E-topia?

Contextual Scenarios for Digital Futures

Final Report

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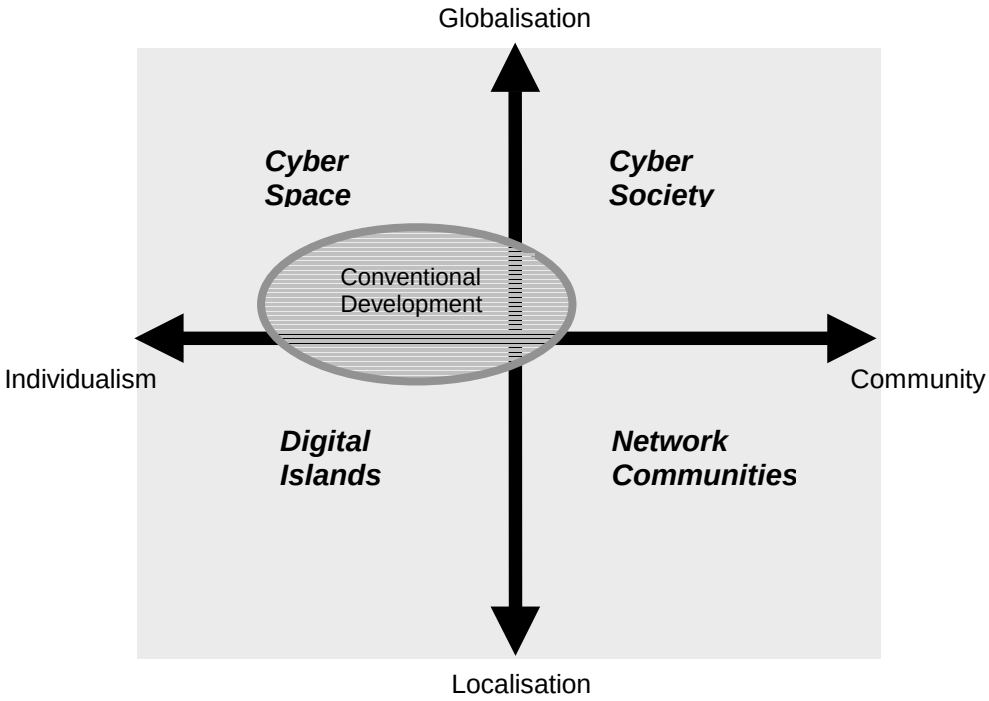
Executive Summary

Four scenarios are presented for the development of e-commerce and its impact on sustainable development in the UK over the period to 2010 and 2020. The scenarios are exploratory not predictive. They provide self-consistent pictures of the future that illustrate alternative paths of development for e-commerce. They describe a possibility space that forces us to reflect on the longer-term consequences of choices made in the present. An exploratory scenario approach stresses the uncertainty about the direction and nature of future developments and begins with some qualitative principles from which futures storylines and indicators can be generated.

In this study we see e-commerce markets, and the technologies that enable these markets to function, as being shaped by broader social and political developments in society. Information and communication technologies (ICTs) or e-commerce are not seen as independent forces of change, but recognised as *co-evolving* with social and economic changes. The way in which cyberspace is organised and controlled will to a large extent reflect and mirror the way in which the 'real' economy and society are organised and controlled. There are new aspects about the virtual world and services provided in it, such as their infinite reproducibility, but we conceive of the real and the virtual worlds as being embedded one in the other, not separated and distinct.

The four scenarios: **CyberSpace**, **DigitalIslands**, **CyberSociety** and **NetworkedCommunities** are defined using two dimensions: values and governance. The horizontal **values** dimension captures alternative developments in core social and political values as they may affect choices made by consumers and policymakers. At one end of the spectrum ('INDIVIDUALISM'), values are dominated by a desire to satisfy individual aspirations for personal freedom. At the other end ('COMMUNITY'), values are shaped by greater concern for the common good. The vertical **governance** dimension aims to show differing configurations of political and economic power and decision-making. At one end of the spectrum ('GLOBALISATION'), the power becomes more distributed across local, national and global levels of governance. These are connected, interdependent worlds. At the other end of the spectrum ('LOCALISATION'), economic and political power is retained at national (DigitalIslands) and regional (NetworkedCommunities) levels. These are more fragmented worlds where sovereignty and autonomy are maintained.



For each of the four scenarios storylines are set out describing the size and scope of the digital economy in the UK in the 2010s, the distribution of e-commerce transactions (the balance between B2B, B2C, for instance) and the major technological developments in infrastructures and devices. To give an example, we see the CyberSpace scenario as a world of high technological convergence in ICT networks with a stress on mobile devices, while DigitalIslands is a scenario with more limited convergence and interoperability, and a greater reliance on fixed devices like interactive digital TV.

Having sketched out the economic, market and technological background, impacts on social and environmental sustainability are then assessed comparatively. A range of impact categories were chosen and are listed in Table 1.

	Impact category
Social	'Digital divide'
	Consumer protection and security
	Public services
	Citizenship
	Regional development
Environmental	Resource efficiency
	De-materialisation
	Consumption patterns
	Transport
	Environmental governance

Table 1: Social and environmental impacts assessed

Summarising the results overall, we find that while under some impact categories there are similar outcomes under all scenarios, while quite different outcomes result under other scenarios. On questions of access we find that the 'digital divide' persists to varying degrees under all scenarios, but that the issue changes from being about connection to digital networks to being about access to digital services on those networks. Consumer protection and privacy issues are already regarded as critical to Internet development, and here the scenarios point to a choice between market-based voluntary approaches, and more regulatory approaches that could emerge in future. Provision of public services on the Internet (G2C transactions) are seen as generally enhancing their effectiveness, but this will be dependent to a large extent on widespread access to the Web and the capabilities of more socially excluded groups to use these services. Under some scenarios, a serious 'capabilities gap' persists. Finally on social impacts, the analysis points to deep disruptions in the pattern of regional development under all scenarios due to industrial structure changes, changes in retailing and new infrastructures that are built to enable the New Economy.

Environmental impacts of the e-economy across the scenarios also suggested a very mixed picture. Eco-efficiency gains on production processes and the design and use of products were seen as characteristic of all scenarios, but analysis also suggested that claims for de-materialisation (and virtualisation) may have been overplayed by other analysts. This innovations and substitutions of information for materials and energy are seen as generating limited environmental benefits at the level of the UK economy over the next decade or two. The analysis also suggests that falling prices and greater access to goods and services under all scenarios, partly as a consequence of e-commerce, is likely to produce a 'rebound' effect. The scope of consumption is extended in all cases, and the capacity for policy to influence this appears to be limited. Lastly, we believe that while there will be substitutions of communication for mobility (a 'demobilisation' effect) the general effect of e-commerce in all scenarios will be

for more high volume, flexible and rapid transport systems. Under some scenarios these will be planned with environmental objectives in mind, and not in others.

What then are the lessons for policy? While the scenario approach employed here stresses uncertainty about the future and the plausibility of many different outcomes, it also stresses the scope for choice. But this choice is not concerned with 'picking winners' or pursuing a trajectory of change into a preferred scenario. We stress instead the need for 'robust strategies' for policy that will bring benefits across a range of futures.

In this study the following robust policy strategies were identified:

1) *Governments have a role to play in fostering institutions for governing the Internet, including its impacts on social and environmental sustainability*: The Internet is not one community, but a complex of communities, each with their own objectives and expectations. Governments have a role in moderating between these, often conflicting, interests.
2) *Network diversity should be encouraged*: The scenarios reveal very different outcomes in terms of the development of technologies and markets for services. In a period of rapid change, it is still too early to predict what dominant systems will emerge. New standards and economic regulation are likely to be needed to prevent premature 'lock in' to dead-end technologies.
3) *A holistic approach to service obligations should be developed*: While the web can encourage much wider access to digital services, many services, even some 'essential' services, are liable to be highly unevenly distributed under all scenarios. Service obligations which take into account the multi-channel nature of digital services (television along phone lines and telephony via digital TV, for instance) will ensure that wide social access to service content to encouraged.
4) *Dematerialisation needs to be enabled by investment in modern transport and energy systems*: Information and communications technologies do provide opportunities for 'step change' transformations in the way we consume materials and energy. But such opportunities cannot be achieved by digital networks alone. They depend on heavy investments in the modernisation of transport and energy infrastructures, and in the built environment in general.
5) *Greater transparency and better information is critical to behaviour change*: In an 'information society' information will play a greater role in environmental governance, increasingly with the aim of achieving changes in the behaviour of producers and consumers. Governments have a role in encouraging and mandating greater transparency about corporate activities.
6) *The need for more research*: There is no doubt that the impacts of ICTs and the Internet are profound. It is also likely that the impacts on social and environmental sustainability will be large. But we have insufficient knowledge and evidence about the links. There is a need for major longitudinal research that can clarify the patterns and dynamics and change, and how actions by governments, business and consumers may mitigate negative impacts.

1. Aims of this report

This report presents ideas about how electronic commerce could develop in the UK over the next 10 to 20 years, and draws conclusions about the implications of e-commerce for social and environmental sustainability. The aim is to suggest that a number of alternative futures are available for service providers, consumers and for policy makers, and that choices exist over which of these futures will unfold. If the right choices can be made now, at the beginning of the development of e-commerce, greater benefits may result and potential dangers may be avoided.

But looking at the future is never easy. We need to be both creative and modest. While there are evident continuities in social and economic development, we can also be sure that much that is unexpected will occur especially when an apparently radical technological innovation like the Internet begins to have an effect right across economic activity. In this study we have been faced with two particular sources of uncertainty. The first is about the future of e-commerce itself. With technologies, services, markets and regulation still undergoing rapid innovation it is difficult to identify the paths of future change. The second is over the impacts of e-commerce on sustainability. Due to the relative novelty of e-commerce there is a lack of knowledge about what its wider impacts on society and the environment might turn out to be.

We are therefore faced with the difficult problem of seeking to make better decisions in the face of deep uncertainties about the course and impacts of future change. The strategy adopted in this report is to project pictures of future worlds (storylines) that describe a *possibility space* – a set of plausible futures that span a range of conceivable outcomes. These e-commerce storylines have been used to deduce possible impacts, with differing patterns of impacts reflecting differences in storylines. The e-commerce storylines and their potential future impacts on sustainability are illustrated with a set of quantitative and qualitative indicators.

Taken together, the storylines and indicators make up the futures scenarios. In this report we have developed a framework that generates four scenarios: **CyberSpace**, **DigitalIslands**, **CyberSociety**, and **NetworkedCommunities**. These scenarios are intended to be coherent representations of possible futures that can stimulate analysts, policymakers and strategists to question their own assumptions about how e-commerce may develop in a systematic way. They are conceptual vehicles for framing ideas about what the future may be like. They are expressly not intended to be predictions of the future, but they are intended *to inform choices today that will shape future outcomes*. The scenarios are one of the outputs of the Digital Futures project.

In building these scenarios, we have taken as a starting point the social and political make-up of possible future worlds. Technology is therefore not seen as an autonomous force of change, but as being embedded in social, political and economic settings that shape its use and diffusion. Technology makes things possible, but whether or not these new opportunities are seized depends on whether service providers and consumers see some clear benefit in doing so. The pattern of incentives and obstacles to innovation are largely determined by the way in which markets, regulations and consumer tastes develop. This is why we have taken social and political factors as the foundation on which to build these Digital Futures scenarios.

The report is split into eight sections. In section 2 the scenarios approach used in the study is further discussed. Section 3 discusses some common themes that are highlighted by the scenarios. This is followed in section 4 with storylines for the four scenarios. Section 5 discusses potential social and environmental impacts of different pathways of e-commerce development. Section 6 draws on the results of the study to make some policy recommendations, and the Annex lists a number of quantitative indicators for 2010.

2. The scenarios approach

Scenarios are planning and communication tools that are used to explore complex, uncertain and sometimes disputed futures. In this study we have chosen an exploratory approach to scenario construction that is open and participative. The scenarios presented in this report have three main objectives:

- to illustrate broad socio-economic contexts within which e-commerce may develop;
- to identify specific features of Internet and related technologies and e-commerce markets under these different socio-economic contexts; and
- to provide a basis for a preliminary assessment of the social and environmental impacts of alternative e-commerce futures.

The scenarios consider the development of e-commerce and its impacts in the UK set in a European and global context. We have adopted two time horizons – 2010 and 2020. Whilst the 2020 horizon is highly speculative with respect the development of information and communications technologies, the Internet and e-commerce, it is included to take account of much slower changes in infrastructures (such as roads and digital networks) on which e-commerce depends.

The scenarios framework used in the E-topia study draws on earlier studies: the Natural Resources and Environment Foresight Panel's *Environmental Futures* study; the DETR *Socio-economic Futures Scenarios for Climate Impact Assessment* project; and the Foresight Programme Integrated Transport Chain Futures Task Force Report on *Actions for Sustainable Transport: Optimisation across modes*. Results of several recent studies on the future of E-commerce and information and communication technologies (ICTs) were also consulted: an unpublished scenarios study for the DTI's Radiocommunications Agency (Nervewire, 2000) and the Foresight Programmes' Retail e-commerce Task Force Report *Clicks and Mortar*.

A review of futures studies identified five main dimensions of change (Berkhout et al, 1998):

- population growth and settlement patterns;
- the rate and composition of economic growth;
- the rate and direction of technological change;
- the nature of governance; and
- social and political values.

We have taken the latter two dimensions as our starting point. Social and political values and the nature of governance are seen as critical determinants of future changes, including economic and technological changes. This means that the scenarios have been generated from a set of conceptual associations, rather than from an empirical model of the real world. The strength of this approach is that it brings an intellectual coherence to the scenarios. However, 'values' and 'governance' are not simple or easily definable concepts. In using them to construct a scenario framework we have made a number of simplifying assumptions about what they mean, and about the range of different values and models of governance that are considered. We take *values* to mean contemporary tastes, beliefs and norms, and *governance* to mean the way in which authority and control is exercised in societies – whether local, national or global.[1] While there are obvious connections between values and structures of governance (a democratic society can

[1] By *governance* is meant something wider than *government*. Governance includes both governmental and non-governmental (private sector, civil society, regional and international organisations) institutions with a role exercising and shaping the exercise of power in society. In this study we have been mainly concerned with the structure of governance, specifically at what level political authority is located in a multi-level and international system of governance.

only function if democratic values prevail) we take them to be independent in this scenarios framework.

Values and governance both reflect and shape social and economic changes. National economic growth, for instance, will be determined by the manner in which markets are regulated, by the choices governments make in allocating resources and by the tastes of consumers. The rate of economic growth can therefore be seen as an outcome of an association between a particular set of values and governance arrangements. Similarly the rate and direction of technical change will be determined by the generation and diffusion of innovations. Social regulation and consumer values will have a profound influence on this process of diffusion (cf. genetically-modified food).

The four scenarios are defined by two dimensions, one describing a range of 'values', the other describing a range of 'governance' arrangements. The horizontal **values** dimension captures alternative developments in core social and political values as they might be represented in choices by consumers and policymakers. At one end of the spectrum ('INDIVIDUALISM'), values are dominated by a desire to satisfy individual aspirations for personal freedom. The rights of the individual and the present are privileged over those of the collective and the future. Resources are distributed through free and competitive markets, with the function of governance limited mainly to guaranteeing free markets and trade. At the other end ('COMMUNITY'), values are shaped by greater concern for the common good. The individual is viewed more as part of a collective, with rights and responsibilities determined by broadly-defined social goals. There is greater concern about the future, equity and participation. Civil society is strong and highly valued, and resources are allocated through more managed markets.

The vertical **governance** dimension aims to show alternative structures of political and economic power and decision-making. We assume that future governance in the UK will be greatly influenced by developments within the European Union and in global institutions like the World Trade Organisation. With the governance axis we are seeking to identify different ways in which political authority may be distributed in this system. At one end of the spectrum ('GLOBALISATION'), the power to govern is distributed upwards, downwards and outwards away from national governments. Political and economic co-ordination increasingly takes place at an international level. National political and economic boundaries fade and greater interdependence is fostered. Locally-based decision-making takes place in the context of global trade and environmental regimes, and global economic competition. At the other end of the spectrum ('LOCALISATION'), economic and political power is retained at national (DigitalIslands) and regional (NetworkedCommunities) levels. Sovereignty over key areas of economic, security and social policy is concentrated at one level, and the process of economic globalisation is weakened. Governments have greater autonomy in decision-making, and economic, political and cultural boundaries are maintained or strengthened. National and regional development is based on local capabilities and resources.

These two dimensions can be used to describe a possibility space containing four alternative futures scenarios (see Figure 1). Elaboration of the scenario storylines involves tracing through the implications of a particular association between 'values' and 'governance'. This is primarily an act of the imagination, drawing sometimes on well-founded theories, often on expert judgement and sometimes on intuition to build up a picture of a future state of development.

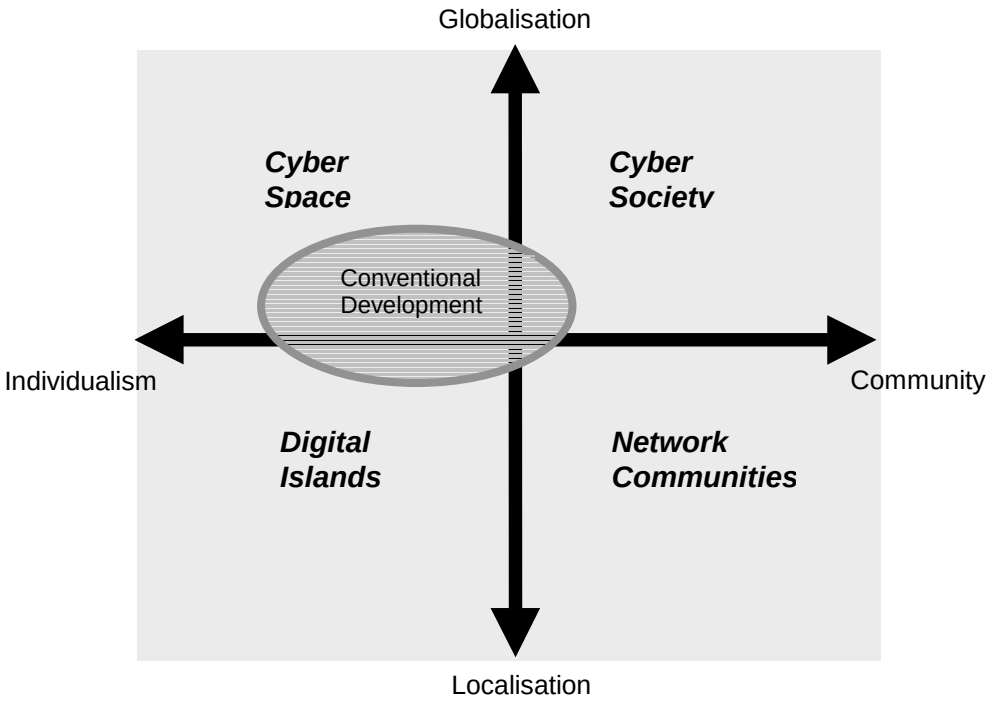
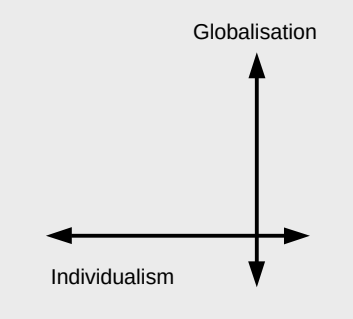


Figure 1: Four contextual e-commerce scenarios

The following section describes each of these possible futures in turn and is structured as follows. First a brief description of the key features of each scenario is given, including indicative indicators for economic growth, the relative volume of e-commerce, road traffic congestion and greenhouse gas emissions. *A full set of contextual and impact indicators is provided in Annex 1.* The principal features of the global and UK economies and evolution of the e-economy under each scenario are then discussed. The varying governance styles and priorities under each future are examined, with particular attention given to the role of policy in shaping technological and market opportunities and outcomes. The rate and direction of innovation, the technological development paths of networks and devices, and the structure of access to e-commerce are then considered in some detail. Finally some additional socio-economic context is provided enriching our picture of each future world, with broad-brush accounts of developments in transport, population and settlement patterns, and public service provision.

3. Scenario storylines



CyberSpace

Scenario Highlights
This is a future world of consumerist values, a highly integrated world trading system, and significant economic expansion (**3.5% average GDP growth**). Liberalised, open markets are sustained and regulated through international governance institutions. Regulatory controls at both the national and global level are weakened. Global oligopolies flourish in many sectors. Sovereignty over economic policy is increasingly lost by national governments whose function becomes the implementation of common codes and rules. The development of a global *convergent* ICT environment (probably around mobile devices) is accompanied by *maximum migration* of commerce to the digital domain (**e-commerce 25% of UK GDP by 2010**). Leading-edge technology is increasingly oriented towards delivering high-value consumer services. There is no formal access or content regulation for digital services. Industry self-regulation predominates. Growing disparities develop in the extent to which digital services become embedded in business, educational, health and leisure activities, with the benefits mainly going to the affluent. Rapid growth is experienced around metropolitan centres, but extensive excluded peripheries persist. This is a high mobility, transport-intensive future (**11% of UK road network at 100% stress by 2010**). Social and environmental objectives are regarded as secondary to economic growth. Greenhouse gas emissions increase under this scenario (**780 MtC equivalent in 2010** *c.f.* 773 today), whilst equity declines.

	Economy and e-commerce
Economy	Liberalised and open markets, an integrated world trading system, buoyant consumer demand, and the adoption of new technologies (ICT and biotechnology) brings sustained high levels of world **economic growth (3.5% GDP growth)**. E-commerce is viewed as a catalyst of economic integration and growth by extending the scale and scope of markets, providing more transparency and efficiency, and allowing a reduced burden of regulation. Countries, firms and consumers who best adapt to and exploit the new e-economy prosper. Large global businesses drive the development of increasingly integrated 'content' led global networks, with structured access (a mix of open and closed networks). As a result of an innovative, entrepreneurial and 'global' culture small businesses also flourish servicing specialised international markets.
Digital	The **digital economy** becomes increasingly dominant across the EU,

economy

accelerating the decline of manufacturing and agriculture. Particularly high growth is seen in the ICT and logistics sectors underpinning the new economy. There is high migration to the virtual economy across all sectors, and the total volume of e-commerce is very high. As a proportion, B2B transactions become less significant over time, with the growth of stable B2C e-relationships. E-money and banking become the norm, promoting common global currencies.

National governments' ability to collect **tax revenues** is curtailed by the growth of global e-economy. Tax avoidance becomes easier as a result of global e-banking and the elimination of import duties on all goods. Attempts to tax Internet transactions fail through lack of enforcement. By 2010 the outcome of 2005 UK referendum on joining the Euro is seen as increasingly irrelevant due to the emergence of global cyber-currencies.

Business to Consumer

Economic transformation is pioneered by rapid expansion of **B2C** e-commerce in: finance; retailing and logistics; travel; media and entertainment; the education and health sectors; and in personal services (advice, security, privacy and pleasure). Routine consumer purchases become increasingly automated as intelligent intermediaries and avatars are developed to scour the WWW for goods and services. This stimulates further rapid growth in global logistics and transport services. Customised marketing and strong relationships with high-income customers become increasingly critical for service providers. Retail space is transformed with an emphasis on leisure and entertainment, demonstration and servicing, and high-value purchases.

Business to Business

Tighter supply chain control and major efficiency gains are achieved from the automation of **B2B** transactions. Development of transparent international electronic clearinghouses facilitates the continued globalisation of the production and retailing of goods and services. Integration and efficiency gains lead to substantial innovation in logistics sector with an emphasis on greater scale, speed and quality. However, strong anti-trust controls limit development of joint purchasing and supply chain management tools.

Government services

Administrative reform continues in government, in part enabled by moving many functions onto the Internet. The cost saving, the continued privatisation of **public services** and the emergence of public-opinion-led policymaking (through referenda etc) all drive the development of e-government, including the early introduction of electronic voting.

Regulation and Governance

Policy style

There is convergence of political cultures and policy styles. **Governance** becomes internationalised, multi-level, and less accountable. Growth is paramount and the role of national governments shrinks. **Regulation** is increasingly transferred to regional and global bodies, in which business interests play a key role. **Social and environmental objectives** play a subsidiary role, and are not integrated into economic policy and trade regimes. Economic instruments (ecotaxes, tradeable permits) are used to control acute environmental degradation. Global environmental issues are addressed only where they are recognised as business issues by powerful corporate interests

Competition policy

Deregulation in all markets is underpinned by a powerful global trade regime committed to the continued removal of **trade** barriers and enhanced competition. A WTO e-Directorate, is established in 2003 to set standards for international e-commerce. Its remit expands rapidly over following decade as it takes on the role of policing global anti-trust regulation of **network standards**; a strong IPR regime; transactional security and consumer redress agreements;

and e-taxation. **Content regulation** is very limited and is largely exercised through service providers' self-regulation and the sale of commercial blocking soft/hardware. Pornography, gambling and new forms of commercial e-exploitation flourish on the Internet.

E-commerce technologies

Innovation

This is a consumer-driven future where rapid economic growth and strong IPR go hand-in-hand with high private **investment** in research and development. Innovation is driven by the provision of customised, high-value interactive services to global markets. A convergent ICT environment is based on open global **networks** co-existing with closed private networks. *De facto* inter-operability is achieved through industry-set standards. Mobile satellite-based networks grow rapidly, although major new investments will also be made in extending and enhancing optical fibre networks. The costs of access will fall, but remain high for highly capacity broadband services (UMTS, ADSL, etc).

User technologies

Many user **devices** become mobile and location independent. By 2010 wearable computers and plug in devices begin to replace conventional PCs. Encryption and **ID technologies** become increasingly sophisticated, as user devices become personalised. On-line access underlies many home-based goods and services (nutrition, health, security, leisure, education). Interactive digital television (iDTV) achieves rapid market penetration and dominates the entertainment, providing another entry point to e-commerce. User interfaces develop rapidly for premium markets: voice control, micro head-up displays, video and universal language translation all achieve significant market penetration between 2005 and 2015. Highly capacity search engines and avatars deal with information overload. Personal digital assistants (PDAs) filter information, make routine decisions and create leisure time for the affluent.

User access and control

User **access** is mediated by the market, with premium services targeted at an affluent global elite. E-commerce markets are segmented through customised advertising and marketing, and through the price of services. The digital divide takes a new form, with near universal access to e-commerce being achieved through DTV and PDAs by 2010, but access to on-line services being limited by cost and capability.

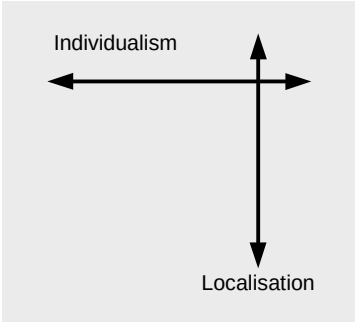
Socio-economic context

This is high mobility **transport** scenario. Energy prices are generally low, but with periodic price hikes due to oligopolistic behaviour and concerns over resource security. Car ownership and use grow rapidly, as do road and airfreight. Congestion increases. Hybrid cars are introduced from 2010 and in-car telematics improve the efficiency of road use. There are major investments in global-scale infrastructures including airports, ports and railways.

There is slow population growth in the UK, but a truly global labour market for many skills leads to an increasingly mobile labour force. More open borders encourage labour migration. The trend to smaller households intensifies, bringing high demand for **housing** near to centres of growth. A weak planning system promotes relatively unconstrained development for housing, commercial and leisure uses.

The State's role in the provision of **education, welfare and health** services declines, resulting in deepening inequalities of access and standards. State provisions are increasingly target only the very poor and most disadvantaged.

For the middle classes private sector provision becomes the norm. There is a major increase in demand for both high-tech curative healthcare and more holistic health promotion services.



DigitalIslands

Scenario Highlights
This is a future world of consumerist values, with governance systems primarily located at the national level. Markets in the UK are liberalised, but the process of economic integration and globalisation is constrained. The benefits of retaining some measure of economic and political independence are viewed as outweighing the risks of further integration. There continues to be high political and economic diversity in the international system. National government structures and processes are preserved with little change. There is moderate but unstable economic growth (**2% average GDP growth**), and relatively less structural change in the economy. There is limited technological convergence of ICTs. 'Walled gardens' are the norm in this future in which *private closed networks* controlled through self-regulation by competing national incumbent firms become dominant. There is fairly rapid, but *unstable migration* of business and consumer activity to the digital domain, hampered by inadequate integration and common standards (**e-commerce 15% of UK GDP by 2010**). The growth of E-commerce reinforces more powerful business and commercial interests. This is a car-dependent future (**13% of UK road network at 100% stress by 2010**) characterised by weak planning controls, except in wealthier areas that can secure their private interests. This is a high emissions scenario (**845 MtC equivalent in 2010**)**.** Equity declines, resulting in substantial social tension.

Economy and e-commerce

Economy

This future is defined the combination of consumerist values, and the UK government retaining substantial power in key policy areas (money, tax, defence). The UK pursues an independent economic and political path, separated from the EU and North America. The more restricted scope of the UK market and slower growth of the world trading system dampen **economic growth**, and limit the potential of e-commerce. The rate of decline in manufacturing slows, but inward investment stabilises and export-led sectors face lower growth rates.

Digital economy

The rate of Internet driven structural change in the economy is slower than under the CyberSpace scenario. The **digital economy** tends to reinforce industrial concentration and the power of incumbent producers and service providers. Commercial 'walled gardens' and trusted brands predominate. A limited number of vertically integrated global and regional networks compete both through technical differentiation and price. There is unstable migration to e-commerce, driven by the search for efficiency gains and cost reduction rather than the rapid innovation of new web-based services. The absolute volume of e-

commerce is moderate, reaching a plateau as established markets become saturated and opportunities for efficiency gains dry up. 'Pirate islands' emerge as a base for hacking, e-fraud and cyber-terrorism. These continue to be a threat to the integrity and viability of e-commerce.

Tax revenues remain secure, with tax collection undergoing incremental change. E-commerce transactions are taxed effectively, and a 'byte tax' is introduced. Sterling is retained in the UK, mainly due to public mistrust of the Euro. Financial services become mainly web-based, however, there is only limited development of e-money.

Business to Consumer

After a period of experimentation, **B2C** e-commerce settles down and focuses upon existing services, such as finance, entertainment, travel, and some retail markets. The uptake of e-commerce remains confined primarily to the young and the affluent. For other groups the costs of access, and the lack of perceived advantages of clicks over mortar subdue demand. Routine consumer purchases are increasingly automated for the affluent and time-poor. High-value mobile broadband services are targeted at a narrow and slowly growing market. Buyers clubs emerge seeking bulk discounts for communities in less affluent areas excluded from home delivery by the low value of individual purchases. There are experiments with the use of existing community services for delivery. There is also a large increase in 'grey' e-tailing.

Business to Business

In terms of value, **B2B** remains the primary focus of e-commerce. Opportunities for greater control and cost reduction lead firms to exploit electronic purchasing and supply chain management using the Internet. New smaller-scale UK manufacturers exploit the efficiency gains offered by the greater integration of supply chains. In some sectors producers are able to use their market power to raise margins through B2B e-auctions.

G2B/C

Progress toward **e-government** is limited by the continuation of traditional governance structures and processes, and by persistent barriers to universal access.

Regulation and Governance

Policy style

The 'Westminster model' of **government** in the UK remains more or less intact. The process of devolution is curtailed, as there is a return to greater centralisation in government primarily as an attempt to improve management of the economy. Political discourse becomes more populist and fractious. **Social and environmental issues** remain a low priority. Environmental policy sees more experimentation with voluntary and market-based instruments.

Competition policy

Trade continues to grow, but the opening and liberalisation of global markets is hampered by the lack of political convergence an international level. The WTO system is maintained more or less in its present form. The interventionist competition policies of national governments seek to balance the promotion of genuine **competition** with a desire to protect national capabilities in key sectors. National incumbents in the telecoms, financial services and retail sectors remain strong. Price regulation for digital services is ineffective. Transactional security and consumer redress is handled at a national level, and little progress is made establishing an enforceable international regime. The maintenance and enforcement of tariffs on traded physical goods limits the international potential of e-commerce. Patchy **content regulation** is exercised through national courts and commercial self-regulation. Although the affluent and well connected can buy their way around these controls.

E-commerce technologies

Innovation

Innovation is driven mainly by the needs of B2B transactions, except in high-value niche markets for consumer services. This is a less 'consumer-driven' future. Moderate, less stable economic growth and weaker anti-trust regulation go hand-in-hand with lower private **investment** in research and development (a continuation of British 'short-termism' in R&D). UK companies are not leading technology holders in software, hardware or digital communications equipment. Limited convergence and inter-operability results as the small band of global service providers and national ICT incumbents exploit technical differentiation to preserve their market share. Terrestrial cable **networks** continue to be the primary vehicle for digital communications, and there is limited development of broadband mobile networks (especially those that are satellite-based). Business and private 'islands' develop closed networks, controlled by vertically integrated infrastructure and service providers.

User Technologies

Leading edge technologies – voice recognition, head-up displays, language translation, encryption, etc – are marketed primarily to business markets. Innovation and diffusion of advanced technologies is limited by infrastructure and market constraints. DTV and WebPhones achieve rapid market penetration as the cost to the user of the hardware falls. DTV dominates the entertainment market and is the major point of access to the Internet.

User access & control

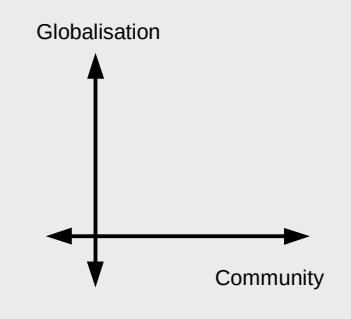
The 'digital divide' comes to describe the gap between those who have restricted **access** and are passive consumers of new web-based media, and those who have the resources to obtain 'universal access', premium services and actively control their cyber-interactions. By 2010 rival service providers will give away DTVs and WebPhones to even relatively poor UK consumers. However, these basic units will only provide access to the franchised portals offered by the service provider, giving limited choice to most consumers. More affluent and educated consumers will buy or be given 'universal' access to the WWW.

Socio-economic context

This is a car-dependent **transport** scenario, but with steadily rising fossil fuel prices, and relatively low levels of investment in infrastructure or public transport. NIMBY objections and public finance restrictions limit the building of new roads, Congestion increases. Despite this experiments with congestion charging prove unpopular and are scrapped. Telematics begin to play a role on many major routes, as efforts are made to improve the utilisation of the motorway network. Road freight predominates and grows. Air traffic increases more slowly.

The UK **population** grows slowly. There household numbers remain approximately stable. There is an erosion of the green belt for new high-income housing. The planning system is weakened, but new developments attract strong protests.

There is a steady shift towards the private provision of **education, welfare and health** services. State provision becomes more uneven, primarily because of lower economic growth, and fiscal conservatism.



CyberSociety

Scenario Highlights

This is a future world where social and ecological values shape global markets, and international political institutions predominate. Sovereignty over many areas of policy is relinquished by national governments in pursuit of economic stability and political convergence. Strong global and regional governance is underpinned by partnerships between governments, industry, and non-governmental organisations. Moderate-to-high economic growth (**2.75% average GDP growth**) is maintained with low levels of inflation. Innovation continues at high rates and is shaped by sustainable development objectives. Convergent global ICT environments facilitate shaping of the New Economy to a 'one-world' ethos. Open networks, shareware and mediated access prosper. There is selective migration to e-commerce (**e-commerce 20% of UK GDP by 2010**), with less experimentation. Universal service obligations, transactional security, consumer redress and content regulation are all effectively policed under global regimes.

Rapid technological change coupled with high investment in public transport de-couples energy and transport intensities. Therefore this is a relatively low emissions scenario (**625 MtC equivalent in 2010**). However, some road traffic congestion problems remain (**9% of UK road network at 100% stress by 2010**). Issues of equity and development impact on all decision-making processes, reshaping the global distribution of environmental and technological resources.

Economy and e-commerce

Economy

This is a radical future of global social, economic and technological transformation, to a more managed global economic and trading system, which aims to reconcile **economic growth** with global equity and fairer trade. The emergent e-economy is shaped by a prevailing 'one world' ethos, with e-commerce is harnessed for both economic and social goals. The Internet is viewed as a means of building more sustainable economic and social networks, improving the accountability of governments and business, and encouraging social access to goods and services. The UK economy is export-led, with continued growth in services and the new e-economy. Resource intensive manufacturing and agriculture decline.

Digital economy

Commercial network infrastructures are dominated by a small number of global providers, licensed on a supra-national regional basis by an international agency. Providing a broad 'level playing field' for international development of e-commerce. Migration to e-commerce high, but at a slower pace due to the need to manage development and meet broad access objectives internationally. The absolute volume of e-commerce is high (more data, less value). G2B/C

transactions are particularly important in this scenario, whilst B2B transactions become relatively less significant over time.

EU monetary union is strengthened by the UK's entry into the Euro in 2003. European **tax** harmonisation is achieved and a complementary currency, the E-Euro, is introduced in 2005 and 2010 respectively. A Global Digital Bank is established to collect and distribute taxation on global e-commerce in 2010.

Business to Consumer

With strong consumer protection regulation in place, there is rapid growth in **B2C** e-commerce across many markets, such as retailing, travel, banking, and leisure. High public and private investment in sustainable modes of transport and transport infrastructure also boost retail e-commerce. There is widespread utilisation of common logistics services for consumer deliveries. Government support is given to encouraging access to consumer services that bring sustainability gains (for instance, web-controlled energy services, and integrated socially accessible mobility services). There is high growth in virtualised services and virtual experience. Trusted web intermediaries, agents and buyers clubs flourish. Service providers develop much closer and interactive relationships with consumers on a global scale, with strong emphasis placed on quality and customisation across all markets.

Business to Business

There is growing penetration of **B2B** e-commerce in all sectors, permitting more efficient transmission of purchasing, legal and other information, and allowing the greater transparency along supply chains required under tougher producer responsibility obligations. Manufacturers across all sectors are transformed into service providers selling 'value' rather than units. Integrated supply chain and life cycle management is adopted by business both to reduce costs and manage social and environmental impacts. Net conferencing and virtual reality tools are widely used to reduce business travel.

Government services

The web is used extensively to develop more open and participative policy-making processes. All **public services** are moved onto the web, improving the efficiency of service delivery, and active policies for universal access implemented.

Regulation and Governance

Policy style

Strong partnerships between governments, industry and NGOs aim to achieve stable sustainable development at a global scale. Sustainable development becomes an important organising principle of international **governance**. Global harmonisation and co-ordination of sustainability policy begins to take shape. New environmental treaties and regimes are formed and given real authority. An integrated approach is taken to **sustainable development**, employing a mix of market based and regulatory instruments. Information and producer responsibility instruments become more important. Global equity of access to resources becomes a significant constraint on economic policy in the industrialised world. For example, in relation to climate change, fixed and declining carbon budgets are introduced at national and regional scales.

Competition policy

Competitive global markets are managed by powerful, but politically accountable, global regulators. Agglomeration and concentration continue in many sectors, such as autos, telecommunications and banking, are managed by internationally negotiated service agreements and price regulation. Collaborative **self-regulation** and covenants become more significant at a regional and global level. There is little formal regulation of network standards, but strong formal legal guarantees with respect to transactional security and consumer redress. A weak IPR regime promotes the use of open source software. Both positive and

negative **content regulation** is established by international agreement and enforced by new agencies. However, minority activists claim a loss of cultural diversity and freedom of expression.

E-commerce technologies

Innovation

Public **investment** in research and development is an important driver of technological development, whilst social and environmental drivers play of key role shaping innovation processes in companies. Fiscal, regulatory and information policies encourage the adoption of technologies enabling services with a small environmental footprint. A strongly convergent ICT environment is based on open global networks developed from existing **networks**. The greater bandwidth required to carry higher quality information requires expensive and slower infrastructure development. Access from fixed networks (broadband cable) dominates. Mobile networks complement fixed networks.

User Technologies

There is less differentiation of user technologies, with integration of multiple functions into a limited range of standardised units. **Devices** are leased to the consumer to ensure wide access. An OECD/UN sponsored development programme releases universal language translation shareware (text: 2008, voice: 2012).

User access & control

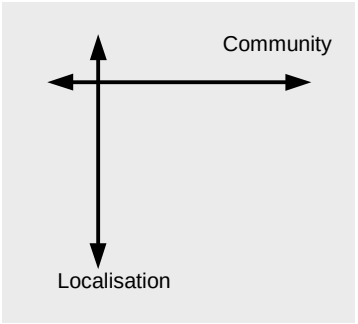
Universal **access** provisions promote a stable and uniform environment for the development of services to mass markets. Governments require business to provide access to networks and public services for all as a condition of entry into the market. Mass channel broadcast media grow and move onto the web.

Socio-economic context

Major innovation and investments in **transport** infrastructure (road, rail, sea and air) are made providing high access-low environmental impact mobility. Many of these infrastructures have a global scope involving international public-private partnerships. There is high penetration of low/zero emissions vehicles and transport telematics. Heavy freight is encouraged to shift to rail and water through a combination of pricing mechanisms and regulation. Encouraging the substitution of virtual transactions (teleworking, teleconferencing) for mobility has some impact on transport demand. However, the growth of tourism and global business operations results in a rapid growth of air traffic.

There is a stable **population** and reduced internal migration within UK. Household numbers increase at long-term average rates with a higher turnover of the housing stock. A strong planning system aims to achieve high access to physical services, high environmental quality and low resource use.

Public expenditure increases as a proportion of national and global income. Public **education, welfare and health** systems are maintained and improved. Equal access to high quality public education is promoted at a global level.



NetworkCommunities

Scenario Highlights

NetworkedCommunities is a future world of communitarian - social and ecological - values exercised through local participatory democracy. The power of global institutions is checked through stronger accountability mechanisms, and there is greater emphasis on community self-reliance and autonomy. As a result there are fewer opportunities to gain economies of scope and scale. Markets are more fragmented and international trade is lower than in the other scenarios, as is economic growth (**1.25% average GDP growth**). However, some localities do foster political and economic links with other regions across the world enabled in part by the digital economy - there a tension between the social and political importance attached to 'localisation' under this scenario and the more open nature of virtual space.

Regionally specific digital solutions emerge, often built around legacy systems, and there is little technological convergence. Closed networks predominate, but with diverse outcomes (in some places there are strict content controls, not in others). Management and ownership of networks is community-based, rule governed and 'democratic. E-commerce plays a limited role (**e-commerce 5% of UK GDP by 2010**), and is used to primarily to encourage more efficient and shorter supply chains. Nevertheless, new forms of local electronic exchange and e-money flourish, and the use of the Internet for information and public services also grows rapidly.

Lower economic activity and demand for mobility make this a low transport intensity (**5% of UK road network at 100% stress by 2010**) - low emissions (**600 MtC equivalent in 2010**) - scenario. Equity also improves, although tensions arise reconciling social and environmental objectives.

Economy and e-commerce

Economy

NetworkedCommunities is a future in which communitarian - social and ecological - values co-exist with governance increasingly exercised at a local and regional level. Global institutions play a lesser role. Autonomy in decision-making at a local level is highly valued, and local and regional markets become more important, in part enabled by the greater use of information and communication technologies. International trade and regional **economic growth** slow in comparison with long-term trends. This is a relatively low investment future, of diverse regional outcomes, with greater reliance placed on communities' knowledge and resource base. Economic policy is dominated by the need to encourage efficient small-scale production, while also meeting ambitious social objectives of equality and participation.

Digital

The Internet and the **digital economy** are viewed as an asset in building community self-reliance. There is local ownership of digital infrastructures and

economy

control of network standards. The world wide web is maintained through regional collaborative agreements, underpinning new models of economic development. The smaller scope of markets and the focus on local demand brings advantages to smaller-scale production of good and services. There are fewer opportunities for economies of scale, and a greater emphasis is placed on customisation and a rich information environment. Stable producer-consumer relationships are managed to facilitate the growth of local markets and exchanges. There is more limited migration to e-commerce and the absolute volume of e-commerce is low. C2C, B2C and G2C transactions are particularly important in this scenario.

A greater proportion of **tax** is raised at regional and local levels. Revenue collection moves onto the web, and there is strong enforcement of tax codes. Britain does not join the Euro, which is seen as impinging on national autonomy. However, new forms of local exchange flourish, as E-barter and e-LETS sites facilitate the electronic exchange of goods and services for B2B, B2C and C2B transactions.

Business to Consumer

The main growth areas of **B2C** e-commerce are in retailing and information services. Strong 'trust based' relationships between local producers and consumers are highly valued, and facilitated via mobile digital devices and PCs. There is greater supply chains transparency to the consumer and a revival of home delivery for many goods. Barter and information exchange also come to play a role in economic relationships, complementing cash settlement. Buyers' clubs emerge, aggregating demand for the benefit of producers and consumers alike. International e-tailing on the web is limited to specialist goods/services not available through local markets.

Business to Business

B2B e-commerce is rapidly adopted as a way of making shorter supply chains more flexible and responsive, and of driving down costs in regional and national markets. B2B procurement and supply chain management becomes predominantly web-based. Producers and retailers form procurement networks to purchase materials and goods not available regionally. Local e-co-ops, bringing small-scale producers together, become more common. Email and Net conferencing tools are widely used to substitute for business travel.

Government services

The Internet is widely used in the provision of **public services** such as welfare, health and education. Voting in elections and in referenda is increasingly transferred to the web, and greater participation in local decisions is encouraged through accessible, simple to use web interfaces. Government becomes far more open, transparent and 'virtualised' through 'electronic town halls'.

Regulation and Governance

Policy style

Government is carried out through devolved participatory democracy. Emphasis is placed on the principle of subsidiarity (policy should be enacted at the lowest level of governance), the devolution of power and participatory decision-making at a local level. In **environmental policy** there is an emphasis on behavioural and structural economic changes that protect both natural resources and the environment.

Competition policy

Competition policy aims to stimulate new ventures and safeguard competition within more geographically constrained markets, while also supporting well-defined sustainability goals. There is patchy regulation of **network standards**. International regulation of transactional security, consumer redress, and product standards are relatively ineffective. Together with relatively weaker transport links this constrains the international potential of e-commerce. Weak IPR

regimes promote the use of open source software. Mechanisms are developed for strong community-based content regulation on web. However, the extent to which such mechanisms are employed varies greatly between different communities.

E-commerce technologies

Innovation

Innovation is constrained by low levels of **investment** in research and development, and shaped by the predominant pattern of demand: B2B and G2C. Innovation focuses on low cost devices and applications. Weak IPR regimes allow diverse incremental adaptations of existing systems. Where local solutions are developed they tend to be diffused rapidly, sometimes with public sector support. There is little convergence of **network** technologies, mainly due to a persistence of legacy systems and reduced availability of capital. Inter-operability remains limited and barriers between local/regional systems and networks persist. Emphasis is placed on the adaptation of existing infrastructure. This leads to the development of mixed networks: local broadband in urban communities, telephone lines (Public Service Telephone Network PSTN) in rural communities. There is also scope for local experimentation with novel technologies (strip aerials, helium balloons, etc). Public health concerns inhibit the development of mobile networks and technologies.

User Technologies

For end consumers, PC-based systems continue to dominate access to the web and e-commerce. There is slower market penetration of DTV, and mobile devices are less significant as a vehicle of e-commerce due to the existence of alternatives and lower consumer demand. High growth digital services include information and public service (health, education) delivery, teleworking and virtualised leisure services.

User access and control

There is variable private **access** to closed networks of diverse quality, but very high access to public services on the web. Community intranets with limited access to specified services become important.

Socio-economic context

This is a low **transport** intensity scenario as a result of declining trade, lower mobility and higher (internalised) energy costs. Regulation, incentives and investment in public transport reduce demand for personal mobility. By 2010 car sharing and leasing, traffic management, planning measures, and home deliveries result in declining absolute car ownership. By the 2020s zero emission vehicles become the norm for shorter trips, and mass public transport the norm for longer journeys.

Overall UK population is stable. Although there is a slight decline in household numbers, coupled with migration from larger cities to small and medium sized towns. A strong planning system protects against urban sprawl and encourages denser **housing** and better managed commercial developments.

There is a high level of public provision of **education, welfare and health** services, with an emphasis on equity and open access, financed primarily from taxation.

4. E-commerce impacts on sustainability

Research into the potential environmental and social effects of e-commerce faces a number of difficulties: the complexity of the issues; the pace of development; and a lack of reliable data. All limit the validity of current studies. But more importantly, many of the decisions and investments (in technologies, regulatory frameworks, transport and logistics systems and so on) have not yet been made. Early research suggests that these decisions will largely decide whether the beneficial potentials of e-commerce can be realised.

The qualitative evaluation of these impacts presented here aims to provoke a debate rather than to give answers. It offers a framework for analysis and to enrich the current discussion, which often appears to be dominated by a controversy between 'e-commerce optimists' and 'e-commerce pessimists'. Drawing on research carried out within and outside the Digital Futures project, the scenarios highlight at least three important aspects of e-commerce and sustainable development:

- The scope and shape of the 'new economy' are not yet determined - diverse pathways are possible;
- The sustainability impacts are likely to be mixed and trade-offs will be necessary;
- Forward-looking and well-targeted policy measures can influence the social and environmental impacts of the 'new economy'.

3.1 Social Impacts

Digital Divide

In most scenarios, digital access is not an issue of cost, IT skills or the availability of online devices. In CyberSpace and DigitalIslands, intense competition has brought down the price of Internet-enabled mobile phones and other personal devices, and many are available free of charge. Simple to use hand-held devices and digital television also increases online access for people with lower technical skills. This is, however, not true for NetworkedCommunities where most online access is still PC-based. Due to slower technological development, IT skills and costs exclude a quarter of the population from online access.

But other, often more subtle obstacles to equal access arise. In CyberSpace, sophisticated systems analysing credit rating and buying records will prevent the poorer population from using many services. In DigitalIslands, the dominance of digital television gives the few main service providers even greater control over content and access to specific services. Under all scenarios, those who do not have a bank account and a credit card are excluded from online shopping. They have to rely on 'bricks and mortar' shops. Government funded programmes bring 95% of the population online in CyberSociety and service obligations encourage wider participation in web transactions. Similar efforts exist in Networked Communities, but their success is limited through the obstacles described above.

In all scenarios, a significant percentage of less skilled or poorer people remains offline. This is particularly problematic in CyberSpace and CyberSociety where online services increasingly replace traditional goods and services. Elderly people who missed the digital revolution feel excluded. For the majority of the population, however, shopping possibilities and free (advertising-funded) information services improve greatly.

More broadly, participation in the knowledge-based economy is far from equal. In all scenarios, the capability to use effectively information and communication services becomes more important in all areas of life: in education, the job market, shopping, leisure, etc. Excluded parts

of the population, such as homeless people, become even more disadvantaged and obstacles for a return into the society increase.

Consumer Protection and Security

The level of consumer protection varies greatly between the scenarios. In CyberSpace and DigitalIslands, standards are based on industry self-regulation. Large e-commerce companies are eager to ensure trust in online transactions and implement high voluntary standards. There are, however, incentives to fully exploit the increasingly sophisticated consumer information. Many dot.com companies engage in the trade of consumer data allowing the targeting of product information and marketing. The emergence of 'mass customisation' that depends on this type of information also points clearly to new forms of inequity. In CyberSociety and NetworkedCommunities, personal and consumer information is protected through stringent laws. Strict rules limit the use and dissemination of personally identifiable information. Enforcement of these rules is more difficult in the CyberSociety scenario because more international transactions are made. International privacy law is negotiated and implemented, but may be difficult to enforce.

Fraud on the supply side, for example online sale of faulty products and dubious services, flourishes in CyberSpace due to relatively open, globalised networks against the backdrop of weak regulators. This is partly offset by new encryption technologies. The commercial 'walled gardens' of the DigitalIslands scenario are less vulnerable to manipulation from outside. However, some companies intentionally exploit the weakness of consumer protection regulation to do fraudulent business, leading in turn to a drop in confidence in e-transactions. CyberSociety and NetworkedCommunities oblige strong legal guarantees and security for consumers through transaction guarantees and toughened product warranties.

Public Services

The nature of public services (health, education, social services) under the different scenarios is largely determined by factors other than the use of ICT technologies. These include decisions on the funding and organisation of these services. Nevertheless, online technologies will have an effect on the quality, accessibility and 'client focus' of these services.

As the drive for cost-efficiency of the public sector intensifies, online technologies play an increasing role in supporting the provision of these services (to a lesser extent in NetworkedCommunities). Most public services will be online by 2010: advice is given on the Internet, appointments are made via email, courses taught online. Online services partly replace traditional letters, forms and information brochures. This trend is particularly strong in CyberSpace where the digitally excluded will have difficulties in accessing some basic services. Even if a large majority of the population is online by 2010, this does not imply that everybody knows how to make full use of the available services. This problem is much less marked in NetworkedCommunities where online services supplement rather than replace traditional services.

Citizenship

ICTs also affect the political system, although in very different ways. In all scenarios (to a lesser extent in DigitalIslands), new technologies are used in the exercise of political decision-making and the achievement of greater transparency and accountability. The introduction of national online opinion polling in CyberSpace leads to a more public-opinion-led policymaking, but not to a wider participation of citizens in the political process. Online voting is introduced and increases voter turnout at elections. In NetworkedCommunities and CyberSociety, the Internet is used to encourage greater participation and for stakeholder dialogue. This is especially important in CyberSociety where more internationalised governance structures suffer deep 'democratic deficits'. In NetworkedCommunities, local communities experiment with ICT-supported participatory decision-making processes.

Regional development
In CyberSpace (and to some extent in DigitalIslands), rapid growth in retail e-commerce closes down some local shops, banks and services. High streets tend to decline as banks, department stores, travel agencies, bookshops and electronics stores close less profitable branches. Effects are much smaller in the other scenarios because the Internet and other networks are dominated by non-commercial uses. In most scenarios (not CyberSpace) effects on town centres and shopping areas are moderate.

In CyberSpace and DigitalIslands, the 'new economy' widens the gap between poorer and richer parts of Britain. The south east of England benefits most from new dot.com business and the growth of the communications sector more broadly. In CyberSociety regional development is more evenly distributed through public provision of ICT infrastructure, active programmes of government and international support, and by stringent service obligations on providers. NetworkedCommunities is generally less affected by this trend. Here, ICT contributes to a strengthening identity of local communities, connected through local networks.

3.2 Environmental Impacts

Resource efficiency
In all scenarios, the extended use of ICTs will improve the resource efficiency of the productive parts of the economy. This trend will be particularly strong in CyberSpace where technological development is most rapid. Price signals, including the introduction of higher taxes on resource use reinforces these effects. Increased ICT use in production reduces the use of energy and materials, as well as the generation of wastes. Similar, but less marked effects will occur in private households. More efficient energy and lighting services, which grow rapidly in the CyberSociety and NetworkedCommunities scenarios, bring important reductions in the energy intensity of buildings.

Business to business e-commerce will lead to better-managed supply chains. Here, cost-efficiency and environmental efficiency are likely to go hand-in-hand. For example, new online services will make markets for secondary materials (e.g. chemicals, construction) more efficient. New more agile and flexible manufacturing systems contribute to increased eco-efficiency. ICTs will also reduce the need for inventories of goods that have negative environmental effects (use of energy, materials and space). Less space will be required for warehousing and retailing. The NetworkedCommunities scenario will benefit from these developments only to a limited extent because economic growth and investments are low and B2B e-commerce increases slowly. Equally, DigitalIslands will not be able to realise the full potential of these efficiency gains due to medium economic growth and a lack of tax incentives. The main counter-trend will be experienced in the CyberSpace scenario in which the scope of supply systems becomes increasingly global, and in which the value of physical resources tends to fall (value of services being measured more by their knowledge-content).

De-materialisation
A number of products and services will be purchased and used in digital rather than in physical form. All scenarios will see some digitalisation of services (such as banking, billing, information services) and products (music, photography, books). Over the period to 2010, the environmental benefits of this de-materialisation are likely to be small. In CyberSpace and CyberSociety, sales of digital products and services grow rapidly. But as in the case of the 'paperless office', the expected environmental benefits are not met. Digital products often supplement rather than replace traditional ones. For example, digital music files available on the Internet promote interest in music and lead to increased sales in CDs. Online information is printed out rather than read on screen. And web-based travel information stimulates more travel. In DigitalIslands

and CyberSpace, the small environmental gains are offset by a steep rise in purchase and use of Internet phones, digital television sets and personal computers.

Consumption Patterns

The use of ICTs will lower the costs of many products and services and e-commerce will make shopping and other activities more efficient. Impacts on resource use and pollution will depend on how consumers choose to spend the freed time and money. Especially in the market-oriented scenarios (CyberSpace and DigitalIslands), people will consume more goods, most of them tangible. The environmental outcomes of these activities will be diverse and are difficult to assess. It is likely that they will lead to a rise in environmentally burdensome leisure activities, such as travel. The current experience with the fuel consumption of cars (efficiency gains are offset by the trend towards larger cars) will be repeated in many areas. In CyberSociety this effect will be avoided through strong economic incentives and regulation to use less energy and materials. Due to the lower efficiency gains, NetworkedCommunities does not see a comparable 'rebound effect'.

E-commerce also increases the power of consumers. Shoppers are able to choose between a large number of suppliers, compare prices and specify requirements. In the NetworkedCommunities and CyberSociety scenarios this effect will promote green consumerism. New websites will compare the environmental effects of different products and link consumers with suppliers of green goods. For example, locally produced organic food will be sold online in the NetworkedCommunities scenario. Strong environmental awareness and low incomes lead to a boom of second hand websites where consumers buy, sell and exchange a variety of goods.

Transport

In transport, efficiency improvements of e-business tend to have positive environmental impacts under all scenarios. In particular in the scenarios with relatively strong B2B e-commerce (CyberSpace, DigitalIslands and CyberSociety) ICTs will stimulate logistics to be made more efficient, compress supply chains and optimise the flow of goods through the supply chain. The potential of e-commerce to increase utilisation and therefore reduce the number of vehicles will be fully exploited only in CyberSociety. Here, high fuel prices and planning controls encourage the emergence of efficient and sustainable distribution systems. Efficiency gains are partly offset by a higher volume of goods transported in CyberSpace (due to rapid economic growth) and DigitalIslands (due to slow structural change towards services).

The impacts of distribution to the final consumer are significantly more diverse. Here, the structure of local distribution systems and consumer behaviour will determine whether transport emission and noise decrease or increase. In all scenarios, the traffic of light goods vehicles will rise, especially in residential areas. In CyberSpace (and to a lesser extend in DigitalIslands), rapid growth of competing distribution systems increase road traffic considerably. This effect is reinforced by consumers' expectations of rapid delivery. By 2010, e-commerce distribution does not yet replace individual shopping trips to a very significant degree (except in CyberSpace).

The digital economy contributes to rising air transport, which is a major issue of environmental concern in all scenarios except NetworkedCommunities. This trend is due to international trade facilitated by ICTs (B2B and B2C). It concerns air freight as well as business travel. In addition, more leisure time and global communication increase the demand for long-distance travel.

Environmental Governance

In all scenarios (except DigitalIslands), online services increase the transparency of business operations and their environmental effects. Large companies are under pressure to disclose environmental information about their products and production processes. In CyberSociety and

CyberSpace non-governmental organisations use the Internet to lobby for stringent and enforceable international environmental laws.

5. Comparing scenarios and impacts – UK in 2010

The scenario storylines are matched to quantitative and qualitative indicators that illustrate the magnitude of change, allow a quick and systematic comparison between scenarios, and aim to make the scenarios more accessible. Indicator values should not be interpreted as predictions or forecasts. They are based on statistics and expert judgement. No formal modelling has been undertaken within this project, but consistency checks have been applied to ensure that different indicators are telling the same story.

Indicator	CyberSpace	DigitalIslands	CyberSociety	Networked Communities
SCENARIO CHARACTERISTICS				
GDP growth per year	3.5%	2%	2.75%	1.25%
Unemployment	6%	9%	5%	6%
Private car use	85%	90%	78%	75%
GHG emissions (million tonnes)	780	845	625	600
Waste (million tonnes)	250	200	175	125
Dominant device for online access	mixed	Digital TV	PC/mixed	PC
Dominant use of networks	commercial	Commercial	mixed	private
Dominant form of e-commerce	B2C	B2B	mixed	B2B
POTENTIAL SOCIAL IMPACTS OF THE NEW ECONOMY				
Low cost access to online services	✓✓	✓	✓✓	✗
Access without IT skills	✓✓	✓	✗✗	✗
Equal access to all online services	✗	✗✗	✓	✓
Equal opportunities for 'offline population'	✗✗	✗✗	✗	✓
Strong consumer protection	✓	✗✗	✓	✓✓
High efficiency of public services	✓✓	✓	✗	✗✗
Improved political participation	✓	✗	✓	✓✓
Balanced regional development	✗✗	✗	✓	✓
POTENTIAL ENVIRONMENTAL IMPACTS OF THE NEW ECONOMY				
Resource-efficient production	✓✓	✓	✓✓	✗✗
Resource-efficient supply chains	✓✓	✓	✓✓	✗
De-materialisation of products	✓✓	✓	✓	✗
Sustainable consumption patterns	✗✗	✗	✗	✓
Green consumerism	✗	✗	✓✓	✓✓
Less heavy goods transport	✓	✓	✓	✓✓
Less light goods transport	✗✗	✗	✗✗	✓
Fewer individual shopping trips	✓	✗	✗	✗

✓✓	progress towards objective
✓	some progress towards objective
✗	no progress towards objective
✗✗	movement away from objective

6. 'Robust strategies' for policy

6.1 Common themes for the development of robust policy strategies

In this final section we begin by acknowledging that the evolution of e-commerce will be the outcome of complex technological, economic and regulatory forces, many of them improperly understood. Governmental and intergovernmental policy has a role in shaping both e-commerce and its sustainability, but it must also be capable of adapting to a broad range of potential outcomes. Policy has a role in creating incentive structures, send appropriate signals to producers and consumers, and in supporting co-ordinated actions. The exploratory and participative scenario approach we have used here stresses the uncertainties inherent in future e-commerce developments, and suggests alternative sets of impacts on sustainable development under different circumstances. Our analysis has also generated several broad themes around which 'robust policy strategies' could be built that would bring sustainability benefits across a range of scenarios.

There are different pathways to securing these more sustainable outcomes. Development of the Internet and e-commerce will be influenced profoundly by the outcomes of larger political debates and conflicts about the rights of the consumer, the role of the state, the future of the world economy and so on. We have taken the analytical position that the 'virtual' social and economic space of the Internet cannot be separated from the 'real' socio-economic space in which governments, corporations, markets and people continue to exist and interact. The virtual is embedded in the tangible, and the tangible shapes the virtual world. As Saskia Sassen (2000) has argued:

> 'There is no purely digital economy and no completely virtual corporation. This means that power, contestation, inequality, in brief, hierarchy, inscribe electronic space. And although the digitised portions of these industries…have the capacity to subvert the established hierarchies, new hierarchies are being formed, born out of the existing material conditions underlying power and the new conditions created by digital space.'

Given this basic insight, the following considerations seem vital to the construction of effective and responsive policy approaches and structures.

Robust policy requires that 'e-effects' are disentangled from other drivers of change

Information and communication technologies are co-evolving with social and economic changes (Mansell and Steinmuller, 2000). However, this does not mean that impacts of e-commerce on society and the environment cannot be examined. The challenge for impact assessment is to *disentangle* the sustainability impacts of the digital economy from the effects of broader economic, social and technological drivers of change. All the scenarios suggest that these relationships will not be linear - that the causes of impacts will not be the availability of e-commerce facilities and competencies alone, but the way these tools are used by organisations and people who may or may not be motivated by sustainability objectives. E-commerce is at best only a part of a sustainability solution. In this respect, e-commerce policy cannot substitute or compensate for lack of policy action on other fronts whose relationship to sustainability issues is already well defined. We should also be aware of 'what the Internet cannot do' (Economist, 2000).

Claims about the environmental benefits of e-commerce need to be treated cautiously

Many commentators have begun to speculate about the potential impacts of e-commerce on sustainable development (Cohen, 1999; Kelly, 1999; Romm, 1999). On the whole, these assessments present positive 'bottom up' accounts of opportunities for environmental gains. Potential efficiency gains in production and logistics are identified which may lead to a less wasteful use of resources. In addition, the dematerialisation and 'virtualisation' of goods and

services through the substitution of 'bytes for bits' is seen as another way in which economic development may be de-coupled from environmental damage (Leadbeater, 2000). These authors imply that a significant portion of consumption will switch to information and knowledge-based products and services that are environmentally 'clean' and sustainable.

Many of these arguments seriously underestimate the close interactive relationships between material and non-material product environments. Although services now command a substantial and increasing portion of the value created in industrialised economies, most existing and new service markets relate to physical products. Perversely, many of the economic indicators of e-commerce impact may turn out to be antithetical to the goals of environmental sustainability. For example, if on-line procurement were to reduce unit costs in an industry, we would expect this to lead to increased sales - a positive economic indicator. The question would remain, whether environmental gains from making buying more efficient would be offset by environmental losses caused by increased consumption overall, and by a growth in transport infrastructures to service this growth.

Governments have a role to play in fostering the governance of access to the Internet
Many Internet pioneers saw cyberspace as a free and open space in which to build relationships and exchange knowledge and ideas, unencumbered by the kinds of regulation and control applied to previous generations of communication networks. This distributed network of networks would bring greater freedom, and with it greater equity and empowerment. As the scenario analysis seeks to draw out, the Internet is not one community, but a complex of communities, each with its own objectives and expectations. Moreover, stakeholder interests are likely to conflict in many areas.

The need is growing for ways of governing the Internet that ensure reasonable equity in the digital space for the needs of many different stakeholders. Informal systems suffice in some instances, but pressure has emerged already for more formal protection in areas like fraud, privacy and security, and for more rational control over the domain name registration system. The process of institution-building has only just begun, and the role of government is not entirely clear. Each of the scenarios would benefit from effective and transparent governance, with clear rules and norms established for redress and consumer protection. The borderless nature of the Internet makes institutional development an even greater policy challenge.

Governments should encourage network diversity
The scenarios reveal very different outcomes in terms of the development of technologies and markets for services. A proliferation of new devices can be linked to an expanding range of services. Some services will have general applications, whereas others will be oriented to the needs of particular user groups. As Internet services diversify (into areas like broadcasting, for instance) there is no guarantee of consensus as to what will constitute public and private spheres of network activity. A fundamental question for governments is to determine how much of this new milieu will be defined as a 'public network', to which equitable access and use should be guaranteed.

As the Internet evolves the social distribution of access will be a key policy problem – with different outcomes possible. The broad social diffusion of technologies that could support broader access is not a 'given'. A major influence will be how the development of network infrastructures will affect the cost of the bandwidth available to users. With few exceptions, those markets providing low cost access to generous levels of bandwidth are also the markets in which Internet use is greatest and most widely distributed. Different scenarios could lead to divergent outcomes in terms of bandwidth and cost.

In some cases, ensuring diversity in network technologies will require the provision of new standards to enable different devices and service environments to interconnect and

communicate with each other. In other cases, it is likely that economic regulation will be required to encourage more groups of users to use a greater range network interfaces. For example, access to the next generation of mobile networks may come at a premium price affordable only to some users. Higher value internet services will be oriented mainly to these environments, excluding those without access. New standards and economic regulation is likely to be needed to prevent the premature lock-in to 'dead-end' technologies, or oligopolistic control over key network interfaces. The scenarios indicate that aiming for maximum network diversity is the safest policy.

A holistic approach needs to be taken to service obligations

Historically, service obligations (the obligation on providers to offer a given level of service to all customers) on network providers have been a strong policy tool for ensuring wide access to network services. Most existing service obligation policies have operated across stable and exclusive networks with single service packages (the Post Office, BBC TV). This approach does not fit in today's digital environment where different network facilities can be used to provide many of the same services - television over telephone lines, telephony via digital television.

Service obligations need to be thought of differently. The market provides suppliers of Internet network facilities and terminal equipment with high incentives to get people connected. But the same is not true across-the-board for traders who buy and sell commercial products and services on-line. Some companies use e-commerce to reach markets more-or-less indiscriminately (thereby emulating the high street shop), but many others choose their customers and partners carefully. This is particularly true in business-to-business procurement chains where the great bulk of e-commerce actually occurs.

Exclusivity applies to some extent in virtually all commercial transactions, but it is not a 'given' that the Internet will reduce exclusivity. Indeed, as electronic transactions generate more information about buyer and seller behaviour, exclusivity may actually increase. In an Internet environment characterised more-and-more by commercial motives, the lines between services that are necessary to everybody and services that are exclusive to a few may blur. As a result, policies that concentrate on access only - i.e. putting a computer in every home, or putting all government services on the web - address only a small part of the problem. Many services, even some 'essential' services, are liable to be highly unevenly distributed on the web. Access and content must be treated as part of the same policy problem, and content is where the bulk of investment (public or private) is likely to be required.

Dematerialisation needs to be enabled by investment in modern transport and energy systems

Information and communications technologies do provide opportunities for 'step change' transformations in the way we consume materials and energy. But these opportunities cannot be achieved by digital networks alone. They depend on heavy investments in the modernisation of transport and energy infrastructures, and in the built environment in general.

Energy is useful because it provides warmth, light and mobility. The energy services concept, talked about for many years, may have found a crucial enabling technology in the internet. Interactive, real-time control of energy consumption in industrial and domestic buildings is now possible via the web, permitting energy distributors to manage demand far more effectively. This form of dynamic control would also provide economic opportunities for small-scale distributed energy systems. Here the information network could facilitate the transformation of energy networks to achieve environmental gains.

Government policy should support, through incentives and regulation, the more rapid diffusion of the energy services idea, especially because it promises to generate large savings in energy demand. Some claims for large-scale energy savings as a result of e-commerce are only

achievable if these market and regulatory developments occur. Energy services would be one way of achieving this. Similarly, the economic potential and environmental benefits of e-commerce under all scenarios will depend on the available physical transport infrastructure and logistics systems. The future success of the e-economy will depend upon progress towards a clean, efficient and integrated transport system. It will not be a substitute for it.

Greater transparency and better environmental and ethical information is critical to changing behaviour

In the Information Society, and with freer more global markets, information comes to play a more central role in environmental governance. Traditional environmental regulation is being complemented by voluntary and market-based policy instruments. The consumer has been also been recognised as critical. All these new developments, many of which are underscored across all the scenarios depend on greater environmental transparency and reporting. The Internet can become a primary vehicle for the delivery of tailored, appropriate and authoritative environmental information to consumers, businesses and government alike. To achieve this will n many cases require government support, funding and regulation.

The need for more research

This study has shown how limited is the empirical basis from which to draw conclusions about future developments. To some extent this will always be the case, but in the midst of the major technological shift caused by information and communication technologies and the Internet, the breadth of uncertainty is wider. This is why continuous research and evaluation of the link between the Internet and sustainability is important. If decision-makers are to be able to modify this relationship in order to meet a number of environmental and social goals, they need a regular and well-founded source of information and analysis.

7. Annex

Contextual and e-commerce indicators for the four scenarios for 2010

Indicator	Today	2010 linear projection	CyberSpace	DigitalIslands	CyberSociety	Networked Communities
Economic Development						
GDP growth (% change per year)	+3 % p.a.[2]	+2 % p.a.	+3.5 % p.a.	+2 % p.a.	+2.75 % p.a.	+1.25 % p.a.
GDP per capita (current prices)	£ 14,000	£ 18,000	£ 21,500	£ 18,000	£ 19,500	£ 16,500
Economic activity in sectors (%)[3]						
services	66 %	increase	75 %	68 %	72 %	70 %
production	27 %	decrease	20 %	25 %	22.5 %	22 %
construction	5 %	decrease	4 %	5 %	4 %	5 %
agriculture	2 %	decrease	1 %	2 %	1.5 %	3 %
ICT sector (% of value added)	3.3 %	4.9 %	6.5 %	5 %	6 %	4 %
Total investment (% of GDP)	19 %	--[4]	22 %	18 %	20 %	16 %
Social Development						
Qualification at age 19 (% of people with level 2 qualifications)	75 %	100 %	85 %	75 %	90 %	95 %
Unemployment (% of economically active)[5]	5.4 %[6]	decrease	6 %	9 %	5 %	6 %
People in workless households (% of working age population)	13 %	--[7]	13 %	17 %	11 %	12 %
Poverty (% of people with income below 50% of average income)[8]	19 %	25 %	25 %	30 %	15 %	10 %
Health life expectancy (years lived in good / fairly good health)	67.25 years	68 years	68.5 years	67.5 years	69 years	68 years

[2] First two quarters 2000.

[3] Per cent of value added.

[4] No stable trend

[5] ILO definition: People without a job who were able to start a job within 2 weeks and had either looked for work in the previous four weeks or were waiting to start a new job.

[6] May to July 2000.

[7] *Lack of time series data*

[8] Average is the arithmetic mean.

Indicator	Today	*2010 linear projection*	*CyberSpace*	*DigitalIslands*	*CyberSociety*	*Networked Communities*
Online Technologies						
Population online[9] (% of total)	32 %	100 %	90 %	90 %	95 %	75 %
Overall use of online technologies (transactions, 1999 = 100)	100	--[10]	1000	600	800	400
Online devices (% of time spent)						
PC	95 %		40 %	30 %	60 %	70 %
digital television	2 %	--[11]	30 %	60 %	20 %	20 %
personal devices (e.g. phone)	3 %		30 %	10 %	20 %	10 %
Use of Online Technologies						
Online transactions (%)						
non-commercial[12]	90 %	--[14]	70 %	60 %	80 %	90 %
commercial[13]	10 %		30 %	40 %	20 %	10 %
e-commerce (% of GDP)	0.5 %	--[15]	25 %	15 %	20 %	5 %
e-commerce (% of turnover)						
supply chain (B2B)	60 %	--[16]	40 %	60 %	50 %	70 %
retail (B2C)	40 %		60 %	40 %	50 %	30 %
Government services online (% of total)	33 %	increase[17]	90 %	70 %	100 %	60 %

[9] Includes access at home, work, school, college etc.

[10] No reliable statistics available.

[11] No reliable statistics available.

[12] Includes public services, non-governmental organisations, interest groups, private e-mail, etc.

[13] Includes online sales of products and services, excludes advertising.

[14] No reliable statistics available.

[15] No long-term trend, but strong growth forecast.

[16] No long-term trend.

[17] Current government plans projected to get 71% of government services online by 2002 (e-minister and e-envoy (2000). *Annual report*. London).

Indicator	Today	*2010 linear projection*	*CyberSpace*	*DigitalIslands*	*CyberSociety*	*Networked Communities*
Transport						
Passenger transport average change per year passenger-kilometres	716 billion	1 % 810 billion	2 % 910 billion	1 % 810 billion	1.5 % 860 billion	0 % 715 billion
Private car use (% of total passenger transport)	87 %	88.5 %	85 %	90 %	78 %	75 %
Goods transport average change per year tonne-kilometres	245 billion	1.5 % 290 billion	2 % 310 billion	1.5 % 290 billion	1.25 % 285 billion	0.5 % 260 billion
Goods transported on road (% of total freight transport)	65 %	70 %	68 %	70 %	62 %	60 %
Traffic congestion (% of network at 100 % stress)[18]	6 %	increase[19]	11 %	13 %	9 %	5 %
Energy						
Energy efficiency[20] % change energy per million £ GDP	269	- 1 % p.a. 235	-1.5 % p.a. 215	- 0.5 % p.a. 253	- 2% p.a. 197	-1 % p.a. 235
Primary energy consumption[21] average change per year tonnes of oil equivalent	229 million	+ 0.7 % p.a. 249 million	+ 1.7 % p.a. 278 million	+ 1.5 % p.a. 272 million	+ 0.1 p.a. 232 million	+ 0.1 % p.a. 232 million
GHG emissions[22] (tonnes of CO_2 equivalent)	773 million	--[23]	780 million	845 million	625 million	600 million
Waste[24] (tonnes)	170 – 210 mn	--[25]	250 million	200 million	175 million	125 million
Loss of land to development uses (hectare per year)[26]	6,500 hectares	4,500 hectares	6,000 hectares	4,500 hectares	3,000 hectares	1,000 hectares

[18] England only, built-up major roads (excluded motorways).
[19] If no action is taken, congestion is expected to rise to 10 % by 2006.
[20] Assumptions are made on the basis of change of energy efficiency and GDP. Figures for energy efficiency, primary energy consumption (% change) and primary energy consumption are calculated from these two figures.
[21] Includes the consumption of all primary energy for electricity generation, transport, domestic and industrial use, expressed in tonnes of oil equivalent (TOE).
[22] Based on 'primary energy consumption' and rough estimates for the fuel mix (gas, coal, oil, nuclear and renewables).
[23] No stable trend. Emissions are currently decreasing, but expected to increase after 2005. Kyoto target: 676 million tonnes per year over the period 2008-2012.
[24] Includes commercial, household, construction and demolition waste.
[25] No time series data available.
[26] Annual average over a five year period, England only.

Data sources for contextual and e-commerce indicators

Indicator	Statistical Source
Economic Development	
GDP growth (% per year)	Office for National Statistics (2000). *Annual abstract of statistics.* London. National Statistics – the official UK statistics site (http://www.statistics.gov.uk).
GDP per capita (at factor cost, current prices)	Relates to UK sustainable development indicator H1. National Statistics – the official UK statistics site (http://www.statistics.gov.uk).
Economic activity in sectors (%)	Office for National Statistics (2000). *Annual abstract of statistics.* London.
Value added in communication sector (%)	Office for National Statistics (2000). *Annual abstract of statistics.* London.
Total investment (% of GDP)	UK sustainable development indicator H2. DETR (1999). *Quality of life counts.* London.
Social Development	
Qualification at age 19 (% of people with level 2 qualifications)	UK sustainable development indicator H5
Unemployment (% of population)	National Statistics – the official UK statistics site (http://www.statistics.gov.uk).
People in workless households (% of working age population)	UK sustainable development indicator C5. DETR (1999). *Quality of life counts.* London.
Poverty (% of people with income below 50% of average)	Office for National Statistics (2000). Social Trends 30. London: The Stationery Office
Health life expectancy (years lived in good / fairly good health)	UK sustainable development indicator H6. DETR (1999). *Quality of life counts.* London.
Online Technologies	
Population online (% of total)	e-minister and e-envoy (2000). *Annual report*. London.
Overall use of online technologies (transactions, 1999 = 100)	Expert estimations, no reliable statistics available.
Devices for online services (% of time spent)	Expert estimations, no reliable statistics available.
Use of Online Technologies	
Online transactions (%) non-commercial commercial	Expert estimations, no reliable statistics available
e-commerce (% of GDP)	e-minister and e-envoy (2000). *Annual report*. London.
e-commerce (% of turnover) supply chain (B2B) retail (B2C)	e-minister and e-envoy (2000). *Annual report*. London.
Government services online (% of total)	e-minister and e-envoy (2000). *Annual report*. London.

Indicator	Statistical Source
Transport	
Passenger transport average change per year passenger-kilometres	Office for National Statistics (2000). *Annual abstract of statistics*. London.
Private car use (% of total passenger transport)	Office for National Statistics (2000). *Annual abstract of statistics*. London.
Goods transport average change per year tonne-kilometres	Office for National Statistics (2000). *Annual abstract of statistics*. London.
Goods transported on road (% of total freight transport)	Office for National Statistics (2000). *Annual abstract of statistics*. London.
Traffic congestion (% of network at 100 % stress)	UK sustainable development indicator H11. DETR (1999). *Quality of life counts.* London.
Environment	
Energy efficiency % change energy per million £ GDP	Calculated from: Office for National Statistics (2000). *Annual abstract of statistics*. London.
Primary energy consumption average change per year tonnes of oil equivalent	Office for National Statistics (2000). *Annual abstract of statistics*. London.
GHG emissions (tonnes of CO_2 equivalent)	UK sustainable development indicator H9. DETR (1999). *Quality of life counts.* London. Projections based on DTI *Digest of UK Energy Statistics 1999.* London
Waste (tonnes)	UK sustainable development indicator H15
Loss of land to development uses (hectare per year)	UK sustainable development indicator S1

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