Possible uses of nanosatellites for various mission applications

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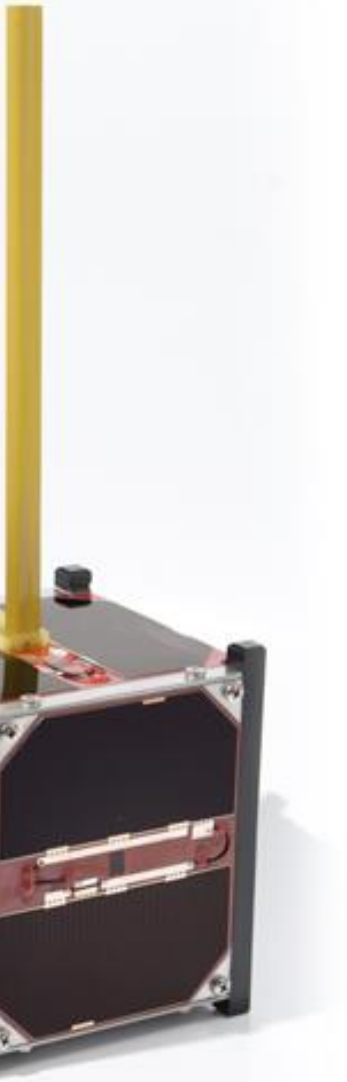
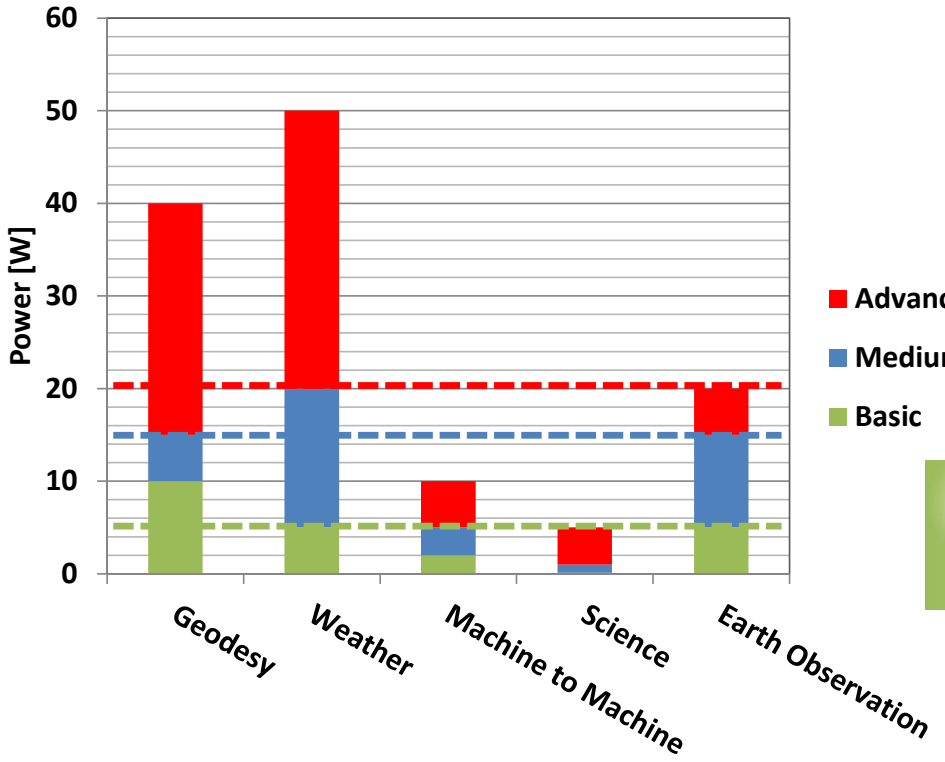
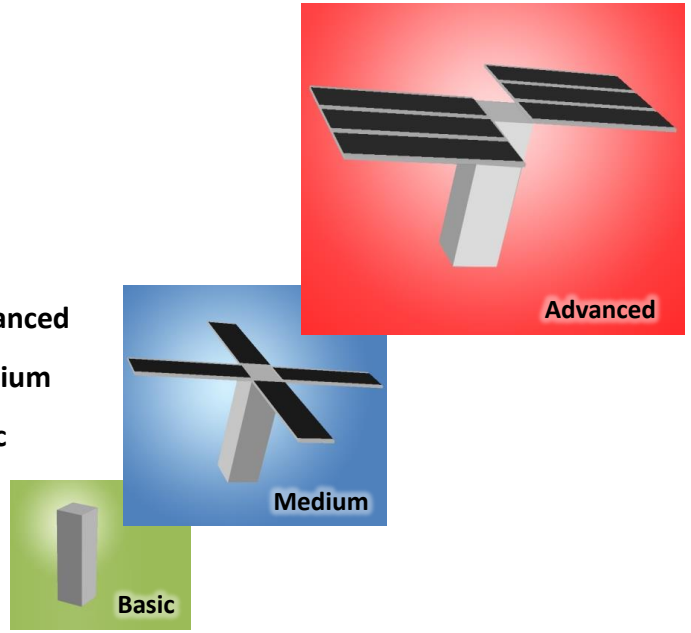
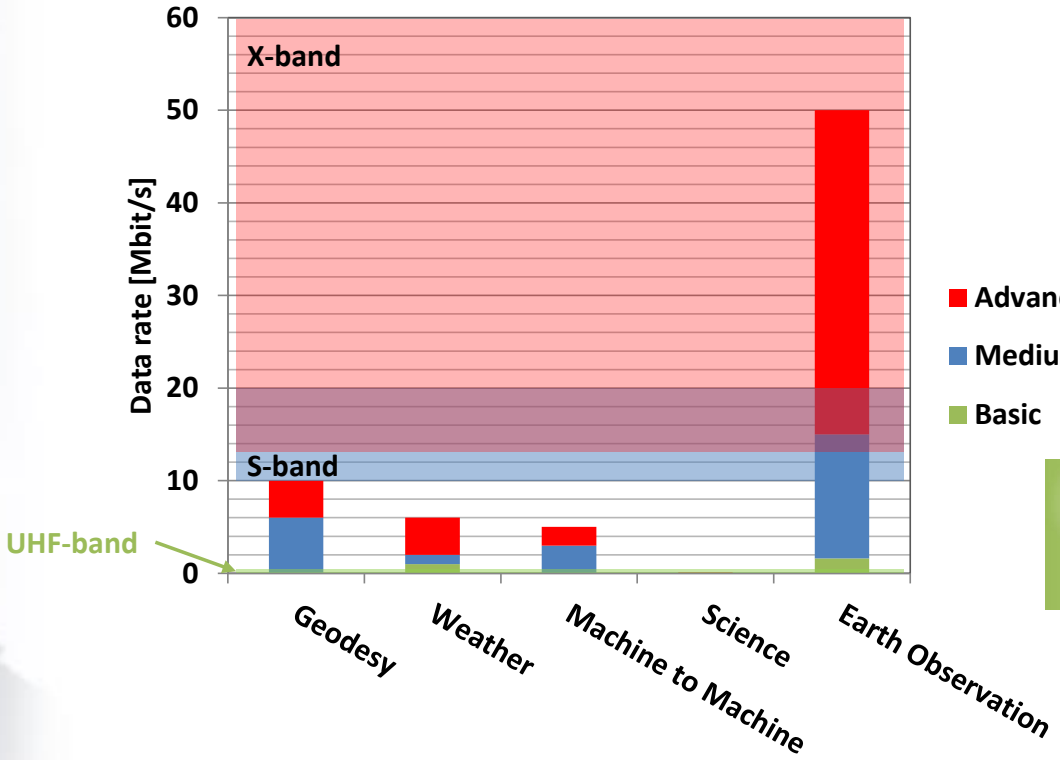
CubeSat Capabilities – Power

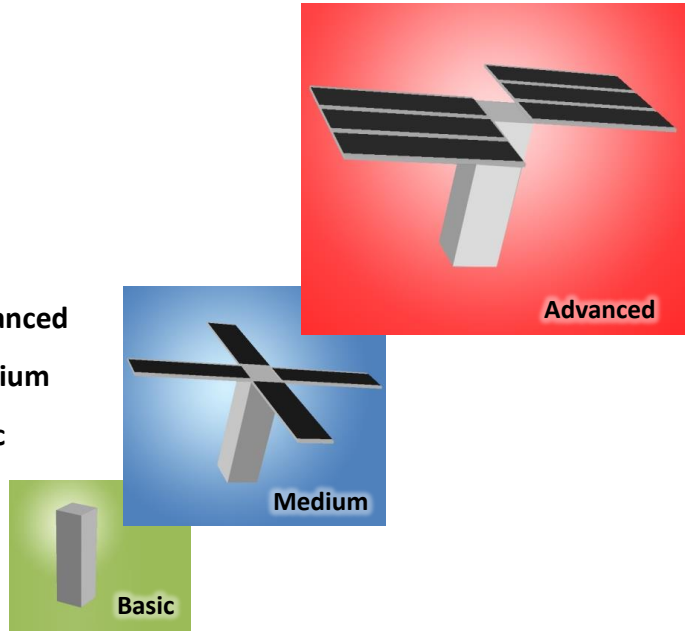




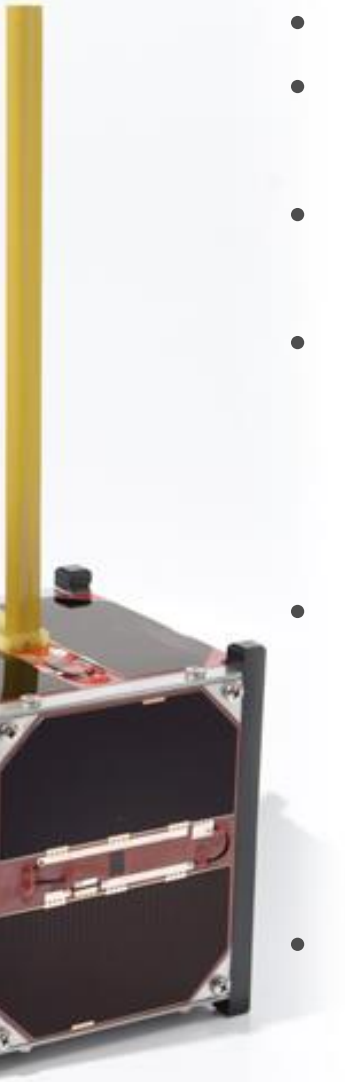


CubeSat Capabilities – Data rate

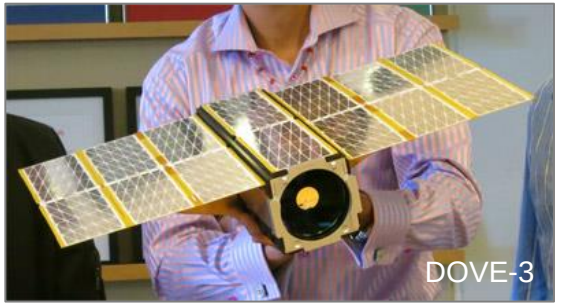


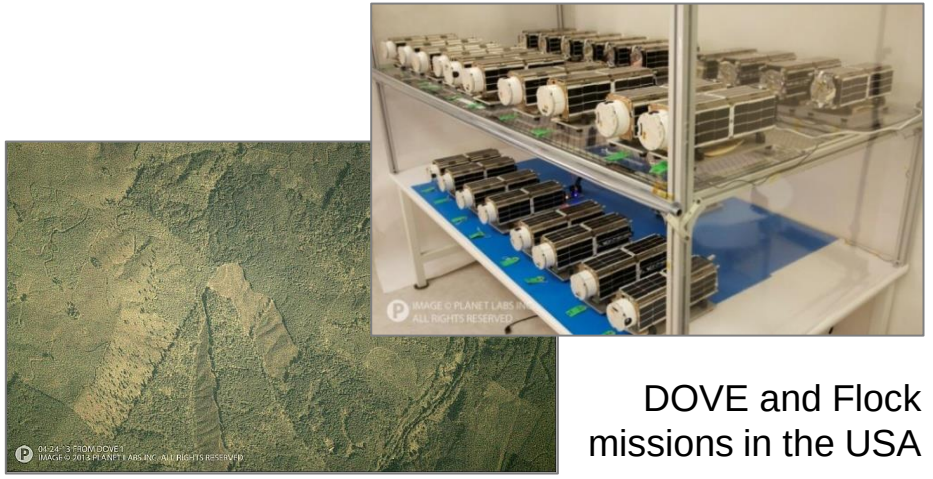


Remote Sensing Applications



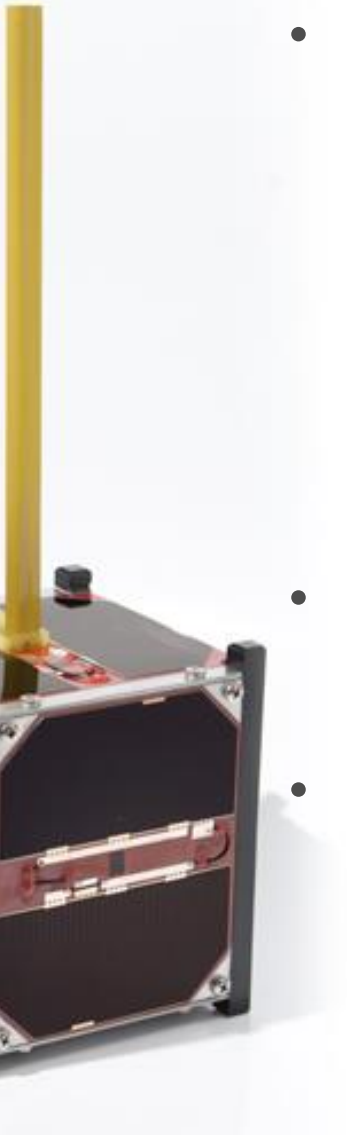
- Gaining information without direct physical contact
- Every segment is fully covered by professional service providers
- Imaging requires sophisticated optical instrument / system
- **Importance of remote sensing**
  - Homogenous data-collection about extensive areas
  - Good spatial and time resolution, fast access to new data
  - Relatively small investment, processes can be fully automated
- **CubeSat based remote sensing versus large satellites**
  - Development time: CS advantage
  - Launch costs: CS advantage
  - Response & revisit time: CS advantage
  - Optical performance: CS is constrained
- **CubeSat capabilities**
  - P < 20W
  - m < a few kg
  - V < a few dm^3





DOVE and Flock missions in the USA

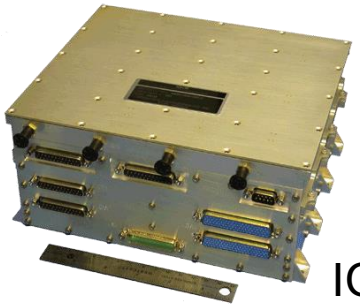
Weather Applications



- **Some professional payloads could be adopted to CubeSats**

Instrument / Application area	Mass [kg]	Power [W]	Data rate [bps]
Limb-scanning sounder	8	15	3 M
Special scanning or non-scanning MW radiometer	15	20	?
MW sounding radiometer with cross-track scanning	14	26	320
Solar irradiance monitors	6-15	10-15	600-16 k
GNSS radio-occultation sounders	3-6	10-50	0.5-40 k

- **Dedicated CubeSat missions for weather observation (3U & 6U)**
  - ^{3}Cat-2, CHARM, MicroMAS, PolarCube, SIMBA
  - Typical payloads: scatterometer, MW radiometer (183 GHz), cavity radiometer
- **There are payloads developed especially for use on-board a CubeSat**
  - Light Detection And Ranging, Radar Altimeter
  - Typical requirements: 1-6kg, 1-40W, 100k – 6Mbps



IGOR

TIM

Geodesy Applications

Typical application areas which might benefit from CubeSat technologies:

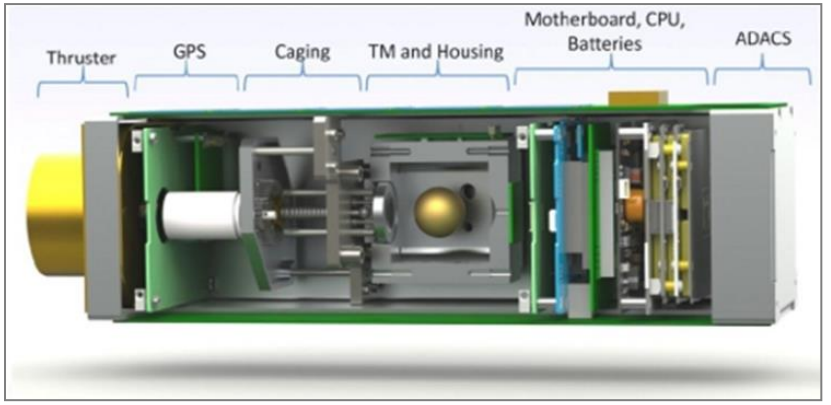
- Geoid measurement
- Tectonic plate motion
- Earth rotation measurements
- Oceanography
- Tides

DORIS Generations

LRR: Laser Retro-Reflector (CHAMP)

Geodesy CubeSats

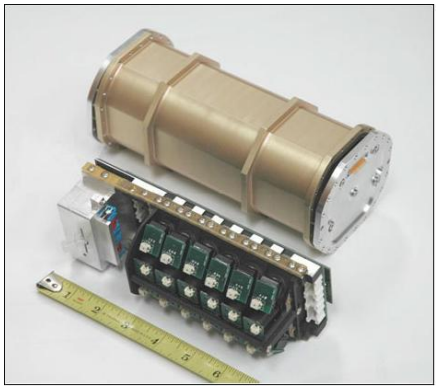
- DORIS (~1 kg, ~1U, ~10 W)
- GPS (0.1 kg, 96 x 90 x 11 mm, 1.3 W)
- Altimeter (3.1 kg, 95 x 95 x 320 mm, 10 W)
- Satellite-Satellite Tracking (1-1.5U)
- Drag-free (2U, 6.5-9.3 W)

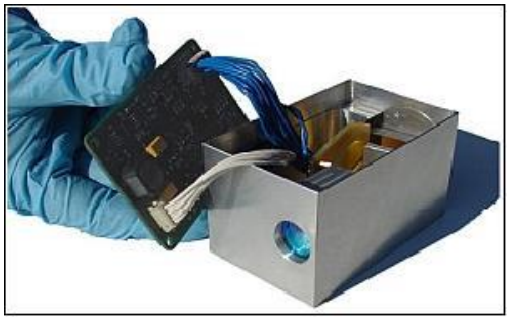


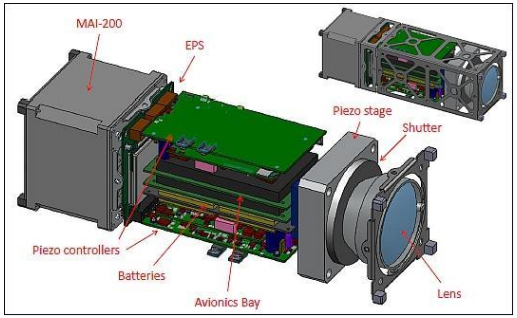
Drag-free CubeSat (Stanford University)

Science and Technology Satellites

- Lower resolution, lower sensitivity (size, mass, power constraints)
- Higher spatial and time resolution and coverage (small sat constellations)
- **Astronomy**
  - Astronomical observations on different wavelength
  - Long term observations, detecting and tracking changes
- **Examination of the Earth's vicinity**
  - Space weather: magnetic field, gravity field, ionosphere, plasmas, radiation, micro-meteorites, chemical investigation of the upper atmosphere
- **Materials technology research**
  - Material sciences, semiconductors, electronics, single event effects
  - How the space environment effects the lifetime and reliability of different devices, components
- **Biological research**
  - Biological samples in space environment
  - Observing biological processes in microgravity







Telecommunication Applications

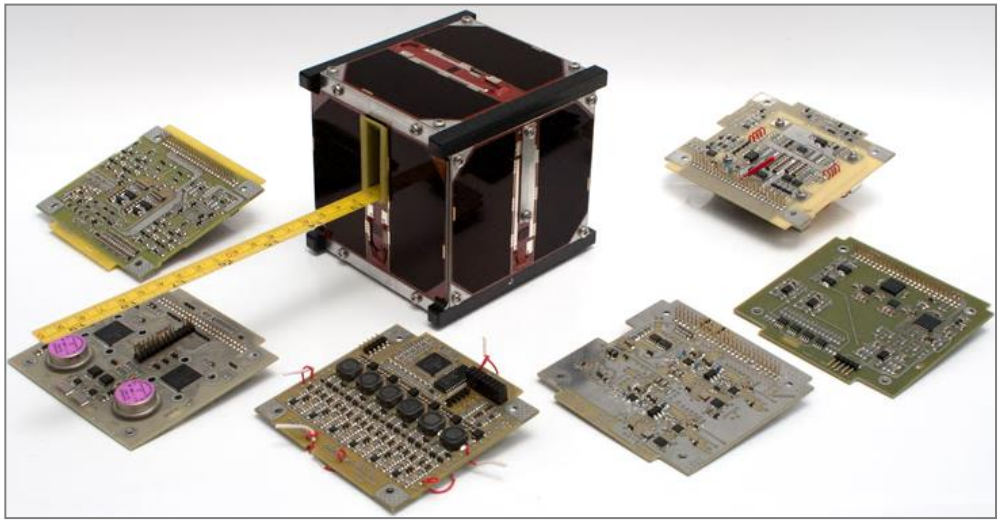
- **Typical application areas which might benefit from CubeSat technologies:**
  - Telemetry & Telecommand
  - TAG tracking (bird, animal, buoy, …)
  - AIS (ship tracking)

ISIS Triton 1 satellite with an on-board AIS receiver

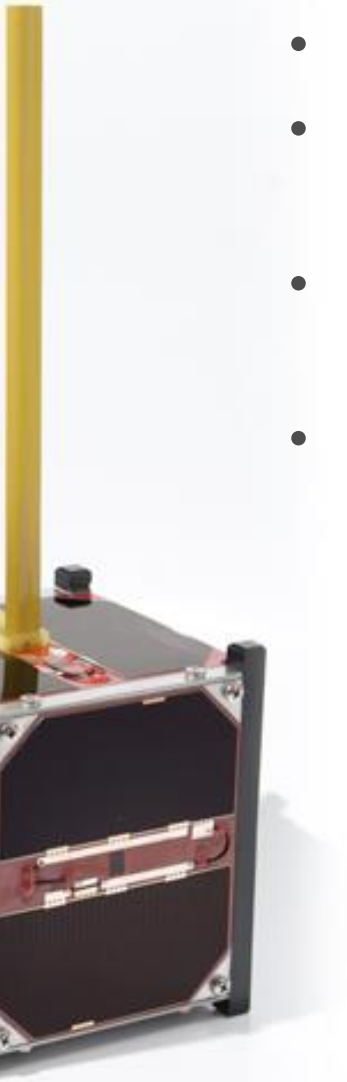
Masat-1 Introductoin

1U CubeSat

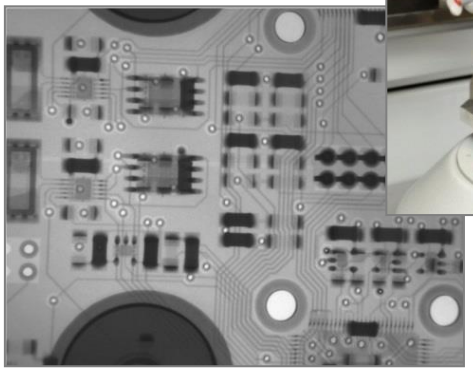
- 1st satellite of Hungary
- Built at the Budapest University of Technology and Economics
- Student initiative, 10 intensively involved, altogether 20 persons
- More than 60.000 work hours
- Fully custom built, redundant main subsystems
- 2.500 electrical and mechanical components
- Up to 250 photos from space
- Up to 5.000.000 received tm packets
- Up to 220 radio amateur tracking Masat-1

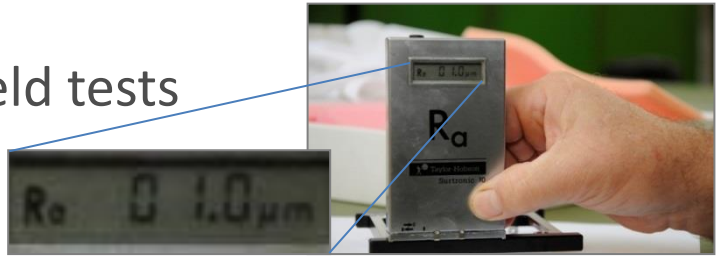


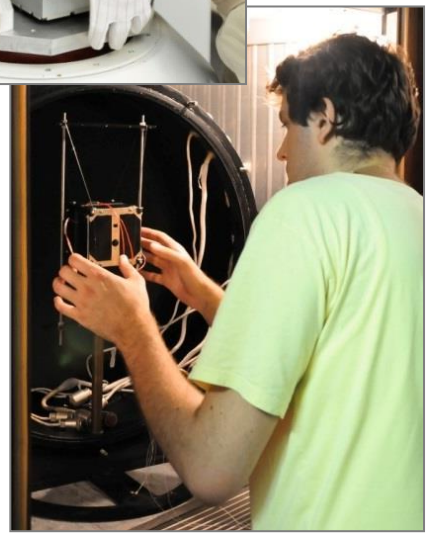
Qualification tests passed



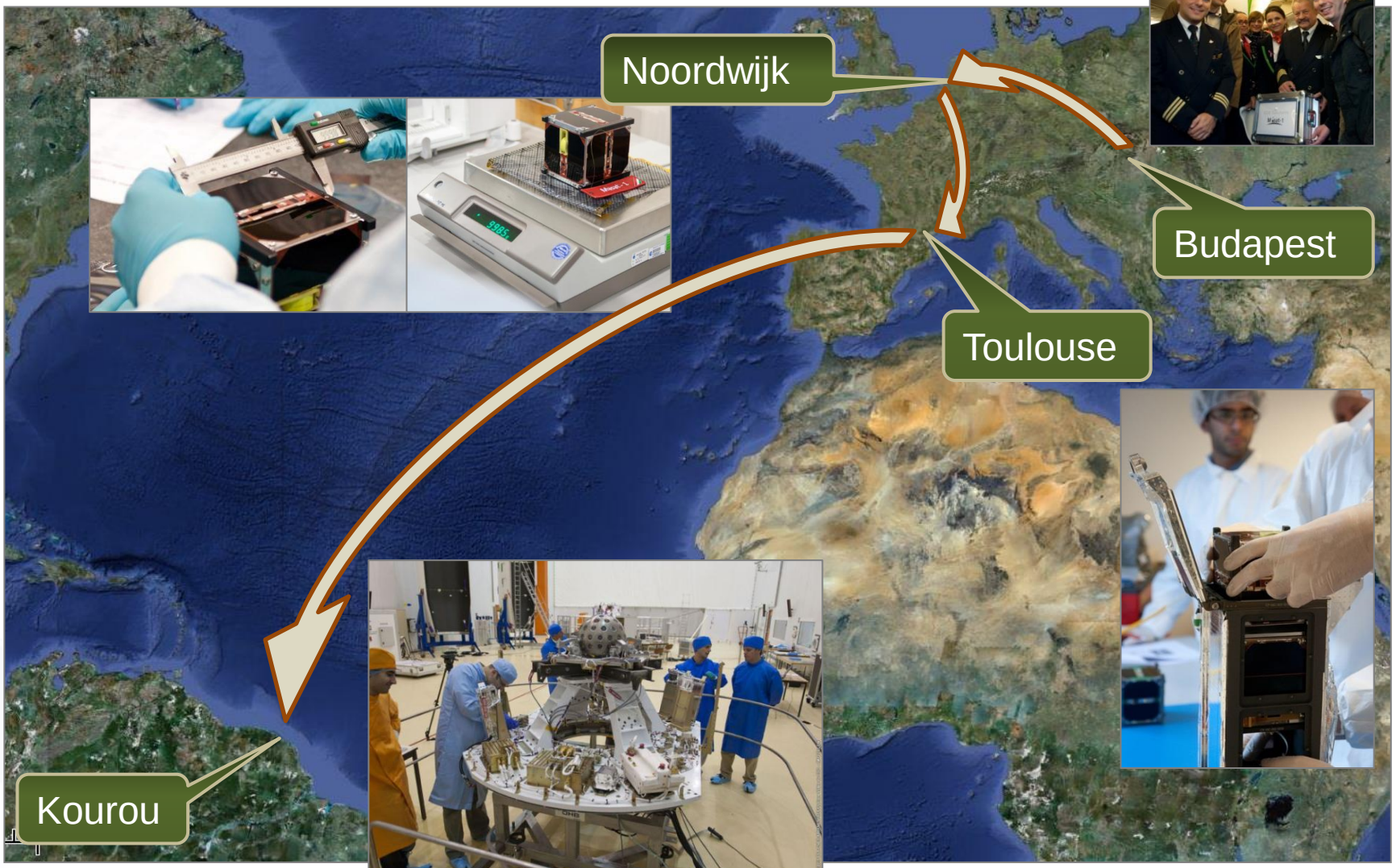
- Calculated, simulated, and measured every critical function
- First satellite: safety factors, on-board tune and check capabilities to compare tests with flight results
- Testing is very important
  (1:1 development/test time)
- Flight Model tests:
  - Functional (assembly)
  - Thermo-vacuum
  - Vibration
  - X-ray
  - Sensor calibration
  - Communication field tests







Road of Masat-1 to launch pad



Cooperation with ESA

THEN:

- Launch campaign
- Documentation
- Acceptance tests
- P-POD integration
- Integration to Vega adapter
- Launch
- Lessons Learned meeting and Operation reports

NOW:

- Development of CubeSat technologies
- Robust Fault Tolerant On-Board Computer with Redundancy
- Telemetry-Telecommand Transceiver with CCSDS compatibility
- 3U CubeSat Structure for high density electrical components

Main administrative milestones

Before start

- NMHH, ITU, IARU
- Export license

After start

- OSCAR-72
- 2012-006E-> Masat-1
- UN registration
- HSO – Satellite register

United Nations ST/SG/SER.E/648

Secretariat

Distr.: General
20 April 2012

Original: English

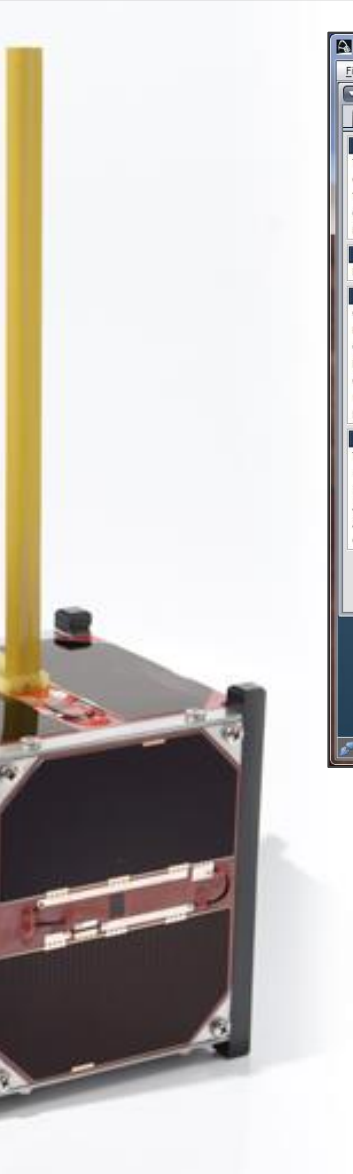
Committee on the Peaceful Uses of Outer Space

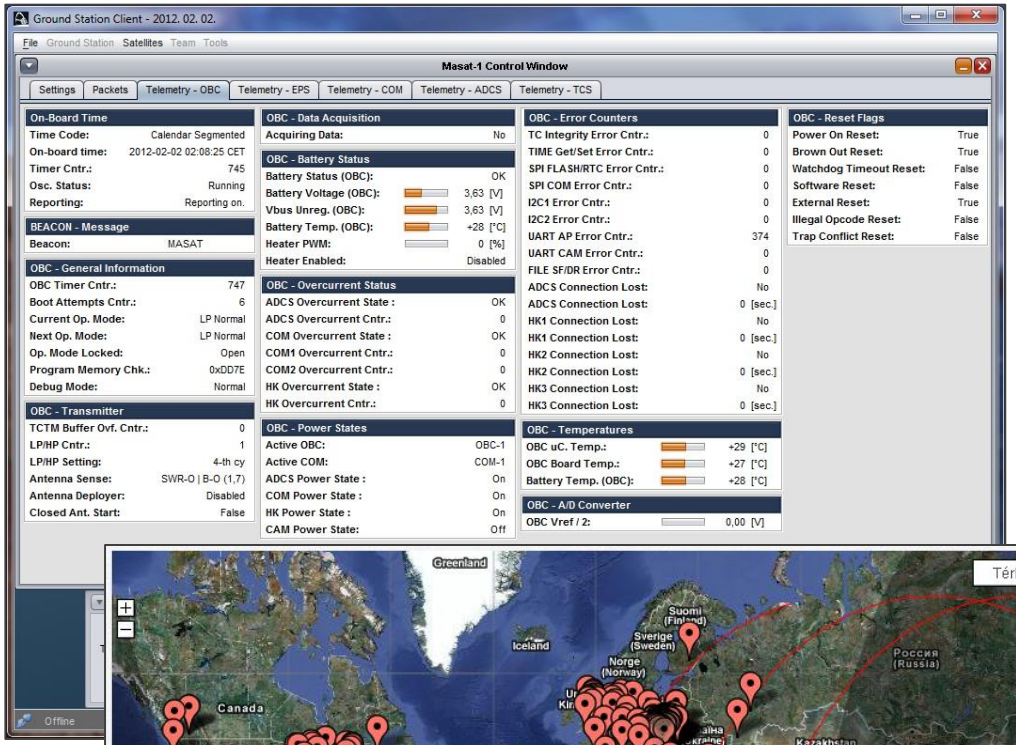
Information furnished in conformity with the Convention on Registration of Objects Launched into Outer Space

Note verbale dated 12 April 2012 from the Permanent Mission of Hungary to the United Nations (Vienna) addressed to the Secretary-General

The Permanent Mission of Hungary to the United Nations (Vienna) presents its compliments to the Secretary-General of the United Nations and, in accordance with article IV of the Convention on Registration of Objects Launched into Outer Space (General Assembly resolution 3235 (XXIX), annex), has the honour to transmit information concerning Hungarian space object Masat-1 (international designator 2012-006E) (see annex).

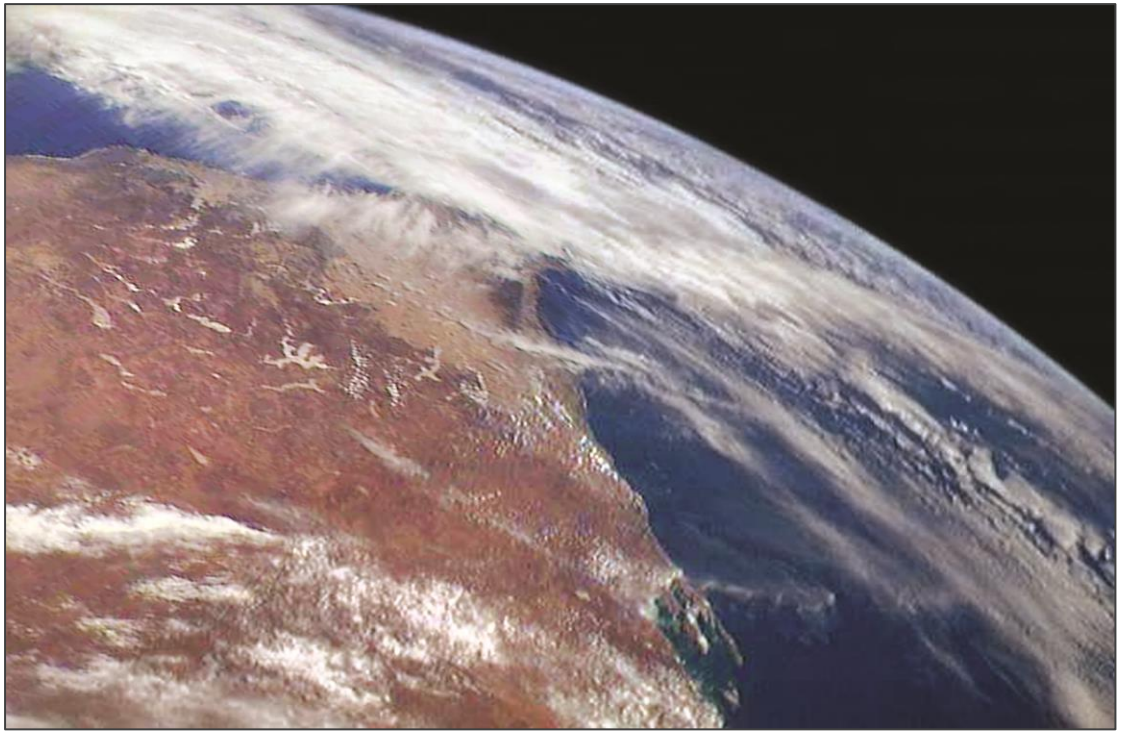
International cooperation with HAMs

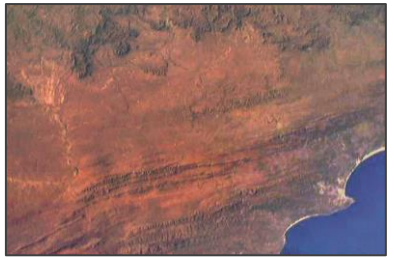




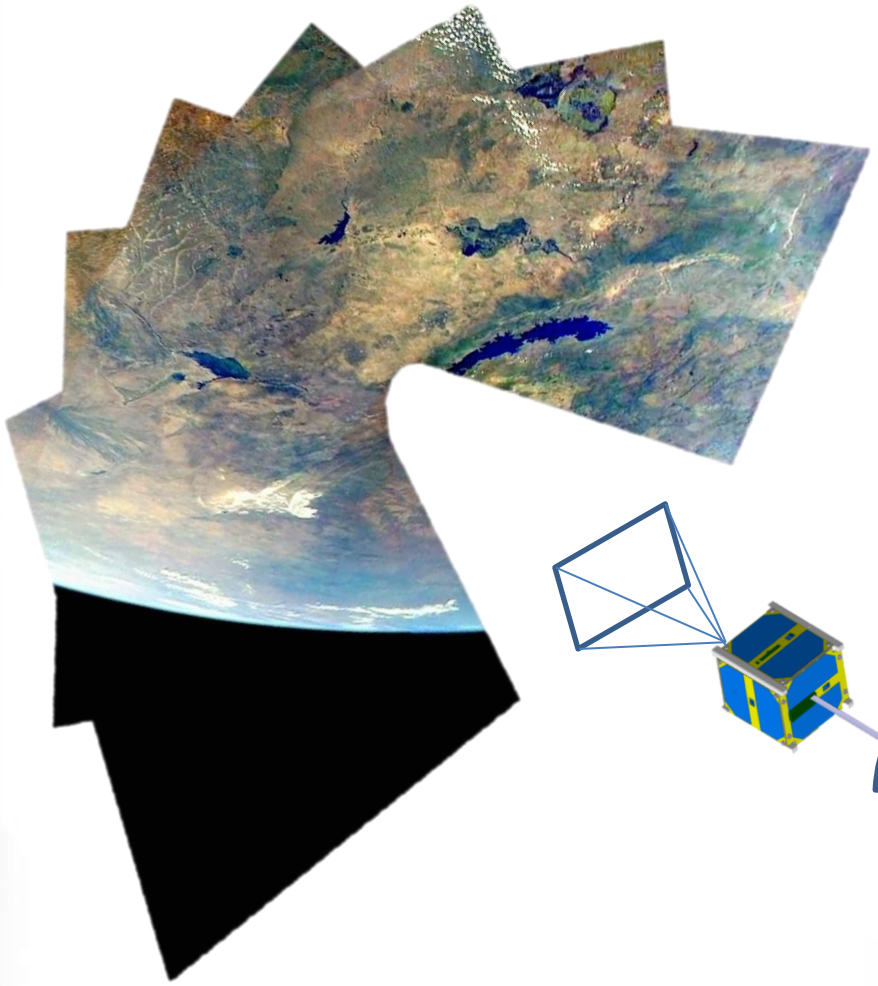
Google play

Photos taken by Masat-1





Mosaic and 3D picture



Conclusion and strategic plan

- **Education**
  - Give student hands on experience in the field of space electronics
  - Provide new and amazing space related opportunity for students
  - Continuously updated educational portfolio
  - To train high qualified engineers for the space industry
- **Space industry**
  - Upgrade the results to market-capable devices, services
  - To include and strengthen the SME sector
  - Provide long term engineering support for the industry
  - Participation in international projects
- **Space research**
  - Provide a satellite bus for future scientific missions
  - Provide opportunity for Hungarian research centers