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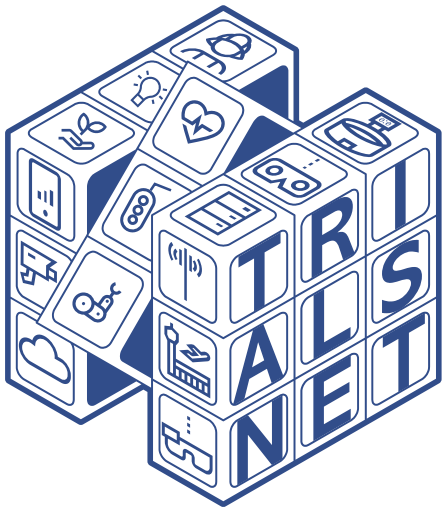

TrialsNet: TRials supported by Smart Networks beyond 5G

Deliverable D7.1

Open Call Applicant Handbook

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Table of Content

List of Acronyms and Abbreviations

Acronym	*Description*
3GPP	3rd Generation Partnership Project
5G	Fifth generation of mobile communications
6G	Sixth generation of mobile communications
CERTH	Ethniko Kentro Erevnas Kai Technologikis Anaptyxis
CNIT	Consorzio Nazionale Interuniversitario per le Telecomunicazioni
ETSI	European Telecommunications Standards Institute
EU	European Union
FAQ	Frequently Asked Question
KPI	Key Performance Indicator
KVI	Key Value Indicator
PIC	Participant Identification Code
PIIU	Promozione per l'Innovazione fra Industria e Università Associazione
SME	Small-Medium Enterprise
SNS	Smart Networks and Services
TEI	Ericsson Telecomunicazioni S.p.A
WP	Work Package

Executive Summary

The main objective of the TrialsNet Open Call is to onboard new key stakeholders (i.e., third parties such as verticals, companies, research centres, start-ups, or any other relevant entity as well as facilities and infrastructure owners) providing added value to the project's activities in order to maximize its impact on boosting 5G deployment in Europe and fostering Europe's technology sovereignty towards 6G. The main actions related to the TrialsNet Open Call to reach such objective are:

- To populate the project with innovative use cases, and to undertake a set of data-driven trials in the context of three project's domains of i) Infrastructure, Transportation, Safety & Security, ii) eHealth and Emergency, and iii) Culture, Tourism, and Entertainment,
- Involve key actors to perform beyond 5G large-scale trials through diversified and heterogeneous vertical use cases that cover key industrial and societal sectors,
- Support the deployment of new trials over the project platforms and network solutions as well as to extend its infrastructures domain in other geographical locations in Europe (to complement the main project's clusters).

In this context, the Work Package 7 (WP7) of TrialsNet has been responsible of the activities devoted to the preparation the Open Call in line with the project objectives, methodology and structure defined in the context of WP1 and reported in D1.1 [1]. With reference to this specific activity, WP7 prepared a set of documents to support the third parties during the whole application process. Due to its transversal nature, the Open Call preparation has been performed in strict collaboration with the technical WPs of the project, in particular WP2 for what concern the platforms and network solutions deployment, WP3, WP4, and WP5 for the use cases design and implementation, and WP6 for what concern the Key Performance Indicators (KPIs) and Key Value Indicators (KVIs) frameworks definition. During the preparation phase, the new role of Open Call Strategy Manager was also established in order to manage the interaction between the technical WPs and define a common strategy for the launch of the Open Call.

This document provides the guidelines to be followed by the third parties to apply for the Open Call of TrialsNet, covering all the legal and administrative aspects in line with the project's objectives. Moreover, this document also includes supporting technical material as a reference for the applicants to learn on one hand about the activities of the project, and this way to assist them in submitting a competitive proposal in terms of innovation and technology implementation, and on the other hand to be informed about the available infrastructures and the use cases there implemented in the different sites in case they wish to make use and integrate them within their proposal. In addition to that, the provided technical material introduces also the framework adopted by the TrialsNet in terms of its objectives, addressed domains of the urban ecosystems, transversal implementation of the use cases over different clusters, KPIs and KVIs definition, measurement and evaluation, and, last but not least, the project's methodology that will be asked to be followed for the execution of the large-scale trials. Such documentation has been prepared based on the project's deliverables D2.1 [2], D3.1 [3], D4.1 [4], D5.1 [5], and D6.1 [6] respectively.

Besides the documentation described above, to further support the applicants in the preparation of their proposals, TrialsNet organized two webinars, the first one on the 7th of November 2023 with a focus on the terms and conditions of the Open Call, and the second one planned for the 5th of December 2023 to illustrate the sites and infrastructure provided by the project as well as the KPIs and KVIs frameworks that will be adopted for the measurement and evaluation activities. In addition, applicants can also take advantage of the Feasibility Check procedure in order to share their intentions of contribution and verify the feasibility of their proposal receiving an informal and not binding feedback on it. A help desk has been also established to answer all the administrative and technical questions from the applicants.

Finally, it should be highlighted that the Open Call launch has been conceived as an agile approach to listen to the applicants and adjust it based on their needs as well as the project's challenges in order to guarantee a balanced and fair process to all the third parties willing to apply. Related to this, for example, TrialsNet drafted two templates for the proposal description and the budget request respectively, as well as maintains a living web page on the project's site in which the frequently asked questions (FAQs) are reported.

1 Introduction

This deliverable provides all the support material that the project makes available for the applicants and participants of the Open Call of TrialsNet.

The WP7, titled “Open Call and Support to Third Parties”, is responsible for the management of the calls and to provide support to third parties in line with the project objectives and structure. In the context of WP7, the Task 7.1 (T7.1) “Open Call scope, documentation and evaluation process definition”, is responsible for the preparation of material for the applicants in terms of a “Handbook for Applicants” which is this document.

This “Handbook for Applicants” contains the text of the Open Call including the complete legal and administrative part, such as the methods with which the selection will be conducted, the opening conditions and transparency, the decision-making procedures for selecting proposals, eligibility, and exclusion conditions. In addition, support material for the applicant is also provided, including the technical description of the infrastructures and the use cases that will be implemented by the project, as well as a description of the KPIs and KVIs framework that will be validated through trials’ activities.

In this document, Section 2 presents an overview of the project, in terms of vision and scope, domains, clusters and technologies of the 13 use cases that will be implemented by TrialsNet consortium.

Section 3 deals with the Open Call describing its objective, the allocated grants and eligibility criteria.

Section 4 provides information to applicants on how to submit a proposal through the following steps: how the evaluation process is conducted, the assessment criteria, third party agreement, payment and reporting, intellectual property rights, and ethics requirements.

Finally, the conclusions section provides a short summary and reports about the next steps, while Annex A collects all the supporting material that has been made available to the applicants.

2 TrialsNet overview

2.1 Motivation, vision and goals

Smart Cities have already attracted attention as one of the possible solutions to improve “livability” and people’s quality of life. Beyond 5G and 6G are candidate technologies to positively impact aspects of immense social value as sustainability, resilience, inclusion, trust, security, etc.

TrialsNet vision is to enable the realization of compelling societal values through the implementation of 5G and beyond applications, which will be propaedeutic for the transition towards the next generation of mobile networks.

TrialsNet will deploy full large-scale trials to implement a heterogenous and comprehensive set of innovative 6G applications based on various technologies such as Cobots, Metaverse, massive twinning, Internet of Senses, and others, covering the three relevant domains of the urban ecosystems in Europe identified as i) Infrastructure, Transportation, Security & Safety, ii) eHealth & Emergency, and iii) Culture, Tourism & Entertainment. This future ecosystem is on course to be more collaborative and inclusive than previous generations of network, and TrialsNet aims to lead the way by promoting open architectures, large experimentation sites and taking a multi-stakeholder approach with the objective to connect the digital with the physical and natural worlds.

TrialsNet will propose technological innovations towards real-life services in the communication area, to support Europe in the standardization process (e.g., 3rd Generation Partnership Project - 3GPP and European Telecommunications Standards Institute - ETSI) towards a leading position in the global ICT market over the coming years.

Thanks to its activities, TrialsNet will contribute to Europe’s technological leadership in communication technologies and in future emerging enabling technologies, by strengthening European capacities in key parts of future services.

2.2 Use cases and infrastructures

In the context of the three domains introduced above, TrialsNet is designing and implementing 13 innovative use cases that will be developed over wide coverage areas with the involvement of extended sets of real users in 4 geographical clusters, located in Italy, Spain, Greece and Romania respectively. The TrialsNet use cases have been conceived as transversal: the pan-European clusters of TrialsNet targets use cases for the identified domains and, most importantly, different implementations of the same use case are deployed in more clusters. This approach allows for a holistic evaluation of the network KPIs and KVIs of the 6G applications in different contexts and scenarios, including different network deployments and solutions.

The documents describing the sites, related infrastructures, and use cases of each cluster as well as the TrialsNet framework including the overview of the KPIs and KVIs can be downloaded from the Open Call page.

3 Scope and terms of the call

3.1 General objectives

The project TrialsNet, co-funded by the European Union's Horizon Europe program, launches an Open Call to invite third parties such as verticals, companies (including Small-Medium Enterprises - SMEs), research centres, start-ups, or any other relevant entity as well as facilities and infrastructure owners, to undertake a set of new or complementary use cases to further enrich the TrialsNet domains and to perform related beyond 5G large-scale trials.

The proposed use cases should address one of the main areas identified by the project:

- Infrastructure
- Transportation
- Security & Safety
- eHealth
- Emergency
- Culture
- Tourism
- Entertainment

The main objective of the TrialsNet Open Call is to provide added value to the project through the following main actions:

- Involve key actors to perform beyond 5G large-scale trials through diversified and heterogeneous vertical use cases that cover key industrial and societal sector.
- Support the deployment of new trials over the project platforms and network solutions, as well as to extend its infrastructures domain in other geographical locations in Europe (to complement the core clusters).

The Open Call will maximize the impact and accelerate the adoption of TrialsNet solutions by demonstrating its flexibility, user acceptance, and technology transfer.

Through its Open Call, TrialsNet will foster the further take-up of TrialsNet solutions as well the enlargement of scopes and scale of beyond 5G demonstration activities by inviting new or complementary innovative use cases towards the new generation of mobile networks.

TrialsNet is giving the opportunity to the applicants of the Open Call to participate through two different options:

- **Option 1**:
  a) **New use case(s)** and field trials **supported by one or more TrialsNet infrastructures** in terms of platforms and network solutions,

  or

  b) **Improvement of TrialsNet use case(s)** by the integration of software applications, features, devices, new users, and datasets
- **Option 2**: **New use case(s)** leveraging **on new additional field trials infrastructures** such as experimental, private, and/or commercial network deployments.

For both Option 1 and Option 2 single or multiple (maximum 3) beneficiary proposal is possible.

The Open Call will have a clear European dimension.

The sub-projects selected in the Open Call will be requested to provide feedback on the required improvements and infrastructure evaluation to meet the need of 5G services evolution. All trials should gain high levels of exposure and visibility.

3.2 Grants offered by the Open Call

TrialsNet allocates in total **€5.580.900** to provide financial support to the selected applicants. Each of them will run for a period of 12 months and will receive a funding up to **€200.000 (under Option 1)** or **€300.000 (under Option 2)**.

A single applicant may receive up to €200.000.

A specific Helpdesk is active to support the applicants for both technical and administrative questions: open-call@trialsnet.eu.

3.3 Eligibility criteria

The call for applications is accessible to legal entities located in eligible countries. These entities must be established in the Member States of the European Union or Associated Countries, following the rules of Horizon Europe.

Following the Council Implementing Decision 2022/2506, as of 16th December 2022, no legal commitments can be signed with Hungarian public interest trusts established under Hungarian Act IX of 2021 or any entity they maintain. A list of these institutions can be found here. The restrictions apply case-by-case using the (Participant Identification Code) PIC number. The most updated information on what are the entities 'maintained' by public interest trusts concerned by the Council Implementing Decision 2022/2506 can be found on this page of the EU Funding and Tender Portal.

Applicants must maintain complete independence from project partners, their affiliated entities, and/or any controlled companies. Institutions, organizations, or other legal entities funded by or affiliated with a TrialsNet partner are ineligible.

TrialsNet reserves the right to reject a selected application if any of the aforementioned conditions is not met.

Successful applicant(s) awarded funding will be required to sign the TriaslNet Third Parties agreement with CERTH, on behalf of the TrialsNet Consortium, in order to be able to receive the funds and become third party of the project.

The submitted proposals must meet the following criteria:

- Proposals shall be submitted on time (deadline: **19th of January 2024 at 17:00 CET**).
- Proposals should be presented by consortia of legal organizations registered in a Member State of the European Union or in a Horizon Europe Associated Country.
- Compliance with TrialsNet Ethics guidelines that will be provided to the selected applicants during the contract phase
- Proposals should respect the page limit according to the template.
- The language of the applications must be English.

3.4 Exclusion

Grants will not be awarded in the event of:

- Bankruptcy, winding up, court-administered affairs, creditor arrangements, suspended business activities, or other comparable procedures (including procedures that involve persons who have unlimited liability for the applicant's debts).
- Non-compliance with social security or tax obligations (including if such non-compliance is committed by persons with unlimited liability for the applicant's debts).
- Commission of grave professional misconduct (including if such misconduct is committed by persons who possess powers of representation, decision-making, or control, beneficial owners, or those who are crucial for the award or implementation of the grant).

4 How to apply

4.1 General

This section outlines the procedures for the submission of applications to the TrialsNet Open Call.

Applications should be submitted electronically via the dedicated Funding Box tenders portal submission system using the forms provided inside platform.

The structure and presentation will correspond to the instructions given in the forms. Applications will be discharged in case they are not complete and don't contain all parts and mandatory Annexes and supporting documents.

Applications should be written in English, be readable, accessible, and printable. Sections subject to text limits are clearly shown in the application form inside the platform.

The evaluation is limited to 60 eligible proposals. Priority is given by the time stamp of the completion and submission of the proposal.

4.2 Application form

The Application Form is online, available through the dedicated Funding Box tenders portal and requires filling in information regarding the following aspects:

- Legal and contact information
- Description of the proposed use case(s) and related trials (a proposal template is provided)
- Applicants' experience
- Applicants' activities plan
- Expected impact
- Applicants' capabilities

Resource/budget allocation (a budget request template is provided)

The maximum length of the text for each section is set in the platform and all fields are mandatory to be filled in.

The applicant shall indicate the estimated allocation of resources (person-months) and costs, specifying a budgetary breakdown per direct cost item (staff, travel and subsistence). A 25% (calculated on direct costs) flat rate as overhead costs may be added. A budget request template is also provided to support the applicants.

The total costs allocated for the application must not exceed 200,000 euros for Option 1 and 300,000 euros for Option 2.

The cost reduction towards the ceiling will not be considered as a preferential criterion for the evaluation of the application.

The previous categories are broken down into specific questions in the application form, which can be found and submitted through the dedicated Funding Box tenders portal.

4.3 Submission of the applications

The online Application Form shall be completed any time after the launch of the Open Call (16 October 2023) until the **19th of January 2024 at 17:00 CET**.

The form will be deactivated on 19 January 2024 at 17:00 PM CET, therefore any applications received after the specified deadline will be automatically rejected. It is highly advised that applicants submit their applications well in advance of the deadline to account for any potential technical or connectivity issues and ensure timely delivery.

Upon receipt of the application, TrialsNet will send a confirmation receipt to the provided email address. This confirmation serves as acknowledgment that the application was received on time but does not certify that it is complete and suitable for evaluation.

4.4 Further information

Applicants are invited to visit regularly the TrialsNet Open Call page in order to get the latest news.

In case of specific queries on the call, applicants may write an e-mail to opencall@trialsnet.eu with the subject "Support" to receive help from the TrialsNet Applicant Helpdesk team.

4.5 Support material

The applicants may refer to the TrialsNet website to get more familiar with the project concept, approach, use cases, infrastructures and trials, as well as with the project outcomes so far, and to be informed about upcoming webinars. Downloadable material related to the Open Call is at the disposal of the applicants on the Open Call page, while the most useful one would be the project deliverables published on the TriaslNet website in the dedicated page.

4.6 From application to experimentation

4.6.1 Feasibility check

The Open Call applicants are encouraged to contact the TrialsNet consortium to share their intentions of contribution in order to verify the feasibility of the proposal and to receive informal and not binding feedback on it. To perform the feasibility check, the applicants need to fill the online Feasibility Check Form accessible through the Open Call page. A **draft version of the proposal** (applicants are invited to use the proposal template provided by TrialsNet) can be also sent to opencall@trialsnet.eu indicating in the subject the short name of the proposal to provide more detailed information in support to the Feasibility Check Form. Received requests will be processed according to their arrival and feedbacks will be provided not later than 5 working days.

Feasibility check requests can be submitted until the **10th of December 2023 at 17:00 CET**.

4.6.2 Eligibility status

After closing the application phase, all received applications will be first filtered, according to their eligibility status, based on criteria described below; for all non-eligible applications, no further evaluation will take place. Extra information may be requested by the applicants to validate their legal entity status characterization (i.e., to fill in documents related to the "Declaration of Honour on exclusion criteria and absence of conflict of interest", downloadable from the Open Call page).

As regards eligibility rules for participation and funding in the Open Calls, the General Annexes to Horizon Europe for the Work Programme 2023-2024 apply. The call for applications is accessible to legal entities located in eligible countries. These entities must be established in the Member States of the European Union or associated countries, following the rules of Horizon Europe.

Following the Council Implementing Decision 2022/2506, as of 16th December 2022, no legal commitments can be signed with Hungarian public interest trusts established under Hungarian Act IX of 2021 or any entity they maintain. A list of these institutions can be found here. The restrictions apply case-by-case using the PIC number. The most updated information on what are the entities 'maintained' by public interest trusts concerned by the Council Implementing Decision 2022/2506 can be found on this page of the EU Funding and Tender Portal.

Applicants' organizations can submit multiple proposals; however, only one proposal per organization can be selected for funding in this Open Call.

Beneficiaries of the TrialsNet project are not eligible to participate in this OpenCall.

4.6.3 Third party agreement

Once a proposal is selected, the applicants organization will be contracted by the project as a third party receiving financial support. This will require the signature of the Declaration of Honour that can be downloaded from the Open Call page together with all the other Open Call relevant documentation.

4.6.4 Further remarks

Before awarding any grants to a third party, it will be checked whether the third party is a legal entity with a history of at least three years of commercial operations and has not been declared insolvent.

Any third party funding agreement will contain a clause ensuring that the European Commission and the Court of Auditors can exercise their powers of control, concerning documents premises and information, including those stored on electronic media.

The final number of contracts will be a function of:

- The amount of request grants,
- Testbed availability/capability constraints (for proposals following Option 1).

4.6.5 Limitation of evaluated proposals

In case the number of applications passing the feasibility check is higher than 60, the proposal latest submitted will be discharged, and only the first 60 will be evaluated.

This process will indicatively take 15 working days from the closure of the submission phase. At the end of this, the selected applicants will be informed via email.

4.7 Contracting time

The successful applicants will be informed by the contracting party and they will be put in contact with the suitable testbed.

Granted applicants will be asked to sign an appropriate Non-Disclosure Agreement.

The selected applications will start the contracting phase, which should end within the official kick-off of activities (planned date: within May 2024).

4.8 Reporting

The experimentation cycle ends with the creation of a report describing the activities and the results that have been achieved during the validation phase.

In case the produced outputs of the experiments lead to scientific publications or if they are presented in presentations or webpages, they should include an acknowledgement to TrialsNet, the Smart Networks and Services (SNS) program and the European Commission with the respective logos.

4.9 Assessment criteria

The following aspects will be considered and evaluated. The criteria that will be evaluated are presented in bullet form:

- Capacity of the applicants to perform the field trial (Threshold 3/5; Weight 2).
- Relevance for TrialsNet and for 5G evolution (Threshold 3/5; Weight 2)
- Industrial and/or scientific innovation (Threshold 3/5; Weight 1).
- Clarity and methodology (Threshold 3/5; Weight 1)
- Impact for market and society (Threshold 3/5; Weight 1)
- Technology expertise and quality (Threshold 3/5; Weight 1)

Each criterion is scored on a scale from 0 to 5, as follows:

- **0 - Fail**: The proposal fails to address the criterion under examination or cannot be judged due to missing or incomplete information.
- **1 - Poor**: The criterion is addressed in an inadequate manner, or there are serious inherent weaknesses.
- **2 - Fair**: While the proposal broadly addresses the criterion, there are significant weaknesses.
- **3 - Good**: The proposal addresses the criterion well, although improvements would be necessary.
- **4 - Very good**: The proposal addresses the criterion very well, although certain improvements are still possible.
- **5 - Excellent**: The proposal addresses successfully all aspects of the criterion.

4.10 Evaluation process

All submitted proposals will be evaluated using criteria similar to Horizon Europe. Evaluations will be organized in three steps.

Initially, each proposal will be assigned to at least two external expert evaluators, acting as independent experts not belonging or involved in the TrialsNet Consortium.

After individual evaluation, the experts will have a consensus telco to agree on a common evaluation text and an overall score.

Finally, to smooth out any human factors, all evaluators will have a common panel telco together with the project's representatives to rank and short list the proposals.

4.11 Legal disclaimer

The information and views set out in this document are those of the author(s) and do not necessarily reflect the official opinion of the European Union. The information in this document is provided "as is", and no guarantee or warranty is given that the information is fit for any specific purpose. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein. The TrialsNet Consortium members shall have no liability for damages of any kind including without limitation direct, special, indirect, or consequential damages that may result from the use of these materials subject to any liability which is mandatory due to applicable law.

4.12 Attendance to the meetings

Attendance at the meetings listed below is required. It is therefore recommended to budget these in the proposal:

- General meeting with the project's representatives within one month from the contracting date.
- At least 2 technical meeting to be held by the chosen testbed: TBD case by case
- Trials results will undergo a formal review by the project. The formal review is required for obtaining full payment of the selected applicants.

4.13 Acceptable costs

As the selected applicants will be linked to the TrialsNet consortium as third parties receiving financial support, specific arrangements are given by the EC with respect to financial costs and payment schemes.

As a third party, the applicant needs to include an overview of the estimated costs in its proposal at the time of submission. Costs consist of personnel costs, direct costs (such as travel, consumables, etc.) and indirect costs.

The project contribution to the third parties will be 100% of the declared costs, in accordance with the corresponding rules for participation in the SNS program.

The costs incurred by a third party must adhere to the regulations and principles outlined in the Horizon Europe program and must be properly documented in the third party's financial records. This means that the rules

pertaining to cost eligibility, identification of direct and indirect costs, upper funding limits, as well as controls and audits, must be followed.

The costs of a third party have to comply with the rules and the principles mentioned in the Horizon Europe AGA - Annotated Grant Agreement, in the same way as the beneficiaries, and must be recorded in the accounts of the third party. In other words, the rules relating to eligibility of costs, identification of direct and indirect costs and upper funding limits apply. Equally those concerning controls and audits of the European Commission.

4.14 Payments schedule

The payment is scheduled in three parts, subject to the level of development of the action, the submission of deliverables and the accomplishment of KPIs as reflected in the description of the trial:

- 20% of the assigned Grant after 1 month from the Grant signature against presentation of a detailed plan of activities,
- 65% at completion of the contracted activities,
- 15% when the EC accepts the projects final results.

4.15 Audits

The selected Third Parties should ensure in written that, as recipient of EU financial support, allow the Commission, the European Anti-fraud Office (OLAF) and the Court of Auditors to exercise their powers of control on documents, information, even stored on electronic media, or on the final recipient's premises.

4.16 Intellectual property rights

Regarding intellectual property rights (IPR), we outline the principles that will govern the management of IPR within the third-party project. The grant awarded to the chosen applicants will not impact the ownership of any pre-existing intellectual property, including background technologies, designs, works, inventions, software, data, techniques, know-how, or materials. The third-party that contributes with TrialsNet will retain ownership of the intellectual property.

4.17 Ethics requirements

The selected beneficiaries must adhere to the recommendations outlined in the project's Ethics Requirements that will be provided during the contract phase as well as the guidance provided by the project.

Furthermore, the beneficiary must follow the instructions and comply with the project's Data Management Plan that will be provided during the contract phase.

If applicable, the beneficiary is responsible for obtaining all necessary ethical and regulatory approvals from the relevant committee(s) before engaging in any project activities that require such approvals. Additionally, if involving human subjects or their legal guardians in the project, the beneficiary must obtain properly signed informed consent and acknowledgement forms.

Failure to comply with the ethical obligations outlined above will be considered a serious violation of the contract, resulting in its premature termination.

5 Conclusions

Based on the vision and scope of the project, WP7 takes care of integrating new third parties through a specific Open Call. The TrialsNet Open Call aims to maximize the impact and accelerate the adoption of TrialsNet solutions by demonstrating its flexibility, user acceptance, and technology transfer, by adding new use cases and further enhance the 13 project use cases towards the new generation of mobile networks.

This deliverable provides all the information that is needed for the applicants to the TrialsNet Open Call to submit their proposals: the Open Call objective, how to apply, what is the evaluation process, what are the expected contribution by covering both the legal and technical domains with detailed documentation.

The content of this document represents the information available yet to date. For the benefit of applicants willing to apply to the TrialsNet Open Call, the project may supplement with additional information that will be published on the project website as soon as it becomes available.

In August 2024 the following WP7 deliverable, D7.2 “Open call launch, proposal evaluation, and grant awards”, will report about the evaluation process and the selected applicants.

Acknowledgment

TrialsNet project has received funding from the European Union's Horizon-JU-SNS-2022 Research and Innovation Programme under Grant Agreement No. 101095871.

References

[1] TrialsNet, “Deliverable D1.1 Project Management Handbook”, 30 March 2023
[2] TrialsNet, “Deliverable D2.1 Preliminary design aspects for Platforms and Networks solutions", 30 June 2023
[3] TrialsNet, “Deliverable D3.1 Use Cases definition for Infrastructure, Transportation and Security & Safety (ITSS) domain”, 30 April 2023
[4] TrialsNet, “Deliverable D4.1 Use Cases definition for eHealth and Emergency (eHE) domain", 30 April 2023
[5] TrialsNet, “Deliverable D5.1 Use Cases definition for Culture, Tourism, and Entertainment (CTE) domain", 30 April 2023
[6] TrialsNet, “Deliverable D6.1 First report on validation and dissemination activities”, 31 October 2023

Annex A - Supporting material

This Annex contains all the supporting material in terms of administrative and technical documentations that have been made available to the applicants and that can be downloaded from the Open Call page. In particular:

- TrialsNet Sites and Use Cases description
- TrialsNet framework and KPIs/KVIs overview
- Feasibility Check Form
- Feasibility Check Report
- Proposal template
- Budget Request template
- Declaration of Honour for Applicants

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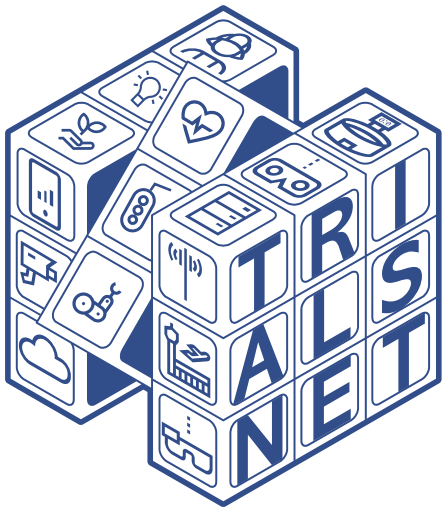

TrialsNet: TRials supported by Smart Networks beyond 5G

Open Call

Sites and Use Cases description

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1 Introduction

TrialsNet project aims to deploy full large-scale trials to implement a heterogenous and comprehensive set of innovative 6G applications based on various technologies and covering three relevant domains of the urban ecosystems in Europe identified as i) *Infrastructure, Transportation, Security & Safety*, ii) *eHealth & Emergency*, and iii) *Culture, Tourism & Entertainment*. In the context of these domains, TrialsNet is going to design and implement 13 innovative use cases that will be developed over wide coverage areas with the involvement of extended sets of real users in 4 geographical clusters, located in Italy, Spain, Greece and Romania respectively:

- **Infrastructure, Transportation, Security & Safety**
  - Use Case 1 “Smart Crowd Monitoring” (Madrid)
  - Use Case 1 “Smart Crowd Monitoring” (Iasi)
  - Use Case 2 “Public Infrastructure Assets Management” (Athens)
  - Use Case 3 “Autonomous APRON” (Athens)
  - Use Case 4 “Smart Traffic Management” (Iasi):
  - Use Case 5 “Control Room in Metaverse” (Turin)
- **eHealth & Emergency**
  - Use Case 6 “Mass Casualty Incident (MCI) and Emergency Rescue in Populated Area” (Athens/Madrid)
  - Use Case 7 “Remote Proctoring” (Pisa)
  - Use Case 8 “Smart Ambulance” (Pisa)
  - Use Case 9 “Adaptive Control of Hannes Prosthetic Device” (Pisa)
- **Culture, Tourism & Entertainment**
  - Use Case 10 “Immersive Fan Engagement” (Madrid)
  - Use Case 11 “Service Robots for Enhanced Passenger's Experience” (Athens)
  - Use Case 12 “City Parks in Metaverse” (Turin)
  - Use Case 13 “Extended Reality (XR) Museum Experience” (Turin)
  - Use Case 13 “Extended Reality (XR) Museum Experience” (Athens)

Additional and more detailed information about the use cases and the infrastructures of TrialsNet can be found in the public deliverables D3.1 “Use Cases definition for Infrastructure, Transportation, and Security & Safety (ITSS) domain” [1], D4.1 “Use Cases definition for eHealth and Emergency (eHE) domain” [2], D5.1 “Use Cases definition for Culture, Tourism, and Entertainment (CTE) domain” [3], and D2.1 “Preliminary design aspects for Platforms and Networks solutions” [4] available for download on the project’s site [5].

In the following sections, the document provides the description of the sites and related infrastructures that are going to be deployed by TrilasNet in support of its large-scale trials’ activities. In addition, the document also describes the use cases that will be developed and implemented throughout the course of the project. For both infrastructures and use cases, the document provides a set of challenges that could be addressed to further extend or enhance the solutions provided by the project.

As such, this document can serve as a particularly useful source for the Open Call candidate applicants, to learn on one hand precisely about the activities of the project and this way to assist them in submitting a competitive proposal in terms of innovation and technology implementation, and on the other hand to be informed about the available infrastructures and the use cases there implemented in the different sites in case they wish to make use and integrate them within their proposal.

2 Description of TrialsNet sites

This section provides an overview of the TrialsNet's platform and network solutions designed, deployed, and integrated for the implementation of the trials in the four clusters located in Italy, Spain, Romania and Greece. More in detail, the Italian cluster consists of two different sites located in Turin (see sub-section 2.1) and Pisa (see sub-section 2.2), while the Spanish, Romanian and Greek clusters (described in sub-sections 2.3, 2.4, and 2.6, respectively) will consist of one site each. It should be highlighted that the Romanian cluster will also relay on an ad-hoc experimental infrastructure that will be initially deployed in IMEC premises in Belgium (see sub-section 2.5) and then moved to the trial site in Romania. Overall, the cluster framework provided by TrialsNet is going to address both commercial and experimental domains providing a complete package of trials activities which results will be evaluated to validate further the benefits of B5G system and deriving the requirements towards 6G.

2.1 Italian cluster (Turin site)

This section describes the main infrastructure components of the Turin site in which UC5 "Control Room in Metaverse", UC12 "City Parks in Metaverse", and UC13 "Extended XR Museum Experience" will be implemented. The Turin site in the Italian cluster includes a very extensive set of technologies, that will leverage on the previously gathered experience in the 5G EVE projects as well as other available software component such as the XR platforms provided by TIM.

2.1.1 Short description

The mobile connectivity in the Turin site will be essentially provided by the 5G commercial network deployment of TIM. Taking advantage of the different products releases that will become available during the project's lifetime, the development of large-scale trials covering very extended areas and reaching a multitude of end-users with 5G enabled devices (phones, tablets, Virtual Reality (VR) visors, etc.) will be therefore possible. In terms of network infrastructure equipment, the Turin site is deployed on commercial products from Ericsson. The current network deployment is based on the 5G NSA (Non-Standalone) architecture imple-mented with Option 3 as per 3GPP Rel-15 using the 3.7 GHz band in which TIM owns 80 MHz. During the lifetime of the project, the TIM commercial network will evolve to the 5G Standalone (SA) architecture based on Rel-16 products.

2.1.2 Services offered by the infrastructure

The Turin site will make use of the facilities deployed in the context of the 5G EVE project. In particular, the 5G EVE platform in Turin offers different radio environments for testing with dedicated CNs, including commercial 5G network that can be used with commercial Access Point Name (APN) for internet access and/or via private APN (5geve.tim.it, available with enabled SIM cards) to access the 5G EVE facilities. Radio and CN are based on Ericsson equipment. The facility is multi-location, interconnected by high performance links (via TIM transport network or dark fiber), as depicted in Figure 1.

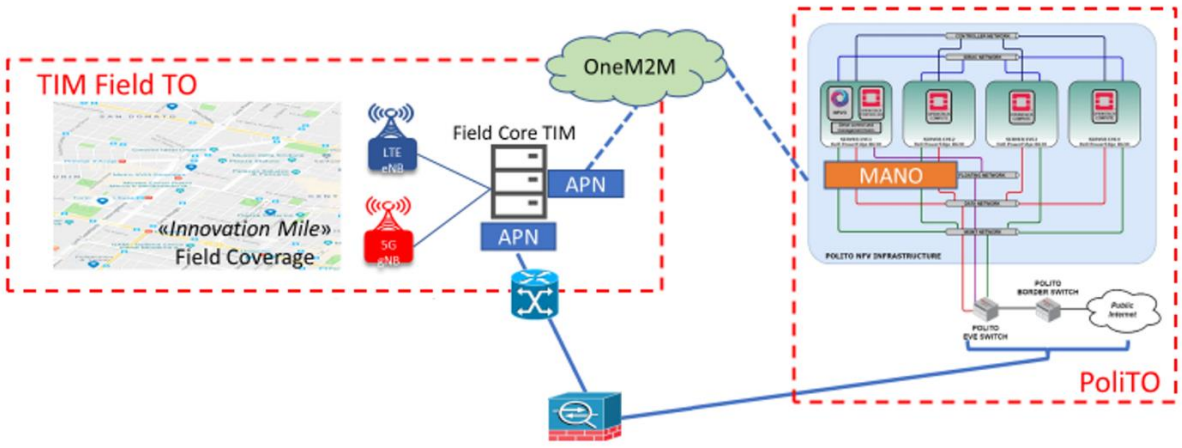


Figure 1. 5G EVE Turin site architecture.

Between the several functionalities that the 5G EVE platform can provide, TrialsNet will mostly make use of the service cloud infrastructure hosted by CNIT at Politecnico di Torino premises and managed by NextWorks. This infrastructure is based on Openstack and it can onboard both Virtual Network Functions (VNFs) and Physical Network Functions (PNFs) and consists of three physical servers. The first one is acting as service server container, where all the services related to the 5G EVE infrastructure are instantiated. The other two servers are configured as OpenStack Compute nodes, where the VNFs are executed based on a Management and Orchestration (MANO) operating at service/ Virtual Machines (VMs) layer.

2.1.3 Main assets of the infrastructure

The TIM eXtended Reality solutions are a set of platforms, developed by TIM that offer the possibility to build Augmented Reality e Virtual Reality digital services in various fields such as culture, retail, entertainment, education. The two main platforms, here described, are the **XR Platform** and **XR Streaming Platform** that will be used in the project to support the development of UC12 and UC13.

As said, both platforms are used to develop Augmented Reality (AR)/VR or more in general Mixed Reality digital services but with a substantial difference related to the rendering functionality, i.e., the capability to show digital content on the screen/device of the user starting from a 2D/3D Model.

In the case of XR Platform, this rendering functionality is performed directly by the end user device meaning that the user equipment must have the computational ability to perform this graphical functionality.

In the case of XR Streaming Platform, the rendering functionality is moved on the cloud (or telco edge cloud), it means that the user device could be “thin”, less performant and with smaller computational ability than the ones that are expected to be used with the XR Platform. The rendering functionality is done by a server with the render application, and through the network the user device receives a video stream that contains the digital content related to the XR experience. In this way, the user can experience a very high quality of detail of the 3D content regardless of the device.

In this case, an important role is played by the network since high bandwidth and low latency are needed to allow the user device to send to the server-side components some parameters, e.g., head-mounted display (HMD) tracking data, controllers input, sensors input data such as gyroscope, accelerometer, etc., that are required to select the right stream to be sent back to the user device in real time.

With the XR Streaming platform, the difference between an AR and VR experience lies simply in transmitting a video with or without transparency. If the video content (always related to a 3D content processed by the server) has a transparent background, it is possible to overlay it on the image of the smartphone/tablet webcam to obtain an AR experience. If the content of the surrounding 3D environment is also added, it can simply transform the service experience into a more immersive VR.

By separating the 3D surrounding environment from the scene objects (digital twins), it is possible to dynamically switch between an AR and VR experience (on devices where AR is possible), as well as having multiple users involved in the same experience with different visual options (AR or VR). For example, with two users connected to the same experience using a tablet and a VR headset, the user with the tablet can see and interact with different digital twins in their real environment, while the user with the VR headset can do the same but immersed in a virtual 3D environment. The interaction between avatars and VoIP session (to naturally speak each other) completes the experience for both users.

It is important to emphasize that the two platforms are not mutually exclusive. In cases where devices are powerful enough or where user-side device control is possible, or even where high details in the experience are not essential, it is possible to use the XR Platform, which still has lower costs on the server side.

The XR Platform is a TIM Software as a Service (SaaS) product already commercially available to its customers with different offers for various application areas, while the XR Streaming platform is currently being experimented in TIM Innovation Labs in Turin and Rome. The servers that manage the XR Platform are available in the cloud, while the servers of the XR Streaming platform are physically located between the two laboratories. Moe details about the two platforms, including information on the Software Development Kits in support to the creation of AR/VR applications are reported in D2.1 [4].

2.1.4 Extensions and new features

As previously reported, the 5G commercial network of TIM will evolve to the 5G SA architecture based on Rel-16 products during the lifetime of the project.

2.2 Italian cluster (Pisa site)

The Pisa site will serve for the deployment and validation of three use cases reported in D4.1 [2]: UC7 “Remote Proctoring”, UC8 “Smart Ambulance”, and UC9 “Adaptive Control of Hannes Prosthetic Device”.

2.2.1 Short description

The three use cases will be supported by a 5G network at 26 GHz covering the indoor and outdoor experimental areas in the CNR campus in Pisa. The Fondazione Monasterio hospital in Massa will host the training surgical room for UC7 and the emergency unit for UC8. The TIM site in Turin will house part of the 5G Core Network (CN) and the Ericsson Orchestration system. The initial deployment of UC9 will take place in the Ericsson 5G laboratory in Genoa, and later it will be moved to Pisa.

2.2.2 Services offered by the infrastructure

The infrastructure to support the use cases in under deployment so no services are currently offered by the network.

2.2.3 Main assets of the infrastructure

Figure 2 depicts the main assets for the of the Pisa site infrastructure. The RAN will comprise a BB system located in a dedicated room inside the CNR Building A and two antennas: an indoor antenna system (Ericsson Radio Dot) for UC7 and UC9, and an outdoor antenna system (micro cell) for UC8. The Core Network (CN) will be divided between TIM premises in Turin and Pisa. These sites will be connected through a VPN using specific packet gateways. The 5G infrastructure will be supported by the commercial Ericsson Orchestrator located in TIM's premises in Turin. Additionally, there will be an "ER Innovative Orchestrator" co-located with the BB system in Pisa. This second orchestration module is designed to manage vertical use cases with more complex end-to-end QoS requirements and optimal utilization of infrastructure resources. The infrastructure components are orchestrated dynamically and automatically to accommodate each specific service, including those that demand guaranteed and deterministic performance levels. The mapping of resources is based on actual traffic behavior to ensure effective service delivery.

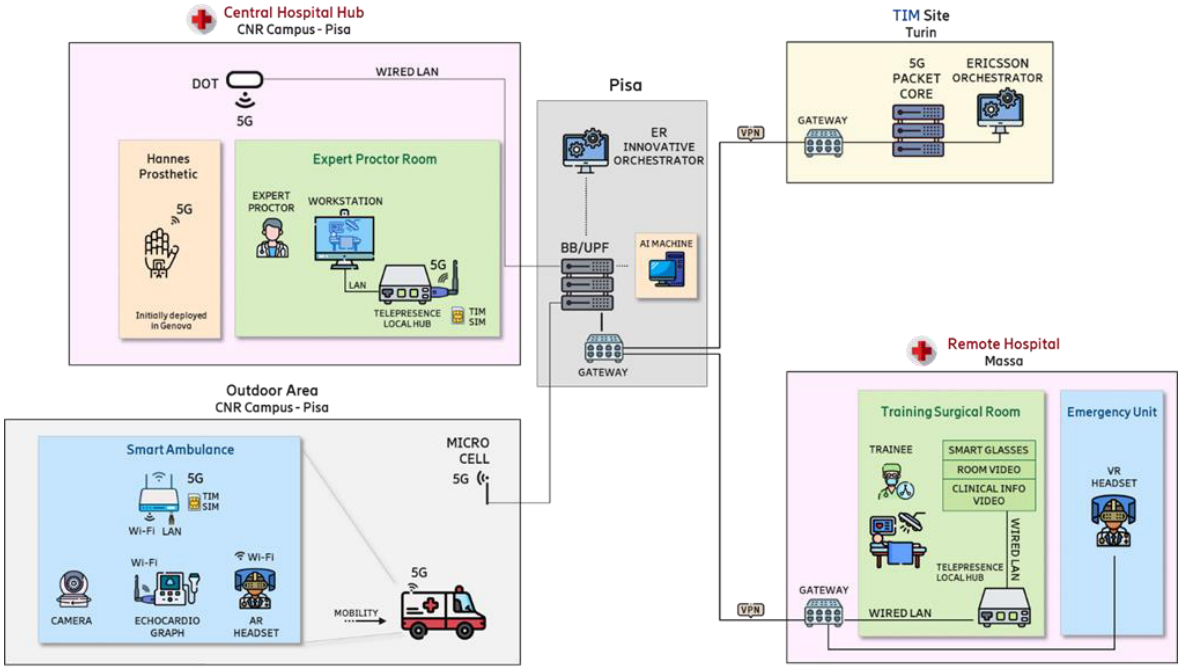


Figure 2. Main assets of the Pisa site infrastructure.

2.2.4 Extensions and new features

Since the network solution is going to be deployed from scratch, the primary goal is to develop a working solution according to the requirements of the current use cases. Possible enhancements will be considered if the experimentation of use cases identifies specific needs.

2.3 Spanish cluster

The Spanish cluster will support the implementation of UC1 “Smart Crowd monitoring” [1], UC6 “Mass Casualty Incident (MCI) and Emergency Rescue in Populated area” [2], and UC10 “Immersive Fan Engagement” [3].

2.3.1 Short description

The Spanish cluster is based on 5Tonic laboratory in Leganés (Community of Madrid) for the setup of the uses cases applications with 5G/B5G infrastructure. 5Tonic is an open laboratory for research and innovation that focus on 5G technologies. The 5Tonic co-creation laboratory was established to provide an open environment where members from business, industry and academia could collaborate with the telecoms innovation projects. The aim is to support innovation and help organizations work together to develop applications and business ventures. Ericsson provides the 5G System that supports the experimentation with the key objective of fostering 5G research and development and strengthening the competitiveness of European industry in the areas of 5G and innovation.

Uses cases of the Spanish cluster will be tested in real-life environment, so remote location deployment would be needed in addition to the laboratory part. For that purpose, Ericsson have developed a flight rack that contains the infrastructure with Radio Access equipment and User plane function that could support these uses cases in the events planned by the stakeholders. The overall scenario for the Spanish cluster, with the different locations of the equipment and how to support the uses cases in the lab and in remote location is depicted in Figure 3.

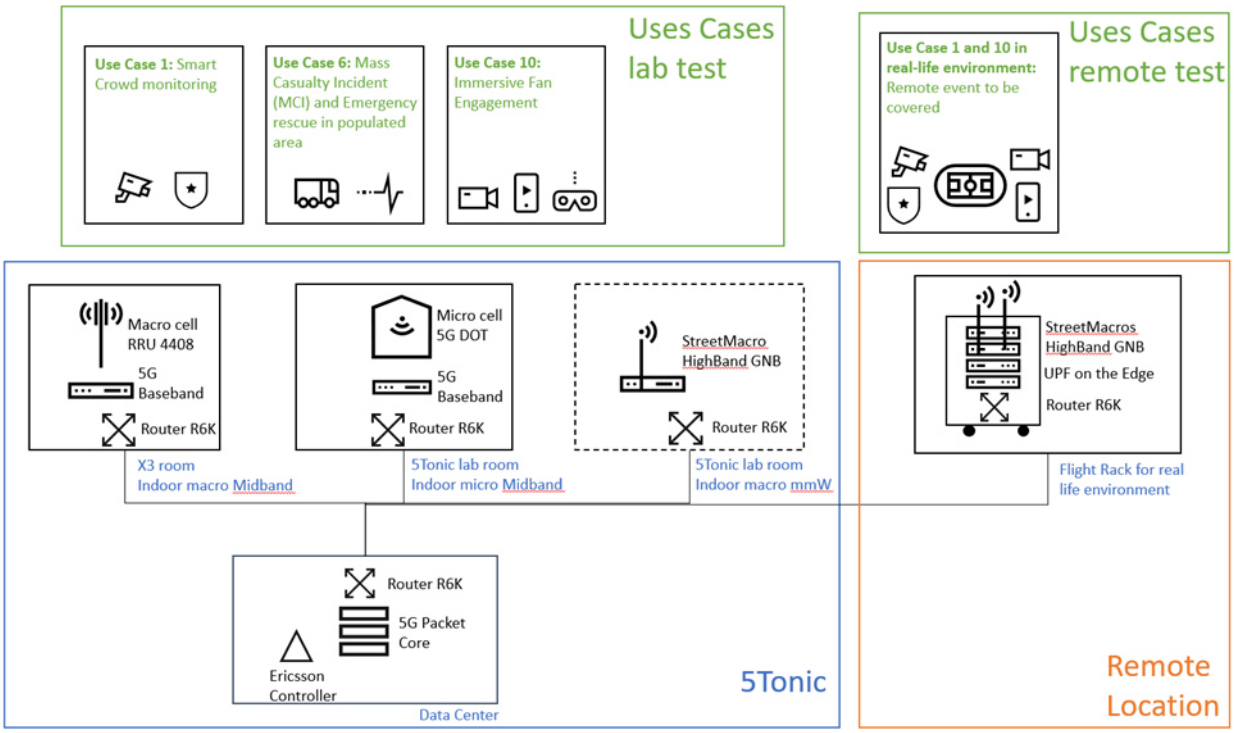


Figure 3. Spanish cluster overall scenario.

5Tonic infrastructure is in a continuous process of improvement and evolution, by incorporating new technologies that allows to experiment with new business cases where 5G technology is key for innovation. In the following sections the detailed infrastructure provided by Ericsson in the 5Tonic laboratory that will support the project is described.

2.3.2 Services offered by the infrastructure

5Tonic has two main areas of RAN coverage called X3 room and 5Tonic lab room respectively, with 5GC CP centralized in the data center (DC). It is also planned a future deployment with high-band node based on the StreetMacro gNB, that will be located also in the 5Tonic lab room. To support the remote tests in real-life environment, a flight rack with high-band antennas and UPF on the Edge will be used.

The actual infrastructure implemented uses 5G RAN equipment in mid-band (n78 - 3,5 GHz) and Stand-alone (SA) technology. Software installed in RAN and CN components are 3GPP Release-16 compliant and support projects with QoS/QoE guaranteed in the concurrent services implementation. As RAN configuration and spectrum available is limited due to commercial agreement by operator, actual network could serve eMBB (700Mbps DL/150MBps UL) or URLLC (E2E RTT <20 ms).

2.3.3 Main assets of the infrastructure

2.3.3.1 RAN X3 room coverage

The main area of coverage, also called X3 room, is the experimentation room and is shown in Figure 4. This main experimentation facility of 5Tonic is where the concurrent experiments are executed. The goal of this area is not only to have access to 5G technology but also to have access to the experimentation tools like for example the KPI framework or the graphical dashboard of the experiments.

Figure 4. X3 room coverage area.

This experimentation room has 5G mid-band outdoor antenna deployed for covering the experimentation facility as well as the outdoor space of 5Tonic. The Figure 5 shows a diagram of the RAN equipment used in the the X3 room coverage area.

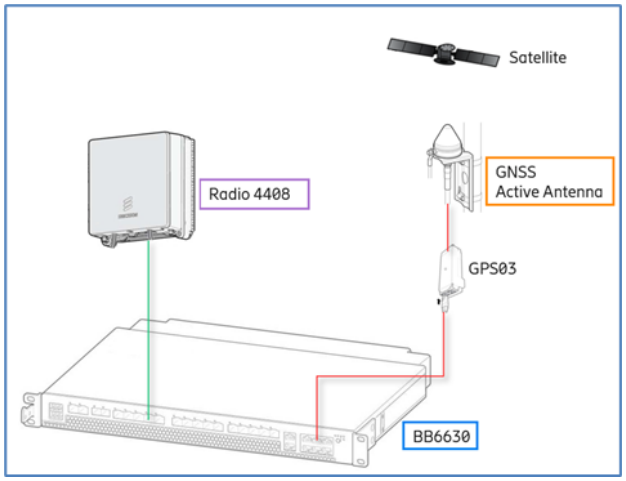


Figure 5. RAN equipment diagram for the X3 room area.

This RAN deployment is composed by the following equipment:

- **RRU 4408 n78L (B43):** Micro radio designed for more flexible and easier deployments and still efficient single and multiband. It consists in a four duplex Transmit (TX)/Receive (RX) branches supporting up to 4 x 5 W output power
- **Baseband 6630:** This equipment provides switching, traffic management, timing, baseband processing, and radio interfacing. It has the capability to be configured in mixed mode (more than one Radio Access Technology (RAT)).
- **Router 6675:** High-capacity access router, designed to provide high density 10 interfaces. It supports VPN services over Internet Protocol (IP)/Multi-Protocol Label Switching (MPLS) networks, service provider Software Defined Networking (SDN), service exposure using Network Configuration Protocol (NETCONF)/Yet Another Next Generation (YANG), extensive QoS and precise synchronization features.
- **Global Positioning System (GPS) receiver (Rx):** This component consists of a Global Navigation Satellite System (GNSS) Active antenna and a GPS signal is needed to have a time and phase synchronization required for 5G with Time-Division Duplexing (TDD) strategy. Precise signal is needed to synch the Download Link (DL) and Upload Link (UL) frames and to synch between the node B sites.

Figure 6 shows the RRU 4408 used for this deployment. Note that is the small antenna below the big antenna that is in the back that was the AIR6488 used in the first 5G deployments.

Figure 6. X3 RRU 4408 n78L (B43) antenna.

2.3.3.2 RAN 5Tonic laboratory

5Tonic also provides coverage to the 5Tonic laboratory room. This coverage is provided using DOTs antennas (small cells) that works in mid-range bands (same n78 band) for 5G NR and has indoor coverage purpose. Figure 7 is a picture of this room, with the DOT antennas installed on the roof.

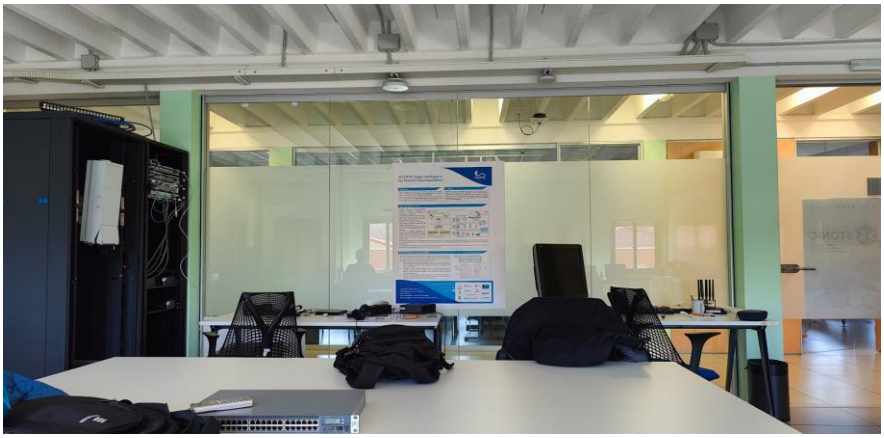


Figure 7. 5Tonic laboratory coverage.

The Figure 8 shows a diagram of the RAN equipment used in the 5Tonic laboratory coverage area:

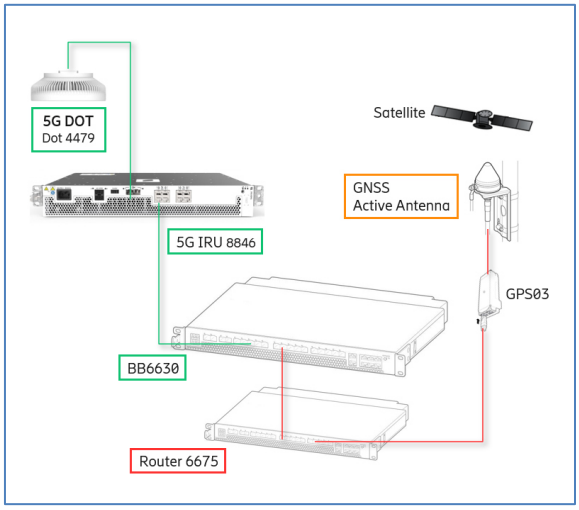


Figure 8. RAN equipment diagram for 5Tonic laboratory area.

This RAN deployment is composed by the following equipment:

- **5G DOT:** Smallest Ericsson's radio used to cover indoor areas for NR 5G purpose. Is a 4x4 MIMO antenna that offers an innovative and high performing solution that effectively connects indoor users to the whole mobile eco-system.
- **5G IRU:** This equipment has the transmission of signals as main purpose. It provides an interface to the Radio DOTs (RDs) through the Radio Dot Interface (RDI) and supplies power to the RDs through the RDI.
- **Baseband 6630:** Equipment that provides switching, traffic management, timing, baseband processing, and radio interfacing. Ithas the capability to be configured in mixed mode (more than one RAT).
- **Router 6675:** High-capacity access router, designed to provide high density 10 interfaces. It supports VPN services over IP/MPLS networks, service provider SDN, service exposure using NETCONF/YANG, extensive QoS and precise synchronization features.
- **GPS receiver:** As was already mentioned in the previous sections, it is used for time and phase synchronization in TDD.

Figure 9 shows the 5G DOT antenna used for this deployment with the IRU and the Baseband in the Rack in the back. This 5G DOT covers the area of the experiments performed in the desk below, as this mechanic arm.

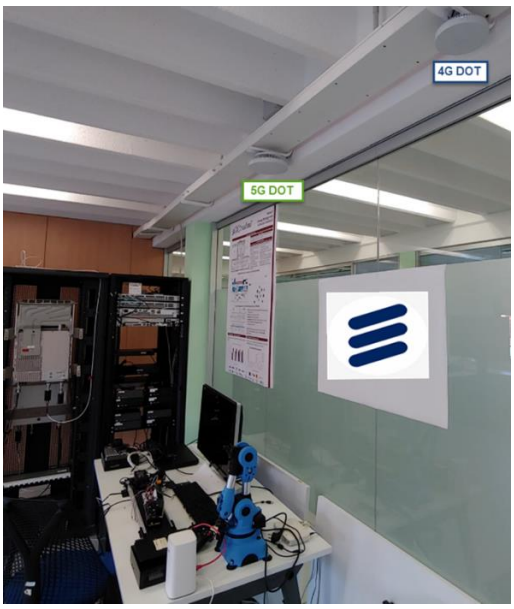


Figure 9. 5G DOT antenna, IRU and Baseband.

2.3.3.3 5G Core

The 5GC is deployed at the 5Tonic DC and it contains the basic NFs required for supporting the 5G System:

- **Basic NF:** NRF, Network Slice Selection Function (NSSF).
- **Subscriber NF:** UDM, UDR.
- **Control NF:** AMF, SMF, Policy Control Function (PCF).
- **User Plane NF:** UPF.
- **Exposing:** Network Exposure Function (NEF).

The 5GC is the cloud-native version of Ericsson and runs on top of a Kubernetes deployment. The Kubernetes-based solution is a container as a service (CaaS) platform that runs directly on the underlying HW, this provides the support for cloud-native applications as the fastest and most cost-efficient way:

- Automation of a Kubernetes over bare-metal cloud infrastructure is easier to achieve since the lack of a virtualization layer significantly simplifies the architecture, with fewer products and components to maintain, and fewer people needed to operate the technology,
- A Kubernetes over bare-metal infrastructure is more suitable for distributed cloud infrastructure deployments to provide edge solutions, where 5GC or Cloud RAN applications are needed,
- The introduction of new acceleration technologies (smart Network Interface Controller (NIC), etc.,) becomes easier for new 5G UCs,
- APP performance is better and more deterministic,
- Savings in the magnitude of 30 percent are possible, including costs for energy, operations and maintenance, software licenses, and HW.

The 5GC running on top Kubernetes over bare-metal infrastructure delivers a simplified architecture compared to running containers in VMs, and greater efficiency, performance, and automation can be achieved. The solution is simpler stack and makes better use of the underlying HW compared to virtualized infrastructure, enabling more efficient continuous integration and continuous deployment capabilities.

2.3.3.4 Portable system

Ericsson developed at 5Tonic a portable system, based on the concept of Non-Public Network (NPN), which is able to provide 5G NR coverage to sites outside 5Tonic premises but using the 5GC and the experimental infrastructure of 5Tonic. This portable infrastructure could support UCs implementation in remote locations.

The design of the NPN deployment shown in Figure 10 takes the advantage of the new capabilities provided by 5G, such as Control User Plane Separation (CUPS) and UP flexibility, to deploy at vertical premises only the equipment required for providing the access network (gNB) and the local break-out of the UP (UPF, transmission routers).

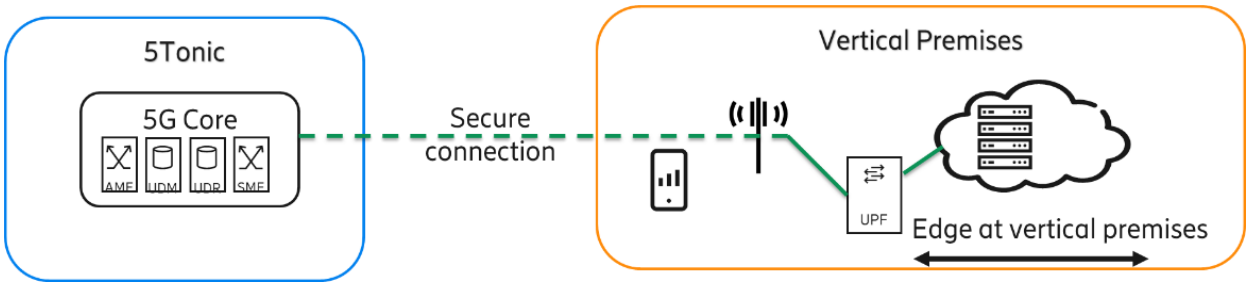


Figure 10. Diagram of NPN deployment.

The on-premises equipment uses a secure connection towards 5Tonic facilities in order to get access to the CP part of the 5GC. The secure connection used is Internet Protocol Security (IPSEC), a secure network protocol suite that authenticates and encrypts packets of data to provide secure encrypted communication between 5GC and 5G RAN. With this on-premises equipment, the 5Tonic 5G coverage can be extended to external premises and hence provide the same capabilities that 5Tonic has, including all the experimentation infrastructure.

2.3.3.5 Controller

Ericsson has a system that is used to orchestrate elements from the network deployed. This element is an open application that is developed to be able, at the RAN side, to collect the configuration of the gNB and counters information related to network behaviour. This system could also make changes in the network configuration and even change RAN features on real-time, but this feature would not be available in the context of the UCs implementation. The system could also operate over the UPF with the same purpose.

2.3.4 Extensions and new features

The actual 5G infrastructure deployed in 5Tonic has supported many UCs related to industry, gaming as the requirements is aligned with what is achievable by the network. However, the analysis of the needs from actual UCs, in terms of high user data rate with small jitter experience, requires the network setup evolves to be feasible.

With this objective, Ericsson and terminals manufacturers roadmap have been studied and conclude the deployment of high band frequencies in combination with Stand-alone technology will the best solution.

High-band have the advantages of:

- Having wider bandwidth and could aggregate more carriers.
- There is a latency reduction in high-band compares with mid-band due to numerology.
- High-band is not largely deployed in Spain compared to mid-band, so it will be easier to deploy in real-life scenarios with not affective operator's user traffic.

Actual Software does not support the combination of high-band with SA, however high-band equipment exists and is supported in a NSA. When Software will be available to support SA case, the network will be updated.

The Figure 11 shows a diagram of the RAN equipment for high band that will be used in the 5Tonic, which is composed by:

- **StreetMacro 6701:** This equipment is for high-band frequency (n257) and includes baseband, RU and antenna.
- **GPS receiver:** As was already mentioned in the previous sections, it is used for time and phase synchronization in TDD.

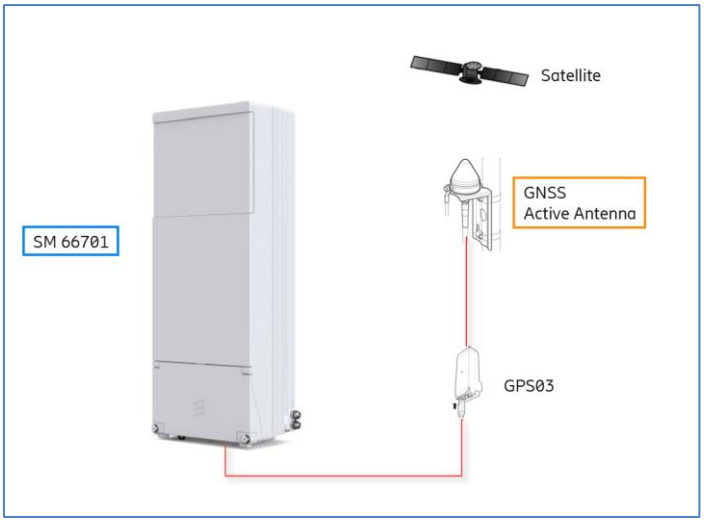


Figure 11. RAN equipment diagram for high-band solution.

Figure 12 shows a picture of the Highband equipment and the installation in the 5Tonic lab coverage area. This equipment is the Ericsson solution for a massive deployment in big cities (is known as StreetMacro), and when the software will support SA technology, will be the B5G solution in the road to achieve demanding requisites of the UCs.

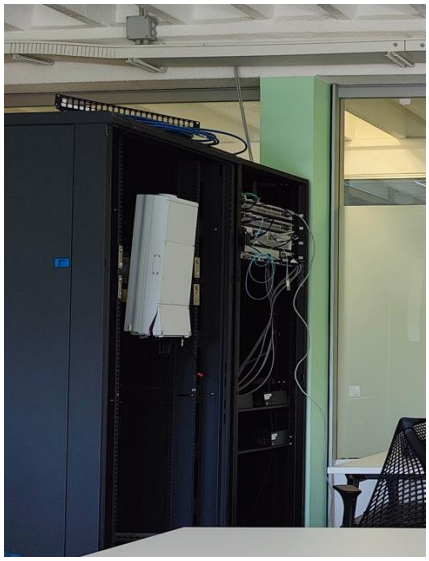


Figure 12. 5G StreetMacro 66701 for high band frequency located in 5Tonic laboratory.

2.4 Romanian cluster

This section describes the main infrastructure components of the Iași site in which UC1 “Smart Crowd Monitoring” and UC4 “Smart Traffic Management” [1] will be implemented and the testbed sibling from Bucharest.

2.4.1 Short description

The ORO 5G Labs, from both Bucharest and Iasi, are the primary locations for hosting the infrastructure for this use-case and will be the desired places for testing and validation of the related applications. The Bucharest 5G Lab is located within the CAMPUS Research Center of the Polytechnic University from Bucharest (UPB) and currently implements a full 5G SA infrastructure. The Iasi 5G Lab, depicted in Figure 13, is ORO’s main testbed for the project and is located within the Iasi Technical University (TUIASI) and currently hosts only indoor 5G SA radio connectivity. In the next months it will be prepared so that it will have similar capabilities to the Bucharest laboratory and in the medium term the RAN will be extended so that the use-cases areas will be covered with 5G SA connectivity. However, the commercial 5G NSA network, with existent coverage on the use-cases areas, will be used initially for piloting and testing of the developed solutions.

Figure 13. Iasi Orange 5G Lab 5G Experimentation Area.

2.4.2 Services offered by the infrastructure

The testbed, with the architecture represented in Figure 14, is capable to provide multi-slices implementations, with QoS/QoE guarantee in the concurrent services implementation, as eMBB (1500Mbps DL/150MBps UL) or URLLC (E2E one way delay <4 ms), based in 3GPP NSSAI parameters.

Use case developers and also potential 3rd party experimenters currently have access to the Edge-Compute facility from the Bucharest 5G Lab that implements virtualization and orchestration features. The deployment of network applications on this infrastructure will be performed through a project dedicated onboarding and instantiation platform that will require minimal inputs from the developer's side.

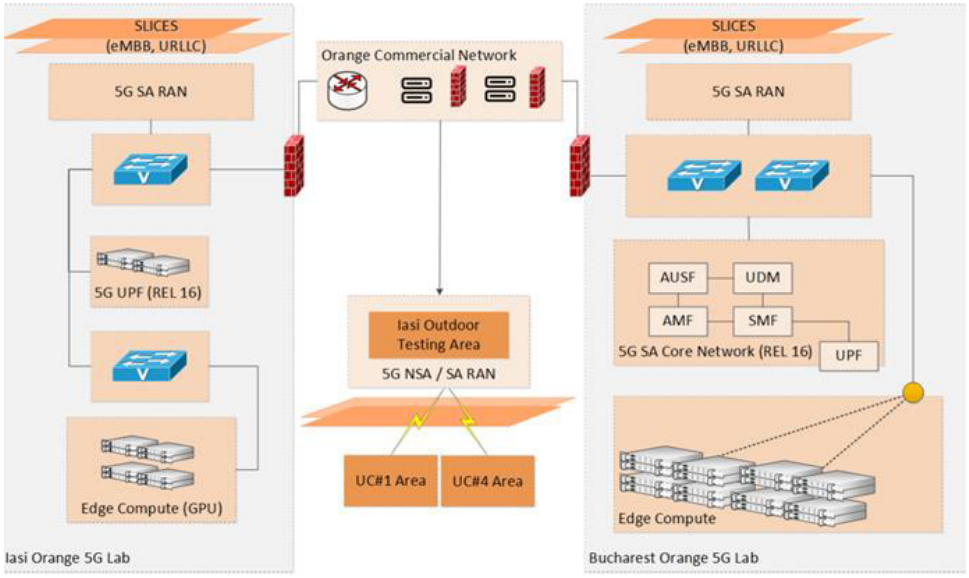


Figure 14. Orange 5G Labs architecture.

The Romanian testbed will pilot the envisioned use cass within two different phases, looking at first at the preliminary results using the current commercial 5G NSA network and then evaluating the applications performance when running on a 5G SA private network:

- **Phase 1:** Testbed deployment started with a commercial 5G NSA implementation in Iasi, for early trials, with the 5G NSA RAN and Core Option 3x (virtualized core solution). In the scope of the project, a private APN will be created, so that all the traffic from the surveillance cameras installed in the use-case areas, as described in D3.1 [1], will be directed to the edge-compute facility from the Bucharest 5G Lab or the one that will be deployed on the premises of the Iasi 5G Lab. The 1st phase will also include testing and validation activities that will be performed indoors, in the Orange 5G Labs from Iasi and Bucharest, through a private 5G SA 3GPP Release 16 network.
- **Phase 2:** In the 2nd phase, ORO's testbed is expected to implement an outdoor 5G service over SA network in a private mobile network concept, that is integrated in the Bucharest 5G Lab testbed from Control Plane and a local UPF in Iasi (Control Plane/User Plane separation) that is 3GPP Release 16 compliant. The 5G is running on dedicated virtualized infrastructure, 5G SA option 2 implementations.

2.4.3 Main assets of the infrastructure

2.4.3.1 Outdoor 5G NSA coverage

As described, for Phase 1, the commercial 5G NSA network will be used for the development and large-scale trial of the envisioned use-cases in the designated areas as well as the private 5G SA network from the 5G Labs indoor premises. For UC1, that will take place on the Stefan cel Mare pedestrian alley, as well as for the UC4, that will run in the Podu Ros intersection area, the 5G NSA coverage is provided as seen in Figure 15 and Figure 16 respectively.

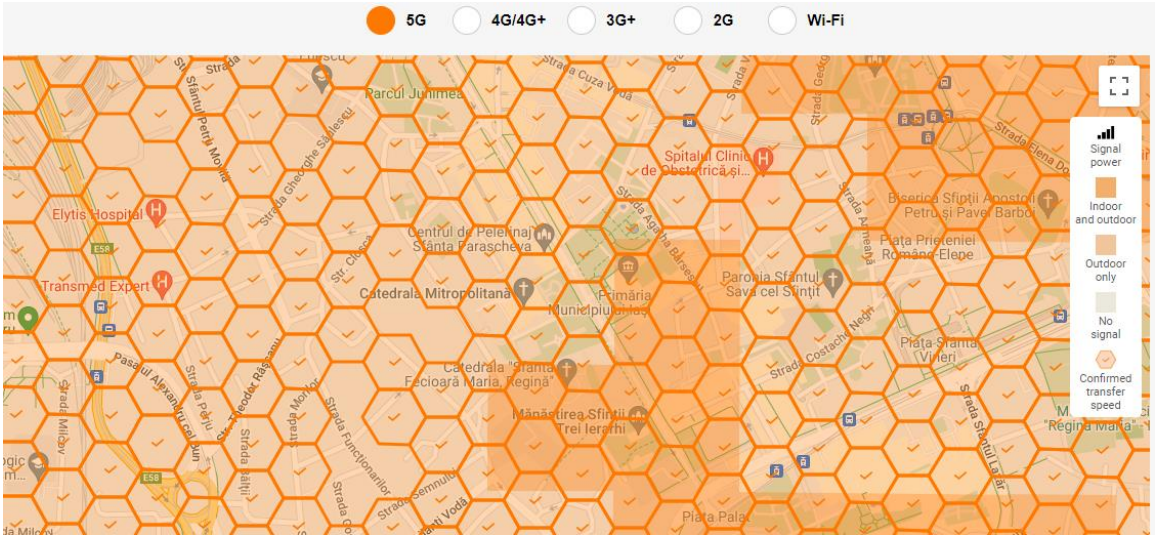


Figure 15. 5G NSA Stefan cel Mare pedestrian alley coverage simulation map.

Figure 16. 5G NSA Podu Ros Intersection coverage simulation map.

2.4.3.2 Network and management functions

In the testbed, OSMv12 is ORO's orchestrator that is compliant with ETSI MANO architecture and is offering an orchestrator tool that integrates with infrastructure controllers and can build different VNFs and Network Slices across all the platforms inside the lab. It will act as an umbrella deployment and management tool for different slice networking deployment, 5G ready use cases. Ansible and Terraform are the automation core tools triggered from CI/CD managers that create the automation back bone of the 5G lab used for provisioning and configurations of any applications. All these tools are facilitating automation in TrialsNet and make the environment ready for any integration oriented in 5G SA present and future use cases that will come through the open-call program.

2.4.3.3 Edge-Compute facility

The edge-compute facility that will be used in the Romanian testbed will be hosted in the Iasi 5G Lab datacenter and can be extended to the Bucharest 5G Lab datacenter if needed. It will feature two HPE servers of which one will be fitted with a NVIDIA GPU for Machine Learning acceleration tasks. This testbed infrastructure will be ready to host and accommodate applications and services in both bare metal and containerized forms by leveraging both classical virtualization software as well as containers orchestration tools.

2.4.3.4 Applications onboarding platform

In the context of unitary Applications onboarding steps, the Romanian testbed onboarding platform, developed in the context of H2020 VITAL-5G project (GA #101016567, 2021-2023, 5GPPP), will be implemented as a flexible platform, which can be adapted to serve and streamline the specific needs of the UC#1&4 application developers and 3rd party experimenters, being focused on the creation, deployment, management and validation of applications, including service & network monitoring, slice inventories, service and testing capabilities and orchestration. By setting up an integrated web portal, where the Application developers can select the needed resources from the service catalogue, ORO aims to ease the integration of applications that require novel 5G services.

2.4.3.5 Secure access to the TrialsNet platform for developers

In the scope of the TrialsNet project, ORO will install in the premises of the Iasi 5G Lab Datacenter a security solution designed to alleviate the issues and concerns that may appear in the open-call experimenters onboarding and operation phases. A firewall deployment will streamline the access procedure to the testbed for the experimenters and will assure the proper isolation between different network applications and services.

2.4.3.6 Equipment for experimentation

Orange Romania is able to provide to interested 3rd parties a set of devices that are compatible to both 5G SA and NSA networks and are able to support the development of novel 5G-enabled use cases. The devices are depicted in Table 1.

Table 1. Orange Romania devices for 3rd party experimenters.

Equipment	Item	Description
	Milesight MS-C8266-X4GPC	The Milesight MS-C8266-X4GPC is a 5G SA/NSA surveillance camera that can record 4K footage. This camera will be used for 2K/4K video capturing in the area defined for the use-case. This video stream will be transmitted directly to an Edge-compute facility via the 5G SA/NSA network, this way eliminating the security risks involved with the transmission of sensitive data through publicly accessible switches.
	Nokia FastMile 5G14-B	The Nokia FastMile 5G14-B is a 5G SA/NSA outdoor CPE that can connect simultaneously to multiple slices, with different IPs and different Package Data Unit (PDU) sessions, with a single SIM card specifically provisioned to support 2 or more DNN profiles. The CPE splits the traffic into separate VLANs and ends the connection into a switch that allows devices to access different slices. This Nokia CPE is also able to connect to a TR-069 Automatic Configuring Server (ACS), this way being able to transmit real-time metrics about the UL and DL traffic values for the connected slices and the radio signal parameters. The CPE will be configured to connect to both an eMBB slice and an URLLC slice. This way, the non-cellular cameras and the sensors will use the eMBB for data transmission, while the VRUs will be notified by the security system through the URLLC slice.
	Quectel 5G M2 EVB and RM500Q-GL	The Quectel 5G M2 EVB is a development board on top of which we can place the Quectel RM500Q-GL, this way being able to connect to both 5G SA and NSA and pilot different use cases and devices. The board is fitted with USB C and Ethernet connectivity.

2.4.4 Extensions and new features

In the scope of the project, in order to improve the E2E system latency for UC#1 and UC#4, the 5G network architecture will be further developed in a Distributed Cloud/MEC type of approach with the deployment of a virtualized UPF in the Iasi 5G Lab Datacenter. This UPF will be integrated in the 5G SA CN from Bucharest (Control Plane), will be connected to the Iasi gNBs and the local edge-compute facility and will have direct access to several DNNs (including Internet).

The proposed design, highlighted in Figure 17, is taking into consideration all the network segments and transmission characteristics, for latency between UE and base station (LLC slice) ≈ 3ms, gNB to 5GCN ≈ 1.5ms and 5GCN to MEC less than 0.5ms, as they are collocated and fiber links interconnected, offering the E2E delay budget of ≈ 4.5ms, under analysis from the Network Application perspective for the UC1 and UC4 envisioned developments based on video feeds from surveillance cameras.

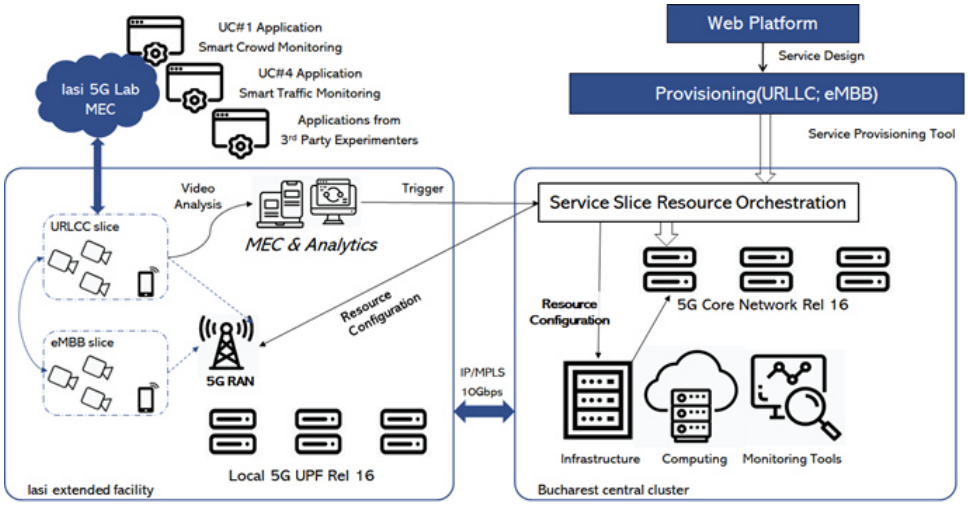


Figure 17. Romanian testbed MEC implementation.

2.5 Romanian cluster (experimental facilities in Belgium)

The IMEC testbed ecosystem located in Belgium provide an experimentation setup based on real-life testbeds such as CityLab, Smart Highway, and 5GOpen. Although in the TrialsNet project, this experimental site is defined as a supporting trial site for the Romanian cluster use cases, for the Open Call, it will be used as a completely standalone (i.e. independent from the Romanian cluster) testing setup with network and virtualized infrastructure resources to support the implementation and trials of third parties use cases.

2.5.1 Short description

This ecosystem provides an extensive experimentation setup based on real-life testbeds such as CityLab Smart City, Smart Highway, 5GOpen, and portable 5G. As such, the overall setup is being used as supporting trial site for the Romanian cluster and use case Smart Traffic Management, where IMEC is using both network and virtualized infrastructure resources to build and test the 5G and beyond enablers such as zero-touch network and service management, flexible and autonomous radio resource management, and creation of flexible and virtualized vertical service deployments following the design of Edge Network Applications.

2.5.2 Services offered by the infrastructure

The IMEC testbed ecosystem provides the following services:

- **Edge computing capabilities**: various distributed edge computing nodes deployed within CityLab and Smart Highway testbed, offering computing capabilities for sensor data fusion & large-scale analytics, as well as deployment of latency-sensitive services close to the end users (e.g., vehicles and vulnerable road users)

- **Real-time monitoring of resources and services**: tools for monitoring performance of services and their resource usage are available on the testbeds described in the following subsection, offering dashboards to monitor performance, but also databases and APIs to collect real-time and historical data potentially useful for training AI/ML models
- **Smart orchestration of edge services**: open-source orchestration tools such as Open-Source MANO and Kubernetes are used on all testbeds to perform orchestration of edge services, including necessary extensions in terms of intelligent decision-making algorithms that improve the overall decision-making taking into account service requirements and real-time network performance
- **Flexible radio resource management**: O-RAN-based frameworks that facilitate the use cases in terms of optimal configuration of available wireless technologies (5G and Wi-Fi) based on the data traffic requirements and the wireless environment conditions.

2.5.3 Main assets of the infrastructure

2.5.3.1 CityLab testbed

The CityLab testbed is intended for large-scale wireless networking and edge computing experimentation in a highly realistic environment in an area of 0.5km by 0.5km in the city of Antwerp. The 50 CityLab IoT gateways work as edge nodes for sensor data fusion and large-scale data analytics.

2.5.3.2 Smart Highway

The Smart Highway test site is built on top of the E313 highway, and it consists of a highway strip of 4 km equipped with Roadside Units (RSUs). The testbed concerns various application domains such as Smart Mobility, Cooperative, Connected and Automated Mobility (CCAM), and Autonomous Driving. As such, it is designed for Vehicle-to-Everything (V2X) communication & distributed/edge computing research, thereby providing means for creating scalable and reliable V2X system, with opportunities to validate automotive requirements for automated driving with industry in real-life trials. Besides the RSUs that are deployed along the highway, there are three Onboard Units (OBUs) which are either in-vehicle or rooftop units. The important feature of such OBUs is their flexibility and adjustability, as they can be easily mounted on any regular car. In addition to that, testbed is equipped with two testing vehicles that can be used in experimentation activities. The Smart Highway testbed consists of seven RSUs in total, and they are deployed on top of the gantries along the E313 highway in Antwerp. Each of those RSUs is fully managed remotely, which facilitates the federation of testbed resources and resource usage by external experimenters. The testing car is a BMW X5 with automatic gearbox from 2014 that is provided by the University of Antwerp. The car is equipped with an OBU, power system, and communication hardware. Both in-vehicle and rooftop OBU are equipped with computing capabilities as well, with Intel NUC7iDNKE and Nvidia AGX Xavier, respectively. This car can be driven and used as a mobile node in a 6G V2X context. The Smart Highway architecture empowers researchers and external experimenters to place functions at different computational locations ranging from the OBU up to the cloud, leveraging RSUs as distributed edge computing units. Latency, network load and processing time can be further reduced by dynamically selecting the location of the data processing and the used communication links.

2.5.3.3 5GOpen testbed

The 5GOpen testbed is located in Antwerp offering indoor and temporarily outdoor 5G connectivity based on two gNodeBs and a 5G Core Stand Alone deployment where different combinations of Open RAN combinations can be tested. IMEC has obtained a Belgisch Instituut voor postdiensten en telecommunication (BIPT) test license, which is valid for the 3800-4200MHz frequency range (N77 upper) and the stretch on the road covered by the above-mentioned Smart Highway testbed. One of the planned activities is to extend this license to the CityLab locations where gNodeBs are scheduled for deployment. Currently, 5GOpen testbed is deployed as a testbed in a box, containing both radio and core capabilities, offering tools to pursue 5G validation, integration and testing, in both office and open environments. On the Core side, we have OpenAirInterface (OAI), Open5GS, and Free5GC. The 5G New Radio (NR) is based on OAI and srsRAN. Further, for User Equipment (UE), we use Commercial Off-The-Shelf (COTS) implementation (Intel NUC with 32GB RAM, and Intel i7-10710U processor) with Quectel modules (RM500Q). Finally, to enable computing capabilities of the testbed, we enabled Proxmox enabled Supermicro servers suitable for provisioning virtualized resources, 128GB RAM,

two Intel Xeon E5-2620 CPUs (8 Cores, 16 Threads each), and one USRP X310 over 10GB link to passthrough to VMs where application services and AI/ML models are running.

2.5.3.4 Portable 5G testbed

The portable 5G testbed is located in Ghent, offering a transportable 5G standalone network in a box solution that can be used for 5G network testing, experimentation and novel research on 5G and beyond network technologies. The testbed consists of two portable 5G units including both commercial off-the-shelf (COTS) and software defined radio (SDR) equipment enabling flexibility for extensions and customization beyond features offered in 3GPP releases and capability for end-to-end experimentation involving business-critical and/or mission-critical applications with demanding QoS requirements in dynamic wireless environments.

2.5.4 Extensions and new features

The integration of 5GOpen testbed with CityLab and Smart Highway testbeds is ongoing and planned to be finalized during 2023, for the purpose of providing 5G connectivity in all test sites within IMEC testbed ecosystem, and to ease the integration of zero-touch mechanism into the Romanian cluster. In addition, testing vehicles are part of the Smart Highway testbed and as such will be equipped with corresponding 5G modems and additional testing equipment. Also, some of the planned upgrades for both CityLab and Smart Highway testbed are related to the sensors (air quality, lidar) are planned for purchase and installation in order to enrich the testbed capabilities for testing smart city and automotive applications, AI/ML capabilities at the network edge, among others.

The deployment and validation of capabilities for advanced zero-touch service management and flexible and autonomous radio resource management is going to be performed within the IMEC testbed ecosystem, focusing on the Smart Traffic Management use case. Such or similar use cases can be deployed and demonstrated to validate the effectiveness of intelligent traffic management within a robust zero-touch management of edge services.

2.6 Greek cluster

This section describes the main infrastructure components of the Athens site in which UC2 “Proactive Public Infrastructure Assets Management” [1], UC3 “Autonomous Apron” [1], UC6 “Mass Casualty Incident (MCI) and Emergency Rescue in Populated Area” [2], UC11 “Service Robots for Enhanced Passengers' Experience” [3], and UC13 “Extended XR museum experience” [3] will be implemented.

2.6.1 Short description

Use cases of the Greek cluster will be trialed at the Athens airport (AIA) and at public area in the city of Athens such as Technopolis venue. At these locations the Greek cluster will mostly rely on the commercial 5G network. In addition, WINGS private network infrastructures will be also utilized for leveraging its high-speed connectivity, low latency, and wide coverage to support the data-intensive applications required by the use case, to conduct testing activities, validation and demonstration, prior to the deployment on the field but also to allow for greater flexibility in the experimentation.

2.6.2 Services offered by the infrastructure

The public, commercial 5G network uses NSA architecture and operates at a frequency of 3.5 GHz. The allocated band for this network is 80-100 MHz, which will provide high-speed connectivity and low latency to support the data-intensive applications required by the use cases.

The WINGS testbed provides E2E 5G/B5G functionality, along with extensive cloud and edge computing capabilities, leveraging the 3GPP (Release-16 and beyond) Public Network Integrated Non Public Network (PNI-NPN) with shared CP (at a first phase) and isolated, Stand-alone Non-Public Network (SNPN), with all NFs (UP and CP) inside WINGS premises, isolated from the public network in the final phase. The site offers a range of 5G/B5G services and will be gradually evolved to 6G. It supports- various vertical domains, with WINGS providing the necessary HW, software, and configurations to enable the testbed to handle these UCs. WINGS testbed serves as a testing ground for services, equipment, and new features before they are commercially released. Figure 18 reports the WINGS testbed high-level architecture.

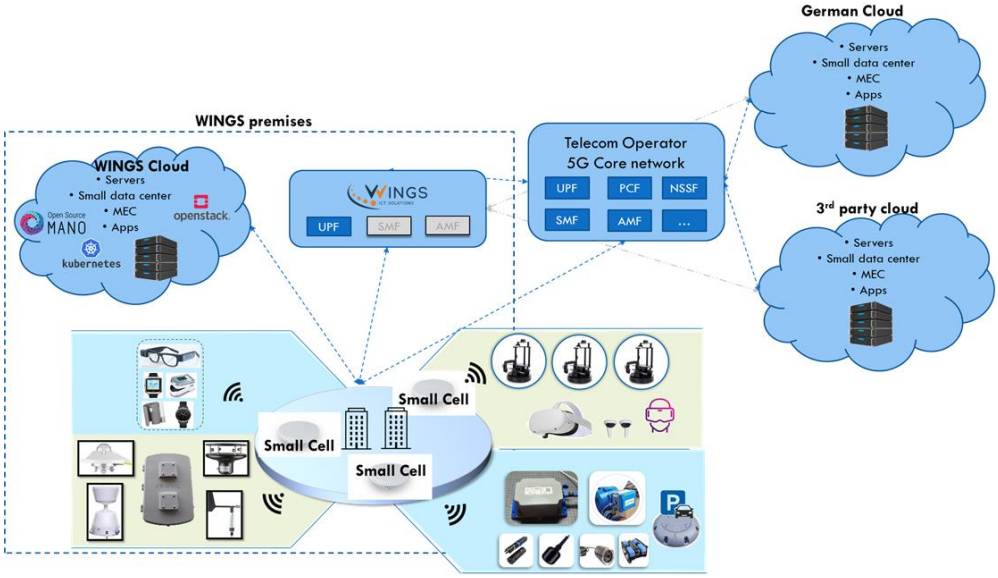


Figure 18. WINGS testbed architecture for experiments

WINGS has progressively extended the existing software, HW, and network functionality to support Cloud, Mobile Edge Computing (MEC), Extreme Edge and IoT functionalities. WINGS has demonstrated advanced UCs on DTs, Collaborative Robots with native-AI B5G/6G capabilities of the system. Also, the required frameworks to build, test, and validate innovative 6G applications are part of the overall infrastructure.

The WINGS testbed utilizes AI mechanisms to support diagnostics, intelligent management, and orchestration. The management of the facility is done using a combination of existing and new software, covering DevOps, AI/MLOps, monitoring, profiling, diagnosis, and service-aware resource allocation and orchestration. An AI-enhanced MANO component inherited from 5G-TOURS project is used to enable advanced automation and optimization. Monitoring, profiling, and diagnostic components provide information on available resources and network capabilities to help find the optimal deployment of a vertical service.

The WINGS testbed utilizes open-source software such as Openstack, Kubernetes and OSM MANO to provide a flexible and scalable infrastructure for verticals, as well as other open-source tools like Kafka, MQ Telemetry Transport (MQTT) and Robot Operating System (ROS). These components can support VMs, containers, and serverless execution of code from cloud to extreme edge devices such as raspberry pi.

The WINGS testbed prioritizes protection and privacy-preserving mechanisms to ensure reliability, security, privacy, confidentiality, and integrity of data. Open-source tools like Keycloak or Blockchain technology may be used where appropriate, and OpenNAC for Network Access Control. Strong authentication, user management, and secure services will be provided with minimum effort from the verticals. The solutions selected will comply with General Data Protection Regulation (GDPR) article 5 to ensure appropriate security and protection against unauthorized or unlawful processing, accidental loss, destruction, or damage. They will employ consolidated Public Key Infrastructure (PKI) certificate-based cryptographic systems for critical communications to encrypt personal data during transmission.

2.6.3 Main assets of the infrastructure

2.6.3.1 WINGSPARK++

The WINGSPARK++ platform (see Figure 19) is a fully integrated management system for transportation and infrastructure that provides solutions for various stakeholders such as public and private transport providers and infrastructure operators. WINGSPARK++ utilizes advanced monitoring, fault detection, performance optimization, security, and configuration capabilities in the areas of infrastructure, parking, and stations. As part of the TrialsNet project, data collected from multiple sources will be transmitted through the 5G network, enabling further data extraction, and processing. The resulting data will be ingested into a highly scalable datastore, which will serve as input for AI processing. WINGSPARK++ will leverage advanced AI technologies to analyse data

and provide insights, such as infrastructure faults. In addition, the platform will enhance its user interfaces with a dashboard that will provide insights and alerts to the remote experts. To further improve accessibility and convenience, mobile apps will also be developed, providing users with easy access to information and insights on the go. WINGSPARK++ will be used in UC2, UC3 and UC11.

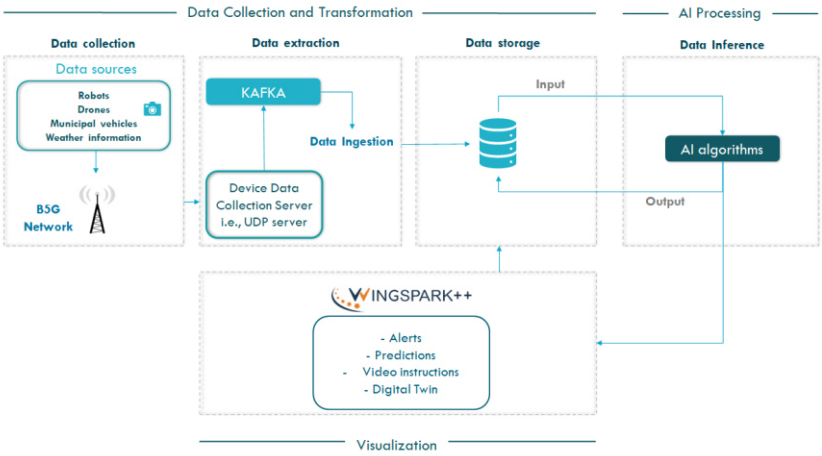


Figure 19. Overview of WINGSPARK++ platform.

2.6.3.2 WINGS STARLIT++

WINGS STARLIT++ (see Figure 20) is a cloud-based platform that will be used for UC6. The services provided will be an extension of the functionalities of the existing STARLIT platform (https://www.wings-ict-solutions.eu/startlit/). STARLIT++ will exploit devices such as cameras, drones and robots to develop an electronic triage monitoring APP to handle victims' health data, triage status, and its dynamic development through secondary and transport phase, current location, while support for evacuation operations will also be provided. The devices capture images, video, and other data, which are transmitted over 5G networks to a central platform for processing and analysis using AI models and techniques. For the MCI case, devices, will also comprise wearable devices for monitoring of vital signs, such as heart rate, oxygen saturation, body temperature, blood pressure, etc. The platform comprises AI powered mechanisms for providing insights on a range of factors (e.g., estimated number of victims, potential issues for first responders to address in the field, estimated location of users, user's vital signs evolution, forecasting of future issues and health emergencies, notification for designated doctors and first responders, etc). In addition, the routing algorithms to be developed (adapted to the particular needs of the project) for the calculation of the optimal evacuation routes, will be connected as a service to the STARLIT platform. This way, a direct and continuous transfer of data is to be utilised, to make use of the latest updated information collected and to channel the generated information through the common applications/interfaces to be decided and defined for each scenario (e.g., a smart device or XR glasses, tec.).

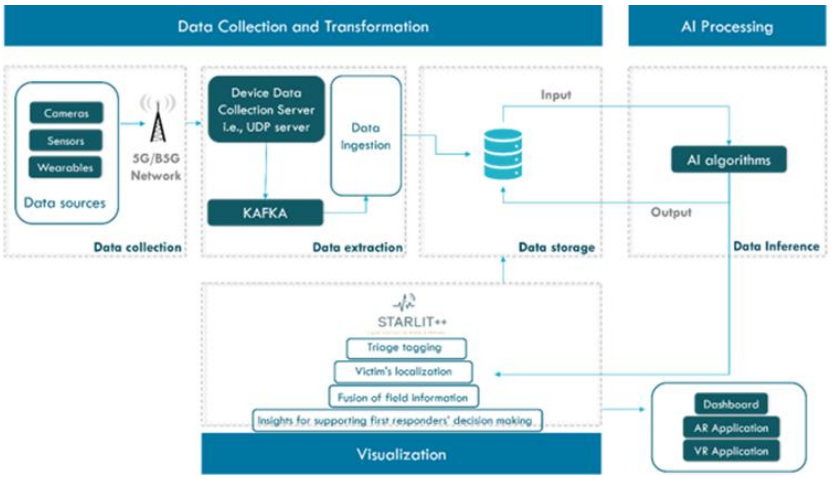


Figure 20. Overview of STARLIT++ platform.

The current list of equipment and devices used in the Greek cluster for the supported use cases is presented in Table 2. It should be noted that the list may be augmented as the implementation of the use cases progresses.

Table 2. Equipment and devices for Greek cluster.

Equipment	Item	Description
	Clearpath Robotics Jackal Unmanned Ground Vehicle	Clearpath Robotics Jackal Unmanned Ground Vehicle/UGV is a small, fast, entry-level field robotics research platform. It has an onboard computer, GPS, 3D LIDAR, camera and IMU fully integrated with ROS. Jackal's chassis is made entirely from welded aluminium and provides IP65 protection rated to operate from -20 Celsius or +45 Celsius. The high torque 4x4 drive train gives Jackal maximum traction, with enough on-board power available to traverse obstacles or unconsolidated terrain.
	Tarot Quadcopter Custom Drone + PixHawk controller	A custom-made quadcopter with a PixHawk flight controller and carbon ultra-light weight body can be an excellent tool for aerial photography, mapping, and surveying applications. The PixHawk is a popular open-source autopilot system that provides advanced control algorithms for stabilization, navigation, and mission planning. The PixHawk flight controller provides stable and reliable flight performance, thanks to its advanced sensor fusion algorithms that combine data from multiple sensors, including accelerometers, gyroscopes, and magnetometers. This ensures that the quadcopter remains stable and responsive, even in challenging environments.
	Rasberry pi 4	The Raspberry Pi 4 is a powerful single-board computer that can be used for a wide range of applications, including drone technology. Its quad-core ARM Cortex-A72 CPU running at 1.5GHz, combined with its high RAM options, makes it a suitable choice for drone technology. With its small form factor, low power consumption, and various connectivity options, the Raspberry Pi 4 can be integrated into a drone's flight control system, providing real-time data processing, image and video capture, and even remote-control capabilities. Additionally, the Raspberry Pi 4's multimedia capabilities can be used to enhance a drone's camera and video streaming capabilities.
	Ouster OS1	Some of the sensors that will be used are the Ouster OS1 which is a type of LIDAR sensor used for 3D imaging applications. LIDAR stands for "light detection and ranging" and it uses lasers to generate a 3D map of the surrounding environment. The Ouster OS1 is designed for use in robotics and autonomous vehicles like the Jackal robot. The sensor has up to 128 laser beams that emit light in a 360-degree pattern, allowing it to capture a comprehensive image of the surrounding environment. It has a range of up to 200 meters and can generate up to 5.2 million points per second. In this robotic use case, the Ouster OS1 can be mounted on a robot/autonomous vehicle to provide a real-time map of the surrounding environment. The LIDAR data can be used to help the robot navigate and avoid obstacles, such as walls, people, or other vehicles delivering a clean, dense data across its entire field of view for accurate perception and crisp mapping.

	Intel RealSense Depth Camera D455	Intel RealSense Depth Cameras will be integrated into the robots, to capture images of faults and other defects. By using these cameras, the robots will be able to more accurately and efficiently identify and address issues within the area. The high-resolution capabilities and depth sensing based on stereo camera array of these cameras will provide a level of detail and precision that would not be possible with traditional inspection methods. The cameras can capture full HD video to up to 10 meters combining depth information with a wide field of view making it the preferred solution for applications such as robotic navigation and object recognition even in low-light areas allowing robots to navigate spaces in dark environments.
	Vision RTK 2	GPS devices will also be incorporated into the robotic assets to facilitate easy tracking of their location. This integration will enable the system to monitor and control the movement of the robots with greater accuracy and precision, avoiding potential hazards and obstacles. The selected GPS receivers use GNSS technology to provide location solutions that are 100 times more accurate (centimetre-level positioning) than traditional GNSS solutions. The combination of GPS and camera data will be used to train AI/ML algorithms for analysing the environment. This analysis will run on specific GPUs like the NVIDIA's GeForce RTX 3070 GPUs or newer for a better and faster analysis of the collected data. With tensor and cuda cores the system will be optimized for parallel computing or accelerated deep learning and AI workloads that this use case needs.
	Samsung Galaxy S10 5G	This Smartphone will be used for the mobile applications, including the XR application that will be provided for the evacuation case.
	Smart watch (A16) Aitaer Technology Co., Ltd	This smartwatch will be used as a device for monitoring of vital signs of the injured people in order to be analysed in real time in the STARLIT++ platform.
	LoCoBot WX250	The LoCoBot WX250 robot is a versatile robot designed for use in various industries, including transportation, logistics and healthcare and is capable to be transformed into different forms by adding sensors, screens, or even a 3D printed body to form a more visually pleased robot for better interaction with humans. The robot can be equipped with stereo camera, lidar, a 5G wireless module, and Global Positioning System (GPS) equipment, making it an ideal tool for the airport operations use case described. With its powerful depth sensing capabilities that can capture both Red Green Blue (RGB) and depth images the robot's internal computer can generate depth maps of the environment, thus accurately detecting the presence of people and objects in the airport terminal with estimation of their distance from the camera. The high-resolution video can be sent to the cloud platform for further analysis of the environment and crowd analysis.

	Intel® RealSense Depth Camera D435	The integrated Intel RealSense Depth Camera D435 can capture high-quality images and videos, can be used for a variety of tasks, such as passenger recognition, tracking, and anomaly detection.
	RPLIDAR A2M8 360° lidar	The robot is also equipped with lidar, which use laser beams to detect obstacles in the environment. The lidar can be used to map the airport, and also detect passenger flows and congestion. Specifically, the RPLIDAR A2M8 360° lidar is a powerful sensor that can scan the area around the robot and create a detailed 3D map of the surroundings, which can be used to accurately detect the presence and position of people and objects. In the context of the use case described, by using the 360° scanning capabilities of the lidar, the robot can create a detailed map of the check-in area and detect any anomalies in real-time, allowing it to alert the TOS and their office assistant and take action to prevent congestion and improve the passenger experience.
	Quectel RM500Q-AE wireless module	The 5G wireless module (Quectel RM500Q-AE) allows the robot to communicate with other devices and systems in real-time. This feature is essential for the airport operations use case as it enables the robot to receive data from sensors and transmit information to the TOS. The Quectel RM500Q-AE is a 5G cellular module designed for high-speed data transmission in various industrial applications supporting download speeds of up to 2.5 Gbps and upload speeds of up to 660 Mbps over different cellular network standards, including 5G New Radio (NR), LTE-A Pro, LTE-A, and Wideband Code Division Multiple Access (W-CDMA), allowing it to operate in different network environments. The module features built-in of most Global Navigation Satellite Systems. The module is designed for industrial applications that require reliable, high-speed data transmission and accurate positioning information. Its multi-mode support and industrial-grade design make it suitable for use in various environments and applications.
	NUC8i3BEH MiniPC	With the utilization of the sensors the robot can use its cameras and lidars to inspect the airport facilities for infrastructure faults, defects, and cleanliness issues. It can alert the relevant help desk if any issues are detected. The initial computation is done at the robot internal computer an Intel NUC NUC8i3BEH Mini PC which is a compact desktop computer that is powered by an 8th Gen Intel Dual-Core i3 processor with 8GB of DDR4 RAM, which provides ample processing power and memory for these computing tasks. The NUC8i3BEH also comes equipped with WiFi, Bluetooth 5.0, Gigabit Ethernet, Thunderbolt 3 and USB C connectors allowing connection to the internet and other devices with ease.

2.6.4 Extensions and new features

As part of the effort to support the envisaged KPI target values, work in the scope of the project will focus on the enhancement of the WINGS private network infrastructure with the small cells and the 5GCN functions. Further enhancements include adaptation of the WINGSPARK++ platform for UCs 2, 3 and 11 and of the STARLIT++ platform for UC6. Initial testing will take place in Q1 of 2024. Further testing will take place at the Q1 of 2025 with execution of the final trials towards the end of the project (Q3 of 2025).

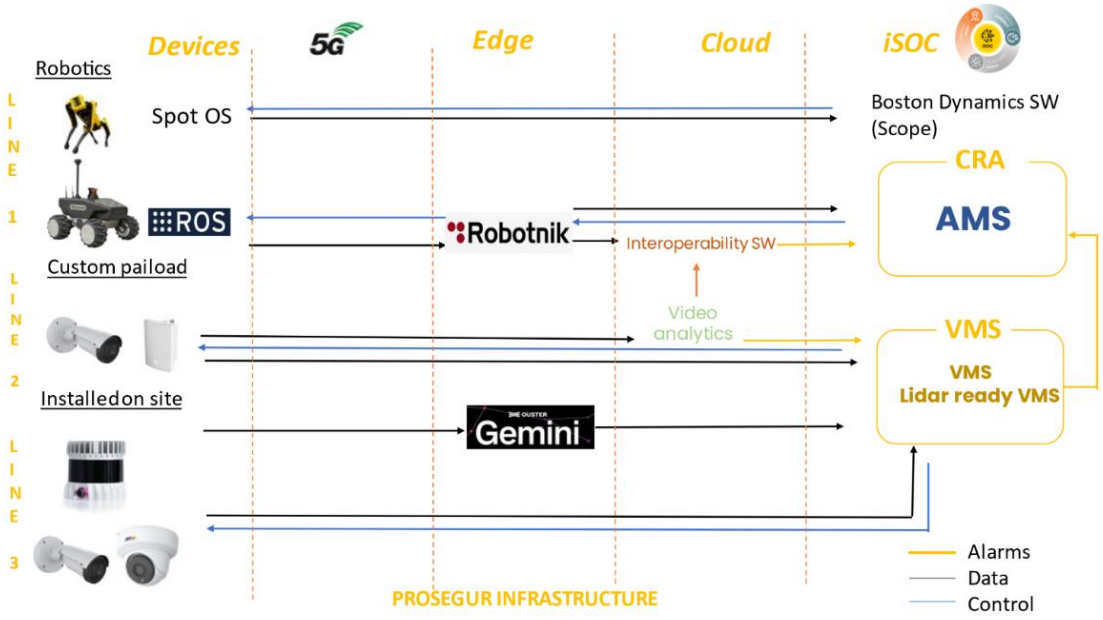
2.7 Challenges of the TrialsNet infrastructures

In the following some examples of challenges that could be addressed in order further extended the TrialsNet's infrastructures and functionalities are reported:

- Expanding the TrialsNet sites with new platform and network solutions in support of the use cases implementation
- Adding new clusters in the TrialsNet project, including new infrastructures in terms of experimental, private and/or commercial networks
- Unification of the TrialsNet infrastructures with common platforms for network monitoring and edge applications deployment
- Adding Network Exposure Functions capabilities to the TrialsNet infrastructures
- Integrating network sensing capabilities in the TrialsNet infrastructures to save energy
- Expanding the TrialsNet infrastructures with O-RAN compliant solutions, including RAN infrastructure, RICs and xApps
- Expanding the TrialsNet infrastructures that host traffic-heavy applications with Content Distribution Networks for improved QoE

3 Description of TrialsNet use cases

This section provides an overview of the 13 use cases that will be implemented in the context of the TrialsNet large-scale trial activities. For each use case a short description and main objectives are reported, main implementation aspects (including equipment and devices) are described, and examples of challenges that could be addressed to enhance the use case are also listed.

UC1 – Smart Crowd Monitoring (Madrid)
Use case description and main objectives
The use case is oriented to deploy several technology solutions that enable to ensure the security and safety of people at highly busy areas whether they are concentrated in one area or moving from one area to another. The use of surveillance cameras and LIDARs together with artificial vision algorithms will be applied to support in the following tasks: crowds prevent free access to the facility, violent activity such as people fighting or riots, vandalism, weapons, suspicious activities such as loitering, or person running and abandoned bags. Fixed and robot-based cameras will send the video streams to the cloud where different AI algorithms will help to detect the above-mentioned risky situations. Moreover, two terrestrial robots will circulate around the environment facilitating vision through its onboard cameras. The communication between the devices deployed at the facility towards its control Software (SW) deployed in the Edge will use the 5G network for the communication.    **Application architecture**
Implementation aspects, equipment, and devices
Two robots' models will be used. The first is Yellow, a robot that will be teleoperated by a trained operator by Boston Dynamics software. The second robot, Kiiro, will move completely autonomously. This robot will send its status and malfunctions to its proprietary software (Robotnik-KMI). The Robots have an onboard payload, this is, a backpack with the electronic components necessary for the security service. It includes cameras, intercom, computers for artificial intelligence, etc. The video and audio streams are sent to the iSOC VMS (Video Management System). Cameras and LIDARs will also be used and will send data to VMS and Gemini software. AMS (Alarm Management Systems) is an advanced alarm management system that allows users to monitor and manage alarms from multiple locations in real-time. The network infrastructure to be deployed for this use case will be a 5G/B5G Ericsson Non-Public Network (NPN).

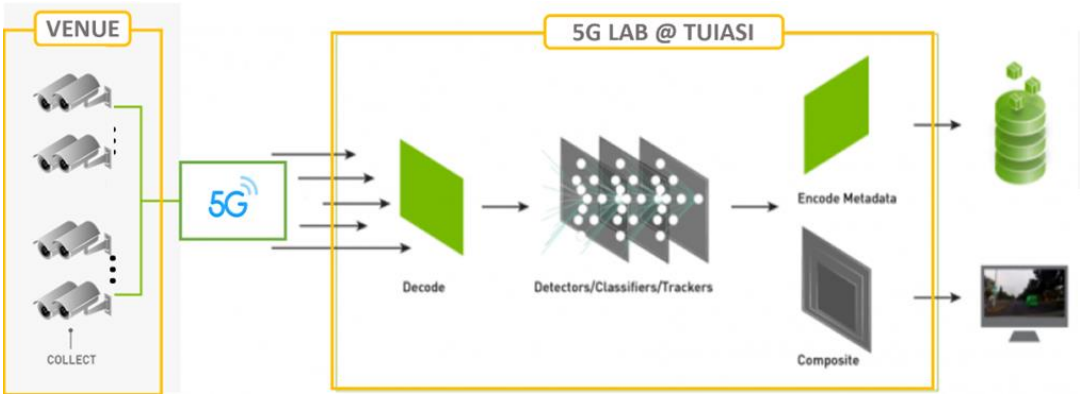
Challenges
• Extend the classes of situations to be detected by the application, including the onset of fires, falling people, lost pets. • Implement prediction algorithms to estimate crowd dynamics. • Monitoring the status of infrastructure (sport venue, public spaces etc). Potentially new sensors to be used connected by the B5G network. • Address pedestrians' safety at street crossings or other areas of interest.

UC1 – Smart Crowd Monitoring (Iasi)

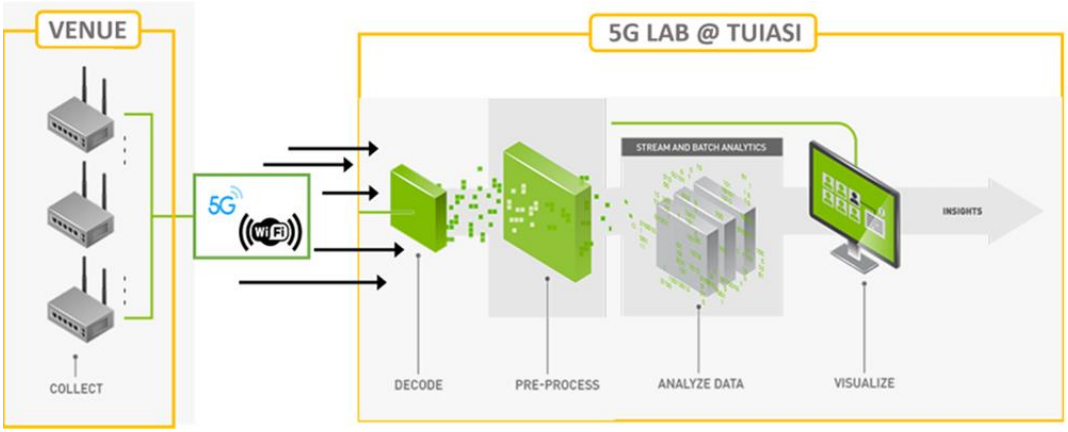
Use case description and main objectives

The use case will aim for improving the protection of people in crowded public spaces. The information provided by the use case will help the authorities to better plan public events and to efficiently react in case abnormal situations occur. Two scenarios will be followed for implementation: i) crowd characterization in terms of people counting, density, and dynamics of large numbers of persons (flow directions, spread, speed) during outdoor public events and ii) detecting special situations during normal traffic scenarios (e.g., presence of various objects such as cars, trucks, motorcycles, etc. in restricted access areas).

Several cameras will be installed on poles already available on the premises, along with Wi-Fi Access Points (AP's). Video streams and information related to the number of Wi-Fi enabled devices present in the region under study will be sent (through the 5G communication infrastructure put in place by ORO) to a server located in the 5G Lab facility within the "Gheorghe Asachi" Technical University of Iasi. Specific (AI-oriented) algorithms will run on the server side, aiming at reliably estimating the number, density, and dynamics of large crowds, along with the identification of special events of interest (e.g., cars entering restricted access areas or people falling on the street). Analytics results provided by the algorithms will be transmitted to the relevant stakeholders and made visible through appropriate interfaces.

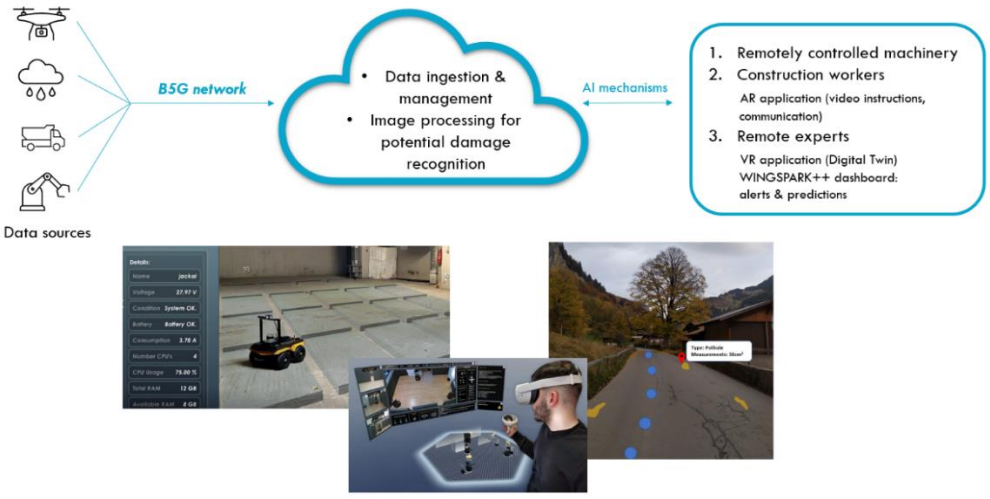


Smart crowd-monitoring use case in Iasi with cameras



Smart crowd-monitoring use case in Iasi with Wi-Fi

Implementation aspects, equipment, and devices
The camera-based solution will consider the acquisition and transmission of video streams from the devices on place to a server installed in the "Gheorghe Asachi" Technical University of Iasi. The video stream will subsequently be the subject of video analytics algorithms aiming at providing statistical information to be further sent to interested third parties (city administration, 112 emergency service, etc.). The video processing flow will be based on the (free) DeepStream SDK package provided by Nvidia that integrates continuous acquisition, AI-based algorithms implementation, and decision-making. Initially the commercial 5G NSA network, integrated with the Iasi Edge-compute facility, will be used for piloting and testing of the developed solutions. In the second stage the RAN will be extended so that the use-case area will be covered with 5G SA connectivity. 5G enabled cameras and Wi-Fi Access Points will be used in order to implement smart crowd management.
Challenges
• Extend the classes of situations to be detected by the application, including the onset of fires, falling people, lost pets. • Implement prediction algorithms to estimate crowd dynamics. • Monitoring the status of infrastructure (sport venue, public spaces etc). Potentially new sensors to be used connected by the B5G network. • Address pedestrians' safety at street crossings or other areas of interest.

UC2 – Public Infrastructure Assets Management
Use case description and main objectives
This case will be implemented in two areas within the Greek Cluster: the Athens International Airport and public infrastructure provided by DAEM in the Municipality of Athens. The solution will utilize data from various sources, such as municipal vehicles, weather information, security cameras drones and robots, to assess the structural health of buildings, pavements, and roads. The data collected will allow for more efficient and effective proactive management of public infrastructure assets, leading to cost savings and improved operations and services. The use of Augmented Reality (AR) will allow construction workers to have an on-site view of buildings or other assets blueprints and receive live bidirectional communications with remote experts who can provide assistance and video instructions. Remotely controlled or unmanned vehicles will be used to reduce risk and accelerate the building process. AI techniques, such as Neural Networks (NN) and Deep Learning (DL), will be used to assess the state of public infrastructure assets, produce alerts and suggestions for city authorities, improve workers' safety, and schedule predictive maintenance. Digital Twins of public construction sites will be used to validate complicated technical plans without wasting physical resources.    **Proactive public infrastructure assets management**

Implementation aspects, equipment, and devices

The proposed application design depicted in Figure UC2 involves the deployment of autonomous devices such as drones and robots for real-time monitoring of public infrastructure and critical assets. The devices capture images and other data, which are transmitted over 5G/B5G networks to a central platform for processing and analysis using AI techniques. The WINGSPARK++ enables users to view and analyze the data collected by the devices. Users can access various features such as data visualization, anomaly detection, and predictive analytics. Additionally, there is a Digital Twin module that provides a detailed virtual representation of the airport and its infrastructure.

To support the operation of advanced technologies, robots, drones, and other devices, a public 5G network will be used, leveraging its high-speed connectivity, low latency, and wide coverage. In addition, a WINGS owned, private network infrastructure will be utilised, to conduct testing activities, validation, and demonstration, prior to the deployment in the field.

Challenges

- Extension with additional robots and devices to enhance visual surveillance and context awareness.
- Development of a system for predictive maintenance of additional public infrastructure assets such as lighting or solar panels (e.g with the use of drones). High-quality cameras and sensors may be used to detect any damage or issues.
- AI mechanisms to predict and prevent network failures and security breaches with a consequent improvement of security and trustworthiness of data and traffic flows.
- Address the industrial transport and logistics domain with novel 5G applications.

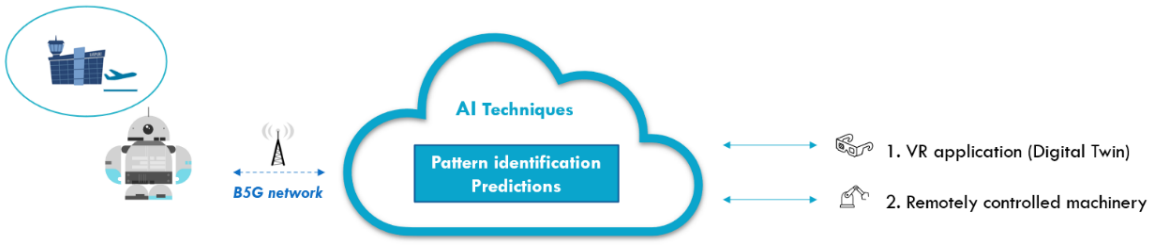
UC3 – Autonomous APRON

Use case description and main objectives

The use case focuses on showcasing how autonomous and smart systems can perform typical ground handling operations at the APRON such as passenger handling, in-flight catering, aircraft fuelling, potable water & aircraft toilet servicing, baggage and cargo handling, and Foreign Object Damage (FOD) prevention. This will be achieved using remotely controlled or unmanned vehicles, such as collaborative robots. The Digital Twins of the APRON will be accessed by VR headsets, enabling a real-time depiction of the physical world inside the virtual one. Digital Twins have a significant impact in optimizing the operations of the staff supervising APRON, ensuring safer and incident-free operations. Operators can intervene remotely and take control of vehicles in critical situations.

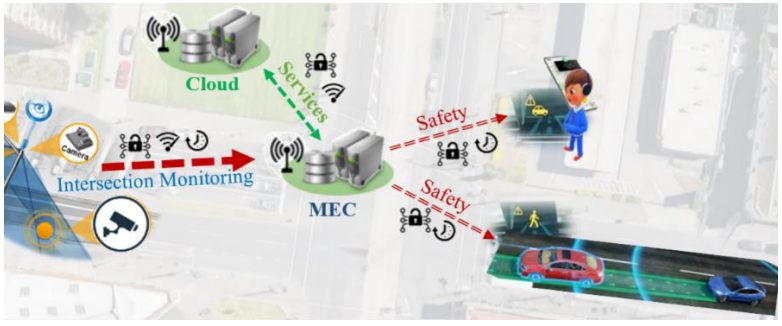
Data will be collected from vehicles in the airport APRON and robots using a variety of sensors, including LIDAR and GPS, as well as images and videos from security cameras. Advanced AI techniques will be employed to analyze the data, identify patterns, and make accurate predictions, allowing for continuous monitoring and analysis of airport operations. Based on these analyses, alerts and suggestions will be generated to improve operations and enhance overall airport efficiency.

The integration of a distributed monitoring system will enable the continuous monitoring of unmanned vehicles, collaborative robots, and relevant resources. This system can collect data across the Edge and far Edge resources, and traffic profiling will be conducted to detect network anomalies and predict/prevent failures and security breaches. Automated mitigation procedures will be applied to address any issues that arise.



high level architecture

Implementation aspects, equipment, and devices
For the implementation of the use case, the Jackal unmanned ground vehicle will be utilized. Given the robots capabilities, it will be able to perform a range of APRON operations, such as baggage transport and cargo, debris clearing, or other related tasks. Its agile mobility and advanced autonomous capabilities will allow it to navigate the APRON's terrain quickly and efficiently while ensuring the safety of nearby personnel. This will enable the robot to perform more substantial tasks and increase overall operational efficiency. The use of LIDAR sensors will also be explored as part of the project. LIDAR is a remote sensing method that uses laser light to measure distances and generate precise, high-resolution 3D maps of environments. The data collected from cameras and robots will be sent by a public 5G network to the cloud for further analysis. The autonomous APRON application design will also involve the creation of a Digital Twin of the airport APRON area that will provide a virtual representation of the physical environment.
Challenges
• Extension with robots acting as companions for supporting APRON maintenance staff in everyday tasks. This includes the development of components that enable the robots to respond to individual questions and behaviours through a naturalistic dialogue. • Development of IoT solutions for autonomous APRON operations that includes devices embedded in the ground, on the equipment or even on personnel. These IoT devices may use sensors to detect vibrations, pressures, and other environmental factors to ensure safe operations. The system will be designed to alert ground crews and equipment operators of any potential hazards or malfunctions, such as fire or equipment failure. • AI mechanisms to predict and prevent network failures and security breaches with a consequent improvement of security and trustworthiness of data and traffic flows. • Network Monitoring System to simplify and automate the monitoring of unmanned vehicles and collaborative robots from a network point of view, including the automated execution of mitigation procedures in case of detected network issues.

UC4 – Smart Traffic Monitoring
Use case description and main objectives
The use case aims to improve traffic management in a very crowded intersection in Iasi and to detect and prevent potentially dangerous situations. The traffic flow will be monitored to create predictive models and suggest intersection rules adaptation to reduce congestion. Safety will be increased especially by protecting Vulnerable Road Users (VRUs) by creating a traffic digital model, capable of identifying hazardous traffic situations. In addition, an air quality heat map will be created by collecting data from the IoT sensors for Environmental Monitoring. Two additional enablers will be trialed, thereby measuring their impact on the service performance. The first one is zero-touch management, Edge resources and RAN optimizations, which will be tested and validated in trialing activities along with the use case-related scenarios with traffic management and enhancements for VRUs. The second one is related to the framework for designing and developing vertical applications for B5G systems, i.e., Edge Network Applications.    **Application design**

Implementation aspects, equipment, and devices

The Platform will ingest available data from arrays of Sensors and Cameras deployed through the city, communicating over reliable B5G and Wi-Fi networks and outputting insights and actionable intelligence on Traffic Monitoring.

Initially the commercial 5G NSA network, integrated with the Iasi Edge-compute facility, will be used for piloting and testing of the developed solutions. In the second stage the RAN will be extended so that the use-case area will be covered with 5G SA connectivity.

The application design presented in Figure UC4 will use and follow the principles of B5G/6G Network Edge Applications (EdgeApps), which are considered as building blocks of Edge application services that boost network performance with data-driven insights for enhancing situation awareness. EdgeApps are designed to be programmable, modular, and configurable, based on specific service requirements (e.g., URLLC for sending prioritized notifications to VRUs, or eMBB for collecting data from distributed sensors, such as cameras).

5G enabled cameras and Wi-Fi Air Quality sensors will be used in order to implement smart traffic management.

Challenges

- Development of tracking and prediction algorithms to predict traffic incidents, advanced traffic analytics and advanced safety applications for VRU protection.
- Development of a fused digital traffic model based on different types of sensors (e.g., cameras and radars), using digital traffic model based on more intersections and generate corridor-type traffic analytics.
- Use data collected from a drone to enhance the digital traffic model.
- Address pedestrians' safety at street crossings.
- Address smart city mobility with car sharing, e-bikes and scooters management and optimization applications based on 5G.
- Address road users' compliance with the traffic laws with monitoring applications based on 5G.
- Address the industrial transport and logistics domain with novel 5G applications.

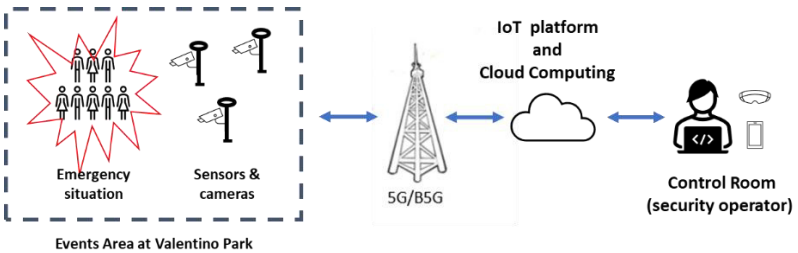
UC5 – Control Room in Metaverse

Use case description and main objectives

The purpose of this use case is to employ XR, Metaverse and IoT technologies for remote, multi-agency and environment tailored XR training and real-time visualization of behavioral anomalies/movement patterns. UC5 enhances the management of large events and situations of panic by contributing to improved decision-making and reduced intervention times in the event of an emergency on the side of emergency responders.

By already knowing elements such as the planimetry of the intervention area and the exact location of people, including those in need of urgent assistance (e.g., injured, wounded), emergency responders can save precious time and increase expediency. The control room will thus enable emergency responders to:

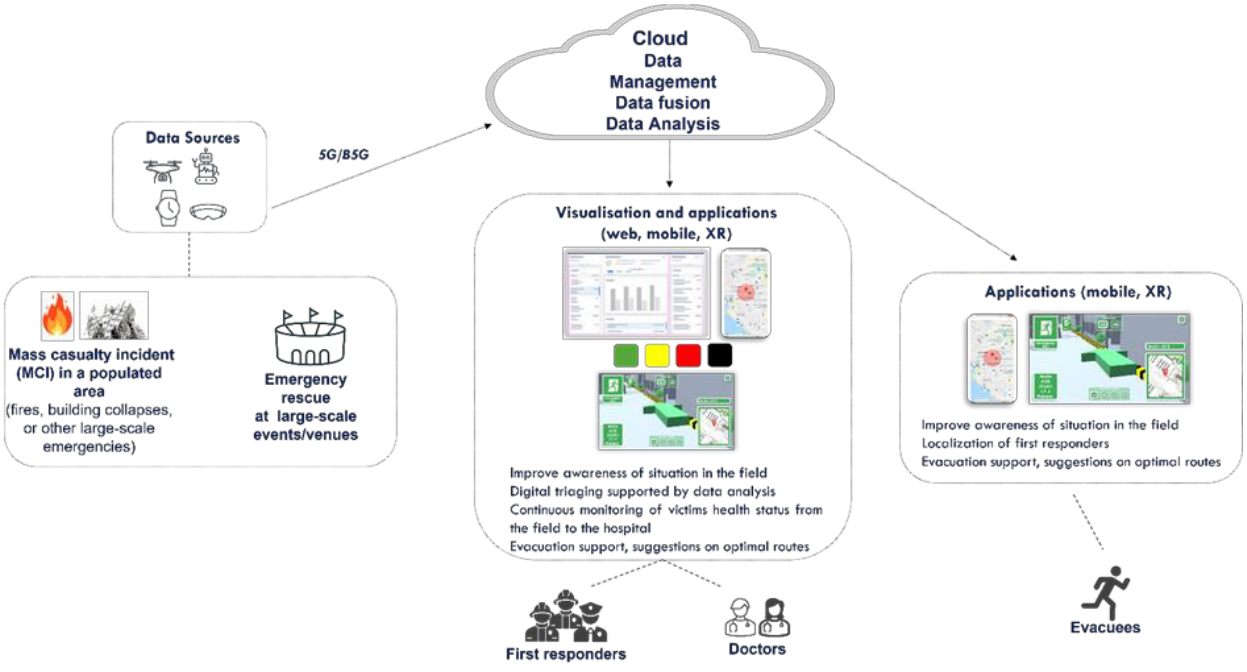
- Undertake immersive remote, environment-tailored, inter-agency XR training for mission planning, intervention protocol testing, real-time communications exchange, and mission debriefing.
- Access real-time analytics from sensors and cameras-detected data on movement patterns and behavioural anomalies.



High-level description

Implementation aspects, equipment, and devices
The 5G connectivity for the use case implementation will be provided by the commercial network deployed by TIM in Torino. Two main platforms will be used to implement the use case control room in metaverse, namely Mozilla Hubs for the implementation of the metaverse component, and Symphony, for the management of IoT devices and transmission of analytics directly into the control room in metaverse which will both be deployed in the Cloud. The main components that will be available locally are 5G solar-powered cameras a set of sensors (Wi-Fi sniffers, mm-waves), smartphones, tablets and VR headsets.
Challenges
• Development of more environment tailored XR training modules scenarios such as panicking crowds, street accidents, fires, floods, and other potential emergencies for the control room in metaverse to provide more context based coaching and real operational solutions. • Development of solutions to provide authorities with a smart-navigation system for smart route identification, avoiding closed roads and traffic jams and to connect with trapped people and redirect them towards safe areas. • Development of a scalable model, that can be applied, after a process involving precision photogrammetry and 3D modelling and rendering, to other venues of the city.

UC6 – Mass Casualty Incident (MCI) and Emergency Rescue in Populated Area
Use case description and main objectives
This use case aims to offer cutting-edge technological solutions created by TrialsNet for the most effective coordination for first-case responders in the context of i) triage and coordination of resources at the scene of mass casualty incidents, which could be building collapses, earthquakes, fires, or other large-scale emergencies, and ii) an emergency evacuation in the context of a crowded sporting or cultural event. This use case has the ambition to demonstrate the viability of a coordinated response in a densely populated area as well as more effective and digitally traceable pre-hospital care by first responders in the event of MCI. Through this use case, cutting-edge (and 5G/B5G/6G) technologies will be shown off in a large-scale field exercise for more effective first responder communication, quicker and more efficient triage, and pre-hospital treatment, and they will be compared to the baseline approach using conventional approaches.



MCI and Emergency Rescue in populated area

Implementation aspects, equipment, and devices

The evacuation part of the use case will be implemented both in Athens and in Spain with the use of a different Fifth generation of mobile communications (5G) infrastructures.

In Athens the network will use Non-Standalone architecture (NSA) and operate at a frequency of 3.5 GHz. The allocated band for this network is 80-100 MHz, which will provide high-speed connectivity and low latency to support the data-intensive applications required by the use case. In Madrid, the network infrastructure to be deployed for the implementation of the emergency evacuation scenario will be a 5G/B5G Ericsson Non-Public Network (NPN).

The proposed application design is based on the STARLIT++ platform and involves the deployment of devices such as robots or drones with the appropriate equipment (thermal cameras, sensors, etc.) Devices will also comprise wearable devices for monitoring of vital signs, such as heart rate, oxygen saturation, body temperature, blood pressure, etc. The platform comprises AI powered mechanisms for providing insights on a range of factors.

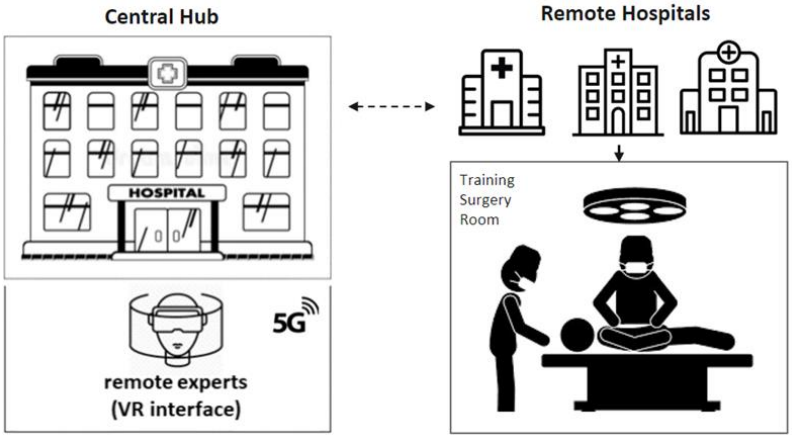
Challenges

- Address individuals' health tracking with smart devices that leverage the 5G technology (partially covered)
- Solutions for dynamic management of network resources including but not linted to solutions supported by flex topologies and orchestration mechanisms over the network continuum to ensure 100% reliability of communications in the case of emergencies.

UC7 – Remote Proctoring

Use case description and main objectives

This use case aims to support remote proctoring activities in the field of interventional cardiology, offering innovative solutions based on smart tools for telepresence in the surgical field to connect expert proctors and remote hospitals. UC7 will be deployed by connecting two sites at a geographical distance, via a dedicated Virtual Private Network (VPN), and equipping with tailored 5G coverage the site where the proctor is located. This allows increasing the number of remote hospitals that can leverage the support of remote experts and improve the entire eHealth workflow of interventional cardiology.



Remote proctoring use case concept.

Implementation aspects, equipment, and devices

The RAN, which is based on Ericsson systems, consists of two main components. The first component is the baseband unit, the second component is an indoor radio antenna that covers the experimental area. Part of the CN is hosted in Pisa and part in Turin. More specifically: Unified Data Management (UDM) module is hosted in the TIM Innovation site located in Turin and UPF module is hosted in Pisa. Turin and Pisa are connected through a VPN which is active between two specific packet gateways. The overall 5G infrastructure is supported by the commercial Ericsson Orchestrator, located at TIM's premises in Turin.

In the UC7, two operational macro-modules will be implemented, one operating in a remote hospital and the second one in the central hospital. The macro-module in the remote hospital for surgery operating room will be constituted by i) a clinical-certified commercial telepresence system, constituted by acquisition tools and connection hub installed in the surgical room, and ii) a local wired LAN provided by the hospital IT service and related gateway. The acquisition tools of the telepresence system will be formed by smart glasses for the same view as the surgeon, a 360-degree camera for the view of the operating room, and a hub for video streaming of clinical monitors to obtain complete monitoring of surgical operations. The macro-module in central hospital for remote expert will be composed by i) a telepresence platform, i.e., a workstation with High Definition (HD) monitors and control interfaces, ii) a VR headset for an immersive telepresence experience, and iii) a 5G indoor network infrastructure.

Challenges

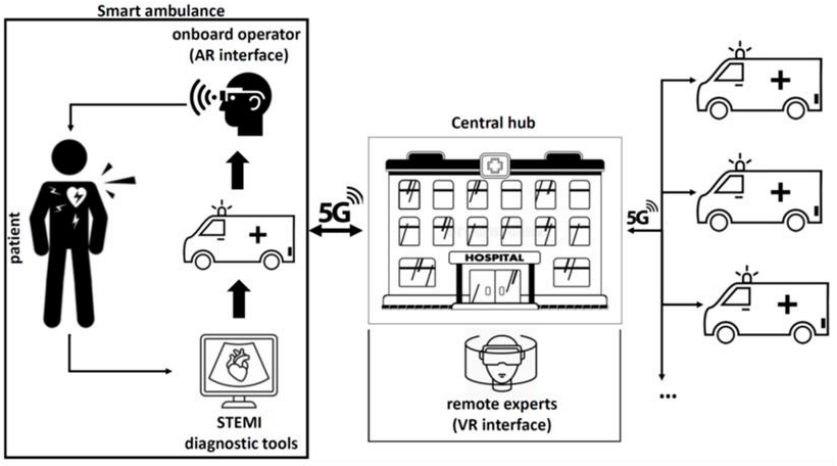
- Intervention radiology use case. The basic idea is to constantly monitor the absorption of radiation due to diagnostic investigations during a surgical operation, both on the patient and on the operators and, consequently, signal excessive radiation and act accordingly in an immediate manner.
- Blockchain technology could potentially be beneficial for UC7. Here are some possible ways in which blockchain could be utilized:
    - Data Security: Blockchain is a very secure technology that can help ensure data is not tampered with or compromised. This could be useful for ensuring the integrity of medical data and patient information.
    - Traceability: Blockchain can provide a detailed audit trail of all transactions, which can be useful for monitoring proctor activities and ensuring accountability.
    - Data Sharing: Blockchain can facilitate secure data sharing across different parties. This could be useful for sharing information between the remote hospital and the proctor.

UC8 – Smart Ambulance

Use case description and main objectives

This use case will propose a 5G-connected smart ambulance operating outdoor in mobility. The use case will develop an infrastructure that will enable ambulances (or small emergency centres) to share diagnostic information with the main centre. The proposed infrastructure will be designed and implemented to equip the ambulance with i) new audio/video communication tools (Augmented Reality – AR - and virtual reality - VR - headsets) between operators on the ambulance and supporting experts in the hospital, ii) diagnostic tools for cardiological pathology and ii) devices to guarantee an efficient and fast 5G connection in remote locations and mobility conditions, including emergency high-speed travel through congested urban areas.

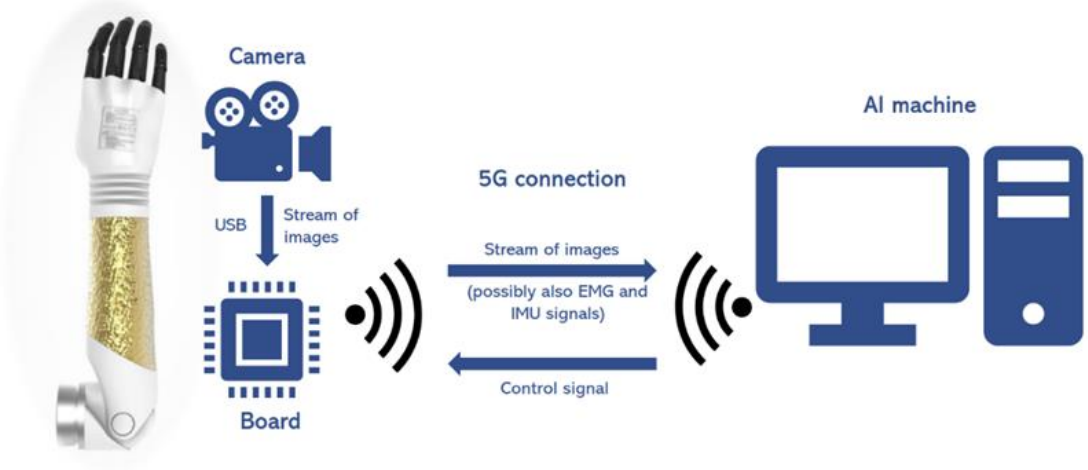
This UC will demonstrate the possibility of sending real-time information to local operators to maximize early intervention and sending information and large data batches (like real-time video and 3D imaging) to a central hub with low latency.



Smart ambulance use case concept

Implementation aspects, equipment, and devices
UC8 trial is served by a 5G network originated by a micro cell covering an outdoor area located in the CNR campus in Pisa. This area is in a vicinity of the "Central Hospital Hub" where the remote proctoring trial (UC7) is deployed. Thus, 5G infrastructure serving UC8 shares most of its components with the infrastructure serving UC7. The main difference is related to the use of an outdoor antenna (micro cell) to provide coverage in the outdoor area where the smart ambulance is planned to operate. The UC8, two operational macro-modules will be implemented, one in the CNR campus area in Pisa and the second one in the hospital in Massa. The macro-module in Pisa will be constituted by: i) an ambulance, ii) commercial echocardiography with real-time stream video functionality, iii) a 5G modem, iv) a commercial AR headset, and v) a 5G-based outdoor network infrastructure. The macro-module in Massa will be constituted by: i) a commercial VR headset, ii) a workstation, and iii) a local wired LAN and related gateway. The remote expert cardiologist in the hospital in Massa will be equipped with the VR headset.
Challenges
• There are no challenges identified.

UC9 – Adaptive Control of Hannes Prosthetic device through Mobile Network
Use case description and main objectives
This use case will focus on designing advanced control capabilities for prostheses, using Artificial Intelligence (AI) methods deployed on the Hannes arm. The main aim of UC9 is to improve the usability of prosthetic hand, leveraging on radio 5G connectivity to provide sufficient computing power to deploy AI methods on Hannes with high reliability and minimal latency.



Architecture of the application for the Use Case 9.

Implementation aspects, equipment, and devices
The Adaptive Control of Hannes Prosthetic trial will be served by a 5G network covering an indoor area located in the CNR campus in Pisa and it is connected via a 5G dongle, which uses a SIM card provided by TIM to ensure access to the network. From the application point of view, this Use case will rely on infrastructure and functionalities solutions from two groups of the Istituto Italiano di Tecnologia, namely, the Rehab Technology (Rehab) laboratory and the Humanoid Sensing and Perception (HSP) research line. The application that will be developed during the project will require the implementation and integration of both hardware (HW) and software (SW) components. The full list of components is reported in D4.1, the main are the Hannes arm, an electronic board mounted on Hannes, an embedded video camera placed either into the palm or into the wrist of Hannes and SW modules for signal pre-processing and the control system.

Challenges
• The standard assessment techniques (i.e., Minnesota Manual Dexterity Test - MMDT, Southampton Hand Assessment Procedure – SHAP and Box and Block Test - BBT) are sufficient to evaluate the system performances. However, an in-depth investigation of the system should also include usability, efficacy and embodiment, using the real system, but also virtual reality-based strategies. The latter could improve the evaluation of a wider range of functionalities for multi degrees of freedom prosthetic devices, like Hannes. These techniques can be used during the real clinical trials as an additional source of information, providing more accurate and specific metrics that could not be differently retrieved. Moreover, these novel virtual environments can help training users to drive such prostheses, helping to achieve a higher level of user acceptance.

UC10 – Immersive fan engagement
Use case description and main objectives
This use case aims at increasing the engagement of people who are fans of sport, e.g., during a football match. Two applications will be developed: the first one for home use, taking the spectator to the front row of the match with Virtual Reality (VR) and immersive video on smartphones; the second one live in the stadium, bringing the action to the fan regardless of its seat (which often offers partial or limited view of the playing field and the players). With a low latency multiscreen application, the fans can follow all the details of the match on their tablet or smartphone. For both applications, some preliminary solutions have been identified for the data flow transmission along with the suitable equipment (cameras, server, VR, and smartphones).

Example of camera selection interface.
Implementation aspects, equipment, and devices
The Immersive Fan Engagement use case will be implemented in the Spanish cluster´s Madrid site. This task will include all activities related to the design (equipment selection), and deployment (venue identification and connectivity over a 5G network), of the permanent installation of cameras and equipment in a sports venue, in order to provide an immersive experience to fans in the venue or in a remote location.
Challenges
• To provide every sports fan in the venue the best experience possible, getting live feeds from the venues is crucial. Therefore, it is necessary to place immersive cameras around the venue space, uploading the streaming video to Edge computing video server with the aid of existing connectivity technologies. Currently available fiber solutions can address this issue, but this restricts the placement of cameras to set sites along existing fiber networks. New possibilities are made possible by wireless connectivity, but this requires significant upload bandwidth (between 50 and 100 Mbps per camera), which is not provided by the existing 5G implementations. New technologies are needed to acquire these two innovative capabilities – wireless immersive camera uploading and high-density downloads for spectators inside the venue. Both features go beyond what is currently possible with 5G network. More particularly, it calls for:

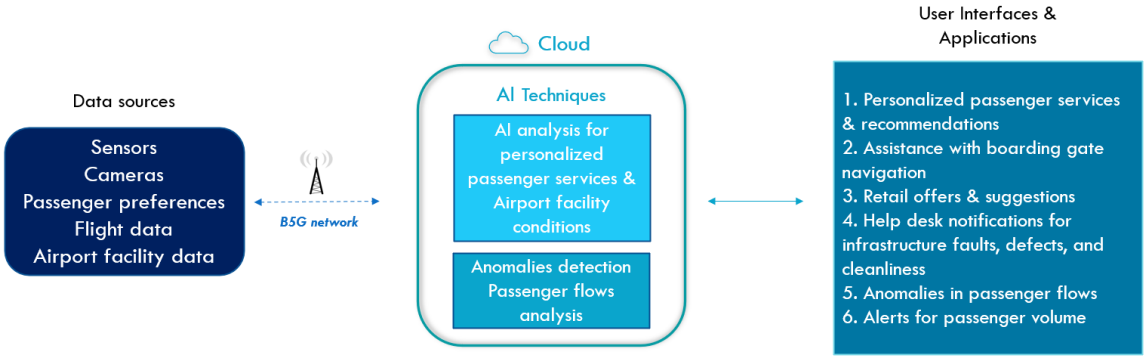
- High-quality camera streams are uploaded around the playing field at a rate of 20 to 100 Mbps per camera.
- The installation of terminals inside the venue for the download of optimal video (15-20-30 Mbps per user, 500-5,000-50,000 users).

- Additionally, edge computing infrastructure is required to process feeds as quickly as possible and redistribute them to both local and remote connected spectators in the stadium.

UC11 – Service Robots for Enhanced Passengers' Experience

Use case description and main objectives

This use case aims at improving passengers' comfort at Athens International Airport, particularly during congested situations. With the use of Artificial Intelligence (AI)-powered algorithms, the passenger flow would become smoother by reducing waiting times and queues, which frequently form in different areas of the airport, such as for baggage drop-off and reclaim, security screening, passport control areas. A solution will be developed to aggregate and analyse the passenger data (e.g., user profile, location, flight details, e-ticket, etc.). These will be collected from various applications, based on which AI-enabled robots will assist/inform/entertain passengers during their permanence at the airport. Various sensors will be installed in different areas of the airport, also to detect critical situations and promptly alert the terminal operator supervisor (TOS).



High level architecture implementation

Implementation aspects, equipment, and devices

The application design of this use case involves various software modules and functionalities, including AI-powered algorithms, 5G/B5G technology, mobile applications, backend systems, and smart service robots. The system consists of several modules that work together to optimize the passenger check-in process and improve the overall airport experience. The GUI of the solution will display a dashboard with visualizations of passenger flow data and insights, such as the number of passengers waiting in each check-in queue, the average waiting time, and the estimated time to process each passenger.

The LoCoBot WX250 will be used for the implementation of the use case. With the addition of new sensors, connectivity, and AI algorithms, the robot could help improve the passenger experience. In addition to the mentioned sensors and modules, a tablet, microphone, and speakers will be added to the robot for interacting with passengers, to become even more capable of providing personalized assistance and guidance to them throughout their journey in the airport. The solution will be supported by a public 5G network and a WINGS owned private network infrastructure.

Challenges

- Extension of the smart services offered to passengers with the use of technology to even more areas within the terminal such as the security screening areas and the passport control areas, but also outside the terminal such as the parking areas in order for airports to achieve a seamless passenger experience.

- Integration with services offered from airport's business partners such as the airlines and/or the handlers in order for travellers to complete the entire airport journey without experiencing delays, disruption or confusion.
- Use of technology capabilities in order for airports to capture more data and leverage of all information gathered in combination with the information available from the community in order to improve in areas such as the Terminal environment i.e. air quality and unexpected situations i.e. terrorist attacks.
- Volumetric holography to improve security and facilitate operations and decisions for enhance passengers experience at the airport. Passengers can walk around the holograms, getting an unparalleled sense of presence. Volumetric video captures will bring human beings into digital, capturing full 3D content that can be seen from any perspective and moves as in reality. The volumetric holograms will communicate the information needed and can perform similar tasks to robots.

UC12 – City Park in the Metaverse

Use case description and main objectives

This use case develops around the social metaverse concept, centered on the idea of creating a virtual world where people can interact with each other, form social connections and participate in a variety of activities. It will take place in the Borgo Medievale, one of the main attractions of the Valentino Park of Turin, reproducing a village of ancient Piedmont. During its closure for renovation from 2024 to 2026, the use case intends offering, as alternative to the tourists arriving to the gate of the Borgo, a virtual visit enriched with a layer for gaming along with the possibility for multiple persons to join the visit with their avatars.

Example of metaverse of Borgo Medievale

Implementation aspects, equipment, and devices

Multi-player mobile game sandbox applications will be developed with layers of interactive game content onto a virtual space. The 5G connectivity for the use case implementation will be provided by the commercial network deployed by TIM in Torino, with the applications running on the Cloud platform. The main components available locally are a set of sensors (Wi-Fi sniffers, mm-waves), two metaverse platforms (Mozilla Hubs and TIM XR) enabling co-presence, which are connected to different devices (smartphones, tablets and VR headsets).

Challenges

- Integration of innovative educational/gaming Apps/layers into a developed metaverse infrastructure, combined with VR/AR technology, to enhance the visitors experience the Borgo Medievale and Valentino Park, allowing visitors to learn about the history, architecture, and cultural significance of the sites in a fun and engaging manner.

UC13 – Extended XR Museum Experience (Turin)

Use case description and main objectives

The goal of this use case is to create a modular metaverse platform for visiting museums and cultural sites in Turin through portable devices. The use case will entail creating new interactive experiences in collaboration with cultural institutions and will exploit different metaverse platforms. Users will be able to visit collections with friends and family in remote locations and/or in presence in selected locations. A captivating narrative will also be developed to make the experience more engaging, interactive, and informative by reusing part of the results of the previous project 5G-TOURS.

Virtual Reality visit at Museo del Risorgimento in Turin

Implementation aspects, equipment, and devices

The application architecture in Turin is composed by three blocks: the client-side code is built on A-Frame that communicates with the server using Web-Socket and WebRTC protocols; the server-side code is deployed on a Cloud platform; the module-side includes several engines for e.g., 3D rendering, audio, room, avatars, video streaming. The 5G connectivity for the use case implementation will be provided by the commercial network deployed by TIM in Torino. The main components that will be available locally are a set of sensors (Wi-Fi sniffers, mm-waves), two metaverse platforms (Mozilla Hubs and TIM XR) enabling co-presence connected to different devices (smartphones, tablets and VR headsets) with processing in the Cloud.

Challenges

- Development of virtual AI-powered guide(s) within the metaverse that can enhance the visitor experience at museums, both for those physically present and those accessing the museums remotely, with trials at Palazzo Madama and/or Galleria d'Arte Moderna in Turin. These AI-driven guides will offer personalized tours by providing real-time response regarding detailed information about the artworks, historical artifacts, and exhibits. This also applies to the Greek Cluster, as the implementation in additional museums/historical places will be investigated.
- Providing new and innovative immersive experiences (e.g., interactive walls, animations, gaming, holograms) in selected museum(s) in Torino, such as Museo del Risorgimento, Polo del 900, Museo dell'Auto) to be integrated in the cultural offer of the city online and in metaverse. This could be also investigated for the Greek Cluster.
- Supporting innovative artistic scenarios, online and in the metaverse, combining different disciplines such as music, arts, dance, theatre, marching band, which will take place simultaneously at different city locations both indoor and outdoor, and which are enabled by the low latency and high bitrate of the 5G technology.
- Digital signage applications for tourism that take advantage of the 5G technology.

UC13 – Extended XR Museum Experience (Athens)
Use case description and main objectives
In the Athens site, AR-based technologies will be used to leverage on content that elaborates on culture/historic aspects. In addition, there will be scope for optimizing the itineraries, to enhance the user experience (and safety when needed). As for the VR capabilities of the application, it will allow visitors to explore a virtual museum space and interact with historical artifacts in a more immersive way. Visitors may be able to pick up and manipulate objects, walk around the museum space, and interact with other visitors in real-time.
 **Model integration in the AR application**
Implementation aspects, equipment, and devices
The application in Greek cluster will have a user-friendly GUI that will allow users to navigate through different sections of the museum, select different artifacts, and access additional information. The AR/VR application that will be developed follows a typical Unity application architecture. To allow the application to communicate with the cloud XR server, the public 5G network and WINGS testbed will be utilized.
Challenges
• Extend the cultural proposal provided by the use case with new historical monuments and touristic attractions in Athens.

Acknowledgment

TrialsNet project has received funding from the European Union's Horizon-JU-SNS-2022 Research and Innovation Programme under Grant Agreement No. 101095871.

References

[1] TrialsNet Deliverable D3.1, "Use Cases definition for Infrastructure, Transportation, and Security & Safety (ITSS) domain", 30 April 2023
[2] TrialsNet Deliverable D4.1, "Use Cases definition for eHealth and Emergency (eHE) domain", 30 April 2023
[3] TrialsNet Deliverable D5.1, "Use Cases definition for Culture, Tourism and Entertainment (CTE) domain", 30 April 2023
[4] TrialsNet Deliverable D2.1, "Preliminary design aspects for Platforms and Networks solutions", 30 June 2023
[5] https://trialsnet.eu

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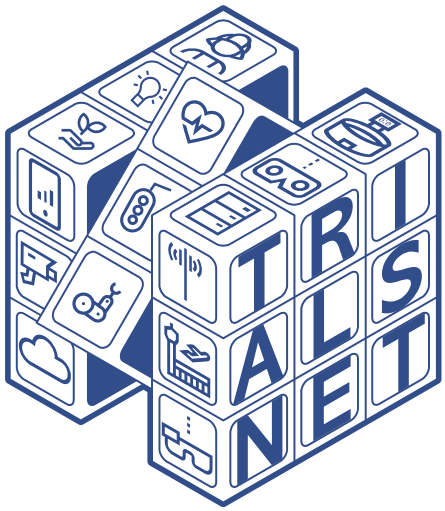

TrialsNet: TRials supported by Smart Networks beyond 5G

Open Call

TrialsNet framework and KPIs/KVIs overview

Table of Content

1 Introduction

This document aims at introducing to the candidate applicants the framework adopted by the TrialsNet project in terms of its objectives, addressed domains of the urban ecosystems, transversal implementation of the use cases over different clusters, KPIs and KVIs definition, measurement and evaluation, and, last but not least, the project's methodology that will be followed for the execution of the large-scale trials. Afterwards, the document also provides an overview of the KPIs and KVIs that are going to be considered in the context of the different use cases implementation and that will be the subject of the final evaluation activity. Further details on the KPIs and KVIs framework of the TrialsNet project will be available in the deliverable D6.1 [1] that will be released end of October.

It is expected that the selected applicants of the Open Call will be able to conduct their activities in line with the framework and related aspects described in this document.

2 TrialsNet framework

TrialsNet will target a set of technical, performance and productivity objectives which will impact the current 5G ecosystem substantially, effectively leading the B5G technology wave that is expected to take place during the project lifetime and drawing compelling requirements towards the next generation of mobile networks. The objectives defined by TrialsNet are the following:

- Objective 1: **Trialling of 6G Applications**
- Objective 2: **Enhance B5G networks to support 6G applications**
- Objective 3: **Introduce societal benefits in different areas, thanks to 6G Apps**
- Objective 4: **Large scale deployment of B5G Networks**
- Objective 5: **Achieve Industrial Impact**
- Objective 6: **Achieve Scientific and Standardization Impact**
- Objective 7: **Create an ecosystem of verticals and technology providers in the trial sites**

To achieve these objectives, TrialsNet will deploy *full large-scale trials* to implement a heterogenous and comprehensive set of innovative 6G applications based on various technologies such as Cobots, metaverse, massive twinning, Internet of Senses, and others, covering three relevant domains of the urban ecosystems in Europe identified as i) *Infrastructure, Transportation, Security & Safety*, ii) *eHealth & Emergency*, and iii) *Culture, Tourism & Entertainment*. In the context of these three domains, TrialsNet will design and implement 13 use cases, according to the categorization reported in Figure 1.

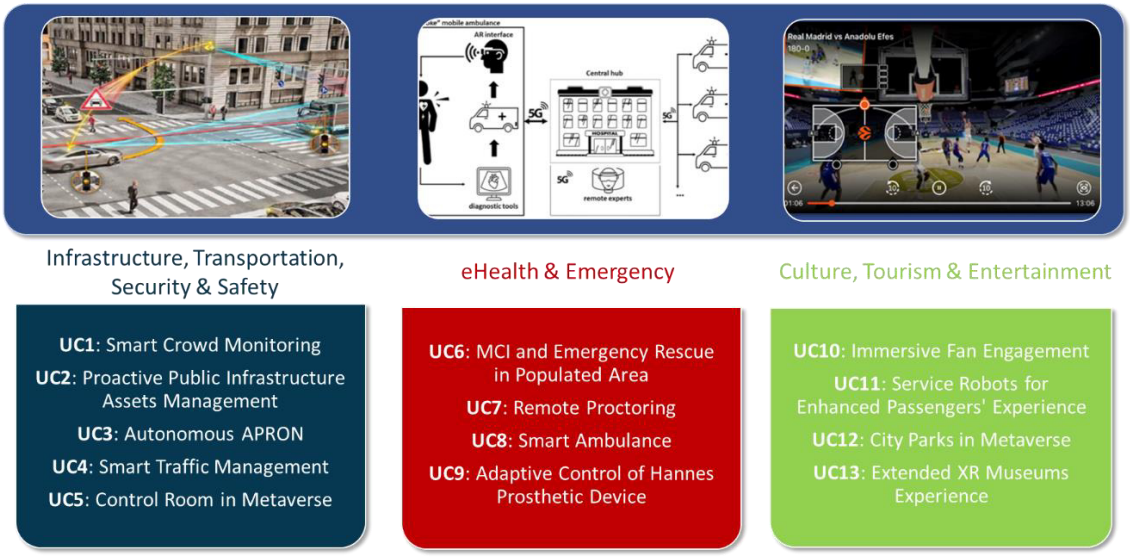

Figure 1. TrialsNet use cases in the three domains.

The use cases will be developed over wide coverage areas with the involvement of extended sets of real users in 4 geographical clusters, located in Italy, Spain, Greece and Romania respectively. The use cases will be transversal: the pan-European clusters of TrialsNet will target use cases for the identified domains and, most importantly, different implementations of the same use case will be potentially developable in each cluster. This approach will allow for a holistic evaluation of the network KPIs (Key Performance Indicators) and KVIs (Key Value Indicators) of the 6G applications in different contexts and scenarios, including different network deployments and solutions. Therefore, in addition to the KPIs evaluation methodology based on the large-scale trials activities, TrialsNet will also develop appropriate technical assessment frameworks, mapping quantitative and qualitative measures and visualizing the dynamics of the use cases for society acceptance. Proper KVIs will be defined, monitored, proved, and refined to provide a socio-technical vision towards early adoption of 6G solutions.

Based on the objectives and the framework described above, TrialsNet has then defined a proper methodology to achieve the overall scope of:

- Understand where current networks are not sufficient to fulfil the performances required by the UCs,
- Derive new requirements for next generation mobile networks.

Such methodology is built on the *iterative approach* reported in Figure 2 based on the four main phases of Deployment, Trials, Evaluation and Optimize described in the following:

- **Deployment:** This initial phase is based on WP3, WP4, and WP5 input that defines the UCs (in certain cases also with the users involvement) and the related network requirements (see D3.1 [2], D4.1 [3], and D5.1 [4]) that need to be fulfilled to support their implementation. Based on such requirements and on the capabilities offered by the platform and network solutions of the different clusters, the network infrastructures can be deployed as the base for the following phase related to the trials execution.
- **Trials:** During the trials execution phase, some UCs are expected to challenge the capabilities provided by the infrastructures of the related cluster. In order to evaluate in which measure the capabilities and the actual resources available in each cluster may differentiate, during the execution phase, proper KPIs as well as feedbacks from the users involved in the trials in terms of questionnaires aimed at assessing the perceived Quality of Experience (QoE), will be collected.
- **Evaluation:** In this phase, the data collected during the trials execution will be analysed to understand where the baseline platform and network solutions could be enhanced. Through the evaluation phase, it will be possible to identify strengths, weaknesses, and potential areas of improvement.
- **Optimize:** Based on the outcomes of the evaluation phase, the platform and network solutions can be accordingly optimized by different means such as the enablement of new network functions (NF)s, the addition of spectrum resources (i.e., bands), the tuning of proper parameters, etc. Additionally, the optimization phase can take advantage of the TrialsNet research-oriented activities through which innovative functionalities can be provided and integrated in the current setup.

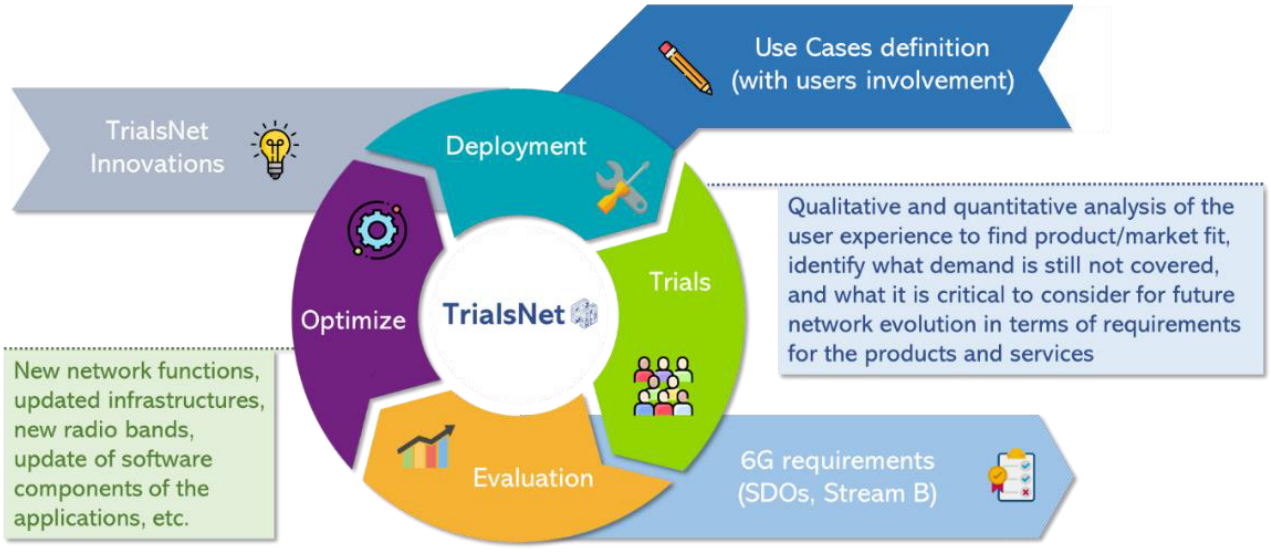

Figure 2. TrialsNet methodology.

TrialsNet aims to complete at least one full iteration of these four phases. However, the possibility of conducting multiple iterations during the project's lifespan remains open and it will strictly depend on the progress of the activities for each single UC. This iterative approach allows for continuous improvement and optimization, enabling TrialsNet to stay at the forefront of innovation throughout its duration. It has to be highlighted that the insights gained through this methodology will be not only limited to TrialsNet but they will also contribute as input in terms of new 6G requirements to the other ongoing Stream B projects [5], as well as the main Standards Development Organizations (SDOs), thus fostering a broader understanding of the subject matter related to the definition of the next generation of mobile networks.

3 KPIs and KVIs overview

In the context of TrialsNet activities, both KPIs and KVIs are defined and measured to validate the use case that will be implemented in the trials. As shown in Figure 3, KPIs enable a quantitative analysis at network level and at application level, in order to assess the achieved level of Quality of Service (QoS) and thus validate the use case. Notably, application KPIs are collected at the user's equipment and typically cannot be inferred directly from the network KPIs. For example, when evaluating the latency experienced by a user interacting with a trial application, the latency must be evaluated at application layer, taking into account also the effects of the different levels of resource virtualization through which the hosting machine runs the application. Such effects are typically not negligible for strictly low-latency applications. Furthermore, the KPIs affect the perceived Quality of Experience (QoE) by each user, which can be evaluated in a quantitative way by leveraging the user's feedback (e.g., through surveys and interviews on a statistically meaningful population). The actual impact of each use case on the society, the environment and the economy are then evaluated through specific KVIs.

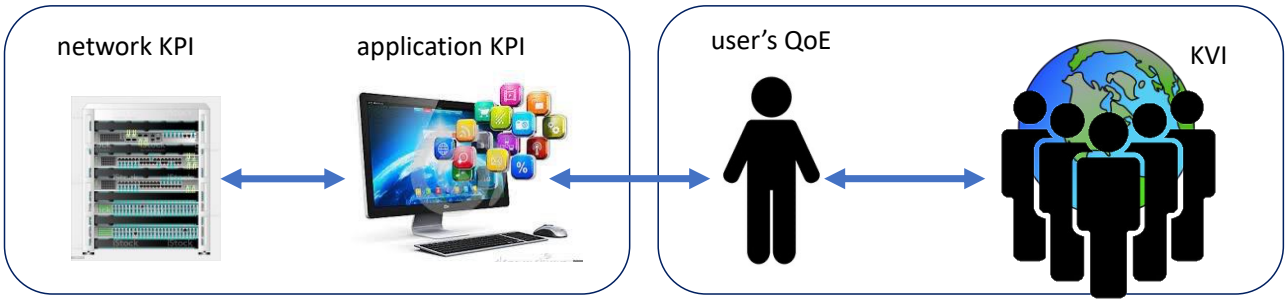

Figure 3. Relation between KPIs and KVIs.

3.1 KPIs from the use cases

Table 1 reports the definitions of the KPIs that will be measured during the trial activities. Such list is the result of the harmonization work performed over the KPIs that were initially defined for each use case. The Open Call applicants are requested to refer to this list when filling the KPIs requirements in the application form. It has to be highlighted the list is not binding, and that additional KPIs can be included depending on the new applications and related use cases that will be implemented.

Table 1. KPIs definitions.

KPI Name	KPI Definition	KPI Category
Downlink throughput per user	Sustained throughput experienced from a user to receive data	Capacity
Uplink throughput per user	Sustained throughput experienced from a user to send data	Capacity
Downlink aggregate throughput	Sustained aggregated throughput experienced in the venue to receive data in the considered application	Capacity
Uplink aggregate throughput	Sustained aggregated throughput experienced in the venue to send data in the considered application	Capacity
Downlink throughput per device	Sustained throughput at device level to receive data	Capacity
Uplink throughput per device	Sustained throughput at device level to send data	Capacity
Coverage	Geographic area where a network signal can be received and used by a device	Capacity

Application round-trip latency	Amount of time it takes for the application to receive a response or output after sending a request or input to a server or network.	Latency
Application one-way latency	Amount of time it takes at application level from the source to the destination application	Latency
AI/ML accuracy	Proportion of correct predictions made by the algorithm.	Compute
AI/ML precision	How often the algorithm is correct when it predicts a positive outcome.	Compute
Recall	How often the algorithm correctly predicts a positive outcome out of all the actual positive outcomes.	Compute
F1 score	Harmonic mean of precision	Compute
Communication reliability	Success probability of transmitting a layer 2/3 packet within a maximum latency required by the targeted service (ITU-R M.2410)	Availability Reliability
Service reliability	Period of time for which the service satisfies the required performance constraints (downlink/uplink capacity, E2E latency)	Availability Reliability
Communication availability	Capability of transmitting a given amount of traffic within a predetermined time duration with high success probability	Availability Reliability
Service availability	Ratio between the amount of time during which a specific component of the use case (application, server, network function, etc.) is responding to the received requests, and the total amount of time that the component has been deployed.	Availability Reliability
Location accuracy	Accuracy in the positioning of the device	Localization

3.2 KVs, KVIs, and enablers definition

A value is a fundamental concept in various fields including mathematics, philosophy, economics, and more. In a general sense, a value represents a principle, belief, or quality that is considered important or desirable. There are different contexts in which the term value can be used:

- **Mathematics**: In mathematics, a value is a numerical quantity that can be assigned to a variable or used in calculations.
- **Economics**: In economics, value refers to the worth of a good or service in terms of its usefulness, utility, or desirability.
- **Ethics and Philosophy**: In ethics and philosophy, values are the principles or beliefs that guide individuals' actions, decisions, and judgments. These can include values such as honesty, compassion, freedom, and justice.
- **Computer Programming**: In computer programming, a value is a piece of data that can be stored and manipulated by a program.
- **Cultural and Societal Contexts**: Values can also refer to cultural, societal, or personal beliefs about what is right, wrong, important, or meaningful. These values shape behaviors and decisions within societies.

- **Environmental**: It refers to the worth or significance of natural resources, ecosystems, and the overall environment to individuals and communities. It encompasses the various benefits and services that the environment provides to both human beings and the planet's ecosystems.

In general, the meaning of value can vary based on the context in which it is used. It generally relates to the significance, worth, or importance assigned to something, whether it's a number, a belief, an object, or a concept. In Figure 4, over 130 values are shown [6]. These values are divided into 4 categories:

- **People**: Social
- **Planet**: Environmental
- **Profit**: Economic viability
- **Progress**: Technological feasibility

The work in [6] explains the relation between value creation and innovation, the values in this context are linked to the business side and unique benefits of a technology or a product. Some of the values shown in Figure 4 can be applied to the use cases of TrialsNet, depending on the vertical and the use case itself.

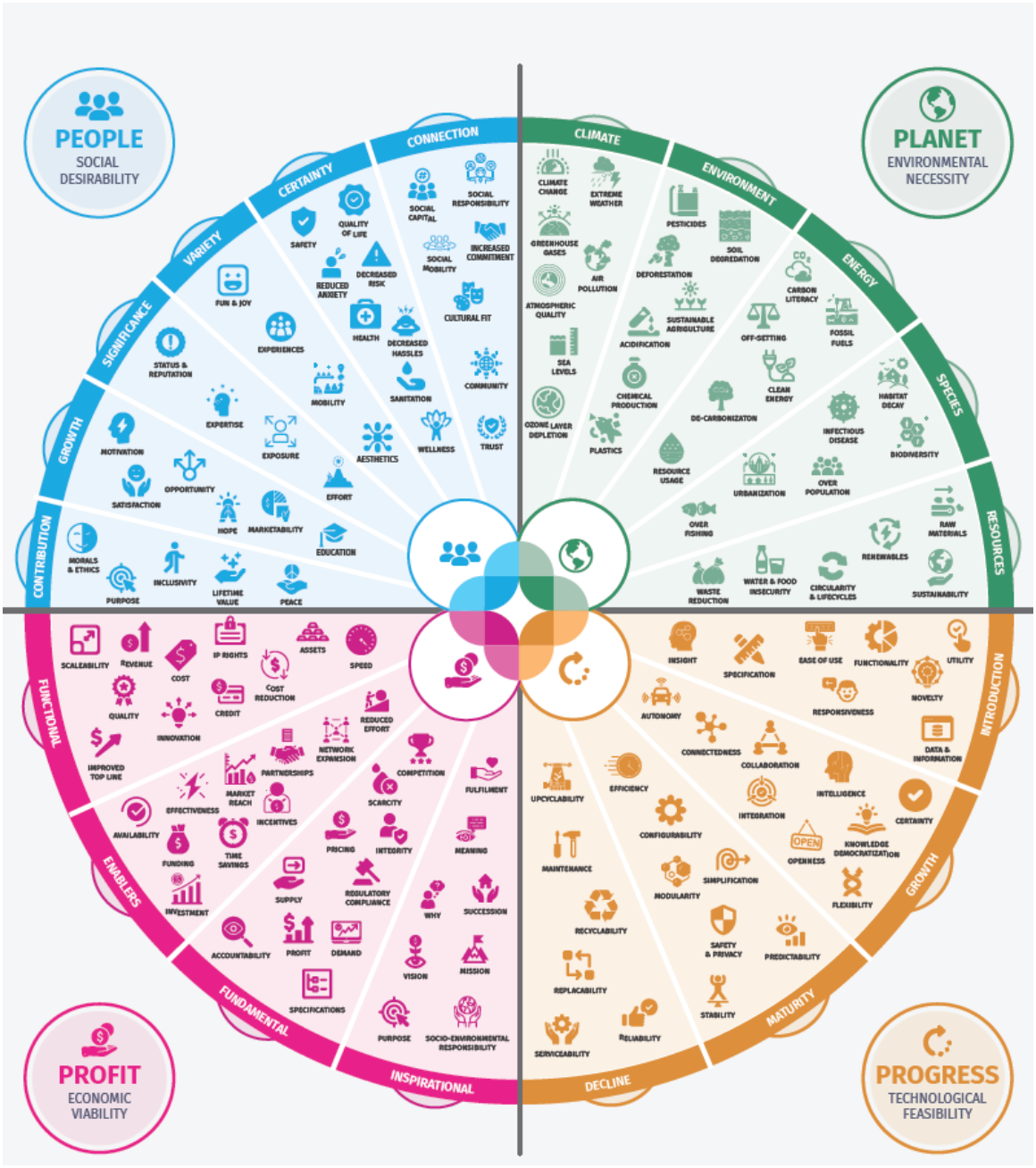

Figure 4. Value types wheel [6].

TrialsNet acknowledges the intricate relationship between enabled business models and societal benefits, which influences technology acceptance models by taking into consideration the environmental impacts. The use cases identified and described in the project have a socio-economic and environmental effects. TrialsNet aims to establish a strong connection between technology and its positive impact on society, environment and economy, hence in the project we analyse the values according to these three categories. The project focuses on developing assessment frameworks that enable the evaluation of use case dynamics for societal and environmental acceptance, specifically in the context of 6G solutions. Hence the concept of KV will be analyzed across the UCs in the project, this increased visibility not only benefits the wireless industry but also aids non-technical adopters, such as users in the public, commercial or environmental sectors, in understanding the advantages. The concept of KV and KVI were recently introduced in the several research works [7] and [8]. According to 6G-IA, the utilization of KVIs in the development of 6G serves two main purposes: first, to demonstrate and validate that 6G can effectively address societal needs, and second, to steer technology development towards directions that yield value driven benefits, a definition of the following new concepts in the technology sector is crucial, in particular:

- **KV**: What is the value that we care about?
- **KVI**: How do assess those values?
- **Enablers**: what factors contribute to those values? How do we make those values happen?
- **KPIs**: What are the technical impacts of those values?

The adopted methodology starts by defining our KVs that are relevant to the UCs in the project, we then provide an assessment of those values, i.e. KVIs. It is also worth analysing the enablers of these KVs and the technical impacts of the values, i.e. KPIs.

In the framework proposed in TrialsNet, the values are categorized as illustrated in Figure 5 in terms of:

- Economical
- Environmental
- Societal

This categorisation will ideally help with the prioritisation of KVs for each use case depending on the direction of the business and funding model.

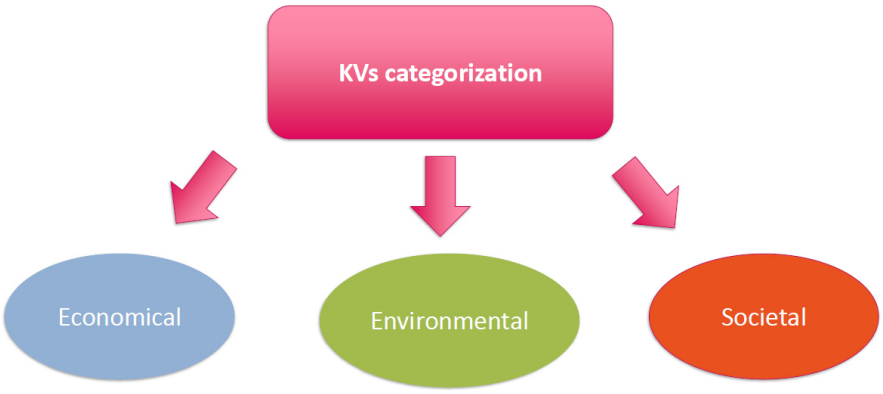

Figure 5. Categories of KVs.

Some values may belong to one category, two categories or even three categories. Some KVs have an economical value by generating business benefits and at the same time have societal value by contributing to the well-being of the society. For example, the KV “business effectiveness” belongs principally to the economical category, as businesses are more efficient and productive, hence eventually a higher growth and profit occurs. However, this KV has also a positive effect on the well-being and development of the society, a lower unemployment rate is recorded when businesses grow.

At the moment of writing this document, the work on KVs, KVIs, and enablers definition has just started and will progress during the next months with the objective to consolidate for each use case the relevant KVs that will be finally evaluated through the feedbacks provided by the users involved into the large-scale trial activities.

Acknowledgment

TrialsNet project has received funding from the European Union's Horizon-JU-SNS-2022 Research and Innovation Programme under Grant Agreement No. 101095871.

References

[1] TrialsNet Deliverable D6.1, “First report on validation and dissemination activities”, 31 October 2023
[2] TrialsNet Deliverable D3.1, "Use Cases definition for Infrastructure, Transportation, and Security & Safety (ITSS) domain", 30 April 2023
[3] TrialsNet Deliverable D4.1, "Use Cases definition for eHealth and Emergency (eHE) domain", 30 April 2023
[4] TrialsNet Deliverable D5.1, "Use Cases definition for Culture, Tourism and Entertainment (CTE) domain", 30 April 2023
[5] 6G SNS JU, “Research for Revolutionary Technology Advancement Towards 6G”
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[7] M. A. Uusitalo, “6G Vision, Value, Use Cases and Technologies From European 6G Flag-ship Project Hexa-X,” IEEE Access, vol. 9, pp. 160 004-160 020, 2021
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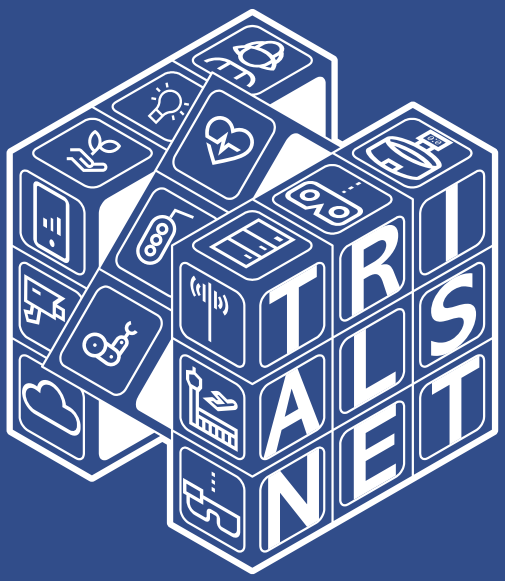

OPEN CALL

FEASIBILITY CHECK FORM

trialsnet.eu | opencall@trialsnet.eu

INTRODUCTION

The Open Call applicants are encouraged to fill the Feasibility Check Form to share their intentions of contribution in order to verify the feasibility of the proposal and to receive an informal and not binding feedback on it. A **draft version of the proposal** (applicants are invited to use the proposal template provided by TrialsNet) can be also sent to opencall@trialsnet.eu (indicating in the subject the short name of the proposal) to provide more detailed information in support of the Feasibility Check Form. Received requests will be processed according to their arrival and feedback will be provided not later than 5 working days.

Feasibility check requests can be submitted until the **10th of December 2023 at 17:00 CET**.

CONTACT INFORMATION

1. **Contact name**:
2. **Company name**:
3. **Additional companies** (in case of small consortium, maximum 2):
4. **Contact email**:

PROPOSAL INFORMATION

1. **Proposal name**:
2. **Option to which the application refers to**:
    - Option 1a
    - Option 1b
    - Option 2
3. **Domain addressed by the application**:
    - Infrastructure
    - Trasnportation
    - Security & Safety
    - eHealth and Emergency
    - Culture
    - Tourism
    - Entertainment
4. **Site selected for the application** (in case of new site please specify country and city):
    - Turin (Italy)
    - Pisa (Italy)
    - Madrid (Spain)
    - Iasi (Romania)
    - Antwerp (Belgium)
    - Athens (Greece)
    - Other

USE CASE SUMMARY

1. **Provide a short description of the proposed use case** (maximum 300 words):

    .....

2. **Which challenges (technical and not) does the proposed use case address?**

    .....

USE CASE IMPLEMENTATION

1. **Which is the most relevant implementation aspect of the proposed use case?**

    - Application development
    - New network functionality
    - New platform functionality
    - Device testing
    - Network equipment testing
    - Other

2. **Which type of devices will be used in the proposed use case?** (multiple answers may apply)

    - Smartphones
    - Tablets
    - VR headsets
    - Robots/drones
    - Cameras
    - Sensors
    - CPEs
    - Others

3. **How many units of the above selected devices are expected be used?**

    .....

4. **Are the above devices going to be self-provided?** (if not, please clarify what support is expected from TrialsNet side)

    .....

5. **What type of network solution is requested to run the proposed use case?**

    - Commercial network
    - Private network
    - Experimental network
    - Other

6. **Is the network solution going to be self-provided?** (if not, please clarify what support is expected from TrialsNet side)

    .....

7. **What type of platforms are requested to run the proposed use case?** (multiple answers may apply)

    - None
    - XR platform
    - IoT platform
    - Others

8. **Are such platforms going to be self-provided?** (if not, please clarify what support is expected from TrialsNet side)

.....

9. **What type of functionalities are requested to run the proposed use case?** (multiple answers may apply)

    - None
    - EDGE
    - Slicing
    - Orchestration
    - Others

10. **Are such functionalities going to be self-provided?** (if not, please clarify what support is expected from TrialsNet side)

.....

11. **Does the proposed use case require a server infrastructure?** (if yes, please specify the main specifications, e.g. Kubernetes and/or Docker support, number of VM instances, CPU, memory, storage, GPU, etc.)

.....

12. **Is such server infrastructure going to be self-provided?** (if not, please clarify what support is expected from TrialsNet side)

.....

13. **Please provide any other information you think is necessary and/or useful realted to the proposed use case implementation.**

.....

TRIAL EXECUTION

1. **Is your proposal already envisioning a trial location?** (if yes, please detail the location, venue description, dates of availability, etc.)

.....

2. **Is the trial involving a vertical?** (if yes, please specify)

.....

3. **What type of real users (depending on the domain) will be involved in the trial?** (multiple answers may apply)

    - Tourists
    - Visitors

- Students
- Passengers
- Citizens
- Employees
- Others

4. **Regarding the duration, and in particular for Option 1, which is the expected time-schedule for the trial?**

    - Limited number of runs / events
    - Periodic (once / twice a week or bi-weekly)
    - Continuos (over a long period)
    - Others

5. **In which terms your trial can be categorised as large-scale?** (multiple answers may apply)

    - Coverage
    - Number of users
    - Duration (including data collection)
    - Others

6. **Please provide some expected values for the above selection(s)**:

    .....

7. **Which are the most demanding requirements of the trial?** (multiple answers may apply)

    - Downlink throughput
    - Uplink throughtput
    - Latency
    - Number of connections
    - Others

8. **Please provide some expected values for the above selection(s)**:

    .....

9. **Which KPIs are going to be measured during the trial?**

    .....

10. **Which KVIs (that can be categorized as societal, environmental or economical) are going to be addressed by the trial?**

    .....

11. **Are questionnaires going to be collected from the user involved in the trial?**

    .....

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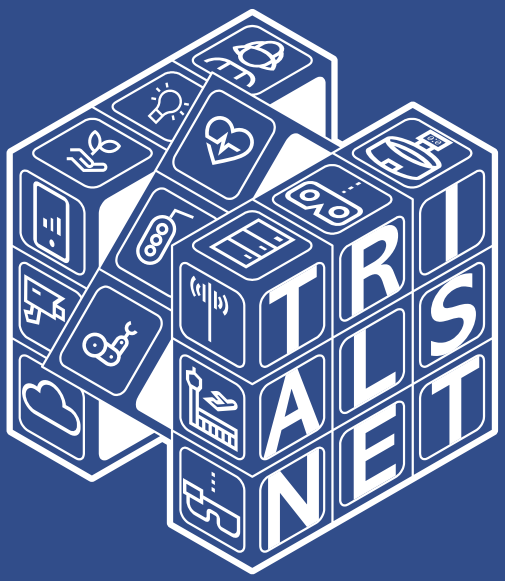

OPEN CALL

FEASIBILITY CHECK REPORT FOR

PROPOSAL NAME

trialsnet.eu | opencall@trialsnet.eu

REFERENCE INFORMATION

Request date	YYYY/MM/DD
Contact Name	TBA
Company Name	TBA
Additional companies	TBA
Contact email	TBA
Proposal Name	TBA
Proposal Option	TBA
Proposal Domain	TBA
Proposal Site	TBA

FEASIBILITY CHECK RESULT

Main topic	Comment
Completeness and validation	*Report if the proposed use case/trial is properly described and it is consistent (i.e., works end to end). If not, detail what is missing.*
Alignment with TrialsNet objectives	*Report if the proposed use case/trial does not properly address the TrialsNet objectives, domains, challenges, etc.*
Implementation: devices	*Report any inconsistency (or request for clarification) with respect to the description of the proposed use case/trial. In case of expected support from TrialsNet, report if the type and number of devices as well as their integration is feasible or not.*
Implementation: network solution	*Report any inconsistency (or request for clarification) with respect to the description of the proposed use case/trial. In case of expected support from TrialsNet, report if the requested network solution is available or not (e.g., area not covered, frequency and/or bandwidth not supported, etc.).*
Implementation: platforms	*Report any inconsistency (or request for clarification) with respect to the description of the proposed use case/trial. In case of expected support from TrialsNet, report if the requested platforms are available or not.*
Implementation: functionalities	*Report any inconsistency (or request for clarification) with respect to the description of the proposed use case/trial. In case of expected support from TrialsNet, report if the requested functionalities are available or not.*
Implementation: server infrastructure	*Report any inconsistency (or request for clarification) with respect to the description of the proposed use case/trial. In case of expected support from TrialsNet, report if the requested server infrastructure is available or not.*
Execution: time-schedule	*Especially for Option 1, report any potential issue related to the proposed time-schedule (e.g., usage of too many resources for a very long period, etc.)*
Execution: large-scale, requirements, KPIs/KVIs	*Report about any inconsistency about large-scale categorization, requirements (in terms of values), and KPIs/KVIs measurements*
Proposal improvements	*Based on the above, summarize here any aspects that should be clarified and/or added in the final proposal. Structure them as question (e.g., "What type of sensors are you going to install?")*

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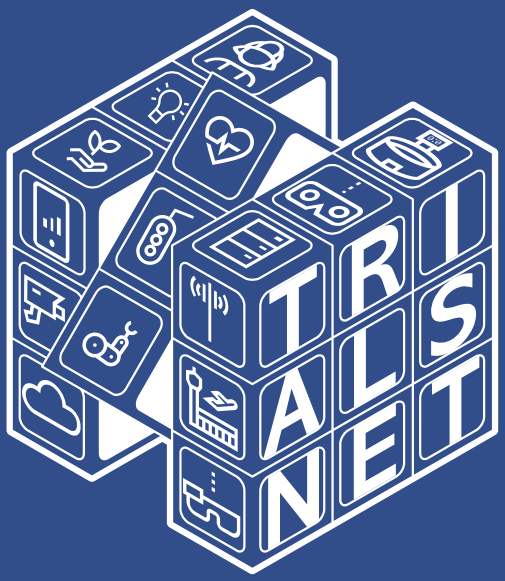

OPEN CALL

PROPOSAL NAME

trialsnet.eu | opencall@trialsnet.eu

GENERAL GUIDELINES (TO BE REMOVED)

Please consider the following general guidelines when preparing your proposal:

- **Follow the structure of this template**. It has been designed to ensure that the important aspects of your planned work are presented in a way that will enable the evaluators to make an effective assessment against the evaluation criteria.
- **Proposal length limit is 12 pages**. Sections from 1 to 6 (i.e., except "Proposal Information") must be included within this limit. Suggested sections length is indicative. The minimum font size allowed is 11 points. Please add explanatory figures where necessary.
- ***Guidelines*** **and** yellow highlights **must be removed from the final proposal**.
- **Follow the instructions provided in the** Guide for Applicants which is outlining in detail the requirements for the proposal.

PROPOSAL INFORMATION

1. **Proposal name**: add here

2. **Option to which the application refers to**: specify here *(select one of the following)*

    - *Option 1a*
    - *Option 1b*
    - *Option 2*

3. **Domain addressed by the application**: specify here *(select one of the following)*

    - *Infrastructure*
    - *Trasnportation*
    - *Security & Safety*
    - *eHealth and Emergency*
    - *Culture*
    - *Tourism*
    - *Entertainment*

4. **Site selected for the application**: specify here *(select one of the following)*

    - *Turin (Italy)*
    - *Pisa (Italy)*
    - *Madrid (Spain)*
    - *Iasi (Romania)*
    - *Antwerp (Belgium)*
    - *Athens (Greece)*
    - *New site (please specify country and city)*

1. USE CASE DESCRIPTION *(3 pages)*

Add text here following the guidelines reported below.

1. ***Provide a description of the proposed use case***

    - *Provide a detailed explanation of the use case from an end-to-end perspective (therefore providing its high-level architecture, a description of the application, the supported and/or requested funtionalities, describing the connectivity aspects between the different elements, how these interacts, etc.) and specifying the role of the end users. One or more figures depicting the use case should be also provided.*
    - *In case of an improvement of a TrialsNet use case describe in detail the new features, software applications and/or devices that are introduced.*
    - *In case of a new infrastructure (i.e. extending the TrialsNet platform and network solutions), describe its main components, functionalities, devices, etc. Please note that new infrastructures are intended to be experimental, private and/or commercial network deployments.*

2. ***Describe which challenges (technical and not) the proposed use case addresses***

    - *Describe the concrete challenges and respective goals of the proposed use case and related field trial.*

2. USE CASE IMPLEMENTATION *(2.5 pages)*

Add text here following the guidelines reported below.

1. ***Describe the most relevant implementation aspect of the proposed use case***

    - *Application development*
    - *New network functionality*
    - *New platform functionality*
    - *Device testing*
    - *Network equipment testing*
    - *Other*

2. ***Describe which type of devices will be used in the proposed use case***

    - *Report in detail the type of devices that will be used and connected to the network such as*
        - *Smartphones*
        - *Tablets*
        - *VR headsets*
        - *Robots/drones*
        - *Cameras*
        - *Sensors*
        - *CPEs*
        - *Others*
    - *Specify how many units of the above selected devices are expected to be used*
    - *Specify if the above devices are going to be self-provided (if not, please clarify what support is expected from TrialsNet side)*

3. ***Describe the type of network solution that is requested to run the proposed use case***

    - *Describe the network solution (in terms of its architecture, supported bands, etc.) that is going to be used for the implementation of the proposed use case such as*
        - *Commercial network*
        - *Private network*
        - *Experimental network*
        - *Other*
    - *Specify if the network solution is going to be self-provided (if not, please clarify what support is expected from TrialsNet side)*

4. ***Describe (if applicable) the type of platforms that are requested to run the proposed use case?***

    - *Describe in detail if the poropsed use case requires a specific platform in support of its implementation such as*
        - *XR platform*
        - *IoT platform*
        - *Others*
    - *Specify if the platforms are going to be self-provided (if not, please clarify what support is expected from TrialsNet side)*

5. ***Describe (if applicable) the type of functionalities that are requested to run the proposed use case***

    - *Describe in detail which functionalities are required for the implementation of the proposed use case such as*
        - *EDGE*
        - *Slicing*
        - *Orchestration*
        - *Others*
    - *Specify if such functionalities are going to be self-provided (if not, please clarify what support is expected from TrialsNet side)*

6. ***Describe (if applicable) the server infrastructure that is requested to run the proposed use case***

    - *Report if the proposed use case requires a server infrastructure for its implementation in terms of*
        - *Kubernetes and/or Docker support*
        - *Virtual Machines support*
        - *CPU, memory, and storage*
        - *GPU*
        - *Others*
    - *Provide the related specfications in terms of mumber of CPU cores, GPU capacity, etc.*
    - *Specify if the server infrastructure is going to be self-provided (if not, please clarify what support is expected from TrialsNet side)*

7. ***Provide any other information that is considered necessary and/or useful realted to the proposed use case implementation***

3. TRIAL EXECUTION *(2 pages)*

Add text here following the guidelines reported below.

1. ***Report if your proposal is already envisioning a trial location***
   - *Please detail the location, venue description, dates of availability, etc.)*

2. ***Report if the trial is going to involve a vertical***
   - *Please specify which tupe of vertical and its role in the proposed use case*

3. ***Report if and what type of real users (depending on the domain) will be involved in the trial***

   - *Describe in detail what type of real users you are expecting to involve in the trial such as*
     - *Tourists*
     - *Visitors*
     - *Students*
     - *Passengers*
     - *Citizens*
     - *Employees*
     - *Others*
   - *Specify the expected number of real users and how they are going to be engaged.*

4. ***Report, in particular for Option 1, which is the expected time-schedule for the trial***

   - *Provide detailed information about the the proposed use case is going to be trialed such as*
     - *Limited number of runs / events*
     - *Periodic (once / twice a week or bi-weekly)*
     - *Continuos (over a long period)*
     - *Others*
   - *Describe the development aspects based on the foreseen time-schedule*

5. ***Describe in which terms the trial can be categorised as large-scale***

   - *Discuss in detail which are the aspects that can categorize the trial as large-scale such as*
     - *Coverage*
     - *Number of users*
     - *Duration (including data collection)*
     - *Others*
   - *Provide the expected values in terms of coverage area, number of users, etc.*

4. KPIs AND KVIs *(1.5 pages)*

Add text here following the guidelines reported below.

1. ***Report which are the most demanding requirements of the trial***

   - *Describe in detail which are the KPIs that are most relevant in the context of the proposed use case such as*
     - *Downlink throughput*
     - *Uplink throughtput*
     - *Latency*

        - *Number of connections*
        - *Others*
    - *Provide the expected values for such KPIs (e.g., minimum throughput, maximum latency, etc.)*
    - *Specify how such KPIs are going to be measured during the trial*

2. ***Report which KVIs are going to be addressed by the trial***

    - *Describe in detail which are the KVIs that are most relevant in the context of the proposed use case for the following categories*
        - *Societal*
        - *Environmental*
        - *Economical*

3. ***Specify if questionnaires are going to be collected from the user involved in the trial***

4. ***More in general, report which are other data that are expected to be collected during the trial***

    - *Specify the type of data that trial is going to provide*
    - *Specify if such data are going to be made available open source*

5. SOCIO-ECONOMIC IMPACTS *(1 page)*

Add text here following the guidelines reported below.

1. ***Discuss the relevance of the proposal in the addressed market***

    - *Provide a description of the current market state of the art and the innovation potential of your proposal*

2. ***Discuss the social economical drivers related to the proposal***

    - *Discuss why the proposal is important from an economical and societal standpoint*

6. WORK PLAN *(2 pages)*

Add text here following the guidelines reported below.

1. ***Describe the main tasks and activities that are needed for the development of the proposal***

    - *Report the development plan by including for instance*
        - *Pert chart*
        - *Gantt chart*

2. ***Describe the main milestones of the proposal development and their means of verification***

    - *Discuss what are the main milestones to be achieved relted to the implementation of the use case and how these are going to be assessed*

3. ***Provide a proposal of a deliverable to report on the trial activities and related results***

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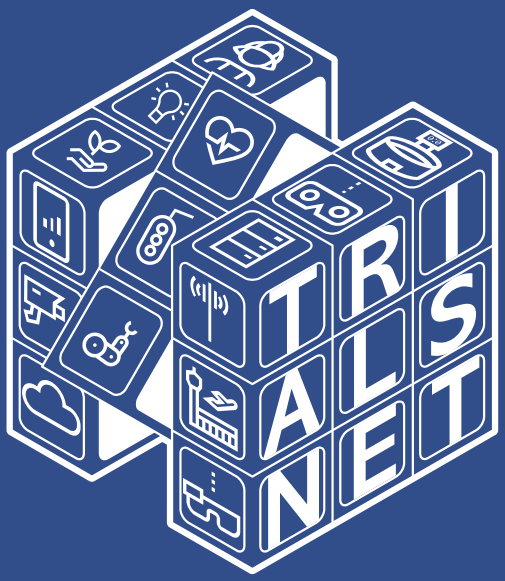

OPEN CALL

BUDGET TEMPLATE

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BUDGET REQUEST

Please provide one table for each partner (in case of small consortium).

Item	PMs	Cost (€)
1. Personnel costs		
2. Other direct costs (travels)		
3. Other direct costs (equipment)		
4. Other direct costs (other goods and services)		
5. Total direct costs (sum of rows 1, 2, 3, and 4)		
6. Indirect costs (25 % or row 5)		
7. Total elegible costs (sum of rows 5 and 6)		
8. Requested funding		

Please provide a justification for the costs related to items 1, 2, 3, and 4.

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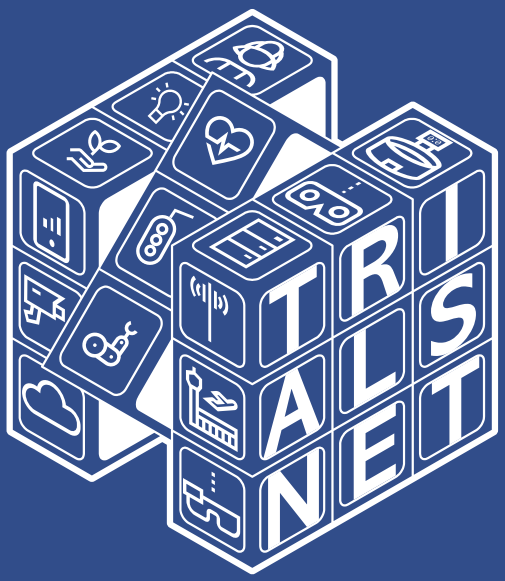

OPEN CALL

DECLARATION OF HONOUR FOR APPLICANTS

trialsnet.eu | opencall@trialsnet.eu

INTRODUCTION

The attached document represents the Declaration of Honour for the applicants that must be signed by the legal representative of the selected applicants and provided back to TrialsNet consortium before starting the contracting phase of the Grant Agreement.

TRIALSNET OPEN CALL

DECLARATION OF HONOUR FOR THE APPLICANT

I, the undersigned person ……. representing the following applicant:

- Full Legal name:
- Full Legal address:

hereby confirm that (subject to the additional declarations below):

- The information provided for participating in the TrialsNet open call action is correct and complete.
- The information concerning the legal status sent to TrialsNet for me/my organization is correct and complete.
- My organization commits to comply with the eligibility criteria and all other conditions set out in the call conditions for the entire duration of the action.

In addition, I declare that my organization:

- Has stable and sufficient sources of funding to maintain the activities throughout the action and to provide any counterpart funding necessary.
- Has or will have the necessary resources needed to implement the action.
- Is committed to comply with the highest standards of ethical principles and research integrity and confirm that the work is free of plagiarism.
- Undertakes to comply with the obligations under the agreement.
- Respects general principles (including fundamental rights, values and ethical principles, environmental and labor standards, rules on classified information, intellectual property rights, visibility of funding and protection of personal data).
- For the submission of financial certificates under the agreement uses qualified external auditors which are independent and comply with comparable standards as those set out in EU Directive 2006/43/EC.
- For controls under the agreement allows for checks, reviews, audits and investigations (including on-the-spot checks, visits and inspections) by the granting authority, the European Anti-Fraud Office (OLAF), the European Prosecutor's Office (EPPO) and the European Court of Auditors (ECA) and any persons mandated by them.
- Is not subject to an administrative sanction (i.e. exclusion or financial penalty decision)[1].
- Is not in one of the following exclusion situations[2]:
    - bankrupt, being wound up, having the affairs administered by the courts, entered into an arrangement with creditors, suspended business activities or subject to any other similar proceedings or procedures.
    - is not in breach of social security or tax obligations.
    - guilty of grave professional misconduct[3].
    - committed fraud, corruption, links to a criminal organization, money laundering, terrorism-related crimes (including terrorism financing), child labor or human trafficking.
    - shown significant deficiencies in complying with main obligations under an EU procurement contract, grant agreement, prize, expert contract, or similar.
    - guilty of irregularities within the meaning of Article 1(2) of Regulation No 2988/95.

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1 See Article 136 EU Financial Regulation.

2 See Articles 136 and 141 EU Financial Regulationn.

3 Professional misconduct includes: violation of ethical standards of the profession, wrongful conduct with impact on professional credibility, false declarations/misrepresentation of information, participation in a cartel or other agreement distorting competition, violation of IPR, attempting to influence decision-making processes or obtain confidential information from public authorities to gain an advantage.

    - created under a different jurisdiction with the intent to circumvent fiscal, social or other legal obligations in the country of origin (including creation of another entity with this purpose).
- Is not subject to a conflict of interest in connection with this grant and will notify - without delay - any situation which could give rise to a conflict of interests.
- It will not, neither directly nor indirectly, grant, seek, obtain or accept any advantage in connection with this grant that would constitute an illegal practice or involve corruption.
- It didn't receive any other EU grant for this action or any similar action and will give notice of any future EU grants related to this action AND of any EU operating grant(s)[4] given to my organization.
- Is aware that false declarations may lead to rejection, suspension, termination or reduction of the grant and to administrative sanctions (i.e. financial penalties and/or exclusion from all future EU procurement contracts, grants, prizes and expert contracts).
- Is aware of the EU general data protection regulation (GDPR) - Regulation (EU) 2016/679 (General Data Protection Regulation) - which governs how the personal data of individuals in the EU may be processed and transferred and will follow the regulation.
- Confirms that there is no infringement on Intellectual Property of any third party by my/our involvement in the TrialsNet Open Call. Usage of any third-party's Intellectual Property requires an ultimate owner confirmation.

and acknowledge that:

- The grant will be signed by CERTH as contracting partner on behalf of the TrialsNet consortium.
- Personal data submitted or otherwise collected by the TrialsNet project will be solely with the purpose of executing and reporting on the open call.

Forename Surname:

Function:

Date:

Signature:

[4] See Article 180 EU Financial Regulation.