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ICT HORIZON PANEL REPORT

DRIVING COMPETITIVENESS AND GROWTH

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DRIVING COMPETITIVENESS AND GROWTH

ENSURING THAT NORTHERN IRELAND IS A GLOBALLY RESPECTED CENTRE FOR ICT EXCELLENCE WITHIN A DECADE WILL BE ONE OF OUR MOST IMPORTANT AND WORTHWHILE ECONOMIC PRIORITIES.

After 18 months of intensive work, it is with pleasure that we present our recommendations for accelerating future growth of the ICT sector in Northern Ireland to the Minister for Enterprise, Trade and Investment.

The ICT sector has a crucial contribution to make to economic growth. It can build on Northern Ireland's success over the past decade and, uniquely, information and communications technologies can contribute to success in all other sectors.

Supporting ICT sector goals will mean reviewing our priorities and approach to skills development. As a small economy, Northern Ireland should seek to establish itself as the most adaptable and responsive skills delivery region in Europe. Adaptability will mean employability.

The Horizon ICT Panel believes that Northern Ireland must aim to become a leading knowledge-based economy to achieve its potential. The Horizon ICT Panel has carried out extensive research and drawn on the experience of leading ICT sector businesses such as Asidua, Citi, Allstate, Singularity, Meridio and Polaris. This significant pool of industry knowledge shows that Northern Ireland already has first-class ICT capabilities.

However, ICT is a globalised sector and to remain competitive, regional and geographical divisions are increasingly irrelevant. We now have the potential to turn this state of affairs to its advantage but we now need to 'up our game' and continuously increase the value of our products and services offerings.

The recommendations contained in this report therefore provide government, industry and academia with a blueprint for the development and growth of the ICT sector. By implementing them, there is genuine potential to build an ICT economic entity which if focused on our niche strengths and capabilities can compete with the best in Europe and beyond.

In that regard I believe the report is a valuable instrument in the process of improving our capacity to master the knowledge society and I warmly recommend the report's outputs.

I would like to thank the many people who provided their very valuable time to assist in the production of this report particularly those leaders from industry, academia and government who gave their time, ideas and commitment to assist in its development. I would like to thank Vice Chair of the Panel, Dr Bryan Keating.

Finally I would also like to to acknowledge the work of Colm Reilly and Frank O'Donnell of PA Consulting, who coordinated the industry consultations and played an important role in the compilation of the report.

Ed Vernon
ICT Horizon Panel Chair

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THE ICT FORESIGHT FOR NORTHERN IRELAND

EXECUTIVE SUMMARY

Part 1: Background
ICT is globally recognised as a key driving force for developed economies. The ICT sector forms the 'backbone' of several industries (such as financial services) and it is an important value-adding component of consumer products, such as mobile phones. ICT is today a dominant force in enabling companies to create new products, exploit new distribution channels and deliver differentiated services to customers. ICT is also an important catalyst for social transformation and economic progression.

Northern Ireland sees the growth of the ICT sector as essential to the development of the economy. In Northern Ireland (Northern Ireland), the ICT sector contributes approximately £500[1] million to the economy, making it the third largest sector after Advanced Manufacturing and Sustainable Production and Consumption. There are approximately 750 companies in the ICT sector in Northern Ireland, employing 11,200 IT-specific employees[2]. These 750 companies represent a blend of inward investment and indigenous companies. Over 100 foreign ICT companies have now invested in operations in Northern Ireland. The remaining 600 companies are indigenous companies in the sector including world-class technology companies like Kainos, Meridio, Aepona, First Derivatives, Singularity, Asidua, Latens and Lagan Technology. These companies are particularly active in technology areas including wireless/internet software, financial services software CRM software, and information management software.

This MATRIX Foresight Panel reviewed current research in the ICT sector at a Northern Ireland, national and international level. Based on current trends, three areas where Northern Ireland has the potential to make significant advances, achieve global leadership and establish new platforms of growth that would have high commercial impact were identified. The aim of the Foresight Panel was not simply to augment mainstream ICT themes in Northern Ireland but also to achieve a step change in thinking, with the potential to offer significantly more to the economy in Northern Ireland in terms of global leadership position and economic growth.

1. DETI Statistics 2005
2. This includes IT employees engaged in other sectors. The number within the sector itself is approximately 9,500.

Part 2

The global ICT market in which Northern Ireland plays is changing

The ICT sector is a globalised sector that is constantly changing based on customer and market demands. These changes tend to be brought about by two drivers - firstly, the technology itself makes radical evolutions, and secondly, the market dynamics change in all sectors. Irrespective of this, the following are global characteristics of this sector;

- The ICT sector is a global supply chain as it seeks both new markets and new innovations that will sustain existing markets;
- Application Software will continue to drive the ICT sector globally and this will be underpinned by developing IT services offerings that are commercially and technically robust;
- Throughout the global ICT environment the availability of high quality skills that are both flexible and fast moving are critical;
- The ICT sector is becoming more integrated into the fabric of other industries and society;
- New standards and innovations are changing the structure of the ICT industry. As the global sector changes, skills and capability remain the fundamental drivers and means of achievement; and
- The concept of 'value added' is extending beyond traditional R&D and including elements such as a specific industry focus or customer understanding.

Part 3

Northern Ireland will transform the current ICT sector into a globally-recognised centre of higher value activities, achieving leadership across specific focus areas in Europe by 2010 and global recognition as a leading region by 2015.

This foresight work identified that Northern Ireland needs to transform the existing sector[3] into a centre of higher value-added activities with three specific focus areas that will support the achievement of global recognition. Achieving global recognition in these focus areas requires extensive collaboration at a local and international level and between industry, academia and government. The three focus areas are:

1. Package Application Software

Northern Ireland will transition the existing bespoke software application capability to packaged software that uses new and innovative delivery mechanisms. This focus will be directed towards the global Financial Services, Telecommunications, HealthCare and Security sectors. The mechanism for the achievement of this transition will be the focus on real-time software delivery that will create a European leadership position by 2010 and a global leadership position by 2015. This capability will be supported further by an interdisciplinary programme that determines how packaged software can be applied to the Financial Services, HealthCare, Telecommunications and Security markets.

2. Nearshoring

Northern Ireland will transition the existing Nearshoring (ITO and BPO) operations from transaction-based services to decision-based services with end customer interaction. This focus will be directed towards Financial Services and Health Care markets with captive or BPO markets and an emphasis on HR/IT and administration functions. The mechanism for the achievement of this transition will be the development of world-class Nearshoring capability with a focus on the movement of operations from a transaction-based environment to a decision based environment, which will create more value and involves the management of an entire business process with end customer interaction.

3. High Performance Embedded Systems

High Performance Computing and High Performance Embedded Systems will allow Northern Ireland to further science and technology development and also attract interest from a wide variety of sectors globally. Northern Ireland needs to be in a position to make high-end computing easier and more productive to use and allow for the development and innovation of new generations of performance computing systems and technologies. This will be supported by the Financial Services Nearshoring focus and Northern Ireland creating an internationally-recognised position in High Performance Computing in Financial Services.

The focus on High Performance Embedded Systems extends to cover all sectors including Automotive, Aerospace, Telecommunications, Security Solutions (authentication etc) and Health Care provision (medical devices). It will be important for Northern Ireland to develop a technology roadmap for these embedded systems and also to define a model for how Northern Ireland can exploit world class IP through alliances, affiliations or other trade opportunities.

3. This transformation has already commenced and the signs are already evident within Northern Ireland

Part 4
Conclusions
Given the changes in the global ICT environment and the developments in the Northern Ireland ICT sector in the past 10 years, the potential for exploiting the collaboration between industry, academia and government is great and with this comes a significant opportunity for economic impact in the next decade. This report concludes that:

- Northern Ireland has a reasonably strong enterprise and research base from which it can develop the focus areas. The pace of the global ICT sector with its increased reach and industry focus requires that Northern Ireland places a clear focus on key areas. To be truly 'world class' needs resources to be invested in only a few areas, even allowing for acceleration in the level of funding available. 'World class' does not come cheap but the returns can be enormous over the medium to long-term.
- The transition of basic innovative research to the testing and market introduction of this research outcome remains a bottleneck and this needs to be addressed with sustainably-funded programmes that are industry-driven, incorporate international collaboration and have a clear objective of obtaining global recognition;
- The quality and quantity of skills remain a concern. Skills are the essential ingredient for the Northern Ireland ICT sector. Without the attraction, retention and extension of skills within the sector, it will not be possible to sustain its development. Skills need to be seen in two contexts - the capacity aspect which relates to the availability of resources to allow the sector to grow and the capability of those resources available to ensure the greatest return on investment for the sector; flexibility and fast moving need to be two characteristics on top of capability and capacity.
- Northern Ireland ultimately needs to integrate the focus areas and the overall policy environment into a cluster model which allows for an innovation system that sustains the development of ICT to keep up with a rapidly-changing global environment. This cluster environment could assist the sector address 'framework conditions' such as:
  - Company capacity to absorb and exploit knowledge;
  - Regulatory framework in Northern Ireland;
  - Competition regime and entrepreneurship in Northern Ireland;
  - Access to finance;
  - Science and technology knowledge creation;
  - Networks and collaboration;
  - Access to customers and suppliers; and
  - Collective marketing of ICT as a rewarding and interesting career

Part 5
Recommendations
The ICT sector is important to Northern Ireland and the areas of focus are well within the capability of the sector. The recommendations in this report seek to create an 'eco-system' for the ICT sector whereby Northern Ireland can look to collaborate, both nationally and internationally, in the focus areas to create an evolving knowledge-based specialist sector which can become a reference point for the global sector.

Northern Ireland will focus on the areas of Package Application Software, Nearshoring and High Performance Embedded Systems. In these areas, a number of distinct themes have been identified for leadership positions. To achieve these leadership positions, Northern Ireland needs to create industry-led international collaboration projects with leading ICT centres globally, with a focus on the specific themes. These focus areas should be sustainably-funded (five to 10 years) and create an international leadership position for Northern Ireland in the specific focus areas within the timescale.

Northern Ireland will remain a net importer of commercial intelligence about the global ICT environment and it will be essential to create networks of commercial intelligence on what is happening within the specific focus areas. This commercial intelligence needs to be organised around the development of specific 'roadmaps' for the sector in Northern Ireland that complies with the global roadmaps. These would need to be developed with the relevant stakeholders within Northern Ireland and identified international partners.

The skills agenda is a critical aspect of the ICT sector and within this report a specific roadmap for addressing this is presented.

The policy infrastructure concerning the ICT sector in Northern Ireland needs to be reviewed and re-organised within the context of the creation of an ICT cluster to address the key framework conditions identified.
The overall promotion of ICT as a rewarding and interesting career for employees in this sector and other industries, will be important.

Part 6
The size of the prize
Any work or proposals for investment in this sector must consider in full the economic implications these would have on the sector. Based on the current expansion plans of existing investors, the Northern Ireland ICT sector is projected to grow to 15,000[4] IT employees by the end of 2008. This represents an employment increase of almost 35%, making it comparable with the fastest-developing clusters in the world. The key determining factor in this growth will be the availability of appropriate skills. New inward investment projects secured and indigenous start-up activity will further increase the size

4. OCO ICT Audit 2006

of the ICT sector to an estimated 16,000[5] employees . It is anticipated that the sector could continue to grow at 1,000 employees per annum within the selected focus areas of this report.

Moreover, the sector is currently seeking to increase GVA per employee as there is a limit on the degree of expansion due to capacity constraints. Current GVA per employee could be seen to grow at 5 - 10% per annum based on an investment in high-profile activities. This would dramatically increase the impact of the ICT sector on the Northern Ireland economy.

The implications of all the proposals in this Foresight report will always need to be measured in terms of turnover and productivity gain. Increasing employment in the sector is not identified as the key challenge but rather the increase in GVA is deemed to be the most significant factor. At all times in the deliberations of this report, an effort has been made to ensure that any proposals or recommendations can accomplish economic growth and sustainability. These achievements would need to be seen in the light of any investments to be made.

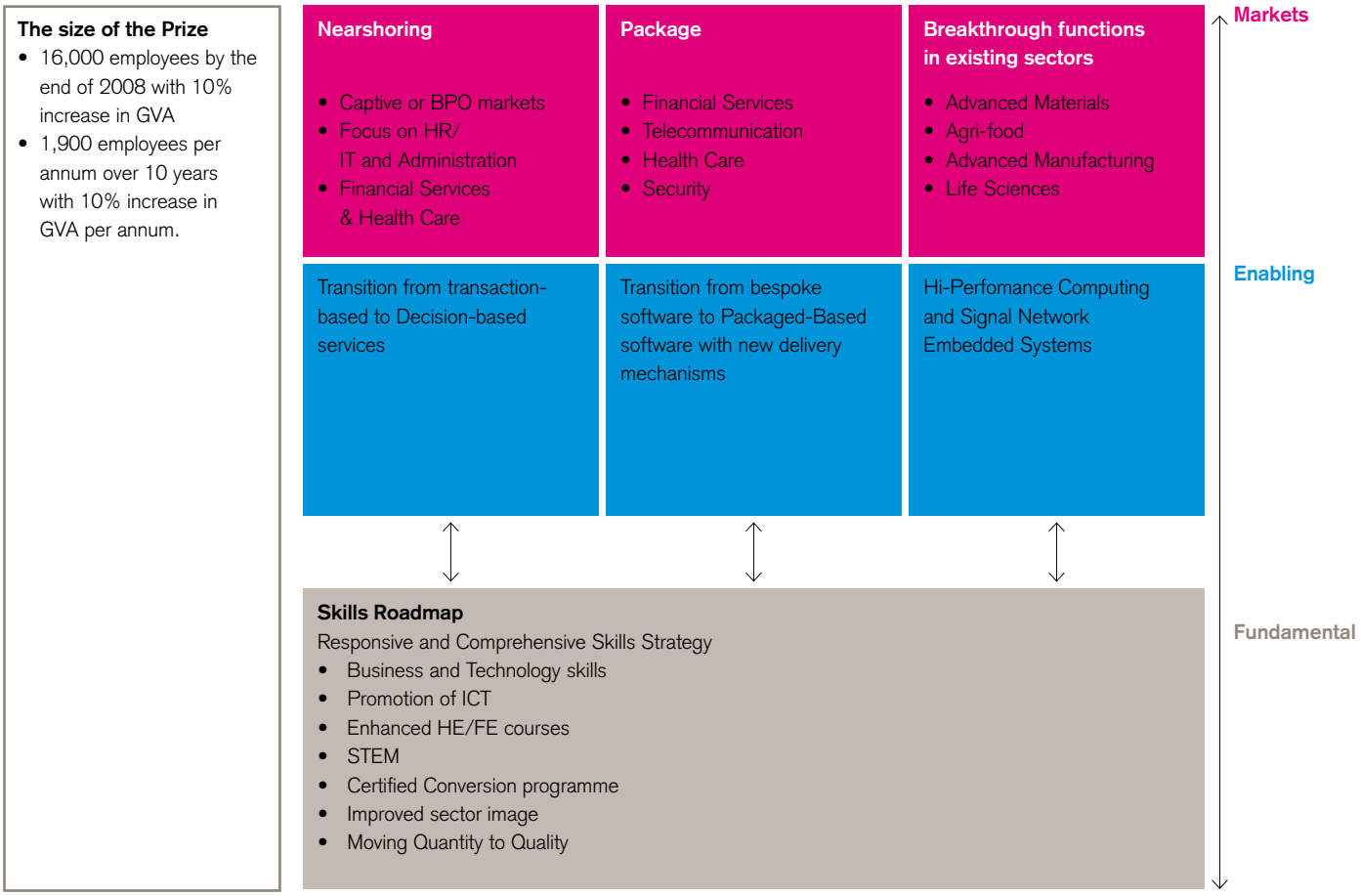
Part 7
Conclusion

The ICT sector is crucial to underpin the further development of all the sectors in Northern Ireland. This is demonstrated clearly by the Foresight work completed by these sectors. Moreover, the capabilities in ICT are also the foundation of global leadership positions for Northern Ireland in specific focus areas which can be used to attract new investments and enterprises to Northern Ireland.

5. OCO ICT Audit 2006

FIGURE 1: A SINGLE REPRESENTATION OF THIS FORESIGHT SUMMARY

Transforming the ICT sector in Northern Ireland to a globally-recognised centre of higher value-added activities, achieving leadership across apecific areas in Europe by 2010 and Global recognition as a leading region by 2015.



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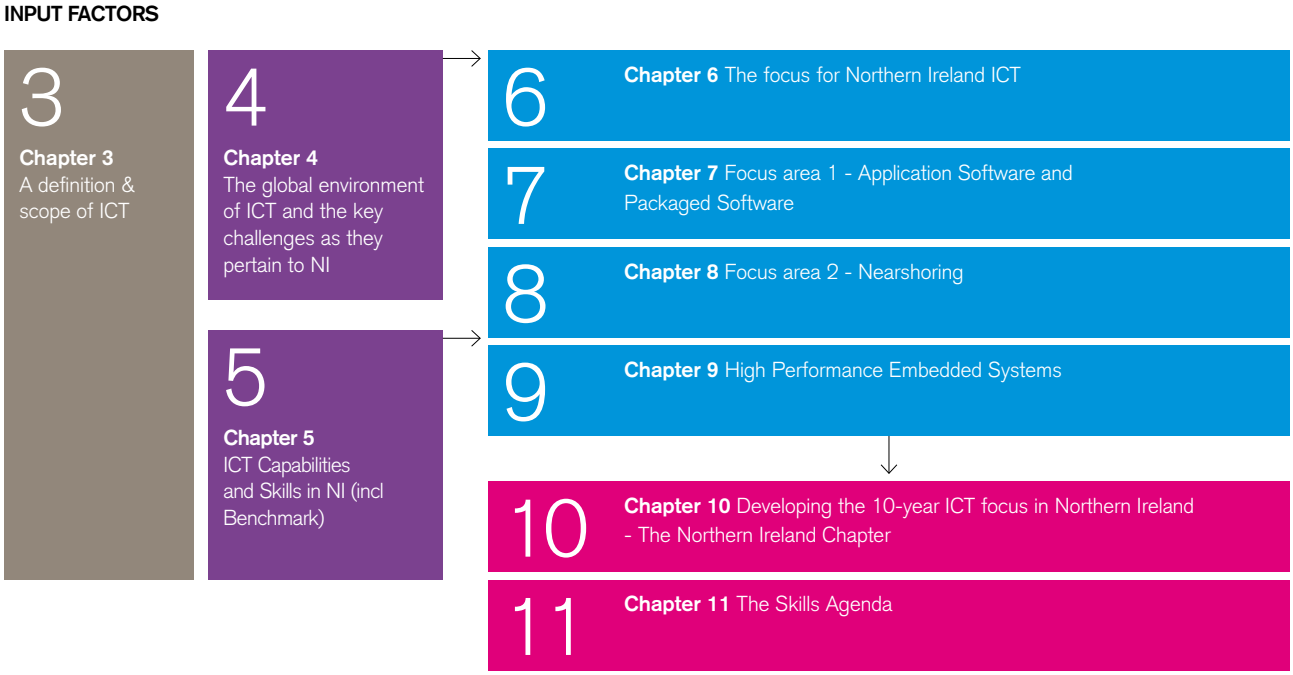
THIS FORESIGHT REPORT

THIS FORESIGHT REPORT LOOKS AT THE ICT SECTOR IN NORTHERN IRELAND AND DEFINES THE FOCUS AREAS. THE FOCUS AREAS ARE DEVELOPED IN TERMS OF TWO-YEAR, FIVE YEAR AND TEN-YEAR HORIZONS. THE REPORT ITSELF BUILDS ON THE TECHNOLOGIES CAPABILITIES STUDY CONDUCTED BY THE DEPARTMENT OF TRADE, ENTERPRISE AND INVESTMENT (DETI) AND THE WORK OF THE HORIZON ICT PANEL. ON OCCASIONS, THE WORK OF THIS PANEL HAS BEEN VALIDATED BY SPECIFIC GROUPINGS ON SOFTWARE, NEARSHORING AND HARDWARE/SYSTEMS.

2

FIGURE 2.1: ICT REPORT NAVIGATION



For the ease of reading, this report has the following navigation as presented in Figure 2.1. There are eight parts in this report and each of them is now discussed in detail below.

Chapter 2: This chapter
It is recognised that this Foresight report is complex in terms of the data it represents and the background to that data. This chapter seeks to provide the reader with clear navigation and a connection between all the individual chapters.

Rationale: This report takes a 'top-down' approach. It defines and scopes the sector, describes the Northern Ireland situation, and then proceeds to develop a concept of Foresight. This concept is based on the evaluation of the global ICT sector and the resident strengths and capabilities in Northern Ireland. From this position, focus areas and leadership areas are identified and these are subsequently developed into recommendations. Each chapter contains a specific set of recommendations pertaining to the content of that chapter.

Approach: This chapter describes each individual chapter in the report and relates them to each other.

Chapter 3: A definition and scope of ICT
In this chapter, the ICT sector is defined and this is expanded to include the specific scope that has been covered by the Northern Ireland Matrix ICT panel. This definition builds on globally accepted definitions of ICT that are

used within all OCED countries. The sector is also sub-divided into categories that allow for international comparisons. Once ICT is defined, the overall context of this report is also presented. Finally, this chapter concludes with a brief overview of the ICT sector in Northern Ireland in terms of employment and GVA.

Rationale: It is important to have a definition of ICT that allows for the fact that ICT is an enabler and a market sector in itself. As the industry is a global industry, it is important that the sub-fields that are used are universally recognised. Finally, it is important to note where the ICT sector is developing from in Northern Ireland as this dictates how further investments can be realised.

Approach: The approach in this chapter has been to ensure compliance with OECD definitions and sub-fields and also to check with specific interests in the USA and other leading ICT industries.

Chapter 4: The global environment of ICT and the key challenges that impact any future direction in Northern Ireland
In this chapter, the ICT sector is described as a global sector and the key challenges that impact this sector are also discussed. These are important as any choices made are dependent on fitting into the global environment.

Rationale: The global ICT sector is relatively new but is seeing significant changes. It is important to understand the changes that are happening and the key drivers for these changes. Over time, these drivers have altered, starting with hardware development and now residing is software development. Irrespective of economic changes, this sector remains strong.

Approach: The approach in this chapter is to look to the global ICT economy and recognise how software now drives that economy. The chapter then discusses the direction of FDI companies, emerging markets, decentralisation, and how products and services are altering the sector in an era of tighter regulation. The chapter concludes with a redefinition of the ICT value chain across the globe and how Northern Ireland needs to prepare for this adjustment.

Chapter 5: ICT capabilities and skills within Northern Ireland
In this chapter, the existing capabilities of Northern Ireland in ICT are presented, focusing on private sector and public sector organisations. These capabilities are used as a baseline against which recommendations of focus areas can be derived. The skills issues pertaining to these capabilities are also identified here.

Rationale: It is essential to understand and know the existing capabilities within the Northern Ireland sector as these create the foundation for the future evolution of the sector in Northern Ireland. Moreover, the sector itself acts as a sector and an enabler and this is also reflected in the underpinning nature of the sector to other sectors.

Approach: This chapter commences with a description of the sector, the key trends within the sector and a detailed discussion on the private sector capability. The key companies within Northern Ireland are discussed; as is the further and higher education sector. The existing capabilities are then summarised. These capabilities are then benchmarked at a UK, European and International level.

Chapter 6: The focus for Northern Ireland ICT
Whilst the ultimate goal of this Foresight is the creation of an ICT cluster, it is recognised that there must be focus areas and leadership areas. In this chapter, the focus areas of ICT in Northern Ireland are identified and justified.

Rationale: Northern Ireland cannot be good at everything in the ICT world and therefore it is important to identify priorities. In this chapter, the global ICT sector is broken down and Northern Ireland capabilities are compared against the scientific and exploitation capability required. The conclusion of this analysis allows for the derivation of focus areas based on existing strengths.

Approach: The approach in this chapter is to compare the global sector to Northern Ireland existing capabilities and to identify where gaps or synergies may exist. This identifies a number of specific areas of focus which are then further justified by the creation of an 'ICT stack' which allows Northern Ireland to understand the positioning of its services to the global sector. There are ultimately three focus areas - Software (application software and packaged software), Nearshoring and Hardware/Systems (Computational Science and Embedded Systems).

These focus areas are then individually discussed in chapters 7, 8 and 9.

Chapter 7: Focus area 1-Application Software and Packaged Software
Software was identified as a key driver of the ICT sector and Northern Ireland has specific competencies in this area. In this chapter, software is further explored as a key focus area for Northern Ireland.

Rationale: Software drives the ICT environment in Northern Ireland and packaged software is essential as Northern Ireland needs to move from application development to packaged software. Additionally, software enhances the competitiveness of other sectors beyond ICT including Agri-food, Advanced Materials, Advanced Manufacturing and Life Sciences.

Approach: The approach has been to evaluate the global software environment and determine specific focus areas within that market for

Northern Ireland. The chapter concludes with a specific roadmap for Northern Ireland.

Chapter 8: Focus area 2 Nearshoring
Nearshoring was identified as a key driver of the ICT sector and Northern Ireland has specific competencies in this area. In this chapter, Nearshoring is further explored as a key focus area for Northern Ireland.

Rationale: The Nearshoring industry is driven by specific requirements in terms of sitting between off-shore and in-house operations. Nearshoring therefore is used as a business mechanism to develop proposition for Financial Services, HealthCare and other business operations. A specific evolution of Nearshoring allows Northern Ireland to develop a specific global position which can be exploited.

Approach: The approach has been to evaluate the global Nearshoring environment and determine specific focus areas within that market for Northern Ireland. The chapter concludes with a specific roadmap for Northern Ireland.

Chapter 9: Focus area 3-High Performance Embedded Systems
Hardware and Systems' is a term used to define High Performance Computing and also High Performance Signal and Network systems. This was also identified as a key driver of the ICT sector and Northern Ireland has specific competencies in this area. In this chapter, these two areas are further explored as a key focus area for Northern Ireland.

Rationale: Both of these areas underpin and support offerings to the global market in terms of Life Sciences, Advanced Materials, Food etc. A specific evolution of these roadmaps, Nearshoring allows Northern Ireland to develop a specific global position which can be exploited.

Approach: The approach has been to evaluate the global Hardware & Systems environment and determine specific focus areas within that market for Northern Ireland. The chapter concludes with a specific roadmap for Northern Ireland.

Chapter 10: Developing the 10-year ICT focus for Northern Ireland - a cluster
All existing reports recognise that Northern Ireland is at a pivotal point of change in this sector. The ultimate goal of any Foresight activities is to create an ICT cluster in Northern Ireland. This cluster needs to have a specific focus and some identified leadership areas.

Rationale: ICT clusters are geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries and associated institutions for whom membership within the concentration is an important element of each member's competitiveness. It is important that Northern Ireland develops a cluster model which it can use as a roadmap for the development of the sector.

Approach: This chapter defines a cluster, describes the cluster lifecycle and its core requirements. It then proceeds to identify the pivotal roles within a cluster (innovation and entrepreneurship) and then develops a specific cluster model for Northern Ireland with a number of elements which are discussed in detail. This model allows for the longer-term creation of an ICT 'ecosystem' in the cluster and concludes with an action plan to build this cluster.

Chapter 11 Skills
It is well recognised that a key driver in the development of the ICT sector is the availability of skills and capabilities to meet the market requirements. No other single factor can drive the sector as much. In this chapter, a specific analysis is undertaken to evaluate the skills situation in Northern Ireland.

Rationale: Skills underpin the ICT sector.

Approach: The approach has been to evaluate the global Hardware & Systems environment and determine specific focus areas within that market for Northern Ireland. The chapter concludes with a specific roadmap for Northern Ireland.

A DEFINITION AND SCOPE OF ICT

IN THIS CHAPTER, THE ICT SECTOR IS DEFINED AND THIS IS EXPANDED TO INCLUDE THE SPECIFIC SCOPE THAT HAS BEEN COVERED BY THE ICT PANEL. THIS DEFINITION BUILDS ON GLOBALLY ACCEPTED DEFINITIONS OF ICT THAT ARE USED WITHIN ALL OCED COUNTRIES. THE SECTOR IS ALSO SUB-DIVIDED INTO CATEGORIES THAT BEAR UP TO INTERNATIONAL COMPARISONS. ONCE ICT IS DEFINED, THE OVERALL CONTEXT OF THIS REPORT IN ALSO PRESENTED.

3

3.1 DEFINING THE ICT SECTOR

The ICT sector is defined as the combination of manufacturing and services industries that support the capture, transmission and electronic display of data and information. This is a sectoral definition and proposed for the ICT panel work.

It is worth separating this definition from the concept of ICT technologies, which are seen to be leveraging technologies that are available to most other commercial sectors in order to advance or enhance the products/processes within those sectors.

ICT is a broad term that refers to both an enabling technology and a sector within itself. However, it is clear that to maximise the impact of ICT in any economy, it must move towards becoming a formal cluster[6].

In evaluation of this sector in Northern Ireland, the following sub-fields and definitions have been used. This categorisation is based on market type and the skills required. However, this same set of definitions is used to define the ICT sector in the USA and Europe.

6. European Innovation Index 2006

TABLE 3.1: ICT SUB-FIELDS AND DESCRIPTIONS.

ICT SUB FIELD	DESCRIPTION
Application Software	Application Software is defined as programs that help the user accomplish tasks: for example, word processing programs, spreadsheet programs, or FTP clients. The Application Software sub-sector includes the following subsets: • Bespoke software • Systems integration • Other business applications software • Kitting and logistics software • eGovernment applications
Digital Content	Digital Content is defined as content or material that is provided in a digital format. It includes eLearning, Games, Digital Television (DTVGF), Animation and Post Production, and Special Effects (SFX). Digital Content is characterised by the fact that the digital medium is driving convergence between formerly independent industries. For example, ICT might once have been seen as separate from Media and Entertainment but the convergence of these sectors is driving the development of new products and services.
Hardware and Systems	Hardware & Systems refers to the physical devices that drive the ICT sector and the systems software that is typically embedded within the hardware to make it operate. This is a broad category that refers primarily to what is termed 'manufacturing' - either assemble to order, assemble to schedule, build to order or turnkey systems. The sub-sector includes: • High Performance Computing • Embedded Systems • Fabrication and Logistics/High Value-Added • Fabrication and Logistics/Medium Value-Added • Fabrication and Logistics/Low Value-Added • ICT Diffusion (as in Intel, Analog Devices) • Computer and peripheral systems with local product development • Process Control Systems including testing
IC Design	Microelectronics Design is defined as the design of materials, circuits and new device structures for the ICT sector. It is the strategic research and development that focuses on identified technology bottlenecks and challenges with the purpose of creating new technology platforms, building blocks and intellectual property to drive the next generation of ICT products and applications.

ICT SUB FIELD	DESCRIPTION
IT Services	The IT Services sub-sector is defined as companies that provide IT functions with a focus on specific solutions for customers based on a mixture of hardware and software. The commercial models vary within this sector and the range of services covers both mature and developing services including: • Package Implementation • Application Maintenance • Internet Service Providers • Application Service Providers • Business Service Providers • Business Process Management Services
Support Services	Support Services relates to the support functions of ICT companies independent of the production of products and services. This includes • Shared services centres; • Back office functions e.g. payroll, accounting, finance, tax; • Front office functions;
Product Software	Software 'products' that are sold and replicated individually or as part of larger solutions around the world. • Mobile Telecommunications (including network management) • Security • Content management software • Financial software • Health Care software • Enterprise software
Mobile Telecommunications	This sub-field deals with Wireless Technology only. It should be noted that telecommunications software has already been excluded from this sub-sector and included under applications software.

3.2 CONTEXT FOR THIS REPORT

There has been a significant focus on the future of ICT within Northern Ireland over recent years. The ICT Horizon Panel, established and supported by the Department of Trade and Investment (DETI), is a central element in defining the future opportunities for ICT in Northern Ireland and the panel has commissioned this report as a continuation of their foresighting activities.

The ICT Horizon Panel is the second technology horizon scanning panel to be established under the Horizon Programme which has been put in place under the auspices of MATRIX - The Northern Ireland Science Industry Panel.

Horizon is MATRIX' flagship strategic technology foresight programme. Horizon will build on the success of past rounds of Northern Ireland Foresight and seek to identify the key technologies which will be of specific commercial value to the Northern Ireland economy over time-spans of between five and 15 years. It will be a rolling programme and will seek to inform both Northern Ireland government policy and private sector business planning to ensure that Northern Ireland is best placed to exploit future commercial opportunities arising from its R&D and science & technology base.

The first round of the Horizon Programme will comprise five technology foresight panels in the fields of Agri-food; Life & Health Sciences; Advanced Engineering (Transport); Advanced Materials; and ICT. Further panels in the fields of Energy and the Environment are also being considered. Each panel is chaired by a member of MATRIX with suitable experience and qualifications in the sector.

Horizon Panel reports are presented to plenary MATRIX meetings as they progress and MATRIX will provide a broad base of expert quality assurance through debate and analysis to help shape the reports' development. This report, when finalised through MATRIX, will be submitted to government through DETI for consideration in future policy development.

3.3 THE REMIT OF THE ICT HORIZON PANEL

THIS REPORT REPRESENTS THE OUTCOME OF WORK LED BY THE ICT HORIZON PANEL OVER THE PERIOD FROM JUNE TO OCTOBER 2007 AND INVOLVING A SERIES OF SPECIFIC ACTIVITIES:

1. The identification of the sustainable market opportunities and the associated key priority technologies for the Northern Ireland ICT sector. Success is measured in terms of the impacts on the economy, the research base, the environment, the growth and sustainability of the ICT sector (and related sectors), as well as on overall quality of life in Northern Ireland;

2. The identification of key Northern Ireland technology exploitation priorities for future economic success matched against the findings of the MATRIX Technology Capabilities Study[7];

3. The establishment of future technology exploitation and market opportunities, prioritised against time as short, medium and long-term objectives, with recommendations for creating the policy environment in which these objectives can be achieved (including gap analyses and the identification of infrastructural inadequacies or deficiencies in critical emerging capabilities);

4. The identification of the wider global science and technology innovations which will present genuine opportunities for exploitation or adaptation by Northern Ireland ICT related businesses over the short, medium and long-term;

5. A focus on early wins and longer-term gains. Therefore, specific deliverables/ recommendations which will lead to profitable growth in the ICT and allied sectors will be developed through the work of the ICT Horizon Panel;

6. The identification of the synergistic actions required across all key technology areas in Northern Ireland to realise the opportunities for exploitation which are likely to arise for the sector;

7. The identification of the enabling networks across government, the research base and the business sector to ensure the successful implementation of the priority recommendations as well as the additional medium and long-term technology recommendations arising from any additional analysis;

8. The identification of the investments, in terms of costs and resources (for the business sector, the FE sector/research base and the public sector), necessary to take forward the priority recommendations for future economic success in the ICT sector;

9. The recommendation - through MATRIX - for further analytical or horizon scanning work to be undertaken or continued with respect to the future of the ICT and/or other sectors in Northern Ireland.

7. Technology Capabilities Study for Northern Ireland, MATRIX, 2007

THE GLOBAL ENVIRONMENT OF ICT AND THE KEY CHALLENGES THAT IMPACT ANY FUTURE DIRECTION IN NORTHERN IRELAND

IN THIS CHAPTER, AN OVERVIEW OF GLOBAL, EUROPEAN AND NATIONAL STRATEGIES AND TRENDS IN ICT IS PRESENTED. THESE PROVIDE A BACKDROP TO THE CHALLENGES AND OPPORTUNITIES OPENING UP TO THE NORTHERN IRELAND ICT SECTOR.

4

4.1 INTRODUCTION

THE GLOBAL ICT ENVIRONMENT IS CONSTANTLY CHANGING. THE CHANGES TEND TO BE BROUGHT ABOUT ON TWO PRIMARY AXES. FIRSTLY, THE TECHNOLOGY ITSELF MAKES CONSTANT RADICAL SHIFTS IN POSITION WHICH CHANGE THE MARKET AND WHAT BUYERS WANT. SECONDLY, THE MARKET CHANGES DYNAMICS - NEW MARKETS OPEN UP, NEW APPLICATIONS ARE FOUND AND NEW SUPPLY CENTRES BECOME AVAILABLE AS MORE COUNTRIES ADVANCE THEIR CAPABILITY.

For some time now, the centres of gravity of the ICT sector throughout market and technology changes have been Silicon Valley, Boston, Texas, Germany (primarily through SAP) and the Republic of Ireland. These centres of gravity were heavily endorsed by three specific generational matters - Year 2000, the Euro (in Europe) and the eCommerce bubble. During the decade 1990 to 2000, companies in the main environment of these locations saw growth rates of 25%. The net output of this change was that innovation and start-ups were high, new ideas were randomly floated and supported, and it was felt that the ICT sector was a panacea to most operational issues.

Since the global downturn, the perspective on this has changed. Existing markets are relatively dormant and customers are less interested in pure inventions and more in consolidation, integration and the realisation of financial benefits from these investments. Innovations, when they occur, are expected to fall within this category. However, this has started to change and businesses are moving to Eastern Europe, Russia, China and South America. These changes are brought about by a convergence of cost-related issues and also the need to be close to markets and to provide commitments to new markets while the older markets of Europe and North America slow down in terms of demand. The changes that have been developed can be perceived to be extremely difficult to understand except that this is something that has also been experienced in other industries before. In effect, the ICT sector as an industry is moving from a National Adaptor and National Centric approach to developing a complete, operational and international supply chain (similar to the motor car and domestic appliances industries). The movement has been supported by technology phases which have evolved and changed the centre of gravity of the industry, allowing for more and more geographic dispersion.
The change to a global supply chain for the entire ICT sector is driven by two compelling factors:

1. Boundaries between software, ICT services and business processes are continuing to disappear (this has been happening for some time now and will continue).

2. Aspects of the global supply chain that are simply cost-dependent are likely to be sent offshore to lower-cost environments, if the skills are available and if the activities are not linked to more critical market value activities.

The global supply chain for the ICT sector will continue to evolve and the offshore element will become more integrated as it moves on from India to other locations. Within the movement to offshore, the criteria of risk-reduction and security will be essential.

This chapter examines the key trends affecting the global ICT sector and FDI, and how they will affect the Northern Irish ICT sector.

4.2 THE GLOBAL PICTURE

4.2.1 THE ICT SECTOR IS GLOBAL

ICT will continue to play an increasingly large and significant role in individual companies, industries and economies that are continuing to reap more and more benefits from its application. Whilst the rate of development is not as fast as predicted by some, it is clear that, notwithstanding considerable changes in the global economy since 2000, the establishment of a knowledge-based economy is still going to happen. The areas of Health Care, Government, Financial Services and other important sectors have yet to fully realise the value from ICT within the context of different approaches to the resolution of traditional issues.

ICT Intensity[8] (ICT markets/GDP) of economies has continued to increase. This has been driven by strong growth in telecommunications demands and continuing growth in software. More importantly, growth is being driven by new economies such as South America and China and these markets are retaining their dynamism in the downturn.

The ICT sector is globalised. International trade in ICT goods alone has grown at almost double the rate of trade in total goods since 1990[9], with exports of ICT equipment equivalent to well over 5% of GDP in some countries. The trade in the IT Services sub-sector has been slower to develop but it is growing faster than the traditional trade in equipment[10]. Countries such as Brazil, India and China are now emerging as key players in the development and export of ICT-related goods.

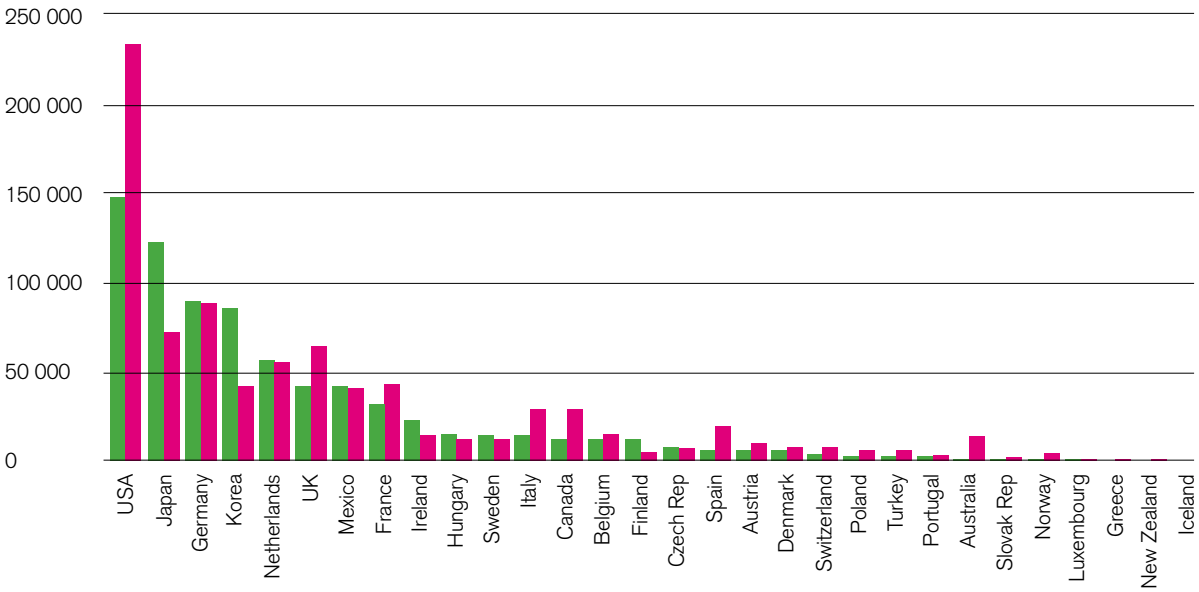
Cross-border investments in ICT are continuing to increase and intra-firm trade is beginning to dominate. Generally, the ICT producers tend to be in the lead. Foreign investment in the ICT sector is strong and the focus of new international investments in ICT is shifting from manufacturing to services activities as the services sector continues to grow fast and the equipment side of the equation become more focused on price. This trend is likely to continue as services undergo greater domestic deregulation and competition, as trade liberalisation continues and as marketed services play a larger part in economic activity. As deregulation has created new markets, telecommunication services have been at the forefront of investment and M&A activities.

The ICT sector is also driven by rapid technological change as product life-cycles become shorter and new markets open up for products and services. This in turn drives technology-oriented M&As and strategic alliances in the ICT sector. ICT companies merge and form alliances so that they can continue to seek ways to exploit emerging technologies (e.g. in IP networking, radio and optical communications, broadband applications) and bring them rapidly to market. Some companies within the sector (e.g. Cisco) make a business policy of scanning the market for acquisitions and then making appropriate moves.

However, the sector has felt the impact of the recent business cycle, with significant reductions in the level of FDI, M&As and strategic alliances likely. However, despite the recent slowdown, the ICT sector's underlying structure and dynamics will ensure that it continues to play a leading role in industrial globalisation.

8. In the chapter 3 on Competitiveness, the growth in ICT Intensity is referenced and comparisons made. Additionally, the topic is address in Appendix E in more detail.
9. OECD Trade in ICT Goods 1990 - 2000
10. Gartner. Vertical Market Analysis 2003

FIGURE 4.1: GLOBAL TRADE IN ICT GOODS



Trade in ICT goods, 2006, USD Millions[11]

Exports

Imports

NOKIA / ICT Trends / Prof. Yrjo Neuro

11. OECT Key ICT Indicators

4.2.2 SOFTWARE DRIVES THE GLOBAL ICT SECTOR

In earlier incarnations of the ICT sector, connectivity and hardware were the prime drivers. However, over time this equation has changed and it is now recognised that software drives the sector because the functionality it enables facilitates dynamic growth of company-level and economy-wide productivity and ultimately competitiveness irrespective of the hardware or network environment.

For this reason, software is one of the most rapidly growing sectors in developed countries, with strong increases in value added, employment and R&D investment. Both packaged software and software-related services have a growing share in overall ICT markets.

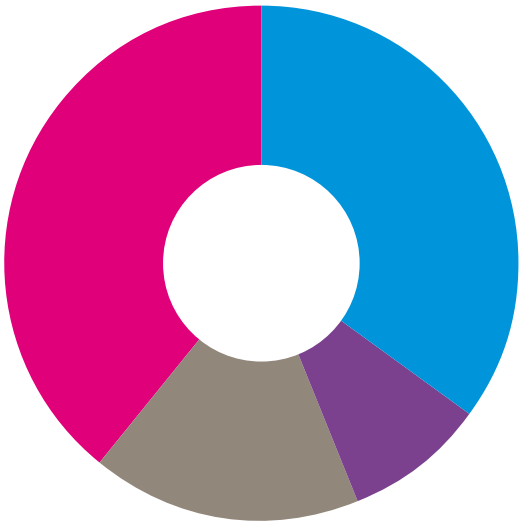
The worldwide packaged software market was estimated at US$196 billion in 2005, 95% of which existed in OECD countries. Businesses across all sectors of the economy increasingly invest in software, and the nominal share of software in business sector gross fixed capital formation has increased steadily since 1990.

Similar to hardware, the market structures in the software sector change rapidly, owing to technical innovation and the emergence of new product segments, new firm entry, alliances, M&As and fierce competition among incumbent firms. The forces that shape the software segment can be considered as follows:

1. The questions of integration, interconnection and software product compatibility are currently doing battle in the rival approaches to software development and exploitation: open and proprietary source code software.
2. Network computing and the ubiquity of the Internet are driving new software supply strategies by application service providers, reinforced by outsourcing-driven business strategies adopted by user firms of all sizes.
3. Innovation is a particularly important driver of change, and software firms are the most R&D-intensive of ICT firms, important recipients of venture capital (up to 20% of total technology venture capital in the USA, over 30% in Europe) and increasingly active in patenting.

Trade in software goods and services is growing strongly but is difficult to measure, partly owing to the increasing diversity of delivery channels. The value of software goods traded on physical supports gives an indication of cross-border sales of software goods although it is becoming less and less complete. The Republic of Ireland and the USA accounted for more than 45% of OECD exports of software goods in 2005 which makes it the largest software country in Europe and the third-largest supplier in the world. The Republic of Ireland has become the European manufacturing and distribution centre for many of the world's top software vendors, accounting for over 40% of all packaged software and 60% of all business software sold in Europe.

FIGURE 4.2: ICT SPENDING BY SEGMENT, 2005



39%	Telecommunications
35%	ICT Services
9%	Software
17%	Hardware

Source: OECD/Dealogic

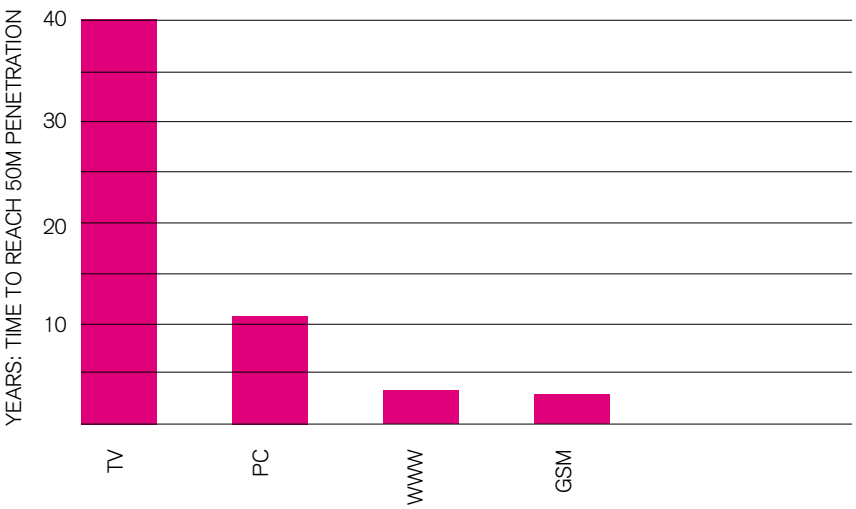
4.2.3 IT SERVICES UNDERPIN THE ICT SECTOR

IT Services are a critical component of the ICT sector and the reason is related to cost. As spending on ICT has increased year-on-year, and as ICT becomes a more integrated component of all sectors, it presents businesses with a contradiction. The technology is easier to use and to buy but the overall cost remains increasingly high. IT services are needed to ensure that value can continue to be realised from these investments.

IT Services is still one of the largest parts of the ICT sector (as illustrated in Figure 4.2) and yet it has continued to disappoint in terms of value delivered. Whilst this will continue for some time, IT Services has to find a model that fits the commercial advantage that it can offer so that the uptake of IT Services becomes a real economic issue for companies.

4.2.4 EMERGING TECHNOLOGIES COMPEL NEW INNOVATIONS

FIGURE 4.3: HOW TECHNOLOGIES MEET MATURITY IN THE ICT SECTOR WITH REDUCING LEAD-TIMES



The ICT sector has always thrived on new technologies that create new innovations. It is also significant to note that these innovations are reaching maturity faster than before, as illustrated in Figure 4.3.

There are a number of new or emerging technologies that are likely to create significant innovations in the ICT sector globally. These are still driven by software and IT Services as outlined above but are worthy of mention due to their specific relevance. They are outlined in Table 4.1.

TABLE 4.1 EMERGING TECHNOLOGIES AND THEIR IMPACTS ON THE ICT SECTOR

TECHNOLOGY	IMPACT
Cloud Computing	This is the popular phrase that is shorthand for applications that were developed to be rich Internet applications that run on the Internet (or 'cloud'). In the cloud computing paradigm, software that is traditionally installed on personal computers is shifted or extended to be accessible via the Internet. These 'cloud applications' or 'cloud apps' utilise massive data centres and powerful servers that host web applications and web services. They can be accessed by anyone with a suitable Internet connection and a standard web browser.
Utility Computing	Utility computing (also known as on demand computing) is the packaging of computing resources, such as computation and storage, as a metered service similar to a physical public utility (such as electricity, water, natural gas or the telephone). This system has the advantage of a low or no initial cost to acquire hardware. Instead, computational resources are, essentially, rented. Customers with very large computations or a sudden peak in demand can also avoid the delays that would result from physically acquiring and assembling a large number of computers. This normally envisions some form of virtualisation so that the amount of storage or computing power available is considerably larger than that of a single time-sharing computer. Multiple servers are used on the 'back end' to make this possible. These might be a dedicated computer cluster specifically built for the purpose of being rented out, or even an under-utilised 'supercomputer.'
Service Oriented Architecture	Service Oriented Architecture (SOA) is an architectural style that guides all aspects of creating and using business processes, packaged as services, throughout their lifecycle, as well as defining and provisioning the IT infrastructure that allows different applications to exchange data and participate in business processes regardless of the operating systems or programming languages underlying those applications. SOA represents a model in which functionality is decomposed into small, distinct units (services), which can be distributed over a network and can be combined together and reused to create business applications. These services communicate with each other by passing data from one service to another, or by coordinating an activity between one or more services. It is often seen as an evolution of distributed computing and modular programming and is very much a driver of existing software applications.

TECHNOLOGY	IMPACT
Wireless	The future of computing is wireless and portable as exemplified below.  The definition of wireless in this context is broad and incorporates newer wireless radio technologies such as RFID etc. These technologies are seen as higher degrees of incorporation into standard devices and applications and driving the global ICT sector forward with newer innovations. Irrespective of opinion, it is clear that the wireless environment will continue to gain significant ground in the years ahead.

4.3 STRATEGIES OF MULTI-NATIONAL COMPANIES IN THE GLOBAL ICT SECTOR

THE PARTICULAR STRATEGIES OF MULTI-NATIONAL COMPANIES PROVIDE AN IMPORTANT SENSE OF DIRECTION FOR THE SECTOR AS A WHOLE. WE REVIEW THE GENERAL TRENDS WITH REGARD TO MNC STRATEGIES AS CONTEXT FOR NORTHERN IRELAND FOCUS.

4.3.1 EMERGING MARKETS AND DECENTRALISATION

Multi-National Corporations (MNCs) are realising that the innovation required to serve the large segments in emerging markets has the potential to make them more competitive in their traditional markets, and therefore in all markets. Over time, the assumption that innovation comes from the MNC centre will gradually fade. Increasingly, as MNCs develop products better adapted to emerging markets, they will find that those markets are becoming an important source of innovation. Telecommunications companies, for example, are discovering that people in markets with no old technology to 'forget' may accept technological changes faster. MNCs, such as Texas Instruments and Motorola, are assigning responsibility for software-oriented business development to their Indian operations. China has become such a significant market for DVD players that the Chinese are likely to be major players in introducing the next round of global DVD standards.

As product development becomes decentralised, collaboration between labs in Bangalore, London, and Dallas, for example, will gradually become the rule. This becomes a component of the global ICT supply chain. New-product introductions will have to take into consideration non-traditional centres of influence. MNCs will increasingly look to emerging markets for talent. India is already recognised as a source of technical talent in engineering, sciences and software, as well as in some aspects of management. All major high-tech companies recruit in India not only for the Indian market but also for the global market. China, given its growth and its technical and managerial-training infrastructure, has not yet reached that stage, but it may well reach it in the not-too-distant future.
In addition to these changes, an increasing percentage of the investment in plant, equipment and marketing will go to the emerging markets. As those markets grow to account for 30% to 40% of capital invested - and an even larger percentage of market share and profits - they will attract much more attention from top management.

The importance of these markets will inevitably be reflected in the ethnic and national origin of senior management. At present, senior management ranks are filled with nationals from the company's home country. By the year 2010, however, the top 200 managers from around the world for any MNC will have a much greater cultural and ethnic mix[12].

Diversity will put an enormous burden on top-level managers to articulate clearly the values and behaviours expected of senior managers and it will demand large investments in training and socialisation. The need for a 'single company culture' will also become more critical as people from different cultures begin to work together. Providing the right glue to hold companies together will be a big challenge.

That challenge will be intensified by an impending power shift within MNCs. The end of corporate-centric thinking suggests more than a new relationship between the developed and the emerging economies. It also suggests an end to the era of centralised corporate power - embodied in the attitude that 'headquarters knows best' and a shift to a much more dispersed base of power and influence.

MNCs will be shaped by a wide variety of forces in the coming decades. The big emerging markets will be one of the major forces they come up against. And the effect will be nothing short of dramatic change on both sides. Together, they will challenge each other to change for the better as a truly global 21st century economy takes shape. The MNCs will create a higher standard of products, quality, technology, and management practices. The process of transition to market economies will be evolutionary, uneven, and fraught with uncertainties. But the direction is no longer in question.

In order to participate effectively in the big emerging markets, MNCs will increasingly have to reconfigure their resource base, rethink their cost structure, redesign their product development process and challenge their assumptions about the cultural mix of their top managers. In short, they will have to develop a new mind-set and adopt new business models to achieve global competitiveness in the post imperialist age.

12. Managing for Shareholder Value - International survey 2004/PA Consulting.

4.3.2 PRODUCTS AND SERVICES

With the trend towards convergence in ICT products and services, offerings are likely to cross over into multiple categories, offering new opportunities, but also increased competition. This is likely to have the effect of more rapid new product introductions, discontinuation of older products, reduced prices and more incentives for customers. MNCs such as Intel are likely to continue to cultivate new business and work with the computing and communications industry to expand its product offerings and Internet capabilities, including infrastructure for wireless access and developing compelling software applications and operating systems designed to take advantage of its higher performance microprocessors and chipsets, as well as its other next-generation semi-conductor components.

ICT customers have stopped thinking of their technology needs just in terms of data centres, storage systems, PCs or a network. Going forward, customers will think of their needs in terms of the entire technical infrastructure on which their businesses run.

In order to expand their product and service offerings, MNCs in the ICT industry will increasingly seek to acquire companies that can provide them will greater capabilities, which in turn will assist them in capturing a greater share of their markets. Ultimately, MNCs will pursue strategies that enable them to provide more complete solutions for their customers.

4.3.3 REDEFINING THE ICT VALUE CHAIN

Traditionally, the MNC approach to the Value Chain was expressed in a simplified version as demonstrated in Figure 4.4. The idea was that Customer Service succeeded Sales and Marketing as the primary contact point with the customer/sector and that Production/Logistics and R&D followed on from the input provided by Sales and Marketing. This encouraged MNCs to search the world looking for cost-effective operations that existed within relevant markets that could provide these functions within a defined corporate strategy.

In the early 2000s, the corporate opinion on this changed. This was primarily driven by two factors:

1. The need to continually cut costs and provide additional value to customers created an issue that this chain could not address
2. The filtering effect of each aspect of the chain on each other, created an aberration in how demand was seen and deemed to be met. This created inventories of products that mislead market analysis.

The Value Chain of MNCs has started to change to embrace a very different structure, which should be constantly capable of reducing costs and providing value-added through the elimination of waste and constant innovation cycles within the organisation. This is represented in Figure 4.5.

The key difference here is the focus and integration of all activities on the market sector or the customer thereby always creating value and driving an innovation cycle that supports and challenges the need for profit and customer focus within the organisation.

The conclusion is that the Integrated Product Development Process is an R&D cycle that works at primary research, applied research and development whilst all the time focusing on customer needs and integrating its designs and concepts with production/logistics requirements, customer support requirements and standard financial requirements. Additionally, Supply Chain Management works to produce,

FIGURE 4.4: EXISTING VALUE CHAIN IN MNCS

FIGURE 4.5: DEVELOPING VALUE CHAIN IN MNCS

distribute and deliver results to the customer, in a manner that they require.

The Customer Care process becomes as focused on customer retention and the sell on of new services as it might in simply supporting the sales process. Within this context of organisational focus, the overarching emphasis on every function is to get closer to the market and the customer and to share data that enables that closeness. Sales and Marketing becomes a vital link in ensuring and facilitating all functions to achieve that closeness. Marketing becomes a mindset of the organisation and not simply a function. This will happen through the linking of market sectors and customers to the innovation cycle and the increasing of influence of all relevant functions within the company.

Within this corporate environment the emphasis shifts from being cost driven to being value-added and driven by market insight. Through this mechanism, business units are more profitable and successful and the value to the overall organisation is increased. In essence, the mandate moves from cost centre to profit centre, using customer contacts (through multiple channels) and a movement to manage the entire customer life cycle within a geography. Within the context of the global ICT supply chain, individual MNCs are focusing on reducing costs where possible and adding the value through market/customer focused activities.

4.4 MACROECONOMIC FACTORS

4.4.1 INVESTMENT AND MERGER & ACQUISITION ACTIVITY

The ICT sector is also driven by rapid technological change, as product life-cycles become shorter and new markets open up for products and services. This in turn drives technology-oriented M&As and strategic alliances in the ICT sector. ICT companies merge and form alliances so that they can continue to seek ways to exploit emerging technologies (e.g. in IP networking, radio and optical communications, broadband applications) and bring them rapidly to market. Some companies within the sector (e.g. Cisco) make a business policy of scanning the market for acquisitions and then making appropriate moves.

Given its volatility, modest growth prospects and relative immaturity, the technology sector could be ripe for consolidation. Commodity players, diverse solutions companies, and small, high-risk new ventures are all eyeing each other's business models. Business service companies, which have become highly technology-intensive, are also part of this mix.

4.4.2 EU ENLARGEMENT

On 1st January 2004, 10 countries from Central and Eastern Europe acceded to the European Union[13]. Many of these countries are well-positioned to compete with Northern Ireland for investment from MNCs, particularly in the ICT sector.

As with Ireland, many of these countries, such as the Czech Republic and Hungary offer strong financial incentives to MNCs wishing to locate in Europe. These include:

- Corporate tax relief
- Job-creation grants
- Training and re-training grants
- Provision of industrial infrastructure at a discount
- Transfer of land owned by the state at a discount

In addition to financial incentives, many of these countries have:

- A well-educated, industrious, articulate and adaptable workforce
- High spend on information technology
- Cheaper labour
- Better broadband access

However, the benefits that membership of the EU brings may be over exaggerated in the context of diverting investment away from Ireland. Membership will bring easier access to markets within the EU, common regulations and high standards of working practices. However, these are not radically different from what has existed for a number of years.

The eastward enlargement of the EU and the requirements of European Monetary Union are increasing the pressure for flexibility of labour markets. The weakness of the trade unions compared to EU has contributed to the high wage flexibility, while the insufficient funding of labour policies and high share of passive measures might have had a negative effect on flexibility.

The main threat is said to come from the lower cost of production (particularly labour costs) and the perception that workforces in the accession countries are well educated and when it comes to more labour or engineering-intensive operations there is very little to differentiate their capabilities from that of Northern Ireland.

However, based on interviews with key stakeholders it appears that despite the perceived benefits that the accession nations can offer MNCs, Northern Ireland has two critical advantages:

1. Better skilled workforce with higher quality processes. This enables Northern Ireland to operate at higher levels in the value chain. This is particularly important when technology-intensive companies are considered.
2. English is widely spoken. Within the ICT sector, English is the predominant language and is vitally important in higher parts of the value chain, where the focus is on technology-intensive activities.

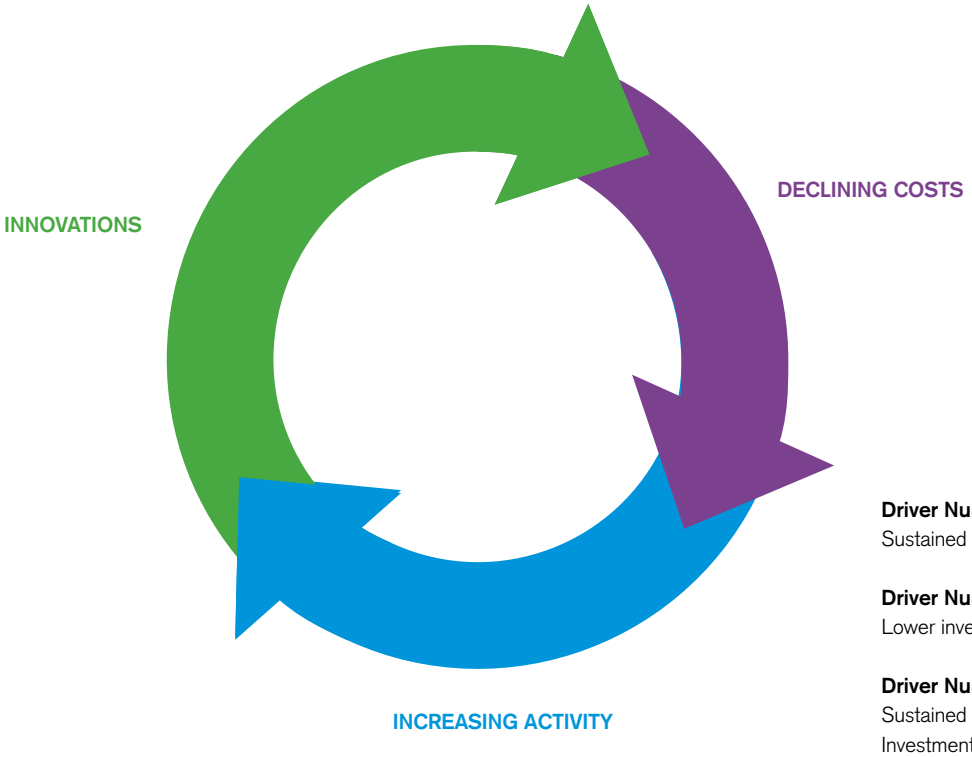
13. The 10 countries are Estonia, Lithuania, Latvia, Czech Republic, Hungary, Slovenia, Malta, Cyprus, Poland, Slovakia

4.5 INNOVATION

Innovation has become the critical driving force within the ICT sector and all identified sub-sectors. In fact, it is innovation that has allowed the sector remain competitive and economically sustaining. Within the ICT sector, innovation works on the general evolution of an ICT Sector Technology Roadmap. In looking at new product and technology roadmaps in ICT, it is essential to look for continuing and sustained trends in capabilities, performance, and cost of the underlying technologies. Increasing capabilities enable more complex applications while declining cost compels an innovation loop, thereby lowering the cost of innovation. This, in turn, enables wider industry learning, thereby sustaining the technology trend. Semi-conductors and the search for improved materials to sustain the Moore's law trends best illustrate this specific approach.

The innovation cycle within the ICT sector is crucial to its ongoing success. However, innovation and the economic cycle of competitiveness that it breeds, needs to be fostered and this is best achieved through the concept of a cluster.

FIGURE 4.6 INNOVATION CYCLE



Driver Number 1
Sustained trends in cost/performance/capability

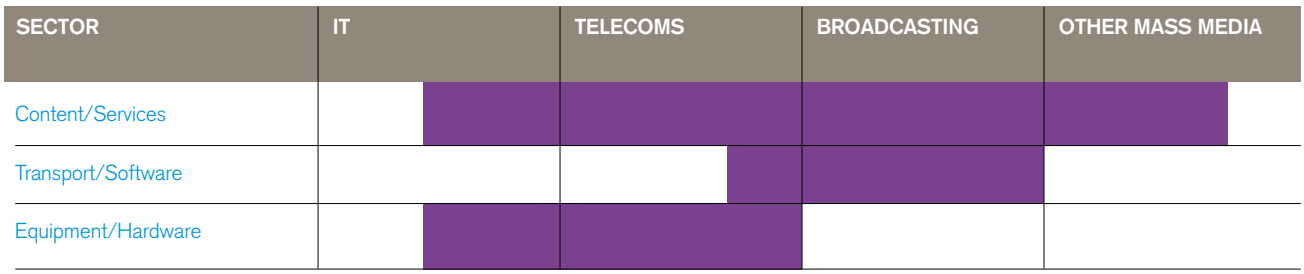
Driver Number 2
Lower investment for innovation

Driver Number 3
Sustained technology lowers
Investment creating further innovation

4.6 REGULATION

4.6.1 ICT REGULATION

FIGURE 4.7: TRENDS IN CONVERGENCE



With the growing economic importance of the ICT sector and its even greater importance in relation to other industries and social developments, regulation of converging communication and information industries have a central importance in the economic development strategies of governments.

There are a variety of technological parameters that influence the convergence processes. Digitisation is the major driver, but not the only factor that can make convergence happen. Different parameters such as network architecture, capacity, Quality of Service (QoS), and the means of use all influence convergence processes. Convergence is not necessarily realised in one integrated network and utilisation of the synergy between different networks can be a more efficient way of providing convergence services. However, these technological changes and developments raise an important regulatory question of how can regulations be adequately changed to a specific state of technological development in a world where technological developments are changing the picture of communications rapidly.

Though the presentation of the three dimensions seems to indicate that they can be inter-related in a three-dimensional model and there is some cross-linking between some of the points in the different dimensions. They, however, present a universe in which a number of possible scenarios for regulations and regulatory institutions can be described. These include:

1. Leave developments in these fields to the market to as large a degree as possible. This entails limiting regulations to a distribution of scarce resources and a general competition regulation of a certain character;
2. The status quo scenario - the different communications and media fields are regulated separately. Telecoms, for instance, is subject to a traditional regulation of scarce resources, interconnection and universal services;
3. Greater interdependency between the regulations of the communications and media infrastructures. However, technology still matters and there are some differences in the regulations of the different infrastructures;

4. Technology-neutral regulation across the different infrastructural platforms, with an explicit goal of creating a dynamic environment for the growth of a converging industry and to promote the growth of certain industrial developments. However, infrastructure and content regulations are kept apart;
5. Infrastructure and content regulation are merged with cross-sectoral regulation in both the infrastructural and content layers. In this scenario, there is also an emphasis on developing dynamic industrial development in the converging communications and media fields.

It is likely that over time regulation will migrate down these scenarios to an endgame wherein infrastructure and content regulation are merged with cross-sectoral regulation at both the infrastructural and content layers.

4.6.2 LABOUR REGULATIONS

There is a possible threat to labour market flexibility with the introduction of new EU legislation, particularly if there is mandatory union recognition. This may have a number of implications, such as:

- Inflexibility in hiring staff;
- Reduced productivity;
- Higher wage costs;
- Slowing down change; and
- Opposition to individually-oriented HRM policies (which are normal in the ICT sector)

In addition, if proposed EU legislation on granting full pay benefits to temporary workers after six weeks of employment is enacted, this will add significant costs to Irish-based businesses and negatively affect the large ICT sector. However, the fact that it would be EU-wide legislation may soften the blow, although in absolute cost terms Ireland may be at a slight disadvantage due to the high basic wage relative to other EU and EU accession countries. Nevertheless, when Northern Ireland's competitiveness is considered on a global scale, proposed EU legislation is likely to increase the attractiveness for MNCs to locate in regions such as South East Asia, China and India.

4.7 GLOBAL ICT SECTOR SUMMARY

This chapter examines the global ICT sector and the changes that are occurring. The key findings from this chapter are:

1. The ICT sector is moving towards a global supply chain as it seeks both new markets and new innovations that will sustain existing markets. This change sees the centre of gravity of the ICT sector move from specific locations to a global supply chain. To continue to operate effectively within the ICT sector will mean that all clusters will have to work together.
2. Application Software will continue to drive the ICT sector globally and this will be underpinned by a developing IT services offering that is commercially and technically robust. However, throughout this environment the availability of high quality skills is the critical success factor. This is shifting the policy focus away from the initial education and training required to drive increased supply, and towards the continuing learning required to underpin the quality and fit of the skills of ICT professionals.
3. The ICT sector is becoming more integrated into the fabric of industries and society. The result of this is that the sector is becoming more industry and customer-focused as it has recognised that true value-added and cost management decisions are best articulated in the context of industry and customer demand. This is a compelling change in FDI companies globally and it will also determine the future of start-ups and existing local companies. Whilst the concept of industry and customer focus is relatively easy to articulate, it is complicated by the fact that industries and customers are becoming more global and are driving standards and procedures to optimise their own operations.
4. New standards and innovations are changing the structure of the ICT industry. Software is driving change and IT services are becoming more important as an underlying foundation to the sector. As the ICT sector changes, skills and capability remain the fundamental driver and means of achievement.
5. The concept of value-added is extending beyond the introduction of R&D and including elements such as industry focus or customer contact.

ICT CAPABILITIES AND SKILLS WITHIN NORTHERN IRELAND

IN THIS CHAPTER, THE EXISTING CAPABILITIES OF NORTHERN IRELAND IN ICT ARE PRESENTED, FOCUSING ON PRIVATE SECTOR AND ACADEMIC ORGANISATIONS. THESE CAPABILITIES ARE USED AS A BASELINE AGAINST WHICH WE CAN DERIVE RECOMMENDATIONS BASED ON THE DEVELOPMENT OF CONCEPTS FOR THE FUTURE OF ICT IN NORTHERN IRELAND WHICH ARE DEVELOPED IN LATER CHAPTERS.

5

5.1 ICT IN THE NORTHERN IRELAND ECONOMY

The Northern Ireland ICT sector has achieved growth in the past 10 years. It now employs almost 11,000 people and has a student population of 24,000. However, these 11,000 employees are spread across 750[14] companies, implying that the majority of companies remain relatively small and supply-based to the local public sector market, where they provide a combination of capacity and some capability resources. By comparison, the Republic of Ireland ICT Cluster employs 115,848 personnel with 1,317 companies in nine sub-sectors[15].

The existence of growth in the Northern Ireland ICT environment has been primarily achieved through a combination of cost competitiveness and an emerging business policy environment. The quality and quantity of skills available augmented this fact[16]. However, the progress of the Northern Ireland ICT environment positions it behind the formal clusters of leading countries such as the Sweden, the USA, Israel and other UK regions[17].

14. OCO Consulting
15. PA Consulting - The Irish ICT Cluster (2004)
16. Northern Ireland has thirteen university research centres in ICT with specific and excellent focus. The quality of graduates from the universities is highly regarded.
17. The source of this analysis is a report completed on Global Clusters published in 2005. Whilst there has been some progress in Northern Ireland in 2006, it is unlikely to overcome this positioning.

FIGURE 5.1: NORTHERN IRELAND ICT GVA AS PART OF THE OVERALL NORTHERN IRELAND ECONOMY[18]

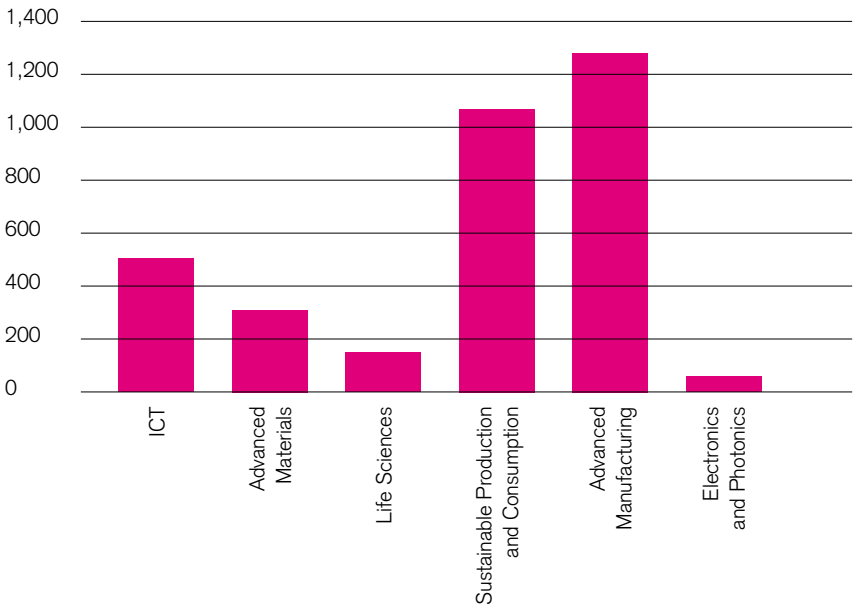
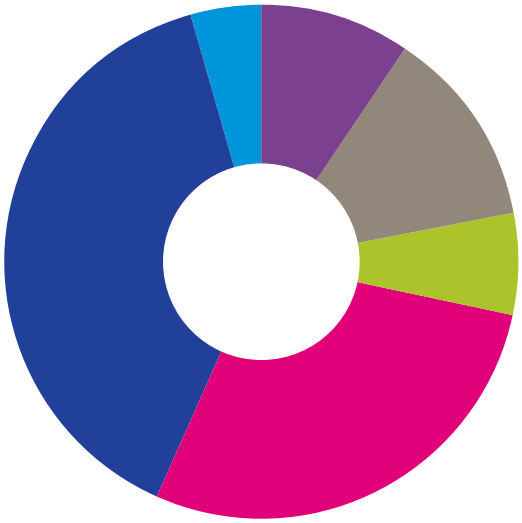


FIGURE 5.2: NORTHERN IRELAND ICT EMPLOYMENT AS PART OF THE OVERALL NORTHERN IRELAND ECONOMY[19]



9% (9,132)	ICT
12% (8,129)	Advanced Materials
6% (3,920)	Life Sciences
27% (18,353)	Sustainable Production and Consumption
37% (24,859)	Advanced Manufacturing
4% (2,470)	Electronica and Photonics

18. DETI Statistics 2005
19. DETI Statistics 2005

5.2 ICT AS A SECTOR AND AN ENABLER

Information Communications Technologies (ICT) is defined as the combination of manufacturing and services industries that support the capture, transmission and electronic display of data and information. This is a sectoral definition and excludes industries that are underpinned by ICT developments such as medical devices etc.

ICT is a broad term that refers to both an enabling technology and a sector within itself. However, it is clear that to maximise the impact of ICT in any economy, it must move towards becoming a formal cluster[20].

5.3 SECTOR DESCRIPTION

The Northern Ireland ICT sector has achieved growth in the past 10 years. It now employs almost 11,000 people and has a student population of 24,000. However, these 11,000 employees are spread across 750[21] companies, implying that the majority of companies remain relatively small and supply-based to the local public sector market, where they provide a combination of capacity and some capability resources. By comparison, the Republic of Ireland ICT Cluster employs 115,848 personnel with 1,317 companies in nine sub-sectors[22].

The existence of growth in the Northern Ireland ICT environment has been primarily achieved through a combination of cost competitiveness and an emerging business policy environment. The quality and quantity of skills available augmented this fact[23]. However, the progress of the Northern Ireland ICT environment positions it behind the formal clusters of leading countries such as the Sweden, the USA, Israel and other UK regions and only slightly ahead of the emerging clusters in Eastern Europe and India[24].

At this point in time, the Northern Ireland ICT environment looks to be in transition. It is losing the low cost competitiveness position and the emerging critical strategic factor is that the Northern Ireland ICT environment builds on the existing platform of technical excellence and competency and creates an environment where it is compounding existing value-added activities through specific industry and customer focus.

The Northern Ireland ICT environment is a relatively recent development compared to developed environments in leading ICT countries such as the USA, the Republic of Ireland[25] and some parts of the UK. The Northern Ireland environment developed from an outsourced base (most other leading countries environments have come from a R&D base) and has overcome inherent barriers of geography and size to become a net exporter of ICT products and services. Traditionally, the Northern Ireland ICT environment has benefited from a moderate policy platform and an excellent skills base.

A feature of the sector is the existence of both FDI and indigenous companies within the sector. The Northern Ireland ICT environment is only becoming export oriented as it has traditionally been focused on the government market from a services perspective. Both the FDI and indigenous aspects of the Northern Ireland ICT environment have been influenced by a number of drivers.

In evaluation this sector in Northern Ireland, the sub-fields and definitions of Table 2.1 have been used.

20. European Innovation Index 2006
21. OCO Consulting
22. PA Consulting - The Irish ICT Cluster (2004)
23. Northern Ireland has thirteen university research centres in ICT with specific and excellent focus. The quality of graduates from the universities is highly regarded.
24. The source of this analysis is a report completed on Global Clusters published in 2005. Whilst there has been some progress in Northern Ireland in 2006, it is unlikely to overcome this positioning.
25. This cluster is considered to be 40 years old

5.4 KEY TRENDS IN ICT

The ICT sector is moving towards a global supply chain as it seeks both new markets, and new innovations that will sustain existing markets. This change sees the centre of gravity of the ICT sector move from specific locations to a global supply chain[26]. To continue to operate effectively within the ICT sector will mean that all clusters will have to work together in the future.

Application Software will continue to drive the ICT sector globally and this will be underpinned by a developing IT services offering that are commercially and technically robust. However, throughout this environment the availability of high quality skills is the critical success factor. The issue relating to the quantity of skills available is becoming less critical internationally. However, the debate surrounding the quality of skills is coming to the fore. This is shifting the policy focus away from the initial education and training required to drive increased supply, and towards the continuing learning required to underpin the quality and fit of the skills of ICT professionals.

The ICT sector is becoming more integrated into the fabric of industries and society. The result of this is that the sector is becoming more industry and customer focused as it has recognised that true value-added and cost management decisions are best articulated in the context of industry and customer demand. This is a compelling change in FDI companies globally and it will also determine the future of start-ups and existing local companies. Whilst the concept of industry and customer focus is relatively easy to articulate, it is complicated by the fact that industries and customers are becoming more global and are driving standards and procedures to optimise their own operations.

New standards and innovations are changing the structure of the ICT industry. Software is starting to drive change and IT services are becoming more important as an underlying foundation to the sector enabling newer models of software package delivery and support services. As the ICT sector changes, skills and capability remain the fundamental driver and means of achievement.

The policy environment is also changing dramatically for the ICT sector. ICT regulation in itself is changing due to liberalisation and imposed regulations. Additionally, labour regulations, in particular from Europe, can change the dynamics of the Northern Ireland labour market.

26. The concept of a global supply chain implies that there will be multiple locations of both supply and demand within the global ICT sector and that these will work of combined products and services from all existing locations.

5.5 PRIVATE SECTOR

The Northern Ireland ICT sector is dominated by the Telecommunications and Software (both application and package software) sub-sectors, representing 53% and 34.3% of sector turnover respectively. Significantly, R&D expenditure as a percentage of turnover across the ICT sector is only 1.9%, with the Software sub-sector representing over 95% of entire sector R&D expenditure. Table 5.1 provides key information on ICT sector.

The entire sector is characterised by a small number of large MNCs, some significant indigenous companies, as well as a large number of small companies. The analytical breakdown of the sector is demonstrated in Table 5.2. Tables 5.3 and 5.4 highlights the leading companies in Northern Ireland by turnover and R&D expenditure, respectively.

TABLE 5.1: ICT SECTOR[27] - KEY INFORMATION

ICT SUB FIELD	EMPLOYEES	TURNOVER (£000s)	R&D EXPENDITURE (£000s)
Application Software	5,037	285,731	14,971
IT Services			
Product Software			
Digital Content	464	16,089	230
Hardware and Systems	425	68,705	0
IC Design	N/A	N/A	N/A
Telecommunications	2,940	441,427	401
Total	**9,132**	**833,585**	**15,463**

27. Source : DETI Statistics 2005. This excludes IT workers that are engaged in other sectors.

TABLE 5.2: ICT CAPABILITY IN NORTHERN IRELAND

SUB-FIELD	DEFINITION	ANALYSIS	SCIENTIFIC CAPABILITY	EXPLOITATION CAPABILITY	ESTABLISHED EMBRYONIC
Application Software	Creation of software for a specific purpose on a 1:1 basis (i.e. limited reuse and licensing)	Strongest part of the ICT sector in Northern Ireland and driven by the single biggest customer - government sector. Companies in this space include AMT-Sybex, Asidua, BT, HP, Fujistu Services, CSC, Fern Computer Services, Finisco, Fionn, Gazer Technologies, Invision, IT Alliance, Siemens Business Services, Modcoms, Momedisys Limited, Raytheon, Vision Consulting etc. This sub-field is driven by capacity only and specific requirements articulated by clients - or in-house organisations.	2	4	
Product Software	Creation of a functional product that requires configuration or minor adaptation to meet requirements. Such a product is sold a large number of times in a variety of markets. This market is very different to the application software market although some of the skills are similar (at a technology level)	Product software is less capacity-dependent but requires deep market insight. In Northern Ireland, there are a number of key areas: • eCRM, which has companies such as Kainos, Amacis, Datatactics, Ion Technologies, Lagan Technologies • Integration such as Invision, Interval Software, Meridio, Nisoft, Singularity. Serpico Software, Swan Labs Ltd. • Financial Services products such as Wombat, SAP Research CEC. • Retail with VME Retail Systems. • Health Care products such as Axis Three, Clinisys Oncology, CanDo Interactive, Steria, Tomcat Systems • Oil and Gas solutions such as 80VER8 and Biznet Solutions. Specifically, these companies tend to be small. However, some have grown and the development of product software capability (and research into same) must be a critical factor for the Northern Ireland ICT sector. This sub-field offers the greatest impact in terms of employment and economic value added as it drives the entire ICT industry.	3	3	

SUB-FIELD	DEFINITION	ANALYSIS	SCIENTIFIC CAPABILITY	EXPLOITATION CAPABILITY	ESTABLISHED EMBRYONIC
IT Services	IT services covers Shared Services, Off shoring, Nearshoring and Infrastructure services.	BT, Bytel, Consilium, Core Systems, Cover.net, Finisco, Fionn Technologies, Memsis, NITEC, Northbrook Technologies, Stream Synstar, Unite, UTV Internet, ICS Computing. There is a large variation in these companies in terms of size, scale of operation etc.	2	4	
Digital Content	Digital Content that covers internet content, digital media, gaming etc.	There are a number of companies in this space that provide local services to local enterprises and business. There are some generated content management solutions but no real product development. Companies include Internet Business Ltd, TiBus, Streamon.net.	2	2	
Hardware & Systems	Combination of processors, sensors, actuators, 'intelligence', hidden computers and deployment which have intensive interaction with an uncertain environment. The characteristic of the Hardware and Software co-design with high degrees of dependability, low power, power harvesting. The new markets for personalised devices that are user-centred and adapt to preferences.	There is a growing development of embedded solution companies in Northern Ireland. These companies range from Ceva, Bluechip Technologies (distribution), Goodrich Control Systems, Sanmina-SCI, Andor Technologies and others that incorporate the latest software models with hardware solutions. The range of application of these devices is from construction to medical technologies.	4	3	

SUB-FIELD	DEFINITION	ANALYSIS	SCIENTIFIC CAPABILITY	EXPLOITATION CAPABILITY	ESTABLISHED EMBRYONIC
Telecommunications	Telecommunications industry is experiencing significant change that allows for new models of revenue-sharing and the introduction of new players to the industry with responsive solutions to meet market or function needs.	There is a strong niche of telecommunications software companies within Northern Ireland. These companies work throughout the Telecommunications OSS structure and include back office functions etc which integrate with new models of revenue sharing. For example, Aepona, Andronics, Atlas Communications, Black Box Communications, Clarity Telecommunications, Kingston, Mobility Data Solutions, Mobile Cohesion, Openwave, and NTL. This can be a strong area of growth for Northern Ireland.	2		4

TABLE 5.3: LEADING NORTHERN IRELAND ICT COMPANIES BY TURNOVER[28]

RANK	COMPANY	EMPLOYEES	TURNOVER (£000s)	R&D EXP. (£000s)
1	BT	2,548	370,339	0
2	Sanmina-SCI	349	62,601	0
3	NTL Group	142	49,979	0
4	Northbrook Technology	1,472	42,130	0
5	Northgate Information Systems	806	37,732	0
6	Fujitsu Services	379	32,813	0
7	Merlin Interactive	250	19,000	99
8	Kainos Software	164	11,025	4
9	Stream International (NI)	397	10,938	0
10	Lagan Technologies	107	9,950	1,745
Total		**6,614**	**646,505**	**1,848**
% of Sector		**72.4%**	**77.6%**	**11.8%**

28. Source: DETI Statistics 2005

The key information to note about the top 10 ICT companies in Northern Ireland by turnover is that:

- They represent 72.4% of full-time employment in the sector;
- They represent 77.6% of sector turnover;
- The top nine companies only represent 0.6% of sector R&D expenditure; and
- Only three of the top 10 are indigenous companies, albeit that one company (Northbrook) is now 100% owned by a US company.

However, despite the level of turnover and employment generated by the top 10 ICT companies, they invest a disproportionately small amount in R&D. This fact is likely to have a major impact in Northern Ireland's ability to generate real value from companies in the ICT sector.

Table 5.4 illustrates the contrast in statistics when R&D expenditure is considered.

The key information to note about the top 10 ICT companies in Northern Ireland by R&D expenditure is that:

- They represent 68.9% of sector R&D expenditure;
- They represent only 5.5% of sector turnover, and 6.6% of sector employment; and
- Eight of the 10 companies are indigenous.

A small number of mid-tier companies (by turnover) represent almost 70% of R&D expenditure in the sector. Twelve of the 119 companies in the sector are spending over 100% of their turnover on R&D, with a further nine companies spending over 50% of their turnover on R&D. All of these companies are indigenous, which reflects the significant level of investment in R&D required by local companies to make an impact on their respective markets. It also highlights the lack of local R&D investment by MNCs.

TABLE 5.4: LEADING NORTHERN IRELAND ICT COMPANIES BY R&D EXPENDITURE[29]

RANK	COMPANY	EMPLOYEES	TURNOVER (£000s)	R&D EXP. (£000s)
1	Openwave Systems	111	7,464	2,274
2	Lagan Technologies	107	9,950	1,745
3	Meridio[30]	147	11,209	2,770
4	Mobile Cohesion	30	38	1,175
5	Ceva	15	1,172	976
6	Aepona	81	6,513	818
7	Singularity	92	7,500	736
8	Texthelp Systems	26	2,069	552
9	Consilium Technologies	84	6,895	396
10	Andronics	14	549	381
Total		**606**	45,828	**10,773**
% of Sector		**6.6%**	5.5%	**68.9%**

29. Source: DETI Statistics 2005
30. Please note that a subsequent update from Meridio have upgraded these numbers beyond those in the DETI database from 2005

5.5.1 KEY COMPANIES

Based on the information provided above, a number of companies have been selected as representative of the some of key ICT companies in Northern Ireland. A summary of these companies is provided in the following sub-sections.

Sanmina-SCI
At Sanmina-SCI's Lisburn plant, the main focus of its activities is precision enclosures assembly and metal fabrication. The Lisburn enclosures facility specialises in low- to medium-volume manufacturing for the data-storage, high-end computing, semi-conductor and industrial markets, offering fast-track prototypes to help introduce new products to market quickly and efficiently. The facility also delivers world-class painting and plating services, welding, volume mechanical and electrical assembly, tool forming, full-system integration and testing. However, although it declared a turnover of £62.6 million in 2005, it only employs 349 people at the facility.

Northbrook Technology
Northbrook Technology specialises in delivering high-quality, low-cost technology and business solutions to its parent company, the Allstate Corporation. Northbrook plays a strategic role in developing, transforming and maintaining the various technology platforms used within Allstate. Essentially, Northbrook offers off-shore IT development and support to Allstate in its day-to-day business, looking after the different systems that Allstate needs to run. The development environment is IBM mainframe/midrange/PC with all the associated technologies.

Northbrook has a second facility in Magee College Campus. The Software Research Park there provides the necessary infrastructure and access to research personnel, resources and graduates. It also has a third facility in Strabane which employs 70 staff, working on a mix of call centre technical support and other back office administrative work for Allstate.

Northbrook also has alliances with a number of bodies such as Momentum and the Centre of Excellence.

Northgate Information Systems
Northgate Information Solutions is a market leader of software applications and outsourcing solutions to the public safety, local government, education and human resources sectors and is also the largest HR and payroll application supplier in the UK. Its main presence in Northern Ireland is due to its acquisition of Sx3 in 2005. Northgate has three major divisions focused on the group's core business areas: Northgate HR; Northgate Public Services; and Northgate Managed Services.

Kainos Software
Kainos is a privately-held company and was one of Northern Ireland's first campus companies, established in 1986 as a joint venture between Fujitsu and the Queen's University of Belfast business incubation unit (QUBIS). Kainos specialises in developing 'mission critical' business systems servicing clients in financial services, public sector, retail and utilities across Ireland and the United Kingdom.

Lagan Technologies
Lagan Technologies provides software solutions to Governments in Europe and North America. Lagan's portfolio of solutions for government now encompasses: Customer Relationship Management, Customer Contact Centre and Case Management solutions for Central & Regional Government, Case Management for Human and Social Services solutions, Shared Service Centre solutions, and Single Non-Emergency Number solutions.

Openwave Systems
Openwave Systems is an independent provider of open software solutions for the communications and media industry. Openwave software solutions are designed to enable customers to accelerate ARPU by rapidly launching value-added communication, information and entertainment services across networks and devices, and comprise a broad range of solutions including content delivery, messaging, music, video, and location.

Meridio
Meridio is a provider of enterprise Document and Records Management (eDRM) software, engineered for Microsoft .NET platforms. It's a privately-owned company founded in 2001. Its investors include ACT Venture Capital, Polaris Venture Partners, QUBIS Limited, and Invest Northern Ireland. Meridio was built around the Products Division of UK-based software house Kainos Software Limited and the Document Management and Process Division of Teamware Group - a Fujitsu subsidiary. Meridio operates an indirect sales model as most eDRM solutions are linked with Process Optimization projects[31].

Aepona
Aepona is a leading provider of application-led products and expert services to telecommunications operators globally, allowing them to rapidly deploy profitable new services across fixed-line, mobile and SIP/IMS networks. Aepona possesses a combination of expertise in both telecoms infrastructure and IT, and its solutions have been chosen by Tier 1 operators such as France Telecom/Orange, KPN, Sprint, E-Plus, Vimpelcom, Eircom and Bridge Mobile Alliance. Aepona's solutions enable operators to adopt new business models, combining externally-hosted with network-resident services to unleash the full power of their networks.

Singularity
Singularity markets a range of component-based client server applications utilising Windows technology. It competes in the global market and is a Microsoft solutions provider with full TICKIT and ISO 9000 certification. The company's second TCS Programme with the University of Ulster's School of Computing and Mathematical Sciences and School of Art and Design, was established to improve the computing of the design and development functions in the company. They were transformed and new design and prototyping teams were established who now work together in product development to ensure that products are 'right first time.' Singularity's new capabilities streamlined the software lifecycle and attracted new business based on prototype development. The company has also increased its product range through the introduction of human-computer interaction (HCI) design services to external software clients.

Texthelp Systems
Texthelp Systems is a software house based in Antrim, which specialises in assistive technology. Texthelp has developed a range of software products designed to assist individuals to improve their reading and writing abilities. Texthelp's products include Read&Write, Browsealoud and Lexiflow, which are software tools for people in the fields of Government, Education and Special Needs.

Andronics
Andronics provides global two-way data solutions for monitoring and control of remote assets. The company has been widely recognised for its technical innovation and commercial success in telemetry applications. Its software contributes to the smooth management of water, effluent, process and energy networks in both the public and private sector.

31. Meridio changed ownership in Oct 2007 having being acquired by Autonomy ($4 bn market capitalisation).

5.6 ACADEMIC SECTOR

Research partnerships with private sector companies are still small in scale but extremely interesting in content at present. For example, the work in the Belfast e-Science Centre (BeSC) was within Queen's University Belfast, which is the regional focus of expertise, knowledge and experience in Grid technology. The BeSC is collaborating with industrial partners to sponsor and manage a number of projects such as GeneGrid (collaborative industrial e-Science R&D project with Fusion Antibodies and Amtec Medical to provide a system for the analysis and mining of the digital data from the human genome) and OpenRiskGrid (a project developing grid technology for First Derivatives, a leading financial services software company based in Newry.)

Equally, the work in ECIT which is based on integrated collaboration conducting blue-sky research and industrial research. There are also hot-housing and incubation facilities to encourage and support the establishment and development of new companies. Companies such as Xilinx, Andor, Octec, OMMIC and TDK are already working within ECIT. This innovation model is of great interest and is a model being followed elsewhere around the world in ICT clusters.

With regards to ICT capability in the FE sector, the following table lists those courses that are currently available throughout Northern Ireland. It shows that there are at present almost 20,000 enrolled in IT-related courses throughout Northern Ireland, with in excess of these studying Information Technology.

TABLE 5.5: SUMMARY OF ICT CAPABILITY IN THE HE SECTOR

NO	INSTITUTION GROUP	LOCATION
58	Computer Science Research Institute (NIKEL (58), NICeB (59) and CSPT (60))	UU
5	ECIT Electronics Communications and Information Technology	QUB
20	Knowledge and Data Engineering	QUB
46	SAP Grid Research Centre	QUB/UU
46	Belfast eScience Centre	QUB
52	Sonic Arts Centre	QUB

TABLE 5.6: SUMMARY OF ICT CAPABILITY IN THE FE SECTOR

SUBJECT CODE OF COURSE	TOTAL	LOCATION
Computing Science	137	BIFHE, Castlereagh, Lisburn, North East
Computer Studies	1,100	BIFHE, Castlereagh, East Antrim, East Tyrone, Fermanagh, Lisburn, Newry & Kilkeel, North Down & Ards, North East, North West, Omagh, Upper Bann
Data Processing	47	Castlereagh, East Antrim
Applied Computing	136	Fermanagh, North East, North West
Software Engineering	241	BIFHE, Causeway, East Down, Lisburn, North Down & Ards, North West
Software	19	Castlereagh, East Down, Lisburn,
Systems Analysis & Design	92	Limavady, Newry & Kilkeel
Programming	60	Castlereagh, Causeway, North Down & Ards, Upper Bann
Computer Education	4,480	BIFHE, Castlereagh, Causeway, East Antrim, East Down, East Tyrone, Lisburn, Newry & Kilkeel, North Down & Ards, North East, North West, Omagh, Upper Bann
Information Technology	10,258	All
Information Systems	118	Castlereagh, East Down, Fermanagh, Lisburn, Omagh
Applied Information Technology	253	East Antrim, East Down, Fermanagh, Limavady, North East
Others in Computing	2,043	Armagh, BIFHE, East Down, East Tyrone, Fermanagh, Lisburn, Newry & Kilkeel, North Down & Ards, North East, North West, Omagh, Upper Bann
Sum	**18984**	

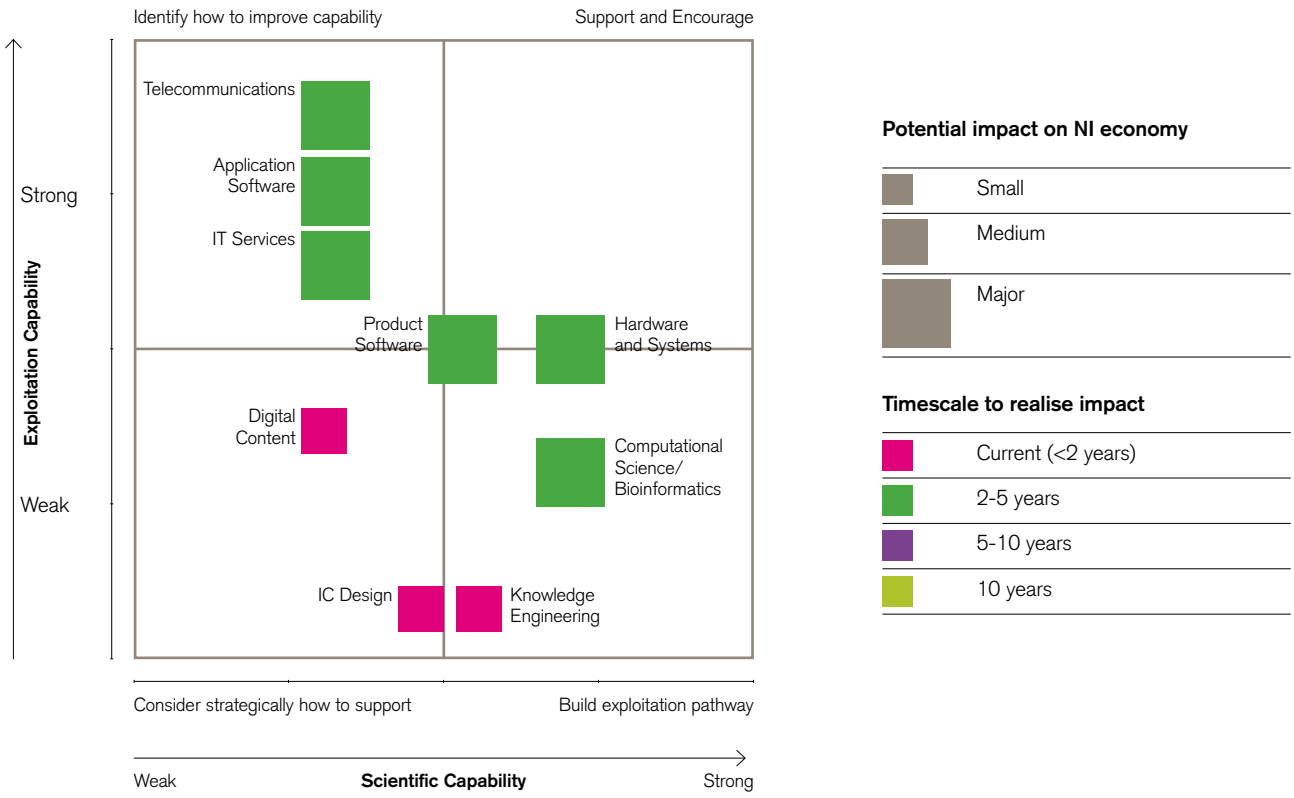
5.7 OVERALL SECTOR CAPABILITY MAPPING AND CONCLUSIONS

The Northern Ireland ICT sector, as defined in this report, is relatively strong and growing. It has missed a number of ICT generational issues which assisted the development of other sectors however there is a strong blend of growing indigenous companies as well as large MNC companies in the sector.

There is some heavy investment by indigenous companies in latest technology and research but in general, this is low across the sector as a whole. Additionally, there has traditionally been a moderate level of academic research, recent investment in ICT research facilities (e.g. ECIT) should 'bear fruit' over the coming years and recent developments such as the involvement of TDK in ECIT and SAP in Grid Computing should advance capability in these critical areas.

Figure 5.3 provides a summary of the Northern Ireland ICT sector's exploitation capability and it scientific capability. It highlights that in some ICT sub-sectors (e.g. Application Software, IT Services, and Product Software) there is an exploitation capability even though some of its scientific capability is less well developed. Similarly, in sub-fields such as Bioinformatics, Embedded Systems and application software it has weak/moderate exploitation capability, yet it has a stronger scientific capability.

FIGURE 5.3: SUMMARY OF ICT CAPABILITY IN NORTHERN IRELAND.



The key message from this analysis are:

- Northern Ireland does not have an ICT cluster at this point in time. The journey to developing a cluster is 10-12 years and should be considered, however in the interim, the platforms of the cluster can be developed showing short-term and medium-term impetus;
- There are also significant disconnects between education, skills and exploitation requirements. This issue is also misunderstood between all parties - education and knowledge is provided in universities, skills are developed and training in companies or further experience centres. Exploitation requires the immediate use of education and skills when provided;
- There are some highly competitive capabilities in the exploitation arena and these clearly lead to new short term opportunities - Nearshoring, product software and application software in telecommunications, financial services for example;
- There are limited capabilities in the hardware and systems aspect of the sector in Northern Ireland. The technology capability identified in this is relatively new. Centres such as ECIT are important developments. There is a need to manage the alignment of such centres with industry within Northern Ireland. The presence of TDK and others does not necessarily guarantee economic impact and this has to be openly tackled;
- Northern Ireland in ICT will always be a 'net importer' of capability in ICT as it is not possible to develop all its own capability. This implies that the growth of the sector is based on collaboration with other centres - an integral aspect of ICT Clustering. There are limited views on how Northern Ireland is currently collaborating with other ICT centres and this should also be addressed in the short term to allow the sector attain critical mass and acquire new experience in areas such as product software etc.

5.7.1 THE SKILLS AGENDA

During the latter half of the 1990s and the early 2000s, there were widespread claims of ICT worker shortages internationally. More recent international analyses[32] have tended to suggest that the extent of the shortage was not as great as had been claimed. There had been a rapid increase in demand for ICT professionals, and there had been evidence of labour market tightness. However, except in narrow areas, labour market indicators, such as the rate of increase in pay, had been broadly in line with other professional occupations, suggesting that ICT professional shortages had been no more severe than for other comparable occupations. Industry internationally appears to have bridged the potential gap in supply by recruiting more people with non-ICT qualifications than previously.

To the extent that current trends and forecasts are a reliable guide to the period to 2015, international ICT labour markets are unlikely to become as tight as in the late 1990s, unless as a result of a very significant decline in student interest in ICT disciplines in developed countries. On the demand side, best estimates are that the rate of growth in ICT markets will be significantly lower, which will restrict demand for new ICT professionals to a level lower than the peak experienced in the late 1990s. On the supply side, countries such as India are increasing their supply of ICT professionals rapidly, with the intention, in large part, of substituting for ICT professionals located in developed countries.

Under these circumstances, the quality of skills, and the extent of the match between those skills and industry needs, will be crucial determinants of the success of export-oriented ICT industries, particularly those that are unable to compete on the cost of labour.

Even in the early 2000s, when most of the international policy focus was on the quantity of skills available, issues to do with the quality of skills and their match with industry needs were important.

Much of the inward investment by major European companies is driven by shortages of specific skills and competencies in their home countries, rather than general shortages of ICT skills, or significant cost considerations.

With issues relating to the quantity of skills available becoming less critical internationally, issues relating to the quality of skills are coming further to the fore. This is shifting the policy focus away from the initial education and training required to drive increased supply, and towards the certified continuing learning required to underpin the quality and fit of the skills of existing ICT professionals. Organisations such as the OECD are now arguing that the main issue of concern for policy makers and companies should now be the gap between the current skills of some ICT workers and those sought by companies[33].

32. Information Technology Outlook 2002/OECD
33. Information Technology Outlook 2006, OECD.

5.7.2 IMPLICATIONS FOR NORTHERN IRELAND

The skills aspect of Northern Ireland becomes very relevant. Rough projections of demand and supply of graduates in computing and engineering within this current study suggest that the supply of computing and electronic engineering graduates available from the higher education sector is likely to fall short of ICT sector opportunities. As these are the primary technology disciplines in which substantial numbers of graduates are required, the projected shortage has the potential to constrain the sector's growth if alternative sources of skills cannot be found. The alternative is to take other graduates through certified conversion programmes (at Masters level) to alleviate this position.

However it is likely that Northern Ireland will have to again draw on significant volumes of skills from other countries. Inward migration from other EU countries will play an important role in this. However, the best sources of some skills will be outside the EU, in countries such as the US, India and Eastern Europe. It will be important that the sector should have access to these sources of skills, both through inward migration and through the establishment of subordinate operations in these countries. Inward migration by students, who may remain in Northern Ireland after graduation, may also have a significant role to play in compensating for reductions in the number of Northern Ireland students interested in pursuing ICT disciplines at college.

5.8 BENCHMARKING THE NORTHERN IRELAND ICT INDUSTRY

In order to gauge the current position of Northern Ireland with regard to its technology capability (across all the sectors outlined above), it is important to benchmark it against other regions in the UK and the rest of Europe. Technology indicators measure capability at an aggregate level to allow tracking of changes over time, to inform policymaking and to ensure that these indicators actually drive economic development[34]. In the past 10 years, all developed economies have become interested in tracking their capability for technology and innovations. There is significant development in this area with the development of the European Innovation Scoreboard[35], the UNIDO (United Nations Industrial Development Scoreboard), OCED and UK regional comparators.

Technology Capabilities are the results of knowledge produced by scientific means and applied research that culminated in new processes, designs, products and consumer goods. From all the indicators of technology measurement, it is clear that this is a complex process but it is worthwhile noting that the bottom line of capability is reflected in economic measures such as employment, exports and productivity.

In comparing Northern Ireland, it is important to look at two groupings of indicators for comparison and these are:

Regional orientation
This evaluates Northern Ireland regionally at a UK and European level in terms of High Technology Employment, Investment in R&D (Business Expenditure in R&D, Government Expenditure in R&D and Higher Education Expenditure in R&D), Private R&D Funding, Competitiveness, Education and an analysis of the industry present in Northern Ireland.

Technological scoring
In technological scoring, a Northern Ireland perspective on scoring was derived based on UK scorings that were adapted for the Northern Ireland position within the UK. These analyses compared Northern Ireland to global players such as Finland, Sweden, Denmark, Japan etc and looked at two categories;

- Environment
  The assessment of the degree to which the environment in Northern Ireland is conducive to the development and use of technology - Markets, Regulatory, Infrastructure etc.
- Readiness
  The assessment of the capability of business, government and individuals to leverage the use of technology - Business Readiness, Government Readiness etc.

The analysis of the benchmarking indicates the following key points:

- Northern Ireland does possess the key drivers for innovation in terms of the supply and quality of science and engineering graduates, the provision of tertiary education and lifelong learning and the quality of youth education. It is worth noting that Northern Ireland is among other 'small nations' in leading the field in this space - Sweden, Finland, Denmark and is ahead of the large players - USA, Japan and India.
- Northern Ireland has the key tenets of a good intellectual infrastructure. The laws and guidelines pertaining to Intellectual Property creation and transfer are clear and known. The political certainty has increased this standing.
- Northern Ireland also creates knowledge but does not exploit this knowledge to full economic gain. Northern Ireland does not match the percentage of GERD/HERD from the leading or emerging leaders - however the quality of outcomes where spending has been made has been positive. Therefore, Northern Ireland needs to scale up investment whilst keeping the same quality level. However, BERD in Northern Ireland is very low by European comparisons and this would simultaneously need to be addressed. The share of High/High Technology R&D is relatively low in Northern Ireland. The university system is doing most of the high technology R&D and attracting significant players internationally however the exploitation conduit needs to be further examined.
- Northern Ireland needs a broader innovation system that supports new and existing companies using the latest technologies. The exploitation of knowledge, once created, is the most significant aspect of focus in Northern Ireland (irrespective of where the knowledge is created). This tends to be sub-divided between the SME sector and the FDI sector. The number of Northern Ireland SMEs innovating in-house, or co-operating with each other, scores poorly at a national and European level. The focus of Northern Ireland SMEs tends to be on cost reduction only. From the sectors analysed above, there is limited focus on innovation in SMEs. The top 10 in all sectors tend to account for most of the identifiable innovation in that sector.
- Northern Ireland needs a significant cultural shift with regards to high technology and how new capabilities resulting from it can be exploited. Northern Ireland is lagging most other European regions in high technology classified employment. There is typically, where R&D drives the new products or processes of a company and creates the growth in employment, revenue and profit.

34. OCED 2000/2002
35. www.cordis.lu/itt

5.9 THE COMPETITIVE POSITIONING OF THE NORTHERN IRELAND ICT SECTOR

The OCO report[36] provided an analysis of the ICT sector in Northern Ireland within the context of the overall Northern Ireland benchmarking contained above. In this analysis, a number of locations were compared to the Northern Ireland ICT sector in terms of:

- Availability of resources that are experienced and inexperienced;
- The presence of an ICT cluster in Northern Ireland in terms of industry size and track record;
- R&D capabilities in ICT; and
- The cost factors for ICT (labour, property and telecommunications).

The fundamental competitive analysis was conducted on a cost-quality basis. The cost aspect was based on a competitive positioning of Northern Ireland baselined to 2006. The key findings of this competitive analysis were:

- In telecommunications software, Belfast in a strong location for investors that do not wish to sacrifice on quality and are looking for a cost-efficient location. Belfast is offering higher-than-average quality levels than most other European locations with a 30% cost differential. Stockholm is the benchmark in terms of quality, however costs are almost 70% higher. Madrid and Reading are very competitive with Belfast as they offer similar quality and cost. Belfast's high quality is driven by skills and labour force. However R&D capabilities are weaker compared to Cambridge, Dublin, Warsaw and Amsterdam;
- In financial services software development, Belfast scores highly in terms of skills and labour force and well in R&D capabilities as there are a number of highly specialist software development research centres in Belfast. Additionally, Belfast offers the second most competitive operating costs for software development, with operating costs 28% below the average, although higher than Eastern Europe and Asia;
- In overall software and IT solutions centres, Belfast is located behind competitors such as Madrid and the emergence of Eastern Europe (Budapest). In terms of investors seeking a developed economy (infrastructure) that offers high quality at reasonable costs, there are two main location options: Belfast or Manchester. Manchester offers higher quality than Belfast, but at higher cost. Manchester offers nearly 10% higher quality than Belfast (i.e. a small difference - mainly due to the much larger labour force and student population in Manchester) but at 20% higher cost (mainly due to considerably higher office costs in Manchester). The final selection between Manchester and Belfast will likely depend on the size of city the investor prefers to invest in, site visits and more detailed due diligence of each location.

In summary, Northern Ireland can be competitive in terms of cost and quality and with the right propositions can provide an impact in the global software markets once the appropriate focus and infrastructure are in place.

36. Northern Ireland ICT sector review/Dec 2006

5.10 SUMMARY

Northern Ireland has a number of distinct characteristics that are important to the global ICT value chain. These characteristics can be further exploited and they are:

- Since 2004, Northern Ireland has been the leading region in Europe in terms of software development centres attracted from foreign investors. There are over 100 inward investors in ICT including major Tier 1 companies such as Microsoft, Oracle, SAP, Northbrook etc.
- There are over 11,200 IT specific workers in NI[37], moreover there are 7,500 ICT university students and over 14,000 students in Further Education[38]. The IT workforce is growing and becoming more competent in market understanding and offer a high degree of multidisciplinary thinking in the IT sector;
- There are high levels of skills in the Northern Ireland ICT sector. These skills are available over a high variety of technologies that are predominantly based on newer technologies;
- There is world-class R&D expertise in Northern Ireland in the ICT research institutes with 25 spin-off companies and R&D collaborations with major innovative ICT companies;
- There is an indigenous presence in the sector to balance the inward investment and these companies are showing significant growth. Some of these are spun out of universities;
- There is an infrastructure in terms of science parks and incubators that lays the groundwork for further expansion of the sector;

37. This is a total number applied across all sectors and not within the ICT sector itself.
38. E-Skills, 2005/HESA 2005

THE FOCUS FOR NORTHERN IRELAND ICT

IN CHAPTER 6, THIS REPORT OUTLINES THE ULTIMATE GOAL OF THIS FORESIGHT WHICH IS THE CREATION OF AN NORTHERN IRELAND ICT CLUSTER WHICH CAN REJUVENATE ITSELF BASED ON MARKET CYCLES AND ROADMAPS BUT ALSO HAS A DEFINITIVE GLOBAL LEADERSHIP POSITION IN SPECIFIC NICHES OF THE ICT SECTOR. IN THIS CHAPTER THE KEY FOCUS AREAS OF THE NORTHERN IRELAND ICT CLUSTER ARE DETERMINED.

6

6.1 INTRODUCTION

In chapter 3, a global ICT structure (with associated sub-fields) was presented and the relevant capabilities of Northern Ireland with respect to that structure was outlined. For completeness this structure is represented here again in Figure 6.1.

The results of the Capability Study presented in Chapter 2 also demonstrated that Northern Ireland has key strengths a specific representation of this structure and this is outlined in the following Table 6.1.

FIGURE 6.1: SUMMARY OF ICT CAPABILITY IN NORTHERN IRELAND.

Northern Ireland NON TECHNICAL FEATURES
Agility/Proximity/Language/Multidisciplinary

GLOBAL ICT INDUSTRY	NORTHERN IRELAND FOCUS		
Product Software	Product Software	Telecommunications	Markets
		Financial Applications	
		Security Applications	
		Healthcare	
Application Software	Application Software	Telecommunications	
		Financial Applications	
		Security Applications	
		Healthcare	
Digital Content	Digital Content		
Hardware & Systems	Hardware & Systems	Embedded Systems	Enablers to Advanced Materials, Manufacturing, Lifesciences & Food.
		Computational Science	
IC Design	IC Design		
IT Services	IT Services	Infrastructure	Enabler
Support Services	Support Services	Nearshoring	Markets
		Call Centres	
SKILLS	PRODUCT INNOVATION		UNIVERSITY/INDUSTRY COLLABORATION

TABLE 6.1: SUMMARY OF THE NORTHERN IRELAND ICT CAPABILITIES AND THE RESULTANT FOCUS AREAS

SUB-FIELD	SCIENTIFIC CAPABILITY	EXPLOITATION CAPABILITY	MARKET POTENTIAL	CONCLUSION
Application Software	Low	High	Northern Ireland needs to develop significant software excellence capability in some facet of software development. Application development drives the sector and when incorporated into Product Software, Nearshoring Services (Financial Services for example) or Embedded Systems creates significant 'amplification' capabilities thereby increasing GVA per employee significantly. This capability attracts significant players also.	This is a focus area for Northern Ireland as it drives the entire industry and underpins the Package solutions, Embedded Systems, Computational Science and Nearshoring offerings.
Product Software	Low	Medium	The evolution of the packaged software industry is a significant evolution for Northern Ireland[39]. Northern Ireland already possesses some players in this space and the market is changing radically. This was identified as a key area for progress for Northern Ireland.	This is a focus area for NI as the market potential here exceeds that of any other offering within the industry. The value-added components of this industry are perceived to exist in Telecommunications, HealthCare, Financial Services and Security.
IT Services	Low	Medium	IT Services cover Shared Services, Off shoring, Nearshoring and Infrastructure Services. Northern Ireland possess good IT infrastructure and on the back of this good IT services are created, particularly for the government market but increasingly for the growing Nearshoring market. Further developments in IT Services will see new models of software distribution. This is a critical enabler for the Packaged Software and Nearshoring[40] markets in the future.	Nearshoring is the focus area for Northern Ireland. This represents a very different focus to off shoring or infrastructure markets.
Digital Content	Low	Low	Very normal capability with limited new technologies deployed. Predominantly a web-based industry.	Not a focus area

39. Packaged software allows a small nation such as the Republic of Ireland to export 40% of total software in Europe and 32% of global software of an ICT cluster of 17,000 people.
40. Nearshoring offers a significant benefit to NI. The off-shoring market is unattainable due to cost and style issues. Infrastructure Services is an enabler of Nearshoring.

SUB-FIELD	SCIENTIFIC CAPABILITY	EXPLOITATION CAPABILITY	MARKET POTENTIAL	CONCLUSION
Hardware & Systems (Embedded Systems)	High	Medium	In this definition, photonics and electronics companies are being included as they add critical mass to an emerging embedded solutions capability in Northern Ireland. The economic implications stretch to Medical Devices, Control Systems, Aviation etc.	Embedded Systems and Computation Science are focus areas due to the existing scientific excellence and the ability to find new markets for these products.
	High	Low	Additionally, Computational Science in all its guises (BioInformatics, Systems Biology, Materials Modelling, Aviation Modelling) is also included within this definition.	Computational Science.
IC Design	High	N/A	This definition includes design of multi-layer material devices for the global IC market.	Not a focus area.
Telecommunications	Low	High	A significant presence of telecommunications companies in Northern Ireland that are working through the OSS of such companies.	The emphasis on the sector in NI is on the software side, hence this focus is included within Packaged Software.

The analysis in this table leads us to conclude that the focus areas for Northern Ireland are based on the following key pointers;

- Application Software with a clear focus on Software Packages. Northern Ireland needs to develop a position on a clear leadership area in application software development, testing and certification;
- The Software Package has a clear focus with emphasis on HealthCare, Security, Financial Services and Telecommunications. The leadership position is to ascertain new delivery models of the packaged software industry;
- Hardware and Systems presents a focus on Embedded System and the integration of software solutions into Embedded Systems and Computational Science. These are primarily focus areas that underpin other sectors and leverage the capabilities of those sectors (e.g. Computational Science in Aviation (composites) and Bioinformatics in Medical Devices);
- IT Services have a focus on two specific areas - Infrastructure Services which are an enabler. The key market growth area is that of Nearshoring with an emphasis on Financial Services, Telecommunications and Business Process Outsourcing services.

6.2 JUSTIFICATION FOR THIS POSITIONING AND THE FOCUS AREAS

The discussions within the Northern Ireland ICT community and the emergence of the global roadmaps in ICT lead to the conclusion that the entire global structure needs to be perceived as a 'stack' of nine individual components.

These components are best represented in Figure 6.2.

The stack demonstrates the logic of the focus areas as selected. The entire industry is established on Infrastructure Services which through serviced facilities and networks provides a building block. Below this level, sits a capability in components in terms of Advanced Materials and Devices which can be combined with software to create the Embedded System solutions.

Once the building blocks of Infrastructure and Management Services are in place, it is then possible to create the environment of software application and software product offerings. These can be diverse in range and move from Financial Services, Telecommunications etc to a focus on Computational Science suites which have specific applicability.

At the highest level of the stack resides Nearshoring capability which includes all of the levels of the stack with specific value added parameters creating significant amplification capability in terms of GVA and employment.

This stack concept becomes easier to map to a skills and capability environment when the certification of the various levels of the stack are brought into the equation. As outlined in chapter 3 above, the industry is driving towards standards and these standards demand changes in skills and the profile of work that is completed. An example of how this is being managed is reflected in Figure 6.3.

FIGURE 6.2: THE GLOBAL ICT STACK

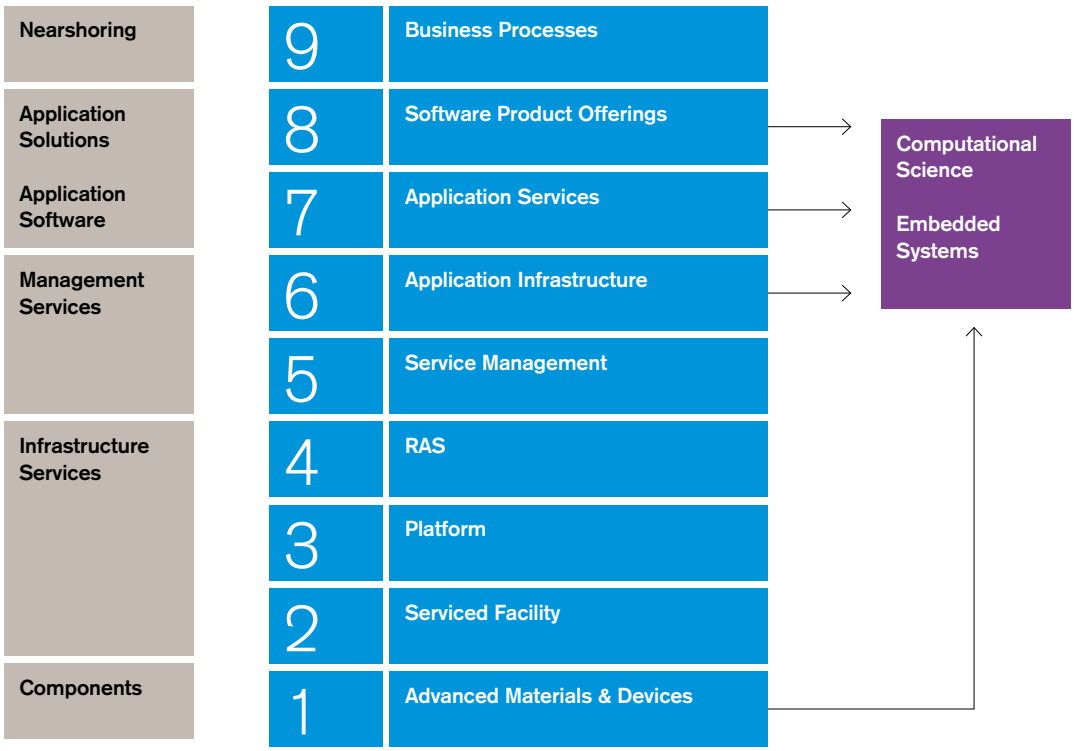


FIGURE 6.3: THE GLOBAL ICT STACK AND CERTIFICATION

8	**Nearshoring**	Business Process Administration or Execution		**Branded Certification**
7	**Product Offerings**	xSP Owned Application	Other Owned Application	**Microsoft Certified Solutions Provider**
6	**Application Services**	White Branded Email, CRM, ERP, Fax etc	APM Application Maintenance	**BMC Software Service Assurance**
5	**Application Infrastructure**	Database, APP, Web Server Integration - EAI, XML, IEI	Client Application Infrastructure	**SunTone Certified**
4	**Service Management**	Call Centre - Monitoring Admin - Backup - DBA - Service Management		**EMC² Proven**
3	**RAS**	High Availability - Scalability Disaster Recovery - Management - ITIL, ITSM		**Security BS7799**
2	**Platform**	Servers - Storage Network (firewall, router etc)		**Oracle**
1	**Facility**	Bandwidth Rack - Security - Power - Cooling		**ISO**

The stack represented above shows the types of activities that exist within each layer and develop the overall focus propositions of Application Software, Packaged Software, Computational Science, Embedded Systems and ultimately Nearshoring services. The layers need to be seen to support each other in a coherent manner. Additionally, the certification aspect supports the development of the levels of global ICT investment market seek.

FOCUS AREA 1 APPLICATION SOFTWARE AND PACKAGED SOFTWARE

IN CHAPTER 7, THE FOCUS AREAS OF THE NORTHERN IRELAND ICT CLUSTER WERE IDENTIFIED. THIS CHAPTER PRESENTS THE FIRST FOCUS AREA APPLICATION SOFTWARE WITH AN EMPHASIS ON MOVING TOWARDS THE GLOBAL SOFTWARE PACKAGED INDUSTRY.

7

7.1 SOFTWARE DRIVES THE GLOBAL ICT ENVIRONMENT

The first focus area for Northern Ireland is application software.
As indicated in chapter 4, application software drives the global ICT sector. It is present in everything from computational science to embedded systems and enables the Nearshoring capabilities which make such activities possible. Hence, any development in the sector must take place in the context of the scientific excellence of application software and the exploitation channels that leverage this capability.

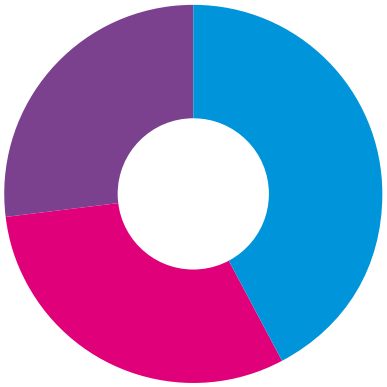
This fact is exemplified in the Figure 7.1 which shows how the USA ICT market is sub-divided.

The indications are apparent. Outside of the basic hardware market (which is excluded from the Northern Ireland focus), packaged software drives the market and shows the highest degree of growth. The services category includes the implementation and integration services that support package software, however these are capacity related (i.e. earnings are based on the number of resources available only). As Northern Ireland has limited capacity (irrespective of what activities are undertaken to build this base), it remains imperative that Northern Ireland enter the packaged solution market.

The same analysis applies to the European market represented in figure 7.2.

FIGURE 7.1: THE USA ICT MARKET

2007 SHARE



42.4% Services
30.8% Hardware
26.8% Packaged Software

$466.8 billion

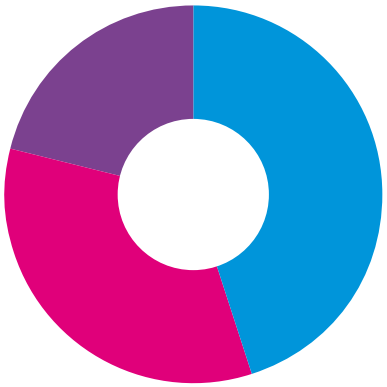
2007 GROWTH

5.3% Services
5.8% Hardware
8.7% Packaged Software

IDC

FIGURE 7.2: THE EUROPEAN ICT MARKET

2007 SHARE



45.1% Services
34.0% Hardware
20.9% Packaged Software

$374.3 billion

2007 GROWTH

5.2% Services
4.6% Hardware
6.6% Packaged Software

IDC

7.2 THE PACKAGED SOFTWARE MARKET IS ESSENTIAL FOR NORTHERN IRELAND TO GENERATE FURTHER GVA

Packaged software implies a multidisciplinary approach to application software and incorporates a number of new capabilities which Northern Ireland has limited exposure to. The packaged software market allows for a greater amplification of individually generated GVA as it ensures that the revenue per person is not limited to the capacity of that person (as is the case with software development). However, there are new capabilities required not least support mechanisms, implementation mechanisms, software distribution techniques, kitting and logistics etc.

These new capabilities have had relatively low exposure in Northern Ireland to date where the focus has traditionally been on application software development. The packaged software market is changing in terms of technology and delivery. This is reflected in the software roadmap which is illustrated in Figure 7.3.

Although software has evolved since the 1950s, the roadmap illustrates the short term, medium term and long term challenges for Northern Ireland.

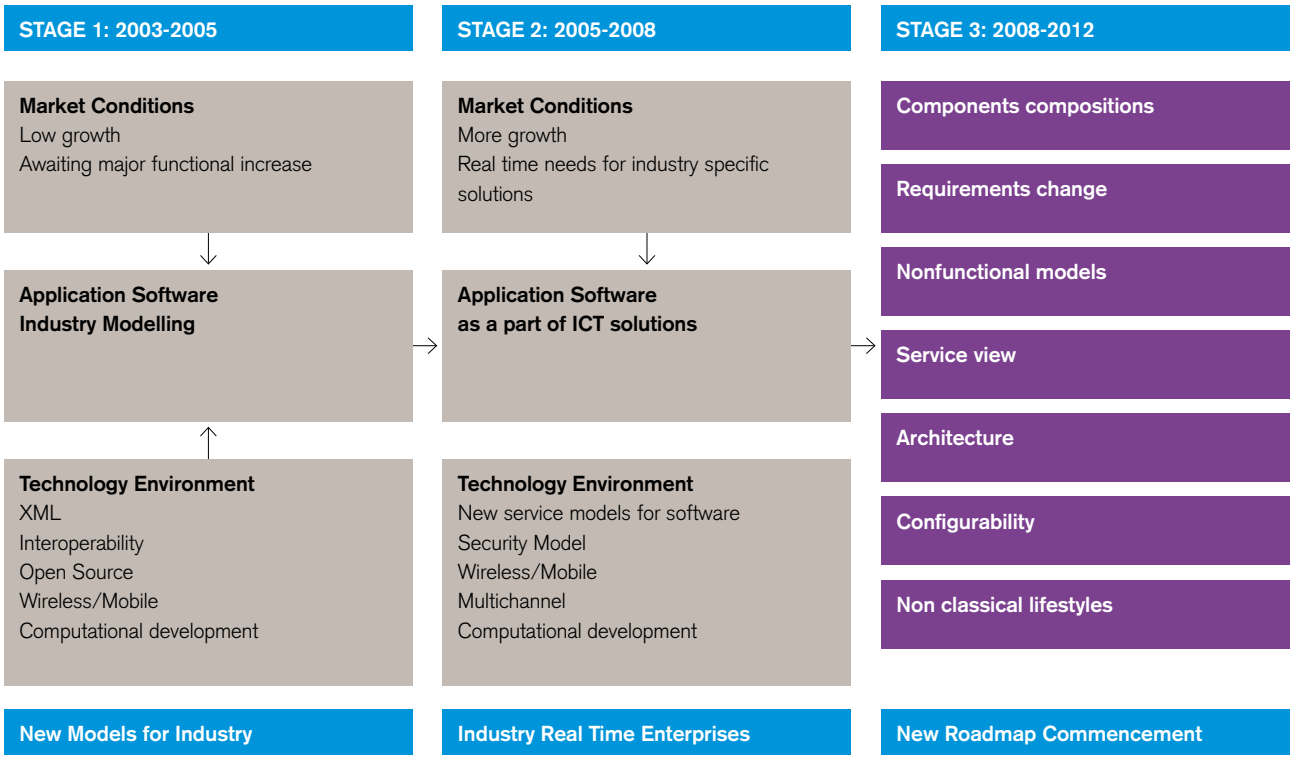
The new technology environment for software is based in new interoperable standards utilising proprietary and open source technologies enabled over mobile solutions. This has subsequently evolved to new models of development that incorporate security and multichannel mechanisms that are delivered of traditional channels (i.e. the customer acquires the software and installs it) to new models such as Application Software Provision (ASP, NSP etc).

The new aspects of the roadmap are;

1. The full understanding and insight into specific 'sectoral' challenges - HealthCare (HL 7), Financial Services (Hedge Funds, Capital Funds), Telecommunications (Value Added Services);
2. The full realisation of real-time in the software context at an affordable cost;
3. The full realisation of component based software (the real 'plus and play' of functions);
4. The ability to rapidly address requirements change through configuration of software at reduced costs through the interoperability of real-time components;
5. The recognition that non-functional aspects of software (reliability, security, availability, data integrity and management information) as now viewed as importantly as the actual functions themselves;
6. The development of new architectures that enable reconfiguration and integration and finally non-classical lifecycles (i.e. the development of non-obsolesce through standards changes).

It is important to recognise that all the key industries in the world can now define how specific application components need to be applied towards their industry. Hence, the development of real-time records management solutions for example. See specific applications in HealthCare, Financial Services (Retail, Capital etc). These applications are increasingly standards-driven (Sarbanes-Oxley, HL7). The specific focus areas are presented in Figure 7.3.

FIGURE 7.3: THE GLOBAL SOFTWARE ROADMAP



7.2.1 THE FINANCIAL SERVICES SOFTWARE MARKET

FIGURE 7.4: THE FINANCIAL SERVICES SOFTWARE ROADMAP

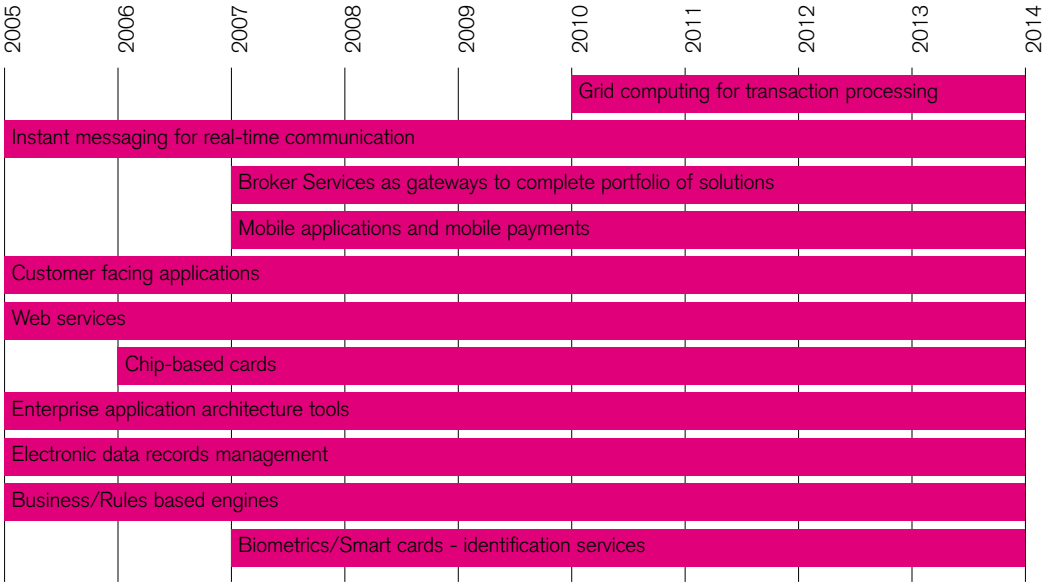


TABLE 7.1: EUROPE BANKING SECTOR IT SPENDING 2005-2009 FORECASTS ($M)

	2005	2006	2007	2008	2009
Retail products	7,622.10	7,891.70	8,208.40	8,586.20	8,964.00
Delivery channels	15,152.60	15,964.30	16,705.80	17,473.30	18,250.90
Wholesale products	5,968.00	6,234.30	6,499.50	6,816.60	7,118.90
Capital markets	7,947.30	8,351.20	8,879.40	9,520.80	10,089.40
Back office	13,536.20	14,311.00	15,148.70	15,926.00	16,716.80
Total	**50,226.20**	**52,752.50**	**55,441.70**	**58,322.90**	**61,140.00**

TABLE 7.2: FDI PROJECTS FOR FINANCIAL SERVICES SOFTWARE DEVELOPMENT BY LOCATION/ORIGIN

REGION	LOCATION OF INVESTMENT	ORIGIN OF INVESTMENT
Western Europe	24%	31%
Central & Eastern Europe	4%	2%
Asia-Pacific	49%	13%
North America	2%	53%
Rest of World	20%	0%

The Financial Services Software market has a complex roadmap which sees software being customised for specific purposes that are being increasingly driven by regulations. The roadmap is presented in Figure 7.4

This roadmap indicates that they key drivers of software are focused on:

- Security and Fraud Management;
- Risk Management and Compliance;
- High Performance Computing of real time transactions;
- Effective Customer Management;
- Payments (SEPA is compelling European banks to change their perspectives on low/high value payment systems which is changing the market;
- Banking Middle Office transformation;
- Shared Services and Integrated Services platforms;

There is a strong and steady FDI growth for FDI in financial services software development. Reports from sources such as OCO and IDC suggest that these projects are increasing in size driven by the factors outlined above and most of these are been driven by the USA market. This is outlined in Tables 7.1 and Table 7.2.

It is worth noting that Western Europe is the next highest originator of Financial Services software and this has significant impact on the Nearshoring proposition for Northern Ireland.

7.2.2 THE HEALTH CARE SOFTWARE ROADMAP

The key global drivers for Health Care can be summarised in one significant global change - demographics. The development of lifestyles with medicine, nutrition and environmental improvement and the result of improving economic situations and the demographic 'baby boom' of the late 1960s and 1970s have left most developed economies where they now possess an ageing population. Population predictions, which reflect fertility rates, life expectancy, net immigration and the impact of an ageing population can be sub-divided into two key areas:

(a) Fiscal Implications. Pensions, support funds etc[41]
(b) Social Implications. Dependency implications and social fabric change.

The key conclusion from this global trend is that the ageing of most developed societies over coming decades will require comprehensive reform, addressing fiscal, financial and labour market implications of ageing alongside the implications for pensions, social benefits, and more importantly applications of health and long-term care.

The impact on Health Care is significant. Countries are spending more than ever and healthcare is becoming an increasingly high percentage of GDP in all countries. The USA spends 13.9% of GDP, Germany 10.7%, and Switzerland 10.9%. The increase in spending is driven by:

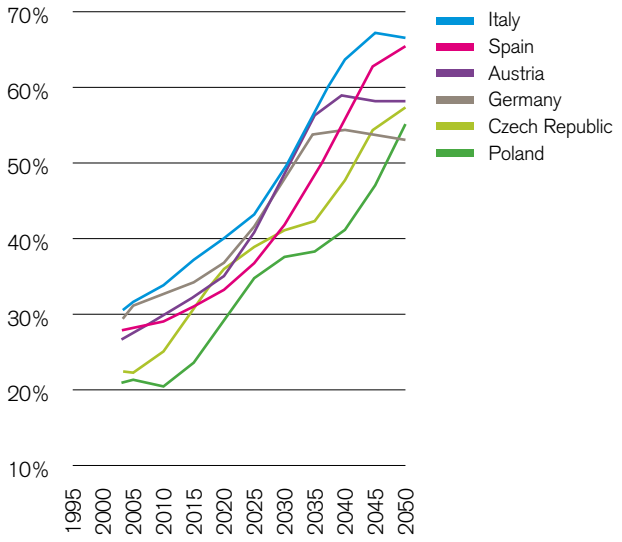
- Pharmaceutical costs - between 1990 and 2001, pharmaceutical spending has increased by more than 70% in developed countries such as the US, Ireland, Finland, Australia, Sweden, Canada etc.[42]
- Diffusion of modern medical technologies - modern medical technologies have made procedures less invasive and allowed for significant efforts to control and manage costs. However, whilst Average Length of Stays (ALOS) is decreasing universally, the cost base remains high. This is due to the fact that health risks have changed their nature and whilst issues such as tobacco illnesses etc have been mitigated, newer issues such as viruses, obesity and others are raising their heads ominously.

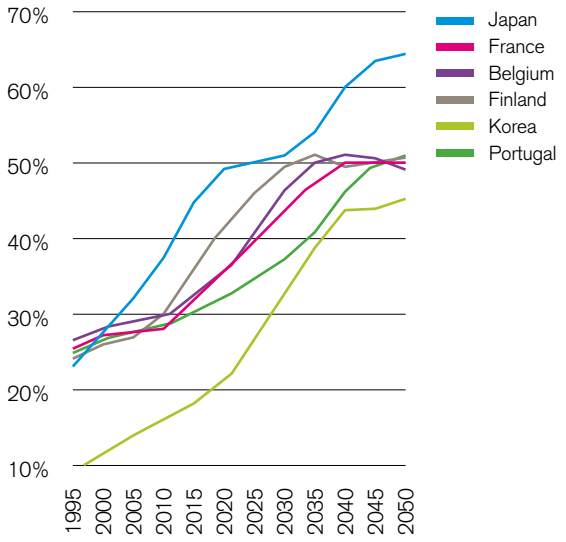
The Health Care industry needs to be seen from the perspectives of supply and demand to understand the overall demand on ICT technologies.

41. OECD report on Ageing and Fiscal and Social Implications (OECD T0011249 2001).
42. OECD Health Data 2003: a comparative analysis of 30 countries

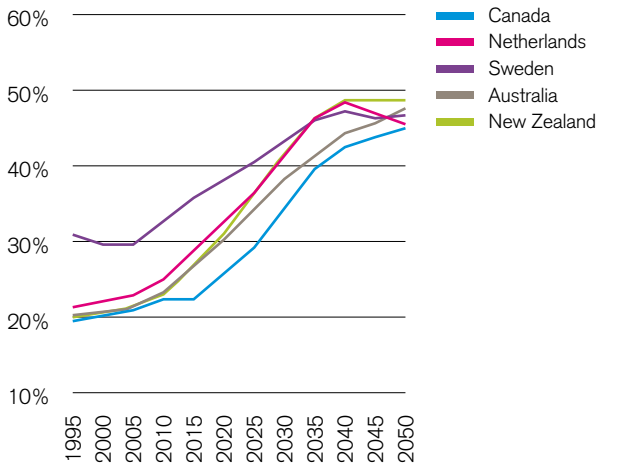
TABLE 7.5: OLD AGE DEPENDENCY RATIO

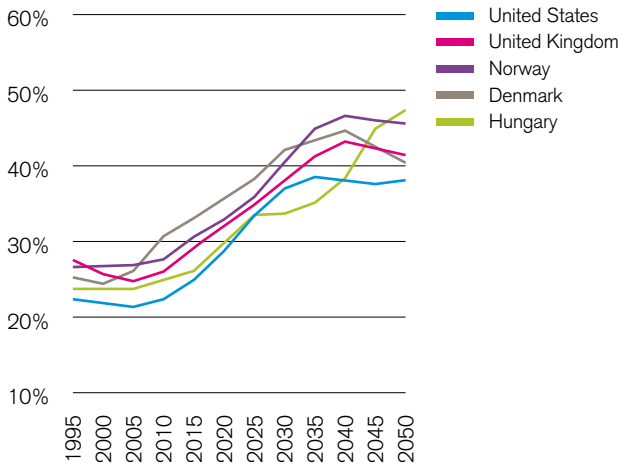
Panel A Faster Ageing Countries





Panel B Slower Ageing Countries





7.2.3 SUPPLY

The supply side of Health Care consists of the providers of Health Care, who are facing critical issues as costs control, patient care quality becomes enshrined in patient charters and there is a constant pressure to reduce medical errors. Previously, it was not seen that ICT would have a role in underpinning any solutions in this regard other than underpinning significant advances in medical equipment.

This is now changing and is foreseen to change in the next 10 years with the application of conventional ICT solutions to the specific Health Care issues of:

- Patient records applications at both fixed and wireless levels. This allows for the collection and monitoring of data to provide single view real-time data sharing on patient information. Additionally, multi-channel data capture such as voice and handwriting recognition will be critical to the advent of these technologies. It is expected that records applications in Health Care, when adapted correctly, will provide the same effect as they have had in the legal and administrative fields, namely the reduction of errors, the sharing of information, the ability to find and administer lower cost treatments, and preventive actions where necessary. It is also expected that traditional workflow engines and forms based (rules based) technologies will be applied to records management to drive the achievement of these process efficiencies. These technologies, when coupled with web and wireless technologies will allow for the significant enhancement of existing solutions in Health Care. The issues confronting Health Care such as taxonomy and safety will delay some of the work in this area but nevertheless the market will absorb significant change in this area.
- The issue of security will become paramount in the management of patient records and hospital management. Secure emails using new PKI structures or newer biometrics will allow for the creation of patient vaults that can protect the privacy of patients but still allow for enhanced patient care.
- The integration of patient records and applications with health insurance, of both the state and private variety, will also be established on the privacy and security of records.

The advent of Health Care Level 7 interoperability standards across the Health Care sector will drive significant changes to Health Care interoperability on a global scale. HL7 standards exist to promote the development of Health Care interoperability standards.[43]

In summary, it is clear that the pure-play ICT sector can take a proactive approach to resolving the traditional and pressing issues faced by Health Care in terms of the reduction of medical errors, the quality and consistency of care and the sharing of critical patient records. Ultimately, these process efficiencies, when achieved should allow for higher and more effective throughput of patients and the management and reduction of medical costs.

43. HL7.ORG

7.2.4 THE DEMAND SIDE

The demand side of the HealthCare equation refers to those who actually demand the services offered and eventually have to pay for them. The actors in the demand side tend to be Government Health departments, Health Insurance companies, Health Management Organisation and specific affinity groups of individuals.

The key issues from the demand side can be classified into two categories:

- Use the transactions of the supply side of the industry to provide more detailed information on patient care and options. This allows for the creation of relevant offerings, schemes and contingencies and all the major attributes of the Business Intelligence applications. This should also lead to a reduction of costs. The end game is the use of Health Care Portals and advice centres.
- Engage the end customers in the relevant financial and Health Care options that are available to them based on Health Care capability and capacity. Effectively, given the constraints of Health Care service, the customer becomes involved in managing these constraints.

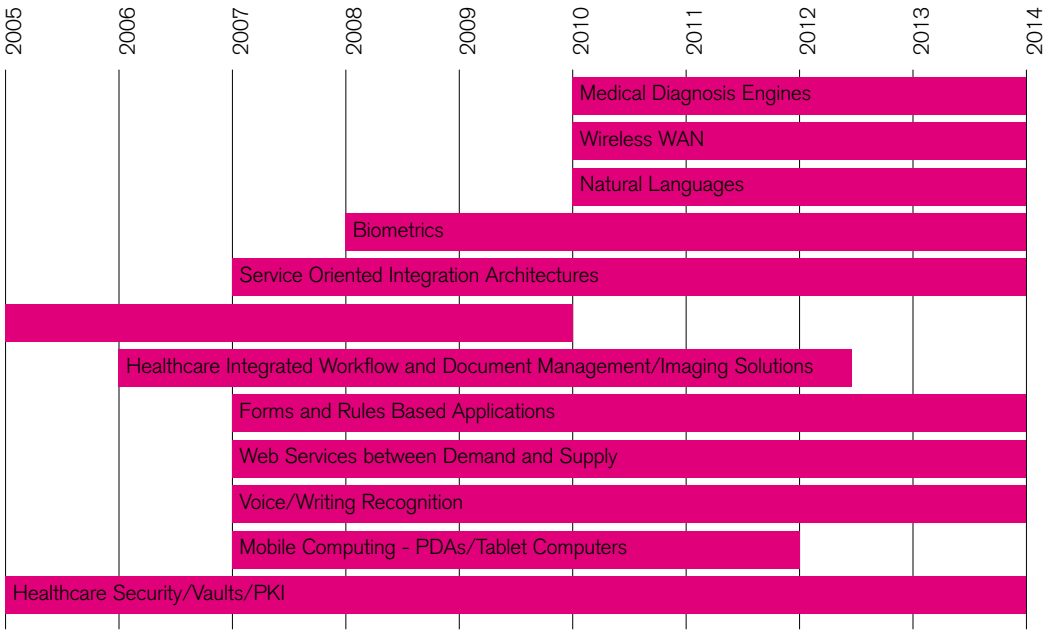
The demands placed on the demand side of the industry will place a great deal of pressure on the need for accurate and relevant information in order to allow the ultimate customers of Health Care understand the processes and options they need to be involved in. Additionally, in truth this meets the supply side wish to manage costs as much as possible and this remains the most significant overlap between both sides in this relationship. It is worth reflecting on the fact that the demand side uses exactly the same information strains as the supply side except in a different manner.

Generally, the industry roadmap for the demand side of Health Care can be seen as:

- Health Level 7 Document Architecture is a framework that defines for the compatible levels of XML most clinical documents such as laboratory reports and discharge summaries.
- Secure Email is standard email encryption applications for users with standard browser usage.
- Patient record management solutions provide clinical data viewing and real-time updates of records management solutions, including all aspects of a patient's records and history. This solution would also include document imaging.
- Workflow engines aligned with Patient Record Management refers to rules based engines that can effectively drive a process appropriately for both the operational and administrative aspects of records and their corresponding patient.
- Tablet Computing including handwriting recognition facilitates the collection of records and the conversion of free-form hand printing and writing into ascii text.
- Medical Taxonomy refers to a standard coding scheme for language and medical concepts that can be a de facto standard for medical records and conditions globally.

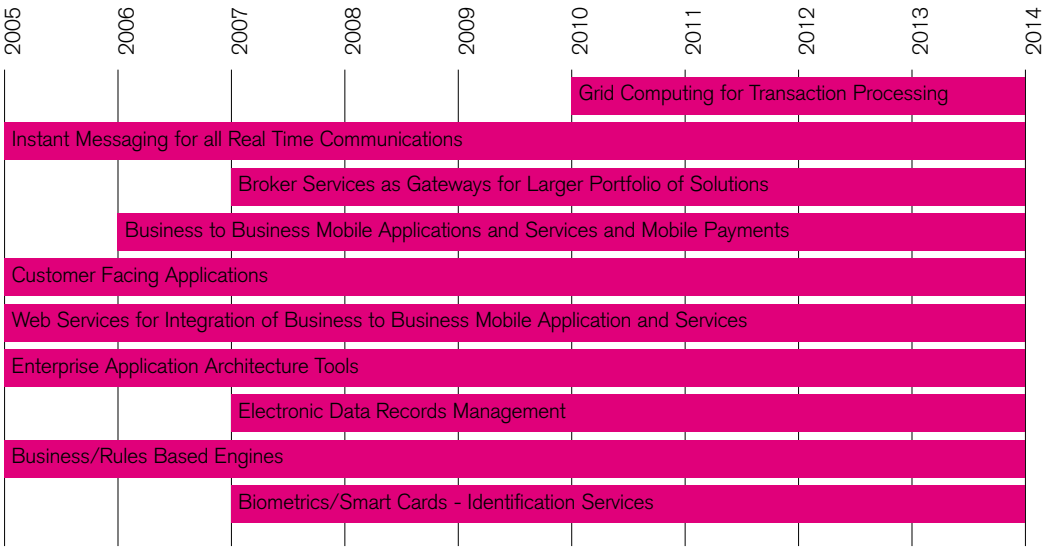
The software roadmap for Health Care is presented in the Figure 7.6.

FIGURE 7.6: THE HEALTHCARE SOFTWARE ROADMAP



7.2.5 THE TELECOMMUNICATIONS SOFTWARE MARKET

FIGURE 7.7: TELECOMMUNICATIONS TECHNOLOGY ROADMAPS



The Telecommunications industry refers to both the fixed-line and mobile operators. This industry saw the most significant 'boom and bust' cycle within the decade of the 1990s, with investment cycles rapidly increasing and then decreasing[44]. This is illustrated by the fact that between 1996 and 2001, OECD Telecommunications revenue grew by 7.2% annually. In 2001, this slowed to 1.6% and the numbers for 2002/2003 showed no real growth[45].

The Telecommunications sector is important because it is a major purchaser of ICT equipment, particularly in the 1990s and early 2000s following deregulation. The Telecommunications sector will continue to use ICT, albeit at a slower rate than initially thought due to financial restrictions.

The key transitions within the industry will be the realignment of the functioning model of telecommunications from a business to consumer model to a business to business model whereby extended applications and functions can be offered based on existing capabilities. This change will enable the successful deployment of technologies that already exist within the Telecommunications market.

Traditionally, this area was one of the largest spenders of ICT however it is projected that spend will increase at a mere 2.6% in Europe[46] and this is likely to be reflected throughout the world.

44. OECD Communications Outlook 2003
45. Merrill Lynch and 'Autorite de regulation des telecommunications', France.
46. Gartner - European IT Market Size

7.2.6 SECURITY SOFTWARE

Although growth is slow, higher growth is anticipated in the services side and not the equipment side, thereby reflecting the emphasis within any roadmaps on applications and value added services, as opposed to equipment.

In Northern Ireland, the telecommunications market is predominantly focused on Wireless and the back office systems that support this market. However, the wireless market is continuing to see substantial growth and competition is forcing prices down and the prices of minutes of voice continue to fall. There are so real flat rates of mobility in the developed markets as yet however the bundling of data/voice/services is well underway and this is fundamentally changing the operations of software in the overall mobile market.

Software providers are now being asked to link into the relevant wireless systems offering services on the network and the revenue sharing models being used are well underway. There is a significant increase in services such as ringtones, music and video that are not operated or run by the network company but which interact heavily with the sector. EMAIL is an example of such an application. In 2006 there were over six million individual mobile email users in Europe and this development is increasing as applications such as scheduling, workforce management, games etc are now being offered over the networks.

Security software and integrated systems have been one of the fastest growth areas in the ICT sector since the events of 2001 and beyond. The key trends driving this aspect of software have tended to be:

- Security is top of the agenda reaching out to all end users. Most recent market reports have highlighted integrated security as requiring the most immediate attention.
- Security is the growing sector of the community as companies across the developed world acknowledge that they need external support for IT security.
- Security was historically seen as a necessary 'add on' at minimum cost however this has changed and comprehensive ICT Strategies now incorporate an integrated approach to security thereby moving away from the traditional point solution.
- Government regulations, general and industry specific, throughout the world are influencing the spending on security services as companies strive to meet compliance mandates. Examples of regulations include the following:
  - Sarbanes-Oxley Act of 2002
  - Gramm-Leach-Bliley (GLB) Financial Modernization Act
  - Federal Information Security Management Act (FISMA) of 2002
  - Federal Energy Regulatory Commission (FERC): Security Standards for Electric Market Participants
  - Health Insurance Portability and Accountability Act (HIPAA) of 1996

Companies are constantly undertaking steps to evaluate their risk and track their security posture. Services such as enterprise risk assessments, incident response planning and preparedness, and business continuity planning have remained in demand because they help an organisation understand its risk posture and identify best practices for mitigating the risk.

The worldwide security market achieved a level of $32 billion in 2005, representing growth of 18% over 2004. IDC currently forecasts this market to reach $67 billion in 2010, representing a CAGR of 16% from 2005 to 2010. This is shown in Figure 7.9.

The growth in this market is being driven by a number of key software categories and these can be listed as:

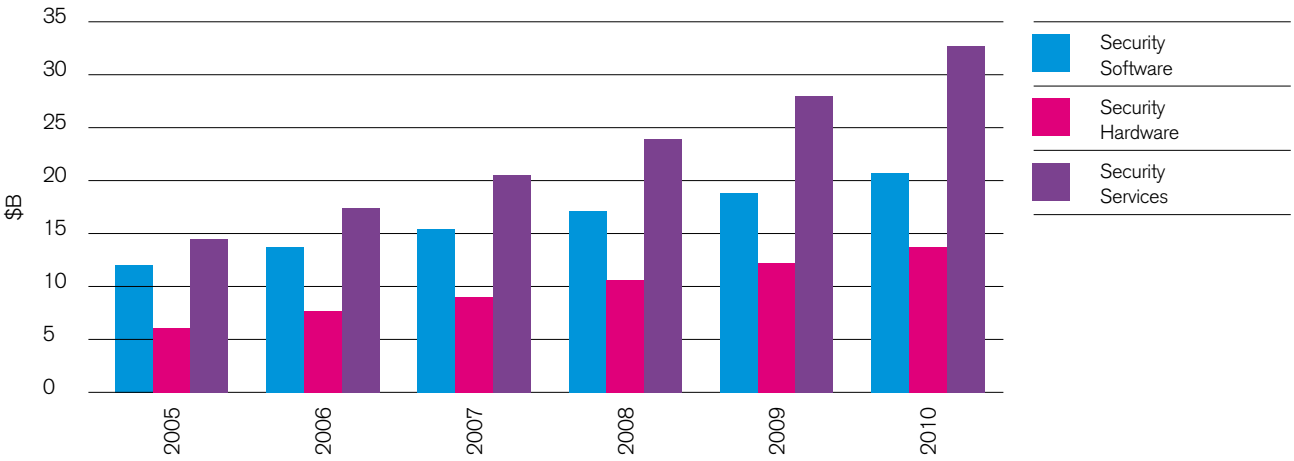
- Internal threats on the rise. Internal threats are quickly becoming a major security concern in organisations of all sizes. Employee error, data stolen by an employee or business partner, and insider sabotage all made the top 10 threats to enterprise security. Addressing the insider threat, however, is turning out to be a complex challenge.
- Spam, Spyware, and Malicious Code. Although internal threats are on the

FIGURE 7.8: THE ICT SECURITY ROADMAP

STAGE 1: MATURE UP TO 2003	STAGE 2: DEVELOPING 2004-2008	STAGE 3: NEW INNOVATIONS 2004 2012
Secure Sockets	Smart Cards	Instant Messaging
Firewalls	Digital Rights Management	Protected Access
Public Key Infrastructure	Authentication and Authorisation	Behaviour Programmes
	Encryption	Integrated Security Platforms
	Biometrics	Cryptography
	Managed Services	
	Web Services Security Standards	

FIGURE 7.9: GLOBAL ICT SECURITY MARKET

Worldwide Security Products Revenue by Segment 2005-2010



Source: IDC, 2006

rise, organisations are still battling to defend against the increasing volume and sophistication of spam, spyware, and malicious code. The threat environment continues to evolve from a mischievous hobby to a money-making criminal venture that has attracted a new breed of sophisticated hackers and organised crime.

- Web Security. The Web is becoming an increasingly more popular threat vector for hackers, spyware, and virus writers. Until recently, email-borne viruses were the most attractive weapon of hackers who sought to damage or disrupt business operations. The digital threat environment is rapidly changing.
- Threat Management. Threat management products have considerable challenges brought on by the popularity of appliances and new infrastructures and technologies. The market will need to continue transforming to remain a central part of an enterprise security posture. It is happening with the creation of a threat management market, which offers security vendors more opportunity to develop the products that best support enterprise network security needs. Developments that will shape this market in the future include the following:
  - Threat management and network admission control;
  - New applications such as voice, Web services, and storage networks;
  - Wireless (WLAN) and mobile security;
  - Endpoint security suites;
  - Application layer protection;
  - Use of appliances for network threat management.
- Security and Vulnerability Management. Security and vulnerability management is continuing to grow as an overall share of the ICT security market. As new technologies are being deployed, new threats are being created. The key sub-fields of this market can be defined as:
  - Risk management; and
  - Security, storage, and systems (3S) management.
- Identity and Access Management. Increasing regulatory compliance mandates (both in the United States and internationally) combined with budgetary and staffing constraints will continue to drive organisations to look for better ways to cost-effectively manage their security infrastructure. It has become evident in the IT industry that identity and access management products are a key component of a compliance platform.

The security software market looks continued for growth and emphasis in the next decade.

7.3 SOFTWARE ENHANCING THE COMPETITIVENESS OF OTHER SECTORS IN NORTHERN IRELAND

Software as an enabler enhances the viability of other sectors in Northern Ireland. For example, the Life Sciences and the Agri-food panels are already seeking software signature projects that will significantly enhance the capability and competitiveness of their sectors. These examples are:

- Agri-food. The Agri-food sector requires full tracing and tracking capability on all food products - even at component level within Northern Ireland. This is essential to ensure the quality of products and provide assurance with respect to disease and contaminants.
- Life Sciences. The Life Sciences sector emphasises a focus on personal health management. This initiative, driven from the Scandinavian countries and the UK, creates a focus for software which can enable the diagnosis and management of patients either remotely or in varying contexts. The ramifications of this for data, information and knowledge within the sector are significant.
- Advanced Manufacturing. The Advanced Manufacturing sector is characterised by manufacturing techniques such as lean production, supply chain management, rapid prototyping and enhanced instrumentation and design that are all leveraged by ICT. The specific roadmaps for this sector demonstrates the dependency on ICT.
- Government. The modernisation of the government sector with the transformation of services and processes based on a citizen-centric approach is underpinned entirely by ICT services supported by process mapping and change management techniques.

7.4 RECOMMENDATION 2: THE NORTHERN IRELAND ROADMAP FOR SOFTWARE

FIGURE 7.10: ROADMAPS OF ACTIVITIES FOR NORTHERN IRELAND TO DEVELOP FOCUS IN THE SOFTWARE INDUSTRY

STAGE 1: 2007-2009	STAGE 2: 2007-2012	STAGE 3: 2007-2017
Target anchor companies from an FDI perspective in terms Telecommunications, Financial Services, Security, Healthcare.		Infrastructure development.
Government sponsored industry led multidisciplinary R&D programme attracting international companies and focussing on a key theme in each sector.	Brand Northern Ireland in terms of international development of world class ICT software.	
Development of a world class software capability centre with a focus on software service delivery standards such as interoperability, real time systems.	Refresh programme with new international players.	
Develop product focussed export led companies with access to markets through alliances or affiliations with RoI or other clusters.	Develop mechanisms to bring private equity into the Northern Ireland software market.	

Policy integration between all Government departments with a clear direction on focus areas, skills and Northern Ireland developed roadmaps that are relevant to each focus area. Policy direction should be focused on developing the themes of cluster within NI.

The roadmap for Northern Ireland to accept the challenges of the global roadmap needs to be seen in three timescales - 2 years, 5 years and 10 years. This enhances the practical nature of such work and ensures that targets and goals can be completed in the short term and medium term to ensure the development of the sector in Northern Ireland. This is illustrated in Figure 7.10.

This roadmap kick starts Northern Ireland software focus. It requests activities to commence in the first two years. These activities cover a number of specific targets which will then be continued through the remainder of the years as the industry evolves. These are illustrated in Table 7.3.

TABLE 7.3: THE NORTHERN IRELAND SOFTWARE ROADMAP

TIMEFRAME	RECOMMENDATIONS
Two-year programme	Northern Ireland target specific FDI investment in the HealthCare, Financial Services, Security and Telecommunications sectors in software. The current INI pipeline is as follows (INI to year end 2008);

COMPANY	SECTOR	JOB NUMBERS	DISCIPLINE	SKILLS 'HIGH LEVEL DES'
Completed				
3ParData	ICT	80	Product - STorage SW	C & C++ device drivers
Broadsoft	ICT	5	Service - Tech Support	e.g. CCNE
Fujitsu	ICT	402	Service - SI and Tech Support	Wide range of s/w and n/w skills
		487		
Best Prospects				
Company	ICT	75	Product - Enterprise IT Admin	C & C++
Company	ICT	100	Product - WAN Optimisation	C, C++ assembler, SCSI, N/W protocols
Company	ICT	50	Service - Adobe SI and VAR	Java, .NET, WinTel, DBA
Company	ICT	100	Service - SI for ETL, CRM and EDRMS	Java, .NET, WinTel, DBA, LDAP, PM
Company	ICT	100	Product - IB Trading applications	.NET, Wintel, Oracle DBA
Company	ICT	100	Product - Enterprise IT Admin	C & C++
Company	ICT	75	Product - Ret, WS, Prvt Banking S/W	Cobol, .NET, Wintel, Unix, DBA
Company	ICT	40	Product - IB Trading applications	.NET, Wintel, Oracle DBA
		640		

The Northern Ireland Government needs to sustainably[47] fund an industry led, world-class software capability programme[48] with a focus on real-time software delivery. This software centre must develop leading edge real-time software solution concepts and strive to assume a leadership position in Europe by 2010 and a global leadership position by 2015. The mechanism for driving this investment is the cooperation of local industry/universities and the insistence of an international presence in the work of leading software companies and academic institutions. The boards of such a centre must be industry chaired with a technology advisory board consisting of leading global figures;

47. This implies a funding programme for a 5 - 7 year period. It is envisaged that such funding is based on industry contributions and EU contributions.
48. This programme is expected to be a virtual programme and not assigned to any specific physical Centre of Excellence. It is effectively a mechanism by which substantial funding is made available outside of the RAE to incentivise industry driven research.

TABLE 7.3: THE NORTHERN IRELAND SOFTWARE ROADMAP

TIMEFRAME	RECOMMENDATIONS
Two-year programme	The NI Government needs to sustainably fund an interdisciplinary programmes[49] to packaged software for the Financial Services, HealthCare, Telecommunications and security markets. These programmes will combine industry and Government funding to tackle roadmap issues in these sectors. The targets are to assume European leadership positions in two of the fields by 2010 and global recognition by 2012. The programmes must contain international presence in the work of at least two leading software companies and academic institutions The boards of such a centre must be industry chaired with a technology advisory board consisting of leading global figures. The Northern Ireland Universities need to develop capabilities in research and teaching in the packaged software market, evaluating and determining new mechanisms of delivery and interoperability within the market; In preparation for the development of an Northern Ireland ICT cluster, the policy infrastructure discussions should be commenced as outlined in Chapter 6.
Five-year programme	It is anticipated that the programmes listed above will deliver results in the 2 - 5 year window. In that timeframe, Northern Ireland would need to build on these programmes to reflect an improved branding with this software focus. All of the programmes outlined above would need to be revitalised in the five year timeframe based on the specific software roadmaps within that timeframe. In this timeframe the focus remains on Financial Services, Telecommunications, HealthCare and Security software products.
10-year programme	The policy environment that enables the creation of the Northern Ireland ICT cluster (chapter 6) is in place and new priority areas are identified.

49. See note 40.

FOCUS AREA 2
THE NEARSHORING INDUSTRY

8

8.1 WHAT IS NEARSHORING

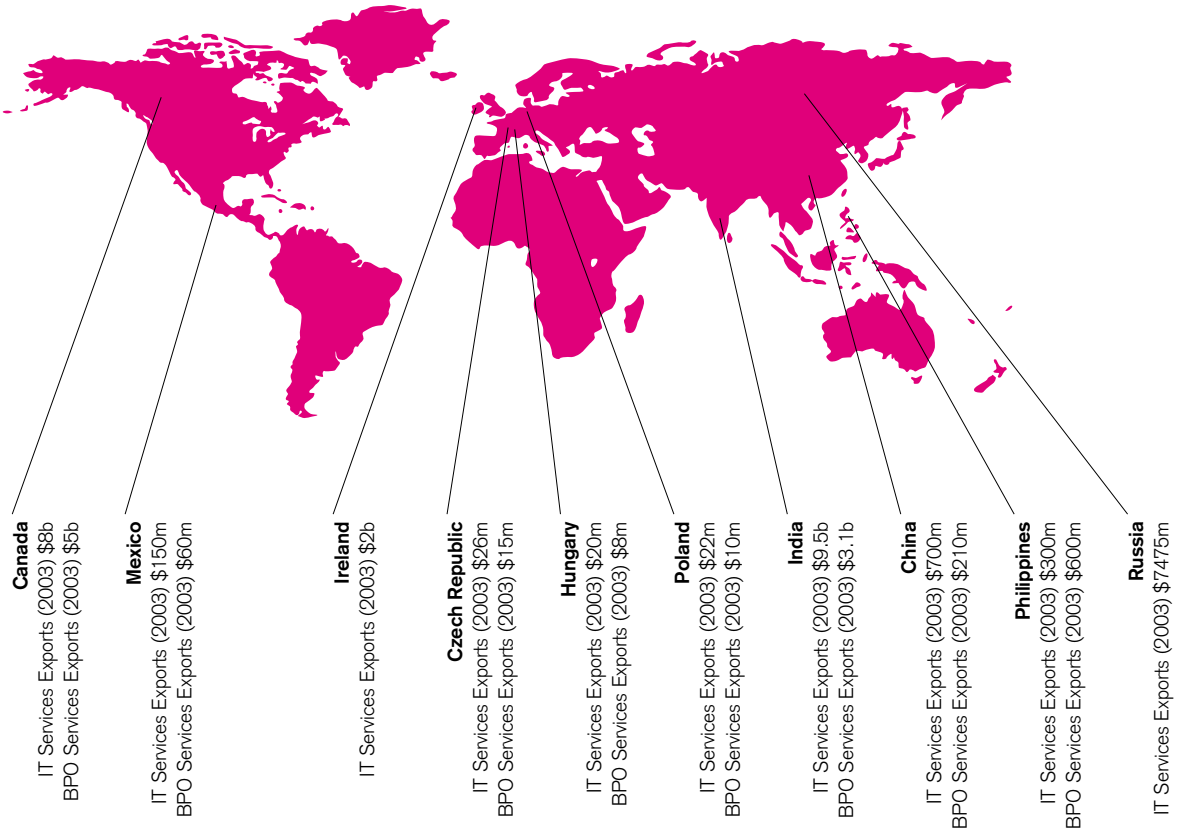
The second focus area is based on the current management paradigm that suggests that companies should focus on activities where they can deliver an edge over competitors and act to 'eliminate, limit or outsource' the other activities. The expectation is that the maximum cost advantage which can be gained by outsourcing these non-value added activities is to low cost geographies i.e. Offshoring. It is important to note that organisations which do focus on these 'non-value added' activities can generate economies of scale by providing services for multiple companies.

Offshoring work to neighbouring countries or cultures is referred to as Nearshoring. Historically, Nearshoring was considered only in the context of geographical proximity and time zones. However this has now expanded to consider less reliance on these two factors alone and a great emphasis on linguistic and cultural similarities. As a result of these characteristics the outsourcing arrangement may benefit from increased efficiency in multiple areas e.g. communication. Northern Ireland may be well positioned to exploit this niche in the outsourcing market, building on some key strengths that it already possesses - not least the language and legal capability.

Companies deciding to outsource do so on the business case that they will reduce the cost base more significantly by moving jobs 'Offshore' to developing nations than they can by deploying to lower-cost domestic locations. This is to be accomplished by maintaining the effectiveness of services for this reduced cost. This appears to be supported by data that reflects that software developers in India (offshore) are paid considerably less than software developers in the USA, Europe or Canada. The new emerging thoughts on this however suggest that all of the critical economic factors such as wage inflation, productivity, service satisfaction, and management overhead need to be considered and that in such a context not all services or operations are applicable of Offshoring. This emerging thought process is suggesting that companies can have a variety of outsourcing needs depending on the type of process which they are considering, within this range some activities will be suitable to offshore while others will be suitable to nearshore.

Since the commencement of the current off shoring trend as a cost cutting and sourcing strategy, India has been the location of choice for many of the developed worlds companies, largely because of its supply of relatively inexpensive English-speaking workers and the regulatory/legal infrastructure. However, the Republic of Ireland, Poland and Czech Republic have retained their growing positions despite the presence of India. Recently, other countries are emerging as competitors, as is illustrated in Figure 8.1.

FIGURE 8.1: SCHEMATIC MAP OF IT AND BPO EXPORT SERVICES



Source: Current Trends in Global Sourcing/KLG

8.2 THE PROFILING OF NEARSHORING UNDERSTANDING ITO AND BPO

8.2.1 ITO

There tends to be two context to Nearshoring - the IT Outsourcing market and the Business Process Services (BPO) market.

IT Outsourcing is predominantly about using Nearshoring operations in tandem with offshore operations to manage a variety of services including:

- Applications Development: were the responsibility for the development and deployment of a packaged or customised software is handed to a provider in a different location. This provider can reside within the company or outside of the company where necessary.
- Applications Management: where the responsibility for the ongoing management of the application, associated data etc are managed via Service Level Agreements. As before, the provider can reside within the company itself or outside of the company. The evolution of this mechanism sees the advancement of concepts such as Utility Computing or Software as a Service (SAAS).

This profile of export services can be put into forecasted numbers for the European market which indicates that growth in this area will continue for quite some time into the future.

TABLE 8.1: EUROPEAN ITO MARKET FORECAST (2005 - 2009)

	2005	2006	2007	2008	2009
Application management	6,585	7,273	8,079	8,911	9,719
IS outsourcing	31,429	33,851	36,398	38,964	41,514
Network and desktop outsourcing	11,813	12,814	13,803	14,781	15,785
Network consulting and integration	5,962	6,355	6,816	7,294	7,772
Hardware deploy and support	16,917	16,813	16,691	16,615	16,373
Software deploy and support	20,257	21,204	22,125	23,038	23,856
Total infrastructure management services	**92,962**	**98,310**	**103,910**	**109,603**	**115,018**

Source: IDC 2006

8.2.2 BUSINESS PROCESS OUTSOURCING

The use of the term BPO in this study refers to top of the ICT stack and refers to customer relationship management BPO (including call centre outsourcing), human resources (HR) BPO, finance and accounting (F&A) BPO, procurement BPO, and back-office (or industry) BPO activities. This market, from a Nearshoring perspective, continues to grow and the European BPO services market continues to demonstrate vigorous health, with strong growth evident across all five 'core' BPO processes in 2005. By comparison to the ITO market in Nearshoring this is a relatively immature market but it is showing significant growth patterns and the total spending on core BPO services that include human resources, finance and accounting, customer care, procurement, and industry-specific BPO, is forecast to grow from $17.8 billion to $39.4 billion at a CAGR of 17.2% for the period 2004-2009.

It is not always obvious as to why BPO is included in Nearshoring in the ICT sector. The reasoning for this is that the viability of this market is driven by ICT tools such as Software (integration and function), Web technologies, and the wide array of both enterprise resource planning (ERP) as well as process specific applications available. These provide large organisations with the tools to determine process integration and automation in multiple locations at reduced costs. However, these technology toolsets have to be complimented by sophisticated transaction and processing services related capabilities that are adapted to individual sectors, change management and process technology consulting and integration skills. This has been particularly evident in the HR, F&A, and industry-specific markets, where these providers have been able to meet client expectations of 20%-30% savings by leveraging their scale and global sourcing expertise to drive down transaction costs.

In the customer care BPO segment, where the practice of locating call centre operations in low-cost regions or countries is now widespread, competition has become increasingly focused around the capabilities of service providers in managing and integrating the CRM solutions with corporate strategic goals.

TABLE 8.2: EUROPEAN BPO SERVICES MARKET, 2005-2009 BY SEGMENT ($M)

	2005	2006	2007	2008	2009
Customer care	8,750.00	10,108.80	11,743.80	13,650.50	15,843.10
Procurement	241	290.7	349.2	418.4	490.5
Human resources	2,410.70	2,813.40	3,277.30	3,814.50	4,440.70
Finance and accounting	1,986.30	2,254.00	2,577.80	2,965.40	3,153.00
Industry-specific	7,607.60	9,294.30	11,153.90	13,240.60	15,448.40
Total WE BPO market	**20,995.60**	**24,761.20**	**29,102.00**	**34,089.50**	**39,375.70**

Source: IDC 2006

8.3 THE GLOBAL NEARSHORING MARKET

There were some concerns in this panel that the Nearshoring market for locations such as Northern Ireland is diminishing and that all potential future work in this sector would migrate to the East of Europe or to India and other emerging countries. However, there are capacity and capability issues emerging in India and there are a large number of drivers which make offshore location attractive for sourcing work, as many of these drivers which are often overlooked can provide real insight into whether the qualities that make the location attractive are sustainable over the long-term. India serves as a relevant example because of its position as the dominant offshore services market. The boom in offshore services that India has enjoyed is due to its well educated inexpensive English-speaking workforce. The low cost of Indian labour relative to that of the economically developed countries of the West is due to the fact that the Indian economy is still in the process of rising from third world status and that its supply of human capital is vast (over 1 billion). Some tasks are basic enough that system failure can be remediated via telecommunications, or of low enough business value that remediation can be put off long enough to accommodate extensive travel. In contrast, there are many other functions, particularly in Financial Services, HealthCare and Security that, although they are not core activities, are of sufficient complexity and business value that they require on-site and timely remediation in order to avoid substantial revenue or client loss.

A related factor is the extent to which a function being considered for deployment is sensitivity to time zone differences. The higher the degree of sensitivity to time zone the less suited a function is for offshore deployment. For example, business processes that are considered for deployment to a distant offshore location which must work synchronously with functions that are not candidates for deployment may require shift work at the offshore site. This can lead to additional costs and business continuity issues that are a consequence of the time differences.

There are other factors that can render offshore deployment inappropriate for an organisation, perhaps the most widely reported being the impact of cultural differences in communications with offshore staff or between offshore staff and the customers that they serve. These will directly affect business operations in an organisation's deployment facility and are as essential in the decision making about deploying functions offshore as cost reduction. Reducing costs from off shoring has to be re-evaluated if the effort to do so inadvertently reduces sales/revenues/ customers.

It is also important to recognise that Offshore and Nearshore strategies are not mutually exclusive. For many companies - especially large, complex corporations with a wide range of functions and processes - one particularly attractive approach involves a mix of both strategies. A number of companies have implemented solutions in which routine, highly structured functions with low risk profiles were deployed to an offshore location (either captive or outsourced) while high value-add, complex, mission critical functions and processes were deployed to a near shore location. The Offshore component provides a sourcing platform providing maximum sustainable savings when the correct functions are channelled there. At the same time, the Nearshore component ensures significant savings (often only marginally less dramatic than if those functions were moved Offshore) that can be sustained long-term, proximity to headquarters, time-zone consistency or proximity, little/no added risk relative to the status quo environment, and a more suitable labour pool.

Another point to note is that the outsourcing market performs well regardless of the economic cycle. Companies are motivated to outsource in bad times to reduce IT and business process costs and in good times to access new markets and increase revenues.

8.4 THE GLOBAL ROADMAP IN NEARSHORING AND HOW THIS IMPACTS NORTHERN IRELAND

Nearshoring is an evolving concept for most FDI companies that are prepared to invest in it. There are two facets of Nearshoring emerging in the current market - the captive (i.e. the actual company itself) and the BPO market (market driven by outsourced suppliers of specialists services). Irrespective of the facet of the market, the characteristics are the same.

In 2006, PA Consulting undertook a survey of 20 large organisations with Nearshore operations. Whilst this survey[50] is not statistically representative, it supports the findings of previous Nearshoring surveys and the results are presented in figure 8.2.

This figure shows that there is a combination of capabilities required in any economy to develop a relevant Nearshoring proposition. These capabilities are:

- Commercial Acumen: a variety of skills in procurement, HR, administrative processes, specific sector processes such as insurance, retail banking, capital funds etc.
- Technical/IT Skills: these are recognized as a 'table stake' of Nearshoring operations - the ability to find specific platform skills that enable the Nearshoring operation. The emphasis moves from these skills being in-house to being available in the market - at a world class certified level. All capabilities through all nine levels of the ICT stack (figure 6.3) are required.
- Supplier Interactions Skills: the Nearshoring market operates through the mechanism of using networked supply chains in the actual operation. The ability to manage these suppliers in a manner that ensures continuity of operations is deemed critical to such operations.
- Customer Interactions Skills: for Nearshoring operations, the mantra becomes 'if there is no customer, there is no value'. Nearshoring must have a customer engagement involved as this drives the value of the operation. Naturally, customer interaction implies language skills.
- Decision Support Skills: the value-added mechanism of Nearshoring operations has altered in the past ten years. Traditionally, Nearshoring operations involved transaction processing only. This work has now been 'Offshored' to cheaper environments. Nearshoring operations are expected to focus on customer interactions (and maximizing the value from those interactions) and Decision Support analysis of these customers and markets. This skill aligned with the control and reporting of Offshore transaction processes adds significant value to Nearshoring activities.

The clear message from this analysis is that whilst Nearshoring is enabled by ICT capability, it requires more than these skills and capabilities to be viable. The emphasis on Decision Support skills, supplier interaction skills and customer interactions skills suggest that this market has moved beyond the fundamental ICT infrastructure and is looking for value-added skills that enable productivity gains in terms. This message implies that the Nearshoring message within Northern Ireland will have to encompass more fundamental business models of operation with a clear focus on value added activities as indicated in Figure 8.3 below.

50. Where to locate/2004/AT Kearney

FIGURE 8.2: WHAT NEARSHORING OPERATIONS WANT

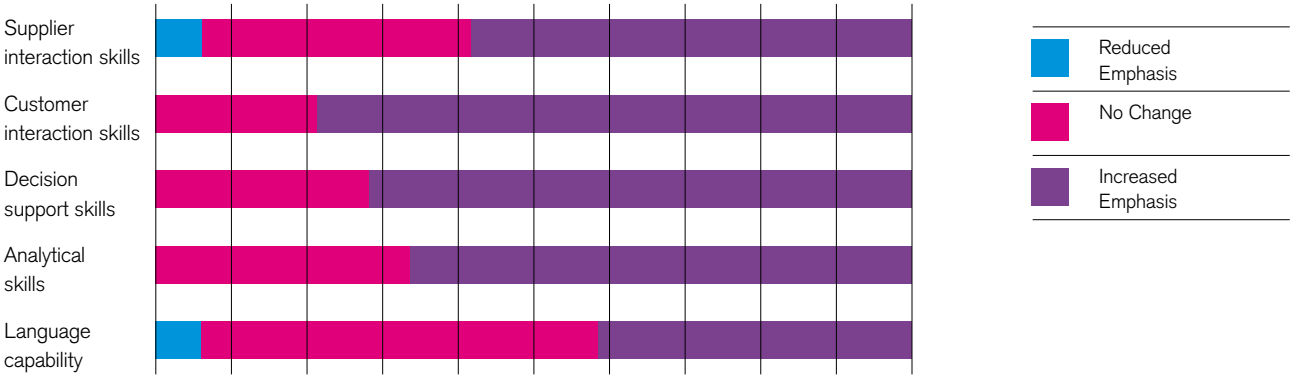
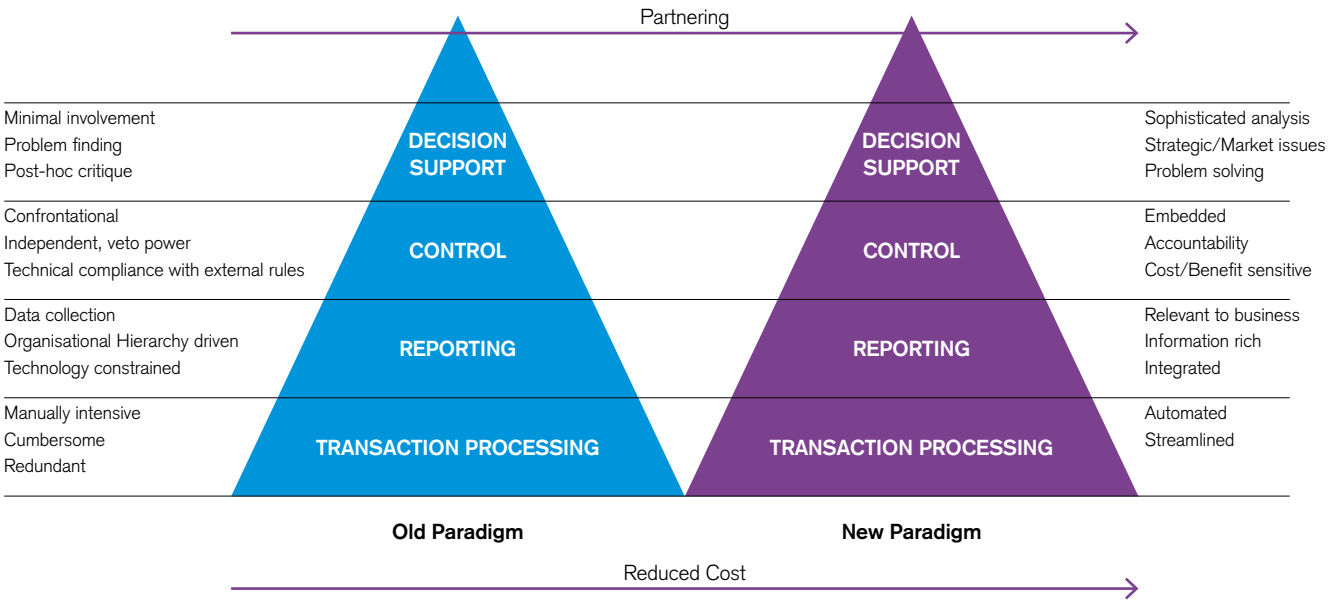


FIGURE 8.3: NEARSHORING VALUE ADDED FOCUS



8.5 A MODEL FOR NEARSHORING IN NORTHERN IRELAND

From the discussions outlined in section 8.3 above it is evident that there is a model that Northern Ireland can create for Nearshoring propositions. This model is outlined in figure 8.4 below and it reflects the need for ICT Infrastructures that are globally competitive but also for additional capabilities beyond the normal ICT set.

This model informs us that Nearshoring is a full Northern Ireland proposition that merges a number of capabilities - ICT Systems and Infrastructures, Facilities and Infrastructure and Regulatory and Taxation issues (Northern Ireland has a strong regulatory environment) and adds the insights from Process Design for specific industries, People and Cultural issues such as language skills, customer orientation etc.

The combination of these facets allows Northern Ireland to create a significant business case for Nearshoring although it must be remembered that in the past five years, the pressure has come on Nearshoring operations to focus on the high impact/low cost/low risk opportunities first thereby demonstrating that the significant investment required is justifiable.

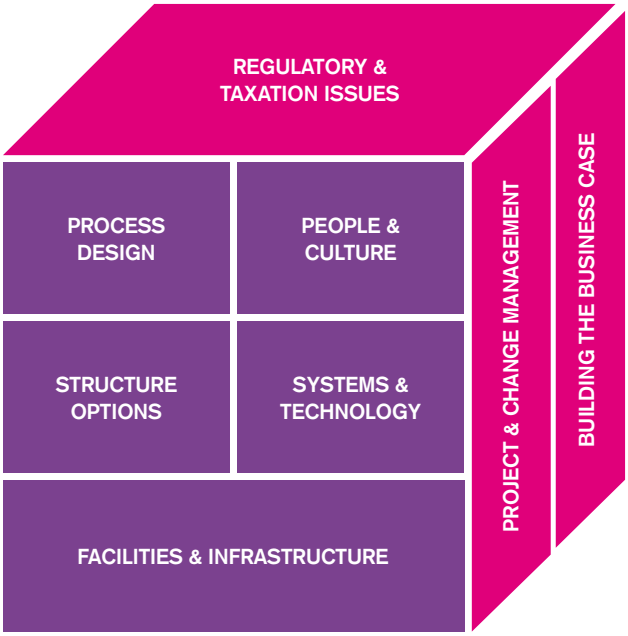
In essence, quick wins are essential to improve project economics, create momentum and credibility and release further investments. This is demonstrated in figure 8.5.

Nearshoring has evolved significant in the past 10 years moving from cost-focused transaction operations to business operations support with critical decision support features. This has happened in all sectors but has been primarily driven by the Financial Services sector.

FIGURE 8.4: A MODEL FOR NEARSHORING IN NORTHERN IRELAND

Process Design Capabilities
Analyse current processes;
Design & validate target processes;
Build a nearshore model that reflects specific customer needs;
Implement target processes;
Identify additional opportunities.

Structure Options
Strategic structure
Reporting structure
Operating structure



People & Culture
Assess current environment
Design target environment
Align culture
Implement target environment
Continuously improve

Systems & Technology
Analyse current systems
Determine functional and technical requirements
Select software
Define technical infrastructure
Implementation planning and start up
Implementation
Enhancement

Facilities Infrastructure
Initiate project
Developcriteria
Identify and evaluate location alternatives
Choose site
Enhance physical facilities

FIGURE 8.5: THE BUSINESS JUSTIFICATION FOR NEARSHORING OPERATIONS

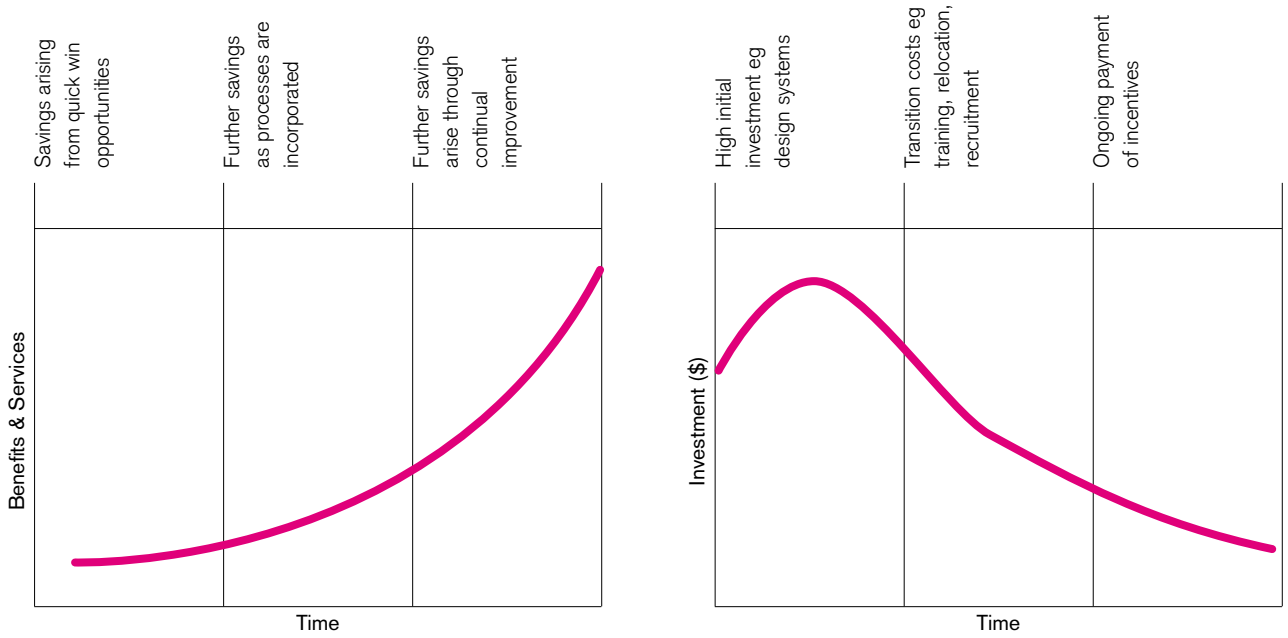
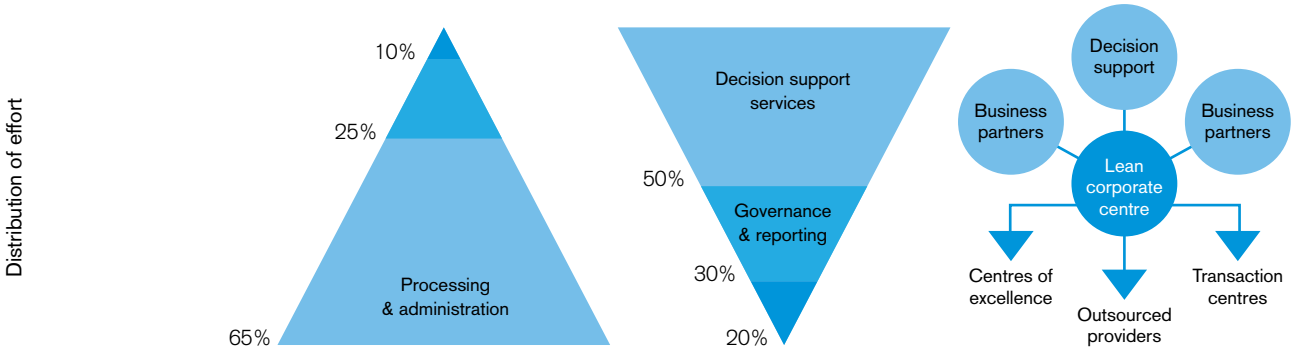


FIGURE 8.6: DRIVING NEARSHORING CHANGES - HOW THE FINANCIAL SERVICES HAVE CHANGES



Business need	Economies of scale	Automated efficiency/better governance	Cost reduction/service enhancement
Transformation path	Process simplification/ rationalisation/re-engineering	Technology - ERP, scanning, OCR, workflow	Shared services, outsourcing, data warehousing, business intelligence
Role of finance function	Administrative function 'score-keeping'	'Shape the Play' through enhanced MI and embedded controls	Virtual function with business partners

8.6 WHAT ARE THE FOCUS AREAS FOR NORTHERN IRELAND IN NEARSHORING

There are a number of key areas that Northern Ireland could develop in real 'Nearshoring' offerings and these can be defined as:

'Quick Start' - matching the overheating from the Republic of Ireland
There is a shortage of capacity in a number of sectors in the Republic of Ireland which Northern Ireland could quickly focus to support that industry. These sectors include:

- Financial Services back-office processing;
- Consumer Services back-office processing;
- Billing and Payments Engines;
- Customer Support;

Strategic focus on Nearshore activities promotion of the key Nearshore activities
Northern Ireland needs a defined strategy to gain market share in the Nearshore marketplace. To do this, Northern Ireland needs to identify the types of activities within ITO and BPO which are suitable candidates for Nearshoring. These are highlighted in tables 9.3 and 9.4 below. This will allow capabilities to be built in these areas through the promotion of skills and industry based in these activities.

Targeting of selected companies
The main question asked by companies which are thinking of Nearshoring is 'why should we outsource and to what location?'. Northern Ireland needs to ensure that it can illustrate their capabilities to some of the largest organisations which are considering outsourcing.

Identification of competitor offerings
Near shore competitors may include Bulgaria, Romania, the Czech Republic and Egypt. Understanding of the strengths and weakness of these near shore competitors is vital to improving Northern Ireland's value proposition.

TABLE 9.3: ILLUSTRATING IDEAL POSITIONING OF ACTIVITIES FOR AND IT BUILD AND IMPLEMENTATION (ITO)

ON-SITE	NEARSHORE	OFFSHORE
Program management	Quick turnaround development	Detailed design
Requirements definition	Defining and scoping requirements	Coding
Prototyping	Interactive development	Unit testing
High level design	Prime time support	Documentation
Usability testing	Testing	Ongoing maintenance
Acceptance testing	Risk diversification	Offshore staff management
User training	High level design	
Implementation/cutover		

TABLE 9.4: THE MOST COMMON PROCESSES SELECTED FOR BPO

PROCESS	PERCENTAGE
Payroll	37%
Benefits Management	33%
Real Estate Management	26%
Tax Compliance	26%
Claims Administration	24%
Application Processing	21%
HR	19%
Internal Auditing	19%
Procurement	15%
Finance/Accounting	14%

8.7 HOW NORTHERN IRELAND CAN FURTHER DEVELOP A NEARSHORING CAPABILITY

Northern Ireland has a significant capability basis to market itself globally as a world class near shore service provider. These capabilities can be split into the following areas:

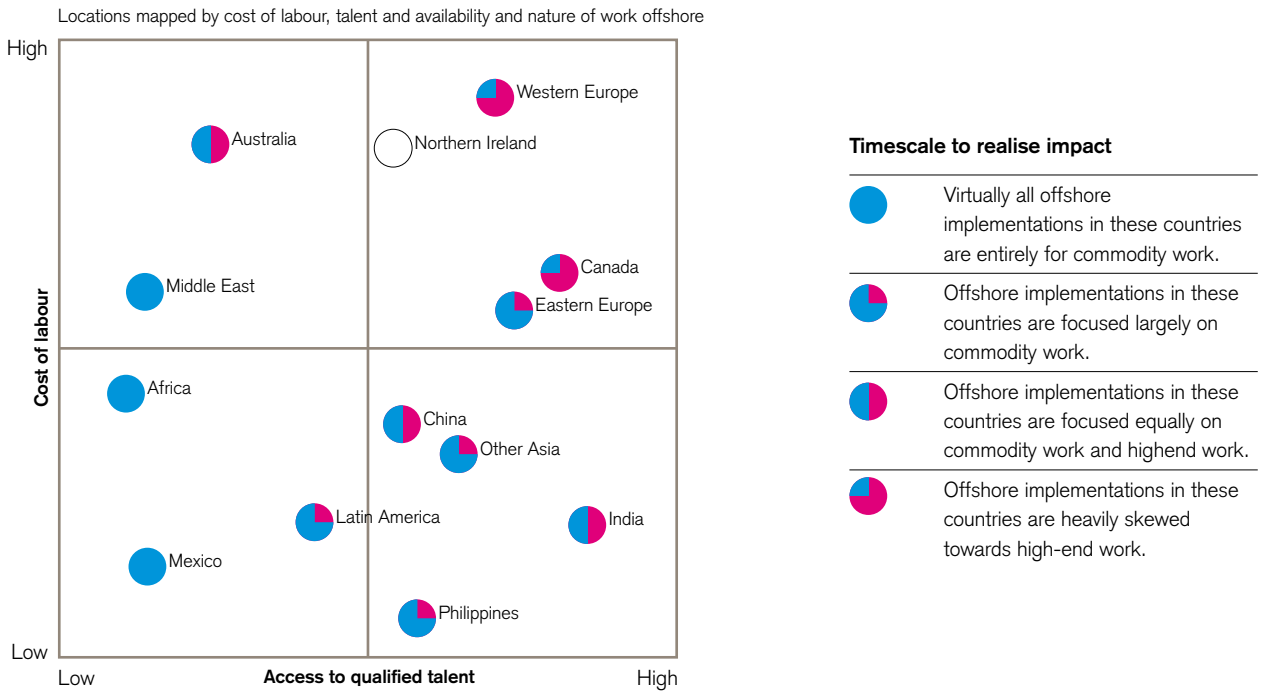
1. Northern Ireland has cultural, geographical and language ties with the major economies with its near shore neighbours - the US, UK, the Republic of Ireland and Western Europe.
   - Close geographic links lower the cost of face-face contact when necessary
   - Decreased time zone differences reduce the management overhead
   - Improved customer service through shared cultural experience/expectations
2. The wage level remains relatively competitive and stable;
3. There is a high basic standard of education;
4. A stable macroeconomic & political situation;
   - The comparative strength of Northern Ireland lies in the more complex high-end work for operations - BPO and ITO, see Figure 8.7. This is supported by the strong cultural background and also the strong experience in complex processes. Note: BPO is the fastest growing area of outsourcing - HR, accounting and finance, facilities management and other support functions;
   - The reduced adverse publicity by Nearshoring of jobs as opposed to outright off shoring of jobs;
   - Northern Ireland already has developed significant contact centre capability across the outsourced services. A short review of the market has shown that there are well over 50 call centres employing in excess of 15,000 people, see Appendix D;
   - As the management paradigm for selective outsourcing gathers momentum active advertising of these capabilities with further strengthen Northern Irelands position

There are some deficits that Northern Ireland needs to overcome however and these can be identified as:

- Northern Ireland cannot boast a real IT specialisation in exports or education. The position of the IT industry in terms of total exports, share of graduates gaining ICT degrees (fundamental for Nearshoring) and the development of these resources is very limited[51]. Northern Ireland may not want to compete in the ICT outsourcing market (commoditisation driven) and instead compete in the BPO outsourcing market;
- International language skills are relatively poor in Northern Ireland. Again this may not be a significant hurdle as Nearshoring partially relies on the assumption that the language skill used is that of the neighbouring country; and
- The total labour supply in Northern Ireland is limited in comparison to other countries. This may limit the scope to present Northern Ireland as an outsourcing hub reducing infrastructure investment.

51. By comparison, the Republic of Ireland has a comparative advantage. It exports computer and information services and other business services at 22% of total exports and growing at a rate of 3.8% CAGR. India comes in second with 16% of exports and a CAGR of 4.5%. The USA is third with 11% and a CAGR of 2%. Source: International Monetary Fund 2005.
52. Developed from nexIT Inc. Offshore White Paper - July 2004

FIGURE 8.7: MATRIX ILLUSTRATING COST OF LABOUR VS. ACCESS TO QUALIFIED TALENT AND NORTHERN IRELAND RELATIVE POSITION[52]



8.8 RECOMMENDATION 3: THE NORTHERN IRELAND ROADMAP FOR NEARSHORING

FIGURE 8.8: THE NORTHERN IRELAND NEARSHORING ROADMAP

STAGE 1: 2007-2009	STAGE 2: 2007-2012	STAGE 3: 2007-2017
Target F100 Focus on captive or BPO in finance, HR, IT and administration	Develop Northern Ireland infrastructure to further develop F100 offerings	Infrastructure development.
Develop RoI linkages with an emphasis on Financial Services Centre and ICT back office functions.	Develop Northern Ireland infrastructure to further develop F100 offerings including London based Nearshoring.	
Commence development of a Finance Service competency in legal, hedge and acturial functions through the development of a NI competency centre.	Further develop mid-range capability on R&D developing a roadmap for value added services.	

To be addressed
Legislation/Regulatory issues, immigration, lifestyles, wage rates, legal support, RoI linkages in general

TABLE 8.5: THE NORTHERN IRELAND NEAR SHORE ROADMAP

TIMEFRAME	RECOMMENDATIONS
Two-year programme	Northern Ireland target specific FDI investment in the Nearshoring markets - looking to the Captive or BPO markets with a focus on HR, IT and all administration (reporting etc). The current INI pipeline covers (need to insert listing); The Northern Ireland Government needs to sustainably fund an industry led, world-class Nearshoring programme with a focus on Nearshore operations delivery. This centre must develop leading near shore solution concepts and strive to assume a leadership position in Europe by 2010 and a global leadership position by 2015. The mechanism for driving this is the cooperation with local industry and the insistence of an international presence in the work of leading Nearshoring operations ('The Nearshore Forum'). The boards of such a centre must be industry chaired with a technology advisory board consisting of leading global figures; The Northern Ireland Universities need to develop capabilities in research and teaching in the Nearshoring markets; Northern Ireland to develop sponsored programmes of development for graduates where they are sent for two years to operations in other parts of the world with a focus on the commercial aspects of the business in which they operate in. In preparation for the development of an Northern Ireland ICT cluster, the policy infrastructure discussions should be commenced
Five-year programme	It is anticipated that the programmes listed above will deliver results in the 2 - 5 year window. In that timeframe, Northern Ireland would need to build on these programmes to reflect an improved branding with this near shore. All of the programmes outlined above would need to be revitalised in the five year timeframe based on the specific roadmaps and findings within that timeframe.
10-year programme	The policy environment that enables the creation of the Northern Ireland ICT cluster (chapter 6) is in place and new priority areas are identified.

The roadmap for Northern Ireland to accept the challenges of the global Nearshoring environment needs to be seen in three timescales - 2 year, 5 years and 10 years. This enhances the practical nature of such work and ensures that targets and goals can be completed in the short term and medium term to ensure the development of the sector in Northern Ireland. This is illustrated in Figure 8.8.

This roadmap builds on successful developments in Nearshoring in Northern Ireland and develops this focus further. It requests activities to commence in the first two years. These activities cover a number of specific targets which will then be continued through the remainder of the years as the industry evolves.

FOCUS AREA 3
HIGH PERFORMANCE COMPUTING SYSTEMS AND HIGH PERFORMANCE SIGNAL AND NETWORKING SYSTEMS

9

9.1 AN INTRODUCTION TO HIGH PERFORMANCE COMPUTING SYSTEMS

In the past two decades, computer modelling and simulation of physical phenomena and engineered systems have become widely recognised as a 'pillar' of science and technology. At this stage, it shares an equal status with theory and experiment.

Simulations are performed on computing platforms ranging from simple workstations to very large and powerful systems known as high performance computers. These enable investigations that were previously impossible, which in turn have enabled scientific and technological advances of significant breadth and depth. At this point in time, high performance computing has become an indispensable tool for carrying out significant missions in science and technology and finds applications in elements such as complex systems such as aircraft (Bombardier), proteins, human organs, Advanced Materials and Advanced Engineering fields. It is now possible to analyse and better understood these worlds through computer models. With advances in high performance computing power, scientists will be able to model such systems in far greater detail and complexity, and eventually to couple individual models to understand the behaviour of an entire system. There is a broad range of research and theory that supports the case that accelerating progress in many fundamental and applied sciences is compelling.

The broad application of the scientific challenges that High Performance Computing addresses is exemplified in the following table:

As an example, Table 9.1 illustrates that fundamental understanding of the emergence of new behaviours and processes in nanomaterials, nanostructures, nanodevices, and nanosystems will require a combination of new theory, new design tools, and high-end computing for large-scale simulation.

The fundamental conclusion of this analysis is that scientific and technological advances in many fields are increasingly reliant on large-scale modelling and simulation and solving many important scientific and technological problems and these require healthy high-end computing environment.

TABLE 9.1: HIGH PERFORMANCE COMPUTING IMPACT ON SCIENCE, TECHNOLOGY AND BUSINESS LEADERSHIP[53]

AREA	APPLICATION	SCIENCE CHALLENGE	POTENTIAL OUTCOME WITH 100 TO 1,000 TIMES CURRENT CAPABILITY
Physics	Astrophysics	Simulation of astrophysical environments such as stellar interiors and supermovae.	Yield understanding of the conditions leading to the origin of the heavy elements in the universe.
	High - Energy Physics	Achieve a detailed understanding of the effects of strong nuclear interactions so that the validity of the Standard Model can be tested to determine whether physics beyond the Standard Model occurs at extreme sub-nuclear distances.	Guide experiments to identify transition from quantum chromodynamics to quark-gluon plasma.
	Accelerator Physics	Accurate simulations of the performance of particle accelerators.	Optimise the design, technology, and the cost of future accelerators, and use existing accelerators more effectively and efficiently.
	Nuclear Physics	Realistic simulations of the characteristics of the quark-gluon plasma.	By developing a quantitative understanding of the behaviour of this new phase of nuclear matter, facilitate its experimental discovery in heavy ion collisions.
Nano-Science	Catalyst Science/ Nanoscale Science and Technology	Calculations of homogeneous and heterogeneous catalyst models in solution.	Reduce energy costs and emissions associated with chemicals manufacturing and processing. Meet Federally mandated NOx levels in automotive emissions.
	Nanoscale Science and Technology	Simulate the operation of nanoscale electronic devices of modest complexity.	Take miniaturization of electronic devices to a qualitatively new level enabling faster computers, drug delivery systems, and consumer and military electronics.
	Nanoscale Science and Technology	Simulate and predict mechanical and magnetic properties of simple nanostructured materials.	Enable the discovery and design of new advanced materials for a wide variety of applications potentially impacting a wide range of industries.

53. Federal Plan 2004 - 2007

AREA	APPLICATION	SCIENCE CHALLENGE	POTENTIAL OUTCOME WITH 100 TO 1,000 TIMES CURRENT CAPABILITY
Aerospace	Simulation of Aerospace, Vehicle in Flight	Simulate a full aerospace vehicle mission, such as a full aircraft in maneuver or an RLV in ascent or descent.	Reduce aerospace vehicle development time and improve performance, safety and reliability.
	Full Liquid Rocket Engine Subsystems Simulation	Simulate full rocket engine subsystems during ascent including turbopump and combustion devices.	Provide capability for risk assessment during Earth-to-orbit and improve safety and reliability of space transportation systems.
	Aviation Systems Simulation	Execute high-fidelity airspace simulations and develop decision system and management tools for terminal area.	Provide capability for effectively managing national airspace and increase safety in terminal area.
Life Sciences	Structural and Systems Biology	Simulations of enzyme catalysis, protein folding, and transport ions through cell membranes.	Provide ability to discover, design, and test pharmaceuticals for specific targets and to design and produce hydrogen and other energy feedstock more efficiently.
	Signal Transduction Pathways	Develop atomic-level computational models and simulations of complex biomolecules to explain and predict cell signal pathways and their disrupters.	Yield understanding of initiation of cancer and other diseases and their treatments on a molecular level, and the prediction of changes in the ability of micro-organisms to influence natural biogeochemical cycles such a s carbon cycling and global change.

AREA	APPLICATION	SCIENCE CHALLENGE	POTENTIAL OUTCOME WITH 100 TO 1,000 TIMES CURRENT CAPABILITY
National Security	Signals Intelligence	Model, simulate, and exploit foreign codes, ciphers, and complex communications systems.	Support US policymakers, military commands, and combat forces with information critical to national security, force protection, and combat operations.
	Directed Energy	Advance the directed energy systems design process out of the scientific research realm into the engineering design realm.	Efficiently design next-generation directed energy offensive and defensive weapon systems. Change the design process from years to days.
	Signal and Image Processing and Automatic Target Recognition	Replace electromagnetic scattering field tests of actual targets with numerical simulations of virtual targets.	Design more stealthy aircraft, ships, and ground systems and create the ability to rapidly model new targets, enabling, more rapid adaptation of fielded weapon systems' ability to target new enemy weapon systems.
	Integrated Modeling and Test of Weapon Systems	Model complex system interaction in real time with precision.	Replace many expensive, dangerous, and time-consuming ground tests with virtual tests resulting in lower test costs and more rapid development of weapon systems.
Earth and Atmospheric Sciences	Climate Science	Resolve additional physical processes such as ocean eddies, land use patterns, and clouds in climate and weather prediction models.	Provide US policymakers with leading-edge scientific data to support policy decisions. Improve understanding of climate change mechanisms and reduce uncertainty in the projections of climate change.
	Weather and Short-term Climate Prediction	Enable dynamical prediction of frequency and intensity of occurrence of hurricanes/typhoons and severe winter storms 90 days in advance.	Provide critical support to deployed naval, air, and land forces in local, regional, and global combat environments. Lives saved and economic losses avoided due to better severe weather prediction.
	Solid Earth Science	Improved statistical forecasting of earthquake hazards (fault-rupture probabilities and ground motion)	Provide prioritised retrofit strategies. Reduced loss of life and property. Damage mitigation.
	Space Science	Realistically simulate explosive events on the sun, the propagation of the energy and particles released in the event through the interplanetary medium, and their coupling to Earth's magnetosphere, ionosphere, and thermosphere.	Provide decision makers (both civilian and military) with status and accurate predictions of space weather events on time scales of hours to days.

AREA	APPLICATION	SCIENCE CHALLENGE	POTENTIAL OUTCOME WITH 100 TO 1,000 TIMES CURRENT CAPABILITY
Energy and Environment	Subsurface Contamination Science	Simulate the fate and transport of radionuclides and organic contaminants in the subsurface.	Predict contaminant movement in soils and groundwater and provide a basis for developing innovative technologies to remediate contaminated soils and groundwater.
	Magnetic Fusion Energy	Optimise balance between self-heating of plasma and heat leakage caused by electronmagnetic turbulence.	Support US decisions about future international fusion collaborations. Integrated simulations of burning plasma crucial for quantifying prospects for commercial fusion.
	Combustion Science	Understand interactions between combustion and turbulent fluctuations in burning fluid.	Understand denotation dynamics (for example, engine knock) in combustion systems. Solve the 'soot' problem in diesel engines.

9.2 HIGH PERFORMING COMPUTING SYSTEMS IN OTHER INDUSTRIES

Although initially seen in the context of Research as outlined in 9.1 above, the roadmap for High Performing Computing Systems has changed dramatically in the past decade as industry usage of this capability has also started to increase

The key factors driving this change are market pressures demanding accelerated innovation cycles, overall cost reduction and the growing need for full lifecycle modelling and analysis. The interesting development has been the relatively new ability to leverage volume markets of industry standard hardware and software to create virtual or real High Performance Systems. This is a more interesting development due to the fact that these solutions can then be rapidly procured, installed and integration relative to the long cycles of traditional high performance systems. This clustering approach to such systems allows for the creation of integrated applications accelerating market growth in sectors such as

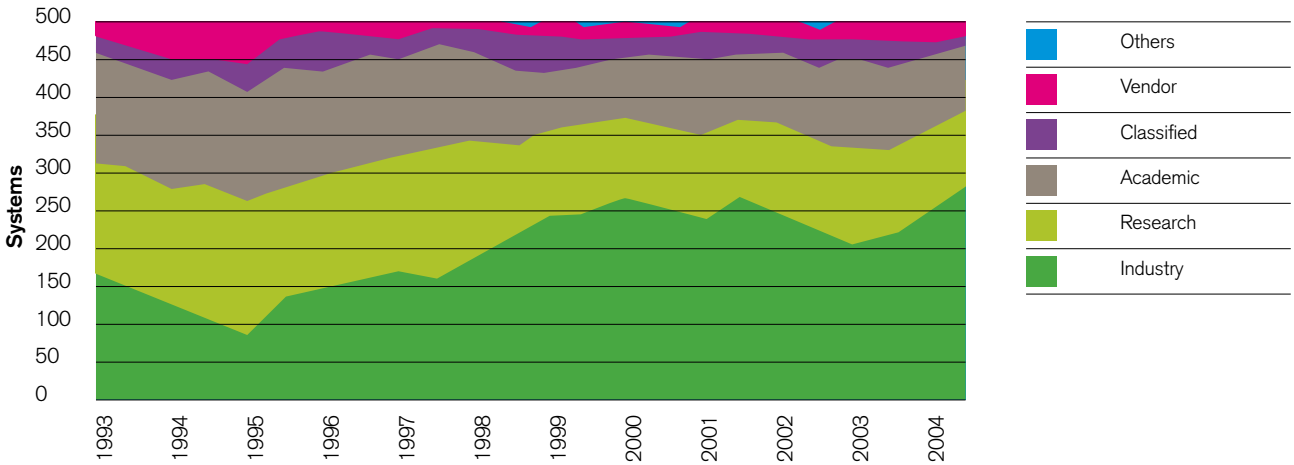
- Advanced Engineering;
- BioInformatics;
- Oil and Gas exploration;
- Financial Services;
- Entertainment services; and
- Government/Research markets.

In essence, across all of these sectors, the convergence of affordable high performance hardware and commercial applications is making high performing computing personal. This roadmap can be understood best by the example illustrated in Figure 9.3 whereby a specific roadmap for High Performance Computing is seen to be altering every decade.

Figure 9.3 illustrates that High Performance Computing is evolving towards a decentralised and networked resource-based solution and this trend can be graphically demonstrated in Figure 9.3

The evolution therefore is seen in marketing terms to be stretching towards 'grid' infrastructures whereby computing grids create a network of clusters and workstations that have a coordinated scheduling of resources and allow for significant evaluation of work to be completed on specific products or markets. These computing grids are then linked to data grids whereby distributed storage and the coordinated management of data allow for the running of algorithms. Web Services are the means to achieve the interoperable Internet-scale computing, including federation of organisations in a loosely-coupled, service-oriented architecture. This starts to reduce the costs and increase the access and resultant impacts.

FIGURE 9.1: HOW HIGH PERFORMING COMPUTING SYSTEMS ARE BEING USED BY OTHER INDUSTRIES OUTSIDE OF RESEARCH AND ACADEMIA[54]



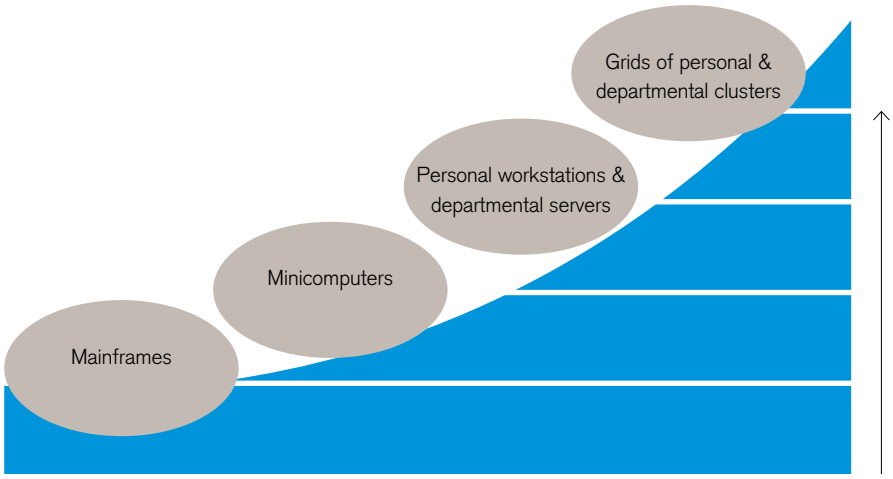
Source: http://www.top500.org

54. TOP500.ORG

FIGURE 9.2: HIGH PERFORMANCE COMPUTING GOES PERSONAL[55]

	1991	1998	2005
System	Cray Y-MP C916	Sun HPC 10000	Shuttle @ NewEgg.com
Architecture	16x Vector 4GB Bus	24x 333MHz Ultra - SPARCIL, 24GB, SBus	4x 2.2GHz x64 4GB, GigE
OS	UNICOS	SOLARIS 2.5.1	Windows Server 2003 SPI
GFlops	~10	~10	~10
Top500#	1	500	N/A
Price	$40,000,000	$1,000,000 (40x drop)	$4,000 (250x drop)
Customers	Government labs	Large enterprises	Every engineer and scientist
Applications	Classified, climate, physics research	Manufacturing, energy, finance, telecoms	Bioinformatics, materials, sciences, digital media

FIGURE 9.3: HIGH PERFORMANCE COMPUTING IS MOVING TOWARDS PERSONAL GRIDS[56]



55. Microsoft Research Faculty 2006
56. ibid

9.3 HIGH PERFORMANCE COMPUTING SYSTEMS IN NORTHERN IRELAND

In Northern Ireland, there are already aspects of High Performance Computing underway. Activities such as the e-Science infrastructure which is based in Northern Ireland demonstrate clearly the multiple aspects of High Performance Computing and how these relate to specific sectors. For example, within the Belfast e-Science Centre there are projects such as:

- RiskGrid: This focuses on Financial Services and deals with companies such as First Derivatives, kxsystems and Data Synapse. This recognises the cyclical nature of the Financial Services sector and in particular risk assessment calculations. This is complicated by the investment banks across multiple continents in an environment where data must be accurately exchanged. The risk aspect of this project is dependent on calculations for competitive advantage and this is very data and computationally intensive.
- GeneGrid: This focuses on Bioinformatics and incorporates the work of companies such as Fusion Antibodies, amtec and BT in a collaborative Industrial R&D project that seeks to create a virtual Bioinformatics laboratory that can be used as a platform for biologists and scientists to access collective skills, experience and results in a manner that is secure, reliable and scaleable. The focus of the current work is the identification of novel protein family members and automated antigenic region detection.

This enabled the companies involved to work collaboratively to identify uncharacterisised and potentially new siglecs in timescales that are a fraction of traditional mechanisms. For example, evaluations of specific genes was reduced from 30 - 60 minutes per gene to 90 minutes for 100 genes.

9.4 RECOMMENDATION 4: HIGH PERFORMANCE COMPUTING FOR NI

IN ORDER TO ENABLE FURTHER SCIENCE AND TECHNOLOGY WITHIN NORTHERN IRELAND THERE ARE A NUMBER OF IMPORTANT STEPS THAT NEED TO BE TAKEN WITH REGARD TO HIGH PERFORMANCE COMPUTING AND THESE INCLUDE:

TABLE 9.2: THE HIGH PERFORMANCE COMPUTING ROADMAP FOR NORTHERN IRELAND

TIMEFRAME	RECOMMENDATIONS
Two-year programme	Make high-end computing easier and more productive to use in the Northern Ireland context: Northern Ireland emphasis should be placed on time to solution, the major metric of value to high performance computing users. Time to solution includes: time to cast the physical problem into algorithms suitable for high-end computing; time to write and debug the computer code that expresses those algorithms; time to optimise the code to the computer platforms being used; time to compute the desired results; time to analyse those results; and time to refine the analysis into improved understanding of the original problem that enables scientific or engineering advances. In addition, a common software environment for scientific computation encompassing desktop to high-end systems will enhance productivity gains by promoting ease of use and manageability of systems. Foster the development and innovation of new generations of high performance computing systems and technologies. Key research, development, and engineering areas must be nurtured to assure continuous improvement of high-end computing systems that meet the needs of applications. In addition to the traditional research areas of hardware, components and systems there is typically a requirement for a common system software base to deliver needed improvements in sustained application performance, ease of use, and manageability of high-end systems, as well as a unified software environment for scientific computation encompassing desktop to high-end systems. Effectively manage and coordinate Northern Ireland high performance computing assets. All high performance computing bodies in Northern Ireland will need to be encouraged to plan and operate facilities in a more coordinated fashion, regularly sharing data on the needs of their user communities. Create an international programme in High Performance Computing with a focus on Financial Services: The Northern Ireland Government needs to sustainably fund an industry led, world-class High Performance Computing programme with a focus on Financial Services delivery. This centre must develop leading near shore solution concepts and strive to assume a leadership position in Europe by 2010 and a global leadership position by 2015. The mechanism for driving this is the cooperation with local industry and the insistence of an international presence in the work of leading High Performance Computing solutions. The boards of such a centre must be industry chaired with a technology advisory board consisting of leading global figures.

TIMEFRAME	RECOMMENDATIONS
Five-year programme	It is anticipated that the programmes listed above will deliver results in the 2 - 5 year window. In that timeframe, Northern Ireland would need to build on these programmes to reflect an improved branding with High Performance Computing. All of the programmes outlined above would need to be revitalised in the five year timeframe based on the specific roadmaps and findings within that timeframe.
10-year programme	The policy environment that enables the creation of the Northern Ireland ICT cluster (chapter 6) is in place and new priority areas are identified.

9.5 EMBEDDED SYSTEMS - HIGH PERFORMANCE SIGNAL AND NETWORKING SYSTEMS

9.5.1 INTRODUCTION TO HIGH PERFORMANCE EMBEDDED SYSTEMS

An embedded system is a special-purpose computer systems that performs one or many dedicated function that can incorporate real time computing constraints. The embedded aspect is that the system is normally part of a complete device including hardware or mechanical parts. This differentiates it from a general-purpose computer which can do many different tasks depending on programming. The embedded system is dedicated to specific tasks and design engineers can optimise it, reduce the size and cost or increase reliability and performance. These devices tend to be used in a large number of applications ranging from MP3 players to traffic lights, factory controllers and the complexity of signal processing and networking used ranges from single microcontrollers to multiple units. The software that drives these solutions tends to be known as firmware and is stored on the chip as opposed to in traditional drives. The user interface of such systems range dramatically from no user interface to full user interfaces similar to desktop operating systems on PDAs.

Processors

The processors used in these systems are in two categories - microprocessors and microcontrollers. The microcontrollers have in-built peripherals on the chip thereby reducing the size of the solution. There are multiple CPU architectures and these can range from ARM (32 bit RISC processor), MIPS, x86 etc. This is very different to the desktop computing market which has fewer competing architectures.

Architectures

The architectures in high performing signal and networking depend on applications. Several architectures (such as PC/104) are used in small low volume and rugged design. The software can range from Linux to real-time operating systems such as MicroC or VxWorks. A common configuration for very-high-volume embedded systems is the system on a chip (SoC), an application-specific integrated circuit (ASIC), for which the CPU core was purchased and added as part of the chip design. A related scheme is to use a field-programmable gate array (FPGA), and program it with all the logic, including the CPU.

Peripherals

Embedded systems talk to the outside world using peripherals such as serial communications interfaces (SCI), Universal Serial Bus, networks such as ethernet, synchronous serial interfaces (RS-232 etc) and specific timers.

Resilience

As they reside in machines that are expected to run continuously for years without errors, and in some cases recover by themselves if an error occurs. Therefore the software is usually developed and tested more carefully than that for personal computers, and unreliable mechanical moving parts such as disk drives, switches or buttons are avoided. Specific reliability issues may include:

- The system cannot safely be shut down for repair, or it is too inaccessible to repair. Solutions may involve subsystems with redundant spares that can be switched over to, or software 'limp modes' that provide partial function. Examples include space systems, undersea cables, navigational beacons, bore-hole systems, and automobiles.
- The system must be kept running for safety reasons. 'Limp modes' are less tolerable. Often backups are selected by an operator. Examples include aircraft navigation, reactor control systems, safety-critical chemical factory controls, train signals, engines on single-engine aircraft.
- The system will lose large amounts of money when shut down: Telephone switches, factory controls, bridge and elevator controls, funds transfer and market making, automated sales and service.

Applications

For high volume systems such as music players or mobile phones, minimising cost is usually the primary design consideration. Engineers typically select hardware that is just 'good enough' to implement the necessary functions. For low-volume or prototype embedded systems, general purpose computers may be adapted by limiting the programs or by

replacing the operating system with a real-time operating system. There are a number of categories of embedded systems involved in high performance signalling and networking and these can be described as:

- Simple control loop: In this design, the software simply has a loop. The loop calls subroutines, each of which manages a part of the hardware or software.
- Interrupt controlled system: Some embedded systems are predominantly interrupt controlled. This means that tasks performed by the system are triggered by different kinds of events. An interrupt could be generated for example by a timer in a predefined frequency, or by a serial port controller receiving a byte. These kinds of systems are used if event handlers need low latency and the event handlers are short and simple. Usually these kinds of systems run a simple task in a main loop also, but this task is not very sensitive to unexpected delays. The tasks performed in the interrupt handlers should be kept short to keep the interrupt latency to a minimum.
- Pre-emptive multi-tasking or multi-threading: In this type of system, a low-level piece of code switches between tasks or threads based on a timer. This is the level at which the system is generally considered to have an 'operating system', and introduces all the complexities of managing multiple tasks or threads running seemingly at the same time. Any piece of task or thread code can damage the data of another task or thread; they must be precisely separated. Access to shared data must be controlled by some synchronisation strategy, such as message queues, semaphores or a non-blocking synchronisation scheme.

Because of these complexities, it is common for organisations to buy a real-time operating systems, allowing the application programmers to concentrate on device functionality rather than operating system services.

- Microkernels and exokernels: A microkzernal is a logical step up from a real-time OS. The usual arrangement is that the operating system kernel allocates memory and switches the CPU to different threads of execution. User mode processes implement major functions such as file systems, network interfaces, etc.
- Monolithic kernels: In this case, a relatively large kernel with sophisticated capabilities is adapted to suit an embedded environment. This gives programmers an environment similar to a desktop operating system like Linux or Microsoft Windows, and is therefore very productive for development; on the downside, it requires considerably more hardware resources, is often more expensive, and because of the complexity of these kernels can be less predictable and reliable. Although expensive in hardware terms, this type of embedded system is increasing in popularity, especially on the more powerful embedded devices such as Wireless Routers and GPS Navigation Systems.

9.5.2 APPLICATION AREAS

There are multiple application areas for the high performance signal and networking embedded systems referenced within this focus area and these include:

- Automotive Electronics (the latest top of the range BMW has over 100 embedded systems);
- Aircraft Electronics;
- Telecommunications - voice/data/ entertainment[57];
- Medical Systems - particularly combinational devices;
- Authentication solutions - security, biometrics, drug delivery;
- Smart construction for energy management and Health Care provision;

The essential considerations in all these applications is related to Response Time, the cost of creating and building the device, the portability of the device, the resilience (the demand is typically for fault tolerance devices) and ultimately power consumption (low power or the ability to harvest power).

The design issues pertain to how hardware and software can be 'co-designed' (this leads ultimately to a skill related issue)[58]. At one level, the system specification (in terms of functions, real time constraints, cost and power constraints) determine the overall solution. This is then managed through hardware software partitioning, hardware synthesis (using CAD tools), software synthesis and code generation and ultimately implementation. Within the hardware - software design, there is a demarcation whereby software is used for features and flexibility however the hardware is essential for performance and security. The equilibrium between performance and features tends to sit in a middle space in the design and requires very specific skills whereby an understanding of hardware leads to the ability to produce efficient software.

With regard to the specific application of focus - Signals and Networking, the applications are being market driven by solutions across all sectors due the fact that signals are increasingly being represented digitally as a sequence of samples. These signals are then processes and include applications such as Filtering, Speech and Image (compression, decompression, encryption, decryption etc), modems that have equalisation, noise and echo cancellation and improved communications channels that use encoding, decoding and equalisation.

The significance of embedded systems is reflected in the following statistics:

- Every year, embedded software is written five times as much as 'application software'[59];
- The vast majority of CPU chips produced world-wide are for the embedded market - a relatively small portion make their ways into PCs;
- Estimated number of software constructors of embedded systems is rising from 2 million (1994) to 10 million (2010)

57. New York Times estimated the average citizen comes into contact with 60 embedded systems every day
58. Traditional design sees software and hardware partitioning completed at an early stage and development proceeds independently. Hardware and software codesign allows the design proceed in parallel with interactions and feedback between the two. There is a continuous evaluation of trade offs and performance yields.
59. IDC

9.6 RECOMMENDATION 5: THE NORTHERN IRELAND ROADMAP FOR HIGH PERFORMANCE SIGNAL AND NETWORK EMBEDDED SYSTEMS

FIGURE 9.4: NORTHERN IRELAND HIGH PERFORMANCE EMBEDDED SYSTEMS

STAGE 1: 2007-2009	STAGE 2: 2007-2012	STAGE 3: 2007-2017
Define a roadmap for hardware and skills in Northern Ireland including the development of specific electronic and software skills.	Attraction of one FDI anchor in this space.	Infrastructure development.
Define a model for how NI can exploit worldclass IP through alliances, affiliations or otherwise. This applies to academic/industry collaborations.	Develop linkages with other embedded areas in Cambridge or RoI.	Attraction of three FDI anchor in this space.
Development of a broader awareness of how this field of work is exploited in multiple sectors and has capability in Northern Ireland.		
Government sponsored industry led multidisciplinary R&D programme attracting international companies and focusing on this area with applications in Med Devices or energy.	Refresh programme with new international players.	

Policy integration between all Government departments with a clear direction on focus areas, skills and Northern Ireland developed roadmaps that are relevant to each focus area. Policy direction should be focused on developing the themes of cluster within NI.

The roadmap for the high performance embedded systems in Northern Ireland is represented in Figure 9.4.

The activities within this roadmap can be broken down as in Table 9.3.

TABLE 9.3: THE EMBEDDED SYSTEMS ROADMAP

TIMEFRAME	RECOMMENDATIONS
Two-year programme	Define a roadmap for High Performance Signal and Network systems within the Northern Ireland ICT sector; Define a model for how Northern Ireland can exploit world class IP through alliances, affiliations or other trade opportunities within this focus area; Develop a broader awareness of how this field is exploited and underpins other industries and how the capability in Northern Ireland can be further exploited; The Northern Ireland Government needs to sustainably fund an industry led, world-class High Performance Signal and Network systems project with a focus on Medical Devices or Energy. This centre must develop leading near shore solution concepts and strive to assume a leadership position in Europe by 2010 and a global leadership position by 2015. The mechanism for driving this is the cooperation with local industry and the insistence of an international presence in the work of leading High Performance Signalling and Networking solutions. The boards of such a centre must be industry chaired with a technology advisory board consisting of leading global figures
Five-year programme	Attraction of one key FDI anchor in this space; Develop linkages with other clusters in Cambridge or RoI; It is anticipated that the programmes listed above will deliver results in the 2 - 5 year window. In that timeframe, Northern Ireland would need to build on these programmes to reflect an improved branding with High Performance Signalling and Networking systems. All of the programmes outlined above would need to be revitalised in the five year timeframe based on the specific roadmaps and findings within that timeframe.
10-year programme	The policy environment that enables the creation of the Northern Ireland ICT cluster (chapter 6) is in place and new priority areas are identified.

DEVELOPING THE 10-YEAR ICT FOCUS IN NORTHERN IRELAND - THE NORTHERN IRELAND CLUSTER

ALL EXISTING REPORTS RECOGNISE THAT NORTHERN IRELAND IS AT A PIVOTAL POINT OF CHANGE IN THIS SECTOR. THE EXPERIENCES FROM AROUND THE WORLD NEED TO BE BROUGHT TO BEAR TO ALLOW THE SECTOR TO CONTINUE TO FLOURISH. THIS CHAPTER DESCRIBES HOW THE ICT PANEL CONSIDERED THE FACTORS INFLUENCING THE DEVELOPMENT OF THE ICT SECTOR IN NORTHERN IRELAND. THIS CONSIDERATION EXTENDED TO A TWO-YEAR, FIVE-YEAR AND 10-YEAR PERSPECTIVE. THE 10-YEAR PERSPECTIVE WAS BASED ON THE CREATION OF A FORMAL ICT CLUSTER WITH AN ASSOCIATED POLICY INFRASTRUCTURE WITHIN NORTHERN IRELAND. HENCE, THE ULTIMATE GOAL IS TO CREATE A VIABLE ICT CLUSTER IN NORTHERN IRELAND IN 10-YEARS TIME AND IN THE INTERIM TO TAKE SPECIFIC PRACTICAL STEPS TO DEVELOP TOWARDS THAT VISION.

10

10.1 IT'S THE FUTURE[60]

IT'S THE FUTURE was published after significant consultation within the software industry in Northern Ireland. It proposed an overriding theme that software should be the number one priority for the future economic development of Northern Ireland. The plan, within the strategic framework it proposed, was to see the industry grow to 18,000 people in high value jobs (revenue of £2 billion) by 2004. The vision of the report was to see Northern Ireland collaborate as a world-class supplier of skills people supplying products and services to the global marketplace. The 10 pivotal recommendations within this strategy covered:

- Skills and resources at all levels of the education system;
- The creation of an eCommerce hub;
- Indigenous company development;
- Incubation capabilities;
- Research and Development;
- Foreign Direct Investment;
- A favourable tax regime;
- The appointment of an e-Minister to provide ministerial leadership;
- The establishment of a software and telecommunications directorate; and
- A strengthened software federation.

The strategy has specific growth targets in terms of indigenous, inward investment and start-ups from universities or research projects. The specific roles of industry and government were identified within the strategy also.

The report clearly formed the concept of a cluster with specific underpinning policies which would enable the sector grow in the five year period of 1999 - 2004. This period however also covered the eCommerce and market slowdowns (2001 - 2003) however notwithstanding that fact, significant growth was achieved.

10.2 NORTHERN IRELAND ICT CLUSTER REVIEW

The Northern Ireland ICT Cluster review was completed in December 2006. This review provides a detailed audit of Northern Ireland's ICT sector. The report identifies the main ICT technology clusters in Northern Ireland and quantifies, for the first time, the Northern Ireland IT skills base. The key findings of this report are:

- Recognition that Northern Ireland is a leading region in Europe for attracting international software development and technical support centres;
- The Northern Ireland ICT sector is comprised of nearly 750 ICT companies, over 11,000 IT employees and 24,000 students;
- The world's leading companies are investing and expanding in Northern Ireland;
- Indigenous technology companies have become global players in specific technology niches
- The wireless/Internet telecom cluster should be the key strategic priority for Northern Ireland;
- Other primary ICT technology clusters are BPO/ITO and financial services software;
- Secondary ICT technology clusters are engineering technologies, CRM software, information management software and digital media;
- Northern Ireland has 13 University Research Centres in ICT;
- Globally, the number of ICT graduates is declining and is not sufficient to meet the demand for new IT employees. This is also reflected in Northern Ireland; and
- Policy action is needed to further develop the ICT sector.

The findings of this Foresight report are aligned with these key points albeit in a different perspective. For example, the sector is more narrowly defined in this report as a number of sectors are seen in terms of the products being supplied to that sector - for example Product Software as a capability is focused on the Financial Services and Telecommunications sectors. Equally, BPO is seen from a 'Nearshoring' perspective.

60. Software Industry Federation

10.3 THE CREATION AND DEVELOPMENT OF AN ICT CLUSTER - A 10 YEAR VISION FOR NI

10.3.1 ICT CLUSTERS

The concept of a cluster is often used within Northern Ireland and sometimes the term is used in a looser sense than that described globally. It is clear that industry networks of affiliations have been created and that these have enabled spillovers and the development of new companies, new capabilities and new sources of revenue. However, there are still some critical factors that exist in other clusters missing in Northern Ireland and these are described in this chapter.

ICT clusters are geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions for whom membership within the concentration is an important element of each members competitiveness. Northern Ireland has to be seen as an individual cluster from a geographical perspective.

10.3.2 ICT CLUSTER TYPES

Clusters are not the same throughout the world. They vary based on their historical legacy, the geography in which they are based and the demographics of that geography. In this report four types of cluster have been defined. These are:

1. Industrial Districts: Where external economics and a traditional industrial atmosphere lead to incremental innovations in ICT developments. Typically, these are based on environments where there is a long history of industrial activity. An example of such would be the Boston cluster.
2. Californian Model: This is based on the Californian experience where new ICT developments were created from the disintegration of older production facilities and the formation of a new and very specialised local labour market. Silicon Valley represents this cluster type, which is probably the oldest ICT cluster is the world.
3. Nordic Model: The Nordic model is that of a learning economy and this highlights innovation and the support of innovation as the basis for new firms starting, gaining competitiveness and co-operating within a cluster. In this model, learning is a localised agenda (i.e. learning serves to focus on the local need) and the diverging innovation capabilities between clusters are the result of specific learning programmes embedded in different institutions. The Finnish cluster outlines a specific example of this, albeit in very recent times.
4. The Porter Model: This model is characterised by an independent process within which policies develop to suit the purpose of the specific geography. Companies develop and become better due to better access to specialised and experienced employees, suppliers, specialised information, and public goods, and due to the motivating of local rivalry and demanding customers. The concept of industry clusters was promoted by Porter in 'The Competitive Advantages of Nations' (1990).

10.3.3 ICT CLUSTER LIFECYCLES

Irrespective of the type of cluster that exists, they all follow a particular lifecycle, which supports a concept of initiation based on degree of historical legacy, be that Foreign Direct Investment in the case of Ireland or a specific strategic decision, as in the case of Finland, or military procurement and investment, as is the case in Silicon Valley, or a tradition in precision engineering and medicine as is the case in Boston. However, clusters do follow a specific lifecycle once they are initiated and the most critical step in the lifecycle in rejuvenation. The most mature ICT Clusters in Silicon Valley and Boston show a remarkable ability to use their underlying capacities and capabilities to rejuvenate themselves in an industry that is renowned for its dynamism and change. The ICT industry is always prone to growth/recession cycles and therefore any changes in those cycles need to be managed as they generally indicate market shifts.

The first step in the process would tend to be a pioneer firm that is located in a geography. After a period of time, and depending on environment conditions, specialised suppliers and service firms would be created to support the pioneer firms and as these firms evolved, new organisations are created to serve the companies that are working together within the cluster. At this stage (Step 3), the cluster is formed and it commences to attract outside companies, skilled workers and innovative new companies based on the availability of expertise, infrastructure and skills that exist there. Within the cluster, information then starts to be circulated creating an important tacit information environment and this in itself can lead to cluster rejuvenation as the cluster develops new markets.

FIGURE 10.1: HOW CLUSTERS EMERGE AND GROW

10.4 ICT CLUSTER CORE REQUIREMENTS

Despite the multiple origins of ICT Clusters, they all share some specific characteristics:

1. Frameworks: The need for a government to provide a flexible and responsive framework so that the cluster can thrive and grow in whatever direction it needs based on market economics. This framework includes an education system that is flexible enough to respond to the changing needs of the cluster, a regulatory framework that supports the cluster and taxation/incentive based schemes that endorse innovation and entrepreneurship.
2. Education and Research Institutions: The need for extensive Research and Development institution (Universities and professional research units) capabilities within the environment which link intensely with industry and the framework that allows for this collaboration in an open and transparent manner.
3. Various sources of financing: The need for financing, both public and private, that can be leveraged in a collaborative manner through the entire lifecycle of a company i.e. formation, growth, etc.
4. Ability to attract and retain capability: The need to be able to attract relevant technical resources that can fulfil the capacity and capability needs of the cluster. Where necessary, these capacities and capabilities may need to be imported from outside of the geography.
5. Culture: The need to develop a culture within the cluster that promotes and encourages risk taking, entrepreneurship and new firm creation.
6. Local demand: The need for a local demand market that can provide initial references through procurement, critical initial revenue for innovative companies and learning opportunities. Where this market is not natural, a Government should seek to fulfil this role.
7. Recognition of potential by Local Leaders and the creation of infrastructure: The need for an infrastructure that leverages the operation of the ICT Cluster without creating additional obstacles for it. The infrastructure expression applies to roads, telecommunications, housing and schools.

10.5 THE PIVOTAL ROLES WITHIN AN ICT CLUSTER

All the analysis of clusters within the core requirements suggest that the most essential elements of the ICT Cluster are:

- Innovation, and
- Entrepreneurship/new firm creation

These ultimately lead to a perpetual cycle of new firm creation. Naturally, not all innovations and entrepreneurs can be successful in a commercial sense, but the natural cycle of innovation is the bedrock on which clusters are formed, sustained and more importantly rejuvenated when they need to be.

ICT Clusters create an environment of co-operation and collaboration wherein costs of operation are reduced, efficiencies and performance are increased and capabilities are created, in effect new learnings are gleaned for the cluster. Effectively, the barrier to innovation and entrepreneurship is further reduced and more and more innovation enters the cycle of the cluster. This in turn creates further enhanced performance and reduced costs and so the innovation cycle continues. Hence the virtuous circle of a cluster continues.

The significance of innovation within this cycle is economic adaptation. Projects may fail commercially but their output and learning can ensure that other projects succeed. It is through this mechanism that clusters will eventually rejuvenate. Innovation allows them to follow the economic market in the most appropriate manner.

Entrepreneurship is the ultimate manifestation of innovation within the cluster. This is not to say that entrepreneurship within companies in not essential. It is, and some companies go to great lengths to ensure that it is captured and sustained but new firm creation provides a useful dynamic to a cluster. It allows the freedom for an idea to have focus and to survive and grow.

The most successful clusters show these roles in abundance, as universities and research institutions are encouraged to allow spin-offs and work with private industry.

A final comment on entrepreneurship would indicate that it takes decades to create a ‘no fear’ culture, which is essential for it to thrive and survive.

It is essential to note that these pivotal roles within a cluster can only survive when the framework requirements discussed above are in place and enabling the innovation cycle within the cluster. Once this happens, the cycle will follow the economic market.

10.6 AN ICT CLUSTER MODEL FOR A CLUSTER IN NORTHERN IRELAND

Despite the variations in cluster types and origins, there are specific business reasons for developing clusters and these can be summarised as:

- A firm cannot capture all the economic benefits of its innovation process;
- There are spillovers that can be captured by other firms;
- Geographical proximity of firms increases the potential of capture; and
- A supportive local infrastructure nurtures the process.

However, to achieve this type of growth and interaction, it is worthwhile to develop an ICT cluster model for Northern Ireland. This model identifies the key components of what is required to develop the Northern Ireland cluster and needs to be seen in the context of a 10-year cycle of development. The elements of this model are shown in Figure 6.3.

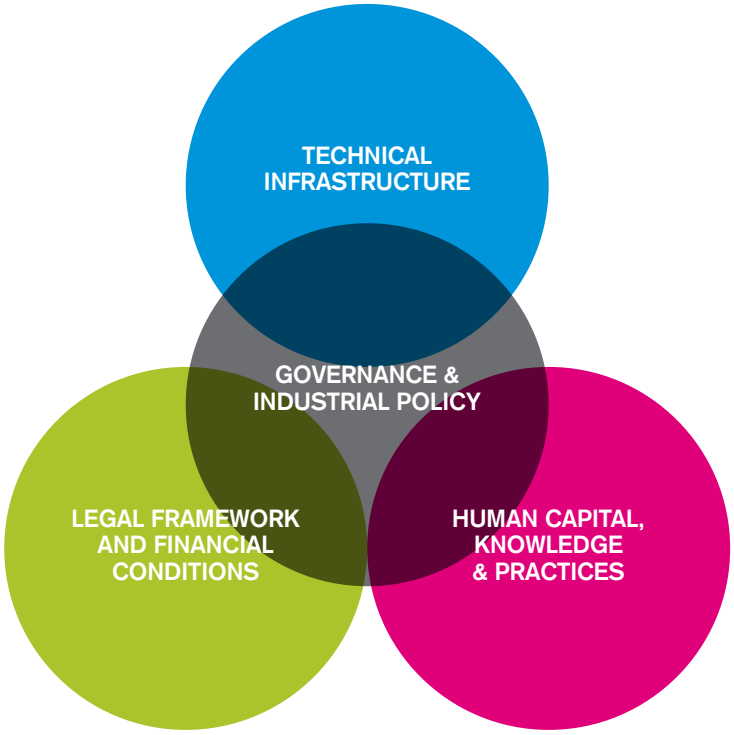
The model demonstrates some key strategic directions that need to be undertaken to allow the Northern Ireland ICT cluster develop. These are:

- Technical Infrastructure: The technical infrastructure component of a cluster consists of three key drivers:
  - The computing and telecommunications infrastructure: This is an ongoing question and relates to having the appropriate bandwidth and peering capability to allow businesses of all sizes and dimensions to work within the environment.
  - Structured architecture protocols and mechanisms: This relates to specific knowledge that is developed about global trends in the industry in terms of technical architectures and methodologies and understanding how these are applied to various selected industries and the offerings to those industries.
  - Knowledge of business and organisational models: Fundamentally, all ICT services in any cluster apply solutions to specific industries. This can only be accomplished when the knowledge gleaned from those industries is well understood and the solutions proposed provide a business case to those models of operation.
- Governance and Industrial Policy: This aspect of the cluster relates to how it is governed in terms of regulation, taxation, incentives for specific developments, R&D and the development of skills. This provides the integration aspects of the cluster and is very important. For example, taxation input influences FDI investment (tax credits etc) but other taxation policies influence venture capital and SME funding. The structure of taxation therefore needs to be seen in the context of what works and what does not work for specific focus areas.
- Human Capital, Knowledge and Practices: All clusters need human capital that is either developed internally or recruited externally. This capital is then constantly augmented through practices that increase and expand knowledge allowing for multiple levels of cooperation, competition and market insight and knowledge. This allows for spillover and although some companies believe that they lose knowledge in this regard, they do not as the knowledge is retained within the cluster.

  This is a significant aspect for Northern Ireland where the relatively slowly changing network of organisations will need to be replaced by more fluid, amorphous and often transitory structures based in alliances, partnership and collaborations which will build an ICT community that shares global business, knowledge and infrastructure.

- Legal Framework and Financial Conditions: All ICT Clusters must operate within a specific legal and regulatory environment whereby standards can be maintained, proven and where compliance is clearly demonstrated. Additionally, the same framework must also enable the provision of a financial continuum of capital that enables the development of products and services to be met.

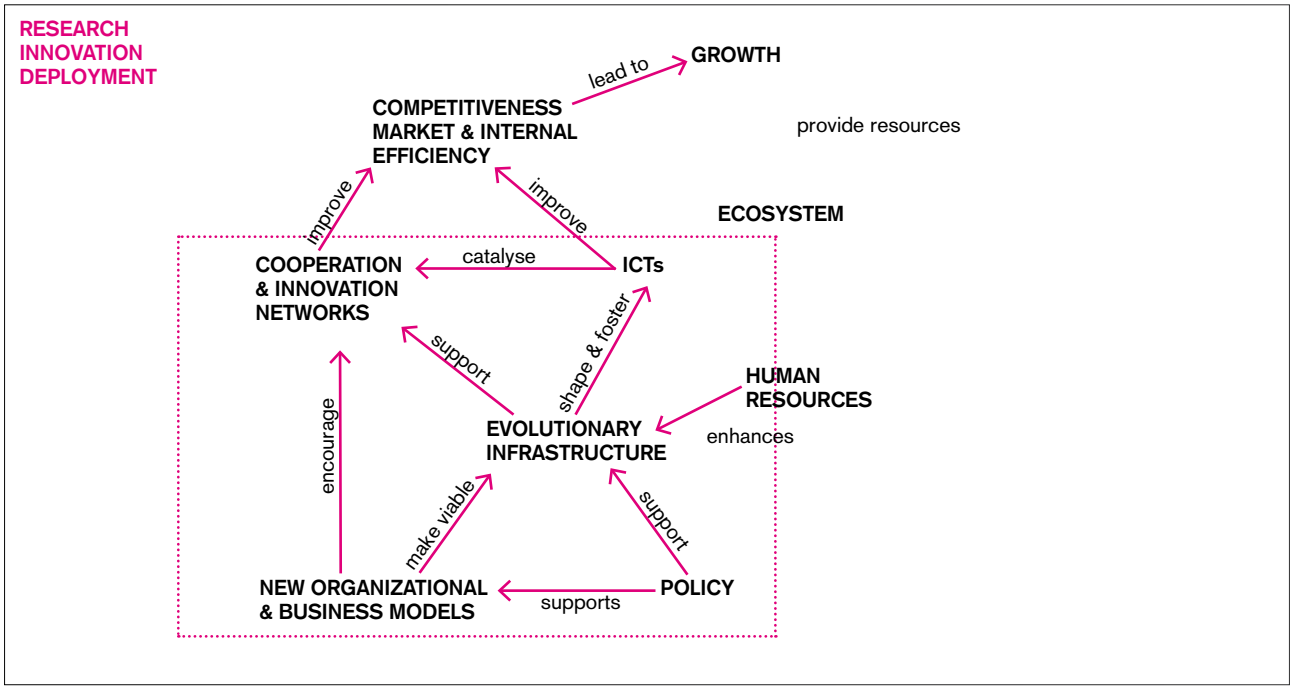
FIGURE 10.2: A MODEL OF THE ELEMENTS OF THE NORTHERN IRELAND ICT CLUSTER



10.7 HOW THE CREATION OF AN ICT MODEL IN NORTHERN IRELAND WOULD WORK

The entire point of the cluster model in section 6.5 is that Northern Ireland creates a favourable environment for ICT businesses and people in what is effectively an eco-system. This eco-system will be a viable economic community of dynamically interacting organisations and individuals within their institutional and regulatory framework. Together they produce goods and services to international customers, who in some cases are themselves members of the ecosystem. Over time, they co-evolve their capabilities and roles, adapting with the future directions in the global industry. This eco-system is driven by an environment of research, innovation and deployment within Northern Ireland which leads to sustained competitiveness and growth as indicated in Figure 6.4.

FIGURE 10.3: CREATING THE LONG-TERM INNOVATION AND GROWTH MODEL FOR THE NORTHERN IRELAND ICT CLUSTER[61]



61. Dini/London School of Economics

10.8 RECOMMENDATION 1: HOW NI CAN BUILD AN ICT CLUSTER IN THE NEXT 10 YEARS

Northern Ireland is missing some key factors in the determination of an ICT cluster and the overriding theme in this report is that there needs to be policy action at the highest level of government, with high degrees of commercial interaction, to support and commit to further develop and promote the ICT sector with a strategic emphasis on the focus areas outlined in this report. This policy action needs to be viewed at the highest level in terms of.

Cluster based strategies over ten year horizons have proven effective in improving the ability to compete and have also influenced the significant growth patterns in an economy. Creating the policy infrastructure that allows a cluster to grow and thrive is an essential aspect of ensuring sustainability. It is acknowledged that the cluster should be created using a collaborative alliance between industry/ government with an appropriate governance structure put in place.

TABLE 10.1: THE POLICY ACTIONS TO BE CONSIDERED IN DEVELOPING THE NORTHERN IRELAND ICT CLUSTER

POLICY FOCUS AREA	DESCRIPTION	POSSIBLE ACTIONS TO BE CONSIDERED
Establishing a solid foundation for the ICT sector in Northern Ireland	All clusters have some fundamental needs that are not cluster specific but relate to the ability to compete with other regions. There are fundamentally seven foundations that allow a cluster sustain success and these are: A competitive tax and regulatory regime; Skilled human resources; Accessible technology infrastructure; Capital availability; Physical infrastructure; Quality of life; and Economic development programmes. Some of these foundations are of more value when they are mode specialised. Some aspects of skills, technologies, tax etc are specific to certain clusters however there are three areas that are essential for all clusters - a creative environment (this comes under quality of life and requires an innovation culture), basic education and physical infrastructure.	
Building Relationships	The real strengths of clusters lie not in their intangible assets but rather the tacit knowledge that lies within the employees and routines of companies and institutions within the cluster and the mechanism they use for sharing this. Therefore, whilst clusters do depend on formalised organisational frameworks to share knowledge there also needs to be informal networks that allow people interact and change ideas. This however does not happen by accident. The Northern Ireland cluster needs a mobilisation strategy where all aspects of the cluster have a membership organisations (such as Momentum) designated to represent them. These organisations exist for the focus areas and create mechanisms for companies to engage and aggregate their needs and demands, create new pipelines for getting information to Government and members and platforms for informal networking and learning. In short, these organisations provide leadership and access to people and resources.	The actions to be considered in this regard therefore would cover the convening of a cluster leadership board, the identification and support of cluster organisations and the creation of a collection of services that can assist the recognition and support of the cluster.

POLICY FOCUS AREA	DESCRIPTION	POSSIBLE ACTIONS TO BE CONSIDERED
A mechanism to deepen skills and talent	Of all the factors that motivate and grow clusters, this is the most universally significant. The availability of pools of experienced and skilled labour and the customised/specialised education and training that produce, upgrade and deepen skills and knowledge are the highest priorities. Companies need talented managers and researchers, mid-level technicians, clerical and support staff. The most highly education and specialised are recruited globally as well as coming from local universities. Clusters demonstrate that the largest impact for the human resource investment derives from access to the pool of employees in the middle of the workforce. These workers are regionally bound, less importable or exportable than any other production factor. Therefore, there is no substitute for a local skilled workforce and the know-how it possesses[62]. However, this is only the beginning, the dependence on an uninterrupted flow of people with the necessary skills and knowledge of the industry and the ability to apply them to routine and unanticipated situations is significant. There is a need for a pipeline of resources that will support anticipated growth and replacements for exist from the environment as technologies change. Additionally, all ICT clusters need continual upgrading as technologies change.	Some interesting factors to be considered are the creation of a cluster based workplace learning programmes that works with schools through to cluster associations and identifies company sponsorships of students/employees, creates workshops for specific businesses and mentors and allows students share experiences
Aligning innovation investments	Within every cluster there is a combination of companies - those that work the status quo and provide significant input in terms of productivity etc and those that are continually seeking new products or practices. The significance of Innovation in ICT is extensive and this is a key driver as outlined in Chapter 3 above. Any cluster needs creative and innovative people as well as implementers (those who can derive commercial value) and imitators who can keep innovations flowing whilst reducing costs. There are three major sources of innovation in Northern Ireland ICT and these are: Research and Development that is commercialised: Universities and their institutions such as ECIT are the vital sources of R&D based innovations and assets to clusters. Although sometimes misunderstood, the patents that these institutions produce are only part of the value they bring. Research that is never commercialised can also influence companies and their research practices; Product and process improvements are essential aspects of innovation also. Employees creatively retrofitting machines or changing ways to reduce cost, speed up software or create new niches are core aspects of innovation; The most overlooked source of effective innovation involves product design changes that influence consumer choices - the creative or appeal of goods and services that distinguish them from competitors or allows customers pay a premium. In the 1990s, ICT innovation really meant technology, now however design and differentiation is seen to be the differentiator[63].	The key actions to be considered are to invest in cluster-based innovation centres, to direct funding to the focus areas of the cluster, to encourage the collaborative and multidisciplinary nature of the R&D being conducted and to support incremental innovations with the increased attention to design as an innovation strategy. Finally, it is important to mobilise investment capital for high-tech start-ups.

62. Later in this report, this skills issue is clearly addressed. It is also outlined in the OCO report.
63. Business Week CEO Survey 2006

POLICY FOCUS AREA	DESCRIPTION	POSSIBLE ACTIONS TO BE CONSIDERED
Accelerating entrepreneurship	Clusters are clearly woven into a complex set of relationships including enterprising entrepreneurs and innovators who can identify opportunities to add value to existing competencies. The additional value may be a new element to an existing value chain or a new niche product etc. Many entrepreneurs are already within clusters, the others come directly from the education system and the remainder are attracted from other places. Clusters influence entrepreneurs by focusing on aspects of the process such as market research, business plans, raising capital and creating an organisation. The cluster itself shapes the nature of these skills. For example, in Northern Ireland there is a shortage of real capital and the cluster needs entrepreneurs who can access this capital - quickly and efficiently.	The actions to be considered in this regard are the support of new entrepreneurial networks, the creation of specialised incubator spaces, the organising of cluster expertise across distinct business centres and an initiative that educates for entrepreneurship.
Collaborate globally	The biggest barrier in cluster growth is isolation. To be competitive and innovative implies a need to be globally aware and engaged. Despite the hype of globalisation, many aspects of the Northern Ireland cluster can still be relatively isolated. Globalisation also means immigrants, imports, exchange students etc. Clusters need global pipelines to knowledge and innovation as much as they need a local energy and direction. Exposure to different operating environments and different cultures is a powerful stimulant for innovation and it is always important to link suppliers and customers in clusters. Additionally, being global means that there is a constant monitoring of the trends in other parts of the world to gain new perspectives and the extension of networks to distant competitors, vendors, trade shows and research partnerships. If a cluster does get cut off from external sources of knowledge, it ultimately loses a competitive position that creates a lock down environment which ultimately means no economic growth.	Initiatives in this regard to be considered includes the support of international participation in events and study tours, the support and assistance of export and export networks and the establishment of cluster based international learning exchanges for students.

SKILLS

SKILLS ARE THE ESSENTIAL INGREDIENT FOR THE NORTHERN IRELAND ICT SECTOR. WITH THE ATTRACTION, RETENTION AND EXTENSION OF SKILLS WITHIN THE SECTOR, IT WILL NOT BE POSSIBLE TO SUSTAIN THE DEVELOPMENT OF THE SECTOR. SKILLS NEED TO BE SEEN IN TWO CONTEXTS THE CAPACITY ASPECT WHICH RELATES TO THE AVAILABLE OF RESOURCES TO ALLOW THE SECTOR TO GROW AND THE CAPABILITY OF THOSE RESOURCES AVAILABLE TO ENSURE THE GREATEST RETURN ON INVESTMENT FOR THE SECTOR. THIS CHAPTER LOOKS AT THE SKILLS REQUIREMENTS WITHIN THE ICT SECTOR UNDER THE FOUR KEY SECTOR AREAS ALREADY IDENTIFIED BY THE PANEL.

11

11.1 INTRODUCTION

Northern Ireland is acknowledged as having a talented and highly skilled ICT labour pool. The continued development and growth of this resource as a result of the attraction of high-end FDI and perpetual investment in educational enhancement is a keystone in moving towards a knowledge economy. This chapter looks at the skills requirements within the ICT sector under the four key sector areas already identified by the panel;

- Application/Product Software
- Nearshoring
- Hardware and Systems (Embedded Systems Solutions and Computational Science)
- Security Solutions

These particular areas were chosen as they represent a section of key growth areas within the global ICT sector that align to potential and existing skill sets within the Northern Ireland ICT sector. Within these focus areas the relevant skills are identified in order to present a focus on developing specific resource skills.

However, a number of challenges relating to skills delivery have arisen which must be dealt with effectively in order for Northern Ireland to maintain economic competitiveness within the ICT arena. From the review of numbers of suitable ICT graduates produced from educational institutions a number of underlying issues and concerns were identified namely;

- Reduction in graduate quality and numbers;
- Deficiencies in certain skills areas;
- Attractiveness of the ICT sector as a place to work.

This paper presents the rationale for future focus areas for ICT in Northern Ireland, sets out the results of recent reviews and feedback from stakeholders in the area, and provides a basis for discussion among the ICT Horizon Panel participants.

11.2 ICT SKILLS REQUIREMENTS IN THE FOCUS AREAS

11.2.1 SKILLS REQUIREMENTS OVERVIEW

This section identifies the skills requirements in the key focus areas within the ICT sector. These are: Application/Product Software, Embedded Systems Solutions, Nearshoring and Security Solutions. The data was compiled from an analysis of previous work carried out by PA on ICT Clusters and online research.

The overarching skills need for all focus areas are high quality degree level graduates in computing, electronic engineering (encompassing computer and telecommunication engineering), production engineering (encompassing mechanical, industrial and manufacturing engineering) and other numerically intensive courses (e.g. maths, computational science - individuals with aptitudes for computation). In addition, many graduates in other engineering disciplines are recruited by the sector, primarily to work in software development.

Furthermore, there is a greater need for research-level degrees producing Masters and PhD's in engineering and computing disciplines to supply the sector.

Another skill requirement is that for systems analysts and project managers who combine business and IT skills (financial services, Health Care etc). This can be accomplished by attracting business graduates into the ICT sector and subsequently providing specific training. These business skills are essential as selling capabilities (selling and sales mgt), commercialisation, marketing, product management, business strategy, customer interaction are as essential a component within the industry as technical know-how.

The skills listed in the preceding section are categorised under the relevant focus areas.

11.3 FOCUS AREAS AND ASSOCIATED SKILLS

11.3.1 APPLICATION/PRODUCT SOFTWARE

Product Development skills & software engineering methodologies demand a myriad of various skills applicable to a variety of areas including:

- Requirements engineering: acquisition, modelling, specification, analysis, and prototyping;
- Design engineering: software architectures, specification, refinement, design methods, strategies, and styles; documentation of design rationales;
- Software testing, analysis and verification: algorithms, techniques and processes for assuring or assessing software with respect to functional or non-functional requirements;
- Configuration management: version control and system evolution;
- Software understanding and reengineering;
- Reuse: techniques for reusing components such as specifications, designs, or code, and for making such products reusable;
- Software process engineering: modelling, analysis, customisation, enactment, evolution;
- Software engineering environments: organisation, tool integration and interoperability; object management, language-directed tools, knowledge-based tools, dedicated tools; software visualisation;
- Measurement, metrics, estimation methods, and empirical studies;
- Human software interaction;
- Collaborative software engineering;
- Special software engineering techniques for: distributed systems, real-time systems, safety-critical systems, secure systems, multimedia systems, and mobile computing;
- Domain-specific software engineering techniques.

Software programming skills

This encompasses specific skills required in the use of the various programming languages in existence. Although, categorised under application/product software these skills of course feed into all the other sector focus areas. Examples include:

- Programming languages: VB, J2EE/JSP/EJB (Java), Cobol, C++, C#, C
- Mainframe platforms: Unix, JCL, CICS, RPG (Report Program Generator), MVS (IBM OS)
- DB skills: SQL, Oracle, Access
- Misc.: e.g. maths workbench languages (MATLAB, Simulink, MathCad, or Mathematica)

Web applications skills

Given the prominence and ubiquity of the internet and its applications to services and product delivery, these skills have been highlighted outside of just programming languages. Skills in the use of web application frameworks (application tools assisting the design of web apps) as well as those involving application architectures are necessary. The latter overlaps with system architecture skills. Examples of web languages include:

- XML, PHP, Javascript, HTML, Flash, DHTML

CRM software skills

The requisite primary skills for CRM are software consultancy (IT services) and systems integration in combination with knowledge of relevant applications such as Oracle (Siebel) or SAP. In addition to this specific business/market knowledge is necessary for its effective use. CRM is a fundamental component within all service providing businesses (e.g. financial services - enabling banks to tailor services for customers in an efficient/effective manner).

XML skills

XML and its variants are not just important to web applications but also for use in system interfaces (for the purposes of integration). With an ever increasing trend of incongruent systems having to communicate during operation, having a suitable and efficient interface is very important. In broad terms then, XML is used where systems interact. Another such example is its use in Database Management Systems.

Systems architecture skills

System architecture is complex and new systems must be robust and effective in use. Systems architects must be capable of designing multi-tier systems within which effective communication is paramount. Knowledge of various architectures along with a combination of the previously mentioned skill sets is required for successful delivery. Examples of architectures include client-server, 3-tier and Service Oriented Architecture (SOA).

11.3.2 NEARSHORING

Outsourcing will increase as companies strive to reduce costs and increase efficiency of service. The components of Nearshoring take the form of IT Outsourcing (ITO) and Business Process Outsourcing (BPO). These can be further divided with various skills assigned to the sub-divisions as shown below. Both elements require business-specific knowledge as well as technical skills around applications architecture and development/design.

- **ITO**
  Application management - business process/management skills as well as technical (programming various languages, systems architecture);
  IS outsourcing - electronic data record management skills needed;
  Network and desktop outsourcing - technical support service skills;
  Network consulting and integration services - systems consulting and implementation skills;
  Hardware deploy and support services - hardware (electronic/computer) engineers required;
  Software deploy and support services - software developers needed.

- **BPO**
  Call centres - operators interface with enterprise applications (e.g. viewing of account details by BT operator). Less highly skilled people needed here. Management and maintenance skills paramount;
  HR;
  Finance and accounting;
  Procurement;
  Back office - other business processes not covered by the above three.

11.3.3 EMBEDDED SYSTEMS SOLUTIONS (INFOCOMMS)

The distributed embedded systems industry is leveraging real-time operating systems, such as Inferno, Windows CE, EPOC, and Palm OS to support mobile communication applications, such as electronic mail, Internet browsing, and network management. Further services will develop offering customers even more facilities from their mobile devices (e.g. making bill payments or funds transfers via wireless handhelds/phones). Skills required to develop these capabilities include:

- Wireless applications skills - applicable to mobile wireless devices using embedded systems
- CPU architectures skills for embedded devices - e.g. ARM, MIPS, Coldfire/68k, PowerPC, x86, PIC, 8051, Atmel AVR, Renesas H8, SH, V850
- Embedded OS software knowledge - use of Embedded Linux, Inferno, ITRON, Windows XP Embedded, VxWorks
- Skills in application platforms for mobile devices - e.g. Java 2 micro edition, Flash. This must to be coupled with web application skills (i.e. javascript, XHTML, etc.)

11.3.4 SECURITY SOLUTIONS

Today, an ever-growing industry around technology security solutions is developing. Protection of data and information from intrusion by third parties is critical for the successful operation of businesses on two main stages - business operating data must be retained for internal use (until released to the public, e.g. finance results of large companies dictate share price fluctuations), and customers demand privacy of their personal data. Some of the skills required are listed below:

- Secure emails - knowledge and use of PKI structures
- Biometrics - used in isolation for identification or can be stored on smart cards. Technologies are continually being developed for applications such as face recognition, finger printing, eye scanning. Skills in digital imaging for face recognition will be required.
- Smart cards - use in credit cards as well as cards storing biometric data. Skills and knowledge are necessary around the hardware i.e. the cards themselves and the accepting devices. These include aspects of small bit rate (9600 bits per second) transmission using a serial bi-directional transmission line (ISO standard 7816/3), half duplex mode for sending the information (data only travels in one direction at a time) and communication protocols using encryption such as DES, 3DES or public key RSA (asymmetric encryption).
- Encryption - skills and knowledge of file compression and encryption standards such as Data Encryption Standard (DES) and Advanced Encryption Standards (AES) for application to emails, data transactions and networks. DES is used for ATM encryption, email privacy and secure remote access to name but a few.
- Cryptography - cryptographic skills (knowledge of cryptographic algorithms and their implementations in programmable code) coupled with IT skills specifically around data transmission and storage and network security.
- Firewalls - skills in IT networking and architectures as well as network security. Various types of firewall exist each depending on where the communication is taking place, where the communication is intercepted and the state that is being traced. These include network layers and packet filters, application-layer, proxies and network address translation.
- Spam-blocking - skills required in anti-spam techniques.
- Integrated security platforms - skills required in a combination of the above security measures to protect networks in particular IP security, firewalls and intrusion protection systems

11.4 SECTOR-RELATED SKILLS REQUIREMENTS

ICT SKILLS THAT ARE PARTICULARLY APPLICABLE TO DEVELOPMENTS IN CERTAIN SECTORS ARE OUTLINED BELOW.

Health Care - applications include:

- Patient records management applications (fixed and wireless) incorporating workflow engines and rules-based technologies coupled with web and wireless capabilities. This incorporates use of database management technologies as well as embedded applications in devices such as tablet computers and PDAs.
- Health Level 7 Document Architecture is a framework that defines for the compatible levels of XML most clinical documents such as laboratory reports and discharge summaries.

Telecoms - applications include:

- Wireless networking - this will require 'harder' skills such as those in electronic engineering as well as 'softer' programming skills. Bluetooth and broadband wireless technology skills will feature.
- B2B mobile applications and services - software development of embedded applications within mobile devices, e.g. sales staff updating accounts data remotely using PDAs, blackberries or tablet computers.

Financial Services - applications include:

- Electronic order routing, order management and trade execution applications enhancement for faster trade completion.
- Customer facing applications - web portals/services allowing customers to perform funds transfer, account queries (balances, etc.) and other functions.
- Enterprise applications - replacement of legacy systems for end to end banking systems that manage accounts, transactions, statements, customer data, etc.
- Electronic records and document management applications - managing the flow of documents through their life cycles and provides specific functionality such as capturing, managing, routing, archiving, storing, linking etc.
- CRM integration - further integration of CRM systems for use in service/product development
- Product development skills - integrated analytics, data management, and business process and integration solutions skills - used in customer service strategies.

Life Sciences - applications include:

- Analytical software development - use of the full spectrum of development skills to create applications for KM software, simulation software (e.g. new drug development), natural language search software, etc.
- Data management software - mobile computing/PDA software, enterprise application architecture tools, business intelligence tools.
- CRM software - used in billing utility customers, etc.

TABLE 11.1: SUMMARY OF REQUIRED SKILLS WITHIN FOCUS AREAS.

APPLICATION/ PRODUCT SOFTWARE	NEARSHORING	EMBEDDED SYSTEMS SOLUTIONS	SECURITY SOLUTIONS
Product development Software engineering Web applications CRM software XML Systems architecture **Healthcare** Patient records management Health level7 doc arch Database management Embedded applications Wireless networks WiFi **Telecoms** Wireless networks (bluetooth & broadband) B2B applications Embedded applications **Financial Services** Electronic trading Customer-facing applications Enterprise (banking) applications CRM integration Product development **Life Sciences** Analytical software development Data management software CRM software	**ITO** Application management IS outsourcing Network and desktop outsourcing Network consulting and integration services Hardware deploy and support services Software deploy and support services **BPO** Call Centres HR Finance & Accounting Procurement Back office function	Wireless applications CPU architectures Embedded OS Embedded application platforms	Secure emails Biometrics Smart cards Encryption Integrated security platforms Cryptography Firewalls Spam blocking

11.5 ICT SKILLS - AN NORTHERN IRELAND ANALYSIS

11.5.1 EXISTING SKILLS SIDE

An analysis of the current core skills capabilities was taken from the OCO Northern Ireland ICT sector review 2006 and the eSkills report.

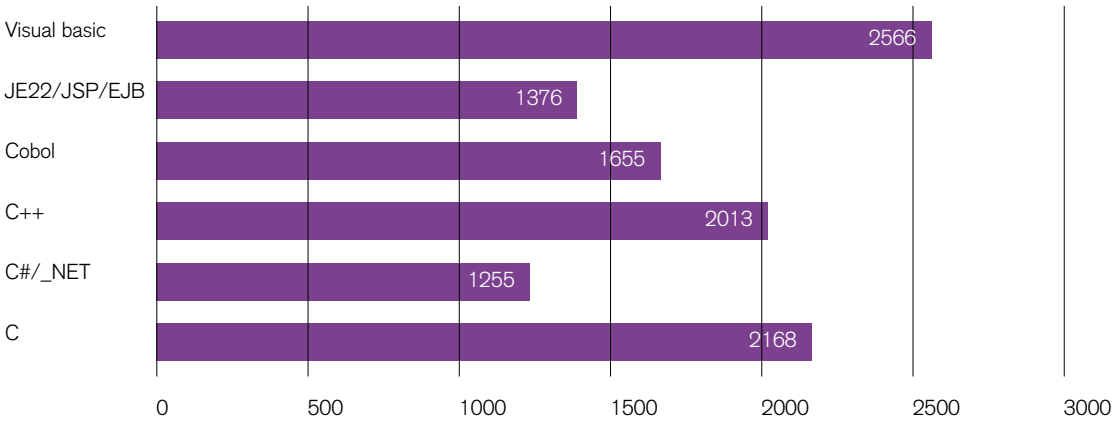
There are in the range of 11,200 - 13,000 IT-specific employees in the Northern Ireland ICT sector (it should be noted that OCO categorises ICT companies to other analyses); this is approximately 85% of employees in IT and computing companies in Northern Ireland (13,000).

The OCO results demonstrate that Northern Ireland has a strong base of IT skills in most areas of software programming, mainframe platforms, web technology, and database disciplines as illustrated in the following diagrams.

The conclusion from these numbers is that skills within the IT industry are easily transferable from one technology/discipline to another related or similar technology/discipline.

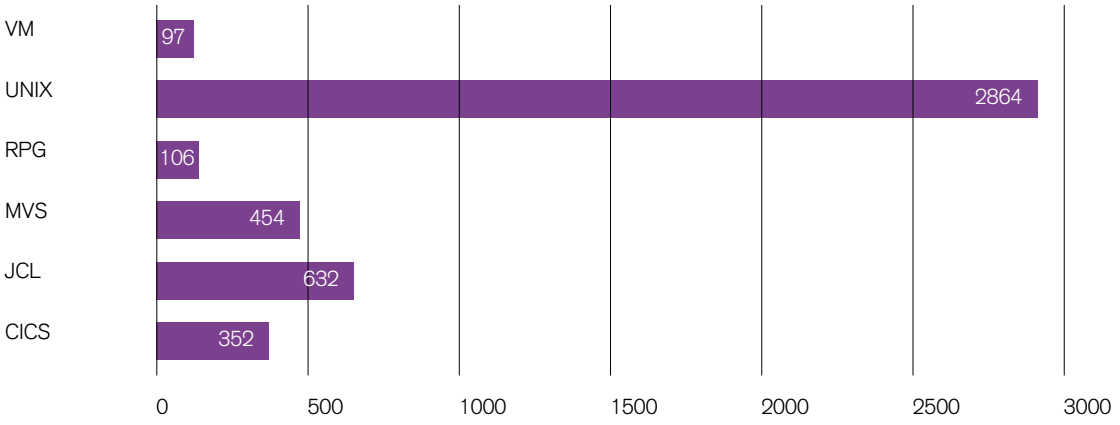
Many of the major programming languages of today are related to each other in some way or another and some more so than others. As can be seen, there is a good level of core skills capabilities in various programming languages within Northern Ireland allowing skills to be interchanged and utilised where demanded.

TABLE 11.2: PROGRAMMING SKILLS IN NORTHERN IRELAND (ESTIMATED NO OF EMPLOYEES WITH SKILL)



Source: ICT companies in Northern Ireland/OCO Consulting (January 2006)

TABLE 11.3: MAINFRAME PLATFORM SKILLS IN NORTHERN IRELAND (ESTIMATED NO OF EMPLOYEES WITH SKILL)

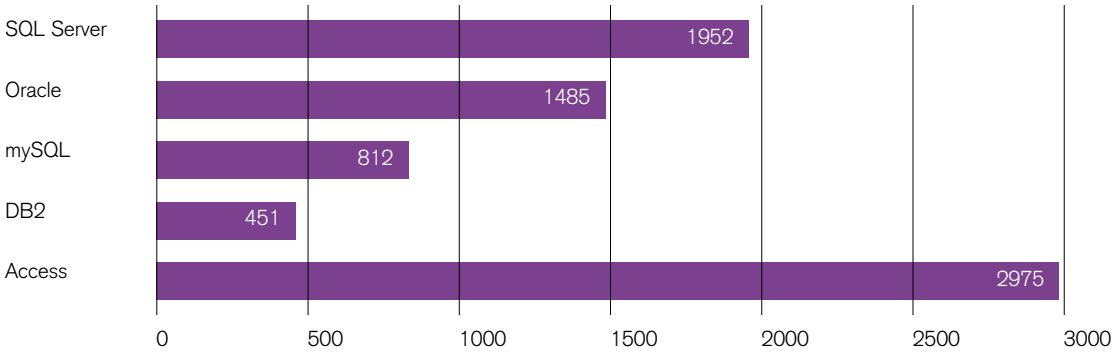


Source: ICT companies in Northern Ireland/OCO Consulting (January 2006)

TABLE 11.4: WEB TECHNOLOGY SKILLS IN NORTHERN IRELAND (ESTIMATED NO OF EMPLOYEES WITH SKILL)

Source: ICT companies in Northern Ireland/OCO Consulting (January 2006)

TABLE 11.5: DATABASE TECHNOLOGY SKILLS IN NORTHERN IRELAND (ESTIMATED NO OF EMPLOYEES WITH SKILL)



Source: ICT companies in Northern Ireland/OCO Consulting (January 2006)

11.5.2 THE SKILLS SUPPLY SIDE

In order to examine the fulfilment of future demand from the ICT sector the supply of graduates from courses suitable for use within the ICT sector were examined. These results are summarised in the following tables.

It should be noted that while the computer science graduate numbers produced have remained relatively constant since 2002, enrolment into the discipline have been in decline during that period. Therefore, further analysis is needed to establish if this supply trend is sufficient.

TABLE 11.6: NO. STUDENTS ENROLLED IN ICT FURTHER EDUCATION IN NORTHERN IRELAND

IT RELATED COURSES (NO. STUDENTS ENROLLED)	2003/2004
NVQ	13,393
GNVQ	1,108
HND and HNC	1,718
Computer science (degrees)	4,020
Mathematical sciences (degrees)	338
Engineering (degrees)	3,117
Total	**23,694**

Source: Based on e-skills Northern Ireland (2005) and HESA

TABLE 11.7: NO. STUDENTS ENROLLED IN ICT UNIVERSITY COURSES IN NORTHERN IRELAND

DISCIPLINE	1998	1999	2000	2001	2002	2003	2004	2005
BSc Computer Science	446	475.5	513	543.5	514.5	402	367	384
BSc M/media or bus	21	116.5	205	221	210	268	288	389
MSc/PG Dip Comp/Inf	114	273	403	257	89	20	0	0
Grand totals	**581**	**865**	**1,121**	**1,021.5**	**813.5**	**690**	**655**	**693**

Source: Based on data provided by Momentum

TABLE 11.8: NO. COMPUTER SCIENCE UNIVERSITY STUDENTS QUALIFYING IN NORTHERN IRELAND

	QUALIFYING GRADUATES BY YEAR							
DISCIPLINE	2002	2003	2004	2005	2006	2007	2008	ALL
Computer science	343	366	395	456	356	325	340	2,581

Source: Based on actual and projected figures from Momentum

11.6 FURTHER ANALYSIS OF SKILLS IN NORTHERN IRELAND

11.6.1 LOW BASE SCENARIO

The Low Base Scenario suggests that 26% of companies in Northern Ireland already have IT user skills. Furthermore, this scenario for the IT industry in Northern Ireland is forecast to grow at 2.4% per year from 2006 to 2021, over three times the rate of overall employment growth in Northern Ireland[64]. It is assumed that these positions require degree minimum resources.

According to figures from e-Skills UK, there are around 13,000[65] people in the IT workforce (combination of IT Industry and IT professionals in other sectors; eSkills did not specify the companies that made up the IT industry in Northern Ireland) in Northern Ireland. Given the projected growth rate of 2.4%, there will be a need for approximately 312 (2.4% of 13,000) new graduates in 2007. Examining the graduate levels for 2007 in the table above, it is apparent that there is already insufficient supply to the sector. This implies a need to recruit from overseas or to develop certified conversion capability in the short term.

11.6.2 HIGH BASE SCENARIO

The High Base Scenario for the sector in Northern Ireland (figures obtained from INI) suggest that over the coming years demand from existing ICT sector companies will be 1,093 in 07/08, 1,203 in 08/09 and 1,030 in 09/10. It is not clear how many of these positions could be filled from FE graduates but it is assumed that these positions require degree-minimum resources.

Examining the graduate levels for these years in the table above, it can be immediately seen that there is insufficient graduate supply to the sector. Past experience has indicated that the sources of resource return, new entrants from other sectors and immigration do not supply substantial numbers and thus, the even greater shortfall in new graduate supply under the high base scenario (781 in 07/08) would be unlikely to be overcome. Given the focus areas of the ICT Panel identified above, it is apparent that in Northern Ireland, the skills required are constantly increasing in depth and breadth. Many traditional entry-level jobs are now being sourced from abroad, and sustainable growth across the whole of the Northern Ireland will be predominantly in high value roles which demand sophisticated skills in business, client relationship and project management alongside deep technical competencies.

From the OCO and eSkills reports, and supplemented by the individual company interviews for this panel, it is apparent that employers are also reporting the need for increasingly high levels of skills in the use of IT.

64. The Sector Skills Agreement for IT: 2007-2010, Action Plan Northern Ireland - www.e-skills.com
65. The figure of 13,000 has been taken from the OCO Northern Ireland ICT Sector Review Report 2006

11.6.3 THE COMPLEXITIES OF SUPPLY AND DEMAND

Given the large scale of numbers presented above, it appears that Northern Ireland supply meets demand in terms of the overall numbers. However, such an assumption overly simplifies the issues and there are broader factors to consider here. In 2002, only 290 new graduates entered the IT workforce in Northern Ireland as their first destination within six months of graduation. Comparing this to the figure of 343 for computer science graduates cited in the table above for 2002, already we see that when considering the low base scenario there is a greater shortfall when not all of the graduate supply, only 85% (290/343), are transitioning to IT roles. Therefore, it becomes harder to assume that additions such as re-entrants to the ICT sector after career breaks, those coming from other industry sectors and immigration can continually sustain the sector.

Further evidence compounding supply issues have been cited by e-Skills UK. Results of their research indicate that in addition to a central forecast of 360 new jobs being created each year in the ICT industry between 2007 through to the end of 2021, a further 1610 new entrants are required to replace those leaving the IT workforce through retirement and other reasons[66]. These figures imply a requirement for 1970 new entrants to the industry each year. It should be noted that the e-skills UK projections are a central estimate and it is entirely possible that this estimate will be exceeded. With this in mind, the graduate supply figures fall far short of demand by almost six-fold.

The other aspect that is over simplified here is the consideration of ICT skills at the macro level without further understanding the differences in skills needed (as set out at the beginning of this paper). In an IT skills gap analysis of Northern Ireland conducted by Gartner Consulting in 2005 a significant skills gap was identified in development and implementation of IT systems and services, which includes demand for technical skills in systems integration, networking, web design and IT architecture to support both custom and packaged integration. This is further supported by consultations carried out by PA Consulting Group where there is a perceived gap in specific skills required for software (product) design and development.

All the consultations[67] in this sector suggest that the numbers attracted to the industry have receded and that the quality of graduates is not as high as it previously was. Hence, the push to source capacity from Poland and Eastern Europe, where the quality of IT recruits is deemed to be higher than in Northern Ireland.

The scenarios set out above suggest a variety of views on the real ICT skills requirement for the future in Northern Ireland and the degree to which current graduate numbers will meet that requirement. There is a need for more coherent analysis across the sector and well informed debate among the key policy makers and agencies responsible for future skills and employment. Progress in this area has been hampered by the lack of integration of the supply and demand views and a fragmented approach to analysis.

66. Northern Ireland ICT Industry Skills Analysis - a briefing paper for the business alliance prepared by Momentum.
67. There have been over 25 consultation meetings. All meetings have been noted however the contents and participants in these meetings are confidential.

11.7 INTERNATIONAL COMPARISONS

During the latter half of the 1990s and the early 2000s, there were widespread claims of ICT worker shortages internationally. Most subsequent international analyses[68] have tended to suggest that the extent of the shortage was not as great as had been claimed.

There had been a rapid increase in demand for ICT professionals, and there had been evidence of labour market tightness. However, except in very narrow areas, labour market indicators, such as the rate of increase in pay, had been broadly in line with other professional occupations, suggesting that ICT professional shortages had been no more severe than for other comparable occupations. Industry internationally appears to have bridged the potential gap in supply by recruiting more people with non-ICT qualifications than previously.

To the extent that current trends and forecasts are a reliable guide to the period to 2015, international ICT labour markets are unlikely to become as tight as in the late 1990s, unless as a result of a very significant decline in student interest in ICT disciplines in developed countries. On the demand side, best estimates are that the rate of growth in ICT markets will be significantly lower, which will restrict demand for new ICT professionals to a level lower than the peak experienced in the late 1990s. On the supply side, countries such as India are increasing their supply of ICT professionals rapidly, with the intention, in large part, of substituting for ICT professionals located in developed countries.

Even in the early 2000s, when most of the international policy focus was on the quantity of skills available, issues to do with the quality of skills and their match with industry needs were important. For example:

- Germany had significant unemployment among ICT professionals with dated skills.
- Much of the inward investment by major European companies is driven by shortages of specific skills and competencies in their home countries, rather than general shortages of ICT skills, or significant cost considerations.

With issues relating to the quantity of skills available becoming less critical internationally, issues relating to the quality of skills are coming further to the fore. This is shifting the policy focus away from the initial education and training required to drive increased supply, and towards the certified continuing learning required to underpin the quality and fit of the skills of existing ICT professionals. Organisations such as the OECD are now arguing that the main issue of concern for policy makers and companies should now be the gap between the current skills of some ICT workers and those sought by companies[69].

Under these circumstances, the quality of skills, and the extent of the match between those skills and industry needs, will be crucial determinants of the success of export-oriented ICT industries, particularly those that are unable to compete on the cost of labour.

68. Information Technology Outlook 2006/OECD
69. Information Technology Outlook 2006, OECD.

11.8 IMPLICATIONS FOR NORTHERN IRELAND

The skills aspect of Northern Ireland becomes very relevant. Rough projections of demand and supply of graduates in computing and engineering within this current study suggest that the supply of computing and electronic engineering graduates available from the higher education sector is likely to fall short of ICT sector opportunities. As these are the primary technology disciplines in which substantial numbers of graduates are required, the projected shortage has the potential to constrain the sector's growth if alternative sources of skills cannot be found.

A significant skills gap was identified in development and implementation of IT systems and services, which includes demand for technical skills in systems integration, networking, web design and IT architecture to support both custom and packaged integration. The on-going attraction of lower level IT employment as discussed previously is having the effect of draining resources and resulting in those resources not being suitably developed to contribute to the industry as they progress through their career.

11.9 RECOMMENDATION 6: THE NI ROADMAP FOR ICT SKILLS

The roadmap for Northern Ireland to accept the challenges of skills in the overall global environment needs to be seen in three timescales - 2 years, 5 years and 10 years. This enhances the practical nature of such work and ensures that targets and goals can be completed in the short-term and medium-term to ensure the development of the sector in Northern Ireland. This is illustrated in Figure 11.1.

This roadmap kick-starts Northern Ireland Nearshoring focus. It requests activities to commence in the first two years. These activities cover a number of specific targets which will then be continued through the remainder of the years as the industry evolves.

FIGURE 11.1: THE SKILLS ROADMAP FOR NORTHERN IRELAND

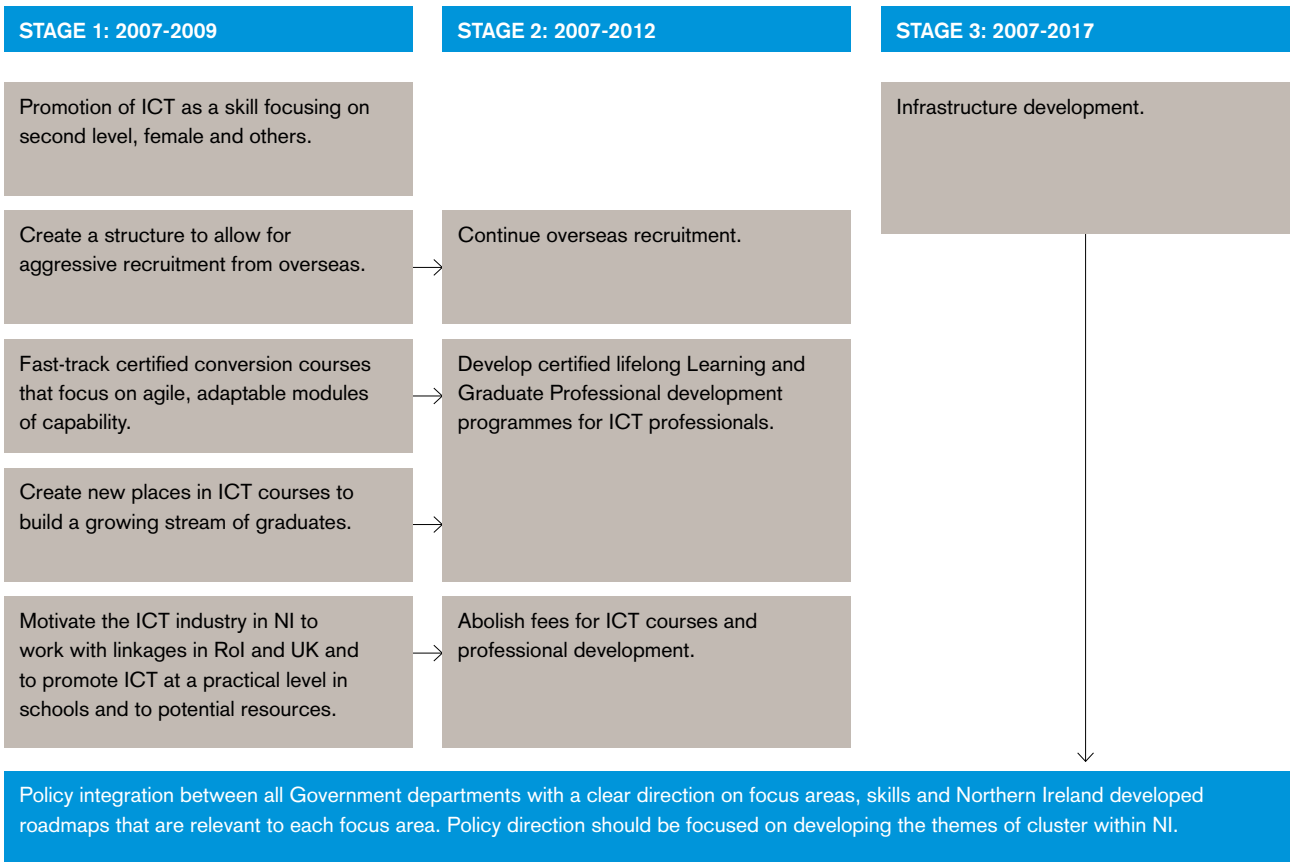


TABLE 11.1: THE NORTHERN IRELAND SKILLS ROADMAP

TIMEFRAME	RECOMMENDATIONS
Two-year programme	To remedy the oncoming shortage of skills to the ICT sector (as well as IT industry) and the issues mentioned above, a number of initiatives can be undertaken: Promotion of ICT sector - this should occur not just at the university level but at the pre-university secondary level, and not just by government but by private sector companies too in an attempt to reverse the somewhat negative impact of the dotcom crash. Some companies already actively engaged six schools in Northern Ireland in order to try and promote not just their business but the sector itself. Attracting high calibre individuals to undertake ICT related courses is paramount. Re-evaluation of the quality of course content at universities - There have been some observations that course notes at some ICT related programs may be eight to 10 years old. Given the dynamic nature of the industry this would seem not to be conducive to the production of high calibre graduates. Development and enhancement of Further Education courses - a greater focus should be placed on teaching industry applicable content as well as higher end skills to supplement any potential shortfall in graduate supply from the universities. At present, employers tend only to source graduates from university degree courses due to quality levels. Most of the IT training in Further Education in Northern Ireland is for IT users and the largest single category is at Level 1. Only 513 Level 4 IT courses were undertaken in FE establishments in Northern Ireland in 2002-2003[70]. If these levels can be used to sustain the lower end IT employment demand, greater focus can be placed on developing the high-end graduates to attract high tech value added FDI in Northern Ireland. Conversion courses to address the short to medium-term needs - One solution is to take other graduates through certified conversion programmes to alleviate this position. The globalisation of the ICT industry however demands that these programmes are accredited and certified, providing a coherent lifelong learning aspect to their work. This will help address short-term needs at lower levels of the ICT value chain but can only form part of a longer-term strategy in Northern Ireland to move the industry in to higher value-add activities and anchor real intellectual property in the region. Improving graduate quality - enhancing course content is redundant unless high calibre students are enrolled in relevant courses. In combination with promotion, entry requirements to such courses must be tightened to ensure that good quality enters and leaves. Issues in ROI with reduction in Leaving Certificate points (A-Level equivalent) required for entry into courses such as engineering has resulting in some concerns in the quality of graduate produced. Improving the sector image - Improving the ICT sector image attracts talented people. Improved university courses produce high calibre graduates from the right supply of talented individuals. These graduates can attract high end value adding FDI as well as supplying and growing existing high value-adding ICT areas. This then fosters development and growth and assists in the move towards a knowledge economy. All these measures are interconnected and must be undertaken concurrently to have the desired effect. Effective inward migration - many companies are already being successful in attracting overseas graduates, from countries such as Poland, Romania and India, to meet their immediate needs. However, the process could be

70. The Sector Skills Agreement for IT: 2007-2010, Action Plan Northern Ireland - www.e-skills.com

TIMEFRAME	RECOMMENDATIONS
	significantly improved through provision of support on administrative aspects such as visas and work permits. In addition a coherent strategy to attract those graduates that have pursued careers outside of Northern Ireland will enhance capability in the industry and introduce global best practice in an effective manner.
Five-year programme	In the medium term, the issue of skills pertaining to quantity and quality needs to be addressed. There is a perceived quality issue which should be evaluated and a quantity issue which needs to be clarified. The range of skills should also be evaluated based on the focus areas of this discussion document.
10-year programme	In the development of an overall ICT Cluster in Northern Ireland and assuming significant growth rates, Northern Ireland needs a specific ICT Skills Strategy that spans the continuum from basic to specialist skills.

FRAMEWORK CONDITIONS

IN THIS CHAPTER THERE IS A BRIEF DISCUSSION ON THE FRAMEWORK CONDITIONS THAT SHAPE THE ENVIRONMENT FOR ICT IN NORTHERN IRELAND.

12

Framework conditions are the elements that make an environment conducive for the research, development and uptake of new technologies. They are not technology-based but refer to general issues such as incentives, funding, skills etc. Throughout all interviews and workshops conducted, a number of framework conditions were continuously raised.

- **Capacity to absorb and exploit knowledge**.
  The results from the competitiveness survey undertaken in the Technology Capabilities study indicate that the sector in Northern Ireland is weak in basic and intermediate skills. Unlike cost reduction or supply chain improvements which are well understood in Northern Ireland, new technologies and the opportunities they present are not fully appreciated. This delays innovation and investment programmes or hampers the transfer to full product development.

- **Regulatory framework.**
  Levels of regulation in the UK in general are an area of advantage, although more could be done to make regulations more outcome-focused to encourage innovative compliance. In particular, smaller firms in Northern Ireland appear to lack understanding of intellectual property rights and the costs of enforcement. There is also uncertainty over their value, which deters many from acquiring such rights. On the regulation front, small firms in Northern Ireland have outlined that they struggle to come to terms with the regulations of the industries and supply chains that they are supplying to.

- **Competition regime and entrepreneurship.**
  Historically, companies in Northern Ireland are under less pressure to use new technologies and apply significant pressure on finding ways to improve their performance through cost reduction alone. This is clearly sufficient for some period of time but eventually must give way to higher value added activities, which include the use of new materials. OCED reports that entrepreneurship rates in the UK (and Northern Ireland performs poorly in the UK context) are at best moderate despite some important advantages in the business and regulatory environment.

- **Access to finance.**
  Although the UK capital markets are well developed and sophisticated, it would appear that weaknesses in innovation performance are probably more due to a lack of incentives and capacity to innovate rather than a lack of funding. Weaknesses in skills have probably affected the demand for, and success in obtaining, finance for innovation.

- **Science and Technology Knowledge Creation.**
  Science, Technology and Innovation in are important inputs to value add Product design and processing. From the Technology Capabilities project, and the international benchmarking of the universities in this region it is shown that the science and engineering base is highly productive. This knowledge, when exploited, leads to the development of new products or processes. There are relatively low levels of adoption of technology developed within Northern Ireland by the companies in Northern Ireland. This needs to be addressed. The ability of companies within Northern Ireland to commercialise within an appropriate eco-system is essential for the development of this sector.

- **Networks and collaboration.**
  Firms in the Northern Ireland appear to have strong network relationships. In areas linked to ICT such as supplier and customer engagement and links with science partners the network relationships appear to be intermittent and driven by short-term decision-making.

- **Customers and suppliers.**
  Customer demand and technological opportunities provide the incentive to innovate. These vary widely in ICT due to the consumer driven nature of the sector. There appears to be a discontinuity between these in Northern Ireland.

- **Skills - quantity and quality.**
  There is a recognised shortage of appropriate skills within Northern Ireland to progress the overall ICT sector. There appears to be an issue attracting people to this sector with a view that there are limited career opportunities. Also, company interviews indicated that there is an emerging quality issue with the level of skills that are available in the market.

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