Development of an Unmanned Aerospace Test Site
U-space Sandbox

Project CACTUS

Action Plan for U-space Sandbox Implementation

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1. Introduction

ANRA Technologies, Inc. (ANRA), in partnership with the Tartu Science Park Foundation (TSP) are pleased to submit this document in support of the Development of an Unmanned Aerospace Test Site (U-space Sandbox). The project is called CACTUS, an acronym for "Competent Authority Coordinating Testing in U-space Sandbox."

This document satisfies Deliverable 2.2 (Action Plan for U-space Sandbox Implementation).

2. Background

A U-space sandbox is a testing environment, implemented in an identified operational environment which serves as a broad-based development and deployment of unmanned aviation technologies. U-space sandboxes provide the expertise and environment for carrying out research and development activities in unmanned aeronautics test centres, bringing end-users together with service providers, and for interested organisations and institutions to collaborate in bringing the technical solutions and business models of unmanned aeronautics to the market, including the appropriate and innovative infrastructure for developing innovative services and solutions.

Broadly speaking, there are two main different types of sandboxes: operational sandboxes and regulatory sandboxes.

Operational sandboxes are testing environments where hosted data can be accessed and used, while regulatory sandboxes are collaborative processes where regulators and firms evaluate new technologies within a regulatory framework. More succinctly, operational sandboxes actually handle data, and regulatory sandboxes provide dialogue and guidance on how data is handled.

The U-space sandbox implementation in the Tartu region has to take into consideration both the sides as the vision is:

- A wider test environment for climate neutral aviation technologies which offers opportunities for the development and testing of unmanned aviation and new technologies on a wider scale.

- Serve as an integration platform for U-space and validation platform for the National Aviation Authority.

The Roadmap proposed in the following sections will include:

- Vision and goals of the U-space sandbox: what are the approaches that need to be adopted and what are their implications
- Timeline definition and milestones: both for the short term and long term
- Risk definition: what are the risks associated with a sandbox implementation
- Resource allocation among stakeholders: what is the required level of effort required for both the short term and long term
- Future development: what is the scalability associated with the U-space sandbox development in the long term

3. Roadmap

3.1 Vision and goals

In order to establish an operational, manageable and economically sustainable unmanned test site (U-space sandbox), several factors have to be considered as part of the Estonian ecosystem.

Typically, the establishment of a sandbox involves significant funding and change for the parties involved.

A successful implementation development has to follow a continual process of alignment, in order to ensure that the U-space sandbox programme and its subsequent projects remain linked to strategic objectives, as depicted in Figure 1.

The Tartu U-space sandbox mission and vision is achieved through the business strategies, policies, initiatives and targets that are influenced and shaped by the political, economic, sociological, technological and legal environment in which it will operate.

The implementation strategy has to consist in strategic cases that define the U-space sandbox programmes needed to deliver the intended outcomes and benefits.

The programmes initiate and align the projects and related activities required to deliver the outputs, which can be new platforms, products or services, processes, capabilities, and so on.

It is important to note that only when the U-space sandbox will deliver and implement the required outputs into business operations, the achievement of the outcomes and the full benefits of the programme can be realised.

This is a key aspect in the U-space sandbox implementation process as the implementing changes and improvements to the target business operations may need to respond to changes in strategies or accommodate new initiatives or policies.

Figure 1 - Typical environment for new projects

The U-space sandbox development, implementation and subsequent management will only deliver the intended outputs if:

- It provides a strategic fit and it is supported by a strong case for change
- It maximise public value to the Estonian ecosystem through the selection of an optimal combination of capabilities, products and services
- It is commercially viable and attractive to the supply and demand side
- It is affordable and fundable over time
- It can be delivered successfully by the organisation and its partners

All the above mentioned points relate to specific cases associated with the implementation process of the Tartu U-space sandbox:

- Strategic Case
- Economic Case
- Commercial Case
- Financial Case
- Management Case

3.1.1 Strategic Case

The purpose of this case is to initiate the desired change in the Business As Usual operations and administration tasks and to demonstrate how the new change will provide strategic fit. In order to provide a robust case for change, the goals, scope and objectives must be clearly understood, in order to

be able to determine the existing arrangements related to the actual Business As Usual operations, business needs, and to determine the key requirements.

1. Goals:
    1. Part of Estonia's strategy to champion as a base for new aviation technologies, in alignment with the European U-space regulation, enabling local companies to enter into the market and foreign companies favourable opportunities for activities in Estonia.
    2. Amendment of the Estonian Aviation Act for the implementation of the National U-space regulation
2. Scope:
    1. Short term (2023-2025): U-space regulation implementation to enable business operations in the U-space sandbox locations.
    2. Mid-term (2025-2030): Enable the U-space business operations in a national-wide manner, including connecting remote islands and initial cross-border operations with surrounding countries.
    3. Long-term (2030+): Integrated and highly digitalized national framework to enable the implementation of IAM and UAM services in the metropolitan areas and between the Baltic countries.

As part of the overall project scope, the focus will be on the U-space sandbox implementation for the Short term objectives (2023-2025), providing the basis for the seamless evolution in respect to the Mid term and long term scope.

Objectives:

It is important to specify objectives for the U-space sandbox in order to have a clear understanding of what is seeking to achieve, what is currently happening and what is required to close the gap between the current situation and the envisaged future.

The proposed strategic objectives of the U-space sandbox are:

- U-space stakeholders are able to accomplish their roles and responsibilities in accordance with the EU Regulation 2021/664, 2021/665 and 2021/666 as a result to achieve their business strategies.
- U-space stakeholders to test platform or product conformance with the EU U-space regulation in order to be ready on the market.
- Provide a test environment for de-risking and maturing technologies and services that conform with the EU U-space regulation.
- Ability for the Competent Authority to set up regulatory challenges aimed at accelerating the innovation and market uptake.

Business needs:

The business needs help to identify and define the improvements and changes that are necessary to occur in order to fulfil the agreed determining objectives. This helps to clearly identify operational needs.

The following table identifies the business needs associated with the determining objectives.

Objective	Business need
U-space stakeholders are able to accomplish their roles and responsibilities in accordance with the EU Regulation 2021/664, 2021/665 and 2021/666 as a result to achieve their business strategies	● Connecting with the market to ensure common understanding ○ Compliance with the capabilities and performance requirements of the U-space airspace ○ Operational conditions and authorisation compliance ○ Contingency measures, emergency management systems, occurrences reporting and procedures available ○ Management systems compliance with regulatory requirements ○ Business plans ● Develop a consistent U-space airspace implementation plan ● Certification and U-space oversight
U-space stakeholders to test platform or product conformance with the EU U-space regulation in order to be ready on the market	● Technologies ready to get approved ● Familiarisation with the certification process
Provide a test environment for de-risking and maturing technologies and services that conform with the EU U-space regulation	● Contributing to R&D and standardisation activities ● Develop a consistent U-space airspace implementation plan ● Technologies ready to get approved
Ability for the Competent Authority to set up regulatory challenges aimed at accelerating the innovation and market uptake	● De-risking and maturing technologies in order to get approved ● Develop a consistent U-space airspace implementation plan ● Certification and U-space oversight

Table 1 - U-space sandbox objectives and business needs

The objectives are linked with several items which are part of the European U-space regulation 2021/664 which are divided into three different macro-blocks: business, tech/business and technical. Please, refer to Deliverable 2.1 section 6.4 for details on the macro-blocks.

Key requirements:

The business needs are identifying the operational capabilities required to satisfy the objectives in a continuum manner. The business needs will have an associated list of the key requirements which are necessary to be put in place.

This will assist in avoiding 'scope creep' during the implementation phase of the U-space sandbox.

It is recommended to prioritise the following key requirements:

- Resources: It is necessary to have enough resources available in order to efficiently engage with the customers
- Infrastructure: it is necessary to have furniture, accessories, configuration with existing environment, internet access
- Funding: available economic resources for the U-space sandbox operation
- Partners: social, political and industry support
- Equipment: it is necessary to have minimum equipment (e.g. contingency management platform(s), communication methods based on priority levels) and supplemental equipment list (e.g. additional system feeds, real-time and predictive analytics data)

3.1.2 Economic Case

The purpose of this case is to identify the best available options needed for the U-space sandbox implementation, which includes technological, social, environmental, and cost considerations.

It is expected that a specific number of possible options are realistic and achievable in order to meet the key requirements in the short term, and the preferred way forward for the mid and long term.

The key requirements in the short term must include the Business As Usual use cases and their relations with the different cost options.

Options identification:

It is necessary to identify the realistic and possible options for the successful implementation of the U-space sandbox. It must include an option that provides the continuation of current arrangements as if the intervention under consideration were not to happen, the 'Business As Usual' (BAU). This serves as a benchmark to compare alternative interventions. At the same time it must also include realistic 'do minimum' based on the core functionality and key requirements identified in the Strategic case.

The creation of the different options are based on a series of choices to be made in sequence.

The 'why' is already provided in the scope defined in the Strategic case. The next stage is to identify and appraise the choices to be made in relation to the 'what', 'where', 'how', 'who', 'when' and 'funding'. These choices have to be appraised in relation to the operational scope, solution, delivery vehicles, implementation timeframes and funding mechanism for the U-space sandbox.

Feature	Description
Operational scope	The 'what', in terms of the potential coverage of

	the U-space sandbox
Solution	The ‘how’ in terms of delivering the ‘preferred’ scope for the U-space sandbox
Delivery	The ‘who’ in terms of delivering the ‘preferred’ scope and solution for the U-space sandbox
Implementation	The ‘when’ in terms of delivering the ‘preferred’ scope, solution and service delivery arrangements for the U-space sandbox
Funding	The ‘funding’ required for delivering the ‘preferred’ scope, solution, service delivery and implementation path for the U-space sandbox

Table 2 - Features explanation

Options for further appraisal. These should include: ‘Business As Usual (BAU)’ – the benchmark for value for money. ‘Do minimum’ – a realistic way forward that also acts as a further benchmark for value for money, in terms of cost justifying further intervention. One or more other possible options based on realistic ‘more ambitious’ choices not discounted.

For the U-space sandbox implementation, the potential options associated with the operational scope are linked with the number and position of the locations which are part of the U-space sandbox implementation. For each option, the ‘recommended’ one will be the preferred way forward at this stage.

Three different options are considered, as follows:

Feature	Business as Usual	Do minimum	Intermediate option	Do maximum
Operational scope - in line with the strategic case	Case by case basis	● EAVA ● Estonian Aviation Museum	● Connection between EAVA and Estonian Aviation Museum ● Connection between EAVA and TSP	Corridors to be activated/deactivated between EAVA, TSP and Estonian Aviation Museum

Table 3 - Operational scope feature

The ‘Business As Usual’ option can be considered as the baseline for measuring improvement and value for money. However, other realistic ‘Do minimum’ are presented, based on the core functionality and key

requirements for the U-space sandbox. The preferred way forward in this case will be to start from the 'Do minimum' locations, as will be the ones chosen for the Part 2 validations of the CACTUS project.

It is to be taken into consideration that based on a poll conducted by ANRA at the Stakeholder Workshop, it was found that stakeholders are most interested to perform their use cases in the following locations:

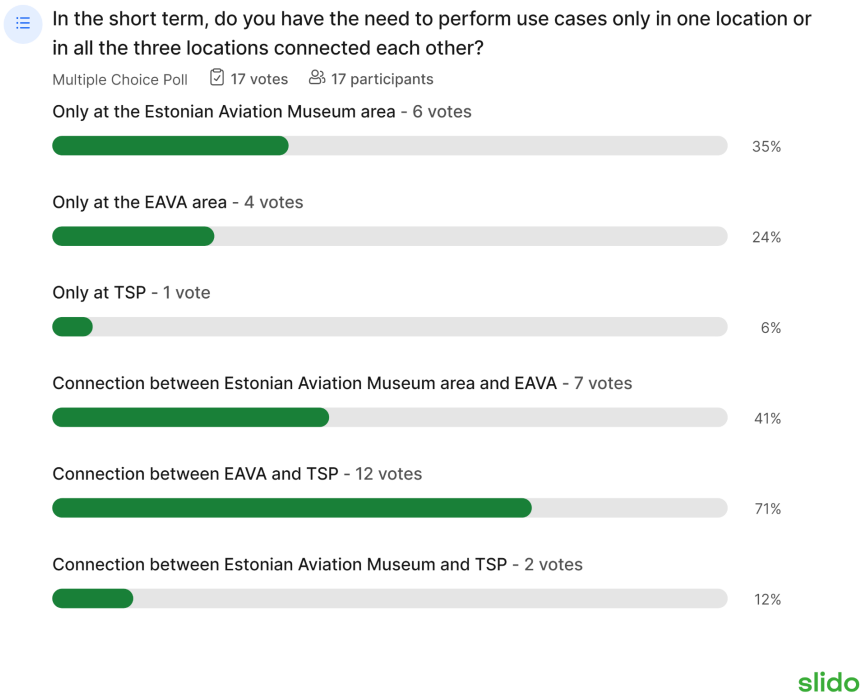

Fig.2: Poll on number and position locations conducted by ANRA Technologies at the CACTUS Stakeholder Workshop

Feature	Business as Usual	Do minimum	Intermediate option	Do maximum
Solution - in relation with the operational scope	Do nothing - Applications autonomously submitted with no support	Test area - Innovation department with high-level preliminary guidance and support	Test area - Innovation department with regulatory experts guidance and support and initial U-space technology available	Test area - Innovation department with intermediate U-space technology available in order to set up U-space operational challenges and all previous options available

Table 4 - Solution feature

The preferred way forward in this case will be the intermediate option to have a test area with initial U-space technology available and with regulatory experts support and guidance. This will provide strategic support from the regulator and willingness to fast-track the market uptake for the customer.

Feature	Business as Usual	Do minimum	Intermediate option	Do maximum
Delivery - in relation with the operational scope and solution	-	Local firms and companies	National firms and companies	International firms and companies

Table 5 - Delivery feature

The preferred way forward in this case will be the intermediate option in order to allow, in the short term, national firms and companies to get involved with the U-space sandbox operations, setting the bases for its development in the mid-term and long-term.

Feature	Business as Usual	Do minimum	Intermediate option	Do maximum
Implementation - in relation with the operational scope, solution and method of delivery	Unknown	Phase of 1 year (2024)	Phase of 2 years (2025)	Phase of more than 2 years (mid-term)

Table 6 - Implementation feature

The preferred way forward in this case will be to have an intermediate option with a phase of 2 years in order to achieve the strategic objectives, and expand the sandbox location areas in the Tartu region.

Feature	Business as Usual	Do minimum	Intermediate option	Do maximum
Funding- in relation with the operational scope, solution, method of delivery and implementation	-	Outsourcing	Public Private Partnership (PPP)	Direct public sector provision

Table 7 - Funding feature

The preferred way forward in this case will be to have an intermediate option with a Public Private Partnership (PPP), at the condition that both of the interests are strategically aligned, in order to not act

in their own interests. Generally speaking, PPP options can offer higher levels of specialist and operational management expertise, greater management flexibility and focus and improved risk management. Anyway, lifetime costs and risks involved as part of the U-space sandbox implementation process, including those arising from early termination must be considered, as addressed in the next sections.

3.1.3 Commercial Case

The purpose of this case is to demonstrate that the selected, assessed and analysed options will result in a viable and well-structured procurement solution. This can only be achieved upon a clear understanding on how the U-space sandbox will be procured competitively between the public sector, the service providers and the customers of the U-space sandbox.

Several steps have to be considered:

- Procurement strategy. Outline the proposed procurement strategy based on the selected options.
- Contractual arrangements. Outline the nature of the contractual relationship that will exist between the customer and the U-space sandbox responsible owner.
- Charging mechanism. Outline mechanism to be established, as well as additional funding/income to be realised.

3.1.4 Financial Case

The purpose of this case is to demonstrate the affordability and funding for the selected, assessed and analysed options, which includes the necessary support from stakeholders and customers.

This case requires a complete understanding of the capital, revenue and whole life scheme costs and how the different selected options will have an impact on the income and expenditure and pricing arrangements of the U-space sandbox.

Please, refer to the methodology described in section 5 of D2.1.

3.1.5 Management Case

The purpose of this case is to demonstrate that robust arrangements are in place for the implementation and subsequent operation and monitoring of the U-space sandbox, which include feedback regarding the Strategic Case.

Here the selected, assessed and analysed options must be evidenced to be managed following the best practices and assurance levels.

In order to do so, it is necessary to embrace the principles of programme and project management and to adopt a methodology for both, based on quality and on best practices.

The U-space sandbox project framework should include key aspects related to:

- Structure: processes, tasks, resources and tools

- Reporting arrangements: establish the processes associated with reporting information, communication and data
- Governance arrangements: establish points of contact for internal and external coordination and provision on dispute resolution
- Roles and responsibilities: establish personnel roles and responsibilities

It is recommended to designate a senior responsible owner on the U-space sandbox, which will be accountable for the U-space sandbox projects by ensuring that it meets its objectives and delivers the expected benefits.

It is also recommended to develop a project plan which will be used to control and track the progress and delivery of the operations in the U-space sandbox and resulting outcomes. It will describe how, when and by whom a specific task, milestone or set of targets will be achieved.

Also, the use of specialist advisers is encouraged where the necessary capabilities and competencies are in short supply. The requirement for special advisers usually falls into four key categories: financial, legal, technical and programme / project management.

Finally, a benefits realisation strategy should set out arrangements for the identification of potential benefits, their planning, modelling and tracking. The benefits must be captured within a benefits register which should also indicate how those benefits are to be realised.

The benefits register should be updated and reviewed continuously in the Final review phase after each sandbox phase and it should capture the following information:

- Benefits number
- Benefits category and class
- Description: description of the activity performed
- U-space requirement feature: what aspect of the U-space regulation covers
- Potential costs: incurred during delivery
- Activities required: in order to achieve the benefit
- Responsible officer
- Performance measure: Key performance indicator
- Target improvement: level of change
- Timescale

3.2 Timeline definition and milestones

Several activities have been identified, characterised by objectives and duration organised along three years, corresponding to the periods 2023-2024-2025, through the completion of which it will be possible to reach increasing levels of maturity (first solution for exchange of information in U-space, temporary segregated areas, U-space airspace(s)) capable of enabling increasingly more complex use cases, in suburban and urban environments.

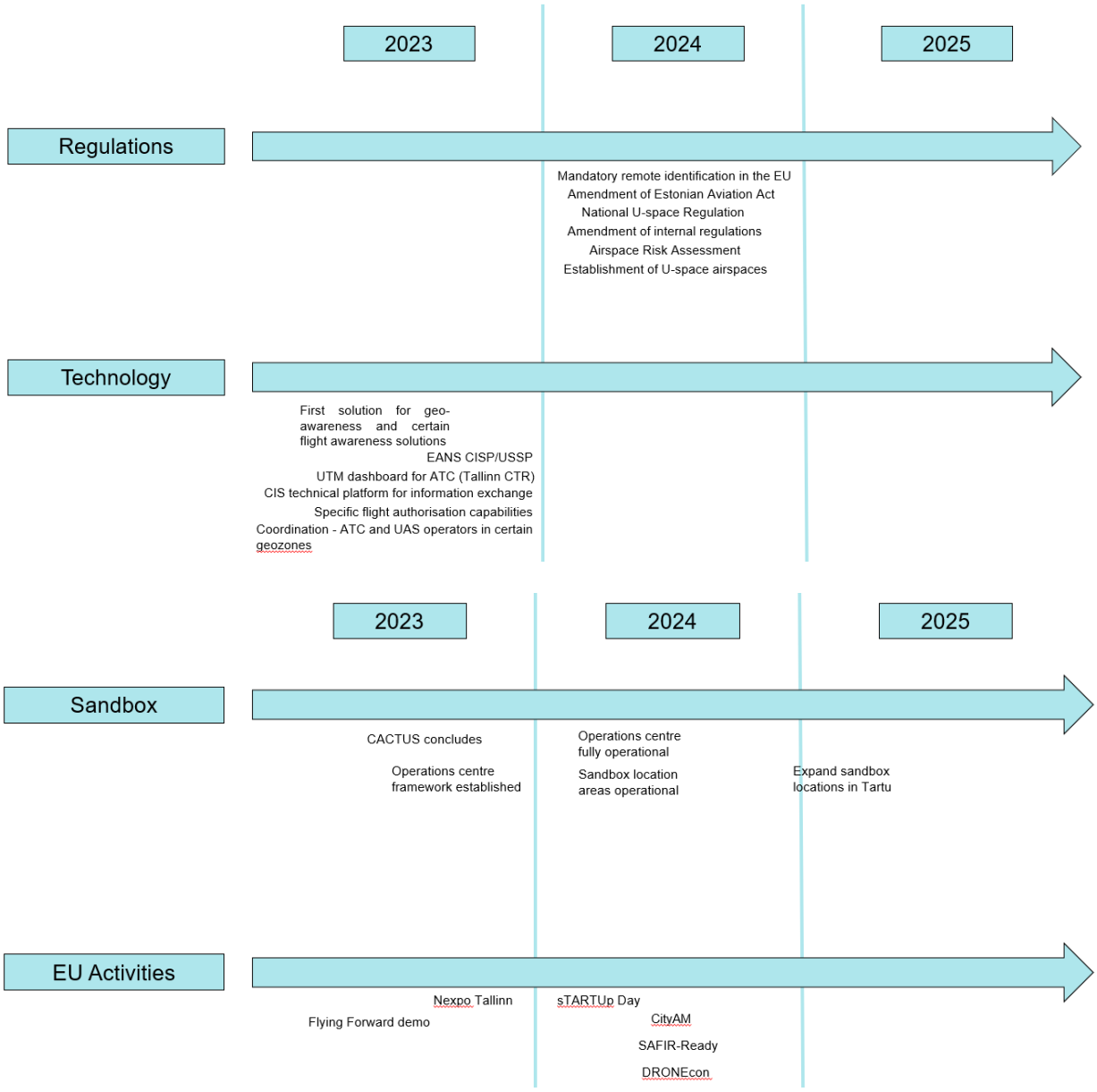

Fig.3: Project timeline continuum

3.3 Risk definition

Associated with the U-space sandbox implementation, there are certain risks to be considered. Risk is the possibility of a 'negative' event occurring, adversely impacting on the U-space sandbox implementation and subsequent management. The risk definition is based on the PESTLE analysis, a strategic framework used for understanding external influences for a new business, product, project or service.

PESTLE is the acronym for Political, Economical, Social, Technological, Legal and Environmental factors to be considered as part of the risk definition plan.

Risk categories	Description	Type
Political risks	Risks related to the extent to which the government may influence the economy or a certain industry	● Regulatory procrastination ● Inadequate institutional arrangements (transition from CACTUS to the sandbox activities from October 1st, 2023) ● Changes in policy direction
Economical risks	Risks related to the economy's performance that directly impacts a company and have resonating long term effects	● Competition issues (winners picking, uneven playing field) ● Monopoly issues ● New risks associated with products and services ● Stretching regulatory capacity – too expensive
Social risks	Risks related to the events that affect the market and community socially	● Social acceptance of the drone industry ● Coordination issues
Technological risks	Risks related to the innovations in technology that may affect the operations of the industry and the market favourably or unfavourably	● Technological disruption (new techniques emerging changing the processes) ● Research funding and development
Legal risks	Risks related to all legal aspects like employment, quotas, taxation, resources, imports and exports, etc.	● Liability issues in case of failed testing ● Limited capacity of the stakeholders to run sandbox
Environmental risks	Risks related to all those that influence or are determined by the surrounding environment. These include but are not limited to climate, weather, geographical location, ground conditions, etc.	● Extreme weather conditions in Estonia to perform flight tests ● Decentralised location in the EU

Table 8 - U-space sandbox risks

For this reason it is recommended to produce and share a risk register in order to overview all the risks and take necessary actions to mitigate them accordingly.

3.4 Resource allocation among stakeholders

The following table lists the tasks to be performed by the U-space stakeholders identified in the RACI.

Stakeholder	Task	Expected objective
TA	● Overview activities in the U-space sandbox ● Coordination mechanism established ● U-space airspace risk assessment ● Perform additional airspace risk assessment	● Adoption of the national U-space regulation in Estonia ● U-space airspace implementation ● Expand U-space sandbox operation locations in Tartu
EAVA	● Designate staffing ● Establish structure and governance arrangements ● Attract and support entrance of firms and businesses ● Support coordination mechanism	● Operations center fully operational ● U-space airspace implementation ● Expand U-space sandbox operation locations in Tartu
EANS	● Provide CIS and ATM technology ● Support coordination mechanism	● Operations center fully operational ● U-space airspace implementation ● Expand U-space sandbox operation locations in Tartu
MoEC	● Support coordination mechanism	● U-space airspace implementation ● Expand U-space sandbox operation locations in Tartu
Tartu city	● Support coordination mechanism ● Attract and support entrance of companies	● Support U-space airspace implementation ● Expand U-space

	and businesses	sandbox operation locations in Tartu
TSP	• Attract and support entrance of firms and businesses • Support coordination mechanism	• Operations center fully operational • U-space airspace implementation • Expand U-space sandbox operation locations in Tartu
ANRA	• Provide USSP technology and technical support • Support coordination mechanism	• Operations center fully operational • U-space airspace implementation • Expand U-space sandbox operation locations in Tartu

Table 9 - Resource allocation among stakeholders (Based on RACI document)

It is recommended to focus on the U-space sandbox activities which will run starting from October 1, 2023.

This means that, in order for the U-space sandbox to be successfully implemented and managed right after CACTUS, it is necessary to have in place all the stakeholders to perform the tasks listed in the Table 9 above.

3.5 Future development

As stated in the strategic case scope, the development of the U-space sandbox has to take into consideration the mid-term (2025-2030) and long-term (2030+) vision. For the mid-term, in order to enable U-space business operations nationwide, including connecting remote islands and initial cross-border operations with surrounding countries, it is necessary to establish a robust regulatory framework, establish sufficient U-space airspaces where complex operations may occur, encourage market penetration and competition, provide certain incentives to attract companies to develop and provide U-space services that meet performance requirements, and provide societal benefits through the deployment of this technology to ensure continued social acceptance.

In the long-term, an integrated and digitised national framework is required, so that complex operations using drones and VTOLs can be performed using U-space services. Cooperation between metropolitan areas in the Baltic countries may be established, which would greatly aid cross-border operations and support in harmonising digital infrastructure, thereby enabling interoperability. Potential use cases would increase exponentially, which would augment the market value of the UAS industry, leading to a positive economic ripple effect.

4. Objectives

4.1 Goal decomposition

As stated in the Strategic case section above, two main goals are envisaged as part of the U-space sandbox implementation:

1. Part of Estonia's strategy to champion as a base for new aviation technologies, in alignment with the European U-space regulation, enabling local companies to enter into the market and foreign companies favourable opportunities for activities in Estonia.
2. Amendment of the Estonian Aviation Act for the implementation of the National U-space regulation

These goals can be decomposed into the target described in the section below.

Goal number	Target
1	● Operations centre fully operational ● Expand U-space sandbox operation locations in Tartu
2	● U-space airspace implementation ● Adoption of the national U-space regulation in Estonia

Table 10 - Goal decomposition

4.2 Target definition

For each year, in order to meet the short term goals, it is suggested to perform specific tasks and to monitor their stage of progress based on several milestones.

Year	Target	Task	Milestone	Expected time required
2023	Operations centre framework established	● Look for funding schemes ● Assess available equipment and infrastructure ● Initial engagement with service providers and UAS operators	● Funding scheme individuated ● Equipment purchased and infrastructure availability granted ● Stakeholder engagement on services	3 months
2024	Operations centre fully operational	● Designate staffing ● Establish	Qualification period established ● Pre-application period ● Application period	5 months

		structure and governance arrangements	● Application review period ● Sandbox phase ● Final review	
2024	U-space airspace implementation	● U-space airspace risk assessment ● Coordination mechanism established	● Preparation phase concluded ● Reference scenario concluded ● Assessment phase concluded	12 months
2024	Adoption of the national U-space regulation in Estonia	● Overview activities in the U-space sandbox	● Improvement in aviation KPAs	12 months
2024/ 2025	Expand U-space sandbox operation locations in Tartu	● Perform additional airspace risk assessment	Activated/deactivated corridors established	8 months

Table 11 - Target definition