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Technology and skills in the Digital Industries

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Technology and Skills in the Digital Industries

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Foreword

The UK Commission for Employment and Skills is a social partnership, led by Commissioners from large and small employers, trade unions and the voluntary sector. Our ambition is to transform the UK's approach to investing in the skills of people as an intrinsic part of securing jobs and growth. Our strategic objectives are to:

- Maximise the **impact** of employment and skills policies and employer behaviour to support jobs and growth and secure an internationally competitive skills base;
- Work with businesses to develop the best market solutions which leverage greater investment in skills;
- Provide outstanding labour market intelligence which helps businesses and people make the best choices for them.

The third objective, relating to intelligence, reflects an increasing outward focus to the UK Commission's research activities, as it seeks to facilitate a better informed labour market, in which decisions about careers and skills are based on sound and accessible evidence. Relatedly, impartial research evidence is used to underpin compelling messages that promote a call to action to increase employers' investment in the skills of their people.

Intelligence is also integral to the two other strategic objectives. In seeking to lever greater investment in skills, the intelligence function serves to identify opportunities where our investments can bring the greatest leverage and economic return. The UK Commission's third strategic objective, to maximise the impact of policy and employer behaviour to achieve an internationally competitive skills base, is supported by the development of an evidence base on best practice: "what works?" in a policy context.

Our research programme provides a robust evidence base for our insights and actions, drawing on good practice and the most innovative thinking. The research programme is underpinned by a number of core principles including the importance of: ensuring 'relevance' to our most pressing strategic priorities; 'salience' and effectively translating and sharing the key insights we find; international benchmarking and drawing insights from good practice abroad; high quality analysis which is leading edge, robust and action orientated; being responsive to immediate needs as well as taking a longer term perspective. We also work closely with key partners to ensure a co-ordinated approach to research.

This research was carried out in conjunction with the UK Commission and e-skills UK, the Sector Skills Council for Business and Information Technology. It addresses the role of technology in driving high level skills needs, a skills priority that has been identified in many recent Sector Skills Assessments. To assist employers in understanding these skill needs in more depth and to provide intelligence to the UK Commission to support investment in skills, this research provides insights into the role of four emerging technologies (Cyber security, Mobile technologies, Green IT, and Cloud Computing) in driving high level skills in the Digital Sector.

Sharing the findings of our research and engaging with our audience is important to further develop the evidence on which we base our work. Evidence Reports are our chief means of reporting our detailed analytical work. All of our outputs can be accessed on the UK Commission's website at www.ukces.org.uk

But these outputs are only the beginning of the process and we are engaged in other mechanisms to share our findings, debate the issues they raise and extend their reach and impact.

We hope you find this report useful and informative. If you would like to provide any feedback or comments, or have any queries please e-mail info@ukces.org.uk, quoting the report title or series number.

Lesley Giles

Deputy Director

UK Commission for Employment and Skills

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Views and opinions expressed in this report do not necessarily reflect the views of the UK Commission for Employment and Skills.

Table of Contents

Executive Summary	ix
1 Introduction	1
1.1 Purpose of the report	1
1.2 Summary of methodology	1
1.3 Defining the sector	2
2 Digital Sector Overview	3
Chapter Summary	3
2.1 Introduction	4
2.2 Contribution to the economy.....	4
2.3 Employment trends	5
2.4 Higher level skills: occupations, qualifications and skills mismatches	5
2.4.1 Occupational structure	6
2.4.2 Qualifications profile	7
2.4.3 Skills mismatches.....	8
2.4.4 Training and skills supply.....	9
3 Cyber Security	11
Chapter Summary	11
3.1 Introduction	12
3.2 Drivers of demand	12
3.2.1 Breaches and threats.	12
3.2.2 Technological Change	14
3.2.3 Regulation and compliance	14
3.2.4 Economic opportunity.....	15
3.3 Current and emerging skills and occupations	17
3.3.1 Occupations and roles in Cyber Security	17
3.3.2 Skills associated with Cyber Security	18
3.4 Recruitment and supply of skills	20
3.4.1 Recruitment	20
3.4.2 The supply of skills.....	23
3.5 Future skills outlook.....	26
4 Mobile Technologies	28
Chapter Summary	28

4.1	Introduction and background.....	29
4.2	Drivers.....	30
4.2.1	Consumerisation.....	30
4.2.2	Bring your own device (BYOD)	30
4.2.3	Cost reduction.....	32
4.2.4	Enterprise mobility	32
4.2.5	Mobility across the economy	33
4.3	Current and emerging skills and occupations	35
4.3.1	Occupations and roles in mobile	35
4.3.2	Skills associated with mobility.....	36
4.4	Recruitment and supply of skills	38
4.4.1	Recruiting	38
4.4.2	Skills supply	40
4.5	Future skills outlook.....	41
5	Green IT	44
	Chapter Summary	44
5.1	Introduction and background.....	45
5.2	Drivers.....	46
5.2.1	Cost reduction.....	46
5.2.2	Reducing carbon emissions.....	47
5.2.3	Legislation and regulation	48
5.2.4	Managing reputation.....	48
5.3	Current and emerging skills and occupations	49
5.3.1	Occupations and roles	49
5.3.2	Skills associated with Green IT	50
5.3.3	Skills supply	51
5.4	Future skills outlook	52
6	Cloud Computing	54
	Chapter Summary	54
6.1	Introduction and background.....	55
6.2	Drivers of demand	55
6.2.1	Economic opportunity.....	56
6.2.2	Cost reduction.....	57
6.2.3	Technological change	57
6.2.4	Consumerisation.....	58
6.3	Skills and occupations	59

6.3.1	Occupations and roles	59
6.3.2	Skills associated with Cloud Computing	60
6.3.3	Recruitment and supply of skills	62
6.4	Future skills outlook.....	63
7	Future insights for higher level skills	65
	Chapter Summary	65
7.1	Introduction	66
7.2	Forecast employment.....	66
7.3	Emerging themes for higher level skills.....	67
7.3.1	Drivers.....	67
7.3.2	Skills.....	68
7.3.3	Supply of skills and ‘pipeline’ issues	71
7.4	Implications, opportunities and challenges.....	72
	Appendix A: Methodology.....	74
	Appendix B: Definitions	77
	Appendix C: Sector profile – data tables	80
	Glossary.....	83
	Bibliography	86

Tables and figures

Table 1: Occupational distribution, Digital sector by nation, 2012	6
Table 2: Employment of IT specialists, Digital sector and all sectors, 2012.....	7
Table 3: Employment growth and replacement demand by occupation in the Digital sector	67
Table 4: Summary of higher level occupations.....	68
Table 5: Summary of higher level technical skills requirements	70
Table 6: Summary of higher level business skills requirements	71
Table 7: Change in employment, 2009 – 2012 in the Digital sector	80
Table 8: Occupational distribution, by employment sector, 2012.....	80
Table 9: Employment of ICT s pecialists, by employment sector, 2012.....	80
Table 10: Highest qualification held, by employment sector, 2012	80
Table 11: Skills lacking in Skills Shortage Vacancies (UK)	81
Table 12: Impact of having hard-to-fill vacancies (Digital Sector, UK)	82
Table 13: Employees receiving training (Digital Sector, UK).....	82

Executive Summary

The aim of this report is to provide new insights on the role of four emerging technologies: Cyber Security; Mobile technologies; Green IT and Cloud Computing, in driving high level skills needs in the Digital sector. This report combines data analysis, literature reviews and qualitative interviews with over twenty employers and experts to provide a comprehensive assessment on the nature of skills needs, job roles and career pathways for these technologies.

Sector overview

The Digital sector is at the heart of contributing to the economy, underpinning growth through the technology it develops and the services it provides. The Digital sector employs 3 per cent of the UK workforce and contributes nearly £69 billion Gross Value Added to the UK economy (7.4 per cent).

Per employee job, the sector is one of the most productive in the UK economy and employment has grown 5.5 per cent between 2009 and 2012, more than three times that recorded within the wider economy. The dominant characteristics of Digital sector employment are permanent, full time and male.

A total of 1.1 million people work as IT specialists in the UK, with those working outside the Digital sector most likely to be employed in Finance and Professional Services, Manufacturing or the Public Sector.

An analysis of the sector workforce shows over half of all workers to be employed in 'Professional' level occupations, well above the UK overall proportion. There is a particular concentration of higher level IT occupations in the Digital sector itself. Digital sector workers are also amongst the most highly qualified members of the UK workforce.

Skills shortage vacancies equate to 17 per cent of all vacancies in the sector, and are experienced by over 3,000 employers. Hard to fill and skill shortage vacancies are concentrated in Professional and Associate Professional and Technical occupations. The most common skills thought to be lacking are job specific, and advanced IT or software skills.

The impact of hard to fill vacancies includes difficulties introducing technological change and delays in developing new products and services. These issues are more keenly felt in the Digital sector than across other sectors. This evidence suggests that skills mismatches are affecting the ability of these high value firms to grow and develop as quickly as they might be able to, should they be able to source skills more easily.

Cyber Security

Cyber Security covers the protection of systems, networks and data. It is particularly driven by factors such as technology (new and legacy) and the increasing threat of security breaches; changes in business awareness and risk appetite; regulation and compliance (including legislation and industry standards).

Key factors driving Cyber Security growth in the UK also include: consumer expectations; reputation (damage to the business reputation is a greater concern than the risk of fines due to breaches/non-compliance); and Intellectual Property (IP) and asset protection.

Skills needs include a sound base of technical understanding, knowledge and competencies; understanding and awareness of security issues and industry standards; analytical skills, risk analysis and risk management.

Communication skills, relationship management, and customer facing presentation skills are also seen as critical to achieve active support for Cyber Security from other business leaders.

Estimates of growth potential go hand in hand with reports of significant recruitment and skills issues including an inability to source appropriate information security professionals in particular higher level specialists such as Security Architects and Security Analysts.

The most common pathway into Cyber Security roles is via internal recruitment and from general IT specialist roles which would suggest that whilst entry also includes apprenticeships (seen as a pathway into higher skilled roles) and graduates, businesses continue to seek skilled professionals to work in this area.

Training includes mandatory courses for compliance/audit but also to address the need for secure technology development and greater awareness of security across the business more widely.

There is a general sense that the market for Cyber Security will continue to grow. A proactive outlook where higher level skills will continue to be needed to provide the products and services required to deal with progressively more complex Cyber Security, increasing breaches and threats and the impact of new technologies.

Mobile technologies

Communications, devices and applications are integrating and converging enabling multiple uses and advanced collaboration. This requires constant innovation and new technology solutions. Businesses are using mobile technology solutions as part of a multi-channel approach to connect with clients and to improve employee productivity.

Mobility is primarily being driven from a consumer perspective and the pace of mobile use as a primary channel by consumers is faster than most businesses expected. An emerging theme is the growth of Bring Your Own Device (BYOD) where employees are driving change in the workplace.

There are significant challenges for IT specialists managing mobility, but mobile technologies bring new operational models to businesses providing opportunities for growth and more efficient working methods for employees.

Mobile technology skills are needed in many IT specialist job roles, whether in design and development, management or support. Highly skilled occupations in mobility include: IT Architects, Developers, User Experience Designers and Project Managers.

Agile techniques, technical pre-sales, sales, marketing, account management support and an extensive understanding of customers' industries are noted as key skills requirements alongside the need for a high degree of interaction between technical specialists, the user experience design team and the end client/customer.

Mobility is increasingly a thriving part of Digital sector products and services with massive potential for growth, and an area where significant recruitment and retention pressures are emerging, particularly in the recruitment of mobility specialists who need extensive technology experience together with specific mobile technology skills. Hard to find occupations were noted as IT Architects, Developers, User Experience Designers, Testers and Sales and Pre-sales staff.

Recruitment into mobility roles is often addressed by upskilling existing staff. Specific training is often provided by employers to increase the capability of their existing staff in mobile technologies but, because the market is relatively immature, experience is generally preferred over certifications in terms of recruitment.

The machine to machine 'connected device space' will potentially create a huge amount of information and will generate the need for highly valued analytical skills and for Big Data Specialists in particular, to exploit the data generated.

Securing mobile devices is becoming increasingly recognised and important for all organisations looking to integrate mobile technologies into their future business plans and will be, without question, a key skills challenge.

The increasing demand for skills in high level mobility roles is currently an issue, but in time it was felt that the skills will catch up, provided sufficient talent comes into the Digital sector.

Green IT

Green IT refers to sustainable IT through the invention, design and implementation, of infrastructure and services whilst minimising their environmental impact. It is a subset of sustainability.

Rising energy costs and environmental concerns were the original drivers behind Green IT but wider implementation may have paused, pending economic recovery. A key area for exploitation in implementing Green IT is virtualisation and the efficiencies allied to Cloud Computing (including energy optimisation) are also driving the uptake of Green IT.

Companies were emphatic that they have to demonstrate a responsible view of sustainability, either as a technology provider or a technology user company, and brand reputation in this area is a huge driver.

IT Architects and Solution Designers are key high level roles for Green IT. Staff working in this area tend to have extensive IT backgrounds, experience and capability before specialising in Green IT. There is general concern about the lack of volume of IT specialists who go on to specialise in Green IT. Certifications are less widely used with a solid technical background and experience being favoured, perhaps with a higher level degree.

Key skills requirements are around energy management expertise, data collection and analytics and integration. It was noted that research and development and high level mathematics skills are not readily available, highlighting the need for STEM skills. As found in other technologies investigated for this project, IT skills need to be complemented with sector or domain specific skills (e.g. in construction or logistics)

Business and commercial awareness, communication and presentation skills were found to be needed at a higher level to increase awareness of sustainability issues across the business as well as with customers.

Evidence from the literature review and interviews undertaken in this project suggests that there is potential for greater growth in Green IT in the future, and opportunities for the sector to offer more products and services as sustainability gradually pervades all parts of customers' businesses.

Growing the workforce to deliver this requires not only people with higher level technical skills, extensive experience and sector specialisms but also those that have a real interest/passion in this area.

Cloud Computing

Cloud Computing is a model for delivering internet based information and technology services in real time or, 'on-demand' and is particularly driven by: economic opportunity; cost reduction; technological change and consumerisation.

The current economic climate is seen to be a strong driver with Cloud Computing enabling companies to not only move into new markets, reduce costs and become more agile but also to provide growth through the enablement of new business models.

Mobile technologies provide new delivery platforms for the full benefits of Cloud Computing to be realised but employers report that security is a key challenge in implementing and managing cloud technologies. Cloud Computing is very much driven by a new generation of consumers and employees.

A wide range of technical skills are needed for Cloud Computing although security, networking, virtualisation skills and big data analytics are considered to be the key skills for Cloud. However, IT specialists need broader business skill-sets, especially risk management and business stakeholder management, to bridge the divide between IT and wider business operations.

The growth in demand expected for cloud services has significant implications for the high level skills required by service providers – particularly as cloud systems become more complex, higher skills levels will increasingly be needed of IT specialists working in this area. However, employers report that generally competition for higher level IT skills means that they find it difficult to recruit into cloud roles, relying on contractors/consultants while they redeploy and upskill their existing staff.

Cloud Computing can be leveraged for growth across all sectors and is in itself a key factor in Mobility, Green IT and Cyber Security technologies. It is clearly a growing area for the Digital sector but for the uptake to continue, service providers will need to understand the consumer better and nurture innovation.

Future insights for higher level skills

The Digital sector is considered in its own right to be a major driver of the economy over the next ten years. Workforce growth in the Digital sector is slightly higher than across the economy as a whole, and future trends and forecasts all predict the continuation of the demand for high level skills in the sector.

The sector requires nearly 300,000 recruits at Professional, Manager and Associate Professional level to fulfil growth potential and replacement needs to 2020. The increasing demand for entrants to these occupations may lead to increasing competition between sectors for highly skilled recruits.

Priority themes across technologies emerge as cost reduction - technology enabling a reduced cost base; consumerisation - businesses and individuals driving uptake; and security - a common theme and increasing requirement across technologies.

The research showed that employers currently have to address labour market issues around the new technologies. A recurring finding across the technologies was the need for high level IT Architects, Big Data and Security specialists. The growing need for IT staff with the ability to analyse and interpret Big Data was widely reported. This data is becoming increasingly valuable to organisations as they seek to gain competitive advantage from the knowledge that can be unlocked from this new resource. Similarly, a common skills theme emerging from employers across all of the four technologies investigated was the need for specialist cyber security staff. The concern being expressed was that as technology connects more and more devices the risk of security breaches becomes more and more an issue.

The core of technical / computing skills remain but upskilling existing IT specialists with broader, deeper skills and more new specialisms is critical for continued growth and innovation in the new technology areas.

Business skills manifest themselves in the need for high level sales and technical pre-sales skills and techniques that are currently hard to source together with the need for IT specialists to communicate with their customers more proficiently and extensively.

There are already indications there is increasing competition for higher level skills across these new technologies, with recruitment difficulties in higher value roles and in occupations with specialist skill sets such as IT Architects, User Experience Designers, Analysts and Developers. Finding suitably skilled staff is recognised as a key challenge for employers in the sector to realise business growth and capitalise on the opportunities that these emerging technologies offer.

Employers were however realistic about the disruptive impact of emerging technologies and rather than being seen as an issue, it is thought, in a positive sense, to actually foster innovation and drive growth in the Digital sector and across the wider economy.

Employers raise serious concerns about the future supply of talented IT people that will be needed to fill the ever growing number of roles created by these emerging technologies. Sourcing the required numbers of suitably skilled staff to capitalise on the opportunities that these technologies offer is recognised as a key challenge for employers in the sector, which if not addressed will seriously compromise future business growth potential.

1 Introduction

1.1 Purpose of the report

The aim of this report is to provide strategic LMI on the role of four technologies in driving high level skills needs in the Digital sector in order to provide intelligence to support the UK Commission and investment in skills.

The role of technology in driving high level skills needs was identified as a skills priority in many of the Sector Skills Assessments undertaken in 2012¹. This new research will provide an in depth understanding of the supply and demand (current and future) of high level skills in the Digital sector relating to: Cyber Security; Mobile technologies; Green IT and Cloud Computing.

The report seeks to provide a profile of the technologies in the Digital sector and user sectors, and determines how these technologies interact with other drivers of skills demand. It looks to see how demand and supply for skills may develop in the future, in the context of the current profile and status of the sector.

1.2 Summary of methodology

This report combines data analysis, literature reviews, qualitative interviews and a review of the findings with employers and experts to provide a detailed analysis of the role of technology in driving higher level skills in the Digital sector.

Across the four nations the Digital sector is highlighted as having particular importance to the economy. In England, Northern Ireland and Wales, it is considered to be a 'priority sectors' and in Scotland, there is a recognised need for skills to enable the exploitation of IT to increase sustainable economic growth. Interviews for this report included employers based in all four nations of the UK.

The approach ensures that this strategic Labour Market Information (LMI) report is developed through detailed input by over twenty employers and experts in these technologies working in the Digital Sector and also in user companies. See Appendix A for full details of the methodology.

¹ <http://www.ukces.org.uk/ourwork/research/lmi/sector-skills-assessments>

1.3 Defining the sector

The Digital Sector, for the purposes of this report includes IT & Telecoms and is defined using the following two digit Standard Industrial Classification (SIC):

- SIC 61 Telecommunications
- SIC 62 Computer programming, consultancy and related activities
- SIC 63 Information Service Activities
- SIC 95 Repair of computers and other goods

IT specialists primary role involves the design, development, implementation, operation, support or maintenance of IT or Telecommunications for either a firm or for their customers. Using the Standard Occupational Classification (SOC) IT specialists comprise eleven occupational codes at managerial, professional, associate professional and skilled trade levels.

Each chapter gives an overview and background to the technologies discussed in this report. See Appendix B for a full definition of the sector and occupations.

2 Digital Sector Overview

Chapter Summary

- The Digital sector is at the heart of the economy, underpinning growth and contribution to the economy through the technology it develops and the services it provides. The Digital sector employs 3 per cent of the UK workforce and contributes nearly £69 billion Gross Value Added to the UK economy (7.4 per cent).
- Per employee job, the sector is one of the most productive in the UK economy and employment has grown 5.5 per cent between 2009 and 2012, more than three times that recorded within the wider economy. The dominant characteristics of Digital sector employment are permanent, full time and male.
- A total of 1.1 million people work as IT specialists in the UK, with those working outside the Digital sector most likely to be employed in Finance and Professional Services, Manufacturing or the Public Sector.
- An analysis of the sector workforce shows over half of all workers to be employed in 'Professional' level occupations, well above the UK overall proportion. There is a particular concentration of higher level IT occupations in the Digital sector itself. Digital sector workers are also amongst the most highly qualified members of the UK workforce.
- Skills shortage vacancies equate to 17 per cent of all vacancies in the sector, and are experienced by over 3,000 employers. Hard to fill and skill shortage vacancies are concentrated in Professional and Associate Professional and Technical occupations. The most common skills thought to be lacking are job specific, and advanced IT or software skills.
- The impact of hard to fill vacancies includes difficulties introducing technological change and delays in developing new products and services. These issues are more keenly felt in the Digital sector than across other sectors.
- This evidence suggests that skills mismatches are affecting the ability of these high value firms to grow and develop as quickly as they might be able to, should they be able to source skills more easily.

2.1 Introduction

This study is particularly interested in higher level skills and how technology drives these. The premise is that firms that use technology intensively are likely to operate high value added product market strategies and therefore be vital for economic recovery. Skills shortages experienced by firms that are dependent on advanced technology therefore pose a threat to recovery.

The findings from the rest of the project (specific to the four technologies this project is investigating) are set in the wider labour market overview outlined in this section. It provides a summary of the nature of the Digital sector the extent of higher level skills and occupations, indications of skills issues and the importance of the sector to economic recovery.

Analysis in this chapter is based on data from the ONS Labour Force Survey (2012, four quarter average). Additional data is sourced from the Sector Skills Assessment for the Information and Communication Technologies Sector (e-skills UK, 2012). Definitions can be found in section 1.3 and Annex B of this report. Data tables and further information supplementing this Chapter of the report can be found in Appendix C.

2.2 Contribution to the economy

The Digital sector is at the heart of the economy, underpinning growth and contribution to the economy through the technology it develops and the services it provides across the UK.

National priorities

The Digital sector is recognised as key to economic recovery: IT is a priority sector in Northern Ireland and Wales. In Scotland skills and the exploitation of ICT are acknowledged as essential to sustain economic growth². In England, the Industrial Strategy (BIS, 2012a) identifies the Information Economy as one of the strategically important sectors, based on its contribution in its own right and the fact that it underpins growth and employment across the whole economy.

The Digital sector contributes nearly £69 billion Gross Value Added (GVA) to the UK economy (7.4 per cent). Measured by GVA per employee job, the sector is one of the most productive in the UK economy at £83,000 per annum, almost twice the UK average for all sectors.

² See Scotland's Digital Future <http://www.scotland.gov.uk/Topics/Economy/digital> [Accessed 21 June 2013]

Analysis undertaken for the Sector Skills Assessment (e-skills UK, 2012) shows that there are over 131,000 establishments in the Digital sector and nearly 57,000 businesses have two or more employees. Businesses in the sector tend to be small with 83 per cent of businesses classified as micro-businesses, having between two and nine employees.

2.3 Employment trends

Approximately 3 per cent of the UK workforce (826,000 people) were working in the Digital sector in the UK 2012. Despite the onset of recession in 2008, employment within the Digital sector has actually risen substantially over the past three years, and with an overall growth rate of 5.5 per cent between 2009 and 2012, the observed increase in Digital sector employment is more than three times that recorded within the wider economy (1.8 per cent). The dominant characteristics of Digital sector employment are permanent, full time and male.

Employment in the sector is heavily centred in England (and London and the South East in particular) with 89 per cent of total sector employment in England, seven per cent in Scotland, two per cent in Wales and two per cent in Northern Ireland

Technological change not only drives the sector itself from within, through innovation and research and development, but also is driven by the continuous demands of businesses looking to exploit technology in much smarter and more productive ways. As well as the direct effect on skills within the Digital sector, new technologies are also driving skills changes across the whole economy. Indeed, more IT specialists are employed outside the Digital sector than within it (Table 2). Of the total 1.1 million IT specialists, just 41 per cent are in the Digital sector (467,000 equating to 57 per cent of the sector workforce). IT specialists working outside of the Digital sector are most likely to be employed in Finance and Professional Services, Manufacturing and the Public sector.

2.4 Higher level skills: occupations, qualifications and skills mismatches

This study is particularly interested in high level skills in the workforce and how the specific technologies drive these skills. Methods for measuring skills levels include consideration of the occupational profile and qualifications held by the workforce (UKCES, 2010).

2.4.1 Occupational structure

An analysis of the sector workforce shows over half (51 per cent) of all Digital sector workers to be employed in ‘Professional’ level occupations – a figure well above that associated with the UK workforce overall (19 per cent).

The occupational make-up of the sector is broadly similar across each nation with professionals being the largest occupational group. However, as Table 1 shows, there are some differences in the concentration of professionals, with the Digital sector in Northern Ireland having a much higher proportion of professional level employment (68 per cent of all employment in the Digital Sector), and Wales a slightly lower proportion (49 per cent) than the average across the UK.

Table 1: Occupational distribution, Digital sector by nation, 2012

	UK	England	Scotland	Wales	Northern Ireland
Managers, Directors, Senior Officials	10%	10%	4%	3%	3%
Professionals	51%	50%	53%	49%	68%
Associate Professionals/ Technical staff	16%	16%	15%	13%	5%
Administrative / Secretarial staff	7%	7%	9%	3%	5%
Skilled Trades	10%	9%	8%	23%	13%
Other	7%	7%	11%	10%	6%
Total	100%	100%	100%	100%	100%

Source: e-skills UK analyses of data from the ONS Labour Force Survey, 2012 four quarter average

As would be expected, IT specialists (those who design, develop, operate and support corporate ICT systems/services³) account for a substantial share of the Digital sector workforce (56 per cent) and of these, again, the largest proportion (60 per cent) are found to be employed in ‘Professional’ level roles which are typically focussed on systems/software design/development/implementation type activities.

Whilst there is a similar occupational pattern of IT specialist occupations across industries, the proportion of IT specialists at Professional level is lower (48 per cent of all IT specialists compared to 60 per cent in the Digital sector itself) and the proportion of technical level IT specialists is higher (i.e. 11 per cent of IT specialists within the Digital sector work in IT Technician roles compared with 18 per cent within the economy as a whole, Table 2). This indicates that whilst IT specialists predominantly work at a high skill level regardless of sector of employment, there is a particular concentration of higher level IT occupations in the Digital sector itself.

³ See Appendix B2 for occupational classification of IT specialist occupations, descriptions and related job titles.

Table 2: Employment of IT specialists, Digital sector and all sectors, 2012

Occupational Group	IT specialist occupation	Digital Sector		All sectors	
		Number	%	Number	%
Managers/ Directors	IT & Telecoms Directors	27,000	6%	53,000	5%
	Specialist IT & Telecoms Managers	52,000	11%	184,000	16%
	IT & Telecoms Project and Programme managers	25,000	5%	57,000	5%
	Total 'Managers/Directors'	104,000	22%	294,000	26%
Professionals	Business Analysts, Architects & System Designers	33,000	7%	96,000	8%
	Programmers & Software Development Professionals	125,000	27%	240,000	21%
	Web Design & Development Professionals	27,000	6%	58,000	5%
	IT&T Professionals NEC	94,000	20%	157,000	14%
	Total 'Professionals'	279,000	60%	551,000	48%
Associate Professional/ Technicians	IT Operations Technicians	27,000	6%	113,000	10%
	IT User Support Technicians	23,000	5%	87,000	8%
	Total 'Technicians'	50,000	11%	200,000	18%
Engineers/ Skilled Trades	Telecoms Engineers	18,000	4%	57,000	5%
	IT Engineers	17,000	4%	31,000	3%
	Total 'Engineers'	35,000	8%	88,000	8%
Total	IT specialists	467,000	100%	1,133,000	100%

Source: e-skills UK analyses of data from the ONS Labour Force Survey, 2012, four quarter average.

2.4.2 Qualifications profile

The qualifications of the Digital sector workforce align with the workforce occupational structure which, as outlined in Section 2.4.1, is predominantly Professional.

Digital sector workers are amongst the highest qualified members of the UK workforce and approximately 63 per cent were identified as holding a Higher Education level qualification in 2012. This compares with an average of just 40 per cent for the workforce as a whole. This pattern of a highly qualified Digital sector is repeated across each nation. Northern Ireland notably has a higher proportion of the workforce qualified at higher levels. Further analysis of qualification levels in the Digital sector (e-skills UK, 2012) shows that qualification levels have been rising since 2002.

2.4.3 Skills mismatches

The rationale for this project suggests that firms that use technology intensively are likely to operate high value product market strategies that are vital to economic recovery. However, if these firms are experiencing skills challenges this is likely to impact the scale and speed of this recovery. This section sets out an overview of current skills challenges using the latest available data on skills gaps and shortages in the Digital sector from the UK Commission's Employer Skills Survey 2011 (UKCESS), as reported in the Sector Skills Assessment (e-skills UK, 2012).

There were over 29,000 vacancies in the Digital sector at the time of the survey in 2011, equivalent to five per cent of total employment in the sector and the highest proportion across all sectors.

Where there are hard to fill vacancies in the sector (5,449), the vast majority (91 per cent or 4,937) of these were skills shortage vacancies⁴, equating to 17 per cent of all vacancies in the sector at the time, and experienced by over 3,000 employers.

Hard to fill and skill shortage vacancies were concentrated in Professional and Associate Professional and Technical occupations and the most common skills thought to be lacking were job specific, and advanced IT or software skills. Across the economy more than a fifth of skills shortage vacancies (21 per cent) were lacking advanced IT or software skills, reflecting the importance of IT across sectors.

Of particular interest for this project is data from UKCESS (Davies *et al*, 2012) which indicates that the impact of hard to fill vacancies includes difficulties introducing technological change. Interestingly, this is much more keenly felt in the Digital sector (reported by 40 per cent of employers with hard to fill vacancies) than across other sectors (22 per cent of employers with hard to fill vacancies). Similarly, the impact of hard to fill vacancies in the Digital sector is more intensively felt in delaying the development of new products and services (68 per cent) compared to across the economy as a whole (41 per cent).

This evidence suggests that skills mismatches could indeed be affecting the ability of these high value firms to grow and develop as quickly as they might be able to, should they be able to source skills more easily.

⁴ Vacancies that are proving hard to fill due to a lack of skills, experience or qualifications among applicants.

Nearly one in ten employers in the sector reported skills gaps in the workforce in 2011, one of the lowest rates across all sectors, however skills gaps affect a higher proportion of the workforce than average with six per cent of employees generally in the Digital sector (34,775) having skills gaps⁵ rising to seven per cent in Professional occupations (9,414 employees). The main skills gaps in the Digital sector were reported as job-specific skills; planning and organisation skills; problem solving skills; written communication skills; and customer handling skills.

2.4.4 Training and skills supply

Training is viewed as a common remedy by employers for skills gaps. However, it would appear from UKCESS results that whilst a higher proportion of employers in the sector provided training for Professionals (17 per cent v 11 per cent) and Associate Professionals (22 per cent v nine per cent) than is the case across the whole economy, the proportion of these employees receiving the training is significantly less than for their 'peer' occupations.

For example only 43 per cent of Professionals in the Digital Sector had received training in 2011 compared to 61 per cent of Professionals across the economy. Furthermore the proportion of the sector workforce receiving training has fallen in recent years. Employers cite a lack of money to fund training as a common barrier to training in the sector.

A higher proportion of employers training but a lower proportion of employees trained could indicate that training is particularly targeted in the sector. Furthermore, training and development instigated by individuals themselves, or more informal continuing professional development is thought to be particularly widespread in the sector and may not be captured by these statistics.

Analysis (e-skills UK, 2012b) indicates that 18 per cent of new intake into the IT specialist workforce is from education (predominantly graduate level and higher); 43 per cent of people come from occupations other than IT, and 39 per cent enter IT specialist job roles from other sources, such as from unemployment or a career break.

⁵ Skills gaps within the existing workforce are evident when employees are not fully proficient in their job.

However, data from UCAS shows that there has been a large decrease in the number of applicants to Computing degree courses⁶, decreasing by 28 per cent from 2002 - 2010 in comparison to 51 per cent increase in applicants to all Higher Education. The past couple of years show slight increases in applicants and qualifiers from the subject, however, mismatches are still apparent with Computing graduates having the highest unemployment rate of all subject areas six months after graduation (HESA, 2012).

⁶ Defined using JACS codes G4-G7.

3 Cyber Security

Chapter Summary

- Cyber Security covers the protection of systems, networks and data. It is particularly driven by factors such as technology (new and legacy) and the increasing threat of security breaches; changes in business awareness and risk appetite; regulation and compliance (including legislation and industry standards).
- Key factors driving Cyber Security growth in the UK also include: consumer expectations; reputation (damage to the business reputation is a greater concern than the risk of fines due to breaches/non-compliance); and IP and asset protection.
- Skills needs include a sound base of technical understanding, knowledge and competencies; understanding and awareness of security issues and industry standards; analytical skills, risk analysis and management.
- Communication skills, relationship management, and customer facing presentation skills are seen as critical to achieve active support from business leaders.
- Estimates of growth potential go hand in hand with reports of significant recruitment and skills issues including an inability to source appropriate information security professionals in particular higher level specialists such as Security Architects and Security Analysts.
- The most common pathway into Cyber Security roles is via internal recruitment and from general IT specialist roles which would suggest that whilst entry also includes apprenticeships (seen as a pathway into higher skilled roles) and graduates, businesses continue to seek skilled professionals to work in this area.
- Training includes mandatory courses for compliance/audit but also to address the need for secure technology development and greater awareness of security across the business more widely.
- There is a general sense that the market for Cyber Security will continue to grow, a proactive outlook and higher level skills will continue to be needed to provide the products and services required to deal with increasingly complex cyber security, increasing breaches and threats and the impact of new technologies.

3.1 Introduction

Cyber Security is the protection of systems, networks and data in cyber space. This covers not only the internet but other digital networks used to store, modify and communicate information to support business, infrastructure and services we all use (Cabinet Office, 2011).

Key areas covered in Cyber Security are: network and information security; data protection; end user education and dealing with complex threats in real time. It can also be thought about in terms of the two broad areas of:

- infrastructure security, which covers threats to major national infrastructures, for example utilities, networks or air traffic control
- secure coding, which works at every level from guarding against identity theft to securing corporate secrets and working against IP theft and espionage and denial of service (DoS) attacks (for example, attacks that temporarily disrupt or suspend access to users of high profile websites)

3.2 Drivers of demand

Drivers of demand have been derived using available literature and from employer and expert interviews. The evidence suggests that Cyber Security is particularly driven by: the increasing threat of security breaches; technological change; regulation and compliance; and economic opportunity.

3.2.1 Breaches and threats

There are weekly if not daily media reports of cyber warfare and espionage between countries⁷, IP attacks and threats to infrastructure. The UK National Security Strategy categorises cyber attacks as a Tier One threat to national security with the Cabinet Office saying “The threat to our national security from cyber attacks is real and growing. Terrorists, rogue states and cyber criminals are among those targeting computer systems in the UK.”(Cabinet Office, 2013)

IT security companies⁸ also note the dominant trend of an increasing number of Cyber Security threats (to reputation, brand, revenue, key assets and data) and more sophisticated attacks.

⁷ Although there are many reports, the origins of security breaches are often unverified, un-attributed or denied. See however Mandiant (2013) for their observations and conclusions from a review of activity of prolific cyber espionage group ‘APT1’. <http://intelreport.mandiant.com/>

⁸ Estimates report the UK suffered around 44 million cyber attacks in 2011 (Kaspersky 2011). McAfee report they are now dealing with 60,000 new computer viruses a day and two million criminal websites a month (Warren and Whyatt, 2013)

The Cabinet Office (2013) report that 93 per cent of large corporations and 76 per cent of small businesses reported a cyber-breach in the past year and the cost of security breaches is high. However, the recession has meant that some businesses have fallen behind on technology security measures (PWC, 2013) and resources to protect against cyber crime and data theft are not a high priority for the majority of SMEs (IET, 2013). At the same time cyber criminals have got more technologically sophisticated.

These factors led to the view from some interviewees that currently Cyber Security is predominantly reactive and driven by the need to contain 'inevitable' breaches. There was a feeling that the sector should be challenging this somewhat defeatist mindset by setting out to develop systems and software that are secure, expanding the use of secure development lifecycles for example.

However, there is evidence that in response to increased breaches and threats, UK organisations are moving into a much more proactive state of mind regarding Cyber Security. Cyber Security is a priority area of concern for IT companies and other businesses, topping most industry surveys of technology professionals in 2012 and 2013 (see for example, Ashford, in Computer Weekly 2013 and Phillips, 2013), and analysts suggest there is no indication the trend of increasing cyber crime will change. Key security threats for the future extend from advanced persistent threats, mobile malware and cloud computing risks to internal threats leading to infection and spyware⁹.

Whilst business awareness has often been catalysed by the occurrence of a Cyber Security breach or problem of some sort, businesses are now becoming more vigilant, proactive and aggressive in terms of protection. Deeper defences have been deployed, not just in reaction to regulation and compliance but as a consequence of the range of drivers outlined above.

Boards and business leaders (particularly in security sensitive sectors) are therefore becoming increasingly aware of the need to put in place secure technology, and the Chief Information Security Officer (CISO) is now a strategic decision maker. Risk appetite and ownership of risk at senior levels were cited in many of the employer interviews undertaken as part of this research as a significant driver of Cyber Security, with a more proactive and confident approach to risk management becoming apparent. That Cyber Security is now considered at Board level is seen as a significant change.

⁹ Although internal breaches are due to employee negligence in the main rather than malicious intent.

3.2.2 Technological Change

Technology is a key driver of Cyber Security with old (legacy) and new technologies posing challenges for Cyber Security professionals.

IT companies delivering Cyber Security products and services do so for both defensive and offensive applications covering IT and Telecoms but also industrial equipment. Legacy systems, including infrastructure and industrial control systems, that were never designed for the connected world but have been brought online are now key targets for cyber crime. For example SCADA¹⁰ control systems, which were generally not designed with security in mind, have been shown to be particularly vulnerable to network attacks as they now connect to each other and to other systems.

In addition to the challenge of securing legacy systems, it is reported that only a minority of projects currently consider security at project inception (PWC, 2013) although businesses interviewed suggest this is changing with much greater awareness, integration and collaboration between roles and across departments, although technology adoption would seem to be moving faster than security adoption.

The emergence of mobile technologies and the ever increasing pervasiveness of cloud computing is driving the requirement to have more and more complex Cyber Security protection and a stronger and more proactive risk and ownership strategy. As is the case with legacy systems, joining technologies means more controls need to be in place. The challenge is summed up by Accenture in their Technology Vision: “Increasingly connected means increasingly exposed.” (2012, p. 39)

3.2.3 Regulation and compliance

Legislation, regulation and compliance are key drivers of Cyber Security from an internal and external perspective.

In the UK and Europe, legislation regarding Cyber Security is increasing in prominence; of note are the proposals on mandatory breach notifications from BIS and the EU¹¹. Observers noted that there is much to be thought through in implementing these directives, not least that what constitutes a ‘significant’ breach is highly subjective.

¹⁰ Supervisory control and data acquisition. SCADA type systems are used for monitoring and control for complex, large and often disparate processes, for example in industries such as manufacturing and utilities.

¹¹ Draft Network and Information Security (NIS) Directive.

So whilst proposed directives could provide market opportunity for businesses providing specialist Cyber Security services there is also the view amongst some employers and experts that growth and innovation in the UK could be limited through excessive legislation and the subsequent burdens and distractions on businesses¹², particularly smaller businesses (Ashford, 2013c). However, the government response to the EU says:

“The UK would not support legislative proposals that are aimed at enhancing cyber security but which stifle the possibilities for economic growth or have the potential for unintended consequences.” (BIS, 2012b, p. 3)

Interviews with employers and experts confirmed that industry best practice standards and specifications (e.g. ISO 27001¹³), specific sector regulation (e.g. PCI DSS¹⁴ and Sarbanes-Oxley in Financial Services), government standards (e.g. CESG¹⁵ Good Practice Guide, HMG Security Policy Framework) and client requirements are all very much driving Cyber Security provision and skills requirements. For example, employers in the sector highlighted that Cyber Security is driven by the public sector and central and local government as key customers. The requirement for robust Cyber Security is increasingly needed as government bodies become more proactive in sharing between each other but have particular audit, regulation and data protection requirements.

3.2.4 Economic opportunity

Employers interviewed for this project viewed Cyber Security as an integral part of their business strategy driven by good business sense, competition and gaining market share/new markets. Indeed, Cyber Security is needed by all industry, as demand in the UK, and globally, grows for vibrant and innovative Cyber Security products and services to bolster growth (Maude, 2013). Increased security brings economic growth through increasing online transactions and business applications, particularly for small businesses, across the economy. Key factors driving the role of Cyber Security in economic growth in the UK include: consumer expectations; reputation; intellectual property and asset protection.

¹² The US is generally considered to be less regulated.

¹³ “ISO/IEC 27001:2005 – Information technology – Security techniques – Information security management systems – Requirements” are information security standards that mandate specific requirements. Organisations can be certified by a third party as compliant.

¹⁴ Payment Card Industry Data Security Standard

¹⁵ CESG (originally the Communications-Electronics Security Group) is the UK Government's National Technical Authority for Information Assurance.

Consumer expectations and reputation: In addition to the ‘push’ of regulation, business and legal requirements that require data to be protected, there is also a pull from consumers (whether businesses or individuals) who are themselves driving better security standards by expecting organisations to protect their data. Consumer trust in data protection and Cyber Security is a key factor in purchasing decisions and businesses can therefore use good cyber protection as a competitive advantage.

In addition to the cost of cyber crime to the economy and individual companies, cyber crime is reported to have a significant impact on business reputation and loss of customer business. This was confirmed in employer interviews where the damage to the business reputation was seen as a greater concern than the risk of fines if there was a cyber breach or if the business was not seen to comply with legislation. So whilst government may be more concerned with state sponsored acts and cyber terrorism, hackers and organised cyber crime are more of a concern to those in sectors such as Financial Services, where company reputation is a key priority and future business is directly related to the perception and reality of robust Cyber Security.

Intellectual Property and business assets: As well compliance issues, there is a need to protect the value of Intellectual Property and assets from a commercial point of view from cyber attacks. Certain industries are more prone to specific cyber threats with theft of Intellectual Property (IP) particularly affecting industries such as Pharmaceuticals and Biotech as well as Software and Computer Services, and industrial espionage targeted at Financial Services, Mining and Aerospace (Detica, 2011). Furthermore, IP theft and espionage is determined to be the most costly type of cyber crime to the UK economy (Detica, 2011 and New Statesman, 2013).

An article in Computer Weekly, suggests that each business needs to understand the threats specific to them:

“A pharmaceutical company, for example, needs to protect the unpatented bright ideas of its scientists; a law firm needs to safeguard its clients’ information; most international companies need to protect their strategic expansion plans.” (Stollery, 2013)

The research suggests that sector and nature of business has a strong correlation with the type of Cyber Security risk and the response required.

3.3 Current and emerging skills and occupations

3.3.1 Occupations and roles in Cyber Security

In the provision of Cyber Security solutions and services, many 'traditional' IT roles are evident but have security specialisms. Evidence from interviews suggested that most, if not all, roles were at least at System Analyst level.

Work undertaken for the Cyber Security Learning Pathways Programme (Lyons and Harris, 2012) based on analysis of recruitment data shows that the most common Cyber Security roles¹⁶ are: Information Security Manager, Information Security Consultant, IT Security Consultant and CISO (Chief Information Security Officer).

At the high skills/professional level, Security Architects look at the 'blueprint' of a security programme, developing a holistic picture and Security Designers develop the key components of a system. Security Architects were found to require the most developed skills and the highest level of seniority in research conducted in 2012 for Cyber Learning Pathways (George, 2012)¹⁷. Security Analysts use data to look for security alerts, events, and incidents to respond to, using real time decision making skills, monitoring data and use reverse engineering – to work out how breaches happen.

As well as bid and pre-sales, there are implementation (project managers), operations and engineering roles specific to Cyber Security, but interviewees particularly mentioned the higher level roles of CLAS¹⁸ Consultants and Security Professional Services occupations to deal with audit, compliance and risk assessment.

¹⁶ Across IT specialist occupations there tends to be a plethora of titles that may apply to similar jobs or roles. For example a Chief Information Security Officer (CISO) is also sometimes known as a Chief Security Officer (CSO) although this role could include a broader (non-technical) remit.

¹⁷ This report summarises the findings from a consultation on the views, skills and experience of 40 of the UK's Chief Information Security Officers (CISO's) and Senior Information Security professionals from across industry, interviewed between June and August 2012. The participants interviewed are responsible for 6,716 Cyber Security professionals in England. Additionally, of those interviewed, 30% had a European, EMEA (European, Middle East and Asia) or global remit.

¹⁸ CESG Listed Advisors Scheme

3.3.2 Skills associated with Cyber Security

The research suggests the following are key skills areas for Cyber Security.

Technology related skills¹⁹

Many occupations in Cyber Security have a basis in IT infrastructure and thus will require the base technical understanding, knowledge and competencies. Engineering design skills were seen to be critical in increasing the extent to which systems 'fail gracefully' i.e. in a controlled manner. Key skills areas highlighted in interviews with employers and by the Cyber Security Challenge²⁰ include: security layers including defence, detection, reaction; encryption; mathematics and algorithms; incident and threat management and forensics; configuration management; data analysis. Cyber Security specialists may also need to have other specialisms – for example Security Architects may need to understand the technology around financial transacting for work in Financial Services.

This technical expertise needs to be based in a broad knowledge and awareness of security issues, according to the recent ISC² study. Employers interviewed also raised that general security awareness is key across occupations, from those working with networks to developers and analysts.

Analysing large volumes of intelligence data requires new tools, analytical skills, investigative and 'sleuthing' skills, as well as proactively scanning for threats. The effective use of advanced intelligence is also enabled by effective risk management and decision making skills as outlined in a report on advanced Cyber Security intelligence:

“Good cyber security intelligence is fundamental to preventing advanced security threats and enabling security staff to do their jobs effectively...such intelligence also enables good decision making; IT staff need to react to fast moving events and be confident to raise the alarm and know how loud it should be: however, they do not want to be accused of crying wolf.” (Tarzey and Longbottom, 2012, p.4)

¹⁹ See also section 3.4.2 on Certifications.

²⁰ A partnership of public and private organisations who care about the future of the profession.

Management and cross business working

Good Cyber Security requires sound management and a common theme in the literature reviewed was that active support from other business leaders and top level management is critical as Cyber Security is a 'business issue and not just *"an IT thing"*' (Stollery, 2013). The Frost & Sullivan/Booz Allen Hamilton report for ISC² (Suby, 2013) also reports that the first priority in securing infrastructure is management support of security policies. This was also stressed in some interviews, for example an employer said:

"Across organisations there needs to be a leadership culture which promotes security as a key element of every aspect of the business." John Palfreyman, Director - Defence, Intelligence & Public Safety, Software Group Europe CTO Team, IBM

Risk analysis and management were skills that were raised by interviewees as key and increasing in importance, with risk assessments becoming mandatory in business as well as in government. In relation to this, Suby suggests that "information security professionals must be highly adaptable in learning and applying new skills, technologies, and procedures in order to manage a dynamic range of risks" (2013, p.3) This adaptability was seen as an important quality for successful Cyber Security specialists to have.

Interpersonal skills were also raised as particularly in demand because of the important role of communication and collaboration across other parts of the business. In an IT services company, for example, Cyber Security specialists will be working across other product and service teams. Additionally, they will need to work with wider IT departments, suppliers, personnel, legal (advice and prosecution for Internet crime and data protection) and operations, and with the Board and C-level executives²¹. An interviewee for this project summed this up saying that *"security specialists needed to have relationship management skills to work across the business, raising the trust of others and gaining credibility."*

Within the context of anonymity there is a call for more public-private partnerships, and the need for skills to work across businesses in a collaborative manner. One expert interviewee suggested the following solution:

"Whilst organisations do not necessarily cooperate with each other regarding breaches of security because of commercial sensitivities, they may cooperate on security issues such as fault prevention and claims that can be dealt with anonymously."

²¹ For example the Chief Executive Officer, Chief Operations Officer or Chief Financial Officer.

Some of the employers suggested that pre-sales staff increasingly need high level technical knowledge combined with customer facing presentation and communication skills – and that this combination is generally hard to find. Interviewees also suggested that multinational working is becoming increasingly important and that the skillset of the future (that needs to be developed now) will be to work successfully with global teams.

A Kaspersky Lab poll²² (2011) suggests again there is a lack of understanding in the wider business about Cyber Security threats and a lack of personnel trained to deal with IT threats, saying that “teaching company personnel all the basics of IT security is no less important than installing the latest security software.” (Kaspersky, 2012 p.21) This was echoed by employers who thought that awareness across business was increasing but needed to be ubiquitous.

Interviewees were keen to stress that education, training and awareness for the whole workforce is needed so there is a baseline level of security skills and an understanding of risks and awareness across the whole business.

3.4 Recruitment and supply of skills

3.4.1 Recruitment

Cyber Security is a growing technology area (as cyber attacks increase across the board²³) and the weight of evidence would suggest that businesses continue to seek skilled professionals to work in this area.

Results from a survey that was conducted by Computerworld in June 2012 (Pratt, 2012) show that 27 per cent of companies surveyed plan to hire for this skill in 2013. Security has long been a concern of IT leaders, and demand for specialised security professionals is growing as the task of safeguarding systems and data becomes increasingly complex. Similarly, an Information Week report (2012) shows security is the top area for increasing staff levels in 2013²⁴ through hiring or reassignment.

²² Poll of 3,000 IT professionals, including 200 from the UK.

²³ See for example high profile media coverage of the Cyberbunker – Spamhaus dispute in March 2013, DDoS attacks on US banking websites reported in May 2013, the Lulzsec international hacking gang and public sector incidents such as NHS patient record losses (reported in October 2012).

²⁴ Online survey of 1,391 business technology professionals (decision makers, subscribers) in North America, July 2012.

Cyber security vacancies

ITJobsWatch²⁵ tracks advertised demand for over 80 different Cyber Security titles with an average of 5,000 permanent and contract advertised vacancies recorded as mentioning these titles in each quarter of 2012. This indicator of demand also suggests that vacancies may have doubled in the last four years.

The most commonly advertised job titles at the end of 2012 are shown below. These ten roles comprise nearly two-thirds of advertised demand in Cyber Security.

Security Engineer	Network Security Engineer
Security Consultant	Security Specialist
Security Analyst	Information Security Consultant
Security Manager	Security Officer
Security Architect	Network Security Analyst

Alongside the requirements for Security Cleared, Information Security and Network Security skills, CISSP is mentioned in an average of over 1,000 advertised vacancies per quarter in 2012. Cisco ASA and PCI DSS (aforementioned as required mainly in relation to Financial Services Cyber Security), Penetration Testing, Security Management and IPsec (Internet Protocol Security) complete the list of the most commonly mentioned skills and certifications in permanent and contract Cyber Security job adverts.

Estimates of growth potential go hand in hand with reports of significant recruitment and skills issues. For example:

- A report for the international information security professional body ISC² suggests that there will be 11 per cent annual growth over the next five years but those shortages will continue (Suby, 2013).
- The Cyber Security Challenge Chief Executive reports in an article for the New Statesman (Daman, 2013) that the opportunities for a career in Cyber Security are plentiful but the industry is struggling to find enough recruits with the right skills and aptitude to enter the profession. Reported in the same journal is a shortfall of 4,000 qualified people to combat current cyber attacks (Warren and Whyatt, 2013).

²⁵ IT Jobs Watch sources data from IT recruitment websites and operates independently to provide an impartial outlook. Their surveys are continuous to ensure the information presented is up to date. <http://www.itjobswatch.co.uk/>

- Accenture reports (2012) there is a real challenge for IT leaders in user businesses as the specialists required are in short supply, partly due to demand from the sector itself (security software vendors).
- 85 per cent of participants in the Cyber Security Learning Pathways study (George, 2012) said they had problems in recruiting the right people, with the right skills.
- The National Audit Office (2013) also reports that addressing the UK's current and future ICT and Cyber Security skills gap is a key challenge. They report suggestions from government that the number of IT and Cyber Security professionals in the UK has not increased in line with the growth of the internet and that shortages of cyber and more widely IT specialist skills hamper the ability of the UK to protect itself from an increasing cyber threat:

“Interviews with government, academia and business representatives confirmed that the UK lacks technical skills and that the current pipeline of graduates and practitioners would not meet demand.” (NAO, 2013, p. 27)

The IET survey of 250 SMEs (2013) found that the main challenge (for medium sized organisation in particular) is recruiting senior and experienced staff. Employers interviewed also cited a general lack of supply for senior staff and particular difficulties in getting higher level Cyber Security specialists such as Security Architects, Pre-sales and Security Analysts. Particular skills cited as difficult to recruit were analytical skills and forensics (also mentioned as a weak area world-wide) and risk management.

Employers report that contractors are often used to back-fill positions on a short term, reactive basis, indicating a shortage in the mainstream labour market. Employment of contractors is also used as a method for gaining expertise for a short period of time, with the ability to re-call these skills at short notice and as a method to remove the need to increase overall permanent head-count.

Whilst increasing demand generally increases churn, retention amongst specialists was not seen as a particular problem by interviewees, who were on the whole larger companies, who said that Cyber specialists were happy to stay as the work is seen as challenging, in a changing market and it is well paid. However, there evidence from a wider sample (George, 2012) that over half of companies working in this area have experienced retention problems.

3.4.2 The supply of skills

There was generally a preference amongst the employers interviewed for internal recruitment into Cyber Security roles. The pipeline is, on the whole, developed from placements, graduate intake and professional development. For example, 87 per cent of respondents to the Cyber Learning Pathways study (George, 2012) said they would retrain an existing IT employee to be a Cyber Security professional.

General development or training then enables movement or recruitment into specialisms, such as Cyber Security, although employers do sometimes recruit graduates directly into security roles from Computer Science, Information Security and Computer Forensics degrees for example.

There is some evidence of employer engagement with specific or local universities to attract new graduates and build the 'company brand' but at the moment it is perceived that universities are not dealing with cyber skills needs and the market is generally vendor led. At the very least there is a call for computer security and secure development to become more inherent parts of computing related degrees and that industry should be more involved in degree development²⁶.

In line with the findings earlier in this chapter, highlighting the need for more general awareness across businesses, it was also suggested that security issues need to be covered in business schools as well and indeed suggested that information security should be a core skills across all graduates.

Non-graduate intake was also mentioned in terms of IT savvy business people (for example entry to CISO roles is often from a non-IT role), entry into apprenticeships or from college level, given the right aptitude and attitude.

It was noted that many people outside of IT or Cyber Security have skills and experience in risk management, and this is currently an under-used recruitment source. With an inherent understanding and core skills in risk management, the right aptitude and attitude, these recruits would need to pick up an information security mindset, but could provide valuable resource and the higher level skills needed for many Cyber Security roles.

²⁶ From 2015, education in cyber security will be a mandatory component of software engineering degrees accredited by the Institution of Engineering and Technology (IET). <https://www.gov.uk/government/policies/keeping-the-uk-safe-in-cyberspace/supporting-pages/making-cyber-security-a-mandatory-component-of-software-engineering-degrees> [Accessed 17 June 2013]

There was general consensus that complex Cyber Security learning should be delivered once individuals have a thorough and broad basis of Computing on which to build, and specialist training is more likely to be in work or through conversion or higher level courses once individuals have built up some basic experience.

More generally, it was widely raised by interviewees that there is a need to get people interested in technology careers earlier. The loss of general IT specialists with a good grounding in fundamental Computing principles is already occurring. It was suggested that existing IT/Cyber specialists and early retirees could teach in schools and colleges and mentor IT specialists or others in work who wish to enter a Cyber Security role.

Qualifications and certifications

Analysis from Lyons and Harris (2012) shows that just under half of cyber professionals have an undergraduate degree, most commonly IT related. This proportion would seem relatively low compared to those within IT specialist roles as a whole (where 63 per cent have a degree) but the Cyber pathways data does, however, suggest that a higher proportion of people in more junior roles have degrees compared to their more senior counterparts, indicating a more recent shift to recruitment of graduates.

The same report and the employer interviews conducted for this research also suggest that the most common pathway into Cyber Security roles is via general IT roles (tying in with the need for good technical/IT background) which would suggest that whilst entry levels may also include Apprenticeships the educational level of cyber professionals is likely to continue to increase.

Higher level degrees (for example MSc Infosec) are most likely to be held by those in particularly specialised job roles such as those within Computer Forensics, Network Security and Information Security whereas MBAs are generally found to be held by those in CISO and commercial (sales) types roles.

Lyons and Harris (2012) also identify that CISSP (Certified Information Systems Security Professional)²⁷ is the most common professional certification, held by 54 per cent of those in technical cyber roles, rising to 73 per cent of IT Security Managers and Consultants.

²⁷ For more information see <https://www.isc2.org/cissp/Default.aspx> [Accessed 17 June 2013]

Employers mentioned other commonly held and required qualifications/certifications in the Cyber area which include: CISM, ITPC, CCP²⁸ and TOGAF (for enterprise architecture), CIPP, CRISK and ISO for lead auditor (ISO 27001). Juniper, Checkpoint and Cisco were also cited as relevant vendor certifications.

Whilst widely recognised, many certifications are desirable but not always mandatory although in the case of CCP the certification is required for UK Government Information Assurance Professionals and more generally across a wider range of roles. This is seen as driving uptake in the UK across the private sector as well and is leading the way internationally. In addition CLAS consultants need to be CCP certified.

Some of these certifications are seen as relatively broad providing only the knowledge component and employers stressed they are looking for candidates that not only have the knowledge and skills but have the relevant experience, professionalism and the attitude to do the job. Apprenticeships and higher apprenticeships are increasingly seen in the sector as a pathway into higher skilled roles, the apprenticeship providing the basis of technical skills and experience required to then progress to more specialist Cyber Security roles.

Training

The interviews undertaken for this project suggested that training is seen as particularly important for Cyber Security specialists. Some businesses said there were mandatory courses and that training was an important part of compliance and audit – internally, but also for external business benefit as well. More widely, and to address the need for greater awareness across the business and at board and business leader level, security is increasingly included in induction programmes.

Whilst pressures on training budgets were mentioned, there was a general sense of a collaborative, internal approach to skills development, often with groups of specialists taking training before then disseminating out to their colleagues.

There was also a view that early on all IT specialists should be security trained, whatever their role, to ensure that security is factored in at the start of career development.

In one company interviewed for this research, a ‘secure development kit’ for their developers has been created so that security is efficiently and consistently implemented in all technologies, products and services, from the outset and across the company.

²⁸ CESG Certified Professional, using the IISP skills framework.

This employer, and many other of the interviewees spoke about a culture of ‘on the job’ knowledge transfer which is essential to develop higher level skills in the workforce. Methods used include the use of technology to share information and best practice and using experienced colleagues, consultants who have been hired on a short term basis and specialists to help raise workforce skills levels. Knowledge transfer was also highlighted by many interviewees in the Cyber Learning Pathways consultation:

“Fifty-five per cent of participants said their Cyber Security professionals were in ‘communities of specialisms’ thereby acknowledging that professionals learnt and shared information very effectively with their peers, providing consistency and a strong knowledge pool.” (George, 2012 p. 1)

Coaching and mentoring also seemed to be the preferred method for higher level and interpersonal skills. The result being that there is a norm of development and progression, a flow from existing workforce into higher level roles and an increase in employee efficiency and professionalism.

3.5 Future skills outlook

There is a general sense that the market for Cyber Security will continue to grow and higher level skills will continue to be needed to provide the products and services required to deal with increasingly complex cyber security.

Higher level roles in Cyber Security encompass those from development to delivery but increasingly, Cyber Security specialists are making strategic decisions and interacting across the business at a senior level, using relationship management and communication skills to spread greater awareness and understanding of security issues. The Rt. Hon David Blunkett in a preface to a report by ISSA-UK on Information Security – The Next Decade (Lacey, 2010, p.1) wrote: “There is a substantial effort to increase awareness, followed by a return to relative complacency” indicating one of the key challenges for government, employers and Cyber Security specialists themselves, is to maintain a focus on increasing awareness in the longer term.

Managing and countering the number of growing threats and anticipating future challenges is a key area of concern for Cyber Security specialists, government and business in the UK. Dealing with these ever-increasing and complex threats requires Cyber Security specialists to be ‘one step ahead’ but there is a challenge to find enough highly skilled individuals to both address legacy technology and develop new technologies securely from the start. This is especially difficult in a climate of reduced spend where the tendency for security is to be reactionary or short term and the sector is experiencing significant skills and recruitment issues.

The consensus is that the challenges posed to Cyber Security by new technologies are addressable, but nevertheless, there is a general concern that increasing mobility, proliferation of technology, the ‘information tsunami’, integration and increasing connectivity will all increase the difficulty of managing technology securely²⁹.

In terms of a more proactive approach, businesses are starting to ensure that secure systems are built from the start and security becomes part of the solution through secure development lifecycles, with the consequence that more and more IT specialists need security skills. Increasing reliability will be a key opportunity in reducing breaches and future threats. New technologies³⁰ may even remove security worries for the public cloud, although this could be some way in the future.

The evidence in this research suggests Cyber Security specialists not only need a broad base of computing knowledge and experience but also an interest in the specialism, which could be fostered earlier in career development. Key specialist areas of skills need such as advanced intelligence, forensics and general areas such as analytics and risk management need to be developed more widely to address current skills issues.

The ISSA-UK report on the future of Information Security (Lacey, 2010) suggests a “quantum leap” is needed in capability to address the challenges and to seize opportunities. Overall, the challenges Cyber Security presents requires a more proactive attitude and adaptable professionals who can anticipate future threats and develop the skills to counter them. Government, the sector and educational establishments are all well placed to work in partnership, creating more opportunities for entry to the wider IT profession and to increase the pool of Cyber and Information Security specialists.

²⁹ For example the Internet of Things is expected to generate particular security concerns.

³⁰ An example being homomorphic encryption which allows conversion of data into cipher that can then be worked and analysed on e.g. in the cloud, without access to the original data See for example <http://searchsecurity.techtarget.com/definition/homomorphic-encryption> and http://www.theregister.co.uk/2013/05/03/ibm_open_source_homomorphic_crypto/ for examples of how this might work.

4 Mobile Technologies

Chapter Summary

- Communications, devices and applications are integrating and converging enabling multiple uses and advanced collaboration. This requires constant innovation and new technology solutions. Businesses are using mobile technology solutions as part of a multi-channel approach to connect with clients and to improve employee productivity.
- Mobility is primarily being driven from a consumer perspective and the pace of mobile use as a primary channel by consumers is faster than most businesses expected. An emerging theme is the growth of Bring Your Own Device (BYOD) where employees are driving change in the workplace.
- There are significant challenges for IT specialists managing mobility, but mobile technologies bring new operational models to businesses providing opportunities for growth and more efficient working methods for employees.
- Mobile technology skills are needed in many IT specialist job roles, whether in design and development, management or support. Highly skilled occupations in mobility include: IT Architects, Developers, User Experience Designers and Project Managers.
- Agile techniques, technical pre-sales, sales, marketing, account management support and an extensive understanding of customers' industries are noted as key skills requirements alongside the need for a high degree of interaction between technical specialists, the user experience design team and the end client/customer.
- Mobility is increasingly a thriving part of Digital sector business with potential for greater growth, and an area where significant recruitment and retention pressures are emerging, particularly in the recruitment of mobility specialists who need extensive technology experience together with specific mobile technology skills. Hard to find occupations were noted as IT Architects, Developers, User Experience Designers, Testers and Sales and Pre-sales staff. Recruitment into mobility roles is often addressed by upskilling existing staff.
- The machine to machine 'connected device space' will create a huge amount of information and highly valued analytical skills are needed to exploit the data generated.
- Securing mobile devices is becoming increasingly recognised and important for all organisations looking to integrate mobile technologies into their future business plans and will be, without question, a key skills challenge.
- The high level of demand for mobility skills and roles is a current issue, but in time it was felt that the skills will catch up provided sufficient talent enters the Digital sector.

4.1 Introduction and background

Mobile technologies enable software and applications to run on various and multiple devices. Communications, devices and applications are integrating more into day to day work and this requires constant innovation and new technology solutions. Mobile technologies are converging IT and Communications technologies to change the original purpose of mobile phones and other mobile devices (handheld/Tablet PCs, Smart phones) to enable multiple uses and advanced collaboration.

The use of mobile technologies in business is clearly on the increase although not yet completely mainstream. The IBM Tech Trends Report (Lo *et al.*, 2012) cites Cisco data which identified that by the end of 2012 mobile devices were expected to outnumber people.

Analysis from Ovum (Jennings, 2013) suggests that this emerging ‘always-on connected world’ has had a profound effect on business. Businesses are looking for mobile technologies to provide solutions so they can both connect with clients and also improve employee productivity. Many of the IT sector companies interviewed have identified mobility as a key revenue/growth area in recent years and have set up dedicated mobile teams/business units.

The uptake of mobile technologies, however, was often referred to by employers as a ‘disruptive’ trend and whilst this may be the perception/case, businesses need to develop strategies for engaging with customers, creating reach into new markets and developing new business models which, most importantly, includes delivering products and services on the move. Deloitte’s analysis of technology trends sees mobile changing the nature of business operations:

“The next wave of mobile may fundamentally reshape operations, businesses and marketplaces – delivering information and services to where decisions are made and transactions occur. And the potential goes far beyond smartphones and tablets to include voice, gesture and location-based interactions; device convergence; digital identity in your pocket; and pervasive mobile computing. The very definition of mobile is changing.” (Deloitte, 2013, p. ii)

4.2 Drivers

The consensus from the literature review and the interviews is that there are fundamentally four drivers around mobile technologies: consumerisation, 'bring your own device' (BYOD); cost reduction and enterprise mobility.

4.2.1 Consumerisation

Mobility is being driven from a consumer perspective. For ever discerning consumers businesses need a multi-channel approach to deliver their services, using technology across different devices (PCs/tablets/mobile/smart phones). Consumers are particular that the look and feel of their interactions needs to be right from the end user point of view – they now demand a rich multi-channel experience. Most consumer facing companies now have to provide new, innovative and exciting offerings to meet customer/consumer expectations.

The pace of mobile use as a primary (and preferred) channel by consumers is faster than most businesses expected. Web channels (through PCs) have been overtaken as a preferred channel by consumers as they quickly switch to mobile devices e.g. Facebook is now accessed by many of its users on mobiles whereas this was a minimal trend three years ago. Consumers will still use multiple channels but mobile is increasingly the preferred option – it is a transformational technology enabling individuals a more personalised interaction. Interestingly it is suggested that for lower income people the smart phone is the preferred device for communication – with many not necessarily having broadband access or a PC at home.

Ovum's Chief IT Analyst summarises mobility, saying:

“Mobility has put powerful, connected technology in the hands of consumers, in their concurrent roles as citizens, customers, and employees...CEOs rate this changing technology landscape as the single most important external factor impacting their businesses” (Jennings, 2013, p. 1)

4.2.2 Bring your own device (BYOD)

A key theme emerging from the literature and interviews is the growth of Bring Your Own Device (BYOD) with the recent Computer Weekly/Tech Target survey suggesting that 55 per cent of IT managers want to accommodate end-user tablet devices within their corporate network.

Whilst Gartner Analyst, Mark Raskino, encapsulates the challenges of BYOD by calling it a “headache for IT” (Saran, 2013), it can also be seen more positively in attracting younger workers who expect to be able to use their own devices in the workplace, effectively bringing consumerisation to the workplace.

Employees do not want to have to carry around multiple mobile devices – they, as consumers, are used to mobility in their personal lives. Most people’s preference is to just have one phone and one PC/tablet device. This is creating a big change in the way mobile technology is used by employees. For this trend to continue to roll out businesses will need to re-consider their rules and regulations, their employee policies – essentially to consider whether to change their attitudes to the new ways of working that their employees demand. Many employers realise that employee satisfaction will be an issue here – whether or not they have smart devices which they are ‘allowed’ to use for business as well as personal use.

Consequently, many businesses are stepping into this area but in a controlled way, integrating the easier business related applications first. For example, email is normally the first area addressed, then organisations are putting a core set of mobile business functions on employee devices like HR functions, expense forms, room booking, leave requests and some are also providing training materials.

Not all organisations interviewed were convinced about extensive rollout of mobility through their organisations. Some cited practical integration issues around existing technology infrastructure and in some cases the difficulties of legacy systems and security issues were also identified as a major concern, with the safeguard of ‘remote wipe’ frequently mentioned.

However, where organisations believed that their employees could be more productive on the move they generally reported that mobility would eventually permeate through the business and will be perceived by employees almost as a ‘flexible benefit’.

As mobility grows, boundaries between personal computing and business IT are blurring as consumer devices and applications cross over into small business and enterprise markets.

4.2.3 Cost reduction

Streamlining costs is on the agenda for most businesses and is an area that is always under constant review. Changing new business models and improving customer experiences has driven all sorts of interesting innovation in the use of mobile technologies. Whilst there are significant challenges for the IT department in managing different mobile devices and integrating new applications into existing IT infrastructure, in many sectors a mobile enabled workforce is more efficient and less cost than a fixed workforce. The savings in the amount of fixed office space traditionally needed for a static workforce compared to that required for the provision of mobility to employees is an obvious example.

4.2.4 Enterprise mobility

Mobility is often the preferred term used by organisations for the 'mobilisation of the enterprise'. It is more than just having a smart mobile phone/tablet device, it is about employees being able to use many different devices with any technology services in many locations.

All businesses look to increase the productivity of their workforce. Mobile technologies bring new operational models to businesses to allow more efficient working methods for their employees. Some of the first uses of mobility were for those organisations that have a significant 'field force'. Early examples of this would be the use of mobile devices in the utilities sector where handheld devices were used to take meter readings, or the use of devices by logistics companies to get parcel recipient signatures. The ability to be able to instantly relay data back to 'head office' without delay, and without paperwork, has changed many business methods in the field.

Businesses with significant sales forces have quickly and extensively adopted the use of mobility to realise the efficiencies that technology on the move can offer.

Interestingly many businesses now are also identifying mobility as an ideal channel to deliver remote training to their employees. This could be in the form of live online training delivery to a remote workforce or recorded sessions for future use by employees, for example using downtime when travelling to update their skills.

4.2.5 Mobility across the economy

Software developers in many technology companies are developing end to end mobile solutions. Their customers for these new offerings are often in sectors where the business to customer interface is intensive, for example in retail or banking. The banking sector now has rapidly moved the provision of its customer banking services from fixed locations, initially into call centres, then onto PC based customer applications and now to the provision of banking on the move via mobile devices.

One of the challenges for the IT companies developing new solutions is that the end consumers expect just as rich an experience on their mobile device as they would get on their PC. Mobility solutions need not only provide clever and rich experiences but also need to be seamless across different mobile devices and operating systems.

Mobility transforming business: the airline industry

The airline industry is a good case study of how mobile technologies have transformed industry business models with the early uptake of mobility recognised as a competitive differentiator. Historically, IT in the airline industry has been providing services to all the supply chain elements of an airline operation – providing services to, and integration across, the key areas of the business e.g. retail, engineering, logistics, catering, airport terminal services etc.

All these separate but necessary functions traditionally had created a high cost base for the business with much of the IT investment keeping the airline operating. Then, initially, along came the internet, where the low-cost airlines drove change using internet based technology, but more recently the rapid use of a variety of mobile devices and smart applications is transforming the way airlines work with their supply chain.

This explosion of mobility has also transformed the way in which the airline industry now interacts with their customers as the power in the airline market began to shift to the consumer, with passengers driving change and the airlines themselves realising that they needed to interact in new ways with their customers. Mobility now allows passengers to use the technology to quickly and efficiently carry out tasks in the passenger process e.g. using mobile applications to manage the whole booking process, seat allocation, meal selection, boarding passes held on mobile devices, checking in baggage etc. Whilst simplifying the process for the traveller, this mobility experience also enables increased productivity. For example check-in has transformed and simplified (both for the passenger and the airline) with online check in, baggage drop, self check-in at airports, and the like.

Mobility in the airline sector is not just for travellers but is being adopted as a much more efficient ways of processing information in real time. Cabin crew now have mobile devices with passenger details/records that can be constantly updated as passengers check in, move through the airport and change their preferences. Mobile devices are also being identified as a method for providing access to technical and operational documentation concerning the aircraft and flight details for flight crew.

Many of these changes and improvements in the airline business are enabled by the use of mobile technology. Mobile technology in all this experience is the enabler. It is providing the 'channel shift' in delivering services to the consumer and allowing the business itself to operate more efficiently.

4.3 Current and emerging skills and occupations

A study of the 'App' economy suggested that it is responsible for roughly 466,000 jobs in the United States, 'up from zero in 2007 when the iPhone was introduced' (Mandel, 2012). Whilst the data does not exist to size the workforce working with mobile technologies in the UK, it is likely that mobile technologies will be part of many IT specialist occupations whether in design and development, management or support. According to IBM (2012), capabilities will need to include mobile integration, mobile security and privacy, mobile application architecture, design and development. Networks, scalability and ease of use are also seen as key skill areas for development.

4.3.1 Occupations and roles in mobile

There are many technology occupations contributing to mobility but a number of highly skilled occupations were mentioned by employers that are key to a business's ability to perform in the mobile arena. These were identified as IT Architects, Developers, User Experience Designers and Project Managers.

- **IT Architects** are the people creating the overall 'blueprint' solutions for mobility and are critical and highly skilled. Architects listen to the client and translate the client's requirements into a mobile solution. They will generally have come from a career path involving development and/or design, moved into a traditional IT architecture role but have added additional mobility skills.
- **Developers** working in mobility again tend to have a developer background but will have moved into mobility by increasing their skills base with mobile specialisms. The types of skills important to these developers would typically be Objective C, C and Java in particular for development on Android devices and with the increasing need for HTML5, Javascript and CSS.
- **User Experience Designers** are interesting in that they will generally be technologists but with design flair. They also could be graphic designers who learn some IT and are key to the design of the user interface for mobile solutions. They will look at the business flow of the interface, the branding, as well as the look and feel of the whole user experience.
- **Project Managers** are critical to driving mobility solutions to end product/service. They must understand all aspects of mobility thoroughly and often they need to have experience in using Agile techniques to ensure they have the skills for adaptive planning, evolutionary development and delivery, a time framed iterative approach and the mindset for a rapid and flexible response to change.

- Most iterations of mobile solutions undertaken in this manner will often involve the project management of a cross functional team working in all aspects of: planning, requirements analysis, design, coding, unit testing, and acceptance testing.

Mobility: advertised demand

Advertised demand (as tracked by ITJobsWatch³¹) indicates the five top job titles advertised with specific reference to mobility, are:

- iOS Developer
- Mobile Developer
- Android Developer
- Mobile Applications Developer
- Senior iOS Developer.

Specific mentions of mobile in jobs ads would appear to have increased ten-fold over the past three years³². Job adverts for Senior iOS Developers are noted to have increased more than 100 per cent year on year and iOS Developers and Senior iOS Developers were also associated with a particularly long continuous demand increase (of ten and nine successive quarters respectively).

4.3.2 Skills associated with mobility

Technology related skills

For mobile computing some of the classic technology skills don't change – there is still a need for large systems to run in the background integrating functionality of the smart user facing applications. To the same extent the core skills technologists have in respect of understanding specific sectors is still needed – e.g. for mobility to progress in banking some IT specialists will still need to have an in-depth understanding of the banking systems and the existing banking technologies.

³¹ IT Jobs Watch sources data from IT recruitment websites and operates independently to provide an impartial outlook. Their surveys are continuous to ensure the information presented is up to date. <http://www.itjobswatch.co.uk/>

³² Based on the top twelve 'mobile' job titles in 2012.

Thinking initially about the technology skills there are definite complexities emerging around the development of mobile technologies. The 'knitting together' of all the front end and back end IT systems that make up the whole end to end mobile solutions are key, essentially the architecture design and integration. Existing IT technology infrastructures often lie behind the whole (new) mobile user experience.

Equally, capabilities around development and design of the same mobile solution for a number of different platforms, e.g. Apple, Android etc. will be essential and in great demand.

At the front end of mobility solutions, technologists are now learning that no matter how smart the technology is, the (only) part of the solution that consumers care about is the customer/user experience. Initially it was said that they expect at least as rich an experience on their phone as they might have on their tablet or PC, but now it is equally true that the user interface experience on the mobile device is setting the benchmark expectation. Design of this user experience therefore is a key priority for IT specialists and is a key skills requirement alongside deep technical capabilities. The attractiveness of the user experience for mobile products and services is therefore critical for customer/user uptake.

Some organisations reported that, to ensure a great user experience, their IT Architects, Designers and Developers were working with imaginative design agencies to create great user interfaces. There is, therefore, a high degree of interaction between the technical people, the user experience design team and, of course, the end client/customer.

Mobile technologies bring together a whole range of high level technical skills organisation wide, including, systems and infrastructure, enterprise architecture, data management, storage, networking, security/compliance, risk management and application development. It is also clear that businesses have to now include people who have developed innovative design skills, or at least ensure their IT specialists work along highly skilled designers experienced in mobile user interface issues.

Business skills

Employers consistently reported that their IT staff, in addition to deep technical competencies, also need a range of business skills to work within their mobile technologies business units. In fact the areas of pre-sales, sales, marketing and account management support were specifically mentioned where it was identified that for the development of client mobile solutions technical excellence was not enough, the whole development programmes had to be business led.

Other literature also identifies the need for skills around flexibility in development, procurement, vendor management, employee support, security policies and legal compliance (Hayward, 2012).

To enable this business led approach to development, agile development skills are additionally often required as this method of breaking tasks into small increments with minimal planning is a growing preference for the rapid development of many new mobile solutions.

Employers reported the need for their highly skilled IT Architects, Designers and Developers to speak in the language of their customers. This is now more complex than it used to be, in that they could now be selling to/working with a matrix of the 'C suite' personnel, the CEO, CFO, CTO and, the CMO³³, the field engineer head, and customer services staff. In essence, the skills to communicate with the clients' employees who have the business problem to be solved, rather than the traditional approach where selling generally was to the CTO and was often predominately around service levels and costs.

Technical skills and business skills in this complex area require IT specialists with high skills levels in both but also selling mobility end to end solutions to customers also requires technical people to have an extensive understanding of customers' individual industries. This means that they will need to articulate the proposed mobile developments in a strategic business/industry context. They will need to be able convince clients that they have an understanding of the appropriate channels to market and potential viral marketing strategies, essentially to be able to articulate to a specific client the transformative effect mobile technology could have on that client's business.

4.4 Recruitment and supply of skills

4.4.1 Recruiting

There is little UK information about hiring trends for mobile technologies but information from the US (Pratt, 2012) suggests that short term IT hiring will include jobs that focus on mobile technology as well as Cloud computing and business intelligence. The InformationWeek report "Filling the Talent Gap in Big Data Analytics" (2012) indicates mobility/BYOD program/end-user device management as an area of increasing staff levels in 2013, with 15 per cent of companies reporting an increase in this area through hiring or reassignment.

³³ Chief Executive Officer, Chief Finance Officer, Chief Technology Officer, Chief Marketing Officer

Employers reported that mobility now has a very fast moving labour market, recruitment of professional level staff is difficult – candidates need extensive technology experience where experience in particular is reported as vital and whilst many may not have mobility skills as such, employers do require flexible attitudes and aptitudes to move into this emerging market.

Companies interviewed confirmed rapid growth in their mobility business units over the last few years. Some organisations did not have a mobile division, as such, two years ago but now it is recognised as a thriving part of their business with massive potential for sales/revenue growth and, in consequence, an area where significant recruitment and retention pressures are emerging. One organisation reported that their mobile business unit was five times bigger than it was twelve months ago.

Employers were concerned that there is a current gap in the labour market in getting experienced people with specific mobility technology skills into the increasing number of available mobile job roles. Unsurprisingly therefore mobility specialists were noted to be in short supply. Hard to find occupations were noted as Architects, Developers, User Experience Designers and Sales and Pre-sales staff. Companies reported that they had turned to using high end contractors to fill their current skills gaps, at least in the short term (up to 2 years).

The use of contractors, who had acquired mobile technology skills early on, were thus seen not only as a sensible way to mitigate the current risk of a shortage skills in the mobility labour market but they were also being used to help organisations upskill their internal IT staff for the medium/longer term.

Mobile Testers were also mentioned as a particular occupation that was hard to fill. Testing was noted as an area that is less popular than other mobility roles, such as development, but was crucial to the progression of mobility solutions, particularly because of all the different technical platforms for a variety of mobile devices, and the proliferation of versions of the same Operating System, for example. Some businesses in the Digital sector have seen this shortfall in testing skills more widely as an opportunity to set up dedicated testing services that can be provided (sold) to other businesses as required.

Overall the mobile labour market is seen as very difficult, it is not stabilising or maturing yet and, as such, employers find it very hard to plan mobility resources for the future.

4.4.2 Skills supply

In addition to external recruiting many companies reported that they had formal programmes to upgrade their current technology skills base by providing specific training for their existing IT staff in mobility skills.

Programmers for mobile were often sourced either from their stock of existing developers, coming from the normal IT pools of programmers, analysts, and the like, or being brought in from internal graduate programmes. These existing staff, who are recognised as already having sound technology skills, do need, however specialist skills development in mobile technologies combined with sector specialisms. Analysis of job adverts suggests that finance and banking, e-commerce, telecoms and retail are key sectors mentioned in recruitment demand for mobile specialists, indicating again that industry specific knowledge is of particular value for IT specialists wanting to enter or progress their career in the mobile area.

There was a note of caution for new entrants in that graduates were sometimes noted as lacking in mobile technology skills, and employers reported that these new entrants often take a while to get 'up to speed' and properly productive in the mobility area.

There was also a concern around IT staff becoming 'too creative', they stressed the need for the industry to have broadly and deeply skilled tech savvy people that had a sound understanding of engineering and systems development and design.

In order to supply the pipeline for their highly skilled staff, whether for their mobility activities or other areas of the business, one organisation identified their strong graduate intake programme built around internship/placement programmes coupled with effective engagement with local universities. Typically, their new entrants would have a degree (95 per cent), many with that degree in computing and a high proportion would have first class honours. They also will take graduate entrants from maths and engineering disciplines and also were keen to recruit at PhD level, typically in physics and geophysics. Of their placement programme an estimated 80 per cent of placements were estimated to be taken on as employees. Further, they noted that their placement students, during the period of their placement, were treated effectively the same as their employees, and therefore received very intensive training and became quickly integrated into the business.

Training and certifications

Companies generally identified that across all technology areas there was a cultural norm for staff development and progression. Some had formal training programmes such as developer forums, road shows for training and regular talks by specialist technologists either live or online, and often recorded for on-going future use. Training to internal standards and certification is also common for formal development and project management methods (for example design standards, coding standards and documentation), ensuring there is consistency across an organisation.

Mobile technology is still a relatively immature market and so in terms of hiring and people development, certifications are not a 'swing' factor in recruitment decisions. It is generally employees or candidates experience that is important to employers for recruiting into mobility roles.

For IT Architects The Open Group Architecture Framework (TOGAF), which provides a comprehensive approach for designing, planning, implementing, and governing enterprise information architecture, is considered particularly important.

For projects managers with responsibilities in mobile solution development, where frequently projects are too complex for the customer to understand and specify their complete solutions in advance of prototype testing, agile project management techniques were identified as a key skills requirement.

4.5 Future skills outlook

Spending on mobile devices is forecast to grow according to Gartner (Saran, 2013) and IT leaders with current mobile initiatives are planning to increase investment over the next 12 months (CIO Magazine, 2012). Employers interviewed also believe that there will continue to be an explosion of mobile devices and, as such, IT companies will continue to develop more mobile services. This identified growth area for technology companies will continue to put significant stress on the future resourcing of their mobile business units.

Already there has been significant demand increases for IT specialists with mobile skills. In the mobile development area alone the highest growth for jobs has been recognised in those IT staff with mobile Operating System (OS) development skills with ten-fold increases in the last three years. Increased competition for individuals with these skills will continue to be a pressure for companies engaged in mobile solutions development.

A number of highly skilled occupations have already been identified by employers as key to a business's ability to perform in the mobile space, and the view is that in the future these particular occupations, notably IT Architects, Developers, User Experience Designers, Sales/pre-sales specialists and Project Managers will continue to be hard to fill.

In the future all respondents recognised that more and more devices would become connected and the machine to machine 'connected device space' had a huge amount of potential/growth, effectively moving into the 'internet of things' concept. In this respect, the view was that currently we are only experiencing the tip of the iceberg.

With all this connectivity the amount of information/data that will be available is anticipated to be enormous. Businesses, government and individuals will want to use and exploit this data. According to employers and experts, the Big Data³⁴ arena will continue therefore to expand hugely as will the need for the highly skilled individuals, Big Data Specialists, who are able to make sense of all the information/data available, essentially, the Big Data Developers, Architects, Analysts, and Data Scientists.

Creating new business systems and customer experiences via mobile technologies will provide the opportunity for organisations in virtually all sectors to stay ahead of their competitors. There are plenty of sectors that have significant future demands for mobility and many of the IT companies recognise the huge market opportunity mobility offers. The high level skills therefore sought by these companies will be in great demand. These will not only be the technical skills relating to systems and infrastructure, enterprise architecture, data management, storage, networking, security/compliance, risk management and application development but also skilled individuals who are innovative and highly experienced in the design of the mobile user interface/experience. Equally employers will need their future IT specialists working in mobility to have a range of business skills including agile development team working, skills in procurement, vendor management, employee support, security policies and legal compliance.

Almost without exception all employers reported that securing mobile devices is becoming increasingly recognised and important for all organisations looking to integrate mobile technologies into their future business plans and will be, without question, a key skills challenge.

³⁴ Big Data – whilst no singular, internationally recognised definition of what constitutes big data exists, however it is generally understood to encompass data with volume (e.g. at petabyte level), velocity (the requirement for real time collection/analysis) and variety (data in diverse formats e.g. structured or unstructured, and from different sources. See e-skills UK, 2013 for more detail.

The general consensus amongst employer respondents was that demand for high level mobility skills will continue to grow as virtually every technology solution will have a mobility strand. They do not see the market stabilising nor slowing down in the next 3-4 years, and this will create a continuing challenge for them to plan, build and resource their mobility services. There are, additionally, challenges simply around the newness of this whole technology area. A frequently reported concern was having the right resourcing levels of IT staff with up to date skills who are abreast of new technologies, as the speed and intensity of mobile technologies change. Looking to the future employers report increasing concerns about getting an adequate pipeline of talent into IT careers which will then, in time, feed into the new technology areas such as mobility.

Device manufacturers, platform developers and apps developers are all competing vigorously not only to have the mobile solutions of choice for their consumers but they are also competing for the same skilled IT specialists who will be needed to fuel this continued mobile market growth. There are a huge number of players in the mobility space and there will be winners and losers.

The big worry, therefore, for employers and the UK more generally, is that if there is not sufficient talent coming into the IT industry then eventually the high value, high skills work will end up being offshored – as well as the low value work.

5 Green IT

Chapter Summary

- Green IT refers to sustainable IT through the invention, design and implementation, of infrastructure and services whilst minimising their environmental impact. It is a subset of sustainability.
- Rising energy costs and environmental concerns were the original drivers behind Green IT but wider implementation may have paused, pending economic recovery.
- A key area for exploitation in implementing Green IT is virtualisation and the efficiencies allied to Cloud Computing (including energy optimisation) which are also driving the uptake of Green IT.
- Companies were emphatic that they have to demonstrate a responsible view of sustainability, either as a technology provider or a technology user company, and brand reputation in this area is a huge driver.
- IT Architects and Solution Designers are key roles at a high level. Employees tend to have extensive experience and capability in IT before specialising in Green IT.
- As found with other technologies investigated for this project, IT skills need to be complemented with sector or domain specific skills (e.g. in construction or logistics)
- Key skills requirements are around energy management expertise, data collection and analytics and integration. It was noted that research and development and high level mathematics skills are not readily available, highlighting the need for STEM skills.
- Business and commercial awareness, communication and presentation skills were found to be needed at a higher level to increase awareness of sustainability issues across the business as well as with customers.
- There is general concern about the lack of volume of IT specialists who go on to specialise in Green IT. Certifications around sustainability are less widely recognised, with individuals with a solid technical background/experience being favoured, perhaps with a higher level degree.
- Evidence from the literature review and interviews undertaken in this project suggests that there is potential for greater growth in Green IT in the future, and opportunities for the sector to offer more products and services as sustainability gradually pervades all parts of customers' businesses. Growing the workforce to deliver this requires people with higher level technical skills, sector specialisms/experience and those who also have a real interest/passion in this area.

5.1 Introduction and background

Green IT refers to sustainable IT through the invention, design and implementation of infrastructure and services whilst minimising environmental impact. Respondents emphasised the distinction between Green IT and sustainability, and that Green IT was effectively a subset of the whole area of sustainability.

Whilst much of the current emphasis has been focused on data centres and storage, Green IT refers also to the direct effects of IT through software/hardware power management, server virtualisation³⁵ and cloud computing. Green IT also offers multiple opportunities for the Digital sector through the development of new products and services³⁶ for user businesses that lack the knowledge and skills to deploy Green IT effectively. One commentator suggests the existence of specialist companies who are already offering low carbon technologies means a distinct 'sub-sector' should be recognised.

“At present it is a growing but fledgling industry subsector that needs support from policymakers. Because the industry is so new, and not yet identified as a discrete subsector, it remains difficult to identify its boundaries and descriptive statistics, such as market size, rate of growth, and so on.” (Catulli and Fryer, 2012, p.300)

Rising energy costs and environmental concerns (particularly by consumers/customers with increasing awareness of environmental challenges) may have been the original drivers behind Green IT but, as suggested by various analysts (see for example IBM, 2013 and Hayward, 2012), Green IT has been widely off the mainstream agenda for implementation until economic recovery takes hold. Further confirmation from Catulli and Fryer (2012) notes that it is likely that investment and support for low carbon technologies developed by companies in the sector is lacking in the current economic climate and analysts Ovum note that, despite the cost saving benefits in the long run, just 13 per cent of IT infrastructure projects focus on energy efficient computing (Computer Weekly/Tech Target, 2012).

Gartner (2013) estimates that the IT industry is directly responsible for around 2 per cent of global CO₂ emissions with other sources saying it could be higher (IBM, 2009). All agree the sector faces challenges to keep its own growing carbon footprint in check.

³⁵ Virtualisation creates and pools available computing resource and provides that resource to workload regardless of physical location. Virtualisation can be applied across servers, networks, storage, desktops and applications.

³⁶ Such as environmental impact assessments, development and evaluation of Green ICT strategies.

A 2011 Greenpeace report suggested that “IT’s own growing demand for dirty energy remains largely unaddressed by the world’s biggest IT brands” (p. 5). Data centres are estimated to consume 1.5 to 2 per cent of all global electricity, growing at 12 per cent a year.

5.2 Drivers

The available evidence together with the views of expert and employer respondents suggests that Green IT is particularly driven by cost reduction, legislation and regulation, reducing carbon emissions and managing reputation. These four drivers are discussed in the following sections.

5.2.1 Cost reduction

It is well established that energy efficient computing has the potential to cut running costs and although the extent of the offset against energy usage is still debated, there is a feeling that companies implementing Green IT are not “wrapping them [solutions] up in a sustainability message” but that cost reduction through energy optimisation is the real driver (Longbottom, 2013).

One of the new technologies that employers identified as a key area for exploitation in implementing Green IT is virtualisation. The OECD report on ICT Skills and Employment explains the concept and role of virtualisation in creating a greener economy:

“Virtualisation is one of the most promising technologies for improving the energy efficiency of data processing and data centres. It replaces physical computers with software applications that simulate computers. Because it is possible to deploy multiple virtualised computers on a single physical machine, virtualisation enables the consolidation of physical servers and helps optimise energy consumption.” (OECD, 2012b, p. 28)

Employers commented that they are also realising the benefits of passing the ‘sustainability lens’ over their whole business to look at inefficiencies and cost savings. In fact, many are now offering this process as a service to their own customers, looking at energy utilisation, storage, use of precious resources, waste and recycling processes.

The businesses treatment of sustainability was also commented upon by a number of employers. Their view was that business behaviours and processes should be an important driver in moving to more sustainable IT. It was suggested that budgetary control should be applied to sustainability issues with targets and responsibilities set out clearly in business plans as is the case with operational expenditure (OpEx), capital expenditure (CapEx) budgets and headcount.

The efficiencies allied to Cloud Computing were referred to by many employers as an area where cost benefits were driving the uptake of Green IT. Competitive cloud offerings from service providers need careful management of energy consumption – particularly around data centres, whilst user businesses migrating to the cloud can also now be to manage their energy consumption more efficiently, for example utilising storage on a pay as you use basis, and/or having more efficient back up/disaster recovery models with less duplication and parallel energy usage.

Cloud, also in a sustainable context, creates an environment where virtualisation is more easily achieved and this in turn creates a reduction in physical IT assets and more sustainable working options.

5.2.2 Reducing carbon emissions

Employers identified that businesses need to look at achieving emissions management and achieving operational excellence. Driving Green IT implementation, sustainable sourcing/procuring and the monitoring of performance requires that the knowledge and skills in sustainable practices are in place across the whole business. Some employers reported that they were already involved with the growing area of ‘intelligent infrastructures’ – the use of business assets more intelligently which includes smart scalable technologies with real time information feedback.

In particular, the green data centre is seen as key in transforming the sector’s approach to sustainability with the worldwide market for green data centres growing at a compound annual growth rate of nearly 28 per cent (Pike Research, 2012). Older data centres are becoming much less acceptable as environmental impact is one of the first considerations of planners (Computer Weekly, 2013a).

It is recognised that digitisation has the potential for positive environmental impact across sectors, from water utilities with sensors that reduce leakage, saving water and money, to fleets of trucks with digital GPS devices ensuring efficient journeys that reduce greenhouse gas emissions (Dutta and Bilbao-Osorio, 2012), to construction and building management systems with ‘smart cities’ that improve energy efficiency and use technology to recycle energy on a local basis.

One estimate of the contribution IT makes to CO₂ reductions suggests the sector could enable emissions reductions across other sectors of 15 per cent by 2020 (The Climate Group, 2008), and the Catulli and Fryer article (2012) suggests the term 'ICT application' sits alongside Green IT and refers to the enabling effects, i.e. the impact these technologies have across the economy. They note areas of low carbon applications including intelligent transport, transport substitutes, green energy production and distribution, carbon accounting and advanced metering / smart grid technologies.

5.2.3 Legislation and regulation

It is suggested that the introduction of carbon tax and rising energy costs will bring sustainable IT back onto the agenda where it had dropped off in importance due to global financial uncertainties (Hayward, 2012). In Europe, e-waste legislation has compelled companies to think about end of life management of products, and in the UK carbon taxes introduced in 2013 will indirectly affect all consumers of electricity.

Some employers reported that there has been a degree of uncertainty around sustainability regulation and they generally viewed it as a risk area. In the public sector in particular there are initiatives and targets to drive down carbon footprint.

Legislation³⁷ will drive business behaviour towards Green IT and will increase the demand for supporting services such as energy monitoring and carbon accounting (Catulli and Fryer, 2012). Indeed, legislation has been put to positive effect in Iceland, where the government has changed taxes to encourage inward investment of IT companies. European businesses who are looking to reduce their carbon footprint are increasingly making use of the cheaper energy and natural cooling resources available there (Computerweekly, 2013a).

5.2.4 Managing reputation

The IBM Expert Network suggests that sustainability and Green IT are important for brand reputation and to mitigate supply-side energy risks and rising costs (Horizon Watching Community, 2013) and employers interviewed were emphatic that they have to demonstrate a responsible view of sustainability, either as a technology provider or a technology user company.

³⁷ For example schemes such as the CRC Energy Efficiency Scheme which is mandatory for large companies in the UK and Climate Change Agreements which seek to improve energy efficiency and cut emissions.

Brand reputation in this area is clearly a huge driver with employers reporting that consumers and customers are constantly reviewing suppliers and scrutinising whether they operate in a sustainable manner. Sustainability policies and practices have to be demonstrably explicit, and businesses often have to sign up to their customers' sustainability policies just to be able to bid/work for them. This is a higher priority for work with the utilities, travel, logistics and public sectors. Consequently brand and reputation around sustainability becomes an issue to maintain and increase a customer base.

It is interesting to note however that respondents recognised that there could be tensions in this area, particularly when consumer technology crossed over into fashion. One question posed was “does fashionable IT trump Green IT?”

5.3 Current and emerging skills and occupations

5.3.1 Occupations and roles

According to the definition provided by OECD/Martinez-Fernandez, Hinojosa and Miranda green jobs are “jobs that contribute to protecting the environment and reducing the harmful effects human activity has on it (mitigation), or helping to better cope with current climate conditions (adaptation)” (2010, p 28) and the largest share of ICT-related green jobs can be expected to exist among ICT-skilled workers, partly because they are spread widely across the economy.

Employers suggested there are strategic, general and technical specialist roles in Green IT together with hybrid job roles working across the sustainability agenda. Unsurprisingly, Green IT related jobs are concentrated in research and development, as well as installation, deployment and maintenance. IT/business strategists, IT Architects, Solution Designers and System Designers are identified again by employers as key high level roles required in Green IT. These individuals are required to understand the totality of the business problems they are trying to solve and to then design environmentally friendly and business focused solutions. They need to be able to not only translate what IT can and cannot do to solve the particular business problems but they need to also articulate the sustainable business case for the proposed solution.

Systems Managers and Network Specialists are required to manage the infrastructure/physical side of Green IT, in particular in relation to performance monitoring and the overall efficiency of systems. This leads on to the generation of better data which in turn is collected and analysed by a range of Big Data Specialists. These specialists (for example Data Scientists and Big Data Analysts who have particularly high skills levels) turn complex data into meaningful analysis that changes and improves business processes.

5.3.2 Skills associated with Green IT

Technical skills

The Catulli and Fryer article (2012) concludes that constraints on growth include a lack of capacity and skills shortages, particularly in energy management expertise.

Employers also confirmed this, citing that many of the issues in Green IT are in the area of virtualisation skills, power management software, the use of tele-presence and video conferencing and enterprise sustainability management systems. They also identified skills around the roll out of applications to support energy reduction. Interestingly, companies developing hardware products are investing significantly in power utilisation circuits that are not just focused on clock speed but also on significant power reduction.

The IBM Expert network suggests the following skills areas that are critical to Green IT: data collection and analysis to report on sustainability progress, in particular via innovative sensor networks; supply chain management and reporting; managing and monitoring sensors; and using big data and analytics to investigate and interpret cost and energy usage insights.

Additionally, cloud/data centre facilities are now very much interconnected with sustainability issues and skills in the areas of data analytics, server consolidation, data storage, optimisation and virtualisation are also noted as particular requirements.

Employers also noted that individuals whose skillsets combine IT knowledge and experience with building design and operation are highly sought after in the construction and facilities management sectors.

In Green IT, as in the other emerging technologies skills are also required to integrate the new technologies across business systems infrastructure, tying together cohesively and robustly the newly designed systems/solutions with the existing legacy infrastructures.

There was consensus from the respondents that research and development was an area where the UK could differentiate itself globally in Green IT issues, but employers identified that high level/advanced research and development skills and high level mathematics skills are not readily available.

Many Green IT solutions are focused in specific sectors, as the construction example above identifies, and similarly the use of telemetry, combining new IT and communications technologies in the logistics sector is a key contributor now to efficiency savings and productivity gains. Employers emphasised that the IT people developing these types of sector specific solutions, as was the case for other technologies, need a good grounding of sector or domain specific knowledge and experience.

Business skills

Business and commercial awareness and risk management were seen by interviewees as key skills in sustainable solutions development along with sales and consulting skills, all key to presenting the comprehensive business case. Really good communication skills, which employers commented are often difficult to find, are required of IT specialists to increase awareness of sustainability issues with customers, across the whole organisation (HR, Marketing, Facilities etc.) in order to get the buy in of a cross section of business managers to foster sustainability themselves. Additionally, collective intelligence suggests real partnership working between companies and customers is an increasing trend expected in the development of new Green IT solutions.

5.3.3 Skills supply

Employers reported a general concern about the volume of IT people that progress to become specialists in Green IT or sustainability. Employers reported that ideally they were looking for those individuals who not only have the technological understanding of issues like data science, virtualisation and analytics, but also see the bigger picture in terms of how IT sustainability can affect the bottom line, the return on investment, brand image and marketing strategy. The general trend of recruitment seemed to be that around 80 per cent of recruits into sustainability come from a technical background and 20 per cent from specialisms (e.g. environmental sciences).

The general consensus from the organisations interviewed was that there are no widely recognised formal qualifications in the green/sustainability area, although the BCS Green IT special interest group has competency certifications. BREEAM and LEED were also mentioned as useful for technical specialists with a software background.

There are degrees and masters courses in particular that specialise in sustainability but the view of employers was that these are not yet mature. There is a possibility, they suggested, that formal types of qualifications may start in industry consortia (foundations and institutes).

The development of sustainability skills within organisations often tended to be delivered through the use of existing employees or consultants, experienced in sustainability, who would share their knowledge and train other IT specialists. Employers interviewed spoke of wider training and education needed across the workforce, described by Accenture in their Sustainability Academy as the need to develop a ‘sustainability mindset’ in managers (Accenture, 2010).

Employers reported that webinars and online materials/knowledge banks and the like are being used to provide development opportunities for their employees. These are not only low carbon solutions themselves, but at the same time also reduce delivery costs and provide accessible training materials to their whole workforce.

5.4 Future skills outlook

Evidence from the literature review and interviews undertaken in this project suggests that there is potential for much greater growth in Green IT in the future, and opportunities for the Digital sector to offer more products and services, as sustainability eventually pervades all parts of the customers’ business.

Strategic skills at a high level are needed to meet the challenge of solving sustainability problems and creating solutions. These skills need to be combined with deep technology skills built on fundamental STEM principles, mathematics and research and development.

The organisations interviewed felt that future Green IT opportunities are likely to be around:

- Big data, performance monitoring and the provision of connected devices, which are becoming more and more pervasive.
- ‘Intelligent cities’ as they become a reality and the norm driving the sustainability agenda – particularly as there is forecast to be significant population growth in most cities globally.

Employers felt there were fantastic opportunities across many sectors as the sustainability agenda continues to make an impact at board level, with the pressures of sustainable working and the need to offer sustainable products and services becoming more and more a competitive driver. Sector specific skills therefore will also be in demand for those IT specialists working in Green IT/sustainability, particularly in utilities, construction (in its widest sense), business services, logistics and the public sector.

Driving the business case and influencing sustainability across the whole business requires more people working in Green IT with excellent communication skills who will increase awareness, particularly at higher levels within the business and with customers.

- Employers suggested that passionate individuals and evangelists of sustainability will be needed in the future to create a drive and enthusiasm which may mean that change would not necessarily need to be IT led, as has often been the case in the past.
- Change it is expected therefore will be led by many business areas across organisations as the permeation of sustainability across the business fosters a better understanding. However employers were realistic in appreciating that there was a significant challenge in the short term to build this capability and awareness/appreciation across the business.

6 Cloud Computing

Chapter Summary

- Cloud Computing is a model for delivering internet based information and technology services in real time or, 'on-demand' and is particularly driven by: economic opportunity; cost reduction; technological change and consumerisation.
- The current economic climate is seen to be a strong driver with Cloud Computing enabling companies to not only move into new markets, reduce costs and become more agile but also to provide growth through the enablement of new business models.
- Mobile technologies provide new delivery platforms for the full benefit of Cloud Computing to be realised but employers report that security is a key challenge in implementing and managing cloud technologies. Cloud Computing is very much driven by a new generation of consumers and employees.
- A wide range of technical skills are needed for Cloud Computing although security, system architecture and integration, virtualisation skills and big data analytics are considered to be the key skills for Cloud.
- IT specialists also need broader business skill-sets, especially risk management and business stakeholder management to bridge the divide between IT and broader business operations.
- The growth in demand expected for cloud services has significant implications for the high level skills required by service providers – particularly as cloud systems become more complex, higher skills levels will increasingly be needed of IT specialists working in this area.
- However, employers report that generally competition for highly skilled IT people means they find it difficult to recruit into cloud roles, relying on contractors/consultants while they also try to redeploy and upskill their existing staff.
- Cloud Computing can be leveraged for growth across all sectors and is in itself a key factor in Mobility, Green IT and Cyber Security technologies. It is clearly a growing area for the Digital sector but for the uptake to continue, service providers will need to understand the consumer better and nurture innovation.

6.1 Introduction and background

Cloud Computing is a model for delivering internet based information and technology services in real time or, 'on-demand'. This involves web-based tools or applications that users can access and use through a web browser as if it was a programme installed locally on their own computer. It involves the convergence of traditional information technology and communications technologies to provide a consistent experience regardless of device, location or time.

The model is delivery of technology as a 'service' rather than a 'product' and covers a range of resources from networks, services, storage and applications. Infrastructure as a Service (IaaS), Software as a Service (SaaS) and Platform as a Service (PaaS) are the three main services delivered as cloud solutions. Cloud Computing is categorised into private cloud, public (external) cloud or a hybrid model, all with differing benefits.

One of the key features of Cloud Computing is summarised by the US National Institute for Standards and Technologies (NIST) who say that Cloud Computing can be "rapidly provisioned and released with minimal management effort or service provider interaction." (CEBR, 2010, p. 8)

Whilst the general consensus from companies that were interviewed is that cloud is fairly established in the Digital sector other data from various sources suggests it may be seen as still emerging or in the early stages of adoption/deployment in user companies who are still expanding their uptake (see for example, IBM, 2012 and Computer Weekly/Tech Target, 2012). There are also indications of increased spending in public cloud services to make the IT department more flexible and efficient (Goodwin, 2013).

Most analysts agree that cloud is a top target for investment increases over the near term future with forecasts from the Computer Weekly & Kew Associates Cloud Survey in 2012 suggesting that system software in the cloud will be used by 80 per cent of respondents by 2017, whereas application packages will have 90 per cent usage by the same date.

6.2 Drivers of demand

Analysis of the available evidence suggests that Cloud Computing is particularly driven by: economic opportunity; cost reduction; technological change and consumerisation. In addition it is noted that Cloud Computing systems are deemed to be environmentally sustainable due to features of reduced waste and energy consumption.

6.2.1 Economic opportunity

At a macro level, the European Commission predicts that Cloud Computing could boost European economic output by €160bn a year, and increased use of cloud technologies will also create 2.5 million jobs by 2020 helping to redress high unemployment amongst the youth across Europe (Ashford, 2013). At a company level, Cloud Computing enables businesses to move into new markets, creating new opportunities for them to connect to global market opportunities.

In their report on the economic benefits of Cloud Computing to business and the wider EMEA³⁸ economy, CEBR predict that the cumulative economic benefits of Cloud Computing to the UK will be €117,989 million between 2010 and 2015 with direct and indirect employment of 289,000. Their analysis is based on increasing levels of cloud adoption to 2015 and they note that Cloud Computing adoption has the potential to support “significant direct and indirect job creation” (CEBR, 2010,p. 7). CEBR reports that the hybrid cloud model is likely to produce the greatest economic benefits of the three models.

A Danish Technological Institute report for the EU says that “Cloud Computing is considered a key growth area for the ICT sector and a key enabler of growth in ICT-using industries.” (2012, p. 6). This sectoral perspective on Cloud Computing usage and impact is referenced by CEBR (2010) who suggest that the UK is expected by 2015 to have relatively high rates (compared to other EU countries) of cloud adoption in the Banking, Finance and Business Service sectors. Furthermore, because these sectors have relatively high IT spend, adoption will produce a greater level of benefits.

The potential of Cloud Computing to reduce costs, speed up application deployment and increase innovation is important particularly for business start-ups and entrepreneurs. The Danish Technological Institute (2012) suggests that a small proportion of SME companies are advanced users of cloud, using (as well as designing and developing) applications critical to their core business (e.g. for customer facing requirements or production management). In fact the weight of literature would suggest that Cloud Computing suits small and agile businesses – these companies are likely to have high innovation potential, an international growth outlook and highly skilled employees.

Whilst for SMEs across user sectors there are recognised challenges due to the extent of choice and range of services, one commentator suggests this provides a market for ready-made solutions suited to specific business sectors (Buss, 2013).

³⁸ Europe, Middle East and Africa.

6.2.2 Cost reduction

The current economic climate is seen to be a strong driver of Cloud Computing. Overall, cost reduction and business agility (including the ability to scale capacity up or down) are the two key drivers for Cloud Computing with new cloud activity increasingly driven by business managers as well as the IT department. As with most technologies, increasing adoption will make cloud services progressively cheaper (costs continue to fall) and better value as services mature (CEBR, 2010).

Cloud Computing potentially offers up front cost benefits – it can provide a cost effective way for a user (business or individual) to develop and run technology without the complexity of buying and managing hardware and, more usually, purchasing and frequently upgrading software. It simplifies maintenance and support for the user company, and will reduce the need for on-premises licenses, hardware and software.

“A new set of technologies, such as various cloud solutions are going to be so compelling, pervasive and cost changing that CIOs will increasingly stop buying and building their own capital infrastructure for IT” Dave Ryerkerk, Global IT Advisory Leader (Ernst & Young, 2012, p. 7).

Interviewees reported that users of cloud see cost savings by exploiting on-demand cloud services through efficiency savings, productivity increases and growth potential together with the innovation around the enablement of new business models. Managing the flexibility of the budget will become more important in user companies – if, and as, consumers use more, they pay more. This concept brings in new charging and business models which it is suggested could be seen as both a challenge and an opportunity for the sector and users together, as it challenges conventional budgetary processes.

6.2.3 Technological change

Cloud Computing is in itself a catalyst for change; utilising IT and communications convergence and mobile technologies in particular to create an environment in which the full benefit of Cloud Computing can be realised, for example through virtualisation³⁹.

The use and further penetration of cloud into businesses and into personal use will be further enhanced as the wired infrastructure continues to be improved and also as the wireless environment becomes more and more pervasive. With better infrastructure, smarter mobile technologies and mobile devices the use of the cloud will become the norm for businesses and individuals.

³⁹ See also Section 5.2.1 of this report on virtualisation, Cloud Computing and Green IT.

Organisations interviewed reported that Cloud Computing itself is, in essence, the result of a number of technologies (infrastructure, data developments and technical architecture for example) all developing in their own right and coming together to enable/create Cloud Computing.

However, the World Economic Forum report on Global IT (2012) states that there needs to be a common understanding on standards, interfaces, and security specifications. They say that uniform standards will enable the cost of Cloud Computing to be reduced further thus enabling greater take up and on-going development.

Employers identified security as one of the key challenges in implementing and managing cloud technologies. A Capgemini Business Cloud Study⁴⁰ found that the top impediments preventing cloud take up were fear of security breaches, issues with data sovereignty and a lack of integration. Computer Weekly also reported that “Security continues to hinder organisations in adopting cloud computing, at least for mission critical or sensitive data applications” (Ashford, 2013b). Gartner’s White Paper on the impact of cloud on banking (Pfeiler, 2010) also suggests that security concerns are reputational for financial (and other) businesses as well as fraud, data theft.

Interviewees also reported that a minor driver is that organisations can use the cloud to manage their carbon footprint and energy consumption more efficiently.

6.2.4 Consumerisation

Cloud Computing is very much driven by a new generation of consumers and employees. ServiceNow, a provider of cloud based services summarise this as the ‘cloud generation’, saying:

“A new breed of employee has entered the workplace and even seasoned professionals are working in different ways. Today’s business user is more tech-savvy, more independent and more social than ever before.”
(ServiceNow, 2012, p. 3)

However, they also report that this could lead to decentralisation and a potential loss of control by the IT department where employees circumvent it.

Respondents also identified that the use of cloud is being driven by the continuing consumer uptake of mobile devices. Consumers and customers are also demanding new cloud services and want to be able to access the same things from any device.

⁴⁰ 460 telephone interviews including 211 in EMEA countries of UK, Germany, France, Netherlands and Sweden in July 2012.

For them it is about flexibility and speed. Employees are also influencing cloud with their drive to 'bring their own device' (BYOD) into the workplace.

In this regard, Cloud Computing is recognised as having a particular effect on how people work, allowing employees to work anywhere that has network coverage, thereby increasing the potential for collaboration and productivity benefits. The World Economic Forum Global IT report summarises the impact of IT and communications convergence in the cloud stating:

“Another advantage of ICT convergence for enterprises is that employees can boost their production efficiency by leveraging collaborative tools that synchronously deliver intense functions, such as instant messaging, audio and video communications, data sharing, whiteboard sharing, and interactive polling. This applicability allows multinational enterprise teams to cooperate across geographic regions while slashing communications costs. Having virtual teams across the world that work as “one world, one team” is no longer just a dream.” (Dutta and Bilbao-Osorio, 2012, p.42)

6.3 Skills and occupations

6.3.1 Occupations and roles

Roles range from configuration and development to operations covering the development of business need through to deployment. The Corporate Executive Board Company (CEB) report that the focus on service management is driving changes in IT roles and skills saying, “IT organisations are developing service managers, service architects, information architects and user experience designers” (2012, p. 18)

It has also been suggested (CEBR, 2010) that user companies could reduce or redeploy IT staff as a consequence of implementing cloud solutions, and at the most extreme it has been suggested that the CIO and IT department in smaller user companies could disappear with the CIO and COO roles merged (ComputerWeekly/TechTarget, 2012).

Further evidence to support the theory of some redeployment of staff is found in data from an online survey of InformationWeek subscribers in North America (2012) which indicates end user support/helpdesk staffing levels are the top area for reduction in staff with 11 per cent of companies looking to decrease staff in this area.

Similarly, it is suggested by ServiceNow (2012) (a provider of cloud based services) that cloud is more consumer friendly and requires “little to no IT or end-user training”, inferring that the IT team will spend less time providing basic instruction to non-tech staff.

However, a study on Cloud Computing in Europe undertaken by the Danish Technological Institute suggests that Cloud Computing will in fact enhance the role of IT specialists:

“Looking a few years ahead, the future of ICT will be characterised by a pervasive cloud computing infrastructure as a basic backbone for companies, and in conjunction with other technologies and trends, such as mobile and social media, this will enable innovative business models and alternative service applications. Accordingly, this will place the ICT practitioners in a pivotal position in SMEs.” (2012, p. 4)

6.3.2 Skills associated with Cloud Computing

The growth in demand expected for cloud services has significant implications for the high level skills required by service providers in particular.

Technical skills

The general consensus from the interviews was that the skills associated with cloud are not dissimilar to traditional IT skills with emphasis on technical architectural design, product development, security, data analytics, systems and service integration⁴¹, governance, implementation and configuration, monitoring, data management and storage. As the cloud systems become more complex, higher skills levels will be needed of the IT specialists working in cloud. Respondents confirmed that many of the people working in cloud will have been brought in from other technology areas, for example from security or data intelligence.

The IBM Tech Trends Report (2012) suggests it is the “Pacesetters” in Mobile and Cloud Computing that, despite adoption hurdles, are forging ahead and are developing cloud security, administration and enterprise cloud architecture. Managing cloud performance / optimisation, data integration, data management and mobile cloud are also skills areas for development and the Danish Technological Institute refers to ‘e-competencies’ for cloud as being: product and project management, user support, design and development, deployment, testing and programming and process improvement. Innovation is noted to be a key skill to design and develop services and products that are designed to be cloud hosted. Service management (moving from service delivery) is seen to be increasing in importance for the IT role as cloud technologies increase.

Employers reported that virtualisation, not only provides an opportunity for cloud to become mainstream through economic business models, but that it is probably the key cloud skill along with networking and security.

⁴¹ For example where cloud is replacing or coming in alongside a large complex in-house system.

It was also highlighted by organisations that one of the consequences of Cloud Computing would be an emergence of more use of large volumes of data in real time, or near real time, and people skilled in big data analytics will be needed who can understand and interpret the benefit of this new data resource in the business context.

Security skills are a key skills area, and as this is one of the main barriers to uptake it is no surprise that development of new skills in cloud security is noted by nearly three-quarters of respondents to the ISC² survey (Suby, 2013). Because of the volume of data and storage in the cloud, security skills for development include: how security applies to cloud; the understanding of cloud security guidelines and reference architectures; knowledge of compliance issues and enhanced technical knowledge. CWJobs (2012) also suggest that Cloud Computing requirements mean a need for security specialists with data integrity skills, recovery and privacy as well as legal skills to deal with issues such as regulatory compliance and auditing.

Cloud technology skills

Some specific cloud skills do register in job vacancy descriptions⁴², for example Windows Azure and Amazon Web Services (AWS) for developers. Analysis of these application platforms in job adverts shows that significant mentions of these two skills⁴³, noticeably started in 2010. Although they appear in only a small proportion of all IT vacancies advertised, growth in Cloud Computing is indicated by the rapid escalation of jobs requiring these types of skills. Specifically, jobs citing Windows Azure have increased five-fold from 2010, to number nearly 1,800 in 2012 and in the same period, Amazon AWS has increased sixteen times and now appears in over 2,000 jobs adverts.

However, a Skills Compass White paper suggests that overall, demand for cloud skills do not tend to reference specific cloud platforms or skillsets because the technology is still developing. They suggest that specific software references and platform skills will increase in prevalence in the future as will the number of business facing roles that require cloud competencies. The report concludes: “Technology professionals should, therefore focus on understanding the infrastructural and service propositions which cloud platforms make available rather than a particular technology.”(2012, p.25).

⁴² IT Jobs Watch sources data from IT recruitment websites and operates independently to provide an impartial outlook. Their surveys are continuous to ensure the information presented is up to date. <http://www.itjobswatch.co.uk/>

⁴³ Over 100 during the course of the year.

Business skills

The Danish Technology Institute talk about business orientation where the divide between IT and the business is broken down: “Cloud computing turns the ICT practitioner into a business integrator” (2012, p. 8). They also suggest: purchasing, sales, documentation, and forecasting skills will be important in cloud implementation alongside problem and risk management (particularly during transition), business stakeholder management and contract negotiation.

Employers reported that the gap between business and technical skills is closing. IT specialists are working more closely across their customers whole businesses and therefore need a broader skill-set to respond accordingly as different business areas see the specific benefits of cloud for their particular business units.

Technical IT people now have to perform in front of a variety of senior customer personnel (CEOs, CTOs and CMOs), so broader customer engagement skills, both oral and written, are required to present compelling business cases.

Some respondents suggested that problem solving with cloud and other emerging technologies requires a different approach. Traditionally, questions were asked, the problem was identified and a solution was developed, but now much wider creative and innovative thinking is required. There is a need for IT specialists to hypothesise the problem, reframe the problem and come up with innovative solutions.

“For every one person we produce as a technical IT person we should be producing ten IT people with business exploitation skills”. Ronan Miles, Director Donation Platform Development, BT

6.3.3 Recruitment and supply of skills

The literature review showed that there is little available information on recruitment of IT specialists with cloud skills or skills mismatches in this area although a KPMG/REC agency survey in 2012 suggested SaaS and cloud skills are in short supply in applicants.

Employers interviewed for this project confirmed that generally they don't have enough people and find it difficult to recruit into cloud roles. They reported that there was just too much competition in recruitment for good IT specialists, so they are prepared to pay for them by 'buying in' people (contractors and consultants most usually) or they will where possible redeploy/retrain existing staff. However, employers realise that this creates a 'hole' somewhere else in their IT workforce. Some cloud providers in fact confirmed that they specifically recruit at post graduate level to get a higher initial level of skills into this area and, where UK recruiting is not possible, they will look to the US for cloud skills.

But the US market is also increasingly competitive with reports showing cloud is a growing area. Wanted Analytics (2012) report an increase of 61 per cent in companies in the US seeking recruits with Cloud Computing skills from 2011 to 2012 where employers were looking for IT specialists with cloud knowledge, and IT administrators with cloud architecture experience and skills and Computerworld (Pratt, 2012) suggests that a quarter of IT executives surveyed⁴⁴ plan to hire for Cloud/SaaS skills over the next year.

In terms of the certification of cloud skills, larger vendors and training providers are already providing cloud certification programmes but input gathered during the Danish study for the EU (2012) suggested there should be 'holistic thinking' and better alignment between Cloud Computing, Security and Green IT certifications.

6.4 Future skills outlook

Cloud Computing is clearly a growing area and companies in the Digital Sector delivering cloud solutions will benefit from the increasing market for outsourced services. Furthermore, the evidence gathered in this project suggests that Cloud Computing can be leveraged for growth across all sectors and is in itself a key factor in Mobility, Green IT and Cyber Security trends.

As Cloud Computing expands and grows with demand there will be a need for more IT specialists to have skills in this area, and, working from an existing base of higher skills levels in this area today, these skills are seen to be predominantly at professional level, moving from service delivery to service management. Key skills for the future, which will increase cloud deployment include virtualisation, analytics, networking, innovation and security as well as commercial awareness to implement new business models.

However, the evidence analysed would also suggest that Cloud Computing may bring about a change in roles, especially in SMEs and user businesses where other higher level, non-IT specialist occupations could expand their role. Furthermore, Cloud could bring about a squeeze on middle level IT specialist jobs currently focussed on user support. Any reduction in need at intermediate level could free up additional resource/labour pool and be used to fulfil growth in higher level jobs and ultimately provide an increased volume of upskilled and experienced IT professionals to recruit into specialist areas.

⁴⁴ 334 IT executives who responded to Computerworld's 2013 Forecast survey

A broader range of business skills are required in IT specialists to drive up successful implementation and grow the cloud business. Professionals need the skills to understand and manage the customer better, in particular to work with larger companies with complex legacy systems over the longer term. These skills include communication, people and business management skills to work with functions across the customer business and address the current challenges that users perceive. Gartner's white paper on Cloud Computing in Banking identifies three challenges to future uptake:

“Despite the advantages, the majority of banks are reluctant to move mission-critical applications to cloud computing over concerns and challenges related to security, compliance and data integration.... All three challenges will need to be adequately addressed by the cloud providers if the market is to move beyond peripheral solutions.” (Pfeiler, 2010 p. 2)

Finally, Cloud Computing is likely to increase the demand for higher level skills across occupations and sectors more widely due to the potential for increased collaboration and productivity benefits that cloud brings across business operations.

7 Future insights for higher level skills

Chapter Summary

- The Digital sector is considered in its own right to be a major driver of the economy over the next ten years. Workforce growth in the sector is higher than across the economy as a whole, and future trends and forecasts predict the continuation of the demand for high level skills.
- The sector requires nearly 300,000 recruits at Professional, Manager and Associate Professional level to fulfil growth potential and replacement needs to 2020. The increasing demand for entrants to these occupations may lead to increasing competition across many sectors for highly skilled recruits.
- Priority drivers across technologies emerge as cost reduction – technology enabling a reduced cost base; consumerisation – businesses and individuals driving uptake; and security – a common theme and increasing requirement across technologies.
- The research showed that employers currently have to address labour market issues around the new technologies. A recurring finding across the technologies was the need for high level IT Architects, Big Data and Security specialists. The core of technical / computing skills remain but upskilling existing IT specialists with broader, deeper skills and more new specialisms is critical for the continued growth and innovation in new technology areas.
- Business skills manifest themselves in the need for high level sales and technical pre-sales skills which were reported by employers as hard to find, together with the need for IT specialists to have higher and more relevant communication skills to engage with a wider range of people across their customers organisations.
- There are clear indications there is increasing competition for higher level skills in the technologies studied with recruitment difficulties already identified in higher value roles and in occupations with specialist skill sets.
- Employers were realistic about the disruptive impact of emerging technologies and rather than being seen as an issue, it is thought to foster innovation and drive growth in the Digital sector and in turn across the wider economy.
- Employers raise serious concerns about the future supply of talented IT people that will be needed to fill the ever growing number of roles created by these emerging technologies. Sourcing the required numbers of suitably skilled staff to capitalise on the opportunities that these technologies offer is recognised as a key challenge for employers in the sector, which if not addressed will seriously compromise future business growth potential.

7.1 Introduction

The highly skilled workforce within the Digital sector enables it to pursue high value product market strategies and with a workforce of three per cent of the UK total, the sector contributes over seven per cent of total GVA. However, these same high skills levels within the sector workforce are also increasingly required in the competitive global marketplace in which the sector operates.

Employers were emphatic in their views that they will face even greater challenges in the future in finding highly skilled people to fill the growing number of new jobs that will be created by emerging technologies.

This section concludes the report by looking at forecast employment, emerging themes for higher level skills across the sector, implications, opportunities and challenges.

7.2 Forecast employment

The sector is considered in its own right to be a major driver of the economy over the next ten years, but within the Digital sector itself Working Futures data, presented in the Sector Skills Assessment, forecasts there to be an increase of 50,000 workplace jobs by 2020 through growth of six per cent between 2010 and 2020. Predicted growth in the Digital sector is slightly higher than across the economy as a whole, and future trends and forecasts all predict the continuation of the demand for high level skills in the sector.

Replacement demand will generate an additional 321,000 job openings in the sector which in addition to the 50,000 jobs created by growth means there is a total requirement of 371,000 between 2010 and 2020 (table 3). Growth and replacement demand, suggests that the sector requires a large number of recruits at Professional, Manager and Associate Professional levels (299,000 to 2020) – with these occupations making up over 80 per cent of the total requirement.

These higher level occupational areas are precisely those that are forecast as the greatest areas of need across the whole economy. Thus, whilst Working Futures predicts the supply of people holding higher level qualifications is also predicted to grow, the increasing demand for skills and entrants to these types of occupations more generally may lead to increasing competition between sectors for highly skilled recruits, with a consequent potential increase in skills shortages, wages and migration if the supply of labour is not able to meet future employer demand.

Table 3: Employment growth and replacement demand by occupation in the Digital sector

	1990	2000	2010	2015	2020	Net change	Replacement demand	Total requirement
	000s	000s	000s	000s	000s	000s	000s	000s
Managers, directors and senior officials	62	103	136	145	157	21	57	78
Professional occupations	153	290	338	348	371	33	125	157
Associate professional and technical	76	142	147	150	157	10	53	64
Administrative and secretarial	55	100	58	53	50	-8	27	18
Skilled trades occupations	88	97	72	67	63	-9	27	18
Caring, leisure and other service	5	10	11	13	14	3	5	8
Sales and customer service	43	65	54	53	53	0	17	17
Process, plant and machine operatives	7	11	12	11	11	-1	5	4
Elementary occupations	11	18	14	15	15	1	5	6
All occupations	500	837	843	853	893	50	321	371

Source: *Working Futures, Warwick Institute for Employment Research / Cambridge Econometrics, 2011*

7.3 Emerging themes for higher level skills

The explosion of connected devices and systems creates huge opportunities and challenges for the Digital sector – and this has implications for higher level skills that need to be broader, deeper, and with more specialisms to realise the growth potential.

7.3.1 Drivers

Common and priority themes across technologies emerge as:

Cost reduction – businesses in general are looking at all ways in which technology can help them reduce cost. For example Cloud Computing enabling companies to reduce their capital expenditure on infrastructure and move to a lower cost operating model, Green IT – where technology enabled devices in the logistics sector are driving down fuel consumption – not only reducing cost but also contributing to longer term sustainability. Mobile technologies – empowering employees in terms of productivity and efficiency but also providing potential reduction in office based overheads.

Consumerisation – businesses and individuals are driving the uptake of all four technologies. Mobile – where consumers demand technology on the move, for example mobile banking services, Cloud Computing – where consumers and employees expect to be able to store and access services from any location and from any device, Green IT – where consumer values are much more discerning with regard to purchasing sustainable, environmentally friendly products and services and Cyber Security where consumer expectations are that their data will be protected.

Security – unsurprisingly this was identified as a common theme across business sectors and an area where there is an increasing requirement for higher level skills across all the technologies: “increasingly connected means increasingly exposed”.

7.3.2 Skills

The tables in the following section set out the key higher level skills and occupations that emerged from the research into the four technology areas. Whilst it is not possible to estimate the current or future workforce in the particular technology areas, the majority of individuals working in Cyber Security, Mobile Technologies, Green IT and Cloud Computing will be employed at a professional level (551,000 IT professionals across the UK economy) and some will also be categorised as IT Managers (294,000 across the UK economy)⁴⁵. The information presented below can be used to view cross cutting skills and occupations in the Digital Sector.

Table 4: Summary of higher level occupations

Cyber Security	Mobile Technologies	Green IT	Cloud Computing
Security architects	IT architects	IT architects	Information architects
	Big data specialists	Big data specialists	Big data specialists
Security officers	Security specialists		Security specialists
	Project managers		Project Managers
	User experience designers		User experience designers
	Developers		Developers
Security managers		System managers	Service managers
Network security analysts		Network specialists	
Network security engineers	Testers	IT / business strategists	Systems and services integrators
Security engineers	Sales (related occupations)	Solution designers	Operations
Security consultants	Pre-sales/technical sales occupations	System designers	
Security analysts			
Information security consultants			

⁴⁵ See Table 2 on page 7

A recurring finding across the technologies was the need for high level specialist IT Architects, Solution Designers, Big Data and Security specialists. The need for these occupations is also evidenced by the technical skills employers said were required across the technology areas, highlighted below.

Technical skills

The skills profile for high level technical people is changing. The core of technical and computing skills remain – there is consensus across employers that there is need for a strong technical skills base before individuals can specialise and work in emerging technology areas but they also stressed that the future will not be about working in silos.

- There is a consistent emphasis on upskilling existing IT specialists into new areas e.g. ‘bolt on’ specialisms for example in Green IT or Mobility, IT Architects are now being required to integrate traditional infrastructure including legacy systems with the very latest mobile applications.
- Skills for IT specialists will need to be ‘deep and wide’. Skills development was seen to need to move from ‘T shape’ (broad based with a particular ‘depth’ in one specialism) to ‘W shape’ (broader but with multiple depths/specialisms). This means there is a common requirement for ‘hybrid skills’ – with a core base of technical competencies supplemented by a sector and technological specialism/s. For example in Green IT (sustainable water usage) or Mobile (mobile payments and financial sector experience).
- The need and value of specific qualifications and certifications varied across the technologies studied. For example in Cyber Security there are some widely recognised certifications that are ‘the norm’ for many security roles. However in mobility the market is still relatively immature and therefore certifications are not necessarily a deciding factor in recruitment.
- Across the technologies (particularly where consumers are the end users) design and development skills for the application/user interface are increasingly in demand and reported as hard to find.
- A common skills theme emerging from employers across all of the four technologies investigated was the need for specialist cyber security staff. The concern being expressed was that as technology connects more and more devices the risk of security breaches becomes more and more an issue.

- Across all areas, but in Mobile and Cloud Computing in particular, employers reported the growing need for IT staff with specialisms around Big Data. These technologies are already creating large amounts of data, and will continue to create even larger volumes of data, both structured and unstructured, and people with the ability to analyse and interpret this data will become increasingly valuable to organisations as they seek to gain competitive advantage from the knowledge that can be unlocked from this new resource.

Table 5: Summary of higher level technical skills requirements

Cyber Security	Mobile Technologies	Green IT	Cloud Computing
Knowledge and awareness of security issues	Security and compliance		Security
Analytics		Analytics	Data analytics
Data analysis	Big data	Big data	Big data
	Data management and storage	Data collection and storage	Storage
Sector specialisms (e.g. finance)	Sector specific specialisms	Sector specific specialisms	Data management
	Knowledge and understanding of customers' industries	IT knowledge and building design experience	Data integration
IT infrastructure	Systems integration	Integration	Systems integration
	Testing		Testing
Configuration management			Configuration
Engineering design	User experience design		Design and development
Risk analysis		Energy management	Technical architectural design
Mathematics	Agile development skills	Energy expertise	Performance management of cloud
Incident and threat management	Application development	Virtualisation	Virtualisation
Forensics	Networking	Mathematics	Product management
Encryption	Systems and infrastructure	Supply chain management and reporting	User support
Algorithms	Enterprise architecture	Managing and monitoring sensors	Process improvement
		Server consolidation	Project management
		Optimisation	Programming
		Enterprise sustainability management	Mobile cloud
		Use of tele-presence and video conferencing	Service management

Business skills.

- Technology specialists need to have deep technical skills but increasingly need to have better business skills and awareness to promote the application of technology to their customers. There is a need for hybrid technical skills to be delivered in the context of industry knowledge. One option for the development of these skills is through increased employer collaboration across industries.
- As a consequence of new technologies and changing business models there is a need for IT specialists to be able to communicate with their customers more proficiently and extensively.
- This manifests itself in the need for high level sales and pre-sales skills and techniques that are currently hard to source. For example, no longer are IT suppliers selling just to the CIOs but the requirement now to sell to CFOs and CMOs means there is a need for more and higher level communication/presentation skills, together with more extensive business and financial awareness expertise.

Table 6: Summary of higher level business skills requirements

Cyber Security	Mobile Technologies	Green IT	Cloud Computing
	Sales and Pre-sales	Sales	Sales
Communication	Communication	Communication	Customer engagement
	Marketing	Business and commercial awareness	Contract negotiation
Customer facing presentation	Account management support	Presentation	Innovation
Relationship management	Partner management	Consulting	Business stakeholder management
Interpersonal	Procurement		Purchasing
Investigative	Vendor management		Forecasting
	Employee support		
Risk management	Risk management		Risk management
	Security policies and legal compliance		

7.3.3 Supply of skills and 'pipeline' issues

There are already indications there is increasing competition for higher level skills in the technologies studied. There are some recruitment difficulties, particularly at the higher end and in occupations with specialist skill sets.

Technologies are emerging so fast that the challenge for employers is to have their employees with the right skills in the right quantities and to then build on and develop particular specialisms. The solutions employers are pursuing are as follows:

- In the short term hiring contractors is widely noted as a necessary method of fixing the shortfall. In some cases, companies had fixed the problem through acquisition, thus expanding both their market share and their high level skills base 'instantly'.
- Most frequently mentioned by employers was that they were consistently working to upskill their own selected IT specialists into new technology specialisms, something they recognised as being a medium term solution and time limited.
- In the long term there was a positive consensus that a healthy and growing pipeline of talented new entrants into IT careers was essential to provide the future flow into IT specialist occupations and provide a base for upskilling and recruiting into new/emerging technology areas.

7.4 Implications, opportunities and challenges

There will continue to be an explosion of new devices and services not only in the business and consumer markets but also across the public sector. There is also a general consensus that IT is being regarded more as a revenue and growth generator for business, rather than just a necessary cost centre.

Throughout the research study the sense that everything will be "connected" came through strongly as a consequence of the emerging technologies. The use of sensors will proliferate and consequently data is being collected in ever increasing quantities and the ability to intelligently interpret data, will be key to many organisations for competitive advantage.

The research showed that employers currently have to address labour market issues around the new technologies. Skills across emerging technologies are in short supply and, as a consequence, employers reported increasing competition across different types of companies, the vendors, service providers and end users, for the limited pool of highly skilled specialists that design, develop, implement and maintain new products and services. It is apparent from the quantitative data and qualitative research undertaken in this project that skills mismatches and recruitment difficulties in higher level / higher value roles are detrimentally impacting the development of new products and services across the emerging technologies.

However, employers were realistic about the impact of emerging technologies on skills demand; the view being that historically new technologies are often disruptive and destabilising but this was not particularly seen as an issue, but almost as a norm, where innovation is at the heart of growth of the Digital sector.

The natural course of new technology development is recognised within an emerging, stabilising, maturing and commoditising cycle. For example, employers commented that 'mobility skills are where web skills were 15 years ago' and Cloud is now moving to 'business as usual'.

However, employers all specifically identified serious concerns about the future supply of talented IT people that will be needed to fill the ever growing number of roles created by these emerging technologies. Sourcing the required numbers of suitably skilled staff is therefore recognised as a key challenge for employers in the sector, which if not addressed will seriously compromise future business growth potential.

Appendix A: Methodology

This report was produced by the e-skills UK research team, commissioned by the UK Commission for Employment and Skills. This technical appendix provides information on the approach to producing the report, information on core data sets and other secondary quantitative data sources, and the outline of the literature review.

The research undertaken in the preparation of this report includes: analysis of quantitative datasets to provide a broad context of the labour market for the Digital sector; a literature review of relevant reports and studies; qualitative interviews with experts and employers in the sector across the UK to provide a rich and detailed understanding and insight into each technology; and a review of findings.

Analysis of quantitative datasets

The sector profile in this report uses data from the Office for National Statistics (ONS) Labour Force Survey (LFS) to describe the profile of the Digital Sector workforce⁴⁶. The LFS is the largest household survey in the UK and is carried out on a quarterly basis. The sample is of around 41,000 households in Great Britain every quarter, and around 1,600 households in Northern Ireland. Annual data presented within this report is based on an average of four consecutive quarters of data and uses SIC 2007 and SOC 2010. Full user guidance can be accessed at: <http://www.ons.gov.uk/ons/guide-method/method-quality/specific/labour-market/labour-market-statistics/index.html>

The Sector Skills Assessment for the Information and Communication Technologies sector report (e-skills UK, 2012) incorporates findings from the UK Commission's Employer Skills Survey 2011 (UKCESS) and Working Futures. The Sector Skills Assessment is used as the main source in this report to highlight key skills requirements and mismatches in the sector. The full report can be accessed at: <http://www.ukces.org.uk/publications/ssa12-ict>

- UKCESS was the first large-scale economy-wide employer skills survey to be conducted across the whole of the UK. The survey was managed by the UK Commission for Employment and Skills and was conducted by three contractors: IFF Research, BMG Research and Ipsos Mori (Davies et al, 2012). Fieldwork was carried out from March to July 2011.

⁴⁶ To facilitate comparison, the sector definitions used in the UKCES commissioned Sector Skills Assessment suite of 15 reports has been used.

- Working Futures projections were prepared by the Institute for Employment Research (IER) and Cambridge Econometrics (CE) on behalf of the UK Commission for Employment and Skills (UKCES). A number of different data sources are used to provide a picture of employment prospects up to 2020, giving an indicative picture of likely trends. Further methodological details can be found at <http://www.ukces.org.uk/publications/working-futures-technical-report>

e-skills UK also undertook analysis of IT Jobs Watch data for this report. This resource sources data from IT recruitment websites and operates independently to provide an impartial outlook. Their surveys are continuous to ensure the information presented is up to date. <http://www.itjobswatch.co.uk/>

Literature review

The literature review undertaken from this project used existing material to provide a profile of the technologies, to explore the drivers of demand and to identify insights into how the technologies might develop in the future. A thorough internet based review across the four technologies was undertaken locating and sifting through technology journals, report, publications from global experts and the views of employers, government and technology analysts,.

Whilst numerous studies and surveys have been conducted on these technologies in recent times, there is little available information on the skills requirements that will contribute to and guide competitiveness and innovation in the Digital sector and in user companies.

The literature review therefore informed the subsequent qualitative interviews with experts and employers which focussed more heavily on skills requirements.

Drivers of demand were determined initially by using the model of drivers of changes set out in the UKCES National Strategic Skills Audit (UKCES, 2010). The literature review and subsequent discussions with employers around drivers provided greater detail and depth, breaking some of the categories down further, allowing for sectoral and technological insights and prioritisation.

Qualitative interviews and review of findings

Qualitative fieldwork with employers and experts through semi structured interviews provided a rich and more detailed understanding and deeper insights for this project.

The analysis of data and the literature review conducted in the first stages of the project were used to develop a topic guide for the interviews, which was further refined by discussions with industry experts (one in each technology area) before finalising for use in the employer interviews.

In the course of the project 24 individuals from 17 organisations were interviewed, seven of whom participated in an expert capacity for initial discussions or in the review phase. The sample of employers included both industry (ranging from IT consulting to services providers and developers), and user companies (a total of four, including public and private sector) to gather a wide range of views and covered at least one employer in each UK nation (Scotland 1, Wales 1, Northern Ireland 3). Many of the companies interviewed are part of international organisations and are relatively large in size. The experts interviewed come from employers (where individuals are recognised as thought leaders in the field), industry organisations and academia.

As such, this report is not designed to provide a comprehensive assessment of sectoral skills issues at national or all size/sector level but to provide some insight from leading employers and recognised experts into the potential impact of emerging technologies on higher level skills.

A first draft of the report, based on all the input gathered in the course of the project, was then used for comment and discussion by employers and experts in order to synthesise and validate the key points for each technology and further refine the findings.

Appendix B: Definitions

B1 Digital Sector (Industry definitions)

The Standard Industrial Classification (SIC) codes used in this report to define the Digital Sector are as follows:

SIC (2007)	Description
SIC 61	Telecommunications comprising wired, wireless, satellite and other telecommunications activities
SIC 62	Computer programming, consultancy and related activities comprising Computer programming and consultancy activities, computer facilities management and other information technology and computed service activities
SIC 63	Information Service Activities covering data processing, hosting and related activities; web portals; news agency activities and other information service activities
SIC 95	Repair of computers and other goods includes repair of: computers and peripheral equipment; communication equipment; consumer electronics; household appliances and home and garden equipment; footwear and leather goods; furniture and home furnishings; watches clocks and jewellery; and repair of other personal and household goods.

B2: Occupational Classifications

The Standard Occupational Classification (SOC) used for IT and Telecoms specialists are as follows:

SOC (2010)	Description	Related job titles
1136 IT & Telecoms Directors	Job holders in this unit group plan, organise, direct and coordinate the work and resources necessary to provide and operate information technology and telecommunications services within an organisation.	<ul style="list-style-type: none"> • IT Director • Technical director (<i>computer services</i>) • Telecommunications director
2133 Specialist IT & Telecoms Managers	IT specialist managers plan, organise, manage and coordinate the provision of specialist IT services and functions in an organisation.	<ul style="list-style-type: none"> • Data centre manager • IT manager • IT support manager • Network operations manager (<i>computer services</i>) • Service delivery manager
2134 IT & Telecoms Project and Programme Managers	Jobholders in this unit group manage, coordinate and technically supervise specific IT projects and programmes of a discrete duration and/or budget.	<ul style="list-style-type: none"> • Implementation manager (computing) • IT project manager • Programme manager (computing) • Project leader (<i>software design</i>)
2135 Business Analysts, Architects & System Designers	Workers in this unit group provide advice on the effective utilisation of IT and design IT systems in order to meet the business objectives or to enhance the business effectiveness of the organisation.	<ul style="list-style-type: none"> • Business analyst (computing) • Data communications analyst • Systems analyst • Systems consultant • Technical analyst (computing) • Technical architect
2136 Programmers & Software Development Professionals	Programmers and software development professionals design, develop, test, implement and maintain software systems in order to meet the specifications and business objectives of the information system; they also design and develop specialist software e.g. for computer games.	<ul style="list-style-type: none"> • Analyst-programmer • Database developer • Games programmer • Programmer • Software engineer
2137 Web Design & Development Professionals	Jobholders in this unit group design, develop and maintain websites to meet a client's specified requirements.	<ul style="list-style-type: none"> • Internet developer • Multimedia developer • Web design consultant • Web designer
2139 IT&T Professionals NEC	Job holders in this unit group perform a variety of tasks not elsewhere classified in MINOR GROUP 213: Information Technology and Telecommunication Professionals.	<ul style="list-style-type: none"> • IT consultant • Quality analyst (computing) • Software tester • Systems tester (computing) • Telecommunications planner

3131 IT Operations Technicians	IT operations technicians are responsible for the day-to-day running of IT systems and networks including the preparation of back-up systems, and for performing regular checks to ensure the smooth functioning of such systems.	<ul style="list-style-type: none"> • Computer games tester • Database administrator • IT technician • Network administrator • Systems administrator
3132 IT User Support Technicians	IT user support technicians are responsible for providing technical support, advice and guidance for internal/external users of IT systems and applications, either directly or by telephone, e-mail or other network interaction.	<ul style="list-style-type: none"> • Customer support analyst • Help desk operator • IT support technician • Systems support officer
5242 Telecoms Engineers	Telecommunications engineers install, maintain and repair public and private telephone systems and maintain, test and repair telecommunications cables.	<ul style="list-style-type: none"> • Cable jointer • Customer service engineer <i>(telecommunications)</i> • Installation engineer <i>(telecommunications)</i> • Network officer <i>(telecommunications)</i> • Telecommunications engineer • Telephone engineer
5245 IT Engineers	IT engineers install, maintain and repair the physical components of computer systems and equipment.	<ul style="list-style-type: none"> • Computer repairer • Computer service engineer • Hardware engineer <i>(computer)</i> • Maintenance engineer <i>(computer servicing)</i>

Appendix C: Sector profile – data tables

This appendix provides supplementary tables to Section 2 on the profile and characteristics of the Digital Sector in the UK. Data is from the ONS Labour Force Survey⁴⁷ and the Sector Skills Assessment for the Information and Communication Technologies sector (e-skills UK, 2012) which incorporates findings from UKCESS and Working Futures to highlight key skills requirements and mismatches⁴⁸.

Employment and employment trends

Table 7: Change in employment, 2009 – 2012 in the Digital sector

	Employees (000s)	Self-employed (000s)	Total (000s)
2009	660	120	780
2010	635	123	758
2011	646	150	796
2012	668	153	821

Source: e-skills UK analyses of data from the ONS Labour Force Survey, four quarter average

Occupational profile

Table 8: Occupational distribution, by employment sector, 2012

	Digital sector	All sectors
Managers, Directors, Senior Officials	10%	10%
Professionals	51%	19%
Associate Professionals/ Technical staff	16%	14%
Administrative / Secretarial staff	7%	11%
Skills Trades	10%	11%
Other	7%	35%

Source: e-skills UK analyses of data from the ONS Labour Force Survey, four quarter average

Table 9: Employment of ICT specialists, by employment sector, 2012

	Digital sector	All sectors
ICT Managers, Directors, Senior Officials	22%	26%
ICT Professionals	60%	49%
ICT Associate Professionals/ Technicians	11%	18%
ICT Engineers	7%	8%

Source: e-skills UK analyses of data from the ONS Labour Force Survey, four quarter average

Qualifications profile

Table 10: Highest qualification held, by employment sector, 2012

	Digital sector	All sectors
Degree/equivalent	54%	30%
Higher education	9%	10%
A-level / equivalent	19%	24%
GCSE grades a*-C / equivalent	13%	21%
Other qualifications	3%	9%
No qualification	2%	6%

Source: e-skills UK analyses of data from the ONS Labour Force Survey, four quarter average

⁴⁷ To facilitate comparison, the sector definitions used in the UKCES commissioned Sector Skills Assessment suite of 15 reports has been used. Data is four quarterly average for 2012 unless otherwise specified.

⁴⁸ See Appendix A for more details on the sources used.

Skills mismatches

Table 11: Skills lacking in Skills Shortage Vacancies (UK)

	Digital Sector		Whole economy	
	Number	%	Number	%
Basic computer literacy / using IT	488	10	16,832	16
Advanced IT or software skills	2,617	53	21,988	21
Oral communication skills	1,801	36	39,113	38
Written communication skills	1,831	37	33,859	33
Customer handling skills	2,035	41	41,349	40
Team working skills	1,167	24	33,728	33
Written Welsh language skills	6	**	1,574	2
Oral Welsh language skills	6	**	1,680	2
Foreign language skills	955	19	16,773	16
Problem solving skills	2,210	45	37,882	37
Planning and Organisation skills	2,298	47	42,431	41
Strategic Management skills	1,227	25	29,853	29
Numeracy skills	1,103	22	26,775	26
Literacy skills	1,174	24	30,151	29
Office admin skills	589	12	17,559	17
Technical or practical skills	2,424	49	47,992	46
Job specific skills	3,931	80	68,385	66
Experience/lack of product knowledge	109	2	1,668	2
Personal attributes e.g. motivation, work ethos, common sense, initiative, reliability, commitment...	51	1	2,743	3
Other	30	1	911	1
No particular skills difficulties	127	3	7,129	7
Don't know	93	2	3,777	4
Weighted base	4,937		103,453	
Unweighted base	360		7,197	

Source: UK Commission's Employer Skills Survey 2011, Davies et al, 2012

Base: All skills shortage vacancies

NB: Employment weight. Column percentages sum to more than 100 since multiple responses were allowed.

Table 12: Impact of having hard-to-fill vacancies (Digital Sector, UK)

	Digital Sector		Whole economy	
	Number	%	Number	%
Increase workload for other staff	3,196	89	75,165	83
Have difficulties meeting customer services objectives	1,392	39	40,550	45
Lose business or orders to competitors	1,795	50	37,879	42
Delay developing new products or services	2,443	68	37,635	41
Experience increased operating costs	1,615	45	35,766	39
Have difficulties meeting quality standards	646	18	30,498	34
Have difficulties introducing new working practices	1,187	33	29,065	32
Outsource work	1,416	39	23,666	26
Withdraw from offering certain products or services altogether	1,145	32	23,180	26
Have difficulties introducing technological change	1,447	40	19,905	22
None	152	4	5,476	6
Don't know	9	**	361	**
<i>Weighted base</i>	3,596		90,770	
<i>Unweighted base</i>	225		5,160	

Source: UK Commission's Employer Skills Survey 2011, Davies et al, 2012

Base: All employers with hard to fill vacancies

** Denotes a figures of greater than 0% but less than 0.5%

NB Column percentages sum to more than 100 since multiple responses were allowed.

Training

Table 13: Employees receiving training (Digital Sector, UK)

	Digital Sector		Whole economy	
	Number	%	Number	%
Manager, Director and senior officials occupations	50,036	32	2,413,145	45
Professional occupations	61,579	43	1,904,780	61
Associate professional and technical occupations	37,989	44	1,022,510	56
Administrative and secretarial occupations	21,841	30	1,607,984	45
Skilled trades occupations	11,186	50	1,041,373	55
Personal service occupations	1,238	7	1,606,254	70
Sales and customer service occupations	37,182	44	1,937,670	55
Process, plant and machine operatives	4,401	32	902,782	47
Elementary occupations	5,012	30	1,938,793	48
Other	2,776	n/a	100,845	n/a
All occupations	233,240		14,476,137	
<i>Weighted base</i>	233,240		14,476,137	
<i>Unweighted base</i>	20,344		1,517,802	

Source: UK Commission's Employer Skills Survey, 2011, Davies et al, 2012

Base: All employees receiving training.

Glossary

AWS	Amazon Web Services
BCS	British Computer Society
BIS	The Department for Business, Innovation & Skills
BYOD	Bring Your Own Device
BREEAM	Building Research Establishment Environmental Assessment Method
CapEx	Capital Expenditure
CE	Cambridge Econometrics
CEB	Corporate Executive Board
CEBR	The Centre for Economics and Business Research
CEO	Chief Executive Officer
CESG	Communications-Electronics Security Group.)
CFO	Chief Financial Officer
CIO	Chief Information Officer
CISO	Chief Information Security Officer
CISSP	Certified Information Systems Security Professional
CLAS	CESG (Communications-Electronics Security Group) Listed Advisors Scheme
CMO	Chief Marketing Officer
CRC	Carbon Reduction Commitment
CTO	Chief Technology Officer
DoS	Denial of service
EMEA	Europe, Middle East and Africa
EU	European Union

GPS	Global Positioning System
GVA	Gross Value Added
HESA	Higher Education Statistics Agency
HMG	Her Majesty's Government
IaaS	Infrastructure as a Service
ICT	Information and Communications Technology
IDC	International Data Corporation
IER	Institute for Employment Research
IET	Institution of Engineering and Technology
IP	Intellectual Property
IPSec	Internet Protocol Security
ISO	International Organization for Standardization
ISSA	Information Systems Security Association
IT	Information Technology
LEED	Leadership in Energy and Environmental Design
LFS	Labour Force Survey
LMI	Labour Market Intelligence
MAM	Mobile Application Management
MCM	Mobile Content Management
MDM	Mobile Device Management
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
OpEx	Operational Expenditure
PaaS	Platform as a Service

PCI DSS	Payment Card Industry Data Security Standard
SaaS	Software as a Service
SCADA	Supervisory control and data acquisition
SIC	Standard Industrial Classification
SME	Small and medium-sized enterprises
SOC	Standard Occupational Classification
SSA	Sector Skills Assessment
STEM	Science, Technology, Engineering and Mathematics
TOGAF	The Open Group Architecture Framework
UCAS	Universities and Colleges Admissions Service
UKCES	The UK Commission for Employment and Skills
UKCESS	UK Commission Employer Skills Survey
US NIST	US National Institute for Standards and Technologies
VDI	Virtual Desktop Infrastructure
WEF	World Economic Forum

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