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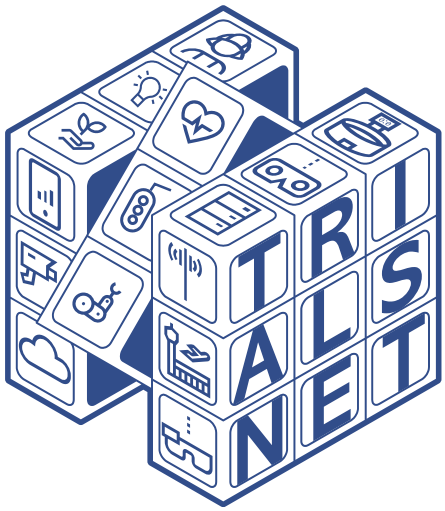

TrialsNet: TRials supported by Smart Networks beyond 5G

Open Call

TrialsNet framework and KPIs/KVIs overview

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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.

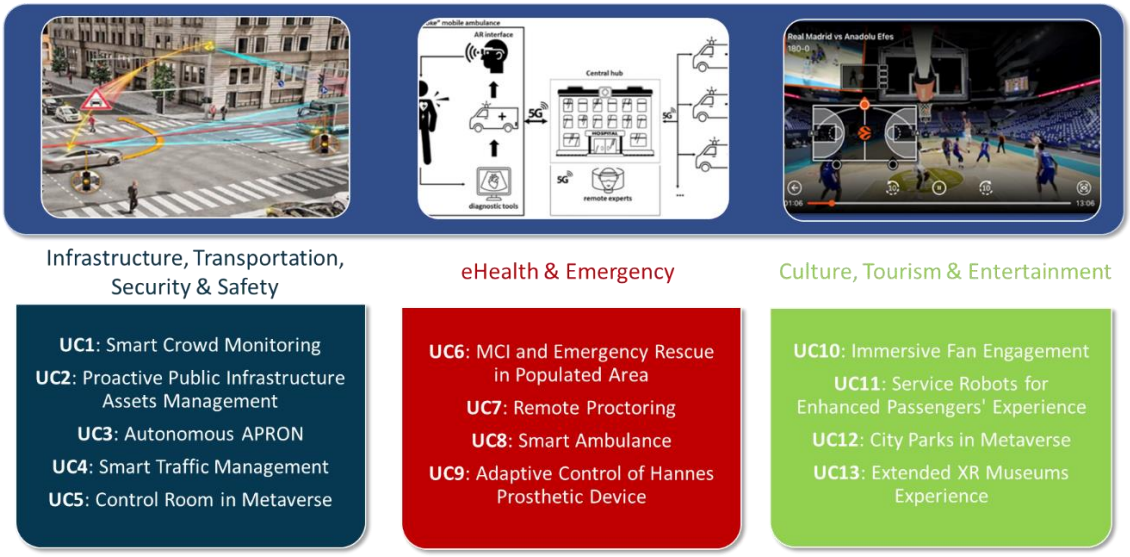

Figure 1. TrialsNet use cases in the three domains.

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.

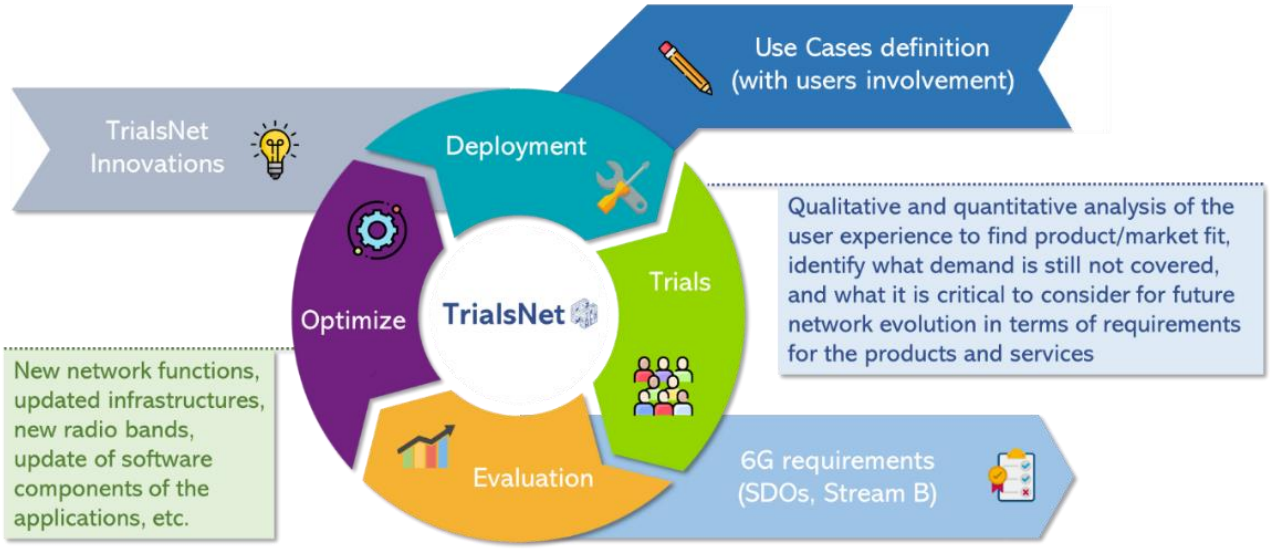

Figure 2. TrialsNet methodology.

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.

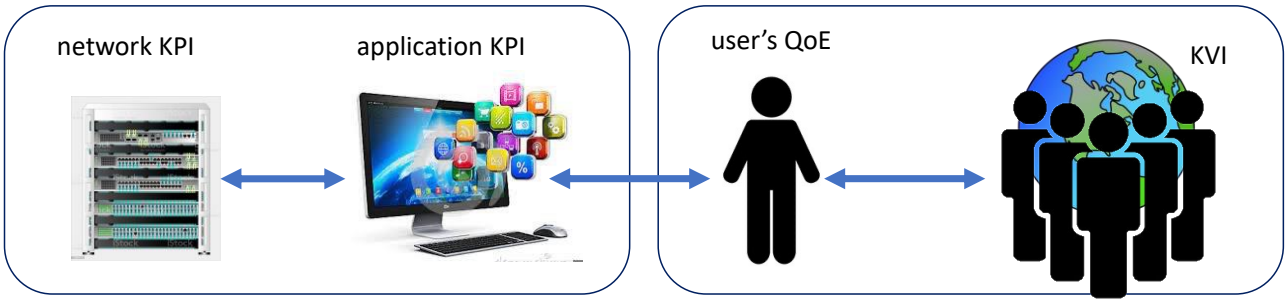

Figure 3. Relation between KPIs and KVIs.

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.

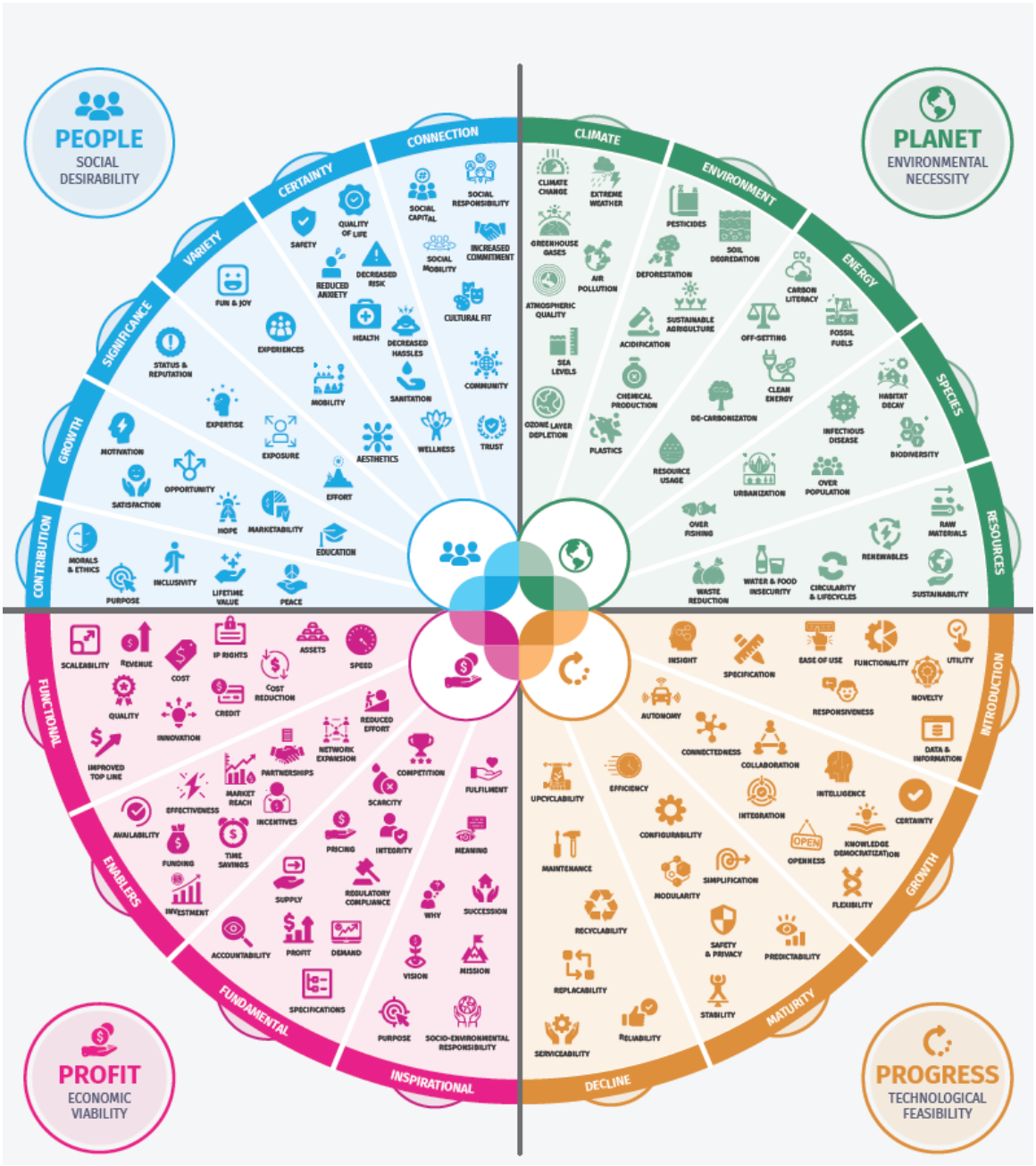

Figure 4. Value types wheel [6].

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.

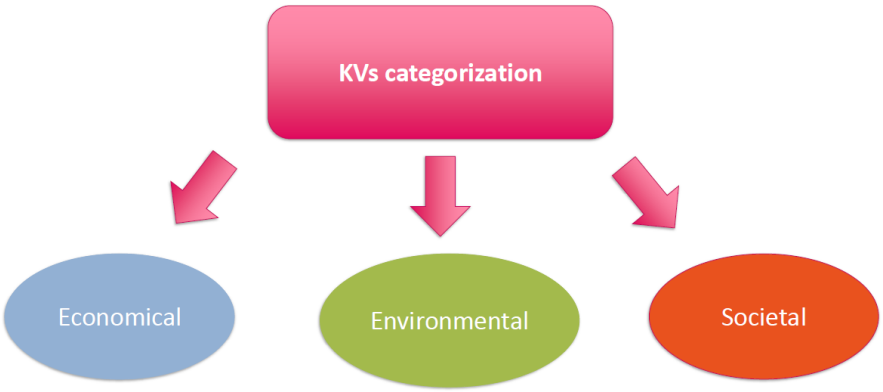

Figure 5. Categories of KVs.

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.

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