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INFORMATION & COMMUNICATION TECHNOLOGIES CLUSTER: WORKFORCE NEEDS ASSESSMENT
SACRAMENTO CAPITAL REGION

February 2016

JPMorgan Chase & Co.

Burris Service Group

VALLEY VISION
Connect. Partner. Impact.

TABLE OF CONTENTS

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Economic and Workforce Development Program

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INTRODUCTION

Starting in 2008, the six-county Sacramento Capital region (El Dorado, Placer, Sacramento, Sutter, Yolo and Yuba counties) was rocked by the global recession, losing 10 percent of the region's jobs. In response, regional leaders initiated Next Economy, an action plan to accelerate job creation and new investment in six high-growth business (industry) clusters. Valley Vision, a regional civic leadership organization, managed the three-year Next Economy design, research and implementation process on behalf of a wide range of private and public sector partners.

By late 2015, after a lagging recovery, the region's economy picked up momentum, with the unemployment rate decreasing while job growth accelerated. Valley Vision received funding from JPMorgan Chase & Co. to better understand how the region's key growth industry clusters have changed since the original Next Economy research was conducted in 2012 and what new opportunities are emerging. Valley Vision is partnering with the Los Rios Center of Excellence and the Burris Service Group on this effort.

Cluster research is a widely accepted standard of practice for developing regional prosperity strategies to address multiple facets of a region's complex economy. Industry clusters reduce operating costs by shortening supply chains; increasing the flow of information regarding new business opportunities; concentrating workforce training needs in select occupations; and speeding up the identification of gaps in products or services.[1] Firms in identified clusters may also have a reduced risk of failure, as these firms are better supported by the supply chain and can respond more rapidly to shifts in the marketplace.

This report presents findings on the analysis of the Information and Communication Technologies (ICT) cluster. It is one in a series of six covering Next Economy-identified clusters. Additional reports include advanced manufacturing, the "clean economy," education and knowledge creation, food and agriculture, and life sciences and health services.[2] Each report provides an overview of the cluster, industry trends and economic impact, as well as an overview of the top demand occupations in the cluster requiring postsecondary education or training, along with projected occupational demand, institutions providing related education and training, and possible workforce gaps. Visit **valleyvision.org** or **coeccc.net** to access completed reports.[3]

This research will be used to develop cluster-based workforce action plans. Valley Vision will work alongside regional education, and workforce and economic development partners to convene six cluster-based employer focus groups, setting priorities and developing strategies to address critical workforce gaps, better align education and workforce development resources to meet employer and workforce needs, and strengthen the regional economy overall.

[1] *Cluster Manufacturing: A Supply Chain Perspective*

[2] Sacramento Area Council of Governments (SACOG) is the principal researcher for the Food and Agriculture Cluster study, which will focus primarily on industry trends and excludes workforce development and training needs.

[3] Reports will be posted to the valleyvision.org and coeccc.net websites throughout the spring 2016 when finalized.

CLUSTER DEFINITION

Information and Communications Technologies (ICT) is the convergence of computer networking and telecommunications. The ICT umbrella organizes technologies related to telecommunications, computing, networks, and other high-tech fields. ICT job functions impact all businesses, regardless of industry type or size of employment. However there are a core set of industries that engage primarily in ICT activities that can be used to define the cluster.

- **Computer and Electronic Market Retail/Wholesalers** – This industry group comprises establishments primarily engaged in the merchant wholesale distribution and retail of computers, computer peripheral equipment, loaded computer boards, and/or computer software. These establishments are also engaged in retailing all types of merchandise using the Internet, Internet auctioning, and business-to-business electronic markets.

- **ICT Component Manufacturing** – This industry group comprises establishments primarily engaged in manufacturing computers, storage devices, terminals, telephone apparatus, broadband and wireless communications equipment, fiber optical cable, and other peripheral and telecommunication equipment.

- **System Programming, Design, Management and Training Services** – This industry group comprises establishments primarily engaged in programming, planning and designing computer systems that integrate computer hardware, software, and communication technologies. This group also includes establishments that provide on-site management and operation of clients' computer systems and/or data processing facilities or training services.

- **System Repair and Maintenance Services** – This industry group comprises establishments primarily engaged in repairing and maintaining computers, office machines and telecommunications equipment.

- **Telecommunication/Data Processing Centers** – This industry group comprises establishments primarily engaged in operating and/or providing access to transmission facilities and infrastructure that they own and/or lease for the transmission of voice, data, text, sound, and video. This group also includes establishments that resell telecommunication services; provide specialized telecommunications services; provide data processing, hosting, and related services; and provide Internet publishing and broadcasting.
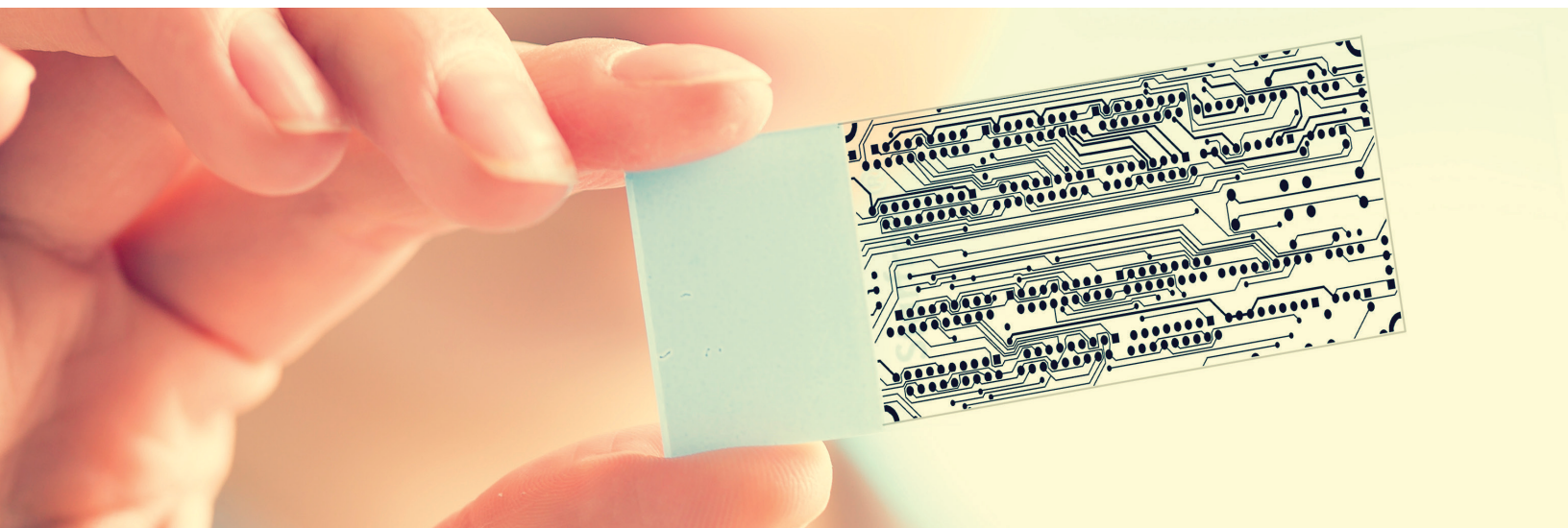
ESTABLISHMENTS

Exhibit 1 displays establishments and the average number of jobs per establishment by ICT subsector in the Sacramento Capital region. As shown, system programming, design, management and training services is the largest subsector with over 2,300 establishments, which is nearly six times the size of telecommunication/data processing centers or computer and electronic market retail/wholesalers. System repair and maintenance services is the smallest subsector with only 47 establishments. The average number of jobs per establishment, ranging between 10 and 23, indicates that the ICT cluster is composed of mostly small organizations.

Exhibit 1: Establishments and Average Employment by Subsector, 2014[5]
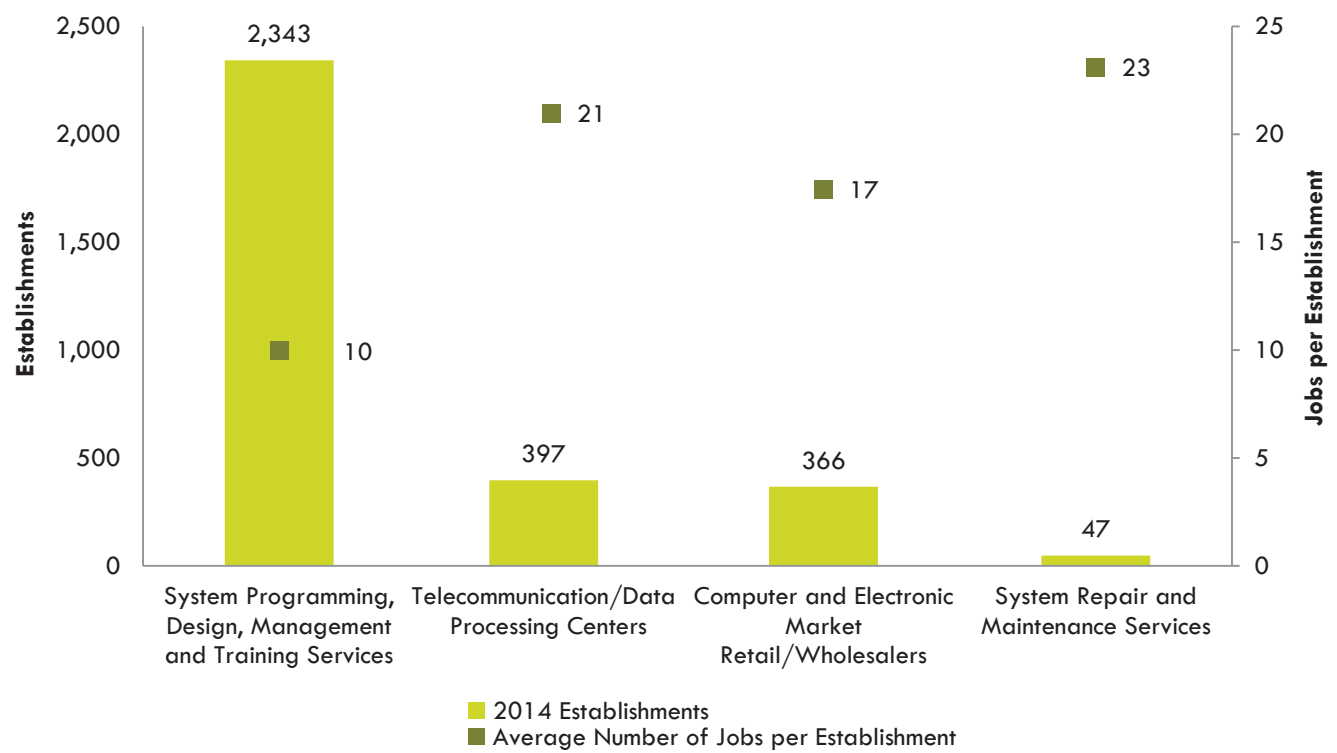
2014 Establishments
Average Number of Jobs per Establishment
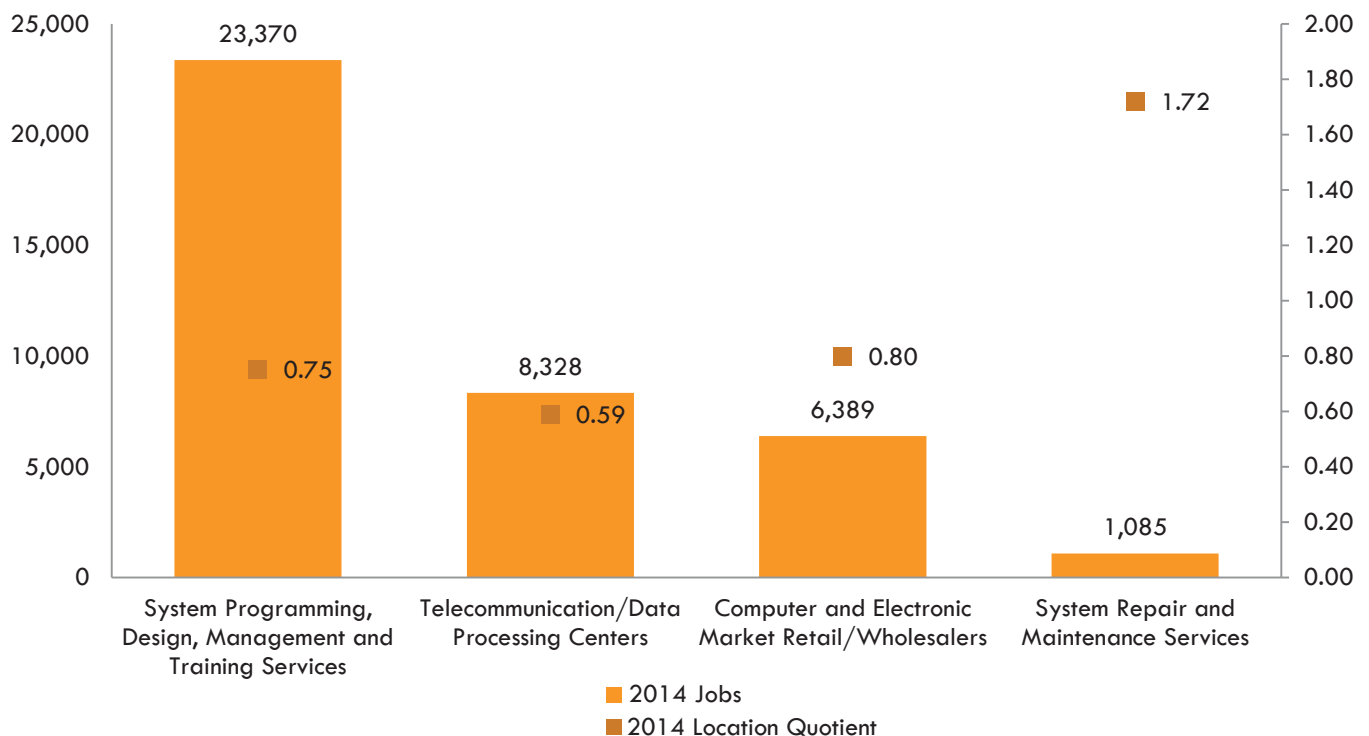
CONCENTRATION OF EMPLOYMENT

In 2014, there were about 39,200 ICT cluster jobs, about four percent of the total employment in the Sacramento Capital region. As shown in Exhibit 2, the majority of ICT jobs were in system programming, design, management and training services (60%; 23,370 jobs), followed by telecommunication/data processing centers (21%; 8,328 jobs) and computer electronic market retail/wholesalers (16%; 6,389 jobs).

Location quotient analysis compares the total employment in a region relative to the total employment in a larger area — in this case, California. A location quotient of less than one indicates a lower concentration of employment for that industry in the region than in the state overall. A location quotient of more than one indicates a higher concentration of employment for the region than in the state overall.

Three of the four ICT subsectors in the Sacramento Capital region have a location quotient that is less than one, indicating a lower concentration of employment than in other areas of the state. System repair and maintenance services, while it represents relatively low employment compared to the other subsectors, has a larger than one location quotient indicating a higher concentration of employment than the state. Within the subsectors, there are industries with above average location quotients, indicating a high concentration of employment for those industries than in the state overall. These include:

- **System Programming, Design, Management and Training Services**: Other Scientific and Technical Consulting Services (2.38 LQ).

- **Telecommunication/Data Processing Centers**: Cable and Other Subscription Programming (1.85 LQ); and Telecommunications Resellers (1.33 LQ).

- **Computer and Electronic Market Retail/Wholesalers**: Computer and Computer Peripheral Equipment and Software Merchant Wholesalers (1.12 LQ).

- **System Repair and Maintenance Services:** Computer and Office Machine Repair and Maintenance (2.45).

Exhibit 2: Total Employment and Location Quotient by Subsector, 2014[6]

TRENDS AND PROJECTIONS

The ICT cluster has experienced several ups and downs in the last few years with both increases and declines in overall employment. However, over the next five years, the ICT cluster is projected to grow steadily, adding nearly 5,300 jobs by 2019. The system programming, design, management and training services subsector is projected to add the most jobs, followed by computer and electronic market retail/wholesalers.

Exhibit 3: Employment Trends and Projections, 2009–2019[7]
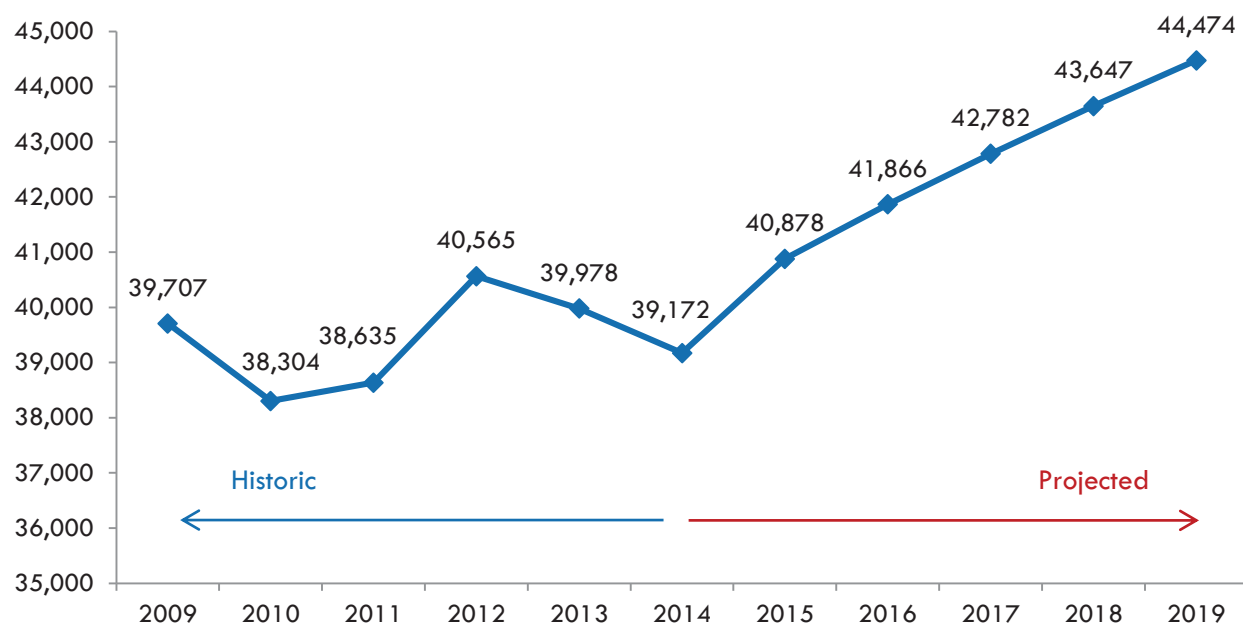
Exhibit 4: Employment Projections by Subsector, 2014–2019[7]

ICT Subsector	2014 Jobs	2019 Jobs	Change	% Change
System Programming, Design, Management and Training Services	23,370	26,667	3,297	14%
Telecommunication/Data Processing Centers	8,328	8,870	542	7%
Computer and Electronic Market Retail/Wholesalers	6,389	7,741	1,352	21%
System Repair and Maintenance Services	1,085	1,196	111	10%
Total ICT Jobs	**39,172**	**44,474**	**5,302**	**14%**

[7] EMSI: QCEW Employees, Non-QCEW Employees, and Self-Employed, 2015.2

TRENDS AND PROJECTIONS

The following bubble chart compares the projected five-year growth rate to the concentration of employment in the region, where the size of the bubble indicates the total number of jobs for that subsector.

- Systems repair and maintenance services has an above average concentration of employment in the region compared to other parts of the state but is the smallest subsector in the cluster.
- Computer and electronic market retail/wholesalers has the fastest projected growth rate with the second highest location quotient.
- Systems programming, design, management and training services is the largest subsector with a strong projected growth rate and the most projected number of new jobs.
- Telecommunication/data processing centers has the lowest location quotient with a moderate projected growth rate.

Exhibit 5: Growth Rate vs. Subsector Concentration[8]
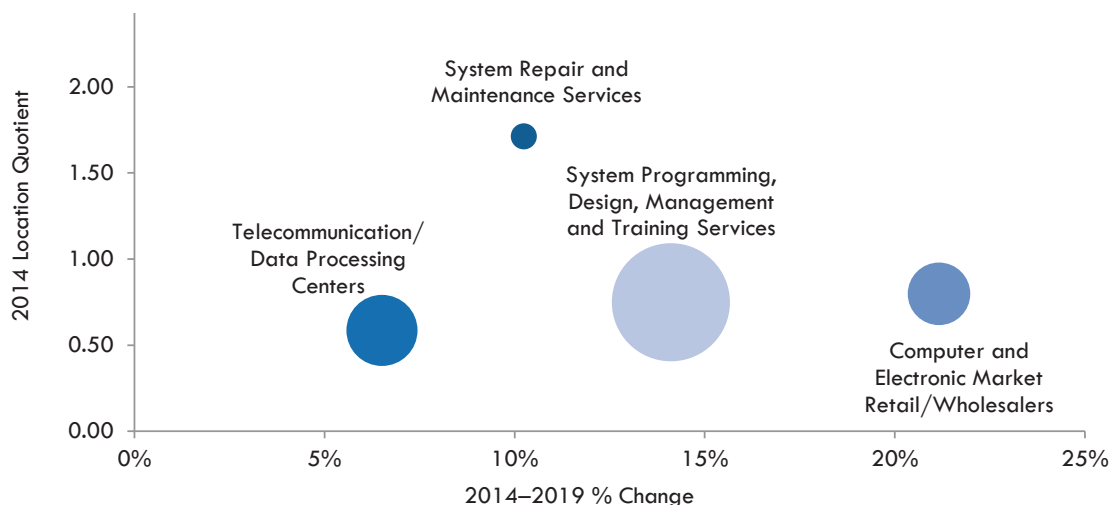
EARNINGS

In the Sacramento Capital region, telecommunication/data processing centers provide the highest earnings in the cluster, followed by systems programming, design, management and training services. The earning calculation includes an average of all wages, salaries, proprietor earnings and supplemental earnings (such as reti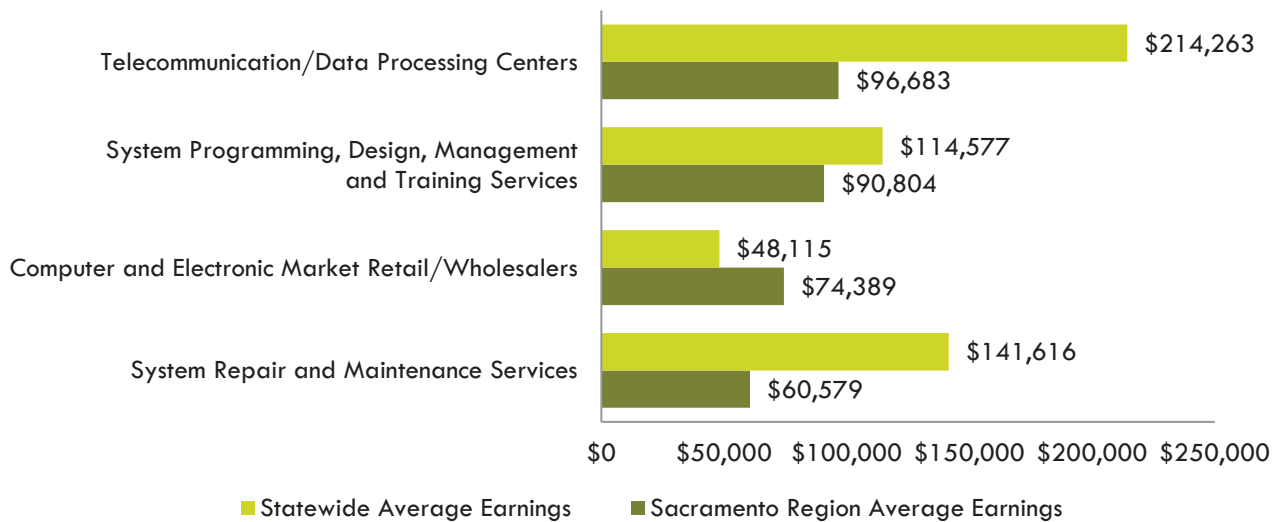rement benefits, bonuses, etc.) for all occupations in the sector. With the exception of computer and electronic market retail/wholesalers, the ICT subsectors earn lower wages than the statewide average for the same subsectors. However, the ICT subsectors (with exception of system repair and maintenance services) provide earnings above the region's average earnings across all industries, which is $63,400.[9]

Exhibit 6: Earnings by Subsector, 2014[10]

Bar chart showing earnings by subsector, comparing Statewide Average Earnings and Sacramento Region Average Earnings:

Subsector	Statewide Average Earnings	Sacramento Region Average Earnings
Telecommunication/Data Processing Centers	$214,263	$96,683
System Programming, Design, Management and Training Services	$114,577	$90,804
Computer and Electronic Market Retail/Wholesalers	$48,115	$74,389
System Repair and Maintenance Services	$141,616	$60,579

■ Statewide Average Earnings   ■ Sacramento Region Average Earnings

[9] The average earnings across all industries in the Sacramento region is $63,400 and includes wages, salaries, proprietor earnings and supplements.

[10] EMSI: QCEW Employees, Non-QCEW Employees, and Self-Employed, 2015.2

SHIFT SHARE ANALYSIS

Shift share analysis is a method for determining how much of regional job growth can be attributed to national trends and how much is due to unique regional factors. Exhibit 7 displays four key components:

- **Industrial Mix Effect** – represents the share of regional industry growth explained by the growth of the specific industry at the national level.
- **National Growth Effect** – represents how much of the regional industry's growth is explained by the overall growth of the national economy. Given that the nation's economy is growing, it is normal to see positive change in each subsector.
- **Expected Change** – the change expected due to national growth effect and industry mix effects.
- **Regional Competitive Effect** – explains how much of the change in the subsectors is due to some unique competitive advantage that the region possesses, because the growth cannot be explained by national trends in the industry or the economy as a whole.

Three of the four subsectors are outperforming national trends, while the largest ICT subsector, systems programming, design, management and training services, is underperforming compared to national trends. This suggests that the region has a slight competitive advantage in the ICT cluster overall.

Exhibit 7: Shift Share Analysis by Subsector, 2013–2018[11]

	Industrial Mix Effect	National Growth Effect	Expected Change	Regional Competitive Effect
Computer and Electronic Market Retail/Wholesalers	(51)	406	355	996
Telecommunication/Data Processing Centers	(583)	530	(53)	595
System Programming, Design, Management and Training Services	3,088	1,486	4,574	(1,277)
System Repair and Maintenance Services	(41)	69	28	83
Total ICT Cluster	**857**	**1,630**	**2,487**	**472**

[11] EMSI: QCEW Employees, Non-QCEW Employees, and Self-Employed, 2015.2

ECONOMIC IMPACT

Economic impact provides a quantitative method to estimate the total economic benefit from a project, or in this case, an industry cluster. In other words, it is the "ripple effect" of all economic activities resulting from that cluster. Impact analysis is typically comprised of direct, indirect and induced impacts:

- Direct impacts are those resulting from the expenditures of operations within that industry cluster.
- Indirect impacts are those resulting from suppliers of that cluster spending money and hiring employees.
- Induced impacts are the combined value of employees of the industry cluster spending money at a household level.

Combined, these three variables equate to the total economic impact of a project or industry cluster.

The ICT cluster impacts the Sacramento Capital region's economy in several ways. The IMPLAN input output model was used to measure the cluster's total economic impacts. First, the cluster directly benefits the economy through the operations and jobs supported by the establishments within its subsectors. As shown in Exhibits 8 and 9, the ICT cluster directly contributes $9.1 billion in output and 39,000 jobs to the regional economy. In addition to this direct effect, these establishments generate an indirect impact through their supplier purchases — about $3.7 billion in output and 24,000 jobs are created within sectors that generally supply this cluster. Finally, the ICT cluster creates an induced effect of nearly $2.8 billion and approximately 20,000 jobs as a result of consumption activities within the local economy of both direct (cluster) and indirect (supplier) employees.

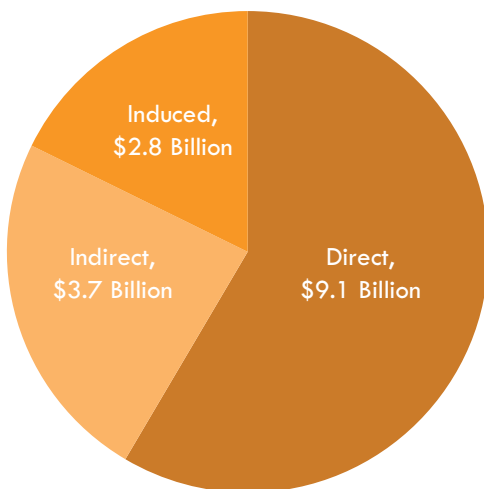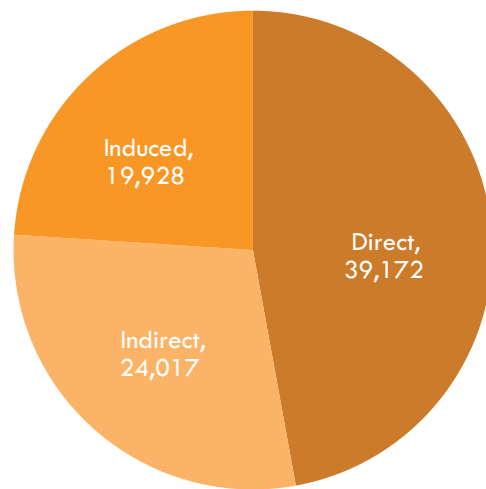## Exhibit 8: Total Output Impacts[12]

Induced, $2.8 Billion
Indirect, $3.7 Billion
Direct, $9.1 Billion

Exhibit 9: Total Employment Impacts[12]

Induced, 19,928
Indirect, 24,017
Direct, 39,172

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[12] EMSI employment and IMPLAN 2013 data coefficients

ECONOMIC IMPACT

The ICT cluster contributes approximately $15.5 billion in total output, 83,000 jobs and $5.1 billion in labor income. Exhibit 10 provides the employment impacts by each subsector within the ICT cluster and by output, employment, and labor income (which includes all forms of employment income, including employee compensation and proprietor income). With about $5.9 billion in output, 45,000 jobs, and $2.8 billion in labor income, the system programming, design, management and training services subsector, overall in all of these categories, accounts for the largest share of the cluster's total economic impacts while the system repair and maintenance services subsector has the smallest share.

Exhibit 10: Total Economic Impacts by Cluster Subsector[13]

	Direct	Indirect	Induced	Total
Output				
Total	$9,080,548,307	$3,694,286,066	$2,752,772,808	$15,527,607,181
System Programming, Design, Management and Training Services	$3,189,988,342	$1,190,000,192	$1,540,133,653	$5,920,122,186
Telecommunication/Data Processing Centers	$4,989,995,373	$2,159,633,047	$874,877,205	$8,024,505,625
Computer and Electronic Market Retail/Wholesalers	$759,038,485	$311,938,680	$274,495,375	$1,345,472,541
System Repair and Maintenance Services	$141,526,107	$32,714,148	$63,266,574	$237,506,829
Employment				
Total	39,172	24,017	19,928	83,117
System Programming, Design, Management and Training Services	23,370	10,642	11,151	45,163
Telecommunication/Data Processing Centers	8,328	11,151	6,332	25,811
Computer and Electronic Market Retail/Wholesalers	6,389	1,973	1,986	10,348
System Repair and Maintenance Services	1,085	251	459	1,795
Total Labor Income				
Total	$3,015,555,540	$1,163,537,349	$915,425,452	$5,094,518,341
System Programming, Design, Management and Training Services	$1,834,464,422	$499,935,315	$512,195,958	$2,846,595,695
Telecommunication/Data Processing Centers	$783,107,729	$548,602,167	$290,909,569	$1,622,619,465
Computer and Electronic Market Retail/Wholesalers	$315,214,132	$103,141,120	$91,269,584	$509,624,836
System Repair and Maintenance Services	$82,769,256	$11,858,747	$21,050,341	$115,678,344

ECONOMIC LEAKAGE

Supply chain leakage is a primary factor in determining the value of an industry multiplier used to define the total "ripple effect" of that industry cluster. Stronger supply chain linkages, better described as a cluster using more locally sourced products and services, has a reciprocal benefit of lower leakage, increasing the multiplier and the total impact on the surrounding economy.

It was determined through an in-depth analysis of the ICT industry cluster and its subsets, that there is a relatively high level of supply chain leakage, roughly 64 percent. Conversely, 36 percent of goods and services supporting the industry cluster are purchased within the region.

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[13] EMSI employment and IMPLAN 2013 data coefficients

ICT TRENDS

The life cycle of advancements in information and communication technologies (ICT) has been developing exponentially rather than in a sequential, linear fashion, and is projected to continue in this way. Because technology innovations are progressing at such a rapid pace, businesses are challenged to balance their technological agility to adopt new computing platforms, software, enterprise applications, and devices while continuing to drive growth and achieve productivity. This section reviews significant ICT trends affecting the business environment and the implications for workforce development and planning.

- **The Internet of Things (IoT).** By 2020 the number of things connected to the Internet is predicted to exceed 50 billion, nine times today's estimate of 4.9 billion. Smart devices or objects connected to the Internet are collecting and transmitting data and transforming the world both personally and socially, and influencing business opportunities and competiveness. Described as the Internet of Things (IoT) because the network connectivity range is from everyday devices like mobile phones and tablets, individual health monitoring and kitchen appliances, to smart cities that track roadways for transportation planning, and monitoring energy consumption, atmospheric emissions, e-waste and water usage.

    Whether data is used for personal use, business development to build and apply the systems, or to support sustainability such as green ICT initiatives driving socio-economic impacts for businesses and government organizations — all of these intelligent devices need to be programmed and integrated. And for optimal use, the data obtained needs to be analyzed and shared to be of value to business, governments, education, civic organizations and consumers.[14]

- **Big Data.** With the deluge of data obtained and driven by smart machines, sensors and chips connected to the Internet, many aspects of work in the Sacramento Capital region will be reshaped in the coming years. Cloud data storage and virtual computing server platforms such as Amazon Web Services, Microsoft Azure, and Google Cloud,[15] and the proliferation of sensors, chips and devices connected to the Internet, all translate into a flood of data streams. Being able to work with data will become more of a necessity for most professions, especially within the ICT cluster.

- **"Everything-as-a-Service" (XaaS).** For many companies, transitioning from the old infrastructure to the newest technologies creates implementation challenges, such as migrating systems, training, and motivating employees to adopt and use the new technology. To address these challenges, many organizations are opting to outsource to service providers and forgo the use of on-site services and personnel. Termed "Everything-as-a-Service" (XaaS), organizations can customize their computing environment on-demand from network management and data storage services to enterprise-hosted applications.

- **Cybersecurity and Privacy.** As new technology comes into the marketplace on a functioning digital network, cybersecurity and the impact on the workforce will be significant, driving demand for a variety of security-related occupations, such as information security professionals, computer programmers, forensic science technicians, and intelligence analysts.

These innovations will change not only the content of work but many new occupations will arise. As such, it's critical for education and training providers to continuously update curriculum to reflect the most current knowledge and skill requirements in the field.

WORKFORCE CHALLENGES

Government entities at all levels are experiencing difficulty attracting talented ICT workers who often prefer the private sector with higher wages and benefits such as stock options and even student loan debt repayment. As public sector ICT workers begin retiring in larger numbers, closing the talent gap is necessary to ensure that public services continue to operate securely and meet constituent needs. This will require public employers to rethink how they attract and retain ICT employees and/or change how they maintain and manage their IT services (e.g. XaaS, rather than internal infrastructure).

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[14] https://www.comptia.org/resources/sizing-up-the-internet-of-things

[15] *Amazon's $160 billion business you've never heard of.* Found at http://money.cnn.com/2015/11/04/technology/amazon-aws-160-billion-dollars/

OCCUPATION DEMAND

Fifteen occupations were selected for inclusion in the study based on the following criteria:

- Annual job openings were significant
- The minimum education requirement is a high school diploma plus on-the-job training, postsecondary award, associate degree or bachelor's degree.

Exhibit 11 displays the employment demand for ICT occupations selected for inclusion in the study.[16] For each occupation, replacement estimates include retirements and general separations, but not turnover within the occupation. As such, replacements and new job growth combined is a good measure of demand for workers.

Combined, there are nearly 6,200 total job openings projected between 2014 and 2019 for the occupations selected for inclusion in this study. Computer systems analysts is the largest occupation in the group, with the most job openings over the next five years. Software developers and computer user support specialists are also large occupations with significant annual openings created by new job growth and replacement needs.

Exhibit 11: Employment Outlook, 2014–2019[17]

Description	2014 Jobs	2019 Jobs	2014–2019 Change	2014–2019 % Change	Total Replace-ments	Total Openings	Annual Openings
Computer Systems Analysts	9,568	10,468	900	9%	800	1,700	340
Software Developers, Systems Software	5,275	5,626	351	7%	413	764	153
Computer User Support Specialists	3,843	4,247	404	11%	330	734	147
Software Developers, Applications	3,309	3,780	471	14%	235	706	141
Computer and Information Systems Managers	2,801	3,015	214	8%	205	419	84
Computer Programmers	2,361	2,458	97	4%	328	425	85
Network and Computer Systems Administrators	1,810	1,980	170	9%	160	330	66
Computer Occupations, All Other	1,273	1,338	65	5%	117	182	36
Computer Network Support Specialists	1,239	1,298	59	5%	103	162	32
Web Developers	1,158	1,276	118	10%	100	218	44
Computer, Automated Teller, and Office Machine Repairers	997	1,057	60	6%	124	184	37
Computer Network Architects	556	614	58	10%	59	117	23
Database Administrators	542	595	53	10%	57	110	22
Information Security Analysts	446	531	85	19%	40	125	25
Total	**35,178**	**38,283**	**3,105**	**9%**	**3,071**	**6,176**	**1,235**

[16] This report does not provide occupational data isolated to the ICT cluster, but rather includes occupational employment estimates and projections across all industries to provide a complete picture of demand for all employers.

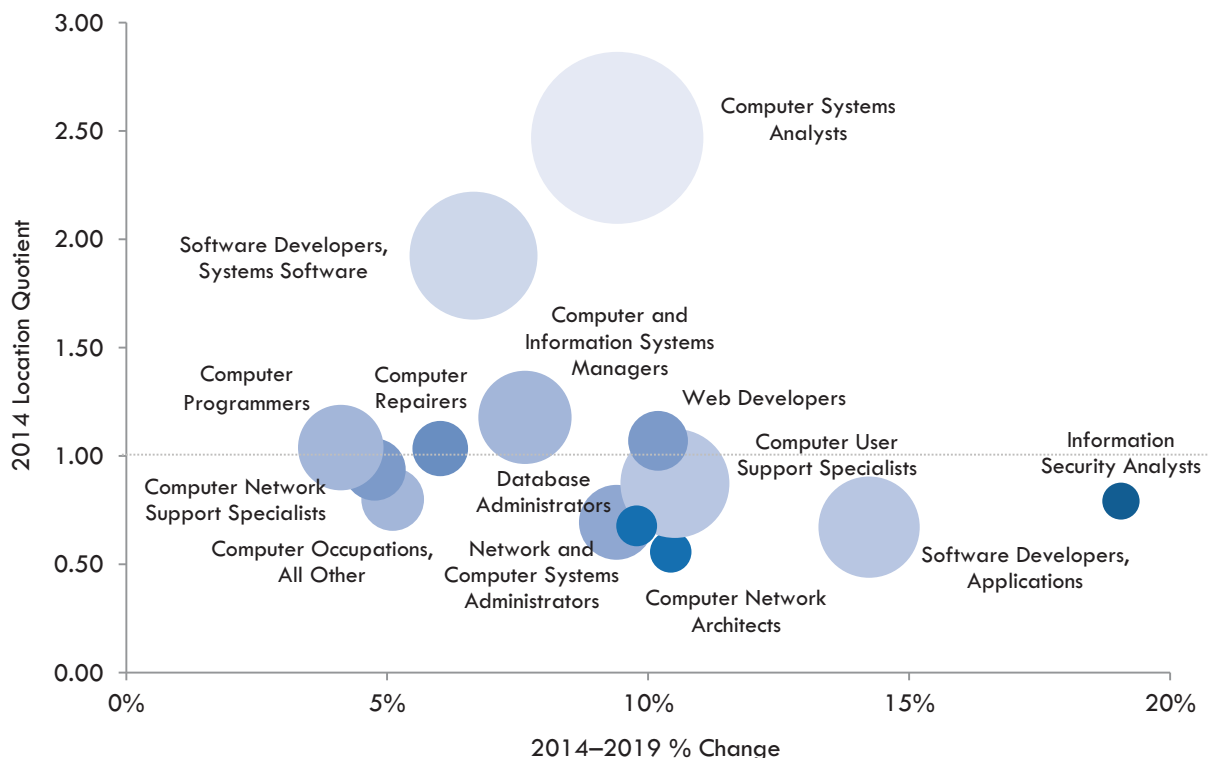[17] EMSI: QCEW Employees, Non-QCEW Employees, and Self-Employed, 2015.3

OCCUPATION DEMAND

In addition to industry analysis, location quotient can also be applied to occupations. In this case, the location quotient compares an occupation's total employment in the region relative to the state's total employment for that occupation. A location quotient of less than one indicates a lower concentration of employment for that occupation in the region than in the state overall. A location quotient of more than one indicates a higher concentration of employment for the occupation than in the state overall.

The following bubble chart compares the concentration of occupation employment to the projected five-year growth rate in the region, where the size of the bubble indicates the total number of jobs for each occupation. As shown below, more than half of the ICT occupations have a location quotient that is close to one (LQ .8 to 1.18) indicating an average concentration of employment compared to other regions in the state. Relative to the other occupations in the group, computer systems analysts is the largest occupation in the group with a high location quotient and a moderate projected growth rate. System developers, systems software is also a large occupation with a high location quotient and a modest growth rate. Information security analysts is the smallest occupation in the group with the highest projected growth rate.

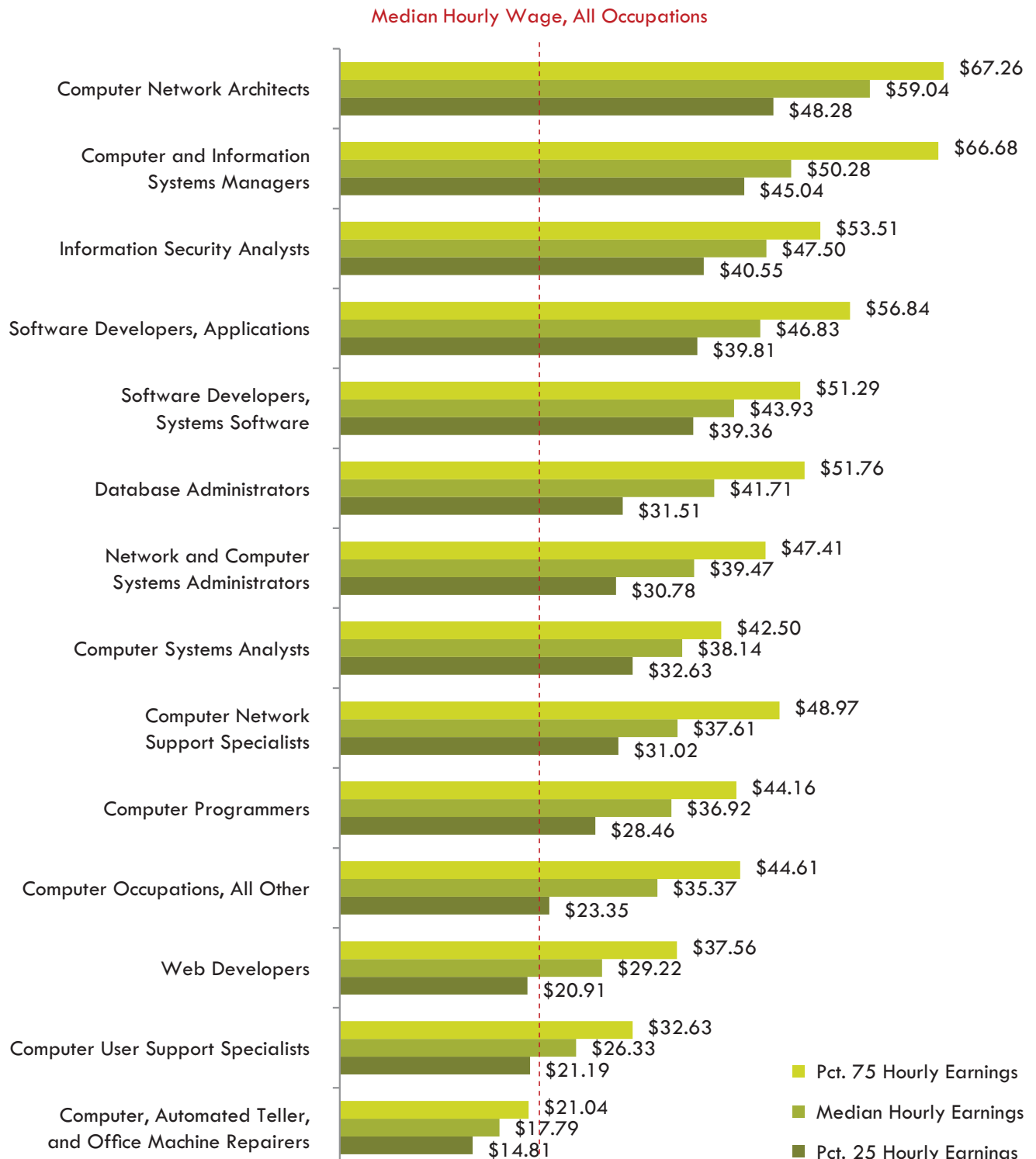## Exhibit 12: Growth Rate vs. Occupation Concentration[18]

OCCUPATIONAL WAGES

The median hourly wage across all occupations in the Sacramento Capital region is $22.69 per hour. With the exception of computer, automated tellers, and office machine repairers, all of the occupations in the ICT cluster earn wages above this regional average. Computer network architects is the highest paid occupation, followed by computer/information systems managers and software developers, applications.

Exhibit 13: Hourly Wages, 2015[19]

Median Hourly Wage, All Occupations

Occupation	Pct. 75 Hourly Earnings	Median Hourly Earnings	Pct. 25 Hourly Earnings
Computer Network Architects	$67.26	$59.04	$48.28
Computer and Information Systems Managers	$66.68	$50.28	$45.04
Information Security Analysts	$53.51	$47.50	$40.55
Software Developers, Applications	$56.84	$46.83	$39.81
Software Developers, Systems Software	$51.29	$43.93	$39.36
Database Administrators	$51.76	$41.71	$31.51
Network and Computer Systems Administrators	$47.41	$39.47	$30.78
Computer Systems Analysts	$42.50	$38.14	$32.63
Computer Network Support Specialists	$48.97	$37.61	$31.02
Computer Programmers	$44.16	$36.92	$28.46
Computer Occupations, All Other	$44.61	$35.37	$23.35
Web Developers	$37.56	$29.22	$20.91
Computer User Support Specialists	$32.63	$26.33	$21.19
Computer, Automated Teller, and Office Machine Repairers	$21.04	$17.79	$14.81

Legend:
- Pct. 75 Hourly Earnings
- Median Hourly Earnings
- Pct. 25 Hourly Earnings

[19] EMSI: QCEW Employees, Non-QCEW Employees, and Self-Employed, 2015.2

EDUCATION ASSESSMENT

This section provides a review of the educational supply supporting the ICT cluster in the Sacramento Capital region. Minimum education requirements are assigned to two categories:

- **Mid-level occupations** require postsecondary training, certificate or associate degree. Some employers may prefer applicants with a bachelor's degree.

- **Advanced-level occupations** typically require a bachelor's degree. However, some employers will accept an associate degree as the minimum education requirement.

Exhibit 14 identifies the minimum education requirements for the top 15 occupations in the ICT cluster by education category.

Exhibit 14: Minimum Education Requirements

Mid-level
- Computer, Automated Teller, and Office Machine Repairers
- Computer User Support Specialists
- Computer Network Support Specialists
- Web Developers

Advanced-level
- Computer and Information Systems Managers
- Computer Systems Analysts
- Information Security Analysts
- Computer Programmers
- Software Developers, Applications
- Software Developers, Systems Software
- Database Administrators
- Network and Computer Systems Administrators
- Computer Network Architects
- Computer Occupations, All Other

EDUCATION ASSESSMENT

Exhibit 15 displays the total number of certificates and degrees conferred annually in the Sacramento Capital region. Six public community colleges, two public universities, and five private education institutions provide training programs that support the ICT career pathway. Combined, these education institutions confer an average of 1,009 degrees and certificates annually. At a high level, this data suggests a possible training supply gap, as there are more projected annual openings than degrees conferred. Further analysis is necessary to assess alignment among specific training programs and regional workforce needs.

Exhibit 15: ICT Associate Degrees & Certificates Conferred Annually, Sacramento Capital region[20&21]

| Program	Certificates	Associate Degrees	Bachelor's Degree	Master's Degree	Total Awards
Computer and Information Systems Security			12		12
Computer Engineering, General			68	6	74
Computer Graphics			23		23
Computer Information Systems	5	20			25
Computer Infrastructure and Support	17	22			39
Computer Networking	82	131	8		222
Computer Programming	20	40	1		60
Computer Science	1	27	152	60	240
Computer Software Development/Engineering	1			4	5
Computer Support	168	15			183
Database Design and Administration	14	4			18
Other Information Technology	54				54
Software Applications	15	8			23
Wide Web & Multimedia Administration and Design	14	7	10		31
Total	**391**	**274**	**274**	**70**	**1,009**

[20] California Community College Chancellor's Office Data Mart. National Center for Education Statistics (NCES). Higher education institutions are required to report completion data to NCES if they participate in any federal financial assistance program authorized by Title IV of the Higher Education Act. Completion data not reported to the NCES or CCCCO Data Mart were not included in the estimate.

[21] For private education institutions and private/public universities, the 3-year average includes academic years 2011–12, 2012–13 and 2013–14. For California Community Colleges, the 3-year average includes academic years 2012–13, 2013–14, and 2014–15.

EDUCATION PATHWAYS

There are multiple education pathways to obtain employment in the ICT field. Some pursue a career in the ICT field by following a specific academic path — AS to BS to Master's degree then employment, while others take only a few courses that pertain to a specific career path — such as programming or networking courses that prepare for a specific certification. In addition, it is not uncommon for incumbent workers of all education levels to take community colleges courses that help them stay current in their field or gain specialized skills that allow them to transition to a new ICT specialty.

Exhibit 16: ICT Education Pathways
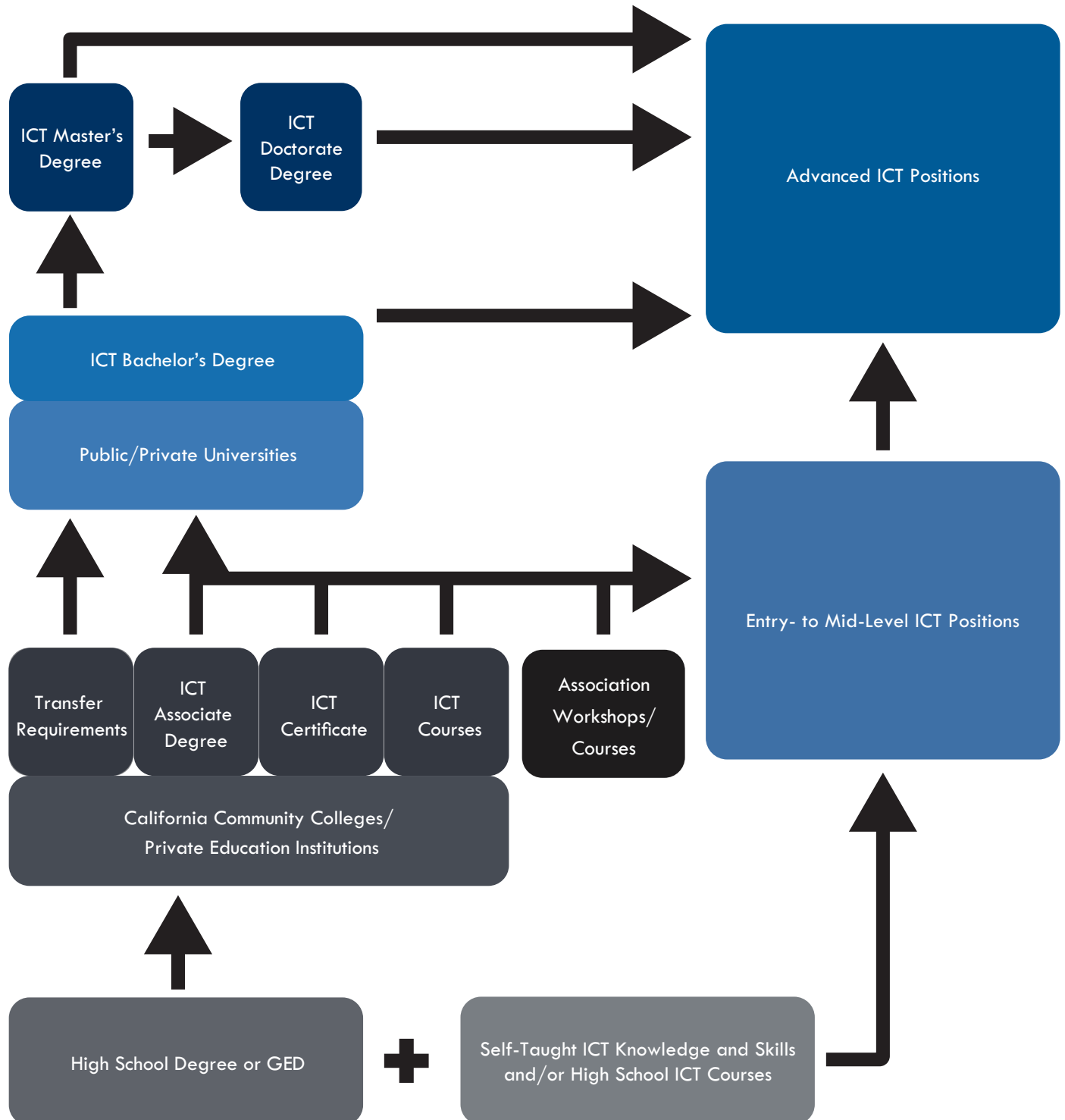
SKILLS ASSESSMENT

Exhibit 17 displays the top skills and professional credentials for the ICT occupations selected for inclusion in this study. The data is based on analysis of job posting data, aggregated by Burning Glass. This online tool uses intelligent "spidering" to search the Internet for job listings, removes duplication, and aggregates the data into a searchable database. As shown below, most of the skills/knowledge areas are specialized and require specific training and/or certification.

Exhibit 17: Skill and Professional Credential Preferences, ICT Occupations

Occupation	Top Skill/Knowledge Areas	Top Certifications/ Professional Credentials
Computer Systems Analysts	Oracle, business process, SQL, SAP, systems analysis, JAVA, technical support, LINUX, Enterprise Resource Planning (ERP), system and network configuration	Certified Information Systems Auditor, Certified Information Systems Security Professional
Software Developers, Systems Software	Systems engineering, LINUX, Python, JAVA, PERL, C++, UNIX, SQL, Domain Name System (DNS), System and Network Configuration, and debugging	Microsoft Certified Systems Engineer, CISCO Certified Network Associate, VMWARE Certified Professional, CISCO Certified Network Professional
Computer User Support Specialists	Technical support, help desk support, repair, software installation, IT support, computer installation and setup, systems and network configuration, LINUX and Transmission Control Protocol/Internet Protocol (TCP/IP)	Certified A+ Technician; Microsoft Certified Systems Engineer
Software Developers, Applications	JAVA, software engineering, JavaScript, SQL, LINUX, Python, C++, Microsoft C#, Object-Oriented Analysis and Design (OOAD), software development, Oracle, Extensible Markup Language (XML)	None Listed
Computer and Information Systems Managers	Business Process, SAP, Oracle, collaboration, SQL, business development, JAVA, mentoring, Enterprise Resource Planning (ERP), ITIL, and Systems Development Life Cycle (SDLC)	Project Management Certification
Computer Programmers	SQL, JAVA, JavaScript, Python, LINUX, .NET Programming, C++, Microsoft C#, Oracle, Extensible Markup Language (XML), and jQuery	None Listed
Network and Computer Systems Administrators	Technical support, CISCO, LINUX, repair, network support, system and network configuration, and Transmission Control Protocol/Internet Protocol (TCP/IP)	CISCO Certified Network Associate, Red Hat Certified System Administrator, Red Hat Certified Engineer, Microsoft Certified Systems Engineer
Computer Network Support Specialists	Oracle, technical support, SQL, JAVA, UNIX, MySQL, LINUX	CISCO Certified Network Associate, CISCO Certified Network Professional
Web Developers	JavaScript, web site development, jQuery, HTML5, JAVA, Hypertext Preprocessor (PHP), web applications, AJAX, web site design, Adobe Photoshop, User Interface (UI) design, JSON, Extensible Markup Language (XML)	None Listed
Computer, Automated Teller, and Office Machine Repairers	Technical support, repair, technical training, record keeping, and schematic diagrams	Certified A+ Technician
Computer Network Architects	CISCO, telecommunications, network engineering, Wide Area Network (WAN), VoIP, firewalls, LINUX and OSPF	CISCO Certified Network Professional, CISCO Certified Network Associate, CISCO Certified Internetwork Expert
Database Administrators	SQL, database administration, Oracle, Extraction Transformation and Loading (ETL), SQL Server, data warehousing, database design, LINUX, JAVA, Python, UNIX and data modeling	None Listed
Computer Operators	Data management, scheduling, ITIL, LINUX, system administration	None Listed
Information Security Analysts	Information security, firewalls, network security, LINUX, cryptography	Certified Information Systems Security Professional, Certified Information Systems Auditor, Certified Information Security Manager

SKILLS ASSESSMENT

The pace of technology is driving corporations away from requiring specific education, placing a higher value on professional certifications and skills rather than degrees. Professional credentials often increase a worker's starting salary, as well as provide a means to promote and advance in a career. The following industry certifications are considered the most in-demand according to the annual 2016 employer survey conducted by Robert Half Technologies:[22]

- **Cisco certifications**: Cisco Certified Network Associate (CCNA), Cisco Certified Networking Professional (CCNP)

- **Microsoft certifications:** Microsoft Certified Solutions Associate (MCSA), Microsoft Certified Solutions Expert (MCSE). These credentials replace the Microsoft Certified Professional (MCITP) certification which was retired in 2014.

- **Project management certifications:** Project Management Professional (PMP)

- **Security certifications:** Certified Information Systems Security Professional (CISSP)

- **Virtualization certifications:** VMware Certification Professional (VCP)

Beyond technical skills — soft skills and business skills are highly desirable. Some of the most commonly cited in-demand skills include: collaboration, communication, critical thinking, motivation, perseverance, problem solving, project management, and versatility.

[22] https://www.roberthalf.com/sites/default/files/Media_Root/images/rht-pdfs/robert_half_technology_2016_salary_guide.pdf

SUMMARY

The ICT cluster organizes technologies related to telecommunications, computing, networks, and other high-tech fields. ICT job functions impact all businesses, regardless of industry type or size of employment. However, there are a core set of industries that engage primarily in ICT activities that can be used to define the cluster. These include: computer and electronic market retail/wholesalers; ICT component manufacturing; system programming, design, management and training services; system repair and maintenance services; system repair and maintenance services; and telecommunication/data processing centers.

The ICT cluster is projected to grow moderately, adding nearly 3,000 jobs by 2019. The system programming, design, management and training services subsector is projected to add the most jobs. Most of the ICT subsectors (with exception of system repair and maintenance services) provide earnings above the region's average earnings across all industries. Three of the four ICT subsectors in the Sacramento Capital region have a location quotient that is less than one, indicating a lower concentration of employment than in other areas of the state.

The ICT cluster is evolving rapidly, not only changing the content of work but also increasing demand for ICT positions. Some of the technologies impacting the region's workforce needs include:

- **Big Data.** Cloud data storage and virtual computing server platforms and the proliferation of sensors, chips and devices connected to the Internet, all translate into a flood of data streams. Being able to work with data will become more of a necessity for most professions, especially within the ICT cluster.

- **The Internet of Things (IoT).** Smart devices or objects connected to the Internet are collecting and transmitting data and transforming the world both personally and socially, and influencing business opportunities and competiveness. All of these intelligent devices need to be programmed and integrated. And for optimal use, the data obtained needs to be analyzed and shared to be of value to business, governments, education, civic organizations, and consumers.

- **"Everything-as-a-Service" (XaaS).** On-demand outsourced ICT services from network management and data storage services to enterprise-hosted applications.

- **Cybersecurity and Privacy.** As new technology comes into the marketplace, cybersecurity and the impact on the workforce will be significant, driving demand for a variety of security-related occupations, such as information security professionals, computer programmers, forensic science technicians, and intelligence analysts.

Fifteen ICT occupations were selected for inclusion in this study based on total number of job openings and minimum education requirements, including:

- Software Developers, Systems Software
- Computer User Support Specialists
- Software Developers, Applications
- Computer and Information Systems Managers
- Computer Programmers
- Network and Computer Systems Administrators
- Computer Occupations, All Other

- Computer Network Support Specialists
- Web Developers
- Computer, Automated Teller, and Office Machine Repairers
- Computer Network Architects
- Database Administrators
- Computer Operators
- Information Security Analysts

SUMMARY

There are six public community colleges, two public universities, and five private education institutions that provide ICT training in the Sacramento Capital region. Combined, these education institutions confer an average of 1,009 degrees and certificates annually. At a high level, this data suggests a possible training supply gap, as there are more projected job openings (1,235 annual openings) than degrees conferred (1,009 degrees). The total certificates and degrees conferred provide some information about the supply of workers to an industry or cluster. However, it is limited in that there are several unknown variables that impact the supply, such as graduate migration trends, employer preferences, worker preparedness, and graduate/completion duplication. Further analysis is necessary to assess alignment among specific training programs and region workforce needs.

In addition to formal education, it is also common for ICT employers to require professional credentials. Some of the most in-demand certificates include: Cisco, Microsoft, project management, security, and virtualization certifications. Because skills and certifications are sometimes valued more than degrees, there are multiple education pathways to obtain employment in the ICT field. Some pursue a career in the ICT field by following a specific academic path, while others take only a few courses that pertain to a specific career path. This not only makes it challenging to assess supply gaps, it also makes it difficult to standardize curriculum.

The dynamic changing nature of the ICT cluster requires a nimble education system that can develop and offer new or revised curriculum to meet evolving workforce needs. To keep current, faculty need to upskill their knowledge of and instruction in new technologies, relevant software, and certification standards. As these activities would likely occur outside of classroom instruction, faculty would need additional assigned time funded for them to do so. Having faculty externships available at high-tech companies during summer or other school breaks are a way to enhance their industry experience needed for teaching relevant and in-demand skills.

Valley Vision, along with the Center of Excellence and other partners, will be conducting focus groups with ICT employers to review the cluster findings, high priority occupation and skills gaps that can be addressed through a concerted cluster workforce action plan. Priorities that may be elevated based on this analysis include:

- Conduct a post-employment outcomes assessment to determine misalignment to existing programs.
- Align curriculum among California Community Colleges to increase the ease of transferring for students and consistent standard of instruction recognized by employers and industry.
- Invest in equipment/software and professional development for ICT instructors and educators to ensure that they are teaching the most up-to-date technology.
- Develop strong career pathways between K-12, community colleges and four-year institutions.
- Partner with businesses to increase internship opportunities for community college students and externships for instructors and faculty.

APPENDIX A: INFORMATION AND COMMUNICATION TECHNOLOGIES CLUSTER DEFINITION

The ICT cluster is comprised of the following NAICS codes.

Computer and Electronic Market Retail /Wholesalers

423430 Computer and Computer Peripheral Equipment and Software Merchant Wholesalers

443142 Electronics Stores

454111 Electronic Shopping

454112 Electronic Auctions

425110 Business to Business Electronic Markets

Telecommunication / Data Processing Centers

511210 Software Publishers

517110 Wired Telecommunications Carriers

517210 Wireless Telecommunications Carriers (except Satellite)

517410 Satellite Telecommunications

517911 Telecommunications Resellers

517919 All Other Telecommunications

518210 Data Processing, Hosting, and Related Services

519130 Internet Publishing and Broadcasting and Web Search Portals

515210 Cable and Other Subscription Programming

System Programming, Design, Management and Training Services

541511 Custom Computer Programming Services

541512 Computer Systems Design Services

541513 Computer Facilities Management Services

541519 Other Computer Related Services

611420 Computer Training

541330 Engineering Services

541430 Graphic Design Services

541490 Other Specialized Design Services

541690 Other Scientific and Technical Consulting Services

541990 All Other Professional, Scientific and Technical Services

System Repair and Maintenance Services

811212 Computer and Office Machine Repair and Maintenance

811213 Communication Equipment Repair and Maintenance

APPENDIX B: CALIFORNIA COMMUNITY COLLEGES DEFINING ICT CAREER PATHWAYS

The California Community College's ICT-Digital Media Sector of the "Doing What Matters For Jobs and the Economy Initiative" has created two structured career pathways in a statewide branded effort to increase employment in the ICT field. Featured are the Business Information Worker Pathway and the IT Technician Pathway. Both pathways align learning content from existing courses that have been validated to meet the needs of business, government and organizations for skill sets in demand. They also help students prepare for specific ICT careers by providing clear and defined knowledge and skills necessary to acquire industry certifications and employment.

Educational Pathways

Sacramento Capital region community colleges have identified existing courses that meet the Business Information Worker pathway and the IT Technician Pathway, and are promoting both to students and industry partners.

Business Information Worker Pathway (BIW)

A short-term pathway to entry-level, middle-skill office jobs requiring training of six months or less — leading to a wide variety of office positions from entry-level clerk to administrative positions in the top industry sectors in the Sacramento Capital region. This pathway offers a set of digital and soft skills in demand. Students can return for advanced credentials and pathways as their income permits.

Business Information Worker Pathway	Courses in Pathway
Requires six-months of less of training	Keyboarding, Microsoft Office, Information Systems, Business Communications, and Human Relations/Customer Service
Sacramento Colleges Identifying BIW Pathway Programs	American River College, Cosumnes River College, Folsom Lake College, Saramento City College, Sierra College and Yuba College

IT Technician Pathway (ITTP)

A four-stage pathway that identifies IT skill sets in demand, each stage defined by knowledge and skills to acquire third-party industry certifications and employment in the field. Suggested two-years to complete, but can be accomplished in stages over time. Stage Four is currently under development.

IT Technician Pathway	Student Learning Outcomes – Pathway Descriptors
Stage One: Computer Retail Sales & Support	Students learn fundamental IT, business and customer service by taking the first 6 IT Technician Pathway courses and the CompTIA A+ Certification exam
Stage Two: Help Desk/User Support	Students build on the IT Technician Pathway by completing additional networking and security coursework along with suggested industry certifications
Stage Three: IT Technician	Students can further their careers by taking IT courses that teach advanced concepts, including Cyber Security (Ethical Hacking), and Routing and Switching Essentials, and become certified
Stage Four: Further Specialization Options [Under development]	Additional specialty courses include Mobility and Mobile Design, Cloud Essentials, CCNA Preparation, and Project Management/Process Improvement
Sacramento Colleges Identifying ITTP Pathway Programs	Sierra College

For more information, please visit ict-dm.net.

MORE ABOUT...

More About The Centers of Excellence

The Centers of Excellence (COE) for Labor Market Research deliver regional workforce research and technical expertise to California community colleges for program decision making and resource development. This information has proven valuable to colleges in beginning, revising, or updating economic development and Career Technical Education (CTE) programs, strengthening grant applications, assisting in the accreditation process, and in supporting strategic planning efforts.

The Centers of Excellence Initiative is funded in part by the Chancellor's Office, California Community Colleges, Economic and Workforce Development Program. The Centers aspire to be the leading source of regional workforce information and insight for California community colleges. More information about the Centers of Excellence is available at www.coeccc.net.

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More About Valley Vision

Since 1994, Valley Vision's work has driven transformative change and improved lives across Northern California. An independent social impact and civic leadership organization headquartered in Sacramento, Valley Vision strengthens our communities through unbiased research, boundary-crossing collaboration and change leadership. Our work improves overall quality of life and creates the conditions for economic prosperity and community health and vitality.

More About Burris Service Group

The Burris Service Group (BSG) is a full-service consulting practice providing expertise in economic development, strategic economic research, real estate site strategy, management, and institutional growth. The company was established based on the clear need that advisory services be delivered in an "action-oriented" form. The founder of BSG, Robert Burris, brings to his clients an active local and international network of professionals, as well as 20 years of experience in economic development, market and economic analysis, commercial real estate information, corporate sales, and consulting.

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