ISICOM Programmatic Definition - draft

FISI - WP3

Deliverable D3.2.1

Reference:	FISI_WP3_D3.2.1_V1.0
File:	FISI_WP3_D3.2.1_ V1.0
Classification:	Public
Contract:	EU FP7 Grant Agreement n° 257118

Prepared by:	TPZ
Version:	V1.0
Date:	14/09/2011
Signature:	

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Change Records

Issue	Date	Changes	Contributors
V0.1	September 9th, 2011		TPZ (Vincenzo Fogliati Antonella Catucci) FISI Partners as members of the ISICOM TF
V1.0	September 14 th, 2011	Insertion of further inputs	TPZ (Vincenzo Fogliati Antonella Catucci) FISI Partners as members of the ISICOM TF


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1. FORWARD

This document illustrates activities performed by WP3, started in the project period from January 1st and August 31st, 2011, focusing on the identification of the basic elements for the ISICOM Programmatic Definition. Chapter 2 starts with the analysis of existing and planned Satcom assets and related programmes, which is the basis for the subsequent preliminary identification of ISICOM differentiators and potential added value. The illustration of the main characteristics of the ISICOM system and the first options for its proposed high level system architecture are dealt with in chapter 3, followed by considerations related to the technical innovation and R&D areas to be considered in order to meet the mission requirements and develop the proposed architectural options (chapter 4). Some preliminary considerations about the regulatory and standardisation framework to be set up for the development of the system and a review of the main involved actors and their possible roles are presented in the last two chapters. The WP3 activities related to all of these aspects, started in the first project reporting period, will continue in the next FISI project period, thus resulting in the final elaboration of the programmatic elements for the ISICOM Initiative, which will be illustrated in the next version of this Deliverable (D3.2.2).

2. EXISTING AND PLANNED INSTITUTIONAL SATCOM ASSETS/PROGRAMMES AND PRELIMINARY ISICOM ADDED VALUE IDENTIFICATION

In the last decade the important obtained results in space activities has permitted Europe to grow in scientific and technological prestige, reinforcing its independence and global position.

The growing commitment of the principal European players, within the European Union (EU), the European Space Agency (ESA) and their respective Member States, is due to recognition of the strategic value of space technology and services for the EU and corresponding improvements in the well-being of European citizens.

Governments has played a key role in the space industry during the decade from 2000 to 2009. This situation, in the past few years, has changed due to cuts to public expense in all the major European countries and the new forms of collaboration between public entities and private companies for the development and management of satellite systems, which resulted in a relative decline of purely governments funded satellite launches.

2.1. EXISTING AND PLANNED INSTITUTIONAL SATCOM ASSETS AND DEVELOPMENT PROGRAMMES

Over the last 40 years, Governments have been heavily involved in the growth of the satellite communication (SatCom) industry and markets through their R&D, procurement, and regulation activities. Their historical involvement within domestic and international public satellite operators placed these operators in a pivotal position within the satcom industry as major clients of satellite manufacturers and as key services suppliers. With the emergence of the SatCom industry as a mature business, governments began scaling back their involvement, as demonstrated by the privatization of the International

Governmental Organizations in the late 1990s (e.g. Intelsat, Inmarsat, Eutelsat). Governmental investment was then mainly targeted at two objectives:

- The acquisition of operational satellite communications resources for domestic civil and/or defense needs

- The funding of R&D and technology demonstration programs in order to develop, acquire and validate domestic capabilities

Over the last few years however, SatCom sector has been experiencing new developments that have significantly reshaped the landscape of government activities in this area including:

- A strong commitment from many governments to renew, expand or acquire dedicated SatCom capacity for defense and security purposes; resulting in defense agencies becoming the primary clients and partners for the SatCom industry.

- A consistent decline from many civil space agencies in funding SatCom R&D with a (wrong) perception that this industry is becoming mature enough to self support innovation

- Increasing partnership/risk sharing requirements from both defense and civil agencies, that wish to share costs for system procurement, service delivery and/or R&D programs

- A consistent rise of projects sponsored by developing countries who wish to build/acquire their own SatCom system for autonomy, prestige or business purposes. These new customers twist traditional market conditions and competition landscape for satellite manufacturers.

- A total of 115 ComSats were launched by governments between 2001 and 2010, of which 60 were for defense applications: Geostationary orbit was the dominant application, with 77 satellites launched (67% of the total); three to seven MilComSats have also been launched each year since 2002 (albeit at a slower rate compared to the late 1990s) with multiple launches of Russian MilComSats in LEO orbit; civil ComSats tend to be more stable, launching between six to seven units per year, (except for between 2003 and 2005 when this number decreased to three before coming back to its previous level). Finally, in 2011, 26 ComSats are scheduled to launch and are expected to be mainly for civil applications, particularly in India and Russia, although launch delays are expected.

Defense applications are the primary driver influencing governments to invest in SatCom programs. Of the top five largest satellite communications programs, four are driven by defense considerations.

- The US spends $5.8 billion in 2010 in SatCom of which 99% comes from the DoD ($5.97 billion) while NASA's program is kept to a minimum. At the moment, the US DoD is at a peak-period of investment due to the renewal of its entire communication satellites fleet which should be completed by 2014.
- The European Space Agency (ESA) has the only civil-oriented SatCom program of the top five agencies. ESA SatCom funding reached €324 million ($427 million) in 2010.
- Russia invested $280 million in 2010 on its civil space program driven by strong requirements to renew the national civil SatCom fleet managed by RSCC and Gazprom Space Systems. Military expenditures are classified and therefore not accounted. Although not disclosed, Russian MilSatCom spending are considered significant, certainly pushing Russian government overall investment over the billion dollar mark, second only to the US.
- With $219 million invested in 2010, Australia entered the top-five SatCom spending

countries aided through the acquisition of domestic/in-partnership capabilities (i.e. a hosted payload on Intelsat 22 and a partnership on the US' DoD WGS) reflecting the growing interest of a number of countries in securing access to SatCom capacity.

- The UK stands in 5th position with its long-term investment in the military Skynet 5 program which was contracted through a Private Finance Initiative agreement with Astrium Services/Paradigm Secured Communications.

Most of European satellite communications R&D is undertaken through ESA and, over the years, the agency has offered the European SatCom industry the only significant and accessible program to help support innovation and competitiveness. In comparison, national agencies in Europe tend to limit their domestic R&D support funds as they consider SatCom as a commercially mature application, or they focus their investments into ESA's programs instead.

However, the ESA fair-return principle has succeeded in convincing European countries to focus their R&D efforts into the ARTES program, thereby supporting their respective national industry. The Telecommunications Long Term Plan (TLTP) for the 2009-2013 period provides guidance and investment priorities for ESA with the objective of supporting European industry competitiveness on the commercial market through R&D (its traditional priorities) and the development of operational systems for European users (a new mandate for ESA who used to focus on non-operational system development).
Funding to the ESA SatCom program has been increasing since 2004 as the agency entered into a cycle of investment in multiple activities for both R&D and system development, from €146 million ($209 million) in 2005, to €324 million ($427 million) in 2010. Posting a five-year CAGR of 14%, SatCom currently represents 11% of ESA's overall budget as opposed to 6% in 2005. Member States investing the most in ESA SatCom programs include: Germany (24% of the budget), the United Kingdom (14%), France (13%), and Spain (11%).

As mentioned, ESA SatCom activities are carried through the ARTES (Advanced Research in Telecommunications Systems) program which provides flexible legal and financing mechanisms to help undertake its activities. ARTES is composed of nine programmatic elements with each element having its own specific area of action and implementation scheme. Those elements receiving the largest funding include: ARTES 3-4 (28% of ARTES total budget), ARTES 11 (20%) and ARTES 8 (17%).

ESA's current SatCom priorities include:

- **European Data Relay Satellite (EDRS) mission**: Following successful tests with the ARTEMIS satellite, ESA is working on the development of an operational system to provide continuous data relay services to current and upcoming European satellite missions (e.g. GMES and Galileo), orbital infrastructures (e.g. ISS), and launch vehicles (e.g. Ariane/ATV). Other possible areas of use could include UAVs, terrestrial, maritime and aeronautical communications. The current EDRS architecture includes two data relay piggy-back payloads and a dedicated satellite including a data relay payload and a data dissemination/repatriation payload. The total cost of the program is expected to be in the range of €250-350 million. The business model of EDRS has yet to be fully defined. ESA intends to select a service provider, who will then liaise with the satellite operator(s) and satellite prime(s) to help build the EDRS infrastructure. The EDRS is planned for a 2014 launch.
- **Alphabus/Alphasat**: The Alphabus/Alphasat program was jointly initiated by ESA and CNES. The aim of the project is to support industry in the development of a multipurpose satellite platform for high-powered communication payloads. The platform is jointly developed by EADS Astrium and Thales Alenia Space. In June 2007, Inmarsat entered into an agreement with ESA to operate the first communications satellite using the Alphabus platform. The Alphabus project represents an expenditure of €440 million by 16 ESA Member States.
- **IRIS**: IRIS aims at developing a satellite-based Air Traffic Management (ATM) system in line with the technical requirements and time schedule of the Single European Sky

ATM Research (SESAR) program. The final architecture of IRIS is not yet fully defined but plans include the launch of a demonstrator in 2014 followed by at least two large GEO satellites around 2020 for operational services. Similarly to EDRS, ESA is working on the definition of a business plan for IRIS which may lead to the implementation of a PPP with a commercial operator.

- **Small GEO**: The ESA Small Geostationary Satellite Initiative is aiming at the definition of a general purpose small GEO satellite platform to enable the European Industry to supply a competitive product in this market segment. The German company OHB System signed the platform prime contract with ESA in November 2008. OHB leads a European consortium comprised of the Swedish Space Corporation, Oerlikon Space (Switzerland), and LuxSpace (Luxembourg). In December 2008, ESA signed a contract with FSS operator Hispasat to operate the Small GEO platform (Hispasat AG-1), with for an expected launch in 2012.

The implementation of a domestic defence communication satellite system responds to specific strategic needs and has high funding requirements which make such investment complex when compared to civil satellite communications. In addition, defence budget investment in SatCom consists of the procurement of operational systems as well as investment to support industry (and not R&D activity). As such, defence agencies act like commercial clients with cyclical needs and according to their procurement phases.

In 2010, 12 countries had invested in a domestic dedicated MilSatCom system attesting the increasingly strategic nature and importance of SatCom for a growing number of defence agencies. These countries include: the US, Russia, UK, China, Australia, Germany, the UAE, Israel, Italy, France, Canada, and Spain. This represents a two-fold increase in the number of Countries investing in a dedicated MilSatCom (from the six countries at the onset of 2000: US, Russia, China, France, UK and Italy). As anticipated, the US DoD maintains an unchallenged funding and capacity level accounting for 77% of the world's (unclassified) spending.

SatCom contributes to a broad range of defense operations, including operational/tactical incombat missions, peacekeeping, and disaster communications. Satellites in these types of situations are considered as the only reliable means with which to communicate. Defense customers have different SatCom requirements depending on the operations in which they are involved (thus system flexibility is a key performance parameter). For instance, crisis prevention requires a continuous flow of information and situational assessment in order to support decision-making, while crisis-management requires real-time information to support in theatre and tactical operations.

In addition, quantitative and qualitative requirements for SatCom applications are significantly different from one country to another and are mainly related to its level of participation to military operations. However, an increase of the number of involved Countries in such a type of activities has occurred and is expected for the future.

Parameters on which various defence agencies have to focus attention and make choices when implementing a MilSatCom program are, often, quite the same, namely:

- Security (information encryption and access control/authentication)
- Interoperability with third party systems and equipments
- High data rate communications (bi-directional and multidirectional) and data cast, among fixed users
- Very high data rate connections between space based assets and sea/land/air platforms and assets
- Low to medium data rate mobile communications
- Cost effective wide-band air to ground communications.

A growing number of European countries have initiated MilSatCom programs to support their participation to multinational defence/security/peacekeeping operations overseas. Contrary to civil programs through which European countries have traditionally joined their efforts through ESA, MilSatCom programs have been implemented so far at national levels with, until now, limited coordination among the EU Countries involved (this approach could

lead to cost duplication/multiplication and lack of coordination/inter-operability among different systems while operating within a joint multinational framework). The development of national procurement of military communication satellites led to a significant rise of related spending in the 2000s with a peak of €506 million ($744 million) total funding for MilSatCom in Europe in 2008. Investment remained high in 2010, with €315 million ($466 million), representing 75% of overall European investment in military space applications.

Investment is concentrated within the five countries possessing a national MilSatCom program (France, UK, Germany, Italy, and to a lesser extent, Spain). The investments aim at procuring operational systems (and not supporting R&D) reflecting the cyclical nature of European military spending compared to European civil agencies. In the five cases, the countries opted for specific funding mechanisms, including traditional procurement processes (France, Italy), Private Finance Initiatives (UK), or other Public Private Partnership (PPP) models (Germany, Spain).

Cooperation has been a recurring issue debated among European countries, since attempts at creating a joint MilSatCom effort in the 1990s failed to materialize with the EU/tri/Bi-MilSatCom initiative.

So far, rather than Pan-European cooperation, European countries have preferred to opt for bilateral agreements, for example: France/Italy for Athena-Fidus and Syracuse-3/Sicral-2, Norway and Spain with a potential joint procurement. However, the converging operational lifetime of national systems continues to revive cooperation intentions as recently demonstrated by the French and UK government statements that they may consider a joint development for their next generation system post-2020. However, this type of cooperation remains conditional on the right mix of political, operational, industrial and financial factors, which have proved so far to be quite difficult in the European military sector, but could lead to significant benefits in terms of overall cost reduction and higher performance/inter-operabilty at EU level.

A synthesis of the activities in the five Countries is reported hereafter:

➢ **France**: Between 2002 and 2008, the French MoD's procurement agency spent an average of €251 million ($310 million) per year on MilSatCom, (representing 57% of its overall space budget) in order to finance the Syracuse-3 program. Its investment fell to below €40 million in 2009 and 2010 with the end of the procurement process. France is considering the resell of its Syracuse-3 system to a private company, similarly to the UK's MoD decision several years ago, in order to achieve cost reduction. France also announced that it was in discussions with the UK on a future joint MilSatCom system by 2018 (focused on mobile broadband in X and Ka-band).

➢ **UK**: The UK Skynet-5 program is financed via a PFI contract signed with Paradigm (an EADS subsidiary). The satellite system is owned and operated by Paradigm that leases back capacity to the MoD and allied governments. The 18-year PFI contract is valued at £2.5 billion ($4.2 billion) for the development and operation of four satellites (Skynet 5A to 5D). Smoothed over the contract period, the UK MoD expenditures have averaged £140 million ($215 million) per year since 2009. The UK intends to maintain the PFI model for its next generation system, whether or not it is developed in cooperation with France.

➢ **Germany**: SatCom BW consists of a two-satellite system completed in 2010. Under a multi-year contract, the system is managed by Milsat Services GmbH, a subsidiary of Astrium Services that will support the Bundeswehr during the satellite's lifetime. The contract represents an annual expense of about €100 million (or, $135 million) from 2007 to 2010. As the system has been operational since mid-2010, German MilSatCom expenses are expected to decrease in the coming years.

➢ **Italy:** deployed the second satellite of its Sicral-1 program in 2009. As a consequence, Italian MoD investment in SatCom decreased significantly in 2009 to €12 million as opposed to $118 million in 2008 essentially due its participation to the Italian French

dual use Athena Fidus program, with some remaining components of Sicral 1 and R&D for Sicral 2. In 2010, the Italian MoD renewed its spending to start the development of Sicral 2 estimated to cost €38 million, or $50 million. Sicral-2 will be co-developed with a French Syracuse 3 satellite.

- **Spain:** Since 2006, the Spanish MoD has leased about 10 X-band TPEs on board both the XTAR/Hisdesat's satellites (XTAR-EUR and XTAR-LANT) corresponding to annual spending of approximately €15 million ($20 million). Moreover, at the end of 2009, the Spanish MoD announced that it would be cooperating with Norway to procure a common satellite for a 2014 launch.

2.2. ISICOM ADDED VALUE PRELIMINARY IDENTIFICATION

As summarised in the previous paragraph, at present there are several satellite systems that differ in terms of service and technological characteristics, purposes (institutional/commercial), type of configuration (Low Earth Orbit LEO / Geostationary Earth Orbit GEO) and coverage area.

The EU Member States governments having technical and economic capability to develop their own communication satellite system are a minority; today and in the future, the majority of EU Countries do not/will not have a national satellite communication infrastructure, thus also resulting in a higher difficulty/gap for these Countries to fulfil their security, civil protection and emergency management requirements.

The Lisbon Treaty decreed the need for Europe to have a space policy and a space programme, which are essential instruments to ensure access to space infrastructures and suitable strategies and plan for the development and proper utilisation of them by all of the EU Countries, in a coordinated and integrated way.

Moreover, the existence of the current economic and financial crisis reinforces the need for a system that is not financed by one or two Member States only, thus permitting to share costs and avoid cost duplications/multiplications.

Another important parameter to be considered is the coverage area of the satellite systems: disasters and crisis situations occur everywhere in the world, and Europe should be able to respond to them by reinforcing its capability to communicate on a worldwide scale.

These considerations have led to identify a set of parameters - primarily related to the Institutional User requirements in the security and emergency management domain- which can be used to compare the various existing and planned satellite systems with respect to the ISICOM main characteristics. This comparison is shown in the following table (to be considered as preliminary: next FISI WP3 analyses, to be performed in the next project reporting period, will permit to integrate/refine the table).

	Defence/ Institutional (Domestic- EU MS)	*Defence/ Institutional (Domestic- Non-EU Country)*	*FSS Commercial*	*MSS Commercial*	*ISICOM*
Full utilisation by all EU Member States	NO	NO	YES (according to specific agreements)	YES (according to specific agreements)	YES
Limited use through intergovernmental agreements within EU	Possible, but difficult to reach	Very difficult	-	-	YES
Global coverage	NO	NO (normally)	Depending on the selected system	YES (for some systems)	YES
Real availability of transmission capacity (when needed) by all EU Member States	uncertain / subject to intergovernment agreements	uncertain	uncertain / subject to transponder availability / no priority for security applications	uncertain / subject to transponder availability / no priority for security applications	YES
Full Integration/interoperability with navigation (GALILEO) and Earth Observation (GMES) Systems	NO	NO	NO	NO	YES
Confidentiality and authentication level	high	high	low	low	high
Capability to fulfil user requirements in the security and emergency domains	high	medium	low	low	very high
System cost sharing/duplication avoidance for EU Countries	NO	NO	-	.	YES

Some brief explanations of the criteria/parameters/categories included in the Table are reported hereafter:

1) Identified Satellite Systems categories:

- **Defence/ Institutional (Domestic- EU MS) is referred to existing/planned systems developed by EU Countries,** like: Sicral, Athena-Fidus, Skynet , SatComBW, Syracuse.
- **Defence/ Institutional (Domestic- NON EU Country) is referred to systems developed outside the EU,** like: DSCS and MUOS, Raduga, KoreaSat, DFH or ChinaSat.
- **FSS Commercial is referred to satellites systems like those operated by:** Intelsat, Eutelsat and SES.
- **MSS Commercial is referred to systems like :** Iridium, Orbcomm, Thuraya, Inmarsat.

2) Parameters included in the Table and brief explanation of the (preliminary) resulting considerations

Full utilization by all EU Member States: the ISICOM satellite system concept implies the possibility for it to be freely used by all EU Member States, regardless of their technical and economic capabilities/assets in the satellite communication domain, thus also including European nations not having developed a domestic institutional Satcom system.

Limited use through intergovernmental agreements within EU: the growing complexities of the international (political and economical) scenario will likely complicate and aggravate the (always existing) difficulties of reaching possible intergovernmental agreements for a limited use of domestic national systems by nations other then the ones having developed the systems themselves (within a security related context and/or during an emergency

phase too). In this context, the ISICOM satellite system (being a “EU system”) can be used by EU Member States without special intergovernmental agreements.

Global coverage: it refers to the capability of providing a global coverage to serve users anywhere around the globe and anytime.

Real availability of transmission capacity (when needed) by all EU Member States: the ISICOM concept implies a guarantee, for all EU Member States, to have access to real transmission capacity **immediately, when and where needed.** For other systems, this immediate availability is quite uncertain, since it is subject to intergovernmental agreements or commercial transponders availability.

Full Integration/interoperability with navigation (GALILEO) and Earth Observation (GMES) systems: nowadays and for the future, an increasing request of integrated services and suitable devices supporting data provided by different satellite systems (including localization and earth observation systems) is/will be experienced. With regard to these trends (not realized neither through existing systems nor through planned ones), the ISICOM concept is based on a full interoperability with navigation and EO systems, as Galileo and GMES.

Confidentiality and authentication level: the importance and nature of transmitted information for services and application related to security issues makes of fundamental importance the problem of authentication and confidentiality.
Information has to be exchanged among authorised institutional actors only (National Institutions, Civil Protection Agencies, International Organizations and others) for which the privacy and authentication of information represent essential characteristics. In this respect, the use of commercial systems, (which, by nature, are not fully addressing such authentication and confidentiality issues), could not represent a suitable answer to these needs. On the other hand, Defence/Institutional systems are able to provide a high level of confidentiality/authentication capabilities.

Capability to fulfil user requirements in the security and emergency domains: the ISICOM system concept is being "ad-hoc" designed with the main purpose of fulfilling security and emergency user requirements. Other systems can certainly able to partially meet some of these requirements but are not able to address all of them (since they have been designed and developed for other purposes).

System cost sharing and cost duplication avoidance for EU Member Countries: this parameter relates to the possibility to develop an European System which can allow the sharing of related investments/costs among the EU member countries, thus avoiding the risk to duplicate/multiplicate investments and costs due to the implementation of different (domestic/regional) systems characterized by similar services/performances.

3. ISICOM OVERVIEW AND HIGH LEVEL ARCHITECTURE

The ISICOM concept has been conceived mainly through the work of the ISI ETP ISICOM Task Force, whose activities have been (and will be) supported and coordinated through the efforts made by the FISI Project Partners. Other ISI ETP Members have also contributed to the activities of the Task Force and to the definition of the ISICOM concept. In this chapter and the following ones, considerations, concepts and preliminary outcomes coming from the Task Force activities (supported by FISI) are summarised.

ISICOM aims at providing global, flexible, secure and resilient SatCom services able to operate worldwide to ensure routine operations and support crisis management. ISICOM features are:

- High-speed broadband seamless services to and from fixed and mobile terminals with low operational constraints, either directly or backhaul through several hops
- High Quality of Service

- Adequate data security (encryption, access control, …)
- Minimum response time
- Fast deployment and mission re-configuration
- Seamless interoperability with terrestrial systems / networks
- Integration with satellite based earth observation and navigation systems. (data-relay services for raw data collect and geo-spatial product dissemination, geo-localization based services,)
- Integration of the SatCom infrastructure and its related services into overall crisis management tools
- Resilient and flexible network architecture
- Services to unmanned platforms such as UAVs or HAPS (such as HD video transfer in real time)
- Sharing of the satellite capacity amongst many users, terminals, and services

The ISICOM Initiative aims at serving the European Institutional SatCom demand and supporting the European SatCom industry in the development of breakthrough technologies for advanced features and performances. The ISICOM initiative is targeting the development and deployment of an innovative SatCom system infrastructure:

- Providing a short notice dependable and trusted satellite based network, delivering mobile and broadband interactive services while being integrated with terrestrial networks
- Leveraging on existing and planned SatCom systems to form a seamless global common space infrastructure
- Increasing the available bandwidth with innovative spectrum management, radio transmission and protocol techniques
- Reducing the costs of ground and space segments with standardised design
- Improving the interoperability of the different communication features of the Public Safety users

- Proposing a scalable and modular design well fitted to incremental deployment in coverage and capacity by accommodating additional satellite resources and upgrading the ground component
- Allowing to share the system and its capacity by many organizations, through intelligent capacity allocation schemes
- Defining a progressive implementation plan

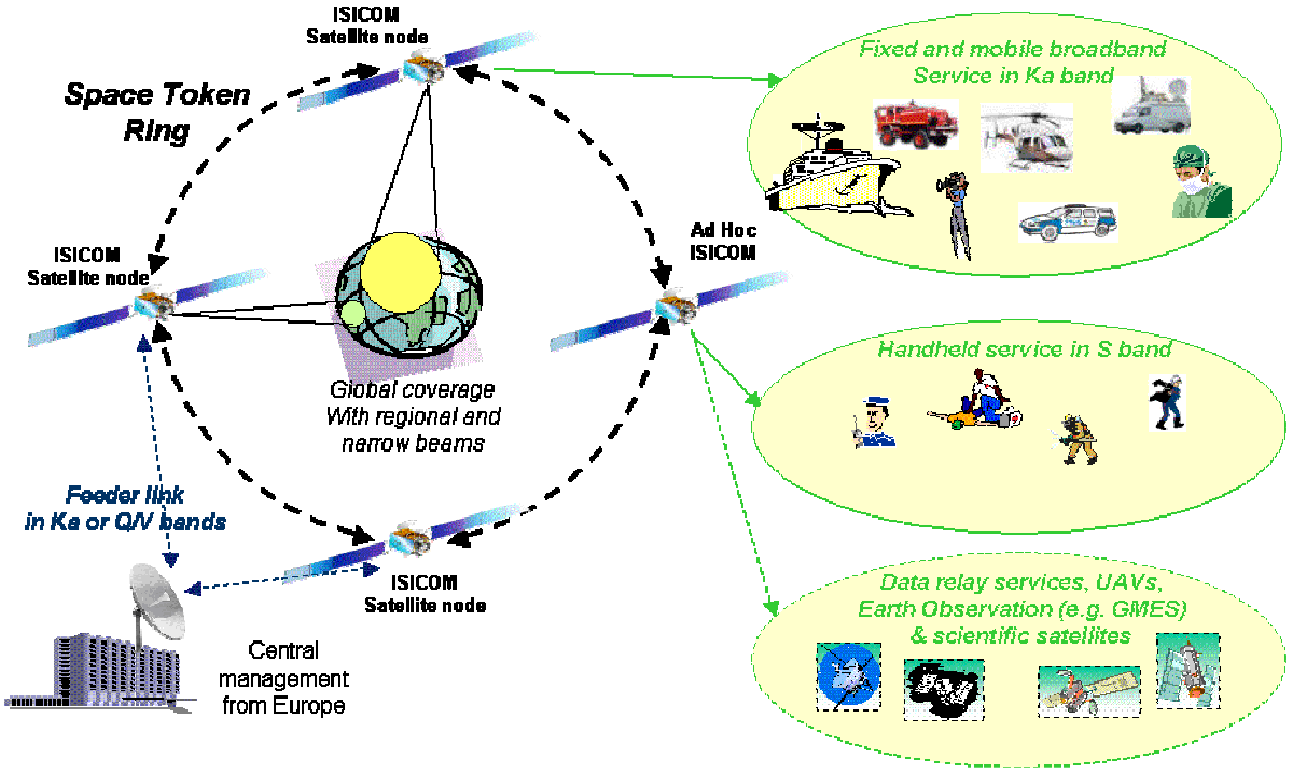

Figure 1 : ISICOM infrastructure

The general architecture depicted in Figure 1 represents a first/preliminary possible option and is not to be considered as the final ISICOM architecture, whose elements are (and will be) under discussion within the ISI ETP ISICOM Task Force (these discussions have been

and will be actively supported/coordinated by FISI). It is also important to note that the final aim is to propose an architecture fully able to fulfil the user needs and (at the same time) avoiding any un-necessary complexities (which could make the system “not-affordable” for EU).

ISICOM benefits for the European citizens including relevant users are:

- Faster response time in the crisis management
- Provision of permanent, secure and resilient communications

ISICOM benefits for the European Union are:

- Improvement of its efficiency in handling crisis situations
- European autonomy on the key assets supporting EU security policy
- Cost optimisation associated to resilient telecommunication services for security
- Harmonised infrastructure to support the pan-European civil protection organisation
- Cost sharing between many organizations, while providing each of them “always-on” connectivity
- As a tool to provide capacity that would considerably help to serve TLC needs of Developing Countries when appropriate

ISICOM benefits for the Europe SatCom industry are:

- Contribution to the set-up of a coherent European Space Industrial policy
- Efficient cross-fertilization and technology transfer between space and non space sectors
- Development and deployment of innovative SatCom program able to federate public and private R&D effort
- Development of breakthrough technologies
- Development of innovative satellite enabled services addressing security, emergency and societal challenges

- Further strengthening (at global level) of European universities and research centres on SatCom

ISICOM initiative developments will take advantage of the state-of-the-art applicable user experiences in the various institutional sectors, by collecting their best practices in use in the whole European Union, moreover the initiative will gather the major outcomes of past R&D results.

The ISICOM service architecture will be built by, possibly, leveraging on the existing planned national assets and pursuing a “federated approach” that integrates and possibly complements their infrastructures towards a truly European wide institutional service offering in a sustainable way,

Some initiatives, at Member State level, show the economical and operational advantage of a pursuing a “federated approach” by answering in an homogeneous way to the needs of many central and peripheral civil protection/defence institutions. As matter of fact many Organisations at national/sub-national level share dedicated sustainable ku band FSS service infrastructure that, by quickly transportable solutions, generates “on the pause” communication links for First Responders whose bandwidth cost is shared among different national/peripheral Institutions after having established a jointly accepted governing rule.

Other examples of existing “on the move” institutional services are those relevant to Organisations that have assets/personnel needing to move in an harsh/hostile environment (i.e. peace keeping/enforcing, relief organisations, ...). They currently can rely only on commercial low rate L-band public networks that, for economical reasons, do not offer guaranteed services nor highly secure terrestrial tails, typical required by many mission critical institutional services.

The FSS scenarios is evolving with the introduction of innovative commercial Ka band satellites, offering higher capacity at lower prices while introducing more complex terrestrial ground segment architectures. In the picture there are also new ka band national satellite missions dedicated to institutional users, characterised by fixed coverage at national scale and complementary steerable spots.

The service fragmentation as well the FSS/MSS different technological characterizations, pose some obstacles toward the creation of an overall "unified and federated" service approach that only can make mission critical services economically viable for all the EU Institutions.

The ISICOM initiative also aims at responding to the above challenge by demonstrating the viability of an integrated and jointly operated system, composed as much as possible by existing/planned building blocks and inserting newly developed components so to be seen virtually as a "unique infrastructure" able to provide sustainable high quality fixed and mobile mission critical services to all of the EU Institutions.

From a high level/general architectural perspective, the ISICOM system architecture is characterised by:

- Very high-speed broadband internet class services to fixed, transportable and mobile terminals including UAVs
- Voice, video, messaging and data services to hand-held services;
- Backbone connectivity services to remote terrestrial local area networks (e.g. Public Safety);
- Inter-Orbit Link with Earth Observation satellites for data relay services
- Inter-Satellite Link (ISL) to connect all satellites of the ISICOM architecture, avoiding double satellite hops via costly ground infrastructure in case of far range communications around the Earth and allowing new classes of services.

Furthermore ISICOM will activate synergies/interoperability with commercial and defence satellite communication systems. The integration can take place at ground level or even directly in the space via the ISLs and on board routing .

The approach is to leverage on existing or planned satellite assets owned by Institutions of European Member States, European commercial entities, or that can be accessed via European controlled gateways, operating in different frequency bands.

It shall develop progressively additional space and ground segment resources allowing to provide:

- global coverage to serve users anywhere and anytime thanks to a constellation of interconnected geo-stationary satellites ;
- very high access rate capability of several tens of Mbps to support upcoming very high speed broadband internet services;
- large throughput of tens of Gbps to accommodate the global trends in broadband traffic evolution;
- mesh network capability for single hop communication between any terminals or gateways in the system whether they are under the same or different beams, the same or different satellites;
- mobility management with the support of various types of terminals including handheld, transportable, land mobile, vessel or aeronautical mounted devices able to roam or hand-over between beams and/or satellites while ensuring reinforced end to end security to meet the institutional users requirements;
- integration with terrestrial network to extend the service coverage in urban as well as indoor environment.
- immediately usable backup to terrestrial connections
- fast network set up and deployment

ISICOM satellite resources may require geo-stationary and/or non geo-stationary satellites. They can represent full or a piggy back payloads.

It is also important to highlight that the ISICOM system concept is based on a hybrid satellite-terrestrial architecture, able to fully interoperate with private and public communication networks used by Public Safety users. These Public Safety networks are Private Mobile Radios (TETRA-TEDS, TETRAPOL), civilian public networks (GSM/UMTS) used at present by European Public Safety organizations, and future ones (LTE/SAE) that will be potentially used by them.

4. ENABLING TECHNOLOGIES AND RESEARCH PRIORITIES

Particular emphasis will be put to ensure that the developed technologies, products and services at ground and space segment level can be re-used in future satellite systems of other SatCom markets and maximise the European industry competitiveness.

ISICOM will also capitalise on technologies and services successfully demonstrated with proof of concepts.

Here below are listed potential Technologies/R&D areas to be developed within ISICOM.

System features	Technology enablers/R&D area
Global coverage	Constellation, smart antenna systems, ISL, GEO fixed and mobile satellites
Large access rate	Large reflector antenna, high power satellite platform, protocol optimization
Throughput	Multi beam antenna for spectrum re-use, exploitation of Q/V bands; channels adaptation / pre-distortion, optimised fade mitigation techniques as Adaptive Coding and Modulation scheme, routing, new transport protocols and cross layer techniques;
Security	New encryption techniques, authentication, confidentiality
Resilient	Mesh topology, auto-configurable, alternative paths.
Direct access and mesh networking	On board Processor, Inter Satellite Links Ground level: low cost terminals, flexible gateways; cognitive

System features	Technology enablers/R&D area
	radio and interference mitigation techniques. Mesh networks with automatic traffic routing
Low cost terminals	Small form factor terminals, regenerative processors, SDR-based terminals, low profile tracking antennas
Mobility management and integration with terrestrial networks	Mobility management including hand-over, NGN, delay-tolerant and opportunistic networking to cope with intermittent connectivity in mobile environment.

The research areas will include innovative technologies in the area of satellite and ground segment, looking for an integrated and dedicated Public Safety networks. It would also take into account possible synergies and mission improvements thanks to the integration with sensor networks (wireless sensors, satellite sensors, aerial sensors) and with navigation systems (GPS, GALILEO) and integration of Earth Observation Missions ground segments (both EU GMES as well as the national ones like Cosmo Skymed).

The interoperability of the hybrid satellite-terrestrial architecture solution with professional and public communication networks used by Public Safety users will be analysed in deep to be able to provide efficient, effective and affordable solutions.

5. REGULATORY, FREQUENCY AND STANDARDISATION ASPECTS

The deployment of such a system requires a harmonised regulatory, frequency and legislative framework together with the availability and protection of the required spectrum resources allowing the targeted services globally.

The current plan for the ISICOM system development foresees the use of Ka Band (for Fixed and Mobile Satellite Services) and S Bands (for Mobile Satellite Services). In addition, use of portions of the Q and V frequency bands could be envisaged for the feeder

links. Approach to spectrum management authorities is envisaged in order to develop spectrum policies at International, European and Member States to facilitate certainty for the SatCom operations free of harmful interference.

The regulatory aspects are fundamental for the successful development and provision of Space Communications Services and, in particular, the access to spectrum is a fundamental issue to deal with. Space-based applications can only be deployed if spectrum is available. Today we can already identify a number of spectrum and regulatory threats impacting future Satellite Communications systems, such as the different uses of the same frequency band in different Countries and some substantial threats to satellite spectrum that can impede future developments (in particular, the assignment of new terrestrial services to the Satcom frequency Bands and the proposals to make more intensive use of important spectrum parts for terrestrial service). In addition, hybrid satellite/terrestrial solutions offer unique advantages over terrestrial-only systems and need sufficient spectrum to encourage future growth in mobile services.

Some recommended approaches could imply the reconsidering of spectrum, technology and R&D policies in favour of more hybrid satellite/terrestrial use of spectrum. Strong protection of priority of satellite services in all the current satellite frequency bands shall also be considered.

It is also recommendsed that the end to end system architecture be defined in coherence with the work of standardisation organisations (e.g. ETSI) to meet the need of harmonisation at pan-European level enabling certification procedures and interoperability between equipments of sub-systems from several vendors. It is also recommendsed to leverage on European developed Satellite Radio Interface (e.g. DVB-S2, DVB-RCS2) as well as other networking technologies developed for terrestrial networks.

A preliminary list of regulatory and standardisation bodies, which will addressed by the subject activity is as follows: ITU, CEPT, SAP-REG, National Agencies and Ministries, Radiocommunication Sector, ETSI TC SES (S-UMTS, SDR, BSM, RCS), CENELEC TC 206, DVB (SH, S2, RCS).

6. ROLES OF DIFFERENT ACTORS AND GOVERNANCE/PARTNERSHIP MODELS

For the development and operational phase, ISI proposes to consider the following possible cooperation model with separation of tasks. According to this model:

The European Commission would

- capture the European institutional needs and aggregate the institutional demand to serve the targeted European institutional user organisations;
- prime the infrastructure development and deployment until full operational status. This includes satellite procurement under EU rules;
- mobilise adequate instruments and budgets under an EU operational programme

The European Space Agency supported by National Space Agencies would

- support the technology R&D and validation phase;
- manage the operational and full deployment phases until the operational transfer to the selected operator.

The satellite service provider(s) would be responsible for

- the system design with the support of the industry;
- the ISICOM system operations and development of service portfolio;
- the sharing of the satellite resources by the different European institutional user organisations according to EC defined rules.

The European industrial consortium would be responsible for the system development and deployment.

These possible roles and a suitable partnership model have to be discussed and elaborated both with EU relevant Directorates and with ESA/national space agencies.

7. CONCLUDING CONSIDERATIONS AND WORK TO BE DONE DURING THE NEXT PROJECT PERIOD

This document has illustrated activities performed by WP3, started in the project period from January 1st and August 31st, 2011, focusing on the identification of the basic elements for the ISICOM Programmatic Definition. The WP3 performed analysis of existing and planned Satcom assets and related programmes has been the basis for the subsequent preliminary identification of ISICOM differentiators and potential added value. The WP3 performed analysis has led to identify a set of parameters - primarily related to the Institutional User requirements in the security and emergency management domain- which can be used to compare the various existing and planned satellite systems with respect to the ISICOM main characteristics. This comparison is shown in the table reported in paragraph 2.2 (to be considered as preliminary: next FISI WP3 analyses, to be performed in the next project reporting period, will permit to integrate/refine and finalise the table).

The ISICOM concept has been conceived mainly through the work of the ISI ETP ISICOM Task Force, whose activities have been (and will be) actively supported and coordinated through the efforts/analyses/activities made by the FISI Project Partners. Other ISI ETP Members have also contributed to the activities of the Task Force and to the definition of the ISICOM concept. In this document, considerations, concepts and preliminary outcomes

coming from the Task Force activities (supported by FISI) are summarised (dealing with architectural, innovation/R&D, regulatory/standardisation and partnership models).

The WP3 activities, started in the first project reporting period, will continue and be finalised in the next FISI project period, thus resulting in the final elaboration of the programmatic elements for the ISICOM Initiative, which will be illustrated in the next version of this Deliverable (D3.2.2).

Activities to be done by WP3 during the next project reporting period will permit to finalise the ISICOM programmatic definition, through:

- Consolidation of the proposed ISICOM System Architecture, fully meeting mission requirements identified in the Deliverable D3.1.2 (including the elaboration of a compliance matrix showing coherence between system architecture consolidated characteristics and consolidated mission requirements)
- Elaboration of the related regulatory, spectrum, standardisation and R&D activity plan, linked to the ISICOM Initiative development.
- Definition of roles of the involved actors and of the partnership model
- Elaboration of the ISICOM Road Map, including a Work Programme with the identification of relevant responsibilities.