

Matrix Digital ICT Report 2016

FORESIGHT & HORIZON SCANNING



MATRIX DIGITAL ICT PANEL

Table of contents

CHAIRMAN’S FOREWORD	4
INTRODUCTION	5
MATRIX DIGITAL ICT PANEL MEMBERS	6
SCOPE OF THIS REPORT	7
Structure of the report	7
METHODOLOGY	8
SIC Codes	8
Data Sources.....	8
EXECUTIVE SUMMARY	9
The Digital ICT landscape.....	9
Global mega trends	10
Matching local skills to global opportunities.....	15
Challenges for the Northern Ireland Digital ICT sector	16
Characteristics of a leading digital economy.....	17
Summary of recommendations.....	19
THE DIGITAL ICT LANDSCAPE IN NORTHERN IRELAND	20
Overview.....	20
Export figures	22
The workforce	23
Earnings	25
Gross Value Added (GVA) per employee.....	26
Foreign Direct Investment.....	26
Northern Ireland’s core ICT strengths.....	27
ICT as a sector & an enabler	28
ICT clusters in Northern Ireland	29
Research and Development (R&D).....	30
CHALLENGES FOR THE NORTHERN IRELAND DIGITAL ICT SECTOR	33
Talent.....	33
Supply of talent	34
Attraction and retention of talent.....	39
Leadership and the need for a digital strategy	40
Government support of the sector	40
Smart specialisation	41
Funding the sector.....	42
GLOBAL TRENDS.....	44
Digital trends	44
Global mega trends	46

MATCHING LOCAL SKILLS TO GLOBAL OPPORTUNITIES.....	52
Assessment criteria	52
Software engineering	54
Cyber security.....	56
Data Analytics.....	58
Advanced Networks and Sensors	60
CHARACTERISTICS OF A LEADING DIGITAL ICT SECTOR.....	62
A Digital Strategy	63
Human Capital	63
Foreign Direct Investment.....	63
R&D Capability.....	64
Support for Innovation.....	64
Funding and Investment Activity.....	64
Building Clusters	65
Maintaining Digital Infrastructure	65
Smart Specialisation	66
Strong Brand Identity	66
Summary.....	67
RECOMMENDATIONS FOR THE NORTHERN IRELAND DIGITAL ICT SECTOR.....	68
Continued investment in skills	69
Centre for data analytics	70
Engage a leading industry expert to act as a Chief Digital Officer	71
Government as an expert and strategic customer of digital technology.....	72
Continued support for the cyber security sector	73
Supporting recommendations.....	74
APPENDIX 1: LEADING DIGITAL ICT NATIONS.....	75
APPENDIX 2: CHARACTERISTICS OF A LEADING DIGITAL ICT SECTOR.....	88
APPENDIX 3: REF 2014 SCORES	104
APPENDIX 4: UNIVERSITIES OVERVIEW	107
APPENDIX 5: 2015 ICT SALARY OVERVIEW	111

Figures

FIGURE 1:	NUMBER OF VAT AND/OR PAYE REGISTERED BUSINESSES OPERATING IN NORTHERN IRELAND 2009-2015	20
FIGURE 2:	NUMBER OF VAT AND/OR PAYE REGISTERED DIGITAL ICT BUSINESSES OPERATING IN NORTHERN IRELAND 2009-2015 BY SIC.....	21
FIGURE 3:	TURNOVER OF NORTHERN IRELAND ICT BUSINESSES 2008-2013 (£M).....	21
FIGURE 4:	NORTHERN IRELAND DIGITAL ICT EXPORTS 2011-2014 (£M)	22
FIGURE 5:	NORTHERN IRELAND DIGITAL ICT TURNOVER & EXPORT 2011-13 (£M)	22
FIGURE 6:	NORTHERN IRELAND ICT WORKFORCE 2015.....	23
FIGURE 7:	BREAKDOWN OF DIGITAL ICT JOBS IN NORTHERN IRELAND IN 2015 BY SIC CODE.....	23
FIGURE 8:	GROWTH IN THE DIGITAL ICT WORKFORCE IN NORTHERN IRELAND 2007-2015 ..	24
FIGURE 9:	MEDIAN GROSS WEEKLY EARNINGS FOR NORTHERN IRELAND TECH SPECIALISTS 2015	25
FIGURE 10:	MEDIAN WEEKLY EARNINGS FOR EMPLOYEES IN NORTHERN IRELAND ICT COMPANIES 2015	25
FIGURE 11:	GVA FOR NI DIGITAL ICT WORKERS 2008-2013 COMPARED TO NI AVERAGE	26
FIGURE 12:	DIGITAL ICT CONTRIBUTION TO NI GVA (IN £MILLIONS)	26
FIGURE 13:	KEY GLOBAL TRENDS WHICH INFORM THE ICT SECTOR AND HELP SHAPE THEIR OUTPUT TO OTHER SECTORS	27
FIGURE 14:	ICT& DIGITAL AS BOTH A SECTOR AND AN ENABLER.....	28
FIGURE 15:	NORTHERN IRELAND ICT BERD SPEND 2010-2014.....	31
FIGURE 16:	ICT EXPENDITURE AS PROPORTION OF ALL BERD EXPENDITURE IN 2013.....	32
FIGURE 17:	PERCENTAGE OF NORTHERN IRELAND ICT COMPANIES REPORTING SKILLS GAPS FOR ICT SPECIALISTS 2012-2014.....	34
FIGURE 18:	TOP 10 SKILLS ANNUAL AVERAGE UNDERSUPPLY – NQF L4-5.....	35
FIGURE 19:	TOP 15 SKILLS ANNUAL AVERAGE UNDERSUPPLY NQF L6+	35
FIGURE 20:	IT APPRENTICESHIP STARTS IN NORTHERN IRELAND BY GENDER AND SUBJECT, 2013/14	36
FIGURE 21:	DIGITAL ECONOMY AND SOCIETY INDEX 2014	76

CHAIRMAN'S FOREWORD

It is with great pleasure that we present our recommendations for the future growth of Northern Ireland's Digital ICT sector to the Minister for Enterprise, Trade and Investment. This report is the output of a specialist subpanel assembled by Matrix to examine Northern Ireland's capabilities and identify both the areas where improvements are needed and the global trends most likely to create opportunity for Northern Ireland when matched to our specific strengths.

When the first Matrix ICT report was published back in 2008, it was recognised that the global ICT sector had two drivers – radically evolving technology and fast changing market dynamics. In the eight years since then, both global opportunities and local capabilities have developed exponentially, often in unanticipated ways. We were therefore well aware of the intrinsic difficulties of predicting future trends in the sector when we began work on this report. However, we believe that it offers a valuable and unique insight into Northern Ireland's digital economy as well as an overview of the challenges specific to growing the sector.

This report followed Matrix's traditional process of panel discussions supported by commissioned research. Given how quickly technology has moved and how rapidly the market has changed, Matrix and all its sub panels are now moving towards a new methodology which is more agile and time sensitive.

Northern Ireland has a real opportunity to build on its present capability in software engineering, data analytics, networks and sensors and cyber security. The Centre for Secure Information Technologies is just one example of how Northern Ireland can become a sector leader. We have the potential to repeat that success in other areas, such as data analytics. This report's recommendations – the need for a Digital Strategy for Northern Ireland, the engagement of a Chief Digital Officer, the creation of a centre for data analytics while continuing to support cyber security and the need for government to become an expert and strategic ICT consumer – are soundly rooted in evidence gathered from a wide range of business, academic and government sources. We hope that these recommendations will form a blueprint for the further development and growth of the sector. If they are implemented fully, there is real potential to build a globally competitive economy focused on our niche strengths.

I would like to thank all the members of the Matrix Digital ICT Panel for their time and expertise given in the production of this report. I would particularly like to thank the Vice Chair of the panel, Tom Gray and the Matrix Chair, Bryan Keating for their input and support throughout.

John Healy

Managing Director - Allstate, Belfast

Introduction

MATRIX, the Northern Ireland Science Industry Panel, formed a subpanel of experts in the Digital ICT sector to look at the opportunities within the sector and produce a capability assessment and foresight study into Northern Ireland's Digital Information and Communications Technology sector.

The purpose of this report is to present an insight to the Digital ICT sector and to provide recommendations to enable the exploitation of market opportunities for the sector in Northern Ireland over a time horizon of between three to five years and beyond.

The expert panel was drawn from across Northern Ireland's Digital ICT sector, led by industry but including representatives from government, academia and the UK Digital Catapult. The panel sought to not only reach a consensus on the region's ICT strengths and capabilities, but also to identify areas of opportunity.

They also looked at other regions which are recognised to have built successful digital economies to map how the report's recommendations, along with initiatives being carried out by other stakeholders, might allow us to achieve our goals.



MATRIX Digital ICT Panel Members

John Healy (Chair)	Allstate
Tom Gray (Vice Chair)	Kainos
Bryan Keating	MATRIX NI
Neill Crockett	UK Digital Catapult
Sinclair Stockman	Digital NI 2020
Stephen McKeown	Analytics Engines
Brendan Crossey	Asystec
Rob McConnell	SQS
Professor Gerry Parr	Ulster University
Stephen Wray	Queen's University Belfast's ECIT Institute
Michael Gould	Department for Employment and Learning
David Hughes	Department for Education
Barry Lowry	Department of Finance and Personnel
Mark Maguire	Invest NI
Canice O'Doherty	Moy Park
Consultants	Deloitte LLP

Scope of this report

This report uses the term Digital ICT sector to include sectors that support the capture, transmission and electronic display of data and information as well as the enterprise software, middleware, storage, and audio-visual systems which enable users to access, store, transmit, and manipulate information.

When referring to the Digital ICT sector, the data refers to companies registered under SIC codes J61, 62 & 63 – that is, telecommunications, computer programming and consultancy and information service activities. Where it has not been possible to gather data for these SIC codes we have provided data for all ICT businesses, i.e. SIC code J.

The report does not examine the creative industries sector.

Northern Ireland's Digital ICT sector as defined above demonstrates several specific strengths, such as the quality of talent in software engineering, the availability of public funding and the quality of both clustering and R&D. It has the potential to grow significantly in the next decade.

However, to progress further, there are a number of weaknesses to be addressed.

The 2016 MATRIX Digital ICT Report aims to:

- clearly identify future opportunities - global trends which will play to Northern Ireland's specific strengths
- suggest how best to tackle barriers to success
- make recommendations and suggest ownership and timelines for implementation.

Structure of the report

- Section 1 provides an overview of the Digital ICT sector in Northern Ireland.
- Section 2 examines the challenges facing the sector.
- Section 3 identifies global trends and the emerging opportunities of Digital ICT.
- Section 4 examines Northern Ireland's areas of capability and suggests future focus for the Digital ICT sector.
- Section 5 identifies the characteristics of leading digital economies and maps Northern Ireland's performance.
- Section 6 sets out clear recommendations and a roadmap to progress.

Methodology

SIC Codes

The UK Standard Industrial Classification of Economic Activities (SIC) is used to classify businesses by the type of economic activity in which they are engaged.

The panel used the SIC codes J61 – 63 inclusive to identify the ICT Digital sector:

J - Information & communication	J61	Telecommunications
	J62	Computer programming, consultancy and related activities
	J63	Information service activities

There were some difficulties associated with this and the panel has made a recommendation on the use and value of SIC codes in future reports.

Data Sources

Sources for data include:

- NISRA
- DETI
- ONS
- InvestNI
- E-skills
- Deloitte LLP
- DEL
- IDC
- QUB
- UU

Executive Summary

The Digital ICT landscape

The Northern Ireland Digital ICT sector comprises over 1,200 companies, over 100 of which are international businesses such as Allstate, SAP, Citi and Cybersource. The sector offers particular strength in its software engineering expertise and has clusters in mobile telecoms, financial software, information management, cyber security and connected health.

The sector employs around 13,000 people, with the total ICT workforce (including ICT specialists in non-ICT businesses) standing at around 28,000.

2% of Northern Ireland employees work in Digital ICT



IN 2013
THE SECTOR
ACCOUNTED FOR
£870m
OF ALL ECONOMIC OUTPUT
IN NORTHERN IRELAND,
REPRESENTING GROWTH OF
32%
OVER THE LAST 5 YEARS

THERE ARE
OVER
1,200
DIGITAL ICT
COMPANIES
IN BUSINESS ACROSS
NORTHERN IRELAND
INCLUDING
BIG NAMES LIKE:



The GVA for Digital ICT workers is

£65,514
that's **28%**
above the NI average.

In 2014 Digital ICT exports were worth

£283m
an increase of 25% over the last 3 years

Source: NISRA

Global mega trends

The panel commissioned Deloitte LLP to identify a number of global megatrends and match them to key skillsets where Northern Ireland has the best prospect for growth and innovation over the coming years.

Ageing population & wellness

Demand is increasing for ICT products which help people manage their own health and wellness. There is also increased pressure for health services to find ways to improve efficiency in the delivery of healthcare.

33% of the population is over 60
Average life expectancy is 80
Birth rate is dropping year on year (Source: UN)



THERE IS A HUGE INCREASE IN UPTAKE OF MOBILE HEALTHCARE APPS

500m

SMARTPHONE USERS
WORLDWIDE ARE USING
HEALTHCARE APPS

By
2018

50%

SMARTPHONE & TABLET USERS
WILL HAVE DOWNLOADED A
HEALTHCARE APP

Opportunities for Northern Ireland

- **Data analytics:** analysis of medical data reveals new ways to identify health risks, diagnose conditions and personalise treatment and care.
- **Applications:** wellness applications for smartphones and tablets can be tailored to the needs of an ageing population.
- **Cyber security:** medical and wellness records must be secure and trusted to be secure.
- **Sensors:** there is an opportunity for wearable sensors for diagnostic or monitoring applications.

Smart infrastructure and urbanization

Smart city infrastructure is locally relevant, and so are the opportunities globally to export solutions to urbanisation challenges

THE WORLD IS BECOMING INCREASINGLY URBANISED



% OF GLOBAL POPULATION LIVING IN URBAN AREAS (SOURCE: UN)

Urbanisation within NI is not a major factor, but there are opportunities to develop smart city infrastructures locally and to export solutions to urbanisation challenges.

THE CHALLENGES OF RAPID URBANISATION



GOOD STANDARD OF HOUSING



EFFICIENT PUBLIC SERVICE DELIVERY



INFRASTRUCTURE



HEALTHY ENVIRONMENT

Opportunities for Northern Ireland

- **Sensors:** as cities and other locations become increasingly connected, dense sensor networks connected via data aggregation and analytics platforms to multiple applications will increasingly help manage public administration, emergency services and transport.
- **Advanced networking:** urban areas require the densest networks, and have led to the development of small cell mobile networks and heterogeneous networks (HetNets).
- **Applications:** city administrative and other government functions are being transformed through the development of online and mobile applications, in areas such as payments and information services.
- **Cyber security:** as more critical data runs over city networks the networks, applications and data need new approaches to security.
- **Data analytics:** aggregation of data presents an opportunity for insight and value to be created through the combination of data sets and the analysis of rich data.

The 'digital native'

There is a need for the delivery of devices, networks, services and applications that support the demands of 'digital natives' – i.e. those whose who are fully at ease with technology.

WHAT DOES A 'DIGITAL NATIVE' LOOK LIKE?

'ALWAYS ON' OR
'ALWAYS CONNECTED'
THEY EXPECT TO ENGAGE
WITH ORGANISATIONS &
BRANDS 24 HOURS A DAY
CONNECTED THROUGH
SOCIAL MEDIA TO OTHER
PEOPLE, COMPANIES &
INSTITUTIONS INCLUDING
GOVERNMENT &
PUBLIC SERVICES

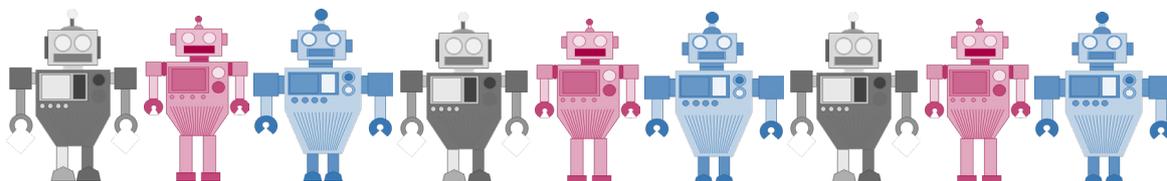


Opportunities for Northern Ireland

- **Advanced networking:** Digital natives expect to interact 24x7 with guaranteed levels of responses. Networks must be resilient and high-performing to ensure service delivery.
- **Applications:** This next generation processes information more quickly, multitasking across devices. They have access to thousands of applications, transforming and pushing the development of the user experience.
- **Cyber security:** Digital natives take security for granted, expecting technology and organizations to protect their private information. The line between public and private is far more porous than for those born before the digital age. As huge volumes of personal data are exchanged, the importance of privacy, trust and security increases.
- **Data analytics:** The ability to engage proactively with digital users will be enabled through data analytics and will assist delivering localised services by anticipating demand and proactively meeting needs. Exploitation of anonymised and aggregated data offers opportunities for innovation, the development of new services and alternative revenue streams.

Automation and the rise of machine learning

As the capabilities of computers expand beyond routine work, tasks that were once considered too complex for automation will be converted into well-defined problems capable of digital solutions.



Exponential growth in computing power, combined with a dramatic reduction in cost has seen computer technologies transform the work place, displacing labour from some jobs but also creating new types of work that call for different skills.

**GOVERNMENT &
PUBLIC SECTOR
BODIES SAY**
70%
**OF THEIR OPERATIONS
HAVE BEEN IMPROVED
THROUGH THE
AUTOMATION OF TASKS**

KNOWLEDGE WORK
AUTOMATION HAS THE
POTENTIAL TO AFFECT OVER

230m

**KNOWLEDGE WORKERS
AROUND THE WORLD
AND NEARLY**

\$9trillion

IN EMPLOYMENT COSTS

**JOB'S THAT BARELY EXISTED
FIVE YEARS AGO SUCH AS**

**IOS/ANDROID
DEVELOPER**

DATA SCIENTIST

CLOUD SERVICES

SPECIALIST

BIG DATA ARCHITECT

**WILL EXPERIENCE AN INCREASE
IN DEMAND BY EMPLOYERS**

Opportunities for Northern Ireland

- **Advanced networking:** the increased capability to move large amounts of data allows business activity to take place anywhere.
- **Applications:** more sophisticated applications are replacing human activity in lower-skilled work in all sectors. However there are also major job opportunities where automation can complement and enhance human activity.
- **Data analytics:** understanding of transactional data can lead to changes in the location of business functions, from manufacturing to provision of IT services, while the automation of data analysis changes the pattern and location of business processes.
- **Cyber security:** as organisations rely increasingly on networks and cloud-based services running on virtualised infrastructure, securing data becomes more challenging.

Globalisation and economic shift

Clustering, cooperation and global niche manufacturing networks can bring market opportunities through strategic partnerships & collaborative technologies.



By 2025, 1.8bn people around the world will enter the consuming class, nearly all from emerging markets, and emerging-market consumers will spend \$30tr annually, up from \$12tr in 2015.

Globalisation fuelled by digital technologies has meant that 35% of goods cross borders, up from 20% in 1990.

More than one third of all financial investments in the world are digital international transactions, and a fifth of internet traffic is cross-border.

90% of Ebay sellers export their goods to other countries, compared with an average of 25% for traditional small companies.

Opportunities for Northern Ireland

- **Advanced networking:** the increased capability to move large amounts of data anywhere, quickly and reliably changes where economic activity is located.
- **Applications:** more sophisticated applications are replacing human activity in lower-skilled ICT work.
- **Data analytics:** understanding of transactional data can lead to changes in the location of business functions, from manufacturing to provision of IT services; and automation of data analysis changes the pattern and location of business processes.
- **Cyber security:** as organisations rely increasingly on networks and cloud-based services running on virtualised infrastructure, securing data becomes harder.
- **New ICT service models:** the rise of cloud-based applications mean that IT services are no longer delivered from data centres close to the point of use, and sometimes from unknown locations.

Matching local skills to global opportunities

Focus areas were assessed against market and capability factors to establish their strength and determine how ready Northern Ireland is to exploit them. Two criteria were used to assess each of the focus areas:

- **Attractiveness** - Current market size and trajectory, attractiveness to investment over the next 3 years and the maturity of the market were considered.
- **Ability to execute** - Northern Ireland's capability to make an impact in the short and medium term, critical mass of expertise with associated R&D and infrastructure.

Focus Area	Predicted Market Growth	Summary
Big Data Analytics	IDC expects that the Big Data technology and services market will grow at a 26.4% compound annual growth rate (CAGR) to \$41.5bn through 2018.	Strong capability which can be aligned to Northern Ireland industry sector strengths to develop specialist tools and capability for export. Also supports the development of machine learning.
Software	IDC expects CAGRs of 5.1% and 5.3% for the United States and Western Europe, respectively, between 2015 and 2019.	Software engineering is the underpinning capability within Northern Ireland, supporting all the other sectors. It's important to note that the emphasis for growth in this sector is in cloud based services.
Cyber Security	MarketsandMarkets expects the global cyber market to grow from \$106.32bn in 2015 to \$170.21bn by 2020, at a CAGR of 9.8%.	Northern Ireland has a strong cyber security cluster with evidence of world class capability and research. The sector has recently created over 900 new jobs with a further 300 in the pipeline.
Internet of Things (IoT)	IDC expects the global IoT market to grow at a 17% CAGR from \$698.6bn in 2015 to nearly \$1.3tr in 2019.	Northern Ireland has specific capability in Advanced Networks and Sensors, two areas which offer opportunity for growth in terms of the IoT market. In Advanced Networks, Northern Ireland has a cluster of over 50 companies in wireless communications, internet technologies and advanced networks. While capability to manufacture sensor devices is small, there is a significant volume of R&D being conducted that could produce design and process IP which could be leveraged and exported globally.

Challenges for the Northern Ireland Digital ICT sector

Challenges specific to growing the Digital ICT sector to enable the exploitation of global markets include:

Supply of skilled, committed & passionate talent - There must be a clear pathway for young people through school, enabling and inspiring them to acquire appropriate skills within the existing curriculum, generally in STEM subjects and specifically in software development. They should be offered progression routes to Apprenticeships and Further and Higher Education. At the same time, a framework of support should be made available to allow teachers to deliver the curriculum effectively.

Leadership and the need for a digital strategy - For Northern Ireland to become a truly digital society we must engage and empower a leading industry expert as RoI and other UK regions have. The appointment of a Chief Digital Officer and the development of an ICT strategy for Northern Ireland is essential. Analysis shows that countries with robust digital economies have a clear delivery strategy aligned to their programme for government.

Government support of the sector - The UK Government has become a world leader in the provision of user-led Digital Transformation. Northern Ireland has the opportunity to use its skills and innovations for the benefit of its citizens, and to realise the cost savings and service improvements that other territories are benefiting from. Northern Ireland's size and governance structures should enable it to become a global exemplar for Digital Transformation by 2020. However, it is still difficult for local suppliers to sell effectively to our public sector.

Smart specialisation - Smart specialisation is an innovation policy concept designed to promote the efficient and effective use of public investment in research. The goal of smart specialisation is to boost regional innovation in order to achieve economic growth and prosperity, by enabling regions to focus on their strengths. Northern Ireland's challenge is to focus on smart specialisation and avoid fragmentation.

Funding the sector – Private equity is going through a period of rapid change, with the emergence of new funding models such as crowd-funding and corporate venture capital and the implications of these changes for Northern Ireland are not straightforward or easily predictable. Significant progress has been made in ensuring government support is available for companies through Invest NI, InterTradeIreland, the NI Science Park and others; however there are a range of areas where improvements are still needed. HMRC offers R&D Incentives and as incentive rates have increased and the scope of the schemes has been enhanced an increasing number of NI businesses recognise and utilise the value of R&D Tax Credits, in particular.

Characteristics of a leading digital economy

The panel identified the following characteristics that leading digital economies share and examined Northern Ireland's performance against them. They then mapped any shortcomings to current government activities and the remaining gaps were incorporated into the panel's final recommendations.

A Digital Strategy - Leading countries have industry advocate(s) who advise government on the development of its ICT sector and a focused strategy and action plan that identifies opportunities in the sector and measures its impact on the region's economic development prospects. Northern Ireland currently has no digital strategy.

Human Capital - The panel noted that while Northern Ireland has a particular strength in the calibre of its software engineers, it has a weakness in the *quantity* of talent that is available to support the growth of the ICT sector.

Foreign Direct Investment - Northern Ireland has a proven ability to attract and maintain FDI. Further opportunities for growth are being achieved by narrowing the focus (smart specialisation) to attract high-value jobs in specific target areas for growth.

R&D Capability - Whilst the trend of investment in research-based activity in Northern Ireland is positive, levels of BERD remain lower in contrast to other UK regions, which indicates that there is some way to go to become world-class.

Support for Innovation - Whilst focus on innovation is growing in Northern Ireland, it is behind exemplar regions in the UK in terms of innovative active businesses and the level of innovation or the absorption of funding to support innovation.

Funding and Investment Activity - Northern Ireland has put in place a number of tailored, publicly funded programmes for innovation and R&D, but take-up of available funding outside of Northern Ireland specific schemes such as Innovate UK and Horizon 2020 is lower than other regions in the UK.

Building Clusters - Invest NI's Collaborative Network Programme (CNP) supports the development of business-led collaborative networks but it is acknowledged that there is an opportunity to achieve more through formal clustering to assist and progress R&D and promote capability to a global marketplace.

Maintaining Digital Infrastructure - Northern Ireland is establishing itself as one of the most connected regions in Europe. The quality of the technology infrastructure must be maintained to an exemplary level going forward and be able to support 4G, 5G and beyond.

Smart Specialisation - Smart specialisation involves exploiting digital technology to transform government, business and individual processes to deliver significantly better outcomes. Northern Ireland is regarded as having a strong financial services and health

ICT capability. However, Northern Ireland does not align its industry strengths alongside ICT as much as it could do.

Strong Brand Identity - Northern Ireland’s Digital ICT brand is not as distinguishable as it could be.

Where NI needs improvement and actions being taken

Action required	Comment
Develop a dedicated digital strategy	MATRIX recommends the appointment of a Chief Digital Officer to develop and deliver a digital strategy for Northern Ireland.
Address the talent gap	An ICT Future Skills Action Plan has already been produced by DEL, and ICT is now embedded in the revised curriculum as a skill across all Key Stages. MATRIX also recommends the development of a Skills Investment Plan.
Encourage BERD	HMRC offers financial incentives to encourage businesses to carry out inhouse R&D.
Support innovation	The 2014 Northern Ireland Innovation Strategy envisions that by 2025, Northern Ireland will be recognised as an innovation hub and will be one of the UK’s leading high-growth, knowledge-based regions.
Improve take up of Horizon 2020 and Innovate UK funding	DETI is currently developing a Northern Ireland Strategy for Horizon 2020.
Develop formalised ICT clusters	MATRIX recommends a centre for Data Analytics and a focus on formal ICT clusters, plus continued focus on CSIT.
Focus on Smart Specialisation	DETI published the <u>Northern Ireland Smart Specialisation Framework</u> in 2015 detailing strategies to deliver on innovation priorities.
Improve Northern Ireland brand identity	MATRIX recommends the appointment of a Chief Digital Officer to develop and deliver a digital strategy for Northern Ireland which would incorporate brand development.

Statements in bold refer to an action which forms part of the report’s recommendations

Summary of recommendations

The report makes several recommendations and suggests owners and timescales for completion. It also suggests three supporting actions:

- A report dedicated to the creative digital and content sector in Northern Ireland.
- The Department for the Economy to clearly define the Digital ICT sector to establish the full contribution the digital economy makes to the overall economy.
- That the existing digital infrastructure is maintained and further developed.

Action	Suggested owners	Timescale
1. Develop a 3-5-10 year Skills Investment Plan for the Digital ICT sector		
Focus the skills investment plan to support the areas examined by this report and to consider ways to create the skills required in the future.	DE and DfE	6 – 12 months
Develop an action plan to support the development and delivery of digital skills and computing in schools.		
2. Create a centre for Data Analytics		
Carry out a feasibility exercise to establish the benefits innovative high technology SMEs and industry sectors will gain from a centre for Data Analytics.	DfE, DfP, QUB & UU	12-18 months
Employ a clear leadership and governance structure to attract public sector resources that complement the private sector's expertise.		
Create a centre for Data Analytics that will advance the development of commercial spin offs and new products and services for the market.		
3. Engage a Chief Digital Officer		
Commission a leading industry expert to support Government to build a digital society and an exemplar region to meet the expectations of 21st century citizens.	DfE and DfP	6 – 12 months
Develop and deliver a coordinated Digital Strategy to bring together the key stakeholders and initiatives required to transform Northern Ireland into a fully digitized and Smart society.		
4. Government as an expert and strategic customer of digital technology		
Create an agile delivery process that responds to the changing requirements of purchasing of ICT products and services to ensure solutions meet requirements.	DfP, DfE and local government	1-3 years
Ensure that NI has an exemplar digital infrastructure within and between urban areas resulting in Northern Ireland as an exemplar smart, connected region.		
Provide an integrated, agile platform, based on open standards which expose appropriate data and service APIs to nurture the development of an innovative ecosystem.		
Make it easier for local businesses, particularly SMEs, to do business with Northern Ireland Government.		
5. Ensure that the cyber security sector is supported and developed		
Continue to support CSIT with its vision of establishing a global innovation hub for cyber security.	DfE	Ongoing
Support the growth of the NI cyber security cluster with targeted support for start-ups, indigenous businesses and FDI in the sector.		
Develop a portfolio of cyber skills and training initiatives, from PhDs and MSc courses through to relevant Assured Skills programmes.		

Section 1

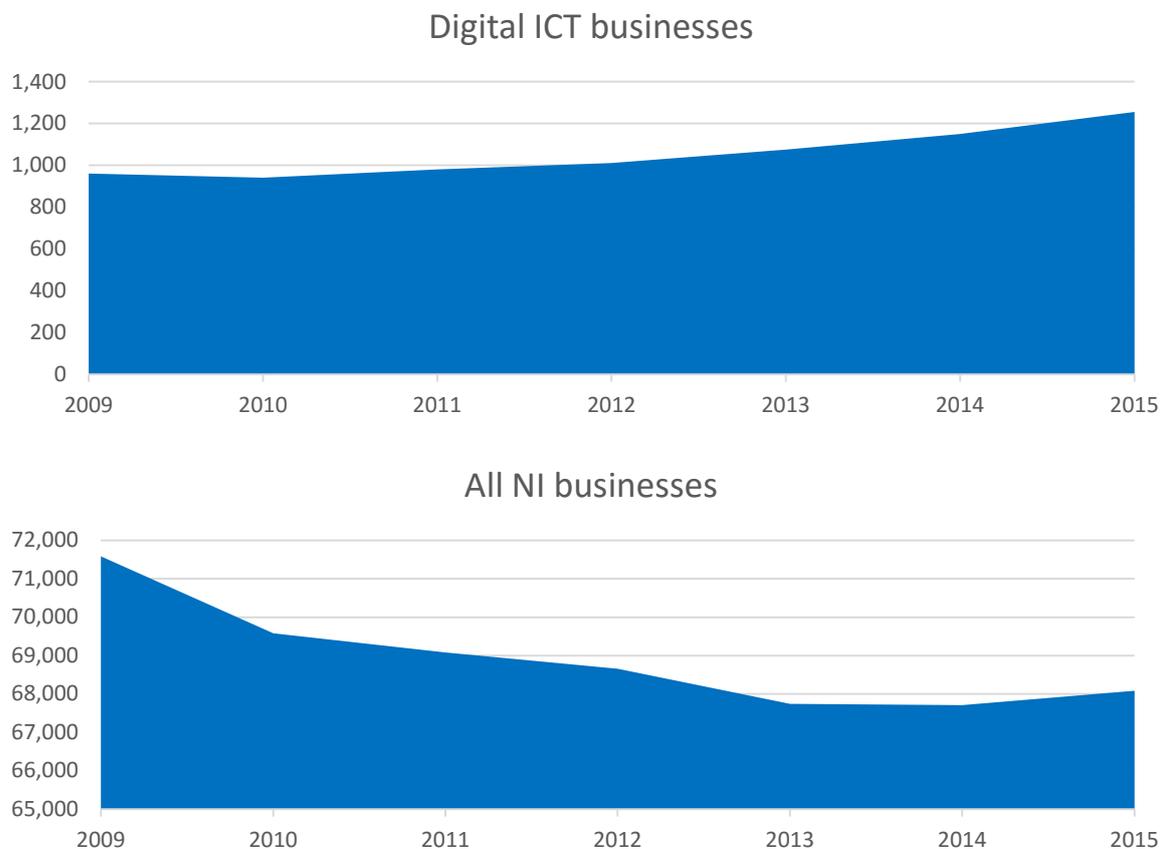
The Digital ICT landscape in Northern Ireland

Overview

The Northern Ireland Digital ICT sector comprises over 1,200 companies, over 100 of which are international businesses such as Allstate, SAP, Citi and Cybersource. The sector offers particular strength in its software engineering expertise and has clusters in mobile telecoms, financial software, information management, cyber security and connected health.

Over the last six years, while the overall number of businesses registered for VAT and/or PAYE in Northern Ireland has decreased by 5%, the number of Digital ICT companies has increased by 31%.

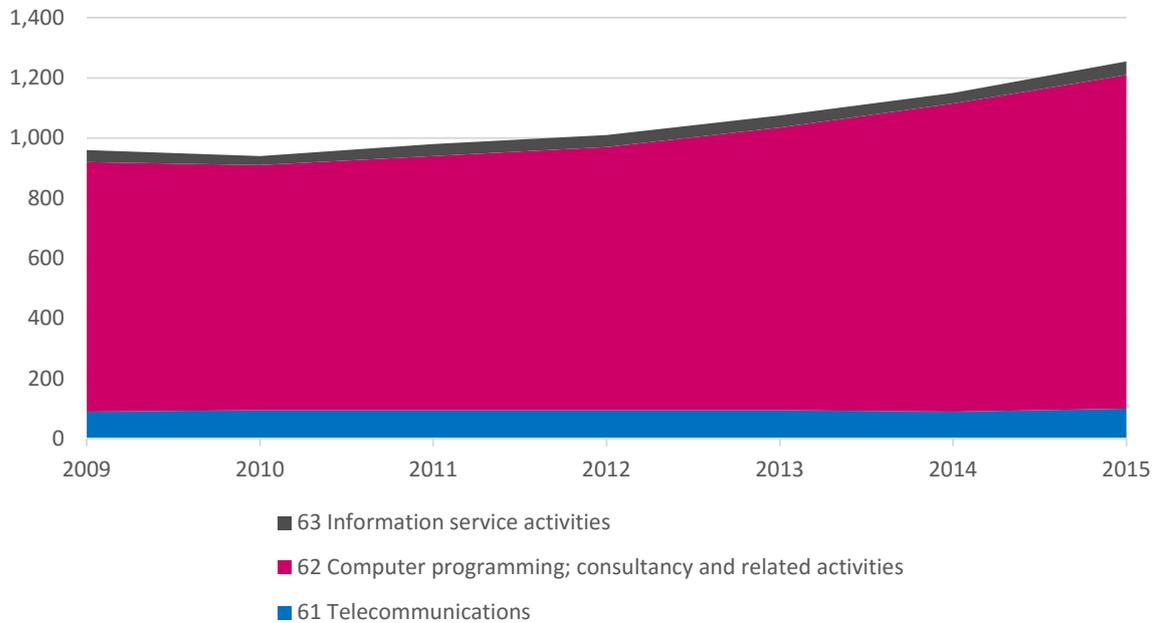
Figure 1: Number of VAT and/or PAYE registered businesses operating in Northern Ireland 2009-2015



Source: Inter-Departmental Business Register, NISRA

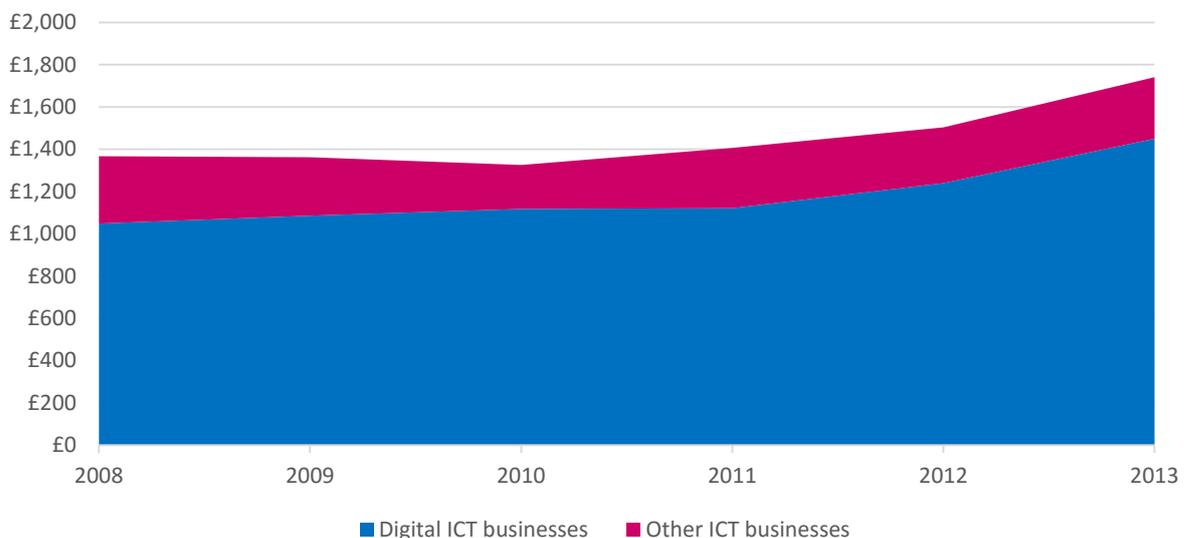
The breakdown of Digital ICT companies shows that the greatest increase has been in computer programming and consultancy businesses (rising 34% from 830 in 2009 to 1,110 in 2015), while the number of information services and telecoms businesses has remained fairly static.

Figure 2: Number of VAT and/or PAYE registered Digital ICT businesses operating in Northern Ireland 2009-2015 by SIC



Turnover in Northern Ireland ICT businesses has increased steadily over the last five years, despite the economic downturn, with Digital ICT businesses accounting for 2.26% of all business turnover in 2013, up from 1.8% in 2008. Turnover by digital ICT companies during that period increased by 38% from £1,049m to £1,450m compared to an average growth in turnover across all Northern Ireland businesses of 11%.

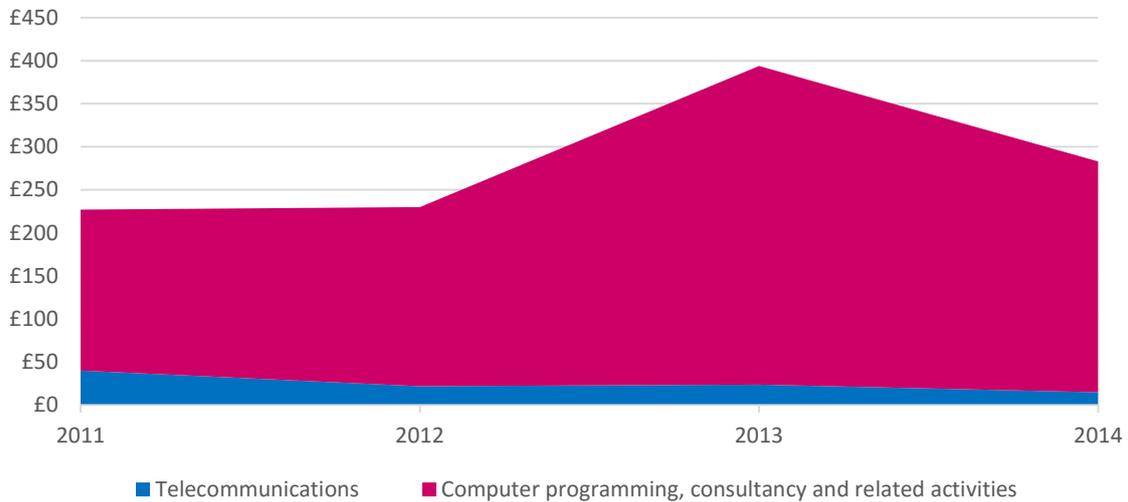
Figure 3: Turnover of Northern Ireland ICT businesses 2008-2013 (£m)



Export figures

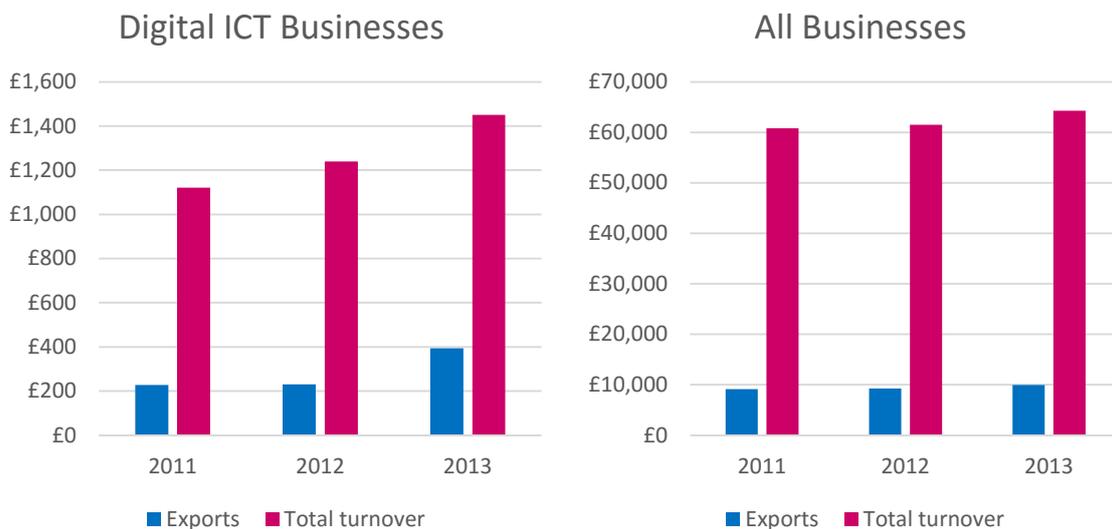
In 2014 Northern Ireland Digital ICT businesses exports were worth £283m – 28% down on 2013 but showing an overall increase since 2011 of 25%. This compares to export growth of 7% across all Northern Ireland businesses during the same period.

Figure 4: Northern Ireland Digital ICT exports 2011-2014 (£m)



Digital ICT companies created 2.9% of all Northern Ireland exports in 2014. The chart below shows a clear growth trend in both turnover and exports in the sector when compared to the overall figures.

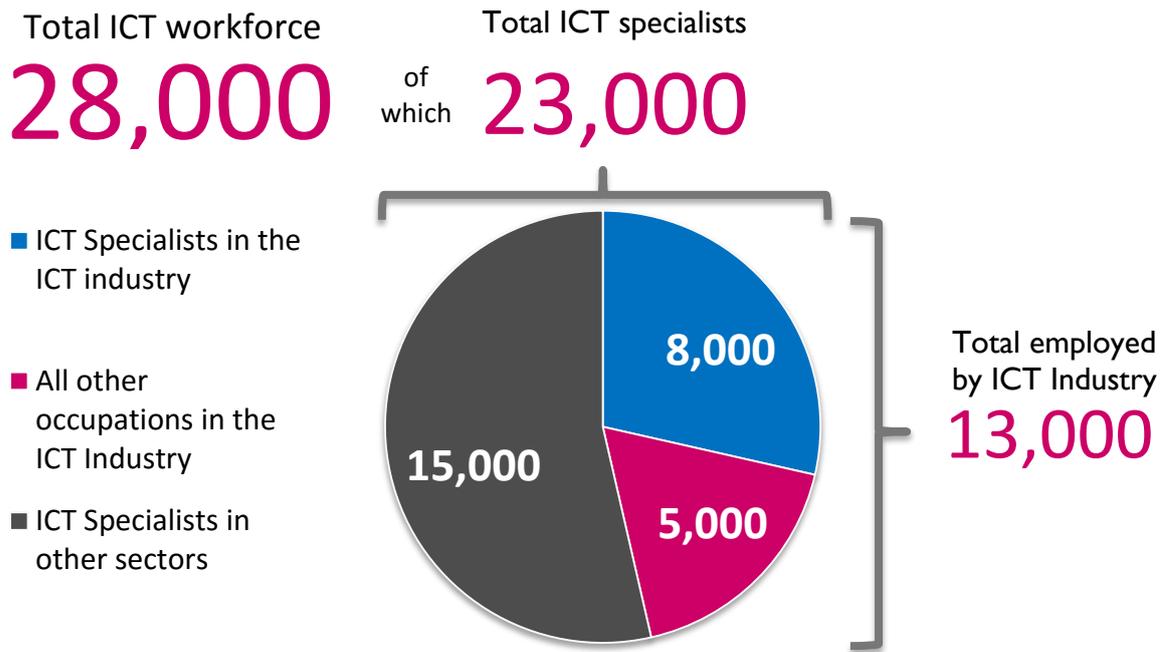
Figure 5: Northern Ireland Digital ICT turnover & export 2011-13 (£m)



The workforce

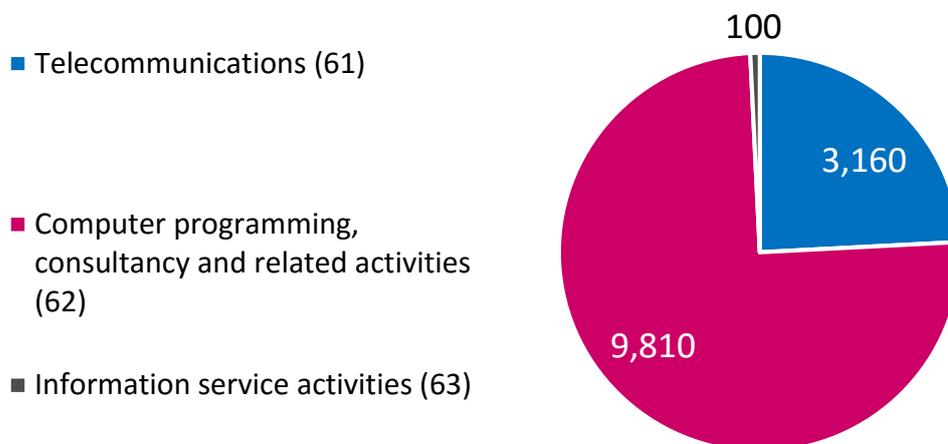
The sector employs around 13,000 people (up from 11,090 in 2007), with the total ICT workforce (including ICT specialists in non-ICT businesses) standing at around 28,000.¹ The total number of professionals working as Digital ICT specialists in Northern Ireland rose by 25% between 2010 and 2015². According to NISRA, 2% of all Northern Ireland employees now work in the ICT sector.

Figure 6: Northern Ireland ICT workforce 2015



Of the 13,000 employed by the Digital ICT sector, more than 75% are employed in computer programming & consultancy.

Figure 7: Breakdown of Digital ICT jobs in Northern Ireland in 2015 by SIC code

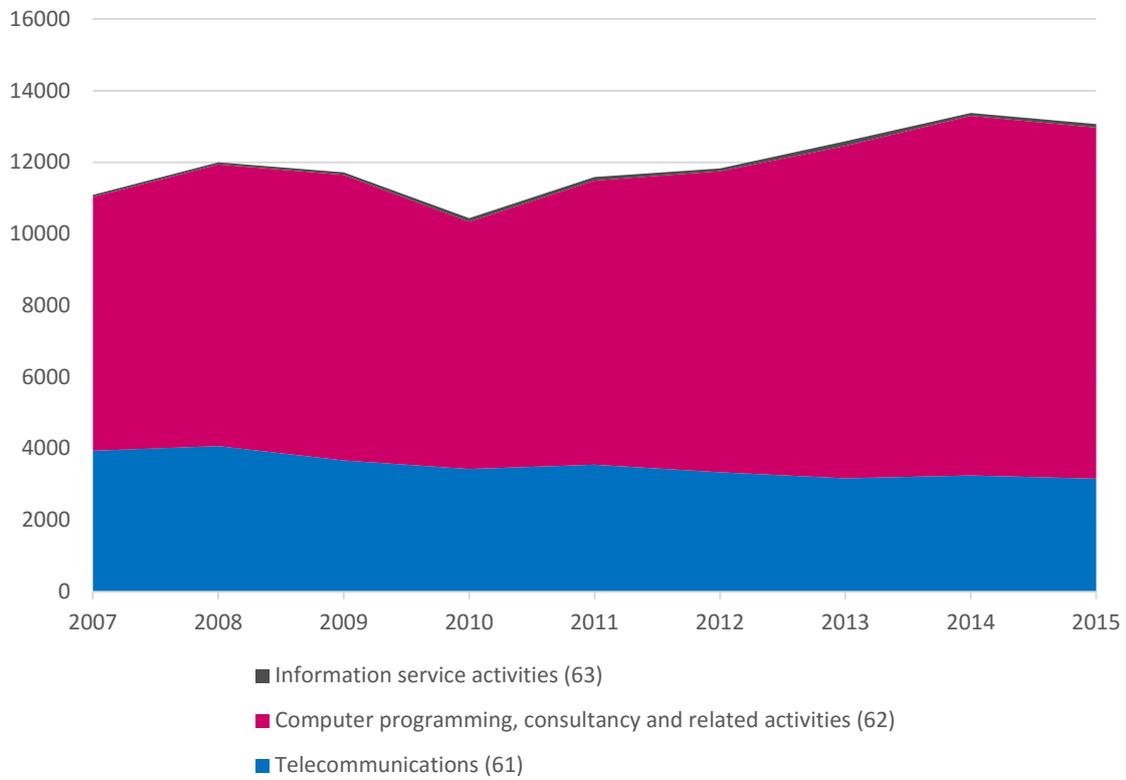


¹ Source: e-skills UK analysis of data from the ONS Labour Force Survey, four quarter average Q1-Q4 2013

² Quarterly Employment Survey, NISRA (figures taken for quarter one from each year)

The growth in employment has come from computer programming and consultancy businesses, with the telecoms workforce reducing over this period.

Figure 8: Growth in the Digital ICT workforce in Northern Ireland 2007-2015

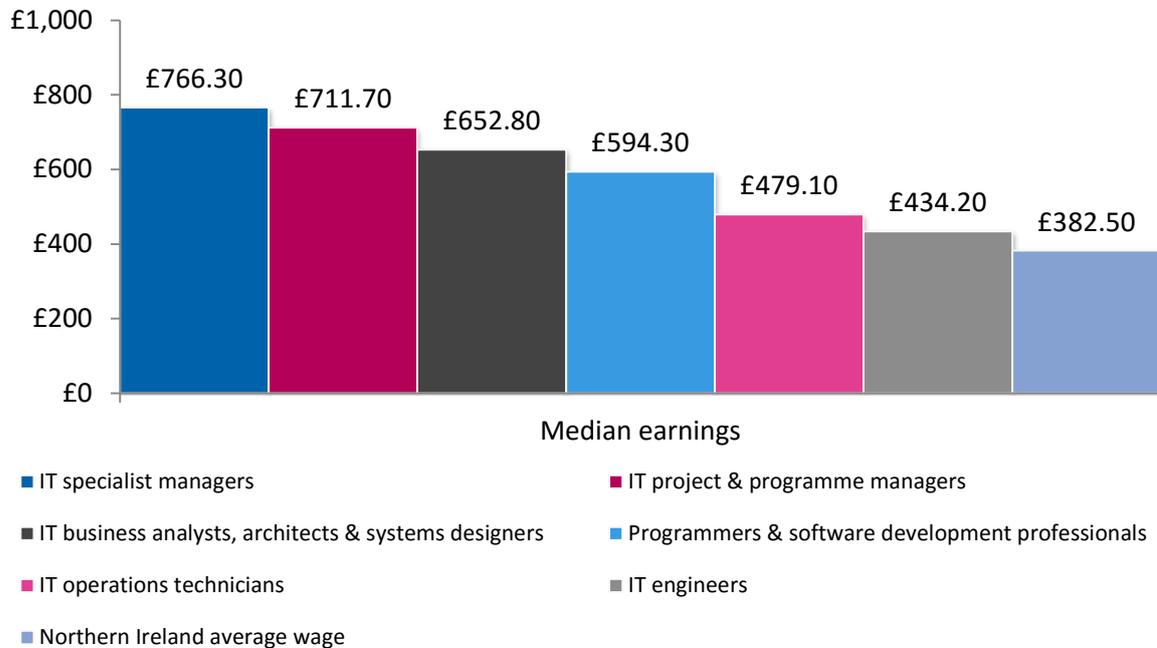


Source: NISRA

Earnings

The median earnings for ICT specialists in Northern Ireland is well above the region’s average salary. ³ This represents the highest “pay premium” (44% in 2014) for ICT specialists in any UK region. ⁴ A more detailed breakdown of salaries is at [Appendix 5](#).

Figure 9: Median gross weekly earnings for Northern Ireland tech specialists 2015



In addition, ICT companies overall pay better than average wages.

Figure 10: Median weekly earnings for employees in Northern Ireland ICT companies 2015



Note: No data available for J63 (Information service activities)

³ Source: Annual Survey of Hours and Earnings 2015

⁴ Source: SEPTEMBER 2015 Tech Partnership Datasheet: Earnings of tech specialists

Gross Value Added (GVA) per employee

GVA measures the contribution to the economy of each individual producer, industry or sector in the UK. The Gross Value Added (GVA) for each IT worker in Northern Ireland in 2013 was £65,514 – 28% higher than the Northern Ireland average. GVA in the sector also grew by 17% 2008-2013, compared to average growth of 9% across the whole Northern Ireland economy.

Figure 11: GVA for NI Digital ICT workers 2008-2013 compared to NI average

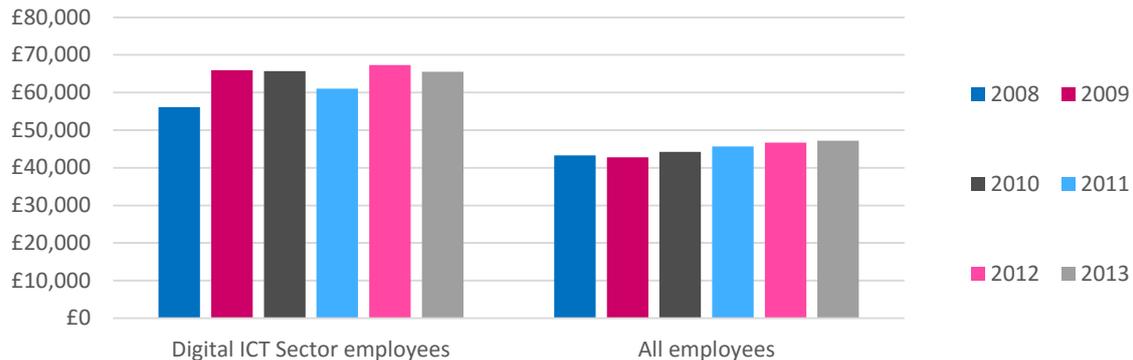
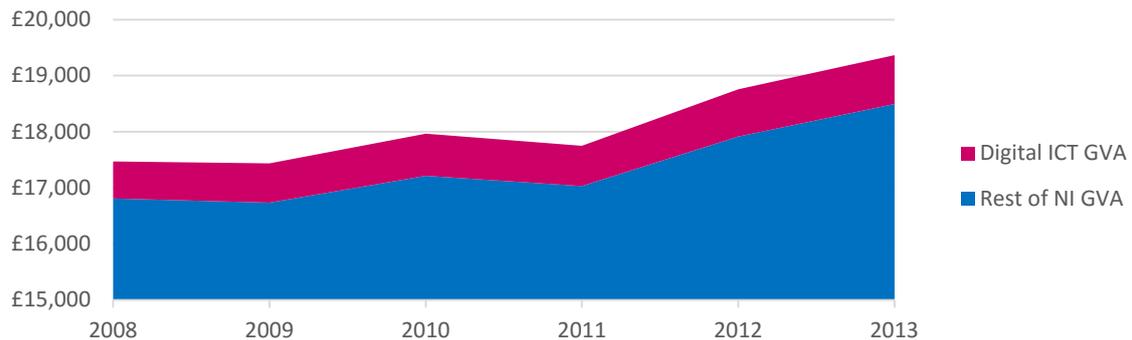


Figure 12: Digital ICT contribution to NI private sector GVA (in £millions)



Source: NISRA, ONS

Foreign Direct Investment

Northern Ireland is currently the leading foreign direct investment (FDI) region in Europe for software development centres and IT technical support centres.⁵ Inward investors are attracted by the strong ICT focus of Queen's University Belfast and Ulster University, leading-edge research and development, a ready availability of graduates and an attractive cost base. Northern Ireland is now a base for several multinational ICT companies and a number of medium sized growth companies. According to UKTI⁶, in 2014/15 Northern Ireland received a total of 48 FDI projects, creating 4,007 new jobs. This was the highest number of new jobs per FDI project (83) for any UK region.

⁵ <http://www.investni.com/invest-in-northern-ireland/sectors-and-opportunities/ict-and-electronics.html>

⁶ UKTI *Inward Investment Report 2014 to 2015*

Northern Ireland's core ICT strengths

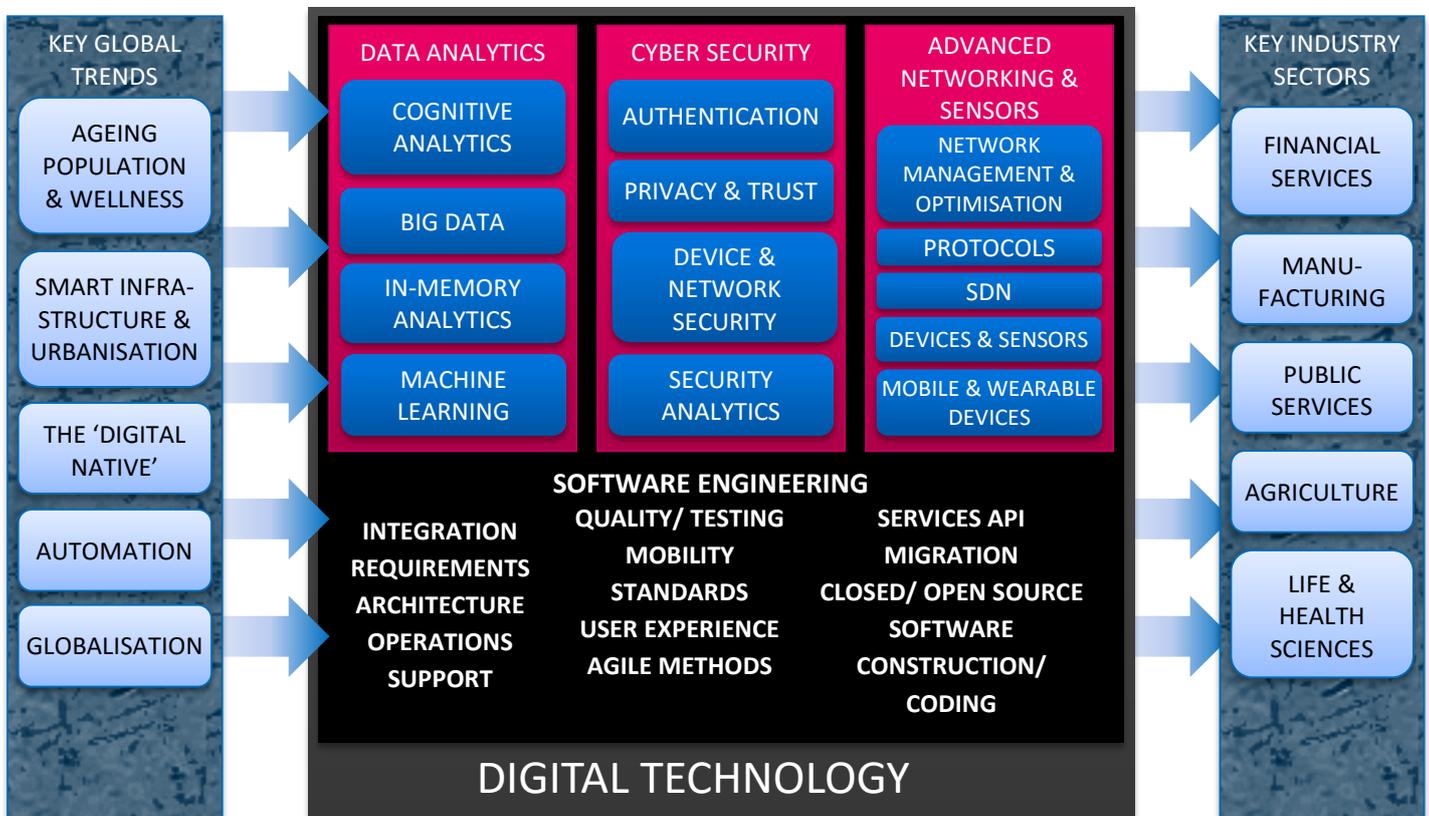
Northern Ireland's core strengths include capability in:

- software engineering
- mobile, cloud-based and internet-based application development
- cyber security
- data analytics
- advanced networks & sensors.

Northern Ireland also has specific ICT capability in particular industries, most notably financial services and health. This enables the delivery of higher value ICT services through the application of ICT skills combined with industry knowledge.

The figure below shows how a strong local base of generalist software engineering skills supporting a number of specialist strengths (Data Analytics, Cyber Security & Advanced Networking & Systems) gives Northern Ireland the opportunity to focus on key global trends which in turn help shape their output to other local business sectors.

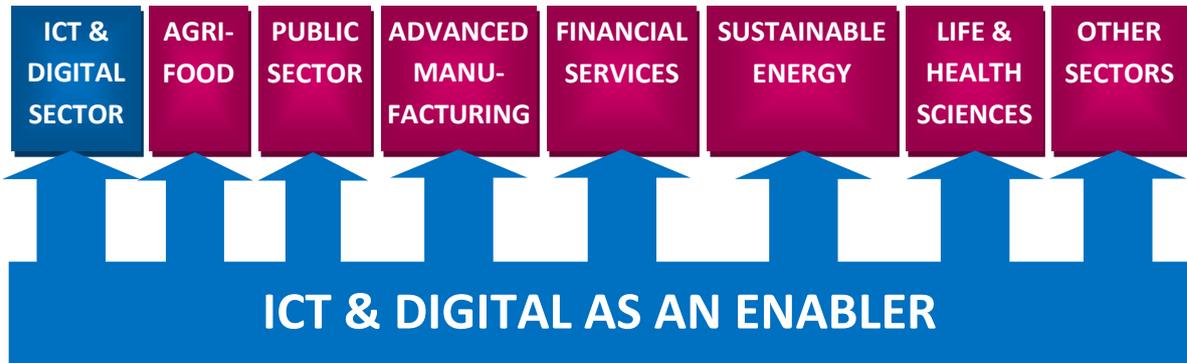
Figure 13: Key global trends which inform the ICT sector and help shape their output to other sectors



ICT as a sector & an enabler

ICT is an industry sector in its own right, but it also enables other sectors. The Northern Ireland ICT sector has become a net exporter of products and services. It is growing steadily and is becoming one of Northern Ireland's most competitive sectors.

Figure 14: ICT& Digital as both a sector and an enabler



Life & Health Sciences

The fast growing NI Life & Health Sciences sector uses ICT as an enabler, particularly in the use of big data, which can transform the way illnesses like diabetes can be managed and treated, and connected health.

Connected health and sensory technologies allow Northern Ireland to meet growing demands across health sectors. Dementia provides a good example. The economic and social burden of dementia is primarily on the patient and the immediate caregiver. ICT is becoming a crucial tool, both for the care of the patient and to support the caregiver's needs.

Northern Ireland's strength in connected health is in the management of long term and chronic conditions. The TF3 tele monitoring service, which remotely monitors chronic conditions in the elderly, is just one example of how ICT, advanced networks and sensors are being used by the sector.

ICT clusters in Northern Ireland

The Northern Ireland ICT sector is composed of a number of discrete but important clusters.

Financial services

The financial services cluster has grown from local companies such as First Derivatives in Newry (now employing around 1,200 people globally) and Wombat Technologies, a Belfast based company which developed a platform for high-frequency trading and was acquired by the New York Stock Exchange in 2008 for \$200m. Wombat Technologies is now part of SR Labs. Other notable companies include Airpos, Citi, Fidessa, Allstate and CME Group. The sector employs about 3,500 people according to Invest NI.

IT services

IT services providers offer bespoke software development and support, computer systems design and data processing facilities management. Major companies include Fujitsu, BT and Kainos.

Telecom, Mobile & Data Networks

Northern Ireland is known for innovation and excellence in wireless application and development, R&D, and telecoms software development. A well-developed communications cluster of companies includes BT, Openwave, BroadSoft, IBM, mFormation, DTS, Aepona, Asidua, CSR, BTI Systems and ByteMobile.

Healthcare IT

Under the label “connected health”, a new cross-sectoral field is emerging which uses ICT to develop sustainable healthcare systems and the digitisation of healthcare services to increase efficiency and save costs. Prominent companies include Yarra, Kainos & Intellisens.

Cyber Security

The cyber security sector supports around 900 jobs and has grown by a third since last year. Belfast has the highest concentration of cyber security jobs in Europe. Notable companies include Proofpoint, Rapid7, WhiteHat and Alert Logic. The rapid expansion of this sector is supported by CSIT, an academic Centre of Excellence in Cyber Security Research which offers MSc and PhD programmes in Cyber Security.

Data Analytics

A fast-growing cluster that addresses a large market. Companies include Exploristics, Analytics Engines, AquaQ Analytics, Datactics, Kainos, Data Analytics Labs and Equiniti.

Research and Development (R&D)

University research

Queen's University Belfast

Queen's has a combined school of Electrical and Electronic Engineering and Computer Science (EEECS) with seven research clusters across the two disciplines. The Institute of Electronics, Communications and Information Technology (ECIT) was established by Queen's in 2004 as a research anchor for the Northern Ireland Science Park with initial funding of over £37m. In 2009 ECIT was chosen to host the UK's National Innovation and Knowledge Centre for cyber security – The Centre for Secure Information Technologies (CSIT).

University of Ulster

The Computer Science Research Institute (CSRI) at the University of Ulster currently comprises over 50 academic staff, approximately 30 contract research staff and 90 PhD students across three schools in the Faculty of Computing and Engineering: the School of Computing and Information Engineering, the School of Computing and Intelligent Systems and the School of Computing and Mathematics.

Industry focused R&D

R&D facilities are available at several globally recognised ICT-related research centres in Northern Ireland, including:

- ECIT Institute, which has four research clusters – secure digital systems, speech, image and vision systems, digital communications and high frequency electronics systems.
- CSIT, which brings together research specialists in data encryption, network security systems, wireless enabled security systems and intelligent surveillance technology.
- Nanotech NI, which is focused on the design, fabrication, characterisation and commercial exploitation of nanotechnology processes, devices and systems.
- Intelligent Systems Engineering Laboratory, which researches intelligent embedded systems, hybrid intelligent machine vision systems, re-configurable computing, hardware-software partitioning, design automation and self-repair of complex embedded systems.
- SAP's Campus-based Engineering Centre (CEC) Belfast, which was founded as the research centre of SAP (UK) Limited, working on next generation enterprise service-oriented architecture (SOA) and advanced web technologies.

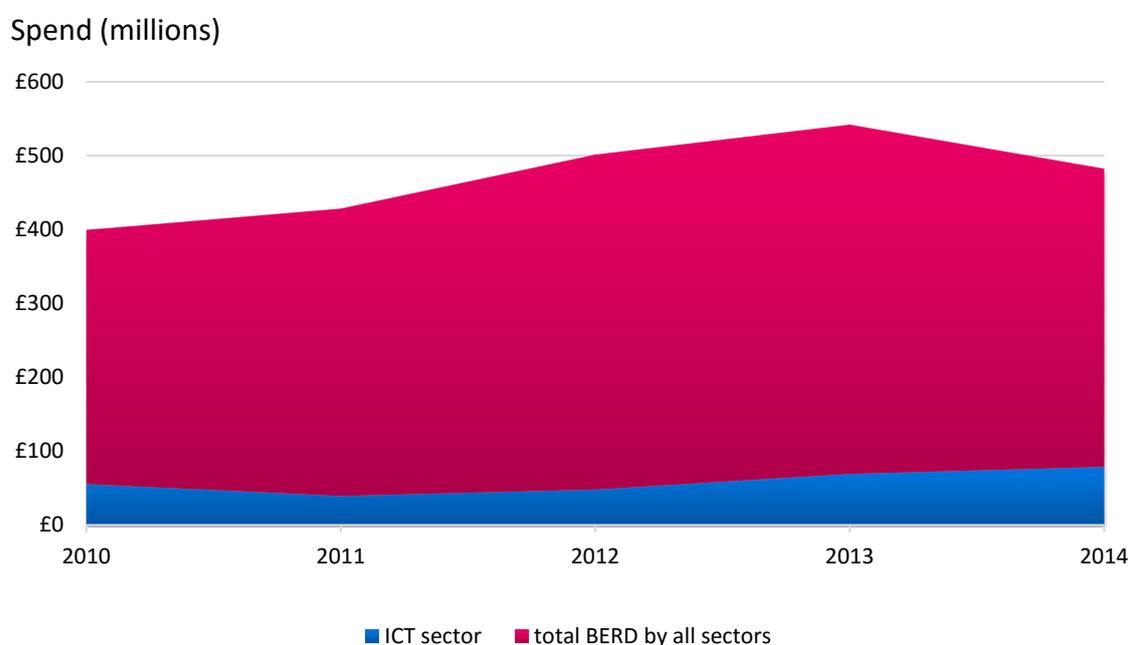
Business Expenditure on R&D

Given the strong links between R&D and competitive economies there remains an overarching need to maintain and, where possible, continue to increase Northern Ireland business expenditure on research and development (BERD).

In particular, increasing the focus on SMEs and encouraging more companies to invest in R&D remain important drivers in the manufacturing and high technology sectors.

Despite historically poor performance in comparison to other EU regions, Northern Ireland's R&D performance has improved dramatically (between 2008 and 2014, business R&D expenditure increased by 119%).

Figure 15: Northern Ireland ICT BERD spend 2010-2014



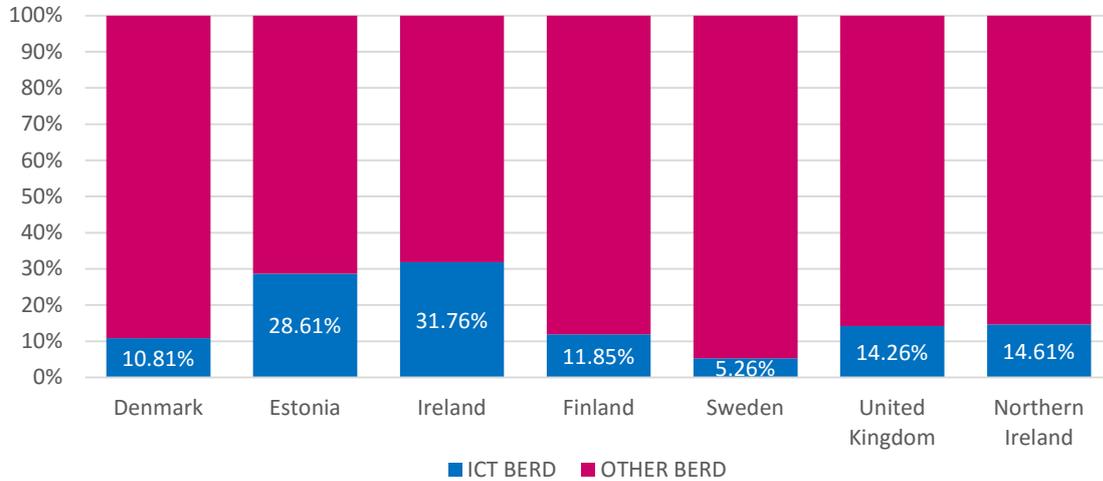
However, with 43% of R&D spend concentrated in just 10 firms, a small number of large, foreign owned companies have been responsible for most of that R&D spend and the substantial increases seen in the last few years.

This investment has been tremendously important and maintaining the investment levels by these firms is crucial; however, there is a need to increase the number of firms undertaking R&D and particularly indigenous SME expenditure on R&D, to reduce the reliance on (and potentially vulnerability to the loss of) the top R&D companies.

At a sectoral level, Northern Ireland's BERD across the ICT sector has increased steadily 2011-2014. In 2014 Northern Ireland ICT companies spent almost £80m on R&D.

In terms of ICT BERD as a % of total Northern Ireland BERD, levels are consistent with other comparator regions (Finland/Denmark/UK) but considerably lower than e.g. Estonia and RoI (ICT BERD accounts for 31.37% of RoI's total BERD).

Figure 16: ICT Expenditure as proportion of all BERD expenditure in 2013



Core Systems

Core Systems is a Belfast company which provides interactive offender technology solutions for use in prisons and in the community.

The company is investing almost half a million pounds in R&D, with Invest NI support, to develop its Direct2Probationer product; a digital portal to deliver key services to people on probation, enabling probation officers to spend more time working in the field with their clients.

Patricia O'Hagan MBE, CEO of Core Systems said: "Our innovative approach to research and development and our understanding of the market has enabled us to identify and develop a product which is unique and not currently on offer anywhere else in the market place.

"The R&D support from Invest NI means that we are able to bring this exciting new product to market and we hope to use this product to win more business in the US market and use exporting as a means to substantially grow our business."

Identifying Difference For Better Security

Section 2

Challenges for the Northern Ireland Digital ICT Sector

Challenges specific to growing the Digital ICT sector to enable the exploitation of global markets include:

- The need for sustained development, attraction and retention of talent
- The need for leadership
- The need for focus on smart specialisation (including the development of relevant specialist skills) to capitalise on public investment opportunities in R&D
- The need for digital transformation of the public sector to make Northern Ireland government an expert user and strategic customer for digital technology using informed buying power to define best practice.

Talent

Northern Ireland has benefited from the teaching of best and emerging practice across third level institutions in the province and in closely aligning course delivery with industry.

The concept of a 'placement' year (mandatory in Northern Ireland but not in other regions, including ROI and GB) has served the sector well and is instrumental in developing industry aligned talent. Continued emphasis should be placed on teaching software engineering skills as they underpin the majority of activities in the sector.

Females consistently achieve higher grades than males in IT-related subjects, but they fill just 18% of IT specialist posts in Northern Ireland.⁷ The continuing decline in females entering the IT profession is a real threat for Northern Ireland (as it is throughout the UK) and an issue that needs to be addressed.

⁷ https://www.thetechpartnership.com/globalassets/pdfs/research-2015/womeninit_scorecard_2015.pdf

Supply of talent

Northern Ireland needs an ambitious regional strategy to support the development and delivery of digital skills and computing in schools.

To ensure that all young people are digitally literate and are able to develop skills to support our rapid economic development, it is essential that we empower our schools and train our teachers appropriately.

There have been several initiatives to introduce and support introductory coding and digital skills in Northern Ireland classrooms, but there is a need for a cohesive long-term strategy to provide skills pathways for young people throughout their education.

It is crucial that teachers and educators are empowered to make informed choices regarding the strategic development of the digital education agenda, and a proactive approach with industry will position Northern Ireland in a global leadership position.

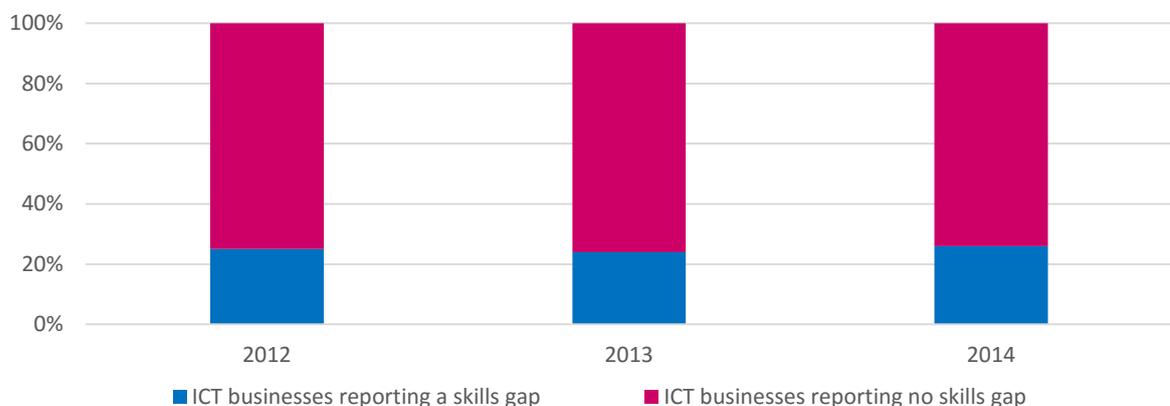
There must also be a clear pathway for young people through school, enabling and inspiring them to acquire appropriate skills within the existing curriculum, generally in STEM subjects and specifically in software development. They should be offered progression routes to Apprenticeships and Further and Higher Education. At the same time, a framework of support should be made available to allow teachers to deliver the curriculum effectively.

The output will be a rich pipeline of talent to support the ICT Sector and a globally credible digital-enabled economy.

The skills gap now

25% of all Northern Ireland companies report gaps between the skills in their ICT specialists and the skills needed by the business for these workers. This proportion is slightly higher amongst ICT (26%) than non ICT (23%) firms.⁸

Figure 17: Percentage of Northern Ireland ICT companies reporting skills gaps for ICT specialists 2012-2014



⁸ Source: NI ICT Snapshot survey 2014

The predicted future skills gap

The Department for Employment and Learning published a Northern Ireland Skills Barometer in December 2015⁹. It forecasts a significant undersupply in mid-level skills (NQF L4-5) in engineering & manufacturing, science & mathematics, arts, media and publishing & ICT. It also shows a significant shortfall in the number of computer science graduates and above (NQF L6+).

Figure 18: Top 10 Skills Annual Average Undersupply – NQF L4-5

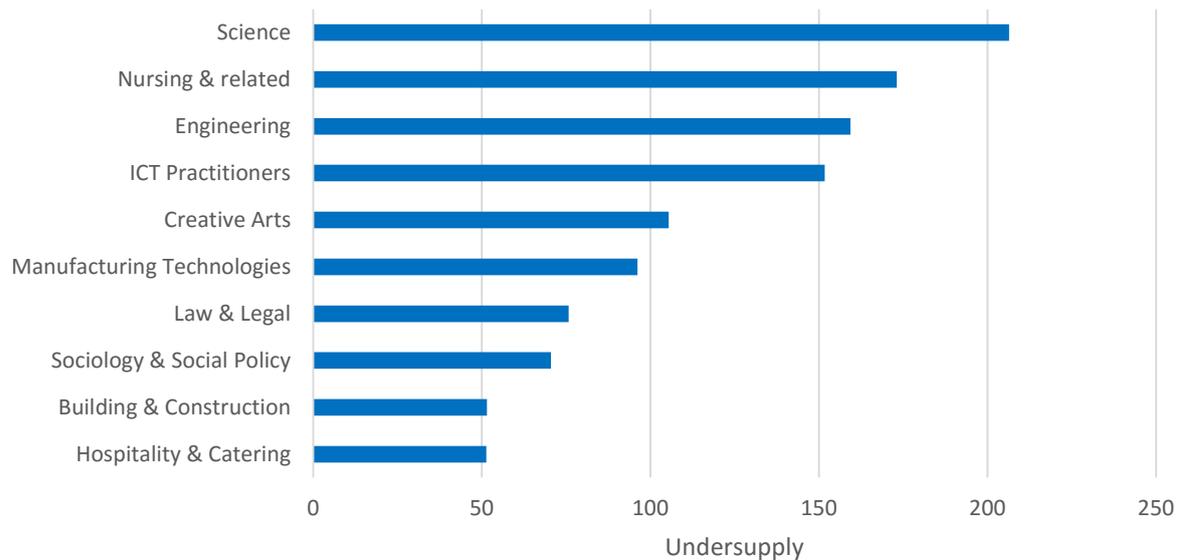
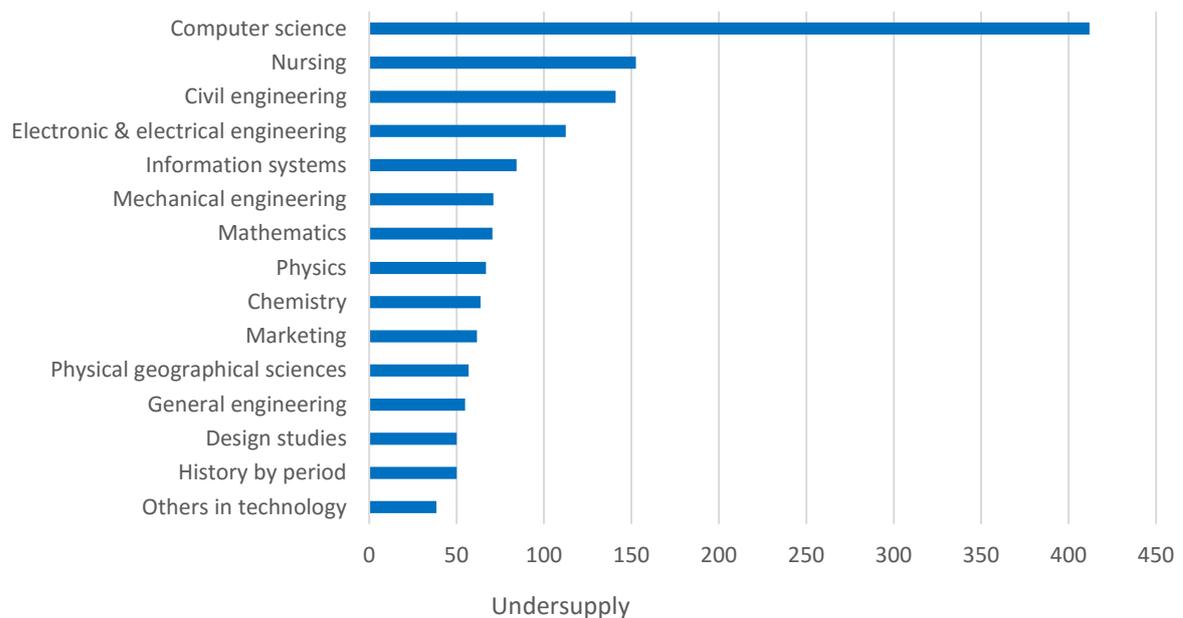


Figure 19: Top 15 Skills Annual Average Undersupply NQF L6+



⁹ <https://www.delni.gov.uk/publications/ni-skills-barometer>

Undersupply in STEM subjects

An undersupply in STEM related subjects is a consistent finding across skills research for many years now. There are a number of reasons for this finding, not least because sectors such as ICT and engineering have significant growth potential and the skills are in demand across a wide range of sectors and occupations.

However, a further reason could be that ICT and engineering are amongst a relatively small number of occupations that require a qualification in a relevant subject discipline. This places greater significance on the volume of qualifications being achieved in these subjects on an annual basis relative to other subject areas.

In contrast, an occupation such as accountancy (also technical, numerate and at a professional level) does not recruit solely from accountancy related disciplines. Accountancy firms recruit graduates from a wide range of degree disciplines, including the Arts, who then embark on a 3 year “training contract” to achieve their chartered status.

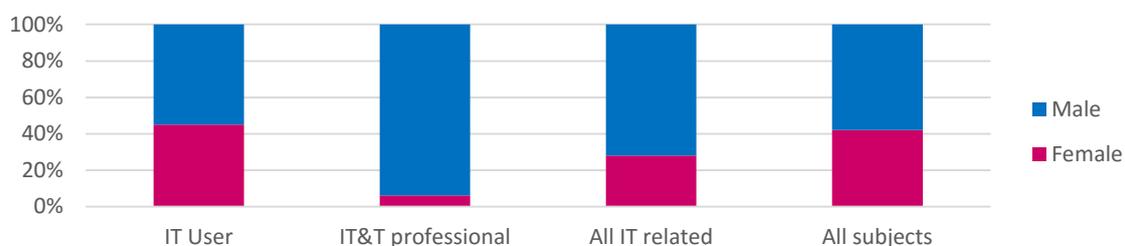
Gender imbalance

More girls than ever are taking STEM subjects at A Level in Northern Ireland. In 2015 the number of female students taking A levels in Biology was up 5.7% from 2014, with Chemistry up 3.3%, Physics up 2.1%, Mathematics up 10.6% and Design and Technology up 24.5%.

However this does not translate into women taking up IT related subjects in further and higher education. In the 2013/2014 academic year, just 26% of full-time, first year undergraduate enrolments at Northern Ireland universities in computer science were female.¹⁰

The same theme emerges in apprenticeships - while the uptake in IT user apprenticeships among females is around the overall average across all subjects, women account for only 6% of Professional IT apprenticeships in Northern Ireland.

Figure 20: IT apprenticeship starts in Northern Ireland by gender and subject, 2013/14



Source: Tech Partnership Women in IT Scorecard

¹⁰ NISRA – Women in Northern Ireland 2015

The trend continues into the ICT workforce, with women making up around 30% of employees in ICT businesses according to NISRA. Just 18% of IT specialists in Northern Ireland are female – though it should be noted that this is also the UK average.¹¹

Doubtless the continued poor representation of women within the Digital ICT workforce is an inevitable waste of valuable potential resource and, as such, is an issue which warrants further examination.

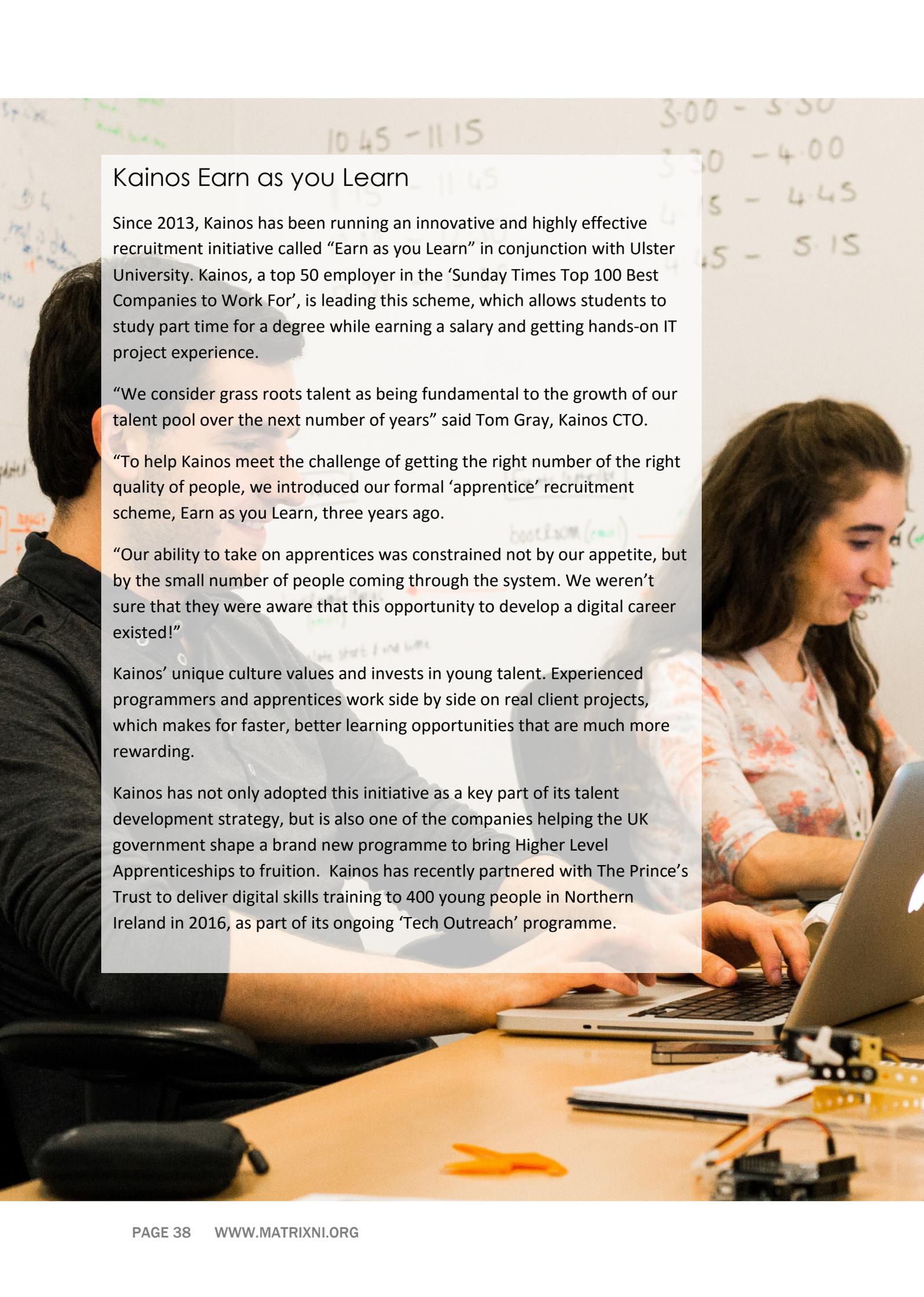
Apprenticeships

A Higher Level Apprenticeship is an apprenticeship with a targeted qualification between Level 4 (HNC equivalent) to Level 8 (PhD equivalent) – the areas with the greatest shortfall in skills. A Higher Level Apprenticeship can help develop professional and technical skills, as well as gaining recognised higher qualifications while in paid employment.

A few years ago apprenticeships were in decline, but now every political party in Northern Ireland has pledged to increase the numbers of apprentices. A new system will be introduced to Northern Ireland in 2016, driven forward by a strategic advisory forum chaired by Matrix Chairman Bryan Keating.

This new approach to apprenticeships will ensure a continuum from youth training right through all levels of apprenticeship training, from Level 2 to Level 6.

¹¹ Women in IT Scorecard 2015

The background image shows a young man and woman sitting at a desk in a classroom or office environment. They are both focused on their laptops. The man is on the left, and the woman is on the right. In the background, a whiteboard is visible with some handwritten notes and numbers. The overall scene suggests a professional learning environment.

Kainos Earn as you Learn

Since 2013, Kainos has been running an innovative and highly effective recruitment initiative called “Earn as you Learn” in conjunction with Ulster University. Kainos, a top 50 employer in the ‘Sunday Times Top 100 Best Companies to Work For’, is leading this scheme, which allows students to study part time for a degree while earning a salary and getting hands-on IT project experience.

“We consider grass roots talent as being fundamental to the growth of our talent pool over the next number of years” said Tom Gray, Kainos CTO.

“To help Kainos meet the challenge of getting the right number of the right quality of people, we introduced our formal ‘apprentice’ recruitment scheme, Earn as you Learn, three years ago.

“Our ability to take on apprentices was constrained not by our appetite, but by the small number of people coming through the system. We weren’t sure that they were aware that this opportunity to develop a digital career existed!”

Kainos’ unique culture values and invests in young talent. Experienced programmers and apprentices work side by side on real client projects, which makes for faster, better learning opportunities that are much more rewarding.

Kainos has not only adopted this initiative as a key part of its talent development strategy, but is also one of the companies helping the UK government shape a brand new programme to bring Higher Level Apprenticeships to fruition. Kainos has recently partnered with The Prince’s Trust to deliver digital skills training to 400 young people in Northern Ireland in 2016, as part of its ongoing ‘Tech Outreach’ programme.

Attraction and retention of talent

The international mobility of talent is important in attracting talent, but this mobility is also a risk to Northern Ireland retaining its talent and requires us to ensure that fulfilling and rewarding careers are available for our highly skilled local talent.

The Irish Government's current policy of attracting external talent to fill jobs in their growing ICT sector poses a serious future threat to Northern Ireland's talent pool. Young people entering the workforce and work ready talent equipped to take the next step in their career don't have to leave the country to secure work at ICT giants such as Microsoft, Google, Facebook and other big name brands who have their European headquarters in RoI.

The RoI Approach

The Irish Development Association (IDA) has focused on attracting ICT companies to Ireland for more than two decades now; a strategy that has proven immensely successful.

ICT giants such as Microsoft, Intel, Facebook, Twitter, LinkedIn and Google have all set up in Ireland, often basing their European HQ there. Google's Dublin office, the largest outside their HQ in California, employs 2,000 people.

These brands are seen as attractive companies to work for by many young people entering the IT sector and those who have worked at such companies are attractive to other employers who are seeking work-ready new talent.

The wider picture

The need for digital talent goes far beyond the Digital ICT sector. We need to ensure that next generation has foundational digital skills and an understanding of how to apply them. Teachers (particularly at Primary level) need help to develop their own digital skills in order to teach effectively and industry could provide support in this process.

Leadership and the need for a digital strategy

For Northern Ireland to become a truly digital society we must engage and empower a leading industry expert as ROI and other UK regions have. The appointment of a Chief Digital Officer is essential. A Digital ICT strategy for Northern Ireland is also essential. Analysis shows that countries with robust digital economies have a clear delivery strategy aligned to their programme for government. These countries also:

- Appointed an advocate to lead the development of the Digital ICT sector.
- Implemented a targeted talent strategy that addressed how talent should be attracted and grown within the sector as well as from outside their region.
- Maintained network readiness through a healthy digital infrastructure.
- Provided access to funding to supporting start-up growth – with funding coming from both public and private venture capital sources.
- Focussed growth in key areas of capability by following the principles of a smart specialisation strategy.

Section 5 examines these characteristics and maps Northern Ireland's performance against them in detail.

Government support of the sector

The UK Government, led by the Cabinet Office, has become a world leader in the provision of user-led Digital Transformation. The technology skills and innovations required to deliver this include Software Engineering. Northern Ireland has the opportunity to use these skills and innovations for the benefit of its citizens, and to realise the cost savings and service improvements that other territories are benefiting from. Northern Ireland's size and governance structures enable it to become a global exemplar for Digital Transformation by 2020.

To enable this, the appointment of a Chief Digital Officer is essential. Other regions of the UK, ROI and other leading digital technology countries have taken this approach to support and grow the sector. The appointment of an independent industry expert would support government and industry with the continued integration of new technologies and to create a digital culture facilitating the pragmatic and simplified purchase by government of digital products and services.

Smart specialisation

Smart specialisation is an innovation policy concept designed to promote the efficient and effective use of public investment in research. The goal of smart specialisation is to boost regional innovation in order to achieve economic growth and prosperity, by enabling regions to focus on their strengths.¹²

CSIT is an exemplar of a centre of excellence which has carved a niche in cyber security technology, embraces the smart specialism concept and has proven to be an important catalyst to attract continued business expenditure in research and development activity, as well as academic research in this growing specialist area.

The Centre for Secure Information Technologies

The Centre for Secure Information Technologies (CSIT) at Queen's – a major hub for research and innovation in cyber security – was awarded a Queen's Anniversary Prize for Higher and Further Education in December 2015. The award came two days after the Chancellor, George Osborne, announced plans to double funding to fight cybercrime in an effort to protect the UK from online attacks.

The Queen's Anniversary Prizes are part of the national honours system and recognise and honour outstanding achievement by universities and colleges in the United Kingdom.

Based at the Northern Ireland Science Park, in Belfast's Titanic Quarter, CSIT, with 90 people, is one of Europe's largest university cyber security research centres. It has developed breakthrough innovations, including novel technology to improve security for online financial transactions; anti-counterfeit technology to prevent internet fraud; and new processors to deliver filtered internet to homes and businesses, stripping out viruses, malware and malicious content.

¹² <http://www.ec.europa.eu>

Funding the sector

Private equity

It is difficult to estimate the level of early stage and growth finance in Northern Ireland. There is no official or comprehensive source of official data available for this type of finance, with a number of unofficial sources each giving a different estimate. DETI research suggests that, over the period 2005-13, there have been an average of 11 investments each year at a scale of around £4m per annum.¹³

The DETI Future of Early Stage and Growth Finance Report (2015) noted the emergence of new funding models such as crowd-funding and corporate venture capital and warned that the implications of these changes for Northern Ireland are not straightforward or easily predictable. Some, such as crowd-funding, may be positive, widening the pool of investment that firms in Northern Ireland are able to access. Others may present greater downside risks, such as the clustering of accelerators leading to further concentration of venture capital investment in London (notwithstanding DETI's commitment to create a Northern Ireland based accelerator).

Government support

Significant progress has been made in ensuring support is available for companies by Invest NI, InterTradeIreland, the NI Science Park and others in recent years. However there are a range of areas where improvements are still needed.

There is a recognised need for additional funds to enable entrepreneurs to develop products at the pre commercial stage. Invest NI in particular, has extended its funding for the Northern Ireland Spin Out (NISPO) Programme which has provided additional funding for Proof of Concept grants and seed funding. In addition, a further fund (techstart NI) was launched in July 2014 and is significantly larger than under NISPO and its extension. Follow-on funding for commercialisation and growth is now provided by the Growth Loan Fund, Co-Fund NI and the Development Funds. The Development Funds were announced in October 2013 and provide two £30m funds offering development capital, compared with just one fund at £22.5m previously. In addition, the Co-Fund NI has been extended from £7.2m to £12.5m due to strong demand.

Availability of government support in Northern Ireland for early stage and growth finance is now recognised as a key strength against international exemplars. It is important that increasing demand for this type of finance continues to be met going forward.¹⁴

¹³ DETI Future of Early Stage and Growth Finance in Northern Ireland

¹⁴ EAG Access to Finance Update 2015

HMRC R&D Incentives

The UK Government has set aside approximately £1.5bn per year for companies under various R&D relief regimes. As incentive rates have increased and the scope of the schemes has been enhanced (companies can now claim cash repayments of up to 33% of the qualifying R&D expenditure), an increasing number of NI businesses recognise and utilise the value of R&D Tax Credits.

The rise in the rate of relief for SMEs in particular (the cash value of claims for tax paying companies has increased to £26 for every £100 of R&D spend from April 2014 (based on a 21% tax rate) and £32 for companies with losses) has made claiming for this relief a lot more valuable to SMEs, and similarly the introduction of the Research and Development Credit (RDEC) has made the large company scheme much more generous.

Likewise, the HMRC Patent Box regime enables companies to apply a lower rate of Corporation Tax to profits from patented inventions. These fiscal incentives play a vital role in the R&D funding equation and have the potential to make a significant, positive impact on a business' decision to undertake R&D activity.

It is essential that eligible businesses are made fully aware of these incentives. Continued availability of the incentives and access to the advice and guidance provided by HMRC's NI Corporate Tax Office (NIrCTO) should be a priority going forward.

Section 3

Global Trends

This section examines the digital trends which affect the Digital ICT sector and the global megatrends which could best offer business opportunities.

Digital trends

The pace of digital change makes predicting the future difficult but there are a number of trends that are driving innovation and development in the Northern Ireland Digital ICT sector.

Digital disruption

When the last MATRIX report was published in 2008, the ICT sector was largely dominated by traditional telecommunications and software industries. Since then, there has been huge growth in new digital technologies and approaches. Every few years a wave of new technologies and accompanying innovative solutions either produce new markets or revitalise old ones, often in unanticipated ways.

A number of 'disruptive forces' are worth noting.

- **'Software-defined everything'** - allowing 'virtualisation' of the entire technology stack – computing, networking, storage and security layers. It offers cost savings, improved productivity and increased agility in the way companies deliver IT services.
- **Increasing connectivity** - the rapid growth of fixed and mobile broadband networks has enabled the move to cloud storage and computing and supports the 'always on' culture.
- **Increasing performance of hardware** - enabling the fast growth of embedded sensors.
- **Open standards** – along with increasing availability of application programming interfaces (APIs), this allows much greater interoperability and speeds the development of new products and services.
- **Increased mobility** - enabled through advancement in mobile networks and greater levels of application functionality from remote devices.

Data driven technology

The whole economy is being transformed by data, analytics, and modelling.¹⁵ New and emerging technologies and the rapid growth in the number of mobile devices will fuel the growth of data. A recent report from Deloitte estimates that the direct value of public sector information alone to the UK economy is around £1.8bn per annum.¹⁶

Open data

In 2015 the Department for Finance & Personnel published an ambitious Open Data Strategy for Northern Ireland¹⁷ which aims to create an 'open by default' culture where the publishing of open data becomes an everyday practice. The release of public sector data in open data formats has the potential to generate significant economic value for businesses. Some data is already available through www.opendatani.gov.uk, with priority being given to datasets deemed to be of high value in terms of their potential for reuse.

Data analytics

Data analytics uses data to enhance business strategy and performance and has evolved in recent years to be predictive and prescriptive. The capabilities of data analytics software are increasing as computing power increases. Data analytics is a significant global market opportunity predicted to grow at 6% to £266bn by 2017. As discussed in the previous section, the generation of data by both industry and government remains largely unexploited in Northern Ireland. A model similar to CSIT in the area of Data Analytics offers the potential to exploit Northern Ireland's wealth of data for its own benefit and develop innovative products, services and processes.

Machine learning

Machine learning allows a machine to look at large amounts of data and be trained to look for specific information and recognise its meaning. Applications for machine learning include biometrics (fingerprint, facial recognition), fraud detection, customer behaviour prediction, hiring decisions, plagiarism detection, driving directions and driverless cars. It is increasingly driving efficiency in financial, health industries and global supply chains, and driving innovation across the digital economy. The necessary foundation for effective machine learning is a large body of data, and machine learning complements and enhances the Northern Ireland investment in Big Data and Analytics. Increasingly machine learning services will complement and underpin bespoke software engineering activities in the same way data storage currently does. Organisations and territories who do not invest in building skills and capability run the risk of becoming uncompetitive.

¹⁵ HM Government Information Strategy 2013

¹⁶ BIS: Market Assessment of Public Information - Deloitte 2013

¹⁷ <https://www.dfpni.gov.uk/publications/open-data-strategy-northern-ireland-2015-2018>

Internet of Things (IoT)

The Internet of Things (IoT) is the network of physical objects, devices, vehicles, buildings etc. which are embedded with electronics, software, sensors, and network connectivity, allowing these objects to collect and exchange data. It allows objects to be sensed and controlled remotely across existing network infrastructure, creating greater integration between the physical world and computer systems and resulting in improved efficiency, accuracy and economic benefit. The UK Government predicts that by 2020 sensor data will be created by as many as 50bn connected devices worldwide.¹⁸

Global mega trends

Megatrends are large, transformative global forces that define the future by having a far-reaching impact on business, economies, industries, societies and individuals. Within the course of the MATRIX study, Deloitte LLP was commissioned to identify a number of global megatrends and match them to key skillsets where Northern Ireland has the best prospect for growth and innovation over the coming years.

Ageing population and wellness

- Demand is increasing for ICT products which help people manage their own health and wellness and improve the efficiency of healthcare delivery, reducing costs.

Smart infrastructure and urbanization

- Smart city infrastructure is locally relevant, and so are the opportunities globally to export solutions to urbanisation challenges.

The 'digital native'

- There are opportunities for those delivering devices, networks, services and applications that support the demands of 'digital natives' – i.e. those whose who are fully at ease with technology.

Automation & the rise of machine learning

- As the capabilities of computers expand beyond routine work, tasks that were once considered too complex for automation will be converted into well-defined problems capable of digital solutions.

Globalisation and economic shift

- Clustering, cooperation and global niche manufacturing networks can bring market opportunities through strategic partnerships & collaborative technologies.

¹⁸ Seizing the data opportunity: A strategy for UK data capability 2013

Ageing population & wellness

In 2050, an estimated one third of the EU population will be aged 60 or over and the total government spending on pensions, health care, long-term care, unemployment benefits and education will increase by almost 20%, while spending on long-term care will double.¹⁹

Ageing facts:

- In 2008, there were 3.2 people of working age for every person of pensionable age. This ratio is projected to fall to 2.8 by 2033.
- At least a quarter of babies born in 2012 will live to see their 100th birthday.
- The proportion of older, old people will continue to rise - there were 3m 80+ year olds in the UK in 2010, projected to rise to 4.5m by 2030 and 8m by 2050.
- There were 10m 65+ year olds in the UK in 2010 – this is projected to rise to 15.5m by 2030 and 19m by 2050.
- It is estimated that the spending power of the 'silver economy' will grow from the current level of £79bn to £127bn by 2030²⁰.

Higher life expectancy and falling birth rates will have far-reaching effects on budgets such as health, but effective digital solutions could help to address these issues.

Health, wellness and wellbeing become more important to an ageing population. Using ICT solutions for preventative care in particular can improve quality of life by producing personalised medical solutions; while integrating data and information technology into the healthcare planning process will reduce costs and improve delivery.

Opportunities

The most significant opportunities offered by this trend are:

- **Data analytics:** analysis of medical data reveals new ways to identify health risks, diagnose conditions and personalise treatment and care.
- **Applications:** wellness applications for smartphones and tablets can be tailored to the needs of an ageing population.
- **Cyber security:** medical and wellness records must be secure and trusted to be secure.
- **Sensors:** there is an opportunity for wearable sensors for diagnostic or monitoring applications.

¹⁹ UNDESA, Population Division, United Nations Department of Economic and Social Affairs

²⁰ <http://www.nesta.org.uk/news/innovation-must-match-challenge-ageing-population-says-nesta#sthash.H1y65QpF.dpuf>

Smart infrastructure and urbanization

Increasing urbanisation influences all aspects of the world economy. Integrating data and information technology with urban planning allows the development of intelligent cities that use sophisticated open technology platforms to deliver better services at reduced cost – and that can adapt to risks like climate change, growing populations, transportation and ageing infrastructures.²¹

Smart infrastructure facts

- By 2020 the total number of connected devices will grow from approximately 9bn today to over 24bn and mobile connected devices will double from more than 6bn to 12bn.
- By 2025 around 81% of the UK population will live in urban areas and there will be 200m connected devices.²²
- An estimated 500m people will be urbanised by 2030, meaning around 60% of the world's population will be living in cities.

This explosive growth of connected devices will present a serious market opportunity in urban centres and the digital ecosystem.

Opportunities

The most significant opportunities offered by this trend are:

- **Sensors:** as cities and other locations become increasingly connected, dense sensor networks connected via data aggregation and analytics platforms to multiple applications will increasingly help manage public administration, emergency services and transport.
- **Advanced networking:** urban areas require the densest networks, and have led to the development of small cell mobile networks and heterogeneous networks (hetnets)
- **Applications:** city administrative and other government functions are being transformed through the development of online and mobile applications, in areas such as payments and information services.
- **Cyber security:** as more critical data runs over city networks the networks, applications and data need new approaches to security.
- **Data analytics:** aggregation of data presents an opportunity for insight and value to be created through the combination of data sets and the analysis of rich data.

²¹ Smart Urbanization – Key to Sustainable Cities Neha Bansal, Vineet Shrivastava, Jagdish Singh (2015) Unfpa.org; UN 2014

²² Frost and Sullivan's Mega trends in the UK 2013

The rise of the 'digital native'

A digital native has an innate confidence in using new technologies such as the internet, videogames, mobile telephony and all the other toys and tools of the digital age.

Digital native facts

- By 2025 digital natives will account for 75% of the global workforce and digital native managers will significantly influence how their teams and businesses work.
- UK businesses recently valued the unused digital skills of young people at £6.7bn²³.
- 16-24s squeeze over 14 hours of media and communications activity into 9 hours 8 minutes each day by multi-tasking, using different media and devices at the same time.²⁴

Digital natives will drive business transformation, not only by altering an enterprise's internal operations but also its efforts to address the needs of connected employees. This opens many opportunities for mobile applications, cloud computing, collaborative social media tools and IT infrastructure.²⁵

Opportunities

The most significant opportunities offered by this trend are:

- **Advanced networking:** Digital natives expect to interact 24x7 with guaranteed levels of responses. Networks must be resilient and high-performing to ensure service delivery.
- **Applications:** This next generation processes information more quickly, multitasking across devices. They have access to thousands of applications, transforming and pushing the development of the user experience.
- **Cyber security:** Digital natives take security for granted, expecting technology and organizations to protect their private information. The line between public and private is far more porous than for those born before the digital age²⁶. As huge volumes of personal data are exchanged, the importance of privacy, trust and security increases, presenting significant opportunities.
- **Data analytics:** The ability to engage proactively with digital users will be enabled through data analytics and will assist delivering localised services by anticipating demand and proactively meeting needs. Exploitation of anonymised and aggregated data presents opportunities for innovation, the development of new services and alternative revenue streams.

²³ <http://news.o2.co.uk/?press-release=young-peoples-digital-skills-valued-at-6-7billion-by-uk-businesses>

²⁴ OFCOM 2015 Communications Report

²⁵ MEGATRENDS – A wave of change impacting the future

²⁶ <http://www.biztechmagazine.com/article/2013/08/security-age-digital-native>

Automation & the rise of machine learning

Computer technologies are transforming the workplace, displacing labour from some jobs but also creating new types of work that call for different skills. In the past, computerisation has been limited mainly to repetitive tasks that can easily be specified in software and performed by machine.

The future will be different. The capabilities of computers are expanding beyond routine work: as a result, tasks that were once considered too complex for automation will be converted into well-defined problems capable of digital solutions.²⁷

Automation facts

- By business sector, 84% of transport, travel and hospitality companies expect changes in technology to have a positive impact, compared with 81% of Technology, Media and Telecom companies.
- Government and public sector entities say 70% of their operations have been improved through the automation of tasks and 60% of financial and business services all report a positive impact in their sector.
- As more types of work across all sectors continue to be displaced by technology, certain manual jobs will never be replaced once automated; however, upgraded jobs that barely existed five years ago such as iOS/Android developer, Data Scientist, Cloud Services Specialist and Big Data Architect roles will experience an increase in demand by employers.²⁸

Opportunities

The most significant opportunities offered by this trend are:

- **Advanced networking:** the increased capability to move large amounts of data anywhere quickly and reliably changes where economic activity is located.
- **Applications:** more sophisticated applications are replacing human activity in lower-skilled ICT work.
- **Data analytics:** the necessary foundation for effective machine learning is a large body of data, and machine learning complements and enhances Northern Ireland's investment in Big Data and Analytics. Increasingly machine learning services will complement and underpin bespoke software engineering activities in the same way a data storage currently does.
- **Cyber security:** as organisations rely increasingly on networks and cloud-based services running on virtualised infrastructure, securing data becomes more challenging.

²⁷ <http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf>

²⁸ <http://www2.deloitte.com/content/dam/Deloitte/uk/Documents/uk-futures/london-futures-agiletown.pdf>

Globalisation and economic shift

Developments in Digital ICT, transport and communications have accelerated the pace of globalisation over the past 30 years. The internet has enabled fast 24/7 global communication and the use of containerisation has enabled vast quantities of goods and commodities to be shipped across the world at an extremely low cost.

Globalisation facts

- By 2025, 1.8bn people around the world will enter the consuming class, nearly all from emerging markets, and emerging-market consumers will spend \$30tr annually, up from \$12tr in 2015.
- Digital technologies also play a major role in improving the production, distribution and operations of physical goods with online platforms such as eBay reporting 90% of sellers export their goods to other countries, compared with an average of 25% for traditional small companies.²⁹
- Globalisation fuelled by digital technologies has meant that 35% of goods cross borders, up from 20% in 1990.
- More than one third of all financial investments in the world are digital international transactions, and a fifth of internet traffic is cross-border. Services and people are far less internationally traded because of their intrinsic link to relatively immobile human capital. However, this too is changing.³⁰

Opportunities

The most significant opportunities offered by this trend are:

- **Advanced networking:** the increased capability to move large amounts of data anywhere quickly and reliably changes where economic activity is located.
- **Data analytics:** understanding of transactional data can lead to changes in the location of business functions, from manufacturing to provision of IT services, while the automation of data analysis changes the pattern and location of business processes.
- **Cyber security:** as organisations rely increasingly on networks and cloud-based services running on virtualised infrastructure, securing data becomes more challenging.
- **New ICT service models:** the rise of cloud-based applications mean that IT services are no longer delivered from data centres close to the point of use, and sometimes from unknown locations.

²⁹ ibid

³⁰ Global Flows in a Digital Age: How trade, finance and people connect the world economy.

Section 4

Matching local skills to global opportunities

This section assesses the potential for Northern Ireland to exploit the economic opportunities across each of its strengths.

Assessment criteria

The focus areas were assessed against a number of market and capability factors to establish the strength of the opportunities and determine how ready Northern Ireland is to exploit them. The prioritisation of opportunities has been based on a commercial and economic rationale, and prioritises those areas with the greatest economic potential, aligned to Northern Ireland strengths.

Two criteria were used to assess each of the focus areas:

Attractiveness

- Current market size and trajectory (using CAGR³¹) to determine the potential scale of the opportunity.
- Attractiveness to investment over the next 3 years. Greater alignment with investment and funding indicated a greater strength or opportunity or a particular societal or market need.
- The maturity of the market (time to exploit) is considered to identify timeframes for activity required to establish a world-class platform to execute.

Ability to execute

- An assessment of Northern Ireland's capability to make an impact in the short and medium term.
- Does Northern Ireland have a critical mass of expertise with associated R&D and infrastructure to exploit innovation within the focus areas? The strength of capability will determine the scope of intervention required and the ease with which the opportunity can be exploited.

³¹ Compound Annual Growth Rate

Software engineering

Software engineering is the design, development and maintenance of software – the foundation on which all other capabilities are built. Specific opportunities within software engineering include:

- **Legacy application migration** – as businesses and public organisations change the way their ICT systems work to adapt to new requirements, migrating applications is a technology service and skill set in its own right.
- **Architecting for cloud** – many digital services are now delivered on virtualised infrastructure located in multiple locations connected via the internet (collectively, ‘the cloud’); applications must be optimised for this deployment and delivery model.
- **Mobile platforms** – many applications now need to be optimised for Smartphones and tablets. This has implications for how mobile applications are managed and secured. Mobile platforms will be increasingly enabled by secure containers (an authenticated encrypted area of a user's mobile device) which will enable the improved management of secure data on mobile devices that can be used to insulate sensitive corporate information from personal information.
- **Bespoke applications** – while many applications are available off the shelf or as cloud-based services, there is still a need to develop bespoke applications to suit organisations’ specific infrastructure and requirements.
- **User experience** – the adoption of digital products and services is fundamentally linked to the ease of use of the technology – both in the mass market and in specific areas such as health. The idea goes beyond design of the product and service to encompass the complete set of interactions a user has with the provider.

Attractiveness

IDC expects constant currency CAGRs of 5.1% and 5.3% for the United States and Western Europe, respectively, over the forecast period 2015-2019.³²

It’s important to note that the real growth is in cloud based subscription software or SaaS. In 2014, 12.6% of all commercial software revenue was generated from public cloud subscriptions, up from a 10.5% share in 2013 and expected to reach 22.2% by 2019. This translates to a public cloud CAGR of 18% in the five-year 2015–2019 forecast period compared to an on premise/other CAGR of 2.9%.

Research conducted by Deloitte in association with the National Venture Capital Association (May 2014) highlights that overall VC investor confidence in Enterprise and Consumer software markets has increased by 3% over 2013 – 2014, with the sector confidence rated as positive.

³² IDC Worldwide Software Forecast, 2015–2019

Ability to execute

Figures provided by Invest NI indicate that software engineering represents 43% of the ICT sector in Northern Ireland. There is demonstrable capability in a range of areas including finance, healthcare solutions and mobile enterprise applications.

The sector is supported by a strong skills pipeline of graduates, with both QUB and UU producing around 1,000 Computer Science graduates per year. University research groups include Artificial Intelligence and Applications, Intelligent Systems Research Centre and Knowledge and Data Engineering.

Northern Ireland's software engineering skills are the foundation on which the following specialisms are built. It also supports a diverse range of industries in Northern Ireland, including financial services, connected health and the creative industries and plays a pivotal role in making the whole economy more productive and internationally competitive.

Summary

Strong growth is predicted as the sector evolves to meet the increasing demand for mobile and Internet-based applications. The Northern Ireland sector is historically strong, with 550 organisations being supported by a strong skills pipeline.

Cyber security

Cyber security is security applied to computers, computer networks, and the data stored and transmitted over them. Computer systems now include a very wide variety of "smart" devices, including tiny devices which form part of the Internet of Things, and networks include not only the Internet and private data networks, but also Bluetooth, Wi-Fi and other wireless networks. Cyber security covers all the processes and mechanisms by which digital equipment, information and services are protected from unintended or unauthorized access, change or destruction and the process of applying security measures to ensure confidentiality, integrity, and availability of data both in transit and at rest.

The exponential growth of connected devices and networks has meant that the focus on cyber security has become a necessity for organisations and individuals.

Specific opportunities within cyber security include:

- **Identity and authentication** - achieved through a series of technologies and processes including identity and access management tools and people and device authentication mechanisms.
- **Privacy and trust** – legislators and regulators as well as public and private sector organisations must protect their information from cyber-based attacks and maintain the trust of the customers and citizens that they serve. Technologies, policy and processes are used to manage privacy, improve data governance, and thereby increase trust in digital applications and services.
- **Network security** - the explosion of new online services and applications taking advantage of real-time connectivity between devices, sensors and centralised computing resources means that it is imperative that networks are secure and robust.
- **Security analytics** - forensic data clustering and anomaly detection research is being applied to online graph-based mining algorithms to process data in real-time. Data mining approaches are being developed to learn inference rules about events and engage multi-criteria decision making for autonomous cyber security threat assessment.

Attractiveness

Market research firm Gartner says global spending on IT security is set to reach \$101bn in 2018. The cyber security market is estimated to grow to \$170bn by 2020, at a CAGR of 9.8% from 2015 to 2020, according to a report from Markets and Markets. The aerospace, defence, and intelligence vertical continues to be the largest contributor to cyber security solutions³³.

Cyber security is a focus area for Horizon 2020 and Innovate UK with funding particularly aimed at smart cyber-physical systems, cyber security and trustworthy ICT.

Ability to execute

Northern Ireland has a vibrant and innovative cyber security sector with a number of indigenous and FDI companies operating in key areas such as web application security, real-time security intelligence, fraud detection and compliance.

The focal point of the subsector is CSIT, the UK's largest cyber security research centre, which has fostered a world-class reputation and developed relationships with multinational partners. CSIT supported UKTI and Invest NI secure over 900 jobs in the sector through FDI, with up to 300 jobs in the medium term pipeline – which represents over £60m per annum. QUB has strategically focused on nurturing and developing its world leading capability and expertise in cyber security.

Both QUB and UU have focussed research groups in Secure Digital Systems, Digital Communications and Intelligent Systems Research, publishing research in these areas.

Summary

The cyber security market is maturing and due to the increasing threat of cybercrime the subsector is experiencing rapid year on year growth. The defence and intelligence verticals continue to be the largest contributor to cyber security solutions. Northern Ireland is well placed to exploit this opportunity with specialist university research, a broad capability, and both FDI and indigenous companies operating in key cyber security domains.

³³ <http://cybersecurityventures.com/cybersecurity-market-report>

Data Analytics

Data analytics is the practice of using data to enhance business strategy and performance. It includes a range of approaches and solutions, from looking backwards to evaluate what happened in the past to looking forward to carry out scenario planning and predictive modelling. Data analytics has evolved in recent years to be predictive and prescriptive.

The ability to collect, aggregate, manipulate and analyse very large volumes of data is transforming the ways that businesses and public organisations work.

Commercial data analytics software, available for several years, is becoming more powerful and cheaper, and is available using new models such as cloud services to many more organisations than in the past. The capabilities of data analytics software are increasing as computing power increases.

Specific opportunities within data analytics include:

- **Cognitive analytics** – specific software or other technologies that analyse large amounts of data in depth to enable companies and organisations to develop better products and services tailored to market segments or even to individuals. It will become more important in sectors and functions such as healthcare, financial services, supply chain, customer relationship management, telecommunications, and cyber security. It will also be of increasing interest to sectors that seek to exploit automation, which will be powered through cognitive analytics and machine learning.³⁴
- **Big data** – Big data is often described using five Vs: Volume, Velocity, Variety, Veracity and Value. The use of big data, often collected as a result of digital natives' 'always connected' lives, requires new analytical approaches such as cognitive analytics. There is an increasing need to gain meaningful insight from larger and larger volumes of data, either in real-time in the case of supply chains and automation, or in "near real-time" to support areas such as healthcare.
- **Supercomputing, high-performance distributed computing (HPDC) and in-memory analytics** – leveraging high powered computers or the parallel and distributed processing capacity offered by multiprocessors, clusters and grid computing to solve computational problems that cannot be solved with the processing power and memory of a single computing system.

³⁴ Deloitte Technology Trends 2014 Report

Attractiveness

The Big Data technology and services market represents a fast-growing multibillion-dollar worldwide opportunity. In fact, a recent IDC forecast shows that the Big Data technology and services market will grow at a 26.4% CAGR to \$41.5bn through 2018, or about six times the growth rate of the overall information technology market.

Significant investment is being made in the data analytics subsector and is a focus area for Horizon 2020 and Innovate UK. Funding is available for range of data analytical-related projects. In addition, data analytics is also a feature of a number of strategic initiatives including the Innovation Strategy for Northern Ireland 2014-2025.

Ability to execute

Invest NI has identified 22 companies directly engaged in the data analytics subsector. Whilst Northern Ireland does not have a formal cluster, it has a burgeoning sector with a wide range of organisations developing deep expertise in this area. A Tech Nation report³⁵ published in 2015 highlights Belfast as a leading data management and analytics region.

Both QUB and UU have research groups specialising in areas such as Knowledge & Data Engineering, High Performance & Distributed Computing and Smart Environments and have published research titles relating to this field including: A Capabilities-Aware Framework for Using Computational Accelerators in Data-Intensive Computing and A Context-Dependent Algorithm for Merging Uncertain Information in Possibility Theory.

Summary

Strong growth is predicted in the data analytics subsector, with analysts predicting a 6% CAGR by 2017. The capability in Northern Ireland is relatively small compared with other subsectors however it has developed a strong reputation and compares favourably to other regions within the UK.

³⁵ Tech Nation Powering the Digital Economy 2015

Advanced Networks and Sensors

Increasingly referred to as the Internet of Things, the networking of physical objects using sensors is predicted to be the fastest growing area of all. The range of applications of sensor networks is vast: from health & fitness, energy and industrial control to transportation and traffic management and agriculture.

Such applications are already being introduced more widely, in cars for example to allow insurers to base premiums on actual driving behaviour and in the health sector, where patients can be monitored in their own homes to improve their management of chronic diseases.

Specific opportunities within advanced networks and sensors include:

- **Network management and optimisation** – network management covers a wide area, including:
 - **Security** - ensuring that the network is protected from unauthorized users.
 - **Performance** - eliminating bottlenecks in the network.
 - **Reliability** - making sure the network is available to users.
- **SDN, NFV and virtualization** – technologies that enable the more efficient and economic deployment of networks by separating the network functions from the underlying hardware infrastructure, both in telecom operator networks (NFV) and in single and distributed data centres (SDN).
- **Large scale data transmission, cloud connectivity & communication protocols** - as we move into an environment that is increasingly software defined, networking must support cloud-to-cloud connectivity and alongside this there is a need to support larger and faster data transfers created by the demand of analytical solutions.
- **Devices and (Wireless) sensor networks** – dense networks of sensors and devices (some may be self-powered using energy harvesting technology) communicating using open protocols in innovative network topologies such as mesh architectures.
- **Mobile and wearable devices** – wirelessly connected devices of multiple types from smartphones to drones, equipped with sensors of various kinds (including cameras / image sensors), and including clothing and personal accessories, often with embedded sensors, for instance to monitor health and fitness.

Attractiveness

The impact of advanced network and sensor technology on the global market is estimated to be as high as \$6.2tr by 2025. Gartner predicts that the market for Software Defined Network (SDN) equipment will surpass \$11.5bn worldwide by 2017. Advances in technology will see the sensors market move beyond wearable devices to a demand for smart pills or ingestible devices by the health and agri-food sectors. The global market for

sensors reached \$68.2bn in 2012 and is expected to rise at a CAGR of 7.9% and reach \$116.1bn by 2019³⁶.

The Internet of Things (IoT) continues to gain momentum as vendors and enterprises begin to embrace the opportunities this market presents. According IDC, the worldwide Internet of Things market will grow from \$655.8bn in 2014 to \$1.7tr in 2020 with a compound annual growth rate (CAGR) of 16.9%.³⁷ Devices, connectivity, and IT services will make up the majority of the IoT market in 2020. Together, they are estimated to account for over two-thirds of the worldwide IoT market in 2020, with devices (modules/sensors) alone representing 31.8% of the total. By 2020, IDC expects that IoT purpose-built platforms, application software, and "as a service" offerings will capture a larger percentage of revenue.

Ability to execute

Northern Ireland has emerging capability in wireless communications, internet technologies and advanced networks with a cluster of over 50 companies, with around 20 companies engaged in advanced networking solutions R&D that moves beyond the traditional network provisioning.³⁸ The majority of these companies are foreign owned, leveraging local expertise and know-how, but there are also a small number of indigenous companies developing SDN and NFV enabled solutions and services.

The sensors market has typically high barriers to entry for organisations that lack economies of scale, supplier relationships, logistics infrastructure and established R&D departments.

QUB and UU have research groups in areas including Secure Digital Systems, Information Communications Engineering, Smart Environments, Biomaterials, Functional Materials & Devices, High Frequency Electronics and Intelligent Systems Research and have published research papers in related areas as well as working on major projects with industry and governments.

Summary

The advanced networking market is relatively immature - however significant growth of 35% is predicted by 2018. Northern Ireland is well positioned to exploit the potential of this emergent area of the global digital platform, provided it is supported and retains its current capability. Northern Ireland's capability to manufacture sensor devices lies with a relatively small number of high-tech manufacturers – however, a significant volume of R&D is being conducted that could produce design and process IP which could be leveraged and exported globally.

³⁶ Forecast Overview: SDN and NFV in Carrier Infrastructure, Worldwide. Gartner 2013

³⁷ IDC Worldwide Internet of Things Forecast, 2015–2020

³⁸ Figures provided by Invest NI, January 2015

Section 5

Characteristics of a leading Digital ICT sector

World-class capability is defined as having the depth of expertise in the sector and the potential to exploit an identified capability to generate assets for a country.

In this section we have identified ten components which are essential components of a world class economy:

- Digital strategy
- Human capital
- Foreign Direct Investment
- R&D capability
- Support for innovation
- Funding & investment activity
- Building clusters
- Maintaining digital infrastructure
- Smart specialisation
- Strong brand identity

A more detailed analysis of comparator countries is available at [Appendix 1](#)

A Digital Strategy

Leading countries have industry advocate(s) who advise government on the development of their ICT sector.

They also have a focused strategy and action plan that identifies opportunities in the sector and measures its impact on the region's economic development prospects.

Many of the components of a delivery strategy are in place to progress the sector. The merger of DETI and DEL in 2016 to form the new Department for the Economy should offer an opportunity for greater cohesion of the sector.

However, there are clear weaknesses in the current planning, including the absence of an overarching delivery plan.

Human Capital

Leading counties have a strong focus on education and training, drawing on a tech savvy workforce with exemplary project management and system integration strengths.

Northern Ireland has a particular strength in the calibre of its software engineers. However, it has a weakness in the *quantity* of talent that is available to support the growth of the ICT sector.

Talent production needs to accelerate past addressing the current shortfall to drive growth, rather than maintain the status quo. In addition, a digitally talented and capable workforce will drive the whole economy, not just the digital sector.

The attraction of talent from outside of Northern Ireland offers a major opportunity to address the talent gap and introduce a diversity of talent and skills that other regions thrive on to progress.

Foreign Direct Investment

Northern Ireland has a proven ability to attract and maintain FDI (despite global trends). Further opportunities for growth are being achieved by narrowing the focus (smart specialisation) to attract high-value jobs in specific target areas for growth and put in place measures that encourage R&D and collaboration with companies to foster the growth of the ICT sector.

R&D Capability

Universities in leading countries build alliances with ICT companies, which helps build greater capacity in R&D activity and attract the diversity of PhD students and private sector funding to commercialise ideas faster. The Innovation Strategy for Northern Ireland 2014-2025 sets out an action plan to grow the private sector by stimulating innovation, R&D and creativity.

However, whilst the trend for investment in research-based activity in Northern Ireland is positive, levels of BERD are lower in contrast to other UK regions, which indicates that there is some way to go to become world-class.

Support for Innovation

Leading countries put in place intensive innovation programmes that are targeted on their particular areas of technological strength and the societal needs of the country.

Whilst focus on innovation is growing in Northern Ireland, it is behind exemplar regions in the UK in terms of innovative active businesses and the level of innovation or the absorption of funding to support innovation. Significant improvements have been made in the level of BERD in Northern Ireland, but this is not converting into an increase in the number of patents filed with the IPO (although it should be noted that this is not the only measure of successful BERD, particularly since software is not patentable within the EU).

As a region, Northern Ireland hi tech patent applications per million inhabitants has fallen by 65%, and whilst ranked 6th in the UK, equal with Scotland, lags well behind the RoI.

Funding and Investment Activity

Private equity and venture capital is essential to fuel growth in the regions who lead in the ICT sector. A balance between government start-up funding and private equity is a key strategic objective in leading countries.

Northern Ireland has put in place a number of tailored, publicly funded programmes for innovation and R&D such as:

- The Invest NI Grant for R&D Programme - R&D support for all stages of company development from £3k to over £1m.
- Competence Centres - industry led organisations comprised of businesses and academic researchers working collaboratively to deliver market focused projects which generate benefits for industry.
- Invest NI growth fund proof of concept programme which offers grants of up to £40k.
- The Techstart NI fund.

However take-up of available funding outside of Northern Ireland specific schemes such as Innovate UK and Horizon 2020 is lower than other regions in the UK.

Building Clusters

Having formal clustering policies in place helps leading countries retain their Digital ICT strength and world class ranking.

Northern Ireland has demonstrable strengths in clustering, evidenced by the success of the Northern Ireland Science Park, while CSIT (Centre for Secure Information Technology) is widely regarded as having world-class capability in the absence of a formal clustering policy. Initiatives such as the European Connected Health Alliance, DNI2020 and the Capital Markets Collaborative Network are also closely aligned to ICT sector.

However it is acknowledged that there is an opportunity to achieve more through formal clustering to assist and progress R&D and promote capability to a global marketplace.

Maintaining Digital Infrastructure

Telecommunications and power infrastructure play a fundamental role in enabling the ICT and Digital sectors. The availability of efficient infrastructure services is an important determinant of the pace of market development and output growth and, in addition, access to affordable infrastructure services for consumption purposes serves to improve household welfare. It is estimated that the availability and take-up of faster broadband speeds across the UK will add about £17bn to the UK's annual Gross Value Added (GVA) by 2024.

Northern Ireland is establishing itself as one of the most connected regions in Europe. The quality of the technology infrastructure must be maintained to a competitive level going forward and be able to support 4G, 5G and beyond.

Smart Specialisation

Smart specialisation involves exploiting digital technology to transform government, business and individual processes to deliver significantly better outcomes.

Northern Ireland is regarded as having a strong financial services ICT capability as is evident from the number and scale of organisations that are associated with that sector. Similarly, there are also pockets of combined capability in areas such as health.

However, there is scope for Northern Ireland to better align its ICT strengths alongside key industry areas.

Strong Brand Identity

ICT capability does not translate into wealth unless there is an underpinning 'go-to' market plan. There are four fundamental components:

- Market channels
- Focussed marketing of a brand
- Capacity and capability to sell
- Understanding demand

Northern Ireland does not have any clearly distinguishable brand for its Digital ICT sector.

Summary

Below is a summary of the areas where there is scope for Northern Ireland’s performance to improve, with commentary on the actions currently being taken. Bold comments refer to recommendations made in this report.

Action required	Comment
Develop a dedicated digital strategy	MATRIX recommends the appointment of a Chief Digital Officer to develop and deliver a digital strategy for Northern Ireland.
Address the talent gap	An ICT Future Skills Action Plan has already been produced by DEL, and ICT is now embedded into the revised curriculum as a skill across all Key Stages. MATRIX also recommends the development of a Skills Investment Plan.
Encourage BERD	HMRC offers financial incentives to encourage businesses to carry out inhouse R&D.
Support innovation	The 2014 Northern Ireland Innovation Strategy envisions that by 2025, Northern Ireland will be recognised as an innovation hub and will be one of the UK’s leading high-growth, knowledge-based regions.
Improve take up of Horizon 2020 and Innovate UK funding	DETI is currently developing a Northern Ireland Strategy for Horizon 2020.
Develop formalised ICT clusters	MATRIX recommends a centre for Data Analytics and a focus on formal ICT clusters, plus continued focus on CSIT.
Focus on smart specialisation	DETI published the <u>Northern Ireland Smart Specialisation Framework</u> in 2015 detailing strategies to deliver on innovation priorities.
Improve Northern Ireland brand identity	MATRIX recommends the appointment of a Chief Digital Officer to develop and deliver a digital strategy for Northern Ireland.

Section 6

Recommendations for the Northern Ireland Digital ICT sector

Action	Suggested owners	Timescale
Develop a 3-5-10 year Skills Investment Plan for the Digital ICT sector		
Focus the skills investment plan to support the areas examined by this report and to consider ways to create the skills required in the future.	DE and DfE	6 – 12 months
Develop an action plan to support the development and delivery of digital skills and computing in schools.		
Create a centre for Data Analytics		
Carry out a feasibility exercise to establish the benefits innovative high technology SMEs and industry sectors will gain from a centre for Data Analytics.	DfE, DfP, QUB & UU	12-18 months
Employ a clear leadership and governance structure to attract public sector resources that complement the private sector's expertise.		
Create a centre for Data Analytics that will advance the development of commercial spin offs and new products and services for the market.		
Engage a Chief Digital Officer		
Commission a leading industry expert to support Government to build a digital society and an exemplar region to meet the expectations of 21st century citizens.	DfE and DfP	6 – 12 months
Develop and deliver a coordinated Digital Strategy to bring together the key stakeholders and initiatives required to transform Northern Ireland into a fully digitized and Smart society.		
Government as an expert and strategic customer of digital technology		
Create an agile delivery process that responds to the changing requirements of purchasing of ICT products and services to ensure solutions meet requirements.	DfP, DfE and local government	1-3 years
Ensure that NI has an exemplar digital infrastructure within and between urban areas to secure Northern Ireland as an exemplar smart, connected region.		
Provide an integrated, agile platform, based on open standards which expose appropriate data and service APIs to nurture the development of an innovative ecosystem.		
Make it easier for local businesses, particularly SMEs, to do business with Northern Ireland Government.		
Ensure that the cyber security sector is supported and developed		
Continue to support CSIT with its vision of establishing a global innovation hub for cyber security.	DfE	Ongoing
Support the growth of the NI cyber security cluster with targeted support for start-ups, indigenous businesses and FDI in the sector.		
Develop a portfolio of cyber skills and training initiatives, from PhDs and MSc courses through to relevant Assured Skills programmes.		

Continued investment in skills

Perhaps the most significant challenge facing Northern Ireland companies and institutions is training and attracting enough suitably skilled people. There should be a clear plan for developing skills locally, and for retaining suitably qualified talent who have the skills required to enable the economy to build capacity.

Northern Ireland needs an ambitious action plan to support the development and delivery of digital skills and computing in schools. There is a need to build capacity for delivery, with introductory and accredited pathways for teacher professional development and a framework to support sharing of good practice within the education sector. Innovative approaches should be sought and developed, taking into account good practice in other regions with growing knowledge economies, with good quality research driving progression. At the same time, a framework of support for the teaching profession will ensure that high-quality teaching and learning is available to young people to progress and to develop an interest in ICT that can be applied not only to this sector but to the industry sector of their choice. There is a need to encourage innovation in education and mobilise a generation of young people to create, rather than simply use digital technologies.

One of the key outputs of this report is to look at the skills which will be required in the future. However, to fully capitalise on the speed at which market opportunities arise, a more innovative approach is required, including training “ahead of the curve”, i.e. before the need arises in the local economy. The supply of young people with the appropriate qualifications at level 3 (A Level) and above should be managed by policy makers through the coordination of institutions and industry in support of a clear skills strategy.

Key Action 1: Develop a 3-5-10 year Skills Investment Plan for the Digital ICT sector

Develop a 3-5-10 year skills strategy for the sector that includes:

- A coherent educational progression model which embeds the necessary skills from primary level onward, a framework for teacher professional development in digital skills and a clear skills investment action plan for the Digital ICT sector.
- Focus the skills investment plan to support the areas examined by this report and consider ways to create the skills required in the future.
- Highlight within the investment plan the sector-specific requirements to attract the best talent to Northern Ireland especially in key capability areas.

Suggested owners of this recommendation	Department of Education (DE), the Department for the Economy (DfE)
Timescale for implementation of this recommendation	Short-term 6 months to 1 year from the publication of this report

Centre for data analytics

To realise the potential of Northern Ireland's capability in data analytics it is suggested that a centre for data analytics is established.

The purpose of the centre is to explore advanced data exploration techniques and models of analysis that can support academic research and interpret real world data in real time for the commercialisation of new products. It will also seek to solve complex societal pressures for all government in a bid to provide cost saving economic solutions in the delivery public services.

Establishing such a centre will be costly and may call for industry support, possibly in the form of a partnership agreement between industry, government and academia.

Key Action 2: Create a centre for data analytics

- Carry out a feasibility exercise to establish the economic benefits that a centre for data analytics will have for innovative high technology small and medium sized enterprises (SMEs), corporate businesses, academia and government.
- Employ a clear leadership and governance structure to attract public sector resources that complement the private sector's technological expertise.
- Create a centre for data analytics that will advance the development commercial spin-offs and new products and services for the market, by converting data into valuable market information using advanced statistical modelling techniques and advanced software solutions.

Suggested owners of this recommendation	Department for the Economy (DfE) the Department of Finance and Personnel (DfP), Queen's University Belfast and the Ulster University
Timescale for implementation of this recommendation	Short to medium term -1 year to 18 months from the publication of this report.

Engage a leading industry expert to act as a Chief Digital Officer

The opportunity for Northern Ireland is clear. The UK Government, led by the Cabinet Office, has become a world leader in the provision of user-led digital transformation. The technology skills and innovations required to deliver this are strong Software Engineering, Cyber Security, Data Analytics and Digital Networks – recognised strengths of the Northern Ireland Digital ICT sector. Northern Ireland has the opportunity to use these skills and innovations for the benefit of its citizens, and to realise the cost savings and service improvements that other territories are benefiting from. Northern Ireland’s size and governance structures offers the potential for it to become a global exemplar for digital transformation by 2020, but work must start now.

The appointment of a Chief Digital Officer is strongly recommended to lead the integration of new technologies and to create a digital culture across government facilitating the pragmatic and simplified purchase by government of digital products and services.

Key Action 3: Engage a leading industry expert to act as a Chief Digital Officer (CDO) to advise government and industry on the digital transformation of Northern Ireland

- Commission a leading Digital industry expert to support Government to build a digital society and an exemplar region to meet the expectations of 21st century citizens.
- Develop and deliver a coordinated Digital Strategy to bring together the key stakeholders and initiatives required to transform Northern Ireland into a fully digitized and Smart society.

Suggested owners of this recommendation	Department for the Economy (DfE), the Department of Finance and Personnel
Timescale for the implementation of this recommendation	Short-term - 6 months from the publication of this report

Government as an expert and strategic customer of digital technology

To meet public policy objectives that deal with budgetary reform, on-going urbanisation and an increased knowledge intensive economy, the adoption of a policy to make Northern Ireland’s cities “Smart”³⁹ requires a strategic, coordinated approach by policy makers to build connected and data driven information systems.

It is necessary therefore to provide an integrated, agile, data and services platform, based on open standards, to pioneer applications and new technologies, to deliver the services citizens and visitors expect.

Key Action 4: Adopt an integrated collaborative approach to building smart-city information systems to exploit the intelligent processing of data from across a variety of city resources

- Create an agile delivery process that responds to the changing requirements of purchasing of technology products and services to ensure solutions meet business requirements.
- Ensure that Northern Ireland has an exemplar digital infrastructure within and between urban areas resulting in Northern Ireland as an exemplar smart, connected region.
- Provide an integrated, agile platform, based on open standards which expose appropriate data and service APIs to nurture the development of an innovative ecosystem. The products and services created by this ecosystem will benefit both Northern Ireland citizens and the economy through exports to other Smart City environments.
- Make it easier for local businesses, particularly SMEs, to do business with Northern Ireland Government.

Suggested owners of this recommendation	Department of Finance and Personnel the Department for the Economy (DfE) and local government.
Timescale for the implementation of this recommendation	Medium term 1 -3 years from the publication of this report

³⁹ European Innovation Partnership on Smart Cities and Communities – Strategic Implementation Plan 2013

Continued support for the cyber security sector

With global spending on IT security set to reach \$101bn in 2018 and the cyber security market expected to grow to \$170bn by 2020, Northern Ireland is well placed to exploit this opportunity with its specialist university research, a broad capability, and both FDI and indigenous companies operating in key cyber security domains such as web application security, real-time security intelligence, fraud detection and compliance.

The focal point of the subsector is CSIT, the UK's largest cyber security research centre, which has fostered a world-class reputation and developed relationships with multinational partners. CSIT supported UKTI and Invest NI secure over 900 jobs in the sector through FDI, with up to 300 jobs in the medium term pipeline – which represents over £60m per annum.

It is vital that support continues for cyber security in Northern Ireland, particularly for CSIT. This will allow Northern Ireland to fully exploit a fast growing and developing market where we have proven world-class expertise.

Key Action 5: Ensure that the cyber security sector is supported and developed

- Continue to support CSIT with its vision of establishing a global innovation hub for cyber security.
- Support the growth of the NI cyber security cluster with targeted support for start-ups, indigenous businesses and FDI in the sector.
- Develop a portfolio of cyber skills and training initiatives, from PhDs and MSc courses through to relevant Assured Skills programmes.

Suggested owners of this recommendation	Department for the Economy
Timescale for the implementation of this recommendation	Ongoing

Supporting recommendations

In addition to the main key recommendations there are also a number of supporting actions that should be progressed to achieve the outcomes set out at the beginning of this report, specifically:

- The creative digital and content sector, whilst highly dependent on Digital technologies and professional ICT skills, it is a highly progressive sector in its own right. A report should be dedicated to that sector to provide a focus and determine how the economic potential can be exploited. As part of this, there should be a clear and agreed definition of what is considered the digital ICT sector and what is considered the core creative industries.
- The new Department for the Economy should seek to develop a clear definition of the Digital ICT sector to establish the full contribution the digital economy makes to the overall economy. The integrated nature of the digital economy was made by NESTA in a report⁴⁰ that showed that only 47% of those working in ICT-related jobs in 2015 were employed in a ICT sector company, meaning that a large proportion of what may be considered contributing to the Digital Economy is not captured using analysis based on traditional industry classifications (SIC) codes.⁴¹
- There is a need to ensure the existing world-class digital infrastructure is maintained and further developed to the necessary standard to support Northern Ireland businesses in the ever-progressing digital economy. Close attention must be paid to the emergence of 5G technologies and beyond as well as increasing bandwidth demands of industry and continual improvement plans must be in place to maintain Northern Ireland's ICT infrastructure.

⁴⁰ <http://www.nesta.org.uk/blog/measuring-information-economy-using-big-data>

⁴¹ http://www.ons.gov.uk/ons/dcp171776_419158.pdf

Appendix 1: Leading Digital ICT Nations

World-class capability in Digital ICT is defined (for the purpose of this report) as having the depth of expertise in the sector and the potential to exploit an identified capability to generate assets for a country. Denmark, Estonia, Finland, Ireland, New Zealand, Singapore and Sweden are nations appropriate for comparison with Northern Ireland⁴² because they are demographically similar and they consistently score highly in global Digital ICT competitive assessments, such as the Digital Economy and Society Index (DESI)⁴³ and the 2015 Global IT Competitiveness Report conducted by the World Economic Forum (WEF).⁴⁴

The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness. The annual Global IT Competitiveness Report is a comprehensive assessment of the competitiveness of 147 world economies. Using a mixture of quantitative and survey data, it ranks countries overall by combining 113 indicators grouped under 12 pillars of competitiveness.

⁴² Northern Ireland is included in the ranking for the UK in the DESI

⁴³ <https://ec.europa.eu/digital-agenda/en/desi>

⁴⁴ <http://reports.weforum.org/global-information-technology-report-2015/>

European nations considered world class for Digital ICT

The DESI 2015 illustrated below shows the European Union (EU) and individual Member States progressing towards a digital economy and society. However, member states are at different levels of development and are progressing at different speeds. Denmark, Sweden and Finland are not only ahead of the EU average but they are world leaders in the adoption and business use of digital technology. DESI considers the UK to be a medium performer in digital, which means it is doing well in certain areas but needs attention in others - e-Gov and e-Health for example. Northern Ireland’s performance is included in the UK score.

Figure 21: Digital Economy and Society Index 2014

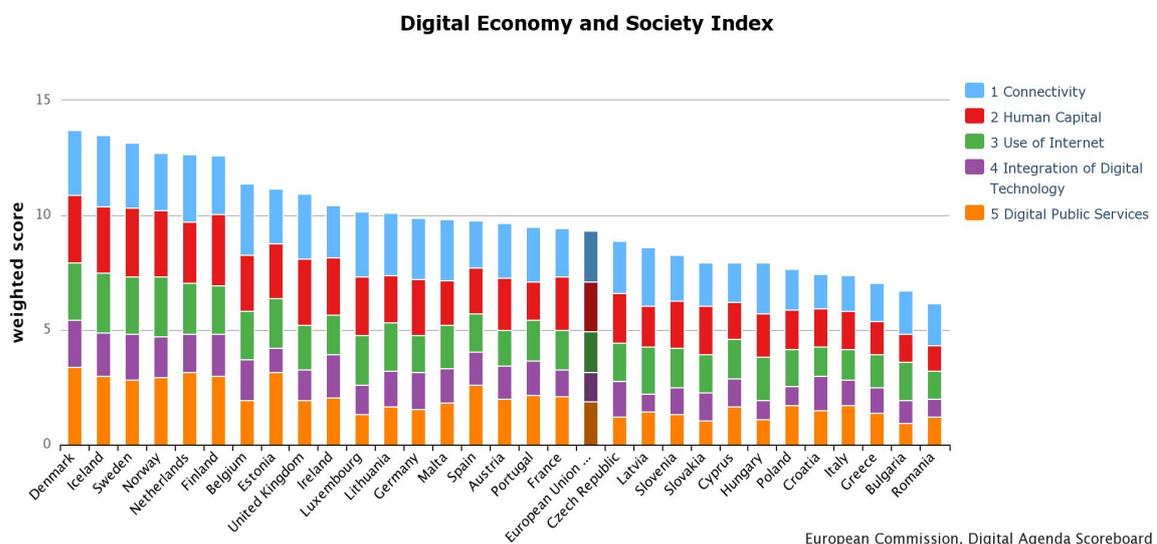


Table 3 below lists three indicators (Human capital, Integration of Technology and Digital Public Services) in the five EU countries considered comparable to the UK for depth of digital expertise, and the potential to exploit their position to generate assets for their region.

DESI 2015 Digital Performance Ranking

DESI 2014 Performance Ranking out of 28 Member States						
	Finland	Denmark	Sweden	Ireland	Estonia	UK
Human Capital	1	3	2	7	10	4
Integration of Digital Technology	4	1	2	3	22	15
Digital Public Services	4	1	5	9	2	11

Human Capital

Finland is ranked first among EU member states for Human Capital and it is also one of the best performing nations for ICT specialists in the workforce. Finnish, Swedish and Irish students are the most attracted to a career in ICT, with 2.2% of 20-29 year olds holding a STEM (Science, Technology, Engineering, Maths) degree. Sweden has almost double the EU average of ICT specialist in the workforce (4.8%) and while Ireland produces 20 STEM graduates per thousand (20-29 year olds), the percentage of individuals with basic digital skills (53%) is below the EU average (59%) highlighting the need for more skilled ICT professionals in Ireland.

The Irish Government's current policy of attracting in external talent to fill jobs in their growing ICT sector poses a serious future threat to Northern Ireland's talent pool. Young people entering the workforce and work ready talent equipped to take the next step in their career don't have to leave the county to secure work at ICT giants such as Microsoft, Google, Facebook and other big name brands who have their European headquarters in the south of Ireland.

The demand for ICT professionals outstrips supply in most EU nations hence it is important for regions to uphold efforts in human capital development. Estonia ranks 10th among EU countries on Human Capital an improvement over the 12th place occupied in 2014. Estonians are also well skilled in the use of digital technologies (69%) and their digital skills (82%) are above those of the average EU user⁴⁵ which is also reflected in the high ranking in business and government usage rates of e-services by Estonians in the WEF Competiveness Index.

Integration of Digital Technology

The adoption of digital technologies is an important driver of labour productivity and growth. Danish businesses fully exploit the possibilities offered by digital technologies giving Denmark the best performance score in the EU.

The percentage of businesses using technologies such as electronic information sharing (ERP-42%), e-invoices (59%) and Cloud services (28%) in Denmark is high, compared to low adoption of the same technologies by UK businesses (ERP-12%, e-invoices-11%, Cloud-15%).

Sweden, Ireland and Finland perform well in business integration of digital technology building Digital ICT capability in their commercial sectors. However their small to medium enterprises (SME's) need more support to amalgamate their internal processes by using electronic information sharing and e-commerce. Estonia surprisingly records a low ranking (22nd out of 28 member states) in this category as its businesses are only starting to exploit the possibilities offered by on-line commerce. The Government in Estonia is a global leader on the development and use of government e-services. Therefore, Estonia's

⁴⁵ <http://ec.europa.eu/digital-agenda/en/digital-agenda-scoreboard>

ranking on the integration of digital technology by businesses is expected to improve in the coming years as the region develops its digital economy.⁴⁶

Digital Public Services

Modern public services offered online are an important vehicle to better the efficiency of public administration for enterprises and citizens. Denmark records the most advanced use of digital public services out of the 28 member states. For example, 69% of internet users send returned forms online to public authorities in Denmark compare to 38% in Estonia and 8.6% in the UK. E-Health is also more advanced in Denmark with 92% of General Practitioners (GP's) exchanging medical data electronically compared to only 53% in the UK.

The Estonian government has introduced a wide variety of e-services, accessed through electronic identity cards (e-ID) which also serve as a digital signature to allow Estonians to sign contracts, vote, submit their tax returns, purchase tickets for public transport and check their children's progress at school electronically. Estonia has probably the most joined up digital government in the world. Its citizens can complete just about every municipal or state service online and in minutes. You can formally register a company and start trading within 18 minutes.⁴⁷

The UK has made significant progress introducing more digital public services. It has moved up five places in the index scale from 16th in 2014 to 11th in 2015. However, the sophistication of provisioned services could be improved upon. In the domain of e-Health for example as, only 53% of GP's exchange data electronically compared to Estonia and Denmark. Additionally, medications prescribed to patients by GP's using an e-prescription are much less widely utilized in the UK. Only 21% of all medications issued are done so electronically compared to 100% in Estonia and Denmark. In Sweden 97% and in Finland 82% of citizens receive prescriptions in an electronic format.⁴⁸

Details on individual countries listed in the Digital Society Economy Index can be found at on the [Digital Agenda for Europe website](#).

⁴⁶ ibid

⁴⁷ <https://gds.blog.gov.uk/2013/10/31/government-as-a-data-model-what-i-learned-in-estonia>

⁴⁸ <http://ec.europa.eu/digital-agenda/en/digital-agenda-scoreboard>

Global nations considered world class in Digital ICT

The annual World Economic Forum (WEF) Global Technology Report assesses up to 147 countries on the ability of their businesses and the wider community to utilise information and communication technology in order to support growth, competitiveness and development. The Network Readiness Index (NRI) measures the country's ability to use ICT to boost competitiveness.

Singapore and New Zealand were selected for comparison because they are demographically similar to Northern Ireland⁴⁹ and they consistently score highly in global Digital ICT competitive assessments – making them world class digital nations.

Table 3: WEF Network Readiness Index - Sub-Indexes 2015: the top 10

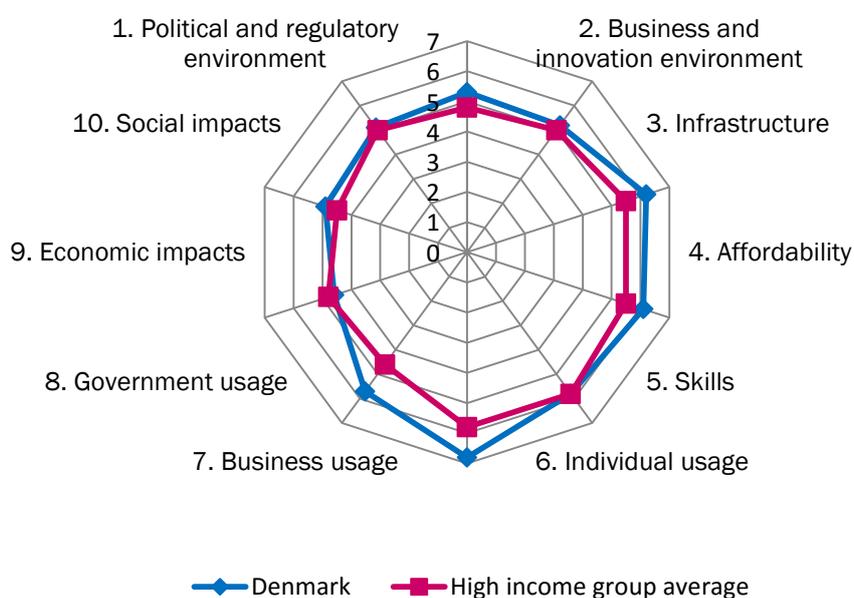
	Political and Regulatory Environment	Business Innovation and Environment	Business Usage	Skills	Government Usage
1st	New Zealand	Singapore	Switzerland	Finland	Singapore
2nd	Singapore	United-Arab Emirates	Japan	Singapore	United-Arab Emirates
3rd	Luxembourg	Hong Kong	Sweden	Switzerland	Korea, Rep
4th	Finland	Canada	Finland	Belgium	Bahrain
5th	United Kingdom	United States	Germany	Qatar	Qatar
6th	Norway	New Zealand	Netherlands	Netherlands	Estonia
7th	Netherlands	Norway	United States	New Zealand	Japan
8th	Canada	Netherlands	Denmark	Ireland	Saudi Arabia
9th	Switzerland	United Kingdom	Israel	Canada	Malaysia
10th	Sweden	Switzerland	Norway	Germany	New Zealand

Source: The Global Information Technology Report 2015: ICTs for Inclusive Growth

⁴⁹ Northern Ireland's score is included as a contribution to in the UK's ranking

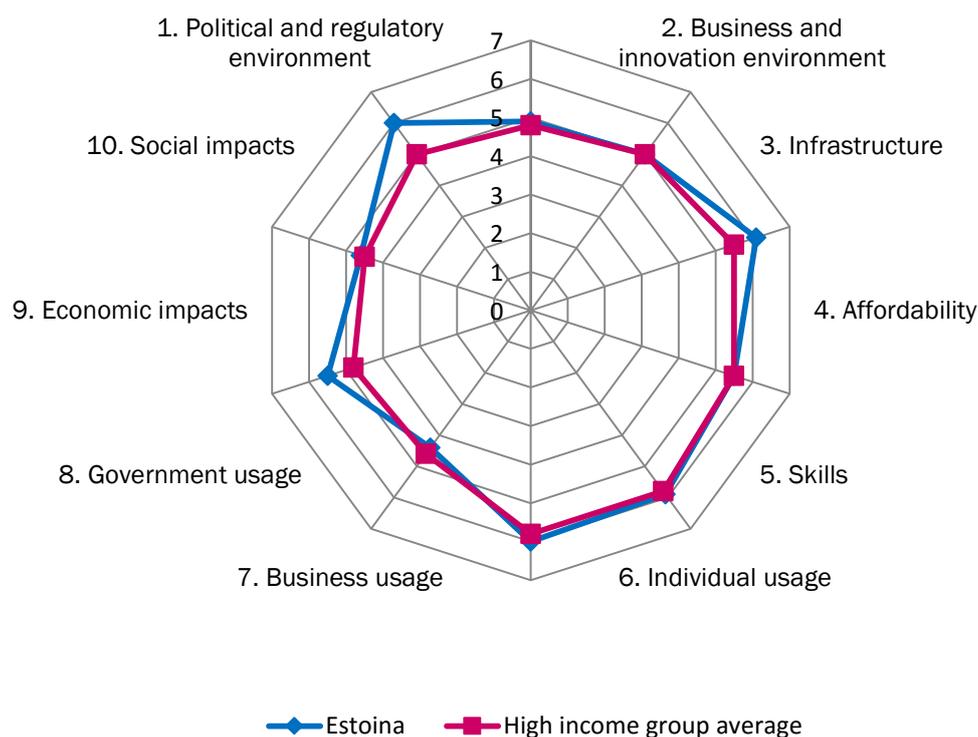
Denmark

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	15	5.5
Networked Readiness Index 2014 (out of 148)	13	5.5
Networked Readiness Index 2013 (out of 144)	8	5.6
A. Environment subindex	16	5.2
1st pillar: Political and regulatory environment	16	5.3
2nd pillar: Business and innovation environment	18	5.2
B. Readiness subindex	13	6.0
3rd pillar: Infrastructure	20	6.2
4th pillar: Affordability	33	6.1
5th pillar: Skills	19	5.8
C. Usage subindex	9	5.7
6th pillar: Individual usage	1	6.8
7th pillar: Business usage	8	5.7
8th pillar: Government usage	40	4.6
D. Impact subindex	21	5.0
9th pillar: Economic impacts	18	4.9
10th pillar: Social impacts	30	5.1



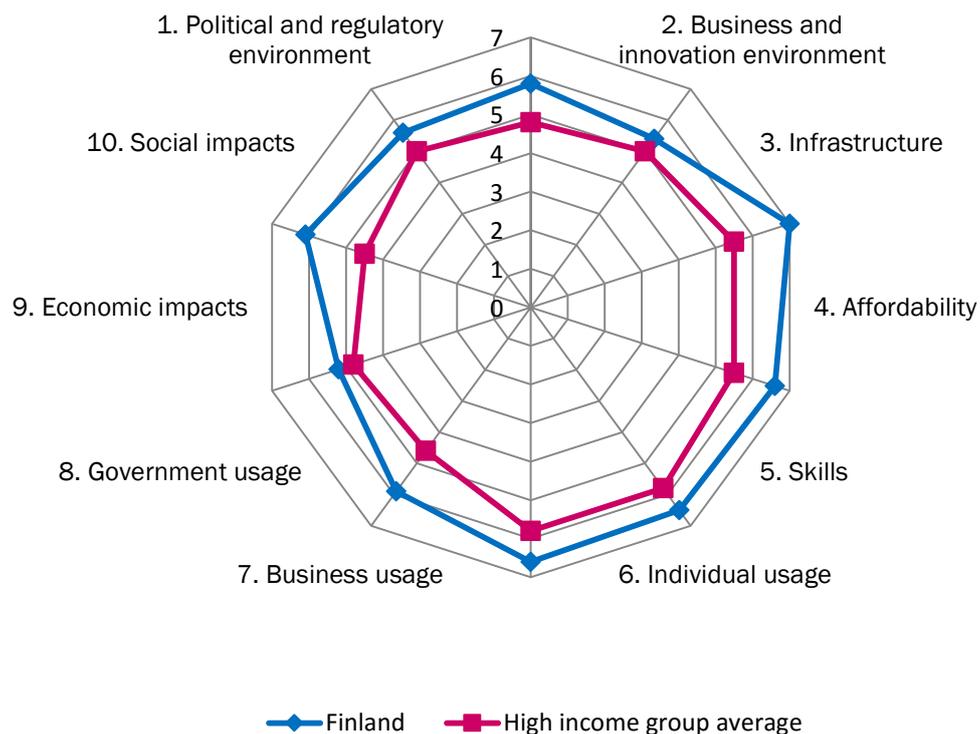
Estonia

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	22	5.3
Networked Readiness Index 2014 (out of 148)	21	5.3
Networked Readiness Index 2013 (out of 144)	22	5.1
A. Environment subindex	23	5.0
1st pillar: Political and regulatory environment	23	4.9
2nd pillar: Business and innovation environment	25	5.0
B. Readiness subindex	22	5.8
3rd pillar: Infrastructure	23	6.1
4th pillar: Affordability	62	5.5
5th pillar: Skills	16	5.9
C. Usage subindex	23	5.3
6th pillar: Individual usage	16	6.0
7th pillar: Business usage	28	4.4
8th pillar: Government usage	6	5.5
D. Impact subindex	14	5.3
9th pillar: Economic impacts	25	4.6
10th pillar: Social impacts	5	6.0



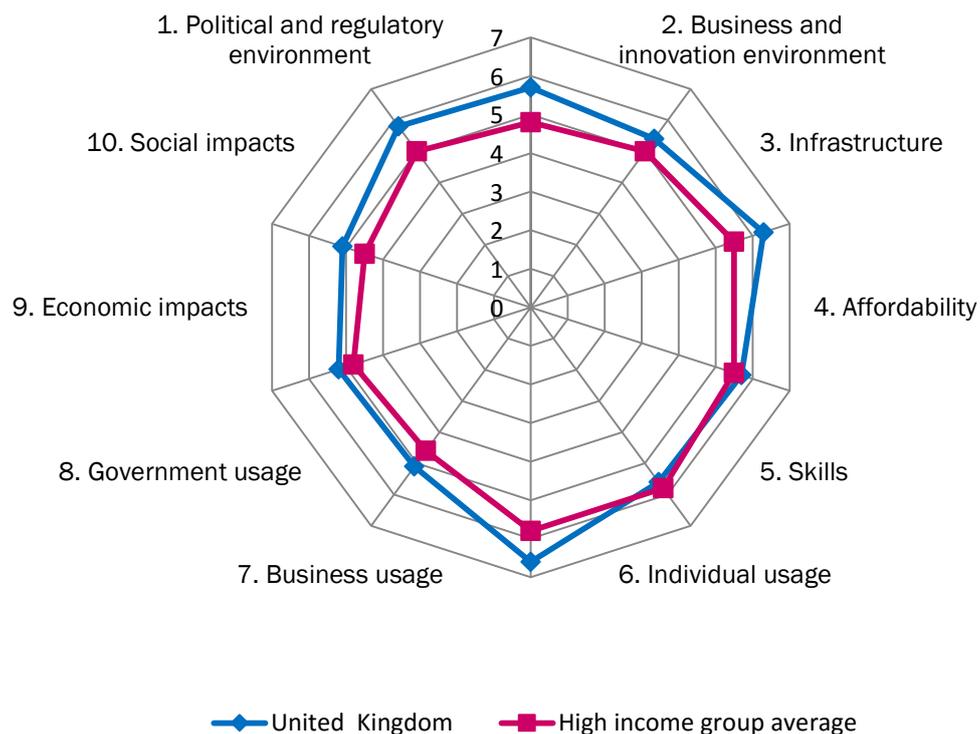
Finland

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	2	6.0
Networked Readiness Index 2014 (out of 148)	1	6.0
Networked Readiness Index 2013 (out of 144)	1	6.0
A. Environment subindex	3	5.6
1st pillar: Political and regulatory environment	4	5.8
2nd pillar: Business and innovation environment	11	5.4
B. Readiness subindex	1	6.7
3rd pillar: Infrastructure	5	7.0
4th pillar: Affordability	9	6.6
5th pillar: Skills	1	6.5
C. Usage subindex	3	5.9
6th pillar: Individual usage	5	6.6
7th pillar: Business usage	4	5.6
8th pillar: Government usage	17	5.2
D. Impact subindex	3	5.8
9th pillar: Economic impacts	1	6.1
10th pillar: Social impacts	12	5.6



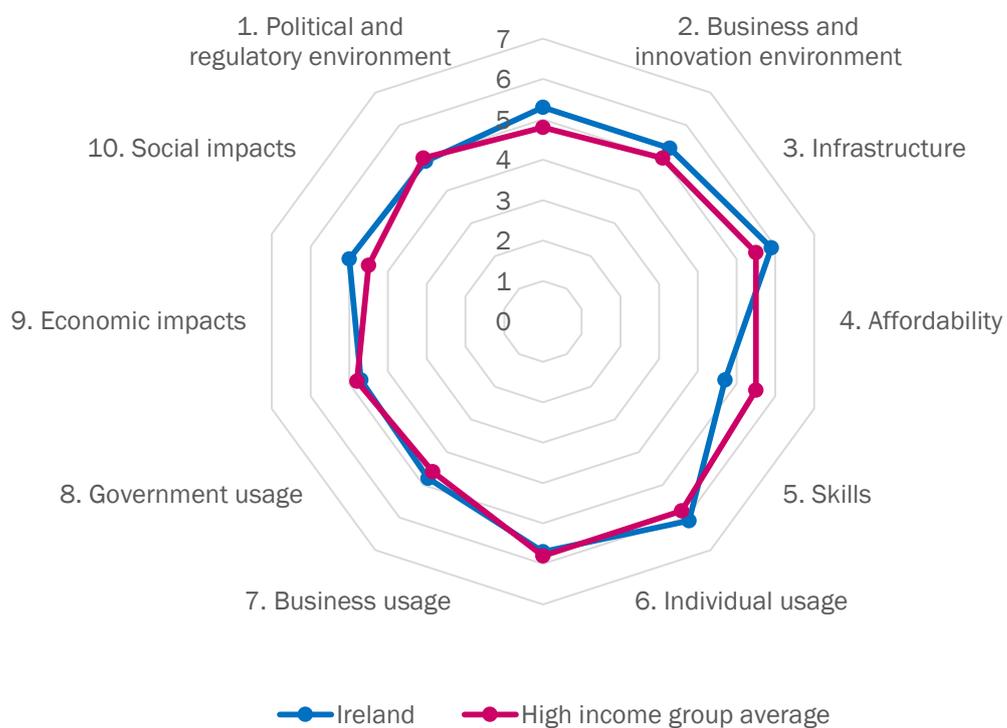
United Kingdom

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	8	5.6
Networked Readiness Index 2014 (out of 148)	9	5.5
Networked Readiness Index 2013 (out of 144)	7	5.6
A. Environment subindex	4	5.5
1st pillar: Political and regulatory environment	5	5.7
2nd pillar: Business and innovation environment	9	5.4
B. Readiness subindex	21	5.9
3rd pillar: Infrastructure	15	6.3
4th pillar: Affordability	51	5.7
5th pillar: Skills	31	5.6
C. Usage subindex	12	5.6
6th pillar: Individual usage	4	6.6
7th pillar: Business usage	16	5.1
8th pillar: Government usage	16	5.2
D. Impact subindex	9	5.5
9th pillar: Economic impacts	13	5.1
10th pillar: Social impacts	6	5.8



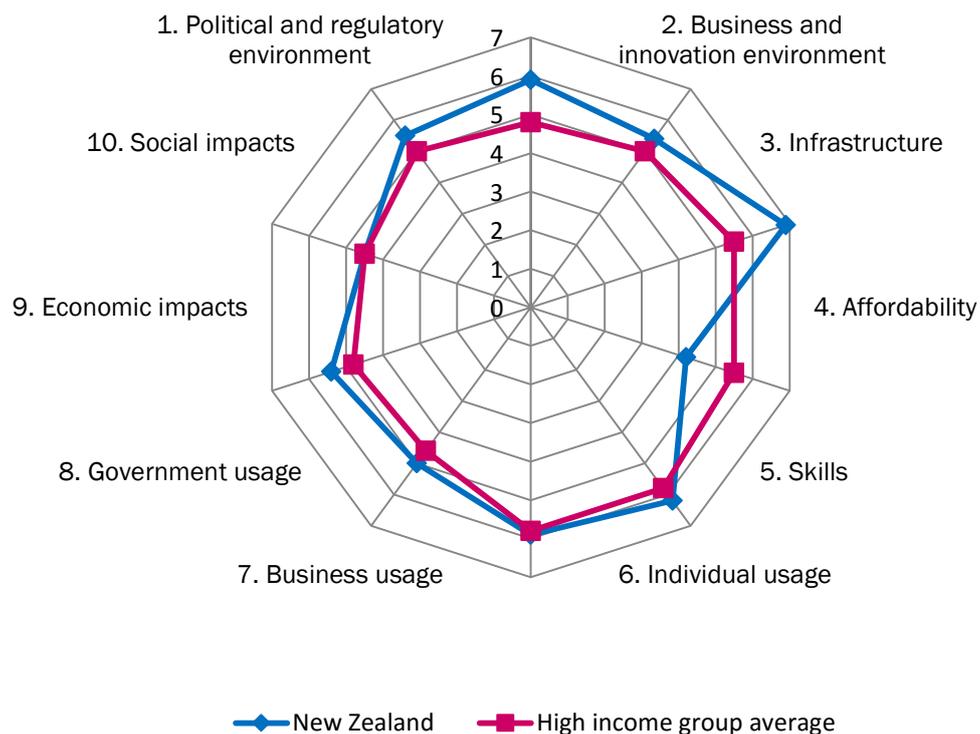
Ireland

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	25	5.2
Networked Readiness Index 2014 (out of 148)	26	5.1
Networked Readiness Index 2013 (out of 144)	27	5.1
A. Environment subindex	12	5.3
1st pillar: Political and regulatory environment	14	5.3
2nd pillar: Business and innovation environment	13	5.3
B. Readiness subindex	29	5.6
3rd pillar: Infrastructure	26	5.9
4th pillar: Affordability	87	4.7
5th pillar: Skills	8	6.1
C. Usage subindex	28	5.1
6th pillar: Individual usage	27	5.7
7th pillar: Business usage	22	4.8
8th pillar: Government usage	33	4.7
D. Impact subindex	24	5.0
9th pillar: Economic impacts	15	5.0
10th pillar: Social impacts	38	4.9



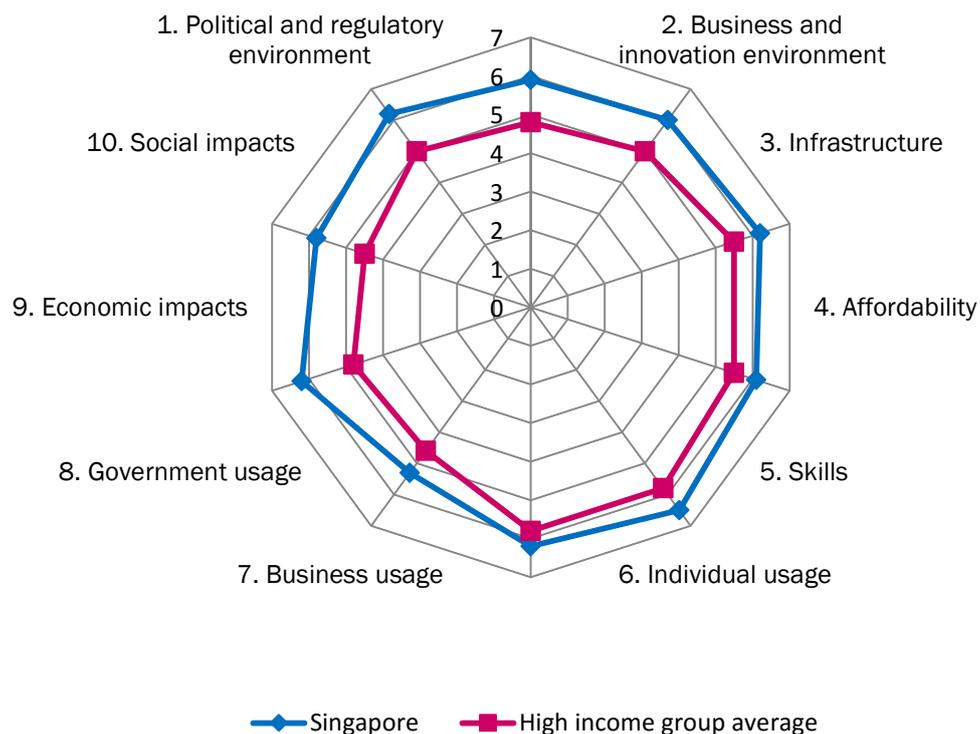
New Zealand

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	17	5.5
Networked Readiness Index 2014 (out of 148)	20	5.3
Networked Readiness Index 2013 (out of 144)	20	5.2
A. Environment subindex	2	5.7
1st pillar: Political and regulatory environment	1	5.9
2nd pillar: Business and innovation environment	6	5.4
B. Readiness subindex	24	5.8
3rd pillar: Infrastructure	9	6.9
4th pillar: Affordability	101	4.2
5th pillar: Skills	7	6.2
C. Usage subindex	16	5.4
6th pillar: Individual usage	22	5.9
7th pillar: Business usage	19	5.0
8th pillar: Government usage	10	5.4
D. Impact subindex	20	5.0
9th pillar: Economic impacts	26	4.5
10th pillar: Social impacts	15	5.5



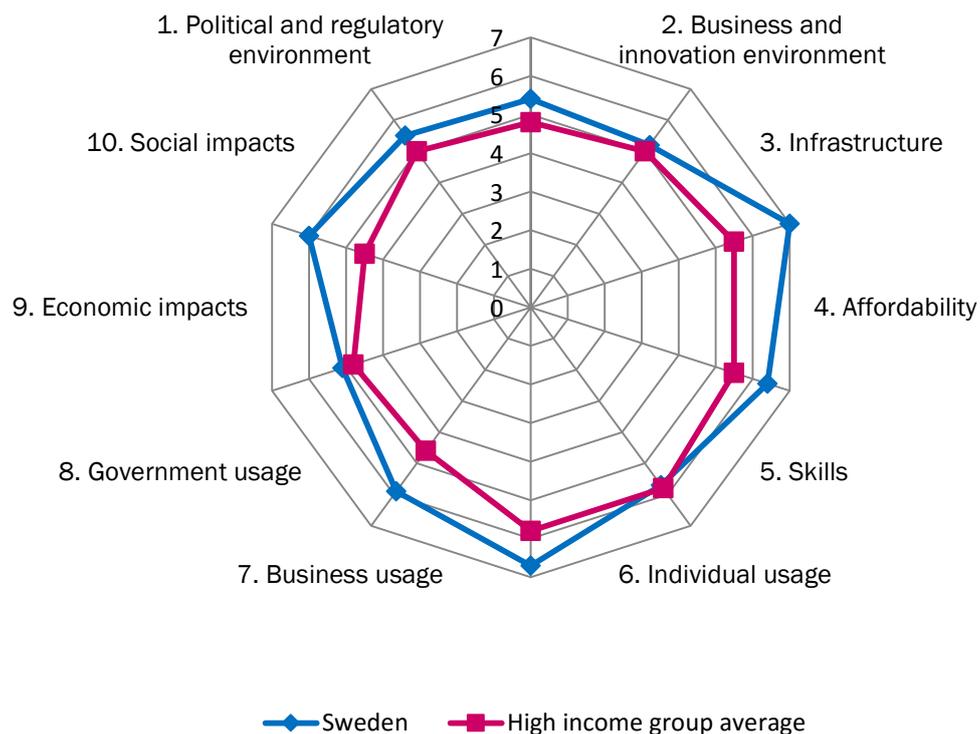
Singapore

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	1	6.0
Networked Readiness Index 2014 (out of 148)	2	6.0
Networked Readiness Index 2013 (out of 144)	2	6.0
A. Environment subindex	1	5.9
1st pillar: Political and regulatory environment	2	5.9
2nd pillar: Business and innovation environment	1	6.0
B. Readiness subindex	8	6.3
3rd pillar: Infrastructure	19	6.2
4th pillar: Affordability	30	6.1
5th pillar: Skills	2	6.5
C. Usage subindex	2	5.9
6th pillar: Individual usage	11	6.2
7th pillar: Business usage	14	5.3
8th pillar: Government usage	1	6.2
D. Impact subindex	1	6.0
9th pillar: Economic impacts	4	5.8
10th pillar: Social impacts	1	6.2



Sweden

	Rank (out of 143)	Value (1–7)
Networked Readiness Index 2015	3	5.8
Networked Readiness Index 2014 (out of 148)	3	5.
Networked Readiness Index 2013 (out of 144)	3	5.9
A. Environment subindex	13	5.3
1st pillar: Political and regulatory environment	10	5.4
2nd pillar: Business and innovation environment	19	5.2
B. Readiness subindex	4	6.4
3rd pillar: Infrastructure	3	7.0
4th pillar: Affordability	18	6.4
5th pillar: Skills	28	5.7
C. Usage subindex	1	5.9
6th pillar: Individual usage	2	6.7
7th pillar: Business usage	3	5.9
8th pillar: Government usage	20	5.1
D. Impact subindex	4	5.7
9th pillar: Economic impacts	2	6.0
10th pillar: Social impacts	16	5.5



Appendix 2: Characteristics of a leading Digital ICT sector

An observation of countries that are considered early adopters and leaders in Digital ICT and who are also demographically similar to Northern Ireland revealed the following attributes.

Components of world class capability	Observation
A Digital ICT Strategy	Leading countries have in place an industry advocate(s) who advise government on the development of its Digital ICT sector. They also have a focused strategy and action plan that is focused on harnessing the opportunities the Digital ICT sector and its impact on their region's economic development prospects. Singapore for example bases its economic strategy around mobile technologies due to the high usage of mobile devices by its population – it is a world leader of new mobile technologies.
Human Capital	Finland and Singapore have a strong focus on education and training drawing on a tech savvy workforce with exemplary project management and system integration strengths, and when required they increase the talent pool by attracting foreign talent to fill essential skill gaps.
Foreign Direct Investment	Midsize markets such as Ireland captured 18% of FDI projects attracted to the EU in 2013. This was less than Germany or France but the size of the projects they managed to secure were bigger in scale. Business Services and Software accounted for 25% of the total tier 2 FDI investment deals. To attract Greenfield FDI projects, level of human capital and the speed in the commercialisation of R&D activities are two essential factors required to be an attractive FDI market.
Leading R&D Capability	Universities in leading countries alliances with ICT companies help to build greater capacity in R&D activity and attract the diversity of PHD students and private sector funding to commercialise ideas faster. In South Korea research intensive companies led by Samsung have modernised the whole economy.
Support for Innovation	Nordic countries have put in place intensive innovation programmes that are targeted on their particular areas of technological strength and the societal needs of the country. Singapore has excellent pro-business conditions and the government co-invests 85% of capital in selected start-ups.
Funding and Investment Activity	Private equity and venture capital is essential to fuel growth in the countries who lead in the Digital ICT sector. A balance between government start-up funding and private equity is a key strategic object in countries like Singapore and Finland.

Components of world class capability	Observation
Building Digital ICT Clusters	Having formal clustering policies in place assists countries like Finland and Sweden retain their Digital ICT strength and world class ranking.
Maintaining Digital Infrastructure	Finland became the first country to make broadband a legal right and has the best digital infrastructure in the world which is highly utilised by its population for business purposes. Finland is reaping the rewards of investing heavily in ICT in the mid-1990s, which it did in response to a financial crisis.
Smart Specialisation	Smart specialisation involves exploiting digital technology to transform government, business and individual processes to deliver significantly better outcomes. Denmark is the leading the way in this strategic approach creating solutions for tomorrow's applications across government and its key industry sectors.
Defining a Brand Identity	Countries highly ranked in the Digital ICT field have in place an underlying "Go to Market" plan and distinct brand. Both are supported by the key values of the sector's areas of strength and promoted as such. The Nordic countries and Singapore adopt this strategic approach.

Fortunately Northern Ireland has the majority of the key components already in place. What is required now is to assemble the components in such a manner that it will elevate Northern Ireland's status to a leading digital society and a producer of world-class digital technology innovations.

To build a world class capability within the Digital ICT sector a number of key components are essential to foster innovation and entrepreneurship in the private sector and to help policy makers make informed choices about future funding decisions.

The rest of this section details the ten key components needed to build a competitive, world class Digital ICT sector in Northern Ireland.

A deliberate, committed and co-ordinated delivery strategy

What is it?

A strategy is an iterative process by which a country, region or organisation focuses on its key capabilities to build its competitive advantage. For the purpose of this report it is suggested a deliberate strategy has been the approach used by leading nations to focus on their key strengths in Digital ICT that has enabled a digital economy in their region. Analysis across leading countries determined that the top nations all had a centrally co-ordinated delivery strategy that was aligned to the country's programme for government. The countries who took a committed strategic approach and built world class capacity and status did so by doing the following:

- Appointing an advocate to lead the development of the Digital ICT sector.
- Implementing a targeted talent strategy that addresses how talent will be attracted and grown within the sector as well as how talent will be attracted from outside their region.
- Maintaining network readiness owning a Digital Technology infrastructure which is advanced and accessible to almost everyone.
- Providing access to funding to supporting start-up growth – with funding coming from both public and private venture capital sources.
- Focusing growth in key Digital ICT areas of capability by following the principles of a smart specialisation strategy.

Who is doing it well?

Ranked as first for the availability of latest technologies⁵⁰, Finland's vision was to be an equitable and inclusive information society, providing all its citizens and businesses with high speed connections and opening up its data to promote sustainable development in new technologies.

Singapore's government developed a clear Digital ICT strategy based on an objective to offer the best online services in the world using mobile technology. Success in achieving the best in the world vision is linked to mobile devices being the medium of choice by most, if not all its citizens to access the internet and use digital services. The Republic of Ireland's focused strategic approach to attract top tier FDI's, targeting ten of the top ten technology companies in the world to set up operations in the region, achieved its key objective to build its ICT ecosystem and to make Ireland a global ICT powerhouse. Estonia's full scale cyber-attack in 2007 was the impetus to push for digital leadership as a

⁵⁰ World Economic Forum Technology Report 2015

strategic cornerstone for e-governance resulting in Estonia becoming a world leading best practice example in the delivery of digital public sector services.

How does Northern Ireland compare?

Many of the components to deliver a purposeful Digital ICT strategy for the Digital ICT sector in Northern Ireland are in place yet they are diverse, unharnessed and need to be pulled together in an integrated and inclusive manner to realise the full value digital technologies have for the Northern Ireland economy. There is a clear weakness in the current planning, including the absence of a committed delivery plan that sets out:

- **Leadership;** identifying the need for an advocate to direct and promote the Digital ICT sector;
- **A fresh and bold ambition and vision for the Digital ICT sector;** to make digital transformation in all sectors a level 1 strategic priority in the next Programme for Government defining the priority focus areas that need to be progressed over a three to five year and beyond time horizon,
- **A clear talent strategy;** that will improve educational outcomes in schools and higher education, switching resources currently focused on classroom technology to facilitate teacher education and professional development to achieve a long term sustainable impact. Recruit global talent to the sector in mid to senior levels.
- **Measurement and promotion of success;** coordinate and identify the key success factors on which to measure Northern Ireland's advances in Digital ICT highlighting and promoting the economic impact they have regionally, nationally and globally.

Human Capital

What is it?

The concept of human capital recognizes that not all labour is equal and that the quality of employees can be improved by investing in them.⁵¹

Analysis of countries considered to be developing and retaining world class talent capability demonstrates that they have put in place a number of underpinning measures to invest in Digital ICT skills. These include:

- Creating incentives to attract a higher number of students to undertake Science, Technology, Engineering and Maths (STEM) subjects at both further and higher education levels
- Creating a strong alignment between academia and industry to correlate the curriculum with industry requirements
- Increasing the number of high-achieving (STEM) students attracted to careers in the Digital ICT sector
- Providing a range of entry points for those of working aged between to choose careers in the Digital ICT sector.

Who is doing it well?

Finland has a significant focus on education and training in ICT to provide a skilled workforce to its rich start up scene and FDI's who have established R&D centres in the region. Singapore's positioning as a "Living Digital Hub" draws on its tech-savvy workforce who have traditional strengths in project management and systems integration but it relies on foreign talent drawn from its access to large regional markets such as China, Korea and Australia. Other regions who have successfully positioned themselves as ICT and Digital economies such as the Republic of Ireland, Tech City in GB or Silicon Valley in the US, have in place a skills investment plan to meet their workforce demands by attracting external resources into their regions, with non-indigenous workers forming as much as 25-50% of the workforce.

The World Economic Forum Human Capital Index⁵² measures a country's human capital on their ability to develop and deploy healthy, educated and able workers through four distinct pillars: Education; Health and Wellness; Workforce and Employment; and Enabling Environment. Switzerland topped the index in 2015, followed by Finland (2nd) and Singapore (3rd). Six of the remaining seven countries in the top 10 are in northern Europe, including Germany (6th) and the United Kingdom (8th)⁵³.

⁵¹ <http://www.investopedia.com/terms/h/humancapital.asp>

⁵² http://www3.weforum.org/docs/WEF_Human_Capital_Report_2015.pdf

⁵³ ibid

In comparison the Digital Economy and Society Index (DESI) that tracks the evolution of EU Member States digital competitiveness, found that in 2015 Luxemburg, Finland and Sweden score the highest for basic skills and usage of digital skills, while Ireland and the UK score the best for advanced skills and development. average.

How does Northern Ireland compare?

Across the C-suite executives report high expectations for digital's impact on company growth and high performing companies are reallocating their resources and their best people to digital work. Challenges relating to scale, the volume of industry ready talent, in addition to retaining and attracting skilled digital technologists and data scientists to Northern Ireland, act as main barriers to building capacity and comparative advantage in the sector. The potential to recruit more talent from outside of Northern Ireland offers a genuine opportunity to address the widening talent gap, and exploring avenues such as multi diversification or the fusion of arts with science could introduce scale, diversity and innovation into the sector.

Since 2009 applications to computing related disciplines have increased by approximately 90%⁵⁴ highlighting the success of encouraging and influencing undergraduates to consider the field computer science as their first degree. Queen's University Belfast and the Ulster University (UU) have begun to address the deficit for skilled professionals by putting in place MSc Computing conversion courses supported by the Department for Education and Learning (DEL). However, recent budget cuts have led to a reduction in other courses.

The six Further and Higher Education colleges offer a wide range of Digital ICT programmes including professional vendor qualifications such as Cisco, Microsoft and CompTIA certifications to address sector entry level demand. Sectoral partnerships have been set up to deliver and monitor new apprenticeship programmes. The role of the Sectoral Partnership is to ensure the vocational apprenticeships are economically relevant, have sufficient breath to support portability and progression, and that they build the capacity of the apprentice model and its operation.

The talent challenge is a persistent one and given the way in which digital trends accelerate business change, the continued demand for suitably qualified and skilled individuals will remain a priority issue.

Foreign Direct Investment

What is it?

Foreign Direct Investment (FDI) refers to the inward investment (inflows) made by companies who set up an operations or R&D facilities in a foreign country. Countries with

⁵⁴ http://www.e-skills.com/Com/NorthernIreland/BringITOnNI_ProgressReport_2013-14.pdf

world-class Digital ICT capability have successfully leveraged Tier 1 FDI investments to accelerate the growth of their economy, where it:

- adds value to the local economy through creating high-value jobs and supporting skills development
- participates in R&D and product development
- engages with local education establishments to align industry skills requirements with university outputs
- trades with the indigenous sector and incorporates indigenous companies into their supply chain
- engages in acquisition activity within the indigenous sector.

Who is doing it well?

According to the EY European Attractiveness Survey 2015, the UK, Germany, France, Spain and Belgium together shared 59% of FDI projects in the EU in 2013. Midsized markets such as Ireland captured 18% of projects while attracting fewer but bigger FDI projects. Business services and software continued to be the number 2 FDI sectors in Europe accounting for 25% of total investment decisions in 2013.⁵⁵

The flags on the podium remain the same
Top 10 countries by FDI projects

		2013	2014	Change %
	UK	799	887	11%
	Germany	701	763	9%
	France	515	608	18%
	Spain	221	232	5%
	Belgium	175	198	13%
	Netherlands	161	149	-7%
	Poland	107	132	23%
	Russia	114	125	10%
	Turkey	98	109	11%
	Ireland	111	106	-5%
	Other	955	1,032	8%
	Total	3,957	4,341	10%

Top 10 countries by FDI jobs creation

		2013	2014	Change %
	UK	27,953	31,198	12%
	Russia	13,621	18,248	34%
	Poland	13,862	15,485	12%
	France	14,122	12,577	-11%
	Germany	10,350	11,327	9%
	Romania	6,157	10,892	77%
	Spain	11,138	9,750	-12%
	Turkey	8,696	8,175	-6%
	Slovakia	3,493	7,978	128%
	Ireland	6,895	7,306	6%
	Other	49,996	52,647	5%
	Total	166,283	185,583	12%

Source: EY's Global Investment Monitor, 2015.

Source: <http://www.ey.com/GL/en/Issues/Business-environment/ey-european-attractiveness-survey-2015-key-findings>

Interest to invest in the BRIC countries (Brazil, Russia, India and China) has reduced slightly according to EY, in favour of Northern Europe due mainly to a favourable upturn

⁵⁵ <http://www.ey.com/GL/en/Issues/Business-environment/ey-european-attractiveness-survey-2015>

in mergers and acquisitions (M&A) and a weakening Euro, making this type of FDI projects more affordable⁵⁶. However the US, India and Russia continue to be an attractive market for Greenfield FDI investors due to the scale of human capital and speed of commercialisation of R&D activities.⁵⁷

How does Northern Ireland compare?

Northern Ireland has a significant strength and proven ability to attract tier 1 FDI boasting a world class clusters in a variety of sectors. Invest NI report at almost 75% of new inward investors have already reinvested in Northern Ireland or they are gearing-up to invest more⁵⁸. The Digital ICT sector is recognised as a key driver of growth for Northern Ireland and to sustain this position, a balanced argument for a measured government policy on FDI attraction is required to explicitly state the quantity and type of investors that are needed to fill gaps in the current ecosystem, with a particular attention being paid to the current deficit of skilled professionals in the Digital ICT sector.

Research and Development

What is it?

Research and Development (R&D) provides one of the key inputs into firms' innovation activity. Research and development is one of the means by which business can experience future growth by developing new products or processes to improve and expand their operations. Not only can R&D provide the new knowledge or technological discovery which might drive innovation there is also substantial evidence that R&D personnel are important in enabling firms to identify external knowledge or technologies which may help to develop the firm's own innovation⁵⁹.

Research and development is predominately undertaken by universities, research institutions or by businesses in order to develop Intellectual Property (IP) and Intellectual Assets (IA) for market commercialisation.

Who is doing it well?

Whilst the US has the highest aggregate levels of R&D investment, Finland is considered to be one of the world's most digitally-ready regions.⁶⁰ It has an excellent track record in the commercialisation of R&D, and is investing a greater percentage of its GDP into R&D than the US. In South Korea, research intensive companies led by Samsung have

⁵⁶ <http://www.ey.com/GL/en/Issues/Business-environment/ey-european-attractiveness-survey-2015>

⁵⁷ Recent trends in FDI activity in Europe. www.dbreserch.com

⁵⁸ www.investni.com/trackrecord

⁵⁹ <http://www.enterpriseresearch.ac.uk/wp-content/uploads/2015/05/Benchmarking-Local-Innovation1.pdf>

⁶⁰ World Economic Forum Technology Report 2015

modernised the whole economy. Samsung's annual spend on Digital ICT R&D is \$26.96billion⁶¹.

Finland has the highest number of ICT-related patent applications per capita globally and it established the Tekes programme to focus and promote R&D in specific target areas. New Zealand's ICT sector has grown substantially, driven forward an ambitious R&D agenda. The Mosaic Innovation Network provides one-on-one R&D opportunities to firms by matching them with world-class enabling technologies, technical skills and applied professionals.

How does Northern Ireland compare?

Academic research capability

The quality of research conducted by QUB and UU is measured regularly as part of a UK-wide research assessment exercise, most recently the REF 2014. This was formerly the Research Assessment Exercise (RAE) 2008. The REF results were published in December 2014. A further summary of the REF 2014 results (Intensity, Power and GPA) has been provided in [Appendix 3](#).

Computer Science & Informatics

QUB and UU are ranked at 28th and 53rd in the UK when viewed through Research Intensity lens. However when viewed by Research Power QUB and UU are ranked 34th and 17th in the UK respectively. The Grade Point Average (GPA) indicates that QUB's score has increased 15% since 2008 and UU's score has increased by 10% over the same period.

Electrical & Electronic Engineering, Metallurgy & Materials

QUB and UU are ranked at 8th and 30th in the UK when viewed through Research Intensity lens. Accordingly when viewed by Research Power QUB and UU are ranked at 13th and 27th respectively.

Support for innovation

What is it?

Innovation is the successful generation and exploitation of new ideas. It is about transforming creative thinking into new products, new and improved processes and technologies to support new ways of doing business. Innovation is critical because it is an integral part of a virtuous circle. It drives research and development, which in turns leads

⁶¹ The Bloomberg Innovation Index 2015

to economic growth. Companies who are innovative are more productive, growing sales and employment twice as fast as their non-innovating competitors⁶².

Who is doing it well?

Nordic countries are ranked highly as the best performing countries in innovation. Both Sweden and Finland have put in place extensive programmes (Vinnova and Tekes respectfully) that seek to build innovation capacity for sustainable growth. Common characteristics across both programmes included:

- Targeting innovation on specific areas of strength and societal needs of the country
- Providing calls for innovation and R&D in specific subject areas
- Providing business mentoring
- Supporting organisations access funds for innovation
- Providing prototyping and testing facilities for new ideas
- Funding public sector bodies and matching them with private sector organisations to progress new ideas.

Singapore is regarded as having excellent pro-business and pro-innovation conditions. The government provides assistance to early stage start-ups through the 'Technology Incubation Scheme' which co-invests up to 85% of capital in selected start-ups, capped at the equivalent of \$400,000 (or £253,840) in 2015. New Zealand has put in place support networks to match local business interests with advice and guidance from professionals to assist nurture and accelerate the progression of start-ups.

How does Northern Ireland compare?

September 2014, the Northern Ireland Executive agreed the Innovation Strategy for Northern Ireland 2014-2025 which states that Northern Ireland, by 2025, will be recognised as an innovation hub and will be one of the UK's leading high-growth, knowledge-based regions which embraces creativity and innovation at all levels of society.

The focus on innovation is growing in Northern Ireland however it lags behind exemplar EU regions in terms of innovative active businesses and the level of innovation or the absorption of funding to support innovation. Northern Ireland is currently considered an Innovation follower ranked 12th out of the 12 in the UK Regional Innovation Ranking that identifies the percentage of companies in a region that are innovation active. By 2025 the goal for Northern Ireland is to be ranked in the top five and to also shift from an Innovation Follower to become an Innovation Leader in the European annual benchmark of innovation performance. An important consideration, alongside the provision of funding to achieve Northern Ireland's Innovation aspirations, is the creation of an

⁶² <http://www.detini.gov.uk/innovation-strategy-2014-2025.pdf>

innovative culture that is nurtured with business mentoring support. Innovate UK is the UK's main innovation funder and works with Invest NI & DETI to offer a range of support methods for NI businesses and many of their "thematic priorities" offer opportunities for the Digital ICT sector, so the funding mechanism is already in place.

Funding and Investment

What is it?

Investment funding is essential for innovation and R&D, particularly at the seed and early stages of business development where universities, start-ups and SMEs face many financial constraints because of their inherent riskiness and weaknesses. A report recently published by OECD presents evidence which shows that innovative SMEs in the Euro area considered access to finance one of their most pressing problems following the sovereign debt crisis in 2011⁶³.

Who is doing it well?

World-class regions combine state funding alongside the attraction of private equity and venture capital to fuel growth. For example, Singapore has been working towards striking a balance between sufficient government start-up funding and attraction of private equity. They are providing \$79m (£51.72m as at 2015) worth of funding for start-up activity as part of a \$12bn (or £9.1bn as at 2015) pledge towards R&D.

Finland, ranked 2nd in the European competitiveness report in relation to availability of finance, combines private company funding alongside government funding and have established a number of agencies to distribute and align funding. Every year, Tekes, Finland's main funding organisation finances some 1,500 business research and development projects, and almost 600 public research projects at universities, research institutes and HE institutions. Across the rest of the UK and ROI, funding innovation is a major priority. All regions in the UK offer a range of research funding and support. This is generally tailored to business size (i.e. whether SMEs or large companies) and targeted towards different stages in the R&D and innovation process, for example feasibility studies, pre-production development, prototype development or commercialisation. In Scotland and Wales, these elements are woven into their current economic recovery strategies.

How does Northern Ireland compare?

The European Commission classifies Northern Ireland as a 'low user with low rates of use of Structural Funding (SF) under research, technological development and innovation

⁶³ <http://www.oecd.org/sti/outlook/e-outlook/stipolicyprofiles/competencetoinnovate/financingbusinessrdandinnovation.htm>

priorities. In this respect, Northern Ireland does not perform as well as the Republic of Ireland or a number of regions in the UK. Whilst work has been progressed by Invest NI and DETI to improve access to funding to support organisations and research institutions to gain greater access to Horizon2020 and Innovate UK funding, Northern Ireland still lags behind the rest of the UK in terms of the absorption of available funding.

Access to private finance is key to all sectors in the knowledge economy, and especially the Digital ICT sector, where the ability to take new products to market quickly can deliver rapid growth. The Northern Ireland sector is characterised by a large number of small value funding deals, and indeed the total value of VC deals is at the lowest since 2005. In addition, whilst venture capital funding is available, it lacks the scale of that available in other regions in the UK and the RoI.

Building effective Digital ICT clusters

What is it?

The Economic Forum for Competitiveness⁶⁴ defines clustering as ‘a group of companies sharing local resources, using similar technologies, and forming linkages and alliances’. These linkages can take the form of buyer-supplier relationships, sharing of employees, joint marketing, training, or research initiatives, associations, and lobbying.

Formal clustering stimulates growth, fosters innovation, creates a brand and improves a region’s attractiveness to new and existing investors. The most successful clusters establish formal links between firms and between the private sector firms and the mainly public-sector providers of important local sources of competitive advantage – schools, universities, research centres, venture capitalists and regulators.

Who is doing it well?

Countries such as Finland and Sweden have advanced clustering policies in place, which correlate to the strength of their innovation. The Swedish Government has established a Globalisation Council to promote a deeper knowledge of globalisation issues, draw up economic policy strategies and broaden public dialogue about what needs to be done to ensure that Sweden can compete successfully in a world marked by continued rapid globalisation. The Council comprises representatives from the business sector, the Government, social partners, the government administration, the media and the research community.

How does Northern Ireland compare?

Northern Ireland has demonstrable strengths in clustering, as is further evidenced by the success of NISP and CSIT (Centre for Secure Information Technology) is widely regarded as having world-class capability in the absence of a formal clustering policy. However,

⁶⁴ <http://www.ecgroup.com/methodology/cluster.htm>

whilst it is acknowledged that there are pockets of excellence in the other areas, such as the work undertaken by Ulster University's Computer Science Research Institute into digital networks design, it is acknowledged that there is an opportunity to achieve more through formal clustering to assist and progress R&D and promote capability to a global marketplace.

Strength of underlying Digital ICT infrastructure

What is it?

Digital ICT infrastructure supports the use and connections between content, data, hardware and software, much of which can be shared over the internet. Digital infrastructure includes data and software and the mechanisms needed to enable them to work together seamlessly so that they can be shared, managed, combined and collaborations can take place⁶⁵.

Who is doing it well?

World-class regions combine state funding alongside the attraction of private equity and venture capital to fuel growth. For example, Singapore has been steadily advancing in developing a world-class digital infrastructure, through public-private partnerships, to entrench its status as a regional communications hub. Through ongoing investment, it remains an attractive destination for start-ups, and for private equity and venture capital.

Finland became the first country to make broadband a legal right in 2010 and has an outstanding ICT and Digital infrastructure, viewed as the best in the world, which is highly utilised by its population for business. Denmark also has excellent ICT and Digital infrastructures with almost universal Internet use across its population, and almost every business utilises broadband further supporting economic growth.

How does Northern Ireland compare?

Over the past 5 years there has been considerable investment in Northern Ireland's communication infrastructure, enabling it to compete on a level playing field with other advanced economies. Upwards of 95% of premises already have access to high speed cable and fibre to the cabinet (FTTC), which provides speeds between 25 and 100 megabits. Northern Ireland has one of the highest levels of superfast broadband access in Europe, and competes well with regions across the globe.

4G mobile access continues to be deployed across the region, with coverage exceeding 95% of premises. This combined with increased deployment of WIFI services, provides an excellent platform for mobile users. In addition to the mainstream technologies of direct

⁶⁵ http://itlaw.wikia.com/wiki/Digital_infrastructure

fibre, FTTC and cable, Northern Ireland has been proactive in exploiting and deploying Wimax, Microwave and satellite technologies. Combined with the mainstream infrastructure, this means there is nowhere in Northern Ireland (assuming it has electricity), which cannot be connected to the global digital environment.

The communications infrastructure deployed in Northern Ireland provides an excellent platform for the development of SMART government and citizen services, including health and education. To be effective, it is imperative that a proactive approach is taken to the exploitation of this digital opportunity, to make Northern Ireland a recognised exemplar region, which in turn will attract additional investment into the economy.

Smart specialisation – developing an industry focus

What is it?

Smart specialisation is a policy concept adopted by the European Union designed to promote the efficient and effective use of public investment in research. The aim of the policy is to boost regional innovation in order to achieve economic growth and prosperity, by enabling EU regions to focus on their strengths to identify the key areas, activities or technological domains where they are likely to enjoy competitive advantage. More generally, smart specialisation involves a process of developing a vision, identifying competitive advantage, setting strategic priorities and making use of smart policies to maximise the knowledge-based development potential of any region, strong or weak, high-tech or low-tech.⁶⁶

Who is doing it well?

Denmark is focusing on growing its ecosystem⁶⁷ through building on its industry strengths. Its' Digital ICT industry is particularly strong when it comes to developing solutions for tomorrow's applications across industries such as health and welfare, energy, manufacturing, e-Trade and e-Government, and finance technology. In Finland, in order to design a national strategy, a vertical link was formed between the National Innovation Strategy, the Ministry of Employment and Economy Corporate Strategy and Sectoral Strategies, the Finnish Funding Agency for Technology and Innovation Investment Strategy (Tekes) and the Regional Innovation Strategies.

In Estonia, ICT companies have a very strong association of enterprises – Estonian Association of Information Technology and Telecommunications plays a leading role in cluster and education development. The Estonian ICT Cluster aim to offer highly functional, reliable services and integrated solutions to various industrial sectors and countries based on the complementary experiences existing in the Estonian ICT sector as

⁶⁶ <http://s3platform.jrc.ec.europa.eu/home>

⁶⁷ Danish ICT Industry Innovation for Society, The Danish ICT Ambassador Taskforce – DICTAT, April 2011

a whole. This includes the creation of several world class e-and m-services (the ID-card applications, m-parking solutions) for both public and private sector⁶⁸.

How does Northern Ireland compare?

A Strategic Policy Framework for Smart Specialisation for Northern Ireland was agreed with the EU Commission in July 2013. The framework encompasses a portfolio of existing and proposed policies, including the Programme for Government, Economic Strategy and Innovation Strategy.

In recent years, Northern Ireland has been developing Innovation Policy which aligns with the Smart Specialisation best practice methodology of:

- Analysis of the regional context and potential for innovation
- Governance: Ensuring participation and ownership
- Vision for the future
- Identification of priorities
- Definition of policy mix and action plan
- Monitoring and evaluation⁶⁹

Brand and access to markets

What is it?

ICT capability does not translate into wealth unless there is an underpinning 'go-to' market plan. Deloitte have identified four fundamental components⁷⁰:

- **Market channels:** economic growth is dependent upon generating sales of ICT products and services into local and international markets
- **Focussed marketing of a brand:** countries and companies sell into their target markets based on the strength of their specialisation and brand around those strengths
- **Capacity and capability to sell:** companies must have the capability and commercial acumen to sell effectively into existing and emerging target markets. Agility and the ability to respond to changing market conditions or reconfigure their products or services to remain marketable. An entrepreneurial culture and capability that fosters sales and marketing, that includes mentoring as businesses move from idea generation through to going to market is a key component

⁶⁸ <http://www.oecd.org/sti/inno/smart-specialisation.pdf>

⁶⁹ <https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/link/smart-specialisation-framework-northern-ireland>

⁷⁰ adapted from Deloitte's 100 Routes to Value

- **Understanding demand:** Sales are dependent on having insight into opportunities that exist, and the capacity to take products and services to market to meet the demand.

Who is doing it well?

Countries such as Singapore, Denmark, Ireland and Finland have clear target markets supported by an underlying plan of how to 'go-to-market' and focussed marketing around their regional ICT strengths. Each of these countries has a distinctive ICT brand around areas of strength to promote their regions into both new and existing markets.

Singapore re-capture global mindshare for its ICT industry by positioning itself as a vital Living Digital Hub where innovative and complex ICT solutions are created, tested, commercialised and deployed. Going forward, Singapore also extended its reach to new markets and moved up the value chain in its usage of ICT solutions. This enabled it to achieve our economic targets of: growing ICT contribution to GDP From 7% to 10% and more than doubling employment opportunities. "Infocomm Singapore" is the overarching brand identity that is used to market and brand Singapore's ICT exports in external markets. The aim is to harness the Infocomm capabilities of Singapore's enterprises under a unified brand and to position them successfully in the global market⁷¹.

How does Northern Ireland compare?

The success of Northern Ireland in attracting FDI is testament to the work carried out by Invest NI, DETI, DEL and the Digital ICT sector to develop awareness around Northern Ireland's capabilities in software engineering and to promote this strength globally.

However, there remains an underlying weakness in the recognition of Northern Ireland's specialism's and as a brand.

⁷¹ <https://www.ida.gov.sg>

Appendix 3: REF 2014 Scores

REF summary

Unit of Assessment	QUB		UU				Total #. of institutions
	Research intensity rank	Research power rank (3* & 4*)	GPA	Research intensity rank	Research power rank (3* & 4*)	GPA	
Computer Science & Informatics	28	34	38	53	17	48	89
Electrical & Electronic engineering, Metallurgy & Materials	8	13	=9	30	27	24	37
Mathematical Sciences	19	41	42	NA	NA	NA	53

The research groups within each UOA have been derived from the 2014 REF returns from both universities. There is broad alignment between the research groups and the technology focus areas discussed in sections 5 and 6 of this report.

*Four star Quality that is world-leading in terms of originality, significance and rigour.

*Three star Quality that is internationally excellent in terms of originality, significance and rigour but which falls short of the highest standards of excellence.

REF research groups

Unit of Assessment	QUB Research Groups	UU Research Groups
Computer Science & Informatics	<ul style="list-style-type: none"> • High Performance and Distributed Computing (HPDC) • Knowledge and Data Engineering (KDE) • Speech, Image and Vision Systems (SIVS) 	<ul style="list-style-type: none"> • Artificial Intelligence and Applications • Information and Communication Engineering • Intelligent Systems Research Centre • Smart Environments
Electrical & Electronic engineering, Metallurgy & Materials	<ul style="list-style-type: none"> • High Frequency Electronics (HFE) • Digital Communications (Digi Comms) • Energy, Power and Intelligent Control (EPIC) • Secure Digital Systems (SDS) 	<ul style="list-style-type: none"> • Biomaterials • Functional Materials & Devices • Structural Materials

The 2014 REF results show improvement for both QUB and UU. A direct comparison with the RAE submissions cannot be made across all subject areas due to changes in the UOA, (e.g. merger of Electrical & Electronic engineering, Metallurgy & Materials), however, the table below provides an indication of the improvements made.

Comparison of RAE 2008 and REF results 2014

	Ulster University GPA			Queen's University Belfast GPA		
	RAE 2008	REF 2014	Change	RAE 2008	REF 2014	Change
	★★★★★ ★★★★ ★★★	★★★★★ ★★★★ ★★★		★★★★★ ★★★★	★★★★★ ★★★★	
Computer Science and Informatics	55%	65%	+10%	60%	72%	+12%
Electrical and Electronic Engineering, Metallurgy and Materials	50%	79%	+29%	60%	93%	+33%

The REF 2014 focused on the quality of research being undertaken by the universities. It does not consider the undergraduate teaching demands and contribution to talent development. This is of particular relevance to Computer Science and Informatics, a key course for developing a pipeline of high-calibre talent for the ICT sector.

GPA figures in REF indicate that QUB and UU have a large amount of 'internationally 3*' research which displays scope to increase, progress and push a larger percentage of these areas into the 4* world leading category.

Appendix 4: Universities overview

Queen's University of Belfast

After the release of the REF 2014 results, the Times Higher Education REF 2014 rankings in terms of Research Intensity placed QUB joint 8th in the UK.

Alongside the University of Cambridge and the Institute of Cancer Research, Queen's returned over 95% of academic staff, which was the joint third largest percentage of staff returned in the REF2014. The University has 14 subject areas ranked within the UK's top 20 and 76% of its research classified in the top two categories of world leading and internationally excellent.

As mentioned, Units of Assessment covered by REF most relevant to this report are 'Computer Science and Informatics' and 'Electrical and Electronic Engineering, Metallurgy and Materials'.

Queen's has a combined school of Electrical and Electronic Engineering and Computer Science (EEECS) with seven research clusters across the two disciplines. The Institute of Electronics, Communications and Information Technology (ECIT) was established by Queen's in 2004 as a research anchor for the Northern Ireland Science Park with initial funding of over £37M. ECIT employs 180 people and works closely with companies nationally and internationally in an environment that spans "blue-skies" research to industrial "proof-of-concept". Four of the seven research clusters from EEECS are based in ECIT. These are High Frequency Electronic Systems, Wireless Communications, Secure Digital Systems and Speech Image and Vision Systems.

ECIT has a strong track record of research commercialisation, having created 10 "spin-out" companies, and facilitated more than 25 "spin-in" (externally created IT companies) at the early stage of their development. ECIT has numerous case studies of capacity support for Industrial partners and in particular local SMEs (be that contract research, co-tendering, co-founding, IP licensing etc.). ECIT is actively involved in a number of European Research programs (FP7 and Horizon 2020) and has extensive links around the world.

The Centre for Secure Information Technologies (CSIT) is an EPSRC/Innovate UK Innovation and Knowledge Centre (IKC) and was established in 2009 at the ECIT Institute with initial funding in the region of £30M. A critical component to the UK's strategy for emerging technology, CSIT is accelerating the exploitation of cyber security innovation and acting as the nucleating point for an emerging cyber security cluster. CSIT's activities are shaped by; Member Companies, government stakeholders and a growing list of Associate Members (currently 16 SMEs).

The ECIT Institute and indeed CSIT, maintain a balanced focus on Commercialisation with Research Excellence as recorded by the significant innovation impact and strong results in REF2014, particularly for Electrical and Electronic Engineering related research.

Computer Science and Informatics Research Intensity rank of 28/89 shows Queen's as above average in this respect. This highlights that QUB has a solid base for 'internationally excellent' research however there is scope for improvement so that over the next few years this research can progress and become 'world-leading.'

Electrical and Electronic Engineering, Metallurgy and Materials results highlights that Queen's fares much better in this unit, by being ranked 8/37. 93% of research assessed was judged as 'world-leading' or 'internationally excellent'. It should also be noted that when Electrical and Electronic Engineering (EEE) is separated from this combined Unit of Assessment, Queen's ranks 4th in the UK for EEE, highlighting the strengths of this department.

University of Ulster

Established in 2004, the Computer Science Research Institute (CSRI) at the University of Ulster is at the centre of the University's institutional strategy to facilitate greater selectivity in research support. The Institute currently comprises over 50 academic staff, approximately 30 contract research staff, and 90 PhD students across three Schools in the Faculty of Computing and Engineering: Schools of Computing and Information Engineering; Computing and Intelligent Systems; and Computing and Mathematics.

Over the last 10 years CSRI has more than doubled in academic and research staff, in the number of PhD students graduating annually, and in the volume of highly competitive external research funding that we attract. Within the last 5 years CSRI has completed extensive new research facilities, with over £12.6M of infrastructural investment, and with a further £8.5M external funding to develop new infrastructure recently secured to expand and sustain research activity over the next 5-year period. 90% of Computer Science research environment at Ulster is rated world-leading or internationally excellent in REF2014, increased from 64.5% in RAE2008.

CSRI conducts internationally excellent and world-leading research in intelligent systems, assistive technologies, next generation networks, and semantic analytics, within four highly active research groups and Centres:

Information and Communications Engineering (ICE) research group

Focusing on knowledge engineering and data analytics, applications in healthcare modelling and computer vision, and increasingly, performance management of next generation networks, systems and services

Artificial Intelligence and Applications (AIA) research group

Focusing on pattern recognition, reasoning, and semantic analytics, with applications in text mining, intelligent document analysis, ambient assisted living, and security-based scenario recognition

Smart Environments research group (SERG)

Focusing on multi-disciplinary and collaborative research in sensor-based technologies, and applications in behavioural analysis, activity recognition, and assistive technologies for healthcare and independent living

Intelligent Systems Research Centre (ISRC)

Focusing on cognitive robotics, computational neuroscience, and biologically-inspired computation, with applications in robotic systems, neural modelling, and BCI

In Computer Science and Informatics the University of Ulster was the 14th largest submission nationally (top 16%, with FTE staff volume 1.7 times the UK average). Ulster Computer Science was ranked 21st out of 89 universities for research power (top 24%, with research power 1.5 times the UK average), and 17th out of 89 for the total number of FTE staff with 4* or 3* quality research (top 20%, with FTE (4* + 3*) research 1.6 times the UK average).

Appendix 5: 2015 ICT salary overview

Extracted from Grafton Recruitment's 2015 Salary Guide⁷²

Commentary

The IT industry in Northern Ireland is growing, the growth is directed into specific areas of IT such as the need for experienced software developers who have skills with technologies such as Java and C#. As there is a high demand for people with these skills, most large companies are offering above the market salary, as they are being driven by supply and demand.

As more companies start to expand their operations in Northern Ireland, there will be a high demand for highly experienced candidates such as, directors, managers, tech leads amongst others.

As companies look to hire internally for these more senior roles, there will be increased competition for the junior and middle tier roles that open up, leading to above market salary rates.

Salaries

Project Managers and Business Analysts

Job Titles	Northern Ireland Regional (£ 000's)	Belfast City Centre (£ 000's)
Senior Program Manager	65 - 80	70 - 90
Program Manager	55 - 65	60 - 70
Senior Project Manager	40 - 55	45 - 55
Project Manager	35 - 45	35 - 45
Senior Business Analyst	40 - 50	45 - 55
Business Analyst	26 - 34	30 - 36
Systems Analyst	26 - 34	28 - 34

⁷² <http://www.graftonrecruitment.com/downloads/NISalarySurvey2015.pdf>

Infrastructure & Support

Job Titles	Northern Ireland Regional (£ 000's)	Belfast City Centre (£ 000's)
CTO	90+	70 - 120
IT Director	65 - 80	65 - 95
IT Manager	35 - 45	40 - 50
Technical Support Manager	26 - 34	28 - 36
Help Desk Team Leader	20 - 25	22 - 27
Help Desk Support	15 - 19	15 - 22
Field Service Manager	26 - 34	28 - 36
Field Service Engineer (1-3 yrs experience)	20 - 25	20 - 28
Field Service Engineer (3-5 yrs experience)	26 - 34	26 - 38
Network Manager	26 - 34	30 - 38
Network Engineer (1-3 yrs experience)	15 - 19	18 - 24
Network Engineer (3-5 yrs experience)	20 - 25	26 - 32
UNIX Administrator	26 - 34	28 - 36
Citrix Engineer	26 - 34	26 - 36
CISCO Engineer	26 - 34	26 - 36
QA Manager	35 - 45	40 - 50
QA	26 - 34	28 - 36
Software Tester (1-3 yrs experience)	20 - 25	22 - 30
Software Tester (3-5 yrs experience)	26 - 34	30 - 36
Localisation Manager	35 - 40	40 - 45
Release Manager	30 - 35	35 - 45
Senior Localisation Engineer	26 - 34	28 - 36
Localisation Engineer	25 - 30	25 - 32
Technical Writer	25 - 30	25 - 32

Development

Job Titles	Northern Ireland Regional (£ 000's)	Belfast City Centre (£ 000's)
Architect	45 - 60	55 - 70
Senior Architect	55 - 70	60 - 80
Development Manager	65 - 85	70 - 90
.NET Developer	26 - 34	28 - 40
Senior .NET Developer	35 - 45	36 - 45
Dev. Lead	45 - 60	50 - 65
C/C++ (1-3 yrs experience)	26 - 34	28 - 36
C/C++ (3-5 yrs experience)	35 - 45	36 - 50
Java (1-3 yrs experience)	20 - 25	25 - 30
Java (3-5 yrs experience)	26 - 34	30 - 36
Web developer	26 - 34	26 - 36