



National Naval Responsibility ***Naval Engineering***

National Academies of Science Study
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ACCELERATING TO THE NAVY & MARINE CORPS AFTER NEXT



Why are we here?

Update of the National Naval Responsibility for Naval Engineering

- What is Naval Engineering?
- Health of those S&T disciplines
- Health of the naval engineering workforce pipeline (undergraduate & graduate)
- Issues



Background

ONR



Naval Research: A Framework for Accelerating to the Navy & Marine Corps After Next

ALIGN

–

ALLOCATE

-

ACCELERATE

ALIGN

R&D to Shared Priorities

DON-wide alignment in commitment and execution

Priorities

- ✓ *Augmented Warfighter*
- ✓ *Integrated and Distributed Forces*
- ✓ *Operational Endurance*
- ✓ *Sensing & Sense-Making*
- ✓ *Scalable Lethality*

ALLOCATE

Resources to Speed Results

Align to the Framework Priorities

Portfolio allocation decisions must consider the following factors:

- ✓ *Technology Unique Timelines*
- ✓ *Evolutionary and Revolutionary Capabilities*
- ✓ *Resource Efficiency*
- ✓ *Technical lead vs Follow*
- ✓ *Appropriate Allocation of Risk*

ACCELERATE

Technology-Enabled Capabilities

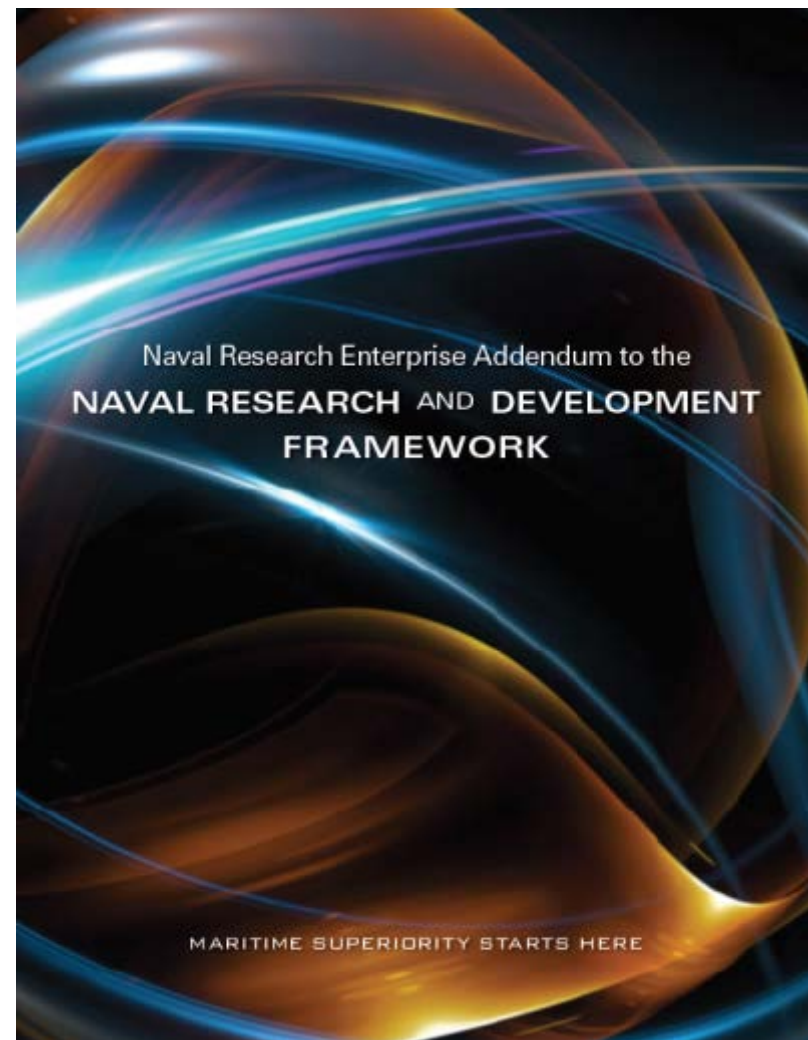
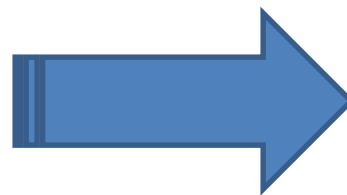
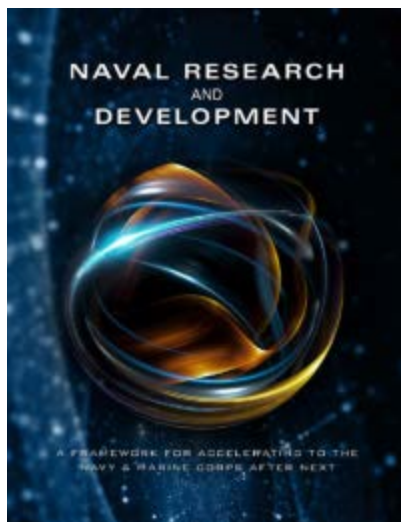
Goals

- ✓ *Alignment to Priorities*
- ✓ *Agile & Responsive Business*
- ✓ *Empowerment of our People*

To Win We Must Be “First to Field Decisive Capabilities”



Applying the Framework



NRE Addendum to the Framework:

- Six priority-driven, research Portfolios
- Smarter, earlier risk-taking
- Faster, agile, flexible business processes

Maritime Superiority Starts Here



Naval Research: *A Framework for Accelerating to the Navy & Marine Corps After Next*

Framework Priorities – Linking Research to Future Force Attributes

Framework Priority	Description
Augmented Warfighter	Enhance date to decision-making speed by incorporating cognitive augmentation & autonomous processing & more efficient human-machine interfaces.
Operational Endurance	Enables maneuverability, energy efficiency, sustained operations & resiliency for warfighters and platforms, including cyber, regardless of the threat & forward operating environments.
Integrated & Distributed Forces	Enhances dynamic synchronized actions & interoperability for naval forces. Supports collaboration spanning geography, domains, platforms & joint partners. Incorporates autonomous & disaggregate systems into the naval forces to increase flexibility & reach.
Sensing & Sense-Making	Drowning in data, yet thirsting fro knowledge, this priority assures awareness of the operating environment & mitigates risk of operational surprise; enables our naval force to operate in concert with the operational environment rather than despite it.
Scalable Lethality	Enables multi-domain, integrated, scalable kinetic & non-kinetic weapon systems for offensive or defensive purposes.



Integrated Research Portfolios

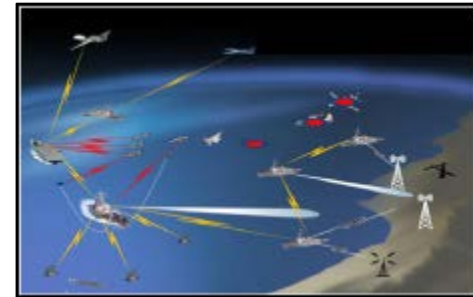
- **Amphibious Expeditionary Maneuver**

Expeditionary Fires and Lethality, Expeditionary C4ISR, Hybrid Threat Defeat, Human Performance and Protection, Amphibious Mobility, Logistics, Sustainment and Maintenance, Expeditionary Power and Energy, Lightening the Load, Accelerated Learning/Decision Making, Information Environment Operations



- **Information, Cyber and Spectrum Superiority**

Advance RF Electronics & Materials, Communications and Networking, Computational Methods for Decision Making, Data Science and Analytics, Electronic Warfare, Sensors and Sensor Processing, Machine Learning Reasoning and Intelligence, Resource Optimization, Precision Navigation & Timekeeping



- **Mission Capable Survivable Sea Platforms**

Naval Engineering, Advance Power Systems, Advance Survivable Sea Platforms, Unmanned Sea Platforms, Autonomy and Power, Advance Naval Materials, Undersea Weapons, Counter-Weapons and Energetics, Sea Platform Environmental Quality, Corrosion Control

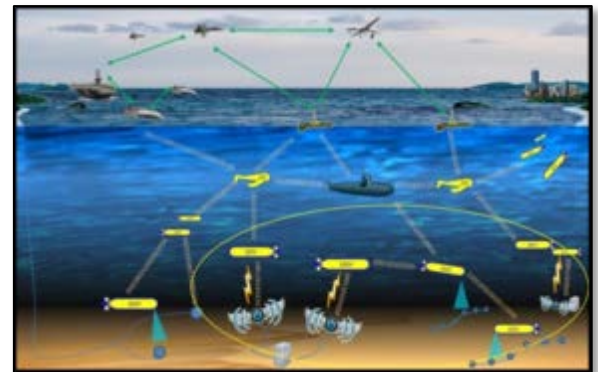


Accelerating Knowledge to Technology to Capability



Integrated Research Portfolios

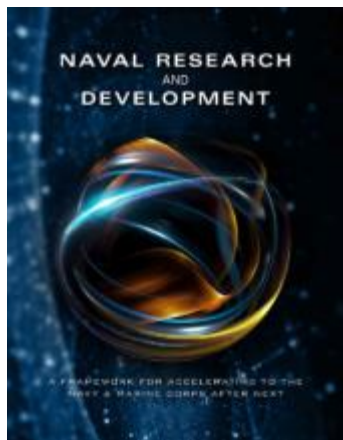
- **Aviation Force Projection & Integrated Defense**
Directed Energy (DE) and Counter DE, Aerodynamics, Flight Dynamics and Control, Propulsion, Structures and Materials, Energetic Materials, Hypersonics, Autonomy
- **Undersea Battlespace and Maritime Domain Access**
Arctic & Global Prediction, Littoral Geosciences and Optics, Marine Mammals and Biology, Marine Meteorology, Maritime Sensing, Ocean Acoustics, Ocean Engineering & Marine Systems, Physical Oceanography, Research Facilities, Space Environment, Undersea Signal Processing
- **Warfighter Supremacy**
Undersea Medicine, Biological Sciences, Biorobotics, Capable Manpower, Command Decision Making, Force Health Protection, Human-Robot Interaction, Noise-Induced Hearing Loss, Training & Simulation



Accelerating Knowledge to Technology to Capability



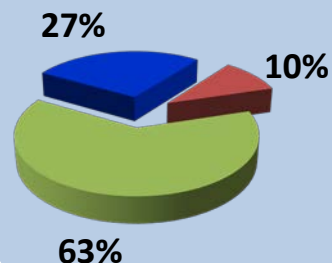
It Begins With Research



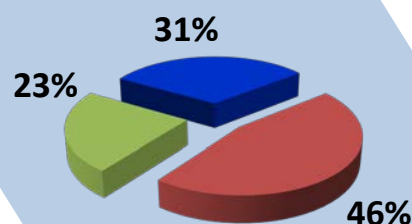
Framework Priorities

- Scalable Lethality
- Augmented Warfighter
- Operational Endurance
- Sensing & Sense-Making
- Integrated & Distributed Forces

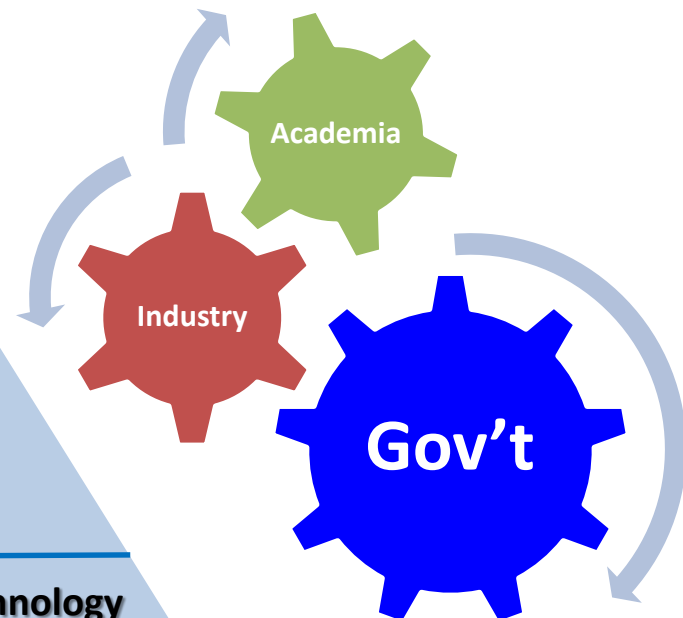
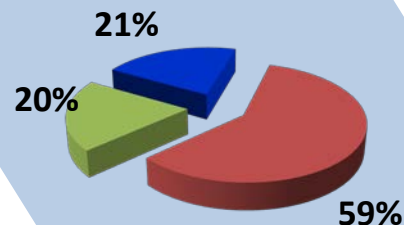
6.1 Basic Research



6.2 Applied Research



6.3 Advanced Technology Development

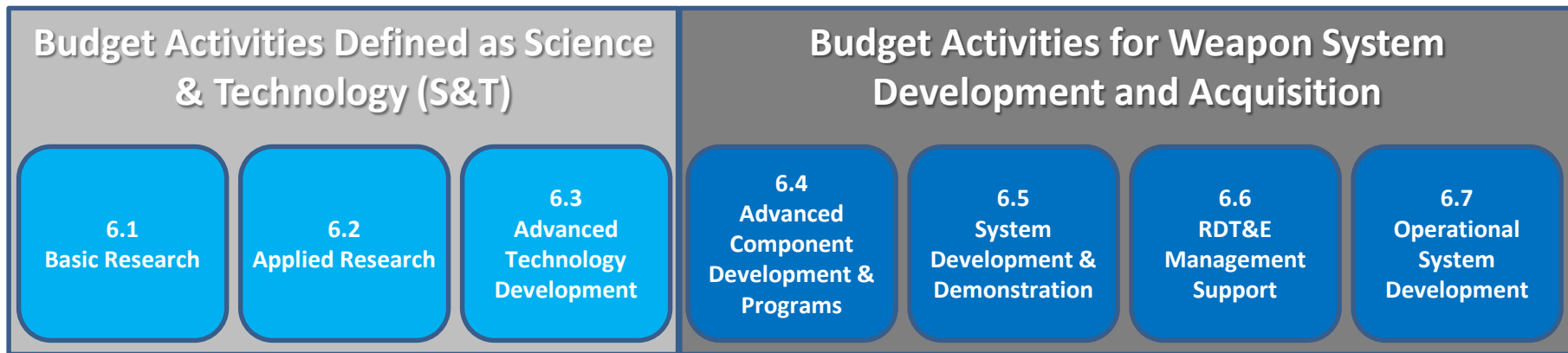


Accelerating Knowledge to Technology to Capability

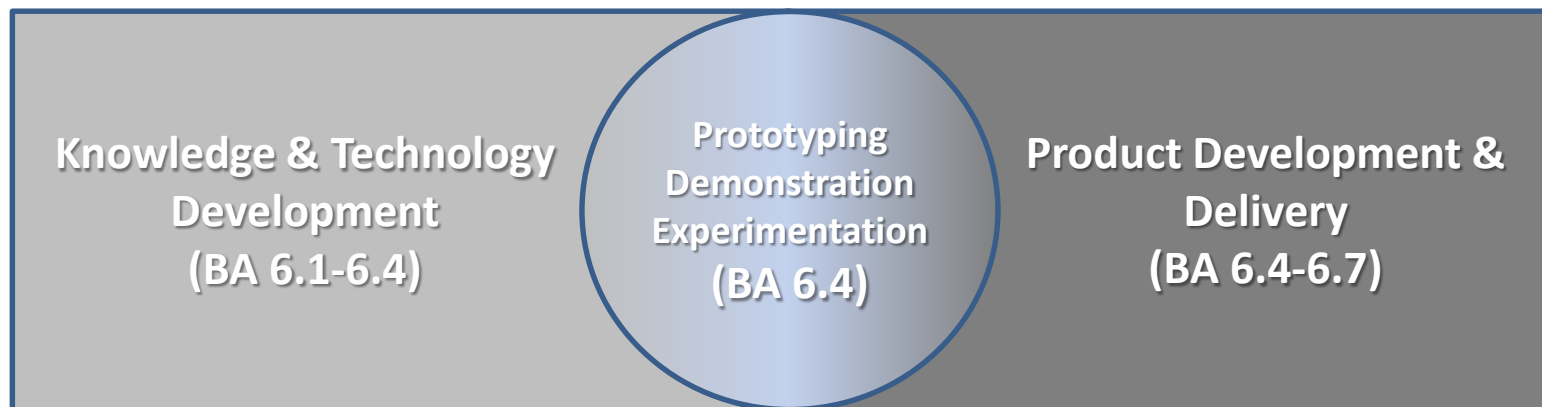


Accelerating R&D

From: Sequential, Budget Activity-driven, program mindset

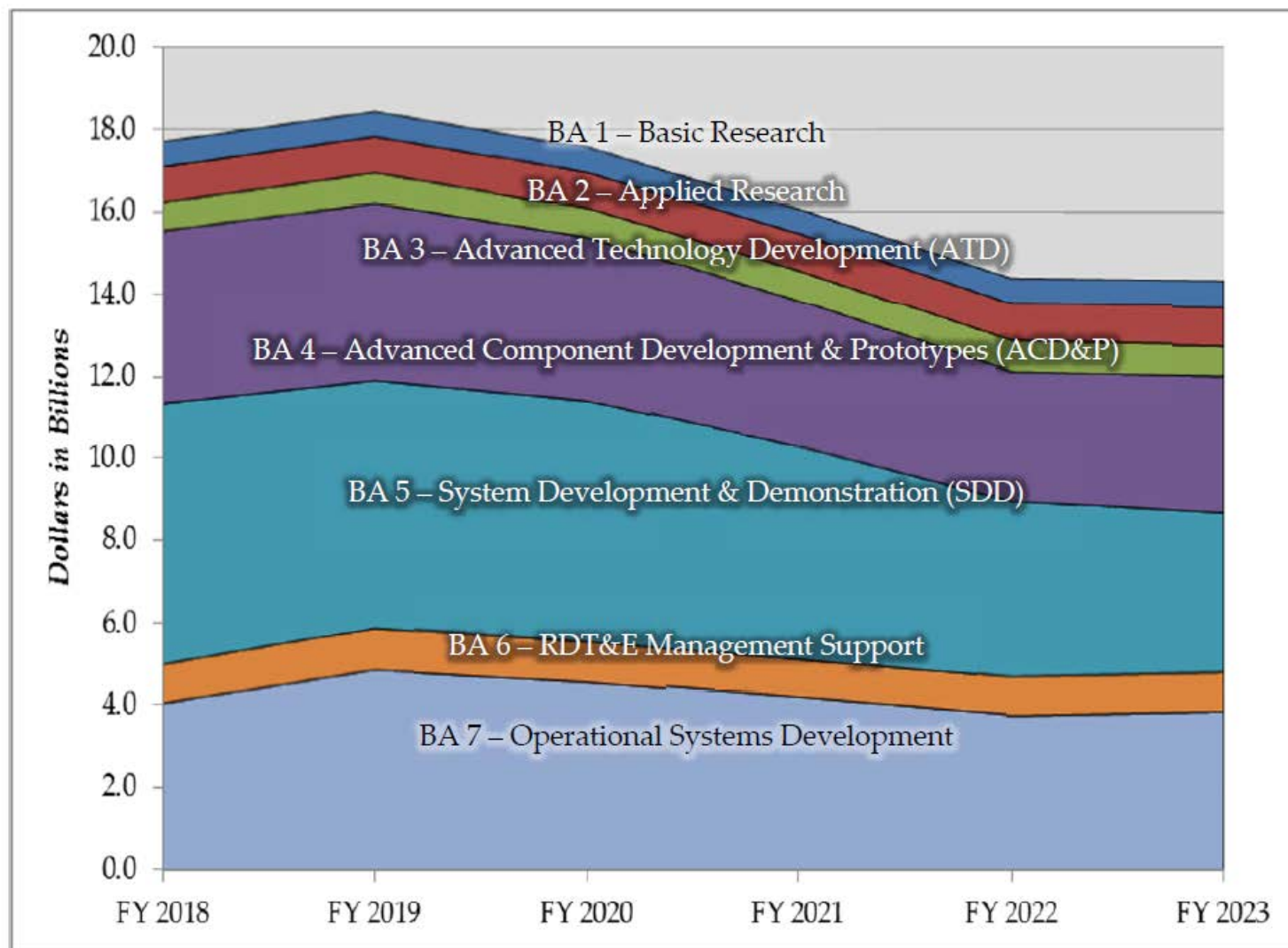


To: R&D Framework, priority-driven, accelerated continuum





USN Research and Development FY19 Budget Highlights



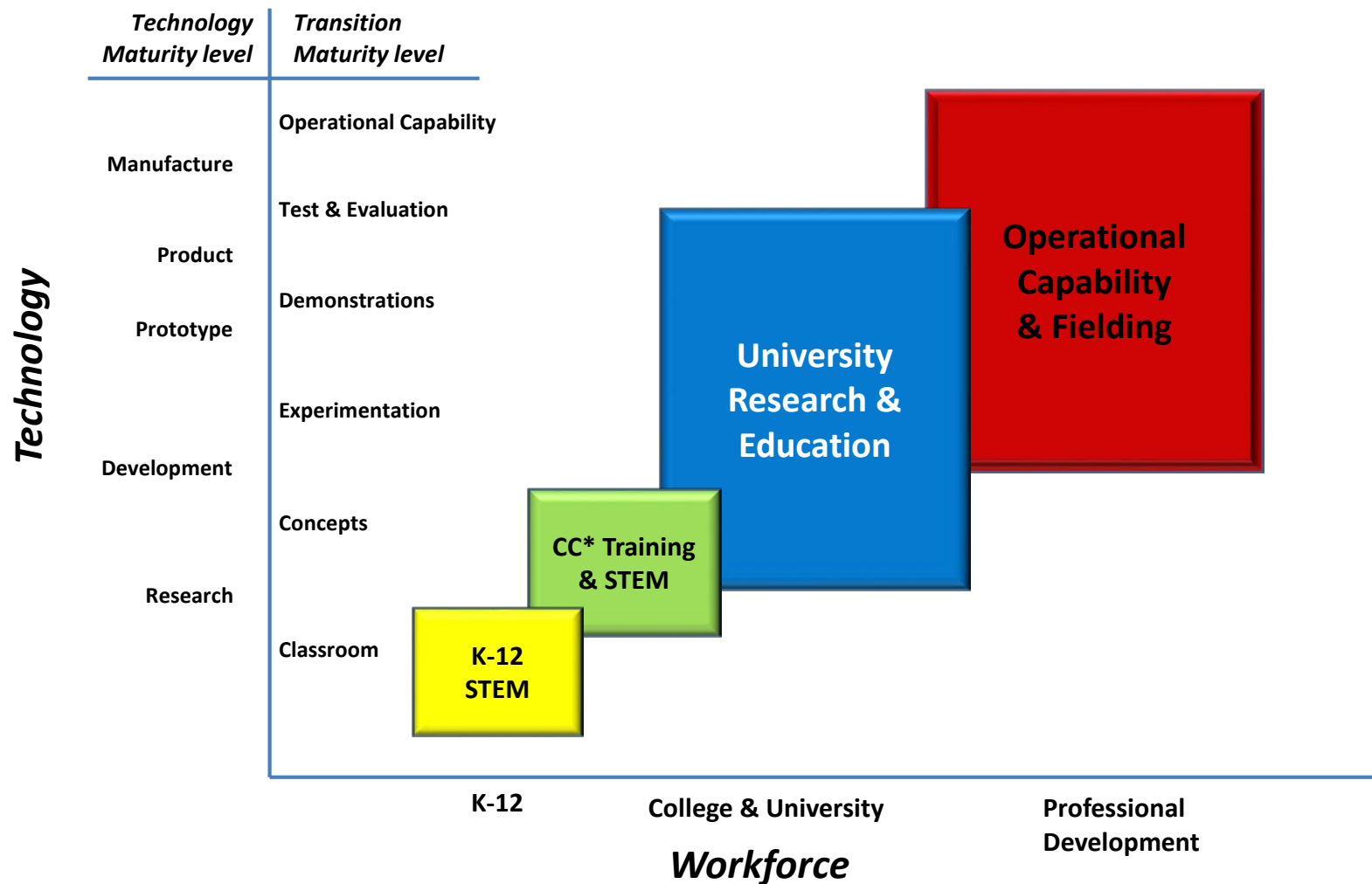
USN FY 2019 Budget Highlights

(http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/Highlights_book.pdf)

Distribution Statement A: Approved for Public Release; distribution unlimited.



Building Capacity from Classroom to Operational Capabilities

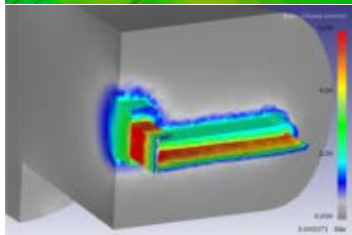
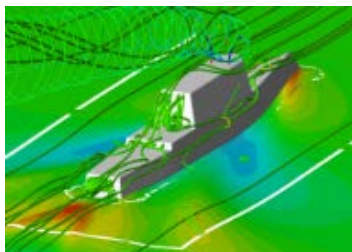


CC* = Community College



Sea Warfare and Weapons Department

Develops and delivers technologies that enable superior warfighting and energy capabilities for naval forces, platforms and undersea weaponry.



Advanced Naval Platforms Division, ONR 331, focuses on providing technologically superior, affordable warfighting capabilities for surface and subsurface platforms, including small surface craft, through investments in Advanced Naval Power Systems; Advanced Sea Platform Design, Performance, & Survivability; Sea Basing Technologies; **Naval Engineering STEM**; and Platform Autonomy & Control.

Naval Materials S&T Division, ONR 332, supports basic and applied research and advanced development in the physical sciences and engineering, materials and processing, and environmental quality that enable enhanced performance, affordability and reliability for future and legacy Navy and Marine Corps systems and platforms.

Sea Weapons and Payloads Division, ONR 333, supports the development and transition of advanced technology for undersea weapons and countermeasures, UxV power and energy systems, and corrosion control.

Manufacturing Technology, ONR 33, addresses manufacturing and affordability in manufacturing for DoN systems through an integrated approach from S&T basic research through industrial base preparedness.

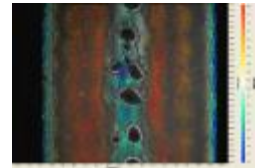
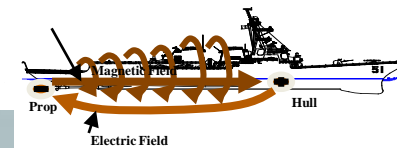
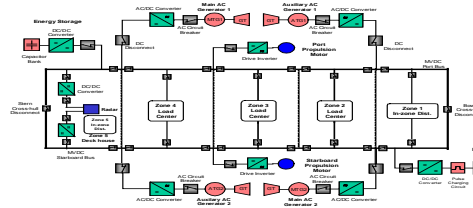


Advanced Naval Platforms Division

Research Sub Areas

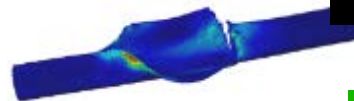
Advanced Naval Power Systems

- Power Generation
- Energy Storage
- Distribution Architectures & Control of Power
- Heat Transfer and Thermal Management
- Motors and Actuators



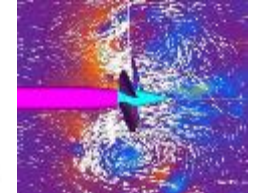
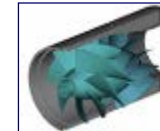
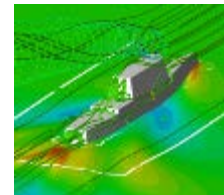
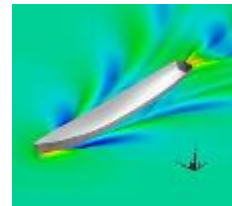
Sea Platform Survivability

- Underwater Signatures
- Above-Water Signatures
- Survivable Structures



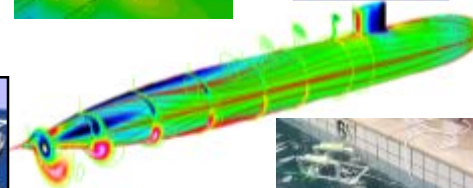
Sea Platform Performance

- Hull Performance (Hydromechanics)
- Propulsors
- Platform Structures
- Platform Autonomy & Control
- Naval Engineering & Platform Design



Naval Engineering Education and Outreach

- Naval Engineering
- Education and Outreach

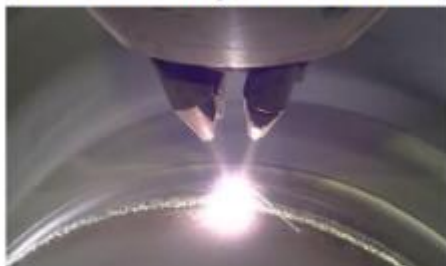




ISSUES, TRENDS, & DRIVERS

Trends for Defense and Security

Manufacturing and materials



Robotics and Autonomy



Global militarization



Renewable energy



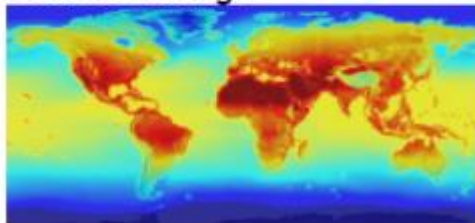
IoT



Cyber warfare and social media



Climate change



Artificial Intelligence



Proliferation of WMD

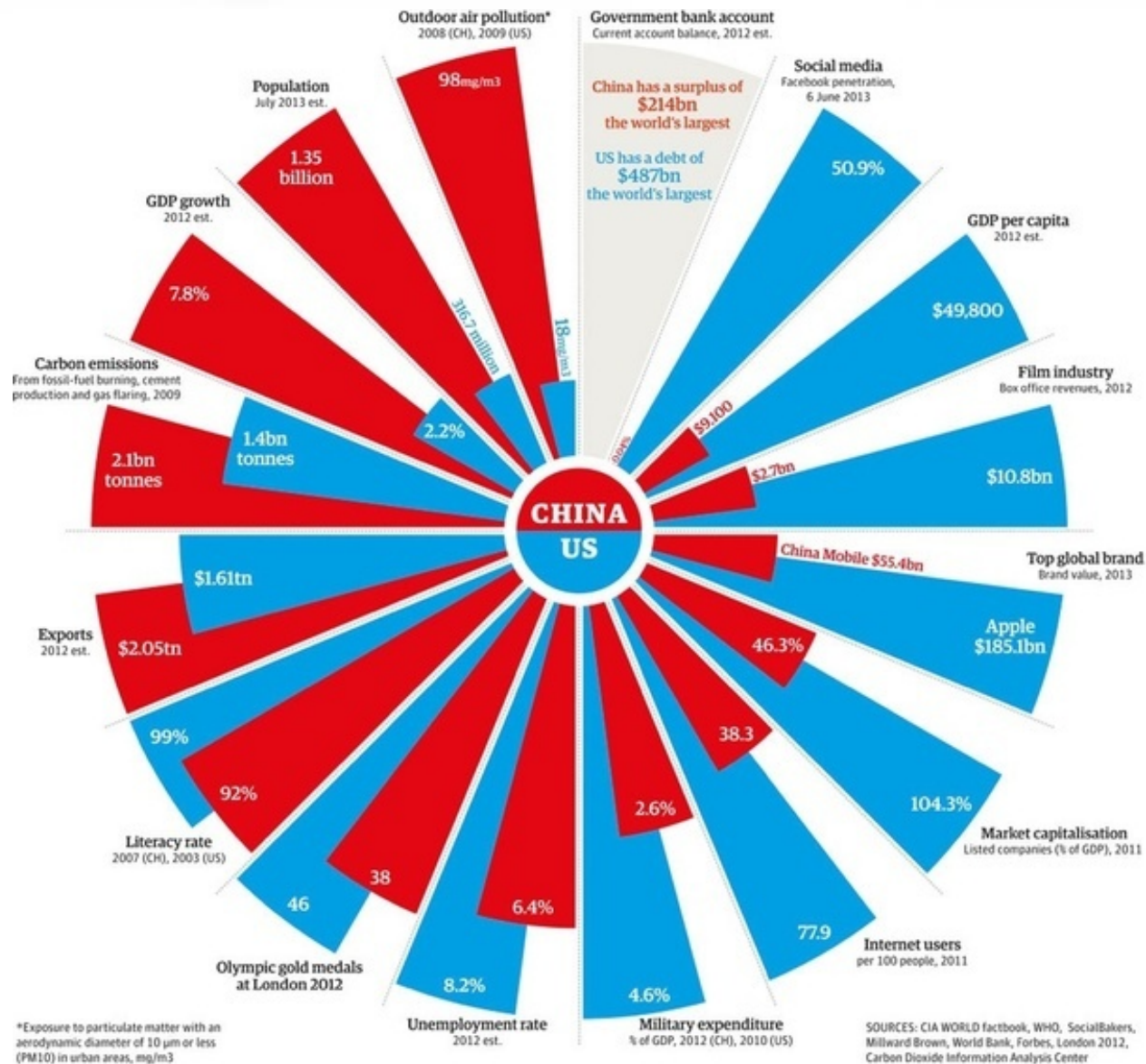




Global Context

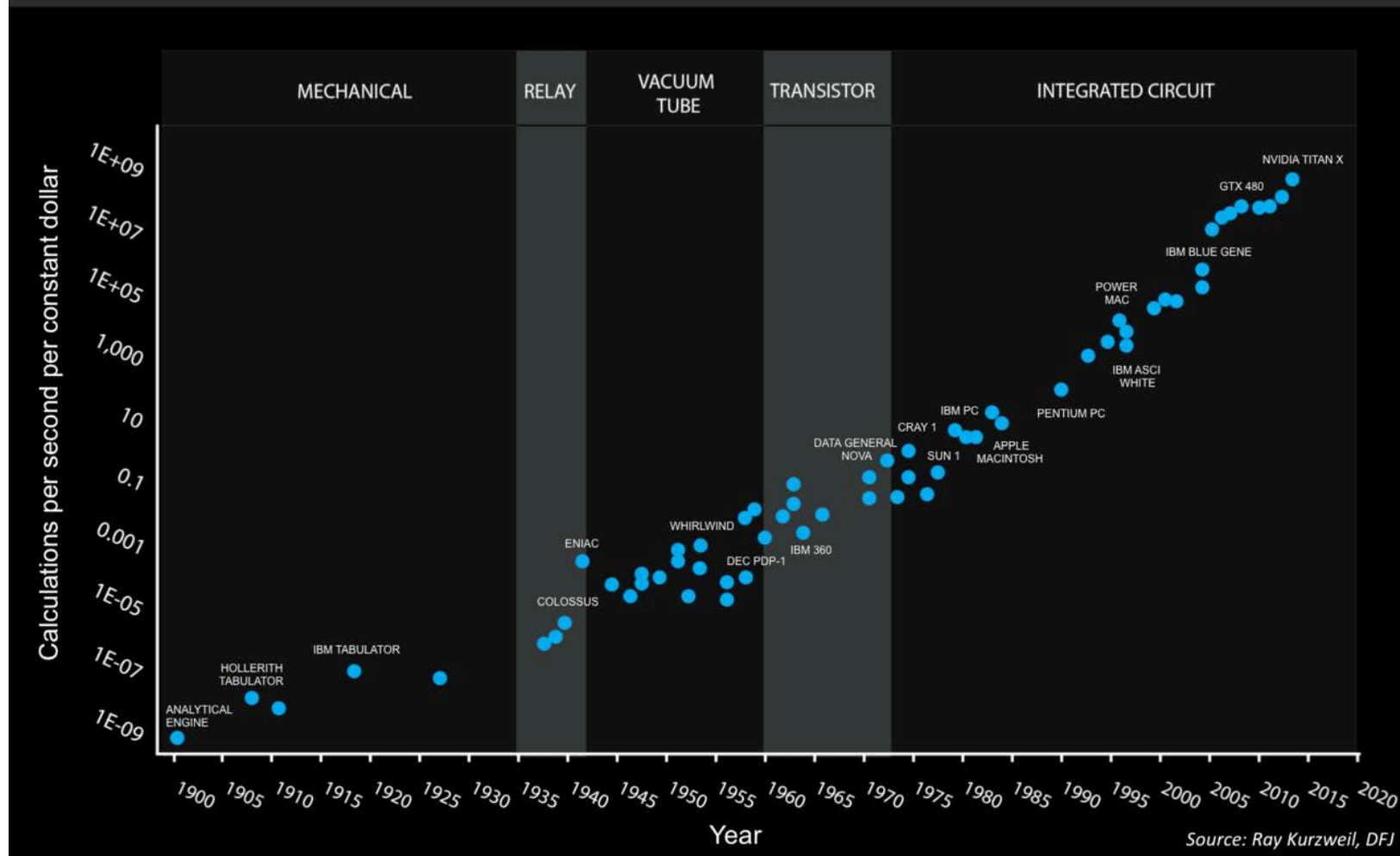
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- A stylized world map with yellow landmasses and light blue oceans, overlaid with a grid of latitude and longitude lines. The map is centered on the Atlantic Ocean.
- **Continuing Conflict**
 - **Rising Peer Competitors**
 - **Security of Global Commons**
 - **Climate Change & Arctic Access**
 - **Budget Constraints and Costs**
 - **Pace of Technology Innovation**

Peer Competitors



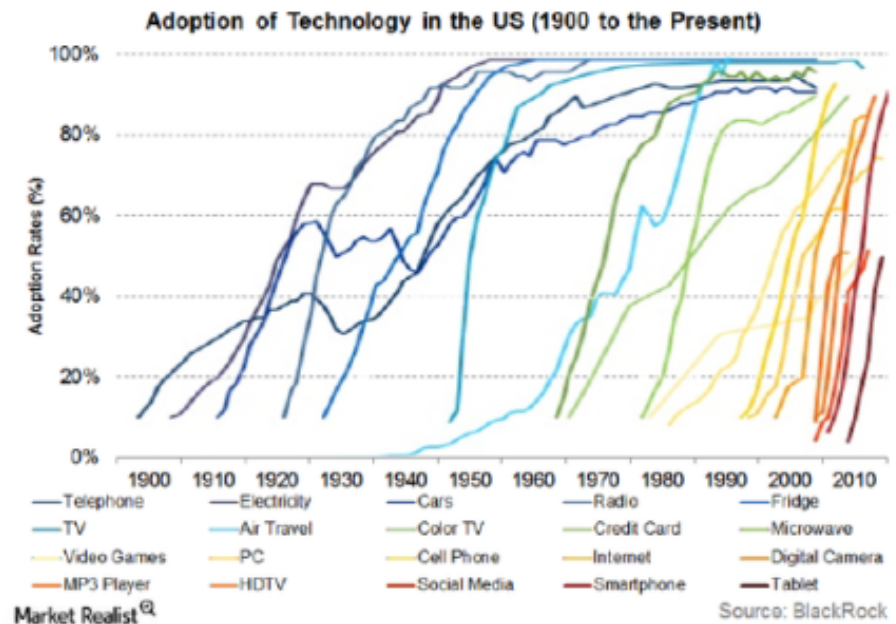
Pace of Development

120 Years of Moore's Law



4th Industrial Revolution

- 4th Industrial Revolution began at turn of the century, and builds on the digital revolution.
- Characterized by
 - Ubiquitous and mobile internet
 - Smaller and more powerful sensors
 - Artificial intelligence and machine learning
- Leads to profound and systemic change
 - Speed of innovation, and adoption, is faster than ever.

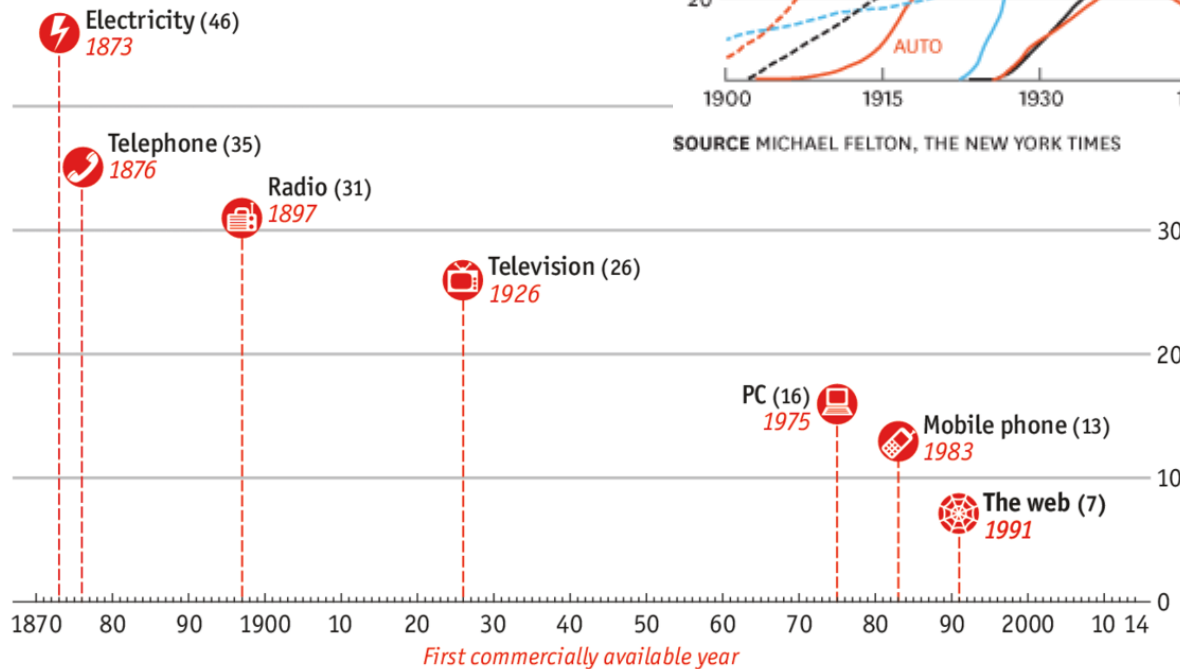




Pace of Technology Adoption

Technology adoption

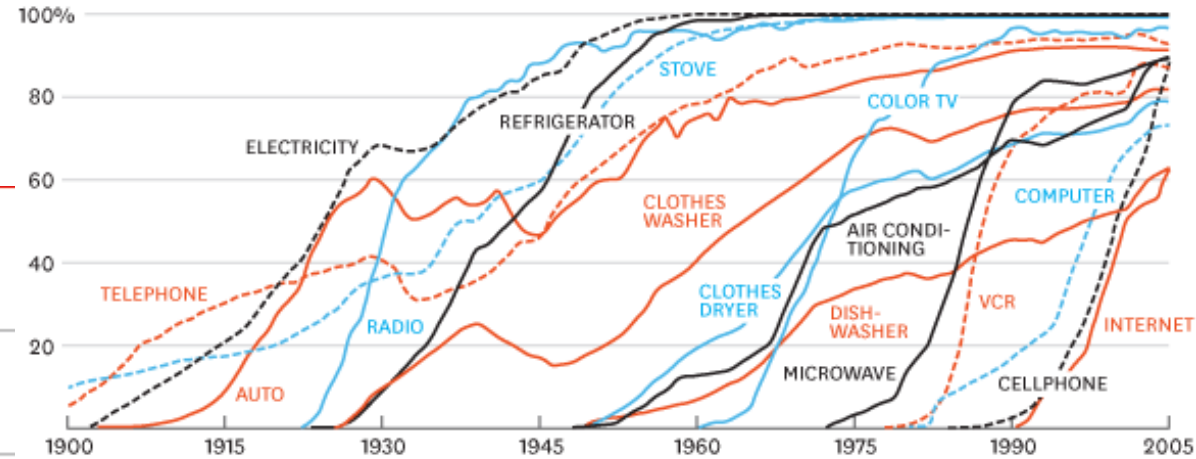
Years until used by one-quarter of American population



Source: Singularity.com

CONSUMPTION SPREADS FASTER TODAY

PERCENT OF U.S. HOUSEHOLDS



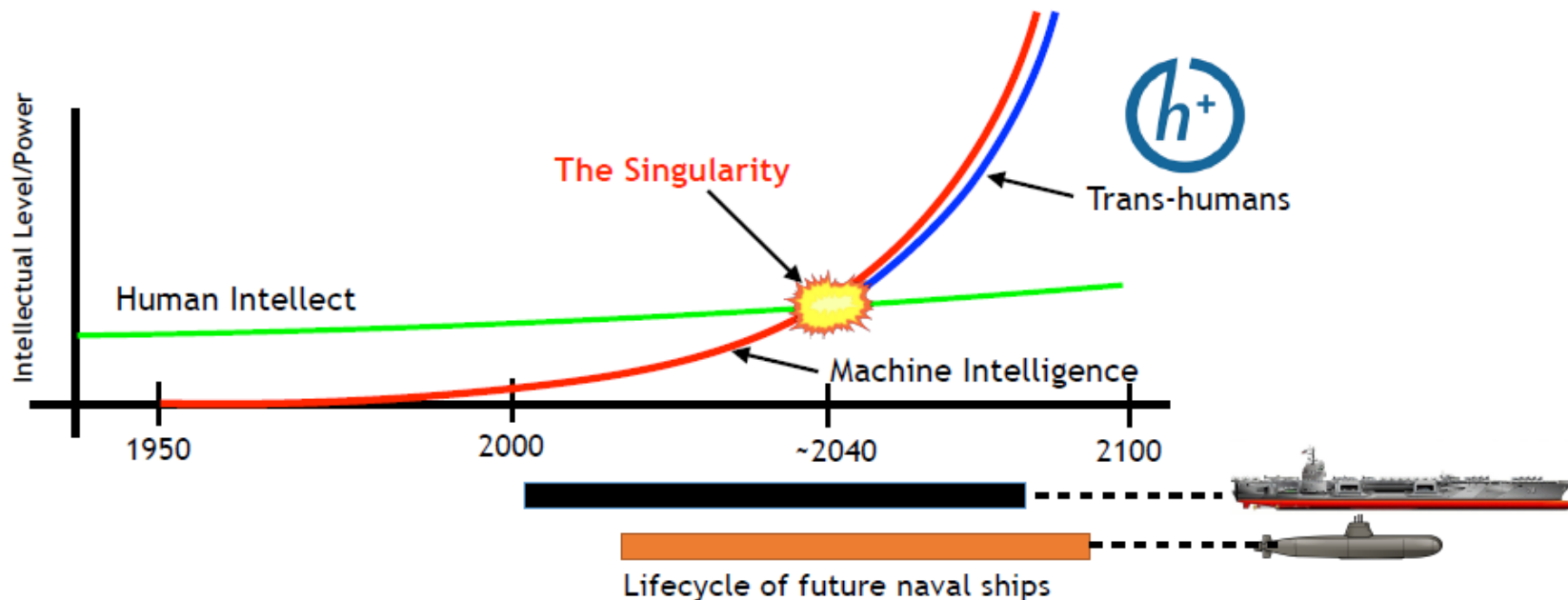
SOURCE MICHAEL FELTON, THE NEW YORK TIMES

HBR.ORG

- The **speed of innovation** and adoption continues to **increase**.
- To maintain competitive advantage we will **need to move faster** to capture those opportunities

Technological Singularity

- The impending technological singularity poses enormous uncertainty for platforms with a life cycle of 50+ years.



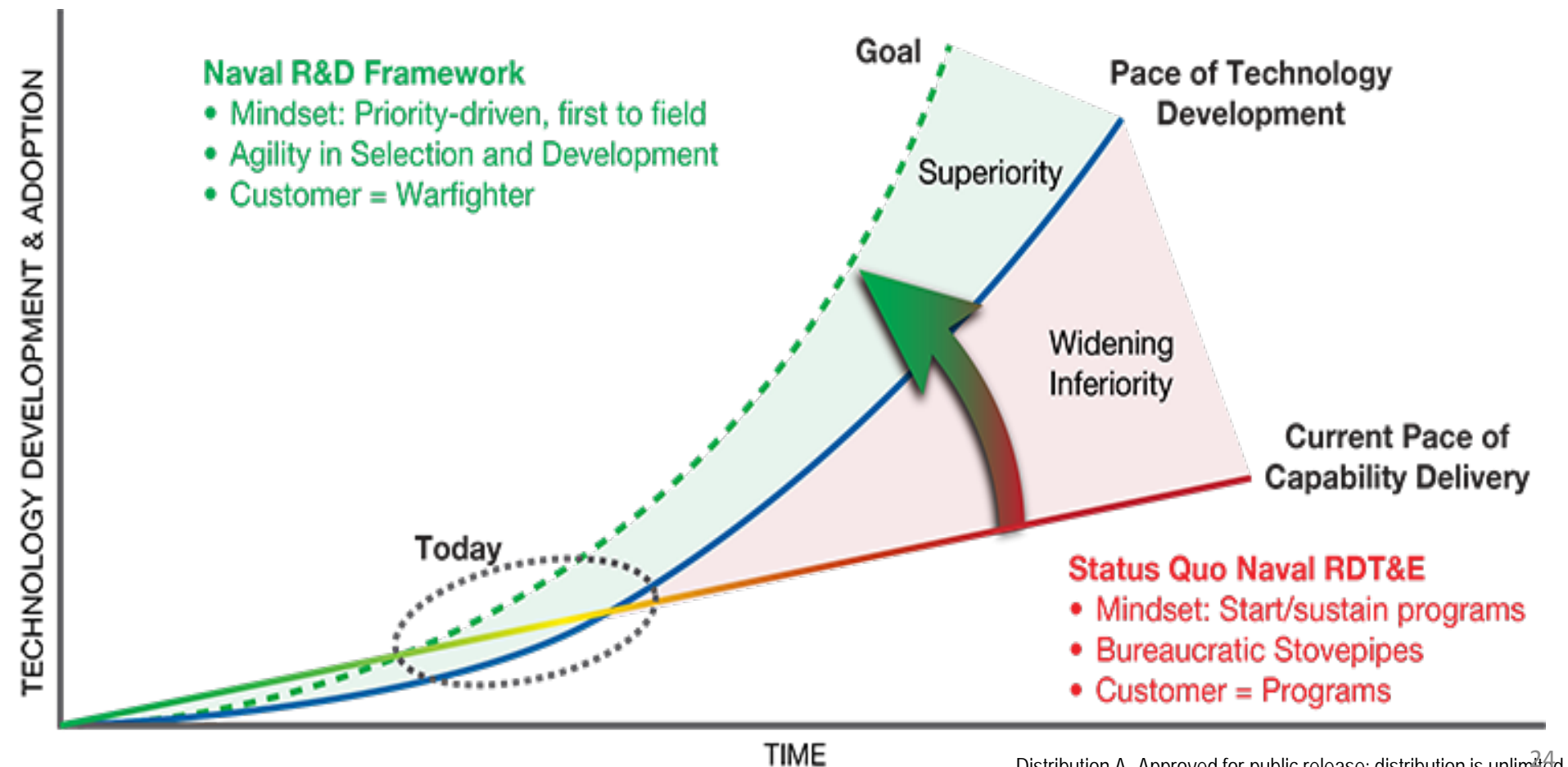
The **technological singularity*** is the hypothesis that the invention of artificial superintelligence will abruptly trigger runaway technological growth, resulting in unfathomable changes to human civilization

*Singularity hypotheses: A Scientific and Philosophical Assessment. Dordrecht: Springer. 2012. pp. 1–2. [ISBN 9783642325601](https://doi.org/10.1007/978-3-642-32560-1).



The R&D Challenge

- Increasing maritime competition
- Outpaced by technology innovation
- Bureaucratic drag of status quo





So we struggle with the future





Questions?

