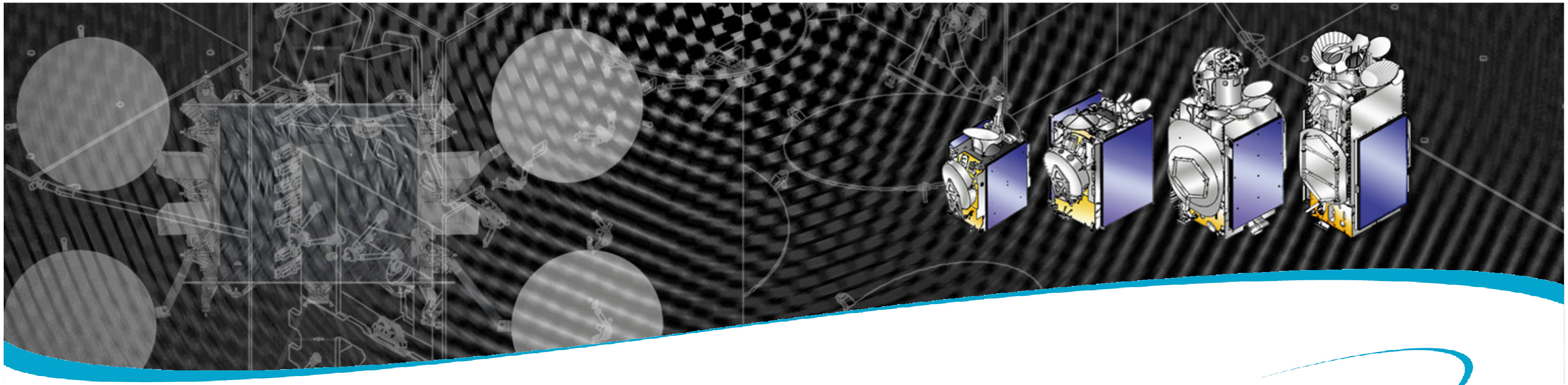


Satellite Technology for Future Applications

WSRF Panel n°4 – Dubai, 3 March 2010

Guy Perez – VP Telecom Satellites Programs

Content

Thales Alenia Space vision on:

1. **Mid-term market evolutions for commercial telecom satellites**

2. **Mid-term evolutions in telecom satellite payloads and buses**

3. **Securing the introduction of new technologies**

Of course, this is not an exhaustive roadmap, but only noticeable evolutions as seen by Thales Alenia Space for commercial satcoms

1 – Mid-term Commercial Market Evolutions

> **The major part of the satellite market in the mid-term (2010-2015) is the structural satellites replacement. This should not lead to significant changes versus the current satellites technology.**

> **Main drivers of the satellite technology evolutions :**
- Emergence of new applications :
  - Satellite broadband solutions (consumer triple play, e-services, internet connectivity, …)
  - Mobile TV (S band)
  - HDTV, 3DTV
- Scarcity of the frequency spectrum

> **Main market evolutions (2010-2015) :**
- Access to Ku Reverse BSS
- Access to Ka-band spectrum, offering higher capacity throughput
- Multibeam missions with frequency reuse scheme (Ka-band, Ku-band, …)
- Flexible payloads to adapt to the true market conditions encountered after launch

> **Due to launchers prices and availability, the satellites should mainly concentrate into two categories :**
- High power satellites (> 11 kW payload ; 6 tons class)
- Low/Medium power satellites (< 7 kW payload ; 3 tons class)

2 – Technology Evolutions - Payloads

> **Evolutions are foreseen mainly for Ka-band missions. These evolutions should also be used for Ku-band payloads**

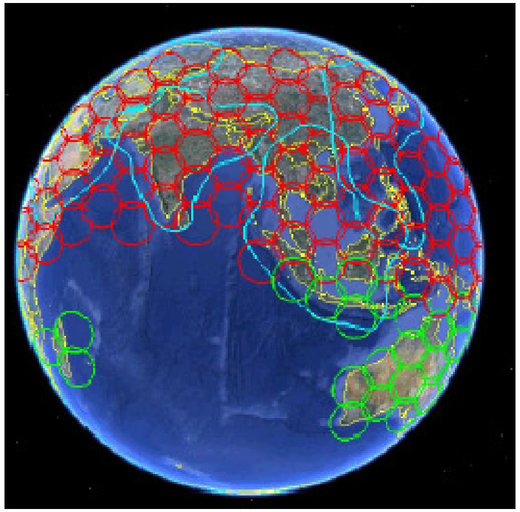
> **TAS has long experience in Ka-band payload missions**

- from Hot BirdTM 6 (launched in 2002), up to Yahsat-1B on-going program

and flight proven technologies should fit most of the new mission demands

- Multibeam architecture with frequency reuse scheme, RF pointing, Digital Transparent Processors, On-Board Processors, MultiPort Amplifiers, Beam Forming Networks, …

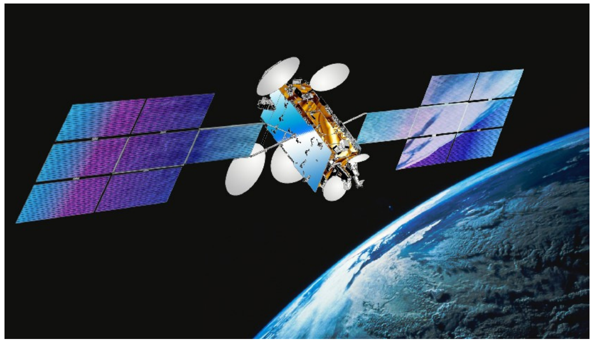
Example of multi-mission satellite combining wide beam coverages and multi-beam coverage



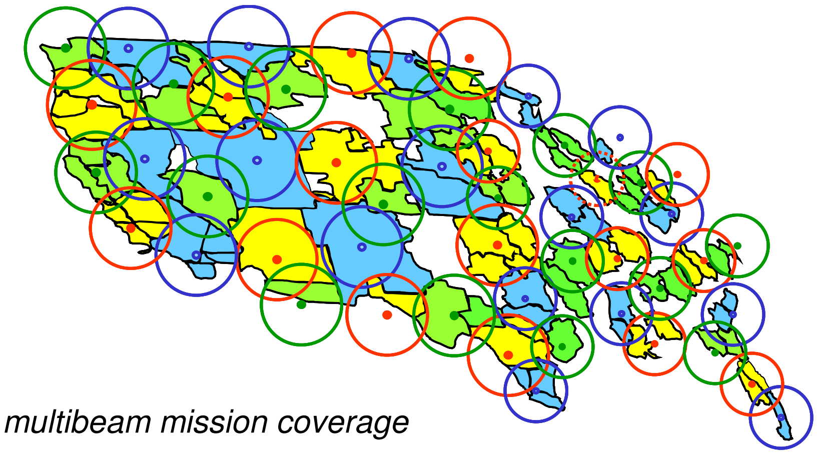
2 – Technology Evolutions - Payloads

> **Key payload technology evolutions to enhance performance and to cope with increasing mission complexity:**

- Multibeam missions with antennas technology to allow smaller spot beams (< 0.4°)
- RF pointing systems offering 0.03° pointing error in all modes (including in station keeping maneuver mode)
- Counter balance coverage segmentation via full flexibility or using Digital Transparent Processors / On-Board processors
- Power/Beam allocation flexibility using flexible TWTAs or MultiPort Amplifiers
- Use of flexible antennas concept (4-axis steerable/zoomable antennas, …)



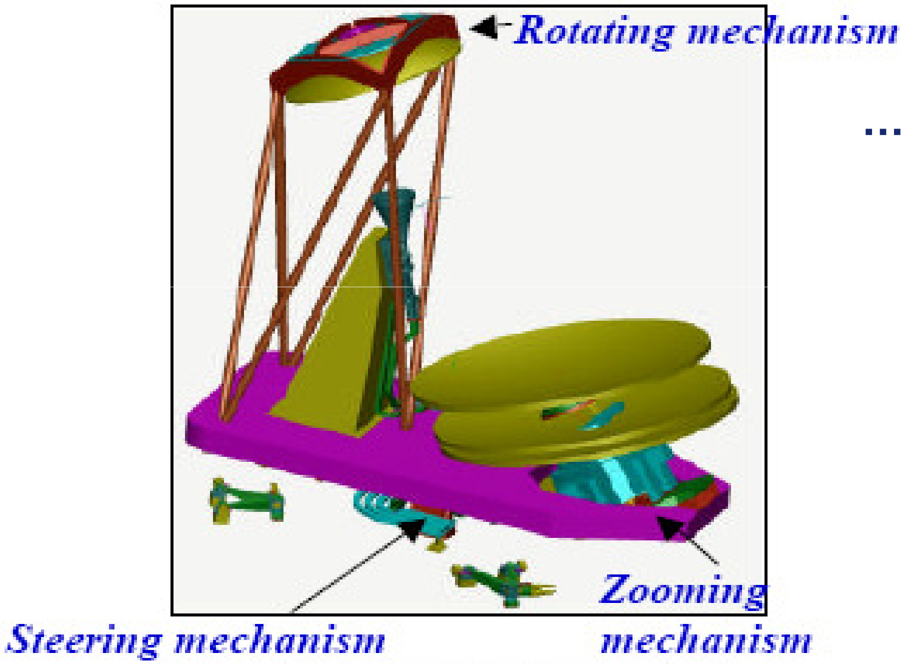
Ciel-2 satellite artist view



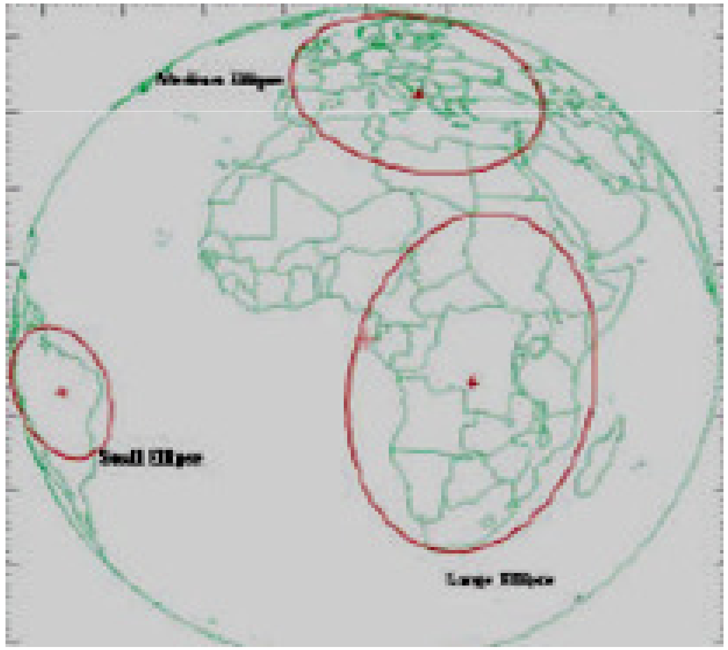
Ciel-2 multibeam mission coverage

4-axis Steerable/Zoomable Antenna

> This 4-axis steerable antenna (3 axes + zooming) …



… allows different and flexible coverages



2 – Technology Evolutions - Buses

> **Key bus technology evolutions**
1. to allow accommodation of new payloads (more complex and more powerful)
2. to meet enhanced performance
3. to globally optimize cost per transponder

> **Payload accommodation**
- Larger antennas and increased number of antennas
- Specific features to support higher dissipative payload units with fluidic loops or deployable radiative panels
- Optimized repeater layout to reduce RF intra-losses (especially relevant for Ka-band)

> **Mass**
- More efficient batteries (Li-Ion) and more efficient cells (AsGa) on solar arrays
- Improved propulsion architecture to reduce the launch mass or to support extended lifetime

> **Power**
- Increased end of life power capability (up to 25 kW)
- Improved spacecraft pointing accuracy to optimize RF power
  - TAS has already strong flight heritage on GEO satellite with Star Trackers

> **Launcher compatibility**
- Satellites design exploiting evolutions of existing launchers (5m fairing, direct GSO injection, …)
- Cope with new available launchers

3 – Securing the introduction of new technologies

1. **Compliance with ECSS rules, as promoted by Space Agencies and European satellite manufacturers, incorporating their long standing experience**
2. **Continuous improvement of products based on capitalization of significant life events**
   - Return of Experience at all levels (component to system) benefiting to new products
   - Prior to entering into its commercial phase, independent team and experts challenge the design and development plan of any new space-borne equipment
3. **Use of standard "V" Development cycle : From satellite to units to satellite**
   - From satellite
     - Design definition, analysis and verification, robustness
       - Definition, design analysis and verification
       - Flow down requirements to units level (thermal, mechanical, electrical, EMC)
   - To unit
     - Design definition, analysis and verification, robustness
     - Qualification of the first specimen (EQM) and acceptance on the next units (PFM, FMs)
       - Sequence: performance verification, environment tests, trend analysis
       - Qualification testing to cover with margin the predicted in-orbit environment and life test for items subjects to wear-out (wheels, mechanisms, batteries,…)

3 – Securing the introduction of new technologies

> To satellite

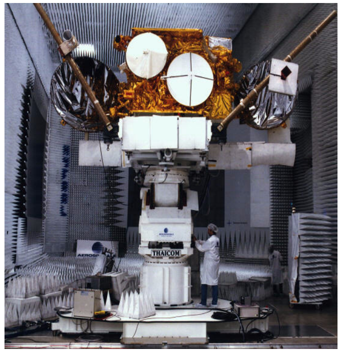
- Ensuring satellite test sequence consistence with the in-orbit mission and the testing at unit level (verification of unit-to-unit interfaces and end-to-end performance)
- Satellite testing
  - Sequence: performance verification, environment tests, trend analysis
  - Qualification testing to cover with margin the predicted in-orbit environment and launcher environment.
  - Verification that units qualification level is not over passed
  - End-to-end payload testing (using compact antenna test range)

Thermal Vacuum Test

Vibration Testing

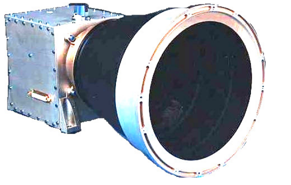
Acoustic Testing

Compact Antenna Test Range



3 – Securing the introduction of new technologies

4. Whenever possible : A step by step approach, based on flight proven heritage, introducing gradually changes with minimum risk on the satellite missions



> **A real example : The Star Tracker introduction on SPACEBUS**

- Strong flight heritage of Star Tracker on LEO platforms (PROTEUS) before introduction on a commercial GEO satcom
- Accommodation of a similar unit on a first SPACEBUS satellite, after the completion of the full “V” development cycle on ground
  - Pitch and Roll axes still controlled through Infra Red Earth Sensor
  - Only Yaw axis controlled by Star Tracker
  - Both Star Trackers (nominal and redundant) kept operational for full monitoring
  - Full unit characterization and test carried in orbit, confirming performance predictions
- Accommodation of the Star Tracker product line on follow-on SPACEBUS
  - All axes controlled by the Star Tracker
  - IRES maintained as a back-up sensor
  - Today : more than 50 years cumulative in-orbit Star Tracker operation lifetime
- Next step : Star Tracker only

ThalesAlenia Space

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Thank you for your attention

THALES

Guy Perez

Thales Alenia Space - Director of telecommunication satellite programs

Background: 25 years of experience in the telecom satellite business

since July 2007: appointed telecom satellite programs director covering bids, execution of awarded contracts and in-orbit support

1985 – 1987: satellite subsystem design engineer (data handling, avionics , payload)

1988 – 1993: satellite lead engineer (Eutelsat 2 series)

1994 – 1997: satellite program manager (Hot Bird 1, Arabsat 2,...)

1998 – 2000: head of satellite product line including management of engineering bid team

2001 – 2006: program director of renovated product line SPACEBUS 4000 and first commercial application (AMC 12)