



Designing Autonomous Systems for Military Use: Harnessing Artificial Intelligence to Provide *Augmented Intelligence*

Briefing for CRUSER TechCon – April 11-12, 2017

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Space and Naval Warfare Systems Center Pacific

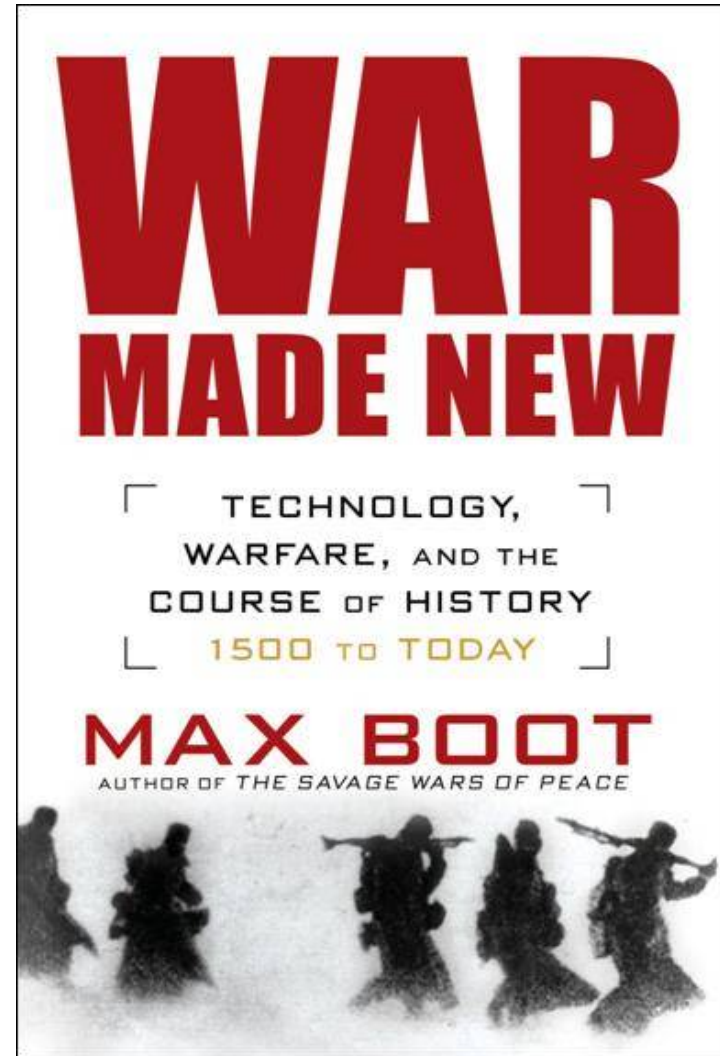
What We'll Talk About Today

- ▼ Perspective
- ▼ The Plan for Autonomous Systems
- ▼ The Need for Offset Strategies
- ▼ Challenges for Autonomous Systems
- ▼ The Dark Side of Unmanned Systems Autonomy
- ▼ Designing in the *Right* Degree of Autonomy
- ▼ Into the Future

“My view is that technology sets the parameters of the possible; it creates the potential for a military revolution.”

Max Boot

War Made New



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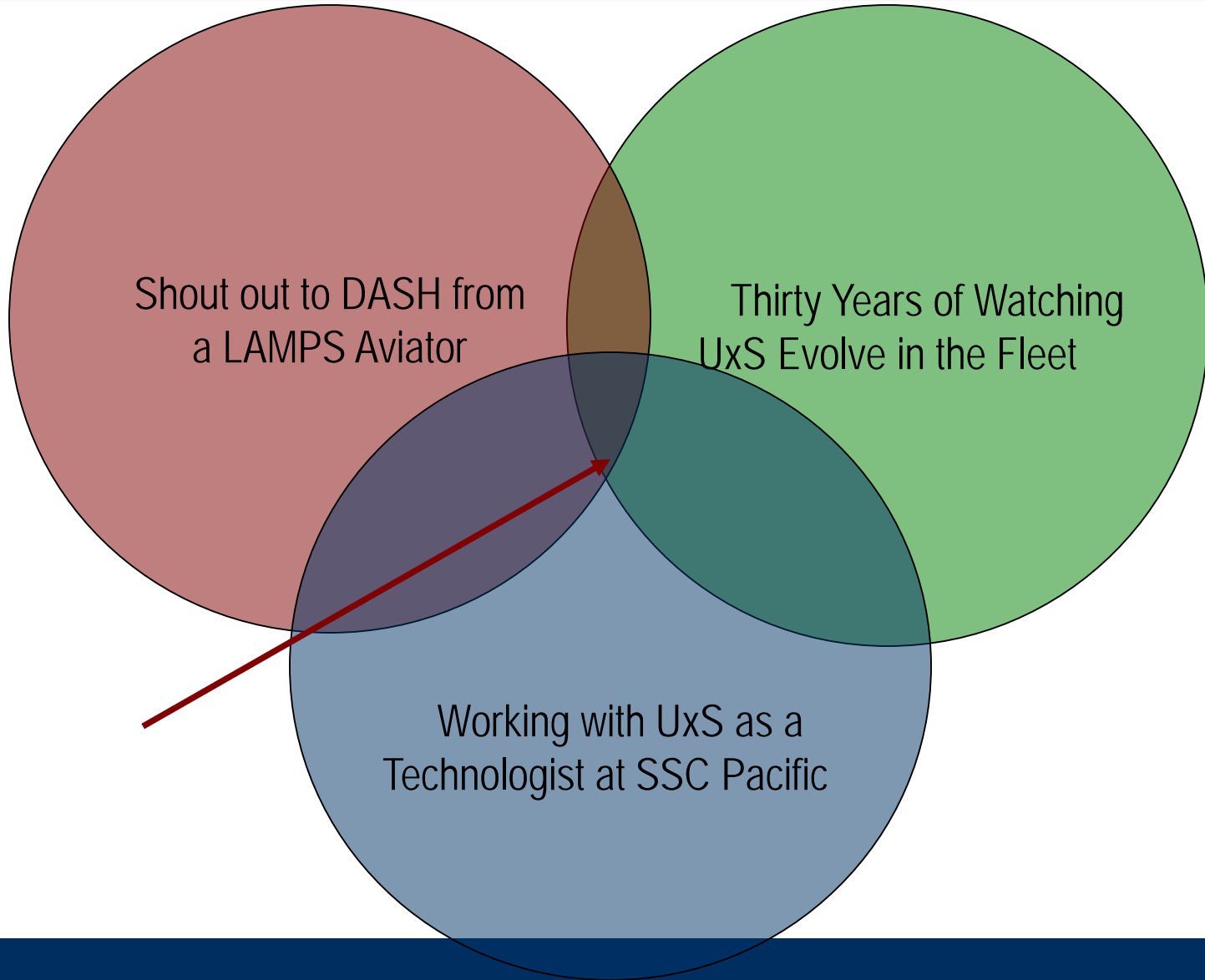
“Continuing a trend that began in the late 1990s, U.S. forces will increase the use and integration of unmanned aerial systems.”

Department of Defense

Quadrennial Defense Review Report

March 2014

Designing Autonomous Systems to Meet Warfighter Needs Today *and* Tomorrow



Unmanned Systems Perspective

- ▼ Exploding use of unmanned systems by the U.S. military
- ▼ Well-documented direction in U.S. security and policy documents
- ▼ Evolutionary changes are making UxS more useful to the military
- ▼ Revolutionary changes are emerging to take UxS to the next level
- ▼ There is a compelling rationale to make UxS more autonomous
- ▼ For weaponized UxS the “art” is making them employable

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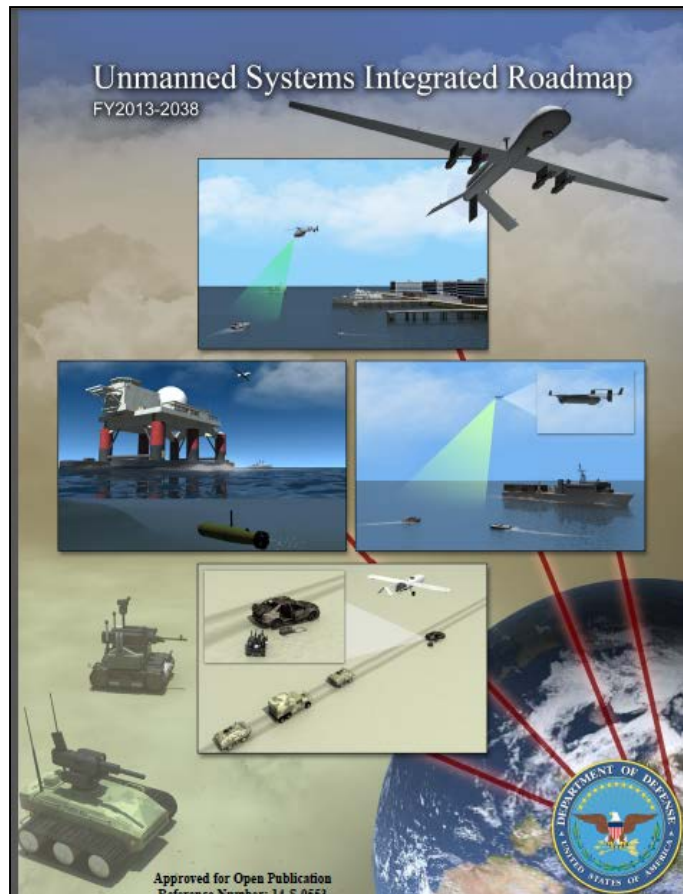
▼ Designing in the *Right* Degree of Autonomy

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“DoD envisions unmanned systems seamlessly operating with manned systems while gradually reducing the degree of human control and decision making required for the unmanned portion of the force structure.”

FY 2013-2038 Unmanned Systems Integrated Roadmap

DoD's Vision for Unmanned Systems



DoD will develop and field affordable, flexible, interoperable, integrated, and technologically advanced unmanned capabilities that will:

- ▼ Prevail in the full range of contingencies and in all operating domains, including cyberspace
- ▼ Enable decisive force effectiveness in Joint and coalition operations
- ▼ Emphasize missions, according to strategic guidance, from ISR; counterterrorism; counter-WMD; and operations across all environments, including A2/AD
- ▼ Protect the homeland
- ▼ Surge and regenerate forces and capabilities

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“As a competitive strategy, we will try to approach this problem without trying to match our potential competitors tank for tank, airplane for airplane, missile for missile [or] person for person. We will try to offset their strengths in a way that gives us an advantage.”

The Honorable Robert Work
Deputy Secretary of Defense
Remarks at the “Securing Tomorrow Forum”
March 30, 2016

Third Offset Strategy



1950s: New Look Strategy



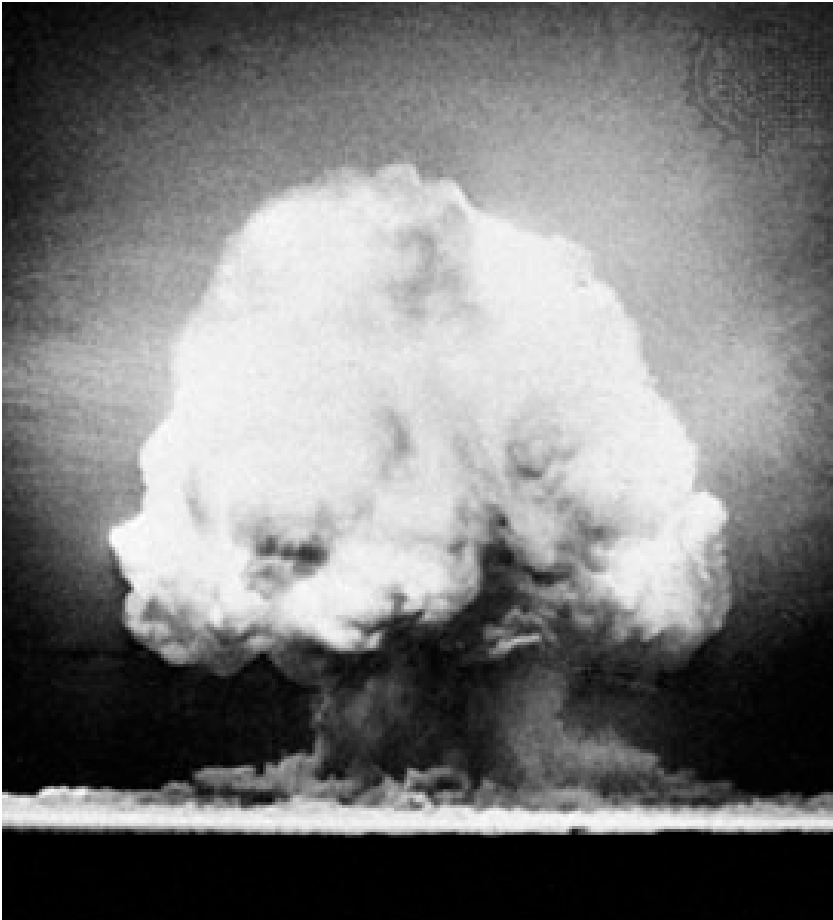
1970s: Offset Strategy



Today: Defense Innovation Initiative

First Offset Strategy

Nuclear Triad



- ▼ Heavy Bombers
- ▼ Intercontinental Ballistic Missiles
- ▼ Submarine Launched Ballistic Missiles

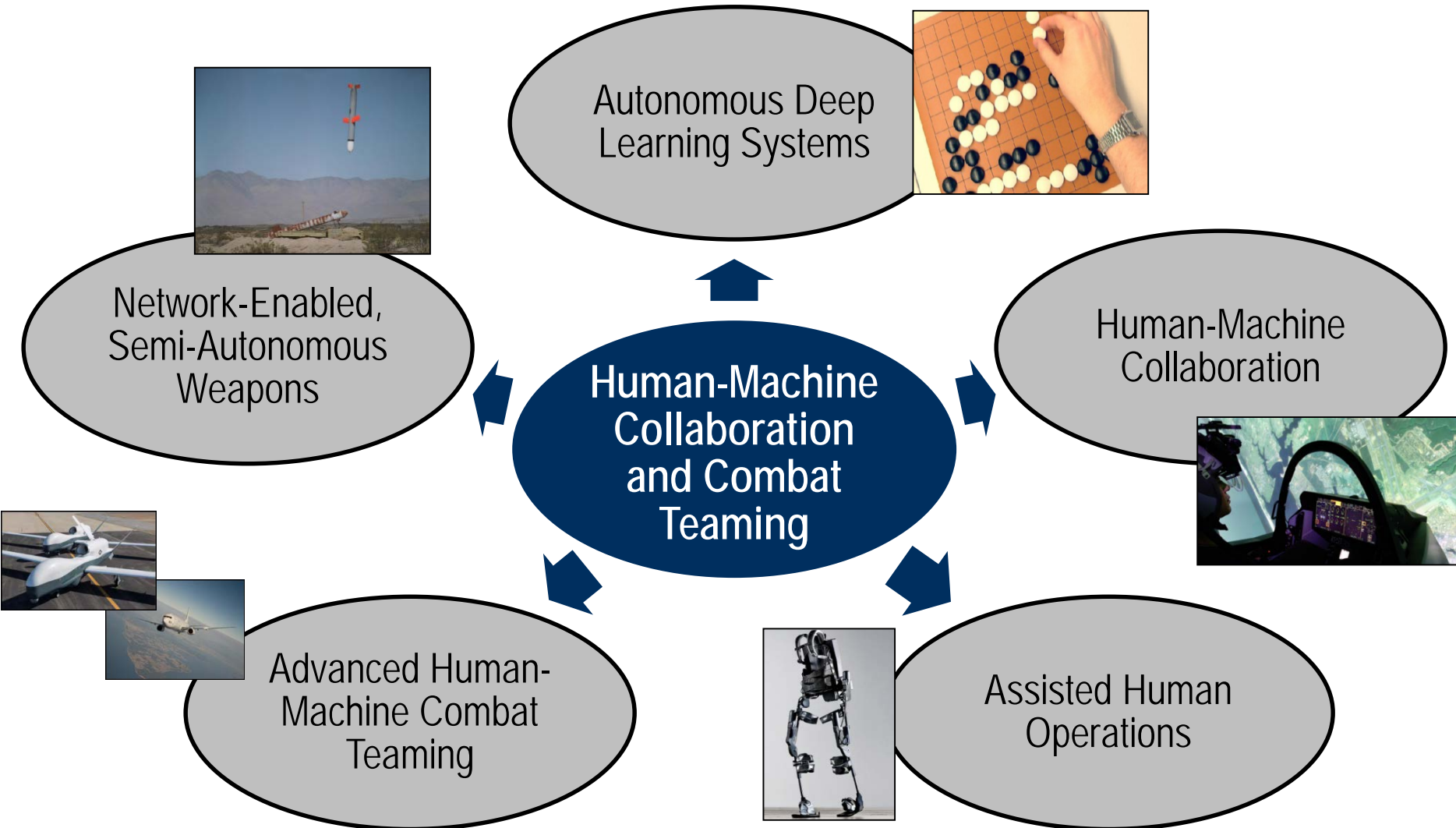
Second Offset Strategy

Key Capabilities

- ▼ Standoff Precision Strike
- ▼ Stealth Aircraft
- ▼ Wide-Area Surveillance
- ▼ Networked Forces



Human-Machine Collaboration and Combat Teaming



Advances in artificial intelligence and autonomy as the foundation

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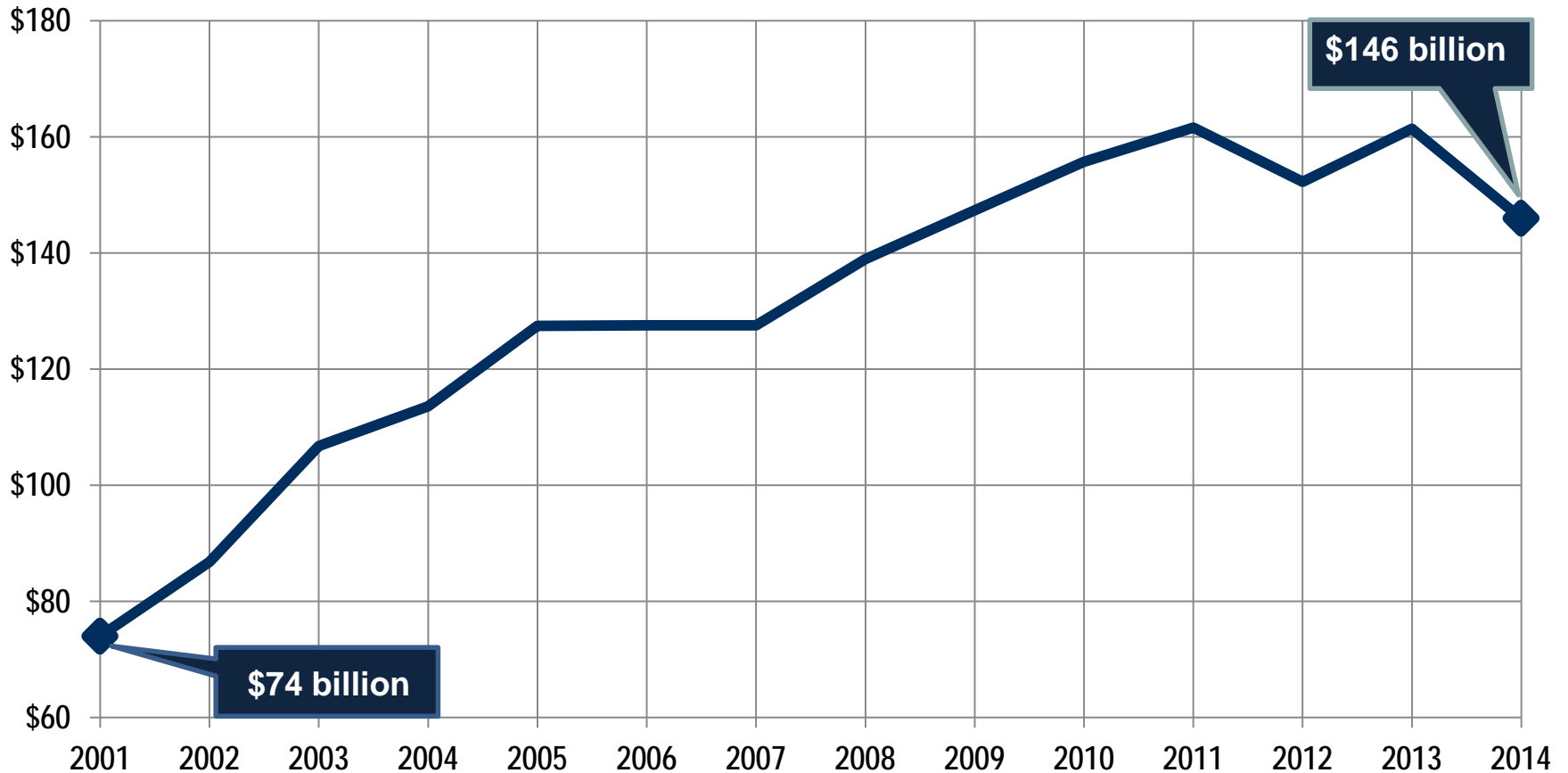
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“One of the largest cost drivers in the budget of DoD is manpower. A significant amount of that manpower, when it comes to operations, is spent directing unmanned systems during mission performance, data collection and analysis, and planning and replanning. Therefore, of utmost importance for DoD is increased system, sensor, and analytical automation that can not only capture significant information and events, but can also develop, record, playback, project, and parse out those data and then actually deliver “actionable” intelligence instead of just raw information.”

FY 2013-20328 Unmanned Systems Integrated Roadmap

Rising Manpower Costs Are Unsustainable

Military Personnel Expenditures (in billions of current dollars)



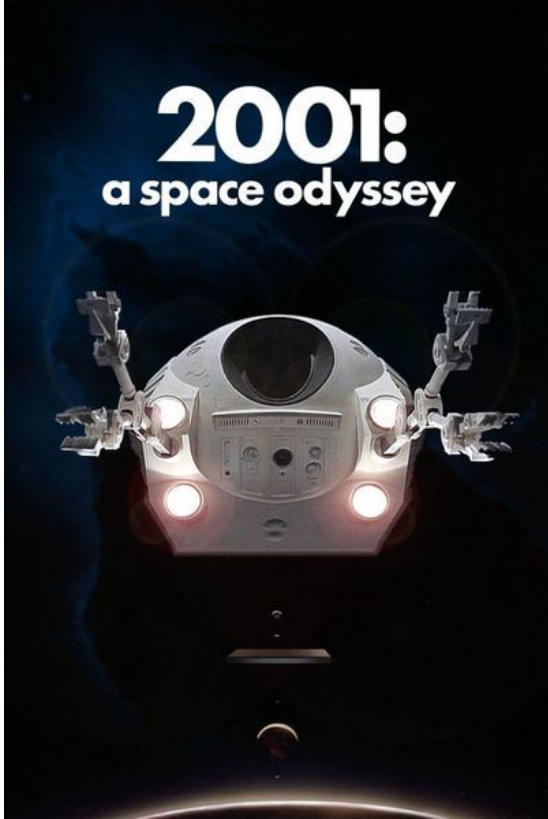
Data from: Office of Management and Budget, *Budget of the U.S. Government, FY 2014, Historical Tables*

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"Astronauts David Bowman and Frank Poole consider disconnecting HAL's (Heuristically programmed **AL**gorithmic computer) cognitive circuits when he appears to be mistaken in reporting the presence of a fault in the spacecraft's communications antenna. They attempt to conceal what they are saying, but are unaware that HAL can read their lips. Faced with the prospect of disconnection, HAL decides to kill the astronauts in order to protect and continue its programmed directives.

From Stanley Kubrick's *2001: A Space Odyssey* (1968)



“The theoretical physicist Stephen Hawking told us that “the development of full **artificial intelligence** could spell **the end of the human race.**” Elon Musk, the chief executive of Tesla, told us that **A.I. was “potentially more dangerous than nukes.”** Steve Wozniak, a co-founder of Apple, told us that “computers are going to take over from humans” and that **“the future is scary and very bad for people.”**

Alex Garland

“Alex Garland of ‘Ex Machina’ Talks About Artificial Intelligence”

The New York Times April 22, 2015

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“Instead of viewing autonomy as an intrinsic property of unmanned systems in isolation, the design and operation of unmanned systems needs to be considered in terms of human-systems collaboration...A key challenge for operators is maintaining the human-machine collaboration needed to execute their mission, which is frequently handicapped by poor design...A key challenge facing unmanned systems developers is the move from a hardware-oriented, vehicle-centric development and acquisition process to one that emphasizes the primacy of software in creating autonomy.”

The Role of Autonomy in DoD Systems
Defense Science Board Report
July 2012

Designing in the *Right* Degree of UxS Autonomy

- ▼ Make the C4 architecture a priority in UxS development
- ▼ Build in a “sense and adapt” capability in all UxS
- ▼ Concurrently develop CONOPS and tactics, techniques and procedures for each UxS
- ▼ Leverage queuing theory to enable UxS to balk or renege on a mission
- ▼ Develop target recognition algorithms that are on a par with those of manned systems
- ▼ Develop anticipatory intelligence and decision support software into unmanned systems

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- ▼ Into the Future *and* “Money Talks”

“Autonomy delivers significant military value, including opportunities to reduce the number of warfighters in harm’s way, increase the quality and speed of decisions in time-critical operations, and enable new missions that would otherwise be impossible.”

Defense Science Board
Summer Study on Autonomy
July 2016

Into the Future

What Kind of Car Do *You* Want?

- ▼ A completely manual car – something your parents drove
- ▼ A driverless car that takes you where you want to go via artificial intelligence
- ▼ A car with augmented intelligence where *you* are in control

Full Autonomy vs. Augmented Intelligence

Some Perspectives On It's *Civilian* Use

"For Now, Self-Driving Cars Still Need Humans"

"Self-Driving Cars in the City: Not so Fast"

"Not Everybody's Ready to Give Up the Wheel"

"A Tesla Driver Using Autopilot Dies in Crash"

"A Driver's Zeal, an Engineer's Worry"

"Tesla's Autopilot Vexes Some Drivers, Even it's Fans"

"Apple Rethinking Strategy on Self-Driving Cars"

"Can Tesla's Autopilot be Trusted? Well, Not Always"

"Uber Halts Self-Driving Tests After Crash"

Full Autonomy vs. Augmented Intelligence

Some Perspectives on Military Use

“Autonomous Weapons’ Safety is Questioned’

“Drone Precision vs. Human Failings”

“Robots in War: The Next Weapons of Mass Destruction”

“Robot Weapons Raise Human Rights Fears”

“Drone Strike Statistics Answer Few Questions”

“Drone Strikes Reveal an Uncomfortable Truth”

The Department Defense is working through the problems of future robotic weapon systems—so-called thinking weapons. **We're not talking about cruise missiles or mines, but robotic systems to do lethal harm—a Terminator without a conscience.** Our job is to defeat the enemy, but it is governed by law and by convention. **We have insisted on keeping humans in the decision-making process to inflict violence on the enemy.** That ethical boundary is the one we've drawn a pretty fine line on. **It's one we must consider in developing these new weapons.**

General Paul Silva
Vice Chairman of the Joint Chiefs of Staff
Center for Strategic and International Studies
"Innovation in the Defense Department"
August 25, 2016

What Would Augmented Intelligence *Look Like* in Military Autonomous Systems?

Augmented Intelligence in Autonomous Military *Surveillance* Systems

- Does the autonomous surveillance systems merely show countless hours of video?
 - Or does it only alert the operator when a vessel is located?
- When the surveillance system finds a vessel does it?
 - Flag it as following a normal shipping channel – or not?
 - Break out the details of the vessel's AIS (Automatic Identification System) data?
 - Show the vessel's port of origin and intended destination(s)?
- Does the surveillance system suggest areas it should search next?
 - Based on vessels it has found (or not found) in certain areas?
 - Based on reports of other friendly surveillance systems?
 - Based on GCCS (Global Command and Control System) or other data?
 - Does the system have automatic detection and classification algorithms?
- Does the surveillance system remind the operator of remaining time on station?

Augmented Intelligence in *Lethal* Military Autonomous Systems

- What is level of confidence this person is the intended target?
- What is this confidence based on?
 - Facial recognition
 - Voice recognition
 - Pattern of behavior
 - Association with certain individuals
 - Proximity of known family members
 - Proximity of known cohorts
- What is the potential for collateral damage to?
 - Family members
 - Known cohorts
 - Unknown persons
- What are the potential impacts of waiting verses striking now?

A Snapshot of Where SSC Pacific is Focusing Its UxS Work

“We will win – or lose – the next series of wars in our nation’s laboratories.”

Admiral James Stavridis

“Deconstructing War”

U.S. Naval Institute Proceedings

December 2005



BASF

Some Representative SSC Pacific UxS Projects

- ▼ ONR UxS Common Control Project
- ▼ DARPA Cross-Domain Maritime Surveillance and Targeting
- ▼ ONR HAMMER (Heterogeneous Autonomous Mobile Maritime Expeditionary Robots)
- ▼ U.S. Navy MQ-4 Triton Unmanned Aircraft Systems Integration Project
- ▼ U.S. Air Force Global Hawk Project Integration efforts
- ▼ ONR Integrated Ground Technology Technologies for Expeditionary Environments
- ▼ PMS 408 Mk18 UUV Program (EOD for UUVs)
- ▼ DARPA CODE (Collaborative Operations in Denied Environment) Project
- ▼ MOCU (Multi-Operator Control Unit) Project
- ▼ LDUUV (Large Displacement Unmanned Underwater Vehicle) Project
- ▼ ACTUV (ASW Continuous Trail Unmanned Vessel) Sea Hunter Project
- ▼ SSC Pacific Human-Autonomy Teaming Project

“SSC Pacific is one of the Department of Defense’s most important engines of innovation. Our biggest investments in science and technology are in the laboratory systems, and they are going to accelerate technology.”

The Honorable Frank Kendall
Undersecretary of Defense for
Acquisition, Technology and Logistics
August 24, 2016

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