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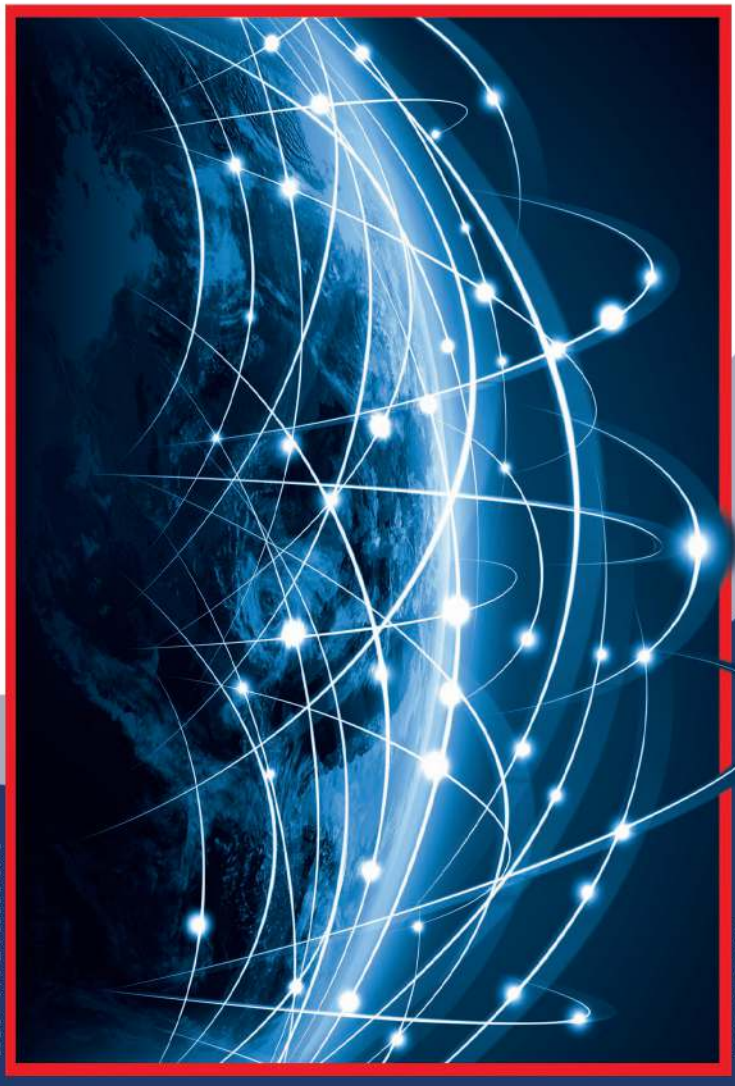
The Opinions

Opinion of AAE on

EUROPEAN SECURE CONNECTIVITY



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ACADÉMIE DE L'AIR ET DE L'ESPACE
Ancien observatoire de Jolimont
1 avenue Camille Flammarion
31500 Toulouse – France
contact@academie-air-espace.com
Tél : +33 (0)5 34 25 03 80
www.academieairespace.com

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1. BACKGROUND

Digital highways are the backbone of a modern economy and society. The EU is fast becoming a knowledge driven economy. Many items other than humans will be connected to the Internet. The Covid-19 pandemic has demonstrated the need for a high performance connectivity infrastructure. Commercial, private and public users need to be able to rely on secure and robust services that are protected against cyber and geopolitical threats (data control).

A secure European telecom and space infrastructure covering the whole territory is an indispensable tool for a more inclusive, competitive digital economy, further integrating the European space sector into the larger digital sector. More than 13 million Europeans have no domestic Internet access and over 62 million have connections of less than 30 Mbps. At the same time such an infrastructure will strengthen the independent and sovereign role of Europe in a global world. Strategic autonomy cannot be achieved without sovereign capabilities.

This paper addresses the challenges, risks and opportunities involved. It identifies the gaps and service needs for setting up such a critical European infrastructure.

2. KEY MESSAGES

1. The European Union, with its economic weight and geopolitical ambition ("strategic autonomy"), cannot rely on non-EU owned or located critical infrastructure. In this respect maintaining and enhancing connectivity should be a priority. Europe needs its own ubiquitous, robust, sovereign, secure, resilient and cost-efficient connectivity ecosystem as a backbone to our digital society. Such a project can only be realized at the EU ("added value") level.

2. A European Union connectivity project will provide user-driven ("market pull") services for industry as well as for public and private consumers. This will help bridge the digital divide, creating an equal opportunity for both rural and urban citizens, and facilitating the "Internet of things". These services will cover all of Europe, leaving no "dead zones".

3. Some service needs are already covered by existing infrastructure but many gaps remain that will need to be provided by Space means, in the shape of a multi-orbit constellation developed and operated by Europe. The justifications are: sovereignty, global reach including Polar Regions, and low latency for those services requiring it. This will NOT be a stand-alone Space project, but without an additional Space segment, these objectives cannot be achieved.

4. The envisaged EU infrastructure should be doubly inclusive:

   a) working alongside and blending with the terrestrial infrastructure;

   b) integrating European private actors, companies and operators. It is important not to squeeze out the private market but rather to encourage new agile players, such as startups and SMEs, to participate.

The buildup will be progressive ("no big bang"), modular and immediate.

5. The project will unlock the potential of quantum technology and cryptography. It will help secure the future European digital ecosystem with the aim of facilitating digital sovereignty.

6. Performance and cost-effectiveness are prerequisites for successful user uptake. However, the risk level associated with the long-term commercial viability of the system (the "business case") must be weighed against that of a player with geopolitical ambitions being left out of future developments because it lacked the appropriate critical infrastructure.

7. The first condition for success is funding availability and robust governance at the level of the European Union. A Public Private Partnership (PPP) should be a serious option, since such a joint commitment would send a strong signal, underlining the long-term viability of the system. This governance should make full use of "New Space" and establish an overall architecture through collaboration between institutions and the private sector, covering both Space and Terrestrial systems.

In order to illustrate the "Key messages", four appendices provide additional information which should help apprehend the overall context and associated challenges.

APPENDIX 1: SERVICES OF INTEREST FOR A EUROPEAN SYSTEM

The genesis of a communication system lies in the services it is designed to support. The goal is not to provide an exhaustive list of services, but to outline the services that define an envelope of requirements.

Table 1 summarises the services that could be envisaged for a European system. For many applications a satellite communications system is seen as complementary to terrestrial systems, exploiting synergies so that the network of networks offers a wider range of more resilient services to European citizens, governments and their agencies.

The European Union secure connectivity programme is meant as a pragmatic project in response to user needs and EU objectives. The EU has the political ambition to be a global player, which cannot be achieved without means. Space has a geopolitical dimension and Europe should not rely on non-EU critical infrastructures for connectivity.

Europe does not need to start from scratch as was the case with the Galileo navigation infrastructure. European private operators are effectively delivering connectivity services to European citizens and the new connectivity project will integrate and build on these assets.

For high-speed broadband, **terminal costs** also make a difference. In the residential market, a terminal cost of € 200-300 could already be an entry barrier, but this is not so critical for B2B applications, where terminals of thousands or even tens of thousands of euros are still acceptable. Requirements for fixed and mobile services also differ as the relevance of **terminal size** may depend on the application. In general, size and power are less important for fixed services than in mobility. However, for residential broadband, which is fixed, size can be a barrier to entry while a 2.4 metre antenna may be acceptable on a cruise ship, which is mobile.

Security is becoming increasingly important and is perhaps not sufficiently addressed in upcoming satellite systems. Quantum cryptology such as QKD provides some interesting possibilities in this respect. At one end of the spectrum, services like e-banking, e-government and e-commerce are entirely based on the Internet and there is an increased awareness of the need for confidentiality of personal data. On the other side, certain governmental services need to be protected and resilient. Sovereignty also features as a key element.

Users are becoming increasingly technology agnostic. This project will be a sui generis one, demonstrating that Europe is a powerhouse of talents and innovation to deliver cost-effective solutions with the required technical and technological performance, tailor-made to meet the European needs identified. This represents a real European added value.

The services envisaged require high **data rates** since video and imagery are increasingly used in all applications. For argument's sake, a data rate of at least 100 Mbps should be assumed. Services often considered to be **low data-rate** (<1 Mbps) are those for connected devices.

Legend

√ *Required*

(√) A requirement for certain specific applications.

Notes

1 *Low latency is crucial when considering tele-surgery employing haptic techniques and certain key infrastructure connectivity.*

2 *Europe is often involved in humanitarian aid outside Europe.*

3 *The coverage of the territorial waters is required for border control.*

4 *Low latency is not considered a requirement since most operational systems have got around latency through autonomy.*

5 *Resilience and security are a must even under adverse conditions.*

6 *Welfare communications ensure that the soldiers who are in the theatre can remain in touch with home. This is typically outside Europe and supported through commercial capacity.*

7 *Enable more business activity away from urban centres, alleviating the problem of crowding and promoting the distribution of wealth across the country.*

8 *Low latency and security are critical for some professional applications (e.g., financial trading, grid synchronisation, virtual reality, infrastructure real-time control).*

9 *More ubiquitous pan-European broadband coverage supports cohesion within the country and across the EU.*

10 *In 2019, there were over 500 million passengers flying within Europe and about the same number of international passengers in Europe.*

11 *There were also some 8.5 million passengers on cruise ships mainly in the Mediterranean and Baltic seas.*

12 *Within the list of applications, connected devices are the only service requiring less than a few hundred kbps.*

13 *Satellites are technology enablers for these services.*

14 *Cloud is part of the digital transformation. However, this opens up other issues, like security, sovereignty and cybercrime. The data is often not stored in Europe!*

Table 1: Potential services for a European system

		Scope of satellite solution		Critical Features		Service Area	
Application	**Service Type**	**Fixed**	**Mobile**	**Latency**	**Security**	**Global**	**Europe**
Public Safety	Crisis Management (First Responders)	√	√	(√)[1]	√	(√)[2]	√
	Police, border control	√	√		√		√[3]
	Key infrastructure connectivity (ATM)	√		(√)	√		√
Govern-mental	Core Services (Tactical)	√	√	[4]	√[5]	√	√
	Extended Core Services (RPAS)	√	√	[4]	√[5]	√	√
	Welfare	√				√[6]	
Broadband acess	B2B7	√		(√)[8]	√	√	√
	Residential[9]	√			√		√
	Aviation[10] (IFC), maritime[11] (passenger, crew, fleet mgt), Land (trains, buses, lorries)		√			√	
Connected devices[12]	Machine to Machine (M2M)	√	√	(√)		√	√
	Internet of Things (IOT)	√	√				
Backhaul[13]	5G	√			√		√
Cloud[13,14]	Cloud connectivity	√	√	(√)	√	√	√
Secure Services	Precision time applications (GNSS)	√		√	√		√
	EO / Copernicus dissemination	√		(√)	√		√

APPENDIX 2: REVIEW OF CURRENT AND PLANNED INFRASTRUCTURE, HIGHLIGHTING THE GAP AS REGARDS EUROPEAN USERS' NEEDS

Current and future space infrastructures delivering or intending to deliver services in Europe appear at first glance to provide significant coverage of needs. However, by factoring in criteria of European sovereignty and security for telecommunication services, this perception can be seen to be restricted, revealing the gap that needs to be covered by a dedicated and complementary space infrastructure:

The GEO infrastructure partially covers needs and remains a key asset to be leveraged.

For all services considered as essential for a sovereign and secure European communication system, the GEO infrastructure meets and will continue to meet needs **where there is no stringent requirement as to latency or Polar Regions / global coverage**. Thanks to European investment, public and private, Europe is well placed to consolidate and enhance a reliable GEO infrastructure, reinforcing security and traffic flexibility in particular.

The high number of initiatives is requiring dramatically increased efforts in the area of frequency coordination.

The boom in global constellations (MEO and LEO) is drawing extensively on the available frequency spectrum (traditional Ka band and already today Q/V bands), making it very difficult for latecomers to design workable frequency coordination schemes. This de facto situation **is leaving European solutions with little or no practical access** for their critical services needs: B2B, governmental communications, ubiquitous cloud access, M2M and IOT. Coordinated European action on the existing spectrum and that yet to be allocated must be urgently engaged to enable constellation deployment.

Ubiquitous, low latency access to an EU controlled cloud is a growing necessity.

Among the emerging services, **ubiquitous cloud access** is one of the most promising, and US actors are actively working on setting up space infrastructures to cover the Europe zone, reinforcing vertical control of access, infrastructure, and associated content and services. Looking beyond the commercial strategy, the US "Clarifying Lawful Overseas Use of Data Act" or "CLOUD Act" is de facto increasing European dependency. Alongside and in support of the European GAIA-X initiative, the **deployment by Europe of a constellation allowing access to cloud infrastructure (ubiquitous and low latency) will strengthen the position of Europe in the cloud race and provide the means for an independent, sovereign cloud infrastructure**, at least for the most critical services.

Quantum technology is not yet in the equation, giving Europe an opportunity to take the lead.

In the fundamental domain of cybersecurity, quantum technology offers a unique opportunity for Europe. To fully benefit from it, an organization must be set up by Europe to deploy coordinated services such as backup solutions to terrestrial networks, critical B2B services, disaster monitoring and governmental services.

Govsatcom will be reinforced and leveraged by a secure European constellation.

Govsatcom is setting the pace in addressing the fragmented landscape of European telecommunications services offered by both nationally owned and commercial satellite infrastructures, with the aim of providing access to secure services. A European constellation with embedded secure technologies and global coverage, including the Polar Regions, will speed up access to these services, complementing and leveraging Govsatcom assets, by enabling technical coordination and interoperability.

Table 2: Gap analysis with existing and future infrastructure

HIGH MEDIUM LOW **PERF.**	HIGH MEDIUM LOW **REQ.**	LOW MEDIUM HIGH **PERF.**	LOW MEDIUM HIGH **REQ.**
SECURITY		**LATENCY**	

Application	Service Type	Existing Infra				Future Infra			
		European		Non-European		European		Non-European	
		GEO	NON-GEO	GEO	NON-GEO	GEO	NON-GEO	GEO	NON-GEO
Public Safety	Crisis Management (first Responder)	✓	✓	✓	✓	✓	✓	✓	✓
	Police, border control	✓	-	✓	✓	✓	-	✓	✓
	Key infrastructure connectivity (ATM)	✓	-	✓	-	✓	-	✓	✓
Govern-mental	Core Services (Tactical)	✓	-	✓	✓	✓	-	✓	✓
	Extended Core Services (RPAS)	✓	-	✓	✓	✓	-	✓	✓
	Welfare	✓	-	✓	-	✓	-	✓	✓
Broadband access	B2B	✓	✓	✓	✓	✓	✓	✓	✓
	Residential (except gaming)	✓	✓	✓	✓	✓	✓	✓	✓
	Aviation (IFC), maritime (passenger, crew, fleet mngt), land (trains, buses, lorries)	✓	✓	✓	✓	✓	✓	✓	✓
Connected devices	M2M	-	-	-	✓	-	-	-	✓
	IOT	✓	-	✓	✓	✓	✓	✓	✓
Backhaul	5G	✓	-	✓	-	✓	-	✓	✓
Cloud	Cloud connectivity	✓	✓	✓	-	✓	✓	✓	✓
Secure Services	Precision Time applications (GNSS)	✓	-	✓	-	✓	-	✓	-
	EO / Copernicus dissemination	✓	-	✓	-	✓	-	✓	-
Highest Level Security	QCI: Government, banking, critical infrastructure	-	-	-	-	✓	✓	✓	✓

Latency: Not all applications shown will require stringent latency requirement as stated.

APPENDIX 3: KEY SYSTEM TASKS AND PARAMETERS IN ORDER TO DEFINE THE CONSTELLATION

In parallel with a detailed definition of the constellation, it is highly recommended that three key system tasks be performed as a matter of urgency as illustrated in Table 3-1 of this appendix.

Table 3-1: Three tasks to be performed in parallel with constellation definition

Perform a thorough Mission analysis	Exhaustively identify all requirements related to traffic, user access, coverage and user terminals, in order to meet the following goals: • provide secure governmental communications, as a complement to already existing systems, • provide broadband access, IoT and ADS-B services, without white zones to all European users, • secure European sovereignty, • provide access to the Cloud, in close coordination with the GAIA-X development project.
Select and secure the necessary frequencies	First consider frequency filings already agreed, and other constellation initiatives (USA and Canada, China etc.). Then, select & secure the right frequencies: this is a top priority task, as frequency filings are subject to tough worldwide competition between candidate constellation operators. Note that Ka band could be used to fulfill the mission if enough coordinated spectrum is available, but other options are possible.
Define the Governance and anticipate the End User Services	End User services will be provided by the constellation once deployed. Those services must be developed in parallel with the constellation and with the same level of priority. In fact, European sovereignty depends not only on communications but also on the related content and services to be distributed to the End Users.

In addition, as a consequence of the analysis whose outcome is summarized in appendices 1 and 2, a multi-orbit constellation appears the natural optimum solution to satisfy the needs of European citizens. Table 3-2 of this appendix offers some considerations.

Table 3-2: Some parameters to be considered for the definition of the constellation

	Comments
Overall constellation	**Total capacity envisaged around 10 Tbps, to be shared between:** • **A GEO component (higher capacity over Europe)** • **A LEO constellation for low latency and Polar Regions / global coverage.**
LEO Orbit selection and Satellite sizing	• Higher orbits ease management and communications with planes. • Consider follow-up of launches performed by Europe. • Some room must be kept for on-board processing, ISL to offload the ground, and hosted payloads to improve the business case.
User's terminals	Different classes will be defined, e.g.: man pack, residential, transport (air, train, maritime), backhauling, trunking. • The size of the terminal is a function of the bit rate. • Phased array facilitates multi-satellite tracking, hand-over, ergonomic.

APPENDIX 4: CHALLENGES FOR SUCCESSFUL DEPLOYMENT OF A EUROPEAN SATELLITE CONSTELLATION

From a technical standpoint, a number of critical challenges are listed in the Table below:

Table 4: Critical technical challenges

AREA	ELEMENT	COMMENT
Space segment	Spacecraft autonomy with integrated collision avoidance.	
	Mitigation of Space debris and pollution on astronomical observations.	
	High performance On-Board Processing (OBP) with Deep Sub-Micron technology and radiation tolerance.	
	Millimeter Wave (Q/V & W frequency bands) technology.	Include solutions for management of site diversity.
	Quantum communications with on board intricated photon sources and Quantum Key Distribution (QKD).	
	Optical Inter-Satellites links.	
Ground segment	Artificial Intelligence for system management.	Number of satellites to be managed and smart maneuver execution.
	Cyber-security management.	
	Cost effective user Terminals.	Chipsets for all types of missions.
	Photon detection & synchronization for QKD.	

From a programme standpoint, particular attention will be given to the approach in order to ensure timely development and successful deployment of the constellation at minimum cost. This necessitates the use of up-to-date agile methodology, the inclusion of all potential "disruptive" contributors with special focus on start-ups & SMEs, and well-organized competition that will explore new procurement schemes and trigger the necessary innovation to the benefit of EU.

ACRONYMS

ADS-B	Automatic Dependent Surveillance – Broadcast (planes)
ATM	Air traffic management
B2B	Business to Business
EO	Earth Observation
EU	European Union
GEO	Geostationary (Orbit)
GNSS	Global Navigation Satellite System
IFC	In-flight connectivity
IoT	Internet of things
ISL	Inter Satellite Link
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
M2M	Machine-to-machine
Mbps	Megabits per second (Tbps: Terabits per second)
OBP	On-Board Processing
QCI	Quantum Communication Infrastructure
QKD	Quantum key distribution
RPAS	Remotely piloted aircraft system
SME	Small and medium enterprise

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