Commonwealth Research and Technology (R&T) Strategic Roadmap

November 1, 2014

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Executive Summary

Innovation is widely recognized as the premier path to economic expansion, and success in innovation requires smart investments not only in the infrastructure and environment that support strategically important industry sectors and technologies, but in research and commercialization to advance those promising sectors.

Virginia is often looked to as a leader in innovation. The Commonwealth's public higher education system is repeatedly cited as among the best in the nation. CNBC and Forbes.com consistently rank Virginia among the top states for business[1], with Forbes.com ranking Virginia #1 in 2013[2]. Virginia's continued economic leadership requires maintaining investment in research and commercialization, as well as the ecosystem that surrounds innovation.

Each year members of Virginia's General Assembly are presented with funding requests for various initiatives designed to support growth in specific industries and research areas. While sponsors of the initiatives contend that their requests are critical investments in the future of the Commonwealth, legislators can find it difficult to assess these requests during the brief but hectic sessions that include thousands of legislative and budget-related proposals.

As a result, in 2011 the General Assembly directed the Center for Innovative Technology (CIT) to create the Commonwealth Research and Technology (R&T) Strategic Roadmap to help guide legislators in their funding decisions. The Roadmap identifies industry and research areas worthy of economic development and institutional focus and offers a framework for aligning key industry sectors within the state. It is also a guide for investing funds allocated through initiatives such as the Commonwealth Research Commercialization Fund (CRCF). The iterative nature of the R&T Roadmap provides for regular review in what can be a rapidly changing environment and, as needed, revisions to Virginia's strategic technology direction and investments. The initial Roadmap was submitted in November 2011. In accordance with Code of Virginia Sections 2.2-2221.2 D, CIT respectfully submits this update.

The Roadmap is the product of ongoing collaboration from a team that includes Virginia's private sector, led by the Commonwealth's ten regional technology councils, its colleges and universities, federal labs and other research organizations, and economic development officials. A broad range of senior executives from industry, academia, federal laboratories, other research organizations, economic development offices, and the Research and Technology Investment Advisory Committee (RTIAC) contribute to this examination of Virginia's strengths and priorities.

Virginia's Innovation Dashboard, the Innovation and Entrepreneurship Measurement System (IEMS), uses key metrics and outcomes to track the performance of Virginia's innovation economy. This web-

[1] CNBC. (2014). *America's Top States for Business.* www.cnbc.com/id/101758236
[2] Badenhausen, K. (2013, September 25). *Virginia Tops 2013 List of the Best States for Business.* www.forbes.com/sites/kurtbadenhausen/2013/09/25/virginia-tops-2013-list-of-the-best-states-for-business/.

based portal tracks such measures as federal R&D investments in Virginia, federal technology research and commercialization awards, and university patents and start-ups. Although Virginia enjoys a reputation as a top-tier innovation state, there are several key areas in which the Commonwealth's performance needs to improve. The 2014 State New Economy Index, for example, ranked Virginia #22 in industry investment in research and development and #18 in patents[3], compared to, respectively, #15 and #18 in the 2012 report[4]. The reports also indicate a decline in Virginia's venture capital ranking between 2012 and 2014, from #7 to #19. In the National Science Foundation (NSF)'s annual reporting of academic R&D expenditures, Virginia ranked #15 among all states in 2012[5], unchanged from its 2009 ranking[6]. Additionally, according to Jeffrey Sohl of the University of New Hampshire's Center for Venture Research, in 2013 Virginia had a slightly lower angel yield rate than mid-Atlantic states (VA: 13.3; mid-Atlantic: 16.0) and a much smaller proportion of angel capital in the seed and start-up stage (VA: 45%; mid-Atlantic: 76%)[7].

The IEMS allows policy makers to easily track the Commonwealth's innovation ecosystem. The Roadmap assesses research and technology strengths that represent opportunities in high-priority industries and research disciplines with promising out-year growth.

The FY2015 Roadmap identifies the following sectors as research and technology strengths and opportunities that represent high-priority industries, subsectors, and research disciplines with promising out-year growth.

- **Advanced Manufacturing**, with particular interest in additive manufacturing, semiconductors, unmanned vehicles, robotics, remote monitoring and sensing, advanced materials, and nanotechnology – especially nanoelectronics and nanomedicine
- **Aerospace**, with particular interest in launch vehicles and commercial space flight
- **Communications,** with particular interest in developing next-generation broadband networks, wireless telecommunications, and next-generation 911 infrastructure
- **Cyber Security,** with particular interest in enterprise networks, critical infrastructure security, authorization / authentication / identity management technologies, cloud-based security, data and application encryption and key management, and mobile / device security
- **Energy**, with particular interest in clean coal, smart grid, nuclear plant safety and support, wind technologies, biofuels, efficiency, and waste-to-energy applications

[3] The Information Technology & Innovation Foundation and Kauffman Foundation. (2014). *The 2014 State New Economy Index*.
[4] The Information Technology & Innovation Foundation and Kauffman Foundation. (2012). *The 2012 State New Economy Index*.
[5] National Science Foundation. (March 2014). *Higher Education Research and Development Survey, Fiscal Year 2012.*
[6] National Science Foundation. (July 2011). *Academic Research and Development Expenditures, Fiscal Year 2009.*
[7] Sohl, J. (2014). *The 2013 Seed and Start-up Equity Capital Market in the Commonwealth of Virginia.*

- **Environment,** with particular interest in marine science and water and air quality monitoring and control
- **Information Technology**, with particular interest in data analytics
- **Life Sciences**, with particular interest in biopharma, health IT, bioinformatics, biomarkers, personalized medicine, remote care delivery, medical devices and software, diagnostics, and computer-assisted drug design
- **Modeling and Simulation**, with particular interest in energy, transportation, healthcare, and homeland security and defense applications
- **Nuclear Physics**, with particular interest in advanced manufacturing, energy, environment, life sciences, information technology applications, and a 4th generation light source
- **Transportation**, with particular interest in vehicle telematics, vehicle and driver performance monitoring, and intelligent transportation systems

Investments targeted at the intersection of industry capabilities and direction, research strengths, and economic development can create a multiplier effect that increases the benefit of the CRCF and other industry / research growth initiatives.

Two of Virginia's strong and most promising sectors, Cyber Security and Data Analytics, cross multiple regions, and investments will support growth in multiple industries important to the Commonwealth, including National Security, Healthcare and Life Sciences, Advanced Manufacturing, Education, Energy, and Government. Similar synergies across regions and technologies can be found in Advanced Manufacturing, Energy, Life Sciences, and other sectors and subsectors. Identifying and funding these high-impact technologies will have widespread benefit to individual regions and to the Commonwealth as a whole.

Industry strengths and niche opportunities are profiled in the Roadmap along with a sampling of industry, university, and research institute strengths and priorities. These materials are augmented with profiles of Virginia universities and research institutes on CIT's website, www.cit.org/initiatives/research-and-technology-strategic-roadmap/.

Research requires specialized facilities and equipment; at Virginia's public universities, such infrastructure requests may be captured in the Commonwealth's Six-Year Capital Outlay Plan. Most capital projects requested by Virginia's public universities support objectives other than research. However, as in past years, the latest Six-Year Capital Outlay Plan includes research facilities and / or equipment, or facilities that share such purposes as research and teaching.

Introduction

In accordance with Code of Virginia Section 2.2-2221.2 D, CIT submits the Commonwealth Research and Technology (R&T) Strategic Roadmap – a comprehensive framework the Commonwealth uses to identify research areas worthy of economic development and institutional focus. The Roadmap also supports Code of Virginia Section 2.2-2221 (18).

Following assessments of the Commonwealth's strengths, priorities, and commercial opportunities, the R&T Roadmap identifies key industry sectors within the state that merit investment.

The Roadmap uses multiple perspectives to ensure a comprehensive view of the technology landscape, including direct participation from technology executives, economic development groups and technology councils throughout the Commonwealth, research universities, entrepreneurs, investors, and others involved in shaping regional economic priorities. This methodology uses a bottom-up (regional strategies) assessment of industry strengths and opportunities that is augmented and refined by statewide economic development priorities and federal and other market reviews. Since its introduction, the Roadmap has been a dynamic and ongoing initiative. Priorities and opportunities continue to be assessed and cultivated in every region of the Commonwealth; an iterative Roadmap can reflect a changing landscape.

The Roadmap highlights the commercially promising sectors that will drive economic growth in the Commonwealth. Legislators and other elected officials can use the Roadmap to make informed investment decisions in research, technology, and economic development initiatives. In areas where Virginia is already strong, these investments can help robust sectors excel. Where the Commonwealth lags but market opportunities exist, investments will strengthen these sectors, making Virginia even more competitive. Beyond this, the Roadmap will also help inform and align organizations across the state, including public and private universities.

Findings from the Roadmap guide industry sectors and disciplines eligible for awards from the Commonwealth Research Commercialization Fund (CRCF), which drives innovation in new technologies and was appropriated $2.8 million each year for FY2015 and FY2016. Awards from the Fund may only be made to those applications that further the goals set forth in the Roadmap.

The assessment of critical statewide industry sectors and subsectors is a crucial step in identifying research areas worthy of institutional focus and Commonwealth investment. This assessment must consider well-defined regional priorities, statewide economic development initiatives, and industry strengths in light of the external climate and Virginia capabilities. The assessment also takes into account the potential for growth, commercialization, and job creation of various industries and research areas.

Regional priorities and those of academia, federal labs, and economic development professionals reflect many factors, with economic potential for revenue and job and company creation paramount. Cyber security; data analytics; robotics; advanced manufacturing; energy; and healthcare and life sciences are among high-potential sectors. Federal science and technology (S&T) priorities also are a factor, as research and development spending is often highest in those sectors, thus helping drive research, innovation, and often economic development. Federal FY2016 S&T priorities include advanced manufacturing and industries of the future; clean energy, including renewable, efficiency, and transportation; climate research; information technology, including high-performance computing; biological innovation, including in neuroscience; and national security. Other federal priorities, including cross-agency priorities such as cyber security and climate change, also provide opportunities for technology, job, and company creation and growth.

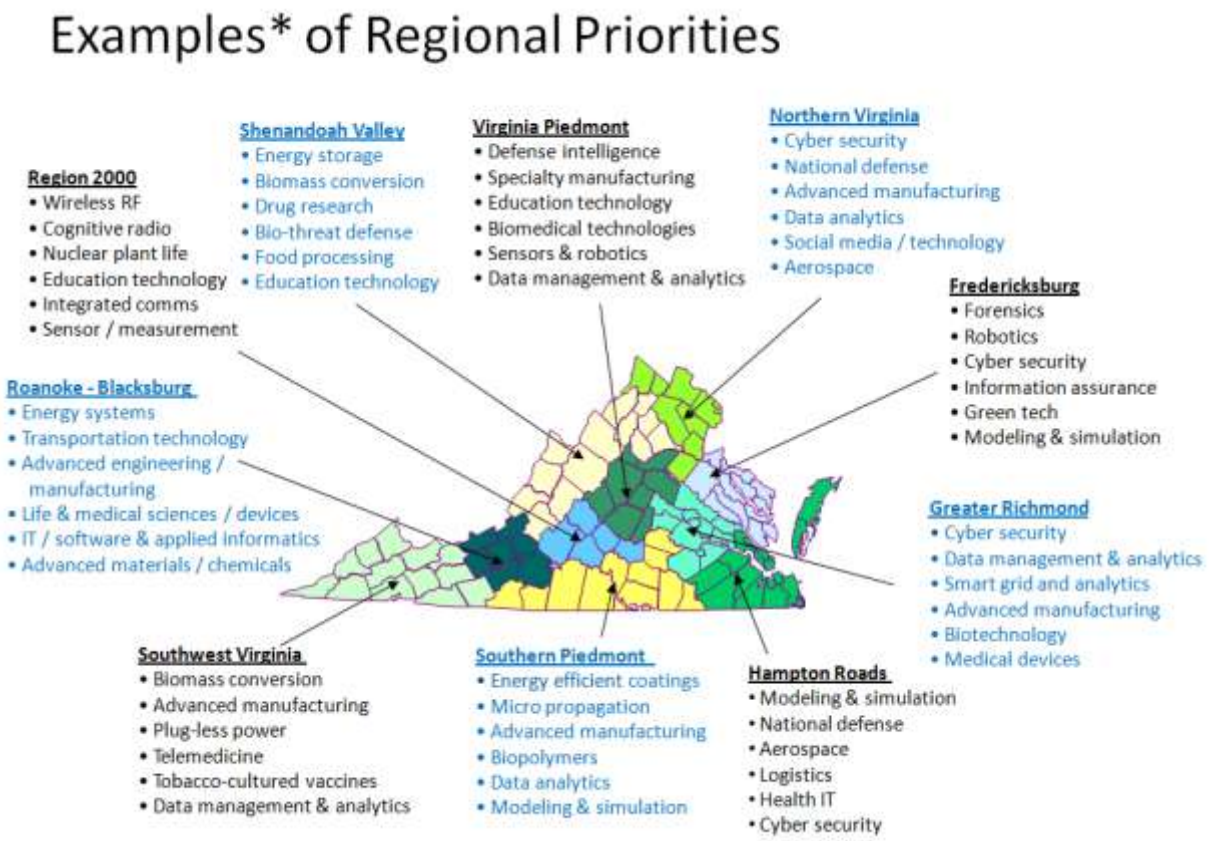
Regional Priorities

An essential element of the Roadmap is that it provides a community-driven or bottom-up perspective on economic priorities. In developing the regional assessment, CIT engaged with Virginia's ten regional technology councils and statewide technology community to identify each region's current and future strategic technology priorities. Beyond identifying local opportunities, the Roadmap assessment included cataloging regional challenges and enabling organizations, institutions, and essential assets.

Regional engagement is an ongoing CIT initiative; regional strategies and investments are monitored and can be revised if regions' needs and priorities change.

Regional Industry Priorities

Virginia's ten regional technology councils take a lead role in providing information about regional priorities, niche opportunities, assets, and gaps. Appendix A provides a complete catalog of these priorities and niche opportunities; the graphic below provides a sampling.



* Full list available in Appendix A

Virginia Economic Development Partnership: Economic Development Priorities

The Virginia Economic Development Partnership (VEDP)'s mission is to improve the quality of life and standard of living for Virginians by expanding the tax base and creating higher income employment opportunities. To fulfill this mission, VEDP focuses on cultivating new business investment, fostering international trade growth, and encouraging the expansion of existing industries, all with the aim of stimulating new job creation and capital investment in the Commonwealth.

VEDP Business Development Markets

VEDP directs its recruitment and outreach resources towards markets it expects will produce strong gains in employment, higher wages, and new capital investment. It works with local and regional partners to identify promising target markets. By then mapping these markets to regional assets, VEDP can best meet the needs of business clients. As of late-October 2014, VEDP was in the final stage of developing its new strategic plan, which includes its 2015 targeted industry sectors and priorities. A working draft of these sectors and subsectors follows.

- **Advanced manufacturing**
  - Advanced materials
  - Aerospace
  - Agribusiness and food processing
  - Transportation equipment
- **Corporate headquarters and operations centers**
- **Information technology**
  - Cyber security
  - Data centers
  - Modeling and simulation
  - Systems integration and design
- **Life sciences and medical technologies**
  - Biotechnology and life sciences
  - Medical devices
  - Personalized medicine / health IT
  - Pharmaceuticals
- **Professional and business services**
  - Federal contracting
  - Financial services
  - Process management
- **Transportation, distribution, and logistics**
  - Logistics, supply chain management, and support
  - Maritime and port-related
  - Trucking and warehousing
- **Special focus areas**
  - Energy
  - Federal operations

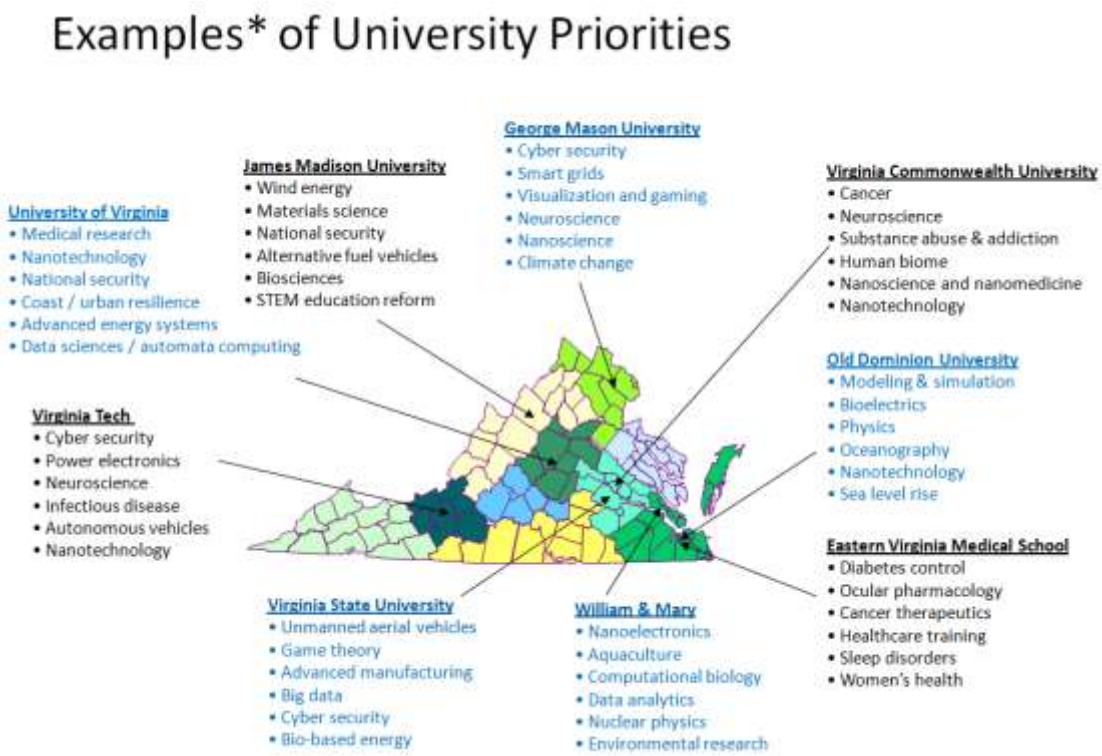
Academia

Background

The Roadmap identifies common themes among Virginia's research universities with the goal of mapping university capabilities to industry and research organizations' strengths and priorities. This benchmark provides insights into research areas that are the most likely to result in science and technology commercialization. For the purposes of this study, a "research university" is defined as one with more than $5 million in annual R&D expenditures, as reported by NSF for FY2012. Virginia's research universities, by this definition, include: the College of William and Mary (W&M), Eastern Virginia Medical School (EVMS), George Mason University (GMU), Hampton University (HU), James Madison University (JMU), Norfolk State University (NSU), Old Dominion University (ODU), the

University of Virginia (UVa), Virginia Commonwealth University (VCU), Virginia State University (VSU), and Virginia Tech. Input also was solicited from George Washington University (GWU) on the basis of its research expenditures and impact on the Commonwealth from its Virginia Science and Technology campus, located in Loudoun County.

In order to identify and gauge strengths and priorities at these research universities, each institute was asked to provide a profile identifying key areas. Responses were compiled and analyzed in order to identify common research priority areas. The graphic below identifies a sampling of research strengths and priorities, and the profiles online provide additional information about each institution.



*Profiles available online.

University Strategic Plans

Universities' strategic plans focus on mission, vision, goals, and outcomes over a several-year period, addressing such topics as academic excellence, faculty, outreach and engagement, research, and other priorities; however, they typically do not identify specific research and / or technologies that support the plan. In recent years, however, emphasis has been on interdisciplinary research and research collaborations, including with the private sector. Universities have also built partnerships that allow them to leverage expertise and resources from national laboratories, government, and other universities. These partnerships also allow Virginia's universities to compete for funding that increasingly has been awarded to large-scale interdisciplinary teams rather than individual investigators.

Additionally, Virginia universities are increasingly focused on research commercialization, innovation, and entrepreneurship that span a multitude of sectors and include both students and faculty. These are common themes among the universities engaged in the Roadmap.

University Research Priorities

Collectively, the Commonwealth's research universities have strengths and strategic interests in the 11 technology sectors called out in this Roadmap as Virginia's research and technology strengths and priorities. Within these areas, interdisciplinary work is underway in such fields as bioinformatics, biopharma, bioengineering, climate change, sustainable design, modeling and simulation, national security and nanotechnology. In addition, opportunities in Energy, including wind, biofuels, solar, nuclear and sustainability are among the priorities of most universities. Research priorities at numerous Virginia institutions can be found online at www.cit.org/initiatives/research-and-technology-strategic-roadmap/.

Other Research and Development Assets

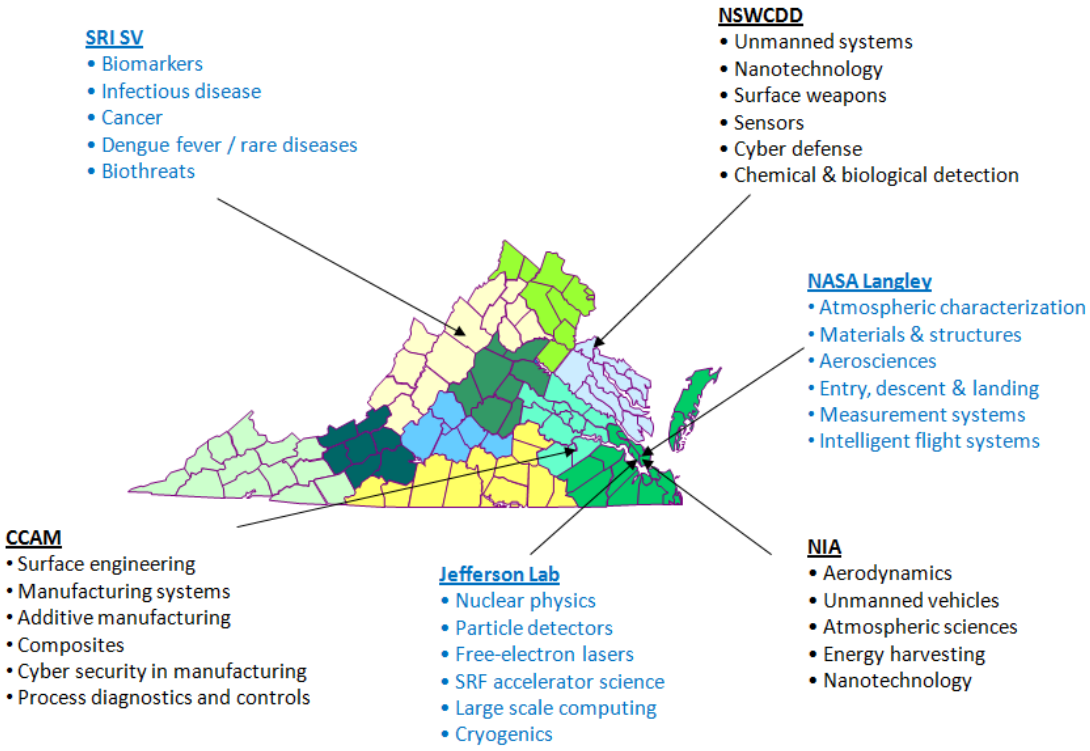
Virginia is home to research and development assets that augment the state's capabilities in research, technology development, and education. CIT engaged with six R&D institutions: three federal labs – the Thomas Jefferson National Accelerator Facility (Jefferson Lab), NASA Langley Research Center (NASA Langley), and the Naval Surface Warfare Center Dahlgren Division (NSWCDD, Dahlgren) and three research organizations – the Commonwealth Center for Advanced Manufacturing (CCAM), SRI Shenandoah Valley (SRI SV), which houses the Center for Advanced Drug Research, and the National Institute of Aerospace (NIA).

Commonalities among the Commonwealth's R&D Assets

Commonalities exist among the research institutes and federal labs of the Commonwealth. All of the organizations emphasize basic research, and many also focus on applied research and technologies. Likewise, the institutions share an interest in innovation and commercialization. A common thread is the dedication to the development of life-changing technology that will be key to advancing the innovation continuum and economy.

Both a high level of synergy and diversity exists among key industry sectors represented by the research institutes and federal labs. The graphic available below provides a sampling of strengths and strategic priorities, and the online profiles discuss organizations in greater depth.

Examples* of Research Institute Priorities



*Profiles available online.

Intellectual Property

Intellectual property (IP) agreements are a cornerstone of success in the research enterprise. Straightforward, win-win agreements that provide incentives for all parties can drive collaboration, commercialization, and other desirable outcomes. IP agreements, however, are influenced by an array of policies and perspectives. This includes the nature of the research and the longstanding, individual policies among Virginia universities, research institutions, and industry.

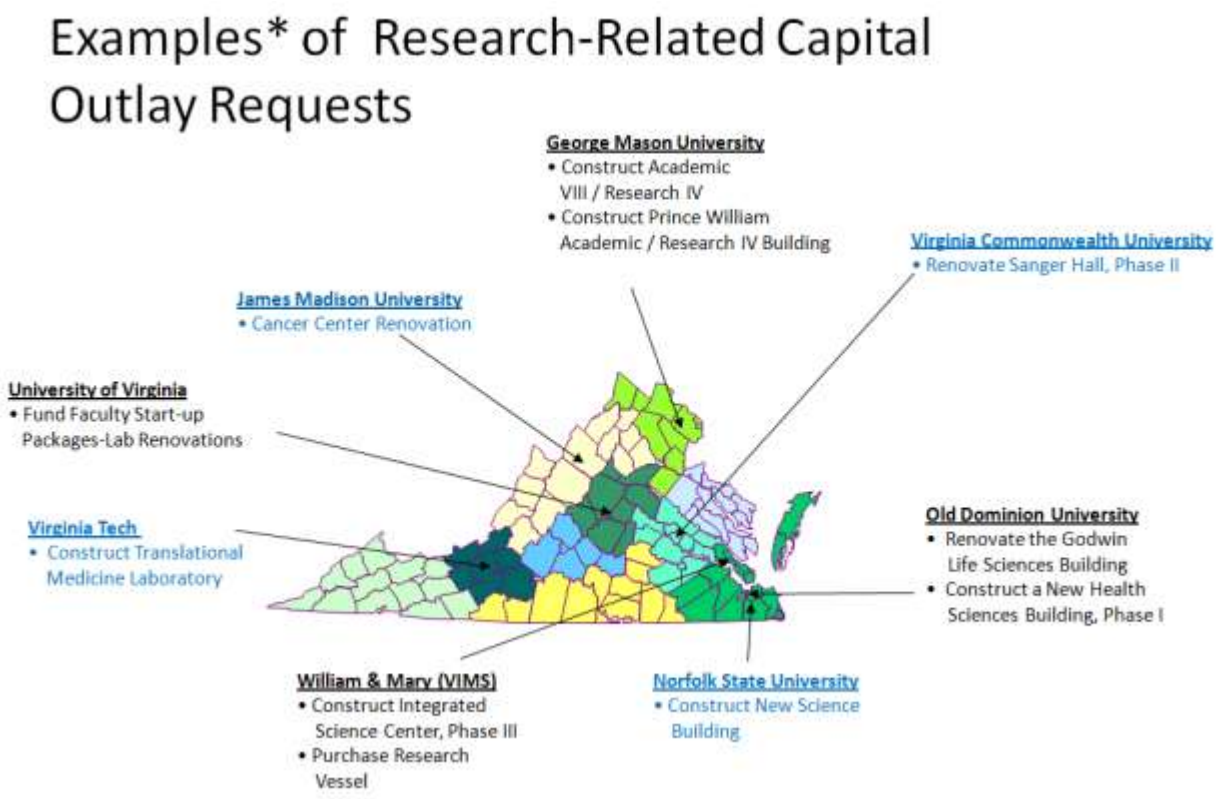
For awards made under CRCF, the FY2015 policy requires that an intellectual property agreement be executed, when IP is or may be jointly developed, before funding is disbursed. Universities or other parties that apply for CRCF funding are expected to use their respective existing approved IP policies and, as appropriate, to negotiate an agreement that has been accepted by and indicates the rights and obligation of all parties. This continues the policy established in the 2011 Roadmap and implemented in the FY2012-14 solicitations. It has worked well, and CRCF applicants, CIT, and others in Virginia's technology community have expressed support for this approach.

Capital Outlay

The Commonwealth's Six-Year Capital Outlay Plan addresses the continuing and emerging infrastructure needs of the Commonwealth's public colleges and universities. Capital outlay encompasses large non-recurring expenses, which can include acquisition, construction, improvements to infrastructure, and equipment. It can also include improvements to real property leased for use by a public educational institution[8]. Although most capital projects requested by Virginia's public universities support objectives other than research, a few research facilities and / or equipment are included among infrastructure requests.

The 2008 Special Session of the General Assembly established the Six-Year Capital Outlay Plan Advisory Committee to assist the Governor in the creation of the Six-Year Capital Outlay Plan[9]. Committee members include the Director of the Department of Planning and Budget (DBP) and the Executive Director of the State Council of Higher Education for Virginia (SCHEV); CIT works with both organizations regarding capital outlay requests and Roadmap findings. Recent infrastructure requests include research and teaching laboratories that support medical and such other research as bioscience, computational, mechanical engineering (including robotics), materials testing, and wind tunnels. The graphic below provides a sampling of infrastructure requests.

[8] Commonwealth of Virginia Auditor of Public Accounts. (January 2014). *Review of Capital Outlay Funding and Cash Flow Processes.*
[9] Commonwealth of Virginia Auditor of Public Accounts. (January 2014). *Review of Capital Outlay Funding and Cash Flow Processes.*



*Additional information on capital outlay projects and requests available at www.dpb.virginia.gov.

Summary

This iteration of the R&T Roadmap examined research strengths, priorities, and opportunities in the Commonwealth's private sector, universities, research institutes, and federal labs to identify and align key industry sectors within the state and, ultimately, assess which sectors present the Commonwealth with the most commercial promise. Information was gathered on regional priorities, existing and projected research and commercialization capabilities, economic development initiatives, and an evaluation of the external climate. The findings represent a high-level direction the Commonwealth may take for future investments in addition to research and technologies eligible for FY2015 CRCF awards. These opportunities follow:

- **Advanced Manufacturing**, with particular interest in additive manufacturing, semiconductors, unmanned vehicles, robotics, remote monitoring and sensing, advanced materials, and nanotechnology – especially nanoelectronics and nanomedicine
- **Aerospace**, with particular interest in launch vehicles and commercial space flight
- **Communications,** with particular interest in developing next-generation broadband networks, wireless telecommunications, and next-generation 911 infrastructure.

- **Cyber Security,** with particular interest in enterprise networks, critical infrastructure security, authorization / authentication / identity management technologies, cloud-based security, data and application encryption and key management, and mobile / device security
- **Energy**, with particular interest in clean coal, smart grid, nuclear plant safety and support, wind technologies, biofuels, efficiency, and waste-to-energy applications
- **Environment,** with particular interest in marine science and water and air quality monitoring and control
- **Information Technology**, with particular interest in data analytics
- **Life Sciences**, with particular interest in biopharma, health IT, bioinformatics, biomarkers, personalized medicine, remote care delivery, medical devices and software, diagnostics, and computer-assisted drug design
- **Modeling and Simulation**, with particular interest in energy, transportation, healthcare, and homeland security and defense applications
- **Nuclear Physics**, with particular interest in advanced manufacturing, energy, environment, life sciences, information technology applications, and a 4^{th} generation light source
- **Transportation**, with particular interest in vehicle telematics, vehicle and driver performance monitoring, and intelligent transportation systems

APPENDIX A: Regional Industry Priorities

Region	Industry	Niche Opportunity
Charlottesville	Energy	Nuclear and fossil fuel power generation
		Green construction
	Information Technology	Data management, analytics, and storage
		Software development and applications
		Education-based technologies
	Life Sciences	Biotechnology
		Health IT
		Medical devices and software
		Drug discovery and therapeutics
		Bioinformatics
	National Security	Defense intelligence
		Cyber security
		Information assurance
	Specialty Manufacturing	Components and systems
		Surface engineering
		Electronics
		Sensors and robotics
		In-vitro diagnostic substances manufacturing
		Perishable prepared food manufacturing
Fredericksburg	Energy	Green technology – efficiency and conservation
		Green construction and net-zero buildings
		Smart grid
		Smart meter technology
	Information Technology	Cyber security
		Information assurance
		Software development for data analytics
		Modeling and simulation
		Health IT
		Robotics software
	National Security	Secure federal telework
		Human factors engineering
		Defense logistics training
		Forensics
Hampton Roads	Advanced Manufacturing	Next-generation shipbuilding
		Robotics and unmanned vehicles
		Port security
		Sensors and environmental monitoring
		Cyber security
	Aerospace	Remote environmental monitoring
		Support to federal research
		Instrumentation and calibration services

		Autonomous systems for space exploration
	Energy	Offshore wind component manufacturing, installation, and service
		Power electronics component manufacturing, system integration, and service
		Algal biofuel production
		Landfill and biomass waste-to-energy power generation
	Life Sciences	Computer-assisted drug design
		Regenerative medicine
		Cancer treatment and prevention
		Medical devices – advanced prosthetics
		Health IT
	Modeling and Simulation	Transportation, logistics, and evacuations
		Homeland security and defense – extreme event and risk analysis, emergency management
		Cognitive development and rehabilitation, training applications
		Logistics, business, and supply chain optimization and planning
		Hardware and software development for simulators and training devices
Northern Virginia	Advanced Manufacturing	Semiconductors
		Nanotechnology
	Aerospace	Satellites
		Launch vehicles
		Missile defense systems
	Cyber Security	Cyber security
		Information assurance
		Homeland security and defense
	Energy	Green engineering and construction
		Smart grid applications and analytics
		Alternative energy
	Information Technology	Data management, analytics, and storage
		Software and application development
		Telecommunications and broadband
		Modeling and simulation
		Social media / technology
	Life Sciences	Biotechnology and biometrics
		Bioinformatics
		Health IT
		Personalized medicine
		Medical devices and software
Region 2000	Advanced Manufacturing	Integrated communications
		Sensing and measurement technologies
		Machine support to nuclear industry

		Robotics
		Nuclear materials container design, analysis, fabrication, and testing
		Welding technologies
	Communications	Wireless RF
		Remote sensor development and monitoring
		Software-defined (cognitive) radio
		Integration of 4th generation cell technology into radio use
	Education Technology	Mobile and distance learning
	Energy	Existing nuclear plant life extension
		Nuclear fuel reprocessing
		Small modular reactors
		Nuclear control room simulation
		Plant and grid security
		Control room technologies
Richmond	Advanced Manufacturing	Surface engineering
		Robotics and automated materials handling
		Chemicals
	Energy	Energy storage and efficiency
		Smart grid applications and analytics
		Smart appliances
		Alternative energy
	Information Technology	Cyber security
		Data management, analytics, and storage
		Software and application development
	Life Sciences	Biotechnology
		Pharmaceuticals
		Health IT
		Medical devices and software
Roanoke – Blacksburg	Advanced Engineering / Manufacturing	System-based manufacturing
		Advanced materials / chemicals
		Nanotechnology
	Energy Systems	Power electronics
		Smart grid technology and applications
		Energy data mining, management, and analytics
		Smart and net-zero construction
		Heavy duty vehicle conversion to hybrid
		Carbon capture and storage
	Information Technology / Software Applied Informatics	Data management, analytics, and storage
		Web 2.0 and social networks
		Software and application development
		Utility computing, web services
	Life and Medical Sciences / Devices	Bioinformatics
		Drug discovery and design
		Personalized medicine

		Remote patient monitoring and care delivery
		Integration of social media and technology
		Health-related wireless sensors and networks
	Transportation Technology	Intermodal port operation
		Vehicle / driver monitoring
		Smart infrastructure sensing and technology
		Autonomous vehicles
		Vehicle telematics
Shenandoah Valley	Energy	Alternative transportation fuels
		Energy data analytics
		Energy usage monitoring devices
		Energy storage devices
		Wind turbine blade testing
		Production of renewable energy from customer-owned wind and solar systems
		Biomass-to-energy conversion
	Information Technology	Information assurance
		Data management and analytics
		Education technology
	Life Sciences and Agriculture	Biotechnology
		Drug research
		Cancer treatment
		Biothreats and defense
		Food processing
Southern Piedmont	Advanced Manufacturing	Advanced fuel cell research and manufacturing
		Custom manufacturing
		Robotics and unmanned systems
		Nano solar cells used to make hydrogen for fuel cells
		Energy-efficient coatings
	Energy	Plug-in hybrid electric conversion
		Energy storage platforms - NaBH4 / H2O2 fuel cells in autonomous vehicles and robots and ultra-capacitor technology
		Vehicle performance
		Energy-related mining and equipment technology
	Information Technology	Health IT
		Data analytics
		Data imaging and forms processing
		Information security
		Modeling and simulation
	Life Sciences and Agriculture	Biopolymers
		Micro propagation
Southwest Virginia	Advanced Manufacturing	Defense ordinance and tactical systems
		Advanced energy efficient coatings
		Mine safety and productivity systems

		Telecommunications and power distribution equipment
	Energy	Bioenergy – cellulosic ethanol
		Energy-related mining and equipment technology
		Biomass waste-to-energy
		Plugless power
		Coal bed methane conversion
		Landfill gas utilization
	Information Technology	Health IT
		Application development
		Data analytics and storage
	Life Sciences and Healthcare	Telemedicine – remote patient monitoring and care delivery
		Personalized medicine
		Tobacco use for incubating vaccines
		EMR data storage, mining, and analytics