

**European Space Agency**  
**ARTES 4.0 Core Competitiveness Element**  
**Programme Component “A” Advanced Technology**

**Work Plan 2026**

## **1. Introduction**

A key role of ESA within the satellite telecommunications sector is to promote high levels of Research and Development activity within Participating State industry to help ensure both their preparedness and competitiveness in both the short and long terms.

ARTES Core Competitiveness Element Programme Component “A” Advanced Technology is concerned with early development stages of systems and exploitation of promising technologies for satellite communications. In some instances ARTES AT activities are a continuation of activities such as ARTES Future Preparations and the Technology Development Element.

Through ARTES AT, ESA supports the introduction of new technologies into equipment designs so that in the long-term, industry will be able to introduce state-of-the-art equipment and (sub)systems to the commercial marketplace. ARTES AT encompasses activities related to the development of both (sub)systems and equipment for satellite communications.

ARTES AT is the Agency's main programme for preparatory development of satellite communications technology. ARTES AT involves long-term R&D activities inherently incorporating a significant level of technical risk, and is therefore fully funded by the Agency.

The Work Plan for 2026 specifically addresses technology and equipment activities in support of the priorities defined in the Telecommunications Long Term Plan. The Work Plan for 2026 has been coordinated with ESA technology programmes. The activities are organised per application area and grouped as Ground Segment, System, Payload or Platform related.

In September 2025, a further 24 Work Plan activities were approved for 2026. The full list of activities can be found in Annex I and described in Annex II.

## **2. Implementation**

The implementation of the ARTES AT Work Plan activities will follow the Specific Implementing Rules for the ARTES 4.0 Generic Programme Line “Core Competitiveness”, Component A “Advanced Technology”. The following implementation will be followed:

**Phasing:** phasing of the contractual activities may be considered depending on the risks associated with the development, the maturity of the technologies, and potential early market perspectives.

**Parallel contracts:** in accordance with the ARTES 4.0 Specific Implementing Rules for the Generic Programme Line “Core Competitiveness”, proposals that have not ranked first in the Tender evaluation, may be re-considered for award of a parallel contract under the following conditions:

- The proposal is ranked at least “good” (60)
- The proposed technology is innovative and technically mature
- The starting TRL is lower than 4.
- The delegations concerned reconfirm their support for the proposal.

**Procurement Policy:** the following procurement policies are foreseen for the proposed activities:

- C: Activities in open competition without any further restrictions.
- C1: Activities in open competition limited to non-Large System Integrators (LSIs) as prime. LSIs are allowed to participate as sub-contractors.
- C2: Activities are in open competition, where a significant participation of non-LSIs is requested.
- C3: Activities restricted to SMEs & R&D organisations, preferably in cooperation.
- C4: Activities in open competition, subject to the SME subcontracting clause.

For the full definition of these procurement policies, please refer to document ESA/IPC(2005)87, rev.4.

**Implementation Category:** The activities comprising this work plan are designated as either B (Baseline) or R (at the Request of Delegates). The assignment of activities into these implementation categories is not a declaration of technological, commercial, or programmatic priority. Instead, it simply indicates whether an activity requires a prior request from a Delegation for the ITT to be generated and released. This categorisation could, for example, be related to a limited industrial landscape for the proposed activity.

Activities identified as B will be issued according to the schedule published (and regularly updated) on the ESA-STAR website and ESA ARTES web site: [ARTES 4.0 planned activities Summary table \(AT, ScyLight, 4S and 5G\) | ESA CSC](#). B activities for which industry and Participating States declare an interest will be given precedence when preparing Invitations to Tender (ITT). Such interest can be notified directly to the ARTES AT Programme Office.

Activities designated Implementation Category R will only be initiated either:

- On the explicit request of at least one delegation; or
- On the initiative of the Executive following consultation of the JCB.

## Annex I: SUMMARY TABLE FOR THE ARTES AT WORK PLAN 2026

Activity Ref.	Activity Title	Cost Phase 1 (k€)	Cost Total (k€)	Classification	Cost (k€) (Classification B)	Cost (k€) (Classification R)	Proc. Policy
<b>1. SYSTEM/NETWORK/PROTOCOLS</b>							
<b>1.1 System, Networking and Management</b>							
3A.233	Fast network entry procedure for user terminals in multi-orbit broadband systems	N/A	1,000	R	0	1,000	C
<b>Subtotal</b>					<b>0</b>	<b>1,000</b>	
<b>1.2 Coding, Modulation and Access</b>							
3C.053	Frame-by-frame switching of DVB-S2X and RCS2 in return link	750	2,000	R	0	2,000	C
<b>Subtotal</b>					<b>0</b>	<b>2,000</b>	
<b>1.3 Small Satellites</b>							
3E.033	In-orbit experiment of intelligent autonomous avionics enabling multi-environment satcom satellite operation in LEO	2,000	7,000	R	0	7,000	C
3E.034	Dual satellite in-orbit testbed for sensing and communication for low-power devices	3,000	8,000	B	8,000	0	C2
3E.035	In-orbit experiment of a deployer for stacked small satcom satellites	4,000	9,000	R	0	9,000	C
<b>Subtotal</b>					<b>8,000</b>	<b>16,000</b>	
<b>2. SPACE SEGMENT - PLATFORM</b>							
<b>2.1 AOCs</b>							
4C.074	Integrated avionics and platform design for a scalable high aspect ratio satcom satellites for constellations	2,000	5,500	B	5,500	0	C
4C.075	Autonomous and adaptable attitude and orbit control for satcom constellations	N/A	800	B	800	0	C
<b>Subtotal</b>					<b>6,300</b>	<b>0</b>	
<b>2.2 Power System</b>							
4F.182	Standardised functional power control modules for constellations satellites	N/A	2,000	B	2,000	0	C2
4F.183	Scalable photovoltaic technologies for telecommunication constellations mass production	N/A	2,000	B	2,000	0	C2
<b>Subtotal</b>					<b>4,000</b>	<b>0</b>	
<b>2.3 Command and Data Handling</b>							
4G.050	Digital twin of a spacecraft autonomous and collaborative intelligent multi-agent system	1,500	3,000	B	3,000	0	C
<b>Subtotal</b>					<b>3,000</b>	<b>0</b>	
<b>3. SPACE SEGMENT - PAYLOAD</b>							
<b>3.1 Antenna</b>							
5B.256	Fully digital active transmit and receive antennas for emerging medium Earth orbit constellations	N/A	2,500	B	2,500	0	C



5B.257	Ka-band high power active transmit integrated antenna for LEO satcom applications	900	2,200	R	0	2,200	C
5B.258	Highly-integrated and efficient millimetre-wave phased array antenna using advanced packaging solution	1,000	3,000	B	3,000	0	C
<b>Subtotal</b>					<b>5,500</b>	<b>2,200</b>	
<b>3.2 RF Repeater and Signal Processing</b>							
5C.537	Transmit and receive Ka-band differential front-end for direct radiating array antennas	N/A	1,200	B	1,200	0	C
5C.538	High frequency miniature acoustic filters for communication payloads	N/A	800	B	800	0	C
5C.539	European ultra-deep sub-micron beamforming chip IP core for satcom constellations	1,200	5,000	B	5,000	0	C
5C.540	European terabit per second ethernet packet switch/router IP core for multi-orbit constellations	2,000	4,500	B	4,500	0	C
5C.541	Reference programmable oscillator chip for telecom applications	N/A	800	B	800	0	C
<b>Subtotal</b>					<b>12,300</b>	<b>0</b>	
<b>3.3 Small Satellite Payload Equipment</b>							
5E.034	UHF IoT antenna for medium earth orbit smallsats	N/A	800	B	800	0	C1
<b>Subtotal</b>					<b>800</b>	<b>0</b>	
<b>4. GROUND SEGMENT</b>							
<b>4.1 Ground Network Operation Control and Gateway</b>							
6B.147	Multibeam gateway antenna for satcom constellations	N/A	1,300	B	1,300	0	C
<b>Subtotal</b>					<b>1,300</b>	<b>0</b>	
<b>5. USER TERMINALS</b>							
<b>5.1 Professional User Terminals</b>							
7A.088	1 Gbit/s throughput CPU-based DVB-S2/S2X software defined radio	N/A	1,250	B	1,250	0	C1
<b>Subtotal</b>					<b>1,250</b>	<b>0</b>	
<b>5.2 Consumer User Terminals</b>							
7B.090	54 Mbaud software defined demodulator on low-end processor or graphics processing unit	700	1,200	B	1,200	0	C1
7B.091	Multi-band dual-beam C-to-Q/V satcom analogue beamforming integrated circuit	N/A	2,000	B	2,000	0	C
<b>Subtotal</b>					<b>3,200</b>	<b>0</b>	
<b>5.3 User Terminals Mobile</b>							
7C.106	Dual-beam Ka-band-based multi-orbit aeronautical flat panel antenna	N/A	1,500	R	0	1,500	C
<b>Subtotal</b>					<b>0</b>	<b>1,500</b>	
<b>TOTAL (k€)</b>		<b>19,050</b>	<b>68,350</b>		<b>45,650</b>	<b>22,700</b>	



## Annex II: DETAILED DESCRIPTION OF ESA-INITIATED ACTIVITIES PROPOSED FOR THE ARTES AT WORK PLAN

### 1. SYSTEM/NETWORK/PROTOCOLS

#### 1.1 System, Networking and Management

Activity Ref.	Activity Title	Budget (kEuro)	Classification
3A.233	Fast network entry procedure for user terminals in multi-orbit broadband systems	1,000	R
<b>Objective:</b>	The aim of the activity is to design, develop and test a network entry procedure mechanism for user terminal modems of multi-orbit constellation systems.		
<b>Targeted Improvements:</b>	Reduction by 50% the time to enter the network compared to single orbital shell procedure used today.		
<b>Description:</b>	<p>Modem procedures for initial entry into the network are relatively complex in Non-Geostationary Orbit (NGSO) systems, in comparison to Geostationary Orbit (GSO), due to the needed management of mobility aspects. Modem procedures for initial entry into the network can take up to tens of minutes, depending on the starting conditions at modem switch on and constellation characteristics (e.g. orbit altitude and number of satellites). Most major satcom operators now feature multi-orbit capabilities combining LEO/MEO and GEO assets, however nowadays these procedures are still mostly implemented considering a single orbital shell and the user terminal must connect to each shell independently. In the frame of multi-orbit topology this is sub-optimal as only a subset of satellites are used. Besides there is a benefit to using the more "static" shells (e.g. GEO or MEO orbit) of a multi-orbit constellation to facilitate beam scanning and coarse synchronisation. The challenge is to design the specific mechanisms on the control plane that would enable to use all satellites of a multi-orbit constellation for network entry procedure, even if a different satellite from a different shell will eventually be used for the user traffic.</p> <p>The activity shall design, develop and test a signalling mechanism enabling to perform network entry on any satellite of a multi-orbit constellation, independently of the satellite targeted for passing the traffic. All aspects of the network entry procedure shall be covered until a steady state connected mode is reached, i.e. initial satellite search (e.g. via beam scanning), coarse synchronisation and modem acquisition, log-on procedure, etc. The procedure shall be assessed over different starting conditions around modem switch-on (e.g. "cold" start without location information, coarse location information, etc.). The ground segment architecture shall also be taken into consideration. A testbed shall be developed, implementing the multi-orbit constellation as well the waveform and signalling mechanisms, to perform the performance verification.</p>		
<b>Deliverables:</b>	Summary report and tested network entry procedure in a representative environment.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	Yes		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



## 1.2 Coding, Modulation and Access

Activity Ref.	Activity Title	Budget (kEuro)	Classification
3C.053	Frame-by-frame switching of DVB-S2X and RCS2 in return link	2,000	R
<b>Objective:</b>	The objective of this activity is to develop and test a prototype terminal capable of DVB-S2X and RCS2 real-time switching in the return link utilising a Commercial-off-the-Shelf (COTS) modem ASIC. In a second step, the activity will develop a hub burst demodulator and scheduler, capable of using both, DVB-S2X and RCS2 frame types, allowing a flexible bandwidth share based on traffic types. End-to-end testing will include performance evaluation of the full return link comprising hub and user terminal.		
<b>Targeted Improvements:</b>	Increase return link spectral efficiency up to 30% and demonstrate throughput beyond 100 Mbaud while retaining the intrinsic flexibility of MF-TDMA to retain low latency for low throughput applications.		
<b>Description:</b>	<p>In 2024 DVB updated the DVB-RCS2 specification to include non-geostationary satellite systems. This allowed DVB-S2X constant or burst mode in the return link, allowing higher spectral efficiency and throughput. DVB-S2X and RCS2 can be mixed within the return link time plan, and a single terminal can theoretically switch between them on the fly. This allows the increase of return link spectral efficiency up to 30%, through the implementation of S2X in the return link to carry traffic requiring large frames in a steady stream more efficiently, while retaining the ability to carry bursty, small packets more efficiently the majority of the time.</p> <p>This activity will be implemented in a phased approach:</p> <ul style="list-style-type: none"> <li>- In the first phase, the activity will focus to develop the software controlling the COTS modem ASIC and to develop a prototype terminal capable of DVB-S2X and RCS2 real-time switching in the return link and to test and evaluate the performance in a laboratory environment. The budget for this phase is up to 750 kEuro.</li> <li>- The second phase will develop a hub burst demodulator and scheduler, capable including a software or FPGA-based burst demodulator capable of switching between DVB-RCS2-based MF-TDMA and DVB-S2X frames in real-time. A scheduler algorithm will be developed and tested able to accommodate the expected traffic types, with intelligent switching between frames as needed. Finally end-to-end testing will include performance evaluation of the full return link comprising hub and user terminal in a relevant environment.</li> </ul>		
<b>Deliverables:</b>	Summary report and prototype terminal, hub burst demodulator and scheduler.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	N/A		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	12 - Ground Station Systems and Networks		



### 1.3 Small Satellites

Activity Ref.	Activity Title	Budget (kEuro)	Classification
3E.033	In-orbit experiment of intelligent autonomous avionics enabling multi-environment satcom satellite operation in LEO	7,000	R
<b>Objective:</b>	The objective of the activity is to design, develop, launch and test autonomous and intelligent avionics enabling satcom constellation satellites to operate autonomously across multiple environmental conditions in Low Earth Orbit (LEO). Breadboarding and in-orbit testing of critical platform functions including health monitoring, orbital control and resource management will be carried out. As part of the in-orbit experiment, a payload technology demonstrator will be developed to experiment with innovative approaches of autonomous payload configuration and control.		
<b>Targeted Improvements:</b>	Enabling autonomous operation and reconfiguration of a satellite in a range of orbital LEO environments. This entails orbital control, platform resource management, health monitoring capability, autonomous decision-making capability and autonomous communication to ground.		
<b>Description:</b>	<p>Satellite operators currently face limitations when relying on single orbits (e.g. geostationary or low Earth orbit) for communications. These limitations affect system performance, resilience, and service continuity, especially in the aviation, maritime, governmental, and remote enterprise networks sectors. There is a growing need for an intelligent on-board control system that is capable to operate constellation satellites in multiple orbital LEO altitudes and environments. Such avionics systems must operate reliably across multiple orbital shells under varying environmental conditions, such as radiation, power constraints, and thermal fluctuations, particularly in very low earth orbits. Developing avionics that could autonomously detect the need for adaptation/changes of orbit and will enable:</p> <ul style="list-style-type: none"> <li>- autonomous multi-orbit operation</li> <li>- orbital transfer</li> <li>- repositioning of satellites in fleet and constellations.</li> </ul> <p>The activity will develop an intelligent avionics module enabling autonomous operation. An experimental satcom platform and payload will be developed and an in-orbit experiment will be carried out across a large range of space environmental conditions (e.g. eclipse period, radiation levels, thermal loads) in LEO.</p> <p>The activity will be implemented in a phased approach:</p> <p>Phase 1 (budget up to 2 MEuro) will design, develop and integrate an intelligent avionics module to full engineering model enabling autonomous satellite operations. Phase 1 will develop and test:</p> <ul style="list-style-type: none"> <li>- autonomous operations logic that enables real-time system response to varying environmental conditions</li> <li>- adaptive AOCS and GNC functions to adapt to different orbits</li> <li>- health monitoring and diagnostic decision-making</li> <li>- autonomous TT&amp;C communication to ground.</li> </ul> <p>Phase 2 will develop the flight engineering model of the avionics module. A satcom experimental payload will be developed to support experimentation with intelligent, autonomous payload reconfiguration (e.g. transmit power, beam pointing, coverage change, temperature stabilisation, etc.) to maintain services during dynamic events such as orbital transfers and changes to operational space environmental and resilience response to sub-system failure. Avionics and payload will be integrated into a satellite. Phase 2 will launch and operate experiments in multiple LEO altitudes and environmental conditions.</p>		
<b>Deliverables:</b>	Summary report, intelligent avionic full engineering and flight engineering model and experimental payload.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	Yes		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	05 - Space System Control		





Activity Ref.	Activity Title	Budget (kEuro)	Classification
3E.034	Dual satellite in-orbit testbed for sensing and communication for low-power devices	8,000	B
<b>Objective:</b>	The objective of this activity is to design, manufacture and launch a dual satellite in-orbit testbed for sensing and communication for low-power devices with both transmit and receive user capability and inter-satellite link.		
<b>Targeted Improvements:</b>	Enabling the development of protocols and operations concepts for the communication and geolocation from space with low-power terrestrial devices.		
<b>Description:</b>	<p>There is currently no European in-orbit capability to test and validate low-power communication directly between LEO satellites and standard ground devices. This limits the development of protocols, modulation schemes, and system architectures for emerging applications in low-power geolocation, environmental sensing, and ubiquitous IoT connectivity.</p> <p>This activity will develop a test bed that supports the exploration of disruptive use cases in low power direct communications between terrestrial devices and LEO satellites. The testbed will comprise two satellites operating in tandem that can (at a minimum):</p> <ul style="list-style-type: none"> <li>- Establish a bi-directional low power (Tx/Rx) communications link between satellite and terrestrial devices</li> <li>- Provide Inter-satellite links (ISL) between the two, supporting cross-traffic, redundancy as well as geolocation of devices and interference sources</li> <li>- Test new protocols (e.g. SigFox, LoraWan, Bluetooth) and modulation schemes optimised for low-power signals.</li> </ul> <p>The activity will be implemented in a phased approach:</p> <ul style="list-style-type: none"> <li>- Phase 1 with a budget of up to 3MEuro will design and develop a dual-satellite payload testbed able to directly communicate with terrestrial low-power devices. It will mature the key technologies and communication protocols from using simulation and laboratory testing to demonstrate feasibility and system readiness for in-orbit demonstration. Deliverables from Phase 1 are a summary report and full engineering model.</li> <li>- Phase 2 will build the flight equipment, launch, and operate the dual-satellite platform to experiment with direct low-power, low frequency communications in orbit. The in-orbit experiment will test real-time user communications, validate geolocation concepts, evaluate inter-satellite link performance and collect performance data to inform future protocol standardisation and system architectures. Deliverables from Phase 2 are a summary report and 2 x flight engineering models.</li> </ul>		
<b>Deliverables:</b>	Summary report, full engineering model test bed and 2 x flight engineering model testbeds.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
3E.035	In-orbit experiment of a deployer for stacked small satcom satellites	9,000	R
<b>Objective:</b>	The objective of the in-orbit experiment is to conduct an experiment and develop the ability of a stack of small satellites to be deployed from a launch vehicle. The activity will design and build a launch vehicle adapter, satellite deployer and compatible test satellite/s which will be subjected to an on ground and in-orbit experiment test campaign examining the deployment dynamics from a launch vehicle in microgravity conditions and subsequent orbit behaviour of the launch vehicle upper stage and test satellites.		
<b>Targeted Improvements:</b>	Enabling a European or Canadian source for small satellite deployers for stacked satellites within the launch vehicle fairing, allowing for 50% increase in utilisation of the launch volume compared to the current state of art.		
<b>Description:</b>	<p>Current satellite deployment approaches which integrate satellites on a vertical satellite payload adapter structure within a launcher fairing underutilise the available volume, limiting the number of small satellites that can be launched per mission. Stacked satellite integration could increase volume and mass utilisation by up to 50% for a given launch increasing the number of satellites deployed per mission, reducing mission capex and reducing time to deploy an operational constellation. However, there are no European solutions currently in use for deploying multiple small satellites in a stacked configuration. A Small Satellite Design Guideline (SSGL) has recently been developed that provides design guidelines for platform developers which allow for the horizontal and vertical stacking of multiple satellites in medium and heavy lift launch vehicles. This concept has carried out critical technology derisking through on-ground tests and simulations.</p> <p>This activity will make use of the SSGL and the activity will be implemented in a phased approach:</p> <ul style="list-style-type: none"> <li>- Phase 1, with a budget of up to 4 MEuro, will design and develop the Stack Deployment Mechanism and LV adapter, Test Satellites and validate their mechanical and deployment performance in ground-based environments and simulations preparing it for the in-orbit experiment. Deliverables from Phase 1 are Study Report and Full Engineering Models of the deployer and test satellites.</li> <li>- Phase 2 will build the flight equipment, launch, and operate the satellites. The structural performance of the stack will be monitored through the launch phase. The deployment performance will be investigated through satellite GNSS and attitude data, as well as relative position and poise estimation from sensors based on the launch vehicle adapter. Data generated in this phase help to increase the precision of mathematical models and digital twins used for solving satellite motion during deployment and orbital mechanics verification required to refine the SSGL. Deliverables from Phase 1 are summary report and flight engineering models of the deployer and test satellites.</li> </ul>		
<b>Deliverables:</b>	Summary report and engineering models of a deployer and test satellites.		
<b>Estimated current TRL:</b>	4		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	Yes		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	20 - Structures		



## 2. SPACE SEGMENT – PLATFORM

### 2.1 AOCS

Activity Ref.	Activity Title	Budget (kEuro)	Classification
4C.074	Integrated avionics and platform design for a scalable high aspect ratio satcom satellites for constellations	5,500	B
<b>Objective:</b>	The objective of the activity is to design build and test a scalable High Aspect Ratio Satellite (HARS) platform encompassing the development of an integrated avionics architecture (including core functionality, minimal harnessing and modular interfaces). A second phase will extend the work and develop a scaled engineering model of a HARS platform with integrated thermal solution and with integrated avionics. The design shall be applicable to HARS from 1m to 4.6m, and able to be scaled up to 8m.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Reduction in mass by 25%</li> <li>- Reduction in AIT time by 50%</li> <li>- Half the overall part count compared to the current state of art for SatCom satellite in the 500-2500kg range.</li> </ul>		
<b>Description:</b>	<p>High aspect ratio satellites allow for the efficient and fast development and deployment of satellite communications constellations. High aspect ratio platforms also offer distinct advantages for satcom applications including enhanced solar power generation and large surface areas for payload antennas. Nevertheless, this concept presents challenges in thermal management, accommodation of standard equipment, accommodation in launch vehicles, deployment into orbit. Additionally, the effective production of high aspect ratio satellites will require design for assembly methodologies not currently in use.</p> <p>To address these challenges this activity will design build and test a scalable High Aspect Ratio Satellite (HARS) platform encompassing the development of an integrated avionics architecture. The design shall be applicable to HARS platform from 1m to 4.6m, and able to be scaled up to 8m.</p> <p>The activity will be implemented in a phased approach:</p> <ul style="list-style-type: none"> <li>- Phase 1, with a budget of up to 2 MEuro will develop the enabling technologies resulting in an integrated avionics design and test them as a scaled engineering model. The functionality of the platform shall include: <ol style="list-style-type: none"> <li>1. Core avionics functions (OBC, Thermal, ADCS/AOCS, GNSS, TT&amp;C, FDIR).</li> <li>2. Modular interfaces to allow integration with peripheral equipment (AOCS sensors and actuators, data storage, thermal equipment, ISL, propulsion units, payload/payload controllers).</li> </ol> <p>Deliverables of Phase 1 include a Summary report and scaled engineering model of the core avionics.</p> </li> <li>- Phase 2 will extend the work and develop a scaled engineering model of a platform with a primary structure that includes an integrated thermal solution and integrated harness. A structural solution for the stacking of additional HARS within the launch vehicle will be included. A compatible satellite dispenser/payload adapter for integration into the Launch Vehicle will also be developed. The combined avionics/satellite/dispenser will be tested in a representative environment capturing the equipment level loads, equipment and structure interactions.</li> </ul> <p>Deliverables of Phase 2 include a Summary report, scaled engineering models of a satellite platform and dispenser.</p>		
<b>Deliverables:</b>	Summary report, scaled engineering model of core avionics and scaled engineering model of HARS platform and satellite dispenser.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	24 - Materials and Manufacturing Processes		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
4C.075	Autonomous and adaptable attitude and orbit control for satcom constellations	800	B
<b>Objective:</b>	The objective of the activity is to design, develop and test an Attitude and Orbit Control System (AOCS) with increased level of on-board autonomy, robustness to failures, mission adaptability for satcom constellations.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Increased AOCS autonomy, reduction of ground Telecommands, flight procedures and operational constraints by 30%</li> <li>- Faster response to on-board failures/improved system availability by 20%</li> <li>- AOCS adaptable to different missions, facilitating industrial re-use</li> </ul>		
<b>Description:</b>	<p>Telecom missions make use of frequent communication ground control and current state-of-the art AOCS for such missions have a limited degree of on-board autonomy. While this may simplify the overall design of AOCS on-board functions, it results in a significant ground operational effort such as mode-switching and specific configuration changes. Moreover, today's AOCS architectures require significant effort and time to be adapted for different missions. Recent studies have shown that increased level of autonomy can be potentially achieved for specific operations such as orbit raising to nominal orbit (e.g. to GEO), orbit management (e.g. station keeping) or collision avoidance. Furthermore, other studies showed that implementing a single-mode AOCS with virtual sensors/actuators abstraction modules employing advanced estimation/control techniques could potentially reduce the operational effort in managing the AOCS during the mission.</p> <p>The activity will design, develop and test (in a high-fidelity simulator with Processor in-the-loop) a novel AOCS on-board software based on state-of-the art single AOCS mode and virtual sensors/actuator modules consisting of all the main AOCS functions (sensors/actuator processing, estimation, guidance, control, embedded FDIR). The AOCS software will implement advanced estimation, control, optimisation algorithms alongside decision-making capabilities, enabling the system to adapt to various spacecraft configurations/mission phases without mode transitions and ground assistance. In addition, the AOCS software will run with any number or types of sensors/actuators requiring minimal adaptation and will be agnostic to the type of on-board processor used. The use case shall cover all the mission phases from separation orbit acquisition to nominal pointing modes, orbital manoeuvres, safe mode and controlled re-entry.</p> <p>This activity shall demonstrate and evaluate:</p> <ul style="list-style-type: none"> <li>- reduction of operational effort and ground interfaces thus increasing on-board autonomy</li> <li>- increased availability thanks to embedded FDIR</li> <li>- adaptability of the architecture to any mission phase</li> <li>- re-usability for different missions.</li> </ul> <p>This activity complements the definition work performed on the architectures for autonomy identified in the frame of the Intelligent System Initiative.</p>		
<b>Deliverables:</b>	Summary report and AOCS simulator, algorithms, software.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	Yes – 2024 – AOCS/GNC Systems		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	05 - Space System Control		



## 2.2 Power System

Activity Ref.	Activity Title	Budget (kEuro)	Classification
4F.182	Standardised functional power control modules for constellations satellites	2,000	B
<b>Objective:</b>	The objective of the activity is to design, build and test standardised functional power modules resulting in a Commercial-off-the-Shelf-based Power Conditioning and Distribution Unit (PCDU) consisting of the solar array regulator, the controller module, the battery management module, the power distribution module and the deployment module, for telecoms constellations applications. Techniques and technologies to improve the power efficiency will be studied and implemented as well as health monitoring capabilities as needed to comply with Zero Debris requirements.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Power module manufacturing time reduction by 80% and reduction of risk of production delay</li> <li>- PCDU efficiency improvement of up to 15% thanks to solar regulator efficiency improvement by 10 percentage points and 50% improvement of the power distribution module.</li> </ul>		
<b>Description:</b>	<p>Typical space power units are designed and built to comply with project-specific specifications. As a consequence, manufacturers implement different solutions, which are not compatible nor interoperable. Therefore, a specific power unit can only be built by a specific manufacturer. When large number of units have to be built this often poses a supply chain challenge. APA is an advanced power architecture standard developed with European Primes with the potential to overcome supply chain bottlenecks. It aims at standardising the electrical and mechanical interface of modular power distribution units and hence unit production can easily be spread among multiple suppliers.</p> <p>This activity will identify opportunities for standardisation of power control modules for constellations satellites taking the APA and other available standards as a starting point. The activity will then design, manufacture and test key functional power modules for a Commercial-Off-The-Shelf (COTS) based Power Conditioning and Distribution Unit (PCDU), consisting of the solar array regulator, the controller module, the battery management module, the distribution module and the deployment module, for telecoms constellations applications. Techniques and technologies to improve the power efficiency will be studied. This shall include wide band-gap semiconductor technology and the use of switched latching current limiters. Health monitoring capabilities as needed to comply with Zero Debris requirements will be developed and implemented. Standardised power control engineering modules will be built, tested and assembled forming a COTS-based PCDU full engineering model. Testing will be carried out in a representative environment to evaluate the performance.</p>		
<b>Deliverables:</b>	Summary report and full engineering model of a PCDU with standardised power control modules.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	Yes - 2025 - Power Management and Distribution Dossier		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	03 - Space Systems Electrical Power		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
4F.183	Scalable photovoltaic technologies for telecommunication constellations mass production	2,000	B
<b>Objective:</b>	The objective of the activity is to develop and test innovative III-V solar cell s processes and associated disruptive photovoltaic assembly technologies aiming to reduce the complexity, manufacturing and assembly time to meet the high demand of telecommunication satellites constellations. III-V solar cells will be developed and tested using the developed processes along with flexible Photovoltaic Assembly (PVA) mini modules.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Enabling a European source of III-IV solar cells and PVAs for satcom constellations by - At least a factor of 2 reduction of the epitaxial growth time</li> <li>- Enabling substrate reuse in the fabrication - Enabling a standardised and flexible PVA mini module for mass production of solar arrays.</li> </ul>		
<b>Description:</b>	<p>In the space telecommunications sector, the shift from GEO satellites to LEO constellations requires advanced solar technologies that offer a balance of high performance, scalable manufacturing and proven reliability across diverse LEO mission profiles. Within this evolving landscape, III-V multi-junction cells remain the benchmark in terms of efficiency and performance, but complexity, manufacturing and assembly time must be significantly improved to meet the growing demand for constellations. In order to achieve this goal, innovative processes must be developed to increase the production capacity. Development efforts should not focus solely on solar cell technology but must also extend to the photovoltaics assembly (PVA) level, enabling the realisation of standardised modular and scalable PVA solutions tailored to constellation needs.</p> <p>This activity will focus on III-V solar cells and their associated PVA technologies. It will study and develop solutions to two main primary factors currently limiting the scalability of III-V solar cells:</p> <ul style="list-style-type: none"> <li>- Reducing epitaxial growth time at least by a factor of 2 by increasing the growth rate of III-V materials while maintaining high opto-electronic properties. For doing so, new and disruptive epitaxial growth processes must be developed.</li> <li>- Enabling substrate reuse in the fabrication through the implementation of innovative Epitaxial Lift-Off (ELO) processes either chemical or mechanical based. The ELO process provides a dual benefit, as it supports the production of flexible, ultra-thin solar cells (e.g. 30um thick) and contributes to reduce the use of critical materials in the substrate (e.g. Germanium recycling). A combination of a mechanical and chemical lift-off approaches will be studied and developed to optimise the overall ELO process.</li> </ul> <p>The resulting developed III-V based solar cells will be manufactured and tested. They will serve as a critical building block for the development of a flexible PVA blanket. Interconnection and encapsulation technologies will be developed and tested. Finally, a standardised and flexible PVA mini-module, designed to function as a plug-and-play building block for mass production of solar arrays, will be developed and tested.</p>		
<b>Deliverables:</b>	Summary report, III-V solar cells engineering models, flexible PVA mini-module engineering model.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	Yes - 2020 - Solar Generators and Solar Cells		
<b>Dependency:</b>	Yes		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	03 - Space Systems Electrical Power		



## 2.3 Command and Data Handling

Activity Ref.	Activity Title	Budget (kEuro)	Classification
4G.050	Digital twin of a spacecraft autonomous and collaborative intelligent multi-agent system	3,000	B
<b>Objective:</b>	The objective of the activity is to design, implement and test a smart digital twin that can be used to develop and test autonomous satcom building blocks and their collaborative interactions. Examples of building blocks are the onboard computer and remote terminal unit, software, power management and fault detection, isolation and recovery. The digital twin will enable the exploration of a wide range of innovative solutions for managing single or multiple hardware failures, advanced testing aspects and autonomous systems to support controlling the S/C.		
<b>Targeted Improvements:</b>	Enabling intelligent satcom satellites and constellations by creating a digital twin tool for faster, flexible and integrated development and testing of intelligent (autonomous) satcom systems based on multi-agent architecture, not existing today in Europe.		
<b>Description:</b>	<p>The market is continuously requesting satcom systems to improve in adaptability, resource efficiency, autonomy and fault tolerance. The introduction of intelligent satcom systems has the potential to not only improve the operational efficiency and reliability of the satellite or satellite constellation but also enhance its ability to perform complex tasks in orbit with minimal or no intervention from ground. To enable future intelligent satcom constellations, implementation of Multi-Agent Systems (MAS) will be pivotal. The decentralised, collaborative nature of MAS allows each system to operate independently, but cooperatively, managing subsystems and components within a satellite, an entire constellation of satellites or even the complete end-to-end satcom system, including the ground segment. This will result in coordinated behaviour, optimal resource utilisation, safe reconfigurability, autonomous decision-making among spacecraft, predict and manage overall system/constellation behaviour, identify and resolve potential anomalies, and support mission operations through continuous synchronisation with real-time telemetry data.</p> <p>This activity will develop a satellite digital twin based on a MAS architecture. The digital twin shall be designed to run in parallel with a referenced system development and shall be capable of updating itself using the reference system incoming telemetry. The digital twin shall be a digital model of a reference satellite with a refined digital model of the avionics (OBDH and AOCS/GNC). Other blocks (e.g. power, thermal management) will be modelled at higher, architecture level. The digital twin shall encompass a diagnostic module, for health monitoring and prognostics, including analysis of performance drifts, anomaly detection and failure prediction. The digital twin shall track the state of the spacecraft, even in conditions that differ from those anticipated at launch. The digital twin shall predict future behaviour and guide operational decisions with insight into the system's internal dynamics. It shall be able to assist in the evaluation of design and spacecraft configuration choice and trade-offs and performances.</p> <p>The activity will be implemented in a phased approach:</p> <ul style="list-style-type: none"> <li>- Phase 1 shall include the development of the digital twin concept and software architecture with a maximum budget range of 1200kE. Phase 1 output will comprise of a digital twin architecture and preliminary digital models of critical avionics blocks.</li> <li>- Phase 2 shall include the full development of digital models of the avionics blocks as well as diagnostic models. The remaining blocks shall be developed at architecture level with critical functions. Phase 2 output will comprise of the digital twin software beta version.</li> </ul>		
<b>Deliverables:</b>	Summary report and digital twin beta software.		
<b>Estimated current TRL:</b>	4		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	01 – On-board Data Subsystems		



### 3. SPACE SEGMENT – PAYLOAD

#### 3.1 Antenna

Activity Ref.	Activity Title	Budget (kEuro)	Classification
5B.256	Fully digital active transmit and receive antennas for emerging medium earth orbit (MEO) constellations	2,500	B
<b>Objective:</b>	The objective of this activity is to develop an architecture of a fully digital active transmit and a fully digital active receive antenna with a high number of radiating elements (i.e. 4000) and capable to generate a significant number of beams (i.e. 1000) to support MEO satellite constellations. A transmit and a receive scaled engineering model will be designed and developed and experimentally tested to evaluate the performance.		
<b>Targeted Improvements:</b>	Enabling development to achieve fully digital beamforming with an increase of about a factor of two of number of beams in comparison to current state of art in MEO.		
<b>Description:</b>	<p>The first generation of medium-earth-orbit (MEO) satellite systems have been using passive antennas employing reflectors to generate multiple beams. In the second generation of MEO satellites, active antennas started to be adopted in combination with digital beamforming. Recent developments in this field have seen active antennas that offer global coverage, low latency, maximum flexibility, multiple gigabits per second capacity, independent electronic repointing of the individual beams, reduced interference, and coexistence with GEO satellites sharing the same frequencies. Active antennas enable also RF-power-allocation reconfigurability amongst the beams. Today, there is a need to develop the next-generation MEO satellites for commercial and governmental applications. The main expected improvements are associated to increased communication data rate and flexibility, requiring larger antennas and an increased number of beams.</p> <p>This activity develops an architecture of a fully digital active antennas with a high number of radiating elements (i.e. 4000) and capable to generate a significant number of beams (i.e. 1000). Radiating elements, beamforming network, and the thermal design components shall be designed, optimised, manufactured and tested. For the active components, existing commercial-off-the-shelf products may be used, prioritising European products. The digital processor development is not part of this activity. However, interfaces and interconnects between the digital beam ports of the fully digital antenna and the payload processor shall be defined, quantified and implemented. Use cases for different types of MEO orbits shall be evaluated including inclined orbits and equatorial ones. The antenna design shall exploit power efficient solutions to deliver digital beamforming tasks reducing the processing in the digital domain. Recent advances in area of reconfigurable beam forming networks and exploitation of symmetries when designing beaming networks will be studied.</p> <p>The scaled engineering models shall include active and passive RF and digital building blocks of the antenna and beamforming network and shall be scalable to meet the performance requirements of the difference MEO use cases.</p>		
<b>Deliverables:</b>	Summary report and 2 reduced-scale engineering models (one for transmit and one for receive).		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	TBD		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	07 - Electromagnetic Technologies and Techniques		





Activity Ref.	Activity Title	Budget (kEuro)	Classification
5B.257	Ka-Band high power active transmit integrated antenna for LEO satcom applications	2,200	R
<b>Objective:</b>	The objective of this activity is to design, develop and test a scaled engineering model of a Ka-Band 45dBW EIRP class active transmit highly integrated antenna for LEO constellations (orbits up to about 1000km) for governmental and commercial application. This includes a thermal management system compatible with high power requirements, use of SiPs to reduce the volume and higher number of elements and beams.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Enabling 45dBW EIRP class active phased array antenna for governmental and commercial connectivity applications.</li> <li>- 2 to 3 times increased number of beams compared to state of the art today in Europe.</li> <li>- 40 to 50% improvement in mass compared to analogue beamforming-based architecture.</li> </ul>		
<b>Description:</b>	<p>Low Earth Orbit (LEO) satellite constellations require high-capacity integrated active phased array antennas. Today the active antennas available can guarantee only limited flexibility in terms of number of beams, bandwidth and power dissipation. For both commercial and government applications, there is a demand for active antennas composed of more than 1000 radiating elements and enabling a minimum of 40 to 64 simultaneous beams. However, the high integration requirements for accommodating in LEO satellites operating in orbits up to about 1000km creates thermal management challenges. In order to achieve these challenging requirements, current active antenna technology must be significantly improved. On the thermal management, novel heat dissipation concepts must be investigated, developed and demonstrated. Exploring new promising solutions including Pulsed Heat Pipes should be considered. On the beamforming network, trade-off between fully digital and hybrid should be performed, considering the latest technology available on digital processors (using ultra-deep sub-micron technologies) and System-in-Package (SiP) commercial solutions. On radiating elements, recent promising results have been achieved on antenna based on waveguide and PCB technology.</p> <p>This activity will study, develop, and implement a beamforming architecture and thermal management solution for LEO high-capacity integrated active phased array antennas. The selected concept will be implemented as a scaled engineering model and tested in critical environment.</p> <p>This activity will be implemented in a phased approach where:</p> <ul style="list-style-type: none"> <li>- Phase 1 will study design concepts of beamforming architectures and thermal management solutions for active antenna technology. The solution will be designed and optimised, considering aspects such as the beam forming network architecture, the digital signal processing architecture, the amplification sizing and the thermal management. This phase will include de-risking module implementation at breadboard level with testing. The budget for Phase 1 is up to 900 kEuro.</li> <li>- In the second Phase, a scaled engineering model shall be produced, capable of operating over the full bandwidth to produce flexible number of beams between 4 to 10. The design must be scalable and must include active elements and optimised thermal management system. This scaled engineering model will be developed and validated in a critical environment. The scaled engineering model shall comprise one or more representative payload building blocks, including frequency conversion, signal processing beam forming, high power amplification, filtering and radiating element functions.</li> </ul>		
<b>Deliverables:</b>	Summary report, scaled engineering model of 45dBW EIRP Tx integrated active antenna.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	Yes - 2022 - Array Antennas and Periodic Structures		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
5B.258	Highly integrated and efficient millimetre-wave phased array antenna using advanced packaging solution	3,000	B
<b>Objective:</b>	The objective of the activity is to design, build and test a highly integrated and efficient millimetre-wave phased array antenna using advanced packaging solution for multi-chip, multi-technology assembly, including 3-dimensional heterogeneous integration interconnects, thermal and power management.		
<b>Targeted Improvements:</b>	Enabling disruptive technology to enable thermal management of highly integrated phased arrays, with a twice the RF power handling capability.		
<b>Description:</b>	<p>The development and deployment of millimetre-wave phased array antennas present several challenges that can reduce their efficiency and performance. These challenges include low RF power per element across different orbits (Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Earth Orbit (GEO)) due to the use of silicon chips and the inefficiency in thermal management. Further limitations are introduced by the use of 2D packaging, which prevents the integration of high-power handling capabilities and enhanced thermal management technologies. The power efficiency and dependability of the antenna are reduced by signal strength degradation caused by the low RF output power per element. These performance issues directly affect satellite-to-ground communication as well as intersatellite communication.</p> <p>To overcome these limitations, transitioning from 2D to 3D Heterogeneous Integration (3DHI) interconnect technology can significantly improve the thermal and power performance of phased array antennas. By stacking components vertically, more space can be allocated for effective thermal management, and the integration of multiple layers with thermal vias allows for better heat dissipation. This approach also enables the integration of diverse materials and technologies within the same package. Novel materials like Gallium Nitride (GaN) and Silicon Carbide (SiC) offer superior thermal conductivity and higher power handling capabilities compared to traditional silicon. Incorporating these materials into the antenna array, using an Integrated Antenna-on-Chip (AoC) approach, can increase the RF power per element while alleviating thermal constraints.</p> <p>This activity will be implemented in a phased approach:</p> <ul style="list-style-type: none"> <li>- Phase 1 will develop an antenna concept, investigate and develop key processes necessary to fabricate a millimetre-wave 3DHI active antenna. This includes integrating low-power silicon chips, RF power amplifiers, thermal management solutions and advanced packaging techniques. During this phase, critical components will be developed to breadboard level to assess the effectiveness of 3D packaging methods, such as vertical integration and thermal vias, in addressing thermal dissipation and RF power handling challenges. Phase 1 output will deliver an antenna concept supported by critical breadboard test results. The budget for Phase 1 is up to 1,000 kEuro.</li> <li>- Phase 2 will focus on developing a scaled engineering model of a millimetre-wave phased array antenna using 3DHI technology in Q, V, or W-Bands. Phase 2 will include refining the design, manufacturing, and testing the antenna's performance in representative operational environments.</li> </ul>		
<b>Deliverables:</b>	Summary report and scaled antenna engineering model.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	Yes		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



## 3.2 RF Repeater and Signal Processing

Activity Ref.	Activity Title	Budget (kEuro)	Classification
5C.537	Transmit and receive Ka-Band differential front-end for direct radiating array antennas	1,200	B
<b>Objective:</b>	This objective of the activity is to design, develop and experimentally validate a full-scale engineering model of a transmit and receive differential front-end in Ka-band for direct radiating array antennas for satcom applications, employing differential MMIC amplifiers (power amplifier and low noise amplifier), a differential diplexer, and suitable differential RF transitions.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Size, power and weight reduction by 30%.</li> <li>- Simplified front-end architecture by halving the number of RF lines and reducing number of transitions.</li> <li>- Reduction of common mode noise levels and cross-polarisation isolation by at least 10 dB compared to single-ended solution.</li> </ul>		
<b>Description:</b>	<p>The development of differential front-ends for full-duplex in-band communications enables improved RF performance compared to single-ended equivalent, as differential circuits have inherent high-cross polarisation isolation and a higher immunity to noise and electromagnetic interference, which are essential for high-data throughput satcom. By combining the RF active and passive differential development, it becomes possible to co-design MMIC amplifiers and their drivers along with passive devices (such as diplexers and RF transitions). Therefore, impedance matching at active/passive interfaces can be simplified. Additionally, solid-state power amplifiers in differential-mode operation can achieve better linearity and larger voltage swing. MMIC amplifiers use on-chip combining networks to combine the power of multiple transistor cells at their output. These on-chip combining networks are a source of losses inherent to the power amplifier MMIC. By employing a differential configuration, on-chip combining structures can be eliminated which leads to the reduction of losses. This enables the required output power for Direct Radiating Arrays using a simplified architecture with a better efficiency.</p> <p>This activity will investigate and develop transmit and receive differential front-end architectures for Ka-band direct radiating arrays. Trade-offs investigating different semiconductor technologies to realise differential MMIC amplifiers (power amplifier and low noise amplifier) will be performed. Critical breadboarding will be undertaken to characterise the selected front-end architecture concept and the selected technology(ies). A full-scale engineering model of the selected implementation for a transmit and receive differential front-end in Ka-band will be manufactured and tested in relevant environment.</p>		
<b>Deliverables:</b>	Summary report and full-scale engineering model of a transmit and receive Ka-band differential font-end.		
<b>Estimated current TRL:</b>	4		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
5C.538	High frequency miniature acoustic filters for communication payloads	800	B
<b>Objective:</b>	The objective of this activity is to develop, manufacture and test miniaturised high frequency acoustic filters engineering models up to Ku-band.		
<b>Targeted Improvements:</b>	Reduction of the size and mass with at least a factor of 10 compared with state-of-the art on-board technologies.		
<b>Description:</b>	<p>The market is continuously requesting mass and volume reduction improvements in payload technology. However, current state of the art electromagnetic (EM) resonator filter technologies, such as cavity and planar filters, all bulky and are reaching their limitation in terms of compactness. The introduction of acoustic wave filter technology has the potential to overcome these limitations, and the reduction in size and mass will enable integration into the payload receivers and frequency converters. In addition, the technology can also offer semiconductor compatibility, enabling high integration of RF front ends.</p> <p>Currently, standard acoustic filter technology is limited up to S-band frequency capability, which prevents its wider use in telecommunication payloads equipment. The worldwide explosion in mobile smartphone usage has been enabled by the development of piezoelectricity-based acoustic wave resonators and filters. Various technical advances are ongoing in the frame of 5G/6G terrestrial infrastructure applications. Recent developments in advanced engineered substrates such guided surface acoustic wave (SAW) and single crystal eXtended Bulk Acoustic Wave (XBAW), open the possibility of developing high performance and medium frequency filter components. Bulk Acoustic Resonator (BAR) technology has emerged during recent years where filters in the C-band has been demonstrated, and the quality of thin piezoelectric plates has improved. BAR devices offer high Q-values with a small size/footprint with critical dimension of the metallisation pattern not necessarily limited to the acoustic wavelength. This enables BAR devices in the C-band and beyond.</p> <p>This activity will develop, manufacture and test engineering model acoustic wave-based filters up to Ku-band, for integration in telecom payloads. Suitable packaging technologies will also be assessed. The performance will be quantified by testing at wafer and packaged device levels under representative environment.</p>		
<b>Deliverables:</b>	Summary report and filters engineering models up to Ku-band.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	Yes - 2022 - Microwave Passive Hardware		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
5C.539	European ultra-deep sub-micron beamforming chip IP core for satcom constellations	5,000	B
<b>Objective:</b>	The objective of the activity is to develop a European beamforming chip IP core based on ultra-deep sub-micron technology for satcom constellations. Power consumption shall be minimised. Selectable waveform specific features shall be implemented to support a wide range of use cases including pre-coding and beam hopping. A test chip with compatible interfaces to high speed SerDes (Serialiser/Deserialiser) providing reliable connectivity for high throughput satellites of LEO and MEO constellations shall be designed and manufactured.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Enabling a European or Canadian source of digital beamforming IP core for active phased array antennas.</li> <li>- Enabling features such as signal structure, beam hopping and precoding.</li> <li>- Minimised power consumption of less than 300mW per channel.</li> </ul>		
<b>Description:</b>	<p>Due to the demand for large capacity and high spectral efficiencies, active array antennas are being increasingly employed for telecom satellites. These antennas are already playing an important role in next-generation high throughput satellite (HTS) communications together with the large low Earth orbit (LEO) and medium Earth orbit (MEO) constellations being implemented worldwide. Digital Beamforming (DBF) is considered the most flexible beamforming architecture and has advantages over analogue beamforming for receiving and transmitting wideband signals, and for multi-beam reconfigurable applications. However, it requires data converters and RF front-ends for each antenna element, increasing the complexity and power consumption.</p> <p>In this activity, a digital beamforming IP core will be developed, fabricated as a scaled Engineering Model test chip and tested based on ultra sub-micron technology (targeting 7nm or lower). Power consumption shall be minimised, targeting 300mW per channel. Selectable waveform specific features shall be implemented to support a wide range of use cases including pre-coding and beam hopping. The IP core shall enable Beamforming Networks with a total bandwidth scalable from GHz to hundreds of GHz for dynamic beam configuration, to achieve a BFIC of 32 GHz capacity with scalable frequency from L-Band to Ka-Band and frequency agnostic topology.</p> <p>This activity will be implemented in a phased approach where:</p> <ul style="list-style-type: none"> <li>- Phase 1 includes a comparative architectural study of at least four digital beam forming IC integration models. An evaluation of technology node implications shall be performed (e.g. leading-edge vs. trailing-edge). Phase 1 shall explore if a common architecture could support different use-cases (broadband, D2D) e.g. lowering DAC/ADC sampling rates and smart switching (bypassing digital mixing, decimation/interpolation) to maintain beam count while adjusting per-beam bandwidth. A system topology shall be evaluated and defined from the digital processor to the antenna for the placement of the beamforming network (daisy chain, star etc.). The output of Phase 1 is an evaluation of the critical IP blocks via design simulation concluding with tape-out of the design. Phase 1 budget is up to 1,200kEur.</li> <li>- In Phase 2 the architecture and technology for the beamforming chip IP shall be fully designed, implemented and tested to scaled engineering model level. This test chip will be representative of a scaled version of the final potential product. Scaled EM testing will include radiation exposure, thermal cycling, and performance benchmarking against existing space-grade beamforming chips.</li> </ul> <p>IP cores developed in this activity shall be available for further development by ESA Member State and Canadian industries at fair and reasonable market conditions.</p>		
<b>Deliverables:</b>	Summary report, ultra-deep sub-micron beamforming chip IP core implemented in scaled engineering model test chip		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	Yes		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
5C.540	European terabit per second ethernet packet switch/router IP core for multi-orbit constellations	4,500	B
<b>Objective:</b>	The objective of the activity is to develop, manufacture and test an Ethernet switch/router Intellectual Property (IP) core and test chip supporting layers 1 to 3 packet processing for constellations. The IP core shall be developed, implemented on a test chip using the optimal UDSM ASIC technology node(s) selected as part of this activity to achieve the desired performance, and tested using a validation breadboard.		
<b>Targeted Improvements:</b>	Enabling a European or Canadian source of terabit class ethernet switch/routers for multi-orbit constellation applications.		
<b>Description:</b>	<p>Cost sensitive, high volume multi-orbit constellation solutions require a tailored ethernet packet switch/router adapted to high data rates (at and above 100 Gbps), number of ports (16 and more) and supported protocols. An ethernet switch/router, scalable in data rate and number of ports and supporting layer 1 to 3 protocols, is not available from a European or Canadian supplier. Existing commercial solutions cannot be readily adapted to the needs of satcom applications in low earth orbit and multi-orbit constellations.</p> <p>This activity will be implemented in a phased approach. In Phase 1, an ethernet switch/router IP core shall be developed utilising ultra-deep sub-micron (UDSM) ASIC technology (targeting 7nm or below) to achieve 1 terabit per second data throughput for low earth orbit and multi-orbit constellation applications. The data rate per port and number of ports forming a channel shall be configurable to suit multiple applications (configurable number of ports from 4 to at least 16 ports, with configurable port data rate from 1Gbps to at least 100Gbps per port). Multi-protocol label switching and the internet protocol shall be supported. Phase 1 will conclude with the completed IP core design, verified and synthesised in the design environment, to generate the ASIC test chip tape-out files ready for fabrication. The budget for Phase 1 is up to 2,000 kEuro.</p> <p>In the second phase, the IP core will be implemented in the selected UDSM ASIC technology as an ASIC test-chip (via a Multi Project Wafer Run or shared Full Mask Run). A validation breadboard shall be designed and built to undertake performance testing of the test chip. The test chip shall be representative of a scaled version of a final product and shall be tested in relevant environment.</p> <p>IP cores developed in this activity shall be available for further development by ESA Member State and Canadian industries at fair and reasonable market conditions.</p>		
<b>Deliverables:</b>	Summary report, ethernet switch/router IP core implemented in scaled engineering model test chip.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	Yes		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
5C.541	Reference programmable oscillator chip for telecom applications	800	B
<b>Objective:</b>	The activity objective is to design, manufacturing and test a high-performance programmable reference oscillator based on microelectromechanical (MEMS) resonator operating in the 10 - 500 MHz range to serve as a reference oscillator or to attend directly as local oscillator the lower frequency range for telecom application.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Enabling a European or Canadian source of a MEMS oscillator chip suitable for system on chip (SoC) integration.</li> <li>- Size, weight and power reduction by several orders of magnitude versus current technology of quartz OCXO.</li> <li>- Increase of fractional-N frequency generation by a factor of more than 5.</li> </ul>		
<b>Description:</b>	<p>Current telecom satellite payload equipment used mainly quartz-based oscillators for clock generation reference signals, used for track-and-hold amplifiers and digital-to-analogue (DAC) and analogue-to-digital (ADC) blocks in direct conversion (zero-IF or homodyne) frequency converters; for I-Q demodulator blocks in fully digital beamforming networks; and in double conversion super heterodyne frequency converters local oscillators (LOs) at different carrier frequencies. However, European sources of quartz-based oscillators are becoming more limited, and these solutions are expensive, with a form factor and power consumption that becomes challenging when incorporating into highly integrated payloads. Current state-of-art oscillators based on microelectromechanical (MEMS) resonators display competitive phase noise and frequency stability performance compared to quartz-based solutions, but there are no European or Canadian sources of such products. Important advantages of such MEMS resonators compared to quartz-based oscillator can be seen, where MEMS achieves performance in between the Temperature Controlled Crystal Oscillator (TCXO) and Oven Controlled Crystal Oscillators (OCXOs) but with the advantage of their extremely small form factor, low power consumption and integration capability with Silicon process. One more important aspect is that the MEMS fundamental mode frequency can be much higher than that of a Quartz crystal, whereas cost reduction is expected at lower frequencies and better performance at higher frequencies.</p> <p>This activity will design, manufacture of an engineering model oscillator chip based on European microelectromechanical technology in the 10 and 500 MHz frequency range. The performance shall be suitable for a range of application scenarios in telecom payloads. The engineering model chip shall be built and tested in a critical environment, including thermal test.</p>		
<b>Deliverables:</b>	Summary report, Engineering Model (EM) oscillator chip.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	Yes		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 - RF Subsystems, Payloads and Technologies		



### 3.3 Small Satellite Payload Equipment

Activity Ref.	Activity Title	Budget (kEuro)	Classification
5E.034	UHF IoT antenna for medium earth orbit smallsats	800	B
<b>Objective:</b>	The objective of this activity is to design, develop and test an engineering model of a UHF antenna suitable for operating from MEO-based smallsats.		
<b>Targeted Improvements:</b>	10-dB gain increase compared to current state-of-the-art UHF antennas.		
<b>Description:</b>	<p>UHF antennas have been already developed for Low-Earth-Orbit (LEO) smallsats/nanosats. Moving from LEO to Medium-Earth-Orbit (MEO) enables a reduction of the number of required satellites in the constellation to provide global coverage. However, for operation from MEO, larger antenna sizes are required in order to be able to close the RF link, which makes it more challenging to stow the antenna in the same volume.</p> <p>In this activity, a UHF antenna, stowable in smallsat for IoT applications shall be designed, including the stowage and deployment system, and a full engineering model shall be manufactured and tested, including RF range testing.</p>		
<b>Deliverables:</b>	Summary report and full engineering model.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	06 – RF Subsystems, Payloads and Technologies		





## 4. GROUND SEGMENT

### 4.1 Ground Network Operation Control and Gateway

Activity Ref.	Activity Title	Budget (kEuro)	Classification
6B.147	Multibeam gateway antenna for satcom constellations	1,300	B
<b>Objective:</b>	The objective of the activity is to design, manufacture and test a single aperture Ka or Q/V band gateway multibeam antenna, capable to serve multiple satellites located in a large field of view.		
<b>Targeted Improvements:</b>	Replacing multiple (up to 12) gateway antennas based on reflectors with a single aperture multi-beam gateway antenna ; Reducing by a factor 10 the complexity of a conventional active array antenna.		
<b>Description:</b>	<p>With the proliferation of satellite constellations, there is a strong interest, need, and market opportunities for innovative multibeam antennas for Gateway stations. These antennas should be able to generate multiple simultaneous beams in order to guarantee the link with different satellites. Existing gateway antennas are mainly based on reflectors dishes repointable mechanically, and able to track a single satellite instantaneously. Multibeam gateway antennas based on active phased arrays are also under development. They can generate multiple simultaneous beams, but they are not competitive yet in terms of complexity, power dissipation, thermal issues, cost. For these reasons, in this activity innovative multibeam antennas with a reduced complexity should be developed. The beamforming could be analogue, digital or hybrid. A significant simplification can be obtained by limiting the multiple beams directions in a limited portion of the field of view where the majority of the satellites are expected to be visible. In facts, the number of active controls in the antenna is proportional to the extension of the angular field of view. Another simplification can be obtained by assuming a minimum angular separation between two contiguous beams corresponding to two different satellites. The design must be customisable based on the longitude and latitude of the gateway station considering also the orbital position and orientation of the constellations to be served. By applying these simplifications and customisations, significant simplifications in the gateway antennas should be obtained.</p> <p>The activity will design, manufacture and test a single aperture Ka or Q/V band gateway multibeam antenna, capable to serve multiple satellites located in a large field of view. At least two promising technical solutions will be identified and studied. Trade-offs will be carried out and the most promising concept will be selected and implemented in a reduced scale prototype. The developed multibeam gateway antenna will be tested in a relevant environment establishing a link with a real satellite and scanning two independent and simultaneous beams.</p>		
<b>Deliverables:</b>	Summary report and reduced scale representative prototype.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	Yes – 2022 – Array Antennas and Periodic Structures		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	07 – Electromagnetic Technologies and Techniques		



## 5. USER TERMINALS

### 5.1 Professional User Terminals

Activity Ref.	Activity Title	Budget (kEuro)	Classification
7A.088	1 Gbit/s throughput CPU-based DVB-S2/S2X software defined radio	1,250	B
<b>Objective:</b>	The objective of the activity is to design, develop and test a 1 Gbit/s DVB-S2/S2X demodulator and 500 Mbit/s multi-frequency TDMA modulator on a high performance x86, ARM, or similar CPU based Commercial-off-the-Shelf (COTS) platforms.		
<b>Targeted Improvements:</b>	10-fold data rate increase compared to existing full DVB standards-compliant software defined radio implementations.		
<b>Description:</b>	<p>Current software-defined modems have demonstrated throughputs of around 100 Mbit/s, with some claims of significantly higher performance using specialised hardware and limiting the demodulator to one modcod only. Conversely, a high-performance modem running on a generic CPU platform opens up the possibility to deploy field-upgradable modems on server hardware for professional and governmental applications.</p> <p>This activity will study the implementation of DVB-S2 and S2X compliant demodulation algorithms as well as DVB-RCS2 MF-TDMA compliant modulation algorithms on high-performance x86, ARM, or similar CPU based Commercial-off-the-Shelf (COTS) platforms. A CPU-based software-defined radio with a throughput of 1 Gbit/s in DVB-S2X and 500 Mbit/s in MF-TDMA will be designed and developed. The software-defined radio will be tested in a relevant environment using a hardware modulator and burst demodulator, or dedicated test equipment.</p>		
<b>Deliverables:</b>	Summary report and 1 Gbit/s DVB-S2/S2X software defined radio software prototype		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	12 - Ground Station Systems and Networks		



## 5.2 Consumer User Terminals

Activity Ref.	Activity Title	Budget (kEuro)	Classification
7B.090	54 Mbaud software defined demodulator on low-end processor or graphics processing unit	1,200	B
<b>Objective:</b>	The objective of the activity is to design, develop and test a 54 Mbaud DVB-S2 and 5G NR demodulator on a low-end Graphics Processing Unit (GPU) or Central Processing Unit (CPU).		
<b>Targeted Improvements:</b>	Enabling a 54 Mbaud software defined radio for low end platforms not existing today in ESA Member States.		
<b>Description:</b>	<p>Previous projects have demonstrated that carriers of equivalent bandwidth can be demodulated in software on x86 server-level CPUs. Also, by using high-performance GPUs and parallel processing, bandwidths of hundreds of MHz or even many GHz could be demodulated. To date, a low-cost GPU or CPU-based demodulation solution with typical consumer terminal performance have not been developed. Such technology would allow field-upgradable terminals that can enable the deployment of new waveforms without expensive hardware swaps in the middle of the life of the system.</p> <p>This activity will develop and test a software-based demodulator running in a consumer GPU as found in a games console or a PC graphics card or a low-end CPU (Intel Core i3 or equivalent), with a throughput equivalent to a TV receiver or a consumer satellite broadband terminal. Superior demodulation algorithms than those in common open-source Software Defined Radio (SDR) toolkits will be studied and further developed and implemented.</p> <p>The activity will be implemented in a phased approach:</p> <ul style="list-style-type: none"> <li>- Phase 1 shall implement and test a DVB-S2/S2X demodulator on one of the hardware platforms described above. The DVB-S2/X demodulator software will be tested against a hardware modulator or dedicated test equipment in the relevant environment to ensure the baud rate is met and fully compliant with as a minimum the DVB-S2 specification. Phase 1 deliverable will be a DVB-S2/S2X demodulator on a low-end CPU or GPU platform. Budget is up to 700 kEuro.</li> <li>- Phase 2 shall implement and test in the relevant environment 5G-NR waveform or other proprietary waveform development on the hardware platform delivered by Phase 1.</li> </ul>		
<b>Deliverables:</b>	Summary report and full-scale prototype.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	6		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	12 - Ground Station Systems and Networks		



Activity Ref.	Activity Title	Budget (kEuro)	Classification
7B.091	Multi-band dual-beam C-to-Q/V satcom analogue beamforming integrated circuit	2,000	B
<b>Objective:</b>	The objective of the activity is to design, manufacture and test a wideband analogue beamforming integrated circuit (BFIC) capable of covering the entire frequency range from C- to Q/V-band, with two beams. This BFIC will serve as a modular and scalable solution for user-terminal flat-panel arrays, enabling multi-band and multi-product compatibility.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- Frequency coverage extended from C-band to Q/V-band in a single BFIC.</li> <li>- Fostering high-volume production scalability and economies of scale.</li> <li>- Enhanced design modularity, enabling flat-panel antennas to scale in aperture size (same number of beams) and/or number of beams (same aperture).</li> </ul>		
<b>Description:</b>	<p>Conventionally, different BFICs have been used in applications at different frequency bands, e.g., the C- to Q/V-bands relevant to satcom. Also, such conventional BFICs typically generate a single beam. To enable the use of the same BFIC in a broad range of satcom products, this activity will develop a next-generation dual-beam analogue BFIC with wideband coverage from C- to Q/V-band. Thus, the envisioned BFIC will serve as a fundamental building block for future flat-panel antenna arrays, supporting scalable designs by allowing additional BFICs to be integrated based on performance requirements. The development of this BFIC shall leverage insights from recent state-of-the-art wideband single-/dual-beam BFICs, such as the C- to Ka-band BFICs, which are developed outside ESA Member States. These contributions highlight the growing industry demand for multi-beam and frequency-agnostic BFIC solutions, which can reduce system complexity and accelerate product development, with the potential for higher volume production in comparison to single-band BFICs. Therefore, the envisioned BFIC will cover the entire C- to Q/V-band range and generate two beams, which will enable its reuse across multiple product lines and reduce the need for band-specific BFICs. The design will emphasise performance consistency across the wide frequency range, minimising variations in gain, noise figure, and linearity.</p> <p>Additionally, the activity will assess the thermal and power consumption challenges associated with multi-beam and broadband analogue BFICs at millimetre-wave frequencies, ensuring that the proposed solution is viable for both low- and high-end satcom applications. Successful execution will position Europe as a leader in wideband BFICs, securing our competitiveness in the evolving satcom ecosystem. The wideband analogue BFIC will be tested against DVB-S2/S2X or 5G-NR waveform in a relevant environment.</p>		
<b>Deliverables:</b>	Summary report and reduced scale prototype.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	Yes (standard IPR regime applies)		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	12 - Ground Station Systems and Networks		



## 5.2 User Terminals Mobile

Activity Ref.	Activity Title	Budget (kEuro)	Classification
7C.106	Dual-beam Ka-band-based multi-orbit aeronautical flat panel antenna	1,500	R
<b>Objective:</b>	The objective of this activity is to design, manufacture and test a Ka-band based (Ka-only or Ka and Ku) dual-beam electronically scanning flat panel antenna able to simultaneously connect to two satellites located at two different orbits. Four beams, two for transmit and two for receive path, will be implemented with two apertures.		
<b>Targeted Improvements:</b>	<ul style="list-style-type: none"> <li>- 50% antenna surface reduction required for the generation of 2 simultaneously active antenna beams compared to conventional phased array implementation.</li> <li>- Complexity reduction of the associated beamforming networks compared to phased arrays based on digital beamformers or multi-band beamformers.</li> </ul>		
<b>Description:</b>	<p>The growing trend of combining the use of GEO and NGSO satellite systems for the provision of in-flight connectivity to airplanes suggests the use of antenna terminals able to connect simultaneously to two satellites located on different orbits. A possible operational scenario could envisage the use of LEO satellites for latency-sensitive content to be supplemented by GEO satellites connectivity, possibly over congested areas that are commonly found in lower latitudes that do not require extreme antenna scanning angles to connect to equatorial orbits. At higher latitudes, two concurrently operated antenna beams could simultaneously connect to two LEO satellites to provide aggregate data traffic. The approach of deploying a single antenna aperture per antenna beam leads to doubling the overall terminal surface occupation. Alternatively, producing more than one beam from a single array of radiating elements would require complex design for the radiating elements themselves as well as for the associated beam-forming network. The observation that connecting to NGSO systems does not require scanning the antenna beams to very wide angles suggests that the inter-element spacing can be relaxed, allowing for interleaving two simple arrays sharing a common antenna surface, each array could then be fed by a simple single-beam beam-forming network, resulting in a practical implementation.</p> <p>This activity will design a dual-beam electronically scanning flat panel antenna to exploit a common surface to implement two simultaneously operating antenna beams connecting to two satellite operating from different orbits and possibly at different frequencies (Ku- or Ka-band), this for the transmitting as well as for the receiving antenna functions. This will result in an antenna aperture generating two independent receiving beams and a second one generating two independent transmitting beams. A reduced scale prototype of a dual-beam flat panel antenna, either operating in transmit or in receive mode, will be developed and tested.</p>		
<b>Deliverables:</b>	Summary report, dual-beam flat panel antenna reduced scale prototype.		
<b>Estimated current TRL:</b>	3		
<b>Target TRL:</b>	5		
<b>Technology harmonised:</b>	No		
<b>Dependency:</b>	None		
<b>S/W Clause:</b>	No		
<b>Service Domain:</b>	5		
<b>Technology Domain:</b>	07 - Electromagnetic Technologies and Techniques		