

# Who is “the IT Workforce”?: Challenges Facing Policy Makers, Educators, Management, and Research

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## ABSTRACT

Despite over six decades of research on the role and definition of the IT workforce, there remain numerous, and often contradictory, definitions related to the identity of this group. The IT workforce is made up of IT professionals, computer scientists, software developers, and business professionals trained in MIS, as well as various occupational sub-categories in organizations including programmer, analyst, network specialist, and project manager, to name only a few. Despite this, some researchers, funding organizations, and practitioners refer to the “IT workforce” as if this term represents a homogeneous group of individuals that is clearly defined and understood. Our findings contradict this assumption, and raise a number of challenges for management, researchers, policy makers, educators, and funding agencies. We argue that a clear definition of the IT workforce would assist at all levels, and might bring some additional clarity to training, hiring, and retention issues.

## Categories and Subject Descriptors

K.7.3 The Computing Profession

**General Terms:** Management, Human Factors, Theory.

**Keywords:** Role of IT professionals, IT Professional, IT Identify.

## 1. INTRODUCTION

There is no question that the role of information technology (IT) has become increasingly important to organizational processes and competitive strategy. The Internet and other telecommunications technologies have only increased the demand for a skilled IT workforce. A recent Bureau of Labor Statistics (BLS) report (BLS, 2004) forecasts that employment in computer and mathematical occupations is expected to increase by almost

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35% between 2002 and 2012. Similarly, software publishing and computer systems design and related services industries are among the top four fastest growing industries.

The question remains, however, of who actually make up the IT workforce? In predicting employment changes by industry division, the BLS forecasts that the “Information” industry category will experience an 18.9% increase during the same period, yet clearly *all* of the other eleven industry divisions identified also employ IT workers (financial services, professional and business services, education and healthcare, federal government, as a few examples).

Our interest in this question began while seeking to identify a standard definition of the IT workforce for another research project. We quickly realized that this question on its own deserves attention. As we continued to explore existing literature and research on the IT workforce, we discovered a number of challenges and gaps in research that motivated our study.

These challenges include:

1. Multiple agencies and associations that provide conflicting and potentially exclusionary definitions that influence educational curricula and funding opportunities.
2. Changing competitive expectations that have expanded requirements for IT management knowledge outside of the IT function.
3. Increased skill requirements for IT as a critical component of both white collar (knowledge workers and clerical jobs) and blue-collar (manufacturing and labor) jobs.
4. Increased role conflict related to IT function’s responsibilities with an increase in joint liaison mechanisms and shared budgeting responsibilities.

The importance of this question of who is the IT workforce has crept up on us without fanfare; however, it may represent a critical aspect of the identity confusion facing the IT profession as a whole.

Drawing upon literature and existing research, sections 2 to 5 present our findings on the gaps and challenges listed above.

Section 6 of this paper presents our findings from a pilot study of 251 alumni of a top ranked IT program. We conclude with recommendations for policy makers, management, educators, and researchers.

## 2. PROBLEM # 1: DEFINITIONS

Have you ever tried to do a search on research related to IT workers or locate a definition of IT employees? You will find that the definitions are many. For example, in a bibliometric analysis of conflicting roles presented in organizational theories, Guzman and Kaarst-Brown (2004) found they had to search using many different terms, including: *IT or IS employee, professional, personnel, workforce, worker, labor, information systems, information technology, computer.*

Drawing on the sociological theory of professions, Orlikowski and Baroudi (1989) argued that Information Systems (IS) workers should not be called “professionals” at all, and instead they should be recognized as an occupational group with distinct occupational culture, required knowledge set, and skills.

### 2.1 Agencies and Association Definitions

IT academics or practitioners can belong to many associations. These associations to varying degrees control the standards of the IT occupation in terms of training, membership, and right behavior. The following quotes show the mission statements of four of these organizations and the broad description of their members.

“The Association for Computing Machinery (ACM), founded in 1947, is “a major force in advancing the skills of information technology professionals and students worldwide.”

The Association for Information Systems (AIS) is “the premier global organization for academics specializing in Information Systems.”

The Society for Information Management (SIM) describes their role as “established in 1968, SIM is the premier network for IT leaders comprised of nearly 3,000 members, including CIO’s, senior IT executives, prominent academicians, consultants, and other IT leaders. SIM is a community of thought leaders who share experiences and rich intellectual capital that is applied, and who explore future IT direction.”

The IEEE Computer Society (IEEECS) is the “world’s leading organization of computer professionals with nearly 100,000 members.”<sup>1</sup>

Paradoxically, the organizations stress membership benefits for different – and yet similar – groups. They also influence development of occupational definitions for the IT workforce. These definitions may further influence academic programs and research. For example, below are a sample of three formal definitions of the IT workforce provided by a government organization and two professional associations.

1. Bureau of Labor Statistics (BLS)
2. Association of Information Technology Professionals (AITP)
3. Association of Computing Machinery (ACM)

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<sup>1</sup> <http://www.isworld.org/Researchdesign/drisISworld.htm>

The Bureau of Labor Statistics Data defines this “homogeneous” group of “Computer and Mathematical Science Occupations” to include a rather *heterogeneous* grouping. This group includes the following occupations:

Computer and Information Scientists, Research; Computer Programmers; Computer Software Engineers – Applications; Computer Software Engineers – Systems Software; Computer Support Specialists; Computer Systems Analysts; Database Administrators; Network and Computer Systems Administrators; Network Systems and Data Communications Analysts; Actuaries; Mathematicians; Operations Research Analysts; Statisticians; Mathematical Technicians; and a residual category referred to as “All Other”.

The Association of Information Technology Professionals (AITP) currently has about 9,000 members, and describes itself as “the Information Technology professional organization of choice for providing leadership opportunities, professional development and personal growth”. This association welcomes current employees in organizations that declare themselves as IT professionals based on their interest and job responsibilities. Under the AITP’s concept, *all* their members are IT professionals.

Another institution that plays an important role in the development of the IT workforce is the Association of Computing Machinery<sup>2</sup>, mentioned earlier. “Founded in 1947, ACM is a major force in advancing the skills of information technology professionals and students worldwide. Today, our 78,000 members and the public turn to ACM for the industry’s leading Portal to Computing Literature, authoritative publications and pioneering conferences, providing leadership for the 21st century.” In fact, this association contributes formally to the academic programs that would train IT workers, working collaboratively with other associations such as SIM and IEEECS.

All of these groups vie for the membership of the IT workforce, yet it remains unclear who is being included and who is being excluded. While associations may leave it up to members to decide if they belong, funding agencies are not so liberal.

### 2.2 Funding Organization Definitions

The National Science Foundation (NSF) funds many research endeavors across a variety of scientific and social disciplines at US colleges and universities. Under the Directorate for Computer and Information Science and Engineering, and the Division of Experimental and Integrative Activities (created in 2000), NSF supports research studies on the under-representation of women and minorities in information technology (IT). A recent email from an NSF representative from this division, however, provided us with a definition that specifically excludes business school graduates in MIS – even if they are female or minorities.

This is surprising, given the considerable linkage between MIS and IT training. For example, despite this apparent exclusion by this division of NSF, various MIS associations (AIS, ICIS, SIM) – we use the term MIS loosely – have devoted considerable time developing educational standards for MIS graduate and undergraduate curricula. The expectation has been that many of the graduates with specializations or concentrations in MIS will

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<sup>2</sup> <http://www.acm.org>

go on to work full time in an IT related occupation. Business schools and MIS associations are not alone in their focus on preparing the next generation of the “IT workforce”; however, they appear to fall outside of at least one funding definition.

### 2.3 Educational Definitions

This leads to the question of who is training the IT workforce? The challenge for students interested in gaining formal accreditation has increased with a proliferation of business schools with full MIS degrees, business schools offering MBA and undergraduate programs with MIS concentrations, Information Schools that offer Telecommunications or Information Management degrees, Library schools that offer Information Studies degrees, Computer Science programs that run the gamut from programming to security, and various Informatics schools (social, medical, etc).

So, what are the differences? Based on the broad range of occupations and work opportunities for these graduates, academic institutions created academic programs that emphasize different sets of skills. However, once these graduates go to the job market, and start working in the IT field, they are considered part of the IT occupation. Frequently, their jobs will not differ much regardless of the type of schools they came from. More often, differences will be related to interests, skills, and work experiences each individual acquired outside the academic environment.

According to Von Dran (2004) academic programs in Information Schools, referred to as “I” schools, prepare IT professionals for the diversity of “real” IT jobs because the programs are grounded in the needs of the people seeking knowledge and skills, with a broader range of IT courses and more flexibility in individual program design.

For example, technology, policy, management, and people/user issues are the four pillars that support both the education endeavors and the research of “I” schools.

Among traditional computing programs, Anthony (2003) looked at the 61 computing programs offered at 39 universities. The goal was to identify a model for differentiating the computing disciplines of “information technology”, “computer science” and “information systems” based on the type (e.g. business, math, and technology) and number of credits earned in each program (Anthony, 2003). This study found no significant difference between IT programs and CS programs, but found a significant difference in the number of business credits offered between IS programs, and comparable CS and IT programs.

Going further and looking at the social aspect of the IT field, Kling (2003) argued that the failure of many information systems, often called “IT failures”, are a consequence of computer science programs that do not include a socio-technical perspective and are not “sufficiently broad nor sufficiently flexible to effectively educate a wide range of IT professionals”.

The definitional confusion and turf battles over who educates the IT workforce are also manifesting in budget cuts to many business school MIS programs, the merging of computer science and information schools, and the rapid growth in the number of “Information” schools (“I-Schools” - up from a handful in the late 1990's to over 40 in 2004).

**Table 1. Job Responsibilities of IT Professionals in the Work Environment (Adapted from Benamati and Lederer, 2001)**

Job Responsibilities	Number of Subjects	Percent of Subjects
Technology Evaluation	139	57%
Project Management	126	51%
Systems Analysis	126	51%
MIS management	124	50%
Systems Design	123	50%
Strategic Planning	112	46%
Applications Programming	101	51%
Team Leadership	99	50%
Data/Database Administration	92	37%
Telecommunications	75	30%
Systems Programming	54	22%
Other	20	8%

### 2.4 The Work Environment Definitions

The definitional issue extends into the terms that are used by those who make up the IT workforce. What do we call ourselves? Well, it varies.

In an earlier study (Benamati and Lederer, 2001), the authors collected 246 usable responses from those who called themselves “IT professionals” and who subscribed to an IT practitioner journal. Subscribers were qualified based on their involvement in the selection and purchase of enterprise-wide software for all computing platforms. They included managers and staff.

From this group, ninety-three percent had a college degree. Ninety-two percent indicated that their job responsibilities fit within those listed in Table 1. Only eight percent described their job responsibilities in a different way.

From a general perspective, all of the responsibilities detailed in Table 1 are those of “IT professionals”. A graduate from an MIS program in a business school might have a position of “Project Manager”, and a graduate from computer science might have a position as “system analyst”, or vice versa. Both are part of the IT workforce, and both would describe themselves as “IT professionals”. Similarly, people trained outside IT could find themselves in the role of Team Leader.

Kling (2003) commented on the study presented in Table 1, and stated that the study actually does “not know how many of all those self reported ‘IT professionals’ in industries were formally educated in an academic IT program, and how many entered occupations such as programming, systems analysis, or web site design from another field (such as mathematics, management or the arts)”. This leads us to the second problem, which is competitive job expectations and knowledge convergence.

### **3. PROBLEM # 2: COMPETITIVE EXPECTATIONS AND KNOWLEDGE CONVERGENCE**

Along with the widespread diffusion of information and communication technologies in today's organizations has come a radical shift in how firms compete. Automation has become more than a case of increasing operational efficiency as companies struggle to attract and retain customers. Information and Internet technologies are playing a critical role in this effort and the task of meeting competitive pressures has fallen on both the IT function and business management.

Changing competitive expectations have vastly expanded requirements for IT knowledge outside of the IT function and into the business units. The alignment literature is full of exhortations to management people to increase their IT knowledge and to IT personnel to increase their understanding of the business goals they support (Boynton, Zmud and Jacobs, 1994; Chan, Huff, Copeland and Barclay, 1997; Henderson, 1990; Hussin, King and Cragg, 2002; Kaarst-Brown and Kelly, 2005; Reich and Benbasat, 1996; Reich and Benbasat, 1999).

A recent Computer World survey of 244 IT professionals indicated that shortcomings of IT graduates are in the areas of business skills, troubleshooting skills, interpersonal communications, project management, and systems integration (Von-Dran, 2004).

The average business manager can also expect that they will have at least some involvement in IT related business decisions, and therefore must possess or acquire increasing IT related knowledge so that they can perform their jobs. At the very least, they likely now supervise various practices that have a large technical component, be this transaction processing systems, databases and expert systems, customer relationship management systems, and corporate intranet or other web-based applications.

A few organizations are achieving IT-business knowledge goals by hiring former IT managers and project leaders in non-IT business jobs, circumventing the time required to develop high levels of IT expertise (Kaarst-Brown and Reich, 2004; Reich and Kaarst-Brown, 1999; Weill, 2004). Others hope that educational programs, corporate management development, and "in situ" learning are keeping their management up to date.

### **4. PROBLEM # 3: INCREASED IT-RELATED SKILLS AND TASKS IN NON-IT JOBS**

In the early 1990's, Kaarst-Brown (1995) found that in a weekly sample of job postings for non-technical clerical jobs in one firm, 9 of the 10 jobs required computer expertise, ranging from word processing and presentation software skills to database expertise. The literature is rife with references to the increased role of knowledge workers (Agarwal and Ferratt, 2001; Rada, 1999; Rousseau and Shperling, 2004). The increase in computer skills required by blue-collar workers is also significant, and reflects the pervasive nature of microchip and computer integrated technologies. Just about everything is computerized, and requires a similar shift in skills.

Similar to an earlier era of stenographic and typing pools, we once

had data entry work performed by a private group of individuals. Now, most companies use various forms of direct or automated data entry or the average employee does data work as part of the normal task. Data entry work has expanded into PC-based systems development using desktop computing software that rivals the capabilities of mainframe technology.

This change in skill requirements has caused considerable conflict among those who do not desire to acquire new skills (Brown, Massey, Montoya-Weiss and Burkman, 2002; Stam, Stanton and Guzman, 2004), with labor unions (Townsend, Demarie and Hendrickson, 2001), and has increased both computer budget expenses and training costs (Adams, 2002). This has paralleled the shift to telecommuting (or telecomputing) by workers who are part of distributed or virtual work teams (Allen, 1997; Brown, 1994; Cohen, 1997). This is not news, as these challenges have been facing public and private organizations for decades now (Allen, 1982).

What *is* new is that as we look at who represents the IT workforce, we see that we have significant IT skill components and task requirements outside of IT, even in organizations with centralized IT structures. These employees may be viewed as "users", just as Orlikowski and Baroudi (1989) labeled earlier data input staff "users" because they did not develop systems. This may be too narrow a generalization, however, as some so-called "user" jobs involve systems and web development using powerful desktop tools. This begs the question of where the cut-off line should be drawn on a definition of the IT workforce.

While the growing number of business managers and employees who understand technology may aid competitive pressures, it presents a significant challenge for those seeking to understand future career options as a quasi IT workforce member. It creates a greater challenge for educational institutions and for researchers seeking to bound definitions.

### **5. PROBLEM # 4: INCREASED ROLE CONFLICT**

IT structural changes in organizations go beyond issues of centralization or decentralization of the IS function in organizations. These changes have extended into the proliferation of budgeting arrangements and IT prioritizing or steering committees (Brown, 1997; Weill, 2004). Cultural assumptions about who should control IT direction and resources have also been found to complicate further the IT governance issues in organizations (Kaarst-Brown and Kelly, 2005; Kaarst-Brown and Robey, 1999).

The IT function is expected to understand the business needs, emerging technologies, process issues, data structures, security and privacy issues, and last but not least – the customer. We are not suggesting that every single person employed in the IT division works on all these issues, but collectively even small groups are expected to understand a complex gamut of issues facing today's business (Guzman and Kaarst-Brown, 2004; Prior, Rogerson and Fairweather, 2002; Teo and Pian, 2003). These pressures are reflected in increasing conflict and ambiguity regarding the role the IT function is to serve (Guzman and Kaarst-Brown, 2004; Kaarst-Brown and Kelly, 2005; Niederman, 1993; Niederman and Trower, 1993; Zmud, 2002).

The pressures facing employees in the IT division, and the

opportunities that increasingly exist outside in business units and entrepreneurial firms, have also had an impact on turnover and retention challenges (Arnold and Niederman, 2001; Grupe, 2003; Moore, 2000; Moore and Burke, 2002; Niederman, 1993; Niederman and Trower, 1993). These challenges predate Y2K and extend beyond the dot-com bubble of the late 1990's and turning century.

The issue of role conflict or role ambiguity is further exacerbated by the convergence in knowledge and skills and the increased number of joint IT-business liaison or linking mechanisms mentioned earlier. These linking mechanisms are recommended to improve communications (Brown and Ross, 1996), project management (Du, Johnson and Keil, 2004; Reich and Kaarst-Brown, 2003), and innovation capability (Cohen and Levinthal, 1990). Power issues and turf battles are just another element of the IT identity crisis (Benbasat and Zmud, 2003) that reflect the broader challenge of defining where the IT workforce begins and ends.

## 6. PILOT STUDY OF ALUMNI 1999-2004

In addition to our investigation of formal definitions, curricula, IT governance, and review of research on the IT professional or the IT workforce, we also conducted a pilot study of alumni of a top IT program. The purpose of the pilot study was to assess not only if alumni are employed by IT companies, in IT related fields, and have IT job titles, but given the literature, we also wanted to see how clearly the definitional or occupational boundaries were presented. We began with two broad propositions consistent with traditional definitions and expectations of educational programs.

P1: The majority of those educated in a top IT schools would be employed in IT jobs.

P2: Having graduated from a top IT program, those employed in IT jobs would have clearly defined roles easily distinguished as part of the IT profession (for example, programmer, project manager, analyst, and so forth).

The data for our pilot study was provided by a school of information in Central New York who gave us access to a blinded database of 818 registered alumni. These alumni graduated from the Bachelor of Science Program in Information Management and Technology between 1999 and 2004. Using voluntary self-reporting, 251 alumni (30.7% response rate) provided data about their current "job titles", "employer", and "field of work". (Table 2 summarizes sample information.)

### 6.1 Data Analysis

The authors independently coded the data into three categories: IT jobs, non-IT jobs, and unclear, discussing and coming to agreement on differences.

IT jobs were coded as those that self-reported under the computer profession or provided enough detail to be classified as such. For example, someone who described his or her "field of work" as "Computer Profession" and the "job title" as a "Database Developer" or "Database Architect" would be coded as being in an IT job. Another example that is less clear but that was coded as IT is where the individual self-reported "Marketing" as his or her field of work, but the job title was "data integration specialist".

Non-IT jobs were coded as those with a job title describing a non-IT job such as "Loan Administrator" or other general descriptions

of job title such as "Director of Sales", and in addition, the "Field of Work" was something like "Finance".

		Response Rate
<b>Graduation Period</b>	1999-2004	
<b>Surveys Sent</b>	818	
<b>Surveys Returned</b>	251	30.7 %

Classification into the "unclear" category includes very general descriptions of job title as well as in the field of work. For example, "Consultant" in "Consulting", "Instructor-Adjunct" in "Education", or "Lead Technical Writer" in a "Novelist-Writer" field of work.

### 6.2 Findings

Our coding resulted in identification of 130 IT jobs, 115 non-IT jobs, and 6 unclear jobs, as summarized in Table 3 below.

The classification using self-reported identification illustrates many of the dilemmas raised in the earlier discussion.

	#	%
<b>IT Jobs</b>	130	51.8 %
<b>Non-IT Jobs</b>	115	45.8 %
<b>Unclear</b>	6	2.4 %

Table 4 presents three interesting examples where individuals are working in IT jobs and yet do not seem to consider themselves as doing so.

An employee of IBM Corporation, reported field of work as "Other Profession", and job title as "Project Manager".	It is interesting how this graduate did not state this position under the category of "computer profession", but perhaps their role at IBM is not IT related?
A graduate reported the field of work as "Retail", and the job title as "Retail Salesman". Because this person is working in "Comp USA", a large technology retail chain, it would suggest that this is a relatively technology-oriented job.	Did they presume that we would know they were in an IT related job from the employer name?
As a final example, one of the alumni is working as adjunct faculty at an I-school and teaches a network security class. He also writes reviews of security products such as routers, firewalls and so on for a trade magazine.	This graduate reported himself as working in the field of work of "education", with the job title as "Instructor". If he is not in the IT occupation, who is?

This is only a pilot study, and it would be interesting to conduct a larger study with results coded by IT experts, HR specialists, or senior managers. Would there results and interpretations be different from ours? Despite the potential limitations, three conclusions are easily drawn from our analysis.

First, contrary to our first proposition, although slightly more than half the alumni appear to be employed in IT jobs, almost half apparently found themselves in jobs outside the IT profession.

Second, our second proposition was also not found to be the case, as even those employed in IT jobs are not all in what would be defined as traditional IT jobs.

Third, as illustrated in the three examples in Table 4, many of the older definitions would exclude these individuals from the "IT workforce". Also excluded would be other examples from our sample, such as human resources recruiters for the IT division or marketing specialists who do data mining as part of product development or customer relationship management (CRM) program design.

Lastly, our findings support the challenges identified earlier in the paper.

So, what is the solution?

## 7. THE BROAD OLD-NEW DEFINITION OF THE IT WORKFORCE

Based on the common understanding of the occupation from agencies, education, industry, and research perspectives, we support that the IT workforce should be treated as "a general occupational work with several specialties that frequently require the acquisition of new IT skills or knowledge from a variety of formal and less formal sources". New categories are also needed that reflect the dispersion of this occupation throughout the organization, the dual skill requirements (IT and domain knowledge), and the emergence of highly skilled IT workers outside the IT division of organizations.

A challenge for the emergence of a formal IT occupation is that the updating of IT skills may come from magazines or books, IT certifications that are based on technologies (such as Microsoft, Cisco, Linux, etc), and software applications used in companies. These do not come necessarily from formal academic programs.

"Required skills" for the IT workforce may be related to management or finance, but increasingly need to be acquired by IT staff who are interested in emphasizing the achievement of business goals in organizations (Kaarst-Brown and Kelly, 2005; Moore and Swartz, 2003; Wang and Kaarst-Brown, 2004). In terms of defining the IT workforce, the work environment increasingly defines what constitutes required skills, and certainly needs to be considered by formal programs (even if they are currently attained outside of them). There appears to be an inherent disconnect between government agencies trying to anticipate future business needs and educational institutions trying to develop programs to meet them.

This view is consistent with changes in organizational compensation toward competency or skill/knowledge based compensation programs, and with the challenges noted in this paper. However, this recommendation challenges the traditional definition of both profession and of occupation (Orlikowski and Baroudi, 1989; Trice, 1993).

Rather than focusing on schools and programs in isolation, it is time for a complete review of the future IT workforce. Therefore, we also recommend that strict educational or program guidelines be re-evaluated and re-invented, rather than relaxed. Turf battles about who teaches what to whom need to be set aside, so that students can meet degree *and skill* requirements with outside courses.

The challenges of the new work environment need to be considered in redefining the IT workforce.

## 8. CONCLUSIONS

The question of who really make up the IT workforce was initially motivated by a search for a construct definition in a dynamic and growing information economy. Our search has led us to explore significant gaps and challenges that need to be addressed.

In the review above, we identify four main challenges, supported by the findings in our pilot study: outdated or exclusionary definitions, competitive pressures on pervasive IT knowledge, IT skill integration into non-IT jobs, and role conflict within organizations related to IT governance. Some of these challenges have far-reaching implications for educational programs, policy makers, management, and researchers.

Educational programs are experiencing a shakeout related to IT as we see in the reduction of students in computer science schools, merging of different schools, and the increase in specialized schools for informatics and information studies. The battle between "B-schools" and "I-Schools" is ongoing and presents many challenges for students seeking the best degree program for them based on hoped for career outcomes. Many of those who graduate from "I-schools" end up in the business side of the organization, but similarly, many of those who graduate with MIS skills or degrees from business schools end up working in the IT division.

Researchers face as great a challenge as they turn to government funding agencies for research funds. While the reality of the workforce is that it presents considerable overlap in skills, educational backgrounds and such, outdated definitions not only constrain, but also perpetuate false divisions between groups and may seriously limit research into critical human resources issues.

We propose a new definition that takes into account some of the gaps and challenges. Of greater interest to us, however, is that governing and educational bodies will turn their attention to this challenge and develop a set of definitions that better serve our changing IT workforce.

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