

Commissioning of High Voltage primary equipment in pandemic times

Jean SOUBIES-CAMY*
jean.soubies-camy@ge.com

José FERNANDES
jose.fernandes1@ge.com

Florent DESPONTIN
florent.despontin@ge.com

Jean-Luc RAYON
jean-luc.rayon@ge.com

**GE Renewable Energy, Grid Solutions
France**

SUMMARY

The COVID-19 pandemic has opened a durable era during which adaptation and innovation as growth levers became even more strategic in the field of energy and beyond, where site service cannot suffer discontinuity.

Whilst specific advanced skills are required at site for some challenging commissioning, deputing traveling experts and « flying doctors » to final site often yields noisy tensions within teams, unanticipated costs, emergency logistic challenges and scheduling conflicts, finally participating to global warming.

This is where mixed reality offers an accessible spectrum of ready-to-use solutions for an efficient remote support that preserves confidentiality, cyber security and top service quality. It has gone from being an emerging technology dedicated to IT experts to becoming a lightweight tool that any non-specialist staff can appropriate in minutes.

This paper briefly describes the existing technology and presents its concrete declination through some recent examples on the field.

KEYWORDS

Mixed reality, augmented reality, virtual reality headset, field commissioning, site acceptance tests, factory acceptance tests, remote support, High Voltage primary equipments

I. Introduction - Context

The concept of mixed reality not only digitizes a given 3D environment and transports it over the Internet in real time, but also allows remote peers to concretely and intuitively act on it through a cybersafe channel, 100% integrated into the company IT infrastructure : this is how an expert can now remotely draw 3D virtual marks and symbols or animate any part of a machine that local staff needs to work on. So that these marks are kept in place in the local reality even when the staff moves. Immediate expert diagnostic replaces multiple emails, real-time troubleshooting replaces one-shot procedures, and local staff learns on the fly. Furthermore, recording of such remote assistance sessions might feed training materials with immersive situations extracted from the real life rather than modelling.

Just as a good sketch is worth long sentences, a mixed reality session breaks language and cultural barriers so that a remote expert can bring added value to the other side of the planet in seconds... from home.

Practically, a mixed reality headset gets shipped to site in a lightweight, rugged and secured traveling case together with portable accessories (Wifi router, 4G modem, power banks...) : site staff just puts it on underneath safety helmet, powers it up and gets immediately connected to remote experts via the Internet.

II. Mixed reality: the technology

There are many effective professional hardware (headsets, glasses) and software solutions answering to mixed reality use cases. Here goes an overall functional description of the ones evaluated in our cases.

✓ Hardware:

Mixed reality headset embedding many sensors to provide a smooth and intuitive fast-learning user experience, among which:

- 4 head tracking cameras
- 2 eye tracking cameras
- 1 depth sensor

From the data of these sensors, the headset can track the movements of the end-user as well as those of his eyes. It also includes a built-in hand + fingers tracking model to enable the interaction of the end-user and virtual objects. To that end, it comes with a player to open and display objects from CAD files.



Figure 1: mixed reality headset

✓ Software considerations:

On top of the headset, out-of-the-box solutions exist to manage mixed reality Call-conferencing, i.e. inviting attendees, attendees lobby management, screen sharing or video stream sharing, interaction of remote attendees with the video stream of the person wearing the headset.

To go further, there are stable mixed reality design solutions to develop custom mixed reality applications that can compute both the headset sensor data and remote data coming from any network source. This opens possibilities to display and interact with industry digital twins.



Figure 2: the user can interact with both virtual and real objects

✓ Cybersecurity considerations:

- The headset must be protected from unwanted connection or use attempts. Solutions to force a network connection before any action takes place on the headset exist. These allow to check that a given physical headset is entitled to connect to an end-user company resources, before accessing them.
- Communications between the headset and the end-user company must be secured with encryption and VPN access.

III. Use case examples: remote Acceptance Tests

A. Factory Acceptance Tests (FAT)

We ran in 2021 a remote FAT session for a GCB (Generator Circuit Breaker): while the factory operator was wearing a mixed reality headset, the customer was remotely connected via a his usual conferencing software.

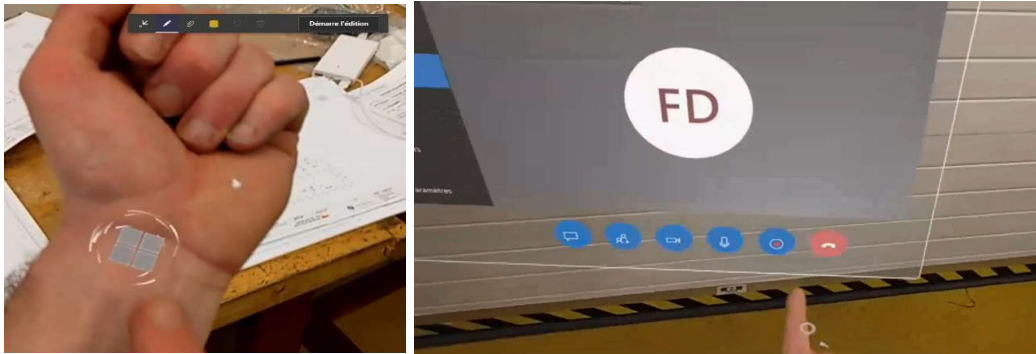


Figure 3 conferencing within seconds thanks to an intuitive user interface

The communication is fluid and provides a high level of interaction. The local operator can provide demonstrated answers immediately to remote customer questions.

The full stream can easily be recorded at both ends so that the FAT session can be replayed later on any standard video player. This is also how mixed reality experience may feed training sessions with concrete Return of Experience.

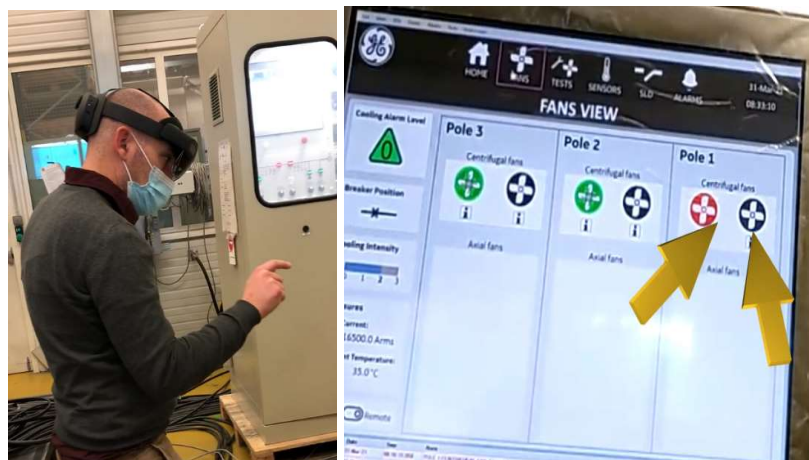


Figure 4 remote user (customer) and factory operator wearing the headset interacting via 3D virtual marks

Such a remote FAT session allows running specific scenario on-the-fly upon customer request (e.g. beyond the standard testing plan), as shown on Figure 4 where the remote customer was requesting to simulate a fan failure so that the corresponding alarm well appears on the GCB display, and the backup fan automatically starts.

Not only this experience saved traveling time, costs and carbon footprint, but it did not alter the customer satisfaction level compared to a conventional (presential) FAT process.

B. Site Acceptance Tests (field commissioning)

Mixed Reality was used in 2021 for the remote commissioning of a Point-On-Wave controlled system made of a CSD100 (electronic device) located in the relay room of a High Voltage substation, driving a primary equipment (HV Circuit Breaker used as a shunt reactor feeder).

Since such commissioning requires a preliminary certification based on specific procedures and no certified staff was available when the end user needed to energize the HV bay, a local non-specialist technician was wearing a mixed reality headset, interacting in real-time with a remote certified expert via a commercial conferencing software.

A secured communication could be set up in seconds, thanks to the use of a mobile Single Sign On profile that had been assigned by the company IT to this portable headset: a smartphone was used in the field as a local Wifi hotspot, sharing its 4G Internet access.

A few minutes were required at startup for the local technician to adjust the headset mounting kit to his safety helmet (Figure 5), calibrate the headset as per his personal viewing comfort and get familiar with basic interaction commands such as moving and anchoring windows.



Figure 5: the mixed reality headset can be adjusted to the safety helmet thanks to homologated adapters

As can be seen on Figure 6, mixed reality was largely used during this commissioning when local actings were required on hardwired connections: the remote expert could deliver real-time guidance and clarify instructions in real-time simply using a video conferencing software, remotely identifying and highlighting real parts of the local technician environment.

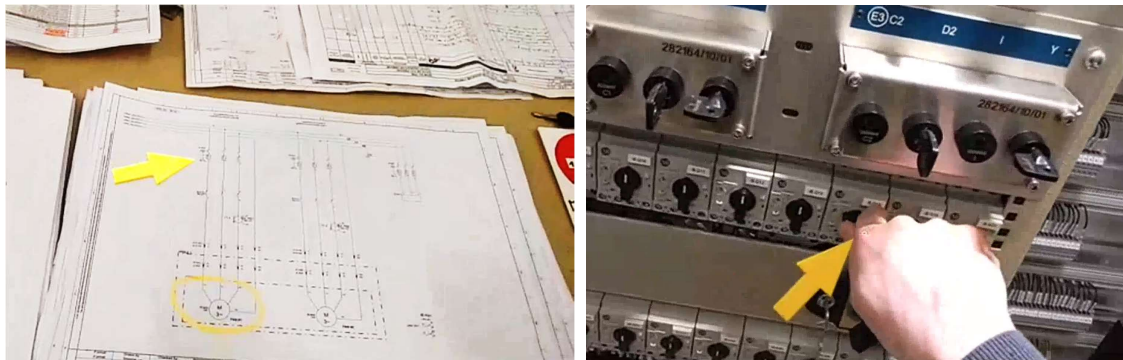


Figure 6: the remote staff can directly act on the local staff's environment using a simple mouse

Compared to conventional commissioning conditions, this experience revealed a good efficiency and high responsiveness. Beyond a significant mitigation of the costs and logistics (travel, logistics...) that it allowed, this experience also was also an opportunity for the local

technician to feel comfortable upon the validation of challenging milestones during Site Acceptance Tests. However this also revealed that wearing the headset might turn uncomfortable after several hours (extra weight and heat). The headset's battery autonomy is questionable (2 to 3 hours), as well as its actual viewing height (around 30°, versus ideal 80°).

IV. Conclusion

Mixed reality is an emergent advanced technology that can already be used in the field of High Voltage primary equipments on the field. Some use cases have been successfully tested during the COVID-19 pandemic (remote support, remote commissioning, remote Factory Acceptance testing runs), that not only satisfied HV equipment end users, eased cost reductions and prevented project ending postponements due to complex traveling constraints, but it also opened the door to further applications for the near future (full interaction with digital twins of HV primary equipments).

Beyond this, this technology demonstrated that sharing opportunities are not limited to virtual objects and remote interactions: it is also a new way to transmit confidence and serve continuous improvement purposes (feeding training development by realistic return of field experience).