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Entrepreneurial Cities in the Technology Economy*

> The pattern of development of cities today is subject to control, *it is not* the result of uncontrollable forces, *is not* the result of iron economic laws whose effects states are powerless to influence.
>
> *—Peter Marcuse and Ronald van Kempen*

> The overriding public policy need is for leadership in creating a cohesive framework for public and private investment in digital technology systems for communities.
>
> *—Thomas A. Horan*

The technology economy is changing the landscape of local government. As the previous chapters have shown, localities have reasons to not just be aware of these changes but respond to them. Accordingly, the role that local policymakers play in shaping their response to these changes, and the activities that they pursue as a result, are a key part of any description of the technology economy. As expected, all cities are not responding in a common manner because the technology economy has differential effects. Understanding what issues cities are responding to and how cities are crafting their responses is the focal point of this chapter. To this end, I examine entrepreneurial actions in seven cities that are designing planning efforts and strategies with respect to the technology infrastructure and sectors in order to overcome conflict with the private sector or lack of knowledge about their technology infrastructure and their competitiveness at a regional or national level. Each of these cities utilizes its technology infrastructure as an asset, whether it be through creating and maintaining an inventory on the location, capacity, and ownership of all technology infrastructure; incorporating and formulizing a role for technology and telecommunications into economic development planning documents; or using technology infrastructure as a specific policy device. Most cities have crafted a role for technol-

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ogy infrastructure with the intent of positive economic development returns, and in many cases have designed strategies to create, retain, and attract technology sectors appropriate for their economies. Consequently, the collection of these cities' stories demonstrates a holistic policy approach leading to a position of strength in the technology economy.

Traditionally, local economic development policymakers all struggle with the same question: how to use economic development policy to increase the well-being of their local citizens. The trade-offs that accompany this pursuit are many. Should better jobs, more jobs, and/or greater tax collection come at the expense of quality of life? Roger Vaughan's definition of economic development demonstrates a multifaceted decision: "Economic development is the process of innovation through which we increase the capacity of individuals and organizations to create wealth. The goods and services we value include not only those items that are traded in the marketplace but also less tangible things—the quality of our environment, public security, and other elements that contribute to our sense of well-being" (Vaughan 1984, 2). In shaping policies, local policymakers allocate tax dollars and other resources that will have differential impacts on citizens and local business. How technology economy issues enter into these decisions is often a result of a number of factors: competitiveness, peer pressure, a lack of alternatives, local leadership, business demands, and fiscal health as well as shortfalls, to name a few. Regardless, the roles of technology infrastructure and sectors in local economic development policy are not disengaged from the desire for a livable and prosperous community.

In focusing on a few entrepreneurial cities, I discuss four basic approaches that local governments use to integrate the building blocks of the technology economy into their cities' economic development and planning strategies. The first approach is more global in nature and directly addresses how cities view technology infrastructure relative to economic development strategies. A number of cities position technology infrastructure as a formal objective or key element of their economic development planning documents. These documents are often part of a city's comprehensive plan—the city's official statement concerning future growth and development—which includes policy plans to guide land use, development, housing, environmental impact, and capital facilities budgeting. Some of these elements address technology infrastructure; however, within the economic development plans, local policymakers view technology infrastructure as having an instrumental

role in the growth and development of business and citizenry's well-being. In this first approach, technology infrastructure is an overarching concern or guiding principle to economic development in a city.

The second approach is related to the first approach because technology infrastructure has a role in economic development efforts; however, the second approach focuses on how cities utilize technology infrastructure, highlighting specific policy actions. For example, cities can utilize technology and telecommunications infrastructure in targeted capacities, like promoting technology zones or incubators for business and deploying fiber-optic networks for superior telecommunications services in a targeted area, without it being a guiding vision for economic development.

The third approach is also related to economic development efforts, but it is more exclusively tied to certain types of business development—how a city uses technology infrastructure to grow, retain, or attract the other building block of the technology economy, technology sectors. Cities that use this approach perceive a more focused or nuanced role for technology infrastructure, which points to how city leaders think about technology sector business in their local economies.

Finally, the fourth approach that cities use to address the technology economy is through a citywide or neighborhood assessment of technology infrastructure availability and capacity. The creation and maintenance of an inventory on the location, capacity, and ownership of all technology infrastructure serves as a major planning tool and asset for economic development, transportation, public works, and local government's own information technology capacity. The presence of this inventory in a variety of cities indicates how these cities link technology infrastructure to the local economy and to the overall livability of their cities. This can also be said about the other three approaches, to varying degrees, suggesting that technology infrastructure and the technology economy are interwoven in different ways in different cities.

The four approaches are not mutually exclusive. In fact, in cities that are the most entrepreneurial in their approach to the technology economy and economic development, all four approaches are combined—they have economic development that targets the technology economy and benefits the community overall, they employ policies that fit with this strategy, they target sectors and work with the private sector to make sure sectoral strategies are successful, and they map, or inventory, their technology infrastructure to ensure that they know where technology infrastructure is located and where it is needed.

This chapter presents examples of technology economy approaches from seven cities that responded to the Economic Development and Technology Economy Survey detailed in Chapter 4. Although a number of cities revealed use of technology infrastructure in economic development efforts, the cities in this chapter show a range of entrepreneurial efforts and are exemplary because of the level of process and implementation needed to fashion a new vision of economic development in relation to the technology economy. The cities examined are Tacoma, Washington, Lansing, Michigan, San Jose, California, Roanoke, Virginia, Mesa, Arizona, Portland, Oregon, and Charlotte, North Carolina. They are diverse in a number of ways. Table 5.1 provides information on each city with respect to technology economy infrastructure, technology economy industry, as well as traditional socioeconomic characteristics, while presenting how each compares to the average city in the survey.

As in Chapter 3, I use data from the survey as well as secondary sources like the Census of Population and the Economic Census. Table 5.1 demonstrates that the cities are located in different regions of the country and represent a range of population sizes, economic and demographic characteristics, and governmental structure. The cities are not all economically robust. For example, of the seven cities, Lansing and Portland experienced the least employment growth between 1998 and 2001 (0.46 percent and 2.03 percent, respectively), and they lag behind next lowest, Roanoke (4.92 percent), by more than a factor of two for Portland and a factor of ten for Lansing. Most of the cities are not even examples of technology-driven success, even though several seem to have above-average technology sector employment. The variation seen in these cities' technology sector employment is also present in their technology infrastructure. Some of the cities find their high-speed lines, wireless towers, or metropolitan bandwidth to be superior to those of the average city in the survey, but in general, variation in infrastructure exists. For example, Roanoke has above-average metropolitan bandwidth but is below average on every other technology infrastructure measure. The diversity of the seven cities examined here, in terms of the factors shown in Table 5.1, suggests that cities do not necessarily need to be leaders in the technology economy to be entrepreneurial in local policies aimed at capturing the benefits of the technology economy. In examining these seven cities' efforts, I provide an overview of the landscape of technology infrastructure and sectors in terms of the local policymaking environment that other cities are likely to follow.

Table 5.1

Characteristics of Highlighted Cities

	Mean/ Mode	Roanoke, VA	Tacoma, WA	Lansing, MI	Charlotte, NC	Mesa, AZ	San Jose, CA	Portland, OR
Technology economy infrastructure								
Telecom strategy usage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Deploy fiber	Yes	No	Yes	Yes	No	Yes	Yes	Yes
Technology zones	No	Yes	No	Yes	No	No	Yes	No
Technology incubators	No	Yes	No	Yes	No	No	Yes	No
Smart buildings	No	Yes	No	Yes	No	Yes	Yes	Yes
Telecom improvements	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Metropolitan bandwidth per capita	0.11	0.21	0.05	0.00	0.10	0.04	0.28	0.07
High-speed lines per 1,000 pop.	0.175	0.009	0.015	0.019	0.004	0.012	0.006	0.006
High-speed lines per square mile	1.12	0.86	2.55	1.66	0.70	0.69	1.85	1.49
Wireless towers per 1,000 pop.	0.095	0.031	0.114	0.084	0.109	0.048	0.019	0.064
Wireless towers per square mile	0.23	0.07	0.44	0.29	0.24	0.15	0.10	0.25
Technology economy industry								
% Technology employers	4.17	2.78	2.48	3.73	5.65	3.77	16.43	5.93
% Technology generators	2.83	2.10	1.59	2.35	3.84	2.42	14.05	4.11
Patents per 1,000 pop.	3.14	2.57	1.07	1.38	1.92	3.52	11.15	3.89
% College graduates	16.28	12.13	13.08	13.78	25.97	14.87	20.84	21.25
Traditional characteristics								
Employment growth rate	7.55	4.92	6.34	0.46	5.56	7.36	7.74	2.03
Median household income	43,600	30,719	37,879	34,833	46,975	42,817	70,243	40,146
Poverty rate	12.14	15.95	15.90	16.86	10.62	8.92	8.82	13.07
Housing affordability rate	0.46	0.47	0.37	0.56	0.42	0.40	0.19	0.32
Population 2000	62,830	94,911	193,556	119,128	540,828	396,375	894,943	529,121
% Black	9.87	26.74	11.24	21.91	32.72	2.52	3.50	6.64

% Age 25–34	10.55	11.44	11.38	13.43	14.33	11.71	13.13	13.63
% Over age 64	13.31	15.83	11.34	9.44	8.57	12.83	7.98	11.06
Violent crime rate	9.96	13.85	13.53	15.56	15.24	9.38	19.73	15.20
Urban area/cluster	UA	UA	UA	UA	UA	UA	UA	UA
Principal city	NPC	PC	PC	PC	PC	PC	PC	PC
Metropolitan/micropolitan	Metro	Metro	Metro	Metro	Metro	Metro	Metro	Metro
Form of government	Council manager	Council manager	Council manager	Mayor council	Council manager	Council manager	Council manager	Commission
General revenue from taxes per capita	446.43	1,204.00	552.00	456.00	418.00	222.00	499.00	638.00
General expenditures per capita	1,034.99	2,654.00	1,342.00	1,323.00	1,061.00	920.00	999.00	1,364.00
Quality of life	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Climate	No	Yes	No	No	Yes	Yes	Yes	Yes
Parks	Yes	Yes	Yes	No	No	Yes	No	Yes
Setting	Yes	Yes	Yes	No	No	Yes	No	Yes
Health care	Yes	Yes	No	Yes	No	Yes	No	Yes
Workforce	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Quality of schools	Yes	Yes	No	No	Yes	Yes	Yes	Yes

Sources: Employment (U.S. Census Bureau 2001b); patents (Hall, Jaffe, and Trajtenberg 2001); unemployment, incomes, poverty, and housing affordability rate (ratio of median family income to median value of owner-occupied housing), population, college graduates, race, and age categories (U.S. Census Bureau 2000a); crime (U.S. Federal Bureau of Investigation 1999); UA = urban area and UC = urban cluster (U.S. Census Bureau 2000c); NPC = not a principal of the metropolitan or micropolitan statistical area and metropolitan (U.S. Census Bureau 2004); regions (U.S. Census Bureau 2002b); bandwidth (Gorman 2004); high-speed lines (Federal Communications Commission 2002); wireless towers (SpectraSite 2004); remaining variables from survey (Hackler 2002).

Technology Infrastructure and Economic Development Plans

Most local governments recognize the importance of their technology infrastructure; however, it is often lumped in among other core or physical infrastructure such as roads, sewer and water lines, and utilities. Some cities distinguish technology infrastructure, recognizing the important role that communications infrastructure plays in growth and development. Some cities highlight technology infrastructure as an essential piece of their economic development policy, incorporating and formulizing the role of technology and telecommunications into their vision and goals. Three of the seven cities fit the latter description: Tacoma, Lansing, and San Jose. Through the description of each city's vision for technology infrastructure, a local government's needs and focus also become evident.

The Pacific Northwest city of Tacoma bills itself as a wired city, evidenced by a website address of Wiredcityusa.com. The city of almost 200,000 in population is located thirty-four miles southeast of Seattle. Its wired-city reputation is a direct result of the technology infrastructure development associated with its city-owned municipal electric utility, Tacoma Power. In the early 1990s the utility planned to build a fiber-optic network to upgrade and control its substations, but it determined that through this expansion the new network would be capable of offering a wide range of telecommunications services within Tacoma city limits. The upgrades resulted in both a hybrid fiber coaxial network and carrier grade fiber network. As of November 1998 Tacoma Power authorized various partnerships with private providers, allowing them to lease their connections and capacity from the "Click! Network" in order to offer residents and businesses of Tacoma cable TV and high-speed Internet broadband services. In addition, businesses can purchase higher-speed services and capacity (Click! Network Tacoma Power 2004).

The Click! Network, a major technology infrastructure project for Tacoma Power and the city, is indicative of the level of interest and commitment that Tacoma has with respect to technology infrastructure. The older northwestern port city has mainly been the homestead for manufacturing industries. Gazing often to the northeast, Tacoma hopes to capture some of the growth that the Seattle area has garnered since the rise of Microsoft and its multitude of spinoffs. The economic vision of Tacoma states that by leveraging the Click! Network investment, the city "has

improved the quality of life in the city and established a broadband infrastructure servicing businesses and residents" (Tacoma Economic Development Department 2001, 40). The primary goal for Tacoma centered on its prior and continued investment to provide the "best possible broadband access to business and residents at affordable prices" (Tacoma Economic Development Department 2001, iii). Tacoma's technology infrastructure is directly tied to the economic development goals for the city, and the economic development plan calls for continual monitoring of this investment. The utility and the city conduct a series of affordability and performance benchmarks for the Click! Network operation and services in order to ensure that it is consistent with industry standards and demand. To assess demand, the city works with private providers to determine whether the level of technology infrastructure investment meets the needs of local businesses and is nationally competitive.

Tacoma's vision for technology infrastructure culminates in a number of direct and indirect policy actions, some of which I address in sections on other approaches to technology infrastructure below. However, what makes Tacoma different is the level of importance and priority that the city places on technology infrastructure in its overall strategy for growth and development. The city's economic development visions and goals are set to guide city efforts in future years. Tacoma revisits this vision approximately every five to six years. The current plan, adopted in late 2001, serves as the foundation and suggests that Tacoma realizes that the technology economy is essential to the city's economic vitality.

The critical role that technology infrastructure plays also fits well with Tacoma's overall vision in its comprehensive plan, which is to "serve local investment by keeping pace with infrastructure and capital facility improvements" (Tacoma Economic Development Department 2001, 41). The municipal utility upgrades provided Tacoma with the opportunity to become a city with a superior technology infrastructure, providing residents and businesses with telecommunications services that were beyond what they would have received in 1998 and leaving the city in an advantageous position today.

Tacoma's technology-based vision demonstrates a desire to be more like its large neighbor city, Seattle. Tacoma's port and manufacturing reputation could have led to slower deployment of technology infrastructure in its city limits and would have most certainly not resulted in the level of coverage that the city now possesses. While not all cities are

able to draw upon a municipally owned utility to deploy technology infrastructure, Tacoma's strategic use and leveraging of its assets is noteworthy. The city's continual dedication to the success and development of the Click! Network through further investment demonstrates the longevity of technology infrastructure to economic development in Tacoma.

While the city examples presented in this chapter do not all possess the same set of assets, each city has designed an economic development strategy for technology infrastructure that is similar to Tacoma's.

Lansing is in a more challenging position than Tacoma. Although it is the state capital of Michigan, it is also an aging urban core city and its technology infrastructure reflects this status. Over the past two decades, Lansing has suffered from the decline of the automobile industry and two state government workforce policy changes that have undermined the economic base of the city, and in particular the office and commercial lifeblood of Lansing's downtown. The first state workforce policy shift was the outsourcing of various government functions, once conducted in Lansing, to private contractors in Massachusetts and Colorado. The second policy change was the relocation of state employees to private office buildings outside of Lansing's Washington Square corridor, a tax increment finance (TIF) district. The TIF district subsequently lost tax income, and the city lost sales and property tax revenues due to less commercial and retail activity. On the surface, technology economy issues would seem of minor concern in comparison, but Lansing is included in this analysis because of the entrepreneurial spirit of the city's previous mayor, David Hollister. In 2001, Hollister sought to change the economic outlook of Lansing through technology. Like the municipal utility of Tacoma, Hollister provided the motivation and direction to examine the relationship between economic development and technology infrastructure in the city. Announced as the Mayor's Information Technology (IT) Initiative, the city's strategy emerged during a period of time when local governments, including Lansing, were fiscally stable and very much aware of the technology boom that was driving the national economy.

Lansing's IT Initiative sought to understand how IT related to Lansing's citizens and business community and how Lansing could establish itself as a technology leader in the region. The initiative included the assembly of a Lansing IT Assessment Task Force, which evaluated the city's readiness for the "networked world" with the support and participation of Lansing's Economic Development Corporation and the Tax

Increment Finance Authority. The city conducted an "IT Digital Readiness Assessment." This assessment included two forums held among local leaders and stakeholders during which the participants addressed the strengths, weaknesses, opportunities, and constraints in achieving digital readiness. Based on the assessment, Lansing leaders created an overarching vision to guide economic development activities: "Lansing is an economically diverse city that provides education and training opportunities for every person to ensure that the benefits of technology are realized by the entire city" (City of Lansing 2001, 6). Using the vision to guide policy, the task force and city leaders focused on key segments of society (government, schools, business, quality of life, and citizens) to formulate an "e-conomic development plan" in which technology was a focal point (specific policies of the initiative are discussed in the sections to follow).

Today, the IT Initiative continues to guide Lansing's economic development activities, but the initiative has suffered a number of setbacks. First and foremost, the economic recession created and continues to create large budget deficits (nearly $7 million in 2005), generating an atmosphere of workforce reductions and spending cuts across city programs. Second, in January of 2003, the leader of the initiative, Mayor David Hollister, resigned to lead the state of Michigan's newly reorganized State Department of Labor, Economic Growth, and Urban Development. Interim Mayor Tony Benavides pledged continued support, but the mayoral election of 2005 ushered in a new mayor, Virg Bernero. While Mayor Bernero created a taskforce to examine infrastructure and information technology, changing leadership is unlikely to stabilize the initiative. Lansing's experience points to the importance of city leadership to sustain technology-centered economic development initiatives.

The city of San Jose also integrates technology infrastructure into its economic development planning documents. San Jose is in the heart of the Silicon Valley and promotes itself as a high-tech capital through multiple messages and visions. It is not surprising that technology infrastructure is part of San Jose's overall strategy. However, given its privileged location in the midst of a technology hub in the world economy, San Jose might have taken the relationship between technology infrastructure and economic development for granted. In fact, some city officials in widely recognized technology centers claim they do not need to do much since the private market will come to the area based on the demand alone. San Jose, instead, has taken the position that its locational advantages must

be nurtured. The city's goals broaden the application of technology infrastructure to a wider audience with their vision of being a "tech savvy city that uses and showcases technology to improve daily life" (Office of City Manager and Office of Economic Development 2003, 16). Tacoma and Lansing each had a motivating agency or leader to focus their attention on technology infrastructure in their goals for economic development and growth. San Jose's motivation is a result of its advantaged position in the technology geography, but it does not want to lose its position as a leading city in the technology economy. More recently, the negative effects of the technology and dot.com bust, with over 92,000 jobs lost in the San Jose metropolitan area alone, has prompted San Jose to capitalize on its assets of global business and reputed technology geography for the sake of economic recovery. San Jose's economic development strategy with respect to technology infrastructure plays out in a number of policies that I address in the sections below.

Tacoma, Lansing, and San Jose are unique in that technology infrastructure plays a strong role in shaping the vision for economic development of each of them. As with any vision, the impetus behind this result provides insight into the manner of their policymaking in the technology economy. In each city an opportunity presented itself. In Tacoma, a desire to capture some of the benefit of its proximity to Seattle and, specifically, the upgrading of Tacoma Power's network suggested that entrepreneurial actions could spill over beyond utilities into economic development. Lansing's entrepreneurial leadership prioritized technology infrastructure as a necessary economic development component to forge a new economic direction for the city. And finally, for San Jose, the city's desire to maintain its position relative to other technology economy competitors resulted in a natural partnership between technology infrastructure and economic development. As cities reflect on the implications of the technology economy for their futures, capturing these opportunities in technology infrastructure may provide a foundation for economic growth. Each of the other cities from which examples are drawn in this chapter distinctly utilizes technology infrastructure in a less strategic, more functionally narrow role.

The remainder of this chapter focuses on three specific approaches that are often, but not always, related to economic development: specific and limited technology policies and strategies, positioning technology infrastructure relative to retention and recruitment of technology business, and finally, assessment and inventorying of local technology infrastructure.

Technology Infrastructure Policies

Technology infrastructure policies are those that carry a specific policy action focused on a particular component of technology infrastructure. Cities that integrate technology infrastructure into their economic development plans as a broader vision or strategy often outline a number of policy actions related to the deployment or development of technology infrastructure. Some cities, however, only have a component, or a few components, of technology infrastructure as specific policy objectives. This section examines the technology infrastructure policies of six cities: Roanoke, Lansing, Mesa, Tacoma, San Jose, and Portland. Although some of the policy actions may seem less novel, others represent entrepreneurial approaches to technology infrastructure in economic development.

Roanoke is the smallest city in this examination of entrepreneurial technology infrastructure policies; however, the range of its approaches is anything but small. It is located about 150 miles east of Richmond, works cooperatively with surrounding counties, cities, and towns as a metropolitan area known as the New Century Region. The city also has its own economic development department that addresses technology infrastructure through a variety of policies. Working to transition its economy during the 1990s from a manufacturing base, Roanoke targeted industries such as biotechnology, optics, information technology and software, and transportation-related manufacturing and services. To facilitate this objective, the city developed and implemented a Technology Initiative in 2001 that included the development of a Technology Zone and redevelopment of Warehouse Row to ready it for technology businesses, as well as providing information on the location and capacity of fiber-optic cable and WiFi networks on the department's website.

After the approval of recommendations, guidelines, and incentives, the city recently had its first technology business locate in its Technology Zone, a zone that encompasses the downtown area and a stretch of land near one of the city's primary transportation connections, Interstate 581. To receive incentives and be able to locate in the zone, qualifying businesses must be engaged in research, design, development, or manufacture of commodities, services, or solutions used in factory automation, biotechnology, chemicals, computer hardware, computer software, computer systems, defense, energy, environmental, manufacturing equipment, medical materials, pharmaceuticals, photonics, subassem-

blies and components, testing and measurement, telecommunications, and transportation. In addition, qualifying businesses must increase the average number of full-time jobs by at least 10 percent and make a new capital investment of at least $30,000, resulting in an increase of at least 20 percent in assessed value of the firm's real estate and/or in the cost of its personal property. In exchange, businesses would be eligible to receive grants to pay for 50 percent of the costs of extending telecommunication services to their location as well as cover 50 percent of the net increase in taxes (business personal property and real estate taxes) from the capital investment (Roanoke Economic Development 2005).

To facilitate Roanoke's Technology Zone, the city took a number of steps to ready the technology infrastructure and real estate, concentrating on the redevelopment of the downtown area, dubbed Roanoke's e-Town. As a result of a public-private partnership, Roanoke has had a free wireless Internet zone (WiFi) downtown since 2003.[1] The city recently expanded the WiFi network to increase coverage in the downtown area as well as reach the main public library. In addition, the city redeveloped warehouses into smart building space (Warehouse Row Business Center) in order to provide wired office space for technology companies. Finally, these projects are supported through the department's Wired for Business website. The pages provide information on the Technology Zone, e-Town, the WiFi Network, as well as fiber-optic cable maps for the region, city, downtown area, and in the Technology Zone. Roanoke's Department of Transportation created these maps and helps maintain them to keep economic development abreast of any changes with privately financed renovation of buildings in the city. Roanoke combined a number of policy actions using various aspects of technology infrastructure to create a new environment capable of supporting the city's desired growth. The Technology Initiative and its strategies are central to Roanoke's recruitment of targeted business into a redevelopment zone. The city's partnership to provide free wireless broadband and its role as an information disseminator of telecommunications options in the city and region point to the city's commitment to the interdependence of technology infrastructure and future economic development growth.

Lansing's IT Initiative included a number of goals that had broader effects than economic development, like e-government and educational training programs for schools, families, and nonprofit organizations. Yet the initiative's central vision guided the creation of the e-conomic de-

velopment plan. The plan outlined the city's desire for technology infrastructure and how this related to the attraction, growth, and retention of IT-based businesses. The city sought to develop a technology infrastructure plan that included a phased approach to ensure high-speed affordable Internet at various price ranges. To facilitate this objective, the city envisioned that an assessment of all telecommunications infrastructure demand and supply would be essential. The mapping of the infrastructure could allow the city to understand current capacity and plan for future needs, but the analysis of demand and forecasting of usage by different types of business, organizations, schools, and libraries, as well as government entities, could provide a clearer picture of the city's readiness for change. The city partnered with the Lansing Board of Water and Light, the municipal utility provider, and other service providers, like Ameritech, to map fiber-optic cable and DSL infrastructure. For the demand assessment and greater mapping of other wireless and hybrid fiber coaxial cable infrastructure, the city participated in the analysis conducted by the Regional Economic Development Team for the counties of Ingham (containing Lansing), Eaton, and Clinton under the state's Link Michigan program of the Michigan Economic Development Corporation (Regional Economic Development Team 2003). The analysis indicated that Lansing was second only to Detroit in the level of technology infrastructure connectivity, but that this infrastructure was aging and had little capacity to serve increased and more sophisticated access. In addition, there was a lack of public awareness of technology and benefits of computerization among both businesses and residents.

With this information, the city set out to examine how it could provide policies and incentives to provide a more digitally ready Lansing, from educating businesses on the benefits of available technology to working with private real estate providers to educate them on the importance of building readiness, or smart buildings. The city's outreach efforts resulted in collaboration with the Lansing Regional Chamber of Commerce, supporting both its TechConnect Program, which promotes the increased use of technology and technical services by businesses, and its Small Business Services division.

The city continues to hold educational and stakeholder forums to evaluate the IT Initiative's goals. In June of 2004, "Destination Cool: Visioning Lansing's Technology Future" brought technology end users, service providers, public officials, and economic development professionals together to discuss Lansing's current trends and challenges

in technology and broadband use. Although the forum highlighted a number of topics and critical needs, participants expressed that the government's presence is needed to support the implementation of technology infrastructure through the provision of incentives and removal of regulatory barriers (similar to those provided to the manufacturing sector) and to provide current technology infrastructure maps. From the city leaders' perspectives, the economic recession has slowed much of the progress on the deployment of technology infrastructure. However, a few local private service providers are continuing to facilitate working toward technology infrastructure goals. One participant in the IT Initiative forums and Destination Cool conference is in the process of deploying a high-speed wireless network throughout downtown Lansing. While there is a broader economic development strategy for technology infrastructure in Lansing, as outlined in the previous section, the strategy is made tangible through a variety of technology-centered policies, as described here.

The city of Mesa, twenty miles east of Phoenix, is located in one of the nation's fastest-growing metropolitan areas. As the fortieth largest U.S. city by population, Mesa adopted two programs in 2000 that strongly influence its economic development efforts around technology infrastructure—E-Streets and Connecting Mesa. Both programs support the economic development goal of creating comprehensive transportation, communication, and infrastructure systems to ensure movement of commerce and information. The two programs are the outcome of the city's inability to land a major corporation's data center in 1999, a result attributed to the city's lack of telecommunications infrastructure. In response, the city, with the assistance of stakeholders from business, communications services, education, and real estate development, conducted an assessment of its infrastructure to benchmark Mesa's connectedness in 2000. The city utilized an established assessment tool and was the first city in the state of Arizona to undergo such a self-evaluation. The overarching product of the process was an inventory of technology infrastructure—mapping of fiber-optic lines, wireless networks, DSL and cable modems. Although the city seemed to have adequate fiber-optic lines, only 20 percent of residential homes were able to receive high-speed services. In addition, the city realized that each of the key stakeholders had a role in this technology infrastructure problem and the connections to economic development: (1) the real estate industry could improve the planning and wiring of office and homes; (2) residen-

tial access needed improvement to nurture the flexibility of working from home; (3) businesses desired greater access to e-government services like online permitting; and (4) small businesses were in need of training and education programs to understand how to utilize technology (Mesa Electronic Streets Task Force 2000).

Connecting Mesa emerged from these latter realizations, resulting in specific programs to address education of students, residents, and small businesses in technology usage, workforce development, and wired real estate. Although each program addressed economic development concerns, the city chose another route to directly address the state of technology infrastructure in Mesa. The city created the Electronic Streets (E-Streets) Initiative "to aid the work of the private sector that is necessary to support the construction of robust community-wide broadband telecommunication networks for use by the community" (Mesa E-Streets and Licensing Broadband Development Office 2004b). The city placed the initiative under the direction of the E-Streets and Licensing Broadband Development Office in Mesa's Department of Financial Services. The office "advocates for and protects the public interest in the regulation and development of broadband telecommunications and cable communications systems, which make use of the public rights-of-way within the City of Mesa, and monitors and helps resolve subscribers' concerns" (Mesa E-Streets and Licensing Broadband Development Office 2004b).

The technology infrastructure focus of the initiative complemented the existing activities of this office. For example, through the licensing process, the office maintains knowledge of the location and capacity of all available telecommunications infrastructure in the 175-square-mile city. However, the E-Streets Initiative goes beyond licensing. The city leverages the deployment of its own networks in an entrepreneurial venture to increase broadband networks in the city. The city has constructed over thirty-five miles of in-road trenches or duct banks, and each of the E-Streets duct banks includes twelve conduits, the pipes that are necessary to protect fiber-optic cable networks in any trench deployment (Mesa E-Streets and Licensing Broadband Development Office 2004a). The city maintains four of the conduits for its own institutional fiber-optic network to provide the network facilities for fire, police, and utility services as well as traffic surveillance in the growing city. The remaining eight empty conduits are available for commercial sale and provided to interested parties at the lowest practical cost. Mesa views this venture as

a way to entice infrastructure investment, but the city remains free of maintenance and operation of all private networks in the trenches beyond the city-designated conduits that provide only city services. Each telecommunications service provider must maintain and repair its respective conduit and network.

The economic development office's comprehensive infrastructure strategy calls for the continuation of E-Streets Initiative and stresses its importance to the facilitation of new telecommunications and information technology applications in the city. In addition, E-Streets' construction of the city's network is flexible with economic development priorities. With advance planning, the network provided fiber-optic spurs off of the main loop architecture to several economic development projects (Ellsworth, Queen Creek, Williams Gateway, Arizona Health Park, and Falcon Drive). The network also has several extensions to accommodate other city needs like a sewer interceptor project, fire stations, and traffic coordination. The cost of extending while the roads are torn up and the trenches are open is much less than with new construction at a separate time.

Mesa's E-Streets trench venture spills over into other licensing activities in the office. When a telecommunications provider wants to deploy more telecommunications infrastructure on city-owned property, the provider must receive a permit or license because the construction will occur in an area that is under Mesa's rights-of-way. The E-Streets Office negotiates these licenses and is often able to receive extra services from the granting of the license. For example, a recent negotiation provided the city with 1.7 miles of fiber-optic cable for $100,000 instead of the market price tag of $300,000 to 400,000 if the city built the span itself. Mesa's approach to technology infrastructure is as direct as possible without building the infrastructure and providing it directly to business and residents. The leveraging of existing projects, both public and private, shows Mesa's entrepreneurial capacity in addressing an earlier lost opportunity.

The city of Tacoma has the municipal electric utility advantage, and the economic development efforts of the city have embraced this relative advantage to implement a number of technology infrastructure policies. With regard to the city's growth management, economic development impacts and analysis address all infrastructure, capital improvements, transportation, and land-use issues, not unlike other cities. However, for Tacoma all growth management plans address the

question of whether the city's technology network should be extended. This is particularly true in the case of all new private developments and buildings, where the city considers whether it is possible to connect all new developments to the Click! Network. City leaders believe that in leveraging private investments, the city receives the best return on public infrastructure investment. As a side benefit, such expansions will increase the longevity and sustainability of the Click! Network. This approach is also applied to redevelopment projects. For example, network expansion is part of the city's strategy to improve older city assets like the Port of Tacoma. In a partnership with the Port of Tacoma, the city is seeking to expand broadband facilities to the port to support the growth in marine traffic and improvement in communications between other countries and the port (Tacoma Economic Development Department 2001).

The city of San Jose has a number of technology infrastructure–focused policies. As one of the first cities in the United States to offer a free wireless network in its downtown in the area around pedestrian-friendly San Pedro Square and its convention center, the city is currently looking to expand the network. The city has hired a private consultant to benchmark what other cities are doing in WiFi and gather stakeholder input through a series of focus groups to determine what the uses of additional capacity could be in libraries, parks, recreation centers, and at the airport. City municipal workers, neighborhood business associations, opinion leaders, and local service providers will offer ideas about possible uses, such as parking meters, traffic surveillance, and water and other utility meter reading. The exercise will determine the feasibility of the wireless network before tax dollars are spent. This process comes on the heels of San Jose having already reached its goal of 100 percent broadband service coverage (cable modems and DSL). Although mainly a private market phenomenon, the city prompted and monitored the progress of service providers like SBC and Comcast attaining this wired community feat.

Finally, Portland is a city that is just beginning to recognize the importance of technology infrastructure to its economic development potential. Although this Pacific Northwest city has a reputation for both high-technology and bioscience industry, until recently Portland had not considered the development of technology infrastructure as an important part of its environment. In 2002, the mayor appointed a Blue Ribbon Committee to develop the city's second economic development plan.

Under the guidance of the Portland Development Commission, a comprehensive economic development strategy declared that the city did not have "a clear strategy to support the development or the expansion of telecommunications infrastructure essential to accommodate today's business operations" (Portland Development Commission 2002a, 8). Seeing this as a serious problem to facilitating the redevelopment of Portland's industrial base, the plan laid out a strategy for telecommunications that included support for the expansion of a state-of-the-art communications technology for Portland business.

Portland worked with private sector providers to ensure that infrastructure was present and services could be provided. The result was the development of Unwire Portland, a project designed to provide high-capacity bandwidth to buildings, retain and expand the opportunity for creative and high-technology services, and improve broadband services for local residents. Unwire Portland will be a wireless network developed by a selected private telecommunications provider. The Portland Telecommunications Steering Committee will define requirements of the network, which will be financed, built, and managed by the private company; Portland will be an "anchor tenant." As the largest customer of the network, the city plans on using it for various government services, public safety, and providing Internet service to riders of TriMet, Portland's public transit. The city believes that the wireless network will lower city telecommunications expenses and encourage competition (Portland Development Commission 2005). The city disseminated a request for proposals in September of 2005 so that private providers could bid for the project; in April of 2006 Portland selected MetroFi Inc., a wireless network provider headquartered in Mountain View, California, to deliver and operate a citywide WiFi network. The project participants envision that the network services will be available by the end of 2007. The city views this technology infrastructure strategy as providing a foundation for Portland's future while lessening the present gaps in Portland's existing infrastructure.

Each of the cities highlighted in this section has made efforts to offer technology infrastructure as a specific policy device or action in hopes of generating economic growth and development. Although the cities' policies vary from more narrow ones looking at specific infrastructure projects or for specific industries, to broader effects on business and residents through wireless networks, technology infrastructure is seen as a key policy component in economic development efforts.

Recruiting Technology Sectors with Technology Infrastructure

Thus far, the review of how cities are employing technology infrastructure within economic development plans has focused on the efforts to utilize technology infrastructure in a more generalized and overarching manner—from it being a foundation upon which cities design their visions and goals for economic development to specific policy actions related to the deployment or development of technology infrastructure to attain economic development objectives. All of the cities discussed above also craft a role for technology infrastructure with the intent of creating, retaining, and/or attracting technology sectors appropriate for their economies, often referred to as high-tech or IT (see Chapter 2). As found in Chapter 3, telecommunications infrastructure in aggregate has a positive effect on a city's employment in technology sectors. Local physical technology infrastructure is more likely to affect technology employers while local policies and strategies that integrate infrastructure into economic development plans are more likely to affect technology generators. Understanding how cities create and structure such policies is essential for understanding the technology economy, as well as for providing an awareness of what is viable for local economic development practitioners seeking to partake in the technology economy.

The city of Roanoke refers to its economic development strategy as "three legs of a stool," with the city concentrating on development of tourism, industry, and biotechnology. The city expanded on the biotechnology leg in its "Vision 2001 2020," seeking to target a number of sectors under a strategic initiative, but noting that the new economic initiatives would require a shifting of gears for the city. The initiative sought to develop a new economic base for the city through the development and implementation of an economic development strategy that attracts, retains, and expands businesses in biotechnology, optics, and information technology/software. In the process, the city recognized that this strategic change would require investment in the critical amenities of education, land use, environment, and recreation to provide the high quality necessary to attract the desired industries. "Roanoke must attract knowledge-based industries by having a pool of qualified workers, a research and development presence, telecommunications infrastructure, transportation services (air and rail service), water quality, noninterruptible power, and a high quality of life" (Roanoke 2001, 57).

To develop this new base of technology industries, the city prioritized technology infrastructure that would have the most supportive effect. To begin with, the city approached all normal in-road utility improvements in a strategic manner, installing extra conduit for future use and sale. This strategy, not unlike Mesa's joint trench venture, reduces the overall cost of future fiber-optic network deployments because it lessens the impact on the city's roads. With conduit available, the city's rights-of-way will be under less stress from future requests of telecommunications providers because more of these networks can be deployed without additional construction; this works to increase the road infrastructure's life while reducing citizen complaints about the inconvenience of road closures.

The city also has a number of indirect technology infrastructure programs to support technology sector development. For example, through Roanoke's e-Town initiative, the Warehouse Row Business Center was completed and fully leased to technology companies requiring flexible, wired office space; the city also established the previously mentioned Technology Zone, in which technology infrastructure is a benefit and an enticement to businesses looking for a location. In addition, the city has two industrial parks. The first, the Roanoke Centre for Industry and Technology, is a 440-acre park that the city acquired, developed, and marketed in its local enterprise zone. The city's other venture is with Roanoke's Redevelopment and Housing Authority and the Carilion Roanoke Memorial Hospital. The resulting Riverside Centre for Research and Technology is a plan for a new 100-acre business park that is only recently under way. In 2005, the public-private partnership broke ground for the Carilion Biomedical Institute. The Institute already has a number of innovation-oriented companies signed on as new residents (American Biosystems, Medical Enzymatics, and Luna Innovations); in addition, the presence of Carilion has resulted in Roanoke's being home to three other biomedical companies (PhysioAdvantage, Surgical Tools, and Zpro) through various early-stage partnerships. Whether through direct or indirect investment, public-private partnerships in Roanoke help the city achieve its goal of attracting technology businesses with a diverse and strategic balance of technology infrastructure policies to provide the necessary infrastructure.

San Jose has a similar approach to attracting technology sector companies with indirect and public-private-focused approaches to investing in technology infrastructure. Through several strategic partnerships with

San Jose State University, the city created the Bioscience Incubator and Innovation Center. Located in the Edenvale Technology Park, the incubator and center opened in late 2004 and includes 2,312 acres, with 8 million square feet of research and development, office, and manufacturing space. The incubator provides a number of services normally found in such spaces like start-up assistance programs, support services, educational and mentoring services, networking opportunities, technology transfer services, commercialization services, and links to investment and venture capital funds. The city also has incubators serving smaller, new technologically-oriented environmental products and software companies in the environmental and software business clusters. In both Roanoke's and San Jose's technology parks and incubators, the cities ensure that the spaces are able to meet the functional telecommunications and other technology infrastructure requirements of the targeted technology companies as well as supply various small company needs.

Mesa's economic development office looks to entrepreneurial and small businesses for technology economy growth. The city works to maintain relationships with technology businesses through roundtables and other city-sponsored networking opportunities in order to understand their needs. During a recent mayoral roundtable, one technology company owner reported that employees regularly complained about its Mesa location, voicing concern about the city's conservative, religious, homogeneous reputation in comparison to Tempe's young population and university-centered entertainment and nightlife. The city has used this and other feedback to develop a long-term plan to address this problem, mainly through renovation of its downtown. Mesa is opening a new $95 million arts center and creating a community college campus downtown. However, the desires of these companies do not stop at quality-of-life amenities. The downtown area also suffered from a lack of technology infrastructure. Through Mesa's self-assessment and mapping of infrastructure, the city created an open channel for communication between local telecommunications providers and the city in terms of technology services for business and citizens. The city held meetings with telecommunications providers to show where the city's technology infrastructure was not meeting business needs, and this information influenced the capital improvement plans of telecommunications providers, as some providers shifted resources to areas with greater need. When the city reevaluated their technology infrastructure, they found that coverage had expanded substantially, but noted that this was also due to the surge in

investment during the telecommunications boom in the late 1990s and early part of 2000–2001.

However, other employment areas suitable to technology industry in Mesa also lacked infrastructure. E-Streets' East Loop project is one example of how Mesa is trying to utilize technology infrastructure to assist with technology sector development. With more than twenty miles of the thirty-five-mile loop completed and fourteen slated for construction this year, the finished loop will connect Falcon Field, a general aviation airport, to Williams Gateway, a former U.S. Air Force base. This construction over the past three years has been important to the growth and retention of business in the area. For example, Falcon Field is home to Boeing's Apache helicopter production facility as well as MD Helicopters, formerly McDonnell Douglas, a production facility for the Model 500 series military helicopters. The construction of the city's telecommunications network in this East Loop extended city services to the area as well as affording a number of service providers the opportunity through the E-Streets' joint trench venture to become a provider at a lower cost than if they constructed their own networks. The project has assisted in the growth of aviation support and spillover businesses as well as other services in the area.

The strategy in Mesa suggests that the city views the private sector as the leader in defining technology infrastructure needs, but the city government makes policies and choices about the infrastructure (usually in response to private sector needs). The city's self-assessment and its creation of the E-Streets trench venture program are two examples of Mesa's approach to technology infrastructure investment.

The city of Tacoma, on the other hand, finds itself in a very different position as the owner of the fiber-optic network of Tacoma Power. The city utilizes this technology asset to attract and grow advanced technology industry, especially emerging computer-related business. The city addresses the development of this industry through financial incentives, land use and zoning, and direct technology infrastructure planning. For example, Tacoma does not require Internet service providers to pay a business and occupation tax (a common form of business taxation in cities in the state of Washington). The city also monitors the amount of built space and developable land available to accommodate the needs of advanced technology companies. This includes the consideration of innovative zoning and site assembly for larger campus sites (Tacoma Economic Development Department 2001). Each of these actions includes

a role for technology infrastructure. The city maintains maps of the location of high-speed fiber connections, working to ensure that a majority of privately-owned and -developed buildings are served by fiber. The city reviews the technology infrastructure needs of companies and targets city resources to address shortcomings, whether through leveraging the existing municipal utility network or working with private telecommunications providers. In general, the city seeks to understand what technology companies consider to be the area's advantage or disadvantage when contemplating a move to Tacoma or choosing to leave. Knowledge of how technology infrastructure fits with respect to other location factors is a priority for Tacoma's technology sector efforts.

Portland's foray into Unwire Portland is also, to some degree, driven by the desire for a vibrant technology sector. Portland's Blue Ribbon Commission report recognized the importance of several factors for the growth and expansion of technology industries. The commission's findings noted the importance of building space with high-speed lines and recognized that the success of the Pearl District (a now-prospering commercial and residential sector on the east side of the city's downtown) with dot.com growth during 2000 and 2001 was a result of technology renovation (Portland Development Commission 2002b). At this point in time, the Unwire Portland initiative is in an incubating phase because the city hopes it will create a technology infrastructure platform for entrepreneurs, high-bandwidth office buildings, and a marketing buzz about Portland being a technologically savvy city.

The analysis of technology infrastructure vis-à-vis technology sector development in the cities examined above demonstrates the versatility of technology infrastructure policy options. The desire for a growing technology sector is met by both direct and indirect investments in technology infrastructure development, from provision of capacity to creating suitable technology spaces in incubators and smart buildings. The feature that all of these cities share is a strong emphasis on public-private partnerships, in terms of identifying the needs of targeted businesses and sectors and in working with private sector technology providers to develop and implement plans for technology infrastructure investment.

These strategies, however, are not necessarily limited in capacity to influencing a narrow sector. Strategies for technology infrastructure investment tend to act as an enabling force. The benefits of the investment often disperse beyond just the recruited firm. Most of the cities discussed

in this section are approaching technology infrastructure in an entrepreneurial manner. Cities see the connection to economic growth and seek to exploit it through strategic investments that leverage public and private investment and are based on assessments of public and private needs.

Technology Infrastructure Inventories

The fourth approach in terms of city strategies in the technology economy deals with how cities utilize technology infrastructure inventories and assessments, some of which has been addressed through the description of the other three approaches. The majority of cities that are creating and maintaining inventories of the location, capacity, and ownership of technology infrastructure do so to serve three general functions. The first is related to economic development attraction, growth, and retention programs, where economic development policymakers use the information to ensure that buildings or developable lands meet the functional telecommunications requirements of business prospects looking to relocate or expand in the city. Second, in some cities the department of transportation or planning keeps an inventory of all private telecommunications deployments in order to strictly manage a city's rights-of-way, limiting chaos and costs associated with multiple network deployments and construction in and below city streets. The third function is also related to rights-of-way management, but instead of transportation coordination, the inventory serves as the foundation for licenses and franchises through which the city negotiates for some extra functionality, whether it is collected fees, joint venture opportunities, or additional infrastructure for schools, underserved areas, and/or public spaces.

Although identifying each type of inventory provides background on the project, the uses of these inventories quickly blur departmental boundaries in city governments. This is not unexpected, and actually local government agencies should not isolate such entrepreneurial collections of information. Indeed, of the cities with inventories of technology infrastructure, most have found a number of strategic uses beyond the impetus behind the original collection of information. Cities that use the inventory information in multiple ways have noted that their inventories influence other planning and policy activities, which in turn increases interdepartmental support for timely updating of their infrastructure inventory. Just as the benefits of technology infrastructure policies for technology sector development disperse, so do the benefits of inventories.

Inventories and Economic Development

The preceding sections examined technology infrastructure as it relates directly to the economic development efforts of cities. Several of the cities sought to understand what the locality had to offer in terms of technology infrastructure for business and its citizens. Often the self-evaluation process or assessment of technology infrastructure came as part of a new technology economy strategy. Lansing's IT Initiative is a perfect example. As part of the city's desire to bring affordable broadband to business and citizens, in 2002 the city's Infrastructure Subcommittee began to inventory Lansing's existing information technology infrastructure and services, including hardware such as computers and broadband components and providers of technology services (Lansing Economic Development Corporation 2003). The city wanted to map all types of users, from business and nonprofit organizations, government, and schools to local residents. It also leveraged its municipal assessment of technology infrastructure with a regional and statewide initiative, Link Michigan. This approach brought in local partners like the Lansing Board of Water and Light, Ameritech as the telecommunications provider, and the Regional Economic Development Team.

What makes Lansing's initiative unique is that it did not just stop at understanding the supply of technology infrastructure; it also used the leveraged partnerships to gain information about how the community of Lansing was using the existing capacity of technology infrastructure and how community demand was evolving. The demand analysis indicated that there was a lack of public awareness of IT and benefits of computerization among both businesses and residents. Given the primary goal of the IT Initiative—to extend the benefits of technology to everyone in Lansing—the Infrastructure Subcommittee's first move was to look at how educational opportunities could be expanded, working with Lansing School District middle school students and a local nonprofit, the Black Child and Family Institute, to offer families the chance to connect to the Internet at home in an affordable way and to receive hardware and software training. In addition, the city worked with Lansing's Regional Chamber of Commerce to improve technology training and understanding with local businesses. Lansing's IT Initiative drove the inventory of technology infrastructure to understand how it fit into the economic development opportunities of the city's residents and businesses.

Several other cities have produced an assessment of technology infrastructure for similar economic development reasons; however, to some degree each has embedded the function of inventorying into the governing process so that the data are updated on a semi-regular basis. Roanoke's Vision 2001 2020 called for the inventory of all technology infrastructure, and the city's Department of Transportation took the necessary steps to provide various maps of fiber-optic, wireless, and other broadband infrastructure for the city. As part of the implementation of the 2001 2020 plan, the responsibility for this function remains with the Department of Transportation. But as part of the government's coordinated effort to understand the city's position in technology infrastructure and convey this to local telecommunications providers and interested parties, the plan is seen as benefiting Roanoke's economic development efforts and its transportation and planning departments as well.

Economic development concerns also drove Mesa's original assessment of technology infrastructure after it lost a desired business prospect due to its lack of connectivity. The city thought that it had adequate capacity; however, the experience made the city realize that it needed better knowledge of where technology infrastructure was located and what capacity the existing networks actually provided. In the cases of both Roanoke and Mesa, the original inventory actions were a result of intragovernmental partnerships, but after completion the information had a number of external and internal uses, serving internally as an educational device for future plans and developments and serving externally to influence private capital investment. Most importantly, both cities maintain the inventory function outside of economic development offices. The transportation, planning, and licensing related agencies are often better positioned with resources and capacity to continue updates.

Another city with an inventory of its jurisdiction's technology infrastructure is Tacoma. Tacoma sees the benefit of maintaining inventories beyond its own fiber-optic network, the Click! Network. City leaders believe that it is essential to know the location and capacity of privately provided telecommunications services in order to look to future expansion of the city's own network in underserved or newly growing areas as well as leveraging opportunities for other economic development. In general, Tacoma's municipal utility absorbs the function that the transportation and planning departments in other cities have taken with technology infrastructure inventories. Tacoma's economic development

strategies regarding technology infrastructure stress the importance of coordination across departments.

Economic development may drive the initiation of technology infrastructure inventories and even one-time assessments in most of these cities, but the information gained in the process permeates multiple government agencies because of its usefulness. Where the inventory finds a home is related to which agency has the capacity and resources to continue updates while facilitating the sharing of information across multiple agencies.

Inventories for Rights-of-Way Management

The research on the technology economy suggests that cities involved in technology infrastructure are thinking about larger issues and seem to have a stake in what the future will be in their local economies regardless of their regional setting. The technology infrastructure inventories reviewed above indicate that even economic development–driven inventories served multiple local policy agendas. Although the majority of this chapter examines the relationship of infrastructure to economic development efforts at the local level, cities utilize technology infrastructure beyond this basic need. In fact, the majority of cities examined in this chapter have infrastructure inventories, whether they exist from one-shot assessments, intermittent audits, or continual update and maintenance: Roanoke has its maps for economic development and planning, San Jose its tracking of the city's level of broadband coverage; Lansing has its initiative-driven assessment for broad economic development goals, Mesa its targeted self-assessment providing needed information to a number of departments, and Tacoma its semi-private concern for the development and longevity of the Click! Network. Charlotte, North Carolina, however, stands alone among these examples in its development of its technology infrastructure inventory. Its single purpose is to allow the Department of Transportation to maintain an inventory of all private telecommunications deployments. Although economic development policymakers are aware of the inventory, the main goal of the inventory is to strictly manage the city's rights-of-way, limiting chaos and costs associated with multiple network deployments through city streets. Charlotte's single-purpose use of the inventory could be the result of its success in attracting a variety of telecommunications providers. A local economic development official reported that access,

while thought to be a problem in 1998, has diminished as the city experienced large growth, with the number of fiber-optic network projects jumping from nineteen in 1999 to thirty-two in 2000.

The birth of Charlotte's technology infrastructure inventory is unique in comparison to the other cities examined in this chapter. Charlotte's impetus was not the result of a self-assessment or technology initiative. Instead, the motivation was fending off the growth of the technology economy following the passage of the Telecommunications Act of 1996 (Telecommunications Act of 1996, 1996). The act, promoted as a way to increase competition, stated that municipalities cannot prevent companies from building new networks, but they can limit where the networks are located. The extremely vague statute did not dictate what municipalities' rights were beyond that they were allowed to manage their rights-of-way in reasonable ways. According to city officials, during the boom in the late 1990s and early 2000s, Charlotte had as many as four to five companies requesting permits to deploy their networks in the same route. In response, the city decided that telecommunications providers would need to receive their permits in the same way as other utilities (sewer, water, and electricity)—they would need to apply under the same utility encroachment agreement in order for the city to track and monitor the expansions (Charlotte Department of Transportation 2005).

Charlotte placed the development of telecommunications under the management of the Department of Transportation, where other encroachment permitting processes were located. Charlotte's approach is a result of an entrepreneurial management team, from the city attorney, who had an encroachment agreement that was quickly adjusted for telecommunications issues, to several leaders in the development services and rights-of-way management sections of the transportation department. The guidelines of the interim telecommunications rights-of-way encroachment agreement provided the foundation for the city to allow the network deployments of as many as twenty-four telecommunications companies within a three-year period at the height of the technology boom. Most of these infrastructure providers were new to the city.

The city did not allow the information from this rapid expansion to disappear. Charlotte's biggest concern was that the increased development was leading to an undue burden on the city and its residents—the degradation of rights-of-way, interruption in vehicular and pedestrian traffic, damaged water lines, increased maintenance costs because the cutting of streets often results in the city having to repair 15 percent of

the patches originally made by contractors, and reservation of space for future deployments. The city developed and maintained a routing map for all telecommunications infrastructure for the popular uptown area as of 1998. In addition, the city began to act as an intermediary between telecommunications providers desiring access to the same routes, suggesting that those companies lease from the main company. The resulting ventures often had telecommunications companies paying less for access to an existing network than it would cost to deploy their own network. The city's desires were met, and telecommunications companies often saved time and money. In general, Charlotte's actions have resulted in good relationships with telecommunications providers even though Charlotte is one of the more strict municipalities in its permitting requirements.

Charlotte has also been able to receive multiple benefits during the negotiation process of most encroachment agreements. Thus far, telecommunications providers have donated approximately $800,000 in conduit to the city, enabling Charlotte to connect to the state's network and deploy numerous miles of fiber-optic cable. These exchanges, as well as the strict maintenance of the rights-of-way, are done for good reason. Charlotte sits on a bed of granite that discourages making open cuts in roads for new fiber routes because the granite is too hard a substance. Most providers are only allowed to bore holes, but a limited number of these are in city streets. Instead, the majority of approved deployments are under sidewalks. Consequently, Charlotte's geographic disadvantage has resulted in a physical advantage when it comes to telecommunications network deployment, with fewer manholes in the streets.

Charlotte's role as the intermediary among telecommunications providers that are competing for market share and for space in the ground for networks has been noticed throughout the state of North Carolina. In fact, the success of the telecommunications interim encroachment agreement can to some extent be measured by the desire of surrounding cities (Greensboro, Raleigh, Winston-Salem) to replicate the agreement for their own process. Charlotte's approach is regarded as a municipal best practice. The interim encroachment agreement is still in use nine years after the passage of the Telecommunications Act. The city has started to draft a new ordinance to replace it, but the city's original agreement was sufficiently forward looking. In the event of a new ordinance, all telecommunications agreements to date will automatically convert to the new ordinance's needs and requirements.

Inventories for Licensing

The third function of inventorying technology infrastructure is also related to rights-of-way management. Instead of transportation coordination, the inventory serves as the foundation for licenses and franchises through which the city negotiates extra functionality, whether it is collected fees, joint venture opportunities, or additional infrastructure for schools, underserved areas, and/or public spaces. Mesa's E-Streets Office operates in such a manner. Mesa's inventory originated from a self-assessment of technology infrastructure described in the section above. The assessment process included multiple private and government stakeholders, such that the departments of Planning, Transportation, Public works, and Financial Services invested time and energy to make it possible. Although Mesa's desire to conduct an assessment of technology infrastructure occurred mainly due to economic development concerns, the assessment process indicated many overlapping needs among the involved departments. In order to fully utilize the information collected, the home for the inventory became the E-Streets and Licensing Broadband Development Office, but strong communication lines existed among this office and Economic Development, Transportation, and Planning.

The inventory of technology infrastructure was beneficial to the city's transportation and other planning processes encompassing the continued design and upgrade of the city's institutional network responsible for all city-related services and transportation/traffic operations. Before the assessment, the city neither had a firm understanding of where private telecommunications providers' infrastructures were located nor was it aware of the capacity of those networks. This made many of its institutional network expansions unable to leverage existing capacity without multiple evaluations and discussions with a number of carriers. At the same time, economic development efforts to recruit or accommodate business telecommunications needs required a similar chaotic process if the business did not go directly to the provider on its own. Both issues are a result of telecommunications providers' keeping information about their networks confidential. They consider any logistics regarding their networks as proprietary in order to keep their competitors in the dark.

Mesa realized that this was not an efficient situation, and that government should fulfill a basic role in telecommunications infrastructure and be an educator in the market. Mesa cobbled together the technology infrastructure information gained through the assessment in a series of

maps that corresponded to the city's employment areas with fiber-optic lines, broadband services (cable modem and DSL), and wireless networks. Finding that the older employment centers had better coverage than new and developing ones, the city used this information to inform local telecommunications providers that growing areas were in need of new infrastructure. A number of providers admitted to not realizing the magnitude of this disparity, and, recognizing the strategic opportunity, some providers began to shift resources to areas with greater need. The process influenced the capital improvement plans of several telecommunications providers, but almost as important is that it opened lines of communication between the city and telecommunications providers for economic development and planning.

To institutionalize this process, the city continues to monitor telecommunications and cable deployment through the E-Streets and Licensing Broadband Development Office. The office is responsible for licensing issues for broadband telecommunications and cable communications systems as providers request use of the city's public rights-of-way. The process keeps the city aware of what type of technology infrastructure providers are deploying, and the city documents these changes. In addition, through the licensing process the city leverages the use of its rights-of-way costs in a number of ways allowable under the Telecommunications Act of 1996. For example, the city has been able to extend its network in areas where private telecommunications providers already have networks, and the negotiation process often provides the city with access or ownership at a cost less than it would incur to either purchase or build in the open market. The city also reports that some negotiations produce additional conduit or fiber-optic cable for city use, access for public uses (from cable access channels to wireless hot spots for government and schools), and service to underserved areas. Although all are important to the city, Mesa's documentation of the location and capacity of the technology infrastructure for which a license is requested is one of the most important issues for the city. It allows it to continue to monitor its technology infrastructure while supporting a number of other city goals beyond economic development.

Beyond maintaining the technology infrastructure inventory, the office through the E-Streets Initiative is responsible for a network with joint trench venture opportunities for private telecommunications providers. The office spearheads the construction of the city's new fiber-optic network deployments around the city, but mainly in the east.

Several projects and growth in the eastern part of Mesa demanded the expansion of the city's institutional network. Instead of just building the network for city purposes, the city financed and deployed additional conduits for private sale. Mesa is neither losing money nor making a profit. The city sees this added expense as a cost in facilitating broadband and infrastructure development in areas that need better services and are growing employment areas where businesses need to have access to telecommunications services. At some level, the city's financial commitment to the E-Streets Initiative is counterbalanced with the pursuit of additional city services through licensing negotiations, but each function serves to develop greater technology infrastructure and knowledge in Mesa.

The process of identifying how and why each of the highlighted cities in the analysis of inventories now has technology inventories provides a greater perspective on the use of technology infrastructure in cities. Although the nexus of technology and economic development efforts is a focus of this book, the various machinations of the technology economy in cities suggest that the boundaries of economic development with other policy actions are blurry. Technology infrastructure inventories provide a foundation for multiple strategic uses. This hints at an explanation of why the presence of an inventory had an insignificant effect on technology sector employment (see Chapter 3). Conducting and maintaining an inventory of technology infrastructure in and of itself, while an entrepreneurial enterprise, does not suggest much action toward building a local technology economy. However, the integration of multiple technology infrastructure policies, including an inventory, seems to be the more likely policy environment in these cities. How technology infrastructure is prompting a response from a variety of city departments and agencies suggests that it has strategic uses beyond the impetus driving the original collection of information.

Insights and Observations

The examination of these seven cities demonstrates a variety of methods by which local governments are seeking to shape their responses to the technology economy. Using the framework of economic development, the directions that many cities take do not necessarily conform to narrow economic development policies. Multiple types of policymakers in authority and location within government play large roles, but most

of the cities' motivations to concentrate on technology infrastructure vis-à-vis the economy, technology sectors, and quality-of-life issues are a result of some recognized opportunity or challenge.

For the city of Tacoma, the need for an upgrade to the networks of their utility seemed like an appropriate time to reflect on how this investment could produce greater results for the city. Lansing's economic struggles and strong mayoral leadership refocused its approach on growth and development. Roanoke experienced a similar desire for a new economic base, and through several partnerships, designed technology infrastructure policies to create the needed environment. Mesa's loss of a desired business due to a lack of technology infrastructure surprised local policymakers enough to produce a dedicated effort and new communication models among government agencies and the private sector. In San Jose's case, the city was already in an advantaged position for looking at technology infrastructure issues, but the recession and other competing cities made the city realize that technology infrastructure investment was still needed. Charlotte's foray into technology infrastructure is limited mostly to the inventory because the private market provided enough development to meet demand, causing the city's economic development department to change its course. However, this development required diligent oversight to ensure a more structured outcome. Finally, Portland's examination of economic development opportunities suggests that the city had a lack of knowledge and concern for technology infrastructure. In honing its focus, Portland saw opportunities to create desired growth as well as provide city services needed in the Unwire Portland venture.

Vision-oriented thinking about how a city can be ready for and take advantage of the technology economy represents only one side of the technology infrastructure spectrum, which in the case of Lansing was even broader that its economic development home. However, vision by itself is not enough, as evidenced in the analysis in Chapter 3 as well as the examples presented here. Only cities that went beyond vision with multiple technology infrastructure policy actions reported greater technology economy results and successes. Integration into the economic development vision did not provide a direct enough effect, but when vision transformed into strategies, cities had success. These cities' actions demonstrate a dedication to technology economy factors and a refocusing of the way that cities are thinking about the future—whether it is economic development, transportation, or planning. In the eyes of

many, technology infrastructure is no longer an isolated core infrastructure, and slowly but surely it is moving into more active uses.

As with technology infrastructure inventories, the multiple faces of technology infrastructure in these cities show its expanded influence, stimulating other planning and policy activities beyond economic development. In fact, the separation of technology infrastructure solely within economic development seems counterproductive. The blanketing effect of technology infrastructure on economic development, planning, transportation, public works, and even finance departments suggests the structural importance of this factor and is an indication that the technology economy has broad application in cities. As shown in Chapter 3, economic development strategies that address technology infrastructure are important factors to technology sector employment, yet the presence of the strategy in economic development visions or inventories alone is not sufficient. The examination of cities in this chapter indicates that this may be because both the benefits and, often, the costs are dispersed. Multiple technology infrastructure policies often have impact beyond limited targets, and as other departments become involved we see a distribution of costs across government priorities and an even greater distribution of benefits. As a true infrastructure, early planning, awareness, and coordination disperse the benefits to multiple projects and individuals, which is why many cities experienced commitment from a number of departments and agencies even if they were not sure the direct effect would be beneficial. The effects of technology have always created measurement problems, and the stories from these cities show how certain strategies or actions blur boundaries within local government and economic development, which makes it more difficult to measure the direct impact of even one strategy.

The cities examined here view technology infrastructure as an enabler of private sector development and local economic development. Whether this public-private technology infrastructure "enabling" strategy is more efficient in terms of public cost per rate of change in local job growth than the conventional firm-focused tax and expenditure subsidy has yet to be determined given the time horizon of these initiatives and the difficulty in measuring the overall effect of multiple policies. However, the commitment of local governments beyond typical economic development strategies and its influence on multiple departments and offices suggest some level of awareness that technology infrastructure is key to the future of cities' economic well-being. The research for

this book suggests that we see technology infrastructure having a positive effect on a city's employment in, and beyond, the targeted technology sectors. The intersection of technology infrastructure and technology sectors is consequential to the future of local economic development, and state and local economic development policymakers may need to take notice of the comparative effectiveness of technology infrastructure in the local economic development policy sphere.