Knowledge Society Strategy

Technology Actions to Support the Smart Economy

July 2009: Final

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1 Executive Summary

Introduction

Technology Actions to Support the Smart Economy is the first report in the *Knowledge Society Strategy* process. This process will produce a broader report in 2010 covering the wider social and economic developments that will be needed to progress a Knowledge Society in Ireland.

The function of this first report is to identify key actions that will deliver the critical technology infrastructure and signature knowledge-intense projects necessary for the development of a Smart Economy. The emphasis is on promoting greater productivity and increased employment via specific projects, which can be progressed quickly.

The Report will be circulated to the EU and OECD and is aimed at attracting foreign direct investment by promoting Ireland as a test location for new Information Communications Technologies (ICT). This innovation model marries the expertise of high-tech multinational companies based here with state-funded R&D and indigenous digital and energy supply companies. The potential for new disruptive technologies in the use of ICT to deliver greater energy efficiency is a particular focus of this work.

Favourable demographics, high-rates of participation in third-level education, time-zone location, being the only Anglophone nation in the Euro zone and smart corporate taxation all contributed to our recent economic growth. The report '*Building Ireland's Smart economy: a framework for sustainable economic recovery'* sets out the Government's strategy for building on this success. It recognises the need for significant expansion in broadband availability; the rapidly growing R&D capability of our educational institutions; and new green technologies as the main driver of the next stage of our economic development.

Economic advantage will be secured by being early adopters of new digital and clean energy technologies. Popular participation in the emerging digital world of work and leisure will create domestic markets and develop the workforce for Smart Industries. Digital tools offer significant opportunities to cut carbon emissions in the home and workplace. eLearning will offer alternative paths in education and training allowing second chances to many disaffected by traditional classroom-based rote learning, thus increasing the size of the skilled labour workforce. eGovernment will lower the cost and increase the productivity of public services. eInclusiveness is a key requirement for bringing the wider public into the Smart Economy and raising Ireland's international profile as a technologically sophisticated nation.

The Future Internet, which will see the full integration of infrastructure and user services, is now a key driver of the Smart Economy. The Irish people – at home and abroad – are increasingly an online people. In early 2009, Facebook had over 400,000 Irish users. In 2007, Bebo had over one million Irish users. We are now one of the most advanced countries in the world for

wireless and mobile broadband technologies. A competitive market is delivering broadband speeds for Irish consumers from a range of broadband providers. In a recent report on the delivery of Next Generation Access networks the Government set out its view on the need for a collaborative, as well as competitive, approach to the development of broadband networks. Such 'open access' collaboration is exemplified by a number of recent initiatives undertaken by the Government, often on an open-access basis. These include the National Broadband Scheme to cover currently unserved areas, opening up fibre ducting carried alongside a range of state owned infrastructure, supporting new transatlantic fibre connections and promoting innovative new spectrum allocation policies.

This paper sets out six actions, which can improve the efficiencies of these new next generation networks, and the new applications they will inspire. The five areas for action are as follows:

Exemplar Smart Communications Network

Network (IP) traffic is doubling every two years. Unable to contend with this huge increase in the volume of data, the existing switching and routing technologies are becoming bottlenecks across the network. Ireland is establishing itself as a world-leader in developing a revolutionary, technological solution to this problem, deriving from the cutting-edge optoelectronic research that has been funded by Government over the past 20 years.

Founded in 1999, Intune Networks is an Irish company focussed on building a platform for Optical Burst Packet Switching. Holders of worldwide patents in key areas of this new technology, their early clients include MIT, the European Space Agency, NASA and the US Defence Advanced Research Projects Agency (DARPA). The founders commenced developing their technology in the early 1990s in UCD and are receiving ongoing support from Science Foundation Ireland backed institutions such as the Tyndall National Institute at UCC. Enterprise Ireland is an investor in the company.

Moving to Optical Burst Packet Switching and Transport, a technology based on transferring images and data using coloured light (tunable laser technology) will unblock the Network and, by lowering the requirement for switches and routers, significantly reduce the energy requirement for running the network. It will also dramatically improve image quality. Until now it has only been possible to transport images and data using fibre optic networks. Intune has succeeded in making the fibre optic network programmable. This breakthrough innovation allows the possibility of sending, switching and collecting digital data and images in a single optical infrastructure.

Ireland now has an opportunity to capitalise on its leadership in Optoelectronics R&D and the emerging solutions from Intune to develop a low energy and ultra-fast *Exemplar Smart Communications Networks*. This will enhance Irish ICT capacity and act as a magnet for FDI and research. It presents the opportunity for emergence of an Irish multinational company to emerge onto the global ICT stage and to place Ireland's leadership in Green

Technology in the spotlight. The Exemplar Network will also provide a test-bed for the trial and further development of next-generation communications devices and technologies including mobile TV, interactive video and a large range of other applications.

While it is always difficult to predict the exact number of new jobs which could arise from break-through technology, it is estimated that 5,000 direct jobs and a further 5,000 indirect jobs could be established over a 5-10 year period as a result of the Exemplar Network.

To progress the development of such an Exemplar Network there will be a stakeholders' workshop in Summer, 2009, involving Irish and FDI companies and potential network users. It is anticipated that the technology will start to be deployed next year on a state-owned fire optic network.

Energy-efficient Data Centres and Cloud Computing

Data is the lifeblood of business. Data Centres house the servers that hold the data; they also automate a range of essential back end functions that manipulate data for end-users.

Cloud Computing allows individuals and companies to store their data remotely, thereby lowering their server and energy costs. Data is stored, backed-up and secured by expert companies on a scale impossible for even large companies to match. This allows for significant increases in server efficiency. Savings on hardware and electricity are shared by the provider and customer.

Nonetheless, data centres themselves consume a significant amount of energy. This has led to ever-increasing demands for reducing the cost of data centres by improving their energy efficiency, the so-called Green Data Centre.

Establishing Ireland as a centre for energy efficient Data Centres and Cloud Computing not only allows us to capitalise on this growth opportunity but it also realises the objectives of the Smart Economy. Though Data Centres in themselves are not large employers, they do support valuable International and European Headquarters. As an example, EMC in Cork has an advanced Data Centre supporting 1,700 jobs. IBM has its European Cloud Computing Centre located in Dublin and Microsoft will open its state-of-the-art facility in Dublin later this year. Ireland has significant expertise in the design and management of Data Centres. It is estimated that a minimum of 10,000 high value jobs based on advanced Data Centres could result over the next 5-10 years.

An expert group will be established to put in place the priority measures necessary to position Ireland as a centre for Green Data Centre technologies. It is expected that an outline plan for such a development will be in place by the end of this year.

International Content Services Centre (ICSC)

The establishment of an International Content Services Centre modelled on the IFSC attempts to harness Ireland's reputation in three areas:

1. Digital creative Arts (film, games, music and animation);
2. Modern communications technology;
3. Legal and other professional services.

The ICSC will house content and provide content generation, distribution and management expertise. This facility will support the ongoing development of the 1,000 or so digital content companies currently located in Ireland. The majority of these companies are small (1-10 persons) and highly creative with high potential for growth. The central mission of the proposed centre is to establish itself as a world-class broker between the digital content developers and owners and the major content distributors. There is an added challenge posed by the fact that a significant amount of existing data is transferred illegally. Content developers will benefit from being able to exercise their legitimate property rights and content users will be assured of the legal status of the content they access. The ICSC's success will also depend on the development of a certain and consistent regulatory environment at both the national level and within the Single European Market. The Minister will establish a stakeholder group over the coming months with the aim of establishing the International Content Services Centre next year. This proposed development has the potential to create up to 10,000 jobs over the next 5-10 years.

Smart Electricity Networks

A *Smart Electricity Network* will facilitate bi-directional flows of energy and information. This will enable the connecting of micro-generators, improved planning, optimised pricing and a range of efficiency measures.

Irish companies such as Glen-Dimplex are already developing a range of intelligent home heaters using smart meters and motion detectors. Having introduced significant State supports for domestic renewable heating and insulation schemes, the greatest potential for further economic and energy performance improvements lies in this area of smart energy management systems.

Ireland also has the potential to play a lead role in the widespread deployment of electric vehicles, which rely on and support the development of smart grid technologies. The ESB is committing to developing an EV charging system involving the standardisation of connections and open data management systems.

A Working Group has been established in the Department of Communications Energy and Natural Resources to set out how we will meet the Government's target of rolling out a smart meter to every home in the next five years. To date, some 8,000 meters have been installed as part of the testing phase of the project. The Government has signed a Memorandum of Understanding

with the ESB and Renault Nissan with the aim of having a first fleet of new vehicles from those two companies available in Ireland by the end of 2010.

The Internet of Things

One of the key characteristics of the new digital world will be the Internet of Things, extending the Internet to include information coming from sensors attached to equipment and physical objects. Technologies like RFID, short-range wireless communications, real-time localisation and sensor networks are now becoming increasingly common, bringing the Internet of Things into commercial use.

There are a series of actions identified in the report that will allow Ireland to become an early-mover in the commercialisation of the Internet of Things. In particular, the report focuses on the development of projects such as Work Flow and Smart Bay.

Work Flow

Work Flow is a new concept using web-enabled mobile traffic sensors, communication and collaboration tools and flexible work practices to increase productivity, reduce congestion and lower carbon emissions. Live feeds of real-time estimates of commute times between company and home office enables workers to choose optimum travel times. Smoothing peak hour traffic will also result in better return on transportation investment and shorter business delivery times.

Unified communications and collaboration tools and services open up possibilities for rich, real-time integration of home and work offices and for the development of eCentres outside the main cities. Working from home or local eCentres will save on commuting time and traffic congestion and could provide the necessary economic stimulus for smaller towns and villages – now often reduced to ghost status during the workday.

A Pilot Scheme for Work Flow will be rolled-out in 2010 with the assistance of the Department of Communications, Energy and Natural Resources, the Department of Transport and industry partners.

Smart Bay

SmartBay is a key action of the marine component of the Government's *Strategy for Science, Technology and Innovation 2006-2013*. As an island nation, Ireland is both threatened by the marine elements of climate change and ideally placed to develop smart solutions for both national consumption and international export. Combining indigenous and FDI businesses with Government-funded R&D will provide the capacity to develop commercialisable products and services.

SmartBay aims to establish a Marine Research, Test and Demonstration Platform in Galway Bay. It will link surface and underwater sensors and networks to enable environmental research. By understanding whole marine systems, new technologies will be developed that will aid oil and gas

exploration, port and harbour development and mitigation of storm surges, coastal flooding and rising sea levels.

IBM Ireland and Intel are already working with the SmartBay project. EpiSensor, an Irish SME, has already worked with DCU on a product developed in the SmartCoast project (funded by the Marine Institute and the EPA) and is now working with IBM to develop environmental monitoring solutions.

Over the course of 2010 and 2011, SmartBay will be graduated from a pilot to a full-scale national platform and test-bed, involving the upgrading of its wireless facilities and laying of fibre on the seabed.

Conclusion

Ireland has a history of economic courage and innovation. We created new models of regional economic development using special tax designation status; we pioneered duty free shopping and low corporation taxation. We have acknowledged centres of excellence in manufacturing in ICT and Healthcare.

From being a manufacturer of products, we have migrated up the value chain and are now a leading exporter of high-tech products and traded services, and a location of choice for second generation ICT companies like Google and Facebook.

In the next ten years, Ireland will move decisively to being a creator, developer and exporter of products and services meeting real needs in an era of serial crises – climate change, peak oil, energy, water shortages, food production, etc.

We must harness our creativity, vision and connectedness and develop these solutions in an economically, socially and environmentally sustainable way. Building on our expertise in Advanced Technologies and our strengths in education and R&D, we will develop the new infrastructures and services that will allow our people – at home and abroad – to play their part in an already globalised world.

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2 Introduction and Background

2.1 Introduction

To develop as a successful society, Ireland will need to build a Smart Economy, one that is based on knowledge and sustainability. Competition in general requires smart responses to survive and prosper; in a major worldwide economic downturn the pressures to use all resources wisely – people and material – is significantly increased. Moving to a low carbon economy is an environmental and economic imperative.

The response to the threats posed by climate change demand urgent and radical cuts in carbon emissions. Emissions-as-usual is not an option. Information and Communication Technology (ICT) is a key element of a Knowledge Economy and will also be a key driver in delivering a low carbon economy. Digital technologies will provide the smart tools to drive the sustainable energy agenda in conservation, creation and transmission; to deliver new forms of communication and collaboration thereby lowering transportation emissions; and to create new capabilities in monitoring, analysing and reducing carbon outputs.

Responsibility for delivering the energy component of a low-carbon economy lies with the Department of Communications, Energy and Natural Resources (DCENR) and, since 2008, so too does the responsibility for developing the *Knowledge Society Strategy*. Having both areas in the same department affords an exciting opportunity to deliver on current Irish strengths:

- Installed ICT base – international and domestic;
- Significant investment in science and technology research;
- Alternative energy potential – wave, wind, etc.

This is the first Knowledge Society report and a comprehensive *Knowledge Society Strategy* is under preparation and will be published in 2010. This first report will also act as a consultation document and is likely to identify additional opportunity areas which can be considered as part of the broader *Knowledge Society Strategy*.

The *Knowledge Society Strategy* will cover:

- Broadband access;
- eInclusion;
- eGovernment;
- the role of ICT in all stages of education;
- eLearning;
- eHealth;
- Citizenship;
- Technology innovation;
- Actions from *Technology Actions to Support the Smart Economy, 2009.*

Extensive stakeholder consultation will take place and the strategy will be developed in a whole-of-Government approach. Society at large will need to understand and embrace this new direction. The benefits and impacts of this knowledge-based approach will have to be clearly defined in order to ensure a wide buy-in and the active involvement of the public.

The smart economy is a witness to the combined effect of globalisation and deep penetration of ICT. If Ireland does not seek to maximise the opportunity presented by the smart economy, we are likely to be adversely impacted.

This initial report, coming out of the developing *Knowledge Society Strategy*, follows the government's *Building Ireland's Smart Economy, a Framework for Sustainable Economic Renewal* published in December 2008. The Framework firmly commits Irish economic development to the smart path – combining knowledge and sustainability.

The *Knowledge Society Strategy* will cover both social and economic implications and opportunities of moving to a knowledge-based society and economy. This report focuses primarily on enabling technologies and actions likely to accelerate the development of Ireland as a Smart Economy particularly in ICT and electricity, leveraging Irish expertise, industry and research. It documents the strength of the relevant research base resulting from significant Government investment in both research capacity and knowledge development, as evidenced by the Government's *Strategy for Science Technology and Innovation, 2006-2013.* Throughout, there is an emphasis on using the combination of existing industry and research strengths and on developing Ireland as a test-bed and incubator for commercial applications in ICT and Green Technology.

It will also provide an update on existing eInclusion and eGovernment programmes and document some Irish Green Economy innovations. The creation of high value jobs and the maintenance of existing employment are central to the broad *Knowledge Society Strategy* and to the health of wider Irish society.

2.2 Background

Ireland is not unique in pursuing a knowledge agenda. Many of the EU countries and developed economies outside the EU have either already published or are developing knowledge society strategies.

2.2.1 Characteristics of Knowledge Societies

Knowledge Societies and their economies have a range of characteristics. These include:

- Advanced high-speed broadband – domestic and enterprise;
- High level of electronic transactions in public, private and government services;
- High speed broadband and systematic usage in schools;
- High participation of students in advanced mathematics and science;
- World ranking Universities with high level of international connectivity;

- Technology industry producing innovative products and services for export;
- Well defined national ICT research programmes which focus on documented strategic national needs;
- High ranking in IT international surveys and global competitiveness;
- High number of full-time researchers in industry and at third-level;
- Strength in ICT, Biotechnology and Pharmaceuticals with high added-value indigenous manufacturing sectors;
- Evidence of Government endorsement of the knowledge agenda;
- Sophisticated intellectual property systems with high level of patents, trade marks and licensing revenue;
- High level of international business connectivity with strong export revenues from products and internationally traded services;
- Significant Government effort is underway to ensure social inclusion and active citizen participation in topical and political issues.

2.2.2 Ireland's standing internationally

Ireland has many strengths that will facilitate our transition to a Knowledge Economy; first and foremost is our young, educated and English-speaking population. Ireland has the highest proportion of people under 15 in the EU and the lowest proportion of people over 65. Over 85% of 20-24 year olds have completed at least a secondary education (2nd highest in the EU15) and 40% of those aged 25-34 have a third-level qualification (joint highest with Belgium in the EU15, and higher than the US).[1]

To help make Ireland an 'Innovation Island' as outlined in *Building Ireland's Smart Economy* the Government is committed to enhancing skills in mathematics and science and nurturing an interest in innovation in second level institutions. Moreover, working in partnership with industry to invest in ICT equipment and connectivity; the Schools Broadband Programme will be continued, expanding the range of services and digital content available to schools while pursuing the objective of equipping second-level schools with 100 Mb per second broadband connectivity[1].

Ireland is making rapid progress in penetration of ICT and availability and uptake of broadband. The CSO[2] reports that in the first quarter of 2008, 70% of all households[3] had a home computer. This figure has been rising every year since 2005 when the level recorded was 55%. Moreover, the Irish broadband market has improved significantly since 2000 when there were only 4,000 broadband subscribers; at the end of 2008, there were in excess of 1.2 million broadband subscriptions in Ireland[4]. 99% of residential broadband subscriptions have contracted speeds in excess of 1Mbps and 60% are between 2Mpbs and 10Mpbs.

[1] Building Ireland's Smart Economy, 2008.
[2] Central Statistics Office 2008
[3] Household refers to households where at least one member is aged between 16-74
[4] ComReg Quarterly Key Data report Q4 2008

Mobile broadband subscriptions increased by 142% in the twelve months to December 2008. There are now 308,909 active subscriptions to mobile broadband.

Ireland generally occupies mid-table positions in many of the international Knowledge Society league tables. According to the OECD broadband subscriber indicator (calculated as the number of broadband subscribers per 100 inhabitants), Ireland is at the lower end of the OECD scale at 20.6 (i.e. 20.6 subscribers per 100 inhabitants have broadband) while the OECD average is 22.6. However, the average number of people per household is significantly higher in Ireland than in most other EU countries and a combination of both greater family size and younger average age means that this indicator does not reflect the true degree of penetration of broadband in our population. A more meaningful indicator for Ireland would be the penetration of broadband per household. Eurostat has calculated that broadband uptake in Irish households has increased significantly each year from 2003 to 2008 (Table 1). Denmark and the Netherlands have the highest household broadband penetration in the EU at 74%.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**
EU average (27 countries)		14%	23%	30%	42%	49%
Ireland	1%	3%	7%	13%	31%	43%

Table 1: Eurostat 2008 – Penetration of broadband per household

Ireland rose from 26th place to 18th in the ITU[5] ICT Development Index (ITU, 2009). Overall, Ireland was one of 10 countries that had gained most in a five-year period. Ireland's biggest gain was in the technology usage category, climbing from 32nd to 19th. The price of technology was another consideration that has a bearing on ICT uptake and was an area where Ireland ranked 17th, one place ahead of the UK in the list of lowest mobile prices. Sweden tops the Index followed by Republic of Korea, Denmark, and the Netherlands.

The European Innovation Scoreboard (EIS) 2008 bases performance over a five year period. Countries are grouped into innovation leaders, innovation followers, moderate innovators and catching–up countries. Ireland is in the group of innovation followers along with Austria, Luxembourg, France, Belgium and the Netherlands and is the best improving country in the group. The Summary Innovation Index (SII) gives an overview of aggregate national innovation performance and is calculated as a composite of 29 EIS indicators. Switzerland, Sweden and Finland lead the SII while Ireland ranks 7th. Ireland's strengths, compared to the country's average performance, are in human resources, throughputs and economic effects while relative weaknesses are in the areas of firm investments and linkages and entrepreneurship. Ireland's innovation performance and rate of improvement are above the EU27 average; the growth in Science and Engineering and Social Sciences and Humanities doctorate graduates, private credit and Broadband access by

[5] International Telecommunication Union

firms are identified as the main drivers of Ireland's improvement in innovation performance.

2.3 Actions to support a Low Carbon and Smart Economy

Building Ireland's Smart Economy – A Framework for Sustainable Economic Renewal (December 2008) clearly states that the smart economy will be developed via a transition to a low carbon economy. A digital service export economy is also a stated ambition. These will require a combination of a smart electricity network with significant renewable energy sources and a high speed broadband network. Smart and Green, and successful and sustainable are becoming synonymous. Thomas Friedman in the New York Times (July 15th 2007) linked the concept of green and smart when he stated "You can't make a product greener – whether it's a car, a refrigerator or a traffic system – without making it smarter.*"*

This first report from the Knowledge Society Strategy process seeks to build on existing Irish strengths and leadership to ensure that future Irish growth is smart growth – based on knowledge and sustainability.

Open markets, EU membership, low interest rates, low corporate and direct taxes, long-term investment in and commitment to education, a young English-speaking population all helped create recent rapid growth in the Irish economy. Increasing investment in research and a now well established manufacturing base in ICT and Pharmaceuticals augur well for the country's scientific and technological future. However neither the Celtic Tiger model nor current strengths guarantee a successful and sustainable future. Competitors have copied policy successes and are leveraging their own advantages in people and place. Building a Smart Economy will require new approaches and urgency in a time of great uncertainty and ever increasing competition.

Ireland is preparing logically for the challenges ahead by investing further in research and higher education for its people and in new enterprises working in the knowledge economy. Ireland is also facing up to its over-dependence on imported fossil fuels and increasing greenhouse gas emissions. The recent White Paper on Energy[6] (2007) sets out ambitious targets for the development of renewable energy sources in Ireland. A range of Government actions have been launched including a strategy to develop Ocean Energy[7] (2005) and the Ocean Energy Initiative launched in January 2008[8], with similar actions under preparation in other energy sectors.

Rising to Energy and Climate Change challenges will require creativity – this creativity in turn can unleash smart development which will provide the new tools and services to be traded globally. Necessity will be the mother of invention again; the only question is: who will reap the benefits of invention? An opportunity exists to engage Irish industry (ICT sector in particular but also Bio-Tech and emerging Green-Tech) to work with Government in identifying sustainable development opportunities which will succeed in raising Ireland's

[6] Government White Paper "Delivering a Sustainable Energy Future for Ireland", 2007
[7] DCMNR, *Ocean Energy in Ireland*, October 2005
[8] DCENR Press Release *Minister Ryan launches major new Ocean Energy initiative* 15th January 2008

profile as an innovative location to conduct research and enterprise and at the same time develop Ireland as a test location for such high-tech developments. In effect, Ireland must develop its low carbon economy at the same time as we progress our Knowledge Economy, each will be dependent on the other but the combination will provide the great commercial opportunities for the coming decades. Given that we have many of the necessary components, we should aggressively advance the Smart Economy agenda.

Ireland has a very strong ICT sector to support the Smart Economy. There are 210 foreign–owned ICT companies in Ireland including most of the global leaders such as Microsoft, Intel, IBM, Dell, Google and others. There are 660 indigenous software companies ranging in activities from financial services, security, gaming, animation, healthcare to educational solutions.

Turnover in the Irish ICT sector is approaching €55 billion per annum. The ICT sector accounts for half of the total Irish business investment in R&D. The Irish Government allocated €8.2 billion in 2006[9] for research over the period 2006-2013. ICT will be the largest sector benefiting from this investment. However significant sums will also be spent on Sustainable Energy and Research.

Internationally ICT is the largest sector investing in R&D. Since 1990, well over $2 trillion has been invested and has resulted in over 3 billion people having mobile communication devices and over 1 billion enjoying Internet access. A range of sophisticated network solutions have been introduced with revolutionary impact on social and business practices. In the light of such impressive innovation it is logical to consider the likely impact of this sector on sustainable issues. If Governments can provide catalysts and inducements, the exciting prospect of a non-linear approach to resolving major environmental challenges arises.

The current planning for emissions reduction serves as a good comparator. Today's approach is very much linear/incremental which will probably, after a lot of effort, lead to the achievement of the Kyoto targets[10]. On the other hand, a shift in focus by the ICT industry could unleash completely new tools and methodologies, allowing for higher targets to be set (e.g. in the range of targets discussed in Bali 2007[11]). A number of larger corporations are now including ICT solutions to national sustainability issues as part of their corporate strategy. At a recent Sustain IT[12] conference held in London in April 2008, Industry participation was very noticeable. This is an interesting shift, as up to now this topic was the domain of Non-Governmental Organisations (NGOs) and of Intergovernmental organisations. The keynote address at Sustain IT was given by Motorola and practical case studies were presented by Volvo and Unilever. The term *Silicon Offsetting* has been coined to describe how ICT can provide solutions for environmental management.

[9] Government of Ireland *National Development Plan* Ch. 8 P155
[10] Kyoto Protocol 1998
[11] The United Nations Climate Change Conference, Bali (3-15 December 2007)
[12] Sustain IT, London: Green Power Conferences (22-23 April 2008)

The impact of ICT on emissions reduction can be categorised under the following headings:

- Behavioural (work practices and energy efficiency);
- Infrastructural (intelligent systems and design);
- Transport (smart flow systems, vehicular performance sensors);
- Manufacturing efficiencies;
- Energy efficiency of ICT products (Data Centres and devices).

This new approach is very much in its infancy but, already, the calculation of potential greenhouse gas emission reduction through smart ICT usage has engaged the OECD, EU and NGOs. The subject has been on the agenda of the World Economic Forum (Davos 2008[13]) and at meetings of the G8 plus 5 (March 2008[14]) and G8 (May 2008[15]).

The importance of the link between ICT and sustainable development is also underlined by the European Commission in its recent communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions called "*Addressing the challenge of energy efficiency through Information and Communication Technologies"*. The OECD is also actively involved in the ICT and Environment area. Its recent organisation of a well attended international workshop in Copenhagen and its planned conference in Denmark in 2009 provide valuable stimulus to this growing link. On March 12, 2009, The European Commission adopted a Communication on "*Mobilising ICT to Facilitate the Transition to an Energy-Efficient, Low Carbon Economy"*.

SMART 2020 is a report by the Climate Group on behalf of the Global eSustainability Initiative (GeSI): *Enabling the low carbon economy in the information age*. Specific ICT opportunities are identified in the report which could lead to emission reductions of five times the carbon footprint of the ICT sector, up to 7.8 GtCO2e or 15% of total BAU emissions by 2020.

Teleconferencing and telecommuting offer great opportunities to reduce work related travel. Again, ICT is providing new options to lower carbon emissions, traffic and also time wastage. A recent joint report published by the European Telecommunications Network Operators' Association (ETNO) and the World Wildlife Fund (WWF)[16] stated that 22.17 million tonnes of CO_2 could be saved (EU25) in 2010 by a flexi-work approach and 22.35 million tonnes (EU25) saved by a 20% reduction in business travel through videoconferencing. The American Consumer Institute (2007) claim that use of broadband networks will reduce annual US oil imports by up to 11% over the next 10 years[17]. UPS reported that they save nearly 30 million miles annually when they use their

[13] World Economic Forum, Annual Meeting 2008, Davos, Switzerland (27-28 January 2008)
[14] G8 + 5 Meeting Chiba City, Japan (14-16th March 2008)
[15] G8 Environment Ministers Meeting Kobe City, Japan (24-26th May 2008).
[16] ETNO and WWF "Saving the Climate @ the Speed of Light"
[17] American Consumer Institute "Broadband Services: Economic and Environmental Benefits" (2007)

smart transportation system with savings of 3 million gallons of gasoline and 32,000 tonnes of CO_2 emissions[18].

In a similar manner, calculations have been made with regard to energy efficiency (e.g. smart homes and intelligent buildings) and a wide range of eCommerce applications.

Ireland can develop or deploy a range of proven options as part of an integrated strategy using ICT to contribute to a lower-carbon economy with Industry as a key partner.

[18] UPS Factsheet *UPS Avoids Left Turns to Save Fuel, Reduce Emissions and Improve Safety*

3 Research

Research is critical to the activities of Knowledge Societies and Economies. Until recently, Ireland has neglected the research area, giving it little investment or recognition. This changed dramatically from 1998 onwards with the establishment of the Programme for Research in Third Level Institutions (PRTLI) and shortly afterwards, Science Foundation Ireland (SFI).

PRTLI is the Higher Education Authority's fund to strengthen the research capabilities of third-level institutions. Since 1998, PRTLI has invested €865 million in human and physical infrastructure. PRTLI aims to establish Ireland's international profile as a premier location for carrying out world-class research and development.

SFI is the Government agency with responsibility to invest €1.4 billion in the academic research likely to generate new knowledge, leading edge technologies and competitive enterprises in the fields of science and engineering. It funds research centres, research groups and individual researchers in ICT, Biotechnology and Sustainable Energy.

In 2006, the Government published its Strategy for Science, Technology and Innovation, 2006-2013 (SSTI). The Strategy guides the achievement of the vision that:

"Ireland by 2013 will be internationally renowned by the excellence of its research, and will be to the forefront in generating new knowledge for economic and social progress, within an innovation driven culture."

The Government has committed €8 billion to achieving this vision over the period 2006 - 2013. A whole-of-government science governance system has been put in place, including a Cabinet Committee on Science and Technology and a related Interdepartmental Committee.

The justification of the SSTI investment is to advance the Government's goal of establishing Ireland as a Knowledge Society built on excellence in science, technology and innovation. The SSTI recognises the importance of increasing the skills of the population and ensuring that levels of scientific and mathematical literacy increase. The Strategy aims to harness our tradition of creativity and our talent for communications. It brings together researchers and innovators from a wide range of disciplines, including the physical and social sciences, arts and humanities, to meet the challenges and opportunities presented by a diverse and rapidly changing world.

A key goal of the SSTI is to double the output of PhDs from third-level institutions. A substantial number of these researchers should be employed by the enterprise sector in order to advance the goal of developing, manufacturing, licensing and exporting products and services based on our own ideas. This is a key characteristic of a Knowledge Economy.

Likewise, we will have to take immediate action at all levels of our education system to improve scientific and mathematical literacy. Society at large will

need to be convinced of the need for such action and the benefits which will result from such an approach. We will also need to take steps to ensure an increase in societal appreciation of science and engineering. The numbers opting for Higher Level science and mathematics subjects at Leaving Certificate level need to significantly increase - as do the numbers taking science and engineering degrees at third level. For this to happen, it will be essential that an interest in science is stimulated at primary school level and sustained at secondary level. The earliest exposure to digital content and the use of ICT in teaching and learning will contribute to ensuring that the population becomes digitally literate at an early age.

3.1 SFI-Funded Centres for Science, Engineering and Technology

SFI is the main funder of ICT-related research in Ireland. Its Centres for Science, Engineering and Technology (CSETs) receive the most significant funding. Six CSETS, manly in ICT, are highly relevant to the development of the Smart/Knowledge Economy.

3.1.1 Digital Enterprise Research Institute

The Digital Enterprise Research Institute (DERI) is dedicated to researching the technologies that will underpin the next generation of the World Wide Web – the Semantic Web. SFI has supported DERI since 2003 with approximately €25 million in grants. It aims to develop the software that allows the Internet to become a platform where organisations and individuals communicate more easily with each other, to carry out commercial activities and provide value-added services.

DERI has partnered with many companies, including Nortel, Storm, Ericsson, IBM, Cisco and others and has already grown to approximately 100 people, comprising senior researchers, post-doctorates, post graduates, outreach and administration. DERI continues to expand its workforce and expertise with additional funding from EU projects and continued support from SFI.

3.1.2 Centre for Telecommunications Value–Chain Research

The Centre for Telecommunications Value–Chain Research (CTVR) was established in 2004, as a five-year, €69 million programme, between Lucent Technologies, Bell Labs, IDA Ireland and SFI. CTVR is designed to make Ireland a world-leading location for research in telecommunications design, engineering, manufacturing and servicing. The project established a Bell Labs global headquarters for research into telecommunications and supply chain technologies in Ireland.

CTVR focuses on advancements in next generation networks and the value chains used to design, build, market and service them. It is a collaboration between industry and academia and government agencies. CTVR works closely with eight Irish Universities, where it currently funds some 80 research staff. In addition to having Bell Labs as its major industrial partner, CTVR includes an ever-expanding range of affiliate industrial partners participating at varying levels of engagement. CTVR works closely with SFI, IDA and EI to

help ensure that its discoveries and inventions are successful in the marketplace.

As the major partner, Bell Labs not only conducts its own research, but also transfers many of the innovations that come from CTVR into commercially viable products and services. The Bell Labs facility is located in Blanchardstown, Dublin and CTVR is headquartered at TCD. Between them, the two centres are creating opportunities for 120 researchers. The knowledge and expertise of some of Bell Labs' top talent is also available to the research teams, while Lucent Technologies will use its worldwide reach to help commercialise and exploit the research.

In the future, CTVR is expecting to partner also with Intune Networks, Xilinx and many other companies.

3.1.3 The Irish Software Engineering Research Centre - Lero

Lero, the Irish Software Engineering Research Centre, advances the state-of-the-art in software engineering for specific domains. With a €11.7 million commitment from SFI, Lero is a partnership of academic researchers and industry, led by the University of Limerick.

Lero is researching, developing and validating theories, technologies, methods and notations that help make software production more predictable and more efficient. It is also working on making the software itself more reliable, more flexible and more easily changed.

Focusing on research challenges that are of relevance for a specific domain facilitates more rapid uptake and more effective use of the research results produced. Lero is establishing a centre - and developing a community of researchers who will work together - to address key challenges in automotive software engineering. Proven results in this sector can have a significant impact on other software dependent industry in Ireland and abroad. As it develops, Lero expects to address additional domains such as medical devices.

3.1.4 Centre for Next Generation Localisation

The Centre for Next Generation Localisation (CNGL) is an academia-industry partnership funded as an SFI CSET. With over 100 researchers CNGL is developing novel technologies addressing the key localisation challenges of volume, access and personalisation.

In an increasingly globalised economy and information society, language barriers constitute a formidable obstacle to the free flow of information, products and services. Localisation is the industrial process of adapting digital content to local culture and linguistic environments with high quality, speed, volume and with low cost. It is the key enabling, value-adding, multiplier component of the global software and content distribution industry. Industrial-scale localisation originated in Ireland and is now a key segment of the Irish ICT industry.

The major research strands within the CNGL are Integrated Language Technologies, Digital Content Management, Localisation Technologies and Processes and Systems Framework. The CNGL vision is to enable people to interact with content, products and services in their own language, according to their own culture, and according to their own personal needs.

CNGL will carry out the fundamental and applied research underpinning the design, development, implementation and evaluation of the blueprints for the Next Generation Localisation Factory. This new factory will be distributed, virtual, highly automated and based on novel language and digital content management technologies. It will provide solutions to three massive challenges facing the Localisation Industry:

- Volume: the amount of content to be localised is growing at rapidly increasing rates and outstrips the supply of human translators;
- Access: digital content delivery and interface devices are changing to enable pervasive, on-the-move access to digital content;
- Personalisation: a new type of localisation - Personalised Localisation - is emerging with the rapidly growing multilingual digital content available on the web. This content needs to be localised in real time and personalised to individual user requirements.

Among companies that are working with CNGL are Microsoft, IBM, Symantec, Dai Nippon Printing, Traslán and others.

3.1.5 CLARITY

CLARITY is an SFI-funded CSET focusing on the research intersection between Adaptive Sensing and Information Discovery. The overall theme of CLARITY is bringing information to life; harvesting and harnessing large volumes of sensed information from both the everyday physical world and the digital world of modern communications and computing. CLARITY will bridge the physical-digital divide by producing a new generation of smarter, more proactive information services. This will include:

- New ways to monitor the impact of exercise on health;
- Technologies to support our aging population;
- Innovative social and interactive media services to take advantage of emerging opportunities in the digital media sector;
- Technology that can automatically monitor the quality of our environment.

CLARITY aims to impact on Ireland’s economy and society. It will contribute to improving people’s quality of life in areas such as personal health, digital media and the management of our environment.

CLARITY is based on the research undertaken as part of the Adaptive Information Cluster (AIC), funded by SFI as a Strategic Research Cluster. This was a multi-disciplinary research effort combining computer scientists, engineers and material scientists with a view to exploring the science and application of next generation, sensor-based, adaptive information systems.

Among companies that are working with CLARITY are IBM, Big Green, Vodafone, Ericsson, Foster-Miller, ChangingWorlds, Fidelity Investments, Critical Path and others including the Environmental Protection Agency, the Marine Institute and the National Museum.

3.1.6 Biomedical Diagnostics Institute

The Biomedical Diagnostics Institute (BDI) is a multidisciplinary research institute focused on the development of next generation biomedical diagnostic devices. These devices will be applied in both point of care and self-test home use. The availability of sophisticated personal-use diagnostic devices will allow for early detection of life-threatening events. They will also allow chronic diseases to be controlled more effectively.

The current industrial partners include multinational and SME companies:

- Becton Dickinson and Co;
- Analog Devices Inc.;
- Hospira Inc.;
- Inverness Medical Innovations Inc.;
- Enfer Technologies Ltd.;
- Amic AB.

BDI involves four Irish academic institutions:

- The National Centre for Sensor Research at DCU;
- The National Centre for Biomedical Engineering Science at NUIG;
- Royal College of Surgeons in Ireland (including the Clinical Research Centre at Beaumont Hospital, Dublin);
- The Tyndall National Institute at UCC.

The BDI operates an Associate Membership scheme offering official association with the Institute, limited access to the outputs and opportunities to interact with the full partners.

BDI's research programme encompasses both fundamental and application-focused research. Fundamental research projects address generic issues that underpin the development of novel diagnostic devices (e.g. biorecognition; transduction, microfluidics). Application-focused projects are informed by the commercial vision of the Institute's industry partners, addressing significant unmet or emerging market needs. These projects integrate specific outcomes of the fundamental research into working demonstrators.

3.1.7 Other Relevant SFI Initiatives

As mentioned above, SFI also funds a large number of Strategic Research Clusters. Several of these are relevant to enabling technologies and actions to support the Smart Economy:

- Waterford Institute of Technology's recently-announced FAME (Federated, Autonomic Management of End-to-end Communication Services), with funding of €5.9 million;

- UCD's CASL cluster on Graph & Network Analysis.
- The StratAG, Advanced Geotechnologies SRC, led by NUIM, works on the general theme of geospatial monitoring and early warning. This includes sensor integration, spatial algorithms, spatial visualisation and location-based services. Industry partners include ESRI-Ireland, eSpatial, BKS Surveys, Pavement Management Systems, and IBI Group. Government agencies include the Ordinance Survey Ireland, Geological Survey of Ireland, the Environmental Protection Agency, the Marine Institute and the National Roads Authority.
- CLIQUE is a recent SRC, which is involved in data mining of graphs and networks, with applications to virtual communities
- The Irish Centre for High End Computing, ICHEC, runs an IBM Blue Gene and other high end, compute-intensive, support services. ICHEC carries out virtual science and engineering in areas such as meteorological modelling – with Met Éireann; environment and climate modelling; materials science for nanotechnology and quantum information processing; systems biology; and other application fields.

In addition there are a number of SFI-funded groups performing research of direct relevance to the Smart Economy including:

- Tyndall's Photonics projects on Photonics System Research, Photonics Integration and the Physics of Photonics;
- RINCE's project on the applications of fast wavelength tuneable lasers in future high speed optical networks;
- NUIM's Next Generation Communication Networks project.

SFI's recent strategy for 2009-2013 "Powering the Smart Economy", presents a welcome update on plans to establish Ireland as a location for internationally-recognised research and innovation.

3.2 PRTLI-Funded Centres

PRTLI has established thirty research centres/institutes and two Research Libraries to date. Three of the centres are involved in relevant ICT/Advanced Communications research.

3.2.1 Research Institute for Networks and Communications Engineering

The Research Institute for Networks and Communications Engineering (RINCE) is a national centre of excellence in ICT. Established in 1999, RINCE is located in DCU and addresses major research challenges related to the complexity and integration of new global communications networks.

The Research programme of the Institute is based on three research centres:

- The Centre for Image Processing & Analysis;
- The Centre for High Speed Devices & Systems;
- Network Innovations Centre.

The Radio and Optical Communications Laboratory, is central to RINCE. This Laboratory focuses on the design, simulation and demonstration of new technologies for future broadband photonic communication systems. Specific research themes of relevance include:

- All-Optical Switching and Sampling;
- Optical Packet Switching using Tuneable Lasers;
- Radio-over-Fibre Communication Systems;
- Very High Speed Optical Pulses;
- High-Speed All-Optical Processing.

3.2.2 Boole Centre for Research in Informatics

The Boole Centre for Research in Informatics combines research expertise from the UCC's Department of Computer Science and the School of Mathematics. The computation facilities of the centre include a 100-node Beowulf cluster parallel computer and connection to the Irish computational grid. Research themes include information theory, theory of computation and computing power.

3.2.3 Institute for Information Technology and Advanced Computation Research

The Institute for Information Technology and Advanced Computation (IITAC) was established in TCD in 1999. It is housed in a purpose–built facility and conducts a strategic research programme in computational and bio-molecular sciences. IITAC links computer, physical and biological sciences in a programme coordinated and supported by the TCD Centre for High-performance Computing.

IITAC research themes include proteomics, structural biology, bio-molecular modelling, physical sciences (molecular dynamics and quantum chemistry), mathematics, computational physics and computational chemistry.

The IITAC facilities include 850 m^2 of research space for computational mathematics, physics and chemistry along with a purpose built 104 m^2 machine room.

PRTLI - SFI Connections

The SFI and PRTLI programmes are closely related. Approximately two thirds of SFI CSETs and over half of the SFI Strategic Research Clusters are hosted within PRTLI facilities. In addition, 73% of currently-funded SFI researchers are based within PRTLI-supported facilities. PRTLI is the main funder of postgraduates in Ireland, with 1,638 supported since 1999.

3.3 National Digital Research Centre

The National Digital Research Centre (NDRC) is a translational research centre located in the Digital Hub, Dublin. Collaborative industry and academic joint venture projects take place within the NDRC. The mission and raison d'être of the NDRC is to create market capital by developing and commercialising market-viable digital and digital media technologies and

content through collaborative translational research. Market capital is a value creation objective, manifesting itself in partnership formation, follow-on investment, and job creation. Translational research is a gap-bridging, innovation activity between industry and academia. It leverages the knowledge, skill-sets and assets of both parties.

NDRC invests in and proactively facilitates value creation from applied digital technology research, effectively bridging the gap between innovative research and impact in the marketplace. This investment is made in joint venture projects between industry and academia undertaking late-stage commercially focused research and innovation. Typically, those projects seek to leverage value from previous research expenditure.

Collaboration, based on multi-disciplinary and multi-party (including industry and academia) project teams, is core to the NDRC ethos and ensures that efforts are firmly solution-focused. Concurrent and interdependent twin research streams of technology advancement and business development ensure that value and impact in the marketplace guide project direction. Agile, market-aware processes add value by mutually informing technical and business case development. The NDRC is supported by specialist expertise, networking capabilities and developmental processes. A culture of vibrant and collaborative projects provides an environment where innovative ideas and technologies can transition to industry adoption, and ultimately increase market capital.

Key focus areas for the NDRC span digital and digital media content and technologies. These include human-technology interfaces, mobile and sensor platforms, and software engineering and data management. The NDRC is focused on the following application domains and marketplaces:

- Entertainment technologies, aimed for example at mobile and console gamers;
- Mobile applications aimed for example at mobile gamers and students;
- Both healthcare services and medical devices, aimed at healthcare professionals and consumers;
- Education applications aimed at education agencies, eLearning publishers, and sectoral educationalists (e.g. professional bodies, RCS, etc.)

Founded in 2006 by a consortium of third-level institutions with the support of the Department of Communications, Energy and Natural Resources, the NDRC operates as an independent, not-for-profit centre of excellence with a focus on converting digital research into marketplace success. The consortium members comprise DCU, TCD, UCD, Dun Laoghaire Institute of Art, Design and Technology and the National College of Art and Design.

3.4 Technology Research for Independent Living (TRIL)

This is an interesting example of a Centre operating at the convergence of Life Sciences and ICT which focuses on research relating to new technologies to enable people to live independent lives for as long as possible in the environment of their choice. The TRIL centre is an active research collaboration between Industry and Higher Education partners including Intel, TCD, UCD and NUIG. The Centre created dedicated laboratories at Intel and in each of the Universities involved and is driving bi-directional knowledge and technology transfer through the collective work of a multidisciplinary team.

The work of TRIL is highly relevant to eHealth programmes that will feature prominently in the Knowledge Society Strategy, which will be published in 2010.

4 Communications Network

This section looks at how communications networks can enable the realisation of the Smart Economy. After years of sustained investment in R&D in next generation communications based technologies, Ireland has arrived at the point where it has attained a critical mass of innovation which, with one final push, will leapfrog the nation into the a position of pre-eminence in the global communications market.

It presents ideas to transform data centres into smart, energy-efficient digital economic engines, to create the foundation for a future International Content Services Centre, and a viable frontier communications network for SMART Grids and Networks, all of which have a common requirement i.e. early access to the world's most advanced new communications network based on Irish technology and expertise. A new Exemplar Smart Network for Ireland is the starting point and a fulcrum for a potential array of largely yet unknown inventions for Ireland.

4.1 An Exemplar Smart Network for Ireland

It is acknowledged globally that, a robust, reliable and dynamic telecommunications network is needed to establish and grow a Knowledge-Based economy. Internet-based services have become the lifeblood of modern life: business communications; eCommerce; personal communications and entertainment; social networking; information sharing and research.

There is nothing that the World Wide Web does not touch today to the point that broadband services are now considered comparable to what land-line voice services were over the last 40 years. The next 40 years will see the World Wide Web mature and become even more deeply embedded into everyday life. This means that today's technology will be replaced with even more exciting technologies tomorrow – most of which are being invented and developed today. Globally, Singapore is currently at the forefront of next generation network's infrastructure for the new digital economy based on a conventional network design blueprint. They are pushing the envelope of the possible. The NGN is based on a set of technological barrier premise compensations that date back to the early 1970's which were first modelled in Stanford University. Arising from a scientific breakthrough in early 2003, Ireland has resolved the original conventional barriers to the simple, fast and low cost network originally planned for today's Internet and this will enable Ireland take a lead globally in the next phase of communications network evolution and be positioned first with all the new opportunities it presents.

4.1.1 Historical Perspective

Ireland has a history and track record of investing in advanced telecommunications infrastructure to stimulate economic activity. Ireland invested in a digital telephone exchange in the 1980. Earlier, the first undersea transatlantic cable was laid between Ireland (Valentia Island) and Canada (Hearts Content) in 1858. In 2000, the Government partnered with Global Crossing to deliver a high capacity fibre optic cable providing

telecommunications connectivity between Ireland and 40 European cities as well as cables between Europe and the USA. This resulted in a quantum reduction in the cost of international telecommunications from Ireland and the attraction of significant FDI and the generation of thousands of new jobs.

Project Kelvin is a current collaboration with the Department of Enterprise, Trade and Investment in Northern Ireland involving the roll out of further direct international telecoms connectivity. Kelvin will involve connecting a new submarine cable from Co. Derry to an existing transatlantic cable 22 miles off the north coast of Ireland. The €32M project will provide faster, cheaper broadband and direct international telecoms connectivity for the North, the border counties and Dublin.

4.1.2 The "Metro" Bottleneck

If Internet services are the lifeblood of modern life, it is the Metro Network which is the beating heart. The metro network connects all of the devices and people at the edge (the Access Network) to the Internet brains providing the services. It is the Metro Network that pumps out packets going to and from the Internet Protocol (IP) service hosting centres to the devices and people requesting those services.

The Metro Networks of today face two key challenges. They are currently struggling to cope with IP traffic loads that are growing strongly and expected to continue growing for many years. The second challenge is how to meet future traffic and service demands cost–effectively with a low carbon footprint.

IP Traffic to Grow Strongly

IP traffic growth is doubling every two years, driven by Internet services never envisioned even five years ago. The key drivers of IP traffic growth to 2012 are:

- Internet Video Services;
  - A global compound annual growth rate (CAGR) of over 50% is predicted with some regions approaching 70% CAGR[19];
- Social Networking and Peer-to-Peer Services;
  - 31% global CAGR is forecast, with some regions approaching 50%[19];
- Mobile Data and Mobile Internet Services;
  - 125% global CAGR with some regions approaching 200%[19];
- Web Services, Cloud Computing, and the Programmable Web;
  - Analysts estimate that this segment is projected to grow approximately threefold between now and 2012 yielding an annual market worth approximately $100B and representing an estimated 30% of all ICT spending.

Companies that are now used daily by hundreds of millions of subscribers did not exist or were barely known just a few years ago. Skype, YouTube, BBC iPlayer, My Space, Bebo, Facebook, Hulu and many others barely existed in

[19] Cisco Visual Networking Index – Forecast and Methodology 2007 – 2012 (2008).

2004. These companies now generate most of the IP traffic growth today. In addition, companies such as Amazon and eBay are now moving into Web Services and Cloud Computing. Amazon's Web Services for Cloud Computing traffic now generates three times the traffic of their eCommerce sites – this was achieved only three years after Amazon launched the service. Skype is now the largest phone company in the world both by number of subscribers and by number of voice minutes. The BBC iPlayer is the fastest growing video web site in the UK and is currently estimated to be between 15 - 20% of total UK telecoms traffic. The Current Metro Network systems deployed are forecast not to be viable to cope with the Video internet traffic Tsunami building in the Network.

Implications for the Smart Economy

The Metro Bottleneck presents the most critical problem for the development of a low carbon Knowledge Economy. The collision of this dramatic increase in IP traffic with legacy technology and products in the Metro Network has raised serious issues including:

- Fibre under-utilisation and exhaustion in Metro Optical Networks resulting in near-term capacity shortfalls and slowing the roll-out of future services. Major Metro Optical Networks sometimes operate with less than 1% utilisation of one of the most expensive assets in the network i.e. the fibre optical cables;
- Internet switches & routers are consuming an ever-increasing amount of electrical power due to orders of magnitude increases in IP traffic. The Internet is one of the fastest growing consumers of electricity due to the vast amount of silicon and electronic memory chips required to switch and deliver IP packets;
- Challenges to cost-effectively operate and maintain large-scale networks due to the complexity of the current technology and network architectures. It can take carriers months to adjust their networks to the dynamic IP traffic flows, only to find that the IP traffic patterns have yet again changed and the networks need to reconfigured;
- Fixed and mobile broadband access will increase over the coming years (50 - 100 Mbps per subscriber is expected over the next 5 years). These broadband speeds will increase the risk of metro optical networks "packet brownouts" or potentially, total network collapse.

Next Generation Networks

These issues have triggered the search for solutions. Universities, carriers and network equipment vendors around the world are looking to Next Generation Network (NGN) architectures and technologies.

Optical Burst Packet Switching and Transport

There is general agreement that Networks must become (a) more optical and less silicon-based, and (b) less IP-routed and more packet-switched. Optical Burst Packet Switching and Transport has been identified as the leading disruptive innovation capable of delivering a viable Metro NGN to solve the

chronic problems of the Internet for the next 30 years. In parallel, by moving to this new paradigm, it will release the delivery of future Cloud Computing and Network Virtualisation services, cost-effectively and with a low carbon footprint.

The core benefits of a Network based on Optical Packet Switch and Transport include:

- Improves today's overall Network Performance threefold with the ability to linearly scale without complex routing and switching overheads;
- Reduces the carbon footprint by at least 75% over current Internet switches and routers;
- Reduces capital expenditure by 50-70% depending on population density and Internet services usage;
- Reduces ongoing operational costs and complexity by over 60%;
- Raises fibre utilisation from 1% to 83% thereby increasing sunk asset value and length of life-time service;
- Enables the same infrastructure to be used by any operator for fixed, mobile and enterprise access at any broadband speeds.

4.1.3 A Smart Irish Network Opportunity

Ireland is in a unique position to showcase a Smart Network enabler for the Knowledge Society.

Irish Technology Leadership - Intune Networks

Ireland has an opportunity to become a leader in Smart Networking based on Optical Burst Packet Switching and Transport (OPST) combined in one unified Networking platform for Fixed, Mobile and Cable networks. Intune Networks, an Irish-based technology company, has developed the world's most advanced OPST networking system required to build a next generation Metro Networks. The company was founded in 1999 by two UCD graduates and early clients include MIT, the European Space Agency, NASA and the US Defense and Advanced Research Projects Agency. Intune, in which Enterprise Ireland has invested, has been awarded a series of global patents around its core and proprietary innovations. Intune has received €25m in private venture funding to date from Irish and international investors. The company has solved one of the most critical problems in the development of next generation fibre-optic communications networks (cracking the colour code of light), delivers the USA's original vision of a superfast digital highway of the 90's and achieves a significant reduction in energy utilisation. The company has 98 employees in Dublin and Belfast (of which 92 are employed in R&D and half are PhDs) and is set to grow rapidly. Intune is a global leader in optical burst switching for Metro Networks[20]. Intune uses tuneable light (from semiconductor lasers) to switch and transmit telecoms traffic. This leads to a simplified network with improved predictability and performance while at the same time reducing power consumption. This means that a completely new low cost, green and ultra high speed communications infrastructure can

[20] Heavy Reading-Vol. 7, No 3, March 2009.

be introduced to replace end-of-life network equipment. The new system has been modelled extensively by four of Europe's major telecommunications carriers over the last 3 years and trials commence in June 2009. The new network will transform the Metro Heart of the Global Internet as we know it today and may be one of the most disruptive enablers for the delivery of new digital economy services worldwide in years to come.

Exploiting Enterprise Leadership and Government Investments and Geography

Having an ambitious company with world-leading Optical Networking technology is a unique advantage that Ireland can exploit and simultaneously progress the Smart Economy. This opportunity is strengthened by the existence of particular Government investments and potentially by Ireland's geographic position.

An opportunity exists to create an Exemplar Smart Network based on Intune's new network which will draw attention to Ireland as an innovative leader, and potentially deliver significant economic benefits. The Network would be embraced initially by Universities, multi-nationals and other Irish technology companies for research and development enabling the Knowledge Economy.

The Exemplar Smart Network would be used to demonstrate and highlight Ireland's foresight, technologies, research and corporate capabilities in order to attract more inward investment, rapidly expand job creation and stimulate the Smart Economy.

Ultimately, the Exemplar Smart Network could have significant tangible benefits. Creating a sustainable "ecosystem" around a new Metro Network offers the potential to create a substantial number of new jobs, lay the foundation for restoring Ireland's NGN communication infrastructure and ignite a wave of Internet based export opportunities that heretofore have been the gift of the PacAsia countries in particular.

Government MANs

Key to the success of the Exemplar Smart Network, are the Irish Government Metropolitan Area Networks (MANs).

MANs are State-owned, open-access telecommunications networks in towns and cities that are offered to service providers on a wholesale basis to allow them to provide services without the need to build their own networks. They consist of carrier-neutral duct and fibre rings linking the main commercial and public buildings in the selected towns and cities. Each MAN has at its hub a co-location centre where telecommunications companies can house their equipment and access the network on an open access basis. The MANs offer wholesale duct space, dark fibre, co-location facilities and managed services to telecoms operators to enable them to deliver high speed broadband services to their retail customers. By making these MANs available to all operators on an open access, carrier neutral basis they are stimulating

competition by removing the need for service providers to provide their own networks.

Phase I of this Programme delivered optical fibre based networks to twenty-seven towns and cities throughout the country. All twenty-seven are operational and open for business. The cost of the Phase I MANs Programme was approximately €85 million.

A further ninety-four towns were identified as locations for MANs under Phase II of the Programme. Fifty-nine of these MANs, covering sixty-five towns, have been completed to date. A further MAN is currently under construction and is expected to be completed in early 2010. The cost to date of Phase II of the MANs Programme is approximately €87 million. Figure 3 below is a map of the MANs.

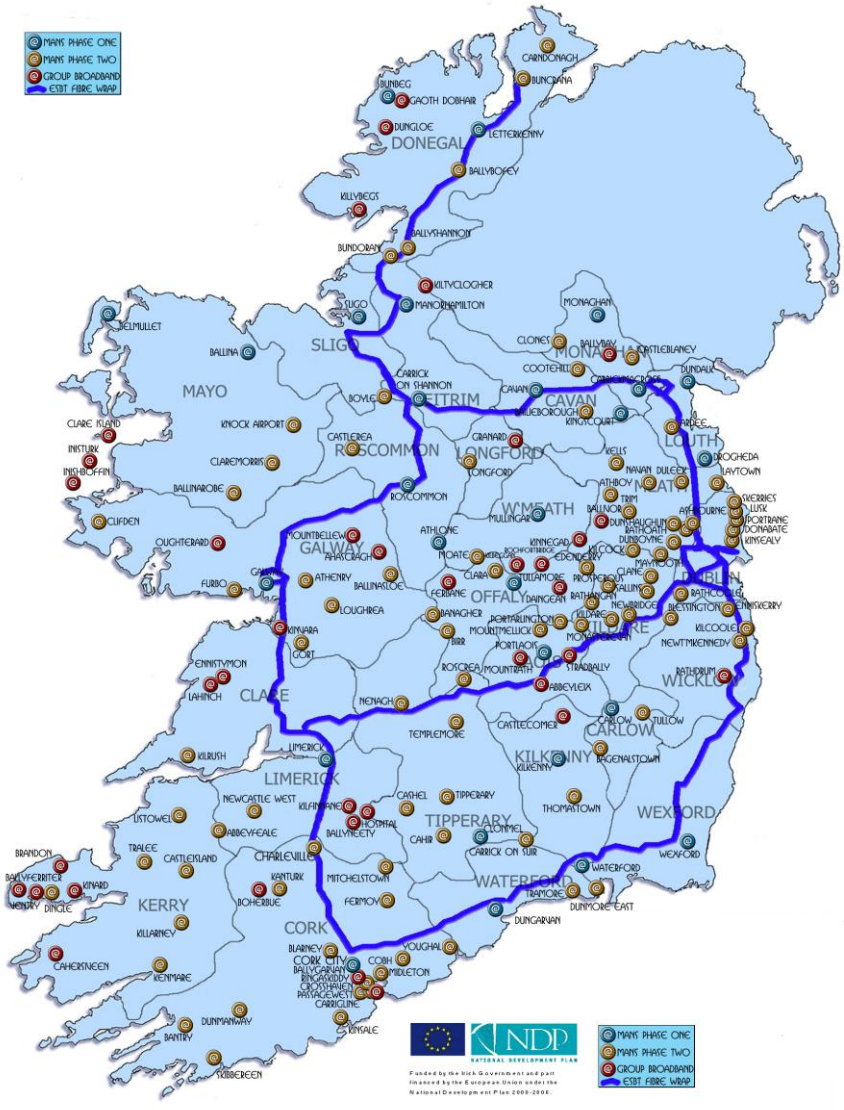

Figure 1: Map of the Government's MANs. Available at: http://www.dcenr.gov.ie/NR/rdonlyres/22D50F69-4E4A-4261-B990-E3B7D9B95669/25902/2005_05_dcmnr_bb_map1.jpg

Research Infrastructure

The vision for the Exemplar Smart Network leverages world class Irish research expertise, resulting from recent investments in the research sector. High-performing optical networking and switching research groups, that are already funded by Government, and which have clear potential to contribute include Tyndall National Institute's Photonics groups and RINCE's Optical Communications Laboratory.

In addition, other Government-funded research programmes offer potential linkages e.g. the CTVR researching and developing the value chain of the network (Section 3.1.2 above) and Waterford Institute of Technology's Telecommunications Software and Systems Group (TSSG) researching the operation, management and service exploitation aspects including relationship to Autonomic Services, to name just two. Furthermore, there are Irish start-up companies commercialising related but complimentary technology, for example Eblana Photonics. The potential is there for these world class R&D performers to join the Exemplar Smart Network ecosystem, help achieve its vision and positively impact on its outcomes.

International Dimension

Ireland's location at the periphery of Europe and the edge of the North Atlantic means we are close to several important transatlantic fibre-optic cables. These are key global telecoms links connecting Europe to North America. While the currently proposed Exemplar Smart Network focuses on the Metro Network within Ireland, ultimately there is potential for major benefits by applying the same principles to International Networks. The cables that pass our shore provide easy access to that Network. The possibility of extending the proposed Exemplar Smart Network to International Networks opens the possibility for Ireland to capture value from International traffic. This is particularly so if the proposal for the "International Content Services Centre" is pursued. The essence of the idea is to use unique features of the network technology to support the realisation of a highly-efficient global content distribution business. The potential value to Ireland is enormous.

4.1.4 The Exemplar Smart Network

The Exemplar Smart Network's primary objective is to provide a catalytic State of the Art Network platform to enable the Smart Economy Without this new Network platform Ireland would be waiting for critical technology and services to arrive from overseas at the tail end of the innovation cycle. The Exemplar Smart Network will be a shared open facility providing a NGN based upon the first unique Optical Burst Packet Switching and Transport Network invented and developed in Ireland.

The Exemplar Smart Network will support research and development by Universities, multi-nationals with local facilities and indigenous companies (established and start-ups). The concept is that authorised usage would be based upon application and acceptance, as well as commitment to fund and provide resources in Ireland.

The implementation of the Exemplar Smart Network would include:

- A main facility consisting of the core hardware, software and test equipment necessary to operate and maintain the network;
- Metro nodes at sites such as Universities, Government data centres and industry research offices within the greater Dublin area.

A proposed architecture, illustrated in Figure 22 is detailed in Appendix 1. This will be the subject of detailed stakeholder examination concerning the feasibility, cost and benefit of the proposal.

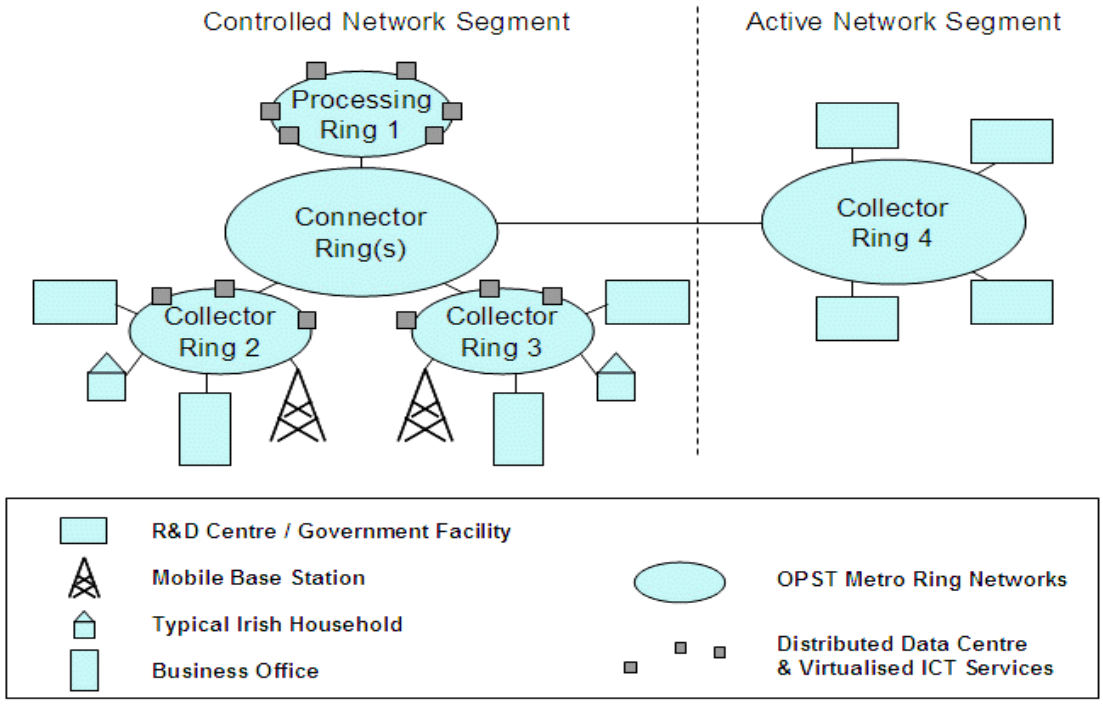

Figure 2: Proposed Exemplar Smart Network

The left-hand side is a Controlled Network Segment, to be housed in a single facility location. All services being demonstrated will be implemented and tested at this facility. This architecture is a model for a single national network over which consumer, business, R&D, government, Data Centre and mobile service applications are all supported.

The right-hand side of Figure 2, features an active network segment is proposed to be connected to the controlled facility by a point-to-point link. The active network segment is intended to link up a number of chosen Universities and Government sites and run live traffic over existing optical fibre cable runs around a metro area network. Services that have been tested in the controlled site will then be demonstrated over live fibre.

The Exemplar Smart Network will also be set up to host demonstrations and other events to showcase significant technologies, services, products, and

software applications to corporate executives and others from around the world.

The initial users of the Exemplar Smart Network are likely to include:

- Optical networking and communications research groups;
- Other research groups and centre e.g. high performance computing installations in several Universities;
- Multi-national companies;
- Indigenous SMEs and Start-ups;
- Government departments and agencies with large data transfer requirements (e.g. Revenue, GSI);

The Exemplar Smart Network will complement and enhance investments made by SFI, IDA and EI. The Exemplar Smart Network is intended to maximise investments being made in basic research, start-up companies, multi-national recruitment and expansion, workforce training and energy independence. It will simultaneously ensure early deployment of the Exemplar Smart Network infrastructure in Ireland required to develop other elements of the Knowledge Economy.

The goal is to achieve first mover status for Ireland and ensure that Irish industry and researchers have access to leading technology and infrastructure.

Over time, other potential users of high bandwidth services delivered over the Exemplar Smart Network are likely to include organisations such as HEANet and commercial Content Centres.

4.1.5 Target Markets and Applications

Four initial target markets and applications are planned for the Exemplar Smart Network. These are Telecommunications, Video Content, Energy/Sensing and Web applications.

Telecommunications Networks and Services

Estimated to be worth almost $2 trillion a year[21], the worldwide telecommunications market (network equipment, software and services) is one of the largest in the world. Capital expenditure, at around $240 billion represents about a quarter of this market. In order to create a Smart Economy there must be a Smart Network. One of the primary markets to target is therefore telecommunications hardware, software and services.

Almost every major carrier in the world is expected to undertake network transformation programs in the coming years. Ireland could become a centre of excellence for the design and operation of NGN Smart Networks. This would attract companies from around the world to come to Ireland for NGN Smart Networks research and development. In particular, the PacAsia

[21] Gartner Press Release 17th September 2008

telecoms carriers[22] which have already invested extensively in optical fibre networks will be motivated to increase the utilisation of those networks while reducing overall capital and operational expenditure. Carriers also want to "Green" their networks by dramatically reducing power consumption and the amount of resources required for operations and management.

If the major carriers come to Ireland to see and work with the world's first Smart Network, the world's major network equipment vendors[23] can also be expected to come.

Video Content Distribution and Delivery

The challenge posed to current networks by the enormous and increasing volume of video traffic being delivered across the Internet as streaming or IPTV broadcast services has already been mentioned. There is also the transition to digital TV - replacing the legacy analogue TV - distributed and delivered over an IP network[24]. Video delivery is moving beyond streaming services (e.g. YouTube) to delivering broadcast-quality video directly to subscribers regardless of their location or access device.

Consumers now expect that they can have broadcast-quality video content on demand, anytime, anywhere. The Exemplar Smart Network will allow for large content companies, such as RTE, to research and develop the technologies, applications and services that will be the basis for future consumer entertainment and information access.

The Exemplar Smart Network will allow for the scaled testing of next-generation video services delivered over a network infrastructure that was designed for the distribution and delivery of on-demand video. It will offer a guaranteed level of quality that can be audited and verified.

Smart Energy and Sensing

Renewable, green energy projects will need to be integrated with energy management applications and services. These energy management applications and services will be based on a new wave of sensing and monitoring technologies. The Exemplar Smart Network will provide the infrastructure for testing new sensors and sensing applications and integrating them with renewable and smart energy projects. This could provide an opportunity to link with the SFI-funded CLARITY CSET.

The integration of optical sensors, a Smart Network and web services applications will be critical for Smart Energy to be realised. Real-time automated control of energy distribution and device consumption must be achieved in order to substantially reduce national and individual carbon footprints. Energy production must also become much more efficient with

[22] Including KT (Korea Telecom), Chunghwa Telecom (Taiwan), Reliance Telecom (India), Tata (India), SingTel (Singapore), NTT (Japan)
[23] Including Fujitsu, NEC, Huawei, Alcatel, Cisco
[24] The digital dividend associated with this switch is discussed in Section 4.3.

higher resource utilisation. This can be achieved through the integration of optical sensors, a Smart Network, and web services.

Ireland can use the Exemplar Smart Network to facilitate the development of new optical sensors and web services applications and demonstrate the efficiency and value of these solutions to countries and companies world-wide. These applications could include the monitoring and management of oil fields, water distribution and the environment. The number of potential markets and applications is very wide.

Web Technologies, Services, and Applications

Web 3.0 – the next generation of web technologies and applications - is expected to be based on the Programmable (Semantic) Web. The Programmable Web will require a Smart Network where the web is in the network. Web services will have an entirely new set of protocols and capabilities and the Exemplar Smart Network will provide Researchers and Developers (e.g. the SFI-funded DERI CSET) with the NGN Smart Network upon which to create new Web 3.0 services, technologies and applications.

The Exemplar Smart Network based upon the Intune OPST platform will be developed upon embedded Web Services software, protocols and technology. This places the Web in the network and will enable an entire generation of new services and applications to be developed.

The ability to call bandwidth on demand in real time directly from a Web application will represent a fundamental shift in the industry. It will also challenge the current financial value chain paradigm requiring a new economic model and value chain. This will be the focus of much research at the University level and will attract researchers from around the world.

ICT Virtual Services, Cloud Computing, Software as a Service

ICT services will be virtualised, and the Smart Network will be the main channel for virtualised ICT services which are hosted and distributed from within the network itself. These virtualised services will include most aspects of ICT, business efficiency applications and software as a service. The following functions will be provided:

- Data and application hosting;
- Storage and data management;
- Liquid bandwidth on-demand with guaranteed quality;
- Web services that can directly call and manage bandwidth.

Every major carrier in the world has launched pilot projects to research virtual ICT services and Cloud Computing. This is probably the single most important next-generation project for the carriers in order to ensure future value creation as opposed to commoditisation such as happened with Web 2.0. The lack of value in traditional networks and the way of creating future value are key aspects of future research requiring an Exemplar Smart Network. This could provide opportunities to link with SFI-funded CTVR (Centre for Telecommunications Value–Chain Research) and FAME (Federated,

Autonomic Management of End-to-end Communication Services) research projects.

The major ICT software and service providers and the largest ISPs are also working to establish themselves in this very significant emerging market[25]. This will also require access to an Exemplar Smart Network.

4.1.6 Benefits of the Exemplar Smart Network

The Exemplar Smart Network offers significant benefits to Ireland. It will position Ireland as a global technology leader, with world-class research and a competitive Smart Network, enabling inward investment and job creation.

Ireland as a Global Thought and Technology Leader

The Exemplar Smart Network will place Ireland in first-mover status. Ireland will become known as the leader in Smart Networks for the emerging Smart Economy. This first-mover status will make Ireland a "magnet" in attracting inward investment, research investment and visits from Government leaders and corporate executives from around the world. Ireland will have several years' lead in the development of the newest services, applications and technologies. This will enable the creation of global companies established in Ireland.

Early leadership in new markets, based upon a proprietary and defensible set of technologies and products, is crucial to long-term economic success and the development of an extensive and robust ecosystem. The world's carriers and the industries dependent on them are all seeking a next-generation network upon which to develop a next generation of services. Ireland can become the centre of excellence and magnet for the research and development of these product and services by achieving first-mover status through the Exemplar Smart Network.

Job Creation

The Exemplar Smart Network will initially create hundreds of new, well-paid jobs. Between 2011 and 2016 it is envisioned that associated job creation will increase dramatically. These jobs will be first rate R&D engineering positions combined with commercial applications development, support and management of telecoms hardware, software and services, as well as ICT services and hosting centres.

The establishment of a value chain creates an ecosystem which over time begets an industrial base. It is the creation of an Irish ecosystem with the potential of developing a long term and sustainable industrial base in the global Knowledge Economy which is the primary objective of the Exemplar Smart Network.

[25] Including IBM, Oracle, Microsoft, Tata, Cap Gemini, EMC, HP, NEC

Expanded World-Class Research

The Exemplar Smart Network will elevate Ireland as a centre of excellence for research into the Smart Network, the Smart Economy, and the Knowledge Society. The Exemplar Smart Network will attract leading researchers from around the world to Irish Universities and will attract inward investment into research programs performed by multi-nationals. In the next five to ten years it is envisioned that Ireland will be a centre of learning and research in key areas of the Knowledge Economy. This will include the economic and financial modelling for the potentially new industrial value chain (and value creation).

Ireland has the unique opportunity to establish global leadership in a segment critical to the future of the global economy. This will require research across many disciplines which is focused, coordinated and directed. It will also require government support enabling the research to be viable, executed quickly and ultimately successful.

The Exemplar Smart Network is the critical and necessary infrastructure upon which to base this research. It will attract the best and brightest experts from around the world.

Inward Investment Expansion & Permanent Presence

The Exemplar Smart Network will attract increased inward investment. It will facilitate expansion by the multi-nationals currently operating in Ireland and it will attract new multi-nationals to locate facilities here. The Exemplar Smart Network will be a major attraction for companies and countries in regions that are and continue to feature high growth:

- Pacific Asia: PacAsia countries are still the highest per capita consumers of Internet services and have the most extensive optical fibre networks. These countries and their carriers and vendors do not have the disruptive innovation that can be offered by Ireland. There is an opportunity to receive direct research investment as well as export products and services;
- Middle East: The Middle East will continue to invest heavily in network and ICT technologies and services. With limited technological innovation, this region will invest extensively in research and development and offer long-term export potential.

There is a significant near-term opportunity to partner with countries and companies from the PacAsia and Middle East regions. This would create substantial investment in research as well as creating a large and long-term export market supporting stable employment in Ireland.

4.1.7 The Digital Leapfrog Program

It is envisioned that the Exemplar Smart Network would be the first phase of a multi-phase program “Digital Leapfrog”. Digital Leapfrog is an option to expand the Exemplar Smart Network into a commercial Next Generation Network covering all of Ireland – and potentially beyond. The Digital Leapfrog

program would allow the Government to create a NGN optical network that would be open to all Government agencies, universities, carriers, enterprises and service providers. Digital Leapfrog is structured so as to ensure the Government has direct input and oversight in the design, development, use, deployment and management of the next generation broadband network – the Smart Network. Each phase can be implemented at the discretion of the Government, based upon an agreed cost/benefit analysis. Five phases of Digital Leapfrog are planned.

Phase 1 – Exemplar Smart Network

The primary objective of the first phase would be to create the Exemplar Smart Network so that Ireland would be the first nation to have a Next Generation Network based on Optical Burst Packet Switching and Transport (OPST) for research and development. This would be the world's first Smart Network. The Exemplar Smart Network would be used for University research and multi-national product R&D and would facilitate indigenous established and start-up companies in developing products and services for the Smart Economy. The Smart Network would also be a global demonstration centre, attracting Government officials, telecommunications executives and multi-national executives from around the world. The Exemplar Smart Network would allow Irish companies to be first to market with new products and services based on a NGN. Having the first Smart Network in place will also encourage FDI.

Phase 2 –Smart Network Commercial Launch

Ireland could launch the first Smart Network deployment in the world based on an OPST platform. This Smart Network would be based on the work from the Exemplar Smart Network partners and Intune Networks' continuing technology and product development. It would be based on existing Government-owned fibre assets. This would initiate international exports of products and services developed in Ireland and lead to enhanced job creation.

Phase 3 –Smart Network Commercial Expansion

The NGN Smart Network deployment will be expanded to cover the main population centres, Universities, industrial parks and content distribution sites across Ireland. This would ensure the initial development of a true Knowledge Society, supported by the world's leading NGN Smart Network coverage. Irish companies and multi-nationals in Ireland would deliver rapid job expansion across all elements of the Smart Economy, and Irish research would be at the forefront of these new technologies and sciences.

Phase 4 –Smart Network at Scale-up

The national Smart Network would integrate and connect all aspects of the Smart Economy across a single infrastructure, to create the backbone of the Knowledge Society. It would include environmental sensing applications, renewable power technologies and usage monitoring, as well as smart ICT for application and storage hosting centres. The national Smart Network would

be open to all network operators and third-party networks based upon well-structured, guaranteed levels of service with associated fees and licensing. Irish companies and Irish-based multinationals would be global leaders for Smart Networks, the Smart Economy and the Knowledge Society.

Phase 5 –Smart Network at International Scale

There is the possibility to extend the scaled-up national Smart Network internationally through connection to fibre-optic cables passing nearby Ireland. This would be prepared for through focused research efforts of various partners involved in the earlier phases. The Smart International Network would first involve establishing an international test gateway to trial the technology over long distances with international networking systems. Realisation of the Smart International Network based on OPST has the potential to create significant value for Ireland and the companies involved. Ultimately, this also has the potential to provide a highly competitive infrastructure to underpin the proposed International Content Centre (see Section 4.4) along with extending its reach and impact.

Way Forward: A series of workshops is being planned with potential users of the Exemplar Smart Network, relevant state agencies and contractors, along with Intune Networks and relevant Research Centres to consider the design, benefits and implementation of the proposed network.

4.2 Data Centres and Cloud Computing

4.2.1 Data Centres

The modern corporation runs on data. Data centres house the thousands of servers that power applications, provide information and automate a range of processes. There is growing demand for data centre capacity while the power consumed by the servers is responsible for rising operating costs and increased greenhouse gases[26]. Data centre efficiency is a strategic issue for both companies and the economy.

A data centre is a facility used to house mission-critical computer systems and associated components for companies and organisations. It generally includes environmental controls (air conditioning, fire suppression, etc.), redundant and/or back-up power supplies, comprehensive data communications connections and high security.[27]

Data centre service providers help companies to reduce costs by consolidating their IT requirements, resulting in easier management, improved security, better utilisation of their IT facilities and improved business continuity. They also offer hosting and internet connectivity. The service provider manages the data centre, infrastructure, server hardware, and operating system through a Service Level Agreement. Although data centres consume a lot of energy, they still represent a considerable overall energy

[26] The McKinsey Quarterly, *Data centers: How to cut carbon emissions and costs* November 2008
[27] The Data Centre Journal Website

saving for an organisation by means of virtualisation and optimisation of resources.

Data storage has become one of the fastest-growing parts of IT budgets due to enterprise-wide transactional systems, massive data warehouses and explosive growth in email traffic.[28] If this growth continues to rise, it will become harder for companies to store and exploit new forms of data. Companies often store many more copies of data than they need and would benefit from simpler storage configurations.

Greening Data Centres

Corporations are coming under increasing pressure to make their data centres more energy efficient, particularly in the current economic climate. Energy costs have become significant, exceeding IT capital costs over a five-year period. Energy consumption continues to increase, with the growing consolidation of distributed IT in data centres. Furthermore, legislation is expected in relation to carbon emissions arising from the Kyoto Protocol and the European "Code of Conduct on Data Centres Energy Efficiency". In many cases, planning requirements for data centres require partial on-site power generation as climate change is becoming a high profile issue.

In 2007, data centres were typically 33% efficient. Half of the data centres built before 2002 were obsolete by 2008 because of insufficient power and cooling capabilities.

Power usage effectiveness (PUE) is a metric to determine the energy efficiency of a data centre. In an ideal case, the power feeding a data centre would be exactly equal to the power used to run the computer infrastructure within it. PUE is therefore expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1. PUE was created by members of the Green Grid, an industry group focused on data centre energy efficiency.

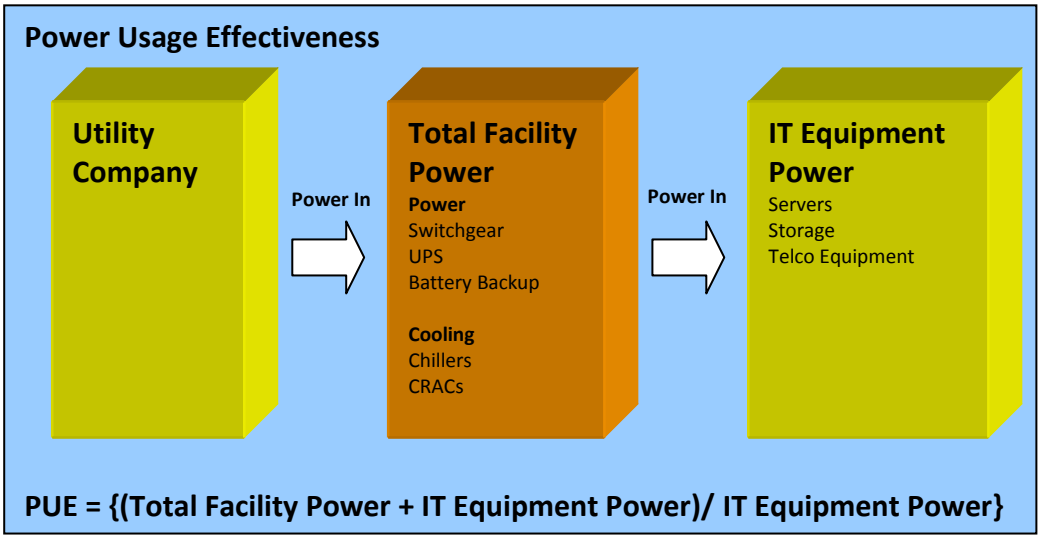

Figure 3

[28] The McKinsey Quarterly**,** *Meeting the demand for data storage*, June 2008

The development of powerful chillers (cooling systems) and associated computer room air conditioning (CRAC) units has allowed modern data centres to install highly concentrated server clusters. Chillers typically consume the largest percentage of a data centre's electricity.

Data centres are evolving rapidly including:

- Development of high-utilisation IT systems to reduce the space required and the power consumed;
- Design of energy-efficient data centres with lower PUEs to achieve emissions targets and meet legislative requirements;
- Development of renewable energy sources such as wind turbines, Hydrogen fuel cells and Bio-fuel.

Historically, data centres were designed with large tolerances to allow for operational and capacity changes including possible future expansion. Many today use design practices that are outdated. Wider operating tolerances in the latest hardware means that equipment can run hotter than before and requires less heating, ventilation and air-conditioning to operate efficiently. These factors lead to power consumption inefficiencies. In most cases only 15% to 20% of the grid power consumed by the data centre actually gets to the IT systems. Most enterprise data centres today run large amounts of redundant power and cooling systems typically to provide higher levels of reliability. Additionally IT systems are running at an average utilisation of 15% to 25%. Over-provisioning, ensuring availability and the associated costs were considered a negligible risk to business performance; energy costs used to be relatively small in comparison to the IT budget and environmental responsibility was not a key remit of IT organisations. However, with rising energy prices this is no longer the case. Energy consumption at the individual data centre level is becoming increasingly important. Operating energy costs, along with the ecological impact of the energy consumption, are now important in the overall cost of ownership of data centres.

Policy Opportunity on Energy -efficient Data Centres

Achieving a competitive green rating is important if Ireland is to continue to attract FDI. Ireland needs a combination of cheap renewable power and locations connected by high speed optical networks. Emerging trends indicate a move towards software as a service, and similarly, towards hardware as a service. There are also indications of a more general movement towards Cloud Computing.

To make Ireland a unique hub for Data Centre location, Ireland needs an explicit policy on encouraging energy-efficient data centres. This would attract FDI, build skills capacity, generate intellectual property and create jobs.

Ireland could take the lead in this area to become the first country in Europe to define a National Green Standard for Data Centres . Ireland already has distinct advantages in terms of climate, geographical location and topology. Several multi-national companies have already built large Data Centres in Ireland and are locating their Regional HQs here as a result. Supporting such

investment will attract further companies to Ireland and build on these achievements. The majority of new jobs will result from the ancillary business and industry activities around Data Centres. Locating Data Centres here will drive the content industry. Innovations in Data Centres and communications networks can be linked to develop new classes of Data Centre with Ireland in pole position.

Adding Value to Data Centres

In addition to storing data securely and reliably, Data Centres have the potential to add significant value by offering data processing services. Examples include data retrieval search engines, data correlation and mining and "Deduplication" of data.

An overwhelming amount of data is duplicated in corporations, consuming storage space and power. Significant cost savings can be made by removing this duplicated data. Deduplication is a method of compressing data by storing only changes to the original data. For example, when a document is created, it is stored as a regular, complete file. When changes are made, deduplication stores only the data that has been modified in a subsequent file with indexes to the original.

In file deduplication, only one copy of the file is stored even though it may be referenced from many sources. For example, if the same attachment is used in several e-mail messages, the second and subsequent messages are changed to link to the original attachment rather than duplicating it each time.

4.2.2 Cloud Computing

The central concept of Cloud Computing is that a Data Centre takes over the administration and operation of a company (or consumer's) IT infrastructure. This can include networks, servers, operating systems, data storage, and applications. The company or consumer can then access these capabilities remotely using an increasing range of wireless devices.

Familiar examples of "cloud services" include web-based email, word-processing, spreadsheets and online data storage. Firms that provide software as a service (SaaS) over the internet have been growing steadily. Cloud Computing is a far more efficient way of running IT systems.[29]

Cloud Computing will not only reduce costs, it will profoundly change the way people work. It will also change the way companies operate, allowing digital technology to penetrate every facet of the economy and society.

Cloud Computing is a quickly-emerging business opportunity for ICT service providers. Within Cloud Computing there are service opportunities in:

- Infrastructure (VoIP, security, storage);
- Software (email, directory services, business applications);

[29] Economist, *Let it rise* 23rd October 2008

- Information (data warehousing, knowledge repository and management).

Cloud Computing will make true flexible working possible. In spite of flexible working policies, many workers ultimately remain tied to 'their' particular PC, on which they have saved the documents they need. When all files are stored in the "Cloud", this barrier evaporates. Indeed, the organisational culture or mindset of a business that embraces Cloud computing changes fundamentally. Rather than thinking of a job in terms of a physical location where a specific activity takes place, workers and managers will begin to think of what they do as a specific activity that takes place online - which can be anywhere. Businesses should not underestimate just how differently their employees' minds will work when the software they use is situated somewhere they can access from anywhere.

With the proliferation of multiple devices and the availability of mobile broadband there will be increased opportunity to access data as required from a central repository which would otherwise be inaccessible on a hard disk drive.

A corollary of this is greater collaboration and the innovation rewards that go with it. Stripping infrastructure out of a process is about removing barriers. Creating a barrier-less working environment - one in which employees, their clients, partners, suppliers or customers can all work together more fluidly - greatly enhances collaboration.

Cloud Computing facilitates 'co-creation', a form of collaborative working. Content becomes owned by a group of people, who work together in a totally natural way, without technological or location-based hindrance (because the software is online). Adopting this principle, Content Centre operators and back-office service providers based in Ireland could utilise Cloud Computing to further innovate and virtualise their existing off-shore business models and services.

Definition

Cloud Computing is a pay-per-use model for enabling available, convenient, on-demand network access to a shared pool of configurable computing resources (networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service-provider interaction[30].

Cloud Computing promotes availability and is comprised of five key characteristics, three delivery models, and four deployment models. These are detailed in Appendix 2.

[30] National Institute of Standards and Technology, Information Technology Laboratory, USA, May 2009

Virtualisation

Virtualisation is an exciting emerging concept, whereby, idle network capacity is used more effectively and efficiently. Consider the case of ten servers being used at just 10% capacity. Virtualisation can focus usage onto a single server operating at 100%, making the other servers redundant and saving power and money. As the technology develops, it is anticipated that these techniques will be applied across entire Data Centres, multiplying the economic and environmental benefits. Ultimately, managers will have an at-a-glance understanding of all of the processing power available to them across an entire Data Centre. The automation that is happening in many other IT-led business processes will be mirrored in Data Centre automation. Much of today's scheduling is done by administrators. But, by removing the need for high levels of hands-on human management and monitoring, Data Centres could be relocated wherever power is cheaper[31].

4.2.3 Showcase Developments in Ireland

There are significant ongoing developments in Data Centre and Cloud Computing in Ireland. Three examples are presented below.

Example 1: The Cork Internet eXchange - A Hyper Energy-efficient Data Centre

The Cork Internet eXchange (CIX) is a new multi-million Euro investment on the north side of Cork City offering energy-efficient Data Centre facilities to businesses (and Government). Customers are aiming to reduce their overheads and focus more on their core function as they move to a more competitive business model. CIX is a carrier-neutral IP point of presence intended to provide peering and cost-effective backhaul to businesses in the Munster region. The company also provides disaster recovery and business continuity capabilities to businesses nationally.

The facility is one of the world's most energy-efficient data centres, with an annualised design efficiency objective of 80%. It has been designed with N+ 1 capability in its power, cooling and connectivity. CIX has a 15% energy budget for air-conditioning. Several design features are combined synergistically to achieve the required efficiency. The CIX facility features:

- Free-cooling Chillers;
    - Ireland's relatively low (11 degrees Celsius average) ambient temperature allows pre-cooling of chilled water prior to refrigeration;

[31] BT A Realist's Guide to Green Data Centres, 2007

- Dynamic Chiller Set Point;
    - Maximises the opportunity for free-cooling chillers;
    - Reduces the need for humidification by maximising the chilled water temperature to minimise condensate in CRAHs (computer room air handlers);
    - Reduces (and almost eliminates) cold and warm water mixing in the CRAHs;
- Cold Aisle Containment;
    - Maximises the opportunity for free-cooling chillers and maximises refrigeration efficiency;
    - Eliminates warm and cold air mixing in the data centre;
    - Low-resistance air paths (high ceilings and deep, 800 mm, floor cavities) reduce air circulation energy;
    - Reducing electrical power consumption in the CRAH by maximising warm return air temperature and minimising or eliminate water mixing in double regulation valves (DRV) and using direct-drive fans to eliminate belt drive losses.

CIX has a 5% energy budget for electrical power loss. This is divided into transformer and UPS losses:

- MV Substation;
    - A 10 kV substation has been built into the Data Centre to minimise transmission losses;
- Efficient UPS;
    - General Electric Pure Pulse UPS systems operate at 98.4% efficiency at 50% load;
- Demand Response;
    - CIX is one of the first companies in Europe using demand response (DR) principles to reduce energy costs. As well as reducing costs, DR allows increased renewable penetration onto the Irish electricity grid. These principles are widely adopted in the USA.

CIX will participate in the Irish Government's initiative to improve the competitiveness and efficiency of technologies such as Data Centres, and to enable advances in Cloud Computing that will support the Smart Economy.

For all-Ireland to participation in the Smart Economy, there is a need to build a low-cost, high-resilience, high-bandwidth, low-latency fibre backbone throughout the island. Such an infrastructure would allow CIX to demonstrate, in partnership with IBM and others, the capabilities of Cloud Computing and the capabilities of Data Centre consolidation using geographically dispersed regional facilities.

Example 2: Cloud Computing and the IBM Dynamic Infrastructure for a Smarter Planet

IBM – The Global Perspective

As part of the 'Smarter Planet' initiative, IBM has developed a strategy for 'dynamic infrastructure'. This will help organisations to address higher service expectations, rising cost pressures along with new risks and threats. It will also lay a foundation for breakthroughs in productivity, accelerate value creation and increase the velocity needed to reach the faster pace that business and society demand. In this smarter world, we need our infrastructure to propel us forward, not hold us back. This infrastructure becomes instrumented, interconnected and intelligent to bring together the business and IT functions to create new possibilities across the organisation.

IBM's new approach spans both physical and digital assets. It includes Data Centre systems, distributed computing resources, business processes and software solutions to address both current and emerging business imperatives. Through investment in the Technology Campus in Dublin, IBM is demonstrating concrete progress towards developing a dynamic infrastructure.

IBM – The Irish Perspective

The IBM Datacentre is located on the Technology Campus in Dublin 15. The campus location is deliberately configured by IBM to be an on-demand facility, able to react rapidly to changes in business requirements. In recent times IBM, together with the IDA, has announced several key new missions that significantly extend our leadership in offering Dynamic Infrastructure locally and globally. These include:

- The Dublin Cloud Laboratory, one of nine IBM cloud laboratories across the world. The Dublin Cloud Lab has created a unique innovation ecosystem combining clients and academic partners working on the next generation of emerging Cloud technologies. The output of IBM's Cloud Labs is actively used in its products and technologies to deliver dynamic, resilient and scalable computing infrastructure. This firmly places Ireland at the centre of Cloud Computing innovation in IBM;
- The Green Centre of Excellence is leading IBM thinking on the smart use of constrained resources such as water and energy. For example, the 'SmartBay' project (See Chapter 6) provides a demonstrator capability, allowing IBM to develop and test innovations in the smart metering and monitoring of energy, water and waste;

- The Research Data Centre, under construction in the Campus, further strengthens IBM's capability to deploy and test advanced monitoring technologies in the area of green and sustainable Data Centres. This facility is designed as an energy-efficient, instrumented 'sand-box' that IBM and partner researchers can use to test resource management and monitoring technologies in a Data Centre environment.

Recognising the strategic value of these projects and the need to deliver world-class service to clients, the IBM Data Centre is purposely designed to accommodate a High Density Computing environment. It is targeted at hosting Cloud and Virtualised software solutions for IBM and its Managed Services customers as well as supporting research projects. The infrastructure is fully redundant with energy-efficient operation at its core. The site itself has dual power feeds from the National Grid and significant on-site capacity for both power and space expansion.

The Data Centre Suite has been sized to maximise the usable raised floor space supported by an independent infrastructure. This allows for expansion on a modular basis, introducing new capacity as needed. It also maximises the energy efficiency of the facility over its lifespan by only having to add necessary infrastructure components on demand and it provides the flexibility to invest in newer, energy-efficient technologies when they become available. For example, the in-room cooling systems utilise the latest energy-efficient EC fan technology to cool both the data and plant rooms. Each of these units uses only about 25% of the power of similar capacity air handling systems found in most Data Centres.

IBM plans and regularly reviews the arrangement of equipment within a standardised Hot Aisle/Cold Aisle layout. The dedicated IBM Data Centre Services Team, which has global analysis and optimisation experience, is used. The optimisation team use both Computational Fluid Dynamics analytical software and proprietary systems (MMT) to map, manage and measure the temperature and volume of airflows from vented tiles. This enables directing the precise amount of cooling required to each rack.

By adopting a stringent air management strategy and constantly analysing the environment to this level, IBM eliminates potential 'hot spots' and therefore minimises wasted energy. IBM has also installed a dynamic range of sensors throughout the room, which constantly provides real-time data used to monitor and efficiently operate the raised floor environment.

In summary, IBM has long recognised the need for an integrated and dynamic approach to infrastructure. This is embodied in the Dublin Data Centre facility where an ecosystem has been created incorporating high-specification operational infrastructure with the best use of emerging Cloud Computing and smart sensors technologies. This ecosystem is a key component of IBM's strategic plan for future growth in Ireland and is a template for the design of 'Smarter Planet' solutions.

Example 3: Microsoft's Software Plus Services Initiative

No initiative is more important to Microsoft than Software-plus-Services, which today includes more than 200 online and live services including Bing, MSN, Windows Live, Windows Live Hotmail, Xbox Live, and a broad range of communications and collaboration services. In the future, nearly every product from Microsoft will include some type of online service component to add value to customers. To support these services and deliver continued innovations and improvements in efficiency, the company continues to invest heavily in an innovative and environmentally sustainable cloud infrastructure via our data centres.

Four core areas of focus drive Microsoft efforts in this area:

- **Infrastructure Services** – continually optimising to reduce costs and improve performance in our data centres and connecting networks
- **Global Delivery** – delivering the world's largest array of online services 24x7x365
- **Online Security** – delivering trustworthy, available online services that create a competitive advantage for Microsoft and our customers
- **Environmental Focus** – helping to lead the industry in energy efficiency, reducing waste, and using recycled resources wherever possible

Microsoft's Data Centre Presence in Ireland

Microsoft infrastructure operations in Ireland encompass all four areas of focus noted above. Our newest mega data centre in Dublin is a key facility in improving the global delivery of the company's growing online services. The Dublin facility (opening in autumn 2009) is also the proving grounds for the company's latest developments in energy efficiency and other efforts toward environmental sustainability. For instance, Microsoft engineers have been at the forefront of industry efforts to run data centres with less reliance on chillers, which consume vast amounts of energy. The Dublin facility will use outside air for almost all of its cooling, thereby saving substantial amounts of energy.

The facility will also make use of shipping containers, each capable of housing up to 2,500 servers, thereby increasing energy efficiency and eliminating the waste previously incurred when servers were delivered in packaging materials that are discarded immediately. That waste can add up fast for data centres as large as the Dublin facility, which will contain tens of thousands of servers.

Microsoft's strategy for containers to house servers has been in the works for a couple years now, and the Dublin data centre will take the approach to a new level. In the future, the company plans to expand the facility with

a Generation 4 modular addition that will apply a modular building approach to the entire infrastructure, including the electrical and mechanical systems. The payback for this innovation will come from the commonality, manufacturing, supply chain, and integration of these modules, which will provide a plug-and-play infrastructure along with modularised server environments. This “building block” approach will allow Microsoft to add data centre capacity as it is needed, scaling the infrastructure to business demands, smoothing capital investment, and driving down costs.

Another revolutionary aspect of Generation 4 is the lack of need for traditional roofing and concrete walls, which are no longer required because the modular components provide their own enclosures. Doing away with the need for vast amounts of concrete and steel—which require large amounts of energy to produce—is another way the Dublin facility will introduce significant improvements in environmental sustainability.

Ireland is also home for the Microsoft organisation that localises and globalises the company’s online services for markets around the world. Launching and supporting new enterprise services involves a great deal of complexity in terms of languages, market needs, performance issues and cultural and geopolitical sensitivities. The localisation team in Ireland assists product teams worldwide by fine-tuning services to specific market needs and addressing unique requirements such as countries with high mobile phone usage or lower network connectivity.

In summary, Microsoft recognises that the world’s largest Internet populations and greatest growth potential in the next few years lies in Europe, Asia, and Latin America. The company’s operations in Ireland play a key role in helping Microsoft deliver the best experience possible for this global audience, and for making progress with shared concerns such as those around energy consumption and the environment. As different phases of the Dublin data centre come online and Microsoft launches new services requiring globalisation expertise, the contribution of Microsoft operations in Ireland will continue to grow.

Example 4: eircom Managed Services Data Centre

eircom, Ireland's largest telecommunications company, is a leading provider of co-location and managed data centre services for companies needing single site and multi-site solutions. From its portfolio of four data centre facilities, eircom has enabled multinational corporations to use Ireland as a European or EMEA headquarters.

In 2008, eircom opened Ireland's newest and most technologically advanced managed services data centre in Clonshaugh, Dublin. The 125,000 sq. ft. facility, representing an investment of more than €100 million, incorporates advanced power, cooling, fire suppression and biometric security. The facility is designed to minimise power usage through the deployment of a range of energy efficiency techniques including free-to-air cooling, energy management and building management systems. The centre makes extensive use of technology to manage technology, including intelligent utilities for systems set-up, monitoring, alerting and trouble ticketing.

The Clonshaugh facility and eircom's three additional data centres are tightly integrated with the eircom international IP network, which provides a high capacity and highly resilient IP backbone out of Ireland, and with eircom's nationwide next-generation IP network, which facilitates high-speed IP services at 238 aggregation points around the island of Ireland.

In Citywest, Dublin, another eircom facility was the first commercial data centre in the Republic of Ireland to achieve the Information Security Management System (ISMS) certification, BS7799 (now known as ISO27001). Global demand for facilities offering this certification is increasing, as the certification supports compliance in a number of areas including SAS70, PCI and Sarbannes-Oxley.

Colocation and managed data centre services from eircom are used by clients including Microsoft, Sage and Ingersoll Rand, and by the Irish government for high-use, citizen-facing online services including transactional services for automobile tax renewal and digital certificate handling for income tax payment.

4.2.4 Opportunities and actions

The DCENR held a High Level Strategic Workshop on Data Centres and Cloud Computing on 1st May, 2009. The key opportunities and actions identified by the workshop are summarised below.

1. International Connectivity

Problem: International access from Ireland is routed via other hubs, resulting in increased latency for IP traffic to and from Data Centres.

Proposed Action: Direct access to an international IP backbone is needed in the southern part of Ireland akin to the Kelvin Project in the North. The Government should first assess the possibility of interconnection to an existing submarine cable at the nearest point.

A marketing programme (IDA) is needed to attract the tier-1 backbone providers that do not currently have IP backbone points of presence (PoPs) here. The Government should explore the need for a direct connection to Europe that does not route through the UK, possibly using advanced communications technology. This would enable Ireland to be a virtual extension of the main internet exchanges in mainland Europe (AMSIX, DECIX, ESPANIX, etc). While communication & branding may be for a later date, Government should plan how to position Ireland globally in this space, and promote the opportunities and ideas within Ireland.

A cross-industry forum should be established in this area to determine the facts around expected demand, current available capacity, network topology issues, operational specifications (e.g. latency) and market competitiveness.

It is also imperative that connectivity between Dublin and the regions is improved using existing fibre infrastructure owned by Semi-state companies – ESBT, etc. The Government should consider intervention on national connectivity at high-capacity levels (multiple wavelengths or even dark fibre) from Dublin (where the only IP backbone PoPs are) to the major urban areas outside of Dublin (Cork, Limerick, Galway) as current pricing is not competitive.

Benefit: Reduced latency on international IP links would make Ireland a more attractive location for Data Centres and associated FDI. Such investment would capitalise on and complement the Kelvin Project. This would also make it attractive and feasible to locate data centres outside Dublin.

If a cost-effective solution is put in place using the existing infrastructure, many of the current regional (Cork) latency issues will be removed. It would also generate an income from infrastructure that is sitting idle and would also allow businesses (IBM, Microsoft and CIX) to begin testing the Cloud/Distributed Computing concept between regions.

This would also prove the concept of reducing the number of Government Data Centres, (point 2 below) and be the first step towards setting up an R&D centre for Data Centres and Cloud Computing, (point 3 below).

2. Government Procurement Consolidation

Problem: At present, Government departments, local authorities and agencies have multiple Data Centres.

Proposed Action: Government Data Centres should be consolidated into a greatly reduced number of technically and environmentally-advanced facilities. These should be interconnected via a single, resilient high-speed network. The Government should take the lead in bringing this about and make Ireland a world-leading location for energy-efficient Data Centres. The Government should appoint a high level CTO with the authority to drive cultural change across the many departments and agencies.

Public procurement policy should be adapted to stimulate and drive innovation and cost transformation across the public service. When the total costs of ownership are considered, ICT services could be operated and provisioned on a much lower cost basis. When allied to innovation targets, the public sector could lead the way in harnessing the latest technologies to provide more cost-effective services with enhanced quality and functionality.

As an example, Japan's Ministry of Internal Affairs and Communications plans to build a massive Cloud Computing infrastructure to support all of the government's IT systems. The new infrastructure will be built in stages through to 2015. The goal of the project is to consolidate all Government IT systems into a single Cloud infrastructure to improve efficiency and reduce cost. By consolidating current Data Centres, the Cloud will eliminate the need for individual ministries to maintain their own IT systems and allow each ministry to use only the computer resources necessary through the Cloud platform.

Benefit: This new facility will enable significant infrastructure cost savings and, over time, will facilitate the migration of Government applications to the new Cloud Computing model. Workloads will shift dynamically across Data Centres and networks to where the cost/benefit is best delivered. It will become a showcase for Irish Government technology leadership. Furthermore, the savings associated with this facility should be ploughed back into making the facility a "sandbox" and incubator for Irish companies to develop new technologies for Data Centres and Cloud Computing. This will also lead to creating benchmark performance data for tracking public service competitiveness.

3. R&D Centre for Data Centres and Cloud Computing

Problem: Cloud Computing and other approaches such as 'Software as a Service' initiatives, have a huge reliance on high-speed, reliable customer access to centralised IT services. Current network and Data Centre architectures will potentially become performance bottlenecks in this

centralised model. New, innovative approaches are required to optimise end-user experience in a Cloud Computing environment.

Proposed Action: Set up an R&D centre using the funds generated by the consolidation of government Data Centres and networks. Demonstrate how the Data Centres of the future could be achieved by distributing them across the network, using the latest technology developments. Demonstrate that this is a scalable solution applicable to other countries and export the technology. Make the R&D centre an open facility for others to proof-test concepts and attract FDI. Make a leapfrog change to bring Ireland into a world-leading position in Data Centre design and development by leveraging the latest technology developments.

There should be a wider discourse on the design and development of Data Centres and supporting network infrastructures. A national R&D centre within this domain could facilitate a collaborative approach with industry for research, development and commercial incubation. An example of this approach is BT's collaboration with the Tyndall Institute on advanced fibre optic network propagation techniques. There are opportunities for collaboration with the NUIG's DERI to focus a shared research effort around Cloud Computing.

Opportunities for linkage to the proposed Exemplar Smart Network and other national research expertise exist.

Benefits: Ireland would become the world leader in Data Centre design and development having leapfrogged competing countries using technology developed in Ireland. Ireland would become a Data Centre and Cloud Computing hub, attracting FDI and developing intellectual property, skills and jobs in this area. Synergistic value would be derived from the Exemplar Smart Network and national research infrastructure.

4. Green Standard

Problem: There are various standards and metrics that define energy efficiency for Data Centres and the IT platforms deployed in them, but none that is universally accepted as a 'de-facto' standard. Adoption of standards by organisations will depend on their being confident that the methodology is recognised and would be evaluated in a fair manner. Performance metrics for Data Centres based on data throughput do not yet exist.

Proposed Action: Ireland should be at the forefront in defining an appropriate set of metrics and standards (a Green Grid Standard) to apply to Data Centres and associated infrastructure that promotes energy efficiency in the most holistic sense possible. These standards should be adopted and deployed as part of any government consolidation programme as outlined earlier. Much of this could and should be built around the European Code of Conduct for Data Centres. The Data Centre infrastructure Efficiency (DCiE) measurement outlined in the Code of Conduct could be used as the metric with mandatory targets being set for all new data centres in Ireland. BT has

recently published a “Realist’s Guide to Green Data Centres” which may help to frame a green standard for Data Centres.

Benefit: The use of a consistent method for assessing Data Centre energy efficiency could be used to define benchmarks and identify best practices.

5. Incentives

Problem: The adoption of green IT policies and the driving of energy efficiencies can be hampered by perceived implementation costs. The cost of energy-use in Data Centres has risen considerably with increased throughput, prompting companies to think about energy-saving opportunities. However, reliability is still the main driver for change. Incentives are needed to ensure that IT managers see the value in managing energy use.

Proposed Action: Incentivise companies to change behaviour and adopt a green ICT policy with a discount scheme relating to the cost of energy. Encourage the use of standardised energy management within Data Centres (particularly large ones) through, for example I.S. 393 – the Irish Energy Management Standard. Promote best practices by identifying the technologies that can best reduce the energy use in Data Centres.

Through liaison with the local energy companies, it should be possible to agree a set of ‘best practice’ energy management guidelines that could then be codified into an energy incentive programme to promote Cloud Computing.

Any such incentives should include an appropriate approach to ‘carbon pricing’ that is not a disincentive for investment in Data Centres but offers incentives for best practice in the design and operation of them.

Benefit: Clear political signal of commitment to a low Carbon economy.

6. Regulation

Problem: Regulation is not keeping pace with technology. Cloud Computing presents many complex legal, regulatory and technical issues. These include security, privacy, jurisdiction, data protection and retention, IP and law enforcement. In many respects, the law is a technology follower and hence the legal and regulatory implications of a technical innovation may not be fully resolved for some time (years) after the technology is proven. In the intervening period, technology companies and services providers operate in a twilight informed by their own judgement and professional advice, but which may be subject to legal investigation or prosecution years later.

Proposed Action: Develop a progressive regulatory regime that can keep pace with technological developments and can help provide greater legal clarity for companies seeking to avail of Cloud opportunities.

Benefit: Provide opportunities for innovation and establish a distinctive advantage for Ireland over other countries. Enable Ireland to be viewed as a progressive and world-leading economy for IT services. Legislative clarity and

certainty will ease the deployment of new and innovative IT services delivered from Ireland.

7. Skills

Problem: Third-level institutions are not sufficiently familiar with the latest developments in technology, such as service-oriented delivery.

Proposed Action: A Principal Investigator should be appointed to bring this expertise into Ireland and foster better links between industry and academia.

Way Forward: The proposed actions from the recent workshop will be analysed and prioritised by the stakeholders.

4.3 Digital Dividend

The Digital Dividend is the segment of spectrum that will be released following the migration of terrestrial television broadcasting from traditional analogue to digital transmission. This transition is often referred to as the Analogue Switch Over (ASO). Digital transmission will support new types of broadcasting products and services and the ASO will free up significant amounts of ultra high frequency (UHF) spectrum providing significant extra communications and broadcasting capacity.

The mobile sector has been to the fore in promoting the concept of the Digital Dividend and outlining various uses for some of the spectrum within their sector. The broadcasting sector, in developing the Digital Terrestrial Television (DTT) technology, has being promoting the potential of the Digital Dividend for developing increased choice and improved quality. The telecoms sector has highlighted the potential of the Digital Dividend spectrum being used for the development of broadband - particularly rural broadband[32].

Ireland is currently experiencing severe economic difficulties and is unfortunately some way behind other countries in both Digital Terrestrial Television deployment and Analogue Switch Over. It is vital that we maximise the opportunities of the Digital Dividend at the earliest possible opportunity. The Government has proposed that Commission for Communications Regulation (ComReg) should examine the potential for additional spectrum besides the 790-862 MHz sub-band identified at WRC-07 and that access to Digital Dividend spectrum should be accelerated.

Societal and economic development, cohesion and participation will be promoted by access to voice, messaging and low-rate data services. For a modern, sustainable society to prosper fully, broadband communications must be available to the entire population in all areas; this is a particular challenge for Ireland due to the distributed nature of the population. While the technology is available to achieve this, progress has been delayed by spectrum allocation decisions taken half a century ago.

[32] DCENR *National Policy Framework for identifying spectrum for the Digital Dividend*, February, 2009

To begin addressing these issues the ComReg recently concluded a consultation on *Digital Dividend in Ireland: A new approach to spectrum use in the UHF Band.*

4.3.1 Test and Trial Licensing

Ireland has a relatively small population density and, for this reason, our commercial spectrum requirements often lag more densely populated countries. However, it is possible to obtain localised test and trial licenses which can be very valuable for R&D activities. ComReg operates a novel spectrum licensing regime to encourage innovation and development involving new radio technologies or services. Two types of license are available, one covering technology tests and the other covering service trials involving third parties or the public. Both licences are intended to support genuinely novel research and development activities. This support for innovation and development in the use of the Digital Dividend positions Ireland as an attractive place for industry to develop new products and services for both home and global markets.

For example, since 2003 Ericsson has carried out significant Inter-Operability Developmental Testing for a number of equipment vendors based on its test and trial licenses. A small live or over-the-air network of sites has been built which allows interoperability tests to be carried out at an early stage of development.

Spectrum released by the Digital Dividend has wide coverage range and can penetrate buildings. This is essential for connecting devices such as smart meters and elements of mobile health and smart transport systems in an economically sustainable way.

4.3.2 Policy Framework

With significant numbers of jobs dependent on the use of wireless radio, spectrum-related activities have become an increasingly important part of the Irish economy in recent years. The economic benefits of spectrum use are important, but the innovation, R&D, social, green and cultural benefits arising from spectrum use are also significant.

Without some revision to the national broadcast frequency plan, the Digital Dividend spectrum released for use by other services could end up being fragmented. DCENR recently issued a policy framework to provide certainty around the availability of spectrum for innovation[32].

4.3.3 Significance of the Digital Dividend

The UHF Band amounts to almost 400 MHz of spectrum, which is also equivalent to the total spectrum licensed to all 2G and 3G mobile service operators today. This spectrum is to be shared between broadcasting and non-broadcasting services with broadcasting being allocated spectrum for 6 Digital Terrestrial Television muxes according to legislation. The spectrum available for non-broadcasting services may therefore be of the order of approximately 150 MHz at most.

The spectrum targeted for new communications services in the USA at around 700 MHz has superior propagation characteristics to the 2G and 3G bands and can provide wider wireless broadband coverage in a commercially viable way. The oft-stated political goal of delivering 'broadband for all' comes at a much lower cost: broadband wireless coverage in a given area using a given amount of spectrum in the UHF band can be rolled out for only about one-third the cost of providing the same coverage in the 2,000 MHz range.

For the maximum benefits to be realised, it has been suggested that approximately 120 - 140 MHz would be the optimal required for allocation to the mobile sector, with 100 MHz being the minimum.

4.3.4 Opportunities

The Digital Dividend provides a once in a lifetime opportunity. The Digital Dividend offers real opportunities for wireless innovation in relation to a range of different services. The mobile and broadcast sectors have been promoting the benefits of the effective use of the digital dividend and outlining various uses for some of the spectrum within their sectors. For example:

- Wider coverage and availability of advanced services such as high speed broadband in remote and rural areas;
- New mobile services, with high quality video and interactive media delivered to handheld devices;
- The enablement of the "internet of things" supporting smart cities, m-health, m-government, smart grids etc;
- Business and broadcasting services, such as those used to support major sporting events;
- Additional television channels including possible High Definition (HD) channels carried on Digital Terrestrial Television networks.

It is important to note that some of these possible uses pose a risk of exhausting the Digital Dividend.[33]

In the digital age, entertainment, music, video, etc. is increasingly delivered over broadband networks. The wireless broadband networks that the Digital Dividend will enable will not just provide increased mobile entertainment opportunities, these same networks will enable increased mobile Internet access and enhance social inclusion through the development of web-based social communities. Youth, seniors, professionals, the entertainment sector, e/m-government, e/m-learning and small indigenous Irish industries will benefit.

Wireless broadband will enable these features to be rolled out quickly in rural areas where physical infrastructure build-costs are high and time consuming. However, wireless delivery is unlikely to provide for very high capacity broadband which would be needed for multi-room multichannel TV viewing over broadband. It is likely that fibre networks will ultimately be required for the best broadband.

[33] RSPG Opinion on EU Spectrum Policy Implications Of The Digital Dividend, 2007

Interactive, personalised services will be the norm in future communications. New radio technologies will be able to use spectrum for advanced interactive services, including high-speed Internet access and broadcasting content delivery.

The smaller cell sizes of communications systems enable a wide variety of targeted content to be delivered to different cultural, ethnic and language groups.

4.3.5 More interactive, more personalised

The growing popularity of user-generated content and the higher expectations of interactivity and personalisation are driving the need for bi-directional broadband capabilities.

In contrast to the traditional one-way TV broadcast model, people are becoming accustomed to choosing content and time of viewing for themselves. To succeed, media and content providers will need delivery channels that offer interactivity and a wide selection of on-demand content delivered over many different channels. With a large proportion of the financing for commercial media coming from advertising, these delivery channels need to be able to offer greater knowledge of consumer preferences and usage.

Way Forward: DCENR will liaise with the ComReg and Industry in order to review innovative actions required.

4.4 International Content Services Centre

4.4.1 Background

This proposal was prepared by the Digital Media Forum following discussions between Neil Leyden, Chairman, Digital Media Forum and the Department of Communications, Energy and Natural Resources with input from a range of stakeholders. The following section outlines the current situation, what is required to achieve the aims, the potential obstacles and an outline of proposed actions.

4.4.2 Current situation

Content, thanks to the proliferation of broadband, is now a globalised commodity. The means of production of content have been “democratised” to such an extent that consumers are now also creators. Put simply, anyone with a broadband connection, a PC or laptop and a digital video camera can start creating, distributing and monetising compelling content for a global audience. This content can be accessed on increasingly affordable pervasive internet-enabled devices such as mobile phones, games consoles, desktops and notebooks.

However, traditional content creators and rights holders are still saddled with traditional forms of funding and distribution that have in turn inhibited the free flow of content. For example, in order for a European film producer to raise

funds to finance a film they inevitably trade their distribution rights to broadcasters in various European territories thus inhibiting the free availability of this content over video-on-demand (VOD) platforms. Even US films and television programmes are hobbled by the same distribution bottleneck. They have sold off broadcasting rights to their content to a plethora of broadcasters, meaning that their content often cannot be made available over VOD platforms such as Apple iTunes outside of the US.

This “scarcity” in the retail end has led in turn to piracy. In digital format, any audio-visual content is easily distributed through the network, with or without the rights-holders permission. This situation has become unsustainable. Large rights-holders such as film and music studio conglomerates have taken aggressive steps to target individuals who are downloading illegally and, more recently, are now targeting the ISPs. In turn, the pirates – such as The Pirate Bay – have become more entrenched, both philosophically and technologically. There is a huge opportunity to be a broker between these two entrenched positions and serve the consumer. The proposed International Content Services Centre is a potential brokerage model.

However the opportunity does not stop there. Content in binary format can encompass many different forms and formats – games, imagery, eLearning, eBooks, archival material, newspapers, magazines, etc. There is immediate value in the delivery and rights management associated with this rapidly growing content. Further opportunities will present in nurturing, developing and harvesting intellectual property in Ireland.

4.4.3 Ideal situation

The ideal situation would be a centralised, back-office clearing house to help rights-holders manage and distribute their content globally. This would be in a tax-incentivised, pro-business and flexible regulatory environment matched with the required infrastructure and technological solutions to ensure Quality of Service in terms of warehousing and distribution. It would also be part of an innovative and creative technology hub linked to emerging enterprises and University research and development to ensure that the centre would keep “ahead of the curve” in terms of emerging media opportunities. This, in essence, would be an International Content Services Centre based in Ireland.

The International Content Services Centre (ICSC) would be located in Dublin providing a centralised administrative centre for a range of services related to digital content. The centre would serve both multi-national interests as well as local indigenous players with global scale (Setanta, RTE, Riverdeep, etc.) or ambition (MUZU.TV).

The centre would be a public/private partnership. The key to its success will be co-ordinating private interests as key tenants with public service support (infrastructure, tax designation, EI and IDA focus and support, etc.)

The private tenants might include:

- Multinational content holders “housing” their content in Ireland for beneficial purposes (such as tax relief, service offerings, etc.);
- Offices of legal firms with particular specialisation in global digital rights management and intellectual property;
- Centralised back-office administrative functions for cloud-computing and data-warehousing enterprises;
- Dedicated service enterprises managing brokerage, rights clearance, VOD platform services, security, etc.;
- SME Digital Enterprises in the content sector, both indigenous and foreign;
- Centralised Localisation services for content holders;
- R&D teams/Technology Transfer officers in the digital content space.

The International Content Services Centre takes advantage of two global opportunities:

1. The rapid technological convergence in the content space and the corresponding demand that has been created;
2. The demand for legal services from content holders to protect and deliver their content.

1. Technology solution

There is a real opportunity to focus and co-ordinate new and existing technology competencies in Ireland towards a specific aim. For example, we have expert competencies in Semantic Web (Digital Enterprise Research Institute, Galway), next generation telecom platform deployment (Intune Networks), Internet Protocol (IP) Multimedia Subsystem (IMS) - the generic architecture for offering Voice over IP and multimedia services (Ericsson, Waterford Institute of Technology) and data warehousing and cloud computing (Microsoft, IBM, Hosting 365, etc.); these are the necessary building blocks for a Global Content Services offering.

In particular, we have the proposed Exemplar Smart Network which facilitates content developers and distributors to model the next generation means to securely distribute their products in a haven from which all the Software, Human Resources, Legal and Commercial advantages proposed in the ICSC can be leveraged.

2. Legal solution

Ireland’s primary strengths here are that we operate under Common Law and have a flexible, pro-business regulatory environment. Many of our legal firms have global service.

4.4.4 What are the obstacles?

The success of such a centre demands the co-ordination of a number of activities and stakeholders with a clear focus on achieving the environment set out above. Potential obstacles include:

1. Providing sufficient incentives for tenants – tax, financial, regulatory;
2. Flexibility in terms of the necessary legal and tax framework;
3. Funding such an initiative in the current economic climate;
4. Co-ordinating stakeholders – IDA, EI, Department of Finance, multinationals, data-warehouses, etc.;
5. Provision of infrastructure (broadband, data-warehousing, etc.), technological solutions, legal and administrative expertise;
6. Competition from other territories with similar ambition e.g. Singapore, Dubai, Malaysia;
7. Buy-in from important stakeholders – rights-holders, EU, Multinationals, Telco's, etc.;
8. Entrenched traditional business models of television and film;
9. Unforeseen technical innovations;
10. Content piracy becoming ubiquitous.

4.4.5 What are the resources and why Ireland?

As well as a highly educated workforce, a world-renowned legal system for the arbitration of disputes, a designated locality for many European hubs, Ireland has an international brand related to creativity and innovation that is unsurpassed globally.

At government-level, we have shown time and time again that we have the necessary flexibility and willingness to accommodate global enterprises. We already have many of the multinational technology players such as Microsoft, IBM, Google and Ericsson based here; their technologies underpin the delivery of content worldwide. We can co-ordinate these interests and attract content owners (both new and old) to locate their intellectual property here in a fully-serviced centre.

Current elements of the Finance Bill could be exploited to attract multinationals and high potential start-up foreign enterprises through measures such as Tax Relief on Intellectual Property and the three years free corporation tax for start-up enterprises. We have a reputation for being open for business; we need to gather the necessary stakeholders to implement the required measures to create a business environment suitable for the global knowledge economy.

4.4.6 Potential customers

Existing multinationals

Microsoft, IBM and Google are all in the cloud-computing space which increasingly will have a demand for rights clearance and content brokerage. Google's YouTube, in particular, has a particular issue with rights management that could be solved within such a centre. As advertising online becomes increasingly of the rich media variety, there is an opportunity to centralise ad networks back-office functions to one territory like Ireland.

Targeting new multi-nationals

The IDA could be tasked to approach content rights-holders and organisations worldwide with a view to them becoming clients of the ICSC. With Disney now buying into Hulu.com, the third most watched video content site in the US, there is an opportunity to help roll out this service worldwide with Ireland being the base for European operations.

Other potential customers include music rights organisations, large traditional media content holders like Time Warner or online games providers/vendors such as Codemasters or EA. Ireland already has a number of online games companies who have been attracted here to set up their European operations – the ICSC could be a galvanising initiative.

Ericsson Ireland are developing the concept of a Media Trading Floor - a project that consists of developing, promoting, growing and leading an international trading floor of distribution for content providers. This is a combination of an emerging Digital Media Exchange (DME) platform complemented by a trading floor, positioned at the crossroads of content value chain and telecommunications value chain.

Indigenous clients

Ireland has a range of indigenous potential clients who will need to look at exploiting their content archives globally. These include the national broadcaster RTÉ, rival broadcasters Setanta and TV3, not to mention the wealth of state-owned content in the archives. These archives have potential value in terms of digital libraries; this opportunity was recognised as far back as 2002 in the Forfás Digital Content Strategy Report, but has not yet been developed.

There are also a wealth of emerging companies who are clients of Enterprise Ireland who could benefit from the activities of the ICSC. These include animation studios like Brown Bag Films and Jam Media, distributors like Monster and Element Films, mobile content companies such as Zamano, digital media companies such as DV4, Global DMX, iFoods TV and MUZU.TV and eLearning companies such as Riverdeep, Intuition and Third Force.

High-Potential Start-Ups

There are a number of well-funded high potential start-ups – both indigenous and foreign – that could be attracted to this centre. These include a variety of eLearning companies and a global news vendor start-up.

4.4.7 Required actions

- Continued Consultation
    - Ensure involvement by various stakeholders in the traditional and new media content industry to assess their views on the International Content Services Centre and how it might help their business.

- Working Group
    - Set up a working group of stakeholders (legal, content, enterprise, multi-nationals, government, etc.) to flesh out this proposition. This working group would assess the opportunities on a case by case basis and be able to report back to government on the needs and requirements in terms of legislation, tax codes, statutory support, etc. It could also help IDA Ireland and Enterprise Ireland to focus their strategies in this regard.
- Feasibility Document
    - Draw up a feasibility document assessing the proposition, the obstacles and the resources required.

Way Forward: A working group of stakeholders (legal, content, industry, state agencies) will be established and charged with producing a feasibility plan for the establishment of the proposed centre.

5 A Road Map for Smart Grid and Networks

5.1 Electricity Infrastructure

In an age of increasing energy uncertainties, a robust electrical power system that has the infrastructural capacity and technological capability to facilitate the development of Ireland's renewable energy potential and to improve overall energy efficiency, is the cornerstone of the country's long-term strategy to ensure a sustainable, secure and competitive economy. Building a 21st century national electricity grid is an indispensable component towards achieving government economic and environmental policy and is the foundation stone for achieving all national and EU sustainability targets.

The strategic importance of the electricity power system is emphasised in both the Government's 2008 document on "Building Ireland's Smart Economy"[1] and in the 2007 White Paper on "Delivering a Sustainable Energy Future for Ireland[6]." These policy documents highlight the vital role of the electricity power system in helping to achieve a substantial increase in the use of renewable energy, a decrease in national CO_2 emissions and an increase in energy efficiency levels throughout the country. With the right electrical power system in place Ireland can harness its secure and renewable energy resources, integrate a range of new Network technologies that support energy efficiency and support the development and deployment of electric vehicles throughout the country.

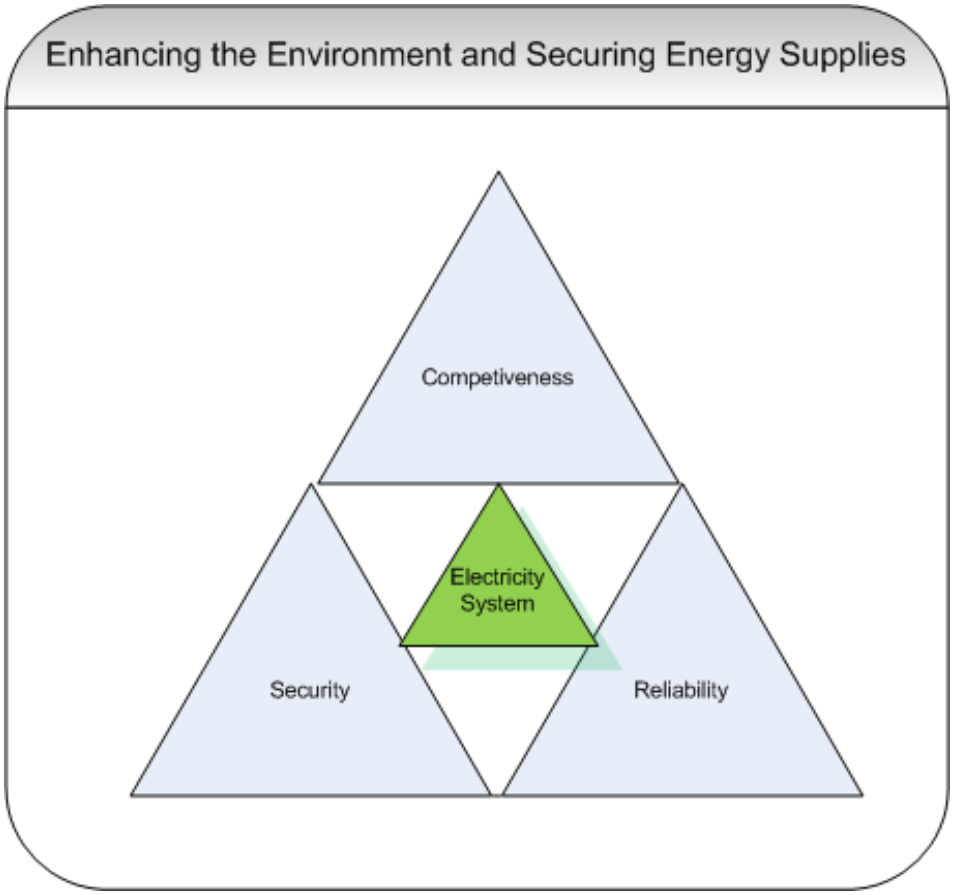

Figure 4

Of course, developing an electricity system that will support government policy through the integration of renewable energy on the supply-side and the integration of new technologies on the demand-side will require radical changes in the design, operation and embedded intelligence of electricity networks (Figure 5). EirGrid plans to spend €4 billion between now and 2025 building a new electricity transmission system designed to tap into Ireland's renewable energy resources and to facilitate the integration of new Smart Network technologies.

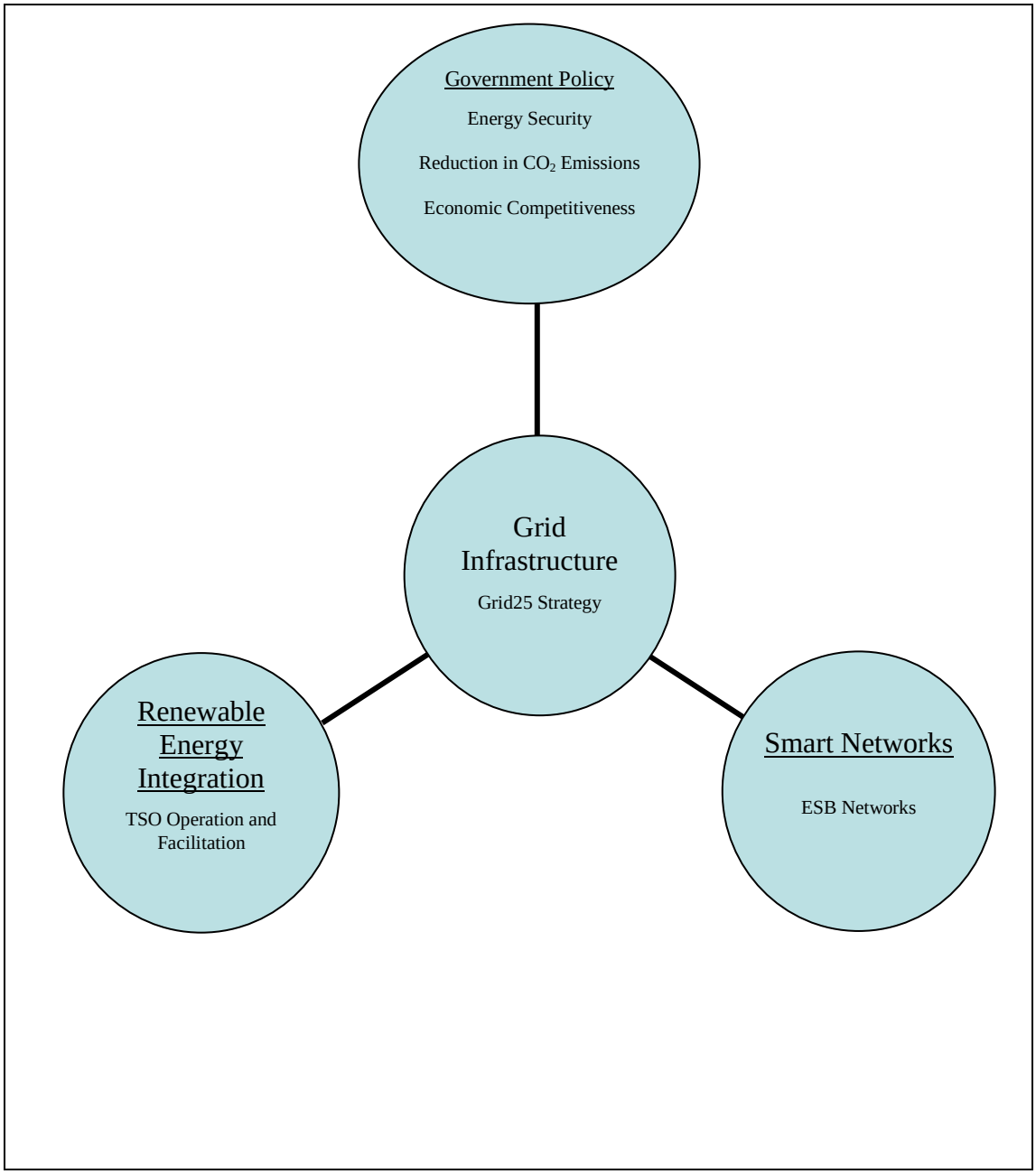

Figure 5

The central aspects of this transformation will involve:

- Providing the infrastructural requirements through the development of Smart Networks or Smart Grid. Networks of the future will need to be smarter, more accessible and more efficient (Figure 9). In the US, the new administration has invested almost $5 billion to promote their Smart Grid. In Europe, the SmartGrids Technology Platform has set out deployment priorities for Smart Networks. In Ireland, many of the building blocks for Smart Networks are already in place or are being developed (see Grid25[34]).
- Harnessing the indigenous renewable resources to power the system into the future.
- Providing the right policy and economic incentives to foster further growth in the renewable sector.

5.2 Cleaning up Energy

Governments worldwide now acknowledge the need to urgently address the threat of climate change from $C0_2$ and other greenhouse gases. The need to develop a more sustainable relationship with the planet is also clear. Three areas of particular focus are electricity generation, transportation and energy use in the built environment (Figure 6).

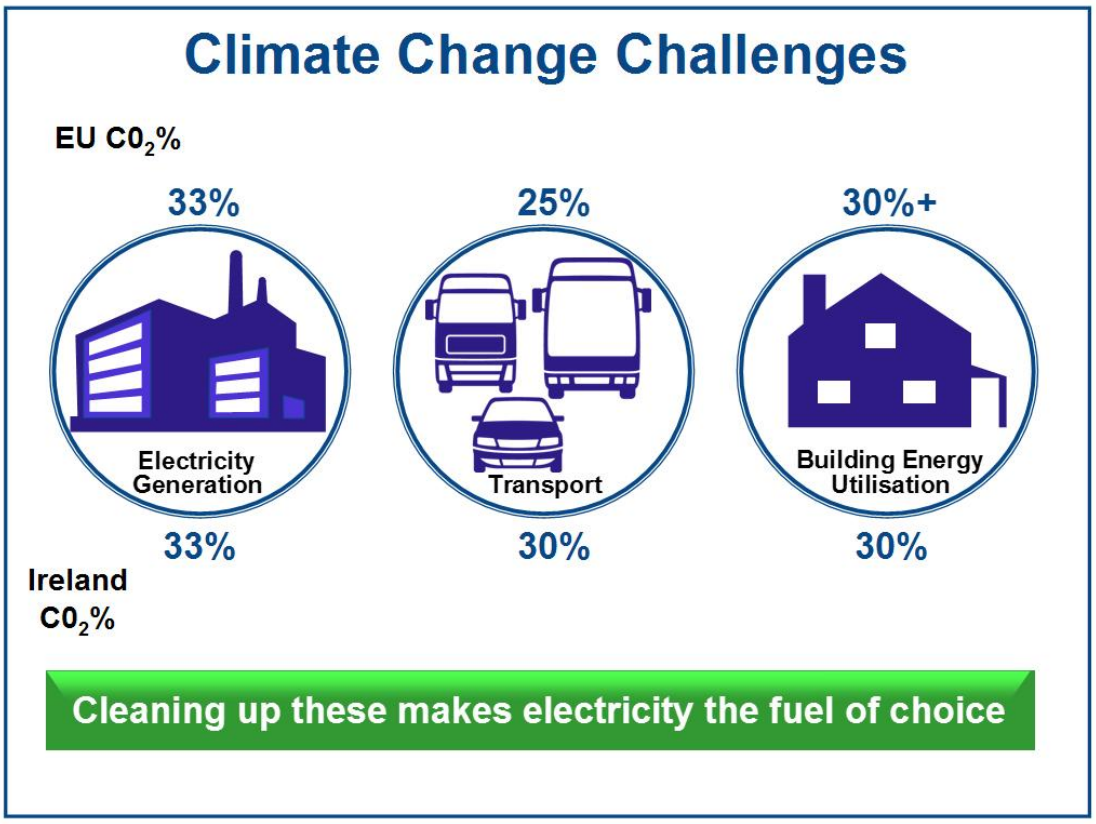

Figure 6

[34] EirGrid 2009 *Grid25 A Strategy for the Development of Ireland's Electricity Grid for a Sustainable and Competitive Future*

5.2.1 Electricity Generation

The Government's 2007 White Paper, "Delivering a Sustainable Energy Future for Ireland" set out a series of structural goals, actions and targets for how the electricity sector could contribute to reducing the country's overall CO_2 emissions up to 2020 and boost our national economic competitiveness. At the heart of this strategy is a commitment to substantially increase the use of renewable energy throughout the island. While the White Paper sets a target of 33% of electricity to come from renewable energy by 2020, this was subsequently increased in the 2008 carbon budget to 40%. To support these Government policy and targets, EirGrid published its Grid25 strategy in 2008. This forward-looking document details the necessary infrastructural requirements to met government targets for renewable energy.

The move towards using renewable energy for electricity generation is well under way in Ireland and around the European Union. Indeed, in the last decade, the development and deployment of renewable generation has exceeded all expectations and Ireland has been a part of this positive development. In Ireland today, approximately 11% of electricity generation comes from renewable energy. This percentage is more than double Ireland's 1990 level.Tapping these renewable energy resources will enable Ireland reduce our dependence on expensive fossil fuel imports, ensure a reliable energy supply for the long term, reduce our greenhouse gas emissions and enhance our economic competitiveness. During 2008, the level of 1,000 MW of wind energy was exceeded and this will increase significantly under the current connection processes.

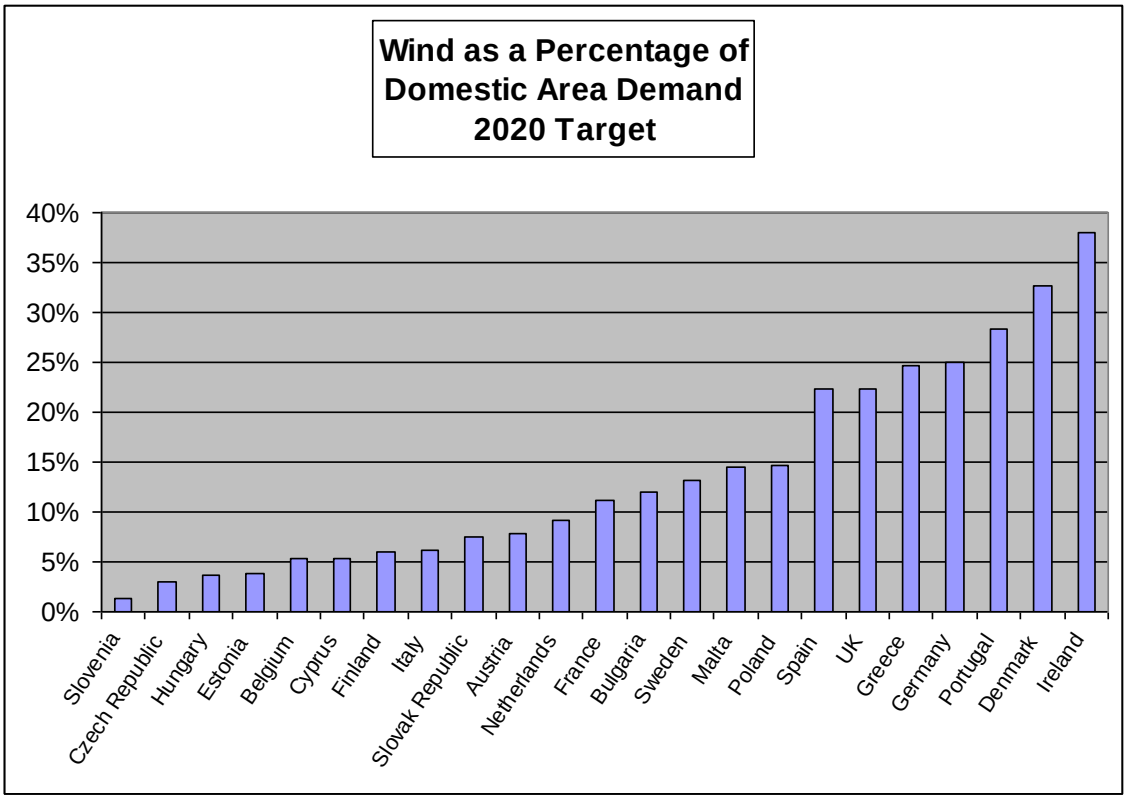

Figure 7

Ireland's target to have 40% of electricity generation from renewable energy by 2020 positions us at the forefront of Europe and when implemented, will set an ambitious target for others to follow. The delivery of Grid25 is the first crucial step to position Ireland as a world leader in clean energy production and the integration of Smart Grid technology and will assist in the country's overall transition to a low-carbon economy.

Noting that approximately 50% of this renewable energy will be connected to the distribution system, ESB Networks and Eirgrid are working together to develop the electricity infrastructure that will facilitate the Government's target of 40% renewable energy by 2020 and enable the integration of new technologies that will promote energy efficiency.

Integrating 40% of renewable energy into Ireland's electricity generation is a complex task and through its Facilitation of Renewables study group, EirGrid/ESB Networks are working to assess the ability of the power system to absorb large amounts of energy from renewable sources. These studies will help increase our understanding of the behaviour of the power system with large amounts of renewable generation, identify any potential related technical issues and make recommendations as to what measures are deemed necessary to manage an electrical power system with 40% renewable penetration.

5.2.2 Electric Vehicles

Governments in Europe and the US have signalled a major commitment to developing the electrification of transport. Ireland has a target of 10% penetration of electric vehicles (EV) by 2020. Turning this target into reality requires major national commitment and industry leadership. The recently announced Memorandum of Understanding between the Irish Government, ESB and Renault Nissan[35] is a first step in this regard. Many challenges remain including:

- Roll-out of national public charging infrastructure;
- Standardisation of charging connections and interoperability between cars, changing infrastructure and electricity networks;
- Smart charging to minimise system peak implications of high penetration of EVs;
- Open and Flexible IT and data management systems to enable all electricity suppliers compete for EV charging.

[35] DCENR Press Release *Government moves forward with plans for electric vehicles* 3rd April 2009

5.2.3 Smart Metering

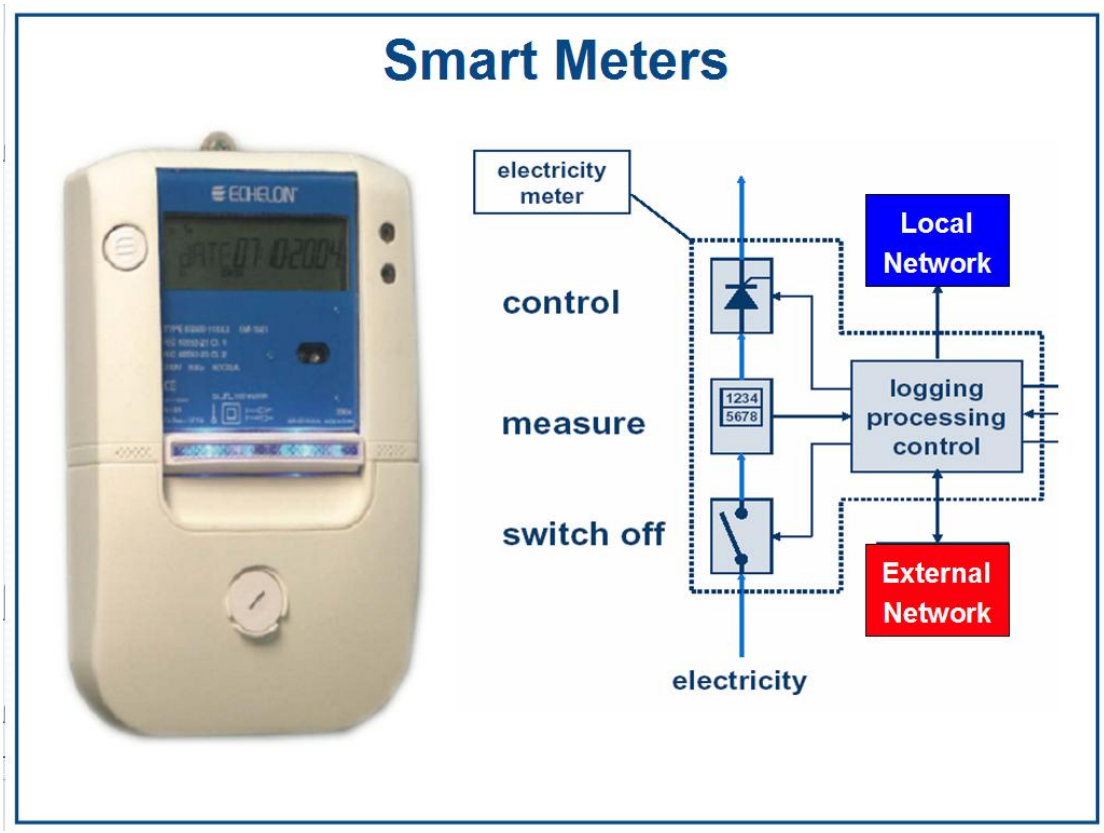

Figure 8

Developments in the areas of Smart Metering and utility advanced metering infrastructure (AMI) are seen as a gateway between electricity networks and customers. Smart meters are intelligent two-way communications devices with digital real-time power measurement. Apart from the obvious advantages of remote operation and meter-reading, Figure 8 illustrates how Smart Meters also offer the potential for real-time pricing, new tariff options, Demand-side Management (DSM) and an interface with Home Area Networks (HAN).

- Additional distributed intelligence and sensors to help improve load factor, system losses, outage performance and “self healing” in the event of faults;
- Leveraging the latest developments in materials, superconductivity, energy storage and power electronics.

ESB Networks is already investigating many of these and is linked with the US Electric Power Research Institute (EPRI), the UCD Electricity Research Centre and SEI. Along with ESB International, the complex solutions required to bring the many components of Smart Networks (Figure 9) to successful implementation stage are being investigated and researched.

Grid25 incorporates plans for the use of new ‘Smart Grid’ technology in the form of smart metering (AMI), which will establish a two-way flow of information between supplier and user and will enable customers to actively participate in the control of their individual energy consumption levels (DSM).

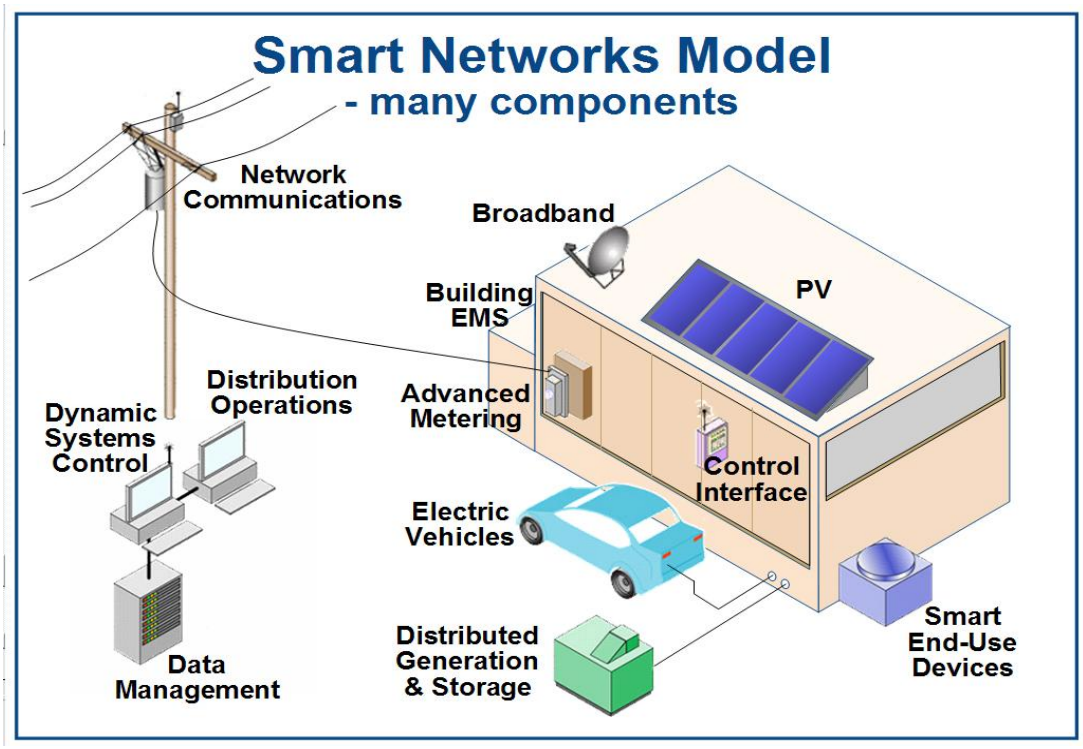

Figure 9

5.3 Smart Networks - Benefits across the Industry Chain

Smart Networks will bring major changes in terms of enabling the generation, transportation and utilisation of cleaner electricity; arguably the impact of Smart Networks will mirror that of the Internet on telecommunications. However, the real issue is the extent to which they can create value along the entire industry value chain. Strategically important is the value Smart Networks create for customers and the economy. The roadmap and implementation path for Smart Networks will focus on delivering:

- Lower electricity prices;
- Improved quality;
- Security of supply.

As part of a coordinated strategy across the energy industry to address national energy efficiency and CO_2 challenges, Smart Networks have other potential benefits. Opportunities exist to achieve even more in terms of research, development and commercialisation of new systems and products needed to support a more sustainable future. ICT, support infrastructure, DSM programmes, EV technologies and even battery production offer great potential for Irish businesses to exploit inside and outside Ireland.

This will require real industry leadership along with new skills especially in the engineering and applied sciences. It will also require a coordinated and more focussed approach from Government, the Energy Industry and Ireland's Research and Development community. The prize for energy customers and Ireland's economy is one that must be aggressively competed for; Smart Networks offer substantial rewards in an age of strategic uncertainty.

6 Sustainable Development

The following section provides examples of programmes and projects which illustrate Ireland's current plans and future intentions in sustainable development.

6.1 ICT and Energy Efficiency

Energy and Communications are within the same Government Department led by the Minister for Communications, Energy and Natural Resources. This organisational structure favours the convergence of ICT and Energy plans and developments. A state agency – Sustainable Energy Ireland (SEI) – leads an extensive range of energy efficiency programs.

Energy efficiency is central to tackling the problems of energy security and climate change and its importance has increased as a result of the current financial downturn.

Recent studies agree that ICT can play a significant role in energy efficiency programmes. The European Commission recently published a communication on the subject (COM (2009) 111 Final) on *Mobilising Information and Communication Technologies to facilitate the transition to an energy-efficient, low-carbon economy.*

The European Commission has calculated that energy savings of 13% could be achieved by 2020 (COM (2008)772 Final[36]). They see ICT playing an important role in:

- Monitoring and directing energy consumption;
- Providing a quantitative basis for energy-efficient strategies;
- Developing tools for energy-efficient business models;
- Reducing energy use through:
    - innovation e.g. thin client computers;
    - grid computing and virtualisation technologies;
    - new solutions in building and construction
    - new models of intelligent transport solutions.

Ireland has recently published its national energy efficiency action plan for the period 2009-2020: *Maximising Ireland's Energy Efficiency,* which proposes a wide range of actions to improve energy efficiency, many utilising ICT tools.

Sustainable Energy Ireland implements intensified energy efficiency programmes, aimed at reducing energy consumption and, at the same time, contributing to economic growth.

6.1.1 Background on Energy Efficiency

Energy efficiency can contribute to meeting all three goals of energy policy, namely: security of supply, competitiveness and protection of the environment. The economic benefits include direct savings, lower fuel costs

[36] European Commission, 2008. (Com (2008) 772 Final) *Energy efficiency: delivering the 20% target*

and a reduction in the need for investment in supply. It can be achieved through technological, behavioural or economic changes and is seen internationally as the cheapest and most significant means of reducing carbon emissions. Over the last four decades energy efficiency has contributed more to energy services than any single fuel. Analyses by the International Energy Agency (IEA) have shown that efficiency improvements between 1973 and 2004 enabled IEA economies to use 56% less energy.

E.U. Energy Efficiency Policy Targets

At a European level there are currently two overarching energy efficiency targets. An Energy Policy for Europe[37] specified a target of saving 20% of the EU's energy consumption compared to projections for 2020. The Energy Services Directive[38] (ESD) specifies a 1% per annum energy efficiency improvement resulting in a cumulative 9% increase in energy efficiency by 2016. The 20% saving by 2020 is across all sectors while the ESD target refers to non-Emission Trading Sectors (non-ETS) only and international aviation is also excluded.

Irish Energy Efficiency Policy Targets

The White Paper on Energy set a target for a 20% reduction in energy usage across the whole economy by 2020. There is an indicative target of 30% energy efficiency savings to surpass the EU ambition. A saving of 6500 GWh has been set as the interim target for 2010 to meet the ESD target of 9% by 2016. Both the ESD target and the 2020 target are set out in the *National Energy Efficiency Action Plan* (NEEAP). A draft version was released in October 2007 and the final version was published on 8th May 2009.

Ireland's *National Energy Efficiency Action Plan* was initially submitted to the European Commission in September 2007 and constituted Ireland's first Energy Efficiency Action Plan, as required by the *Energy End-use Efficiency and Energy Services Directive* (ESD). Since that time, a national consultation period was completed and the document developed to address both Ireland's 9% ESD target for 2016 and our national 20% energy savings target for 2020. SEI is responsible for modelling expected savings from current programmes and for providing analysis of the economy to determine opportunities for further energy efficiency measures with potential to contribute to achievement of the 2020 target. Ongoing input will be provided by SEI as new programmes are developed for 2009 and beyond. Further analysis will be required to enable reporting of our progress towards targets and to identify new programmes and initiatives to fully exploit existing opportunities for energy efficiency improvements in the Irish economy.

Energy Efficiency Statistical Analysis:

- Energy efficiency improved by 10% (0.9% per annum) between 1995 and 2007. The cumulative effect between 1995 and 2007 was savings

[37] European Commission 2007, *An Energy Policy for Europe*.
[38] European Commission 2006, Directive 2006/32/EC on energy end-use efficiency and energy services

of 1.1 Mtoe. Total final consumption of energy would have been 8.4% higher in 2007 but for energy efficiency improvements over the period 1995 to 2007;

- The energy efficiency index for industry (intensity at constant structure) decreased from 100 in 1995 to 84 in 2007 indicating a 16% improvement in energy efficiency;
- Energy efficiency improvements for the residential sector increased by 18% over the period 1995 to 2007 (1.6% per annum);
- For the period 1995 to 2007 Ireland experienced improvement in efficiency of 10% compared with a 9% improvement for the EU-15.

6.2 SEI Energy Efficiency Programme Activities

6.2.1 Built Environment

As part of the *Energy Performance of Buildings Directive* (EPB)[39], a *Building Energy Rating*[40] (BER) certificate, which is effectively an energy label, is required at the point of sale or rental of a building, or on completion of a new building. SEI is charged with the transposition of this legislation and is implementing a building energy rating system to residential and non-residential buildings. Since January 2009 this labelling system applies to existing buildings as well as new domestic and non-domestic buildings in Ireland. New building regulations[41] came into effect in July 2008. It was estimated that the new standards would reduce energy requirements by 40% in new dwellings depending on the type and size of the dwelling. The budget for BER in 2009 is €2 million.

A pilot *Home Energy Savings Scheme* was introduced in 2008 to reduce energy and CO_2 emissions from the existing housing stock. SEI is providing grants and other incentives to householders to upgrade the energy efficiency of older homes through the *Home Energy Saving* scheme. The subsequent full national *Home Energy Saving Scheme* was launched in February 2009 with a budget of €49 million in 2009.

Energy efficiency programmes managed by SEI in the residential sector include the *Low Carbon Homes* programme. The programme explores the technical solutions that have the potential to reduce CO_2 emissions from energy use in a typical new home by at least 70% relative to a "reference dwelling" built to baseline Building Regulations 2005 standards. Through this scheme, SEI is preparing the house-building sector and wider society for the adoption of ever higher building energy standards by supporting developers who build to standards well above those prescribed by law. A similar scheme for the Commercial sector will be launched in 2009. The budget for *Low Carbon Commercial* in 2009 is €0.5 million.

The *Low Income Housing* (LIH) programme supports energy efficiency upgrading measures in low income homes. Core delivery of the low income

[39] European Commission, 2002 and recast 2008 Energy Performance of Buildings Directive
[40] Sustainable Energy Ireland, Building Energy Rating
[41] Dept. of Environment, Heritage and Local Government, 2008. Building Regulations (Part L Amendment).

housing scheme is through the *Warmer Homes Scheme* which incorporates the installation of attic insulation, draught proofing, lagging jackets, energy efficient lighting, cavity wall insulation and energy advice. The budget for LIH in 2009 is €15 million.

The *Public Sector* programme promotes energy efficient design, technologies and services in new and retrofit public sector projects. SEI is supporting exemplary design and energy management practice by public sector organisations through SEI's *Public Sector Building Demonstration Programme*. SEI will initiate a programme to maximise the energy efficiency of commercial new buildings through encouragement of best practice/exemplar designs that far exceed the energy performance standards of current building regulations. The budget for *Public Sector* in 2009 is €0.57 million.

These projects are excellent examples of good practice and a demand leader for the services and technologies involved. The programme has three main elements.

1. A *Design Study Support Scheme* which provides support for professional expertise to examine the technical and economic feasibility of design and technology solutions;
2. A *Model Solutions Investment Support Scheme* supports energy management and technology solutions in existing buildings and new build specifications;
3. An Energy Management Bureau supports outsourced energy management services to report on energy usage and identify energy-related projects.

6.2.2 Industrial

Sustainable Energy Ireland operates a number of key energy efficiency programmes in the industrial sector:

- The *Large Industry Energy Network*[42] (LIEN) is for the largest industrial energy consumers in Ireland. LIEN is developing a set of role-model companies to demonstrate better energy management. SEI is supporting the networking and exchange of best energy efficiency practice by the largest industrial energy users through the network;
- The *Energy Agreement* programme for industry is based on the Irish energy management standard IS393[43]. SEI is supporting businesses in maximising their energy efficiency through adoption of IS393, the Irish Standard for Energy Management, and is assisting smaller businesses with limited resources to improve their energy management, and provide advice on their energy management, through the Energy MAP initiative. SEI's service for SMEs offers energy advice, assessment and monitoring, with the aim of cutting 20% off their energy use. The budget for Energy in Business in 2009 is €4 million. A new programme

[42] Sustainable Energy Ireland Large Industry Energy Network
[43] Sustainable Energy Ireland Energy Management System, I.S. 393 (2005)

targeting public sector energy management is being introduced in 2009. The budget for Public sector support in 2009 is €6 million;

- The *Accelerated Capital Allowance* (ACA) scheme was introduced in the Finance Act 2008. This scheme enables businesses to write off the entire cost of a limited set of energy efficient motors, lighting and building energy management systems in the first year of purchase;
- The *Combined Heat and Power (CHP) Deployment Scheme* provides grant support to assist the deployment of small-scale (<1 MWe) fossil fired CHP and biomass (anaerobic digestion (AD) and wood residue) CHP systems. The budget for CHP in 2009 is €2.75 million;
- The *Renewable Heat Deployment* (REHeat) programme provides assistance for the deployment of renewable heating systems in industrial, commercial, public and community premises in Ireland. The budget for REHeat in 2009 is €2.5 million;
- SEI is funding the pilot *Smart Metering Scheme* to investigate the potential for on-site generation of electricity for own use. Under this scheme, electricity was generated via small-scale technologies, such as wind turbines and solar power, with the potential to sell excess power back to suppliers. Grant support to meet 40% of the initial start-up costs was made available for the installation of micro-generation systems in approximately 50 trials to be conducted nationwide.

SEI is also recognising and rewarding best achievements in energy efficiency through the *Sustainable Energy Awards*.

6.2.3 Additional activities

SEI is planning to examine the convergence of communications and electricity generation and distribution networks in order to develop a smart grid. This is the next step after the SmartMetering programme and involves an assessment of the convergence of communications and electricity generation and distribution networks in order to develop a Smart Grid approach which can increase the overall electricity network efficiency and which can incorporate high inputs of renewable energy generated mainly from variable sources (wind and wave).

A Smart Grid is one which can automatically control energy demand by signalling connected equipment to power down at times when increased demand might cause the system to exceed its optimum efficiency. This can improve continuous matching of supply to demand and can allow seamless integration of intermittent renewable energy sources into a power grid. Smart Grids can also facilitate the introduction of variable pricing tariffs, to incentivise users to use energy only at times when it is more available (e.g. lower price energy offered at off-peak times when there are high winds). Smart Grids reduce the need to store energy generated by renewable sources. (See Chapter 5).

SEI is also planning to demonstrate the significant potential available through ICT efficiencies. This involves working closely with the industry, utilising technological solutions such as virtualisation, co-location, efficient IT hardware, optimised cooling technologies, and energy management controls.

Irish industry is also interested in developing smart products related to energy efficiency. Irish company – Glen Dimplex – serves as a good example. It is the largest supplier of electrical heating systems and products with annual turnover of €1.5 billion and 8,500 employees globally. The development of renewable and smart energy technologies and solutions is of key strategic importance to the company. They have combined smart meters and sensors with electricity storage heaters to provide an effective storage and heat distribution system. The smart meter communicates tariff information to the smart heater which, in turn, dynamically matches daily heating requirements with the most economic tariff. They have also developed a dual infra-red and occupancy sensor linked to the smart heating system. The company reports up to 50% savings by the use of such smart sensors. A number of Irish companies are focusing on the development of smart green products.

6.3 The Internet of Things

One of the key characteristics of the new digital world will be the Internet of Things, extending the Internet to include information coming from sensors attached to equipment and physical objects. Technologies like RFID, short-range wireless communications, real-time localisation and sensor networks are now becoming increasingly common, bringing the Internet of Things into commercial use.

There are a series of actions identified in the report that will allow Ireland to become an early-mover in the commercialisation of the Internet of Things. In particular, the report focuses on the development of projects such as Work Flow and Smart Bay.

6.3.1 SmartBay

SmartBay is an initiative of *Sea Change, the National Marine Knowledge, Research and Innovation Strategy for Ireland 2007-2013* and a key action of the marine component of the Government's Strategy for Science, Technology and Innovation 2006-2013.

Opportunity

Water management, climate change and renewable energy development are some of the key global issues facing the planet over the next generation. For a variety of reasons Ireland is uniquely well placed to serve as a natural laboratory for the development and testing of the technologies that will be needed to deal with these challenges. The SmartBay project represents an exciting intersection between knowledge, technology and the ocean and could offer Ireland a major niche and competitive opportunity in the global market for smart technologies.

The global market for water monitoring and management systems was valued at $3.6 billion in 2007. Marine and coastal applications accounted for approximately 60% of this market representing a value of $2.1 billion in the same year. These systems are predominantly used in the oil and gas sector, ports and harbours and by the aquaculture industry. Real-time monitoring of

water quality, storm surges and coastal flooding is becoming more common, driven by the demands of public safety.

With the growing awareness of climate change, attention is now turning to the development of solutions to mitigate the threat of natural water-related disasters and to improve the management of water as a valuable resource. Opportunities exist for indigenous Irish companies to work with research teams to develop and roll out niche sensing and communications technologies capable of remote sampling and analysis over extended periods. These would become the building blocks of an environmental nervous system based on real-time, web-enabled distributed sensing devices.

The market for real-time monitoring of ocean systems in the renewable energy sector (wind, wave and tidal) is also expected to increase rapidly. Additional commercial applications will evolve as technologies are deployed, for example, gas pipeline and port security.

Proposition

The SmartBay initiative seeks to develop a dynamic partnership between multi-national companies, indigenous enterprises, academia, Government and the public. The aim is to establish a Marine Research, Test and Demonstration Platform consisting of a communications and sensing infrastructure deployed in Galway Bay. It will link surface buoys and submarine cabled systems, Autonomous Underwater Vehicles, satellite-based sensing and shore deployed units. Unique within Europe, SmartBay will harness indigenous intellectual and technological creativity and build on the successful SmartBay pilot project to establish Ireland as a hub for the emergence of next-generation marine and environmental sensing technologies and a focal point for the development of innovative solutions to important environmental issues.

The SmartBay platform will be utilised collaboratively by researchers and industry to develop new products and services for global technology markets and to deliver valuable environmental management solutions. The intention is to develop a cluster of projects over time involving multinationals, SMEs and third level groups harnessing a mix of deep skills in scientific and engineering fields in addition to computational, analytical and data management expertise. These projects will build on existing capacity and synergies will be developed with industry and with SFI, CSETs (specifically CLARITY in DCU, DERI in NUIG, CTVR in Trinity and Lero in UL) and Strategic Research Clusters (specifically EEDSP[44] in UCC, Advanced Geotechnologies in NUIM and FAME in WIT). In many instances, the technologies already exist, but applications have lagged. SmartBay presents an opportunity for early wins in piloting new applications of existing technologies. At the same time, research and the knowledge that it generates will open up new possibilities for industry to innovate, develop & commercialise solutions.

[44] EEDSP - Efficient Embedded Digital Signal Processing for Mobile Digital Health Making Medical Sensor Systems

Successful SME engagement will be critical and SmartBay can provide a stimulus to commercialisation. R&D collaboration schemes run by Enterprise Ireland, such as innovation partnerships, proof of concept and commercialisation programs, provide grant assistance to SMEs partnering with 4th level research. A process will be established to communicate and create ongoing awareness of the potential of SmartBay across relevant industry-led research groupings and Enterprise Ireland supported networks such as WiSEN[45]. SmartBay also provides the opportunity to take existing technologies and apply them in traditional industries to improve efficiencies – for example, sensors in fishing.

It has already been recognised that one of the best ways for Ireland to exploit our base of existing FDI investment is to identify emerging areas of technology and market convergence. SmartBay is ideally positioned to be a catalyst to convergence and will promote a multidisciplinary approach across different sectors. The consequence of convergence is the creation of a portfolio of commercial opportunities – new products, devices, solutions, demonstration projects, software applications or services. Individual SmartBay research consortia will seek to have a mix of partners so that the possibility of SME/MNC collaboration exists. SMEs may be a source of disruptive innovation for multinationals. Success for SmartBay will be the product commercialisation and the spin-outs that result from a portfolio of significant and important R&D projects involving 4th level research, MNCs and SMEs.

Strategic Importance of SmartBay

SmartBay will:

1. Catalyse new commercial technology and business opportunities for Irish based MNCs and SMEs;
    a. Providing a unique platform to research, test and demonstrate a wide range of new technologies;
    b. Leveraging the existing base of FDI investment in Ireland and stimulating new opportunities for collaboration, value creation and market convergence;
    c. Positioning Ireland as a major player in emerging niche markets for smart environmental technologies;
    d. Attracting inward investment;

2. Generate new knowledge and IP to enhance marine resource development opportunities in Ireland;
    a. Promoting and supporting multidisciplinary research consortia to develop new commercial opportunities to accelerate the development of renewable ocean energy, to improve the competiveness of our ports and harbours and our shipping industry and to underpin sustainable development of our fishing, aquaculture and coastal tourism sectors;

[45] WiSEN - Wireless Sensors Enterprise Led Network

3. Enhance Ireland's global position and profile in marine science and technology;
    a. Attracting international research projects, FP7 funding and developing strategic international collaborations;
    b. Facilitating Irish teams to lead international research FP7 consortia;
    c. Generating new knowledge and demonstrating the benefits that real-time observation can provide in policy support and the development of innovative environmental management solutions;
    d. Securing Irish participation in a European Seafloor Observatory Network.

Cross-over sensor technologies can be imported into marine environmental monitoring. Applying technologies/sensors/analytical systems from other disciplines is a cost effective path to achieving near ready sensors for new marine chemical, physical and biological targets. Monitoring the aquatic environment is a multidisciplinary process and, to adequately monitor this environment, sensors and technologies will have to be imported from non marine technology sectors. For example major advances in bio-medical sensing technologies could be adapted for applications in marine biological sensing.

Case Studies – Existing Industry Partners

In its pilot phase over the past 2 years, SmartBay has already demonstrated that it is a valuable resource to industry and a successful example of state and private sector partnership.

IBM Ireland

In 2008, IBM and the IDA announced the establishment of an IBM Centre of Excellence for Water Management. Located in Dublin, this new facility focuses primarily on innovative research and services for monitoring, managing and forecasting environmental challenges in fresh water, marine and oceanic environments. One of the Centre's first projects was collaboration with the Marine Institute, Ireland on the SmartBay pilot project. The project was designed to develop and test a next generation water management system to provide scientists, commercial companies, monitoring agencies and the public with access to environmental information in a similar way to how we forecast and report the weather.

Utilising the SmartBay platform we have established a foundation and "end to end" reference architecture with large scale solution commercialisation potential to support IBM's Big Green Innovations Strategy. It has enabled us to develop, test and "fastpath" a number of new technologies appropriate for water management and advanced cyberphysical systems. It has also enabled us to build skills locally (for Ireland and EMEA) and enhance our partner ecosystem for sensor based solutions through collaboration with select multi-nationals, SMEs and academic institutions. We are also excited about opportunities to collaborate with Sustainable Energy Ireland and the ocean

energy test site operated by the Marine Institute in Galway Bay on the development of management and communications technologies for wave and ocean energy systems – Robert McCarthy, IBM.

Intel Ireland

Intel has already partnered with the Marine Institute to undertake initial steps in the proposed challenging pilot deployment of Mobile WiMAX across Galway Bay. The 'over water' aspect of this undertaking is critical; this will be one of the first Mobile WiMAX 'over water' deployments worldwide. Broadly speaking Intel will use its technology expertise to explore and discover new Usage and Exploitation models within SmartBay, on the Environmental monitoring side looking at pollution and weather monitoring, fishing industry and tourism benefits. We are also very excited by the technology opportunities associated with areas of Wave Power, Tidal Energy and Wind on Ocean. – Brian Quinn, Intel.

EpiSensor

EpiSensor is an Irish SME founded in 2007 and based in Limerick. The company has developed products for energy consumption monitoring, street light control, water quality monitoring and building climate control. The company is already working with DCU and IBM to commercialise a phosphate sensor developed by DCU researchers through the SmartCoast project jointly funded by the Marine Institute and EPA.

Building on this project, IBM and EpiSensor are now collaborating to develop real-time, environmental monitoring solutions for energy, water and carbon management. The interconnecting devices integrate with existing technology investments, linking low power sensors to environmental controllers, leading to increased efficiency, improved performance, lower costs and reduced environmental impact. EpiSensor will combine its expertise and know-how in developing environmental monitoring solutions using the open and interoperable ZigBee global standard for wireless sensor technology with IBM's research, enterprise software, advanced modelling and complex network management abilities.

Way Forward: A consortium of state agencies will consider how to optimise the development of this project.

6.3.2 Work Flow

Background

The greater Dublin area has a population fast approaching 2 million. The city has very few high rise buildings and land prices rose sharply during years of rapid growth – particularly in areas approaching the city centre. Public transport systems are underdeveloped with resulting long car commuting distances and travel times to work.

Communications and collaboration tools are now mature and proven in their ability to enable combinations of teleworking, mobile working and office

hoteling (office space provided on as-needed basis). Presence and awareness, intelligent routing and personalisation add to a rich suite of voice, data and video tools in increasingly interactive portable, desktop and conference room settings.

Tools formerly developed in the workplace and later released to the home sector are now being developed in the mass market and then repackaged for sale to corporations. The result is that smart citizens are using the same sets of tools in work and personal lives; by-products are an increase in market size and an increase in the skills base of the population. A digitally Smart Economy will exploit these increases and place itself at the forefront of experimentation and development in both work and life style changes. Ireland has the full range of ICT companies to power this development.

Combining smart travel, smart work options and communication and collaboration tools will result in significant cost, time and emissions savings. Embracing these options enthusiastically will open up strategic advantages for Ireland against its competitors.

Social networking, virtual worlds and gaming make use of many recently developed communication tools. Companies will invest where they can find a large pool of tech-savvy workers. ICT skills are not just learned in colleges but also in places that have embraced the digital lifestyle. Ireland has the tools and the people but has not yet fully embraced the lifestyle – at work or home.

Work Flow – Project

Work Flow is a new project under consideration. It combines flexible work practices and dynamic linking of home and office work-stations (using on-line audio and video) and gives the worker/commuter a continuous real-time estimate of the predicted commuting time between office-home-office. Using this information, commute time can be minimised. In effect, the smoothing of the peak hours (morning and afternoon) traffic saves considerable time and results in a significant reduction in CO_2 emissions. Commute-time is calculated by using web-enabled fixed and mobile (i.e. on-vehicle) sensors.

Next evolutions in video conferencing are also under consideration. The aim is to deploy both affordable video-conference units and also state–of–the-art Telepresence systems (high definition video systems). Improvements in technology and ease-of-use combined with greater workplace acceptance of the need to save on travel time, cost and carbon emissions could lead to an increase in video conference use resulting in significant reduction in CO_2 emissions.

The enabling technologies for *Work Flow* include sensor web technology and IPv6 protocol, allowing environmental parameters to be continuously updated in real time with uniquely addressable sensors. Unified Communications and Collaboration technology will allow for high quality fully featured collaborative working. Location-based services may also be considered.

Full service e-Centres could be developed in currently empty office space in the outlying commuter towns. These centres would have the highest connectivity available including both basic teleconferencing tools and high-end Telepresence. Benefits would accrue in time saved, emissions reductions and local economic development. Workday commuter ghost towns could be reborn with multiple positive effects for the local community.

DCENR is part of the interdepartmental group coordinated by Department of Transport on Intelligent Transport Systems. The Work Flow concept will be further developed by this group with a view to organising a feasibility trial in the greater Dublin area.

Way Forward: The interdepartmental group on intelligent transport will consider the concept. A stakeholders group, including industry, will consider the implementation of a pilot project

7 Update on eInclusion and eGovernment

7.1 eInclusion

7.1.1 The importance of eInclusion

The Government recognises the importance of eInclusion. Attaining higher levels of eInclusion will result in benefits for all. Citizens, businesses and society all stand to gain from more people participating in the knowledge society. Government therefore remains committed to working to achieve a more eInclusive society. This will be achieved by building on previous initiatives and by involving key stakeholders and focusing on priority issues and groups. Our objective is to realise a future in which all can enjoy the benefits and opportunities that the Knowledge Society can offer.

Research, analysis and liaison with stakeholders are currently underway with a view to determining the appropriate specific eInclusion objectives, actions and approaches to be included in the new strategy. These objectives will need to be realistic. It is currently envisaged that the focus on eInclusion in our next strategy document will include a range of measures relating to a number of key themes. The proposed themes and likely content within them are outlined below.

7.1.2 Availability and Access

Objectives and actions under this theme will focus on the availability of digital infrastructure (including broadband) to enable citizens to participate in the Knowledge Society. The new National Broadband Scheme will be important in this context. Accessibility for people with disabilities is another important dimension of this theme. In this context, it is anticipated that objectives and actions will focus on approaches to facilitate accessibility to increasingly crucial technologies – e.g. public sector websites for people with disabilities.

7.1.3 Digital Literacy, Skills and Competence

It is clear that the lack of the requisite digital literacy skills can be an impediment to the participation of many people in the Knowledge Society. Research also shows that many of the people we want to assist to participate in the Knowledge Society lack confidence. They are therefore less likely to take the steps necessary to participate. Provision for the teaching of the requisite skills in the formal education system will continue to be important as will the ICT in Schools programme to promote an eLearning culture in our schools. Future eInclusion strategy will also have regard to other existing initiatives and policy measures including *Towards 2016* and the *National Skills Strategy*. It will in addition incorporate measures to address the skills and confidence deficits amongst those who have completed their formal education. These measures will build on the successful *BenefIT* eInclusion grant scheme. This is an initiative in which Government (through the DCENR) partners with the community, voluntary and not for profit sectors in the delivery of eInclusion projects across the country. These projects focus on encouraging, facilitating and enabling people in the target groups to participate in the Knowledge Society. In particular they concentrate on helping

people to acquire the new skills they need to participate in and enjoy the opportunities the Knowledge Society affords.

7.1.4 Awareness and Motivation

Research indicates that lack of awareness of the potential benefits of participating in the Knowledge Society (especially through the use of the internet as well as the wider range of increasingly converging technologies) is a significant issue. When those who do not yet use the Internet discover how it can be of use to them most then show an interest in learning and engaging. The issue of awareness-raising with a view to motivating current non-users – particularly older people and those who have had less formal education – will therefore be a theme of focus in our eInclusion strategy. Our objective will be to help people to discover what such technologies can do for them as well as the value of these technologies to them in their everyday lives.

7.2 eGovernment

7.2.1 Background

Following on from the Comptroller and Auditor General's Special Report on eGovernment in January 2008 and the OECD's Review of the Irish Public Service on 28 April 2008, the Government has mandated a renewed focus on achieving progress with eGovernment initiatives.

An agreed Dáil motion on 30 April 2008 and subsequent Government Decision (15 July 2008) have set a number of priorities for delivery in the short term, including an instruction for all relevant Departments and Offices to take steps to progress eGovernment services included in the European Commission's eGovernment benchmarking exercise. These priorities have been reinforced by the report of the Task Force on the Public Service, "Transforming Public Services" in November 2008.

7.2.2 Responsibility for eGovernment

The Taoiseach announced on 7th May 2008 that responsibility for eGovernment was to be consolidated in the Department of Finance. Responsibility for the delivery of individual eGovernment projects will remain the responsibility of individual Departments and Offices. This new arrangement will ensure that there is strong, coordinated leadership from the Centre, with regular communication between the Department of Finance and the various Departments, Offices and Agencies with responsibility for various projects.

7.2.3 Setting eGovernment Priorities

The Department of Finance has issued Circular 6/09 on Arrangements for eGovernment in March 2009. This Circular requires all Departments, Offices, Agencies, and all non-commercial public bodies and authorities to develop eGovernment plans which set out all ongoing, planned and potential eGovernment projects. These plans will be approved by each organisation's senior management and submitted by the Accounting Officer to the

Department of Finance for evaluation. Such plans will be set in the context of the wider modernisation programme underlying the need to, *inter alia*:

- Improve the quality of customer service
- Drive administrative and process simplification
- Improve value for money in a tightening fiscal environment
- Improve Ireland's standing in international benchmarking and public perception
- Improve the public's perception of ICT usage in the public service

This work will also determine which services are not amenable to electronic interactions and why that is the case.

Progress in relation to the plans will be monitored by the Department of Finance and included in reports to Government.

7.2.4 Reporting Arrangements

Progress reports on eGovernment targets will be submitted by the Department of Finance to Government on a six-monthly basis. These reports will be based on reports on individual eGovernment services, submitted by the responsible Departments, Agencies and Offices to the Department of Finance which will include key details, including, *inter alia*:

I. Ownership
II. Schedules/Timelines
III. Facilities being offered
IV. Costs
V. Benefits/Impacts
VI. Capacity of Organisation to deliver
VII. Monitoring arrangements
VIII. Progress to date

8 Future Directions

8.1 General

This report has focused on enabling technologies in communication, electricity networks and ICT and energy efficiency because of their centrality in supporting the development of a Smart Economy. As such these technologies are at the interface between the developing *Knowledge Society Strategy* and *Building Ireland's Smart Economy, a Framework for Sustainable Economic Renewal (2008).*

Establishing exemplar projects and programmes using Ireland as a test bed with the aim of exploiting strengths, demonstrating leadership, improving competitiveness and exporting innovations will be a key approach of the *Knowledge Society Strategy*. Ireland has particular strategic advantages and specific opportunities suited to this approach. With our successful high-tech, pharmaceutical and healthcare sectors allied to our research capabilities, we have the relevant skills to support such exemplar models. Healthcare and Education will be primary areas of focus for the Strategy.

In Healthcare, Ireland has high-tech manufacturing in pharmaceuticals, medical devices and medical diagnostics and a strong research base in life sciences. Government funds the vast majority of health care costs and this could provide leverage to establish suitable exemplars. Clinical trials and research are a further possibility, as one of the leading global clinical trials companies – Icon – is Irish. eHealth will be a major target due to its high social and economic potential.

Work is underway to address the challenge of incorporating ICT products into all levels of Education in order to support teaching and learning. A start has been made in connecting 75 secondary schools with high speed broadband; these schools have the potential to become an exemplar in teaching and learning practices. Ireland has good expertise with eLearning products with market leader Houghton Mifflin, which merged with Riverdeep in 2007, basing its global R&D centre here in Ireland.

The shift from mainframe to desktop has been mimicked by the shift to laptops and (via PDAs) now to cell phones. Almost all citizens in Europe carry or have access to a cell phone; as such they are the democratic digital tool. The range of tools and services available on average modern cell phones is extensive and the interconnectedness of these devices with computers, cameras, radio etc. turns them into both mobile computers and mobile hubs. Cell phone culture, like social networking, is ubiquitous, affordable, easy and fun; no special training is required and there is no significant user skill threshold. There is now an opportunity to draw in people of limited education and technical self-confidence to the Digital World of communications and collaboration and, through the Digital World, to the heart of the Knowledge Society itself.

The election of President Obama in the US has changed the way politics is done. Communication and collaboration tools, social networking services,

'traditional' text, email and voice had already changed the way people live, work and play; now they are changing how people motivate, organise and reform their societies. A curious and educated people with great ICT companies and an open attitude to the world are ideally placed to lead in developing the next usages of technology – the usages that will define Digital Citizenship in connected cities, towns, villages and rural areas.

The Knowledge Society will offer new ways of connecting across traditional divides. All parts of Ireland – North and South – have centres of excellence in Digital Media and both jurisdictions have shown keen interest in developing alternative energy and smart grids. Harnessing the work of our island-wide universities, research centres and companies will provide increased scale in expertise and markets for both jurisdictions. The creativity of local centres of excellence will draw together Dublin, Belfast, Derry, Galway, Limerick, Cork, Waterford and cities and towns in joint initiatives and enterprises to build the next elements of Smart Economies; doing so will challenge traditional divides – North/South, Dublin/non-Dublin, town and country. No place with broadband infrastructure and talented people will ever be remote again.

8.2 Update on emerging projects

Exemplar Smart Network based on Optical Packet Switch Technology

A workshop is being planned with potential users of the Exemplar Smart Network, relevant state agencies and contractors, along with Intune Networks and relevant Research Centres to consider the design, benefits and implementation of the proposed network for Summer, 2009. The implementation of the first phase of the network is planned for 2010.

While it is always difficult to predict the exact number of new jobs which could arise from break-through technology, we conservatively estimate that 5,000 direct jobs and a further 5,000 indirect jobs could be established over a 5-10 year period as a result of the Exemplar Network.

Ireland as a Centre for Data/Cloud Computing Centres

The proposed actions from the recent workshop will be analysed and prioritised by the stakeholders and an Action Plan completed by the end of 2009. It is estimated that a minimum of 10,000 high value jobs based on advanced Data Centres will result over the next 5-10 years.

Digital Dividend

DCENR will liaise with the ComReg and Industry in order to review innovative actions required by end of 2009.

International Content Services Centre

A working group of stakeholders (legal, content, industry, state agencies) will be established and charged with producing a feasibility plan for the establishment of the proposed centre by the end of 2009. This proposed

development has the potential to create up to 10,000 jobs over the next 5-10 years.

Work Flow

The interdepartmental group on intelligent transport will consider the concept. A stakeholders group, including industry, will guide the implementation of a pilot project in 2010.

SmartBay

Develop SmartBay from a pilot to a full-scale national platform/test-bed for marine and environment including upgrading its wireless facilities and laying of fibre on the seabed – 2010/2011.

Contact

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Appendix 1: The Proposed Exemplar Smart Network Details

Architecture

The Exemplar Smart Network will be the world's most advanced digital packet network platform. It will be capable of providing a single infrastructure for all possible digital network applications in the future, as it is a fully-connected network (every location can communicate with every other location). It can also guarantee quality of experience such as video delivery and life-line (i.e. emergency) services. It is intended to be a platform for any future service many of which have yet to be created, particularly those that can take advantage of guaranteed video delivery capabilities.

It is intended to provide this platform first to Irish researchers and product developers and open up the possibilities for an entirely new set of network services. The next section shows a set of illustrative services - this is only the tip of the iceberg in terms of what is possible.

Components

The Exemplar Smart Network rings will be based on Intune's Optical Packet Switch Transport (OPST) platform: the iNX 8000. The iNX 8000 is a distributed Layer 2 optical packet switch which delivers 800 Gbps of switching capacity over a 1.6 Tbps optical transport fabric. The iNX 8000 will deliver 40 to 80 wavelengths in a fully meshed bi-directional path switched ring with a 300 Km geographic reach. This provides fully resilient and robust any-to-any connectivity. The iNX 8000 will support a variety of network interfaces, including 10G bps Ethernet Ports, 1 Gbps Ethernet Ports and 10 Gbps and 2.5 Gbps SDH ports. A sister product, the iNX 200, will support a variety of slower-speed ports ranging from 10 Mbps Ethernet up to 1 Gbps Ethernet.

The iNX 8000 will be deployed with between 4 and 16 nodes per ring. The nodes will be at various locations as agreed with all participants, including Universities, Government facilities and the Intune support and integration centre.

The Exemplar Smart Network will also include network equipment from other vendors, as required, to fully replicate existing network architectures, services, protocols, and management systems.

Capabilities

The Exemplar Smart Network will be the world's most advanced digital network platform and will have a very large number of possible uses. It is designed to allow existing services to co-exist with a large range of possible new services. The platform is intended to be a key enabler for Irish researchers to develop new services that have never been demonstrated before.

Examples of the initial services that will be demonstrated on the exemplar network platform are listed below. Some of these services will be developed

and tested on the Exemplar network, while some of them already exist, but have limitations due to current network performance constraints.

Consumer Triple-Play Services

The proposed Controlled Network Segment will model the typical Irish home, showing the home network and the voice, video and data services each citizen can expect in the future. These services will arrive and be serviced through the distributed Data Centre functions built all around the network rings as shown earlier in Figure 2. Peer-to-peer services between homes will also be demonstrated with guaranteed connection performance.

Business Services

A model of a typical Irish work environment will be built and multi-media and database services will be shown to operate including Cloud Computing and IT computer services distributed inside the network. The network becomes a Cloud of IT services for each business.

Mobile Services

The exemplar network will demonstrate how mobility can be handled by the various technologies involved. Mobile phone and laptop users will be able to log on to the network and then move to various connection points in the facility to demonstrate the continuity of service and consistency of quality of experience for a variety of applications.

R&D and Government Facilities

Distributed Data Centre and Cloud Computing facilities will be demonstrated working over the network. This will demonstrate how Government Data Centres can be connected and scaled to greatly reduce cost and increase the efficiency of distributed service delivery to the citizens of Ireland. Similarly, the Cloud Computing model will be capable of illustrating how advanced R&D applications and services such as modelling of weather, oil exploration, genetic research and other studies can be performed collaboratively, sharing computer resources on-demand across a distributed system.

Processing Centres & Digital TV Delivery

Centres where content is created, generated and distributed will contain their own ring network and link to the connector rings. This will demonstrate video search, video content synchronisation, and other network applications such as hosting of local business servers. For example, an Irish national digital TV service could be provided through this network platform.

Digital TV and radio will give a powerful boost to applications in transport and education, as well as the cultural and creative industries, not least through enhancing the convergence with the online communities. The switching off of analogue TV and radio by 2012 will support this.

Scalability

The 3-ring model will demonstrate how this system can scale to cover a national network with a single 64 Tbit/s switch, giving bi-directional high-bandwidth links between all of the consumers, businesses and organisations in the country when required.

Live Traffic

The Active Network Segment will link real Government and University campuses together to demonstrate live traffic versions of the technologies, services and applications tested and built in the controlled segment.

Operations

Structure and Operations

It is proposed to develop, maintain and operate the Exemplar Smart Network in partnership with selected Research Centres and agencies. It envisions a virtual facility with third-party development and demonstrations taking place at a selected facility. Provision of integration, test, support, and maintenance is proposed at an extension to Intune's existing facilities. Additional locations and facilities can be added for network nodes, hosting centres, development centres, research centres and expanded demonstration and conference facilities.

A Proposed Architecture

The following table provides an outline of the proposed Exemplar Smart Network.

Category	Notes
Intune's iNX 8000, iNX 200 and related test and support kit	A minimum of 25 Nodes is required to build a robust test and verification function as well as the operational network
Other Network Equipment: IP routers, Ethernet Switches, connectors, cables	Will use existing assets or contributions from participating organisations to manage costs and enhance the Exemplar Smart Network. It is anticipated that the network fibre and outside plant facilities could be provided by HEANet and ESB Telecom as coordinated by DCENR.
Network support and maintenance facility: racks, facilities, furniture, audio-visual etc.	This is the network hub and operations facility including space for third-party research and development personnel.
NGN build-out: labour; facilities; racks, connectors, etc	Extra participants and locations will drive higher costs

Table 2: A Proposed Architecture

Funding and Participation

It is proposed that the Exemplar Smart Network would be an infrastructure asset to facilitate research and development in Ireland for the Knowledge Society and the Smart Economy.

It is anticipated that many of the Exemplar Smart Network partners would provide funding and resources for its enhancement and operation.

Appendix 2: Cloud Computing characteristics, delivery and deployment models

Key Characteristics

On-demand self-service: A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed, without requiring human interaction with each service's provider.

Ubiquitous network access: Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).

Location-independent resource pooling: The provider's computing resources are pooled to serve all consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. The customer generally has no control or knowledge over the exact location of the provided resources. Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.

Rapid elasticity: Capabilities can be rapidly and elastically scaled up and scaled down depending on demand. To the consumer, the capabilities available for rent often appear to be infinite and can be purchased in any quantity at any time.

Pay per use: Capabilities are charged using a metered, fee-for-service, or an advertising-based billing model to promote optimisation of resource use. For example the storage, bandwidth, and computing resources consumed are measured and charged for the number of active user accounts per month. Clouds within an organisation accrue cost between business units and may or may not use actual currency.

Delivery Models

Cloud Software as a Service (SaaS): The consumer can use the provider's applications running on a cloud infrastructure accessible from various client devices through a thin client interface such as a Web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure, network, servers, operating systems, storage, or even individual application capabilities, other than limited user-specific settings.

Cloud Platform as a Service (PaaS): The consumer can deploy consumer-created applications onto the cloud infrastructure, using programming languages and tools supported by the provider (e.g., java, python, .Net). The consumer does not manage or control the underlying cloud infrastructure, network, servers, operating systems, or storage, but has control over the deployed applications and may possibly configure the application hosting environment.

Cloud Infrastructure as a Service (IaaS): The consumer can rent processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, included operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly select networking components (e.g., firewalls, load balancers).

Deployment Models

Private Cloud: The cloud infrastructure is owned or leased by a single organisation and is operated solely for that organisation.

Community Cloud: The cloud infrastructure is shared by several organisations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations).

Public Cloud: The cloud infrastructure is owned by an organisation selling cloud services to the general public or to a large industry group.

Hybrid Cloud: The cloud infrastructure is a composition of two or more clouds (internal, community, or public) that remain unique entities but are bound together by standardised or proprietary technology that enables data and application portability (e.g., cloud bursting).

Each deployment model can be either internal or external. Internal clouds reside within an organisation's network security perimeter and external clouds reside outside the perimeter.

Appendix 3: Members of High Level Consultancy Group

Minister for Communications, Energy & Natural Resources	Eamon Ryan, T.D.
Minister of State with special responsibility for Science, Technology, Innovation and Natural Resources	Conor Lenihan, T.D.
Minister of State for Communications, Energy & Natural Resources	Seán Power, T.D.
DCENR	Peter O'Neill
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Delta Partners	Shay Garvey
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Dublin Institute for Advanced Studies	Dervilla Donnelly
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Ericsson	John Hennessy
ESB Networks	John Shine
Forfás	Martin Cronin/Michelle Kearney
Fujitsu	Regina Moran
Google	Niall O'Riordan/Iarla Flynn
Higher Education Authority	Tom Boland/Caitriona Ryan
Houghton Mifflin	Fiona O'Carroll
IBEC	Kathryn D'Arcy
IBM	Michael Daly
IDA Ireland	Denis Molumby/Brendan McDonagh
Independent Consultant	Sean Baker
Microsoft	Paul Rellis; Terry Landers
National Council for the Blind	Mark Magennis

New Game Technologies/TCD	Steve Collins
Oracle	Paul O'Riordan
Science Foundation Ireland	Frank Gannon/Fionn Murtagh
Sustainable Energy Ireland	Owen Lewis/Katrina Polaski
DCENR	Roger O'Connor
DCENR	Brendan Whelan
DCENR	Suzanne Duke

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