Apophis T–9 Years: Knowledge Opportunities for the Science of Planetary Defense – Session 3

Apophis and the Waves

The need for Frequency Coordination and Radio Amateur and University Community Support Before, During, After Close Approach

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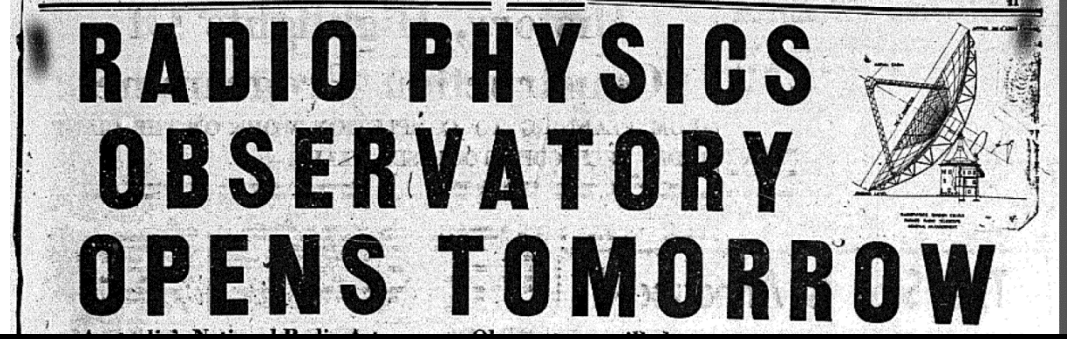
*licensed radio amateurs

Objective

- This is the beginning of a start of the discussion
- Create awareness of potential problems
- Find potential of synergy that is normally lost

This is a 1-in-1000 years chance!



Background

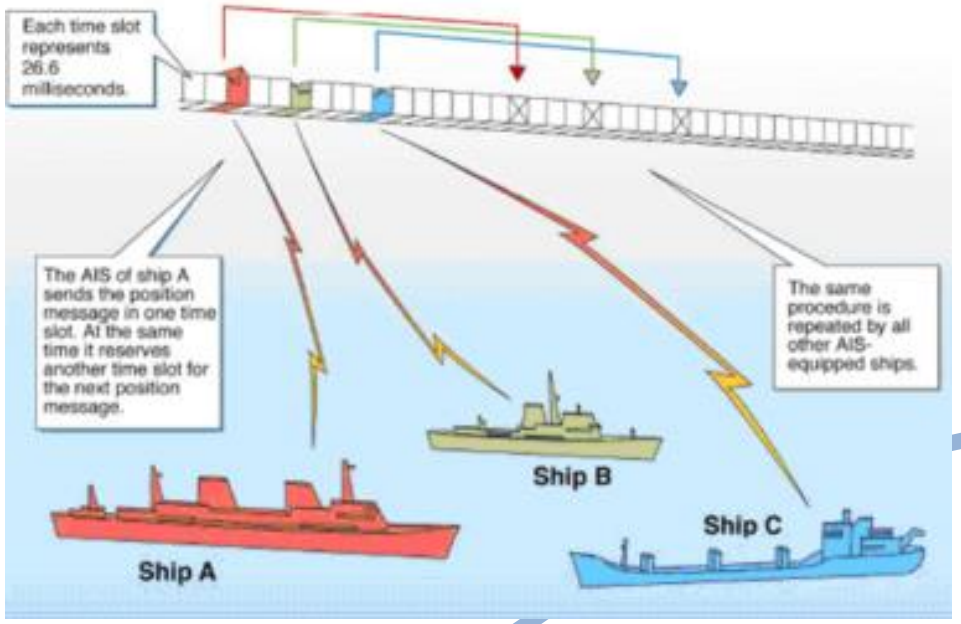
- the **DLR Institute of Space Systems** cooperated with the radio amateur community on several satellite projects
  - support, Q&A, consulting, reviewer on university cubesats
  - concurrent engineering (CE) studies for AMSAT-DL
  - design & operation of the AISat-1 nanosatellite
  - in-house EMC chamber

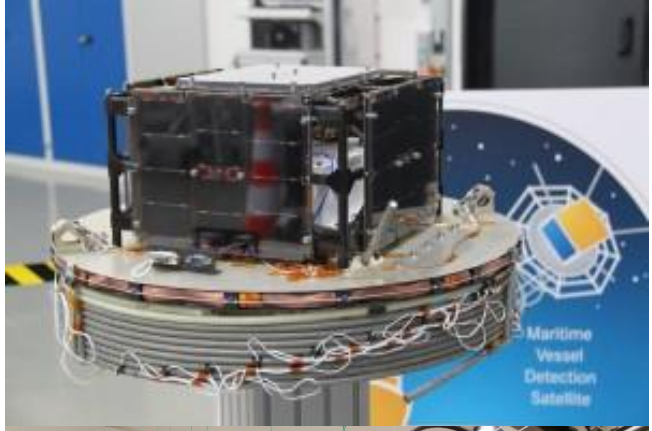
- in-house Electronics Laboratory (E-Lab)
  - managed by active radio amateurs
  - operate ground station on the roof
  - antenna design & testing

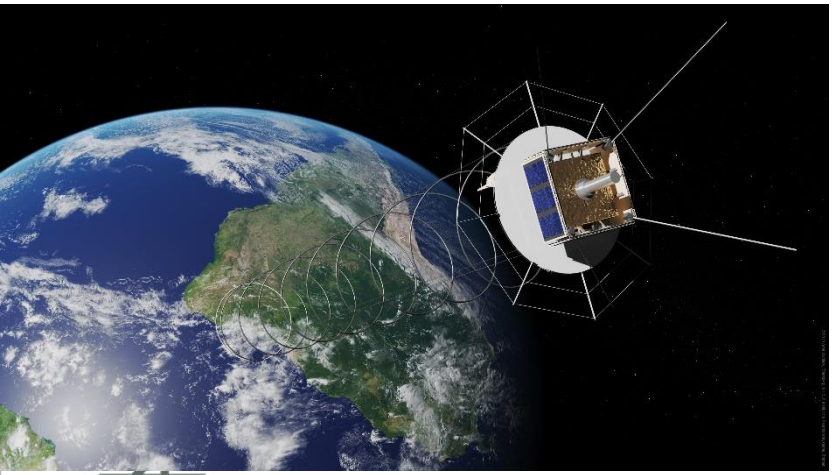
- space situational awareness work since AsteroidFinder
  - MASCOT2 mission study system engineering

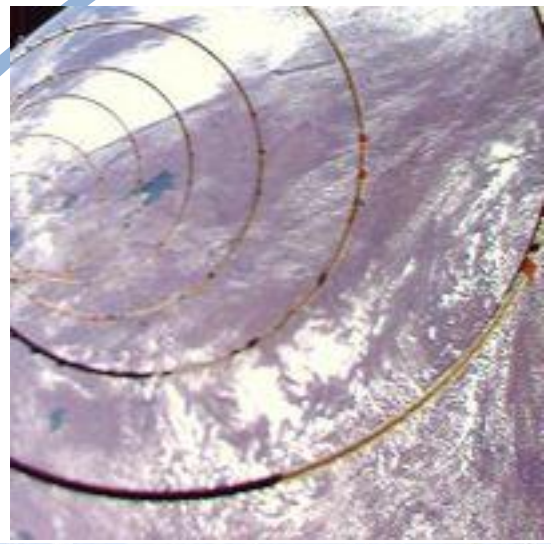
AISat-1

- monitoring of Automatic Identification System (AIS) emissions from space
- antenna and signal processing enable to pick out individual ships in very crowded regions









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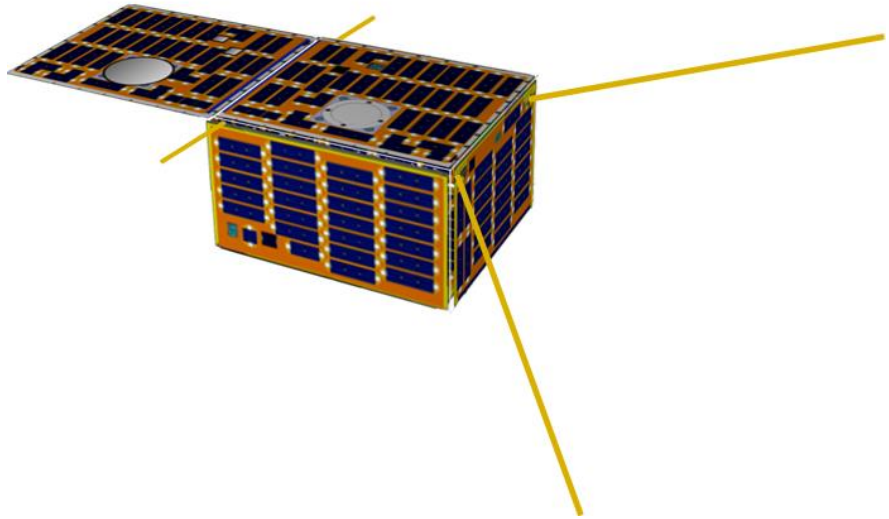
MASCOT2 @ AIM and the *System Perspective*



- Low-Frequency Radar (LFR) payload for “Didymoon” (now: Dimorphos)
- planned for AIM mission, descoped on HERA

- LFR is sounding the interior in bistatic mode with a 2nd unit aboard the AIM main spacecraft
  - ➔ *see Alain Hérique’s talk*

- “side effect”: strong ~40 W peak (power input) transmitter on board
  - typical communication: 0.1…1 W RF power

- coincided with research on long-range MASCOT communication options (>>100 km … ?? limit ??) and ideas of a multi-spacecraft multi-band amateur radio payload AO for GOSSAMER-1 also cancelled

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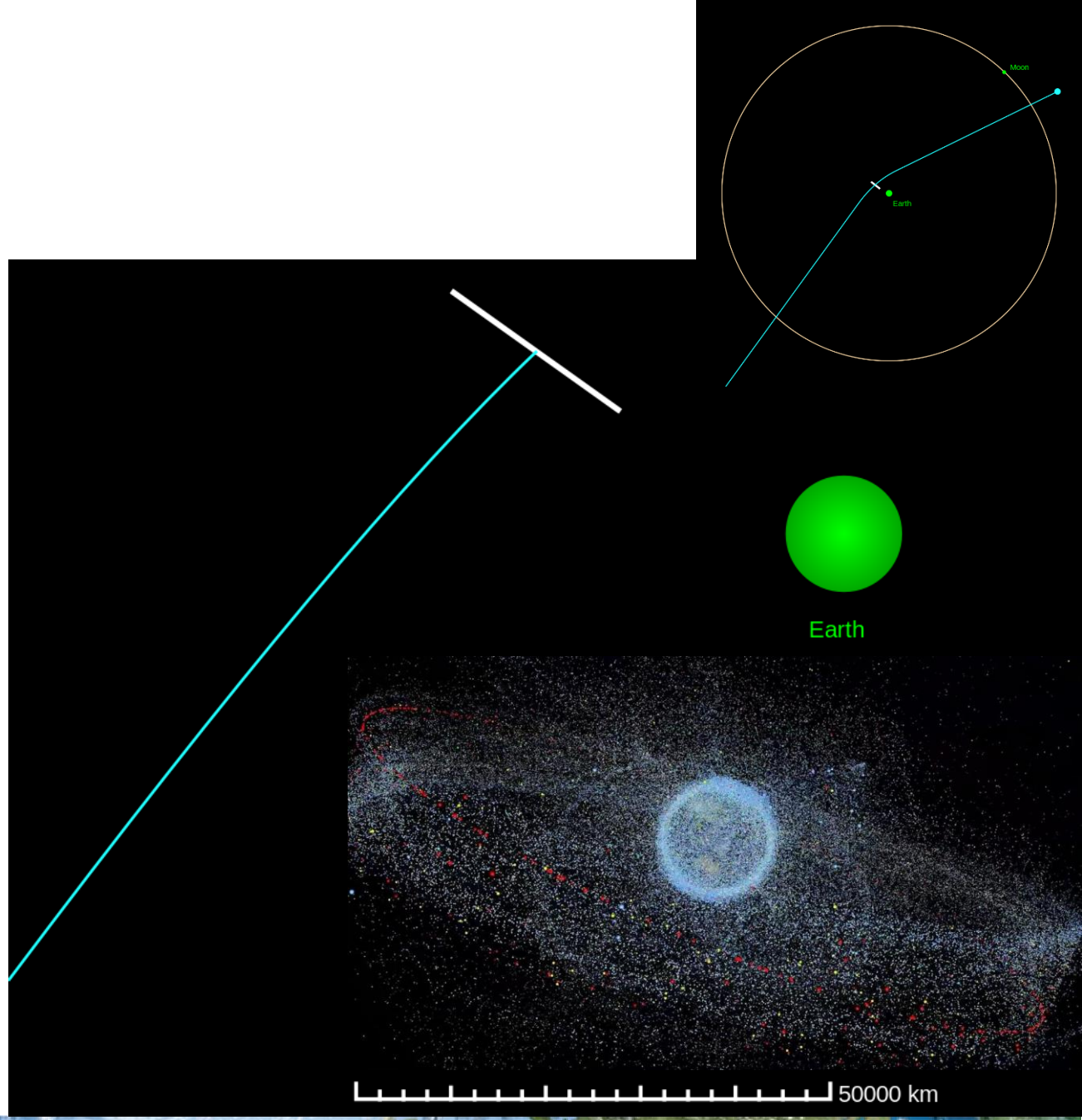
a special situation …

- Apophis comes in range of many more radars than the 2-3 that normally do asteroid work
- space debris monitoring radars definitely reach to GEO for m²-sized objects
- radio amateurs “routinely” work Earth-Moon-Earth connections

anyone who could get an echo will try



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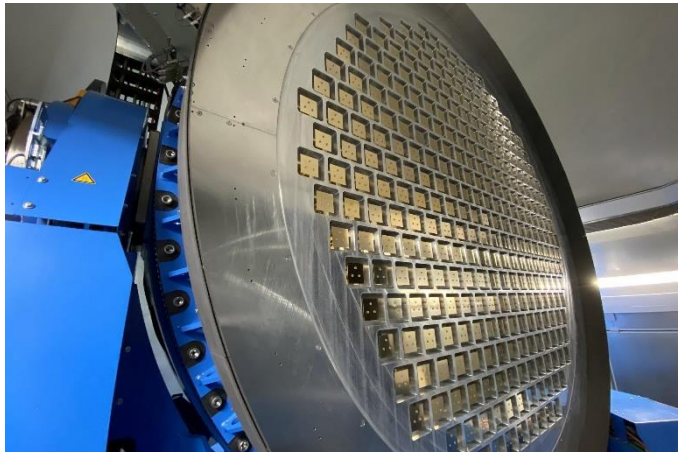
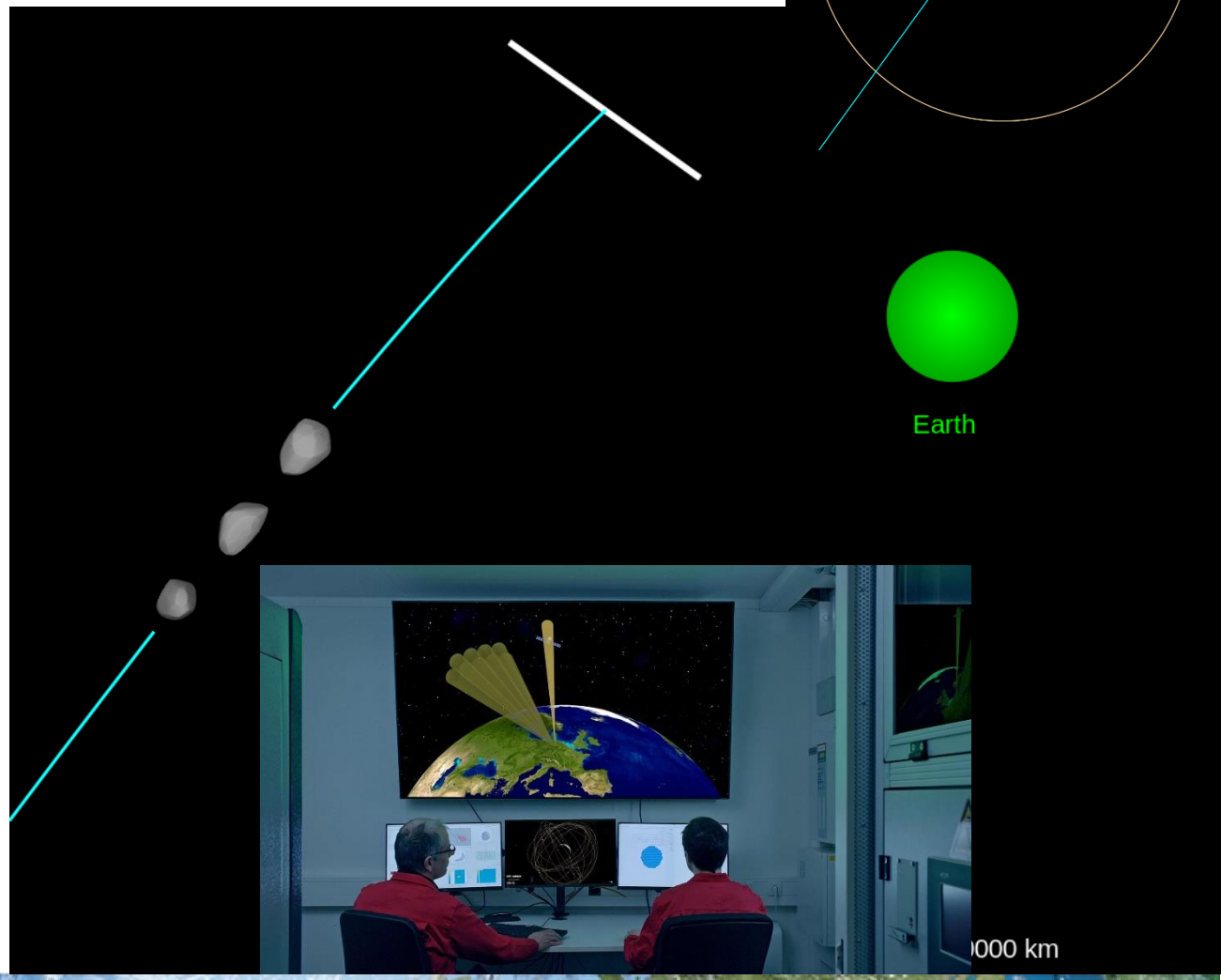
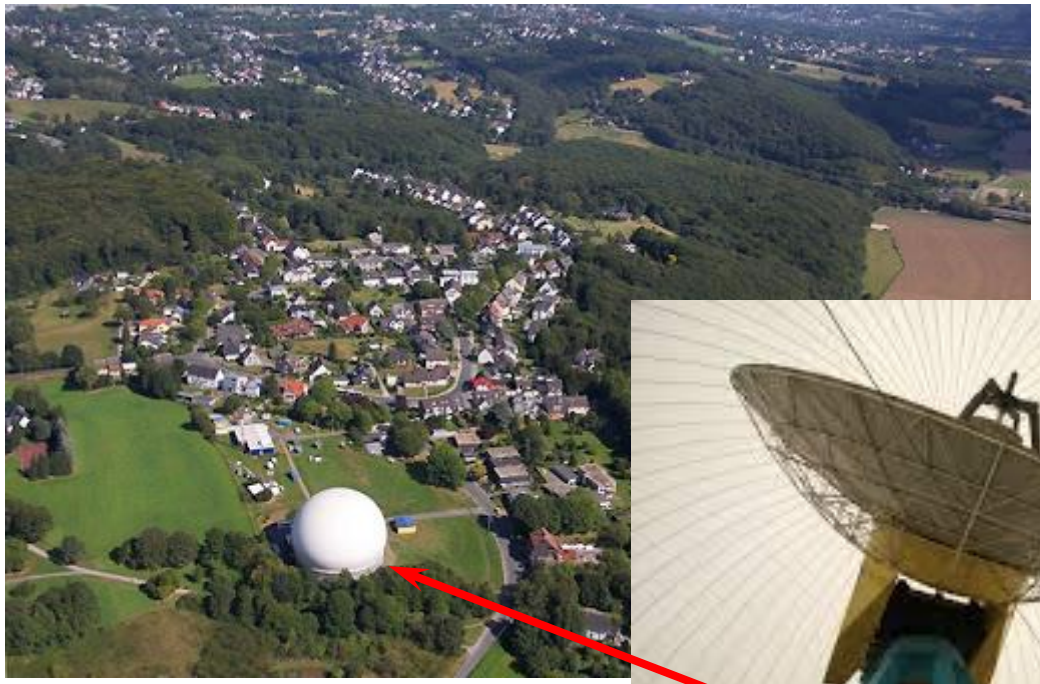
and why not?





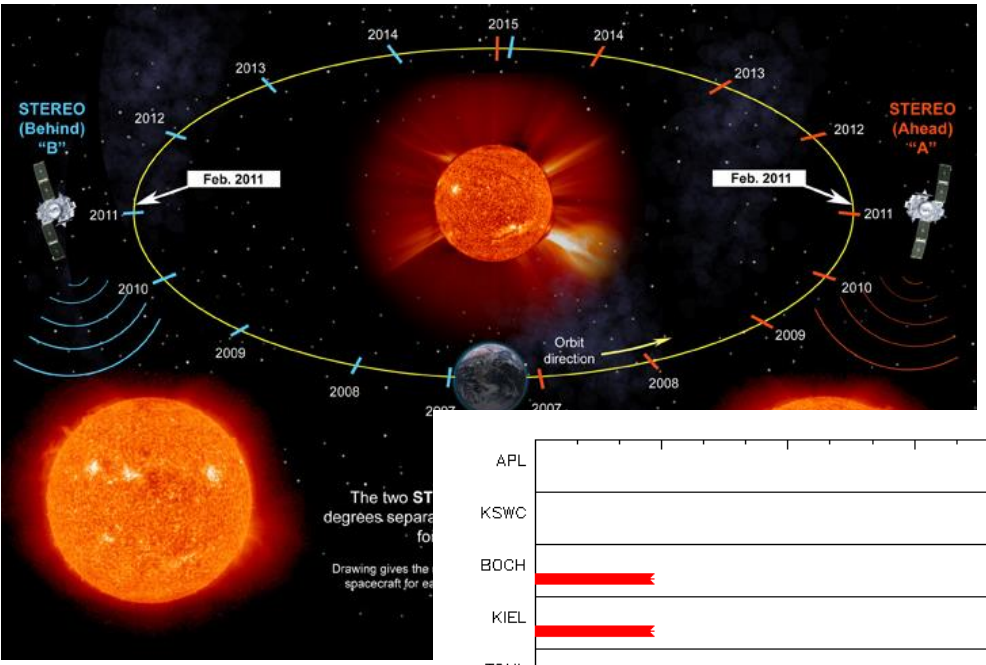
“there are people with a 10 m radio dish in the backyard”

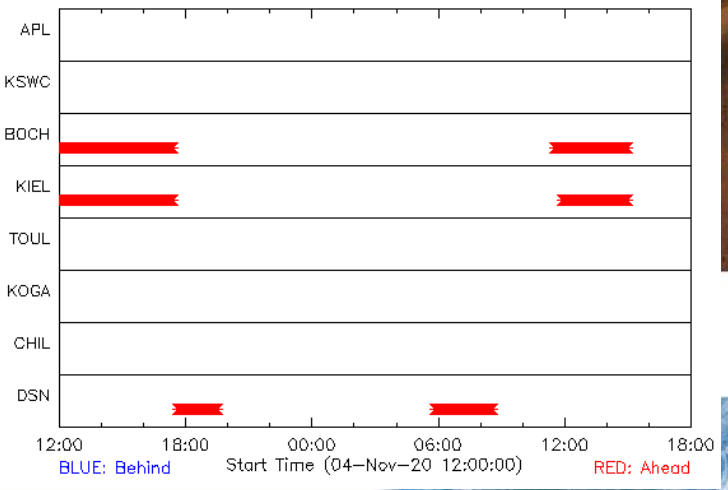
- amateurs can compete with professionals in astronomy & radio facilities



“there are people with a 10 m radio dish in the backyard”

- radio amateurs support space missions
  - ▼STEREO-A/B live spaceweather beacon
  - Lunar missions were studied ►





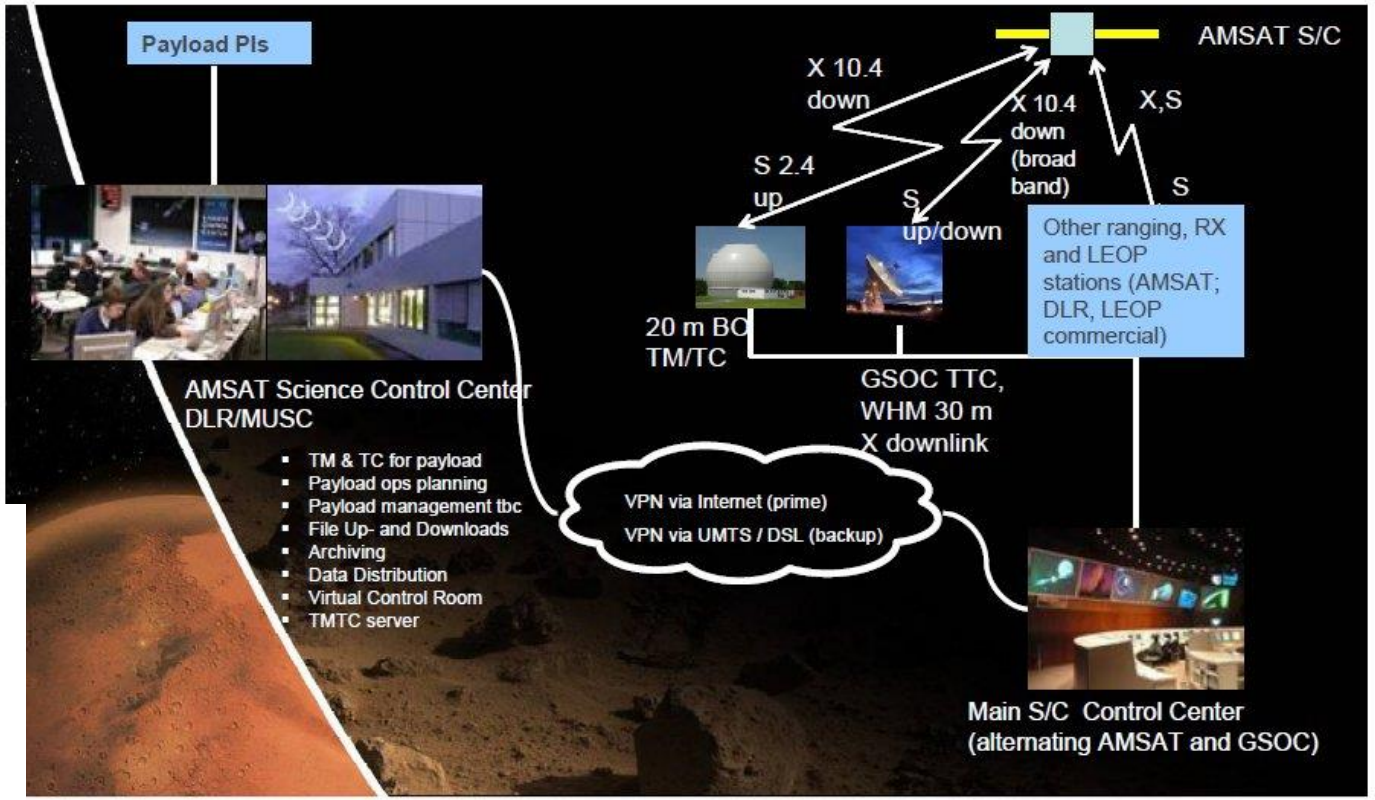


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Abbildung 12: *Konzept für DLR-AMSAT Groundsegment (Mondmission)*

Ideas involving the Ham Radio community

DLR mobile ground station
L.A.R.S.

Ham Radio sat antenna
@DLR RY HB

- Make use of the agile crowdsourcing of the Ham Radio community
- Popular examples: WSJT/WSPR network
- Idea: Multi-/bistatic radar / multilateration
  - One designated transmitter
  - Multiple receivers from the ham community at different locations

⇨

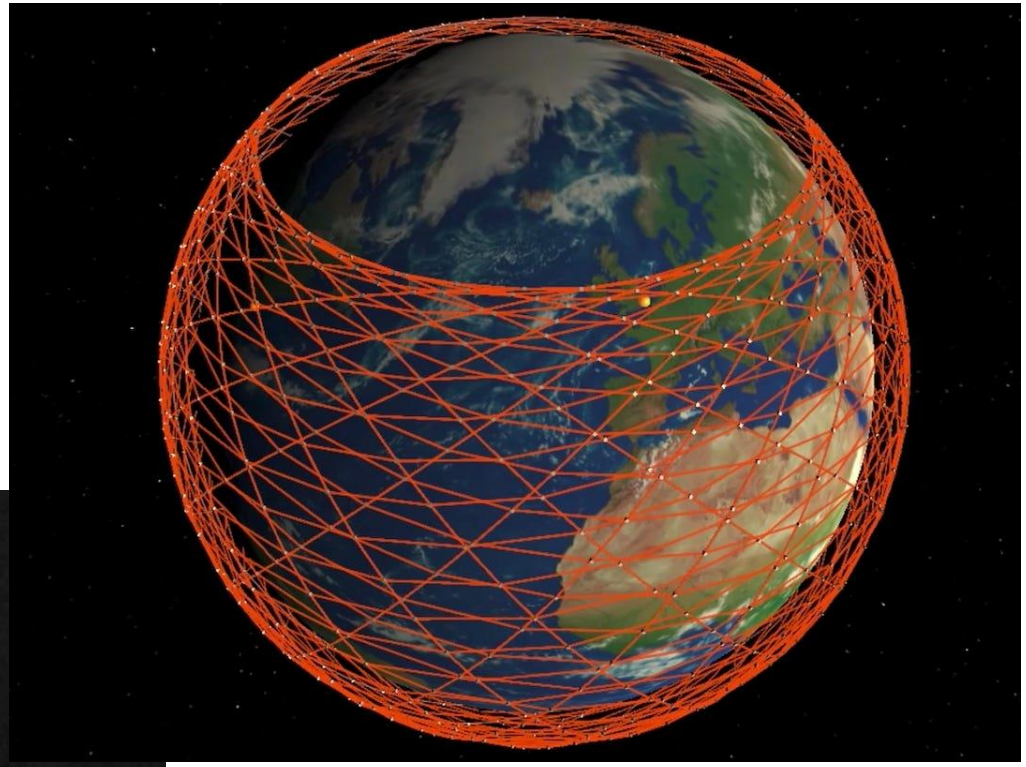
- Enhancement of spatial and trajectorial resolution, more information gathered

- But need for exact time distribution and complex signal processing
- Another onset to avoid inaccuracies due to different and not well characterized receive stations: Supply unified receiver kits to the community

Image sources: Apophis Model, Astronomical Institute of the Charles University: Josef Ďurech, Vojtěch Sidorin
Cooby Creek Yagi Array, Hullwarren, Wiki Commons

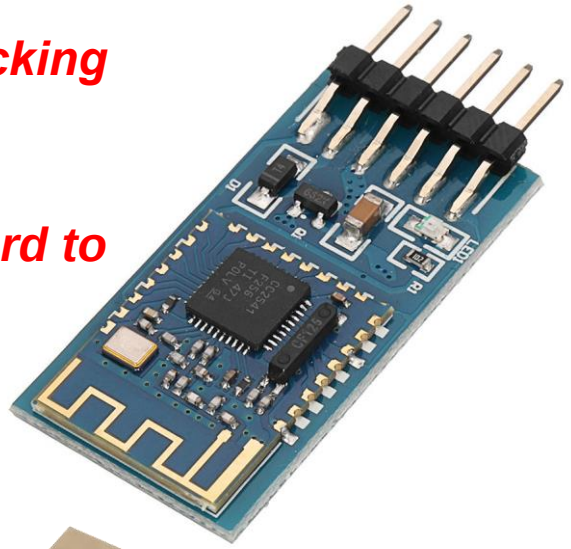
The risks & problems: there are 9 years of electronics & space progress ahead

- StarLink - >10000 satellite constellation, all transmitting



The risks & problems:
there are 9 years of electronics & space progress ahead

“ …and now imagine someone hacking a million Bluetooth modules and building a Square Kilometer Array pocket book edition in their backyard to get a ping on Apophis…

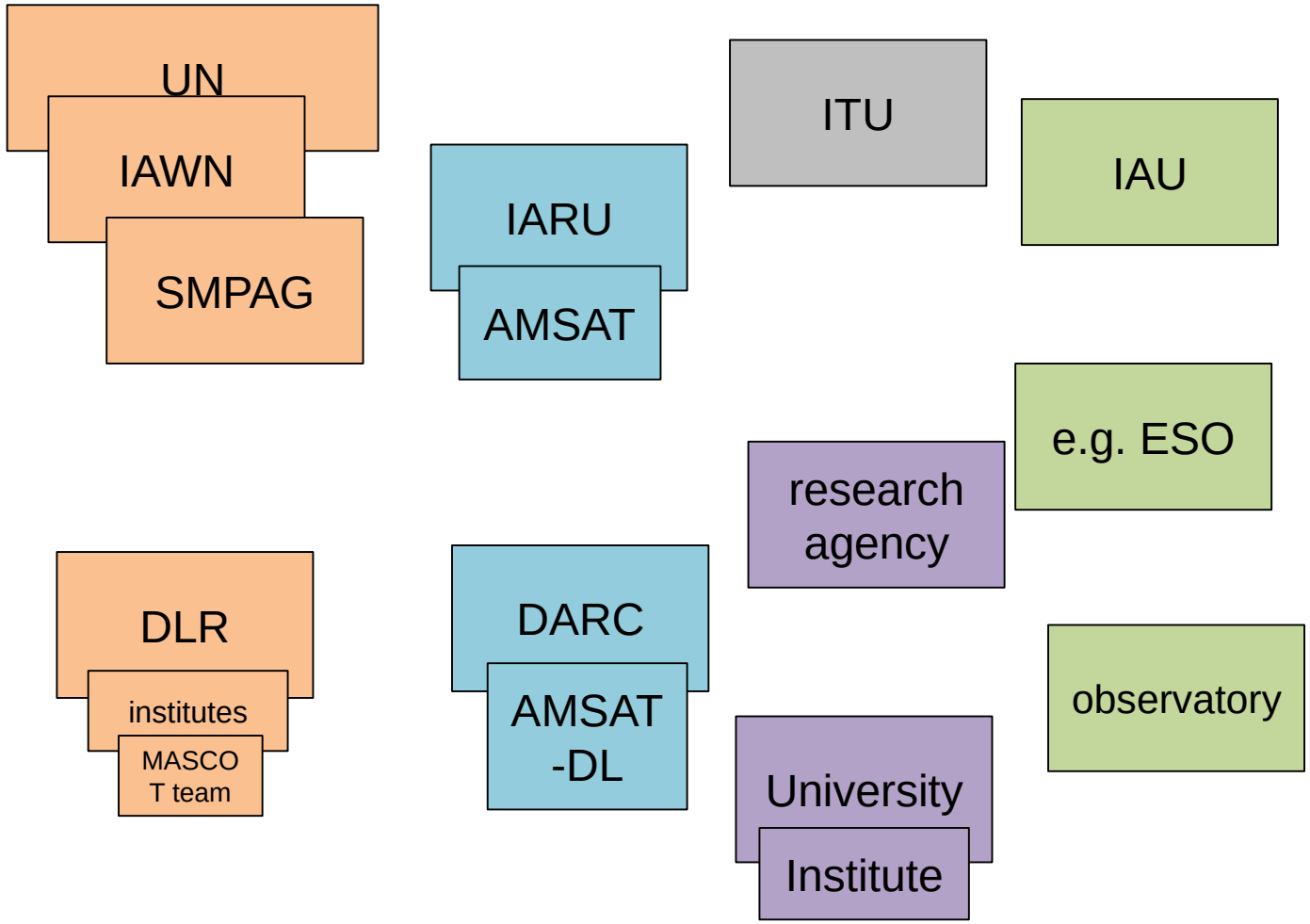


Approach: use what's there!

- national radio amateur associations
- national space agencies

- international asteroid/space framework
  - IAU
  - IAWN
  - SMPAG

- International Amateur Radio Union (IARU)
- International Telecommunication Union, ITU



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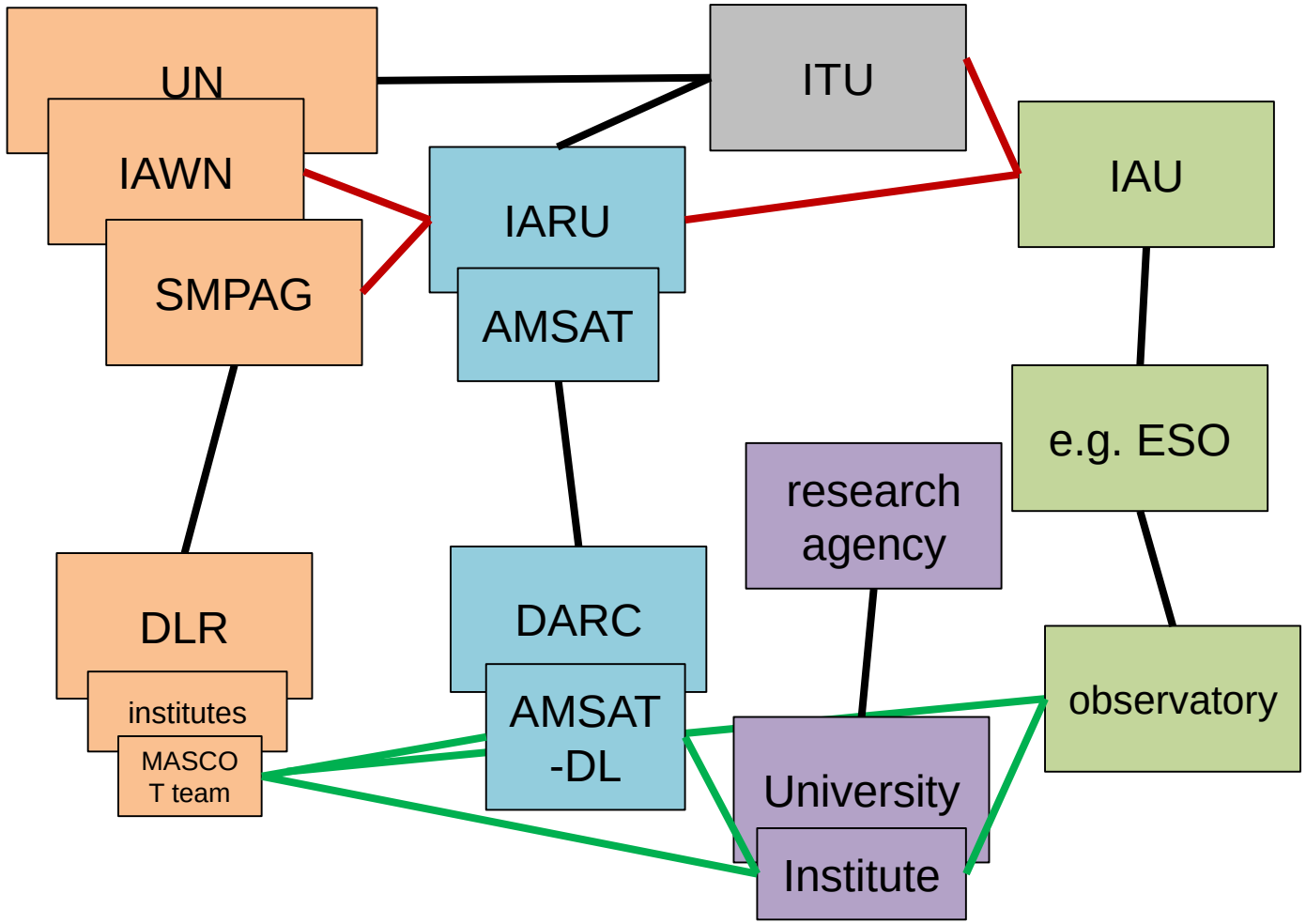

- lateral linking for systematic work: between small agile teams
- vertical linking: national – multi-national – international ***exists***
- lateral coordination worldwide: will be interesting to get working

…and talk & tell the people!

Thank you! – Questions, please ☺