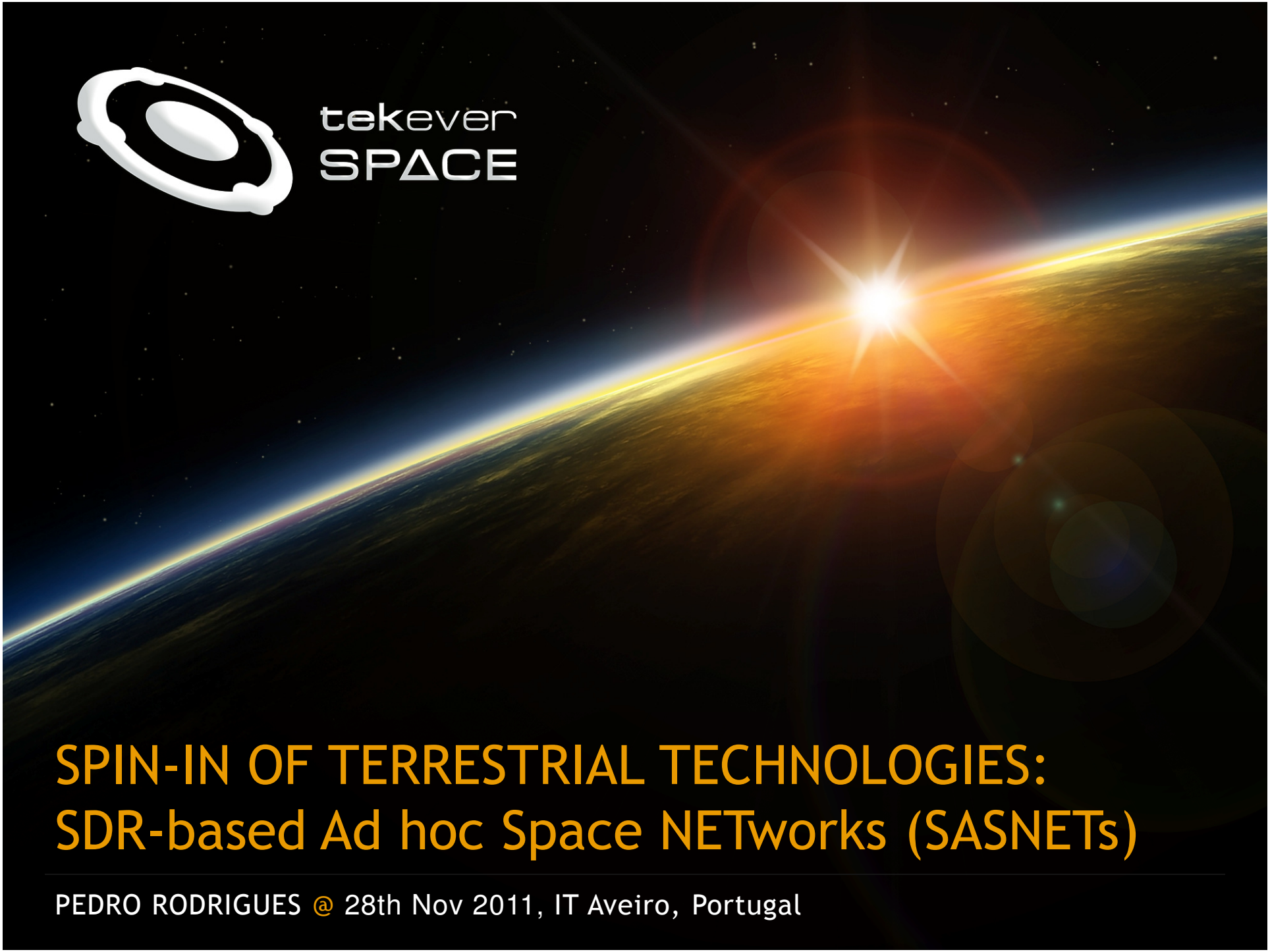


SPIN-IN OF TERRESTRIAL TECHNOLOGIES: SDR-based Ad hoc Space NETworks (SASNETs)

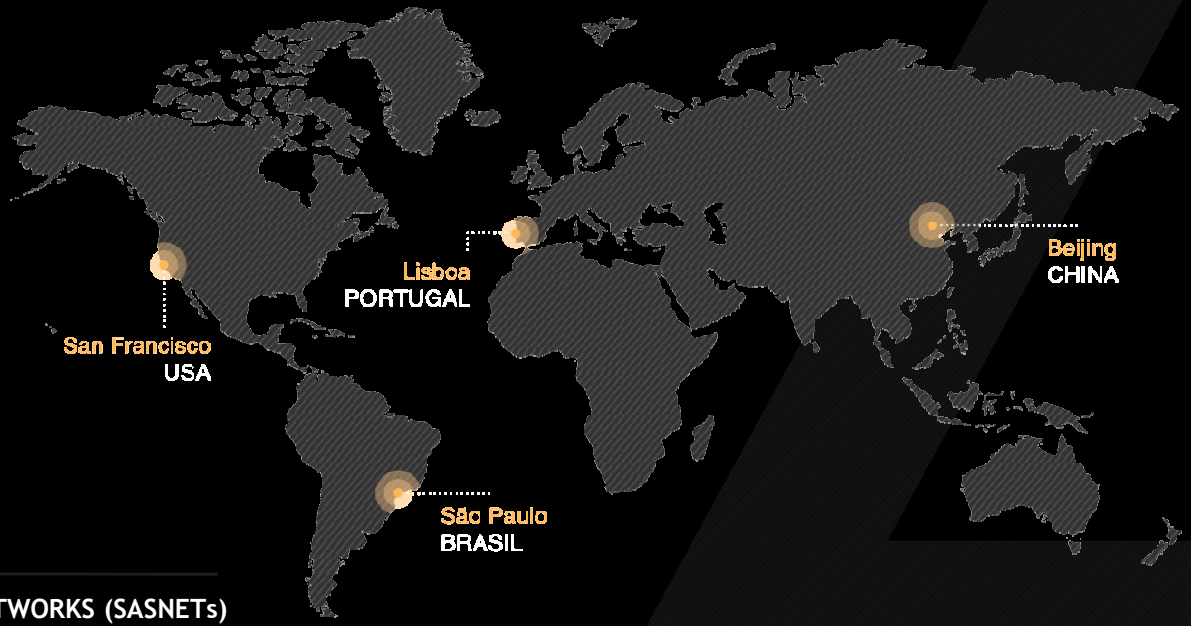
PEDRO RODRIGUES @ 28th Nov 2011, IT Aveiro, Portugal

TEKEVER GROUP

- Technology Group with core competencies in Software, Electronics and Communications.

- Founded in Portugal in 2001 and initiated international expansion in 2006.

- Offices in 4 continents, with growing international partner network and excellent references in several Fortune 500.



TEKEVER GROUP

tekever

tekever INFORMATION TECHNOLOGY

Develops and delivers ground breaking products that leverage mobile technologies, wireless communications, location awareness, distributed computing and artificial intelligence.

OZONO

Providing ground-breaking technology, products and services for the global Energy & Utilities market.

mobizy

Providing SMEs around the world with high quality, low cost mobile solutions for any kind of operational activity.

tekever AEROSPACE | DEFENSE | SECURITY

TEKEVER Aerospace, Defense and Security division develops and delivers advanced technology and products that improve the quality of communication, information and execution in organizations.

tekever AUTONOMOUS SYSTEMS

Developing multi-purpose, multi-mission air, ground and underwater autonomous systems for the Civilian and Military markets.

tekever COMMUNICATION SYSTEMS

Creating innovative tactical communications equipment for the Civilian and Military markets.

tekever SPACE

Developing innovative technology, systems and subsystems for the space sector.

TEKEVER SPACE

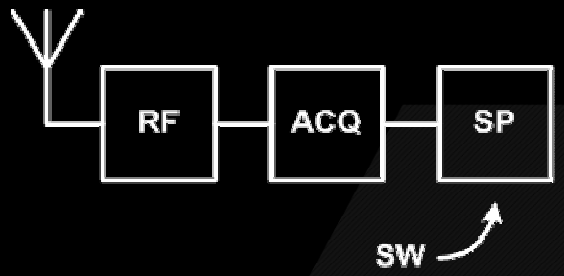
TEKEVER Space is bringing cutting-edge technology into orbit, to create innovative products that are engineered to provide excellent reliability with a high return on investment.

- Created in 2009 as a spin-off of the Space Systems Division of the TEKEVER Group.

- RTD Axes
  - **Space validation with affordable costs**
    Low-cost, short-timeframe platforms for validating small payloads (small satellite platforms, Atmospheric balloons).
  - **Space-based Software-Defined Radio**
    Satellite and inter-satellite communications, vehicle positioning and attitude determination capabilities (formation flying and planetary exploration missions).
  - **Space Inflatable Structures**
    Research and development of analytical models for inflatable structures, packaging and deployment techniques.

SOFTWARE-DEFINED RADIO (SDR)

- Digitization is performed at some stage downstream (upstream) from the antenna and the remaining processing required by the radio is performed by software.



- Advantages:
  - Modularity (changes without HW intervention)
  - Flexibility (several “radios” on the same platform)
- Disadvantages:
  - Vulnerability to SW threats (viruses, malware, etc.)
- Challenges:
  - Faster DSPs or FPGAs
  - Larger bandwidth ADCs
  - Resolution and linearity

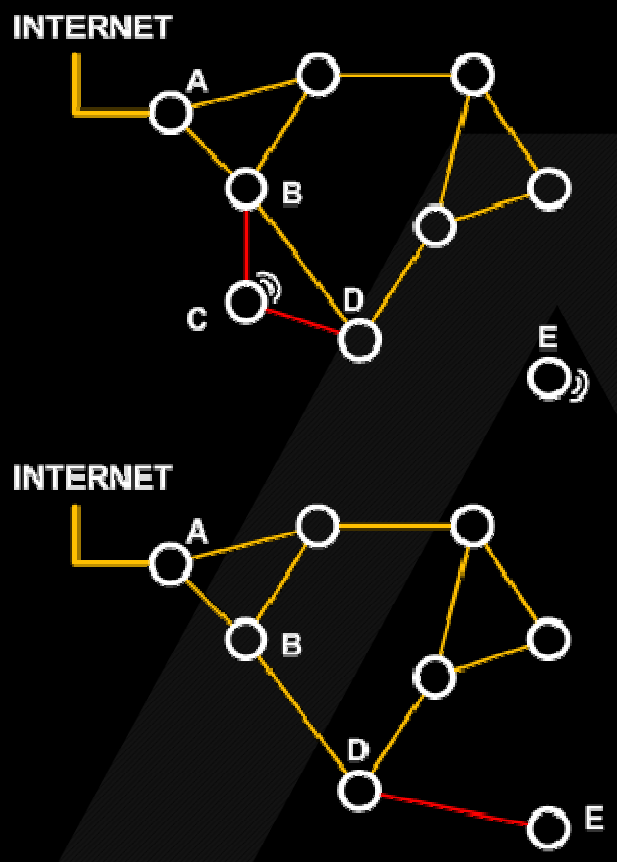
MOBILE AD HOC NETWORKS (MANETs)

- Dynamic network topology where all nodes connect to all nodes in range.
- Nodes are mobile and enter and leave the grid without affecting the network.
- Multihop enables communication between nodes out of range.

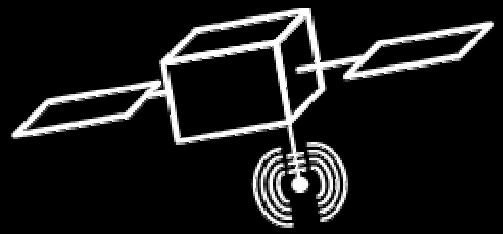
- Advantages:
  - Robust and flexible
  - Easy and quick to deploy
  - No need for infrastructure

- Disadvantages:
  - Complexity

- Challenges:
  - Optimize the routing algorithms
  - Minimization of traffic overhead
  - Network scalability



INNOVATE



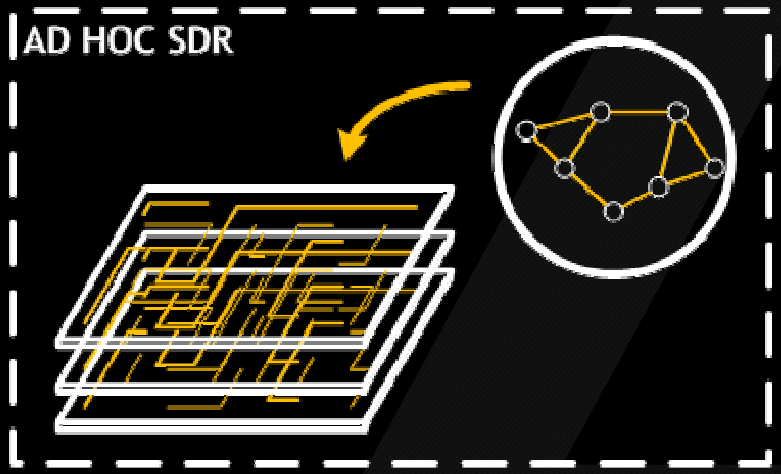
SPACE

SPIN-IN

GROUND

Expertise:
- ESA
- EDA
- EC FP

Applications:
- Military
- Civilian
- Safety

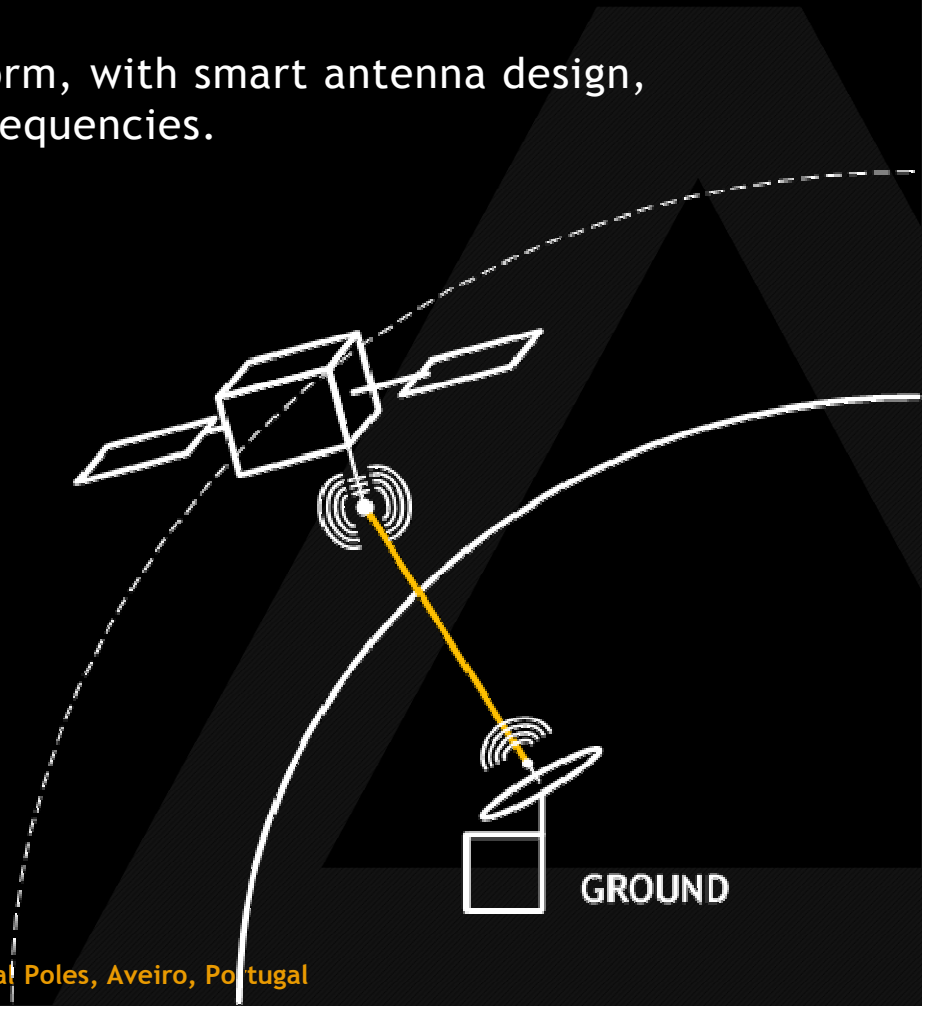


GROUND-SATELLITE COMMUNICATIONS

- Current approach: different radios on-board for different frequency communications.

- SASNET radio: One hardware platform, with smart antenna design, can (virtually) communicate in all frequencies.

- Features:
  - Mass and space savings.
  - Modifications from Ground.
  - Change operating frequencies.
  - Higher Ground coverage.

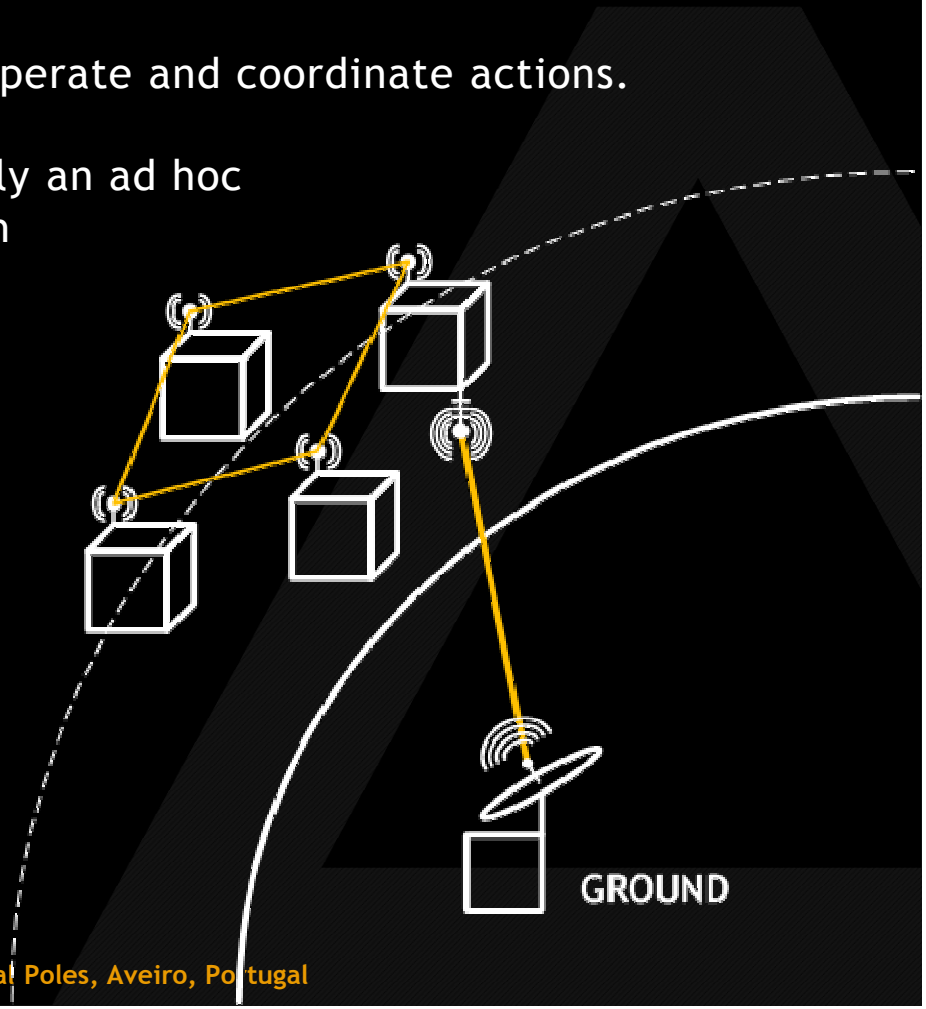


INTER-SATELLITE LINK (ISL)

- Required in emerging swarm and formation flying missions, with more than one satellite.

- Need to establish a network to cooperate and coordinate actions.

- SASNET radio: Creates automatically an ad hoc ISL between the cloud elements with Ground link capabilities.



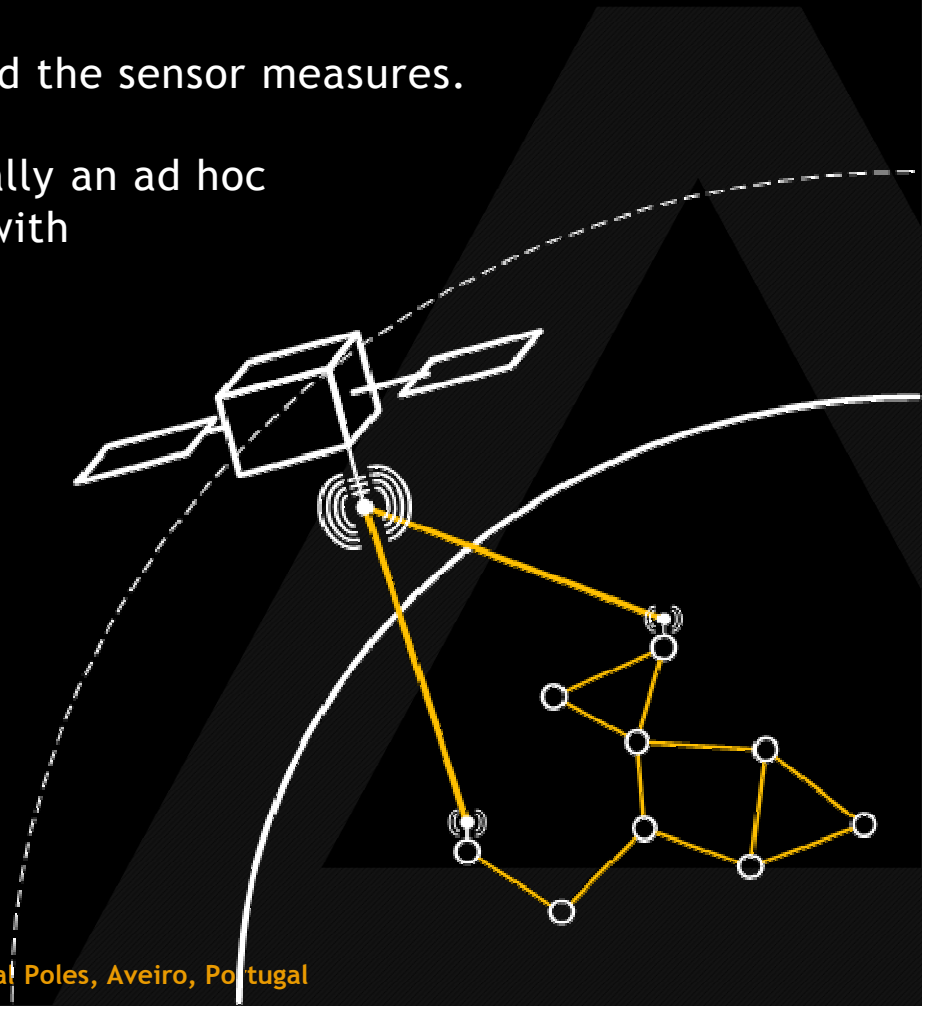
- Features:
  - Automatic configuration.
  - Robustness.
  - Higher spatial coverage.

WIRELESS SENSOR NETWORKS (WSNs)

- Essential for planetary exploration: monitoring the surface environment or measuring spatial gradients.

- Need to establish a network to send the sensor measures.

- SASNET sensor: Creates automatically an ad hoc network between the sensor nodes with homing satellite link capabilities.



- Features:
  - Automatic node discovery.
  - Immune to sensor failure.
  - Higher spatial coverage.

FURTHER APPLICATIONS

- **Intra-Satellite Links:**
  - On-board wireless devices connected together.
  - Eliminates physical data links.
  - Reduces harnessing.
  - Interesting for large satellites.
- **Position determination in LEO:**
  - SDR can receive GPS signals.
  - Decoding done by software.
  - Interesting for small satellites.
- **Attitude determination:**
  - Antenna arrays.
  - Phase difference between elements.
  - Interesting for small satellites

TECHNOLOGICAL CHALLENGES

- **Radiation-hardened components:**
  - Vulnerability of high-speed FPGAs to radiation.
  - Fault-tolerant implementation techniques.
  - EXPENSIVE!

- **Communication and network protocols:**
  - Terrestrial standards not yet validated in space.
  - WLAN applicability not yet fully assessed.
  - Influence of space environment on RF models.
  - Adaptations for effectiveness and efficiency.
  - Comply with international space agencies' standards.

VALIDATION CHALLENGES

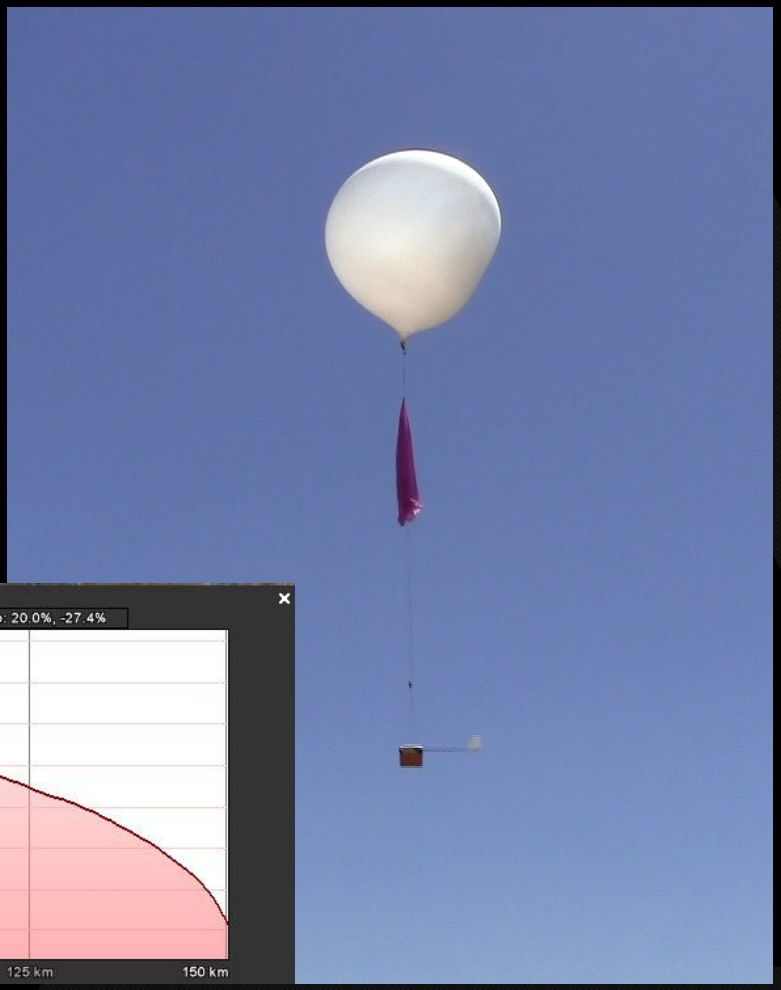
- **Technology validation platforms:**
  - Expensive simulation and test facilities on Ground.
  - Expensive and long special validation missions.
  - Solution: small satellite missions (micro-, nano-, pico-satellites).
  - Cheaper, shorter and standardized missions.

- **Launch vehicles:**
  - EXPENSIVE!
  - Piggyback launches: no chance of choosing orbit parameters or insertion date.
  - Inexpensive, dedicated and fast launch campaigns.
  - Disruptive technology is needed!

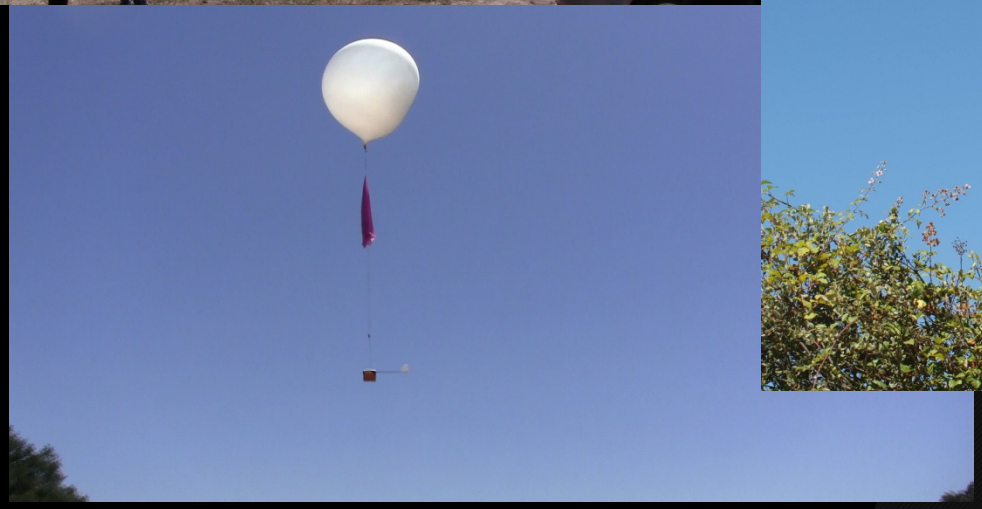
TRADE-OFF CHALLENGES

- **Redundancy:**
  - SDR maps multiple functionalities in the same equipment.
  - May create Single-points of failure.
- **Capabilities:**
  - Separate tasks VS duplicate tasks.
- **Costs:**
  - Several devices with different functionalities may be more expensive to build than one standardized device.

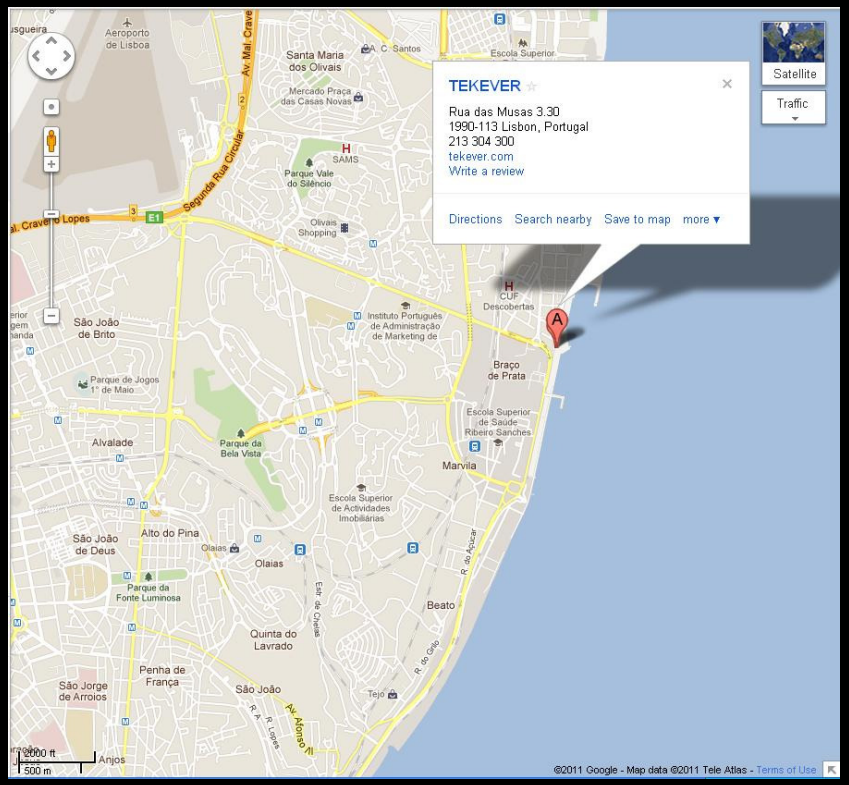
ATMOSPHERIC BALLOONS



ATMOSPHERIC BALLOONS



CONTACTS



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