



Technology Surprise—Need for Rebalance of R&E Investments

18 March 2014

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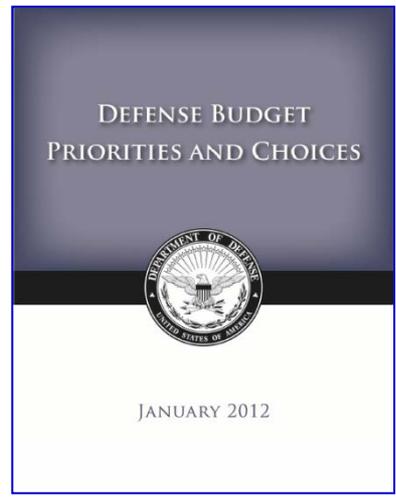
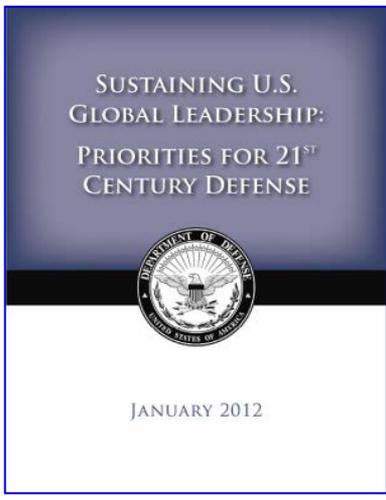
**Acting Assistant Secretary of Defense for
Research and Engineering**



Key Elements of Defense Strategic Guidance

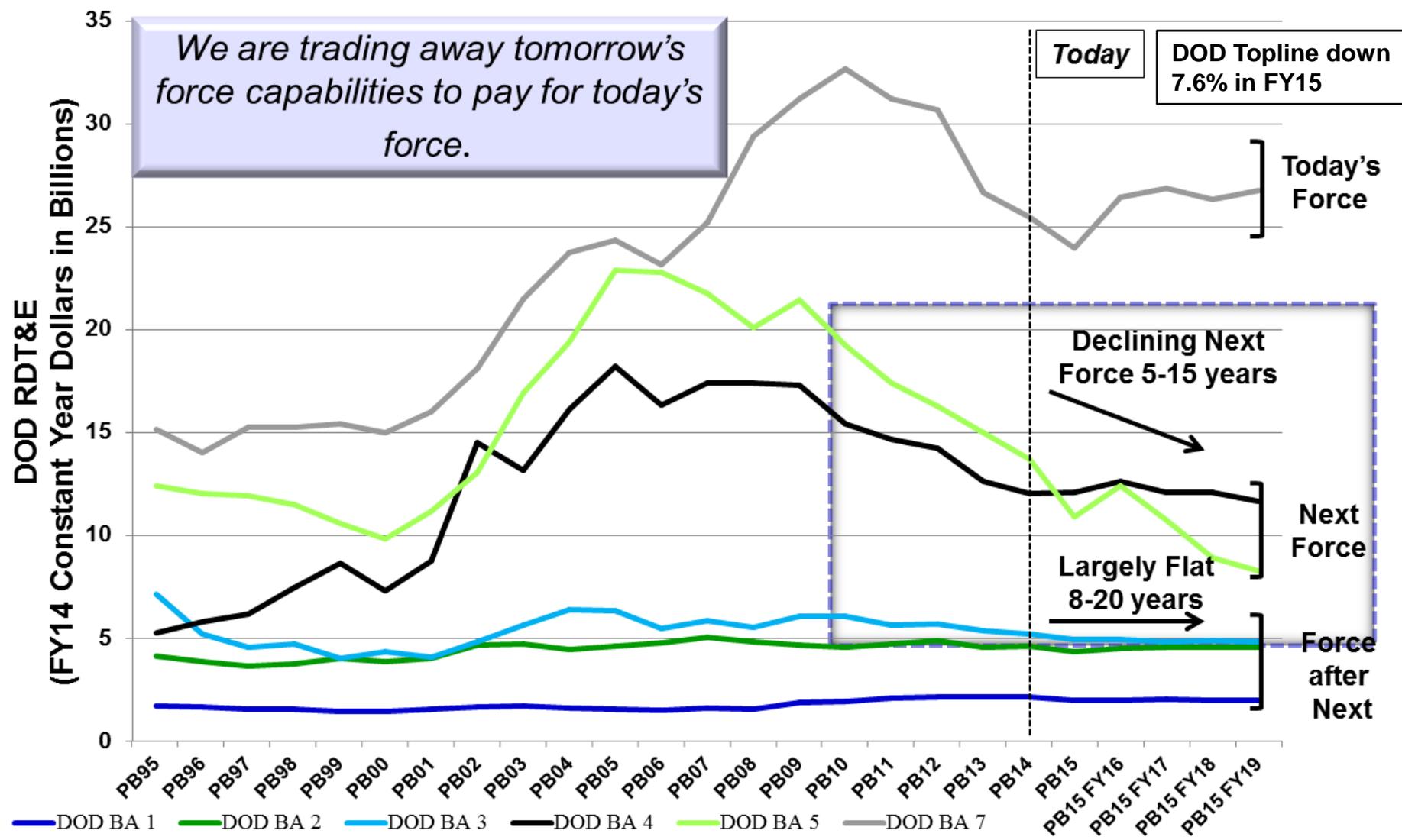


- The military will be smaller and leaner, but it will be **agile, flexible, ready and technologically advanced**.
- Rebalance our global posture and presence to emphasize Asia-Pacific regions.
- Build innovative partnerships and strengthen key alliances and partnerships elsewhere in the world.
- Ensure that we can quickly **confront and defeat aggression from any adversary anytime, anywhere**.
- Protect and prioritize key investments in **technology and new capabilities**, as well as our capacity to grow, adapt and mobilize as needed.





DOD RDT&E – PBR1995-PBR2015

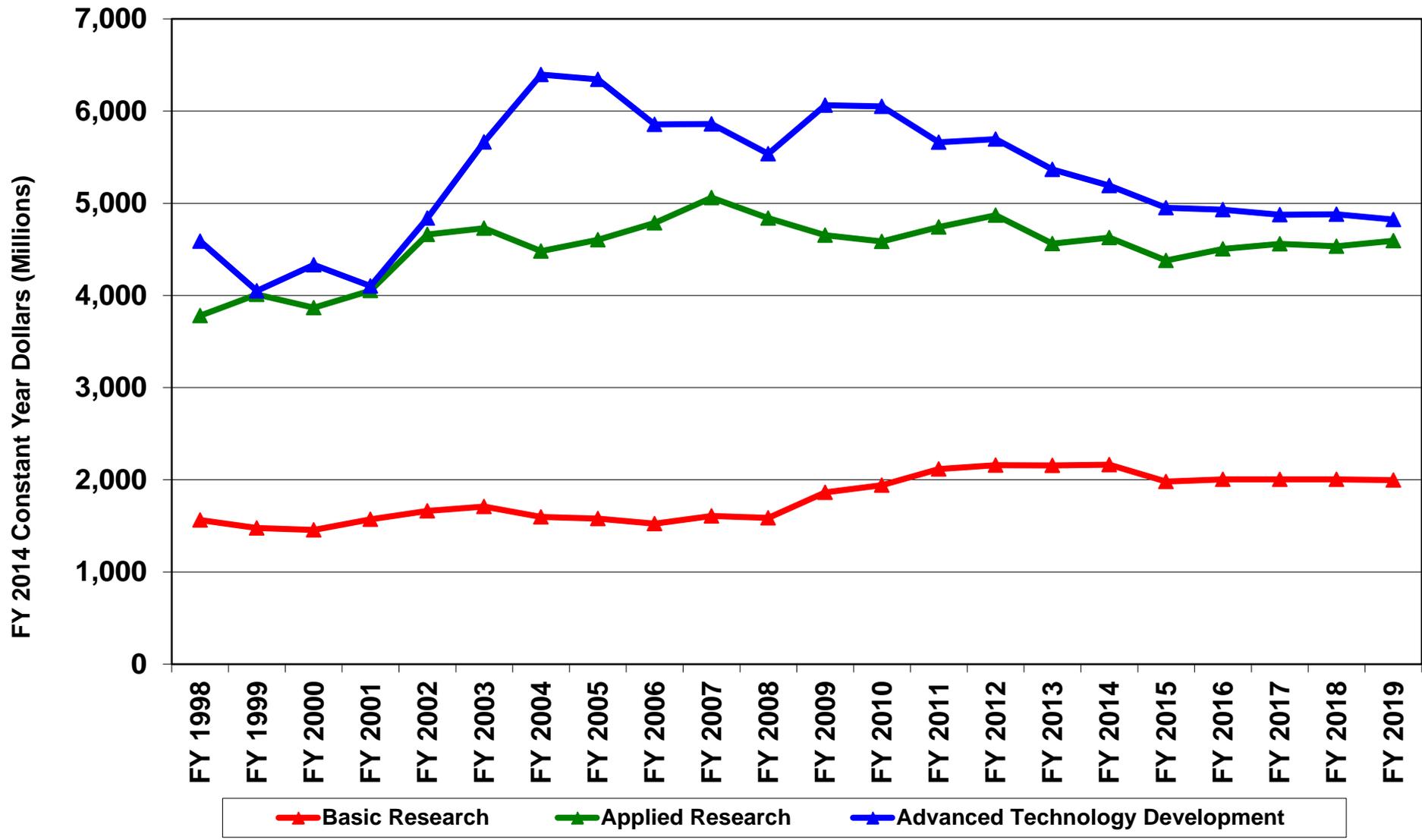




DoD S&T Funding by Budget Activity

FY 1998-2019

(President's Budget Request)





Defense R&E Strategy



“Protect and prioritize key investments in technology and new capabilities, as well as our capacity to grow, adapt and mobilize as needed.”

-SECDEF, January 2012 Strategic Guidance

1. **Mitigate** new and emerging threat capabilities

- Cyber
- Counter Space
- Electronic Warfare
- Counter-WMD

2. **Affordably** enable new or extended capabilities in existing military systems

- Systems Engineering
- Prototyping
- Interoperability
- Modeling and Simulation
- Developmental Test & Evaluation
- Power & Energy

3. **Develop** **technology surprise** through science and engineering

- Autonomy
- Human Systems
- Quantum
- Data-to-Decisions
- Hypersonic

Technology Needs

- Cyber / Electronic Warfare
- Engineering / M & S
- Capability Prototyping
- Protection & Sustainment
- Advanced Machine Intelligence
- Anti-Access/Area Denial (A2/AD)

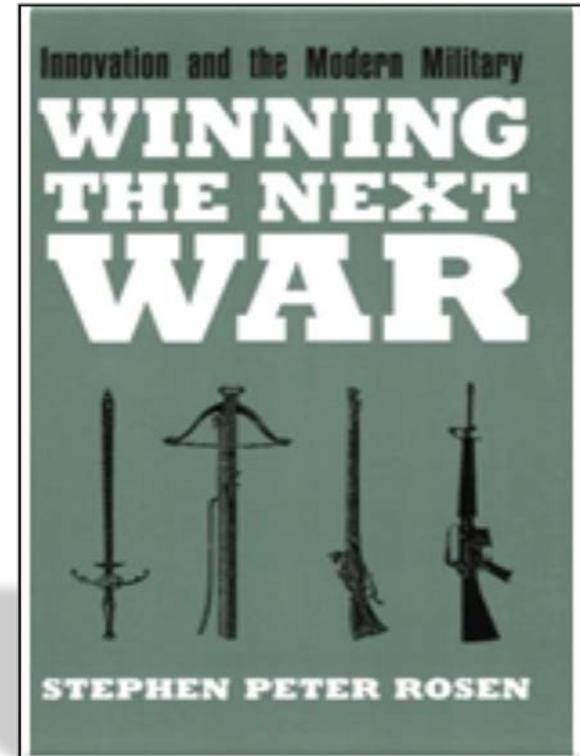


“Winning the Next War”

-Stephen P. Rosen



- Armies and navies are not forever doomed to "fight the last war." -- Rather, they are able to respond to shifts in the international strategic situation.
- To not lose the war one needs to keep investing in new capabilities between the wars.

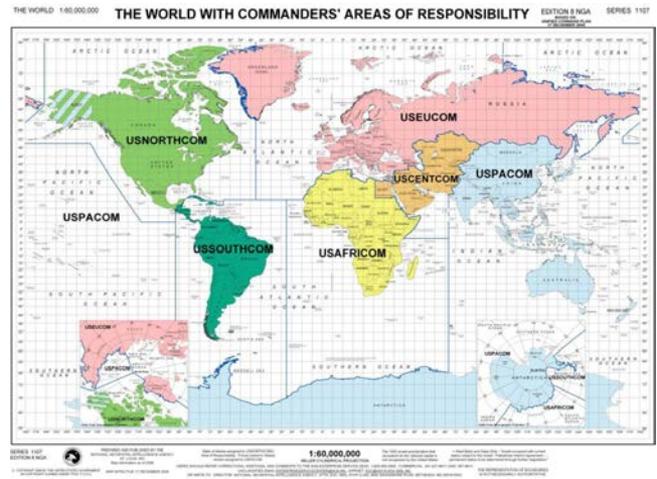




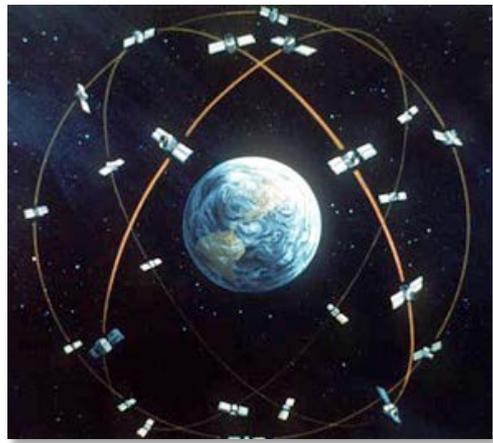
Rise of the Commons



Electronic Warfare



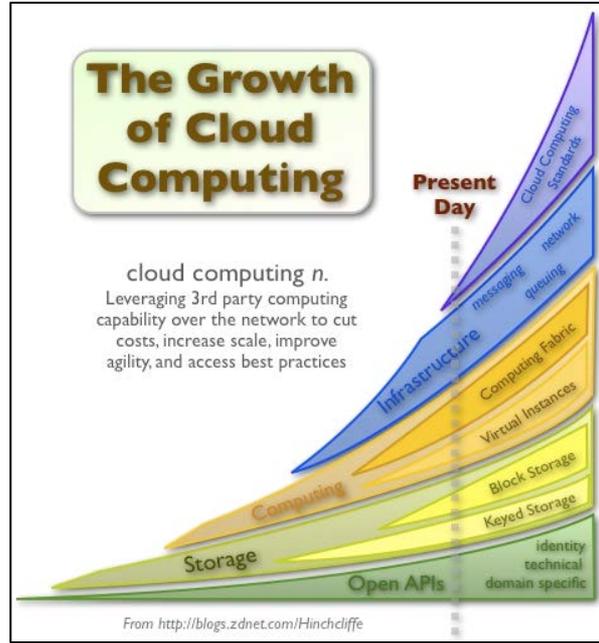
Oceans



Space



Cyber

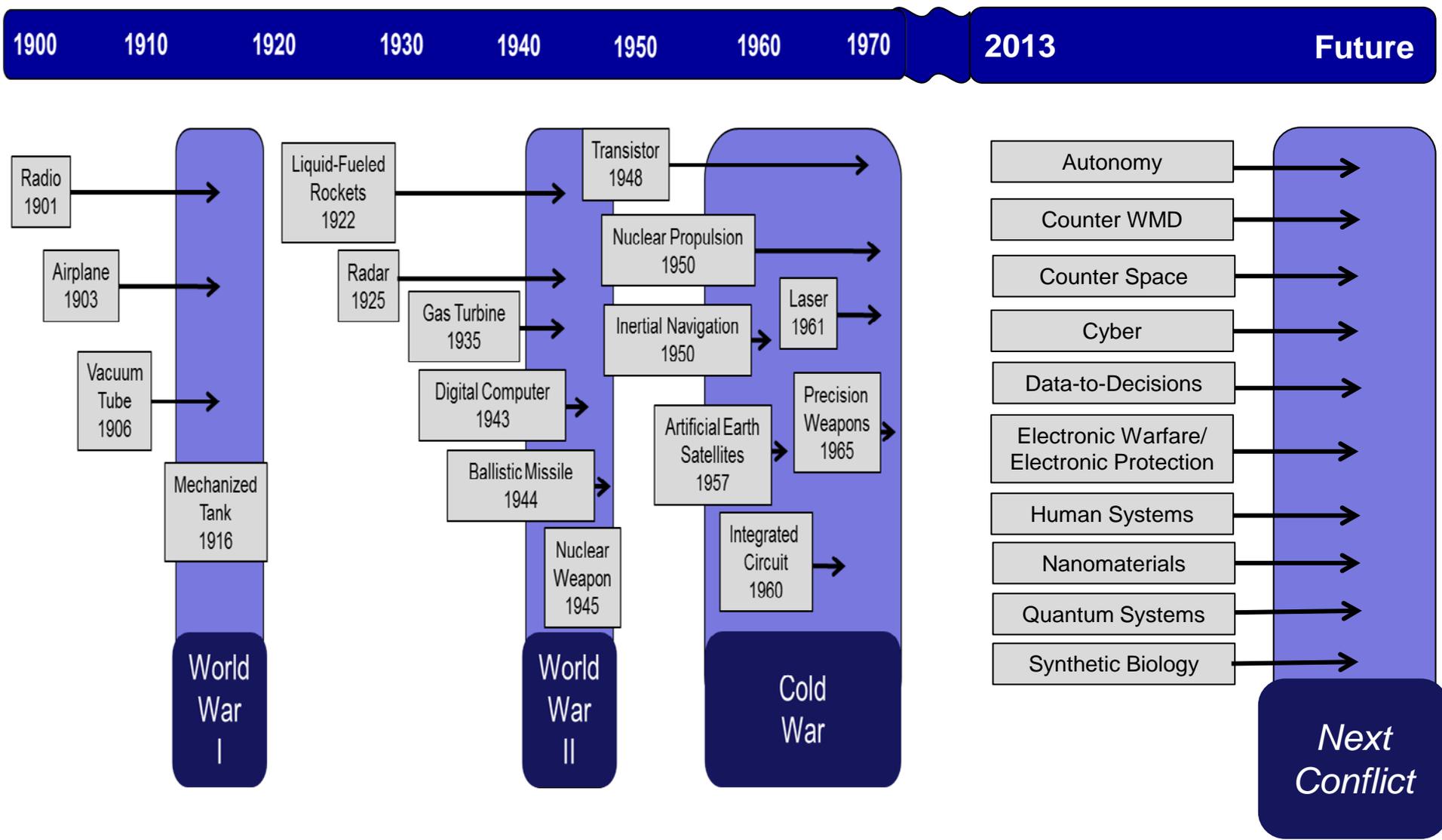


Ubiquitous Data

Military Operations Increasingly Depend on Being Able to Operate in Places "No One Owns" – *The Enablers*



Lab Demo to Forcing Function: Technology Investment Stocks Cupboard





Capability Prototyping Proof of Concept: "X"- Plane Prototyping



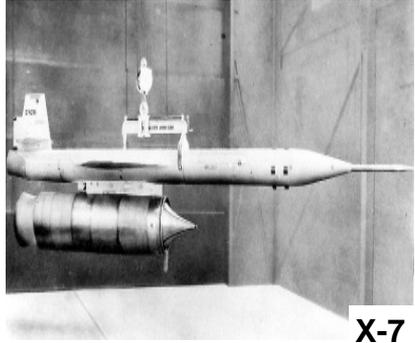
X-1

First flight: 1947
Speed: Mach 1.26



X-2

First flight: 1952
Speed: Mach 3.2



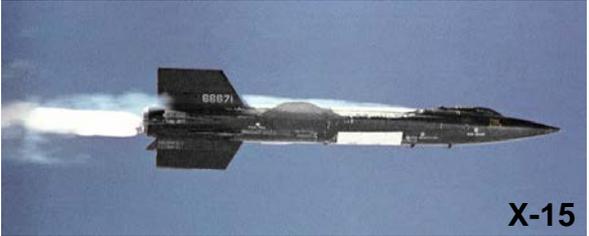
X-7

First Flight: 1951
Speed: Mach 4.31



X-10

First Flight: 1953
Speed: Mach 2



X-15

First Flight: 1959
Speed: Mach 6.7



X-43

First Flight: 2001
Speed: Mach 6.83



X-51

First Flight: 2010
Speed: Mach 5.1

The Department can cost-effectively drive innovation in aviation, space, maritime and ground combat systems through prototyping



Autonomy

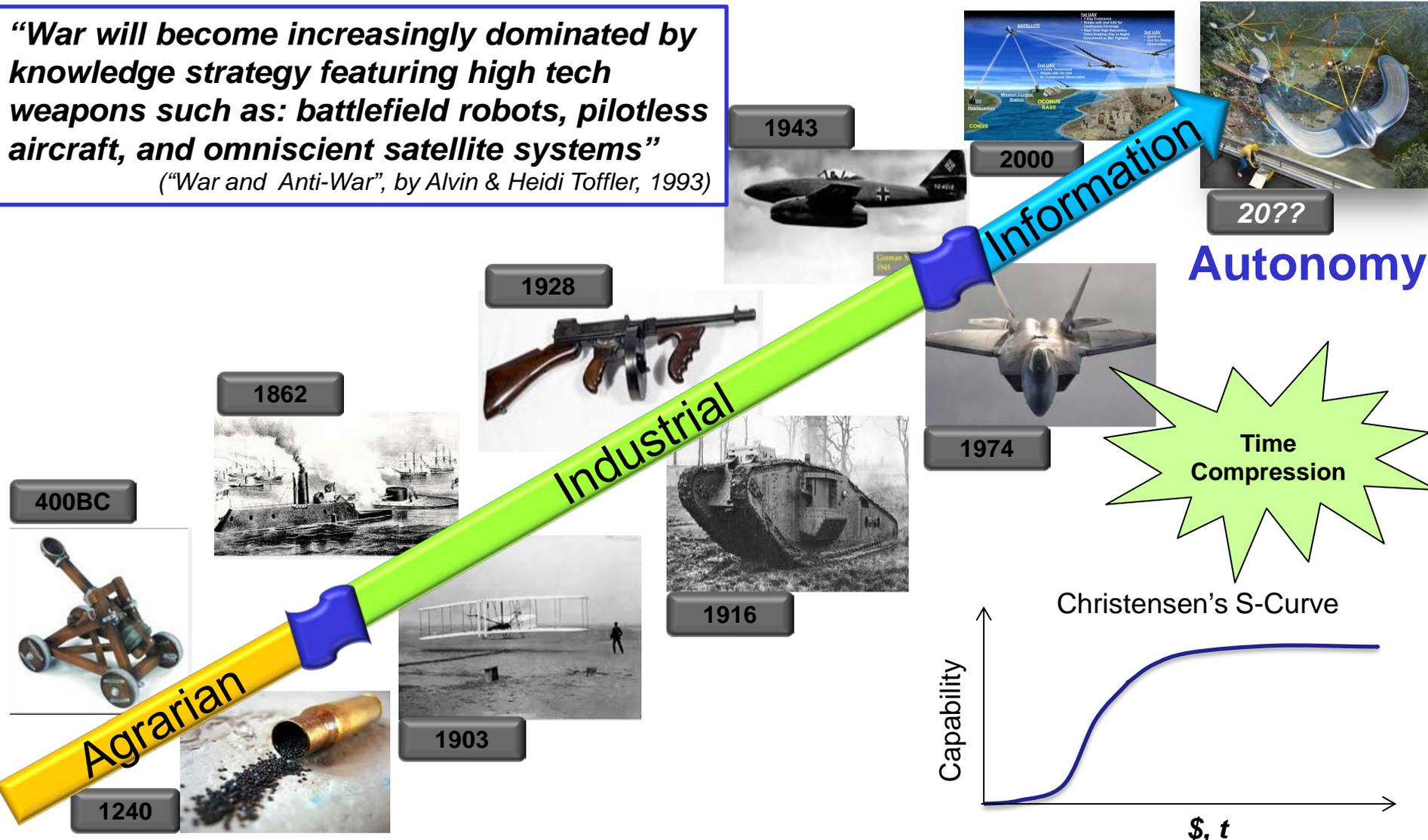


- Three Revolutions
 - Autonomy
 - Speed
 - EM



Revolutionary Military Capability

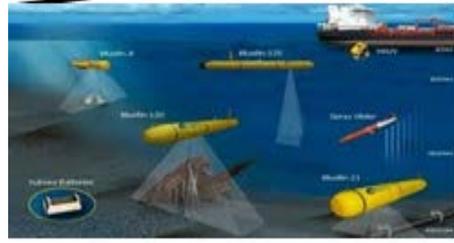
“War will become increasingly dominated by knowledge strategy featuring high tech weapons such as: battlefield robots, pilotless aircraft, and omniscient satellite systems”
(“War and Anti-War”, by Alvin & Heidi Toffler, 1993)





Autonomy

- *Autonomy* enables a particular action of a system to be “automatic” – The machine will make decisions
- *Autonomy* won't replace the human
- *Autonomy* is a data problem



Autonomy allows Warfighters to focus on their primary mission, not on operating their tools

Autonomous systems promise to allow DoD to address *Manpower and Force Safety*



Key Operational Challenges Addressed by Autonomy



Decentralization, Uncertainty, Complexity...Military Power in the 21st Century may be defined by our ability to adapt – adaptation is THE underlying foundation of autonomous technology

- Manpower efficiencies
- Harsh environments
- Rapid response and 24/7 presence
- New mission capabilities
- Advanced medical applications
- Capabilities beyond human limits



Autonomy is not about making widgets...
It is to allow existing/future systems to be more self-governing



High Speed Weapons



Hypersonic Air Vehicle and Propulsion Technologies Enable Long Range at High Speed with Effective Payload

Precision Strike

Variable Warhead Effects

Long Range



High Speed

Aircraft Systems

Internal bombers
External fighters

Net Enabled

In-Flight Targetable

Rapid, Responsive Strike in Anti-Access/Access Denied (A2/AD) Environments



Hypersonics

Building on Recent Success

- **X-51A**

- M4.7-6+; fixed geometry; B-52 launch; JP7 fuel
- 1st flight in May 2010 partially successful
- 2nd flight in June 2011 unsuccessful (fuel system)
- 3rd flight in August 2012 unsuccessful (flight controls)
- 4th flight full success (300+ second flight)



- **Conventional Prompt Global Strike (PGS)**

- High M boost glide; advanced materials and thermal protection
- Hypersonic Test Vehicle (HTV-2): two flight tests did not meet objectives; substantial data obtained
- Advance Hypersonic Weapon (AHW): first flight test met objectives

- **HIFIRE**

- Foundational flight test experiments; collaborative with Australia
- 4 (of 5) flight tests successful
- Engineering systems and avionics, aerodynamics and aero heating, hydrocarbon scramjet operability to Mach 8, hydrogen scramjet at Mach 8

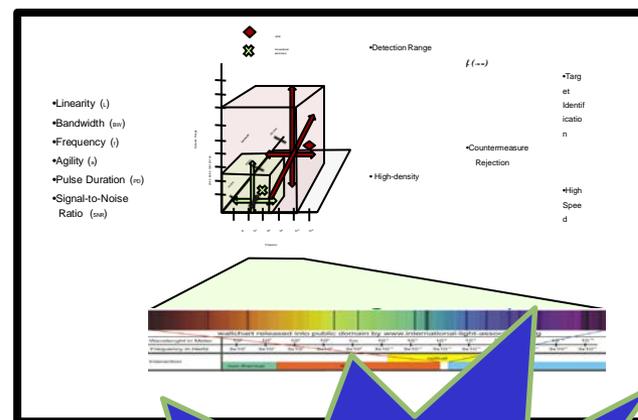




Electronic Warfare

U.S. EW Superiority is Being Broadly Challenged

- Digital signal processing expanding
- Threat systems more lethal, longer range, mobile
- Sensors are networked and active – passive combinations are appearing
- Radar and radio systems are trending to software-driven waveform generators
- Weapon seekers are more sophisticated with spectral diversity and ECCM processing
- Advanced jamming techniques and technologies are now available to adversaries



**OPPORTUNITIES
FOR NEW
APPROACHES**



Globally Accelerating Technology



Electronic Warfare Summary



- **Threats are in development that will push legacy EA system capability beyond the horizon**
- **New methods, platforms, and architectures are needed and the underlying technology solutions are being defined**
 - Technology adaptation strategies to facilitate rapidly reconfigurable, lower cost systems
 - Advanced mechanisms for delivery of EW attacks in high threat domains
 - Normalized frameworks for combat value analysis
 - Advanced methods for modeling non-kinetic effects on combat outcomes
 - Cost containment & reduction strategies and technologies
 - Affordable, expendable, agile
 - Streamlined manufacturing, integration, and fielding options



Global Change



Radio Frequency Systems

- **Extended-range detection and engagement systems**
 - Passive Sensing , Multi-aperture tracking
 - Tailored weapons
(UAVs, Specialized Jammers , ASCMs, TBMs)
- **Emergence of complex, adaptive waveforms and advanced digital processing**
 - Agile LPI/LPD
 - Accelerated by commercial designs/algorithms
- **Active Jamming, Decoys, High Power Defensive Systems**
 - Counter-Targeting, Counter-HARM
 - COMMS Jamming
 - Counter- Space/PNT

**LONG RANGE SENSORS &
STANDOFF WEAPONS OF HIGH
LETHALITY**

Electro – Optical Systems

- **Multi Function Seekers**
 - Combined optical and RF tracking
- **Damage Class Lasers**

EXPANDED PRESENCE OF DIGITAL PROCESSING AND NETWORKING



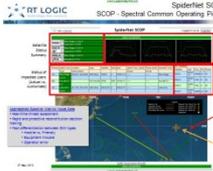
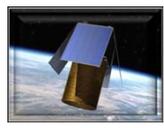
Resilience and Operate Thru



In order to deter attacks on U.S. or allied space systems, DoD will mitigate the benefits to an adversary of attacking U.S. space systems by enhancing the resilience of our space enterprise and by ensuring that U.S. forces can operate effectively even when our space-derived capabilities have been degraded.
- Space Policy DoD Directive 3100.10

Technology & Idea Needs:

- **Small commoditized launchers with rapid launch capability**
- **Large dispersed affordable constellations**
- **Alternate, affordable non-space means for A2/AD environment**
- **Electromagnetic domain awareness and spectrum management tools**
- **Multi-path communications networking – space, air, maritime**





Summary



- DoD S&T aligned to meet priorities for a 21st Century security environment
- DoD Strategic Framework..... lays the foundation for S&T commitments – 7 Priority S&T Areas
- Federal Deficit Reduction will impact; S&T remains steady priority
- Asia-Pacific rebalance is the foundation of our R&E strategy
- DoD R&E is committed to a healthy Defense Industrial Base
- EW is at the forefront of DoD technological superiority efforts