The Dream Payload

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Flexibility is…

- An asset for the optimum commercial exploitation of satellites.
- An essential tool to ensure that spacecraft resources are used to the best economic benefit.
- Herewith limited to 3 areas
  - Frequency Plan
    - Uplink and downlink centre frequencies
    - Bandwidth
  - RF power management
    - Trade-off between EIRP and number of active channels
  - Service area definition.

Flexibility in Satellite Communications: Scope

- Satellite prime mission might evolve during lifetime
- Satellite could be relocated
  - Need to operate the satellite from another orbital location and/or over another service area
- Communication product or system might become obsolete before satellite EOL
- Satellite missions could envisage new frequency bands and/or new service areas
  - This is probably the most difficult to achieve

Flexibility is an important asset for:

- Optimisation of the fleet management
- Optimisation of the payload resources
- Commercial risk mitigation

Flexibility Applications

- Payload flexibility can be divided into three main domains:
  - Frequency plan flexibility including:
    - Channel bandwidth
    - Frequency conversion
    - Selectivity
    - Connectivity
  - Power Allocation Flexibility
  - Coverage Flexibility concerning
    - communications antennas
- The Dream Payload aims at combining these three items into a single payload architecture

Frequency Plan Flexibility: Channel Granularity and Connectivity

- Channel bandwidth granularity enables
  - Optimisation of channels bandwidth to the addressed market
- Channel granularity can be provided by:
  - RF Filter Banks:
    - ✓ conventional equipment/ minimal risk impact on the satellite programme
    - ✗ low granularity
    - ✗ large mass and footprint
  - IF Filter Banks:
    - ✓ high granularity w.r.t RF filters
    - ✓ excellent in-band and out-of-band performance
    - ✗ impact on transponder phase noise important
    - ✗ complex development and tuning
  - Baseband Digital Filtering:
    - ✓ highest level of granularity
    - ✓ good filtering performance
    - ✗ significant impact on system phase noise
    - ✗ complex development

Power Allocation Flexibility: MPA

- Multi Port Amplifiers (MPA) offer
  - Efficient way to manage the payload resources according to the operational requirements
  - Full connectivity and selectivity, sharing the power amongst the transponders on a service area or service areas, with no impact on the output network
  - Possibility of compensating different antenna gains associated with the different service areas
  - Several advantages, among which:
    - More flexible performance of the satellite
    - Larger range of operational scenarios
    - Easier business case in the planning stages because of the enhanced operational flexibility in orbit during the satellite life time

Coverage Flexibility: Reconfigurable Antenna

- Main potential technologies for providing Fully In-Orbit Reconfigurable Antennas:
  - Active phased array antennas
  - Array fed reflector antennas
  - Deformable (sub) reflectors
- Active Antennas (direct radiating or array fed reflector antennas)
  - Ability to produce simultaneously multiple beams and to rapidly change the coverage of each beam
  - Used on military satellites, LEO and MEO satellites and demonstration payloads, e.g. STENTOR and AG1
  - Transmit active arrays have traditionally been limited thermally
- In-Orbit Deformable Reflectors:
  - Renewed interest in the potential of deformable reflectors

It is of primary importance that operators like Eutelsat are well aware of the impact on payload mass, power dissipation, performance, procurement planning of such technologies.

The Dream Payload offers…

- Full flexibility of the frequency plan: channelization and down-conversion
  - Digital transparent payload?
  - FPGAs?
- Flexibility of the power subsystem
  - MPAs?
  - SSPAs?
  - Linear HPAs?
- Coverage flexibility
  - Over a delimited service area?
  - From several orbital locations?
- Payload standardization through equipment and components standardization

Project and Quality considerations

> Component qualification, screening, acceptance

In order to meet satellite delivery schedules for operation, qualified and tested components are required early in the integration schedule. This implies that a standard space qualified product is available with a minimum of project specific features.

> Dependability

Are the current requirements for screening components and assessing reliability sufficient to cover advanced components?

> Redundancy

System architecture should consider the level of redundancy given by the functionality of the component and also the broader aspect of system reliability in the case of failure of a component.

> Testability

As components become more complex, the level of testability must be taken into consideration at component screening and also at system level. Should component testing cover all the possible reconfiguration options of a device? In the case of in – orbit payload reconfiguration, what is the level of validation that is possible ?

These basic questions must be addressed and declared before a dream payload is presented

> Exchangeability

Unfortunately it is the case that equipments / components fail for various reasons during system integration and test phases. As the discrete building blocks become more complex this has an increasing impact on overall schedules if replacement and retesting is required. This should be a consideration in system design

Conclusions

Advantages

- Flexible Payloads are an important asset for
  - Optimisation of satellite resources use throughout lifetime
  - Enhancement of the satellite commercial missions
- Industrial advantages:
  - Development of products that could comply with many different requirements
  - Shortening of the development and tuning phases of long lead items e.g. TWTAs or antennas
  - Reduction of the overall schedule of satellite procurement.

Issues

- Development plan and time-to-market:
  - It shall be ensured that flexible payload components are not on the critical path for the satellite procurement.
- Operational constraint:
  - Constraints for operation of flexible payloads shall be minimised w.r.t conventional technologies.
- Reliability
  - Development and qualification plan shall not question the reliability of the overall mission.
- Mass, power and cost