Technology Strategy Board
Driving Innovation

Information and Communication Technology

Key Technology Area

2008-2011

The vision of the Technology Strategy Board is for the UK to be a global leader in innovation and a magnet for **innovative** businesses, where technology is applied rapidly, effectively and sustainably to create wealth and enhance quality of life.

Our three-year strategy for 2008-2011 is to drive innovation by **connecting** and **catalysing**. To achieve this we are focusing on three themes: challenge-led innovation, technology-inspired innovation and the innovation climate. For more information on the overall strategy see **www.innovateuk.org.**

We have identified a number of key application areas and key technology areas on which to focus, and for which we are developing specific area strategies.

This document presents the strategy for the key technology area of **Information and Communication Technology**.

The Technology Strategy Board would like to thank the information and communication technology community for their help in preparing this strategy document.

Foreword

The Technology Strategy Board is a new organisation with a new vision and ambition to make the UK a global leader in innovation. Our job is to ensure that the UK is in the forefront of innovation enabled by technology.

Our task at the Technology Strategy Board is to "Connect and Catalyse". As part of our challenge-led approach to innovation, we treat societal and economic challenges of the future not just as threats but as opportunities for innovative solutions that enhance the quality of life and increase wealth.

The world is changing. Globalisation, digital communications and the growth of emerging economies present profound challenges to UK business sectors. Yet where there are challenges there are also opportunities. Open access to global supply networks and emerging markets is easier than ever before; the highly skilled UK workforce, world-class science base and open-market philosophy also puts us in a strong position.

ICT has a significant role to play in increasing the competitiveness and sustainability (in all senses of the word) of the entire economy. ICT is also required to address major societal challenges such as the development and support for new models of care for the elderly, and transport congestion

The UK has many strengths in high-value ICT activities: systems engineering, advanced 3G mobile products and services, human factors and artificial intelligence, to name a few. There are significant opportunities for UK businesses to further develop these strengths and to exploit them in novel ways.

This strategy identifies a number of specific technology challenges to focus research and development across four themes. In these themes, the Technology Strategy Board recognises the importance of the experience and perspectives of both technology users and complementary disciplines in the successful development and exploitation of ICT-based solutions.

This ICT strategy provides the context for our investments in this area in the 2008-2011 period. It complements our Electronics, Photonics and Electrical Systems strategy in particular and underpins other key technology and key application area strategies that have significant ICT components. We are looking forward to working with UK ICT businesses and other key partners to implement this strategy, creating wealth through effective use of existing and new high-value ICT.

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Executive summary

Information and Communication Technology (ICT) encompasses systems and services that gather, store, recover, maintain, manage, transmit, process, interpret, present and protect (in house and in transit) information. ICT is embodied in large-scale and complex systems such as telecommunications networks and the World Wide Web, in devices such as mobile telephones and PCs, and in services such as banking, digital television and e-Government. It provides necessary tools and infrastructures for many branches of science and design including environmental science, bioscience and automotive design.

ICT is the backbone of the digital economy. It drives forward productivity across all economic sectors and enables business transformation. ICT creates wealth by allowing firms to:

- extend their reach and capacity;
- reduce costs by streamlining their processes; and
- increase sales by offering higher-quality and more competitive products and services.

In 2004[1], 55% of the UK's total Gross Value Added (GVA) stemmed from IT-intensive sectors while the IT and Telecoms sectors themselves directly contributed 4.9% of total UK GVA between them (£30.6bn and £21.3bn respectively). It is estimated by e-skills UK that continued adoption and exploitation of existing ICT has the potential to contribute an extra £35bn to UK GVA, across all sectors, over the next five to seven years (from 2008) though this depends crucially on firms, especially Small and Medium Sized Enterprises (SMEs), being aware of the benefits that they could accrue. The development and adoption of novel ICTs would contribute further. Given this, investment in ICT innovation and related knowledge transfer across all sectors is strategically important for the UK.

1 Latest available figures from ONS.

Worldwide spending on ICT was $3.4tr in 2007 and is expected to reach $4.3tr in 2011, with annual growth slowing from 10.3% to 3.6% in that period. The UK is the fifth largest ICT market behind the US, Japan, China and Germany, with national ICT spending of $187bn. There are many large global markets for ICT that represent significant opportunities for the UK including those in financial services, retail, e-Government, healthcare, transport, manufacturing, creative industries, construction and education. Across these markets, there are several opportunities for innovation to address increasing volumes of digital data, increasing convergence and complexity of ICT-based systems, advances in hardware capacity and the push for environmental sustainability.

The Technology Strategy Board will invest in stimulating business innovation in ICT through two closely-aligned Key Technology Areas (KTAs): ICT and Electronic, Photonics and Electrical Systems (EPES). The ICT KTA concerns the software components of ICT systems as well as their alignment with people and processes. The EPES KTA covers the hardware components of ICT as well as topics such as lighting which are outside the scope of ICT. Together, the two KTAs will invest to ensure that end-to-end ICT systems are developed, integrated and exploited. Areas in which hardware and software are tightly coupled, such as communications, embedded systems, robotics and parallel computing, provide fertile ground for joint initiatives bringing together the different communities involved, and will be addressed through tightly co-ordinated ICT-EPES activity.

This document presents the UK's technology strategy for wealth creation through innovation in ICT and will be used as a basis for Technology Strategy Board investment during the period 2008-2011. It offers a set of priorities for technology development and exploitation with the aim of seeing significant benefits in the UK within five to seven years.

Throughout implementation, the Technology Strategy Board will work in partnership with business, both directly and through Knowledge Transfer Networks and trade and professional bodies, and with other organisations including the Research Councils, Regional Development Agencies and Devolved Administrations, the Department for Business, Enterprise and Regulatory Reform, the Department for Innovation, Universities and Skills, Office of Government Commerce and UK Trade and Investment.

ICT is a broad area and there are many specific technical challenges in developing high-value systems and services that are:

- **data-driven** – able to reliably and continuously gather data from physical environments;
- **intelligent** – to enable the extraction of value from collected data; and
- **user-centric** – to fit with user requirements, preferences and processes whether the user is a consumer, a business or a government department.

Underpinning these qualities is the development and use of tools and techniques for rapid, cost-effective and reliable **engineering of end-to-end ICT systems** that are fit-for-purpose in dynamic environments. Specific ICT challenges include, for example:

- providing tools to allow manual and automatic configuration and optimisation of sensor networks according to changing data needs;
- analysing huge volumes of data in real- or near-real-time;
- modelling, understanding and predicting the behaviour of intelligent and complex systems;

- supporting and encouraging social inclusion and interactions between people through the use of IT and connectivity;
- providing the flexibility to rapidly configure and validate new systems that are fit-for-purpose and to add new software and electronic sub-systems and components at run-time;
- achieving and maintaining levels of system dependability, multi-level resilience and trust, concomitant with levels of user reliance on the system; and
- developing software engineering technologies and techniques to exploit the capacity that new hardware offers.

A range of technologies and methodologies, some existing and some yet to be developed, are needed to address such challenges. These include, for example: systems engineering; digital communications; optimisation; modelling and simulation; machine learning; multi-modal human-computer interaction; software engineering and virtualisation. The range of technology challenges above can only be addressed effectively by bringing together technology providers and experts from a range of underpinning disciplines and end-uses. Disciplines required include mathematics, computer science, psychology, sociology, business process management, linguistics, law and ethics.

ICT has a key role in enabling other sectors in the UK to be more competitive and sustainable and the UK has many strengths in high-value ICT activities. However, the UK's competitiveness in the future against up-and-coming lower-wage economies cannot be assured without considered investment by business and government.

The Technology Strategy Board will invest strategically to stimulate ICT demand and increased innovation by:

- working with businesses across sectors and investing in knowledge transfer activities around new ICT developments, innovation success stories and best practice, to ensure that businesses and users in general are fully aware of applicable ICTs and how they can be exploited to create wealth, thus increasing their appetite for ICT innovation and strategic adoption of advanced ICT;
- working with government departments and agencies to stimulate an appropriate level of, and approach to, ICT innovation and open systems to fulfil its needs (this could include competitions under the SBRI programme to bring to bear capabilities of a wider range of innovative businesses); and
- encouraging collaborative research and development between businesses and partners to overcome fragmentation in the ICT innovation ecosystem and to deliver high-value systems and services to market.

Closing the gap between users and suppliers will quicken the pace of innovation and make it possible for UK innovators and suppliers to understand, anticipate and react rapidly to changing user needs. The effect on the supply side would be profound – making it easier for innovations to penetrate the market and easier for small and agile start-ups to get established, stay competitive and grow, changing the shape of the ICT innovation ecosystem. An increase in the number of profitable businesses would be seen, not just in the ICT industry, but also across all economic sectors. Success will also lead to greater GVA per worker in sectors making more use of ICT as well as the recognition of the UK as a place where end-to-end ICT systems that are data-driven, intelligent, user-centric and fit-for-purpose can be developed and applied to create wealth. This would result in increases in exports and inward investment.

In addition to the main priorities above, the Technology Strategy Board will:

- ensure the full exploitation of ICT in addressing major societal challenges through all innovation platforms;
- engage with the EU's research and development policy-makers to ensure that UK business capacity can be complemented and increased through greater collaboration with other member states particularly on issues such as standards and infrastructures;
- survey existing facilities for user innovation and technology evaluation, encourage businesses (particularly those without the necessary infrastructure in-house) to exploit them more widely in order to improve the acceptance and quality of their products and services, and work with partners such as the Engineering & Physical Sciences Research Council, the Economic and Social Research Council and the Regional Development Agencies to plug gaps in provision where necessary;
- explore ways to ensure that the software community is in step with hardware developments to allow the UK to exploit these as fully as possible, including targeted knowledge transfer and collaborative research and development activities involving both communities; and
- determine the part it can play with regards to growing demand for professionals and users with high-level ICT skills in all sectors and the predicted shortfall in the supply of the required research and exploitation skills, which may severely hinder innovation and competitiveness, by working with e-skills UK, professional societies, the Research Councils, the Department for Innovation Universities and Skills and the Department for Children, Schools and Families.

1. Background and context

1.1. Purpose of document

This document presents the UK's technology strategy for wealth creation through innovation in Information and Communication Technology (ICT). It offers a set of priorities for technology development and exploitation with the aim of seeing significant benefits in the UK within five to seven years. This document will be used as a basis for Technology Strategy Board investment during the period 2008-2011. During and after this time, the opportunity will be taken to refresh the strategy in line with new global market opportunities and levels of UK capacity.

Throughout implementation, the Technology Strategy Board will work in partnership with business, both directly and through Knowledge Transfer Networks (KTNs) and trade and professional bodies, and with other organisations including the Research Councils (RCs), Regional Development Agencies (RDAs) and Devolved Administrations (DAs), the Department for Business, Enterprise and Regulatory Reform (BERR), the Department for Innovation, Universities and Skills (DIUS), Office of Government Commerce (OGC) and UK Trade and Investment (UKTI).

1.2. Scope of ICT strategy

ICT encompasses systems and services that gather, store, recover, maintain, manage, transmit, process, interpret, present and protect (in house and in transit) information. ICT is embodied in large-scale and complex systems such as telecommunications networks and the World Wide Web, in devices such as mobile telephones and PCs, and in services such as banking, digital television, social networking and e-Government.

ICT systems and services are composed of both electronic and software[2] components, which are supplied by sizeable industries with different characteristics though related value chains.

Engineering end-to-end ICT solutions is not merely a matter of combining appropriate components. There are significant challenges in configuring systems with appropriate attributes such as security, dependability, quality-of-service, usability and accessibility. Innovations are required at the component, system and infrastructure levels, in hardware and software, and at the interface between technology and people to enable the development of effective end-to-end ICT-based solutions.

The Technology Strategy Board will invest in stimulating business innovation in ICT through two closely aligned Key Technology Areas (KTAs): ICT, and Electronic, Photonics and Electrical Systems (EPES). The ICT KTA concerns the software components of ICT systems as well as their alignment with people and processes. The EPES KTA covers the hardware components of ICT as well as topics such as lighting which are outside the scope of ICT. Together, the two KTAs will invest to ensure that end-to-end ICT systems are developed, integrated and exploited. Areas in which hardware and software are tightly coupled, such as communications, embedded systems, robotics and parallel computing, provide fertile ground for joint initiatives bringing together the different communities involved, and will be addressed through tightly co-ordinated ICT-EPES activity.

Given the widespread use of ICT across economic sectors, this strategy will also be aligned with other KTAs and Key Application Areas (KAAs) where appropriate as well as other Technology Strategy Board activities with a strong ICT component including the existing Innovation Platforms in Network Security, Intelligent Transport Systems and Services and Assisted Living, and the relevant Knowledge Transfer Networks (KTNs)[3].

1.3. Impact of ICT on the UK economy

ICT is the backbone of the digital economy and underpins all sectors. It enables businesses to operate globally, consumers to access a wide range of information sources, products and services, and governments to support and protect their citizens. It also underpins much of scientific endeavour by providing necessary data capture, modelling and visualisation tools and high-performance computing infrastructures for many branches of design and science including environmental science, bioscience and automotive design.

IT-intensive sectors contributed 55% of the UK's total Gross Value Added (GVA) in 2004. In terms of GVA to the UK economy, the IT and Telecoms[4] sectors themselves directly contributed 4.9% to total UK GVA (£30.6bn and £21.3bn respectively) [2].

Analysis conducted by the Information Age Partnership indicates that ICT drives forward productivity growth both directly (through improvements to available capital stock and labour productivity) and indirectly (through business transformation) thus allowing firms to extend their reach and capacity, to reduce costs by streamlining their processes and to increase sales by offering more competitive and higher-quality products and services [3], thereby creating wealth.

2 Here, software includes both the instructions that direct the operation of computer equipment and the information content, or data, that computers manipulate [1].

3 See the Technology Strategy Board website (www.innovateuk.org) for the current KTNs in this area.

4 SIC classes 72 (computer and related activities) and 64.2 (telecommunications) – IT hardware and telecommunications manufacturing are not included.

It has been claimed that investments in IT account for half of productivity gains seen in Europe in recent years [4]. As part of ICT, software can be used to provide a huge range of capabilities and is behind the scenes in many of the products and services we take for granted including washing machines, mobile phones and retail services. It can also be embedded in business processes making it difficult to assess its full contribution. For example, *own account software*, which is developed by a company for its own use, makes a significant but less obvious contribution to the economy than sales of products and services. An analysis conducted by the British Computer Society's Initial Working Party for Developing the Future indicates that the contribution of own account software to the UK economy in 2014 will be £18bn (1.5% of expected GDP) [5]. According to the British Computer Society, "productivity gains in the twenty-first century are more likely to be driven by software innovation than any other subset of Information Technology" [5].

It is estimated that continued adoption and exploitation of existing ICT has the potential to contribute an extra £35bn to UK GVA over the next five to seven years, though this depends crucially on firms being aware of the benefits that could accrue [4]. This is particularly true of SMEs given that, generally speaking, there is a direct correlation between company size and extent of ICT adoption.

1.4. Key opportunities

Several developments present opportunities for ICT innovation in the UK and the Technology Strategy Board's priorities for investment take the following factors into account.

Increasing convergence: Consumer demand is driving the convergence of IT, telecommunications, broadcasting, consumer electronics and creative content. This brings together systems that were previously clearly delineated and allows consumers to access and combine information and services in new ways whenever, wherever and however they want, irrespective of how and where the information and services were originally derived. Further innovation is required to increase convergence in response to continued consumer demand and to ensure that converged end-to-end systems can deliver in terms of content, quality, personalisation, accessibility, speed, security and dependability.

Increasing volumes of data and information: The phenomena of information overload and data deluge are oft-cited. According to IDC, there were 161 exabytes[5] of digital information in existence in 2006 and this is set to increase six-fold to 988 exabytes by 2010 [6]. This increase is largely a result of the mass digitisation of analogue data (e.g. films, TV and audio). It is now much easier for consumers and organisations to publish information and make it accessible to others, thereby adding to the information overload. ICT has a role to play in automatically processing much of this to stave off the deluge of data and information.

Increasing hardware capacities: Recent and future advances in hardware will present major challenges to software and systems engineering. In the near-term, the increasing adoption of multi-core processors will necessitate innovation in the area of parallel computing to ensure that the software needed to run on these processors is both readily available and flexible. It is predicted that embedded systems with 4096 cores may be marketable by 2017 in addition to servers with 512 cores and desktops with 128 [7]. In the longer-term, further advances in areas such as quantum or DNA computing will have major implications for the nature of software development.

Need for environmental sustainability: The Stern Report published in 2006 [8] highlighted the need for the UK to consider its impact on the environment. This relates to ICT in two ways: firstly, as a consumer of energy (ICT is said to be responsible for 2% of global carbon emissions [9]) and secondly, as an enabler of energy-saving measures in other sectors of the economy, for example, through the modelling, prediction and control of energy use. *Green IT* or *Green Computing* concerns the study and use of methods for efficient use of computer resources. There are several lines of attack based on the use of low-power electronics. However, software also has a role to play. For example, through virtualisation, multiple logical computer systems can be run on a single set of physical hardware to reduce power used for cooling.

Inclusion: ICT has a role in facilitating social inclusion for all UK citizens, although not surprisingly, ICT uptake is uneven across society and particularly across the generations. Technologies such as collaboration tools and social networking allow distributed users to keep in touch with each other and with the latest news in communities, whether these are real or virtual. Innovation is required to develop ICTs that are user-centric and can be exploited by all users whatever their circumstances.

5 One exabyte is equal to 10^{18} bytes.

User innovation: Perhaps in software more than any other technology area, consumers themselves can provide a useful source of innovation. This may be due in part to the ease of access to necessary tools (e.g. desktop computers, mobile phones and open source software). This cannot be said of the pharmaceutical and manufacturing industries, for example. There are oft-cited reports of hobbyists (particularly teenagers) rapidly creating new software applications and mash-ups in their spare time, using widely available computing resources. Harnessing this form of innovation, being careful not to hinder it, may provide an important source of know-how for the UK.

Alongside these opportunities, threats to ICT innovation in the UK include a growing ICT research skills gap which has the potential to lessen the nation's capacity to develop new technologies and to exploit them effectively across sectors. In addition, there is a concern that the UK's competitiveness will be limited by its broadband access speeds which are lower than those in some other nations. Increases in connection speeds will entail technological innovations in hardware, given current limits on capacity (see the EPES strategy [10] for more details), but will also necessitate innovations in software to manage the network, optimise quality-of-service, and to handle increasing streams of data and information. The Technology Strategy Board will take account of the results of stakeholder group reviews and will consider stimulating innovation, where appropriate, both to increase access and to take advantage of it.

2. Key markets for ICT

Worldwide spending on ICT was $3.4tr in 2007 and is expected to reach $4.3tr in 2011 [12], with annual growth slowing from 10.3% to 3.6% in that period. Currently, 57% of global ICT spend is on telecommunications (including associated equipment manufacture and software), just over 29% on software and IT services and just over 14% on IT hardware. The charts below show spending by category both globally (Figure 1) and in the UK (Figure 2). The UK is the fifth largest ICT market behind the US, Japan, China and Germany, with national ICT spending of $187bn.

Using ICT to improve information flow and operations

Existing IT capabilities can be exploited by businesses to improve performance and output. A Knowledge Transfer Partnership (KTP) between Jackson and Keay Ltd (a specialist supplier of gas cylinder services) and an associate from Nottingham Trent University has led to the development and application of an electronic information flow management system. The Virtual Job Card system enables the integration of operations from the point at which an order is received, through processing and dispatch to billing, and allows employees to retrieve the information they need at any point during the process. The new system is a major improvement on the previous paper-based system which was prone to errors and omissions, improving operations by 40%, quality by 20% and sales by 40%. A £250k increase in profits (before tax) was anticipated as a result of the KTP.

Figure 1 – Global ICT spend in 2007, by category

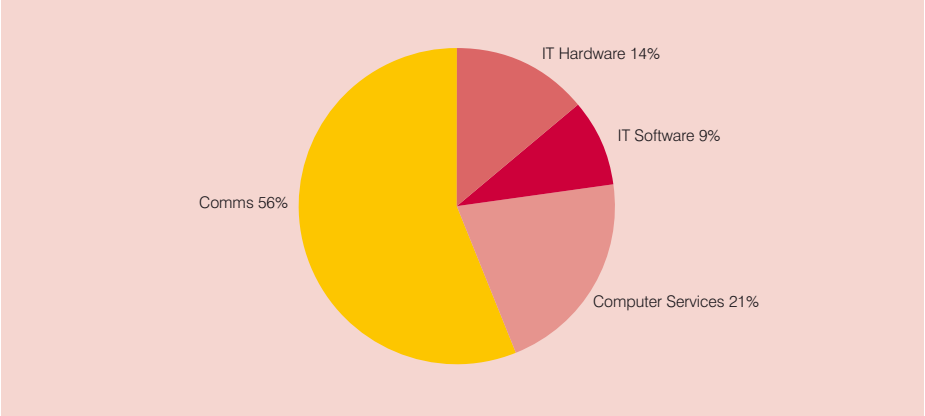
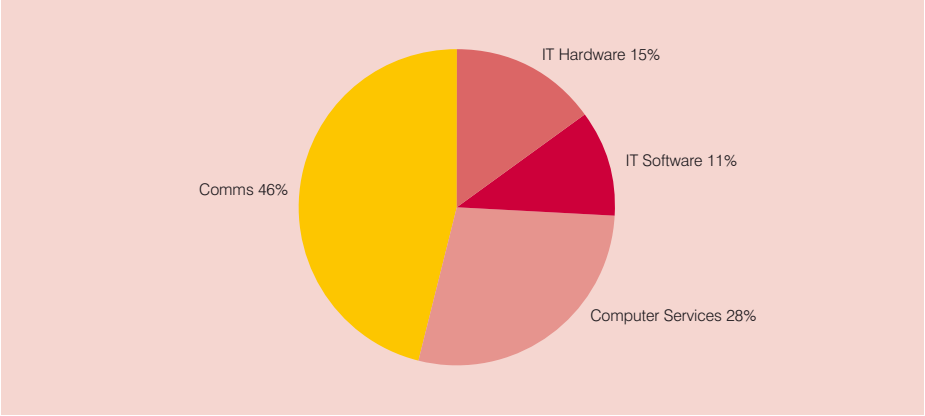


Figure 2 – UK ICT spend in 2007, by category



The charts here (based on figures from [12]) show global ICT spending by sector (Figure 3) and relative ICT intensity (the ratio between the share of ICT spend and the share of output, Figure 4). These indicate that, globally, the top three sectors in terms of ICT spending are Consumer, Financial Services and Government[6]. However, in terms of ICT Intensity, the top three are Financial Services, Transportation and Healthcare.

Within the above sectors, there are a myriad of specific end uses for ICT including geographic information systems, defence, computer games and transformational government. ICT is fundamental to major and high-value UK sectors including for example:

- financial services (£7bn spent on ICT each year [13] for example on analytical and visualisation software);
- retail (£3bn spent on ICT each year [13]);
- creative industries (of the £13bn worth of creative industries exports in 2004, 36% of this was provided by the software, computer games and electronic publishing sectors [14]); and
- defence (numerous software-intensive capabilities needed to meet the UK's future defence requirements including signal and data processing, secure and robust communications, information management and exploitation, and modelling and simulation [15]).

The possibilities for innovation and exploitation of ICT are many and varied particularly in sectors that exhibit low ICT-intensity currently, e.g. construction, manufacturing and educational services.

Figure 3 – ICT spend in 2007, by sector

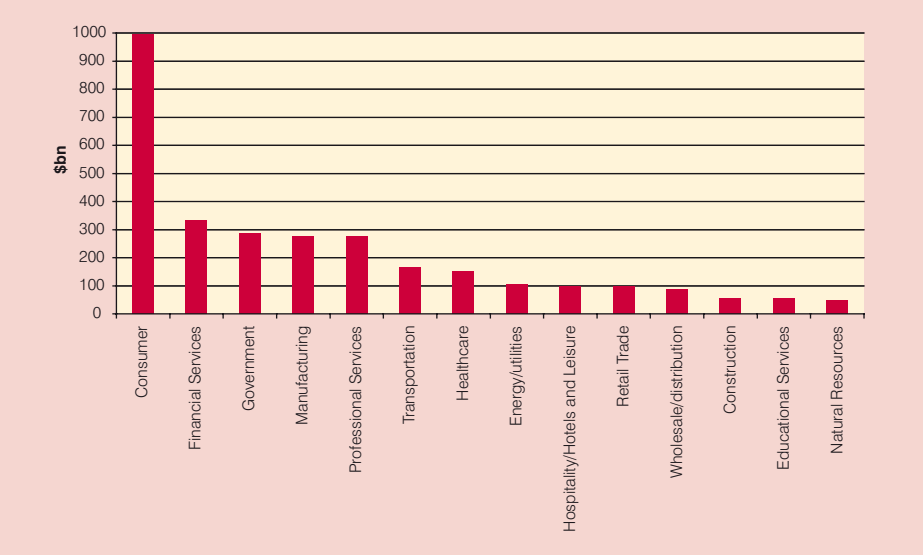
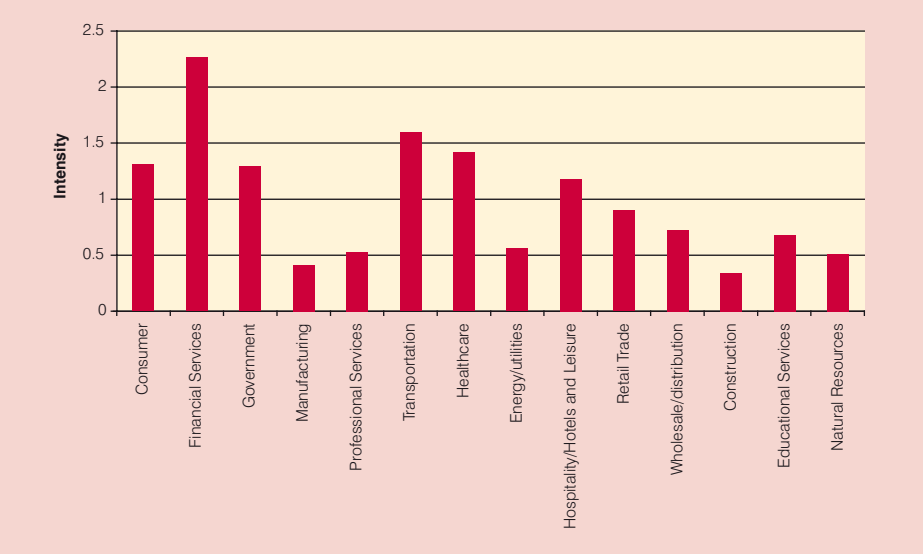


Figure 4 – Intensity of ICT spend in 2007, by sector



6 Figures for the Communications sector are also provided by the data source but these have been excluded here to focus on non-ICT sectors.

3. Industry overview

3.1. ICT value and supply chains

The value chains for information technology, communications, electronic components and content services are interlinked. Figure 5 (based on one provided in [11]) highlights the links that constitute the chains for IT and Services, and Communications.

A typical supply chain for proprietary software is shown in Figure 6. It is estimated that around 70% of software is supplied in this way [16]. In this case, a vendor invests heavily in software development followed by sales and marketing, and then recoups this through software licensing. In this model, the vendor typically receives the greatest share of revenue while the distributor receives the least. There are a number of stages to software or systems development itself, from requirements analysis to testing and maintenance. Though there are major global companies who cover all stages, there are also businesses dedicated to individual ones. Supporting functions include configuration and release management, procurement, documentation, consulting, project management, quality assurance and maintenance.

There is a range of alternative business models including open source, software-as-a-service and advertising revenue generation. In an open-source software model, developers do not recoup their investment via licence fees – consumers are free to re-distribute and amend the source code without paying. Businesses can make money in the open model, for example, by providing value-added services such as testing, certification, support and distribution or by licensing professional or enterprise versions of freely available ones. Currently, there are a number of so-called hybrid developers and resellers who provide both proprietary and open-source software. A benefit of open source is that it makes it easier for users to have software customised to their needs.

An alternative business model, expected to become more popular, is based on Software as a Service (SaaS). Here, end users do not license software when they install and run it on their own systems; instead they buy access to it on-demand over a network from where it is hosted. Employing SaaS reduces the software maintenance, operation and support costs borne by the user and makes it easier for the vendor to protect its intellectual property. Reliable and secure network connectivity is especially critical for this model.

Figure 5 – ICT value chains

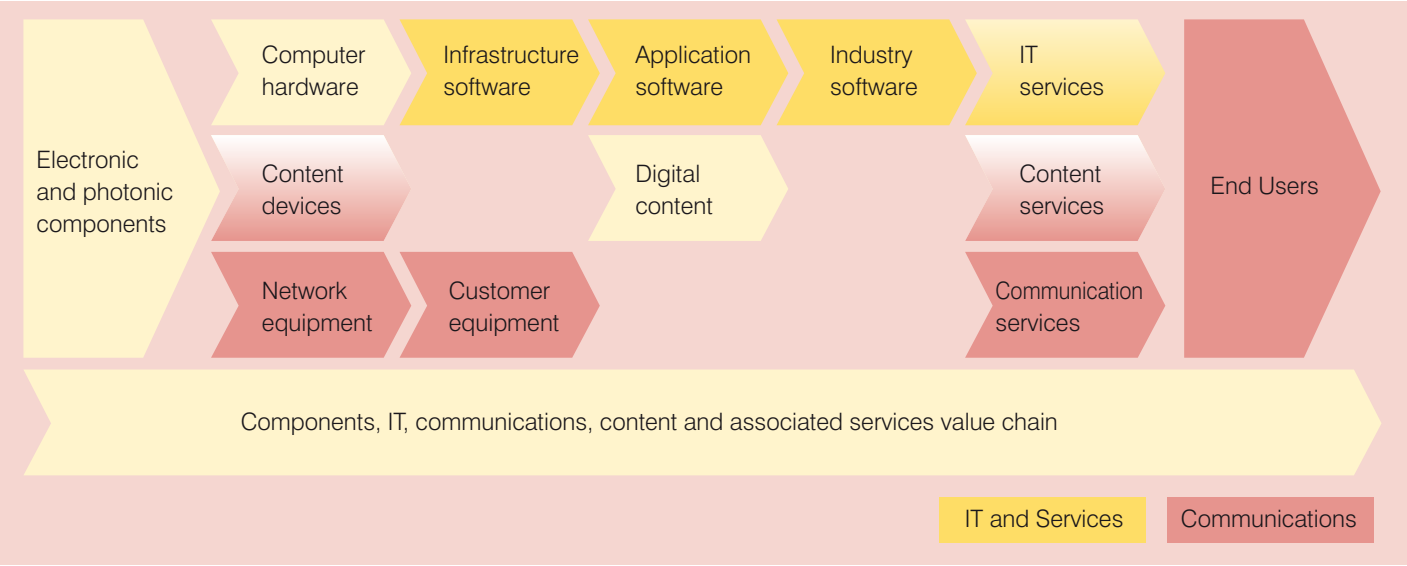


Figure 6 – Typical ICT supply chain

Continued innovation in business modelling is required to keep up with technology, data availability and user demand. A current example of this is dual-core processing. A dual-core machine can be thought of as two separate processors each requiring a license or a single conceptual processor requiring just one license. Additional wealth could be generated through the creation of new and effective business models and revenue centres.

3.2. Global ICT industry

Out of the ten largest software and services companies[7] generating sales figures ranging between $16-98bn, all but three are US-owned [18]. The US is currently the largest IT industry in the world with software revenues estimated at $427bn in 2006[8] and telecoms revenues at approximately $467bn[9] [18]. Out of the ten largest telecommunications companies, generating sales figures ranging between $28-118bn, two are US-owned while the others have headquarters in Spain, France, Japan, China, Italy, Mexico and the UK.

Two of the fastest growing software industries are those of India and China. In 2004-05, the Indian software industry reached $23.4bn in sales revenue while the Chinese industry reached $26.5bn [19]. Whereas the Indian industry is focused on software services (68% as opposed to 5% for products, and 27% for business process outsourcing), the Chinese industry is balanced more evenly between products and services. India is the world's leading exporter of software services though this is primarily at the lower end of the value chain, e.g. programming and maintenance. Although similar in size, the Chinese software industry has, in the past, been focused on the domestic market.

7 In terms of sales, profit, assets and market value.

8 North American Industry Classification System (NAICS) codes 5112, 518, 5415.

9 NAICS code 517.

Table 1 – ICT industry segmentation

ICT consultancy	ICT goods, manufacturing and repair
Software product design and development	Wholesale, trade and distribution
Solutions design and development	New media and e-commerce
Communications (including network design and convergent solutions)	Information assurance Information and broadcast services

In 2007, the European software industry achieved €22bn in revenues (up 6.6% since 2006) and €2.8bn in profits [20]. Recognised strengths of the EU include communications, web services and cognitive systems.

A recent survey of IT industry competitiveness conducted by the Economist Intelligence Unit (EIU) indicated that the most competitive IT industries in 2007 were US, Japan, South Korea, UK and Australia [17].

3.3. UK ICT industry

There were over 107,000 firms in the UK IT and Telecoms industry[10] in 2007, corresponding to approximately 5% of the UK's total industry [21]. The vast majority (93%) of these were computer services firms while the remainder were telecommunications firms. Micro enterprises (0-9 employees) account for 92% of these firms and, between them, the London and South East regions hosted approximately 43% of them. It is not currently possible to determine how the value added is distributed across business sizes. There are more than 1.4m ICT professionals in the UK across sectors [4]. There are a number of technology clusters in the UK which can tap into world-class research groups and successful ICT businesses. Three prominent ones are Silicon Fen, Silicon Glen and the M4 cluster. Global companies, wanting a UK footprint, can be found in such clusters.

10 SIC classes 64.2 and 72.0.

Out of the 32 companies in the Forbes 2000 categorised under Software and Services, two have headquarters in the UK though many more have presence here in terms of R&D and sales and marketing[11]. Out of the 67 in the Telecommunications Services category, three have headquarters in the UK.

The UK ICT industry is focused on providing solutions and services, undertaking activities such as: business consulting; business process design; change management; outsourcing (running IT systems and networks for other companies); systems design and development; application and web development; internet services; telecoms and network services; IT project management; systems integration; networking management; maintenance; and IT support [4].

The UK has strengths in a number of areas reliant on high-value knowledge such as (not exclusively) systems concepts (including requirements capture), software engineering (including software design, validation and verification), development of advanced 3G mobile products and services, interface design and intelligent systems. These capabilities are less easy to offshore to lower-cost economies than tasks such 'lower-level coding' that are not so dependent on know-how built up over

11 Note that there are some major software companies that have been listed as Technology Hardware and Equipment and are not counted here.

many years in the UK's research base. To ensure the Technology Strategy Board's resources are most effectively deployed, it is necessary to identify priorities for encouraging and facilitating ICT innovation in the UK in higher-value activities.

The DIUS R&D scoreboard [23] indicates that R&D active software and computer services companies in the UK are lagging behind the global average in terms of R&D spend according to growth and percentage of total R&D spend. The fixed and mobile telecommunications companies are ahead of the global average.

EIU's survey of industry competitiveness suggests that the UK has strengths in terms of its business environment, talent and IPR protection, and it has opportunities to improve its position through activity in the areas of ambition and Government procurement.

3.4. Realising potential

The software industry has low barriers to entry compared to other industries so intense competition is a key feature. Innovation is therefore vital to companies wishing to remain competitive, especially for SMEs that are most at threat from new entrants. Growth and competitiveness of the UK ICT industry and critically, the sectors it supports, depend on a healthy and sustainable ecosystem of ICT innovators and product and service suppliers. Most potential could be realised by focusing on the demand side – by encouraging users (government departments, businesses and consumers) to be less risk-averse with respect to the use of advanced ICT, more involved in innovation and more demanding in terms of the capabilities and quality of systems and services.

The Technology Strategy Board will do this by:

- working with businesses with low ICT-intensity to increase their appetite for high-value ICT innovation and its exploitation to increase their reach and capacity; and
- working with government departments and agencies to stimulate an appropriate level of, and approach to, ICT innovation and open systems (this could including the funding of technology development that might produce breakthrough capabilities, perhaps through competitions under the SBRI programme).

Closing the gap between users and suppliers will quicken the pace of innovation and make it possible for UK innovators and suppliers to understand, anticipate and react rapidly to changing user needs. The effect on the supply side would be profound – making it easier for innovations to make it into the market and easier for small and agile start-ups to get established, stay competitive and grow, thus changing the shape of the ICT innovation ecosystem. An increase in the number of profitable businesses would be seen, not just in the ICT industry but also across all economic sectors. Success will also lead to greater GVA per worker in sectors making more use of ICT.

4. Technology overview

4.1. Key challenge areas

The ICT space can be partitioned in a number of ways according to market and product/service type. Tables 2-5 introduce four major challenge areas which together draw on the broad ICT space, based on the opportunities identified in Section 1 and the markets highlighted in Section 2. These are more focused on user needs (irrespective of sector) rather than specific ICT industry segments. These tables lead to the assessment of these challenges with respect to UK capacity, timeliness and additionality in Section 5.

Table 2 – Data-driven systems

Name	Data-driven systems
Overview	Informed decision-making in complex and dynamic situations, such as disaster mitigation or transport management, relies on the availability of a wide range of data from heterogeneous and distributed sources in physical environments. The gathering, transmission and storage of this data underpin the ability to exploit it. Key markets for this may include disaster mitigation, aerospace and healthcare. The challenge here is to develop and deploy whole solutions from a range of components that gather data continuously and reliably in complex environments to serve demanding data needs.
Particular technology challenges include:	■ providing wired and/or wireless communications for ad hoc networking; ■ providing tools to allow manual and automatic configuration and optimisation of sensor networks according to changing data needs; ■ processing of data (e.g. filtering) on-board to reduce communications load; ■ optimisation of data transmission to minimise communications overhead and interference between sensors and to maximise reliability and resilience; ■ management and maintenance of data storage to afford access to the broad range of interested users; and ■ provision of meta-data such as source and likely provenance.
Example technologies and methodologies to address these challenges include:	sensor networking, digital communications, low-level signal processing, synthetic environments, computer vision, autonomic computing, optimisation, modelling and simulation, data storage, ad hoc networking and software-defined radio.

Table 3 – Intelligent systems

Name	Intelligent systems
Overview	In many applications, it is advantageous to automate reasoning and decision-making because the volume or complexity of the raw data make manual processing slow, onerous and difficult. ICT has a role to play retrieving, managing, analysing, interpreting and presenting information – generating valuable information from data. A simple example of this is the need to identify and characterise common patterns in events leading up to an environmental disaster in order to develop accurate early warning systems. Key markets for this may include transport, manufacturing and bioscience. The challenge here is to develop and widely exploit intelligent systems to maximise value.
Particular technology challenges include:	■ analysing huge volumes of structured and unstructured data in real- or near-real-time; ■ providing the ability to automatically and accurately extract new information and knowledge from existing databases and information repositories; ■ integrating data and information from multiple and distributed sources and databases; ■ tracking and analysing the provenance of information on which decisions are based; ■ designing systems to act autonomously and safely in dynamic environments (this may require a system to operate at a range of autonomy levels and to switch between them according to the task and the ability and workload of human operators) while maintaining appropriate levels of user involvement (e.g. to intervene in response to unanticipated events); ■ designing autonomic systems to reason about their own performance and to optimise themselves to maintain service levels within appropriate bounds; ■ designing flexible systems that are adaptable (user-configurable) and/or adaptive (self-configuring) for a given situation; ■ modelling, understanding and predicting the behaviour of intelligent and complex systems; and ■ developing tools and techniques for visualisation to aid extraction of meaning and value.
Example technologies and methodologies to address these challenges include:	data mining, machine learning, semantic web, autonomous systems, robotics, optimisation, modelling and simulation, natural language processing, image analysis, complex event processing, decision support, signal processing, algorithm development and data fusion.

Table 4 – User-centric systems

Name	User-centric systems
Overview	The user dimension is vitally important for effective exploitation of ICT. A single system will be used by a wide range of users each with different needs, preferences and skill levels. To ensure technology adoption and inclusion, there is a need to align ICT systems with these. A simple example of this is in e-health where health services are tailored to a patient's needs including preferred ways of interacting with computer interfaces given any disability or location. Key markets for this may include serious gaming, security and pervasive systems. The challenge here is to construct and exploit cross-disciplinary methodologies to ensure user-centricity by bringing to bear all necessary disciplines and to increase the understanding of the key issues affecting developers and end users.
Particular technology challenges include:	■ understanding user goals, values, intentions, decision-making processes, relationships and context in order to support the design and personalisation of systems; ■ supporting and encouraging social inclusion and interactions between people through the use of IT and connectivity; ■ taking into account human relationships and ways of working to design and implement systems that can fit in; ■ exploitation of pervasive systems to support assisted living; ■ enabling users to tailor systems to suit their needs and preferences (working within privacy and consent bounds); ■ designing system security measures for on-line working that fit with usability and accessibility criteria; ■ enabling users to understand and manage their digital footprints; ■ harnessing user innovation and creativity in the design and development of systems; and ■ overlaying real-world observations with digital information to enhance user experience.
Example technologies and methodologies to address these challenges include:	business process management, collaboration tools, social networking, synthetic environments, human factors, multi-modal human-computer interaction, user modelling, augmented reality, affective computing and visualisation.

Table 5 – Engineering of ICT systems

Name	Engineering of ICT systems
Overview	Many of the markets above cannot be addressed by a single application or sub-system. Engineering end-to-end ICT solutions that are fit-for-purpose is not merely a matter of combining appropriate software and hardware components. There are significant challenges to address in configuring systems with appropriate attributes such as security, multi-level resilience, quality-of-service and accessibility. Key markets for this may include communications, defence and education. The challenge here is to develop technologies and methodologies to allow rapid and inexpensive configuration and maintenance of complex, end-to-end systems. See the EPES strategy [10] for hardware-related aspects of this theme.
Particular technology challenges include:	■ allowing distributed and mobile users access to systems and components through a range of access points; ■ providing the flexibility to rapidly configure, manage and validate new large-scale systems that are fit-for-purpose and to add new software and electronic sub-systems and components at run-time; ■ ensuring quality-of-service in the face of changing conditions at all levels from the physical to the application layer; ■ assuring levels of security to mitigate threats from attack, intended or unintended, appropriate to a system's mode of use and privacy and consent conditions on data held; ■ incorporating the socio-technical perspective in system engineering (i.e. considering the user to be inside the system boundary); ■ achieving and maintaining levels of system dependability, multi-level resilience and trust concomitant with levels of user reliance on the system; ■ understanding and optimising infrastructures and networks to maximise utility and environmental sustainability; ■ developing software engineering technologies and techniques to exploit the capacity that new hardware offers; ■ establishing accounting, auditing and billing infrastructures to allow organisations, large and small, to develop and exploit systems; and ■ using open infrastructures and components to generate end-to-end systems.
Example technologies and methodologies to address these challenges include:	systems engineering, software engineering (from analysis of need through design and development to verification, validation and certification), utility computing, virtualisation, grid computing, web services, middleware development, standards design, parallel computing, service-oriented infrastructures, open systems, network security, biometrics, network science, green IT and cloud computing.

Figure 7 provides a conceptual view of these themes in relation to the infrastructure, system and component levels of ICT and to users and physical environments.

These challenges interface in many ways and it is therefore unlikely that any one initiative or project will fall neatly into any one of the four areas. For example, a robust end-to-end communications system will rely on engineering techniques and tools that account for interoperability of components and sub-systems, as well as requirements for qualities such as security and dependability that make it fit-for-purpose. Such systems may incorporate both intelligence (to support adaptive spectrum management) and user-centricity (to personalise services to the consumer). Within this ICT framework, any one technology may be used to address more than one of the challenges. This is not a concern because the aim is to stimulate innovation to address the identified challenges, not to further technologies in isolation.

Table 6 indicates the relevance (high/medium/low) of these challenge areas to the set of opportunities for ICT innovation highlighted in Section 1.

Figure 7 – Conceptual view of themes

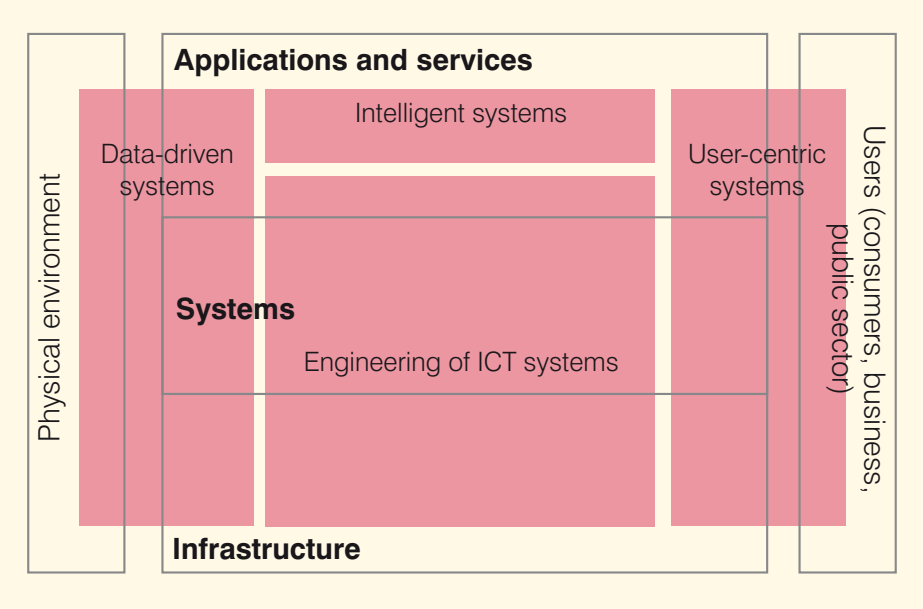


Table 6 – Opportunities and challenge areas

Opportunity	Challenge area			
	Data-driven systems	Intelligent systems	User-centric systems	Engineering of ICT systems
Increasing convergence	M	M	L	H
Increasing volumes of data and information	M	H	M	L
Increasing hardware capacities	M	L	L	H
Need for environmental sustainability	M	L	L	H
Inclusion	L	L	H	M
User innovation	L	L	H	L

Broadly covering the ICT space, the challenge areas apply across all markets and score highly against the Technology Strategy Board criterion for a global market opportunity. In Section 5, they are analysed in terms of the other three Technology Strategy Board criteria to identify specific priorities for action.

The range of technology challenges above can only be addressed effectively by bringing together technology providers and experts from a range of underpinning disciplines and end-uses. Disciplines required include mathematics (providing know-how for system modelling, algorithm development, optimisation, data analysis, etc.), computer science (for engineering complex and efficient computer systems), psychology (to understand human processes and behaviours), sociology (to understand dynamics of social interaction and culture), linguistics (to extract information from content expressed in natural language), electronic and electrical engineering (to integrate hardware and software components and sub-systems) , business process management (to integrate ICT into business processes for the desired business outcome) and law/ ethics (to understand responsibilities and implications of technology). The Technology Strategy Board will consider the contribution of the necessary disciplines when determining which activities and projects to invest in.

Mobile Network optimisation through advanced simulation

Network operators expend significant amounts of time, effort and money on manually tuning their networks to meet the needs of their customers. Given the expense involved, networks are currently tuned sub-optimally to an average loading scenario despite the major load variances that are experienced in practice.

A Collaborative R&D project, between Multiple Access Communications Ltd., Vodafone Group Services Ltd. and Nortel, has shown that it is possible to significantly improve the capacity of a network through the use of simulation and optimisation algorithms to automatically set the most effective parameters for given load level and to reduce the time and expertise needed for current manual processes. In hotspot scenarios, the capacity of a network can be increased by up to 80%. More advanced handover algorithms can increase the overall capacity of a network by 20% while improvements in the cell selection process can provide significant throughput benefits to users in the most disadvantaged locations within the network. The project has also established the feasibility of speeding up the optimisation process further by distributing it across a large-scale computing cluster.

In addition, the project team has contributed to the field by examining the effect that the deployment of small, self-installed domestic base stations, known as femtocells, will have on quality of service.

A large body of know-how has been, and is being, generated through investment by the RCs. Together, four RCs (EPSRC, AHRC, ESRC, and MRC) will be investing £120m in a multi-disciplinary research programme on the Digital Economy to ensure that the UK is at the forefront of ICT use, particularly in sectors in which the management and presentation of information has a significant impact, e.g. healthcare, transport and the creative industries. The result of this will be a large amount of know-how which could be exploited for commercial benefit. The Technology Strategy Board will work with the RCs involved to ensure that knowledge transfer and exploitation occur as effectively as possible across sectors.

4.2. Fit with KTAs, KAAs and Innovation Platforms

The underpinning nature of ICT means that it can be applied across sectors. Table 7 provides examples of the crossovers between ICT and the other key areas in which the Technology Strategy Board currently invests in innovation.

Table 7 – ICT crossovers with key areas

Key Technology Areas	Example areas of crossover
Advanced Materials	■ modelling to enable the prediction of property and lifecycle performance ■ wearable computing
Bioscience	■ bioinformatics for animal and plant genomics ■ systems biology for biotechnology
Electronics, Photonics and Electrical Systems	■ communications ■ embedded systems and their verification ■ parallel computing ■ robotics
High Value Manufacturing	■ condition monitoring and diagnosis ■ process control ■ adaptive production systems ■ networked production
Nanotechnology	■ nanocomputing ■ data processing and storage
Key Application Areas	
Built environment	■ modelling, prediction and design of sustainable urban environments
Creative Industries	■ personalisation ■ computer games ■ content authoring and services
Energy Supply and Generation	■ running and optimising monitoring and control systems ■ analysing interaction of wind turbines and radar ■ collaboration support between diverse pools of SME operators.
Environmental Sustainability	■ modelling and simulation of environments ■ collaborative virtual planning software environments
Emerging Technologies	■ radically new human-computer interfaces ■ quantum computing

Key Application Areas (continued)	Example areas of crossover
High Value Services	■ data transmission and networking ■ trading algorithms ■ complex event processing
Medicines and Healthcare	■ e-health ■ telemedicine ■ systems biology ■ image analysis
Transport	■ intelligent transport systems ■ automotive design
Innovation Platform	
Assisted Living	■ data-driven systems for data collection and sharing, intelligent systems for home-based intelligent processing ■ infrastructures and Interoperability for patient/care portal ■ user-centric systems for patient- and practitioner-centric systems
Intelligent Transport Systems and Services	■ transport network modelling and optimisation ■ information provision for road users
Low Carbon Vehicles	■ automotive design ■ impact modelling ■ fleet management
Low Impact Buildings	■ building management systems
Network Security	■ software vulnerability detection ■ network modelling

5. Assessment against Technology Strategy Board criteria

5.1. Data-driven systems

The UK has world-leading strengths in a number of areas under this theme including sensor technologies and devices, digital communications and systems integration. Ongoing R&D investments in the Wired and Wireless Intelligent Networked Systems (by EPSRC) and International Technology Alliance (by the UK Ministry of Defence and the US Department of Defense) programmes will continue ton develop these. The convergence of key expertise gives the UK a unique capability to develop a world lead in offering solutions. However, the supply chains for this technology area are currently not sufficient to supply commercial end-to-end solutions to meet data gathering requirements.

Supply chains are needed to provide a route to market for the know-how being generated in the science base and in industry, through the ongoing programmes described. The most value would be gained by acting promptly to ensure that these supply chains are in place at the right time.

The Technology Strategy Board has a role in investing in the knowledge transfer and collaborative R&D where appropriate to bring together links in the required supply chains. The Technology Strategy Board supports a number of KTNs active in this area.

Fit against criteria for investment	
Global Opportunity	High
UK Capacity	Medium
Timeliness & impact	High
Added value	High

5.2. Intelligent systems

There is world-class capability in certain industrial sectors (e.g. defence and finance) and academia (supported by EPSRC investment of over £47m in related research as well as funding an Inter-disciplinary Research Centre in Advanced Knowledge Technologies). There are both large and small software vendors who can develop and sell the technology. It is not clear how many micro-enterprises sit in this theme but, as little capital (other than knowledge) is generally required to develop intelligent systems components, it is an area in which they can be active alongside larger firms. The Technology Strategy Board has invested in collaborations between industry and academia in this area with a CR&D call in 2005 in the area of *Data and Content Storage Management, Retrieval and Analysis* which led to more than 55 organisations receiving over £7.5m worth of investment between them.

Although UK capacity is high, there remains a gap in adoption of intelligent systems technology between strategic adopters, such as defence and finance, and other sectors, including manufacturing and healthcare. Realising the value that could be created by its exploitation across sectors depends on encouraging awareness. An example of cross-fertilisation might be the transfer of knowledge in the area of modelling and simulation from the defence and computer games industries to manufacturing for product and process design. This would enable UK industry to maintain and increase competitiveness against up-and-coming industries abroad.

Knowledge transfer between disparate economic sectors is unlikely to happen in the short- to medium-term without public sector support. The Technology Strategy Board has a role to play in facilitating the required knowledge transfer.

Fit against criteria for investment	
Global Opportunity	High
UK Capacity	High
Timeliness & impact	High
Added value	High

5.3. User-centric systems

The science base in this area has been stimulated with significant investment by EPSRC and ESRC respectively in the EQUATOR Inter-Disciplinary Research Centre (which involved over 60 researchers from a range of disciplines) and the People @ The Centre of Communication and Information Technologies (PACCIT) research programme. Investment in the Defence sector, which is particularly strong in this area, has been made in programmes such as the Defence Technology Centre in Human Factors Integration and a Synthetic Environments Tower of Excellence [24]. UK research capacity has not been exploited across all sectors.

There is currently a need for user-centric and personalised ICT-enabled services to be developed and accepted in sectors such as e-Government and e-Health which will impact millions of users with differing needs and preferences. To develop and sell competitive systems, the UK should maintain a capability in this area.

The Technology Strategy Board can encourage knowledge transfer between disciplines and is well placed to encourage or invest in cross-sector initiatives to harness user innovation and technology evaluation.

Fit against criteria for investment	
Global Opportunity	High
UK Capacity	High
Timeliness & impact	High
Added value	High

5.4. Engineering of ICT systems

A lot of know-how has been gained in some areas of the private and government sectors and in academia (for example, through the e-Science Programme and an Inter-Disciplinary Research Centre in *Dependability of Computer-based Systems*). The UK has acknowledged strengths, in both industry and academia, in high-value capabilities, such as systems concepts, software design, communications networks and services, validation and verification, and security, which are vital for this theme and for competitiveness in the knowledge economy. However, in areas such as parallel computing and robotics, the communities concerned are fragmented so are not able to realise fully their potential. Collaboration between academia and industry has been supported by a CR&D call in April 2004 on *Inter-Enterprise Computing*, leading to more than 50 organisations receiving over £8.1m of grant between them. Wider collaboration within specific topics in this area has been supported by the Grid Computing Now! and Cyber Security KTNs.

Flexible and robust computing infrastructures are required to support ongoing e-Government and e-Health initiatives to improve and share services. There are currently significant opportunities to address concerns regarding large-scale systems and infrastructures including complexity, environmental sustainability, cyber security and capacity.

The Technology Strategy Board, with its partners, will seek to invest in knowledge transfer between the private and public sector and initiatives to develop open standards and business models, which are acceptable to users (from large to micro organisations), to encourage widespread exploitation of infrastructures and platforms.

Fit against criteria for investment	
Global Opportunity	High
UK Capacity	Medium
Timeliness & impact	High
Added value	High

6. Implementation

ICT has a key role in enabling other sectors in the UK to be more competitive and sustainable. There are many large global markets for ICT that represent significant opportunities for the UK including those in e-Government, healthcare, financial services, manufacturing, creative industries, construction and education. In addition, there are several opportunities for innovation to address increasing volumes of digital data, increasing convergence and complexity of ICT systems, advances in hardware capacity and the push for environmental sustainability.

The UK has many strengths in high-value ICT activities. However, the UK's competitiveness in the future against up-and-coming lower-wage economies cannot be assured without considered investment by business and Government.

The Technology Strategy Board will invest strategically to stimulate ICT demand and increased innovation by:

- working with businesses across sectors and investing in knowledge transfer activities around new ICT developments, innovation success stories and best practice, to ensure that businesses and users in general are fully aware of applicable ICTs and how they can be exploited to create wealth, thus increasing their appetite for ICT innovation and strategic adoption of advanced ICT;
- working with government departments and agencies to stimulate an appropriate level of, and approach to, ICT innovation and open systems to fulfil its needs (this could include competitions under the SBRI programme to bring to bear capabilities of a wider range of innovative businesses); and
- encouraging collaborative research and development between businesses and partners to overcome fragmentation in the ICT innovation ecosystem and to deliver high-value systems and services to market.

Closing the gap between users and suppliers will quicken the pace of innovation and make it possible for UK innovators and suppliers to understand, anticipate and react rapidly to changing user needs. The effect on the supply side would be profound – making it easier for innovations to make it into the market and easier for small and agile start-ups to get established, stay competitive and grow, thus changing the shape of the ICT innovation ecosystem. An increase in the number of profitable businesses would be seen, not just in the ICT industry but also across all economic sectors. Success will also lead to greater GVA per worker in sectors making more use of ICT and the recognition of the UK as a place where end-to-end ICT systems that are data-driven, intelligent, user-centric and fit-for-purpose can be developed and applied to create wealth. This would result in increases in exports and inward investment.

In addition to the main priorities above, the Technology Strategy Board will:

- ensure the full exploitation of ICT in addressing major societal challenges through all innovation platforms;
- engage with the EU's research and development policy-makers to ensure that UK business capacity can be complemented and increased through greater collaboration with other member states, particularly on issues such as standards and infrastructures;
- survey existing facilities for user innovation and technology evaluation, encourage businesses (particularly those without the necessary infrastructure in-house) to exploit them more widely in order to improve the acceptance and quality of their products and services, and work with partners such as EPSRC, ESRC and the RDAs to plug gaps in provision where necessary;
- work with the RCs to increase knowledge transfer between academia and industry to:
  - ensure that academia is aware of the issues faced by industry on a day-to-day basis (e.g. security, interoperability, scalability, user acceptance and monetisation) and that industry is aware of the latest technological developments; and
  - meet the need for highly skilled and commercially-aware ICT innovators;
- explore ways to ensure that the software community is in step with hardware developments to allow the UK to exploit these as fully as possible, including joint ICT-EPES knowledge transfer and collaborative research and development activities involving both communities; and
- determine the part it can play with regards to growing demand for professionals and users with high-level ICT skills in all sectors and the predicted shortfall in the supply of the required research and exploitation skills, which may severely hinder innovation and competitiveness, by working with e-skills UK, professional societies, the RCs, DIUS and the Department for Children, Schools and Families.

Appendix 1 – Glossary

AHRC	Academic & Humanities Research Council
BERR	Department for Business Enterprise & Regulatory Reform
CR&D	Collaborative Research and Development
DA	Devolved Administration
DIUS	Department for Innovation Universities and Skills
DTI	Department for Trade and Industry (now BERR or DIUS)
EPES	Electronics, Photonics & Electrical Systems
EPSRC	Engineering & Physical Sciences Research Council
ESRC	Economic and Social Research Council
GVA	Gross Value Added
ICT	Information & Communications Technology
IPR	Intellectual Property Rights
KAA	Key Application Area
KTA	Key Technology Area
KTN	Knowledge Transfer Network
KTP	Knowledge Transfer Partnership
MRC	Medical Research Council
OGC	Office of Government Commerce
PACCIT	People @ The Centre Of Communication And Information Technologies
R&D	Research and Development
RC	Research Council
RDA	Regional Development Agency
SaaS	Software as a Service
SBRI	Small Business Research Initiative
SME	Small and Medium Size Enterprise
UKTI	UK Trade and Investment

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