

VECTORIAL ROAD DATA STRUCTURING ACCORDING TO A CONCEPTUAL MODEL
Case of the R_ROAD project (Réseau ROutier Algérien Digitalisé)
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ABSTRACT

The technology improvements together with evolutions due to the decentralization of services and data processing developments have deeply modified most professional practicing in many fields. This variety of fields have a spatial reference and are generally dealt with through Geographical Information Systems (GIS).

Recent awareness for information economic, strategic and social dimensions and the major role of related techniques have lead to an important increase, worldwide of software packages for management and processing usage of spatial referenced data. Even if the use of such tools covers a many fields, thus concerns many products as users needs, it necessitates however several primary treatments such as collecting, cleaning, structuring and updating data and if necessary discarding whatever are useless, etc..

What is particular in spatially referenced database studies is embodied in the fact that they require the implementation of several processes that may solve problems rising from the control of a huge data volume. These data are very complex to deal with because they are twofold : descriptive data (attributes) and spatial data (geometry and topology).

A current project is being undertaken for the implementation of a national road database at the “Centre National des Techniques Spatiales (CNTS Algeria)”. This project entitled R_ROAD (standing for Réseau Routier Algérien Digitalisé) is aimed at implementing a digital representation of the northern road network in Algeria. In addition, the project aims at implementing the investigation tools, which will allow potential users to undertake specific applications.

This paper is aimed to defining the particulars of the vectorial road data structuring and modeling the database, the built up model and the steps of the modeling process will be presented here after.

1 INTRODUCTION

Among all supports that are of interest in any territorial planning, transport infrastructures are the most important because of their strategic character in the current development and no one can deny this. The predominance of road network in cartographic representation of a territory is a good illustration, as the network constitutes the main framework.

Current and future needs for applications related to road geographic information are so many as they are beyond measure. In fact, road traffic management, road maintenance and accident control operations are very difficult to meet by using traditional means such as plans, maps or photographs.

Software share, in solving problems related to road traffic management and control or optimal path searching became greater everyday because of their commercial and strategic aspects. This induces a need for the development of production and digital data manipulation. However, a spatial referenced database is not an end in itself; it requires implementation software or geographic information systems well adapted as needed.

There is a category that transcends all others by its strategic character in the contemporary development; these are infrastructures of transport. This strategic character was of all time and in all recognized. The predominance of the road network in all cartographic representation of a territory, of which it constitutes the skeleton, is a perfect illustration.

2 ROAD GEOGRAPHICAL INFORMATION

Geographical information is defined in a general context as a link between an object or a phenomenon and its position on the earth surface. It is therefore a combination of graphic information and alphanumeric information, which can be shown very clearly by drawing means.

It can represent any information related to a point or a set of points spatially referenced on the earth surface. It is of a great importance for those people in charge of managing objects located in a determined space.

Geographical information concept stands for a variety of data, such as natural resources distribution (soils, waters, vegetation, etc.), infrastructures localization (roads, different facilities network, building, etc.), administrative borders. Even population statistics data can be enclosed in such definition since they have a spatial extension.

A road geographical information is an information related to any road network direct or an indirect entity. It comprises the road network description as well as the elements in relation with this network. It is essentially of a linear type and this imposes the use of computing systems able to deal with vectorial data type during the structuring process (vector GIS).

This information is constituted of two main components:

- A geographical component that describes the network geometry as well as the topological structure (location, entity dimensions and its neighborhood study).
- A descriptive or semantic component that lists the attributes associated to the entity under study.

Thus, a road section will be described geometrically by a set of coordinates with start and end nodes (geometry and topology) and a series of feature such as road width, pavement type, ground level, etc..

3 ROAD DATA BASIS

The road data base (R.D.B.) is a database of road geographical information. Its conception main objective is to provide the necessary information for organizing displacements on the road infrastructures. But, such a database allow also for other applications to be made, like the road traffic management, road maintenance, road cartography, traffic optimization, etc..

One distinguishes the notion of :

- Digital Road Network (D.R.N.) which is a digital representation of the road network.
- The R.D.B. which is a composition of the above D.R.N and other entities spatially referenced, that may come from other databases and are indispensable for describing the network and its environment (e.g. administrative limits, road equipment, towns, etc..)

In addition, the R.D.B. can serve as a support for the development of other databases such as the urban one, power and fluids networks, etc..

To constitute a road database it is necessary to carry on several operations and particular works, according to an organized and thoughtful process. In fact, the use of raw data is inappropriate may even impossible

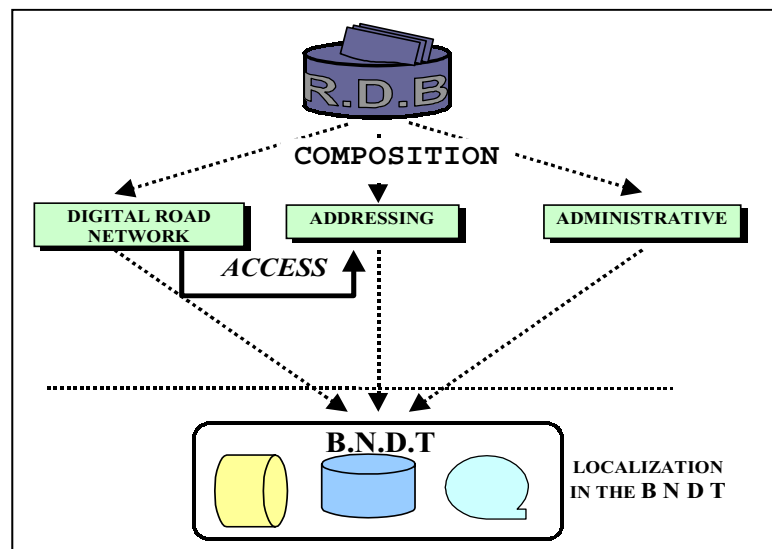


Figure 1. Constitution scheme of the R.D.B.

One needs therefore to carryout the following operations about data : **preparation**, **acquiring**, **conversion** and therefore its **integration**.

The complexity and specificity of geographical database setup in general, and road one particularly require the implementation of several processes passing through different steps, among which the following are cited:

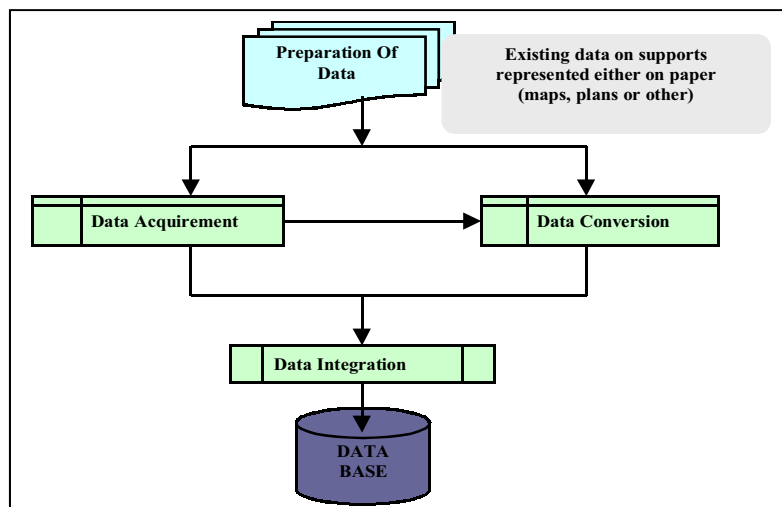


Figure 2. Constitution of the Data Base

1. The implementation of a reference methodology for the R.D.B. conception.
2. According to this methodology, deducing the product the more representative and more rational. From the geographical information point of view, for data grouping, this gives what commonly one call geographical information layers.
3. The definition of an appropriate model for transmission data toward these geographical layers.
4. The implementation of a process for the maintenance of the database.

One of the fundamental stages in the constitution process of a geographical database is the data modeling : development of the conceptual diagram and the data dictionary.

This modeling aims to produce a representation of reality, in terms of the aimed goal and should be irrespective of the used technology type. It is based on notions of entities, relations, cardinalities and identifiants that must verify principles of significance, no redundancy, consistence and normalization.

4 GEOGRAPHICAL INFORMATION SYSTEM

Broadly, a geographical information system (GIS) is a computer system, whereby physical or socioeconomic data are dealt with. These data can be related to a located entity.

This system is characterized by a set of more or less developed functionalities.

- functionality of entering data,
- functionality of management, storage and consultation,
- functionality of analysis, count and statistics,
- functionality of output of reports and maps.

The GIS serve as supports to applications that handle geographical data such as urban planning, dealing with natural resources, cadastral survey, traffic management, etc.. They are information systems whose objective is an information for relationship between an object (or a phenomenon) and it referenced location on the earth surface.

Therefore, the GIS are computer systems allowing, from different sources, to gather and organize geographical located information. They also allow certain operations about these informations such as managing, analyzing, combining, elaborating and presenting them. A GIS, as any other system, does not exist and can not exist alone, it must be integrated in a general context and for that it is necessary to have an organized structure including people, equipment, etc.

Strictly speaking, the term GIS means a software package, but it can be extended to include:

- The equipment: computer and peripherals,
- The data (database),
- The applications or self user treatments,
- The organizational infrastructure (personnel, supports, facilities, etc..).

The implementation of a geographical information system leads to make choices about the content, the way of constitution and management of the database.

Choice of the content: the choice of road data to be integrated into the database is established in collaboration with the user who makes up a list of headings and defines a methodology for information processing. These headings can describe :

- The main geometric features of the studied road.
- The pavement structure features.
- Road use characteristics.
- Road environment, its functions, technical or administrative ranking,...

While creating a database, it is necessary to take into account the fact that data may come from different sources. The geometric data may be taken from maps, aerial photographs, satellite images or field survey, while descriptive data are either collected at actual sites, or provided by the technical service staff. This diversity of sources, of supports, brings about problems of data homogeneity. That must be considered imperatively in the database.

As for the data management, one should make room for a number of operations such as :

- Functions of creation and immediate correction of input errors.
- Data updating with selective storage of previous data.
- The definition of the database management type (centralized, distributed, per geographical unit).

As conceived, a R.D.B. with an appropriated operation software can be used for the following three applications :

- Road network maintenance and management (help for planning) : road signaling, layout design, viability,...
- Optimization: transport (minimum path, minimal cost,...), delivery and journey,...
- Journey choice : zone by pass, capacity of bridges and tunnels for special convoy.

5 THE R_ROAD PROJECT

To satisfy the kind of needs mentioned above, an appropriate project for the implementation of a national road database is in progress at the “Centre National des Techniques Spatiales” (Arzew-Algeria). This project entitled R_ROAD (standing for Réseau Routier Algérien Digitalisé) aims to set up a numeric representation of the northern Algeria road network. It also aims to implement general investigation tools that allow potential users to complete various specific applications.

It will be included into a set of road data and will complete other data derived from other sources and constituting a Road database. This database result from a particular structuring of located data linked to a unique database, the national basis for topographic data (N.B.T.D).

The Digital Road Network must satisfy the general needs identified for as more users as possible. To do these investigations (surveys, meetings, conferences, and reports) should be directed towards bodies concerned with such a type of data. More particularly, one must define the product wished by the greater possible number of users. Showing the very different applications that may come out can do this.

In the R_ROAD project scheme, the road data modeling is executed in order to implement them in the database. The aim objectives sought for are mainly:

- Setting out a numeric representation of the road network of northern Algeria.
- Implementing general investigating tools (optimum journey choices, traffic management and control ...).
- Particular applications with the help of these tools.

To meet these objectives, the project goes through several steps, among which:

- Data production (Preparation - Acquirement - Conversion - Integration)
- Data modeling (Conceptual Schema –Data Dictionary)
- Physical Implementation of data
- Implementation of tools of investigating and analysis (Processing software and management)
- Particular applications (Specific to the road network)

We therefore foresee that the product, once finished, may be able to deal with many applications. These applications may be related to road network elements management, or of the management of entities having direct or indirect links with network components.

Moreover, we consider that such a product can neither be satisfactory or functional permanently unless the data are always updated. Because of this, we paid much attention to the data updating process. This updating will concern the road network data and related data (the Topographic database among others).

A prototype will allow the validation of the methodological steps developed and provided a scientific background for its generalization to the entire national network. The product will be a set of “software - data ” implemented on a P.C. platform easily accessible to the great number of users.

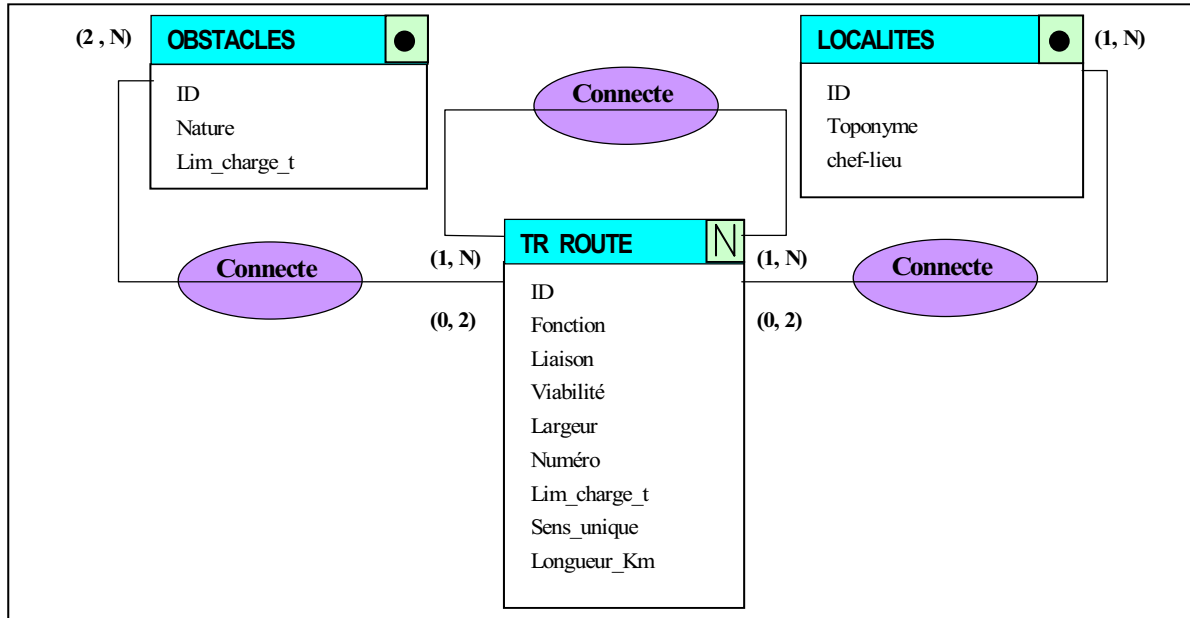


Figure 3. Data Conceptual scheme.

OCCURRENCE OF DATA

Road

- ID: Sequential Number
- Fonction: Highway
Speedway or access way
others
- Liaison Principal
Secondary
- Viabilité: Paved
Améliorée
Partiellement améliorée
- Largeur: Separated roadways
2 large ways and more
2 ways
1 way
- Numéro: Character
- Lim_charge_t: Numeric
- Sens_unique: Direct
Inverse
- Distance_Km: Numeric

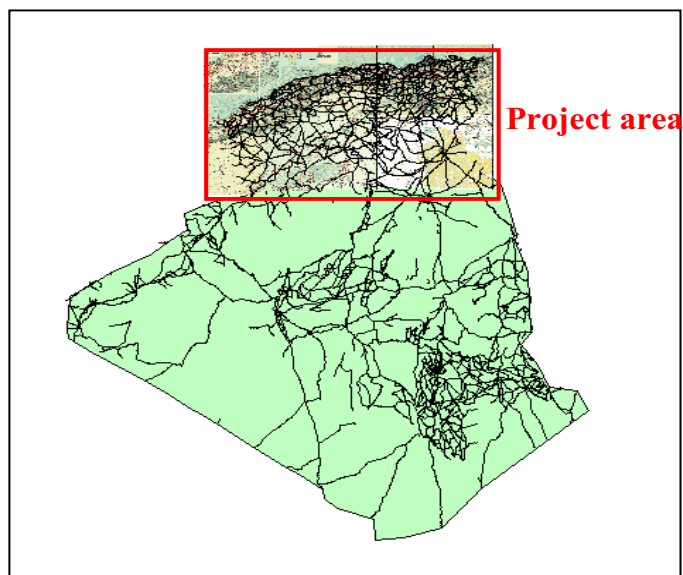


Figure 4. Project Area

Localité

- ID Sequential Number
- Toponyme: Name written down directly
- Chef-lieu: W (Wilaya)
D (Daïra)
C (Commune)
A (Agglomeration)

Obstacle

- ID Sequential Number
- Nature: Narrow Passage
Bridge
Distributed ford
Ford no distributed
- Lim_charge_t: Load limit indicated for bridges.

5 CONCLUSION

This undertaken project mainly deals with the definition of a database constituted of different layers and their disposition relatively to a unique reference assuring homogeneity and a perfect integrity of its data.

Moreover, it is important to point out that the scheme project puts an emphasis on the implementation of the structure of a database including the whole main road network of the northern part of the country. This network is made up of roads that are main or secondary links.

The modeling and the interdependence of data have been dealt with precise and exhaustive way for the whole set of topics in order to secure an extensive use of the system.

The inquiry made clearly identify a need for numeric data and an urgent need for solutions to problems dealing with this kind of data for the whole country.

These data must be put updated later, while preserving or improving as possible the data initial accuracy relatively to the required applications.

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