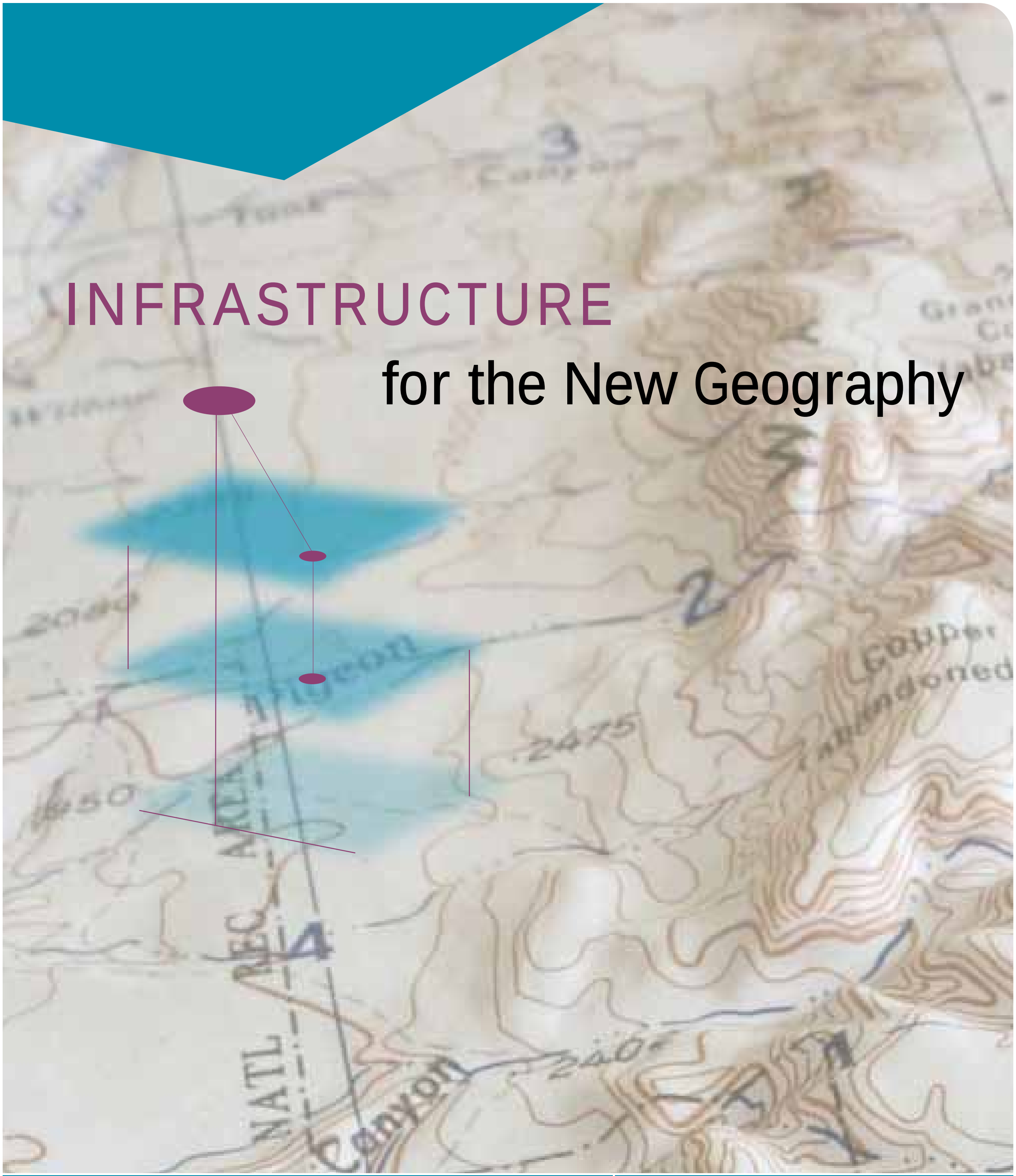
INFRASTRUCTURE
for the New Geography



Institute for the Future

2744 Sand Hill Road
Menlo Park, CA 94025
650.854.6322 | www.iftf.org

Institute for the Future
Technology Horizons Program
August 2004 | SR-869

INFRASTRUCTURE
for the New Geography

Institute for the Future

Technology Horizons Program

August 2004

SR-869

Institute for the Future

650.854.6322 | www.iftf.org

About the …

Technology Horizons Program

The Technology Horizons Program provides a comprehensive forecast that looks beyond any single technology to analyze what happens at the intersections of biotech, information technology, material science, and energy. We identify and evaluate discontinuities that are likely to have major impacts on businesses over the next three to ten years.

Institute for the Future

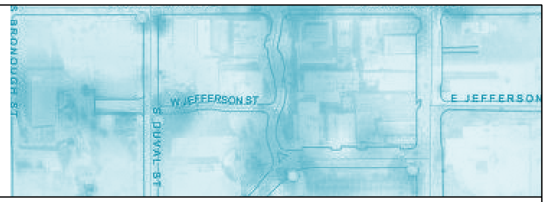
The Institute for the Future is an independent, non-profit strategic research group with 35 years of forecasting experience. The foundation of our business is identifying emerging trends and discontinuities that will transform the global marketplace and providing our members with insights into business strategy, design processes, and new business development. Our research generates the foresight needed to create insights about the future business environment that will lead to action. The results are customized winning strategies and successful new businesses. Our primary research areas are consumers, technology, health and health care, and the workplace. The Institute for the Future is based in Menlo Park, California.

Acknowledgments

Authors:	Michael Liebhold
Peer Reviewers:	Marina Gorbis and Kathi Vian
Editor:	Maureen Davis
Art Direction:	Jean Hagan
Production and Graphic Design:	Robin Bogott

Contents

Introduction: The Evolution of Deep Place



A new physical–digital landscape is emerging, linking places and spaces to unprecedented amounts of information. The infrastructure that will enable this new landscape is actually a rich ecology, including technologies, policies, data repositories, and skill sets. This memo describes the emerging ecology—what it is, why it's important, who the key players are, and what future developments to expect. With this analysis, we hope to lay the foundation for a broader forecast of future business opportunities and dilemmas in "deep place."[1]

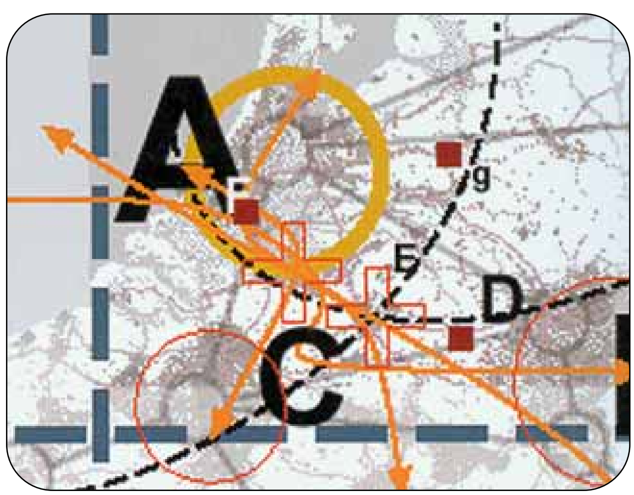
[1] In the Technology Horizons report, *The New Spatial Landscape: Artifacts from the Future* (SR-834 A, March 2004), we present scenarios of daily life in the new spatial landscape and the kinds of issues people are likely to encounter in it. This memo delves more deeply into the enabling infrastructure for this landscape; a future report will detail the business opportunities and dilemmas.

Human beings, unaugmented, are actually rather poor data-gathering sources. As we move about our environment, we register with our senses only a tiny portion of the information that *could* be part of our experience of any given place. An even smaller portion gets stored in our brains in a way that we can retrieve for future use.

Imagine, however, a world in which we can move about physical places, accessing not only what is stored in our brains but also multiple layers of information that have previously been inaccessible: experiences of friends, colleagues, and complete strangers in the same space; information about who lives and works in the place, their demographic characteristics, and perhaps their political affiliations; crime statistics for the area; the history of community events, from celebrations to calamities; information about businesses in the area and their products; changes that have reshaped the natural environment over time, and much more.

This is precisely the physical landscape we will likely inhabit in ten years. Wireless location-aware devices, new geospatial software, global location services, and online geodata repositories are all eroding the limitations to human perception, making accessible a rich spectrum of digital information in real time and in real place. The physical landscape we move in will become "deep" with vast amounts of digital information—in text, images, and other sensory forms.

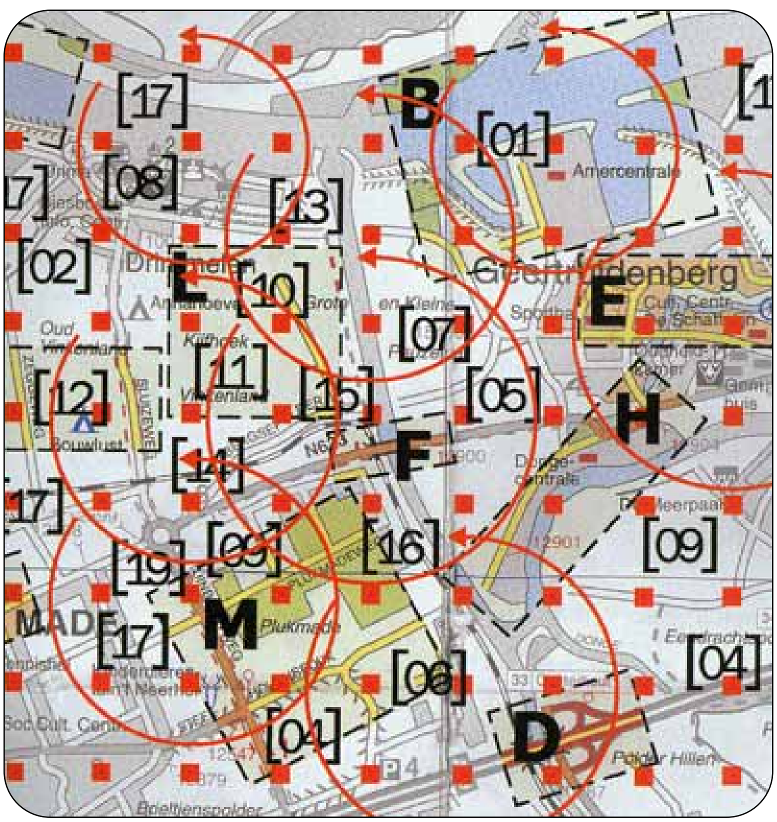
Three big changes will characterize this shift.



Source: Brayer, M. and B. Simonot, eds. *ArchiLab's Earth Buildings*. Thames & Hudson, 2003.

1. Implicit Information Will Become Explicit

Invisible layers of information that are arguably already implicitly available in the people and objects in a landscape will become visible and explicit. The relationship of physical and virtual objects will become obvious as well. We'll be able to use a variety of devices to tap into geocoded text, images, media, and maps. Tags will link near-by objects to a universe of commentary on their history, value, safety, and meaning.



Source: Brayer, M. and B. Simonot, eds. *ArchiLab's Earth Buildings*. Thames & Hudson, 2003.

CARTOGRAPHIC INFORMATION WE'LL BE ABLE TO VIEW IN PLACE AND IN CONTEXT

- Environmental details
- Cultural information
- Historical information
- Mythology
- Social information about people nearby
- Geodemographic information about the local community
- Micro-local commercial information
- Specialized enterprise and industry data
- Safety information based on actuarial data about health, accidents, and crime
- Political data
- Facilities information like telecommunications availability
- Local public services from government agencies

2. Extensions of the Body Will Be the New Interface

Our interface to this new landscape will be a set of body extensions—ranging from wearable map readers to unobtrusive head-mounted displays and eventually even neural implants. As these interfaces become refined, we will gain a new kind of control over what we see and hear in our environment, selectively filtering and displaying the layers of information linked to the physical environment. We'll click floating graphic objects off and on like "digital Post-It notes." Each individual's physical reality will become increasingly personalized.[2]

Here is an artist's rendition of a probable future:

Source: Pat Rawlings, SAIC

[2] For an analysis of this new interface and its implications for human behavior, see the forthcoming Technology Horizons reports on "The Extended Self," scheduled for publication in 2004.

3. The Landscape Itself Will Become Sentient and Aware

The landscape, as well as the people who populate it, will interact with the new geospatial web. Tiny sensors and actuators, gradually embedded in our environment over time, will begin to operate with spatial intelligence. The resulting systems will be increasingly aware, able to make complex interactive decisions without human intervention. Not only will they programmatically respond to environmental changes, they will also anticipate our human context and tasks—*our focus*—to create a safely usable flow of precisely relevant information.

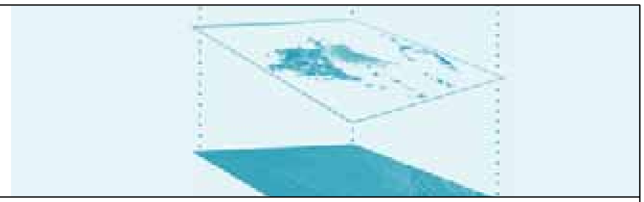
In this memo, *Infrastructure for the New Geography* (SR-869), we explore the key technologies, applications, data, and policies that will shape this emerging geoweb.[3] Aside from the increasingly ubiquitous, low-cost broadband wireless networks and devices, the key elements of this geoweb ecology are:

- Location-sensing techniques
- Geocoded data and information
- Geospatial information integration technologies
- Comprehensive geodata search
- Location-aware applications
- Location-based services
- Geospatial standards
- Geospatial policies

Our first means of access to invisible layers will be through traditional devices such as geo-enabled PDAs, data phones or dashboard displays in our cars.

[3] Many terms have been used to describe the emerging ecology of place-based information—geoweb, geospatial web, spatial web, locative web, and the digital earth. We use the term “geoweb” because it best conveys the combination of geographically related information and the World Wide Web of linked hypermedia.

Location-Sensing Techniques



what are they? **Location sensing techniques make it possible to identify the geographic location of objects. They tell us where things are.**

why are they important? **These techniques are the key underpinning for new services that link place-based information to users of that information in real time and space.**

Location sensing can be accomplished by two means: by giving networks the ability to track someone's location or by embedding location-sensing capabilities in a mobile device.

Location Enabled Networks

Some commercial wireless network are carriers tracking the locations of users' mobile telephones and digital devices by calculating signal strength and direction from various cell towers.These techniques triangulate location based on calculations from several radio towers.

The United States law called E911 (for emergency 911 services) requires that carrier networks routinely track the location of mobile phones in order to provide emergency services. Since tracking is mandatory, E911 is fundamentally intrusive. Network operators and public agencies always know a user's location.

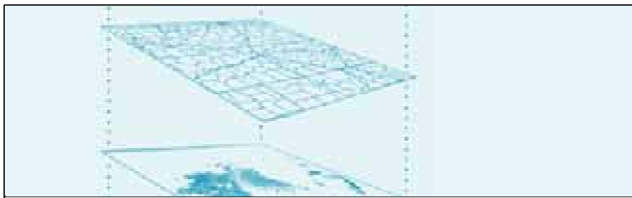
E911 is also enabling some carriers to offer phone-location information, as a paid service to end-user applications. So far, most carriers are not providing this information to subscribers themselves. Those that do are providing location coordinates, for premium prices, to enable enterprise services such as tracking fleet vehicles, delivery trucks, and freight movement.

Vendors of high-end Java-enabled phones, as well as Qualcomm BREW and Nokia/Symbian data-enabled phones, are beginning to offer developers the tools (called open APIs or application program interfaces) to build new location-aware applications. The carriers and partners are beginning to offer location based services built on these capabilities.

Location-Aware Devices

Techniques such as GPS—which uses geo-positional satellite information to establish location—can embed location awareness directly into devices without querying a network. A handheld device, PDA, camera, hand-held game device, or digital sports gear with embedded GPS knows where it is by passively *listening* to signals from multiple special satellites that send time-coded signals; they calculate location by comparing synchronized signal arrival times. Such techniques offer much more privacy of location than network-based techniques, and many new variations on this theme are emerging.

For example, it's possible to triangulate location by listening to and calculating the strength of Wi-Fi signals from access points at known locations. Because the location is computed at the device and not by the network, the user "is not automatically" tracked.



EXAMPLES OF LOCATION-ENABLED NETWORKS

- Bell Canada's My Finder Service returns location information into every handset.
- Sprint has signed separate alliances with Microsoft and IBM to provide location-services infrastructure including location coordinates as part of its Business Mobility Framework.
- Location middleware provider Webraska is helping set up services for many carriers including Orange, O2, Vodafone, Telecom Italia Mobile, Bell Mobility, and Sensis (Telstra Group, Australia).
- The United Kingdom's Skymo is offering location services on O2, Vodafone, Orange, and T-Mobile for a cost of 18–24 cents per location query.
- Almost all new handsets will support Sun JavaLocation services and will be based on the JavaLocation API.
- OS support is provided by Nokia/Symbian, Qualcomm BREW, and Microsoft.

At the University of California, San Diego and several dozen other universities with thousands of Wi-Fi base stations with known locations, engineers have created client-side software to calculate user location via this method. Several commercial vendors—including Ekahau, Quarterscope, Newbury, and others—are now offering very precise indoor Wi-Fi based location services for enterprise network applications such as conditional security access and warehouse management, among others.

In addition, Internet-based volunteer groups like WIGLE have already mapped hundreds of thousands of base station locations by "wardriving" with GPS and Wi-Fi enabled laptops. Corporate research labs at companies such as Intel and Microsoft have publicly revealed their work on geolocation software based on Wi-Fi station location. Soon, both open source and proprietary software will make it trivial for users of Wi-Fi devices to know where they are.

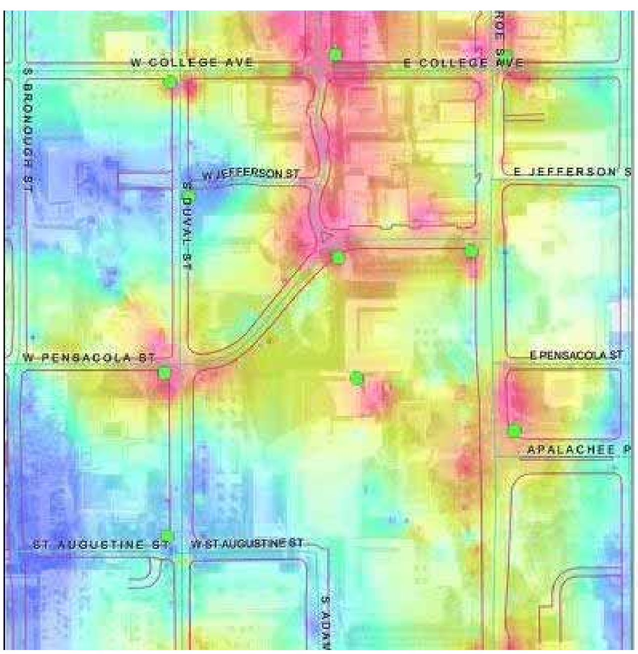
Location sensing will eventually be spectrally independent (that is, not limited to the Wi-Fi spectrum). Software that listens to television and radio signals to calculate location is already beginning to emerge. Radio and television transmission towers have publicly known locations; the new digital television broadcasts also have a digital time stamp. This allows devices to triangulate location by comparing time stamps. A company called Rosum is already using this technique to provide geolocation services.

Whatever signals a device is listening to, it will eventually be able to figure out where it is, and whether the signals are radio, Wi-Fi, cellular, GPS, or television. So multispectral sensing is likely to evolve to provide broad-based location sensing.

RFID: Hybrid Location Sensing

In the future, location-sensitive applications will use microsensors and RFID tags that rely on both *active client software* and *passive* techniques. These small integrated circuits will be connected to antennas and respond to an interrogating radio signal. They will supply simple identifying information, including location coordinates. When queried, the RFID tag will return such location information as latitude and longitude, effectively serving as a digital survey stake.

Alternatively, some special networks may be able to track the location and movement of passive RFID devices. RDFtracker is demonstrating RFID mapping to enterprises in Northern Virginia, with a special interest in tracking people and things. Retailers use this service to detect shoplifted items, which set off alarms as they pass sensors.



Source: Scott Weisman

EARLY LOCATION-SENSING EFFORTS

Intel Place Lab
http://placelab.org

Active Campus, University of California, San Diego
http://activecampus.ucsd.edu/

Ekahau
http://www.ekahau.com/

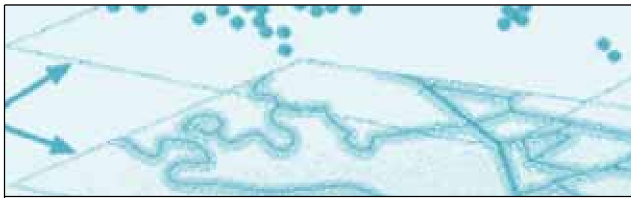
Quarterscope
http://www.quarterscope.com/

Newbury Networks
http://www.newburynetworks.com/

Rosum
http://rosum.com/

University of Rome
http://acts.ing.uniroma1.it/neuwb/file/gm031008-DeNardis-Locationing.ppt

Time Domain Corporation
http://acts.ing.uniroma1.it/neuwb/file/gm031008-DeNardis-Locationing.ppt

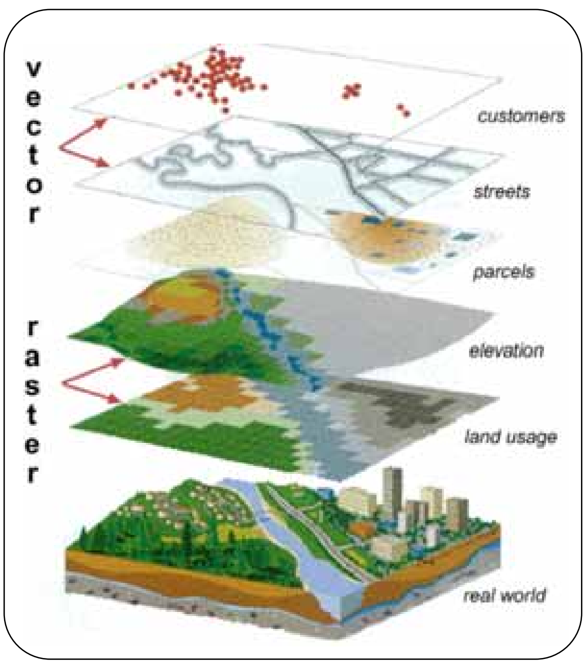


Geocoded Data and Information

what is it? **Geocoded data is tagged with explicit location coordinates, typically latitude and longitude. The tag tells us what location the information is associated with.**

why is it important? **In order to interact with hypermedia or digital information that is directly relevant to a place or physical object, data has to be explicitly identified as relevant to that location; tags with location coordinates provide that information.**

Two kinds of geocoded data will populate the geoweb of the future: traditional cartographic geodata and geocoded hypermedia. Traditional cartographic geodata is already emerging as a commercial growth industry, but geocoded hypermedia may ultimately be the big disruptive innovation of the coming decade.



Source: http://cier.uchicago.edu/gis/gis_layers.gif

Traditional Cartographic Geodata

Traditional geodata is the digital map data created and used in geographic information systems (GIS). Such data can be presented in multiple formats:

- **Points** are used to represent such landscape features as cities and towns, buildings and airports, often with icons.
- **Vectors** are lines used to represent such features as highways, rivers, and boundaries.
- **Polygons** are irregular shapes that typically describe areas with a common attribute, such as a forest or a nation.
- **Raster** data may refer either to a map with combined information or to an unprocessed form of data, such as a photograph or satellite image. Some significant processing is required to convert a satellite image into layered graphical data to make it useful. For those who are not professional image analysts, photographs of a city are not generally useful without extensive analytical preparation or graphical layers of keyed information.
- **Spectral data** are color representations of highly focused collections of meteorological, oceanographic, geophysical, or biological data, generally obtained from special satellites.

Because so much geodata is rendered, stored, and displayed in diverse data formats, it's difficult to combine different kinds of data to create layered maps. In the United States, an organization called OpenGIS has been leading a concerted effort in government and the GIS industry to create a new common interchange format to address this problem. However, to use existing GIS data, some conversion will be required. The large volume of legacy GIS data is one of the major challenges to the dynamic use of traditional cartographic data envisioned in the concept of the geoweb.

Geocoded Hypermedia

Geocoded hypermedia is information encoded with location coordinates and thus searchable by location. A few Web developers have begun to explicitly label Web documents, objects, media, with location coordinates (latitude and longitude) encoded in HTML in a metadata format, using pre-standard formats like GeoURL (a popular "bloggers" geotag, recently retired by the inventor). So far there are no widely accepted standards for annotating Web hypermedia with geocoordinates. However, several groups in the W3C (World Wide Web Consortium) and IETF (Internet Engineering Task Force) are approaching consensus on some of the necessary standard notations.

With these standards, any content on the Web—text, graphics, media, applications—could ultimately be linked to one or more locations by geocoding. This "tagging" provides a broad palette for innovation and creative expression in the physical–digital landscape. Furthermore, geotagging is a distributed, bottom-up process, and it has the same emergent qualities as the World Wide Web. For these reasons, we expect geocoded hypermedia to be a major disruptive innovation, perhaps on the scale of the World Wide Web—with many unanticipated applications and social consequences.

EMERGING GEODATA STANDARDS

GML (Geographic Markup Language) Standard XML markup for cartographic data

WFS (Web Feature Servers) Servers that serve GML layers

WMS format (Web Map Servers) Serve already rendered raster maps

WHAT A GEOTAG MIGHT LOOK LIKE

The RDFIG Geo vocabulary from the W3C (www.w3c.org/) supplies global names for latitude, longitude, and altitude properties. It is gaining acceptance in some open source communities and may become standard for geospatial markup.

<geo:long>X</geo:long>

<geo:lat>Y</geo:lat>

<geo:alt>Z</geo:alt>

Geospatial Information Integration Technologies

what are they? **Geospatial information integration technologies are tools for viewing or using all relevant information about a place—social cultural, historical, commercial, environmental, and physical—regardless of origin or vendor.**

why are they important? **There are many discrete data formats that are not interoperable—or at least not automatically. Integration of these different geo-information types is often critical for building multidisciplinary applications that describe many aspects of a place.**

Two types of interoperability challenges face those who would like to integrate different kinds of data from many sources. The first is the data format itself; the second is the metadata that defines the way the data should be rendered in maps.

Geodata Formats

Several companies have begun to market GIS data commercially, creating special software tools that can interpret the data and render it as maps. These tools use proprietary data formats (in the same way that graphic data can be stored in different formats unique to the program that creates it).

To address this problem, each of the major GIS software vendors—AutoDesk, ESRI, and Intergraph—sells tools to import and convert competitor's formats, as well as emerging open standard data.

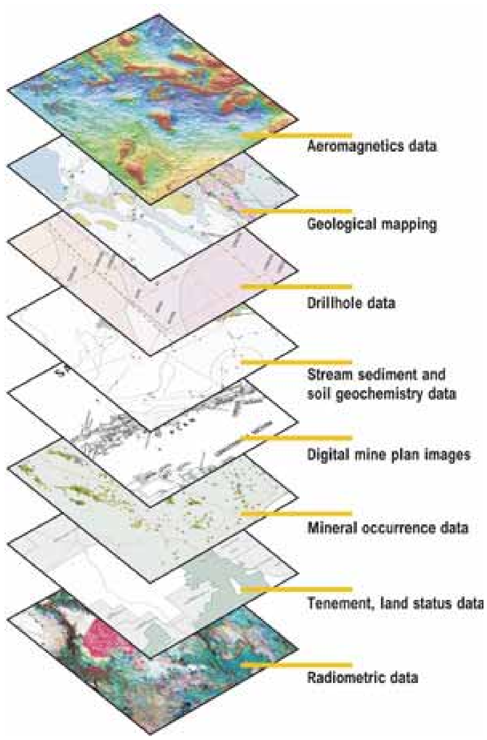
Metadata Standards

In addition to proprietary data formats, both public and private geodata is usually encoded with *metadata* that describes the cartographic projection and map rendering rules, as well as some information about the naming conventions or vocabulary of map layers—the meaning of the words that describe each map layer. These metadata descriptions are typically unique to the discipline that generates the data. For example, public health data for a region will use different metadata instructions from environmental data such as air quality. Yet analysts may well want to superimpose public health trends on air quality trends. The differences here are fundamental to the disciplines, often arising from taxonomies and other intellectual structures that give the individual disciplines their particular perspectives.

Some of the OpenGIS standards mentioned seek to solve this problem by creating an Esperanto-like set of metadata that can be used across disciplines and domains. However, just as Esperanto is a less-than-robust language, many argue that the cross-disciplinary metadata will reduce the semantic richness of the native data.

Nevertheless, scientists at the University of Maine and elsewhere are beginning to develop some semantic computing capabilities to solve the problem of geospatial data integration. They're working on higher level processes to integrate disparate data sets, using artificial intelligence and similar processes based on semantic web metadata markup. Various private and academic research labs are investigating the related fields of geospatial knowledge processing, knowledge representation, and geospatial search.

In addition, the U.S. Federal Geographic Data Committee founded under former Vice President Al Gore's leadership is working to standardize metadata descriptions of geographic information used in federal agencies through an effort called the Content Standard for Digital Geospatial Metadata (CSDGM). Because the U.S. government is the largest producer and consumer of geographic information, this effort will inevitably compel private adoption of these open standards.



Source: http://www.nre.vic.gov.au/

DATA FORMATS OF LEADING GIS VENDORS

AutoDesk, Inc.
AutoCAD DWG/DXF

ESRI
Shapefiles, Arc4Java

Intergraph
ISFF, MGE, GeoMedia

MapInfo
MID/MIF MIPro 7.5

KEY SEMANTIC WEB FORMATS

The semantic web is a set of standards proposed by W3C to provide machine-to-machine exchange and interpretation of data on the Internet. Two of these standards will provide the underpinnings for exchange of geodata across the Internet.

Resource Description Framework (RDF) is the foundation for processing metadata; it provides interoperability between applications that exchange machine-understandable information on the Web. The RDF work is part of the W3C Metadata Activity.

OWL Web Ontology Language is a new extension of RDF, also developed within the W3C. It defines logical classes of data and descriptors for them.

Comprehensive Geodata Search

what is it? **A comprehensive geodata search must ultimately include the ability to retrieve all the attributes of a place—descriptions of its features, maps, aerial and satellite images, plus narrative information about the place. In short, it's a way for users to discover the full digital richness of any place on earth.**

why is it important? **Computerized search of geospatial data is necessary for the geoweb to become a robust new medium of communication. In other words, it's necessary for ensure that the broadest possible base of users can discover the most meaningful information about any unanticipated aspect of a place—and ideally all of the digital information about a place, including its physical and social patterns.**

Just as the success of the World Wide Web required the development of powerful search services such as Yahoo! and Google to provide fast, efficient portals to vast data stores, the geoweb will require a similar capability for geodata search. The requirements are twofold: the ability to search for traditional GIS data and the ability to geocode hypermedia—and ultimately the ability to link them together.

Currently, there is no comprehensive clearing house on the Web where users might find all of the data they want from all domains of knowledge covering all geographies. Instead, there are hundreds of national, regional, local, academic, private, and individual online gateways to geo databases or repositories.

The obstacles are obvious: vast amounts of proprietary and domain-specific geodata produced in nonstandard formats or hosted at Web sites with nonstandard database search capabilities—including the databases of governments, public agencies, and private companies all over the world. These remain largely unsearched and unsearchable.

While very few geospatial information scientists are working on this challenge, a couple of companies are beginning to provide rudimentary search services for geodata. An example is Iconsoft's AsktheSpider.com search for OpenGIS conformant spatial Web services such as WMS and WFS. Unfortunately, since OpenGIS standard data formats are so new, this is a minuscule resource.

In the realm of geocoded hypermedia, Google has developed its own proprietary search index. An experimental location-based search engine finds Web pages linked to a specific zip code. Searches return Web pages in the same format as other Google searches. Ultimately, however, such searches need to return the results in a way that can be integrated with visual maps that include traditional GIS data. User interface is thus another layer of the challenge, on top of universally searchable databases and integration of data formats.

Source: local.google.com

CLEARINGHOUSES FOR GEODATA

Center for International Earth Science Information Network

A useful but limited collection of physical, environmental, and social data.

http://www.ciesin.org/sub_guide.html

GCMD Global Change Master Directory

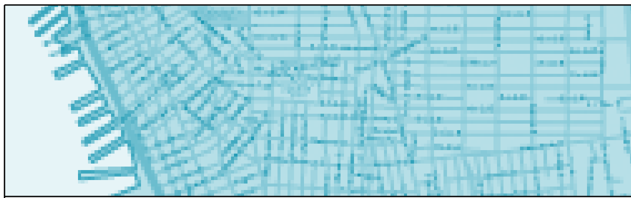
A repository of more than 15,000 descriptions of earth science data sets and services covering all aspects of Earth and environmental sciences.

http://gcmd.nasa.gov/Data/portals/gcmd/param_search/HUMAN_DIMENSIONS.html

Harvard Geographic Information Systems

A wonderfully rich directory of global geodata repositories.

http://www.gis.harvard.edu/Data.html



Location-Aware Applications

what are they? **Location-aware applications are a potentially rich suite of tools that use various geolocation technologies to help users tap into geospatial data about the the "view."**

why are they important? **Location-aware applications will shape the way users experience the enhanced physical–digital landscape described in the Introduction. They are the tools through which the geoweb, as a medium, will become embedded i n everyday life.**

The evolution of location-aware applications has been hampered by the many infrastructure schisms described in the previous pages, as well as by proprietary interests in owning the location-specific data, as well as the applications. The hardware and software for these applications thus remain limited, though the leading edge points to the potential.

Hardware

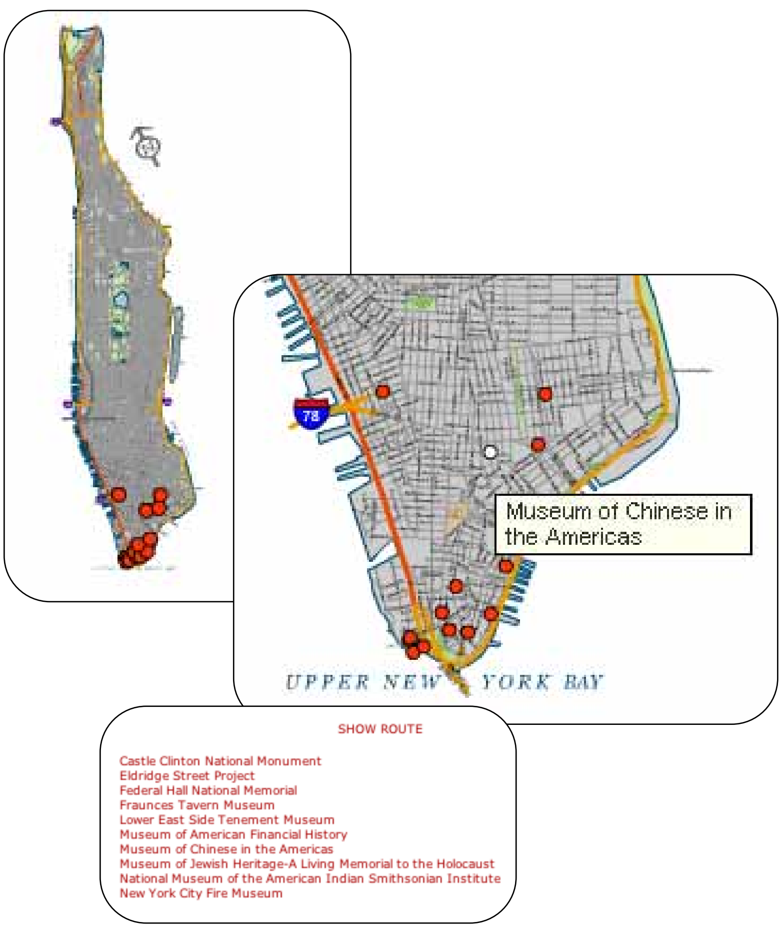
At present, most users access geodata primarily through GIS digital map applications on custom map displays or desktop computers. However, a few field researchers today view geodata through "head-up" augmented reality interfaces or other experimental prototype user interfaces.

Eventually, location-aware applications will allow users to view many kinds of GIS data and geocoded hypermedia, in situ, on a variety of devices and displays—PDAs, mobile phones, laptops, lightweight glasses, and perhaps even contact lenses. Geodata is inherently visual, linked either to a map or an actual view of the landscape or physical environment. The challenge for hardware tools is thus to provide those visualizations in ways that are portable, easy to read, and don't interfere with the direct experience of the environment.

Software

Companies like Autodesk, ESRI, IBM, Integraph, MapInfo, Microsoft, and Oracle offer an extensive array of software tools and middleware for creating, integrating, processing, and rendering geospatial data. Proprietary map-viewer applications like MapPoint from Microsoft and ArcWeb from ESRI allow users to view digital map data on Web PDAs and a few mobile phones. ESRI produces a massive suite of tools, utilities, and services and has the largest GIS software installed base in the world, with more than 1 million users in more than 100,000 organizations representing business, government, nongovernmental organizations, and academia. All over the world, municipalities, private companies, and governments use ESRI's GIS data for resource and facilities management, geospatial business analysis, and dozens of other applications. Microsoft, while far behind ESRI, is trying to catch up and is spending hundreds of millions of dollars annually on its MapPoint products and services.

Meanwhile, leading-edge coders and bloggers, researchers, geographers, and artists worldwide are experimenting with new "locative-hypermedia" applications. These often use open source mapping programs, always running on standard Internet protocols. For example, a suite of tools created by geo hacker Chris Goad and offered on his Map Bureau Web site represent some of the best examples of the new lightweight, semantically savvy, location-aware applications.



Source: www.mapbureau.com

TWO EXTENSIVE DIRECTORIES OF OPEN SOURCE GIS TOOLS ARE:

Open Source GIS
http://opensourcegis.org/

FreeGIS
http://freegis.org/

EXPERIMENTAL MAPPING SITES ON THE WEB

Bio Mapping http://www.biomapping.net/

Blogmapper http://blogmapper.com/

Fotolog
http://www.fotolog.net/browse_countries.html

GPSter http://www.gpster.net/gpster.html

Locative Media Lab
http://www.locative.net/

Metrobot
http://www.metrobot.com/mb/bot

Ocean Biogeographic Information System
http://www.iobis.org/

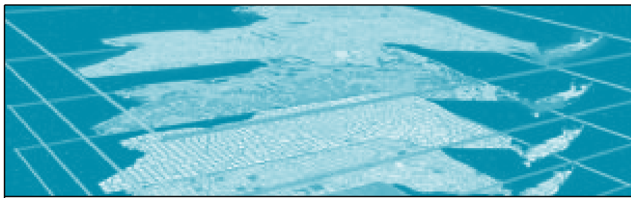
OpenGuides http://openguides.org/

Placeworld
http://www.icinema.unsw.edu.au/projects/prj_placeworld.html

Proboscis http://proboscis.org.uk/

Urban Atmospheres
http://www.urban-atmospheres.net/

Virtual Heritage Network
http://www.virtualheritage.net/



Location-Based Services

what are they? **Location-based services use knowledge about where the user is to provide a location-specific service. For example, the user of a wireless smart phone might be served a guide to special sales in the mall where he or she is currently shopping.**

why are they important? **These services will allow organizations, from retailers to public services, to deliver information, guidance, and assistance with transactions in real time and real place.**

Like so many other elements of the geo-ecology, early location-based services are using different business models and different standards. A simple classification includes the so-called "walled gardens," mobile Internet services, and the experimental Web landscape.

Walled gardens

Telecommunication companies, consumer electronic and automotive companies, and related .net and .com startups are experimenting with new location services, many of which could be described as walled gardens. These are services available only to their subscribers, usually over closed networks.

For example, an owner of a Lexus car in a Verizon network will have access to a set of pre-packaged services—canned points of interest, or POIs. Most of these come from one supplier, InfoUSA. This company claims to compile "the world's finest databases" of 14 million U.S. businesses, 200 million U.S. consumers, and 1.2 million Canadian businesses as well as 12 million Canadian consumers.

Such services, however, might not be encoded in any of the standard data formats. In many cases, they are fundamentally different from open web-like services using standard data over standard IP networks.

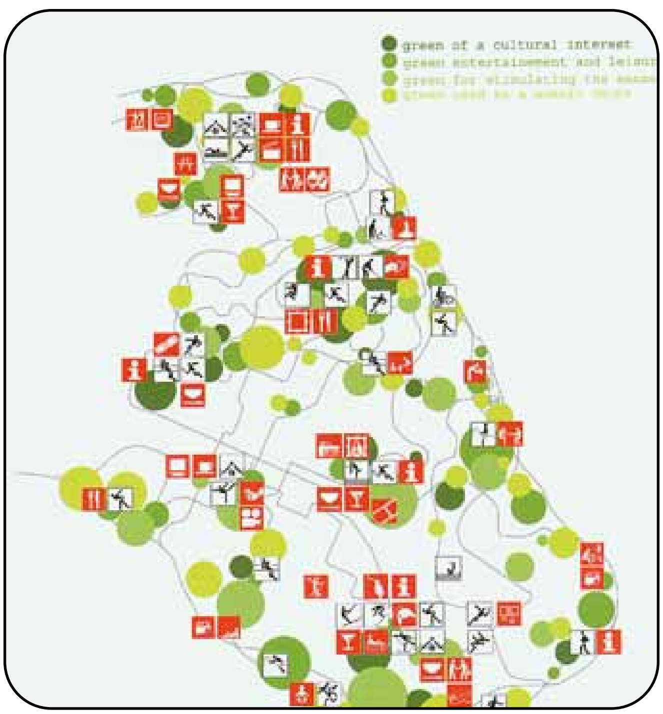
Mobile Internet Services

Since most commercial location services operate on IP networks, major industry standards associations are moving toward open standard services. Unlike walled gardens, these services take advantage of a wide range of Web-based content and open standards. However, some of the carriers pursuing this strategy are trying to limit access to the services and information by defining the Internet and geodata on it as a mobile application, not as a standard basis for an open marketplace of location-based or open geospatial services. They have a number of proposals to limit access to geospatial data and services, to create the basis for proprietary offerings, not unlike AOL or today's cable media. Sprint, for example, has signed separate alliances with Microsoft and IBM to provide location-services infrastructure including location coordinates as part of its Business Mobility Framework.

Open Web-Based Geo-Services

Meanwhile, based on a fairly open mapping protocols like the RDFIG geo-vocabulary from the W3C, as well as universal HTML, HTTP, and Java platforms, thousands of independent developers worldwide are trying to take advantage of the location-aware applications described previously to build different kinds location-based services. These academics, researchers, developers, bloggers, artists, cartographers, and GPS hobbyists are experimenting with everything from augmented reality and robotics to psychogeographic and GPS art.

The parallels are obvious: while walled gardens and proprietary mobile applications represent the kinds of services offered in the early days by Dialog and Prodigy, the open geo-services look more like the period just before the Web and its Web browsers created a game-changing new medium of communication and commerce. If proprietary models don't dominate, some of today's experiments will define the future model for a broad-based platform for location-based services. (By the way, an IFTF forecasting axiom, is that open systems almost always prevail in the long term.)



Source: Brayer, M. and B. Simonot, eds. *ArchiLab's Earth Buildings*. Thames & Hudson, 2003.

POTENTIAL CARRIER-BASED LOCATION SERVICES

- Location-based advertising
- Comic strips
- Stocks and shares
- Download video
- E-photos
- Download audio
- Location-linked trivia/quiz games
- Interactive games
- Step-by-step directions
- Payment of goods

Source: StrategyAnalytics, 2003

COMMONLY MENTIONED ENTERPRISE LOCATION-BASED SERVICES

- Fleet management
- Asset tracking
- Enterprise security
- Precision agriculture
- Facilities management
- Resource management

Geospatial Standards

what are they? **Geospatial standards include a wide range of communication protocols, data formats, and rendering instructions for capturing, accessing, and displaying geospatial information.**

why are they important? **These standards are the key to creating a worldwide platform for location-aware applications and location-based services. In short, they are necessary for the world to enjoy the full benefits of a geospatial web independent of any particular device, operating system, or network.**

Throughout this memo, we've mentioned numerous issues that involve standards, as well as some of the key players who are crafting these standards. Many interoperability standards—including geocodes for marking up hypermedia, standard application program interfaces (APIs), standard map formats, and standard geospatial metadata—are already in place or are in the process of being developed. Here we summarize the status of the most important geoweb standards.

- **Standard geocodes for hypermedia**
  The W3C WGS84 proposal is in review. It will allow hypermedia to be tagged and viewed locally.

- **Standard location, presence, and privacy protocols**
  The IETF GEOPRIV final draft provides rules for noting locations of users and documents.

- **Standard data basis for Wi-Fi base station locations**
  A standard database of Wi-Fi beacons for geolocation is in the process of development.

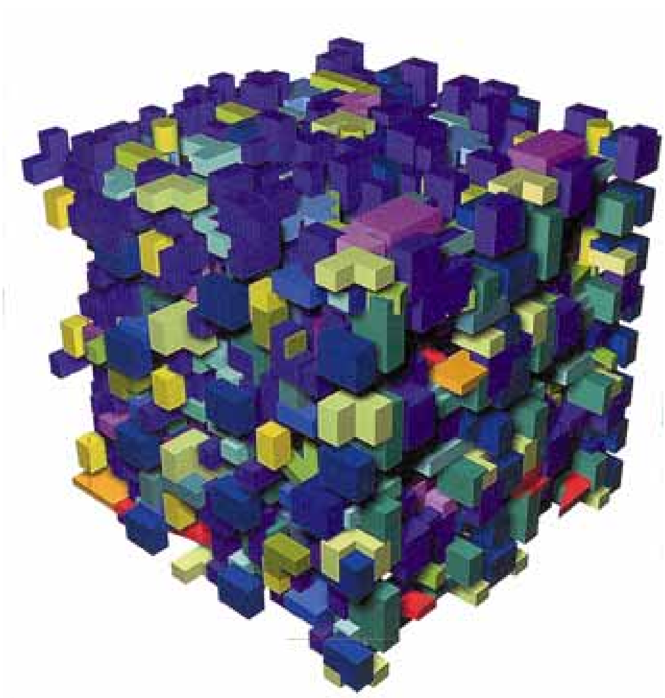
- **Standard APIs for device location**
  The standard location API for Java Mobile Edition (J2ME) is now complete enough for applications to run on many Java-equipped devices.

- **Standard carrier API for E911 location information**
  The OPENLS has been accepted and allows applications to access location information provided by carriers.

- **Standard geographic markup language**
  The GML/XML standards have been defined, providing uniform descriptions for maps and allowing digital map data to be exchanged easily.

- **Standard Web feature services**
  OpenGIS WFS now provides the rules for servers to serve GML standard data.

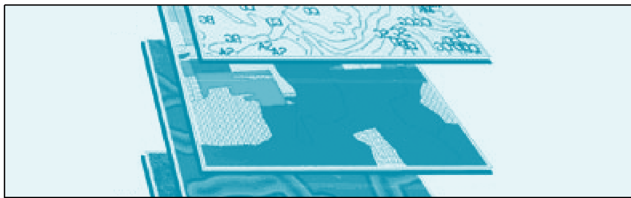
- **Standard Web map services**
  OpenGIS WMS now provides the rules for servers to serve standard raster maps of combined layers.



Source: Brayer, M. and B. Simonot, eds. *ArchiLab's Earth Buildings*. Thames & Hudson, 2003.

THE GREATEST BENEFIT FOR THE MOST USERS: AN OPEN, HETEROGENEOUS WEB ENVIRONMENT

Ideally, a geodata user should be able to flip on a phone regardlesss if it's a Qualcom BREW operating system or a Nokia Symbian OS and see geodata displayed equally well. Standards make this kind of interoperability possible, provided the services are open. For example, while developers are working on standards like Java and WAP (Wireless Access Protocol) to ensure access to Internet services, a carrier may only permit its users to log onto the Qualcomm client network, in which case they won't necessarily get an interoperable, Open IP service. The current situation is comparable to days when Prodigy, CompuServe, and AOL were the only online information services. Over time, a much more open, heterogeneous, web-like environment for geodata will replace it.



Geospatial Policies

what are they? **Geodata-related policies directly or indirectly address geodata access, protection, and use, including such issues as privacy, ownership, and access to public data.**

why are they important? **These policies will ultimately determine how widely accessible geodata will be to the public and the types of applications that will be created using that data.**

Some of the key policies that will ultimately shape access and use of geodata include data ownership, location privacy, secrecy of sensitive data, and development goals.

Data Ownership

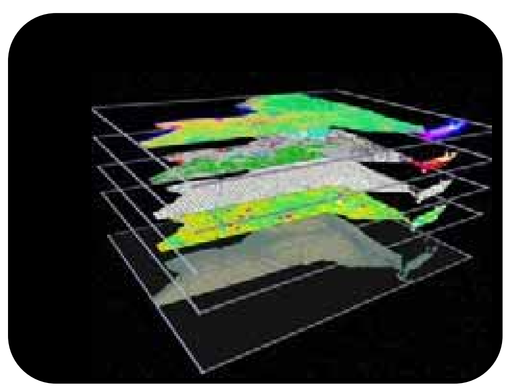
Data ownership will ultimately shape not only access to geodata, but also the kinds of developers who get involved in the geoweb. For example, the British government has its Ordinance Survey that creates and manages public geospatial data, including all the roadmaps. Because of privatization, the Ordinance Survey agency must be financially self-sufficient. As a result, it must sell all its data. This policy is obviously frustrating to open source developers. In many countries, access to geodata is even more restrictive than in Britain.

In the United States, by contrast, the government gives away vast amounts of geospatial data. For example, cartographic and microclimate information for precision agriculture is provided free of charge by policy. As a result, geoweb applications are likely to develop much more rapidly in the United States.

Location Privacy

Allowing network operators and public agencies to track a user's location raises privacy concerns for consumers and advocacy groups. Privacy is fundamental to safety as well. For example, most celebrities really don't want people to know where they live.

Fearing a potential negative impact on location-based mobile commerce, many industry associations are proactively drafting privacy guidelines, while negotiating with regulators over mandatory restrictions. Meanwhile, some carriers are already offering services that allow their customers to track locations of friends and family. Absent some early regulations, these services appear to be inviting abuse. Fortunately, research labs like Bell Labs and Intel Labs are already crafting privacy application toolkits. Similar to caller ID, these applications would allow users to selectively reveal their location to validated authentic friends and family members, as well as authorized colleagues.



Source: http://www.oft.state.ny.us/library/images/gislayers.jpg

Secrecy of Sensitive Data

Security drives another set of policy concerns about geodata. For example, the United States government could fly over the desert with sensors and map high-quality uranium deposits, but it probably would want to keep the results secret. Infrastructure security is another concern: recently a graduate student at Columbia University created a map of the Internet and the electrical infrastructure of the United States that was so detailed the government classified his term paper. And the U.S. Department of Homeland security is currently soliciting comments on proposals to restrict the otherwise free access to massive amounts of public geodata in America.

The California State and National Archaeological Registries also have secret maps of archaeologically sensitive areas because of the problems with pot and artifact hunters. In Utah and Arizona, and even in California, there are still untouched ancient cave art locations and sites where pots still sit on the floor of a cave or dwelling. Archaeological information is an example of information that needs to be protected for the integrity and preservation of the locations.

Development Goals

Governments may invest in mapping resources and infrastructure as part of a deliberate development or financial aid strategy. For example, U.S. farmers are highly productive as a result of U.S. government investment in creating public data repositories. They regularly use sophisticated micro-climate and soil information for planting and farm management, yielding higher returns.

During its rule of Uganda, the Belgian government invested in mapping Ugandan farms, roads, and political districts. The Uganda government has numerous paper maps—the Minister of Roads has a map of roads, the Wildlife Minister has a habitat map, and the Minister of Natural Resources has a map of mines. To take advantage of these maps in a geoweb, however, today's Ugandan government would need to make another investment in digitizing these maps, allowing them to be integrated and publicly accessed. Clearly, GIS planners are at a disadvantage in developing countries where spending development money on digital maps versus other pressing needs remains a policy decision for local, regional, and national governments, as well as international development agencies.

SOME GEOSPATIAL POLICY SITES

International GIS policy issues
http://www.gisdevelopment.net/policy/international/

Restricted access to maps in India
http://www.gisdevelopment.net/magazine/gisdev/1999/mar-apr/rmi.shtml

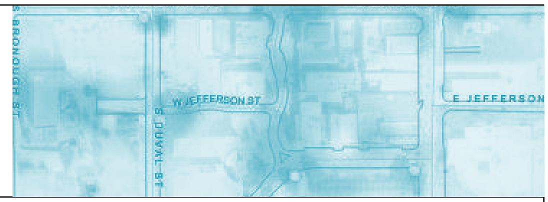
European Geographic Information Policy Discussion List
http://www.ec-gis.org/egip/

Code of Ethics for GIS use by the Urban Regional Information Systems Association
http://www.urisa.org/ethics/code_of_ethics.htm

Location privacy research at the University of Colorado
http://home.cs.colorado.edu/quickstart/index.php?id=35

The Homeland Security Working Group of the U.S. Federal Geographic Data Committee
http://www.fgdc.gov/fgdc/homeland/

Beyond Technology: A New Geospatial Literacy



Regardless of how the geoweb ecology evolves over the next ten years, one thing is certain: it will demand a new geospatial literacy that today exists only among a small portion of the most highly educated population.

Geospatial literacy might be described as the ability to understand, create, and use spatial information and maps in navigating, in describing phenomena, in problem-solving, and in artistic expression—ultimately including the ability to create and utilize information, *viewable in place*, directly associated with physical reality. There are no programs to help people develop this kind of literacy, and even in the most developed countries, those who have achieved a high level of geospatial literacy have done so largely without a compelling formal curriculum.

The problem needs to be approached from two directions. Just as the Internet became a real medium of communication and commerce only after the World Wide Web provided a simple interface and a significant portion of the population acquired basic computer-literacy skills, the geoweb will require both interface innovations that make maps and spatial data intuitive and a growing sophistication among information users of geospatial data. Basic concepts that GIS and map experts take for granted—such as map projections, vectors, and coordinates—will need to find an appropriate expression in the minds of non-professional users. In fact, one indicator of the rise of the geoweb will likely be a new vocabulary of "geo-speak."

How will this new literacy be achieved? Beyond supporting basic curriculum in educational institutions, many players in the world of business can lend a hand. Analysts can aggressively incorporate geodata displays in their reports. IT professionals can begin to develop simple mapping toolsets and templates for standard data reports in their organizations. Graphic designers, presentation builders, and corporate media groups can use maps and other geospatial metaphors in their productions. Product designers can anticipate location-aware applications in their products, exploring interfaces that train and guide users through basic geospatial concepts. Architects and facilities planners can make implicit spatial patterns explicit in a variety of ways.

Ultimately, the geoweb will be a vital source of wealth creation and community building. A concerted investment in geoliteracy skills now will pay off in a broader base of the participation in both processes.