

Building a Workforce Ready for the Internet of Everything

The promise of the Internet of Everything (IoE)—a world in which more and more of its people, processes, data, and things are able to be interconnected—is everywhere. The Internet is the backbone for an increasing number of devices and sensors, which yield rich sources of data that can be combined and analyzed in new and meaningful ways to improve quality of life and spur business growth. We are seeing the promise from many corners of our personal and work lives:

- Smart cities that can provide better management of sanitation, energy, mass transit, and parking
- Cars that can function as connected, intelligent computer networks, talking to other cars about road conditions and getting us to places safer and faster
- Wearable devices, embedded sensors, and environmental monitoring that can make it easier to stay healthy
- Manufacturers that are being put in touch with data that can help them optimize operations and cut costs
- Improved supply chain management that can allow businesses to react in real time to changes in inventory, delivery times, and supply and demand
- Intelligence embedded into myriad tools and processes to provide businesses with increased speed and agility so that they are freer to focus on innovation and be better poised to tap into a worldwide market that could be worth trillions of dollars in new opportunities

Many Technologies Driving IoE

Technologies such as mobility, big data, and cloud computing are contributing to the importance of IoE. The connecting of billions of new mobile devices will fuel IoE by providing organizations and businesses with increasingly valuable amounts of data. Multitudes of sensors will be generating still more data to help guide better and faster business decisions—data that will require powerful analysis capability to be converted into useful information. Cloud computing will continue to allow customers to make significant changes to their network infrastructure as they accommodate more and more connected devices and data; this trend will intensify as these customers seek to take further advantage of IoE and accelerate the speed of doing business.

In addition, the rise of IoE is bringing other technologies to the forefront. It is now well understood that all of the interconnections afforded by IoE to enrich our lives also create new avenues for cybercriminals. Besides security, software-defined networking (SDN), or network programmability, will play an important role in the growth of IoE by making it easier to install, configure, integrate, and run applications across physical, virtual, and cloud-based infrastructures.

A Global Talent Shortage: The Challenge Behind the IoE Opportunity

The job skills associated with these IoE-related technology areas will, not surprisingly, be in high demand as IoE continues to forge connections between people, processes, data, and things. Add to this the fact that large numbers from the Baby Boomer generation will soon be retiring from the workforce faster than they can be replaced by those from the Generation X and Millennial groups, and the prospect of a worldwide talent shortage becomes evident.

Jobs crucial to IoE in areas such as mobility, big data, cloud computing, security, and network programmability will be some of the hardest hit by the talent shortage. World Bank studies estimate that during the next 10 years, there will be two million unfilled information and communications technology (ICT) jobs globally. To connect the unconnected, it is estimated that 220,000 new engineers will be required every year from 2014 to 2022 to manage 50 billion connected devices in the IoE landscape.

“There is a growing disconnect between the skills employers need and the skills that are being cultivated in the labor market today,” says Matt Ferguson, CEO of the human capital solutions leader CareerBuilder and co-author of *The Talent Equation*. “This causes workers and companies to miss out on realizing their full potential and, in turn, causes the economy to fall short of its potential.”

Scope of This White Paper

This white paper aims to explore some of the job roles that will be in greatest demand as a result of the IoE talent shortage and what businesses can do to bridge the gap. The white paper will also look at how one business sector in particular—industrial automation—is attempting to close the gap by embracing the technology of IoE.

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Five Key Job Roles for IoE

CareerBuilder projects that five job roles in particular will be in very high demand as a result of the IT skills gap that IoE is fueling. Its “hot and trending” job roles are as follows:

- Cloud architect
- Cybersecurity analyst
- Data scientist
- Mobile application developer
- Network programmer

“The ‘wave’ has been steadily building for these jobs,” says Kurt Iskrzycki, Senior Analyst, Workforce Analytics, at CareerBuilder. “The movement in terms of technology and advances is making them increasingly difficult to recruit for. We’re not seeing the full force of employer need yet, which only heightens the awareness of the gap between supply and demand.”

Cloud Architect

According to a November 2012 IDC report titled “Climate Change: Cloud’s Impact on IT Organizations and Staffing,” demand for cloud-related positions will grow by 26 percent annually through 2015, with as many as 7 million cloud-related jobs available worldwide. However, the report indicates that IT hiring managers were unable to fill 1.7 million cloud positions in 2012 because job seekers lacked the training and certification needed to work in a cloud-enabled world.

CareerBuilder assesses the 2011–2014 U.S. demand-to-supply ratio for cloud architects to be 6:1.

Cybersecurity Analyst

As opposed to other network security roles that focus on “building the castle,” a cybersecurity analyst pays closest attention to “guarding the castle.” Working in a security operations center, the cybersecurity analyst monitors security equipment, recognizes attacks, and responds to security events.

The fact that retailers, banks, healthcare providers, and other organizations reported 167 different data breaches in the state of California alone during 2013 underscores the need for greater security in the IoE era. The 2014 Cisco Annual Security

Report predicts a shortage of more than a million security professionals across the globe during the next five years.

CareerBuilder analyzes the 2011–2014 U.S. demand-to-supply ratio for cybersecurity analysts to be 3:1.

Data Scientist

IoE is a major contributor to global IP data center traffic, which is already on the order of hundreds of exabytes per month. With all of that data swirling around, the role of the data scientist will be paramount. Data scientists search for patterns in data and analyze data trends, with an eye to learning about user behavior or improving user experience. They also look for potential storage failures or even security threats. As the third annual Cisco Connected World Technology Report indicates, “The data scientist combines creative imagination with IT skills to unlock the power of data.”

The third annual report, which was based on a survey of 1800 IT professionals in 18 countries, reveals that in this IoE era—with its dramatic increase in new connections—the majority of respondents (73 percent) saw their big data strategy as needing to include data from digital sensors, meters, cars, video monitors, and smart devices. The survey also indicates that 40 percent were already using “data in motion,” that is, data in transit—from devices, sensors, video, and monitors—that a data scientist can work with in real time.

According to CareerBuilder, demand for data scientists in the United States has increased 60 percent from September 2013 to September 2014.

Mobile Application Developer

According to the Cisco Visual Networking Index (VNI) Global Mobile Data Traffic Forecast Update, 2013–2018, by the end of 2014, the number of mobile-connected devices will exceed the number of people on Earth, and by 2018 there will be nearly 1.4 mobile devices per capita. The ongoing proliferation of mobile devices will continue to make the job role of mobile application developer highly important to IoE.

The online career community ITCareerFinder named mobile application developer as the number one “best computer job for the future.” Says Daniel Greenspan, Enterprise IT Education Consultant and Founder of ITCareerFinder, “Mobile application development is home to one of the largest skills gaps ever seen in IT employment; there are simply more job

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openings than skilled and educated mobile developers to fill them. This is especially true for Apple iOS and Android application developers, as just under 90 percent of mobile devices in circulation in the U.S. run on these two platforms.”

CareerBuilder projects for the years 2011–2014 that the U.S. demand-to-supply ratio for mobile application developers is as high as 8:1.

Network Programmer

In the IoE world, leveraging programmable networks facilitates a gathering of information that, in turn, enables automation in the configuration of the IT infrastructure. As a result, information can be intelligently applied to infrastructure configuration, allowing the needed scale in the number of devices that can be effectively managed. Programmability helps ensure the correct level of automation, easing the pressure on the IT infrastructure, streamlining the identification and resolution of data bottlenecks, and thereby increasing efficiency.

It is the combination of deep network engineering knowledge and the ability to utilize a programming language such as C, Java, or Python that puts the network programmer in high demand. Career Builder calculates the 2011–2014 U.S. demand-to-supply ratio for network programmers to be 2:1.

A Necessary Response to the IoE Talent Shortage: Upskill What You Have

As fast as IoE is taking hold across all industries and aspects of life, Cisco believes that only a small percent of what could be connected in the world currently is. During the next 10 years, the percentage will go up dramatically. Businesses already facing a shortage with regard to IoE job roles such as the five discussed will be under additional pressure to find a talent solution if they want to stay abreast of technological developments and reap the benefits of a vastly more interconnected world.

Because finding new employees with all the right skills could be extremely challenging—and potentially quite expensive given the salaries that these highly sought-after individuals will be able to command—the answer for many businesses will be to upskill the talent that they currently have. A ManpowerGroup 2014 U.S. Talent Shortage Survey (see chart below) shows that the highest percentage of respondents (22 percent) are addressing their talent gap by providing additional training and development.

For each of the five “hot and trending” job roles that it has designated, CareerBuilder has identified a number of roles that have skills in common to the desired job role and that therefore have “launch potential” for upskilling by an organization looking to bridge the talent gap.

The Solution: Build Out. Don't Expect to Buy Up!

Top Ways U.S. Employers Are Filling Their Talent Gap



Source: ManpowerGroup 2014 U.S. Talent Shortage Survey

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Bridging the Cloud Architect Gap

For the role of cloud architect, sourcing a solutions architect from within the company ranks provides the closest fit, followed by a systems engineer, enterprise architect, integration specialist, and systems architect, respectively. In addition, roles from some of the other IoE job categories can provide a potential bridge, such as data architects and design engineers, among others:

Why Pay 20% More for Talent When You Can Develop It?

Cloud Architect	Cybersecurity Analyst	Data Scientist	Mobile App Developer	Network Programmer
Solutions Architect Systems Engineer Enterprise Architect Integration Specialist Systems Architect	Information Security Analyst Security Engineer Network Security Specialist Systems Administrator Network Administrator	Database Administrator Database Engineer Software Developer Data Architect Data Integrity Analyst	Software Engineer Programmer Java Developer Web Developer Design Engineer	Network Architect Network Engineer Systems Analyst Network Technician Systems Software Engineer

Bridging the Cybersecurity Analyst Gap

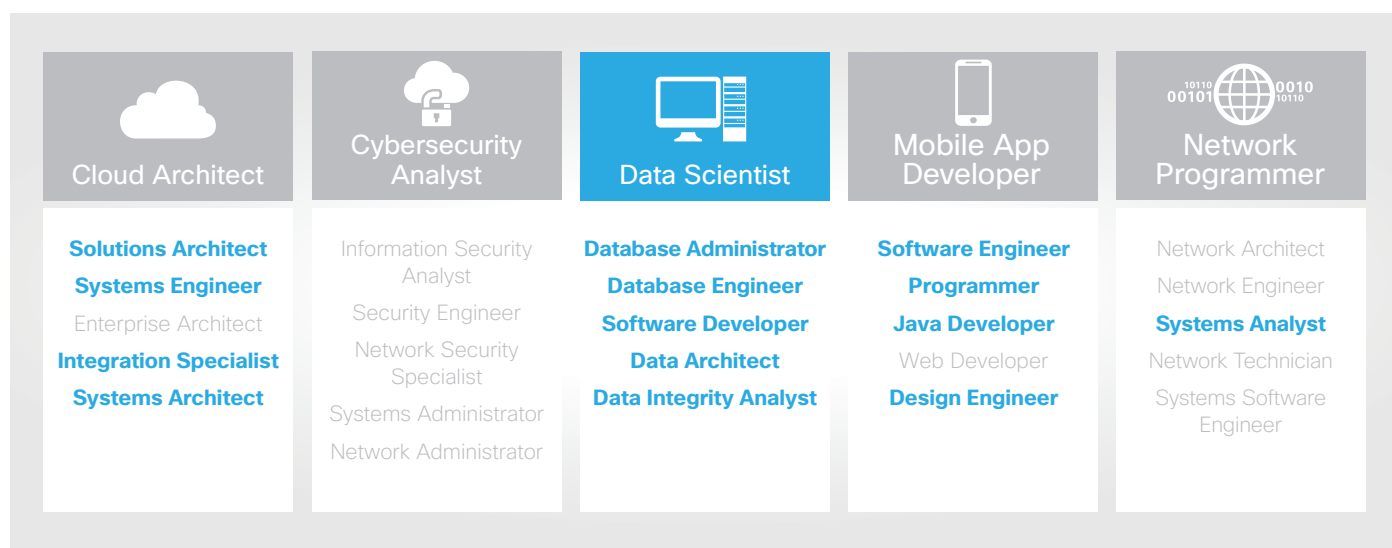
For the cybersecurity analyst role, information security analyst provides the tightest progression pathway, followed by security engineer, network security specialist, systems administrator, and network administrator, in that order. Other roles, however, can also be reskilled for this career, including network engineers, architects, systems engineers, and analysts:

Cloud Architect	Cybersecurity Analyst	Data Scientist	Mobile App Developer	Network Programmer
Solutions Architect Systems Engineer Enterprise Architect Integration Specialist Systems Architect	Information Security Analyst Security Engineer Network Security Specialist Systems Administrator Network Administrator	Database Administrator Database Engineer Software Developer Data Architect Data Integrity Analyst	Software Engineer Programmer Java Developer Web Developer Design Engineer	Network Architect Network Engineer Systems Analyst Network Technician Systems Software Engineer

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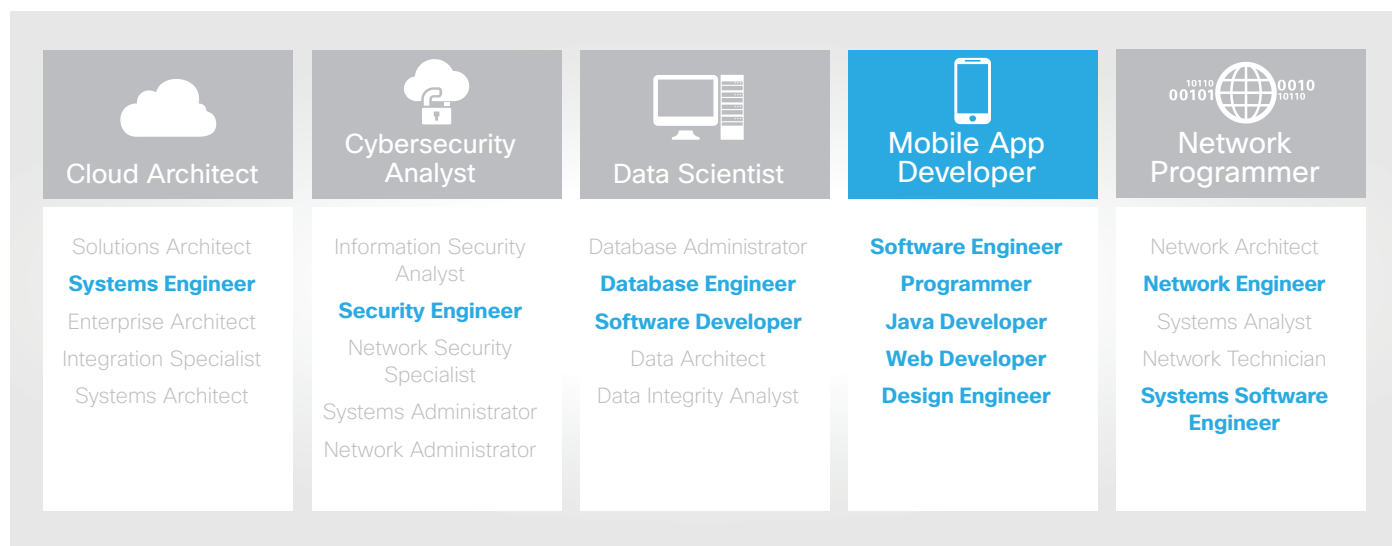
Bridging the Data Scientist Gap

A database administrator, followed by a database engineer, software developer, data architect, and data integrity analyst, can be groomed with additional training and development to fill the data scientist role. Additionally, many job roles from within the cloud architect and mobile application developer spheres are a progression to data scientist:



Bridging the Mobile Application Developer Gap

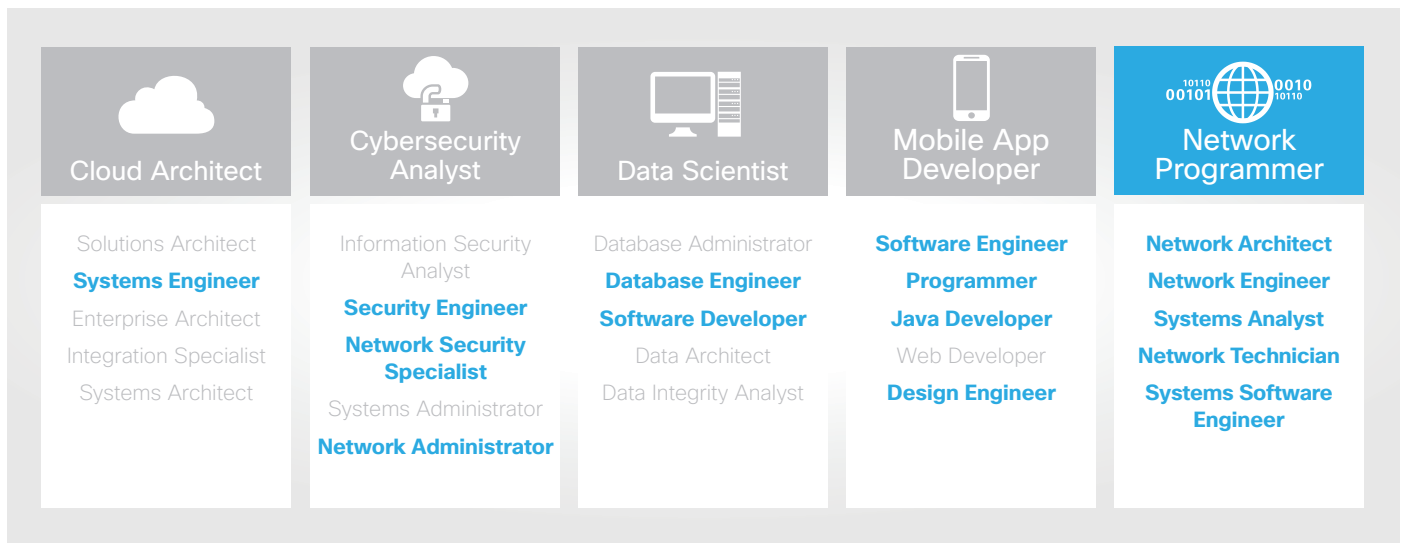
To upskill an employee to the role of mobile application developer, a company might first look to a software engineer, a programmer, Java developer, web developer, or design engineer, or look to reskill from some of the other categories as indicated:



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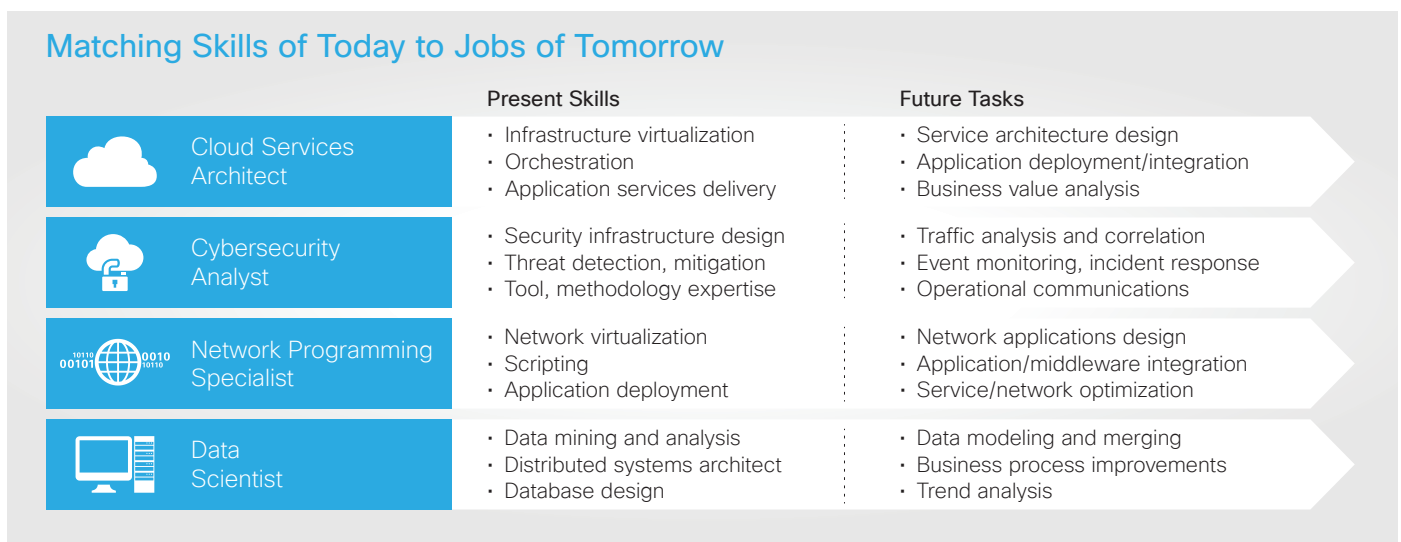
Bridging the Network Programmer Gap

Lastly, one can provide training and development to a network architect, network engineer, systems analyst, network technician, or systems software engineer to bring those individuals to the level where they can assume the role of network programmer. Again, as depicted, numerous other roles could be reskilled as well:



More Holistic Skills for the Future

The following chart shows how the specific skills of employees of today will need to change for the job roles and future tasks of the IoE world of the future:



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In the case of the first example in the chart, the transformation of the cloud services architect will involve bringing some specific technical skills, such as infrastructure virtualization, orchestration, and application services delivery, and building on them to include broader, more holistic abilities, such as service architecture design, application deployment and integration, and business value analysis. As an architect, no longer is the employee just concerned with setting up a solid network or an efficient data center. In the new role, the employee is concerned with the whole system as it relates to driving the best possible business outcomes.

Similarly, with the other roles, one can see how the upskilling enables a transition from specific aspects of system efficiency and support to a big-picture view of not only the technology but the business. The new roles are focused on system agility and the ability for systems to improve—not just serve—business processes.

Industrial Automation: An Arena Ripe for IoE Change

One area that has been gradually embracing IoE and has much to gain from it is industrial automation. While networks and smart devices are not newcomers to the plant floor, using them more strategically to create value is a new concept, says Dan McGrath, Solutions Manager for Industrial Automation at Panduit, a global manufacturer of physical infrastructure solutions that support power, communications, computing, control, and security systems.

“With the Internet of Everything—and the ways it allows information to be shared and analyzed—the data previously locked up inside sensors, instruments, and control systems can do much more to drive operational efficiency and innovation. Tapping this existing data in concert with the growing number of new sensors (for example, temperature, pressure, flows, and energy) being deployed with IP and wireless connectivity provides a rich source of information about assets and conditions that can be analyzed to yield operational insights,” he says.

To achieve this free flow of information, according to McGrath, Panduit has adopted a more holistic architectural approach to installing plant networks—both wired and wireless. This advanced approach has spurred the need for personnel with upgraded skills and a cross-functional knowledge of

IT networking. For example, adds McGrath, plant engineers need a sound understanding of network security, data use, and video traffic in order to design networks that allow remote experts to connect into the plant and share data securely.

The Industrial IP Advantage Coalition

Educating the next generation of skilled operational technology (OT) personnel is one mission of Industrial IP Advantage. This coalition and its website, www.industrial-ip.org, were established by Cisco, Panduit, and Rockwell Automation in 2013. The coalition aims to build a community around the value of IP in the industrial space, and help fill the skills gap created by IoE.

An overriding goal of Industrial IP Advantage is to facilitate convergence of the OT side of the house—focused on the monitoring and control of the plant and its equipment—with the IT side, focused on the use of unmodified Ethernet technology for all the information-processing needs within the plant. As part of this goal, the coalition focuses on communicating the importance of IP to industrial applications, breaking down barriers between the OT and IT worlds, and promoting conversation around networking and key industrial application areas. Those areas include security, wireless, mobility, energy monitoring and management, and video. To help fill the knowledge gaps that exist within industrial organizations migrating to IP technology, the coalition is designing web-based training that will soon be available on its website.

The rate of Ethernet technology adoption in the industrial world has been slower than in the IT space. One reason is the consistent concern among manufacturers about the high cost of unplanned downtime, according to Paul Taylor, a Business Development Manager at Cisco who oversees the Rockwell Automation strategic alliance.

For example, Taylor cites Jaguar Land Rover figures that indicate even one minute of unplanned downtime in a plant can cost the company \$50,000. “An hour and a half of downtime can equate to nearly \$5 million lost,” says Taylor. “That means a lot of cars must be sold to recoup that loss.”

“In almost any industry,” adds Taylor, “simply recognizing that you have a problem takes more than a minute, not counting the process of getting the right person to troubleshoot the issue and fix it. That reality has created a change-averse mindset among manufacturers. They figure, ‘We know this

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way works, so we're not going to try a new approach. The downtime risk is just too high.' This fear is a big reason why Ethernet technology is only now coming to plant floors, 15 years after it's been generally accepted as the network technology of choice everywhere else. Even with progress in this area, so many engineers are not IT trained."

Cisco Efforts to Bring Greater Network Capability to the Plant Floor

To further enable technology convergence within the realm of industrial automation, Cisco and Rockwell Automation have also collaborated on a Converged Plantwide Ethernet (CPwE) architecture. CPwE provides detailed design guidance, recommendations, and best practices for deploying standard Ethernet and IP network technology. The goal is to help manufacturers achieve network convergence between the OT and IT systems within their enterprise, enabling greater business agility and opportunities for innovation with a high degree of security.

In July 2014, Cisco furthered its commitment to closing the IoT skills gap in industrial automation by announcing the Cisco Industrial Networking Specialist certification, which addresses the control engineer and industrial plant administrator job roles. The certification, which has been developed in partnership with industry, focuses on the foundational skills needed to deploy, operate, and manage industrial networks in a connected plant enterprise. The major objectives of the supporting curriculum are as follows:

- Achieve competency and skills to install, maintain, and troubleshoot industrial network systems
- Interpret designs and drawings to recognize industrial topologies and access reference materials
- Help ensure network availability, reliability, and cybersecurity
- Take the first step in a portfolio of educational products toward a career in industrial networks
- Become a certified network specialist

Skills Gap Training Beyond the Plant Floor

The Cisco Industrial Networking Specialist certification is one of the more recent additions to a Cisco education portfolio consisting of more than 45 certifications and accompanying curricula that have helped the industry advance successfully through many transitions in the past, such as from the public switched telephone network (PSTN) to Voice over IP (VoIP), and from Voice to Video and Collaboration. Focusing on job roles and their evolution, Cisco certifications help train and reskill an average of 400,000 people each year. During the past 21 years that its certification program has been in operation, 2.4 million individuals have become certified.

Besides the new industrial networking offering, many of the Cisco training and certification programs, such as those in security and cybersecurity, business transformation, and network programmability, address critical components of IoT.

The Industry Talent Consortium

Cisco and the industry also recognize that the IoT talent gap needs a broader set of players coming together to solve specific challenges related to big data and analytics, security, network applications, and so on. Under the auspices of the Internet of Things World Forum, relevant participants have come together to form an Industry Talent Consortium that is tasked to address specific job roles and skills gaps.

The founding members of the consortium include representatives from academia—Stanford, Massachusetts Institute of Technology (MIT), and The New York Academy of Sciences (NYAS)—who will help define what the key skills areas of focus are for IoT, that is, what to learn and how. Employers like General Electric and Rockwell Automation will provide the specific talent requirements they have as they look to hire in this space. Change agents such as Cisco, Udacity, Knod, and Pearson will then provide educational curricula to help the individuals who have the background get reskilled or upskilled. And these individuals will then be connected to the employers who are looking to hire them.

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The primary areas of focus for the Industry Talent Consortium in Phase 1 will be data sciences, cybersecurity, and industrial networking:

- **Data scientists:** Given the 60 percent increase in demand for data scientists from September 2013 to September 2014, as cited by CareerBuilder, this job role will be of pressing importance to the consortium.
- **Cybersecurity specialists:** The consortium will help address this area of need by educating and certifying individuals using the Cisco Cybersecurity Specialist curriculum, which concentrates on the topics of event monitoring; security event, alarm, and traffic analysis; and incident response.
- **Industrial networking:** The skills shortage within connected manufacturing plants is also significant. Thousands of plant engineers need to be reskilled in IT and networking. Cisco and Rockwell Automation will jointly address the skills gap in the industrial networking space.

In the second phase, the Industry Talent Consortium will expand to identify and address other job roles such as application developers, process scientists, and cloud brokers in arenas such as utilities, oil and gas, mining, healthcare, and retail.

In addition, Cisco offers a global education initiative, the Cisco Networking Academy, which teaches students the skills needed to build, design, and maintain computer networks, aiming to improve their career prospects while filling the global demand for networking professionals. The program operates 9000 academies in 170 countries, and provides education to hundreds of thousands of students each year. In October of this year, as part of the Cisco Networking Academy Partner Summit in Barcelona, Cisco announced that a free, entry-level, self-learning course, "Introduction to the Internet of Everything," would be made available to all Networking Academy students.

With IoE, businesses are now faced with a significant transition, one that promises not just greater connectivity but also tremendous productivity gains, process efficiencies, and business value. It is a promise that can be achieved only with a skilled and competent workforce. While this white paper devoted special attention to industrial automation and manufacturing, other industries such as retail and wholesale trade, finance, healthcare, waste management services, agriculture, construction, transportation and warehousing, mining, and utilities have great value at stake by keeping pace with IoE technology and having their workforce trained and ready to go. In many cases, the jobs of today will not be the jobs of tomorrow, but the options should be promising for organizations and employees willing to understand and grow with new technology.

