2nd 6G-XR Open Call

Stream B Enablers

6G eXperimental Research infrastructure to enable next-generation XR services (6G-XR)

DISCLAIMER

6G-XR (*6G eXperimental Research infrastructure to enable next-generation XR services*) project has received funding from the **Smart Networks and Services Joint Undertaking (SNS JU)** under the European Union's **Horizon Europe research and innovation programme** under Grant Agreement No 101096838.

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

COPYRIGHT NOTICE

TABLE OF CONTENTS

6G-XR Consortium

No	Partner Organisation Name	Short name	Country
1	OULUN YLIOPISTO	UOULU	Finland
2	TEKNOLOGIAN TUTKIMUSKESKUS VTT OY	VTT	Finland
3	NOKIA SOLUTIONS AND NETWORKS OY	NOKIA	Finland
4	FUNDACIO PRIVADA I2CAT, INTERNET I INNOVACIO DIGITAL A CATALUNYA	I2CAT	Spain
5	TELEFONICA INNOVACION DIGITAL SL	TID	Spain
6	CAPGEMINI ESPANA SL	CGE	Spain
7	MATSUKO S.R.O	MATSUKO	Slovakia
8	ERICSSON ESPANA SA	ERI	Spain
9	INTEL DEUTSCHLAND GMBH	INTEL	Germany
10	FUNDACION CENTRO DE TECNOLOGIAS DE INTERACCION VISUAL Y COMUNICACIONES VICOMTECH	VICOM	Spain
11	RAYTRIX GMBH	Raytrix	Germany
12	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM	IMEC	Belgium
13	INSTITUTO DE TELECOMUNICACOES	IT	Portugal
14	MARTEL GMBH	MAR	Switzerland
15	INTERDIGITAL EUROPE	IDE	UK

1 GENERAL OPEN CALL INFORMATION

1.1 INTRODUCTION

The 6G-XR project hereby announces its second Open Call to provide financial support to third parties.

This Call focuses on enablers coming out of Horizon Europe SNS JU Stream B thematises. Out of these thematises, particular topics in the following areas are of interest:

Call Identifier	Areas	Sub-area	6G-XR facility	Selected Node	Mentors
6G-XR-OC2-TOP1	Reflective intelligent surfaces	150 GHz Reflective Intelligent Surface (RIS)	North	UOULU 5GTN	IMEC, UOULU
6G-XR-OC2-TOP2.1	Deterministic communications	Implementation and verification of wireless deterministic communication links on 3D digital twin use case	North	UOULU 5GTN	UOULU
6G-XR-OC2-TOP2.2		Deterministic networking	South	5GBarcelona	i2CAT
6G-XR-OC2-TOP2.3			North	UOULU 5GTN	UOULU
6G-XR-OC2-TOP3.1	Energy measurement	Sustainability enablers for energy measurement and optimisation	North	UOULU 5GTN	UOULU
6G-XR-OC2-TOP3.2			North	VTT 5GTN	VTT
6G-XR-OC2-TOP3.3		Monitoring of energy consumption of VNFs for Multimedia Streaming	South	5GBarcelona	VICOM
6G-XR-OC2-TOP3.4			North	VTT 5GTN	VTT
6G-XR-OC2-TOP4	AI/ML for slicing	AI/ML algorithm for efficient resource optimization in the 5G slicing techniques	North	UOULU 5GTN	UOULU
6G-XR-OC2-TOP5.1	Load balancing	Mechanisms for load-balancing and service migration to enable Device/Edge/Cloud continuum	South	5TONIC	VICOM, CGE
6G-XR-OC2-TOP5.2		Mobility Load Balancing on ORAN campus network	South	5GBarcelona	I2CAT
6G-XR-OC2-TOP6.1	Security and trust mechanisms	Multi-stakeholders security and trust mechanisms for Edge North Bound interfaces	South	5TONIC	CGE
6G-XR-OC2-TOP6.2			South	5GBarcelona	

© 2023-2025 6G-XR Consortium

6G-XR-OC2-TOP6.3		Confidential computing environments for end-to-end energy efficiency	North	VTT 5GTN	VTT
6G-XR-OC2-TOP7	Increased capacity	6G channels	South	5GBarcelona	I2CAT
6G-XR-OC2-TOP8	Other Stream B thematises	Other proposals coming from Stream B thematises	To Be Identified based on the proposal		

Each topic is supervised by a project partner (mentor) who is responsible for supporting the third party projects during execution and following up on the project results.

1.2 CALL INFORMATION

Project full name: 6G eXperimental Research infrastructure to enable next-generation XR services

Project Grant Agreement number: 101096838

Call identifier: 6G-XR-OC2

Call title: 2nd 6G-XR Open Call – Stream B enablers

Feasibility check deadline: 22nd April 2024 @17:00 CET

Final Submission deadline: 22nd May 2024 @17:00 CET

Information Webinar on Open Call 2: 27th March 2024 @12:30 AM CET

1.3 AVAILABLE BUDGET

Open Call	Project duration	Max funding (€)	No of projects	Total funding (€)
6G-XR-OC2	6 months	60.000	10	600.000 €

For the implementation of the third party project, a total lump sum of the awarded amount will be paid upon the completion of the project. No advance payments will be made. The payment of the total amount will be made once the project activities have been performed completely, the deliverables and final report have been reviewed and accepted by the 6G-XR project and a final decision on the approval of the third party project and deliverables has been issued.

1.3.1 Requirements related to the proposer:

- Proposers must be **eligible for funding in the Horizon Europe programme** and be established in an EU Member State or in an Associated Country.

- Proposals will only be accepted from a **single party**.

- Proposals need to come from the European Smart Networks and Services Joint Undertaking (SNS JU) **Stream B thematises**. Proposals are required to justify their linkage to Stream B

thematises, and proposals coming directly from Stream B projects are required to ensure the proposed work is not already covered by the existing Stream B project, but it is in fact novel.

- Feasibility check is mandatory, and the proposals must be submitted for feasibility evaluation before the **Feasibility check deadline**. Proposals failing submission for feasibility will not be evaluated.

- A proposer can only be selected for funding for one proposal, even if the proposer submitted multiple proposals that are ranked high enough to be selected for funding. In the latter case, the proposer may be given the opportunity to choose the one to be retained for funding.

- To avoid potential conflict of interest, **proposals will not be accepted from individuals or organisations who are partners in the 6G-XR consortium or who are formally linked in any way to partners of the consortium**. All proposers will be required to declare that they are aware of no such potential conflict of interest that should prevent them from applying.

- A proposer must select a single Node and at least a single infrastructure to conduct their experiment.

- Language in which the proposal must be submitted: **English**.

- Proposals must follow the provided **template** (see Appendix A of this document).

- Proposals (draft as well as final proposals) must be submitted through the **online submission portal** (http://www.6g-xr.eu/open-calls/oc2/)

1.4 TIMETABLE AND DEADLINES

ACTION	DEADLINE
Submission deadline of draft proposal for the Feasibility check	22.04.2024 @17:00 CET
Submission deadline (of final proposal)	22.05.2024 @17:00 CET
Notification of the result	30.06.2024
Start of the Project	02.09.2024
End of the Project	02.03.2025

2   THE 6G-XR PROJECT

6G eXperimental Research's ambition is to strengthen European leadership in 6G technologies by enabling next-generation XR services and infrastructures that will provide beyond-state-of-the-art capabilities towards the 6G era. The project will develop an experimental multisite Research Infrastructure (RI) to provide a validation platform for various 6G-use cases by developing enablers for networking and computing, radio access technologies beyond 5G, enablers for XR services with in-build federation, trial management, abstraction tools as well as energy measurement frameworks.

2.1 INTRODUCTION TO THE PROJECT

Objectives and Approach - 6G-XR is building its objectives, ambition, and methodology on top of four state-of-the-art research (SoTA) RIs, namely 5GTN UOULU, 5GTN VTT, 5TONIC, and 5GBarcelona. These well-developed RIs represent the most evolved open environments for communications research in Europe. 6G-XR project will enhance the capabilities of these research infrastructures to provide beyond-state-of-the-art (BSoTA) capabilities towards 6G by:

- Building a multisite Research Infrastructure that can provide validation platform for multitude of foreseen (extreme) 6G use cases by developing enablers for networking and computing, radio access technologies beyond 5G, enablers for XR services with in-build federation, trial management, abstraction tools as well as energy measurement framework.
- Validating multi access edge computing scenarios and their integration into a complete cloud continuum, support innovative use cases with vertical actors, beyond 5G capabilities, and support showcasing events.
- Demonstrating and validating performance of innovative 6G applications with a focus on demanding immersive applications such as holographics, digital twins, and XR/VR.
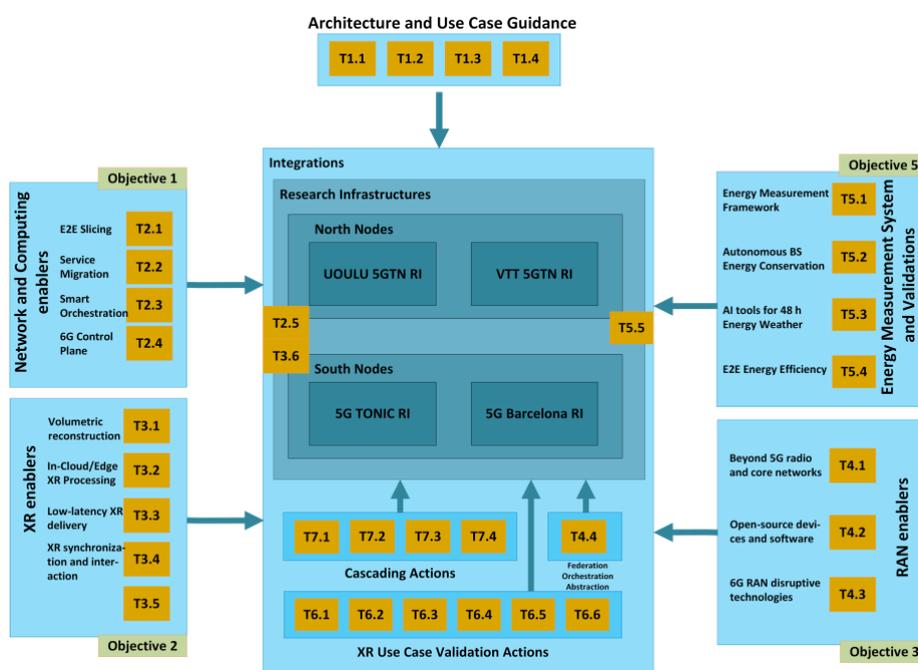

Figure 1. The Approach and objectives of 6G-XR project

Initial Use Case 1: Real-time holographic communications - Key challenges are addressed to successfully deliver real-time multi-party holographic communication services at scale and over heterogeneous environments. 6G-XR will go beyond the state-of-the-art in this field with the goal of increasing the visual resolution of holograms, as well as the performance, scalability, interoperability, and efficiency of such services. The envisioned next-generation holographic services will adopt many new features fully compliant with 6G architectural and communication paradigms, and it will be expected to contribute to the maturity, robustness, and wide adoption of high-quality, scalable, and affordable holographic communication services.

In this context, 6G-XR is exploring strategies to offload processing tasks from end-clients to the edge to alleviate the bandwidth and processing requirements on the client side. Examples of Virtualized Network Functions (VNFs) being provided include: Edge-assisted 3D volumetric reconstruction, Edge-assisted communication modules (e.g., Selective Forwarding Units (SFUs), mixers, transcoders...) and Remote Rendering modules. In addition, 6G-XR is devising 2 Network-as-a-Service (NaaS) APIs for enhancing the adaptability and interoperability of XR services: (i) network-assisted rate control, including Quality-on-Demand (QoD) mechanisms; and (ii) Edge Discovery, Selection and Application Function (AF) Licecycle Management, including the strategic orchestration of the previously introduced VNFs over the Cloud Continuum. Finally, 6G-XR is proposing a new network architecture capable of supporting holographic calls, based on control plane and IMS Data Channel (IMSDC), guaranteeing compatibility and easing integration with state-of-the-art devices.
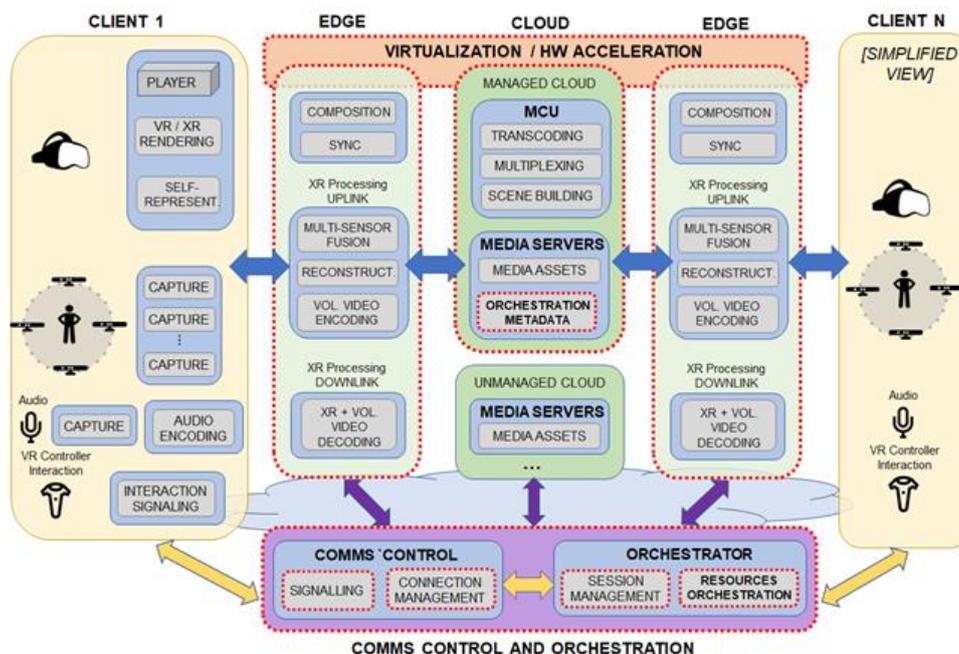

Figure 2. Envisioned evolution of HoloMIT in 6G-XR (newly envisioned components and components to be significantly evolved represented as boxes with red dashed lines).

Initial Use Case 2: Collaborative 3D Digital Twin Environments - The scale of blending digital and physical in VR is still narrow, restricted to simple application areas, and the full potential of XR has not

yet been met. There are some state-of-the-art systems aiming at extending the virtual across the XR spectrum in addition to increasing the entanglement of the digital and physical. Interestingly, collaborative 3D digital twin environments take advantage of existing 3D material for building a mirror world like VR and enhance this environment with remote operation capabilities for robotics and computer mediated collaboration e.g. using private 5G advanced and emerging 6G devices and networks.
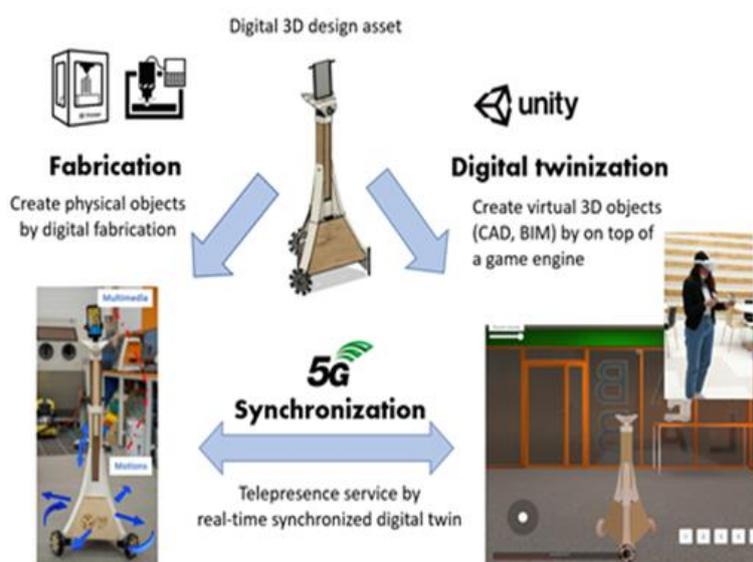

Figure 3. 3D Digital Twin like environment, a cyber-physical system that leverages 5G combining teleoperation of robots via virtual environments and IoT.

2.2 RESEARCH INFRASTRUCTURES

2.2.1 6G-XR North Node (UOULU 5GTN and VTT 5GTN)

The **University of Oulu** (UOULU) has 5G Test Network (UOULU 5GTN) with campus-wide small cell, macro-cell and distributed antenna based cellular network to be complemented by NFV based EPC and 5G backhauling solution (http://5gtn.fi/).

The Full-scale 5G Test Network in the University of Oulu supports usage of 5G devices, higher frequency bands, cognitive management functionalities, system testing tools for new solutions. The 5G Test Network feature evolution follows 5G research and standardisation progress, acting as verification platform for theoretical 5G research. The cellular devices part of the network is composed of 30 LTE small cells (700 MHz, 2.1, 2.3, 2.6, 3.5 GHz) and 2 macro cells (2.3 GHz). The network has two 5GNR base stations (3.5 GHz) complemented with several tens of User Equipment from various manufacturers that are easily integrated to any device, and tens of 5G enabled mobile phones from several vendors. Commercial 5G baseband and radio modules are being updated to new versions during the first half of 2024. The network is currently being complemented by commercial mmW (24-28 GHz) 5G NR base stations with several mmW capable UE's as well as with 36 remote radio head (RRH) based cloud RAN 5G NR devices. The network is controlled by operator grade EPC (Evolved Packet Core), thus making UOULU in practice a network operator with own SIM production for mobile

devices. The current operational EPC version is 5G NSA compliant, but for research purposes 5G stand-alone (SA) solution with its own core and macro base station is also available. SA network with its commercial grade cloud core is being integrated and available March 2024. The network within the campus is complemented by wireless sensor network (IoT, internet of things) extension with estimated 2000 different kinds of sensors with wireless connectivity through NB-IoT, LTE-M and LoRa. Furthermore, the network has big data computing servers for network data analytics purposes. Some of these servers are distributed as edge servers within the network thus allowing multi-access edge computing (MEC).

On top of the commercial 4G, 5G and mmW solutions also open standard solutions are offered. Several different 4G and 5G core solutions are available for research use. Technologies in use are for example Open5GS core, Open Air Interface (OAI), different kinds of USRP radios, etc.

Several different kinds of test equipment and software is offered to be used. There are for example commercial grade radio parameter measurement equipment and software available. For IP network traffic an extensive Quality of Service (QoS) test software is in use.

The main **VTT Technical Research Centre of Finland Ltd** (VTT) site for 6G-XR experiments is located in Oulu. The current radio coverage is deployed with 4G LTE, 5G NR, Wi-Fi 6 and LoRa technologies. The current deployment includes the following licensed frequency bands:

- 4G LTE:
  - B1/n1: 2100 MHz (BW: 10 MHz)
  - B3/n3: 1800 MHz (BW: 5 MHz)
  - B7/n7: 2600 MHz (BW: 10 MHz)
  - B28: 700 MHz (BW: 3 MHz)
  - B31: 450 MHz (BW: 5 MHz)
- 5G NR:
  - n77: 3700 MHz (BW: 100 MHz)
  - n78: 3500 MHz (BW: 60 MHz)
  - n258: 26 GHz (BW: 800 MHz)

The network has been designed to support dynamicity in the experimentation. Network configurations (e.g., number of cells, frequency) and antenna setups including transmitting power may be changed towards specific vertical use case requirements. While the network coverage with high frequency 5G NR is typically < 1 km, with cellular IoT technology such as, NB-IoT the coverage will reach above 10 km distances for mMTC. In addition to 4G LTE and 5G NR coverage test sites include indoor deployments with WiFi6 technology. The available user equipment (UE) includes newest commercial UEs, evaluation boards as well as a software-defined radio (SDR) based UE emulator (Keysight) capable of emulating with current setup up to 1000 4G LTE and 100 5G NR UEs. Radio Access Network (RAN) options based on commercial eNBs/gNBs and SDR-based solutions running open-source srsRAN protocol stack are available. A limited set of Open RAN (O-RAN) interfaces and service models as well as RAN Intelligent Controller (RIC) functionality are available with both RAN options. For the deployed core networks there are carrier-grade telco cloud and open-source Open5GS instances available.

Edge processing has been deployed with several edge platform implementations with local data break out following the ETSI multi-access edge computing (MEC) specifications and application development in local / private networks. Edge solutions include general hardware and open-source software as well as well as commercial proprietary solutions. Deployment includes Nvidia H100 GPUs for AI processing at the mobile network edge server, which can be tailored to process application/service data or large

telecom data from our carrier-grade cellular network. Fixed backbone includes 40/100 Gb connections on site as well as 10 Gb links towards world-wide internet connection. The test site also includes an off-grid powering system for the cellular network site components including local power production with solar cells. The system is modular and capable of supplying both 48 VDC and 230 VAC for the indoor and outdoor RAN components

6G-XR North Node Beyond State-of-the-Art

The described beyond state of the art below is a roadmap towards what the North Node will have available by the end of the project. At the time of Open Call 2 all of the components may not be available and feedback from the feasibility check can be used to match the proposals to the current state of the RIs.

VTT 5GTN and UOULU 5GTN will be upgraded throughout the 6G-XR project to allow B5G and 6G experimentation and research activities. 3GPP 5G-Advanced evolution will be supported by upgrading the 5G core network (commercial and open source), RAN, and user equipment with 3GPP Rel. 16/17 functionality as it becomes available. The focus of the upgrades at 3.5-3.7 GHz and 24-26 GHz frequency bands will be to support URLLC and at 450-850 MHz frequency bands to support mMTC. Possible new frequency bands and support for both 5G NR TDD and FDD is also expected. For non-3GPP technologies, WiFi 7 technology will be adopted when it comes available.

The different experimental facilities will adopt O-RAN architecture and interfaces at some extend to study the impact of having virtualised distributed function splits in the RAN. The different RAN functionalities will be managed and monitored by the near-time and non-real-time RIC. The controlling and monitoring aspects of O-RAN will enable AI algorithms for RAN resource consumption and energy efficiency optimisations. Virtualised radio unit (RU) functionalities will run on SDR platforms providing up 140 MHz radio links and MIMO schemes.

Accurate time synchronization for the deployed network equipment is provided with a GNSS-based PTPv2 grandmaster. Accurate and robust atomic clock-based time synchronisation is also available for mobile clients and indoor environments. Time synchronisation plays a key role for the accurate data delivery and measurement timings expected to be needed in the various validation test cases.

The test network infrastructure has been equipped with accurate power meters for continuous measurement of the power consumption at different network elements. Measurements can be collected at 1/s intervals. For developing and validation purposes of sustainable and energy-efficient 5G-Advanced, as well upcoming 6G technology, this project will also build a validation environment providing E2E energy forecasting system, storing assets and autonomous base station(s) with energy optimization features. The network will be equipped with intelligent off-grid power systems as well to maximize the utilization of renewable and local energy by the network components.

2.2.2 6G-XR South Node (5GBarcelona and 5TONIC)

i2CAT Foundation offers 5GBarcelona, a fully-fledged 5G network for experimentation purposes in the city of Barcelona (https://5gbarcelona.org/). This is a multi-site network distributed in various locations of the Barcelona metropolitan area, mixing indoor and outdoor deployments. Sites are interconnected with dedicated point-to-point fibre links (10 Gbps) to i2CAT's headquarters. 5G Barcelona covers media, health, industry, transport, security, and automation, among other services, ranging from encouraging the adoption and validation of 5G technology, and the transfer of knowledge in 5G, to the

creation of business opportunities. Its current equipment can be categorized in the (1) radio, (2) edge and (3) datacentre segments. Under an open and multi-vendor perspective, the (1) radio infrastructure is composed three 4G small cells (two in b43 and one in b42, both with a maximum bandwidth of 20MHz), one 5G small cell (N77 with a maximum bandwidth of 100 MHz and a starting frequency of 3900 MHz), as well as 23 multi-purpose SDRs (each of them with a maximum bandwidth of 50MHz, central frequencies of 100-6000 MHz, and featuring 4G and 5G in NSA/SA modes). The cellular infrastructure is connected to a fully virtualized 5G core (5GC) from different open-source projects (i.e., Open5GS, Free5GC, OpenAirInterface), and all of them support NSA and SA modes. Regarding non-3GPP radio access, 5GBarcelona has six WIFI nodes (five WIFI 5 and one WIFI 6), that can be used either as access points or as backhaul links. On the (2) edge segment, 5GBarcelona features 3 NUCs with a combined maximum theoretical capacity of ~700 vCPUs and 192 GB of memory. Finally, the (3) datacentre segment consists of 3 servers with a maximum capacity of ~2600 vCPUs and 512 GB of memory. The whole cellular and WIFI infrastructure is managed by a radio controller developed by i2CAT. On top of this, i2CAT's Slicing and Orchestration Engine manages the whole lifecycle of network slices. 5GBarcelona will be interconnected with 5TONIC with the best available alternative in terms of throughput and latency with the objective of easing the federation of resources across network slices.

Telefónica/Ericsson/Capgemini Spain operate 5TONIC, an open research and innovation laboratory focusing on 5G technology integration, adoption, and evolution (https://www.5tonic.org/). 5TONIC aims to create an open global environment where members of industry and academia alike can work together on specific research and innovation projects related to 5G technologies with their combined insight allowing them to boost technology and business innovation ventures. Ericsson is the partner that provides the RAN and the 5G core network of the laboratory. The infrastructure supports common 5G Services: (1) enhanced Mobile Broadband (eMBB), (2) massive Machine Type Communication (mMTC) and (3) Ultra Reliable Low Latency Communications (URLLC). It provides a 5G NR access network in low, mid and millimetre waves bands with different bandwidths (20,40,50, 60, 100 MHz) and with the possibility of doing carrier aggregation, to achieve sustained throughput beyond the Gbps and lower latency than LTE networks (up to 4 milliseconds in the access network). The access network also supports MIMO technology, NB-IOT and Cat-M for testing machine-to-machine use cases, and a dedicated edge data network that is in less than 1 millisecond from the access and allows to deploy vertical applications at the network edge.

5TONIC also provides a full-fledged portable 5G network that can be used for demonstrating use case in the vertical premises or in an event. It allows for exploring and validating a variety of Edge Computing models by extending the URLLC slice towards the location of the use case. The portable network is composed by a Radio Access Network and the 5G core user-plane, which are the elements deployed near the users, and allows to connect through a secure connection with the 5TONIC central core for managing the control plane. The portable system support two kind of antennas for providing outdoor (e.g., a 5G MIMO mid-band antenna) and indoor (e.g., Ericsson Dot system) coverage. Such coverage is used to extend 5G coverage in vertical offices or in events. 5TONIC regularly cooperates with 5G handset and CPE manufacturers for their use in E2E validation activities of mutual benefit. 5TONIC establishes regular cooperation with 5G handsets and CPE manufacturers for their use in E2E validation activities of mutual benefit. WNC, Fivecomm, Xacom and ASKEY are representative manufacturers engaged in 5TONIC activities. 5TONIC also integrates in its 5G Core a MEC implementation, compliance with ETSI MEC specification, that offers multiple capabilities, accelerators and frameworks for rapid development of MEC solutions with optimized HW infrastructure resources and increased computing and IOPS (Input/output Operations per Second) performance and reduced network latency. The platform integrates OpenNESS and can reside on micro data centres close to the access network, aggregation points, regional data centres and central offices, as best suited for edge app developers. The platform offers API integrations compliant with Linux Foundation CAMARA APIs and GSMA Operator Platform specifications. .

6G-XR South Node Beyond State-of-the-Art

The described beyond state of the art below is a roadmap towards what the South Node will have available by the end of the project. At the time of Open Call 2 all of the components may not be available and feedback from the feasibility check can be used to match the proposals to the current state of the RIs.

5GBarcelona and 5TONIC will see upgrades on its equipment and functionality to support the 6G capabilities by addressing four main pillars: (1) AI/ML powered XR service awareness; (2) holistic end to end XR awareness, service migration and continuity, (3) XR-aware eMBB/URLLC; and (4) native XR session control. The infrastructure will also be upgraded to meet these capabilities. Firstly, (1) the AI/ML powered XR service awareness aims to integrate decision-making components and algorithms that enable to optimize the usage of resources (e.g., XR applications, energy efficient policies) in each segment and keep track of their serving needs across multiple domains. Secondly, (2) the holistic E2E XR awareness, an extension to AI/ML-powered XR service awareness that will require extending the inter-domain and intra-PLMN mechanism and APIs defined by the GSMA and TMF, as well as mechanisms for edge federation and PLMN roaming / federation with focus at service migration / continuity. Thirdly, (3) the XRaware eMBB/URLLC is an evolution of the eMBB/URLLC use case aiming at dealing with superior downlink and uplink bandwidths and, at the same time, minimizing E2E application delay. In practice, this evolution for XR will require the use of additional carriers or RATs (Radio Access Technology) and an optimal selection of edge resources based on load conditions and/or proximity to the end user to reduce latencies. Finally, (4) the Native XR session control will take care of the integration of the XR service control layer (e.g., IMS) with the XR services and ecosystem (e.g., the media session orchestrator), as well as with the holistic XR orchestrators mechanism derived from above mentioned development.

Besides this, the infrastructure will also be upgraded: (i) RAN will be extended to operate in new mid and mmW bands with commercial and open solutions, as well as updating the existing radio infrastructure to 3GPP Release 16 and 17 and WIFI 7. (ii) The edge will add new servers, mostly focusing on cores and memory processing (considering both CPU and GPU resources, e.g., to use with AI workloads). The (iii) data centre will introduce new servers in 5TONIC to achieve full compliance of the 5G core network with 3GPP releases 16 and 17. Finally, (iv) 5GBarcelona will incorporate XR infrastructure, in particular, two volumetric, light field powered, capture sub-systems and four holo-portation nodes, including VR headset, VR-ready PCs or laptops, and RBG-D capture sensors.

2.3 RELEVANT DELIVERABLES

The 6G-XR project has produced at the time of the publication of this info document two deliverables containing relevant and more detailed information related to the use cases and infrastructures:

- D1.1: Requirements and use case specifications, available at the 6G-XR website here.
- D2.1: Orchestration, AI techniques, End- to-end slicing and signaling for the core enablers – design, available at the 6G-XR website here.

3   SCOPE OF THE CALL

The purpose of the second Open Call is to validate, test, and/or incorporate enablers coming out of Horizon Europe SNS JU Stream B thematises. Out of these thematises, in particular proposals on the topics and subtopics in the following **AREAS (and 6G-XR Infrastructures)** are requested:

1. Reflective intelligent surfaces

    a. 150 GHz Reflective Intelligent Surface (RIS) [Node: North; RI: UOULU 5GTN; Mentors: IMEC, UOULU]

2. Deterministic communications

    a. Implementation and verification of wireless deterministic communication links on 3D digital twin use case [Node: North; RI: UOULU 5GTN; Mentor: UOULU]

    b. Deterministic networking [Node: South or North; RI: 5GBarcelona or UOULU 5GTN; Mentor: i2CAT, UOULU]

3. Energy measurement

    a. Sustainability enablers for energy measurement and optimisation solutions [Node: North; RI: UOULU 5GTN or VTT 5GTN; Mentors: UOULU, VTT]

    b. Monitoring of energy consumption of VNFs for Multimedia Streaming [Node: South or North; RI: 5GBarcelona or VTT 5GTN; Mentors: VICOM, VTT]

4. AI/ML for slicing

    a. AI/ML algorithm for efficient resource optimization in the 5G slicing techniques [Node: North; RI: UOULU 5GTN; Mentor: UOULU]

5. Load balancing

    a. Mechanisms for load-balancing and service migration to enable Device/Edge/Cloud continuum [Node: South; RI: 5TONIC; Mentors: VICOM, CGE]

    b. Mobility Load Balancing on ORAN campus network [Node: South; RI: 5GBarcelona; Mentor: i2CAT]

6. Security and trust mechanisms

    a. Multi-stakeholders security and trust mechanisms for Edge North Bound interfaces [Node: South; RI: 5TONIC or 5GBarcelona; Mentor: CGE]

    b. Confidential computing environments for end-to-end energy efficiency [Node: North; RI: VTT 5GTN; Mentor: VTT]

7. Increased capacity

    a. 6G channels [Node: South; RI: 5GBarcelona; Mentor: i2CAT]

8. Other Stream B thematises

    a. Other proposals coming from Stream B thematises [Node, RI, and Mentor: To Be Identified based on the proposal]

All approved projects performed during this Open Call must be made available to other experimenters during the rest of the 6G-XR project duration. In order to ensure that a balance of the Open Call topics is kept and the widest impact of Open Call enablers is reached a maximum of three proposals will be funded under any given (sub)topic above. Funding more than three projects on a given (sub)topic will result in too much redundant repetition of a particular innovation area within the 6G-XR scope and diminishes the expected wide-scale impact of both cascading actions and 6G-XR targets. This will further ensure the mentors, infrastructures, and use case owners can guarantee high-quality mentoring of funded Open Call 2 topics.

All proposals passing the feasibility checks of Open Call 2 will be sent for evaluation by 6G-XR project external experts and will receive an independent scoring. All proposals are then ranked based on the points they receive out of that evaluation. However, only the top three projects of any given (sub)topic will be considered for funding.

A more detailed description of the above topics is as follows.

1. **Reflective intelligent surfaces**

    a. **150 GHz Reflective Intelligent Surface (RIS)** [Node: North; RI: UOULU 5GTN; Mentors: IMEC, UOULU]

The expected outcome of the proposed project is to test a prototype that can be used in a laboratory environment in over-the-air (OTA) measurements. The reflection control should be done electronically, if possible. At least one RIS prototype should be delivered to 6G-XR project for demonstration purposes. 6G-XR project will provide the experimental infrastructure of 150 GHz radio link and laboratory environment for the OTA link.

The full OTA laboratory test bed will contain following:

1) 150 GHz radio transmitter and receiver, which will be provided by 6G-XR project,

2) 150 GHz RIS provided by the Open Call project, and

3) RF Laboratory with needed measurement equipment that will be provided by 6G-XR project.

The RIS demonstration aims to evaluate the feasibility of the RIS with a 150 GHz radio link that enables future 6G extreme data rate network deployments.

2. **Deterministic communications**

    a. **Implementation and verification of wireless deterministic communication links on 3D digital twin use case** [Node: North; RI: UOULU 5GTN; Mentor: UOULU]

Wireless deterministic communication capabilities (minimum jitter, traffic shaping) are required in 3D digital twin applications. Mission critical XR interactions and machine control signals are prioritised traffic compared to massive video streaming. This topic looks for proposals providing deterministic networking, especially covering the wireless link parts in the environment.

b. **6G Deterministic Networking** [Node: South or North; RI: 5GBarcelona or UOULU 5GTN; Mentor: i2CAT, UOULU]

While deterministic communication standards in wired network domains have already emerged, including Time Sensitive Networking (TSN) and Deterministic Networking (DetNet), and recent advances in the 5G domain have started to addressed the interworking with those standards, the full combined potential of 5G-advanced scenarios with TSN and DetNet is far from being fully exploited yet. This topic encompasses novel and standards-compliant advances in this domain, including but not limited to: (i) 6G features for deterministic and predictable wireless transmission and wireless-friendly enhancements for TSN and DetNet, ensuring minimum latency levels and optimum communication paths; (ii) 6G time synchronization solutions to ensure global time awareness over distributed cloud continuum ecosystems integrated with 6G environments; (ii) hybrid wired + wireless enablers to guarantee deterministic networking over heterogeneous environments.

3. **Green Services / Energy measurement**

a. **Sustainability enablers for energy measurement and optimisation solutions** [Node: North; RI: UOULU 5GTN or VTT 5GTN; Mentors: UOULU, VTT]

This topic seeks proposals for sustainability enablers for energy measurement and optimisation solutions for the 6G-XR north node. Suitable proposals should offer enhanced energy measurement solutions which are to be integrated with the 5G Test network as part of the energy measurement framework. The proposals should provide advanced energy measurements for energy forecasting, production, storing and consumption, using ML/DL algorithms to predict network and energy resource consumption and availability for achieving E2E energy efficiency and self-sustainability in next-generation mobile networks. The energy measurement solution should be capable of identifying or estimating energy consumption per network element.

These proposed solutions should measure energy and network related data with an average sampling rate of every second and capable of dynamically adjusting the network parameters, such as bandwidth optimisation, through energy-aware network orchestration. Moreover, they should aim to implement end-to-end energy efficiency and develop orchestration algorithms to identify and rectify areas of energy wastage. By utilising AI and ML, they can predict when and where the network will require more or less power, thereby enabling more efficient management.

Target 6G-XR RI: North Node

UOULU 5GTN provides the following topic specific enablers:

- AI tools to predict the 48h local availability of renewable energy from the solar panels.

VTT 5GTN provides the following topic specific enablers:

- 5G RAN and CN components measured with external power meters for baseline/comparison energy consumption data.

- 5G RAN components that can be powered directly from local solar panels, batteries, or power grid to optimize utilization of renewable energy, price of the consumed energy, cell site resiliency, etc.

   b. **Monitoring of energy consumption of VNFs for Multimedia Streaming** [Node: South or North; RI: 5GBarcelona or VTT 5GTN; Mentors: VICOM, VTT]

This topic seeks solutions for energy consumption monitoring of Multimedia Functions. In the South Node, several VNFs to process multimedia information (audio and video) are being developed to process and deliver XR/AR content. These VNFs are designed to be provided with an adaptive rate control configuration based on network information (network-assisted rate control). This approach could be further improved by enabling information on energy consumption of the VNF and the media processing operations. In the North Node, application VNFs can be used for multimedia operations including encoding and transcoding functions with real-time dynamic controlling prospects.

The applicant should provide a framework to measure the energy consumption of VNFs, especially when considering multimedia processing operations (for example, energy consumption of video encoding or video streaming sessions). Optionally, the applicant could include optimization strategies to expand the network-assisted rate control by considering energy-efficient aspects. In addition, detailed energy consumption estimations/measurement in user devices (preferably smartphone) or inside application functionalities would bring essential in-depth information and understanding on how to better optimize the streaming parameters for end-to-end energy efficiency.

Target 6G-XR RI: South Node or North Node

South Node / 5GBarcelona provides the following topic specific enablers:

- Server capacity at the network edge/local cloud for virtualised multimedia functions.

- Remote Renderer VNF and Web players enabled with WebRTC and DASH streaming capabilities. The Renderer VNF employs Unity and GStreamer enabled with NVIDIA GPU acceleration.

North Node / VTT 5GTN provides the following topic specific enablers:

- Server capacity at the network edge/local cloud for virtualised multimedia functions.

- HW server infrastructure measured with external power meters for baseline/comparison energy consumption data and possibility to host test video content.

4. **AI/ML for slicing**

   a. **AI/**ML algorithm for efficient resource optimization in the 5G slicing techniques [Node: North; RI: UOULU 5GTN; Mentor: UOULU]

This topic looks for solutions to use AI/ML algorithms (supervised, as well as distributed deep reinforcement) to control the usage of resources in a sliced 5G network in efficient and dynamic way. Project proposal should define what kind of parameter(s) in the network are to be adjusted. They can be for example air interface resources, transmit power, slice configuration, etc. Project needs to also define the measurement data it needs for the AI/ML from the 5G network. 5G Core that is in use in the

5G network environment for this project is Cumucore. If needed also open source 5G core Open5GS can be used. Commercial Base Stations are used with Cumucore. With Open5GS also the USRP radios can be used. Instead of a stand-alone separate SW implementation also FlexRIC with xAPPS is available in the Open Source environment.

5. Load balancing

a. Mechanisms for load-balancing and service migration to enable Device/Edge/Cloud continuum [Node: South; RI: 5GBarcelona or 5TONIC; Mentors: VICOM, CGE, I2CAT]

In the South Node, two Edge nodes are federated and provide the capability to deploy distributed applications. This topic seeks solutions for enabling flexible service deployment and management between Device/Edge/Cloud nodes. This includes, but not limits to:

- Intra-domain and inter-domain load balancing and service migration. Enabling these capabilities increases the flexibility of the network and its services to adapt to specific application requirements and to guarantee the required E2E performance. This is especially critical with applications requiring high throughput and minimum E2E latency such as holographic comms.

- Task offloading from UE to the network. Rendering operations are GPU-expensive tasks that in some cases cannot be performed in the user's device and must be offloaded to the Edge nodes. Mechanisms, APIs and policies to redistribute tasks between devices and Computing nodes are necessary to enable wider access to holographic comms.

The applicant should provide a framework to balance or re-distribute the workload between Device and Edge/Cloud nodes. The proposed solution could address, but not limit to, multimedia processing tasks considered in 6G-XR project such as Point Cloud rendering, Video encoding and Streaming (WebRTC/DASH).

Target 6G-XR RI: South Node

South Node (5GBarcelona or 5TONIC) provides the following topic specific enablers:

- Server capacity at the network edge/local cloud for virtualised multimedia functions.

- Remote Renderer VNF and Web players enabled with WebRTC and <u>DASH</u> streaming capabilities. The Renderer VNF employs Unity and GStreamer enabled with NVIDIA GPU acceleration.

b. Mobility Load Balancing on ORAN campus network [Node: South; RI: 5GBarcelona; Mentor: i2CAT]

This topic shall cover development of ORAN campus network with OAI that enables testing and validation of mobility load balancing as one of the XR network enablers. The applicants and Open Call project shall include the configuration and the infrastructure required for this enabler. Open-source software or license based is required to cover the usage during the project.

The applicant shall provide two ORAN campus nodes to be connected to the existing core infrastructure of South Node (5GBarcelona) and enable the mobility load balancing between those two nodes.

6. **Security and trust mechanisms**

   a. **Multi-stakeholder security and trust mechanisms for Edge North Bound Interfaces** [Node: South; RI: 5TONIC or 5GBarcelona; Mentor: CGE]

This topic looks for technologies and mechanisms to provide security, privacy and/or trustworthiness for vertical (XR) applications life cycle management on to the edge infrastructure owned in principle by different stakeholder, e.g. the telco operator, so privacy issues could arise.

The applicant should provide a solution to provide trustworthiness around the Edge North Bound Interface (NBI) APIs towards the vertical applications, this is for the app-network-edge APIs.

Target 6G-XR RI: South Node

- Server capacity at the network edge/local cloud for the deployment of the security enablers.

- A baseline North Bound (NBI) Edge APIs as benchmark for comparison/benchmarking studies.

   b. **Confidential computing environments for end-to-end energy efficiency** [Node: North; RI: VTT 5GTN; Mentor: VTT]

This topic seeks enablers for confidential computing solutions, taking into consideration the end-to-end energy efficiency goals of the overall network infrastructure. The enablers can run either at the network edge or at the local/remote cloud. Specific interest in the topic is to assess the energy consumption of different security levels and configurations for the computing environment utilized in the end-to-end communication path with different end user applications and/or use case scenarios.

The applicant should provide a confidential computing or security enabler to be deployed on top of the 6G-XR North Node RI and define a set of test cases to assess the energy efficiency of the provided solution with varying security levels and use case scenarios. The effect of security overhead in relation to energy consumption should be assessed.

Target 6G-XR RI: North Node

VTT 5GTN provides the following topic specific enablers:

- Server capacity at the network edge/local cloud for the deployment of confidential computing and other security enablers.

- HW server infrastructure measured with external power meters for the collection of accurate energy consumption reference data.

7. **Increased capacity**

   a. **6G channels** [Node: South; RI: 5GBarcelona; Mentor: i2CAT]

Next-generation wireless networks are envisioned to provide performance levels close to those provided by wired networks, in terms of data rates, ultra-low latency, and reliability, while providing other key features like mobility (i.e. wired free connections) and sensing (accurate localization of targets). This topic aims at encompassing novel and standards-compliant 6G enablers that contribute to this mission, including but not limited to: (i) strategic aggregation of parallel transmission channels; (ii) radio channels using spectrally efficient and robust bands; (iii) intelligent mesh networking protocols for private networks; (iv) accurate Integrated Sensing and Communication (ISAC) capabilities; etc.

8. Other Stream B thematises

a. Other proposals coming from Stream B thematises [Node, RI, and Mentor: To Be Identified based on the proposal]

This topic covers other proposals coming from Stream B thematises. The Node, the RI, and the Mentor will be determined based on the proposal. Proposers are encouraged to contact 6G-XR representatives as early as possible to make sure the proposal can pass the mandatory feasibility check.

4   GUIDE FOR PROPOSERS & SUBMISSION

4.1 ELIGIBILITY

A proposal will be considered eligible for the 6G-XR Open Call 2 if it complies will ALL the following rules:

- The proposal is submitted by a legal entity established and based in one of the EU Member States or a Horizon Europe Associated country. The targeted organisations in this Call are (i) SMEs; (ii) Industry; (iii) Research/scientific organisation; (iv) Academia.

- The proposal is submitted by a single party. The submission of proposals by consortia is not eligible.

- The proposer **CANNOT BE AFFILIATED TO ANY OF THE CONSORTIUM PARTNERS OF THE 6G-XR PROJECT**.

- The proposal complies with the type of activity qualified for financial support: (i) Personnel costs; (ii) Travel costs; (iii) Indirect costs (25% of the direct costs). No other cost categories are eligible.

- The proposal is submitted in English.

- The proposal is submitted through the official Open Call Submission Tool on the 6G-XR website providing all the required documents (completed proposal template and declaration of honour).

- Proposals need to come from the European Smart Networks and Services Joint Undertaking (SNS JU) Stream B thematises. Proposals are required to justify their linkage to Stream B thematises, and proposals coming directly from Stream B projects are required to ensure the proposed work is not already covered by the existing Stream B project, but it is in fact novel. If the proposal is based on Stream B action, there needs to be a clear justification how the proposal goes beyond the project's description of action, or what is the difference between the respective description of action and this proposal. 6G-XR reserves the right to terminate a funded Open Call project during execution if these conditions are found not to be respected.

- Feasibility check is mandatory and the proposals must be submitted for feasibility evaluation before the Feasibility check deadline. Proposals failing submission for feasibility will not be evaluated.

- The proposal has been submitted within the deadline set in this document. Late proposals will not be admitted.

- The proposal complies with the Regulation (EU) 2016/679 (General Data Protection Regulation) regarding all personal data that might be included in the proposal.

4.2 PROPOSAL TEMPLATE

The use of the specific proposal template is mandatory.

The full proposal template can be found in Appendix A of this document.

Please note that in the draft proposal that will be submitted for the feasibility check, **at least sections A, B, C and J should be fully completed**. Please be aware that the partner responsible for the feasibility check will NOT review draft proposals or propose any changes to the proposal. The partner will only give feedback on the feasibility of the proposed Experiment based on the completed sections A, B, C and J. The feasibility check does not provide a commitment that the proposal will be selected.

4.3 SUBMISSION PROCESS

Before submitting the proposal, please download and carefully read the provided documentation and templates through the link below:

https://www.6g-xr.eu/open-calls/oc2/

The proposal must be submitted in English and through the 6G-XR online form that is located on the same page.

All form fields should be filled with no exceptions.

A feasibility check is required before submission. Proposers **MUST submit their draft proposal by April 22ⁿᵈ, 2024 at 17:00 CET** (for more details see Section 4.4).

Once the deadline for submitting a proposal is reached, the call will be closed and the evaluation process will start. The duration of the evaluation of the proposals and approval by the EU is planned to be kept within 1,5 month. The outcome of the evaluation will be communicated to the proposers via email as soon as the process is completed. The notification will include a report of the evaluation process where for each criterion the score and the motivation of the evaluators will be reported.

It is highly recommended to submit your proposal well before the deadline. If the proposer discovers an error in their submitted proposal, and provided that the call deadline has not passed, the proposer can re-submit it (for this purpose please contact us at opencalls@6g-xr.eu).

Failure of the proposal to arrive within the deadline for any reason, including network communications delays or working from multiple browsers or multiple browser windows, is not acceptable as an extenuating circumstance.

Selected experiments can start at the earliest in September, 2024. Please note that a later start may imply a shorter experiment.

4.4 FEASIBILITY CHECK & MENTORING

The Open Call 2 is looking for proposals in the European Smart Networks and Services (SNS) – Stream B domain. In particular, enablers suited for the development of holographic communications, digital twinning, and network energy sustainability are being sought after.

The Open Call proposers are encouraged to contact the 6G-XR consortium and share their intentions to verify the feasibility of their proposals to be implemented in the scope of the project. The feasibility check will be carried out by the 6G-XR consortium partners acting as Mentor organisations with the support of other partners as needed. The description of the experimental facilities in Section 2 of this

document provides insights of the state and targets of each of the facilities and hence proposals should adhere to those targets. Initial feedback will be provided for the proposed planned activities. In order to be eligible and receive feedback, a description of planned experiment (sections A, B, C and J of the proposal template) **must be submitted through the 6G-XR Open Call Submission Tool on the project's website by the designated deadline** https://www.6g-xr.eu/open-calls/oc2/ **(Monday, 22 April 2024 at 17:00 CET).** Under the tab 'Stage', please select the option 'Feasibility Check' in order to submit your proposal for a feasibility check. Please note that in order to make a final submission, you have to select 'Final Submission' under the tab 'Stage'. **If you have submitted your proposal under the 'Feasibility Check' option, it will not be considered as a final submission and will not be evaluated.**

Actual feasibility check of the proposal will be conducted after the submission deadline.

Each awarded project will be supervised by a project partner (mentor) who is responsible for supporting the experimenters during execution and following up on the experiment results.

The key responsibilities of the mentors to the third-party experimenters will be to:

- Understand the requirements and needs of the experiment.

- Providing insight into the technical capabilities.

- Follow the progress and reporting process for each experiment.

- Making recommendations to the 6G-XR consortium (Work Packages 2-6) for upgrades and helping validate the experiment's applicability.

- Coach the experimenter during the execution phase.

- Follow up on the results/outputs of the experiment.

- Identifying issues to be escalated to the 6G-XR partners which pose a risk to the experiment.

4.5 FURTHER ASSISTANCE & CONTACT INFORMATION

Important information is already included in the available Open Call 2 documents (Information Document, Proposal Template, Declaration of Honour, Draft Third Party Agreement). Please review thoroughly these documents as well as the Frequently Asked Questions section of the Open Call 2 page.

If the answer to your question cannot be found in the documentation, you can send your question to the following email address: opencalls@6g-xr.eu. In case your question refers to technical details of the offered research infrastructure, you can send your question to the same email address opencalls@6g-xr.eu, clearly mentioning which infrastructure the question relates to.

Questions can be sent at the latest 7 calendar days before the submission deadline.

5 EVALUATION AND AWARD PROCEDURE

Evaluation and ranking will be carried out by an external jury of experts, which cannot be part of the consortium and cannot evaluate proposals where a conflict of interest can be identified. For each of the received proposals, at least two assigned experts will perform reviews independently of each other. Afterwards, consensus meetings among involved experts will be held, where a common opinion and rating will be built up for the proposals, based on which the final ranking along with a reserve list will be defined.

Proposals submitted by Parties meeting the requirements will be further evaluated according to the following criteria:

1. **Clarity and methodology:** Soundness of the approach and credibility of the proposed methodology.

2. **Ambition:** Advancement regarding the state-of-the-art and expected output. The proposal is required to justify and position itself with relation to a SNS JU Stream B thematises.

3. **Impact:** Technology and domain fit to 6G-XR scope and objectives.

4. **Replicability** of the proposed solution.

5. **Contribution to standardisation** of the proposed solution.

6. **Team capacity to perform**; knowledge, technological and business expertise; commitment; research domain & track-record.

7. **Value for money:** quality and effectiveness of the requested resources.

8. **SME participation** is encouraged.

9. **Gender dimension awareness** requested to the proposers.

10. **Maturity/trajectory of the proposing organization/proposed development** in the specific field of their proposal.

Criterion	Short description	Weight	Maximum score	Minimum threshold
1	Clarity & methodology	1	5	2
2	Ambition	2	10	5
3	Impact	2	10	5
4	Replicability	2	10	5
5	Contribution to standardisation	1	5	2

6	Team capacity	2	10	5
7	Value for money	1	5	2
8	SME participation	1	2	n/a
9	Gender dimension awareness	1	2	n/a
10	Maturity of the proposing organisation	1	5	2
Maximum total score			**64 (max)**	**28 (min)**

Proposals not reaching the minimum thresholds either in individual criteria or in the overall score will not be considered for funding. The proposal template requires to provide an implementation plan including deliverables, and a cost estimate justifying the costs and resources. In the evaluation phase, the resource adequacy to fulfil the planned work will be assessed and the justification of the budgeted items. Before the award of the grant, it will be checked whether the third party is a legal entity with a stable financial history and has not been declared insolvent.

6 REPORTING

The third party will be required to submit a final report after completion of the Experiment. The below template, which is subject to changes, needs to be used and will include the following sections:

Part A. Summary

Part B. Detailed description

This section describes the details on the Experiment It includes:

- B.1 Concept, Objectives, Set-up and Background

- B.2 Technical results and Functionality Validation

- B.3 Impact

Part C. Feedback to 6G-XR

This section contains valuable information for the 6G-XR consortium and describes the third party's experiences while performing the Experiment.

Part D. Promotion Material

This section provides information that can be used to create communication material based on your Experiment for promotional purposes.

Part F. Method of Replicability

This section describes how the proposed solutions can be replicated.

This report will serve as an evaluation tool to approve the payment of the third party, but will also serve as: (i) input for the further development and/or extension of the 6G-XR facilities, and (ii) identification of gaps in the offered facilities and functionalities. Part of this report may be used by the 6G-XR consortium for inclusion in their reporting documents to the European Commission and in public presentations. Inclusion of confidential information should therefore be indicated and discussed with the 6G-XR consortium. This report will also be used for the formal review by the European Commission, which the third parties should attend if required by the European Commission. The final template will be made available during the execution of the Experiment.

7   FINANCIAL AND CONTRACTUAL INFORMATION

7.1 THIRD PARTY AGREEMENT

Once a proposer is selected to perform the proposed Experiment, the proposer will become a third party receiving financial support, and to this end needs to sign a Third Part Agreement.

The template that is available on the project website https://www.6g-xr.eu/open-calls/oc2/ is a draft and is subject to changes.

7.2 PROPOSAL TEMPLATE

The proposal template is available on the project's website https://www.6g-xr.eu/open-calls/oc2/ in a Word document format. Instructions for filling in all sections are included. Please follow the submission instructions.