



*It is essential that we as a nation reaffirm, revitalize, and **strengthen substantially the unique partnership** that has long existed among the nation's research universities, the federal government, the states, and philanthropy by enhancing their roles and linkages and also providing incentives for stronger partnership with business and industry. In doing so, we will encourage the ideas and innovations that will lead to more high-end jobs, increasing middle-class incomes, and the security, health, and prosperity we expect.*

National Research Council, *Research Universities and the Future of America* (2012)



Virginia's Challenge

- We urgently need additional significant private sector economic drivers.
 - Our economic growth rate is in decline
 - We are over reliant on dwindling defense funding – we must diversify
 - Low growth of high-paying jobs in growing industries
 - We are losing young talent to other states
 - Opportunities are passing by
- Our investments in universities are not yielding sufficient economic development
- Our economic development efforts are fragmented, localized and not aligned



Virginia Research Alliance

A Powerful Partnership for Innovation

- University partners include EVMS, GMU, ODU, UVA, VCU, VT, & W&M
- Commitment to:
 - Recruit and reward/retain world-class, innovation-focused academic scientists and engineers
 - Build and operate shared research and innovation tools, instruments and infrastructure for use by both academic and private sector innovators
 - Develop and sustain strong university-industry partnerships
 - Effectively translate research outcomes into products and services by creating alignment among federal, state and private sector initiatives



The Commonwealth is:

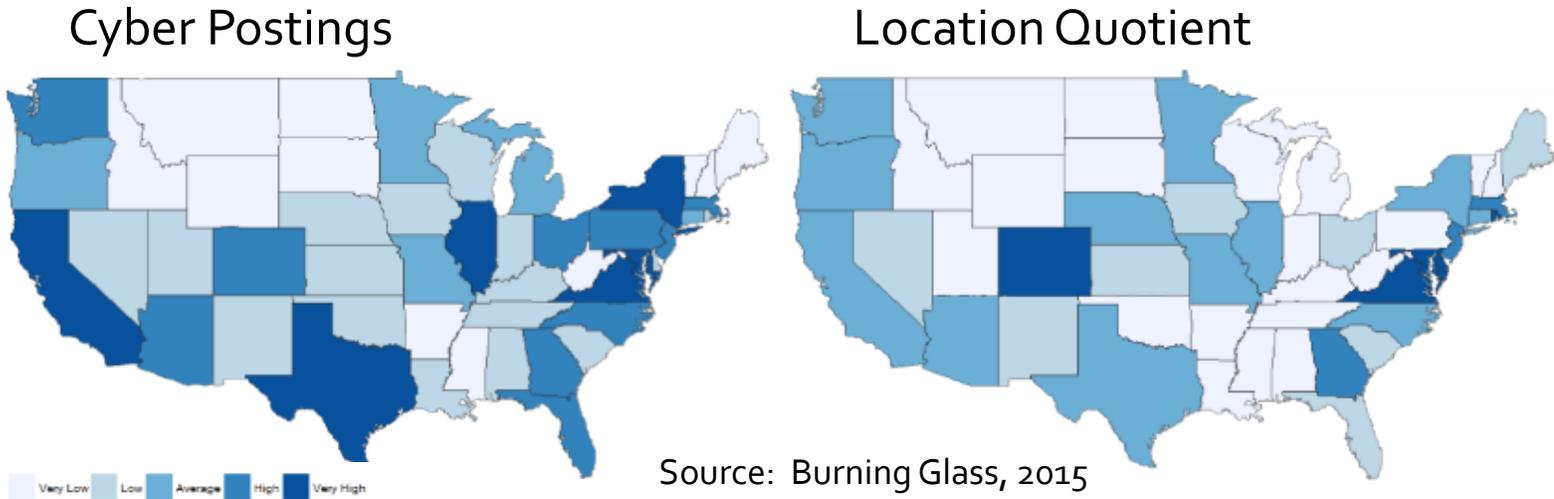
- a national leader in the \$75B cybersecurity industry
- well positioned to capitalize on explosive growth in cyber-physical system (IoT) security that diversifies portfolio across multiple industry sectors
- at risk of losing competitive advantage as new opportunities emerge without investments in growth of a vibrant technology entrepreneurial ecosystem

VRIF support of Virginia's universities strengthens the ecosystem for the Commonwealth to lead the nation in cybersecurity industries by:

- creating a network of leading talent across Virginia
- providing network of open access state-of-the-art facilities
- enhancing competitiveness for investment in cybersecurity research and commercialization

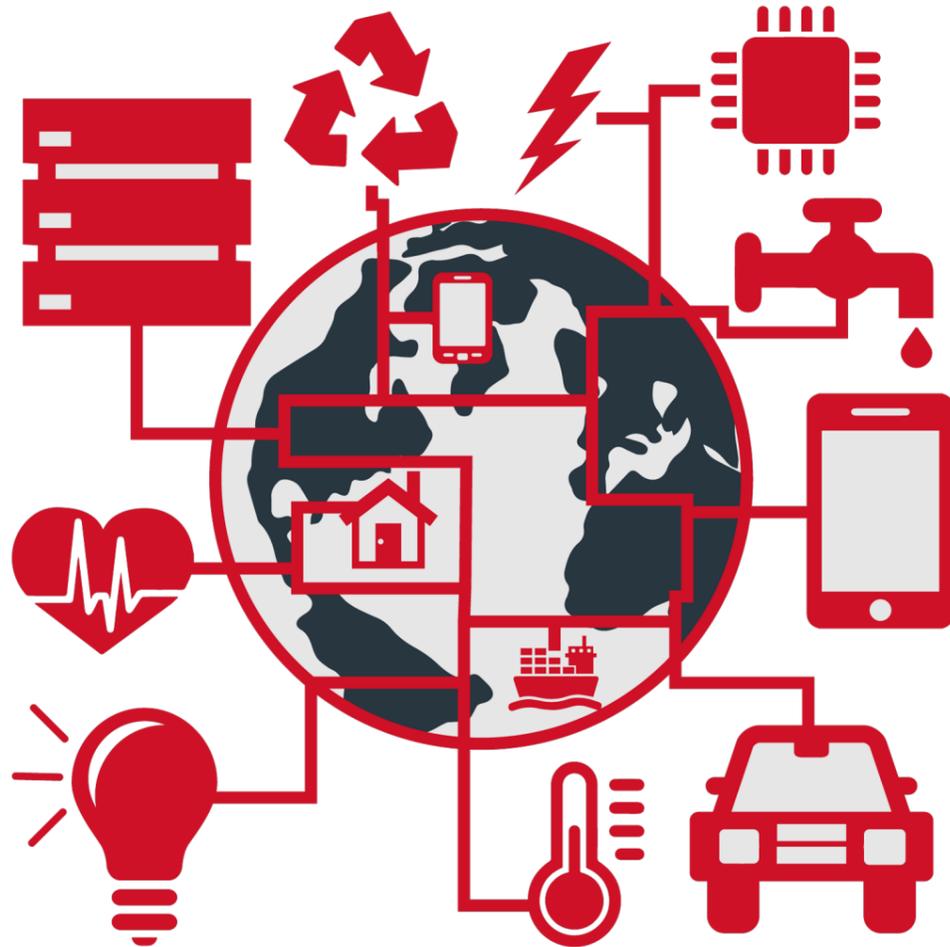
Cybersecurity: Opportunities & Threats for Virginia

	State	Total Postings	Location Quotient**	% Growth (2010-2014)
1	California	28,744	1.02	75%
2	Virginia	20,276	3.09	38%
3	Texas	18,525	0.92	113%
4	New York	14,089	0.97	104%
5	Illinois	11,428	1.16	163%
6	Maryland	11,406	2.40	39%
7	Florida	9,847	0.67	135%
8	Georgia	8,757	1.22	121%
9	New Jersey	8,268	1.21	80%
10	Massachusetts	7,911	1.45	92%
11	Colorado	7,688	1.77	111%
12	North Carolina	7,503	1.06	127%
13	Ohio	6,281	0.72	141%
14	Pennsylvania	5,745	0.59	69%
15	Arizona	5,502	1.18	87%



- Virginia ranks 2nd in job postings and 1st in concentrated demand, yet high projected growth of 38% is lower than competitors
- Virginia ranks 2nd in number of cybersecurity companies (150) on Cybersecurity 500 list
- Universities are critical to this ecosystem

Cyber-physical system security is pervasive across multiple industrial sectors



- More than 30B connected devices by 2020
- Spending on IoT security to reach \$120B by 2020 with overall cyber spending to be \$500B-\$1T from 2017-2021

Source: BI Intelligence, Gartner

Non-traditional wireless systems represent fastest growing segment of connected devices

High-Paying Cybersecurity Jobs



>17,000 vacant cyber jobs in Virginia

Growing needs for higher-level **Security+X** skills:

- Data science
- Wireless
- Advanced Manufacturing
- Autonomous vehicles
- Energy Systems
- Health and Medical Devices
- Financial / Insurance / etc.

Virginia universities play a critical role in creating a talent pipeline

Virginia's Current University Capabilities

Number of faculty
actively engaged in
research and instruction

> 150

Annual extramural
expenditures in research
and instruction

> \$70 M

Centers and Institutes with >\$5M Ann.

Applied Research Institute

Applied Research Corporation

Center for Secure Information Systems

Data Science Institute

Hume Center for National Security

Select sector-specific with >\$2M Ann.

ASSIST Center

Biocomplexity Institute

Center for Air Transportation Systems

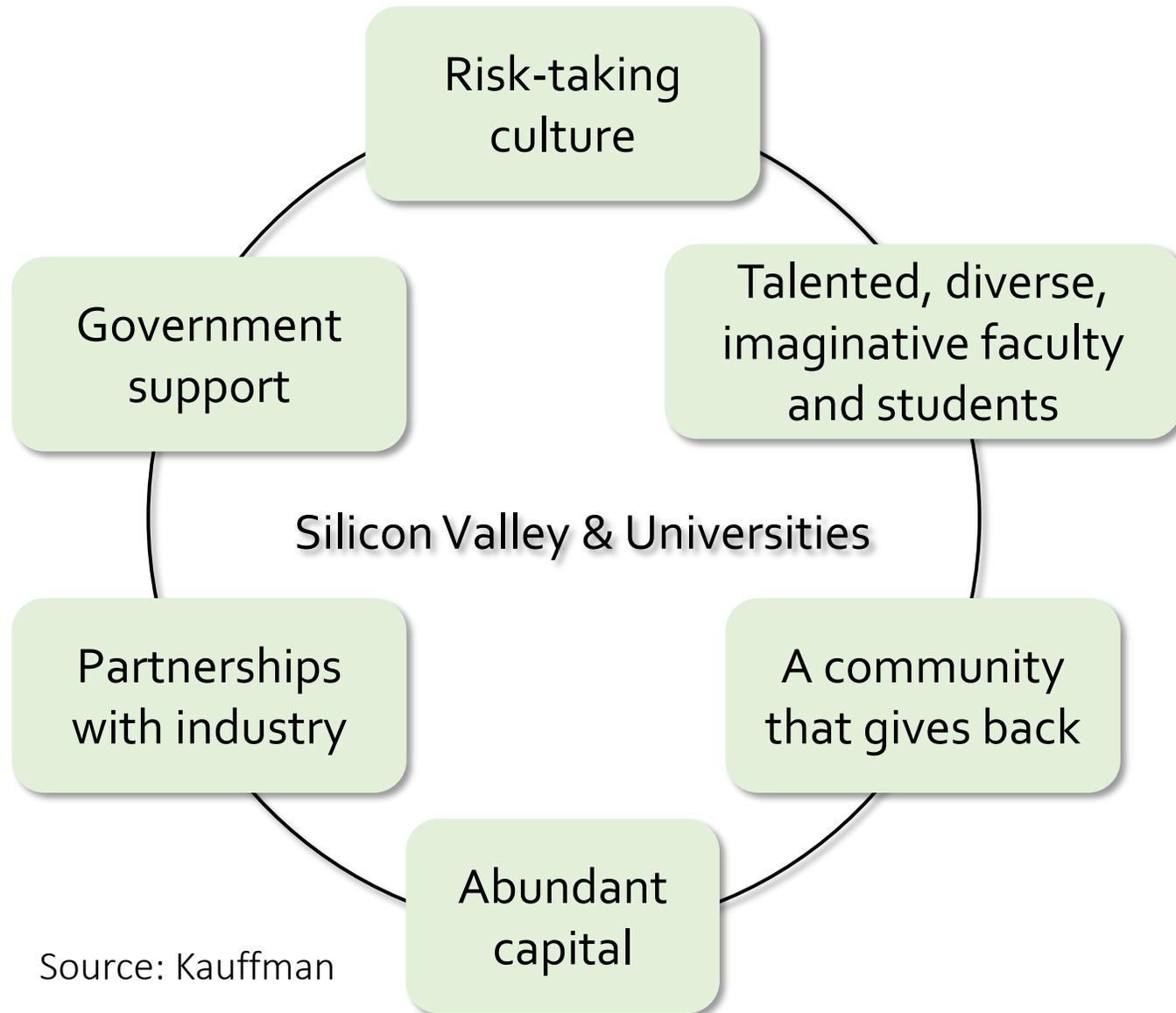
Mid-Atlantic Aviation Partnership

Transportation Institute

Virginia Cyber Range

*Estimated (minimum amounts)

Technology Entrepreneurial Ecosystem



The DC region ranks among the top ten cities in the US where startups received the most venture funding, and Virginia leads the DC region

Virginia is uniquely positioned near the Federal government and its various agencies

Source: Tech.co

Network of universities with leading expertise are central to vibrant ecosystem

Select Security and Related Sector Industry Partners*

Supported > \$15M in cybersecurity and sector programs over last 3 years

Allied Minds Federal Innovations	General Electric	Raytheon
Millennium Space Systems	United Technologies	Orbital Tech
Centripetal Network Inc.	Siemens	NEC
Shared Spectrum Company	Boeing	Battele
Aerospace Corp	Torc Robotics	Torc Robotics
Ventura Solutions	HRL	Google
MacAulay-Brown Inc	Dominion Power	Oceus
Harris Corp	Volvo	Motorola
CACI International	General Motors	CAER
L3 Advanced Programs Inc	HRL	Vencore
Lockheed Martin	ABB	MS Technologies

*confidential list - many publicity restricted

Select Cybersecurity and IoT Start-ups

VA University-based start-ups raised >\$100M in venture funding in 5 yrs

Scit Lab, 2007, Federal funding

PFP Cybersecurity, 2010, \$0.3M raised, CIT gap funds, Blue Venture

Invincea, 2011, \$21.1M raised, New Atlantic Ventures, Aeris, Dell

Optio Labs, 2012, \$11.6M raised, Allied Minds

Federated Wireless, 2012, \$34.0M raised, Allied Minds, Woodford, P3 Capital

DataFission, 2013, commercial sales

PsiKick, 2014, >\$20M raised, Osage Partners, New Enterprise, U Michigan

HawkEye 360, 2015, \$18.3M raised, Allied Minds, In-Q-Tel, Raytheon, Razors Edge

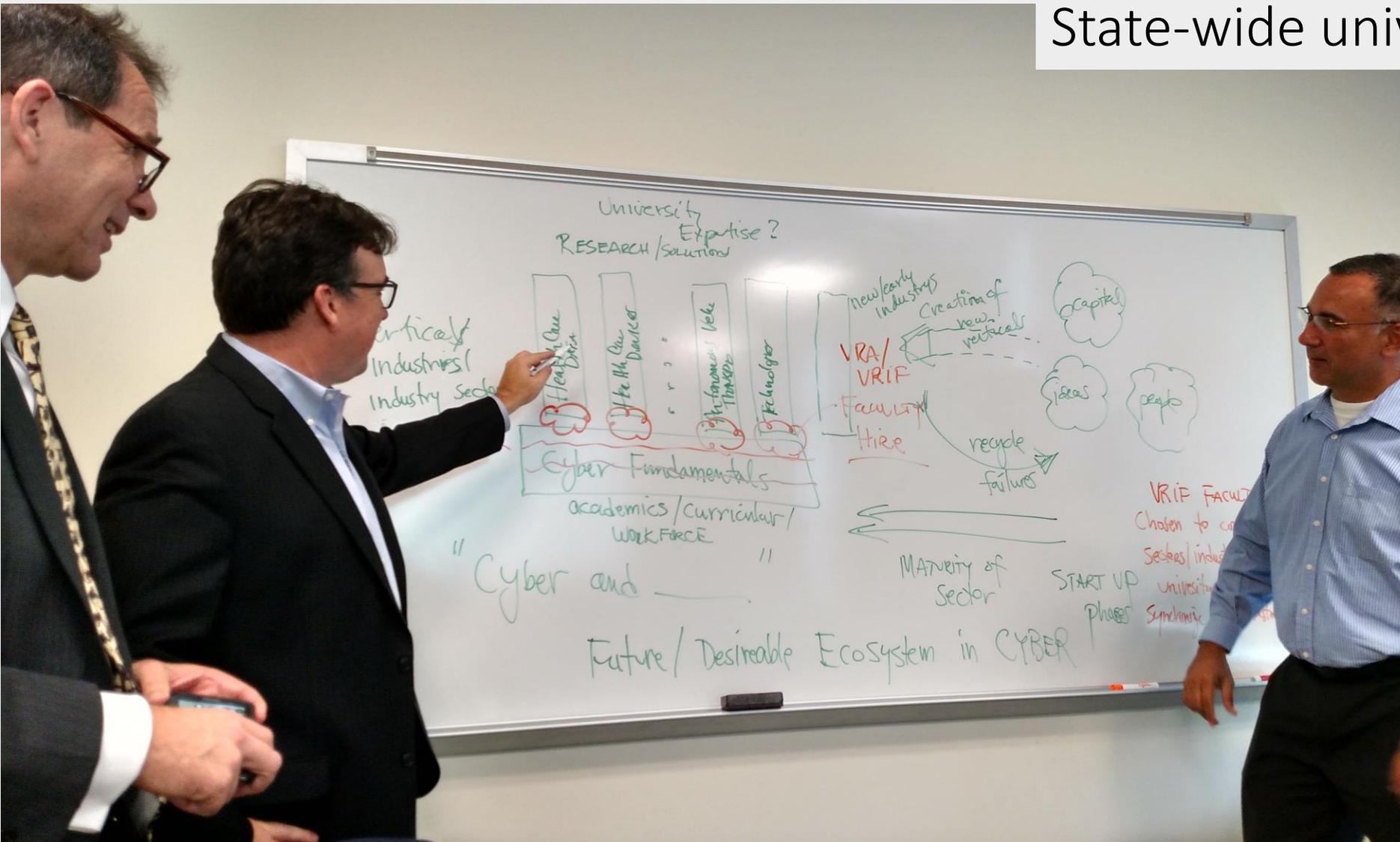
Counter Drone Research Corp, 2016, CRCF awardee

Cyvision Technologies, sales to US government

Cyberrock Inc., CRCF awardee, Federal funding

VRIF Support to Enhance Cybersecurity Ecosystem

State-wide university network of:



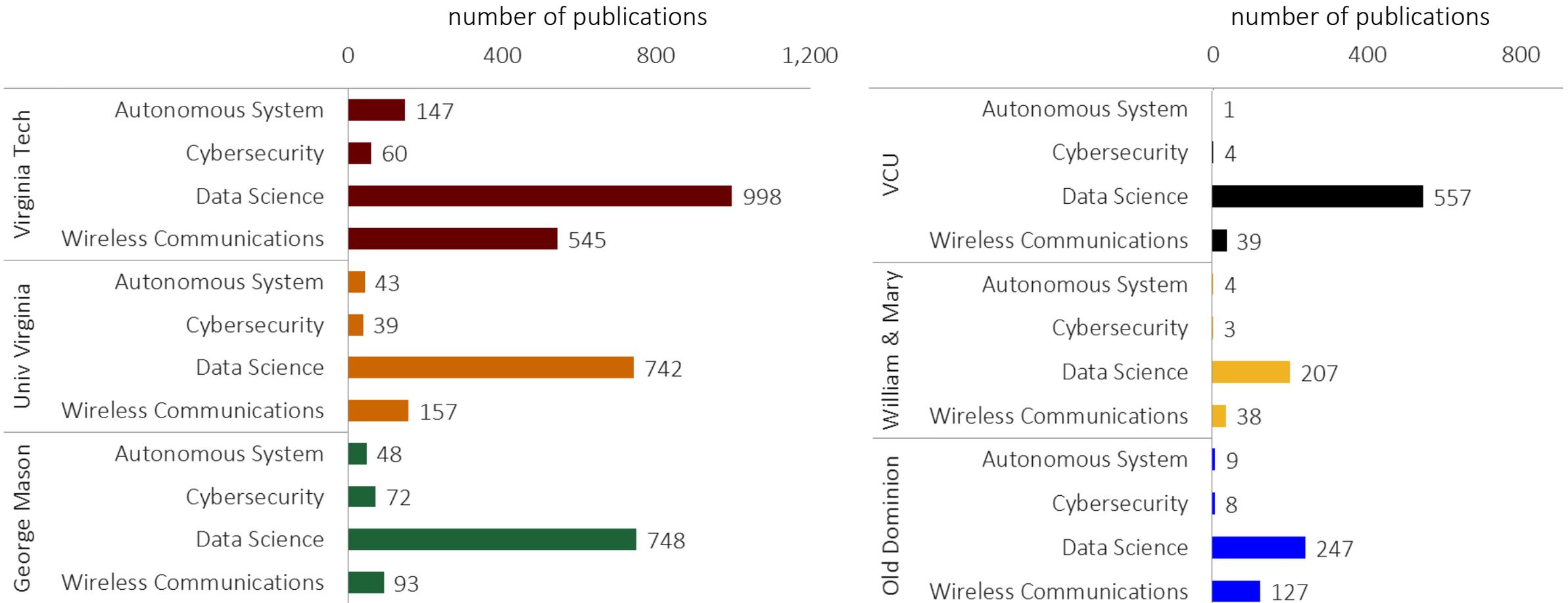
Security+X talent aligned with university strengths and translation goals

state-of-the-art open access cyber facilities

industry, govt, venture partners

curriculum and training materials

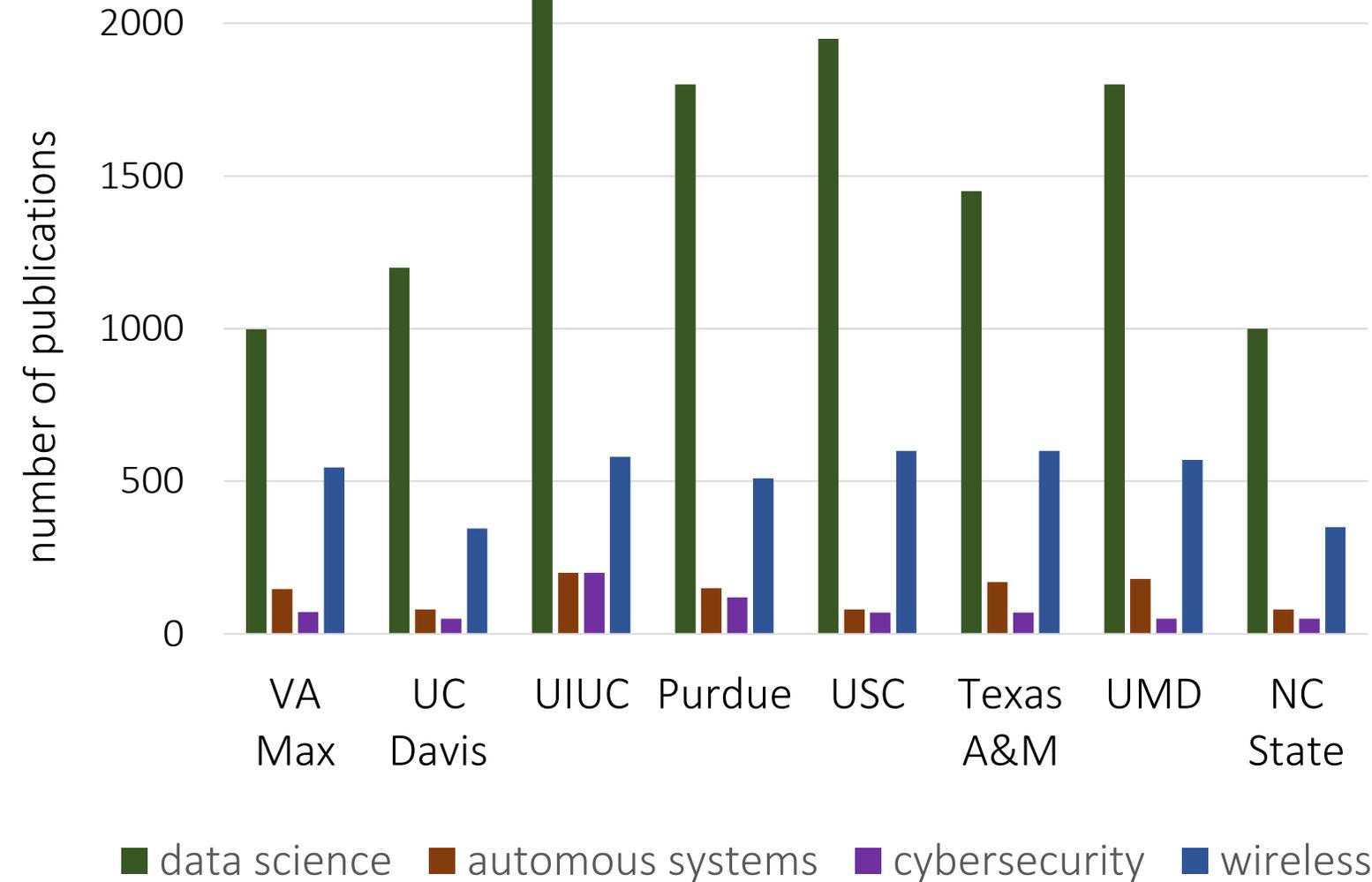
Cybersecurity and Sector Specific Publications



Publications can be accurately benchmarked and provide a measure of expertise and reputation

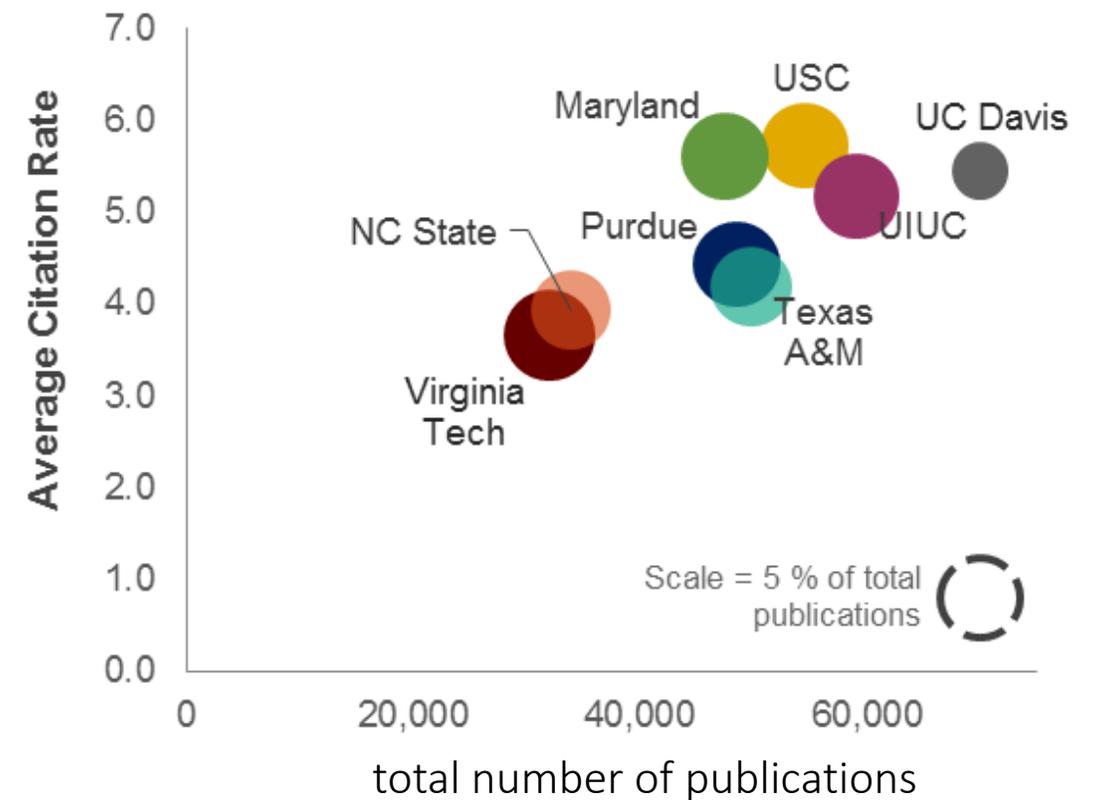
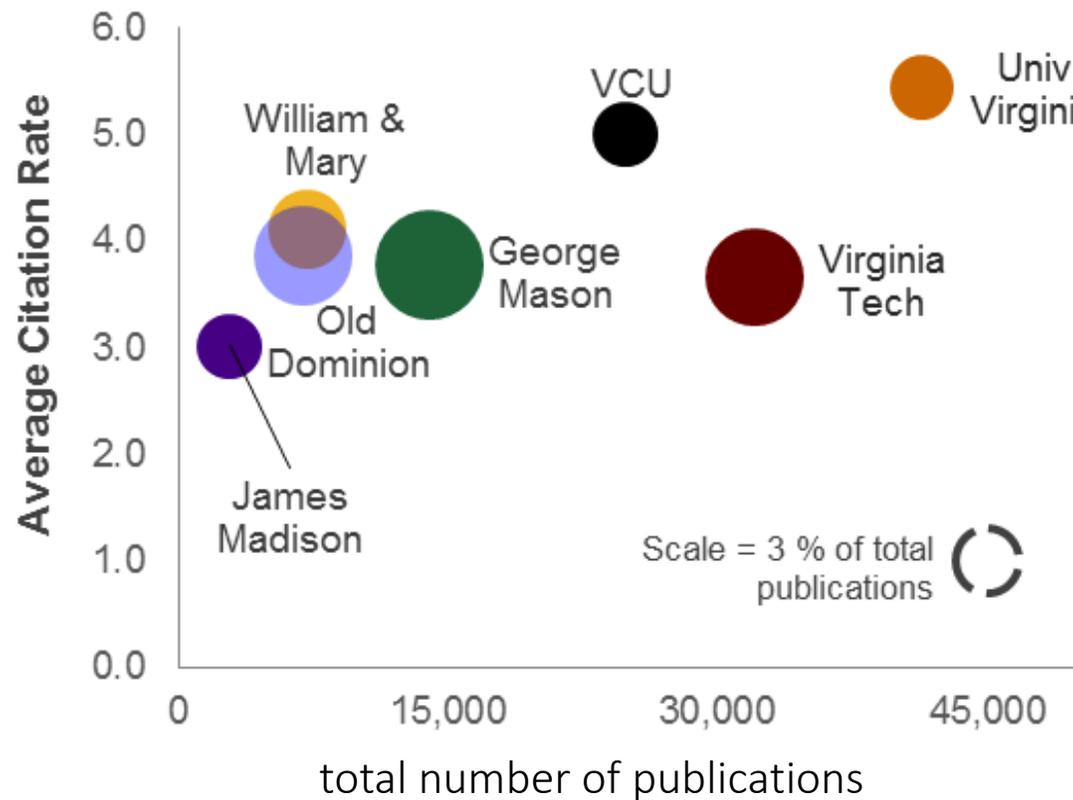
Source: Web of Science Core Collection (2006 – 2015)

Comparison to SCHEV Peers: Cybersecurity



Strategic investments in talent and infrastructure would enhance competitiveness of Virginia universities in cybersecurity-related efforts when compared to top-ranked peer institutions

Comparison to SCHEV Peers: All Publications



Size of the bubbles indicates that emphasis of cybersecurity-related research as compared to the total is high compared to peers



The Case for Neuro



Current Industry & Nonacademic Partners



• **Health Systems**

- INOVA
- Carilion
- Kings Daughters Childrens Hospital
- UVA Health
- Veterans Administration

• **Neurodegeneration**

- Michael J Fox Foundation
- Janelia Farms

• **Injury & Trauma**

- NFL
- NCAA

• **Pharma**

- Astra Zeneca
- Medimmune
- Boehringer Ingelheim

• **Big Data**

- Booz Allen Hamilton
- Mitre
- IBM Watson
- Parabon

• **Neurotechnologies**

- Imaging
 - Philips
 - Siemens
 - PETNET
 - Johnson & Johnson
 - Focused Ultrasound Foundation
 - DuPont



Neuro: Intellectual Property & Startups

- UVA Licensing & Ventures Group (2012-16)
 - 56 invention disclosures in neuro
 - 40 licensing deals
 - 3 startups
- VCU Innovation Gateway (2012-2016)
 - 63 invention disclosures in neuro
 - 11 licensing deals
 - 4 start-ups
- VT, GMU, W&M, ODU, EVMS (2012-2016, data still being gathered)
 - >10 invention disclosures in neuro
 - >10 issued patents
 - > 3 start-ups
- SBIR/STTR opportunities
- INOVA Venture Fund
- VBHRC, CIT





Peer Comparisons

Research and translation leaders

- MIT
 - McGovern Institute for Brain Research, estab. Feb' 2000 (\$350M philanthropic gift)
 - 250+ researchers and support staff: 1 Nobel Prize, 1 National Medal of Science, 5 National Academy of Science, 3 National Academy of Medicine, 1 HHMI Investigator
 - 85,000 nsf, including Dept. of Brain and Cognitive Sciences, Picopower Inst. for Learning and Memory, Martinos Imaging Center, OpenMind Computer Cluster, other cores
- CalBRAIN (California Blueprint for Research to Advance Innovations)
 - Estab. 2014; collaboration across University of California System
 - Seed support – focus upon new technologies for monitoring widescale brain activity
 - \$2M in seed funds awarded thus far
 - Support for Federal funding opportunities
- Regional: Major centers at U Maryland and North Carolina with faculty from Medicine, Engineering and Sciences (similar to new BRAIN Institute at UVA)





Areas Meriting VRIF Support in Neuro

1. Commonwealth Professors: Key Faculty hires and retentions (highest priority)
2. Establish Commonwealth Core Network of critical instrumentation at common rates for all sites (VCores)
3. Procurement of critical instrumentation not currently available from throughout the VCore Network
4. Translational Neurotechnology program initiative
 - Modeled after highly collaborative and successful i6 Grant from Department of Commerce



Virginia Innovation Partnership

Department of Commerce i6 Challenge 2012

Linking talent, ideas and capital across the Commonwealth

10 universities

5 community colleges

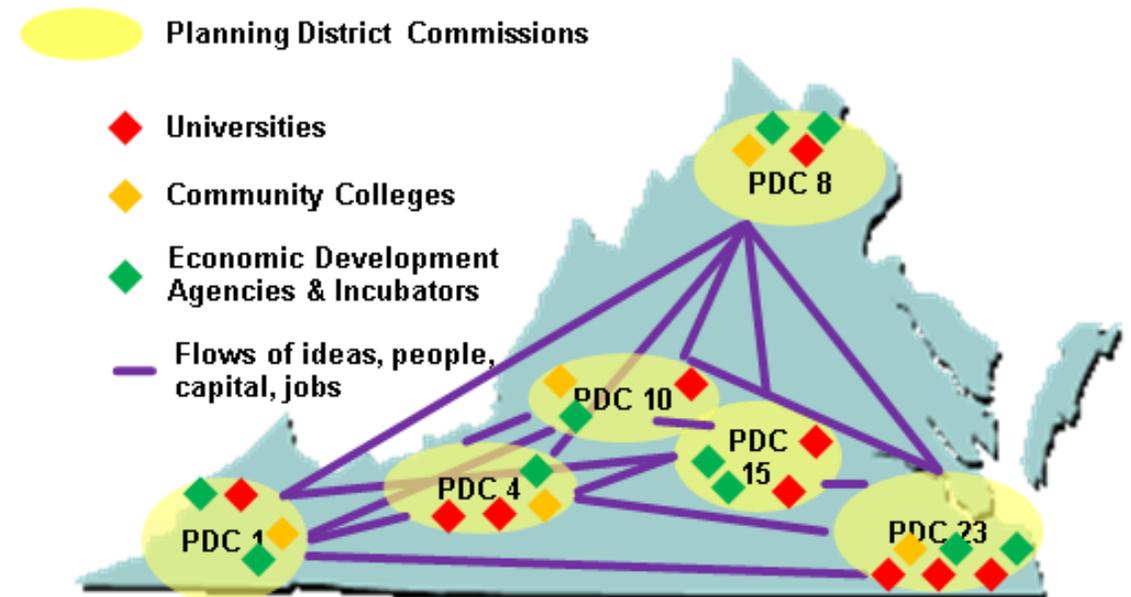
15 corporate partners

10 incubators

- Diverse review group
- Annual venture capital summit
- Mentoring network

Challenges:

Motivating proposals from all regions
Sharing ideas freely across the network
Maintaining engagement of teams



Virginia Innovation Partnership TIES
Talent, Innovation, Entrepreneurship Statewide

Match Funding: Other university \$, corporate, and non-profit organizations



Virginia Innovation Partnership (VIP) 2012-2014 Program Summary

- 147 Total Submissions Received
- 12 Number of Academic Institutions
- 36 Projects funded
Total funding awards - year 1 (\$838,000) - year 2 (\$800,000)
- 13 New ventures launched
 - Eastern Virginia Medical School (1)
 - George Washington - Science and Technology Campus (1)
 - Old Dominion University (1)
 - University of Virginia (4)
 - Virginia Commonwealth University (4)
 - Virginia Tech (1)
 - William and Mary (1)
- \$4.3M+ Follow-on funding received from state/federal agencies, industry and private investors to advance the projects

