fostering emerging

TECHNOLOGY SECTORS IN ARLINGTON COUNTY

By Heike Mayer, Ph.D., Terry Holzheimer, and Hal Glidden

INTRODUCTION

To uncover emerging technology sectors, we conducted a quantitative and qualitative study of the Arlington County, Virginia, economy. The study took place from August 2003 to October 2004 and involved detailed analysis of employment trends in high technology[i] as well as an in-depth study of emerging technology sectors. Arlington County's economic developers are currently implementing the strategy and have already seen some success in promoting knowledge creation and innovation in the emerging technology sectors.

Arlington County is home to a number of fast growing, innovative high technology firms and numerous federal agencies that are involved with technology research and development. Given the presence of this strong technology community, the central question we examine in this article is the growth potential and suitability of emerging technology sectors such as cybersecurity, bio IT, wireless telecommunication, advanced distributed learning, nanotechnology, and homeland security.

Arlington Economic Development (AED), Arlington County's economic development department, partnered with Dr. Heike Mayer of the Department of Urban Affairs and Planning at Virginia Polytechnic Institute and State University to analyze emerging technology trends and examine how economic development efforts can be strategically targeted to foster emerging industry sectors. This article reports the findings of the larger study and implications for an economic development strategy. The full report is available online at http://www.arlingtonvirginiausa.com/emergingtechnologies.

Arlington companies are surrounded by innovation

To assess the suitability of emerging technology sectors, we analyzed data about Arlington County's high technology economy and created a profile of the county's high technology sectors. In a second step, we convened focus groups comprised of national and regional experts and "thought leaders" from key emerging technology sectors. In these focus groups, we assessed Arlington's potential to foster emerging technology industries and gained

AN ECONOMIC DEVELOPMENT STRATEGY FOR KNOWLEDGE CREATION AND INNOVATION

Industry cluster studies have become a mainstay in economic development practice. Such studies can tell planners what industry sectors their economies are specializing in. However, cluster studies don't anticipate trends and opportunities in fostering those technology industries that are just emerging. Arlington County, Virginia, is going beyond cluster-based economic development by adopting an economic development strategy to foster emerging technology sectors. In this article, we report on a study assessing the county's potential in growing technology sectors such as nanotechnology, cybersecurity, bio IT, homeland security, wireless communication, and e-learning. Adopting a forward-looking approach to economic development positions the county well to foster next generation technologies and to take advantage of innovation and knowledge creation.

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insights on trends, issues, and strategies. In the next section we briefly review key findings. We then provide a detailed overview of the Arlington County high technology economy and data from the focus groups.

SUMMARY FINDINGS

1. **Arlington County has a strong and established economy.** Arlington experienced strong economic growth in high paying industry sectors in the 1990s. Within the region, Arlington County ranks fifth behind Fairfax County, the District of Columbia, Montgomery County and Prince George's County in terms of jobs, but has the highest concentrations of technology jobs in certain subsectors.
2. **Arlington's high technology industry specializes in the service sector.** Arlington County is home to over 26,000 workers who are employed in more than 1,200 high technology service businesses. While Arlington's high technology manufacturing employment counts for a minimal share of total high technology employment, the high technology service sector is very strong. The most concentrated service segments are management consulting, computer systems design, human resource consulting, R&D in social science and humanities, engineering services, custom computer programming, environmental consulting, and other scientific and technical consulting services. Overall, Arlington County maintains a 14 percent share of Northern Virginia's high technology economy. Over the last two years, Arlington County saw a decline in high technology employment, but this is consistent with regional and national trends.
3. **Arlington's technological competencies relate to federal government agencies.** Arlington's high technology firms are very innovative and contribute to emerging technology sectors. Arlington's innovation capacity (as measured by registered patents) has increased since the mid 1990s (with a slight decrease in 1999). Most patents are registered in high technology areas. Arlington County firms attracted venture capital mainly for computer software and services, Internet, communications and media. Additionally, Arlington has a strong base of innovative and R&D-oriented federal government agencies. Some, like the National Science Foundation and the Department of Defense (Defense Advanced Research Projects Agency (DARPA), Office of Naval Research (ONR), Air Force Office of Scientific Research (AFOSR), fund, set policy, and contract for emerging technologies.
4. **The federal government is the major innovation driver for policy, funding and application.** Federal government agencies and laboratories that are located within the Washington, D.C. region are the major innovation drivers for the examined emerging technology sectors. In particular, the federal government plays a key role in policymaking (especially with regard to standard setting), funds high-risk research and development, and is the world's largest customer for emerging technology applications.
5. **Existing industry clusters are important innovation drivers.** The Washington, D.C. region's strong industry clusters: information technology, telecommunications and biotechnology, play an important role in advancing industrial activity. These clusters have distinct geographic locations, while offering opportunities for synergy. For example, opportunities exist for Northern Virginia's information technology industry to leverage Maryland's biotechnology industry for Bio IT applications. These clusters offer a deep and talented labor pool, entrepreneurs, supportive business services, cutting-edge customers and suppliers, and a "brand" for which the region is known. Located at the center of these industry clusters, Arlington County is ideally positioned to leverage this strength.
6. **Certain "high value" federal government agencies and laboratories drive research and development**. Not all federal agencies are involved in advancing science and technology. Our research revealed that certain agencies influence emerging technologies more than others, and warrant specific focus by AED. These agencies include: the Department of Defense (DARPA, ONR, AFOSR), Department of Homeland Security, National Institute for Standards and Technology, Office of Naval Research, National Science Foundation, National Institutes of Health, National Telecommunications and Information Administration, Federal

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Communication Commission, and the CIA's venture capital arm In-Q-Tel. These agencies drive technology development as both customers and financiers.

7. **The region's universities play a relatively minor role.** Most focus group participants agreed that the region's universities play a minor role in the growth of emerging technology sectors. Areas of academic strength include law and policy, as well as life science and biotechnology. Findings indicate that there is a need for more interaction among industry, academia and government as well as increased technology transfer to foster the emergence of new industry sectors.
8. **The region's advantages can support emerging technology sectors.** The region in general and Arlington County specifically possess several strategic advantages that can support the growth of emerging technology sectors. First, proximity to the federal government is the most important comparative advantage. Government contractors, academic institutions, and industry associations, among others, critically depend on personal interactions with government officials. Second, the region has developed an entrepreneurial climate that can contribute to the development of new technology sectors. First and second generations of entrepreneurs have evolved in the area, as well as the availability of necessary support services including venture capital, incubator facilities, and mentoring services. Arlington County in particular has a strong reputation for emergency response; Arlington should leverage this reputation for the application of innovative technology to homeland security.
9. **The region's disadvantages offer opportunities for an effective economic development strategy.** Findings indicate that some regional disadvantages, including a lack of a risk-taking, entrepreneurial culture, may offer opportunities for targeted economic development efforts. Focus group participants also reported a lack of innovation and technological advancement and a perception of being "too stodgy" when compared to other high technology centers such as Silicon Valley and Boston. Closely associated with these disadvantages is the lack of a major scientific university. Nevertheless, these disadvantages offer opportunities for Arlington Economic Development. In particular, a focus on entrepreneurship and innovation would help to change these perceptions.
10. **Arlington County is strategically positioned in the government-industry-university triangle.** Arlington County's geographic proximity to key economic actors in the Washington, D.C. area provides the basis for an economic development strategy. Government agencies, key industry sectors, and academic institutions form the innovation triangle. The triangle metaphor implies that there are close linkages among the three sectors and that these connections are instrumental for economic development. Examples include contracting between defense firms and the Pentagon or research relationships between DARPA and leading academic institutions. Arlington County should position itself at the center of the triangle and facilitate interaction among the three sectors.

Arlington is located in the center of public policy making for all technologies.

To gain an in-depth understanding of the challenges and opportunities in fostering emerging technology sectors, we had to examine the county's high technology industry. The next section illustrates an in-depth analysis of high tech employment trends and a location quotient analysis at the six-digit NAICS level utilizing ES-202 data.

ARLINGTON'S HIGH TECHNOLOGY ECONOMY

In 2003, about 1,300 businesses comprised Arlington County's high technology economy. These firms employed 26,321 workers[ii]. From 2000 to 2003, total high technology employment in Arlington County declined on average by 2.6 percent per year. This rate of decline is lower than the national rate (- 4.0 percent) but higher than the rate of decline (- 1.3 percent) in Northern Virginia[iii]. The decline in Arlington County's high technology employment is consistent with the national and

Table 1: High Technology Employment in Arlington County, 2000-2003

	2000	2001	2002	2003	Average Annual Growth Rate 00-03
High Technology Manufacturing	651	842	830	848	6.6%
High Technology Services	28,564	28,742	26,527	25,473	-2.9%
Total High Tech Employment	**29,215**	**29,584**	**27,357**	**26,321**	**-2.6%**

Source: ES-202 (Virginia Employment Commission)

Table 2: Number of Establishments in High Technology
Arlington County, 2000-2003

	2000	2001	2002	2003
High Technology Manufacturing	79	97	96	86
High Technology Services	1,106	1,168	1,219	1,217
Total High Tech Firms	**1,185**	**1,265**	**1,315**	**1,303**

Source: ES-202 (Virginia Employment Commission)

regional technology slowdown that began in 2001, especially in the telecommunications and Internet sectors which were hit especially hard.

Compared to other high technology regions such as Silicon Valley or Boston, the Washington, D.C. metropolitan region was less affected by the national technology slowdown. Overall, the metropolitan economy outperformed the national economy for the last six years. The area's strong economic performance is tightly linked to continued strong federal spending (especially in technology-related sectors) and increased opportunities to grow non-federally dependent businesses (Fuller, 2004). The outlook for Arlington County's high technology economy bodes well. Fuller (2004) projects economic growth for the Washington, D.C., metropolitan region in the range of 2.0 to 2.3 percent.

Arlington County's high technology economy is primarily concentrated in technology services. This bias towards services may serve Arlington County well as the national economy experiences a shift from a manufacturing-based to a service-based economy. In addition, the concentration on high technology services may shield Arlington's economy from cost-driven outsourcing of high technology manufacturing.

Arlington's high technology services economy is driven by a concentration in computer systems design and programming, various knowledge-intensive consulting and engineering services, scientific research and development services, and Internet-related and data processing businesses. These sectors have strong contractual ties to federal agencies located within Arlington County and the broader Washington, D.C., regional economy. Arlington County's high technology economy accounts for 14 percent of Northern Virginia's total high technology economy.

Figure 1 illustrates each jurisdiction's share of the total high technology economy in Northern Virginia. Fairfax County garners the majority of high technology activity, with Arlington County ranked second.

The Arlington high technology economy accounted for 1,303 firms in 2003 as shown in Table 2. Of the 1,303 high tech firms, only 86 were manufacturing related firms while 1,217 were service related firms.

The majority of firms engaged in the high technology service sector in Arlington are very small, with more than half employing fewer than five people (see Table 3). Firms with more than 100 employees accounted for only about 4 percent of the total. Some 90 percent of all high technology service firms in Arlington's economy employ 20 or fewer workers.

Arlington County's concentration in small high technology service firms has several advantages. First, small, high technology firms are commonly

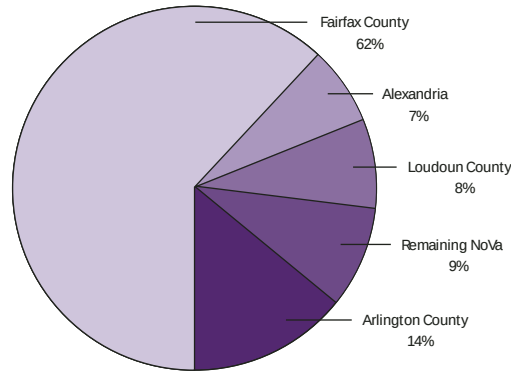

Figure 1: Share of high technology economy in Northern Virginia, 2003
Source: ES-202 (Virginia Employment Commission)

more flexible and adapt better to changing economic conditions and market opportunities. Second, a high concentration in small- and medium-sized firms is also a positive indication for entrepreneurial dynamics. The most successful high technology industry clusters are characterized by a set of dynamic small- to medium-sized firms. Among this group of firms, incentives for collabo-

Table 3: High Technology Service Firms by Firm Size

Arlington County, 2003

Firm Size (Number of Employees)	**Number of Firms**
250 to 499	8
100 to 249	38
50 to 99	73
20 to 49	136
10 to 19	146
5 to 9	142
under 5	698

Source: ES-202 (Virginia Employment Commission)

ration and subcontracting are higher because each firm typically specializes in a certain technological or market niche.

To determine the relative concentration of a certain industry segment in Arlington's economy relative to other geographic areas, we conducted a location quotient (LQ) analysis.[iv] Arlington's overall location quotient for the high technology economy increased from 3.01 in 2001 to 3.21 in 2003. This means that high technology industries were 321 percent more concentrated in Arlington than in the nation as a whole. High technology services are particularly concentrated in Arlington as indicated by a location quotient of 5.43 in 2003. Arlington County's high technology economy has higher location quotients compared to Northern Virginia as a whole (see Table 4).

The industry segments with the highest location quotients reflect the region's specialization in information technology and consulting services. Arlington has very high location quotients (above 1.25) for computer systems design and programming, management, scientific, and technical consulting services, scientific R&D services, Internet services, architectural and engineering services, and data processing.

Industry segments in which employment in Arlington is more concentrated than in the Northern Virginia region as a whole include management consulting, human resource search consulting, environmental consulting, scientific and technical consulting, social science and humanities R&D, and engineering services. The management, human resource, and social science R&D segments may benefit from Arlington's close proximity to the District of Columbia while the technical and engineering services may benefit from the presence of federal agencies such as the Pentagon, NSF and DARPA (see Table 5).

As our location quotient analysis shows, Arlington County specializes in high technology services. The next question we asked was about the

Table 4: Location Quotient Analysis for Northern Virginia and Arlington County, 2001-2003

	Northern Virginia			**Arlington County**		
	2001	**2002**	**2003**	**2001**	**2002**	**2003**
High Technology Manufacturing	0.54	0.57	0.61	0.21	0.24	0.27
High Technology Services	4.52	4.59	4.68	5.31	5.42	5.43
Total High Technology	**2.71**	**2.80**	**2.91**	**3.01**	**3.13**	**3.21**

Source: ES-202 (Virginia Employment Commission) Bureau of Labor Statistics

Table 5: Detailed Location Quotients for Arlington County, 2003

High Tech Sector (4-digit) / High Tech Sector (6-digit)	**LQ NoVa**	**LQ Arlington County**
5112 Software Publishing		
511210 Software Publishing	3.41	0.63
5415 Computer Systems Design & Related Services		
541511 Custom computer programming services	7.07	7.11
541512 Computer systems design services	9.47	8.95
5416 Management, Scientific and Technical Consulting Services		
541611 Admin & general management consulting services	6.21	10.64
541612 Human resource & exec. search consulting services	2.63	8.68
541613 Marketing consulting services	1.55	2.04
541614 Process, phys dist & log consulting services	12.96	3.39
541618 Other management consulting services	3.58	2.74
541620 Environmental consulting services	3.25	6.27
541690 Other scientific & technical consulting services	1.89	5.84
5417 Scientific Research and Development Services		
541710 R&D in physical, engineering & life sciences	2.18	2.80
541720 R&D in social sciences & humanities	3.22	8.58
5181 Internet Service Providers		
518111 Internet Service Providers	8.98	1.53
5413 Architectural, Engineering, and Related Services		
541310 Architectural services	1.35	1.37
541330 Engineering services	4.08	7.69
5182 Data Processing		
518210 Data Processing, Hosting, and Related Services	3.02	2.31
Total High Technology Services	**4.68**	**5.43**

Source: ES-202 (Virginia Employment Commission) Bureau of Labor Statistics

innovation capacity of the county's economy. The following section examines patenting activity and the amount and type of venture capital investments as indicators for innovation.

INNOVATION COMPETENCIES

The volume and types of patent activity can be a barometer of technological innovation. According to patent analysis, Arlington County's high technology firms and federal agencies are extremely innovative. Patents registered by organizations and individuals in Arlington County have grown by 3.4 percent annually during the 1975 and 1999 period. This rate is slightly lower than the rates for Washington-Baltimore CMSA and for the states of Virginia and Maryland.

Patents in Arlington County are registered in a variety of technology areas. Those technology areas that show a higher concentration of patents are associated with telecommunications, television, education and demonstration, and military related technologies.

Arlington County has attracted a healthy share of venture capital investment to support the growth of entrepreneurial businesses. Most venture capital was invested in firms in the communication and media sector as well as the computer software and service sector. Investment was also made in Internet-related businesses. Following their peak in 2000, venture capital investments began to decline nationally between 2001 and 2003. A similar pattern emerged for the Washington, D.C., region and for Arlington County. Investments in Arlington County startups peaked with $231 million in 2000 and declined to $23 million in 2003 in the midst of a national economic contraction.

In Arlington, venture capital investments in computer software and services remained strong and received $15 million in 2003. This pattern follows a national trend: software companies have generally garnered a large share of venture capital investments after the downturn in 2001. The other sectors that had strong growth nationally are telecommunications and biotechnology. Both of these sectors have a strong presence in the Washington, D.C. metropolitan region and are among the top sectors that attracted investments.

Finally, Arlington County hosts a range of federal agencies. However, in terms of innovation potential and economic development impacts through subcontracting, spinoff activity, and innovation spillovers, only certain federal agencies should be

Table 6: "High Value" Federal Agencies in Arlington County

Federal Agency	Submarket	Technological / R&D Competencies
Air Force Office of Scientific Research (AFOSR)	Ballston	Aerospace Sciences, Material Sciences, Chemistry, Life Sciences, Space Sciences, Math, Physics, Electronics
Immigration & Naturalization Service (INS)	Ballston	Homeland Security
National Science Foundation (NSF)	Ballston	Across many sectors
Office of Naval Research (ONR)	Ballston	Information, Electronics, Surveillance, Ocean, Atmosphere, Space Engineering, Materials, Physics, Human Systems, Data Mining
Defense Intelligence Agency (DIA)	Clarendon	Military intelligence
Defense Information Systems Agency (DISA)	Columbia Pike	Defense Information System Network, Systems Interoperability
US Marshals Service	Crystal City	Electronic/Air Surveillance Court Security
Department of Defense (DoD)	Pentagon	See DARPA and ONR
National Guard Bureau	Pentagon	IT Applications
Transportation Security Administration (TSA)	Pentagon City	Homeland Security (Shipping, IT infrastructure)
US Drug Enforcement Administration (DEA)	Pentagon City	Computer Forensics Laboratory testing
Mine Safety and Health Administration (MSHA)	Rosslyn	IT Applications
State Department Bureau of Diplomatic Security	Rosslyn	IT Applications, Homeland Security
Defense Advanced Research Projects Agency (DARPA)	Virginia Square	R&D for DoD: Security applications,Military products
Federal Deposit Insurance Corporation Training Center	Virginia Square	IT Applications

Source: Arlington County Economic Development

considered as "high value." Table 6 presents a brief description of the R&D concentrations of certain "high value" agencies.

EMERGING TECHNOLOGY SECTORS

During the course of the study, seven focus groups with regional and national technology experts were conducted to determine detailed information about emerging technology sectors. The groups explored emerging technologies such as cybersecurity, bio IT, nanotechnology, wireless telecommunication, and distributed learning. A separate group was conducted with venture capitalists. These focus groups provided insights into the technology trends, innovation drivers, major players and linkages within industry sectors, the locational advantages and disadvantages of the Washington, D.C. region, and suggestions for ways in which AED could contribute to economic development (see Table 7).

Discussions about technology trends were the most varied among the groups. This is not surprising because each emerging technology has different technological challenges. Still, several trends and issues were common to all of the focus groups. Two issues that stand out were interoperability and the need for common standards. Both issues deserve attention by Arlington's economic developers because there may be ways to strategically position the county. The key to interoperability across technologies is to incorporate interaction among different sectors into the development process. Standard setting involves close collaboration and coordination between industry and standard-setting agencies such as the National Telecommunications and Information Association and Federal Communications Commission in the field of wireless telecommunication. Across the groups, there was also a strong consensus on a variety of market applications. In particular, focus group participants saw homeland security (including emergency management and response and cybersecurity), bioinformatics, and telecommunications as very promising fields.

In terms of innovation drivers for the emerging technology sectors, participants commonly saw the federal government as the most important driver. Several groups made the distinction among three aspects of the federal government that drive innovation in the fields. The first is policymaking, with an emphasis on standard setting. The second driver is funding for research and development in fields such as nanotechnology or bio IT. The third driver is related to the government as the customer, and its application of technological advancement in military, homeland security, and other areas. Several groups mentioned the region's industry clusters – in particular Northern Virginia's information technology and telecommunication industry and Maryland's biotechnology industry – as important innovation drivers.

Table 7: Commonalities Across Focus Groups

Issues	Commonalities Across Focus Groups
Technology Trends	– Interoperability – Convergence – Standards
Market Applications	– Homeland Security & Emergency Management – Wireless Communications – Bio IT – Military
Innovation Drivers	– Federal government: Policy, Funding, Application – IT and telecommunication industry in Northern Virginia – Biotechnology industry in Maryland – Competitors in respective sectors – Needs and threats
Major Players and Linkages	– Federal government agencies and labs with contractors (tight connections) and with academia (national reach) – Federal agencies most important: DARPA, DHS, NIST, ONR, NIH, NTIA, FCC, In-Q-Tel – Industry groups and associations (ITAA, TIA, PCIA, etc.) – State and local governments – Universities play a role but not as strong in the Washington DC region
Regional Advantages	– Proximity to federal government – Region's industry and workforce capacity (IT, telecommunication, biotech) – High educational attainment – Technology entrepreneurship – Political leadership (especially in Virginia) – Quality of life – Arlington County's reputation for emergency response – Arlington County's information and communication technology network (fiberoptics) – Universities strong in some fields (i.e. law, policy); other strong academic institutions (i.e. UVA, VT, GMU, GWU, Marymount) – Pool of potential entrepreneurs and funders: retired government scientists, cashed-out/serial entrepreneurs
Regional Disadvantages	– Lack of "Silicon Valley like" entrepreneur and investment culture – High cost of living and labor – Region not known for innovation and technological advancement ("too stodgy") – Lack of a major scientific research university – No national direction/strategy for some fields (like cybersecurity and homeland security)

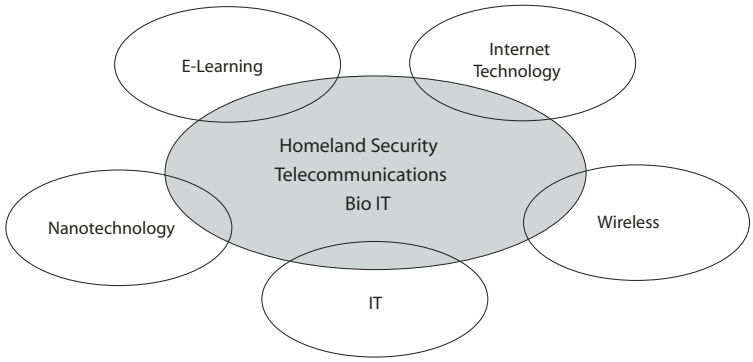

Figure 2: Convergence of Core Competencies and Emerging Technology Applications

Major players in the region include several agencies of the federal government. Participants most often mentioned the Department of Defense, the Department of Homeland Security, the National Institutes of Health, the National Institute of Standards and Technology, the CIA's venture capital arm In-Q-Tel, and standard setting agencies such as NTIA and FCC.

Interestingly, the discussions of the region's advantages and disadvantages revealed many commonalities among focus group participants, regardless of the industry they represented. The proximity to the federal government was seen as the most important comparative advantage the Washington, D.C. region has over other parts of the nation. Participants mentioned the continued importance of face-to-face interactions despite other means of communication. The second most mentioned advantage was the region's information technology, telecommunication and biotechnology industries and the associated labor pools, sets of competitors, and support services. Participants highlighted the industry cluster effects and opportunities associated with this critical presence. Technology entrepreneurship, the region's quality of life and educational attainment, and university strength in law and policy were cited as well. Arlington County's reputation for emergency response was reiterated by the majority of the groups.

The most commonly mentioned location disadvantages include the lack of a more risk taking entrepreneurial culture and venture capital investments, high costs of living and doing business, the region's "stodgy" character, and the lack of a major scientific research university. Participants felt that the region is not known for innovation and technological advancement in spite of its high levels of technology employment.

BASIS FOR AN ECONOMIC DEVELOPMENT STRATEGY

This analysis shows that the Washington, D.C. region benefits from the presence of three industry sectors: information technology, telecommunications and life sciences/biotechnology. These sectors have strong ties to the federal government through contracting, funding, and policy-making relationships. Related industries such as the association and nonprofit sector, R&D, engineering, technical services, and business support services (law, public relations, venture capital, etc.) support this economic ecosystem and are necessary for the growth of the dominant industry clusters. Arlington County benefits from this economic constellation because the county is located in a geographically strategic location.

The findings indicate that an economic development strategy should focus on the convergence of multiple technologies around a core area of competitive advantage. For Arlington County, these core competencies, or areas of excellence, are homeland security, bio IT, and telecommunications. Figure 2 illustrates the inter-connectedness of the core competencies and the emerging technology applications.

Arlington County is in a unique position to leverage the emerging technology sectors we examined in the report. Arlington is geographically close to critical federal government agencies that not only contract for high technology services, but also invest in research and development and set policies and standards for emerging technology applications. The study shows that AED must strategically position itself at the center of a government-industry-university triangle (see Figure 3).

The government-industry-university triangle can serve as the basis for Arlington's economic development strategy. The triangle metaphor implies that there are close linkages among the three sectors and that these connections are instrumental for economic development. Examples include contracting relationships between defense firms and the Pentagon, research relationships between DARPA and national and local academic institutions, lobbying relationships between small technology start-ups and regulatory federal agencies, among others. In these cases, the federal government functions as the customer, as the funder, and as the regulator.

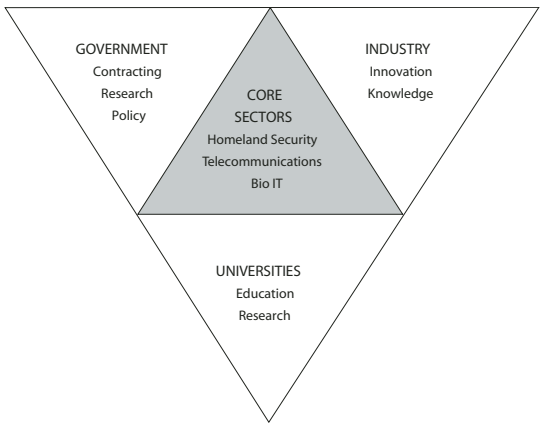

Figure 3: Arlington County's Innovation Triangle

Crystal City represents the highest concentration of defense contractors in the nation.

As a customer, agencies will drive innovation by establishing their needs.

Currently, technology applications related to homeland security represent a high priority for the federal government. Increasingly, technology companies are focusing on these security-related needs, indicating a promising sector for local economic development purposes. As a funder, the federal government (through DARPA and NSF, for example) shapes and influences the national research and development agenda and is in close contact with academic institutions. As a regulator, the federal government critically influences the evolution of technology sectors, such as wireless telecommunication.

In the Washington, D.C. region, the university connection is often the weakest link in the triangle. Much of the technology-based research in the core areas important to Arlington is conducted elsewhere. Arlington's strategy may be to "import" universities through development of special research centers or through partnerships or alliances.

COMPONENTS OF A STRATEGY

Arlington County could more effectively focus on emerging technology sectors if it would develop an economic development strategy that focuses on the following components:

- **Support technology entrepreneurship**

  AED should support high technology entrepreneurs. An explicit focus on technology entrepreneurship would allow Arlington to capture dynamic, high-growth companies that are active in emerging technology sectors. Specific economic development activities could include the facilitation of interactions among governmental agencies, venture capitalists, and potential entrepreneurs, making flexible office space available, and developing incubator facilities, mentoring programs, and the support of technology transfer programs.

- **Use Arlington as a test bed or pilot for emerging technology**

  Several focus groups highlighted Arlington County's reputation for emergency response, and suggested that Arlington could benefit by leveraging this reputation. In partnership with industry, Arlington could develop a facility where technological applications to homeland security are tested and piloted. These applications could then be showcased to policymakers and industry. A similar approach may be applicable to telecommunications, where the compactness of Arlington's business districts would be ideal for testing wireless applications.

- **Function as a facilitator among academia, government, and industry**

  The focus groups themselves proved to be a successful economic development strategy. The groups functioned as facilitation exercises and brought industry, government, and academia together, offering insights not only for the participants themselves but also for Arlington's economic development staff. Focus group participants often remarked on the positive experience they had in the groups and suggested that Arlington continue such facilitations. In addition, AED should host events at which entrepre-

neurs interact with government representatives, venture capitalists, and academics.

- **Provide information on micro-sectors or market niches**

  Information dispersion is imperfect and can be greatly improved through collection and dissemination. AED can serve as a repository of information that integrates research activities and findings that are directly applicable to the core competency areas.

- **Serve as a focal point for policy-making**

  Arlington could gain competitive advantage by promoting policies that support industry growth in target sectors. The alignment of local tax and land use policies with the overall strategy would also prove beneficial. Lastly, industry would value access to the federal and state policy processes through connections among federal agencies, industry groups and university policy vehicles.

- **Promote local education and workforce development**

  Arlington should develop resources that ensure that the local and regional labor force have the skills needed to implement the strategy, as well as seeking to expand educational offerings at all levels. Greater opportunities may exist through recruitment of educational institutions with exceptional capabilities in the core competencies.

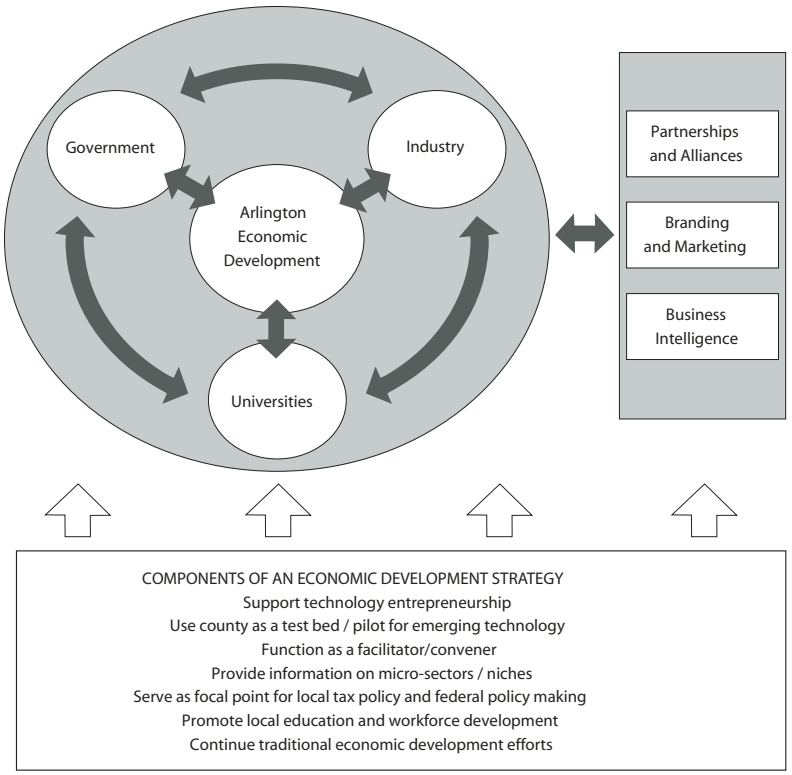

Figure 4: The Strategy Model

CACI is one of the nation's leading information technology companies.

- **Continue traditional economic development efforts and support strategic, long-term emerging technology strategy**

  Arlington should also continue with its traditional economic development efforts, but make sure that industry, academia and federal government agencies know the services and programs AED offers. In addition, Arlington should ensure that the strategy for supporting emerging technology sectors has a strategic focus and a long-term orientation.

Each of these components of the economic development strategy need to be applied through a series of actions that will implement the strategy.

- **Create partnerships and alliances with critical participants**

  Major participants in the policy and convening arenas include industry associations such as the Information Technology Association of America, the Telecommunications Association, among others. These organizations provide access to the companies, agencies, and individuals that are major players in the Washington, D.C. area, and will add to the innovation triangle.

- **Brand and market Arlington as a location for developing emerging technology**

  Once the strategies mentioned are underway, Arlington should focus on marketing and branding itself as a location where emerging technology is developed and commercialized. The power

of being known for certain kinds of economic development activities cannot be underestimated. Silicon Valley, for example, has built a powerful reputation as the premier technology hub. Executives, high tech engineers, and entrepreneurs know that the region offers them plenty of opportunities.

- **Develop business intelligence (thorough knowledge) of the linkages among government, industry, and academia.**

  Only a clear understanding of these linkages can result in effective action. The maintenance of databases and ongoing research efforts will continually update knowledge of the linkages, which change constantly as new firms enter the market, research is commercialized, and as contractual relations evolve.

These components and action recommendations form the basis of a strategy model that integrates all of the pieces into a coherent strategy. The key element is the innovation triangle – the relationships among government, industry and academia. While the triangle concept applies to each of the core competency areas separately, the connections among the three players differ for each target industry niche. What is common to each niche is the need to form partnerships and alliances, to brand and market Arlington relative to each niche, and the process of collecting business intelligence about each triangle. The strategy for effecting economic growth within each market niche is the customized application of the key strategy components. Figure 4 illustrates the integrated strategy approach.

CONCLUSION

Arlington County is in a good position to leverage the growth of emerging technology sectors. Arlington's strategic location at the center of the government-industry-university innovation triangle provides a comparative advantage over other business locations. AED is committed to leveraging its strengths and to fostering the creation and expansion of technology businesses. As a next step, AED will implement the strategy components to support knowledge creation and innovation. Furthermore, Arlington will study in more detail the relationships among government, academia, and industry around key thematic areas such as homeland security, bio IT, and telecommunications.

ENDNOTES

i We utilized a definition of high technology industries that was developed by Carnegie Mellon University's Center for Economic Development (Paytas & Berglund, 2004). Their definition was used to analyze the ES-202 data. Paytas and Berglund's (2004) derived their definition from a systematic analysis of industries that employ at least nine percent science and technology occupations. The occupation-based definition was developed by Chapple et al (Chapple, Markusen, Schrock, Yamamoto, & Yu, 2004).

ii The ES202 data (which will soon be called Census of Quarterly Employment and Wages (QCEW)) is "employer based", in other words, where the data covers employment numbers for locations where the employer is physically located. The high technology definition used in this report covers only those employers that are classified in the respective NAICS codes. Federal government agencies such as DOD or NSF will be listed under NAICS code 92 "Public Administration" and are *not* counted in this high technology definition.

iii The Northern Virginia (NoVa) economy includes: Arlington County, Clarke County, Culpeper County, Fairfax County, Fauquier County, King George County, Loudoun County, Prince William County, Spotsylvania County, Stafford County, Warren County, Alexandria city, Fairfax city, Falls Church city, Fredericksburg city, Manassas city, and Manassas Park city. Es-202 Data was analyzed at the 6-digit level for Northern Virginia only because of data limitations for the other states that are part of the Washington, DC metropolitan area.

iv The formula for computing a location quotient is as follows: LQI = (ei/e)/(Ei/E); where:

ei = Local employment in industry I

e = Total local employment

Ei = National employment in industry I

E = Total national employment

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