

GEOG 104: Geographic Information Science and Spatial Reasoning

Distributed Geographic Information Services (GIServices):

Internet GIS and Mobile GIS

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<http://moat.nlanr.net/Software/Cichlid/>

What is the Internet?

The Internet is a modern information relay system that connects hundreds of thousands of telecommunication networks and creates an “*inter-networking*” framework.

(Similar to the keyword: **cyber-infrastructure**)

Figure 1.1 Pigeon Post, Woodcut from 1481

Three Paradigms of GIS architecture

Traditional GISystems **Client/Server GISystems** **Distributed GIServices**

The Change of GIS Platforms

Mainframe GIS **Desktop GIS** **Distributed GIS**

Figure 1.2 A Development Path of Distributed GIS

Why Internet GIS?

Flexible Information Access / Exchange
(End-Users only need a web browser)

Information Sharing and Integration
(Access multiple Internet Map Servers at the same time— local governments, USGS, EPA, Census Bureau, etc.)

Real-time Information Update and Distribution Gather data from client sides (polices, firefighters), distribute updated data from server sides (control centers)

Sharing Data, Information, and Knowledge



Three Kinds of Internet GIS

Data Sharing

Applications

- On-line data warehouses (data archive)
- On-line data clearinghouse (metadata)

Information Sharing

Applications

- Web-based map display
- Navigation Services

Knowledge Sharing

Applications

- On-line GIS models
- Web-based spatial analysis tools

Development History



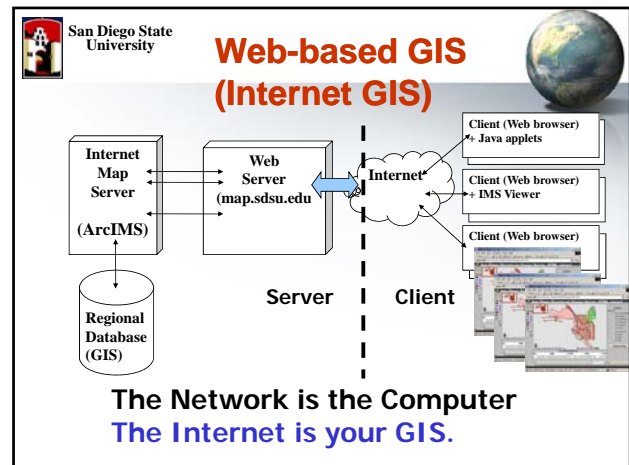
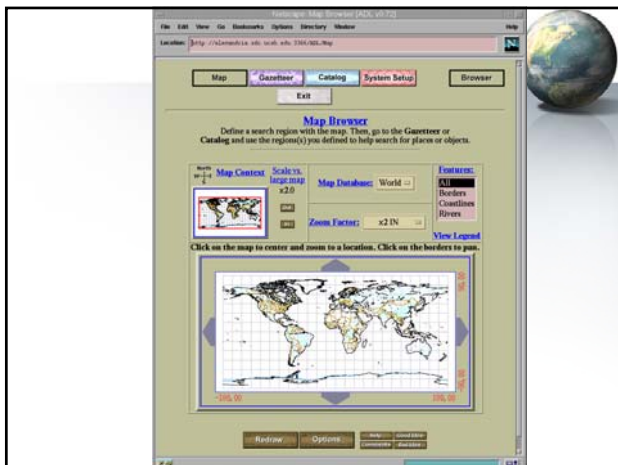
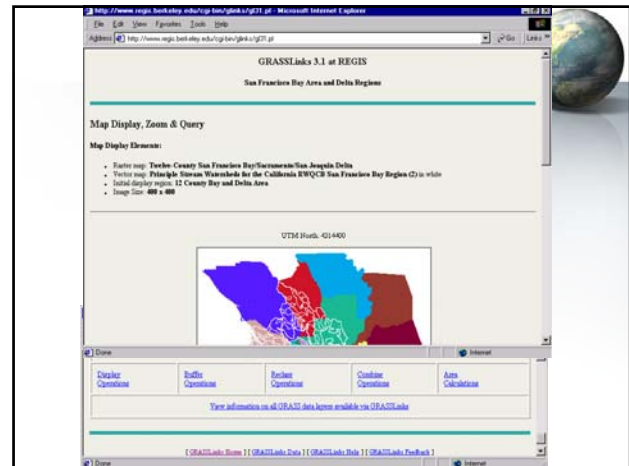
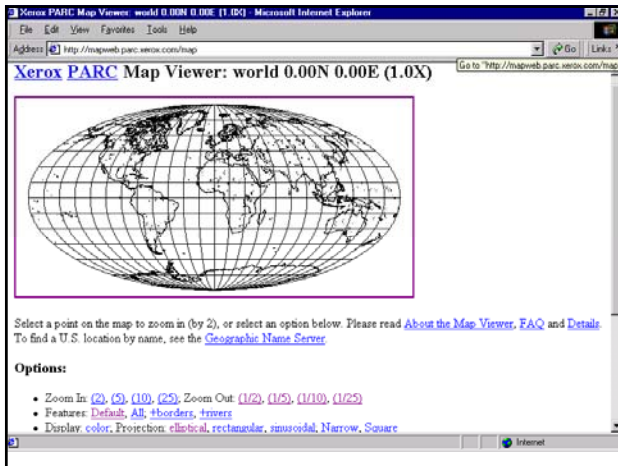
- Internet (ARPANET 1970s, TCP/IP 1983)
- World Wide Web (HTTP 1990, Mosaic 1993)


On-line GIS

- The Xerox PARC Map Viewer (Putz, 1994)
- GRASSLinks (Huse, 1995)
- The Alexandria Digital Library (1994)

Organization



- The Open GIS Consortium (OGC, 1994)
- ISO/TC 211 (the 211 Technical Committee of the International Standards Organization, 1994)





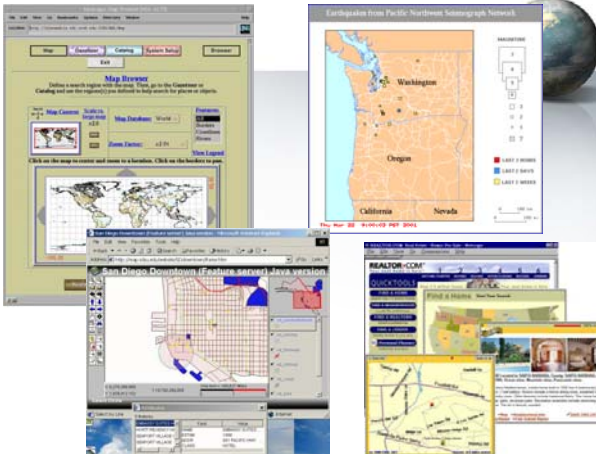

The Three Faces of "GIS"

- Geographic Information **Systems**
- Geographic Information **Science**
- Geographic Information **Services**


Geographic Information Services

- **GIServices** provide a **flexible** and **interactive** tools to help **users** achieve their goals by browsing, searching, processing, interpreting, analyzing, and exchanging geographic information (Tsou, 2005).
 - Services are **user-oriented**, customizable, and dynamic.
 - The Internet and **mobile devices** are great tools to provide GIServices. (ArcIMS, Mobile GIS, Pocket PC)
 - **Network-based** Information Access/Dissemination

Challenges with Distributed GIServices

- **Globalization of Information Access / Distribution**
 - How to find out the requested information? – **match-making (brokers)** between **service providers** and **service requestors**.
- **Decentralization of Database Management / Update**
 - How to ensure the requested data is accurate and validated? *The Integrity of GIS data sets ? (Download a SD-roads dataset)*
- **Ad-hoc Technology-centered solutions:**
 - The lack of an **sustainable** architecture which can be upgraded to new environments and new technology.



How to provide Dynamic GIServices? (Tsou, Ph.D. dissertation, 2001)

LEGO-Like GIS Components

Operational Metadata

Agent-based Communication


GIS Nodes

↔

GIS Nodes

↔

GIS Nodes



LEGO-Like GIS Components

Services

↑

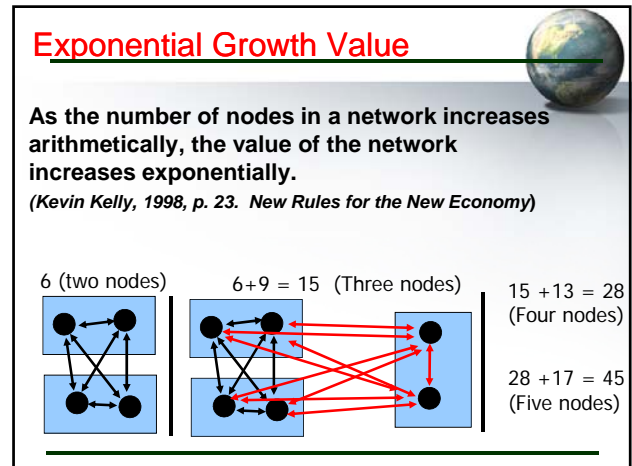
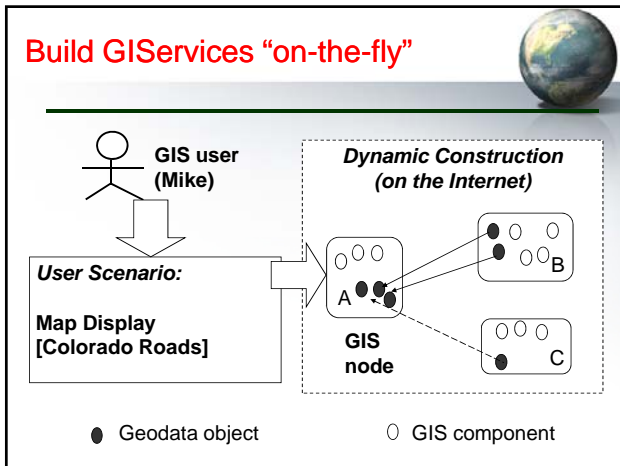
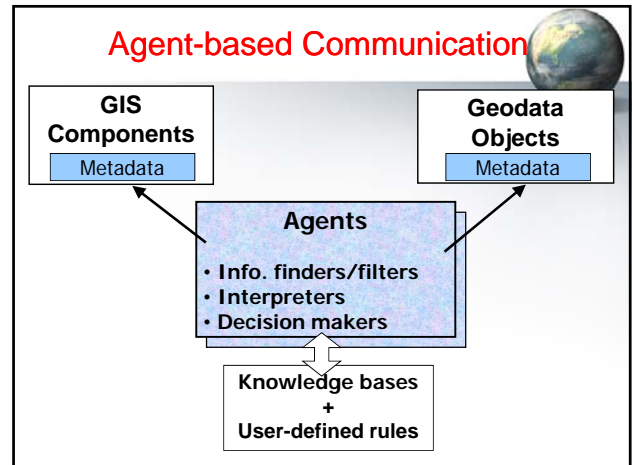
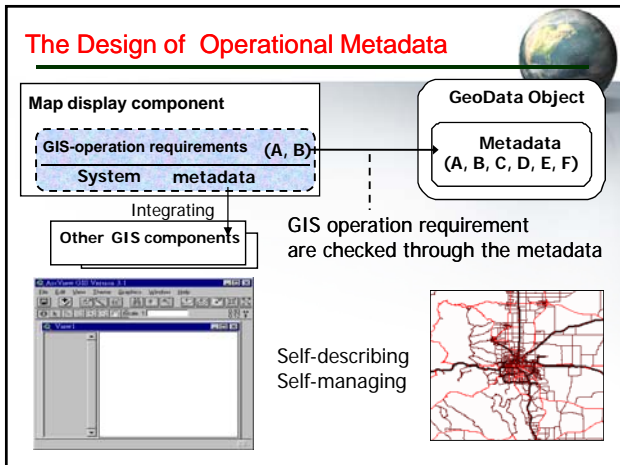
Components (Programs) + Data

Font and Formats Control
 Spell Check Control
 Display Component
 Print Preview Component

Graphic User Interface

Equation Editor Control
 Color Scheme Control
 Shading Control

A Word Processor Package
A Display Component



San Diego Wildfire 2003

San Diego Wildfire 2003
<http://map.sdsu.edu/Fireweb>

Quick time movie

Fire Perimeters (San Diego)

Web-based Mapping Services for the 2003 San Diego Wildfires

Research Static maps Interactive Maps GIS Mobile GIS About Links

During the week of October 24, 2003 two wildfires (Cedar and Paradise) ravaged San Diego County. The wildfires killed 18 people and burned down 3427 homes and businesses (source: www.springsandiego.com). These fires caused the worst damage in the history of San Diego and California. This web site was created immediately on October 27 to provide web mapping services for helping our local community. This site is updated daily and provides maps of the San Diego wildfires with various live archived web mapping services, static maps, and research articles. Most maps on this site have been created by the faculty, staff, and students in the Department of Geography, San Diego State University.

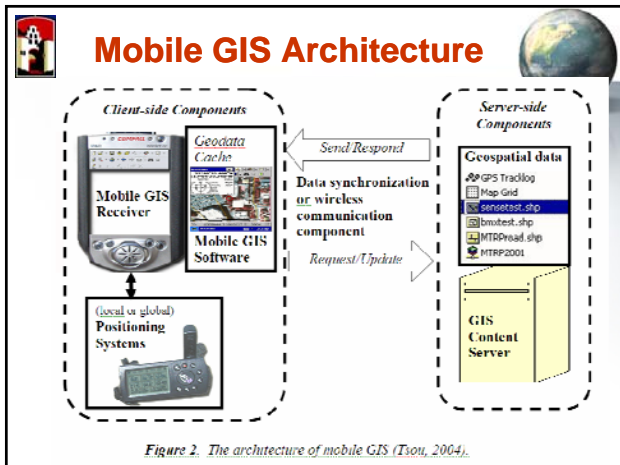
Mobile GIS

- Mobile GIS** refers to an integrated software/hardware framework for the access of geospatial data and services through **mobile devices** via **wireline or wireless networks** (Tsu, 2004).

(Notebooks, PDA, Tablet PC, Pocket PC, etc.)

WHY mobile GIS

- Field work: data collection and validation process, coupled with GPS and wireless communications.
- Real-time update / change
- Global Positioning System (GPS) integration.



Wireless Mobile GIS Integration Prototype Testing (2003 at MTRP)

(Notebook Web Server (IIS) + ArcPAD + Blue tooth GPS + Wi-Fi)

This block features a collage of images demonstrating the integration of various technologies for mobile GIS. It includes a laptop connected to a notebook web server, a car equipped with a wireless antenna, a person using a mobile device, and a field report showing a pocket PC, GPS, and wireless card. A diagram shows Wi-Fi wireless communication (up to 1000 feet) between a laptop and a mobile device.

User Scenario: Environmental Monitoring and Management

Mission Trail Regional Park (short movie)

Movies shot before the 2003 Wildfire.

After the Wildfire, another testing was conducted by helping the park ranger to evaluate the damages of wildfire and landform changes.

[\(Link to the movie MTRP.wmv\)](#)

Wireless Local Area Network (WLAN)

Wi-Fi or WiMAX Technology

Different from cellular phone communication (CDMA, GPRS)
Fast Transmission Speed. Good for GIS applications (large size of data/images)

- **Wi-Fi (802.11b, 11Mbps, 2.4 Ghz), Wi-Fi5 (802.11a, 54Mbps, 5GHz), 802.11g, and 802.11n (up to 200Mbps) -- MIMO (multiple input multiple output).** Short distance: **300 feet**.
- **WiMAX (available in late 2006) 802.16d, 802.16e (Wireless Metropolitan Area Network (WMAN)).** 30 – 75 Mbps, **4 – 6 miles**

The diagram shows a central Wireless Access Point (Wi-Fi Station) with a 300-foot range to three Receivers (Pocket PCs). To the right, a diagram shows WiMAX Wireless Communication with a range of 4-6 miles.

Real-time Data Update from Pocket PC (ArcPAD) to Internet Map Server (ArcIMS)

Submit new polygons (Hot-zones) from Pocket PC to Internet Map Server (ArcIMS) via Wi-Fi channel.

Mobile GIS with Real-time Tracking Server

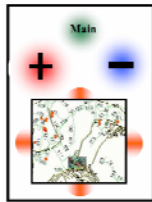
ESRI ArcIMS Tracking Server (beta-version)

Dynamically Display the location of in-field agents (park rangers, fire fighters, etc.) -- Two way communications

The screenshots show the ArcIMS Tracking Server interface, displaying a map with real-time tracking data for various agents, including park rangers and fire fighters.

Future Mobile GIS Development

- Simplified Mobile GIS User Interface
- Finger-touch Mobile GIS + voice commands (simplified user interface)



A simplified "finger-touch" user interface design for Mobile GISs



Digital Earth (1998)

<http://www.digitalearth.gov/>

The Digital Earth:
Understanding our planet in the 21st Century
by Vice President Al Gore
Given at the California Science Center, Los Angeles, California, on January 31, 1998.

A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of information about our planet and a wide variety of environmental and cultural phenomena. Much of this information will be "georeferenced" - that is, it will refer to some specific place on the Earth's surface.

The hard part of taking advantage of this flood of geospatial information will be making sense of it - turning raw data into understandable information. Today, we often find that we have more information than we know what to do with. The Landsat program, designed to help us understand the global environment, is a good example. The Landsat satellite is capable of taking a complete photograph of the entire planet every two weeks, and it's been collecting data for more than 20 years. In spite of the

Digital Earth will be a **virtual representation** of our planet that enables a person to **explore and interact** with the vast amounts of **natural and cultural information** gathered about the Earth.
(Consensus definition adopted at the Intergovernmental Workshop, 1999 Sept 23)



What impacts will the development of Digital Earth (3D Virtual Globe) have?

The Medium is The Message
(McLuhan, 1967)

(discussion in 2006 AAG session)



Message behind the Virtual Globes Technology

- Is Virtual Globe/Google Earth a medium? a **new medium?** (Hybrid space)
- **Evolution or Revolution?** (linking to traditional GIS tools)
- **What Messages We Got?** (a new paradigm in analyzing geospatial information?).
- **What kinds of impacts for us?** (business applications, web services, Geography awareness)

The Medium is the Message



Google Earth Movie



Movie created by video editing software - adding titles, effects, sounds, and music.



The Medium carries the Message (Movies are better than PowerPoint Slide!)

- Is Virtual Globe/Google Earth a medium? a **new medium?** a **better medium?**
 - GIS is a medium. Internet is a medium. 3D graphic is a medium.... Google Earth/ArcGIS Explorer combine all together.
 - What are the **contents or concepts** communicated via the Medium? Geography Awareness? GIS concepts? Protecting our watershed?

Everyone gets the Message!

- **Evolution or Revolution?** (linking to traditional GIS tools -- Cowen & Remington)
 - Google Earth/Virtual Globe is **an evolution from the software development perspective.** – ArcGlobe, Keyhole, VRML, ..
 - Google Eath/Virtual Globe is **a revolution from a general public perspective. (Why? They never see such things before! Because Google Earth is the first to combine both Data and Viewer for FREE!)**
 - **New Generation of Explorers!** The Users of Google Earth/Virtual Globe are different from traditional GIS users. (on-line community, BBS, chat rooms – new sub-culture?).

San Diego State University Google Earth Learning Modules

March 3rd, 2006, 120 Helix High students visit our GIS labs to learn GIS and GPS technology.

San Diego State University The Message could be WRONG?

- **What Messages We Got?** (a new paradigm in learning and analyzing geography?).
 - Geography is **FUN!** (really? Or 3D-fly-through is FUN?) and **IMPORTANT?**
 - **No Secrets under the Sun. (You can watch your neighbor's swimming pools or foreign nations' military bases?)** Locational Privacy?
 - **TRUE? or FALSE? (Out of date information?)** How to update the information on Virtual Globe?)
 - **Wrong Messages? (GE/Virtual Globe is not "real-time" monitoring...)** **The World is not Flat?**

San Diego State University What can We DO?

- **What kinds of impacts for us?** (business applications, web services,)
 - **Our Scientific Community** (Delcan Butler, *The Web-Wide World, Nature*, vol. 439, Feb. 16, 2006).
 - **Our General Public** (disaster management, business models, location-based services, etc.)
 - **Our Geographers -- ??? What Geography version 2.0 means?** (Alan Glennon).

Nature, vol. 439, Feb. 16, 2006
By Delcan Butler, *The Web-Wide World*,

The web-wide world

Life happens in three dimensions, so why doesn't science? Delcan Butler discusses tools, led by the Google Earth virtual globe, are changing the way we interact with our world.

Later this year, a browser researcher will be only a few clicks away from watching his neighbor's swimming pool or a foreign nation's military base. The power and utility of GIS and Google Earth into people's minds (see page 787). Before Google Earth appeared, most people did not wish that World Wide Web. It would be a good idea to upgrade your software to use GIS. Nowhere is this more so than in the field of environmental science. GIS has a part to play in the way we manage our world. As more people use GIS, the more we will see of it. As more people use GIS, the more we will see of it. As more people use GIS, the more we will see of it.

"We are going to be able to display curtains of atmospheric data and look into them from above or fly alongside them." — David Whiteman

Related Links and References

Thank You

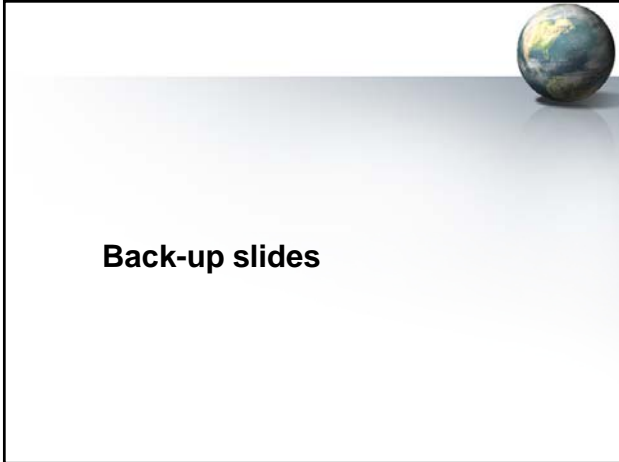

Q & A

Books & Papers (PDF available upon request)


Internet GIS (book)
<http://map.sdsu.edu/qisbook>

Tsou, M.H. (2004). Integrated Mobile GIS and Wireless Internet Map Servers for Environmental Monitoring and Management. *Cartography and Geographic Information Science*. 31(3), pp. 153-165.

Tsou, M.H. (2004). Integrating Web-based GIS and On-line Remote Sensing Facilities for Environmental Monitoring and Management. *The Journal of Geographical Systems*, No. 6: 1-20.

NSF- ATE (Advanced Technological Education) Program) **2004 Award – 3 years**




A Scalable Skills Certification Program in Geographic Information Science (GIS)
NSF-ATE DUE #0401990


San Diego State University
Mesa College (Community College)
San Diego School District (High School)

Overview:

- Provide on-line, **Web-based GIS learning modules** for high school students and teachers.
- Provide grounding in **fundamental GIS theory and concepts for community college students.**
- Help students assess their interest in and aptitude for **GIS-related careers,**
- Form an **on-line community and portal** for GIS-education research and related projects.




An Integrated GIS Education Program




- **High Schools** (GIS 1c/2c)
- **Community Colleges**
(Mesa College GIS 110, 111, 112)
- **Universities (four years undergraduate and graduate study – M.A., M.S. and Ph.D. programs)** General Education– GEOG 104
Advanced: GEOG 381, 484, 584, CS 537, CS 657.

- **(Seamless GIS Education Integration)**
Students can continue the learning of GIS technology and get some transfer credits between the three levels.



GEOG 104 Geographic Information Science and Spatial Reasoning
(<http://map.sdsu.edu/geog104>)

First General Education (GE) course in Foundation: Math and Quantitative reasoning



- On-line lecture notes
- Web-based GIS exercises
- On-line Quiz
- Introduction to Cartography, Remote sensing, GPS, GIS and spatial analysis.