RESPOND-A

Next-generation equipment tools and mission-critical strategies for First Responders

How can AR be used to improve first responders operations: an overview

Harbil Arregui - Vicomtech

2021 April 20th

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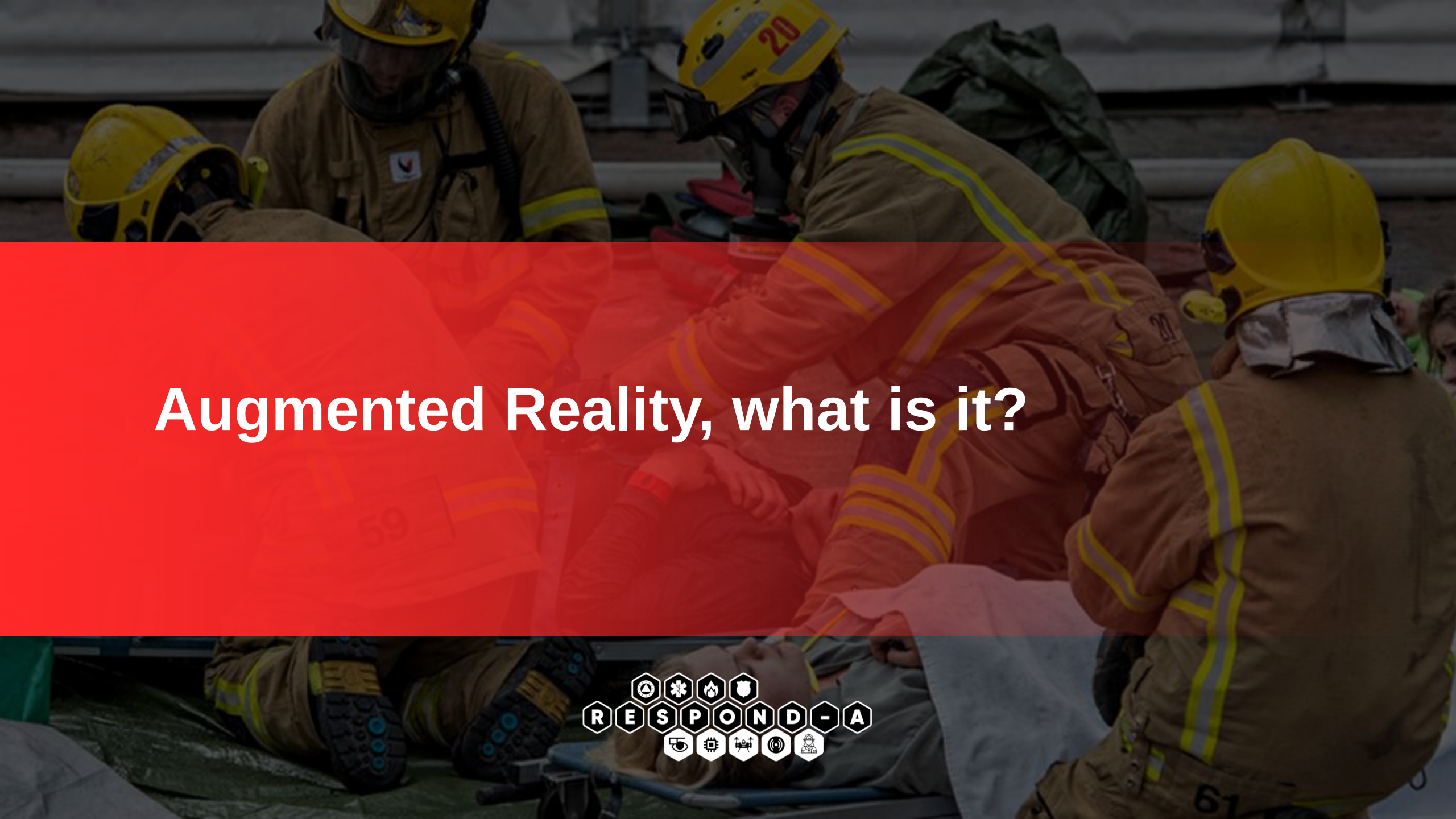
Augmented Reality, what is it?



Augmented Reality definition

A real-time **direct or indirect** view of a **physical real world** environment that has been **enhanced / augmented** by adding virtual computer generated information to it

Augmented Reality objective

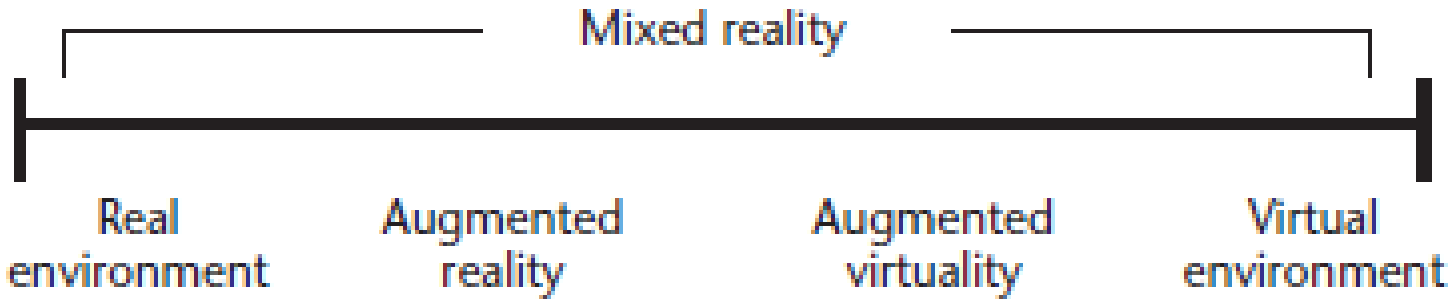
To simplify the user's life by **bringing virtual information** not only to his **immediate surroundings**, but also to any **indirect view** of the real-world environment, such as live-video stream.

AR enhances the user's perception of and interaction with the real world.

Augmented Reality vs. Virtual Reality

Augmented Reality	Virtual Reality
■ AR **allows the user to see the real world**, with virtual objects superimposed upon or composited with the real world. ■ AR **supplements reality**, rather than completely replacing it. ■ Virtual and real objects **coexist** in the same space	■ VR relies on a virtual environment. ■ Completely immerses a user inside a synthetic environment. **The user cannot see the real world around him/her**.

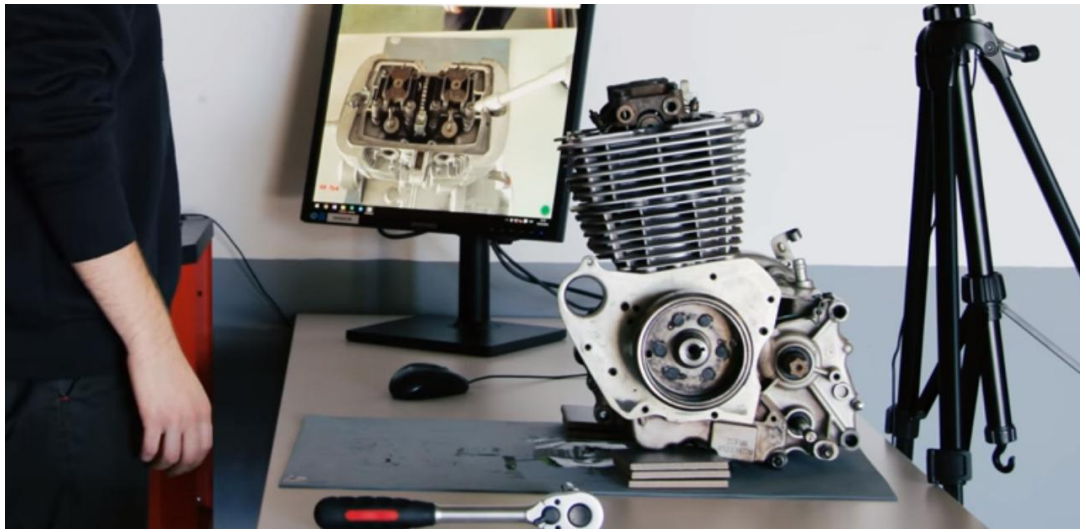
Mixed Reality



Milgram's reality–virtuality continuum.

R. Azuma et al. Recent Advances in Augmented Reality. *IEEE computer graphics and applications* 21.6 (2001): 34-47.

AR examples



Real-time markerless tracking for assembly of metallic parts
https://www.youtube.com/watch?v=T0wS6Uh42Vo

Medicine Segmentation and visualisation of structures
https://www.youtube.com/watch?v=GvFsXRDwTns

Technological aspects

AR technologies

Marker recognition (natural vs. artificial)

Location-based AR

Simultaneous Localization And Mapping (SLAM)

Frameworks

	Vuforia	ARCore	Kudan	EasyAR	Maxst	ARKit
Type	SDK	Framework	SDK	SDK	SDK	Framework
Price	Free, Commercial	Free	Free, Commercial	Free, Commercial	Free, Commercial	Free
Platform Support	A, iOS, W	A (iOS)	A, iOS	A, iOS,W	A, iOS, W	iOS
Geo-Location	–	–	–	–	–	–
Smart glasses support	yes	yes	–	–	yes	yes
Unity3D	yes	yes	yes	yes	yes	yes
SLAM	–	–	yes	–	yes	–
Cloud recognition	yes	–	–	yes	yes	–
Open CV	–	–	–	–	–	–
Total	7	8	6	5	7	8

	Onirix	Pikkart	Layar SDK	Lumin	AR.js
Type	SDK	SDK	SDK	SDK	Framework
Price	Free, Commercial	Free, Commercial	Free, Commercial	Free, Commercial	Free
Platform Support	A, iOS, W	A, iOS	A, iOS	Lumin OS	Web
Geo-Location	+	+	+	–	–
Smart glasses support	–	yes	–	yes	–
Unity3D	yes	yes	yes	yes	–
SLAM	yes	–	yes	yes	–
Cloud recognition	yes	yes	yes	yes	yes
Open CV	–	–	–	–	–
Total	7	7	6	5	7

https://invisible.toys/best-augmented-reality-sdk/

Hardware

Head-mounted displays (glasses, goggles, helmets…)

- Optical see-through displays: provides the AR overlay through a transparent display
- Video see-through displays: uses video capture from head-worn video cameras as a background for the AR overlay

Handheld displays

- Smartphones/Tablets: flat-panel LCD displays that use an attached camera to provide video see-through-based augmentations

Spatial/Projection displays

- The desired virtual information is projected directly on the physical objects to be augmented

Applications and limitations for First Responders

Emergency/disaster management (1/2)

Iterative and comprehensive handling of emergency-related tasks. The fundamental mission of emergency management is to propose an operable, accurate, and cost-effective plan to cope with different unforeseen events.

PRE-EMERGENCY

Mitigation

Prevention and reduction of the impact of imminent and potential crises.

NEAR-EMERGENCY

Preparedness

Pre-crisis measures to develop and improve crisis response and operation capability

DURING EMERGENCY

Response

Crisis-time actions to rescue people and prevent the loss of property and casualties

POST-EMERGENCY

Recovery

Measures to reinstate normal life, resume economic growth, and recover or rebuild the infrastructure

Applications for First Responders

- **Minimizing Required User Input**
- Incident commanders already use multiple devices. Input needs to be minimal to avoid distraction and maximize time for decision-making and coordination.
- Gesture-based commands and the integration of preincident plans superimposed onto the environment eliminate a need for multiple devices.

- **Visualization of spatial information**
- Judging height distances for a multiple story structure requires time and effort.
- Distances for height and from the hydrant to the scene are easier to calculate and comprehend. This kind of information is already available in the construction and engineering domains through BIMs.

- **Information Filtering**
- The incident commander is bombarded with radio conversations about irrelevant information, particularly when multi-agency response is required.
- Configure the display to show only necessary information or allow for customization according to incident commander's preferences.

K. A. Kapalo et al. *"Sizing Up" Emerging Technology for firefighting: Augmented Reality for incident assessment*.

Applications for First Responders

- **Video/Image Capture**
- The first-due officer wants to show the next due officer changes in conditions, so that he/she can strategize, and change courses of action as needed upon arrival.
- Incident commanders can view multiple images or videos to compare critical cues and changing conditions. This can give the incoming officers an advantage over current technology.

- **Multi-perspective views**
- An overhead view, view of all building sides (360º), and the ability to see the perspective of other crew members can enhance the incident commander's understanding of the incident scene.
- (…) firefighters use both primary (the surrounding environment) and secondary (pre-incident plans, maps, etc.) sources. AR leverages the ability to view both at once, or the ability to switch seamlessly between views.

- **Predicting future states**
- Exposures and changes in the conditions may require a change in fire suppression tactics.To be successful, incident commanders must think ahead.
- AR can scaffold an incident commander's mental model by allowing them to manipulate information that is superimposed on the real-world environment.

K. A. Kapalo et al. *"Sizing Up" Emerging Technology for firefighting: Augmented Reality for incident assessment*.

Applications for First Responders

“Example of a see-through image appearing to the trainee.
In order to understand whether a building is damaged, the trainee should reach it and verify its current status. To make the status of a damaged building immediately evident, it appears surrounded by a red line filled by a semitransparent red color. “

M. Sebillo et al. ***The Use of Augmented Reality Interfaces for On-site Crisis Preparedness*****.**

Limitations

- Maturity level to provide off-the-shelf services is still low
- The extreme environmental conditions can be quite limiting for the use of some kinds of devices
- According to the application (3D images, the use of SLAM…) battery-life might be limited.
- High-quality renderings and compositions aren't currently feasible in real time
- Heterogeneous needs for different types of emergency first responders. Personalisation is needed.

References

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- K. A. Kapalo, P. Bockelman, and J. J. LaViola Jr. *"Sizing Up" Emerging Technology for firefighting: Augmented Reality for incident assessment*. Proceedings of the Human Factors and Ergonomics Society Annual Meeting · September 2018
- J. Cao, L. Zhu, H. Han, and X. Zhu, *Modern Emergency Management*. 2018.

WEBSITE
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RESPOND-A has received funding by the European Union's Horizon 2020 – Research and Innovation Framework Programme, under grant agreement no 883371.

How will AR be integrated within RESPOND-A platform?

Harbil Arregui - Vicomtech

2021 April 20th

Next-generation equipment tools and mission-critical strategies for First Responders

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01 Main Objectives

02 General Architecture and proposed AR solutions

03 Use Cases / Pilots

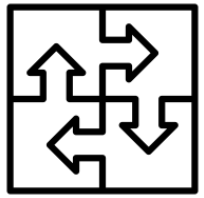
Main Objectives

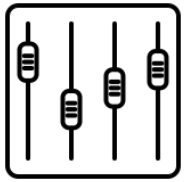
Main Objectives (1/2)

- Framed under WP5: Common Operating Picture through AR and MCX :
  - Development and implementation of a **Common Operating Picture** for the First Responders through **Augmented Reality** and Mission Critical Communications

- Enable operators to view mission-salient information as part of an **integrated common operating picture**

1



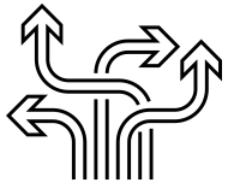


2

- User information and the models producing it will be **personalised to each end-user** (Control Centre, First Responders in the field)

- Experiment and assess **different ways of using AR** technology for integrating data in Responders' operations

3



4

- Organize a coherent User Interface **on different levels of First Responder operations**: command & control room, firefighters police officers, Emergency Medical Technicians, etc.

Icons from https://thenounproject.com/
By Becris
By Dama
By Luis Prado
By Adhikara
By Juan Pablo Bravo

Main Objectives (2/2)

- **Minimise the cognitive load** required for managing the information from several sources.

5

6

- Integrate both **presentation and interaction components** and provide a comprehensive framework capable of being adapted to the specific needs

- **Analyse HW solutions** for hosting AR applications in operational conditions

7

8

- Allow users to **manipulate and interact multimodally** with the virtual information/objects presented in the AR world, which will include also scene metadata

Icons from https://thenounproject.com/
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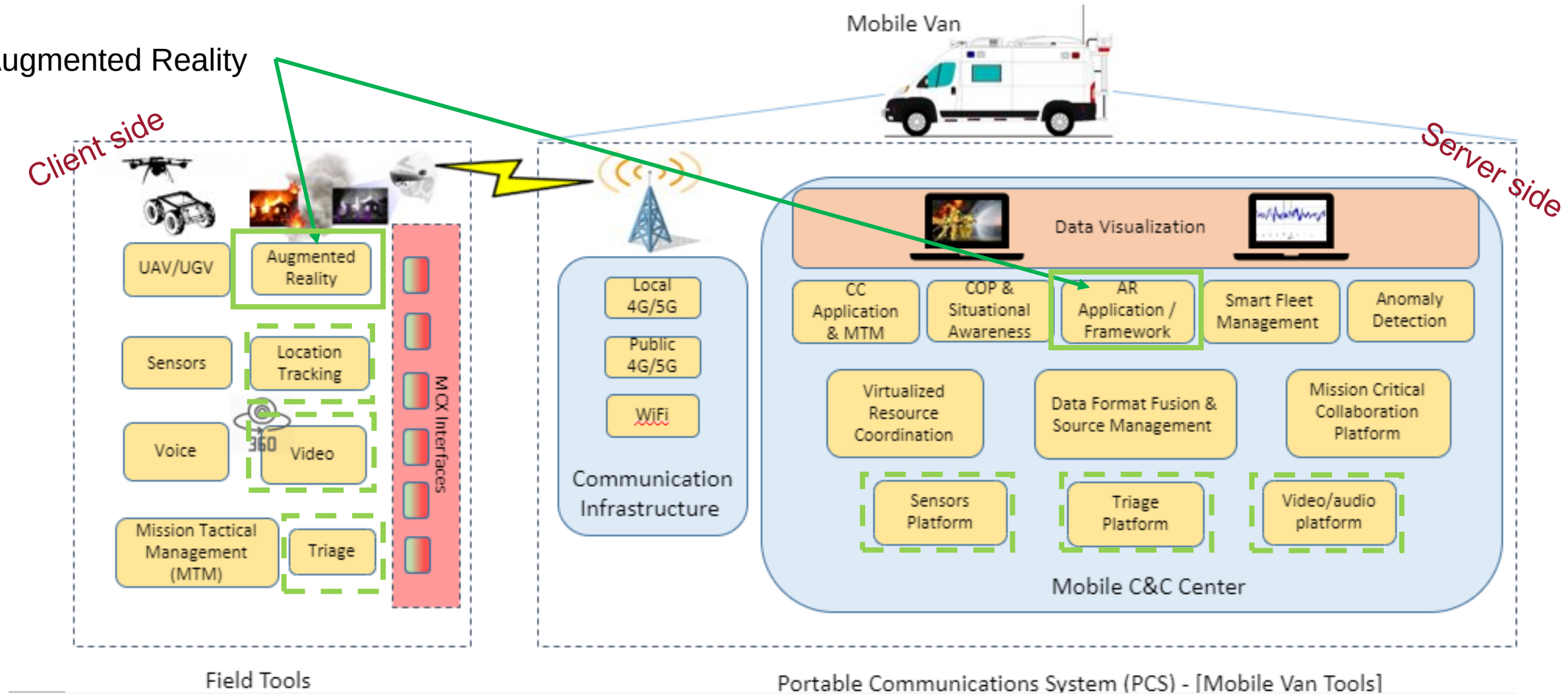
General Architecture and AR solutions

General conceptual architecture



Some FR inputs regarding AR/VR (1/2)

Q28	***Which of the following statements best describes your experience regarding the use of smartphones during operations:***			
	a – I can't carry or use any smartphone	*b – I can carry a smartphone, but I wouldn't be able to use it (kept in a pocket, for instance)*	*c – I can carry and use a smartphone sometimes*	*d – I can carry and use a smartphone most of the time*
	-	2	6	1

Q29	***Which of the following statements best describes your experience regarding the use of helmets during operations:***		
	a – I don't wear a helmet and I couldn't without impeding my operations	*b - I don't usually wear a helmet, but I could*	*c – I usually already wear a helmet*
	-	6	3

Some FR inputs regarding AR/VR (1/2)

Q30	***Which of the following statements best describes your experience regarding the use of VR goggles during operations:***		
	a – I couldn't use VR goggles without impeding my operations	*b - I could use VR goggles sometimes*	*c – I could use VR goggles most of the time*
	4	**5**	-

Q31	***Which of the following statements best describes your experience regarding the use of helmets with augmented reality data displays during operations:***		
	a – I couldn't use helmets with augmented reality data displays without impeding my operations	*b - I could use helmets with augmented reality data displays sometimes*	*c – I could use helmets with augmented reality data displays most of the time*
	4	**4**	**1**

AR solutions in Emergency Management stages

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Mitigation

Prevention and reduction of the impact of imminent and potential crises.

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AR solutions proposed in RESPOND-A

During Training

- Training to learn how to proceed in an emergency situation
  - Occulus Quest (Virtual Reality)

  - Hololens 2

During Emergency

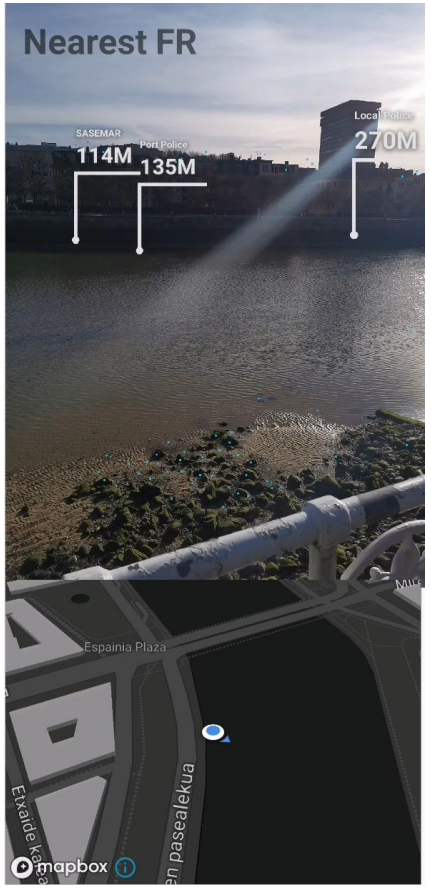
- Thermal video
- MCX Augmented Expert
- Location based Services
- Casualty Health Record for Paramedics
- Wearable sensors' alert status

Vuzix M4000

- 360º video over dronster/drone (Virtual Reality)

AR solutions proposed in RESPOND-A during emergency

Location based Services



Use Cases

Use Cases (1/3)

Severe forest fire, a common occurrence in countries in the south of Europe during the summer months

- Actions performed from the moment a fire breaks out up until the deployment of FRs on the scene
- Fire firefighters go missing during the early stages of a forest fire and later on they are found in need of medical assistance
- Citizens trying to escape from the area affected by the fire
- The forest fire approaches a highly critical area (e.g., an electricity station, satellite antennas, a military camp with explosives close to residential areas)

Use Cases (2/3)

Severe earthquake damaging buildings and provoking fires

Rescue of a victim inside a collapsed building

Rescue of a victim and a rescuer inside a flaming building

Use Cases (3/3)

Natural and provoked disasters in a port area and its surroundings

Oil spill accident that occurs in the neighbouring coast of the port when a container vessel crashes with port's breakwater

Crash of two trucks in the port producing a fire in the affected area, provoking the emanation of toxic gases

Summary of use case challenges and potential solutions

Use case scenario	Main challenges	Potential AR (and VR) solution(s)	Supporting capabilities
Fire	High temperatures, low visibility, difficulty to reach objectives, fast response needed, very high health risks for FR	Thermal Camera, Location based services, Casualty Health Record, Wearable sensors' alert status	Robots/UGV, Wearable sensors
Smoke, toxic gases	Low visibility, limited human access, very high health risks for FR	360º video VR, Location based services, Casualty Health Record, Wearable sensors' alert status	Robots/UGV, Triage system, Wearable sensors
Missing victims or FRs	Difficulty to trace an extensive outdoor area	Thermal Camera, Location based services	Drones
Hazards in critical infrastructure	Risks/solutions may be unknown without special experts input	Thermal Camera, MCX Augmented Expert	Robots/UGV, Drones
Collapsed buildings	Difficulty to locate people, possible high number of victims	Location based services, MCX Augmented Expert, Casualty Health Record	Indoor localization system, 5G, MCX
Maritime spills	Unknown extent of the spill, difficulty to estimate displacement, locate bathers and areas in risk from the coastline.	Location based services, 360º video VR	Drones, AI

Augmented and Virtual Reality offer capabilities to **display and represent** information in multiple suitable ways.
Data/information will be obtained through multiple sensor types and communication systems.

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