



→ SERVING EUROPEAN
COOPERATION
AND INNOVATION

Small satellite developments in ESA satellite telecommunications group

www.esa.int

Frank Zeppenfeldt

What do we do?

1. We fund research and development in the field of satellite communications, using a program called **ARTES** (Advanced Research in Telecommunications Systems)
2. Satellite communications is a very commercial business – so products need to be **competitive**
3. We issue tenders for **long-term developments – we fund 100%**
4. **You** can always submit a proposal for a mid-term development you see a market opportunity for – **we co-fund 75 to 50%, you bring 25 to 50%**
5. We fund developments or studies in **ground segment, space segment, payload and system – including in-orbit validation**



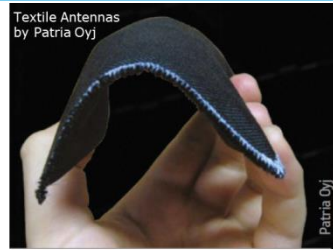
Sample of outcomes of our contracts



SAT3PLAY (voice, data, TV) by NEWTEC



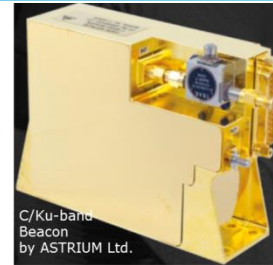
Global Navigation Satellite System Receiver - by Septentrio



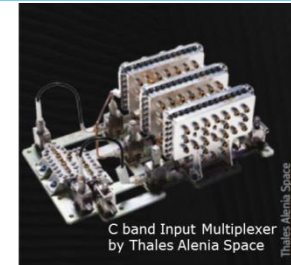
Textile Antennas by Patria Oyj



Tracking Multimode Feed Horn Design Optimisation - by TICRA



C/Ku-band Beacon by ASTRUM Ltd.



C band Input Multiplexer by Thales Alenia Space



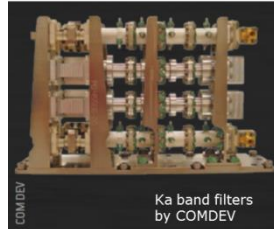
Efficient Mobile Antenna Land, Sea and Air by JOTRON



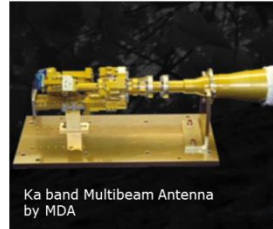
Media Fleet Manager by ND SatCom



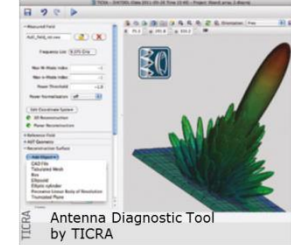
Connecting Remote Communities by Altorbridge lite-site™ solution



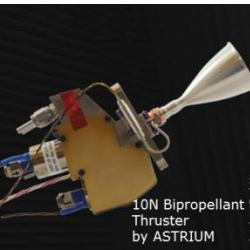
Ka band filters by COMDEV



Ka band Multibeam Antenna by MDA



Antenna Diagnostic Tool by TICRA



10N Bipropellant Thruster by ASTRUM



745 Litre Tank for EUROSTAR 3000 by ASTRUM GmbH



Improvement of Eurostar 3000 Mechanical Platform by ASTRUM Ltd.



Power Conditioning Unit (PCU) by Thales Alenia Space ETCA



Coarse Sun Sensor by TNO

...and many, many prototypes and systems studies

Smallsat and commercial telecom – what is missing?



1. Technical

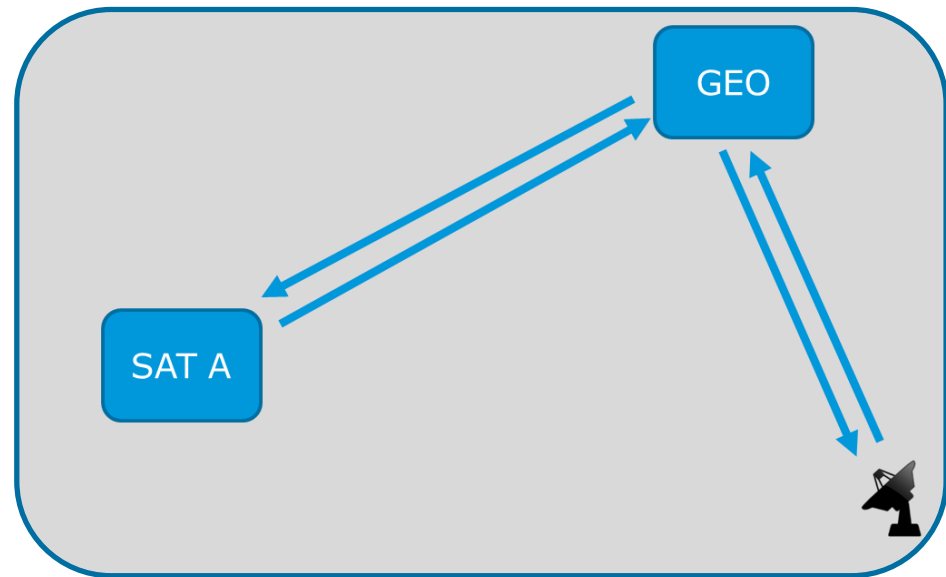
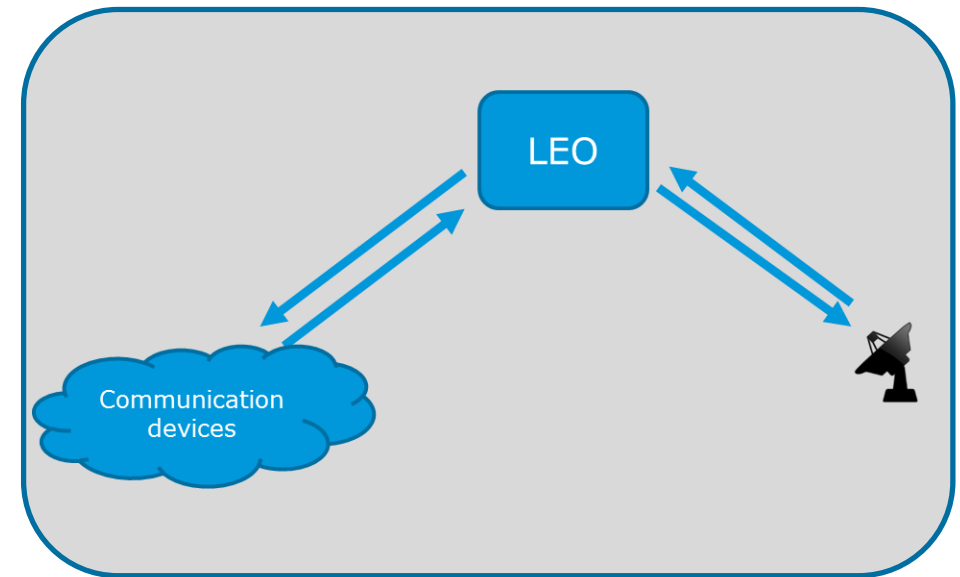
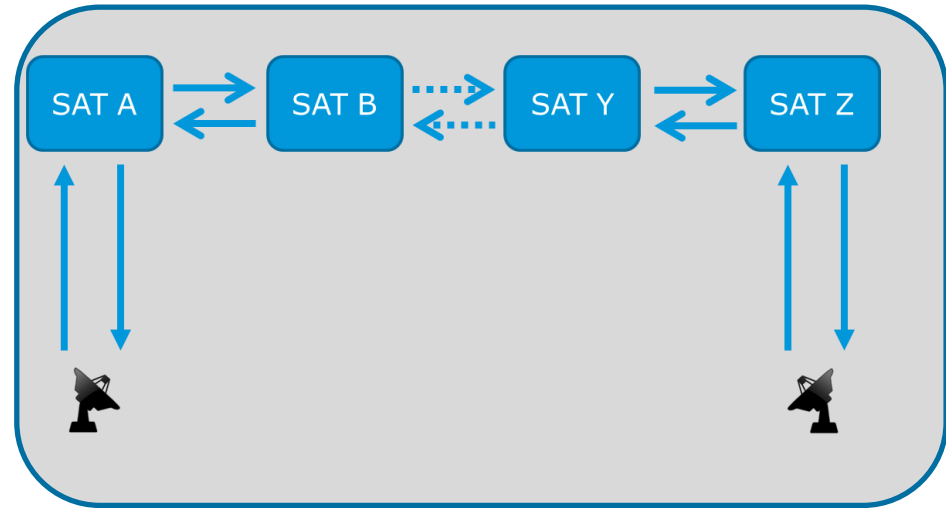
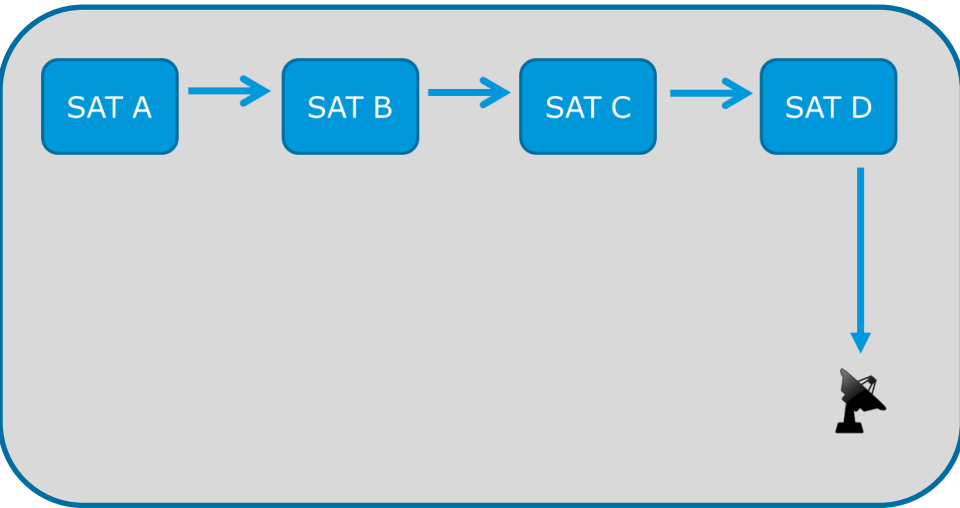
- **Baseband and RF equipment** using commercial telecom frequency bands which would allow higher data rates (i.e. C or Ka-band)
- Ability to increase the **gain** of antenna's and allow **pointing**
- Ability to have a **low-cost inter-satellite link** (optical or RF) to GEO to receive or send data to smallsats
- Ability to implement **simple ISL** between multiple smallsats

2. Regulatory issues (filing & coordination process at ITU)

- Is being addressed and will supported also by us for WRC-19

3. Other issues (AOCS, power, propulsion, new launcher methods, space debris mitigation, QA/PA...) are also important but **seem to be taken care of** by a community outside of telecom (science, EO missions, weather)

Four mission topologies where we see gaps in communication capabilities



Our plans for closing gaps



1. Technical – we issue this year a number of tenders for smaller satellite payload developments:

- a. Miniaturised **Ka-band FSS** transponder
- b. C-band transceiver
- c. LEO-LEO ISL RF (60 GHz or Ka-band ISL ? Fully transparent? Only intra-plane?)
- d. Network and link layer solutions for **inter-satellite** links between small satellites
- e. **Ka-band** Medium-gain antenna and pointing mechanism for smallsats
- f. Deployable antenna structure
- g. Small receive-only inter-satellite link **Ka-band 23 GHz** antenna and demodulator for use on smaller satellites

$\Sigma = 3.5 \text{ M€}$


2. Regulatory – some support to opportunities for smaller satellites, more support for WRC-19 small satellite issues planned

What more is happening – 1a

1. We tendered a small satellite or hosted payload for the so-called VDES (VHF Data Exchange System)

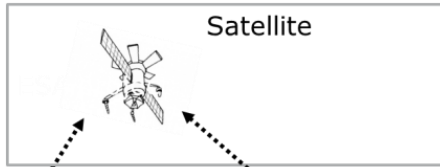


VHF patch antennas in sailing jackets

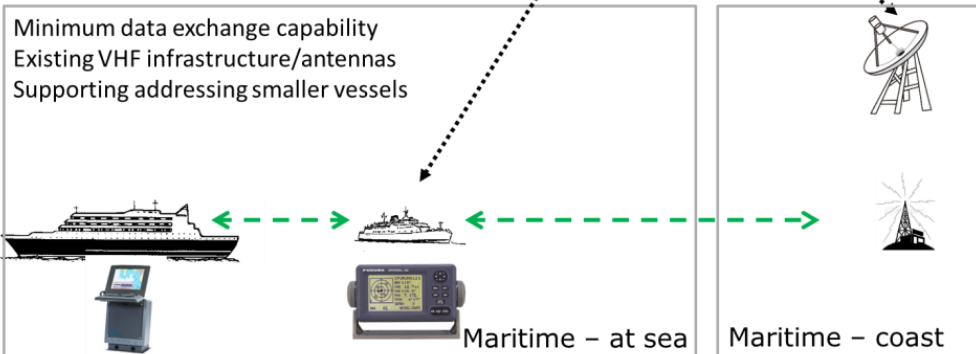


1024	1084	1025	1085	1026	1086
157200	157324	157250	157274	157300	157324
VDE1					
SAT up1					

2024	2084	2025	2085	2026	2086	2027	ASB1	2028	ASB2
161800	161824	161850	161874	161900	161924	161950	161974	162000	162024
VDE1						ASM1	ASM2		
SAT Downlink						SAT up1	SAT up2	SAT up3	SAT up4



Satellite



Minimum data exchange capability
Existing VHF infrastructure/antennas
Supporting addressing smaller vessels

Maritime – at sea

Maritime – coast

Radiocommunication Study Groups



Subject: WRC-15 agenda item 1.16
Resolution **360 (WRC-12)**

**Revision 1 to
Document 5A/TEMP/204-E
22 May 2014
English only**

Working Party 5A (Working Group 5A-4)

LIAISON STATEMENT TO WORKING PARTY 5B

WRC-15 AGENDA ITEM 1.16

In addition to the response (Document [5B/479](#)) to your request on WRC-15 agenda item 1.16 on the proposed VHF data exchange system (VDES) (Document [5A/302](#)), Working Party 5A (WP 5A) defined the following power flux density mask at the Earth's surface from the MSS space systems, which provides protection to the MS for which the concerned frequency band in the agenda item is allocated on a primary basis.

$$PSFD(\theta^\circ)_{(dBW/(m^2 * 4 kHz))} = \begin{cases} -149 + 0.16 * \theta^\circ & 0^\circ \leq \theta < 45^\circ; \\ -142 + 0.53 * (\theta^\circ - 45^\circ) & 45^\circ \leq \theta < 60^\circ; \\ -134 + 0.1 * (\theta^\circ - 60^\circ) & 60^\circ \leq \theta \leq 90^\circ. \end{cases}$$

That mask shall be used for elaboration of necessary regulatory proposals in the CPM text with regard to possible new allocation to MSS downlink around 160 MHz.

WP 5A would like to be kept informed of any development related to mobile service under this agenda item.

Status: For action

Contact: Evgeny Tonkikh

E-mail: et@nir.ru

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1. Many, many hours made before general support for a new satellite allocation (~ 5€/Hz)
2. Regular preparatory technical teleconferences
3. Only after some time, industry buys into the concept and supports
4. Initial spectrum request without clear application requirements

More awareness and lobbying is required.....



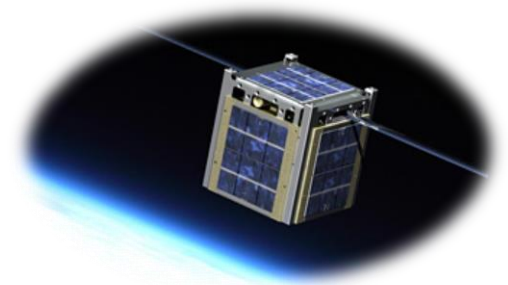
At the World Radiocommunication Conference (WRC-15) only administrations have decisive power



2. In 2015 we will tender a **Cubesat for W-band** (70/80 GHz) channel measurement. Any ideas on requirements or how to enhance such a mission very welcome !

W-band workshop 8 April ESTEC

<http://congrexprojects.com/2015-events/15m17/introduction>



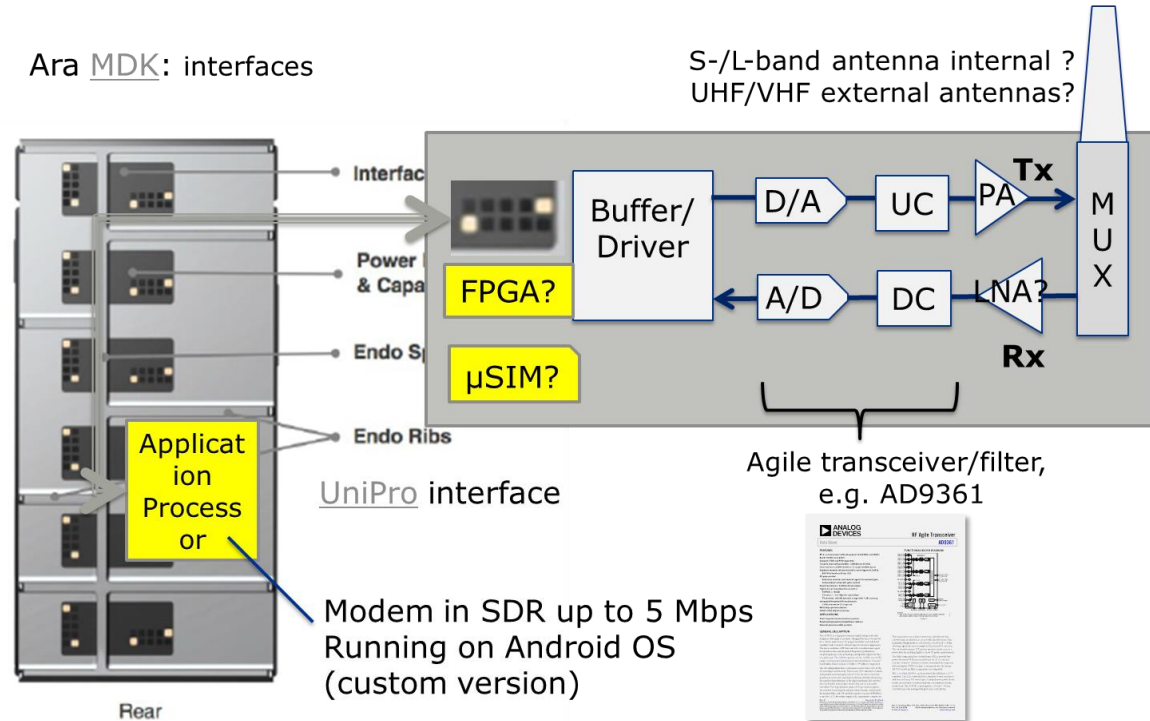
3. We are running a study contract to make an inventory of what is missing more for small/nano satellite in order to offer **commercially sustainable communication services.**
4. We will soon tender a **smallsat mission study** for monitoring of the radiation environment between **LEO and GEO** in order to support an accurate solar generator sizing for the orbit raising of future GEO satellites using electric propulsion

What more is happening – 3

5. Satcom Module for Google ARA project - spin off from mobile industries – development in 2015



Ara MDK: interfaces



Modem in SDR up to 5 Mbps
Running on Android OS
(custom version)



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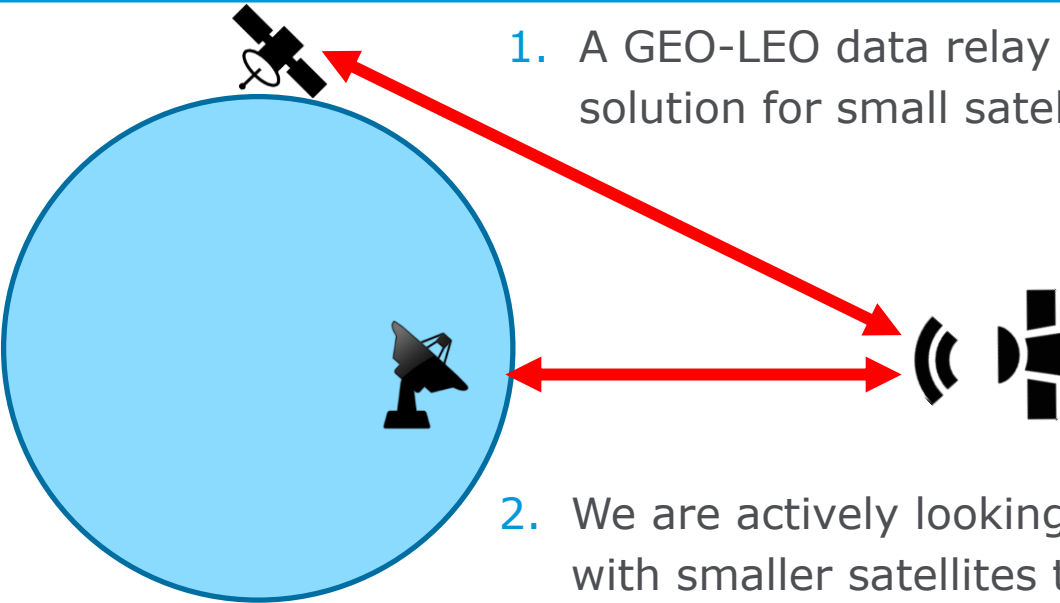
Future TT&C/payload(?) from smaller satellites



1. We support further work towards favourable position for smaller satellites at WRC-19
2. Modifications to ITU filing and coordination mechanisms (Art 9 and 11) are unlikely. Other ways to facilitate coordination **among small satellites** could be investigated in ITU. Ideally, studies to see if it is possible to identify a **dedicated spectrum range** and **an agreed access mechanism**.
3. ESA satellite communications group would be interest to support also the **GEO-LEO data relay component**
Artemis Listens Out For ATV Whisper On Route To ISS
by Staff Writers
Paris (ESA) Mar 27, 2012
ESA's Artemis communications satellite is in action again to ensure the safe arrival of Europe's third Automated Transfer Vehicle at the International Space Station with vital supplies.
Containing fresh supplies of fuel, water, oxygen, air, food, clothing, experiments and spare parts, ATV Edoardo Amaldi is a true lifeline to the astronauts on the Space Station. A prompt arrival is critical for the orbital outpost.
4. This is already in place for e.g. ATV with spread-spectrum access method



Future TT&C/payload from smaller satellites - 2



1. A GEO-LEO data relay can contribute to a future TT&C solution for small satellites
2. We are actively looking for demonstrations of such concepts with smaller satellites to prove **technical feasibility** and **collect requirements**
3. In case of interest and you have a small satellite which supports:
 - a. S-band Rx/Tx in 2 GHz or
 - b. Ka-band Rx/Tx on 22.55-23.55 GHz/25.25-27.5 GHz (EESS/SRS only 5.536) → **Contact us !**

1. ESA's satellite telecommunications group will fund various **payload developments** to stimulate telecommunication applications of smaller satellites
2. We seek **requirements** to make these developments useful for you
3. If you want to go faster – **put some of your own money** and we go at your speed
4. We believe **data relay via GEO** can **enhance** various smallsat missions and **ease coordination burden**. There is a need to experiment and test. **We seek candidates.**
5. We propose to support any WRC-19 studies, for example by funding a study on future TT&C concepts for smaller satellites, **including** the LEO-GEO relay component

6. We **also fund smallsat** developments – as long as they address a telecommunications service

7. We are collecting ideas for our **next work plan activities in 2016**

→ More **optical** for smallsat ??

Optical space communication workshop X April ESTEC

→ Demonstration mission linking up two smallsats with ISL's at high speed?

→ System studies for TT&C concepts, constellation management ?

→ Any specifics on ground segment (multiple satellites in view?)

→ More open source developments (HackRF alike, GNU Radio based?)

8. Contact:

ESA Satellite Communications

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