From Space to Earth & back: how standards support space applications for Europe

Final report

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Rue de la Science 23 - 1040 Brussels – Belgium
Tel: +32 2 550 08 11 - Fax: +32 2 550 08 19
info@cencenelec.eu - www.cencenelec.eu

From Space to Earth & back: how standards support space applications for Europe

Context

CEN and CENELEC, together with the European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), organized the stakeholder workshop "From Space to Earth & back: how standards support space applications for Europe" with the objective of bringing the research, industry and standardization communities closer together. This one-day event discussed emerging technology in the space ecosystem, identified where research and standardization activities are required, as well as enabled discussions on innovation and industrial competitiveness.

The event was also driven by two European Regulations. The first is the European Commission Regulation (EU) No 1025/2012 on European standardization, which states (article 9) that the Commission's research facilities shall "*provide European standardisation organisations with scientific input, in their areas of expertise, to ensure that European standards take into account economic competitiveness and societal needs such as environmental sustainability and safety and security concerns*". The second is the Regulation of the European Parliament and the Council, which establishes the space programme of the Union and the European Union Agency for the Space Programme and repealing Regulations (EU) No 912/2010, (EU) No 1285/2013, (EU) No 377/2014 and Decision 541/2014/EU (COM(2018) 447 final).

Why?

Space is still seen as one of the last frontiers of humanity. And yet, far from being something remote and unattainable, space is already part of our daily life. Whether it is road navigation or geo-marketing, the use of space technology, data and services has become indispensable for all Europeans. For this reason, the EU is working on the establishment of a European Space Programme, with the ambition to boost its space leadership beyond 2020. This one-day interactive

workshop pinpointed how standardization supports the European space industry and reinforces Europe's autonomous access to space.

During the event, representatives from the space industry, technology providers, policy makers, civil society and the standardization community discussed various aspects of downstream space technology, including:

- **The Space Strategy for Europe**
- **Applications from the global navigation satellite system Galileo and EGNOS for road, rail, air and maritime transport**
- **Socio-economic benefits from Earth observation, its application for safety and security of society and its meteorological purpose**
- **Space surveillance and tracking**

By the conclusion of the workshop, the group was able to identify the areas and ways in which standards help Europe remain a global leader in space applications and methods that would increase the use of space data for the well-being of citizens.

What?

This stakeholder workshop aimed at helping CEN and CENELEC, and in particular, the CEN- CENELEC Joint Technical Committee JTC 5 'Space' to:

- **Identify** the **ambitions** and associated **challenges** of the industry
- **Identify barriers** preventing the sector to deliver its **future ambitions**
- **Establish** ways in which **standards** can **support** the **industry's ambitions and challenges**
- **Adjust** the **standardization priorities** and implementation **roadmaps**
- **Propose** new **projects** to modify the **standardization** process and tools

Who?

The workshop involved diverse stakeholders from the space industry (satellite navigation and earth observation), space research institutes and technology providers, policy makers, security representatives and standardisers.

The outputs of the workshop are therefore:

i. A publicly available report (present document) addressing the conclusions of the workshop
ii. Establish a roadmap to be implemented by relevant organisations and stakeholders (mainly the CEN-CENELEC Join Technical Committee on Space (JTC 5 – 'Space') and associated stakeholders)

Report Results

Opening remarks

Dany STURTEWAGEN, President – CENELEC

KEYNOTES

The speakers came from a variety of backgrounds, thus allowing for a diversity of approaches to the issue:

Rodolphe Munoz, Legal Officer at the European Commission's DG GROW, gave an overview on the current European space policy initiatives and on future plans.

Britta Schade, Head of Product Assurance and Safety Department at the European Space Agency (ESA) and Chair of CEN and CENELEC JTC 5 'Space', who presented the European standardization activities in relation to Space.

Pierre Lionnet, Director of Research and Studies at Eurospace, who dealt with the global trends and challenges affecting the European space industry.

Each speaker presented the ambitions, challenges and opportunities for the space industry as seen from three different perspectives: policy maker, space community and the industry.

Notes from the discussion:

Mr. Munoz gave a short introduction on the legal partnership between European Standardization Organizations and the European Commission with a focus on Mandated M/496 addressed to CEN and CENELEC requesting the developments of standards for the Space industry.

While discussing current European space policy initiatives, plans for the future, the Space European Programme, as well as the role of the European Space Agency and individual Member States, he highlighted the importance of collaboration between actors a way of realizing the joint European goals. It is crucial that the collaboration should not only remain at EU level but be further extended to international level.

Ms. Schade provided an overview of the European standardization work programme in relation to space, including dual use aspects, systems of systems, and both upstream and downstream applications.

Particular attention was given to the pillars of standardization and the benefits related to standardization activities.

The general benefits can be summarized into the following categories:

- Competitiveness
- Interoperability
- Ease of trade
- Efficiency
- Knowledge transfer

The chair of CEN-CENELEC Joint Technical Committee 5 'Space' introduced the working groups within the Technical Committee and a short overview of their scopes.

The focus was then shifted to the difference between upstream and downstream standards and what each activity entails. The market dynamics are changing with the transition from classical key players to new initiatives that have revolutionized the commercial space field. New Space is thriving and bringing new initiatives to the space environment.

She identified the main differences between new space and classic space and highlighted the importance of the involvement of small players and implementing a system that is acceptable and applicable by all (as summarized in **Figure 1**).

To summarize the presentation:

Figure 1. *Conclusions*

Mr. Lionnet discerned challenges that European space industry faces as an actor on a global market. China, as an emerging player, has changed the market dynamics, but unfortunately Europe's position is not improving. He proceeded to showcase in concrete details and made comparisons for the positioning of Europe as global player.

The comparison was done based on several variables:

- 1) Europe was put into an international 'scale' and compared to competitors for the mass of space missions launched in 2018. Europe does not progress so well in comparison to others; fourth in the list and with a tendency towards decreasing.
- 2) Europe was put into an international 'scale' and compared for the mass of spacecraft launched in 2018, in which they were also the manufacturers. In a total of 392,8 T Europe lists forth with only 59,5 T. The fact that European positioning in the global market is not improving calls for urgent alignment between European Space stakeholders and a robust unified EU space strategy.

Space is still a military driven industry. This trend is currently changing, because the world is changing rapidly towards more data driven societies. The arrivals of new players in space (e.g. Google and Amazon) has opened a path towards new developments. At the moment, telecommunication applications are the most important development in space. However, despite all the innovations and developments, New Space is still considered tricky for suppliers, because of the risk associated with the failure of most startup companies.

He concluded by sharing with the audience the key trends affecting the sector. Geostationary satellites are the recent European trend with ESA remaining the number one customer of the Space industry.

Key trends affecting the sector were summarized as follows:

- New space and the GAFA (new founding models, new markets and applications)
- Acceleration of change (faster obsolescence, short product life-cycle)
- Data driven society and economy
- Satcom shifting markets (flexibility, processing, 5G, digital divide)
  Digital transformation, AI, New manufacturing techniques, mass production
- Compactness of space systems, miniaturisation, functionalised materials, very high processing powers
- Reducing cost of access to space and developing in space transportation

The keynote speakers were invited to answer questions raised by the audience addressing the main challenges that the standardization community and space community face while working together to develop space standards.

Challenges discussed[1]:

- 80% of standards are produced for the military, therefore there is a need for a common coordination between the military and the industry.
- From the development of 'New Space' arises the problem of the involvement of new players in standardization activities considering that it takes a big effort and training to bring players on the same level.
- TV broadcasting is changing to broadband and this is changing the industry. To implement the changes easily, standards also need to be ready for the change.
- In developing standards, Europe is a step ahead of its competitors thanks to approach of involving all players into the standardization process. However, European standards should go hand-in-hand with international standards and therefore collaboration with international institutions is crucial.
- Even though cooperation agreements with Japan and China are already in place, Europe needs to work more on being open and interoperable.

DEEP DIVE 1: SPACE DATA AND SPACE SERVICES

The break-out session allowed in-depth discussions on specific topics. These sessions allowed participants the opportunity to exchange their views on the use of space data for different applications (from geo-positioning to security) and the standardization priorities for space.

This interactive deep dive session was focused on exploring the different challenges in attracting more users, efficiency and reliability of space data applications for the use of safety and security. Participants discussed various aspects of space applications, highlighted the opportunities they bring, and assessed what gaps need to be addressed at European level.

Questions of Deep Dive:

- **What are the other issues that need to be addressed to boost the European space industry's competitiveness?**
  - There's a lack of knowledge transfer and education
  - Taking ownership of the data and having a big data platform:
    - accuracy and reliability of data
    - larger horizontal integration into applicative landscape

[1] *The presentations can be found under 'Useful links and documents' following the link: https://www.cen.eu/work/Sectors/Transport/Pages/AircraftandSpacecraft.aspx*

- Keeping up with the pace of change of industries by other space agencies:
  - gap between budget available in Europe and the one available to competitors
  - innovation of best practices and standards
- Coordination between stakeholders:
  - easier procurement procedures
  - access to funding and resources
  - lack of contract regarding specific niche products and services
  - conservative behavior of space agency
- Use new technology from industry:
  - example, 3D print in asset management
  - if CubeSats are failing from multiple launchers, difficulty to identify which is which (recovery becomes impossible)
- To make existing standards more flexible/simpler for 'New Space':
  - to reuse/adopt standards developed in other sectors for mass productivity
  - find better mechanisms for SMEs to contribute
  - space standards made understandable for non-space players
  - recognition of ENs by international players, especially The Japan Aerospace Exploration Agency (JAXA) and China Academy of Space Technology (CAST)
- Military spacecraft tracking systems have rather high errors. More accurate commercial methods are available but not widely used (e.g. space situational awareness is limited):
  - How far do standards take military needs into account and thereby expand market hence competitiveness
- More medical space applications.

➤ **What are the main challenges that you face in the space sector?**

- How to access information from the satellite users:
  - massive amount of data being collected, but EU lacks a common platform for the access and use of this data
  - Workforce renewal, knowledge transfer (ECSS could be a tool for knowledge conservation)
  - Diverse data sets of tracking data from sat operators containing space situational awareness (data fusion hindered, and accuracy limited)
- New operators increasing the amount of space debris (controls and practices on how to deal with it):
  - ECSS and CubeSat standards do not work together at this stage
- Governance and legislation ensuring a global and integrated governance of the space sector:
  - fragmentation of the space sector (budget driven)
  - Growth of international competition

  - lack of public programmes that enable market development and education
- Competitiveness a fundamental requirement - not just nice to have:
  - understand different users and requirements
  - interdisciplinary communication- awareness and return of investment ROI) as performance measure
    challenges: how to involve the scattered actors of services using earth observation data (limited by available budget)
- Lack of standards to correlate diverse data sets from remote sensing sources, developments of value-added services is constrained by that:
  - how to assess navigation systems for demanding road applications (auto guidance systems for automated vehicles)
- Cybersecurity, Artificial Intelligence, access classification.

➢ **What are the three priorities for satellite data driven applications for the future in European space landscape?**

Priority 1: Data availability and data continuity
Develop solutions to increase the value of such data, interoperability, harmonized use of earth observation data to support their processing that provides a service, accuracy of data

Priority 2: Market education and development
Secure long-term public private partnership, participation of industry in the use of satellite data, integrate value chain where the service supplier is also the provider of sensors and infrastructure, open access to knowledge for SMEs

Priority 3: Disaster management and Air Traffic Management (ATM) for space.

Main challenges were identified, as follows:

- Lack of resources is a brake to the implementation of Innovation;
- Face the competition in the global market;
- Standardization is an observatory to new development (e.g. cybersecurity – need to collaborate with ENISA);
- Fragmented lack of data sets;
- Dual use of standards.

PANEL DISCUSSION ON SPACE DATA

An industry and society panel that presented major findings from the breakout sessions and compared common threads cut across multiple areas of space applications. The aim of the panel sessions at CEN-CENELEC workshops was to have a lively interactive debate and draw on the 'deep dive' discussions.

Members of Panel 1:

Juliette Marais, Researcher on Geopositioning for Land Transport Applications- IFSTTAR
Geoff Sawyer Secretary General - EARSC
Jane Ribergaard Holm, Director Business Development - GomSpace
Pierre Lionnet, Director, Research and Studies - Eurospace
Alessandra Vernile, Project Officer - Eurisy
Lucio Colaiacomo, Chief Technology Officer - European Union Satellite Centre

Topics

1. *Key trends in relation to space application and service*
2. *Main challenges for each sector*
3. *Similarity between different domains and cross sectoral collaboration*

Ms. Marais commented on digitalization trends for the Railway sector and being faced with more and more new technologies and innovations for digital applications. She introduced the use of navigation technologies, also known as Global Navigation Satellite System (GNSS).

For GNSS applications, two types of applications are used:

- Non-safety critical ones (passenger information, application for asset management)
- Application of data related to safety

The challenge for research and industry also is to prove that the data coming from satellites and used in the two categories of applications mentioned above is accurate, reliable with and does not come with a high cost. The obvious solution for the railway industry and not only is to reduce cost and increased efficiency.

Mr. Sawyer brought to attention three important trends of the workshop: **artificial intelligence, cost reduction, and digitalization.** He added that the summary of challenges is to be able to face the changes, to have the speed of adaptability, and finding agility within the whole space ecosystem.

From the New Space domain, **Ms. Ribergaard Holm** voiced concerns of her sector, in relation to the missing standards based on the CubeSat system. New Space companies have no other alternative to develop and implement their own standards. She went into detail about the importance of CubeSat standards for 'New Space' as a system to lower the costs.

As a society representative, **Ms. Vernile**, reflected on the trends presented in the conversation:

a) raised awareness of what satellite applications can do for society as the immediate task to be addressed;

b) facilitated the exchange between the local actors and service providers.

Question raised from discussion: *Does the skepticism of how to use these applications come from not seeing the whole picture clearly or thinking it's too complicated?*

The panelists acknowledged that the skepticism is related with the Return of Investment (ROI) and the fact that industry players must see a return to validate a project. In some cases, they don't see it immediately. The moderator then followed with more questions on the easing of access information and if developing dual use technology makes it more difficult to reach harmonization purposes.

The question was answered by **Mr. Colaiacomo**, who focused his attention on 'industrialized' standards meaning standards that are applied properly and are effective.

> *"The obstacle is the format of the data and in order to achieve compromise we need to develop standards that can be applied to all actors in the industry" elaborated Mr. Colaiacomo.*

The discussion continued into what extent there are cross-cutting common challenges for all of you sectors and a common solution, whether the main challenges are the same for all the sectors, even though specific domains need specific approach. Another challenge would be the crushing the general society's resistance to satellites working in harmony with other applications, as it would be a solution for some interoperability issues.

Summary of panel outcome:

- difficulty to adapt the system to new technology and data fragmentation
- make space data simpler and accessible to general public
- EU Member States should work together instead of pursuing own interests; collective spirit is missing at European level
- need more collaboration between different domains
- take CubeSat into account while developing standards

ADVICE of the PANELISTS – How to IMPROVE?

Juliette Marais: Be close to the changes of other industries. The trend in the railway sector is to digitalize and modernise. GNSS data is used in two types of applications: Non-critical to safety and application data related to safety.

Geoff Sawyer: The role of the government is crucial in providing a safe net for the European Space industry.

Pierre Lionnet: EU member states should function as one.

Jane Ribergaard Holm: Combining ECSS standard with CubeSat standards is difficult. Trying to alienate the differences between the two.

Lucio Colaiacomo: The need of standards that applied properly and being able to address data fragmentation.

Alessandra Vernile: Try to raise awareness and increase knowledge on the benefits of the data coming from satellites.

CASE STUDY: PricewaterhouseCoopers

Robin Pradal, Senior Associate, PwC Space Practice-presented the results of the study funded by the European Commission, on the politics involved in the standardization and certification processes related to the EU space sector.

The PwC study highlighted most gaps previously identified in the first half of this workshop. Solutions for the gap included an evolution scenario on how to precisely address the identified shortcomings with the highest benefit. Some of were already identified problems, however, new gaps were not addressed included: 1) for the use of GOVSATCOM, there are different certification procedures for the user-segment for each satellite operator and no standard for hybrid user-segment; 2) the development of standards for production and docking technologies could support the emergence of Internet Operating System (IOS) activities. The presentation was concluded with the positive impacts that the evolution scenarios would bring to standardization and certification activities of the European space ecosystem.

DEEP DIVE 2: STANDARDIZATION PRIORITIES FOR 'SPACE'

Identifying areas in which standards can support the industry ambitions.

- **How can standards help to realize the full potential of space data and services in the modern economy?**
  - Standardization facilitate communication and exchange of data:
    - Standardization helps to manage and reduce the complexity in harmonizing and using data
    - Standardization of Metadata allows to use/exploit the value use and governance of data, and enable common European data platform

- Standards can help organizations from the need of reinventing the wheel all the time:
  - standards are needed to define format of data, but also to define processes to be followed, in order to evaluate services and relevant hardware involved
  - standards should have a shorter time to market
  - a lower threshold in cost and time for new entrants
  - reducing the time to market of new integration applications
  - standardization is the first step towards automation
- Paving the way to new regulatory applications.
- Standards should focus on test evaluation methods.

➢ **Based on the three priorities of the future of European space that were identified during deep dive 1 what should be the priorities for future of standardization activities?**

- Meta-data standardization
- More flexible standards tailored to serve classic and new space markets
- Support for SME to participate in the standardization process (resources / founding)
- Standards should facilitate competition and opening up the space industry market, instead of sealing it of
- Cybersecurity of data, accessibility of the data, configuration of data
- Interoperability
- Finding a way to involve downstream players in preparation of standards
- EWS (Early Warning Services)
- Address the CubeSat and similar actors' difficulties
- Use a system derived of Air Traffic Management (ATM), as base for space traffic management (satellite congestion)
- International collaboration is essential
- Involve multiple domain in the development of standards.

PANEL DISCUSSION ON SPACE STANDARDIZATION[2]

The Panel discussion on space standardization brought together both the standardization community and policy makers, who then presented key findings of Deep Dive 2 and discussed the role of standardization has with policy. Key priorities for standardization for a future roadmap on 'Space Standardization' and its relationship with the European Space Agency included: space data play a decisive role in a variety of sectors where standardization is of high relevance over several sectors.

[2] Sectors referenced in discussion: transport and logistics, smart & clean mobility, cars, railways, aviation, agriculture, telecommunication, health and safety.

Members of Panel 2:

Miguel Ortiz, Researcher Geopositioning – IFSTTAR; Convenor of CEN/CENELEC/JTC5/WG1
Britta Schade, Head Product Assurance and Safety Department, ESA Chair of CEN/CENELEC/JTC5
Erwin Vermassen, Senior Manager- Standardization and Connectivity, ERTICO
Jean-Marc Payssé, Director Quality Management System, Thales Alenia Space
Hans Bracquené, Chairman, SME4SPACE
Alberto Fernandez-Wyttenbach, Market Segment Leader- Road Transportation & Automotive, European GNSS Agency

Topics

1. *Standards as a barrier to innovation*
2. *Standards fit for purpose*
3. *Solutions to fill the gaps*
4. *SMEs in the standardization process*
5. *The development timing to early or to late can be problematic*

Mr. Ortiz addressed a major controversy by clarifying that standards **should not be seen as a barrier to innovation**. Standards build methodologies of assessment in a fair way.

With regards to developing standards fit for purpose, **Ms. Schade** and **Mr. Vermassen** clarified that work still has to be done related to geo- positioning: the information coming from satellites must be accurate, addressing the issue of cybersecurity, developing better methods of navigation using information from Galileo. As an industry representative **Mr. Paysse** identified the gaps that need to be taken into account by the standardization organizations. In doing so, he highlighted the importance of digitalization and Internet of Things that need to be addressed in the nearest future. Due to the discussions, the importance of getting SMEs involved in the standardization process is still one of the major outcomes of this workshop.

Therefore **Mr. Bracquené** consolidated that finding a way to bring to the table the point of view of each SME can bring added value to the standardization process. The process of the inclusiveness should involve not only SMEs, but whoever has interest in joining standardization works. **Mr. Fernandez-Wyttenbach** responded by calling for more cross-sectoral collaboration.

One of the questions raised by the audience concerned the need of global standards and whether there is really a need for global standards in places where there is not a global space market for several specific domains. From a small European company perspective, is the global standardization really necessary? The emphasis was put on a collaboration that should not only remain at EU level but be further extended to international level.

Summary of panel outcome:

- better integrate Innovation and Standardization
- importance in continued development and maintenance of Safety and Security Standards
- need for international cooperation
- more involvement of SME in standardization
- focus on technical and standardization issues: standards must follow innovation more quickly, innovation incorporated quickly for competition reasons, need to compile data to increase reliability
- about standardization: harmonization is good. Reduce costs will continue to help, but need a more agile update of standards; collaboration within different domains is important; consensus building;
- security becomes paramount.
- threads: lack of founding, duality use of data work with the military

ADVICE of the PANELISTS – How to IMPROVE?

Miguel ORTIZ: Analyse where we are to oppose the perception that standards are a barrier to innovation.

Britta SCHADE: Standards fit for purpose. Take into consideration Space traffic management to deal with the pollution so that it leads the way to new launches.

Alberto FERNANDEZ-WYTTENBACH: Working on bringing the right people to the table.

Jean-Marc PAYSSÉ: Be very close to the market. Keep industrial partners close to the standardization process.

Hans BRACQUENÉ: Common standards to be able to test globally.

Erwin VERMASSEN: Be aware of what is going on in other communities. Discussion amongst other technical committees is necessary.

Conclusions of the workshop

These workshop discussions provided a first overview of the main needs and opportunities for standardization in the field of Space. A strong focus was put on standardization for downstream applications, i.e. applications using space data to the benefit of business and society.

As Pierre Lionnet (Eurospace) explained, "space provides global solutions for local problems". Indeed, space data from Galileo can be useful for many aspects of our life, such as mobility, health, safety, and transports and logistics.

Key words for programme:

Cybersecurity, stronger SME involvement, autonomous operations, intermodal transportation/data access and transfer, interfaces between the different subsystems... In this context, European standardization's role is to foster innovation, creates links across the space community and reduces barriers to access. Building on a long tradition of engagement with the space industry, the workshop contributed to define the next steps in space standardization, ensuring that the European space industry is successful and efficient.

Going forward, we need to develop the right standard in the right format and at the right time:

- develop the right standard: Prefer quality to quantity;
- in the right format respecting digitalisation, identify the requirements of the standards and deliver them in an appropriate format to be immediately used (first step);
- at the right time, flexibility, become quicker, but respect quality needs work (case by case decision).

Space (external):

- develop connections to the other domains and sectors and possible at international level to facilitate the standardization of interfaces in a space-friendly manner.

Key priorities for standardization for a future roadmap on 'Space Standardization'

- Gaps to be addressed by JTC 5 based on the outcome of the workshop and the PWC study.
- Earth observation gaps in terms of standardization are mainly found in the use of data by SMEs and end users a concern that arose during deep dive discussions:
  - absence of standards for processing and formatting activities;
  - lack of harmonised set of standards to be applied to widely diversified actors;
- Lack of resources by industry players, call to encourage further engagement from SMEs in the standardization process
- Data processing methods for the three domains composing Space Situational Awareness (SSA), are scattered between different stakeholders, which impedes the harmonisation of activities that require international cooperation to be fully efficient:
  - issues with SST data compatibility;
  - absence of standards for technical interface of Near-Earth Objects (NEO) capabilities;
  - absence of a common and well-defined set of SWE metrics and scales;
  - lack of "Space Traffic Management" system to regulate and standardise Low Earth Orbit (LEO) for satellite operators.

- For the use of GOVSATCOM, different certification procedures for the user-segment with each satellite operator and no standard for hybrid user-segment
  - no common certification procedure for user-segments
  - no standard for hybrid user-segment
- Reinforcement of standardization and certification practices for mega-constellations activities required to ensure a sound exploitation of space
  - absence of standardization and certifications applicable to all market players
  - lack of standards for mass-production and qualifications for COTS and processes which are considered by new entrants
- No standardization and certification framework tailored to small-satellite activities
  - absence of a universal definition of small satellites
  - low level of maturity for standardization practices applied to small-satellite integration
  - existing upstream space standards are not fully adapted to small-satellite activities
- Micro-launchers do not benefit from a mature set of standards and certifications
  - qualification of launch vehicles
  - lack of awareness and flexibility
- Digitalisation domain appear at upstream level
  - compatibility of new manufacturing technologies with existing standards
  - absence of standards for frequency use for upcoming constellation dedicated to Internet of Things
- The development of standards for production and docking technologies could support the emergence of Internet Operating System (IOS) activities
  - none of the several types of services provided by IOS are regulated or standardised
  - no standards, or certifications for docking technologies, for both client and servicing satellites
- Standardization bodies could be supported to promote user uptake
  - difficulty to reach downstream and inform on the existence of standards
  - difficulty to reach and support new entrants in their understanding and adoption of standards
  - Scarcity of experts for some of the JTC5 working groups (Future activities in space standardization)

For more information on the work of CEN-CENELEC Joint Technical Committee 5 - 'Space' , see the following brochure.

*See below for live graphic recording (see Figure. 2, 3, 4)

Figure 2. Mind Map – Space Standardization (Keynote speakers)

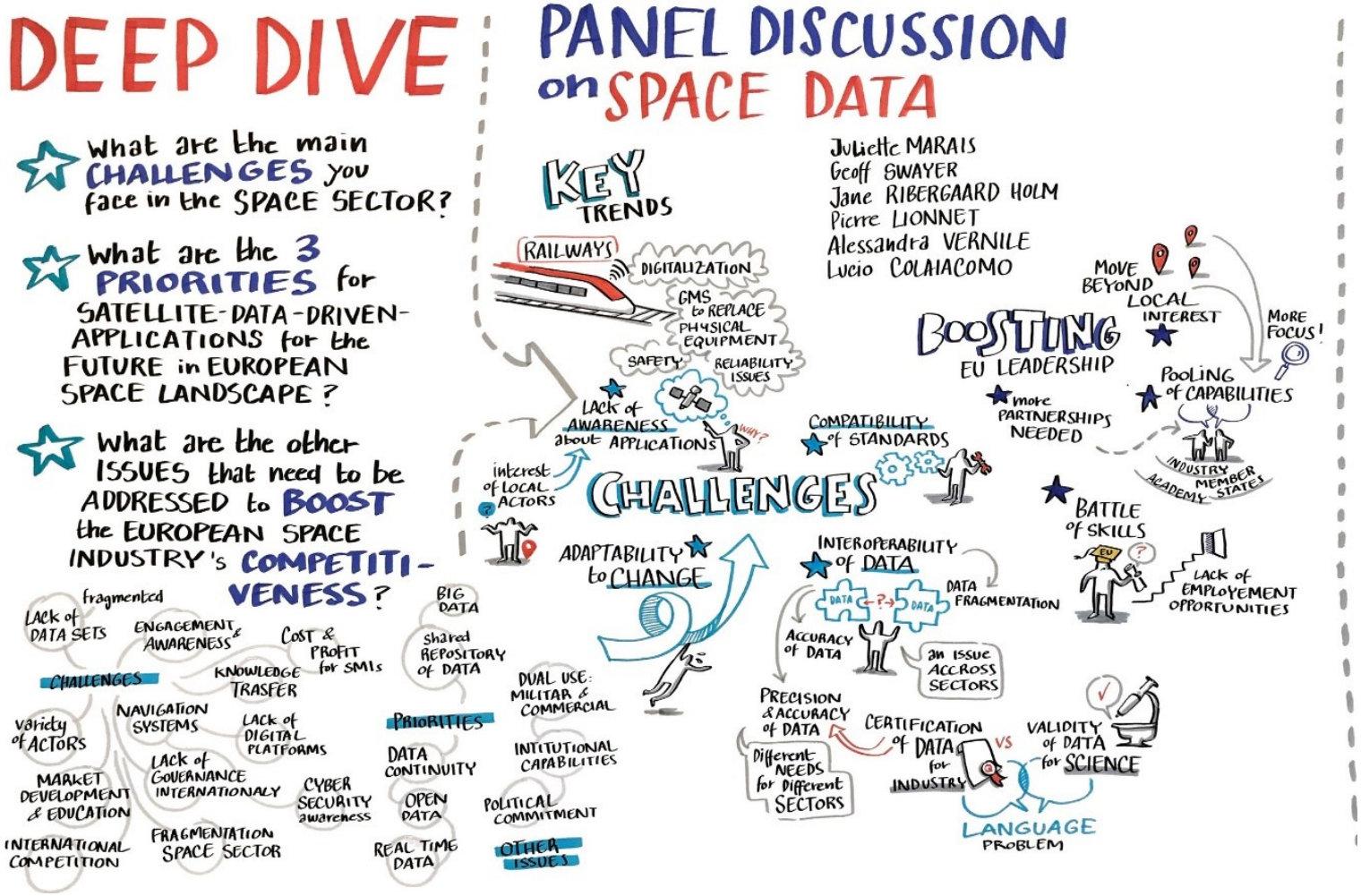

Figure 3. Mind Map – Space Standardization (Deep Dive 1/Panel Discussion)

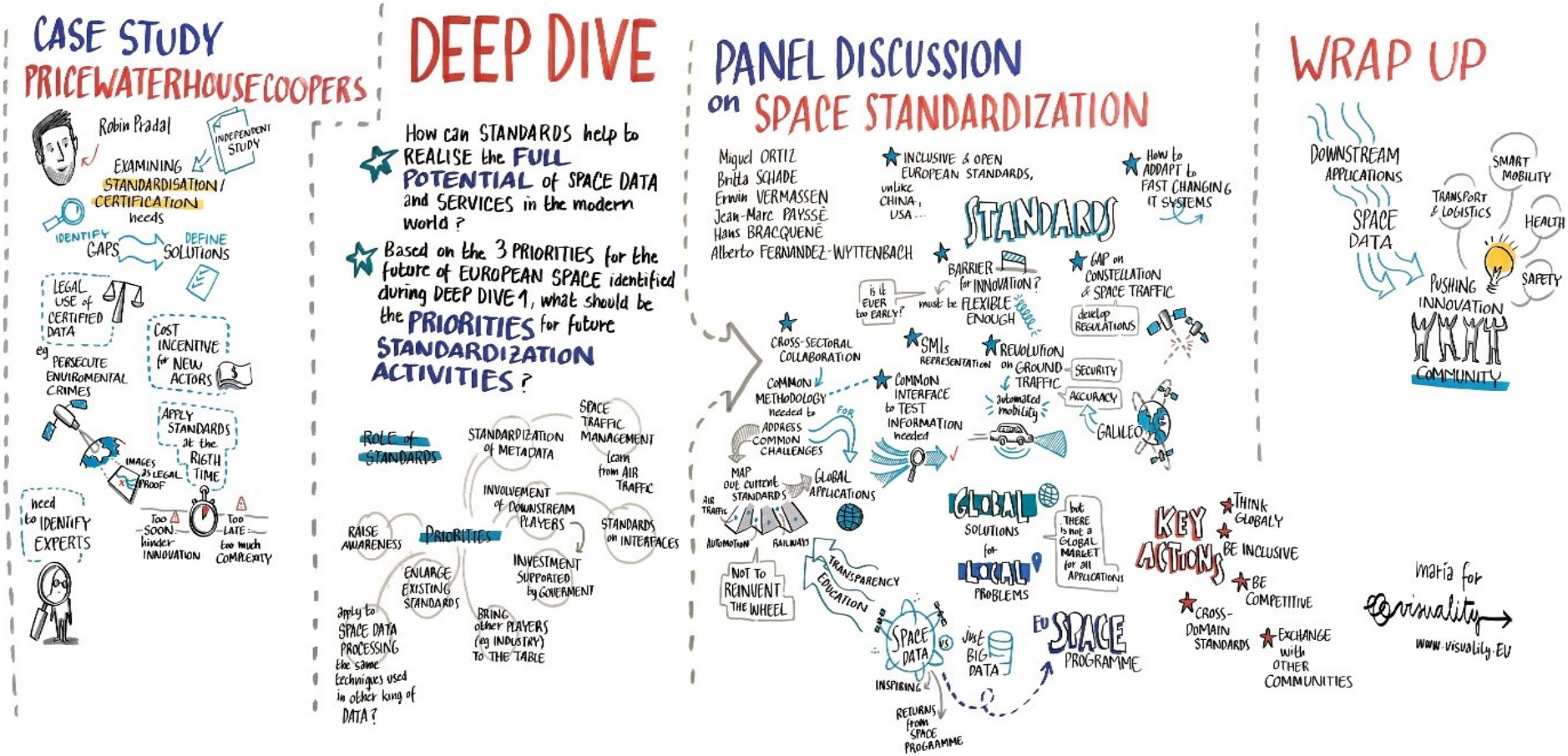

Figure 4. Mind Map – Space Standardization (Deep Dive 2/Panel Discussion)