Trends in Internet and Ubiquitous Cartography

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The widespread distribution of maps through the Internet is a direct result of the introduction of the World Wide Web in the early 1990s. The mobile Web, enabled through cell phones, is now creating an even more ubiquitous map form. These methods of map distribution facilitate greater access to spatial information, increased levels of interactivity with maps, real-time locational information, and greater integration of multimedia content through pictures, sound, and video. While normally not networked, GPS navigation devices have also changed the map-use landscape. Examined here are the current trends in online- and cell-phone-delivered maps.

INTRODUCTION

A remarkable transition has taken place in cartography since the introduction of the Mosaic World Wide Web browser in 1993. No longer tied to paper, millions of maps are now distributed through computer networks. These maps appear almost instantly on computer monitors or on the tiny screens of cell phones. In some cases, the spatial information is no longer disseminated in graphic form but as computer-generated verbal instructions. Site-specific delivery of spatial information has fostered a new area of development called location-based services (LBS).

The growth of LBS has been particularly dramatic in recent years with the introduction of new devices, such as Apple's iPhone, that incorporate positioning by GPS and cell phone tower triangulation. It is estimated that 43 million people worldwide used location-based services on cell phones in 2008, almost triple the number from 2007. It is projected that the LBS market will mushroom from $1.3 billion in 2008 to $8.1 billion by 2011 (Nakashima 2008).

"The availability of user-defined maps anywhere at anytime has fostered the new concept of a "ubiquitous cartography"."

The availability of user-defined maps anywhere at anytime has fostered the new concept of a "ubiquitous cartography." The Commission on Ubiquitous Mapping of the International Cartographic Association sees this form of cartography as an extension of ubiquitous computing, which presupposes a society in which individuals carry small, networked computers that may be augmented by local transmitters, such as radio-frequency identification (RFID), that will communicate site specific information. The new "wireless Internet" or "mobile Web" is driving most of the growth in Internet mapping. The focus here is on developments within North America of both wired and wireless Internet mapping. We begin with Internet use in general.

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GROWTH IN INTERNET USE

As of 2008, approximately 21 percent of people in the World are users of the Internet on a regular basis. The percentage for the US is 71 percent (Internet World Stats 2008). The majority of new users to the Internet are through mobile devices – not "wired" users from traditional laptops or desktops. As a result, most of the growth in Internet usage is coming from the mobile Web.

Home broadband connection to the Internet has hit a plateau. Currently, about 22 percent of the US population is connected to the Internet at home through broadband, either through a cable modem or DSL. Home broadband connection rates are higher in most of the countries of Europe, as well as the Bahamas, Canada, South Korea and Hong Kong (Internet World Stats 2008). Rates in some of these countries reach into the mid-30s.

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Another way to examine the growth of the Internet within a country is to look at options for free wireless connection (wi-fi). Free wi-fi varies by geography and institution. Wireless access at libraries is now common in the US. In a strange twist, most lower-end hotels in the US now offer free wireless while more expensive hotels still charge for use. Independent coffee shops also offer free access while major chains do not. Smaller airports have free access while larger airports charge for access. Notable exceptions include Las Vegas, Denver, Kansas City and Pittsburgh. To help pay for the service at these airports, customers are shown ads before they are able to log-on, or ads are shown on the side during the entire session (Stellin 2008). The Denver airport reported a sharp increase in Internet usage after it implemented free service. The company, FreeFi Networks, reports that the Denver airport has become the world's largest free Wi-Fi airport and is exceeding the revenue of the previous paid Wi-Fi service (Business Wire 2008).

INTERNET MAP USE

With the increased use of GPS navigation devices and the mobile Web, one might expect that online mapping sites would begin to show a decline in use (Mindlin 2008). This does not seem to be the case. The distribution of maps through the Internet is still increasing. The year 2007 saw a 10 percent overall rise in the four major online mapping sites, although some of this traffic is coming from Web-enabled mobile devices such as Apple's iPhone that is closely tied to Google Maps.

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Online Street Mapping

While there are many aspects to Internet map use, most attention is directed toward the intense competition between the four major online mapping sites: MapQuest, Google Map, Yahoo Maps, and MSN Live Search. MapQuest, the leading online street map provider since 1996, still dominates with over 50 percent of all online map requests (see Figure 1). Yahoo Maps began 2007 in second place with about 20 percent but dropped to 13 percent by the end of the year. Google Maps saw a sharp increase during the year at the expense of both MapQuest and Yahoo Maps. Google Maps started the year at about 10 percent and increased to over 22 percent of all online street map requests. Use of MSN Live Search remained flat at only 4 percent (Hopkins 2008).

Use of MapQuest seems to have hit a plateau in mid-2007 and is now declining. The dominance of the Google search engine seems to be affecting MapQuest use. In a change that occurred in March 2007, Google now

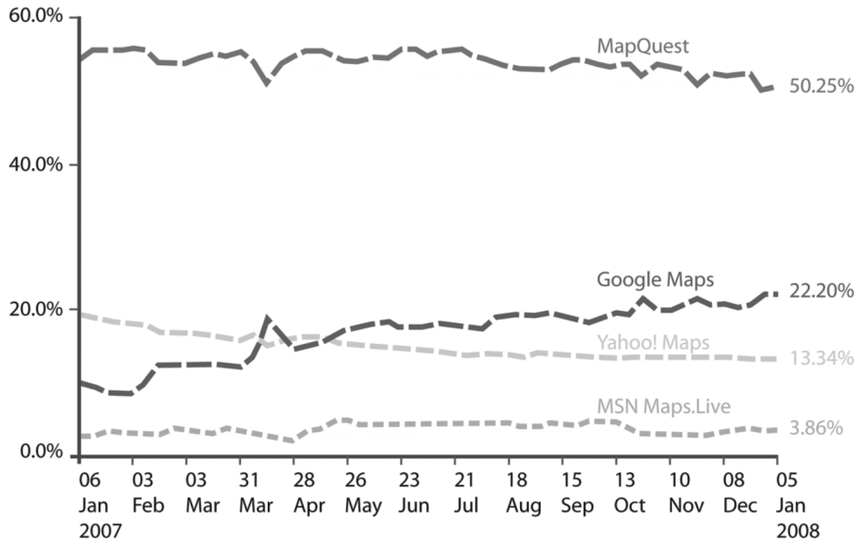

Figure 1. Visits to the four major online mapping sites – MapQuest, Google Maps, Yahoo Maps, and MSN Maps.live – during 2007. Use of Google Maps is increasing at the expense of MapQuest and Yahoo Maps. http://Weblogs.hitwise.com/us-heather-hopkins/2008/01/google_maps_making inroads_aga.html. (see page 79 for color version)

sends more users to its own mapping site than to MapQuest (Hopkins 2008). Even with this decline, searches that include MapQuest outnumber Google Maps by a factor of 10.

"Another important aspect of these mapping sites is how many requests for maps are based on paid listings, the only way for these sites to generate income."

Another important aspect of these mapping sites is how many requests for maps are based on paid listings, the only way for these sites to generate income. About 19 percent of map requests for Google Maps are based on sponsored links. Sponsored links to MapQuest account for only 10 percent of the total. This means that Google has the potential to generate more income than MapQuest through its online maps.

While MapQuest dominates online mapping with nearly half of all maps produced (Hopkins 2008), many wonder why MapQuest has not lost more ground to Google. The answer may be in the brand name. MapQuest has been around much longer and the name is firmly engrained in people's minds. When most people in the US think about acquiring an online map, they think about MapQuest.

Integration with GPS-enabled devices

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A cross-over development between online mapping and mobile mapping are services that download map searches to a GPS device. A Google Map search can be downloaded to a Garmin or TomTom device, as shown in Figure 2. The results of a MapQuest search can be sent to OnStar (a subscription service provided for some General Motors cars) or a cell phone, as shown in Figure 3.

Open Source Maps

The OpenStreetMap (OSM) project seeks to create a road map of the world that anyone can use without having to pay license fees to cartography firms or government agencies. Essentially a wiki (a Web site whose contents are editable by its viewers) for mapping, the site relies on thousands of amateur mappers and their GPS devices. Coordinates are recorded by

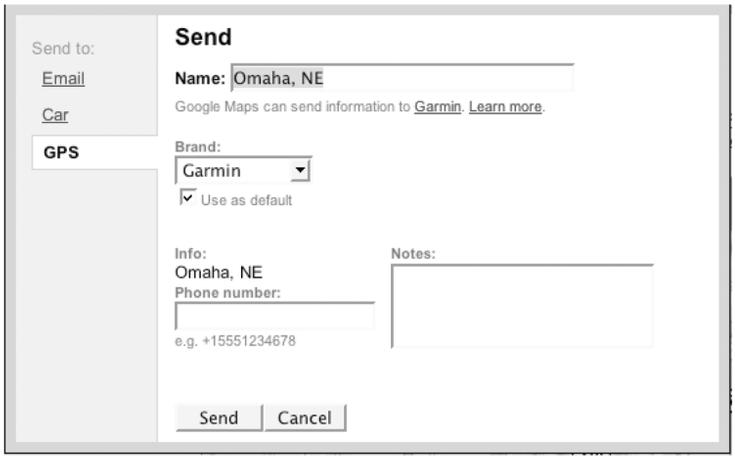

Figure 2. Google Map option to send the results of an online map search to a GPS device. (see page 79 for color version)

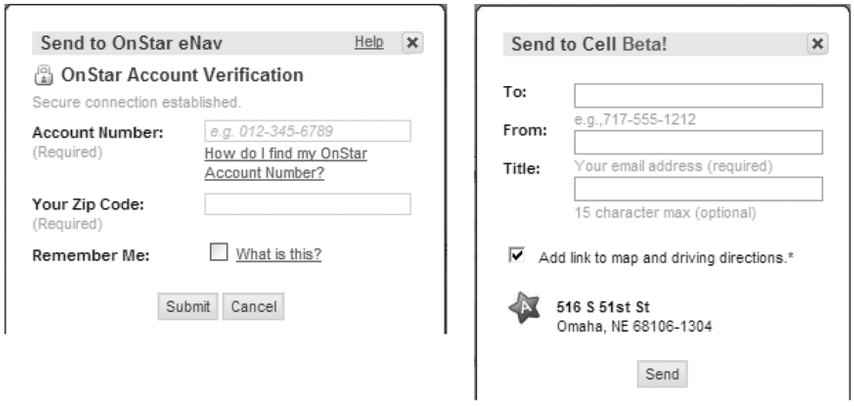

Figure 3. MapQuest output options include OnStar, a service of General Motors, and a cell phone. (see page 80 for color version)

the devices, either through driving, cycling or walking, and then uploaded to the central OSM Web site.

The project is especially useful in those countries that limit the distribution of spatial data. In contrast to commercial mapping sites, OSM also allows users to add and update map content. Another example of the social networking aspect of the new Web 2.0, the project attempts to democratize the Web by keeping map users involved in the map input and map update processes.

The project has proven especially useful in some countries. The OSM map of Baghdad, made by users tracing streets on air photos, is the most accurate map available online of the Iraqi capital (Rocha 2007). Most developed countries have contributed their maps to the project. Other countries, however, are barely represented on the site.

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Map sharing on commercial sites

In a partial response to the open source movement in online mapping, MapQuest has announced it will let users correct its maps if they see a mistake (Rocha 2007). This has yet to be implemented as of mid-2008.

A five-year agreement signed June 30, 2008 between Dutch mapmaker Tele Atlas and Google will direct user updates from the Google Map site back to Tele Atlas, the provider of map data to Google. To this point, Google has simply used Tele Atlas data. With this agreement, Google users will be able to update the Tele Atlas database with new or updated information (Zeman 2008).

"After signing-on with a Google account, users can draw, label, describe and moderate map content, including borders, regions, roads, railways, waterways, and points of interest."

Google's Map Maker, written by Google programmers in India, was introduced in June 2008. It allows users to "contribute, share, and edit map information for certain regions around the world" (Google 2008). After signing-on with a Google account, users can draw, label, describe and moderate map content, including borders, regions, roads, railways, waterways, and points of interest. Becoming a "citizen cartographer," in the eyes of Google, will help improve the quality of maps and local information–and everyone is invited to join. Initially, the product is only available in specific countries as shown in Figure 4.

Working with Google Map Maker is relatively simple. To investigate the editing and moderation processes, the Star Cinema movie theater was arbitrarily added on the outskirts of Multan, Pakistan (see Figure 5). The location was chosen randomly. A few days later, an unknown moderator accepted the change. The fictitious site can be found in Google Map Maker by searching "Star Cinema, Multan, Pakistan."

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Any sort of online map update will be problematic. If users can add new roads, they will also presumably be able to modify existing roads–perhaps even delete them. Experience from Wikipedia has shown that accuracy is based on the size of the user-community. For any topic in Wikipedia, there may be millions of people who look at the page, and many thousands that will take the time to fix any errors. With maps, the user-community will be those people who have a vested interest in a particular area. Aside from densely populated parts of the world, the user-community for any one spot will be relatively small. This means that changes can be made and few will care. It is possible that users would be able to alert a company like Tele Atlas of an error, and then air photos could be used to verify the change. But, the number of such errors reported would likely exceed the ability of Tele Atlas to respond to each.

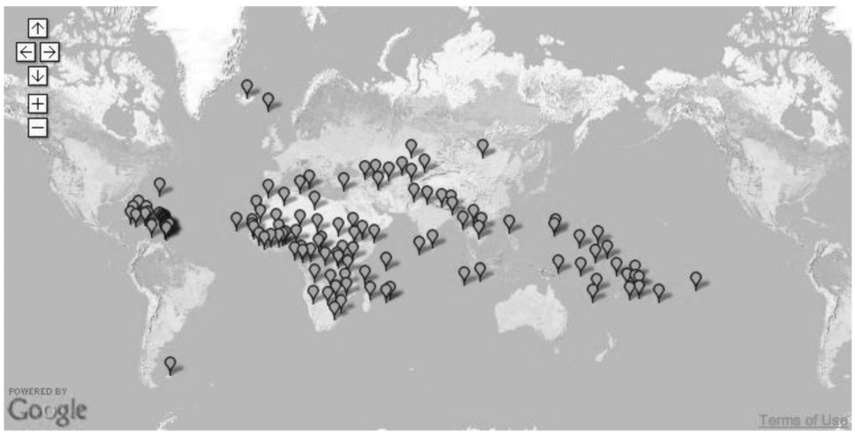

Figure 4. Countries served by Google Map Maker are mostly in the Caribbean, Africa, Asia, and the Pacific. (see page 80 for color version)

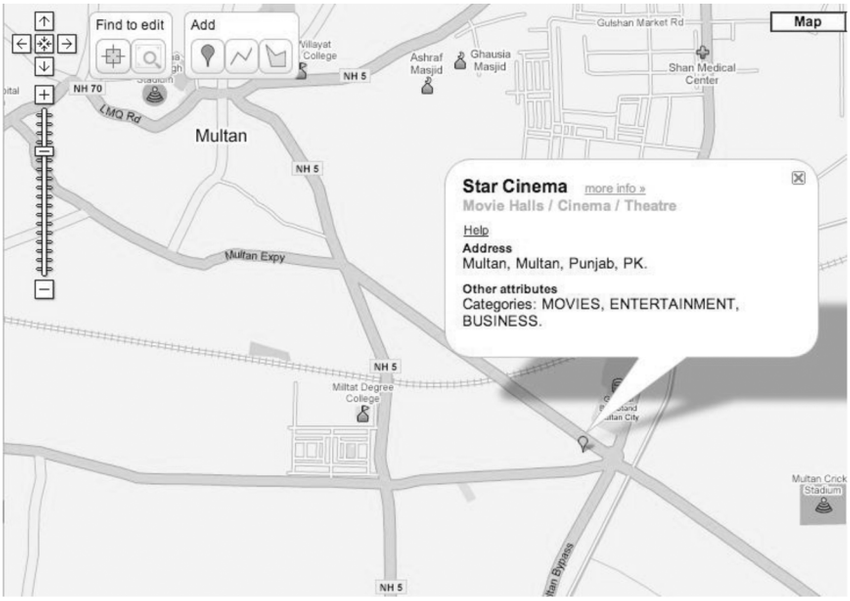

Figure 5. The Star Cinema movie theater was added to a Google Map Maker map of Multan, Pakistan. There is no movie theater at this location. (see page 81 for color version)

Rooftop advertising

Another approach to manipulating the underlying online map database is through the satellite imagery and aerial photography that is associated with online maps. Signs have started to appear on rooftops to take advantage of the free form of advertising, and businesses are now making sure that people can find where they are (Wilson 2008). Many of these messages are near airports and were originally designed to be visible from airplanes. Now, the signs are showing up everywhere, and companies specialize in making them. The term "Spamming Google Maps" has been used to refer to the new phenomena. Calls for more frequent updates to the imagery are also an indication that problems with online imagery are noticed by the public.

Google Map Search Trends

One way of assessing online map trends is to examine changes in what is being searched through Google, the major search engine that accounts for nearly 70 percent of all Internet searches. For example, searches for the word "map" has declined steadily since 2005 (see Figure 6). This may indicate that people are no longer searching for static maps but are increasingly using interactive services. This is verified by similar declines in searches for terms like "Africa Map" and "Europe Map" (see Figure 7).

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MOBILE PHONE USE

The first mobile phone network was started in Sweden and Norway in 1981. As of November 2007, worldwide mobile telephone subscriptions surpassed 50 percent of the world's population with 3.3 billion users (Virki 2008). Of these, approximately 2.6 billion are using GSM (Global System for Mobile communications). The number of users has expanded rapidly in the more rural areas of China and India as the price of cell phone ownership has fallen (Virki 2007).

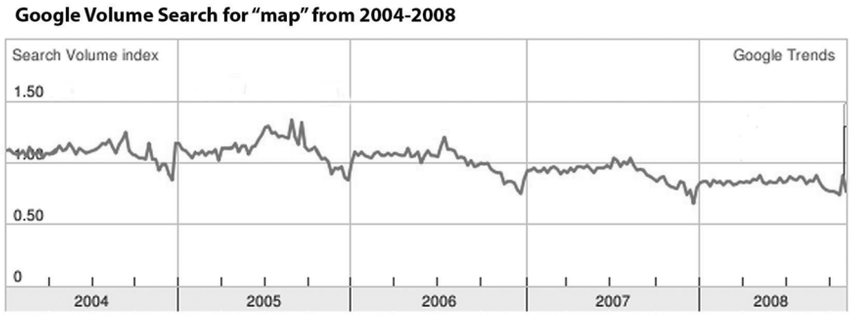

Figure 6. The Google search trend for the word "map" from 2004 to mid-2008. Google Trends scales the term entered so that its average search volume is 1.00 in the chosen time period. In this example for the word "map", 1.00 is the average search volume of "map" from 2004 to present. We can see a high point in 2005 with the line over 1.30, indicating that search traffic in 2004 is approximately 1.3 times the average for all years showing a general decline in the search for the word "map". Increased use of interactive mapping sites seems to be leading to a decline in the search for static maps. (see page 81 for color version)

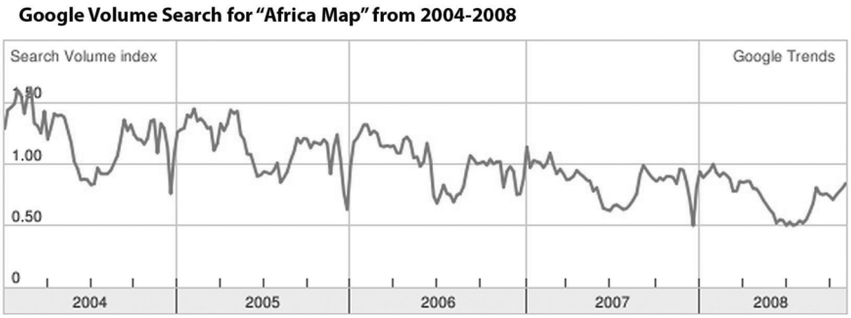

Figure 7. Google search trends for "Africa map" and "Europe map" also shows a similar decline since 2004. The search for "Europe Map" also shows a cyclical cycle with a low point before the end of each year, a reflection perhaps of school and holiday schedules. (see page 82 for color version)

Four major cell phone providers dominate wireless communications in the United States. As of mid-2008, these are AT&T (formerly Cingular Wireless) with 63 million customers, Verizon Wireless with 60.7 million, Sprint Nextel with 53.6 million, and T-Mobile with 26 million. The total for these four companies is 203.3 million, about two-thirds of the US population.

Mobile phone navigators

Navigation devices are mainly dependent on a GPS receiver although it is possible to determine the general position of a mobile phone by triangulating from nearby cell towers or wi-fi hot spots. Most cell phones lack spatial locator abilities. Of the over 3.3 billion cell phones in use, only 175 million have GPS (Bray 2008). While the US Federal Communications Agency has a mostly maintained a *laissez-faire* relationship to cell phone industry, it did mandate automatic location identification (ALI) on cell phones to make sure that emergency workers could find cell phone callers. Wireless carriers were required to have 95 percent ALI-capable handsets among their subscriber bases by Dec. 31, 2005. Sprint/Nextel, Alltell, and U.S. Cellular are facing federally-imposed fines for failing to meet this requirement. The ALI requirement is the main impetus for the growth of GPS-enabled cell phones, at least in the US (GPS World 2007).

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At first, GPS-enabled cell phones would only activate with a call to the police. There was no way for the consumer to use the GPS capability. This has changed and most mobile phone companies in the US now offer some type of navigation service based on GPS-enabled devices. For example, Verizon's VZ NAVIGATOR, a $10 a month service begun in November of 2005, through startup Networks in Motion, displays a small map and provides spoken directions through a natural sounding human voice (Bray 2008). The timing of the directions is sufficiently accurate so drivers can use it as a turn-by-turn navigator. The service quickly recalculates a route if you go off-track (Wilstrom 2007). The current location of the user is determined through a combination of embedded GPS and cell phone tower triangulation. The service also shows you the location of the nearest bank, hotel, or movie theater–and provides the appropriate phone number. It lacks a pedestrian mode so that it may lead you on a way that is best for cars but not best for walking. This is particularly a problem in cities with one-way streets.

Version 4 of VZ NAVIGATOR was released allowing customers in 75 US cities to access information about traffic incidents on major roadways, obtain traffic updates and find detours around traffic congestion and accidents. The new version of the VZ Navigator location-based service (LBS) application offers a 3D perspective view of maps, a movie and events finder, weather reports and forecasts and gas prices at nearby gas stations. The traffic tracking center monitors conditions continually along the user's routes, providing proactive alerts on conditions ahead and offering detour options, while maps are displayed to enhance use (Verizonwireless.com).

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Networks in Motion also offers a service through the American Automobile Association (AAA) for Verizon, Sprint and Alltel phones. Essentially the same as VZ Navigator, the AAA version can guide you to businesses that offer discounts to AAA members. It also integrates with AAA roadside assistance if your car breaks down (Bray 2008).

Ulocate (uLocate) Communications has developed over 70 applications for phone-based GPS. One is called GasBuddy that directs you from your current location to the nearest gas station with the lowest price. Other so-called "widgets" list local entertainments events, an airport finder, a flight-time updater (Yu 2008). The ShopLocal widget shows currently available products and where to buy them in the local area. Other widgets are more esoteric. One shows the opposite side of the earth from where you are currently located (Bray 2008).

The market research firm, Metrics, reported that 30 million dedicated navigation devices were sold last year, outpacing navigation-enabled

mobile-phone sales by 50 percent (RCR Wireless). About 10 million GPS devices were sold in North America in 2007, vs. 2.5 million in 2006, and the industry expected sales of 20 million during 2008 (Yu 2008).

They expect, however, that in the coming years, "navigation-enabled mobile phones will be used for auto navigation, pedestrian navigation and many other types of location-based services" (RCR Wireless). This shift poses a major threat to companies like Garmin and TomTom that currently dominate the market for standalone devices. This helps explain why Navteq, a provider of digital mapping databases and on the verge of being acquired by TomTom for $4.25 billion, was instead acquired by telecommunications giant Nokia for $8.1 billion in mid-2008 (RCR Wireless).

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The Mobile Web

Many cell phones have the capability of accessing the World Wide Web. In terms of Web usage, a study by Nielsen/Netratings has shown that there are 40 million mobile subscribers to the Internet in 2008, roughly 15 percent of the active mobile user population (Knight 2008). The UK at 14 percent and Italy at 11 percent were close competitors. Nielsen views this as critical mass and a sign that the mobile Web is about to take-off as a new form of information delivery in the US.

The Nielsen report also states that about 14 percent of mobile Web users access the Internet through an unlimited access plan. These access plans seem to be associated with areas that have Third-Generation (3G) service. This would mean that 86 percnet of users access the mobile Web on a pay-by-usage system which tends to limit use (Knight 2008). The unlimited plans can be very expensive. The cheapest AT&T monthly plan for the iPhone is $70, $40 for voice and $30 for data. The plan includes 450 minutes of call time and unlimited use of the mobile Web. Unlimited plans from Verizon cost between $99 to $139. The plan includes unlimited domestic roaming, unlimited Internet access, unlimited messaging, V Cast Video, VZ Navigator and e-mail.

Mobile Web usage is very similar to the normal use of the Word Wide Web. The leading destinations for mobile Web users are Yahoo Mail (14 million users), Google Search (9 million users) and Weather Channel (8.6 million users) (Knight 2008).

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3G Network

The main complaint about the mobile Internet is the speed of access. Third Generation (3G) is a faster mobile communication network that can have speeds comparable to a cable Internet connection. Data communications speeds are up to 14.4Mbit/s on the downlink and 5.8Mbit/s on the uplink. This network was available in Japan by 2001 and South Korea in 2002. The largest 3G network in the US is based on the slower Code Division Multiple Access (CDMA) standard implemented by Verizon. CDMA has a speed comparable to a dial-up connection. Figure 8 depicts the 3G network coverage in the US for AT&T, widely regarded as having the fastest 3G service. As of 2008, about 28 percent of cell phones in the US are 3G-capable. In Europe, about 25 percent of cell phones can use 3G (Knight 2008).

iPhone

Introduced in 2007, Apple's iPhone has had a major influence on the number of people that access the mobile Web. The well-thought out interface

Figure 8. AT&T G3 coverage areas correspond with the larger cities. Many states are without coverage. (Source: http://www.wireless.att.com/coverageviewer/) (see page 82 for color version)

made it much easier to use the Internet through a mobile device. Within a year, 6 million iPhones were in use and 10 million of the devices were expected to be sold during 2008 (Kellner 2008). Initially priced at $599 and $499 for the 8GB and 4GB models, the 3G iPhone model introduced in mid-2008 was reduced to only $200. AT&T, the exclusive provider, subsidizes Apple by $350 per device and re-coups this cost through monthly fees.

"The iPhone opened the mobile Web for millions of users."

The iPhone opened the mobile Web for millions of users. More than 80 percent of iPhone owners use the mobile Internet, in contrast to only 32 percent for other "smart phone" users. ComScore M:Metrics, has found that even on slower mobile networks, the iPhone has increased mobile Internet consumption by a factor of 13 times in the category of social networking. E-mail is another popular feature, with nearly 70 percent of iPhone users sending and receiving e-mail with the device, compared to just 26 percent among other smartphones users and 7.6 percent of the cell phone market overall (MediaMetrix 2008).

Internet in cars

Another aspect of the mobile Web is providing access to the Internet within cars. UConnect and Chrysler have announced that they will bring Internet connectivity to Chrysler cars in 2009. The wireless router and cell-based Web connection will work with wi-fi enabled computers (computers not needing an Ethernet cable for networking purposes), the iPhone, and other portable devices. The option will add approximately $500 to the price of the vehicle plus a $29 monthly subscription fee (Woodyard 2008).

MAPS AND CELL PHONES

"Maps on cell phones have been limited by extremely small screen sizes–a 160x120 pixel display is typical."

Maps on cell phones have been limited by extremely small screen sizes–a 160x120 pixel display is typical. But, the small display does not seem to deter map users. By 2006 it was reported that MapQuest was among the top mobile Web destinations for U.S. subscribers drawing more than 3 million visitors in June of that year. At that time, MapQuest had more visitors than CNN, AOL, and weather and search offerings from Yahoo (Gibbs 2006).

The iPhone, introduced in 2007, has one of the largest current mobile phone displays but is still only 480 x 320 pixels, although it has a very high-resolution screen at 163 points per inch. Most desktops and laptops are around 100 points per inch but depict a much higher number of pixels. Figure 9 shows the screen resolution for all browsers accessing the Uni-

	Screen Resolution	Visits
1.	1024x768	39.77%
2.	1280x800	21.05%
3.	1280x1024	15.20%
4.	1440x900	9.36%
5.	800x600	3.51%
6.	1680x1050	2.34%
7.	1920x1200	2.34%
8.	1280x768	1.75%
9.	1400x1050	1.17%
10.	1600x1200	1.17%
11.	1152x720	0.58%
12.	1152x864	0.58%
13.	1344x840	0.58%
14.	1366x768	0.58%

Figure 9. Screen resolutions for browsers accessing the University of Nebraska at Omaha Cartography and Geographic Information Systems Laboratory server for mid-July 2008. (see page 83 for color version)

versity of Nebraska at Omaha Cartography and Geographic Information Systems Laboratory for mid-July 2008. Nearly 40 percent use a screen resolution of 1024x768. Another 20 percent have a widescreen resolution of 1280x800. Just over 15 percent have a screen resolution of 1280x1024. These screen dimensions are typical of current computer users.

Google Maps for cell phones

Google Maps, introduced in 2005, was a late entry into online mapping but the company has been very successful at transitioning its maps to mobile phones. Google Maps for Mobile 2.0 was released in November of 2007. It introduced a "my location" feature that utilizes the GPS location of the mobile device, if it is available. This information is augmented by software determining the nearest cell phone towers. The software then looks up the location of the tower from a database. The software plots a blue circle around the estimated range of the cell site based on the transmitter's rated power, among other variables (see Figure 10). The estimate is refined by triangulating the cell phone signal strength of surrounding towers.

iPhone maps

From the beginning, Google Maps was closely integrated with Apple's iPhone. Maps can be easily displayed and zoomed-in or out by touching the screen with two-finger control called MultiTouch. The 3G model incorporates both wi-fi and cell phone triangulation in addition to GPS, and displays the current position of the user with varying degrees of blue to indicate accuracy of the position.

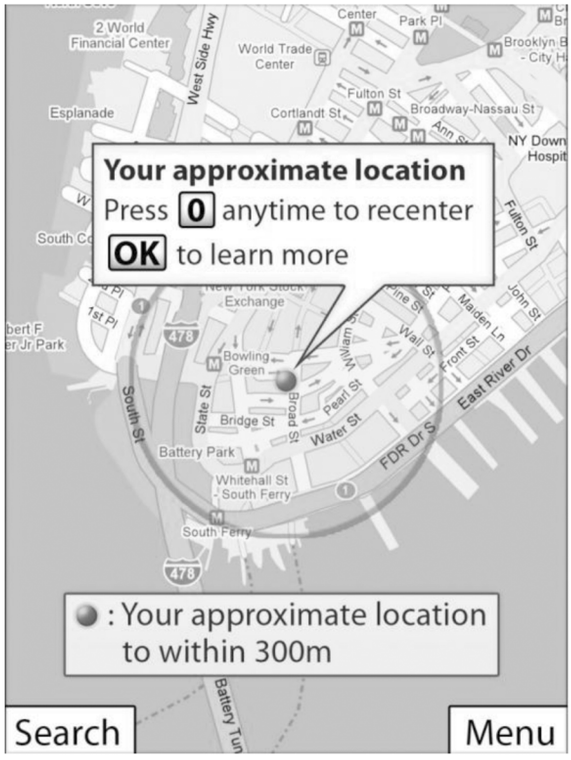

Figure 10. Google Maps for Mobile showing current estimated position based on surrounding cell phone towers. (see page 83 for color version)

A variety of spatially-aware applications have been developed for the iPhone 3G that are available for download through Apple's iPhone App-Store. In one called Loopt, the current location of friends can be placed on a map. A message can even be broadcast by a user that is displayed on the map as a virtual sign. The technology could also be used to locate a child with a cell phone.

Pelago's Whrrl shows users "cool places" that friends have visited and recommended. The application can filter recommendations by user. A user can look for a bar and browse to see if any friend has recommended it (Yu 2008). Spatially-aware advertisements are also a possibility. A coupon could be delivered to entice a potential customer to a nearby store, restaurant or movie theater.

Other spatially-enabled applications include Wikitude that can provide a Wikipedia description of nearby points of interest. SynchroSpot can automatically bring up a shopping list as you walk into a supermarket. Traffic alerts and updated weather conditions are the most popular real-time tools for travelers (Yu 2008). Google Maps also recently launched a feature that provides public transportation options to your destination.

"The term locational privacy is used to refer to the concept that a person's location should not be made available without consent."

Locational Privacy

The sensitive issue of who can track whom via GPS devices–and for what purposes–is still being worked out (Yu 2008). The International Association for the Wireless Telecommunications Industry (CTIA) has issued guidelines for location-based services that stress consumer notice and consent, and data security. The main problem is that there is no oversight on whether these guidelines are being followed. Technically, if your cell phone is on, someone can find you.

The term locational privacy is used to refer to the concept that a person's location should not be made available without consent. There seems to be generational element to this concern. It has been noted that younger people are less-concerned about being tracked while the older generation sees this as an invasion of privacy.

Methods of tracking are not limited to cell phones. Using an EZ-Pass system for tolls on highways means that someone can find out where you are driving, and when. There is also a concern that automated methods to track road usage will be a threat to our locational privacy. Some proposed systems require a GPS transmitter in every car to assess charges based on the car's recorded path (Blumberg & Chase 2005).

"The expansion of the mobile Web means that people will have access to all Internet maps via small mobile devices."

CONCLUSION

The world of maps is clearly changing. The Internet has certainly expanded the distribution of maps, whether to computers or cell phones. The expansion of the mobile Web means that people will have access to all Internet maps via small mobile devices.

When it comes to navigation, spatial information is often conveyed to the user without the use of a map. The user simply follows the directions of a friendly computer-generated voice as it guides the user from place-to-place. While a map is often displayed, the user has little time to examine it. The danger, of course, is that people will not create a mental map of their surroundings, thus always having a sense of being lost. This does not seem to be a major concern for most people and they seem to eventually develop a mental map by navigating through an area multiple times.

The coming years will likely see a continued expansion of the mobile Internet. New types of user input – including voice and gestures – will

be introduced and will cross-over to laptop and desktop devices. For example, Apple's MultiTouch system developed for the iPhone and iPod touch screen has migrated to Apple's laptop touchpad. Other innovative methods of user input for mobile devices will certainly be developed. The way we use maps and computers in the future may well be based on how we use mobile devices.

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