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The revenge of geography

It was naive to imagine that the global reach of the internet would make geography irrelevant. Wireline and wireless technologies have bound the virtual and physical worlds closer than ever

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IN THE early days of the internet boom, there was much talk of the "death of distance". The emergence of a global digital network, it seemed, would put an end to mundane physical or geographical constraints. There was some truth in this. E-mail made it cheap and easy to stay in constant touch with people, whether they lived around the corner or on the other side of the globe. Companies could communicate with customers and employees no matter where they were. And like-minded individuals who shared a common interest could get together online from all round the world.

Actually, geography is far from dead. Although it is often helpful to think of the internet as a parallel digital universe, or an omnipresent "cloud", its users live in the real world where limitations of geography still apply. And these limitations extend online. Finding information relevant to a

particular place, or the location associated with a specific piece of information, is not always easy. This has caused a surge of innovation, as new technologies have developed to link places on the internet with places in the real world—stitching together the supposedly separate virtual and physical worlds.

The first step in this process was to map the internet's physical infrastructure, and in particular the locations of the end-points on its edges, where users are connected. A number of companies, including Quova (http://www.quova.com/) , Digital Envoy (http://www.digitalenvoy.net/) , NetGeo (http://www.netgeo.com) and InfoSplit (http://www.infosplit.com/) , offer “geolocation services” that enable websites to determine the physical locations of individual users. This is done using a database that links internet protocol (IP) addresses of users' computers to specific countries, cities or even postcodes. Groups of IP addresses are assigned to particular universities, companies or other organisations, which often have known locations; providers of internet access allocate specific IP addresses to customers in particular regions. When you visit a website that uses geolocation technology, your IP address is relayed to the geolocation provider's server. It looks up where you are and passes the information back to the website, which can then modify its content accordingly.

Once your location is known, existing demographic databases, which have been honed over the years to reveal what kinds of people live where, can be brought into play. Targeted advertising is the most obvious application for geolocation, but it has many other uses.

It can help, for example, to determine the right language in which to present a multilingual website. Or e-commerce vendors and auction houses can use geolocation to prevent the sale of goods that are illegal in certain countries. Online casinos can stop users from countries where online gambling has been outlawed from gaining access. Rights-management policies for music or video broadcasts, which tend to be based on geographical markets, can also be enforced. The pharmaceutical and financial-services industries, both of which are subject to strict national regulation, can be confident that, when offering goods and services for sale online, they are staying within the law. So much for the borderless internet and the death of distance.

While the notion of war-chalking has gained much attention, hardly anybody actually does it

Geolocation finds the physical location corresponding to an internet address, but it can also be used to do the reverse: to find the internet-access point nearest to a particular location. The necessity of doing this arises from the growing popularity of 802.11b or Wi-Fi technology, which provides wireless internet access to suitably equipped laptops within 100 metres or so of a small base-station, or “hotspot”. Many of the thousands of hotspots around the world are deliberately made available to

anybody who happens to be passing. Others are run by operators who charge a fee for access in hotels, airports and other places. One operator, T-Mobile, is installing Wi-Fi base-stations in thousands of Starbucks coffee shops in several countries.

But how can you determine if Wi-Fi coverage is available in a particular area—or, if not, the location of the nearest hotspot? A number of websites, such as wifinder.com (http://www.wifinder.com) and 80211hotspots.com (http://www.80211hotspots.com) , have sprung up that act as global directories of Wi-Fi base-stations. Type in a postcode or street address, and you can see where they are. In some cities, Wi-Fi enthusiasts have produced maps showing hotspot locations.

This has been taken to its logical extreme by researchers at the University of Kansas (at www.ittc.ku.edu/wlan (http://www.ittc.ku.edu/wlan)). First, they drive around a particular neighbourhood with a laptop, looking for Wi-Fi coverage and monitoring the signal's strength. Next, this information is combined with aerial photography of the neighbourhood, with colour-coding to show signal strength. The result is a map showing how strongly the internet obtrudes into the real world.

A low-tech approach that achieves the same end is the concept of “war chalking”, a term coined by Matt Jones, a British designer. He has proposed a set of symbols that can be scribbled on the pavement using chalk to signal the presence of a nearby hotspot. Again, the idea is to show where the parallel worlds of reality and the internet touch. While the notion of war-chalking has gained much attention in the media, however, hardly anybody actually does it.

Your nearest web page

Mapping internet infrastructure is just a start. Things get more interesting when you begin to establish links between real places and virtual information. Imagine that you have a huge pile of documents. Keyword searching is one way to find what you are looking for. But for geographical searches—say, finding all the pages relevant to a particular city—keywords are too blunt an instrument.

The ideal solution would be to embed a “geotag” or “geocode” in pages containing geographical content, to make geographical queries possible. A number of methods have been put forward to add such geotags to pages automatically, based on analysis of their content. Last year Google, the leading internet search engine, held a programming competition in which participants were given a chunk

of the Google archive and index to play with. The winner, Dan Egnor, wrote software that added geotags to pages based on the analysis of postcode and address information, so that search results could be returned in order of geographical proximity to a particular point.

Another approach is taken by MetaCarta (http://www.metacarta.com/) , a company based in Vienna, Virginia, and financed by In-Q-Tel, the venture-capital arm of the nearby Central Intelligence Agency. Its “geo-parser” software examines documents and looks for geographical references, including country, city and state names, postcodes, internet addresses, and the names of famous landmarks. These are looked up in a gazetteer, a place-name dictionary with over 10m entries, which knows, for example, that the Statue of Liberty is in New York. The results are then combined using natural-language processing rules derived from a corpus of 50m documents. If the word “Paris” appears near the word “France”, for example, then the document is more likely to be about the Paris in France than the Paris in Texas. Using a combination of many such rules, the system determines the document's corresponding location, and applies a geotag to it. Around 80% of text documents contain geographical references, says MetaCarta's Randy Ridley.

Geotagged documents can be used in a number of ways. One approach is simply to plot a selection of documents on a map. MetaCarta's clients include intelligence agencies, and the potential for such a system in anti-terrorism is obvious. Documents from a computer confiscated from a suspected terrorist can be analysed and plotted on a map, to see where they cluster. The same technology also has applications in local law enforcement, insurance and the oil industry, all of which generate large amounts of place-specific information. And it can be applied to web pages, once they have been geotagged. Type in a search term, and you can then see how the resulting pages are distributed geographically.

A different approach to the generation of geotags is taken by Junyan Ding and Luis Gravano of Columbia University in New York. Their “Geosearch (http://geosearch.cs.columbia.edu/) ” search engine determines the geographical scope of a page by looking at the locations of pages that link to it, as well as its content. The *New York Times*, for example, is a newspaper that covers global issues, and is thus relevant to the whole world; this is reflected in the fact that websites all over the world link to the *New York Times*. Websites relevant to a particular state, city or region, on the other hand, are less likely to have links from pages outside that locality. The researchers specifically

looked at links to target pages from American educational sites—those with internet addresses ending ".edu"—since their location can usually be determined precisely.

However, there is a limit to how far such retrospective geotagging techniques can go, notes Martin Dodge, an analyst of cybergeography at University College London, who is co-author of the "Atlas of Cyberspace". The problem, he points out, is that whereas most countries have some form of postal code, there is no global standard. But the usefulness of a search engine able to classify results by geographical proximity to a specific place is clear. You could use it to find a nearby plumber, or a hotel near a landmark you plan to visit. The best approach would be to have a global standard for geotags, and to get the authors of web pages to include them automatically.

Several such standards have been proposed. The OpenGIS consortium, for example, is made up of 230 companies, including the world's main hardware and software vendors, industrial giants, and specialists in geographical information systems (GIS), all of which are backing a common standard to "geo-enable" the web and wireless devices. The idea is to provide a *lingua franca*, so that geographically tagged data of all kinds, from satellite photos to customer lists, can be easily combined and analysed.

Another initiative is GeoWeb, part of the Digital Earth research project at SRI, a non-profit research institute in Menlo Park, California. Its aim is to make it as easy as possible to find information on the web associated with a specific location, but in a way that can be scaled up indefinitely as more and more information is geotagged. It does this by sitting on top of the internet's domain-name system, a hierarchical look-up arrangement that translates domain names (such as economist.com) into internet addresses (such as 170.224.17.153). Similarly, GeoWeb is a hierarchical look-up system that maps latitude and longitude co-ordinates on to relevant pages that can also be filtered by other criteria. Co-ordinates can be typed into a browser as a special kind of internet address, ending in ".geo". However, SRI's proposal for a special .geo domain has yet to be approved.

Web of neighbours

In the meantime, a number of websites are providing geographically specific look-ups and searches. Geourl.org (http://www.geourl.org) is a website that maps locations on to web addresses, so that websites "near" a particular place can easily be found. So far, it is mainly being used by web-loggers, or "bloggers" (people who maintain diary-style personal websites, or "blogs") to anchor their blogs in the real world, and identify other bloggers nearby. Blogmapper.com

(http://www.blogmapper.com) goes further, providing the tools to create "geoblogs" that are organised by geography, rather than by date.

Upmystreet.com (http://www.upmystreet.com/) is a clever British website which, given a postcode, can tell you about local house prices, crime rates, schools, tradesmen, public transport and government services. Discussion boards were recently added to the site, with a search function that makes it possible to see discussions taking place near a given location. The site even calculates how "far away" each discussion is. The result might be termed "geochat".

Links between web pages and particular locations are central to "geocaching", a high-tech form of orienteering that involves using a global-positioning system (GPS) handset to find a hidden cache of items at a location specified on a web page. The custom is to take one item (a toy dinosaur, say) from the cache and replace it with another, and then return to the web page corresponding to the geocache and leave a message to announce that you have found it. Geocaching.com (http://www.geocaching.com) calls this "the sport where you are the search engine"; you access the internet, and then you find the corresponding physical location. The result is a powerful sense of the internet overlaying the real world; or, conversely, a sense that the world is a three-dimensional aspect of the internet.

An even more dramatic example of digital content that is relevant only in a specific location is geoencryption, an idea championed by Dorothy Denning of Georgetown University in a research paper published in 1996, subtitled "Grounding cyberspace for better security". Geoencryption encodes a stream of data in such a way that it is only intelligible to somebody in a specific location; the output from a GPS device is used to unscramble the data. This idea could be used, for example, to distribute movies in such a way that they can only be unscrambled by people in particular places —in other words, your location is your password. GeoCodex, a start-up based in Arlington, Virginia, is now commercialising this idea. As well as safeguarding entertainment broadcasts, the technology has military applications, says Dr Denning.

The greatest potential for linking the virtual and physical worlds, however, is on mobile devices that can access the corresponding region of cyberspace from anywhere in real space. Using your location as a search term, you can then reach directly from one world to the other. The mobile-telecoms industry calls this "location-based services". So far, the services available in most countries are not particularly exciting. Provided everything works as planned, which is not always the case, you will be able to use a mobile phone to locate the nearest petrol station, cash dispenser or Italian restaurant.

Much of the time, however, the usefulness of such services is limited by the lack of an accurate

positioning system. There are various ways to determine the position of a mobile handset. The crudest is simply to look at which cell of the cellular network it is in. That narrows down the location to within a few hundred metres, at least within cities, where cells are generally quite small. Some improvement is possible by triangulation—determining the handset's distance from base-stations in multiple cells, by measuring the signal's strength. Another approach is to ask the user to enter a postcode or phone number corresponding to his location, but that is clunky.

On the face of it, the ideal solution would be a GPS receiver built into the handset. But GPS reception in cities with tall buildings can be patchy. Hence the hybrid approach being taken by Qualcomm, an American wireless firm, with its “gpsOne” technology, which combines a GPS receiver with ranging information from local base-stations. The result is accurate enough to determine the latitude and longitude of a mobile handset, and even its altitude, to within a few metres.

Where are your friends?

This kind of accuracy changes the game completely. Handsets equipped with gpsOne, over 10m of which are now in use worldwide, in countries including South Korea, Japan and America, can be used to send street maps and detailed directions to pedestrians, taking into account the possibility that they might be on a walkway or a footbridge above a road. According to Tom Wrappe of SnapTrack, Qualcomm's location-based services subsidiary, “friend finder” services are also popular in Japan. Registered users of such services can specify “geo-fencing” limits and be alerted when somebody they know comes into range.

Handsets also allow users to “geomark” a location, and then send details to other people, who can then use their handsets' positioning capabilities to go to exactly the spot. This has social uses (such as marking a picnic place or a meeting place at a music festival), but it may also be used in business. A manager on, say, a construction site can send a message to indicate where a consignment of building materials ought to be delivered. Built-in digital cameras are also becoming increasingly common in Japanese and Korean handsets, and they can send geomarked photographs, too. There are also some rather more culturally specific functions: one Japanese service enables users to locate haunted places; another sends sarcastic messages if you stay too late in the office on Friday evening.

A mobile device linking the real and virtual worlds could change your perception of your surroundings

Unlike internet-based systems, however, wireless networks are tightly controlled by their operators, so there is much less scope for bottom-up innovation by users. The internet is an open platform, but it lacks ubiquitous wireless coverage and proper positioning technology. Only when openness, ubiquity and GPS-grade positioning are available in the same handset will it be possible to realise the true potential of location-based services. This may happen fairly soon, as Java-enabled handsets proliferate, and other internet technologies cross over from computers to phones. In the meantime, a few examples show the kind of things that might be possible.

Many interesting possibilities are opened up by "user-generated location-specific content"—a fancy phrase for digital wireless graffiti. An early example of this, says John Cunningham of SnapTrack, is a Japanese restaurant-review service that allows reviews contributed by previous customers to be called up by somebody outside the restaurant who is wondering whether to eat there. In effect, previous customers leave their comments floating in the air around the restaurant, where they can be read by anybody with the right handset.

This concept has been generalised by a number of wireless-software firms into the idea of digital graffiti—messages that can be posted using a handset, and which correspond to a particular location. Generally, there are two kinds of graffiti supported by such systems: public (which can be read by anybody) and private (which can be read only by associates of the person who posted the message). Just because this kind of thing is technologically possible, however, does not mean that anybody is actually doing it yet. There are also versions of this idea that work within Wi-Fi hotspots, such as the GeoNotes system devised by Per Persson of the Swedish Institute of Computer Science. But Wi-Fi is best suited to laptops: it uses up too much power for use in handheld computers or mobile phones—and laptops are hardly ideal things to lug around the streets.

Ultimately, the logical conclusion of wireless graffiti systems would be the ability to attach information to any object or place on earth with an accuracy of a metre or less. This has been dubbed the "WorldBoard" by Jim Spohrer, a researcher at IBM's Almaden Research Centre in San Jose, California. He had the idea while hiking, when he saw an unusual sort of plant, and wished he could look it up on the internet; he then realised that other passers-by might also want to know the same thing, and wished he could somehow stick the information on to the plant, like a virtual Post-It note. "A WorldBoard is in some sense bigger than the world wide web," he says, "because it allows cyberspace (the digital world of bits) to overlay and register with real space (the physical world of atoms)."

As well as making it possible to scribble virtually anywhere, linking the real and virtual worlds through mobile devices could also change users' perception of their surroundings, says Jason Devitt

of Vindigo (http://www.vindigo.com) , a company based in New York that provides location-based services on both handheld computers and mobile phones. “You should be able to stand on a street corner and find out everything that's going on around you,” he says. “In the grandest sense, I think these devices are capable of extending your senses.” Instead of just looking along the street at what is visible, he suggests, “it should be possible to know and see everything that people make available to you.”

Several applications spring to mind. While wandering through an attractive neighbourhood, you might ask your mobile device about apartments for rent nearby, the crime rate, local amenities, and so on. After all, websites such as Upmystreet.com have put together most of this information already. This kind of thing, says Mr Devitt, “could change the way people relate to each other and their environment.” If people start using mobile devices to find shops or restaurants, then prime real-estate on the high street would no longer be so valuable. Having an eye-catching sign might matter less than being listed in the right wireless databases and yellow-pages services.

The potential for mobile devices to transform the urban environment is of particular interest to Anthony Townsend, an urban planner at the Taub Urban Research Centre at New York University. Good location-based services, he believes, will be integrated with architecture and urban design. However, the technologies to determine location, extract relevant information and deliver it via a wireless connection are only just starting to come together, and so far in rather primitive ways. Mr Townsend draws an unfavourable comparison with the early days of the web.

Even so, devising a website “was a relatively easy design challenge compared with this.” And whereas web designers could build on established metaphors of human-computer interaction (HCI) —windows, icons, and so on—designers of location-based services face a more complex challenge. The HCI people are good at the human-machine interface, he points out, and the architects at the human-environment interface. “But nobody is good at human-machine-environment interfaces.” The best examples at the moment are in-car navigation systems, he notes, and they have taken 20 years to develop.

Undaunted, Mr Townsend is acting as an adviser, together with a group of academics from the Massachusetts Institute of Technology, to a South Korean project to build a “digital media city” on the outskirts of Seoul. South Korea is one of the world's most advanced countries when it comes to mobile phones, and the world leader in broadband adoption. An important aspect of the project is to try to imagine what kind of location-based services (and other wireless services) will be appropriate in a high-tech city 20 years from now. “It has given me an appreciation for how slowly this is going to unfold, and how slowly killer applications will evolve,” says Mr Townsend.

It is thus early days for technologies that link the physical and virtual worlds. Location-finding technology must become more ubiquitous, and common standards are needed, if the "real-world" internet is not to fragment into multiple separate overlays on reality. What is striking, however, is that, even in the absence of mature technologies or standards, an enormous amount of innovation, experimentation and reinvention is going on—exactly the opposite of what you would expect to be happening if the internet was really just a placeless cloud. Geography matters online after all; it has certainly not been killed by the internet. In fact, the two seem to be getting along rather well.

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