

# FREQUENCIES CONSIDERATION FOR SURFACE COMMUNICATIONS IN THE LUNAR REGION

Olivier BOMPIS, Jean-Luc ISSLER

Centre National d'Etudes Spatiales,

Instrumentation, TT&C, Propagation Department

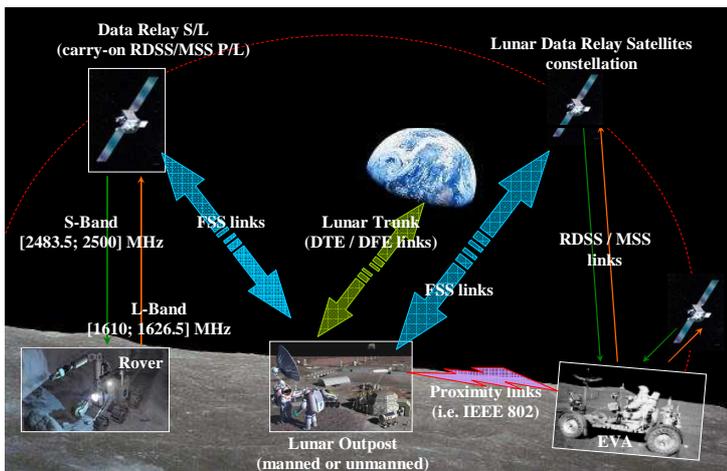
e-mail: [Olivier.Bompis@cnes.fr](mailto:Olivier.Bompis@cnes.fr) / [Jean-Luc.Issler@cnes.fr](mailto:Jean-Luc.Issler@cnes.fr)



## CONTEXT & OBJECTIVE

- World allocation of Mobile Satellite Services (MSS) Downlink frequencies [2483.5 – 2500] MHz to Radio Determination Satellites Services (RDSS) at WRC-12.
- Interesting synergies between communications and radio navigation applications are expected in short – middle time frame.
- International Technical Working Groups are currently studying interoperability of communications systems which provide surface-to-surface proximity links in the Lunar vicinity,
- Frequencies assignment guidelines for the Lunar vicinity are currently studying at the Space Frequency Coordination Group (SFCG) by the Lunar Martian Spectrum Group (LMSG).
- ✓ MSS downlink S-Band [2483.5 – 2500] MHz, and MSS uplink L-Band [1610 – 1626.5] MHz can be suitable in the Lunar vicinity for Orbit-to-surface and Surface-to-Orbit communications links.
- ✓ Promote a MSS communication system which provides medium data rate communications links for robotic exploration systems (rovers, lunar seismological sensors LGEP), or even for manned mission at the lunar surface (Voice, TT&C, Comm & Nav Data).

## ENVISIONED LUNAR MSS COMMUNICATION SYSTEM

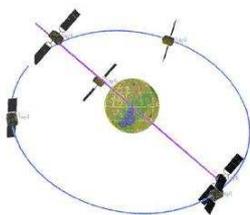


From pictures of ALICE SEEDS IV mission analysis, and "In the shadow of the Moon" movie (Discovery Films, FilmFour, Passion Pictures).

### Link Types (from the SFCG Baseline Lunar Communications Services Requirements)

Link Type	Frequency Band	Users	Service Type	Data Rate per User	Number of Users
3.0 Lunar Orbit to Lunar Surface and Lunar Surface to Lunar Orbit	[2483.5 – 2500] MHz	EVA's	Voice/ TT&C/Data (comm & nav)	~(o)10 kbps (bi-directional) Up to 1 Mbps (downlink)	>10
		Rover-LGEP	Voice/ TT&C/Data (comm & nav)	~(o) 10 kbps (bi-directional) Up to 1 Mbps (downlink)	>10
	[1610 – 1626.5] MHz	Surface hubs (Hab, Landers, etc)	Voice/ TT&C/Data (comm & nav)	~(o) 10 kbps (bi-directional) Up to 1 Mbps (downlink)	>10

## MSS DATA RELAY CONSTELLATION



Fold of Coverage	Average % Surface Area Covered
0-fold (no coverage)	0.00005
1-fold or more	99.99995
2-folds or more	92.7
3-folds or more	33.9
4-folds	3.8

Coverage Statistics regarding the number of satellites in co-visibility on a 10-years period

Envisioned MSS Data Relay Satellites constellation contains 6 satellites in 2 plans on eccentric elliptical orbit (40° inclined, semi-major axis of 7500-km). This constellation is issued from the Ely and Lieb publication [1], and provides global lunar coverage with a limited number of satellites, taking into account of the disrupted gravity field of the Moon

## INTERFERENCE RISK ASSESSMENT

Compatibility study between the envisioned lunar MSS communication system and existing Earth-Based MSS System (Globalstar)

Interference Noise Density  $I_n$  with existing MSS Earth-based systems on [2483.5 – 2500] MHz

Estimated Inter-system interference level $I_0$ from a Earth-based MSS system on a Lunar-based one (dBW/Hz)	-246.7
Estimated Inter-system interference level $I_0$ from a Lunar-based MSS system on a Earth-based one (dBW/Hz)	-243.4

\* Calculations are made considering the same MSS Lunar system characteristics as described in this paper. The terrestrial MSS system considered is similar to the Globalstar System characteristics.

## CONCLUSION & REFERENCE

- No major compatibility issues are identified with local or terrestrial systems in terms of radiofrequency interference risk assessment.
- These considerations tend to promote benefits or reusing low-cost technologies and fully developed techniques for MSS / RDSS terrestrial applications in order to provide Communications and Radio navigation Services at the Lunar vicinity.

[1] T. A. Ely, E. Lieb, Constellations of Elliptical Inclined Lunar Orbits Providing Polar and Global Coverage, AAS/AIAA Astrodynamics Specialists Conference, Lake Tahoe, CA, August 7-11, 2005.