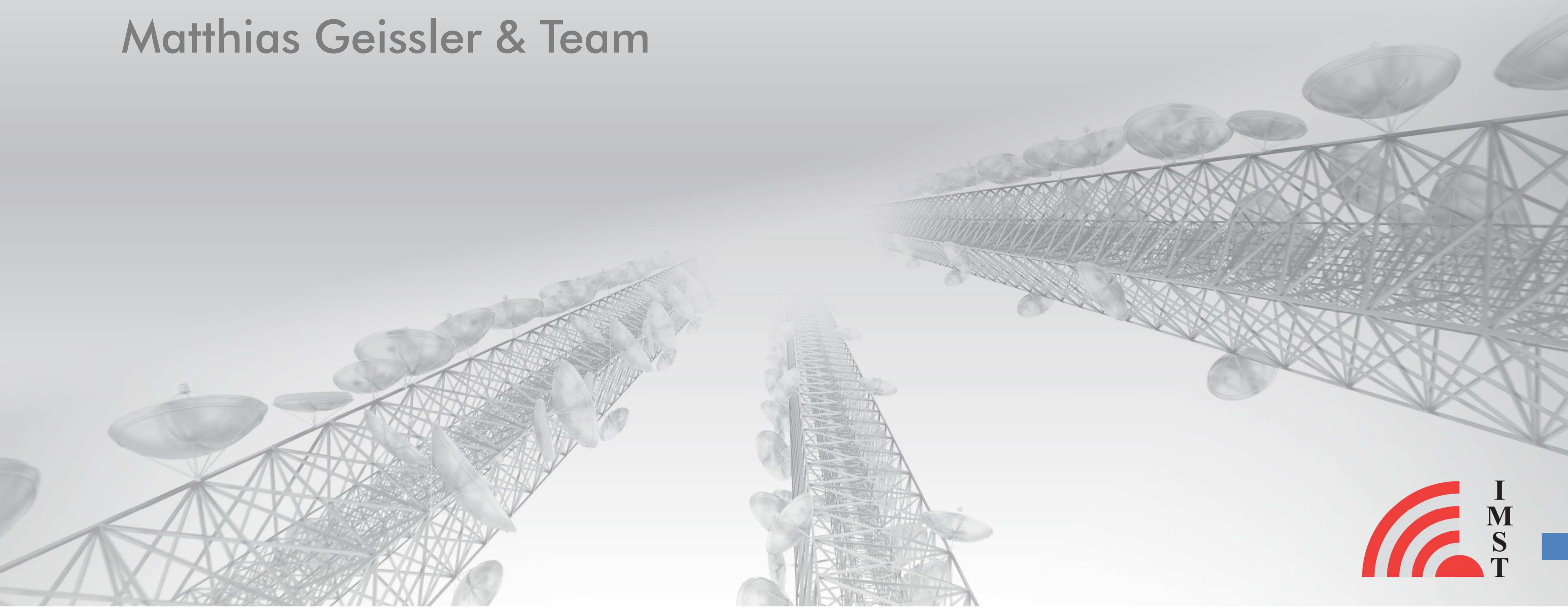
Antennen für fliegende Netzknoten

Matthias Geissler & Team



Contents

- The 3D network
- Flying network nodes
- Requirements for antennas
- Example: SANTANA IV
- Summary

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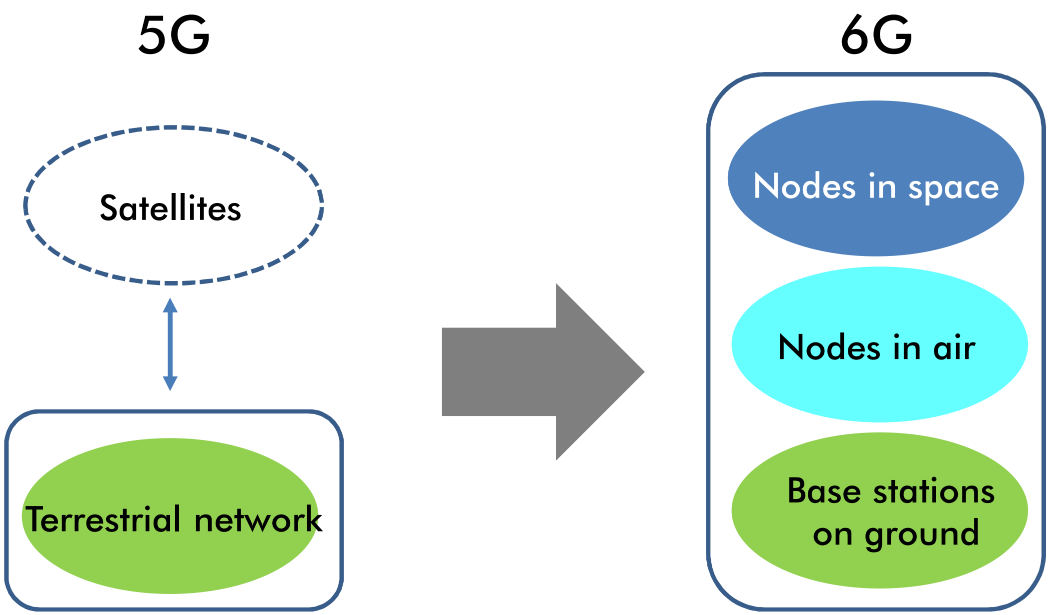
Whats new about the 3D network?



- Strong focus on terrestrial network
- Possibility of satellite integration

- Holistic approach: ‚Real 3D network'
- Network architecture optimized for flying nodes

Potential of 3D networks

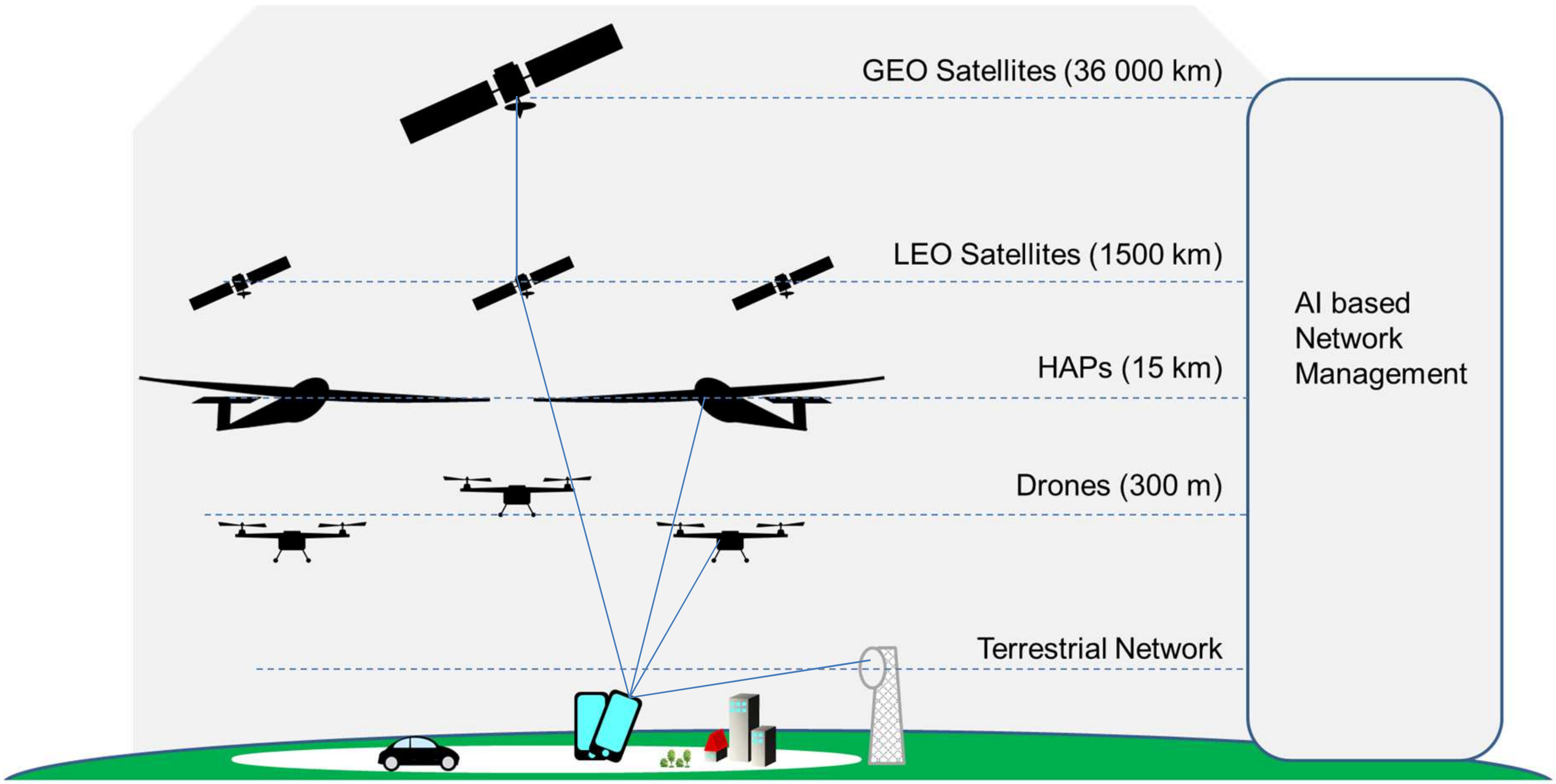
Intended functionality

- ‚**Equal importance**' of terrestrial base stations and flying nodes
- **Automatic routing** through the network based on availability, data rate, latency requirements, costs
- **Seamless handover** between nodes, terrestrial or flying

Potential

- Terrestrial network only needs to **cover the basic capacity**
- **Peak capacity** can be supported by flying nodes
- **Fast recovery** of network in case of desaster (e.g. Ahrtal)
- **Filling of gaps** in the network at low cost
- Basic coverage of **rural areas** at low cost
- Basic coverage of the **oceans**

The 6G vision



6G-TakeOff:
Holistic 3D Communication Networks for 6G

Project idea: Combine terrestrial, air-borne and space-borne processing platforms in a holistic manner as infrastructure for communication network elements

Consortium Partners:

Project coordinator: Deutsche Telekom

Contact person: Markus Breitbach

Start | Duration: 2022/08/01 | 3 years

Volume:

- approx. 1000 person months / 13 mn €
- 38% SME, 31.7% industry, 30.3% research institutes and universities

Supported by:
Federal Ministry of Education and Research

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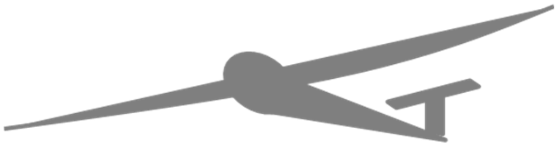
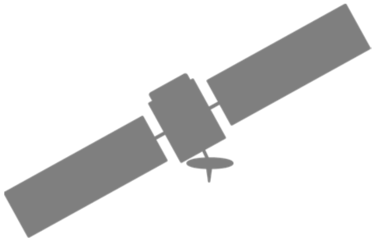
Flying nodes

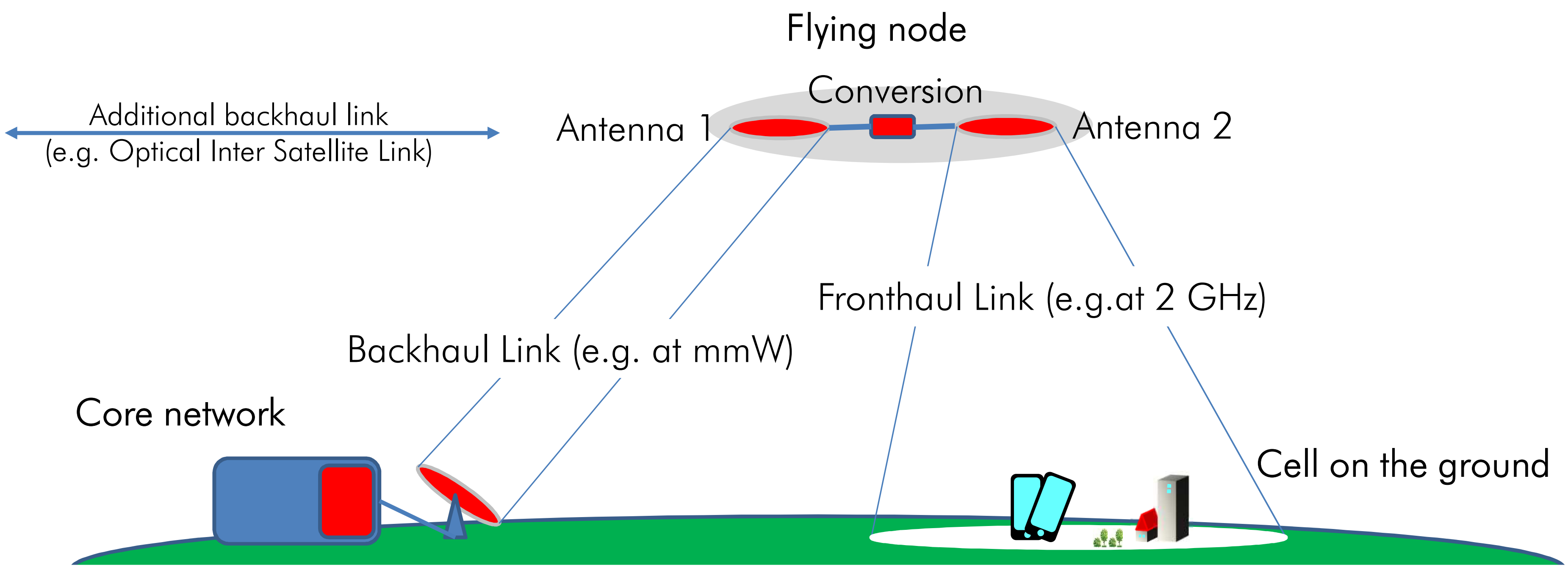




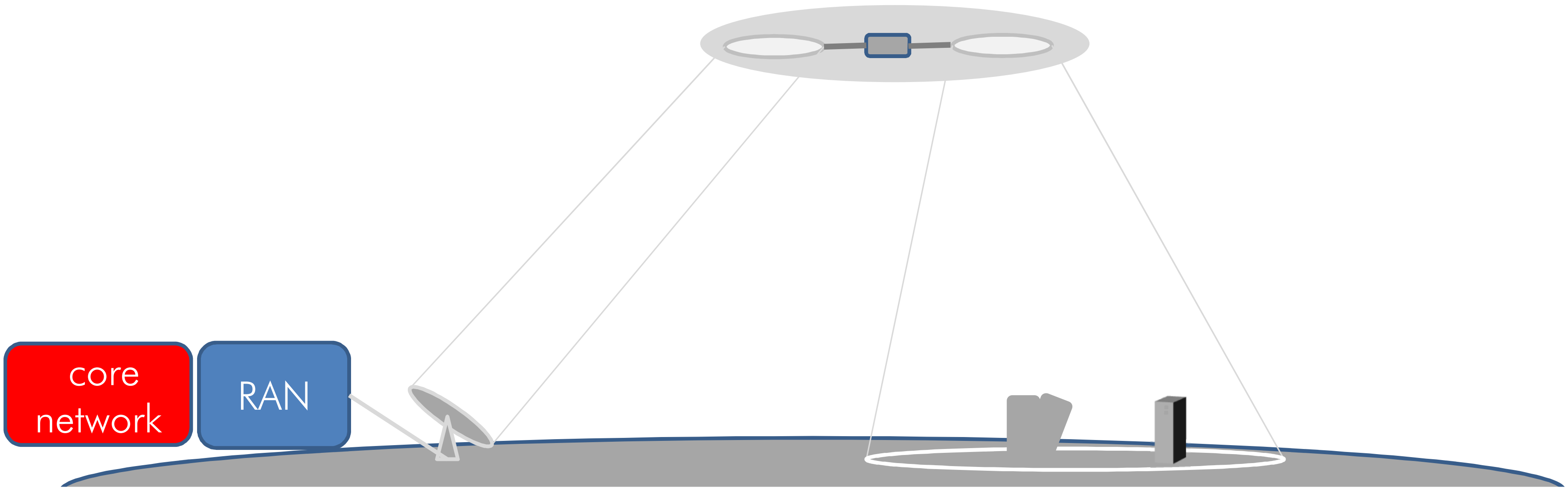
- **GEO satellite**: Satellite in geostationary orbit with defined (maybe reconfigurable) footprint on the earth surface
- **MEO or LEO satellite**: Satellite in low or medium orbit, relative movement vs ground, constellation needed
- **HAPS**: High Altitude Plattform Station e.g. stratospheric glider
- **LAPS**: Low Altitude Plattform Station, e.g. small drone or copter

➢ **Nodes are very different in type and in potential application in the network!**

Linking the flying node to the network

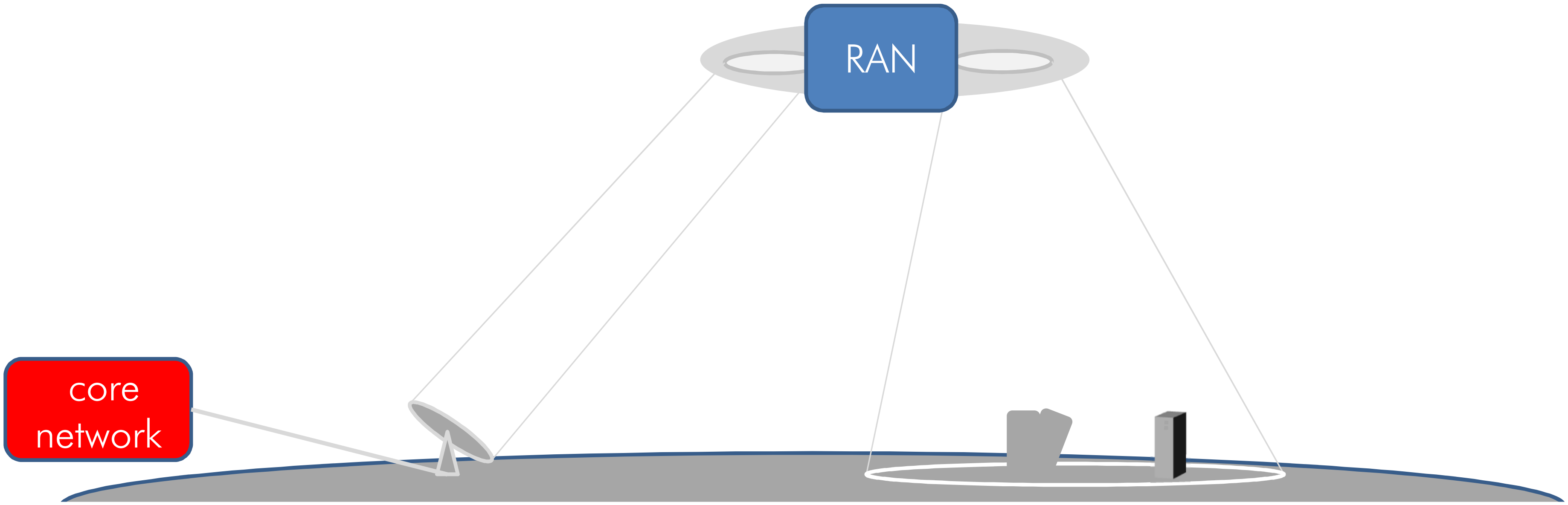


Extreme setup 1: Fully transparent link



- Base station is on the ground
- Flying node acts as repeater only
- Advantages: Central control and configuration in core network, Payload ist more simple, lower energy consumption
- Disadvanteges: High gross data rate required, very high latency requirements

Extreme setup 2: Flying base station



- Fully functional base station on the flying node
- Advantages: Backhaul link optimized for data transfer only, lower (net) data rate, specific protocol can be used
- Disadvantages: More complex functionality on the node, more power consumption

➢ **Level of node transparency depends on network architecture: central vs distributed control**

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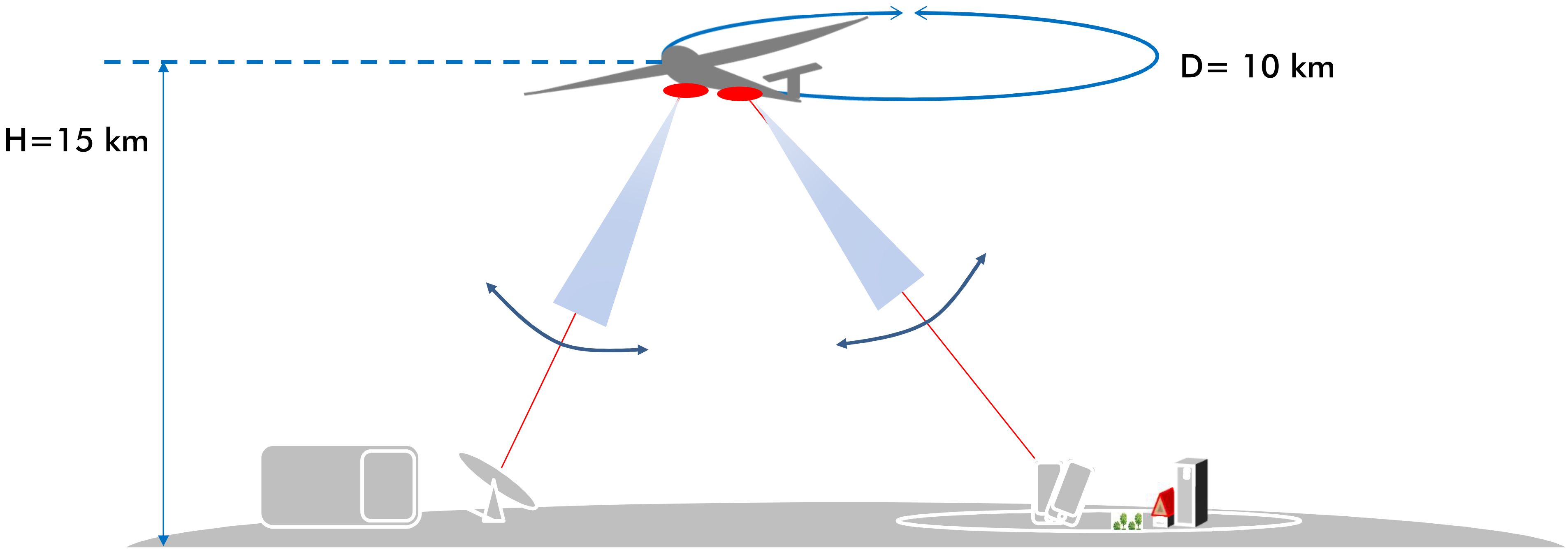
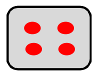
Reliable and robust beam tracking



- Stratospheric glider in continuos circular movement above ground
- Both beams, backhaul and fronthaul beam, need to continuosly move to maintain the link
- Mechanical steering platform would suffer extremely
- Electronical steering allows for higher MTBF

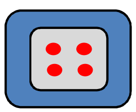
Antenna size differs with node type

- LAPS vs HAPS: Very different requirements in terms of link budget, antenna weight and size
- Solution : Modular approach

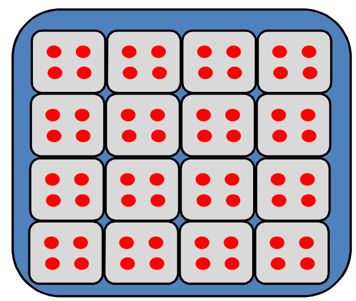


Antenna module (e.g. 4 x 4 or 8 x 8 elements)

Antenna for LAPS



Antenna for HAPS



Modular approach

➢ Re-use of modules for several applications
➢ Higher production quantity for modules
➢ Fast prototyping for new applications

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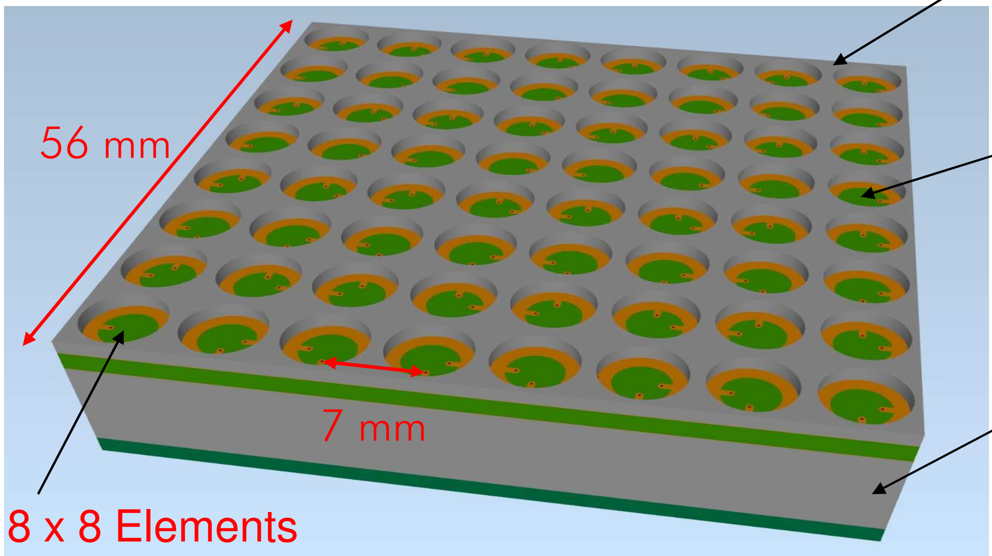
Module: Top view

- Small Horn-Antennas fed by circular polarization
- Separate apertures for Tx und Rx
- Multilayer-Board carries chips and feeding structures



Upper metal frame:
- Antenna elements
- Heat Spread

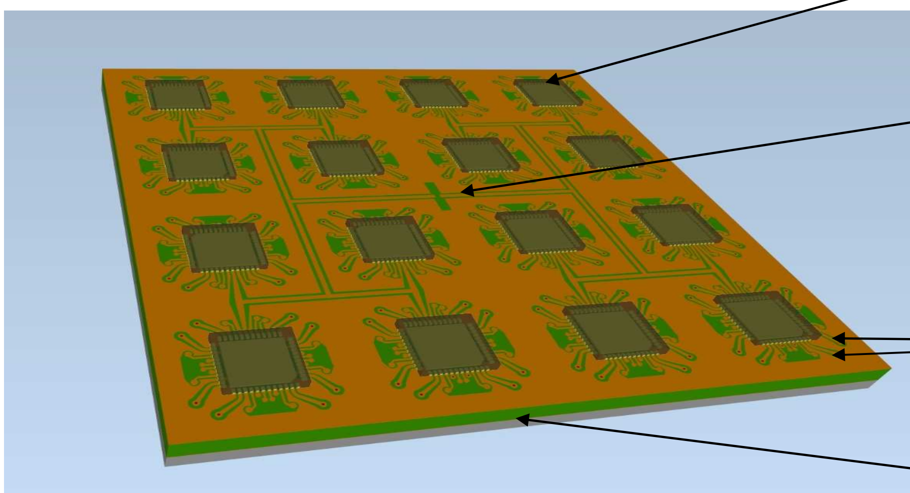
Multilayer:
- Antennena frontend with 1:16 Divider
- Beamformer Chips

Lower metal frame:
- Passive cooling
- 1:8 Divider (waveguide)
- Filter (waveguide)

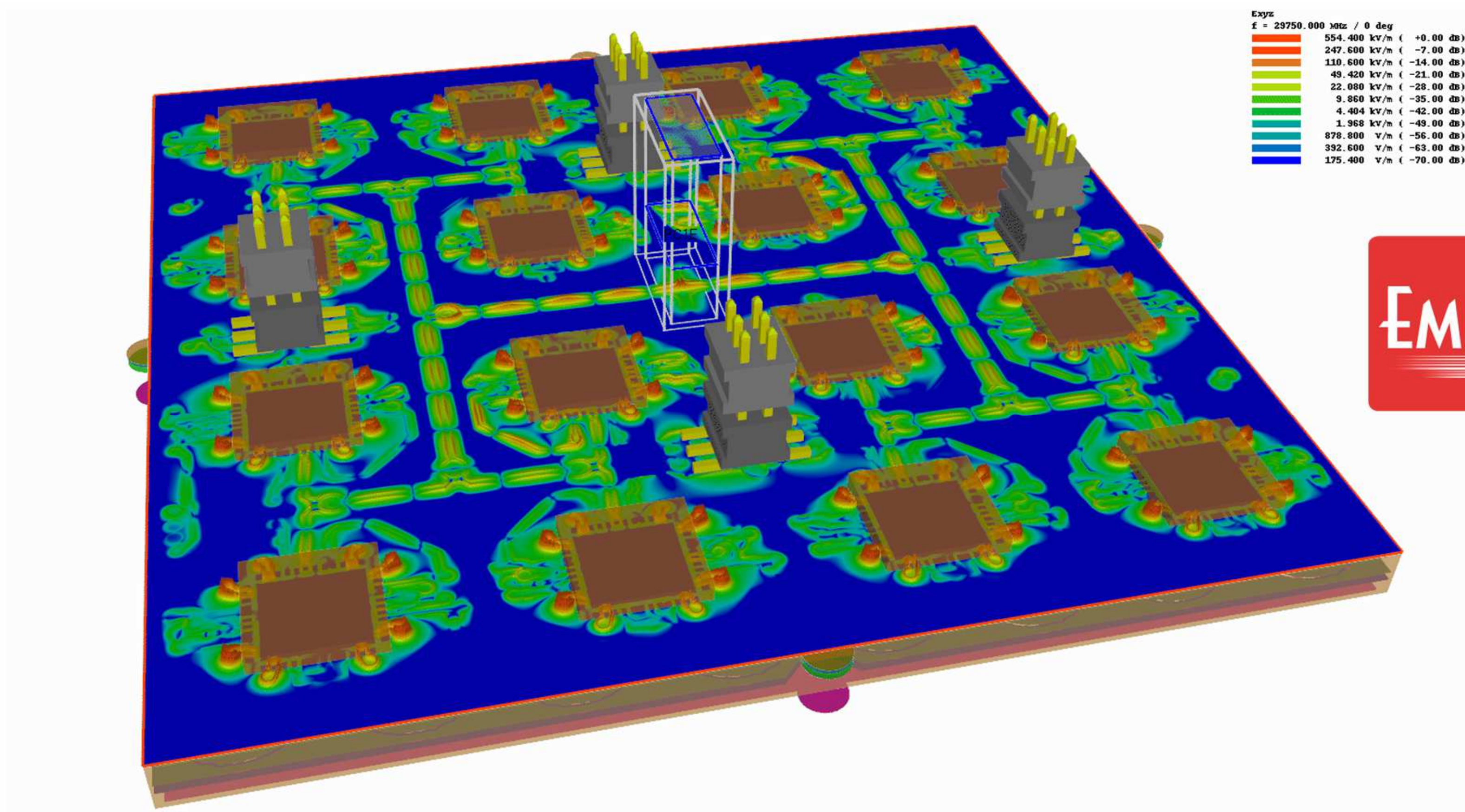
f= 28-30 GHz

Module: Bottom View

- New generation of beamformer chips: One chip drives 4 elements times 2 polarisations
- Any polarisation type possible
- Board in standard technology
- Only one RF interface vs BUC / LNB!

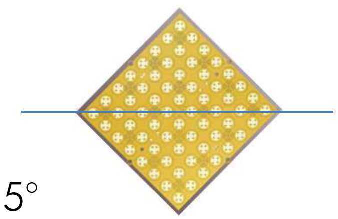


Frontend – Simulation: bottom view



EMPIRE XPU

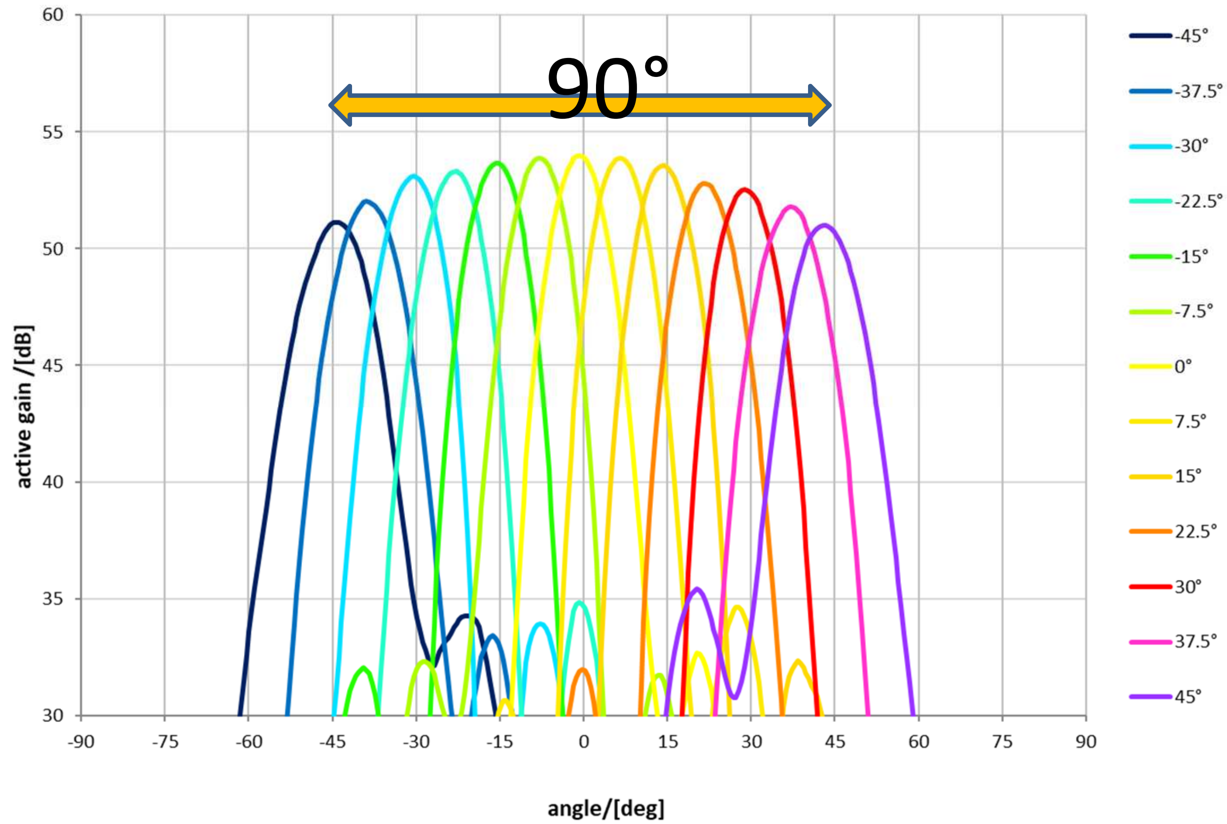
Measurements: Active Gain in farfield



Phi=45°

Theta = 0°-45°

(7.5° steps)



SANTANA IV*: Phased array for aeronautic applications

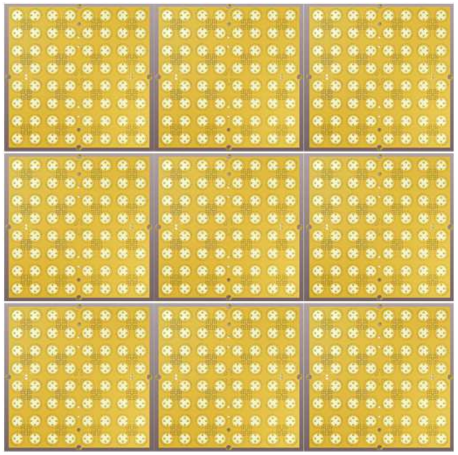
Single Module:

- 8 x 8 Elements
- Antenna Module Directivity: ca. 25dBi

Module can be combined to built large, powerful arrays

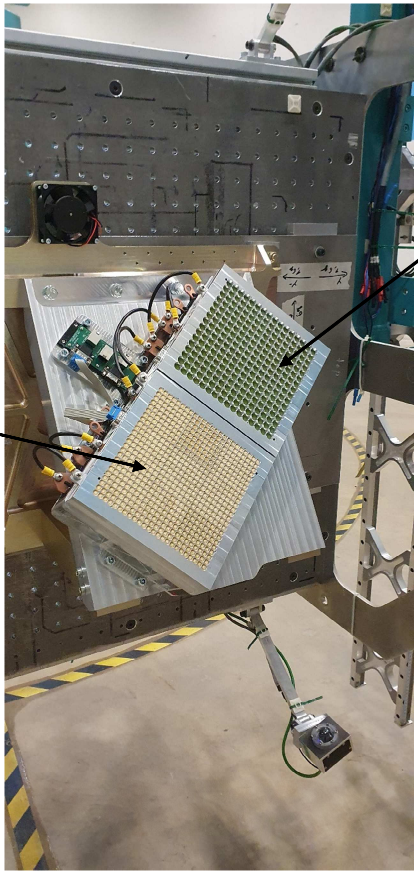
- Directivity scales with number of elements
- Output power also scales with number of elements

➢ **Each doubling of array size increases EIRP by 6 dB!**



*Funded by DLR Space administration, Bonn, Germany, FKZ 50RK1925

Fully assembled Rx/Tx-Array for test in flight



SANTANA flight test

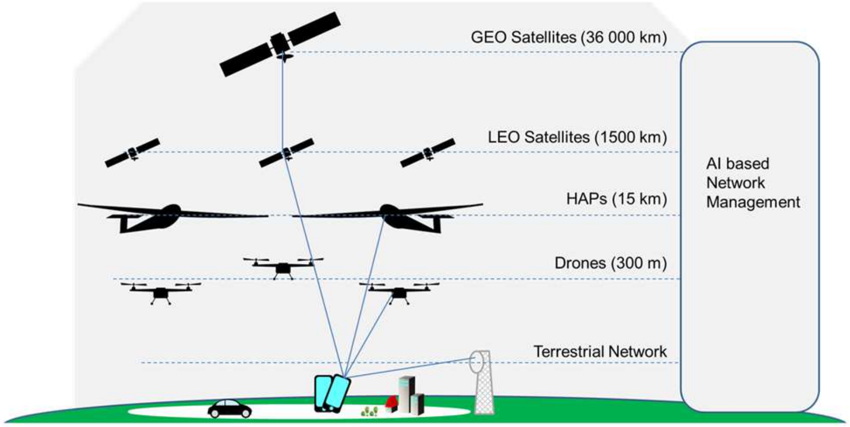
In-flight Testing of a satcom link to a geostationary satellite: successful!

IMST experts at DLR Airport Braunschweig, Germany

Contents

Summary

- **6G:** holistic network approach, real 3D network
- **Equal importance** of terrestrial and flying network nodes
- **Demanding requirements on antennas:**
  - High beam agility, continuos beam movement
  - Robust design
  - Size and weight adaptable to node capability



- **Antenna solution**
  - Eletcronical beamsteering is well suited in terms of functionality and lifetime
  - Modular approach allows easy adaptation

- **Good candidate: SANTANA IV antenna**
  - 8 x 8 antenna module using horn radiators and beamformer chips
  - Very good performance, standard production technologies
  - Antenna already successfully tested in flight

Danke für ihre Aufmerksamkeit!