



Maritime Security Challenges 2016: Pacific Seapower

Panel: Game Changers: Technical Advancements in the Maritime Realm

The Rise of Autonomous Vehicles: The Impact on Maritime Operations

Captain George Galdorisi (U.S. Navy – retired)
Space and Naval Warfare Systems Center Pacific

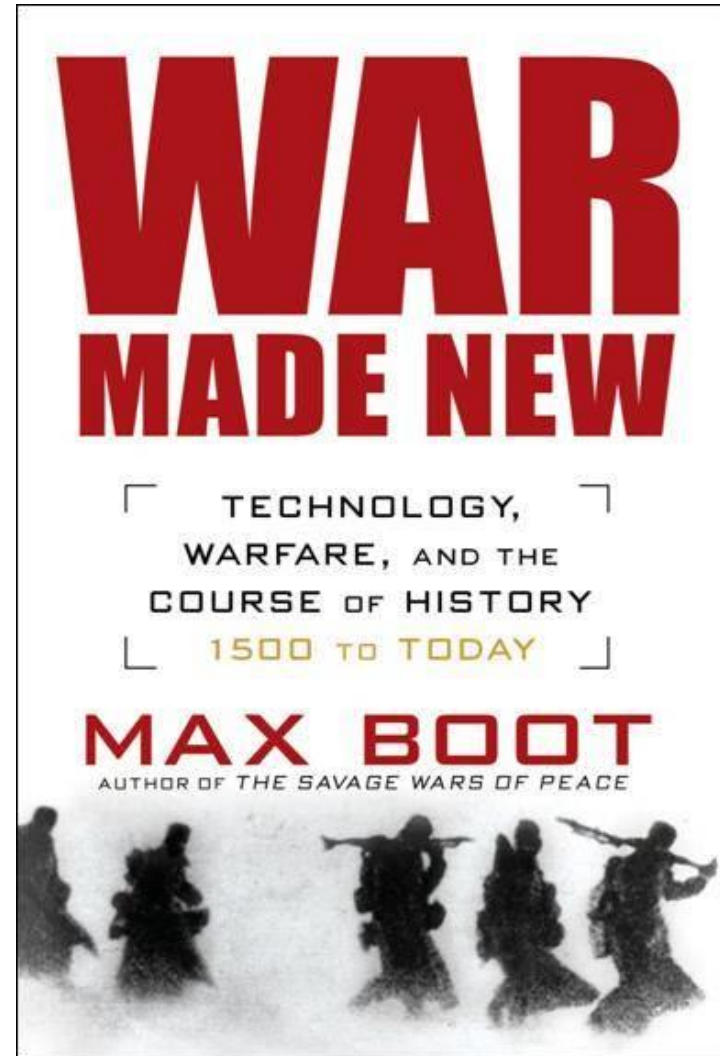
What We'll Talk About Today

- ▼ Perspective
- ▼ The Plan for Autonomous Systems – A U.S. Perspective
- ▼ For the U.S.: 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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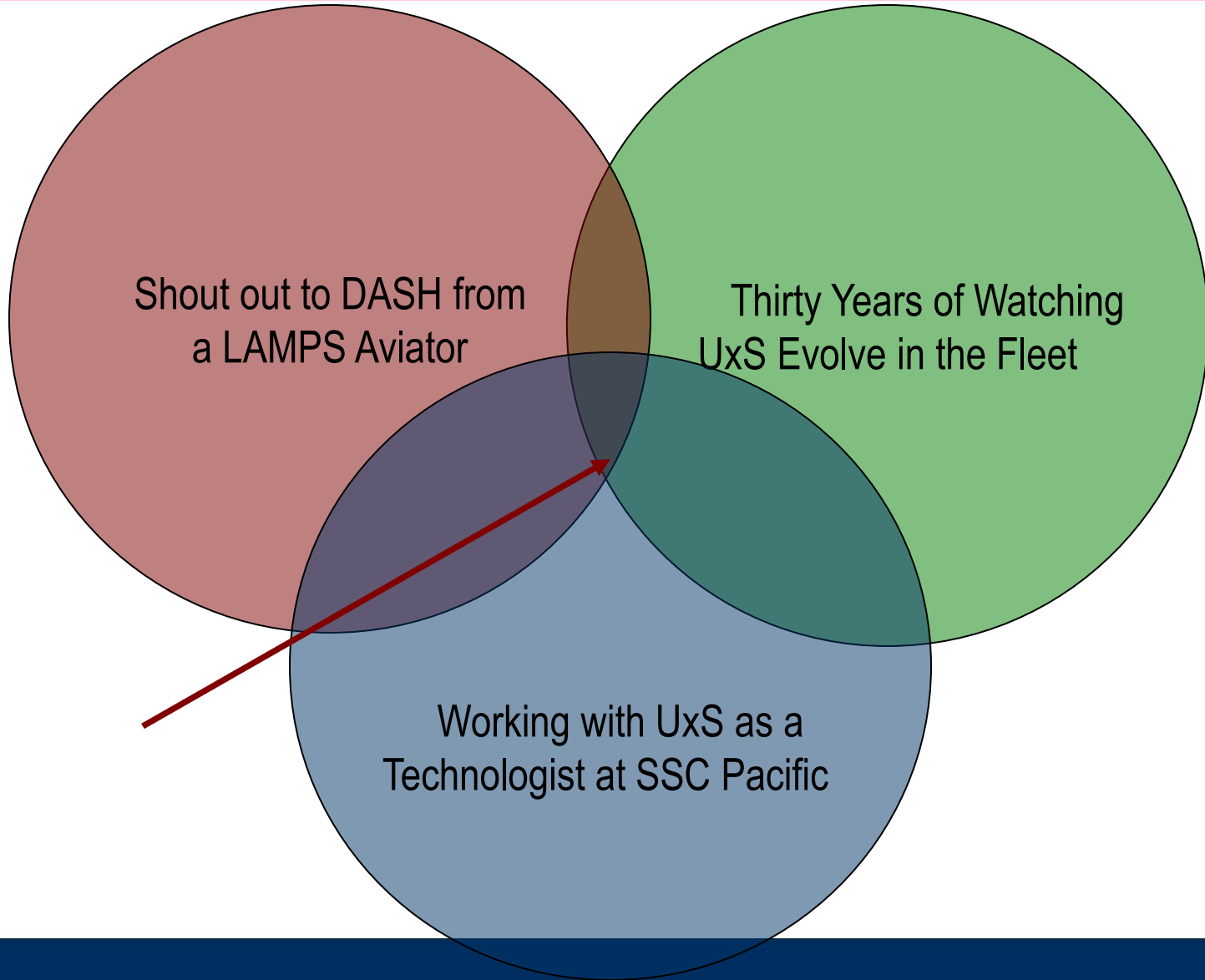
“Continuing a trend that began in the late 1990s, U.S. forces will increase the use and integration of unmanned aerial systems.”

Department of Defense

Quadrennial Defense Review Report

March 2014

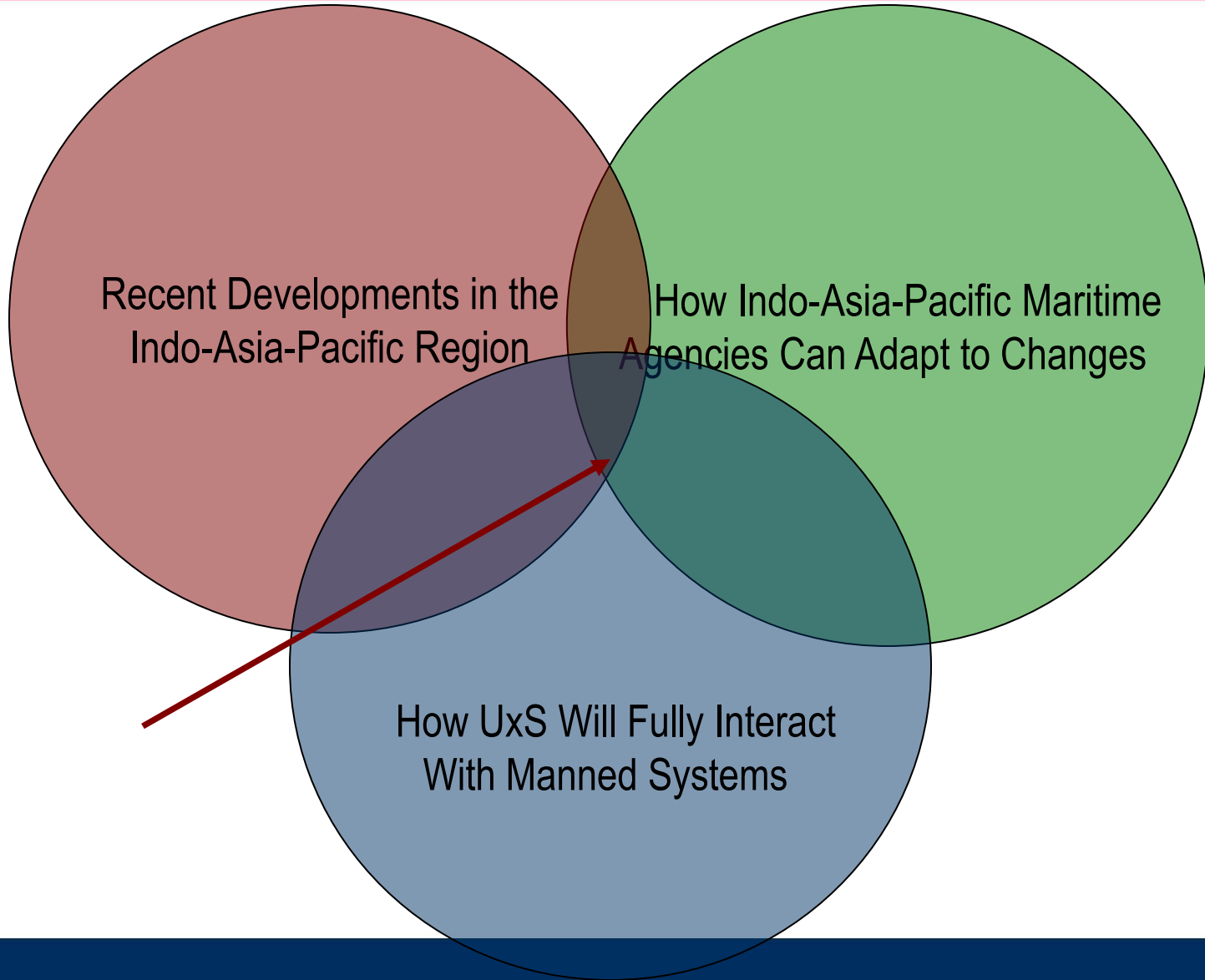
Designing Autonomous Systems to Meet Warfighter Needs Today *and* Tomorrow



Unmanned Systems Perspective

- ▼ Exploding use of unmanned systems by the militaries worldwide
- ▼ For the U.S.: Well-documented policy and security direction
- ▼ 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

Questions for Our Panel



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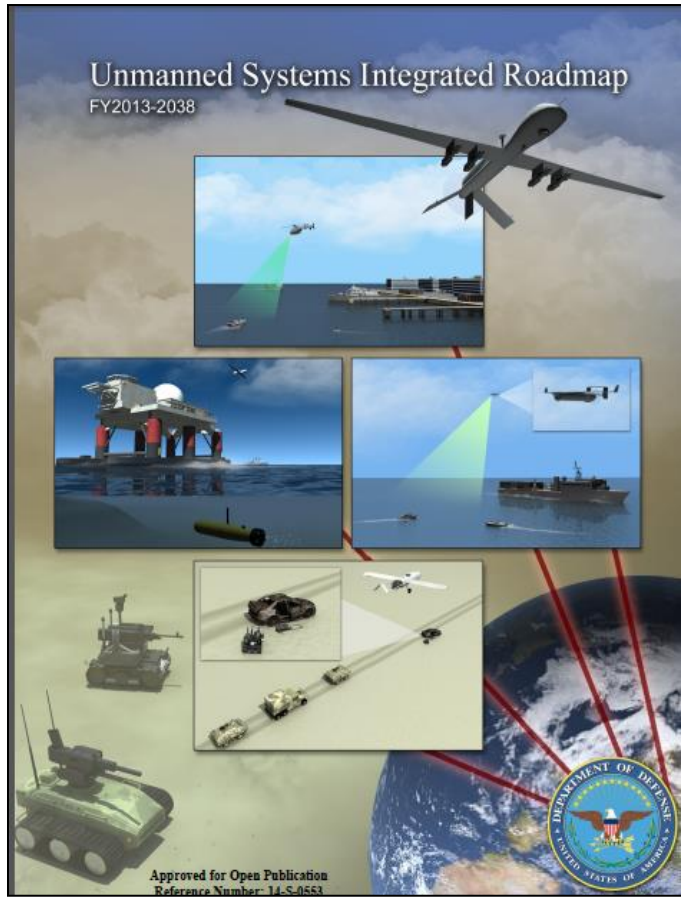
▼ Designing in the *Right* Degree of Autonomy

▼ Into the Future

“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

U.S. 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

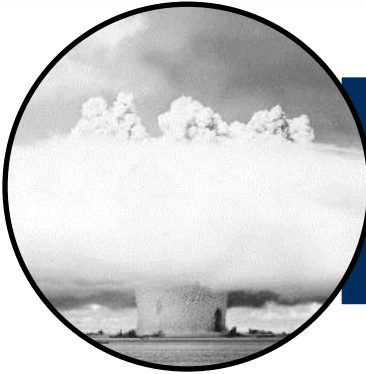
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“As a competitive strategy, we will try to approach this problem without trying to match our potential competitors tank for tank, airplane for airplane, missile for missile [or] person for person. We will try to offset their strengths in a way that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

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

Offset Strategies



1950s: New Look Strategy



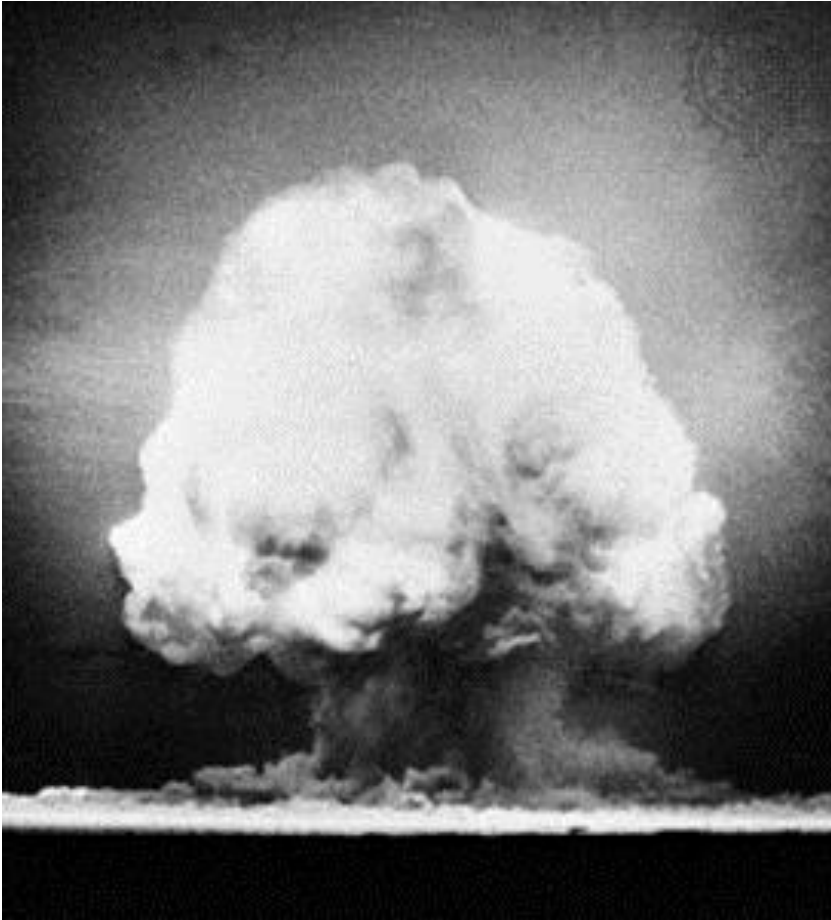
1970s: Offset Strategy



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



Why a Third Offset Strategy?

“Disruptive technologies and destructive weapons once solely possessed by only advanced nations have proliferated widely, and are being sought or acquired by unsophisticated militaries and terrorist groups.”

Secretary of Defense Chuck Hagel
Defense Innovation Days Keynote
September 03, 2014



**Congressional
Research Service**

Informing the legislative debate since 1914

A Shift in the International Security Environment: Potential Implications for Defense—Issues for Congress

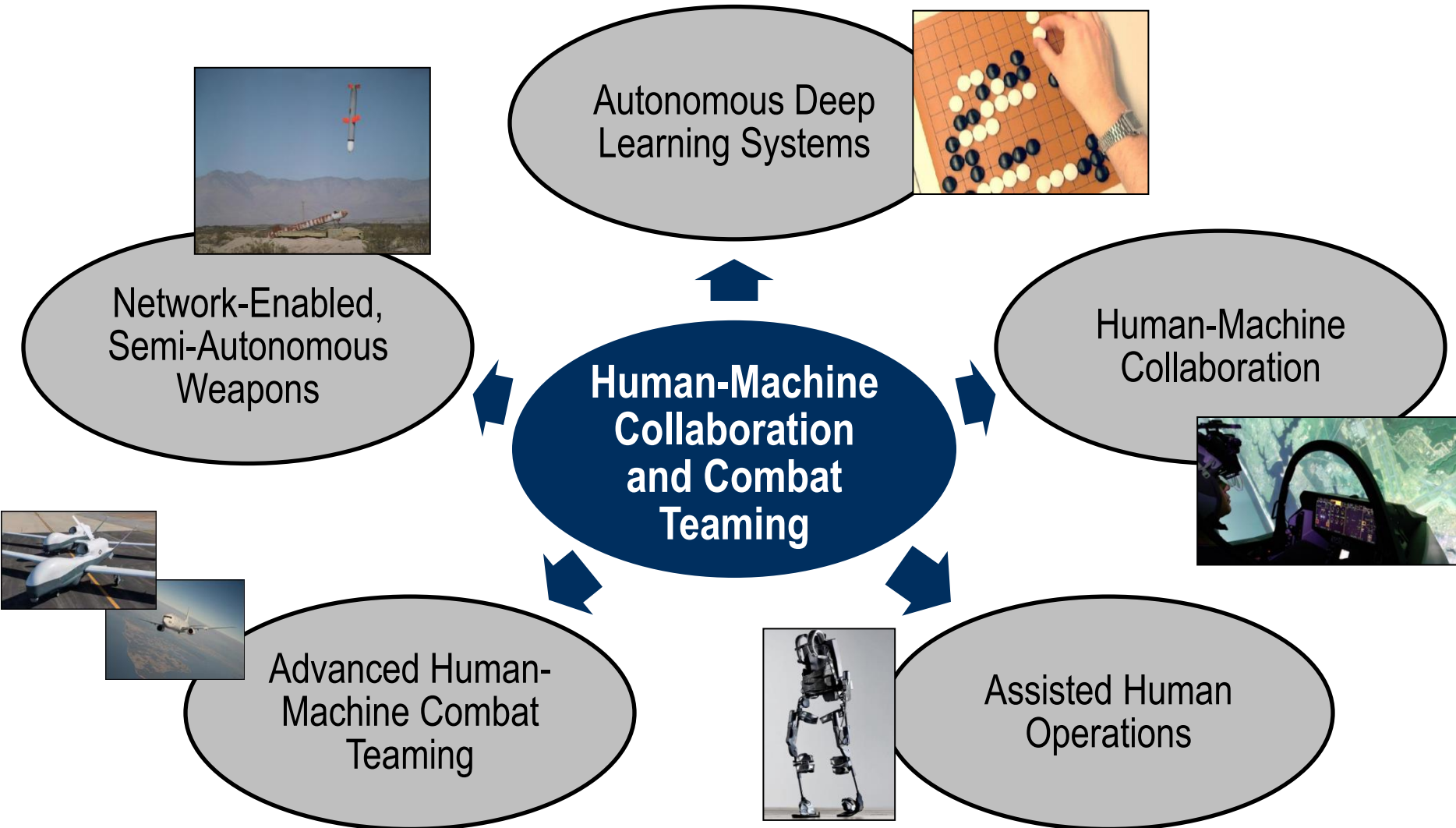
Ronald O'Rourke
Specialist in Naval Affairs

December 31, 2014

Congressional Research Service
7-5700
www.crs.gov
R43838

CRS REPORT
Prepared for Members and
Committees of Congress

Human-Machine Collaboration and Combat Teaming



Advances in artificial intelligence and autonomy as the foundation

What We'll Talk About Today

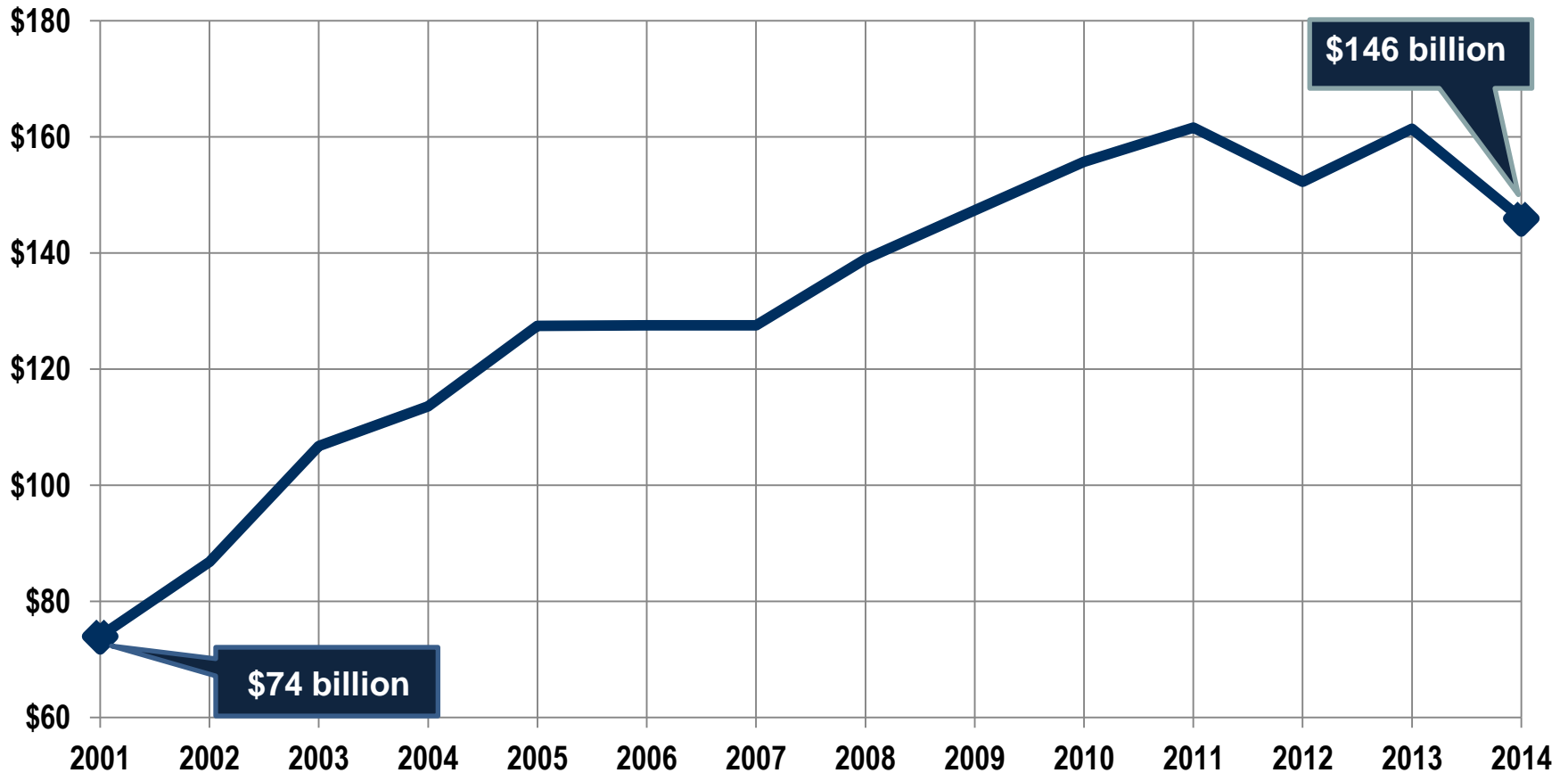
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“One of the largest cost drivers in the budget of DoD is manpower. A significant amount of that manpower, when it comes to operations, is spent directing unmanned systems during mission performance, data collection and analysis, and planning and replanning. **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)



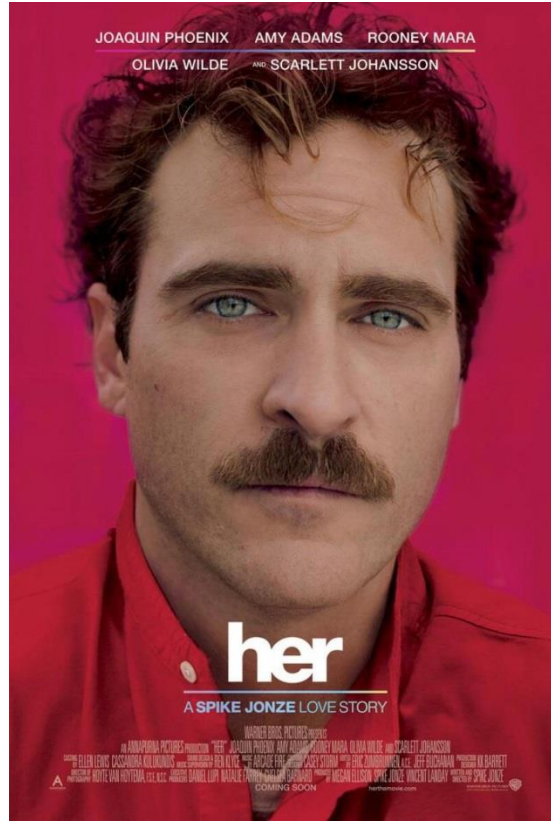
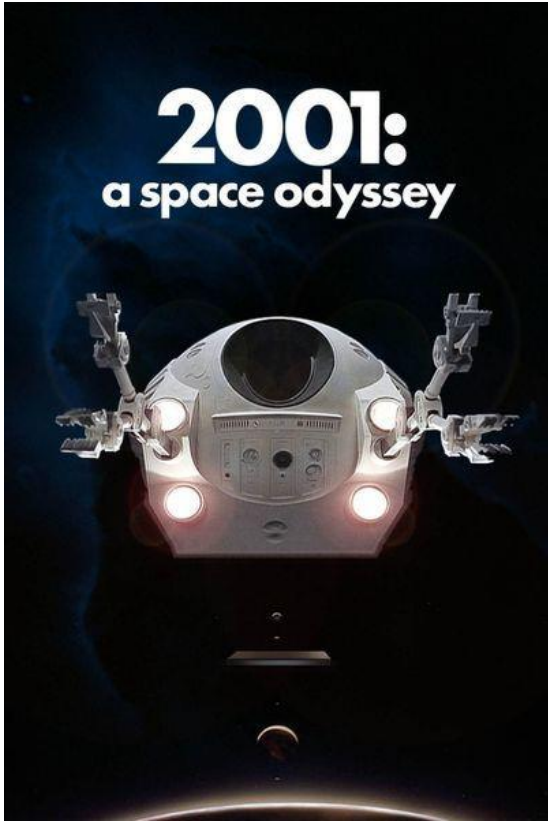
Data from: Office of Management and Budget, *Budget of the U.S. Government, FY 2014, Historical Tables*

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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

- ▼ Ensure that the autonomous systems can perform a “hierarchy of tasks:” from elementary navigation and comms, to higher-order actions up to weapons release
- ▼ Reconcile the various “views” of what the UxS is asked to accomplish: The user view, the robotics view, the machine learning view and the cognitive view.
- ▼ Ensure that there is early collaboration between engineers, ethicists, lawyers, policymakers and others as the UxS design process evolves
- ▼ Industry and the military must exploit best HFE/HSI practices in designing/developing UxS – just answering an RFP and issuing a contract is insufficient
- ▼ Given the complexity of the software that delivers autonomy and AI to UxS, it is important not to “over-allocate” development time to the platform itself.
- ▼ Develop CONOPS early for UxS that will operate directly with manned platforms (P-8A Poseidon/MQ-4C Triton, MH-60S Seahawk/MQ- 8C Fire Scout)

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“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 Its *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”

Full Autonomy vs. Augmented Intelligence

Some Perspectives On Its 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

Some Representative SSC Pacific UxS Projects

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

“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



For more on this subject:

The paper associated with this briefing....

and

“Keeping Humans in the Loop,” *Naval Institute Proceedings*, February 2015....

BACKUPS

Navy Working Capital Fund: Analogous to Industry

- ▼ UxS projects our sponsors fund (all Navy Systems Commands +)
- ▼ DARPA and ONR UxS projects
- ▼ UxS projects where we team with industry
- ▼ UxS projects where we spend (scarce) internal R&D funding

The image shows the BASF logo, which consists of a stylized square with a smaller square inside it, followed by a small square separator, and the word "BASF" in a bold, white, sans-serif font. The entire logo is centered on a solid green rectangular background.

BASF

Unmanned Systems at SSC Pacific

▼ Infrastructure for all UxS domains

- 40+ Active UxS Projects
 - Advanced Autonomy
 - Human Machine Teaming
 - Sensor Fusion
 - Communications
 - Payloads
 - Operational T&E
 - S&T Research

▼ Expert Personnel

- 400+ government scientists and engineers
- 40+ years in unmanned systems



We Make Unmanned Vehicles Smarter



“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

“As they become smarter and more widespread, autonomous machines are bound to end up **making life-or-death decisions** in unpredictable situations, thus assuming—or at least appearing to assume—moral agency. Weapons systems currently have human operators “in the loop”, but as they grow more sophisticated, it will be possible to shift to “on the loop” operation, with **machines carrying out orders autonomously**. As that happens, they will be presented with ethical dilemmas...More collaboration is required between engineers, ethicists, lawyers and policymakers, **all of whom would draw up very different types of rules if they were left to their own devices**.

“Morals and the Machine”
The Economist June 2012

“If you find the use of remotely piloted warrior drones troubling, **imagine that the decision to kill a suspected enemy is not made by an operator in a distant control room, but by the machine itself.** Imagine that an aerial robot studies the landscape below, recognizes hostile activity, calculates that there is minimal risk of collateral damage, and then, with no human in the loop, pulls the trigger. Welcome to the future of warfare. While Americans are debating the president's power to order assassination by drone, **powerful momentum** – scientific, military and commercial – **is propelling us toward the day when we cede the same lethal authority to software.**

Bill Keller “Smart Drones”

The New York Times March 2013

SSC Pacific UxS History



Technology as an Enabler



Recent experience suggests that the right technology, used intelligently, makes sheer numbers irrelevant. The tipping point was the Gulf War in 1991. When the war was over, the **United States and its coalition partners had lost just 240 people. Iraq suffered about 10,000 battle deaths**, although no one will ever really be sure. The difference was that the allied forces could see at night, drive through the featureless desert without getting lost, and put a single smart bomb on target with a 90 percent probability.”

Bruce Berkowitz
The New Face of War



Real-time Info Sharing | Wind Farm Woes

PROCEEDINGS

U.S. NAVAL INSTITUTE | The Independent Forum of the Sea Services

SOUTHERN Partnerships

Lessons in Search
and Rescue

How to Lead Millennials

Unmanned—and
Autonomous



February 2015
www.usni.org

