

ADCSS Session 1 TAS-F acquired experience on the development of the last 3 major constellations and challenges for future mega constellations

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Constellations drivers and stakes

Impact on the Avionics for the three major telecom constellations

Future challenges of the constellations

## **ADCSS Session 1: Constellations drivers and stakes**

- In the past 10 years the 3 major telecom constellations have been developed by Thales Alenia Space:
  - On LEO orbit: GlobalStar 2 with 24 SV, and IRIDIUM NEXT with 81 SV
  - On MEO orbit: O3b with 20 SV
- For each constellation, avionics enhancement has been performed to meet the objectives :
  - Recurrent cost improvement
    - Recurrent cost makes the overall cost even if High NR
  - In flight autonomy
    - Launch by batches of 10 satellites
    - Ease and lighten ground operations
  - High production rate
    - Up to 4 Satellites produced per month





#### Integration and test duration

3

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### Recurrent cost improvement: (1/2)

#### Design to cost :

- Avionics architecture has been optimized to simplify the electronics in term of redundancy and cross strap: trade off based on reliability at constellation level
- Units optimization has been done with suppliers leading to specification modifications or different layout on satellite or function transferred into software

#### COTS use: First factor of cost improvement

- COTS selection has been performed and shared with suppliers
- Production flow has been modified to warrant the same level of confidence than grade 1 or 2 components
- Even with a reduced list, significant cost decrease has been performed

Recurrent cost improvement: (2/2)

- Increased electronic integration
  - Higher integration decreases the number of components
    - ASICs have been developed to embed processor and companion chip
    - FPGAs even if still more expensive have been kept to meet the schedule constraint while allowing late flexibility
  - STR function optimization between Optical Heads and the platform computer
    - STR SW embedded in the platform computer
    - Specific STR SW management performed to cope with CPU throughput
    - Peltier management by the platform unit



# In flight operation: optimize operation workload

- Automatic raising in NOM (Earth pointing)
  - Requires automatic mode transition with adequate success criteria to warrant Satellite power
  - Used for launch: the 10 Satellites go automatically in NOM after separation without ground intervention
  - Used after SAFE recovery: the ground enables the automatic transition in NOM
- Automatization capability in flight
  - Features embedded to optimize operations without any SW modification
  - Free macro command list available to factorize repetitive actions
  - On Board Procedure capability can be uploaded



# High production rate

- Autotest including trend capability has been developed and validated by the Avionics
  - On board procedure and test report with reduced duration and high repeatability
  - Platform health check testing performed in 2 hours
- > Optimized test plan from supplier up to satellite AIT
  - Verification by trend on families
  - Reduced test plan for High Rate production
  - Test optimization campaign according to lessons learnt

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Impact on the Avionics of the three major telecom constellations

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### Cost to market

- Competition has increased in the last years for telecom constellations, price target is driven by the ratio Mbyte/\$
- This statement drives us in our new design and development solution in order to fulfill drastic reduction of the cost/performance ratio



## **ADCSS Session 1: Future challenges of the constellations**

### Development duration

- According to telecom space and ground competitors, delivery time of a constellation is a key driver
- Thanks to experience acquired on constellation development, further improvement through engineering tools enhancement
  - Extensive use of the modelling
    - Common abstraction level allowing parallel design
    - Model reuse from specification consolidation down to validation testing
  - Software Autocoding deployment
    - Systematic use on algorithm functions
    - Optimize validation effort on algorithm simulators and SW simulators
  - Benefit from experience to rely on numerical simulation
    - Early development of simulators
    - Extensive validation on simulators in term of functional and performance
    - "Rendez vous" points with suppliers to correlate the simulators
    - Reduced test plan with a driver: "test as you fly"

# **ADCSS Session 1: Future challenges of the constellations**

#### Hardware cost decrease

- Starting round 16 SV for a constellation, recurrent cost is a major driver
  - Components represent more than 80% of the units cost
  - Higher integration and component cost reduction
- COTS component approach is an opportunity to improve competitiveness
  - Need to qualify COTS to the LEO/MEO missions radiation environment
  - Need to have the agreement of the customers to this approach successfully held on NEXT
- Further electronics Integration thanks to next available computer technology
  - Use of multicore on same FPGA to manage platform, GPS and STR SW
    - Single component use
  - Use of re programmable FPGA with secured access for functional variability management and development schedule compression

## **ADCSS Session 1: Future challenges of the constellations**

### Security management

- Constellation market show an increased interest of the customers in term of secured commanding and telemetry of the platform management in flight
  - This leads to use expensive external units for TC decryption and TM encryption: almost the same price than the computer itself
- The future challenge is to provide hardware and software integrated solution with the same level of confidence than external procured HW one
  - Need to integrate the constraints at the beginning of the development
  - Need to share this approach with the customer and the end users

- For Globalstar 2, O3b and IRIDIUM NEXT, Thales Alenia Space has developed Avionics which has met the constellation challenges while keeping high reliability levels for 10 up to15 years flight lifetime
- In the frame of constellation market with high reliability levels further effort shall be done on
  - Design based on COTS facing high radiation environment
  - Reduced development cycle