D8.6 Exploitation Plan, Innovation Management and Business Outlook

SHOTPROS

Deliverable	D8.6
Deliverable Lead	USE
Related work package	WP8
Author(s)	Birgit Harthum (USE)
	Markus Murtinger (USE)
	Emma Jaspaert (KUL)
Dissemination level	PUBLIC
Due submission date	31.10.2022
Actual submission	31.10.2022
Project number	833672
Instrument	RIA
Start date of project	01.05.2019
Duration	42 months
Version log	V1.0

Versions

Vers.	Date	Author	Description
V0.1	18.06.2022	Valerie Schlagenhaufen (USE)	First Draft
V0.2	Summer 2022	Birgit Harthum (USE)	Content integration
V0.3	Sept 2022	Emma Jaspaert (KUL)	Integration Competitor Analysis
V0.4	11.10.2022	Chris Haarmeijer (RL)	Input Technology partner
V0.5	14.10.2022	Helmut Schrom-Feiertag (AIT)	Input AIT
V0.6	Mid Oct	Birgit Harthum (USE)	Combination all input
V0.7	20.10.2022	Markus Murtinger (USE)	Check and additions
V0.8	21.10.2022	Birgit Harthum (USE)	Division public/confidential version
V1.0	31.10.2022	Valerie Schlagenhaufen (USE) Gerhard Helletzgruber (USE)	Final Formatting & Upload

List of Acronyms and Abbreviations

Acronym / Abbreviation	
AR	Augmented Reality
CM	Consortium Meeting
DMA-SR	Decision-making and acting in stressful and high-risk situations
DoA	Description of the Action
IPR	Intellectual Property Rights
KER	Key Exploitable Results
LEA	Law Enforcement Agency
NCPs	Non-Player Characters
TRL	Technical Readiness Level
USP	Unique Selling Proposition
VR	Virtual Reality
XR	Extended Reality

Table of Contents

Executive Summary

This deliverable aims to present a viable plan to exploit the results of the SHOTPROS project on a commercial and a scientific level. Based on the 5 main objectives of the project and the identified key exploitable results (KERs) throughout dedicated workshops, a business plan was derived. The consortium systematically evaluated the SHOTPROS outcomes for exploitation potential and generated innovation strategies to make use of the outcomes on a scientific, societal, and economic level.

To be able to define a business plan, the needs of European law enforcement agencies (LEAs) towards training simulation for high-risk situations and stress were defined by evaluating the **problems** of them. **Alternatives** that are **currently** used to solve these problems were added and then the project solution is described as **unique selling proposition**. Furthermore, an overview on the **market** and the potential **competitor** for the technological solution is given. Based on this information, a SWOT analysis and a Lean Canvas was derived and build the base for the detailed analyses of the exploitation in SHOTPROS, described in a **business plan**.

Although SHOTPROS was already a very tangible and hands-on project with a functioning solution that was already used throughout the field trials to execute realistic training sessions, the SHOTPROS VR solution (the main exploitable result of the project) needs some further steps to be commercialised as a final product. Other exploitable results of the project will be used commercially for a future consulting strategy for law enforcement organisations in their digitalisation process, as a certified DMA-SR training as well as for the VR and police network to raise awareness of the VR topic amongst LEAs and foster knowledge exchange and networking.

> **Note:** As this deliverable is public, only an overview on the SHOTPRPS exploitation is given in this document at hand. The full document will be found in the annex of the confidential deliverable D1.8, CM meeting minutes report.

1   Added value

1.1   Relation to the SHOTPROS Work packages (WPs)

The present deliverable is part of the horizontal **WP8** and by this provides a final view on the elaboration throughout the project. Especially WP6 (studies) and WP7 (field trials and final conference) delivered most of the insights on the market and on LEA needs towards VR as a training tool.

1.2   D8.6 is informed by the following deliverables

	How did these deliverables influence 8.6?
D1.1	The basic exploitation plan and the processes how to deal with this topic throughout the project were defined in D1.1, which influenced the set-up of D8.6 and vice-versa
D8.5	The policy maker toolkit delivered an insight on the needs LEAs have during the introduction of VR training to their organisation and consequently influenced many decisions and analyses carried out for D8.6
D7.5	Input on how a DMA-SR training should be set up and how this influences the VR solution delivered insights for the analyses of D8.6
D7.6	Input on the VR guidelines regarding a LEA tailored VR solution was used as a base for the analyses in D8.6 and vice-versa
D7.2	Information from the field trials regarding the expectations of participants towards VR training solutions and their view on the market was incorporated in D8.6
D7.3	Information from the final conference regarding the expectations of participants towards VR training solutions and their view on the market was incorporated in D8.6

Table 1: Deliverables informing this deliverable 8.6

1.3   D8.6 consequently feeds into the following deliverables

	How does D8.6 influence other deliverables within SHOTPROS
D8.5	The market data and the need of decision-makers analysed throughout the project influenced the focus of the policy-maker toolkit.
D7.6	The analysis of the market, the competitors and the potential customers influenced the decision on suitable features for the VR solution as well as the outlook on future features.

Table 2: Deliverables influenced by this deliverable 8.6

1.4 Relation to the SHOTPROS objectives

There is a strong relation between this deliverable and the 5 objectives of SHOTPROS (see Figure 1) as these all were considered throughout the whole project as key exploitable results with the aim to create results that are usable and create an impact even after the end of the project. All 5 objectives and the corresponding results will be exploited in its own way, whereas most of them have already started its roadmap to a business plan or as scientific publications. Details on that will be evaluated throughout the deliverable at hand and are also visible in D8.9, the dissemination report.
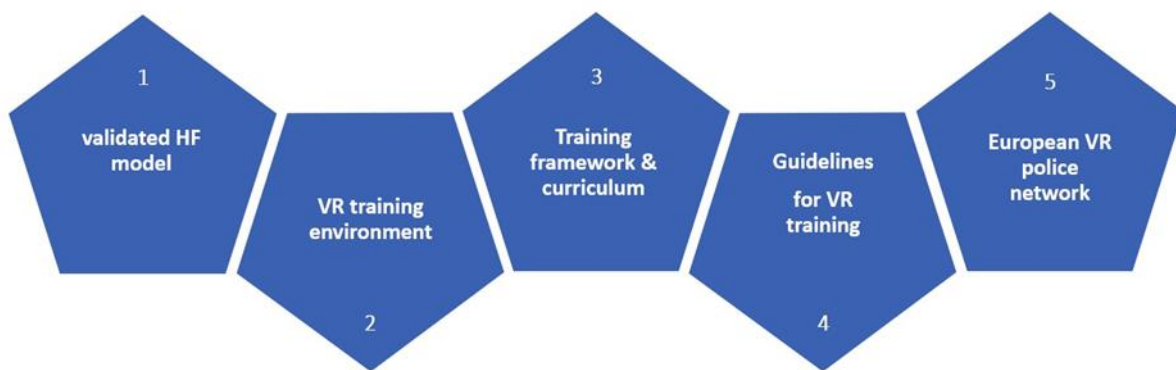

Figure 1: The 5 SHOTPROS objectives

2 Exploitation Strategy SHOTPROS

Exploitation refers to the use of results gained in course of a project. Without using the results, no impact on a societal, political, economic, environmental and/or scientific level can be created. The exploitable results in SHOTPROS as presented below, were continuously monitored with respect to the progress and the exploitation potential by the consortium led by USE throughout the course of the project as defined in D1.1, the Project Manual. With every bi-annual consortium meeting and also as part of the quarterly status meetings, the IPR management tool was updated, and possible future exploitation options discussed in dedicated workshops (as outlined in the exploitation plan in D.1.1 and in the periodic technical reports).

To be able to generate exploitation and to consequently create impact, key exploitable results (KERs) were defined within the consortium throughout the project. Based on them, analyses were made on different levels to set up a Lean Canvas and a business plan.

2.1 Key Exploitable Results (KERs)

The following KERs were identified in the course of the SHOTPROS project. In the columns of the table, the deliverable where the detailed results of the certain KER can be found as well as what is planned for exploitation and by whom, are listed.

The defined KERs cover the full range of usable results from the SHOTPROS project. The focus within commercial exploitation though, is on the technological SHOTPROS VR solution and possible additional products (KER 1) and therefore the different analyses in the following chapters of the deliverable, mainly focus on KER 1. Most of the analyses are valid for the other KERs as some of them are part of the SHOTPROS VR solution (especially KER 6-9) and will be considered in the exploitation roadmap for the steps after the end of the project. KER 5, the "VR and Police Network" as well as other commercial products (consultancy - KER 4 and certified training – KER 2&3) will be described in a separate chapter.

Table 3: SHOTPROS - KERs and Exploitation strategy

KER	Results	Exploitation Plan	Target Groups	Who (Lead Partners)
1 - **SHOTPROS VR solution** and experimental environment plus compact product approach	D4.6 D5.1 D7.6			RL in cooperation with AIT and USE
2 - Human Factors-based **DMA-SR Model**	D7.4			VUA, UHEI, AIT, KUL
3 - **Training Framework** and Curriculum for **DMA-SR training** (in the VR)	D7.5			VUA, AIT, USE, LEA partners
4 - **Policy Maker Toolkit** & **Strategies** for LEAs on VR introduction	D8.5			USE, LEA partners
5 - VR and Police **Network**	D8.10 D8.9	*- Confidential details in D1.8*		VESTA, LEA partners
6 - Repository of **Stress Cues**	D4.1			AIT, RL
7 - Tool Suite for **stress measuring** during training	D5.4			AIT, RL
8 - **Trainer Dashboard** for In- and After-Action Monitoring (Real Time Training Assessment Tool)	D4.5			AIT, RL
9 - **VR Guidelines**	D7.6			AIT, RL
10 - **VR Training** Scenarios and **VR Scenario Guidelines** for DMA-SR training	D7.7			AIT, RL, LEA partners

3   Lean Canvas

To be able to put the business plan in a clearly arranged structure at one page, the Lean Canvas was used in SHOTPROS. The structure was continuously updated and specified towards the end of the project. It helps to fine-tune and develop the exploitation strategy and the business plan for a KER having in mind four questions:

- Who is "my customer"?
- What is "her/his" problem?
- How does "she/he" solve the problem now?
- Is our solution more efficient than the current one?

Based on these results, detailed analyses of the market and the competitors were implemented which built the base for a product definition and business roadmap for the phases after the end of the project

The confidential details can be found in D1.8

3.1 Problems regarding training currently faced by LEAs

High-risk stressful situations in police operations are on the rise in Europe. The best way to prepare for them is suitable and continuous training. Typically, this is provided by tactical, scenario-based training. In real-life training simulating these situations is resource intensive, and needs time, money, and a suitable location.

Evaluation of (complex) real-life training is difficult – the necessary debriefing and feedback phases are complicated (many camera views (if even installed) need to be evaluated manually, the right situation from the right angle needs to be found etc.). Trainers often lose time discussing with trainees if a certain situation in training really happened or not. This could be frustrating to all participants if no clear facts are available and the discussion cannot focus on the learning aspects.

The confidential details can be found in D1.8

3.2 Alternatives used by LEAs

Currently, police training is either done in real-life training with most of the challenges mentioned above. Many organisations try to avoid this by introducing VR solutions. But many

VR solutions focus on single learning and not scenario-based training. They are often not multi-user capable, not cable free, limited to small fields (limited movement), scenario adaption is only possible with large efforts and/or the solutions do not provide haptics and realistic police gear

The confidential details can be found in D1.8

3.3 Unique Selling Proposition (USP) – SHOTPROS

> The SHOTPROS VR solution provides an immersive full-body motion capturing VR training solution for the law enforcement to train decision-making and acting under stress and at high risk with scientifically analysed stress cues for effective training.

The confidential details can be found in D1.8

In comparison to the competitors in the market, the SHOTPROS solution delivers the following advantages:

Table 4: SHOTPROS solution - market advantages

Advantage *SHOTPROS VR solution*	Details
Haptic & realistic tactical belt to use	
Stress & performance measurement	
User-friendly Scenario Editor	
After-action review (AAR)	*The confidential details can be found in D1.8*
Mobile & location independent	
360° free movement	
Role-player mode	
Multi-User / group training	
Trainer Ghost mode & change of roles	

3.4 Market Overview

VR and nowadays also Extended Reality (XR) is a recurring topic since many years. VR was defined in the 90ies by Paul Milgram and received big technology enhancements in the last

few years by the second wave[1] of VR. The European XR market is expected to grow between EUR 35 billion and EUR 65 billion by 2025. VR and augmented reality (AR) have the potential to add 1.5trillion USD to the global economy by 2030[2]. Development and training are expected to contribute 8.8 billion to that growth.

A massive enabler always was the entertainment and gaming industry and still is. Many entertainment-oriented providers also enter the professional (training) market for VR. This raises the demand for more reliable, cheaper, and more user-friendly hardware and software and enlarges the market. At the same time, the progress is still not high enough to provide standardised professional solutions for complex training requirements. There are still struggles regarding motion sickness, platform accessibility, physical hardware setup, PC compatibility in combination with free movement and tracking and motion control calibration.[3] It is not solved on a standardised level for professional training applications, but the release of the Quest2 starts to set at least new standards towards entertainment.

Figure 2: VR Market - Growth Drivers relevant for SHOTPROS (based on PwC - Seeing is believing)

But from the user side (in our case B2G) the needs rise and the market grows. The PwC 2022 US Metaverse Survey found that 51% of companies are either in the process of integrating VR into strategy or have already built VR into at least one dedicated line of business.[4] In this strategy, training is in the focus. Thirty-four percent say that one of the biggest metaverse benefits they currently enjoy or foresee is "a more effective way to develop and train our people." In the law enforcement this will cover training of regulations and laws but also tactical skills and decision-making and acting as well as applied skills or resilience training. SHOTPROS focused on one aspect, but the training types and needs are big and show a broad

---

[1] Anthes, C., García-Hernández, R. J., Wiedemann, M., & Kranzlmüller, D. (2016, March). State of the art of virtual reality technology. In 2016 IEEE Aerospace Conference (pp. 1-19). IEEE

[2] https://www.pwc.com/seeingisbelieving

[3] https://arstechnica.com/gaming/2022/10/what-happened-to-the-virtual-reality-gaming-revolution/

[4] https://www.pwc.com/us/en/tech-effect/emerging-tech/virtual-reality-study.html

potential for providers. From end user events throughout SHOTPROS we also know, that showing digital approaches and innovative forward-thinking in learning is also an important factor to attract new students as the registrations are expected to be higher. This is also seen as a driver for the growth of the VR market in general.[5] With fewer resources available in the future, the aspect of scalability of learning is very relevant for deciders in the education and training of law enforcement. VR will not substitute classroom or even physical training completely, but for many aspects of the education and training of police officers, VR might be a useful solution int he future and has the potential to scale.

Even if these numbers confirm the enormous potential of VR/XR technologies and the willingness to spend money on that technology, there are still many challenges that need to be solved for successful integration. According to a study by Statista[4], more than 58% of XR professionals surveyed said a lack of understanding of the benefits or opportunities is preventing them from integrating the technology. Clear processes, guidelines and products are needed. According to a report by Zerres Marketing[6], most larger companies are familiar with VR/XR technology, but still need to educate themselves. This offers potential for consultancy in this field which can be either supplied by the VR provider or external agencies to bring in a more neutral view. Consequently, companies providing more than just the product, but guidelines, processes and research-based standards will be more accepted by deciders in the current phase of the technology.

Another reason for businesses to explore the benefits of VR and AR now, is that the technology is finally maturing. Some people's past experiences of VR and AR may have been clunky, but the hardware and software are evolving every day, content is becoming more sophisticated and engaging, and improved connectivity is opening up a new range of business use cases. This is at the same time a challenge for providers as they need to follow the new developments with their products, but this also means another boost in the market and adaptable providers are in the first line to set standards themselves.

4   Competitor Overview

To analyse the current market, we identified potential competitors on the European market and used a selection of criteria for tender documents defined in the Policy Maker Toolkit (D8.5) for comparison of them. In general, several VR solutions providers exist on the market,

---

[5] https://www.pwc.com/gx/en/technology/publications/assets/how-virtual-reality-and-augmented-reality.pdf
[6] https://www.zerres.marketing/wp-content/uploads/2021/02/Extended-Reality-Chancen-Herausforderungen-und-Anwendungsbeispiele-fuer-KMU-low.pdf

but only a handful are relevant for developing VR training solutions specifically for law enforcement. In this chapter we will provide a short overview of the ten providers identified by the SHOTPROS consortium including the SHOTPROS development partner RE-liON. When touring with the SHOTPROS field trials (see D7.2) and during many different dissemination events (see D8.9) we received information by police deciders and trainers on the topic of VR, the market and the competitors. The common challenge is, that there are providers and they start focusing on the law enforcement market, but it is difficult to compare for LEAs as the technology used is not the same and the comparison is difficult to master without VR knowledge (this topic was tackled by the SHOTPROS project in general but especially compressed for LEAs with D7.6, the VR Guidelines and D8.5, the Policy-Maker toolkit). The most often mentioned providers were (the order is influenced by the fact, that many events were also SHOTPROS events and therefore RE-liON was present): RE-liON, Refense, Hologate, AXON, VRTS/OneBonsai and towards the end of the project also Ramrodt. The others are either very specialised or not active in the European market (at the moment).

After a short overview on the providers on the market in the table below, criteria selected from D8.5 for tender processes were analysed to compare the market. A company profile for each selected competitor can be found in the appendix A.

VR provider	Product name	Product comprises	Available since	Company Country
RE-liON	SHOTPROS VR solution (commercial name will be BLUESUIT)	A turn-key VR training platform for (almost) every budget and requirement.	2023	The Netherlands
Refense	ATTS	Motion tracking system with HMDs, tracking markers and various weapons and props. A rudimentary after-action review tool and an enhanced level editor.	2019	Switzerland
HOLOGATE	HOLOGATE X (permanent) & M (mobile)	A turnkey system with optical full-body tracking and haptic feedback. Possibility to integrate different weapons.	2019	Germany
AVRT	AVRT platform	VR headset and accompanying physical objects such as weapons, a tracking matt, an instructor laptop, microphone, weapon control and a wireless router	n.s.	UK
VRTS	VRTS	Helmets, computers, handguns, long guns, non-lethal and torch for a pair of operators.	2020	Belgium
WRAP	WRAP Reality	A high-performance gaming computer, HTC Vive Pro 2 headset with wireless kit, hardware that simulates standard police tools	2016	USA (Arizona)
V-armed	V-armed	n.s.	2016	USA (New York)
AXON	AXON VR	Compact VR setup with a Taser and a pistol	n.s.	Global

Asterion / Ramrodt X	CQB ModulMaze	n.s.	n.s.	France, Germany
Apex Officer	Apex Officer	HMD, standard firearms and equipment, a VR-ready workstation with operating system, haptic feedback suit, dynamic scenario generator, after-action debriefing tool, officer analytics, wireless tracking technology, operator laptop and workstation	n.s.	USA (Nevada)

Table 5: Overview of competitors

4.1 Competitor – Criteria analysis

The companies listed above, were all contacted via e-mail with the question if they could provide us with information about their product. Five companies delivered a comprehensive document with information about their VR solution: VRTS, AVRT, WRAP, Refense and Hologate. For the other four companies (V-armed, AXON, ASTERION VR, and Apex Officer), information was used that could be retrieved from their websites. However, not all websites were equally comprehensive or detailed, so certain aspects about their systems remain unknown. The information will be published at the SHOTPROS website as well as at the VRPN website for LEAs to access.

For the analysis, we compared all providers with the SHOTPROS system, on a set of **14 criteria**:

Table 6: Competitor analysis criteria

CRITERIA	DESCRIPTION
Product use	Description of the VR solution that the provider offers
Target group	What is the main target group and who are customers?
Purchase model	What is the usage model and how is support provided?
Hardware	Which hardware is used and how does it work?
Set up of system	What is needed for the usage of the system and how long does it take?
Preparation for training	How quick can trainees start the training?
Biosignal measurement	Is mental load measured and if yes, how is it measured?
Visualization & scenario editor	Which scenarios are available and how can they be created or adapted?
Training itself	How does the trainee experience the VR?
Police related equipment	Which equipment is available and how is it tracked?
NPCs/avatars	What types of characters are available and how are they steered?
Trainer options	What can a trainer do during the training?
After action review	Is there a debrief possible and if yes, how does it work?
Pros & Cons	What are the main advantages and challenges of the system?

4.1.1 Product use

VR provider	Type of training	User manual?	Training to use system?	Operator needed?	Data security concept	General security concept
SHOTPROS/ RE-liON	Operational DMA-SR training	Yes	Courses available: train-the-trainer, scenario designer, technician.	Yes, 1 operator. Additional trainer advised	All data is stored locally with the customer	Complies with local laws (GDPR, etc) and IT security standards
Refense	From basic education to special forces training	Yes, German and English (can be translated)	Instructors: 1-day certified course Trainees: 5-minute briefing	Yes, 1. Trainer and operator can be the same	Only authorized Refense employees can access the system. System can be operated offline.	EVB-IT contract standards and BSI security standards compliant
HOLOGATE	Operational and leadership training	Yes, German and English (can be translated)	Instructor: user manual and hangouts for suit-up area and control panel	Yes, minimum 1 for 4 trainees. Trainer and operator can be the same	All data is saved locally. Simulators can be used offline. No personal data is used or stored.	Any local law can be complied with
AVRT	Operational instructor level training	Yes, English (can be translated)	Instructor: training is provided (not further specified) Trainees: 30-second safety brief	Yes, 1 operator. But system also has pre-scripted content for a single user.	All data is stored locally with the customer. AVRT does not retain, process or control the data	Any local laws can be complied with
VRTS	Operational training	Yes, English, Spanish and French	1 hour training	Yes, 1. Trainer and operator can be the same	All data is stored locally with the customer. No data transfer	Any local laws can be complied with
WRAP	Operational training for patrol officers and academy recruits	Yes, English	Instructor: training is provided (not further specified)	Yes, 1. Trainer and operator can be the same (but an extra trainer and safety person is advised)	All data is stored locally with the customer. Optionally, data can also be stored with AWS GovCloud component	AWS GovCloud component is CJIS compliant
V-armed	Large-scale training	n.s.	n.s.	n.s.	n.s.	n.s.
AXON	De-escalation	Yes, Axon Academy	n.s.	n.s.	n.s.	n.s.

Asterion VR	CQB training	n.s.	n.s.	Yes, at least 1 (but n.s.)	All data stays with the customer in the Asterion server racks. No data kept or to third parties.	n.s.
Apex Officer	UoF, de-escalation and crisis intervention training	n.s.	n.s.	n.s.	n.s.	n.s.

Table 7: Competitor overview on (1) Product Use

4.1.2 Target group and customers

VR provider	Target group	Existing customers	Frequency of use	Multiplayer?	Interdisciplinary training?
SHOTPROS/ RE-liON	Whole range of police officers: education, training as well as mission preparation for SWAT-type units.	National Police Netherlands. Many field trials within SHOTPROS, and pre-existing customers in other markets (e.g. Dutch Army, Singapore Fire Services)	Used in real life trainings as part of the SHOTPROS field trials	Yes, typically teams of 3-4. Up to 16 trainees possible	Not in SHOTPROS focus, but possible due to other RL products
Refense	Police officers, SWAT, military, private security, other first responders	E.g., Stadtpolizei Zürich, Polizei Baden-Württemberg	Depends on owning the system or purchasing training blocks with a training provider	Yes, typically in teams from 2 to 8	No, but in development
HOLOGATE	All kinds of emergency services and military	We currently work with over 6 military branches and some universities	n.s.	Yes, can be used by 4 trainees, but could be extended up to 16	Yes
AVRT	All police	University of Greenwich, Essex Police, Derbyshire Constabulary	Can be built in any training schedule	Yes, typically in teams of 4. Any number of trainees possible.	No, but in development
VRTS	Basic police, elite units, academy recruits	Police, army, security guards	n.s.	Yes, typically in teams of 2, but large intervention groups also possible	Yes, with emergency teams and firefighters
WRAP	Street police, academy recruits	Many LEA's in the USA	Normal usage is quarterly (in police departments) or throughout semester (academy)	No, single player. System can support 2 trainees simultaneous, but it requires 2 sets of hardware.	No, but in development

V-armed	Military and LEA (n.s.)	n.s.	n.s.	Yes, allows up to 10 trainees	n.s.
AXON	Police (n.s.)	e.g., Phoenix PD, Halton police service	n.s.	No, single player (but remote collaboration possible)	No
Asterion VR	Special forces, military	n.s.	n.s.	Yes, allows up to 6 trainees	n.s.
Apex Officer	Police officers and LEA	E.g., state troopers, LAPD, New Jersey Sheriff's office	Unlimited usage	No, single player	n.s.

Table 8: Competitor overview for (2) Target group and customers

4.1.3 Purchase model

VR provider	Usage model	Price	Included in basic system	Support	Updates/bugs
SHOTPROS/ RE-liON	Purchase and lease.	On request	Bespoke	Bespoke	Bespoke
Refense	Full purchase, lease, or purchasing individual training blocks in a training centre	Pricing starts from €350.000 for basic setup	Hardware, software, training, & support for 3 y	24/7 technical support	No fixed schedule for new releases
HOLOGATE	Purchase with remote support as service or training/infra-structure as service	On request	n.s.	24/7 remote support	System is usually frozen, updates depend on customer's requirements
AVRT	Purchase of annual, enterprise-wide software license to use the system, with 3-year rental model for the hardware	On request	n.s.	Full support during business hours	Periodical updates (typically every 6 months)
VRTS	All formulas available	On request	n.s.	Type of support depends on location of customer	100% stable. Upgrades and purchase of new scenarios available
WRAP	Initial hardware purchase with an annual support contract that provides all newly created training modules and upgrades	$25.000 in initial hardware + a tiered service contract based on the size of the agency (average cost around $65.000)	n.s.	E-mail support within 24h. live phone support out of Phoenix, Arizona	Monthly software releases (new content and features, and bug fixes)
V-armed	n.s.	On request	n.s.	n.s.	Endless open-source bank of assets. Monthly updates and improvements.

AXON	n.s.	On request	n.s.	Online support via Axon Academy	n.s.
Asterion VR	n.s.	On request	n.s.	n.s.	n.s.
Apex Officer	Purchase of a VR training simulator package with unlimited usage, training modules and 35ft x 35ft training space	On request	The training simulator, 35ft x 35ft training space, 100+ training modules, 24/7 support	24/7 support	Weekly updates of the software

Table 9: Competitor overview for (3) Purchase model

4.1.4 Hardware (3 parts)

VR provider	Hardware general	Hardware/gear for trainee	Off the shelf?	Malfunctions?
SHOTPROS/ RE-liON	Bespoke	VR HMD incl. headset (helmet); VR SUIT incl. sensors and vibration for full body tracking; full tactical police duty belt, additional long gun	Currently not	Bespoke
Refense	Motion tracking camera system; calibration hardware; wired and wireless networks; 4D effects; workstations (host, arena management, motion capture, AAR); operator tablet; props	VR HMD; headset; back-tracker; trackers for hands/feet; weapons. (Holster, shock belt, custom props optional)	All hardware is COTS, expect for the active trackers and custom-built props.	24/7 technical support. Replacement parts will be provided free of charge if covered by warranty. Otherwise, they can be ordered or mailed in for repair.
HOLOGATE	It is a turnkey system with no need for extra hardware, although additional hardware can be integrated on request	Six sensors for full-body tracking; HMD; weapons (or regular controller or blaster)	COTS is used whenever possible. Newer HMD/better graphics cards can be integrated	Replacement of broken parts and even upgrading them, depending on customer's requirements
AVRT	Instructor control: laptop, microphone, weapon controller and wireless router	HMD, headphones and appropriate weapons	Majority is adapted consumer grade technology with some custom equipment built in	Replacement of the full unit within agreed SLA. Hardware is not user-maintainable.
VRTS	Depends on customer. If customer is already equipped with (some) hardware, that is fine	Belts with operator's equipment. Weapons (airsoft replicas)	All hardware is COTS.	Replacement either by warranty or by quotation

WRAP	Gaming PC, 4 base stations	HTC Vive headset, Use of force options	Most is COTS, but the simulated UoF options are proprietary	Full warranty on all COTS components for the term of the service contract. The UoF options are warrantied against manufacturer defects for 30 days.
V-armed	n.s.	HMD; weapons. No further specification	n.s.	n.s.
AXON	n.s.	HMD; weapons. No further specification	n.s.	n.s.
Asterion VR	The ModulMaze is a turnkey solution. Comes with walls	HMD; weapons; inside-out 3D position trackers	n.s.	n.s.
Apex Officer	VR-Ready workstation. No further specification	Haptic feedback suit; HMD; standard firearms and equipment	n.s.	n.s.

Table 10: Competitor overview on (4) Hardware - part 1

VR provider	Type of tracking	Tracking exactness	Finger tracking?	How movement tracking?
SHOTPROS/ RE-liON	On request	On request	no	On request
Refense	Motion tracking with active markers uniquely identifying each tracker and object (optical tracking)	+/- 0.2mm across the tracking area	Optional	Active markers and a motion-capture camera system. The active markers use an encoded infrared-LED system. Markers are worn on the users' heads, backs, hands, and feet and are built into various props
HOLOGATE	Full-body tracking	Very exact	Optional	Sensor fusion with optical tracking, with trackers on feet, hands, body and HMD
AVRT	Optical (IR) tracking from a floor mat.	Accurate weapon behaviour and exact user tracking	No, but under assessment	Optical tracking from floor mat
VRTS	Vive tracker	Perfect. 99.99% shooting accuracy	Optional	With base stations and Vive trackers
WRAP	Inside-out tracking using IR Base Stations	Millimetre accuracy	No	Tracking by headset in relation to the base stations
V-armed	Body tracking on the floor. Additional props tracking.	n.s	n.s.	n.s.

AXON	n.s.	n.s.	n.s.	n.s.
Asterion VR	"Low cost tracking system compared to motion tracking" Endogenic inside-out 3D position tracking system	Very accurate	n.s.	n.s.
Apex Officer	Apex Wireless Tracking Technology	n.s.	n.s.	n.s.

Table 11: Competitor overview on (4) Hardware - part 2

VR provider	Trainee size considered?	Size of training field?	Training in same field?	Training on split locations?
SHOTPROS/ RE-liON	Yes, size and arm length are measured to provide a scaled avatar	Playing field up to 70 x 100 m. plus space for operation and Trainer station – outdoor capabilities	Yes, typically teams of 3-4. Up to 16 trainees possible as is shown in the military market.	Yes, systems in different locations can be connected
Refense	Yes, system automatically detects trainee's height and sizes the avatar accordingly	Minimal room size is 12x12m. ideal room size is 12x22m or larger. Virtual: because of directed walking and elevator, the virtual environment can be larger than the physical environment	Yes, up to 10 trainees together	No
HOLOGATE	Yes, size, arm length and leg length are measured to provide a scaled avatar	Minimum 6x6m for a 2-player system, which has a 5x5 player space. Standard is a 10x10m or 20x10m area, resulting in a 9x9m or 19x9m player space	Yes, 4 trainees together (could be extended to 16)	Yes, systems in different locations can be connected
AVRT	Yes, user avatar adjusts according to the height of the trainee	VR training space has no limits – the tracking mat is completely scalable	Yes, with no theoretical trainee limit	Yes, possible with good quality, low latency connection
VRTS	Yes	Surfaces of 6x6m. Can be mounted up to 30x30m and more depending on customer requirements	Yes, up to 16 trainees together	Yes
WRAP	Yes, trainee height is calibrated during set-up	Minimum size is 2x2m, maximum size recommended is 5x5m. But software can accommodate any size that hardware can support	No, single player. System can support 2 players simultaneously, but it requires 2 sets of hardware.	No
V-armed	n.s.	Training space ranging from 30x30sqf to 200x200sqf or more. Space does not have to be square. Also portable system for up to 2 trainees in smaller space.	Yes, up to 10 trainees together. For the portable system: up to 2 trainees.	n.s.
AXON	n.s.	n.s.	No, single player	Yes, remote collaboration possible
Asterion VR	n.s.	Modulmazes from 42m² up to 108m². Required physical space not specified	Yes, up to 6 trainees together	n.s.
Apex Officer	n.s.	35x35sqf training space. Required physical space not specified.	No, single player	n.s.

Table 12: Competitor overview for (4) Hardware - part 3

4.1.5 Set-up of system

VR provider	Room requirements	Who sets up system?	Set-up time?	Mobile system?	Outdoor use?
SHOTPROS/ RE-liON	No distracting Wi/Fi, size according to training field, free power sockets, at least 2,5 m ceiling hight,	Training operator	1h first training day, 10 min each day	Yes (1 van)	yes
Refense	- Room size at least 12x12m for training ground + extra space for operator desk and suits station - Small room for AAR - Ceiling height: over 2.5m - Vibrations as low as possible, no direct sunlight - Air-conditioned room of 20°C or lower - RF shielding to prevent interference	By operator or trainer, after training by Refense	Approx. 30 minutes for first training day. No additional time for additional day	No	No
HOLOGATE	Room size: at least 6x6m. No other requirements specified.	Depends on customer: either HOLOGATE provides an operator ("training as a service"), or they train the in-house trainers	10 minutes for HOLOGATE M (mobile version). 5 days for HOLOGATE X (permanent setup). For an additional day, set-up will be less than 5 minutes.	HOLOGATE M: yes HOLOGATE X: no	HOLOGATE M: yes, if no direct sunlight at the tracker or HMDs. HOLOGATE X: no
AVRT	- Flat, indoor space of at least a few m² - A few power sockets nearby Otherwise, no requirements. System comes with its own Wi-Fi network.	Organisation will be fully trained	Typically about 1h for a large (100sq) mat. For additional day, set-up is under 5 minutes	Yes, large mat can fit in a small van	No
VRTS	An empty room of minimum 6x6m and a power socket	VRTS provides the installation and train the trainer	If installation is fixed by VRTS (recommended), no set-up time needed. If used as mobile system, it takes 1h to set up.	Yes	No

WRAP	- Vibrations as low as possible, no direct sunlight - Room with standard humidity level - 4 power outlets with extension cords or power strips	Organisation will be fully trained and support by WRAPs customer success team	About 15-30 minutes by a trained operator. For additional day, it takes 2-5 minutes	Yes, system fits in trunk of standard sedan (2 Pelican cases and 1 tripod bag)	No
V-armed	n.s.	n.s.	n.s.	n.s.	n.s.
AXON	n.s.	n.s.	n.s.	n.s.	n.s.
Asterion VR	n.s.	n.s.	n.s.	n.s.	n.s.
Apex Officer	n.s.	n.s.	n.s.	n.s.	n.s.

Table 13: Competitor overview for (5) Set-up of system

4.1.6 Preparation for each training group

VR provider	Calibration - dressing time	#trainees per day	Guided process?	Ideal training duration	Tutorial scenario
SHOTPROS/ RE-liON	Dressing: 10 min Calibration: 5 min	Depending on the training goals. The aim is that trainees are better prepared.	Video tutorial for dressing and basics, Guided tutorial scenario for usage of gear; Instructions by trainer and operator during training	Depending on the scenario and the necessary repetitions and stress levels – under 1,5 h (incl. dressing and AAR) no DMA-SR learning effects – see D7.5 on details	Yes
Refense	Under 5 min	Optimally, several dozens of trainees. But depends on system size, scenario, number of gear sets	Instructions by system operator	Varies according to scenario. Anything between 3-30 min (+ 10-20 min AAR)	Yes
HOLOGATE	Between 5-10 min for first-time users. For regular users less than 3 min. Calibration time is 3 seconds.	Depends on scenario, training level, learning goals, trainer, …	Guide for trainees; hangouts for suit-up; instruction video and in-game video in VR. But, trainer gives scenario-specific instructions	Max 10min for more repetition. But depends on group, targets, …	Yes
AVRT	Under 2 min	50+ trainees is feasible, but depends on scenario and level of AAR	Instruction by operator (30 second safety brief)	Fully dynamic scenarios typically 5-10 min	No
VRTS	No calibration needed	40 trainees	Instructions done by trainer	20-minute sessions + debriefing	No
WRAP	Between 2 to 5 min	Between 24-32 trainees	Instructions done by trainer	Usual training involves running through 2-3 modules, which takes 15-20 min	Yes
V-armed	n.s.	n.s.	n.s.	n.s.	n.s.
AXON	n.s.	n.s.	n.s.	n.s.	n.s.
Asterion VR	n.s.	n.s.	Instructions done by trainer	n.s.	n.s.
Apex Officer	n.s.	n.s.	n.s.	n.s.	n.s.

Table 14: Competitor overview for (6) Preparation for each training group

4.1.7 Biosignal measurement

VR provider	Mental load measured?	What?	How?	How visualized?	Calculated or plain results?
SHOTPROS/ RE-liON	Yes	Heart rate and heart rate variability	Scientifically validated strass algorithm	Color coded for overview plus details on a graph	Calculated and linked to a stress level
Refense	No, under development	///	///	///	///
HOLOGATE	No, but can be integrated	///	///	///	///
AVRT	No, but can be with additional technology (e.g., Tesla suit)	*Heart rate and galvanic skin response*	*Tesla suit*	*Heart rate as a graph and timeline view*	*Heart rate is calculated*
VRTS	No	///	///	///	///
WRAP	No	///	///	///	///
V-armed	Yes, biometric measures	n.s.	n.s.	n.s.	n.s.
AXON	n.s.	n.s.	n.s.	n.s.	n.s.
Asterion VR	n.s.	n.s.	n.s.	n.s.	n.s.
Apex Officer	Yes	Heart rate	Apex Vitals – Proprietary Heart-Rate Monitoring system	n.s.	n.s.

Table 15: Competitor overview for (7) Bio signal measurement

4.1.8 Graphics/visualization and Scenario Editor

VR provider	Available scenarios	Creation of scenarios	Process for adapting or creating scenario	Adaption during training?	Who?
SHOTPROS/ RE-liON	High variability of environments available to select from; creation of new environments with Terrain editor and adaptability of environments through Scenario Designer (change of floors, walls, objects, avatars etc.) – see D7.6	Scenario Editor in close cooperation with the customer; trained customers can adapt themselves	Instructions by trainer	Yes, anytime at Operator Station	By operator or trainer
Refense	Several out-of-the-box training scenario. But in general, the scenario will be custom developed together with customer	Refense works closely with customer to develop custom scenarios	Highly dependent on extent of adaptation	NPC behaviour can be adapted on the fly. Major adaptations to existing scenario with level editor in advance	By the operator
HOLOGATE	Six maps (environments) are available, with 20 more in development	Maps can be built by HOLOGATE or other parties. Scenarios can be created by the trainer	Trainer can quickly adapt existing scenarios on touch screen. New scenario can easily be created manually or randomly. Cost of additional maps depends on requirements	Not yet during the training, will be added in 2022	By the trainer
AVRT	Unlimited scenarios by selecting from a library of 'building blocks'	Instructor can build the scenario in second	Pricing for additional 3D assets such as new environments depends on complexity and scale	Instructor can control movements, actions and gestures of VR characters	By the trainer
VRTS	Shooting range, building progression, de-escalation of violence, AMOK, pedagogical environment, etc.	VRTS can create new scenarios if needed	On quotation	Yes, in real time	n.s.
WRAP	35 law enforcement scenarios	New scenarios released quarterly by WRAP development team	On quotation: localization of language: customization and localization involving NPCs,	NPCs can be controlled during training.	By trainer

			environment, prop, and animation; new scenario creation	Scenarios can be adapted before training.	
V-armed	Unlimited, via an endless open source bank of assets	Trainers can create and edit scenarios on their own	Creation with the Scenario Editor & Creator software	n.s.	n.s.
AXON	n.s.	n.s.	n.s.	n.s.	n.s.
Asterion VR	Each ModulMaze comes with 3 environments and 45 scenarios chosen by customer from library	Trainer can design and generate the real maze settings. New environments developed by Asterion every month	Scenarios via ModulMaze Designer by trainer. Or new environment by Asterion on quotation	NPCs can be controlled during training.	By trainer
Apex Officer	100+ training modules and 100.000+ training scenarios	Dynamic scenario generator: using machine learning and AI to create multi-incident scenarios	n.s.	n.s.	n.s.

Table 16: Competitor overview for (8) Graphics/visualization and scenario editor - part 1

VR provider	Graphic engine	Police specific elements	Implementation of existing environments?
SHOTPROS/ RE-liON	Unreal	Uniforms, cars, gear, avatars as perpetrators (aggressive, hostile etc.)	Digital Twins: yes
Refense	Unity	Hostile avatars, civilians, weapons, lighting conditions, 4D effects (wind and scent)	Yes
HOLOGATE	Unreal Engine 4 (we will change to Unreal 5 if it is VR-ready)	Environments, many objects, and NPCs. Whatever is needed can be built quickly	Not currently. We are working on integrating an API for CAD data and other formats. Scanned environment (e.g., LIDAR scans) can be integrated too.
AVRT	Unity	Standard police environments: street, gas station, car park, industrial street, loading bay, rooftop, train station, domestic interior, public house interior and exterior	Not currently, but possible within a given technical framework and the AVRT technical team integrating and testing
VRTS	Unreal	Uniform, police vehicle, cover, …	Yes, on quotation
WRAP	Unity	Urban, suburban, and rural environments. Interiors and exteriors of buildings. Various vehicle types. Full complement of props	No, currently not available
V-armed	n.s.	Open source bank of assets	n.s.
AXON	n.s.	n.s.	n.s.

HORIZON 2020

| Asterion VR | Unreal | Ex. of environments: hostage situations, terrorism, domestic violence, suicidal objects, daily situations of the street, … | n.s. |
| Apex Officer | n.s. | Ex. of scenarios: terrorism attacks, suspicious subjects, sex crimes, vehicle operation, crowd control, classroom hostage, … | n.s. |

Table 17: Competitor overview for (8) Graphics/visualisation & scenario editor - part 2

4.1.9 During training

VR provider	Movement within scenario?	Type of communication	Haptic feedback	Pain stimulation	Other supporting senses
SHOTPROS/ RE-liON	Natural free movement	Communication between all via headset	Yes, the VR suit provides haptic feedback when bumping into wall or objects. Weapons give recoil.	Not with the current system bit will be available in the future (tests only)	Various scents, wind, heat
Refense	Natural free movement	Trainees' headset and/or officers' radios allow for communication within the team, with the dispatcher and with trainer	To a degree: - Handguns and rifles provide simulated recoil - Pain stimulation when injured	Yes, through the use of a shock belt around trainee's waist. Electric shock can be adjusted or set to vibrate or deactivated	Various scents, wind, heat, and rain
HOLOGATE	Natural free movement	Communication between all via headset	Haptic feedback depending on scenario and degree of immersion that is needed	No, not yet. Will be integrated and available to buy as upgrade	Heat, wind and scents
AVRT	Natural free movement	Radio communication in the team, with trainer and dispatcher through the system (all Wi-Fi). Also normal physical verbal communication possible	Weapons give recoil. Optional additional tactical feedback with Tesla suit	Optional, via Tesla suit	No, but possible if required
VRTS	Natural free movement	All is possible	Haptic jackets can be provided	No	No, but possible on quotation
WRAP	Natural free movement	Trainer can speak as dispatch (with radio squelch) or as NPC (with	No	No	No

		approximated lip-sync). Trainees communicate through headset			
V-armed	Natural free movement	Communication with body gestures and verbal commands	n.s.	n.s.	n.s.
AXON	Natural free movement	n.s.	n.s.	n.s.	n.s.
Asterion VR	Natural free movement	Trainer can design and generate the real maze settings. New environments developed by Asterion every month	Yes, body feedback through kinaesthetic sensations. Weapons give recoil.	Yes, via the StressX PRO Belt	n.s.
Apex Officer	Natural free movement	n.s.	Yes, with haptic feedback suit	n.s.	n.s.

Table 18: Competitor overview for (9) During training

4.1.10 Police related equipment

VR provider	Police gear available	Weapons the gear represents	Duty belt?	Equipment tracked?	Additional equipment?
SHOTPROS/ RE-liON	Pistols, Rifles; Tactical belt with: pepper spray, electroshock gun, baton, flashlight	Bespoke	Yes – belt and holster individually equip-able incl. correct representation	Yes (sensor included)	Yes, possible as an option
Refense	M4 replica; universal prop; trigger module for pistols and rifles	Varies according the client's needs	Yes, gear can be placed on belt individually and will be represented correctly	Yes, using an active marker	Body armour can be worn. Ballistic helmets cannot be worn due to the player gear
HOLOGATE	Pistol, assault rifle and holster. Handcuffs and other tool currently being integrated	P8, G36	No, we will find a fitting solution if there are particular tools the client wants to integrate	Yes	No, but can be integrated
AVRT	Carbine rifle, pistol, Conducted Energy Weapon. Incapacitant spray currently in development	Glock range of pistols, G36C carbine rifle, and commonly-used CEWs	Yes, can fit into existing holstering equipment and represented accurately	Yes, through the matting. Trackers and electronics are implanted into the replica weapon	Users can use whatever personally issue equipment they would typically wear

VRTS	Basic kit includes handgun, long gun and torch. Other tools optional	The most famous weapon models are represented	Yes	Yes, with tracker on the weapon	Yes, possible as an option
WRAP	BolaWrap 100/150, handgun, AR-15/M4, pepper spray, taser	BolaWrap 100/150, Glock, SigSauer, AR-15/M4, any model taser	Yes, they can use their standard duty belt and all gear is represented accurately	Yes, equipment tracked using Vive trackers	Body armour possible. Ballistic helmet not due to player gear
V-armed	Variety of hand and long guns. Soon also a stung gun, pepper spray, baton, flashlight, radio and handcuffs	n.s.	n.s.	Yes	n.s.
AXON	Existing TASER 7 weapons	Existing TASER 7 weapons	n.s.	n.s.	n.s.
Asterion VR	Natural free movement	Trainer can design and generate the real maze settings. New environments developed by Asterion every month	Yes, body feedback through kinaesthetic sensations. Weapons give recoil.	Yes, via the StressX PRO Belt	n.s.
Apex Officer	Natural free movement	n.s.	Yes, with haptic feedback suit	n.s.	n.s.

Table 19: Competitor overview for (10) Police related equipment

4.1.11 NPCs/avatars

VR provider	Types of characters	Steering of NPCs possible?	Role playing possible?
SHOTPROS/ RE-liON	Can be adjusted by Operator, but basic behaviour is aggressive or cooperation Various and diverse avatar visualisation selection available	Yes – path, movement etc. pre-defined, on triggers or on-the fly when needed by operator- in case: role player can switch anytime, Voice also over trainer headset possible	Yes – also switching of roles
Refense	Custom characters in accordance with customer's needs	NPCs are controlled by an AI system. Operator can intervene and select various actions to (de-)escalate the situation	Yes. The number depends on the number of player gear sets available.
HOLOGATE	Different genders, ages, ethnicities, and types	Not currently, but will be integrated in 2022	Not currently, but will be integrated in 2022
AVRT	Configurable characters based on skin tone, gender, clothing type and colour, …	NPCs are available alongside the instructor-controllable characters. NPCs have a set pattern or action and use basic AI to modify this where required	Yes. There is no real limit to how many characters can be controlled by the instructor
VRTS	Multitude of avatars	The monitor can in real time change the mood of the avatar	Yes, possible on quotation
WRAP	Different genders, ages, ethnicities and skin tones	Yes, NPCs are controlled (movement, actions, verbal responses) by the trainer using a point-and-click interface	No, role playing of NPCs (movement, gesticulation, eye contact) is not available. However, the trainer can speak as the NPC.
V-armed	n.s.	n.s.	Yes, trainees can interact with real avatars
AXON	n.s.	n.s.	n.s.
Asterion VR	n.s.	Autonomous agents with emotional AI, whose behaviour can be influenced by the trainer	n.s.
Apex Officer	Natural free movement	n.s.	Yes, with haptic feedback suit

Table 20: Competitor overview for (11) NPCs/avatars

4.1.12 Trainer options

VR provider	No. of trainers involved	Possibilities during training	Training model	Types of trainings possible
SHOTPROS/ RE-liON	1 per training group (a second for more detailed AAR if parallel training and AAR is required)	Trainer Station of in-action monitoring (all views, all KPIs, all stress levels etc.), adaption of stress level, audio/video + microphone for communication – or as "ghost" in the VR (with suit on)	Tactical readiness training based on DMA-SR scientific curriculum	All, but VR is typically favoured for: tactical training, laws & regulations and communication/de-escalation, awareness training in difficult to re-build situations
Refense	Typically 1	Monitor the training from multiple vantage points, control NPCs, use the radio to communicate with trainees	Trainings are customized to meet customer's needs	Many trainings, e.g., life-threatening situations, active shooter, hostages, negotiation, de-escalation, domestic violence, stress management, unclear situations, …
HOLOGATE	Typically 1	Monitor, restart, pause and end the scenario. Communicate to team via headset. Join as spectator. By the end of 2022, trainer can intervene or trigger actions manually	Simulator gives trainer total flexibility with different maps. Trainer increases the scenario's complexity	Many trainings, e.g., assault operation, life-threatening situations, basic training, close protection, leadership, … We aim to deliver a platform where even non-train use case like crime scene inspection or mission briefings could be done
AVRT	Typical 1 trainer and 1 safety instructor	The instructor has full control over the training session (monitoring, intervention, …)	System is highly versatile and can deliver any curriculum and framework	Any kind of scenario, experiential or judgment-based training can be carried out
VRTS	n.s.	Monitoring and intervention	Depends on the trainer	Many trainings, e.g., de-escalation, tactical movement, shooting from cover, communication, shooting/non-shooting, working in dark, …
WRAP	Typically, 1 trainer and 1 safety instructor	Trainers adjust the branching and flow of a module in real-time based on the trainee's verbal communication with the NPCs and their decision-making	Brief -> Evaluate -> Debrief	Many trainings representative of patrol officers' experience in the field, from trespassing and DUI to violent confrontations and active shooters
V-armed	n.s.	n.s.	n.s.	n.s.

AXON	n.s.	n.s.	n.s.	Community engagement training, simulator training scenarios such as UoF training or de-escalation training
Asterion VR	n.s.	Trainers can monitor trainees and anticipate contacts with opponents. They can communicate with the trainees and modify in real time the progress of each scenario	n.s.	Many tactical trainings, e.g., CQB, terrorist hostage-taking or attack, domestic violence, suicidal subjects, suicide bomber, high risk entries, …
Apex Officer	n.s.	n.s.	Case Law -> Training simulation -> Debrief and review	Unlimited training possibilities for police officer training scenarios and law enforcement training

Table 21: Competitor overview for (12) Trainer options

4.1.13 After-action review

VR provider	How does the AAR work	Advantage of the AAR	Performance-based statistics	AAR storage and replay possible?
SHOTPROS/ RE-liON	AAR can be re-played (audio and video) at its own Trainer station incl. a touch screen and steering options (views, events, KPIs, stress levels etc.)	Debriefing and model-learning options from different perspectives; evidence-based feedback on performance and decisions-making and acting	KPIs defined with LEAs during studies (e.g. shots, line of fire, usage of gear from tactical belt etc.)	
Refense	AAR plays back training on a separate computer. Different angles possible.	Trainees' actions can be reviewed step-by-step, allowing for accurate assessment of performance and detailed feedback	Exact movements, trainee's field of view, weapons' aim lines, shots fired, hit zones, slow motion, audio recordings	AAR files are stored locally, but are inaccessible without the appropriate software. However, customers can use screen capture software if they wish to export video files
HOLOGATE	Ego-perspective, top down, free camera (more by end of 2022)	AAR assists the trainer in focusing on the most critical situation and making the debriefing more efficient	Depends on customer requirements and specific training. Examples: POV, line of sights, timing of actions, fired shots, trajectories, …	Yes, separate AAR station (tv). Replays can be exported or imported to show on another device.

AVRT	Full 3D replay, from user or full 3D free-roam angle. Jump to specific actions. Timeline view of significant actions	AAR gives the instructor an evidence-based approach to debriefing the user without any approximation or having to rely on memory or perception	Key metrics, e.g. shot placement, distance from subject, reaction times, …	System can do both: export and store externally or remove once viewed
VRTS	Several views available	Instructor has opportunity to do a complete debriefing, including real life positions	Shooting result, wounded, missed, training time, …	Can be replayed in another room. All recorded sessions can be stored.
WRAP	3 different types: 1) simple review of history of events, 2) immersive 3rd person review with trainee remaining in VR, 3) "God's Eye View" with trainee sitting next to trainer on PC	AAR allow trainers to go through a trainee's performance, second-by-second, from any angle. Trainers can reinforce the learning objectives and provide feedback	Duration between events, reaction time, accuracy, location of shots, …	Replays can optionally be stored in secure GovCloud environment. Trainee perspective can be rendered as an mp4 video and replayed on any device.
V-armed	Replay from unlimited points of view	Ability to assess, guide and improve trainee's performance	Reaction time, shots and trajectories, weapon muzzling, biometric measuring, …	n.s.
AXON	Detailed AAR reports and video recordings	Enables opportunities for coaching and program development	n.s.	Yes, training recordings and analytics can be stored and replayed later
Asterion VR	All user's paths are recorded. Trainees can go back in the simulation and view recorded actions in "God Mode". Slow motion possible	Yes, body feedback through kinaesthetic sensations. Weapons give recoil.	Number of ammunitions fired per zone and accuracy of shots	n.s.
Apex Officer	Recording and playback	n.s.	Yes, but n.s.	n.s.

Table 22: Competitor overview for (13) After-action Review (AAR)

4.1.14 Pros and cons

4.1.14.1 What do you see as the big 3 advantages of your system?

VR provider	Advantage 1	Advantage 2	Advantage 3
SHOTPROS/ RE-liON	Developed with hundreds of LEA feedbacks during the SHOTPROS project and based on scientific studies with DMA-SR training incl. stress measurement and calculation and visualisation	Easy-to-use scenario Editor for the creation of many various environments	Detailed and intuitive AAR based on LEA needs
Refense	Fast delivery times for the system and custom scenarios through in-house hardware and software development	Developed based on customers that use the system in real annual trainings with 100s of police officers	Refense has a complete feature set to train virtually from base education to special forces training. Running and fast movements are possible with close to 0% motion sickness.
HOLOGATE	Our tracking solution based on sensor fusion with optical tracking is the market's most precise technology	Our platforms are your flexible VR space, meaning they are more than a single-use simulator. You can add your applications or third-party content, we can integrate your specific hardware and tools, …	We believe that the best graphics are essential for the best training results. The Unreal Engine is on the way to photorealism, bringing the training to the next level, and our systems are state-of-the-art to use the given opportunities
AVRT	Natural movements in a wireless, free-roam environment. Natural actions as familiar weapons can be holstered into existing kits. Adaption time for users is virtually zero	Fully interactive, adaptive and dynamic scenarios that deliver the exact learning outcomes needed without costly changes.	Fully scalable, warehouse-scale tracking in a portable solution turns any venue into a training venue
VRTS	n.s.	n.s.	n.s.
WRAP	Verbal communication skills – trainees get to use natural language with the NPCs, providing trainers the ability to control the responses and dialogue required to achieve a learning outcome	De-escalation skills – trainees aren't forced into shooting in every module. Wrap Reality allows them to use all the tools on their toolbelt to solve the problems presented to them	Debriefing capabilities – Wrap Reality features the most comprehensive debriefing capability on the market. Allowing trainers to ensure that trainees take away valuable new skills from every training session

4.1.14.2 What do you see as the biggest challenges of your system?

VR provider	Challenges of the system
SHOTPROS/ RE-liON	Backdated graphic is not convincing on first sight – but during training graphics are not the first need (changes planned in near future)
Refense	• Constraints of hardware (e.g., the field of view of current HMDs) • Regulatory challenges as the customer base is expanded
HOLOGATE	We started our journey agilely, so we know some missing functions still need to be implemented
AVRT	AVRT has been developed from the ground up using human-centred design. This meant that most challenges have been addressed as an intrinsic part of the development process and assessed by users immediately. The biggest challenge is one of education – potential users' understanding the different VR applications and that a free-roam, natural action dynamic VR system such as AVRT has a very different use-case to traditional 3D video VR and realizing the benefits that advanced VR bring
VRTS	n.s.
WRAP	• Localisation – Wrap Reality was primarily built for the policing environment in the U.S. We realize that different countries have different policing standards, environments, and societal issues. Wrap Technologies is working hard to build tools that will allow for more less expensive customisation and localisation to meet those needs in the future • Mobility – currently, the movement of the trainee is limited to that of the "play space", which provides constraints when designing modules. We're working on tools that will allow the trainee to navigate much larger environments by coordinating their movements with the trainer • Multiplayer – Wrap Reality supports 2 trainees at a team, each in their own "play space". We're working on developing a deeper multiplayer experience that will allow 8 or more people to operate in the same virtual environment over the internet. This will also allow for a trainer to be located off-site in a different region.

4.1.14.3 What is the added value of your system?

VR provider	Added value
SHOTPROS/ RE-liON	Pre live the future, be better prepared. Benchmark yourself
Refense	• Fully immersive – the solution offers a multiplayer full-body VR experience with very little training time. The use of props, pain stimulation, and 4D effects make the training highly realistic • Cost savings – no need for consumables or costly training grounds that must be built, rebuilt, and maintained

	• Injuries – effective police training is prone to injuries that do not occur in VR training • Noise emissions – as no real shots are fired, emissions are kept to a minimum, and training centres can be in residential areas • AAR – every minor detail of the training is recorded, allowing the trainer to assess the trainee's performance accurately • Virtual environment – training scenarios are repeatable and fully customizable • Ballistics – in VR, surfaces can be defined to let a bullet through or not, which is not possible in traditional FX training • Unlike a traditional training ground, VR training is not limited by physical constraints. The same training field can be used for multiple environments
HOLOGATE	• Our platforms make the impossible possible. You can record everything and can review every situation from every perspective, or you can train in a former inaccessible area without needing to travel • The training will be safe at all times, so you can train in dangerous situations regardless of the training level. Moreover, you could use new methods like 'trial and error' because nothing harmful can happen • You will cut spending, not only for less travel but also the labour or infrastructure costs • All organizations will suffer under demographic change. Our platforms will help you to be more efficient.
AVRT	Organisations can dramatically increase the exposure of their officers to scenario-based and judgement-based training without incurring additional costs for consumables and other cost areas.
VRTS	n.s.
WRAP	WRAP Reality provides repeatable, branching, scenario-based training for academies and police agencies. Allowing trainers to provide realistic simulations of dangerous situations that an officer may encounter without any physical risk to the trainee. Trainees are injured every year by role players in real-life training. With Wrap Reality you don't have to worry about egos flaring and someone getting hurt. The modules can be replayed again and again with different dialogues, escalations, and outcomes. This variable-based repeatability and the in-depth debriefing capabilities provide unmatched learning outcomes for trainers.

4.1.14.4 *What are the main developments planned in the future?*

VR provider	Main developments planned in the future
SHOTPROS/ RE-liON	Finishing up the Unreal port, less equipment on the trainee, faster setup times.
Refense	• General ATTS, REEL, and RAAR improvements based on increasingly complex customer requirements • New tracking technology to enable mobile training, accommodate a much larger physical space to increase the number of trainees who can train simultaneously, and lower system cost • Improving the ability to host interdisciplinary training sessions

HOLOGATE	Within the following years, we will add more automatization and an assisting A.I.
AVRT	Further and ongoing development of content to increase the library of scenario building blocks for the system
VRTS	n.s.
WRAP	Wrap Reality plans to both create new content that will be released quarterly, as well as expand the existing modules to provide more branching and voice line options. The roadmap includes the development of new navigation capabilities, a deeper multiplayer experience, and the creation of tools that will allow trainers to easily modify existing content to their local needs.

5   SWOT Analysis SHOTPROS solution

An overview of the above (chapter 2,3,4) analysed most valuable aspects is summarised in a SWOT-analysis featuring the internal (strengths and weaknesses) and the external (opportunities and threats) view on the SHOTPROS VR solution. The description of each quadrant is enhanced with actions that should be taken to foster or mitigate the described aspects.

The confidential details can be found in D1.8

6   Business Plan – Exploitation Roadmap

Based on the above-described exploitation strategy and the lean business canvas that focuses on problems, solutions, key metrics and competitive advantages and visualises a clear structured overview of the main business relevant plans, a business plan and an exploitation roadmap was set up. For this, an overview on the current technological development of the solution is given, the following chapters describe in more detail the planned product approach and how to target customers and a go-to-market model.

6.1.1   TRL Status and Development Roadmap

After 42 months of the SHOTPROS project, we have overachieved the technical readiness level (TRL) planned in the DoA in many aspects. Although the combination of the existing and experimental environment is the largest step to be done in the future, already the existing environment leads to successful DMA-SR training and was used like a product in the field trials and (real) police training sessions were executed.

Also, at the final conference in September 2022, where LEAs external to project tried out the system in training sessions led by experienced SHOTPROS VR trainers, the results were very positive, and we exceeded most expectations by participants towards an average "research project". There were almost no restrictions on the usage for the trainees and trainers and the satisfaction was very high. Nevertheless, to create a commercial product, some steps still need to be taken.

The confidential details can be found in D1.8

6.1.2   Product approach

The confidential details can be found in D1.8

6.2 Buyer's journey & entry channels

Considering the steps, a VR training solution buyer needs to do before being able to contact providers (see Policy Maker Toolkit, D8.5), it is necessary to provide the relevant information in **target-audience tailored material** even from the beginning.

The confidential details can be found in D1.8

6.3 Target Market & Customer Segmentation

Although there are many options how VR can be used in the future as a training and educational tool within law enforcement, the SHOTPROS target market is still a niche market.

Within this market we have different target groups.

The confidential details can be found in D1.8

6.4 Go-to-Market Use Model - Pricing and Revenue Streams

6.4.1 Use and pricing

Simply put, for technology products two approaches regarding pricing are typically used. Either as a **purchase** with a one-off payment and a regular (e.g. monthly or yearly) fee for maintenance and support or a second approach as a **subscription** model with a regular (monthly) fee (typically per user), including support, service and maintenance. Both models have their advantages and drawbacks.

B2G (Business to Government) is more **complex** than B2B or B2B as tender processes and complex budgeting regulations need to be considered by the provider.

The confidential details can be found in D1.8

6.5 Additional Revenue options

As described throughout the project, there is more than the technical VR solution as a result of SHOTPROS. Also, the DMA-SR training itself as well as consultancy options for LEAs and policy-makers on the topic of digitalisation of training as well as the VR and Police network itself are major additional revenue options that will be exploited after the end of the project.

Brief descriptions on that plans are available below.

6.5.1 Certified DMA-SR police training

The DMA-SR training is built on scientific data and the model established throughout the project. Already other research and innovation projects (such as MED1stMR – www.med1stmr.eu) were funded and took the human factors model generated in SHOTPROS as a base to be further elaborated in another context (medical first responders) and another technology (mixed reality).

The confidential details can be found in D1.8

6.5.2 Consultancy for LEAs & policy makers

Based on D8.5, the Strategies & Toolkit for Policy Makers, USE and AIT plan to set up consultancy strategies for LEAs to support them in the journey of digitalisation in general (an existing business model used by USE and AIT) enhanced with the aspects of VR as a training tool and its necessary adaptions within the organisation.

The confidential details can be found in D1.8.

6.5.3 VR and Police network (VRPN)

Based on the DoA, the VRPN was officially kicked off as part of the SHOTOROS final conference (see D7.3) to show continuation of the topic within LEAs. Already more than 1 year before this kick-off, the soft-opening of the network took place with SHOTPROS partners and first members in Vienna, as part of an Advisory event with the Austrian Security Academy (SIAK – August 2021). The feedback was so positive and the need for knowledge exchange so urgent, that another meeting took place approximately 6 months later in Gimborn (see D8.9 – March 2022), a dedicated knowledge event for VRPN members. Since then, regular online meetings have been held and the number of participating LEAs is growing each time.

From the beginning the SHOTPROS LEA partners were able to present their knowledge but also had an exchange with LEAs who had experience outside the project. This aim of awareness and knowledge should continue in the future. Therefore, VESTA will keep the VRPN active and had first meetings with interested international organisations to take over the hosting and continuation of the network.

The confidential details can be found in D1.8

7   Roadmap: Key Activities

The confidential details can be found in D1.8 – but an overview is listed here:

- IPR definitions after the end of the project (bi-lateral)

- SHOTPROS VR solution - brand and product definition

- SHOTPROS VR solution - further development:

- Introduce consultancy methods based on SHOTPROS results

- Develop the VR and police network

- Standardisation of the training approach (DMA-SR) with the corresponding features

8   Business Planning: 5-year outlook

Within the following business plan, the cost and revenue structure for the go-to-market product of the SHOTPROS VR system is displayed. The basis of the calculated costs and revenues was created in several business meetings with the core partners of future marketing and sales. Mainly RE-liON, AIT and USE were in charge of this process and were supported by LEA representatives. This business plan also serves as a starting point for future cooperation between the partners and intra-community contracts on participation in turnover.

The confidential details can be found in D1.8

9 Appendix A - Competitor Company Profiles

9.1.1.1 RE-LION

RE-liON was founded in 1999 in the Netherlands and focusses on creating lifesaving solutions for its professional customers, using the latest technologies in the fields of VR & AR, for them to stay relevant and be ready for operations. The systems are carefully designed for professionals in crisis management that risk their lives daily and covers training as well as in- or pre-operation support solutions. The platform RE-liON developed is called Small Unit Immersive Trainer (SUIT). The terrain databases required for training and to tailor these virtual environments to their learning objectives.

In SHOTPROS, RE-liON provided the VR platform and was responsible for the complete technical development covering the virtual environment, hardware, the development of defined police VR scenarios, the integration of stress measurements and creation of the innovative performance measurement tools. In addition, they functioned as a technical advisor in all work packages and provided the VR platform for human factor studies, field trials and showcases for dissemination.

9.1.1.2 REFENSE

REFENSE AG was founded in 2019 with a background from the VR entertainment sector and then focused on the professional training market of first responders with the goal of developing a training simulator for police, paramedics, and the military. After a successful pilot project with the Zürich City Police, Refense has further developed the prototype into a product, launching the Advanced Tactical Training Simulator (ATTS) in October 2020.

Their product, the Advanced Tactical Training Simulator (ATTS) is designed to train various operational situations in a team. The training area is virtual and scenarios can be flexibly loaded and exchanged. The instructor controls the action from a bird's eye view and can thus influence the scenario. Virtual civilians and perpetrators can be supplemented by instructors who slip into the perpetrator role. The After-Action Review records the complete training in picture and sound for debriefing purposes.

The product comprises (a) the ATTS, a training simulator consisting of a motion tracking system with HMDs, tracking markers and various weapons and props, (b) the RAAR, an after-action review tool, and (c) the REEL, an enhanced level editor which can be used to create custom scenarios.

9.1.1.3 HOLOGATE

HOLOGATE is a fast-growing extended reality company headquartered in Munich, Germany. They are a large location-based immersive media network. Since 2013, they offer innovative VR and immersive media solutions for entertainment and enterprise. Hologate XR Enterprise, which started in 2019, focuses on training of real-world situations or high-risk scenarios to sharpen skills and boost retention, or to prepare professional teams for the challenge of the completely unexpected.

Their products, HOLOGATE X (permanent set-up) and HOLOGATE M (mobile system), are turnkey systems with optical full-body tracking and haptic feedback. Different weapons can be integrated. Up to four trainees can use the standard 20x10m platform (and up to 16 trainers in an unlimited space). An instructor can start several scenarios for other use cases. The platform gives the opportunity to change or randomize training and is open for third-party development. An after-action review helps the instructor and trainee to have the same value as you have with one-by-one training.

9.1.1.4 AVRT

The Adaptive Virtual Reality Training (AVRT) platform is a cutting edge, fully immersive and free-roam VR system designed for the training of police officers, emergency services, military and high-risk operatives in scenarios that may be difficult or prohibitive to simulate otherwise. The AVRT system allows trainers to put users through simulations to test their performance in situations up to and including the use of lethal and less-lethal force. The AVR system is a delivery method for pre-existing curricula which is delivered using the instructors' own skills and experience in fully-dynamic, controllable scenarios. First person and full 3D replays, body positioning and metrics such as distances and shot placement all come together to provide effective assessment methods that aren't possible with traditional training provisions. The product is on the market since 2020.

9.1.1.5 VRTS and OneBonsai

VRTS, short for VR Training Solutions, is a Belgian company that is 100% focused on police and army Virtual Reality training. Together with the VR development company OneBonsai, they invested 3 years of research and development done side-by-side with active police trainers. Their rolled-out their VR Police Training in June 2020.

Their product, VRTS, is an educational tool for police. More than just a computerized firing range or a simple simulator of use-of-force situations, VRTS is a simulator of human interactions. The VRTS give police officers in training the opportunity to deal with complex situations and face real-time responses to their actions. They have all the options for de-

escalation and/or use of force. Each scenario can be made easier or more difficult during a training session. At the end, an effective debriefing process provides an opportunity for learning and improvement. At any time, the instructor can analyse a trainee's ability to de-escalate the situation. Police officers can adjust the situation to fit their personality, their voice and their strategies, from de-escalation to the use of force. VRTS offers thousands of different training scenario combinations.

9.1.1.6 WRAP

WRAP offers innovative training and tools to take individuals safely into custody without having to use force and reducing the risk of injury to subjects and to officers. Their primary product is the BolaWrap 150 which discharges a Kevlar cord that can temporarily restrain an individual from up to 25 feet away.

Their WRAP Reality VR training platform is a fully immersive simulator that unites the best of modern Virtual Reality technology with law enforcement content to create a training solution for a better future of policing. It handles real-world calls. Trainees can train virtually with essential gear and can run through scenarios centred around marksmanship, de-escalation, and judgment. The product has been available since 2016.

9.1.1.7 V-armed

V-armed is a company established in 2016 and based in the USA. It specializes in military and law enforcement immersive training. It creates custom 3D VR simulations for large-scale training. Their life-like multiplayer scenarios enhance mission readiness and situational awareness for defense, law enforcement, first-responder and engineering teams.

Their 6-DoF stationary VR system allows up to 10 trainees to participate simultaneously within a free roaming scenario. Trainees are fully armed and can move within the virtual training world allowing interaction with either real or virtual avatars. The After-Action Review system records the entire training session to be replayed from unlimited points of view providing trainers with the ability to assess, guide and improve the trainee's performance. Their Scenario Editor & Creator (SCE) software allows trainers to create and edit an unlimited number of scenarios on their own.

9.1.1.8 AXON

AXON VR provides immersive de-escalation training that ultimately makes both communities and officers safer. It brings immersive training scenarios, state-of-the art technology and innovative training methods to public safety.

Their Simulator Training allows trainees to sharpen their skills on the firing range and to practice the application of de-escalation techniques in dynamic and realistic scenarios that require real-time assessment, split-second decision-making.

9.1.1.9 Asterion VR

ASTERION has been developing VR simulators for special forces and military for more than 15 years. They created the Merged Reality and enriched the virtual with real walls, as such blurring the lines between real and virtual reality.

One of their products is called ModulMaze, which is a turnkey modular tool with real walls for Close Quarters Battles (CQB) training in VR. You can design the maze you need depending on the area you have. Each ModulMaze CQB comes with three environments and 45 scenarios chosen in their library.

9.1.1.10 Apex Officer

Apex Officer (AO) is a group of law enforcement and VR experts that have been advocating for VR and training solutions since 1995, to improve communication and knowledge transfer from simulation-based learning and safety training to interactive training applications that provide realistic experience anytime, anywhere. Apex officer provides police officers and law enforcement agencies with turnkey virtual reality force options training simulators and VR technology training solutions. They are based in the USA.

Every AO VR simulator features over 1 million police training scenarios. Police and law enforcement training must go beyond sharpening reflexes, developing muscle memory, and keeping skills fresh. They also need to hone a complete set of decision-making tools. Unlike other simulators on the market, AO training scenarios do not have predetermined outcomes.