

Advances in Distributed and Mobile Computing: An Update for Chapter 9

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The following information is organized by topic area, based on the research issues listed in the original chapter plus other issues that have emerged recently.

Standards

Standards for distributed and mobile computing have continued to mature. There is currently a tension between the general IT industry standards (e.g. W3C SOAP/XML and ISO SQL), geo-industry standards (e.g. OGC GML and Open LS) and geo-industry vendor standards (e.g. KML). The limited computing capabilities of the underlying platform make it challenging to develop generic standards for mobile systems

User interfaces

Much research has gone into user interaction with small, mobile devices. Cartographers have worked on techniques to make effective use of small screens, and GIScientists have examined alternative input and output devices and modalities (Special Issue of *CAGIS* 31(3) 2004). A major difference between smartphones and PDAs is an absence of a stylus and touch sensitive screen in the former. Innovations such as these continue to provide challenges and opportunities for geo-UI designers.

Sensor networks

A very active research focus has emerged in addressing the requirements of large networks of distributed sensors. These may be scattered or placed in the environment, may communicate peer-to-peer, and may be carried by human subjects. They may report location, as well as various ambient parameters such as temperature or air pollution (Stefanidis and Nittel, *Geosensor Networks*, CRC Press, 2004).

Geo-portals

The concept of a geo-portal has largely replaced earlier concepts of clearinghouses, spatial data archives, and geolibraries. A geo-portal provides a single point of access to both data and services, and uses geographic location, time, scale, and theme as its primary search parameters. In the U.S. the Geospatial One-Stop is a prominent instance of a geo-portal sponsored by federal agencies, and similar efforts can be found in many other parts of the world. Geo-portals allow data to be downloaded, and also support simple GIServices that can be invoked from browsers. Geo-portals rely on the widely adopted Web standards of the OGC (Special Issue of *CEUS* 29(1) 2006, Peng and Tsou, *Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks*, Wiley, 2003).

Social issues

Schuurman has described new ways of thinking about metadata that go far beyond existing standards and represent a much stronger focus on the user. The dominance of communication and the Internet in current thinking about GIS has led Sui to argue for a

major shift in paradigm, from GIS as the intelligent personal assistant to GIS as a medium of communicating what is known about the planet. The concept of Digital Earth, and its manifestation in the current generation of geo-browsers, typified by Google Earth, have added to this perception. Several analyses have been made of the potential of distributed and mobile computing to alter human activities, and the locations of those activities on the Earth's surface.

Locator technologies

GPS and GLONASS will be joined shortly by the EU's Galileo, and the services they provide are increasingly available through small, mobile devices. Much research has gone into nascent technologies for extending the use of GPS indoors, in urban canyons, and under tree canopies where the GPS signal is not available. RFID (radio-frequency identification) is a rapidly growing locator technology that is being widely exploited in retailing, logistics, agriculture, and many other areas, where it may eventually replace the optically read bar-code.

Emergency management

The events of 9/11/2001, Hurricane Katrina, and many other disasters have drawn attention to the importance of GIS in all phases of emergency management—planning, response, recovery, and mitigation. Detailed imagery and other data on the impact of Katrina was available on the Internet via the Geospatial One-Stop within hours. Several conferences, workshops, and committees have drawn attention to the use of GIS in this context, and to the potential of distributed and mobile computing (<http://www.gdmc.nl/events/gi4dm/>, <http://lsdis.cs.uga.edu/UCGIS/>, <http://www8.nationalacademies.org/cp/projectview.aspx?key=BESR-U-02-09-A>).

Servers and Web services

As we look forward to the next five years of distributed and mobile computing it is clear that servers will become ever more important as the engines for performing geographic computations. Coupled with Internet connections able to pass messages and data in XML format, we believe that this will be the critical infrastructure for enabling more distributed and mobile computing. GIS vendor products are already in the market to support this vision.

Data infrastructure

The coverage of communications networks will continue to constrain the spatial domain of full-function computing. Small-area broadband (WiFi) currently enables some mobile functionality, mostly at the individual user-ISP level in small defined areas such as coffee shops or hotels. Wide area wireless networks (WiMAX), roadside Intelligent Transportation Systems infrastructure, and ad hoc wireless networks are now radically expanding this capability, both geographically and technologically, allowing autonomous agents to communicate with each other without a mediator. For example, vehicles can establish temporary links with other nearby vehicles, to provide advance warning of braking and traffic hazards such as icy pavement. The technology raises questions about the broader possibilities for data that rapidly change in space and time, that can be shared with neighbors and the community.