TECHNOLOGY: ENHANCING GROWTH AND EFFICIENCY

Yohann Leroy, Chief Technical Officer
Agenda

1. Introduction
2. Cost reduction
3. Increased efficiency
4. Enhanced end-user experience
5. Conclusions
Innovation is part of Eutelsat’s DNA

► Innovation: the right balance between creativity and rigour

► Open innovation
  • Collaborate with customers and other partners
  • Explore new opportunities (e.g. Internet of Things)
  • Stakes in innovative projects and companies

► Look beyond the satellite itself
  • Satellite is part of a broader system
  • Innovation across the communication chain
One goal, three enablers

- Cost reduction
- Increased efficiency
- Enhanced end-user experience

Improve value creation of our capacity
Agenda

1. Introduction
2. Cost reduction
3. Increased efficiency
4. Enhanced end-user experience
5. Conclusions
2.1 Electric propulsion

2.2 High throughput satellites

2.3 Productivity initiatives
Propulsion for both orbit raising and station keeping

**ATTAIN ORBITAL POSITION AFTER LAUNCH**

- **APOGEE**
  - Altitude 35,786 km
  - Radius = 42,164 km
  - Inclination = 0 deg

- **GEO Orbit**
  - **PERIGEE**

- **GTO Orbit**

**MAINTAIN OR CHANGE ORBITAL LOCATION**

- Satellite thrust manoeuvre to move inclined orbit to e.g. equatorial orbit

- **Inclined orbit plane**
  - Inclination angle

- **Equatorial orbit plane**

**ΔV~ 1500m/s**

**ΔV~ 50m/s per year**

Two thirds of propellant is used during orbit raising
### Electrical propulsion and more competitive launch costs as game changers

#### PROPELLION

<table>
<thead>
<tr>
<th>BEFORE</th>
<th>NOW</th>
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**Propulsion**

- **Chemical propulsion for orbit raising**
  - Propellant is > 50% of the mass

- **Electrical propulsion for station-keeping**
  - A proven technology used since 2000 on Eutelsat’s fleet

- **Electrical propulsion for orbit raising**
  - More efficient thrust per kg of propellant
  - Longer to reach orbital position

- Reduced satellite mass
- Enhanced payload
- Or mix of both

**Launcher**

- Lower position on Ariane 5 rocket the only cost-effective solution for lighter satellites
- SpaceX Falcon 9 rocket provides a cost efficient alternative to Ariane 5 for lighter satellites

- Reduced launch cost
- Or mass savings leading to enhanced performance
... leading to significant reduction in programme cost

CAPEX BREAKDOWN OF A TYPICAL PROGRAMME

- 50% Satellite
- 34% Launcher
- 6% Insurance
- 10% Other

Average saving linked to electric propulsion

~10% reduction in programme cost

INCREASED SATELLITE LIFE

- Estimated operational average lifespan increased typically from 15 to ~18 years

Eutelsat 115 West B launch

Estimated reduction in Capex/transponder/year of ~20%
Eutelsat benefiting from early adoption of electrical propulsion

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Key Features</th>
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<tbody>
<tr>
<td>KA-SAT</td>
<td>- Electrical propulsion for station keeping to maximize the satellite throughput</td>
</tr>
<tr>
<td></td>
<td>✓ Reduced cost per bit</td>
</tr>
<tr>
<td>EUTELSAT 115 WEST B</td>
<td>- First full electric commercial satellite</td>
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<td></td>
<td>✓ Launched as a pair on Falcon 9, halving already competitive launch cost</td>
</tr>
<tr>
<td>EUTELSAT 172B</td>
<td>- First European full electric commercial satellite</td>
</tr>
<tr>
<td></td>
<td>✓ Compatible with Ariane 5 low position, reducing launch cost by ~40% vs. upper position</td>
</tr>
<tr>
<td>AFRICAN BROADBAND SATELLITE</td>
<td>- First Spacebus NEO satellite</td>
</tr>
<tr>
<td></td>
<td>✓ Higher throughput and compatible with most competitive launch solutions</td>
</tr>
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</table>
Cost reduction

2.1 Electric propulsion

2.2 High throughput satellites

2.3 Productivity initiatives
Eutelsat a pioneer in HTS capacity

► 2010: KA-SAT over Europe, World’s highest capacity HTS commercial satellite

► Upcoming launches to extend our footprint:
  ► Q4 2015: ETL 36C (Russia)
  ► Q1 2016: ETL 65WA (Latin America)
  ► 2016: AMOS-6 payload (Africa)
  ► H1 2017: ETL 172B (Pacific)
  ► 2019: African Broadband satellite (Africa)

► Ka-band the band of choice for consumer broadband HTS
Significant reduction in bandwidth cost for broadband applications

**CONVENTIONAL FSS PAYLOAD**

- Total Bandwidth: 1.0 GHz (4x250 MHz)
  - (Polarisation 1) F1 F2
  - (Polarisation 2) F1 F2

- A given frequency can be used only once in a given coverage

**HTS PAYLOAD**

- Total Bandwidth: 4.5 GHz (18x250 MHz)
  - (Polarisation 1) F1 F2
  - (Polarisation 2) F1 F2

- The same frequency can be used over separate zones, without creating interferences

- The quality of the link is improved

Bandwidth cost can be reduced by 1 order of magnitude
Bigger is better... up to a point

► The bigger the satellite, the greater the economies of scale
  • Payload is mostly a variable cost (a function of capacity)
  • But platform and launcher are mostly fixed costs

► But there is no point in launching a satellite which cannot be quickly filled up

COST PER GBPS AS A FUNCTION OF TOTAL CAPACITY

Cost per Gbps (in M€)

Satellite capacity (in Gbps)

Cost per Gbps produced

Cost per Gbps sold after 3 years
Cost will continue to fall as time and technology progress.

**SELECTED ENABLING TECHNOLOGIES**

- **PLATFORM**
  - Electric propulsion
  - Full electric propulsion
  - Larger more powerful and thermally optimized platforms

- **PAYLOAD**
  - Larger reflectors
  - Q/V band
  - Photonics
  - GaN SSPA

- **SYSTEM**
  - DVB-S2X
  - Optical links

Medium-term target: €1m/Gbps

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1 Solid State Power Amplifier
2 Modulation of the forward link
Cost reduction

2.1 Electric propulsion

2.2 High throughput satellites

2.3 Productivity initiatives
Enhancing design-to-cost approach

In depth review of investment process and overall contractual and technical requirements

- Internal iterations to better adjust mission requirements
- Perform trade-off analysis and enhance the value-for-money
- Distinguish ‘must-have’ versus ‘nice-to-have’
- Win-win design-to-cost discussions with manufacturers

Greater interaction between strategic assessment, commercial needs, cost and technical solutions
Supporting initiatives to industrialize satellite manufacturing

► Work underway on new concepts and new production techniques
  • 3D manufacturing (E172B)
  • Use of commercial parts (under study for next generation platforms)

► LEO constellation initiatives will help accelerate this evolution

► Eutelsat Quantum aimed at developing genericity at satellite equipment level by transferring complexity from hardware to software

Reduction of mass, lead-time and costs
Increased efficiency

3.1  Flexibility at fleet level

3.2  Eutelsat Quantum

3.3  Flexible HTS
A flexible fleet for Eutelsat…and its customers

- Flexibility essential to adapt to market evolution over the 15+ year lifespan of a typical satellite

- Eutelsat satellite design incorporates flexibility features in terms of orbital location, coverage, frequency plan

- Main benefits
  - Possibility to relocate satellites as part of an overall deployment strategy
    - Optimize launch failures strategies
    - Seize commercial opportunities
  - Value for the customer in terms of restorability of service and continuity

- Flexibility of fleet much easier to implement for large satellite operators
Case study: ramp-up of 7/8°W orbital position, creating leading Video hotspot in MENA

Number of physical transponders operated at 7/8°W

- Launch of E8WB
- E8WC and E8WA relocated with Nilesat 201
- Launch of ETL 7WA
- AB4A is relocated at 3°E
- HB4 satellite relocated at 7°W under the name AB4
- Launch of AB4A positioned at 7°W. AB4 is relocated at 16°E.
- Hot Bird 13A relocated at 8°W under the name E8WC
- Launch of E8WB E8WC and E8WA relocated

Timeline:
- Nov-08: 15
- Nov-09: +24
- Nov-10: +15
- Nov-11: 39
- Nov-12: +10
- Nov-13: 54
- Nov-14: +26
- Nov-15: 78
- Nov-16: 104
Increased efficiency

3.1 Flexibility at fleet level

3.2 Eutelsat Quantum

3.3 Flexible HTS
### Eutelsat Quantum: wide-ranging benefits

<table>
<thead>
<tr>
<th>BENEFITING EUTELSAT...</th>
<th>...ITS CUSTOMERS...</th>
<th>... AND THE INDUSTRY AS A WHOLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better synergy within the fleet</td>
<td>Adaptability to demand in terms of coverage, power and frequency allocation</td>
<td>Independent building blocks from applications and ITU regions</td>
</tr>
<tr>
<td>Optimized usage of spectral and power resources</td>
<td>Ideal match for government, mobility and surge requirements for data applications</td>
<td>From “on-demand” manufacturing to pre-production of hardware</td>
</tr>
</tbody>
</table>
| Future-proof design to cope with market uncertainties | First-mover advantage | • Lower production cost  
• Shorter production cycle |
| First-mover advantage | | |

A win-win-win innovation
Flexible power allocation

Low demand

High demand
Flexible coverage on the return link

TYPICAL WIDEBEAM COVERAGE

HIGH G/T AREA

PEAKS 9-10DB/K

OR TWO INDEPENDENT AREAS

2dB/K

5dB/K

3dB/K

3dB/K
<table>
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<td>3.1</td>
<td>Flexibility at fleet level</td>
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<tr>
<td>3.2</td>
<td>Eutelsat Quantum</td>
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<tr>
<td>3.3</td>
<td>Flexible HTS</td>
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</table>
Flexible HTS: The concept of optimal flexibility

- Cost per bit sold matters more than the cost per bit produced
- Flexibility introduces complexity and therefore extra costs...
- ... but if optimally defined, the benefits will significantly outweigh the increase in cost
  - Faster ramp-up
  - Higher fill-rate at run-rate

- Eutelsat’s future African Broadband satellite factors in:
  - Design improvements
  - Technological progress
  - ‘Optimal flexibility’ features

The cost per bit sold of African Broadband satellite will be between half and one third of KA-SAT’s
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Enhanced end-user experience

4.1 Smart LNB

4.2 Multi-screen delivery solution

4.3 Interference protection
Smart LNB applications beyond connected TV

<table>
<thead>
<tr>
<th>VIDEO</th>
<th>BROADBAND</th>
<th>MACHINE TO MACHINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ Smart LNB: a low-cost return-link via satellite for “satellite-connected-TV”</td>
<td>▶ Smart LNB to provide anywhere internet access</td>
<td>▶ Low equipment cost – consumer grade terminal</td>
</tr>
<tr>
<td>▶ Allowing interactivity</td>
<td>▶ Forward link up to 8 Mbps / return link up to 160 kbps per user</td>
<td>▶ Low service cost - high-efficient protocol for message-based transmissions</td>
</tr>
<tr>
<td></td>
<td>▶ Low-cost satellite terminal</td>
<td>▶ Targeting Smart Grids, Environment Monitoring, Wireless Sensor Networks</td>
</tr>
</tbody>
</table>

New opportunities for growth in other applications
Enhanced end-user experience

4.1 Smart LNB

4.2 Multi-screen delivery solution

4.3 Interference protection
Multi-screen delivery solution via satellite

► Eutelsat the first enabler for multiscreen delivery via satellite to portable devices

► Combination of native IP multicast with local WiFi distribution

► Compatible with all mobile devices

► No increase in distribution costs as the number of users increases

► Benefits for broadcasters
  • OTT via satellite in markets underserved by terrestrial networks
  • Increased channel reach with detailed audience measurement
  • Nomadic TV reception in public spaces
  • Formats tailored for smartphones and tablets enabling up to 100 channels per transponder and richness of channel line-up
  • Universal coverage
Enhanced end-user experience

4.1 Smart LNB

4.2 Multi-screen delivery solution

4.3 Interference protection
Anti-jamming protection

- Interference (Intentional or not) can be an issue for certain applications (Government Services) and geographies (e.g., MENA)

- Eutelsat is a pioneer in anti-jamming protection
  - EUTELSAT 8 West B: additional uplink coverage in Rambouillet
  - EUTELSAT Quantum: improved detection of jamming sources and possible reconfiguration of uplink coverage

EUTELSAT QUANTUM – EXAMPLE OF JAMMING MITIGATION
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To sum up

- Eutelsat has a track record of leadership in innovation
- Electric propulsion, HTS and productivity initiatives enabling cost reduction
- Enhance flexibility at fleet and satellite level for increased efficiency
- Technology to improve customer experience
- Leading to greater value creation from our capacity