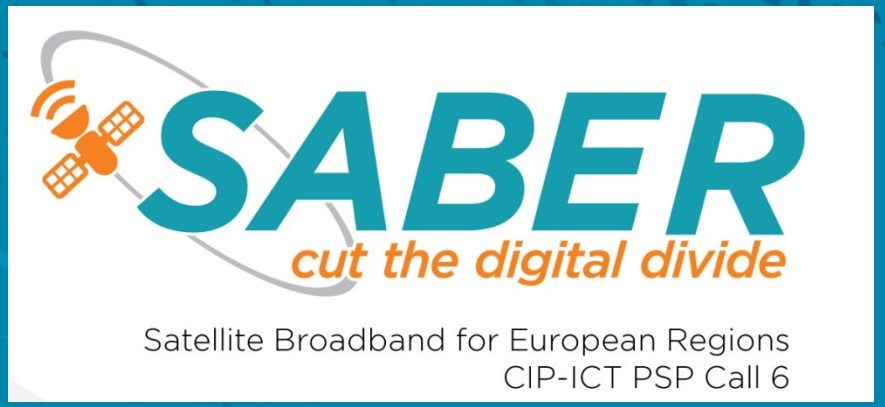

Satellite broadband
Future technology roadmap

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SABER 5th Workshop, Toulouse, January23d

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Future satellite broadband technologies
SABER WP4

SABER WP4 tasks include a Future Technology topic

- Describe and assess the satellite technology evolution roadmap enabling satellites broadband services to serve the DAE 2020 targets.
- Give confidence to Public Authorities in satellite services sustainability and evolution

➔ SABER will describe the technologies evolution needed to allow satellite solutions to serve the DAE 2020 goals in the future, with a viable economical model.

Presentation focus

The challenge is twofold

- **Technology**: need to evolve platform and payload technologies to reduce cost of bit-per-second while increasing throughput
- **Market**: Market environment and public frameworks must encourage operators investment

➔ Need for European public support and accompanying measures on both fronts, as done outside Europe

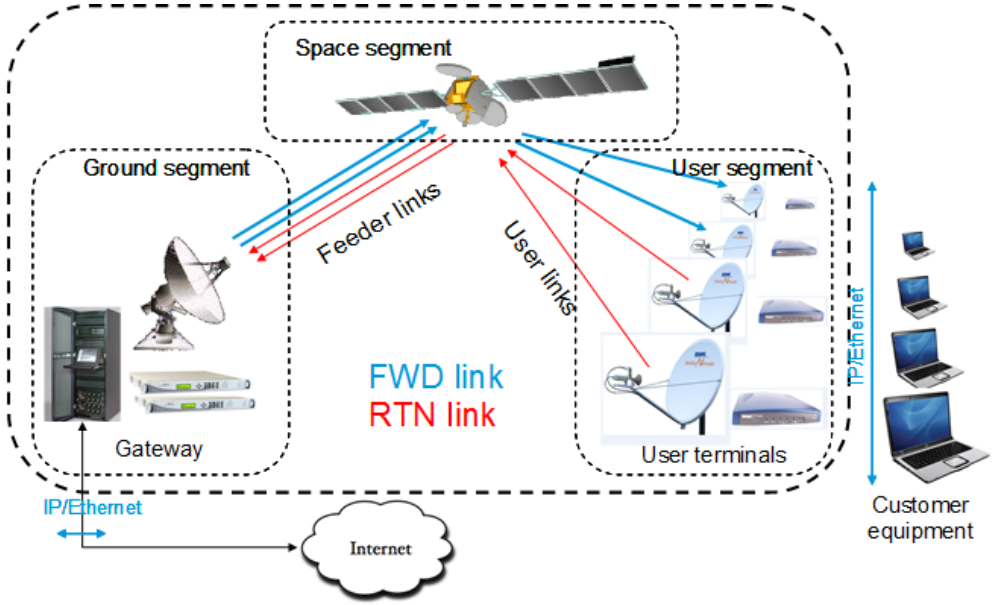
Current calendar to reach DAE target performances

- Consumer 50 Mbps offer in ~2017
- Consumer 100 Mbps offer ~2020

Main features of High Throughput Satellites (HTS)

Access to Internet backbone requires

- two-way connectivity terminals
- a few gateways which are connected to the Internet backbone.
  - one gateway serves several - 4 to 16 - spot beams

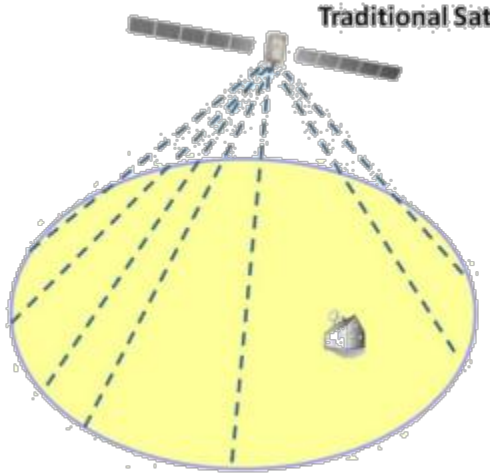


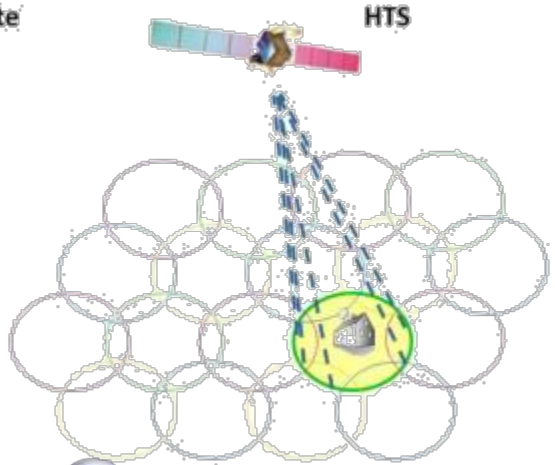
Use of maximum available spectrum and increased performance

- Maximized frequency reuse thanks to a set of narrow spot beams
- Increased power per beam and isolation ➔ Increased spectral efficiency
- State of the art: ~80 beams, 0.5°/1 Gbps per beam

Frequencies

- Today: Ku-band or Ka-band frequencies for all links
- Trend: Q/V-band or optical links for the feeder link.





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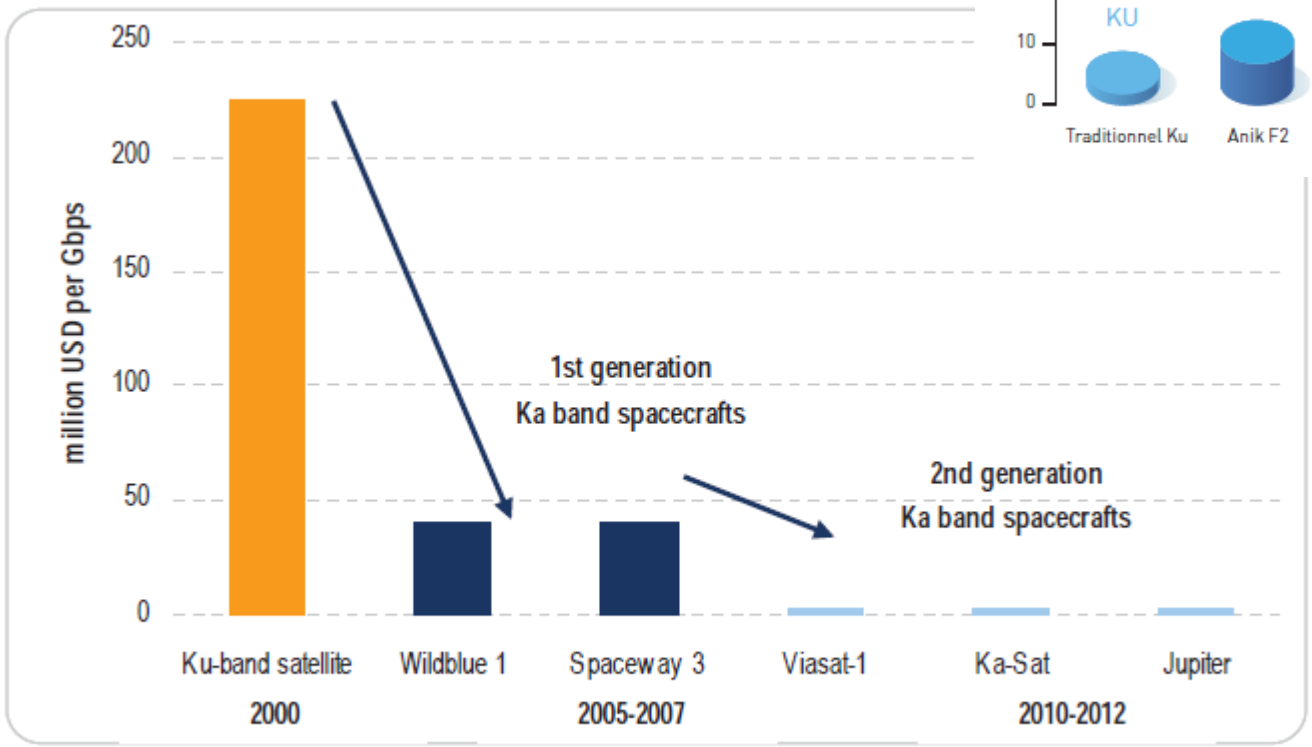
Main features for HTS systems

A drastic performance evolution in the last years.



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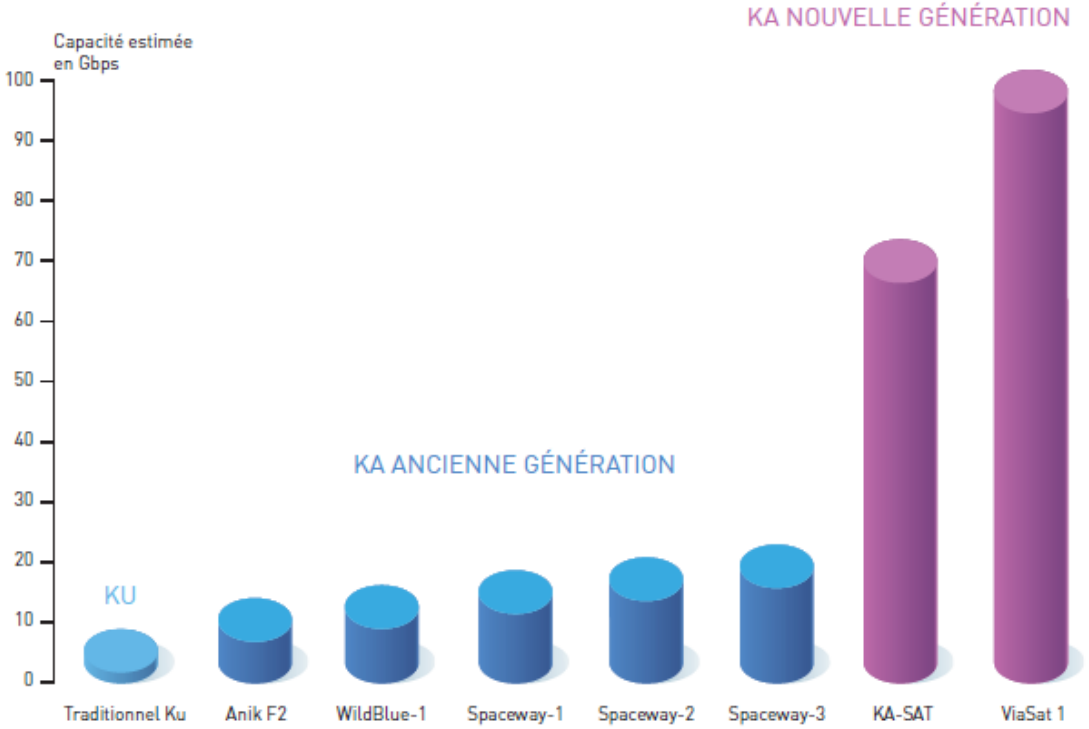

But to meet the Digital Agenda 2020 objectives: necessary to investigate next generation HTS systems providing an order of magnitude improvement (Terabit/s satellite capacity).

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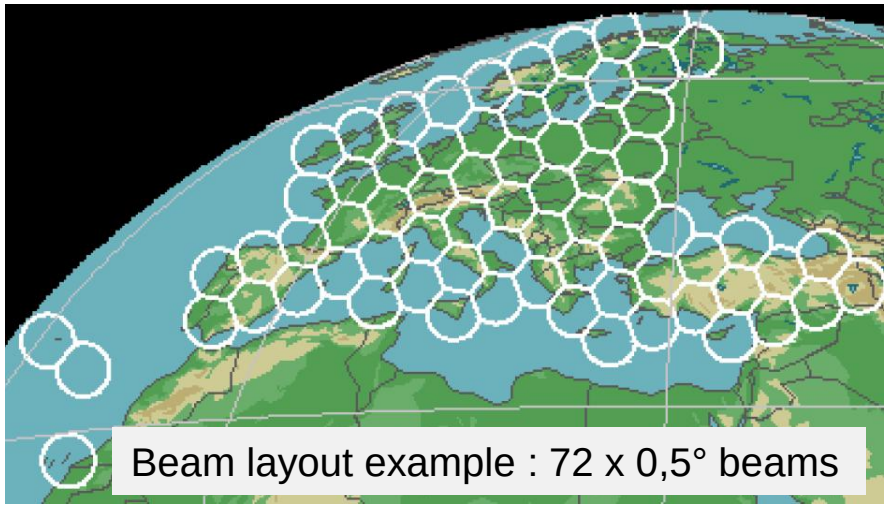
How to improve High Throughput Satellite systems performance?

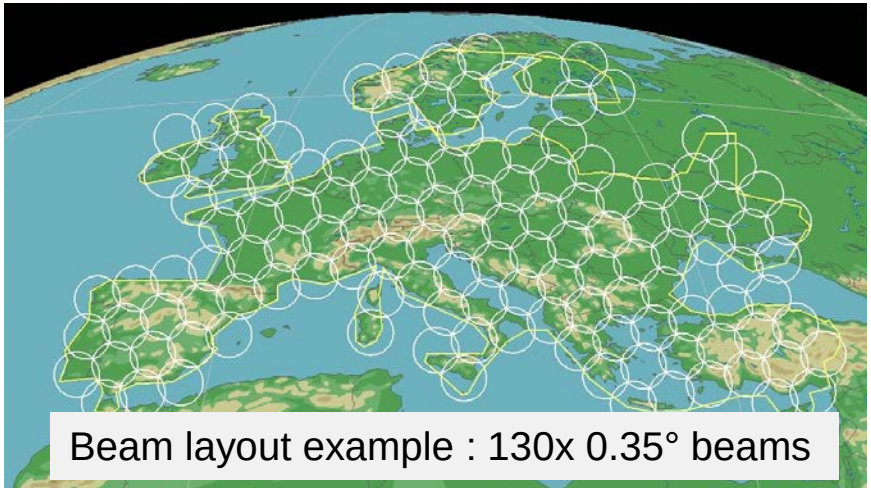
At spacecraft system level this can be achieved by increasing

- **the frequency re-use factor through reduced beam sizes**
  - More beams for the same service area ie more frequency reuse but also more payload equipment and more gateways.
  - Better antenna gain and isolation ie additional margin on link budget but bigger satellite reflectors.
- **the available user link spectrum**
  - Using new frequency bands (Q/V band or optical) for the feeder link

Other tracks maybe pursued at ground and operational level.



Beam layout example : 72 x 0,5° beams



Beam layout example : 130x 0.35° beams

How to improve High Throughput Satellites systems performance?
➔ A different and higher frequency for the Feeder link

Principle:

- **Use the shared Ka-band spectrum for user links only (otherwise occupied by feeder links)**
- **Shift feeder link to higher bands such as Q/V-band or optical frequencies (laser link).**

Advantages

- **Allows locating the gateways within the service area (no more risk of interference between feeder and user links).**
- **Larger amount of potentially available spectrum : multiply the available downlink user Ka bandwidth by 5 to 6 per polarization.**
- **Implement the feeder link in frequencies allowing much more capacity per gateway/ground-stations.**

How to improve High Throughput Satellites systems performance?
➔ Feeder link in Q/V band

Option 1: Q/V feeder link characteristics

- **Smaller gateway antenna size expected, circa 5m**
- **Typical frequencies:**
  - Feeder Uplink: V-band (42,5 – 51,4 GHz)
  - Feeder downlink: Q-band (37,5 – 42,5 GHz)

Topics to investigate further

- **Fading due to atmospheric phenomena (mainly rain, but also clouds, gasses and scintillations) much higher compared to Ka and Ku bands ➔ Smart diversity techniques necessary to adapt to propagation impairments**
  - Gateways to be positioned in strategic locations w.r.t environmental conditions
  - Low maturity of Q/V band technology (but R&D work is carried out by manufacturers at European and national levels)
- **High number of gateways necessary to transmit the increased data rate**
  - A few tens of gateways (<50) must be deployed to serve hundreds of Spot beams
  - A few diversity gateways (<5) must be deployed to ensure service availability

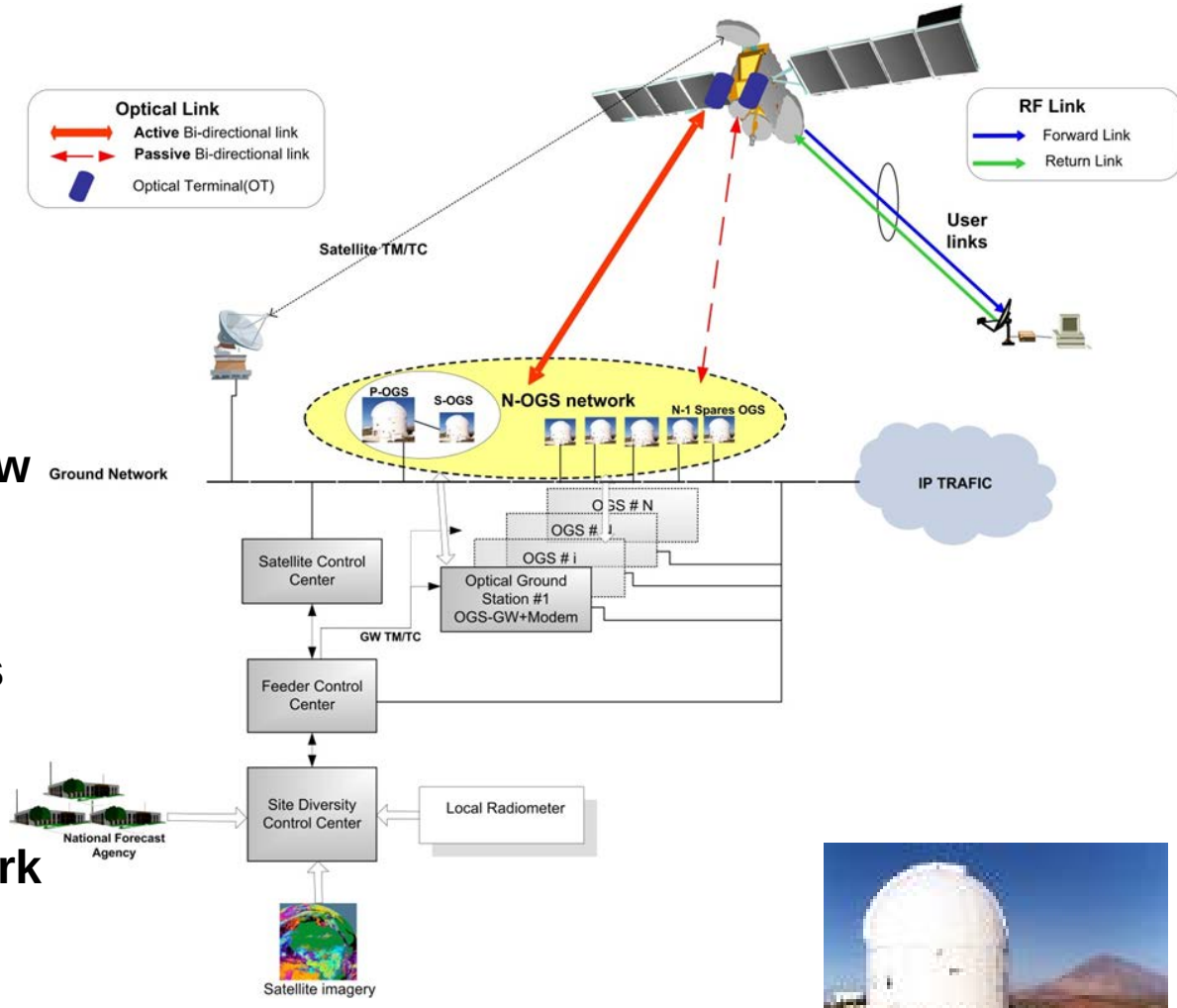
How to improve High Throughput Satellites performance?
➔ Optical feeder link

Option 2: Optical link characteristics

- **Intrinsic high operating frequency (200 to 400 THz) leading to very high optical antenna gain**
- **Allows extremely high data rate above several hundreds of Gbps**
- **Optical terminals exhibit small volume, low mass and power consumption**

Topics to investigate further

- **Feeder link does not work through clouds**
  ➔ Site diversity has to be introduced to fulfil the requested system availability. Need to carefully define the overall network (architecture and operations).
  - 1 gateway for the data rate + less than 10 diversity gateways for availability



How to improve High Throughput Satellites performance? Payload technology and system design roadmap

R&D work has started using industry and public (national and ESA) funds.

- **H2020 Space call perspectives for 2014 a bit disappointing in this field although an EU societal challenge is at stake.**

Non exhaustive insight of the activities at stake:

- **Large foldable Ka-band antennas to increase throughput per beam**
  - ~5 m antenna reflectors: addressed by PIA THD-SAT 2 (France) and addressable by ESA ARTES
  - Reflectors beyond 5 m: H2020 Space would be well suited
- **Equipments and antennas in higher wavelength**
  - Q/V: addressed by ESA ARTES and PIA THD-SAT (France)
  - Optical feeder end-to-end system: H2020 Space would be well suited
- **Diversity management techniques**
  - H2020 Space would be well suited