

Harmonisation of dynamic traffic data, based on GDF

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ABSTRACT

This paper proposes to build dynamic traffic databases based on the concepts of the current European standard for road databases, Geographic Data Files (GDF). This will avoid duplication of effort and lead to a uniform and standard concept that benefits the entire ATT community. It is foreseen that dynamic digital road databases will form the backbone of many future ATT applications.

Developed in 1985, GDF has come a long way until its acceptance as a CEN standard in 1994. Now seems the right time to capitalise on this achievement and start building dynamic applications with GDF.

Dynamic digital road databases will form the backbone for many future ATT applications

BACKGROUND

Digital road maps are becoming an increasingly common phenomenon. Unlike a scanned map, which does not have any intelligence attached to individual map objects like roads but can be used as a backdrop for reference purposes, a digital road map contains attributes associated with objects that provide relevant information for transportation and traffic.

The object 'road' is described by its geographical position, the category (motor way, country road, etc.), the number of lanes and so on. In all, roads can have more than 100 attributes. Digital roads maps are needed

for computer applications simply because a computers cannot read maps. They can be used for applications as diverse as:

- car navigation to offer road guidance
- (dynamic) route planning to find the shortest and fastest way to drive in using the road network
- traffic control centres to indicate traffic jams, accidents and road closures
- traffic monitoring to evaluate traffic volumes and speed limits
- emergency & dispatch services (police, ambulance and fire brigade)
- public traffic information

Currently most European roads are converted to digital format. And before 2000 it is expected every road will be available on CD ROM. These maps, however, contain mainly static information about roads, rivers, bridges, city boundaries and services - such as hotels, restaurants and banks.

The only dynamic information available from the CD are things like the planned opening date of a road, traffic jam sensitivity and changes in driving direction during rush hours.

PROBLEM DESCRIPTION

Many DRIVE and other EC-funded traffic pilots are handling dynamic traffic data. More than half of those projects share the same goal: displaying traffic information on a computer screen. Examples of traffic objects are:

- emergency vehicles,
- traffic flows and volumes,
- incidents (accidents and road works),
- Public transport vehicles

For display of traffic objects a data model is needed, and the digital road map is part of that model. A few pilots make use of a standardised digital road map based on GDF, but quite often ad-hoc solutions are tried to display traffic information. This is because either GDF maps are not available or GDF does not meet the requirements of the project.

USAGE OF DIGITAL ROAD MAPS

Most pilot projects take a top-down approach. (See figure on next page.) The data model dictates what the digital road map should contain. If, for example, the pilot requires beacon information to be displayed on the

computer screen, the data model will be designed to accommodate the communication infrastructure of the beacons.

The type of information that is broadcast by the beacon, transmitted data, signal quality, identifier of the beacon are examples of data that should fit in the data model.

It makes sense to indicate to which street the beacon belongs. In data modelling terms, it means that a relation should be made of the kind 'beacon along road x' or 'beacon is at intersection of road x and road y'. Beacons are examples of dynamic traffic objects. Road sensors that measure the number of cars per time interval will also be related to roads or intersections.

GDF does not offer any modelling concepts for this dynamic integration yet, but a consistent approach is needed. In practice, many different methods are applied to building data models, which should inevitably lead to incompatible solutions. What's more, it also leads to a situation where the proverbial wheel is constantly re-invented.

On the contrary, this paper recommends a bottom-up approach. Start with a GDF digital road map, make a uniform concept for all sorts of dynamic traffic objects (beacons, traffic jams, accidents, sensors, vehicle positions) and model this into a dynamic database. This database can then be used for many ATT applications as shown in the figure below.

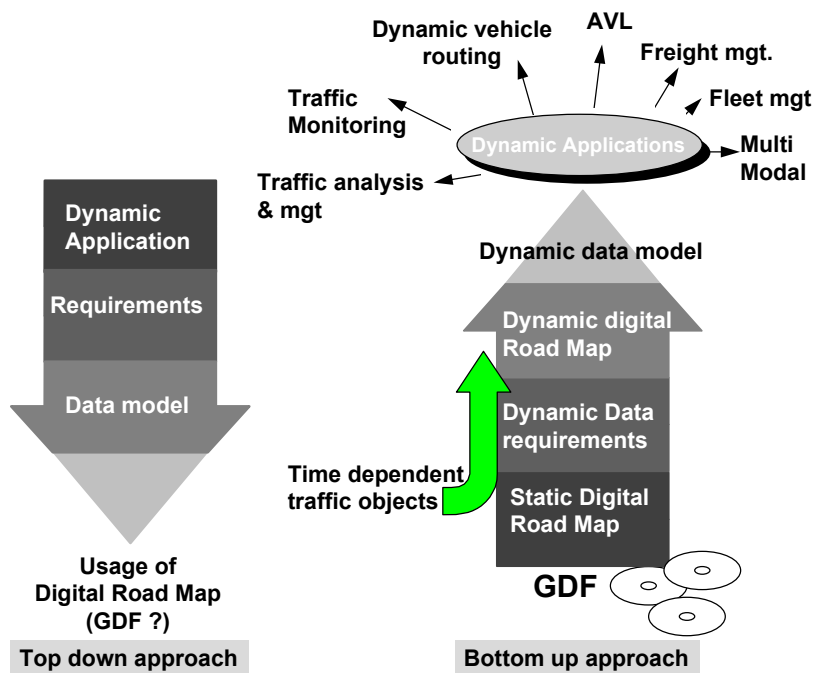


Figure 1 Top down versus bottom up

DYNAMIC TRAFFIC OBJECTS

Some traffic situations change every minute, others every second. Data models should be able to describe and manage these dynamic traffic objects properly. But what are these dynamic traffic objects? Let's put the various traffic objects on a gliding scale from static to dynamic :

1. **Static map.** This map will contain information about roads, rivers, hotels, petrol stations, and many more. The digital map will give both the location of the object and its attributes and their interrelationships. But also the relation with other roads is given - for instance, this road has priority over other roads.
2. **Long-term predictable traffic objects.** These are objects whose changes are planned well in advance. Typical examples are: a certain road is planned to be opened in 1995 or a road will be widened from 2 to 4 lanes end of 1994. Or every workday peak-hour traffic jams are expected from 7 till 9 am on certain roads. In the last case the traffic jam is the object and the time period can be predicted.
3. **Short-term predictable changing objects.** These are defined as traffic objects that can be predicted within days or event-driven. Examples are: 'roadworks scheduled for tonight; two lanes will be blocked'. Or 'because of Remembrance Day, roads xxxx are blocked'. There is obviously a 'grey area' between long-term and short-term prediction. A strict separation between the two categories cannot be made.
4. **Actual traffic reports.** These objects are reports describing actual traffic situations. DRIVE projects like STRADA and ALERT have defined objects like traffic jams, accidents and road closures. Traffic reports often take the form of a message broadcast either by the RDS or GSM, and are processed between a minute and an hour.
5. **Real-time traffic.** This could be data coming from beacons, sensors in the road or detection by video cameras. Examples of data that is obtained from real time traffic objects are traffic volumes, speed of vehicles and vehicle positioning. This data should typically be captured and processed within one minute.

These five types of traffic objects should be represented in the dynamic digital road database based on GDF. This includes the (unambiguous)

definition of new dynamic features as well as the relationships of dynamic objects with one another. For example, a GDF definition of a road sensor could read like this: the feature is 'road sensor' with attributes, including type of sensor, number of trucks per minute, number of private cars per minute and quality of signal. The relationship with the road could be expressed in a statement like 'sensor along road x'. By modelling it this way, every pilot that works with road networks and road sensors is suitably equipped to set up a database for capturing and storing traffic objects.

CURRENT SITUATION

All main European digital road data suppliers have adopted GDF as the future standard to capture and exchange digital road data. This means an enormous boost for the acceptance of the standard. It also means GDF is not just an academic but a 'de facto' industry standard. In a few years from now, digital road databases covering every street in Europe will be available on CD ROM at the local PC shop.

Just as with paper maps, the customer can select the accuracy of the map (large scale map, regional map and city maps) as well as the contents (roads, city limits, land usage, water ways). Using these maps will save the ATT pilot projects and applications a lot of work and give them a head start.

One of the important issues that needs to be solved before further expansion of GDF can take place is the unique referencing of geographical traffic objects and how the various location methods can be linked. The technical CEN committee TC278 sub work group 7.3, is tackling the problem of addressing (problem) locations with a single number. Based on a 16-bit number (1-65535) a number should be defined for a specific location. In The Netherlands, this could be 'A4 between the Hague and Schiphol'.

The location referencing technique, however, will only form a part of the overall location referencing used by people and instruments. For instance, a GPS receiver will give the latitude and longitude co-ordinates with a certain accuracy. Road authorities tend to express locations in a relative offset 'Road nr M25, 2 kilometer before exit 7'. Some computer systems only accept x,y,z locations, whereas most people would give their address as their unique location.

The GDF dynamic model should be able to handle different referencing techniques and have concepts to convert one referencing system to another as shown in the figure below.

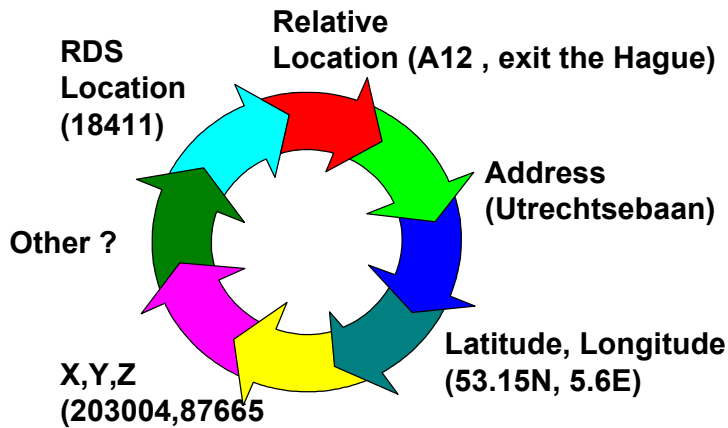


Figure 2 Conversion from one referencing system to another.

Several DRIVE projects are also working with so-called semi real-time data. The ALERT project is a case in point. It defines traffic objects in the form of a message list - the ALERT C message list. The message list has been further developed into Bearer Independent Format (BIF). The IFMS project - formerly known as FLEET - defines structured messages to be sent from base to driver and back. Other projects like ACCEPT, INTERCHANGE and RHAPIT gathered experiences with broadcasting and receiving traffic messages.

All these projects have in common that information is collected and encoded at one side of the communication line and decoded at the other end. The 'other end' could be a car with a board computer.

A division can be made between information that is for general use and should thus go into the GDF dynamic digital road map and information that is application-specific. Messages about traffic jams and road blocks could be considered general information, for example. These types of messages should thus be defined as GDF dynamic traffic objects and have direct links with GDF road elements.

On the other hand, the cargo of a lorry is only of interest for fleet managers who perform hazardous goods monitoring. This information could be classified as application-specific and should therefore not be part of the GDF dynamic definition.

DRIVE projects like GERDIEN and DYNA are working with dynamic traffic models; traffic objects change every second. This requires a different type

of communication infrastructure than is needed for coping with semi real-time traffic objects. The time that passes between capturing real-time data and receiving it is crucial for the success of systems that apply the model.

Real time data collectors like road sensors capture information that is related to a road included in the digital road map.

Just as with semi real time data a distinction can be made between data intended for general use and application-specific data. The traffic volume on a road could be used by many applications, including:

- traffic monitoring; the computer displays roads, each having a different colour to match a certain traffic volume (free flowing, busy, slow, congested).
- dynamic route guidance; the computer calculates a new optimum route based on up-to-the-minute statistics on traffic volume per road.
- travel information; the computer gives motorists an overview where traffic problems occur so that alternative routes or modes of transport can be chosen.

A vehicle's position, captured by a beacon or GPS, could also be of general use in a GDF dynamic database. In almost all cases the position of the vehicle should be related to the road where the vehicle is driving.

An example of real time data that should not go into a dynamic database is for instance 'type of sensor used' or 'quality of data signal'. This information is too specific to be considered for general-purpose dynamic digital road databases.

FUTURE DIRECTION

The question remains why GDF has not included dynamic concepts into its definition.

The answer is quite simple. Besides the great variety in DRIVE pilots in different countries with different requirements, the work on the static level of GDF will be completed in September 1994. At that time GDF 2.2 will be published. It contains almost all road-related information in digital form. The dynamic component of GDF will limit itself to the definition of time-dependent attributes.

Dynamic traffic objects like traffic jams and accidents are not part of GDF 2.2 yet, but the future direction of GDF has been charted in this paper. As stated before, it is impossible to cover all types of dynamic data in GDF. The model would become too big for a general purpose road database.

However, a definition of the commonly used dynamic objects in GDF **can** be achieved. Such a model will be useful and usable.

An example will illustrate this. Say, we would have to specify the requirements for a computer system for dispatching emergency services. In the data model we could define ~50 traffic objects. Most of these objects - duties, scheduling, assignments - are application-specific, but some could go in the dynamic database. The number of commonly used dynamic objects could be less than five.

Future GDF dynamic digital road databases should make it possible to take an existing GDF data set from CD-ROM plus a prescription book of dynamic traffic objects so that dynamic databases could be built in a uniform way. The matrix below gives an example of the various stages of GDF against its dynamic applications.

		Traffic management	Automatic vehicle location	Dynamic vehicle location	Public information	Fleet management
Real Time	Satellite position		•	•		•
	Road sensors	•				•
	Beacons			•		
	Video	•				
	...					
Semi Real Time	TMC messages	•		•	•	•
	Fleet messages					•
	Travel, tourist info	•		•	•	
	Manual entrance	•		•	•	•
	...					
Static	Roads	•	•	•	•	•
	Admin. areas	•				•
	Services				•	
	Settlements		•	•	•	
	Boundaries	•				
	...					

Figure 3 Dynamic data matrix

For each application a requirement selection can then be made of what is needed. For instance, for automatic incident detection, the static information about roads is needed plus the real time information from sensors and video. The semi real time does not seem to play a significant role here. The structure of the dynamic database will then be provided by GDF.

The task of expanding GDF into a dynamic definition should soon start taking input from as many existing ATT application areas as possible. It will save time and duplication of effort in future ATT applications, and it will improve the efficiency of these applications.