The OdySSEy to Transform Mission Readiness and Training Effectiveness

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ABSTRACT

Introduction/relevance to the Symposium
BAE Systems have developed a Single Synthetic Environment (SSE) which focusses on multi-domain, large scale training exercises that better prepare the armed forces for complex high-intensity warfare. We have developed the SSE to be easily configured for multiple scenarios, across the whole mission cycle.

Rationale:
Military simulation standards are at a crossroads. Project OdySSEy has evaluated the most complex issues, and challenges around simulation including fidelity and connectivity, creating a hybrid architecture that ensures we build upon an interoperable, open architecture, and scalable solution. To tackle these challenges, BAE Systems has leveraged technology from multiple small and medium enterprises (SMEs), operating in both the defence and non-defence markets.

Description of methods employed and results obtained
Project OdySSEy harnesses capabilities from over 8 different SME companies, including gaming technology, cloud computing, data analytics, biometrics, artificial intelligence and machine learning. These capabilities have been integrated and developed in an AGILE way, with sprints and iterative requirement updates, enabling rapid solution evolution.

Conclusion
Much has been learnt from Phase 1 of Project OdySSEy: the benefits of cloud computing and Artificial Intelligence/Machine Learning (AI/ML); the power of collaboration with SMEs; and the need for hybrid simulation standards. Phase 2 will build on this success, evolving the optimal hybrid architecture to support greater simulation technology ambitions.

1.0 INTRODUCTION

'Odyssey': *a long series of adventures, filled with notable experiences and hardships.*

The requirement to deliver mission readiness and training effectiveness, at scale, has never been so strong, clear and ultimately, in demand. There are multiple interlinked factors that drive this: the worldwide geo-political instability, the evolution of society and human expectations and of course, the continued development of technologies beyond the military and defence sectors.

This paper describes the designed and developed proof-of-concept Single Synthetic Environment, initially focussed on a collective training solution, and explains why BAE Systems chose to go on this journey as a consortium with multiple SME companies under the banner of "Project OdySSEy" and lays out the results and learning points from this development project, some of which lie outside the original scope of the project.

This paper also breaks down the next steps for "Project OdySSEy", exploring how we continue this journey to deliver a productionised, truly next generation capability that rewrites the criteria on what is mission readiness and how to most effectively train our way there.

1.1 Strategic Context

The drive for a synthetic collective training solution can be broadly categorized into the following subject criteria:

- Physical Space: To support live collective, multi-domain training for the latest generation of platforms and weapons systems, a significant amount of physical space is required. This includes air space, ranges, and the underpinning infrastructure that supports effective live collective training. The ability to make this space workable and available is near impossible, without impacting the quality of the training delivered.

- Asset Availability: Military Forces, generally speaking, have reduced in size and diversity of assets. Budget constraints, complexity of the military assets and the reliance on them to be "multi-role" [1] means the likelihood of prioritising the assets you need to conduct meaningful training is highly unlikely or requires a long, complex logistical/planning period.

- Distance: The need to train with peers at distance is critical when considering multi-national level training exercises**.** Live training with military forces on the scale of North Atlantic Treaty Organisation (NATO) and its' Allies can be high cost and a logistical burden to plan and deliver. Current synthetic training solutions are either air-gapped single location, or they are network connected but the fidelity of training is degraded due to technical and security constraints and limitations, especially when connecting with other nations [2].

- Adversaries: The ability of adversaries to monitor training and tactics via satellite and other Intelligence, Surveillance and Reconnaissance (ISR) techniques has meant the value of training is degraded by the need to protect tactics and technologies.

- Affordability/Environmental Impact: Despite recent events taking place in Eastern Europe, the challenge is at the forefront of government and military leaders agenda to maximise the value they get from the ever tightening 'purse strings' [3]. Even more so, the environmental challenges, underpinned by global environmental initiatives [4] add pressure on industry and military leaders to collaborate to ensure ensuring forces can train effectively whilst reducing the impact on the planet.

- Increase Live Training Effectiveness: It is important to note that the need for a synthetic training solution is not to replace live training, but to greatly supplement and increase the mission readiness levels of military forces as efficiently and effectively as possible, before or whilst they undertake live training. There has been a level of fortuity in recent times that military forces have been able to train with relative freedom with little threat beyond political gestures as a response. If the geo-political environment was to increase in tension however, the need for military forces to be able to continue to train, in a safe, secure and effective way is essential – synthetic training is a viable solution to enable this, but only if the level of fidelity, complexity and security is high enough to deliver mission readiness [5].

2.0 PROJECT ODYSSEY OVERVIEW

'Project OdySSEy': the title given to a proof-of-concept / path-finding project that focusses on how multi-domain, large scale synthetic training exercises, can better prepare the armed forces for complex high-intensity warfare. The initial stage of this project was to agree the principles that we would hold ourselves accountable to when designing, developing and delivering the output of the project. The following principles were agreed:

2.1 Complexity

Connecting simulators using the same Computer Generated Forces (CGF), Image Generator (IG), terrain data and simulator specification is something that has been established countless times, and with reasonable customer success. The aim of Project OdySSEy was to be open to integrating multiple types of capability, whether this was at an infrastructure network level, the synthetic environment itself (i.e. different CGFs and IGs) or the means of interfacing (Desktop, XR) and to ensure the training solution has capabilities beyond the status quo. The project would not shy away from complex challenges, as these are the challenges our customers face today.

2.2 Fidelity

Synthetic Training has many positives, as detailed previously, but if the fidelity of the training solution is degraded (intentionally or not), the impact on the end user can either be reduced training quality or even worse, negative training. Fidelity doesn't just mean graphically speaking either, as proven if you have tried high-quality games such as Microsoft Flight Simulator [6]. The graphics are genuinely world-leading, but without the rest of the world being "alive", and without a requirement to interact with the world beyond landing/take-off, it is easy to become disconnected to the simulation (with the exception of avid flying enthusiasts of course). An example of this from a military training perspective could be an aircraft carrying out an air-to-surface mission. In current live and synthetic environments, the aircraft will be able to identify the target, but will likely not have to deal with external factors that may impact decision making or communication routes e.g. civilians in the vicinity, suspicious vehicle movements and degraded intelligence.

Project OdySSEy thus had to prove that synthetic training could deliver high-fidelity training, which immerses the trainees in the training scenario and stimulates them to a level that would be as close as possible to real life operations.

2.3 Security

The focus on security created debate in the early workshops. It is well understood that connecting high-classification simulators and utilising representative data is a challenge for some of the biggest synthetic training contracts [7]. This project aimed at rapid development and proving the viability of integrating next generation technologies whilst working with non-defence SME capabilities. It was decided that this is not the stage of the project to resolve these issues. Instead, the project aim was to develop at a "code low" level [8] whilst stimulating and leading the security requirements for future phases. User confidence with plugging into Project OdySSEy would be essential to ensuring the environment would be trusted to host and responsibly manage and control the data exchanges of higher classification data.

3.0 THE JOURNEY TO DEVELOPING A NEXT GENERATION CAPABILITY

Project OdySSEy is not the first collaborative training and simulation project to take place, nor will it be the last. BAE Systems has led multiple exploratory training and simulation projects, as visualised in Figure 1. The way in which we developed the Project OdySSEy capability needed to be different and it needed to be world-leading. The following sections provide an insight into how Project OdySSEy succeeded in achieving this aim.

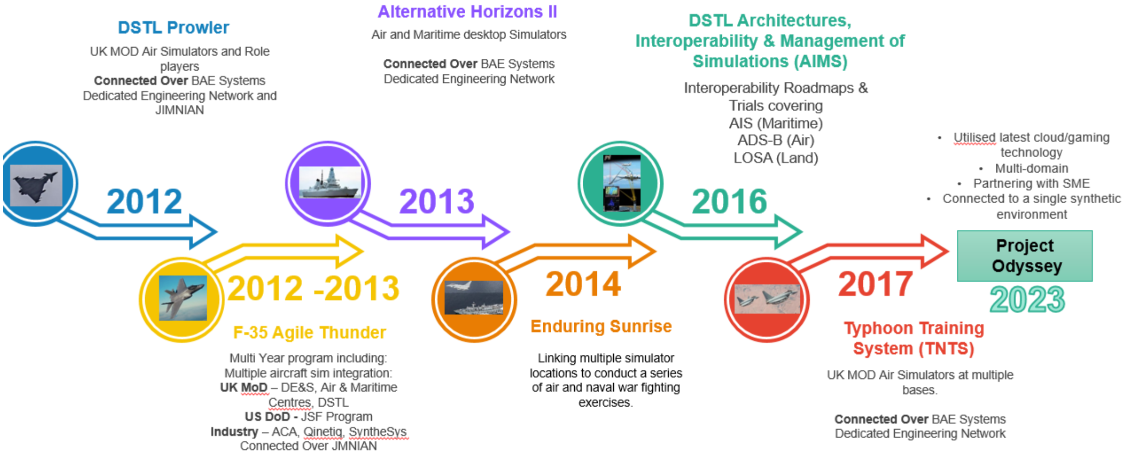

Figure 1 - BAE Systems Simulation Trials Timeline

3.1 PRIME + SME = COGNITIVELY DIVERSE INNOVATION WITH PURPOSE

Historically, there is a perspective that large prime defence contractors are inflexible and lack innovation. This contrasts with the view that SME companies are agile, dynamic and develop niche capabilities [9]. To challenge this status quo, Project OdySSEy had a key message from day 1: This is a collaborative partnership (See Figure 2), everyone has an equal voice, and the project intent will only be satisfied by integration of all of the parts. The solution workshops and subsequent development sprints underpinned this mantra. For every technology and software solution the SME had to offer, BAE Systems and the other Defence SMEs were able to align them to customer needs and hot buttons, whilst steering the development programme away from previously trodden mistakes. BAE Systems were also able to pair the SMEs with their own breadth of talent, including Human Factors, Software Development and Simulation Specialists.

Even with the advice of avoiding previous mistakes, the SMEs were encouraged to challenge this assumption, offering novel ways to navigate through previously un-crossable junctions. This also included a healthy level of challenging each other and recognising that this is an opportunity to establish a long term relationship with the partner companies. An example of this includes the previously understood entity count limits on the development aircraft simulators. This was assumed to be a project limitation, but was challenges by the SMEs, who had technical ideas and software tools to be able to help improve the entity count limit.

Cognitive diversity was a key factor in the assembly of the team to ensure the development of novel and creative solutions. For this project, the engineering lead had never led a training and simulation project before. This could be seen as a weakness, however this enabled an environment where the team felt confident to challenge perspectives (See Figure 3). The BAE Systems project delivery team focussed a lot on maintaining and nurturing this environment. At an enterprise level, the integration of companies from the gaming, data analytics and rail industry ensured the development of the project continued to open new opportunities to explore.

Figure 2 - Project OdySSEy Phase 1 Partners

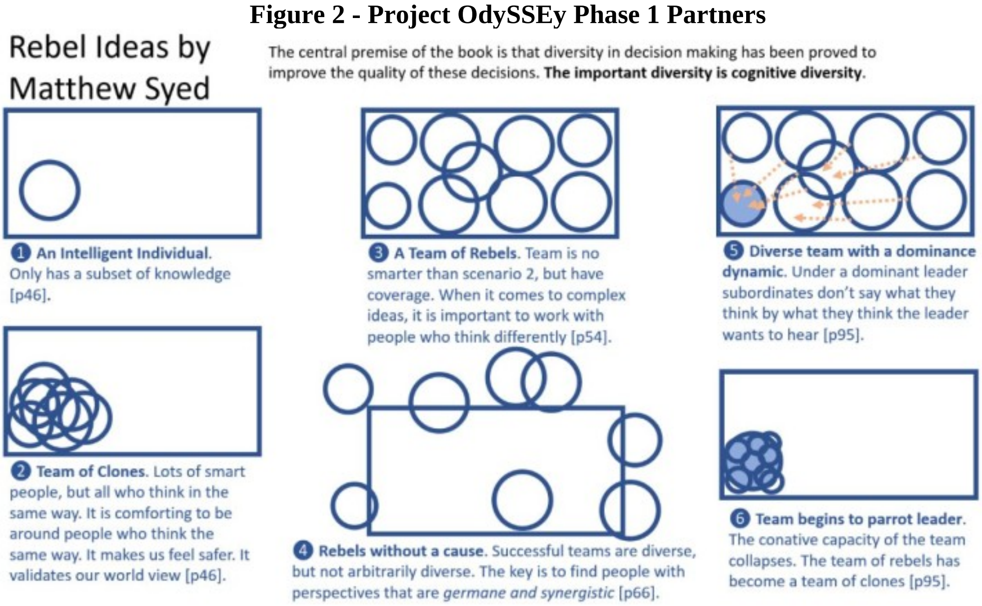

Figure 3 - Cognitive Diversity [10]

3.2 AGILE DEVELOPMENT APPROACH

There are many factors that contributed to the projects ability to adapt elements of the AGILE development principles [11]. See table 1 below for the list of AGILE principles and a post-project delivery 'Learning from Experience' assessment of how the project and engineering team performed:

Table 1 - AGILE Development Principles Assessment

AGILE Principle	Compliance Status (RAG)	Rationale
Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.		The first development sprint (+ 1 month into development) delivered a Minimum Viable Product (MVP) demonstration to all stakeholders, enabling vital feedback to be captured. This was repeatedly incremented throughtout the development programme and continues to be iterated.
Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.		Constant changes were rapidly assessed for feasiblity and captured into development. Examples include the late inclusion of the battlespace viewer and 3rd party software as well as training scenario adjustments.
Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.		As per rationale 1, rapid development was a priority through the project.
Business people and developers must work together daily throughout the project.		A major success. The core project team created the training strategy and project vision, ensuring close relationships between the developers, the SMEs and the business stakeholders.
Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.		Trust and accountability given to the SMEs and the developers to deliver the vision, led by a highly motivated project delivery team.
The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.		A by-product to a constraint for remote development. All integration sprints were face-to-face, ensuring the most complex issues were properly assessed, debated and concluded.
Working software is the primary measure of progress.		Project development was completed on the day of the customer/stakeholder demonstration, with a software update delivering multiple key fixes tested on the demonstration morning.

Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.		Business processes/mindsets require evolution. The extra effort to overcome this means the pace was not sustainable.
Continuous attention to technical excellence and good design enhances agility.		Steep learning curve for the team on how to capture and configure the design in an agile manner.
Simplicity: the art of maximizing the amount of work not done is essential.		The 3 principles "Complexity, Fidelity and Security" ensured no waste incurred investigating or developing non-relevant solutions.
The best architectures, requirements, and designs emerge from self-organizing teams.		Multiple examples of team self-forming, e.g. the project software requirement and architecture lead was initially a developer and development lead, but naturally progressed into the broader role as the programme matured.
At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.		Utilisiation of engineering Lifecycle Change Management (LCM) reviews and regular sprint After Action Reviews (AAR) ensured the team pro-actively adjusted approaches to development. A key example was the movement of the development area from 4 separate lab rooms to 1 open plan demonstration space, enabling greater collaboration and freedom of movement and a project location identity.

3.3 MVP vs Sunk-Cost Fallacy

A Minimum Viable Product (MVP) is defined as a version of a new product which allows a team to collect the maximum amount of validated learning about customers, with the least effort [12]. The Project OdySSEy approach to development fully encompasses this, ensuring feedback is obtained at the earliest point without any wasted development. The most effective way to manage MVP development and delivery was to fix early milestones that hosted in person engagements, into the programme, thus ensuring the team focussed on how best to convey the product intent and obtain feedback.

The focus on developing a MVP also prevented the cognitive bias behaviour known as "sunk cost fallacy", which is a tendency to continue with an endeavour we have invested money, effort, or time into, even if the current costs outweigh the benefits [13]. There are many examples of defence procurement activities investing heavily in the beginning of the Research & Development (R&D) Programme which results in them feeling like they cannot change course. Although this is a positive in many aspects as it arguably creates stability, there is an inherent risk in the programme making irrational decisions based on the previous, already spent investment.

Project OdySSEy was strategically marked as a "path-finder" project to mitigate this potential outcome. If the result of the project was that the technology wasn't mature, the relationships didn't materialise and the capability did not function as planned, all that was lost was 4 months of development and a relatively low amount of internal investment, with the gain of all of this learning and experience. Fortunately, the results were much more positive than this, as detailed in the following section.

4.0 THE RESULT

"There is an element of irony in that, in our effort to deliver a comprehensive collective training environment for our customers, we have, as partners, come together collectively as a whole team."
Sir Stuart Atha – Project OdySSEy Business Sponsor, UK Demo debrief, March 2023.

The Project OdySSEy development activity came to a close with a week-long series of back-to-back demonstrations in March 2023. The demonstrations were delivered to a diverse set of audiences, ranging from senior BAE Systems leadership, potential customer stakeholders, external industry representatives, technical specialist and the UK technology media [14]. The following sections provide detail on the solution itself and the demonstration results and associated development learning from experience.

4.1 Phase 1 Demonstration Solution Description

The Phase 1 Project OdySSEy capability consisted of:

Humans in the Loop:

- 2 x BAE Systems development Typhoon aircraft simulators (1 x desktop, 1 x Virtual Reality (VR))
- 1 x VRAI developed Typhoon simulator (VR)
- 1 x D3A developed JTAC simulator (Mixed Reality (MR))
- 3 x configurable trainee battle manager roles consisting of a Tactical Air Control Party (TAC-P), Battle Captain and Intelligence Analyst
- 2 x White Force training delivery roles
- 2 x configurable role-player stations (set-up to cover drone Intelligence, Surveillance and Reconnaissance (ISR), Command & Control (C2) and Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR)

Synthetic Environment:

- **VBS 4 -** generated and stimulated the military entities and the mission scenario. Broadly consisting of an air-supported ground supply mission which is compromised, leading to a search and rescue air-land co-ordinated effort with Command and Control assessing, prioritising and directing the operation.
- **Hadean Simulate** – scaled the AI civilian pattern-of-life simulation, utilising cloud computing middleware and collaborating with UCrowds, a crowd-based simulation software SME, dynamically scaled and managed the simulation to up to 60,000 individual entities, limited only on the air-gapped computing resources (3 x HP Z8 workstations). The civilians acted as independent entities, interacting with the synthetic environment and the military entities. This included civilians reacting to danger, fire and position events in a realistic manner (e.g. running away, crowds, freezing).

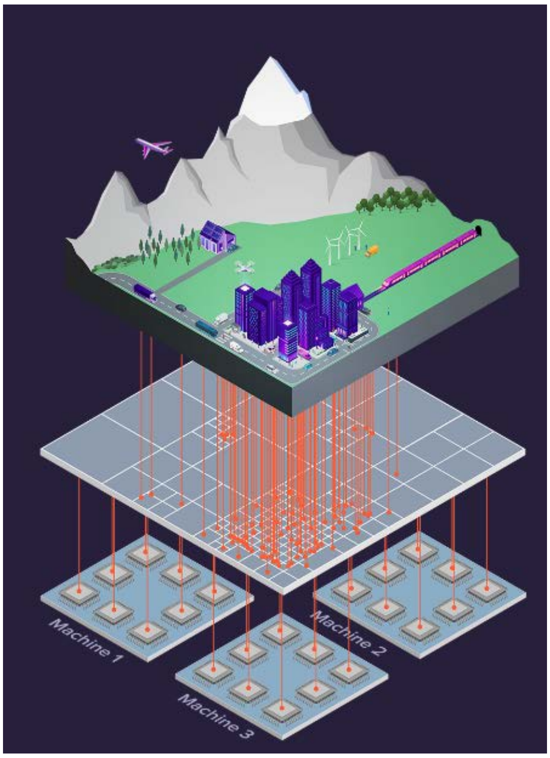

Figure 2 - Hadean Simulate [15]

- **Civilian AI -** The civilians generated social media, both in their normal state, as they travelled to work or to a place of interest, but also in their danger state, creating spikes of activity, and intelligence in doing so. The civilians would also develop their knowledge during the scenario. For example, an initial show of force proved very effective at dispersing crowds of civilians, but by the 2nd and 3rd time, the impact on the civilians was less as they adapted to the danger.

Network Integration:

- A hybrid architecture broadly consisting of a Distributed Interactive Simulation (DIS) / High Level Architecture (HLA) network for simulation data and communications exchanges, with an on-premise cloud data scaling solution integrated into the simulation via BAE Systems developed plug-ins, which can be configured and expanded as required.

Data Analytics:

- **VRAI HEAT Platform –** A cloud hosted solution, 'HEAT' captures, stores, analyses and presents data insights on trainee performance during simulation sessions to enhance training outcomes. The HEAT platform was successfully integrated into all human-in-the-loop training roles to provide individual training insights.

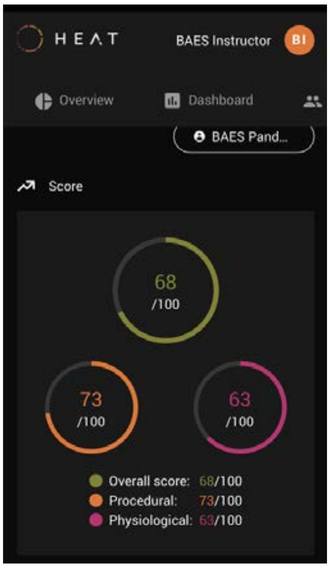

Figure 3 - HEAT Platform

- **Psycho-Physiological Data –** BAE Systems Human Factors Subject Matter Experts, including Dr Jacob Greene, led the integration of multiple cognitive/psycho-physiological data measurement devices – including the Tobii V3 eye glasses and Polar heart monitors, synced into the VRAI HEAT platform to provide a single source of data insights.

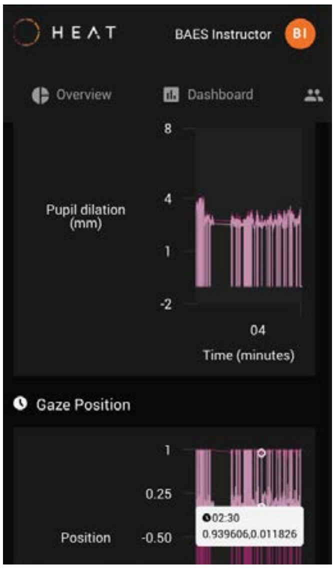

Figure 4 – HEAT Psycho-Physiological Data

Visual Interfaces:

- **XR –** All forms of visual interface were developed and tested to connect into the Project OdySSEy Synthetic Environment, including Mixed Reality, Virtual Reality, Standard 3-Screen and Augmented Reality, all tailored to each use case or to provide comparison between different visual interfaces.

Figure 5 - Project OdySSEy AR Battlespace Visualizer

- **IG –** The debate for users operating different IGs and the potential impact to training when visualising the synthetic environment is well understood. For this phase of development and to support a collective training use case, a common operating picture for all trainees was a vital requirement. This meant ensuring the legacy simulators were able to visualise the same models and entities as the simulators running Unreal Engine or VBS 4 / Blue IG.

Figure 6 - IG Visuals during Demonstration

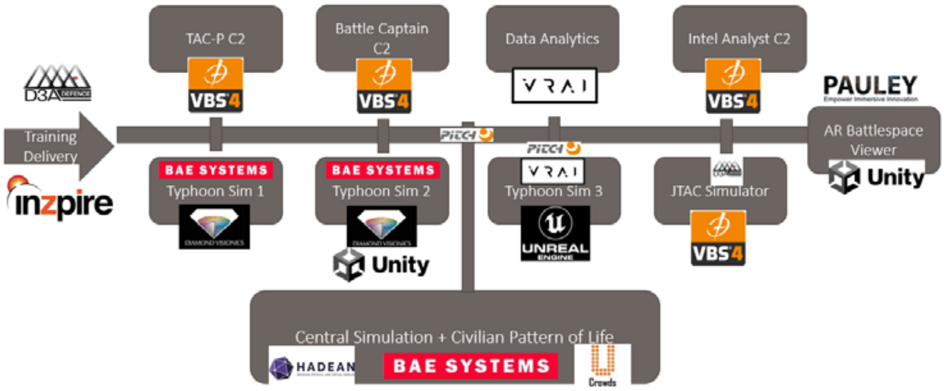

Figure 7 - Project OdySSEy High Level Overview

4.2 Limitations

During the design, test and evaluation process, the following limitations of the Project OdySSEy capability were identified, to enable learning from experience and to help plan for future development iterations:

Entity Visualisation Limits – Despite the quantity of entities being generated and distributed across the network being dynamically scaled to up to 60,000 within the simulation, the configuration and capabilities of the Image Generators in use limited the quantity of entities that could be visualised to approximately 250 at one time. This was managed via Hadeans interest management solution “Muxer” (Now referred to as “Connect”) [16] to ensure the simulation remained stable whilst still visualising a realistic output to the end user. The negative impact of course is that if there is an entity of interest or key to the simulation mission/training scenario, or they are interacted with from a land simulation perspective, the collective training output will not be credible.

Bohemia Interactive Simulation have announced that VBS4 version 23.2 will contain an update that replaces “Interop API” (Automatic Programmable Interface) with VBS4 ECS (Entity Component System). This will deliver the ability to render more externally controlled entities at a high Frames per Second (FPS).

IG Visualisation Discrepancies – A key technical objective to Project OdySSEy was to explore technical integration activities and the training impact from utilising multiple IGs to visualise the training simulations, at a multi-domain level. Project OdySSEy integrated 5 visual engines successfully. Whilst all engines could successfully visualise, the time frame did not allow for consistent visuals across all engines, e.g. civilian and building models were visualised differently and for certain training scenarios did impact the immersive experience. For example, the Typhoon utilising its sensor pod based on intelligence of civilian behaviours spotted on a VBS terminal, was not able to be fully validated through the military “kill-chain” [17] due to IG discrepancies.

Simulator Limitations – The simulators utilised were unclassified by design, replicating the performance and capabilities of the associated platform. The use of unclassified Typhoon simulators, designed for engineering development purposes, enabled the rapid test and integration of the training synthetic environment and reduced the likelihood of product security / export risks, as well as enabling the Project OdySSEy SME partner companies to operate in a non-restricted manner.

The unclassified nature of the simulators however meant certain classified functions and platform capabilities were not available for the trainees (e.g. Radar/DASS/Comms/Datalink functions). Although these were supplemented/simulated in other ways, such as role-player inputs, it did impact the quality of the training solution for the players in the simulators.

Civilian Behaviour Stability – The civilian behaviours are based on 2 key states, "normal" and "danger". These states are influenced by the inputs into the simulation, either via AI entities or humans in the loop. Inconsistent reactions were observed when events such as military entities firing weapons or travelling through the simulated towns. This created confusing situations for the trainees, and in particular, the training delivery white force to be able to navigate. Arguably, the unpredictable civilian reactions could be associated with real-life scenarios, however this has been identified as a package of work to provide more Graphical User Interface (GUI) tools to configure and manage the intricacies of a complete "Human-Terrain", including but not limited to: infrastructure, electromagnetic spectrum, civilian transport and social interactions [18] and to do further robust development and testing, with academic backed human terrain behaviour states introduced to create further immersive capabilities.

Data Upload – The HEAT platform is a cloud enabled data analytics and visualisation solution, thus it is optimized when utilising the end-to-end cloud collection to visualisation solution. Due to the challenging timescales needed to design and implement the required cyber-security and product data security management solutions, connecting the full Project OdySSEy architecture to the internet was not a feasible initial step. Instead, the data was collected and held on the air-gapped network, with a manual data transfer process exporting the data and uploading it to the HEAT dashboard. Although this didn't impact the quality of the data or the result, it did mean the data was not able to be displayed at near real-time for the trainees or training delivery team to observe, and it also required extra technical team resource to undertake the manual data export. The solution has now been approved and tested for cloud connectivity, expanding the opportunities for product development and user testing.

4.3 Demonstration Outcome

The original week plan had 7 scenario run-throughs scheduled at a total of 10 hour 30 minute system runtime. In reality, 12 x scenario run-throughs, at a total of 18 hours system runtime was clocked, with live updates including the modification of red air, civilian population and modification of civilian behaviours and placement, showcasing the agility and flexibility of the simulation.

The simulation had zero catastrophic failures, running consistently stable with over 10,000 entities populated across the simulation. This level of stability highlights the value of performing over 100 scenario tests during the development to identify and resolve any potential bugs and integration fails.

As an added complication, a decision agreed between the engineering lead and the software team leader, introduced a partially tested core simulation software update – providing key updates to the behaviours of the civilians in the simulation. The risks were discussed between the technical subject matter experts before deciding the updated software would be an acceptably low risk. The deciding factor on this go/no-go decision was after reflecting on the ethos of this project: Rapid development, using AGILE methodology, where working software was the primary measure of success.

4.4 The Unintended Benefits

Project OdySSEy had clear objectives, as identified at the start of this paper. As the project moved into the design and development phase however, multiple unintended/unexpected benefits were being explored, highlighting the benefit of complex, integrated path-finder style projects. These benefits include the following:

Training to Accelerate Technology – Technologies such as biometric measuring devices, augmented reality and other human-centric examples are often being developed for complex, expensive and challenging use cases. For example, the testing of human factors biometric equipment for use in the cockpit requires testing methods such as in-flight testing, where the expense is high in terms of platform use, personnel requirements and the qualification and safety approvals are complex and long in duration – just to complete basic testing of equipment that may not deliver the required value to justify the exploration in the first instance. Utilising a synthetic environment, with a training simulated activity taking place – enables rapid, repeatable, measurable and safe product testing, across all different systems, including operation software, experimental platform use and military personnel equipment.

Competitive and Gamifying Training – During the integration testing and scenario run-throughs, the data collection process from all users was tested. This enabled the users to review and analyse their performance data from both a procedural and psycho-physiological perspective. The direct data comparison between roles such as pilots post scenario created a level of competitive and curious behaviours resulting in the players wanting to improve their own scores and also score higher than their peers. Although some environments may require more sensitivity around the access to performance scores, there is no denying that providing users with their own "Strava for Military" style profile of performance data, based on objective measures, improved the players' engagement and also stimulated a level of stress caused by the competitive aspects of the data collection. If this was to be replicated at a collective level, the results of collective team vs team style training could drive higher training engagement.

XR impact – The use of different XR solutions for the platform simulators enabled significant user feedback and associated technical data to be captured for future analysis. For example, the immersive benefits of VR integrated into the Typhoon simulator were validated, especially in air-to-air and low-level operations, but there was a clear trade off with user sickness, technical reliability, comfort and cockpit hand tracking accuracy. Although the impact of the trade-offs differed per user, it has provided vital data for the engineering team to improve the simulator performance.

Augmented Reality (AR) use cases – The development of the AR Battlespace Visualizer was an experimental addition to the Project OdySSEy development. The resulting output was a visually impactful, highly configurable, common operating picture that can be streamed across any visual interface but was primarily used to augment the battlespace. The first key beneficiaries were the battlespace manager trainees, who were able to use the visualizer to assess the battlespace form a 3D perspective, improving their situational awareness. The second beneficiary was for supporting debriefs, either in real time or as a recording for After Action Review, providing an impactful perspective for the trainees and white force team to review training performance.

Pattern of Life Impact – The training impact of integrating a scalable pattern of life solution into the synthetic environment included multiple factors, such as the land and air domain players increasing communication and using collective techniques to try to move the civilians that crowded round an aircraft that had crashed. The unpredictable nature (sometimes unintentionally) of the civilians also meant each time the training scenario was undertaken, different civilian reactions ensured the training scenario did not become predictable. Finally, the potential impact of the social media data was regularly demonstrated, with early social media intelligence sometimes being spotted by the intelligence analyst, ensuring a different training sequence of events took place. This did create uncertainty to the White Force Team who were delivering the training scenario, with feedback captured to give the Exercise Controller the ability to easily manipulate and impact the civilians. Future phases of increasing the complexity and fidelity of the human terrain is likely expected to further improve the multi-domain collective training experience.

5.0 WHAT NEXT FOR PROJECT ODYSSEY?

Project OdySSEy has been able to design and deliver a collective training capability that has integrated and tested next generation technologies in pursuit of demonstrating the key project objectives. Along the way, the project has also provided intelligence, data and stimulated creative thinking for what comes next as we look to develop on the foundation of the Project OdySSEy solution. Although not exhaustive, the following list provides an insight into the next steps for Phase 2 of Project OdySSEy:

Collective Training Initiatives – Examples such as the Platform Enabled Training Capability (PETC) offer an opportunity to integrate synthetic environment capabilities together to provide a broader, multi-domain training solution.

Scalable Military Entities – Utilising spatial computing and cloud deployed technologies to scale high quantities of civilians is important, but for large-scale collective training aspirations, the ability to accurately scale and simulate large quantities of military entities is a capability hot button. Swarm drones for example, are a challenge to be able to simulate without compromising fidelity.

Human Terrain / Pattern of Life – As described in the limitations section, there are several directions to improve the "Human Terrain" capabilities, including the pattern of life. The scope of work can be broadly summarised into 3 sections; improved GUI, greater integration between different levels of the Human Terrain and greater integration into the training scenarios.

Calibrated and Validated Collective Training Metrics – The testing and demonstration phase has generated a large quantity of procedural and psycho-physiological data. This data requires cleansing and deeper analysis to calibrate and generate further key insights.

Cross-Domain Security Enablement – A key infrastructure / networking enabler is the implementation of cross-domain security solutions, to enable the transfer of data at different classifications between sub-systems of the Project OdySSEy solution itself, and 3rd party software, hardware and data.

External Parties Integration – Collective training benefits from co-located training exercises, in particular during debriefs where in-person discussions can take place and where of course, the ability to host higher classification simulations is in some aspects more achievable. However, enabling external data, simulators and players to connect into the Project OdySSEy network will enable greater deployment, wider use and broader applications.

Live Virtual Constructive (LVC) Integration – Integration of live and increased expansion of virtual and constructive simulations is a critical next step. The challenge is ensuring the integration provides new insights to the development of Project OdySSEy as well as aligning to potential customer use cases. LVC integration also includes integrating operational tools to interoperate with the synthetic world, such as customer mission planning and intelligence analyst tools providing a 3 way interface between training, operations and product development– see Figure 10.

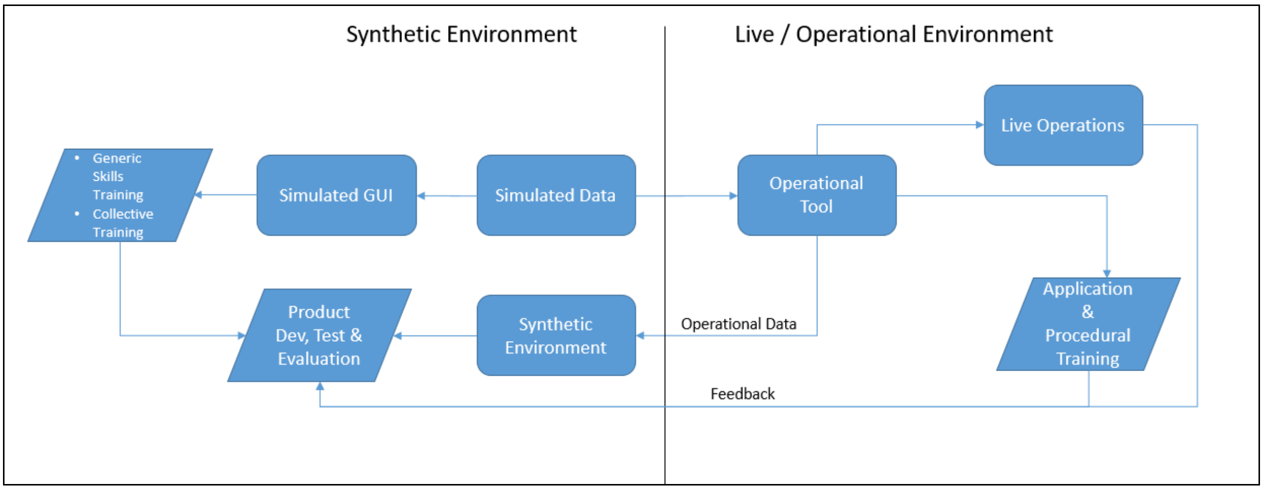

Figure 8 - Synthetic / Live Integration Outputs

Broader Use Cases - Developing the synthetic backbone foundations to enable broader use case capabilities, by adjusting the levels of scalability, speed, AI, human in the loop and fidelities of simulation. This will enable the development of capabilities across the full engineering and mission life cycle, from engineering design and development thru to mission rehearsal, what-if analysis and even procurement/logistics analysis.

SME input - Continue to work with SMEs to develop the roadmap for synthetic environment based training, horizon-scanning the latest technologies to rapidly test and evaluate these generation after next [19] capabilities.

6.0 CONCLUSION

Project OdySSEy is a proof-of-concept / path-finding project that focusses on how multi-domain, large scale synthetic training exercises can better prepare the armed forces for complex high-intensity warfare. The key objectives were to demonstration "Complexity, Fidelity and Security" capabilities by working in partnership with SMEs and utilising non-traditional and next generation technologies.

The project was able to deliver in line the key project objectives, with limitations and learning from experience also identified. The benefits of working with SMEs, utilising not only their unique technology but also their agile behaviours and diversity in thought, enabled a truly unique but also stable and reliable, integrated collective training solution to be developed in rapid timescales. This provides the foundations for future development and enhancements, as there is a long way still to go following the first step on the '*odyssey*' to delivering the future needs of our military forces.

More so, the project also identified multiple unplanned benefits, a product of the agile methodology of being open to change and bringing together key stakeholders from engineering and the business, which will form part of not only the Project OdySSEy future development roadmap, but other capability development programmes that can learn from the methods and results of this path-finding project.

Project OdySSEy has ultimately proven that synthetic environments and the integrated technologies have a vital role in training military forces today and in the future, but more importantly, it has proven that there is no one-size-fits-all solution to training and simulation. Instead, it highlights the need to integrate multiple types and levels of software, hardware and data sources, thus requiring greater interoperability, interchangeability and technical integration development to maximise the training effectiveness and ensure mission readiness.

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