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S&T organization

MILITARY METAVERSE CONOPS

MSG-197- NATO Modelling & Simulation Group (NMSG) Symposium
Bath UK
20/21 October 2022

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Outline

- Study Background
- What is the Metaverse?
- Why is the Metaverse of Interest to Defence?
- Military Metaverse CONOPS 2035
  - *aka – A Vision for a Future Defence Integrated M&S Ecosystem*
- Conclusions

STUDY BACKGROUND

SSE 28 Innovation Proposal (Sep 21)

Create a "Military Metaverse CONOPS 2035"

our idea:-

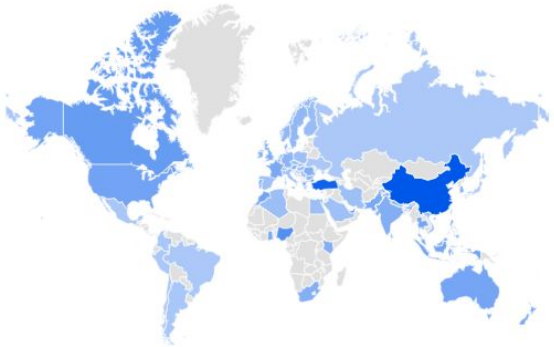
A Military Metaverse CONOPS could provide defence stakeholders with a unified vision of a future integrated multi-domain defence M&S Ecosystem

We set the CONOPS in 2035 to provide time for existing M&S programmes to align

The study also aimed to provide a guide to the metaverse for defence decision makers

GOOGLE TRENDS "METAVERSE"

Keeping Up!

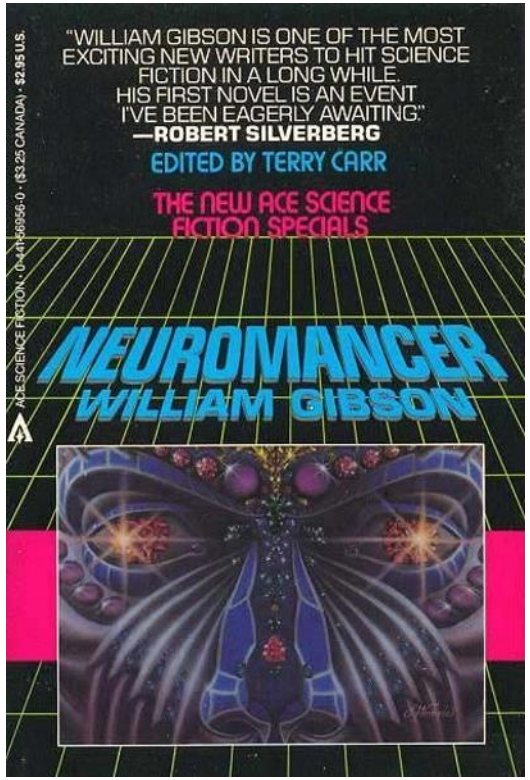


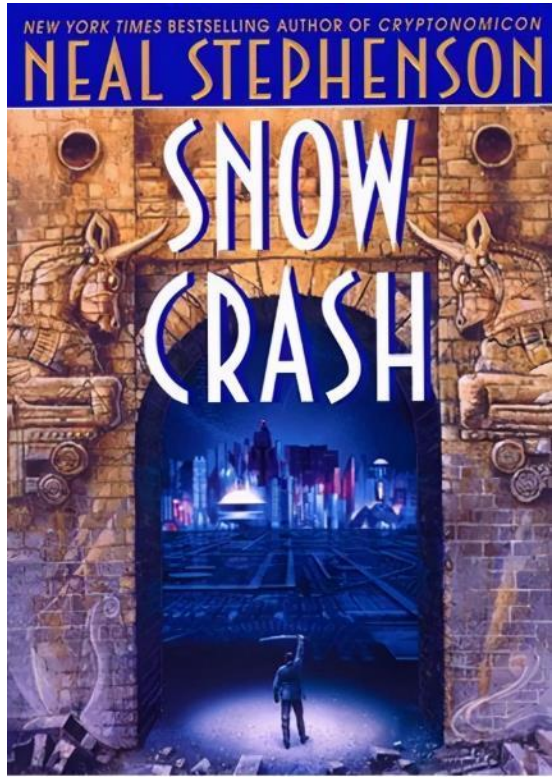
Facebook changes company name to Meta – 28 Oct 21

2020 2021 2022

WHAT IS THE METAVERSE?

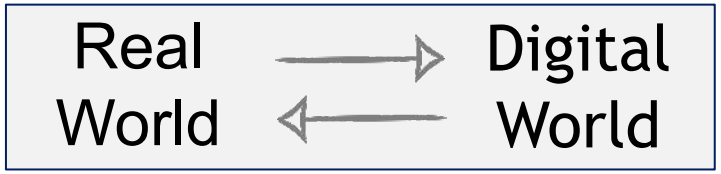
IT'S SCIENCE FICTION…



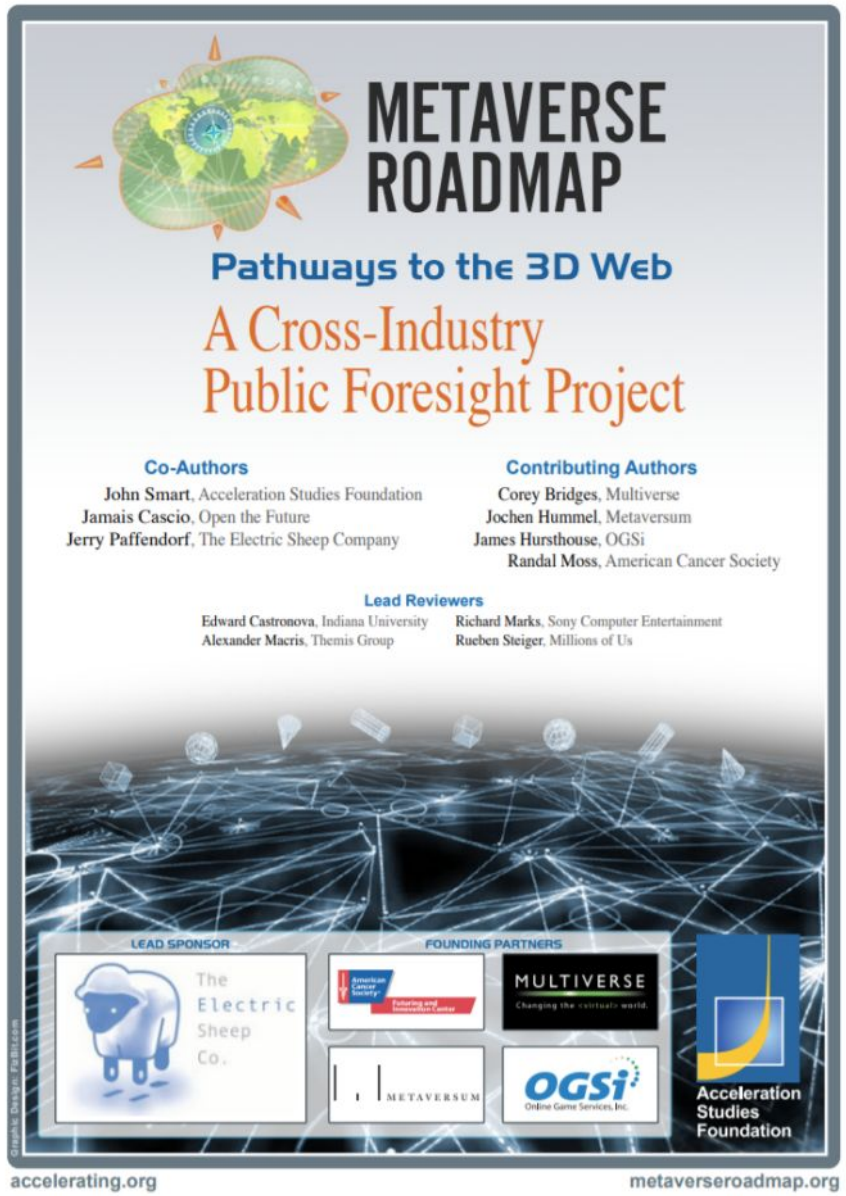


1984 – Created by Gibson, the word "**Cyberspace**" is popularised and "*had no real semantic meaning*" a "*mass consensual hallucination*" in computer networks

1992 – Stephenson creates the word "**Metaverse**" a portmanteau of "meta" (meaning beyond) and "universe" " … *a computer-generated universe* …"



SOME MORE HISTORY - 2007



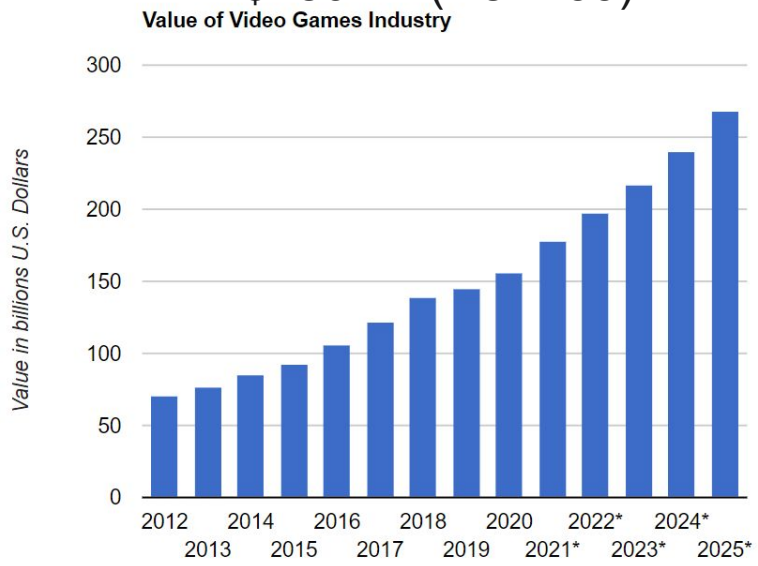
"In sum, for the best view of the changes ahead, we suggest thinking of the Metaverse not as virtual space but as the junction or nexus of our physical and virtual worlds."

Inc. SONY HARVARD UNIVERSITY

WHAT IS DIFFERENT NOW?

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

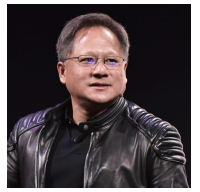
The games market in 2021 generated total revenues of $180BN (Newzoo)



Source - WePC

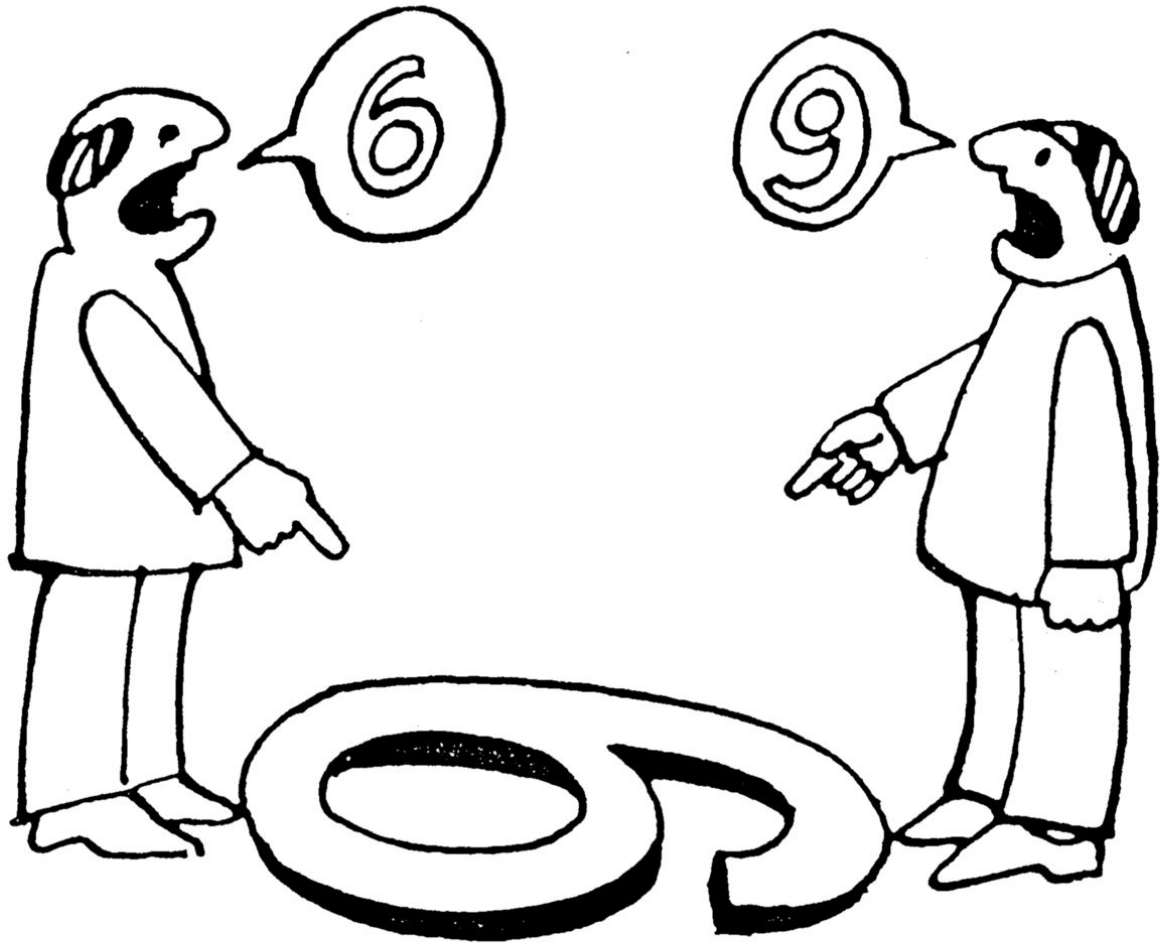
SOME CONTEMPORARY METAVERSE DESCRIPTIONS …

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)	"The metaverse is a seamless convergence of our physical and digital lives, creating



J.P.Morgan

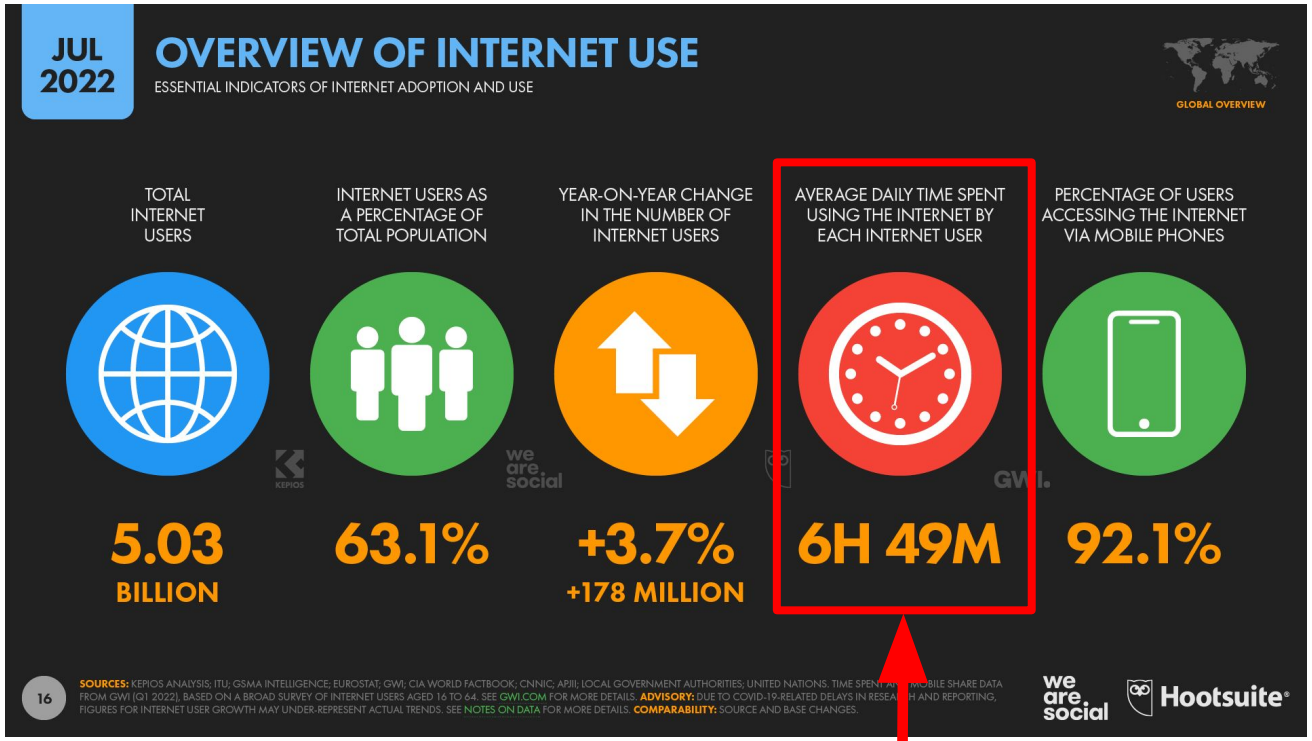
DIFFERENT PERSPECTIVES



METAVERSE OR OTHERWISE, MAJOR DIGITAL TECHNOLOGY TRANSFORMATION IS TAKING PLACE

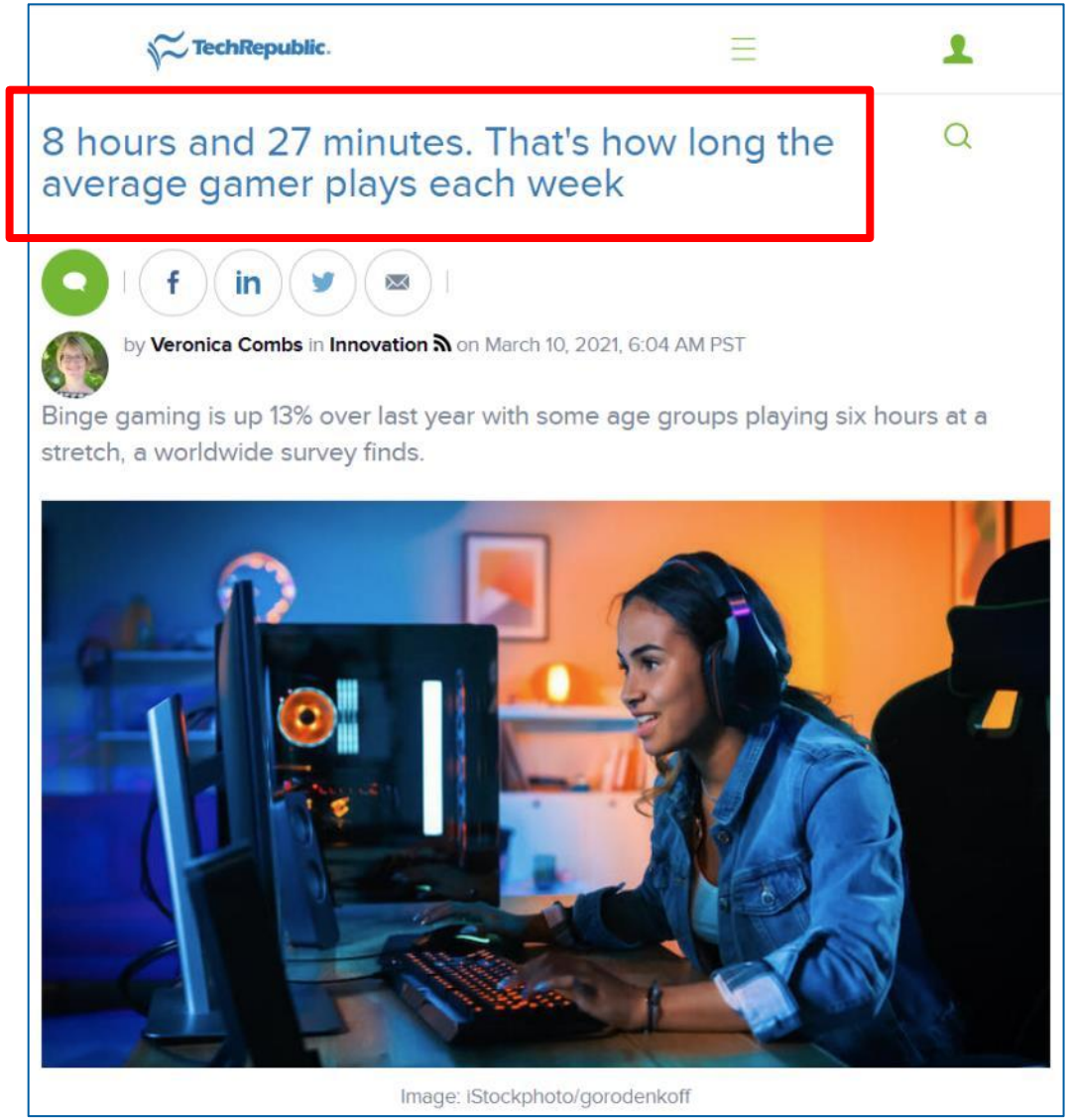
Science Fiction? - The (2D) Internet & Gaming Dominate our Waking Lives

Gaming
>1 hr/day



https://datareportal.com/global-digital-overview

Internet
~7 hrs/day



London
"Rush Hour"

Friday
0830 Hrs - 9 Sept 2022

MS Teams/Zoom

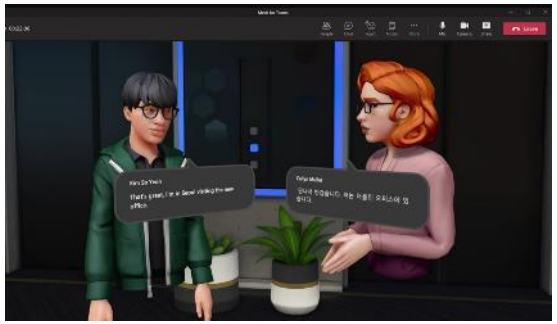
+

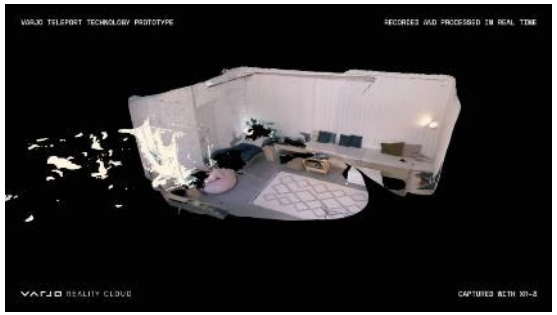
Culture Change

?

CONTEMPORARY PROTO-METAVERSE DEVELOPMENTS

- **Microsoft**
  - Mesh - a collaboration and communications platform supporting virtual collaboration across multiple devices and the Microsoft Metaverse Apps Stack
- **Nvidia**
  - Omniverse™ a scalable, real-time reference development platform for 3D simulation and design collaboration and CloudXR™ delivers XR across 5G and Wi-Fi networks
- **Varjo Reality Cloud** – "Teleport VR"
- Reportedly >10m **Meta Quest 2** HMDs sold (> sales than Xbox consoles in 2021)
- **Epic Games Unreal** – supports mobile, XR, through to flight sim domes (CAE)
- **Roblox** - 225m monthly active users, creating and playing 3D games, played by >50% US children (<16) in 2020
- **Second Life** – launched 2003, a persistent 3D virtual world (GDP $650m (2022))
- **Decentraland** - open source 3D virtual world platform with NFT-based land ownership (opened Feb 2020)



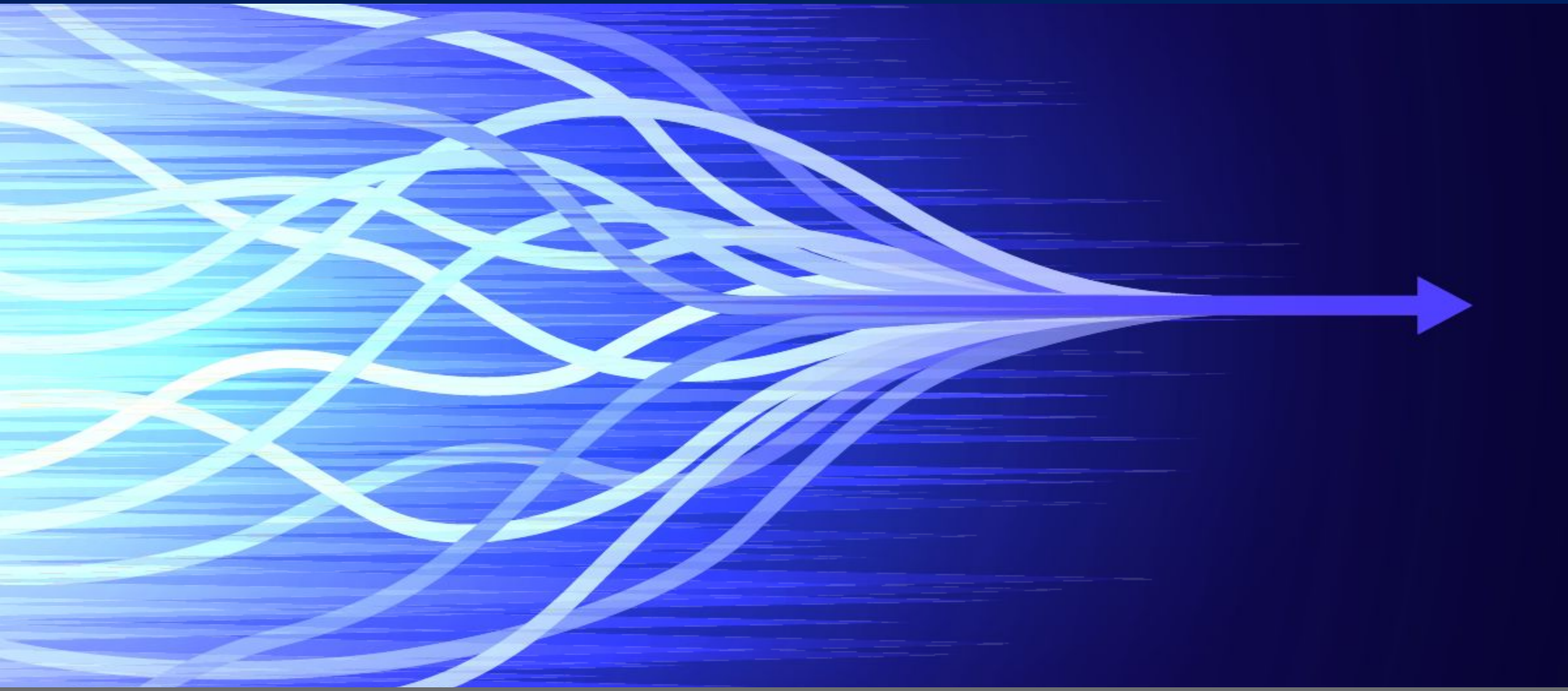


WHY IS THE METAVERSE OF INTEREST TO DEFENCE?

Metaverse v (Our) Military Metaverse Features Mapping

Matthew Ball	Jon Radoff	Lik-Hang Lee et al	Newzoo	Roblox	Microsoft	Nvidia		Military Metaverse
Hardware		Network	Gateways - Centralised	Identity	Mesh & HoloLens	Omniverse Apps		Discovery
Networking	Experience	Edge/Cloud	Gateways - Decentralised	Friends	Azure AI & Autonomous Systems	Omniverse Platform		User Interfaces & Immersion
Compute	Discovery	Artificial Intelligence	Avatar & Identity	Immersive	Power Platform	Artificial Intelligence		Robotics/Sensors/IoT
Virtual Platforms	Creator Economy	Computer Vision	User Interfaces & Immersion	Low Friction	Azure Analytics	Graphics		Data & Digital Twins
Interchange Tools and Standards	Spatial Computing	Blockchain	Economy	Variety	Azure Maps	Compute		Virtual Economy
Payments	De-centralization	Robotics/IoT	Social	Anywhere	Azure Digital Twins	RTX GPU		Content, Services, & Assets
Metaverse Content, Services, & Assets	Human Interface	User Interactivity	Cloud, Scalability & Hosting	Economy	Azure IoT			AI & Computer Vision
User Behaviours	Infrastructure	Extended Reality	Play-to-Earn/Collect	Civility	Physical World			Interchange Tools & Standards
		Avatar	Visualisation & Digital Twin					Network
		Content Creation	Artificial Intelligence					Edge/Cloud
		Virtual Economy	Decentralised Infrastructure					Security, Privacy & Culture
		Social Acceptability	Adtech					Procurement
		Security & Privacy	Connectivity					
		Trust & Acceptability						

Metaverse Big Picture …
A Convergence of Technologies & Human Behaviours



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

A MILITARY METAVERSE?

"Persistent secure networked interoperable live, virtual and constructive simulations, synchronized with multi-domain operational systems and enterprise-wide digital twins of equipments, platforms, infrastructure and personnel and the wider human and natural world."

WHAT ABOUT TECHNOLOGY STANDARDS?

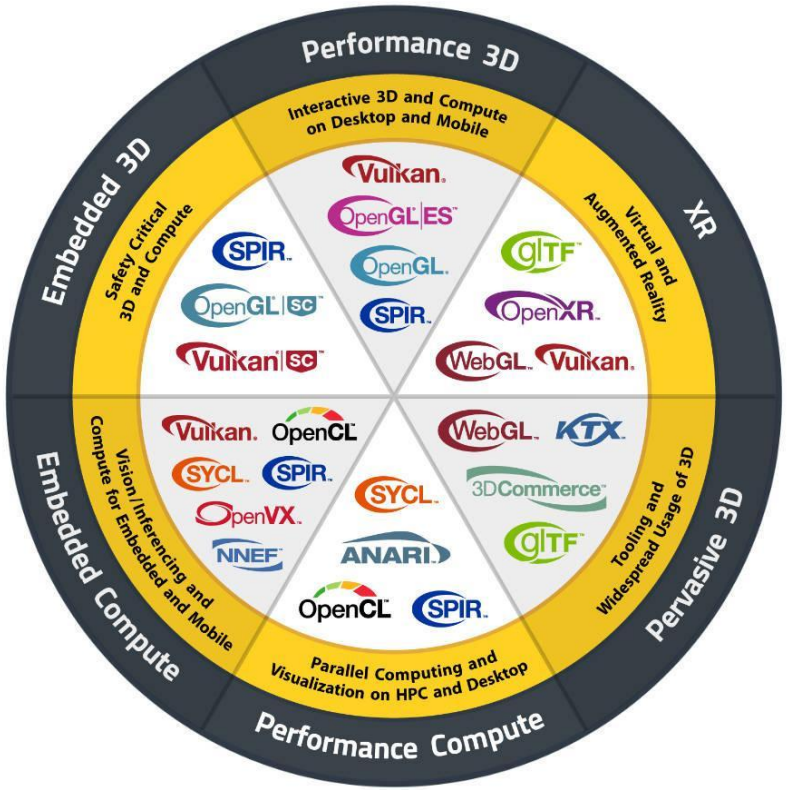
Metaverse-related Standards Developments

- **The Khronos Group**, Inc. is an open, non-profit, member-driven consortium of 170 organizations developing computing open standards
- **Universal Scene Description** (USD) is Disney's Pixar open-source file format and is the basis of Nvidia's "Omniverse" tool
- The **Digital Twin Consortium** comprises industry, government, and academia founded "to accelerate the development, adoption, interoperability, and security of digital twins and enabling technologies"
- **MPEG-V** (2020) – specifies standards to enable interoperability between virtual worlds, as well as between the real and virtual worlds.
- **Cesium** is an open platform for exploiting 3D geospatial data using the 3D Tiles open standard

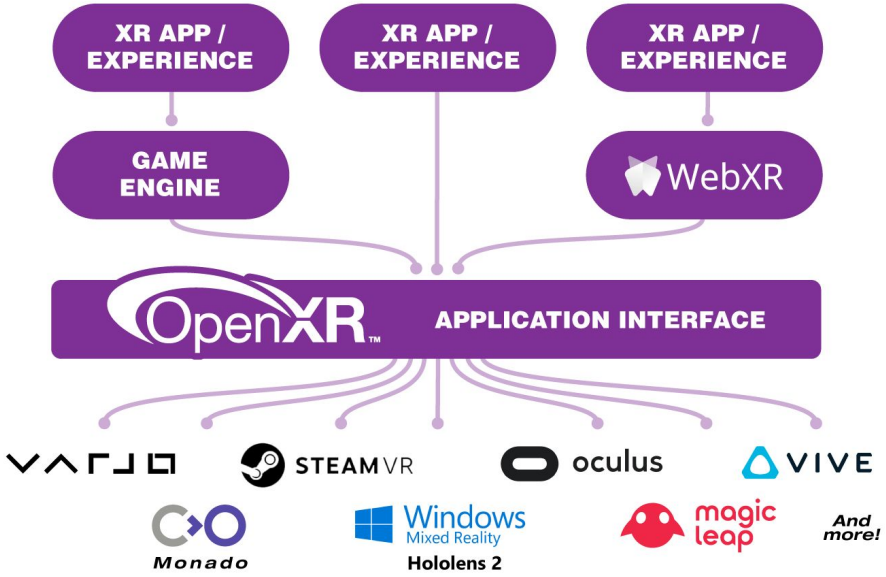
Fun Fact - In ***Snow Crash***, the metaverse's design is "fixed by a protocol, hammered out by the **Association for Computing Machinery's Global Multimedia Protocol Group**"

The Khronos Group (Founded 2000)

Khronos Group Promoter Members (150+ members)



Khronos currently identifies six market segments relevant to developers with similar requirements

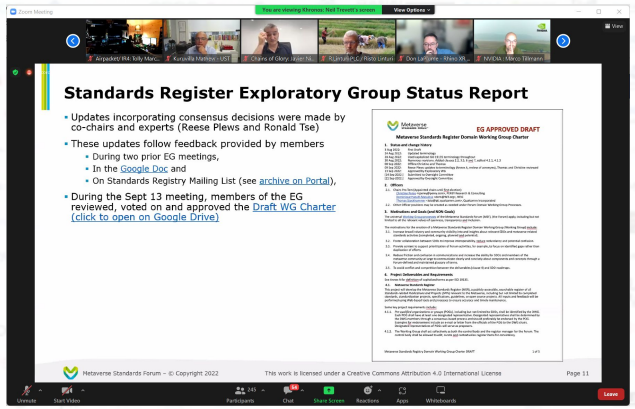


OpenXR provides a single cross-platform, high-performance API between applications and all conformant devices.

Metaverse Standards Forum (est. June 2022)

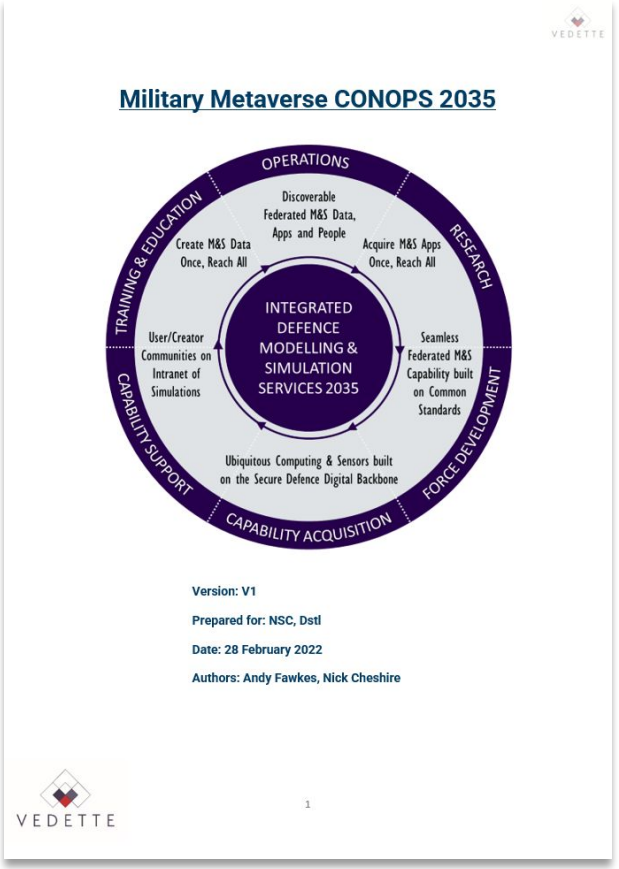
Not aimed at developing open (metaverse) standards, but coordinating, fostering and accelerating their development. Upvoted domains include:

- **Interoperable 3D Assets**
- **Privacy, Safety, Security, Inclusion**
- **User Identity**
- **Avatars and Apparel**
- **Real/Virtual World Integration & Geospatial**
- **Teaching and Education**
- **Payments and Economy**
- **XR and UI**



1500+ Members of the Metaverse Standards Forum in August 2022

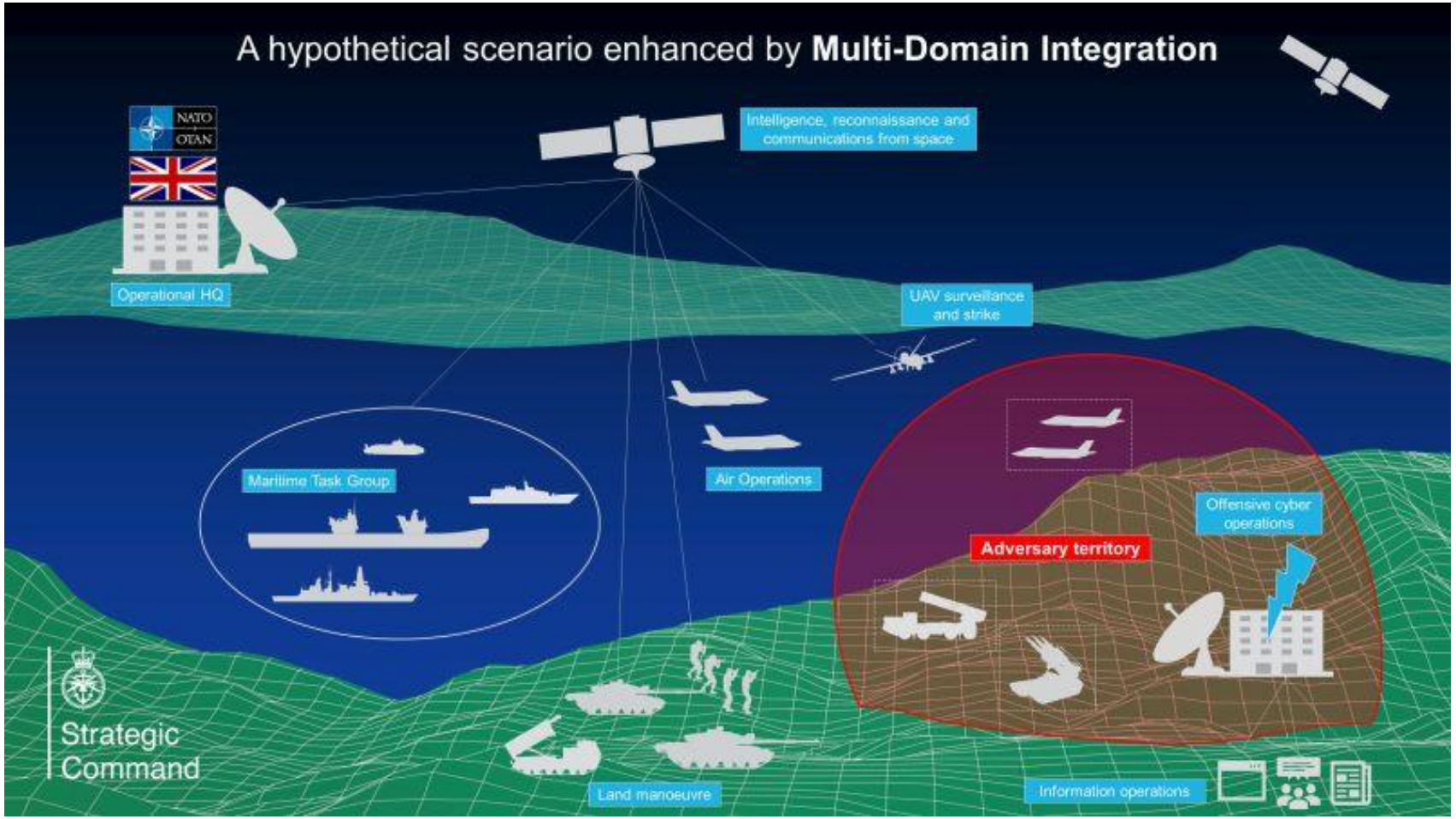
MILITARY METAVERSE CONOPS



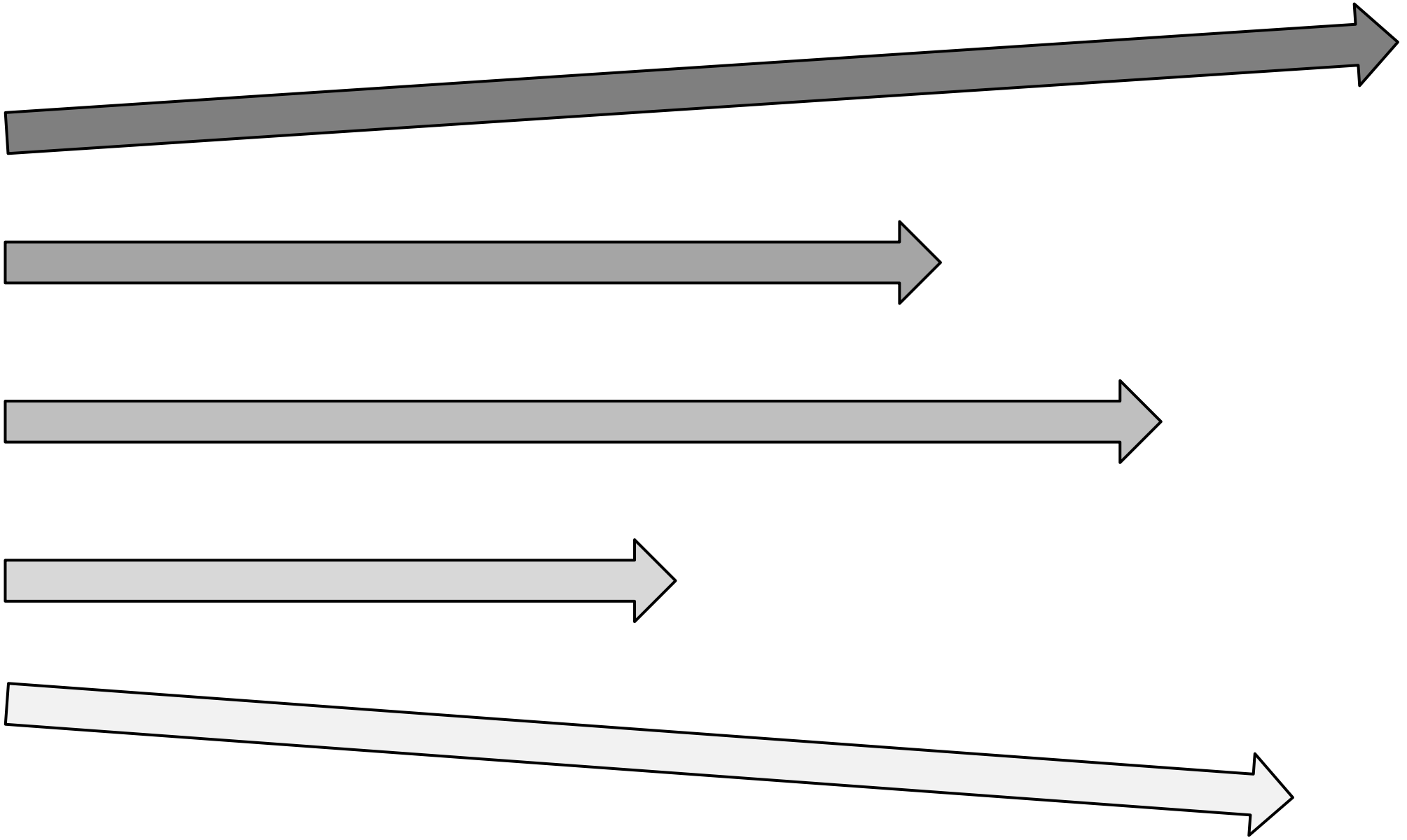
Why a Military Metaverse CONOPS?

Concurrent (UK) Stovepipe M&S Initiatives	Some Common Technology Themes
CTTP	Discovery
Gladiator	User Interfaces & Immersion
MFTS	Robotics/Sensors/IoT
TFST	Data & Digital Twins
Project Selborne	Virtual Economy
JCAST	Content, Services, & Assets
Vulcan	AI & Computer Vision
JFST	Interchange Tools & Standards
DVS	Network
T&E Digital Twins	Edge/Cloud
…	Security, Privacy & Culture

MULTI-DOMAIN INTEGRATION ≡ MULTI-DOMAIN M&S



SIMULATION PROGRAMMES - A SHARED MULTI-DOMAIN FUTURE?



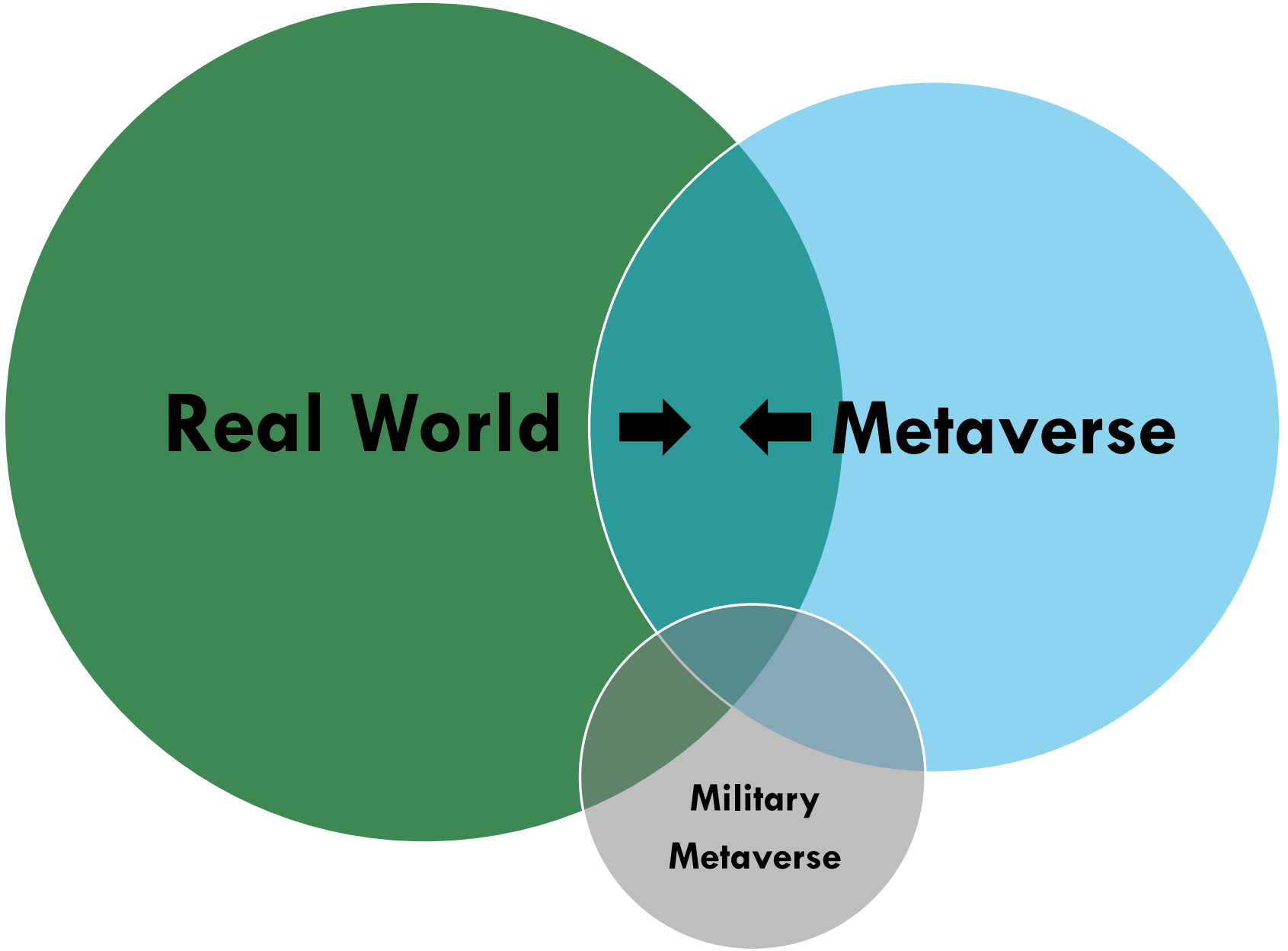
Can we all have the same long(er) term vision for Defence M&S?

WE SET THE GOAL FOR 2035

Current day M&S capabilities include many legacy systems, plans and assumptions, but it was envisaged that by 2035 the necessary course corrections might be made now for current and planned M&S programmes

ASSUMPTION:-

SIMILAR, SEPARATE & CONNECTED



ASSUMPTION:- MILITARY METAVERSE CONSUMERS/USERS

Operations

Training & Education

Research

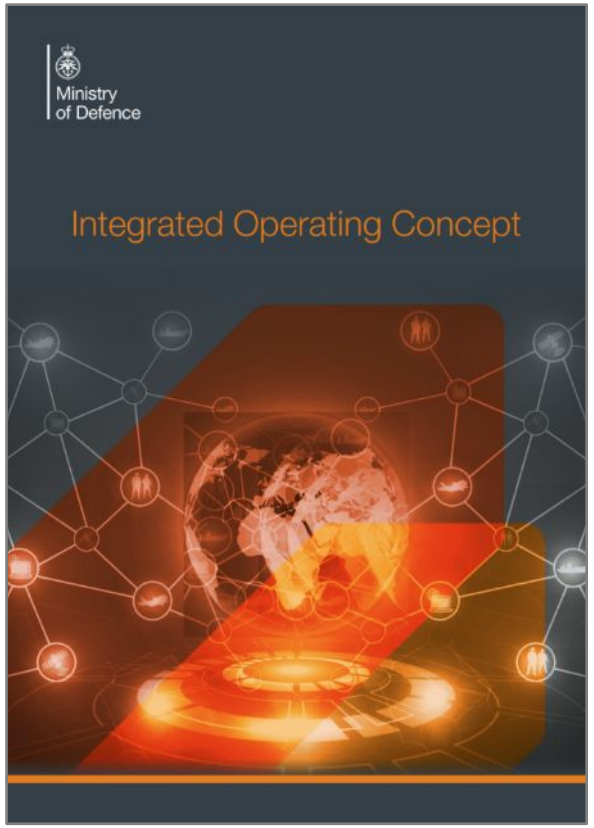
Capability Support

Force Development

Capability Acquisition

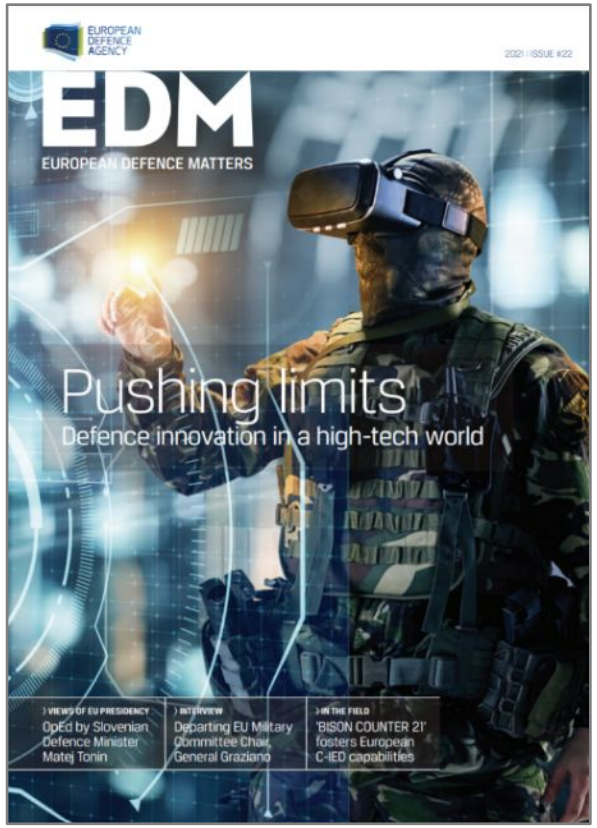
THE WORLD IN 2035 – SOME HIGH LEVEL DOCUMENTS

March 2021



Sept 2021

May 2021



Nov 2021

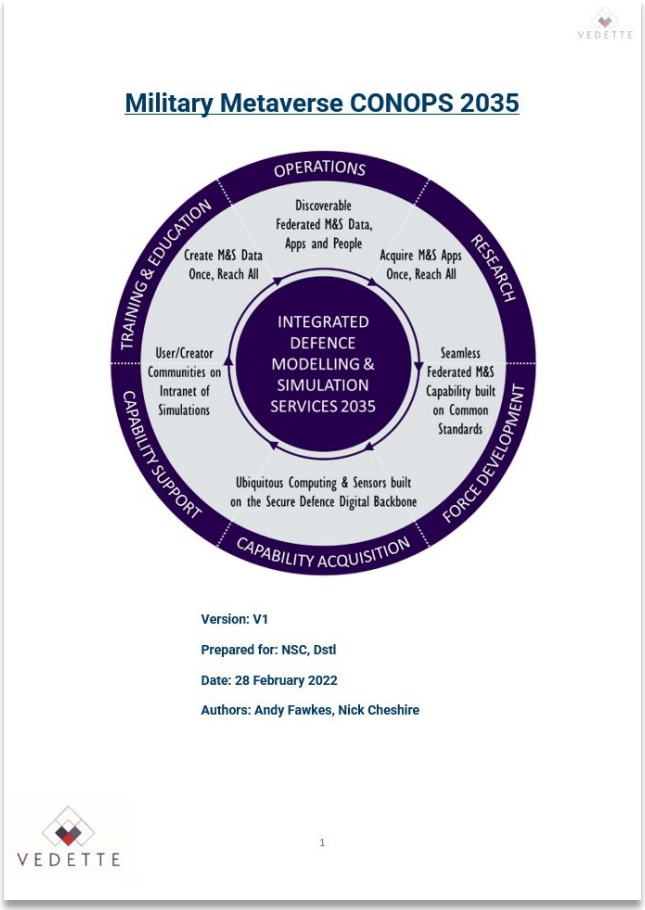
M&S Aligning with MoD's Digital Strategy (2021)

- Defence will value **Data as a strategic asset**
- Data is **catalogued, accessible, useable**
- **A secure, singular, modern Digital Backbone** connecting sensors, effectors and deciders across military and business domains and with partners
- Technology - **multi-class hyperscale cloud**
- Integration: **common architectures and standards** driving design and delivery integration by default
- Delivery requires a **strongly co-ordinated and integrated pan-Defence approach,** with action taking place in a federated approach

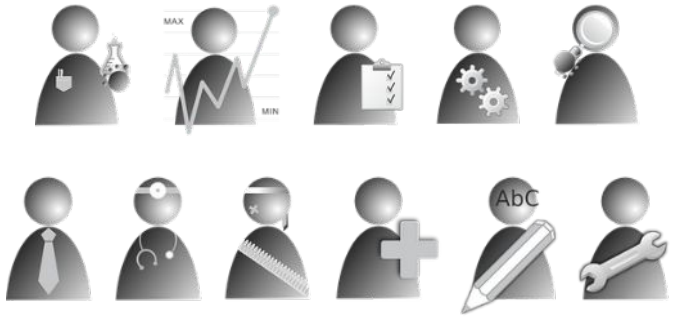
CONOPS – FORMAT BASED ON ISO/IEC/IEEE 29148:2018

The CONOPS serves as a basis for the organization to direct the overall characteristics of the future business and systems, for the project to understand its background, and for the users of this document to implement the stakeholder requirements elicitation

1. Purpose
2. Scope
3. Strategic plan
4. Effectiveness
5. Overall operation
6. Governance

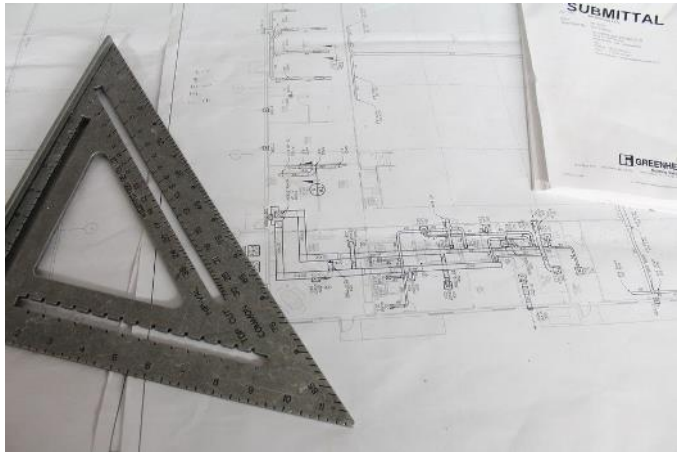


Use Cases



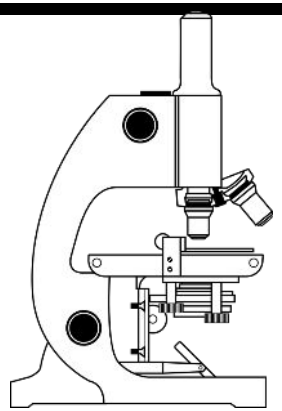
Defence Activity	Challenge	Military Metaverse Support	Benefits
Operations	Preparing for a Multi-Domain Mission	Links warfighters across a single distributed multi-domain simulation that represents the latest operational status	Warfighters can prepare with others across the multi-domain spectrum in timely and representative simulation
Training & Education	Training simulators represent the latest systems/ platforms	Simulators automatically update as new system/ platform models are verified	Warfighters train in updated simulators avoiding negative training
Capability Support	Integration of new systems into existing platform	Stakeholders access legacy digital M&S together with digital representation of new system	Project stakeholders can assess and decide how new capabilities can cost effectively be integrated
Capability Acquisition	Distributed collaborative design by stakeholders	Geographically distributed project stakeholders can instantly interact with latest and legacy digital models in a virtual space	Decision making is timely, consistent, traceable, collaborative and travel is reduced
Force Development	Exploring and optimising human-machine teaming	Humans/warfighters can operate with autonomous systems in simulated environment	Human-machine balance is optimised across Lines of Development
Research	Programming autonomous systems across a spectrum of use cases and environments	Autonomous systems are trained in a broad range of simulated environment	Autonomous systems programming is robust and verifiable while operating in a broad range of scenarios

Design Principles



MM2035 Design Principle	Comment
Built on Defence's Digital Backbone	M&S is intrinsic to, and integrated with, wider operational and business Information Systems
Ubiquitous Computing & Sensors	Digital Backbone supports secure cloud through to edge computing technologies across the M&S ecosystem
Intranet of Simulations	Defence simulations are federated and connected permanently (and as necessary) to support multi-domain integration and sharing, both for the UK and with MoD international partners
Support Widest Range of Human Interfaces	Users can interact with M&S using the most appropriate hardware (eg. mobile device, or XR, through to full immersion)
"Create Once, Reach All" Data	Projects create/procure and manage their M&S data through life as a strategic asset, and ensure it is discoverable, interoperable with, and accessible to, projects and users and creators across the M&S Ecosystem
"Acquire Once, Reach All" M&S Applications	M&S Applications are acquired once and then made available across M&S Ecosystem
M&S Applications and Data are Discoverable	M&S Application and Data usage is optimised, consistent and cost effective
M&S is Verified and Cost Effectiveness Benchmarked	Defence understands the quality and cost effectiveness of its M&S systems and optimises its balance of investment
User/Creator Communities Supported	Technology, processes, and culture support vibrant supportive user/creator communities that optimise the use of M&S
Common M&S Standards	Commercial and military standards are exploited to enhance interoperability and maximise cost effectiveness
Federated Defence M&S Catalogues and Libraries	Sharing, reuse and coherence of tools and data will be everyone's responsibility and achieved through network-wide access to verified tools and data

Example Research Questions



Topic Area	Example Research Question(s)
M&S Data	Establish common M&S metadata standards and evaluate and recommend sharing tools
Connectivity	Identify MM2035 bandwidth and latency requirements and balance between fixed and mobile infrastructure (eg. 6G)
Cloud/Edge Infrastructure	Set requirements for M&S computing requirements and balance between cloud and edge
Discovery	Evaluate and recommend tools for data and tools/applications discovery
Communities	Evaluate sharing and communication tools and foster an M&S sharing community culture(s)
Security and Privacy	Establish policy for capture, storage, and access to personnel data
Standards	Engage with wider metaverse standards groups (eg. Khronos Group)
People & Process	What SQEP does MM2035 require and what culture and processes will maximise M&S exploitation and sharing?
Experimentation	*Technology(s) to be evaluated with users prior to wider fielding*

"MM2035 Co-ordinating Authority"

Serial	Task (0-3 years)
a	Develop a Metaverse Strategy for Defence
b	Develop MM2035 Measures of Effectiveness
c	Develop "Ready for MM2035" rules and guidance
d	Be the co-ordinating authority for Defence M&S
e	Establish Common M&S-based research themes and lead their exploitation
f	Customer for central investments in M&S tools, data and networks
g	Lead a federated approach to creation & access to defence M&S tools & data
h	Build on the Defence Modelling & Simulation Coherence (DMaSC) M&S Standards Profile (DMSP) with wider metaverse-related standards (eg. Khronos Group)

MILITARY METAVERSE 2035

Military Metaverse > ∑

As well as serving use cases across defence, a military metaverse could ensure M&S capabilities are always up to date, consistent, verifiable, cost effective and reach all that can benefit

… realising the full potential of defence M&S, irrespective of distance.

Conclusions

The current interest/hype reflects a distant vision that does not seem so distant now

The metaverse is not one technology, but an umbrella term for many converging M&S and wider digital technologies

No one is currently saying it will be a single virtual world

The metaverse will embed computing into the real world and embed the real world into computing

The metaverse is of great significance to defence M&S and the wider digital domain

The weight of $ external to defence will drive developments, which are likely unpredictable

Defence needs to be an "intelligent customer" for metaverse technologies and standards

A "Military Metaverse" could exploit metaverse-related standards, technologies and approaches, and provide now a unifying vision for future defence enterprise-wide M&S services

NEXT STEPS?

A Military Metaverse Summit?

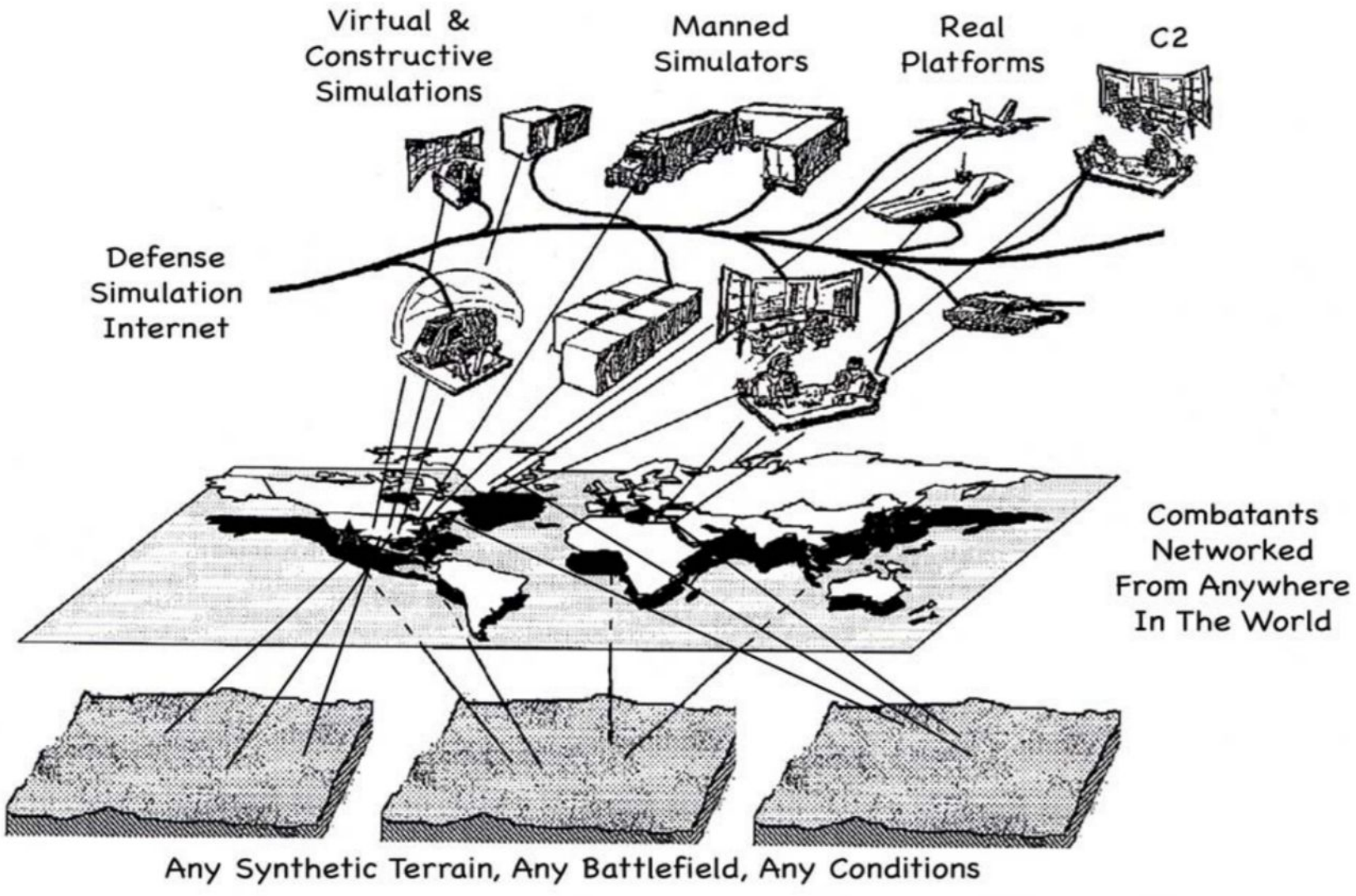
- Pan MoD/Military/Govt M&S Stakeholders
- Defence industry
- Wider Tech/Gaming Industry and Academia

How can Defence best exploit metaverse technologies and approaches and realise the full potential of networked M&S?

Multi-Domain Integration as a theme

A MILITARY PROTO-METAVERSE:

1980s DISTRIBUTED SIMULATION VISION AND SIMNET BLUEPRINT



SIMNET's 1980s Vision - Jack Thorpe PhD (Colonel, USAF, retired)

Q&A?

VEDETTE

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Nick Cheshire
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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 describes a defence M&S ecosystem built on metaverse technologies, standards, and approaches, together with benefits, use cases and actions to take.

It provides a future 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.