State of the art and future development of (very) small satellites

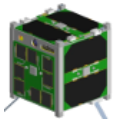
Field Report of TU Berlin, M. Buscher

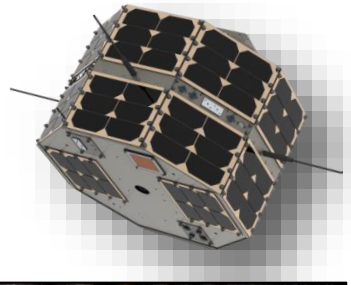
ITU Regional Seminar for CIS and Europe "Development of modern radiocommunication ecosystems", 6 to 8 June 2018, St. Petersburg, Russian Federation | M. Buscher

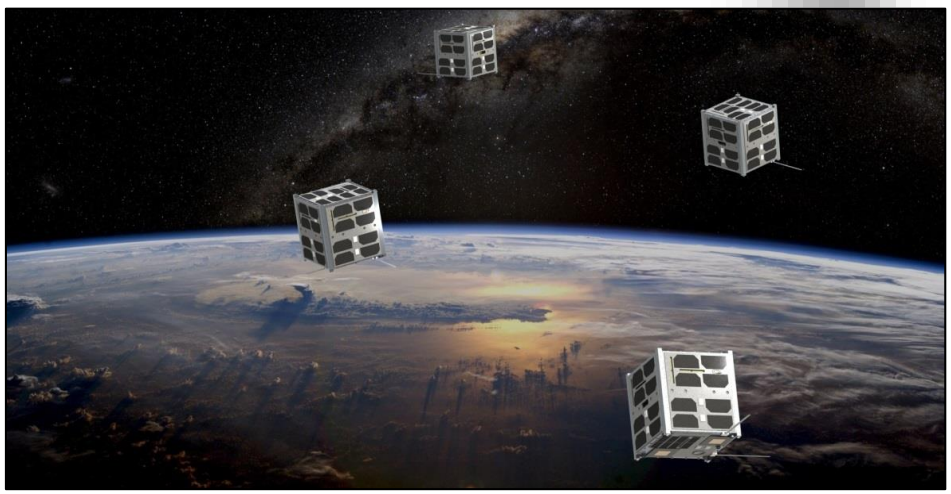
Background of TU Berlin

Design, practical realization and operation of small satellite missions

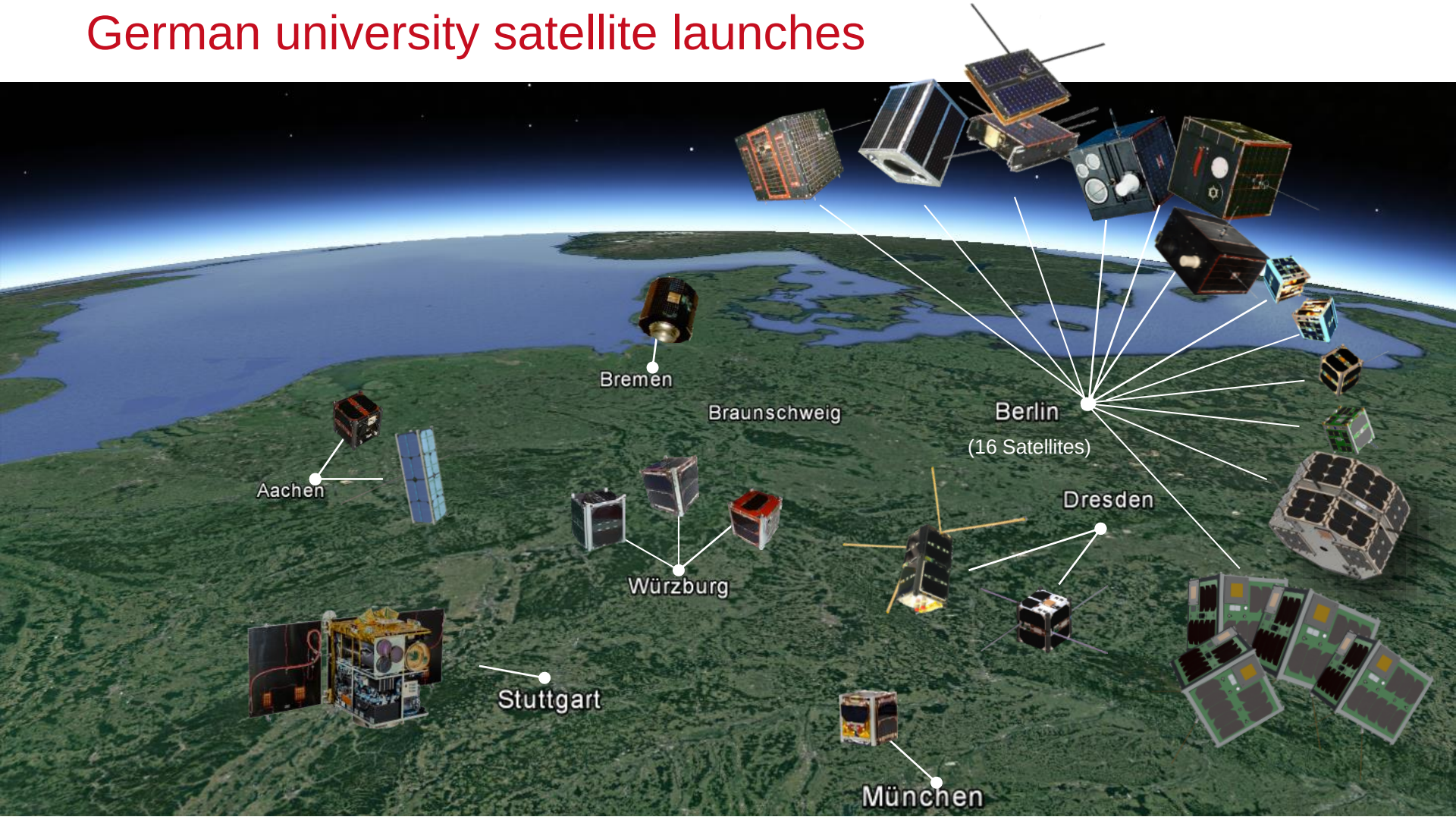
- **Picosatellites**
  - BEESAT-1 2009
  - BEESAT-2 2013
  - BEESAT-3 2013
  - BEESAT-4 2016
  - BEESAT-5…-8 2018
- **Nanosatellites**
  - Technosat 2016
  - S-Net 2018
  - TUBIN 2019
  - SALSAT 2020
  - QUEEN 202x







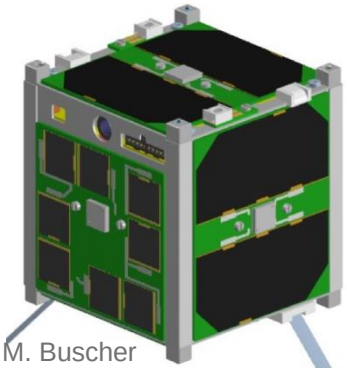
German university satellite launches



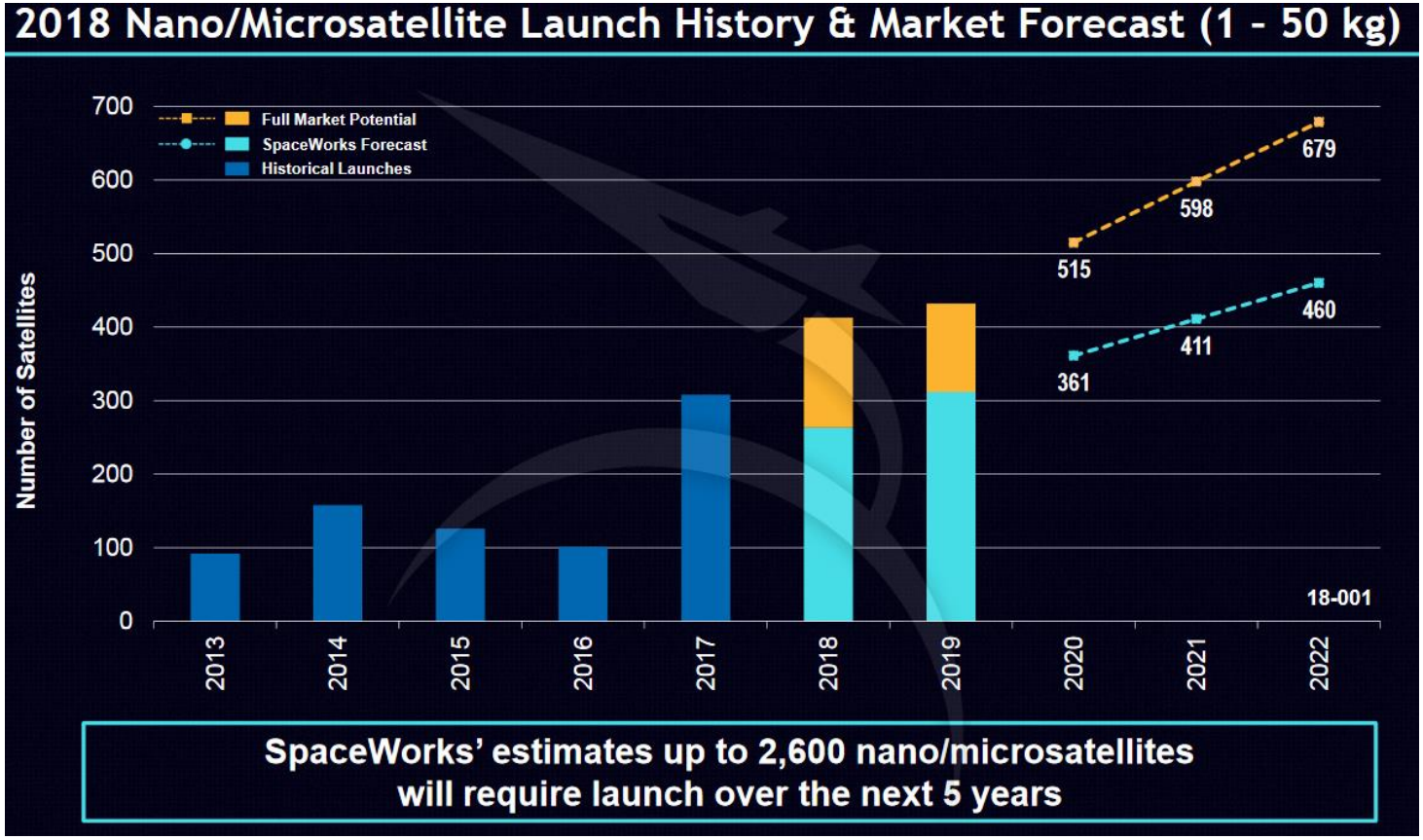
Why small satellites?

- Inexpensive development & launch compared to traditional satellites
- Great potential in education and training of students and young researchers
- Comparatively easy access to space
  - For universities
  - For newcomers in the field of space mission design & operations
  - For new fields of commercial applications

Mass	< 50 kg
Edge length	< 50 cm
Development time	< 5 years
Mission lifetime	< 3 years

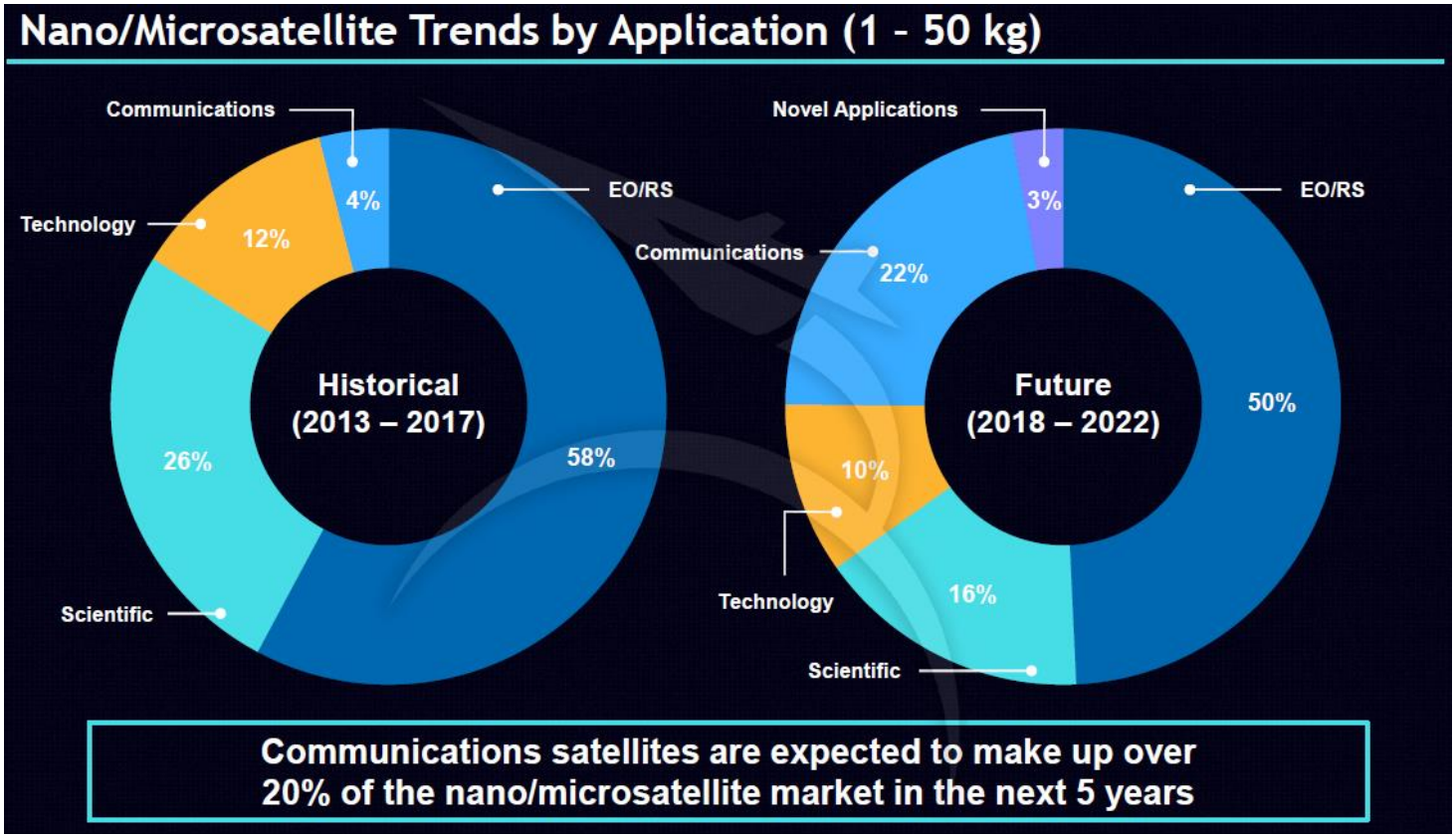


SpaceWorks Market Study



Source: http://www.spaceworkscommercial.com

SpaceWorks Market Study

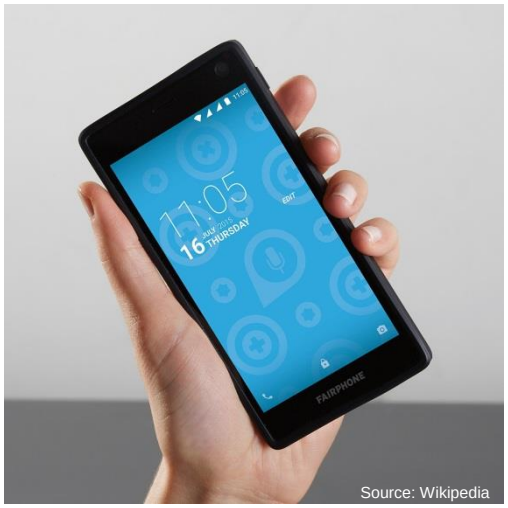


Source: http://www.spaceworkscommercial.com

Future trends


Source: Time.com

Source: Kickstarter



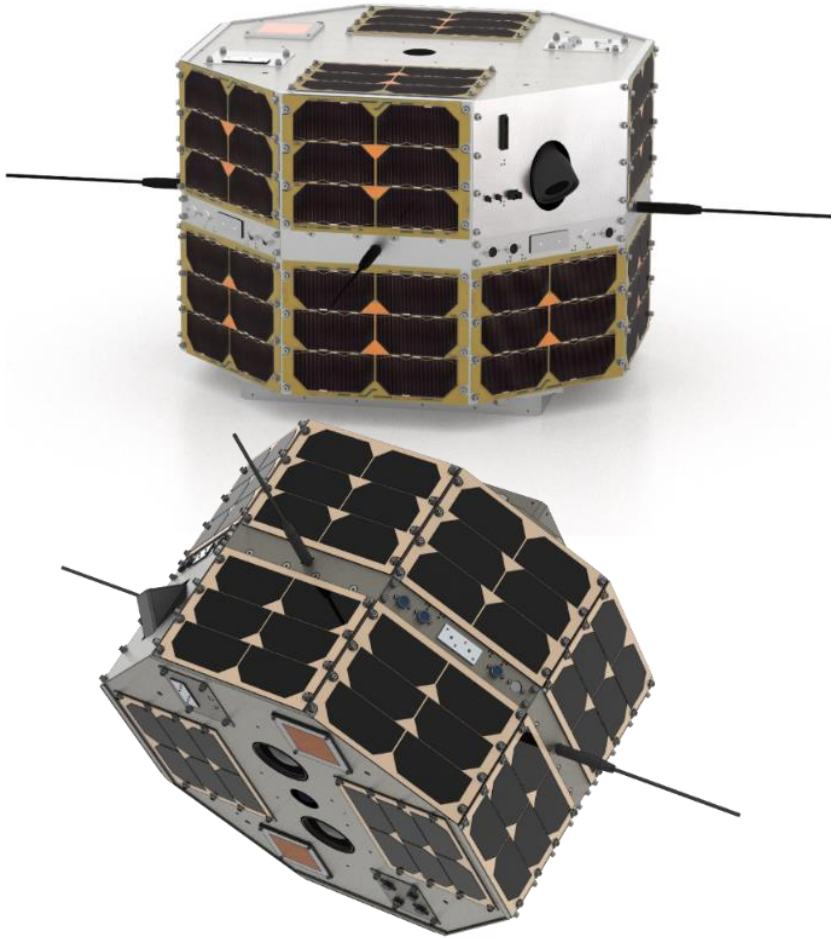
Source: Wikipedia

- Miniaturization led to smaller systems
- As with cell phones, satellites now tend to become a little bigger to allow real applications

Application examples: Educational & Scientific missions

TechnoSat/ TUBIN
Technische Universität Berlin

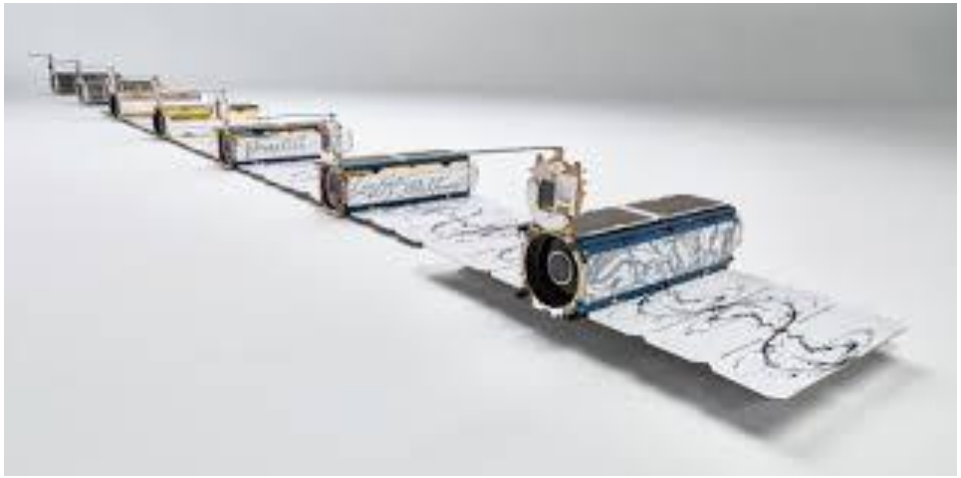
- 20 kg satellite
- 465 x 465 x 305 mm³
- **TechnoSat** (2016):
  - Technology demonstration
- **TUBIN** (2019):
  - IR payload for wildfire detection



Application examples: Earth Observation

Flock Constellation
Planet

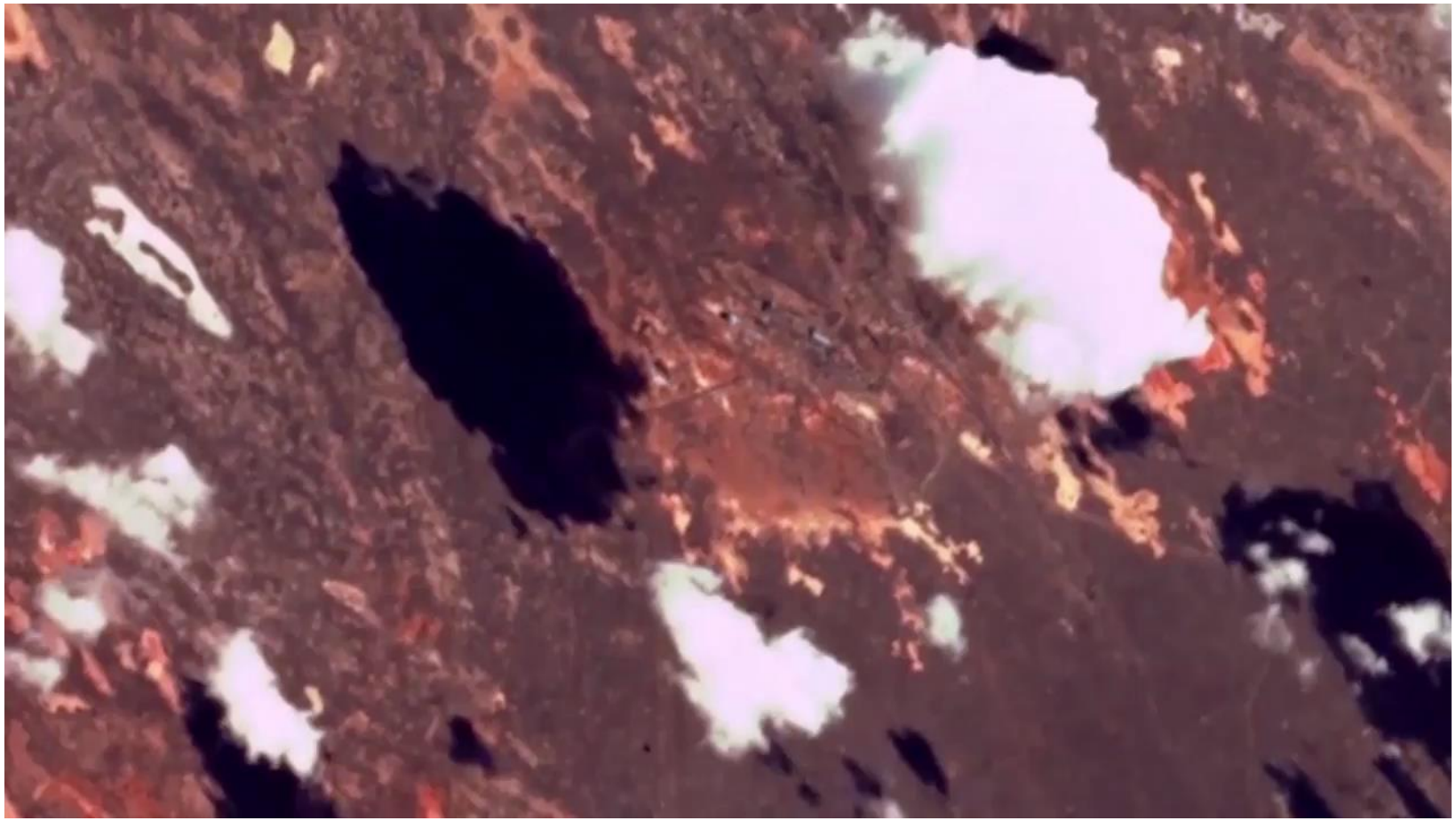
- 3 Unit CubeSats
- Mega-Constellation of „Dove“ Satellites
- 3-5 m ground resolution



“Dove satellites” Photo: Planet

“Dove satellites” Photo: Planet

Application examples: Earth Observation



Dove satellite captures Soyuz launch. Source: Planet/YouTube

Application examples: Technology Demonstration

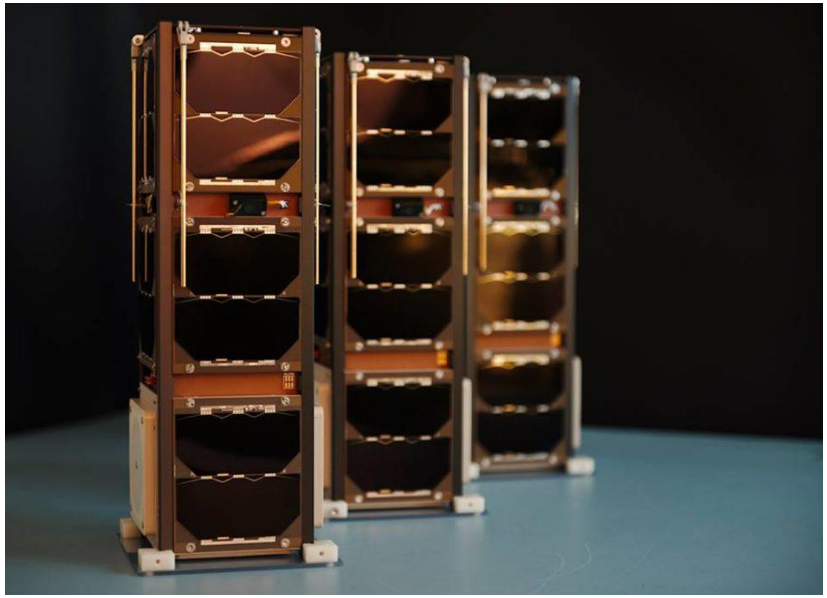
Groove
German Orbital Systems

- 3 Unit CubeSat
- Offers 10 slots for on-orbit technology demonstration
- First launch in 2019

Application examples: Communications

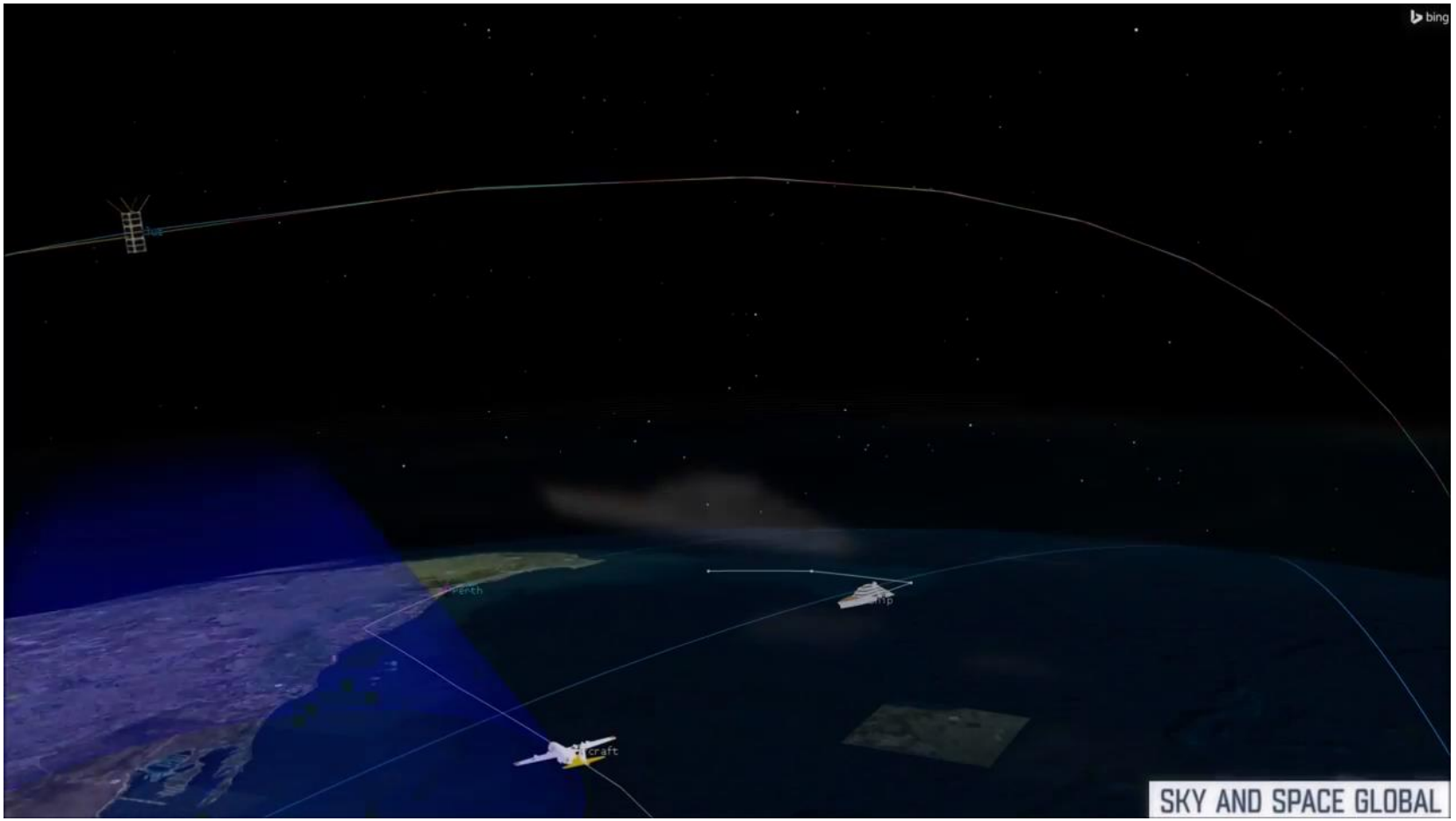
Three Diamond
Sky and Space Global

- 200 nanosatellites
- UHF, L & S band
- Intersatellite link
- 3 demonstrators launched in 2017



“Three Diamond” Photo: Sky and Space Global

Application examples: Communications

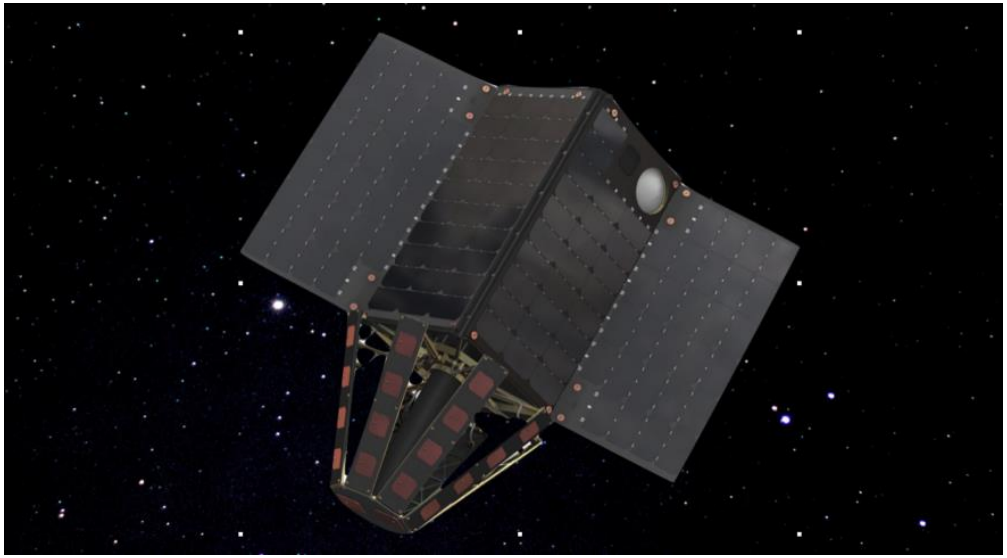


3 Diamonds Concept. Source: Sky and Space Global/ YouTube

Application examples: Communications

Helios Wire

- Microsatellites constellation
- 16 Unit CubeSat
- S band
- M2M, IoT
- First launch in 2018



“Artist Concept of HeliosWire Satellite” Photo: Helios Wire

And many more!

Astro Digital

Astrocast

Helios Wire

Kepler Communications

Satellogic

Spire

…

Regulatory Challenges

How can we deal with the vast number of new satellites?

ITU-R WRC-15 Agenda Item 1.2:
Establishment of in-band power limits for earth stations operating in mobile-satellite the meteorological service, the meteorological-satellite service and the Earth exploration-satellite service in the frequency bands 401-403 MHz and 399.9-400.05 MHz

ITU-R WRC-15 Agenda Item 1.7:
Studies to accommodate requirements in the space operation service for non-geostationary satellites with short duration mission

…and more studies & conflicts will come in the near future.

Conclusions

- Small satellites are not experimental prototypes anymore
- Great market potential and business opportunities
- Hundreds of new satellites expected in the near future
- Regulatory treatment has to be carefully observed and potentially modified