ILNAS

STANDARDS ANALYSIS

AEROSPACE SECTOR
LUXEMBOURG

Version 2.0 · October 2016

ANEC

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ILNAS
Institut luxembourgeois de la normalisation,
de l'accréditation, de la sécurité et qualité
des produits et services

ANEC
AGENCE POUR LA NORMALISATION ET
L'ÉCONOMIE DE LA CONNAISSANCE

EXECUTIVE SUMMARY

The survey and analysis of European and international standards in the space sector has been initiated by the *Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services* (ILNAS). This work is conducted by ILNAS in order to develop an information and exchange network for space-related standardization knowledge in the Grand Duchy of Luxembourg.

Conducted in several steps, this survey is basically built on a standards watch that allows the identification of standardization technical committees related to the space sector at the European and international levels. Detailed information concerning the main standardization technical committees is provided in the present report. Then, in order to induce stakeholder interest, the national market of the space sector has been characterized through four sub-segments and a keyword system. Through this classification system, potential interests and opportunities to participate in the standardization process (via ILNAS) have been identified.

Conceived as a practical tool, this report is evolving and should be used to quickly identify issues and interests for the national stakeholders of the space sector. The present report constitutes the second version of this analysis which will continue to be updated on a regularly basis according to the market interest.

FOREWORD

The ***I**nstitut **L**uxembourgeois de la **N**ormalisation, de l'**A**ccréditation, de la **S**écurité et qualité des produits et services* (ILNAS) is an administration under the supervision of the Minister of the Economy in Luxembourg. It was created on the basis of the law of May 20, 2008 (which has been repealed by the law of July 4, 2014, regarding the reorganization of ILNAS) and started its activities on June 1, 2008. For reasons of complementarity, effectiveness and transparency as well as for purposes of administrative simplification, ILNAS is in charge of several administrative and technical legal missions that were previously the responsibility of different public structures. These assignments have been strengthened and new tasks have since been assigned to ILNAS corresponding to a network of skills for competitiveness and consumer protection.

To promote standardization in Luxembourg, a national standardization strategy, approved by the Minister of the Economy, had been drawn up by ILNAS in June 2010 for the decade 2010-2020. This national strategy, directly related to the Horizon 2020 strategy of the European Union, has been updated in January 2014 with the "Luxembourg Standardization Strategy 2014-2020"[1], which is more in line with the needs of the national market and the priorities identified after three years of active promotion of technical standardization in Luxembourg. The new position can be summarized by the motto: "Technical standardization as a service".

To meet the new priorities, the strategy is based on the three following pillars:

1 INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)

Given the dynamism and the vital importance of the ICT sector for the national market:

- Continued support and development of the standardization field dedicated to ICT (also in terms of education and *ad hoc* promotion) according to the "Luxembourg's policy on ICT technical standardization", published in 2013 with latest update in 2015[2];
- Detection of niche opportunities for national economic developments.

2 NATIONAL INFLUENCE AND COMPLIANCE WITH LEGAL ATTRIBUTIONS

In order to increase the influence of Luxembourg:

- Strengthen the influence of the Grand-Duchy of Luxembourg within European and international standards organizations;
- Active support in respecting legal attributions in terms of European standardization;
- Detection of opportunities for the national economic market.

[1] http://www.portail-qualite.public.lu/fr/publications/normes-normalisation/orientations-strategiques/strategie-normative-2014-2020/luxembourg-standardization-strategy-2014-2020.pdf

[2] http://www.portail-qualite.public.lu/fr/publications/normes-normalisation/orientations-strategiques/politique-luxembourgeoise-pour-la-normalisation-technique-des-TIC-2015-2020/Policy-on-ICT-technical-standardization-_2015-2020_.pdf

3 PRODUCTS AND SERVICES

- Support through products and services[3] in the field of standardization (diagnostic, awareness/training sessions, targeted watch, sector-based analysis, etc.), mainly upon requests of the national market.

Since October 2010, ILNAS has been supported by ANEC GIE in implementing the national standardization strategy. The role of ANEC GIE is to support the development of standardization and metrology activities at the national level and particularly to promote the benefits of participating in standardization.

Its mission is to raise awareness, deliver trainings and monitor the developments in the fields of standardization and metrology. ANEC GIE also has assignments in applied research in order to support the competitiveness of companies in Luxembourg. Thus, ILNAS, with the support of ANEC GIE, can effectively contribute to the economic diversification policy pursued by the Government in niches for economic developments.

In the context of the third pillar of the "Luxembourg Standardization Strategy 2014-2020", ILNAS commissioned ANEC GIE to carry out a sector-based analysis of European and international standards of the space sector, which is presented in this document. Indeed, in line with the priorities set by the Government of the Grand Duchy of Luxembourg, this sector has been identified as a carrier for the national economy.

[3] http://www.portail-qualite.public.lu/fr/normes-normalisation/produits-et-services/index.html
Training catalogue: http://www.portail-qualite.public.lu/fr/publications/normes-normalisation/information-sensibilisation/catalogue-formation-2016/Catalogue_de_formation_2016_WEB.pdf

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1 INTRODUCTION

Many of the systems and services that are today essential for our well-being and security depend directly or indirectly on space. Without being aware, people rely on space technologies when they use their mobile phones, make financial transactions, take an airplane, watch the weather forecast or look for the nearest restaurant using their cars' navigation system. Space has become part of our daily lives.[4]

Europe's space industry is a driver for growth and innovation and a highly strategic sector, helping us face both societal challenges and create innovative technologies and services. Existing space programs Galileo and EGNOS are expected to generate economic and social benefits worth around 60-90 billion euros over the next 20 years[5].

Initiated by ILNAS, the standards analysis described in this document constitutes indeed a sector-based "snapshot" for fostering and strengthening the national space sector in its involvement in standardization work. Based on the detailed information provided, the aim is to involve national stakeholders in a global approach to standardization in this sector in the Grand Duchy of Luxembourg in order to support the sector in terms of competitiveness, visibility and performance, while enhancing the international recognition of the Grand Duchy of Luxembourg at the standards level.

The survey and analysis of European and international standards related to space sector have been realized in several steps listed hereafter:

- execution of a standards watch of the targeted sector (inventory of standards – both published and under development – at the European and international levels; identification and description of technical standardization committees);
- targeting the national market of the related sector by identifying national stakeholders (public and private);
- definition of logical links between the national market, the different stakeholders and the results of the standards watch;
- preparation of a final report of analysis and opportunities.

The report structure follows the same execution sequence. After introductory chapter dedicated to standardization in general (**Chapter 2**) and the context of the space sector (**Chapter 3**), the method applied for the standards analysis is described in **Chapter 4**.

Chapter 5, **Chapter 6** and **Chapter 7** then present the main results of the standards analysis, the description of the national market and the interests in standardization for national stakeholders. In order to bring the national stakeholders of the space sector into an active approach to standardization, logical links were established between the national market and the standards watch results. Thus, these chapters offer an overview of the different segments identified for the space sector. In the second step, the potential interests to take part in the standardization process are then highlighted for all stakeholder categories characterizing the national market.

[4] http://europa.eu/rapid/press-release_MEMO-13-146_en.htm

[5] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0152:FIN:EN:PDF

The same potential interests for different stakeholder categories constitute opportunities for the sector as a whole. **Chapter 8** presents them in order to engage not only an individual but also a general perspective about the benefits of standardization.

Considering the results of the standards watch as relevant information, the **Appendix** is dedicated to a detailed presentation of complementary standardization technical committees[6] identified at the European and international levels. Through this form, the information is directly available for someone seeking to estimate his or her interest for a specific technical committee.

Finally, the **Conclusion** rounds up the standards analysis, with a summary of the information and statement of the goals of this report.

[6] Note: In accordance with the ILNAS policy on participation in standardization Technical Committees (TCs), the term "standardization technical committee" is in this report a generic term that covers also the "technical committees", "subcommittees", "working groups", etc.

2 STANDARDIZATION

2.1 DEFINITIONS

ILNAS

This acronym designates the *"Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services"*. ILNAS is an administration under the authority of the Minister of the Economy. It was created by the law of May 20th, 2008, and began its activities on June 1st, 2008. Since August 1, 2014, the law on the reorganization of ILNAS, dated July 4, 2014, constitutes the new legal basis of the administration.

OLN

This acronym designates the *"Organisme luxembourgeois de normalisation"*. OLN is an ILNAS department, which fulfills the ILNAS missions as the national standards body, according to the law of July 4, 2014. It is a member of the European and international standardization organizations.

ANEC GIE

This acronym designates the Interest Economic Grouping *"Agence pour la Normalisation et l'Economie de la Connaissance"*. ANEC GIE was created in October 2010 by ILNAS,*"Chambre de Commerce"*, *"Chambre des Métiers"* and STATEC. It is divided into 3 departments: Standardization, Knowledge-based Economy and Metrology. The role of the standardization department of ANEC GIE is to implement the national standardization strategy established by ILNAS in order to support the development of standardization activities at national level and to promote the benefits of participating in the standardization process.

STANDARDIZATION

Standardization corresponds to the definition of voluntary technical or quality specifications with which current or future products, production processes or services may comply. Standardization is organized by and for the stakeholders concerned based on national representation (CEN, CENELEC, ISO and IEC) and direct participation (ETSI and ITU-T), and is founded on the principles recognized by the World Trade Organization (WTO) in the field of standardization, namely coherence, transparency, openness, consensus, voluntary application, independence from special interests and efficiency. In accordance with these founding principles, it is important that all relevant interested parties, including public authorities and small and medium-sized enterprises, are appropriately involved in the national, European and international standardization process.[7]

[7] Based on Regulation (EU) N°1025/2012 of the Parliament and of the Council

STANDARD

A standard is a *"document established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context"*[8].

They have a national, regional or international concern. Standards are created by bringing together all interested parties, such as manufacturers, consumers and regulators of a particular material, product, process or service. All parties benefit from standardization. Several categories of standards exist: core standards, standards of analysis and testing, standards of specifications, methodological standards, etc.

STANDARDS BODY

A standards body can be defined as a standardizing organization recognized at national, regional or international level whose main function is the preparation, approval or adoption of standards available to the public. This report considers not only formal standards bodies (e.g. CEN or ISO) but also non-formal standards bodies (e.g. ECSS, CCSDS or NAS).

STANDARDIZATION TECHNICAL COMMITTEE

A standardization technical committee is a technical decision-making body with a precise title, scope and work program, within a European and/or international standardization organism, essentially to manage the preparation of deliverables as standards according to an agreed upon business plan.[9]

NATIONAL MIRROR COMMITTEE

A national mirror committee is a national structure to European or international standardization technical committees, ensuring, for example, the formulation of coherent national positions as a first round of consensus finding.

2.2 STANDARDIZATION OBJECTIVES AND PRINCIPLES

As stated in the Regulation (EU) N°1025/2012 on European standardization, and according to the World Trade Organization (WTO)[10], standardization is based on founding principles, which are observed by the formal standards bodies for the development of international standards:

TRANSPARENCY

All essential information regarding current work programs, as well as on proposals for standards, guides and recommendations under consideration and on the final results should be made easily accessible to all interested parties.

[8] ISO/IEC Guide 2:2004, ISO/IEC Guide 2:2004, Standardization and Related Activities - General Vocabulary (definition 3.2)

[9] Based on the information available on the CEN website/BOSS

[10] Source: Second triennial review of the operation and implementation of the agreement on technical barriers to trade – Annex 4: Decision of the committee on principles for the development of international standards, guides and recommendations

OPENNESS

Membership of an international standards body should be open on a non-discriminatory basis to relevant bodies.

IMPARTIALITY AND CONSENSUS

All relevant bodies should be provided with meaningful opportunities to contribute to the elaboration of an international standard so that the standard development process will not give privilege to, or favor the interests of, a particular supplier, country or region. Consensus procedures should be established that seek to take into account the views of all parties concerned and to reconcile any conflicting arguments.

EFFECTIVENESS AND RELEVANCE

International standards need to be relevant and to effectively respond to regulatory and market needs, as well as scientific and technological developments in various countries. They should not distort the global market, have adverse effects on fair competition, or stifle innovation and technological development. In addition, they should not give preference to the characteristics or requirements of specific countries or regions when different needs or interests exist in other countries or regions. Whenever possible, international standards should be performance based rather than based on design or descriptive characteristics.

COHERENCE

In order to avoid the development of conflicting international standards, it is important that international standards bodies avoid duplication of, or overlap with, the work of other international standards bodies. In this respect, cooperation and coordination with other relevant international bodies is essential.

DEVELOPMENT DIMENSION

Constraints on developing countries, in particular, to effectively participate in standards development, should be taken into consideration in the standards development process. Tangible ways of facilitating developing countries participation in international standards development should be sought.

Standardization is an efficient economical tool offering the possibility to pursue various objectives, such as:

- Management of the diversity;
- Convenience of use;
- Performance, quality and reliability;
- Health and safety;
- Compatibility;
- Interchangeability;
- Security;
- Environmental protection;
- Product protection;
- Mutual understanding;
- Economic performance;
- Trade;
- Etc.

2.3 STANDARDIZATION LANDSCAPE

In Europe, the three recognized European Standardization Organizations (ESO) are[11]:

- European Committee for Standardization **(CEN)**;
- European Committee for Electrotechnical Standardization **(CENELEC)**;
- European Telecommunications Standards Institute **(ETSI)**.

At the international level, the three recognized standardization organizations are:

- International Organization for Standardization **(ISO)**;
- International Electrotechnical Commission **(IEC)**;
- International Telecommunication Union's Telecommunication Standardization Sector **(ITU-T)**.

The standardization frame allows cooperation between standards organizations at the same level, or at different levels but on the same topics:

- CENELEC and IEC are specialized in electrotechnical standards;
- ETSI and ITU-T are focused on telecommunications standards;
- CEN and ISO are in charge of the standards in other sectors.

Table 1 presents the main characteristics of the European and international formal standards bodies.

EUROPEAN AND INTERNATIONAL STANDARDS BODIES		DATE OF CREATION	NUMBER OF MEMBERS	NUMBER OF PUBLISHED STANDARDS
ISO	International Organization for Standardization	1947	162	21 133
IEC	International Electrotechnical Commission	1906	83	6 895
ITU-T	International Telecommunication Union's Telecommunication Standardization Sector	1865	270[13]	5 022
CEN	European Committee for Standardization	1961	33	15 985
CENELEC	European Committee for Electrotechnical Standardization	1973	33	6 685
ETSI	European Telecommunications Standards Institute	1988	784[14] (63 countries)	38 500

Table 1: Characteristics of European and international standards organizations[14]

[11] Regulation (EU) No 1025/2012 of The European Parliament And of The Council: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:316:0012:0033:EN:PDF

[12] ITU has a specific way of working compared to the other recognized organizations, as it works through the direct participation of industry stakeholders.

[13] ETSI has a specific way of working compared to the other recognized organizations, as it works through the direct participation of industry stakeholders.

[14] Source: Websites of organizations – July 2016

From a national perspective, one or several standards bodies protect national interests within the European and international standardization organizations. In Luxembourg, ILNAS – the only official national standards body – is member of the European and international standardization organizations CEN, CENELEC, ISO, IEC and ETSI.

Several bridges exist between the national, European and international standardization organizations in order to facilitate the collaboration and coordination of the standardization work on the different fields (Figure 1).

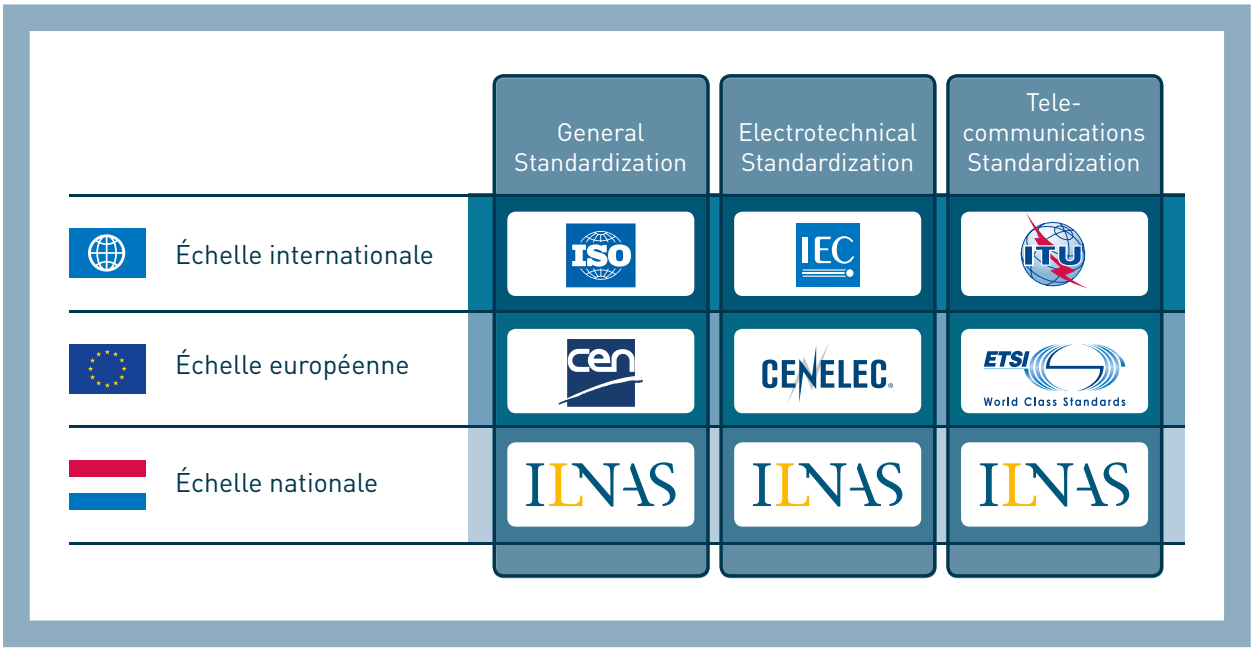

Figure 1: Interactions between the standardization organizations

A strong collaboration exists between the European and international standardization organizations. Indeed, in order to ensure transparency in the work and avoid the duplication of standards, several agreements have been signed between European and international standardization organizations.

In 1991 ISO and CEN signed the Vienna Agreement[15], which is based on the following guiding principles:

- Primacy of international standards and implementation of ISO Standards at European level (EN ISO);
- Work at European level (CEN), if there is no interest at international level (ISO);
- Standardization documents should be approved between the two organizations.

Similarly, the Dresden Agreement[16] was concluded in 1996 between IEC and CENELEC with the aim of developing intensive consultations in the electrotechnical field. This agreement is based on the following guiding principles:

- Development of all new standardization projects by IEC (as much as possible);
- Work at European level (CENELEC), if there is no interest at international level (IEC);
- Ballots for documents made in parallel at IEC and CENELEC.

[15] Agreement on technical co-operation between ISO and CEN (Vienna Agreement)

[16] IEC-CENELEC Agreement on Common planning of new work and parallel voting (Dresden Agreement)

Under both agreements, approximately 31% of all European standards ratified by CEN, as well as about 71% of those ratified by CENELEC, are now technically equivalent or identical to ISO or IEC standards[17]; in that respect, the European and international organizations do not duplicate work.

Finally, ITU-T and ETSI have agreed on a Memorandum of Understanding (MoU) in 2012[18] (replacing the former MoU signed in 2000) that paves the way for European regional standards, developed by ETSI, to be recognized internationally.

Agreements also exist between the standards organizations to facilitate their cooperation. ISO and IEC have the possibility to sign conventions to create Joint Technical Committees (JTC) or Joint Project Committees (JPC) when the area of work is overlapping the two organizations. It is to avoid the creation of duplicative or incompatible standards. In this frame, two joint committees have already been created: ISO/IEC JTC 1 "Information Technology" and ISO/IEC JPC 2 "Energy efficiency and renewable energy sources - Common terminology".

ISO, IEC and ITU have also established the World Standards Cooperation (WSC) in 2001, a high level collaboration system intending to strengthen and advance the voluntary consensus-based international standards system and to resolve issues related to the technical cooperation between the three organizations[19]. Similarly, the cooperation between CEN and CENELEC aims to create a European standardization system that is open, flexible and dynamic.

[17] CEN-CENELEC Quarterly Statistical Pack – 2015 Q4

[18] Memorandum of understanding between ETSI and ITU

[19] http://www.worldstandardscooperation.org/

2.4 STANDARDS DEVELOPMENT

Developing a standard is characterized by four main steps:

- Proposal: following an identified need, a party proposes a preliminary draft;
- Study and preparation: a working group studies the draft and prepares the standard draft;
- Public inquiry and approval: the standard draft goes into public consultation and is subject to approval;
- Publication: the ratified standard is published by the standards body.

At each stage, a validation of all participating members of the standardization technical committee is required. This is done automatically through a vote; however, the rules of the vote differ between the European and international level as outlined in Table 2 below.

ORGANIZATION	MEMBERS	METHOD OF ADOPTING STANDARDS	INTEGRATION INTO THE COLLECTIONS OF NATIONAL STANDARDS
International ISO and IEC	National bodies from countries members of ISO (162) and IEC (83)	1 country = 1 voice	Voluntary
European CEN and CENELEC	National bodies complying with membership criteria of CEN and CENELEC[21] (33)	Weighted Vote	Required: countries must eliminate conflicting provisions from their collections

Table 2: Voting rules at European and international level

At the European level, the weighted vote is defined by the "CEN/CENELEC Internal Regulations - Part 2, Common rules for standardization work"[21], which fixes the distribution of the voices for the CEN/CENELEC national members as showed in Table 3.

COUNTRY	WEIGHTING OF VOTES
Germany, France, Italy, United Kingdom, Turkey	29
Spain, Poland	27
Romania	14
Netherlands	13
Belgium, Greece, Hungary, Portugal, Czech Republic	12
Austria, Bulgaria, Sweden, Switzerland	10
Croatia, Denmark, Finland, Ireland, Lithuania, Norway, Slovakia	7
Cyprus, Estonia, Latvia, Luxembourg, Slovenia, Former Yugoslav Republic of Macedonia	4
Iceland, Malta	3

Table 3: Weightings allocated to the CEN/CENELEC national members

[20] CEN-CENELEC Guide 20 "Guide on membership criteria of CEN & CENELEC"

[21] Source: Internal regulation CEN/CENELEC – Part 2 – Annex D

Another particularity at the European level is that the European standards approved shall be implemented identically in both technical content and presentation, with no restrictions for application by each national member. This implies enforcing the new standard through publication and withdrawing all conflicting standards already in place at national level, on average, in six months. The new European standard then takes the status of national standard.

In the Grand Duchy of Luxembourg, the list of new national standards is regularly published by ILNAS in the *"Mémorial A"*[22].

[22] http://www.legilux.public.lu/leg/a/index.php

3 CONTEXT AND DEFINITION OF THE SPACE SECTOR

3.1 GENERAL CONTEXT OF THE SPACE SECTOR

At an international level, the space sector is recognized as a key strategic sector for a long time, and over the last decade the number of public and private stakeholders involved in space activities has strongly increased. Space related technologies have taken a large and essential place in our everyday life, and the sector is considered to be an international motor of economic growth. The Organization for Economic Co-operation and Development (OECD) estimates that revenues derived from the wide diversity of space-related products and services amounted to 256 billion dollars in 2013 (from 165 billion dollars in 2009)[23].

Various types of space applications exist on the market and can be encompassed into three main established fields and one recently emerged field. The **telecommunications market**, that is currently the most important and the most dynamic market for space applications. It includes fixed telecommunications services (voice, data or multimedia); broadcasting (TV and radio services or internet content); mobile services (data, voice or internet). The second market is dedicated to **earth observation** that helps to measure and monitor the climate and environment, and to map resources. This field is extending to a growing number of domains, including agriculture, resource management, exploration, mapping and planning, hazard monitoring and disaster assessment as well as security and defense. Third is the **positioning and navigation** market where satellites are used for localization and navigation purposes.

Finally, **Space mining** has recently received a lot of attention both by private companies and governments. International and national laws are in the process of being updated to incorporate space mining activities and Luxembourg, as the first country in the world, is actively investing in space mining to promote Luxembourg as a central player and space mining hub.

Also at a European level, the space industry is identified as a key strategic sector in constant growth with 38 435 jobs and about 7.53 billion Euro (+4.3%) in 2015 compared to 2014[24]. If the downstream services are counted in as well there are an estimated 320 000 jobs in the EU worth about 52 billion Euro.

Conscious of this key role, the European Union (EU), through the Lisbon Treaty entered into force on December 1st, 2009, provided a legal ground to develop policies on the space exploration and exploitation. Indeed, the Article 189 of this treaty gives to the EU a mandate to take action in this field, including through the implementation of a European space program unifying and coordinating the European efforts.

The communication release by the European Commission entitled "Towards a space strategy for the European Union that benefits its citizens"[25] and the "European Competitiveness Report"[26] both identify the space sector as directly contributing to the Europe 2020 Strategy. The main objectives being: *"the promotion of technological and scientific progress; industrial innovation and competitiveness; enabling European citizens to reap the benefits of space applications; and a higher European profile on the international stage in the area of space".*

[23] The space economy at a glance: http://www.oecd.org/sti/the-space-economy-at-a-glance-2014-9789264217294-en.htm

[24] http://eurospace.org/industry-facts-figures.aspx

[25] EC com: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0152

[26] ECRs: http://ec.europa.eu/growth/industry/competitiveness/reports/eu-competitiveness-report/index_en.htm

The European Commission's Space Research and Development activities are coordinated within the framework of the overall European Space Policy[27].

In order to support research and development in the space sector, the European R&D framework programs FP6 (from 2002 to 2006) and FP7 (from 2007 to 2013) have received 0.24 and 1.43 billion Euros respectively in funding. The current program, Horizon 2020 space (from 2014 to 2020)[28] [29] demonstrates the continued support for developments in the space sector with another total of over 1.4 billion in funding. The general objective is to sustain a competitive space industry by providing support to develop appropriate technologies and services as well as encouraging the research community and the private sector to intensify their efforts and investments in the space sector. Topics covered range from preparation for space exploration, earth observation, data exploitation, climate change monitoring, space weather and debris monitoring to name a few.

The implementation of the European Space Policy requires the effective coordination of the space activities of the European Union, the European Space Agency and EU member states, together with other national and transnational agencies. At the time of writing the European Commission is working on a new space strategy for Europe to be presented in 2016 and providing a strategic vision up to 2030. The space industry experiences dynamic changes in light of a growing global competition, technological breakthroughs, and innovations spurring growing private sector interest in space. Space is increasingly attracting new companies and private entrepreneurs (so-called 'NewSpace'), which challenge the established views and business models of the traditional space industry. These developments present both challenges and opportunities for European industry and it is important for Europe to stay at the forefront of these developments and seize these new opportunities. An indicative roadmap subject to change is made available by the European Commission[30].

The European Space Agency (ESA) was created in 1975 and is located in Paris. It is an international organization dedicated to the space sector with 22 Member States (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and the United Kingdom). Hungary, Estonia and Slovenia are "European Cooperating States" when Canada takes part in some projects under a Cooperation agreement as associated member.

Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world. Through its governing body, the Council, ESA provides basic policy guidelines to draw up a European space program. Each Member State is represented on the Council and has one vote, regardless of its size or financial contribution.

The European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) is an intergovernmental organization created in 1986 through an international convention. Currently, 30 Member States are part of this organization (Austria, Belgium, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom).[31]

[27] European Union Space Policy: http://ec.europa.eu/growth/sectors/space/index_en.htm

[28] http://ec.europa.eu/programmes/horizon2020/en/area/space-0

[29] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-leit-space_en.pdf

[30] http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_grow_007_cwp_european_space_strategy_en.pdf

[31] http://www.eumetsat.int/website/home/AboutUs/WhoWeAre/MemberStates/index.html

EUMETSAT's primary goal is to establish, maintain and exploit European systems of operational meteorological satellites. EUMETSAT is in charge of the delivering of weather and climate-related satellite data, images and products– 24 hours a day, 365 days a year. This information is supplied to the National Meteorological Services of the Member and Cooperating States, as well as other users world-wide. EUMETSAT is also responsible for the launch and operation of the satellites and for delivering satellite data to end-users as well as contributing to the operational monitoring of climate and the detection of global climate changes.

3.2 NATIONAL CONTEXT OF THE SPACE SECTOR

Historically, the interest of Luxembourg for the space sector starts in 1985 where the potential of the satellite telecommunications market was fully understood and initiated the creation of the Société Européenne des Satellites (SES). This was the starting point for the economic development of the national space sector.

Luxembourg pursued its involvement in the space sector when it became an official Member State of the European Space Agency in 2005. With over € 40 *per capita* Luxembourg is currently the member with the highest annual contribution which confirms the commitment of the government to promote Luxembourg as a hub for innovative projects in advanced technologies. Luxembourg participates actively in ESA programs, for example the TIA Advanced Research in Telecommunications Systems (ARTES) program in which Luxembourg is engaged since 2000. ARTES enables European and Canadian industry to explore, through R&D activities, innovative concepts to produce leading-edge satcom products and services.

Though the Grand Duchy of Luxembourg doesn't have a national space agency, it does have a national space program (LuxIMPULSE) launched in 2009. The Luxembourg Space Cluster also remains, to this date, one of the six key technological sectors identified by the Luxembourg Government since the Luxembourg Cluster Initiative was launched in 2002.

In the same spirit the government of Luxembourg developed a national action plan in 2012 concerning space technologies and sciences. The goal was to develop innovative applications, products and services with high added value especially in the domains of Telecommunications as satellite infrastructures, Earth Observation, Navigation & Technology.

The national plan to develop the space sector involves 4 major strategic steps[32]:

- **Diversify**, offer new market opportunities and ensure sustainable economic activities: The short lifecycles of products and services in the context of dynamic and competitive international markets require public policies that foster innovation and diversification;
- **Promote** local experience and know-how in telecommunications and media: Electronic communication services are a key sector for the country. To remain competitive, new applications and innovative services can be promoted such as "hosting services", safety, natural risk management, etc.;
- **Reinforce** companies' and organizations' competitive position: In an extremely competitive international environment, research will be encouraged to identify and occupy niches which have not been taken by major European space players;
- **Develop** Luxembourg's space sector skills and join international networks: Projects at a national level are carried out to better position Luxembourg in the space sector. They include international collaborations, training programs and the development of research activities at the University of Luxembourg and at the public research centers.

[32] Luxembourg Space Action Plan 2012: http://www.gouvernement.lu/4368317/plan-d-action-espace.pdf

In 2005 the Luxembourg government set up a program called LuxLAUNCH[33] to support industry and research organizations in identifying new opportunities and better integrating the international network of European actors in the space sector. One initiative in the context is the yearly Call for Ideas supporting a selected initiative based on a panel evaluation.

Finally, under the new government elected in 2013, the Luxembourg space activities have been attached to the Ministry of Economy, showing an intention to support and build business and value for and from the space sector. One crucial recent development in the sector is the new ministerial level involvement in exploration and use of space resources also referred to as space or *asteroid mining* in the frame of the newly set up Luxembourg Space Resources initiative[34]. Luxembourg sends another strong signal and demonstrates the will to act by partnering and financially backing space mining companies Deep Space Industries and Planetary Resources in June 2016.

3.3 STANDARDS CONTEXT OF THE SPACE SECTOR

The space sector is a sector where the international cooperation and collaboration is of primary importance. The International Space Station is a good illustration. This large scientific cooperative program gathers resources and expertise from all over the world through national space agencies and various contractors.

In this context, it is important for space industries, national governments, users or suppliers to support and to adopt the use of standards in order to facilitate this international collaboration through the integration of products and services. Space missions and satellites have challenging performance and lifetime requirements. The technology is becoming more sophisticated with more and more reliance on on-board intelligence and autonomy while schedule and costs have to be reduced. These issues impose a strict approach to the engineering of the space and ground segments. Finally, especially in the space sector, standards are developed to facilitate the interoperability of products, to reduce the technical barriers between the different stakeholders and to facilitate the interface of systems.

Conscious of this specific context and issues, international and European initiatives have been developed in order to support the development of standards dedicated to the space sector.

The Consultative Committee for Space Data Systems (CCSDS), created in 1982, is an initiative of the major space agencies of the world to provide a multi-national forum for discussion of common problems in the development communications and data systems standards for the space sector. Composed of 11 member agencies, 30 observer agencies, and 99 industrial associates[35], its main objective is to provide recommendations for data- and information- systems standards in order to promote interoperability and cross support among cooperating space agencies, while also reducing risk, development time and project costs.

In 1990, CCSDS started to collaborate with the International Standards Organization (ISO). Under this cooperation agreement, a specific ISO subcommittee was created, ISO/TC 20/SC 13 "Space Data and Information Transfer Systems".

The Object Management Group (OMG) is an international, open membership, not-for-profit computer industry consortium with a specific task force dedicated to the space sector: the OMG Space Domain Task Force. This task force encompasses space professionals willing to increase the interoperability, to reduce

[33] http://www.innovation.public.lu/en/financer/competitivite/esa/luxlaunch/index.html

[34] http://www.spaceresources.public.lu/en/press-corner/press/en_Press-release-03_02_2016.pdf

[35] CCSDS participation figures: http://public.ccsds.org/participation/default.aspx, 2016

costs, schedule, and risk for space applications through the development of space standards. The Space Task Force's goals are to:

- Clarify space, satellite and ground system requirements,
- Provide a transparent space standards development environment open to participation by all,
- Encourage the development and use of Model-Driven specifications that allow future-proofing of space systems,
- Encourage continued space industry member participation to leverage existing OMG specifications.

Created in 1984, the Committee on Earth Observation Satellites (CEOS) is an international mechanism, coordinating international civil space borne missions designed to observe and study planet Earth. Comprising 31 members (most of which are space agencies) and 28 associates[36] (associated national and international organizations), CEOS is recognized as the major international forum for the coordination of Earth observation satellite programs and for interaction of these programs with users of satellite data worldwide. This committee was created in response to a recommendation from the Economic Summit of Industrialized Nations Working Group on Growth, Technology, and Employment's Panel of Experts on Satellite Remote Sensing. This group recognized the multidisciplinary nature of satellite Earth observation and the value of coordination across all proposed missions.

Digital Geospatial Information Working Group (DGIWG) is a multi-national body responsible for geospatial standardization for the defense organizations of member nations. It supports, among others, the requirements identified to address a specific set of operational scenarios, as for example the NATO requirements. The DGIWG geospatial standards are built upon the generic and abstract standards for geographic information defined by the International Organization for Standardization (ISO/TC 211).

At a European level, in 1977, the European Space Agency (ESA) realized the importance of software standards for the proper conduct of complex or critical space software projects and established the Board for Software Standardisation and Control (BSSC). This board released in 1984 a set of software engineering standards (PSS-05 series).

In June 1994, the ESA Council adopted a resolution that transferred the existing system of ESA space standards to a new set of standards prepared by the European Cooperation for Space Standardization (ECSS).[37] The creation of this European space community was based on the fact that there was no uniform system of space standards and requirements in Europe. This initiative was established to develop a coherent, single set of user-friendly standards for use in all European space activities. The partners jointly undertook the development of the system, designed to meet the main objective of providing a single coherent set of standards for use in all European space activities and particularly projects.

In 1994, National Space Agencies and space industry stakeholders joined ESA on the Space Component Ad-Hoc Committee (SCAHC). The goal was to establish a series of recommendations to develop a close partnership between national agencies and industry in the space sector. The objectives of these recommendations were to achieve a European policy, to improve competitiveness, to establish concepts for cooperation and information exchange, to ensure the availability of advanced and strategic components and to identify appropriate resources needed for the implementation of the recommendations. A final report was presented in 1996 containing the 10 recommendations that were endorsed by ESA's Industrial Policy Committee and by all the national bodies of the SCAHC membership.

[36] CEOS organization figures: http://www.ceos.org

[37] http://www.esa.int/esapub/bulletin/bullet111/chapter21_bul111.pdf, 2016

Based on the Recommendation R6 of the Space Components Ad Hoc Committee (SCAHC), the European Space Components Information Exchange System (ESCIES) was established to propose an information exchange system on component data with access available to all European users. ESCIES aims to systematically collect and make available data and documentation produced in Europe in the frame of studies, evaluations, procurement and quality assurance activities related to space components to the European space community.

In addition, in October 2002, the European Space Components Coordination (ESCC) was created between ESA and representatives of National Space Agencies, industry (through Eurospace) and European component manufacturers. This European partnership operates under the Space Components Steering Board (SCSB), supported by a Policy and Standards Working Group (PSWG) and a Components Technology Board (CTB). Major outputs of ESCC are the European Preferred Parts List (EPPL), the ESCC Specification System and the ESCC Qualified Parts List (QPL).

Regarding the European space sector, the European Commission issued in June 2007 the mandate M/415 to CEN, CENELEC and ETSI for the development of a work program for European Standards for the Space industry. This mandate was an element of the European Space Program and thus supposed to help paving the way to integrate the variety of existing space systems in Europe into a European infrastructure. The CEN created a working group, CEN/BT/WG 202 "Space", to work on this mandate. A report was prepared covering the 2 first stages of the work: a feasibility study and the development of a comprehensive standardization work program[38].

To pursue this initiative, in 2011, the European Commission issued another mandate, the mandate M/496 to CEN, CENELEC and ETSI in order to develop European Standards for the space industry. To this end, a new joint Technical Committee was created between CEN and CENELEC, CEN/CLC/TC 5 "Space" and ETSI responded through the existing ETSI/TC-SES "Satellite Earth Stations and Systems". Their mission is to respond to mandate M/496 to develop and adopt European standards in support of European policies and legislation.

With this mandate CEN/CENELEC/TC 5 and ECSS have agreed on a collaboration in their standards work and as an early result TC 5 accepted and adopted many existing ECSS standards. With the further liaisons to CEN/ASD-STAN "Aerospace" this multifold collaboration including ETSI/TC-SES incorporates major standard development bodies in Europe backed by the European Commission.

3.4 PROSPECTIVE DEVELOPMENT IN THE SPACE SECTOR

The increase in traffic of people and goods has raised transportation related issues, such as congestion on the road network, delays in public transport and safety in general. To solve these problems, the European Commission supports the implementation of Intelligent transport systems and services (ITS) across all modes of transport to increase its effectiveness and safety. ITS are advanced systems that use information and communication technologies (ICT) for improved and safer traffic management and effective support of the transportation of persons or cargo. ITS and related processes use equipment able to collect and deliver data about the status of a vehicle or equipment to a control unit. The control unit can also itself send back instructions to the equipment and activate process controls (e.g., a set of equipment designed for traffic control, such as symbols of variable traffic signs, signal characteristics of the light-signaling devices, etc.). With ITS, computer-aided signal coordination optimizes travel speed for a smoother, more predictable traffic flow but also achieves:

[38] http://wiki.services.eoportal.org/tiki-download_wiki_attachment.php?attId=88

- Reduced time lost from delays and stops;
- Reduced fuel consumption;
- Reduced chance of rear-end crashes;
- Improved traffic flow during evacuations;
- Improved emergency response;
- Improved air quality.

In many ITS applications, satellite navigation systems are a key component, because positional information from these systems is integrated into the ITS applications. The main benefit of the deployment of systems and services in terms of social benefits is to increase safety and reliability of transport. Examples of such systems are GPS, GALILEO (with the SPSLux system in Luxembourg) and GLONASS which provide useful features for ITS such as positioning and time synchronization. When coupled with the terrestrial cellular network (3G, 4G, ...), these systems provide features such as turn by turn navigation, real time traffic data and more. It uses the cell towers near the device location to lock the location more quickly with the help from the data connection, referred to *as assisted* (e.g., A-GPS and A-GLONASS). ITS also include telematics and all types of communications in vehicles, between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure).

This is the basis for developments in the area of *Cooperative* ITS, with the goal of increasing the quality and reliability of information available about vehicles, their location and the road environment. Such information may lead to new services for road users, which, in turn, will bring major social and economic benefits.

However, ITS are not restricted to Road Transport; they also include the use of ICT for rail, water and air transport, including navigation systems. In general, the various types of ITS rely on radio services for communication and use specialized technologies as depicted in Figure 2.

In conjunction with IoT and 5G, ITS becomes even more disruptive. With IoT, the type of information collected from and available to vehicles is more diverse and enables a finer grained control over their flow. With 5G providing the backbone of communications, adding speed, reducing latency and providing better coverage to connected vehicles and flow controllers, a new set of applications will emerge to improve ITS even further.

The European Space Agency (ESA) recently launched an ARTES program[39] for encouraging rapid and responsive prototyping of low data rate satellite communications concepts that would be suitable for diverse M2M and IoT applications. With this program, ESA is targeting a sector that does not normally work on satellite communications, but is more consumer-oriented towards terrestrial communications projects such as small embedded systems (e.g. Raspberry PI, Arduino), state-of-the-art Software Defined Radio (e.g. HackRF, GNU Radio, URSP, LimeSDR), and open source FPGA programming boards. A number of such products or concepts are developed within various ARTES projects and some have already been placed into orbit. Furthermore, new satellite communication platform prototypes are being designed for service providers to answer to the growing demand from the M2M and IoT over satcom market. An example is the Norwegian TSAT 4000 Ku-band hub and terminal prototype, which was developed with the support of ESA through the Technology phase of the Competitiveness & Growth element of the ARTES program. This platform is intended to support large captive or shared networks at data rates down to 128 kbps and is designed to integrate with low-power wireless sensor technologies.

[39] https://artes.esa.int/news/makerspace-internet-things-powered-satellite

Figure 2: Intelligent Transport Systems (source: ETSI Cluster)

At the European level, Small and Medium Enterprises (SMEs) are also involved in the space sector through the ESA C1-C4 clauses[40]. The aim of these clauses is to foster competitiveness of equipment suppliers and SMEs (for C1 Clause), and of SMEs and Research Institutes (for C3 Clause), in areas where the concerned organizations have recognized expertise and capabilities. For C2 and C4 clauses these types of actions are open to all, but the main Contractors are requested (under C2 clause) to include an adequate participation (in terms of quantity & quality) of Non-Primes and SMEs - or under C4 clause, uniquely SMEs - in their teams. SME4SPACE[41] also proposes to integrate SMEs in the development and participation in space related programs in collaboration with ESA. The current SME4SPACE projects are:

EPIC: ELECTRIC PROPULSION INNOVATION AND COMPETITIVENESS.

Electric propulsion has been identified by European actors as a Strategic Technology for improving the European competitiveness in different space areas such as in-space operations and transportation. The European Commission has set up the "In-space Electrical Propulsion and Station-Keeping" Strategic Research Cluster (SRC) in Horizon 2020 with the goal of enabling major advances in Electric Propulsion for in-space operations and transportation, in order to contribute to guarantee the leadership of European capabilities in electric propulsion at world level within the 2020-2030 timeframe, always in coherence with the existing and planned developments at national, commercial and ESA level.

[40] http://www.esa.int/About_Us/Business_with_ESA/SME_Small_and_Medium_Sized_Enterprises/Opportunities_for_SMEs/Procurement_policy_on_fair_access_for_SMEs_-_the_C1-C4_Clauses

[41] http://www.sme4space.org/index.php?option=com_content&view=category&layout=blog&id=13&Itemid=12

SHARP: SME4SPACE HARMONISATION SUPPORT.

This process is designed by ESA to achieve better coordinated space technology R&D activities among all European actors, with the *'filling of strategic gaps'* and the *'minimising of unnecessary duplications'* as major objectives. The process is developed in a first mapping and a following roadmapping phase; every year 8/10 topics are foreseen to be harmonized by ESA in two cycles.

ITACA: INNOVATION TECHNOLOGIES AND APPLICATIONS FOR COASTAL ARCHAEOLOGICAL SITES.

This project aims at providing a management system for underwater archaeological sites in coastal regions. The discovery and monitoring service uses innovative satellite remote sensing techniques combined with image processing algorithms. The project develops a set of applications integrated in a system that pursue the following objectives:

- Search and location of ancient ship wrecks;
- Monitoring of ship wrecks, ruins and historical artefacts that are now submerged;
- Integration of resulting search and monitoring data with onsite data into a management tool for underwater sites;
- Demonstration of the system's suitability for a service.

Furthermore, space mining initiatives have recently become a main focus in the space sector with, e.g. the SpaceResources.lu initiative presenting an overall strategy to be implemented progressively for the exploration and commercial utilization of resources from Near Earth Objects (NEOs), such as asteroids. Among the key actions undertaken is the establishment of an appropriate legal and regulatory framework for space resource utilization activities to provide private companies and investors with a secure legal environment. In Luxembourg, a new law[42] will be based on the findings of a study on legal and regulatory aspects for the utilization of space resources conducted by the University of Luxembourg – in cooperation with renowned space law experts in the fields of international space law and policy. The comprehensive legislation is expected to be effective in 2017 and will guarantee operators the right to resources harvested in outer space in accordance with international law. Space resource-dedicated licenses will be issued under the new law, and government supervision of the activities of operators and regulating their rights and obligations will be ensured by Luxembourg in accordance with the Outer Space Treaty[43].

To conclude this short prospective analysis, it is clear that most of the space activities described will rely heavily on a developed, reliable and secure Information and Communications Technology (ICT) infrastructure. High-performance computing (HPC) will be a key enabler to gather all the sensor and map data and do Big Data analytics to finally provide the services for consumers through Cloud Computing platforms. Also, HPC systems are crucial for simulation and preparation of optimized space missions as well as for intelligent logistics and supply systems.

[42] http://www.gouvernement.lu/6058973/07-space-resources

[43] http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html

3.5 DEFINITION OF THE SPACE SECTOR

A common definition for the space sector is that this sector *"includes all actors involved in the systematic application of engineering and scientific disciplines to the exploration and utilization of outer space, an area which extends beyond the earth's atmosphere"*. This definition is useful to distinguish aeronautics and space activities, however because of the recent developments and innovations of the sector, it has started to be limited and too restrictive[44].

NASA uses a broader definition and talks about space economy instead of space sector. For them, it encompasses a full range of activities and the use of resources that create and provide value and benefits to human beings in the course of exploring, understanding and utilizing space[45].

The Organisation for Economic Co-operation and Development (OECD)[46] defines the space sector as a sector including public and private actors involved in the provision of space-enabled products and services. They are part of a long value-adding chain that starts upstream with the manufacturers of space hardware and ranges downstream to the providers of space-enabled products (as GPS-based car navigation systems) and services (e.g. weather forecast satellite services) to final users.

Based on the categorization used by the Luxembourg Space Cluster, the space sector can be divided into 4 different segments, by adding space research. Although space mining may become a future segment in the coming years due to the national ambitions, it is still considered as a prospective sector that is composed by Space and Ground segment activities:

	**Space segment** with R&D, engineering services, manufacturing, testing, integration and launch of platforms (satellites, spacecraft and robotic systems), complete systems, subsystems, and components & materials.
	**Ground segment** encompassing R&D, manufacturing, testing, and integration of facilities on Earth for controlling space-based systems and satellites, for linking satellites to operational terrestrial networks and for processing satellite-derived data.
	**Services segment** with all the development and/or provision of services and value-added products and technologies that are derived from the use of space systems and/or data, and the provision of consulting and engineering services.
	**Space Research** segment containing the research related to non-commercial space activities.

[44] OECD Handbook on Measuring the Space Economy, OECD, March 2012

[45] Extracted from an article published by NASA, Space economies and economics, J. Foust, September 24th, 2007 http://www.thespacereview.com/article/962/1

[46] OECD, http://www.oecd.org/futures/space/thecommercialisationofspaceandthedevelopmentofspaceinfrastructure.htm, 2016.

Figure 3 illustrates these different segments describing the space sector.

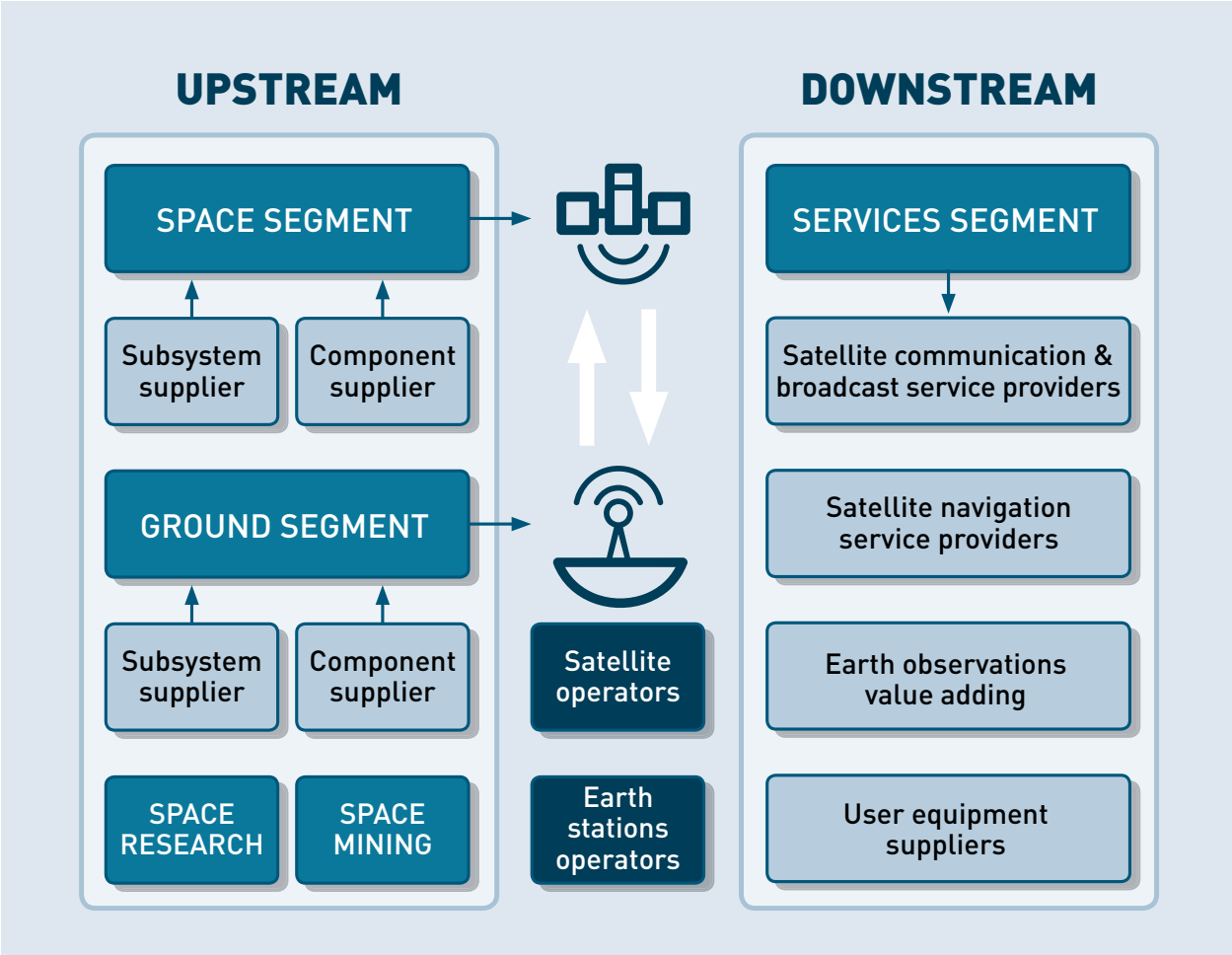

Figure 3: Space sector segments

Based on the UK Space Agency: The Size and Health of the UK Space Industry - A Report for the UK Space Agency Executive Summary, October 2012, link: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/298355/size-and-health-report-oct-2012.pdf *and on the* Luxembourg Space Cluster website.

4 METHODOLOGY OF THE STANDARDS ANALYSIS

In order to meet the national standardization strategy issues, a standards analysis was carried out and is presented in this report. Different steps were followed and are illustrated by Figure 4.

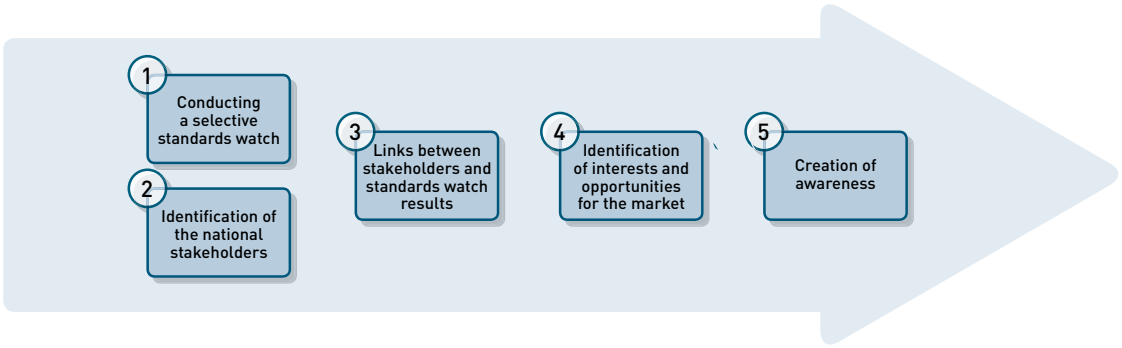

Figure 4: Main steps of standards analysis

4.1 SELECTIVE STANDARDS WATCH

A standards watch was carried out in order to identify the standardization technical committees of potential interests for the national stakeholders in the space sector. These technical committees are either from formal standards bodies (for example, CEN, CENELEC, ISO, ITU or IEC) or managed from non-formal standards bodies (e.g. ECSS, CCSDS or NAS).

The different stages processed to carry out the watch analysis can be described as below.

STAGE 1: IDENTIFICATION OF THE STANDARDIZATION TECHNICAL COMMITTEES IN RELATION WITH THE SPACE SECTOR

The objective of this stage is to identify the standardization technical committees with relation to the space sector. The method consists of identifying the sources of information available, applying the relevant research criteria and recording interesting and useful data. As mentioned before, the search focused not only on formal standards bodies but was opened to non-formal standards bodies.

STAGE 2: SELECTION OF THE MOST ACTIVE STANDARDIZATION TECHNICAL COMMITTEES IN TERMS OF BEING CURRENT, DYNAMIC AND STRATEGIC

This stage gives a selective character to the standards watch in the space sector. The purpose is to keep only the standardization technical committees that could be of potential interest for future national delegates willing to contribute to the standardization and also to be in line with the news and developments of the sector. An important role in the selection process has been the European Commission Mandate M/496 and the creation of TC 5 by CEN/CENELEC and TC SES by ETSI in response. The standardization and collaboration work done by these standards bodies has hence received extra attention in this standards watch as they result in European Standards (ENs) which are important for the application of new legislation at the European Commission level.

4.2 STAKEHOLDERS OF THE NATIONAL SPACE SECTOR

In parallel to the standards watch, the identification of national private and public stakeholders representing space sector in Luxembourg was conducted. This national panorama of the space sector proposes a view of the situation based on the experience and expertise of ILNAS. It reflects the situation at a certain point in time and is not intended to be exhaustive but tries to be as complete as possible. If necessary, it may be adjusted according to comments received after the release of this report.

The overall ensemble of national stakeholders of the space sector has been reviewed, based on the information available. The analysis was carried out by seeking to identify the maximum number of relationships, connections and interactions between the different national stakeholders and their space related activities. The main sources used were the Luxembourg Space Cluster[47] website and the GLAE website[48] as well as various documentation, conferences, news, events, etc.

4.3 INTERESTS AND OPPORTUNITIES FOR THE NATIONAL MARKET

After compiling a list of selected technical committees in relation to the space sector an in-depth analysis of committees and different stakeholders is carried out, to identify the potential interests for the national stakeholders to participate in the standardization work.

This step consists in identifying, for each stakeholder, the potential interests to follow and participate in the standardization technical committees. In practice, it seeks to link stakeholders with other stakeholders and Technical Committees in two levels of granularity. At the top level the actors are assigned space *segments* according to their activity, next they are assigned a number of *keywords* designed to cover all activities in the space sector in a simplified, but efficient, view.

STAGE 1: CLASSIFICATION OF STANDARDIZATION COMMITTEES AND NATIONAL STAKEHOLDERS

As discussed, a common classification system was developed to identify an overlap of common work areas and potential common interests between standardization bodies and national market stakeholders.

At top level the space sector is divided into the four main activity segments of **Space**, **Ground**, **Services** and **Space Research** described in Section 3.5 where an actor can be active in one or any segment at the same time. Table 4 shows the corresponding icons indicating activity or inactivity in a given segment.

ICONS INDICATING **ACTIVITY** IN A SEGMENT				ICONS INDICATING **INACTIVITY** IN A SEGMENT			
							
Space segment	Ground segment	Services segment	Space Research	~~Space segment~~	~~Ground segment~~	~~Services segment~~	~~Space Research~~

Table 4: Segment icons and activity indication

[47] http://www.spacecluster.lu/

[48] http://www.glae.lu/

In the next level, a coarse grained keyword classification methodology was developed (see Table 5) allowing to get a quick overview of the working areas covered by these actors.

The keywords have been divided into three groups: Topics, Disciplines and Subjects to describe a given target, where the target can be a standardization body, a technical committee, a company, an institution or a specific standard.

Topics: refers to the overall area of the target being described, giving a first rough classification.

Disciplines: states the sort of activity involved concerning the target.

Subjects: states the actual objects of the target giving the final most detailed description.

The methodology behind the current grouping of keywords is their generality. As an example, Business is a very wide subject area, hence a *Topic*, whereas *Communication* is not wide enough to be promoted to a general *Topic*. *Business* could also be regarded as a *Discipline*, but it should be regarded more as business *strategy*.

To some extend it may be grammatically valid to concatenate keywords into a sentence, such as "Electrical Engineering of Equipment" or "Mechanical Engineering Procedure".

If the model was to incorporate the additional information of which keywords belong together, it would lose the compact overview feature as the number of valid combinations is very high for some targets (e.g., Technical Committees with more than 1 000 publications).

TOPICS	DISCIPLINES	SUBJECTS
Electrical	Engineering	Parts
Mechanical	Design	Equipment
Hydraulic	Testing	Materials
Biological	Management	Communication
Structural	Processing	Tools
Informatics	Maintenance	Guidelines
Robotics	Manufacturing	Procedures
Geographical	Documentation	Requirements
Business		Infrastructure
Transport		Security
Sustainability		Safety
		Risk
		Software
		Propulsion
		Quality
		Data
		Interface
		Debris
		Vehicles
		Passengers

Table 5: Keyword classification system.

To illustrate how the keywords are used and applied, some examples will be discussed in the following. If for example a company is producing mechanical actuators, used on space crafts it would have the space segment icon and get the following keywords:

[Mechanical | Engineering | Parts].

If the company provides information for disaster and traffic management, it would have the service segment icon and following keywords:

[Geographical, Transport | Documentation | Communication, Safety].

Here the goal is also to capture keywords that would help identify standards that may be relevant to a given company.

Looking at two documents of the committee ISO/TC 204 on "Intelligent transport systems":

- **ISO/TR 21707:2008** - Intelligent transport systems - Integrated transport information, management and control - Data quality in ITS systems
  - *Transport, Management, Data, Quality*
- **ISO 22178:2009** - Intelligent transport systems - Low speed following (LSF) systems - Performance requirements and test procedures
  - *Transport, Requirements, Testing, Procedures*

By aggregating the following set of grouped keywords for TC 204 can be identified:

[Transport | Management, Testing | Data, Quality, Procedures]

Similarly, by looking at three documents of the committee CEN/CLC/TC 5 on "Space":

- **EN 16601-80:2014** - Space project management - Part 80: Risk management
  - *Management, Risk*
- **EN 16602-70-01:2014** - Space product assurance - Cleanliness and contamination control
  - *Quality, Biological*
- **EN 16602-70-21:2014** - Space product assurance - Flammability testing for the screening of space materials
  - *Quality, Testing, Materials*

By aggregating the following set of grouped keywords for TC 5 can be identified:

[Biological | Management, Testing | Risk, Quality, Materials]

Clearly some documents (or targets) do not contribute to all keyword groups. In those cases, the topic or discipline can be regarded as generally unspecified or "space".

To analyze and identify overlap and congruency in opportunities and interests the same sub-segment and keyword classification system is applied to national stakeholders and selected most relevant standardization bodies.

Chapter 5 summarizes these technical committees with classification as well as key characteristics and information. Likewise Chapter 6 describes the national stakeholders.

Further committees are presented in tables included in the Appendix.

STAGE 2: DEFINITION OF THE POTENTIAL INTERESTS FOR STAKEHOLDERS

With the overview of stakeholders on the national market and their activities as well as related standardization committees, potential interest can be determined. First described in general terms for the different types of national stakeholders. Then through the classification system using segments and keywords assigned to the different national stakeholders. This information could be interesting for them in order, for example, to increase their competitiveness or to facilitate their European and international exchanges.

5 RESULTS OF THE STANDARDS WATCH

The standards watch of the space sector has identified more than 80 standardization technical committees (European and international) that are more or less relevant to space sector activities. However, by applying selection criteria, **11 technical committees** were identified with direct implication in the space sector. Support by government and European institutions, a large amount of important industry members and collaborations as well as liaisons with other key standardization bodies played an important role in the selection process.

A wider collection of space related technical committees identified is available in the Appendix. For further information about the other sectors that space relies on, a complete ICT standards watch is published regularly by ILNAS and ANEC GIE[49].

As the standardization bodies have different levels of implication and influence in different sub sectors of the aerospace industry this more in-depth introduction aims at describing what is covered by each of them and with what authority and with what member backing.

The short summaries are intended to give an overview of the general standardization "Landscape" based on available documentation. They represent the key aspects of the standardization bodies, not a full introduction to each.

CEN/CENELEC/TC 5
EUROPEAN COMMITTEE FOR (ELECTROTECHNICAL) STANDARDIZATION - SPACE

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; **Biological**; **Structural**; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; **Testing**; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; **Materials**; **Communication**; Tools; Guidelines; **Procedures**; Requirements; Infrastructure; Security; Safety; **Risk**; **Software**; **Propulsion**; **Quality**; **Data**; Interface; **Debris**; Vehicles; Passengers

With the mandate M/496 issued by the European Commission in 2011, this joint Technical Committee (TC) was created in response by the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC).

Mandate M/496 is drawn up under and in line with the European Space Policy which will pave the way for the integration of space systems in Europe. The European Space Policy requests the development of standards required to support European policies and future European (or global) legislation that are needed to support the implementation of EU-level space projects.

[49] https://portail-qualite.public.lu/fr/publications/normes-normalisation/etudes-nationales/pub-standards-analysis-ict-v6-0

This TC covers all standardization activities in CEN and CENELEC related to space, including dual use aspects, systems of systems, as well as upstream and downstream applications, inasmuch as these topics are not covered by any other existing technical body in CEN or CENELEC or by the European Cooperation for Space Standardization (ECSS) or ETSI. Therefore, it is important and necessary to coordinate the work with relevant technical bodies in ETSI.

A Memorandum of Understanding (MoU) between ECSS and CEN of 2011 seeks to define their collaboration roughly by letting ECSS lead on *Upstream* standards related to space and ground operations, whereas CEN leads on *Downstream* standards relating to space data processing and end user applications. Important points are:

- For *Upstream* specifications CEN will not go on its own without prior agreement from ECSS.
- CEN grants ECSS the "veto right" on the development by CEN in case of an *Upstream* specification only.
- CEN will not offer a common standard, to ISO without prior ECSS agreement, but ECSS asks for CEN's support in case ECSS wants a standard to be offered to ISO.
- ECSS notes that in the large majority of the cases, CEN and/or CENELEC will have the lead for *Downstream* Standards and therefore the CEN & CENELEC processes and drafting rules will apply.

As a result, many original ECSS standards have been adopted by CEN.

CREATION	2011
STANDARDS	98/34 (published/in development)
URL(S)	www.cencenelec.eu ; www.cen.eu ; www.cenelec.eu https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:887985&cs=110F838DFC1615DA9921CE860F40F66D3
LIAISONS	CEN TC 278 - Intelligent transport systems CEN TC 287 - Geographic information ISO TC 20/SC 13 - Space data and information transfer systems ISO TC 20/SC 14 - Space systems and operations ISO TC 211 - Geographic information/Geomatics
COLLABORATION	ASD-STAN (Aerospace and Defence Industries Association of Europe - Standardization) ECSS (European Cooperation for Space Standardization) ...
STRUCTURE	CEN/CLC/TC 5/WG 1 Navigation and positioning receivers for road applications CEN/CLC/TC 5/WG 2 Space Situational Awareness Monitoring CEN/CLC/TC 5/WG 3 Earth observation CEN/CLC/TC 5/WG 4 Payload Interfaces for Launchers CEN/CLC/TC 5/WG 5 Planetary Protection CEN/CLC/TC 5/WG 6 Upstream standards CEN/CLC/TC 5/WG 7 Future activities in space standardization

Table 6: Details of CEN/CENELEC/TC 5

ASD-STAN
AEROSPACE AND DEFENCE INDUSTRIES ASSOCIATION OF EUROPE - STANDARDIZATION

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; **Hydraulic**; Biological; **Structural**; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; **Testing**; **Management**; Processing; **Maintenance**; **Manufacturing**; Documentation	**Parts**; Equipment; **Materials**; Communication; **Tools**; Guidelines; **Procedures**; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; Data; Interface; Debris; Vehicles; **Passengers**

The AeroSpace and Defence Industries Association of Europe (ASD) - Standardization (ASD-STAN) develops and maintains standards for the ASD both for military and civil purposes.

Since the beginning of the 1970s, the organization now known as ASD-STAN has cooperated with CEN and has been recognized by CEN as standardization body and main aerospace standards provider since 1986.

Over the years, ASD-STAN has established a lean and streamlined standardization process for European aerospace standards in agreement with the CEN. However, reducing the lead-time for the standards development process in accordance with industry needs remains a constant goal of ASD-STAN. ASD-STAN transfers all of its projected European Standards (EN) to CEN for publication and in close collaboration with ECSS following a 3-part agreement. This however excludes standards related to parts and materials or standards which are common in space and aeronautics, and these constitute the majority of the standards produced by ASD-STAN.

ASD-STAN publishes and sells online its own standards-library documents and is a distributor for the independently produced SAE ITC E&A (former ADS standards) standards and ASD-STAN related EN standards.

CREATION	2004 (AECMA, EDIG, EUROSPACE merger)
STANDARDS	2266/522 (published/in development)
URL(S)	http://www.asd-stan.org/
LIAISONS	CEN/CLC/TC 5 - Space ISO/TC 20 - Aircraft and space vehicles ISO/TC 20/SC 1 - Aerospace electrical requirements ISO/TC 20/SC 4 - Aerospace fastener systems ISO/TC 20/SC 14 - Space systems and operations ISO/TC 79 - Light metals and their alloys ISO/TC 155 - Nickel and nickel alloys ISO/TC 155/SC 2 - Wrought and cast nickel and nickel alloys ISO/TC 184 - Automation systems and integration ISO/TC 184/SC 1 - Physical device control ISO/TC 184/SC 4 - Industrial data ISO/TC 184/SC 5 - Key performance indicators for manufacturing operations management ...
COLLABORATION	ECSS (European Cooperation on Space Standardization) EASA (European Aviation Safety Agency) EUROCAE (The European Organization for Civil Aviation Equipment) EUROCONTROL(The European Organisation for the Safety of Air Navigation) ASD (The AeroSpace and Defence Industries Association of Europe) EAQG (European Aerospace Quality Group) SAE International (Aerospace Technical Standards Committees) IAQG (International Aerospace Quality Group) EDA (European Defence Agency) ...
STRUCTURE	ASD-STAN/D 0 Technical Authority ASD-STAN/D 1 General ASD-STAN/D 2 Electrical ASD-STAN/D 3 Mechanical ASD-STAN/D 4 Materials ASD-STAN/D 6 Quality ASD-STAN/D 7 E-Standards ASD-STAN/D 8 Customer & Product Support ASD-STAN/D 9 Environment ASD-STAN/D 10 Space ASD-STAN/D 11 Board

Table 7: Details of ASD-STAN

ECSS
EUROPEAN COOPERATION FOR SPACE STANDARDIZATION

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; **Structural**; **Informatics**; Robotics; Geographical; **Business**; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; **Guidelines**; **Procedures**; Requirements; Infrastructure; Security; **Safety**; **Risk**; **Software**; **Propulsion**; Quality; Data; Interface; **Debris**; Vehicles; Passengers

ECSS was created and developed through a partnership between the European Space Agency (ESA), National Space Agencies and European Industry.

Aware of the importance, the ESA actively supports ECSS activities. During the standards development process, the ESA Requirement and Standard division acts as the ECSS central secretariat and in this function provides technical support during the drafting process of new standards and during the subsequent review process as well as administrative support. ESA also supports ECSS by preparing training material in order to train potential users in applying ECSS standards in space projects, or tailor these standards for their specific needs. Finally, through the ESA Standardization Steering Board (ESSB), a list of standards approved for application by ESA space projects and based on published ECSS standards is maintained.

Built around the concept of partnership and on the willingness to reach concrete results, ECSS aims at improving significant aspects of space projects in Europe. ECSS' goal is to provide a set of documents with the overall objectives to:

- be recognized and accepted by the European space community for use in space programs/projects;
- achieve more cost effective space programs and projects in Europe in terms of technical performance, life cycle cost-effectiveness and on-time deliveries;
- improve the competitiveness of the European space sector;
- improve the quality and safety of space projects and products;
- reduce risk and guarantee interoperability and interface compatibility by applying proven and universally recognized requirements and methods;
- facilitate clear and unambiguous communication between all parties involved in space systems development and operation, in a form suitable for inclusion in legally binding documents;
- reflect user needs and feedback of experience from programs, projects and other appropriate sources to improve ECSS Standards, while preserving internal coherency of the ECSS system;
- account for new practices, products, technologies and missions.

In order to meet these objectives, the ECSS policy is to produce an integrated and coherent set of management, engineering, product assurance and space sustainability standards covering all activities, phases and levels for the development and operation of a space system. In addition, ensure that these standards are structured in such a way that they:

- can be made directly applicable in business agreements;
- take into account continual improvement of methods, techniques and technologies;
- define requirements in such a way that they bear on the need to be fulfilled rather than on the means to be used to fulfil that particular need, whenever possible;
- are based on proven and validated approaches, methods and solutions;
- avoid duplication with other standards by incorporating into the ECSS system - where appropriate - available documents from other sources;
- take into account all valid sources of information, expertise and feedback in the preparation and maintenance of ECSS documents;
- make the best use of all available research, including the technology programs of European space agencies and industry;
- take into account in the course of their development, the potential negative impact of space systems during their complete life cycle, on human life, the environment, public and private property, space and ground investments.

To promote the wider usage of ECSS standards the published documents are made freely available worldwide.

CREATION	1993
STANDARDS	125
URL(S)	http://www.ecss.nl
LIAISONS	CEN/CENELEC/TC 5 - Space ISO TC 20/SC 13 - Space data and information transfer systems ISO TC 20/SC 14 - Space systems and operations CCSDS (Consultative Committee for Space Data Systems) ...
COLLABORATION	Airbus DS (Defence & Space) ASD-Eurospace ASI (Italian Space Agency) CNES (French Space Agency) DLR (German Aerospace Center) ESA (European Space Agency) ...

STRUCTURE	- Steering Board (SB) - Technical Authority (TA) - TA Area Responsibles (TAARs), and Discipline Focal Points (DiFP) - ECSS Focal points for each ISO TC20/SC14 WG M-10 Project planning and implement. M-40 Configuration and info management. M-60 Cost and schedule management. M-70 ILS M-80 Risk management E-10 System engineering E-20 Electrical and optical engineering E-31 Thermal E-32 Structural E-33 Mechanisms and Pyro E-34 ECLS E-35 Propulsion E-40 Software engineering E-50 Communications E-60 Control engineering E-70 GSO Q-10/Q-20 PA management/Quality assurance Q-30 Dependability Q-40 Safety Q-60 EEE components Q-70 MMPP Q-80 Software PA U-10 Space Debris U-20 Planetary Protection

Table 8: Details of ECSS

ETSI TC-SES
EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE - SATELLITE EARTH STATIONS AND SYSTEMS

ETSI World Class Standards

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; **Testing**; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; **Requirements**; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; Data; **Interface**; Debris; Vehicles; Passengers

The Technical Committee on Satellite Earth Stations and Systems (TC-SES) is responsible for all aspects related to satellite earth stations and systems. The field includes:

- All types of satellite communication systems, services and applications including fixed, mobile and broadcasting.
- Satellite navigation systems and services.
- All types of earth stations and earth station equipment, especially the radio frequency interfaces and network and/or user interfaces.
- Protocols implemented in earth stations and satellite systems.

Responsibilities of the TC include coordinating the position of ETSI with relevant ITU Study Groups and maintaining and developing Harmonized Standards under the Radio Equipment Directive 2014/53/EU (replacing R&TTE Directive 99/5 EC) as well as participating in the committees dealing with implementation guidelines of the R&TTE directive.

The standards produced cover all types of Earth Stations installed on ships, vessels or trains operating in all types of frequency bands allocated to MSS (Mobile-Satellite Service), FSS (Fixed-Satellite Service) and BSS (Broadcasting Satellite Service) and radio and transmission aspects related to Fixed, Mobile and Global Navigation Satellite Systems operating in any bands allocated to FSS, MSS or RDSS (Radio determination-Satellite Service).

TC-SES encourages spectral efficiency on satellite links and harmonization of satellite radio interfaces to produce specifications that promote integration and inter-working between satellite and terrestrial networks.

Specifications further cover architecture and service requirements, interfaces (user, control and management planes), transport and network protocols, service enablers and encourages the development of network, transport and service layers compatible with various fixed and mobile satellite access networks.

CREATION	~ 1992
STANDARDS	524/22 (published/in development)
URL(S)	https://portal.etsi.org/TBSiteMap/SES/ActivityReport.aspx
LIAISONS	ETSI EMTEL - Emergency Communications ETSI TCCE - TETRA and Critical Communications Evolution ITU-R/SG 4 - Satellite Services ITU-R/SG 4 / WP4A - Efficient orbit/spectrum utilization for FSS and BSS ITU-R/SG 4 / WP4C - Efficient orbit/spectrum utilization for MSS and RDSS CEPT/ECC WG SE - Working Group Spectrum Engineering CEPT/ECC WG SE / SE 40 - Space Service compatibility issues CEPT/ECC WG SE / SE 19 - Fixed Service CEPT/ECC PT1 - IMT Matters ...
COLLABORATION	3GPP/RAN - 3rd Generation Partnership Project / Radio Access Networks EC / RSPG - Radio Spectrum Policy Group CEPT / ECC - Electronic Communications Committee GPSIA - GPS Innovation Alliance ESA – European Space Agency ITU – International Telecommunication Union ...
STRUCTURE	WG HARM - Working Group On Harmonized Standards, R&TTE Directive WG MAR ESV - Working Group on Maritime and Railway Satellite Earth Stations Onboard Vessels and Trains WG SatEC - Satellite Emergency Communications WG SCN - Working Group On Satellite Communication And Navigation

Table 9: Details of ETSI TC-SES

ISO TC 20/SC 13
AIRCRAFT AND SPACE VEHICLES
SPACE DATA AND INFORMATION TRANSFER SYSTEMS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; **Procedures**; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; **Data**; **Interface**; Debris; **Vehicles**; Passengers

Since the creation of ISO TC 20/SC 13 in 1990 it has had a cooperative arrangement with the CCSDS. Under this arrangement, CCSDS-developed recommendations are advanced to ISO TC 20/SC 13 where they are progressed, via the normal ISO procedures of review and voting, into ISO/CCSDS Standards. These documents retain the CCSDS format, but are appended with an ISO cover sheet and control number. ISO TC 20/SC 13 normally meets every six months in conjunction with the CCSDS Management Council meetings.

Charter and Scope of ISO/TC 20/SC 13:

- Is an international forum, which addresses the standardization needs of organizations and personnel involved with data and information transfer and exchange standards for civil space applications.
- Recognizes that technical documents appropriate for international data systems standardization purposes have been developed by other organizations and will utilize these existing documents if they have demonstrated their suitability by wide international acceptance. SC 13 will avoid developing new international standards when adequate standards exist.
- Promote international cooperation and progress in civil space applications by encouraging, supporting, and proposing national and international missions; and seeking and initiating new concepts for international cooperative projects and missions. This includes spacecraft missions, ground based radio science, and space and ground tracking networks.
- Develops both the technical and the institutional framework for international interoperability to facilitate appropriate cross-support opportunities of space data systems.
- Promote opportunities for partnership in space applications, including space and ground tracking networks and data sharing, between industrialized countries and the developing countries.
- Acts as an international information exchange mechanism for data, programs and plans pertaining to space applications and space/ground tracking networks.

CREATION	1990
STANDARDS	84/18 (published/in development)
URL(S)	http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=46612
LIAISONS	CEN/CLC/TC 5 - Space ISO/TC 46/SC 4 Technical interoperability ISO/TC 46/SC 11 Archives/records management ISO/TC 211 Geographic information/Geomatics
COLLABORATION	CCSDS (Consultative Committee for Space Data Systems) ESA (European Space Agency)
STRUCTURE	ISO/TC 20/SC 13/WG 1 Systems engineering ISO/TC 20/SC 13/WG 2 Mission operations and information management ISO/TC 20/SC 13/WG 3 Cross support services ISO/TC 20/SC 13/WG 4 Spacecraft onboard interface services ISO/TC 20/SC 13/WG 5 Space link services ISO/TC 20/SC 13/WG 6 Space internetworking services

Table 10: Details of ISO/TC 20/SC 13

ISO TC 20/SC 14
AIRCRAFT AND SPACE VEHICLES
SPACE SYSTEMS AND OPERATIONS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; Informatics; Robotics; Geographical; Business; Transport; **Sustainability**	Engineering; **Design**; **Testing**; **Management**; **Maintenance**; Processing; Manufacturing; Documentation	Parts; **Equipment**; **Materials**; Communication; Tools; **Guidelines**; **Procedures**; **Requirements**; Infrastructure; Security; **Safety**; **Risk**; Software; **Propulsion**; Quality; Data; Interface; **Debris**; **Vehicles**; Passengers

AIAA (The American Institute of Aeronautics and Astronautics) holds the secretariat for ISO TC 20/SC 14 - Space Systems and Operations. Its scope of work is the standardization for manned and unmanned space vehicles, their design, production, maintenance, operation, and disposal, and the environment in which they operate. Seven working groups provide an international forum for addressing the standardization needs and concerns of organizations and personnel involved with the development and operation of space systems.

Objectives defined for ISO/TC 20 and its sub-committees50:

- To ensure that internationally accepted standards exist for the design, construction, test and evaluation, operation, air traffic management, maintenance and disposal of components, equipment and systems of aircraft and space vehicles, including issues related to safety, reliability and the environment.
- As required, produce, maintain and assure these standards are cost effective and correspond to users' and market needs and that they support the technical projects of the sector.
- Reduce the time to deliver aerospace business driven standards to the end user. ISO/TC 20 will continue to look for process improvements, which will reduce the standards delivery cycle to be competitive.

Part of the strategies identified to achieve defined objectives:

- Encourage active participation in TC 20 activities by regulatory agencies.
- Support the reduction of efforts for control and certifications for multiple national and international audit processes and certifications through recognition of and cooperation with certification organizations such as PRI and ASD-CERT.
- Encourage development of standards offering dual use potential (civil and military).
- Protection of the environment, by more involvement in the development of standards which address environmental issues and their effects on the manufacture, operation, and end-of-life of aerospace products (e.g., noise, emissions, fuel consumption, recycling, SSA etc.).
- Encourage active participation in TC 20 activities by Research and Development or, innovation organizations.

CREATION	1992
STANDARDS	146/35 (published/in development)
URL(S)	http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=46614
LIAISONS	CEN/CLC/TC 5 - Space ISO/TC 197 - Hydrogen technologies ISO/TC 204 - Intelligent Transport Systems ISO/TC 211 - Geographic information/Geomatics
COLLABORATION	ASD-STAN CCSDS (Consultative Committee for Space Data Systems) COSPAR (Committee on Space Research) ECSS (European Cooperation on Space Standardization) ESA (European Space Agency) IAA (International Academy of Astronautics) WCO (World Customs Organization)
STRUCTURE	ISO/TC 20/SC 14/WG 1 Design engineering and production ISO/TC 20/SC 14/WG 2 Interfaces, integration and test ISO/TC 20/SC 14/WG 3 Operations and ground support ISO/TC 20/SC 14/WG 4 Space environment (natural and artificial) ISO/TC 20/SC 14/WG 5 Space System Program Management and Quality ISO/TC 20/SC 14/WG 6 Materials and processes ISO/TC 20/SC 14/WG 7 Orbital Debris Working Group

Table 11: Details of ISO/TC 20/SC 14

[50] http://isotc.iso.org/livelink/livelink/Open/17869916

CEN/TC 287
GEOGRAPHIC INFORMATION

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	Engineering; Design; **Testing**; Management; Processing; Maintenance; Manufacturing; **Documentation**	Parts; Equipment; Materials; Communication; Tools; Guidelines; **Procedures**; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; **Quality**; **Data**; Interface; Debris; Vehicles; Passengers

Geographic Information (GI) plays an increasingly important role in our society. This is due to, technological developments which make the collection and use of GI easier, new markets that are opening up for GI, increasing number of GI-applications on easy to use platforms such as mobile phones and the Internet, growing numbers of application domains where GI can be applied.

With the aim of standardizing the field of digital geographic information a structured framework of standards and guidelines, which specify a methodology to define, describe and transfer geographic data and services is developed. This work will be carried out in close co-operation with ISO/TC 211 in order to avoid duplication of work. The standards will support the consistent use of geographic information throughout Europe in a manner which is compatible with international usage. They will support a spatial data infrastructure at all levels in Europe.

The main objective is to facilitate the development and usage of geographical information in Europe. This will be achieved by:

- adopting the ISO/TC 211 standards series as CEN standards;
- developing and maintaining standards, specifications and profiles of standards;
- developing technical guidance and best practice documentation;
- collaborating with other standards related initiatives;
- educating the user community and promoting the use of standards for geographic information.

CREATION	Before 2003
STANDARDS	48/13 (published/in development)
URL(S)	http://centc287.eu/
LIAISONS	ISO/TC 211
COLLABORATION	OGC (Open Geospatial Consortium)
STRUCTURE	CEN/TC 287/WG 5 Spatial Data Infrastructure

Table 12: Details of CEN/TC 287

ISO/TC 211
GEOGRAPHIC INFORMATION/GEOMATICS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	Engineering; Design; **Testing**; Management; Processing; Maintenance; Manufacturing; **Documentation**	Parts; Equipment; Materials; Communication; Tools; Guidelines; **Procedures**; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; **Quality**; **Data**; Interface; Debris; Vehicles; Passengers

The scope of ISO/TC 211 is very wide, but the work currently concentrates in a few segments:

- The modelling and documentation of geographic information, traditionally important for heavy players like the public sector.
- The spatial data infrastructures (SDIs) with emphasis on sharing and dissemination of geographic information through services.
- The embedding of geographic information in everyday life – ubiquitous geographic information.
- Some specific domains where geographic information is an important component, and where multiple disciplines are involved.

The main view of ISO/TC 211 is geographic information and geomatics as a horizontal and enabling technology – as an infrastructure – much like the focus of Information and Communications Technology (ICT).

The objective in all cases is the support for decision making where location is a component. The standards developed by ISO/TC 211 shall actively contribute to authoritative, evidence-based decisions in any field involving geographic or location content.

Geographic information standards are recognized as an underpinning in the realization of SDIs. They have been developed extensively for the sharing and the integration of geographic data across platforms. They facilitate the discovery, the access, and the appropriate use of geographic information, i.e. interoperability. Interoperability of geographic information is the essential goal of geographic information standards. It also relies on a significant number of standards that are not specifically geospatial. These are Information technology (IT) standards along with domain specific knowledge standards which all together provide the pillars for interoperability.

More generally TC 211 develops standards in the field of digital geographic information. It aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth.

These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital / electronic form between different users, systems and locations.

The work shall link to appropriate standards for information technology and data where possible, and provide a framework for the development of sector-specific applications using geographic data.

CREATION	1994
STANDARDS	72/29 (published/in development)
URL(S)	http://www.isotc211.org
LIAISONS	ISO/IEC JTC 1 - Information technology ISO/IEC JTC 1/SC 2 - Coded character sets ISO/IEC JTC 1/SC 24 - Computer graphics, image processing and environmental data representation ISO/IEC JTC 1/SC 29 - Coding of audio, picture, multimedia and hypermedia information ISO/IEC JTC 1/SC 32 - Data management and interchange ISO/IEC JTC 1/SC 35 - User interfaces ISO/IEC JTC 1/SC 36 - Information technology for learning, education and training ISO/TC 20/SC 13 - Space data and information transfer systems ISO/TC 20/SC 14 - Space systems and operations ISO/TC 20/SC 16 - Unmanned aircraft systems ISO/TC 23/SC 19 - Agricultural electronics ISO/TC 46 - Information and documentation ISO/TC 59/SC 13 - Organization of information about construction works ISO/TC 69 - Applications of statistical methods ISO/TC 154 - Processes, data elements and documents in commerce, industry and administration ISO/TC 172/SC 6 - Geodetic and surveying instruments ISO/TC 184/SC 4 - Industrial data ISO/TC 190/SC 1 - Evaluation of criteria, terminology and codification ISO/TC 204 - Intelligent transport systems ISO/TC 207 - Environmental management ISO/TC 207/SC 7 - Greenhouse gas management and related activities ISO/TC 241 - Road traffic safety management systems CEN/TC 287 - Geographic Information CEN/TC 278 - Road Transport and Traffic Telematics
COLLABORATION	DGIWG (Defence Geospatial Information Working Group) ESA (European Space Agency) IEEE (Institute of Electrical and Electronics Engineers) OASIS (Organization for the Advancement of Structured Information Standards) OGC (Open Geospatial Consortium) OMG (Object Management Group) ...

STRUCTURE	
	ISO/TC 211/AG 1 - Outreach Advisory Group
	ISO/TC 211/WG 1 - Framework and reference model
	ISO/TC 211/AHG 1 - Control body for the ISO geodetic registry network
	ISO/TC 211/AHG 2 - Best practices for UML modelling
	ISO/TC 211/AG 3 - Programme maintenance group (PMG)
	ISO/TC 211/WG 4 - Geospatial services
	ISO/TC 211/AG 4 - Joint advisory group (JAG) ISO/TC 211 and OGC
	ISO/TC 211/AHG 4 - Strategy and business plan
	ISO/TC 211/WG 6 - Imagery
	ISO/TC 211/WG 7 - Information communities
	ISO/TC 211/WG 9 - Information management
	ISO/TC 211/WG 10 - Ubiquitous public access

Table 13: Details of ISO/TC 211

CEN/TC 278
INTELLIGENT TRANSPORT SYSTEMS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; **Business**; **Transport**; Sustainability	Engineering; Design; **Testing**; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; Software; Propulsion; Quality; **Data**; **Interface**; Debris; Vehicles; Passengers

CEN/TC 278 operates in close cooperation with ISO/TC 204 Intelligent Transport Systems, which is responsible for developing international standards. Many standards are developed in joint working groups, so that expertise from around the globe can be used to set the best standards for Europe.

The European Telecommunications Standards Institute (ETSI) produces globally-applicable standards for ICT. In the area of ITS (Intelligent Transport Systems), these standards are complementary to the ones produced by CEN/TC 278; together they form a coherent set of ITS standards for Europe. The coordination of the work programs is handled by the ITS Coordination Group (ITS-CG).

Priority areas of TC 278 are:

- Electronic fee collection;
- Public transport;
- Data dictionaries and exchange;
- Cooperative ITS.

Strategic directions for ITS future work:

- Electronic fee collection and access control;
- Automatic vehicle and equipment identification;
- Freight and fleet management;
- Telematics in public transport;
- Road and traffic data;
- Parking systems;
- Human-machine interfaces;
- Architecture and terminology;
- Recovery of stolen vehicles;
- eSafety;
- Cooperative ITS.

The European Commission Mandate M/453 to CEN, CENELEC and ETSI has as objective to support interoperability of cooperative systems for intelligent transport in the European Community by leveraging the field of information and communication technologies.

CREATION	1992
STANDARDS	142/44 (published/in development)
URL(S)	http://www.itsstandards.eu/index.php/about-cen-tc-278
LIAISONS	CEN/CENELEC/TC 5 - Space ISO/TC 22 - Road vehicles ISO/TC 204 - Intelligent Transport Systems ETSI TC-ITS - Intelligent Transport Systems +consortia and fora
COLLABORATION	ITS-CG (ITS Coordination Group) ...
STRUCTURE	CEN/TC 278/WG 1 Electronic fee collection and access control (EFC) CEN/TC 278/WG 2 Freight, Logistics and Commercial Vehicle Operations CEN/TC 278/WG 3 Public transport (PT) CEN/TC 278/WG 4 Traffic and traveller information (TTI) CEN/TC 278/WG 5 Traffic control (TC) CEN/TC 278/WG 7 ITS spatial data CEN/TC 278/WG 8 Road traffic data (RTD) CEN/TC 278/WG 9 Dedicated Short Range Communication (DSRC) CEN/TC 278/WG 10 Man-machine interfaces (MMI) CEN/TC 278/WG 12 Automatic Vehicle Identification and Automatic Equipment Identification (AVI/AEI) CEN/TC 278/WG 13 Architecture and terminology CEN/TC 278/WG 14 After theft systems for the recovery of stolen vehicles CEN/TC 278/WG 15 eSafety CEN/TC 278/WG 16 Cooperative ITS CEN/TC 278/WG 17 Urban ITS

Table 14: Details of CEN/TC 278

ETSI TC-ITS
EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE
INTELLIGENT TRANSPORT SYSTEMS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; **Business**; **Transport**; Sustainability	Engineering; Design; **Testing**; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; **Requirements**; **Infrastructure**; **Security**; Safety; Risk; Software; Propulsion; **Quality**; **Data**; **Interface**; Debris; Vehicles; Passengers

The Technical Committee on Intelligent Transport Systems (TC-ITS) is responsible for standardization activities to support the development and implementation of ITS service provision across the network, for transport networks, vehicles and transport users, including interface aspects, multiple modes of transport and interoperability between systems.

TC-ITS is leading the drive to achieve global standards for Cooperative ITS, which offers enormous potential through vehicle-to-vehicle and vehicle-to-roadside communication. Applications include road safety, traffic control, fleet and freight management and location-based services, providing driver assistance and hazard warnings and supporting emergency services.

CREATION	2008
STANDARDS	178/61 (published/in development)
URL(S)	https://portal.etsi.org/TBSiteMap/ITS/ActivityReport.aspx
LIAISONS	ETSI TC ERM - EMC and Radio Spectrum Matters ETSI TC MSG - Mobile Standards Group ETSI TC BRAN - Broadband Radio Access Networks ETSI TC RT - Railways Telecommunications 3GPP - 3rd Generation Partnership Project ITU / APSC TELEMOV - International Telecommunication Union / Advisory Panel for Standards Cooperation on Telecommunications related to Motor Vehicles CEN - European Committee for Standardisation ISO/TC 204 - Intelligent transport systems ISO/TC 22/SC 3 - Electrical and electronic equipment ...

COLLABORATION	Car-2-Car Communication Consortium CCC - Car Connectivity Consortium) CEPT - The Conference of European Post and Telecommunications Administrations CEPT/ECC - Electronic Communications Committee ENISA - European Union Agency for Network and Information Security ERA - European Railways Agency ERTICO-ITS Europe IEEE - Institute of Electrical and Electronics Engineers IPv6 Forum - Internet Protocol version 6 Forum SAE International ISOC/IETF - Internet Society/Internet Engineering Task Force ITU - International Telecommunication Union TISA - Traveller Information Services Association ...
STRUCTURE	WG 1 - Application Requirements and Services WG 2 - Architecture and Cross Layer WG 3 - Transport and Network WG 4 - Media and Medium Related WG 5 - Security

Table 15: Details of ETSI TC-ITS

ISO/TC 204
INTELLIGENT TRANSPORT SYSTEMS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; **Business**; **Transport**; Sustainability	Engineering; Design; **Testing**; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; **Requirements**; Infrastructure; **Security**; Safety; Risk; Software; Propulsion; **Quality**; **Data**; **Interface**; Debris; **Vehicles**; Passengers

ISO/TC 204 addresses the newly emerging worldwide market that has come to be known as Intelligent Transport Systems (ITS). ITS is the application of information technology, communications technology, and sensor technology, including the internet (both wired and wireless), to the general challenges and opportunities of surface transportation.

As urbanization and traffic congestion impact the quality of life in many cities, ITS holds the promise of improving traffic management and vehicle safety. ITS enables both government and private industry to improve safety, mitigate traffic congestion and reduce fuel consumption and emissions, as well as increase traveler mobility and convenience via the use of vehicle and infrastructure probe data to provide location-based telematics services.

The major trends are:

- Integrating vehicles with roadway networks through the use of on-board wireless communications.
- Conversion of vehicle and infrastructure data to provide timely location based services to drivers and roadway operators.
- To improve advanced safety applications such as automatic crash notification, secure freight transport and crash avoidance.
- An improved environment through reduced fuel consumption.

There are five primary market targets for ITS:

- Builders and operators of the roadway, public transport, rail, and ferry infrastructure. This is predominantly the public sector, but with a growing private sector presence, especially for toll roads.
- Vehicle manufacturers, who incorporate ITS technology into the automobiles, trucks, and buses they sell.
- Commercial fleet operators (passenger and freight) who use ITS to better manage vehicles, loads and routing.
- End users, as consumers of ITS products and services.
- Public sector regulators of transportation and enforcement entities.

The scope of TC 204 is standardization of information, communication and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects thereof, traveler information, traffic management, public transport, commercial transport, emergency services and commercial services in the intelligent transport systems (ITS) field.

This excludes in-vehicle transport information and control systems which is covered by ISO/TC 22 - Road vehicles.

ISO/TC 204 is responsible for the overall system aspects and infrastructure aspects of intelligent transport systems (ITS), as well as the coordination of the overall ISO work program in this field including the schedule for standards development, taking into account the work of existing international standardization bodies.

CREATION	1992
STANDARDS	220/104 (published/in development)
URL(S)	http://www.iso.org/iso/iso_technical_committee%3Fcommid%3D54706

LIAISONS	ISO/IEC JTC 1 - Information technology ISO/IEC JTC 1/SC 2 - Coded character sets ISO/IEC JTC 1/SC 17 - Cards and personal identification ISO/IEC JTC 1/SC 27 - IT Security techniques ISO/IEC JTC 1/SC 31 - Automatic identification and data capture techniques ISO/TC 8 - Ships and marine technology ISO/TC 8/SC 11 - Intermodal and Short Sea Shipping ISO/TC 20/SC 14 - Space systems and operations ISO/TC 22 - Road vehicles ISO/TC 23/SC 19 - Agricultural electronics ISO/TC 22/SC 31 - Data communication ISO/TC 22/SC 32 - Electrical and electronic components and general system aspects ISO/TC 22/SC 33 - Vehicle dynamics and chassis components ISO/TC 22/SC 39 - Ergonomics ISO/TC 104 - Freight containers ISO/TC 122 - Packaging ISO/TC 154 - Processes, data elements and documents in commerce, industry and administration ISO/TC 211 - Geographic information/Geomatics ISO/TC 241 - Road traffic safety management systems ISO/TC 269 - Railway applications ISO/PC 286 - Collaborative business relationship management -- Framework
COLLABORATION	APEC (Asia Pacific Economic Cooperation) ETSI (European Telecommunications Standards Institute) IEEE (Institute of Electrical and Electronics Engineers) ISOC (Internet Society) ITU (International Telecommunication Union) OGC (Open Geospatial Consortium) TISA (Traveller Information Services Association) SAE (Society of Automotive Engineers)
STRUCTURE	ISO/TC 204/WG 1 - Architecture ISO/TC 204/WG 3 - ITS database technology ISO/TC 204/WG 4 - Automatic vehicle and equipment identification ISO/TC 204/WG 5 - Fee and toll collection ISO/TC 204/WG 7 - General fleet management and commercial/freight ISO/TC 204/WG 8 - Public transport/emergency ISO/TC 204/WG 9 - Integrated transport information, management and control ISO/TC 204/WG 10 - Traveler information systems ISO/TC 204/WG 14 - Vehicle/roadway warning and control systems ISO/TC 204/WG 16 - Communications ISO/TC 204/WG 17 - Nomadic Devices in ITS Systems ISO/TC 204/WG 18 - Cooperative systems

Table 16: Details of ISO/TC 204

IEC/TC 107 (CEN/CENELEC/TC 107X)
PROCESS MANAGEMENT FOR AVIONICS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; Testing; **Management**; Processing; **Maintenance**; Manufacturing; Documentation	**Parts**; **Equipmen**t; Materials; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; **Quality**; Data; Interface; Debris; Vehicles; Passengers

The IEC/TC 107 works in close collaboration with the CEN/CENELEC/TC 107X and the two committees share the same structure and many standardization documents, therefore the IEC is used as reference hereinafter. The general scope of TC 107 is to develop process management standards on systems and equipment used in the field of avionics, including electronics used in commercial, civil and military aerospace applications.

The aerospace industry is increasingly dependent on electronic components, equipment, and systems designed and manufactured mainly for other industries, over which the aerospace industry has less and less control. TC 107 develops standard processes to use and manage these components, equipment, and systems in aerospace applications, possibly in liaison with other industrial sectors also concerned.

The electronics industry is dominated by high-volume applications such as computers and telecommunication products. There is a relentless pressure to reduce component cost, improve their performance and increase their physical integration. This results in products that change rapidly and cause obsolescence and potential reliability and wear out problems. The aerospace industry must respond to these trends while meeting its own cost, reliability and performance requirements. Work is continuing on meeting the impact of legislation on lead-free electronics and counterfeited prevention.

The standards allow to define industries means of compliance with regard to regulatory requirements. They can be used for conformity assessment (for example IEC/TS 62239-1 is the reference for "IECQ ECMP scheme").

CREATION	2000
STANDARDS	21/12 (published/in development)
URL(S)	http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID:1304
LIAISONS	IEC/TC 47 - Semiconductor devices IEC/TC 56 - Dependability IEC/TC 91 - Electronics assembly technology IEC/TC 111 - Environmental standardization for electrical and electronic products and systems ISO/TC 20 - Aircraft and space vehicles ISO/TC 20/SC 1 - Aerospace electrical requirements
COLLABORATION	SAE International STACK International IECQ (International Electrotechnical Commission Quality Assessment System for Electronic Components)
STRUCTURE	WG 1 Aerospace and defence electronic systems containing lead-free solder WG 2 Aerospace qualified electronic component (AQEC) WG 3 Counterfeit electronic parts; avoidance, detection, mitigation, and disposition in avionics applications WG 4 Accommodation of atmospheric radiation effects via single event effects within avionics electronic equipment WG 5 Revision of IEC TS 62239 Ed. 1

Table 17: Details of IEC/TC 107

6 DESCRIPTION OF THE NATIONAL MARKET

The first step in the methodology was to select potentially interesting technical committees in the space sector and to categorize them into segments, the next step proposes a description of the national market. Mainly based on the overview proposed on the website of Luxembourg Space Capabilities[51], of the Luxembourg Space Cluster and the GLAE website but also on a variety of other sources, a national panorama of the stakeholders of the space sector was established.

This panorama reflects the situation at a certain moment from a certain point of view and is not intended to be exhaustive.

- Stakeholders involved in the space sector are either public institutions or privates companies including, but not limited to:
- R&D centers, laboratories, universities, either public or private establishments often playing a role in research and science,
- Manufacturers specialized in satellites, launchers or in the ground segment,
- Operators including satellite signal providers or digital contents providers,
- Services providers working with the ground equipment and devices developers for example.

Figure 4 presents a summary of the different groups of stakeholders identified during the review who are acting in this specific sector in Luxembourg.

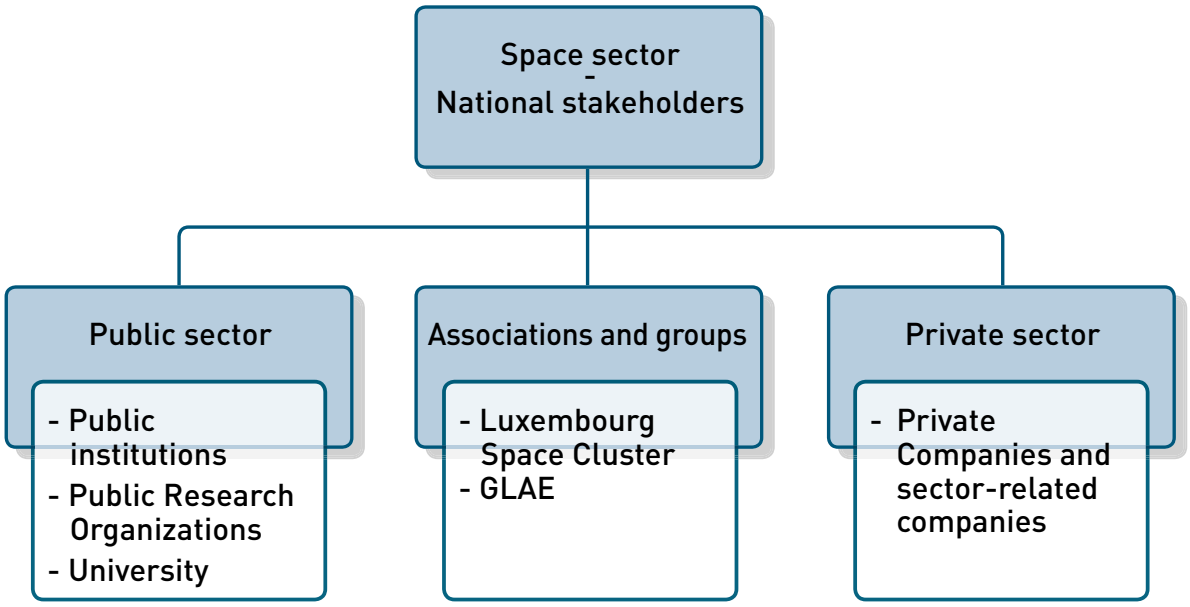

Figure 5: Illustration of the categories of space sector's national stakeholders

The different categories of stakeholders are described in detail in the following sections of the report.

[51] Luxembourg Space Capabilities - Update 2016: www.innovation.public.lu/en/brochures-rapports/s/space-capabilities-2016/catalogue-space-2016.pdf

6.1 PUBLIC SECTOR

6.1.1 PUBLIC INSTITUTIONS

Official bodies and public institutions play a key role in the space economy as developers, investors, owners, operators, regulators and customers for much of the space infrastructure.

Regarding the space sector, the Ministry of the Economy is in charge of relations with the European Space Agency (ESA). This Ministry is managing the financial, political and programming aspects related to ESA activities and, on the basis of industry and public research capabilities and objectives, opens program lines and supports the set-up of specific projects.

Luxinnovation GIE, the National Agency for Innovation and Research, is the Luxembourg National Contact Point for ESA matters. The agency provides information to companies and research organizations on how ESA operates and on the different research programs that exist. It also offers advice and support to national stakeholders willing to work with ESA.

6.1.2 RESEARCH ORGANIZATIONS

The Luxembourg Institute of Science and Technology (LIST) is the only Public research organization dealing with the space sector in Luxembourg. LIST was created from the merger of the Public Research Centers Gabriel Lippmann and Henri Tudor and is in operation since the 1st January 2015. It has three departments focusing on space-related research:

Environmental Research and Innovation (ERIN) department

In the space sector, ERIN is mainly active in the use of Earth Observation (EO) data for environmental and risk management applications. The focus of the research unit "Remote Sensing and Eco-hydrological Modelling" is geared towards a better use of EO data in operational water resources and ecosystem management tools and to integrate remote sensing data (satellite, airborne and ground) together with global navigation satellite systems for near real-time eco-hydrological and hydraulic modelling. The overall objectives are to (1) improve numerical model-based hydrological and hydraulic predictions of streamflow for improved flood and drought management and to (2) integrate advanced remote sensing technologies and environmental modelling for an improved understanding of plant-soil-water interactions across different spatiotemporal scales.

IT for Innovative Services (ITIS) department

The ITIS department has as objective to increase the impact of ICT-based services on the economic and societal development of Luxembourg and the Greater Region. Its experts arrange numerous skills for optimal R&D realizations on IT-enabled business services, service system architectures quality, management & governance of ICT-based services, information intensive service, and collaborative decision support. ITIS is currently participating in several projects related to the space sector.

Materials Research and Technology (MRT) department

The mission of the MRT is to translate cutting-edge materials research into applicable technology. For this, the department cultivates close relationships and joint projects with both academic and industrial partners, and contributes to Luxembourg's and Europe's innovation agenda in materials research and technology. MRT is particularly active in several projects related to the space sector.

Several centers and units of the University of Luxembourg work on space related research projects.

The Geophysics Laboratory focuses on climate, sea level variability and geodynamics. The primary goals include obtaining reliable geodetic measurements of environmental change and assessing the influence of human and natural factors in those changes. To do so, the group has developed a patented differential free-fall gradiometer. Other activities in scientific metrology include advanced high-accuracy Global Navigation Satellite Systems (GNSS) techniques, interpretation of time variable gravity from space and improved modeling of environmental effects on geodetic observations.

The Research Unit in Engineering Science (RUES) is an interdisciplinary group active in the classical domains of civil, electrical and mechanical engineering. Among its various research activities, a particular emphasis is given to numerical simulation in order to reduce the required experimental effort, but the validation of the models will remain an essential asset.

The Interdisciplinary Centre for Security, Reliability and Trust (SnT) aims to become a European center of excellence and innovation for secure, reliable, and trustworthy ICT (Information and Communication Technologies) systems and services. Research activities are carried out through interdisciplinary research platforms targeting key areas of strategic importance for the region. The SnT research activities in Satellite Systems includes: Applications and Services, Satellite Hybrid Networks, Transmission and Reception Technologies, Legal and Regulatory Challenges.

6.2 ASSOCIATIONS AND GROUPS

The *"Groupement luxembourgeois de l'aéronautique et de l'espace"* (GLAE) is a non-profit organization created in February 2005, following the Grand Duchy of Luxembourg's adhesion to the European Space Agency. The GLAE members are Luxembourg based companies active in the space sector: POST Luxembourg, GRADEL S.A., GT Satellite Systems S.A., HITEC Luxembourg S.A., LUXSPACE S.à.r.l., SES S.A., TELINDUS S.A. and the agency Luxinnovation GIE.

Constituted within the Luxembourg Federation of Employers (FEDIL), the objective of GLAE is to create links between its members active in the space sector, advising them and defending their shared professional, economic and social interests at a national and international level.

GLAE is a partner of the government for addressing all questions in relation to initiatives taken by the authorities in the frame of ESA programs and the establishment of a space policy in Luxembourg. It offers to its members the opportunity to create collaborations at the national and European level for both private and public sectors.

The Luxembourg Space Cluster is a platform dedicated to the space sector to support and develop the exchanges between specialized private companies and public research organizations. This network has as aim to create and develop synergies and new partnerships at the national and international level through collaborative Research, Development and Innovation projects.

Membership of the Luxembourg Space Cluster is open to companies, public research and other organizations that are active in the field of Space Technologies and located in Luxembourg.

Based on the main interests of the national market, the Luxembourg Space Cluster focuses on the following thematic areas: Space Telecommunications, Global Navigation Satellite System and Location based Applications, Earth Observation, Maritime Security and Safety, Space related Technologies.

The main objectives of the Luxembourg Space Cluster are to:

- empower the development of the space sector in Luxembourg;
- increase and encourage the uptake of new technologies;
- promote the technological capabilities of private companies and public research in Luxembourg and thereby enhancing their national and international visibility;
- facilitate collaboration between public and private research actors on the national and international level;
- identify new market possibilities.

The Luxembourg Space Cluster and the GLAE work in close collaboration and share common objectives. They are both representing the Luxembourg Space Industry by encompassing private companies and other public organizations active in the aeronautics and space sector.

6.3 PRIVATE COMPANIES

Since 1985, the establishment of SES, a pioneer in satellite telecommunications services, many space-related companies have settled in Luxembourg. This is the result of an active national development policy, supporting research and development and seeking to diversify and expand its national market through innovative sectors as the space sector.

This chapter gives a general overview of the main private stakeholders that have some of their activities dedicated to the space sector. Aware that other private companies could also have a potential interest in developing business in the space sector, this is of course a non-exhaustive list. However, this analysis tries to identify companies that demonstrate a clear interest in the space sector through for example being a member to the Luxembourg Space Cluster or the GLAE.

Note: Several broadcasting companies that have their headquarters in Luxembourg have been omitted. Although their activity is somewhat Space related, their core business is more focused on telecommunications and entertainment and can be viewed more as a space sector users than providers.

adwäisEO

www.acri-st.fr

adwäisEO

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; **Processing**; Maintenance; Manufacturing; **Documentation**	Parts; Equipment; Materials; Communication; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; Software; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

adwäisEO was created in October 2015 as a subsidiary of ACRI-ST, a France based company. Its main activities related to the space sector concerns the Earth Observation from satellites (EO) for environmental monitoring and Geographical Information Systems. The company is particularly working on the development of an open source software framework for EO data processing and on setting up an EO data archiving and distribution center.

COFELY SOLELEC

www.cofelysolelec-gdfsuez.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; Informatics; Robotics; Geographical; Business; **Transport**; Sustainability	**Engineering**; Design; Testing; Management; Processing; **Maintenance**; Manufacturing; Documentation	Parts; Equipment; Materials; Communication; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; Software; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

COFELY SOLELEC provides support for complex and major projects in electrical engineering, from design to commissioning. It designs and manufactures electrical installations (Mv-Lv-Electronics Systems) for the building sector and industry as well as electrical cabinets for distribution and control systems. Regarding the space sector, COFELY SOLELEC provides assistance and ground electrical services for launch sites such as the Space Centre in French Guyana.

AMOVA

www.amova.eu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; **Structural**; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; **Maintenance**; **Manufacturing**; Documentation	Parts; **Equipment**; **Materials**; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

AMOVA, the result of a recent merger of CTI Systems and SMS Logistics, is an industry leader in the supply and installation of integrated automated manufacturing solutions in the area of heavy loads. Their portfolio contains automated material handling solutions, storage systems, surface treatment installations, assembly lines, process software (MES) and integration of machines and installations from other suppliers. They design, develop and supply complete, tailor-made solutions based on the latest technologies particularly with regard to energy efficiency and productivity.

CYBERCULTUS

www.cybercultus.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	Engineering; **Design**; Testing; Management; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

Cybercultus was created in 1999. It proposes innovative digital content solutions to the TV entertainment industry and the multimedia cultural and tourism sectors. It invented an innovative technology with the RAMO "Reactive and Adaptive Multimedia Objects" semantic layer that insulates content producers from the technical complexity of interactive and user immersive applications. Cybercultus works with industries and organizations in Europe and develops partnerships with public and private actors specialized in social / immersive applications (for TV programs, cultural heritage, travel portals) and in GIS technologies (for spatial and temporal mapping of cultural and tourism geo-localized multimedia assets).

DEEP SPACE INDUSTRIES (DSI)

www.deepspaceindustries.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; Structural; **Informatics**; **Robotics**; **Geographical**; Business; Transport; Sustainability	**Engineering**; **Design**; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	**Parts**; **Equipment**; **Materials**; Communication; Tools; Guidelines; **Procedures**; Requirements; Infrastructure; Security; **Safety**; **Risk**; **Software**; **Propulsion;** Quality; Data; Interface; Debris; **Vehicle**; Passengers

Deep Space Industries (DSI) was created in 2015. It is a space technology company with the long-term vision of enabling space resource utilization and the short-term goal of undertaking low-cost, aggressive-schedule space exploration missions using small spacecraft.

DSI has three major space projects: Prospector-X: a risk-reduction mission to demonstrate small satellites exploration technologies; Prospector-1: first private small spacecraft mission to an asteroid, for water mapping and geotechnical reconnaissance; Nanosatellite missions for confidential customers.

DIGITARIA INTERNATIONAL

www.digitaria-international.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

Digitaria International, created in 2012, is an IT Global Service Company having, in the broadest sense, any interest whatsoever in electronic media and the development of satellite technology. The aim of Digitaria is to be predominantly active in the communications area via satellites and to invest, directly or indirectly, in other companies that are actively involved in the dynamic industry of satellite communication and multimedia applications.

DRONELAB

www.dronelab.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; Informatics; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; **Vehicle**; Passengers

DroneLAB was created in 2013 and is specialized in aerial photography, measures and aerial films via the use of drones. The company is developing a new ETS (Embedded Thermography System), a thermographic measurement solution specifically tailored to the drones.

E-XSTREAM ENGINEERING

www.e-xstream.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; **Materials**; Communication; **Tools**; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

Created in 2004, e-Xstream engineering provides simulation software and engineering services focused on advanced material modeling. It develops a nonlinear multi-scale material and structure modeling platform that fasten the development of optimal composite materials and parts (DIGIMAT). It is used by material suppliers and end users to accurately predict the nonlinear micromechanical behavior of complex multiphase composites materials and structures used across the industries acting among others, in the space sector.

EARTHLAB LUXEMBOURG

www.earthlab-galaxy.com/luxembourg/

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	Engineering; Design; Testing; Management; **Processing**; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; **Safety**; Risk; Software; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

EarthLab Luxembourg was formed in 2015 to offer innovative services for professionals managing industrial and environmental hazards, integrating earth observation data with varied sources of information, such as social media, internal exposure databases or ground sensors. EarthLab Luxembourg creates tailored services directly oriented towards the end-user needs, applying adequate technologies to extract information.

EarthLab Luxembourg collects varied structured and unstructured information into a private large storage farm. Different satellite-based Earth observation data are collected on its platform, both optical and radar images, from public (Sentinel, Landsat) as well as from commercial providers (Cosmo SkyMed, Spot, etc.). These different data are treated on a high performance and scalable cluster extracting and combining the information into final indicators for the end users.

EBRC

www.ebrc.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; **Business**; Transport; Sustainability	Engineering; Design; Testing; Management; **Processing**; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; Software; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

EBRC manages the whole supply chain and is thus able to offer a unique one-stop-shop to its clients, ranging from data center services to integrated cloud computing and ICT managed services. Through its infrastructures and services, EBRC is able to support the space sector stakeholders in setting up their projects.

EMTRONIX

www.emtronix.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; Testing; Management; Processing; Maintenance; Manufacturing; Documentation	**Parts**; **Equipment**; Materials; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

EmTroniX provides, since 2001, technological expertise, engineering design, prototyping and production services in advanced electronics and embedded software to customers involved in technological sectors such as Space.

Among other activities, they actively participated in the development of the first Luxemburgish S-AIS receiver embarked on both LEO satellites and the ISS. They also designed, for space applications, a transducer that integrates three calibrated light sensors placed on orthogonal axis and an ambient temperature sensor. When installed on a satellite, it provides an accurate indication of the satellite's zenith and azimuth angles for optimal positioning.

EURO-COMPOSITES GROUP

www.euro-composites.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; **Structural**; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; **Testing**; Management; Processing; Maintenance; **Manufacturing**; Documentation	**Parts**; Equipment; **Materials**; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

The EC-Group is active in the field of advanced and demanding composite products. It offers technical solutions based on advanced composites adapted to the needs of aeronautic and space customers. They develop high-tech composite materials and participate in the development of new satellites.

FOERSOM

www.foersom.com/fase

Foersom

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; Structural; Informatics; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; **Data**; Interface; Debris; **Vehicle**; Passengers

Foersom Sàrl is specialized in engineering and flight service for multirotor Unmanned Aircraft Systems (UAS). Foersom uses electric octo-copter as UAS multi-rotor for aerial photography, video filming, thermography and visual inspection.

INVERTO

www.inverto.tv

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; Maintenance; **Manufacturing**; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

Inverto was established in 1991 and has over 23 years of experience the in the industry shipping millions of LNB, dishes and accessories every year. Over the last two decades, the Inverto team has successfully led key technological transitions and has worked closely with the industry leading partners enabling successful deployments across their focus markets. Operating from Luxembourg, Inverto provides satellite reception equipment with market leading expertise in antenna systems, Low Noise Block converters (LNBs), professional broadcast reception, video encoding and streaming solutions and hybrid set-top-box products.

GOVSAT

www.govsat.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; Informatics; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; **Security**; Safety; Risk; Software; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

GovSat is a public-private joint venture between the Luxembourg Government and SES, the world's leading satellite operator based in Luxembourg. The company's first satellite GovSat-1 is expected to be operational by the end of 2017. This will be a multi-mission satellite which will use dedicated military frequencies to provide high-powered and fully steerable spot beams to support multiple operations in Europe, the Middle East and Africa.

GRADEL

www.gradel.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; Maintenance; **Manufacturing**; Documentation	**Parts**; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

GRADEL was founded in 1965 and develops several activities covering among others the space sector. In the space domain, it provides mechanical engineering and manufacturing solutions, including Mechanical Ground Support Equipment (MGSEs), mechanical parts of satellites and studies for ESA.

HITEC LUXEMBOURG

www.hitec.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; **Maintenance**; **Manufacturing**; Documentation	**Parts**; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; **Safety**; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

Established 1986 in Luxembourg, HITEC Luxembourg developed its business activities in innovative fields including the space sector. It offers high technology solutions such as satellite ground segment technology as well as innovative satellite based products and ICT services to support public safety services in case of crisis or disasters. The company offers a range of Limited Motion (LM) and Full Motion (FM) high end antenna systems. HITEC Luxembourg's experience in satellite ground segment technology allows the company to take part in large international projects like VINASAT and the European Galileo project. The company is ISO 9001 certified for engineering, analysis, consulting, manufacturing, maintenance and sales of systems in mechanics, electronics, physical measuring techniques as well as information and communication technologies.

INTELSAT

www.intelsat.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

Intelsat operates a Globalized Network, delivering high-quality, cost-effective video and broadband services anywhere in the world. Intelsat's Globalized Network combines the world's largest satellite backbone with terrestrial infrastructure, managed services and an open, interoperable architecture to enable customers to drive revenue and reach through a new generation of network services.

INTOREL

www.intorel.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; **Interface**; Debris; Vehicle; Passengers

Intorel is a world class developer of advanced monitoring and control solutions for satellite operators, broadcasters, telecom and other industries. The company's wide range of products can be used for any industrial application that requires reliability, automation and advanced features, regardless of the type or size of an organization. In particular, Intorel products have been used for monitoring and controlling satellite earth stations, sat-com systems, TT&C stations, broadcast stations and other satellite-related systems.

ITRUST CONSULTING

www.itrust.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; **Testing**; Management; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; **Security**; Safety; Risk; **Software**; Propulsion; **Quality**; **Data**; Interface; Debris; Vehicle; Passengers

Created in 2007, itrust consulting is specialized in secure information systems. It performs consulting services, audit, design and implementation of security solutions protecting its clients against data divulgation, data manipulations, and service unavailability. Research domains of the company are not limited to network security as it also works on securing localization data and protecting critical infrastructures. Like this, itrust participates in ESA projects such as Galileo and EGNOS.

LUXSPACE

www.luxspace.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; **Design**; **Testing**; Management; Processing; Maintenance; **Manufacturing**; Documentation	Parts; **Equipment**; Materials; Communication; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; **Software**; **Propulsion**; **Quality**; Data; Interface; Debris; Vehicle; Passengers

LuxSpace provides since 2004, know-how, expertise as well as products and services to the European and global institutional and industrial market in the fields of space and defense system engineering and application development. It focuses on space systems and subsystem design, specification, procurement, manufacturing, integration and test, and quality assurance and also on space applications and service development and operation with focus on Earth Observation & Telecommunication Applications & Services.

M-PLIFY

www.alarmtilt.com

AlarmTILT®

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; **Security**; **Safety**; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

Since its creation in 2000, AlarmTILT, a product of the M-Plify company, focuses on the development of applications as procedure based bidirectional reminder, alerting and messaging applications. The company was involved in two major space projects with ESA (Galileo and MAIA).

MEANSWHAT

www.meanswhat.eu

meanswhat
TECHNOLOGIES and SOLUTIONS

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

meanswhat develop and market solutions to optimize latency sensitive application while communicating over satellite. The company is particularly developing ERP Satbooster, a development project for a system which makes it possible for Satellite Communications Service Providers to operate latency sensitive applications.

POST

www.post.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; **Software**; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

POST Luxembourg is a Luxembourg's leading telecommunications and information services company. It was founded in 1842, and has operated as a public enterprise since 1992.

Post Luxembourg is the incumbent telecom operator of the Grand-Duchy of Luxembourg and as such serves all segments of the community and all ranges of society, from residential to large corporate customers, offering both fixed and mobile services. The Post group comprises 19 sub-companies offering a wide range of innovative and valuable solutions.

SATURNE TECHNOLOGY

www.saturne-technology.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; **Structural**; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; **Testing**; Management; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; **Materials**; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; **Propulsion**; Quality; Data; Interface; Debris; Vehicle; Passengers

SATURNE Technology is a Luxembourg company established in 2001 and specialized in the design and manufacture of High Tech Laser applications (cutting, drilling, welding, resurfacing and laser sintering), microwave plasma and TIG. The company has developed activities of additive manufacturing for the aerospace industry. It particularly proposes additive manufacturing of aluminum and titanium components for spacecrafts.

SES

www.ses.com/techcom

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; **Business**; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; **Equipment**; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

SES is a world-leading satellite operator with a fleet of more than 50 geostationary satellites. Established since 1985 in Luxembourg, it provides satellite communications services to broadcasters, content and internet service providers, mobile and fixed network operators and business and governmental organizations worldwide. It offers a large portfolio of broadcast and broadband solutions for customers and provides internet access and network services to governments, large corporations, small- to medium-sized enterprises and individual households. Its entity, SES TechCom provides operational services, technical consultancy and high-tech products as well as integrated solutions to the satellite industry around the world and is certified ISO 9001:2008.

SPACE4ENVIRONMENT

www.space4environment.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; **Sustainability**	Engineering; Design; Testing; **Management**; **Processing**; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

Established in Luxembourg since 2007 under its former name GeoVille Environmental Services, space4environment is specialized in adding the environmental dimension to Earth observation in the land domain, respectively "using space data to provide space for the environment" as expressed in the company's motto. It offers value-added geographic information and environmental services in the land domain, providing the bridge from technical knowhow in merging geospatial explicit data with statistics to support the analysis of what this information means for the environment. It provides solutions for efficient and optimized spatial data management and analysis.

TELINDUS

www.telindus.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; Design; Testing; Management; **Processing**; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; **Security**; Safety; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

Telindus Luxembourg is a Proximus company and, through Telindus Telecom, the group's enterprise operator, it provides global telecom and ICT solution for businesses in Luxembourg. Since 1978, it provides solutions to a variety of private and public-sector companies. Its expertise domains include enterprise networks and connectivity, datacenters, systems, storage, security, collaboration, applications and mobility.

In the space domain, Telindus positions itself in the activities related to security, virtualization, routing and switching.

AIR LIQUIDE LUXEMBOURG

www.airliquide.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; **Hydraulic**; Biological; **Structural**; Informatics; Robotics; Geographical; Business; Transport; Sustainability	Engineering; **Design**; Testing; Management; Processing; Maintenance; **Manufacturing**; Documentation	**Parts**; **Equipment**; **Materials**; Communication; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; Propulsion; Quality; Data; Interface; Debris; Vehicle; Passengers

Created in 1902, Air Liquide is an international group located in 72 different countries. It was established in Luxembourg 1931 and supports the space industry at two levels: the design and manufacture of cryogenic tanks and equipment, as well as the production of industrial gases, backed up by the provision of associate services.

GT SATELLITE SYSTEMS S.A.

www.gtss.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; Business; Transport; Sustainability	**Engineering**; Design; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; **Infrastructure**; Security; Safety; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

Created in 1998, GT Satellite Systems S.A. (GTSS) provides fixed satellite services as well as media and direct-to-home services. It is part of a group encompassing two main subsidiaries, GT Satellite Systems S.A. (GTSS) and "GeoTelecommunications", LLC (GT). Its core markets are located in Russia and in the CIS. In addition to the Fixed Satellite Services, the group started Media activities in 2006.

LUXIEL TECHNOLOGIES

www.luxiel.eu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; Mechanical; Hydraulic; Biological; Structural; **Informatics**; Robotics; **Geographical**; **Business**; Transport; Sustainability	**Engineering**; Design; Testing; Management; Processing; Maintenance; Manufacturing; Documentation	Parts; Equipment; Materials; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; **Software**; Propulsion; Quality; **Data**; Interface; Debris; Vehicle; Passengers

LUXIEL Technologies Space Division helps Luxembourg's players of the space sector to fulfill their mission in the context of international cooperation. Its engineers contribute to the diversification and sustainability of economic activities in Luxembourg by a proactive approach which consists in consolidating and developing existing skills in the field of media and electronic communication services. With its support services, LUXIEL Technologies is helping to strengthen the competitive position of businesses and public research organizations in the space sector.

MOOG

www.moog.lu

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; **Hydraulic**; Biological; **Structural**; Informatics; Robotics; Geographical; Business; Transport; Sustainability	**Engineering**; **Design**; Testing; **Management**; Processing; Maintenance; **Manufacturing**; Documentation	**Parts**; **Equipment**; **Materials**; **Communication**; Tools; Guidelines; Procedures; Requirements; Infrastructure; Security; Safety; Risk; Software; **Propulsion**; Quality; Data; Interface; Debris; **Vehicle**; Passengers

Moog supplies critical components, subsystems and systems to the launch vehicle and spacecraft markets. Their products position commercial and military satellites, position antennas, control propellant flow to and supply rocket engines, provide structures and vibration isolation, conduct communication on spacecraft through our avionics, and steer launch and space vehicles.

Moog Inc. is a worldwide manufacturer of precision control components and systems. Moog's high-performance actuation products control commercial and military aircraft, satellites and space vehicles, launch vehicles, missiles and automated industrial machinery.

PLANETARY RESOURCES

www.planetaryresources.com

TOPICS	DISCIPLINES	SUBJECTS
Electrical; **Mechanical**; Hydraulic; Biological; Structural; **Informatics**; **Robotics**; **Geographical**; Business; Transport; Sustainability	**Engineering**; **Design**; Testing; **Management**; Processing; Maintenance; Manufacturing; Documentation	**Parts**; **Equipment**; **Materials**; Communication; Tools; Guidelines; **Procedures**; Requirements; Infrastructure; Security; **Safety**; **Risk**; **Software**; **Propulsion**; Quality; Data; Interface; Debris; **Vehicle**; Passengers

Planetary Resources is an American company created in November 2010. It develops a new generation of spacecraft dedicated to asteroid mining. From design to operation, the company is building 90% of its systems entirely in house. In June 2016, the Luxembourg government and the banking institution Société Nationale de Crédit et d'Investissement (SNCI) have signed a Memorandum of Understanding to consider a direct capital investment in a future new office of the company that will be based in Luxembourg. Planetary Resources Luxembourg plans to conduct key research and development activities.

7 POTENTIAL INTERESTS IN STANDARDIZATION FOR NATIONAL STAKEHOLDERS

There are a number of reasons for participating in standardization and it has many advantages with the potential to gain an edge over the competition both nationally and internationally. For many activities in the space sector, especially those related to operation, standards and specifications are crucial.

The below list summarizes main categories of potential interest for national stakeholders involved in or with the intention to be involved in the space sector:

1 INFORMATION

Thanks to the participation in a standardization technical committee, the stakeholders are informed about the last standardization developments relating to their activities, thus allowing them to identify potential future impacts and to anticipate the consequences.

2 PERFORMANCE AND COMPETITIVENESS

Through participation in standardization activities within a technical committee, stakeholders contribute to the increase of their performance in particular: Development of new competencies due to contact with other professionals and experts of the sector (networking); Information on the directions taken by other states or other entities (benchmarking); Translation of the innovations into future rules (knowledge codification); Anticipation of the obligation to comply with European regulatory requirements.

3 ASSURANCE

By applying standards, a company can raise its credibility among clients and partners. In a high-stakes industry like the space sector this factor plays an even more crucial role when doing business. In this industry failure is not an option and by applying standards the risks are also minimized. If a failure should happen, implementing all state-of-the-art standards can justify choices and help mitigate liability in the event of a legal process or trial.

4 SERVICES

The follow-up of standards developments offers in some cases the opportunity for stakeholders to develop new services in line with their activities.

5 PROJECTS

Research projects directly linked to standardization or involving standards in order to codify the acquired knowledge are regularly launched. Stakeholders can access useful information in the framework of a future call for tenders and benefit from specific support to get involved in projects.

6 TRAINING

Thanks to the knowledge of standards and processes, stakeholders have solid and reliable supporting information to update, improve or develop training in the space sector.

7 INVESTMENTS

Stakeholders could have an interest in investing in a new technology or concept. Standardization collaboration can be a trend indicator of ongoing technology development and draw a picture of established consensus in the industry. Such information may be valuable when defining strategy and making management choices.

8 IMPACT

Technology companies strongly involved in standardization can influence the standards development in the favor of their business strategy, products or services.

Looking at the national stakeholders and groups identified in Chapter 6, a general classification of their potential interests can be done:

- **Public institutions** [1] (e.g.: Luxinnovation GIE, Ministry);
- **Public research organizations** [1, 4, 5, 8] (e.g.: LIST, University of Luxembourg);
- **Associations & Groups** [1] (e.g.: Luxembourg Space cluster, GLAE);
- **Private companies** [1, 2, 3, 4, 5, 6, 7, 8].

Public Institutions and **Association & Groups** may be interested in following all space standardization activity for **information** purposes. Maintaining a good level of information on all the segments characterizing the space sector is of interest to ease following the state of the art.

Public Research Organizations and the University should share the same interests. They should have an obvious interest in following all the segments in order to collect general **information**. Research activities, in order to be efficient, have to go with knowledge watch in order to remain as close as possible to state of the art research. Following the standardization activities of the space segments could also constitute an interest for them in terms of **projects** as, by following relevant technical committees, it could lead to collaboration or partnerships, for example. In line with the aspects of networking and partnership through projects, it could also constitute an interest for them in terms of developing new **services**. In terms of **impact**, they could also be interested in implementing some research results into standards and thus valorize their research work internationally.

Private companies should have interest in following all the space standardization work within their work activity. The collection of **information** in general, as well as the development of new **projects**, should constitute a main issue for them.

According to the current activities of the private companies present in Luxembourg, it could be of particular interest for them to follow the Telecommunications & Broadcasting and Space related technologies sectors in terms of **performance** and **services**. This could allow them to improve their networking through collaborations and also to improve the quality of the services already implemented or maybe to develop new services. The same observation could be done in terms of **investment**, as private companies could potentially be interested in investing in any promising sectors. Participating in standardization activities in selected technical committees could allow for the identification of these opportunities.

8 OPPORTUNITIES FOR THE NATIONAL MARKET

The main aim of this analysis is to increase the participation of the national stakeholders in the standardization activities. Previous steps of the standards analysis have permitted the identification and selection of standardization technical committees and, through a link with the different stakeholder categories involved in the space sector in Luxembourg, to point out potential interests for the national players to follow standardization activities. Then, thanks to the potential interests identified for each stakeholder category, opportunities for the national market dedicated to the space sector can be identified and recommended in this report. Indeed, based on common interests shared between different categories of stakeholders, opportunities for future developments in order to give an answer to these identified needs can be proposed.

Of course, the opportunities that are listed below are only proposals. They would be therefore discussed and validated with the national stakeholders of the space sector.

CREATING A NATIONAL FORUM DEDICATED TO STANDARDS DEVELOPMENTS

Based on the common interest identified for all the stakeholder categories in terms of need of information, the creation of a national platform dedicated to the space sector could be an interesting initiative. This "Space Standardization Forum", conducted by ILNAS, could be the place for the respective stakeholders to collect, share, and exchange information and knowledge related to the space sector in terms of standards development.

It could be an interesting opportunity to create a group encompassing members that would like to follow in more detail information related to the standardization work realized in the space sector. ILNAS, helped by ANEC GIE, would conduct this forum and when possible would transmit pertinent and useful information to the members.

This platform could share some activities with the Luxembourg Space Cluster, a national initiative already in place to facilitate the exchange between players acting in the Space sector.

SUPPORTING NATIONAL DELEGATES INVOLVED IN STANDARDIZATION

In being the Luxembourg's national standards body, one of the missions of ILNAS is to provide support for national delegates and to coordinate the activities of the different committees at the national level. These duties are of primary importance and well stated in the national standardization strategy[52] through the following objectives:

- Support and constant development of the standardization field dedicated to Information and Communication Technologies (pillar 1).
- Support in terms of implementation of current products and services in the field of standardization (pillar 3).

Thus, a result expected from this standards analysis focusing on the space sector is to raise awareness and increase the participation of the Luxembourg stakeholders in standardization technical committees, either at a European or an international level.

[52] https://portail-qualite.public.lu/fr/publications/normes-normalisation/orientations-strategiques/strategie-normative-2014-2020

PROVIDING SERVICES IN RELATION TO STANDARDS EVOLUTIONS

Services in relation to standards and their development could be proposed to the space sector. It could be, for example, a standards' watch focusing on a specific segment or a thematic search associating regulatory requirements and standardization duties.

The identification of services to be developed that potentially answer to the expectations of the national stakeholders of the sector would be realized according to the comments received after the release of this standards analysis report.

FOLLOWING RESEARCH PROJECTS INVOLVING STANDARDIZATION

It might be extremely worthwhile for researchers carrying out projects to participate in standardization work. It would help researchers in preparation and project activities, in the codification of the state of the art. Taking into account standards when conducting projects ensures the compliance of the project results with regulatory requirements, and it can also enhance the interoperability, comparability, and compatibility of the project results with what already exists.

STRENGTHEN THE IMAGE OF LUXEMBOURG IN THE STANDARDIZATION LANDSCAPE

Through an enhancement of the participation in the standardization work and the implementation of the opportunities listed above, Luxembourg should strengthen its presence in the standardization field and significantly improve its image at the European and international levels.

To summarize, opportunities identified for the national market related to the standardization activities of the space sector are illustrated in Figure 6.

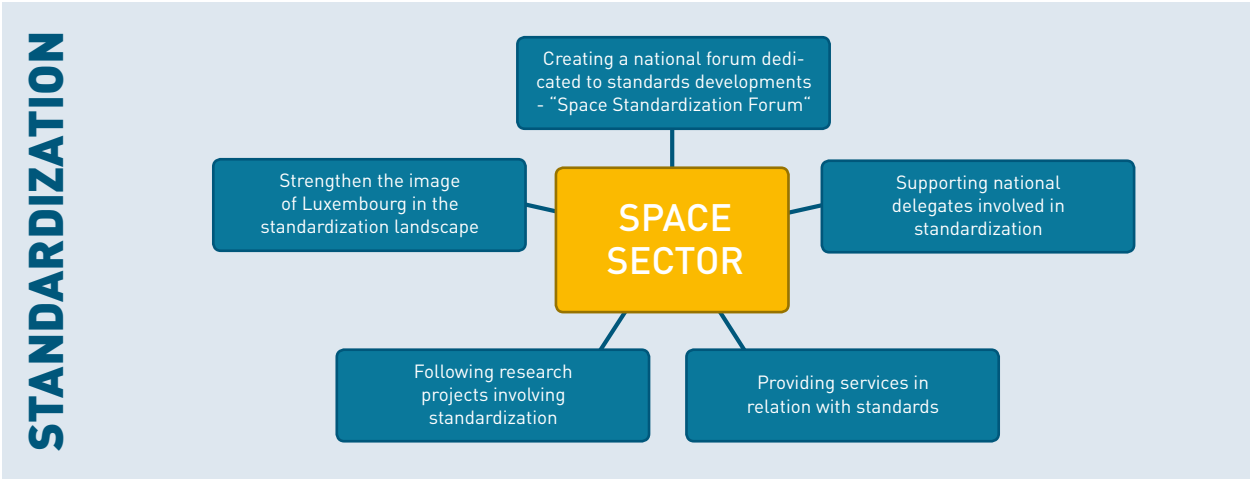

Figure 6: Opportunities for the national market

As long as the stakeholders of the sector wish to seize these opportunities, ILNAS, supported by ANEC GIE, will provide support and contribution actively.

In being Luxembourg's national standards body, ILNAS offers the possibilities to national stakeholders to follow specific standardization works of technical committees, either at the European or international level. ILNAS supports interested persons in their participation in standardization activities through appropriate information and training. Therefore, resources from ILNAS and ANEC GIE are specifically dedicated to these aspects and are able to efficiently support and inform the future national delegates.

9 CONCLUSION

The space sector is largely recognized as a key strategic sector. The last decade has seen an increase in the number of public and private stakeholders involved in space activities especially, in the space services domain. Identified as a priority area in the Europe 2020 strategy, a European space policy is under continued development. At the time of writing the European Commission is working on a new space strategy for Europe to be presented in 2016 and providing a strategic vision up to 2030. This policy, as the previous, is expected to propose actions to support research and innovation, to ensure the EU's independence in space, to make finance and investment more readily available, and to reshape the EU's legislative framework to make it a driver for the industry's competitiveness. This is in a response to the change in the global space industry with new market opportunities and heavier use of information and communications technologies (ICT).

At a national level, the space sector is also seen as a driven sector for the national economy and a motor for the development of innovation. The government of Luxembourg implemented a national action plan concerning space technologies to develop innovative applications, products and services with high added value. With the current government, the Luxembourg space activities have been attached to the Ministry of Economy, showing an intention to support and build business and value for and from the space sector. This is further underlined by the new ministerial level involvement in exploration and use of space resources in the frame of the newly set up Luxembourg Space Resources initiative[53].

However, if a strong support is provided at national, European and international level to the space sector, a main key to success is still based on the implementation of an efficient cooperation and partnership between the different stakeholders, private or public, involved in the development of space innovations. In this context, it is important for space industries, national governments, users or suppliers to support and to adopt the use of standards in order to facilitate this international collaboration through the integration of products and services in a reliable and cost-effective manner.

Based on these issues, standardization activities constitute a key element to strengthen the European and national space sector strategy. In addition, standardization will be a required element in European and International policies and legislation, such as for space debris, planetary protection, militarization of space, security, crisis management, environment, climate, etc.

This standards analysis realized by ILNAS with the support of ANEC GIE, has as main objectives to, primarily, inform the national stakeholders of the space sector of the standards developments and, secondly, to raise their awareness of the potential benefits that they could obtain in following and participating in standardization.

However, more than a simple presentation of a standardization panorama of the space sector, this standards analysis should be seen as a starting point for further discussions and involvement. As stated, the main aim of this analysis is to raise awareness of the national stakeholders of the space related issues for participating in standardization and to perceive this matter as interesting and efficient economic leverage. As participation in standardization is a voluntary process, a clear understanding of these concerns by the national stakeholders is of primary importance in order to master the challenges linked to standardization in the space sector and to initiate the process of participation and collaboration.

[53] http://www.spaceresources.public.lu/en/press-corner/press/en_Press-release-03_02_2016.pdf

10 APPENDIX

10.1 ACRONYM LIST

ACRONYM	TITLE
AMES	Advanced materials technologies department
ANEC	*Agence pour la Normalisation et l'Économie de la Connaissance*
ARTES	TIA Advanced Research in Telecommunications Systems
BT	Technical Board
BSSC	Board for Software Standardisation and Control
CCSDS	Consultative Committee for Space Data Systems
CEN	European Committee for Standardization
CENELEC (or CLC)	European Committee for Electrotechnical Standardization
CORBA	Common Object Request Broker Architecture
CTB	Components Technology Board
EC	European Commission
ECSS	European Cooperation for Space Standardization
EFTA	European Free Trade Association
EGNOS	European Geostationary Navigation Overlay Service
EO	Earth Observation
EPPL	European Preferred Parts List
ESA	European Space Agency
ESCC	European Space Components Coordination
ESCIES	European Space Components Information Exchange System
ESSB	ESA Standardization Steering Board
ETSI	European Telecommunications Standards Institute
EU	European Union
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
FEDIL	Luxembourg Federation of Employers
FP7	Seventh Framework Programme
GLAE	*Groupement luxembourgeois de l'aéronautique et de l'espace*
GNSS	Global Navigation Satellite Systems
ICT	Information and Communications Technology

ACRONYM	TITLE
IEC	International Electrotechnical Commission
ILNAS	*Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services*
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JTC	Joint Technical Committee
JWG	Joint Working Group
MT	Maintenance Team
NAS	National Aerospace Standards
NATO	North Atlantic Treaty Organization
OECD	Organisation for Economic Co-operation and Development
OLN	*Organisme Luxembourgeois de Normalisation*
PT	Project Team
QPL	Qualified Parts List
R&D	Research and Development
RTTE	Radio and Telecommunications Terminal Equipment
SAM	Science and materials analysis department
SB	Standards Body
SC	Subcommittee
SCAHC	Space Component Ad-Hoc Committee
SnT	Interdisciplinary Centre for Security, Reliability and Trust
SSI	Service Science & Innovation department
TC	Technical Committee
WG	Working Group

10.2 TECHNICAL COMMITTEES & STANDARDIZATION ORGANIZATIONS

Technical Committee (TC) Reference	Technical Committee (TC) Title	Creation Date	Scope	Published Standards	Standards under development	Structure
ISO/TC 20	Aircraft and space vehicles	1947	The ISO/TC 20 works on standardization of materials, components and equipment for construction and operation of aircraft and space vehicles as well as equipment used in the servicing and maintenance of these vehicles.	645	232	TC 20/SC 1 Aerospace electrical requirements TC 20/SC 4 Aerospace fastener systems TC 20/SC 6 Standard atmosphere TC 20/SC 8 Aerospace terminology TC 20/SC 9 Air cargo and ground equipment TC 20/SC 10 Aerospace fluid systems and components TC 20/SC 13 Space data and information transfer systems TC 20/SC 14 Space systems and operations TC 20/SC 16 Unmanned aircraft systems TC 20/SC 17 Airport infrastructure TC 20/SC 18 Materials
ISO/TC 20/ SC 1	Aerospace electrical requirements	1983	The ISO/TC 20/SC1 is a subcommittee of ISO/TC 20 "Aircraft and space vehicles". It is specialized on the standardization of the electrical equipment for construction and operation of aircraft and space vehicles as well as equipment used in the servicing and maintenance of these vehicles.	59	125	TC 20/SC 1/WG 1 Aerospace vehicle interconnection installation practices TC 20/SC 1/WG 3 Solid state remote power controllers - Performance requirements and Hybrid remote power controller - Performance requirements TC 20/SC 1/WG 5 Aircraft electric cables - General requirements TC 20/SC 1/WG 8 Heat shrinkable products TC 20/SC 1/WG 10 Elements of connection TC 20/SC 1/WG 13 Characteristics of aircraft electrical systems (Revision of ISO 1540) TC 20/SC 1/WG 15 LED power light
ISO/TC 184	Automation systems & integration	1983	The ISO/TC 184 has its standardization activities in the field of automation systems and their integration for design, sourcing, manufacturing and delivery, support, maintenance and disposal of products and their associated services. Areas of standardization include information systems, automation and control software and integration technologies. There will be active collaboration with the relevant technical committees responsible for areas such as machines, manufacturing resources and facilities, robotics, electrical and electronic equipment, PLC for general application, quality management, industrial safety, information technologies, multi-media capabilities, and multi-modal communication networks.	807	45	TC 184/AG Advisory group TC 184/WG 6 OGI TC 184/SC 1 Physical device control TC 184/SC 4 Industrial data TC 184/SC 5 Interoperability, integration, and architectures for enterprise systems and automation applications

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IEC/CISPR	CISPR - International special committee on radio interference	1934	The IEC/CISPR works in the standardization in the field of electromagnetic compatibility (EMC) including: 1. Protection of radio reception in the range 9 kHz to 400 GHz from interference caused by operation of electrical or electronic appliances and systems in the electromagnetic environment; 2. Measurement instrumentation, facilities, methods and statistical analysis for the measurement of disturbance; 3. Limits for radio disturbances caused by electrical or electronic appliances and systems; 4. Requirements for the immunity of electrical appliances, multimedia equipment, information technology equipment and sound and television broadcast receiving installations from interference; 5. Liaison with IEC Technical Committees that maintain basic standards that apply the prescriptions of methods of measurement of such immunity. Test levels for such immunity tests will be set by CISPR in relevant product standards; 6. The consideration jointly with other IEC and ISO committees of the emission and immunity requirements for devices and products where their standards cover EMC requirements which do not match to the respective requirements in CISPR standards; 7. Taking into account the impact of safety issues on disturbance suppression and immunity of electrical equipment.	102 (including SCs)	28 (including SCs)	**Subcommittees (SCs):** CIS/A Radio-interference measurements and statistical methods CIS/B Interference relating to industrial, scientific and medical radio-frequency apparatus, to other (heavy) industrial equipment, to overhead power lines, to high voltage equipment and to electric traction CIS/D Electromagnetic disturbances related to electric/ electronic equipment on vehicles and internal combustion engine powered devices CIS/F Interference relating to household appliances tools, lighting equipment and similar apparatus CIS/H Limits for the protection of radio services CIS/I Electromagnetic compatibility of information technology equipment, multimedia equipment and receivers CIS/S Steering Committee of CISPR

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IEC/TC 100	Audio, video and multimedia systems and equipment	1995	The IEC/TC 100 is active in preparing international publications in the field of audio, video and multimedia systems and equipment. These publications mainly include specification of the performance, methods of measurement for consumer and professional equipment and their application in systems and its interoperability with other systems or equipment. Note: Multimedia is the integration of any form of audio, video, graphics, data and telecommunication and integration includes the production, storage, processing, transmission, display and reproduction of such information.	449	70	- 13 Technical Areas (TA) TC 100/TA 1 Terminals for audio, video and data services and contents TC 100/TA 2 Colour measurement and management TC 100/TA 4 Digital system interfaces and protocols TC 100/TA 5 Cable networks for television signals, sound signals and interactive services TC 100/TA 6 Storage media, storage data structures, storage systems and equipment TC 100/TA 8 Multimedia home systems and applications for end-user network TC 100/TA 10 Multimedia e-publishing and e-book technologies TC 100/TA 11 Quality for audio, video and multimedia systems TC 100/TA 12 AV energy efficiency and smart grid applications TC 100/TA 13 Environment for AV and multimedia equipment (tentative title TC 100/TA 14 Interfaces and methods of measurement for personal computing equipment TC 100/TA 15 Wireless Power Transfer TC 100/TA 16 Active Assisted Living (AAL), accessibility and user interfaces - 1 Working Group (WG) - 17 Project Teams (PT) - 19 Maintenance teams (MT)
IEC/TC 103	Transmitting equipment for radiocommunication	1996	The scope of the IEC/TC 103 is the standardization of transmitting equipment for radio communications purposes and electronic devices employing similar techniques. The standardization work deals with methods of measurement, safety requirements and transmitter control and interconnection.	33	3	Working Groups: TC 103/WG 3 Methods of measurement and TV transmitters WG 6 Radio on fibre transmitter Maintenance Teams: TC 103/MT 60215 Safety requirements for radio transmitting equipment

Technical Committee (TC) Reference	Technical Committee (TC) Title	Creation Date	Scope	Published Standards	Standards under development	Structure
IEC/TC 108	Safety of electronic equipment within the field of audio/ video, information technology and communication technology	2001	Standardization activities of the IEC/TC 108 is in the field of safety for audio/video and similar technology, information technology and communication technology equipment. Additionally, it prepares requirements for methods of measurement of energy efficiency of information technology and communication technology equipment (consideration of energy efficiency includes power conservation). Horizontal safety function: Methods of measuring touch current and protective conductor current (IEC 60990). This includes, for various types of equipment, methods of measurement of touch current with regard to physiological effects and of protective conductor current for installation purposes. The methods of measurement consider both normal conditions and certain fault conditions. Safety of equipment electrically connected to a telecommunication network (IEC 62151). Group safety function: Audio, video and similar electronic equipment.	28	4	Working Groups: TC 108/WG 5 Maintenance and proposals for IEC 60990 TC 108/WG 11 Particular safety requirements for equipment to be connected to paired conductor information and communication technology networks TC 108/WG HBSDT Hazard based standard development team for IEC 62368-1 and IEC 62368-2 TR **Project Teams:** TC 108/PT 63007 Safety of Modular Data Centres (MDC) **Maintenance Teams:** TC 108/MT 1 Maintenance of IEC 60065 and IEC 62441 TS TC 108/MT 2 Maintenance of IEC 60950-1, IEC 60950-21, IEC 60950-22, IEC 60950-23, IEC 62102 TR and IEC 62151 and IEC 62367 TS
ISO/IEC JTC 1/SC 2	Coded character sets	1987	The subcommittee SC2 of the ISO/IEC JTC1 focuses its standardization activities on graphic character sets and their characteristics, including string ordering, associated control functions, their coded representation for information interchange and code, extension techniques. This scope excludes the audio and picture coding.	54	3	JTC 1/SC 2/WG 2 Universal coded character set
ISO/IEC JTC 1/ SC 23	Digitally Recorded Media for Information Interchange and Storage	1987	The ISO/IEC JTC 1/SC 23 carries on standardization activities in the field of removable digital storage media utilizing optical, holographic and magnetic recording technologies, and flash memory technologies for digital information interchange, including: • algorithms for the lossless compression of data; • volume and file structure; • methods for determining the life expectancy of digital storage media; • methods for error monitoring of digital storage media.	142	2	None

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ISO/IEC JTC 1/ SC 24	Computer graphics, image processing and environmental data representation	1987	The ISO/IEC JTC 1/SC 24 carries standardization activities on interfaces for information technology based applications relating to computer graphics, image processing, environmental data representation, support for the augmented reality continuum (ARC) and interaction with, and visual presentation of, information. It includes the following related areas: modelling and simulation, related reference models; virtual reality with accompanying augmented reality/augmented virtuality aspects, related reference models; application program interfaces; functional specifications; representation models; interchange formats, encodings and their specifications, including metafiles; device interfaces; testing methods; registration procedures; presentation and support for creation of multimedia and hypermedia documents. It excludes from the scope: Character and image coding; coding of multimedia and hypermedia document interchange formats, JTC 1 work in user system interfaces and document presentation; ISO TC 207 work on ISO14000 environment management, ISO TC211 work on geographic information and geomatics; and software environments as described by ISO/IEC JTC 1 SC22.	80	7	JTC 1/SC 24/WG 6 Augmented reality continuum presentation and interchange JTC 1/SC 24/WG 7 Image processing and interchange JTC 1/SC 24/WG 8 Environmental representation JTC 1/SC 24/WG 9 Augmented reality continuum concepts and reference model

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ISO/IEC JTC 1/ SC 27	IT Security techniques	1989	ISO/IEC JTC 1/SC 27 is responsible for the development of standards for the protection of information and ICT. This includes generic methods, techniques and guidelines to address both security and privacy aspects, such as Security requirements capture methodology; Management of information and ICT security; in particular information security management systems, security processes, security controls and services; Cryptographic and other security mechanisms, including but not limited to mechanisms for protecting the accountability, availability, integrity and confidentiality of information; Security management support documentation including terminology, guidelines as well as procedures for the registration of security components; Security aspects of identity management, biometrics and privacy; Conformance assessment, accreditation and auditing requirements in the area of information security; Security evaluation criteria and methodology. SC 27 engages in active liaison and collaboration with appropriate bodies to ensure the proper development and application of SC 27 standards and technical reports in relevant areas.	156	63	JTC 1/SC 27/SWG-M Special Working Group on Management JTC 1/SC 27/SWG-T Transversal items JTC 1/SC 27/WG 1 Information security management systems JTC 1/SC 27/WG 2 Cryptography and security mechanisms JTC 1/SC 27/WG 3 Security evaluation, testing and specification JTC 1/SC 27/WG 4 Security controls and services JTC 1/SC 27/WG 5 Identity management and privacy technologies
ISO/IEC JTC 1/ SC 29	Coding of audio, picture, multimedia and hypermedia information	1991	The ISO/IEC JTC1/SC29 works on the standardization of coded representation of audio, picture, multimedia and hypermedia information and sets of compression and control functions for use with such information, such as: Audio information, Bi-level and Limited Bits-per-pixel Still Pictures, Digital Continuous-tone Still Pictures, Computer Graphic Images, Moving Pictures and Associated Audio, Multimedia and Hypermedia Information for Real-time Final Form Interchange, Audio Visual Interactive Script ware. It excludes from its scope the Character Coding domain.	567	115	JTC 1/SC 29/AG 1 Advisory Group on management JTC 1/SC 29/WG 1 Coding of still pictures JTC 1/SC 29/WG 11 Coding of moving pictures and audio
CEN/ SS T02	Aerospace	1997	(Disbanded)	15	0	(Disbanded)

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CLC/SR 80	Maritime navigation and radiocommunication equipment and systems	na	This TC based its standardization activities on the maritime navigation and radiocommunication equipment and systems. These activities have to take into account the European Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.	49	7	na
IEC/TC 80	Maritime navigation and radiocommunication equipment and systems	1980	To prepare standards for maritime navigation and radiocommunication equipment and systems making use of electrotechnical, electronic, electroacoustic, electro-optical and data processing techniques.	61	24	WG 6 Digital interfaces for navigational equipment within a ship WG 15 Automatic identification system (AIS) WG 16 Maritime navigation and radiocommunication equipment and systems - Bridge alert management - Operational and performance requirements, methods of testing and required test results WG 17 Common Maritime Data Structure (CMDS)
CLC/TC 107X	Process management for avionics	2011	The CLC/TC 107X works in close collaboration with the IEC/TC 107. It develops process management standards on systems, components and equipment used in the field of avionics. Avionics includes electronics used in commercial, civil and military aerospace applications. The work of TC 107X will take into account the special European needs e.g. in the field of ecological and environmental concerns such as disposal or recycling of electronic equipment, including the previous work items of BTTF 91-3 and BTTF 101-3. Furthermore, CLC/TC 107X is to ensure that the specific European requirements will adequately be reflected in IEC/TC 107.	2	0	na

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CLC/ TC 209*	Cable networks for television signals, sound signals and interactive services	1989	The scope of the CLC/TC 209 is to develop harmonised and other European standards and deliverables relating to cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television and sound signals and for processing, interfacing and transmitting all kinds of data signals for interactive services using all applicable transmission media. These signals are typically transmitted in networks by frequency-multiplexing techniques. This includes for instance: - regional and local broadband cable networks, - extended satellite and terrestrial television distribution systems, - individual satellite and terrestrial television receiving systems, - and all kinds of equipment, systems and installations used in such cable networks, distribution and receiving systems. The extent of this standardization work is from the antennas and/or special signal source inputs to the headend or other interface points to the network up to the terminal input of the customer premises equipment. The standardization work will consider coexistence with users of the RF spectrum in wired and wireless transmission systems. The standardization of any user terminals as well as of any coaxial, balanced and optical cables and accessories thereof is excluded.	44	4	TC 209/WG 01 Safety requirements TC 209/WG 02 EMC for equipment and cable networks TC 209/WG 03 Equipment for coaxial cable networks TC 209/WG 05 Equipment and systems for optical cable networks TC 209/WG 07 System performance TC 209/WG 08 Ad-hoc WG « SAT » - Satellite systems and equipment TC 209/WG CAG Chairman's advisory group
EBU/ETSI/ CENELEC JTC BROADCAST	Joint Technical Committee on Broadcast	1995	The joint ETSI/EBU/CENELEC technical committee, JTC Broadcast, is responsible for the standardization of broadcast systems for television, radio, data and other new services via satellite, cable, Satellite Master Antenna Television and terrestrial transmitters, and for the standardization of program transmission and receiving equipment.	632	8	Note: More than 95% of inputs to JTC Broadcast are standardized by ETSI, with CENELEC responsible for the standardization of radio and television receivers (TC 209 and TC 100X)

* National delegate registered for this technical committee among the Luxembourg's national standards body (ILNAS).

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ITU/ITU-R/SG 6	Broadcasting service	na	The ITU/ITU-R/SG 6 is working on radiocommunication broadcasting, including vision, sound, multimedia and data services principally intended for delivery to the general public. Broadcasting makes use of point-to-everywhere information delivery to widely available consumer receivers. When return channel capacity is required (e.g. for access control, interactivity, etc.), broadcasting typically uses an asymmetrical distribution infrastructure that allows high capacity information delivery to the public with lower capacity return link to the service provider. This includes production and distribution of programmes (vision, sound, multimedia, data, etc.) as well as contribution circuits among studios, information gathering circuits (ENG, SNG, etc.), primary distribution to delivery nodes, and secondary distribution to consumers. The Study Group, recognizing that radiocommunication broadcasting extends from the production of programmes to their delivery to the general public, as detailed above, studies those aspects related to production and radiocommunication, including the international exchange of programmes as well as the overall quality of service.	na	na	Working Party 6A (WP 6A) - Terrestrial broadcasting delivery Working Party 6B (WP 6B) - Broadcast service assembly and access Working Party 6C (WP 6C) - Programme production and quality assessment
ITU/ITU-R/WP 4B	Systems, air interfaces, performance and availability objectives for FSS, BSS and MSS, including IP-based applications and satellite news gathering (SNG)	1997	Working Party 4B carries out studies on performance, availability, air interfaces and earth-station equipment of satellite systems in the fixed-satellite service (FSS), broadcasting- satellite service (BSS) and mobile-satellite service (MSS). This group has paid particular attention to the studies of Internet Protocol (IP)-related system aspects and performance and has developed new and revised Recommendations and Reports on IP over satellite to meet the growing need for satellite links to carry IP traffic.	na	na	na

Technical Committee (TC) Reference	Technical Committee (TC) Title	Creation Date	Scope	Published Standards	Standards under development	Structure
ITU/ITU-T/ SG 13	Future networks including cloud computing, mobile and next-generation networks	na	Study Group 13 is for studies relating to the requirements, architectures, capabilities and mechanisms of future networks including studies relating to service awareness, data awareness, environmental awareness and socio-economic awareness of future networks. Responsible for studies relating to cloud computing technologies such as virtualization, resource management, reliability and security. Responsible for studies relating to network aspects of IoT and network aspects of mobile telecommunication networks, including International Mobile Telecommunications (IMT) and IMT-Advanced, wireless Internet, mobility management, mobile multimedia network functions, internetworking and enhancements to existing ITU T Recommendations on IMT. Also responsible for studies relating to NGN/IPTV enhancements, including requirements, capabilities, architectures and implementation scenarios, deployment models, and coordination across Study Groups.	88	56	SG 13/WP 1/13 NGN-e and IMT SG 13/WP 2/13 Cloud Computing and Common Capabilities SG 13/WP 3/13 SDN and Networks of Future
ITU/ITU-T/ SG 16	Multimedia	na	Responsible for studies relating to ubiquitous applications, multimedia capabilities for services and applications for existing and future networks, including NGN and beyond. This encompasses accessibility, multimedia architectures, terminals, protocols, signal processing, media coding and systems (e.g. network signal processing equipment, multipoint conference units, gateways and gatekeepers).	284	103	SG 16/WP 1/16 Multimedia systems SG 16/WP 2/16 Multimedia services and accessibility SG 16/WP 3/16 Media coding and signal processing
AIA/NAS	Aerospace Industries Association (AIA) / National Aerospace Standards Committee (NAS)	1941	The National Aerospace Standards (NAS) are produced by the Aerospace Industries Association (AIA). These standards provide engineers, designers and others working for manufacturers and suppliers of aerospace and national defense systems with information designed to ensure product quality and safety. AIA comprises leading manufacturers and suppliers of civil, military, and business aircraft, helicopters, unmanned aircraft systems, space systems, aircraft engines, missiles, materiel, and related components, equipment, services, and information technology. In addition to all types of screws, nuts, and rivets, NAS define high pressure hose, electrical connectors, splices and terminations, rod end bearings, and many other types of hardware and components.	More than 1400 active standards	na	na

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CCSDS	CCSDS - Consultative Committee for Space Data Systems Standards	1982	The Consultative Committee for Space Data Systems (CCSDS) was formed in 1982 by the major space agencies of the world to provide a forum for discussion of common problems in the development and operation of space data systems. It is currently composed of eleven member agencies, thirty observer agencies, and ninety-nine industrial associates. Since its establishment, it has been actively developing Recommendations for data- and information-systems standards to promote interoperability and cross support among cooperating space agencies, to enable multi-agency spaceflight collaboration (both planned and contingency) and new capabilities for future missions. Additionally, CCSDS standardization reduces the cost burden of spaceflight missions by allowing cost sharing between agencies and cost-effective commercialization.	53 Recom-mended Standards 28 Recom-mended Practices	7 under review	The top-level technical coordination of the overall international standardization process of the CCSDS is ensured by the CCSDS Engineering Steering Group (CESG). It also provides technical management across the 6 CCSDS Areas: • Systems Engineering Area (SEA) • Mission Operations and Information Management Services Area (MOIMS) • Cross Support Services Area (CSS) • Spacecraft Onboard Interface Services Area (SOIS) • Space Link Services Area (SLS) • Space Internetworking Services Area (SIS) Within these areas there are Working Groups (WG), Birds of a Feather (BOF), and Special Interest Groups (SIG) that collaborate.
ESCIES	European Space Components Information Exchange System (ESCIES)	na	The European Space Components Information Exchange System (ESCIES) is a repository for EEE parts information hosted by ESA, on behalf of the Space Components Steering Board, as part of the European Space Components Coordination.	43	na	- Component Standards - Component Quality Assurance: Reliability, Alerts, and Problem Notifications, Non-conformances, Lessons Learned - Component Radiation Data - Component Evaluation - Component Manufacturers and Suppliers Data - Previous Component Usage

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