

Royal Aeronautical Society's
Flight Simulation Conference 2026

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13-14 October 2026

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Simulation of Autonomous Systems: From Digital Twins to the Future Battlespace

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Thinke

Remograph

Outline

- Digital Twin Basics
- Comparing Humans and Machines
- The Rise of the Machine and its Simulation
- A Digital Twin Case Study - Västervik Drone Science Park
- Simulation Standards Challenges
- Looking Back to Look Forward

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What is a Digital Twin?

"A Digital Twin is a Virtual Representation of a Connected Physical Asset"

(AIAA and adopted by NMSG MSG-205)

- Persistent
- Dynamic
- With the physical asset and/or remote
- AI might be considered their brain

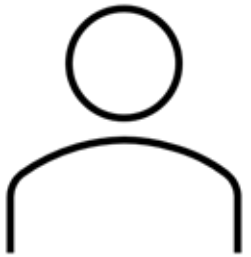
References:

- Digital Twin: Definition & Value – An AIAA and AIA Position Paper 2020 (American Institute of Aeronautics and Astronautics)
- Skinner & Pena Regueiro, STO-MP-AVT-369-29, NATO STO/MSG-205;
- Maglione et al., STO-MP-MSG-207-20, NATO STO/CMRE, 2023

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Humans & Machines

- As a human you are either in the real world, or in a virtual simulation.
  We also have skill fade and forget, and we exist in real time.



- A machine with a persistent digital twin can be in both, simultaneously, continuously comparing notes with itself, learning, reacting to its environment, and it remembers everything.

- A machine can train 24/7 in a simulation, faster than real time, across many parallel scenarios at once. Skills can be shared by all machines.



- And unlike a human training pipeline, this is not learn once then deploy once, it's a loop, real data constantly retesting the digital twin.

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What This Means Now

- Strategic shifts:
  - **Control is shifting human → machine**
  - **Simulation shifting episodic → persistent**

- Together a "battlespace digital twin" simulation is not only an episodic training aid, but always-on developmental and operational infrastructure

- *Have our simulation standards been tailored to episodic events with humans in the loop, whilst we are now moving towards persistent simulations with machines (and humans) in the loop?*

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Why Should this Matter?

- Machines are Transforming Warfare
- Machines Are Multiplying
- Machines Are Rapidly Evolving
- Humans are Organising around Machines
- A Complex and Evolving World of Sim/C2/Non-Defence Standards
- Simulation as a Competitive Advantage

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Machines Are Multiplying and Transforming Warfare





August 2026 (Russian MoD via X)
Ukraine drone deployed an UGV with an anti-tank mine behind enemy lines

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The Economics of Warfare

- UAE's defence against Iran's 28 Feb barrage:
- For every $1 Iran spent on uncrewed, the UAE spent ~$20-28 shooting them down
- PAC-3 Patriot missiles take around 2 years to manufacture, Shaheds do not



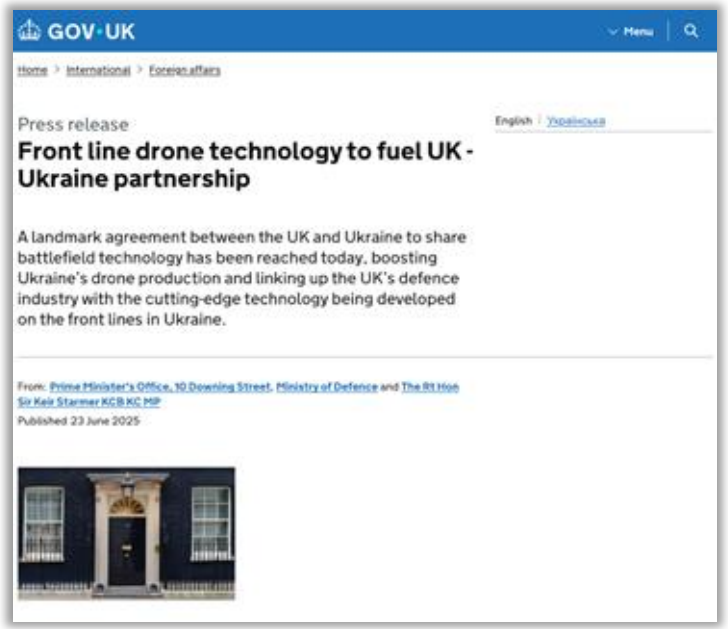
March 27, 2026 - USAF E-3 Sentry ~$500m

Source - Kelly Grieco, Senior Fellow, Stimson Center (US Non-partisan)

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Machines Are Rapidly Evolving

- Iteration in weeks, not years
- It is not all "AI", it is rapid agile engineering and COTS exploitation



No 10 Downing Street, 2025

'drone technology evolving, on average, every 6 weeks'

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Swarms are Coming

- Human Remote control
- Cameras
- + $3,500 MESH Modem Relays forming a chain
- + AI for some targeting

August 2026

- Interception rate 90% ↓ 60%
- Russia making 3,000/month ↑



Sources includes - www.rferl.org/a/russia-ukraine-jet-powered-drones-shahed-geran/33841747.html

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Humans are Organising Around Machines



- Unmanned Systems Forces of Ukraine
- Est. 11 June 2024
- Size 40,000 – 80,000



- General Denis Lyamin
- New Head of Russian Unmanned Systems Forces
- Est. August 2026

en.wikipedia.org/wiki/Unmanned_Systems_Forces_of_Ukraine

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A Complex and Evolving World of Standards

Standards for how uncrewed systems connect to real command and control (not simulation standards).
Each domain seems to be building a rulebook:

- **Air: STANAG 4586, UCI, OMS (UCI & OMS also cover manned aircraft, not uncrewed only)**
- **Land: Army IOP, built on JAUS, the Joint Architecture for Unmanned Systems**
- **Maritime: STANAG 4817, known as CATL, the Collaborative Autonomy Tasking Layer**

None of these appear to automatically and easily connect to simulation environment

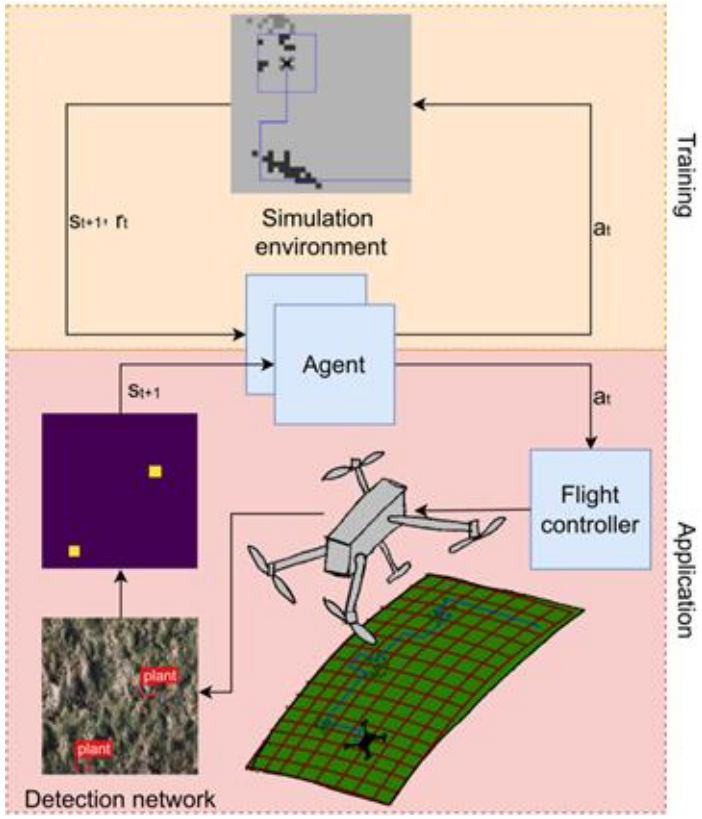
DELTA:
Ukraine may solve multi-domain interoperability but built outside standards bodies

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Simulation as a Competitive Advantage

- Shield AI: part of $2B 2026 raise to acquire Aechelon (simulation)
- Anduril: acquired ExoAnalytic (M&S, space domain)
- Helsing: vertically integrating air/sea/space, bought Grob Aircraft
- Potential Consequence: every vendor validating in its own closed sim, means no shared way to know systems work together in coalition ops

- Counter-example: Auterion's Skynode, an open, vendor-agnostic autopilot and mission-control stack designed to work across different drone manufacturers



arXiv:2505.09278v2

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Case Study



Västervik Drone Science Park, VDSP

- One of Europe’s largest civilian UAS testbeds.
- Strategic location and role in European defense and commercial innovation.

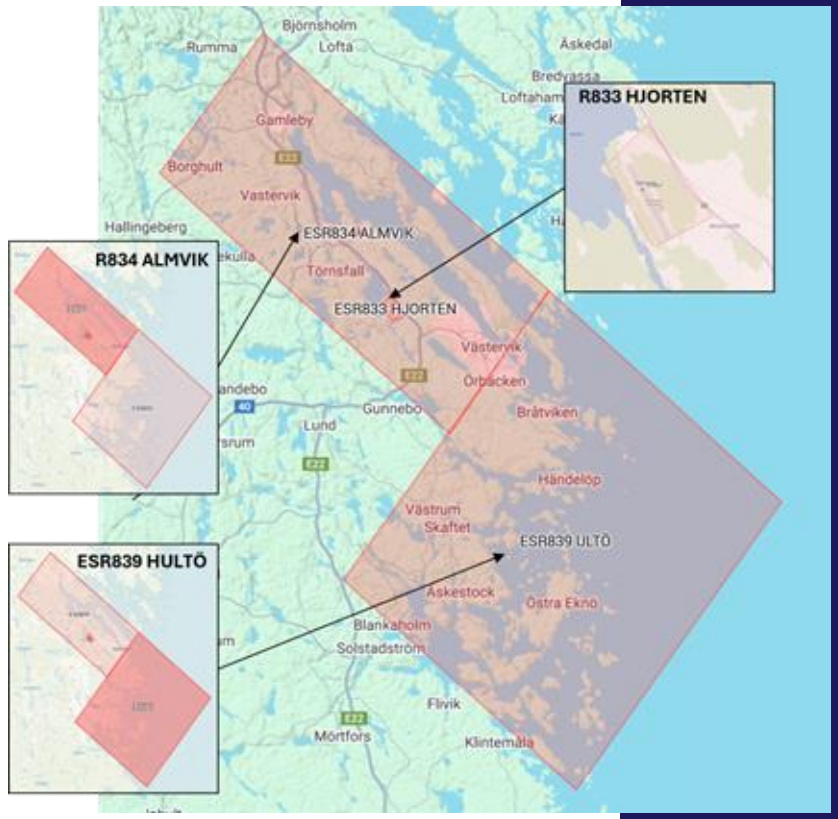
VDSP – Physical Test Environment

Placed around Västervik Airport (ESSW)

- Founded in 2024 for civilian use, now 50% military 1800 square km R-areas, Nordic terrain with forests, archipelagos and open sea
- Critical infrastructure like power lines, railways and windmills for automated inspections and specialized missions

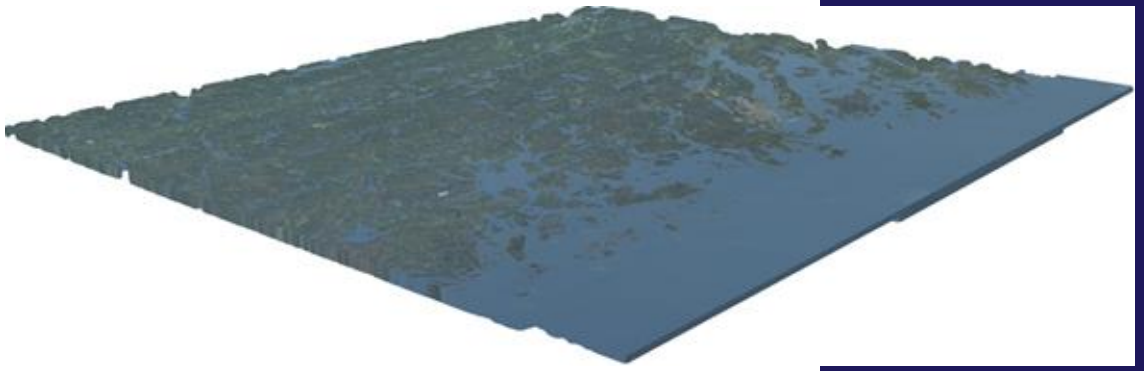
Multi domain

- Air, Land Sea, UxV
- Collaboration
- Academia, Industry, Government
- Defense and Civilian applications



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VDSP - Synthetic Test Environment, Digital Twin



Mapping of a real-world environment into a high fidelity 3D Digital model

- 2600 km²
- Automatically generated from geospatial data
- High-resolution drone captured insets
- Available through a standard web browser



Integration of Real-World Data

- Feeding live sensor and operational telemetry into the digital twin.
- Closing the feedback loop: Virtual simulation - Physical deployment - Model refinement

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VDSP – Digital Twin

Improved Development & Validation

- Validation of autonomous behaviors in a persistent virtual environment, accelerating the development cycle
- Training of AI models
- Introducing simulated effects such as EW and air traffic in the real world

Improved Operator Proficiency

- Provides a bridge between human cognitive bandwidth and machine speed by training drone operators in scenarios they may not have encountered in traditional flight training

Risk Mitigation

- Allows for the testing of drone swarms and complex maneuvers in a risk-free digital environment before physical hardware is even ready for field testing



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Mega Trends

- Proliferation of Rapidly Evolving Uncrewed Machines
- More Autonomous and Cooperating Machines
- Episodic to Continuous Development and Deployment
- Simulation Essential in Support of Uncrewed Machines
- Complex Evolving Uncrewed Machine Standards

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What About Simulation Standards?

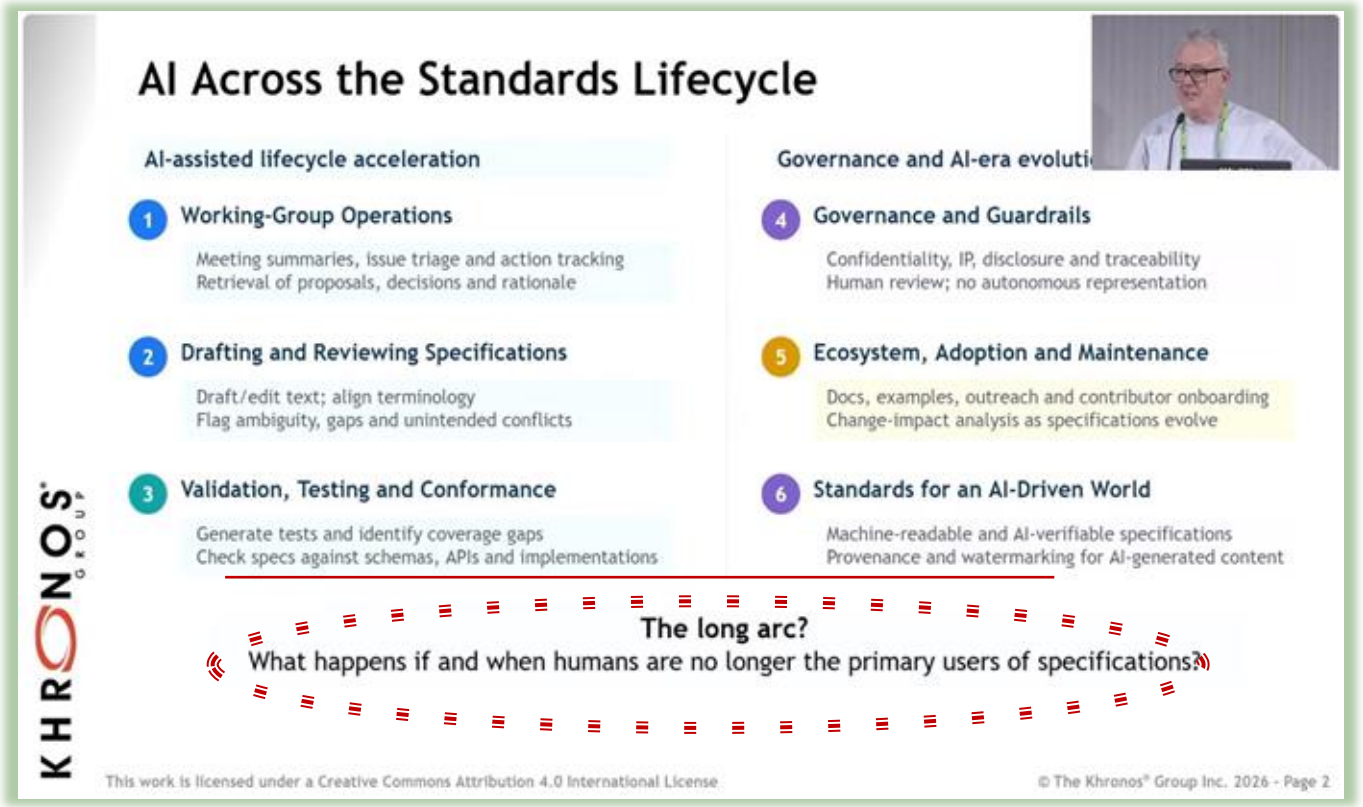
- The Cross Border Challenge - "I'm a Portuguese drone manufacturer. I want to know my system works within German doctrine. How do I convince the Germans?"

- Not one simulation? Not many disconnected unique ones? Many sovereign sims, validated against one shared baseline?

- Three ways forward for standards/SISO:
  - **Adopt** (eg. OpenXR, 3D content already addressed outside defence)
  - **Extend** (eg. HLA for persistence)
  - **Bridge** (eg. C2SIM gateways to operational C2)

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Looking to Other Standards Bodies for Inspiration



SIGGRAPH 2026
August 4th

AI Powered Standards

https://youtu.be/Zd0Rk_u2_qc?si=wvOaikJ0oy-u5bgw

Khronos Group creates and maintains open standards such as glTF, OpenXR, and OpenGL

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Looking Back to Look Forward

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USAF Capt Jack Thorpe's White Paper (1978)



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



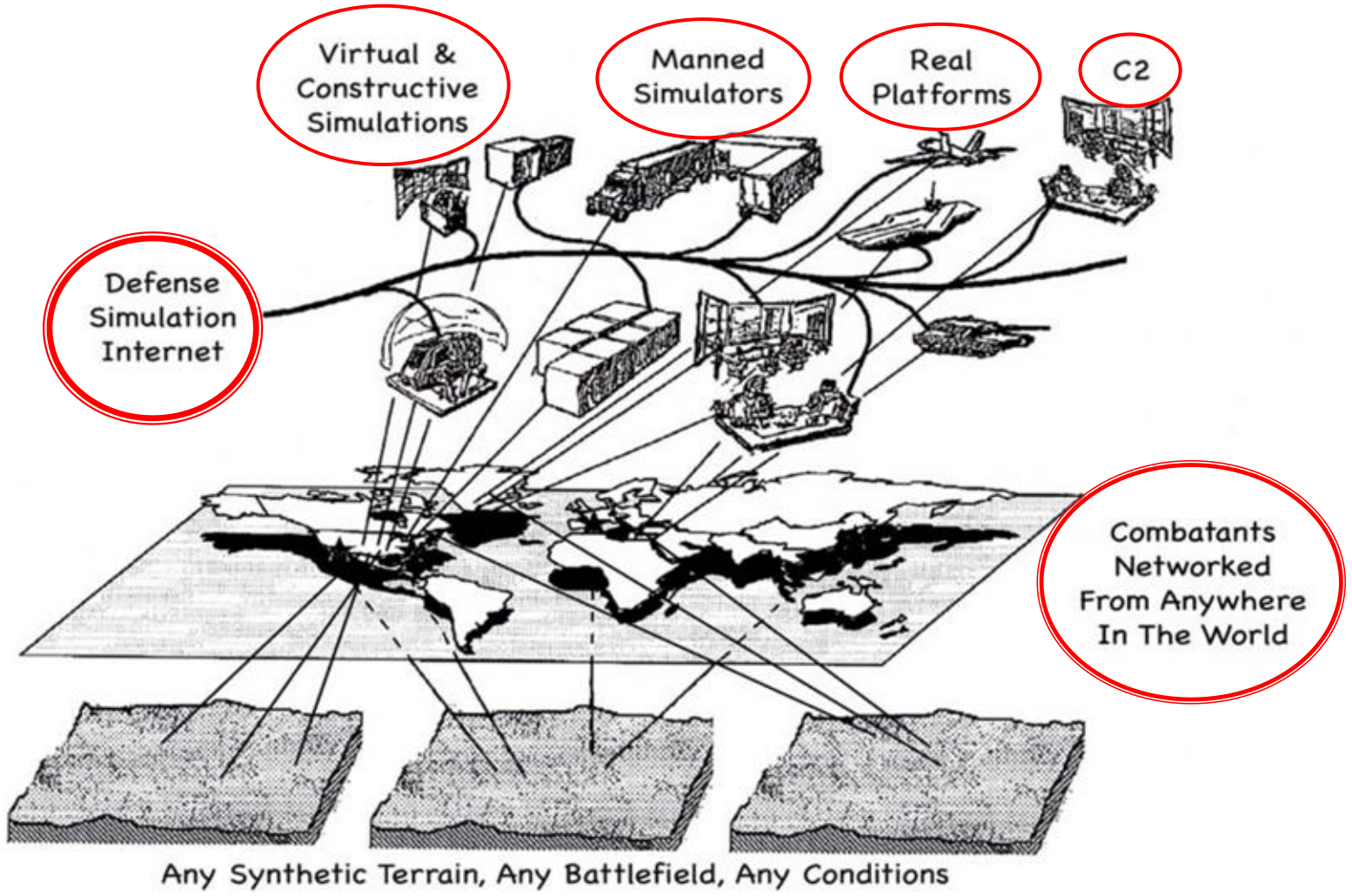
4
Mission execution with real time observation

Tight Integrated ISTAR-Planning-Training-Operational Loop → For Humans

Ref. I/ITSEC 2010 "Trends in Modelling, Simulation and Gaming: Personal observations about the past 30 years and speculatingabout the next 10" Jack Thorpe PhD & SIMNET: An Insider's Perspective: Neale Cosby - March 1995

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Thorpe's SIMNET Distributed Simulation Vision (early 1990s)



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

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Going Back to SIMNET



SIMNET simulators at Fort Knox, KY.
(www.jimmillar.net/BBN.html)

SIMNET, DARPA/US Army 1983-1990

260 simulators across 11 sites showed what's possible connecting human training simulators together

Direct foundation for standards lineage:
SIMNET → DIS (IEEE 1278) → HLA

- **Key question:**

Do we now need a SIMNET of the 2020s, one that connects uncrewed and crewed system simulators

?

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Something to Think About?

SIMNET 2020s

a modernized ”SIMNET" to serve as a collaborative testbed where AI agents, humans, crewed and uncrewed platforms can be developed, tested and prepared for operations within a connected, multi-domain battlespace simulation infrastructure

What War(s) are we Preparing for,
and What Simulation and Standards do we Need?

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Thank You

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