UNITED
NATIONS

E

Economic and Social Council

Distr.
LIMITED

E/CONF.90/L.16
1 April 1997

ENGLISH ONLY

SIXTH UNITED NATIONS REGIONAL
CARTOGRAPHIC CONFERENCE FOR
THE AMERICAS
New York, 2-6 June 1997
Item 5 (b) of the provisional agenda*

REVIEW OF THE LATEST TECHNOLOGY IN CARTOGRAPHIC DATA ACQUISITION, MANIPULATION, STORAGE AND PRESENTATION, WITH SPECIAL EMPHASIS ON POTENTIAL APPLICATIONS IN DEVELOPING COUNTRIES: GEOGRAPHIC INFORMATION SYSTEMS: DEFINITION, FORMATION AND APPLICATION

Standards for the Global Spatial Data Infrastructure (GSDI)

Paper submitted by the United States of America**

---

* E/CONF.90/1.

** Prepared by Henry Tom, National Imagery and Mapping Agency.

97-09995 (E) 130597 190597

INTRODUCTION

Over the past two decades, the introduction of computers to the geographic community has progressed from the automation of manual techniques in cartography to the analysis of spatial data by geographic information systems (GIS). A GIS is an information system which answers the fundamental question of where? In general, geographic information systems organize, analyze, and display spatial data. Beyond producing computer maps, a GIS performs spatial analysis and complex queries. GIS serves as an enabling technology because so much data is inherently spatial through geo-referencing by a coordinate system or set of alphanumeric codes.

The integration of technological advances in computer hardware and software capabilities with mapping and analytical functionality in conjunction with decreasing costs have led to rapid rise and use of GIS technology. GIS capabilities are beginning to be integrated into mainstream information technologies. For example, within the context of a spreadsheet application containing data associated with numerous cities within a country, a simple function would be to selectively display their locations on a map as an option. Portable Global Positioning Systems (GPS) receivers record geographic locations from anywhere on the earth and are used in surveying, mapping, and navigation systems for land vehicles, planes, and ships. The geographic community has invested considerable resources into the conversion of analog spatial data, such as paper maps, into digital form. Satellites, using a variety of sensors, will provide a new and abundant source of spatial data. Optical and radar satellite imagery are important for updating maps and/or originating digital spatial databases Such systems will provide terabytes of spatial data in digital form directly, without the lengthy and costly process of analog to digital conversion, to the geographic community and the information technologies incorporating GIS functionality.

Currently, the declining cost of producing and using spatial data is intensifying the need to share and integrate spatial data. Hence, the availability, accessibility, management, and integration of digital spatial data is becoming a major challenge to the GIS community of data producers, software vendors, systems integrators, and users. Increasingly, the international response to this challenge is the formation of spatial data infrastructures.

Spatial Data Infrastructures

Spatial data infrastructures (SDI) at the national and regional levels are collectively stimulating the emergence of the global spatial data infrastructure. A spatial data infrastructure for a country is considered a national spatial data infrastructure (NSDI), which can vary by country. A regional spatial data infrastructure (RSDI) is comprised of several NSDIs or by a number of countries, in which a country may or may not have its own NSDI. Accordingly, the global spatial data infrastructure is formed by linking national and regional spatial data infrastructures.

Four elements are emerging as major components of a spatial data infrastructure, common to each level of the global spatial data infrastructure. The four components are: ***technology, standards, policy, and institutional framework***. For technology: there was acknowledgment that GIS technology is founded upon generic information technology, which accentuates the need for GIS technology to be fully integrated with the emerging Global Information Infrastructure (GII). For standards: GIS standards are also based on information technology standards and that the GIS standards infrastructure needs to be understood, adopted, and utilized within the broader structure of a spatial data infrastructure. For policy: many policies need to be developed, with an international viewpoint, regarding all aspects of data. For institutional framework: agreements must be ratified for coordinating the formation and linking of national and regional spatial data infrastructures to form the global spatial data infrastructure.

Another important aspect of the global spatial data infrastructure is the concept of ***framework data***. Framework data are those basic datasets upon which most other datasets could be built. Some of the basic datasets identified include: geodetic, cadastral, hydrography, transportation, boundaries, elevation, and digital orthoimagery datasets. It was quite apparent that the underlying dataset for framework data is the *geodetic network*, which provides consistent global geo-referencing for spatial datasets created or derived.

Internationally, there is consensus in recognizing the importance of GIS standards. The correspondence of levels between the GIS standards infrastructure and those of the global spatial data infrastructure facilitates the integration of spatial data. GIS standards can integrate horizontally across a spatial data infrastructure level and vertically integrate between various levels. GIS standards provide the horizontal integration of spatial data at each of the federal government, municipal, county, and state levels and provide the vertical integration of these levels to form the national spatial data infrastructure. Similarly, GIS standards also provide the horizontal integration of spatial data across each of the national and regional levels, while providing the vertical integration of these levels to form the global spatial data infrastructure. Equally significant, the global spatial data infrastructure serves a major role in the development, deployment, and implementation of international GIS standards. The success of standards, in turn, determines the viability of the global spatial data infrastructure. Consequently, a basic understanding of GIS standards and the GIS standards infrastructure is vital.

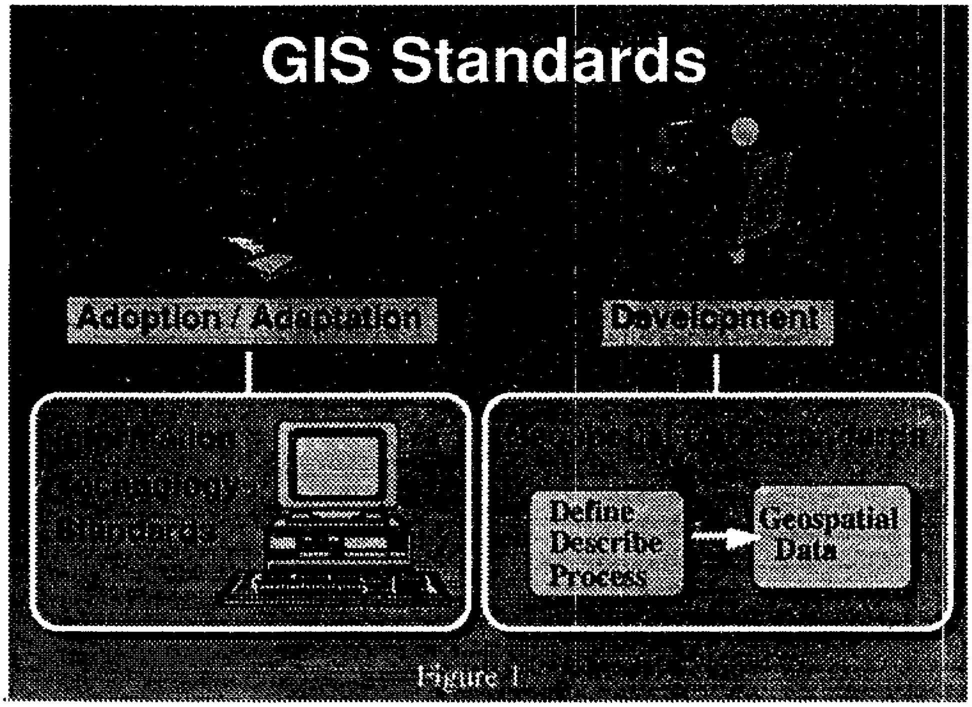

Figure 1

GIS Standards

GIS standards are comprised of both information technology standards and spatial data standards. Information technology standards are either adopted in total or adapted with modification. Spatial data standards are developed to define, describe, or process spatial data. (Figure 1) During the past decade, GIS standardization was focused on developing a spatial data interchange standard. This effort, however, was made by over two dozen countries and international organizations. As a result, several spatial data interchange standards exist. Because this was the first standardization effort within the GIS world, it required a long time to overcome an atmosphere of reluctance and to establish a mindset receptive to standardization within the GIS community. This change in attitude is the true value of these initial efforts in standardization. The GIS community is now accepting standards, such as the forthcoming metadata standard. In conjunction with this acceptance, three trends in GIS standardization have evolved.

First, the development of GIS standards should be anticipatory. Standards developed as a reaction to a problem are usually too late because of the lengthy development time and equally long if not longer time required for approval. The time span required for approval generally reflects the extent of consensus needed. If standardization occurs too late, resistance from established providers and users can derail any coherent resolutions. Timing in standardization is critical. If standardization occurs too soon, it can stifle innovation or even lead technology away from its own course of evolution. Effective standardization requires foresight and begins before the needs and problems arise.

Secondly, the development of GIS standards now includes the participation of end users. GIS users are not only concerned about the interoperability of hardware and software, they are specifically addressing the interoperability of data - in terms of terminology, syntax, and semantics. GIS users, having reached a level of maturity and sophistication, are aware that many of the spatial data standards to be developed, in large part, will be implemented and used by GIS data producers and users.

Thirdly, GIS standards need to be integrated. The GIS community recognizes that standards will be used more as an integrated set of standards than just a number of stand alone standards. Several emerging standards such as the metadata standard and data quality standard will be incorporated as parts of other forthcoming standards.

Globally, the development of GIS standards is occurring at government, national, regional and international levels. This development is not confined to just standards organizations which formally develop and approve standards. Substantial efforts are being made in various user/applications communities. Some user/applications communities may develop standards, while others endorse and/or adopt GIS standards. These communities are, in fact, the user community for GIS standards. There is a definite need to coordinate this development from the standpoints of integration and division of labor to avoid duplication and incompatibility. Collectively, these organizations and efforts form the GIS standards infrastructure which needs to be understood and incorporated into the hierarchy of spatial data infrastructures.

GIS Standards Infrastructure

Standards Organization	Scope of Standards	User Organizations
National Institute of Standards and Technology (NIST)	Government	Federal Geographic Data Committee (FGDC)
American National Standards Institute (ANSI)	National	Open GIS Consortium (OGC) National States Geographic Information Council (NSGIC)
European Committee for Standardization (CEN)	Regional	Digital Geographic Information Working Group (DGIWG) European Umbrella Organization for Geographic Information (EUROGI) Permanent Committee on GIS Infrastructure for Asia and the Pacific
International Organization for Standardization (ISO)	International	International Cartographic Assoc. (ICA) International Hydrographic Bureau (IHB) Open GIS Consortium (OGC)

Figure 2

/...

The GIS Standards / Spatial Data Infrastructures

The GIS standards infrastructure, a specific subset of the global standards infrastructure, provides an institutional structure and process for coordinating and integrating the development of GIS standards. The levels of the GIS standards infrastructure correspond with the global spatial data infrastructure. This correspondence in levels reflects common coverage in organizational jurisdiction and applicability. At the government and national levels, there will be some variation depending on the political and cultural composition of a particular country. The term regional, in the context of the GIS standards infrastructure and the global spatial data infrastructure, applies to a grouping of countries. Regional can also be applied to a grouping of cities, counties, and provinces - depending on the country and its composition. By example, the following is a description of the GIS standards infrastructure primarily from the perspective of the United States of America. (Figure 2)

National Level

For the United States of America, standardization efforts occur at the state government, federal government, national, and international levels - standardization at the local level is incorporated under the state level. (Figure 3) At each level of the GIS standards infrastructure, there can be two types of organizations developing standards: formal standards bodies and user/industry organizations.

Within the United States, standards efforts at the city and county levels form tiers under the state level. These efforts are either formal or user/industry based. States in the US are generally influenced by the activities of other states, associations of states, and primarily, the federal government.

At the U.S. federal government level, the National Institute of Standards and Technology (NIST) promulgates standards for organizations within the federal government. NIST is a formal standards body. The Federal Geographic Data Committee (FGDC) is the primary user group at the federal government level. The FGDC is composed of federal organizations which have a primary interest and activities involving spatial data. In 1994, FGDC was given a mandate to initiate the development of spatial data standards. FGDC has approved the Spatial Data Transfer Standard (SDTS) and its Topological Vector Profile (TVP) and developed the Metadata Standard. FGDC has been quite active and as of September 1996, two standards have completed the public review stage, four standards are either in preparation or out for public review, ten standards in draft, and five proposed standards. (Appendix A)

At the U.S. national level, this consists of the federal and state governments, public, private, academic and professional communities. The formal standards body at this level is the American National Standards Institute (ANSI) accredited X3L1, GIS technical committee. At the national level, user/industry groups include the Open GIS Consortium

(OGC), National States Geographic Information Council (NSGIC), and also the Federal Geographic Data Committee. NSGIC is a council composed of the state GIS coordinator or equivalent for almost all the states in the US. The OGC is a consortium of vendors, integrators, researchers, government agencies, data suppliers, and users. The objective of OGC is to share spatial data and geoprocessing functionality through middleware (software) within a distributed computing environment. The OGC is currently developing the Open Geodata Interoperability Specification (OGIS). When completed, it will be submitted to the formal standards environment for approval as a standard. All participants at the national level contribute to the formal process of GIS standardization through X3L1. X3L1 also serves as the US Technical Advisory Group (TAG) to the recently formed International Organization for Standardization (ISO) Technical Committee 211, Geographic Information/Geomatics.

GIS Standards/Spatia Data Infrastructure

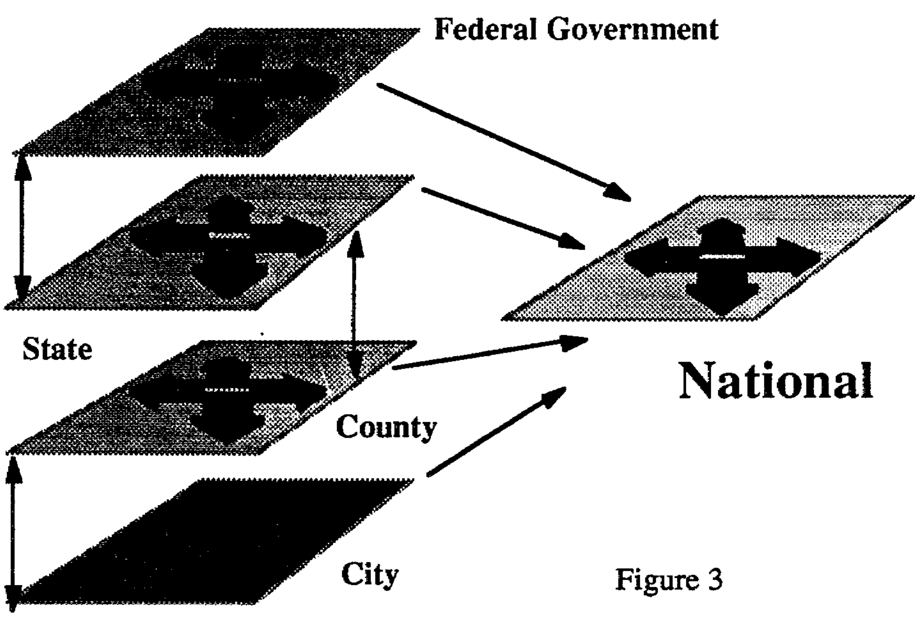

Figure 3

A national spatial data infrastructure formalizes the structure and process for organizing, using and sharing spatial data common to a broad spectrum of applications and users within a country. The concept of a spatial data infrastructure is not new. The need was recognized several years ago. In 1990, the Federal Geographic Data Committee (FGDC) in the United States of America began such an initiative. This effort received substantial visibility when President Clinton issued Executive Order 12906, April 11, 1994 to formally establish the National Spatial Data Infrastructures (NSDI) and the Secretary of the Interior, a member of the President's Cabinet, personally chaired the FGDC. Other countries such a Canada, the United Kingdom, Australia, Japan and Korea, have also established their own NSDI during the past two years. In Chile, the First International Symposium on Spatial Databases of Immediate Access, Oriented to Multi-Users and Multiple Applications was held from October 29-31, 1996 in Valparaiso, Chile. The third day of this meeting was devoted to exploring proposals and possibilities in achieving a global spatial data infrastructure. The resulting proposal is one supporting the development of a national spatial data infrastructure. A robust national level within the GIS standards infrastructure enhances the integration of spatial data across a national spatial data infrastructure while providing the integration paths to a regional and/or global spatial data infrastructure.

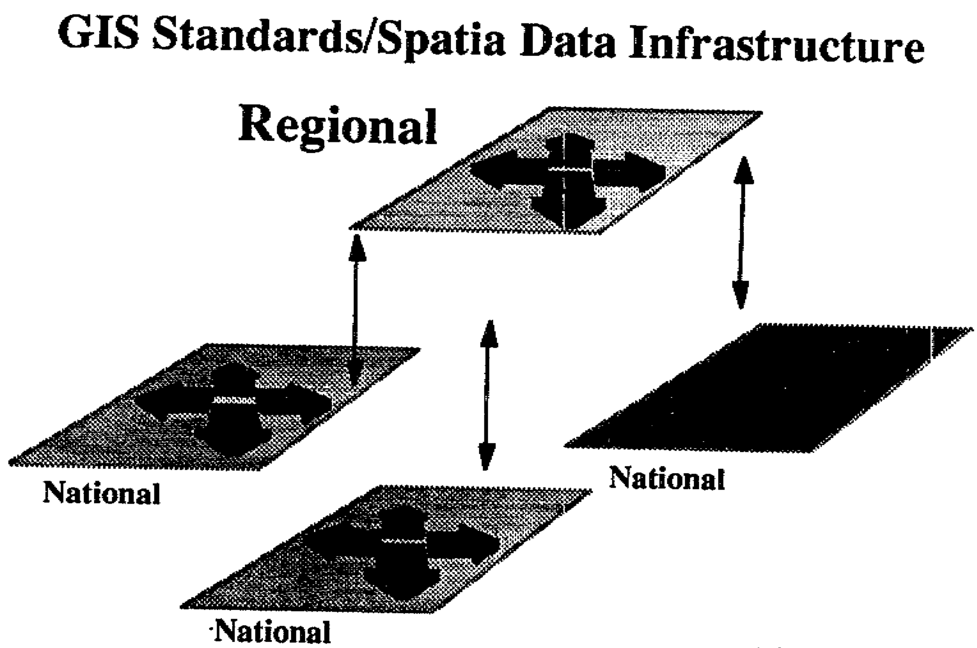

Figure 4

Regional Level

Although the United States does not include a regional level (group of countries), the regional level for European and the Asia and Pacific countries is quite significant. Thus, depending on the region of the world, levels for the GIS standards infrastructure will vary accordingly. (Figure 4)

In terms of a regional level within the GIS standards infrastructure, Europe has a formal regional standardization body. The European Committee for Standardization (CEN) is very active with two technical committees having direct relevance to GIS standards, CEN/TC 278, Road Informatics and CEN/287, Geographic Information. The major user group is EUROGI, which serves as the umbrella organization for 16 national geographic information associations, six pan European organizations, and includes a number of observers. The European community, under the leadership of the European Umbrella Organization for Geographic Information (EUROGI), established the European Geographic Information Infrastructure (EGII), while the Permanent Committee on GIS Infrastructure for Asia and the Pacific was formed recently. Although the Asia/Pacific regional standards body is not currently engaged in GIS standards, this may not be necessary. The Permanent Committee on GIS Infrastructure for Asia and the Pacific, the primary user group for this region, may adopt GIS standards directly from ISO/TC 211. The directors of national surveying and mapping organizations for over 55 countries were invited to attend the meeting in Sydney, Australia from September 29 - October 4, 1996. The Permanent Committee was formed as a result of a resolution passed at the Thirteenth United Nations Cartographic Conference for Asia and the Pacific in Beijing, China in May 1994. The Permanent Committee has made progress in approving the Statutes and Rules of Procedure and the organization of the following working groups and their work plans:

- WG1 Geographical Information Infrastructure and Institutional Framework
- WG2 Issues relating to Cadastral Infrastructure
- WG3 Regional Geodetic Networks
- WG4 Legislation and administrative arrangements for the acquisition and sharing of spatial data.

Both the European and Asia / Pacific regional spatial data infrastructures are converging in their consensus that the work of ISO/TC 211 may provide the GIS standards to enable the global spatial data infrastructure. Also, there was an overall agreement on the need to cooperate and coordinate on issues requiring further study and resolution. At these international meetings, the global sharing of spatial data was deemed essential - providing international benefits which contribute to improving the quality of life and preservation of the global environment. The focus in the European region was data sharing, while in the Asia and the Pacific region, it was technology transfer.

International Level

At the international level, ISO is the formal standards body. There are more than 100 member countries in ISO. Each country has a national standards organization which represents them in ISO. Depending on interest in a technical committee, each national standards body designates a Technical Advisory Group (TAG) to represent the national body within the technical committee. Each country has only one vote. Liaison members to an ISO technical committee may receive technical documents and participate at meetings, however, liaison members may not vote. National body members with an observer status may vote in letter ballots.

User/applications groups at the international level include: International Cartographic Association (ICA), International Hydrographic Bureau, and the International Society for Photogrammetry and Remote Sensing (ISPRS). Because OGC now has memberships from various countries, it can also be considered as an international user organization.

In April, 1994, ISO/TC 211, Geographic Information/Geomatics was established and held its first plenary meeting during November, 1994 in Oslo, Norway. There are twenty-four members and thirteen observing members. From the user perspective, ISO/TC 211 has nine Class A liaisons with international organizations, as well as seven other ISO technical committees. Many of the GIS standards required for spatial data infrastructure, at all levels, are currently being developed by this committee.

The Secretariat of ISO/TC 211 is Norway and the Chairman is Mr. Olaf Ostensen. The current programme of work includes twenty work items which will become standards. The ISO standard identified for this work is ISO 15046, parts 1-20 with completion slated for 1998. (Appendix B) While the programme of work for ISO/TC 211 is substantial and broad, the real measure of success will be whether or not these standards can function as an integrated set of standards. The success of the global spatial data infrastructure is directly dependent upon the GIS standards infrastructure and its international component, ISO/TC 211.

Recently, EUROGI and other leading geographic organizations such as the Atlantic Research Institute, Institute for Land Information (ILI), Deutscher Dachverband fur Geoinformation, Open GIS Consortium, FGDC, and Commission 3, Federation Internationales des Geometres (FIG) under the sponsorship of the European Commissioner, Mr. Martin Bangemann, held a meeting from September 4-6, 1996 in Bonn, Germany to initiate a dialogue on the Emerging Global Spatial Data Infrastructure. There was consensus on the need for a common vision, vocabulary, and an international forum to coordinate such efforts. The meeting was attended by representatives from twenty countries primarily from the European region. (Figure 5)

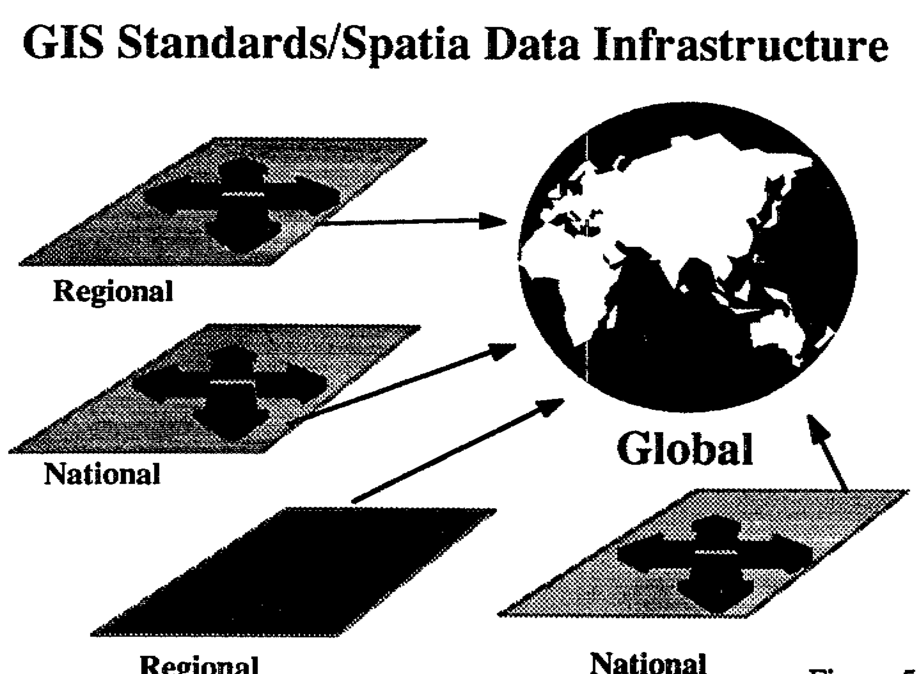

Figure 5

/...

Conclusion

As envisioned, the global spatial data infrastructure has four components to enable its realization: technology, standards, policy, and institutional framework. With standards as a major component, the GIS standards infrastructure is established with a well-defined structure and process. Incorporating the GIS standards infrastructure within the global spatial data infrastructure provides much of the needed integration for spatial data.

Standards for the global spatial data infrastructure represents a rare opportunity to truly make a difference - globally. Many developing countries not currently participating in ISO work may now take an active role. This is because standards and the participation in developing standards is a mechanism for technology transfer. GIS technology is also fundamental for much of the infrastructure development projects in developing regions of the world. Successful regional integration of enabling information technologies such as GIS technology will depend, in no small part, on availability and acceptance of standards.

Appendix A -

Status of U.S. Federal Geographic Data Committee (FGDC) Standards

September, 1996

Approved

Spatial Data Transfer Standard (SDTS)
Spatial Data Transfer Standard (TVP) Topological Vector Profile
Content Standard for Digital Geospatial Metadata

Completed Public Review

Cadastral Data Content Standard
Classification of Wetlands and Deep Water Habitats

Out for Public Review

Vegetation Classification Standard

In preparation for Public Review

Soils Geographic Data Standard
Geodetic Control Networks Accuracy Standard
National Spatial Data Accuracy Standard

Standards in Draft

Standards for Digital Orthoimagery
Standards for Digital Elevation Data
Transportation Network Profile for SDTS
Specification for Encoding a Linear Referencing System
Point Profile for SDTS
Transportation Spatial Data Dictionary
River Reach Coding Standards
Metadata Profile for Cultural and Demographic Data

/...

Geospatial Positioning Accuracy Standards
Digital Geospatial Metadata Standards for Geodetic Data

Proposed Standards

Cartographic and Digital Standards for Geologic Data
Utilities Data Content Standard
Geospatial Environmental Hazards Standard
Facility Identification Data Standard
CADD Profile for SDTS

Appendix B -

Overview of ISO/TC 211, Geographic Information / Geomatics

Scope:

Standardization in the field of digital geographic information. This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analyzing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations. This work shall link to appropriate standards for information technology and data where possible, and provide a framework for the development of sector-specific applications using geographic data.

Members:

P - Members (24)

Australia	*Republic of Korea*
Austria	*Morocco*
Canada	*The Netherlands*
China	*New Zealand*
Czech Republic	*Norway*
Finland	*The Russian Federation*
France	*South Africa*
Germany	*Spain*
Iran	*Sweden*
Italy	*Turkey*
Jamaica	*United Kingdom*
Japan	*United States of America*

Observers:

O - Members (13)

Belgium	*Pakistan*
Denmark	*Poland*
Hong Kong	*Portugal*
Hungary	*Switzerland*
Iceland	*Ukraine*
India	*"Yugoslavia" **
Malaysia	

* "Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States. The United States view is that the Socialist

/...

Federal Republic of Yugoslavia (SFRY) has dissolved and that none of the successor republics represents its continuation.

Class A Liaisons (9):

Digital Geographic Information Working Group (DGIWG)
European Petroleum Survey Group (EPSG)
International Association of Geodesy (IAG)
International Cartographic Association (ICA)
International Federation of Surveyors (FIG)
International Hydrographic Bureau (IHB)
International Society of Photogrammetry and Remote Sensing (ISPRS)
Open GIS Consortium (OGC)
United Nations Economic Commission for Europe (UNECE)

Internal Liaison (7):

ISO/TC 46/WG2	*Information and Documentation*
	Coding of country names and related entities
ISO/TC 82	*Mining*
ISO/TC 184/SC4	*Industrial Automation Systems and Integration*
ISO/TC 204	*Transport Information and Control Systems*

ISO/IEC/JTC 1/SC21/WG 3	*OSI, Data Management and ODP*
ISO/IEC/JTC 1/SC 30	*Open EDI*
ISO/IEC/JTC 1/SWG GII	*Global Information Infrastructure*

ISO/TC 211 work groups and work items:

WG 1, Framework and Reference Model - Convenor, United States of America

Reference Model
Overview
Conceptual Schema Language
Terminology
Conformance and Testing

WG 2, Geospatial Data Models and Spatial Operators - Convenor, Australia

Spatial Subschema
Temporal Subschema
Rules for Applications Schema
Spatial Operators

WG 3, Geospatial Data Administration - Convenor, United Kingdom

Cataloguing
Geodetic Reference Systems
Indirect Reference Systems
Quality
Quality Evaluation Procedures
Metadata

WG 4, Geospatial Services - Convenor, Norway

Positioning Services
Portrayal of Geographic Information

/...

Encoding
Services

WG 5, Profiles and Functional Standards - Convenor, Canada

Profiles
