

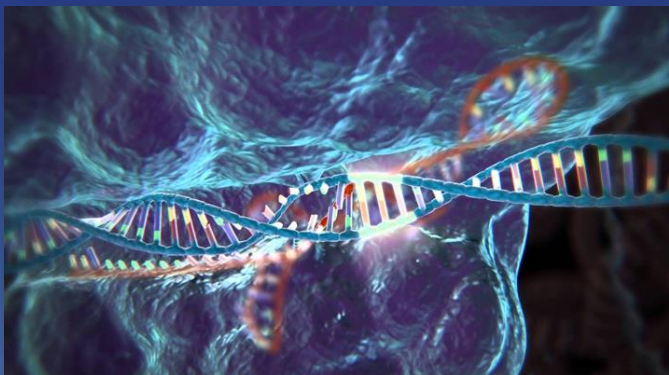


# AI and Future Warfare:

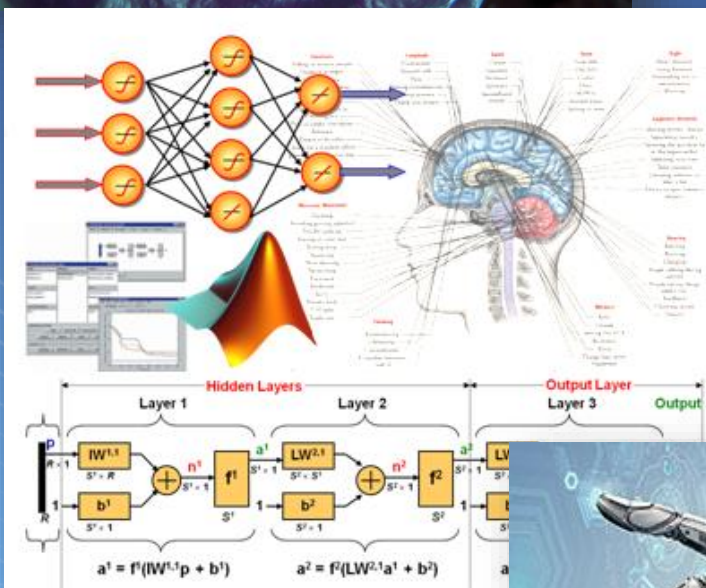
## The Rise of Robotic Combat Operations

Robert O. Work  
Mad Scientist Conference  
University of Texas at Austin  
24 April 2019





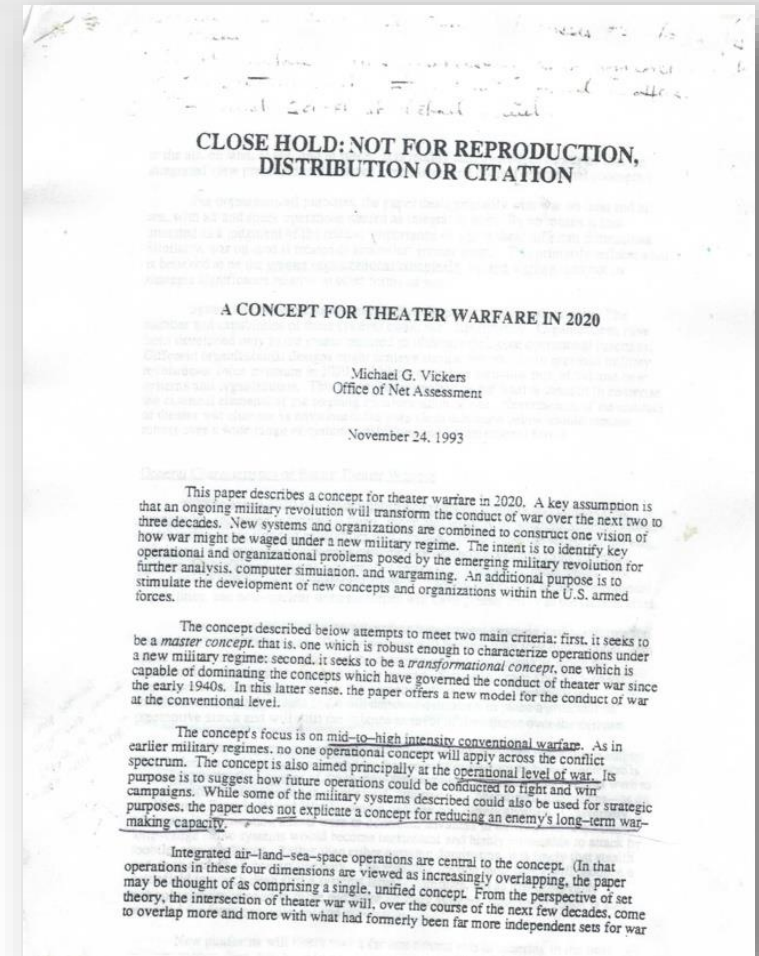
A call to arms:  
Now is the time for all good Mad  
Scientists (and Mad Engineers) to  
come to the aid of their  
countrymen...





# We act today as if emerging changes to the character of war are just becoming clear

- The 1990s saw intense efforts to discern potential changes to the conduct of warfare after the “defining battle” of the guided munitions-battle network regime (e.g., Desert Storm)
  - Future Warfare 20XX
  - Army After Next
  - SpaceCast 2020
- Future Warfare 20XX was sponsored by ONA
  - Began in 1993 with a concept paper entitled, “A Concept for Theater Warfare in 2020”
  - Nine seminar-style wargames and six supporting workshops followed, conducted from 1995-2000
    - Set in “20XX,” but assumed to be ~2025
    - Premised upon major powers having rough parity in guided munitions-battle network warfare (what Andrew Marshall called a mature regime)
  - Culminated with senior officer roundtable in December 2001



# Future Warfare 20XX identified five key operational competitions that would influence the character of future theater war

## **Future Warfare 20XX Wargame Series Synthesis**

By  
**Robert Martinage**

**The Center for Strategic and Budgetary Assessments (CSBA)**

Contract No. HQ0034-07-D-1011-0007

The views, opinions and/or findings contained in this report are those of author and should not be construed as an official Department of Defense position, policy, or decision.

**Anti-access vs. New Forms of Power  
Projection**

**Hiders vs. Finders**

**Stealth & Barrage Attack vs. Active &  
Passive Defenses (Salvo Competition)**

**Space Access vs. Space Denial/Control**

**Cyber & BW Offense vs. Defense**

# Robotics, autonomy, and automation played outsized roles in each of the five operational competitions



- 20XX games saw intensive use of:
  - Highly autonomous unmanned systems across all domains
  - Smart, loitering munitions with cooperative behavior
  - Man-wearable robotics: performance-enhancing exoskeletons
  - Unmanned, distributed logistics
  - Automated defensive measures compelled by speed-of-attack and complexity
  - Sensors/weapons with automated signal processing

# Influenced by the work done in the 1990s, the 2001 QDR established six critical operational requirements to guide force transformation

## Quadrennial Defense Review Report



September 30, 2001

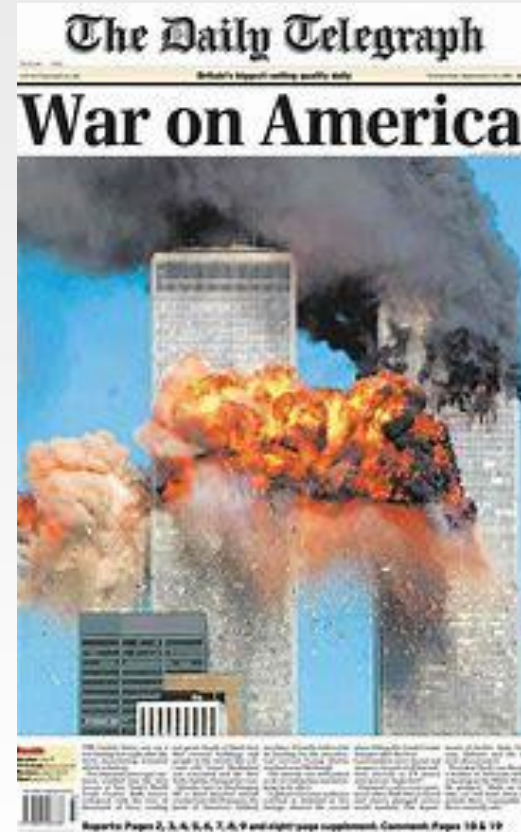
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- **Protecting critical bases of operations** (U.S. homeland, forces abroad, allies, and friends) and defeating CBRNE weapons and their means of delivery;
- **Assuring information systems** in the face of attack and conducting effective information operations;
- **Projecting and sustaining U.S. forces in distant anti-access or area-denial environments and defeating anti-access and area-denial threats;**
- **Denying enemies sanctuary** by providing persistent surveillance, tracking, and rapid engagement with high-volume precision strike, through a combination of complementary air and ground capabilities, against critical mobile and fixed targets at various ranges and in all weather and terrains;
- **Enhancing the capability and survivability of space systems** and supporting infrastructure; and
- Leveraging information technology and innovative concepts to **develop an interoperable, joint C4ISR architecture and capability that includes a tailorable joint operational picture.**



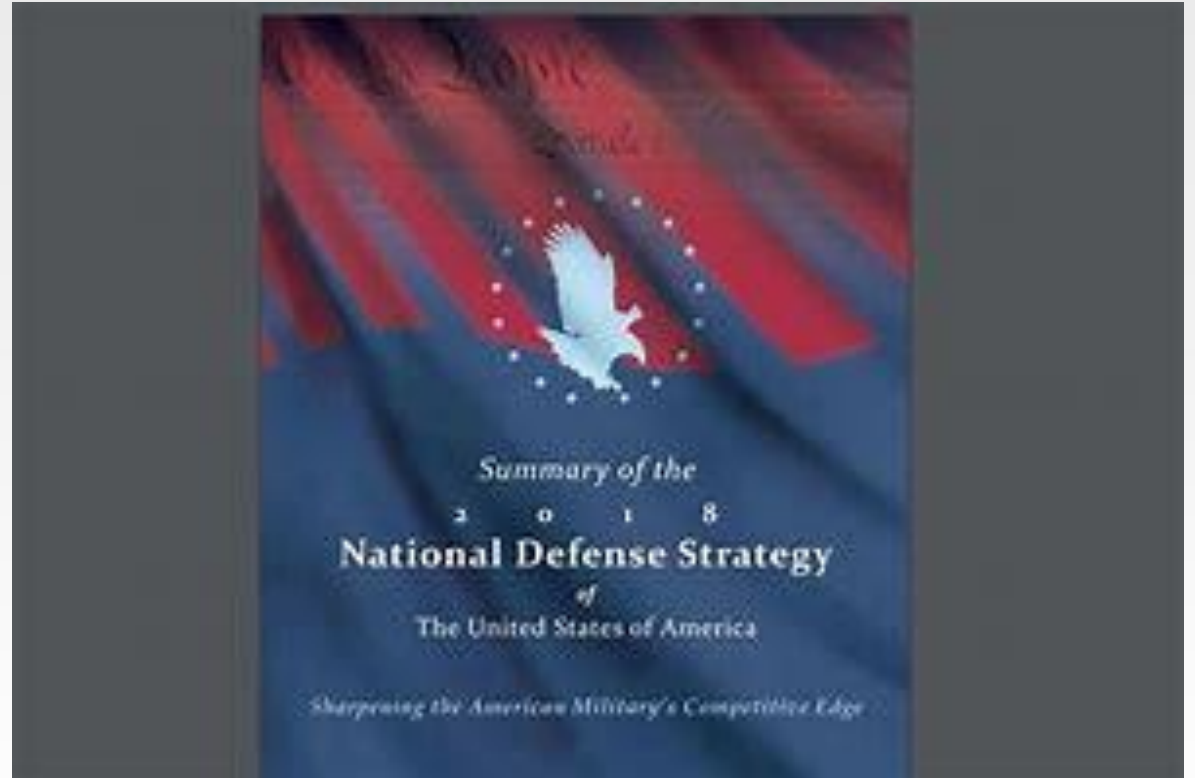
# The road toward future warfare built in the 1990s turned out to be one not taken

- With the attacks of 9-11, the United States entered the longest war in its history
- DoD's institutional focus shifted toward counter-terrorism, irregular warfare, nation building, and security force assistance
- Military transformations for potential future conflicts simply do not occur during long periods of military conflict



# In essence, the 2018 NDS picked up where the 2001 QDR left off—but under significantly more challenging strategic circumstances

- “Today, we are emerging from a period of strategic atrophy, aware that our competitive advantage is eroding.”
  - Central challenge: reemergence of long-term strategic competition with revisionist powers
  - The erosion of U.S. military advantage is undeniable; all operational domains are now contested
  - Rapid technological advancements are changing the character of war
  - Homeland is no longer a sanctuary





# And it doesn't look to get any easier from here...

- **We find ourselves in an intense military-technical competition, with an uncertain outcome**
  - Chinese R&D expenditures increased 30-fold from 1991-2015
  - China now spends more money on R&D than Japan, Germany and South Korea, combined
  - The Chinese are at the leading edge of dual use commercial tech: quantum computing, artificial intelligence and machine learning, synthetic biology and other advanced technologies
  - Are we close to being the victim of a deliberate Chinese “offset strategy”?
- **We won't be able to spend our way back to military dominance**
  - Since 1885, the US has never faced a competitor or even group of competitors with an (aggregate) GDP greater than 40% of its own
  - In 2014, China's GDP was 60% of the United States', when it surpassed the U.S. in purchasing power parity; its GDP may surpass ours in absolute terms sometime between 2025-2030

**“To succeed in the emerging security environment, our Department and Joint Force will have to out-think, out-maneuver, out-partner, and out-innovate revisionist powers.”**

**- 2018 NDS**

# This discussion suggests a different OE continuum...

- **1991-2001: The Era of Diminished Strategic Competition and Confrontation**
  - A post-revolutionary period where the United States readjusted its strategic outlook to account for the end of the Cold War and unchallenged American dominance, and the U.S. armed forces considered how to exploit a new military-technical revolution
- **2002-2017: The Era of Strategic Distraction**
  - A maturing revolutionary period where the United States became bogged down in the Middle East and our adversaries took advantage of new technologies, new doctrine and revised strategic concepts associated with the military-technical revolution to effectively challenge U.S. military forces across multiple domains
  - Rise of Anti-access/Area-denial networks challenge America's ability to project power
- **2018-2030: The Era of Renewed Strategic Competition and Confrontation**
  - A pre-revolutionary period in which great power competition reemerges, and the great powers grapple with significant breakthroughs in technology and convergences in terms of capabilities, which promise the emergence of a new military-technical revolution; the first mover in the new regime will accrue considerable strategic and operational advantage
  - American/allied strategists grapple with counter-P2 strategies in the near abroad of great powers
- **2030-2050: The Era of Strategic Competition and Confrontation from a position of Operational (Inferiority/Parity/Superiority)**  
(Choose one: *the selection is largely determined by the choices made in the Era of Renewed Strategic Competition and Confrontation*)

# The point is that *time is not on our side*: we need to “pursue urgent change at significant scale”

- We’ve lost two decades worth of experimentation and potential transformational activities—and our dominant conventional overmatch along with it
  - We can future cast all we want, but time’s a 'wasting...
- Readiness and modernization are important—but we may need to take more risk in the near term order to prepare for the coming changes in warfare
- The Army, along with the entire Joint Force, needs to pick a new cardinal direction for force design and start moving along it—aggressively
  - Saying we have to be prepared for “high end combat” against Russia and China won’t cut it
- We don’t need to know the exact destination before we start; we just need to get going

**“We must build an agile and adaptive Army that is prepared for the uncertain future. We must develop new technologies and new capabilities that address the way we will be required to fight”**

**- General James C. McConville  
Vice Chief of Staff of the Army**



# Luckily, the broad outlines of future of war—and the way we will likely be required to fight—appears relatively clear

- In the midst of an ongoing technological tsunami, the rapid advancements in artificial (machine) intelligence, “big data”, machine learning, autonomous control systems and robotics all point to a new, potentially revolutionary military-technical regime: algorithmic warfare
- **Algorithmic warfare** will be characterized by combat operations transformed by universal digitization and widespread use of machine intelligence in both systems at rest and systems in motion, leading to new forms of **human-machine collaboration** and **human-machine** and **machine-machine combat teaming**, and the more powerful **collaborative human-machine battle networks** they enable
- Algorithmic warfare is sometimes referred to as “War of Cognition” or “HyperWar”

**AI will eventually be "in everything we do. It is not a question of if these technologies will change the character of war, it is only a question of when."**

**- Gen. John M. Murray  
Army Futures Command**

# And a key aspect of algorithmic warfare will be robotic combat operations—in the form of both human-machine and machine-machine combat teaming

**“Robotics as a force multiplier. Emerging autonomous robotic systems are being increasingly used to augment, rather than simply replace, individuals and platforms. The augmentation of human systems with robotics, particularly swarming, will permit longer duration missions, enable greater lethality, improve the ability to protect capital platforms from attack, and increase individual human and unit performance.”**

***- Joint Operating Environment 2035***

Joint Operating Environment

JOE 2035

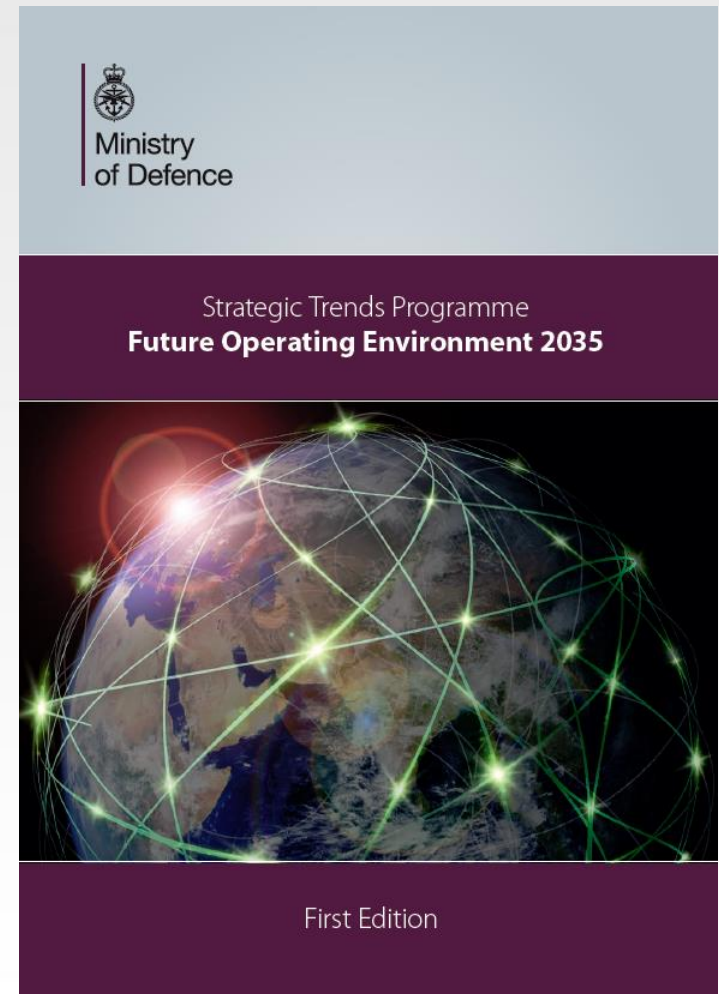


*The Joint Force in a  
Contested and Disordered World*

# Our allies see it the same way...

**“The next two decades will see significant advances in autonomy and machine learning, to include the emergence of robots working together in groups and as swarms. New and powerful robotic systems will be used to perform complex actions, make autonomous decisions, deliver lethal force, provide ISR coverage, and speed response times over wider areas of the globe.”**

***- UK MOD Joint Operational Environment  
2035***





## ...As do our competitors



**“Another factor influencing the essence of modern means of armed conflict is the use of modern automated complexes of military equipment and research in the area of artificial intelligence. While today we have flying drones, tomorrow’s battlefields will be filled with walking, crawling, jumping, and flying robots. In the near future it is possible a fully robotized unit will be created, capable of independently conducting military operations.”**

**- V. Gerasimov, *Military-Industrial Kurier*, 8, no. 476 (Feb. 27–March 5, 2013)**

# Might the U.S. Army be close to another “Own the Night moment”?

- In the late 1970s, fresh out of Vietnam, the Joint Force turned its attention toward a thoroughly modernized Warsaw Pact with conventional combat systems roughly equal to its own...and in far greater numbers
  - U.S. operational planners started to ponder how to “*Fight Outnumbered and Win!!*”
- Toward this end, among the many initiatives introduced by the U.S. Army was a vow to “Own the Night”
  - Army leaders wanted to take advantage of the relative lack of Warsaw Pact night-fighting skills
  - “Owning the Night” entailed much more than just buying new generation night vision goggles (NVGs); it included development of new TTPs and intense training to give the force the confidence needed to operate effectively at night



**“We own the night. It was the ability to attack at night, when all of the rest of the world's defenses are at 10 percent of what they are in daytime, that gave us this huge immediate impact and edge.”**

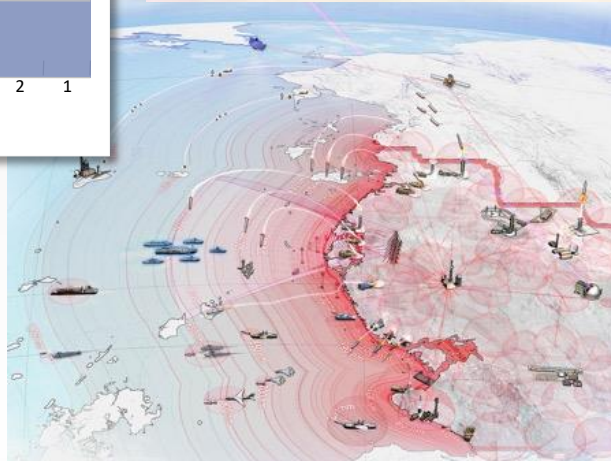
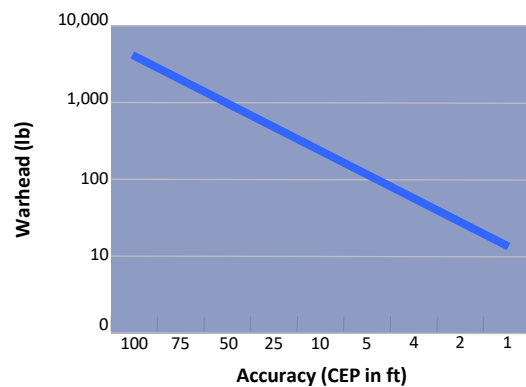
**Former Secretary of the Navy (!) John Lehman  
Testimony before Congress, 1991**



# Four reasons why the Army should “Own Robotic Combat”

**#1: Proliferation of miniaturized guided munitions will make the battlefield increasingly lethal for humans, hastening the development of unmanned autonomous systems to take on the most deadly combat tasks**

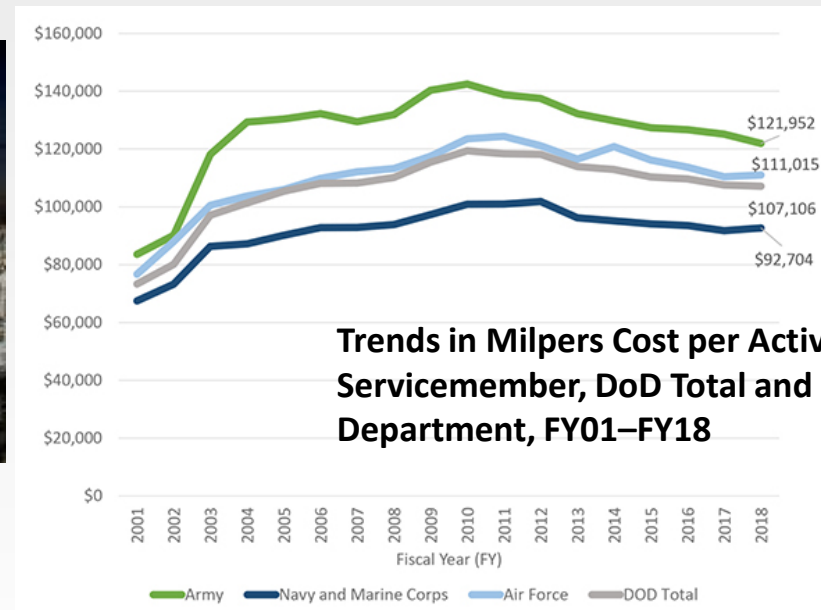
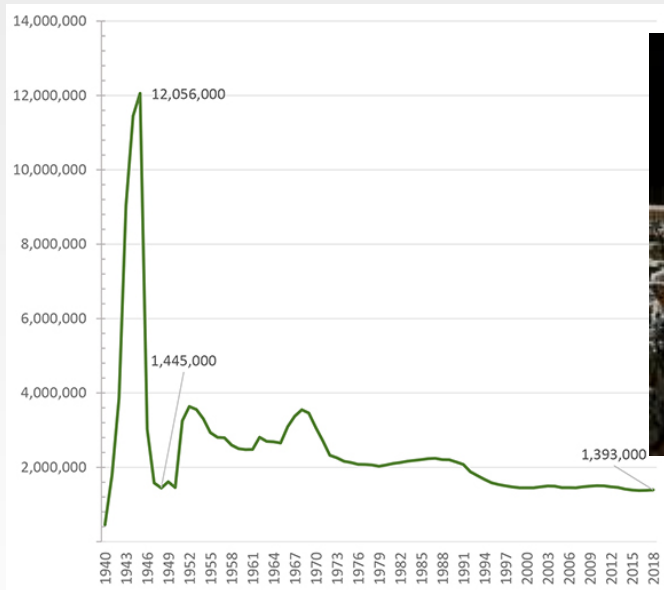
Warhead size as a function of CEP





# Four reasons why the Army should “Own Robotic Combat”

**#2: Humans are becoming more expensive to recruit, train, and retain, hastening the move to unmanned and robotic systems to replace them, especially for ground forces**



**Trends in Milpers Cost per Active-Duty Servicemember, DoD Total and by Military Department, FY01–FY18**

A recent Congressional Budget Office (CBO) report shows that the average cost to maintain an active duty soldier is jumped by 31 percent between 2000 and 2014.

Although costs have moderated from their wartime high, the Army’s average cost per active duty service member still remains higher than any other service.

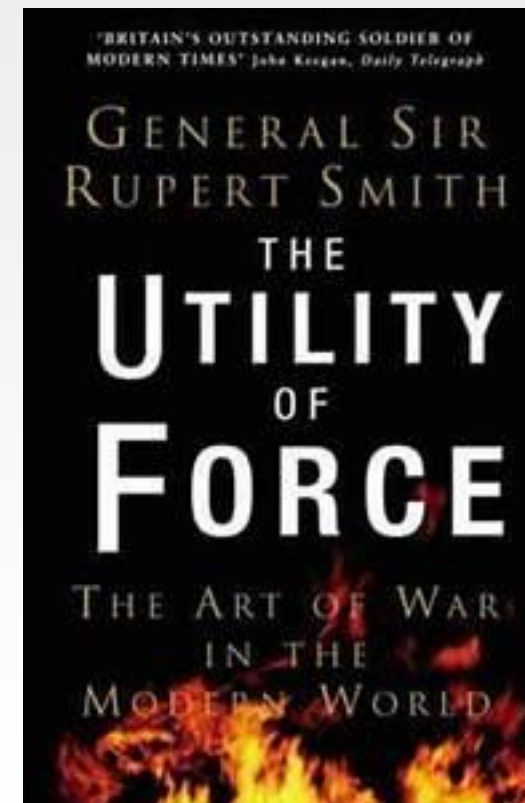
SOURCE: Congressional Budget Office, 2015

# Four reasons why the Army should “Own Robotic Combat”

**#3: Land warfare involves fighting amongst the people, requiring the most demanding performance for autonomous systems in terms of ethics, LOAC (distinction and proportionality), and trust**

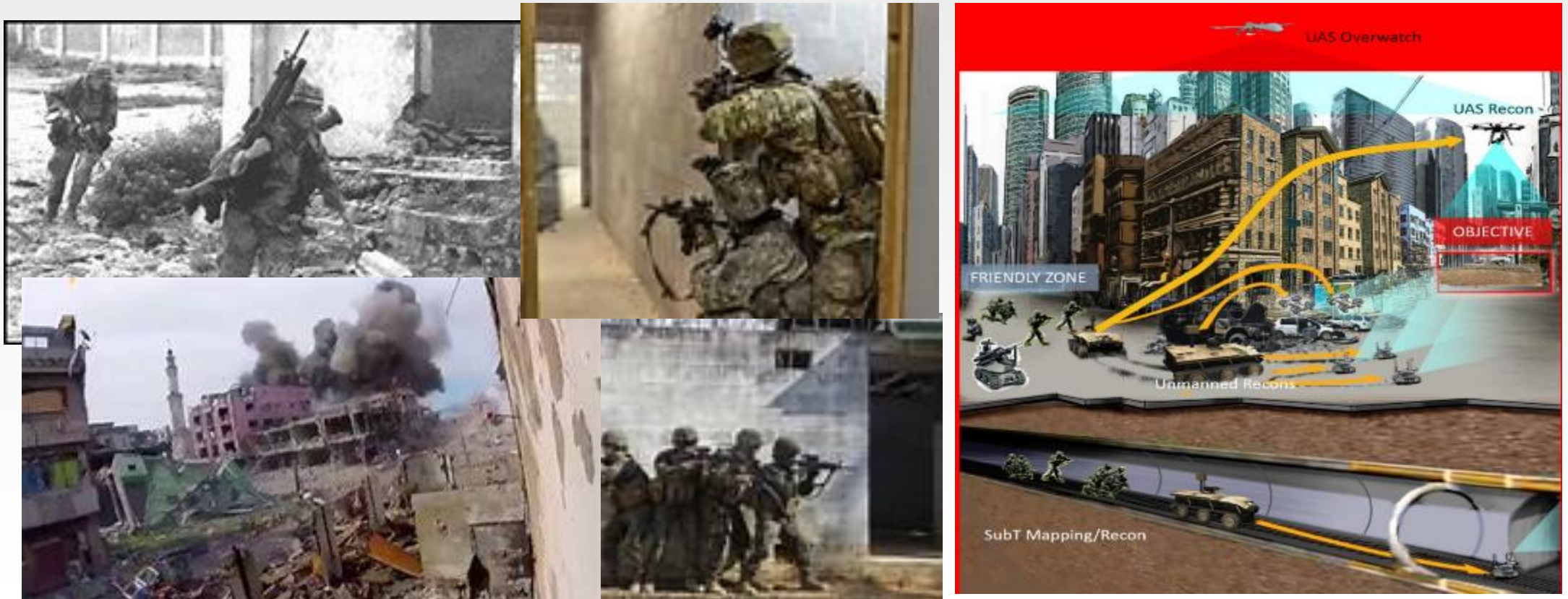
“...the reality in which the people in the streets and houses and fields - all the people, anywhere - are the battlefield. Military engagements can take place anywhere, with civilians around, against civilians, in defense of civilians. Civilians are the targets, objectives to be won, as much as an opposing force”

General Sir Rupert Smith (UK)



# Four reasons why the Army should “Own Robotic Combat”

**#4: Future combat operations amongst the people may occur in dense urban settings, where combat operations will surely rely heavily on human-machine combat teams**

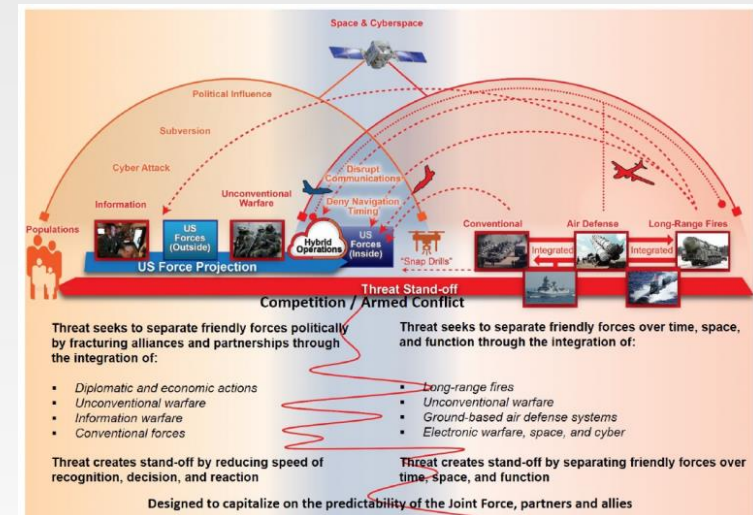




# “Modernization is not defined solely by hardware, it requires change in the way we organize and employ forces.”



**Robotic Combat**

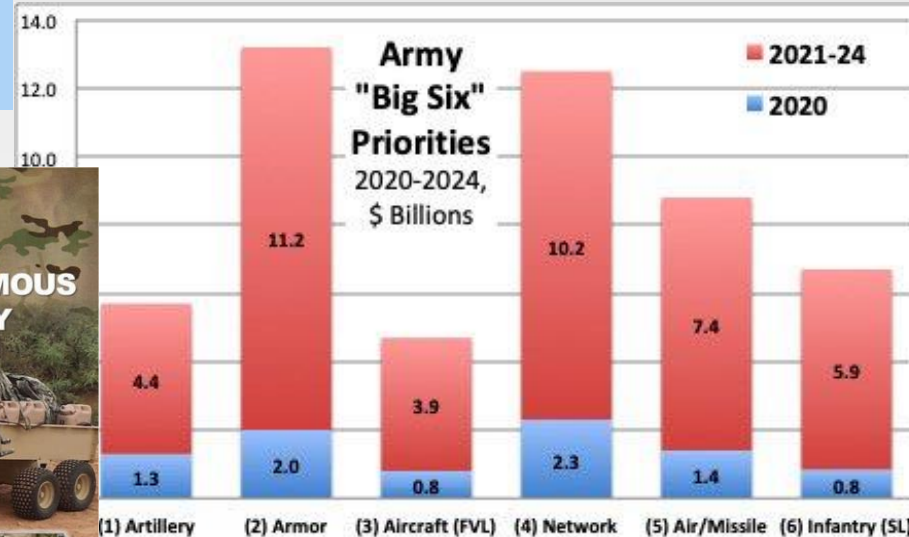
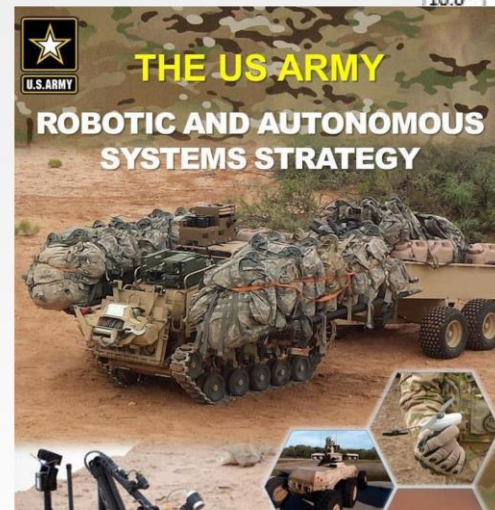


**Multi-Domain Operations**

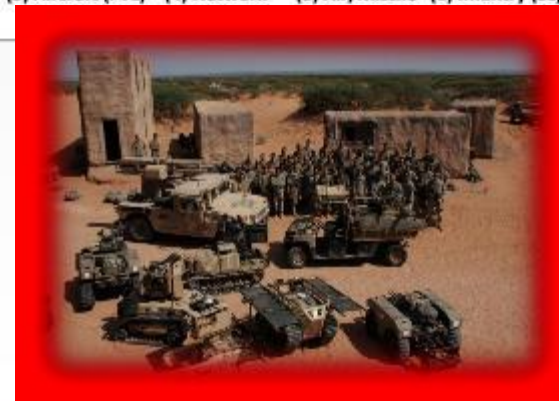
## Human-Machine Multi-Domain Warfare

# Adopting Human-Machine Multi-Domain Warfare as the guiding vector for force design would be an easy pivot for the Army to make

Army AI Task Force  
Army Futures Command



TARDEC MUM-T



# Just a few policy and programmatic choices would send powerful signals

- Do NOT pursue optionally manned combat systems except for legacy platforms that commanders are willing to lose
  - The cost to make a robotic combat vehicle habitable for crew or humans is not worth it
  - Instead, pursue optionally teleoperated robotic combat systems as a bridge to better autonomous control systems
- Some illustrative Big Six examples:
  - Long-range precision fires: develop a cargo round for modular multi-purpose UASs
  - Next-generation Combat Vehicles: halt OMFV; combine RCV + MPF program into one OpTeleRCV
  - Future vertical lift: replace manned scout/recon with a distributed multi-domain reconnaissance system



# Counter-intuitively, perhaps the best model for Futures Command to emulate is the long, dogged pursuit of carrier aviation during the inter-war period

- A problem of **force integration** during a period of immature, but rapidly improving technology
- Need a tight coupling of concept development, wargaming, experimentation, demonstrations and exercises to lead the way and maintain momentum
- Consider establishing a “Bureau of Unmanned Systems”
- Consider funding and building a PPV Robotic Combat Systems Armory

# A fifth reason why the Army should “Own Robotic Combat: Recruiting

**Be a part of the most powerful  
combat team...EVER**



# Questions

**(Let the fireworks begin!)**



# The 1997 NDP foresaw the need to “transform” the U.S. Joint Force to prepare it for the expected demands of future warfare

## Transforming Defense

*National Security in the 21<sup>st</sup> Century*

Report of the National Defense  
Panel December 1997



- **The NDP focused on two specific concerns:**
  - Our diminished ability over time to rapidly and effectively project and sustain US military power to distant regions
  - Growing vulnerability to our space systems
- **The report urged that:**
  - The U.S. should focus its energies and resources on the challenges of tomorrow—even if that means accepting more risk in the near term
  - The Joint Force must experiment—investigate new joint operational concepts, apply advanced technologies in new ways, explore different organizational structures, and stimulate innovative thinking to develop the synergies inherent in the Services and other national assets