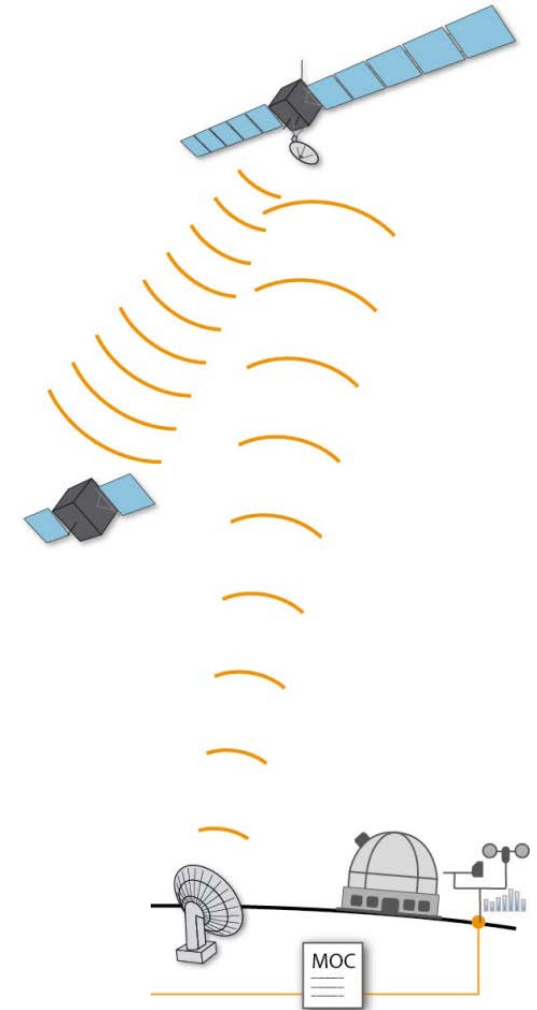
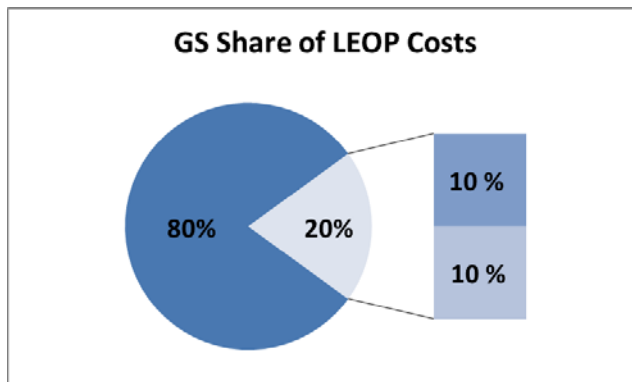


Potential Applications of Ka-ISL

- **Forward Tasking**

- Near-Term / Reactive Mission Planning (Earth Observation / Reconnaissance)
- Optical Direct-To-Earth Link-Planning
- Emergency TM/TC for (Mega-) Constellations

- **Satellite LEOP**

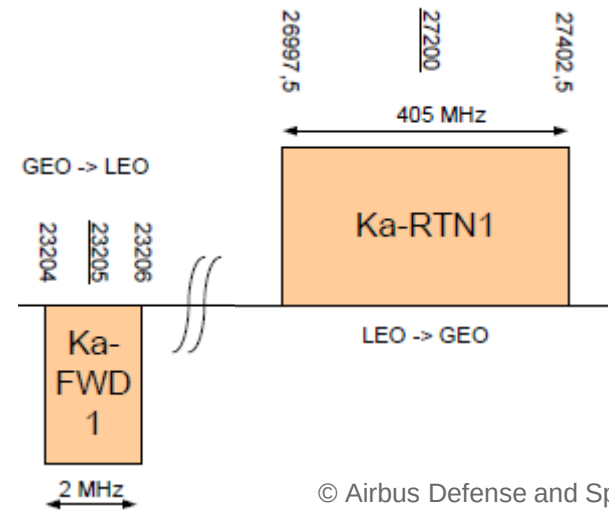


Ka-ISL Payload on EDRS-A

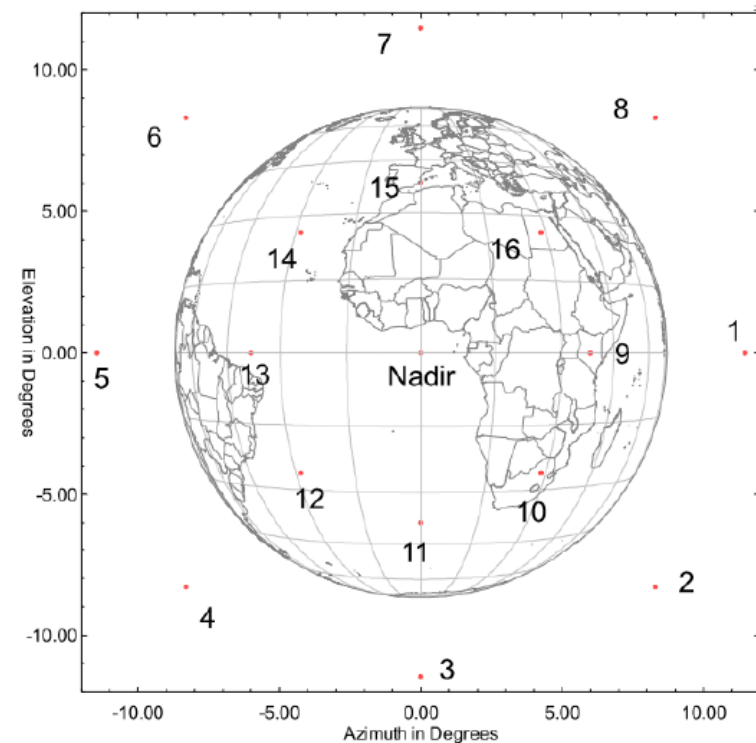


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Service type	Data flow	Data rate
Optical ISL return service	LEO→GEO→Ground	600 Mbit/s or 1.8 Gbit/s
Optical ISL forward service	Ground→GEO→LEO	500 bit/s 4 kbit/s
Ka-ISL return service	LEO→GEO→Ground	300 Mbit/s
Ka-ISL forward service	Ground→GEO→LEO	1 Mbit/s



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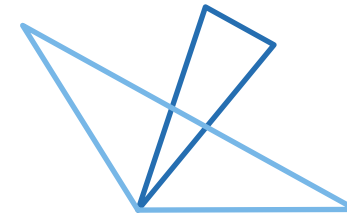
Link Budget of User Terminal – Rough Assessment

Tx Power	1		W
Tx Gain (@ 20° Divergence)	12		dBi
EIRP		12	dBW
Rx G/T (nominal)	15.5		dB/K
k_B	228.6		dB/K/Hz
FSL (@ 46,000 km; 27 GHz)	- 214		dB
C/N₀		42	dBHz

Example:

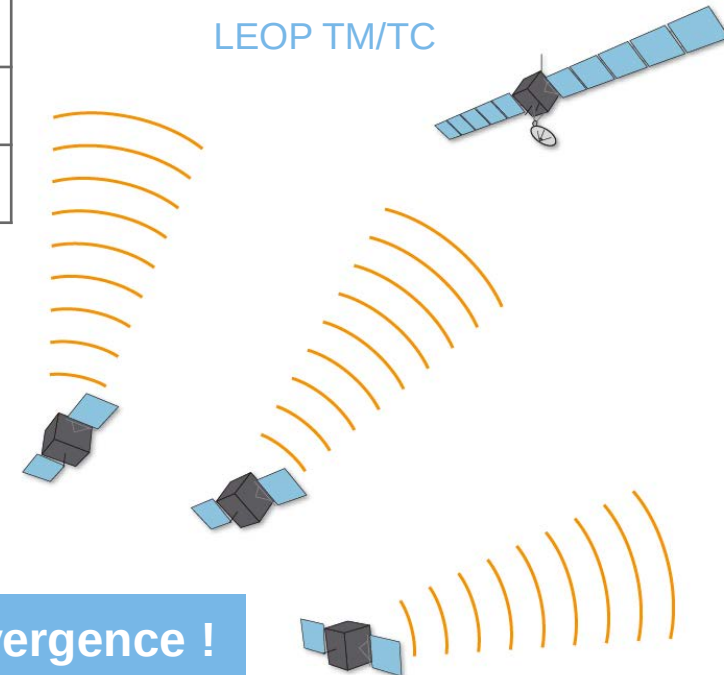
QPSK $\frac{3}{4}$ $\leftrightarrow$ $E_s/N_0 \approx 6$ dB

→ $42 - 6 = 36$ dBHz for the signal,
i.e. 4,000 baud = **6 kbps**



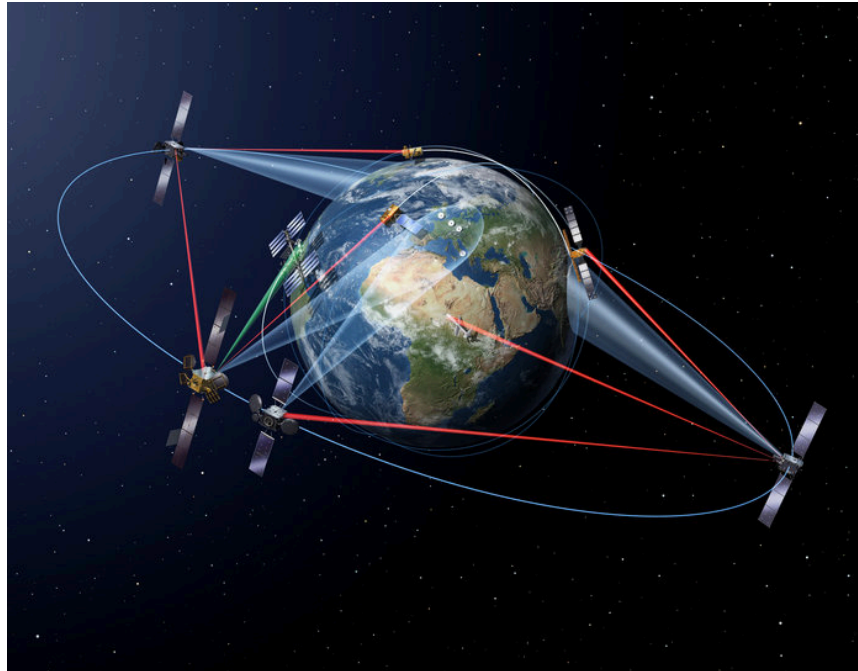
20° (Ka-band)
FWD Tasking

120° (S-band)
LEOP TM/TC

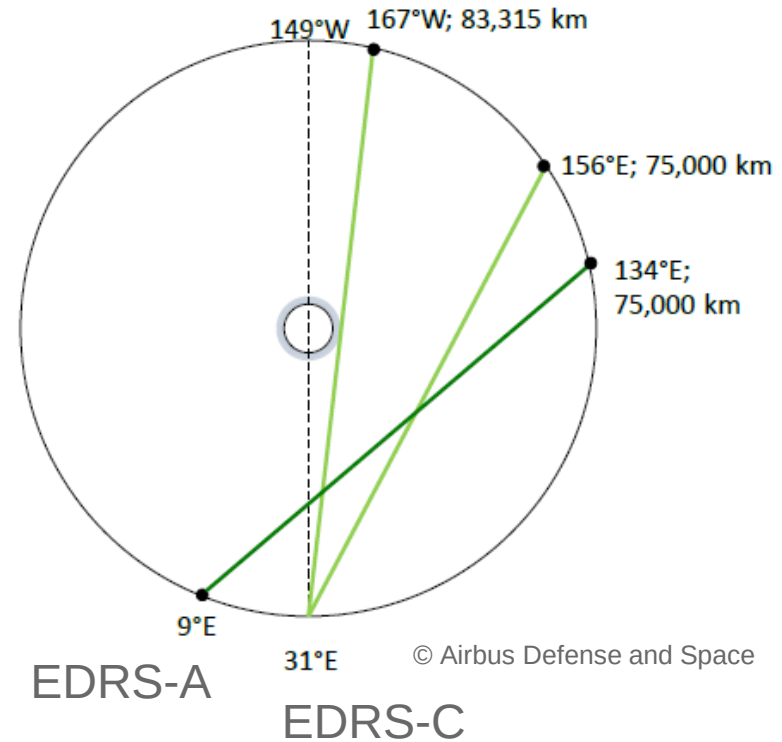


Sufficient for TM/TC, but small divergence !

Ka-ISL Payload on GlobeNet?



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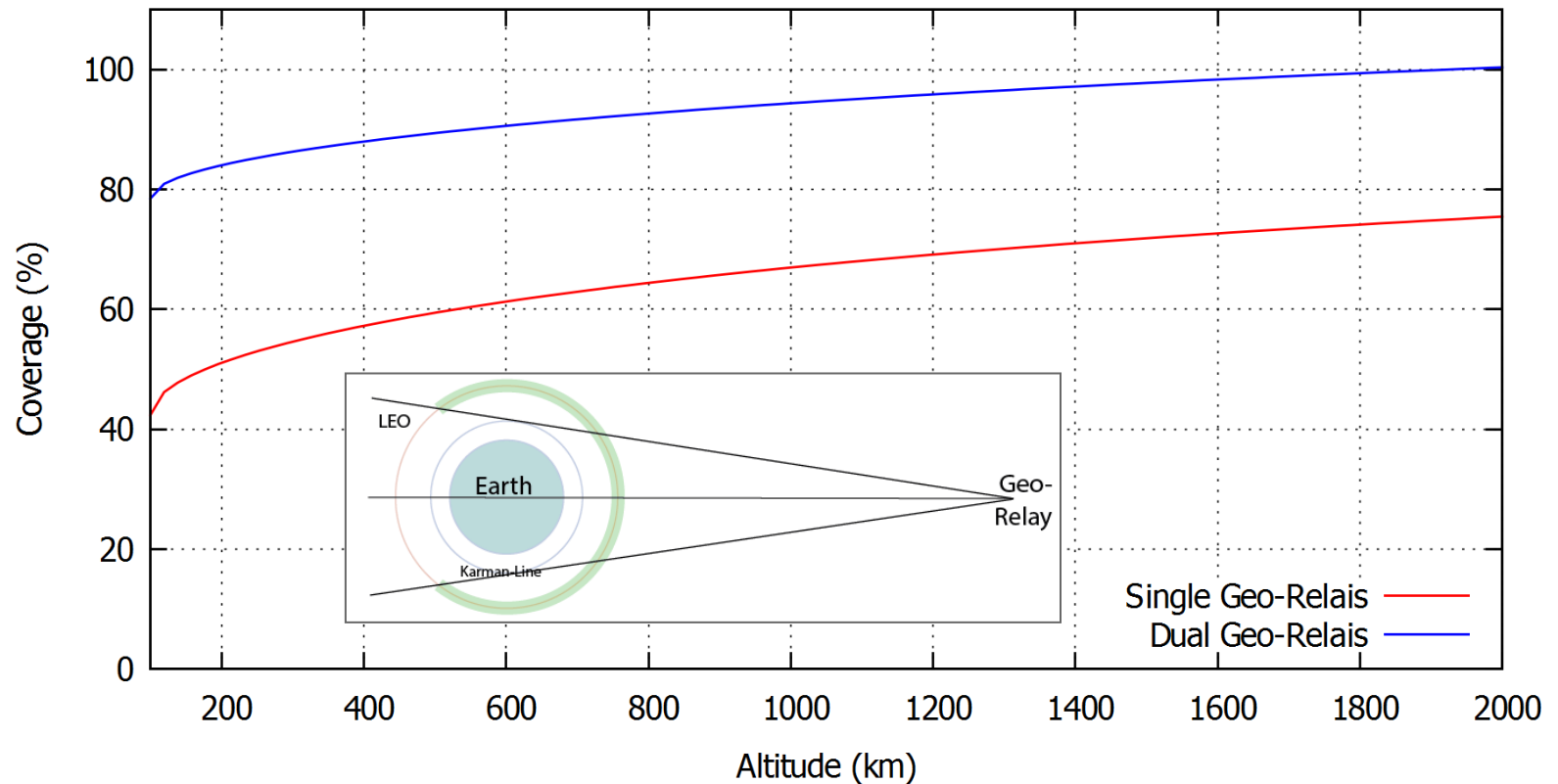


Added value of a Ka-ISL on EDRS-D ?



Coverage of LEOs from GEO-Relay

Theoretical Coverage of LEOs from GSO
Assumption: Links through atmosphere above 100 km possible

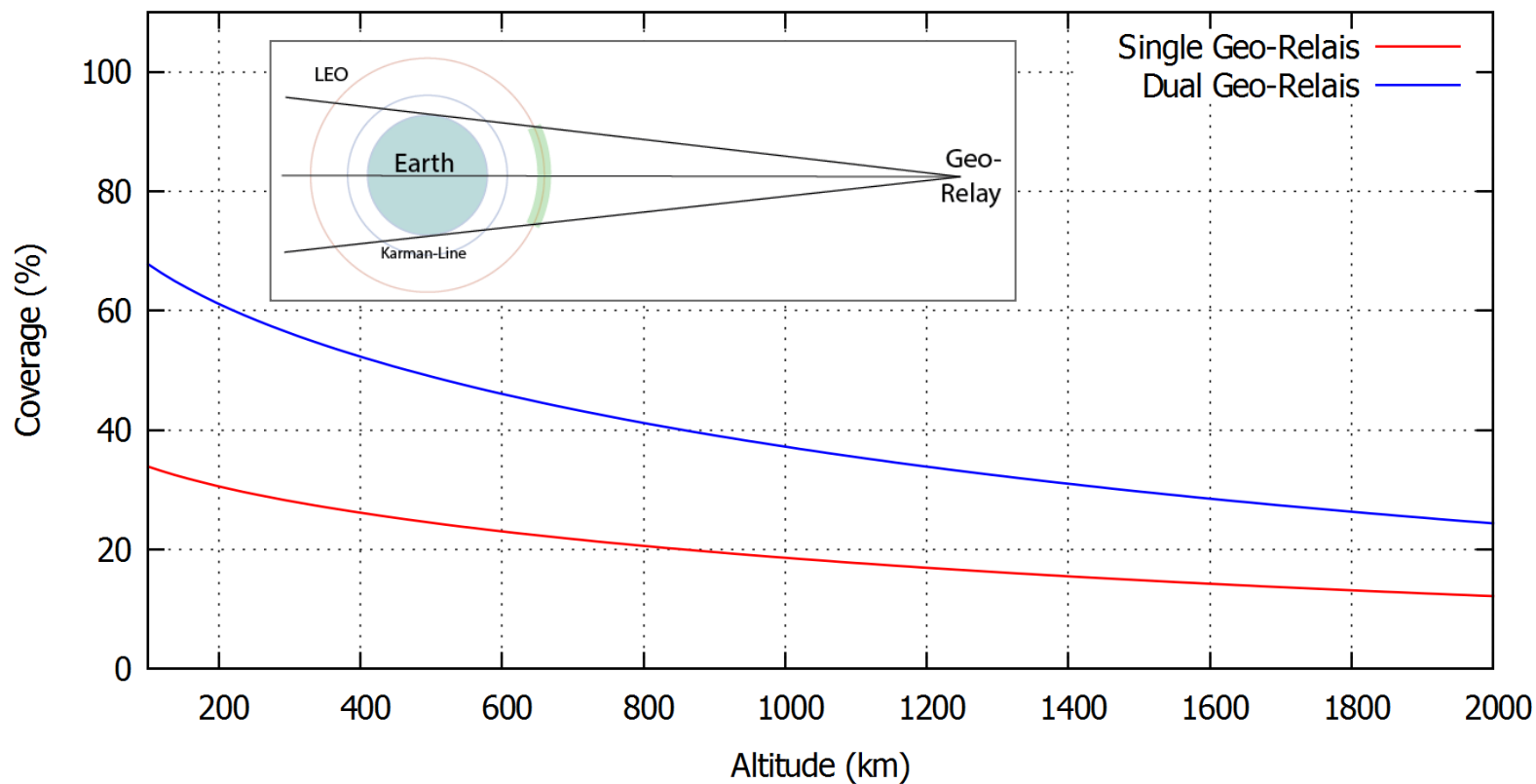


Disregards S/C Geometry and Antenna Pointing, respectively !

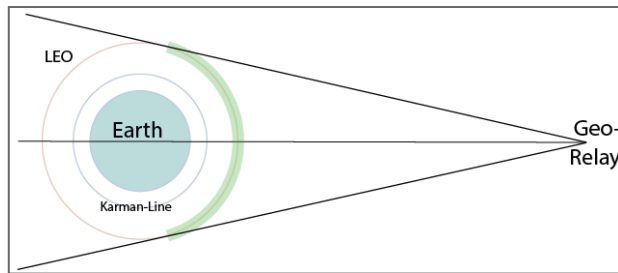


Coverage of LEOs from GEO-Relay

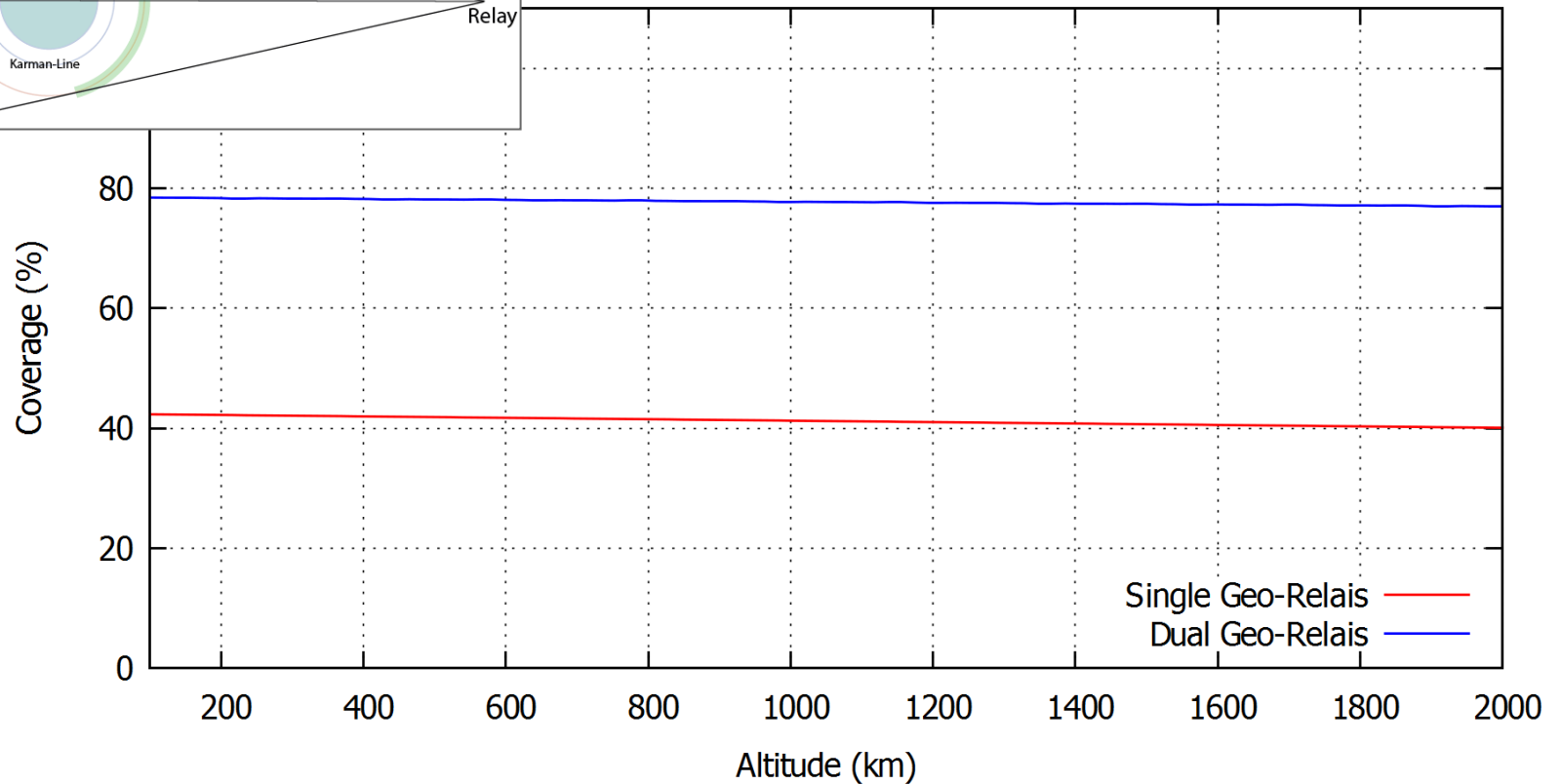
Theoretical Coverage of LEOs from GSO
GSO-FOV = 8.7 deg



Coverage of LEOs from GEO-Relay



Theoretical Coverage of LEOs from GSO
GEO-FOV tangential to orbit



Example:

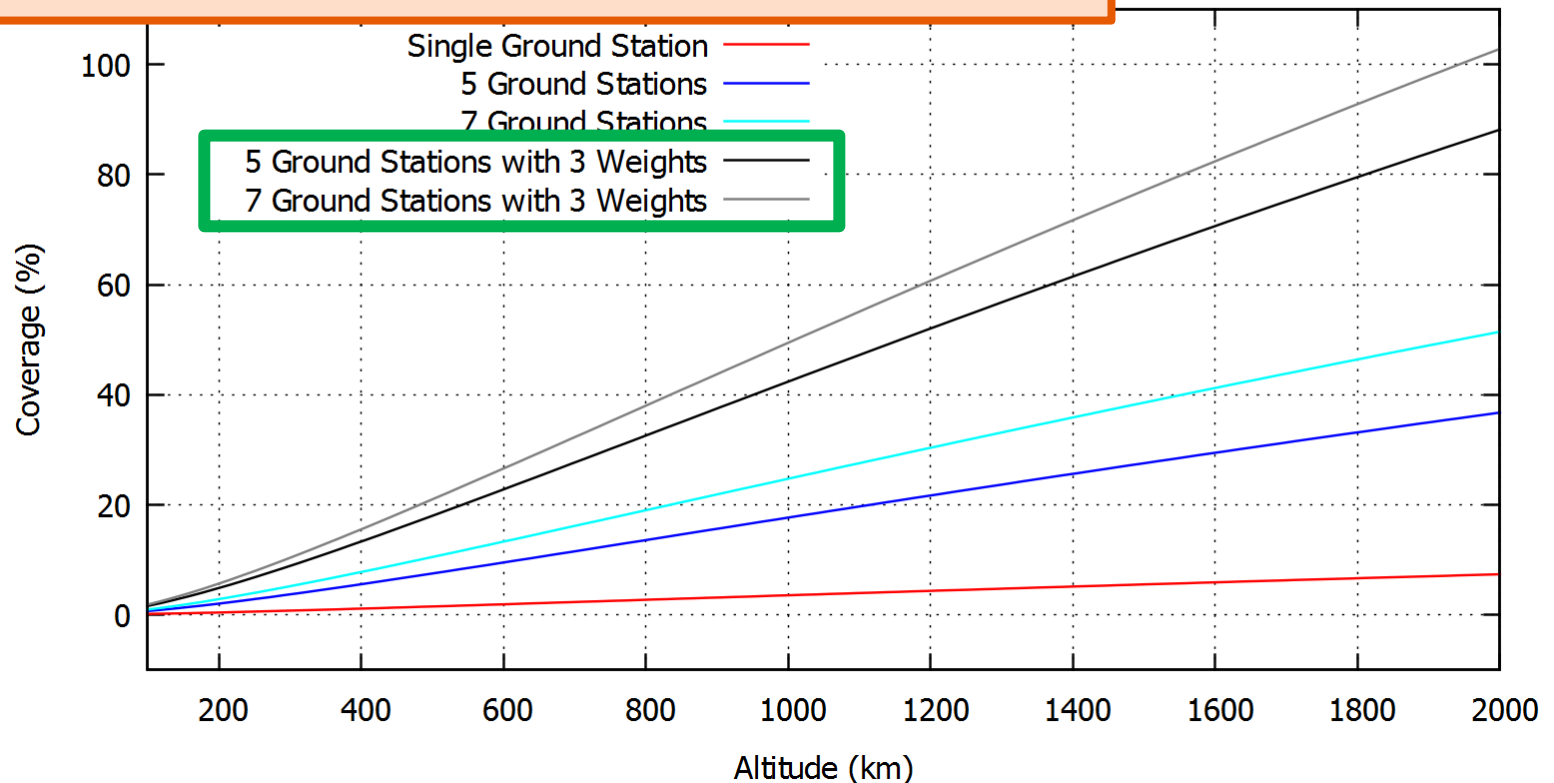
SSO, 400 km

Coverage of LEOs from Ground

Weighted Sum of Single G/S Coverages:

- 4x more contacts from polar station
- 2x more contacts from station above 60° latitude

GS	Availability (%)
WHM	1.12
MGS	3.94
PFS	1.96
SGS	3.98
WOP	0.93
CDS	0.90
AGO	0.87



Example Case: BIROS (FireBird)

- *Launch:* June 22, 2016, 3:56 UTC
- *Carrier Rocket:* PSLV-C34
- *Spaceport:* Satish Dhawan Space Centre, India
- *Separation:* June 22, 2016, 4:14 UTC



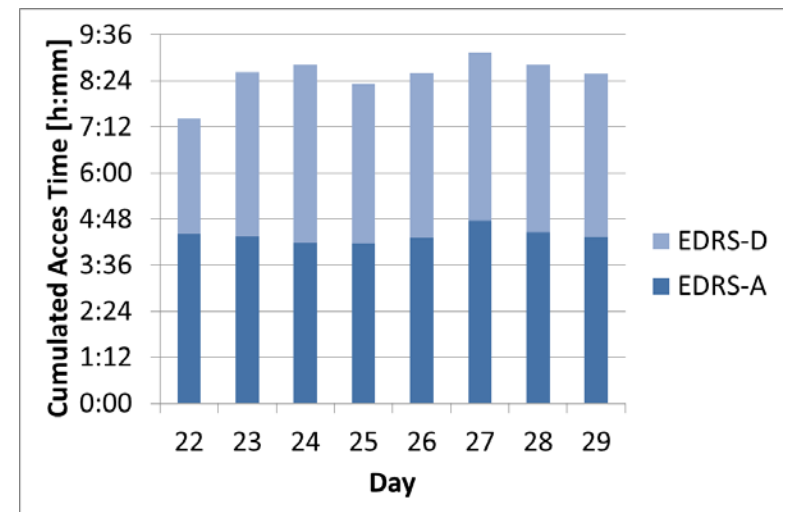
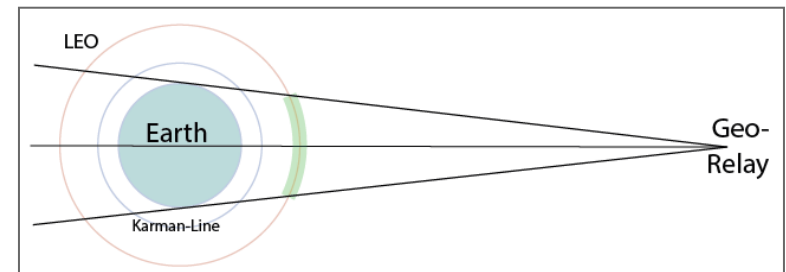
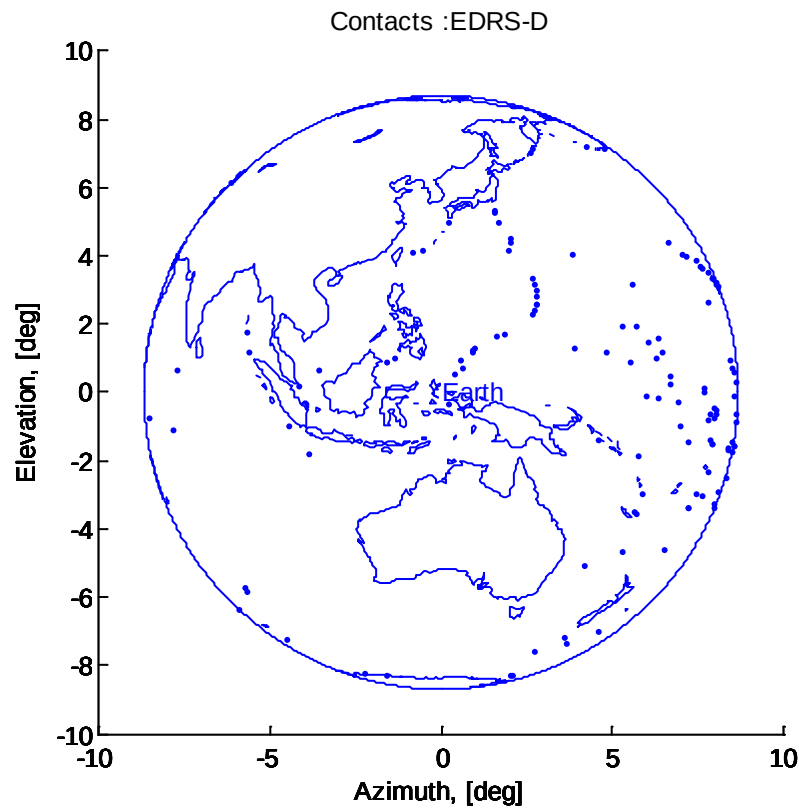
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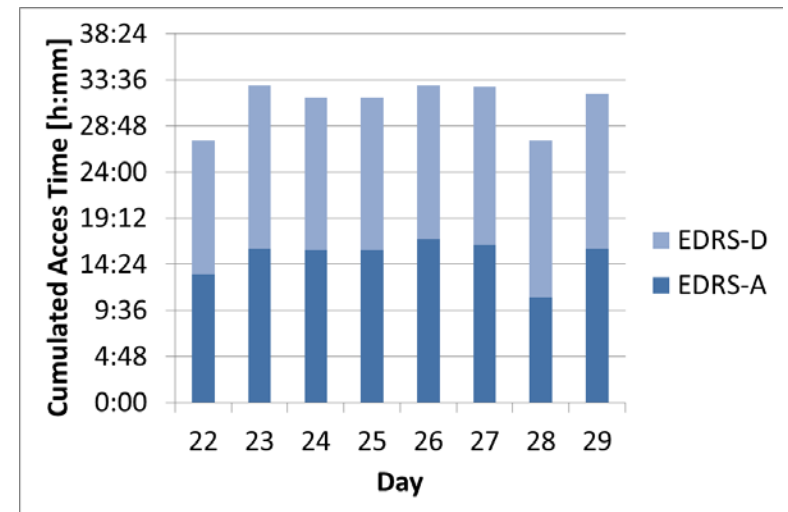
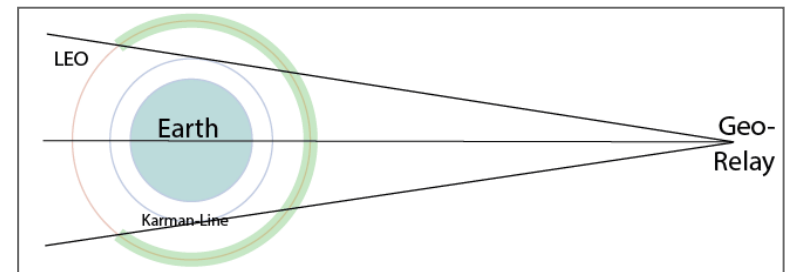
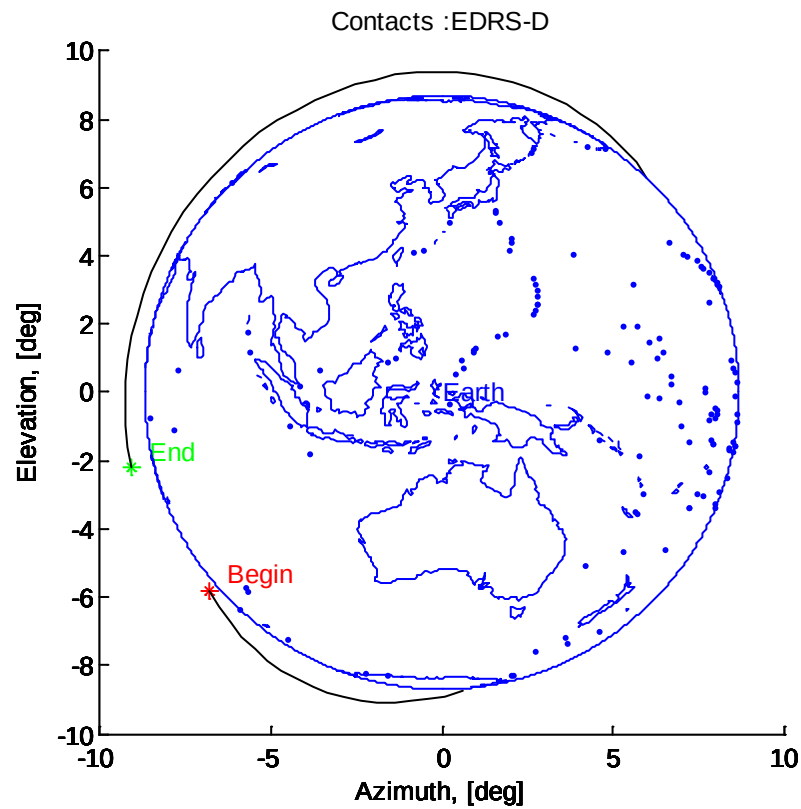
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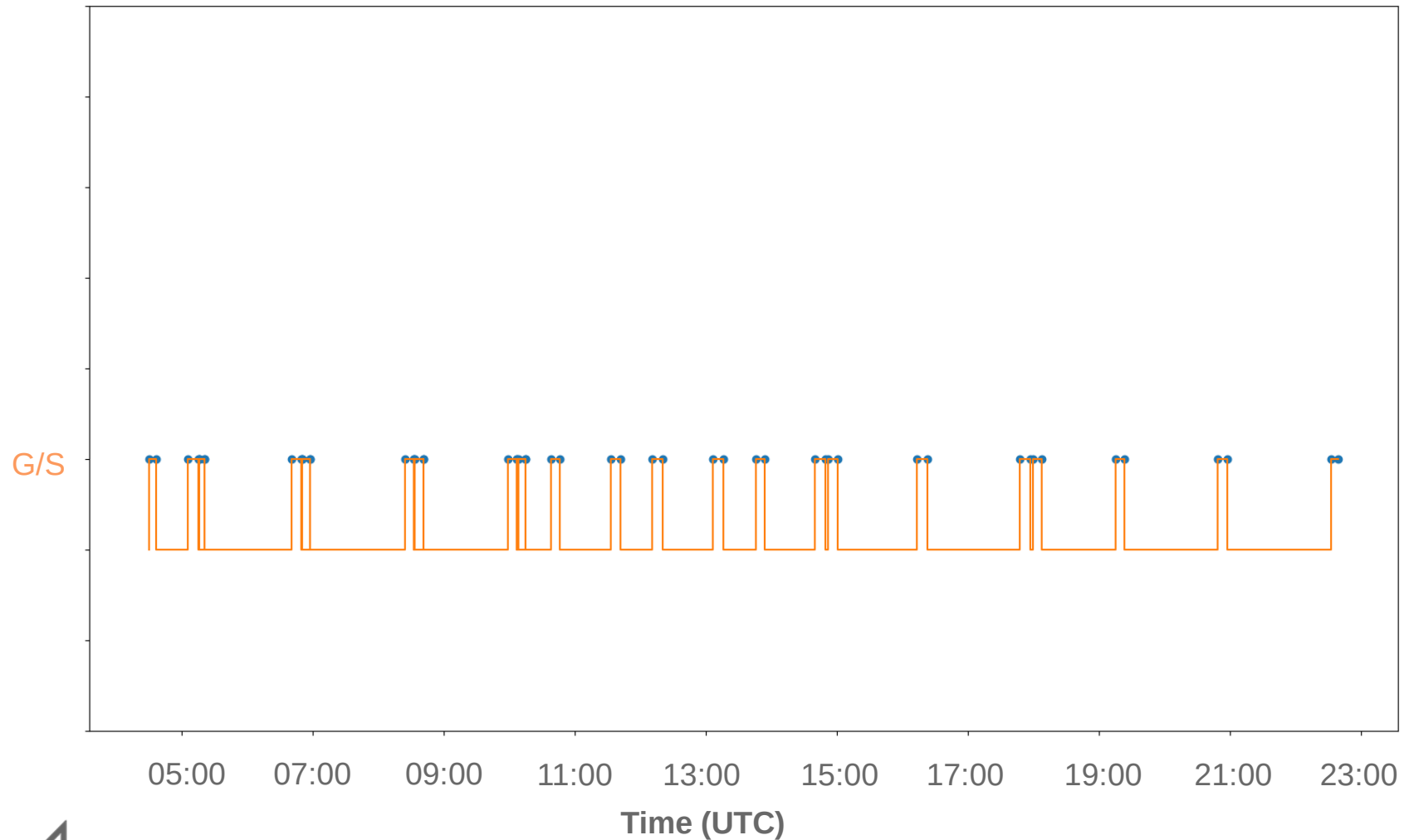
BIROS – LEOP Simulation with EDRS / GlobeNet



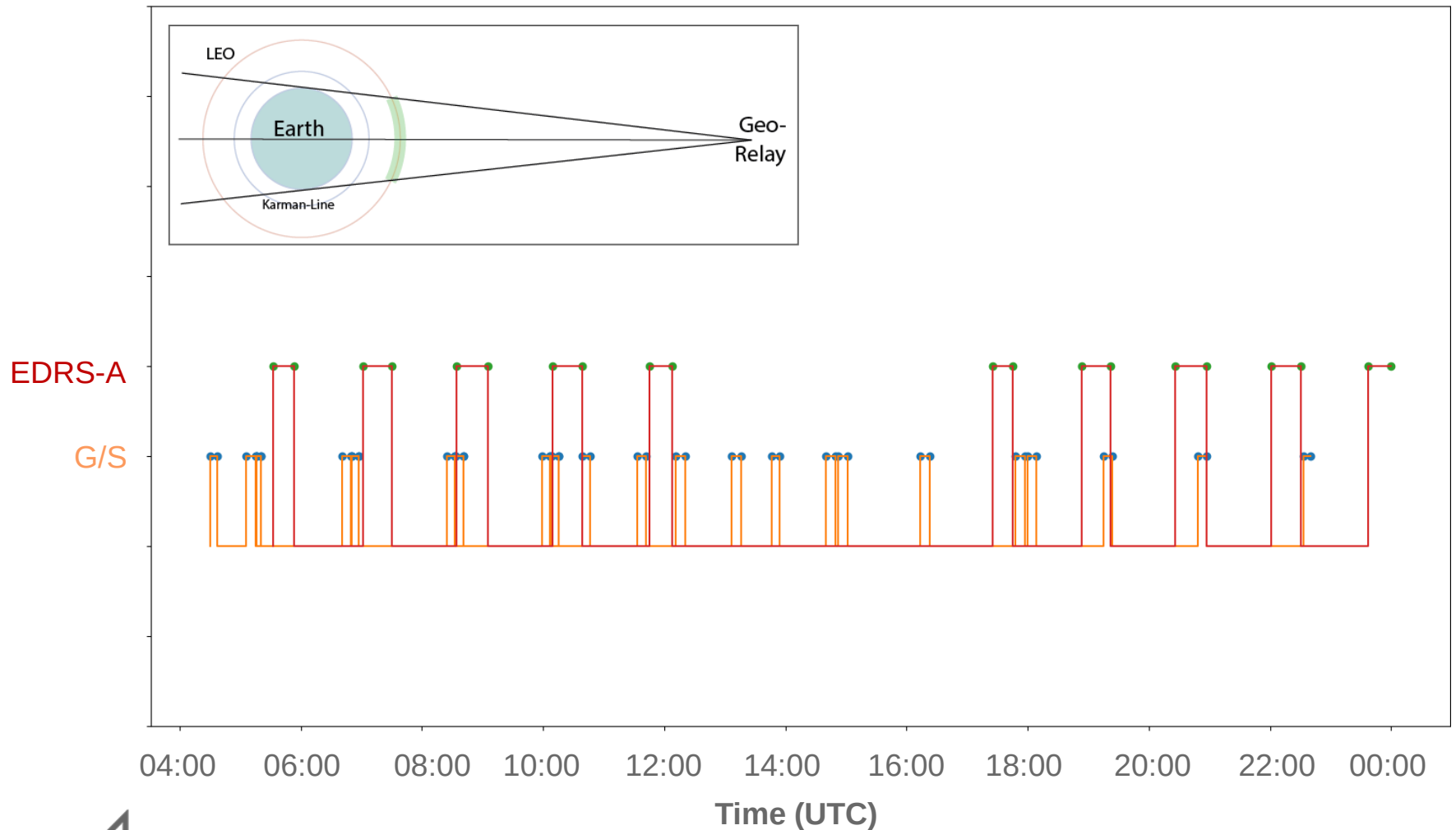
BIROS – LEOP Simulation with EDRS / GlobeNet



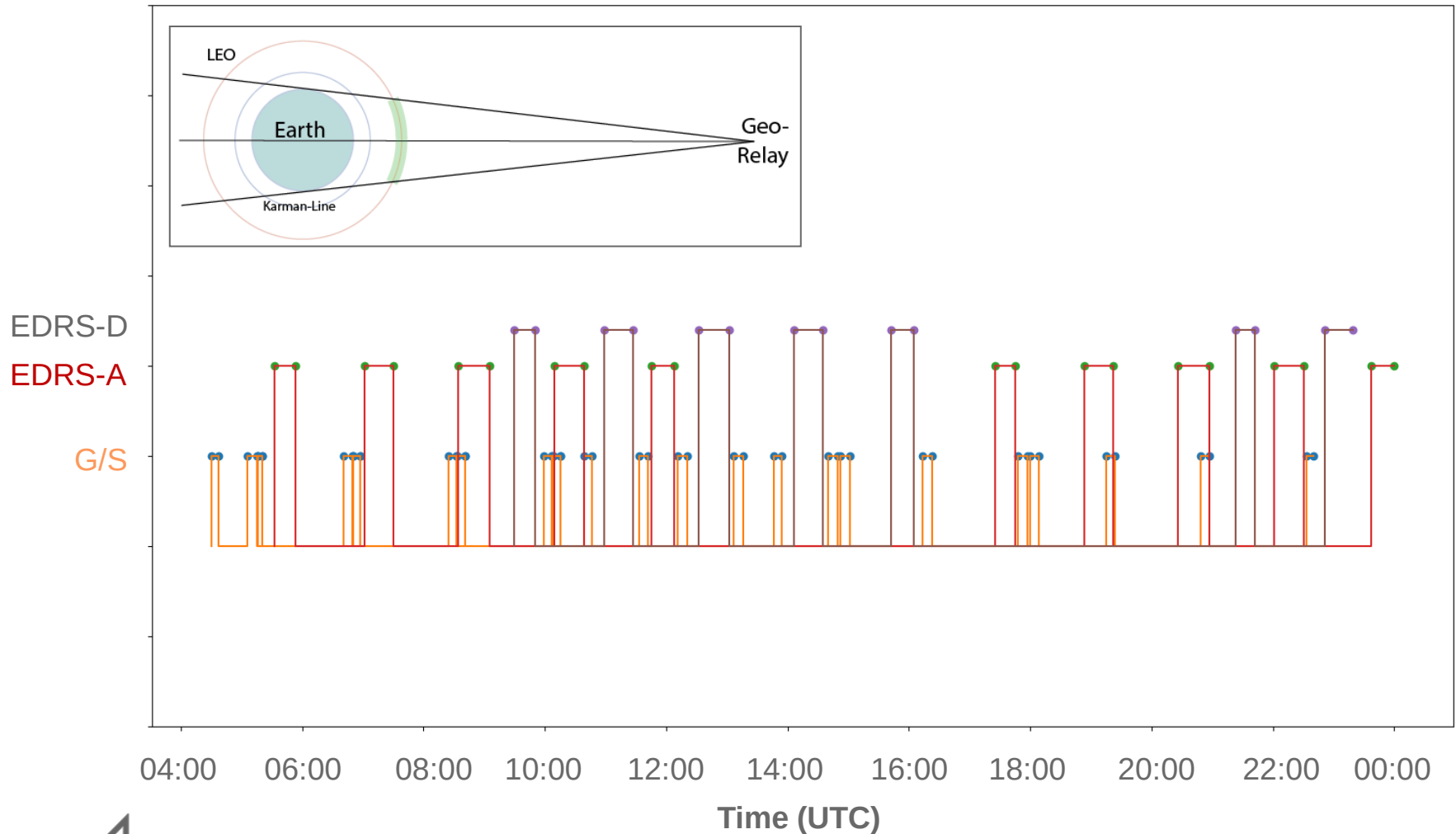
BIROS – LEOP Simulation vs. Real Contacts



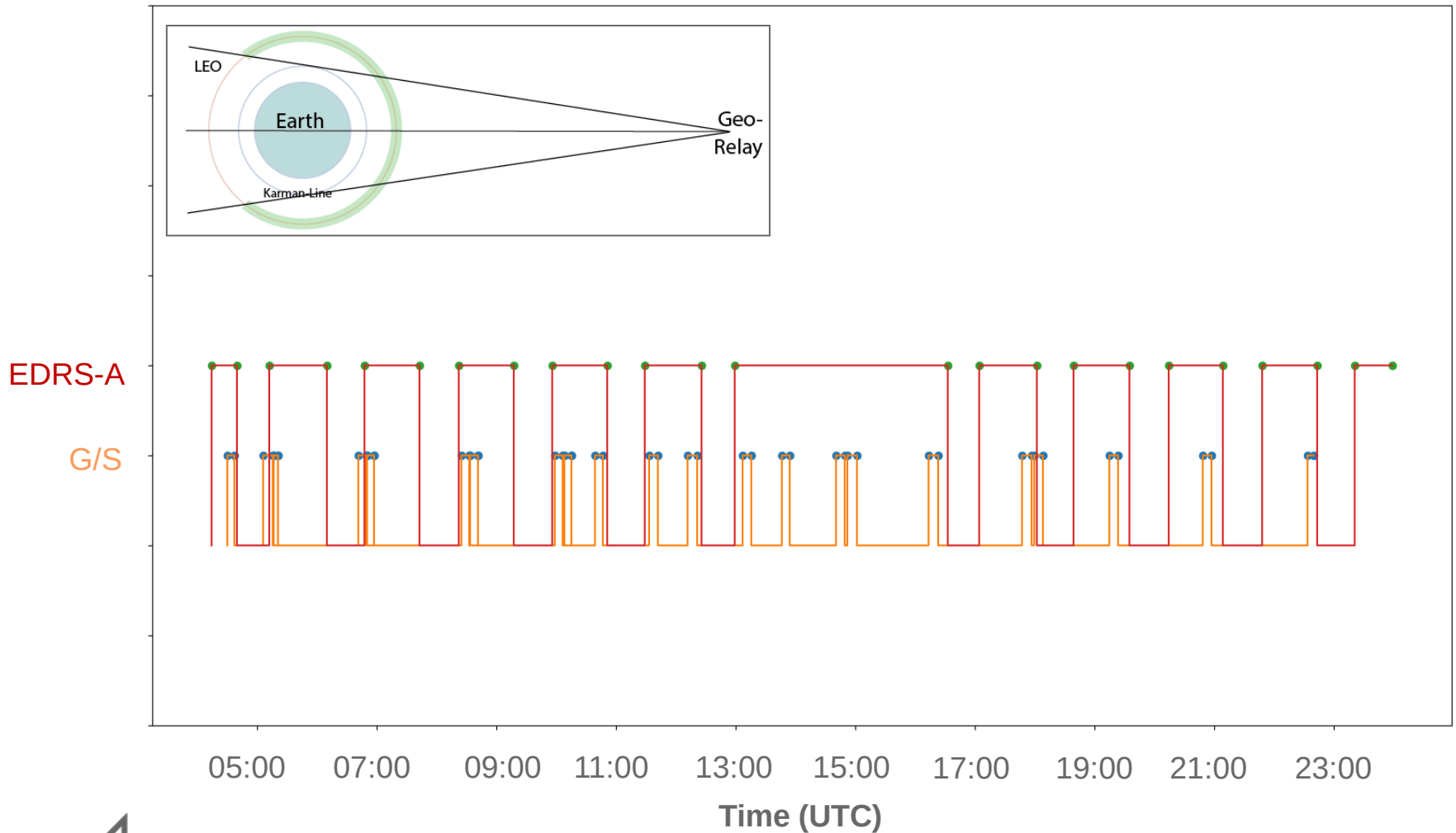
BIROS – LEOP Simulation vs. Real Contacts



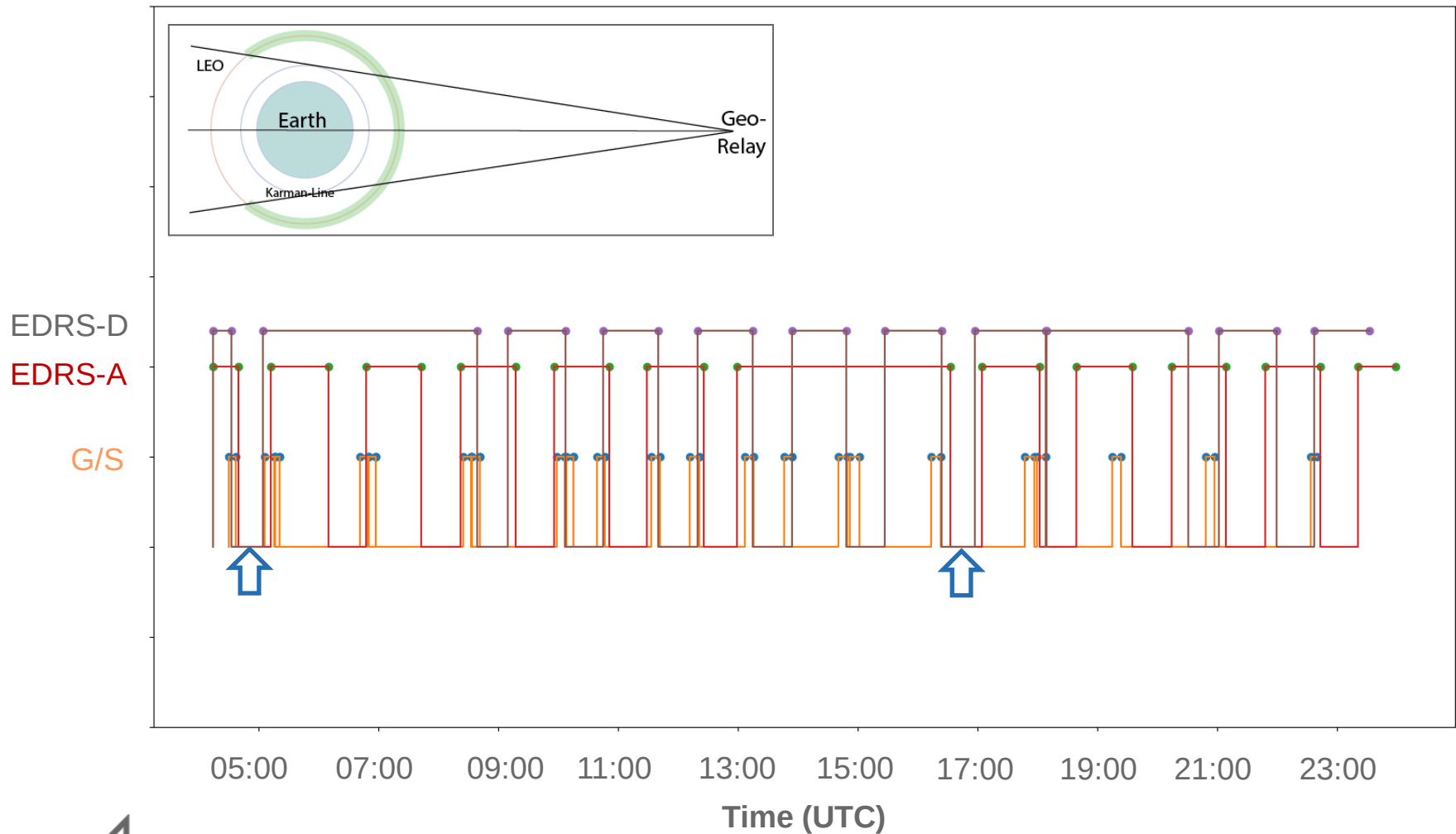
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Summary & Outlook

- LEOP could be an interesting use case for EDRS / GlobeNet
- During the LEOP of BIROS up to 5 Ground Stations could have been substituted by GlobeNet
- With an appropriate Ka-User Terminal LEOPs could be supported by a single GEO-Relay node (EDRS-A), already

Let's push things forward !



Thank You for Your Attention...

