Factors Influencing Technology Transfer:
A DoD Perspective

Presented at NASEM Meeting on Federal Labs

Bernadette Johnson, Chief Technology Ventures Officer

5 December 2019

This material is based upon work supported by the United States Air Force under Air Force Contract No. FA8702-15-D-0001. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the United States Air Force.

LINCOLN LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MIT Lincoln Laboratory

Shared Values –

- **Technical excellence**
- **Integrity**
- **Meritocracy**

DoD Federally Funded Research and Development Center

Systems architecture engineering
Long-term technology development — **~4000 employees**
Rapid system prototyping and transition — **~$1B in FY19**

Why Transfer Technology?

To ensure the long-term competitive position of the United States

- Unique and effective military capability
- US competitive economic advantage
- US competitive educational advantage
- Tools and capabilities that enable social well-being

- Not just a good idea, it's the law

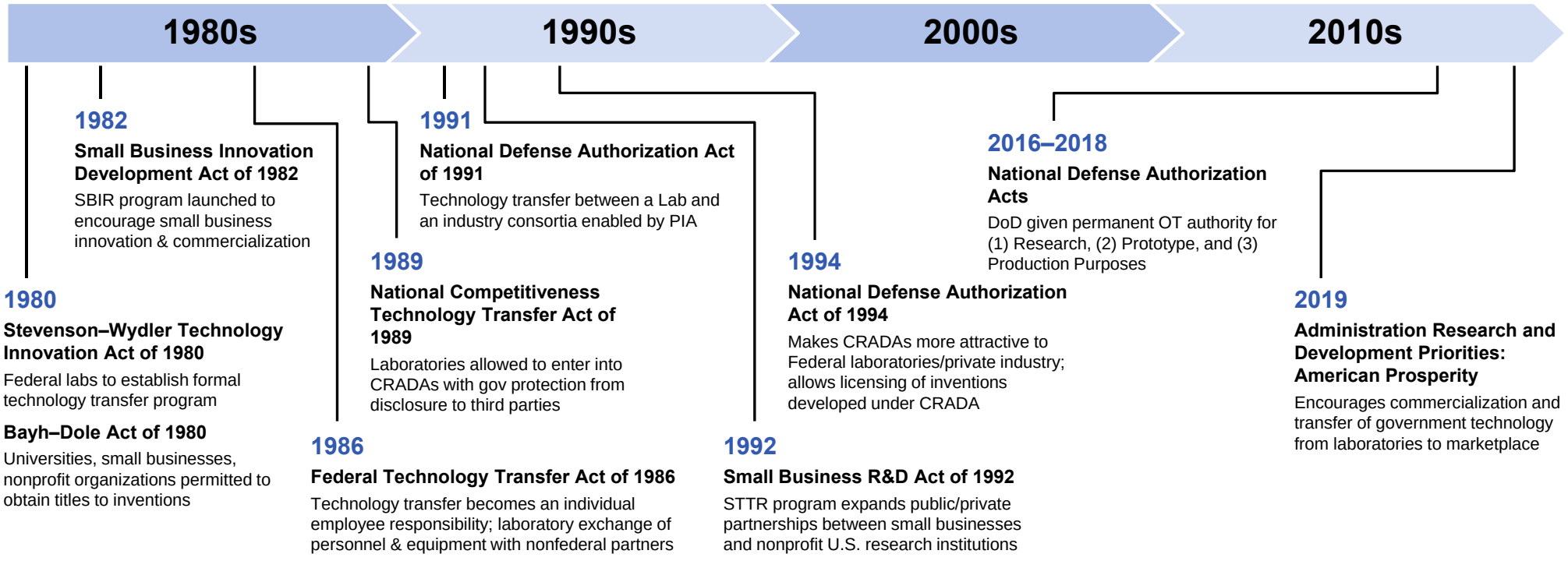
Laws, Policies, Directives Concerning DoD Technology Transfer

- **15 USC 3710(a) – Utilization of Federal Technology**
  - ***It is the continuing responsibility of the Federal Government to ensure the full use of the results of the Nation's Federal investment in research and development. Technology transfer, consistent with mission responsibilities, is a responsibility of each laboratory science and engineering professional.***

- **DoDD 5535.3 – DoD Domestic Technology Transfer Program**
  - ***Domestic technology transfer activities are integral elements of DoD pursuit of the DoD national security mission and concurrently improve the economic, environmental, and social wellbeing of US citizens.***

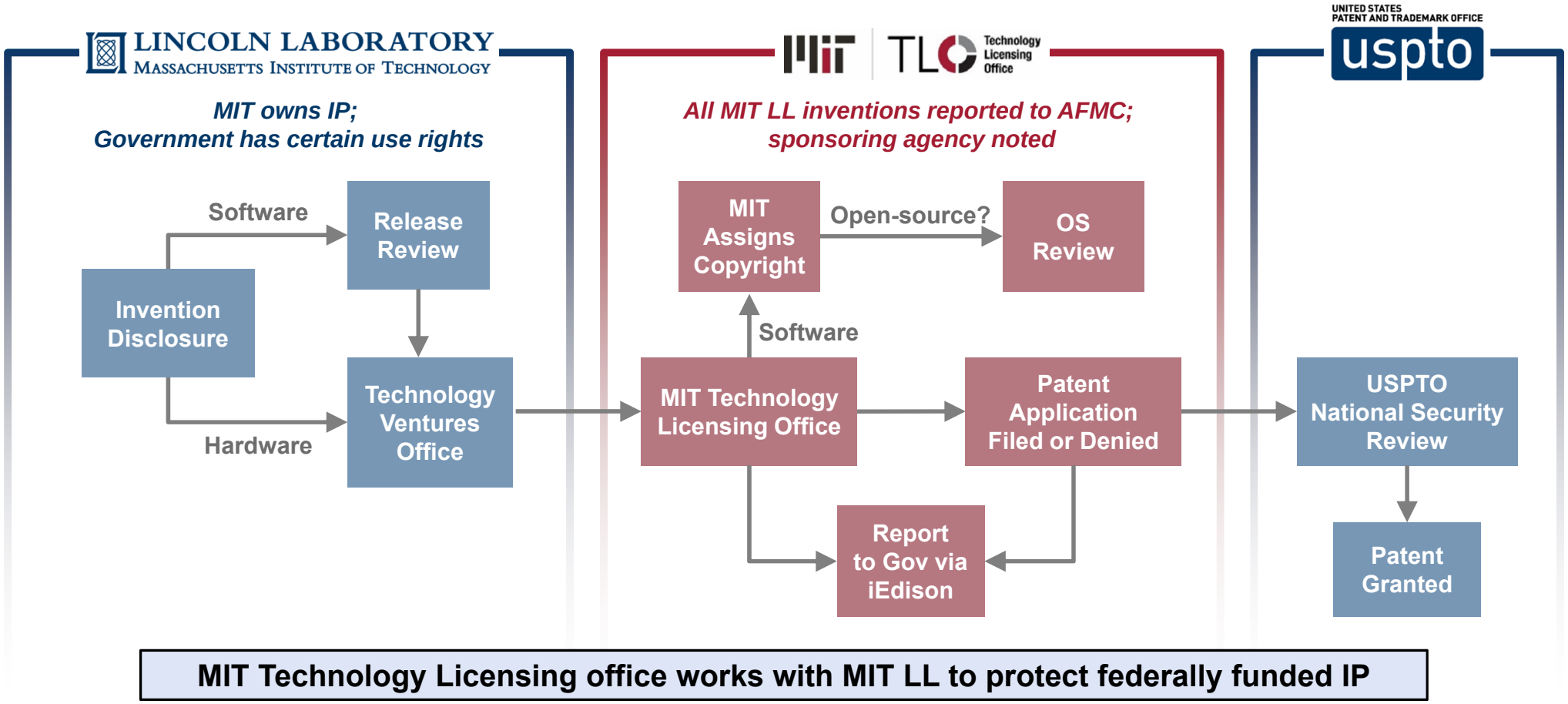
- **DoDI 5535.8 – DoD Technology Transfer Program**
  - ***Technology transfer ensures DoD programs make the best possible use of national scientific and technical capabilities to enhance the effectiveness of DoD forces and systems. Commercial availability of DoD-developed technologies can be expected to lower the costs of acquiring military equipment by providing the opportunity to take advantage of economies of scale and buy from a larger commercial industrial base.***

Technology Transfer Legislative Authority



Since 1980, Congress has passed numerous pieces of legislation allowing FFRDCs to adapt their technology transfer strategies to maximize impact

Intellectual Property Protection Process at MIT LL



MIT Technology Licensing office works with MIT LL to protect federally funded IP

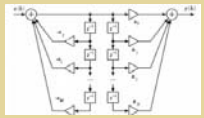
So how are we doing?

68 Years of Impact for the Nation – Enabled by Technology Transfer

First Continental Air Defense System

Protected US from Soviet nuclear attack for 20 years

Digital Signal Processing & Error-Correcting Codes



Inventions of recursive digital filters and Reed-Solomon codes

First Fully-Transisterized Real-Time Computer

Spawned commercial mini-computer industry

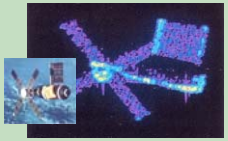
Coincident Core Memory

Birth of nonvolatile memory

First Television Picture Transmission via Satellite

Used NASA'S Echo I Satellite

First RADAR-based Satellite Imaging

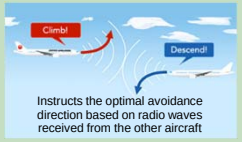


ALCOR radar located at Kwajalein

First Transmission of Packetized Speech

Forerunner of voice over internet protocol (VoIP)

Airborne Collision Avoidance System



Installed on *all* planes with >19 passenger seats

First Prototypes for All Military Comm. Satellites

DSCS, MILSTAR, WGS, AEHF, MUOS

1950–1960s

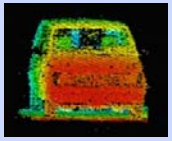
1970–1980s

1990–present

Air Defense of the National Capital Region

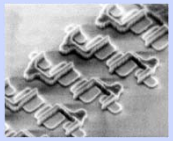
Rapid deployment post 9/11

3-D Laser Imaging



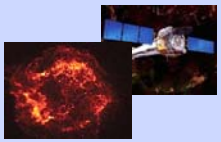
Permits airborne 3D imaging through trees

193nm Optical Lithography



Leap ahead in integrated circuit technology

NASA Chandra X-Ray Observatory



Advanced CCD imaging spectrometer

First Laser Communi-cations from Lunar Orbit

622 Mbps downlink for 30 days with zero bit errors

Recent Technology Transfer Actions

FY19

TECHNOLOGY TRANSFER BY THE NUMBERS

87 Articles in technical journals	**110** Papers in published proceedings	**418** Presentations at conferences
16 Lincoln Laboratory–hosted conferences	**83** Technology disclosures filed	**72** Patents issued

Spinouts/Licensees

jetcool

Notable Lincoln Laboratory Spin-Offs

National Economic Impacts from DoD License Agreements with U.S. Industry, 2000 – 2017*

MAJOR FINDINGS

$58 billion in total economic impact nationwide

$27 billion in total sales of new products and services resulting from the DoD license agreements

$4.5 billion in sales of new products to the U.S. military

$6 billion in new tax revenues (federal, state, and local)

214,791 jobs (11,933 *per year*) with average compensation of $74,762

OTHER FINDINGS

Total outside investment funding: **$776 million**

Number of companies acquired: **25**

Number of DoD technologies sub-licensed to other companies: **64**

Number of new companies created: **144**

* 2018 TechLink Report: Montana State University, Bozeman, Business Research Division; Leeds School of Business, University of Colorado, Boulder

Assessment of MIT LL's Regional Economic Impact from Commercial Licensing

Methodology

INPUT

Commercial Sales
Follow-On R&D
Royalties from Licenses
Sales by Licensees
Spin-Out Companies Sales
Initial Funding

IMPLAN
- County-level data
- NAICS CODES

OUTPUT

Economic Impacts
Employment
Labor Income
Value Added
Total Output

Other Economic Impacts (not utilized by IMPLAN Model)
Total Outside Investment
Total Acquisitions

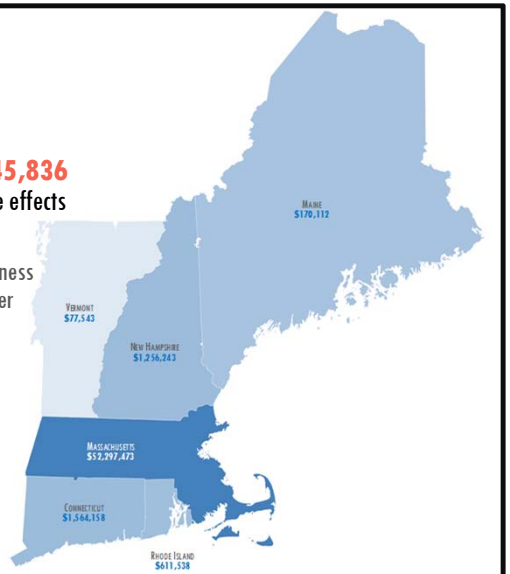
IMPLAN = *Economic Impact Analysis for Planning is the* USG standard for analyzing the regional economy

NAICS = *North American Industry Classification System* is the standard used by Federal statistical agencies

New England Economic Impacts (Q4 2015 - Q4 2018)

Lincoln Laboratory IP supported an estimated **$58,245,836** in licensee revenues annually creating additional ripple effects across New England totaling **$55,977,067**.

Ripple effects include regional business to business purchases along the supply chain and consumer spending by industry employees.

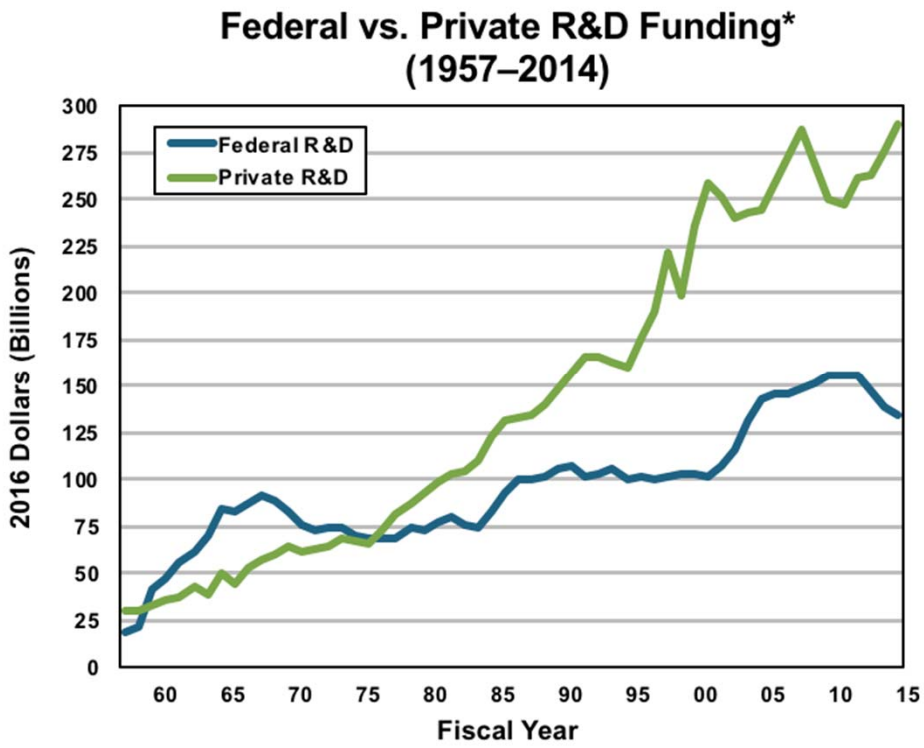


Impact	Employment	Labor Income	Value Added	Output
Direct	433.50	$36,038,196.88	$36,668,778.89	$58,245,836.32
Indirect	94.60	$7,861,775.47	$11,582,310.78	$18,784,388.95
Induced	239.16	$14,262,552.01	$23,158,158.16	$37,192,678.16
Total	767.25	$58,162,524.36	$71,409,247.83	$114,222,903.44

Challenges: Time and Money

Federal vs Private R&D Spending

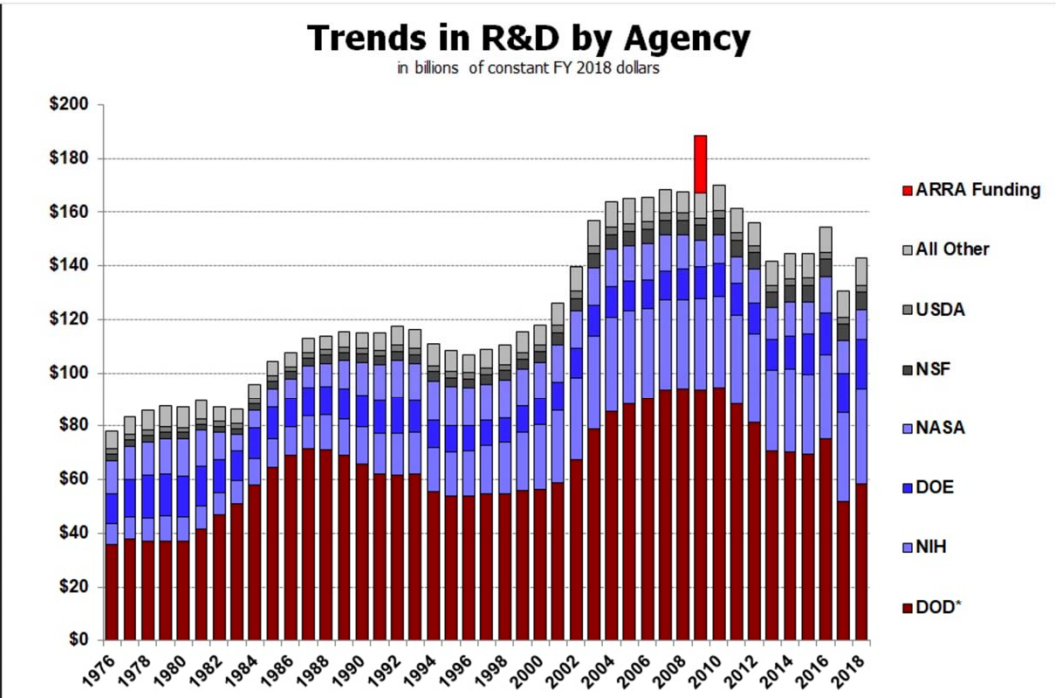
- **Commercial R&D is outpacing Federal R&D > 3:1**
  - $Bs spent on military R&D
  - Development-to-operation timelines often too long
- **Defense Industrial Base spending on R&D diminishing**
- **Nontraditional companies do not always want to do business with the Department of Defense**
  - > $50B R&D derives from companies with fewer than 500 people**
- **US Military often does not have rapid access to best available technology**
  - Adversaries do



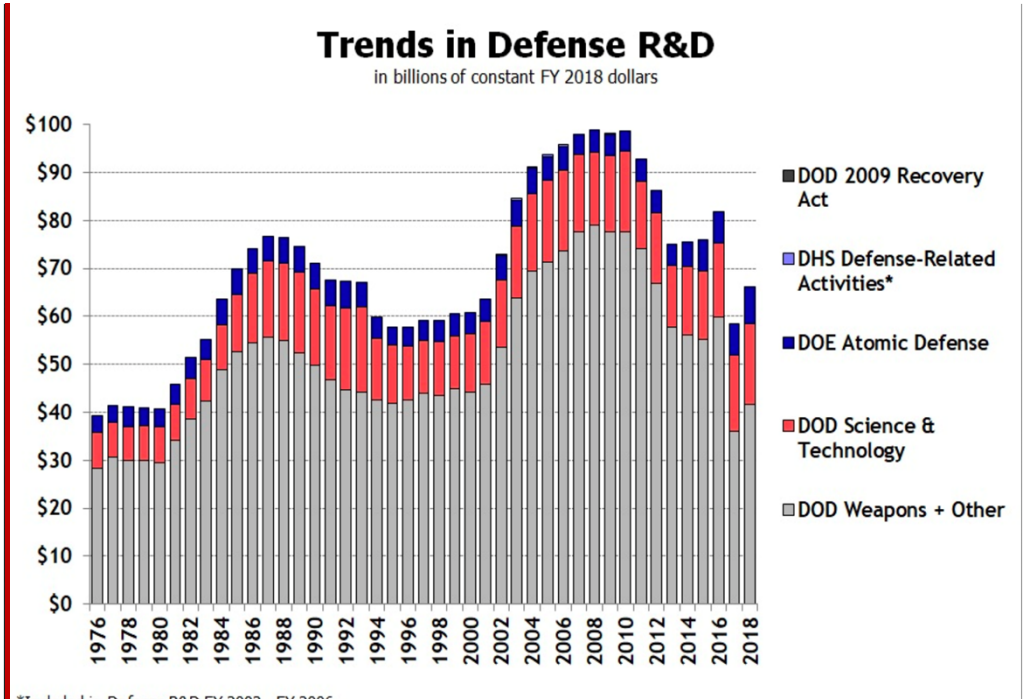
** Sources:
The NSF Business R&D and Innovation Survey (BRDIS) and The NSF Survey of Industry R&D (SIRD)

* Sources: The NSF Business R&D and Innovation Survey (BRDIS), The NSF Survey of Industry R&D (SIRD), and AAAS.org : Historical Trends in Federal R&D

Agency and Defense R&D Spending Comparisons



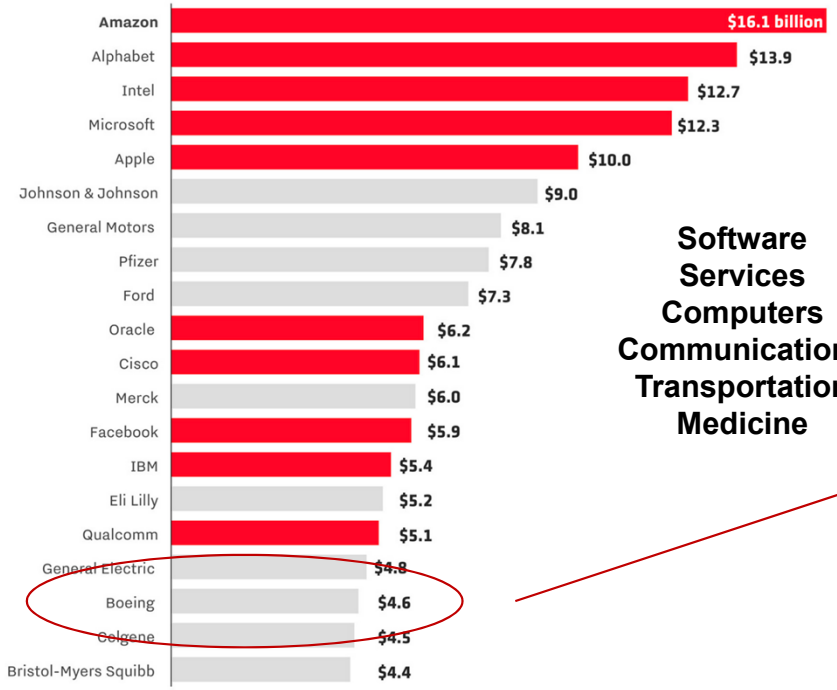
*NOTE: Beginning in FY 2017, a new official definition of R&D has been adopted by federal agencies. Late-stage development, testing, and evaluation programs, primarily within the Defense Department, are no longer counted as R&D.
FY 2018 figures are AAAS estimates based on omnibus-enacted appropriations. 1976-1994 figures are NSF data on obligations in the Federal Funds survey. Source: *AAAS Report: Research & Development* series and analyses of FY 2018 omnibus legislation. © 2018 AAAS



*Included in Defense R&D FY 2002 - FY 2006.
Note: Beginning in FY 2017, a new official definition of R&D has been adopted by federal agencies. Late-stage development, testing, and evaluation programs, primarily within the Defense Department, are no longer counted as R&D. FY 2018 figures are AAAS estimates based on omnibus-enacted figures. Source: *AAAS Research & Development* series and agency budget documents. DOD S&T figures are not comparable for all years because of changing definitions. © 2018 AAAS

How Does Private R&D Compare?

2017 R&D Spending from top 20 US companies = $155B

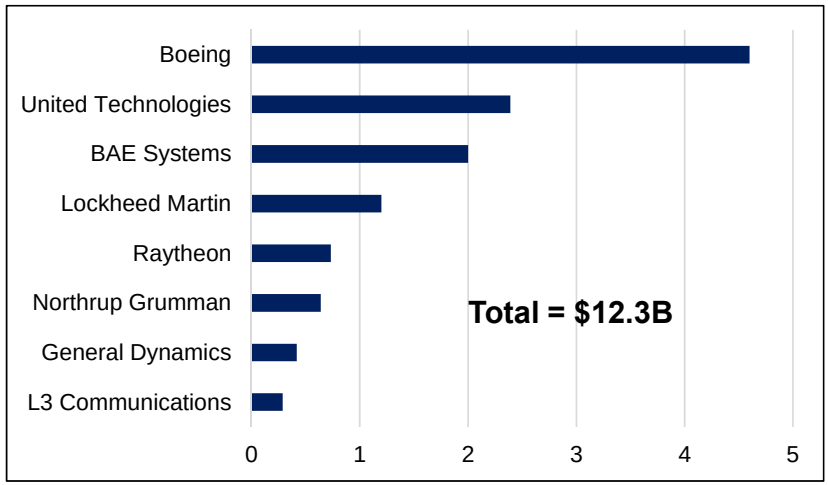


Software
Services
Computers
Communications
Transportation
Medicine

Includes latest fiscal year data for reporting S&P 500 companies.
Source: FactSet

recode

2017 R&D Spending by top defense contractors ($B)



(Compare to all Federal R&D obligations = $128 B)

What has the DoD Been Doing?

- **Reorganize and modify acquisition processes**
  - **Split USD AT&L into USD R&E and USD A&S (Feb 2018)**
  - **Exploiting flexible contracting authorities outside the FAR (NDAA 2016 - 2018)**
  - **Repurposing SBIR/STTR funding (AF) for speed and relevance**

- **Establishing new offices and agencies to develop, attract and leverage non-traditional company participation in national security and promote innovation**
  - **DIU(x)*: accelerating commercial innovation for national security**
  - **NSIN (formerly MD5): National Security Innovation Network**
  - **InQTel, Army Venture Capital Fund, National Security Investment Capital, etc.**
  - **Army RCO, Maritime ACO, SOFWerx, AFWerx, Navy ISG, AFC, etc**

***DISCLAIMER: I worked as Chief Science Officer of DIUx from 2016 - 2018.**

What has MIT Lincoln Laboratory Been Doing?

- Created new Technology Ventures Office in 2018
  - Mission is to facilitate the rapid transfer of advanced technology into and out of MIT Lincoln Laboratory for the benefit of national security
- Implemented new R&D subcontracting opportunities modeled after Commercial Solution Openings
  - Targeting non-traditional defense contractors
- Expanding use of CRADAs and Collaboration Agreements to engage with private sector on joint R&D
- Working with MIT Technology Licensing Office to create streamlined gov-purpose licenses and expanded open-source options
- Developing a more entrepreneurial work force
  - Modified iCorps program taught twice per year
  - New DARPA-funded Entrepreneurial Research Fellowships in FY20 (with LBNL)

Parting Thought: Economic Prosperity Often Derives from Government Investments