Alternate "Realities": Military Applications in the Metaverse Era

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Abstract

This article is intended for 3 primary purposes. The first is to examine different types of realities and their military applications. The second is to explore the rise of the metaverse and its prospects for military use, and the third is to analyze and indicate possible opportunities as well as approaches for the development of Thailand's defence capabilities through Alternate Realities and Metaverse.

This article divides Alternate Realities into 3 main categories, which are Virtual Reality, Augmented Reality, and Mixed Reality. All three categories of alternate realities provide enhancement to defence capabilities in 2 major areas, military training and warfighting. The paper also looks into an upward trend of virtual technology, in which the metaverse is taking on a prominent role. Metaverse has a potential for broader defence implications and can emerge as a key enhancement for battlefield effectiveness with intra-military communication. The advancement in both Alternate Realities and Metaverse has offered a way for Thai armed forces to effectively and efficiently train and operate with a simultaneous intra-military communication as well as an interconnectivity among friendly forces.

Thus, for the full potential of military applications of Alternate Realities and Metaverse to be realized, the article recommends that the Thai defence sector should take 3 key approaches, which are to prioritize digital interoperability of military equipment and systems, to seize an advantage of commercial-off-the-shelf technology, and to promote and enhance system integration capability within the defence sector.

Keywords : Alternate realities, Metaverse, Military applications, Defence capabilities

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เทคโนโลยีโลกเสมือนจริง: การประยุกต์ใช้งานทางการทหารในยุคจักรวาลนฤมิต

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บทคัดย่อ

บทความนี้มีวัตถุประสงค์หลัก 3 ประการ ประการแรกคือ เพื่อศึกษาเกี่ยวกับเทคโนโลยีโลกเสมือนจริงประเภทต่าง ๆ รวมถึงการประยุกต์ใช้งานเทคโนโลยีโลกเสมือนจริงทางการทหาร ประการที่สอง เพื่อศึกษาบริบทความก้าวหน้าของเทคโนโลยีจักรวาลนฤมิต (Metaverse) รวมทั้งแนวโน้มความเป็นไปได้ในการนำมาใช้งานทางการทหาร และประการที่สามคือ เพื่อวิเคราะห์ให้ทราบ พร้อมเสนอแนะแนวทางในการพัฒนาขีดความสามารถของอุตสาหกรรมป้องกันประเทศด้วยการประยุกต์ใช้เทคโนโลยีโลกเสมือนจริงและเทคโนโลยีจักรวาลนฤมิต

จากการศึกษา ผู้เขียนได้จำแนกเทคโนโลยีโลกเสมือนจริงออกเป็น 3 ประเภทหลัก ได้แก่ ความจริงเสมือน (Virtual Reality) ความจริงเสริม (Augmented Reality) และความจริงผสม (Mixed Reality) ซึ่งสามารถช่วยเสริมสร้างขีดความสามารถในการป้องกันประเทศทั้งในมิติของการฝึกและการสู้รบ นอกจากนี้ จากการศึกษาแนวโน้มของเทคโนโลยีโลกเสมือนจริงที่เทคโนโลยีจักรวาลนฤมิตมีบทบาทเพิ่มมากขึ้นเรื่อย ๆ พบว่า เทคโนโลยีจักรวาลนฤมิตมีแนวโน้มที่จะสามารถนำมาประยุกต์ใช้ในทางการทหารได้อย่างเป็นวงกว้าง และมีขีดความสามารถในการเป็นเทคโนโลยีที่สำคัญยิ่งในการสร้างเสริมประสิทธิภาพการปฏิบัติการทางทหารผ่านโครงข่ายการติดต่อสื่อสารทางการทหารและการควบคุมบังคับบัญชา ทั้งนี้ ความเจริญก้าวหน้าของเทคโนโลยีโลกเสมือนจริงและเทคโนโลยีจักรวาลนฤมิตเปิดโอกาสให้กองทัพไทยสามารถทำการฝึกและปฏิบัติการในสถานการณ์จริงได้อย่างมีประสิทธิภาพและประสิทธิผลผ่านโครงข่ายการติดต่อสื่อสาร การปฏิสัมพันธ์ และการเชื่อมโยงข้อมูลอย่างทันท่วงที

ดังนั้น เพื่อให้การประยุกต์ใช้งานเทคโนโลยีโลกเสมือนจริงทางการทหารเกิดประโยชน์สูงสุด บทความนี้ได้เสนอแนะให้ภาคการทหารของประเทศไทยพิจารณาใช้เทคโนโลยีจักรวาลนฤมิตในการปรับปรุงพัฒนาขีดความสามารถกำลังรบใน 3 ประเด็นหลัก ได้แก่ การให้ความสำคัญในการบูรณาการความเข้ากันได้ของระบบและยุทโธปกรณ์ การใช้ประโยชน์จากเทคโนโลยีที่มีแพร่หลายยิ่งขึ้นในท้องตลาด และการส่งเสริมพัฒนาขีดความสามารถในการบูรณาการระบบทางการทหารของหน่วยงานในสังกัด รวมถึงองค์กรภาครัฐและเอกชนในอุตสาหกรรมป้องกันประเทศ

คำสำคัญ : เทคโนโลยีโลกเสมือนจริง, จักรวาลนฤมิต, การประยุกต์ใช้งานทางการทหาร, ขีดความสามารถในการป้องกันประเทศ

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1. Introduction

Alternate Realities are not new to military. They have been largely associated with military trainings as a means to enhance performance and comprehension of military personnel in conducting military operations for many decades. The evolution of "Realities" from Virtual Reality (VR) to Augmented Reality (AR) and Mixed Reality (MR) have opened up a highly effective and cost-beneficial way to provide a variety of military trainings with close-to-real experience. In general, Alternate Reality systems are designed for specific trainings such as flight simulators, ship's bridge simulators, weapon simulators, etc. However, the rise of metaverse which is an interconnected and immersive virtual world has offered an opportunity for multi-platform and multi-user interaction and collaboration that can replicate actual operations in the real world. This article is, therefore, intended to examine the utilization of Alternate Realities for military purposes with the rise of metaverse in mind. The writing first describes different types of realities together with their definitions and examples. Later on, military applications of alternate realities for both military training and warfighting are highlighted. Additionally, the rise and prospects of metaverse for military uses are illustrated. This article also provides a brief analysis of Thai military's and defence industry's capabilities in regard to Alternate Realities and the metaverse, as well as indicating possible opportunities and approaches for the development of Thailand's defence capabilities in the regarding area.

2. Different "Realities"

Alternate Realities can be divided into many categories. However, in order to provide a comprehensive understanding about their military applications, this article divides Alternate Realities into 3 main types, which are Virtual Reality, Augmented Reality, and Mixed Reality.

Virtual Reality or VR refers to a completely immersive digital environment. The Virtual Reality Society provides a technical description of virtual reality as "a three-dimensional computer-generated environment which can be explored and interacted with by a person." [1] VR allows a user to be immersed within the virtual world through specialized interactive devices such as headsets, goggles, gloves, and body suits, and whilst there, the real word is not part of the experience.

Augmented Reality (AR), on the other hand, focuses on the real-world experience with the supplement of digital content to enhance the overall experience. According to the definition provided by Encyclopedia of Multimedia, Augmented Reality is "a system that enhances the real world by superimposing computer-generated information on top of it." [2] Therefore, the technology enables virtual

or synthetic elements to be superimposed on the real-world environment. This can typically be achieved through the utilization of a specialized equipment such as a headset, a smart phone and a tablet.

Mixed Reality, as indicated by the name, is a blend of physical and virtual environment that allows real-time interactions between the two. [3] To illustrate, Intel Company, a computer chip manufacturer, describes on its website that Mixed Reality "provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place". [4] MR uses advanced computer graphics and technology combining with input systems to transcends the display and includes environmental inputs, such as position together with spatial mapping and awareness. A special device can be used to keep track of actual movement in the physical world, then reflects onto the digital environment.

In addition to the 3 primary types of Alternated Realities described above, Extended Reality (XR) is another term that is commonly heard. According to HP, a computer technology company, Extended Reality is a full spectrum of immersive technologies, including VR, AR, and MR. [5] Therefore, XR can be used in referring to Alternate Reality in general.

With regards to all these definitions, there are other terms that fall within the category of Alternate Realties. However, to avoid any confusion, this article will adhere to the definitions provided above.

3. Military Enhancement through Alternate Realities

Alternate Realities which include VR, AR, and MR technology can be beneficial for military as they can enhance the defence capabilities. Military applications of Alternate Realities are involved in two prominent areas, which are military training and warfighting.

3.1 Military Training

Alternate Realities are contemporarily heavily involved with military simulation-based training. Armed forces are accustomed to using them as an alternative way to train personnel. The approach provides a solution for military training in a safe environment with cost-effectiveness and time-efficiency. Additionally, a simulation-based training provides highly immersive experience with a variety of scenarios and allows a training evaluation to be done objectively.

Extended Reality can help to supplement and enhance the benefits of a simulation-based training. The use of alternate reality technologies facilitates military training across multiple simulation domains, enabling the combining of genuine, virtual and constructive elements in an optimal way for a training. To exemplify, the Aircrew Combat Mission Training (ACMT) system, developed by Kratos Defense &

Security Solutions and currently in use by the US Air Force, utilizes mixed reality tools which are a Multi-Position-Aircrew Virtual Environment Trainer (MP-AVET) and Ground Party Simulator (GPS) to train UH-1 Helicopter aircrew along with the ground party in an immersive mixed reality environment. [6] The air and ground crew can have hands-on interaction within a realistic virtual environment with a sense of physical equipment, vibrations and forces, together with visualization, audio, and haptics. These add value to an overall training without having to actually operate in actual operations.

Additionally, Alternate Realities can offer a realistic training scenario with a stressful and life-threatening environment for a military training with an opportunity to safely make mistakes. This kind of trainings provides a learning experience for trainees in mitigating stress which is essential and can be re-run for those in need to overcome it. Although there has been little empirical evidence indicating that a high level of stress can be induced within a simulation-based training, a study on Inducing Stress in Warfighters during Simulation-Based Training by Meredith Carroll, et al., suggests that a certain level of stress can be stipulated through a simulation-based military training. [7] Hence, there is a high possibility that fully immersive experience via Mixed Reality can help in achieving the goal.

Another benefit of using Alternate Realities for military training is that a comprehensive after-action-review (AAR) can be conducted within the virtual environment to provide feedback with analytical data to trainees for a more hands-on approach. For example, the Dismounted Infantry Virtual After-Action Review System (DIVAARS) used by US Army at Camp Atterbury Joint Maneuver Training Center allows users to view digital playback scenario events from different vantage point with statistical data. Training facilitators can also bookmark an event during the training and access it during the review, as well as plot figure layers on top of the simulated scene in facilitating the training. [8]

Alternate reality systems can also provide the ease of use to facilitate military trainings regardless of any limits or constraints by equipment's availability, locations, and weather conditions due to their small footprints that can be easily deployed and utilized even away from bases or training sites. Furthermore, they are cost-efficient comparing to live training sessions with real operational platforms and a high-end full motion simulator. High-end simulators are typically built with proprietary architecture which heightens the cost of procurement and requires substantial budgets for the sustainment and maintenance. On the other hand, VR/AR/MR systems usually deploy commercial-off-the-shelf (COTS) technology such as headset, sensing gloves and smart tablet and open

architecture standards to facilitate the utilization, making the simulation systems available on-demand at a much lower cost and enabling a larger volume of deployment. The general rule of cost comparison between live training and simulation training indicates that the cost per hour to train in a simulator is about 10 percent the cost of training in live platforms. [9] However, the increase availability of VR/AR/MR technology could increase the cost beneficial margin.

3.2 Warfighting

Armed forces are continuing to explore military applications of Alternate Realities in warfare. Devices such as heads-up displays (HUD) and helmet-mounted displays (HMD) have long been used in military aviation. These devices can provide users with situational awareness by projecting critical visual information overlaid onto their view of the actual world. Not only flight information but also mission information including a customizable choice of targeting, sensor, and firing status is displayed through the devices to improve combat capabilities. For instance, F-35 Gen III Helmet Mounted Display System developed by Collins Aerospace is capable of providing a 360-degree view of surrounding with an uninterrupted display of flight and mission information as an overlay. Furthermore, it provides a visual targeting capability which enables a pilot to "target weapons by looking at and designating targets, and target verification when receiving steering cues from onboard sensors or via datalink". [10] Additionally, Integrated Visual Augmentation System (IVAS) is another warfighting enhancement device which is being developed by the US Army. The system is based on Microsoft's commercially available HoloLens 2 with a high-resolution night vision. It provides overlays of "tactically relevant information in a Soldier's line of sight to increase lethality, mobility, and situational awareness." [11]

Other than being used to improved individuals' performance on a mission, alternate reality technology is also implemented within the planning sector of a warfare. In 2005, the US Army Research Laboratory successfully developed the AR military sand table called Augmented REality Sandtable (ARES) to provide a battlefield visualization for the planning purpose. The system used only a COTS projector, an LCD Monitor, a laptop, and a Microsoft Kinect device. [12] ARES is able to efficiently create a model of terrains and scenarios, allowing for a higher degree of engagement in planning.

The aforementioned technologies are only a few examples of warfighting applications of Extended Reality. These new XR-enabled capabilities can enhance the warfighting performance and modernize the warfare with data and precision. The prospect of the advancement of Alternate Realities has suggested that future warfare will intertwine the fight in both real and virtual worlds.

4. The Rising and Prospects of the Metaverse

Metaverse has become an eye-catching disruptive technology, embarking full of potential in both commercial and defence sectors. A general perception of Metaverse is largely related to gaming, social media, and virtual world, which is somewhat reductively, equating its prospect of military utilization to merely training. However, Metaverse has a potential for boarder defence implications and can emerge as a key enhancement for battlefield effectiveness with intra-military communication.

The term "Metaverse" was first coined by Neal Stevenson in his 1992 science fiction novel called Snow Crash in which a parallel virtual reality universe was created from computer graphics, allowing multiusers from around the world to access and connect through devices such as goggles and earphones. 20 years later, an idea of metaverse was literarily reincarnated through Ernest Cline's 2011 novel, Ready Player One, which was later portrayed into a film in 2018. The multiple virtual worlds within one immersive digital world share much common idea with the concept of the metaverse today. According to Encyclopedia 2022, Metaverse is defined as "a perpetual and persistent multiuser environment merging physical reality with digital virtuality. It is based on the convergence of technologies that enable multisensory interactions with virtual environments, digital objects and people." [13] With the advancement in alternate realities and network technologies, the metaverse has recently gain significant interest worldwide, especially after Facebook rebranded itself to become Meta Platforms with a vision to exploit the metaverse.

However, the concept of the metaverse is nothing new to the military. The US armed forces have been exploring networks of virtual worlds for over 40 years. In 1978, Captain Jack Thorpe envisaged that simulators and mission systems would be connected, tightly aligned, and become indistinguishable. [14] By the end of the 1980s, Thorpe had led DARPA's SIMNET Program which linked the networked simulators of platforms such as tanks and aircrafts for over 200 systems through the use of the Distributed Interactive Simulation (DIS) protocol and High- Level Architecture which integrated these military simulations into one world model, allowing warfighters to train and share experience within syntactic training space. Furthermore, in the 1990s DARPA successfully linked actual warfighting platform, USS Wasp with SIMNET's simulation systems posited in different areas including helicopters and tanks, as wells as command centers and an observation node. This integration was developed into the Live-Virtual-Constructive (LVC) network, enabling on-mission warfighters to train and trial their plans.

After the SIMNET program, the military continued to pursue the idea of the combining world between the physical and virtual environment. Optimus System, a Korean's technology firm, has completed the development of the metaverse-based military training systems called DEIMOS in 2019. DEIMOS creates various metaverse military training environments for trainees to be able to react to each other and conduct missions similarly to the real combat situations. [15] The UK Ministry of Defence has also invested in the development of Single Synthetic Environment (SSE), synthesizing a digital twin of the real world to create an integrated common operational picture in a support of planning and decision making of military operations. SSE is perceived to have a potential to be a secure military section of the metaverse.

Noticeably, military applications of Alternate Realities and Metaverse have continued to prosper at a rapid rate to fulfill the potential of digital immersive combat operations. One key benefit of the Alternate Realities and the metaverse is the interconnection within and across the defence. Integrating virtual environment within the defence could provide effectiveness and efficiency not only in force preparation but also in command, control, and communication, enabling interactive feedbacks across defence communities. Accurate data with battlefield visualization and interactive communication through the metaverse could facilitate a better decision-making and a precise execution of a mission. Nonetheless, mega challenges of the military use of the metaverse to accommodate the defence alternate reality experience are a secured metaverse infrastructure and the system integration of alternate-reality activities across the defence, both in existence and in a force modernization plan, which need to be addressed through the cooperation of armed forces and defence industries.

5. Opportunities for Thai Military and Defence Industry

Scoping down to Thailand's defence capabilities and defence industry, military applications of Alternate Realities within the Royal Thai Armed Forces are largely within the training and simulation sector. Thailand's armed forces are mainly end-users of platform simulators. To illustrate, the Royal Thai Army has various type of simulators such as a VT-4 Battle Tank Simulator, a Howitzer Crew Trainer (HCT) for M109A5 Howitzer and a UH-60 helicopter simulator. In the same manner, the Royal Thai Air Force is in the possession of F-16A/B and Gripen flight simulators, whilst the Royal Thai Navy has bridge simulators and submarine simulators. In addition, the Royal Thai Armed Forces possesses constructive simulation systems such as the Joint Theatre Level Simulation (JTLS) and the Naval Warfare Training

Simulator (NWTS) for wargaming. All of these are individual systems which were acquired from different manufacturers at different time, and thus can not be easily linked to each other to create a jointly synthetic training environment.

On the defence industry side, Alternate Realities and Metaverse are relatively new to the Thai defence industry. In 2018, Thailand's Defence Technology Institute (DTI), a primary actor within the Thai defence industry, was able to develop a shooting simulation system, which is a virtual simulator for tactical firearms, to provide a training to pre-cadets at the Armed Forces Academies Preparatory School (AFAPS). Additionally, in 2021, DTI has developed VT4 Main Battle Tank's Crew Training Simulator using XR devices and delivered it to the 3rd Cavalry Division of the Royal Thai Army. The two projects are the key initial footprints of Thai defence industry regarding Alternate Realities for military applications.

Apart from the mentioned efforts to exploit the technologies, Thailand's research and development sector sees a potential benefit within alternate reality technologies, promoting the various research and development projects to satisfy the need of defence technologies to enhance warfighters' performance. This can be exemplified through a list of proposed projects in the capability development of Thai defence industry's researchers for the fiscal year 2022 of the Ministry of Higher Education, Science, Research and Innovation (MHESI), which aims to support the development of Thailand's defence capability requirements. The list includes proposed projects for alternate reality technologies such as a Virtual Reality Parachute Simulator (VRPS), an Operational Simulator for Infantry's Regiment and Battalion Level, and a 3-D Tactical Training Field. [16] This represents a potential growth of Alternate Realities and Metaverse for Thailand's defence applications.

Undeniably, Thai defence sector is playing catch-up with the alternate-reality technological trend, and there are plenty of rooms to improve digitally. However, The Royal Thai Armed Forces (RTARF) has a vision to attain a smart headquarter status by 2037 with an indication to prioritize advanced command and control capabilities with accuracy and precision in a timely manner. [17] In addition, Thailand's armed forces are looking to be more self-sufficient and self-reliable due to a recent downward trend of the defence budget. The 2023 Thai defence budget is reduced by 2 percent (4.3 billion bath) compared with the allocated budget in 2022, [18] which is largely stemmed from an economic pressure from the impact of the COVID-19 pandemic and global economic recession. These open opportunities for military applications of Alternate Realities and the military metaverse to prosper with the technology advancement and their

cost benefits. There is no need for the Thai defence industry to achieve the Original Equipment Manufacturer (OEM) or the Original Design Manufacturer (ODM) status. With contemporary advancement in the field of Alternate Realities, Thai defence industry can take an advantage of existing dual-use and Commercial-off-the-Shelf (COTS) products that can be for military purposes. The method can help to fast-track Thai defence capabilities to become the modern and digitized military with less time and less expenditure.

Furthermore, a common synthetic environment with common protocol, data, terrain, and an open architecture is potentially a key factor in future military readiness and warfighting. The Thai armed forces are currently at an early stage of establishing a joint and common digital architecture to operate on. The rise of the metaverse offers an opportunity for military personnel to interact on a persistent network, share common operational pictures, and execute an operation with effectiveness and efficiency. Therefore, the Thai defence should seize an opportunity to exploit the use of alternate realities and the metaverse for military trainings and operations at this early stage in a systematic way in order to avoid an unnecessary redundancy of systems as well as the incompatibility of systems across the defence, which can result in the waste of budgets for system integration at a later stage.

6. Conclusion

An advancement in Alternate Realities and Metaverse has offered a way for armed forces to train and operate with effectiveness and efficiency with a simultaneous intra-military communication as well as an interconnectivity with friendly forces. Both military training and warfighting applications of Alternate Realities together with the metaverse can generate interoperability among forces, enhancing a chance of success in conducting a mission. As for Thailand's defence, Thai military services have experience in using Alternate Realities primarily as end-users of high-end simulators of military platforms and wargaming. An increase in availability of commercial-off-the-shelf (COTS) alternate realities devices and the rise of the metaverse have creates opportunities for the Thailand's armed forces to gain more access to trainings and get connected for military operations. Thus, in order to modernize and enhance military capabilities, it is recommended that Thai defence sector should take key following approaches:

(1) Thailand's armed forces should prioritize the digital interoperability of military equipment and systems being procured. This is primarily because digital connectivity whether within the real world, the virtual world, or both, will continue to be in the uptrend of military applications as armed

forces from around the world continue to pursue their technological edge over each other to support their national powers.

(2) Thai defence industry should take an advantage of already developed COTS alternate-reality technology to reduce the time and expense in conducting research and development. Investing more on becoming Original Equipment Manufacturer (OEM) rather than starting as Original Design Manufacturer (ODM) will help to close the capability gap of the Thai defence industry with others that have already be in the defence market.

(3) Thai defence industry should seek to promote and enhance system integration capability within the sector. Military trainings and operations are very likely to progress toward digital cohesion which required a tremendous effort in integrating related systems. Therefore, the system integration has a high potential to be a key enable capability for Thailand's armed forces in the future,

The 3 aforementioned approaches are not an exhaustive list of efforts the Thai defence sector should pursue. They are merely suggested initiatives analyzed from the contemporary trend of alternate realities and metaverse that can be beneficial for military modernization. Achieving capabilities in alternate realities and the metaverse can be a force multiplier for the Thai armed forces to preserve the sovereignty of the nation and to maintain the peace and security in the region.

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