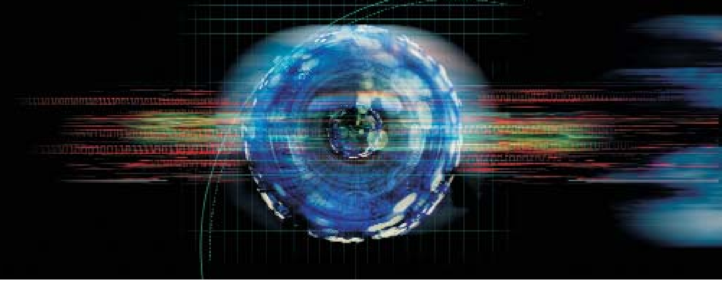
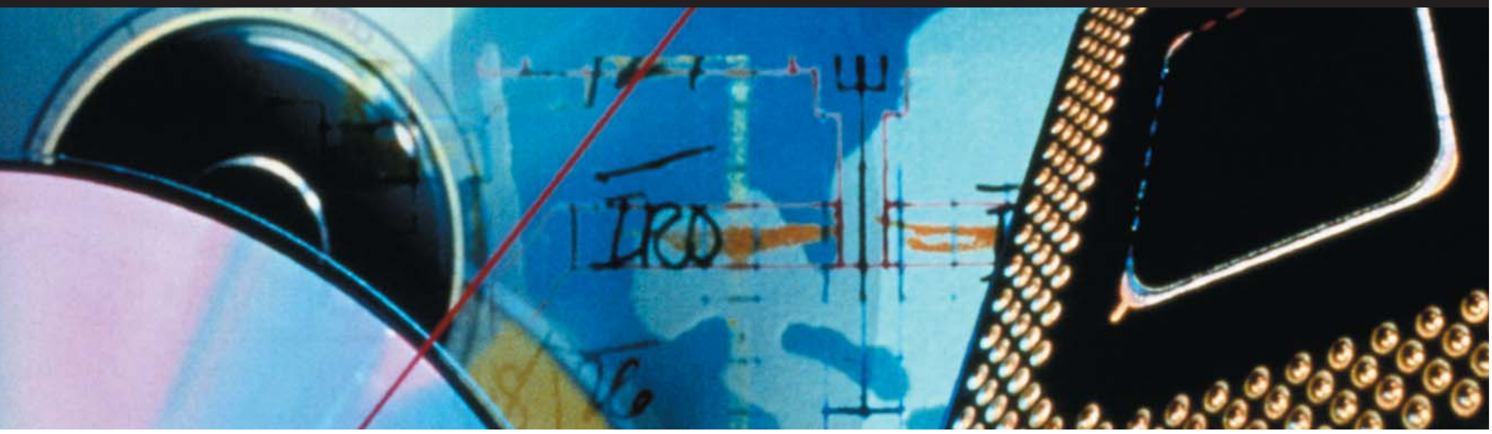


Information and Communication Technologies



The importance of ICT to the overall economy cannot be overestimated; as an example, a quarter of GDP growth within the EU and 40% of productivity growth can be ascribed to ICT. Alongside this, differences in economic performance between industrialised nations are largely explained by those countries' level of ICT investment, research and use. For this research, an overarching view of ICT was taken – defining it as a means of handling the new currencies of advanced economies, namely data and information. How these are handled by ICT gives us six topics to consider within our ICT strategy.

Pervasive systems offer an environment in which billions of pre-programmed or intelligent devices are networked to surround us. In the longer term these interactive devices will disappear and lead to 'attentive computing', in which user interaction is through natural language, gestures or body language.

Key developments in **telecommunications** lie in access and core network systems and the services and content that follow. The challenges include: disintegration, where different economic drivers in the industry cause pressure to separate, convergence of ICT, and fixed, mobile and broadcast technologies, globalisation of the internet and competition from the Far East, and transformational technologies, including ultra-wideband, ad hoc/mesh networks, software radio, all IP networks, Voice over IP, and pervasive ICT.

Inter-enterprise computing is an evolution of distributed computing, providing access to networked resources that are geographically independent in a virtual environment. A key goal will be to allow the creation of new competitive software services

Intelligent systems encompasses techniques such as learning algorithms, adaptive and associative systems. Areas of natural computing include neural computing, evolutionary computing or genetic algorithms and neuro-fuzzy systems. Also relevant here are intelligent agents, knowledge discovery and representation techniques.

The **modelling and simulation** of physical, chemical and biological systems is used to support, reduce and – increasingly – to replace experimentation in engineering. Simulation is especially beneficial when the product development cycle is costly and lengthy, such as in the aerospace and automotive industries. But it is no less relevant in modelling logistics and traffic flows, financial modelling, simulation as part of the computer games and ‘serious’ games industries and in architecture – all part of the UK’s burgeoning knowledge based economy.

End-to-end **information security** solutions must be considered holistically, including all supporting network and physical security measures, such as identity management methodologies and biometric techniques. There are also soft issues surrounding the human/digital interface, underpinning processes and controls, ongoing management and business continuity strategies. These are being developed through the ICT Network Security Innovation Platform.

UK CAPABILITY

Thanks to strong academic research and the existence of highly innovative software and communications companies, the UK has developed a powerful capability in these emerging areas of ICT. Many multinationals have located in the UK because of the innovative talent, particularly around clusters of activity such as Cambridge, Bristol, Manchester and in London and the South East. These clusters feed off a range of important sectors, such as pharmaceuticals, healthcare, aerospace, financial services, retailing, telecoms services, computer games, TV and broadcasting, not to mention the research base itself, all of which have a global capability. It is the synergies between the leading edge research, supplier and user base which underpins the UK capability.

GLOBAL MARKET OPPORTUNITY

To estimate the importance of this market simply in terms of global sales of software and telecoms services would be to underestimate it considerably. All the high value sectors mentioned above rely on the ability to collect, transmit, present, analyse and interpret data. It is early access to, commitment to invest in, and understanding of how best to utilise the latest technologies which will continue to play such an important role in the international competitiveness of all our high value sectors in the years to come.

PRIORITIES FOR ACTION

Our analysis and consultation with industry has indicated three broad priorities for action:

- Developing the technologies above in a way which engages the research, supplier and user communities. We will seek to achieve this in a way which is more challenge or market oriented than hitherto.

- Improving the flow of knowledge about developments, capabilities and market opportunities among the clusters of hi-tech SMEs. The establishment of a Telecoms Knowledge Transfer Network (KTN) to bring together existing networks and initiatives and of a KTN in pervasive systems with a similar remit will ensure the development of sustainable platforms and applications. The recently-established Cyber Security KTN will help address the key barriers to the wider adoption of a range of technologies and techniques that will be key in ensuring trust and confidence in ICT. The Industrial Mathematics KTN must engage further with UK enterprises to exploit the opportunities modelling and simulation provide. Through these KTNs the UK ICT community will also gain a greater contribution to the development of standards in non-traditional settings, such as IEEE, ETSI and W3C.

- Ensuring that the UK’s capability in the area of ICT developments and their innovative application is appreciated globally so knowledge based firms, suppliers and users are attracted to the UK as a truly innovative location, regardless of sector.

PERVASIVE SYSTEMS

INTRODUCTION

The term pervasive systems is used here to mean an environment with billions of intelligent or pre-programmed devices in a networked environment, providing people with services and information when, where and how they need it. Other terms used to describe this future include ambient intelligence, transparent computing and ubiquitous computing.

The devices could be as small as a few square millimetres, operate independently of any user and may be parts of small sensors or be embedded in any type of physical object, from white-goods and traditional 'electronic' goods to bus-shelters and walls. Interaction will be through next-generation PDAs, third and fourth generation mobile phones, set-top boxes, digital TV, clothing and doubtlessly a variety of other human-oriented methods as yet unforeseen.

In the longer term these interaction-devices will disappear and we will move into an 'attentive computing' environment in which user-interaction with devices will be through natural-language, gesture and body-language and in which the networked, intelligent, adaptive, context-aware devices will be able to pool their data and information to predict user needs and either deal with them 'invisibly' or be prepared for the possible user choices.

Attentive computing will operate in a highly networked space. These networks will need to be able to deal with a wide range of devices that could move from one connectivity regime to another while carrying out a task. The network will need to be self-configuring, -monitoring and -repairing.

Louis V Gerstner, Jr of IBM said: 'Picture a day when a billion people will interact with a million e-businesses via a trillion interconnected, intelligent devices. 'Pervasive systems' does not just mean computers everywhere; it means 'computers, networks, applications, and services everywhere.'

The high-added value pervasive systems are characterised by:

Always on – availability of the right content at the right place and time.
User-centric solutions – simple and practical person-oriented solutions.
Invisibility – numerous, casually accessible, often invisible computing devices.
Intelligence – removing the cognitive load through devices with embedded sensing and processing capabilities.
Increasing productivity – market value propositions: saving time, saving money.
Life-enhancing – penetration of technology into mainstream mass market applications.
Innovation – using technology in ways that empower people to work, live, and play in radically new ways.
Omnipresent – embedded into everyday devices and objects all around.
Ubiquity – everyone and everything connected to an increasingly ubiquitous network structure.

UK CAPACITY TO DEVELOP AND EXPLOIT THE TECHNOLOGY

Major companies such as IBM, BT, QinetiQ, HP and Microsoft make significant investments in this area. Microsoft with its recently announced social-digital laboratory at Cambridge is consolidating their commitment. The UK also has many innovative SMEs that need to find ways to engage with these larger players. Digital technology for an ageing society is seen as vital for independent living and organisations such as the Codeworks Assisted Technology Lab are technology leaders in this area.

The UK has world-class research base institutions at Imperial College, Glasgow, Nottingham, Lancaster, Southampton, Cambridge, Loughborough and Edinburgh, among others. The Economic and Social Research Council (ESRC) and the Engineering and Physical Sciences Research Council (EPSRC) have supported and continue to support research in to this area such as intelligent agents, self-networks, human-system interaction and nodes and motes. Pervasive computing is one of the six UK Computing Research Committee Grand Challenges.

The Institution of Electrical Engineers and the British Computer Society have special interest groups relevant to this area. Through the BCS, IEE, etc the UK is well placed to develop the technical and design standards that will be important in achieving acceptable levels of usability.

THE SIZE OF THE GLOBAL MARKET OPPORTUNITY

There are many estimates of the size of the pervasive computing market in forthcoming years: by 2007 there will be a $500 billion market for pervasive computing (IBM), by 2010 there will be a $700 billion market for value-added wireless applications and services (Harbor Research). According to Japan's General Affairs Ministry, Japan's pervasive computing market will grow to over $760 billion by the year 2010. McKinsey & Co predicts that machine-to-machine (M2M) communication of the type featuring in pervasive systems will be a $100 billion-a-year business by 2010.

Currently Japan is pursuing a person-centric pervasive computing strategy under the U-Japan banner (ubiquitous, universal, user-oriented, unique). Figures for the combined direct and indirect economic impact of the U-Japan programme are of the order of hundreds of trillions of yen by 2010.

Estimates of market size often vary as a result of differences in definition: for example sometimes the manufacture of devices is included, sometimes not. One way of capturing the size of the opportunity is through estimates of numbers of devices and users.

By 2010 there will be:

- 35 billion devices connected to the internet (IDC), the majority of which will be simple sensors, but there will be between 1.5 billion (Harbor Research) and 2 billion (Focalpoint) ‘smart' devices.
- 1,000 microprocessors per person (IDC), some 500 billion microprocessors (Focalpoint).

Areas of economic and social activity that will be affected by pervasive systems include:

business (planning systems, monitoring systems); consumer (game systems, consumer electronics, user-created content), creative/media (targeted content, social authoring); environmental (monitoring, deciding, acting); facilities (office equipment, HVAC, access control); healthcare (telecare, medical devices), home (white goods/appliances, virtual brown goods); industrial (automation and control equipment, capital equipment); power (meters, distributed generators, electricity grid and pipelines); retail (SCM, scanners and registers, lighting and refrigeration systems); and transportation (vehicles, aeroplanes, and intermodal transport).

POTENTIAL FOR IMPACT AND TIMESCALE

Pervasive systems present an enormous range of challenges, from the technical (interoperability, scalability, security for resource-constrained devices), to the business (integration of the information provided by pervasive computing systems and services into existing business models). To take pervasive systems of the scale foreseen through the research stage into genuine applications will require the bringing together of a wide range of players with an equally wide range of interests.

Some of the technical challenges will need to be addressed by collaborative R&D projects that integrate the expertise in the SET base with wider industry, including device manufacturers, infrastructure providers, network operators, service providers and content providers and aggregators. However many players e.g. SMEs, business areas that carry out less R&D than is ideal will not have the resources (intellectual or financial) they can risk on projects exploring new business models combining non-traditional consortia without support – this may come from DTI however the RDAs and DAs will have a key role. To some extent this is reflected in the industrial partners involved in the Next Wave Technologies and Markets programme of R&D supported by DTI: as well as IBM, Telewest and Orange, partners included M&S, Severn Trent Water, Tesco, TAHI and the Royal National Institute for the Blind.

The Next Wave and other activities have addressed some of the technical challenges around the development and deployment of these systems. However many of the demonstrators have been with comparatively few nodes in a small number of deployments. The UK will need a ca 1 million node pervasive system in place, to act as the cornerstone of future work in this space if it is to capitalise on its research excellence to exploit a globalised opportunity.

The types of challenge such a system could explore would include: client devices; access and core network infrastructure; service invocation and brokerage; user interfaces; storage management; security and subscriber ID; data synchronisation; device management; quality of service optimisation and integrity assurance; content/application authoring and integration tools; content adaptation tools; personalisation tools and engines; context management frameworks; billing systems; subscriber management systems; service monitoring tools; usage analysis tools; and service integration platforms.

Give the pan-business scope of pervasive systems, any activities that are to reach the full range of potentially interested players will require a networked approach. A Knowledge Transfer Network (KTN) in pervasive systems, tasked with both drawing on existing relevant KTN work being undertaken in more sector-oriented KTNs and on bringing together existing networks (e.g. Interface, UbiNet, PLAN), would therefore be an early priority.

Recommendations

- By 2010 the Technology Programme, with other stakeholders, should deploy a 1 million node platform that will allow projects run on it to address the issues of building and operating pervasive systems. The platform should be used to underpin future research on such systems.
- Over the 3-5 year period the focus should be on collaborative R&D focused on interoperability of pervasive systems and on larger-scale user-trials/demonstrators using hundreds or thousands of nodes that will provide information on the scalability, robustness and the confidence that can be placed in such systems.
- A challenge be developed around a concept like ‘Living and learning in a pervasive world’ as a focus for R&D and demonstrators.
- A pervasive computing KTN be established to draw together the disparate information, standards, technology and application information required relevant to the field and to disseminate the appropriate information to UK industry directly and via other KTNs.

TELECOMMUNICATIONS

INTRODUCTION

Digital communications (telecommunications) is the underpinning technology that will support innovation in: e-health, intelligent transport, e-commerce, e-government, e-learning and remote access to all such services. It also underpins the digital content sector.

Key technology developments are in access and core network systems and the services and content that follow. The drivers of change include: disintegration, where different economic drivers in the industry causes pressure to separate, convergence of ICT, and fixed, mobile and broadcast technologies, globalisation of the internet and competition from the Far East e.g. China, and transformational technologies, including ultra-wideband (UWB), ad-hoc/mesh networks, software radio, all IP networks, voice over IP, and pervasive ICT.

A fundamental issue for the UK is the fragmented R&D scientific community and government support for R&D. Around £70 million of civilian government support is presently going towards digital communications research from DTI, the Engineering and Physical Sciences Research Council (EPSRC), the RDAs and devolved administrations, Ofcom etc. The technology also has an intimate circular relationship with regulation, particularly in the technical regulation of radio spectrum.

UK CAPACITY TO DEVELOP AND EXPLOIT THE TECHNOLOGY

The UK has leading edge communications research, world-class operators, is a preferred location for many inward investors and has hundreds (maybe thousands) of SMEs dependent on the technology. It also has a number of research initiatives and networks, both national e.g. Mobile Virtual Centre of Excellence (VCE) and the Communications Research Network (CRN) from the Cambridge-MIT Institute, and regional.

Despite severe cut backs, following the dot com boom and bust, the UK industry base remains significant e.g. members of the Mobile VCE include: BT, BBC, France Telecom R&D, Vodafone, LG Electronics, NEC, Nokia, Samsung, Siemens, and from a fixed network background the successful bidders to the BT21CN with a UK base include Fujitsu, Huawei, Alcatel, Cisco, Siemens, Lucent, and Ericsson (Marconi).

An assessment of the work of the seven Mobile VCE Universities described it as ‘internationally leading‘ and ‘outstanding’. Other five-star departments and leading institutions include Cambridge, Lancaster, Imperial, UCL. New initiatives include the £30 million Swansea University Institute of Advanced Telecommunications.

THE SIZE OF THE GLOBAL MARKET OPPORTUNITY

In terms of value added, communications services dwarf the contribution of the communications equipment sector accounting for more than £25 billion of the total £27 billion of value added in the sector. This is a change from the situation in 2000 when equipment manufacture accounted for more that 20% of the gross value added (GVA). Table 1 shows how communications services and equipment have fared in 1995, 2000 and 2003. Innovation in the communications industry is fundamental to many areas of UK industry and commerce. The quality of research in the UK

	Telecommunications Services (SIC 64.2)			**Communications Equipment (SIC 32.2/.3)**		
	1995	**2000**	**2003**	**1995**	**2000**	**2003**
Turnover (£M)	20,725	41,640	57,576	9,956	20,314	9,449
GVA (£)	11,065	19,395	25,463	2,998	5,182	2,046
Number of Firms	N/A	6,631	7,698	N/A	2,063	1,773
Employment (000s)	N/A	232	242	N/A	94	54
R&D/GVA (%)	4%	3.5%	2.6%	20%	20%	46%
Exports (£m)	N/A	N/A	N/A	6,236	12,062	8,843
Trade Balance (£m)	N/A	N/A	N/A	185	-1,859	-5,583

Table 1: UK industry indicators, Communications industries[1] [Source: OVUM]

attracts multinational R&D spend and needs to be sustained. According to the EPSRC 'The UK is the business centre of Europe for the world's leading telecommunications companies and has the most competitive environment in Europe for all telecommunication products and services. The combination of leading edge technology, deregulation and general business environment has attracted all the major telecoms operators, service providers and manufacturers. As well as being the biggest global network operation, with an innovative value-added sector, the UK is also a world-leading centre of excellence for research and development.'[2].

The UK is very strong in wireless service provisioning, and innovative in regulation (in terms of spectrum trading and re-use). It is less strong in volume manufacturing of wireless technologies and products – areas dominated by the major vendors situated abroad.

The UK communications industry, (fixed and mobile voice networks, data networks, the internet and broadcast infrastructure, and their associated end-user services), underpins the UK's media and content services industry. The UK communications industry had £67 billion turnover, a GVA of over £27 billion and invested £1.6 billion in R&D in 2003.

The continual increase in demand for mobile communications has contributed significantly to the welfare of the UK economy. The sector employs around 164,000 people in the UK directly and indirectly. In 2000 over £22 billion in licence fees was raised and the contribution to UK GDP was some £5.3 billion annually and £1.3 billion in tax revenue.[3]

Globally, corporate R&D in telecoms has been in decline for some time now. In 2000 Ericsson, Lucent, Motorola and Nortel spent $20 billion on R&D. By 2004, these four had cut spending to just $9 billion. This type of decline is duplicated across the telecoms manufacturing companies across the globe. Figure 1 shows how despite a poor performance in equipment manufacture, the UK is much better represented as a centre of operator R&D.

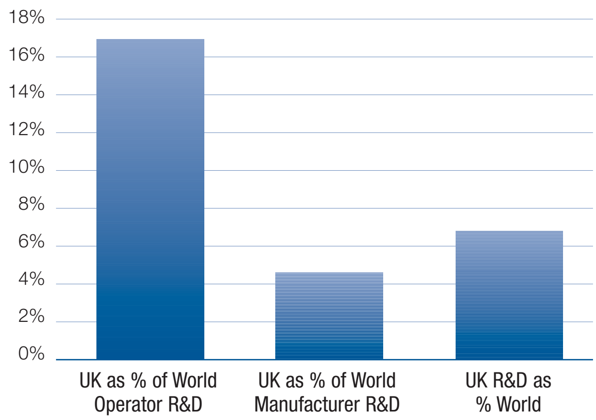


Figure 1: UK share of world telecomms R&D

Source: OECD Communications Outlook 2005, Communications Research Network 2005

In recent years there have been Global Watch Missions led by the Mobile VCE to Japan, China and South Korea. There has also been a recent mission to the USA on WiMax.

POTENTIAL FOR IMPACT AND TIMESCALE

Given the diversity of interest and use of digital communications, an early priority should be to establish a Knowledge Transfer Network (KTN). The KTN could spin out from the Mobile VCE and the CRN (Cambridge MIT) and act as a focal point for road mapping and technology translation through working groups, supporting telecommunications technology requirements in areas such as spectrum policy, cyber-security, intelligent transport and telecare, and addressing the barriers to innovation in telecommunications. It would be closely linked to regional activities as well as standards and regulatory work.

The UK should focus its efforts on developing R&D at the higher levels of the communications stack where the most value is being created. This would involve better exploitation of the existing underpinning research capability and new areas of research identified to address the main technological challenges in this area.

References

1 These figures for services represent SIC Code 64.2: Telecommunications. For equipment, they represent SIC Codes 32.3 and 32.4: Manufacture of television and radio transmitters and apparatus for line telephony and telegraphy, and Manufacture of radio receivers, sound and video recording or reproducing apparatus and associated goods. R&D expenditure based on ONS Report MA14

2 EPSRC Sector Report: Software, Media and Communications

3 Intellect

INTER-ENTERPRISE COMPUTING FUTURES

INTRODUCTION

Inter-enterprise computing (IEC) is an evolution of distributed computing, providing dynamic resources that are geographically independent in a virtual environment. By necessity, the systems are built around standards, and use the internet or intranet as the backbone. The goal of technologies supporting IEC is to improve the agility and responsiveness of industry to accelerate the time-to-market, to respond better to changing business demands and to create new competitive services. Further desired goals are to develop superior decision making support and provide a better level of service, with quality assurance and robustness, and to reduce costs of both capital and support costs.

An IEC system is a set of independent resources combined through a unified software system and networking technologies. To enable robust and secure capabilities there must be a provision for dynamic change of the independent resources including the network connection – there is a requirement for sophisticated diagnostics and self-healing capabilities. Given that the resources are independent, then multiple groups may have authority over the individual components. Inter-enterprise computing provides three capabilities:

- To develop virtual organisations enabling collaboration and creating new organisation structures.
- To enable smaller companies access to large-scale resources by allowing shared resources.
- To provide new business models including outsourcing of computing tasks, utility computing, support for peak load usage and catastrophe planning, as well to provide a new model for service provision.

At the present time most industry compute systems are created by 'hardwiring' the components together to provide a system that meets a specific need. Whilst this might meet the immediate need, as the requirements of the business evolve, re-configuring or upgrading the system may prove difficult and costly. Re-configuration costs may constrain how a company or industry can respond and adapt to changing product requirements and technologies.

There are two evolving technologies that are underpinning the developments of Inter-Enterprise computing, web-services and virtualisation technologies and, together with autonomic technologies, they provide the building blocks required to develop robust, secure, dynamic inter-enterprise systems.

Inter-enterprise computing Distributed resources – co-ordinated, scheduled, metred		
Virtualisation	Web services	Autonomic
Logical view of physical entities. Compute and data	Open standards Service description, discovery and interaction	Self healing Self-configuring Self-optimising Self-protecting

Web services define a set of standards that provide an implementation-independent mechanism through which collaborative applications can interact. They prescribe methods of describing, publishing, discovering, composing and allocating a wide variety of services. The standards are at varying levels of maturity and in some cases competing standards exist. 'Virtualisation' removes the complexity of many disparate resources and interfaces by creating software or hardware partitions which enable applications and services to be isolated from the underlying hardware by offering a single secure operational area. Virtualisation is of growing importance not only on the compute infrastructure but also the storage area networks (SANs) . Autonomic technologies provide the reactive self-healing, adaptivity, such a system must have – keeping track of the devices, networks, and resources which at any point in time define it. These technologies increase in importance as the complexity of the systems increases. Many of the issues here are research topics and there is a need to align research activities with industry need.

Drivers of change

There are many potential drivers for IEC, and arguably, the ever growing importance of existence of data is the most compelling. Data from sensors, simulations, experimentation, customer data, together with other sources such as radio frequency identity (RFID) tags and GPS, provide a rich environment for knowledge creation. An example of this might be the use of RFIDs in car manufacture to identify components of the car, where they were created, the life-cycle management (given that the components may have a very long life cycle), maintenance of the tag information on database, resilience – possibly multiple tags for a single component together with the long-term management and security of that – as well as combining this information with other sensing devices in an effective manner. Another example is that of the redesign of the M25 and the traffic flow on it, where there is a need to integrate real-time data with simulation to design and optimise on ramp access rates and flow.

UK CAPACITY TO DEVELOP AND EXPLOIT THE TECHNOLOGY

Starting in April 2001, the Office of Science and Technology (OST) invested approximately £230 million towards a five-year e-Science programme. As part of that programme the Research Councils together with DTI invested together in the Core Programme to develop infrastructure and support for collaborative science projects. The Core Programme supported a portfolio of around 50 projects with 83 collaborating groups from 61 companies in the UK. The technology vendors, IBM, SUN, BT, SGI, HP and Oracle all contributed to multiple projects with the first three investing more than £1 million each. Matching contributions from industry for collaborative projects in the programme as a whole amounted to around £30 million and covered a wide range of industries including pharmaceutical and life sciences, engineering and manufacturing, healthcare, environment and energy, as well as the IT companies. This programme laid the foundation for further industry developments and exploitation of inter-enterprise computing in areas such as digital content. There has also been significant involvement from UK academia and industry in the EU programmes and other international activities such as standards development. The UK has been seen to be the international lead and as technologies mature and the awareness of the capabilities raised then UK industry is very well positioned to exploit and develop capabilities in new areas as well as strengthen the capabilities in existing areas.

The challenge is to leverage the UK lead in IEC and exploit this in the market. It is important to engage with SMEs, to transfer the knowledge, and to build new collaborations. In order to succeed, it will be necessary to address the legal and social issues relating to shared data, to give confidence in IEC security, to enable personalisation of services and to create appropriate tools to provide effective management of distributed services.

SIZE OF THE GLOBAL MARKET OPPORTUNITY

ICT is increasingly a driver in the many areas of the global economy, impacting aspects from technological fields such as biotechnology, or material sciences as well as increasing the speed of processes in economic markets. Knowledge management within companies and markets is growing in importance and playing a key role in creating competitive leads. In such an ICT driven economy, it is not only the technical dimension to ICT that needs to be considered, but also the social dimensions which must be recognised – in education, health, labour markets and elsewhere. As access to information and knowledge is redefined and remodelled by ICT then it is an individual's capability to utilise ICT that determines the ability of the individual to derive benefits from public services and to operate effectively in society, and these benefits need to be understood in terms of outcomes.

Analysts believe that the IEC market will become an increasing fraction of the world-wide IT market. Companies will use IEC technology to address more and more activities. The budget for development and exploitation is likely to double every year over coming years (starting at an estimated £400 million in 2005).

Based on recent IDC surveys, many industrial sites are using inter-enterprise technologies today for part of their workloads. At this point in time the usage has been largely in technical workloads but are moving to other commercial activities. However, security issues mean that the implementations are often only within internal firewalls or across specific secure network solutions. IDC indicate that in 2004 the usage was beginning to grow from a small base, led by manufacturing and government sectors and a strong technical computing use within universities. They anticipate that by 2007 the use of these technologies in manufacturing will reach over $3.5 billion and in financial services close to $1.5 billion of shared compute resources. They also anticipate a compound annual growth rate (CAGR) in related software of 37.3% from 2003 to 2008 and a growth in revenues from IEC technical services of 36.5% and anticipated a total grid market of $13 billion by 2006.

A recent report by the Insight Research Corporation[1] provides further forecasts. They suggest that whereas in 2006 of the total ICT worldwide market value of $1,017.7bilion, only $1.84 billion is in IEC (GRID computing), in 2010 that will have increased to $19.28billion of $1,284.8 billion. They suggest the highest growth rates will be in wholesale trading and transportation.

POTENTIAL FOR IMPACT AND TIMESCALE

As indicated in the 'Unlocking the Grid' report of the Information Age Partnership, the value in investment in inter-enterprise computing for the UK is at the high-level services, where the IP is at the highest. This naturally requires involvement of technology developers but is driven by a market need or potential new service model. In order to meet the requirements of industrial and commercial applications in the three underlying technology areas in the diagram shown above, further developments will be required which include:

- Security: although virtualisation offers some novel security options on the individual systems, the security in web services and communications and between applications still leaves concerns for high-risk applications.
- Real-time data integration: as the number of applications with real-time data inputs increases – from applications with RFIDs, to sensor input data such as traffic data, there is a need to develop tools and systems to make the data accessible, analysable and curatable.
- Personalisation: as more and more of the social as well as industrial services are delivered through ICT solutions, the desire for personalised solutions increases – this applies as much to banking systems as to healthcare systems.
- Legal and social implications: there needs to be new understanding on how to develop trust across virtual organisations and between enterprises.
- Management tools: all three underlying technologies have open questions regarding management of systems – virtualisation whilst bringing great benefits also negates many system management and audit tools – similarly the deployment and maintenance of applications across a web service environment or within an autonomic computing environment are complex and difficult issues to address.
- Accounting: a type of 'IEC currency' will be required in order to create an IEC market and in order to optimise the overall distributed application. There is still much to be understood about the appropriate economic models for IEC systems.

All of these applications will be dependent upon semantic representation of the resources, the services and their components. Without ontologies, semantics and mark-up languages there will be no mechanisms on which to base any of the manageability of IEC.

Recommendations

This area is considered to be the next stepping stone in developments beyond the internet and the UK should seek to maintain its leading position in this field by:

- Continuing to support excellent university research.
- Encouraging business involvement in research and wider developments in this area by supporting their participation in the full range of activities, listed in the section above, which constitute the main challenges to wider adoption. The very breadth of the issues – technological, legal, social and economic - suggest a holistic approach is required in areas with real applications, such as biotechnology, materials, financial services, healthcare, environment and energy and digital content.
- Developing a wider interest in developments through the activities of the new Knowledge Transfer Network.

Reference

1 Grid Computing: A Vertical Perspective 2005-2010, The Insight Research Corporation.

INTELLIGENT SYSTEMS

INTRODUCTION

Intelligent systems are poised to drive the next generation of ICT capabilities. Computing power is now so cheap and available that intelligent systems can be built to cope with the massive information load generated by our information society. The results will be profound and far reaching, touching virtually every aspect of ICT from security to gaming, from intelligent transport systems to metrology.

Intelligent systems (IS) encompass a range of software technologies that provide enabling capabilities crucial to many key and strategic application domains. The principal technologies can be broken down to a number of areas. Cognitive systems include techniques such as learning algorithms, adaptive systems and associative systems. Areas of natural computing are relevant and include neural computing, evolutionary computing or genetic algorithms and neuro-fuzzy systems. Other relevant technologies are intelligent agents, knowledge discovery and representation techniques including certain aspects of image processing and feature extraction.

The enabling capabilities that these technologies bring include advanced simulation; real-time and real-world analysis; knowledge and rule elicitation; data mining and data fusion; abilities within autonomy including adaptive control, self healing and management; and automated monitoring and novelty detection. At the leading edge of research, IS are being developed towards self awareness, emotional and affective computing and mixed reality systems that merge the physical and digital realities.

The principal drivers include the need for improved security: technologies are required to assist in conventional and identity based fraud prevention and detection, safety systems and internet filtering. The aging population is driving the need for more intelligent healthcare applications that require less staff time and enable prolonged home living. Accessibility is a key driver given that, increasingly, services are becoming digital only. Natural language processing and interaction is becoming a requirement. Other drivers include increased consumer demand, the need for improved metrology systems, information overload, productivity shortfalls and the increasingly pervasive use of the internet.

UK CAPACITY TO DEVELOP AND EXPLOIT THE TECHNOLOGY

The business software sector is intensely competitive and is evolving rapidly. In the UK, supply is dominated by multi-national companies and is relatively concentrated. The top three suppliers control a third of the market and are all US companies (Microsoft, IBM and Oracle), 15 providers control over half of the market. There are four indigenous UK companies among the leading 15 (Sage, LogicaCMG, Misys and Research Machines), the largest of these, Sage, controls just 2% of the market. Of the leading UK software companies, half are vertical market applications providers and primarily focus on financial services (source: Keynote).

There is however a strong UK R&D presence. The leading industrial players all have research bases in the UK and the UK academic standard is very high. The Engineering and Physical Sciences Research Council (EPSRC) has a current grant portfolio of more than £30 million in computer science, £17 million in ICT, almost £20 million in people and interactivity and almost £10 million in human factors including natural language processing. Centres of excellence exist in many UK universities including Imperial College, UCL, Southampton, Oxford, Exeter, Aston, Cambridge, Salford, York and Sunderland.

This suggests that the UK strengths in this field include the provision of added value for services and vertical market applications and the research and development of new enabling technologies. Relevant successes within this technology area include knowledge discovery from modelling and simulation of biological systems.

A review of the Innovation & Growth Team (IGT), Information Age Partnership (IAP) and Foresight papers reveals a compelling case for the UK to benefit from IS technologies. The Aerospace IGT states a need for automated systems, information management and data fusion, simulation and systems for health monitoring and diagnostics. The

Automotive IGT states a need for sensor fusion, distributed control, real time processing and automation and intelligent control and communications systems. The development of intelligent transport systems will rely heavily on this technology. The Electronics IGT identifies many aspects of intelligent systems across many user sectors. The Foresight Cognitive Systems project concluded in 2003 and identified exciting opportunities and Grand Challenges particularly on the interfaces between computer science and medical neuro-science. It also identified robotics as a key capability.

In all of these areas, the UK has both a strategic need for developments and therefore a market potential, and a capability to develop and exploit IS technology.

THE SIZE OF THE GLOBAL MARKET OPPORTUNITY

IS is principally an enabling software technology that can feed into a wide range of markets. The potential global opportunity is therefore complex. At the top level it is worth considering the total software market to gauge the health of the software systems markets in general.

In 2004, the total UK computer software market was worth £8.8 billion, a rise of 8.3% on 2003. Of this total, £7.5 billion was business software, divided roughly in half between applications and systems software. Forecasts predict that the market will continue to grow at between 5 and 8% per annum until the end of the decade.

The global software market is dominated by North America which accounted for 52.6% of value in 2004. Western Europe accounted for 29% and the Asia-Pacific 13.3%. The rest of the world accounted for just 5.2% representing a vast opportunity for the future.

In addition to the global software services markets, much of the exploitable opportunity for this technology area exists in vertical markets. These market opportunities exist within most of the strategically important UK sectors including aerospace; automotive; security; communications; entertainment; financial services; healthcare; and engineering. In addition there are horizontal challenges such as supply chain management: the multitude of enterprises and actors involved in a supply chain use disparate software tools which are not able to exchange information seamlessly resulting in loss of productivity and the use of sub-optimal solutions. IS could assist in inter-enterprise connectivity as well as providing decision support in the management of supply networks.

Concentrating on the target application sectors: The global computer games market was worth $18.2 billion in 2003 and experienced a 111% growth in the previous five years. The UK is currently the third largest global market for computer games. The UK industry employs 22,000 people, 6,000 of which are employed in development roles. Translating this success to the serious games and industrial simulation market, the UK is in prime position to create a globally significant development and application industry.

Worldwide investment in industrial robotics grew by 19% in 2003 to 81,800 units, and had already grown by 18% in the first half of 2004. It is estimated that by 2007, there will be in excess of one million operational industrial robots worldwide. Scope for growth within the UK is dramatic as in 2003 there were only 39 robots per 10,000 manufacturing employees, compared to 322 in Japan, 63 in the US and a European average of 93. Professional service robots are used in cleaning, inspection, construction and demolition, logistics, medicine, security and field applications including milking, the worldwide market for which is worth $2.8 billion. Domestic robots for domestic tasks, entertainment and handicap assistance is worth $6.8 billion.

The UK is the world's leading international financial services centre employing over one million people and with net overseas earnings of £31.2 billion in 2000 (5.1% of GDP). The City of London is one of world's three leading financial centres and the largest centre for many international financial markets. Opportunities for intelligent trading systems are significant.

The importance of intelligent transport systems would be difficult to overestimate. Population density and mobility is continuing to increase at the same time as commercial traffic in all modes of transport, air, road, rail and waterways. The EU has invested €190 million in ITS projects in the last five years.

IS could assist in the generation of alternative digital building designs through the automated/semi-automated assembly of alternative solutions from components and sub-assemblies. The planning and design of sustainable urban environments is challenging in the amount of data that needs to be brought together from multiple disparate sources. Currently, data can be captured through the use of 3D scanners, ground and airborne radar, photogrammetry and combined with social, economic, and environmental data from many other sources including geographic information systems and computer aided design. There is a need for intelligent software systems that assist in automated interpretation and computer representation of such data to facilitate decision making within emerging collaborative virtual planning software environments.

POTENTIAL FOR IMPACT AND TIMESCALE

There is a requirement for collaborative R&D that brings together the IS and end-user communities. Applications would be sought which addressed technology development issues within:

- Cognitive systems
- Natural computing
- Intelligent agents
- Intelligent image processing
- Data mining

and provided applications within:

- Intelligent agents within ‘serious games’ and simulations
- Intelligent transport systems
- Pervasive computing systems
- Robotics and human interfaces
- Tourism and leisure
- Financial modelling and trading
- Security
- Healthcare technologies
- Built environment

Knowledge transfer is also of importance to this area of technology. The community must be encouraged to link with existing communities including the Security and Intelligent Transport Innovation Platforms and the established Knowledge Transfer Networks (KTNs), particularly those in the areas listed above. The ICT-related KTNs should actively encourage the development of Special Interest Groups in Intelligent Systems to ensure their communities have access to and can learn from the UK expertise in this topic.

MODELLING AND SIMULATION

INTRODUCTION

In science and engineering, modelling is the formulation of mathematical representations, or 'models', of real-world phenomena and processes, which are then solved by simulation using analytical and numerical techniques to produce quantitative predictions and understanding.

Modelling and simulation (M&S) have become essential components in several sectors of UK industry, in which they are used to support, reduce and increasingly to replace, or carry out experimentation. Incorporating simulation into the design process creates additional benefit, especially when the product development cycle is costly and lengthy, such as in the aerospace[1] and automotive industries.

In the creative industries, the product itself is often a simulation, with modelling used extensively to provide representations of virtual worlds often on modest equipment such as games consoles. These models can be of real or imaginary phenomena, and simulation then 'animates' them for various purposes, of which training is an important application. Simulations in the absence of an underlying model are outside the scope of this document.

The role of modelling and simulation in underpinning future competitiveness is now widely recognised. For example, the Integrated Manufacturing Technology Initiative in the US[2] has concluded that 'Modelling and simulation are emerging as key technologies to support manufacturing in the 21st century, and no other technology offers more potential than M&S for improving products, perfecting processes, reducing design-to-manufacturing cycle time, and reducing product realisation costs.'

Modelling and simulation are now reaching further than ever before into the business environment, using increasingly powerful technology to support product and process innovation and decision making, and providing industry with the capacity to respond to business and regulatory challenges. This is creating new opportunities for assembling innovative collaborations, which will address the multi-thematic challenges that run across all sectors of the modern economy.

UK CAPACITY TO DEVELOP AND EXPLOIT

Modelling and simulation are prominent in the UK's most R&D intensive companies, the top 15 of which have a combined R&D investment in excess of £10 billion.[3] These companies are representative of sectors where the UK is globally competitive, including pharmaceuticals, aerospace, automotive, oil & gas, and telecommunications, and that are well placed to develop and exploit further advances in capability in order to maintain their competitive position internationally.

The rising importance of service sectors within the UK economy provides broader opportunities for exploiting modelling and simulation, with applications in economically important sectors such as construction, retail and business services that go beyond R&D by supporting strategic decision making, the planning of capital projects and modelling of business processes, including response planning for extreme or potentially catastrophic events.

Also important are synthetic-environment applications, which feature initial modelling, 'constructive' simulation, virtual simulation (human-in-the-loop) and on to increasing complexity and fidelity of systems: these last featuring the interoperation of simulations, systems hardware and software and people.

These major market opportunities in the user community will be underpinned by the effectiveness of the supply network for modelling and simulation services.[4] Recent international reviews of the science base have confirmed the UK's strengths in modelling and in key elements of simulation, such as high performance computing and numerical methods, and recognise that 'the UK has world-class activity in the organisation of industrial mathematics'.[5]

Modelling and simulation cut across formal departmental boundaries, both in companies and in universities and require a hybrid, multidisciplinary approach. UK capacity in the science base will be further enhanced by better collaboration between the key disciplines of mathematics, computing, engineering and the natural and social sciences.[6] The UK's supply network for modelling and simulation is distributed across university research groups, specialist consultancies and software houses, centres of excellence in larger companies, and public sector technology centres such as those in High Performance and GRID Computing. Stronger coherence in this network will enhance UK capacity, better serve UK users and open up international markets.[7]

SIZE OF GLOBAL MARKET OPPORTUNITY

The top 15 most R&D-intensive companies in the UK contribute in excess of £100 billion of value added to the economy.[8] The impact of modelling and simulation within the overall R&D spend is generally not easy to extract, but for instance the Sim-Serv project in FP5[9] estimated in 2004 that the process industries in Europe invest €300 million in modelling and simulation and that globally the benefits in this sector alone could be €40 billion.[10]

Alongside these established areas of opportunity, there are likely to be even greater ones in sectors that are more recent or emerging users of modelling and simulation. Business and financial services[11] contributed £310 billion in GVA to the UK economy in 2003[12] (32% of the total), retail and wholesale[13] contributed £154 billion (16%) and construction[14] contributed £60 billion (6%). Together these three industries contribute over half of GVA. If greater penetration of modelling and simulation can increase their GVA by just 1%, the benefit is over £5 billion.

In healthcare, the use of modelling and simulation for training of medical staff is another emerging area. Benefits here include reduced costs of training surgeons (currently £500,000) and objective assessment of their manual dexterity. Just in the area of radiological intervention procedures, the global market for simulators has been estimated at up to £300 million.

POTENTIAL FOR IMPACT AND TIMESCALE

The proposed strategy is targeted at strengthening the interface between user and provider communities, creating a more effective supply network among providers and showcasing the step-change in performance that closer integration delivers for both traditional and emerging users by means of high profile demonstration projects.
The medium-term objectives over 3-5 years are to:

- Improve the access of high-value users to expertise in universities and specialist providers, to deliver enhanced solutions to business-critical problems.
- Stimulate the uptake of modelling and simulation to achieve competitive edge in industries in which it is currently underutilised.
- Extend modelling and simulation to deliver innovation in business processes and capital projects and help meet the challenges of new business environments in all industries.
- Expand the opportunities for small specialist providers, through access to national facilities in high performance computing for large-scale simulations, and improved networking.
- Increase the supply of young people in both the user community and supply network who are capable of exploiting the commercial opportunity of modelling and simulation.

The proposed activities to achieve these objectives are:

- Collaborative R&D in the form of high-profile demonstrator and benchmarking projects, aimed at emerging opportunities in the high value-added areas e.g. financial services, retail and construction and applications in any sector that integrate the relevant players in the provider supply network. Each project consortium must include a clear end user in the public or private sector and have access to the necessary sources of data for model refinement and calibration. Creation of associated case studies to capture the new capabilities of a more connected supply network, to be marketed through an expanded KTN to a wide business audience, especially in high-profile applications where companies are moving collectively in response to drivers such as the introduction of new technology or regulation.
- In conjunction with management schools and the funding bodies for higher education, growing the discipline of ‘mathematics for commerce’ to support the growing service sector industries. This will include support for ‘champions’ of modelling and simulation from the user community and supply network to convey their shared experience and enthusiasm to young scientists at the masters or doctoral level.

References

1 For example, the use of early CFD tools to predict supercritical flows over wings was instrumental in enabling Airbus to establish itself as the main competitor to Boeing.
2 http://www.imti21.org/resources/docs/Modeling%20&%20Simulation.pdf
3 In 2005 the top 15 highest investors in R&D were GlaxoSmithKline, AstraZeneca, BAE Systems, Ford, Unilever, Pfizer, Airbus, Shell, Rolls-Royce, BT, BP, Land Rover, Vodafone, Marconi-Ericsson and Amersham-GE Healthcare (DTI 2005 R&D scoreboard).
4 A distinction between users and suppliers of ICT more generally was made in the OST paper A Scenario for Success in 2005: Information and Communication Technologies in the UK.
5 http://www.cms.ac.uk/irm/irm.pdf
6 The poor interface between mathematics and computer science, and the corresponding missed opportunities, have been highlighted in the International Review of Research Using HPC in the UK (2005) and in the Smith Institute report Mathematics at the Interface of Computer Science and Industry (2005).
7 The creation of 'Science and Innovation Campuses' announced in Science and Innovation Investment Framework 2004-2014: Next Steps (2006) will be part of this process.
8 DTI 2005 Value Added Scoreboard
9 http://www.sim-serv.com/wg_doc/WG7_Exploitation.pdf
10 Demand for M&S in these and other sectors will be increased by the anticipated introduction in 2007 of REACH, a new EU regulatory framework for chemicals.
11 Increasing regulatory pressures drive the need for wider use of M&S, for example the EU directive on markets in financial instruments (MiFID), http://www.fsa.gov.uk/Pages/About/What/International/EU/fsap/mifid/index.shtml. The Quantitative Finance Network, launched in March 2006, will connect to UK capability in financial mathematics.
12 United Kingdom Input-Output Analyses, 2005 edition
13 M&S are already used to support store location planning and supply chain logistics, but there remain substantial areas of opportunity in areas such as staff utilisation, home delivery, price promotions and replenishment of shelves.
14 M&S are at the heart of the US vision for future capital projects: http://www.fiatech.org/projects/roadmap/cptri.htm

CYBER SECURITY

SCOPE OF TECHNOLOGY, APPLICATIONS AND DRIVERS FOR CHANGE

Cyber security is the ability to secure electronic 'cyber' transactions end-to-end across heterogeneous networks, technologies and information services. It must necessarily consider the security solution holistically, involving the end human users engaging in transactions and the supporting network. Examples of key technologies and trends in the cyber security space are:

- Biometrics and identity management.
- Technologies for trust-worthy computing such as the trusted computing paradigm, secure software development processes and static analysis tools.
- Continued convergence of network and data communications, standards and services.
- Adoption of peer-to-peer computing technologies and nomadic network devices.
- Adoption of safety community defence-in-depth techniques as opposed to perimeter based security solutions.

DRIVERS FOR CHANGE

Drivers for change include:

- Growth in appetite for consumer digital, internet and mobile devices and services brought about by a combination of convenience, fashion and demands for greater flexibility e.g. home working and distance learning.
- The rapid developments in technology, including the pervasion of communications technologies and need for seamless interoperability, continued convergence of voice and data, and biometrics.
- Business demands, as a result of increased dependency on digital communications for business critical applications, often via the formation of opportunistic time-limited networks; an increasing perception that you can increase markets by building trust in products and brand using cyber security; and business efficiency gains (e.g. logistics and supply chains).
- Increased dependence on Critical National Infrastructures for control and management of services (e.g. utilities and transport) and the move towards e-government and intelligent transportation.
- Governance, regulation and legislation are forcing information security onto the corporate agenda, e.g. Sarbanes-Oxley and Data Protection.
- Terrorism is creating a climate of concern which is driving the need for cyber security to overcome fears of exploitation of the Internet by terrorists and vulnerabilities in the Critical National Infrastructure, arising from the use of open-networks and vulnerable digital technologies.
- New technology has enabled techniques for committing fraud and other crimes which is leading to a growth in structured organisation and funding of e-crime by organised crime groups.
- The move towards use of biometrics represents an increase of highly sensitive data assets digitised and available over digital communications media, driving the need for systems security in general, appropriate management and business continuity processes, governance and regulatory environments.
- Decentralisation (e.g. peer-to-peer applications, voice over IP) and deperimeterisation – a move away from boundary based solutions to defence in depth – is both a trend and a key driver of solutions.
- IPR, digital rights protection and new media.

UK CAPACITY TO DEVELOP AND EXPLOIT THE TECHNOLOGY

The UK possesses a variety of strengths which underpin our ability to develop and exploit cyber security technologies, including but not limited to:

- Research capability and global thought-leadership in secure systems and defence-in-depth solutions which include virus and mal-ware protection, fraud detection, formal-methods, high-integrity systems and software reliability techniques, biometrics algorithms and benchmarking.
- Important local drivers including the strength of the mobile telecoms networks and manufacturers in the UK, the importance of financial services and the wider service economy, and experience in dealing with terrorist threat.
- Increasing levels of cooperation between competitive entities when tackling common problems (e.g. trade groups and National Infrastructure Security Co-ordination Centre (NISCC) led information exchanges).

- The Institute of Information Security Professionals will provide a mechanism for developing the UK professional pool of expertise.
- The UK is active in influencing process and standards such as ISO27001.

However, there exist a variety of barriers to exploitation:

- Technology transfer from theoretical research to deployed solutions is sub-optimal, resulting in missed opportunities e.g. a lack of coordination between academia and industry sometimes results in research programmes which are not well aligned with markets and need.
- Fragmentation of UK capability and activities – leading to 'islands of collaboration' – potentially causing the 'stove piping' of ideas and the limiting of innovation and knowledge flow, and making it difficult for larger firms to locate appropriate pools of expertise in SMEs and academia.
- Security costs can be prohibitive for SMEs potentially leading to a lack of appropriate investment; but a lack of appropriate cyber security measures in any Internet users ultimately results in an overall lowering of the UK cyber security baseline.
- There are no widely recognised and implemented metrics for effective security.
- Until recently the evolution of an information security expert community has arisen with no professional institute and the benefits it can provide (such as a vehicle for self-governance, principles of good practice, a unified voice for the profession and a means to provide continuing professional development). However, the new Institute of Information Security Professionals was launched January 2006 and this could provide a vehicle for addressing this barrier to adopting a collective approach.
- The lack of major IT manufactures in the UK hinders our ability to influence products and markets.

SIZE OF GLOBAL MARKET AND OPPORTUNITY

We can use a variety of metrics and statistics to estimate the size of the global market and the opportunity for UK cyber security experts. These include, but are not limited to, the following:

- The Symantec Internet Security Threat Report: Trends for July 05 – December 05 documents that Symantec detected an average of 7.9 million phishing attempts per day, an increase of 39% over the first half of 2005.[1]
- According to the National Hi Tech Crime Unit (NHTCU), in 2004, fighting viruses in the UK cost £747 million and UK businesses lost more than £2.4 billion to hi-tech crime.[2]
- The Cyber Security Industry Alliance Internet Security Survey[3] indicates that 48% of consumers avoid making online purchases for fear that financial information may be stolen, indicating a strong case for security supporting market growth for on-line services.
- Across the whole public sector, UK government spends about £14 billion a year on new and existing information technology and related services, directly employs about 50,000 professionals in this field[4], and is one of the largest customers of the technology industry. It is estimated that £1.4 billion from the current annual spend on legacy systems could be released to new technology enabled reforms in public services. Gartner estimated that North America generated revenue will reach $1 billion in 2005 from $936 million in 2004.

RECOMMENDATIONS: POTENTIAL FOR IMPACT AND TIMESCALE

The following opportunities could capitalise on UK areas of expertise and broader industrial strengths (in each case the approximate timescale for impact is indicated). The strategy, in turn, should be aligned with the EC IST Framework 7 programme and provide the means for collaboration with the US Department of Homeland Security programmes.

Development of metrics for security threat and protection capability (short). We recommend that the strategy develops a unified and scalable model and architecture for measuring cyber security threats and the relative capabilities of protection measures. This should include models for integrating and exploiting existing threat metrics. **Compliance and governance** (medium/long). Public support should be given to the development of more cost effective compliance regimes supported by: high-integrity system development methods and tools and best practice guidance; cost-effective formal evaluation and certification processes operating within market orientated timescales and costs. This will be especially important in regulation driven industry, which seeks to rapidly exploit new networking and communications technologies as market differentiators. It may also help build confidence in technologies.

Cost effective risk management (short). We need to develop methods to make risk management processes faster, quicker and cheaper; so more accessible to society as a whole and benefiting smaller , resource limited users.

Secure software development (short). We recommend the development of cost-effective techniques and appropriate processes for minimising vulnerabilities introduced into systems by software, including the cost-effective assessment of open-source software. This is increasingly important as we move towards more complex and dynamic networks. Furthermore, we should consider a UK scale joint collaboration (akin in effect to the Carnegie Mellon Software Engineering Institute) to lead standards development, best practice, capability requirements and educational strategy in the area of software development.

Trusted applications (medium/long). We need to develop applications, services, trust models and business models for exploiting trusted computing platforms. This will directly support compliance and governance.

ID management process governance (medium). European programmes, and the government identity card and e-borders programmes, provide a range of opportunities and challenges around ID management, including issues such as privacy and social impact, governance and management processes, identity infrastructures, and integration of biometrics technologies into systems.

Human issues (medium). Human factors will be critical to success, and research and development is required to:

- Support new more intuitive and useable user interfaces to security solutions.
- Support automation of prevention, detection and response to reduce the burden on human administrators and users.
- Investigate how to engender trust in trustworthy entities.
- Understand how to increase the appetite for cyber security within the user community; develop a language for communication of cyber security principles suitable for use by non-cyber security experts.
- Explore processes, organisations and technologies for supporting the sharing of trust between entities on a individual, national and international scale (this should include assessment of existing methodologies such as tScheme).

These research activities should necessarily exploit a broad pool of UK experts from a wide range of domains, including cyber security services and solutions, user stakeholders, social sciences, and human-computer interaction.

Anti-malware technologies for mobile devices (short/medium). The importance of mobile communications and the increased evidence of mal-ware, including viruses, indicates that there is a growing opportunity for the UK to capitalise on its capability in the area of anti-malware solutions, including support for intrusion detection systems.

Seamless security across heterogeneous devices and networks (short/medium). The UK's capability in telecommunications and secure systems is well placed to address the challenge of seamless security, without loss of privacy, for users of mobile/ubiquitous services traversing heterogeneous networks and proprietary systems. The work should also consider how to support intrusion prevention, intrusion detection and digital investigations.

The new Cyber Security Knowledge Transfer Network (KTN) and the new Network Security Innovation Platform provide the means for adopting a more co-ordinated approach to these challenges.

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1 https://enterprise.symantec.com/enterprise/whitepaper-cfm?id=2238
2 http://news.bbc.co.uk/1/hi/technology/4420325.stm
3 www.csialliance.org/rsources/pdfs/CSIA_Internet_Security_Survey_June_2005.pdf
4 Transformational Government – Enabled by Technology, E-Government Unit www.cabinetoffice.gov.uk/e-government/ November 2005

ANNEX 1

TELECOMMUNICATIONS NETWORKS, PROJECTS AND INITIATIVES

Mobile VCE – http://www.mobilevce.com/
Communications Research Network (CRN) –
http://www.communicationsresearch.net/
Bristol 3CR – http://www.3cresearch.co.uk/
ITI Techmedia (Scotland) –
http://www.ititechmedia.com/uploads/documents/Press_Release_UWB_Programme.pdf
U Lancaster InfoLab21 –
http://www.infolab21.lancs.ac.uk/index.php
Leeds/ Bradford CIC –
http://www.wirelesscic.com/
Ofcom –
http://www.ofcom.org.uk/research/technology/overview/techrandd200405/

EPSRC –
http://gow.epsrc.ac.uk/ViewPSP.aspx?PSP=884&bannerlink=Programme%20support
DTI – VoCS Project HipNet to be announced.
Mobile VCE project in Pervasive computing.

EU Framework – a search of the EU IST web database shows UK participating in 19 projects in the generic activity Mobile and Wireless Systems beyond 3G (overwhelmingly UK universities), and 18 in the Broadband for All category. See http://www.cordis.lu/ist/projects/projects.htm