**6 th SEMESTER (MAJOR)**

**PAPER 604: PRINCIPLES AND APPLICATION OF REMOTE SENSING, GIS AND GPS**

**UNIT 2: GEOGRAPHICAL INFORMATION SYSTEM**

**By -Rashmi Sarkar**

**Definition and Components of GIS**

**Introduction:**

A Geographic Information System (GIS) is a system of computer software, hardware and data, personnel that make it possible to enter, manipulate, analyze, and present data, and the information that is tied to a location on the earth's surface. This system comprises of Software, Hardware, Data, and Personnel that make it possible to enter, manipulate, analyze and present information that is tied to a location on the earth's surface.

**Definition of Geographic Information System (GIS)**

There are different definitions for Geographic Information System, each developed from a different perspective or disciplinary origin. Some focus on the map connection, some stress the database or the software tool kit and others emphasis applications such as decision support. Defining a GIS can be done by either explaining what it can do (Functions) or by looking at the components. Both are important to really understand a GIS and use it optimally.

* An analysis of the three letters of the acronym GIS gives a clear picture of what GIS is all about:

G: Geographic: Implies an interest in the spatial identity or locality of certain entities on, under or above the surface of the earth.

I: Information: Implies the need to be informed in order to make decisions. Data or raw facts are interpreted to create information that is useful for decision-making.

S: System: Implies the need for staff, computer hardware and procedures, which can produce the information required for decision-making that is data collection, processing, and presentation .

**Definition:**

1. GIS is a system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems (Rhind, 1989)
2. GIS is defined as a decision support system involving the integration of spatially referenced data in a problem-solving environment. (Cowen, 1988)
3. GIS is defined as a powerful set of tools for collecting, storing, retrieving, at will, transforming and displaying spatial data from the real world (Burrough, 1986)
4. GIS is any manual or computer based set of procedures used to store and manipulate geographically referenced data. (Aronoff, 1989)
5. GIS is an institutional entity, reflecting an organizational structure that integrates technology with a database, expertise, and continuing financial support over time (Carter, 1989).
6. In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations. Practitioners also regard the total GIS as including operating personnel and the data that go into the system (United States Geological Survey- USGS).
7. GIS is an integrated system of computer hardware, software, and trained personnel linking topographic, demographic, utility, facility, image and other resource data that is geographically referenced (National Aeronautics and space Administration- NASA)

**Components of GIS**

GIS have mainly 5 components: Hardware, Software, Data,People, and Methods.

**Hardware:**

Hardware is the computer on which a GIS operates; GIS software runs on a wide range of hardware types, from centralized computer server to desktop computers and in stand-alone or networked configurations. Hardware relates to device used by end users such as graphic devices or plotters and scanners. Data storage and manipulation is done using a range of processor. With the development of the Internet and Web based application, Web servers have become part of much system’s architecture, hence most GIS’s follows 3-Tier architecture. It consists of the computer system on which the GIS software will run. The choice of hardware system range from 300MHz Personal Computers to Super Computers having capability in Tera FLOPS.

* The computer forms the backbone of the GIS hardware, which gets its input through the Scanner or a digitizer board.
* Scanner converts a picture into a digital image for further processing. The output of scanner can be stored in many formats e.g. TIFF, BMP, JPG etc.
* A digitizer board is flat board used for vectorisation of a given map objects.
* Printers and plotters are the most common output devices for a GIS hardware setup.

**Software:**

GIS software provides the functions and tools needed to store, analyze and display geographic information. Key software components are

1. Tools for the input and manipulation of geographic information. A database management system (DBMS)
2. Tools that support geographic query, analysis and visualization.
3. A geographical user interface (GUI) for easy access to tools.
4. Software is also a highly dynamic part of the system. Dozens of GIS software packages now exist. These systems are available on many different types of hardware platforms and come with a wide variety of functional capabilities.
5. GIS software provides the functions and tools needed to store, analyze, and display geographic information.
6. GIS software in use are ArcGIS, MapInfo, Global mapper, AutoCAD Map, etc. The software available can be said to be application specific.
7. When the low cost GIS work is to be carried out desktop Global mapper, Mapinfo is the suitable option. It is easy to use and supports many GIS feature.
8. If the user intends to carry out extensive analysis on GIS including modelling and report generation, ArcGIS is the preferred option. For the people using AutoCAD and willing to step into GIS, AutoCAD Map is a good option.

**Data:**

Possibly the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider, A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organizations to organize and maintain their data, to mange spatial data. Geographic data are basically divided into two main groups are **vector and raster.**

* **Vector data/layers** in GIS refer to discrete objects represented by points, lines and polygons. Lines are formed by connecting two or more points and polygons are closed set of Lines. Layers represent geometries that share a common set of attributes. Objects within a layer have mutual topology. Vector sources include digitized maps, features extracted from image surveys and many more.
* **Raster data** is a continuous grid of cells in two dimensions or the equivalent of cubic cells in three dimensions. Raster data are divided conceptually into categorical and continuous. In a categorical raster every cell value is linked to a category in a separate table.

Examples Soil type, vegetation types. Land suitability, and so on. Continuous raster images usually describe continuous phenomena in space such as Digital Elevation Model where each pixel is an elevation value. Data is one of the most important, and often most expensive, components of a GIS. All data in a GIS are either **spatial data or Attribute data.**

* **Spatial data** tells us where something occurs.
* **Attribute data** tells what occurs; it tells us the nature or characteristics of the spatial data.

Geographic data, which is comprised of geographic features and their corresponding attribute information, is entered into a GIS using a technique called digitizing.This process involves digitally encoding geographic features, such as buildings, roads or county boundaries. Digitizing is done by tracing the location, path or boundary of geographic features either on a computer screen using a scanned map in the background, or a paper map that is attached to a digitizing tablet. The digitizing process can be very tedious and time consuming, especially when capturing large datasets such as soil polygons, streams or topographic contours. Fortunately, much of the data GIS users need has been created by government agencies or commercial operations, and is available for free or for purchase from the data provider or from a spatial data clearinghouse. GIS uses Relational Databases to store and manipulate attribute data. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organization to maintain their data, to manage spatial data.

**User/People:**

GIS technology is of limited value without the people who manage the system and develop plans for applying it to real-world problems. The GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work. The final component required for a true GIS is users. The term "user" may refer to any individual who will use GIS to support project or program goals, or to an entire organization that will employ GIS in support of its overall mission. The real power of a GIS comes from the people who use them. Over the past decade, computers have become much easier for people to use and more affordable for companies, schools and organizations to purchase. Today GIS is being used by people, in many different fields, as a tool that enables them to perform their jobs more effectively.

* Police use GIS to solve crimes, Emergency 911 operators use GIS to send emergency personnel to a person in distress.
* Biologists use GIS to protect plant and animal species, teachers use GIS to teach lessons in geography, history or engineering.
* The list of GIS users in the 21st century goes on and on. Whatever the application, the user is the key to a successful GIS.
* GIS users are often envisioned as hands-on computer processing people. While this is in part true, often a broader spectrum of GIS users is chosen.
* One classification scheme (USGS, 1988) classifies users into three groups:

♦ System users ♦ End Users ♦Data Generators

**Methods:**

A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization. Geographic Information System- The organized activity by which people, Measure aspects of geographic phenomena and processes.

* Represent these measurements, usually in the form of a computer database, to emphasize spatial themes, entities and relationships.
* Operate upon these representations to produce more measurements and to discover new relationships by integrating disparate sources.
* Transform these representations to conform to other frameworks of entities and relationships.
* These activities reflect the large context (Institution and Cultures) in which these people carry out their work. GIS is primarily a computer software package for organizing data with location dimension.
* However, its capacity to assimilate the concepts and algorithms from many discipline such as cartography, geography, surveying, statistics, operation research techniques and computational mathematics make it a versatile tool for handling geo referenced data.
* It establishes one-to-one correspondence between the spatial and non-spatial data and there by performs an integrated analysis. The spatial data could be in the form of charts, aerial photos, satellite imageries, plane table surveyed maps and
* Global Positioning System(GPS) generated observation i.e. essentially mapped databases.
* The non-spatial or the attribute data could be in the form of words, numbers and symbols obtained from say census, secondary surveys and other sources.

A successful GIS operates according to a well-designed plan and business rules, which are the models and operating practices unique to each organization. There are various techniques used for map creation and further usage for any project. The map creation can either be automated raster to vector creator or it can be manually vectorised using the, scanned images. The source of these digital maps can be either map prepared by any survey agency or satellite imagery.

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