AGI Foresight Study: The UK Geospatial Industry in 2015

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Introduction

1.1 Background

The geospatial information (GI) industry is undergoing radical change. Stimulated by a range of new global challenges, the balance of power between existing and new players is shifting. UK Government policy is also undergoing transformation with the publication of the UK Location Strategy, the transposition of the INSPIRE Directive into UK law, the passing of the Marine & Coastal Access Bill and plans to change the business model of Ordnance Survey. The economic strictures, under which the public and private sectors will need to operate, as we attempt to handle enormous public debt, are also certain to drive changes in behaviour.

There can be little doubt that in 5 years the industry will look very different.

Over the past year the Association for Geographic Information (AGI) has been exploring the future of the geospatial industry in the UK in the first public foresight project of this kind. The foresight study has a medium-term horizon of 2015, as we believe that any longer-term assessment is not feasible or valuable. In seeking diverse points of view, the study invited almost 40 industry opinion formers to contribute papers in their particular expertise, covering data and technology, vertical market sectors and policy drivers. This was supplemented by: a workshop to debate the main themes of development; a presentation and debate of initial results at an open event; and public participation through an online questionnaire. Reference papers from the wider information technology world and economics and political fields were also consulted to ensure that the resulting analysis took into account influences outside the Geographic Information (GI) industry.

1.2 Structure of the document

We first consider the wider context by examining the broad paradigm shifts that are currently affecting the GI industry and how they might play out by 2015. We then attempt to summarise the political, social, economic, technological and environmental impacts identified by the many inputs to the study, see figure 1.

![Figure 1: Macro-environment influences](http://www.agi.org.uk/foresight)

The paper concludes with an outline of the key considerations that industry players need to address. Annexes list the contributors to the study and a summary of the more significant results of the public survey. Throughout, we reference the more detailed discussion of the issues which can be found in the expert papers, which we strongly encourage you to consult at http://www.agi.org.uk/foresight
1.3 Acknowledgements

The authors would like to thank the large number of experts, practitioners and external parties who have contributed to, reviewed or commented on the study results.

We view this study as a process, not a single event. Its publication marks the beginning of a continuous review of what the market wants from the GI industry and how it can be best delivered.

Geography as context

A paradigm shift unseen in our industry for 20 years

Over the last 20 years the GI industry has been changing, but in relatively small increments. There have been a series of significant breakthroughs, many driven directly by the IT sector: client / server to web enabled; UNIX workstations to desktop; proprietary to interoperability; limited data to a ‘fire-hose’ of data; high to affordable costs; departmental to enterprise solutions; and static to mobile, for example. These drivers of change and their effects emerged at a rate that both businesses and Government could absorb and comfortably adapt to. However, what we are now experiencing, bubbling up around us, is the biggest and fastest paradigm shift the industry has seen in our professional careers – Geography as Context. This paradigm shift is allowing and encouraging serious new players to enter and shape the GI sector as significant opportunities are discovered. The incumbent players have mostly been surprised at the scale and the speed of these investments.

In the past 2-3 years, Google, Apple and Microsoft, amongst others, have entered the GI industry with consumer-focused applications. This has dramatically changed our relationship with geography as electronic versions of mapping pervade our TVs, games, local government websites and our smart phones. A new generation of Internet products, such as Google Earth and Bing, for example, are stimulating a greater interest and use of geography in society. We are much more location-aware and location-based services are reshaping how we plan trips, meet friends and find good local restaurants. While others such as Facebook and Twitter have fundamentally transformed social networking and how we interact socially and professionally.

1.4 So, fundamentally what has changed?

Pace of change – it took the TV 13 years to reach an audience of 50 million world-wide. However, it took the Internet four years, the iPod three and Facebook just two 2 years. These technologies are also highly disruptive and have the power to change entire incumbent industries; the record industry has changed out of all recognition since the iPod arrived.

Speed of Communication – before we had to wait a day for news to be published. However, with the arrival of tools such as Twitter we are seeing news being broadcast in real-time. People were ‘twittering’ the debate during the workshop held to support this study.

Medium of Communication – Advertising revenues from the Internet overtook the traditional sources of television and newspapers in 2009. The web has become the key channel for communications and Apple’s recently announced iPad reflects this continuing transition.
“students starting a 4 year technical degree will find that half of what they learned in their 1st year will be out-dated in their 3rd year”

**Ubiquitous Computing** – in 1992 there were 1,000,000 internet devices. In 2008 there were 1,000,000,000,000! There are chips in everything and they are all being connected across the Internet.

**Cultural Change** – to accompany this paradigm shift in technology and globalisation, the generation growing up with this change, the wired generation (or sometimes referred to as Generation Y) has adapted to this new environment. This cultural or behavioural change has included a refreshing view of the work / life balance and social networking has been fully embraced.

**Moving targets** - with the amount of new technical information doubling every 2 years, students starting a 4 year technical degree will find that half of what they learned in their 1st year will be out-dated in their 3rd year. Not only is knowledge a moving target, but the job market is also a serious challenge - the top 10 in demand jobs in 2010 did not exist in 2004.

To survive and prosper within this highly dynamic and global environment, the UK needs to produce professionals in the GI sector that have core skills to allow them to adapt quickly, collaborate globally and take advantage of these opportunities within ever decreasing cycles. This is not only a challenge for the education sector, but also for all existing professionals to continue their professional development and keep up with this and future changes.

**Political Framework**

**The Chinese have US$2 trillion and are going shopping**

1.5 **Context**

Political frameworks and the associated policies have a considerable influence in shaping and, in some cases, controlling our sector. We are currently experiencing just how dynamic these policies can be. The UK political framework must also operate increasingly within the European and international environments as we participate in the global economy. Microsoft’s recent announcement that it will offer users the choice of browsers other than IE is a response to the investigation by the EU’s Competition Commissioner. We wonder how long it will be before the dominance of Google in the online advertising world falls foul of US anti-trust legislation.

Five years ago hardly anyone had heard of Barack Obama, London had not yet won the 2012 Olympic and Paralympic Games, and the role of China in funding the global economy was only just beginning to be recognised. If we had undertaken this exercise five years ago who would have predicted the Credit Crunch and the first black American President?^2^

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1. Education, Muki Haklay, AGI Foresight Study (2010)
Most governments have now woken up to the power of information and are formulating policies to either free up or curtail access to information, depending on their political dogma. At one end of the spectrum Google have accused the Chinese of an alleged cyber attack on their website while at the other end the UK government is proposing much more open and freer access to public sector information. We need to establish a degree of commonality on policies across countries to allow global trade in product and services, including information services, to operate effectively. This section discusses elements of the political agenda that will touch our sector.

1.6 Globalisation

We live, work and play in a global economy, influenced significantly by what is no longer a trend but a fact of life – globalisation. The reality of this has been brought home significantly by a disaster in the global financial markets, the way in which political leaders in the world’s 20 most developed economies have stepped in to shore up national economies. The financial meltdown of the last two years is not the result of national economic policy decisions; they arise from international markets. The concerted efforts to shore up the banks was taken clearly and explicitly to avoid a total collapse of our banking system and prevent a repetition of the Northern Rock failure with queues of savers trying to withdraw their savings. The consequences of this decision are significant and potentially will be the single most important influence on developing public policy over the next five years.

Information services are also global and the service providers require global coverage for their services. Therefore, if they cannot obtain the appropriate UK data at an affordable cost then they will find alternative sources.

**Balance of World Economic Power**

The aftermath of the global financial crisis highlighted the shifting economic power across the globe. Once the dust had settled, it was clear that the balance had shifted east to China, who are supporting America’s debt directly. Emerging nations like India and Brazil are poised to exert more economic influence.

The Chinese have long been on a shopping spree for natural resources. Now, with US$2 trillion in their pockets, they are shifting their aim towards auto-makers, high tech firms and real estate. Electric cars and mobile phone manufacturing are two areas where the Chinese are challenging the incumbent global players. The GI sector could be on this shopping list, especially since it would help identify global assets for purchase and management.

It is not only the financial advantage of these new global players that is significant, their intellectual capacity is also impressive: China will soon become the number one English speaking country in the world; and India has more honours students than America has children. This will change the global intellectual axis, especially in terms of research and development.
1.7 UK Policy environment

In addition to the obvious drivers of INSPIRE (INfrastructure for Spatial Information in Europe) and the UK Location Program (location.defra.org.uk) there are a number of other UK government policies that will either directly influence the GI sector or provide opportunities for the GI sector to contribute to the support of the policies over the next five years. We expect the majority of these policies will remain relevant no matter which party is in power.

Public Sector Information

Radical but necessary changes in the UK have been too long delayed and are now inevitable. As we write, Government has finalised a consultation on ‘Policy options for geographic information from Ordnance Survey’. This followed the Prime Minister’s proposal to make available certain Ordnance Survey datasets for free and without restriction on re-use. The consultation was issued in the context of the broad long-term strategic options for Ordnance Survey. The Prime Minister has subsequently announced that Ordnance Survey will be obliged to provide certain datasets for free and without restriction on re-use. This is a significant policy shift and will have a major impact (positive and negative) on the GI sector.

Putting the Frontline First: Smarter Government

The government published Putting the Frontline First: Smarter Government White Paper in December 2009. The report outlined a programme of work to reform and restructure government. It focused on developing a more strategic centre, developing new partnerships for performance and value for money in public services, and citizen empowerment and transparency in the information age. This report built on the work and proposals of Sir Tim Berners-Lee and Professor Nigel Shadbolt. It outlined the importance of increasing the transparency and availability of public sector information to better serve citizen and community needs, improve value for money and achieve cashable savings as part of the Making Public Data Public initiative and the subsequently launched data.gov.uk. The data.gov.uk initiative is a programme of work to increase the availability of non-personal public data for re-use and will support the government’s objective of being an enabler of public services rather just a provider. We can expect this to be a central part of driving the UK information economy over the next 5 years.

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3 PSI Policy, Michael Nicholson, AGI Foresight Study (2010).

Other Priorities

Other priority policy areas that will influence the GI sector will be (i) homeland security in the fight against terrorism, (ii) climate change (with increasing rigour applied to the evidence and modelling following the revelations from the University of East Anglia), (iii) disaster management around the increase in incidents related to climate change, and (iv) energy and food security which will become more important in the global context. And we still have to make serious inroads into the health and education sectors.

EU INSPIRE Directive

The European Union’s INSPIRE Directive creates a European Spatial Data Infrastructure by improving the interoperability of spatial information across the EU. The EU INSPIRE Directive was approved by the European Parliament and the Council of the European Union in March 2007 and was transposed into UK law by 31 December 2009. The Directive requires public authorities that create and use spatial information to make their information available to other public organisations across Europe so new products and services may be developed by combining this information. The Directive also requires public authorities to make their information accessible (not necessarily free of charge) to members of the public and to allow re-use. This will significantly change the GI landscape through the UK Location Programme.

Privacy Issues

Location as an application feature is moving from a vertical market characterised by B2B GI processing to a horizontal market characterised by B2C personal location technologies. The traditional GI sector, dominated by players such as ESRI and Intergraph, is set to be overtaken by the giants of the IT industry such as Google, Microsoft and Yahoo who have brought powerful location technology consumer applications into the market. This has set the scene for massive changes to the GI sector over the next few years, in which privacy issues will play a big part.

1.8 Impact on GI Sector over Next Five Years

Competing in a Re-aligned Global Market

The shape of the GI sector will be significantly influenced by the shift of global economic power to China and emerging nations whose economies have not suffered so badly from the financial crisis. The UK GI sector needs to co-exist and compete for opportunities in this realigned global market. We will need new competencies and skills and our education system needs to respond to these challenges; we are currently preparing students for jobs that do not exist, using technologies that have not been invented in order to solve problems that we do not even know are problems yet.
Capacity building will be a key success factor for our sector\textsuperscript{8}.

**Hunting in Packs**

The UK GI sector has been successful in generating SMEs, but has not been effective at migrating the SMEs into major companies to compete at the global level; possibly a cultural issue, but in part due to lack of government support in the sector. A more collaborative approach, even across the public and private sectors, is required to increase our capability and competitiveness abroad (the Canadians adopted this approach many years ago\textsuperscript{9}).

**Generating Welfare and Social Benefits with Public Sector Information**

The emerging policy shift towards more open access to PSI is being guided by the belief that this will generate significant innovation leading to high levels of welfare and social benefits\textsuperscript{10}. If this is to happen then the GI sector needs to be an integral part of the wider information landscape and provide the tools and capacity to realise these expected benefits. This will require a new generation of innovators who can work in this broader information landscape which will increasingly include crowdsourced data.

**Geographic Information Profession**

As GI and associated services become pervasive across society through consumer location based services, the GI industry, needs to get itself much better understood, along with the benefits it can bring to the citizen and society, so as to inform the debate on the ethical challenges, such as privacy. Should AGI’s role be strengthened by making the long and arduous journey from a representative group to a professional body to better support this change\textsuperscript{11}?

**Job Opportunities Moving East**

In the late 70s and early 80s the UK was in recession and many professionals in the GI sector headed to the Middle East for well paid jobs. As the UK is steeped within another major recession, public sector spending about to be draconically cut and markets shrinking will we see another exodus of skills from the UK to seek more attractive jobs in the Middle East and Asia?

\textsuperscript{8} Education, Muki Haklay, AGI Foresight Study (2010)
\textsuperscript{9} www.geoconnections.org
\textsuperscript{10} Openstreetmap Countries, Charles Arthur, AGI Foresight Study (2010)
\textsuperscript{11} Geo-ethics, Iain Greenway, AGI Foresight Study (2010)
Re-engineering the Public Sector

The drive for efficiencies in the public sector will create opportunities for re-assessing our institutional framework. The Northern Ireland model of consolidating ‘land’ services into a Land & Properties Services agency could be followed in GB.

Avoiding Location Crises

In location technologies people and places are at the centre of the service concept and businesses have a direct relationship with the purchasers of the service: this means that that privacy has had to be actively managed. The current overall picture of location privacy is one of ad hoc regulation addressing specific applications as they arise. There is now a case for the Information Commissioner’s Office to update the Privacy and Electronic Communications Regulations 2003, and for the mobile operators to update their code of practice. There should in particular be a debate on what resolution of location information is private on a spectrum from “is in the country” to “is located here to a resolution of x metres”. Over the next 5 years there will be a number of changes to the environment and capability of location technologies that will combine to create “location crises”, unless action is taken to guard against these.  

Social and Economic Perspective
Are we headed for a slope of enlightenment or a trough of disillusionment??

1.9 Context
The individual papers submitted to this study have identified trends and opportunities within specific markets particularly in the B2B arena, this section builds upon those observations rather than summarise them and focus on the broader GI Industry rather than participants in individual sectors.

Whilst detailed economic or social predictions for 2015 are beyond the scope of this study there are several patterns emerging that will influence the state of GI in 2015.

1.10 Economic outlook
The overall economic context to 2015 is (in aggregate) flat. Most forecasts are for limited growth over the next 2-3 years, predictions from National Institute for Economic and Social Research\(^1\) suggest that overall economic output will not reach the Q1, 2008 level until the end of 2012 and GDP per capita will not reach 2008 peak levels until Q1, 2014.

\(^1\) www.niesr.ac.uk

Government expenditure
There is a particular tension in these forecasts for the GI industry given its high dependence on government expenditure. The limited recovery is currently being fuelled by government spending which has replaced the credit bulge as the engine of growth (albeit a weak engine), however regardless of the election outcome it would seem prudent to plan for significantly reduced government spending from 2011 onwards.

The Institute for Fiscal Studies analysed the impact on central government departmental budgets of the commitment to significantly reduce government debt by 2014. After adjusting for the “protected” budgets of Health and Schools committed by both parties, the reduction could be of the order of 13% up to 2012-13; if protection were extended to 2014-14 other budgets would need to be cut by 23.8% (£47.4bn in total)\(^14\)

1.11 Social outlook
It is not our intention to try to summarise all of the numerous studies of social trends and attitudes that might have an influence on the industry by 2015. However we have identified a few factors that we believe will have significant impact on the industry.

Generational changes

There are distinct differences between the so-called Generations X (born in the 1960’s & 70’s) and Y (1980’s & 90’s). We can speculate on exactly how those changes will impact the industry, but we can be certain that the generation that will become the core of the workforce and increasingly the leadership and decision makers of 2015 will have different values, attitudes and expectations to those who have comprised the customers and consumers of the last decade.

This generation that has blurred the distinction between their work and social lives will be a major driver of crossover between the user interfaces and tools of the social web and those in the workplace.

Openness and participation
There is a trend towards openness and participation, which spans attitudes to public data, the use of social media, diminished concern about personal privacy (until the personal impact is recognised), and an expectation that openness will lead to greater participation and influence on public services. This trend can also be identified in the growing interest/commitment to open standards and open source software and data (although open source and open standards should not be considered as the same).

Free
The explosion of free (or apparently free) services on the internet has created an expectation that all digital content can and should be available free online. Media, music and a raft of information industries are wrestling with these expectations, the desire to access new delivery channels and the challenge of determining viable business models.

The culture of free also stimulates innovation both on the producer side and from consumers who appear to be increasingly willing to challenge the legal rights of content owners.

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15 The Energy Market, Berik Davies. AGI Foresight Study (2010)

16 BMR claim that 96% of 18-24 year olds have undertaken some form of illegal copying or downloading.

http://technology.timesonline.co.uk/tol/news/tech_and_web/personal_tech/article4144585.ece
1.12 Impact on GI Sector over Next Five Years

In considering the social and economic context, we will consider the impact on businesses, consumers and the opportunities that may arise within the industry.

B2B or B2C?

Whilst a large part of the GI industry (as represented by the AGI) today is business to business, the widespread usage of personal navigation devices and web mapping services from Google, Yahoo and Microsoft probably represents a substantially larger share of revenue and usage of GI today.

1.13 Business to Business

The traditional B2B markets for the geo industry in the UK have been Government (Central, Local & Defence), Utilities, Transportation, Retail & Marketing, Resources and Financial Services.

Public Sector

Public Sector represents substantially more than half of the B2B sector. Inevitably the cuts in public sector budgets will impact the aggregate demand for GI with most GI usage being in the “unprotected areas” of Central and Local Government expenditure. IT expenditure in general could come under further pressure if the reductions are targeted to minimise impact on front line services.

Our Local Government contributors suggest that Local Government will adopt shared services as a means of reducing costs and also achieving compliance with INSPIRE regulations17.

The numerous policy initiatives that encourage cross organisational collaboration (including the involvement of the third sector in public service provision) to support more holistic solutions to problems depend on an easy means of sharing and interpreting data18.

These drivers represent an opportunity for suppliers who can offer cloud based services or for those who are willing to host more traditional services at prices comparable with the cloud19.

The momentum towards “making public data public” or open data will open up most government data sources of non-personal data within the next 2-3 years. New players will almost certainly emerge to take advantage of the opportunities arising from the availability of this data; they will bring new business models which may represent a revenue opportunity or a threat for the current GI industry.

Commercial Markets

Whilst public sector expenditure on GI is likely to fall up to 2015, commercial markets should deliver some growth as the recovery gathers pace.

In most sectors our contributors anticipate steady growth however there are a couple of markets that they believe do have above average potential.

17 Local Government, Gesche Schmid. AGI Foresight Study (2010)
18 Third sector market, Muki Haklay. AGI Foresight Study (2010).
19 Berik Davis and Natural resources, Tim Duffy. AGI Foresight study (2010).
The combination of environmental concerns and the high cost of fuel will provide the economic impetus for a number of smart logistics applications. Additionally the above average growth of internet retail will have a significant impact on home delivery services and a demand for more precise predictions of time of delivery\textsuperscript{20}.

Whilst the insurance sector has long recognized the geographic pattern of risk distribution, the wider uptake of GI within the sector has been slow. Our contributors anticipate an opportunity for new entrants not encumbered by legacy technology to gain competitive advantage through the use of GI across their businesses\textsuperscript{21}. We can envisage a similar opportunity in other mature commercial markets where GI has yet to be widely adopted in core processes.

\textbf{Location based Services}

Location Based Services (LBS) have been widely touted as “the next big thing” since the late 1990s. A significant development in the next 5 years will be the move of applications aimed primarily at consumers into the enterprise space. Just as today vehicle navigation is used in both the consumer and business space, other geospatial applications that emerge in the consumer market will also be adopted, sometimes in a “hardened” form in the enterprise.

Peter Batty\textsuperscript{22} considers LBS will impact the enterprise in two broad areas: one is that mobile / field based workers will have much better and simpler access to information; and the enterprise will also have a real time picture of where all its employees are (as well as other resources and assets). Traditionally geospatial applications have been more about documenting and analysing the past and planning for the future, but there will be significant growth in applications focused on real time information.

\textbf{1.14 Potential changes to current business models}

\textbf{GI in the mainstream}

GI proponents have been anticipating GI going “mainstream” for some time, it seems likely that by 2015 we will be saying that “spatial is not special”. The widespread adoption of consumer web mapping will influence usage, design and the business models of the current

\textsuperscript{20} Transport market, Mary Short. AGI Foresight Study (2010).

\textsuperscript{21} Financial services market, Graham Wallace. AGI Foresight Study (2010).

\textsuperscript{22} Location Based Services, Peter Batty. AGI Foresight Study (2010).
GI industry\textsuperscript{23}. As spatial ceases to be special it will also cease to attract a scarcity premium which may have a profound impact on businesses and their employees unless they are able to adapt to a much more competitive market.

\textit{The cost of free}

Several contributors predict substantial falls in price levels for data and software (the distinction between data and software is blurring with the trend towards both becoming services)\textsuperscript{24}.

The widespread expectation of “free” is moving from the consumer web market to the business to business GI market. Open Source software and data has now become a viable alternative to proprietary models and whilst Open Source is not strictly free as business models are based on provision of services and support rather than licensing, that in itself will be highly disruptive to businesses focused on licensing and maintenance models.

Consumer web mapping API’s that are apparently free (or have radically different cost recovery or justification models) have already encroached on several fields of activity for the GI industry (e.g. store locators, tracking and other real time data feeds). The entry of “professional” standard services businesses on top of the free API’s will increase competition in web presentation of corporate data. Additionally we can foresee the growth of “enterprise” or “paid for” versions of the free API’s offering premium geo services and features to clients who already use other elements of their offerings (advertising, applications, and platforms).

There are, as yet, no indications that volumes will grow in commercial markets to offset this trend and our contributors anticipate that the current industry will need to focus on premium quality products and services to niches within the wider market\textsuperscript{25}.

\section*{1.15 Consumer markets}

Nearly all of the market contributions to this study have come from the traditional GI industry membership of AGI, which is almost exclusively focussed on business to business markets. That may in itself indicate the extent to which the explosive growth of consumer applications of GI has bypassed the established UK industry.

Maps have become commonplace on the internet. Over 100 million people use a web map each month, virtually none of these maps are provided by the traditional GI industry players and none of them are paid for by the end user.

\textsuperscript{23} The Energy market. Berik Davis. AGI Foresight Study (2010) 
\textsuperscript{24} Thierry Gregorius et al, AGI Foresight Study (2010) 
\textsuperscript{25} Value added data resellers, Thierry Gregorius. AGI Foresight Study (2010)
The pace of adoption of Personal Navigation Devices [PND] (90 million worldwide in 2009\textsuperscript{26}) and GPS enabled smartphones (28 million worldwide in 2009) is accelerating.

A plethora of applications have developed on the back of the web mapping API’s, in the UK there are more than 500 mashups locally focussed with nearly 40 per quarter being added, some recent examples include the locations of Anti Social Behaviour Orders (ASBO), London bus routes, sites of film locations or car parks with spaces available. Increasingly these maps and applications are being accessed from smartphones that can integrate GPS and other positioning technologies with the application. We estimate that there are up to 10 million people in the UK able to access mapping and location based applications from a smartphone today, by 2015 nearly every mobile phone will have this capability implying upwards of 40 million users or potential users.

The increasing functionality of these devices and the mapping API’s that they support will drive a new generation of applications. Turn by turn navigation is already appearing on these devices and several providers are offering free services that will challenge the business model of the PND industry. There has for some time been an expectation that consumer focused location based services would become the next lucrative market space for both traditional and new industry players, recently the focus has shifted slightly towards Location Based Mobile Social Networking which incorporates applications like friend finders, local search enhanced by social recommendations and location based gaming.

A recent study\textsuperscript{27} has forecast the market for mobile Location Based Services (LBS) to exceed $12.7 billion worldwide by 2014 with the largest share of revenues coming from Europe. These forecasts need to be treated with some caution as the revenue models for these services are still evolving. However the rise of application stores linked to mobile phone operating systems has provided a channel for developers to sell their applications, at prices equivalent to the cost of a newspaper or cup of coffee, to large numbers of consumers with limited investment in sales and marketing or distribution channels. Over 15% of applications on Apple’s AppStore utilise location in some way. Advertising has always been seen as a major revenue stream for developers of mobile applications, as the aggregators of advertising inventory start to be able to target more precisely based upon the user’s context (which

\textsuperscript{26} Berg Insight  

\textsuperscript{27} Juniper Research  
includes location, time of day, previous preferences etc) advertising revenues associated with applications that incorporate location will also grow.

The growth in consumer applications envisaged above may be unrecognisable as geographic information to many readers of this study. Even those who have adapted to the use of the term “location” and all it implies may struggle to see these applications as being the natural progression of the asset management, resource planning and spatial analysis solutions that our industry evolved to deliver.

It would seem unquestionable that the growth of consumer applications with varied business models will have dwarfed the business to business sector of the market by 2015. New entrants will reach across from the consumer market to take an increasing share of the business to business market with challenging cost and business models.

The next few years will be shaped by a combination of extreme pressures on public sector expenditure (the bedrock of the current GI industry), new business models and rationales, a shift in business focus towards consumer facing applications and a transformation of data markets as public data is made freely available.

By 2015 spatial will not be special, in all probability it will be no different to the incorporation of time in everyday computer applications today. It may well prove difficult to distinguish a GI industry (as we currently know it) within mainstream IT although many of those active in the UK will have found niches based around quality, currency or specificity in which they can prosper.

“by 2015 spatial will not be special”
Technological advances

Geospatial technologies converge over months not years, location is ubiquitous

1.16 Context

In this section, we consider how technological change will impact upon the geographic information industry. The individual contributions received in this area cover not only advances in hardware, software and systems but also extend to changes in the nature and availability of geographical information.

The concept of “geography as context” is a recurring theme. Geographical information is becoming ubiquitous and as such is an available component of all applications, much in the same manner as time, is a contextual attribute – all that varies is the extent to which it is useful. As Batty\textsuperscript{28} puts it “location tracking will be pervasive in 2015 – all mobile phones will have location tracking ... we will have the ability to know where everyone is all the time.”

Technology convergence also emerges strongly from the papers. The smartphone is perhaps the most obvious example, where devices already support communication by both voice and web but also incorporate locational capabilities in the form of GPS and accelerometer and a camera. The next 5 years will see huge improvements in cost, quality and bandwidth of these devices. The ability to combine data in near real time from airborne LIDAR, laser scanned point clouds and digital photographic images to produce high resolution 3D cityscapes is another manifestation of this trend. A major issue however is cellular network capabilities. They are strained now and struggling to cope with 3G uptake. There could be great disillusionment with devices because of limits in the broadband ‘back-bone’.

Belward\textsuperscript{29} points up another important area of development - “By 2015 Committee on Earth Observation Satellite (CEOS) agencies plan to operate over 200 satellites” leading to the prediction by Dodson\textsuperscript{30} that “it can be confidently expected that within the next 5 years centimetre positioning in a mobile environment will be commonly achievable.”

Cloud computing will become the predominant means of software service delivery. Gartner\textsuperscript{31} believe “it will mean that users of IT-related services will be able to focus on what the service provides them rather than how the services are implemented or hosted.”

\textsuperscript{28}Location based Services. Peter Batty. AGI Foresight Study (2010)
\textsuperscript{29}Satellite Imagery, Alan Belward. AGI Foresight Study (2010)
\textsuperscript{31}Gartner Predicts: 2010 Report.
Open source will become a more significant factor in both software and data accessibility and availability by 2015. Cook\textsuperscript{32} believes that “Sharing and making code and data open will be the “de facto” approach” although some doubts remain about functional maturity of some components and support. We also predict a huge growth in active and passive “crowd sourcing” as Osborne\textsuperscript{33} sees it “If an application can offer a tangible benefit to the user sharing their information, with no perceived loss of control or negative impacts, then they become happy sharing their personal information.”

More imagery, temporal and 3D data will be created as a consequence of many of the developments above. “This will dramatically increase the size of the underlying databases into the terabyte and petabyte range which all needs to be managed... and increases pressure for even faster, larger processing configurations” in the view of Turnill\textsuperscript{34} from Oracle. What Gale\textsuperscript{35} describes as “the information hosepipe of the Internet” will also require the semantic web (web 2.0 / 3.0) to deliver by 2015, the ability to deal with the ill-defined and ambiguous manner in which human beings describe “place”.

\[\text{Open Source Software, Jo Cook. AGI Foresight Study 2010.}\]
\[\text{Crowd Sourcing, Chris Osborne. AGI Foresight Study (2010).}\]
\[\text{Enterprise Computing, Mike Turnill. AGI Foresight Study (2010).}\]
\[\text{Web 2.0& 3.0 - Teaching Human Geography to the Internet, Gary Gale. AGI Foresight Study (2010).}\]

1.17 Impact on GI Sector over Next Five Years

Geospatial Enterprise Systems

Geospatial systems are increasingly being seen as a viable component of enterprise IT transformation projects, both in both public and private sectors. This trend will accelerate over the next 5 years.

The requirement for high quality, nationally consistent “reference geographies”, which form a Spatial Data Infrastructure (SDI), will continue to be needed in order to manage the UK effectively. The SDI will underpin applications such as land registration, development control, emergency response and defence within Government and other in the private sector.

Augmented reality

Augmented and simulated reality, together represent one of the most exciting areas where research is starting to move into usable applications. This is being enabled by the incorporation into the basic smartphones of a number of enabling components:

- GPS
- Camera
- Compass
- Inertial positioning using MEMS (Micro-electromechanical systems)
- Inclinometer

In the short-term there are a number of constraints to mass-market implementation of most appealing applications. These include battery life; the ability of the human brain to outstrip the ability of handheld devices to process data synchronised with eye movement; and mobile bandwidth limitations.

\[\text{Version 1.1 17 May 2010}\]
However, some of the simpler consumer applications are already becoming commercial available, see Hudson-Smith and Sung Hyun Jong. 36

**Cartography & Visualisation**

Mackaness 37 in his study paper foresees a resurgence in cartography in respect to solving the challenges of visualising increasingly complex spatial analyses and 3D and 4D representation needed for augmented reality applications. However, it is not clear if cartographers or visual designers will have more influence in these developments. The contrary view is that we may see the death of the conventional 2D map by 2015. However, we can confidently predict that Google Maps and other consumer applications will produce a much greater map literacy / spatial awareness in population at large during this period.

**Global Navigation Satellite Systems (GNSS)**

Multi-constellation GNSS launched by India, China, the European Union, Russia, United States and possibly others will mean that over 100 satellites will be available for high accuracy positioning by 2015. The control over high resolution signals by the US will be removed. Using signals from these satellites, centimetre positioning will be routinely achievable in a mobile environment in developed countries. Indoor positioning will still require augmentation with other sensor systems, but will allow sub-metre positioning to be achieved commonly. In examining the necessary enablers for optimum exploitation of the opportunities that this offers, Ziebart 38 believes “the trend is clear: a single, accessible, global datum used to store and model all spatial data will evolve and be mandated.”

**Satellite Imagery**

We alluded earlier to the 385 different instruments which will be launched by 2015. These will provide imagery across virtually all parts of the frequency spectrum and serving many different environmental and other applications. Our contributors believe that all 10m – 30m resolution data from these instruments will be publicly available and free and furthermore, resolution restrictions on access imposed on US imagery will disappear. Sub metre resolution imagery from satellites will also become available, although here there is less certainty about whether it will be released widely for commercial use.

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36 Augmented Reality, Andrew Hudson-Smith and Sung Hyun Jong. AGI Foresight Study (2010).
37 Cartography and Visualisation, William Mackaness. AGI Foresight Study (2010).
38 Space Observation, Marek Ziebart. AGI Foresight Study (2010).
Aerial Photography
The major web actors (such as Google and Microsoft’s Bing) are driving demand, however, the needs of these organisations are very different from the traditional client base. Their interests are driving traffic to web sites thus creating the potential for advertising, as such aerial photography is a commodity and should it not generate the required interest (or something better is made available), then their interest will wane as fast as it has risen. However, current indications are that consumer interest is likely to be sustained over the period, leading to the assumption that sub-metre accuracy 3D data will be available for all built up areas in UK by 2015. Prices for capture will inevitably continue to be squeezed by the big buyers.

At the opposite end of the spectrum this will force up costs in the specialist high quality market - in future, those requiring guarantees of quality and timeliness may end up paying more.

A significant technological development is the likely increase in the use of Unmanned Airborne Vehicles (UAV). Lavender comments that UAVs could become an increasingly utilised platform in the future if the legislative constraints are solved.

Ground-based Data capture
It is becoming much less expensive to capture data to relatively high standard through laser scanning. The market for data capture using point clouds will expand as costs of hardware and software reduce. Land surveyors will need to adapt to working with the massive quantities of data produced by laser scanning, otherwise they will be increasingly marginalised as specialist data collectors. There will however still be a need to capture the 10% of data that is difficult to collect automatically by more conventional means.

Semantic Web (Web 2.0 / 3.0)
The number of page views of geospatial content being viewed on search engines is thought to be doubling each year and the increase in advert take up is 5 fold. This rate of increase is expected to continue through 2015 and will keep the big players interested in geospatial. Better interpretation of colloquial and personal geographic inferences is expected to be a major challenge for geospatial web development over the next few years.

Software
The move to web services delivery of geospatial systems is expected to force down prices of software licences from the large vendors, causing them to move to enterprise licensing deals to encourage dependence and the spread of usage.

Open source geospatial software will be 'mainstream' by 2015. Our experts believe that just as IBM funded Linux as competition to Windows and also funded Eclipse, substantial commercial companies will create support facilities around open source GIS. This needs a stronger institutional infrastructure and ecosystem to provide adequate support in industrial strength environments is also recognised.

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39 Aerial Imagery, Andy Wells. AGI Foresight Study (2010)
40 Earth Observation Data, Sam Lavender. AGI Foresight Study (2010)
41 Data capture tools and techniques, Richard Groom. AGI Foresight Study (2010)
42 Gary Gale. AGI Foresight Study (2010).
43 Open Source Software, Jo Cook. AGI Foresight Study (2010).
The browser will be the dominant user environment and the desktop confined to a few specialised applications and very challenging or secure environments. User-centred design, as exemplified by Google, will become an increasingly important focus of software development.

A cottage industry will grow around exploiting GI for many applications i.e. a huge number of applications will be developed in garages around the world – there will be many competing offerings, many of which will die quickly but this will have started to “shake out” by 2015 with many of the apps with the highest potential reaching a level of maturity.

The sheer scale of data volumes creates challenging information management issues. Database management systems will need to have evolved to cope with demands of real time 3D geospatial feeds.

There will be little completely new functionality added to GIS products over the next 5 years. Most of the tools required by the vast majority of users exist and many more are so infrequently used that they will probably be removed from mainstream product sets to aid stability and reduce cost. Exceptions are areas such as change detection, process modelling and feature extraction.

“*We are all sensors now, your photographs, tweets.*’

Specialist accelerator cards, known as Geographic processing units (GPGPU) will become important to handle complex visualisation problems in hardware.

**Crowd sourcing**

Last but not least, we see the importance of crowd sourced information increasing for a variety of applications and scenarios. Crowd sourcing can be essentially active by which volunteers participate in capture (and updating) of spatial data types or associated attribution; or passive, where data is collected from a device, for instance, travel patterns derived from data transmitted from your smartphone automatically and in real time.

Osborne\(^{44}\) characterises this revolution as “We are all sensors now. Your photographs, tweets, restaurant reviews, the speed at which you are driving are all geocoded data that is being recorded and can be mined and analysed.”

\(^{44}\) Crowd Sourcing, Chris Osborne. AGI Foresight Study (2010).
Environmental Impact

The key challenges of the new millennium are all interconnected, with many being perpetrated by climate change.

1.18 Context

At the start of the 21st century the world is facing critical global food and fuels shortages, climate change, urban growth, environmental degradation and natural disaster related challenges as today's world population of 6.8 billion continues to grow to an estimated 9 billion by 2040. This is placing inordinate pressure on the world's natural resources. The recent severe winter and the serious flooding in the north-west of England have highlighted that the UK is very much a part of the global problem and solution. This section investigates how environmental issues will impact the GI sector.

The surge in the price of key food products such as rice and wheat, which last year hit record highs, sparked food riots in some countries. Food security has become a key global challenge. In response to the crisis, many countries and private corporations are exploring new ways of safeguarding their supplies of natural resources; especially crops for food and bio-fuels. A global search is now underway to identify ‘under-utilised’ land in areas suitable for agricultural production and to acquire the land for large scale agricultural production. Significant areas of land in Africa, India and South America have now been bought or leased to foreign countries or corporations – the so called ‘farmlands grab’.

Although these investments attract capital along with technology and market knowledge to potentially improve agriculture, there are many inherent concerns that are not always covered in the associated contracts: agricultural produce is directly exported from countries with a food deficit; there is no ‘unused’ land and in many cases local people are taken off the land with little compensation; the easiest land to acquire is government land and the benefits normally go to the political elite rather than the local people; large scale agriculture does not employ significant numbers of local people; and much common land, such as grazing land, is targeted and lost. It is increasingly relevant that we strengthen land governance across the globe to ensure that all stakeholders understand their roles and responsibilities in managing land, property and natural resources within a sustainable and equitable framework.
The key challenges of the new millennium are all interconnected, with many being perpetrated by climate change. Our understanding of the problems and the formulation of potential solutions will only be achieved through a holistic approach involving collaboration across the professions. Professionals in the GI sector have a key role in this alliance through the effective management of GI related to the built and natural environments and the application of good land governance to help mitigate the damaging impacts on our world and society. We need to adapt our approaches to be more sensitive to and supportive of these new challenges and make stakeholders fully aware of the incentives for adopting this paradigm shift. Good geographic information management must assist land governance to not only control and manage the effective use of physical space, but must also ensure sound economic and social outcomes.

1.19 Environmental outlook

European environmental policy

The major floods across Europe in the 1990’s and the challenges of climate change are the triggers for change. Effective support of this environmental agenda will be a major challenge for the GI sector in the next five years.

Climate Change

Our understanding of the problems and the formulation of potential solutions to climate change is a key challenge. The GI sector has a crucial support role in collating, managing and modelling the related information. This will only be achieved through a holistic approach involving collaboration amongst those involve in the land, marine and atmospheric domains. Increasing sophistication in the analysis, presentation and understanding of uncertainty issues, for example how to communicate probabilistic-based information sets. This issue is particularly relevant for scenario forecasting such as climate change or flood risk analysis, where there are increasingly sophisticated datasets availability

Carbon footprinting

More immediate and direct “footprinting” of the consequences of everyday decisions – if not direct carbon taxes at least the ability to price and understand the consequences of different courses of action. A typical example would be increasing granularity in the insurance market as better tools and datasets become available to determine environmental risks (Oates).

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46 Environmental Management, Bill Oates. AGI Foresight Study (2010)
Sources of renewable energy

The UK government and the devolved administrations have set ambitious targets for the contribution of renewable sources of energy. Achieving these targets will involve significant investments in infrastructure, e.g. land and marine based wind farms and the strengthening of power infrastructures. As the recent Scottish Government approval of the Denny – Beauly inter-connector\(^{47}\) proved, this requires careful assessment and communication of the environmental impacts. The participation of the citizen in the planning process is crucial to this decision making process.

Democratisation of information

Information will increasingly be collected by the public and stakeholder organisations, or if not collected by them, there will be a sense of ownership and entitlement. Data to support the green flag awards for beaches across Europe is increasingly being crowdsourced. This trend is entangled with the mass-market impact of tools like Google Earth, with its climate change data overlays.

Natural resource datasets will be ubiquitously available, discoverable and digitally accessible at much lower access cost to the customer than before. Some forms of data – such as Biodiversity observational data, which lend themselves to public (so called amateur) collection will be increasing in volume and ‘real time’ usefulness. There will no longer be the need for ‘project GIS’ collation of natural resource GIS datasets by consultants etc. as the most up to date information will be discoverable and available direct from the data providers’ web services\(^{48}\).

1.20 Impact on GI Sector over Next Five Years

The Data Deluge

There is a potential paradox at the heart of the information management within this domain, which creates an opportunity in the GI arena: as the cost base associated with data collection is driven down and the volume of data available goes up, the public becomes at best confused and at worst sceptical. In many cases, more information equals greater confusion – another dataset will be around the corner to refute any position. This means that rather than being able to let “the figures talk for themselves” it becomes increasingly important how the information is presented and telling the story associated with the information in a compelling way. This does not mean however to filter the information, to protect it, or to otherwise impede its release – that would be counter-productive. Rather the increasing availability of GIS tools and “geoweb” enthusiasts mean that

\(^{47}\) www.scotland.gov.uk/news/releases/2010/01/06/06141510

\(^{48}\) Natural resources, Tim Duffy. AGI Foresight Study (2010).
there is a wider pool of people who can be partners in understanding and communicating the issues.\(^\text{49}\)

**Data Quality & Transparency**

Prior to the Copenhagen climate summit in December 2009, hundreds of private emails and documents allegedly exchanged between some of the world's leading climate scientists during the past 13 years were stolen by hackers and leaked online. The computer files were apparently accessed from servers at the University of East Anglia's Climate Research Unit, a world-renowned centre focused on the study of natural and anthropogenic climate change. Climate change sceptics who have studied the emails allege they provide "smoking gun" evidence that some of the climatologists colluded in manipulating data to support the widely held view that climate change is real, and is being largely caused by the actions of mankind. The lesson here is that the provenance of data supporting evidence for controversial areas such as climate change must be clearly documented and transparent.

**Crowd sourcing**

Environmental information is increasingly being collected by the public and stakeholder organisations through crowdsourcing. The GI sector must develop approaches to accommodate this valuable source of data to complement more traditional approaches.

**Public Participation**

Successful planning processes involve effective public participation. The challenge to the GI sector is to develop approaches that can communicate complex environmental decisions with citizens. This could involve solutions like augmented-reality, for example.

**Holistic Environmental Information Management**

Environmental information in the land, marine\(^\text{50}\) and air domains have traditionally been managed separately. However, the modelling of environmental phenomena, such as climate change, is increasingly demanding fully integrated environmental information across these domains.

**Disaster Management & Recovery**

The increasing number of environmental related disasters, such as the recent flooding in the north-west of England, requires further initiatives such as Atlantis\(^\text{51}\), to more effectively integrate a wide range of environmental information to support prediction modelling and to help manage disaster recovery.

\(^{49}\) Environmental management, Bill Oates. AGI Foresight Study (2010)  
\(^{50}\) Marine & Coastal, Mike Osborne, AGI Foresight Study (2010)  
\(^{51}\) www.projectatlantis.net
Key Challenges

There are many challenges for the industry over the next 5 years, some are highlighted in this summary paper but many others of a more specific nature are to be found in the expert papers. A few that we believe to be of most significance are:

1.21 Political
- Adapting to global economic power changes;
- Building appropriate GI capacity;
- Creating a UK based global market leader / partnership;
- Supporting a new type of public sector;
- Responding to location privacy issues.

1.22 Economic and Social
- Embracing a continuous turmoil of change;
- Responding to the challenge of free and the different business models that support it;
- Harnessing the crowd;
- New entrants will seize the opportunity to fuse the geoweb and social media – established incumbents will need to react or die;
- Developing the role of location information in socially significant applications, such as participatory democracy, mega city planning and consumer applications;

1.23 Technological
- Discarding the location-specific baggage and enter the mainstream;
- Working with with Google and other emerging global players;
- Engaging with Location-based Services (LBS) developers and service providers;
- Providing services to help users migrate through these paradigm shifts;
- Communicating with end users who don’t understand maps;

1.24 Environmental
- Understanding and responding to climate change.
- Encouraging public participation by explaining complex geographic phenomena in simple terms.
- Integrating and modelling land, air and sea aspects of environmental information.
## Annex 1: List of Contributors

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Annex 2: Public Survey

The following charts are extracted from the results of a public survey conducted in January – February 2010 to sample views on some of the key questions raised in the study. There are about 70 valid responses included in the analysis.

This indicates that although while there is a significant percentage who believe that industry messages about the importance of GI will be recognised, there is still a strong degree of scepticism.
Well over 50% of respondents believe that institutional initiatives will be overtaken by the market.

There is relatively little support (13%) for the view that geospatial advertising revenue will grow exponentially over the next 5 years.
The predominant view seems to be that the market will grow in size but product prices will decrease.

The predominant view is that the UK market will grow strongly to about £250m by 2015.
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