

## 2013 ENVIRONMENTAL SCAN

# ICT INFORMATION & COMMUNICATION TECHNOLOGIES

## Foundational Competency Employment Demand in California

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We would like to acknowledge the exemplary work of our research partner, Davis Research ([www.davisresearch.com](http://www.davisresearch.com)), who provided research design, data collection and data tracking services for this ambitious and complex study.

We would like to thank the U.S. Department of Labor and their team who reviewed the DOL Information Technology (IT) Competency Model that is the focus of this study.

We would like to thank the many organizations who cooperated in helping recruit company representatives to complete the survey, including:

- The California Workforce Association ([calworkforce.org](http://calworkforce.org))
- The ACM Committee for Computing Education in Community Colleges ([capspace.org](http://capspace.org))
- The Silicon Valley NOVA Workforce Investment Board
- The San Francisco Office of Economic and Workforce Development
- The California Community College Chancellor's Office
- The California Department of Education, ICT Consultant
- The WhyITNow.org Initiative
- The CCC Economic and Workforce Development [iima4biz.org](http://iima4biz.org) Initiative
- TechWire.net of the State of California
- Santa Clara County Chamber of Commerce
- Cisco Networking Academies, Western Region
- San Francisco Citizens Initiative for Technology and Innovation ([sfciti.org](http://sfciti.org))
- Juniper Networks
- IBM
- The World Organization of Webmasters ([webprofessionals.org](http://webprofessionals.org))

We would like to thank the 782 employer representatives across California who took the time to complete the survey.

And finally, our special thanks to Laura Coleman from the Center of Excellence Research Hub, hosted at the Los Rios Community College District, for her report formatting and editing expertise.

These results have provided critical information about the ICT workforce needs and requirements of both ICT and non-ICT companies. This information is vital for California's community colleges to use as they develop and strengthen training and education programs for all the businesses in California's economy.

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## Executive Summary

The Mid-Pacific ICT Center (MPICT), the California Community College ICT Collaborative and Centers of Excellence, and Davis Research conducted a web survey of 782 California employer representatives with direct knowledge of ICT workforce needs to validate foundational technical competencies in the U.S. Department of Labor's Information Technology (IT) Competency model. Research design employed a stratified sampling plan to ensure diverse and representative responses from different sized employers, as well as employers from a broad array of industries and regions that represent the California economy.

Of current ICT related frameworks, standards, and curricula, this study team believes the U.S. DOL model should be the most credible in getting employer and educator adoption. There is a critical need to align employer demand and education and workforce development supply to a standard framework and set of competencies to address the IT Skills Gap, in which California employers have difficulty finding appropriately skilled technical workers, even in this poor economy and period of high unemployment.

The DOL IT Competency Model was originally developed in a collaboration, primarily, between the U.S. Department of Labor (DOL) Employment and Training Administration (ETA) and the Information Technology Association of America (ITAA). (ITAA has since merged with TechAmerica.) That model was re-released in the Fall of 2012 and posted on the career-one-stop site.<sup>1</sup>

After interacting with detailed competencies and being exposed to the purpose and structure of the U.S. DOL IT Competency Model, all 782 survey participants were asked to indicate their level of agreement or disagreement with six general statements. That reaches a 99% confidence level for opinions of California employers with direct knowledge of their organization's ICT workforce needs.

### Key Findings for General Questions

- "California's ICT Workforce labor market would work better if there was a detailed, agreed-upon and structured framework for employer ICT Workforce competency demand, which educators and trainers used to prepare ICT Workforce in consistent ways, and employers used to communicate ICT Workforce and ICT job needs." (74.7% agree or very much agree)
- "Our organization would appreciate and be much more willing to entertain hiring students with ICT related credentials from California Community Colleges for ICT Workforce roles if there was a consistent, system-wide, validated foundation of knowledge and skills for ICT education and workforce development programs that addressed both technical and non-technical competency expectations." (70.5% agree or very much agree)
- "If there was a detailed, agreed-upon and structured framework for ICT Workforce competencies, our organization would be willing to reference them in future job announcements for ICT Workers, so applicants could better understand our requirements and match them to their own education and experience, and so we could better map applicant education and experience to our own needs." (68.2% agree or very much agree)
- "Information and communication technologies (ICT) competencies are increasingly important for most of our employers, regardless of role. If there was an agreed-upon standard for "digital literacy", or ICT competencies expected of all workers, regardless of workplace role, my organization would value a credential based on that standard as a way of validating ICT skills for non-ICT workers." (70.5% agree or very much agree)
- "In the 21st century, an ability to work with information and communication technologies is becoming as essential to education, life and workplace success as "reading, writing and arithmetic"." ICT Digital Literacy should be considered a basic skill by educational systems, something taught to and assessed for all students. (85.2% agree or very much agree)
- "Non-technical (soft, workplace or employability) skills are at least as important as technical skills in what we look for in our ICT Workforce." (76.3% agree or very much agree)

<sup>1</sup> <http://www.careeronestop.org/competencymodel/pyramid.aspx?it=Y>

### **Fundamental IT Skills (“Digital Literacy”)**

Based on survey results, we can say with a 99% level of confidence that **85.2%** of California employers with direct knowledge of their organization’s ICT workforce needs, **very much agree or agree** with the statement:

*“In the 21st century, an ability to work with information and communication technologies is becoming as essential to education, life and workplace success as “reading, writing and arithmetic”. ICT Digital Literacy should be considered a basic skill by educational systems, something taught to and assessed for all students.”*

In addition, the average level of employer agreement to keep detailed Fundamental IT Skills (“Digital Literacy”) competencies in the model was 91%. So, we now have an actionable, teachable and assessable definition of what Digital Literacy means.

California’s leaders have the opportunity to move beyond the simple recognition that Digital Literacy is a critical 21<sup>st</sup> century issue, by taking action to assure that all of its students and citizens can use technology to improve their lives, career prospects and society.

### **Foundational IT Workforce Technical Competencies**

Employers from across all regions, industry sectors and business sizes in California have resoundingly approved foundational IT workforce technical competencies of the federal DOL IT Competency Model through a rigorous survey method and research process. For the nine sections of Layer 4, the average level of employer agreement that the competencies in the section should be kept in the model are:

- Principles of Information Technology: 90%
- Databases and Applications: 92%
- Networks, Telecom, Wireless and Mobility: 91%
- Software Development and Management: 89%
- User and Customer Support: 93%
- Digital Media and Visualization: 91%
- Compliance: 92%
- Risk Management, Security, and Information Assurance: 90%

Independent of specialization, we now know in a very detailed way, much better than current advisory models have produced, what the foundational competency expectations for all IT workers are. We recommend that California employers and education and workforce development efforts at least adopt and use the existing DOL IT Competency model in its entirety, in order to create the foundation for a functional IT workforce development and IT workforce market in California.

Additionally, hundreds of wording changes and additions suggested by California employers were received in this study. So, California also has the opportunity to develop and adopt a foundational IT workforce competency model even more rigorous than the rest of the nation.

### **Report Findings and Recommendations**

This report provides a variety of recommendations to diverse stakeholders. However, the primary recommendation is that CCC ICT educators adopt at least the Federal DOL model, base standard IT program common core student learning outcomes (SLOs) on them, and use those standards to align very diverse program offerings to improve articulation and transfer – and job placement. These and other recommended efforts should have a significant positive impact on the IT workforce, employment and economy in California.

## Introduction

### Information and Communication Technologies (ICT)

Information and Communications Technologies (ICT) encompasses all rapidly emerging, evolving, and converging computer, software, networking, telecommunications, Internet, programming, information systems and digital media technologies. It is an umbrella or superset term that includes many different competing subset terminologies. ICT is a comprehensive framework for organizing these inter-related, interdependent, and rapidly changing technologies and high-tech fields - and for organizing the ICT workforce, which spans across organizations of all sizes - in all industries. The ICT term and framework are widely used outside the U.S., by institutions including the United Nations, European Union, World Bank, International Telecommunications Union, and others. ICT is recognized in many global economies as a strategically important industry and employment sector that is a major driver of economic growth.

Despite its size and importance, ICT has not received sufficient attention from policy makers and planners in the U.S. Current frameworks for study, developed by federal and state governments, do not consider the convergence of ICT technologies, industries and employment into one cluster that can be researched effectively. This has resulted in fragmented reporting of ICT related information that does not accurately reflect the true breadth and depth of ICT, because it either includes its companies and workers with other sectors, or it reports on smaller components only (such as computers). As a result, industry and occupational research reporting in the U.S. does not draw as much attention to this strategic sector as research reporting abroad, which likely leads to U.S. policy and planning not paying adequate strategic attention to this very important 21<sup>st</sup> century industry and employment sector.

MPICT advocates use of ICT as a term and framework in the U.S. and in California. A very practical reason to adopt ICT, rather than IT (Information Technology), which is widely used in the U.S., is that ICT is more searchable on the internet and in other information systems. Searching “IT” produces every article in the English language, while searching ICT returns more relevant results.

The paradigm shift from 20<sup>th</sup> century economies dominated by manufacturing, transportation and energy to 21<sup>st</sup> century information, knowledge and innovation economies includes many rapid changes that are difficult to adjust to. All industries are affected. Increasingly, ICT expertise is required by workforce at every level. ICT workforce is in high demand, and employers are reporting difficulty finding appropriately skilled workforce, even in this period of high unemployment. This report is one in a series attempting to analyze ICT industry and employment sectors in California, California Community College ICT related programs and credentials and what California can do to improve our performance in relation to ICT industry growth, ICT employment in all industries and resulting economic impacts.

### Study Collaborators

The Mid-Pacific ICT Center ([mpict.org](http://mpict.org)) is funded by the National Science Foundation (NSF) Advanced Technological Education (ATE) program to coordinate, promote and improve ICT education, with an emphasis on 2-year colleges, in California, Nevada, Hawaii and the Pacific Territories.

The California Community College (CCC) ICT Collaborative ([cccict.org](http://cccict.org)) is a Perkins Title IB (state leadership) funded collaborative, awarded by the CCC Chancellor’s office Career Education Practices Unit<sup>2</sup>. Its mission is “to advance ICT education programs at California community colleges and enable a diverse student population to succeed in meeting industry and business ICT workforce needs.”

The California Community College (CCC) Economic and Workforce Development (EWD) Centers of Excellence (COE) partner with business and industry to deliver regional workforce research customized for community college decision making and resource development, funded in part by the Chancellor’s Office, California Community Colleges, Economic and Workforce Development Program.

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<sup>2</sup> <http://extranet.cccco.edu/Divisions/WorkforceandEconDev/CareerEducationPractices.aspx>

## California Community Colleges

The primary audience for this report is educators and administrators in the California Community College (CCC) system:

- The largest higher educational system in the U.S., 3m students attending 112 colleges annually.
- One in four community college students in the U.S. attends a CCC.
- CCCs have the highest attendance rate of any U.S. community college system.
- CCCs enroll one in three Californians aged 18 – 24.
- Over 80% of CCC students work already.
- CCCs transfer 60% of California State University system graduates.
- CCCs transfer 30% of University of California system graduates.
- Every \$1 invested in CCC education returns \$3 to the California economy.
- CCCs prepare people for the workforce, in addition to preparing students for transfer.<sup>3</sup>

However, this report also includes valuable information for other CCC stakeholders, California legislators and public officials, the California Department of Education and K-12 system interests, California State University and University of California interests, California citizens, the U.S. Department of Labor, California citizens, community based organizations, and others.

## Past Research

Starting in 2009, the Centers of Excellence and MPICT began studying Information and Communication Technologies as a significant industry sector and set of enabling technologies driving growth and productivity in the California economy. The studies were initially presented in a series of reports that focused on different aspects of ICT as it relates to the labor market and workforce development. Following is a brief summary of the focus of each report and its research method, with a link to the full study:

**1. Phase 1 2009 ICT Environmental Scan:** In May of 2009, [MPICT's Advisory Panel](#)<sup>4</sup> of California ICT industry and business representatives informed an introductory report to frame ICT and its importance in California. The [Phase 1 Environmental Scan](#) was completed and released in September of 2009 on the COE [website](#).<sup>5</sup> It introduced the ICT term and framework, how ICT employment is spread far beyond ICT industries, those which produce ICT goods and services, and several broad, plain language categories of ICT employment. It set the stage for Phase 2.

**2. Phase 2 2010 ICT Industry and Employment Outlook:** In August of 2010, the Phase 2 study was [released](#).<sup>6</sup> It maps existing industry NAICS codes to an ICT framework and provides secondary research on how big ICT industries are in California. It maps existing employment SOC codes to an ICT framework and provides secondary research on how big ICT employment is in California and what expectations for ICT employment growth are using existing U.S. and California employment data sources. It also presents primary research, in which over 600 California companies were surveyed about ICT and broad ICT workforce needs in their organizations. MPICT's complete version of this report is available for [download](#).<sup>7</sup> A shorter COE version of the report is available for [download](#).<sup>8</sup> It set the stage for Phase 3.

Among the Phase 2 report's findings:

- 88% of California firms providing ICT goods and/or services and 80% that do not provide ICT goods and/or services either agreed or strongly agreed information and communications technologies were important to the productivity of their organizations.<sup>9</sup>
- Companies providing ICT goods and/or services expected 11.2% growth in ICT workforce employment in the next two years, compared with overall employment growth expectations of 8.5%.<sup>10</sup>

<sup>3</sup> <http://www.foundationccc.org/AbouttheColleges/FactsandFigures/tabid/636/Default.aspx>

<sup>4</sup> [http://www.mpict.org/newsletters/q209/article\\_mpict\\_advisors\\_aid\\_ict\\_workforce\\_study.html](http://www.mpict.org/newsletters/q209/article_mpict_advisors_aid_ict_workforce_study.html)

<sup>5</sup> [http://www.coecc.net/logdownloads.asp?url=ICT\\_scan\\_sw\\_09.pdf](http://www.coecc.net/logdownloads.asp?url=ICT_scan_sw_09.pdf)

<sup>6</sup> [http://www.mpict.org/MPICT-COE ICT-Study-Press-Release\\_8-4-10.doc](http://www.mpict.org/MPICT-COE ICT-Study-Press-Release_8-4-10.doc)

<sup>7</sup> [http://www.mpict.org/ict\\_study\\_phase2.html](http://www.mpict.org/ict_study_phase2.html)

<sup>8</sup> [http://www.coecc.net/register\\_form.asp?url=ICTed\\_sw\\_scan\\_10.pdf&pg=](http://www.coecc.net/register_form.asp?url=ICTed_sw_scan_10.pdf&pg=)

<sup>9</sup> [http://www.mpict.org/ict\\_study\\_phase2.html](http://www.mpict.org/ict_study_phase2.html), MPICT Phase 2 Study, Executive Summary, page 5



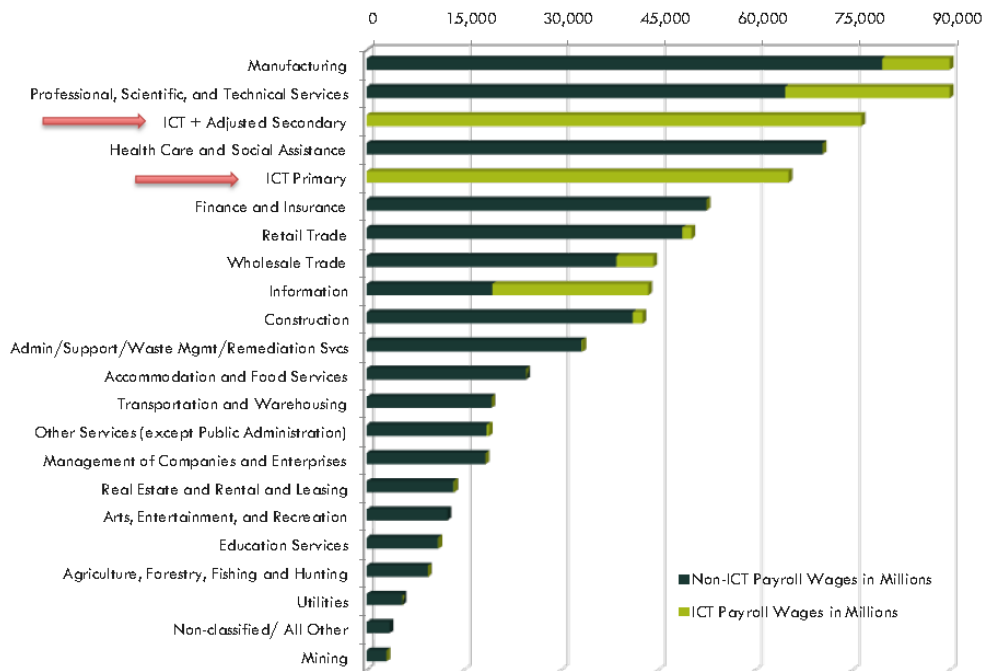
- Companies that did not provide ICT goods and/or services expected -.4% overall employment growth, but expected 3.7% growth in ICT workforce employment.<sup>11</sup>
- More than half of firms reported difficulty recruiting employees with appropriate skills.<sup>12</sup>

Also among the Phase 2 report’s findings, as of 2010, ICT industries in California had:

- About 46,000 companies, 4% of all companies, ranked 12<sup>th</sup> of CA industries by firm count
- Almost \$172B in revenue, 6% of CA private sector revenues, 6<sup>th</sup> of industries by revenues
- About a million California workers, 4% of the workforce, 12<sup>th</sup> of industries by employees
- About \$76B in wages, 12% of private wages, 2<sup>nd</sup> of industries by wages paid
- Wages per employee about twice the state average
- Expected significant job growth approaching 20% from 2006 to 2016<sup>13</sup>

An example of the value of a consolidated ICT framework included the following ranking of ICT industries by wages paid:

**Figure: California Industries Ranked by Wages Paid**



Source data: InfoUSA 2008

Light green shading indicates ICT related NAICS codes. The closest existing U.S. industry classification to ICT is “Information.” Yet, only about half of what is in the Information NAICS code is ICT. The rest includes things like newspapers. As newspaper employment drops, that leads to the false impression that ICT industries are not doing well. In fact, aggregated ICT industry employment is 2<sup>nd</sup> in California.

**3. Phase 3 2011 Educational Program Input:** In September of 2011, the [Phase 3 study](#) was released.<sup>14</sup> It provided:

- More current ICT employment labor market information from EMSI,
- Real time labor market information from Wanted.com and Monster.com,
- Detailed descriptions of ICT related standard occupations and their short term prospects,

<sup>10</sup> [http://www.mpict.org/ict\\_study\\_phase2.html](http://www.mpict.org/ict_study_phase2.html), MPICT Phase 2 Study, Executive Summary, page 6  
<sup>11</sup> [http://www.mpict.org/ict\\_study\\_phase2.html](http://www.mpict.org/ict_study_phase2.html), MPICT Phase 2 Study, Executive Summary, page 6  
<sup>12</sup> [http://www.mpict.org/ict\\_study\\_phase2.html](http://www.mpict.org/ict_study_phase2.html), MPICT Phase 2 Study, Executive Summary, page 7  
<sup>13</sup> [http://www.mpict.org/ict\\_study\\_phase2.html](http://www.mpict.org/ict_study_phase2.html), MPICT Phase 2 Study, Executive Summary, page 5  
<sup>14</sup> [http://www.mpict.org/ict\\_study\\_phase3.html](http://www.mpict.org/ict_study_phase3.html)

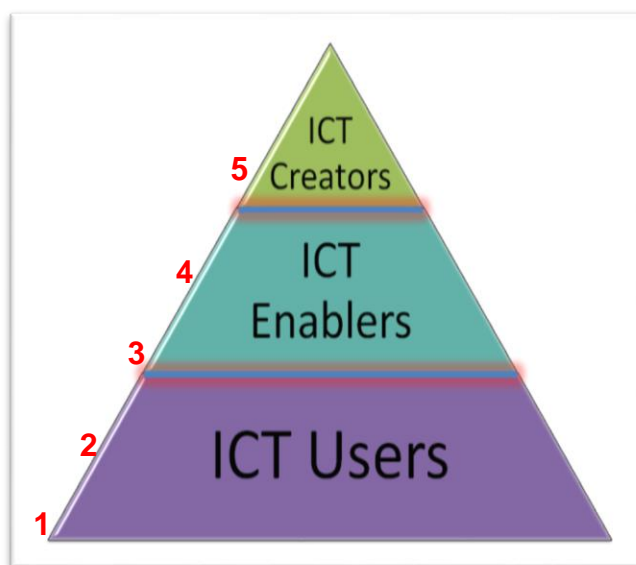
- Preliminary findings from a study of ICT related program academic credentials at 48 of California's community colleges,
- Structure and tools for improved communication between education and business and industry about ICT,
- A consolidation of business and industry input from hundreds of conversations with employers and MPICT's Advisory Panel, and
- Recommendations for additional work to better inform programs.

It announced the creation of the California Community College (CCC) ICT Collaborative to help address ICT in a more coordinated and comprehensive way across the 112 campus CCC system. Among the Phase 3 report's findings:

- ICT workforce employed almost 1.2 million Californians in Q1 '11 across all industries
- 30K Net New ICT Workforce Jobs were expected by 2013 through 80K Job Openings
- Wages paid were about twice the median in California

It introduced a simple ICT pyramid model. "This simple, 3-level pyramid is useful for being able to identify and agree on what depth or dimension of ICT knowledge and skills is being discussed and being sure everyone is talking about the same thing – using plain language that everyone can understand, even if they know nothing about the field."

**Figure: Basic ICT Pyramid**

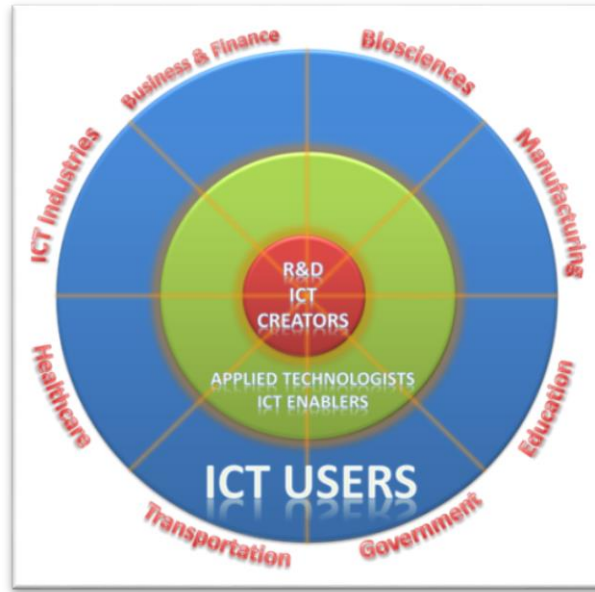


- 1) At the base of the pyramid is the largest group of people, those who use ICT in their schools, jobs and lives.
- 2) The fuzzy line between the first and second level of the pyramid represents entry level ICT workforce positions which support ICT Users. These are people who are competent ICT Users themselves, with good people skills, who help other Users understand and use ICT systems and solutions. In roles like Help Desk support, technician, call center representative and Computer Support Specialist, they help other users realize the benefits of ICT in their lives and jobs.
- 3) The middle layer of the pyramid, "ICT Enablers," is the dimension of applying mature ICT technologies in the real world. These are the core Information Technology (IT) operations of all kinds of enterprises. They deploy developed technologies as infrastructure to support the operations of their enterprises, which Users use. This is the applied technology domain.
- 4) The fuzzy line between the middle and top layers of the pyramid represents the intersection of ICT research and development (R&D) and IT operations, enterprises, consumers and users. At this layer, representatives of ICT companies or business units interact with their consumer and

enterprise customers, to buy and sell goods and services, to understand customer requirements and specifications, to do marketing, to design and install custom customer solutions. These are sales, marketing, engineering, management, and support roles that form the interaction between organizations that create and sell ICT goods and services and their customers, which are IT operations of enterprises or consumers.

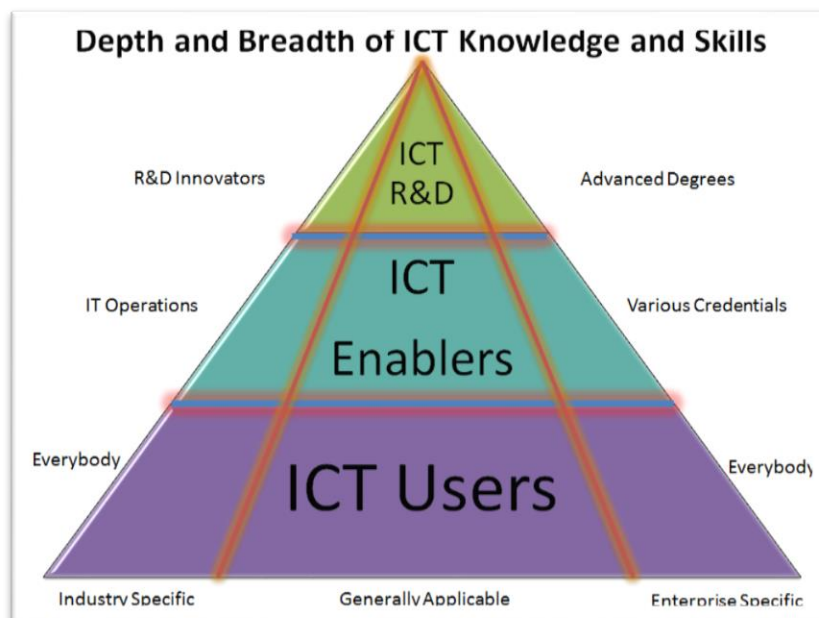
- 5) The top level of the pyramid, "ICT Creators," represents the innovators who develop ICT technologies, goods, services and businesses.

**Figure: ICT Industry Pie**



The ICT Pyramid is not limited to just ICT industries, however. ICT permeates all industries...

**Figure: Comprehensive ICT Pyramid**

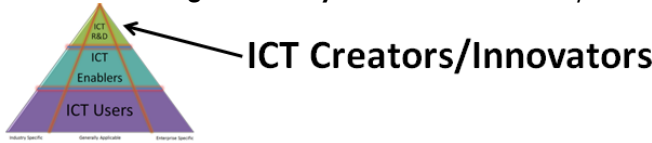


A modification of the ICT Pyramid picks up this industry dimension, and the customizations many individual enterprises create, especially very large ones. It contains all of the dimensions previously described, but it makes space for specialized implementations in an individual industry.

Similarly, some large enterprises have custom ICT hardware and software developed especially for them. It is important to be able to work with those systems if you are working for that employer.<sup>15</sup>

**4. 2011-2012 Advisory Group Refinements to ICT Pyramid:** In the course of two MPICT/CCC ICT Collaborative Advisory Panel meetings in San Francisco and a BATEC NSF ATE Center “IT Skills Summit” event in 2011, further refinements to the ICT Pyramid above were developed, which delineate common employer ICT workforce roles and functions:

**Figure: ICT Pyramid Creator Roles/Functions**



More granularity for ICT Creator/Innovator Dimension

<b>CREATORS</b>	<b>Executive Management</b>	Strategic Planning Input from Various Organizational Divisions (Finance, Marketing, Sales, Operations, etc.) Execution and Organizational Support
	<b>Research</b>	Scientists and Advanced Engineers with Deep Knowledge and Skills of Math, Principles, Science, Research protocols, etc.
	<b>Development</b>	Engineers who design solutions based on requirements and specifications, create and manage project plans, build models and prototypes, develop production processes, etc.
	<b>Testing &amp; Quality Assurance</b>	Engineers who test products under various scenarios to identify solution performance issues feed that information back into R&D teams.
	<b>Requirements and Specifications</b>	People who translate market demand into technical and performance criteria for solutions.

Community college students can achieve at least supporting roles in some of these functions and any of these roles through further study and/or hard work in a career.

**Figure: ICT Pyramid Marketing, Sales and Sales Engineering Roles/Functions**



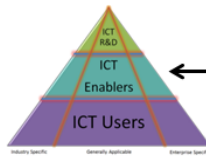
More granularity for Roles interacting between ICT Solutions Creators and Their IT Organization or User Customers

<b>ICT Solution Marketing &amp; Sales</b>	<b>Marketing and Sales</b>	Solution Marketing Strategies, Efforts, Collateral and Events Solution Direct and Indirect Sales Channel Staff Gathering Feedback from Customers for Creators
	<b>Sales Support/ Engineering</b>	Providing Technical Sales Support Designing Custom Customer Solutions Installing and Configuring Customer Solutions Teaching Customers How to Use Solutions

Community college students can achieve at least supporting roles in some of these functions and any of these roles through further study and/or hard work in a career.

**Figure: ICT Pyramid IT Operations Roles/Functions**

<sup>15</sup> [http://www.mpict.org/ict\\_study\\_phase3.html](http://www.mpict.org/ict_study_phase3.html), pages 36-38



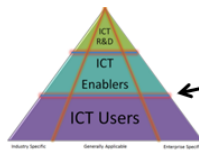
## ICT Enablers, Applied Technology, IT Operations

More granularity for Roles in IT Operations of Enterprises or Infrastructure Groups of Telecoms and Other Service Providers

<b>ENABLERS</b>	<b>IT Management</b>	Organizational Management Operations Management Vendor Selection and Management Solution Evaluations Project Management Documentation Management Institutional Knowledge Management
	<b>Systems Architecture/ Integration</b>	Combining Various Systems into Comprehensive Solutions Diverse and deep knowledge Strong team players
	<b>Solution Management &amp; Maintenance</b>	Solution maintenance, management, monitoring and upgrades Ongoing operations
	<b>Solution Installation and Provisioning</b>	Receive it, accept it, install it, configure it, test it, tie it in to other systems, document it...

Community college students can achieve roles in many of these functions right out of school and any of these roles through further study and/or hard work in a career.

**Figure: ICT Pyramid ICT Technical and User Support Roles/Functions**



## ICT Solution and User Support

More granularity for Roles in ICT Solution and User Support

<b>ICT Solution &amp; User Support</b>	<b>Solution Support</b>	Doing routine tasks associated with keeping systems and solutions operating properly.
	<b>User Support</b>	Helping Users Install, Configure, Maintain, Manage, Monitor, Upgrade, Repair and Generally Use ICT Products and Services Training

Community college students definitely achieve roles in these entry-level functions.

**Figure: ICT Pyramid ICT User Roles/Functions**



More granularity for Roles in ICT Users

<b>USERS</b>	Business Users	Can use business systems
	Consumer Users	Can use consumer systems

Community colleges need to play a major role in developing these foundational abilities, for student success in any field, and for workplace success in almost any job.

**5. 2010-2011 California Community College ICT Related Enrollments and Demographics:** In December of 2012, MPICT released a study of ICT related enrollment and demographic data analysis in the California Community College System, available for download [here](#)<sup>16</sup>. It revealed:

- Students took more than 560,000 ICT related for-credit classes in 2010/11,
- and more than 110,000 noncredit ICT related classes,
- for a total of more than 675,000 ICT related enrollments across the CCC system that year.<sup>17</sup>
- In 2010/11, some 5,700 faculty taught ICT related courses at CCCs.
- Of those, 2,604 were full-time and 3,125 were part-time.<sup>18</sup>
- Students are very diverse, much more so than faculty.
- In 2010/11, 994 ICT related Associate (AS/AA) degrees were awarded, and
- 1,919 ICT related for credit academic certificates and 264 non-credit certificates.
- These are relatively low academic award rates for the number of enrollments.
- Because, anecdotally, academic credentials are not the goals of so many of the students.

**6. 2010-2011 California Community College ICT Related Programs and Academic Credentials:** In December of 2012, MPICT released a study of ICT related programs and academic credentials, available for [download](#).<sup>19</sup> It revealed:<sup>20</sup>

- The 112 CCCs offer ICT education services through 295 different departments; those departments have 175 different names; 149 of those names are only used once in the CCC system; the organizational structure logic is different at different colleges; college websites are structured differently; program messaging is inconsistent; and that can be very confusing to those who are not already deeply embedded in the local college.
- Those 295 different departments offer more than 600 associate level degrees; those degrees have more than 400 unique titles; 374 of the titles are used only once in the CCC system.
- Those 295 different departments offer 1,500 academic certificates; those certificates have more than 1,100 unique titles; more than 1,000 of those titles are used only once across the CCC system.
- Even when degree and certificate titles are the same, the content and rigor are usually different; and these inconsistencies are confusing.

<sup>16</sup> <http://www.mpict.org/pdf/CCC ICT Enrollments and Demographics 12-31-12.pdf>

<sup>17</sup> <http://www.mpict.org/pdf/CCC ICT Enrollments and Demographics 12-31-12.pdf>, pages 9 - 10

<sup>18</sup> <http://www.mpict.org/pdf/CCC ICT Enrollments and Demographics 12-31-12.pdf>, page 44

<sup>19</sup> <http://www.mpict.org/pdf/CCC ICT Programs and Credentials 12-31-12.pdf>

<sup>20</sup> Find descriptions of ICT related programs at each CCC at [http://www.mpict.org/ict\\_education\\_california\\_community\\_colleges.html](http://www.mpict.org/ict_education_california_community_colleges.html).

- It devalues every CCC ICT related certificate to have so many different, inconsistent and poorly understood certificates.
- This inconsistency leads to a lack of coherent articulation and transfer opportunities in ICT. It is too complex and difficult to articulate between programs and credentials when most programs and credentials are unique. The number of articulation negotiations and agreements required to fully articulate a system with 295 different departments is more than 43,000. This does not include articulation with ICT related programs at 4-year colleges and universities, which are also generally unique.
- The current system of informing ICT related programs and credentials in CCCs through local business and industry advisory groups is well intentioned, but the technologies are the same in different regions and the result is chaotic and devalued program credentials across the system.

**7. Other Studies:** MPICT and COEs have also collaborated or independently produced other ICT related studies, including:

- [ICT Sector Profile](#) for *CCC Doing What Matters for Jobs and the Economy* (2012)<sup>21</sup>
- [Cybersecurity](#), (2012)<sup>22</sup>
- [Social Media in California](#), (2012)<sup>23</sup>
- [Mobile Media Occupations in California](#), (2012)<sup>24</sup>
- [Silicon Valley in Transition: Economic and Workforce Implications in the Age of iPads, Android Apps, and the Social Web](#), (2011)<sup>25</sup>
- [Emerging Trends in Mobile Media](#), (2011)<sup>26</sup>
- [STEM in 20](#) – Industries and Occupations of the Future, (2012)<sup>27</sup>

### Need and Purpose for This Study

This past research demonstrates that ICT industries and ICT employment, both within and outside of ICT industries, are very important components of the California economy.

ICT employment represents about 1 in 20 jobs in California, paying about twice the median, demand is growing, and employers are reporting difficulty finding appropriately skilled ICT workforce, even in this period of high unemployment.

*“Nearly 1.5 million computing jobs will become available over the next five years. The problem is, even in this economy, there will only be enough qualified graduates to fill about 30 percent of those positions.”<sup>28</sup>*

Among further evidence of high ICT workforce demand are the *2012 IT Salary Guide* by Bluewolf<sup>29</sup> and *2013 Salary Guide for Technology Professionals* from Robert Half,<sup>30</sup> which show strong increases in salaries for ICT related occupations, indicating strong and unmet employer demand. More than a third of Forbes' Top Jobs for 2013 are ICT related.<sup>31</sup>

<sup>21</sup> [http://www.coecc.net/documents/dwm\\_ict\\_sector\\_CA\\_12.pdf](http://www.coecc.net/documents/dwm_ict_sector_CA_12.pdf)

<sup>22</sup> [http://www.coecc.net/register\\_form.asp?url=cyber\\_scan\\_la-ora\\_12.pdf&pg=](http://www.coecc.net/register_form.asp?url=cyber_scan_la-ora_12.pdf&pg=)

<sup>23</sup> [http://www.coecc.net/register\\_form.asp?url=smedia\\_scan\\_sw\\_12.pdf&pg=](http://www.coecc.net/register_form.asp?url=smedia_scan_sw_12.pdf&pg=)

<sup>24</sup> [http://www.coecc.net/register\\_form.asp?url=mm\\_scan\\_sw\\_12.pdf&pg=](http://www.coecc.net/register_form.asp?url=mm_scan_sw_12.pdf&pg=)

<sup>25</sup> [http://www.coecc.net/documents/tech\\_custom\\_sf-sv\\_11.pdf](http://www.coecc.net/documents/tech_custom_sf-sv_11.pdf)

<sup>26</sup> [http://www.coecc.net/register\\_form.asp?url=ict\\_scan\\_qsac\\_11.pdf&pg=](http://www.coecc.net/register_form.asp?url=ict_scan_qsac_11.pdf&pg=)

<sup>27</sup> <http://www.coecc.net/stemin20/>

<sup>28</sup> <http://www.forbes.com/sites/ciocentral/2012/09/24/tech-jobs-we-need-more-stem-grads-and-we-need-them-now/>

<sup>29</sup> <http://www.bluewolf.com/it-staffing/salary-guide>

<sup>30</sup> <http://www.roberthalftechnology.com/SalaryCenter>

<sup>31</sup> <http://www.forbes.com/sites/jacquelynsmith/2012/12/06/the-top-jobs-for-2013/>



In December of 2012, the Bay Area Council Economic Institute produced a report entitled *Technology Works: High-Tech Employment and Wages in the United States*.<sup>32</sup> Following are quotes from that report indicating the strategic importance of ICT and its strong job growth, wages and economic impact:

“Since the dot-com bust reached bottom in early 2004, employment growth in the high-tech sector has outpaced growth in the private sector as a whole by a ratio of three-to-one. High-tech sector employment has also been more resilient in the recent recession-and-recovery period and in the last year. The unemployment rate for the high-tech sector workforce has consistently been far below the rate for the nation as a whole, and recent wage growth has been stronger.”<sup>33</sup>

“Employment growth in STEM occupations has consistently been robust throughout the last decade, outpacing job gains across all occupations by a ratio of 27 to 1 between 2002 and 2011. When combined with very low unemployment and strong wage growth, this reflects the high demand for workers in these fields.”<sup>34</sup>

“After dipping more than 5 percent between 2000 and 2002, employment in the computer and math sciences occupations expanded at a strong pace. Employment in this subgroup increased 23.1 percent between 2002 and 2011. The growth rate for all occupations was essentially flat during that same period. Employment in the computer and math sciences subgroup has grown by an impressive 8 percent since the beginning of the recession, a period when total employment has fallen by nearly 5 percent.”<sup>35</sup>

“Of the 635,510 net STEM jobs that were added between 2000 and 2011, computer and math sciences occupations accounted for 79.8 percent. This rise increased the computer and math sciences occupations share of total STEM jobs to 55 percent in 2011, up from 52.3 percent in 2000.”<sup>36</sup>

“The growing income generated by the high-tech sector and the strong employment growth that supports it are important contributors to regional economic development. This is illustrated by the local multiplier, which estimates that the creation of one job in the high-tech sector of a region is associated with the creation of 4.3 additional jobs in the local goods and services economy of the same region in the long run. That is more than three times the local multiplier for manufacturing, which at 1.4, is still quite high.”<sup>37</sup>

Despite misinformation in wide circulation that “all the IT jobs went to China and India,” there is very strong and growing demand for ICT workforce in the U.S. and California. Those jobs have a big economic impact, much larger than most other occupational areas. And, this demand for ICT workforce is not being met, despite the poor economy, high unemployment rates and large numbers of students completing academic and career technical education programs.

This issue is frequently characterized as a “Skills Gap Problem.” The workforce and potential employee pool do not have the skills needed by employers. According to CompTIA’s *State of the IT Skills Gap* from February of 2012:<sup>38</sup>

- Information Technology is increasingly strategically important to organizations in most industries (see graph following).<sup>39</sup>

<sup>32</sup> <http://www.bayareaeconomy.org/media/files/pdf/TechReport.pdf>

<sup>33</sup> Ibid, Executive Summary, page 5

<sup>34</sup> Ibid, Executive Summary, page 5

<sup>35</sup> Ibid, page 18

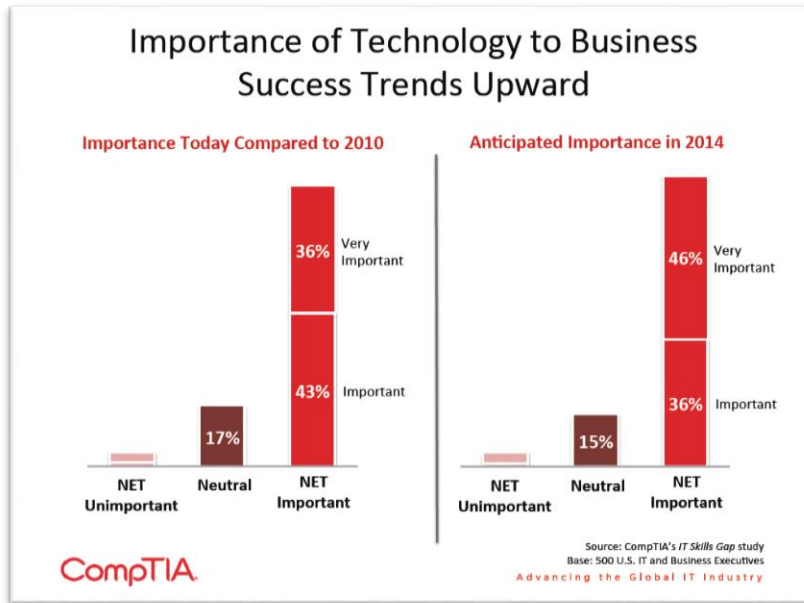
<sup>36</sup> Ibid, page 19

<sup>37</sup> Ibid, Executive Summary, page 5

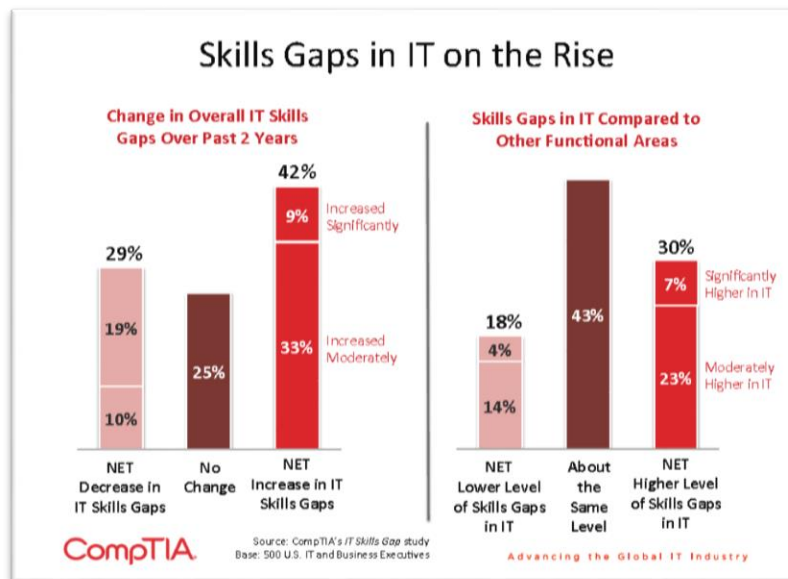
<sup>38</sup> [http://www.wired.com/wiredenterprise/wp-content/uploads/2012/03/Report\\_-\\_CompTIA\\_IT\\_Skills\\_Gap\\_study\\_-\\_Full\\_Report.sflb\\_.pdf](http://www.wired.com/wiredenterprise/wp-content/uploads/2012/03/Report_-_CompTIA_IT_Skills_Gap_study_-_Full_Report.sflb_.pdf)

<sup>39</sup> Ibid, page 3





- “The great majority of employers (93%) indicate there is an overall skills gap, the difference between existing and desired skill levels, among their IT staff.”
- “Nearly 6 in 10 (56%) companies report being only moderately close or not even close to where they want to be with IT skills.”
- “Respondents place the highest levels of importance on skills associated with what could be described as the IT foundation such as networks, servers, storage, security, database management, and IT support.
- “Most (80%) organizations indicate their IT skills gap affects at least one business area such as staff productivity (41%), customer service/customer engagement (32%), and security (31%).
- “Nearly half of respondents cite the dynamic nature of the tech space as a primary cause of skills gaps. Another top cause is the lack of resources for professional development.”<sup>40</sup>
- The IT skills gap is increasing and is bigger than in other functional areas. (See graph following)<sup>41</sup>



<sup>40</sup> Ibid, page 7

<sup>41</sup> Ibid, page 8

Unfortunately, research also shows that many employers are not very aware of community colleges and their efforts to develop ICT workforce – even if they are an extremely important channel of cost-effective ICT workforce development.<sup>42</sup>

A large part of the ICT Skills Gap problem is chaos in the ICT employment market.

“For the most part, employers create their job titles and job descriptions from scratch, customized to their specific needs and desires. An exploratory query of all unduplicated online Primary ICT job postings in a single market using information from Wanted.com, for example, showed 2,380 total job listings. Of those, there were 1,928 different job titles. Even jobs with the same job titles had different job descriptions and requirements.”<sup>43</sup>

ICT workforce demand is chaotic. It is very difficult for educators and other workforce development representatives to sort through that kind of job posting information to understand what they should be developing ICT workforce to be able to do. And, the field is too broad and the employer universe is too large for local advisories to provide statistically significant or adequate guidance on what ICT knowledge and skill sets are truly in highest demand.

In part as a result, there is also chaos on the ICT education and workforce development supply side. In the 112 colleges of the California Community College system, there are 295 different departments offering ICT related programs and academic credentials. They offer more than 600 different associate degrees with more than 400 unique titles and 1,500 academic certificates with more than 1,100 different titles related to ICT. Even when titles are the same, content and rigor differ widely.<sup>44</sup> That makes programs and credentials very difficult to understand, devaluing those programs and credentials for everyone.

“Further, as a result of these inconsistencies, it is extremely difficult to create efficient articulation and transfer options for students in ICT related subjects, both between different CCCs and between any CCC and any 4-year college or university. Every two points in an articulation discussion are unique, and it is a lot of work to figure out what is involved in each program, what to accept credit for and how. The number of department level articulation negotiations and agreements required to fully articulate a system with 295 different departments is more than 43,000. This does not include articulation with ICT related programs at 4-year colleges and universities, which are also generally unique. Many students suffer from a lack of coherent articulation and transfer opportunities in ICT. Students would be better served in California if there was better alignment. To achieve alignment, there has to be something to align to. There are currently no agreed upon standards or frameworks that CCCs use to align ICT related programs.”<sup>45</sup>

To have a coherent and functional ICT employment market and a harmonized and articulated ICT educational and workforce development system, we need a common ICT framework and statistically significant, consistent and coherent ICT workforce competency expectations to align and refer to that is actively used by employers and industry as well as educators and other workforce development efforts. Doing so would create the foundation for a more efficient and effective ICT labor market, as was done in Australia with its *Innovation and Business Skills Australia Environment Scan 2012: Information and Communications Technologies Industry*<sup>46</sup> and Australian government *ICA11 – Information and Communications Technologies Training Package*,<sup>47</sup> for which there is currently no U.S. equivalent. Having

<sup>42</sup> MPICT and Centers of Excellence 2010 Environmental Scan: ICT Information and Communication Technologies in California: Phase 2: Industry and Employment Outlook, pages 37-38, [http://www.mpict.org/ict\\_study\\_phase2.html](http://www.mpict.org/ict_study_phase2.html)

<sup>43</sup> MPICT and Centers of Excellence 2010 Environmental Scan: ICT Information and Communication Technologies in California: Phase 3: 2011 Educational Program Input, page 10

<sup>44</sup> California Community College ICT Programs and Academic Credentials: A Study of Programs and Their Academic Credentials Related to Information and Communication Technologies (ICT) In California Community Colleges, 2010/11, MPICT, page 3-4, <http://www.mpict.org/pdf/CCC ICT Programs and Credentials 12-31-12.pdf>

<sup>45</sup> Ibid, page 10

<sup>46</sup> <http://www.ibsa.org.au/Portals/ibsa.org.au/docs/Research%20&%20Discussion%20Papers/Esca/Escan2012/IBSA%20Esca n%202012%20-%20ICT.pdf>

<sup>47</sup> <http://training.gov.au/Training/Details/ICA11>

national standards that are adopted and used by employers, educators, workforce investment boards, industry academies, industry certification producers and others would tremendously reduce inefficiencies, chaos and endlessly duplicated efforts as so many people around the country try to address problems caused by a lack of common adopted ICT workforce standards in different and confusing ways.

In the U.S., the closest equivalents are:

- Federal National Skills Standard Board work, which is no longer in operation or current<sup>48</sup>
- The U.S. Department of Labor IT Competency Model<sup>49</sup> and ICT related O\*Net occupations<sup>50</sup>
- The 1999 National Workforce System for Emerging Technologies (NWCET) Skill Standards for Information Technology,<sup>51</sup> which are not maintained and have not been updated since 2003
- Association for Computing Machinery (ACM)<sup>52</sup> Curricula Recommendations for Computer Science, Computer Engineering, Information Systems, Information Technology and Software Engineering<sup>53</sup>, which are widely adopted by 4-year colleges and universities, but not optimized for community colleges or focused on hands-on applications of technology, and often not well integrated with employer job postings.

### U.S. Department of Labor IT Competency Model

Of the current ICT related frameworks, standards, competencies and curricula above, this study team believes the U.S. Department of Labor (DOL) should be the most credible in getting employer and educator adoption. Intuitively, people in many situations naturally assume that DOL is doing this work, and it is charged to do this work. Like “nobody will be fired for buying IBM” computing solutions in the 1980s, nobody will be criticized for adopting and aligning to U.S. Department of Labor systems and standards in ICT, and the more who do, the more likely those systems and standards will receive additional attention and be improved.

The DOL IT Competency Model was originally developed in a collaboration, primarily, between the U.S. Department of Labor (DOL) Employment and Training Administration (ETA) and the Information Technology Association of America (ITAA). (ITAA has since merged with TechAmerica.)

ITAA partnered with DOL/ETA in November 2007 to develop the model, referred to as the Competency Model for the Information Technology Industry. The model provides a clear description of the knowledge, skills, and abilities necessary to perform well in IT professions.

“Business and educational leaders, as well as economic development and public workforce professionals participated in focus groups at four locations across the country to shape the model. ITAA collaborated with local and regional industry associations to conduct focus groups in Seattle, Boston, Minneapolis, and the Washington, D.C. region. Participating regional IT associations were the Washington Technology Industry Association, Massachusetts Technology Leadership Council, Minnesota High Tech Association, the Northern Virginia Technology Council and the Technology Council of Maryland.”<sup>54</sup>

In part, perhaps, because there was no recognized representation from California in developing the model, lack of employer validation in California, lack of active efforts to market and recruit engagement with the model in California, lack of exposure to and acknowledgement of the model by educators in California and/or lack of any requirements to do so, in any event, the DOL/ETA/ITAA model has not been widely adopted in California – by industry, educators or employers.

<sup>48</sup> <https://www.federalregister.gov/agencies/national-skill-standards-board>

<sup>49</sup> <http://www.careeronestop.org/competencymodel/pyramid.aspx?IT=Y>

<sup>50</sup> <http://www.onetonline.org/>

<sup>51</sup> <http://itestlrc.edc.org/node/253>

<sup>52</sup> <http://www.forbes.com/sites/jacquelynsmith/2012/12/06/the-top-jobs-for-2013/>

<sup>53</sup> <http://www.acm.org/education/curricula-recommendations>

<sup>54</sup> From October 2008 ITAA Press Release, <http://www.adroit-technology.com/documents/ITAAReleasesITCompetencyModel.pdf>

During the summer of 2012, DOL updated the IT Competency Model, by engaging a panel of Subject Matter Experts in a series of email exchanges and telephone conferences. MPICT's Executive Director, James Jones, was a part of that effort, on behalf of MPICT and the California Community College ICT Collaborative. Also represented were the BATEC,<sup>55</sup> ICT Center,<sup>56</sup> and CTC NSF ATE Centers of Excellence.<sup>57</sup> The team did its best to provide current input into model content.

That model was re-released in the Fall of 2012 and posted on the career-one-stop site<sup>58</sup>, along with similar models for other industries, related links, tutorials, general instructions, worksheets and instructions for linking with O\*Net occupations.

“The Employment and Training Administration (ETA) has worked with the Office of Disability Employment Policy (ODEP) and technical and subject matter experts from education, business, and industry to update a comprehensive competency model for the Information Technology (IT) industry. While the model identifies the knowledge, skills, and abilities needed for workers to perform successfully in the field of IT, it is not intended that IT workers possess all of the competencies listed. The model is rather a compilation of competencies that can be included as a basis for preparation in an IT occupation.”<sup>59</sup>

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<sup>55</sup> <http://batec.org/>

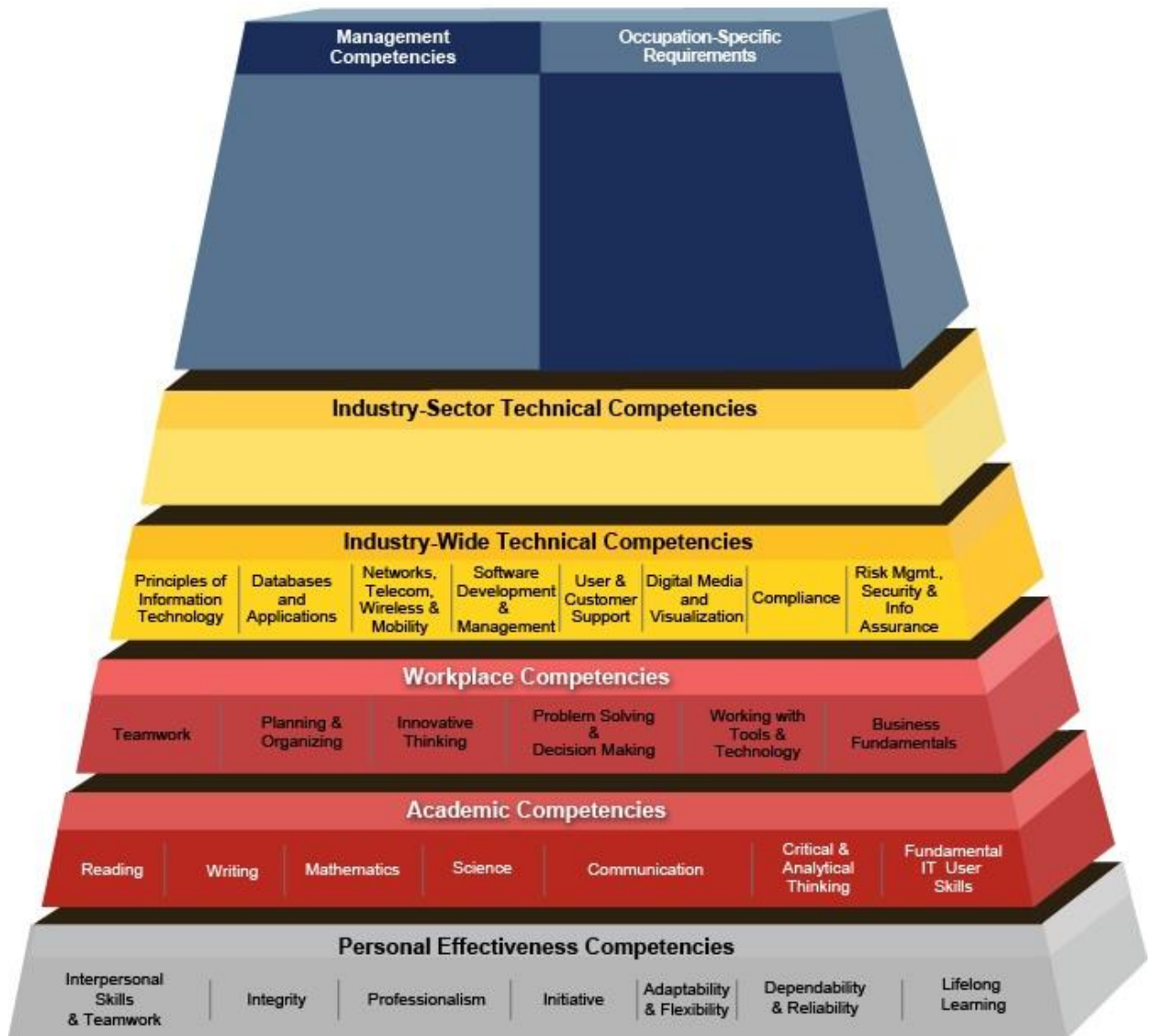
<sup>56</sup> <http://www.ictcenter.org/>

<sup>57</sup> <http://www.connectedtech.org/>

<sup>58</sup> <http://www.careeronestop.org/competencymodel/pyramid.aspx?it=Y>

<sup>59</sup> <http://www.careeronestop.org/competencymodel/pyramid.aspx?it=Y>

**DOL IT Competency Model Described and Explained**



From the “About the Model” Description in the DOL IT Competency Model in Appendix F:

“The IT Competency Model identifies the knowledge, skills, and abilities needed for workers to perform successfully in the field of information technology (IT).

The model is depicted as a pyramid consisting of several tiers. The arrangement of the tiers in this shape is not meant to be hierarchical, or to imply that competencies at the top are at a higher level of skill. Instead, the model’s tapered shape represents the increasing specialization and specificity of proficiencies covered. Its tiers are further divided into blocks that represent competency areas (i.e., groups of knowledge, skills, and abilities), which are defined using critical work functions and technical content areas.”

**Foundational Competencies**

Tiers 1 through 3 represent the “soft-skills” and work readiness skills that most employers demand. Each tier covers a different group of competencies:

**Tier 1 – Personal Effectiveness Competencies** are personal attributes essential for all life roles. Often referred to as "soft skills," personal effectiveness competencies are generally learned in the home or community and honed at school and in the workplace.

**Tier 2 – Academic Competencies** are primarily learned in a school setting. They include cognitive functions and thinking styles. Academic competencies are likely to apply to all industries and occupations.

**Tier 3 – Workplace Competencies** represent motives and traits, as well as interpersonal and self-management styles. They are generally applicable to a large number of occupations and industries.

### Industry-specific Competencies

Tiers 4 and 5 show the industry-wide technical competencies needed to create career lattices within an industry. These competencies are considered cross-cutting, as they allow a worker to move easily across industry sub-sectors. Rather than narrowly following a single occupational career ladder, this model supports the development of an agile workforce. Like the foundational tiers, Tiers 4 and 5 deal with distinct types of competencies:

**Tier 4 – Industry-Wide Technical Competencies** cover the knowledge and skills and abilities from which workers across the industry can benefit, regardless of the sector in which they operate. Because of this, many of the critical work functions on this tier deal with awareness or understanding.

**Tier 5 – Industry-Sector Technical Competencies** represent a sub-set of industry technical competencies that are specific to an industry sector. As a result, the critical work functions deal more with performing tasks than those on Tier 4. The Employment and Training Administration's IT model does not include Tier 5 competencies.

### Upper Tiers

The upper tiers represent the specialization that occurs within specific occupations within an industry. Included in this category are occupation-specific requirements and management competencies. The Employment and Training Administration's IT model does not include upper tier competencies. Information on occupational competencies is available through O\*NET OnLine (<http://online.onetcenter.org/>).<sup>60</sup>

Layers 1 through 3 are foundational workplace ready skills for all workers, and they have been generally validated by DOL work across other industries. The exception is the far right section of Layer 2 Academic Competencies: Fundamental IT User Skills. This is an academic expectation for all workers, but it received special attention in the IT Competency model review in summer of 2012, and it was called out for validation by California employer representatives as part of this study.

The other Layer 1 through 3 workplace ready competencies were not validated with California employers, as part of this study, because they have already been validated with other DOL efforts. That does not mean this study group does not believe they are important. It cannot be overemphasized that employers of ICT Workforce seriously do expect, want and require the competencies in Layers 1 through 3 of this model. It is a very rare conversation with an IT employer about ICT Workforce needs in which "soft skills" or "workplace skills" are not a top priority.

Unlike most other industries, I(C)T employment is not limited to I(C)T industries, so the standard title and description for Layer 4 of this model is misleading. Layer 4 seeks to identify the general or foundational competency expectations for everyone in an I(C)T Workforce role, everyone working in an IT operation. What does the networking specialist need to know about software and security, and vice versa? Layer 4 competencies were the other focus of this study.

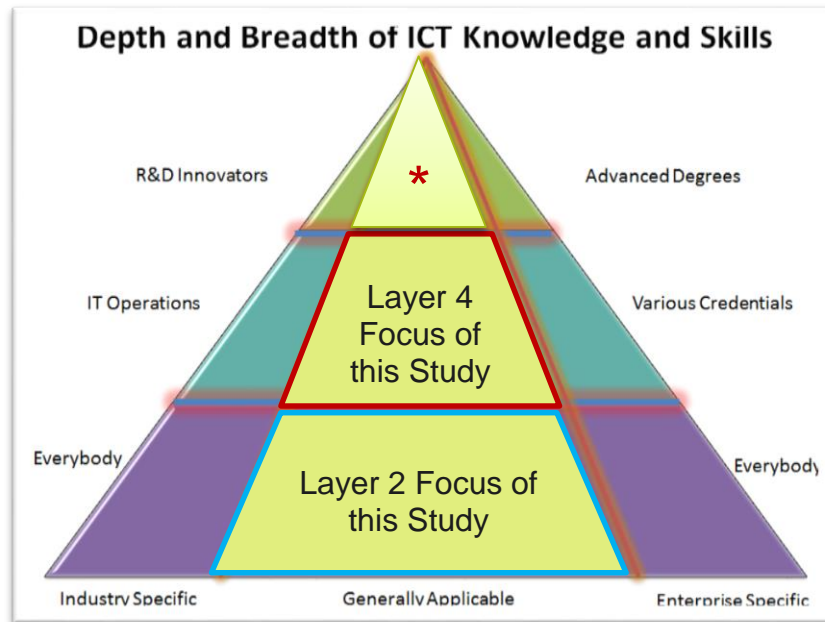
So, the idea is that everyone hoping to join and be successful in the ICT Workforce, or get a job in an IT operation, will need to acquire the competencies in Layers 1 through 4 of this model. In addition, he or she would be expected to develop certain specialized competencies in order to be able to add value to the operation in a specialized role. Those competencies are not specified in this model. DOL aspires to detail

<sup>60</sup> DOL IT Competency Model, pages 1-2



those specializations via occupational descriptions in the O\*Net system. However, those occupations are not sufficiently detailed or up to date, and they are not typically used in the field. Additional work is needed at higher level occupational specialization levels of the model or O\*Net system.

**Figure: Comprehensive ICT Pyramid**



The Layer 2 Academic focus of this study is the basic User level competencies needed by everyone in the 21<sup>st</sup> century.

The Layer 4 I(C)T foundational competencies are generally needed by everyone who works in in I(C)T specialized workforce role, who also need the Layer 1 through 3 workforce ready competencies. That also includes those who generally go through university pathways of science, math and engineering to become ICT technology and business creators and innovators. In addition to Layer 1 through 4 competencies, to be successful, one would also need to acquire additional specialization competencies, developed via industry certifications, degree majors, academic certificates and experience.

To create credibility and incite adoption of this framework by employers and educators in California, MPICT, the CCC ICT Collaborative and CCC Centers of Excellence developed this study effort to engage California employers with Layer 2 “Digital Literacy” and Layer 4 foundational IT workforce competencies in the model content in a statistically significant way.

### Primary Research

MPICT, the Centers of Excellence, and Davis Research conducted a web survey of 782 California employer representatives who have knowledge of the ICT workforce, in order to validate the competencies in parts of the U.S. Department of Labor’s Information Technology (IT) Competency model. The data collection employed a stratified sampling plan to ensure a diverse and representative universe of respondents from different sized employers as well as employers from a broad array of industries that represent the California economy. The responses of the employers were obtained using two recruitment strategies – phone recruitment and online campaign through the webpage that was established for the study. The data collection took place from December 12, 2012 through February 13, 2013.

Of the 782 firm representatives surveyed:

- 37% reported they provide goods and services directly tied to ICT, and 63% do not.
- 46% are from Southern California, 30% from the Bay Area and 24% from other areas in California.
- 37% have 4 or fewer employees, 26% have 5-24 employees, 17% have 25-99 employees, and 19% have 100+ employees.
- Subgroupings of responses were also created for: high technology companies (26%), medium technology companies (27%), low technology companies (24%), healthcare organizations (10%), and government and education organizations (9%).

The sample is large enough to be statistically significant and it is diverse enough to represent ICT and non-ICT companies, the geographic diversity of California, single and multi-location companies and various company sizes. For questions answered by all firms, a 99% level of confidence was achieved, with a maximum margin of error of +/-5.0%.

**Figure: Survey Response Demographics**

		# of Responses	% of Total
<b>Region</b>	Southern California	361	46%
	Bay Area	231	30%
	Other	190	24%
<b>Company Size</b>	0 to 4 employees	292	37%
	5 to 24 employees	202	26%
	25 to 99 employees	136	17%
	100 or more employees	152	19%
<b>Industry Group</b>	High Technology	201	26%
	Medium Technology	213	27%
	Low Technology	186	24%
	Healthcare	80	10%
	Government	74	9%
	Non-classified	28	4%
<b>ICT Company or Not</b>	ICT Company	286	37%
	Non-ICT Company	496	63%
<b>TOTAL</b>		<b>782</b>	<b>100%</b>

Because we could not have a respondent complete a survey and answer questions for all nine sections of competencies being tested (survey would be almost 2 hours long), the research team decided to split the competencies into either three groups:

- Group 1 included Fundamental IT User Skills (Layer 2 of the DOL Competency Model), Principles of IT (Layer 4), and User and Customer Support (Layer 4). **272 firms** evaluated competencies in these sections.
- Group 2 included Databases and Information Systems (Layer 4), Software Development and Management (Layer 4), Digital Media and Visualization (Layer 4), and Compliance (Layer 4). **254 firms** evaluated these sections of competencies.
- Group 3 included Networks, Telecom, Wireless and Mobility (Layer 4) and Risk Management, Security and Information Assurance (Layer 4). **256 firms** evaluated these sections of competencies.

For competency related questions, the level of confidence ranges from 89% to 90%, with a margin of error is no more than +/-5.0%. For more information regarding the study methodology, refer to Appendix E.



## Study Results

### Questions to All Survey Respondents

After interacting with detailed competencies and being exposed to the purpose and structure of the U.S. DOL IT Competency Model, every survey participant was asked to indicate their level of agreement or disagreement with six general statements. We received 782 responses to these statements. That reaches a 99% confidence level for opinions of representatives of California employers with direct knowledge of their organization’s ICT workforce needs.

	Agree or Very Much Agree (Top 2)	Neutral (neither agree nor disagree)	Somewhat or Very Much Disagree (Bottom 2)
1. California’s ICT Workforce labor market would work better if there was a detailed, agreed-upon and structured framework for employer ICT Workforce competency demand, which educators and trainers used to prepare ICT Workforce in consistent ways, and employers used to communicate ICT Workforce and ICT job needs.	74.7%	20.2%	5.1%
2. Our organization would appreciate and be much more willing to entertain hiring students with ICT related credentials from California Community Colleges for ICT Workforce roles if there was a consistent, system-wide, validated foundation of knowledge and skills for ICT education and workforce development programs that addressed both technical and non-technical competency expectations.	70.5%	24.4%	5.1%
3. If there was a detailed, agreed-upon and structured framework for ICT Workforce competencies, our organization would be willing to reference them in future job announcements for ICT Workers, so applicants could better understand our requirements and match them to their own education and experience, and so we could better map applicant education and experience to our own needs.	68.2%	25.8%	6.0%
4. Information and communication technologies (ICT) competencies are increasingly important for most of our employers, regardless of role. If there was an agreed-upon standard for "digital literacy", or ICT competencies expected of all workers, regardless of workplace role, my organization would value a credential based on that standard as a way of validating ICT skills for non-ICT workers.	70.5%	20.6%	9.0%
5. In the 21st century, an ability to work with information and communication technologies is becoming as essential to education, life and workplace success as "reading, writing and arithmetic". ICT Digital Literacy should be considered a basic skill by educational systems, something taught to and assessed for all students.	85.2%	9.2%	5.6%
6. Non-technical (soft, workplace or employability) skills are at least as important as technical skills in what we look for in our ICT Workforce.	76.3%	15.3%	8.3%

1. We can say with a 99% level of confidence, that **74.7%** of California employer representatives with direct knowledge of their ICT workforce needs, **very much agree or agree** with the statement:

*California’s ICT Workforce labor market would work better if there was a detailed, agreed-upon and structured framework for employer ICT Workforce competency demand, which educators and trainers used to prepare ICT Workforce in consistent ways, and employers used to communicate ICT Workforce and ICT job needs.*

20.2% of respondents neither agree nor disagree and only 5.1% somewhat or very much disagree.

	Total	Region			Number of Employees				Industry Group					
		Southern California	Bay Area	Other	0 to 4	5 to 24	25 to 99	100+	High Tech	Med. Tech	Low Tech	Healthcare	Government & Education	Other Nonclassifiable
Total Respondents	782	361	231	190	292	202	136	152	201	213	186	80	74	28
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
<b>Top 2 (Net)</b>	74.7%	74.0%	76.2%	74.2%	72.9%	76.7%	70.6%	78.9%	73.1%	79.8%	73.1%	63.8%	82.4%	67.9%
Very much agree	25.2%	26.0%	25.1%	23.7%	25.3%	27.2%	23.5%	23.7%	21.4%	29.1%	25.8%	26.3%	23.0%	21.4%
Agree	49.5%	47.9%	51.1%	50.5%	47.6%	49.5%	47.1%	55.3%	51.7%	50.7%	47.3%	37.5%	59.5%	46.4%
<b>Neutral (neither agree nor disagree)</b>	20.2%	20.5%	19.5%	20.5%	22.3%	19.3%	21.3%	16.4%	20.9%	14.6%	22.6%	28.8%	17.6%	25.0%
Somewhat disagree	3.3%	3.3%	2.2%	4.7%	3.1%	2.5%	5.1%	3.3%	3.5%	3.3%	3.2%	6.3%	0.0%	3.6%
Very much disagree	1.8%	2.2%	2.2%	0.5%	1.7%	1.5%	2.9%	1.3%	2.5%	2.3%	1.1%	1.3%	0.0%	3.6%
<b>Bottom 2 (Net)</b>	5.1%	5.5%	4.3%	5.3%	4.8%	4.0%	8.1%	4.6%	6.0%	5.6%	4.3%	7.5%	0.0%	7.1%
Mean	3.9	3.9	3.9	3.9	3.9	4.0	3.8	4.0	3.9	4.0	3.9	3.8	4.1	3.8

This is very strong support from California employers for a common and widely adopted framework for ICT Workforce competencies which we could all align to and use to create a functional ICT workforce system. Only 1.8% very much disagreed with this statement. We need something like this in California, and we need to use it consistently on the employer side and on the workforce development side.

- We can say with a 99% level of confidence, that **70.5%** of California employer representatives with direct knowledge of their ICT workforce needs, **very much agree or agree** with the statement:

*Our organization would appreciate and be much more willing to entertain hiring students with ICT related credentials from California Community Colleges for ICT Workforce roles if there was a consistent, system-wide, validated foundation of knowledge and skills for ICT education and workforce development programs that addressed both technical and non-technical competency expectations.*

24.4% of respondents neither agree nor disagree and only 5.1% somewhat or very much disagree.

	Total	Region			Number of Employees				Industry Group					
		Southern California	Bay Area	Other	0 to 4	5 to 24	25 to 99	100+	High Tech	Med. Tech	Low Tech	Healthcare	Government & Education	Other Nonclassifiable
Total Respondents	782	361	231	190	292	202	136	152	201	213	186	80	74	28
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
<b>Top 2 (Net)</b>	70.5%	69.0%	72.7%	70.5%	70.9%	73.8%	64.0%	71.1%	72.1%	64.3%	73.7%	66.3%	79.7%	71.4%
Very much agree	25.4%	25.8%	25.1%	25.3%	27.4%	30.2%	20.6%	19.7%	29.4%	22.1%	25.3%	26.3%	23.0%	28.6%
Agree	45.0%	43.2%	47.6%	45.3%	43.5%	43.6%	43.4%	51.3%	42.8%	42.3%	48.4%	40.0%	56.8%	42.9%
<b>Neutral (neither agree nor disagree)</b>	24.4%	24.7%	22.5%	26.3%	22.3%	23.8%	30.9%	23.7%	21.4%	31.9%	21.5%	28.8%	14.9%	21.4%
Somewhat disagree	3.3%	4.4%	2.6%	2.1%	4.8%	1.5%	2.9%	3.3%	4.0%	1.4%	3.2%	3.8%	5.4%	7.1%
Very much disagree	1.8%	1.9%	2.2%	1.1%	2.1%	1.0%	2.2%	2.0%	2.5%	2.3%	1.6%	1.3%	0.0%	0.0%
<b>Bottom 2 (Net)</b>	5.1%	6.4%	4.8%	3.2%	6.8%	2.5%	5.1%	5.3%	6.5%	3.8%	4.8%	5.0%	5.4%	7.1%
Mean	3.9	3.9	3.9	3.9	3.9	4.0	3.8	3.8	3.9	3.8	3.9	3.9	4.0	3.9

California employers say community college ICT workforce preparation efforts will be much more effective in getting students in front of employers for jobs if CCCs adopt, line up on and use a common, systematic and validated common core for ICT related programs that includes both technical and non-technical skills.

- We can say with a 99% level of confidence, that **68.2%** of California employer representatives with direct knowledge of their ICT workforce needs, **very much agree or agree** with the statement:

*If there was a detailed, agreed-upon and structured framework for ICT Workforce competencies, our organization would be willing to reference them in future job announcements for ICT Workers, so applicants could better understand our requirements and match them to their own education and experience, and so we could better map applicant education and experience to our own needs.*

25.8% of respondents neither agree nor disagree and only 6% somewhat or very much disagree.

	Total	Region			Number of Employees				Industry Group					
		Southern California	Bay Area	Other	0 to 4	5 to 24	25 to 99	100+	High Tech	Med. Tech	Low Tech	Healthcare	Government & Education	Other Nonclassifiable
Total Respondents	782	361	231	190	292	202	136	152	201	213	186	80	74	28
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
<b>Top 2 (Net)</b>	68.2%	67.0%	69.3%	68.9%	70.9%	69.3%	60.3%	68.4%	69.7%	67.6%	68.3%	66.3%	67.6%	67.9%
Very much agree	20.3%	19.9%	22.1%	18.9%	20.5%	22.3%	19.9%	17.8%	17.9%	19.2%	23.1%	18.8%	21.6%	28.6%
Agree	47.8%	47.1%	47.2%	50.0%	50.3%	47.0%	40.4%	50.7%	51.7%	48.4%	45.2%	47.5%	45.9%	39.3%
<b>Neutral (neither agree nor disagree)</b>	25.8%	26.6%	24.2%	26.3%	23.3%	23.8%	32.4%	27.6%	22.4%	25.8%	26.9%	31.3%	27.0%	25.0%
Somewhat disagree	3.7%	4.2%	3.9%	2.6%	3.4%	4.5%	5.1%	2.0%	4.5%	3.8%	3.2%	1.3%	4.1%	7.1%
Very much disagree	2.3%	2.2%	2.6%	2.1%	2.4%	2.5%	2.2%	2.0%	3.5%	2.8%	1.6%	1.3%	1.4%	0.0%
<b>Bottom 2 (Net)</b>	6.0%	6.4%	6.5%	4.7%	5.8%	6.9%	7.4%	3.9%	8.0%	6.6%	4.8%	2.5%	5.4%	7.1%
Mean	3.8	3.8	3.8	3.8	3.8	3.8	3.7	3.8	3.8	3.8	3.8	3.8	3.8	3.9

More than two-thirds of California ICT employer representatives say they would line up on a framework of competencies like this for job postings and expressing ICT workforce demand. The majority of employers say they are willing to take this important step, so applicants can better understand employer requirements and match them to their education and experience.

4. We can say with a 99% level of confidence, that **70.5%** of California employer representatives with direct knowledge of their ICT workforce needs, **very much agree or agree** with the statement:

*Information and communication technologies (ICT) competencies are increasingly important for most of our employers, regardless of role. If there was an agreed-upon standard for "digital literacy", or ICT competencies expected of all workers, regardless of workplace role, my organization would value a credential based on that standard as a way of validating ICT skills for non-ICT workers.*

23.9% of respondents neither agree nor disagree and only 9% somewhat or very much disagree.

	Total	Region			Number of Employees				Industry Group					
		Southern California	Bay Area	Other	0 to 4	5 to 24	25 to 99	100+	High Tech	Med. Tech	Low Tech	Healthcare	Government & Education	Other Nonclassifiable
Total Respondents	782	361	231	190	292	202	136	152	201	213	186	80	74	28
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
<b>Top 2 (Net)</b>	70.5%	70.1%	71.0%	70.5%	71.6%	71.3%	69.1%	68.4%	72.6%	70.9%	69.4%	72.5%	64.9%	67.9%
Very much agree	23.9%	22.4%	24.2%	26.3%	22.6%	26.7%	22.1%	24.3%	22.4%	23.0%	25.8%	22.5%	24.3%	32.1%
Agree	46.5%	47.6%	46.8%	44.2%	49.0%	44.6%	47.1%	44.1%	50.2%	47.9%	43.5%	50.0%	40.5%	35.7%
<b>Neutral (neither agree nor disagree)</b>	20.6%	20.2%	20.3%	21.6%	19.2%	20.3%	22.8%	21.7%	14.9%	22.1%	22.6%	16.3%	31.1%	21.4%
Somewhat disagree	6.6%	6.4%	6.9%	6.8%	6.5%	6.4%	5.9%	7.9%	8.0%	5.2%	5.9%	10.0%	4.1%	10.7%
Very much disagree	2.3%	3.3%	1.7%	1.1%	2.7%	2.0%	2.2%	2.0%	4.5%	1.9%	2.2%	1.3%	0.0%	0.0%
<b>Bottom 2 (Net)</b>	9.0%	9.7%	8.7%	7.9%	9.2%	8.4%	8.1%	9.9%	12.4%	7.0%	8.1%	11.3%	4.1%	10.7%
Mean	3.8	3.8	3.8	3.9	3.8	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.9	3.9

California employers recognize the importance of ICT User competencies across their workforce, outside of IT roles, and they would value a credential validating known Digital Literacy skills.

5. We can say with a 99% level of confidence, that **85.2%** of California employer representatives with direct knowledge of their ICT workforce needs, **very much agree or agree** with the statement:

*In the 21st century, an ability to work with information and communication technologies is becoming as essential to education, life and workplace success as "reading, writing and arithmetic". ICT Digital Literacy should be considered a basic skill by educational systems, something taught to and assessed for all students.*

9.2% of respondents neither agree nor disagree and only 5.6% somewhat or very much disagree.

	Total	Region			Number of Employees				Industry Group					
		Southern California	Bay Area	Other	0 to 4	5 to 24	25 to 99	100+	High Tech	Med. Tech	Low Tech	Healthcare	Government & Education	Other Nonclassifiable
Total Respondents	782	361	231	190	292	202	136	152	201	213	186	80	74	28
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
<b>Top 2 (Net)</b>	85.2%	83.9%	<b>86.6%</b>	85.8%	84.6%	86.1%	83.1%	<b>86.8%</b>	79.1%	88.7%	87.6%	82.5%	<b>90.5%</b>	78.6%
Very much agree	49.9%	45.7%	52.8%	54.2%	49.7%	48.5%	46.3%	55.3%	45.8%	53.1%	49.5%	45.0%	55.4%	57.1%
Agree	35.3%	38.2%	33.8%	31.6%	34.9%	37.6%	36.8%	31.6%	33.3%	35.7%	38.2%	37.5%	35.1%	21.4%
<b>Neutral (neither agree nor disagree)</b>	9.2%	<b>10.2%</b>	7.4%	9.5%	9.6%	8.9%	<b>10.3%</b>	7.9%	<b>13.4%</b>	5.6%	8.6%	10.0%	8.1%	10.7%
Somewhat disagree	3.8%	3.9%	4.8%	2.6%	4.1%	3.5%	3.7%	3.9%	5.0%	2.8%	3.2%	5.0%	1.4%	10.7%
Very much disagree	1.8%	1.9%	1.3%	2.1%	1.7%	1.5%	2.9%	1.3%	2.5%	2.8%	0.5%	2.5%	0.0%	0.0%
<b>Bottom 2 (Net)</b>	5.6%	5.8%	<b>6.1%</b>	4.7%	5.8%	5.0%	<b>6.6%</b>	5.3%	<b>7.5%</b>	5.6%	3.8%	<b>7.5%</b>	1.4%	10.7%
Mean	4.3	4.2	4.3	4.3	4.3	4.3	4.2	4.4	4.1	4.3	4.3	4.2	4.4	4.3

This is the strongest agreement with any of the six statements in this survey. Digital Literacy is now as important to success as reading, writing and arithmetic. This is a new basic skill set, which every member of our society now needs, and every person who emerges from our public educational system should have. Meeting this need has profound implications for our society and economic prosperity in the 21st century.

- We can say with a 99% level of confidence, that 76.3% of California employer representatives with direct knowledge of their ICT workforce needs, **very much agree or agree** with the statement:

*Non-technical (soft, workplace or employability) skills are at least as important as technical skills in what we look for in our ICT Workforce.*

15.3% of respondents neither agree nor disagree and only 8.3% somewhat or very much disagree.

	Total	Region			Number of Employees				Industry Group					
		Southern California	Bay Area	Other	0 to 4	5 to 24	25 to 99	100+	High Tech	Med. Tech	Low Tech	Healthcare	Government & Education	Other Nonclassifiable
Total Respondents	782	361	231	190	292	202	136	152	201	213	186	80	74	28
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
<b>Top 2 (Net)</b>	76.3%	73.4%	<b>81.4%</b>	75.8%	77.1%	72.3%	70.6%	<b>85.5%</b>	73.6%	73.7%	78.0%	76.3%	<b>82.4%</b>	89.3%
Very much agree	33.5%	30.5%	39.8%	31.6%	32.2%	34.2%	32.4%	36.2%	35.3%	31.0%	37.1%	30.0%	28.4%	39.3%
Agree	42.8%	42.9%	41.6%	44.2%	44.9%	38.1%	38.2%	49.3%	38.3%	42.7%	40.9%	46.3%	54.1%	50.0%
<b>Neutral (neither agree nor disagree)</b>	15.3%	16.9%	11.3%	<b>17.4%</b>	14.7%	16.8%	<b>19.1%</b>	11.2%	<b>17.9%</b>	16.9%	13.4%	16.3%	12.2%	3.6%
Somewhat disagree	6.4%	7.8%	5.2%	5.3%	6.8%	7.9%	7.4%	2.6%	7.5%	6.6%	6.5%	5.0%	4.1%	7.1%
Very much disagree	1.9%	1.9%	2.2%	1.6%	1.4%	3.0%	2.9%	0.7%	1.0%	2.8%	2.2%	2.5%	1.4%	0.0%
<b>Bottom 2 (Net)</b>	8.3%	<b>9.7%</b>	7.4%	6.8%	8.2%	<b>10.9%</b>	10.3%	3.3%	8.5%	<b>9.4%</b>	8.6%	7.5%	5.4%	7.1%
Mean	4.0	3.9	4.1	4.0	4.0	3.9	3.9	4.2	4.0	3.9	4.0	4.0	4.0	4.2

More than three-quarters of California ICT Workforce employers are telling us that the Layer 1-3 workplace ready competencies detailed in this model are at least as important as the Layer 4 technical skills. They mean it. It will not work to just teach technical classes in isolation. The California Community College's workforce development response to this need has to include development of personal effectiveness, academic and workplace skills also.

## DOL Framework

### Fundamental IT Skills (Digital Literacy)

The survey focused a third of respondents on a group of competencies that included the Layer 2 Workplace Ready Academic Competency expectations for Fundamental IT Skills, or Digital Literacy. There were 277 California employer representatives with direct knowledge of ICT Workforce needs who responded, which provides a 90% confidence level.

### Layer 2 – Academic Competencies – Fundamental IT User Skills or “Digital Literacy”

#### Area 1: General Computer, Software, Information and Communication Technology Knowledge and Skills

- For 7 of the 9 competencies in this area, 92% or higher of responding employers agreed that the competency should be kept.
- Across all 9 competencies in this area an average of 92% of employers approved of the competencies, with the maximum agreement being 96% and the minimum being 81.5%, for any one competency.

#### Area 2: Digital Media Literacy

- For 2 of the 4 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 4 competencies in this area an average of 84% of employers approved of the competencies, with the maximum agreement being 91% and the minimum being 76%, for any one competency.

#### Area 3: Common IT Applications

- For 10 of the 12 competencies in this area, 90% or higher of responding employers agreed that the competency should be kept.
- Across all 5 competencies in this area an average of 91% of employers approved of the competencies, with the maximum agreement being 97% and the minimum being 74%, for any one competency.

#### Area 4: Cyber Safety

- For all 9 of the 10 competencies in this area, 92% or higher of responding employers agreed that the competency should be kept.
- Across all 10 competencies in this area an average of 94% of employers approved of the competencies, with the maximum agreement being 98% and the minimum being 89%, for any one competency.

#### Area 5: Information and Research Literacy

- For all 7 competencies in this area, 90% or higher of responding employers agreed that the competency should be kept.
- Across all 7 competencies in this area an average of 94% of employers approved of the competencies, with the maximum agreement being 98% and the minimum being 90%, for any one competency.

#### Area 6: Hardware

- For 6 of the 7 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 7 competencies in this area an average of 89% of employers approved of the competencies, with the maximum agreement being 92% and the minimum being 84%, for any one competency.

## Layer 4 IT Workforce Foundational Technical Competencies

California employers have resoundingly approved Layer 4 of the federal Department of Labor IT Competency Model through a rigorous survey method and research process. Employers from across all regions, industry sectors and business sizes in California have validated this IT competency model.

### Layer 4 - Principles of Information Technology

#### Area 1: Fundamental IT Concepts

- For 16 of the 20 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 20 competencies in this area an average of 90% of employers approved of the competencies, with the maximum agreement being 96% and the minimum being 79.5%, for any one competency.

#### Area 2: The Role of IT in Business

- For 14 of the 17 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 17 competencies in this area an average of 90% of employers approved of the competencies, with the maximum agreement being 96% and the minimum being 81%, for any one competency.

### Layer 4 - Compliance

- For 10 of the 11 competencies in this area, 88% or higher of responding employers agreed that the competency should be kept.
- Across all 11 competencies in this area an average of 92% of employers approved of the competencies, with the maximum agreement being 97% and the minimum being 79%, for any one competency.

### Layer 4 - Databases and Applications

- For 15 of the 18 competencies in this area, 89% or higher of responding employers agreed that the competency should be kept.
- Across all 18 competencies in this area an average of 92% of employers approved of the competencies, with the maximum agreement being 98% and the minimum being 89.5%, for any one competency.

### Layer 4 - Digital Media and Visualization

- For all 13 of the competencies in this section, 87% or higher of responding employers agreed that the competency should be kept.
- Across all 13 competencies in this area an average of 90.5% of employers approved of the competencies, with the maximum agreement being 94.5% and the minimum being 87%, for any one competency.

### Layer 4 - Networks, Telecom, Wireless and Mobility

#### Area 1: Fundamentals of Networking and Telecommunication

- For 15 of the 17 competencies in this area, 87% or higher of responding employers agreed that the competency should be kept.
- Across all 17 competencies in this area an average of 91% of employers approved of the competencies, with the maximum agreement being 96.5% and the minimum being 82%, for any one competency.

Area 2: Wireless and Mobility

- For 6 of the 8 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 8 competencies in this area an average of 89% of employers approved of the competencies, with the maximum agreement being 98.5% and the minimum being 76%, for any one competency.

Area 3: Network Security

- For 4 of the 5 competencies in this area, 95% or higher of responding employers agreed that the competency should be kept.
- Across all 5 competencies in this area an average of 95% of employers approved of the competencies, with the maximum agreement being 97% and the minimum being 88.5%, for any one competency.

Area 4: Virtualization and Cloud Computing

- For all 7 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 7 competencies in this area an average of 89% of employers approved of the competencies, with the maximum agreement being 91.5% and the minimum being 86%, for any one competency.

Area 5: Data Storage Systems

- For all 5 competencies in this area, 90% or higher of responding employers agreed that the competency should be kept.
- Across all 7 competencies in this area an average of 93% of employers approved of the competencies, with the maximum agreement being 96% and the minimum being 90%, for any one competency.

**Layer 4 - Risk Management, Security, and Information Assurance**Area 1: Risk Management

- For 5 of the 6 competencies in this area, 90% or higher of responding employers agreed that the competency should be kept.
- Across all 6 competencies in this area an average of 91% of employers approved of the competencies, with the maximum agreement being 95% and the minimum being 84%, for any one competency.

Area 2: Security and Information Assurance Fundamentals

- For 8 of the 11 competencies in this area, 91% or higher of responding employers agreed that the competency should be kept.
- Across all 11 competencies in this area an average of 92% of employers approved of the competencies, with the maximum agreement being 97% and the minimum being 86%, for any one competency.

Area 3: Security Operations

- For 13 of the 14 competencies in this area, 91% or higher of responding employers agreed that the competency should be kept.
- Across all 14 competencies in this area an average of 93.5% of employers approved of the competencies, with the maximum agreement being 98% and the minimum being 80.5%, for any one competency.

Area 4: Business Resiliency

- For 6 of the 7 competencies in this area, 87% or higher of responding employers agreed that the competency should be kept.

- Across all 7 competencies in this area an average of 92% of employers approved of the competencies, with the maximum agreement being 96% and the minimum being 84%, for any one competency.

#### Area 5: Incident Management

- For 5 of the 6 competencies in this area, 87% or higher of responding employers agreed that the competency should be kept.
- Across all 6 competencies in this area an average of 85% of employers approved of the competencies, with the maximum agreement being 89% and the minimum being 72%, for any one competency.

#### Area 6: Secure Information System Development

- For 4 of the 5 competencies in this area, 85% or higher of responding employers agreed that the competency should be kept.
- Across all 5 competencies in this area an average of 86% of employers approved of the competencies, with the maximum agreement being 90% and the minimum being 80%, for any one competency.

### **Layer 4 - Software Development and Management**

#### Area 1: Software Development

- For 8 of the 10 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 10 competencies in this area an average of 87% of employers approved of the competencies, with the maximum agreement being 93% and the minimum being 75%, for any one competency.

#### Area 2: Programming

- For 11 of the 14 competencies in this area, 87% or higher of responding employers agreed that the competency should be kept.
- Across all 14 competencies in this area an average of 89% of employers approved of the competencies, with the maximum agreement being 96% and the minimum being 78%, for any one competency.

#### Area 3: Software Acquisition, Management and Maintenance

- For 13 of the 15 competencies in this area, 86% or higher of responding employers agreed that the competency should be kept.
- Across all 15 competencies in this area an average of 90% of employers approved of the competencies, with the maximum agreement being 97% and the minimum being 61%, for any one competency.

### **Layer 4 - User and Customer Support**

- For 12 of the 16 competencies in this section, 90% or higher of responding employers agreed that the competency should be kept.
- Across all 16 competencies in this area an average of 93% of employers approved of the competencies, with the maximum agreement being 98% and the minimum being 78%, for any one competency.

### **Survey Results Conclusion**

California employers have resoundingly approved Layer 4 of the federal Department of Labor IT Competency Model through a rigorous survey method and research process. Employers from across all regions, industry sectors and business sizes in California have validated this IT competency model.



## Ideas and Recommendations for Action

This study and the resulting set of employer validated ICT workforce foundational competency expectations for 2 years in the future are the most comprehensive, detailed, statistically significant and actionable tool for aligning ICT related education and workforce develop efforts with employer job and career opportunities developed so far in California. Use of study results as a tool could have significant positive impacts on the ICT employment market, on ICT educational program alignment, transfer and articulation, on how employers describe ICT related job opportunities and requirements, on efficiencies with ICT curriculum development, on alignment between K-12, community colleges and 4-year colleges and university ICT related programs, and on efforts to create digitally literate students, workers and citizens in California.

### **Recommendation to at least adopt the DOL IT Competencies as is:**

The methodology of this study may have limitations, but it is the most comprehensive, current work on which to base an understanding of California ICT foundational competencies employers require of their workforce. We welcome any additional work to further clarify ICT workforce competencies.

It is possible to disagree with some or many of the competencies in this model, and it is very likely that many employers will not require all of them. However, for a statistically significant expression of ICT workforce demand across all employers in all segments across the geographic and company size diversity of the state, this is the most comprehensive and detailed expression of ICT Workforce demand to date. This competency list can be used to detail what employers do and do not need in their workforce, or for a specific job or as a method of communicating clearly between educators/workforce development efforts and industry/employers in advisory settings. The lowest approval rating for any single technical competency in this model is 61%. The highest is 98.5%.

Based on the findings in this study, California should adopt the U.S. DOL IT Competency model as its ICT workforce development framework and content, as is. That is how a workforce system is supposed to work, with employers describing for colleges and educators what competencies they require or need for their skilled workforce and educators, colleges and other workforce development agencies figuring out how to deliver that.

Community college ICT educators have an opportunity to respond to this input from employers by aligning their ICT courses, certificates and programs to the competencies that employers have endorsed. ICT educators can even go a step further and create student learning outcomes (SLOs) based on them. Educators should have a high level of confidence in the findings because of the rigorous research methodology the study employed. Once students complete community college educational programs based on these competencies, employers are more likely to hire graduates because they have the skills and competencies employers have indicated they need.

Finally, if employers create job descriptions that include the same skills and competencies from this model, then it again reinforces the point with educators and students that what has been taught in educational programs is very closely aligned with employers' desired qualifications for ICT positions. Over time this has the potential to better align supply and demand in the labor market.

### **Or, California Could Adopt Even Higher Standards Than the Nation:**

In addition to collecting accept or reject opinions from knowledgeable ICT employer representatives, this survey also collected over 141 suggested changes to them. In some cases, wording of the original competencies could have been more clear, or a rephrasing would address additional suggestions or concerns that came out in the comments, without changing the underlying meaning that the majority of respondents agreed to.

In addition, this survey also collected 123 write-in suggestions for additions to the technical competencies in this model. Many of these are very good suggestions, such as including basic electricity safety in Digital Literacy.

Appendix H includes a very preliminary set of possible modified California IT Competencies. Suggested changes are presented with original language, and attempts have been made to consolidate and organize write-in suggestions according to the current DOL model structure.

These suggested changes and additions have not been validated with a broader audience yet. Comments are welcome at [CalifornialICTCompetencies@mpict.org](mailto:CalifornialICTCompetencies@mpict.org).

ICT educators at the 112 community colleges in California (and even K-12 educators with regard to fundamentals of IT/digital literacy competencies) have a tremendous opportunity to go beyond the federal Department of Labor competencies that employers have validated.

It is clear that the vast majority of the DOL IT competencies that were presented to California employers were approved resoundingly as the correct set of competencies for ICT workers. However, the modifications that employers suggested and the new competencies they provided now give California community colleges and other educators a rare opportunity to customize the national DOL competency model to a California version.

California educators can now review the extensive suggested changes to competencies that employers provided during the survey process. Because employers were asked, for each competency, if they wanted to modify or change the competency in some way to improve it, a rich amount of data is available for educators to review and consider. Educators can learn about what California employers have specifically recommended with regard to each ICT competency.

In addition, employers were invited within each section of the DOL model to add new competencies. California employers have proposed new competencies that go beyond the initial DOL model and have the potential to customize and enhance the DOL competency model and make it unique to California.

MPICT is eager to engage community college educators across California in a process of public comment and review of these modified and new competencies that have been proposed by employers in order to identify which of them should be incorporated into a California IT competency model.

Please see Appendix H for the modified and new competencies that have been proposed by California employers.

### **Digital Literacy/"Fundamental IT User Skills"**

To be successful in 21<sup>st</sup> century information, knowledge and innovation societies and economies, students, workers and citizens need to understand how to use information and communication technologies efficiently and effectively.

ICT digital literacy is a big factor for student success, no matter the field of study, because ICT is increasingly used by students to find and apply to schools, get their syllabi and assignments, communicate with teachers, do research and other school work, write papers and do math, get transcripts, get financial aid, and take steps to advance their studies.

ICT digital literacy is a big factor for workplace success, no matter what the job is, because that is increasingly necessary to find and apply for jobs; research prospective employers; create and submit resumes; work with employer organizational systems; communicate with bosses, coworkers, customers and suppliers; do the work, no matter what the work is; track time, expenses and activities; collaborate on projects and generally add value to the effort. Car mechanics, stewardesses, waiter staff, checkout clerks, bookkeepers, taxi drivers and most job roles today require an ability to work with ICT.

ICT digital literacy is increasingly important for being a modern citizen: getting news and information, registering to vote and learning about election issues and candidates, finding and interacting with government services, finding and buying commercial goods and services, for entertainment, for self-education, for communications with family and friends, and generally being part of the modern world.

ICT industries need digitally literate consumers to buy and be able to use their products and services.

All businesses desire digitally literate consumers to want to buy and be able to use their products and services also, and ICT is increasingly how they find, market to, sell, service and support those customers.

From this study, we can say with a 99% level of confidence that:

- 85.2% of California employer representatives with direct knowledge of ICT workforce needs either agree or strongly agree with the statement: “In the 21st century, an ability to work with information and communication technologies is becoming as essential to education, life and workplace success as “reading, writing and arithmetic.” ICT Digital Literacy should be considered a basic skill by educational systems, something taught to and assessed for all students.”
- 70.5% of California employer representatives with direct knowledge of ICT workforce needs either agree or strongly agree with the statement: “Information and communication technologies (ICT) competencies are increasingly important for most of our employees, regardless of role. If there was an agreed upon standard for “digital literacy,” or ICT competencies expected of all workers, regardless of workplace role, my organizations would value a credential based on that standard as a way of validating ICT skills for non-ICT workers.”

In addition, from this study we can now say with better than 80% confidence which specific Digital Literacy or Fundamental ICT User Skills competencies are required for Workplace Readiness, according to California employer representatives with direct knowledge of ICT workforce need. And they are the DOL model competencies.

California could adopt those competencies as basic skills standards for Digital Literacy throughout public education. Any student completing high school, community college or 4-year colleges and universities in California would be assessed for Digital Literacy and employers would know that any degree from a public educational institution in California would include students having those skills, increasing the value of those credentials. Any student entering college at any level without those skills would receive remedial instruction to gain them.

California could develop a credential for digital literacy that functions as a badge, certifying known and understood common digital literacy skills.

California’s K-12 educational system could develop age appropriate educational standards for digital literacy that create digital literacy competencies and develop teachers to teach them for students in each grade, certifying digital literacy competency as a basic skills requirement by the end of high school or completion of a final digital literacy assessment.

California Community Colleges could adopt these digital literacy competencies as basic skills requirements for degree or certificate completion, adding value to those credentials by validating those skills as part of what a student knows and can do after completing college programs.

California State University and University of California systems could adopt these digital literacy competencies as basic skills requirements for degree or certificate completion, adding value to those credentials by validating those skills as part of what a student knows and can do after completing college programs.

Adult education programs could offer these skills and credentials to their populations without them to help develop their workplace readiness.

California Workforce Investment Boards could adopt these standards and help their constituents obtain digital literacy skills to improve their employability and reduce unemployment.

California government, society, education and economies could move beyond a simple recognition of the need for Digital Literacy to actionable plans and known definitions of Digital Literacy that create a truly Digitally Literate citizen population.

### **Employers**

California employers could improve workforce efficiency, effectiveness and productivity by encouraging or requiring all of their workforce to become digitally literate, as defined by the Digital Literacy competencies in this report. That would improve customer relations by improving employee competency in using tools that affect customer relationships, improve operational efficiencies of IT staff supporting employees with user level technical deficiencies, improve supplier relationships and operations by making those work better through users of technology, improve the security of ICT systems by reducing vulnerabilities through system users, reduce liabilities through mistakes related to use of ICT systems, and improve operations at most levels through more efficient User interactions.

Employers could improve communications in their ICT related job announcements and requirements by referencing the Layer 4 competencies produced by this study as foundational requirements for employment in their IT operations, assuring that everyone in the IT operation knows and can do at least what is specified in these Layer 4 competencies. IT operational efficiency should improve, because all team members would know at least the basics of the common ICT technologies in use and understand the basics of what all of the specialized talent in the IT organization does.

Employers could broaden the pool of talent available to hire for their IT operations by recognizing that workforce developed by California Community College programs certifying the general workforce readiness and Layer 4 competencies defined by this study meet minimum requirements for their IT workforce, without requiring 4-year degrees currently often used as Human Resources screens.

Employers can use these competencies, and hopefully future developed higher layer specialization competencies from this study and model, to communicate more effectively with K-12 and college program representatives about their ICT workforce needs.

By adopting these competencies and the adapted DOL model, California employers would be convincing DOL of the value and importance of its IT Competency Model and efforts related to ICT, encouraging future work to keep the model current, improve it, improve how they do it, develop common functional domains for higher level specialized ICT workforce roles and develop the employer competency requirements for them.

### **ICT Industry**

ICT industry could integrate the competencies from this study into industry academy programs and certifications, so their valuable contributions to workforce development align to other workforce development efforts and are clearly mapped to a common framework and competency structure.

ICT industry should benefit from collaborating with these various efforts by having a more competent, digitally literate User base to develop, market and sell ICT related products and services to, a larger market and demand for their products and services.

ICT industry could use the competencies from this study and framework to communicate, interact and collaborate more effectively with education and workforce development systems and better help them develop customers for their products and services and workforce to implement their solutions. It is hard to sell sophisticated ICT products and services to organizations without the technical proficiency to implement them correctly and help the customers realize the benefits of their adoption.

By adopting these competencies and the adapted DOL model, California ICT industry would be convincing DOL of the value and importance of its IT Competency Model and efforts related to ICT, encouraging future work to keep the model current, improve it, improve how they do it, develop common

functional domains for higher level specialized ICT workforce roles and develop the employer competency requirements for them.

### **California Workforce Development System Efforts**

California Workforce Investment Boards (WIBs) and other workforce development agencies could improve the services they provide to job seekers and employers by helping job seekers obtain known and recognized digital literacy and other workplace ready competencies from this study and their certification to improve their employability, no matter what industry or job.

WIBs and other workforce development efforts could help develop employees for the large, growing and well-paid jobs and careers in ICT by steering them to programs and credentials that develop foundational and Layer 4 foundational competencies identified in this model.

By adopting these competencies and the adapted DOL model, California WIBs and other workforce development efforts would be convincing DOL of the value and importance of its IT Competency Model and efforts related to ICT, encouraging future work to keep the model current, improve it, improve how they do it, develop common functional domains for higher level specialized ICT workforce roles and develop the employer competency requirements for them.

### **Community Based Organizations**

California Community Based Organizations (CBOs) could improve the services they provide to students, disaffected populations, job seekers, employers and other organizations by helping their target populations obtain known and recognized digital literacy and other workplace ready competencies from this study, and their certification, to improve their employability, no matter what industry or job.

CBOs could help develop employees for the large, growing and well-paid jobs and careers in ICT by steering them to or developing and delivering programs and credentials that create foundational workplace ready and Layer 4 competencies identified in this model.

### **Government and Policymakers**

State and local governments could:

- improve their efficiencies and operations by adopting and encouraging or requiring all of their workforce to become digitally literate and have the workplace readiness competencies defined by Layer 1-3 competencies in this report. That would improve customer relations by improving employee competency in using tools that affect customer relationships, improve operational efficiencies of IT staff supporting employees with user level technical deficiencies, improve supplier relationships and operations by making those work better through users of technology, improve the security of ICT systems by reducing vulnerabilities through system users, reduce liabilities through mistakes related to use of ICT systems, and improve operations at most levels through more efficient user interactions.
- improve their very significant ICT operations and workforces by aligning government ICT job classifications and descriptions to the foundational workplace readiness and Layer 4 standards, expanding eligible IT workforce beyond current bachelor degree holders to those with the IT and workplace readiness competencies in this report. That should improve the increasing delivery of government services through information and communication technologies.

State policymakers and lawmakers could have a big, positive impact on California society, economic development and economic growth by:

- developing regulations requiring Digital Literacy and workplace readiness skills development and certification by public educational systems in California.

- recognizing the size and strategic importance of ICT industries and technically competent consumers of their goods and services and developing economic development incentives to help them grow as key enablers of 21st century knowledge, information and innovation economies.
- recognizing the strategic importance of competent ICT workforce growth to the health of California knowledge, information and innovation economies. They could support Career Technical Education programs that deliver knowledge and skills needed by that workforce through improved funding and other means, knowing that technical education requires hands-on exposure and experience with technologies that are more expensive than traditional academic subjects, but that those investments provide more than adequate returns to the economy through more profitable businesses, higher employment and higher taxes.
- recognizing the strategic importance of attracting and developing to university academic pathways early the future scientists, engineers and technologists that will drive future information and communication technologies growth and evolution, creating innovations and businesses of the future that will allow California to compete in a global economy.

## K-12

California K-12 educational systems could improve the value of what they do for students by adopting Fundamental IT Skills from this study as Digital Literacy basic skills requirements and addressing that for all students, including age appropriate knowledge and skills development throughout K-12 education, from Kindergarten (don't stick your finger in the electrical socket) through high school.

K-12 systems could contribute hugely to the California economy by aligning Career Technical Education standards, programs and credentials to the competencies in this study, allowing students to develop skills that lead to gainful employment while still in high school, develop knowledge and skills aligned to college competencies and credentials that allow them to accelerate their progress through CTE programs at community colleges, and prepare them for academic pathways related to ICT.

K-12 systems could develop microcredentials/badges for digital literacy, other workplace readiness and Layer 4 IT operational competency boxes in this model and study, consistent with those offered by community colleges and 4-year colleges and universities to improve articulation and transfer to college and communication of workplace readiness competencies to employers.

K-12 systems could improve the California economy and student future livelihoods by providing ICT career exploration opportunities in middle school, to attract students to ICT educational pathways that lead to high quality employment and lifestyles, including increased opportunities for ICT experiences, technical education and attraction to scientific, math and engineering college and university pathways that drive future ICT innovations and economic growth.

By adopting these competencies and the adapted DOL model, California K-12 systems would be convincing DOL of the value and importance of its IT Competency Model and efforts related to ICT, encouraging future work to keep the model current, improve it, improve how they do it, develop common functional domains for higher level specialized ICT workforce roles and develop the employer competency requirements for them.

## California Community Colleges

The California Community College (CCC) system could improve the value of what they do for students by adopting Fundamental IT Skills as Digital Literacy basic skills requirements and addressing that for all students, including remediation of students arriving without them.

CCCs could contribute hugely to the California economy by aligning Career Technical Education standards, programs and credentials to the competencies in this study, allowing students to develop skills that lead to gainful employment, develop knowledge and skills aligned to K-12 schools and 4-year colleges and universities, and prepare them for further academic study related to ICT.

CCCs could develop microcredentials/badges for digital literacy, other workplace readiness and Layer 4 IT operational competency boxes in this model and study, consistent with those offered by K-12 schools and 4-year colleges and universities, to improve articulation and transfer from high school and to 4-year colleges and universities, and improve communication of workplace readiness competencies to employers.

CCC ICT related programs could use this adapted DOL competency model and its content to improve interactions and collaborations with employers of ICT workforce and ICT related program advisors, allowing more specificity of communication about foundational ICT workforce demand.

CCCs could align ICT related foundational curriculum to the competencies of this model as Student Learning Outcomes (SLOs) and use those to radically improve the badly broken ICT articulation and transfer, between CCCs, and K-12 schools and 4-year colleges and universities.

By adopting these competencies and the adapted DOL model, CCCs would be convincing DOL of the value and importance of its IT Competency Model and efforts related to ICT, encouraging future work to keep the model current, improve it, improve how they do it, develop common functional domains for higher level specialized ICT workforce roles and develop employer competency requirements for them.

#### **4-Year Colleges and Universities**

California 4-year colleges and universities could improve the value of what they do for students by adopting Fundamental IT Skills as Digital Literacy basic skills requirements and addressing that for all students, including remediation of students arriving without them.

Colleges and universities could contribute hugely to the California economy by acknowledging very high demand for ICT workforce with hands-on technical skills, and also bachelor degrees, by aligning at least some transfer pathway programs to ICT Career Technical Education standards, programs and credentials and accepting for credit those competencies developed in community colleges, so community college students have good pathways for further study from hands-on ICT technical programs.

Colleges and universities could adopt common microcredentials/badges for digital literacy, other workplace readiness and Layer 4 IT operational competency boxes in this model and study, consistent with those offered by K-12 schools and 4-year colleges and universities to improve articulation and transfer from high school and to 4-year colleges and universities, and improving communication of workplace readiness competencies to employers.

College and university ICT related programs could use this adapted DOL competency model and its content to improve interactions and collaborations with employers of ICT workforce and ICT related program advisors, allowing more specificity of communication about workforce demand.

Colleges and universities could align ICT related foundational curriculum to the competencies of this model as Student Learning Outcomes (SLOs) and use those to radically improve badly broken ICT articulation and transfer, between CCCs and K-12 schools and 4-year colleges and universities.

By adopting these competencies and the adapted DOL model, California colleges and universities would be convincing DOL of the value and importance of its IT Competency Model and efforts related to ICT, encouraging future work to keep the model current, improve it, improve how they do it, develop common functional domains for higher level specialized ICT workforce roles and develop the employer competency requirements for them.

#### **MPICT/CCC ICT Collaborative/CCC Centers of Excellence**

##### **ICT Common Core Student Learning Outcomes (SLOs)**

To follow this study, the Mid-Pacific ICT Center (MPICT) and California Community College ICT Collaborative, in cooperation with California Community College Centers of Excellence, will convene CCC ICT related program faculty representatives to convert at least the IT Fundamental Skills/Digital Literacy

competencies from Layer 2 and Foundational IT Workforce Competencies in Layer 4 identified in this study to Student Learning Outcomes (SLOs).

California Community Colleges are supposed to identify Student Learning Outcomes for all of their Career Technical Education (CTE) programs and courses. Ideally, those SLOs should align to accepted and validated industry standards or guidance. Essentially, SLOs are clear statements about what a student learns and is able to do when successfully completing the program or course, so employers and other interested parties can understand what a program, course or credential represent.

### **Adoption and Alignment to ICT Common Core Student Learning Outcomes (SLOs)**

This effort is not starting from scratch, developing new programs, credentials and programs. California community colleges have 295 different departments offering ICT related programs. Those programs offer more than 600 associate degrees and 1,500 academic certificates, in addition to preparation for industry certifications. In 2010-11, total credit enrollment in identified ICT Top Codes was 562,575, across all 112 campuses. In addition, there were also 116,726 noncredit enrollments, for a total of 679,301 ICT enrollments across the CCC system.

Naturally, program leaders and faculty are not going to discontinue the programs, courses and credentials they have worked hard over years to create and improve. They are heavily invested in those programs and emotionally committed to them. If anyone was to just create new programs, courses and credentials and try to tell existing program leaders and faculty they had to give up the old and adopt the new, there would be enormous resistance. In the CCC system, they also do not have to change. Authority for curriculum is local to the college. Without a change in authority, that avenue to change is probably destined to fail.

However, local program leaders and faculty do care about their programs, courses, labs, credentials and students, and most genuinely want the best possible outcomes for all. They struggle with local advisories and other efforts to stay current with employer ICT workforce demand. Most would genuinely appreciate high quality, statistically significant, detailed input from California employers about what they are looking for in their ICT workforce. The toughest question many of them wrestle with is: *what should I be teaching?*

Rather than ask them to throw out their old programs, courses and credentials to adopt replacements, MPICT and the CCC ICT Collaborative (MPICT/CCCICT) intend to ask them to review the SLOs in their existing programs, courses and credentials and compare them to the new SLOs, identifying which SLOs are already offered and which are not. Then, MPICT and the CCC ICT Collaborative will ask them to work on adjusting their existing programs to deliver the new SLOs in the reasonably near future.

MPICT/CCCICT do not need to proscribe which courses deliver the SLOs, nor would they likely be successful if they did. They just want to move in the direction over time where by the time students complete CCC ICT programs they meet the foundational SLOs required by California employers. That way, everyone would know that, by the time anyone completes a conforming CCC ICT related program, they know and can do at least what is identified in this model of foundational competencies.

It establishes a new baseline for competency for CCC ICT related program completers. It creates a new framework and SLO checklist to align to, improving coherency and known value of CCC ICT related programs, and it creates tools for improving transfer and articulation negotiations. If it is known that two programs both deliver all of these SLOs, attention can be focused only on the remaining SLOs to determine whether two programs, credentials or courses can transfer and be accepted for credit.

This does not inhibit or discourage any of the programs, courses and credentials CCCs have already developed, which help students develop and certify higher level, specialized knowledge and skill sets also required for gainful employment in IT operations. Degree titles can remain the same. At this point, efforts are to establish a new baseline for foundational ICT workforce competencies in California. Specialization credentials are not being addressed.



Employers commonly express a desire for what IBM calls a “T-shaped” employee. That describes a desire for broad, general understanding and competencies across business and technical domains, the horizontal bar in a “T”. Plus, they want a unique value add or specialization, something that person does better than others, the vertical bar in a “T”. This study and effort are focused on the horizontal, general or foundational knowledge and skill sets. Vertical, specialization knowledge and skill sets, degrees and certificates are not being addressed. Those are in the higher levels, above Layer 4, in the DOL IT Competency Model. They have not been addressed by DOL, except for GIS, and they have not been validated or adequately studied in California.

### **Model ICT “Common Core” Curriculum**

To demonstrate integration of this new California employer ICT workforce foundational competency demand, MPICT and the CCC ICT Collaborative will also develop example or model curriculum that align to the new SLOs. That is intended to make it easier for ICT program representatives to understand the new SLOs and how they can be integrated into program curriculum. Possibly, some would choose to adopt the new “common core” curriculum, if they think it is better than what they have.

### **CCC ICT Faculty Working Group Engagement**

In order to accomplish these three objectives, or their revisions, MPICT and the CCC ICT Collaborative will convene CCC ICT faculty representative working groups. Those groups will essentially be focused on how CCCs respond to the new information in this study. Do the objectives identified above make sense? How can they best be accomplished? How can this new information best be shared with CCC ICT programs and faculty? What works as effective communication, and what does not? How can program faculty best be engaged in this change process? Is there other work that makes sense in this context? Should there also be an effort to review and certify programs that meet these new SLOs? What about future work? Should there be an effort to develop CCC system badges or micro-credentials that certify meeting the competencies from the various boxes of the DOL model, which could serve as easily transferable and understood stackable credentials, potentially used or at least recognized by K-12 and university programs?

With agreement about objectives and CCC response to this study, these compensated faculty working groups will then work to deliver on the objectives.

### **CCC “Doing What Matters for Jobs and the Economy” Strategy Integration**

MPICT and the CCC ICT Collaborative will also work to integrate this study and related efforts into the “Doing What Matters for Jobs and the Economy” change effort from the CCC Chancellor’s office.

“Doing What Matters for Jobs and the Economy” (DWM)<sup>61</sup> is the CCC component of the California State Workforce Plan, which aims to create a broader alignment across a broad spectrum of state and local agencies. DWM aims to align state EWD, Perkins 1B Leadership (not 1C) and SB70 funds to focus strategically and in a coordinated manner on places where the CCC system can make the largest impact on improving the California economy and employment.

Among the reasons for this strategy “are: the state’s slow recovery from the recession; continued high unemployment rates; the pressures on industry for increased productivity due to an intensely competitive global economy; lack of qualified candidates in key industry sectors; the impending retirement of baby boomers; increased demands for accountability; and the need to exercise careful stewardship of diminishing public funds.”<sup>62</sup>

The strategy includes braiding “funding streams from multiple sources (public, private, philanthropic, corporate, etc.) to advance our state, regions, and students towards common jobs and economy goals.”<sup>63</sup>

<sup>61</sup> <http://doingwhatmatters.cccco.edu/>

<sup>62</sup> “Overview of Roles & Responsibilities: How Grantees Integrate to Advance the Workforce Mission of the California Community Colleges”, page 1, [http://doingwhatmatters.cccco.edu/Portals/6/docs/RFA/Overview\\_Roles\\_Responsibilities\\_DWM%20Framework%200%206%20with%20line%20numbers.pdf](http://doingwhatmatters.cccco.edu/Portals/6/docs/RFA/Overview_Roles_Responsibilities_DWM%20Framework%200%206%20with%20line%20numbers.pdf)

<sup>63</sup> Ibid

It includes “working regionally, working on sectors and alignment with the State Workforce Plan.”<sup>64</sup> And it includes key strategic roles for Regional Consortia, Sector Navigators, Technical Assistance Providers, and Sector Partnerships. There will be a strategic Sector Navigator for ICT/Digital Media, which received the 2<sup>nd</sup> highest overall strategic focus selections by Regional Consortia (behind Healthcare) in the recent selection process.

MPICT will be working with the new ICT/DM Sector Navigator, and representatives of all of the new strategic roles, to leverage this study and related efforts in the new DWM strategic framework.

## Additional Future Work Needed

MPICT will be advocating for additional future work with DOL and others to identify common, agreed upon sectors of ICT employment specialization, so occupations and competencies can be developed for higher levels of the DOL pyramid, or modifications and updates can be made to ICT related O\*Net occupations. We need to build on the existing work, defining what is needed for specialized (vertical lines in the “T-shaped”) ICT workforce roles.

### U.S. DOL

The U.S. economy would benefit if the U.S. Department of Labor would recognize the high strategic importance and need for a fully-developed framework and higher level competency set for ICT and establish working groups to create common classifications for higher level occupational specialties and the competencies associated with them.

U.S. DOL could consider whether any of the findings or adaptations based on this study of the IT Competency Model content should be used to change the national IT Competency Model.

U.S. DOL should consider changing its nomenclature from IT to ICT, so its valuable work is more discoverable through search functions that turn up everything in the English language when “it” is input.

U.S. DOL could recognize the importance of employer validation of its industry model content, not relying on educator input in an environment of large skills gap problems in which prospective workers are not being developed with appropriate skills for workforce demand.

U.S. DOL could study and improve on the methodology used for this study to find ways of reaching large numbers of employers and other stakeholders for obtaining statistically significant input into its efforts.

U.S. DOL could update and align O\*Net ICT related occupations to completed IT Competency Model structure and content to create a complete and coherent ICT occupational structure and detail.

## Conclusion

In the information and knowledge economies of the 21st century, we increasingly depend on computer, information and communications technologies for productivity, efficiency, connectivity and growth.

The U.S. still has a mostly fragmented view of the technology, industry and occupational clusters related to these rapidly emerging, evolving and converging fields. Much of the rest of the world collects and analyzes data for one large, umbrella cluster, a superset term capturing all of these inter-related and interdependent fields: Information and Communications Technologies (ICT). That helps them understand the strategic importance of ICT. “ICT” is an effective search term, where “IT” is not.

Many other countries, Australia being one example, have also been able to create more effective ICT workforce development systems than the U.S., which is badly fragmented and suffering a serious IT Skills

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<sup>64</sup> Ibid

Gap. Determining ICT workforce needs comprehensively, including knowledge and skills sets, allows them to define the ICT workforce and the workforce development need in an understandable way and develop education and training systems that align to employer job needs.

We badly need a common framework and set of ICT employer workforce competency expectations in California. Employers are simply making up ICT related job titles and descriptions at will, and that is very difficult for educators and workforce development specialists to understand. Partially as a result, ICT related educational programs and credentials are wildly divergent and misaligned, making student transfer and articulation pathways unmanageable.

The U.S. Department of Labor has developed a foundational IT Competency Model which can serve that role. The contents of that model have now been tested in a statistically significant way with 782 California employer representatives with direct knowledge of their ICT workforce needs, and those employers represent the company size, industry and geographic diversity of the State.

California employers resoundingly approved the U.S. DOL model content, specifically the foundational IT workforce technical competencies, which all IT workers should know and be able to do, regardless of specialized role. The model also includes three layers of workplace ready competencies: Personal Effectiveness, Academic and Workplace which have been generally validated by DOL work across other industries. These address critical “soft” skills requirements of employers. At a minimum, California should adopt the competencies in Layers 1-4 of the DOL IT Competency Model and take active measures to align educational, workforce development and employment systems to them.

Further, this study effort collected a high volume of written employer suggestions for competency changes and additions. Those could be used to create an even better California IT Competency Model. (It would not be the first time California has adopted higher standards than the rest of the country.)

Very importantly, this study showed extremely high levels of support for Digital Literacy as a new basic skill in California, and it defines what Digital Literacy means as a set of clear competencies. It would be an extraordinary accomplishment if California adopted these definitions and took action to assure all California students and citizens have these basic skills in the future.

MPICT, COEs and the CCC ICT Collaborative will be working with the California community college system to develop a response to this model, including efforts to align programs to common core SLOs based on these competencies to improve articulation and transfer. There are recommendations here for a variety of other stakeholders also, including recommendations to DOL to improve higher levels of the model, or ICT related occupational specialization descriptions and competency expectations.

These study results and recommendations have powerful potential for helping California develop a strong ICT workforce, workforce development system and employment marketplace – and for improving California’s employment and economy.

**Appendices**

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## A: About CCC Economic and Workforce Development Centers of Excellence

This report is designed to provide current industry data to:

- Define potential strategic opportunities relative to an industry's emerging trends and workforce needs;
- Influence and inform local college program planning and resource development;
- Promote a future-oriented and market responsive way of thinking among stakeholders; and,
- Assist faculty, Economic Development and CTE administrators, and Community and Contract Education programs in connecting with industry partners.

The information in this report has been validated by employers and also includes a listing of what programs are already being offered by colleges to address those workforce needs. In some instances, the labor market information and industry validation will suggest that colleges might not want to begin or add programs, thereby avoiding needless replication and low enrollments.

The Centers of Excellence (COE), in partnership with business and industry, deliver regional workforce research customized for community college 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 grant funding supports multiple projects and written reports through the Center of Excellence. The Centers aspire to be the premier source of regional economic and workforce information and insight for California's community colleges. More information about the Centers of Excellence is available at [www.coeccc.net](http://www.coeccc.net).

## B: About the Mid-Pacific ICT Center

In the information, knowledge and innovation economies of the 21st century, we all increasingly depend on information and communication technologies - and the increased connectivity, productivity and strategic advantage they enable.

Information and Communication Technologies (ICT) is an umbrella term, widely used outside the United States and in the United Nations, to encompass all rapidly emerging, evolving and converging computer, software, networking, telecommunications, Internet, programming, information systems and digital media technologies.

Improvements to deployed ICT technologies, infrastructure, systems and solutions, and people's abilities to productively use them, are strategically important issues to individuals and organizations of all kinds – and to local, state, national and global economies.

To enhance education initiatives in this field, in 2008, the National Science Foundation Advanced Technological Education (ATE) program awarded a 4 year, \$3 million grant to establish the Mid-Pacific ICT (MPICT) Center in San Francisco. In 2012, that grant was renewed for 3 years for \$2.25 million.

MPICT's mission is to coordinate, promote and improve the quality of ICT education, with an emphasis on 2-year colleges, in a region consisting of California, Nevada, Hawaii and the Pacific Territories.

Its primary, high-level goals are:

1. Continue to develop and sustain collaborations among institutions of higher education, K-12 networks, NSF-funded Centers, and other educational initiatives to leverage, expand, improve, and enhance the region's ICT education capacity.
2. Deepen and expand collaboration between education and industry/employers to create a diverse ICT workforce that can meet the economic needs of the region.

3. Identify regional, national, and global best practices in ICT education and disseminate and encourage implementation of these best practices throughout the region, working towards a harmonization of ICT competencies, skills, and education approaches.
4. Advocate for the development of core ICT student learning outcomes that serve as a framework for articulated, comprehensive ICT education pathways throughout the region.

## C: About the California Community College ICT Collaborative

In part through recognition of prior MPICT and COE research, and through MPICT advocacy, in 2011, the California Community College Chancellor's office formally recognized ICT as a strategic sector for Career Technical Education by awarding MPICT team members \$150,000 in Carl D. Perkins Act 1B Sector Leadership funding to establish the California Community College ICT Collaborative.

The CCC ICT Collaborative mission is to advance ICT education programs at California community colleges and enable a diverse student population to succeed in meeting industry and business ICT workforce needs.

The CCC ICT Collaborative meets quarterly with representatives of each of the CCC Regional Consortia and other members. The CCC ICT Collaborative is a major champion, funder and planner of this study.

In 2012, the California Community College chancellor's office provided a special award of around \$70,000 in Economic and Workforce Development funding to establish a statewide ICT advisory for CCCs, use it to inform the methodology for this study and partially fund the study.

## D: Important Disclaimer

All representations included in this report have been produced from primary research and/or secondary review of publicly and/or privately available data and/or research reports. Efforts have been made to qualify and validate the accuracy of the data and the reported findings; however, neither the Centers of Excellence, COE host District, MPICT, nor California Community Colleges Chancellor's Office are responsible for applications or decisions made by recipient community colleges or their representatives, or others, based upon components or recommendations contained in this study.

## E: Survey Methodology

The table below provides a brief overview of the methodology utilized for the project.

**Table 1 Overview of Project Methodology**

Field Dates	December 12, 2012 – February 13, 2013
Method	Web survey with online and phone recruitment
Sample	782 firms in California with ICT knowledge
Universe	About 1.3 million California firms
Level of Confidence	For questions answered by all 782 firms, 99% level of confidence was achieved, with a maximum margin of error of +/-5.0%

## Research Objectives

Prior to beginning the project, MPICT, the CCC ICT Collaborative, and the Centers of Excellence agreed upon the following research objectives for the study:

- Understand in a statistically significant and defensible way which foundational competencies employers with an ICT workforce will need/require their ICT workers to have two years from now (by end of 2014)

- Revise ICT related content in Layers 1-4 of the existing DOL competency model to include what California employers report they need their ICT Users and ICT Workforce to have two years from now (by end of 2014)
- Assess the level of agreement and support CA employers have for the DOL ICT competency model and its content.
- Develop a profile of California employers in different industry categories, regions within the state and size of firm as it relates to expectations for their ICT workforce to have specific foundational competencies.
- Provide educators with recommendations about aligning ICT curriculum to the foundational ICT competencies that employers say they want/need their workforce to have two years from now (by end of 2014), and provide other stakeholder recommendations (e.g. WIB adoption of competency model and engagement with it, employers using competencies in future job postings)

**Questionnaire Design**

MPICT, COE and Davis Research conducted a survey of the California employers in order to validate the competencies in parts of the U.S. Department of Labor’s Information Technology (IT) Competency model. The questionnaire was broken up into four core sections, with the “Core Test Areas” being the main part of the survey. The following represent the four survey parts:

- I. **Screeners:** Determined whether the respondent qualifies for the survey and then captured general information about each respondent (job title, industry, company size, etc.)
- II. **Core Test Areas:** There were nine core sections from the existing DOL Competency Model that required testing. Each section had several competencies that required testing:

Section:	# of Competencies:
1. Digital Literacy Competencies	44
2. Database and Information Systems	20
3. Networks, Telecom, Wireless and Mobility	44
4. Compliance	9
5. Digital Media and Visualization	9
6. Software Development and Management	39
7. Principles of IT	31
8. Risk Management, Security and Information Assurance	49
9. User and Customer Support	15

- III. **ICT General Questions:** Generic questions on the subject of ICT.
- IV. **Closing:** Capture respondent information (name, address, etc.)

Because we could not have a respondent complete a survey and answer questions for all nine sections being tested (survey would be almost 2 hours) we split the Core Test Areas part of the survey into three groups. The three groups were defined as follows:

Group #	Target Sample Size	Sections of Competencies Asked
1	N=250	(1) Digital Literacy Competencies, (2) Principles of IT (3) User and Customer Support
2	N=250	(1) Databases and Information Systems (2) Software Development and Management (3) Digital Media and Visualization (4) Compliance
3	N=250	(1) Networks, Telecom, Wireless and Mobility (2) Risk Management, Security and Information Assurance

Prior to data collection, the questionnaire was reviewed by the research team as well as pre-tested by the subject matter experts in order to ensure the most effective wording of the questions for a respondent. In order to factor out survey fatigue and mitigate order biases, parts of the survey were randomized on multiple levels:

- 1) Large sections within each of the three survey groups were randomized.
- 2) When large sections contained multiple subsections or areas, these subsections were also randomized.
- 3) Individual competencies presented to a respondent within each section or subsection were randomized.

In some cases, where randomization would create confusion to a survey respondent, the order was kept constant. However, there were few of such cases.

## Data Collection

The responses to the survey were obtained using a web questionnaire. In order to drive respondents to the survey, two recruitment strategies were utilized:

**Phone Recruitment:** Davis Research recruited respondents by telephone in accordance with the sampling plan specifications. Each potential respondent was screened for qualification criteria prior to being offered a survey link. The efforts included initial phone calls, reminder calls, email invites, and reminder emails. When a respondent only partially completed the survey, Davis Research sent reminders to those who started the survey, but haven't finished them. *731 survey completes were obtained using the phone recruitment efforts.*

**Online Campaign:** A basic webpage [www.caictresearch.com](http://www.caictresearch.com) was created to inform potential participants about the project and encourage them to sign up to participate in the study. The MPICT, COE and other partners forwarded the link to their networks of ICT professionals. *51 survey completes were obtained using online recruitment strategy.*

Respondents (recruited both online and by phone) who completed the survey were given an opportunity to opt in for a \$50 reward. This incentive helped recruit the participants and drive traffic to the online survey. Of the 782 respondents who completed the survey, 603 (77%) opted in to receive the \$50 incentive.

The following qualification criteria were used to determine survey eligibility:

- Respondent worked for a California firm
- Respondent was knowledgeable about their firm's ICT workforce
- Respondents provided verifiable contact information

The research team continuously reviewed the completed surveys and adjusted data collection targets based on the sampling requirements established. The data collection took place from December 12, 2012 through February 13, 2013.

## Universe and Sample

The sampling plan for the study was based on the assumption that any employer in California can potentially have ICT employees and therefore would qualify to take the survey. Therefore, a database of all 1.3 million firms in the state was considered a universe for this study. The universe of firms was stratified based on industry, size, and region and the sampling targets for each group were established. The goal was to ensure that the survey is representative of employers of different sizes, industries, and locations within the state. Below are the classification structures for each of the employer categories.

### Industry:

Each employer was categorized into one of five general industry classifications based on their two-digit NAICS code. The five general industry classifications are provided with some examples of what industries were included. Quotas were utilized during data collection to ensure representation of firms by industry classification.

- High technology (professional and technical services, information, and higher technology manufacturing)



- Medium technology (utilities, transportation and warehousing, all other manufacturing, management of companies, and other)
- Low technology (retail, accommodations, food services, and other)
- Healthcare
- Government and education
- Non-classified

**Employer size:**

- Micro employers = 0 to 4 employees.
- Small employers = 5 to 24 employees.
- Medium sized employers = 25 to 99 employees.
- Large employers = 100 or more employees.

**Region:**

- Southern California includes Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties.
- Bay Area includes Alameda, Contra Costa, Marin, Monterey, Napa, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, and Sonoma counties.
- Other includes all other counties in California except those identified in Southern California and the Bay Area.

**A Note about Margin of Error and Analysis of Sub-groups**

General sampling targets were established to reflect California’s economy. However, considering the findings from previous ICT related research, there are higher levels of concentration of ICT employment and higher levels of complexity of ICT tasks in the following groups: Bay Area companies, larger companies (100+ employee firms as well as 25-99 employee firms), and high technology firms. These groups were oversampled to make sure that the survey results represent the voices of firms in such categories.

The table following represents the number of responses obtained from each group, percentage of these responses in the total, and the level of confidence achieved assuming a margin of error of no more than +/- 5.0%.

	# of Responses	% of Total	Confidence Level
<b>REGION</b>			
Southern California	361	46%	94%
Bay Area	231	30%	87%
Other	190	24%	83%
<b>NUMBER OF EMPLOYEES</b>			
0 to 4 employees	292	37%	91%
5 to 24 employees	202	26%	84%
25 to 99 employees	136	17%	75%
100 or more employees	152	19%	78%
<b>INDUSTRY GROUP</b>			
High Technology	201	26%	84%
Medium Technology	213	27%	85%
Low Technology	186	24%	82%
Healthcare	80	10%	-
Government	74	9%	-
Non-classified	28	4%	-
<b>TOTAL</b>	<b>782</b>	<b>100%</b>	<b>99%</b>

While the 99% level of confidence was achieved for the questions that all respondents gave answers to, caution should be utilized when analyzing responses from each of the subgroups separately. The sample size for the regional subgroups allowed for the level of confidence from 83% to 94%, with a +/-5.0% maximum margin of error. The levels of confidence for different company sizes range from 75% to 91%

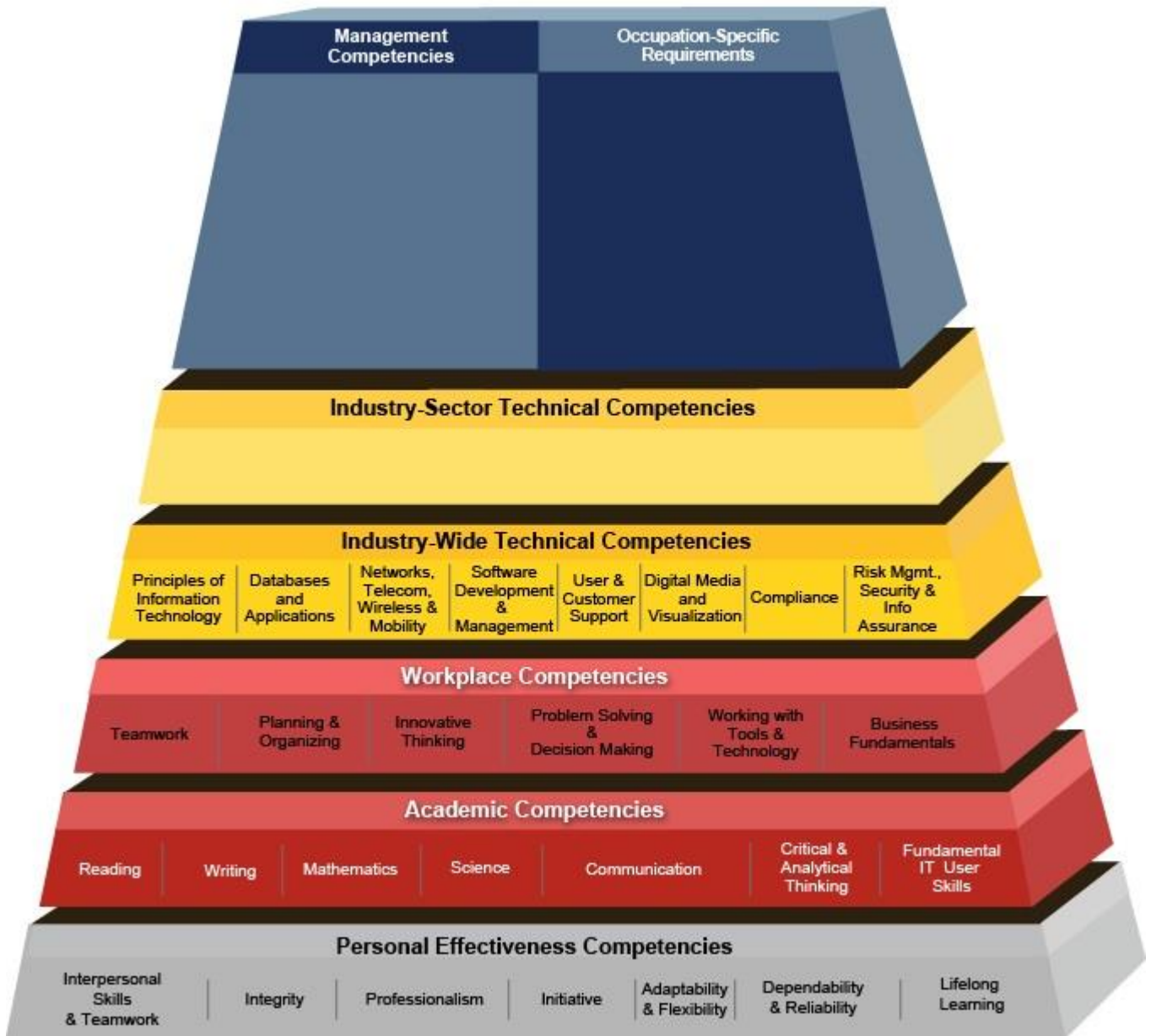
for different subgroups. Regarding the industry, responses can only be analyzed for three of the six groups – high technology (84% confidence), medium technology (85% confidence), and low technology (82% confidence).

Further caution should be taken when analyzing responses from various subgroups to the competencies questions. The level of confidence for Group 1 competencies survey that received responses from 272 employers is 90% (given the same +/-5.0% maximum margin of error). The level of confidence for the other two groups (Groups 2 and 3) was just shy of 90%, with 256 total responses each.

Group #	Sample Size Achieved	Confidence Level	Sections of Competencies
1	N=272	90%	(1) Digital Literacy Competencies, (2) Principles of IT (3) User and Customer Support
2	N=254	89%	(1) Databases and Information Systems (2) Software Development and Management (3) Digital Media and Visualization (4) Compliance
3	N=256	89%	(1) Networks, Telecom, Wireless and Mobility (2) Risk Management, Security and Information Assurance

**F: U.S. Department of Labor IT Competency Model**

**Information Technology Competency Model  
September 2012**



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## About the Model

The IT Competency Model identifies the knowledge, skills, and abilities needed for workers to perform successfully in the field of information technology (IT).

The model is depicted as a pyramid consisting of several tiers. The arrangement of the tiers in this shape is not meant to be hierarchical, or to imply that competencies at the top are at a higher level of skill. Instead, the model's tapered shape represents the increasing specialization and specificity of proficiencies covered. Its tiers are further divided into blocks that represent competency areas (i.e., groups of knowledge, skills, and abilities), which are defined using critical work functions and technical content areas.

### Foundational Competencies

Tiers 1 through 3 represent the “soft-skills” and work readiness skills that most employers demand. Each tier covers a different group of competencies:

**Tier 1 – Personal Effectiveness Competencies** are personal attributes essential for all life roles. Often referred to as “soft skills,” personal effectiveness competencies are generally learned in the home or community and honed at school and in the workplace.

**Tier 2 – Academic Competencies** are primarily learned in a school setting. They include cognitive functions and thinking styles. Academic competencies are likely to apply to all industries and occupations.

**Tier 3 – Workplace Competencies** represent motives and traits, as well as interpersonal and self-management styles. They are generally applicable to a large number of occupations and industries.

**Competency** – A cluster of related knowledge, skills, and abilities that affects a major part of one’s job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved through training, development, and experience.

### Industry-specific Competencies

Tiers 4 and 5 show the industry-wide technical competencies needed to create career lattices within an industry. These competencies are considered cross-cutting, as they allow a worker to move easily across industry sub-sectors. Rather than narrowly following a single occupational career ladder, this model supports the development of an agile workforce. Like the foundational tiers, Tiers 4 and 5 deal with distinct types of competencies:

**Tier 4 – Industry-Wide Technical Competencies** cover the knowledge and skills and abilities from which workers across the industry can benefit, regardless of the sector in which they operate. Because of this, many of the critical work functions on this tier deal with awareness or understanding.

**Tier 5 – Industry-Sector Technical Competencies** represent a sub-set of industry technical competencies that are specific to an industry sector. As a result, the critical work functions deal more with performing tasks than those on Tier 4. The Employment and Training Administration’s IT model does not include Tier 5 competencies.

### Upper Tiers

**The upper tiers** represent the specialization that occurs within specific occupations within an industry. Included in this category are occupation-specific requirements and management competencies. The Employment and Training Administration’s IT model does not include upper tier competencies. Information on occupational competencies is available through O\*NET OnLine (<http://online.onetcenter.org/>).

### Using the Model

While it attempts to cover a wide range of industry competencies, the model is not intended to be a definitive list of all IT knowledge, skills, and abilities; nor is it intended that all workers in the field possess

all competencies listed. The IT Competency Model is instead intended as a resource for further explorations of the competencies needed in this critical industry. Users of the model are encouraged to add or subtract competencies as they see fit, as well as expand the scope of the model to include a specific sector or occupation. For examples of how the model can be used, please visit the Competency Model Clearinghouse (<http://www.careeronestop.org/competencymodel/>). The Clearinghouse also includes the Build a Model Tool, which can be used to edit an existing model or create a new one.

## Tier 1 – Personal Effectiveness Competencies

### 1. Interpersonal Skills and Teamwork: Displaying skills to work with others from diverse backgrounds.

Demonstrating concern for others

- Show sincere interest in others and their concerns
- Demonstrate sensitivity to the needs and feelings of others
- Look for ways to help others and deliver assistance

Demonstrating insight into behavior

- Recognize and accurately interpret the verbal and nonverbal behavior of others
- Show insight into the actions and motives of others
- Recognize when relationships with others are strained

Maintaining open communication

- Maintain open lines of communication with others
- Encourage others to share problems and successes
- Establish a high degree of trust and credibility with others

Respecting diversity

- Demonstrate sensitivity and respect for the opinions, perspectives, customs, and individual differences of others
- Value diversity of people and ideas
- Deal with a wide range of people with flexibility and open-mindedness
- Listen to and consider others' viewpoints
- Work well and develop effective relationships with diverse personalities

### 2. Integrity: Displaying accepted social and work behaviors.

Behaving ethically

- Abide by a strict code of ethics and behavior
- Choose an ethical course of action and do the right thing, even in the face of opposition
- Encourage others to behave accordingly

Acting fairly

- Treat others with honesty, fairness, and respect
- Make decisions that are objective and reflect the just treatment of others

Taking responsibility

- Take responsibility for accomplishing work goals within accepted timeframes, or for not accomplishing those goals
- Accept responsibility/accountability for one's decisions and actions and for those of one's group, team, or department
- Understand that past behavior may affect one's ability to obtain occupation or meet occupational requirements
- Attempt to learn from mistakes

### 3. Professionalism: Maintaining a professional demeanor at work.

#### Demonstrating self-control

- Demonstrate self-control by maintaining composure and keeping emotions in check
- Deal calmly and effectively with stressful situations

#### Maintaining a professional appearance

- Maintain a professional demeanor
- Dress appropriately for occupation and its requirements
- Maintain appropriate personal hygiene
- Wear appropriate identification, as required
- Refrain from lifestyle choices which negatively impact the workplace and individual performance
- Be prepared to represent your organization and effort

#### Maintaining a positive attitude

- Project a positive image of oneself and the organization
- Demonstrate a positive attitude towards work
- Take pride in one's work and the work of the organization

### 4. Initiative: Demonstrating a willingness to work.

#### Persisting

- Pursue work with energy, drive, and a strong accomplishment orientation
- Persist and expend extra effort to accomplish tasks even when conditions are difficult or deadlines tight
- Persist at a task or problem despite interruptions, obstacles, or setbacks

#### Taking initiative

- Go beyond the routine demands of the job
- Take initiative in seeking out new work challenges and increasing the variety and scope of one's job
- Seek opportunities to influence events and originate action
- Assist others who have less experience or have heavy workloads
- Seek the information and assistance needed to be successful

#### Setting challenging goals

- Establish and maintain personally challenging but realistic work goals
- Exert effort toward task mastery
- Bring issues to closure by pushing forward until a resolution is achieved

#### Working independently

- Develop and use effective and efficient ways of performing tasks
- Perform effectively, even with minimal direction, support, approval, or direct supervision
- Strive to exceed standards and expectations
- Exhibit confidence in capabilities and an expectation to succeed in future activities

### 5. Adaptability and Flexibility: Displaying the capability to adapt to new, different, or changing requirements.

#### Employing unique analyses

- Employ unique analyses and generate valuable, innovative ideas
- Integrate related and seemingly unrelated information to develop creative solutions
- Develop innovative methods of obtaining or using information or resources when needed

#### Entertaining new ideas

- Remain open to considering new ways of doing things
- Actively seek out and carefully consider the merits of new approaches to work
- Embrace new approaches when appropriate and discard approaches that are no longer working

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#### Dealing with ambiguity

- Take appropriate action without having all facts or permissions, when necessary
- Change plans, goals, action, or priorities in response to changing, unpredictable, or unexpected events, pressures, situations, and job demands

### **6. Dependability and Reliability:** Displaying responsible behaviors at work.

#### Fulfilling obligations

- Behave consistently and predictably
- Fulfill obligations reliably, responsibly, and dependably
- Diligently follow through on commitments and consistently meet deadlines
- Demonstrate regular and punctual attendance

#### Attending to details

- Understand team or organizational goals, efforts, and requirements sufficiently to be able to assess and understand the purpose and appropriateness of detail work
- Check work to ensure that all essential details have been considered
- Notice errors or inconsistencies that others have missed, and take prompt, thorough action to correct errors

#### Complying with policies and procedures

- Follow written and verbal directions
- Comply with organizational rules, policies, and procedures
- Resolve uncertainties with rules, policies, and procedures to assure compliance

### **7. Lifelong Learning:** Displaying a willingness to learn and apply new knowledge and skills.

#### Demonstrating an interest in learning

- Demonstrate an interest in personal learning and development
- Seek feedback from multiple sources about how to improve, develop, and modify behavior based on feedback and/or self-analysis of past mistakes
- Use newly learned knowledge and skills to complete specific tasks

#### Participating in training

- Take steps to develop and maintain the knowledge, skills, and expertise necessary to perform one's role successfully
- Participate fully in relevant training and professional development programs
- Broaden knowledge and skills through technical expositions, seminars, professional groups, reading publications, job shadowing, and continuing education

#### Anticipating changes in work

- Anticipate changes in work demands and search for and participate in assignments or training that address these changing demands
- Treat unexpected circumstances as opportunities to learn

#### Identifying career interests

- Take charge of personal career development by identifying occupational interests, strengths, options, and opportunities
  - Make insightful career planning decisions based on integration and consideration of others' feedback, and seek out additional training to pursue career goals
-



## Tier 2 – Academic Competencies

### 1. Reading: Understanding written sentences and paragraphs in work-related documents.

#### Comprehension

- Locate, understand, and interpret written information in prose and in documents such as manuals, reports, memos, letters, forms, graphs, charts, tables, calendars, schedules, signs, notices, applications, and directions
- Understand the purpose of written materials
- Attain meaning and comprehend core ideas
- Learn definitions of unfamiliar terms
- Critically evaluate and analyze information in written materials
- Integrate and synthesize information from multiple written materials

#### Attention to detail

- Identify main ideas, implied meaning and details, missing information, biases, differing perspectives, sources, and reliability of written materials
- Note details, facts, and inconsistencies

#### Application

- Integrate what is learned from written materials with prior knowledge
- Apply what is learned from written material to follow instructions and complete specific tasks
- Apply what is learned from written material to future situations

### 2. Writing: Using standard English to compile information and prepare written reports.

#### Organization and development

- Prepare reports that are easy to understand using proper terminology
- Communicate thoughts, ideas, information, messages, and other written information which may contain technical material, in a logical, organized, efficient, and coherent manner
- Present ideas that are well developed with supporting information and examples

#### Mechanics

- Use standard syntax and sentence structure
- Use correct spelling, punctuation, and capitalization
- Use appropriate grammar (e.g., correct tense, subject-verb agreement, no missing words)
- Write legibly
- Proof read finished documents for errors
- Distribute written materials appropriately for intended audiences and purposes

#### Tone

- Write in a manner appropriate for the industry and organization
- Use language appropriate for the target audience
- Use appropriate tone and word choice (e.g., writing is professional and courteous)

### 3. Mathematics: Using mathematics to express ideas and solve problems.

#### Quantification

- Read and write numbers
- Count and place numbers in sequence
- Understand relationships between numbers

#### Computation

- Add, subtract, multiply, and divide with whole numbers, fractions, decimals, and percentages
- Calculate averages, ratios, proportions, and rates
- Convert decimals to fractions and fractions to decimals
- Convert fractions to percentages and percentages to fractions

---

**Measurement and estimation**

- Take and understand measurements of time, temperature, distances, length, width, height, perimeter, area, volume, weight, velocity, and speed
- Use and report measurements correctly, including units of measurement
- Convert from one measurement to another (e.g., from English to metric or International System of Units (SI), or Fahrenheit to Celsius)

**Application**

- Perform basic math computations accurately
- Translate practical problems into useful mathematical expressions
- Use appropriate mathematical formulas and techniques

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**4. Science: Using scientific rules and methods to solve problems.**

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**Scientific Method**

- Understand the scientific method (identify problems, collect information, form and validate hypotheses, draw conclusions) and apply basic scientific research
- Apply the scientific method to IT testing, debugging, and troubleshooting

**Scientific Investigation**

- Formulate scientifically investigable questions, construct investigations, collect and evaluate data, and develop scientific recommendations based on findings
- Evaluate scientific constructs including: conclusions, conflicting data, controls, data, inferences, limitations, questions, sources of errors, and variables.

**Application**

- Apply basic scientific principles to work-related problems
  - Physical
  - Environmental
  - Technological
- Compliance and Quality Assurance

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**5. Communication: Giving full attention to what others are saying, and communicating in English well enough to be understood by others.**

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**Listening**

- Receive, attend to, interpret, understand, and respond to verbal messages and other cues
- Pick out important information in communications
- Understand complex instructions
- Acknowledge feelings and concerns of communications

**Communication**

- Express relevant information appropriately to individuals or groups taking into account the audience and the nature of the information (e.g., technical or controversial)
- Communicate clearly and confidently
- Communicate using common English conventions including proper grammar, tone, and pace
- Track listener responses and react appropriately to those responses
- When possible, effectively use eye contact and non-verbal expression

**Two-way communication**

- Practice meaningful two-way communication (i.e., communicate clearly, pay close attention and seek to understand others, and clarify information)
  - Be able to demonstrate good listening by summarizing or repeating communication back to other speakers
  - As appropriate, effectively use eye contact, posture, and other nonverbal cues
  - Be able to effectively answer questions of others or communicate an inability to do so and suggest other sources of answers
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Persuasion/influence

- Persuasively present thoughts and ideas
- Gain commitment and ensure support for proposed ideas

**6. Critical and Analytical Thinking:** Using logic, reasoning, and analysis to address problems.

Reasoning

- Possess sufficient logic, inductive, and deductive reasoning ability to perform job successfully
- Critically review, analyze, synthesize, compare, and interpret information
- Draw conclusions from relevant and/or missing information
- Understand the principles underlying the relationship among facts and apply this understanding when solving problems
- Be able to differentiate between fact and opinion
- Be able to effectively and efficiently present logic, reasoning, and analysis to others

Mental agility

- Identify connections between issues
- Quickly understand, orient to, and learn new assignments
- Shift gears and change direction when working on multiple projects or issues
- Be a willing, effective, and efficient learner

**7. Fundamental IT User Skills:** Using a computer, communication devices, and related applications to input, retrieve, and communicate information.

General Computer, Software, Information and Communication Technology Knowledge and Skills

- Demonstrate familiarity with the fundamental capabilities of computers, software, information systems, and communications systems
- Demonstrate familiarity with the fundamental principles of accessible technology, including universal design, as they relate to users of computerized content who have disabilities, sensory and/or functional limitations
- Understand terminology and function of common computer, software, information and communication technology devices, components, and concepts
- Understand common terminology related to the use of technology by people with disabilities and/or sensory and functional limitations, including accessible IT, assistive technology, and universal design
- Understand and efficiently use common computer hardware (e.g., desktops, laptops, tablets, PC components, , cabling), software (e.g., operating systems, applications, communication, collaboration and productivity software) and communication devices (e.g., telephony, wireless devices, network and wireless systems) to perform tasks and communicate effectively
- Be able to connect common User devices to networks and secure them appropriately
- Understand and be able to use with appropriate etiquette common communications media, including wired and wireless telephones, audio conferences, videoconferences and online collaboration tools
- Use a computer to search for online information and interact with websites and web applications (enterprise solutions, online stores, blogs, social networks, wikis)
- Understand how to critically evaluate online information and be aware of relevant copyright and data protection issues

Digital Literacy

- Demonstrate ability to create authentic meaningful written and artwork by reproducing and manipulating preexisting digital text, visuals, and audio pieces
- Demonstrate ability to construct knowledge by a nonlinear navigation through knowledge domains, such as in the Internet and other hypermedia environments
- Demonstrate ability to critically evaluate the textual characteristics of digital media alongside their social, economic and cultural implications
- Visualize graphic representation of concepts or data

Common IT Applications Use

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- Use word processing applications to compose, organize, and edit simple documents and other business communications, and produce accurate outputs to print or share electronically
  - Use standard formulas and functions, format and modify content, and demonstrate competence in creating and formatting spreadsheets, graphs, or charts
  - Use spatial software to locate places and interpret spatial data
  - Use and manage electronic mail to communicate with appropriate etiquette
  - Use Internet applications to search for information
  - Use presentation software to effectively share information and ideas
  - Understand and be able to use simple databases
  - Use spreadsheet, database, and presentation software both independently and in an integrated fashion
  - Use audio and video recording equipment and software to produce digital audio and video records and communications
  - Manage file storage: use functions to store, retrieve, and sort documents
  - Understand social media and their appropriate workplace uses
  - Double check work carefully and identify/correct typographical, grammatical and other errors

#### Cyber Safety

- Understand the importance of privacy and potential abuses of private information
- Be able to stay safe in an online, networked environment
- Understand the importance of updating and using the most recent security software, web browser, and operating system to protect against malware, and other online threats
- Recognize and respond appropriately to suspicious vulnerabilities and threats: web sites, web links, emails, posts, online advertisements, phishing, virus infections, etc.
- Recognize secure web addresses, e.g., “https://” or “shttp://”
- Protect and manage your personally identifiable information
- Understand and use privacy and security settings on social networking applications to share only appropriate personal information
- Review the privacy policy and understand what data (location, access to social networks) an application can access prior to downloading and installing
- Understand the risk of connecting to an unsecured or unprotected network
- Use strong passwords, passphrases and basic encryption

#### Information and Research Literacy

- Define: Be able to define a problem that needs information in order to be solved
- Access: Search, find and retrieve appropriate information relative to the task
- Manage: Apply an organizational or classification system to organize retrieved information
- Evaluate: Be able to judge the quality, relevance, usefulness, efficiency, and adequacy of information and information sources for the defined purpose (including the authority, bias and timelines of information)
- Integrate: Interpret and represent data and information gathered, using quality management tools to organize, compare, contrast, summarize and synthesize information from multiple sources
- Create: Adapt, apply, design or author information resulting from the research that describes the research and its analysis and findings, facilitates decision-making, and develops conclusions and recommendations
- Communicate: Communicate that research and its findings effectively and efficiently in person and through written, visual, and digital media in a way that is appropriate for the intended audience

#### Hardware

- Central processing unit (CPU)
  - Memory - random-access memory (RAM) and read-only memory (ROM)
  - Storage media, e.g., internal hard disk, external hard disk, network drive, CD, DVD, USB, flash drive, memory card
  - Input/output ports, e.g., USB, serial, parallel, network port, FireWire
  - Input devices, e.g., mouse, keyboard, trackball, scanner, touchpad, stylus, joystick, web camera, digital camera, microphone, voice recognition, remote control, and head, mouth, and eye operated controllers
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- Output devices, e.g., screens/monitors, printers, speakers, headphones
  - Assistive technology devices, e.g., voice recognition software, screen reader, screen magnifier, on-screen keyboard, closed captioning, text-to-speech
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### Tier 3 – Workplace Competencies

#### 1. **Teamwork:** Working cooperatively with others to complete work assignments.

##### Acknowledging team membership and role

- Accept membership in the team
- Identify the roles of each team member
- Show loyalty to the team
- Determine when to be a leader and when to be a follower depending on what is needed to achieve the team's goals and objectives
- Encourage others to express their ideas and opinions
- Identify and draw upon team members' strengths and weaknesses to achieve results
- Learn from other team members

##### Establishing productive relationships

- Develop constructive and cooperative working relationships with others
- Exhibit tact and diplomacy and strive to build consensus
- Show sensitivity to the thoughts and opinions of other team members
- Deliver constructive criticism and voice objections to others' ideas and opinions in a supportive, non-accusatory manner
- Cooperate with others and contribute to the group's effort
- Respond appropriately to positive and negative feedback

##### Identifying with the team and its goals

- Identify the goals, norms, values, and customs of the team
- Use a group approach to identify problems and develop solutions based on group consensus
- Effectively communicate with all members of the group or team to achieve goals and objectives
- Participate on virtual teams and use tools for virtual collaboration

##### Resolving conflicts

- Bring others together to reconcile differences
- Handle conflicts maturely by exercising "give and take" to achieve positive results for all parties
- Reach formal or informal agreements that promote mutual goals and interests, and obtain commitment to those agreements from individuals or groups

#### 2. **Planning and Organizing:** Planning and prioritizing work to manage time effectively and accomplish assigned tasks.

##### Planning

- Approach work in a methodical manner
- Plan and schedule tasks so that work is completed on time
- Keep track of details to ensure work is performed accurately and completely
- Work concurrently on several tasks
- Anticipate obstacles to project completion and develop contingency plans to address them
- Takes necessary corrective action when projects go off-track
- Apply lessons learned from previous tasks to more efficiently execute current tasks

##### Prioritizing

- Prioritize various competing tasks and perform them quickly and efficiently according to their urgency
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- Find new ways of organizing work area or planning work to accomplish work more efficiently

#### Allocating resources

- Determine personnel and other resources required for achieving project deliverables
- Allocate time and resources effectively and coordinate efforts with all affected parties

#### Project Management

- Develop, communicate, and implement a plan for a project
- Develop a timeline for sequencing the activities of a project
- Keep track of time, resources, assignments, and deliverables
- Anticipate obstacles and develop contingency plans
- Document plans, assignments, changes, and deliverables
- Understand and plan for dependencies (step A must be completed before step B)
- Manage activities to meet plans and adjust plans and communicate changes as needed
- Keep all parties informed of progress and all relevant changes to project timelines
- Engage in parallel-processing to keep multiple tasks moving forward

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### 3. Innovative Thinking: Generating innovative and creative solutions.

- Employ unique analyses and generate new, innovative ideas in complex areas
- Reframe problems in a different light to find fresh approaches
- Entertain wide-ranging possibilities to develop unique approaches and useful solutions
- Seek out and entertain diverse perspectives, including those from other fields and roles
- Understand the pieces of a system as a whole and possess a big picture view of the situation
- Integrate seemingly unrelated information to develop creative solutions
- Develop innovative methods of obtaining or using resources when insufficient resources are available
- Demonstrate innovative thinking by using new and existing technology in new ways
- Find new ways to add value to the efforts of a team and organization

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### 4. Problem Solving and Decision Making: Applying critical-thinking skills to solve problems by generating, evaluating, and implementing solutions.

#### Identifying the Problem

- Anticipate or recognize the existence of a problem
- Identify the true nature of the problem by analyzing its component parts
- Evaluate the importance of the problem
- Use all available reference systems to locate and obtain information relevant to the problem
- Recall previously learned information that is relevant to the problem
- Document the problem and any corrective actions already taken and their outcomes

#### Locating, gathering, and organizing relevant information

- Effectively use both internal resources (e.g., internal computer networks, manuals, policy or procedure guidelines) and external resources (e.g., internet search engines) to locate and gather information relevant to the problem
- Examine information obtained for relevance and completeness
- Recognize important gaps in existing information and take steps to eliminate those gaps
- Organize/reorganize information as appropriate to gain a better understanding of the problem
- Refer the problem to appropriate personnel when necessary

#### Generating alternatives

- Integrate previously learned and externally obtained information to generate a variety of high-quality alternative approaches to the problem
- Use logic and analysis to identify the strengths and weaknesses, the costs and benefits, and the short- and long-term consequences of different approaches

#### Choosing a Solution

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- Choose the best solution after contemplating available approaches to the problem, environmental factors, and conducting cost/benefit analyses
- Make difficult decisions even in highly ambiguous or ill-defined situations

#### Implementing the solution

- Commit to a solution in a timely manner, and develop a realistic approach for implementing the chosen solution
- Observe and evaluate the outcomes of implementing the solution to assess the need for alternative approaches and to identify lessons learned
- Document issues, plans, and solutions; get appropriate permissions; and communicate appropriately to impacted stakeholders

### 5. Working with Tools and Technology: Selecting, using, and maintaining tools and technology to facilitate work activity.

#### Selection and Application

- Identify, evaluate, select, and apply hardware or software tools or technological solutions appropriate to the task at hand (e.g., use statistical tools to show reliability of data)
- Identify potential hazards or risks related to the use of tools and equipment
- Present and obtain approval from decision-makers for acquiring tools and solutions
- Negotiate with and manage relationships with vendors of tools and technologies
- Operate tools and equipment in accordance with established operating procedures and safety standards
- Document tools and technologies and how they are used in the organization

#### Keeping Current

- Seek out and continue learning about new and emerging tools, technologies, and methodologies that may assist in streamlining work and improving productivity
- Take charge of your own personal and professional growth

### 6. Business Fundamentals: Knowledge of basic business principles, trends, and economics.

#### Situational Awareness

- Understand business mission and goals: impact, profit, market share, and/or reputation
- Understand the industry, trends in the industry, and the company's position in the industry and market
- Recognize one's role in the functioning of the company and understand the potential impact one's own performance can have on the success of the organization
- Stay current on organizational strategies to maintain competitiveness
- Understand relevant legal and regulatory requirements of the operation

#### Business Practices

- Apply effective people and project management skills
- Understand fundamental and relevant business customer and supplier relationships
- Use product improvement techniques
- Comply with the norms of conventional business etiquette
- Protect intellectual property and proprietary information
- Demonstrate understanding of the importance of adding value to the enterprise

#### Business Ethics

- Act in the best interest of the company, the community, and the environment
- Comply with applicable laws and rules governing work and report loss, waste, or theft of company property to appropriate personnel
- Demonstrate professional ethics to protect the privacy of the client, the integrity of the profession, and the privacy and integrity of you as an individual

#### Global Awareness

- Understand how IT supports globalization

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- Understand the impact of globalization on the business model
  - Interpret and adhere to global standards and standardization
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## Tier 4 – Industry-Wide Technical Competencies

**1. Principles of Information Technology:** Knowledge of Information Technologies (fundamental concepts, systems, platforms, tools, and technologies), IT industries (hardware, software, and services), the widespread application of IT in other industries, and the common roles of IT professionals.

### Critical Work Functions:

#### Fundamental IT Concepts

- Differentiate between information and data
- Understand the role of number systems
- Identify the elements of the system development life cycle
- Describe the role of technology in converting data and information into organizational knowledge
- Understand concepts of server, desktop, application, and virtualization
- Understand the purpose and function of fundamental communication system hardware, including end user devices, switches, routers, cabling, wireless access points, and radio towers
- Demonstrate fundamental understanding of, and skills with, common operating systems, software applications, and programming languages
- Differentiate between systems software and application software
- Identify and explain characteristics of the common types of application software
- Understand the potential for integration of system and software components
- Understand IT's role in globalization, and globalization's role in IT
- Understand different types of information processing (real-time, event-driven, batch, etc.)
- Keep abreast of IT trends and new technologies
- Demonstrate knowledge of IT procurement processes (services and equipment)
- Demonstrate knowledge of IT equipment disposal processes
- Demonstrate knowledge of user centered design principles and practices, including universal design as it relates to users with disabilities
- Demonstrate fundamental understanding of principles of accessible technology as they relate to users of computerized content who have disabilities and individuals with sensory, and/or functional limitations
- Understand major IT specialization roles and functions
- Explain the importance of good recordkeeping, documentation, and institutional knowledge preservation
- Explain the importance of information security, assurance, and privacy to individuals, organizations, industries, and societies

#### The Role of IT in Business

- Demonstrate behavior that reflects professional business ethics (e.g., honesty, integrity, responsibility)
  - Understand the concept of business analytics and the importance of ensuring that data and information systems support business goals and processes
  - Explain the importance of IT service level agreements (SLA) and their relationship to service provision
  - Demonstrate knowledge of the data requirements of business activities and their relationship to processing functions
  - Explain the need for business impact assessments and the importance of minimizing system down times and user impacts
  - Explain the importance of IT systems that are easy for IT Users to use and the importance of User support
  - Understand the fundamentals of insourcing (internally acquired and managed) versus outsourcing (externally managed “cloud-based”) IT solutions
  - Understand how a Request for Proposals (RFP) process works
  - Explain the importance of coordinating a business group's need/desire to use personal devices with IT's requirements to protect infrastructure and critical data
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- Understand how an IT department in an organization is typically organized, its mission, function, decision-making processes, and internal and external roles
  - Demonstrate knowledge of laws and regulations which require compliance reporting, including laws and regulations which require accessibility of information technology for employees, customers, and members of the public with disabilities
  - Demonstrate knowledge of business resiliency and resumption concepts
  - Explain the importance of user accessibility in achieving business goals, communicating with the public, and meeting federal equal employment opportunity requirements
  - Explain the importance of developing thorough, realistic IT solutions that support organizational objectives
  - Be able to interact with hardware vendors and manage vendor relationships
  - Understand common hardware purchasing, licensing, and maintenance agreements
  - Understand common business processes for installing, managing, and maintaining enterprise hardware and software

**Technical Content Areas:**

## Computers

- Distributed processing (hadoop)
- Laptop
- Mainframe computer
- Massively Parallel computer (e.g., HITACHI SR2201, IBM Deep Blue)
- Mobile Phones
- Netbooks
- Network computer/server
- Personal computer
- Super Computer (e.g., Cray)
- Tablet
- Thin Client/Cloud Computing
- Virtual Machines
- Wearable computers

## Information processing Cycle

- Input
- Process
- Output
- Storage
- Archive

## Types of information processing

- Batch
- Interactive
- Event-driven
- Object-oriented
- Realtime

## Platform Technologies

- Architecture and organization
  - Client vs. Server
  - Cloud computing
  - Computing infrastructures
  - Connected platform technologies
  - Customization and extensions
  - Enterprise deployment software
  - Firmware
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- Hardware
- Interoperability with assistive technology devices
- Open source
- Operating systems

#### IT Organizational Structure

- The IT firm/organization
- IT management and decision-making
- IT support within a company
- Support for business solutions

#### Systems Sourcing and Installation

- Requirements development
- Internal Solution Design
- External Solution Evaluation
- Managing and evaluating external Requests for Proposals (RFPs)
- Analyzing, evaluating, communicating, and selecting appropriate solutions
- Developing and executing installation, transition, and cutover plans
- Activation of user accessibility features
- Documenting solutions and their implementations
- Training ongoing maintenance operations and Users on new systems

#### Systems Administration and Maintenance

- Administrative activities
- Administrative domains
- Applications Installation and Updating

#### Systems Integration and Architecture

- Acquisition and sourcing
- Architecture
- Interfacing techniques between modules, systems, and components
- Compatibility between interfaces and assistive technologies
- Organizational context
- Requirements
- Testing and quality assurance

**2. Databases and Applications:** The use of technology to control and safeguard the collection, organization, structure, processing and delivery of data.

#### Critical Work Functions:

- Understand fundamental concepts of database design and the need for database architectural strategies to fit business or industry requirements
- Differentiate between databases and flat files
- Differentiate between hierarchal and relational databases
- Understand metrics used to characterize data and different kinds of data (structures, unstructured, text-based, character limits)
- Understand importance of very large, unstructured data sets that have to be managed and queried in new ways to find meaning and value (“Big Data”)
- Demonstrate ability to analyze data requirements
- Demonstrate familiarity with common database administration and maintenance tasks
- Follow information management standards and guidelines
- Understand purpose and process of coding and tagging information
- Demonstrate ability to find and select the information, appropriate tools, and processing techniques needed for a task

- Understand logical and physical components of an information storage infrastructure
- Explain the role and relationships of data, information, and databases in organizations, specifically their role in business intelligence
- Describe mechanisms for data collection and management, e.g., automated data collection, input forms, source documents, external devices, interfaces, relational characteristics, and dependencies
- Assess the quality, accuracy, and timeliness of given data
- Demonstrate knowledge of managing data as official records
- Demonstrate knowledge of identifying and protecting privacy data and sensitive information
- Be able to create and query a basic database
- Understand how other applications interact with databases to create and retrieve data

**Technical Content Areas:**

Data Administration

- Concepts and fundamentals of data management
- Data integration
- Data modeling

Database Management

- Data architecture
- Data storage (online, near-line, archive)
- Database query languages
- Managing the database environment
- Metadata
- Semantic Web
- Special-purpose databases
- Use of graphical vs. textual representations of database structures

Data models

- Dimensional models
- Flat files
- Hierarchical model
- Logical databases
- Network model
- Object databases
- Object-relational databases
- Relational model
- Semantic models

Business Intelligence

- Competitive intelligence
- Data analytics
- Data mining
- Data warehousing
- Predictive data modeling
- Web analytics

Data Protection

- Archiving
- Data encryption
- Data masking

**3. Networks, Telecommunication, Wireless, and Mobility:** The processes, hardware, and software employed to facilitate communication between people, computer systems and devices.

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**Critical Work Functions:****Fundamentals of Networking and Telecommunication**

- Identify and describe differences between Local Area Networks (LAN), Wide Area Networks (WAN), Virtual Private Networks (VPN), Internet, intranets, extranets, telephony, Voice over IP (VoIP), and other networks
- Describe common network topologies
- Differentiate between common networking protocols
- Explain the purpose and properties of IP addressing
- Explain the purpose and properties of routing and switching
- Explain DNS concepts
- Explain the purpose and properties of DHCP
- Recognize common network media and connector types
- Identify and explain the need for common network monitoring resources
- Understand basic telephony (e.g., analog vs. digital signals) and how it is integrated into IP networks
- Describe the purpose of network configuration documentation
- Recognize methods of network optimization
- Explain the functionality, integrity, accessibility, and security of internet services
- Explain different server roles, their purpose, and how they interact in a network context
- Differentiate between Cloud-based applications, local server-based applications, and applications installed on a local computer, and know when to choose between them
- Understand key tasks performed during the maintenance, administration, and securing of Local Area Networks
- Identify common network infrastructure troubleshooting techniques

**Wireless and Mobility**

- Identify characteristics of wireless communication standards
- Identify and describe common mobile devices and mobile communications technologies
- Understand basic radio frequency concepts, including signal, signal strength, antenna, receiver, interference, and common frequency bands
- Identify and describe various operating systems used in common mobile devices and discuss their advantages and disadvantages
- Identify and describe basic accessibility features of mobile and wireless devices
- Understand principles of wireless network security
- Explain the benefits and drawbacks of mobile computing, including its effect on business
- Understand concepts of mobile social-networking services
  - Location-related services (e.g., check-in)
  - Visualization mechanisms (e.g., augmented reality showing where friends are)

**Network Security**

- Recognize and describe threats to networked computer systems, including malware (viruses, spyware, adware)
- Understand the purpose and basic features of a firewall, Intrusion Detection System (IDS), and Intrusion Protection System (IPS)
- Recognize methods of network access security
- Explain the importance of user authentication and recognize examples
- Describe malware protection procedures

**Virtualization and Cloud Computing**

- Understand virtualization concepts, features, benefits, and considerations
  - Differentiate types of “cloud services”, including
    - Infrastructure as a service (IaaS)
    - Platform as a service (PaaS)
    - Software as a service (SaaS)
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- Differentiate between public, hybrid, and private clouds
  - Understand the following characteristics of clouds and clouds services from a business perspective:
    - Distribution over the Internet
    - Environmental impact
    - Hardware and independence
    - Operating costs
    - Scalability
    - Security
    - Time to market
    - Variable costs
  - Understand and explain the decision making process when choosing between internally built and managed services and externally sourced services
  - Describe the impact of cloud computing on application architecture and the application-development process
  - Explain the legal, compliance, accessibility, and privacy issues associated with cloud computing

#### Data Storage Systems

- Explain the importance of reliable and efficient data backup and restoration
- Understand the rapid expansion of data and the challenge that places on IT systems
- Explain the concepts of data backup, disaster recovery, data mirroring, and off-site storage
- Describe different types of data storage solutions (e.g., RAID)
- Describe common data backup and storage networking solutions (e.g., SAN, NAS, iSCSI)

#### Technical Content Areas:

##### Foundations of networking

- Architectures, such as
  - TCP/IP
  - SNA
  - Netware
- Network Models
  - OSI model (7-layer)
  - TCP/IP model (4-layer)
- Network components
  - Hubs
  - Switches
  - Routers
  - Firewalls
  - Access points
  - Thin Client Access points
  - WLAN (Wireless LAN) Controller
  - Transmission media (e.g., coaxial cable, wireless, fiber, unshielded twisted pair-UTP)
- Network capacity and performance metrics
- Network mapping
- Network servers and server operating systems
- Integration of desktops into network systems
- LANS, WANS, WLANs, VLANs, virtual networks, intranets, extranets
- Routing and routing protocols
- Ethernet
- IPv4 and IPv6
- Network Storage
  - SAN
  - NAS

##### Internet Services

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- Protocols, such as
    - TCP
    - FTP
    - UDP
    - TCP/IP suite
    - DHCP
  - Internet Connection testing tools , such as
    - Ping
    - Trace route
    - Net stat
    - Host
    - Dig
    - Nslookup

#### Web Management

- Analytics
- Key performance indicators
- Optimization
- Utilization
- Internal vs. external web hosting
- Human usability, including accessibility and usability by people with disabilities and individuals with sensory and/or functional limitations

#### Common mobile technologies, such as

- Laptop and netbook computers
- Mobile phones and 'smart phones'
- Global positioning system (GPS) devices
- Wireless debit/credit card payment terminals
- RFID

#### Mobile communication technologies, such as

- 4G mobile data systems
- Bluetooth
- Dial-up services
- GPS
- 'Third generation' (3G), global system for mobile communications (GSM) and general packet radio service (GPRS) data services
- Virtual private networks
- Wireless fidelity (Wi-Fi)

#### Mobile Operating Systems, such as

- Android
- Bada
- iOS
- Microsoft Windows
- Research in Motion (RIM)
- Symbian

#### Data Storage Systems concepts, such as

- Data Mirroring
  - Fiber-Channel
  - Network Attached Storage (NAS)
  - RAID
  - Storage Area Network (SAN)
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- Tape Backup Systems

**4. 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.

**Critical Work Functions:**

Software Development

- Recognize steps in common Software Development Life Cycle (SDLC) models, e.g.:
  - Analyze user needs and software requirements, including security and accessibility functions
  - Design a secure software solution that fits within time and cost constraints
  - Implement (develop) software based on design
  - Test software, make necessary modifications and assure its quality, accessibility, and usability
  - Deploy and integrate software
  - Maintain and administer software
- Explain the importance of integrating security requirements into SDLC
- Understand and explain the importance of integrating user accessibility concepts and standards into the software development life cycle
- Understand common software architectures, including layered and distributed architecture models
- Describe modern tools for modeling software
- Recognize the existence of platform-specific developmental requirements, e.g., embedded systems, mobile computing, specialized devices, augmented reality, wearable computing
- Understand basic Web development functions and processes
- Recognize the importance of successful collaboration between software developers and designers, i.e., a developer's ability to translate an "artistic" design into a functioning piece of software
- Describe the principles of user-centered design and universal design to increase usability
- Understand how software developers document their work
- Be able to interact effectively with a software development team

Programming

- Understand the importance of creating and understanding flowcharts, logic models, and other models that depict software logic and function
- Know what an algorithm is and how it works
- Understand relationships between software programs and the hardware and operating systems they run on
- Understand the difference between machine languages and higher level languages and how compilers translate between them
- Recognize common programming and scripting languages and what they are used for
- Understand what object-oriented programming is
- Describe secure coding practices and defensive programming techniques
- Understand and explain the relationships between databases and programming
- Describe common business processes for collecting information and feedback on software functionality
- Understand how software can include built-in accessibility features for people with disabilities and also can be designed in a way that is compatible with assistive technology devices
- Recognize the importance of maintenance and testing to the continued functioning of software
- Recognize major software security concerns (buffer overflow, X-site scripting, SQL Injection, etc.) and coding and management techniques to mitigate them
- Understand how programmers document their work
- Be able to interact effectively with programmers

Software Acquisition, Management and Maintenance

- Recognize and have familiarity with common operating systems, e.g., Windows, Mac, Linux, Unix, iOS, Android
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- Recognize and have familiarity with accessibility features of all common operating systems
  - Recognize and have familiarity with common enterprise software applications, e.g., Office Productivity Suites, Customer Relationship Management, Enterprise Resource Planning, Accounting/Finance, Database, Human Resource Management, Email, Online Collaboration
  - Understand and be able to evaluate systems requirements for software
  - Understand differences between enterprise hosted and outsourced software solutions, e.g., cloud
  - Be able to evaluate business needs, software solutions and justify decisions for software solution acquisition, including build versus buy options
  - Understand how 3<sup>rd</sup> party software is augmented with other solutions
  - Be able to interact with software vendors and manage vendor relationships
  - Understand common software purchasing, licensing, and maintenance agreements
  - Understand common business processes for installing, managing and maintaining enterprise software
  - Explain the process of software evolution
  - Understand the purpose of, and differences between, updates, patches, and third-party modifications
  - Recognize the impacts changes in software and interruptions to systems will have on end users and know how to minimize negative impacts, e.g., use of maintenance windows
  - Be able to develop and maintain high quality software documentation (e.g., installation and update history, compatibility issues, license assignments) and communicate this information effectively to stakeholders
  - Recognize the security risks and accessibility implications inherent in updating or modifying software

**Technical Content Areas:**

## Application Architecture

- Configuration and adaptation
- Deployment
- Design Patterns
- Risk management
- Scalability
- Standards
- Strategies

## Development/Programming Fundamentals

- Algorithms (sorting, searching, automating and improving efficiency)
- Application Program Interface (API)
- Basic programming constructs (assignment, arithmetic expressions, loops, conditions, input/output, error handling)
- Data structures (list, vector, array, stack, queue, tree, graph, maps)
- Event-driven programming
- Object oriented programming
- Programming concurrent processes
- Secure coding standards
- Testing/Quality Assurance
- User interface/user experience (UIUX)

## Development/Programming Technologies

- Database
- Integrative coding
- Inter-systems communications
- Machines languages and compilers
- Parallel systems development/programming
- Programming and scripting languages
- Software security practices

## Software Development Life Cycle Models, such as

- Agile model
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- Evolutionary model
- Incremental model
- Spiral model
- Waterfall model

#### Web Development

- Quality assurance
- Technical content
- Web site accessibility
- Web site design and usability
- Web site development/programming and maintenance
- Web site/Internet security

**5. User and Customer Support:** The range of services providing assistance and technical support to help users implement and solve problems related to information technology.

#### Critical Work Functions:

- Describe the importance of understanding different user groups and their perspectives, concerns, and technology uses
- Demonstrate ability to communicate with users/customers for the purpose of assessing their needs and helping them solve problems
- Understand the design and structure of an IT business or product plan
- Assess the user implications of new IT solutions, including the business benefits
- Explain the importance of maintaining business and process continuity throughout IT changes such as software or hardware modifications
- Provide customer service and support for common software/hardware issues
- Provide customer services and support for common accessibility issues, including activating built-in software accessibility features and facilitating compatibility and interoperability with assistive technology devices
- Provide training on new hardware/software
- Demonstrate ability to troubleshoot problems in person or remotely
- Analyze symptoms to identify broad area of user error or technical failure
- Identify measurement techniques for increased productivity due to information support implementation
- Identify and describe quality assurance concepts
- Implements and provides guidance for the evolution of an IT solution (upgrades)
- Understands the importance of identifying and classifying incident types and service interruptions
- Describe the importance of good documentation and recordkeeping in customer service operations
- Describe how call centers typically operate

#### Technical Content Areas:

##### Engagement

- Applications (Apps)
- Communicating with the user
- Community architecture
- Content development and categorization
- Engagement success metrics
- Familiarity with alternative methods of communicating with users (both in person and remotely) who have disabilities and/or sensory or functional limitations
- Inventory and audit of content assets

##### Helpdesk Functions

- Administrative activities
- Application support
- Asset management
- Build-in accessibility features of products

- Computing infrastructures and networks
- Configuration management
- Incident and problem management
- Operating systems
- Release management
- Strategies for engaging the community
- Strategies for supporting the interoperability of operating systems and software with assistive technology devices
- Systems administration, monitoring, and maintenance
- User participation guidelines/ground rules

**6. Digital Media and Visualization:** Conveyance of ideas and information in forms such audio, text, pictures, diagrams, video, photos, maps, 3D models, et cetera.

**Critical Work Functions:**

- Demonstrate awareness of common audio, video, graphic, mapping, and animations software
- Demonstrate ability to work effectively with digital environments, such as user interfaces, that employ graphical communication to effectively find, interpret, evaluate, use and create images and visual media
- Understand how to organize different media together for effective communication (design) and how that needs to work together with technical functionality (development)
- Demonstrate awareness of advanced digital presentation media technology
- Understand the general requirements and impacts on IT systems of different kinds of digital media (e.g., bandwidth, server and storage requirements, network quality of service, processing power)
- Understand the basics of audio- and video-conferencing solutions, their basic components and how they work
- Understand basics of digital printing and common digital printing devices
- Understand the reasons, constraints, and sacrifices that lead to compression technologies and recognize major compression technologies and their uses
- Understand the business importance of different kinds of digital media (e.g., website downtime implications, loss of productivity with loss of media access, etc.)
- Understand the implications to business of digital media as data
- Demonstrate awareness of potential accessibility issues and solutions related to multimedia presentations, including creation of text equivalents of non-text elements and captioning of audio material
- Describe how bandwidth affects data transmission and on-screen image
- Be able to work effectively with both technical and creative users of digital media technologies

**Technical Content Areas:**

- Alternate text presentations and audio descriptions
- Digital media application test and implementation
- Digital media design
- Digital media production and acquisition
- Gaming
- Graphics
- Maps
- Multi-media technology
- Multi-user applications
- Streaming technologies
- Utilization and optimization
- Videos and dialogues
- Visual and functional design

**7. Compliance:** The standards, processes, and procedures in place to ensure products, services, and practices comply with legal and regulatory requirements.

**Critical Work Functions:**

- Abide by a Code of Ethics for professional conduct
- Explain the difference between international, national, state, and local laws, regulations, and technical standards
- Follow governance, risk management, and compliance procedures
- Identify the main data protection rights for a data subject in your country
- Understand measures to ensure that data and information systems comply with federal, state, local laws and regulations, and third party guidelines
- Understand the importance of IT hardware and software accessibility to users with disabilities or sensory and/or functional limitations
- Understand Federal laws and international guidance related to accessibility of technology for people with disabilities
- Explain software licensing agreements and the importance of ensuring that software is properly licensed prior to performing installation
- Understand the concept of an End User License Agreement (EULA)
- Differentiate between open source and proprietary licenses
- Understand creative commons licenses

**Technical Content Areas:**

## Compliance Standards

- Accessibility standards including the U.S. Electronic and Information Technology Accessibility Standards (Section 508) and the Web Content Accessibility Guidelines (WCAG) 2.0
- Global standards
- Internet standards
- Privacy protection standards
- Security standards

## Important Topics

- eDiscovery
- Intellectual property
- Professional ethics
- Safeguarding confidential data

## Public Policy

- Accessibility requirements, including those in Section 508 of the Rehabilitation Act, Section 255 of the Telecommunications Act, the 21<sup>st</sup> Century Communications and Video Accessibility Act, and the Web Consortium Accessibility Guidelines (WCAG) 2.0
- Client program management operations (PMO)
- Code of Federal Regulations (CFR)
- Federal, state and local laws
- ISO requirements

**8. Risk Management, Security, and Information Assurance:** The standards, issues, and applications used to protect the confidentiality, integrity and availability of information and information systems.

**Critical Work Functions:**

## Risk Management

- Explain the concepts and use of risk management frameworks and how to determine threat levels using concepts of vulnerabilities, threat source, motivation, likelihood, and impact
- Explain concepts of risk-avoidance, transference, acceptance, mitigation, and deterrence in the context of an organization's risk threshold
- Understand the importance and use of personnel security and background investigations
- Understand the concept of inherent risk in end user behavior
- Understand "insider threat"

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- Understand the importance of organization-wide awareness of risk management policies

#### Security and Information Assurance Fundamentals

- Explain the concepts of Governance, Risk and Compliance (GRC)
- Explain the need for an organization security program and the use and importance of organizational security policies
- Explain the importance of ensuring accurate data and keeping information systems available to authorized uses
- Explain concepts of Confidentiality, Integrity, and Availability (CIA)
- Understand legal and regulatory requirements and justifications for maintaining information security including the importance of maintaining working knowledge of laws, regulations, directives, and standards for information security
- Understand the importance of protecting data and information systems from accidental disclosure or destruction, unauthorized access or modification, and inappropriate use or malicious compromise
- Describe methods for secure use of social media
- Explain the use and importance of security awareness programs
- Explain importance of configuration management to security operations
- Understand the need for separation of duties and other business controls
- Understand the need for controls and privileges based on an individual's job duties

#### Security Operations

- Describe major access control systems and their function
- Explain concepts involved in IT security technologies, including cyber terrorism and its countermeasures, and various auditing and monitoring tools and techniques
- Recognize potential IT security threats and risks, including common attacks, vulnerabilities, and methods used to compromise systems
- Understand value and limitations of user education
- Identify common measures used to protect privacy and confidential data
- Explain the need for regular backup procedures
- Demonstrate knowledge of vulnerability identification techniques and tools
- Explain the importance and application of physical security measures
- Demonstrate knowledge of system protection services like intrusion detection/prevention, communications filtering, firewall management, malware detection
- Explain common communications protocols and how to apply security to them, e.g., IPSEC, SSL, TLS
- Demonstrate knowledge of methods to protect web services
- Demonstrate knowledge of security concepts for cloud services
- Explain use of encryption technology, e.g., PKI, hard drive encryption, data encryption, encryption-at-rest, and secure communications protocols
- Describe issues with unsecured User devices on secured systems

#### Business Resiliency

- Explain the concept of business continuity
- Understand the difference and use of types of contingency plans (e.g., Business Continuity Plan, Continuity of Operations Plan, Crisis Communications Plan, Disaster Recovery Plan, and Information Systems Contingency Plans)
- Identify the types of IT/technology disaster scenarios that may impact an organization
- Recognize opportunities for strategic improvement or mitigation of business interruption and other risks caused by business, regulatory, or industry-specific initiatives
- Explain business impact assessments and their use
- Identify concepts and techniques for disaster recovery and business restoration
- Identify typical roles and responsibilities in disaster recovery planning activities and scenarios

#### Incident Management

- Describe incident identification, reporting, management, and investigation
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- Describe the use of computer forensics to prevent and solve information technology crimes and security breaches
  - Describe the impact of existing legislation on the practice of digital forensics
  - Explain the concept of electronic discovery (e-discovery)
  - Explain the importance of maintaining evidence integrity and chain of custody during the forensic examination process
  - Identify criminal activity in relationship to cybercrime, the Internet, and Internet trafficking

#### Secure Information System Development

- Explain Secure Development Life Cycle
- Explain concepts of Secure Architecture and design
- Explain concepts and techniques for secure software coding and defensive programming
- Explain concepts of module, unit and system security testing
- Understand concepts of system and human interaction that could affect security

#### Technical Content Areas:

##### Program Management

- Auditing
- Business impact assessment
- Business recovery and continuity
- Capital planning and investment
- Configuration management
- Governance
- Incident management and privacy breach reporting
- Performance management
- Policy development
- Policy enforcement
- Risk management
- Security awareness program
- Security planning
- System accreditation
- System acquisition

##### Data Accessibility

- Access controls (physical and logical)
- Fundamentals of data security
- Mandatory access control (MAC) vs. Discretionary access control (DAC) vs. Role based access control (RBAC)
- Operational issues
- Protecting private, proprietary, or confidential data
- Remote access controls
- User and customer support

##### Data Integrity

- Data Input Validation Intrusion Detection Encryption
- ID management
- Information states
- Interconnection agreements
- Redundancy

##### Data Protection

- Data encryption, “encryption at rest”
  - Data loss prevention techniques and tools
  - Data masking
  - Privacy impact assessments
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- System security controls
  - Test data management

#### Development

- Configuration/change management
- Insure Business analysis/Use cases address business process security
- Secure coding and defensive programming
- Security architecture design
- Security development life cycle
- Security testing

#### Operations

- Incident reporting
- Log management
- Penetration testing
- Security Information and Event Management (SIEM)
- Security monitoring
- System and security documentation
- Testing and Application of software patches/errata/updates
- Vulnerability assessments

#### Legal, Regulations, Investigations and Compliance, such as

- Federal Laws (FISMA, GLBA, Telecommunications)
- HIPAA
- ISO standards
- Payment Card Industry Standard
- Sarbanes-Oxley

#### Security Classification

- Government
  - Classified
  - Controlled but Unclassified (CUI)Unclassified
  - Secret
  - Top Secret
  - Unclassified
  - Unclassified For Official Use Only (UNCLASSIFIED/FOUO)
- Industry
  - Confidential
  - Do Not Forward
  - Need-to-know
  - Proprietary
  - Restricted
  - Sensitive

#### Networking and Communications

- Bluetooth
- Firewalls
- Intrusion detection/protection
- IPSEC
- PKI (Public Key Infrastructure)
- Secure protocols (SSL, TLS, HTTPS, WPA)
- VOIP
- Wireless

#### Physical Security

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- Access Barriers
- Biometrics
- Climate control
- Fire protection
- Key card technologies
- Power protection

#### Threats

- Application
- Attacks, such as
  - Malware
  - Denial of Service
  - Social engineering
- Insider Threat
- Social Media
- Threat analysis model
- Wireless

#### Forensics

- Chain of custody
  - E-discovery
  - Investigation techniques
  - Investigation tools
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## Resources Reviewed

Developer	Resource	URL
Certified Wireless Network Professional (CWNP), Inc	CWNA Exam Objectives	<a href="http://www.cwnp.com/wp-content/uploads/pdf/PW0-105_Exam_Objectives_v5.02.pdf">http://www.cwnp.com/wp-content/uploads/pdf/PW0-105_Exam_Objectives_v5.02.pdf</a>
CompTIA	Cloud Essentials Exam Objectives; Security+ Certification Exam Objectives; Network+ Certification Exam Objectives	<a href="http://certification.comptia.org/home.aspx">http://certification.comptia.org/home.aspx</a>
DRI International	Professional Practices for Business Continuity Practitioners	<a href="https://www.drii.org/docs/professionprac.pdf">https://www.drii.org/docs/professionprac.pdf</a>
Electronics Technicians Association	Wireless Communications Electronics Technician Competencies	<a href="http://www.eta-i.org/Comps/WCM%20Comps.pdf">http://www.eta-i.org/Comps/WCM%20Comps.pdf</a>
European e-Competence Framework	European e-Competence Framework 2.0	<a href="http://www.ecompetences.eu/site/objects/download/5983_EUeCF2.0framework.pdf">http://www.ecompetences.eu/site/objects/download/5983_EUeCF2.0framework.pdf</a>
Federal Communications Commission	Accessibility and Innovation Initiative Accessibility Clearinghouse	<a href="http://www.broadband.gov/accessibilityandinnovation/">http://www.broadband.gov/accessibilityandinnovation/</a> <a href="http://apps.fcc.gov/accessibilityclearinghouse/">http://apps.fcc.gov/accessibilityclearinghouse/</a>
Florida International University	Mark D. Osterman, "Digital Literacy: Definition, Theoretical Framework, and Competencies" in Florida International University: The 11 <sup>th</sup> Annual College of Education and Graduate Student Network Research Conference	<a href="http://education.fiu.edu/research_conference/docs/12/COERC2012Proceedings.pdf#page=152">http://education.fiu.edu/research_conference/docs/12/COERC2012Proceedings.pdf#page=152</a>
ICDL	European Computer Driving License/ International Computer Driving License Syllabus Version 5.0	<a href="http://www.icdlus.org/media/ECDL_ICDL_Syllabus_Version_51.pdf">http://www.icdlus.org/media/ECDL_ICDL_Syllabus_Version_51.pdf</a>
Information Systems Audit and Control Association (ISACA)	Information Assurance, Certification and Documentation	<a href="http://www.isaca.org/Knowledge-Center/Pages/default.aspx">http://www.isaca.org/Knowledge-Center/Pages/default.aspx</a>
International Information Systems Security Certification Consortium (ISC)	Security (Systems, data, network), Certification and Documentation	<a href="https://www.isc2.org/industry-resources.aspx">https://www.isc2.org/industry-resources.aspx</a>
International Society for Technology in Education (ISTE)	The National Educational Standards (NETS) for Students	<a href="http://www.iste.org/Libraries/PDFs/NETS-S_Standards.sflb.ashx">http://www.iste.org/Libraries/PDFs/NETS-S_Standards.sflb.ashx</a>
International Society of Forensic Computer Examiners	CCE Certification Competencies	<a href="http://www.isfce.com/policies/CCE%20Certification%20Competencies.pdf">http://www.isfce.com/policies/CCE%20Certification%20Competencies.pdf</a>
ITIL	The ITIL Foundation Certificate in IT Service Management Syllabus	<a href="http://www.itil-officialsite.com/Qualifications/ITILQualificationLevels/ITILFoundation.aspx">http://www.itil-officialsite.com/Qualifications/ITILQualificationLevels/ITILFoundation.aspx</a>
National Association of State Directors of Career Technical Education Consortium (NASDCTEc)	Information Technology Career Cluster: Career Foundation; Network Systems; Information Support and Services; Web and Digital Communications; Programming & Software Development	<a href="http://www.careertech.org/career-clusters/resources/clusters/it.html">http://www.careertech.org/career-clusters/resources/clusters/it.html</a>
National Initiative for Cybersecurity Education (NICE)	National Cybersecurity Workforce Framework	<a href="http://csrc.nist.gov/nice/framework/">http://csrc.nist.gov/nice/framework/</a>
Research in Comparative and International Education	David Buckingham, "Digital Media Literacies: Rethinking Media Education in the Age of the Internet"	<a href="http://www.wwords.co.uk/rss/abstract.asp?j=rcie&amp;aid=2988">http://www.wwords.co.uk/rss/abstract.asp?j=rcie&amp;aid=2988</a>



Developer	Resource	URL
Social Care Institute For Excellence	Competencies for Knowledge Management	<a href="http://www.scie.org.uk/assets/elearning/knowledgemanagement/km08/object/assets/common/pdfs/competencies_for_knowledge_management.pdf">http://www.scie.org.uk/assets/elearning/knowledgemanagement/km08/object/assets/common/pdfs/competencies_for_knowledge_management.pdf</a>
TFPL	TFPL Knowledge and Information Management Competency Dictionary	<a href="http://kmefcompetenciescop.iwiki.kent.edu/file/view/KIM_dictionary_table1.pdf">http://kmefcompetenciescop.iwiki.kent.edu/file/view/KIM_dictionary_table1.pdf</a>
University of North Texas	Principles of Information Technology	<a href="http://cte.unt.edu/it/curriculum/principles">http://cte.unt.edu/it/curriculum/principles</a>
US Air Force	“Software Life Cycle” in Guidelines for Successful Acquisition and Management of Software-Intensive Systems: Weapon Systems, Command and Control Systems, Management Information Systems - Condensed Version 4.0 February 2003	<a href="http://www.stsc.hill.af.mil/resources/tech_docs/gsam4/chap2.pdf">http://www.stsc.hill.af.mil/resources/tech_docs/gsam4/chap2.pdf</a>
US Chief Information Officers Council (CIO)	CIO Clinger-Cohen Core Competencies	<a href="https://cio.gov/cio-council-releases-updated-clinger-cohen-core-competencies-learning-objectives/">https://cio.gov/cio-council-releases-updated-clinger-cohen-core-competencies-learning-objectives/</a>
US Department of Labor, Office of Disability Employment Policy	Accessible Technology	<a href="http://www.dol.gov/odep/topics/Technology.htm">http://www.dol.gov/odep/topics/Technology.htm</a>
US Department of Labor, Occupational Information Network (O*Net) Occupation Profiles	Computer and Information Systems Managers; Computer Hardware Engineers; Computer Network Architects; Computer Network Support Specialists; Computer Operators; Computer Programmers; Computer Systems Analysts; Computer Systems Engineers/Architects; Computer User Support Specialists; Data Warehousing Specialists; Database Administrators; Database Architects; Document Management Specialists; Information Security Analysts; Information Technology Project Managers; Network and Computer Systems Administrators; Software Developers, Applications; Software Developers, Systems Software; Web Administrators	<a href="http://www.onetonline.org/">http://www.onetonline.org/</a>
US Department of Labor, Office of Apprenticeship	Information Technology Generalist Work Process Schedule	<a href="http://www.doleta.gov/oa/bul07/Bulletin-2007-12-att3.pdf">http://www.doleta.gov/oa/bul07/Bulletin-2007-12-att3.pdf</a>
US General Services Administration	Section 508 and IT Accessibility	<a href="http://www.section508.gov;">www.section508.gov;</a> <a href="http://www.buyaccessible.gov">www.buyaccessible.gov</a>
US Office of Personnel Management	Job Family Standard for Administrative Work in the Information Technology Group, 2200	<a href="http://www.opm.gov/fedclass/GS2200A.pdf">http://www.opm.gov/fedclass/GS2200A.pdf</a>
USA Learning	Information Technology (IT) Workforce Development Roadmap	<a href="http://itroadmap.usalearning.gov/Default.aspx?tabindex=1&amp;tabid=2">http://itroadmap.usalearning.gov/Default.aspx?tabindex=1&amp;tabid=2</a>
The World Wide Web Consortium (W3C)	Web Content Accessibility Guidelines (WCAG) 2.0	<a href="http://www.w3.org/TR/2008/REC-WCAG20-20081211/">http://www.w3.org/TR/2008/REC-WCAG20-20081211/</a>

## **G: ICT Survey Response Data and Statistical Analysis**



## **H: Draft Possible Modified California IT Competency Model Content**

These are working drafts of modifications to DOL IT Model competencies, based on suggested changes and additions provided by employers completing the surveys. These changes have not been validated in a statistically significant way, at this time.