11 The GeoWeb

OVERVIEW

- This chapter describes current and capabilities in distributed GIS, and looks to a future in which GIS is increasingly mobile and available everywhere. The GeoWeb is a vision for the future.
- It is organized into three major sections, dealing with distributed data, distributed users, and distributed software.

LEARNING OBJECTIVES

After studying this chapter, students will understand

- **How the parts of GIS can be distributed instead of centralized.**
- **Geoportals, and the standards and protocols that allow remotely stored data to be discovered and accessed.**
- **The technologies that support real-time acquisition and distribution of geographic information.**
- **The service-oriented architectures and mashups that combine GIS services from different Web sites.The capabilities of mobile devices, including mobile phones and wearable computers.**
- **The concepts of augmented and virtual reality.**

KEYWORDS AND CONCEPTS

Interoperate, Open Geospatial Consortium, cyberinfrastructure, object-level metadata, FGDC, CSDGM, geolibraries, collection-level metadata, virtual and augmented reality, location-based services, GIServices

OUTLINE

CHAPTER SUMMARY

11.1 Introduction

- This chapter describes how the network, to which almost all computers are now connected, has enabled a new vision of *distributed* GIS, in which the component parts no longer need to be co-located.
- There are four distinct locations of significance to distributed GIS:
    - the location of the user and the user interface, *U*
    - the location of the data, *D*
    - the location where the data are processed, *P*
    - the area that is the focus of the project, the subject location, *S*
- Critical to distributed GIS are the standards and specifications that make it possible for devices, data, and processes to interoperate
- Some are universal like ASCII and XML
- Others are specific to GIS and were developed through OGC
- Open Geospatial Consortium (OGC) is an organization set up to promote openness and interoperability in GIS.
- Successes include simple feature specification, Geography Markup Language (GML), and specifications for Web services
- Mentions the notion that today's computing is extended beyond the desktop
    - Cyberinfrastructure describes a new approach to the conduct of science, relying on high-speed networks, massive processors, and distributed networks of sensors and data archives
    - Grid computing is a generic term for such a fully integrated world-wide network of computers and data.
    - GPS data of real-time locations increasingly fed to the Web

    - RFID allows the tracking of objects that have been implanted or tagged with small sensors - widely used in retailing, livestock management, and building construction
- Makes the point that Mashup (see Chapter 5), and the linking of services in general, is a key concept of the GeoWeb

11.2 Distributing the Data

- Many private citizens have become involved in the distributed creation and dissemination of geographic information, in a process known as volunteered geographic information (VGI).
- The vision of distributed GIS goes well beyond the ability to access and retrieve remotely located data, however, because it includes the concepts of search, discovery, and assessment
- Three concepts are important in this respect: object-level metadata, geolibraries, and collection-level metadata.

11.2.1 Object-Level Metadata

- *Object-level* metadata (OLM) describe the contents of a single dataset by providing essential documentation.
- Need OLM for many reasons:
    - to automate the process of search and discovery over archives
    - to assess the fitness of a discovered dataset for a given use
    - to provide the information needed to handle the dataset effectively
    - to provide useful information on the dataset's contents
- It is easy for the complete description of a dataset to generate a greater volume of information than the actual contents.
- OLM are expensive to generate because they represent a level of understanding of the data that is difficult to assemble, and requires a high level of professional expertise.
- The most widely used standard for OLM is the US Federal Geographic Data Committee's (FGDC) Content Standards for Digital Geospatial Metadata (CSDGM) first published in 1993 and now the basis for many other standards worldwide.
    - Box 11.2 lists some of its major features
- Alternatively, the Dublin Core (see Box 11.3) is the outcome of an effort to find the minimum set of properties needed to support search and discovery for datasets in general
    - treats both space and time as instances of a single property, *coverage*

- The principle of establishing a minimum set of properties is sharply distinct from the design of CSGDM, which was oriented more toward the capture of all knowable and potentially important properties of geographic datasets.

11.2.2 Geolibraries and Geoportals

- The term geolibrary has been coined to describe digital libraries that can be searched for information about any user-defined geographic location.
- Since both the spatial and temporal dimensions are continuous, it is impossible to capture them in a single property analogous to author that can then be sorted numerically or alphabetically.
    - Searching based on location or time is possible in a digital system
- A geoportal is defined as a single point of entry to a distributed collection of geolibraries

11.3 The Mobile User

- Briefly summarizes the emergence of mobile computing

11.3.1 Virtual reality and augmented reality

- Research environments that place what humans normally gather through their senses into a database are termed virtual realities
- In most GIS applications only one of the senses is used, sight, and the view is usually from above rather than from the ground
- More elaborate VR systems are capable of immersing the user, by presenting the contents of a database in a three-dimensional environment, using special eyeglasses or by projecting information onto walls surrounding the user, and effectively transporting the user into the environment represented in the database.
- The idea of combining information from a database with information derived directly through the senses is termed augmented reality, or AR.
- Discusses two examples of AR systems
- Golledge's AR for helping visually impaired people perform the simple task of navigation
- Feiner's AR that superimposes historic images and other information directly on the user's field of view

11.3.2 Location-based services

- A location-based service (LBS) is defined as an information service provided by a device that knows where it is and is capable of modifying the information it provides based on that knowledge.
- GPS receivers and cellphones are discussed as means of determining a user's location
- Several applications of LBS are described

11.3.3 Issues in mobile GIS

- GIS in the field or 'on the road' is very different from GIS in the office.
    - The location of the user is important, and directly relevant to the application.
    - The field environment may make certain kinds of interaction impractical
- Battery (or other wireless energy) technology has not advanced as rapidly as other components of mobile systems, such as processors and storage devices.
- Wireless communication using WiFi is still problematic

11.4 Distributing the software: GIS services

- This section addresses distributed processing, the notion that the actual operations of GIS might be provided from remote sites
- A GIService is defined as a program executed at a remote site that performs some specific GIS task
- Asks how would a GIService pay for itself
- The characteristics that would make a GIS function suitable for offering as a service appear to be
    - Reliance on a database that must be updated frequently, and is too expensive for the average user to acquire -- includes geocoding, wayfinding, and gazetteer services
    - Reliance on GIS operations that are complex and can be performed better by a specialized service than by a generic GIS.

11.4.1 Service-Oriented Architecture

- An illustration of the capabilities of distributed GIS and the GeoWeb technology is given for emergency management.

11.5 Prospects

ESSAY TOPICS

1. Define the U, D, P and S of distributed GIS and give examples of applications that 'locate' them in different (distributed) places.
2. Why does the vision of distributed, hand-held, and wearable GIS rely heavily on the existence of mandated standards, and where in the entire process are these necessary?
3. If 'the network' really is 'the machine' of the future, how is grid computing likely to change GIS?
4. What do you understand by the term 'Geoportal', and what services should one offer?
5. How do virtual reality applications in GIS differ from advanced geovisualization (see Chapter 13)?
6. Outline, with examples, what is meant by the term 'object-level metadata' and explain why it is important in geographic resource discovery.
7. Attempt and illustrate a classification of 'location-aware' computing applications.
8. How and why is GIS in the field different from GIS in the office, and what are its major present-day limitations?
9. Outline the business logic behind the development of geographic information services and suggest how companies providing them can develop an income stream.
10. George Orwell's 1949 vision of the world in *Nineteen Eighty Four* featured a Big Brother who was always watching. To what extent, twenty years after the predicted date, has Orwell's nightmare been realized?

MULTIPLE CHOICE QUESTIONS (MCQ)

1. What do most of the world's computers do most of the time? Tick one answer.
   a. Word process
   b. Perform GIS
   c. Nothing
   d. Run games
   e. Analyse non-geographic databases

2. Roughly, how many CDs are need to store a petabyte of data? Circle your answer:

1	10	100	1000	10,000	1,000,000	10,000,000

3. Which of the following are examples of location-based computing?

Activity	**Yes or no?**
Yell/Yellow Pages	
Onstar	
PlayUnderCover	
Virtual London	
Wearable GIS	

4. Expand the following acronyms:

Acronym	**Stands for …**
OLM	
CSDGM	
GML	
CLM	

5. According to the T-Mobile provider, in 2004 how many wireless Internet 'hot spots' were within 1 mile of 1600 Pennsylvania Ave., Washington DC? Circle your answer:

10	37	78	200	1000

6. Which of the following devices is normally 'location aware'? Tick all as appropriate:

Device	**Yes or no?**
Personal digital assistant	
Cell phone/Mobile phone	
Laptop	
WiFi enabled laptop	
GPS	

7. Which two of the following characteristics of a business <u>most</u> make it a candidate for outsourcing to a GI service company?

Characteristic	Yes or no?
Reliance on a large expensive database	
Use of complex GI operations	
Need for frequent database updates	
Large number of concurrent users	
Lack of in-house expertise	

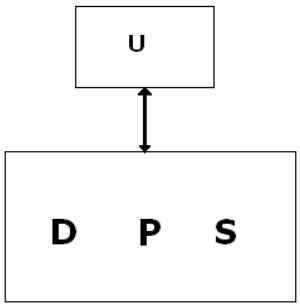
8. Which of the following statements best describes 'grid computing'?

    a. Sharing data between several Internet hosts
    b. Autonomous communicating computers
    c. Using the Internet to allow distributed computation
    d. Parallel processing

9. Which of the following is the major current limitation on mobile computing?
    a. Lack of software
    b. Limited access
    c. Noisy signals
    d. Lack of security

ACTIVITIES

1. The figure shows the location of the User, Data, Processor, and Subject in a desk top GIS. Draw similar diagrams to illustrate possible alternative configurations in a distributed GIS and attempt to find an example of each.



2. Visit www.opengeospatial.org and use it to identify the open standards and initiatives relevant to the development of distributed GIS and LBS. To add structure to this activity, create a list of each and write down a succinct description of what it entails.

Peng Z.-H. and Tsou M.-H. (2003) provide an academic and practical guide to these materials.

3. The Dublin Core Metadata Initiative (DCMI) is fully documented at dublincore.org and has a stated mission 'to make it easier to find resources using the Internet'. Examine the basic standard in order to answer the following questions:
    a. How can geographic metadata be incorporated within it?
    b. Why is it a poor model for such data?, and
    c. How might it be extended for geographic use?

4. Either from direct experience, or using advertising materials, find examples of in-vehicle navigation systems that integrate GPS location awareness with digital mapping and route-finding software. In each case comment on the system usability, accuracy, geographic resolution, and quality of the mapping used.

5. A classroom 'competition' involving a hypothetical response to a business request. Organize teams to respond to the following requirement:

'The 'Good-Eat' ™ fast food chain has over 1000 outlets in towns and cities across the USA, but is losing business to an upstart rival. The rival makes use of distributed GIS to guide potential customers to their nearest outlet using a basic Web mapping facility driven by the customer's ZIP code captured either from their Web page or by way of a text message from a mobile phone. Good-Eat ™ intend to outsource an equivalent service to a GIServices facility. Your company is invited to bid for the contract to design, build, and run the system

Each team has to produce a design for a system, with as full a specification of the necessary components and system architecture as possible, with the 'contract' being awarded after each team has presented to an adjudicating panel of company directors. Past experience with this kind of role play suggests that it is useful if the instructor acts as 'intermediary' to the company to provide additional information about current company data holdings and GIS capabilities.

6. Current capabilities in Internet GIS did not arrive overnight, but are a stage in an evolutionary sequence. Use the Internet to discover examples of the following steps on the way:
    a. Static map publishing
    b. 'Clickable' maps that act as a key to other information
    c. Interactive Web mapping

7. In each case list the technologies and software involved. Peng Z.-H. and Tsou M.-H. (2003, Chapter 4) will be found to be a useful source for this activity.

8. Organize a formal debate on the motion that ‘This house believes that Big Brother, in the guise of geospatial technologies, is now watching us and that this is an invasion of our citizens’ liberties that has to be curtailed’.

9. 'Brainstorming' supplies a formal framework for group-based creative thought and is a useful way to capture ideas. The technique is described by Gold et al (1991, Chapter 5). Either in teams, or as a class, brainstorm a list of possible applications of hand-held and wearable GIS. When the group is exhausted, attempt to formalize the suggestions by creating posters that develop each idea.

FURTHER READING

Câmara A S 2002 *Environmental Systems: A Multidimensional Approach*. New York: Oxford University Press.

National Research Council 1999 *Distributed Geolibraries: Spatial Information Resources*. Washington, DC: National Academy Press.

National Research Council. 2007. Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management. Washington, DC: National Academy Press.

Peng Z-H, Tsou M-H 2003 *Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks*. Hoboken, NJ: Wiley.

This book is a tour de force, covering all of the materials in this chapter and much, much more.

Scharl A, Tochtermann K. (eds) 2007 *The Geospatial Web: How Geobrowsers, Social Software and the Web 2.0 Are Shaping the Network Society*. Berlin: Springer.