

 7th Annual SAE
UAV Technology Conference
26/27 September 2022

Simulation in Support of Military UAV Operations

Andy Fawkes



DVIDS/U.S. Air Force photo/Photo by Airman 1st Class Christian Clausen
"The appearance of U.S. Department of Defense (DoD) visual information does not imply or constitute DoD endorsement."

THINKE



The Presenter

FIMechE

Twitter
@andyfawkes1

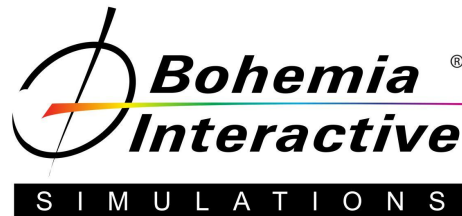
LinkedIn
andyfawkes

email
andy.fawkes@thinke.co.uk

Before



Ministry
of Defence



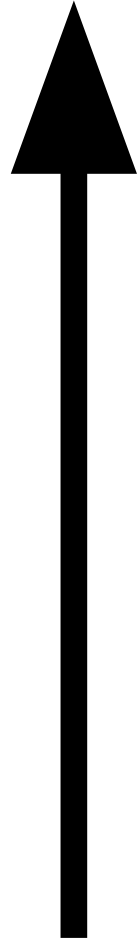
Now





Human Factors and Training Always Last?

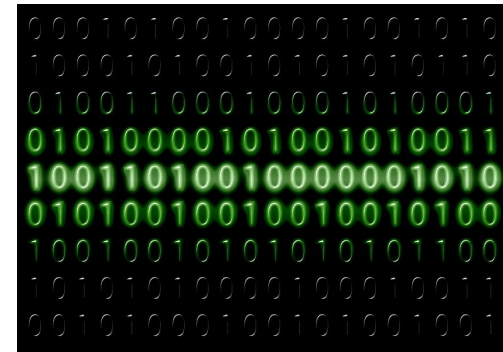
Adaptability



People



Digital

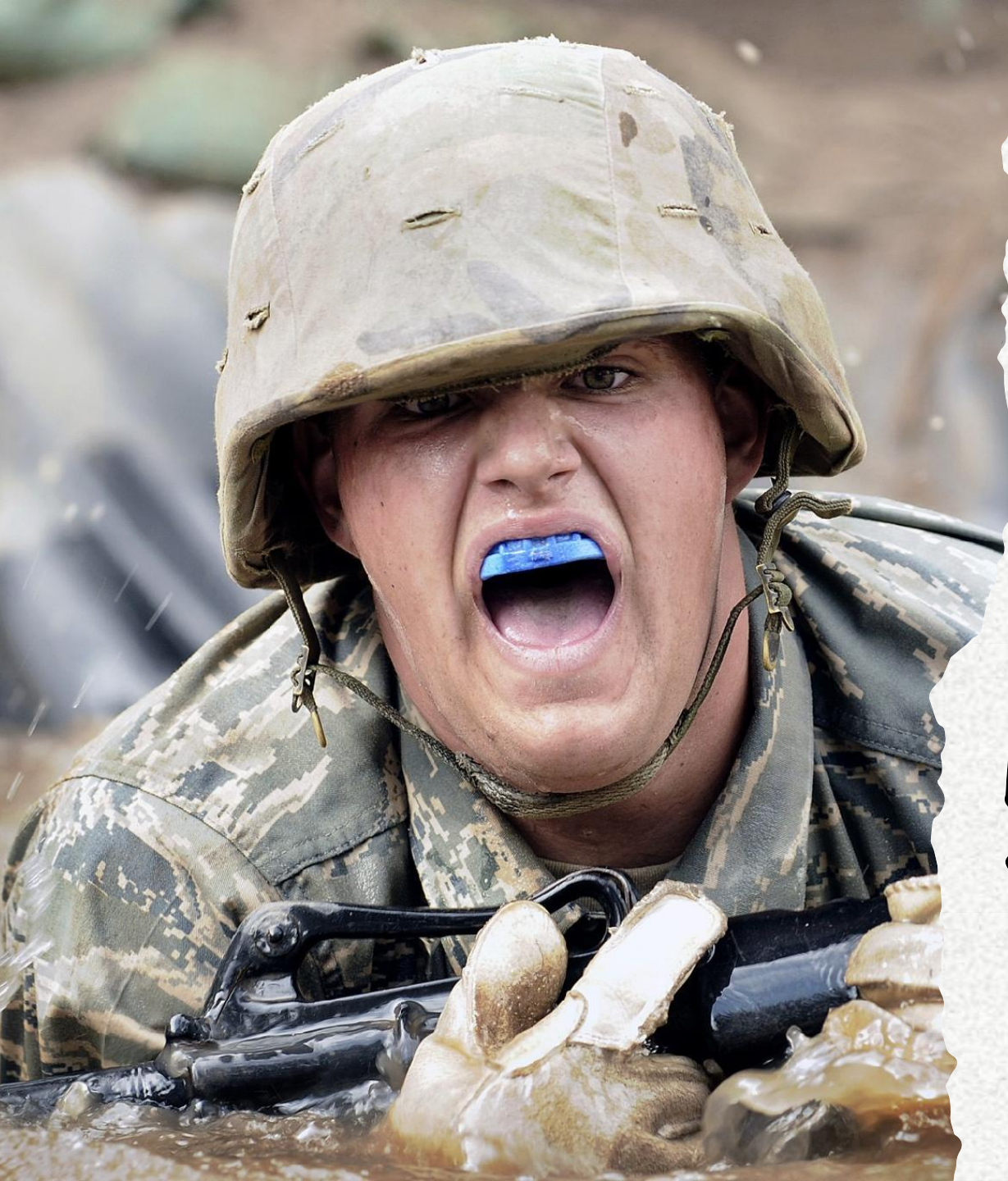


Metal



Outline

- **Simulation and Training**
- **Simulation and UAV Development**
- **The Human Challenges of Automation and Remote Operation**
- **C4ISTAR-Simulation Convergence**



Simulation & Training

What are We Seeking in Training?

Faster



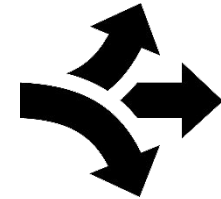
Cheaper



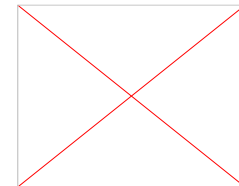
Better



Flexible



Multi-Domain



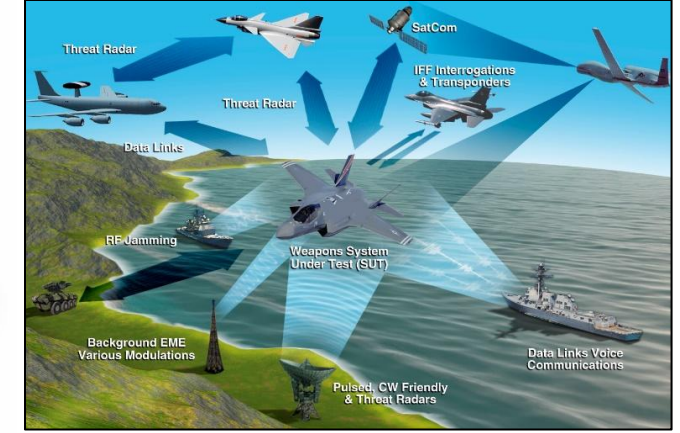
Greener



USAF Predator Mission Aircrew Training System

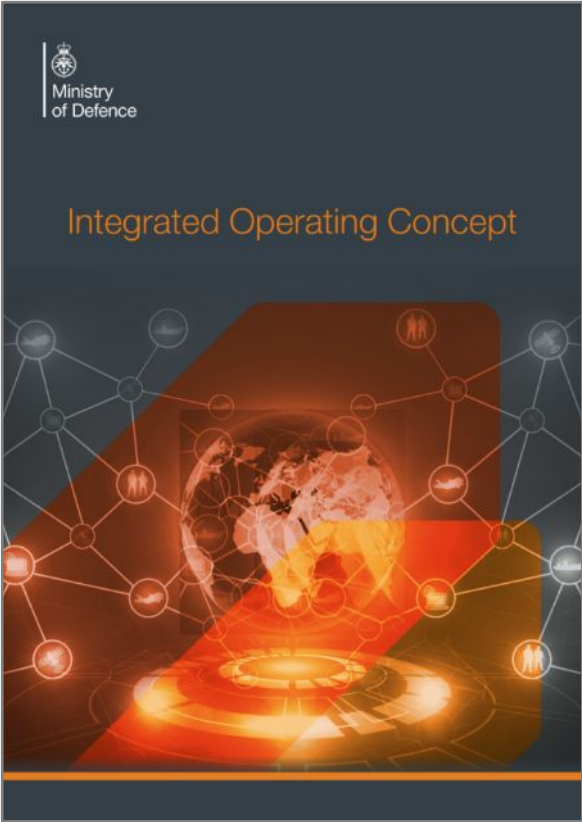


Why Use Simulation?





March 2021



Sept 2021



May 2021



Nov 2021

The UK Strategic Command Strategy (22 Nov 21)



“We need to be better at responding to the **unpredictable**.

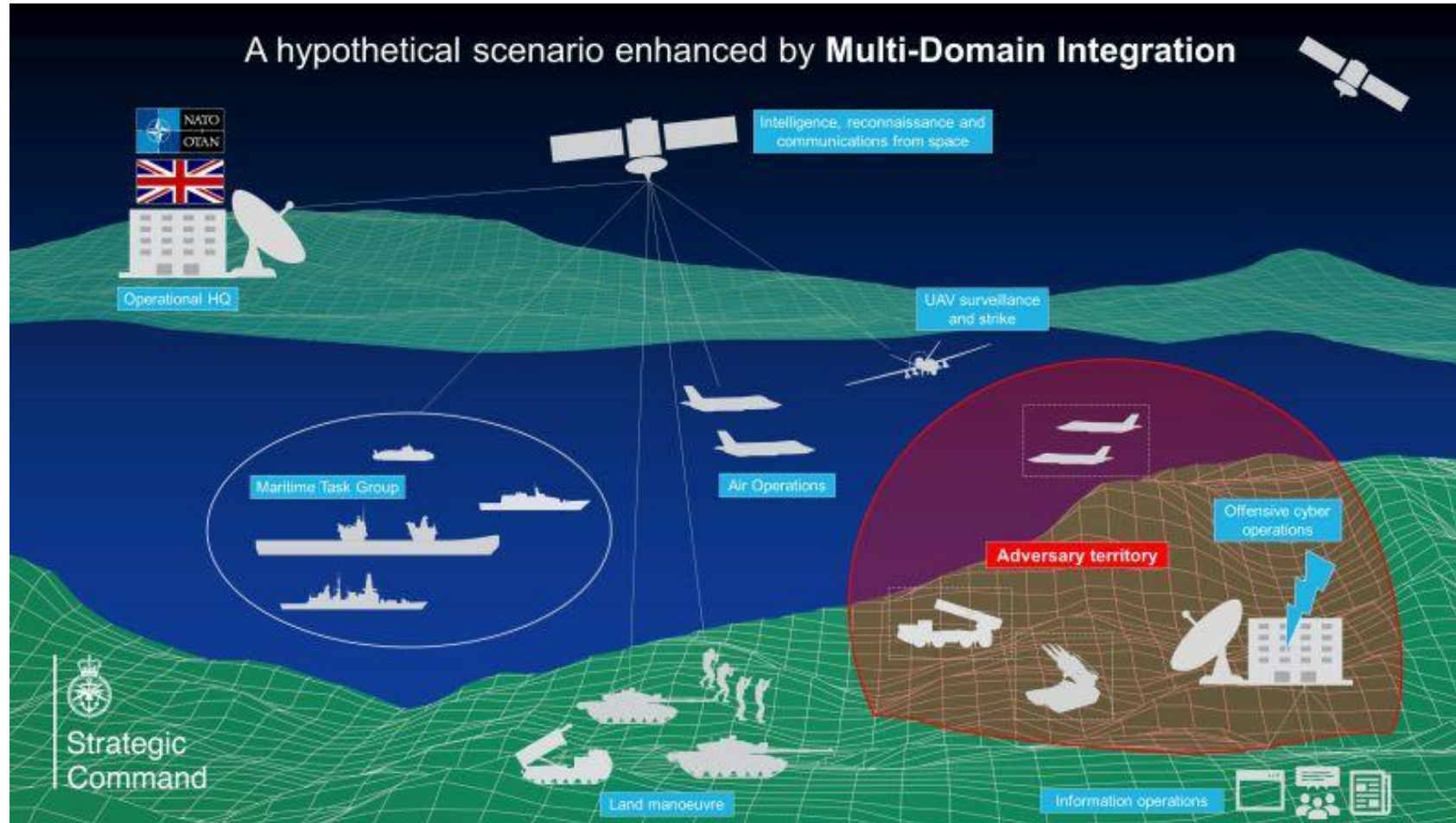
Defence must become **agile**, responsive and able to act in an **integrated** way.

It means **experimenting** with new technology and becoming experts in data exploitation.

We need to **join up our people, equipment and information** through integration.

It’s through this **integrated** approach, which places the use of technology and data at its heart, that we will become more agile and more able to respond to the unknown.”

Multi-Domain Integration $\equiv$ Multi-Domain M&S



Public Domain ISTAR (MAXAR)



**Iranian
Shahed-136
(aka Geran-2)
—
Suicide Drone**



New
Realities?



**Air Chief Marshal
Sir Stephen Hillier
Jan 18**

**“teenagers playing on
their Xbox at home
should take their
gaming to the next
level and join the RAF
to operate real drones”**

MailOnline News

Home News U.S. Sport TV&Showbiz Australia Femail Health Science Money Video Travel DailyMailTV

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Join the RAF for the real thing, Xbox teenagers are told: Head of the air force says young gamers should take it to the next level by operating drones

- Air Chief Marshal Sir Stephen Hillier wants more young people to join the RAF
- The service will be celebrating their 100th anniversary with events this year
- Among the major events planned is a flypast along the Mall before the Queen
- RAF chiefs hope a display of military might could provide a boost to recruitment

By LARISA BROWN FOR THE DAILY MAIL
PUBLISHED: 00:32, 12 January 2018 | UPDATED: 00:53, 12 January 2018

Share 387 shares 194 View comments

Teenagers playing on their Xbox at home should take their gaming to the next level and join the RAF to operate real drones, the head of the air force said yesterday.

Air Chief Marshal Sir Stephen Hillier said the RAF's next 100 years will see a huge shift towards unmanned flying machines as he outlined plans for centenary celebrations.



Military Esports

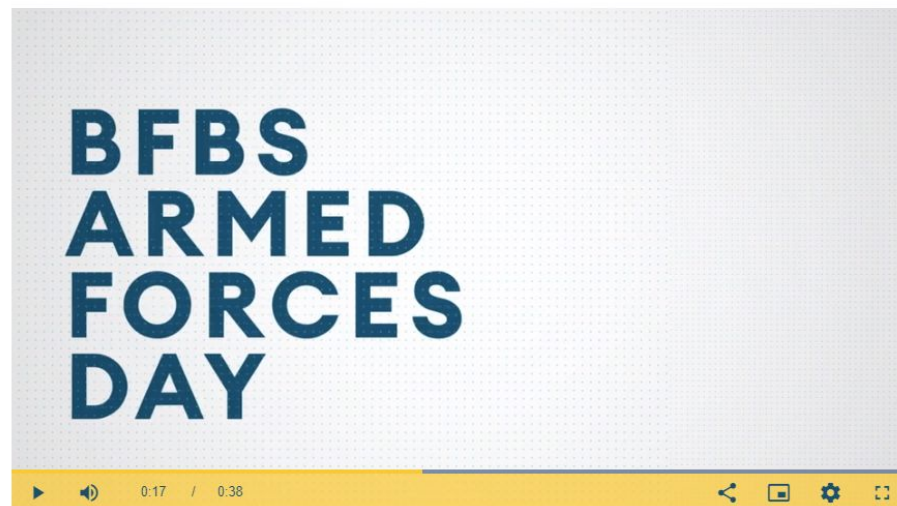


GAMING

Military esports showcased for first time on Armed Forces Day 2022

Produced by BFBS, the event will see military esports teams going up against civilians.

27th May 2022 at 3:08pm



Microsoft Flight Simulator



Search



Olli43
1.46M subscribers

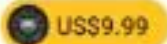
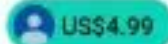


Microsoft Flight Simulator 2020 - London Update Pack & Viewer Suggestions!

114,410 views • Streamed live on 18 Aug 2020

 3K  95  SHARE  SAVE 

Live chat replay ▾

 £4.99  US\$9.99  US\$4.99

Fly through tower bridge



Craig Davies: HIGH END CPU : Ryzen 7 Pro 2700X or Intel i7 9800X GPU : Radeon VII or Nvidia RTX 2080 VRAM : 8 Gb RAM : 32 Gb SSD : 150 Gb Solid State Drive Bandwidth: 50 Mbps



Navdeep Singh : @Olli43 disable Hpet on your computer for smoother gameplay look it up on YouTube.



Siddhant Bhirud: thats me



Jackson Scaletta: do a roll



Hunt3r : - Fly over some stadiums in london



SpursFan214 : omg i found you



Kentucky Fried-Chicken: Who else live near southampton



DodgeGt8 : such a cool gamer moment!



SpLiT pErSoNaLiTy : GTA 5 car meet



TheGamingBluejay : Did he download London or is this streamed?

 Slow mode was enabled 

HIDE CHAT REPLAY

THINKE

Off the Shelf Technology (2021)



**Microsoft Flight Simulator
(live Hurricane Laura)**



**Oculus Quest 2
(\$299)**

Unreal Games Engine Software in CAE Flight Simulator (2022)



Simulation Now - Land, Sea, Air, Space, Anywhere





Simulation & UAV Development

UAVOS (USA) Simulation Software for UAV Testing



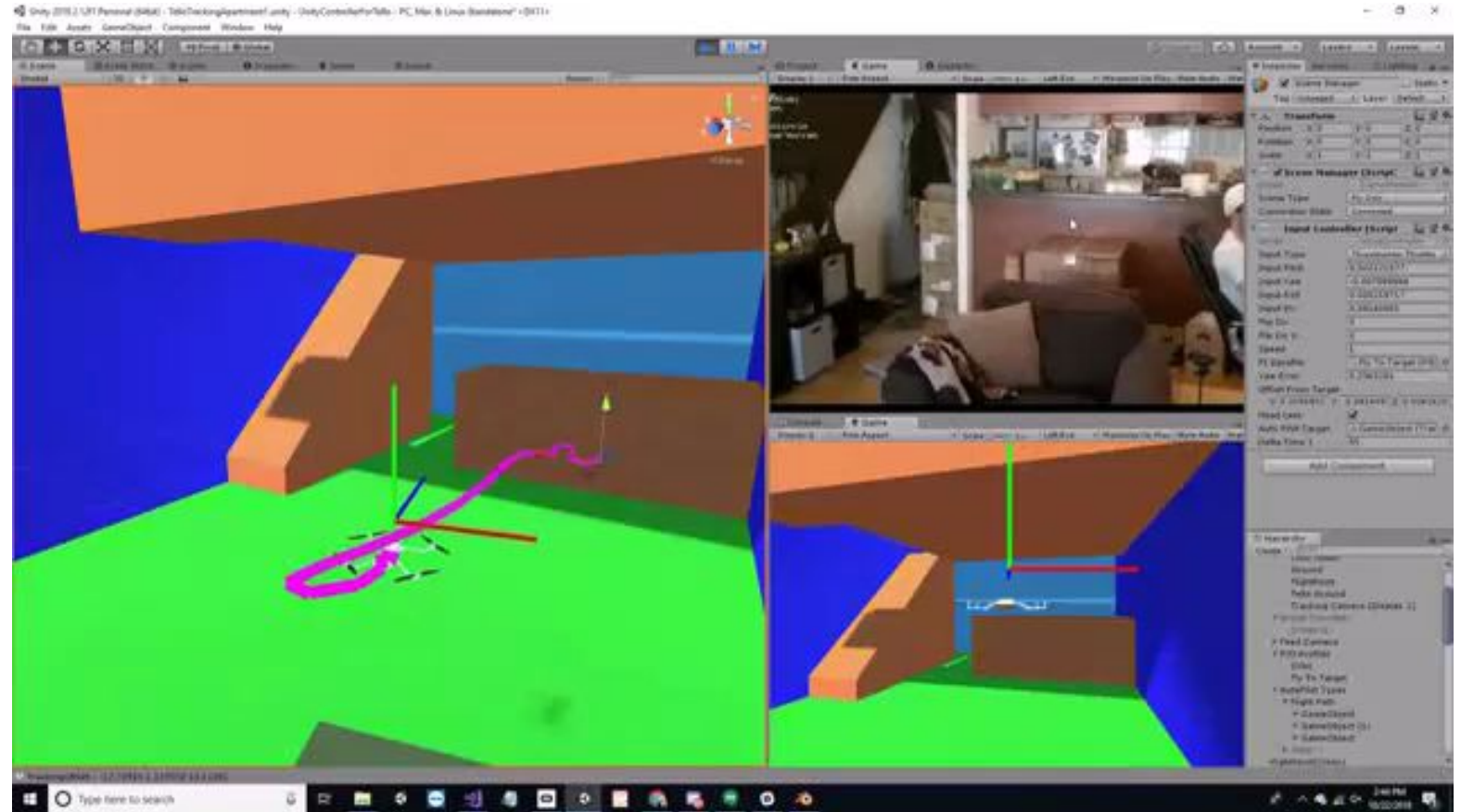
Rift Drone

AR.Drone 2.0 + Oculus Rift + Unity + Xbox 360 Controller



Rift Drone is open source: <https://youtu.be/nD2a0OHRmoM>

Flight Path Programmed in, and Controlled by, Unity Game Engine



Eye Tracking



Just Art?



SIGGRAPH 2021

Skoltech
Skolkovo Institute of Science and Technology

DronePaint: Swarm Light Painting with DNN-based Gesture Recognition

Valerii Serpiva, Ekaterina Karmanova, Aleksey Fedoseev,
Stepan Perminov, Dzmitry Tsetserukou
Skolkovo Institute of Science and Technology
Moscow, Russia.

- Authors: V. Serpiva, E. Karmanova, A. Fedoseev, S. Perminov, D Tsetserukou
- Laboratory: Intelligent Space Robotics and VR/AR Lab.
- University: Skolkovo Institute of Science and Technology, Russia
- Conference: ACM Siggraph 2021, Emerging Technologies



The Human Challenges of Automation and Remote Operation

Queen Bee Target Drone – 1930s/40s



Cautionary Tales



Algorithms...

Security

Brit Watchkeeper drone fell in the sea because blocked sensor made algorithms flip out

Report scolds maker Thales for poorly understood software

By Gareth Corfield 15 Apr 2019 at 13:58

120 SHARE ▼



A Thales Watchkeeper drone. File pic, Crown copyright

A British Army Watchkeeper drone stalled itself and crashed into the sea on a bad weather flight test, military investigators have said – though most of the wreckage was never found.

Investigators concluded that one of its pitot probes used for reading the aircraft's speed and angle of attack (AOA) became blocked, causing the Watchkeeper's onboard flight control logic to enter an erratic series of climbs and dives until it stalled itself and flopped into the sea. They criticised the craft's maker, Thales, for not fully understanding how its algorithms responded to loss of accurate sensor data.

Air Marshal Susan Gray, ~~director general~~ of the Defence Safety Authority, criticised the Ministry of Defence and Thales for their "incomplete level of detailed technical understanding" regarding the drone and its systems.

Monitoring Systems



The Register

{* INTERNET OF THINGS *}

Army Watchkeeper drone flopped into tree because crew were gazing backwards

Live footage of runway and grass verge more compelling than actual flight instruments

Thu 29 Aug 2019 // 10:11 UTC

98 GOT TIPS?

Gareth Corfield BIO EMAIL TWITTER

SHARE

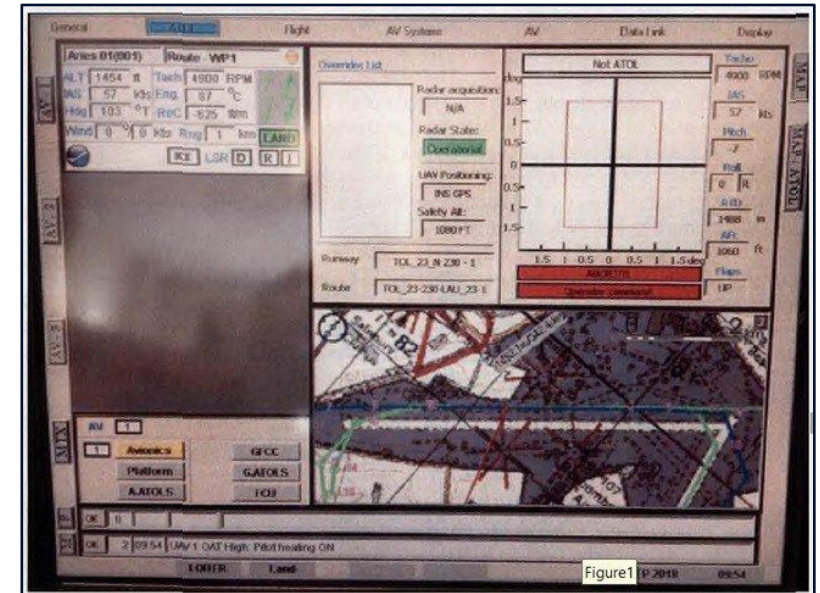
The latest British Army Watchkeeper drone crash happened because its crew became fixated on live footage from an onboard camera instead of their instruments, a Ministry of Defence report has revealed.

An internal Defence Accident Investigation Branch (DAIB) report detailed why the semi-autonomous aircraft, tail number WK050 and flown on the day by two Royal Artillery operators, crashed in June 2018.

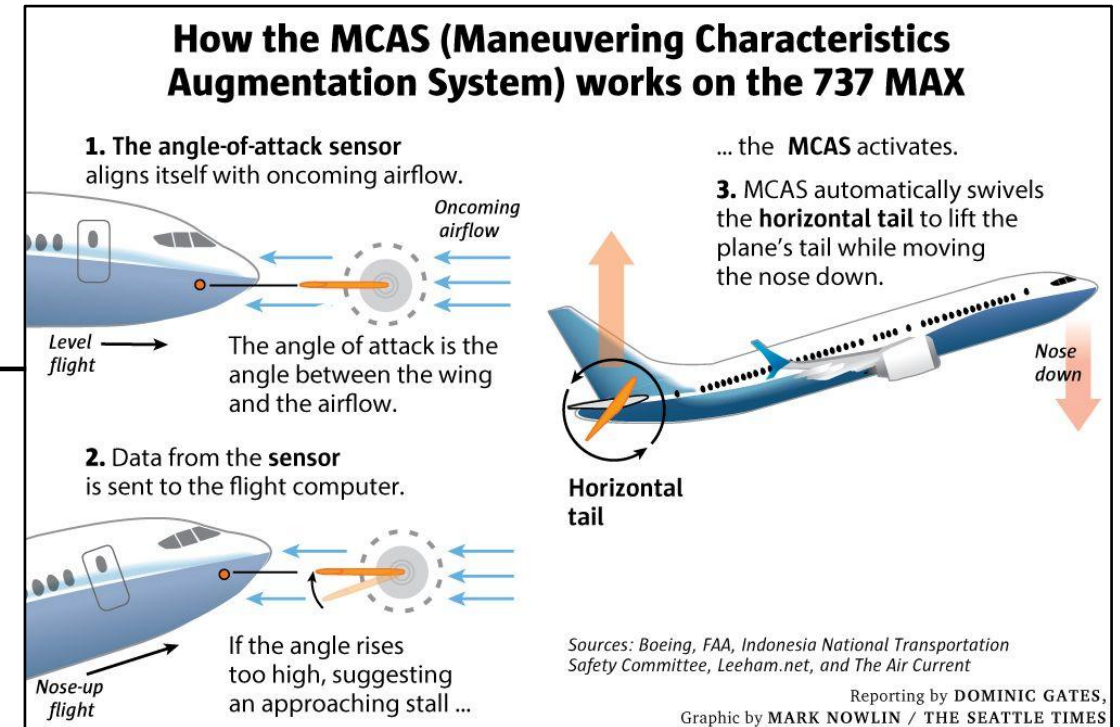
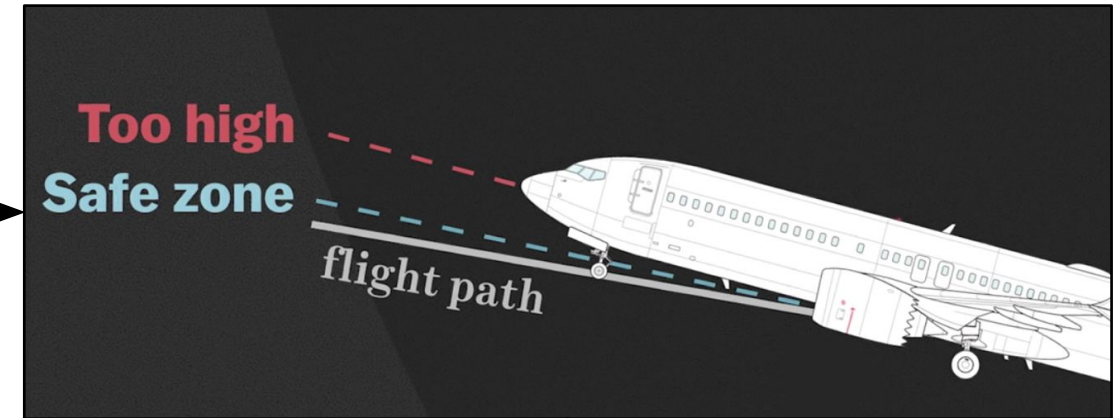
The report, dated February 2019, was [published online](#) by the MoD after the BBC made a Freedom of Information request for it, leading to [news reports](#) over the past few weeks.

WK050 flopped into a tree just beyond the runway of Aberporth airport on the Welsh coast after its Army operators, under the supervision of contractors from a Thales joint venture company, cut its throttle immediately after the drone had landed and lifted off again.

"Had no action been taken, the [Watchkeeper] would have completed its automatic go-around from which it could have been commanded to conduct a further approach," said the DAIB in its Safety Investigation Report, which was written by a major and a Warrant Officer 1 (WO1).

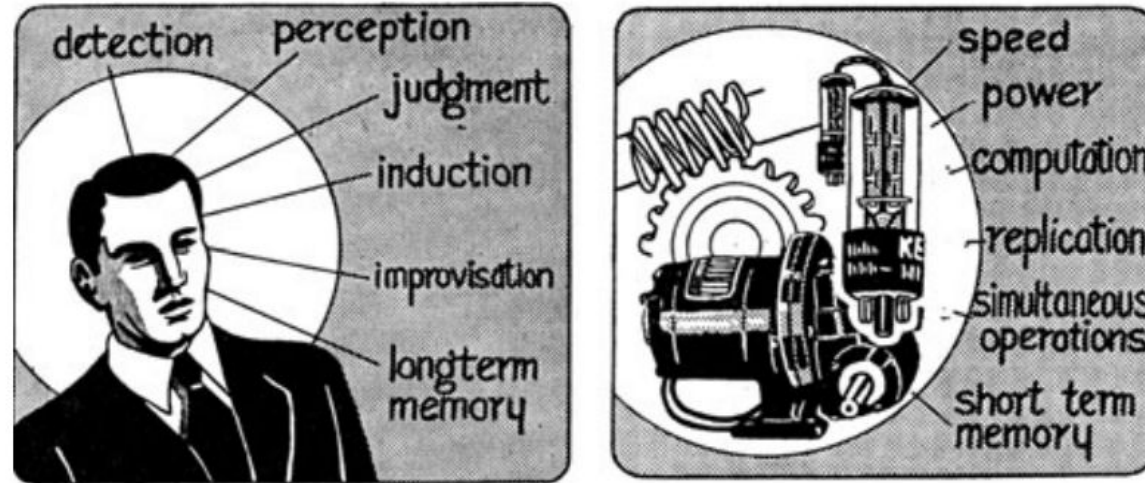


Boeing 737 MAX



Paul M Fitts (1951)

Human Engineering for an Effective Air Navigation and Traffic Control System



- “great caution be exercised in assuming that men can successfully monitor complex automatic machines and take over if the machines break down”
- “engineers should seriously consider systems in which machines would monitor men and prevent them from making dangerous



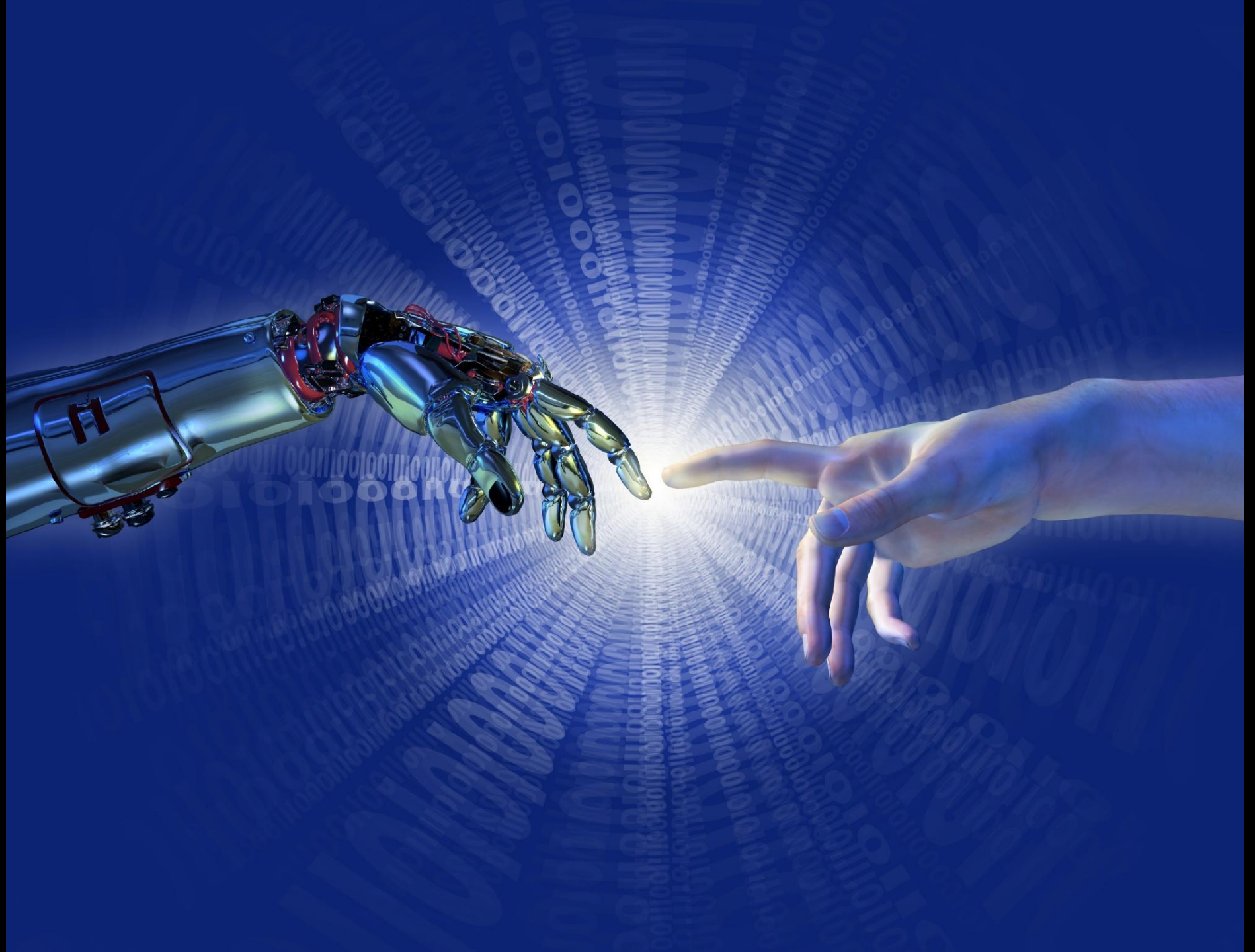
In the Loop ...

"If I'm in the loop mentally I can respond more quickly than if I have to watch an automatic system and take over and then get my mind into the loop.

So I was more comfortable in flying a manual descent than an automatic descent... my mental computer is already running at full speed."

**David Scott
Apollo 15 Commander (1971)**

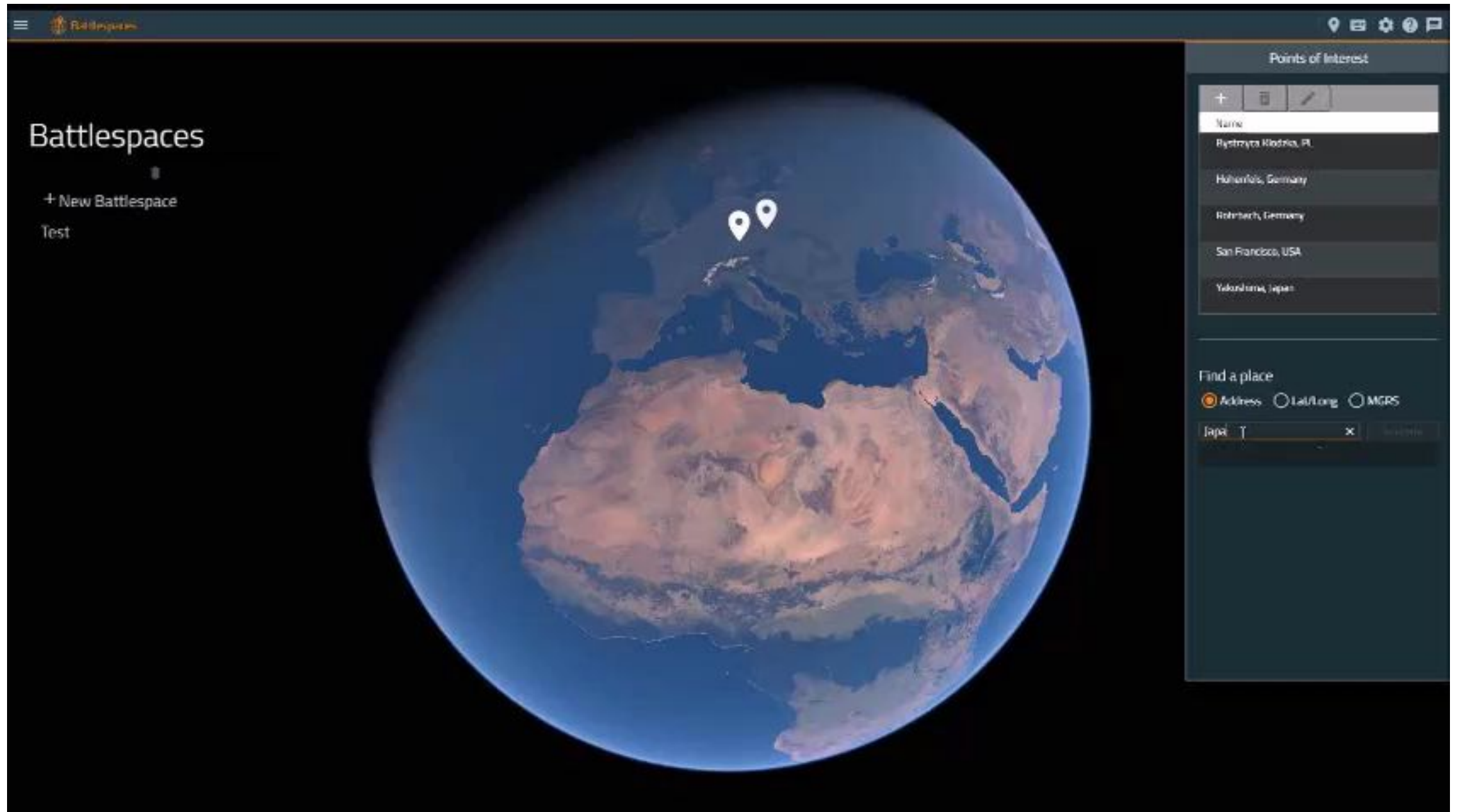
**Maximise
the
Strengths
of Both**





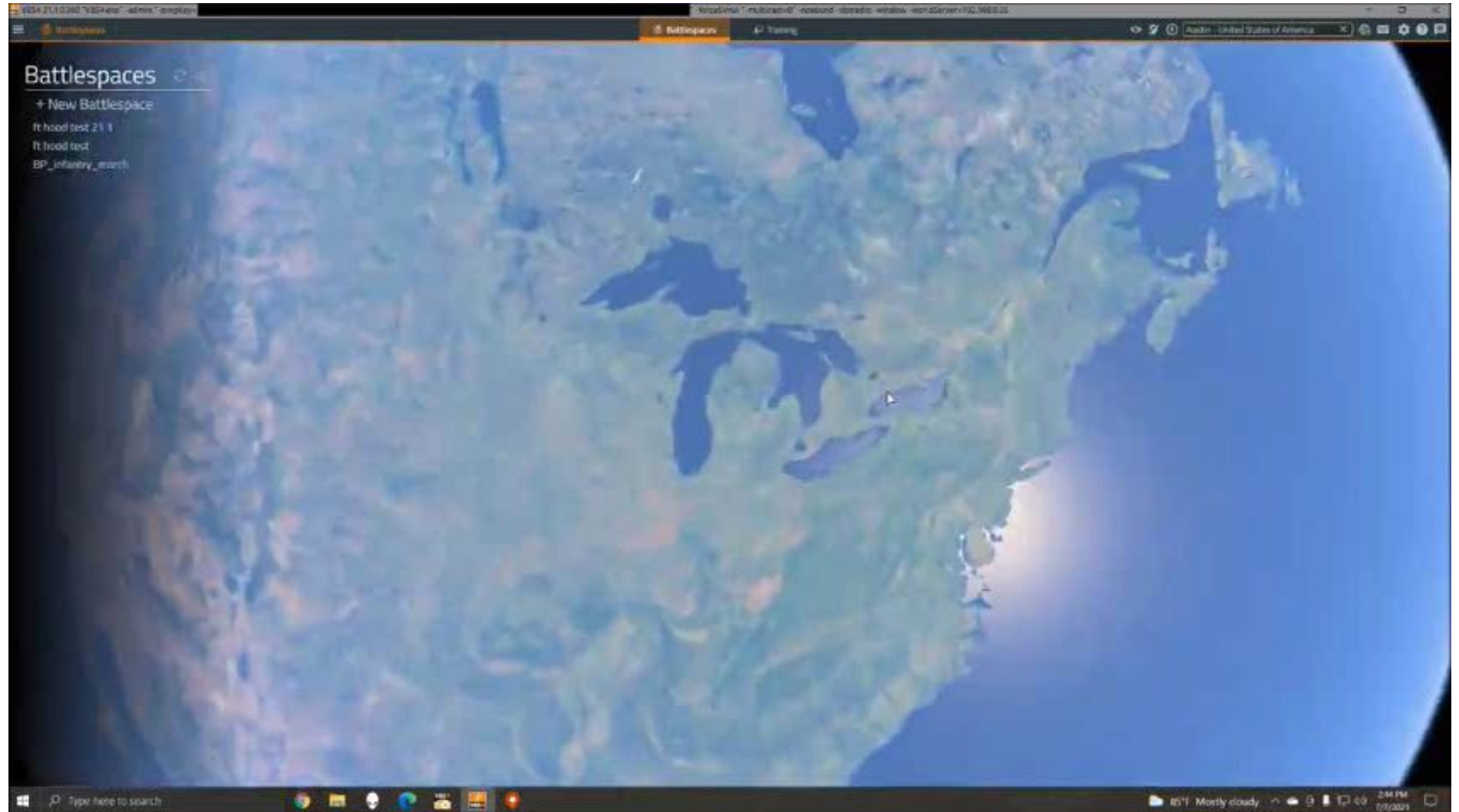
C4ISTAR-Simulation Convergence

Whole Earth Simulation

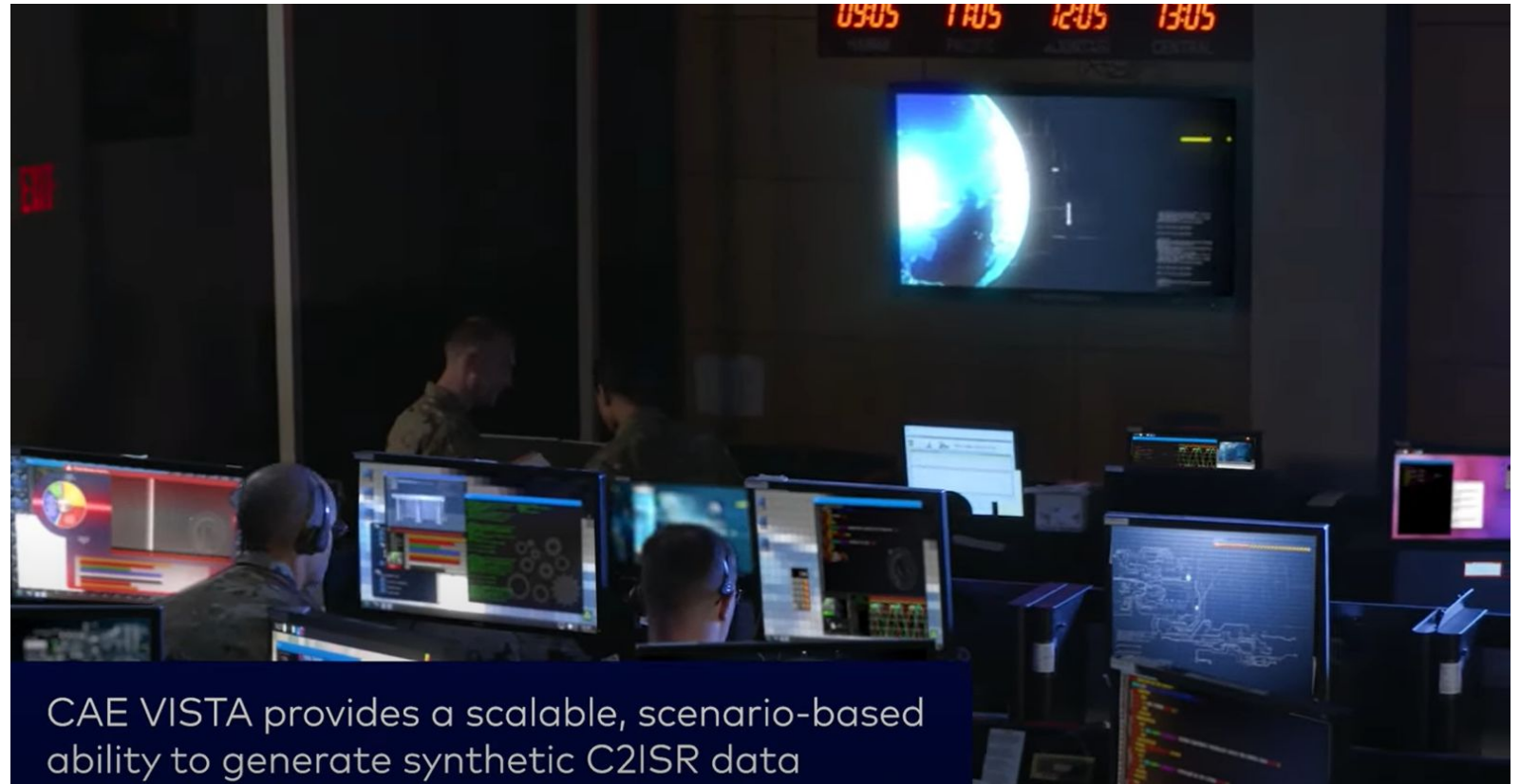


Austin, Texas

**BSim
VBS4
Simulation
+
Microsoft
Bing Data**



CAE Virtual Intelligence Surveillance & Reconnaissance Training Application (VISTA)



CAE USA Contracted for National Geospatial Intelligence Agency Project



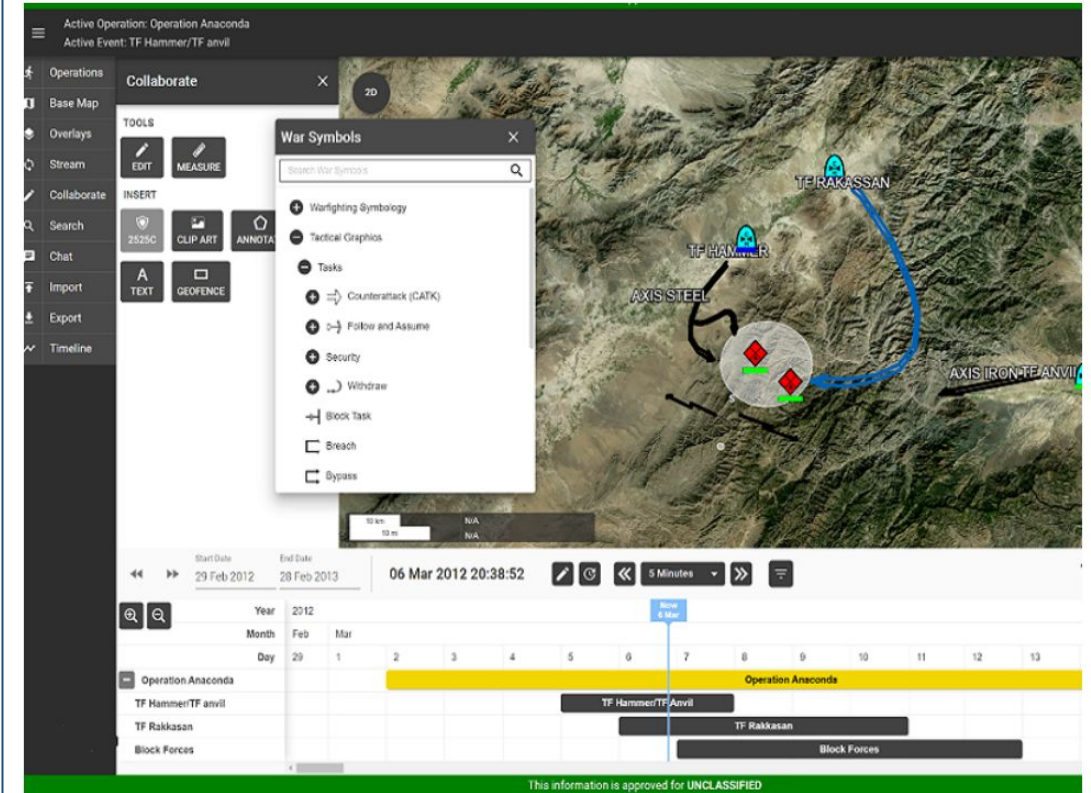
Image credit: CAE USA

OCTOBER 11, 2021

CAE USA has been awarded a contract by the Army Contracting Command-Orlando to lead the Beyond 3D prototype development and integration efforts for the National Geospatial Intelligence Agency (NGA). The total value of the NGA Beyond 3D prototype project, if all options are exercised, is more than US\$37 million.

The Beyond 3D project, led by the Training and Readiness Accelerator (TRex), aims to accelerate NGA's ability to process, exploit, disseminate and generate 3D geospatial data to support real-time analysis, mission planning and tactical operations. TRex is a unique public/private partnership between industry and

CAE Wins Global Situational Awareness Contract



An integrated Common Operational Picture allows real-time mission planning and support for joint, all-domain operations and collaboration. Image credit: CAE

MAY 19, 2021

CAE USA has been awarded a contract valued at more than US\$155 million, including options, by the United States Special Operations Command (USSOCOM) to lead integration efforts for the Special Operations Forces (SOF) Global Situational Awareness initiative.

US Army - One World Terrain



ONE WORLD TERRAIN (OWT)



PM SE

MISSION

To support the training needs of echelons Soldier/Squad up through Army Service Component Command (ASCC) by providing a realistic, common, accessible and automated 3D terrain data set for simulation and, potentially, mission command and intelligence systems, to conduct collective training, mission rehearsal and execution at the Point of Need (PoN).

DESCRIPTION

The Army's One World Terrain (OWT) delivers 3D global terrain capability and associated information services that support a fully accessible virtual representation of the physical Earth accessible through the Army network. OWT is useable by all simulation trainers that represent the complexities of the Operational Environment (OE) and the multi-domain battlefield in support of training as provisioned through the Army's Synthetic Training Environment (STE). OWT is dynamically rendered at the PoN, leveraging game-streaming technologies enabled by new advances in fiber optic and 5G wireless networks.

SYSTEM INTERDEPENDENCIES

- Common Synthetic Environment (CSE)
- Integrated Visual Augmentation System (IVAS)
- Reconfigurable Virtual Collective Trainer (RVCT)

FOREIGN MILITARY SALES

None

The Metaverse and Defence



Military Metaverse CONOPS

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ABSTRACT

Commissioned by the UK's Dstl, this study set out to investigate the origins and latest thinking on the metaverse, leading to the creation of a "Military Metaverse CONOPS". The CONOPS (Concept of Operations) describes a future defence modelling and simulation (M&S) ecosystem built on metaverse technologies, standards, and approaches, together with benefits, use cases and actions to take. It provides a unifying vision for defence to realise the full potential of M&S through an integrated enterprise approach in support of all defence activities including training and operations. The study found that although descriptions of the metaverse vary, it can be considered an umbrella term for many technologies of interest to defence and it is their integration and convergence that are driving metaverse developments, reflecting the evolution of computing itself, from predominately 2D, to 3D interaction and presence. Metaverse technology developments will be predominantly driven outside of defence, but key elements of a military metaverse include ubiquitous networking and computing, pan-enterprise access to verifiable M&S data, and the exploitation of open metaverse standards. The CONOPS approach provided a useful vehicle for communicating why and how technologies might be brought together for defence benefit, informing both M&S policy and the future direction of the M&S research programme.

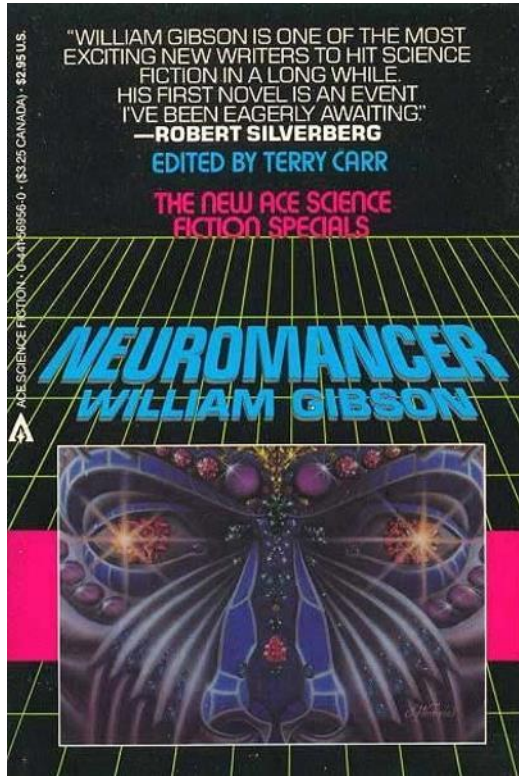
1.0 INTRODUCTION

1.1 Research Background and Approach

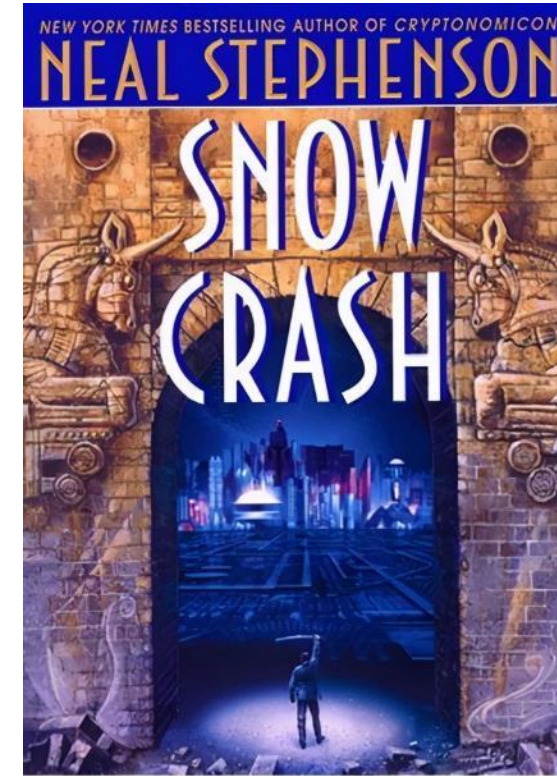
This study was commissioned to support Dstl's Transforming Training, Education and Preparation (TTEP) research activities and is aimed at informing Dstl to gain competitive advantage in support of science and technology (S&T) activities relating to training, education, and preparation. It was suggested by Vedette as part of a simulation and synthetic environment innovation call in August 2021 in order to address two questions. What does the metaverse mean for defence and, by building on metaverse technologies and approaches, could a CONOPS be developed to provide a unifying vision for UK defence's approach to M&S? The study was principally aimed as a think piece and guide for why and how defence might actively explore and discuss metaverse developments and seek out opportunities to exploit externally driven innovation. It was conducted from mid-December 2021 through to mid-February 2022 with outputs of a "Military Metaverse CONOPS 2035" and a supporting report and presentation. This paper has built on the study incorporating key metaverse developments since the study end.

In terms of study structure, the first phase investigated the origins of the word "metaverse", captured the latest thinking on the metaverse, and formed and understanding of its relationship with defence M&S. From this work military metaverse technology summaries and a metaverse features versus defence M&S mapping were developed aimed at explaining the relevance of the technologies to defence. Building on this work, the next phase was to review latest UK Ministry of Defence (MoD) and international policy and thinking on future operations in order to set the scene and inform the military metaverse CONOPS. Finally, the "Military Metaverse CONOPS 2035" was written based on the ISO/IEC/IEEE 29148:2018 standard format for a CONOPS.

It's Science Fiction...

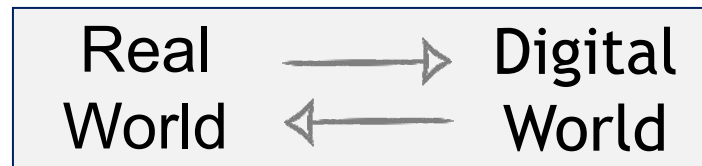


1984 – Created by Gibson, the word “Cyberspace” is popularised and *“had no real semantic meaning”* a *“mass consensual hallucination”* in computer networks



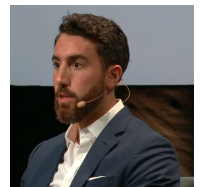
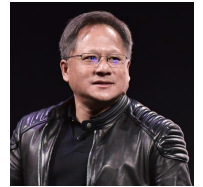
1992 – Stephenson creates the word “Metaverse” a portmanteau of "meta" (meaning beyond) and “universe”

“ ... a computer-generated universe ... ”



Some Contemporary Metaverse Descriptions ...

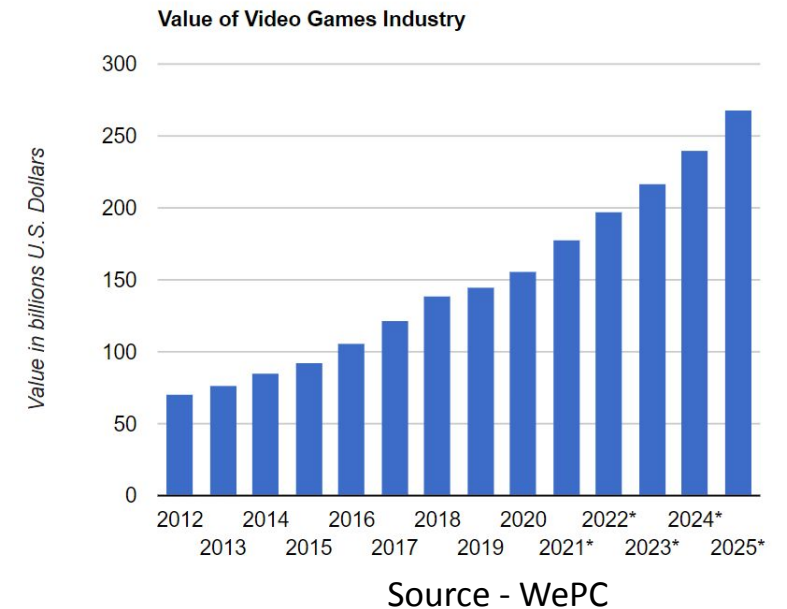
Source	Metaverse Description
Wikipedia (2022)	"In futurism and science fiction, the metaverse is a hypothetical iteration of the Internet as a single, universal and immersive virtual world that is facilitated by the use of virtual reality (VR) and augmented reality (AR) headsets."
Microsoft CEO Satya Nadella (2021)	"The metaverse enables us to embed computing into the real world and to embed the real world into computing."
NVIDIA CEO Jensen Huang (2022)	"The metaverse is the next evolution of the internet ... the internet in 3D, a network of connected, persistent virtual worlds ... where humans will portal into a virtual world with XR devices while AIs will portal out to our world as physical robots."
Matthew Ball (Author) (2022)	"A massively scaled and interoperable network of real-time rendered 3D virtual worlds that can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments."
JP Morgan (Company) (2022)	"The metaverse is a seamless convergence of our physical and digital lives, creating a unified, virtual community where we can work, play, relax, transact and socialize."



J.P.Morgan

What is Different Now?

- **Computing Power and Availability**
- **Network Capacity and Reach**
- **Data Storage and Discoverability**
- **XR (VR/MR/AR)**
- **Ubiquitous Gaming**
- **Investment by Big Tech Companies, e.g.**
 - **Microsoft**
 - **Nvidia**
 - **Meta/Facebook**
- **The Pandemic**





2017

London “Rush Hour”

MS Teams/Zoom
+
Culture Change
?



08:30 Hrs - 10 Sept 2022

A Defence Perspective on the Metaverse

The concepts of virtual reality and avatars in a persistent virtual world(s) remain, however,

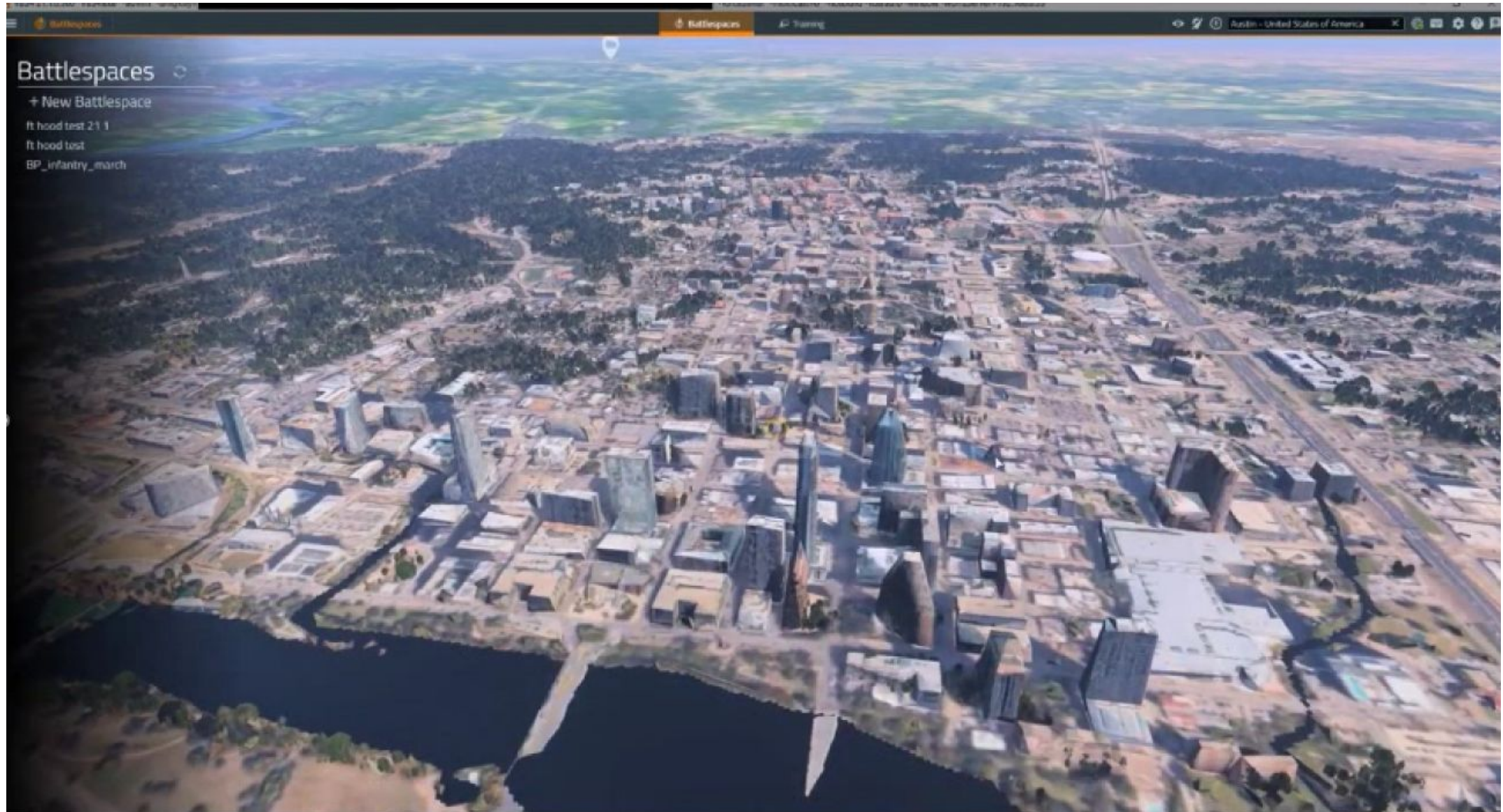
the metaverse can be considered now to also embrace a wider convergence of technologies of varying maturities that are bringing the physical and digital worlds together and,

represents the next evolution of the Internet, a trend from 2D to 3D interaction and immersion between humans, machines and the digital world.

The metaverse could be considered a long standing vision without a fixed roadmap to achieve it

So What?

A Persistent Digital Twin of the Battlespace...



Military Metaverse Users



USAF Capt Jack Thorpe (1978) – Getting Closer?



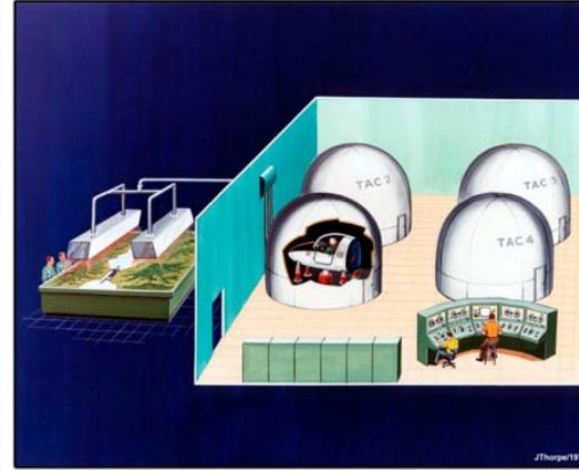
1

Enemy aggression
detected by overhead
sensor



2

Planning a response
using the holographic
electronic sand table



3

Air crews rehearse
the plan and planners
assess suitability



4

Mission execution
with real time
observation

Ref. I/ITSEC 2010 "Trends in Modelling, Simulation and Gaming: Personal observations about the past 30 years and speculating about the next 10" Jack Thorpe PhD

Ender's Game Film (2013)

Leadership



Intuitive Human-Machine Interfaces



Remotely-Operated/Autonomous Agents



Questions?

Prepare for the
Unexpected



**Test & Train
Test & Train
Test & Train**

