# "CORTEX² – EXTENDED COLLABORATIVE TELEPRESENCE FOR FUTURE WORK AND EDUCATION"

**Alain Pagani[1], Narek Minaskan[1], Alireza Javanmardi[1], Yaxu Xie[1], Sylvain Rivier[2], Vincent Bailleau[2], Emmanuel Helbert[2], Pierre-Yves Noel[2], Yazid Benazzouz[3], Jean-Pierre Lorré[3], Franklyn Ohai[4], Maja Nisevic[4], Anton Vedder[4], Gael de Chalendar[5], Vasileios Theodorou[6], Ilia Pietri[6], Maria-Evgenia Xezonaki[6], Florian Andres[7], Lydia Szymendera[7], Olivier Grzelak[7], Cristina Gasch[8] and Azucena Garcia-Palacios[8]**

[1]DFKI GmbH, Germany, [2]Alcatel Lucent Enterprise, France, [3]Linagora, France, [4]Katholieke Universiteit Leuven, Belgium, [5]CEA, France, [6]Intracom Telecom, Greece, [7]Actimage GmbH, Germany, [8]Univeritat Jaume I, Spain

*Keywords: Extended Reality, Telecooperation, Telepresence.*

## Project Outline and Objectives

As consequence of the COVID-19 pandemic, the possibility of working remotely or in "home office" has become mainstream for a large number of companies. A wide range of European companies shifted their activities to remote working due to social-distancing restrictions and safety measures yielding telepresence to become the new deal for many workforce segments. Around 5% of Europeans regularly worked from home before the pandemic, while that figure has now risen to around 12.3% [1]. However, this trend is here to stay, as 97% of workers would like to work remotely at least some of the time for the rest of their careers [2]. Teams have started to take up collaborative remote working environments, adopting online tools such as video- or tele-conferencing systems, using distributed project management platforms and virtual whiteboards. Although basic digital features are gaining popularity, available market services and applications are not yet adequate to support efficiently activities that imply physical interaction with remote objects. Some critical examples include skills training for production sites, remote support for complex maintenance tasks or activity planning that are dependent on local physical configurations. Even for standard business meeting, the currently available solutions are often unsatisfactory because they are limited to participants using devices having identical capabilities.

The new digital era offers more than only exchanging audio and video streams for collaboration. We currently witness the emergence of extended reality (XR) in both Augmented Reality (AR) and Virtual Reality (VR) variants, and concepts such as digital twins for factories and production sites have gained attraction. However, the practical implementation necessitate the digitalisation, calibration, storage and preparation of existing assets, making these tools out of reach for many small and medium enterprises.

In a recently launched European project CORTEX², we are setting the basis for future extended collaborative telepresence to allow for remote cooperation in virtually all industrial and business sectors, both for productive work and education and training. Our idea merges the concepts of classical video-conferencing with extended reality, where real assets such as objects, machines or environment can be digitalized and shared with distant users for teamworking in a real-virtual continuous space.

In essence, the CORTEX² framework allows the creation of shared working experiences between multiple distant users in different operating modes. In the Virtual Reality mode, participants are able to create virtual meeting rooms where each user is represented by a virtual avatar. Participants have the possibility to appear as video-based holograms in the virtual rooms, with an option to anonymise their appearance using a AI-based video appearance generator while keeping their original facial expressions. Participants are also able to exchange documents, 3D objects and other assets and will be accompanied by a AI-powered meeting assistant with extended capabilities such as natural speech interaction, meeting summarization or translation.

In the Augmented Reality mode, participants have the possibility to share their immediate surroundings through a simplified digitalization process, which results in a textured 3D model of their environments. This model is used by distant users to identify, select and point to specific areas. In turn, these areas are then highlighted in the original users' view using Augmented Reality techniques (virtual arrows, virtual highlight).
In order to make the experience more immersive rich contextual IoT information is integrated into video streams, rendered as AR annotations on top of displayed objects and persons. To this end, data gathered from a multitude of heterogeneous IoT devices is ingested, aggregated processed and prepared, ultimately generating layers of insightful information related to smart assets of various different vertical domains. To this end, a versatile IoT Platform is developed, collecting data from connected devices and sensors and bringing them into a unified, IoT-protocol-agnostic view that will allow the seamless management of IoT information and its custom "shaping" into layers of aggregated IoT information.

## Project Partners and their Roles

The coordinator DFKI is an expert of Augmented and Mixed Reality and Deep-Learning based Computer Vision. The key technology of the digital cooperation platform is covered by the expertise of Alcatel Lucent Enterprise (ALE). Intracom Telecom (ICOM) brings in its expertise in the area of Internet of Things. The technologies of speech interpretation and voice recognition are covered by Linagora (LINA). CEA brings its expertise in conversational agents and language technologies. Actimage (ACT) is a developer of Mixed and Augmented Solutions. The Center for IT and Law (CITIP) of KU Leuven brings its strong expertise on ethical and legal analysis of ICT technologies, and the Universitat Jaume I in Spain its expertise on the validation of ICT applications in relation to psychology. Community building aspects are covered by the expertise of Australo (AUS). Finally, the preparation, organisation and follow-up of the third-party calls will be supervised by F6S.

As a team, the CORTEX² consortium has the capacity to deliver exceptional technology as a backbone framework, while ensuring adaptation to user needs and raising awareness for the new generation of XR-based telecooperation activities.

## Project Use Cases and Expected Outcomes

In order to demonstrate the added value of the CORTEX² platform, three practical usages have been selected and are being deployed as representative use cases.

**Remote industrial maintenance use case in Augmented Reality** : we demonstrate that an XR immersive experience can be reached with heterogeneous and off-the-shelf mobile devices and with limited bandwidth condition while improving productivity and reducing environmental footprint. The idea is that the performance of industrial maintenance tasks could be strongly increased if the technician is able to receive contextual live advices augmented with information retrieved and computed automatically and displayed in a relevant manner. On the other side of the communication link, an expert uses an immersive view of the maintenance environment to understand and fix the problem. This experience will showcase the benefit of several technologies such as gesture analysis and scene semantics analysis to inject annotations in video streams, audio transcription and voice commands to control the immersive environment and document and record the intervention, support and mixing of multiple videos and IoT data sources from non-immersive devices to compose an on-demand immersive collaboration space with augmented data.

**Remote technical training use case in Virtual Reality**: we demonstrate that VR/AR allow for efficient knowledge transmission in one-to-many situations where the remote instructor can help simultaneously several trainees, while referring to physical objects such as industrial equipment. The expected solution shall allow the deployment on different hardware and be able to run a varied number of scenarios as well as adaptable to multiple topologies. This use case demonstrates the usefulness of interaction with

a 3D model of the machine for increased training success rate, on-demand display of overlayed information, attention guidance through emphasis of some parts of the model, use of animations and integration of multiple media types.

**Virtual business meetings in Virtual Reality**: we demonstrate that VR/AR enriched business meetings allow seamless integration of remote participants and improve productivity. This tool facilitates integration of remote participants using virtual and augmented reality techniques on the one hand, to provide remote users with a perception of visual and auditory immersion close to real presence; on the other hand, to offer a representation of the remote person to the other participants of the meeting. This use case demonstrates advanced XR features such as visual and audio immersion of the remote user, overlay display for the visualization of information concerning both the collaboration's participants (name, function, profiles, etc.) and the interaction itself, and video-based or rendering based representation of the remote user, with symbolic transcription of the non-verbal communication acts of the remote person.

## Sustainability and future work

From a technical perspective, the framework builds upon an existing videoconferencing platform (Rainbow from Alcatel Lucent Entreprise), while extending it with XR support and additional services. The framework is designed to be device agnostic, with clearly defined APIs which allow the integration of novel devices as requested by the users. As novel technologies are prone to raise concerns about the societal implications and ethical issues, the team of experts developing the framework include experts of legal and ethical issues, as well as experts of psychological and social issues influencing XR interactions.
The CORTEX² platform is designed to be extensible through third parties in order to facilitate the addition of novel features. During the project, two open calls for participation will be launched, which will allow for the development of additional services, and the validation through novel use cases.

**Acknowledgment**: This work presented in this paper is funded by the EU project CORTEX2 (grant agreement: N° 101070192).

## References

[1] 'How usual is it to work from home?'. Eurostat, May 2021..
[2] 'The 2021 State of Remote Work'. Buffer, 2021