D3.2 – GUIDANCE FOR RSU AND OBU PROCUREMENT

Vienna, 01.12.2025

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DOCUMENT HISTORY

Title: Guidance for RSU and OBU procurement

Contractual date of delivery: October 2025

Review update of delivery: December 2025

Version	Date	Description, updates, and changes	Status
0.1	01/06/2025	First draft and alignment with WP3	Draft
0.4	15/07/2025	Relevant C-Roads specifications included	Draft
0.8	15/09/2025	Survey answers from WG2 and WP3 experts included	Draft
1.0	30/09/2025	Deliverable finalised for Supporting Secretariat	Final Draft
1.1	21/11/2025	Review and comments by Urban C-ITS Group, WG2-TF3 and WG-OS included	Draft
1.2	01/12/2025	Draft for review and approval by Steering Committee	Final Draft

1. Introduction

The C-Roads Platform is a joint initiative of European Member States and road operators for testing and implementing C-ITS services in light of cross-border harmonization and interoperability. The goal is to achieve the deployment of interoperable cross-border C-ITS services for road users.

It is in the task of several C-Roads Working Groups to elaborate specifications and agreements for harmonized and interoperable infrastructure-based deployments. Building on top of these specifications and agreements, technical and organizational issues are being piloted in several pilots across Europe, where different organizational frameworks, different technical approaches, different operating environments, and different vehicle fleets test and evaluate performance and feasibility of harmonized C-ITS systems and services.

The objective of WP3 is to perform the cooperation, promotion and dissemination activities of the C-Roads platform. The activities bring together stakeholders to collaborate with the aim to build knowledge with existing and new stakeholders in the C-ITS domain and to increase visibility of the work to support the usage of the C-Roads platform publicly available solutions.

As part of WP3 this document aims to provide guidance on relevant C-Roads specifications and recommendations from C-Roads experts for the procurement of Roadside ITS Stations (short “RSU”) and Onboard Units (short “OBU”).

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2. Scope of this document

This document, titled "Guidance for RSU and OBU Procurement" serves as a valuable resource to provide advice for the procurement of RSU and OBU. Emphasis is laid on being compliant with the C-Roads specifications. It addresses cities, road authorities and planning engineers to access relevant technical and organizational information quickly, guiding them precisely to enable the tendering of interoperable C-ITS equipment.

The first part of the document (Chapter 3) gives an overview of relevant C-Roads specifications. This includes security aspects, system profiles and interface profiles. Chapter 4 contains recommendations from C-Roads experts based on their procurements and deployment activities. The recommendations are a result of a survey among C-Roads partners conducted in 2025. Please refer to Chapter 5 for further facts and figures relating to previously installed units. Chapter 6 summarizes the findings in the guidance document.

3. OBU and RSU related C-Roads specifications

The C-Roads specifications cover a common project life cycle of a system implementation. As a guide to the C-Roads Documentation, a story board based on such a project life cycle is provided in Figure 1. The relevant C-Roads specifications for RSU and OBU procurement are presented briefly in the following chapter. Those include:

- C-ITS Security Requirements and Specifications
- C-ITS Protection Profile
- C-ITS Roadside ITS-G5 System Profile
- Infrastructure Mobile ITS-G5 System Profile
- C-ITS IP Based Interface Profile

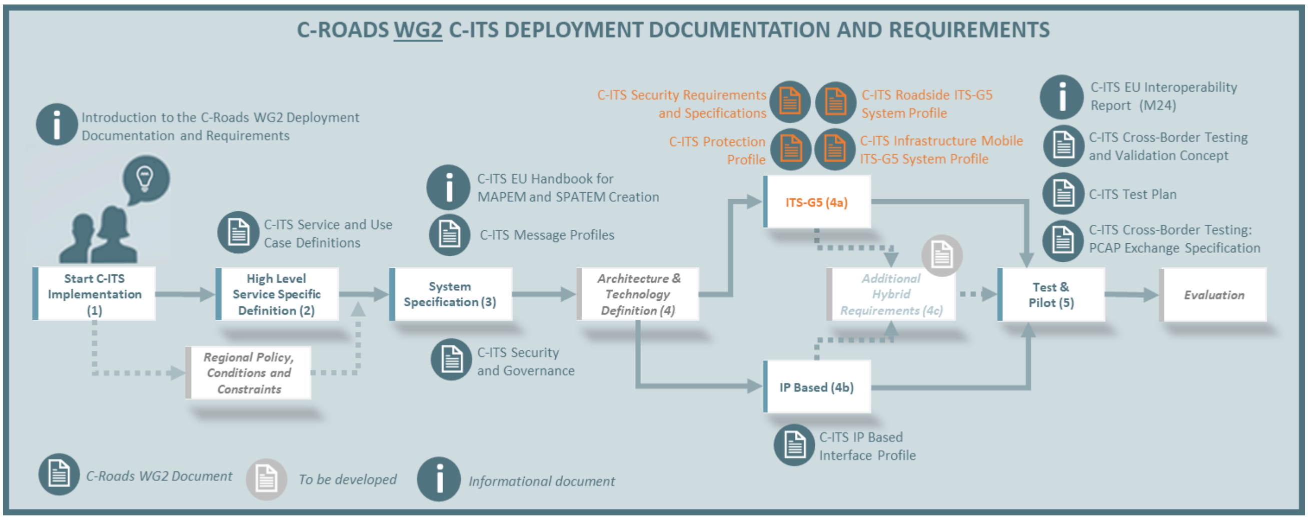

Figure 1: C-Roads WG2 C-ITS Deployment documentation and requirements

3.1 C-ITS Security Requirements and Specifications

The document "C-ITS Security Requirements & Specifications" provides the detailed specifications for the certificates that are required to sign C-ITS messages. This covers service specific permissions that are required for all C-Roads services, e.g. per service and use case. Moreover, the validation and verification of incoming messages is specified from a security perspective. That is to say, the document provides the basis for the creation of security-specific test cases in collaboration with TF5, in addition to the TF3 documents providing the basis for functional test cases.

Note: The TF1 Security and Governance document provides an overall introduction to the common European trust model and builds on the European Certificate Policy for C-ITS, and describes the common agreements that are important for C-Roads and other European C-ITS stakeholders, covering a level of developments and testing within and across different C-Roads pilots as well as the relation to the level of regular and continuous operation.

The European ITS-Station architecture, outlined in EN 302 665, defines four ITS sub-systems; vehicle, roadside, personal, and central. Standards are developed in a neutral and open way such that they include different options to allow diversion and future options to extend the standards later. To realize Interoperability among sub-systems many of these options need to be made more specific. Profiles therefore describe the selected options and include additional specification where required to ensure the expected interoperability. Herein, the roadside sub-system profile is defined.

The Infrastructure Roadside Wi-Fi ITS-G5 System Profile, short called Roadside System Profile (RSP), defines a common base for the Wi-Fi ITS-G5 communication between roadside and vehicle. The communication directions derived from this are also known as I2V.

The profile provides descriptions, definitions and rules for all layers (Applications, Facilities, Networking & Transport and Access) of the ETSI ITS station reference architecture/ITS-S host. Management is included, but Security is out of scope.

3.2 C-ITS Protection Profile

The "Protection Profile for a Roadside ITS Station Gateway" defines the Security Functional Requirements (SFRs) and the Security Assurance Requirements (SARs) for a Roadside ITS Station Gateway. The Roadside ITS Station (R-ITS-S) is an electronic device and part of an Intelligent Transport System (ITS). It exchanges ITS/C-ITS messages with other ITS/C-ITS stations in the context of Infrastructure to Vehicle (I2V) and Vehicle to Infrastructure (V2I) communication. The data exchange includes events, warnings and information related to road traffic. Communication from the Roadside ITS Station to Vehicle ITS Stations can be seen as a digital complement to physical road signs and physical light signals.

Source: Protection Profile for a Roadside ITS Station Gateway. Version 1.0. Certification-ID: BSI-CC-PP-0122

3.3 C-ITS Roadside ITS-G5 System Profile

This document is one of the documents of stage 4 in the C-Roads workflow as shown in Figure 1. This workflow reflects how information flows through the C-ITS station architecture. It starts with an application (referred to as "Service"), which is described in the stage 2 documents. In order to perform its function, the application decides to send out messages and in order to do so, it invokes a Service Access Point (SAP) of a Facility Layer Service (FLS). The term SAP is taken from the OSI reference model for the interfaces between layers, many people today would probably rather call it an API. The Facility Layer Service performs its task according to its specification and uses SAPs of underlying layers (transport, network, access) for doing so. The according specifications are not developed in C-Roads, standards are used for this instead, e. g. [ETSI TS 103 831] and [ETSI TS 103 301] for the Facility Layer services.
The present document specifies the requirements and general settings for most layers of the C-ITS system architecture in the case of a Roadside ITS-G5 System, including:

- The Access Layer
- The Network Layer
- The Transport Layer
- The Management Entity

3.4 Infrastructure Mobile ITS-G5 System Profile

This document defines the C-ITS “Infrastructure Mobile ITS-G5 System Profile”. This profile defines the requirement related to the features of a mobile C-ITS station belonging to a special organisation. This includes all ITS-G5 stations that can potentially be used as mobile stations (e.g. trailers, (aftermarket) vehicle stations).

This document describes the common requirements of all infrastructure mobile C-ITS stations to realize interoperability with other C-ITS sub-systems as defined in [ETSI EN 302 665]. The functional requirements of mobile ITS stations are out of the scope of this document.

The scope of this document excludes the potential interaction between the infrastructure mobile ITS station and the infrastructure, other than the ITS-G5 exchanges with R-ITS-S. This concerns for instance a cellular connection that may link the mobile ITS station directly to the TCC.

This profile currently (V 2.3.0) does not include the usage of C-ITS messages by trailers. The subject is still pending and might impact the present document.

4. Recommendations from C-Roads experts

As part of the Stakeholder Support and Training subtask of the C-Roads Extended Project a survey was conducted to collect experiences and best practices related to the procurement and deployment of Roadside Units (RSUs) and On-Board Units (OBUs). The objective of this activity is to support knowledge sharing among C-Roads partners and to identify common challenges, successful approaches, and lessons learned across different deployment contexts.

The survey focused on practical aspects of RSU and OBU deployment, including:

- Types of C-ITS stations and environments involved.
- Procurement practices, funding sources, and evaluation criteria.
- Deployment experiences and integration methods used.
- Challenges faced and recommendations for future procurements and for new stakeholders entering this field.

Responses were collected from a diverse group of stakeholders from seven countries (Austria, Czech Republic, France, Germany, Hungary, Italy and Portugal) including public authorities, road operators, industry partners, research organisations, and other relevant partners. Due to the diversity of the respondent group in terms of organisational roles, deployment environments and procurement experiences, the analysis does not follow a uniform perspective. A clustering approach is applied to the recommendations, grouping them according to common themes and contexts. This ensures that the findings remain relevant for stakeholders with different backgrounds and responsibilities.

The survey results show that most respondents have experience deploying both RSUs and OBUs, with 57% of participants indicating work with both types of stations (Figure 2). Meanwhile, 26% of respondents reported working exclusively with RSUs, and 17% with OBUs only. These numbers reflect the varied approaches taken across the deployment activities, depending on local priorities, available resources, and the maturity of supporting infrastructure.

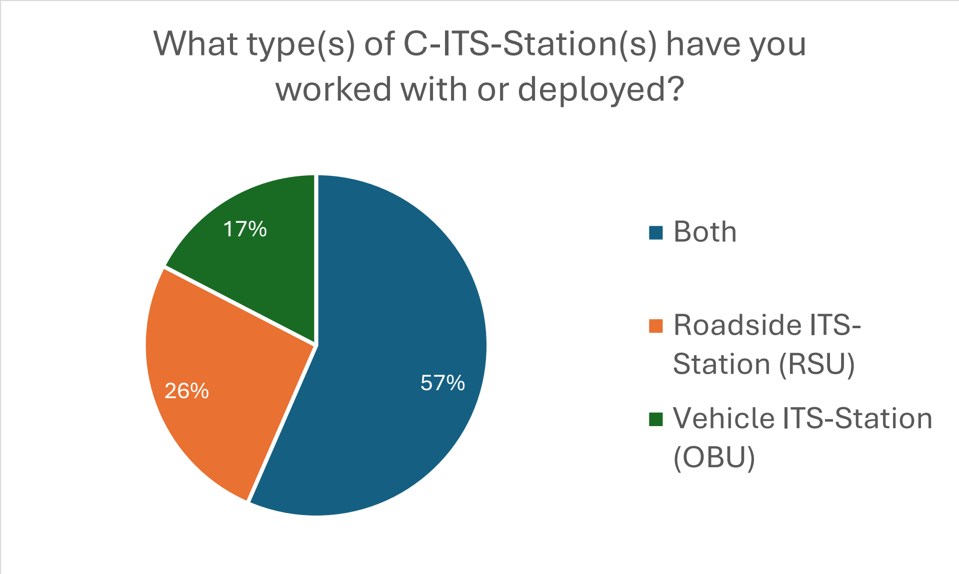

Figure 2: Deployed C-ITS-Station types

The C-ITS deployments have taken place in a variety of environments, with urban areas being the most common (Figure 3). 41% of respondents reported that they are implementing their systems in urban settings. This reflects the growing interest in city applications with a main focus on public transport integration. Motorways and highways were each cited by 18% and 19% of respondents respectively, indicating a focus on long-distance and high-speed corridors. Additionally, 18% of respondents reported deployments across all types of environments. A small percentage (4%) indicated that the question was not applicable to their context.

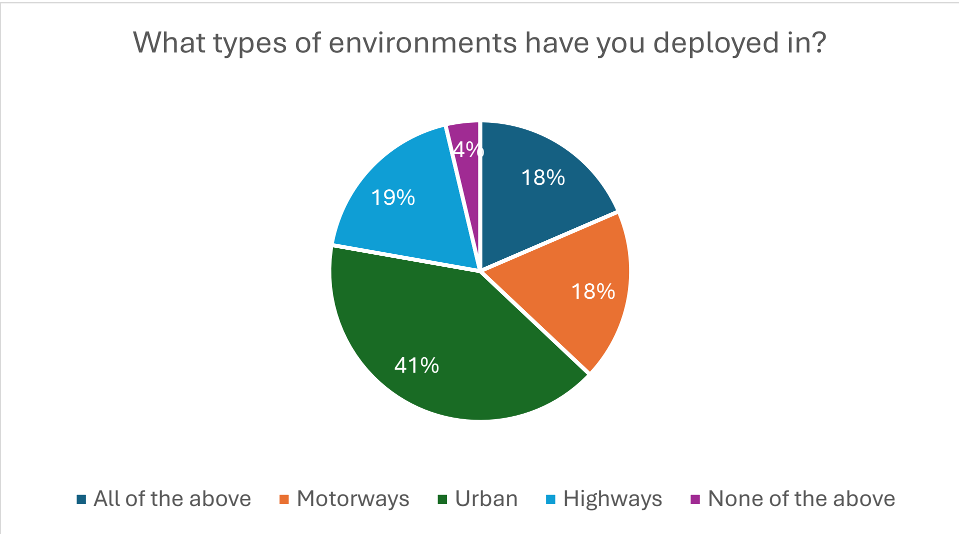

Figure 3: Deployment environment of C-ITS-Stations

4.1 Deployment experience

The survey explored the practical deployment of RSUs and OBUs across different environments and vehicle types. Respondents shared their experiences with integration methods, the scale of deployments, and the operational contexts in which C-ITS stations have been implemented. This section provides an overview of these deployment experiences, highlighting both the diversity of approaches taken and the common challenges encountered, clustered in the following topics:

- Evolving standards and requirements
- Interfaces and system compatibility
- Local and organisational issues.

Evolving standards and requirements

One of the most prominent challenges reported by respondents was the instability and immaturity of standards at the time of procurement and early deployment stages. Many deployments began as early as 2019, when key C-Roads specifications, the IP-based C-ITS interface, and the ECTL requirements were either incomplete or undergoing frequent revisions.

The lack of clarity in specifications during tendering phases created uncertainty and increased the risk of misalignment between procured equipment and future system requirements. Changes in specifications could lead to use case shifts, that result in initial procurement decisions being obsolete or inadequate. Furthermore, the high trust level requirements imposed on both RSUs and OBUs were often difficult to meet with the available commercial products, which were not yet fully adapted to urban or long-term operational contexts.

These experiences underscore the importance of designing procurement processes that are flexible and adaptive. Public entities must anticipate changes in standards and ensure that contracts allow for updates and modifications. Close collaboration with standardization bodies and participation in platforms such as C-Roads can provide valuable foresight and technical support during procurement planning. At the same time, it is precisely such practical implementations and experiences that are crucial for the continuous further development of standards and C-Roads specifications."

Interfaces and system compatibility

Technical integration emerged as another major area of concern. Respondents highlighted the complexity of interfacing RSUs and OBUs with existing infrastructure components, such as traffic light controllers, variable message signs (VMS), and vehicle systems in public transport fleets. In many cases, the lack of standardized APIs and SDKs across different brands of RSUs and OBUs led to significant delays and required custom software development.

Security concerns also played a critical role, especially at the interface between OBUs and vehicle systems. Ensuring IT security and compliance with public key infrastructure (PKI) requirements was essential but difficult to achieve with immature commercial products. In some cases, the lack of flexibility in the software stack prevented the use of non-standard message types required for specific project needs, limiting the scope of experimentation and innovation.

These findings suggest that procurement specifications include detailed interface requirements and prioritize interoperability. Vendors should be selected based on their ability to support flexible and secure integration with existing systems.

Local and organisational issues

Beyond technical and regulatory challenges, many respondents pointed to local and organisational factors that influenced the success of their deployments. A recurring theme was the lack of local expertise and knowledge about C-ITS technologies, which made it difficult for public entities to define procurement criteria and evaluate vendor proposals. In some cases, support from project consortium members was instrumental in overcoming these gaps.

The limited maturity of available products and the small size of the market further complicated procurement efforts. Hardware designed for research purposes often proved unsuitable for continuous operation, requiring frequent maintenance and lacking the robustness needed for real-world deployment. Additionally, securing internal agreements — for example, with bus operators to participate in experiments — was time-consuming and required careful negotiation.

Installation procedures were often labor-intensive and required careful planning, particularly when RSUs were used in exposed environments like motorways. Ensuring reliable power supply and connectivity was a recurring issue, and weather-related risks had to be mitigated through robust installation protocols. In public transport vehicles, installing OBUs involved complex cabling and antenna placement, which was manageable for pilot installations but posed scalability challenges for fleet-wide rollouts.

Maintenance and operational acceptance were also critical issues. Road operators needed to be convinced of the value and reliability of the deployed systems, and ongoing support had to be ensured.

Summary

To address these challenges, it is essential to invest in capacity building and stakeholder engagement. Training local teams, involving operators early in the planning process, and advocating for supportive legislation can significantly improve of the effectiveness of procurement efforts. Collaboration with experienced partners and participation in knowledge-sharing platforms can also help bridge expertise gaps and foster a more informed procurement environment.

The experiences shared by survey respondents reveal a complex scheme of technical, regulatory, and organisational challenges. However, they also point to clear strategies for improving procurement outcomes. Future procurement processes should be designed with flexibility in mind, allowing for adaptation to evolving standards and use cases. Adopting a modular contract structure that allows for updates of technical standards can be recommended. Furthermore, technical specifications must emphasize interoperability and security. The aspects of scalability and the variety of vendors should be evaluated not only on product features but also on their ability to support long-term integration and maintenance.

All relevant stakeholders should be involved in the planning and deployment of the C-ITS systems, even in early stages. By learning from past deployments and adopting a proactive and collaborative approach, future activities can avoid common mistakes and achieve more sustainable and impactful results.

4.2 Procurement aspects

The procurement of RSUs and OBUs for C-ITS deployments is a complex process that requires careful planning. While most of the past and ongoing C-ITS procurement activities benefited from national or European funding schemes, some relied on local budgets and private co-financing (Figure 4). Survey responses reveal that procurement decisions were influenced by a variety of factors, including funding availability, evaluation criteria, and the maturity of the market.

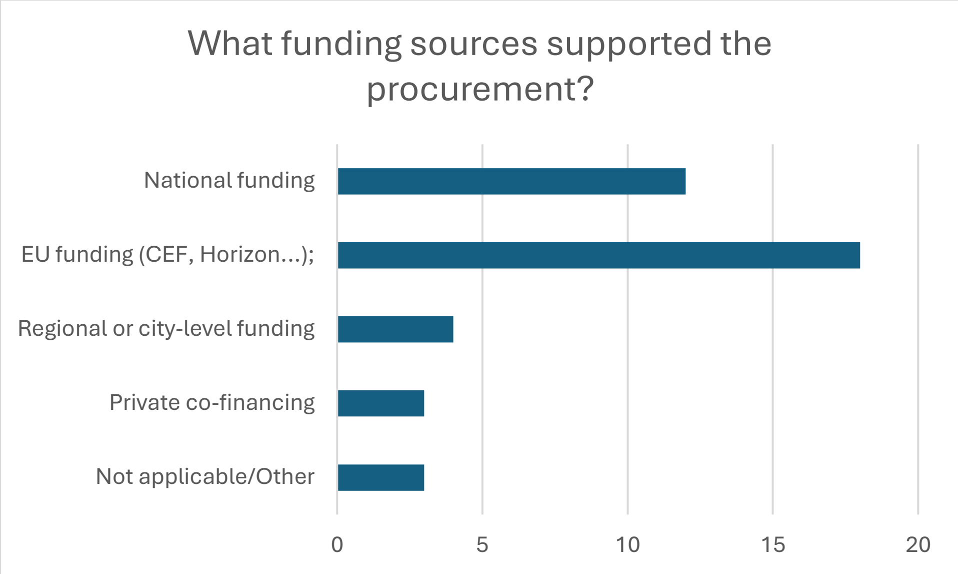

Figure 4: Procurement funding

Tender evaluation criteria varied across deployments, but common priorities included price, interoperability, cybersecurity, and support service, with interoperability being the criteria most frequently mentioned (Figure 5). However, many respondents noted that these criteria were difficult to assess due to the lack of detailed technical documentation and the immaturity of available products, especially in early procurement activities. In several cases, the hardware offered was still in a research or prototype phase, requiring excessive maintenance and lacking readiness for continuous operation.

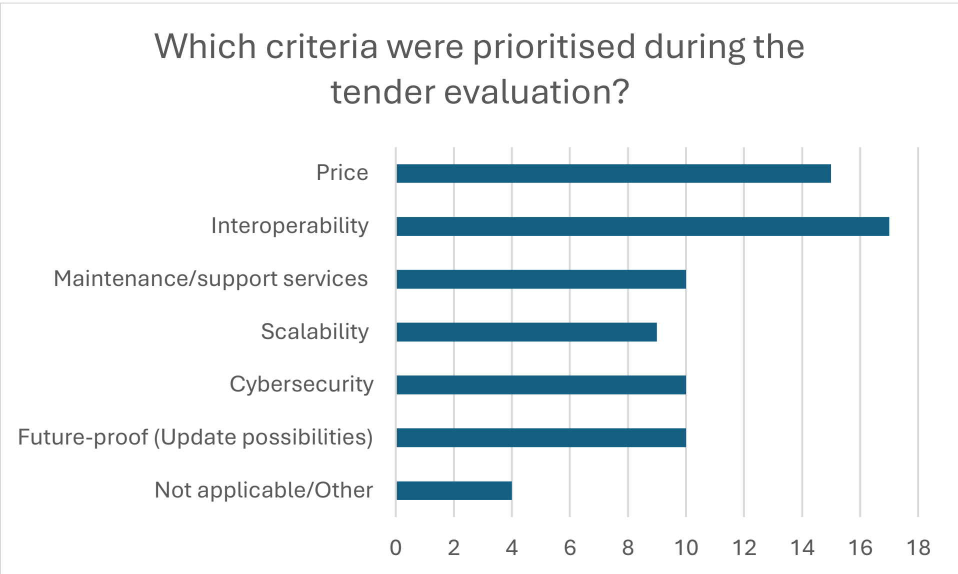

Figure 5: Prioritisation criteria during tender evaluation

One recurring recommendation was to shift from project-based procurement models to more standardized and centralized approaches. This would allow for greater consistency across deployments, better alignment with evolving standards, and improved economies of scale. Some respondents suggested that tenders should include not only the RSU and OBU hardware but also associated services such as PKI provisioning, trust list management, and monitoring of operational quality. Bundling these elements into a single procurement package could simplify integration and ensure compliance with security and trust requirements.

Another key insight was the importance of early and comprehensive technical documentation. Providing interface specifications and integration requirements at the outset of the tendering process was seen as essential, even if it delayed the start of procurement. Several respondents emphasized the need for vendors to supply prototypes for testing, along with documentation that clearly outlines compatibility with existing C-ITS infrastructure. Interoperability testing was highlighted as a critical step, particularly in environments where multiple brands and models of RSUs and OBUs are deployed. For the validation of the interoperability of C-ITS deployments, the cross-border testing and validation methodologies from the C-Roads platform (WG2-TF5) provides an extensive guideline.

Cybersecurity emerged as a central concern in procurement decisions. Respondents stressed the need for vendors to demonstrate robust security measures, both in terms of hardware and software. This includes compliance with ETSI standards (i.e. ETSI TS 103 097, ETSI EN 303 613), secure PKI integration, and protection of interfaces between OBUs and vehicle systems. This can be achieved with state-of-the-art procedures and for example be proofed by penetration tests.

Operational considerations also played a role in shaping procurement strategies. Some respondents noted the importance of involving operators and maintenance teams early in the procurement process to ensure system awareness and long-term support. Service-level agreements (SLAs) with manufacturers were recommended to guarantee maintenance and updates over the lifecycle of the deployed equipment.

4.3 Other challenges and lessons learned

Despite the numerous challenges encountered during procurement and deployment summarised in Chapter 4.1 and 4.2, the majority of respondents indicated a clear intention to operate their C-ITS implementations over the long term (Figure 6). This commitment reflects growing confidence in the strategic value of RSU and OBU infrastructure and highlights the importance of sustainable planning, robust maintenance strategies, and future-proof procurement practices to support enduring system performance. From a few large-scale operations, also the option to set up tenders including a maintenance clause for a validation and, if required, updates of the deployments for a full system compliance after a time span of X years past the initial deployment.

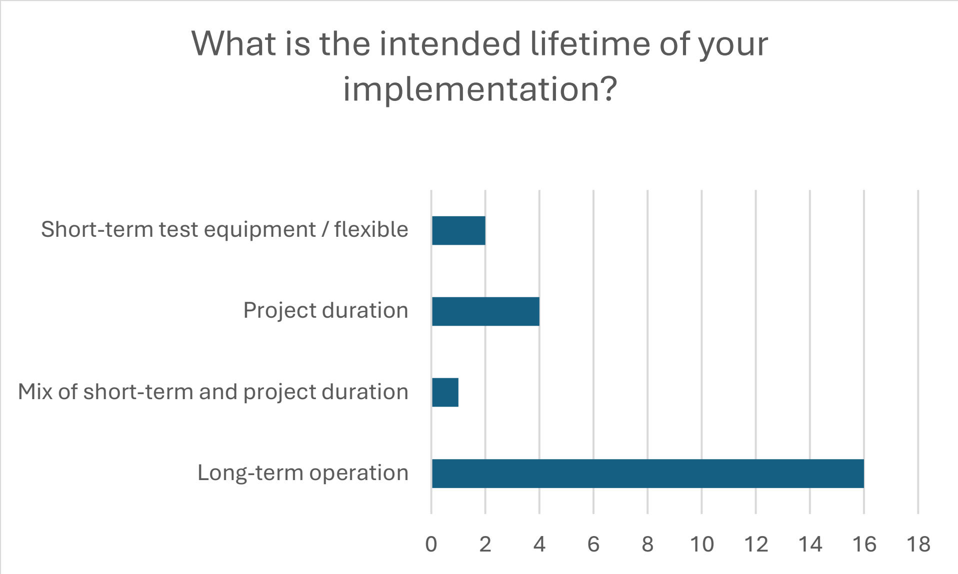

Figure 6: Implementation lifetime

As new stakeholders become increasingly involved in C-ITS projects, they can benefit greatly from the experiences of early deployments. Platforms like C-ROADS play a crucial role in facilitating this knowledge transfer, offering guidance, documentation, and peer exchange to support more informed and effective implementation strategies.

5. Facts and figures

To complement the qualitative insights and recommendations, this chapter provides a structured overview of the quantitative results from the survey. It presents the main figures regarding the number and types of C-ITS stations procured, the vehicles equipped with OBUs, and the implementation methods used in these activities.

The survey results show a diverse range of deployment scales across the respondents. For OBUs, the most commonly reported range was between 4 and 20 units, indicating that many implementations are still in a pilot or early operational phase. However, a few respondents reported significantly larger deployments, with over 100 OBUs, suggesting that some deployments have already progressed toward broader integration (Figure 7). In contrast, the number of RSUs deployed shows a more polarized distribution: both the 4–20 range and deployments exceeding 100 units were frequently reported (Figure 8). This suggests that while some are still in early stages, others have already scaled up their infrastructure significantly, reflecting differing levels of maturity, funding, and underlying strategy.

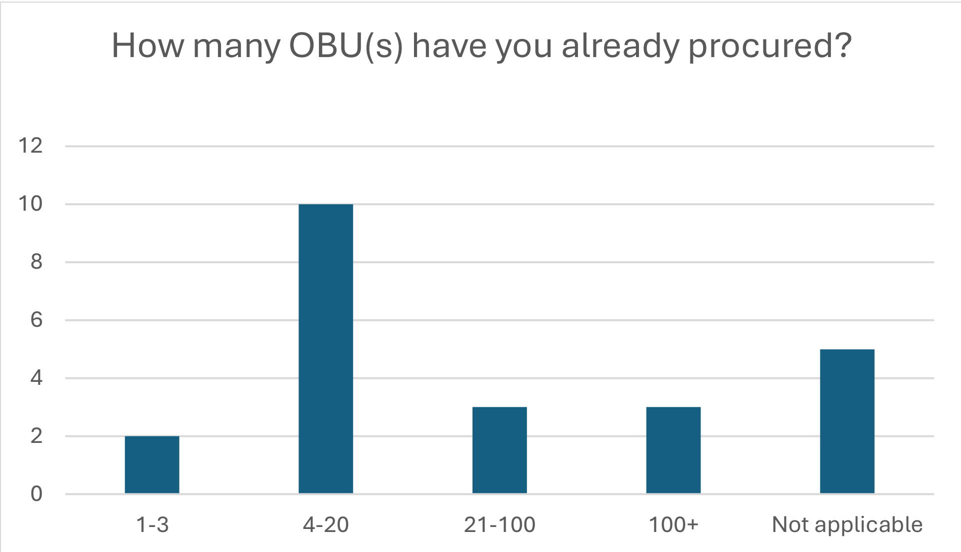

Figure 7: Number of OBUs procured

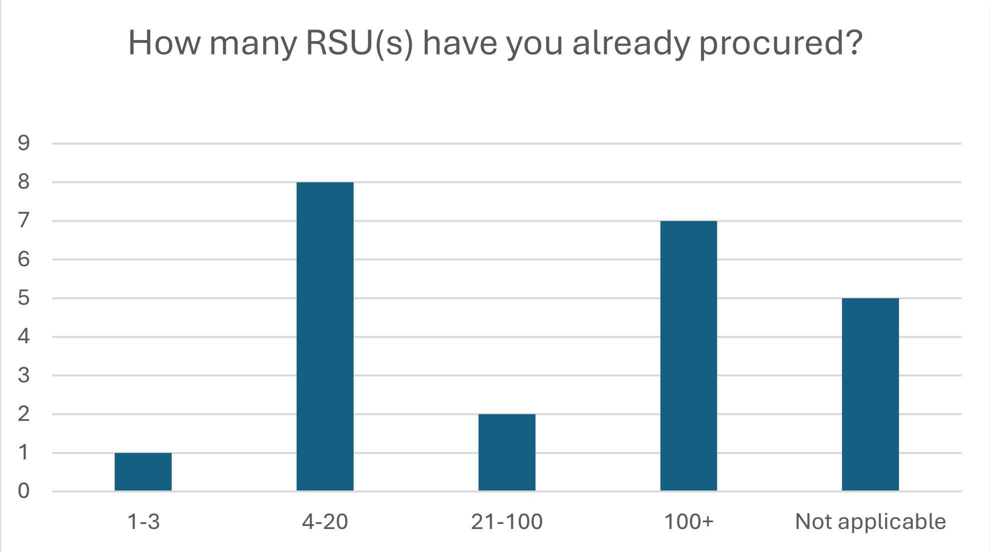

Figure 8: Number of RSUs procured

The survey also provided insights into the types of vehicles being equipped with OBUs (Figure 9). The most frequently mentioned categories were road operator vehicles and public transport fleets, each accounting for 31% of the responses. This reflects a strong focus on operational and service-oriented use cases in early deployments. Blue light vehicles, such as police or emergency services, were mentioned in 15% of the responses, while the remaining 23% referred to other vehicle types, including passenger cars and dedicated testing vehicles.

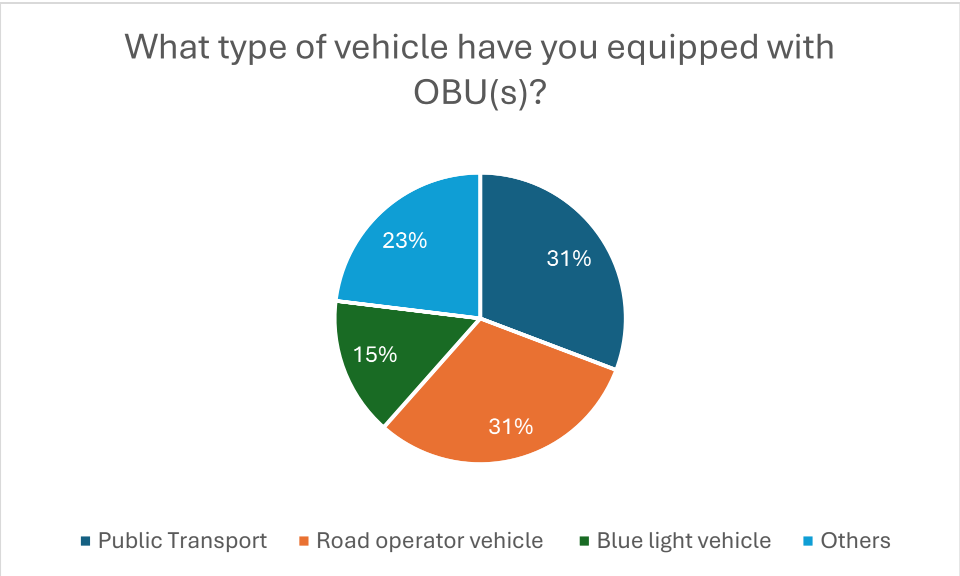

Figure 9: OBU equipped vehicles

The survey results reveal a variety of integration methods used for OBUs, reflecting both the technical maturity of available solutions and the operational constraints of different vehicle types (Figure 10). The most common approach, reported by 43% of respondents, was the use of temporary devices. While this method offers flexibility for testing and short-term deployments, it may also indicate challenges such as limited product maturity or the complexity of integrating OBUs into vehicles like public transport or emergency services. Fixed installations without a human-machine interface (HMI) were used in 29% of cases, suggesting a preference for seamless, backend integration in some contexts. Meanwhile, 28% of

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respondents opted for fixed installations with an HMI, pointing to use cases where direct interaction with the driver or operator was necessary. This distribution highlights the need for adaptable integration strategies that can accommodate both technical limitations and operational requirements.

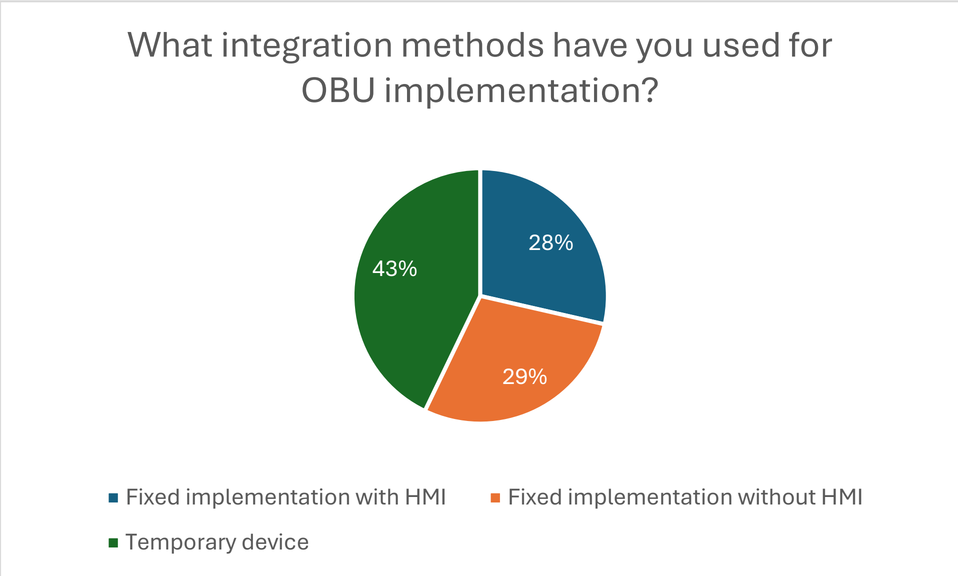

Figure 10: OBU integration methods

6. Conclusions

The deployment and procurement of C-ITS infrastructure like RSUs and OBUs is guided by a number of technical specifications, reference documents and standards. Those are continuously updated based on practical experience. The objective and scope for the procurement relevant C-Roads documents is summarized in Chapter 3. These documents form the basis of current implementation efforts and provide essential guidance for ensuring interoperability, security, and harmonisation. An alignment with these documents is therefore significant for new procurement and deployment activities.

Chapters 4 and 5 show the results of an online study among C-Roads experts and stakeholders. The survey responses reveal a wide range of integration strategies, procurement models, and operational environments, reflecting different local needs and prioritised use cases. At the same time some challenges remain common across the different deployments. The continuously evolving regulation and specifications landscape on the one hand and the need for future-proof deployments on the other can complicate the procurement process. A key conclusion from the study is the importance of collective efforts in overcoming these challenges. For new stakeholders entering the field, learning from existing deployments is essential. In this context, the C-Roads platform plays an important role as it offers structured support, shared experiences and best practices and guidance through concrete specifications. This guidance document aims to contribute to that collective knowledge base.

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