ITU Regional Seminar for RCC countries

Use of Ka-band for satellite communications systems and services

The Astrium experience

Almaty, September 5-7, 2012

All the space you need

ASTRIUM
AN EADS COMPANY

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Introduction

- Astrium is pleased to get this opportunity to present its experience in building Ka band satellites and systems.
- Information and Communication Technologies (ICT) infrastructures stimulate economical development but urgently need to be complemented by satellite coverage.
- Satellite provided applications efficiently benchmark with terrestrial applications and are crucial for underserved areas.
- Technology for Ka ground and space segments is mature and the deployment of a Ka satellite network for can be completed in 3 years.
- Astrium leads High Throughput Satellite (HTS) segment and can build a Ka-band system adapted to specific Kazakh needs.
- Business could even be strengthen in combining civilian and military applications.
- Frequency coordination and suitable partnerships is part of a successful approach.

Ka-band interest

- **Ka-band proposed for:**
  - Spectrum advantage
    - Easier to coordinate (no operational system in orbit yet)
    - Access to large bandwidth
    - Reserve Ka-band frequency rights over Kazakhstan
  - Development of broadband services for commercial/corporate and government applications
    - Capacity
    - User throughput using small affordable terminals and developed network system
    - In line with Kazakh government policy to universal access to broadband services
  - Kazakhstan to become the first country of Central Asia to develop a broadband multi-beam system, following the already operational systems in Europe (Ka-Sat, Hylas) and in Middle-East (Yahsat-1A & 1B, Arabsat-5C).

Ka band capacity to meet increasing traffic demand

Broadband satellite capacity

- **Drivers for system capacity over a given service area are:**
  - Spectrum
    - 500 MHz exclusive Ka-band for user FWD and RTN in 2 polarisations
  - Spectral efficiency (bps/Hz)
    - Typically 2 bps/Hz on the FWD link and 1.5 bps/Hz on return link
  - Frequency re-utilisation factor over the service area
    - Number of beams/beam size: typically 0.5 to 1 deg
    - Frequency colouring scheme: typically 4 colours (giving 250 MHz/beam)
- **Indications of achievable capacities**

Number of beams	5	10	15	20	80
Spectrum/beam (250 MHz)	250	250	250	250	250
Spectral efficiency FWD	2	2	2	2	2
Spectral efficiency RTN	1.5	1.5	1.5	1.5	1.5
Total capacity (Gbps)	4	9	13	18	70

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Kazakhstan Filings at 58.5°E – Ka band

Direction	Ka Band	Filing	API	Validity	Coordination	Notification	Unfavourable	Resubmission of Notification
	17.7-20.1 GHz	KAZSAT-1M	27/12/2006	27/12/2013	09/12/2005	02/08/2010		
	20.1-21.2 GHz	KAZSAT-1	18/02/2005	18/02/2012	09/12/2005	23/12/2009	30/11/2010	16/12/2010
	20.1-20.2 GHz	KAZSAT-1M	27/12/2006	27/12/2013	09/12/2005	02/08/2010		
Downlink	20.1-21.2 GHz	KAZSAT-1M	27/12/2006	27/12/2013	09/12/2005	02/08/2010		
Uplink	27.5-31 GHz	KAZSAT-1	18/02/2005	18/02/2012	09/12/2005	23/12/2009	30/11/2010	16/12/2010

- **Ka Band**
  - Needs covered through three generations of filings
    - KAZSAT-1 valid until 18/02/2012
    - KAZSAT-1M valid until 27/12/2013 declared « BIU » Q1 2012 (using LUCH-5A)
    - KAZSAT-1R with 14/11/2012 as priority date and valid until 30/03/2018
  - Favourable operational context
  - Securing the frequencies
    - Declaration of KAZSAT-1M bringing into use has been sent before validity date
- **Notified filings without operational satellite could be contested**

  Filings would be suppressed if operational interferences occur

  Azeris have also filed Ka at 58.5°E (before KAZSAT-1R)
- **General statement**
  - Ka band subject to coordination under ITU RR Art.9/11

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Applications driving demand for satellite capacity

- **Consumer**
  - Broadband Access
  - Component of Triple Play Offering
- **Enterprise**
  - Remote Access
  - VPN and Networking
  - SCADA and Machine-to-Machine (M2M)
  - Digital Cinema/Digital Signage
  - Interactive Distance Learning
  - Redundancy and Disaster Recovery
  - Nomadic/Maritime
- **Backhaul/Trunking**
  - Wireless Backhaul
  - International Trunking

Source: NSR - 2010

Segmentation of broadband access market

Over-served Market

- Areas within 3 km of next DSLAM, or with FTTH, near cable head-end
- Usually urban areas with **high population density**

Un-served Market

- Areas located further than 5 km from next DSLAM or cable head-end, meaning no terrestrial broadband is available
- Unserved areas usually have a low population density, concerning **rural areas**

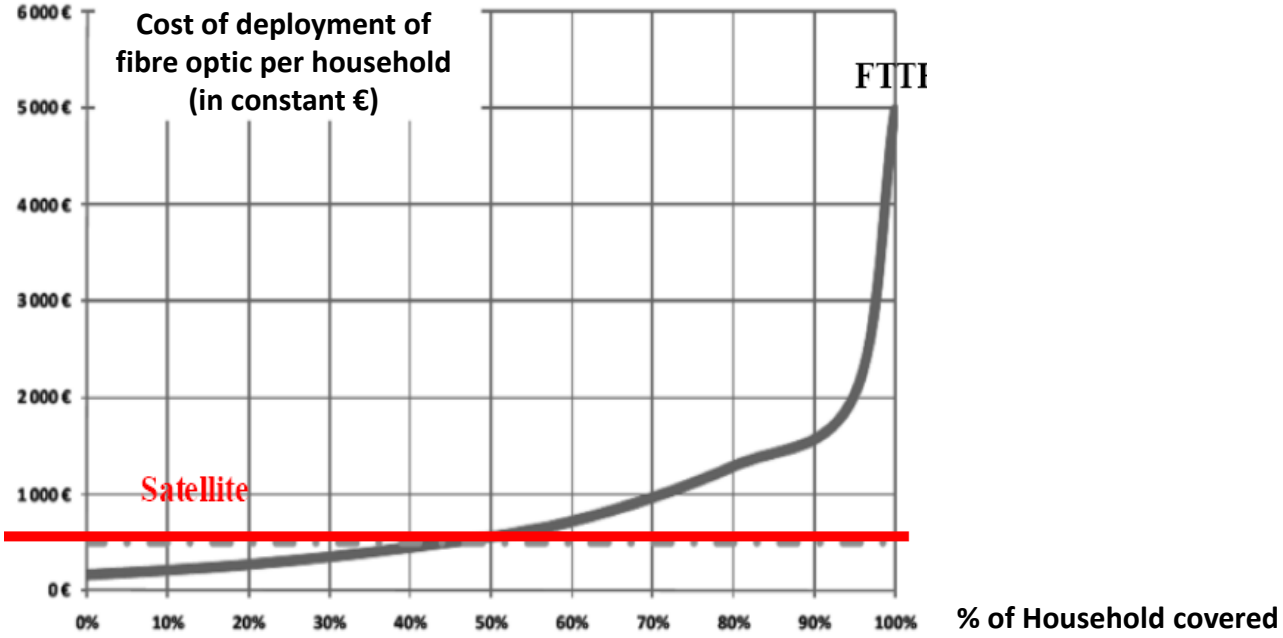
Underserved Market

- Areas within approx. 3-5 km of a DSLAM. Broadband is available at a limited max. speed, up to few Mbps not allowing all kind of services (TV, VoD)
- Underserved homes are usually located in **suburban or urban areas**

Broadband services in Kazakhstan

- **Current situation in Kazakhstan**
  - General upturn in demand for Internet services
  - Internet penetration: 16% of population by end of 2010 (+400 bps on YTY basis)
  - Broadband penetration: 12% of population by end of 2010 (+300 bps on YTY basis)
  - OECD average is 25%
- **Development of Internet and broadband impacted by low-density terrestrial infrastructure**
  - Fixed-line penetration 26% of population with just 6.4% of households
- **Ambitious plan from Government to offer 100% broadband coverage by 2015**
  - but small fraction of population to remain out of reach of Fiber-To-The-Home or terrestrial wireless (WiMax, 3G) because coverage not economically viable
  - Ka band by satellite is The solution
- **Brodband services should also be of great interest for Security and Defence forces (communications / data relays).**

Fibre optic deployment cost per household in France (*)



- Only satellite will provide service to out of reach areas
- Elsewhere, satellite offer benchmarks terrestrial offers
- with easy reallocation of capacity

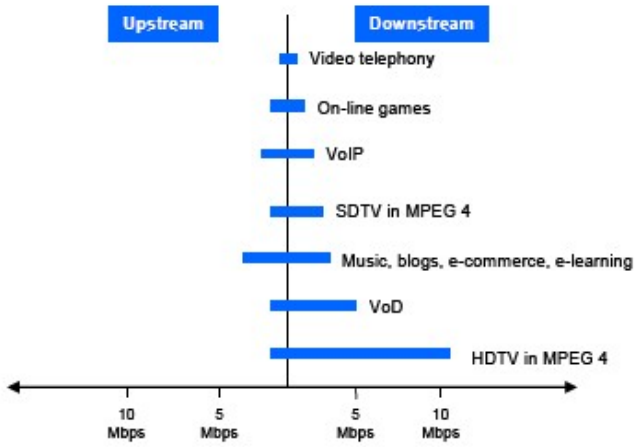
(*) : Source DATAR 02/2010

Consumer broadband access applications

The future digital home will require more bandwidth!

- Ultra high speed Internet
- HD and 3DTV
- Home security
- Home automation
- E-health

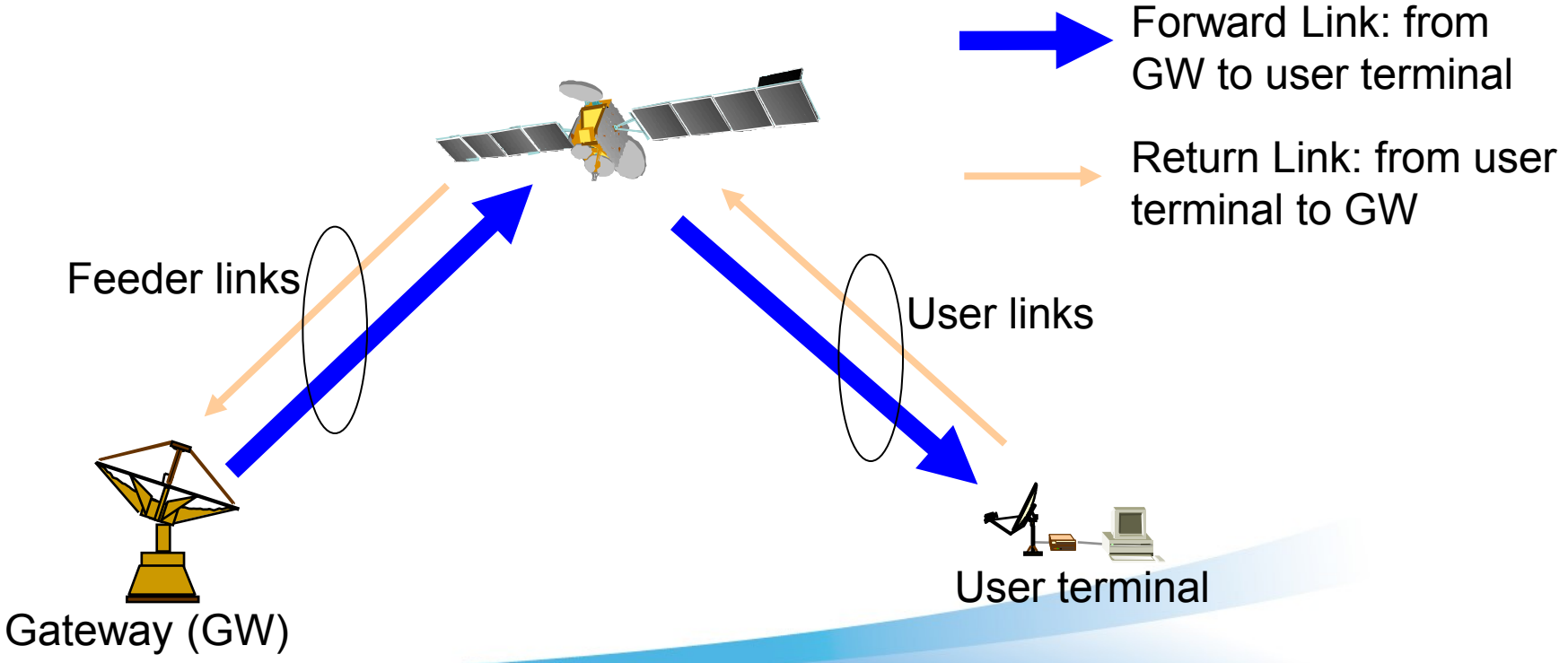
Ideal bitrates will be in the 5-10 Mbps range (downlink)



Source: IDATE – October 2010 - The revolution behind HighThroughput Satellites (HTS) Status of broadband in Europe and market perspectives for satellite

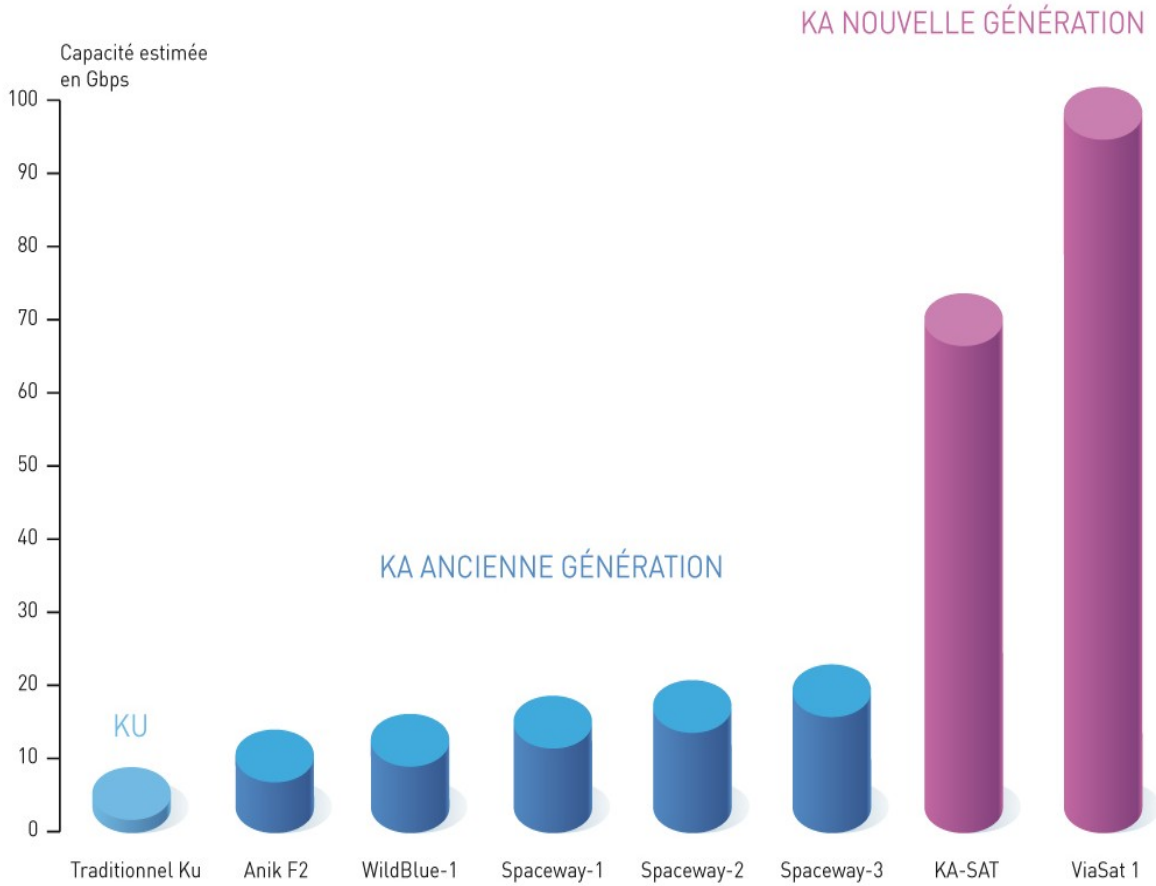
Consumer broadband access system scenario

- **It is assumed that the targeted service is** broadband interactive service **to residential user -> It requires bi-directional links**
- **On the FWD link: TWTA operated with a single carrier at 0.5 dB below saturation.**
- **On the RTN link: TWTA operated with multiple carriers at 4.5 dB output back-off.**



Satellite capacity

- **New generation Ka satellites « througput » compared to previous generation**



Governmental services and applications

- **Reliable and secure global bandwidth**
- **In-theatre communications solutions**
- **IP Connectivity**
  - Broadband internet access
  - Close user group network
  - Site interconnection
  - Tele-presence
  - Backup services
  - Contribution/distribution
  - Trunking
  - SCADA/M2M
  - Multicast services
  - Mobile service

Source:Eutelsat presentation on Governmental services via KA-SAT

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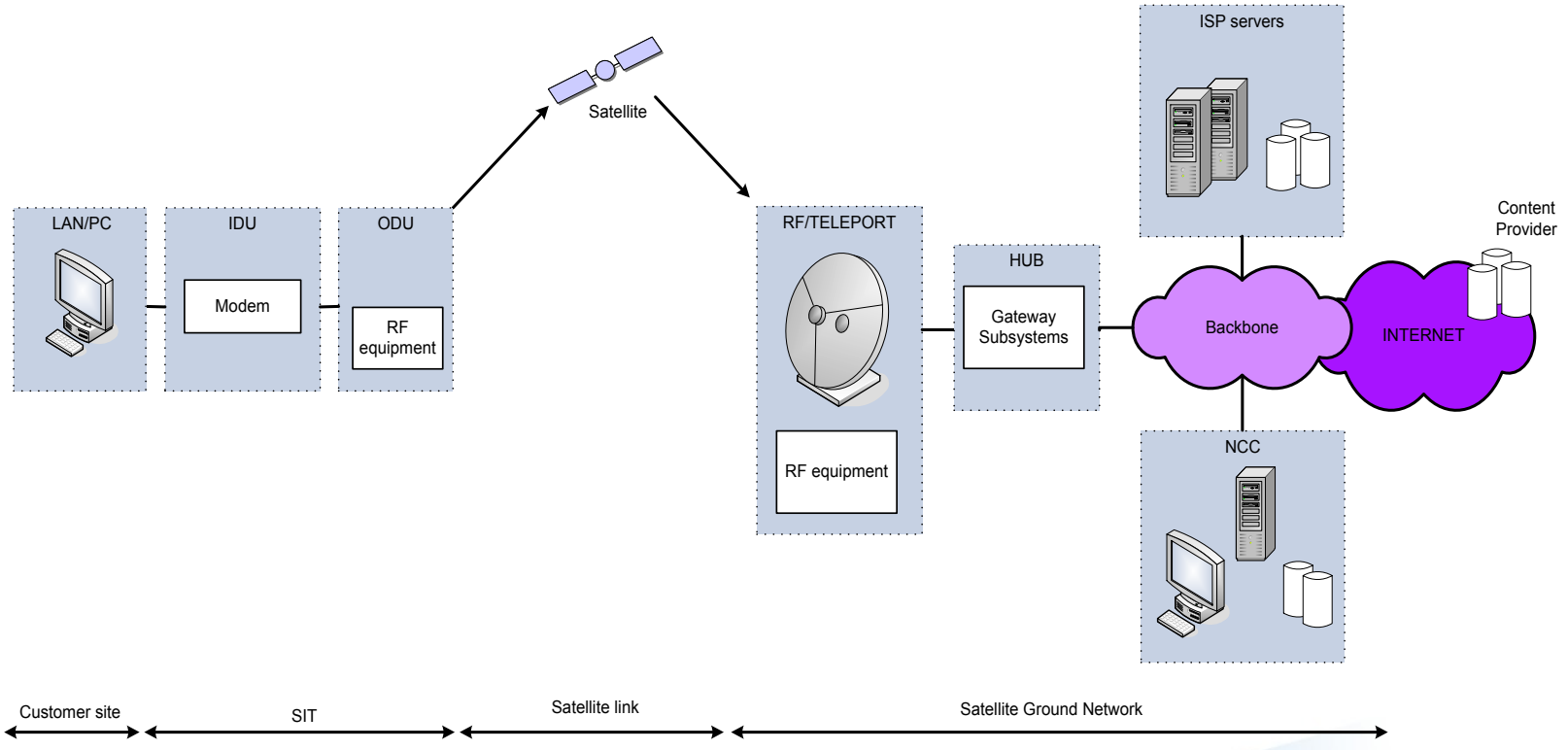
System architecture, today deployed on Ka-Sat



Example of user terminals

Complete range of ODUs

- 67 cm Ka-band
- 96 cm Ku-band
- Automated installation tools for simplified antenna alignment and commissioning

Compact IDU

- Simple customer interfaces:
- Plug and play Ethernet 10/100 Mbps
- Contains all software needed to access the satellite
- Upgradeable via over-the-air software download

IDU throughput	Download	Upload
Basic solution (< 80cm/3W, < 50dBW)		
> TCP/IP traffic	**10Mbps**	**5Mbps**
> UDP traffic	**30Mbps**	**5Mbps**

Source:Eutelsat presentation on Tooway

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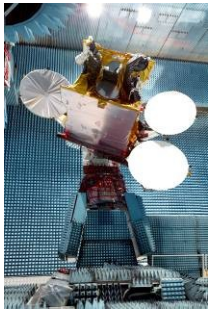
Astrium experience in Ka-band payloads since 1989

Starting In the 80s'

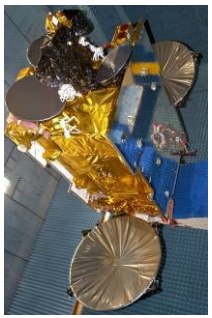
Olympus launched 1989

W3A launched 2004

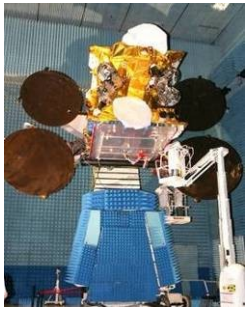
Anik F3 launched 2007



Nimiq 4 launched 2008



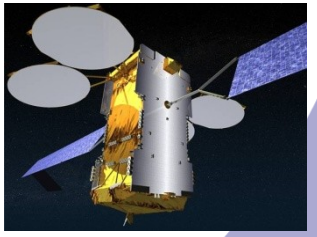
Astra 3B launched 2010



Hylas ***launched 2010***

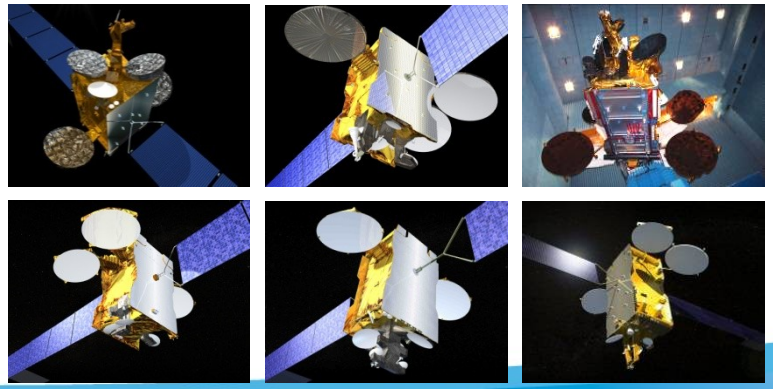
All Ka Satellite …Up to 80Gbps capacity

KaSat ***launched 2010***



Add-On Payload or Main mission

- **Add-on offering more limited transponder count, but with potential to cross links with other embarked payloads (in Ku or C band)**
- **Typical for market entry, recent examples include:**
  - Eutelsat W3A,
  - Telesat Anik F3 and Nimiq 4,
  - SES Astra 3B,
  - Yahsat-1A
  - Arabsat-5C
  - Express AM4
  - Express AM4R under construction

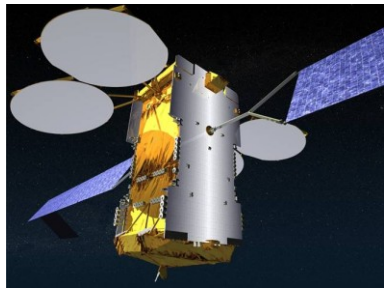


- **Dedicated Ka band Satellites**
  - HYLAS (AVENTI)

    Flexible payload

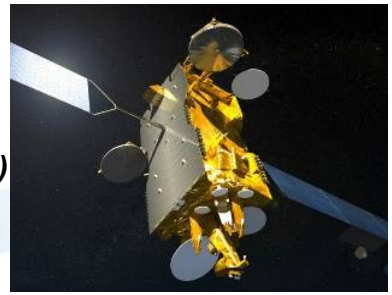
  - Ka-Sat (EUTELSAT)

    80 beams
    70 Gbps capacity



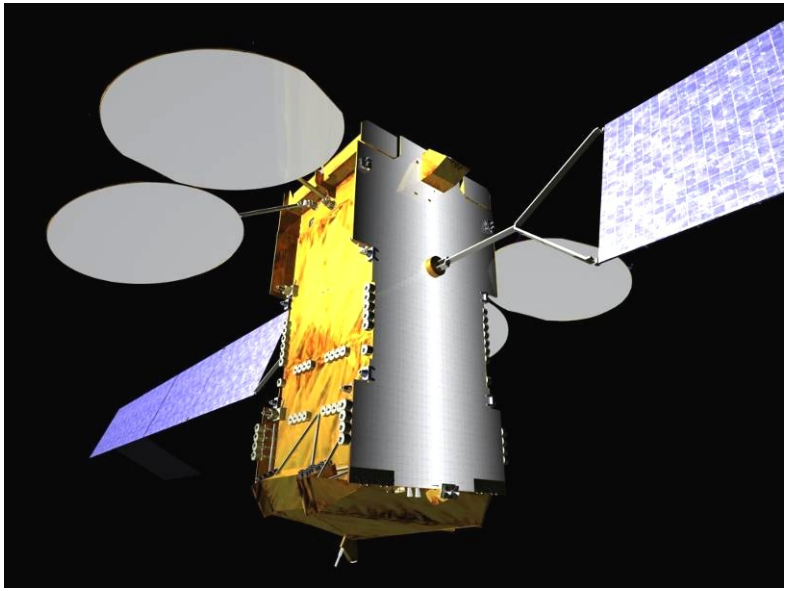
  - Yahsat-1B (UAE)

    Dual use (civil&mil)



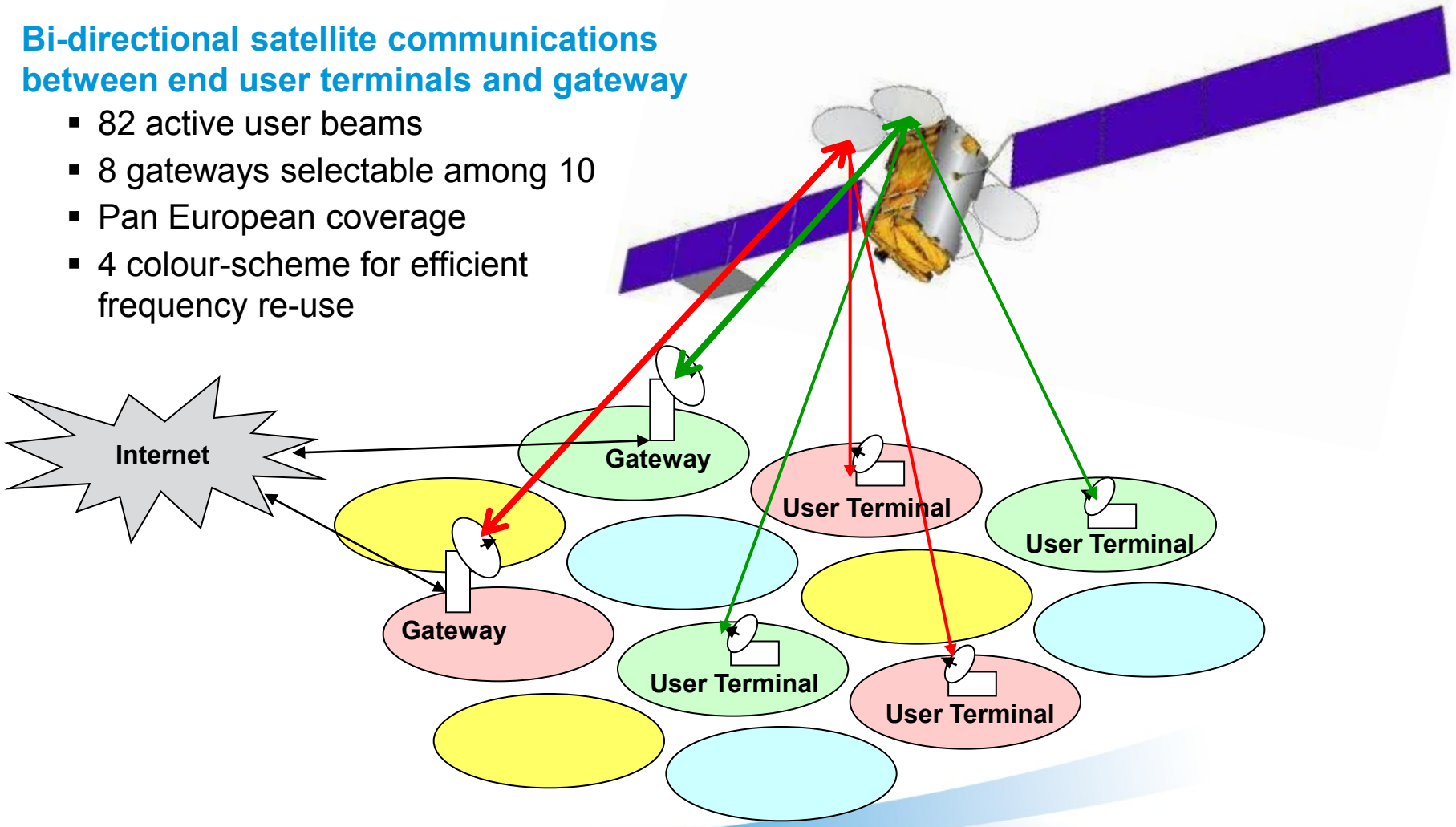
Focus on Ka-Sat satellite

- Ka-Sat is the first multibeam Ka-band satellite over Europe, as well as one of the most complex and biggest satellites ever built by Astrium
- Ka-Sat fits well within the Eurostar E3000 satellite product range, however some adaptations have been required due to the specific needs of the mission
- Ka-Sat has been launched on Dec 29, 2010 and operated succesfully since its deployment in orbit

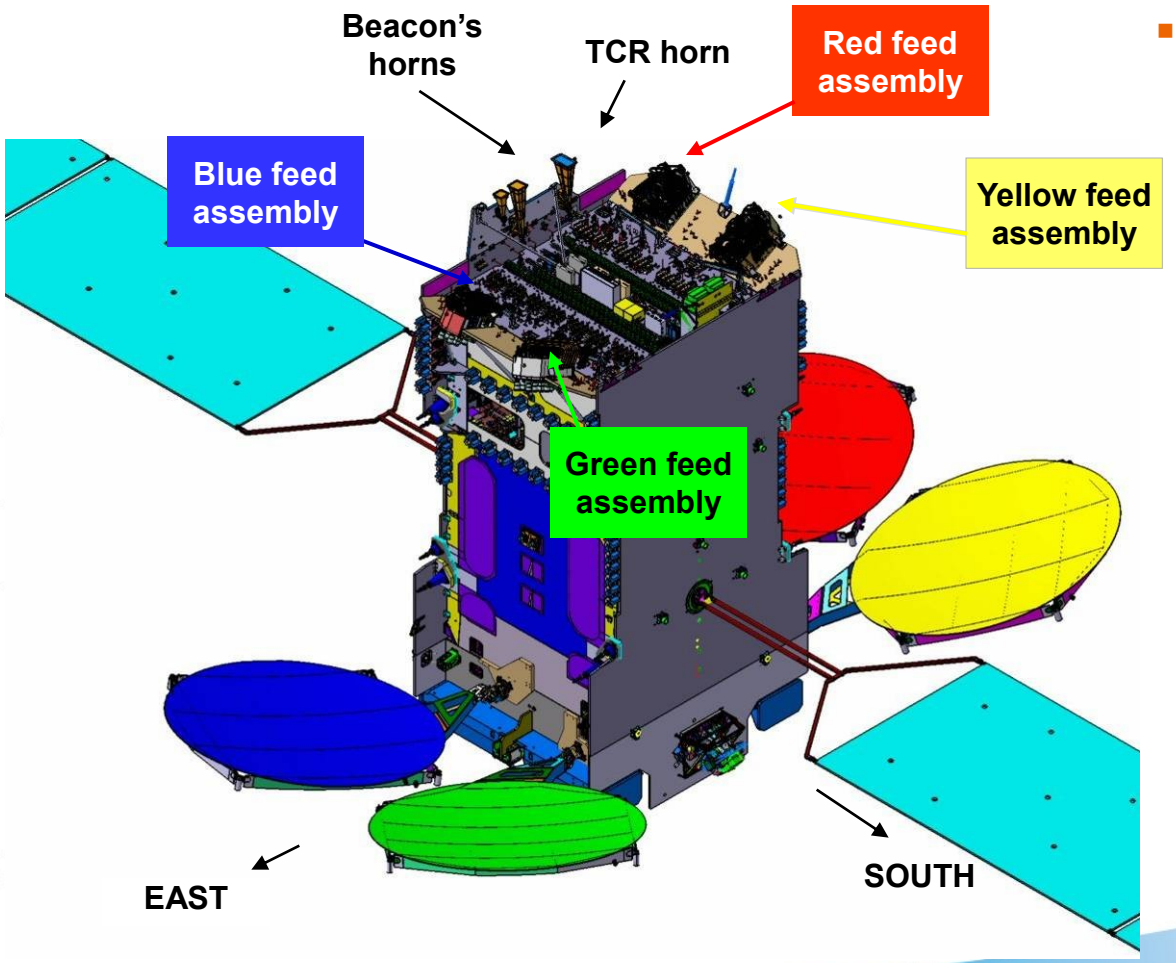


Ka-Sat mission/payload overview

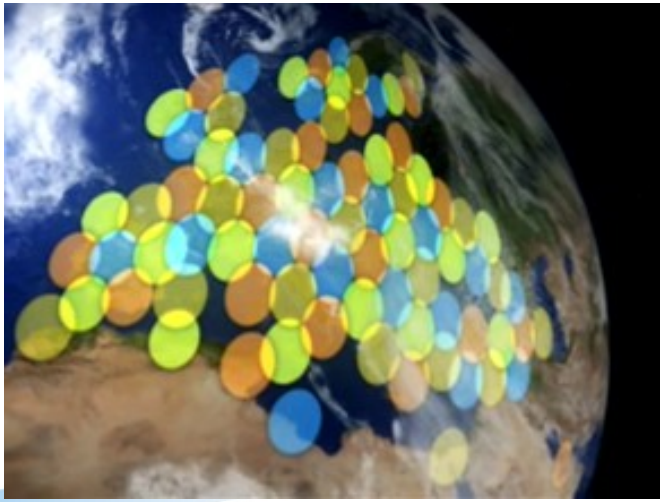
- **Bi-directional satellite communications between end user terminals and gateway**
  - 82 active user beams
  - 8 gateways selectable among 10
  - Pan European coverage
  - 4 colour-scheme for efficient frequency re-use



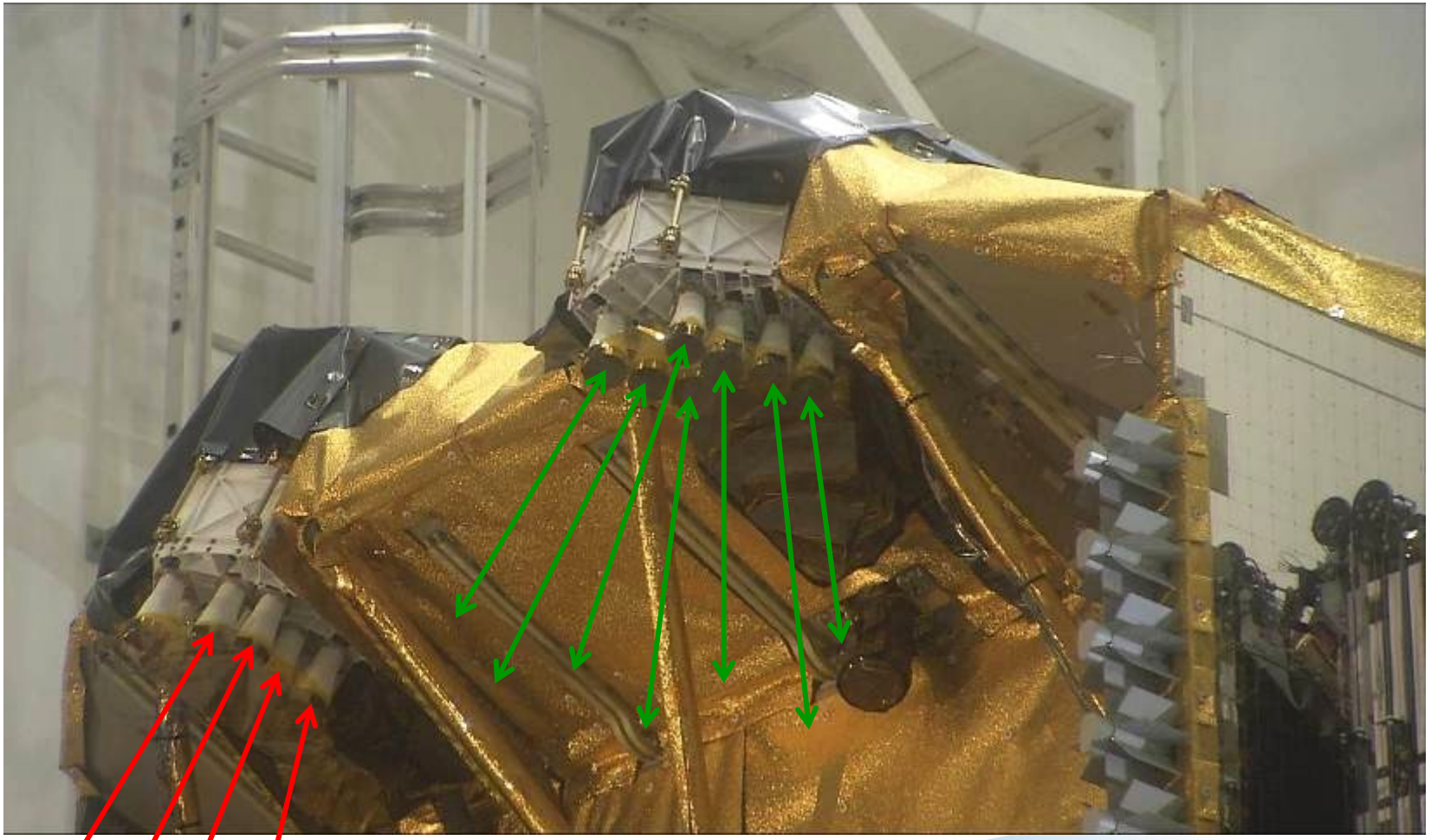
Ka-Sat satellite deployed configuration in orbit



- **Four antennas:**
  - One antenna per colour
  - ~20 feeds in each array
  - 2.6m diameter deployable reflectors



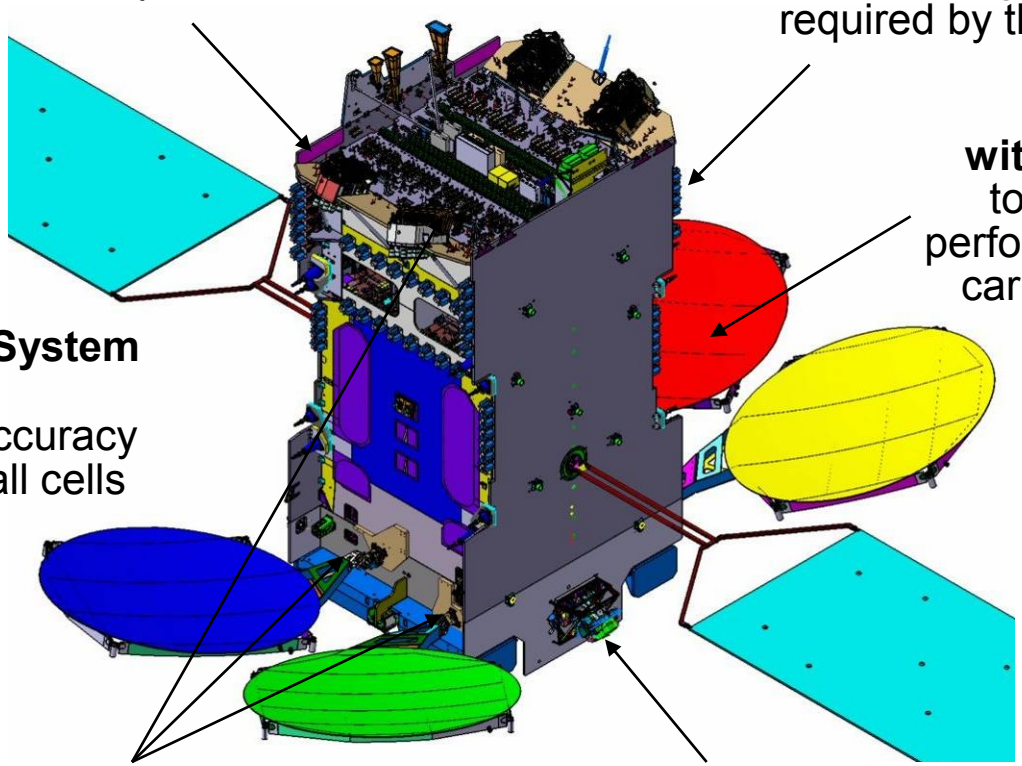
Antenna multi-feed assemblies



Key features of the Eurostar E3000 platform for Ka-Sat

Triple floor E3000 version
Largest size of mechanical platform

Radiative collector amplifiers
combined with high thermal efficiency required by the Ka mission



Large antennas with long focal length
to achieve optimised performance, high gain and carrier to interferer ratio

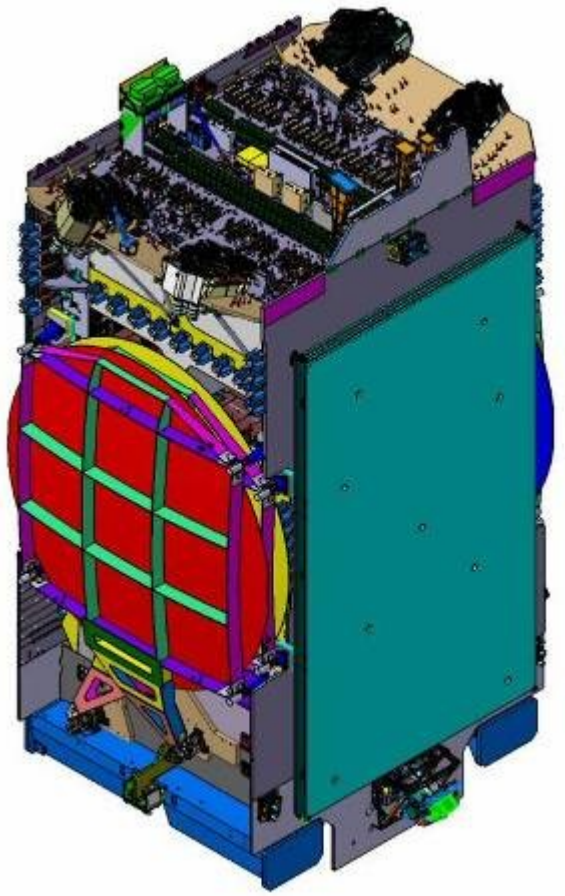
Antenna Tracking System (ATS)
very high pointing accuracy required by the small cells

New mechanical concepts
for antenna feed assembly supports, and reflector deployment and trimming

Plasma propulsion system
to enable significant lifetime for such large spacecraft

Ka-Sat Main Characteristics

- **Satellite Main budgets**
  - Power
    - Spacecraft Power — up to 14 kW
    - Payload DC power — 11.2 kW
    - Solar Array Power — up to 16 kW
  - Satellite launch mass — > 6 tonnes
  - Orbital Manoeuvre life time — > 16 years
- **Orbit**
  - GEO, longitude 9°E
- **Launch**
  - Launch vehicle: Proton
  - Launch date: Dec. 29, 2010



Conclusions

Astrium :

- **believes that introduction of Ka band will put Kazakhstan in a decisive position to join the club of nations developing broadband services;**
- **can propose state of the art infrastructure with flight proven heritage for space segment and mature technology for ground segment;**
- **would be pleased to discuss with Kazakhstan the Ka Kazsat-4 satellite mission and to propose various options;**
- **can fully support the sizing of a Ka system optimized for Kazakhstan :**
  - Coverage & number of beams
  - Frequency plan & number of Gateways
  - Forward / Return asymetry ratio
  - Link budgets, Gateways and Terminals characteristics
  - Waveform, variable modulation, adaptative coding, 99.5% availability
- **can envisage several scenarios including a dual-use system for both civil services and defence/security applications.**