All the World's a Stage (Unless you are in the Military)

Andy Fawkes

Outline

- What's Shakespeare got to do with it?
- An Historical Perspective
- The Rise of Autonomous Systems
- Future of Air Power?
- Conclusions

William Shakespeare (1564-1616)

400th anniversary of Shakespeare's death

“As You Like It” (1599)

“As You Like It” (1599)

All the world’s a stage,
and all the men and women merely players;
they have their exits and their entrances,
and one man in his time plays many parts.

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Different Stages…

Training

Mission Preparation

Analysis

Operations

Images - Wikipedia

Is this a Problem?

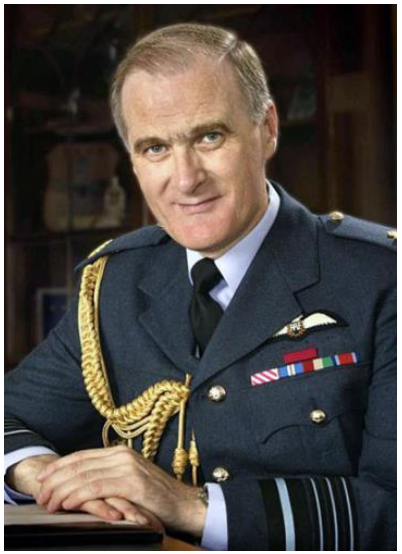
- Military personnel are required to use a number of different training, simulation and C4ISTAR systems
- The systems may work together but will typically have different human interfaces, processes, and digital content that may not be easily shared across systems
- This puts additional workloads on the personnel and runs the risk of confusion and reduced operational agility
- “Train as you Fight”

Ender's Game - 1985

Ender’s Game Film - 2013

Sir Jock Stirrup Chief of Defence Staff

2007 RAeS Edwin Link Lecture



“Lets imagine for a moment a possible future scenario. A commander sits above a battle space with a Gods eye view. He is not actually there he is in a synthetic environment fused from the inputs of multiple and diverse sensors.

By a gesture or a word he can suddenly expand any part of the scene… by word or gesture he can designate targets which are automatically engaged perhaps by unmanned combat vehicles... He sees the results in real time and reacts accordingly... presented also in real time to another commander...

And the scenario that I have described has at its heart the networking of sensors, decision makers and weapons systems… and it fuses synthetic and real world environments in a way that makes it increasingly difficult to distinguish between the two.

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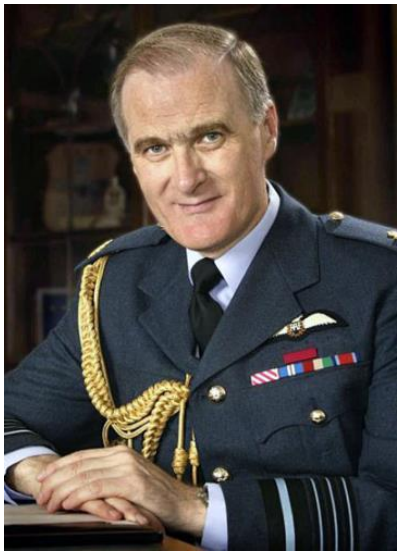

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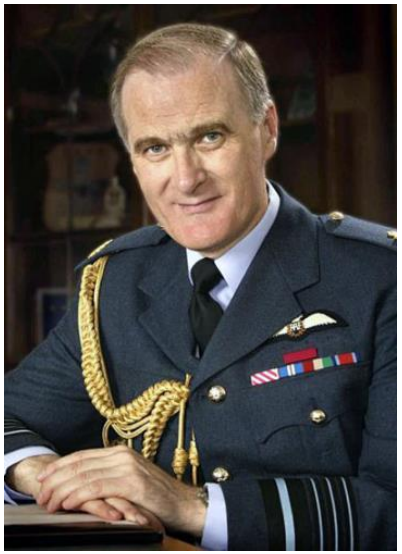

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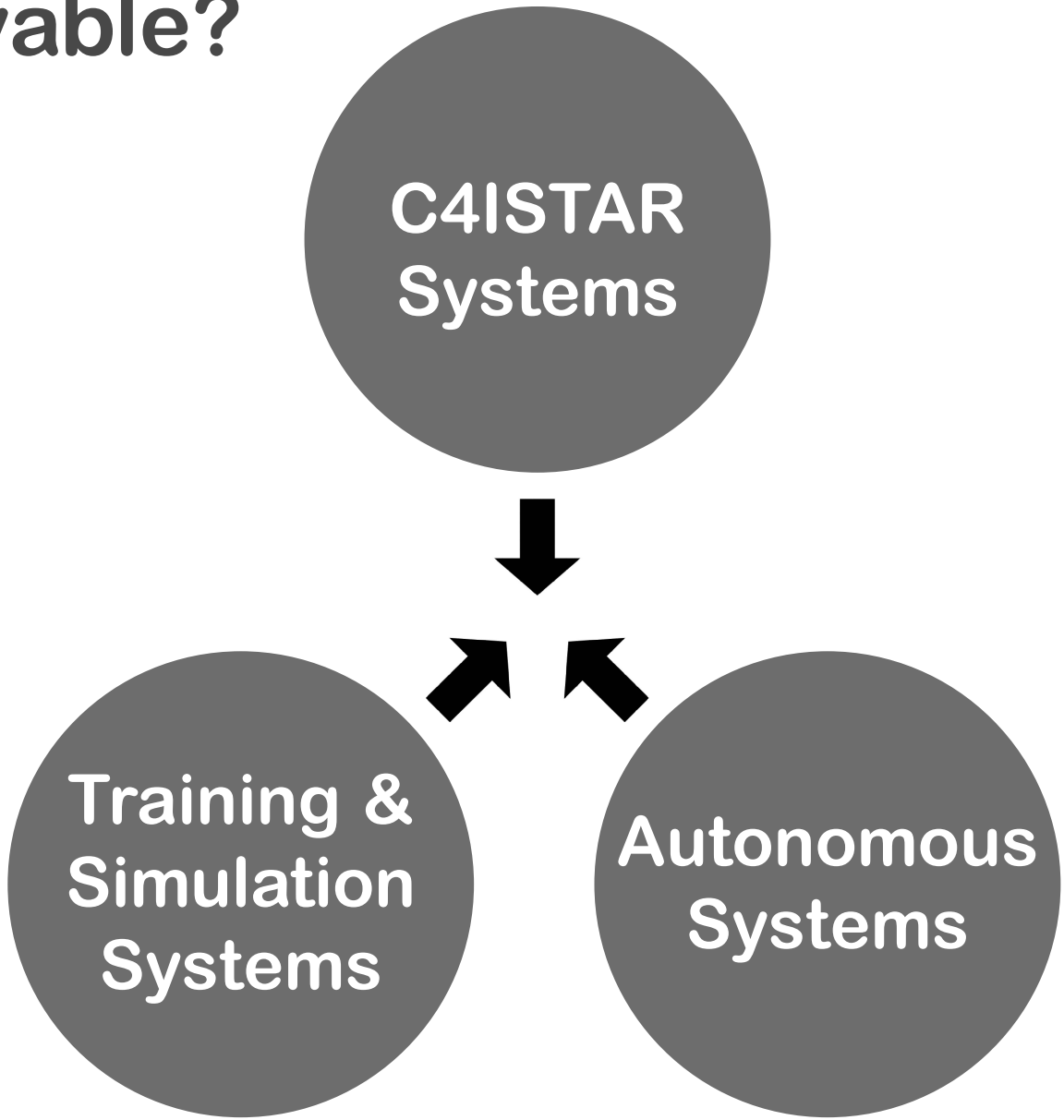
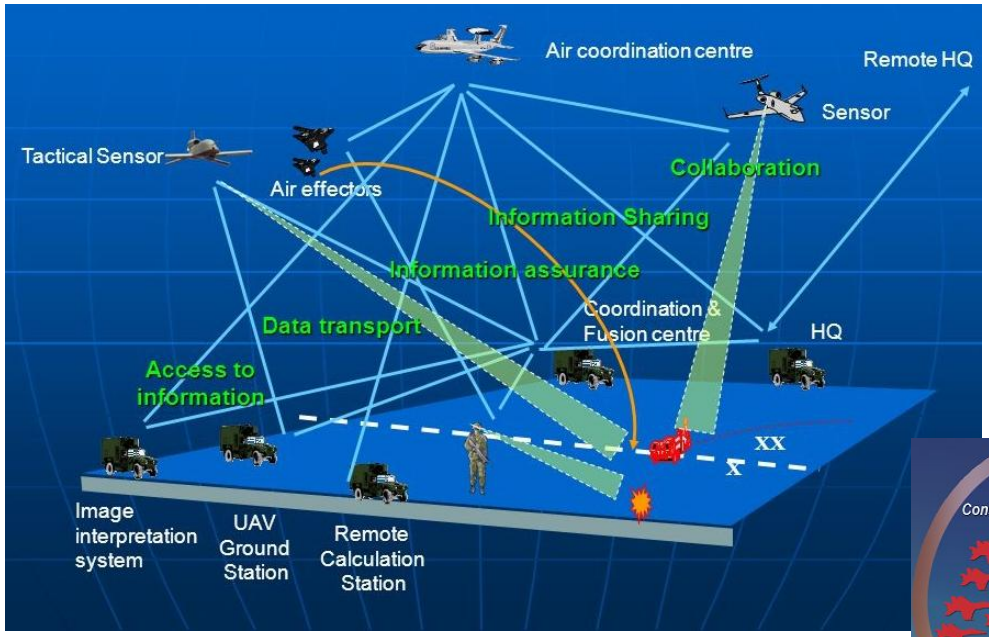
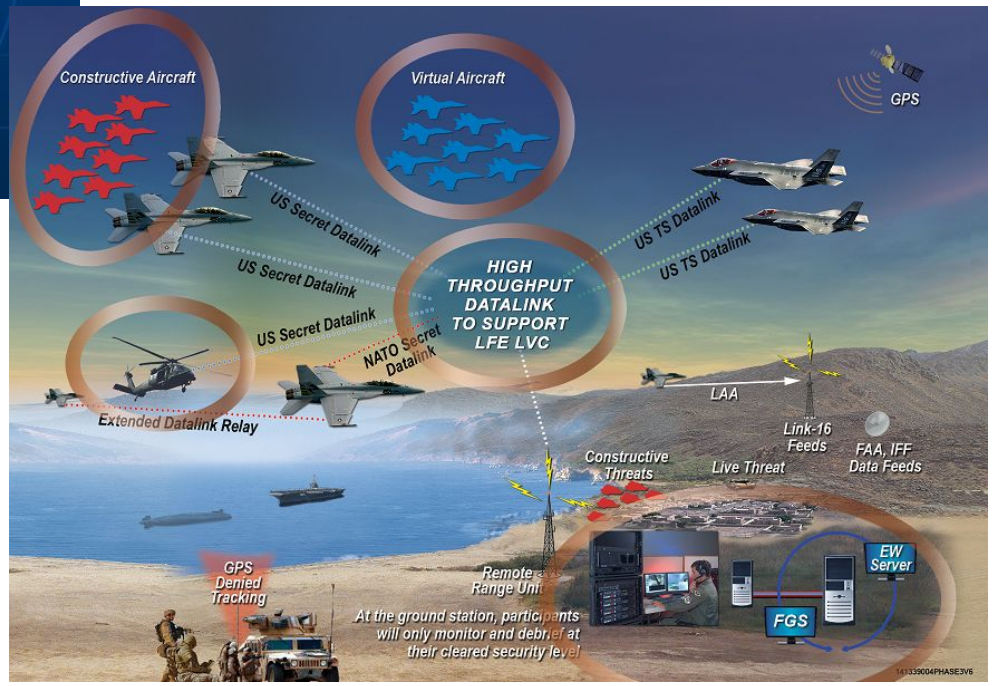
Achievable?


C4ISTAR Systems
Training & Simulation Systems
Autonomous Systems

Joining/Combining Systems



NEC
Network Enabled Capability



LVC
Live Virtual Constructive Simulation

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One System?

- Initiatives to link Simulation & Training and C4ISTAR Systems

- Driven by different research and procurement organisations

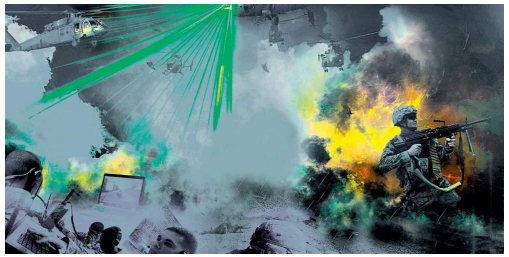
UK Defence Operational Training Capability (Air) DOTC(A)

SRO Mandate

- To provide the Air element of an integrated Defence LVC (Live, Virtual and Constructive) Training Capability by exploiting simulation and synthetically enhancing live training, to satisfy the Team and Collective training requirements at the Component, Joint and Combined levels'.

US Army Synthetic Training Environment (STE)

- Single LVC environment providing an individual, collective, multi-echelon training and mission rehearsal capability
- Operational, institutional and self-development training for the ground, dismounted and aerial platform domains, at the point of need (PoN)
- Specifications
  - Training and mission rehearsal capability
  - Interfaces with operational command networks
  - Interfaces with live training instrumentation
  - One World Terrain within a Common Operating Environment (COE)
  - Immersive and semi-immersive training



An Historical Perspective

SR-71 Blackbird

SR-71 Blackbird

- **Fred Forehand, Singer-Link's SR-71 PM:**
  - **"Every mission was a real mission. Crews were practicing for real-world missions every day,"**
  - **"They created the mission upstairs, and the tape they produced for the simulator was the same tape used onboard in the aircraft computer."**

Training Debriefing Room in the 1970s in Miramar (Top Gun)

- Cubic Defense Systems installed the world's first air combat maneuvering instrumentation (ACMI) system for tracking the aircraft, their firing envelopes, and simulated weapons release.

“Future Views: Aircrew Training 1980-2000”

Captain Jack A. Thorpe, US Air Force Office of Scientific Research - 1978

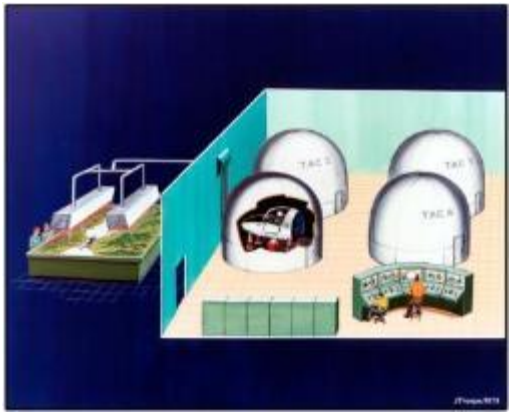
1

Enemy aggression detected

2

Planning a response

3



Rehearsal and analysis

4

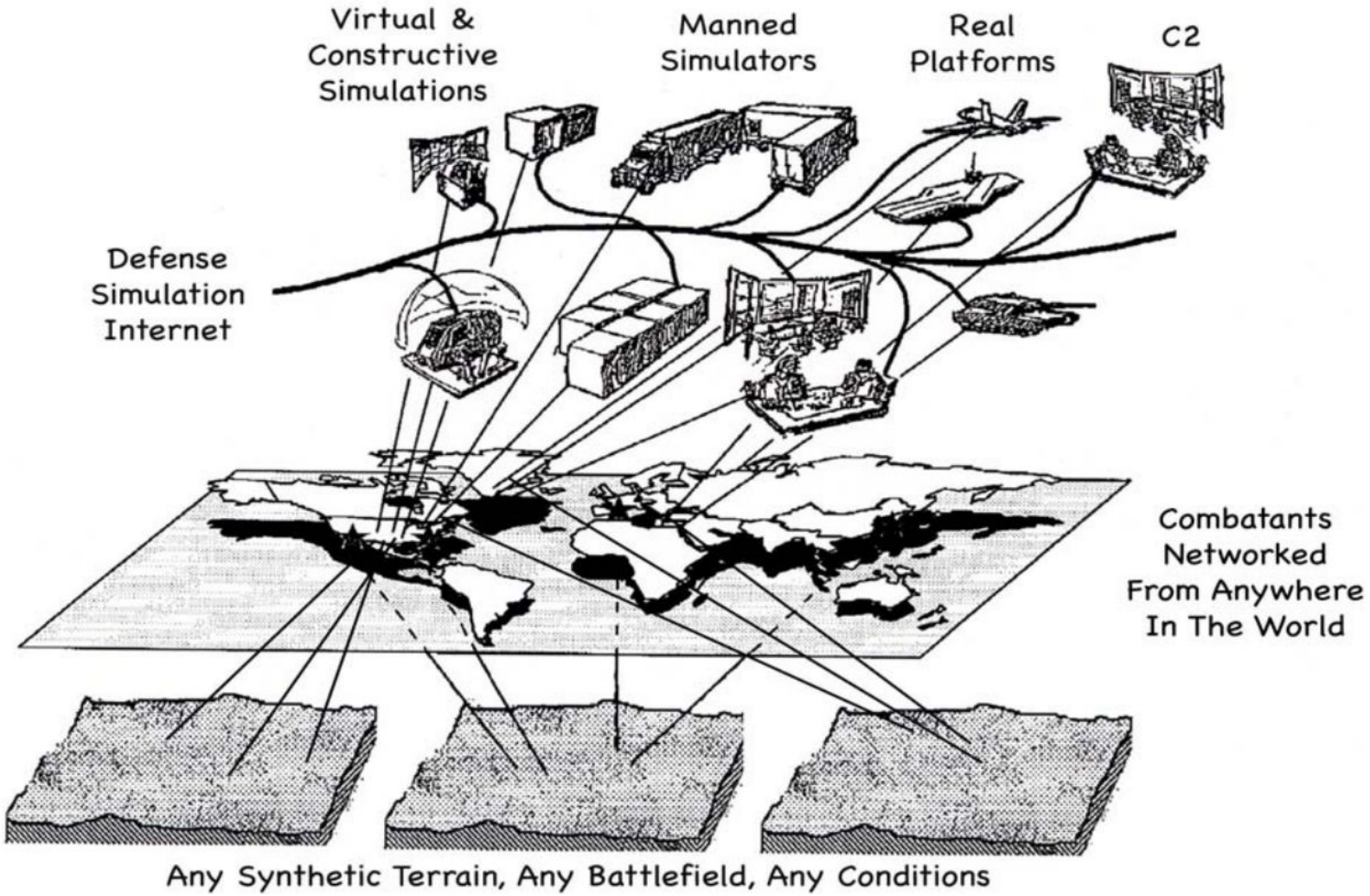
Real time mission observation

1978 - “Future Views: Aircrew Training 1980-2000”

"advances which are seen on the horizon are not simple improvements in teaching techniques or higher fidelity simulators, but rather bold concepts which tightly align training systems with real combat readiness and make them indistinguishable.“

– 1978, Captain Jack A. Thorpe, US Air Force Office of Scientific Research

DARPA SIMNET Distributed Simulation Concept (1983)



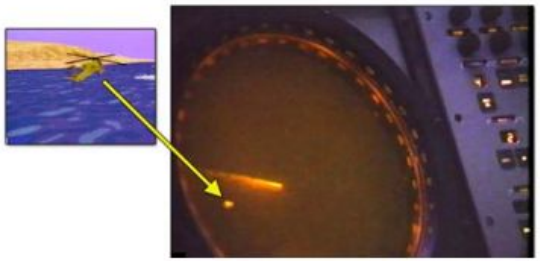
DARPA SIMNET Design Principles

- **Selective Fidelity**
  - Fidelity designed around training need
- **The 60% Solution**
  - "Fast, approximate, and cheap was better than slow, deliberate and expensive"
- **Not driven by training requirements but empowering Commanders to exploit an unconstrained virtual battlefield as they saw fit**

US Navy Battle Force Inport Training (BFIT)

- From mid-80s USN connected ships to pier side simulators and stimulators
- In 1990 this approach was extended to other US-wide simulation systems
- Marines in tanks/rotary designated naval gunnery
- Virtual rotary appeared on real USS Wasp radar

USS Wasp in simulation and in the real world



An Apache helicopter (simulator at Ft Rucker) off the coast of California appears on the air surveillance radar of the USS Wasp

US Navy Battle Force Inport Training (BFIT)

YouTube - https://youtu.be/W9923EwnPGw

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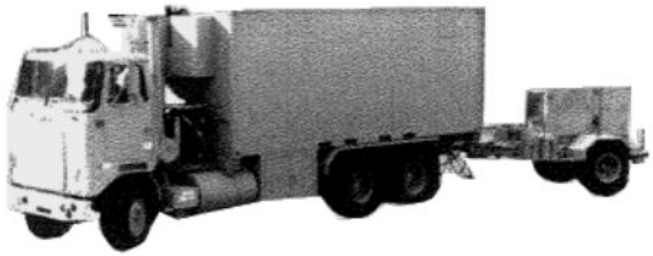
US DARPA Project Odin – 1990/1

- "Simulation centre on wheels"
- Support to Desert Storm
- Provide Commander with perspective visualisation and fly throughs
- "What if" simulation models
- After action replay and lessons learned
- Insufficient time to be integrated in existing command structure



1991/92 Gulf War - 73 Easting

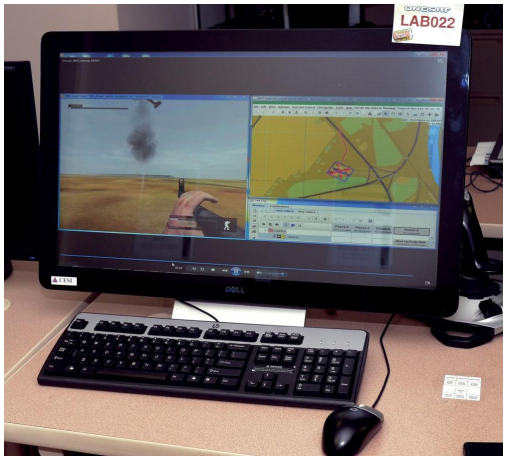
- New interactive, dynamic, means of documenting history
- SIMNET provided the tools to take the 73 Easting data and turn it into an analysis tool.
- Presented on large projection screens, the 73 Easting briefings were given to everyone from visiting diplomats to members of Congress

Millennium Challenge 2002 (MC02)

- US war game exercise costing $250 million, involved both live exercises and computer simulations.
- A test of future military "transformation”

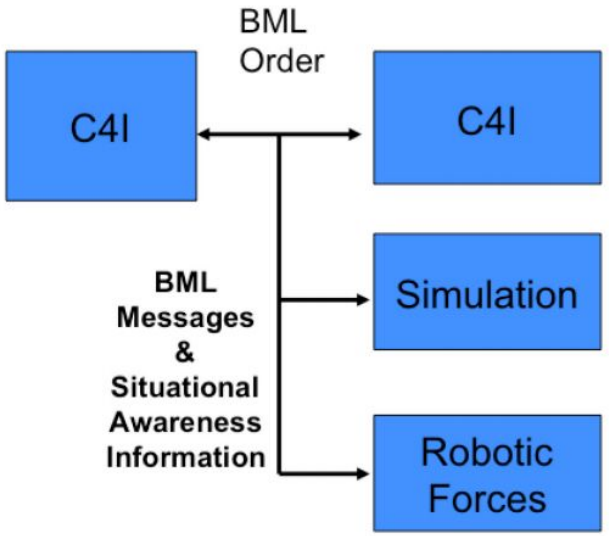
One Semi-Automated Force - OneSAF

- The OneSAF concept originated in 1996 following an extensive study that came to the conclusion that the (US) Army was caught in a wasteful spending cycle, making identical or similar enhancements to legacy simulations across three different user domains.
- OneSAF is aimed at meeting the M&S needs of the Research, Development and Acquisition; Advanced Concepts and Requirements; and Training, Exercises and Military Operations M&S domains.



Battle Management Language (BML)

- Responding to developing new network centric approaches (2001)
- BML was an unambiguous language used to command and control forces and equipment conducting military operations and to provide for situational awareness and a shared, common operational picture.
- Leveraging C2IEDM (Command and Control Information Exchange Data Model)
- Representing the mission in terms of:
  - Who, What, Where, When, Why



Military Scenario Definition Language (MSDL)

- **The Military Scenario Definition Language (MSDL) was a language designed to support military scenario development providing the M&S community with:**
  - **A common mechanism for verifying and loading military scenarios**
  - **The ability to create a military scenario that can be shared between simulations and C4I devices**
  - **A way to improve scenario consistency between federated simulations**

SISO BML/MSDL Standards Now

- C2SIM-LDM (Logical Data Model) a core set of data elements common to most C2 and Simulation systems

- C2SIM-Initialize will supersede the MSDL standard developed with the purpose of initializing the operational environment (OE) in a wide variety of simulations and connected systems.

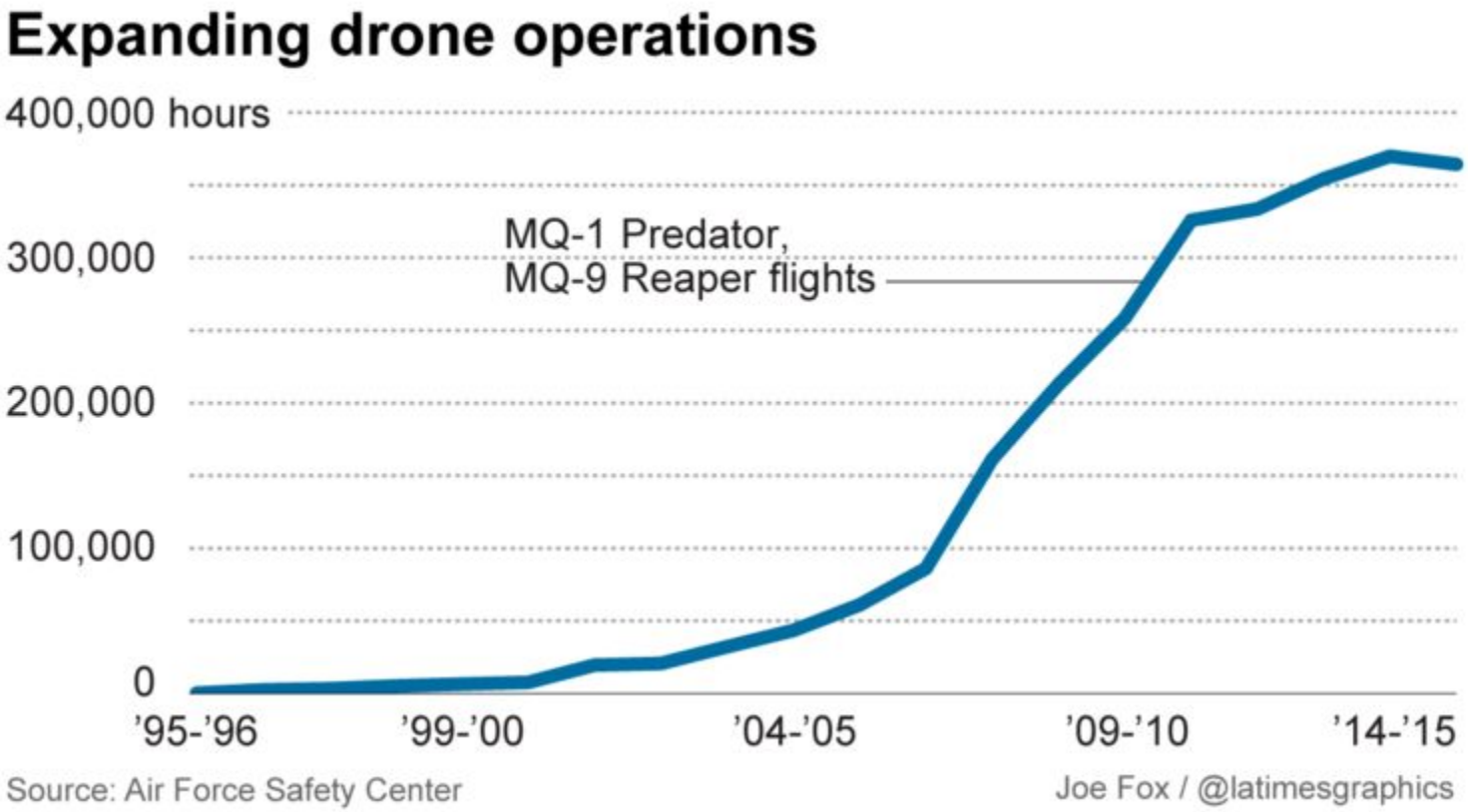
- C2SIM-TaskingReporting will supersede the C-BML standard developed with the purpose of describing task and report assertions in operational or simulation environments.

A Jigsaw of Initiatives

The Rise of Autonomous Systems

Nothing new in the world..
Queen Bee Target Drone – 1930s/40s

US Air Force Drone Missions



US Navy X-47B Drone

August
2014

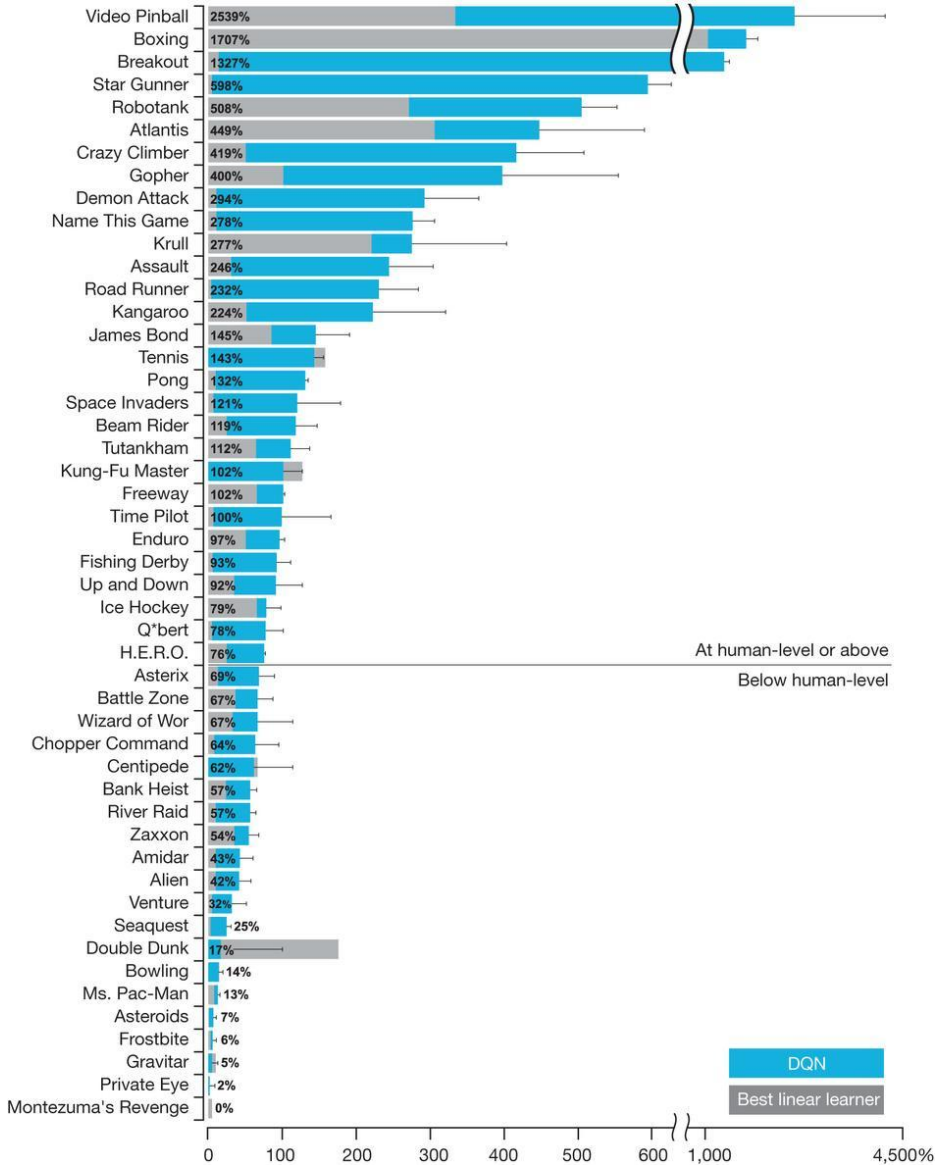
April
2015

Why Aircraft Carriers? – DARPA Tern Project (2016)

Dassault nEUROn (UCAV) Rafale Fighter (2014)

Non-Defence

Google DeepMind AI (2015)



Nature - Human-level control through deep reinforcement learning – Jan 2015

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Google DeepMind AI (2016)

Guardian – 8 Mar 16 - https://youtu.be/Bc326QqlmfI

Google DeepMind AI (2016)

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theguardian

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Artificial intelligence (AI)

StarCraft II: DeepMind unveils latest game its AI plans to conquer

The AI research firm is teaming up with gaming company Blizzard to take on the real-time strategy game

Alex Hern

379

Save for later

After its success at mastering the ancient Asian boardgame of Go, DeepMind is planning to learn its next game – and it's about as different as it can possibly be.

The London-based AI research firm, a subsidiary of Google, is teaming up with Californian gaming company Blizzard to take on the real-time strategy game StarCraft II.

AI v Humans – Strategy Games

So What?

Computers are being programed to learn how to play games, not how to play games

engadget UK

Combat AI beats US Air Force's top tactical experts

And it only requires the processing power of a Raspberry Pi.

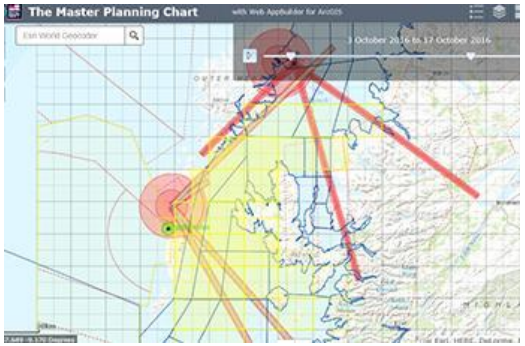
Andrew Dalton , @dolftown
06.28.16 in Robots

A new artificial intelligence flight combat system dubbed ALPHA has taken on one of the Air Force's top tactical experts and won. Retired USAF Colonel Gene Lee -- an experienced combat instructor with "considerable fighter aircraft expertise" -- was repeatedly shot down during engagements with ALPHA in a high-fidelity air combat simulation. Lee called his computerized opponent "the most aggressive, responsive, dynamic and credible AI I've seen to date."

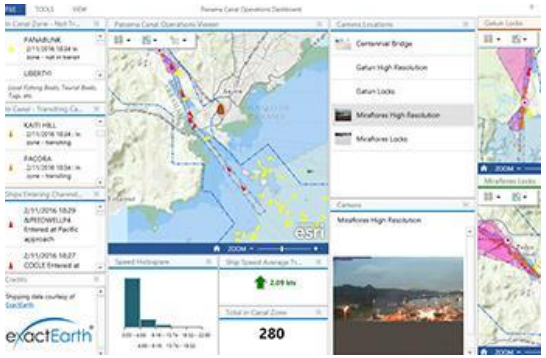
Pilot v Machine (2016)

RN's Unmanned Warrior 2016

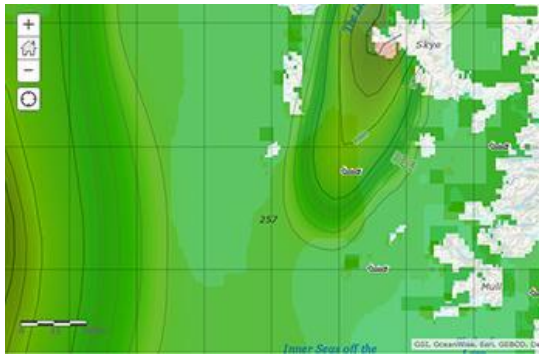
- Esri UK's ArcGIS
- "The first Royal Navy exercise planned in the Cloud"



Planning



Deployment



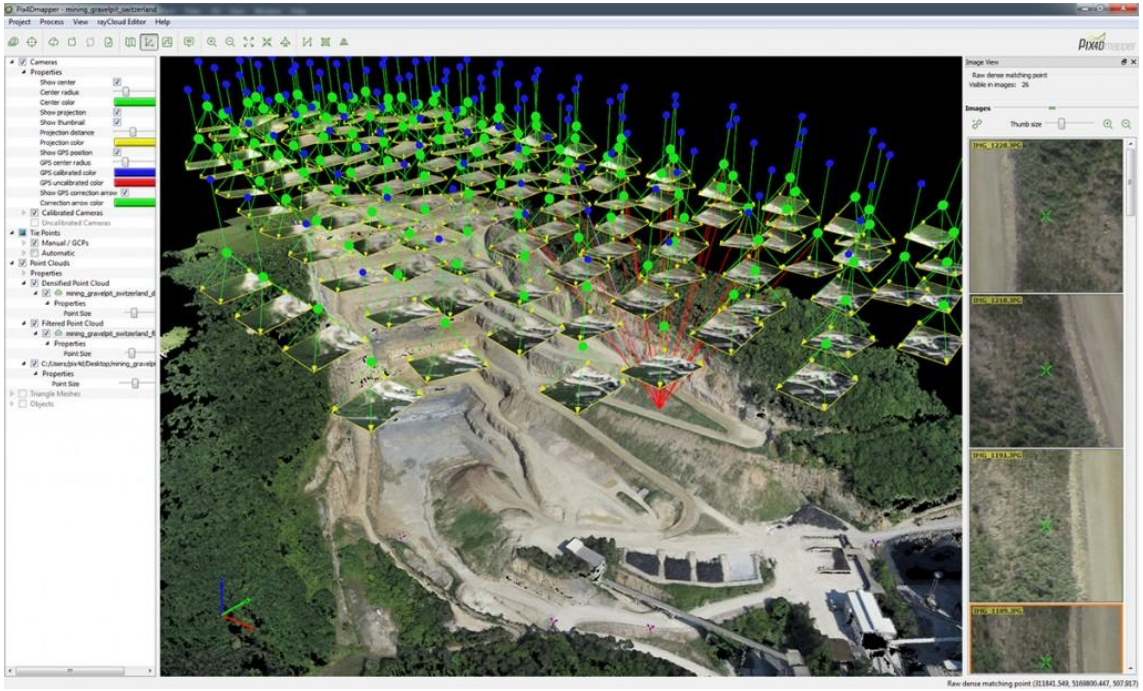
Post Deployment

50 Unmanned Vehicles Demoed

Bohemia Autonomous Systems Research

- **Dstl Autonomous Systems (AS) funded research to develop a simulated operational environment that could be used for AS training, mission planning, rehearsal and execution**

Pix4D



Google Earth VR (Nov 16)

Computers still aren’t that clever

Google Street View

& Humans might get even better…

Neuroscience

US military successfully tests electrical brain stimulation to enhance staff skills

Study paves way for personnel such as drone operators to have electrical pulses sent into their brains to improve effectiveness in high pressure situations

Ian Sample Science editor

@iansample

Monday 7 November 2016 17.48 GMT

Performance of military personnel can slump if the demands of the job become too intense. The study found that electrical brain stimulation can stave off the drop in performance. Photograph: Christian Science Monitor/Getty

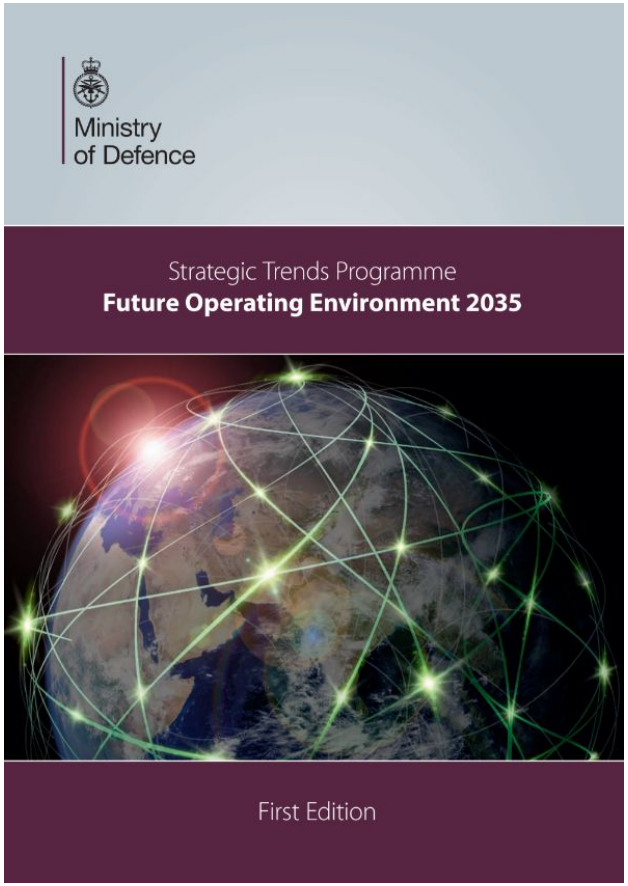
US military scientists have used electrical brain stimulators to enhance mental skills of staff, in research that aims to boost the performance of air crews, drone operators and others in the armed forces' most demanding roles.

The Future of Air Power?

UK MoD Future Operating Environment 2035

“the future operating environment will be more complex and ambiguous, from physical to electronic to human aspects.

…we will habitually be working in an even more combined, joint, inter-agency, intra-governmental and multinational context to contend with the challenges.”



US Air Force Air Superiority 2030 Flight Plan (May 2016)

- Threat capabilities are likely to advance along two major vectors
  - A levelling of capabilities
    - Advanced fighter aircraft, sensors, and weapons are becoming more accessible to more countries which spreads these threats across a wide range of locations and scenarios
  - Increased threat capabilities
    - Increased quantity and sophistication of cyberspace threats and air threats including hypersonic weapons, low-observable cruise missiles, and sophisticated conventional ballistic missile systems.

RAeS Article (7 Oct 16)
Command of the Air in the 2030s

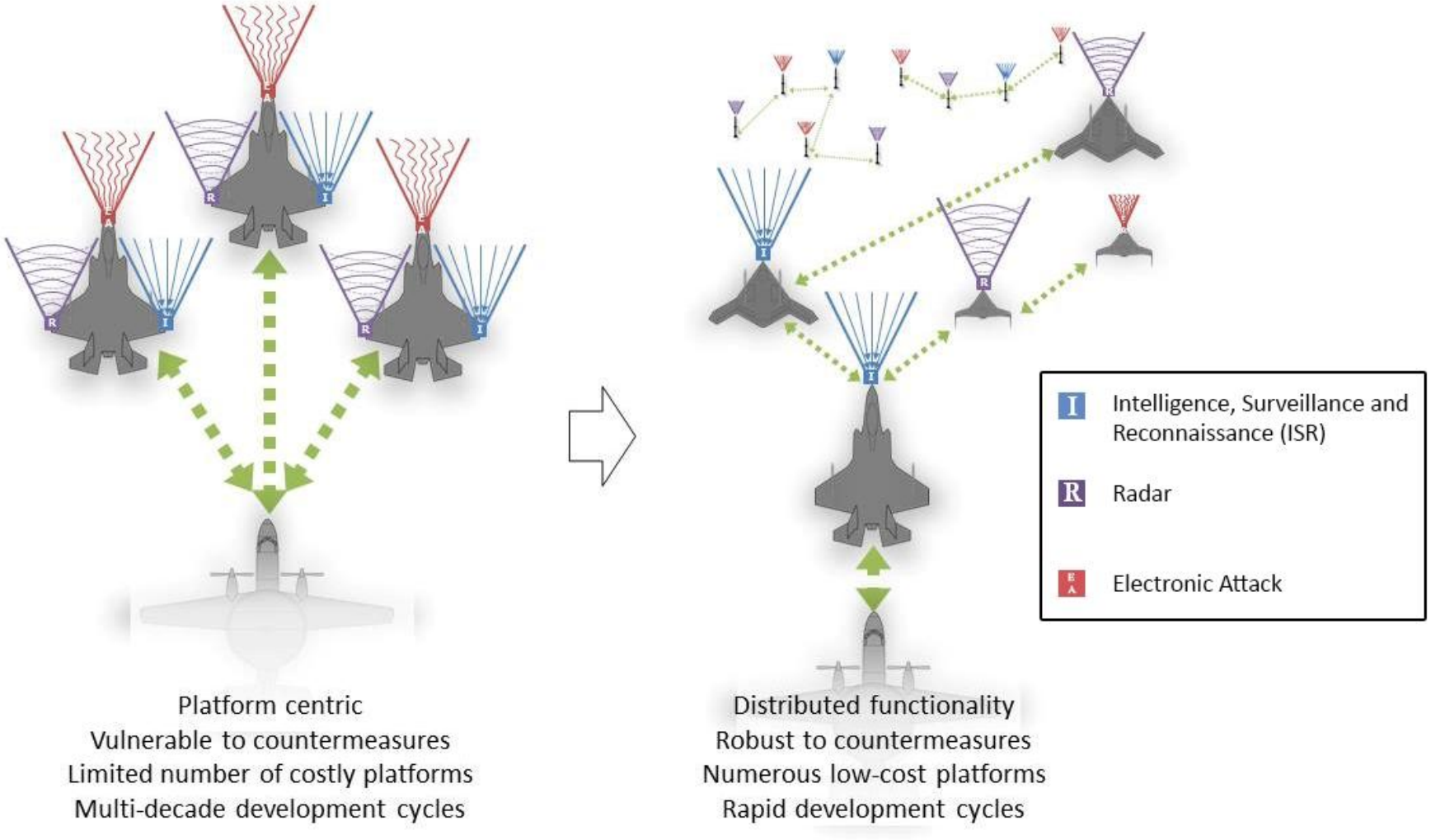
A Future Operational Picture

- The F-35 is close to becoming the only piloted US fighter
- Stealth technologies are now struggling to keep some margin of 'invisibility' against new radars based on reshaped VHF technologies.
- Struggling to keep a secure connection under intense cyber-attacks, Unmanned Combat Air Vehicles, share information and acquired targets with the few remaining human pilots via a high-speed tactical data exchange network.
- Adversaries are now deploying integrated and networked capabilities as part of anti-access/area denial (A2/AD) strategies in highly contested environments.
- It is thus hard for conventional C4ISR platforms like the large AWACS to perform battle management in this electronic and kinetic threat environment.

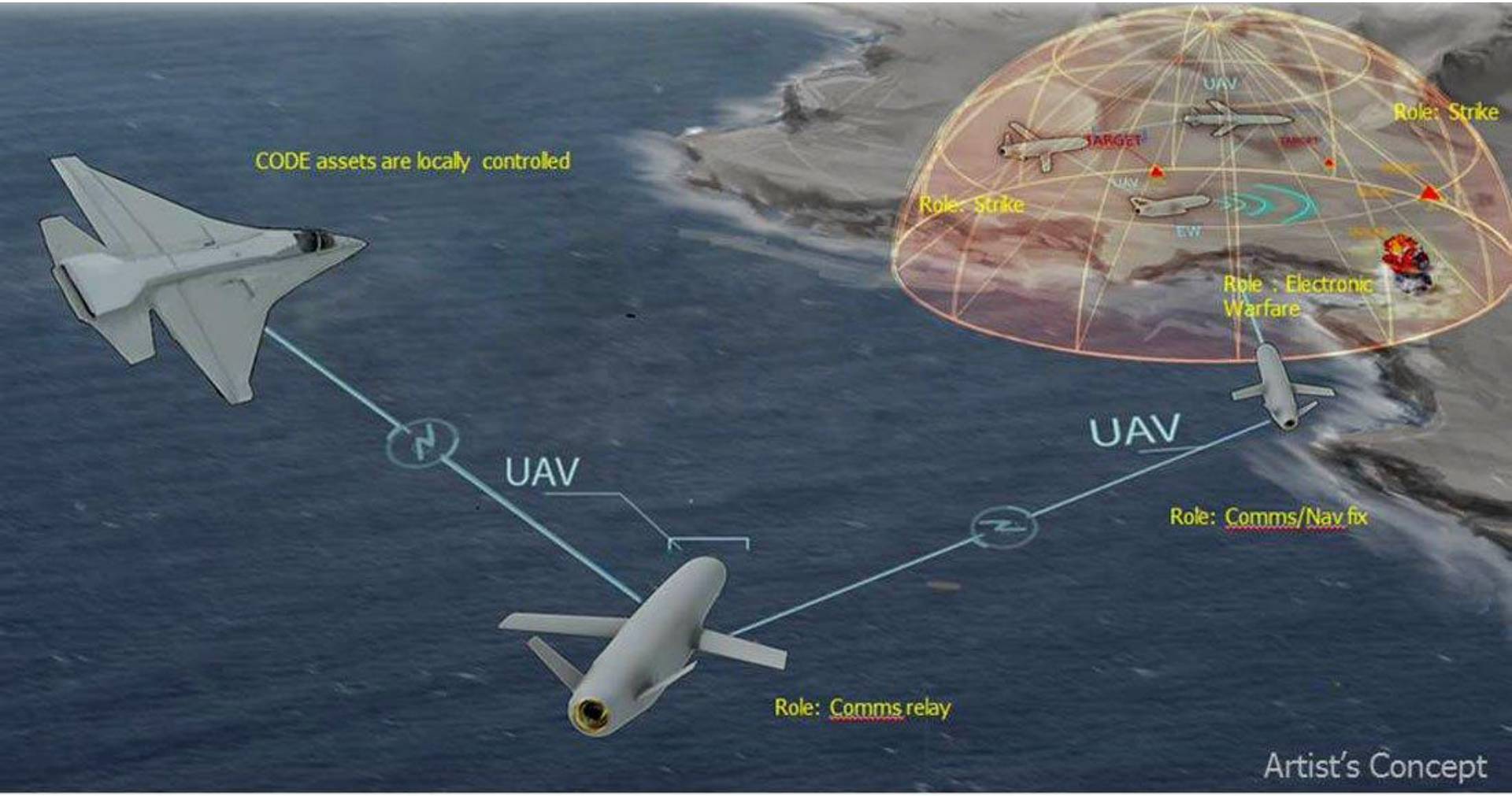
DARPA's *Gremlin* Pathfinders

DARPA's System of Systems Integration Technology and Experimentation (SoSITE) (2015)

- **concepts for maintaining air superiority through novel system-of-systems architectures**



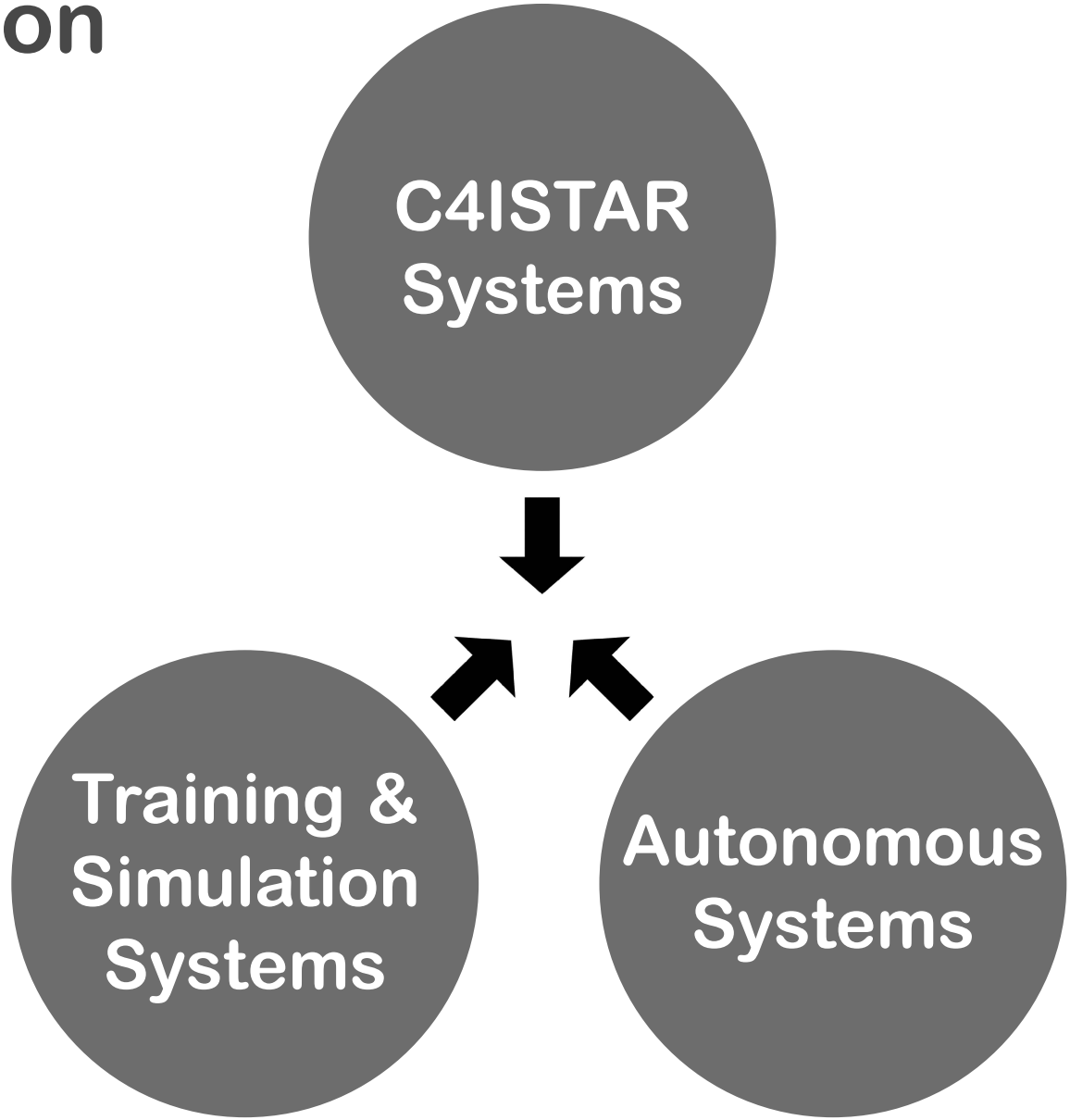
DARPA's Collaborative Operations in Denied Environment (CODE)



CODE allows a single person to visualize, supervise and command a team of unmanned systems in an intuitive manner

Conclusions

Ambition


C4ISTAR Systems
Training & Simulation Systems
Autonomous Systems

Conclusions

- Systems
  - Drive Enterprise-Wide Convergence/ Interoperability of Simulation-C4ISTAR-Autonomous Systems
- Humans
  - Train and Prepare for Integrated Human-Autonomous System Operations

or as Shakespeare might put it more simply

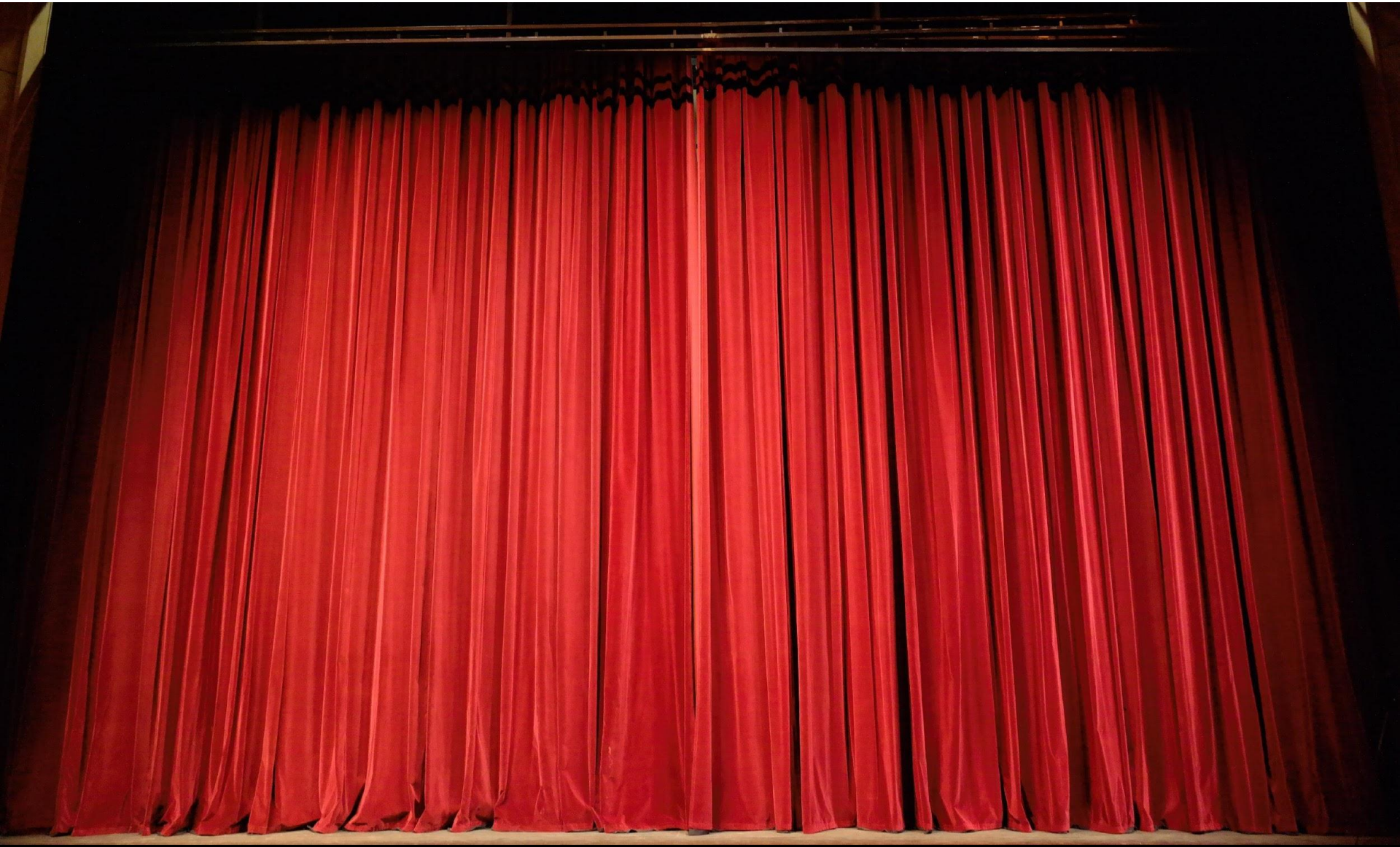
All the world's one stage,

and all the men, women and

autonomous systems merely players

autonomous

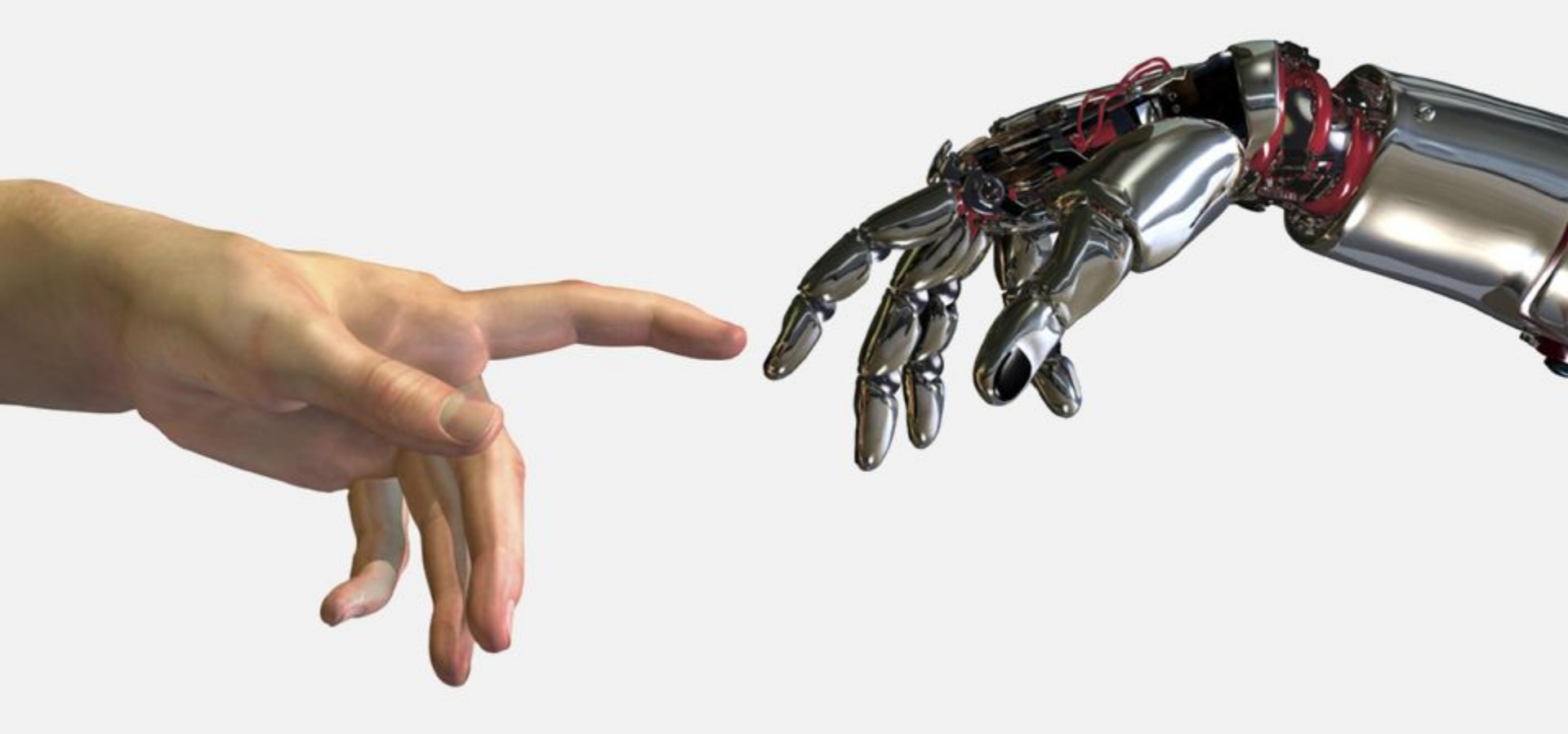
Questions?



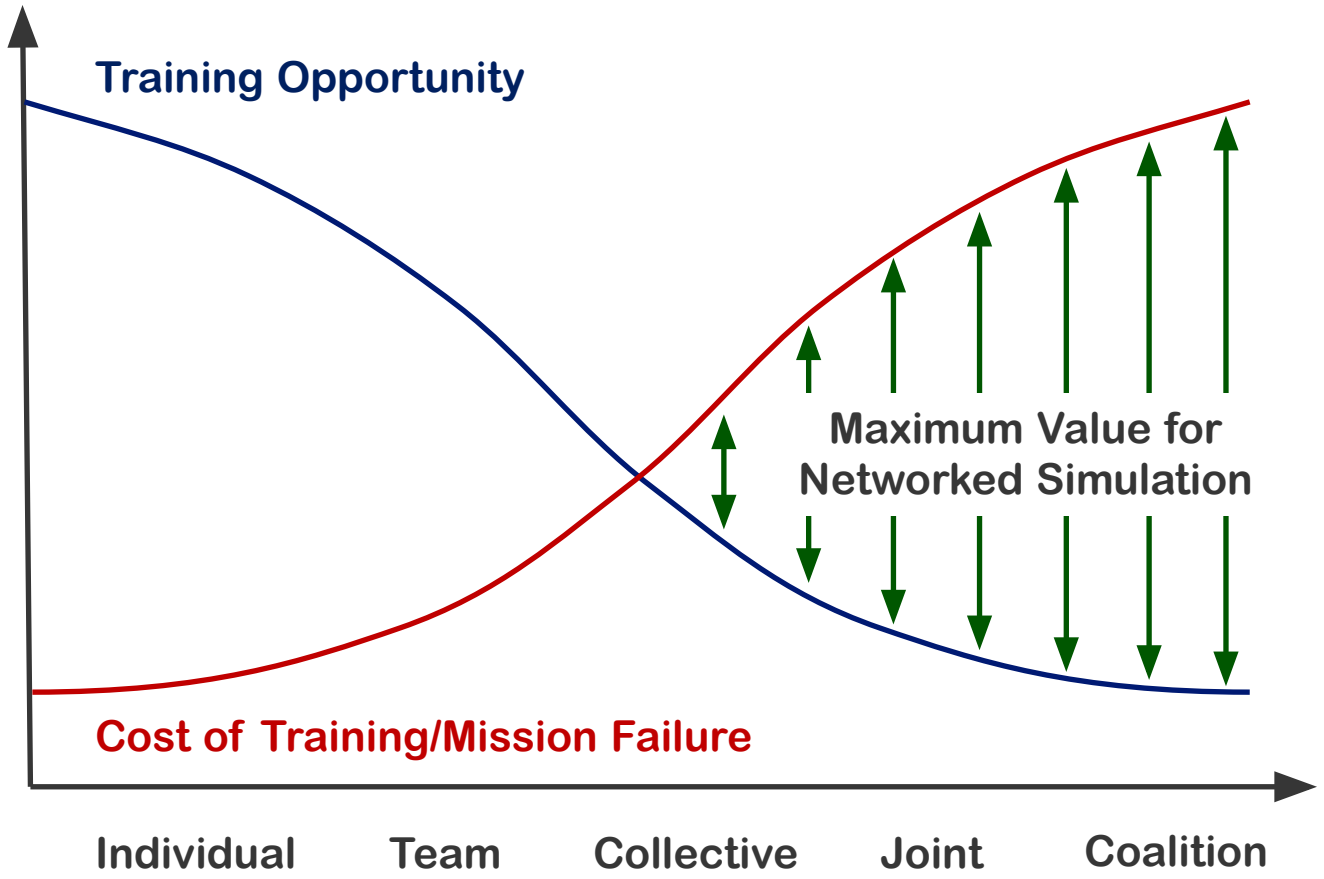
Whole < Sum of the Parts?

The Optimum Human/Machine Blend

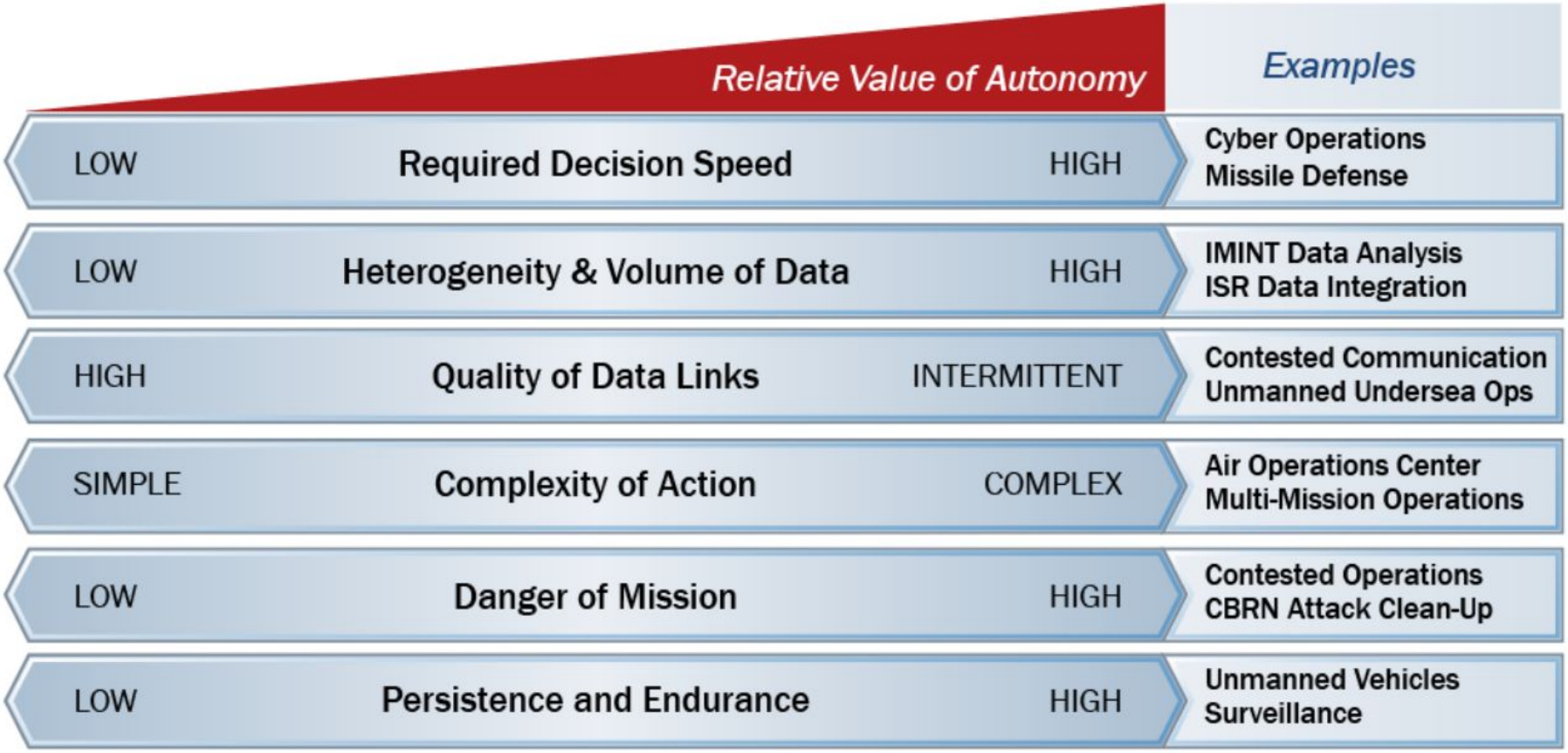
- **Humans & Machines working in Harmony Maximising the Strengths of Both**



DARPA SIMNET Rationale - 1983



US Defense Science Board Summer Study on Autonomy - June 2016



Baron Charles Dupin (1826)

(Géométrie et Mécanique des Arts et Métiers)

- **“We have been very much occupied in perfecting the machines and the tools which the worker uses...**

- **However, if he were only considered as an instrument, a tool, a motor, he would necessarily be placed in the first rank of all instruments**

- **since he has the immeasurable advantage of being an instrument who observes and corrects himself, a self-stopping motor which functions with the motivation of its own intelligence and which perfects itself..."**