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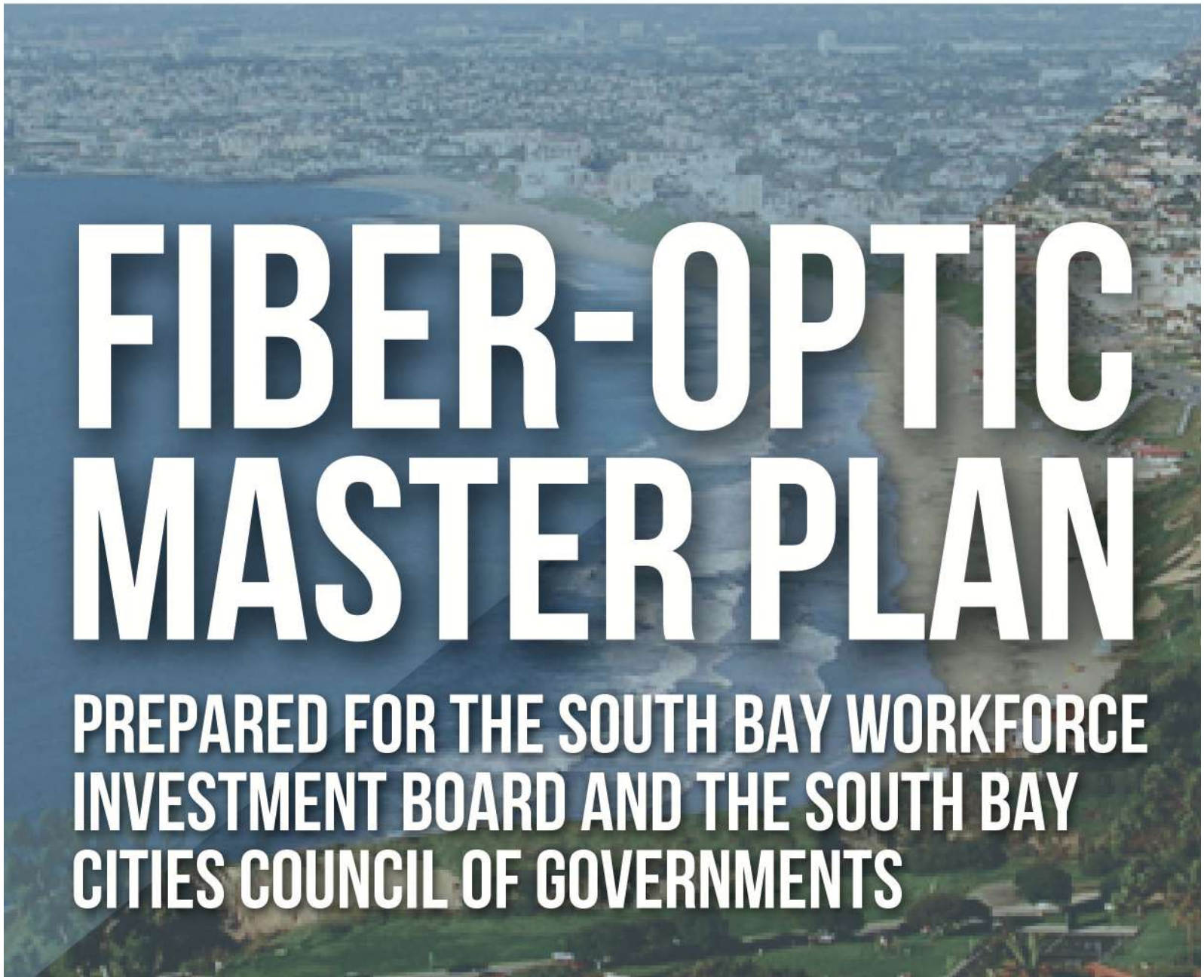

FIBER-OPTIC MASTER PLAN

PREPARED FOR THE SOUTH BAY WORKFORCE INVESTMENT BOARD AND THE SOUTH BAY CITIES COUNCIL OF GOVERNMENTS

Acknowledgements

Magellan Advisors wishes to thank the South Bay Workforce Investment Board (SBWIB), the South Bay Cities Council of Governments (SBCCOG), member Cities, the business community, community anchors, the County of Los Angeles, and South Bay staff for the commitment, time, and thoughtfulness invested in this report.

The information gathered and insights derived through interviews, surveys and documentation have been instrumental in the development of the South Bay's Fiber Optic Master Plan. This Plan serves as the initial assessment outlining recommendations for a regionally coordinated fiber-optic infrastructure development effort within the South Bay.

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South Bay Cities, California: Fiber Optic Master Plan

Executive Summary

The Digital Imperative: Business requires network services and skilled workers

The South Bay has the opportunity to create a new and inclusive economy; supporting quality of life through workforce and economic development. By doing so, the South Bay mitigates the risk of what some are calling the "new urban crisis."[1] Generally, this is seen as a gap between the few who are doing very well and the many who are struggling. The number of wealthy households is increasing while the incomes of middle-class households and college-educated have shrunk. There are plenty of low-wage, low-skill jobs and employers are struggling to find workers with the skills for high-paying jobs. Housing costs have increased with congestion, but the quality of housing stock has not. A few organizations excel with technology, but many struggle with it. These gaps are the results of economic, social, and technological megatrends, which are swamping those communities that unprepared to get on top of the waves of change.

Bandwidth and connectivity are critical factors to success in today's digital economy. Business must have them to move, share, and use data.

Manufacturing has led the way with automation, computer-based design, and supply chain integration, with business processes tightly integrated with electronic processes.

Education and healthcare have digitized assessments, documents, and records for students and patients.

Governments, non-profits, and service industries are automating and transforming their processes via the internet.

High-performing organizations simply cannot work without abundant bandwidth. Communities that don't have it won't keep businesses within the community.

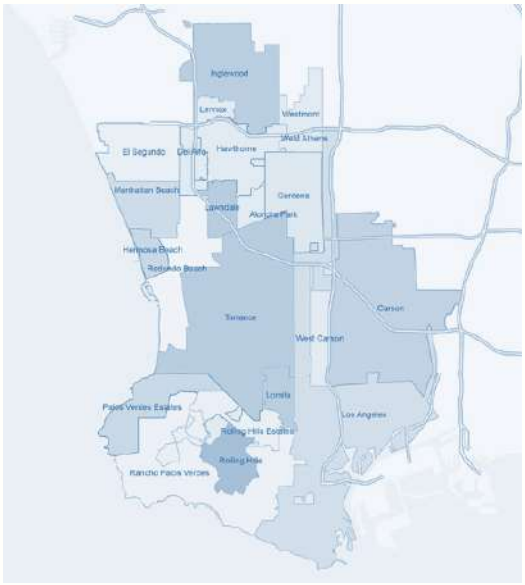
The way markets and organizations operate is changing, and needs for connectivity and skills are changing, too. Too many South Bay organizations have limited connectivity, expertise, and solutions. Consequently, they are under-investing in technology, which puts them at a competitive disadvantage. Organizations are feeling pressure from customers and competitors to do more with technology, and they generally expect their technology needs will increase.

While limited business solutions and network services are issues, workforce capabilities—from executives' knowledge to IT experts' capacity to workers' basic digital skills—represent the critical barrier to additional investment.

[1] *Scholar Richard Florida, who foresaw the return of young "creatives" to urban cores, has a new book entitled "The New Urban Crisis" that details the problem.*

The Digital Inclusion: Creating Opportunity and Economic Development in the South Bay

The South Bay is geographically and economically positioned to significantly contribute to the global economy. This report examines how and why the fifteen South Bay cities (see Figure below) can create a region of digital inclusion that stimulates workforce and economic development – creating a smart region built on a fiber-optic network infrastructure.



South Bay Cities

- Carson
- El Segundo
- Gardena
- Hermosa Beach
- Hawthorne
- Inglewood
- Lawndale
- Lomita
- Manhattan Beach
- Palos Verde Estates
- Rancho Palos Verdes
- Redondo Beach
- Rolling Hills
- Rolling Hills Estates
- Torrance

Needs and opportunities for network services—among the cities, and with local businesses and institutions—are considered in detail. Magellan Advisors conducted interviews and surveys of a range of local business, civic, and technology leaders to provide the information within this report. The availability of infrastructure and services were examined, in addition to the skills, knowledge, and abilities necessary to build and maintain regionally-driven smart city systems. These variables are consistent with technology-intensive company capabilities.

Magellan Advisors found a clear opportunity and strong reasons to interconnect the South Bay cities. The cities can get more internet bandwidth for a lower per megabit rate, and the cities can share systems and data to operate more cost-effectively. The network provides means for the cities to interconnect their sites, provide public access, and even give local institutions and non-profits more bandwidth for less.

A Vision of South Bay's Digital Development

The vision for a Smart South Bay starts with the cities getting more bandwidth for less—the more efficient use of resources to more effectively meet residents' needs. From there, the vision is for improved regional public-sector communications. Emergency services, public works, and transportation will be faster and more effective, making residents safer, healthier, and less stressed. Residents use the network to increase their skills and do new types of work, earning more online. The full vision is of high-tech companies starting up, relocating, and growing across the South Bay, fueled by the local talent pool and by ultra-fast broadband. In the process, businesses repurpose old industrial sites and revitalize the cities' neighborhoods, and the cities develop new technology-enabled revenue streams.

Current Network Costs by City

The South Bay has extensive network infrastructure but it is inconsistent and fragmented. Several South Bay cities own fiber-optic, wireless, and other infrastructure, but some have only basic connectivity. Much of the cities' infrastructure is not interconnected to other network infrastructure, including other cities. There are multiple facility-based providers with infrastructure in the South Bay area but it is not consistently available or readily accessible.

The costs to get to and connect through a fiber network can be prohibitively high. Generally, network infrastructure and services are more available on the west side of the South Bay, and to the north. Eastern and southern South Bay cities have less infrastructure and fewer options. El Segundo, Manhattan Beach, and Redondo Beach have made significant infrastructure investments, and Inglewood is actively studying needs and opportunities.

	Contracted Mbps		Actual Mbps		Monthly cost	Monthly cost per Mbps	
City	Down	Up	Down	Up		Down	Up
Carson	100	100	100	100	$1,500	$15.00	$15.00
El Segundo	100	10	75	7	$531	$7.08	$75.86
Gardena	200	200	200	200	$2,600	$13.00	$13.00
Hawthorne	50	50	42	19	$3,700[2]	$88.09	$194.70
Manhattan Beach	100	100	93	42	$7,800[3]	$83.87	$185.71
Inglewood	1000	1000	850	750	$6,000	$7.06	$8.00
Rancho Palos Verdes	150	150	149	152	$275	$1.85	$1.81
Redondo Beach	100	100	40	38	$6,300	$157.50	$165.79
Rolling Hills Estates	50	50	49	46	NA	NA	NA
Torrance	308	317	54	54	$3,933	$72.39	$72.84
				Averages	$3,627	$49.54	$81.41
				Total	$32,639		

Currently, the cities are paying about $43 per Mbps download and $63 per Mbps upload per month.

[2] The City of Hawthorne is currently contracted with two service providers for 50 Mbps circuits at rates of $2,100 and $1,500.

[3] The costs for Manhattan Beach at the time of the survey in 2016 were for a 50Mb circuit. In June 2017, the City is transitioning to three 1Gb circuits at a rate of $1300 each for a total of $3900 per month. This results in a 50% cost reduction while increase transport capacity by 5900%. Reducing the monthly cost per Mbps to $2.30.

Future gigabit services cost estimates range from $1.25 Mbps to $0.68 Mbps per month for bandwidth from 1 Gbps to 10 Gbps and over one to three year contracts.

Cost estimates to build out a fiber network with gigabit capacity that will connect South Bay cities total between $2.4 million and approximately $3 million, and include non-recurring and monthly recurring costs for a 5-year period. This initial cost estimate is based on current industry pricing and assumes that one priority location within each city would be connected and that IP/transit service capacities would range from 1 Gbps to 10 Gbps. The table below provides an estimate for monthly recurring costs for 12 to 36 month terms.

Estimated Provider IP/Transit						
1x10GE Port	12 Month Term		24 Month Term		36 Month Term	
	Price/Mb	Total MRC	Price/Mb	Total MRC	Price/Mb	Total MRC
1Gb Commit	$1.25	$1,250.00	$1.13	$1,130.00	$1.05	$1,050.00
2Gb Commit	$1.20	$2,400.00	$1.08	$2,160.00	$1.00	$2,000.00
3Gb Commit	$1.15	$3,450.00	$1.04	$3,120.00	$0.95	$2,850.00
4Gb Commit	$1.10	$4,400.00	$0.99	$3,960.00	$0.90	$3,600.00
5Gb Commit	$1.05	$5,250.00	$0.95	$4,750.00	$0.85	$4,250.00
10Gb Commit	$0.85	$8,500.00	$0.79	$7,900.00	$0.68	$6,800.00

Initial cost estimates per city are outlined in the table below and are based on priority locations provided by South Bay cities.

	Estimates for 1 Gbps SMART-Net				Estimates for 10 Gbps SMART-Net			
	Option 1		Option 2		Option 1		Option 2	
City Locations	MRC	NRC	MRC	NRC	MRC	NRC	MRC	NRC
2 Portuguese Bend Rd., Rolling Hills	$929	$288,834	$8,335	$0	$1,394	$288,834	$8,968	$0
340 Palos Verdes Dr. W, Palos Verdes Estates	$929	$250,429	$7,227	$0	$1,394	$250,429	$7,776	$0
24300 Narbonne Ave., Lomita	$929	$142,196	$4,103	$0	$1,394	$142,196	$4,415	$0
701 E Carson St., Carson	$929	$113,947	$3,288	$0	$1,394	$113,947	$3,538	$0
30940 Hawthorne Blvd., Rancho Palos Verdes	$929	$100,298	$2,894	$0	$1,394	$100,298	$3,114	$0
1315 Valley Dr., Hermosa Beach	$929	$99,029	$2,858	$0	$1,394	$99,029	$3,075	$0
12501 Hawthorne Blvd., Hawthorne	$929	$88,237	$2,546	$0	$1,394	$88,237	$2,740	$0
1 W Manchester Blvd., Inglewood	$929	$80,461	$2,322	$0	$1,394	$80,461	$2,498	$0
1400 Highland Ave., Manhattan Beach	$929	$66,019	$1,905	$0	$1,394	$66,019	$2,050	$0
415 Diamond St., Redondo Beach	$929	$65,861	$1,900	$0	$1,394	$65,861	$2,045	$0
14717 Burin Ave., Lawndale	$929	$65,226	$1,882	$0	$1,394	$65,226	$2,025	$0
3031 Torrance Blvd., Torrance	$929	$59,830	$1,726	$0	$1,394	$59,830	$1,858	$0
1700 W 162nd St., Gardena	$929	$57,608	$1,662	$0	$1,394	$57,608	$1,789	$0
350 Main St., El Segundo	$929	$56,973	$1,644	$0	$1,394	$56,973	$1,769	$0
4045 Palos Verdes Dr. N, Rolling Hills Estates	$929	$52,053	$1,502	$0	$1,394	$52,053	$1,616	$0
Totals	**$13,935**	**$1,587,001**	**$45,794**	**$0**	**$20,910**	**$1,587,001**	**$49,276**	**$0**
5-Year Total	**$2,423,101**		**$2,747,640**		**$2,841,601**		**$2,956,560**	

Strategy for Creating a Smart Region: How the South Bay Can Get Smart

The South Bay cities can improve operations, spur economic development, and create new job opportunities with a middle-mile regional advanced technology network. The overall goal is to enable new, sustainable, technology-based economic development, to grow and keep high-performing companies with high-paying jobs. The South Bay cities can almost immediately get much more bandwidth and internet connectivity at a much lower cost per megabit. So, the network makes short-term sense. The network is a platform for a range of smart community applications to support quality of life and government performance.

The concept is to incrementally build-out fiber-optic connectivity. By beginning with connecting the cities to each other and to the internet via fiber-optic cables, the region prioritizes its initial municipal needs with a long-term vision to promote economic development and expanded smart city services. Initially, private providers build and run the network. The cities jointly purchase data transport and internet bandwidth. As cities develop their own infrastructures, starting with conduit and poles, they can spur private technology investment. Benefits increase as municipal offices and community institutions are interconnected. The infrastructure evolves into a publicly owned network to meet public purposes parallel with private services for businesses and residents. The steps are:

1. *Establish an agreement or understanding among the cities to jointly purchase network services.*
2. *Identify additional network users and funding mechanisms.*
3. *Adopt broadband-friendly policies across the South Bay.*
4. *Request competitive bids to build-out and run the network.*
5. *Build-out a provider delivered network.*
6. *Collaborate with private sector to launch smart community applications, identify municipal revenue opportunities.*
7. *Integrate municipal infrastructure into the network and expand network reach.*

The network will give the cities much more internet bandwidth for much lower per megabit rate: 60 to 70 times more bandwidth at about half the average cost per city! The network also allows the cities to better share data and resources for essential services, such as public safety. Initially, the network is designed to connect one site in each city via a private provider, to be expandable to serve a range of community institutions, including all local government facilities, and to incorporate publicly owned infrastructure. The public infrastructure investment can catalyze and complement private investment to serve businesses and residents.

Much, if not all, of the initial cost of network can be covered by savings on the cities' current telecommunications costs. Bringing other network users in will further spread the costs, making it even more economical for each city. If funding can be found to deploy public facilities in key areas, network reach and performance will be even greater and recurring costs will be even lower.

Now is the time for SMART-Net

Now is a prime time to begin realizing the vision of a smart South Bay. Much of the SMART-Net can be provided by the region's substantial but fragmented fiber infrastructure. Small, incremental investments by the cities, made in a coordinated but independent manner, are an economical way to enhance and extend the existing infrastructure. This opportunity may not be available in the future as the market changes. At the same time, the cities are interdependent, sharing many demographic, economic, and geographic resources. When a large employer has a downturn, everyone is impacted. The South Bay cities have an opportunity to leap ahead together, but are also at risk of being left behind.

Digital technology has transformed the economy. Many market leaders of yesterday are gone because they could not adapt. The highest-earning and fastest-growing companies focus on intangible assets—computer code, digital data, and electronic systems. They can virtually locate anywhere with high-capacity networks. Highly adaptable and capable workers are the key factor.

Economic attraction and retention comes down to a simple reality . . .

You must have digitally skilled people and extensive network infrastructure. Technically savvy people and companies simply will not go or stay anywhere without lots of bandwidth and easy connectivity. Broadband has become a utility that is necessary for work, play, and everyday living.

About this report

The South Bay has a unique opportunity to take control of its future if business, institutional, and municipal leaders across the South Bay cities can look into the future and invest today to be prepared for tomorrow. By working together, they can multiply their efforts. The South Bay can grow without the problems experienced by a typical city caught up in a megalopolis. A combination of community and infrastructure development can deliver both connectivity and skills. Existing residents—commercial and industrial businesses as well as residents—can take active roles in the growth, and find employees or employment, goods, and services close to home. At the same time, they are able to deliver products and serve customers anywhere in the world from the South Bay. Taking control of the South Bay's future means using digital technology to engage residents, coordinate and direct investment, enhance quality of place, and enable competitiveness, innovation, and productivity gains.

The South Bay Cities Council of Governments (SBCCOG) and South Bay Workforce Investment Board (SBWIB) are organizations focused on improving the quality of life within the region through the collaboration of local governments. SBCCOG is a joint powers authority of 16 cities and South Bay unincorporated county area that focus on collaborative solutions to regional issues. SBWIB consists of 51 members representing business, labor, education, economic development, the One-Stop partners, and other local workforce system stakeholders. Communities are served through the programs provided by developed by SBWIB's efforts in providing a successful regional workforce, while creating opportunities for workers to prepare for and enter into well-paid careers. Economic development is stimulated by focusing on meeting the needs of business for skilled labor so they are able to grow and expand.

In July 2016, SBCCOG and SBWIB partnered with Magellan Advisors to develop a Fiber-Optic Master Plan for the region to support business retention and layoff aversion. The Fiber-Optic Master Plan addresses the availability of fiber cable and broadband connectivity for cities, businesses, educational institutions and the healthcare industry. Individual households in the region are not included in this study. The connectivity speeds for various community anchors within the region will vary greatly depending on the contracts with local service providers, and based on the demands of the business. The expansion of regional fiber-optic network service levels will increase upload/download data speeds to a gigabyte[4] or more.

The larger issue and question is "why do we need advanced broadband?" This document answers that question by providing a regional vision for the South Bay, focused on technology-enabled smart growth. It provides the rationale as well as cost estimates for a multi-city middle-mile fiber-optic backbone network. Business models and operating structures are considered along with physical network architecture and routes. The report also identifies major workforce issues and trends related to the focus on broadband networking and its contribution to economic development. All of this is considered in the context of a globally-connected region.

[4]A Gigabyte is equal to 1000 Megabytes. In telecommunications and networking, it is a unit of measure for the amount of data per second that can be transported. High bandwidth connectivity currently ranges from 1GB to 10GB to 100GB connections.

Section 1:

Why and How the South Bay should become a Smart Region

The South Bay: At the Global Cross-roads

The South Bay is facing a hollowing out of its middle class and of its economic base, which lead to dual economic imperatives: to attract, grow, and retain business and industry, particularly highly innovative and profitable firms, and to get the workforce into higher-paying jobs. It is practically impossible for the South Bay cities to accomplish these objectives individually; but by collaborating to improve themselves via technology, the cities can become powerful catalysts for economic transformation.

The South Bay is literally at the cross-roads of the world. It lies between the largest container port and the third busiest airport in the United States, is part of the LA global cultural nexus, and has world-leading tech clusters spreading their way along the California coast. The South Bay has gone from wilderness to ranches, to small towns, to industrial centers, to a major metro in just over 150 years. Growth is inevitable; but does it mean improvement or displacement for those who live and work in it? Does it mean more congestion and higher prices, or more convenience and higher wages?

The South Bay is also at the cross-roads in terms of growth. As seen many times around the world, growth comes with challenges that multiply when growth is chaotic and uncoordinated. Some places deal with the challenges proactively, but for too many places, growth degrades quality. The South Bay faces increasing housing costs, and growing traffic congestion. Consider critical workers such as police officers, home healthcare providers, and teachers—if they can't afford a home and face long commutes, what does that mean for communities?

Ironically, growth can lead to industrial disinvestment—the area has lost some 11,000 jobs in the last 5 years (see Table 1)—which leads to more poverty and urban blight. The combination of outdated facilities, rising costs, and changing markets drives low-margin businesses to close or move. This reduces job opportunities and discretionary incomes, undermines the diversity of retail and services, and leads to poorly maintained, under-utilized real estate.

The South Bay can avoid the negative impacts of growth. The "secret" is to connect, enable, and inform people to be active, smart residents rather than passive residents. Digital technology is the key. Technology is infused into all aspects of the economy, but it may still be baffling, expensive, and inaccessible for many businesses and workers. People without the right capabilities get stuck in low-paying, dead-end jobs. Companies that don't make full use of the technology won't be able to compete, nor will places without abundant digital infrastructure that provides critical connectivity. Organizations, including municipalities, must use technology to improve their processes and products. And, workers must upgrade their skills to enable—not just react to—these improvements.

Table 1. The South Bay has lost over 11,000 jobs in major corporate lay-offs in recent years.[5]

Year	Companies	Jobs lost
2012	Aero-Electric, Aerospace Corp., Boeing, BT Americas, Comerica Bank, Hostess Brands, International Rectifier, Kmart, Northrop Grumman, Raytheon, Sanyo Solar, Schenker	1,277
2013	Advantage Rent a Car, Bimbo Bakeries, Blue Shield of California, Boeing, Chromalloy, DirecTV, Hollywood Park Casino, Hollywood Park Race Track, Leidos, NBTY Acquisition, Raytheon, Rhythm and Hues, Transfield Services, Triwest Healthcare, Xerox	2,921
2014	Albertson's, American Medical Response, Boeing, Chivas, Living Social, Raytheon, U.S. Auto Parts Network	505
2015	Anemostat, Apro Distribution, Boeing, Certified Players, Farmer Brothers, Fresh & Easy, Leidos, LG NanoH2O, Mattel, MullinTBG, Panasonic, Providence Health, Ralphs Grocery Company, Ryder Integrated Logistics, Schenker, Tatung, Toyota	2,401
2016	Blue Shield of California, Kubota Tractor, Los Angeles Guild, Normandie Casino, Pathology Inc.	906
2017	Toyota	3,100
	Total	**11,110**

The Economy & Technology: Powerful Forces at the Global Cross-roads

Table 1 summarizes the major lay-offs in the South Bay over the last five years. Why do these things happen? How can they be avoided? They are the results of global mega-trends. The South Bay can be beat down by these trends or it can rise above and ride them. Broadband and other digital technologies are important when they enable people, industries, and communities to avoid or capitalize on these trends.

Anything that can be digitized will be. Digital goods are simply a bunch of bits—ones and zeros. A digital good—a book, movie, product design, or software—may be hugely difficult and expensive to produce, but is very cheap and easy to reproduce. Computers and networks make it easy to access, modify, and share digital goods. Many things that have been digitized—phone conversations, jet fighter designs, and Hollywood blockbusters are just a few examples—need to be secured. We're generating huge amounts of digital data that need to be analyzed and managed. Infrastructure and talent are needed to secure and make sense of digital goods, as well as create and share them.

Every town used to have at least one book store, record shop, and video store. But, no more. Now, these digitized products are bought online from mega-retailers rather than local merchants.

At the same time, Project Gutenberg (https://www.gutenberg.org/) offers over 53,000 books free for anyone to download or read online.

[5] Source: California Worker Adjustment and Retraining Notification notices, http://www.edd.ca.gov/jobs_and_training/Layoff_Services_WARN.htm#ListingofWARNNotices

Digital data represents real things—people, places, products, etc.—how they act and change as well as what they are. Algorithms make these representations "smart." Pictures can contain computer-readable information that humans can't perceive. That information can be used to "sign" the picture or it can be code that tells the computer what to do. Imagine a picture of you that makes a computer behave like you. Now imagine it is much more than a picture; it is a representation of body and environment. Think what this could mean for healthcare and service industries. Of course, there's a downside: computer viruses, malware, and spyware can also be hidden in digital content.

Digitization is even more about the algorithms that tell computers what to do with content than the content itself. Those who develop better algorithms will be the next economic leaders.

Everything local is going global. ***Globalization*** is widely recognized as a major economic trend. It means you can buy most anything—car parts, produce, software code—from most anywhere in the world. It also means you have competitors all over the world. Local and national markets are being integrated into a global market for goods, labor, and services. Globalization has detractors and significant downsides: cheaters, crooks, and unintentional introduction of invasive species can create huge costs and social ills. Globalization's benefits—rising wages and lower consumer prices—outweigh the costs, but are also unevenly distributed: some are hurt or benefit more than others. The simple fact, though, is that places with global connections grow faster than other places. Digital technologies make it possible to avoid the problems of globalization and to help everyone share in its benefits.

"…it is the world's major cities that are the powerhouses of global growth. Teeming with industry and services, brimming with innovation, and home to swelling and increasingly more skilled and diverse labour forces"

The Global 750: Forecasting the Urban World to 2030, Oxford Economics (http://www.oxfordeconomics.com/cities/report)

Do a lot more with a lot less. Cameras, computers, and phones have all gotten smaller even as they have become much more powerful. Improvements in product designs and production processes have greatly reduced the amount of physical materials necessary to meet consumer needs. This is called *dematerialization*. Miniaturization and recycling are forms of dematerialization. The "sharing economy," in which people share bikes, cars, homes, tools, and most everything else, is also a form of dematerialization. Agile software development and Lean production, reduce waste and improve the quality of products, also contribute to dematerialization.

"…many younger consumers are under income pressure, are poorer than the previous generation, and are more cost conscious."

Urban World: The Global Consumers to Watch, McKinsey Global Institute (http://www.mckinsey.com/global-themes/urbanization/urban-world-the-global-consumers-to-watch)

Digital technologies are media and means for dematerialization. Digital media reduces the need for paper, film, video tape, and many other physical materials. The same is true when the internet is used as a medium for buying and selling, replacing catalogs and storefronts with websites. And, digital technology provides means for highly sophisticated designs that require less materials, but are stronger and have better performance characteristics. Computer-aided design and manufacturing (CAD/CAM) allows production processes to run much more efficiently, with less down-time and waste, and results in products that are more compact, functional, and reliable. New materials that are both far lighter and stronger are designed to the molecular level using computers.

Using 3D modeling, scientists have discovered a geometry to make materials ten times stronger than steel with only 5% of its density.

https://futurism.com/mit-unveils-new-material-thats-strongest-and-lightest-on-earth/

Everyone needs a platform. You can manage your money without a bank, book flights and hotel rooms without a travel agent, and get news without a newspaper—examples of what social scientists call *disintermediation*—if you have a platform. Platforms are simply internet resources that aggregate and provide access to other resources for a specific activity. Airbnb, Eventbrite, Facebook, Kayak, Task Rabbit, and Uber are all platforms—for renting out rooms, hosting events, finding others with shared interests, planning travel, helping with tasks, and getting rides. Some platforms are very general purpose; others are quite specific.

Disintermediated people work without middlemen. You can easily get things done and solve tough problems by "crowd-sourcing" tasks to a multitude of people with special abilities or interests. The "gig economy" has highly flexible work arrangements, and the "sharing economy" allows you to let others use—usually for a fee—something you have but aren't using. These create new economic opportunities. Many people make a living by renting rooms via Airbnb or finding people who need rides via Uber.

Virtually anything is possible. Virtualization has numerous means in the technology world. Essentially, though, it means flexibility. A personal computer, for example, can be virtually anything from an airplane (flight simulator) to xylophone (virtual musical instruments). Since they're virtual, the airplane can be a Star Wars X-wing fighter and the xylophone can be a whole orchestra and recording studio. In the same way, digital technology is enabling teams, organizations, factories, and even whole communities to "go virtual." Not only do they need no physical location, they can adapt faster and work more flexibly than their actual competitors.

"The value of a business increasingly lurks not in physical and financial assets that are on the balance sheet, but in intangibles: brands, patents, franchises, software, research programmes, ideas, expertise. Few firms try to measure returns on these assets, let alone publish information on them. Yet they are often what underlies a firm's success."

A Price on the Priceless, The Economist, 1999 (http://www.economist.com/node/322532)

Information infrastructure can do virtually anything. Virtualization also means that infrastructure can be configured via software to work in most anyway. Computers can have virtual machines that are computers within computers. A data center can have any number of virtual servers running within it, and those servers can be flexibly reconfigured and resized. A physical network can support multiple, totally separate virtual networks. These two aspects of virtualization will increasingly merge in the forms of autonomous vehicles, augmented environments, and even more automated production.

Everything is getting smarter and more open. Increasingly, inanimate objects can sense changes in their environments and change their operations to meet needs of humans. Smart appliances, smart homes and smart vehicles know their owners' habits and interests, and act accordingly on their own. Digital technology extends the functionality of devices, too. Smart phones, for example, do much more than old-fashioned telephones could ever do. Such intelligence is not limited to devices: enterprises and places are using technology to improve efficiency, quality, and speed.

Intelligence and openness go hand in hand. Open access, open source, and open standards all share the characteristic of ready availability and transparency. Intelligent vehicles, for example, must be able to acquire information about traffic and weather, communicate with each other, and not be susceptible to malevolent hacking. Openness means that everyone can see, share, and contribute. The result is information that is more accurate and complete and systems that are more resilient and secure.

The South Bay: What are SMART Goals?

With a strong industrial base, global cultural assets, world-class transaction facilities, which are adjacent to the Hollywood-Los Angeles media resources and "Silicon Beach," the South Bay is ideally positioned to capitalize on the mega-trends summarized above. These trends are inter-connected. Globalization and dematerialization have been happening for centuries, but digitization has accelerated these trends. Disintermediation and virtualization depend on digitization but also enable it. As a global cross-road, the South Bay strategy must be based on an understanding of these trends. This strategy must involve building local abilities and infrastructure. And, it must focus on products and services that help other people and other organizations in other places to deal with these mega-trends.

The South Bay can flourish at the intersection of these trends, capitalizing on its current assets and position by developing and using digital technologies. Generally, this means fostering "smart," open, data-driven businesses and civic practices, which require advanced ultra-fast connectivity and a deeply-skilled workforce. But it is what you *do* with the technology that matters. Like the global trends, connectivity and skills are interdependent. They must be aligned to local development policies and municipal operations, or vice-versa. Smart city applications can improve municipal performance, increase efficiency and responsiveness, and even create new sources of revenue.

"The fourth [Industrial Revolution] is about harnessing, finally, the power of data. It's about big data and predictive analytics and artificial intelligence … Smart Manufacturing puts machines in the business of real decision-making—through calculations outside the range of human capabilities."

What is Smart Manufacturing? (http://www.industryweek.com/systems-integration/what-smart-manufacturing)

SMART Goals

Another way to think about smart regions is as places that use technology with SMART goals:

Specific and Shared: The outputs and outcomes of the goal are clearly stated. Stakeholders—anyone impacted by achievement of, or failure to achieve, the goal—are aware of and helped set the goal.

Measureable: The tasks and outcomes have clear metrics associated with them.

Actionable: The goal can be broken down into a series of clear actions or tasks.

Realistic: The tasks can be completed with available resources in a reasonable time.

Time-bound: The tasks begin at a specified time and are to be completed by a specific date.

What is a "Smart Region"?

Imagine "*a physical world that is richly and invisibly interwoven with sensors, actuators, displays, and computational elements, embedded seamlessly in the everyday objects of our lives, and connected through a continuous network.*"[6]

The idea of "smart" places and things has been with us since antiquity, but it has only recently become truly possible. The technologies to realize the vision are available today. It can be expensive, difficult, and complex to design, deploy, and manage these technologies, but they exist.

The key to success—to minimizing costs and negative impacts while getting maximum benefits of a smart region—is clear, shared purpose. *Smart* essentially means better decisions and more effective action. It means residents, industries, and government agencies that are more aware, informed, and truly empowered.

> The purpose of a smart region is to give those who live and work in it a level of certainty, comfort, and control they would not have elsewhere.

Smart Region Applications

As you consider the list of applications below, think about what is required to make each work. What content, data, and functionality are needed for each? How are content and data collected, verified, and used? Does the function involve devices? If so what kinds, and how are they interconnected? Who deploys, manages, owns, and uses each application and related devices? How are they secured to give users the rights to create, read, update, and delete content? Note that while some of the applications clearly fit with existing local government functions, others supplement, even supplant, or require new government functions. Few specific applications are built by public agencies; most are created and sold by private companies. Is that a problem, or is it a good thing?

- Building automation – control the access to lighting and temperature remotely[7]
- Citizen participation– make requests and suggestions, voice opinions, and vote on local plans, policies, and programs
- Environmental monitoring – track air and water temperature, precipitation, smog and other pollution, wind direction and speed, and identify how environmental factors are impacting your place and property
- Government performance – get information on the operations of specific governmental departments, divisions, or programs
- Healthy living – plan activities to improve health, including diet and exercise, based on your conditions, goals, and preferences, and on availability of resources
- Parking and transportation – assess transportation options and locations, including speed, congestion and costs, then select and pay for the service you want
- Paying bills, fees, and fines – conduct transactions with government and non-profit agencies

[6] "The Origins of Ubiquitous Computing Research at PARC in the Late 1980s," by M. Weiser, R. Gold, and J. S. Brown. *IBM Systems Journal*, volume 38, issue 4, pp. 693-696, 1999. http://www.cs.cmu.edu/~jasonh/courses/ubicomp-sp2007/papers/03-weiser-origins.pdf

[7] Building architecture and design phases are also computer-intensive with the use of computer aided design (CAD) software to layout and transfer designs

- Selling, sharing, and trading – let others have or use things that you aren't, or even enable businesses to market directly to government agencies, each other, and to consumers
- Service requests and tracking – document building code, public safety, public works, or other problems and track resolution activities
- Wayfinding – beacons, kiosks, maps, and displays or signs to figure out where you are, where you want to go, and how to get there

Digital Infrastructure

A smart region contains both communications infrastructure and other infrastructure with intelligence built into it. To be smart, all the infrastructure must have virtual, as well as physical, connectivity.[8] The physical and virtual characteristics of the infrastructure must be tracked and managed. The physical infrastructure includes:

- Antenna and wireless access points for various types of communications and connections, including land mobile radio (LMR), Wi-Fi, LTE, and 5G[9], which generally need to be interconnected via fiber-optic cables
- Fiber-optic cables, including cross-connects, conduits/ducts, hand holes, poles, splice blocks, vaults, etc., that allow physical access to and deployment of the cables
    - Copper coaxial and twisted pair cables are only nominal parts of smart region infrastructure because these technologies are outdated, no longer being deployed, and being removed in most locations.
- Network devices, including concentrators/hubs, optical network terminals and units (ONT/ONU), routers, switches, etc., for connecting cables and managing traffic
- Sensors that detect or measure physical properties—heat, light, movement, pressure, vibration, etc.—and generate data for measurement
- Controllers (microcontroller) and actuators for devices and machines such as doors, gates, lights, motors, switches, etc.; a controller is essentially a small, special purpose computer that provides a control signal to an actuator, which physically moves the item, based on input from a sensor[10]
    - Traffic signal controllers may either be installed adjacent to the signal, in the environment, or centralized in a data center.
- Utility and transportation infrastructure with digital infrastructure built into it

Virtual infrastructure is comprised of code, data, and services constructed from code to create, manage, and use data. Consider, for example, an intelligent transportation system (ITS) that enables people to be better informed about and make safer, more coordinated, and 'smarter' use of trans networks. Such a system includes a lot of physical infrastructure, such as traffic lights, gates, and trains. Hidden from view, it is the virtual infrastructure that determines when the lights change, the gates open and close, and the trains move. Code controls the operations via actuators, based on data collected via sensors. The code and data are integral parts of the infrastructure that must be designed and maintained just like their physical counterparts.

[8] Refer to the discussion of virtualization on page 4.

[9] Wi-Fi, LTE (Long Term Evolution), and 5G (fifth generation) are wireless communications standards, each of which has multiple versions. Wi-Fi uses unlicensed spectrum, and each subsequent version of the standard has allowed faster speeds with backward compatibility with prior versions. LTE and 5G both use licensed spectrum, which is expensive but allows exclusive use. LTE is essentially a bridge to 5G, and has also gotten progressively faster with each version but without backwards compatibility.

[10] Controllers are often linked via controller area network (CAN) within a machine. Initially developed for automotive applications, CAN is now widely in automation and aviation. Traffic signals do not use CAN technology.

Workforce Capabilities

Capabilities are simply what you can do with what you have—the combination of ability and capacity—or how well you can function. Smart regions should enhance and increase capabilities: People in a smart region can do more, better. This is due to the region's technological infrastructure, which does things for people and makes what they do more effective. But people within a smart region also need capabilities that aren't necessarily needed elsewhere.

To begin with, people in smart regions need to know how to use the various applications. The applications should be designed to be easy to use but, generally, the more powerful and specialized an application is, the more knowledge and skill required to use it. All information technologies require users to have a basic level of digital literacy, which consists of:[11]

- A variety of skills—technical and cognitive—required to find, understand, evaluate, create, and communicate digital information in a wide variety of formats
- Ability to use diverse technologies appropriately and effectively to retrieve information, interpret results, and judge the quality of that information
- Understanding of the relationship between technology, life-long learning, personal privacy, and stewardship of information
- Use of these skills and the appropriate technology to communicate and collaborate with peers, colleagues, family, and the general public
- Use of these skills to actively participate in civic society and contribute to a vibrant, informed, and engaged community

There are at least a couple of ways of looking at this. The Partnership for 21st Century Learning characterizes *ICT Literacy* as the ability to "apply technology effectively," and as part of ability to create, evaluate, and effectively use information, media, and technology.[12] Mozilla, a non-profit organization dedicated to ensuring the internet remains a global public resources, defines *web literacy* as abilities to participate online, read online, including understanding of "web mechanics," and create or write online content.[13] The Mozilla definition is especially powerful because it includes basic technology production skills, which provide a foundation for more specialized and advanced capabilities.

A smart region needs a workforce that is capable of building and maintaining applications and infrastructure. People must generally know about the contexts and principles of automation and information technologies, and the region must have deep competencies in critical areas, such as:[14]

- Communication, Integration, and Software: Design and implement the infrastructure for automation systems.
- Compliance: The standards, processes, and procedures in place to ensure products, services, and practices comply with legal and regulatory requirements
- Control: Ensuring predictable, stable, and consistent operation at target levels of performance with only normal variations
- Databases and Applications: The use of technology to control and safeguard the collection, organization, structure, processing and delivery of data

[11] Adapted from the American Library Association's definition of digital literacy; see http://connect.ala.org/node/181197 for more details.

[12] ICT stands for "information and communications technologies." For more information about the Partnership for 21st Century Skills' framework for learning and access to their resources, visit http://www.p21.org/about-us/p21-framework.

[13] See https://learning.mozilla.org/en-US/web-literacy for details about Mozilla's approach and resources.

[14] This list was adapted from the Career One Stop occupational competencies for automation and information technology, which can be found online at https://www.careeronestop.org/competencymodel/.

- Digital Media and Visualization: Conveyance of ideas and information in forms such audio, text, pictures, diagrams, video, photos, maps, 3D models, etc.
- Industrial Automation and Control Systems (IACS) Cybersecurity: The knowledge, skills, and abilities needed to understand the purpose and implement the function of cybersecurity in operational technology, including tools and systems
- Measurement, Sensors, and Actuation: The sensing, measurement, and actuation devices necessary for automation
- Networks, Telecommunication, Wireless, and Mobility: The processes, hardware, and software employed to facilitate communication between people, computer systems and devices
- Risk Management, Security, and Information Assurance: The standards, issues, and applications used to protect the confidentiality, integrity and availability of information and information systems
- Software Development and Management: The process of designing, writing, testing, debugging/troubleshooting, and maintaining the source code of computer programs and of managing and maintaining software in an organization
- System Safety and Reliability: Understand, design and implement safe and reliable machinery and process control and safety systems
- User and Customer Support: The range of services providing assistance and technical support to help users implement and solve problems related to information technology

Possibly even more important than having ready supply of these skills is that private enterprises and public agencies must be moving to *employ* them. This means having a plan to use the applications and invest in the infrastructure. This is a step toward such a plan. It provides a vision to guide more comprehensive and inclusive planning. Investment in infrastructure—and in workforce capabilities—must be based on in-depth understanding of willingness to use the applications. Currently, either (a) stakeholders of a smart South Bay are unaware and uninformed about the applications, (b) aware and informed but not acting upon that knowledge, or (c) simply disengaged from the planning process. A "Smart South Bay" initiative should address all these possibilities.

Section 2:

The South Bay Today

The South Bay area is a conglomeration of cities to the south and west of Los Angeles proper. The core of the South Bay, upon which this study focuses, are the cities of (in alphabetical order) Carson, El Segundo, Gardena, Hawthorne, Hermosa Beach, Inglewood, Lawndale, Lomita, Manhattan Beach, Palos Verdes Estates, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, and Torrance. It officially includes unincorporated areas of Los Angeles County and areas of the City of Los Angeles—along the 110, Wilmington, and San Pedro—but these areas are outside the scope of this analysis.[15]

Demographic, Economic Characteristics and Dynamics

According to the most recent estimates,[16] the South Bay has a total population of about 760,000, of whom about a quarter are age 55 or older and another quarter are age 19 or younger. About half of the South Bay's population is between 20 and 55 years of age. The population overall grew 2.1% between 2010 and 2015, or about 0.42% annually. In that same period, the 65-and-older population increased 16.5%, or about 3.3%, while the under-20 population declined about 4.4%, or 0.9% annually. The median age in 2010 was about 39, which rose to 40 in 2015.[17] As shown in table 1, the South Bay's population is growing slower than Los Angeles County overall, the state of California, and the nation but skewing older faster than the county or nation.

Table 2. Population change in the South Bay compared to county, state, and nation

	Total (1000s)			65 years and older (1000s)		
	2010	2015	Annual Change	2010	2015	Annual Change
The United States	303,965	316,51	0.8%	38,749	44,616	3.0%
California	36,637	38,421	1.0%	4,061	4,797	3.6%
Los Angeles County	9,758	10,038	0.6%	1,026	1,190	3.2%
The South Bay	743	758	0.4%	90	105	3.3%

The South Bay has some 19,000 establishments, according to the Census Bureau.[18] Table 2 presents a high-level analysis of four economic metrics for super-sectors: Human and intellectual capital sectors are those that deal with education, health, and knowledge-based services. Production and distribution involves activities to bring consumer products to the market. The retail and service super-sector is comprised of enterprises that do tasks for or sell products to consumers. The FIRE super-sector deals with

[15] These governments are members of the South Bay Cities Council of Governments. All cities, except the Palos Verdes Peninsula cities and the City of Los Angeles, are covered by the South Bay Workforce Investment board. Socioeconomic data are not available for these sub-areas of the City of Los Angeles or unincorporated Los Angeles County.

[16] All information in this section is drawn from the U.S. Census Bureau's 2015 American Community Survey and 2012 Economic Census, unless otherwise noted.

[17] Several statistics are based on medians of medians for all the cities. Descriptive statistics have not been mathematically validated. Census data from 2015 are estimates. These statistics should be considered approximations only, providing a regional perspective of the cities.

[18] Other sources indicate that this number, including public sector establishments, is as high as 45,000.

financial and real assets, brokering, holding, and leasing/lending them for fees. The area economy grew overall—across all metrics for all sectors—at about 4% per year between 2002 and 2012.

Table 3. 2012 economic metrics and 10-year change

Super-sector	Establishments	Product[19]	Payroll[20]	Employment
Retail & services	**6,887**	**17,517,975**	**2,742,692**	**109,062**
% of area economy	36.1%	16.3%	17.1%	35.9%
Annual growth/contraction	0.5%	3.2%	2.6%	1.1%
Production & distribution	**4,175**	**79,019,732**	**8,562,557**	**117,586**
% of area economy	21.9%	73.4%	53.3%	38.7%
Annual growth/contraction	2.4%	2.2%	6.1%	1.4%
Human & Intellectual Capital	**5,713**	**9,237,784**	**3,435,383**	**58,349**
% of area economy	29.9%	8.6%	21.4%	19.2%
Annual growth/contraction	2.0%	6.5%	6.3%	2.4%
FIRE[21]	**2,327**	**1,933,819**	**1,311,140**	**18,579**
% of area economy	12.2%	1.8%	8.2%	6.1%
Annual growth/contraction	12.6%	0.6%	28.3%	8.6%

Human and Intellectual Capital Sectors

Overall, human and intellectual capital enterprises accounted for about one fifth of the area's economy, and saw some of the strongest overall growth. This super-sector grew the most in employment, payroll, and product. It had especially strong growth in product relative to other super-sectors. The growth in payroll and product for this super-sector was nearly three times greater than the growth in employment, which suggests the sector has very strong productivity growth and its employees are being fully compensated for that growth.

Table 4. Economic metrics for human and intellectual capital sectors

2012	Educational services	Health care and social assistance	PST services
Establishments	**264**	**2,748**	**2,701**
Change per year	2.1%	5.6%	1.6%
Product ($1,000)	**155,919**	**4,160,147**	**4,921,718**
Change per year	11.5%	10.3%	2.9%
Payroll ($1,000)	**47,718**	**1,505,042**	**1,882,623**
Change per year	9.7%	12.0%	3.4%
Employment	**1,985**	**33,339**	**23,025**
Change per year	6.9%	7.9%	0.3%

[19] The "Product" is the value of sales, shipments, receipts, revenue, or business done ($1,000), not including foreign subsidiaries.

[20] Annual payroll ($1,000) includes all forms of compensation, such as salaries, wages, commissions, dismissal pay, bonuses, vacation allowances, sick-leave pay, and employee contributions to qualified pension plans paid during the year to all employees.

[21] Finance, insurance, and real estate, including leasing and rental

2015 ACS employees[7]	**74,816**	**34,319**
Change per year	37.3%	16.3%

A look at the sectors within the super-sector (table 3) reveals that much of the growth was in education, followed by professional, scientific, and technical (PST) services. PST services sector is the most productive and infuses the most wealth into the local economy via payroll. Each employee in this sector is associated with over $200,000 of product, well ahead of the other two sectors. (See table 4.) But PST services also has the highest pay per employee, and each dollar of payroll is associated with only $2.61 of product. In contrast, each employee in education is associated with over $78,000 of product, but each dollar of payroll is associated with $3.27 dollars of product. Education has the lowest per employee payroll. Healthcare has more establishments (locations) and employees than the other two sectors in this super-sector, but also the slowest growth in all measures. Each employee in this sector is associated with approximately $125,000 of product, and $2.76 of product has a dollar of payroll. A comparison of data from the 2012 Economic Census and estimates from the 2015 American Community Survey suggests that these sectors' growth has accelerated since 2012.[22]

Table 5. Relationships between metrics for human and intellectual capital sectors

	Educational services	Health care and social assistance	PST services
Pay per employee	$24,039	$45,144	$81,764
Product per employee	$78,549	$124,783	$213,755
Product per dollar of pay	$3.27	$2.76	$2.61

Production and Distribution Sectors

The production and distribution super-sector dominates the South Bay's economy in terms of product and payroll. It seems to have grown about the same rate as the intellectual and human capital super-sector, except in terms of product. A more detailed analysis shows that the growth numbers come from the fact that there was no data for several of the sub-sectors in 2002. Therefore, they seem to have grown from nothing over ten years. In fact, the only production and distribution sector that clearly grew between 2002 and 2012 was the information sector. The wholesale sales contracted moderately, and the manufacturing sector appears to have contracted as well. While it is not accurate to compare data from the 2012 Economic Census to estimates from the 2015 American Communities Survey, such a comparison can give a general sense of the direction and magnitude of changes in these sectors. As shown in table 5, the production and distribution sectors seem to have continued, and possibly accelerated, their contraction in recent years.

Table 6. 2012 Economic metrics for production and distribution sectors

2012	Info	Manufacturing	T&W[23]	Utilities	Wholesale
Establishments	**527**	**1,023**	**1,006**	**20**	**1,599**
Change from 2002	3.4%	-1.6%	NA	NA	-1.0%

[22] This section of the analysis should be taken with a whole shaker of salt because the data come from two different sources. The American Community Survey (ACS) estimates likely overstate the number of employees. The statistics only suggests the direction and magnitude of change, not actual quantities. The number for professional, scientific, and technical services includes administrating, support, and waste management services.

[23] Transportation and warehousing

2012	Info	Manufacturing	T&W[23]	Utilities	Wholesale
Product ($1,000)	**-**	**54,679,900**	**3,890,340**	**-**	**20,449,492**
Change from 2002	NA	NA	NA	NA	-5.2%
Payroll ($1,000)	**1,135,911**	**5,516,005**	**690,919**	**-**	**1,219,722**
Change from 2002	6.9%	NA	NA	NA	0.1%
Employment	**14,464**	**66,247**	**15,908**	**-**	**20,967**
Change from 2002	3.2%	NA	NA	NA	-1.6%
2015 ACS employees	**13,053**	**43,579**	**25,965**		**11,537**
Change per year	-3.6%	-17.3%	12.9%		-27.2%

The production and distribution sectors were outstanding in terms of the relationships between the economic metrics, as shown in table 6. On average, they were three times stronger than human and intellectual capital sectors. Product per employee was especially strong: production and distribution sector employees were five times more productive overall. There was also much better return on payroll in these sectors. The payroll per employee was only slightly higher on average for this sector than for human and intellectual capital.

Table 7. Relationship between economic metrics for production and distribution sectors

	Info	Manufacturing	T&W	Utilities	Wholesale
Pay per employee	$78,534	$83,264	$43,432	NA	$58,173
Product per employee	NA	$825,394	$244,552	NA	$975,318
Product per pay	NA	$9.91	$5.63	NA	$16.77

Retail and Service Sectors

The overall analysis in table 2 shows that the retail and service super-sector has by far the largest number of establishments in the South Bay area, and is second only to production and distribution super-sector in the number of employees. But, its growth has been the weakest overall. Table 7 shows that much of the super-sector's weakness was due to contraction in other services, which declined nearly 2% per year on average across all measures. Arts, entertainment, and recreation (AER) enterprises grew the strongest, averaging 23% annual growth across metrics, but remains the smallest part of the super-sector. Other parts of the super-sector were stable, with substantial growth in hospitality industries. A comparison with 2015 employment estimates from the American Community Survey suggests that other services dramatically changed direction, with strong growth in recent years, while administrative and support services contracted.

Table 8. 2012 Economic metrics for retail and service sectors

2012	Retail	Admin & support	AER[24]	Hospitality[25]	Other services[26]
Establishments	**2,375**	**981**	**384**	**1,857**	**1,290**
Annual change	-0.4%	0.7%	6.3%	1.6%	-0.3%

[24] Arts, entertainment, and recreation

[25] Includes accommodations and food services

[26] Includes a wide variety of advocacy, cleaning, maintenance and repair, and philanthropic services; does not include public administration, which is not included in this analysis

2012	Retail	Admin & support	AER[24]	Hospitality[25]	Other services[26]
Product ($1,000)	**12,531,922**	**1,752,415**	**471,894**	**2,063,732**	**698,012**
Annual change	3.0%	2.7%	38.4%	5.8%	-2.2%
Payroll ($1,000)	**1,056,957**	**781,527**	**131,711**	**576,567**	**195,930**
Annual change	1.4%	2.8%	26.3%	5.9%	-2.0%
Employment	**37,558**	**26,782**	**5,224**	**32,296**	**7,202**
Annual change	0.1%	1.7%	21.5%	2.2%	-2.8%
2015 employment	**36,688**	**12,464**	**36,047**		**19,675**
Change per year	-0.8%	-17.8%	-1.3%		57.7%

Generally, the retail and service sectors had lackluster performance and low pay compared to other sectors. The lowest per employee payroll of all sectors was in hospitality. Only education enterprises had pay per employee as low as these sectors. The product per dollar of payroll was on par with human and intellectual capital sectors, with retail being the notable exception. That sector was also exceptional in the product per employee, which was higher than all sectors except for manufacturing and wholesale.

Table 9. Relationship between economic metrics for retail and service sectors

	Retail	Admin & support	AER	Hospitality	Other services
Pay per employee	$28,142	$29,181	$25,213	$17,853	$27,205
Product per employee	$333,669	$65,433	$90,332	$63,901	$96,919
Product per pay	$11.86	$2.24	$3.58	$3.58	$3.56

FIRE Sectors

The finance, insurance, and real estate super-sector is rather small and—when the sector details are considered—a slow growing segment of the South Bay's economy. As with the production and distribution super-sector, growth numbers are inflated simply because no data were available for finance and insurance in 2002. Thus, that sector appeared to grow from nothing over a decade. Closer examination shows the sector to be growing modestly. Although employment dropped between 2002 and 2012, comparison with 2015 suggests the sector is rebounding.[27]

Table 10. Economic metrics for FIRE sectors

2012	Finance and insurance	Real estate and rental and leasing
Establishments	**1,133**	**1,194**
Annual change	NA	1.6%
Product ($1,000)	NA	**1,933,819**
Annual change	NA	0.6%
Payroll ($1,000)	**939,311**	**371,829**
Annual change	NA	0.9%

[27] Again, this comparison only suggests size and direction of change because the data come from a different source.

2012	Finance and insurance	Real estate and rental and leasing
Employment	**11,512**	**7,067**
Annual change	NA	-2.9%
2015 employment	**25,536**	
Change per year	12.5%	

Comparison of the economic metrics show that employees in this super-sector are paid about the same and are about as productive as employees in the human and intellectual capital sectors. They perform better—economically speaking—than the retail and services sectors, but not as well as the production and distribution sectors.

Table 11. Relationship between economic metrics for FIRE sectors

	Finance and insurance	Real estate and rental and leasing
Pay per employee	$81,594	$52,615
Product per employee	NA	$273,641
Product per pay	NA	$5.20

The economic metrics reviewed above show that the South Bay is very strong in production and distribution sectors. These sectors that are contracting may be explained by higher productivity through automation. which requires higher-skilled but fewer workers. Gains in automation may also make these enterprises more "footloose," enabling them to move out of high-cost areas. Human and intellectual capital sectors are growing but do not yet have the level of economic performance seen in production and distribution sectors. This could be remedied through greater utilization of technology. FIRE sectors hold some promise. Retail and service sectors are uneven, if pervasive, across the South Bay.

Workforce Characteristics

Statistics suggest that household incomes remained about the same between 2010 and 2015, growing at about the same as the rate of inflation. The number of households earning over $150,000 a year grew strongly, while the number of households earning less $150,000 shrank (see Table 12). The most notable contraction was among middle income families. Coincidently, the number of low- and moderate-income households dropped by about the same amount as the number of higher-income householders grew. At the same time, as shown in

Table 13, the numbers of persons entering the workforce and those persons in their prime working years have declined, while the number of persons near the end of their working years has grown.

Table 12. Household incomes

	Households		
Annual household incomes	2010	2015	Annual change
Less than $50,000	99,824	98,791	-0.2%
Between $50,000 and $150,000	122,928	116,804	-1.0%
$150,000 or more	43,786	51,167	3.4%

Table 13. Changes in working-age populations

	2010 Number	2015 Number	2015 % total	Annual change
Under 20	199,555	190,688	26.9%	-0.89%
20 to 55	373,932	372,192	52.5%	-0.09%
55 to 75	128,424	146,405	20.6%	2.80%

Occupations

The largest part of the South Bay's workforce is in management, business, science, and arts occupations, which has grown faster than the overall employed population. Service occupations have grown most strongly in recent years, but are held by less than a fifth of the region's workers. Sales and office occupations, which are held by a quarter of the workforce, have shrunk. Production, transportation, and material moving occupations, which comprise a tenth of the workforce, have grown somewhat.

Table 14. Occupations and types of work in the South Bay

	2010 Number	2015 Number	2015 % total	Annual change
Civilian employed population 16 years and over	358,028	362,463	100.0%	0.2%
Occupation				
Management, business, science, and arts occupations	145,238	149,023	41.1%	0.5%
Service occupations	55,681	61,510	17.0%	2.1%
Sales and office occupations	97,509	92,949	25.6%	-0.9%
Natural resources, construction, and maintenance occupations	22,776	21,458	5.9%	-1.2%
Production, transportation, and material moving occupations	36,824	37,523	10.4%	0.4%
Type of work				
Private wage and salary workers	276,577	285,897	78.9%	0.7%
Government workers	49,238	44,611	12.3%	-1.9%
Self-employed	31,719	31,307	8.6%	-0.3%
Unpaid family workers	494	648	0.2%	6.2%

The strongest growth has been with the type of work done by the fewest workers: unpaid family workers. This finding makes sense given how the region's economy is skewing older. It is troubling both because these persons are foregoing income and are not contributing to economic productivity. Private sector workers comprise the majority—over three quarters—of the workforce, and their ranks have grown faster than the overall workforce. Self-employed work has declined slightly, and is a relatively small but important part of the economy. This type of work is important because (a) these workers can flexibly fill needs of employers and (b) they represent entrepreneurs who start up new enterprises.

Table 15. Educational achievement among South Bay adults (25 years or older)

	2010	2015		Annual change
Less than high school	71,331	73,624	14%	0.64%
High school through associate's	239,053	247,340	48%	0.69%
Bachelor's or higher	188,424	199,713	38%	1.20%

The educational achievement levels and incomes of South Bay residents have generally increased in recent years (see table 10), but the progress has been uneven. The number of persons with less than a high school education increased, and the gains were greater for higher levels of educational achievement. Persons with a high school education, some college, or an associate's degree increased 3.5%, or 0.7% per year, and the increase was 6.0%, or 1.2% annually, for persons with bachelor degrees or better. Given that educational achievement is perhaps the best indicator of earning power, one might presume that incomes also increased.

Ironically, median earnings for all educational levels except the lowest *fell* (or rose at less than inflation rate) between 2010 and 2015 (although there was substantial variation in these statistics between cities). Higher education clearly means higher incomes for the South Bay—persons with graduate or professional degrees earned about four times as much as persons with less than a high school education—but college education became *less* valuable in recent years.

Table 16. Mean and median household incomes and incomes by educational level

	2010	2015	Annual Change
Mean household income	**$133,672**	**$134,738**	**0.2%**
Median household income	**$89,926**	**$85,727**	**-0.9%**
Median incomes by educational achievement			
Less than high school graduate	$22,322	$20,950	3.81%
High school graduate	$32,264	$30,729	0.88%
Some college or associate's degree	$42,513	$42,104	-0.83%
Bachelor's degree	$64,533	$63,250	-0.48%
Graduate or professional degree	$84,174	$84,174	0.53%

The median household income for the South Bay fell overall. At the same time, *mean* income levels rose. In both 2010 and 2015 the mean household income was greater than the median income. This indicates that the majority of household incomes was less than the median income. The increasing mean household income and decreasing median income suggests that the distribution of incomes became even skewed in recent years: A relatively few households are earning much more, while the majority of households are earning less.

Commuting and Housing

Data for commuting shows that the South Bay's workforce spend slightly more time in their cars than the national average mean travel time to work, which is 26 minutes.[28] This translates into lost productive time, degraded quality of life, higher cost of living, and increased social costs from congestion, pollution, etc. To make matters worse, commute time has increased markedly, although alternate commuting means—especially telecommuting—have increased, too, while driving alone and carpooling have decreased (particularly relative to the size of the workforce).

Table 17. Commuting to work: means and mean travel time

	2010	2015	Annual Change
Workers 16 years and over (total)	348,054	351,124	0.2%
Means of commuting to work			
Drove alone	274,145	275,164	0.1%
Carpooled	32,560	30,347	-1.4%
Public transportation	12,368	13,072	1.1%
Walked	6,080	6,629	1.8%
Other means	7,013	7,837	2.3%
Worked at home	15,888	18,075	2.8%
Mean travel time to work (minutes)	**28**	**29**	**0.7%**

The total number of housing units in the South Bay increased only slightly in recent years. The vacancy rate in a robust housing market is around six or seven percent. In the South Bay, vacancy rates are far below this, especially for owner-occupied housing units, and the rates decreased substantially between 2010 and 2015. The number of owner-occupied units decreased slightly, while the number of renter occupied units increased. The median monthly rent for the South Bay increased about 1% annually—this represents 20% of the median annual income, which is about the limit for a family of four to remain solvent.

Table 18. Housing availability and costs

	2010	2015	Annual Change
Total housing units	**281,827**	**283,534**	**0.1%**
Owner vacancy rate	1.0	0.8	-4.4%
Rental vacancy rate	3.4	3.0	-2.8%
Owner-occupied units	139,879	138,230	-0.2%
Median value	$767,800	$736,100	-0.8%
Occupied units paying rent	123,682	125,517	0.3%
Median rent	$1,457	$1,524	0.9%

Oddly, the median value of owner-occupied units decreased. While there is no data on mean value, median values increased on average by 2.77% annually between 2010 and 2015. The average median

[28] https://www.washingtonpost.com/news/wonk/wp/2016/02/25/how-much-of-your-life-youre-wasting-on-your-commute/?utm_term=.be6796e9ed9d

owner-occupied house value in 2015 was approximately $832,000, up from about $767,000 in 2010. This suggests that the change in median value was at least partially due to an increase in low- to mid-value homes. In fact, the statistics show that the number of homes valued between $100,000 and $400,000 increased 6.5% per year between 2010 and 2015.

Conclusions

The South Bay is facing major economic forces, and they're showing up in socioeconomic metrics. The general results are a gulf between high- and low-earners, hollowing out of the middle class, loss of major enterprises as economic scale gets smaller, and a shift toward value-added service. All of this is driven by technology. The difference in the product per employee of various sectors, for example, is largely due to the extent to which technology has infused the industry. The sectors with companies that have made smart investments in technology are those that are fastest growing, highest paying, and most productive. Basically, "smart" means shifting toward intangible assets

Insights from South Bay Leaders

Magellan Advisors conducted interviews and focus group sessions with leaders in various sectors of the South Bay's economy. Some sectors—especially healthcare—are growing and expanding rapidly. Other sectors, such as manufacturing and warehousing, seem to be contracting in some areas. The growth in healthcare is mostly based on demographic and population change. And, what looks like industrial decline may be attributed to improvements in efficiency and productivity, defense department cuts or responses to local economic changes.

Hands-on, manual skills are still required, but increasingly the role of workers is to program and run the machines that do the work. A computer may be perceived as simply a tool, but the technology requires a new way of working and doing business. Producers are using technology to reduce the amount of materials used in—and the costs of—their products, while improving the quality. The technology enables everything from computer resources and networks through whole organizations to be virtualized, making them more flexible and responsive. Digital content is creating new sources of revenue, adding new value to existing products, and making smarter decisions much easier and faster. Generally, capital is becoming more intangible while labor is becoming more intellectual.

At the same time, demographic change and economic growth are creating some vexing problems, specifically traffic congestion and pollution. There are efforts to address these, such as the recently passed Measure M to fund transit. Only about ten to fifteen percent of what the South Bay area contributes will be spent on transit for the area. With its ballot initiatives, congestion, regulations, and taxes, California is generally not perceived as a business-friendly state. There are many things cities can do to address this situation. Business environment depends on the community: it is largely geographical, and each area has a little different economy.

Local efforts to increase the availability and use of broadband can make a huge difference. But broadband is just one thing cities can impact. Events such as hackathons, initiatives to open data, and establishment of "third spaces" where people can connect and collaborate are other low-cost, high-impact tactics. Generally, if these things are available, people will get interested in and involved with them. There are many ways to capitalize on technology for economic and social change, and there are many questions that have no clear, simple answers. Leaders need something concrete to guide their decision-making.

Possibly the best foundation for digital development that increases both broadband capacity and workforce abilities, is to look at what is happening in major sectors, and to understand their challenges and needs. The following section is based directly on information provided by South Bay stakeholders, with active interest and participation in each area.

City Governments

The beach cities seem to have better infrastructure and more choices for broadband than the inland cities. Several of the beach cities own their own fiber or have access to dark fiber as part of cable franchise agreements. There are more data centers and large corporate users, therefore more providers. Some of the cities within the South Bay, such as Manhattan Beach, Inglewood, Redondo Beach and others, are thinking about "smart city" applications and internet-of-things (IoT). The beach cities are starting to analyze the costs of these initiatives. They are using application software that could benefit from more mobile connectivity, and looking at technology-intensive renovations of civic facilities. They are considering how to expand fiber-optic infrastructure to more locations, developing policies to enhance the infrastructure itself, and leveraging existing infrastructure for more connectivity. Rather than focusing on economic development, per se, these cities are focused on sustainability, public safety, mobility, and the circulation of people.

The cities on the east side of the South Bay have some choice but limited broadband options. These cities are seeing businesses leave, in part, because of lack of broadband. They are beginning to look at physical infrastructure, such as conduit and poles, but have not directly addressed fiber-optic or even wireless connectivity. IT, planning, and public works personnel are aware of "smart city" concepts but there has not been any discussion by or with elected officials about projects. They are much more interested in economic development. These cities pride themselves on being business-friendly. Leaders in these areas have never had technology explained to them as a critical asset for business and economic development.

Generally, for many of the South Bay cities, there simply isn't real leadership support for technology utilization. There is support internal to public works, public safety, and IT, where they know that technology adds real value to cities. They are interested in a regional fiber-optic network but still largely in "wait and see" mode. It is incumbent on IT to sell it to leaders. If technologists can do a good job at that, the city councils will buy in. The South Bay cities should review successful initiatives in Santa Monica, Hollywood, and other progressive communities. It is important to demonstrate and communicate to elected officials the benefits and importance of these initiatives. Compare use of technology and impacts as well as the speed and reliability of broadband services.

The City of Carson has established a special citizen commission to help the council members "know what they don't know," and set planning priorities. State-level stakeholders are supportive of broadband and tech-based development for the South Bay. Other cities are bringing department heads together to collaborate on technology projects. They are coordinating anything happening in public ROW, and bringing service providers together regularly to discuss projects. These types of activities build organizational capacity as the cities wait to see what the regional network model is, what the costs and investment might be, what additional staff are necessary, how is it going to be upgraded and replaced, how will it be funded, and what's the level of participation required. Clarity on these issues would help technologists to engage and educated city leaders.

The SBWIB and SBCCOG play an important role providing forums for collaboration among the South Bay cities. The creation of technology committees and events, such as the SBWIB's Technology Committee and the SBCCOG's Annual General Assembly promote knowledge sharing and discussions about technology, economic development, local policy and more. These forums highlight opportunities for municipal leadership, as well as for mutually beneficial partnerships within the region.

Education, Workforce, and Youth

Many South Bay schools are aggressively deploying technology, particularly through "1-to-1" programs that provide each student with a laptop or tablet computer, but not all schools are so well funded. Some have seen as much as 70% reduction in their budgets. Well-funded schools have established "maker spaces" equipped with technology such as 3D printers, and provide STEM (science, technology, engineering, and math) programs. Tech-savvy parents, such as those working in aerospace and software industries, come in to help maintain the technology and mentor students.

Some schools are able to fund technology investments via bonds and other means, and receive e-Rate funds for interconnecting schools and for internet access. Schools with limited funding and/or that can't receive e-Rate funding, particularly vocational schools and adult education, can't afford much technology. For example, they can't provide students with Wi-Fi. But it is these schools that are often charged with teaching skilled trades that are being directly impacted by automation and software.

In schools with ample resources, everyone can be up to speed with the technology together. The majority of teachers—80%—have experience with digital technology. Teachers all get laptop computers, docking stations, and other educational technology resources. They have technical trainers who help them understand how to use technology in the classroom. Teachers who aren't comfortable with the

technology retire, and are replaced by teachers who tend to be younger and tech-savvy. These teachers' online behavior generally doesn't have to be closely monitored because they know to "keep it G-rated."

Students' online behavior can be an issue both because of its impacts on the learning environment and on utilization of technological resources. Through the creation of virtual "walled gardens", so only certain sites and services are available to students, schools are able to block - "throttle back" - certain types of traffic—video—to reduce network congestion as well as avoid inappropriate uses. Middle school students, especially, need to be monitored and educated about online hazards and proper online behavior.

The schools are using a wide variety of administrative and instructional systems and software tools, from Google Classroom to student information systems. Well-funded schools have video surveillance and digital telephone ("voice over IP" or VoIP) systems as well. Some of these systems are fully online, hosted elsewhere or in the "cloud" and accessed through the internet. Other systems run on mission-critical school-maintained servers. The well-off schools typically have back-up servers for these systems hosted by Los Angeles County. The less-well-off schools have old telephone PBX, limited technology for security purposes, very limited IT staff, and out-sourced technology support.

Within the school districts, most schools are interconnected at multi-gigabit speeds, and many school districts have a very fast, typically 1 Gbps, connection to the internet. The connections between schools are over dark fiber that the schools light and operate. This infrastructure is owned and maintained by telecommunications providers, and provided to the schools for little or no cost as part of cable TV franchise agreements with local governments. The agreements are in force for another 10 or 20 years, so the schools are mostly well-prepared for broadband; those in the more prosperous community, at least. Schools without such resources are stuck with much lower speeds—50 Mbps, which is shared by all students, academic and administrative software.

Schools get internet access and other online resources from Los Angeles County, which aggregates school bandwidth demand and manages contracts with telecommunications companies. The e-Rate program pays for about 40% of the cost of internet access, but it does not pay for redundant connections. All the connections run through a single location—a "carrier hotel" and interconnection point at 1 Wilshire Blvd. in downtown Los Angeles. There were major outages recently as infrastructure was changing corporate hands (from Verizon to Frontier). This greatly increased desire for more reliable connections. It seems that CENIC,[29] a non-profit network service provider, has more bandwidth, is less expensive, and is more reliable, so schools are interested in moving to it. Access is not a problem for students who have home broadband, cellular data services, or can use Wi-Fi at a variety of sites—coffee shops, etc.—around the area.

Libraries

There are multiple library systems across the South Bay area (i.e., district, city, and county). The libraries provide computers for patrons to use and wireless (Wi-Fi) internet access. Most libraries turn off their wireless access at night to keep people from hanging out in their parking lots. Computers in the libraries—most of which are in the main libraries rather than branch locations—are in continual use. Libraries' Wi-Fi can be inadequate simply due to the number of users and types of use. The libraries provide a wide range of information services to patrons.

Libraries don't just provide access to online content or databases, librarians also explain how the services work. They get a lot of questions about health, social services, and e-government, which they try to answer as well as possible. Typically, Internet access via the library is a matter of necessity rather than

[29] See http://cenic.org/about/about-overview for more information about CENIC.

convenience for patrons. Many business and social services are digital-only. For example, people come to the library to apply for jobs because they don't have computers or have no way to attach required documents. In response to these needs, the role of the librarian extends to teaching people how to use ancillary technology such as scanners, as well as help them access job application sites.

Lack of technical competency among library patrons and limited capacity of library staff is a huge issue. People often come to the library because they don't know what to do. Consequently, librarians spend a lot of time doing one-on-one support. While much of the support is quick and simple guidance, it can be very time intensive. For example, someone who doesn't have an email address requires a half-hour of support just to get that set up so he or she can use other services. There's often an intermediary such as a child, neighbor, or relative to provide support or translate. While this can be helpful, it tends to increase the time that library must spend to support the patron. Some information services require a credit card number or even just a home address, and some patrons have neither.

The libraries are starting to provide access to online training services, such as Lynda.com, and beginning to add technology to their collections for patrons to check out. Patrons at some libraries can check out laptop computers, projectors, scanners, and even Wi-Fi hotspots that connect to the internet via cellular data. Some patrons use the library for remote access to work while travelling or use the library meeting rooms. Unfortunately, most library meeting are not set up for teleconferencing because of the need for additional bandwidth and equipment. The libraries proctor a range of exams, but generally warn people not to use the library computers or Wi-Fi for this purpose because they can be slow and unreliable.

Libraries are using technology internally too. Librarians are using laptop computers and wireless technologies to take the library services out into the community. RFID is increasingly common for checking out and tracking items in library collections. Patrons expect library websites to look and function like the websites on major corporations. Most libraries require prospective employees to apply online—it demonstrates their digital competencies as well as makes the application process more efficient—and much of librarians' continuing education is done online. This drives demand for more bandwidth and more patron support.

Typically, the main library in a system will have a relatively high-speed internet connection—generally around 300 Mbps—and be connected to branch locations via a separate network for internet access and administrative system. Cities with fiber infrastructure help with interconnection. Internet access is typically contracted from a private internet service provider on a 36-month basis. The libraries receive e-Rate funds to defray the costs for internet access and site interconnection. Many libraries are working to upgrade bandwidth, driven by burgeoning demand. There are disparities between locations to the east and those to the west, with different infrastructure, different providers, and different service options in different parts of the area. The libraries receive more bandwidth at a lower cost from CENIC but it requires libraries to pay for last mile connections from a third party. Currently, CENIC provides Wi-Fi services as well as internet access for some libraries.

Libraries are committed to free and open access to information. They don't track patrons' internet activities, they wipe all patron data from any technology when they check out, and even records of traditional borrowing are minimal to protect patrons' privacy. The libraries address the whole chain of information access and technology use—from availability to acquisition to utilization to supporting non-users—to make sure all residents have access. They see a need for local level advocacy to make sure people have connectivity options, and national level advocacy to treat internet like a utility that is available to all at a reasonable cost.

Healthcare and Social Services

The healthcare and social services sector is in constant change, and technology is accelerating and increasing that change. From WebMD to Googling to Teladoc there are a lot of disruptions in healthcare. Some providers are embracing the change and bringing it in-house, but there are other providers who continue to practice medicine in a traditional manner. At most hospitals and medical offices, extensive patient records are maintained and shared electronically. Providers have systems for guiding examinations and making diagnoses. Medication management is used to alert providers of problems with allergies and drug interactions, as well as to assure patients are properly medicated. Radiological systems generate very-high resolution images of blood vessels, bones, and internal organs. And, there are a wide range of administrative systems used to manage financials, human resources, and most every asset. Online healthcare applications are increasing patients' access to health records. There are a wide range of automated systems used in healthcare, and it's increasing. For example, some providers are experimenting with robots to conduct rounds. The robots can automatically check a wide range of patient indicators and virtually pull in an expert if any of the indicators are out of range.

Privacy and security is paramount with respect to medical records. To keep the data secure, records need to be stored remotely on protected infrastructure, with as little data as possible on local laptops, smartphones, tablets, workstations, or other digital devices. Healthcare providers in the South Bay area operate in-house servers and use cloud-based information systems. Sensitive data flows among providers, between them and insurance companies, and out to regulatory agencies. Larger provider organizations utilize data centers around the nation, especially those that are affiliated with or owned by national healthcare systems. Local connectivity is necessary to reach these data centers, connect local systems, and enable access for diverse end users: patients, practitioners, support personnel, regulators, etc. The HIPAA (Health Insurance Portability and Accountability Act of 1996) ensures data privacy and security to safeguard an individual's medical information. Connectivity within healthcare systems requires a very high capacity and security, because of the amount and types of data that flow across healthcare networks.

Healthcare systems are trying to reduce their physical footprints as much as possible, move care closer to the patient, and this is driving telehealth forward. This means using lots of videos, images, and other forms of digital data, which take a lot of bandwidth. Big data is an area of opportunity for healthcare organizations that have been gathering data for long periods of time: analysis of large quantities of historical data can provide useful insights into operations and treatments. Constant process improvement, whether it be treatments, workflow, or otherwise requires root cause analysis, which requires data-based insights. Medical personnel are required to continuously maintain knowledge and upgrade their skills. Many healthcare providers maintain internal databases of classes, a lot of which are online or offered via enterprise-wide systems for keeping people certified. Healthcare is a people-oriented sector so there is still a lot of training that takes place in-person, but trainings are increasingly attended virtually.

The bandwidth, connectivity, and data flows are driven by bigger, broader changes in healthcare. One driver is demographic: more and older patients with more chronic conditions such as autoimmune disorders, diabetes, and heart disease. Another driver is economic: new, more effective treatments that are also much more expensive. Really, though, the big driver is the simple fact that the more we keep people out of the hospital the better they are. Healthcare is moving from a disease-oriented approach to a wellness-based approach; from treating the ill to keeping people healthy. Regulators are putting teeth behind this by penalizing hospitals with high-readmission rates and low-quality metrics. It is also simply less expensive and more comfortable for patients to be treated, where practical, and to recuperate at home.

Consequently, providers are moving to smaller facilities, closer to customers. Clinics and out-patient surgery centers are supplanting large medical centers. Social workers are moving to work on-site, in real-

time. Medical personnel are doing "pop ups" in neighborhood centers. Administrators and support personnel as well as providers are working from home or other remote locations. The next frontier is to bring more medical services, including check-ups, regular therapies, and simple diagnoses, into the home via digital *telehealth* systems. Consumers are increasingly expecting health services to be available anytime, anywhere via digital devices, including wearable computers. General purpose wearable devices such as Apple Watches and special purpose consumer devices such as Fitbits are just the tip of the iceberg. Special purpose wearables are emerging for a wide variety of conditions, as are assistive technologies such as smart wheelchairs and home care robots. These devices require connectivity at some time, in some way.

The challenges are connectivity, skills, and costs. Consumers don't necessarily have the infrastructure and services to support telehealth, and may not be very savvy about technology. There are also cultural and language barriers—ethnic and tech. Emergency response systems often need a translator. While technology can help with language translations, it can also create other communication challenges. For example, there have already been situations in which persons in trouble have used instant messaging to seek help, but those systems don't integrate with emergency or clinical systems. Practitioners need new skills—technical, professional, and interpersonal—for working remotely, and must make sure they have secure and capacious connections. And, of course, these connections must be available in more locations and in more remote and less economically prosperous locations.

Moving care closer to the customer can reduce overall healthcare costs, but it also tends to shift costs to consumers and smaller providers. Part of the costs are the "soft" costs associated with identifying and implementing the appropriate solution. Large healthcare systems have whole departments and teams of technology professionals to deal with these issues. Small and non-profit providers find it difficult to get unbiased technical guidance. Consumers have a hard time assessing the quality of health information online, and are even more challenged to determine how effective, practical, and secure healthcare technologies might (or might not) be. There is a real need to advocate on behalf of and assist these stakeholders in getting and using broadband and related technologies for health purposes.

Manufacturing

South Bay is somewhat economically unique in the wide geographic distribution and diverse product lines of its manufacturers, as well as their quantity and size. There are many relatively large manufacturing establishments across the area. The entire sector has undergone profound changes in recent decades due to the dual forces of automation and lean production. The next wave of digital, or "smart," manufacturing brings these two together with software that builds on and extends older enterprise resource planning and manufacturing requirements planning (ERP/MRP) software. The real key to this revolution is not just ability to monitor and control production, but being highly responsive to local consumer demand. While supply chains are likely to remain global, especially for commodities, production of high-value finished products is being pulled closer to consumers. The factories at the heart of this approach are "lights out" facilities that can run without human intervention, and that are highly integrated with materials suppliers and distributors. Goods are only produced when and where demanded by the market. Highly standardized, low-value commodity products and very complex, high-value products will continue to be produced in locations with either cheap, low-skill workers or highly paid and highly skilled workers, respectively.

South Bay has high-end manufacturing, especially in aerospace, that needs to be near a highly skilled workforce and customers. And, they need superb connectivity. Industry analysts foresee manufacturing moving into adjacent markets via digital technologies, building it into products and providing value added services such as cybersecurity. Satellites, planes, and now drones have increasing intelligence built into them. Fully autonomous vehicles are already in development, led by aerospace's autonomous drones.

The sector has an innovation pipeline that is evident in the South Bay. For companies in the defense and space industries competitive advantage comes from constantly improving core technology. As new defense and space technologies are deployed and diffuse into use, they create new business opportunities in other sectors, particularly cybersecurity, and information technologies and services, in general.

The key to growth in this critical sector is capable, educated workforce. Manufacturers, particularly aerospace, as well as adjacent high-end, high-pay, high-tech sectors, have a backlog of jobs. They are creating new programs but can't hire enough people fast enough to get up and running. Three factors exacerbate the need for technically skilled workers in aerospace, manufacturing overall, and related industries. First, the workforce is skewing older and many workers are reaching retirement age. Second, competitors, or just similar companies, raid the current employee base. These factors cause brain drain and generate significant from costs from hiring and lost productivity. The third factor is that manufacturing is not seen as bleeding edge or high tech, as easy to understand, or as rewarding, as tech. It has a branding challenge. In the LA region, a fourth factor is traffic congestion, which impedes the flow of people and products.

Retail and Services

The South Bay has diverse and thriving retail and services sectors. Some 8,000 establishments, according to federal statistics, comprise this super-sector. It provides essential support for other sectors, as well as for individuals and households, and provides local low-skill, low-tech job opportunities for residents. But as elsewhere and in other sectors, South Bay's retail and service sectors are changing. Retail establishments have become showrooms for customer who buy online: They come in to check it out then order it from Amazon.com. Meanwhile, most small retailers have limited if any online presence. There are some opportunities for retailers to fulfill orders for manufacturers but manufacturers are competing directly with retailers, too, via online shops. More people are working at home, which could generate business for local professionals and shops, if they are well-positioned. Basically, as a South Bay retailer, if you're only competing on price, you're in trouble.

Services are in a similar predicament. Customers are using service professionals less and online services more. There are a huge range of online applications to bypass local services, and even more making finding and using services cheaper and easier. Zillow and Trulia make it easy to bypass local realtors. Uber and Lyft allow anyone to compete with taxis and transit. Internet technologies are becoming common in service industries, too. From wearables for customer associates to video surveillance, tech is becoming critical. Retail and service companies are realizing new unforeseen benefits from it, such as using video to improve customer service as well as for security. These industries are being caught up in the general move to the cloud and away from outdated custom programs, owning servers, and proprietary systems.

Retail and service employees in the South Bay tend to be basically tech savvy users but without really understanding the technology. While most employees have their own digital devices, such as smart phones and tablets. Employees know they need it to access data and conduct transactions. The huge change is coming with drones and video and other technologies. Digital skills depend on the age of the individual. There is a big difference in skills between the leading edge and the trailing edge of the baby-boomers. The biggest workforce problem is to find prospective employees who have interpersonal skills, because many have problems dealing with real people. In these sectors, strong people skills are required while interacting with the public. The workforce needs hands on education to introduce them to the retail and service sectors and to build leadership skill. Employers are doing more online education and moving their back office into the cloud. These trends require more connectivity, as well as continuously evolving workforce skills.

There is a hodge-podge of broadband services in commercial areas of the South Bay. Service offerings in some places are good and are bad in others. The infrastructure is physically patchy and spread out. Big

companies have lots of connection options, but smaller employers don't and they can't piggyback on big guys. Commercial areas, where businesses are needing more bandwidth, often have less broadband choice than residential areas. They find the services over-priced and limited. For example, the most bandwidth a business in some areas can buy is 6 Mbps, but it's often downgraded service to 3 Mbps for it to be stable. Some companies have effectively been forced to use cellular data connections for Wi-Fi hotspots. Non-profit agencies, which are as diverse and widely-distributed as South Bay's for-profit businesses, also face limited connectivity options.

Broadband is becoming a critical utility for South Bay commerce, and should be treated like one. Retail and service sector stakeholders feel increased broadband would attract more people here, and make the area more competitive. Locations with fiber-optic service are more desirable. Broadband enhances other positive characteristics of properties. Real estate companies keep fingers crossed that it won't come up in areas without good broadband. While broadband providers are at least talking about putting in fiber, most is going underground into more affluent areas. It's just too big of a capital investment in much of the South Bay for providers who don't have much competition or vociferous customers. The concern for retail and services sectors is that people will stay away from areas with poor connectivity. It's very short-sighted to think broadband is not important to residential cities. What's the average age? Who's going to live there? Lack of knowledge on consumers' part means they're not pushing companies who tell customers, "It's old technology, but it works." The young people have the vision for more technology, and It's ultimately going to create a snowball effect in demand for bandwidth and connectivity.

Startup and Technology Companies

The South Bay's startup and technology community is developing. Technologist and technology professional live and work in the South Bay, but they don't know each other and don't congregate. There are a few gatherings or meetups, particularly where the larger tech companies are involved. But, no real "community" exists in the area that entrepreneurs and technologists can reach out to and tap into. Online forums are the primary means for getting insights. Several startup companies are located in the area, but there is not an "entrepreneurial ecosystem" apart from the wider Los Angeles region. Persons in South Bay tend to stay in their own areas and connect with distant people with shared interests rather than finding people like that nearby. In other areas, multiple people got involved in bringing entrepreneurs and technologists together and they had locations such as business incubators, co-working spaces, and makerspaces for groups to gather. Local leaders need a better understanding of startups and tech as means for growing the local economy from within. There could be a Starbucks on every corner but still not enough opportunities and places for South Bay entrepreneurs and technologists to get together. The area needs more thinking about what's next and clearer vision for new economy and new technology.

Startups and tech companies always need more bandwidth. More people are doing more with video, so the availability of more bandwidth is desirable. Screens are basically the same whether they are 3D, augmented reality, or virtual reality. People are going to have more screens, which means more video. There hasn't been much demand for video for local tech applications. The devices require a lot of computing power because the video is not generally a real-time download. Audio uses up a lot of bandwidth, too. The range of related applications, from image and place recognition to content licensing, require additional bandwidth and connectivity. Reliability is a huge issue, too. While broadband for small businesses has generally gotten faster in the South Bay, the costs and reliability have gotten worse. Outages and slow-downs are too common. There just aren't enough options for current, let alone future, broadband needs.

Economic and social change are bigger issues than technological change. Better broadband services and more options would make connectivity and bandwidth more affordable and might democratize technology in the South Bay area. A lot of people don't have access; giving them options could promote

social changes. The area could get more highly skilled people moving in, more tech jobs, and higher incomes. The area is going to develop more of a sharing economy, followed by autonomous vehicles and similar innovations. These innovations won't be available to many people in the South Bay because they don't have adequate broadband.

Startup and tech companies in the South Bay don't do a lot of hiring simply because there are relatively few and they are small. Many have an expectation that they need someone highly skilled but don't want to pay. For example, a company can't hire an entry level person to do Android app development, and experienced developers want $150,000/year. It is hard to find high-level or specific skill sets. It is also challenging to find experienced women in the tech arena. You can hire recent college grads but persons with 2+ years of experience are hard to get. If a company is looking at 22-year old, a degree is the first thing considered. For older people a degree doesn't matter; ability and experience are what matter. And, even when you find someone with the skills, there's a lot of operational knowledge that needs to be transferred to them.

Often startups and tech companies try to do everything for themselves, and to build a community that can back them up. Companies that need software developed typically hire small development shops as a stop-gap, while doing a search. They plan to take three months to hire but end up taking six months, or longer. Sometimes they simply say, "Maybe we don't need to hire someone," and stick with the contractor.

Demand for skills is primarily reactive and demand-driven. The software languages and tools are changing continuously. Everything will be mobile and be built on Swift and Java. Cross-platform stuff still isn't working but the same skill set is needed to design for mobile regardless of platform. The key is that some people are learners, no matter age; younger people are used to re-learning. Companies look for talent rather than education—talent is different than education—don't need the degree. If you're an early adopter, you're an early adopter. Younger people have grown up with it, it's an extension of their hands and minds. That's not enough, though. You need to be very future focused, watching what's emerging and creating new things, too. Kids are learning Swift and Java. But there is a lag because the tech change is so fast and teachers can't keep up. They are teachers, not developers. Schools almost need to have a teacher and programmer teamed up.

Organizational Survey Results

South Bay organizations were surveyed to get additional detailed information about their technology-related issues, needs, and opportunities, especially around broadband. We received a total of 79 responses, of which 12 were from the South Bay cities as individual stakeholders.[30] Unfortunately, this response rate is not adequate for results to be considered representative of the region. Also, the survey response rates by sector are quite different from the relative economic presence of the sectors (see Table 19). Regardless, the results are quite interesting. We recommend that they be treated as "hypotheses" to be tested and verified or revised by future outreach and research. Outreach efforts should focus on under-represented sectors.

Table 19. Sectors of the regional economy compared to survey response rates

Sector	Regional Economy	Survey Responses	Difference
Accommodation and food services	10.2%	3.8%	-6.4%
Administrative and other services	11.5%	15.2%	3.6%
Agricultural and Farming	NA	0.0%	NA
Arts, entertainment, and recreation	1.9%	6.3%	4.5%
Construction	NA	3.8%	NA
Educational services	1.0%	7.6%	6.6%
Finance and insurance	4.9%	2.5%	-2.3%
Healthcare and social assistance	12.7%	3.8%	-8.9%
Information	3.8%	0.0%	-3.8%
Manufacturing	13.6%	16.5%	2.9%
Professional, scientific, and technical services	10.9%	11.4%	0.5%
Public Administration	NA	15.2%	NA
Real estate and rental and leasing	4.3%	5.1%	0.8%
Retail and wholesale trade	20.0%	8.9%	-11.2%
Transportation and warehousing	5.3%	0.0%	-5.3%

Responses over-represent education, arts, culture, and entertainment, administrative and other services, and manufacturing. The response rate for professional, technical, and scientific services and real estate were about the same as these sectors economic size. Retail and wholesale trade, accommodation and food services, healthcare and social services, transportation and warehousing, information, and finance and insurance were under-represented. Survey respondents represented a range of organizations. The largest had 600 locations and 30,000 employees, with 20 locations and 3,000 employees in the South Bay. The clear majority, though, were small. The responding organizations had an average of 139 employees in the South Bay, where the median number of South Bay employees was 10 and the mode is 2.[31] Thirty respondents had ten or fewer employees in the South Bay, and 46 had 100 or fewer employees.

[30] The cities' survey had somewhat different content than the survey of other organizations. Lomita, Palos Verdes Estates, and Rolling Hills did not respond to the survey. Hermosa Beach and Lawndale submitted incomplete surveys. Several cities submitted multiple responses, which were combined using averages and responses by technical personnel.

[31] Average is the total of all responses divided by the quantity of responses. The median is halfway between the largest and smallest response, and the mode is the most common response.

Technology Spending, Plans, Drivers, and Barriers

A look at spending level (Figure 1) reveals that the largest number of respondents had the lowest amounts of spending.

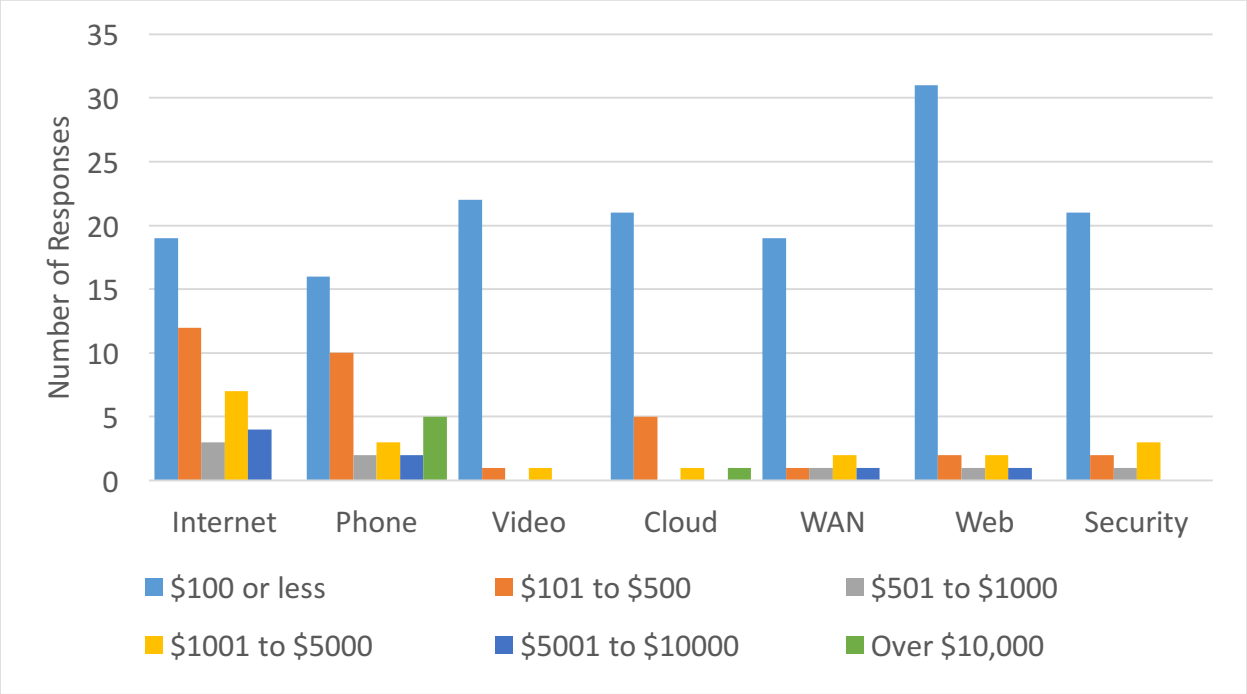


Figure 1. Spending levels for various network services

Respondents are spending the most money on telephone services ($2,600 per month on average), although internet access is a close second ($1,144 per month). While less than a quarter of respondents spent $50 or less per month on internet access, well over three-quarters spend less than that on cloud, security, web hosting, wide-area network. Ninety percent spend less than $50 per month on video services. Only 46 respondents provided spending information. Together they spend about $200,000 per month on network services. The most common amount spent on video, cloud, WAN, web hosting, and security/surveillance is $0. These figures reinforce conclusions discussed above. Most survey respondents simply are not doing much with digital technology. Figure 2 shows this from a different perspective, focusing on major types of network access respondents have at their locations. Note that direct internet access is available at half of respondents' locations but internal (wide-area network) and external (public Wi-Fi) network access is available at less than a quarter of locations.

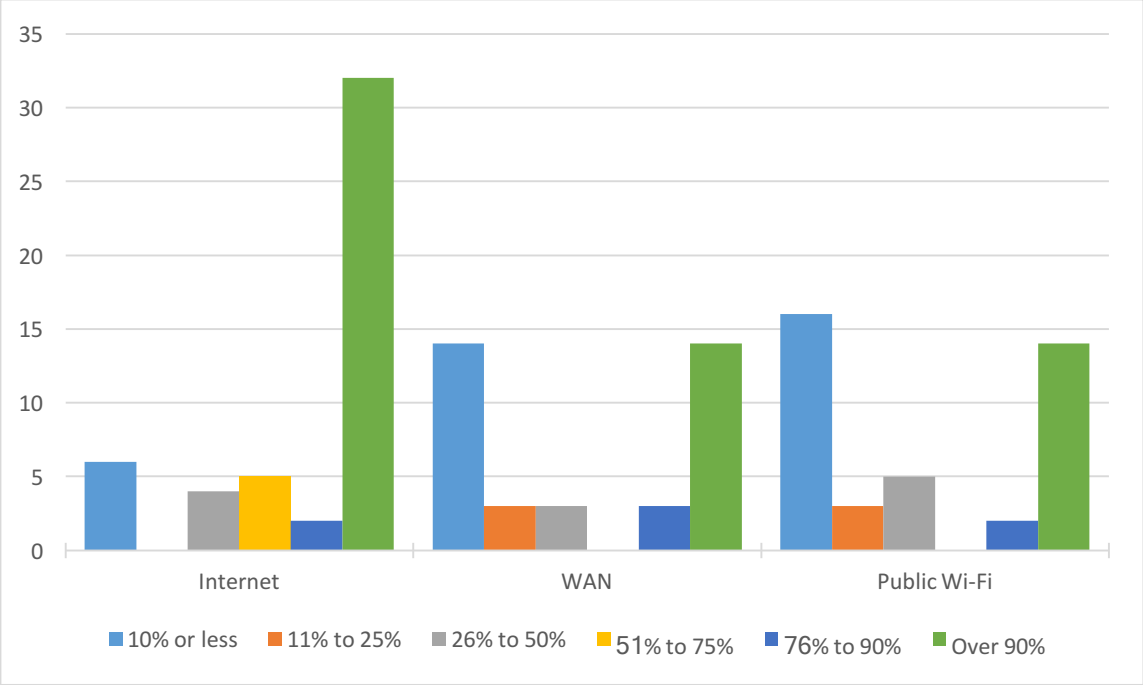


Figure 2. Percentage of locations with major types of network access

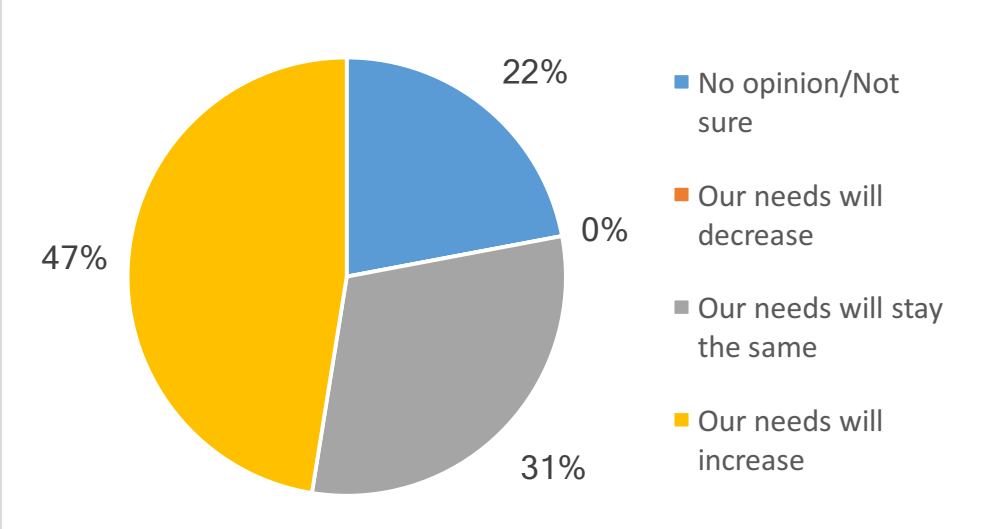


Figure 3. Expected changes in respondents' overall technology needs

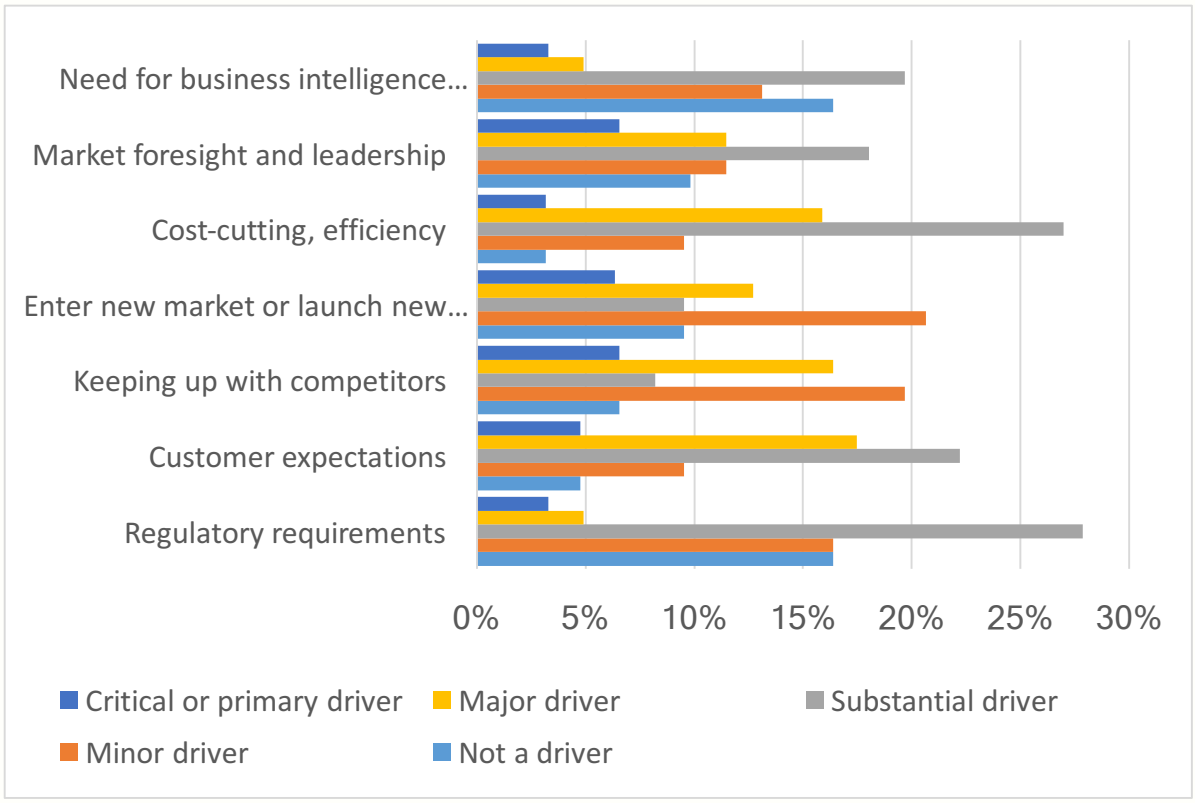


Figure 4. Factors driving technology utilization

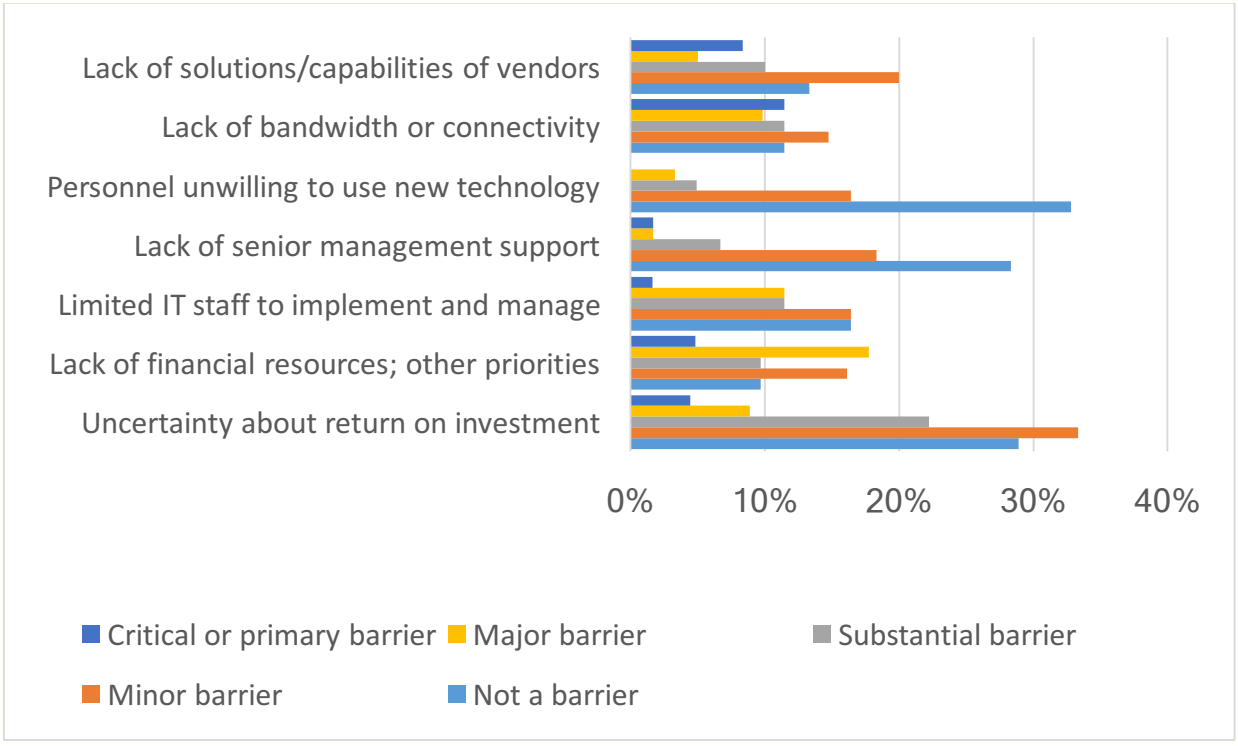


Figure 5. Barriers to technology utilization

No respondents expected their technology needs to decrease. About a quarter were not sure about how their needs might change, and a third expected needs to not change. Nearly half see their needs increasing. Several respondents noted in comments that their companies were growing: increasing production, becoming more automated, and hiring more people. One commenter noted that business success depends on internet access. Several implied that more growth equates to more bandwidth needed. Respondents noted "moving to the cloud," doing more business electronically, and wireless connectivity as central elements of their changing technology needs. Thirteen of 19 comments related to increasing needs for speed, and five comments specifically mentioned reliability as an issue.

In contrast, there was a great deal of variation in what respondents found to be barriers to technology investment. The only common barriers were other priorities ("lack of resources") and bandwidth. Uncertainty about return on investment, limited IT staff to implement and manage, and lack of solutions or capable of vendors were indicated to be barriers, but they were also indicated to NOT be barriers. Generally, the barriers seem to be lower than the drivers are strong. This fits with the finding that needs are expected to increase.

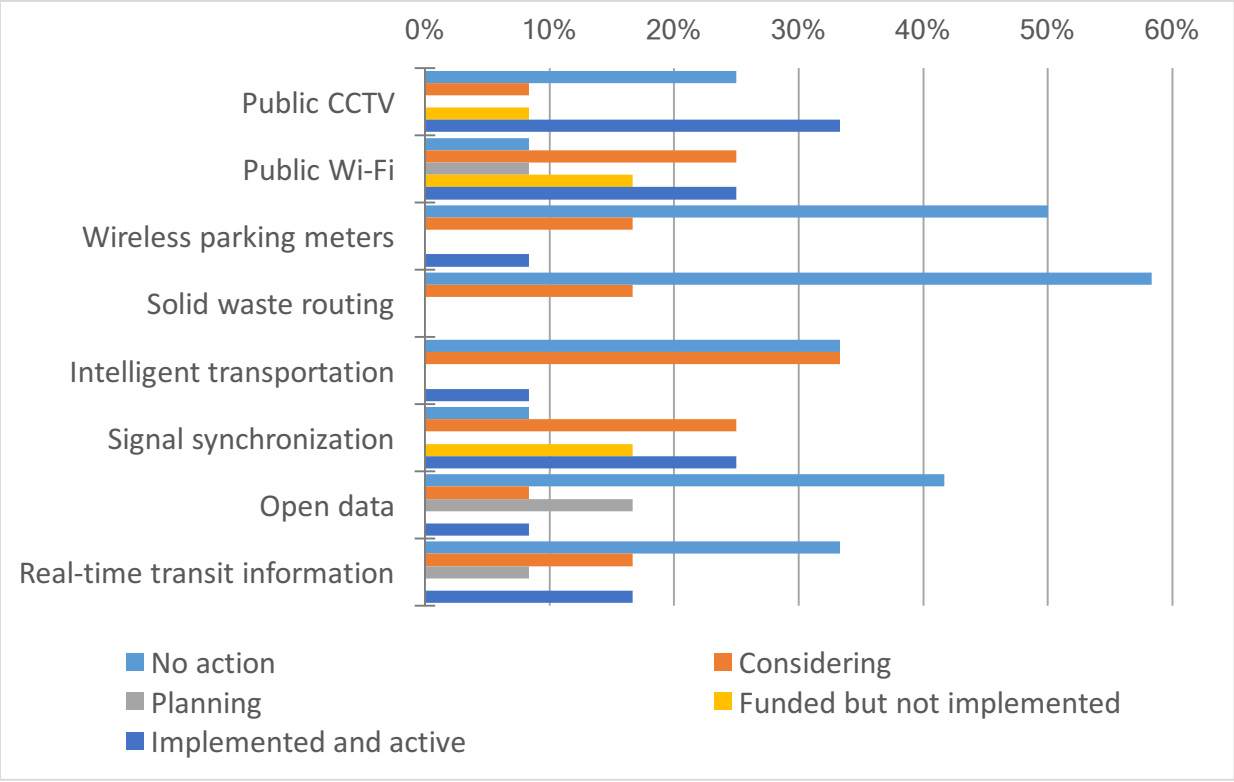


Figure 6. "Smart City" applications in the South Bay

Specific to local governments, closed-circuit television (surveillance cameras), public Wi-Fi, and signal synchronization are the most widely implemented "smart city" applications. See Figure 6. Overall, the most common response was "No action." Seven out of 10 cities indicated that they had broadband infrastructure assets, mostly for connecting municipal buildings in a "campus" network. A few indicated that they were installing conduit or fiber. None said they were unwilling to consider sharing those assets as part of a regional project.

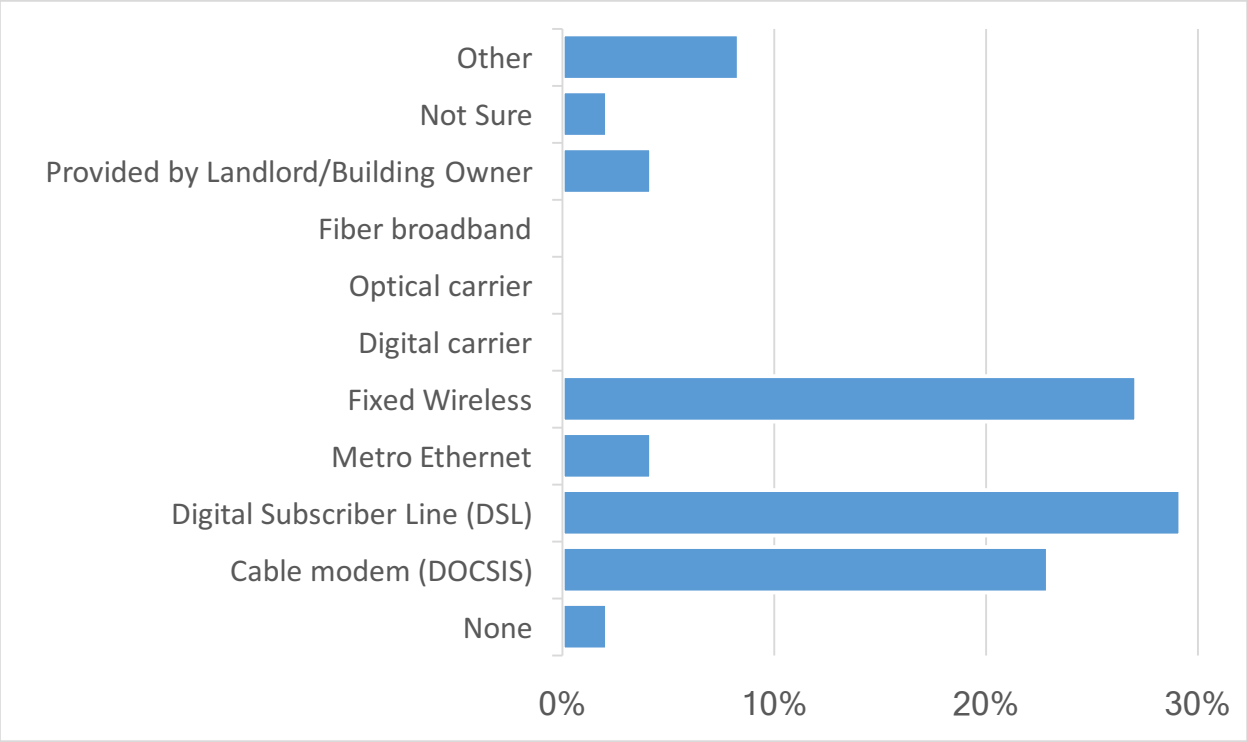


Figure 7. Types of broadband used by respondents

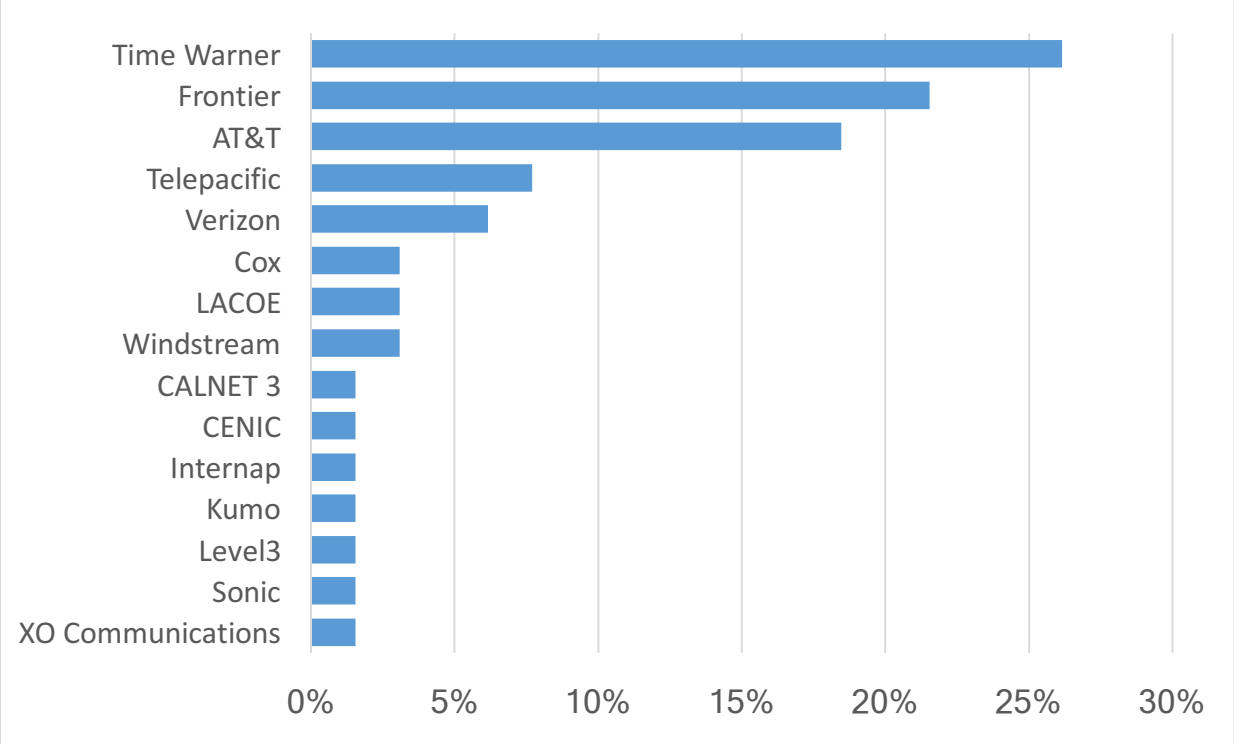


Figure 8. Internet access providers by percentage of responses

Broadband Services

DSL was the most common form of broadband, as shown in Figure 7 used by 29% respondents. Fixed wireless was second. Respondents may have considered Wi-Fi to be fixed wireless, but there are at least two fixed wireless in the South Bay. Note that no respondents replied having fiber-based broadband or internet access via optical carrier. Metro Ethernet uses fiber-optics but is sometimes provided to the customer via copper wire interface. The most common providers are the incumbent cable and telephone companies. The most noted competitive provider was Telepacific, which is used by 8% of respondents.

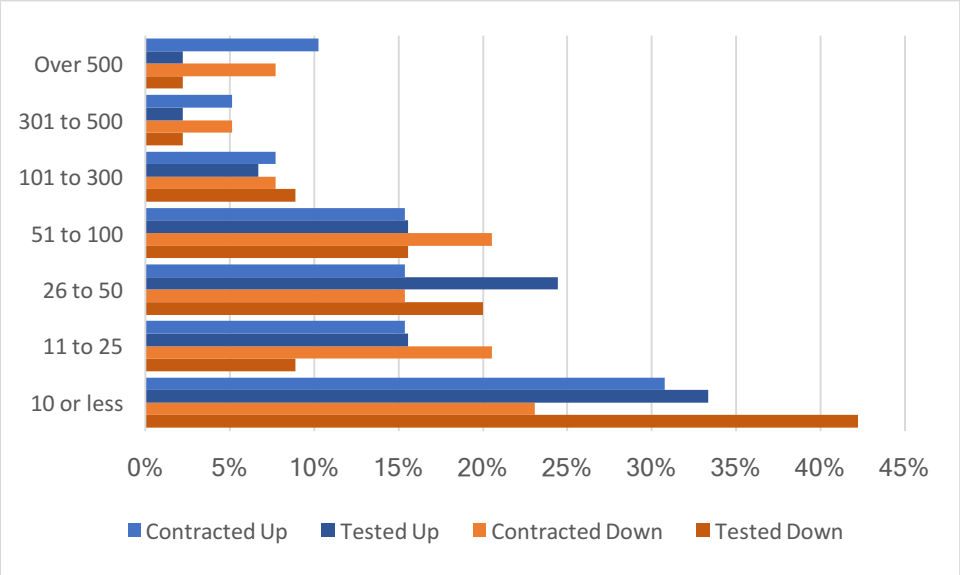


Figure 9. Contract and actual (tested) upstream and downstream speeds compared

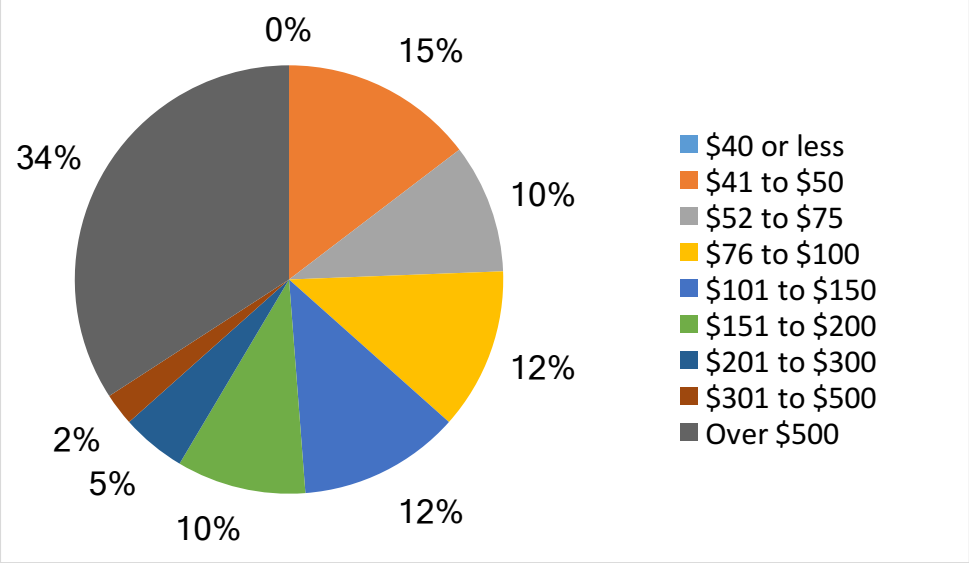


Figure 10. Percentage of respondents paying various amounts for internet access

Figure 9 and Figure 10 show that most respondents had cheaper and slower services, but cost per actual megabits per second varied greatly (see Figure 11). No respondent paid less than $40 per month for internet access. A third paid over $500 per month.

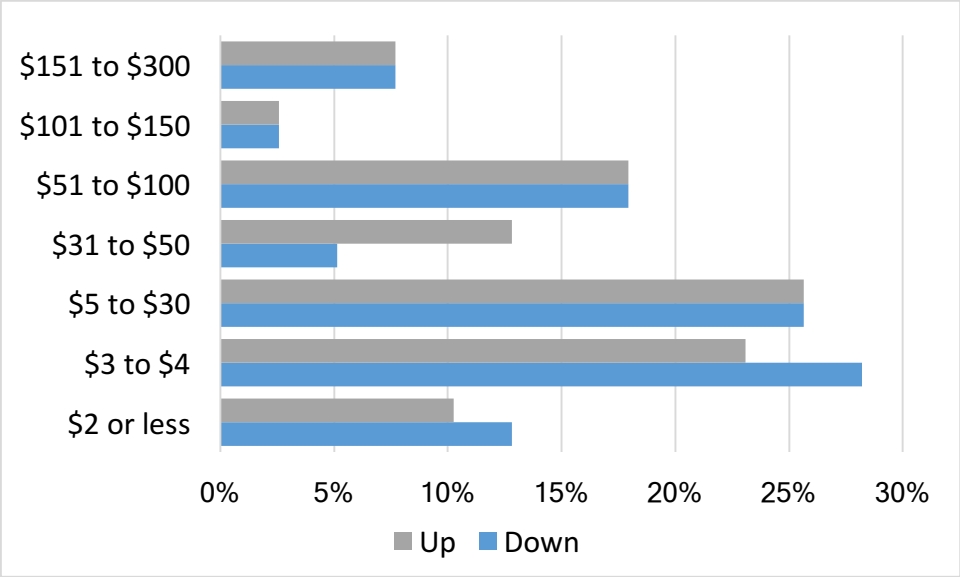


Figure 11. Cost per Mbps per month for actual (tested) speed

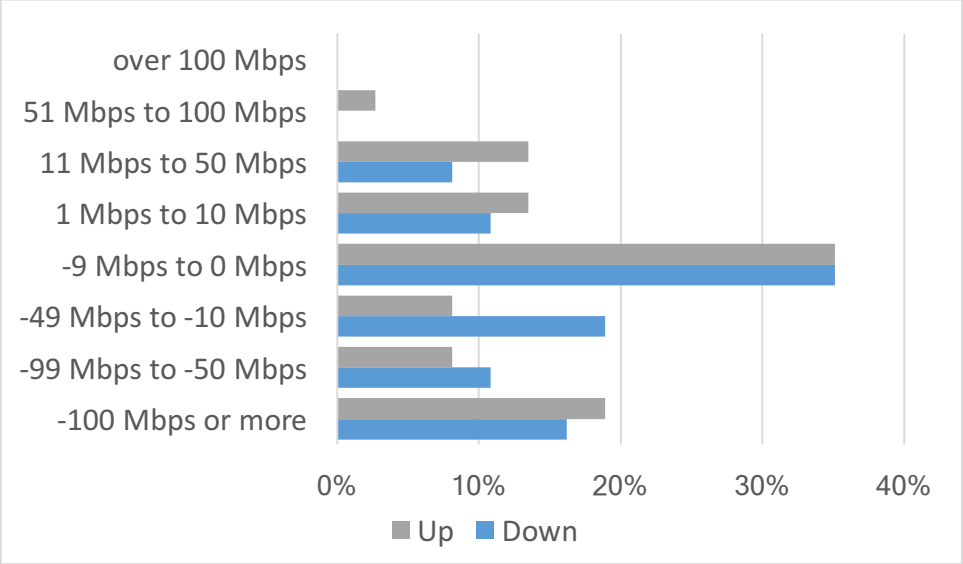


Figure 12. Differences between actual (tested) and contracted downstream and upstream speeds

The average contracted downstream/upstream speeds were 155/144 Mbps, the median speeds were 50/50 Mbps, and mode speeds were both 100/50 Mbps. The actual means were 67/73 Mbps, the medians were 32/32, and the modes were 1/1. While the maximum contracted speeds were 1,000/1,000 Mbps (1 Gbps), the maximum actual speeds were 750/850 Mbps. Generally, respondents were getting much less bandwidth than they were paying for. As illustrated in Figure 12 the clear majority of respondents were getting less than contracted. Nearly a half and over a third were getting less actual bandwidth for downstream and upstream, respectively, than contracted. Five percent of respondents had actual downstream rates that matched the contracted rates, and 16% for upstream. The statistics for tested speeds are unusual because the downstream maximum and mean are lower than the upstream statistics. Typically, downstream speeds are higher than upstream. The data contained upstream measurements that were higher than downstream counterparts.

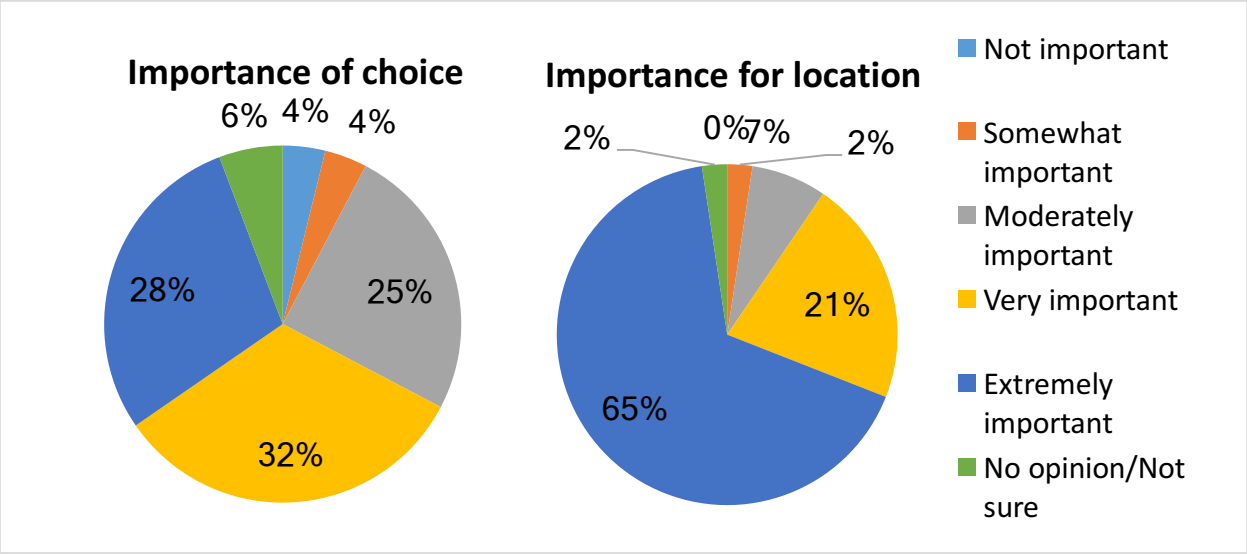


Figure 13. Importance rating of availability and choice of broadband services

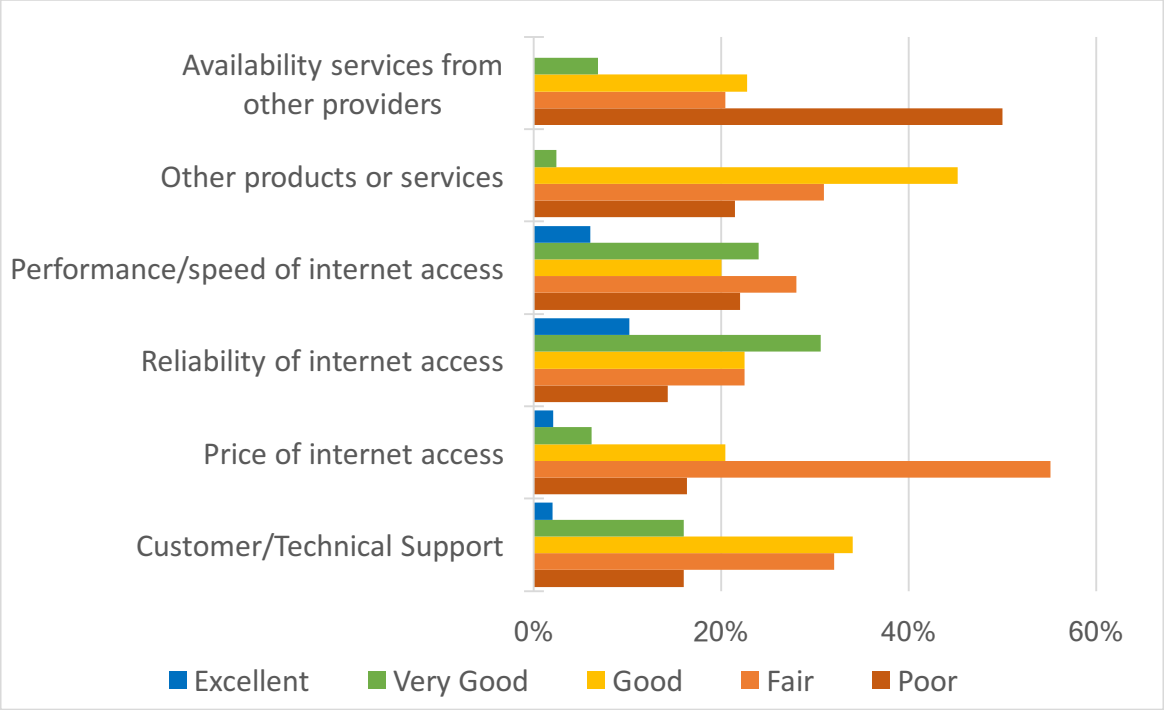


Figure 14. Ratings of internet access services

Respondents were generally not pleased with their internet services, with ratings across metrics tending toward fair or poor (see Figure 14). Seventy-one percent of respondents felt the prices of internet access was fair to poor, and 70% rated availability of alternatives as either fair or poor. Around half indicated that speeds and product offerings were fair or poor. On the other hand, reliability was rated relatively highly, with 41% rating it as very good or excellent. Speed was also rated reasonably well.

Having broadband available and having a choice of providers were both rated highly by respondents (see Figure 13). Sixty-five percent of businesses indicated that availability of broadband was extremely important. Sixty percent of all respondents rated the importance of choice among multiple internet service providers to be either extremely or very important. Given these results, the fact that three

quarters of respondents were likely to switch—and almost a third said they were extremely likely—to a government-built fiber-optic network, as illustrated in Figure 15, should not be surprising.

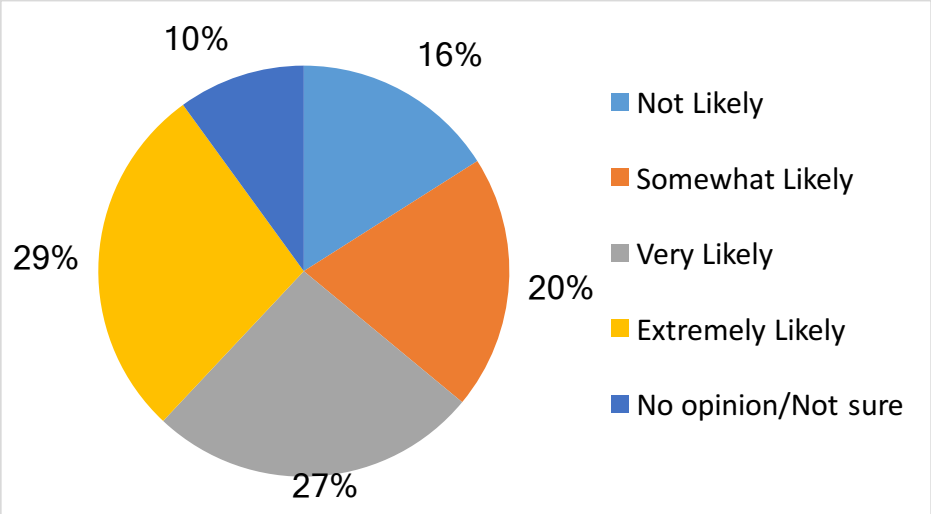


Figure 15. Respondents likelihood of switching to government-built network

Skills Requirements and Workforce Issues

Overall, 16% of jobs among respondents require expert-level digital skills, including abilities to build software or in-depth knowledge of technology, and 19% require advanced digital skills to manage software/systems and support other users. See Figure 16. Nearly a third require ability to use complex and/or specialized software, and over a third of respondents' jobs require people to use common computer and/or simple software. Only 16% of jobs require no digital skills. The greatest need for expert and advanced skills are among professional, technical, and scientific industries, which is a prime sector for regional development. Administrative and other services also seem to require digitally skilled employees. Healthcare and social services and finance and insurance sector respondents indicated pervasive need for abilities to use complex or specialized software. Retail, real estate, education, hospitality and food services, and, to a lesser extent, manufacturing and arts, entertainment, and recreation sectors need most employees to have basic digital skills.

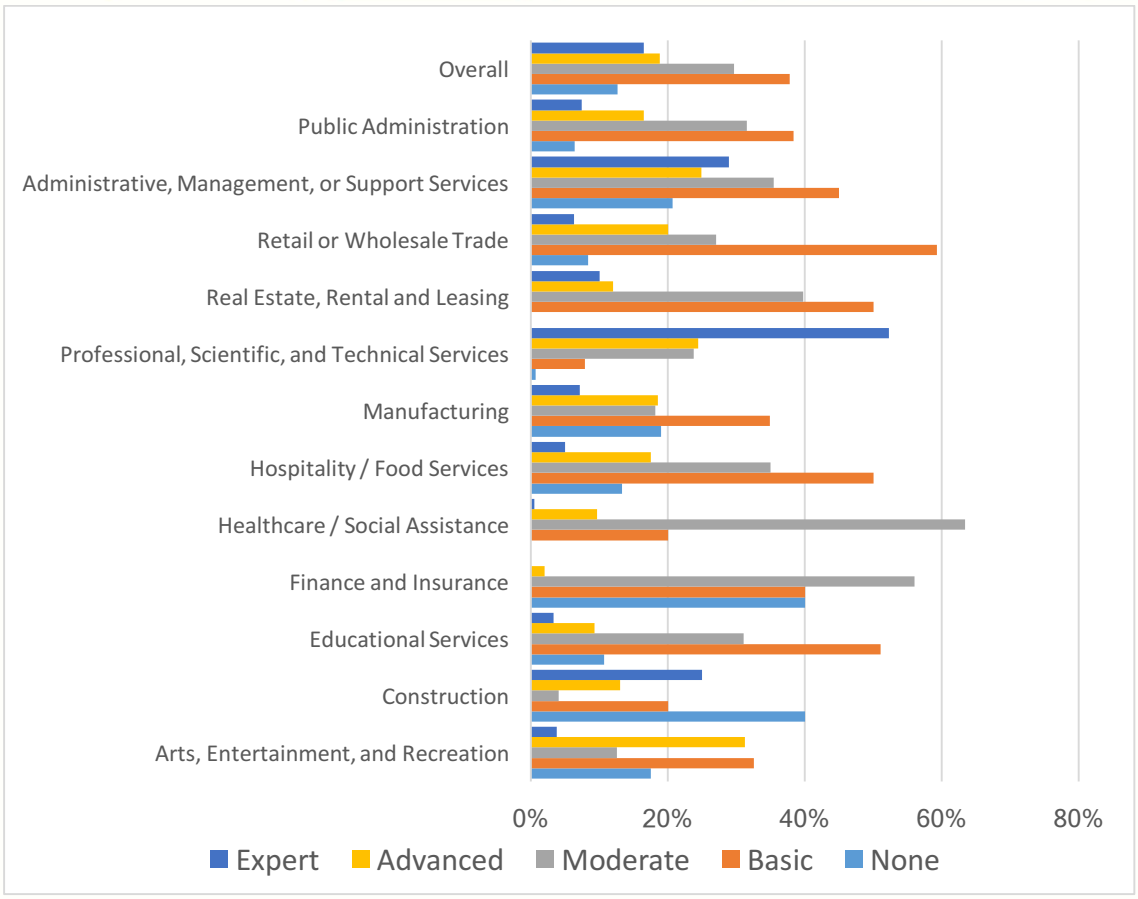


Figure 16. Percentage of jobs requiring various levels of digital skills by sector

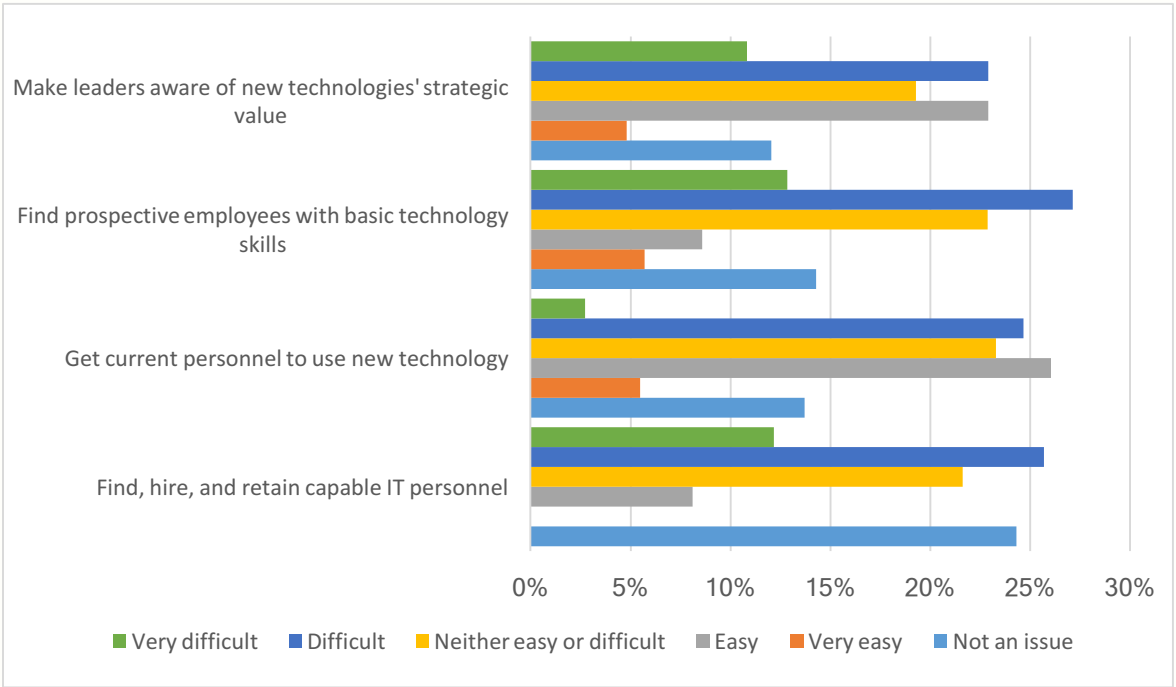


Figure 17. Technology-related workforce challenges by level of difficulty

As far as workforce technology challenges go, the greatest seem to be finding, hiring, and retaining IT personnel and finding employees with basic digital skills. Figure 17 shows that few respondents indicated that these tasks were either "easy" or "very easy" to do. Getting current personnel to use technology does not seem to be difficult for most organizations. But, over a third of respondents indicated that executive awareness was either difficult or extremely difficult. These results suggest that organizations are not making significant investments in or upgrading their technology bases due to workforce issues. Between a quarter and a tenth of respondents indicated technology-related workforce activities were not issues, indicating that they basically don't use technology (therefore don't need to hire IT professionals, inform executives, or have employees with basic digital skills).

Word Cloud

Word clouds can be interesting bridges between quantitative and qualitative analysis. They are a mosaic of words the size of which is determined by the number of times a word is mentioned. Figure 18 is a word cloud derived from the survey. Answers to open-ended questions and comments were pasted into an online word cloud generator.[32] The resulting word clouds provides a sense for how prominent various terms were in respondents' answers. It is notable that terms such as "increase," "need," and "options" appear as large as broadband-specific terms like "bandwidth," "network," and "speed."

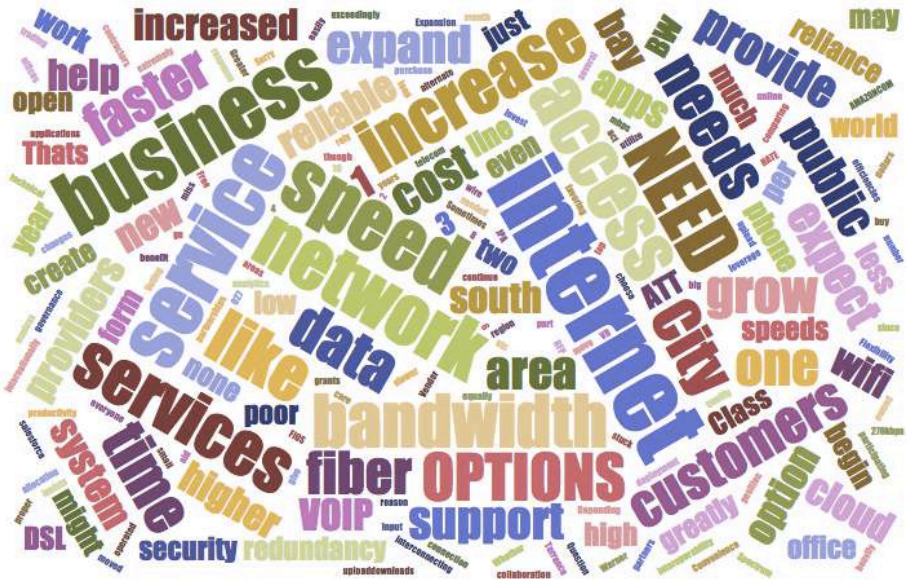


Figure 18. Word cloud of survey comments and answers to open-ended questions

[32] https://www.jasondavies.com/wordcloud/

Broadband Assets, Providers, and Services

Broadband, or high-speed internet access, is just one type of telecommunication service, and telecommunications has become one sector in the much larger universe of information technology services. Traditionally, telecommunications companies were one of four or five types:

1—Cable companies (CATV, originally community antenna television) aggregated television channels—over-the-air broadcast and cable-only—and distributed them via coaxial cable under local franchise agreements. Any particular community only had one cable company because franchise agreements and the cost of overbuilding were insurmountable barriers to competition. There are still some independent local cable systems but most have been consolidated into a multi-system operator, especially Charter and Comcast.

Since the turn of the century, cable has evolved into full-service telecom companies offering "triple play" internet, video, and voice services. They have also moved aggressively into business services. While most cable broadband services are delivered via coaxial cable using DOCSIS (Data Over Cable Service Interface Specification), most cable companies now also provide fiber-to-the-premises (FTTP) in selected areas.

2—Incumbent Local Exchange Carriers (ILEC, or just LEC) were the original local telephone companies, or telcos. The largest were the old regional Bell operating companies, which were divested from and then reintegrated into AT&T. There are many local independents, and others were non-Bell companies, that have evolved into CenturyLink, Frontier, and Windstream—all of which started as multi-location independent telcos. The telcos have evolved to provide internet access, trans services (carrying large amounts of information between locations) and video services, as well as plain old telephone service (POTS) via the public switched telephone network (PSTN). Like the cable companies, the telcos still provide copper-based services (specifically, digital subscriber line (DSL) internet access) but have pushed FTTP in selected areas.

3—Competitive access providers (CAP), competitive local exchange carriers (CLEC), and internet service providers (ISP) are all companies that directly compete with the telcos. It all started with long-distance companies competing head-to-head with AT&T. Many of these companies also had to compete with the telcos to get access to customers. The rise of the internet led to ISPs, especially since the cable companies and telcos were slow to provide internet access. Many of these companies have merged with each other or other IT service providers, or been acquired by cable companies and telcos. Traditionally a distinction was made between "facility-based" providers that own their own infrastructure—almost always fiber-optics—those that leased infrastructure from others, and between local and "long-haul" providers. These distinctions are going away as companies diversify and merge. Some ISPs use fixed wireless connections that are highly flexible and inexpensive but tend to have greater latency and less reliability (due to weather, etc.) than fiber-based networks.

4—Cellular telephone companies provide mobile wireless voice and data services. Many of the original cell phone companies were acquired by (or acquired) telcos, or merged with each other. They are distinct from wireless ISPs (WISP) that provide fixed Wi-Fi-based internet access services in that they are truly mobile, provide PSTN access, and use spectrum licensed from the Federal government. These companies deploy antennas on towers, which need to be connected to the PSTN and the internet to serve an area. These connections are almost always via fiber-optics.[33]

[33] Long distance companies used to use microwave links to carry signals across the country. Competitive providers, cellular phone companies, and ISP also used this technology. That technology has been largely phased out due to capacity and reliability limitations and costs.

Telecommunications Providers in the South Bay Area

The following companies have network assets or nominally provide services in the South Bay area.

- AT&T (https://www.att.com/) is the corporate inheritor of the original "Ma Bell." It was forced to divest its local operating companies in 1984, and reconstituted in 2005 when one of the former regional Bell Operating Companies, SBC, purchased the company. Today it is a diversified company, providing wide technology and telecommunications services, and is the dominant player in many markets.
- Birch (http://www.birch.com/) is a nationwide competitive provider of communications, network, cloud and IT services for small, mid-sized, enterprise, and wholesale businesses and residential customers. The company has more than 500 points of presence in 22 states. Birch's services include broadband fiber-based access and trans services, Metro-Ethernet, MPLS, unified communications (UC), wireless (4G), and hosted data center, file storage, and phone system services.
- Broadview (https://www.broadviewnet.com/) is a competitive provider of diverse network services focused on unified communications, which is a service that brings together multiple forms of electronic communications. Headquartered in Rye, NY, Broadview provides service in all 50 states.
- Cox Communications (https://www.cox.com/) is a cable multi-system operator that provides broadband and voice services as well as cable TV.
- Crown Castle (http://www.crowncastle.com/) provides shared wireless infrastructure for service providers, local governments and property owners. Sunesys (http://sunesys.com/) is a subsidiary of Crown Castle that provides bandwidth services and private fiber optic networks. The company owns, operates, and maintains a high-density fiber optic network in major metropolitan areas across more than 30 states in the U.S. Its SunTran network provides fiber optic trans between more than 100 data centers in nine states.
- Cybernet (http://www.cybernetcom.com/) is a competitive provider of fiber- and fixed wireless-based internet access, phone, cloud, and data network services based in Van Nuys.
- EarthLink (https://www.earthlink.com/) was a competitive provider that was purchased by Windstream Communications (https://www.windstream.com/), an independent incumbent local exchange carrier. Windstream provides high-speed broadband Internet, phone service and Digital TV packages to residential customers as well as products and services for small, medium and large businesses, and government agencies.
- Edison Carrier Solutions (http://www.edisoncarriersolutions.com/) is a "carriers' carrier" that provides fiber-optic trans services to retail telecommunications service providers across southern California. It is a subsidiary of the Southern California Edison power company.
- Frontier Communications (https://business.frontier.com/) provides data, video and voice services to commercial and residential customers in 29 states. The company provides broadband via DSL and fiber, carrier Ethernet services and a variety of trans facilities, including voice grade and digital carrier services (DS0, DS1s and DS3), FTTH, FiOS, SONET and Optical Trans Services, and traditional data services such as PRI data circuits, ATM, and frame relay networking.
- Global Capacity (https://globalcapacity.com/) is competitive provider that provides a wide range of connectivity options for businesses, including other telecommunications companies. It is the product of multiple acquisitions and mergers, and exemplifies the convergence of IT and telecom services into a single company.
- GTT (https://www.gtt.net/) is a global network company that specializes in direct connections to major cloud service providers.
- Level 3 (http://www.level3.com/en/) is a competitive provider that is being acquired by CenturyLink, one of the major telecom companies that was formed by mergers of multiple ILECs. Level 3 provides communications services to enterprise, government and carrier customers. It has an extensive fiber

network that services more than local 500 markets in more than 60 countries on three continents connected by undersea facilities.

- *MegaPath* (https://www.megapath.com/) is a competitive provider of phone, internet (via copper, Ethernet, fiber, and wireless connections), managed network, security, and cloud services based in Pleasanton, California, with offices in Connecticut, Virginia, Washington state.
- *Sonic* (https://www.sonic.com/) is a relatively new broadband company based in Santa Rosa, California, whose mission is "affordable Gigabit Fiber Internet for all."
- *Spectrum* (https://business.timewarnercable.com/) is the new brand for Time Warner Cable business services since being acquired by Charter Communications. These are traditionally cable TV companies that have evolved into full service telecom providers. Spectrum provides internet access, including Wi-Fi wireless, television, and "cloud" file backup and web hosting. The company has extensive presence in about 15 states, substantial footprint in 15 others, including California, especially southern California, and limited geographic coverage in 13.
- *TelePacific* (https://www.telepacific.com/) is a competitive provider of managed services and business communications based on Ethernet services for various technologies and suppliers that best meets the needs of multi-location businesses. Most of TelePacific's locations are in California and Texas with other locations in seven other states.
- *Tierzero* (http://www.tierzero.com/) provides business data and phone services in southern California from its headquarters in Los Angeles, using a variety of network services purchased from incumbent telecom companies.
- *Towerstream* (http://www.towerstream.com/) is a fixed wireless network operator providing property managers, building owners, and their commercial tenants with dedicated, symmetrical Internet connectivity.
- *Verizon* (http://www.verizon.com/) is one of the largest companies in the industry. It is known mostly as a cellular phone provider, but it is the inheritor of multiple incumbent local exchange carriers and provides a wide range of IT and telecom services.
- *Wilcon* (https://wilcon.com/) is a provider of fiber optic and data center infrastructure to deliver dark fiber and ultra-broadband optical services for businesses, wireless carriers and other communications service providers in Southern California. Wilcon also owns and operates data center and carrier-neutral colocation facilities in downtown Los Angeles, including its key hub at the One Wilshire and has diverse routes connecting major data centers, enterprise locations and wireless communications sites. Crown Castle has announced intentions to acquire Wilcon.
- *XO Communications* (https://www.xo.com/) is a subsidiary of Verizon that owns and operates a fiber-based IP and Ethernet network for private data networking, cloud connectivity, unified communications and voice, Internet access, and managed services. Its network extends to 40 states and five continents, including 1.2 million miles of fiber in metropolitan areas.
- *Zayo* (http://www.zayo.com/) owns and operates an 126,000-mile network in North America and Europe. The company offers dark fiber services as well as a range of managed bandwidth lit fiber solutions, including wavelength, Ethernet, IP and video trans for enterprises, carriers and government.

Broadband Availability and Costs

Magellan Advisors randomly selected business addresses from across the South Bay to identify the general availability and costs of broadband. We contacted major "retail" broadband providers, asked what kinds of broadband was readily available at each address, and what the costs are for available services. The results (see Appendix A for details) show how inconsistent the supply of broadband is across the area. All 21 locations had at least one service provider. Three locations had three providers but five of the 21 sites we checked only had one broadband provider. Thirteen sites had two providers. Seven service offerings

were for speeds that are lower than 25 Mbps, the Federal Communication Commission's standard for broadband.

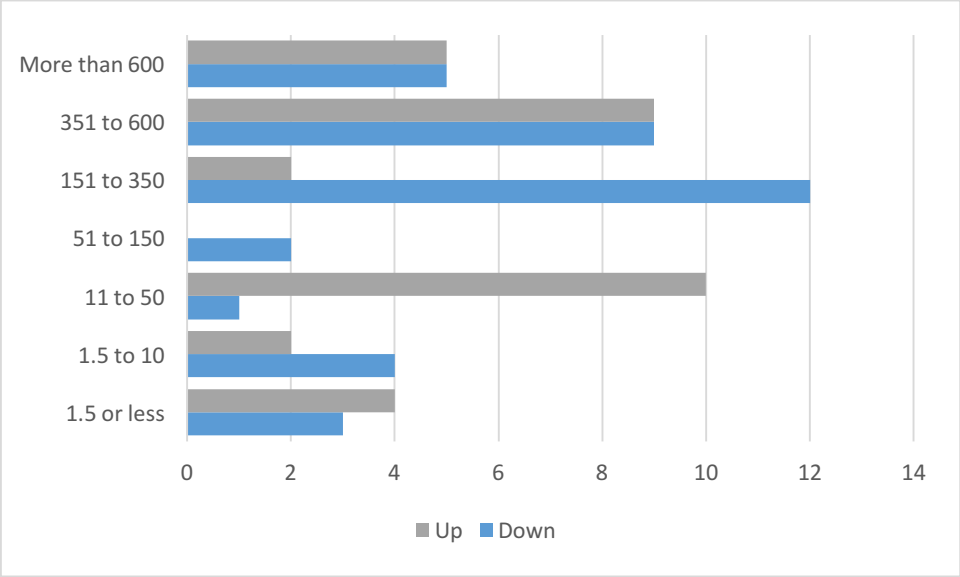


Figure 19. Speed of broadband services at selected locations

The choices weren't always much of a choice. Several locations had the choice between a relatively low-cost (e.g., $50 per month) but also very slow (6/0.768 Mbps) or costly but fast service (1 Gbps symmetrical for $2,938 per month). The most common speed was 300 Mbps downstream. Most upstream speeds were between 20 and 40, while most monthly costs were $300 or $500. There were several services available for less than $100 per month but the average speeds for these services were 29/5 Mbps.

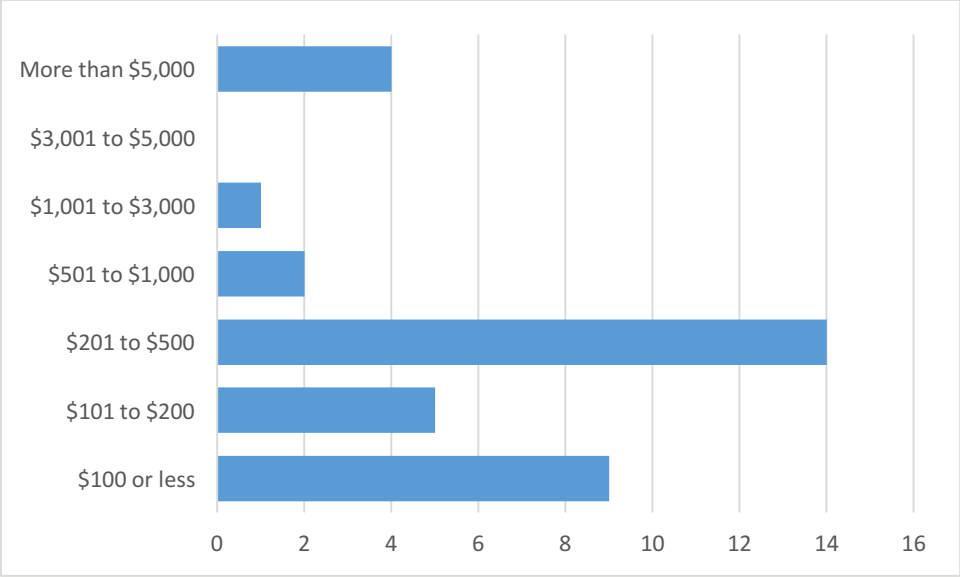


Figure 20. Costs per month for broadband services at selected locations

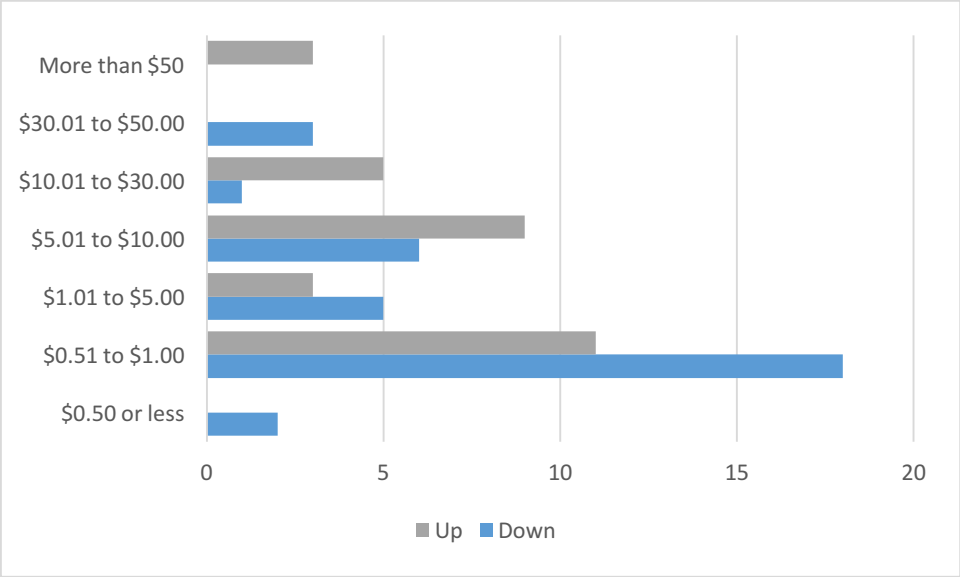


Figure 21. Monthly cost per megabit per second at selected locations

Figure 21 shows the average monthly cost per megabit per second. The most expensive bandwidth was upload and the cheapest was download.[34] Generally, the faster the service the cheaper the bandwidth. Regardless, the cheapest bandwidth was for 100 Mbps downstream service. The 1 Gbps services were nearly $8 per month per Mbps, both downstream and upstream. The most expensive bandwidth was 0.768 Mbps upstream connection for $50 ($65 per month for a megabit per second) and 0.768 downstream for $30 per month ($40 per month for a megabit per second).

Conclusions

While there are numerous network service providers in the South Bay, and the South Bay seems to generally make modest investments in and use of information technology, there is clearly latent demand for additional bandwidth and connectivity. The supply of network services is fragmented and inconsistent across the region, generally consisting of low-cost but low-speed and high-speed but high-cost options. Overall, bandwidth is rather costly. Network services are important to stakeholders, and they are not generally satisfied with the quality of available services. Consequently, stakeholders are looking for options.

There appear to be extensive opportunities to do more with technology in the South Bay. Overall spending on IT is modest. Basic industries—those that export goods and services from the South Bay—are making substantial use of IT, but competitive pressures and customer expectations are driving them to do even more. Some industries, particularly retail and service sectors, have numerous opportunities to benefit more from technology. Local governments also could use technology more to control costs, improve performance and services, and possibly generate new revenue. Perceived lack of bandwidth/connectivity and solutions, and internal IT capabilities are major barriers to increased investment and use. There are also numerous workforce challenges, from making executives aware of technology's value to finding workers with either basic or advanced technical skills.

The statistics suggest that the South Bay's workforce is aging and under real economic pressure. Incomes are down, education is worth less, family commitments are greater, and both commuting times and

[34] Upload and download speeds are used to measure of the amount of data transferred over the network to a device. Download speeds are typically much faster. Higher download speeds and bandwidth capacities enable the streaming of video and other data-intensive formats.

housing costs are increasing. Meanwhile, the area's economy is under-going a pervasive bifurcation: high-skill, knowledge-intensive fields and sectors are growing, as are low-skill, low-paying fields and sectors. Mid-range opportunities are drying up, especially in the region's bedrock production and distribution sectors. The good jobs require many workers to upgrade skills or even switch occupations. The readily available jobs don't pay enough to cover housing costs, let alone other costs. There are plenty of jobs that pay well, but they require advanced—and rapidly changing—skill sets.

There is a similar bifurcation between technology leaders and technology laggards. The area has numerous telecommunications providers, specifically fiber-based providers, yet many South Bay stakeholders are challenged to get cost-effective high-speed, reliable access. Most locations in the South Bay are "on-net" and have fiber connections available but they're expensive. Others are only served by outdated copper infrastructure, and face prohibitive up-front costs to get fiber-optic connections. Technology-intensive companies either work around these gaps or go elsewhere. Companies that don't really use digital technologies are "fine," at least until they are bypassed by consumers as technology-enabled competitors make them irrelevant.

The South Bay faces dual challenges to business retention and sustainable, high-wage employment.

The South Bay faces dual challenges to business retention and sustainable, high-wage employment. The first challenge is the gap between high- and low-speed connections, the inconsistent availability, and the relatively high cost of bandwidth. The second challenge is a pervasive workforce gap in abilities and knowledge about technology. This gap emerges as lack of awareness by executives and as difficulty finding employees with both basic and advanced technology skills. These gaps keep the South Bay from adopting and deploying applications that will make the region's organizations more efficient and productive, consequently also holding down workers' incomes.

A smart region closes these gaps. It drives more consistent—in terms of availability, cost, and performance—network services. It also provides a platform for residents to increase their skills and an understanding of technology. How can the South Bay become a smart region? The focus should be on applications because they are the insight, intelligence, and means to act on these things. Cities must be the starting points because they have the most to lose (and gain); businesses and residents can simply move. The cities can keep them in the South Bay by investing in smart applications. The applications require abundant, cheap bandwidth interconnecting the cities, and they require a range of technological skills. As the cities deploy applications—and involve their residents and companies in that effort—they will drive both development of and demand for capabilities and connectivity. The cities can be catalysts for digital development to make the entire region more competitive, innovative, productive, prosperous, and sustainable—and there are no other entities that can effectively do this. There are abundant network and workforce resources, but only the cities can apply these resources in a manner that will result in broad-based development.

The South Bay cities can be catalysts for digital development to make the entire region more competitive, innovative, productive, prosperous, and sustainable

Section 3:

Building a Smart South Bay

The South Bay is in a unique position to surf a huge wave of global economic, social, and technological change; or to be crushed beneath it. The area needs the right tool and great skills—along with clear, shared vision and a disciplined, steady approach—to get in and stay in the sweet spot. In this case, the right tool is a high-capacity, high-reliability fiber-optic network. The right skills are a set of hard technology skills—particularly for automation, coding, data analytics, and design—combined with interpersonal, organizational, and social soft skills.

No one person or organization can provide—or use—these tools and skills. Every member's contribution in coordination with each other is a critical success factor in the development of the region. There must be clear understanding and agreement on roles, responsibilities, and returns. It is critically important to aggressively and thoroughly engage as many and as diverse stakeholders as possible, across the South Bay and beyond. Acquiring the tool—building the network—will require major investment by multiple partners. But it pales in comparison to the amount of teamwork necessary to make sure the network is usable, useful, and used.

The South Bay will need partnerships focused on applications and processes, as well as infrastructure and workforce. "How can we improve our processes together, to make the South Bay better for everyone? What applications should we deploy? Do we build them or buy them? How do we make sure people can and do use and benefit from those applications?" These are critical questions that need to be asked of—and answered by—as many different stakeholders as possible. The network represents a critical opportunity for asking and answering these questions. It is the collaborative process that will make the network usable and useful, and will make the South Bay region truly *smart*.

Summary of Recommendations

Magellan Advisors recommend that the South Bay undertake a concerted, coordinated effort to deploy applications that provide both better and more information and greater functionality at less cost. In other words, the South Bay should get smart. These applications will require additional network connectivity and workforce capabilities. Refer to section 1 for summaries of the applications, infrastructure, and skills. Also refer to the discussion of SMART goals. Magellan Advisors recommends that South Bay stakeholders work together to establish and work toward such goals for a smart region.

The primary focus and participants for this effort should be the South Bay cities, with the overall goals to improve their performance, services to residents, and value as business locations. In the process, the cities should engage businesses and institutions to also get smart. The broader goals of the effort are to increase the availability of economical network services and the number of workers with both basic digital skills and advanced technical expertise. We recommend that these efforts take three forms, or strategic initiatives:

1. *Establish an Innovation Taskforce to explore smart community applications, related applications in business and industry, and workforce requirements*. Generally, this initiative should focus on goals and benefits. A key overall goal is to increase awareness of the value of digital skills and technologies among both leaders and workers. Specific focuses should be on:

a. Defining objectives and key results for a smart region with input from businesses and residents,
b. Conducting application assessments to determine the impact of implementation and results-oriented deployment strategies, and
c. Identifying partners and resources for achieving the goals and realizing the benefits of becoming a smart region.

2. *Develop local broadband infrastructure improvement programs.* The first step in this effort will be to come to some consensus about the components and structure of such programs (discussed below). The second step is to get the South Bay cities to each launch the programs. And, the third, on-going step will be to align and coordinate the programs to ensure consistency across the South Bay area.

3. *Build a South-Bay Middle-mile Advanced Regional Technology Network (SMART-Net)* to interconnect the South Bay cities, provide them with internet access and inter-site connections, and support deployment of smart community applications. Begin SMART-Net as a provider-provided network and evolve it into an owner-operated network. Make this a "big tent" partnership under which community institutions can also use the network and partners can economically serve commercial and residential customers.

While these efforts can and should proceed in parallel, they should be established and pursued in the order listed above. Initiative #1 provides the rationale and support for the other initiatives. Initiative #2 enables initiative #3, particularly the evolution to an owner-operated network. And, initiative #3 becomes more beneficial and practical as the other two initiatives advance.

Generally, to succeed and prosper in today's environment, the South Bay should focus on entrepreneurship, innovation, process improvement, and creative and technical talent. Focus first on awareness and understanding—what these things are, why they are important, and how a SMART-Net enables them. Then promote local efforts to capitalize on and enable SMART-Net. As these activities develop, build the network to enable the cities' operations, smart region applications, and quality of place improvements. Each of these general steps feeds into the next. In the short-term, we recommend a series of specific steps that feed into these more general, longer-term activities. The following recommendations build on what the South Bay is doing already to establish critical infrastructure and skills for becoming a smart region.

The South Bay cities should get to know each other better, and actively develop opportunities and means for working together. The cities are in this—riding the wave or getting swamped beneath it—together. While each is distinct, it is likely that most people who work, play, and live in the area do not pay much attention to municipal boundaries. Collaboration can make the cities more effective, serving residents, industry, and visitors better, and more economically. The other recommendations, below, will clearly require collaboration, but there are easy starting points.

One general starting point is to establish common policies, particularly related to the subjects of this re: broadband deployment, business growth, and workforce skills. A second starting point, which is also an example of common policies, is to make city data openly available. Ideally, this is based on or leads to a common set of performance and quality-of-place metrics. The last starting point is a commitment to, or at least willingness to make, shared investments. Applications, infrastructure, and skills can all be much more economical and impactful when multiple cities invest in them together.

The Innovation Taskforce

The core challenge for the South Bay is to stay ahead of socioeconomic and technological change, and to fully capitalize on these changes. This goal requires a team of visionaries who are tasked with identifying critical areas for exploration and investment. The *South Bay Innovation Taskforce* (the "taskforce") should reflect central economic drivers and goals of the region. It can act as the initial advisory board or working group for the SMART-Net.

Production and distribution industries must anchor the taskforce, and it should include representatives from retail and services who are pushing the technological envelope. Human and intellectual capital industries—particularly technical services—should have strong representation. And, considering its rapid growth, the finance sector should be represented by new and growing companies. Generally, the taskforce should be heavy with technologists, entrepreneurs, and leaders of rapidly growing companies because (a) they are likely to have the expertise and perspective necessary for the task and (b) these are areas where the South Bay should focus if it is to grow strongly yet sustainably.

The dual roles of the taskforce are to act as a technology "radar screen," and to facilitate adoption and use, including guiding development of infrastructure and skills. The first role involves regular environmental scanning to identify new, emerging, or changing technologies that relate to smart region goals and activities. These include all the applications, infrastructure components, and skills listed in section 1. The second role requires taskforce members to be aware of resources for, drivers of, and barriers to smart region technologies. Resources include everything from grant programs through special initiatives of technology providers to potential investors.

The barriers and drivers relate directly to municipalities and indirectly to business and industry across the South Bay. Why should cities get smart? What's holding them back? And, how can they do it effectively and economically? These are the questions the taskforce should work to answer. Hypothetically, based on results of the survey, the barriers are lack of awareness and capabilities, while the drivers are competitive pressures and customer expectations. The taskforce should develop a detailed, shared understanding of these barriers and drivers for South Bay stakeholders, particularly cities.

Meet regularly, building on meetings currently convened by the South Bay Cities Council of Governments. Bring in speakers on topics of common interest, especially related to using technology. And, cross-pollinate between "stovepipes": Have city managers, economic development directors, fire and police chiefs, GIS and IT directors, public works directors, and even external stakeholder representatives from education, healthcare, industry, etc., attend and present. Rotate host locations so every city is showcased, everyone travels, and there becomes an increased familiarity and understanding of the South Bay as a region.

Reach out to local chambers of commerce, broadband and technology providers, and institutional and business leaders. The outreach should center around smart applications, infrastructure, and skills—what's available and what's needed—but can touch on a wide range of topics, including:

- *"Collision spaces"* are simply places where diverse persons with different but complementary abilities, interests, and resources collide with each other.
    - How and where might the South Bay cities and stakeholders create more places where people can connect, collaborate, and learn together, particularly those with entrepreneurial or technological interests?
        - Business incubators or accelerators for startup companies and pre-startup entrepreneurs to connect with mentors, professional help, and other support resources

  - Community technology centers where residents can use internet connected computers, printers, scanners, 3D printers, virtual reality headsets, etc., and can access applications and content
  - Co-work spaces for independent professionals and small businesses to have access to meeting and working spaces, as well as other tools such as software and hardware
  - Maker spaces or fab labs with a lot of production tools for music & video production, prototyping, software development, arts & crafts, wood working, etc., and with skilled minders to keep folks safe and productive
- Multiple collision spaces exist already in the South Bay. What kinds of activities, content, programs, or resources could the cities provide to attract people to collision spaces?

- *Rethinking redevelopment.* While some areas of the South Bay are thriving real estate markets, other areas are struggling to redevelop sites that were previously used for industrial and warehousing purposes. The needs of residential and commercial tenants are changing along with demographics and lifestyles. There may be opportunities to pioneer new (re)development patterns that couple technology with clustered, human-scale, mixed use buildings. While these approaches are not new, technologies such as autonomous vehicles, drones the internet of things, and augmented/virtual reality could make them even more practical. For example, think about how these technologies might be used to help elders age in place while connecting them with younger people, as well as a full range of intelligent services.

- *Smart community applications*, as discussed above (see Section 1), are a, if not *the*, primary reason for deploying SMART-Net, even if it is eventually expanded for other purposes. The purposes of smart community applications are to improve quality of place and increase value for businesses and residents. The applications do this by supporting, sensing, responding to, reporting on, and controlling various aspects of public assets and spaces. Discussions about what people value about each of the aspects and experiments with smart community applications are important precursors to actual deployments. Broadband infrastructure should be part of these activities because (a) it is an important aspect of the community and (b) it is necessary for most smart community applications.

- *Technology utilization* can be a huge challenge, especially for small and medium organizations. Do key decision-makers have meaningful, unbiased information and resources necessary to capitalize on technology for their organizations? Provide resources and tools for technology assessment, road-mapping, and strategy. These could be wonderful engagement tactics as well as fodder for community and economic development. These multiple applications include:
  - Community/government functions
  - Future smart city applications
  - Community anchor connections
  - Broadband applications
  - Revenue generation
  - Spare capacity
- *Workforce innovation.* Workforce development and planning are challenged to adapt to and adopt rapidly evolving technologies. It is widely recognized that workforce planning and development must be more closely aligned with employers' requirements; they must become "demand-driven." At the same time, programs must connect with and build on the current workforce, including students, mid-career professionals, passive job seekers, "high-potentials," and

advanced, specialized talent. The Taskforce could provide a forum for exploring new approaches, and possibly even do experiments to test innovative approaches to aligning workforce development with employers' needs.

Local Broadband Infrastructure Improvement Programs

Local broadband infrastructure improvement programs (BIIP) can be pursued independently by each city. These programs are basically a set of tactics to encourage broadband infrastructure growth; they facilitate network development. Therefore, network management should promote and support them. Each of the municipalities can develop and adopt broadband-friendly public policies geared toward driving more investments. There may be some broadband-friendly policies already in place, however most are informal and they are not coordinated across all government entities. Management and operations can help make the programs more formal and consistent.

Implementation of broadband improvement programs requires stakeholders and local governments to evaluate current land use, permitting, construction, and right-of-way policies. Informal policies and procedures also need to be examined to determine how broadband-friendly policies can encourage development of broadband infrastructure. In addition, the municipalities should decide whether to require specific conduit for broadband use to be included in all new building construction efforts.

Incorporating broadband infrastructure requirements into municipalities' land development or general plan statutes will allow and encourage broadband construction in conjunction with other capital projects. For example, installation of fiber-optic conduit during all projects involving roads, sidewalks, trails, or lighting projects where the ground is to be opened for other purposes would be less costly than installing conduit through standalone broadband projects. Since most costs to build broadband infrastructure are incurred through underground construction and restoration processes, this strategy can alleviate significant costs by opening the ground once instead of multiple times. In addition, these policies can assist the municipalities in minimizing ROW construction and disturbances. In many states and municipalities, this formalized policy is referred to as a "Dig Once" policy.

Formalizing these policies will lead to installation of broadband infrastructure in conjunction with other public and private infrastructure projects occurring within a jurisdiction. Many of these public policy tools will be codified and implemented according to existing procedures and ordinances, and must be approved by each municipality's elected board. It is recommended that this topic be carefully work shopped with municipal leadership, local government departments that would be affected, and any other community organizations that will participate.

There is little financial risk in broadband improvement programs because they require limited upfront funding if managed correctly. In some cases, municipalities have struggled with incorporating broadband into their existing land use policies because they are unfamiliar with how to manage a new "utility" type of asset. This requires the collaboration of multiple departments and the ability of these departments to work together toward a common goal. The South Bay cities should expect that some new business and operational processes will be required, along with changes to existing processes, for the programs to be effective. Regular communications between public works, traffic engineering, planning, and information technology are critical to broadband infrastructure improvement programs. It may even be necessary to formally include these departments in a working group.

A primary element of a broadband improvement program is installation of conduit. Conduit should be installed during any type of community infrastructure capital project, i.e., road widenings, utility undergrounding, water/sewer/gas expansions. Installations should be coordinated between all relevant

parties, as a basic element within the projects. This practice will save municipalities from having to build the proposed fiber routes independently, and will allow the areas to save large amounts of capital. The municipalities should explore requiring conduit in private developments and buildings. Basic conduit infrastructure can be added in to development projects, again, for a minimal incremental cost, and will allow those buildings and properties to be considered "fiber-ready." Other components of a broadband improvement program are broadband-friendly policies, comprehensive standards and specifications, and development of vertical assets.

In support of this strategy, management should facilitate and promote broadband-friendly public policies. These policies influence how broadband services develop throughout the community and show the community and prospective newcomers that the region is serious about promoting broadband growth and accessibility. A team of broadband champions should develop standard ordinances to allow broadband investments to be made incrementally through each of the communities. The policies should be adopted at all levels, and should include coordination with any private or public utilities.

Broadband Friendly Public Policies

Broadband-friendly public policies are tools that local governments can formalize to encourage broadband infrastructure growth. These include many items that are already informally performed by entities in a community, however there is no coordination. Below is a list of ways that the South Bay and its communities can encourage broadband development through the adoption of broadband-friendly policies:

- Evaluate fees levied on broadband providers for constructing broadband infrastructure to ensure they do not discourage broadband investment.
- Streamline the broadband permitting processes within public rights-of-way to ensure broadband providers do not face unnecessary obstacles to building infrastructure.
- Work with public works, traffic engineering, planning, and information technology departments to identify projects that could include broadband infrastructure at reduced costs.
- Identify opportunities to install broadband infrastructure in conjunction with public and private construction projects.
- Maintain broadband infrastructure specifications in a GIS-based fiber management system, requiring updates as built, and implement processes for maintaining accurate documentation.
- Adopt policies that incorporate broadband as a public utility and create a policy framework to promote its deployment in public and private projects as appropriate.
- Draft policies to municipalities' specific needs and adopt them into local policy, codes, and standards (including dig-once, joint trenching, engineering standards, etc.).
- Incorporate broadband concepts into municipalities' Capital Improvement Plans (CIP), as appropriate, and make a commitment to fund broadband infrastructure.

Any local government agency, using its Capital Improvement Plan and interdepartmental communications, can determine projects that could best utilize this strategy. This policy should also be coordinated with private utilities operating in the region, broadband service providers, and other underground utility organizations to minimize the need to overbuild and to ensure that all service providers have an opportunity to place their infrastructure in capital projects as well. These joint trenching policies can facilitate more opportunities to install conduit, fiber, and other infrastructure due to lower costs. Standardization of these agreements across all potential owners of underground infrastructure can

be established to ensure all parties are aware of the joint trenching opportunities as they become available.

Network Standards, Fiber-Optic Investment, Implementation, Operation and Management

Standards simplify management and operations. They ensure that infrastructure deployed at different times, in different locations, by different entities is consistent and functional. Standardization is a governance best practice that goes directly to all of governance's purposes, that must be managed and operationalized. Generally, management adopts standards based on input from stakeholders, and operations assures the standards are met. Standards include contracts and operating procedures, as well as network facilities. The number of standards increase with service offerings; one benefit of dark fiber is that it involves relatively few standards. Regardless, there is no shortage of issues and resources that should be standardized.

Underground standards are summarized in Appendix B – Outside Plan Underground Specifications. Aerial specifications are going to be highly dependent on the pole segments and ownership. Actual pole routes selection, if required will occur in the network design process. A future design engineering study will also identify the final overhead requirements and specifications. Overhead placement standards and specifications should be coordinated through the public policy process with input from relevant community partners.

The South Bay cities should study the value of fiber investments, and build network infrastructure when and where it makes sense (See Appendix C for more details). City-owned fiber connectivity can reduce operating costs and enable performance improvements. The assets can also be leveraged for community and economic development. A wide range of amenities and applications can be provided via fiber. Fiber leasing or lit services, potentially even retail broadband, can all be revenue generators for cities. And, the assets can be deployed economically when aligned with or incorporated into other developments.

GIS and Infrastructure Record Keeping

As part of the implementation of broadband-friendly public policy measures, all municipalities should require that Geographic Information System (GIS) documentation of all broadband infrastructure installations, upgrades, and other items be maintained and updated. Those that keep records currently utilize GIS to track conduit and fiber segments; however, this does not support fiber inventory or strand mapping. A community should invest in a fiber management platform that will provide this functionality. This will allow the South Bay and related government agencies to maintain a clear understanding of locations of the broadband infrastructure such as conduit, vaults, pull boxes, transitions, fiber-optic cable, and other outside plant resources.

Additionally, the South Bay cities should work with companies deploying broadband infrastructure to put in additional conduit, inner duct or fiber with those projects. Providers will often allow municipalities to "joint trench" and share in the cost of adding additional assets. Some California cities have acquired ownership rights to fiber strands within providers' fiber cables in lieu of permit fees. This is common throughout the United States, and while there can be restrictions placed on the use of this fiber, it does allow public fiber to be constructed very economically.

Implementing Broadband Improvement Programs

Implementation of broadband improvement programs requires SBCCOG and local governments to evaluate current land use, permitting, construction, and right-of-way policies. Informal policies and procedures also need to be examined to determine how broadband-friendly policies can encourage

development of broadband infrastructure. In addition, the cities should decide whether to require specific conduit for broadband use to be included in all new building construction efforts.

Formalizing these policies will lead to installation of broadband infrastructure in conjunction with other public and private infrastructure projects occurring within jurisdictions. Many of these public policy tools will be codified and implemented according to existing procedures and ordinances, and must be approved by a community Commission. It is recommended that this topic be carefully work shopped with city leadership, county departments that would be affected, and any other local government organizations that will participate.

There is little financial risk in broadband improvement programs because they require limited upfront funding if managed correctly. In some cases, municipalities have struggled with incorporating broadband into their existing land use policies because they are unfamiliar with how to manage a new "utility" type of asset. This requires the collaboration of multiple departments and the ability of these departments to work together toward a common goal. The SBCCOG and local governments should expect that some new business and operational processes will be required, along with changes to existing processes, for the programs to be effective.

SMART-Net

Magellan Advisors recommends an incremental, iterative approach to building a South Bay Middle-mile Advanced Regional Technology Network (SMART-Net). The *Innovation Taskforce* and local broadband infrastructure improvement programs are important precursors to SMART-Net. They are the foundation for a successful network initiative.[35] We recommend that the South Bay approach the concept and design of SMART-Net as an initial venture in an extended campaign to bring in other network users and identify partners and vendors. The concept and design should be revised and tuned with input from various stakeholders, especially the cities and their anchor institutions. Specifically, the South Bay cities should seek additional network users, and the concept and design should evolve based on their needs.

The functionality should also evolve. Initially, SMART-Net is likely to function for joint purchasing of internet access. It will also enable on-net access to data centers, etc., for municipal purposes such as mass data storage or specialized applications. And, of course, the cities will be able to effectively share applications and data among them via SMART-Net. This provides the foundation for regional smart community applications for use by all cities and residents. Additional network users—beyond just the cities—will also add functionality to the network, and create opportunities for additional applications and services. For example, the network could be used for limited, secure access to resources for education and healthcare. As these users join the network, it becomes more useful for purposes such as crime reduction and emergency response.

Magellan Advisors recommends that the South Bay also approach construction and operation of SMART-Net as evolving activities. Initially the network should be built and operated by a third-party vendor. This is currently the most practical approach because the cities' resources are limited and there are multiple providers ready to help. But, a provider-provided network should just be the initial version of SMART-Net.

[35] See section 3 of the full report for details on these recommendations, as well as governance of the SMART-Net.

Figure 22. High-level map of SMART-Net

The South Bay should incrementally evolve the network into a community-based owner-operated network. The dual evolutionary paths would be (1) increased availability of publicly-owned broadband infrastructure developed via BIIPs and (2) establishment of a broadband authority with the resources to maintain and manage the network. As these paths converge, the initial SMART-Net provider can either simply hand operations over to the broadband authority or continue as a partner, using the network to sell network services to businesses and residents.

To initiate a discussion and more in-depth design process, Magellan Advisors began with the goal of connecting one site in each of the fifteen South Bay cities (see). As Figure 22 and Figure 23 shows, SMART-Net would interconnect the cities and provide access to numerous data centers and service providers. We used data that Magellan has on file regarding service providers in the region to provide a model network, including preliminary cost estimate. This is a speculative design. The layout and pricing are based on limited information. Different providers are likely to implement this model in different ways. For these reasons, the design is only a starting point for dialog about the SMART-Net concept and design, and the costs should be considered rough estimates.

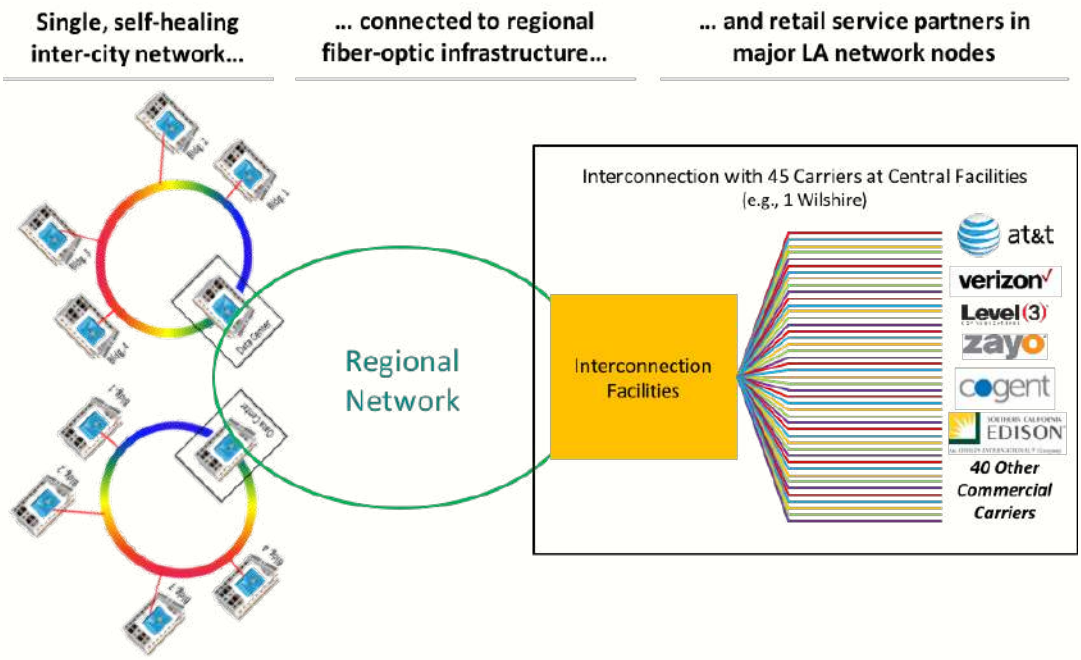


Figure 23. A logical diagram of the SMART-Net design

SMART-NET would generally have a ring architecture with ability to re-route during an outage event. Some sites may be on a single lateral with a potential failure point. The network could be upgraded so that each site has diverse routes—separate paths in and out of the building—which would be more resilient, but would cost more and have a longer lead time to implement. The transport costs cited below include network design and engineering, construction, equipment, permits, easements, etc., to connect a gateway site in each city. The middle-mile backbone routes should be optimized to reach sizeable business and commercial zones, area community anchors, data center facilities, and other key connection points. Cities' BIIPs and the *Innovation Taskforce* activities can help capitalize on this infrastructure for community and economic development, as well as reduce capital expense.

SMART-Net Costs

Table 20. Network design cost estimates for 1 Gbps SMART-Net transport

City Locations	% of Total Cost	Option 1		Option 2	
		MRC	NRC	MRC	NRC
2 Portuguese Bend Rd., Rolling Hills	18.20%	$929	$288,834	$8,335	$0
340 Palos Verdes Dr. W, Palos Verdes Estates	15.78%	$929	$250,429	$7,227	$0
24300 Narbonne Ave., Lomita	8.96%	$929	$142,196	$4,103	$0
701 E Carson St., Carson	7.18%	$929	$113,947	$3,288	$0
30940 Hawthorne Blvd., Rancho Palos Verdes	6.32%	$929	$100,298	$2,894	$0
1315 Valley Dr., Hermosa Beach	6.24%	$929	$99,029	$2,858	$0
12501 Hawthorne Blvd., Hawthorne	5.56%	$929	$88,237	$2,546	$0
1 W Manchester Blvd., Inglewood	5.07%	$929	$80,461	$2,322	$0
1400 Highland Ave., Manhattan Beach	4.16%	$929	$66,019	$1,905	$0

City Locations	% of Total Cost	Option 1		Option 2	
		MRC	NRC	MRC	NRC
415 Diamond St., Redondo Beach	4.15%	$929	$65,861	$1,900	$0
14717 Burin Ave., Lawndale	4.11%	$929	$65,226	$1,882	$0
3031 Torrance Blvd., Torrance	3.77%	$929	$59,830	$1,726	$0
1700 W 162nd St., Gardena	3.63%	$929	$57,608	$1,662	$0
350 Main St., El Segundo	3.59%	$929	$56,973	$1,644	$0
4045 Palos Verdes Dr. N, Rolling Hills Estates	3.28%	$929	$52,053	$1,502	$0
Total	**100.00%**	**$13,935**	**$1,587,001**	**$45,794**	**$0**

Table 21. Network design cost estimates for 10 Gbps SMART-Net transport

City Locations	% of Total Cost	Option 1		Option 2	
		MRC	NRC	MRC	NRC
2 Portuguese Bend Rd., Rolling Hills	18.20%	$1,394	$288,834	$8,968	$0
340 Palos Verdes Dr. W, Palos Verdes Estates	15.78%	$1,394	$250,429	$7,776	$0
24300 Narbonne Ave., Lomita	8.96%	$1,394	$142,196	$4,415	$0
701 E Carson St., Carson	7.18%	$1,394	$113,947	$3,538	$0
30940 Hawthorne Blvd., Rancho Palos Verdes	6.32%	$1,394	$100,298	$3,114	$0
1315 Valley Dr., Hermosa Beach	6.24%	$1,394	$99,029	$3,075	$0
12501 Hawthorne Blvd., Hawthorne	5.56%	$1,394	$88,237	$2,740	$0
1 W Manchester Blvd., Inglewood	5.07%	$1,394	$80,461	$2,498	$0
1400 Highland Ave., Manhattan Beach	4.16%	$1,394	$66,019	$2,050	$0
415 Diamond St., Redondo Beach	4.15%	$1,394	$65,861	$2,045	$0
14717 Burin Ave., Lawndale	4.11%	$1,394	$65,226	$2,025	$0
3031 Torrance Blvd., Torrance	3.77%	$1,394	$59,830	$1,858	$0
1700 W 162nd St., Gardena	3.63%	$1,394	$57,608	$1,789	$0
350 Main St., El Segundo	3.59%	$1,394	$56,973	$1,769	$0
4045 Palos Verdes Dr. N, Rolling Hills Estates	3.28%	$1,394	$52,053	$1,616	$0
Total Allocation	**100.00%**	**$20,910**	**$1,587,001**	**$49,276**	**$0**

There are two options for pricing network transport costs. Table 20 and Table 21 show non-recurring (NRC) and monthly recurring (MRC) costs for both transport options. The first option is for total monthly recurring costs (MRC) to be divided evenly among the 15 cities. Special construction costs would be paid upfront as non-recurring costs (NRC) by respective cities for laterals to the backbone. The second option is for special construction to be financed and included in the MRC, which means there would be no upfront NRC. Magellan estimated both options for 1 Gbps and 10 Gbps internet transport access to each site. Under a third option all costs (MRC and special construction) for transport only would be paid upfront as a one-time NRC at a discounted rate. Service providers may be willing to consider financing this option for a SMART-Net consortium or for individual cities.

Separate from transport costs identified in above, Table 22 below shows additional estimated costs for internet access. The costs vary with the amount of throughput a provider is committed to provide, from 1 Gbps to 10 Gbps for 12, 24, and 36 month terms. These are estimated rates for internet access in the

region based on data maintained by Magellan. They may vary and, like transport costs, can be competitively bid to Internet Service Providers (ISP), collectively as a region or individually for each city, to get lower prices.

Table 22. Cost estimates for 10 Gbps SMART-Net committed Internet access

Single 10 Gbps Ethernet Port	12 Month Term		24 Month Term		36 Month Term	
	Price/Mb	Total MRC	Price/Mb	Total MRC	Price/Mb	Total MRC
1 Gbps Commit	$1.25	$1,250.00	$1.13	$1,130.00	$1.05	$1,050.00
2 Gbps Commit	$1.20	$2,400.00	$1.08	$2,160.00	$1.00	$2,000.00
3 Gbps Commit	$1.15	$3,450.00	$1.04	$3,120.00	$0.95	$2,850.00
4 Gbps Commit	$1.10	$4,400.00	$0.99	$3,960.00	$0.90	$3,600.00
5 Gbps Commit	$1.05	$5,250.00	$0.95	$4,750.00	$0.85	$4,250.00
10 Gbps Commit	$0.85	$8,500.00	$0.79	$7,900.00	$0.68	$6,800.00

Business and Financial Models

The SMART-Net business model is quite simple because it is envisioned—at least initially—as a joint purchasing arrangement. Table 22 lists the internet access South Bay cities are getting and what they are paying for that access, based on survey responses (see Section 2 for additional information on the survey). At the time of the survey, these cities were paying over $32,000 per month in aggregate, and over $3,600 each on average. Their average contracted access speed was about 230/220, but the average of tested speeds was only around 165/140. On average the cities were paying nearly $50 per month per Mbps down, and $81 per month per Mbps up.

SMART-Net would provide the cities with much greater bandwidth for much lower average and total costs than what they are currently getting. The monthly costs for 10 Gbps under option 1 (see Table 21) would be less than half the average current cost to cities. Although actual costs to each city would vary, the average cost of a 10 Gbps connection under option 2 is less than what the cities are currently paying on average. And, this option delivers *sixty to seventy times the bandwidth!* This initial assessment indicates that SMART-Net would immediately deliver much faster internet access to the cities as less cost.

Table 23. South Bay cities contracted and actual (tested) internet speeds and costs

City	Contracted Mbps		Actual Mbps		Monthly cost	Monthly cost per Mbps	
	Down	Up	Down	Up		Down	Up
Carson	100	100	100	100	$1,500	$15.00	$15.00
El Segundo	100	10	75	7	$531	$7.08	$75.86
Gardena	200	200	200	200	$2,600	$13.00	$13.00
Hawthorne	50	50	42	19	$0	$0.00	$0.00
Manhattan Beach	100	100	93	42	$7,800	$83.87	$185.71
Inglewood	1000	1000	850	750	$6,000	$7.06	$8.00
Rancho Palos Verdes	150	150	149	152	$275	$1.85	$1.81
Redondo Beach	100	100	40	38	$6,300	$157.50	$165.79
Rolling Hills Estates	50	50	49	46	NA	NA	NA

City	Contracted Mbps Down	Contracted Mbps Up	Actual Mbps Down	Actual Mbps Up	Monthly cost	Monthly cost per Mbps Down	Monthly cost per Mbps Up
Torrance	308	317	54	54	$3,933	$72.39	$72.84
				Averages	$3,627	$49.54	$81.41
				Total	$32,639		

Beyond the short-term, bottom-line return, SMART-Net has great potential for long-term top-line and intangible benefits. It could possibly be used to provide revenue generating services, either directly to the cities or as a share of partners' income from network customers. Potential revenue streams include dark fiber leasing, lambdas (frequencies of light within the fiber strand), managed bandwidth, enterprise networks, and retail broadband. In the mid-term, SMART-Net provides a platform for the cities to jointly deploy a wide range of smart community applications, and to jointly purchase network services (for basic operational support but also to enable smart community applications). All the mid- and long-term opportunities can be leveraged for community and economic development. Specifically, city investments in SMART-Net would make it possible to provide high-bandwidth connectivity to prime business or industrial prospects, institutions, and startups at very low cost. This could be a powerful differentiator for the South Bay to attract, grow, and retain companies with high-paying jobs that fit the South Bay's workforce capabilities.

Organizational Structure and Governance[36]

Magellan Advisors recommends that the SMART-Net be initially organized as an informal consortium of the South Bay cities for jointly purchasing network services, and that the organization evolve into a joint powers authority. The *Innovation Taskforce* could be an ideal vehicle for this process. The proposed middle-mile network, as a regional asset, should be overseen by individuals who have no personal obligations in the day-to-day operations of the network. From engaging stakeholders, through selecting providers, to evolving to owner-operated, someone will need to keep the initiative moving in the right direction. As such, an appropriate governance structure must be formed and empowered to oversee this very important program. Magellan Advisors defines governance as:

> *A consistent and disciplined set of enterprise policies and transparent business processes that include oversight responsibilities, control, and the use of pre-defined decision criteria through a chartered collaborative effort by an executive team that measures and communicates the strategic risk and value of every broadband investment.*

Governance is future-focused, and deals with transformational issues to ensure relevancy of services, whereas operations deals with daily transactional issues to ensure continuity of defined services. Governance provides executive oversight for establishing and evolving operations. Governance members are typically nominated for appointments and, if accepted by the nominating body, appointed to serve the strategic interests of the organization. They decide program-level directions and investments in

[36] For additional details regarding Key Performance Indicators for the organization and governance of a South Bay regional broadband network, see Appendix B: Outside Plant Underground Specifications.

support of the purposes of the network. Governance, as it applies to broadband, consists of five critical decision domains:

- Ownership Rights
- Service Obligations
- Network Architecture
- Infrastructure Strategies
- Investment Priorities

A formal charter will need to be developed to address and explain the scope of control and levels of diligence that will inform the roles and responsibilities attributable to the appointed members of a governance board. The board will in turn appoint standing or ad hoc committees or work groups to execute issue-specific functions in any one of the decision domains identified above. The optimal design of a governance structure for community-based broadband depends on factors such as existing infrastructure, potential partnerships, ownership control issues, funding mechanisms, and service provisioning. Magellan Advisors has observed and worked with many variations of "optimal governance," and we recommend a joint powers authority (JPA) to facilitate the partnership of SMART-Net. A JPA is a governmental agency that can be created by one or more governmental entities to oversee and make direct broadband investments on behalf of the community.

This will likely face resistance from the incumbent broadband providers if the authority uses public investments for competitive service offerings. There are other governance configurations, such as public-private partnerships or cooperatives, with similar structures, approaches, and access to funding sources, loans, grants or in-kind services. Should the South Bay want to bring private investments to the table, a not-for-profit entity may be the more appropriate governance structure. It could provide oversight through a board of directors comprised of local business, community, and government leaders—any broadband users constituting most the market—without carriers involved. Regardless of the selected structure, the following examples of duties should be anticipated as within the scope of the governance board:

1. Make and execute contractual obligations for the commercial use of broadband assets with other public or private organizations.
2. Set and adopt a formal rate structure for assets that is in compliance with established practices subject to the State of California Public Utilities Commission, or Federal Communications Commission regulations regarding public lease or Indefeasible Right of Use (IRU) relative to dark fiber, trans service, tower space, and physical property.
3. Provide supervisory oversight of an executive director and staff, any or all of whom may be employees or contracted agents of the board.

SMART-Net stakeholders will have to develop consensus as to which governance structure presents the optimal benefits sought by the South Bay Broadband Network stakeholders. While the decision cannot be made at the moment, this discussion cannot be avoided or set aside as it could directly influence regional or community buy-in to the project.

Create a South Bay Broadband Authority

Develop a memorandum of understanding (MOU) for a "smart" region joint powers authority (JPA) and model resolution of support for SMART-Net. The resolution would basically formally state a city's support of the idea and goals of SMART-Net, and commit to connect city assets to the network. The MOU would identify roles, responsibilities, and expectations of each city, the SBCCOG, and other entities, and would

lay out the basics of the JPA's purpose, structure, and operations. Both will require city personnel to work closely with each other over an extended time, especially for the resolutions to be adopted and enacted.

It is important to note that Magellan Advisors is *not* recommending that the South Bay Cities Council of Governments become an internet service provider, or that a JPA be established for that purpose. The cities may wish to offer free public Wi-Fi via SMART-Net as an amenity for residents and visitors. But, this service would be (a) free and (b) operate via devices used for one or more closed, secured Wi-Fi network for purposes such as public safety, public works, or education. Our recommendations at this point are limited to a middle-mile network to interconnect the cities major facilities and key sites of institutions that work closely with the cities. Having said that, the cities may decide to individually or collectively offer internet access services. While, that is beyond the scope of this study we recommend the governance structure accommodate such contingencies.

Any network infrastructure must be secured, as touched on in section 1. SMART-Net will enable greater cyber-security by eliminating multiple, difficult to secure points of access (individual broadband services) and replace them with fewer centralized access points that are easier to secure. It is imperative for the cities to make parallel investments in cyber-security. These investments will be much more economical if the cities collaborate rather than duplicating efforts and costs. Collaboration will also allow the cities' cyber-security to be more effective. The network provides a platform and a precedent for such collaboration. The cities should also consider a plan to develop common, shared cyber-security capabilities.

The South Bay should establish and empower a publicly-chartered entity to guide the development of policies and oversee the deployment and operation of the SCBN broadband assets for the benefit of the community. The creation of this authority, the South Bay Broadband Authority ("the SBBA"), shall require enabling local legislation that, at minimum, satisfies city, county, and state requirements much like those used for established public conveyances. "The SBBA" functions as an independent body; subject to the letter and spirit of the enabling legislation.

The enabling legislation shall direct, at a minimum, the adoption of a governance charter or ordinance crafted to meet and exceed community expectations for collaboration, fairness, and transparency in managing the community's future portfolio of known, planned, and sometimes speculative investments in building a robust broadband-defined communications infrastructure. The enabling legislation shall address general organizational structure items including the type of organization, statutory authority, number of governance board members, voting and elections, quorum, term of board membership, meetings, officers, and signatory authority.

Management Structure

The management structure of the authority is relatively simple. Prior to establishing an authority, the network consortium can be managed by its members. Member roles and rights are best based on their contributions. The operational roles of each member should be clearly defined, and should be considered in determining member rights: Rights depend on how much you do and invest. As the consortium evolves into an authority, the governing board will have to define management, including how to select managers and how to deal with management failures as well as management resources and responsibilities. Operations is an extension of this process. Most actual operations can be outsourced either to a consortium member or to a third party.

Thus, management may initially be limited to a single person, possibly even a part time person or couple of people working part time, who develops plans for 6, 12, 18, etc., months, and reports on results for the last quarter and year. As the authority and the network grow, the management structure will have to

expand. The best structure is yet to be determined, but it is likely divided between administration (tracking and reporting), operations, and stakeholder engagement ("sales"). These roles and management structure, in general, are overhead that must be paid for by revenue to the authority. Management is responsible—with oversight from the governing board—to expand the network if and only when it is economical to do so, including any overhead costs.

Appendix A: Broadband Supply Analysis

Availability and costs detailed results

Address	Provider	Type of Service	Speed in Mbps Down	Speed in Mbps Up	Monthly Cost
124 Manhattan Beach Blvd, Manhattan Beach					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	300	300	$164.99
	Spectrum	Cable	300	20	$249.99
140 Main St, El Segundo					
	AT&T	DSL	6	0.768	$50.00
	Comcast	Ethernet over copper	1000	1000	$2,938.00
	Cox	No service			
	Frontier	No service			
	Spectrum	No service			
1740 Manhattan Beach Blvd, Manhattan Beach					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	300	300	$164.99
	Spectrum	No service			
1801 N Sepulveda Blvd, Manhattan Beach					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	500	500	$369.99
	Spectrum	Cable	300	20	$249.99
2041 Rosecrans Ave # 200, El Segundo					
	AT&T	Fiber	200	40	$260.00
	Comcast	Ethernet over copper	1000	1000	$7,822.00
	Cox	No service			
	Frontier	No service			
	Spectrum	No service			
2141 Rosecrans Ave #3100, El Segundo					
	AT&T	Fiber	200	40	$260.00
	Comcast	Ethernet over copper	1000	1000	$7,822.00

Address	Provider	Type of Service	Speed in Mbps Down	Speed in Mbps Up	Monthly Cost
	Cox	No service			
	Frontier	No service			
	Spectrum	No service			
224 Oregon St, El Segundo					
	AT&T	DSL	6	1	$80.00
	Comcast	Ethernet over copper	1000	1000	$7,822.00
	Cox	No service			
	Frontier	No service			
	Spectrum	No service			
28924 S Western Ave #206, Rancho Palos Verdes					
	AT&T	DSL	0.768		$30.00
	Comcast	No service			
	Cox	Cable	Site Survey Needed		
	Frontier	Fiber	500	500	$400.00
	Spectrum	No service			
319 Main St, El Segundo					
	AT&T	DSL	6	0.768	$50.00
	Comcast	Ethernet over copper	1000	1000	$7,822.00
	Cox	Cable	Site Survey Needed		
	Frontier	No service			
	Spectrum	No service			
3421 Highland Ave, Manhattan Beach					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	500	500	$369.99
	Spectrum	Cable	300	20	$249.99
3463 Tanglewood Ln, Rolling Hills Estates					
	AT&T	No service			
	Comcast	No service			
	Cox	Cable	300	30	$540.00
	Frontier	No service			
	Spectrum	No service			
3530 W Century Blvd #103, Inglewood					
	AT&T	DSL	0.768		$30.00
	Comcast	No service			
	Cox	No service			
	Frontier	No service			

Address	Provider	Type of Service	Speed in Mbps Down	Speed in Mbps Up	Monthly Cost
	Spectrum	Cable	100	10	$44.99
3760 W Century Blvd, Inglewood					
	AT&T	DSL	45		$40.00
	Comcast	No service			
	Cox	No service			
	Frontier	No service			
	Spectrum	Cable	100	10	$44.99
400 S Sepulveda Blvd # 200, Manhattan Beach					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	500	500	$369.99
	Spectrum	No service			
550 Silver Spur Rd, Rancho Palos Verdes					
	AT&T	DSL	0.768		$30.00
	Comcast	No service			
	Cox	Cable	Site Survey Needed		
	Frontier	Fiber	500	500	$400
	Spectrum	No service			
904 Silver Spur Rd, Rolling Hills Estates					
	AT&T	No service			
	Comcast	No service			
	Cox	Cable	300	30	$540.00
	Frontier	Fiber	500	500	$400
2110 Artesia Blvd, Redondo Beach, CA 90278					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	500	500	$360
	Spectrum	Cable	Site Survey Needed		
1312 Kingsdale Ave, Redondo Beach, CA 90278					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	500	500	$360
	Spectrum	Cable	300	20	$179.99
2615 190th St #210, Redondo Beach, CA 90278					
	AT&T	No service			

Address	Provider	Type of Service	Speed in Mbps Down	Up	Monthly Cost
	Comcast	No service			
	Cox	No service			
	Frontier	No Service			
	Spectrum	Cable	300	20	$179.99
1609 Hawthorne Blvd, Redondo Beach, CA 90278					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	DSL	7	1.5	
	Spectrum	No Service			
2919 182nd St, Redondo Beach, CA 90278					
	AT&T	No service			
	Comcast	No service			
	Cox	No service			
	Frontier	Fiber	500	500	$360
	Spectrum	Cable	300	20	$179.99

Appendix B: Outside Plant Underground Specifications

Basic Fiber and Conduit Specifications

Table 24. Outside Plant Underground Specifications

Basic Fiber Specifications

- Backbone cable size – 144/288 count fiber
- Lateral cable size – 12/24 count fiber
- Single mode, loose-tube non-armored cable
- Jacketed central member
- Outer polyethylene jacket
- Sequential markings in meters
- All dielectric
- Gel-free/dry buffer tubes
- 12 fibers per buffer tube
- Color coded buffer tubes based on ANSI/TIA/EIA 598-B Standard Color

Basic Conduit Specifications

- 36” minimum acceptable depth
- 2” HDPE smooth wall reel-mounted pipe for underground duct
- Warning tape installed at 12” or 18”
- Maximum fill ratio of 50%
- Innerduct where appropriate for subdividing duct space
- Vault placement at intersections, every 500ft in commercial corridors
- Vaults sized appropriately to house underground lid-mounted pedestals and splice enclosures

Appendix C: Fiber-Optic Network Assets

Magellan Advisors recommends the South Bay start SMART-Net as a provider network but evolve and expand into an owner-operated network. Part of the BIIP should be deploying fiber-optic assets to enhance and extend the provider's infrastructure. The proposed SMART-Net middle-mile fiber backbone will provide high capacity fiber-optic cables throughout the major corridors of the South Bay. It will likely require underground and aerial construction to connect all identified public anchors and to address other community based needs. The construction could include several high-speed fiber rings resulting in a robust, redundant, and reliable backbone fiber network. Access points would need to be strategically placed throughout the fiber routes to allow easy interconnection with facilities, community assets, business districts, and neighborhoods. Initial network routes place conduit and fiber through major corridors, while future routes should be strategically planned to facilitate easier connectivity to businesses and/or residential communities that may desire access in the future.

The fiber backbone will generally consist of 288-432-count fiber-optic cable on major routes. This cable size will have abundant capacity for the SBBA to allocate to various applications, as appropriate. Secondary or lateral fiber should consist of 12 to 24-strand cable connecting individual community organizations, MDUs, and other end user locations. Certain key facilities may have larger count cables. Individual connections to businesses or residences may be a smaller 2 count drop cable. The network will use an in-and-out splicing design that allows community anchors and points of interest to interconnect their locations in a "ring" topology, if required, that supports high redundancy for their communications needs. A range of specialized connections will be made to accommodate additional traffic signal, smart technology, and broadband applications that should be individually engineered based on the application.

Appendix D: Key Performance Indicators

Governance of a South Bay Broadband Network

Magellan-Advisors views the role of governance as critical to this effort and in meeting community obligations by serving four purposes:

Strategic Leadership. As a strategic function within the community, the Broadband board requires an understanding of the vision and goals of this broadband initiative, the immediate and near-term impacts on residents, businesses, and community institutions that provide for health and education throughout the community. The board is committed to communicating its business throughout the community. The board accepts its role as an oversight resource for the benefit of all South Bay residents and businesses and expects that any member of the board, now and in the future, must serve objectively and unselfishly in the best interests of The South Bay, whose broad needs are greater than the needs of any one institution.

Disciplined Processes. The board recognizes that many benefits, such as increased opportunity and trust, are available to The South Bay by instituting operational processes that are thoughtfully defined and broadly-communicated. Well-established processes have the power to transcend changes in the community.

1. The board delivers great value to the community by instituting decision-making processes that are equitable and transparent. To be equitable requires the availability of an exception process that allows the board to deliberate without pause over atypical or non-standard considerations.
2. The board designs the decision-making processes for quality, simplicity, agility, and speed. This ensures that proposed initiatives, investments, and risks are diligently identified and mitigated.
3. The board executes documented, repeatable processes that allow it to prioritize and recommend initiatives and enhancements.

Collaborative Decision-making. The board understands that within an organization without governance – all projects are of the highest priority. It is a primary goal of the board to make objective, non-parochial, well-communicated, regional investment decisions.

1. Board decision-making is driven by the business needs of the community and by the availability of resources.
2. Board decisions are reached through consensus; the achievement of full support for a decision after a complete airing of differing viewpoints.
3. When considering a proposed initiative, the board consistently applies documented and communicated decision criteria to support strategic alignment with the community's goals.
4. The board values initiatives that focus on service integration and magnification opportunities rather than duplicative or individual solutions.
5. Board investment decision-making is not merely about implementing broadband solutions, but about implementing broadband-enabled change.

Sustained Innovation. The board energizes the South Bay's capacity to grow and sustain a high-performance workforce to serve and support the needs of its residents, visitors, and businesses. Once an

initiative has been approved as a project, the board provides high-level monitoring of the project's status and its consumption of resources. The board incorporates best practices and lessons learned within both business and government to continuously improve its policies and processes.

Education is an important aspect of governance. The board participates as a group and as individuals in educational opportunities on emerging technologies and serves as a sounding board for new ideas and initiatives that may support educational and employment opportunities for all who live in The South Bay and all who are welcome to join.

Fiber Asset Inventory

The SMART-Net infrastructure, unlike today's closed or private stakeholder-operated infrastructures, will be a dynamic composite of shared assets. Therefore, a comprehensive inventory of all assets by location, ownership, design, materials, capacities, age, physical condition and legal status/accessibility must be identified and categorized. As part of this study, Magellan Advisors started to collect an inventory of broadband assets; however, this was an initial effort and there are many assets that have yet to be identified.

For broadband purposes, infrastructure assets include conduit, dark fiber, lit fiber, public and privately-owned vertical structures, right-of-way, bridges, rail lines, rail crossings and property-specific land use restrictions in addition to city, township and County-owned properties and privately-owned and Community Anchor Institutions (CAI). All data relative to the overall configuration of the asset infrastructure should be in an accessible Geographic Information System (GIS)-enabled repository data to ensure that accurate record keeping. Infrastructure assets must be physically inspected, verified, and updated within the GIS system per the requirements to commercialize the broadband assets. This inspection and reporting will become an ongoing function of the operation to verify and certify that conduit, dark fiber, tower space, and physical property are in the condition required for community broadband deployment. The SBBA may also develop partnerships with commercial property brokers, management companies and owners to connect commercial parcels to broadband services and create a regional database for marketing and incentivizing connections.

Open Access Service Governance

The SMART-Net should be "neutral" to the extent that whoever provides the infrastructure will not block, filter, or slow content from any sources. The cities and other SMART-Net users will be responsible for managing network content. The network should be "open" for the cities and other users to access network services such as internet access, cloud storage, compute utilities, or VoIP and video services. The initial SMART-Net user base would be limited to the cities, their departments, and organizations providing services to the cities, and via the cities to their residents. The network will not be open to the public, except in the form of free, public Wi-Fi connectivity, or for commercial use. The South Bay's future provider partner may piggyback on the network to cost-effectively serve residential and business customers. And, the South Bay should work with this partner or bring in a third parties to use the network to expand wireless connectivity.

Should the SBBA choose to function as an Open Access Service Provider (OASP), the governance responsibilities and tasks will be driven by its role as owner and operator of the physical fiber-optic network and trans services through which retail service providers deliver services to last-mile consumers. The OASP provides wholesale trans connectivity to last-mile-service providers, who in turn design and extend services to reach their respective consumers using buried or overhead fiber-optics at broadband speeds or broadband-equivalent speeds via wireless.

Governance of the Open Access Service Provider model alleviates the appointed board from managing any end-point commercial resale services and last mile consumers. It allows retail providers to use the

open access network to reach more customers without the need to build costly fiber infrastructure to subscribers; the open access provider is responsible for this function. Local governments find open access a compelling business model because it allows them to attract multiple service providers to their networks, which helps stimulate competition and keep prices low for subscribers.

Under the recommended OASP model, the SBBA is not permitted to engage in, provide, or support the sale of retail broadband services or related infrastructure for the commercial disaggregation to individuals, businesses, or agencies and/or for the purpose of reselling last mile services. End-to-end, broadband infrastructure assets under the SBBA may very well be a comingling of public and privately-owned assets. Should that be the case, the due diligence required to certify current assets or add future assets may require the creation of an arbitration board to hear and rectify continuity of ownership issues and concerns. Local governments have formed such organizations to leverage publicly owned broadband assets that are under their control. They are implemented similarly in structure and goals.