Highlights of the Space Communications and Navigation Symposium

60th International Astronautical Congress
Daejeon, Republic of Korea

Otto Koudelka
TU Graz, Austria

Outline

- Introduction to the Space Communications and Navigation Committee (SCAN)

- Deorbiting of Non-GEO Satellites
- Data Relay
- Optical Communications
- Deep-space Communications
- Air Traffic Management by Satellite

- Outlook

IAF Space Communications and Navigation Committee (SCAN)

Chairman: Joe Straus (USA)

Co-Chairman: Otto Koudelka (Austria)

Sessions:

- Fixed and Broadcast Services
- Mobile Communications and Navigation Technology
- Mobile Communications and Satellite Navigation Systems
- Near-Earth and Interplanetary Communications Systems
- Advanced Technologies
- Advanced Systems

Disposal of Non-Geostationary Orbit Satellites

Rob Briskman (Sirius XM Radio, USA)
Brian Kemper (Space Systems Loral, USA)

- Non-GEO orbits interesting for navigation, remote sensing, satellite radio satellites
- Regulators in US require licensee to provide disposal plan
- Space debris: major concern

Orbital Disposal

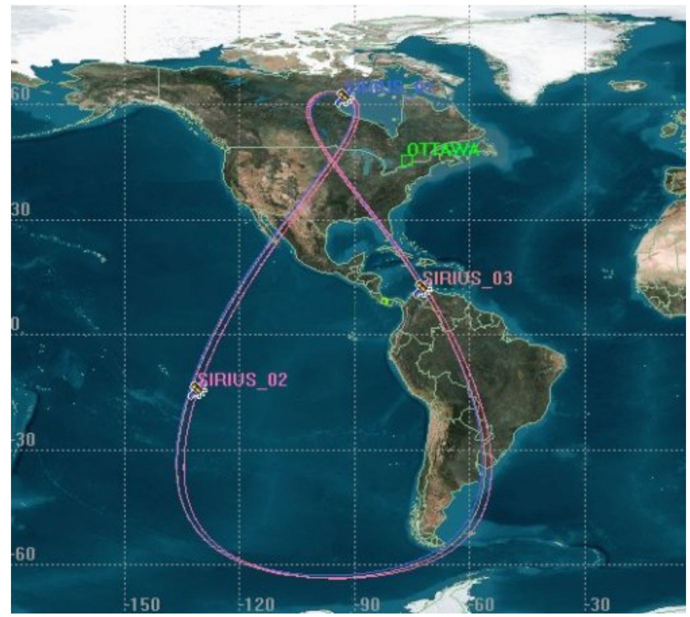
- Deorbiting into atmosphere: disintegration by fricitional heating
  - Impractical for high orbits: high thrust needed

- Disposal in outer space: too much propellant needed to reach escape velocity

- Disposal in orbits, unlikely to be used by other spacecraft, desirable
  - retired GEO satellite in orbit at least 240 km higher than GEO

Non-GEO Disposal

- Satellite radio satellite in 56° inclined orbit
- Nominal lifetime: 15 years

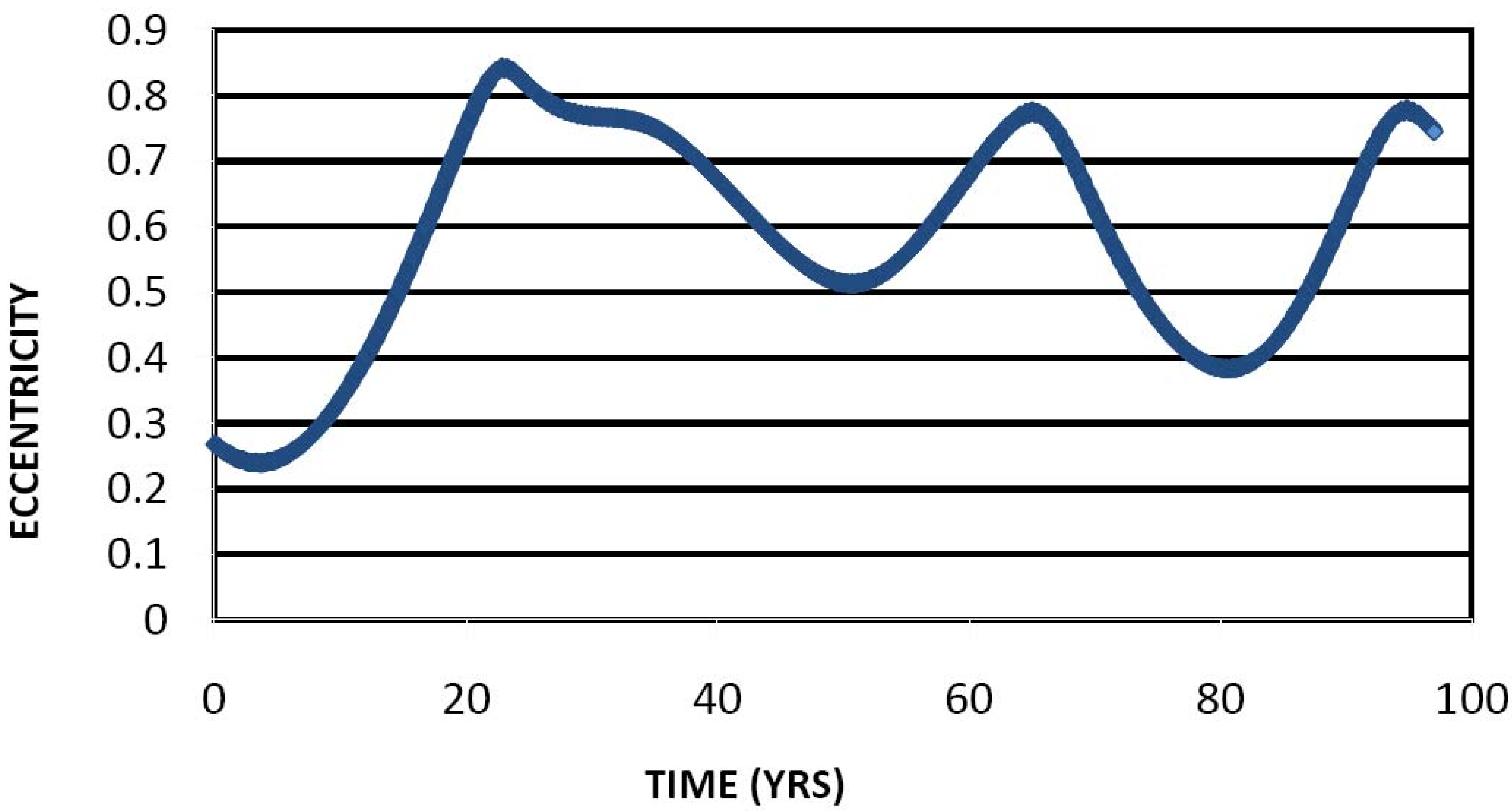


- Analysis of disposal orbits:
  – Most of them discarded due to propellant constraints
  – Long-term predictions difficult (> 100 years): solar activity?

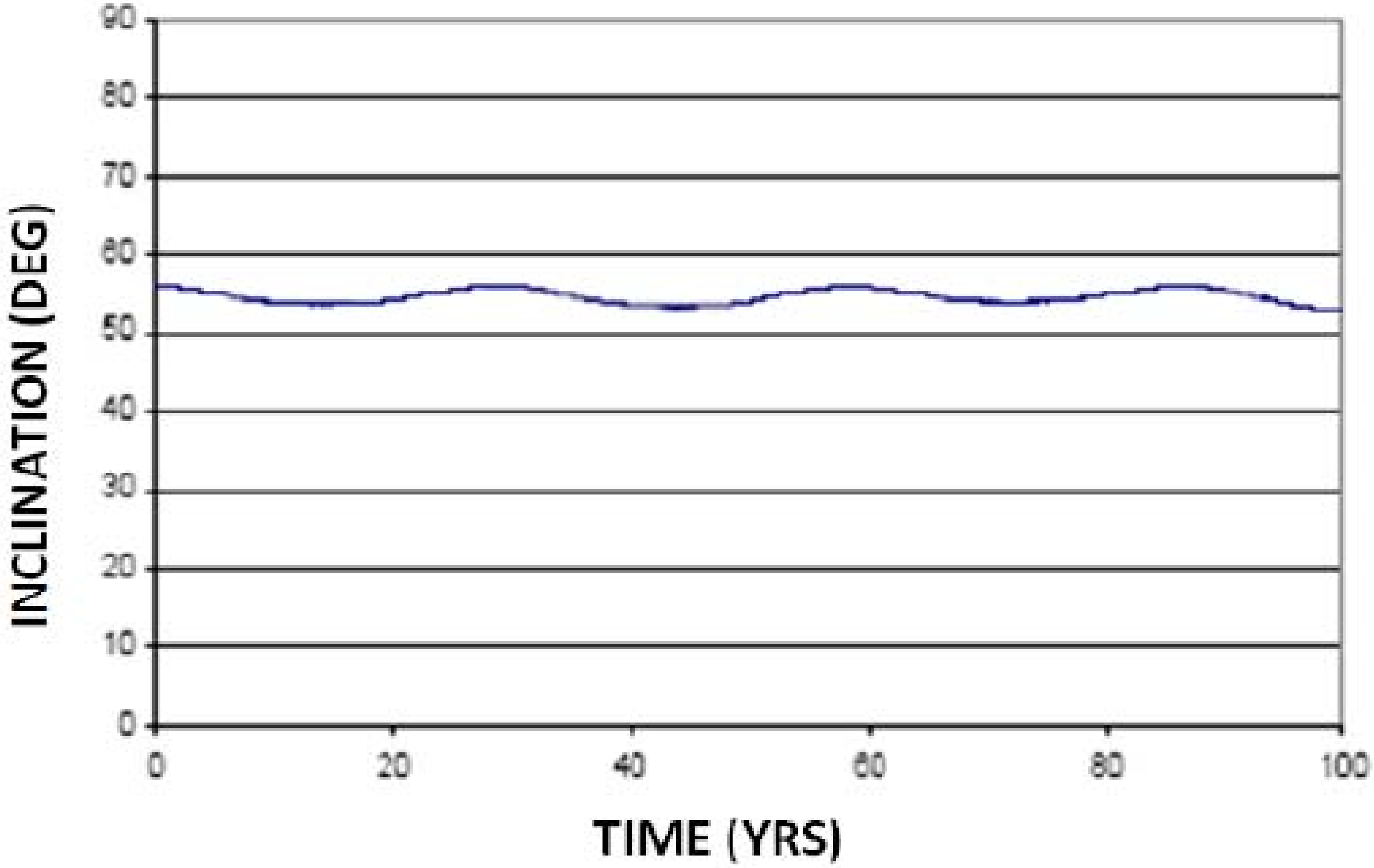
Circular Orbit

- 31.000 km radius
- Below GEO orbit
- Above GALILEO constellation
- High Van Allen radiation: unlikely to be used by other satellites

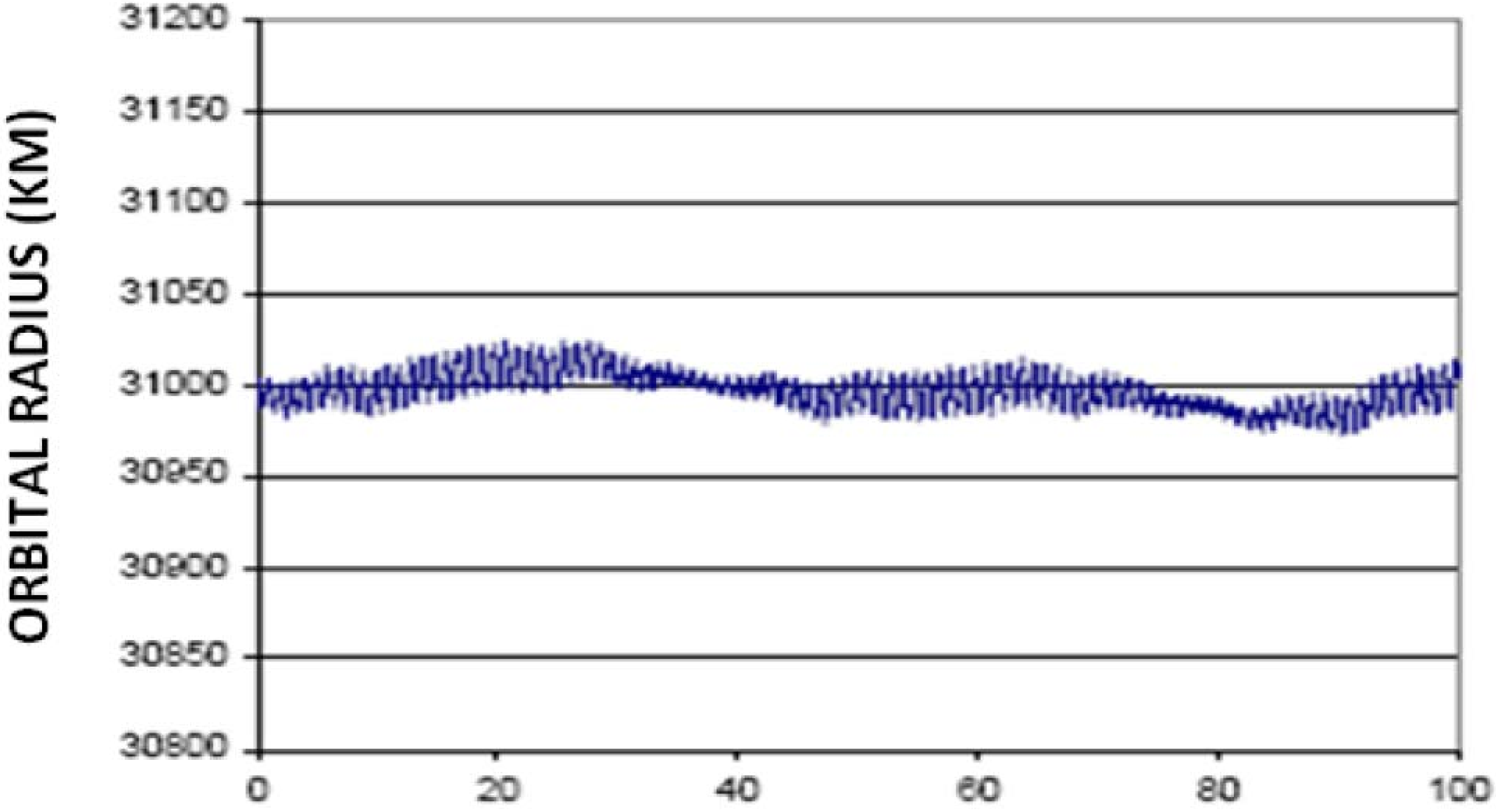
Eccentricity



Inclination



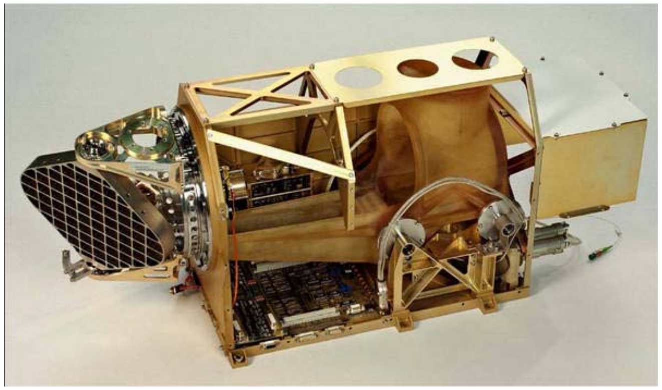
Orbital Radius



A Combined Moon Data Relay Orbiter and Moon Lander Mission Concept

Manfred Wittig and Bernhard Hufenbach (ESA)

- Data relay satellites essential communication elements: enabling technology for exploration (Moon, Mars)
- Increase of communications needs
  - currently S- and X-band used for deep-space communications
  - next step: move to Ka-Band
  - Free-space optics



Free-Space Optics

- Bandwidth limitations in S-, X-, and Ka-band
- Interference issues with terrestrial systems
- Very high bandwidth possible in optical frequency range
- Demonstrated e.g. In SILEX experiment (LEO remote sensing satellite and ARTEMIS data relay)
- Pointing critical
- Space – earth links suffer from atmospheric attenuation

Deep-Space Communications

- Explorer I (1958):
  - 10^{-13} bits/s for Earth-Jupiter distance
  - picture transmission: 317 billion years
- Voyager (1980):
  - 115 kbit/s from Jupiter
  - picture transmission: 8 seconds
- In ~ quarter of century communications capabilities improved by factor of 10^{18}

- Optical communications offer significant advantage
  - 500 Mbit/s between lander and moon data relay

Optical Phased Array in Free-Space Optical Communications Systems

Kevin Shortt (Royal Military College of Canada)

- Free-space optics systems need robust acquisition, tracking and pointing system for the Laser transmitter and optical detector
- Traditional: fine-steering mirrors
- Phased array: dynamically altering the wavefront of a Laser -> no moving parts
- Improve capabilities of optical communications

Innovative Concepts for the Creation of Space Networks Relying on Hybrid RF and Optical Communication

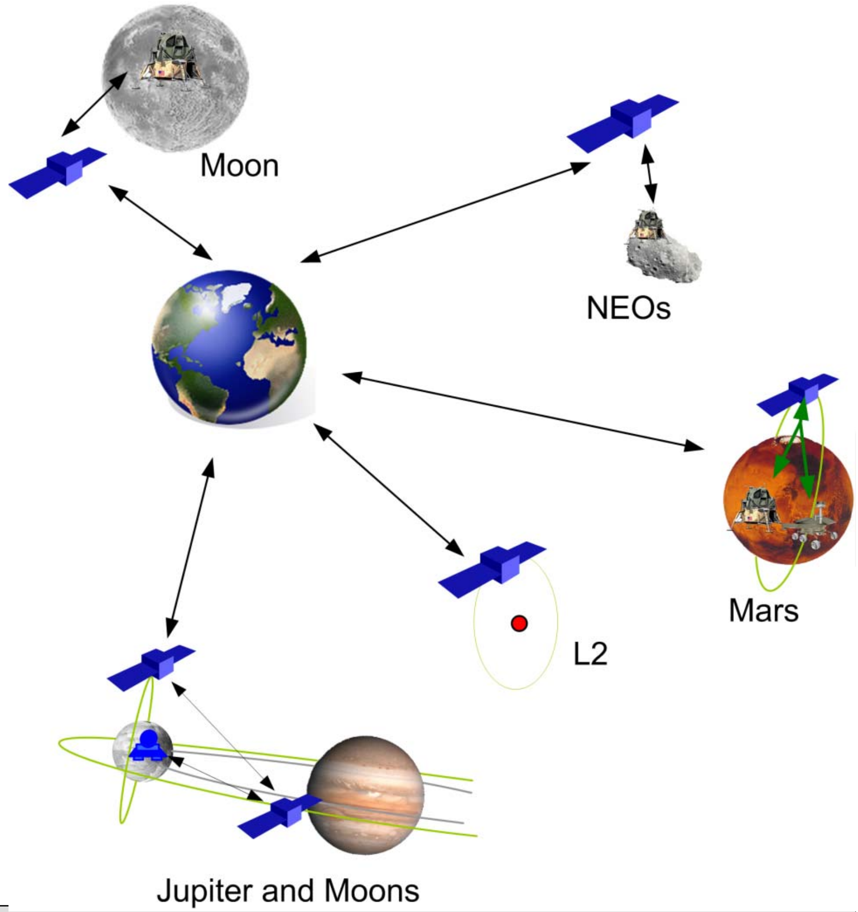
M. Bergmann, P. Romano, P. Schrotter, O. Koudelka, T. Plank

Graz University of Technology, Austria

Lander – Orbiter

Orbiter – Data Relay

Data Relay - Earth



Requirements

Target	Desired data rates per mission	Technical effort	
		RF	*Optics*
Moon	1.5 Gbit/s	Normal effort	Normal effort
L2	600 Mbit/s	Normal effort	Normal effort
Mars	50 Mbit/s	High effort at minimum distance; very high effort at maximum distance.	Very high effort – proper Lasers needed
Jupiter	2-3 Mbit/s	High effort at minimum distance; very high effort at maximum distance.	Very high effort – proper Lasers needed.

Current Technology for Optical Communications

- Optical terminal by ESA (20 cm telescope)
- Optical ground station (Canary Island, South Africa)

- Possible data rates:

- 1.5 Gbit/s from moon
- 300 kbit/s from Mars

ESA IRIS Programme

- Satellite Communication for the European Air Traffic Management System

Natalie Ricard, Catherine Morlet, Franco Ongaro (ESA)

- Future ATM system defined by Single European Single Sky ATM Research (SESAR)
- IRIS: new satellite-based ATM system
- Initiated in 2007
- Study on requirements presented

User Requirements

- High density continental areas: new terrestrial datalink system implemented in parallel to satellite
- Oceanic and remote areas: no terrestrial data link available
- Polar regions: non-GEO satellites

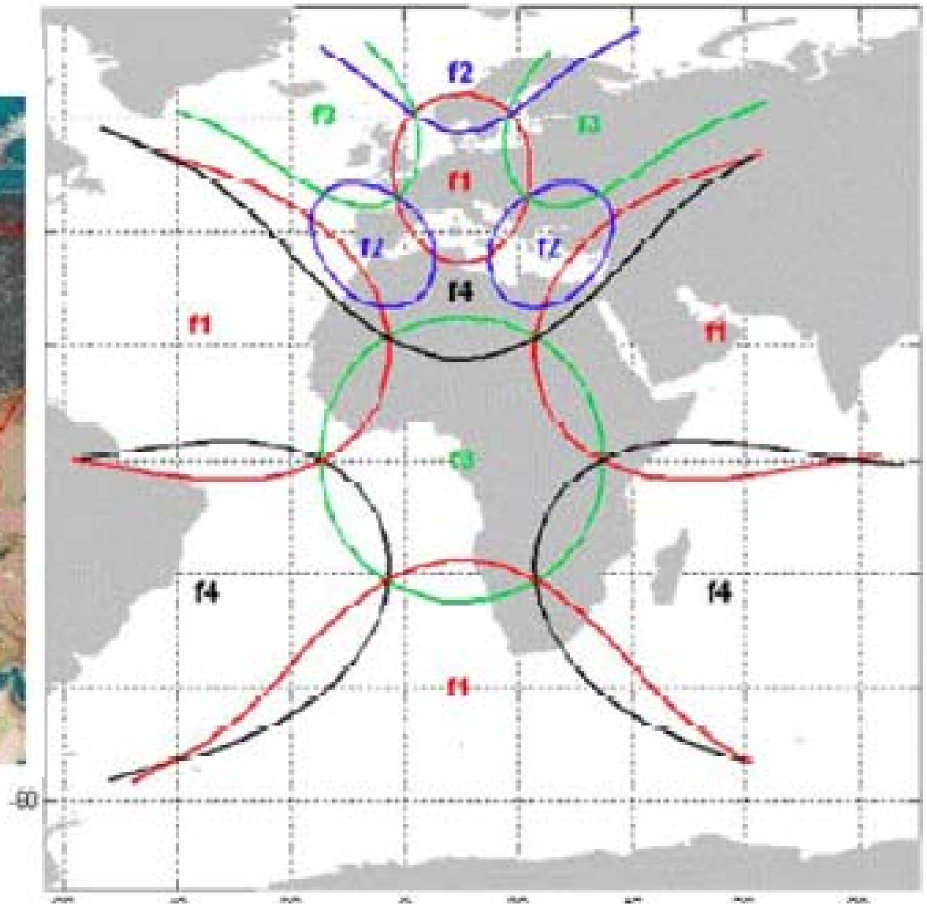
User Terminals

- Low-gain omnidirectional antenna
- RF power not exceeding 40 W
  avoiding interference to other aircraft systems
- Spectrum in L-Band

Space Segment

- 2 satellites in hot redundancy to meet reliability requirements
- Spot beam setup
- Most European traffic concentrated between Amsterdam, London, Paris and Frankfurt (all in one beam feasible)

Spot Beam Configurations



Outlook

- Next SCAN symposium during the 61st IAC in Prague
- Deadline for abstracts begin of March 2010
- Paper selection end of March 2010

- SCAN will actively contribute to the UN/IAF Workshop dedicated to GNSS during IAC2010

- SCAN organises a Plenary Event on Satellite Navigation during IAC2010

Thank You for Your Attention!