



Virtual Private Constellations for Milsatcom and Govsatcom

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Current and Emerging Trends

- Military users are increasingly looking to commercial capacity to provide some or even much of their Satcom needs
- Transparency is a key system enabler for militarisation of commercial systems by using sovereign, militarised waveforms and ground segment through them
- We are seeing the convergence of user terminals and gateways with VHTS satellites and LEO constellations
- The emergence of Gov Satcom as a new sector between military and pure commercial - Airbus are already involved in EU Govsatcom
- LEOs and MEOs having some advantages over Geo in some areas, but potential cost barriers to deploying them
- The ever increasing importance of mobility for military users (Ukraine experience)



Why LEOs are good for Mil / Gov Users

- LEOs can offer some significant advantages over GEO
- Latency is considerably lower
- Coverage is potentially truly global
- Communications geometry is variable which may reduce susceptibility to downlink jamming (double edged sword as can add complexity)
- Link budgets can be 40dB better enabling :
 - Very High Throughputs
 - Low Tx power for LP* communications for Subs , SF etc
 - Disadvantaged terminals with poor / omni antennas / handhelds
 - Mobility whilst communicating using omni antennas as above
 - Anti Jam / robustness benefit due to coverage constraints / beam isolation from strategic threats



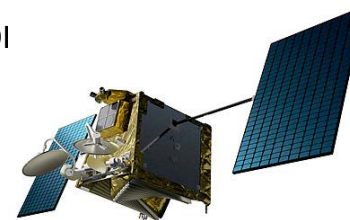
The problem with LEOs

- The basic problem is that they move relative to the ground user
- Military / Government coverage requirements at any one time are likely to be a limited number of relatively constrained geographical areas, but potentially widely distributed over the globe
- To provide continuous service availability in Customer coverage areas, a full LEO constellation is still required
- **This is almost certainly too expensive for most potential users**
- At any one time only a small fraction of the LEO constellation would be active
- For most of their orbit / most of the time, the LEOs wouldn't be doing any useful communicating
- **What Military / Government Customers really need is a share of a LEO constellation, in the right place at the right time**



A new Paradigm (pun very much intended)

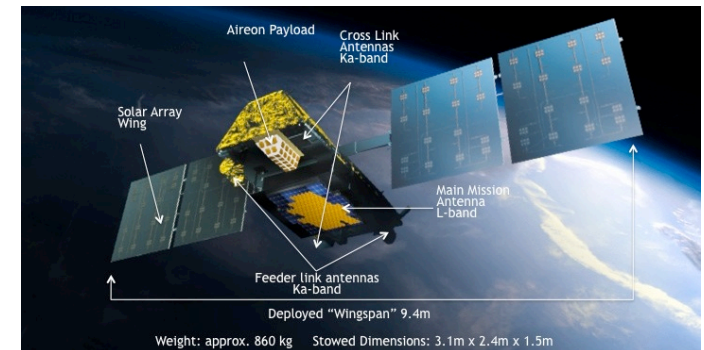
- MoDs, Governments and specialised users are facing the same inescapable logic about LEOs
- What if a hybrid Commercial / Govsatcom / Military LEO constellation existed that MoDs could buy services from to meet their LEO needs, without having to find the capital expenditure to build a constellation?
- Such a service could provide a LEO component into the Gov satcom domain
- Why don't Airbus become a LEO constellation operator, leveraging our OneWeb bus / production experience and our extensive heritage in providing military / assured services?
- Constellation deployment would be funded through normal private finance means like a conventional satellite operator, perhaps with some up front buy in from lead customers
- High assurance would be a USP, this can be enabled through system architecture
- LEO services can then be sold to UK MoD and other parties to meet their needs / provide niche capabilities, without the users having to buy a LEO constellation
- **This Airbus service provider could be the new Paradigm**



The Constellation

Frequency Bands

- Constellation Frequency bands are TBC but could support extended Ka band (Civ plus Mil) allowing provision of services to Civil / Commercial, Government and Military users according to demand
- Military Ka band may be unique for a LEO constellation
- Suggest that the constellation should also support X band, also unique in this respect
- Processing and anchor capacity can be shared between bands
- L and or S band could also be usefully provided
- Flying the Harris Appstar payload or similar could be one way of achieving this
- Hosted services are something else that the constellation could offer depending on bus capacity constraints



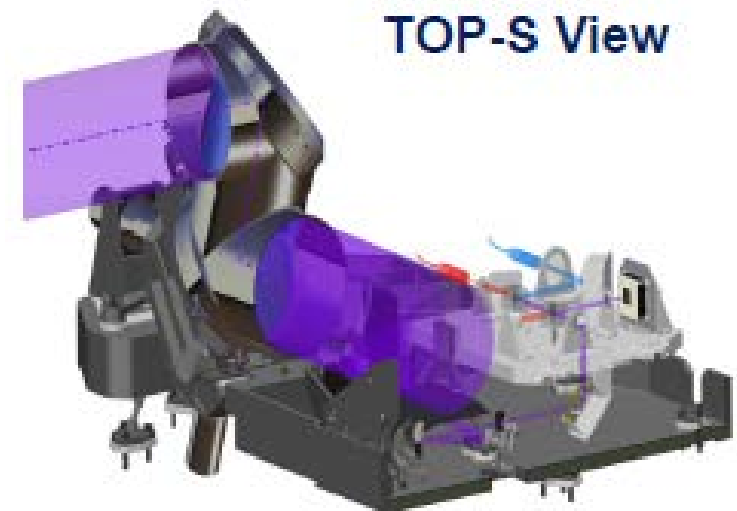
Constellation Design

- Suggest an analog of the LEOsat / Iridium constellation with Oder 66 satellites rather than a One Web / SpaceX etc with hundreds to constrain cost
- Optical cross linking as per LEOsat / One Web 2 is a key feature



RFoOISL, Transparency and Sovereign Anchoring

- This is key
- Using analogue RF over Optical Inter Satellite Links (RF / Optical technique proposed for optical feeders for UHTS satellites, discussed at the MBDA workshop) we can enable 2 key things :
 - Use of Sovereign Waveforms and Crypto end to end by users
 - Anchoring of services wherever they want (i.e. in their own sovereign space) with assurance of tunnelling traffic only through the space based OISL network
- This could be a really good selling point for Military / Gov users
- There are a number of approaches to how the OISLs are used



Types of OISL

- A number of ways of using OISLs are possible, each with slightly different features / potential uses
- Direct Modulated OISL – The whole Optical ISL is modulated to transmit a single or multiplexed data stream (as per EDRS) – may be limited on total throughput by demod capability without multi carrier operation
- RFoISL – The OISL supports analogue, optically converted RF signals in a multi wavelength FDM
- Sample Stream OISL – The OISL supports high rate, optically converted RF signals which themselves carry a sequence of samples representing an original RF signal captured at the OISL source satellite
- Hybrid OISL – OISL supports a mixture of approaches concurrently on the same ISL, potentially supporting different traffic types

Capability Hosting

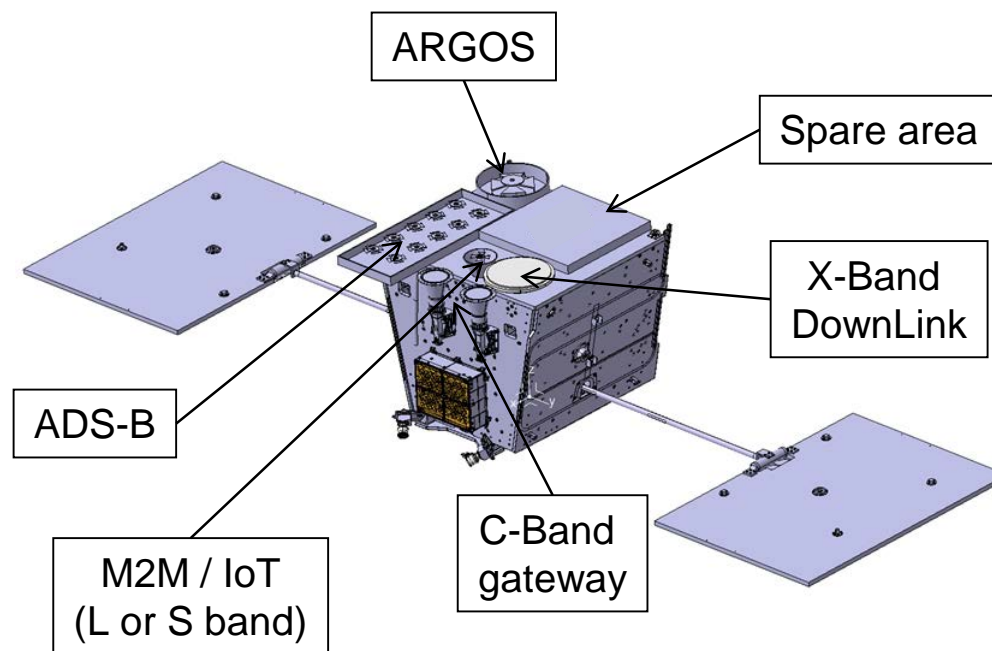


- The utility of the LEO constellation to potential customers could be further enhanced by hosting capabilities for customers on the LEO platforms, there are a number of models for this :
 - 1) Service Hosting – communications services provided via LEO operator owned / provided infrastructure on the satellites - Can include 'Virtual Private Constellation' model where independent ISL routing of signals across the constellation is assured and customer uses own gateway, transparent services routed via ISL network allow use of sovereign waveform and crypto end to end
 - 2) Software Image Hosting – Equivalent to Appstar Customer – Customer provides software to a Software Defined Payload – could include sovereign crypto algorithms / signing / security features
 - 3) DSP Processing Hardware hosting – like the Inmarsat 6 SPP model – customer flies as hosted hardware payload, but shares key infrastructure with the hosting satellite, such as antennas, signal muxing etc
 - 4) Standalone Payload hosting – Equivalent to Appstar owner – customer hosted payload includes own antennas etc

These models may make it possible for a number of sovereign entities / military / government customers to effectively share access to a LEO constellation, with variable levels of investment and corresponding independence / assurance possible

Multi Mission Constellation

- Allowing Margins (Volume, Mas, Power, Thermal, TT&C, OISL network capacity) in the LEO platform design for hosting additional 3rd party payloads could further increase the utility and value of deploying a constellation and make it attractive to a much wider base of potential customers
- The offering would be to host 3rd party payloads on some or all of the constellation satellites with real time access to those payloads for TT&C and mission data transfer via the constellation OISL backbone network
- Earth Observation, SIGINT and Science missions are examples of the types of mission that could be supported



Virtual Private Constellation

- Exploiting RFoOISL to enable transparency, assured privacy and anchoring where you want means that the service offering is effectively a 'Virtual Private Constellation'
- Hosted, customer owned capabilities further progress this concept
- Users can gain the benefits of having a LEO constellation with a high degree of security, freedom of action and autonomy, without the cost of having to pay for the whole constellation – this could be an attractive proposition to many Military / Government users and commercial customers requiring a high degree of autonomy
- Extending the constellation through hosting to support Scientific / Earth Observation missions can further increase the utility of the constellation, distribute cost and widen the potential customer base

Summary

- LEO Capabilities could be very useful for many Military and Government organisations
- Single organisations or even single nations probably can't afford a LEO constellation
- There may therefore be a market gap in terms of a dual Civ / Mil / Govsatcom LEO constellation using commercial build but aspects of service assurance
- Airbus has heritage in LEO constellation build s from One Web and Assured Service Operations from Paradigm
- Airbus could become an operator of a LEO constellation addressing this type of user, providing what UK MoD and many other users need
- RFoOISL could be a game changing enabler for this type of market, allowing users to use their own waveforms and crypto end to end, and anchor wherever they like, with assurance that their signals have only gone through a pipe in the sky between user and anchor
- Hosting Services potentially allow further autonomy and 'sovereignisation' of the capability offered
- A multi-mission constellation could widen the potential customer base to allow further distribution of cost