Implementing Optimized GIS Data Collection To Supply An EMS (France)

Abstract :

The new Essonne County Fire & Rescue Service (ECFRS) Emergency Management System (EMS) will be operational by April 2006. Its cartographic interface is destined to location purposes and to aid decision making. It will be supplied by the ECFRS GIS data stored in ArcSDE.

The efficiency of emergency calls processing and responding will then depend much on the quality, recentness and completeness of the supplied GIS data. Since 2004, the ECFRS Mapping & GIS team has been working on implementing both adequate organization and technical means to quickly get the updated "ground truth" data from remote sources (mainly ECFRS firemen and other public services) and eventually load it into the EMS database. All this started with existing workflows analysis and design, hardware and software selection, hours of data modeling and inputting. Has followed the development of a wizard form-aided ArcMap interface for disconnected editing before deployment on rugged computers.

Keywords : firemen, emergency calls, GIS, digital cartography, databases, updating, methodology, organization.

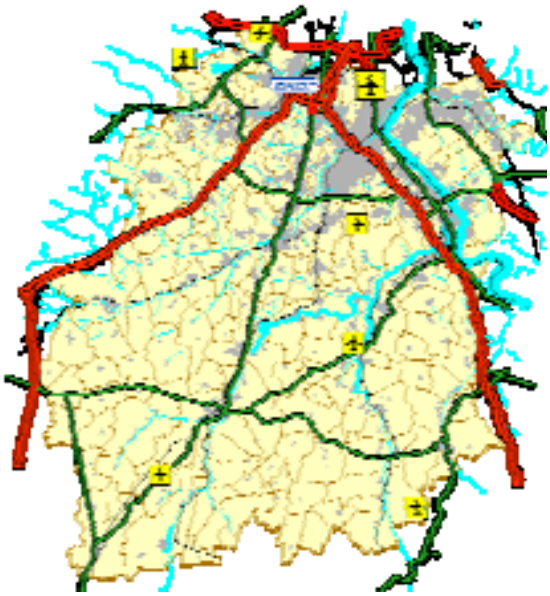
TABLE OF CONTENTS

INTRODUCTION : ESSONNE COUNTY FIRE & RESCUE SERVICE INTEGRATES GIS IN HELP OF EMERGENCY CALL PROCESSING AND DISPATCHING.

1 Geographical and human context : the Essonne County and its fire service.

The Essonne county is the 91st county of France's metropolitan territory. It gathers 196 towns and is located 15 miles south from capital Paris. Its 710 sq mile surface is both rural and urban with a population of 1,145,000+ inhabitants mostly living in the north of the county. The Essonne county has a strong economic activity related to research (ECA, CNRS, CNES, Génopôle) and to new technologies (IBM, HP, SNECMA) which means several identified risky buildings (6 Seveso factories, 2 nuclear plant sites) as well as many transportation ways and infrastructures such as :

- ➔ 40 miles of motorways and 167 miles of major roads
- ➔ A dense local and national railway network (RER, TGV)
- ➔ The navigable Seine river and the Essonne river.
- ➔ Airports among which the international Orly airport.



Thematic map of the Essonne county transportation risks

The Essonne county population is protected by the "**SDIS 91**" which stands for "**S**ervice **D**épartemental d'**I**ncendie et de **S**ecours de l'Essonne", translated in english as **Essonne County Fire & Rescue Service** or ECFRS. The ECFRS has a two-headed authority (County council and Ministry of Interior local representative). Among its main missions are prevention, risks preparedness, training and firefighting as well as medical help. In late 2004, the Essonne county FRS consisted of :

- ➔ 52 fire stations covering the county,
- ➔ 2,200 civilian firemen (both professionals and volunteers),
- ➔ 250 civilian technical and administrative staff,
- ➔ A Fire & Rescue Training School with a technical area unique in France,
- ➔ 93,000+ emergency actions, which means 1 response every 6 minutes.

This both geographical and human context leads the Essonne County FRS to put efforts on risks assessment and planning. In 2000 the need of risks mapping and station location coverage analysis pointed at GIS tools to handle with these objectives.

2 Technical context : mapping and GIS activities at the ECFRS.

Before the GIS project was born, the ECFRS had been producing its own operational road maps since 1992 using Adobe Illustrator software. These maps designed by a team of mapping technicians bring various essential information to firefighter on the field : street names, hydrants location, risky buildings location, key access ways, electrical shutoffs, etc. When needs of spatial information and analysis showed up in the late 90's,

a GIS specialist started collecting, modeling and administrating data of various sources into a GIS data warehouse using ArcView 3.1. Now five technicians, out of the seven consisting in the 5-year-old GIS and Mapping Team, work on GIS using ArcGIS technology, from ArcView and ArcEditor to ArcSDE and ArcIMS.

The first use of GIS remained then in the preparedness domain : experimentations were carried out drawing up statistical maps by georeferencing incidents (fires, medical emergencies, vehicles accidents,...). Thematic maps related to technological, chemical, nuclear, radiological and natural risks were produced to illustrate official reports. Fire stations location coverage got visualized and mapped thanks to the use of the ArcView Network Analyst. The same work was done with hydrants and published with ArcIMS : interactive maps brought to firemen in charge of hydrant controls the possibility to graphically view the zones where water means were lacking for firefighting (actually portions of roadways whose distance to the nearest hydrant is higher than 200 meters which is the maximum length of a water pipe unrolled along the roadway). These documents contributed to their mission of council near the mayors for fire prevention of their town. Within a prospective framework, on the operational field thanks to in-house developed applications based on GIS such as “CartoSITAC”.

Between 2000 and 2004, the Essonne County Fire Service GIS progressively showed its potential and usefulness on both preparedness and operations fields by supplying a new way of viewing and managing spatial data. So the idea of using GIS for emergency call processing made its way along the huge project of centralizing emergency calls and renewing the ECFRS Emergency Management System.

In 2004, geographic information took a major and central role in the ECFRS organizational and technical evolutions (Figure 2).

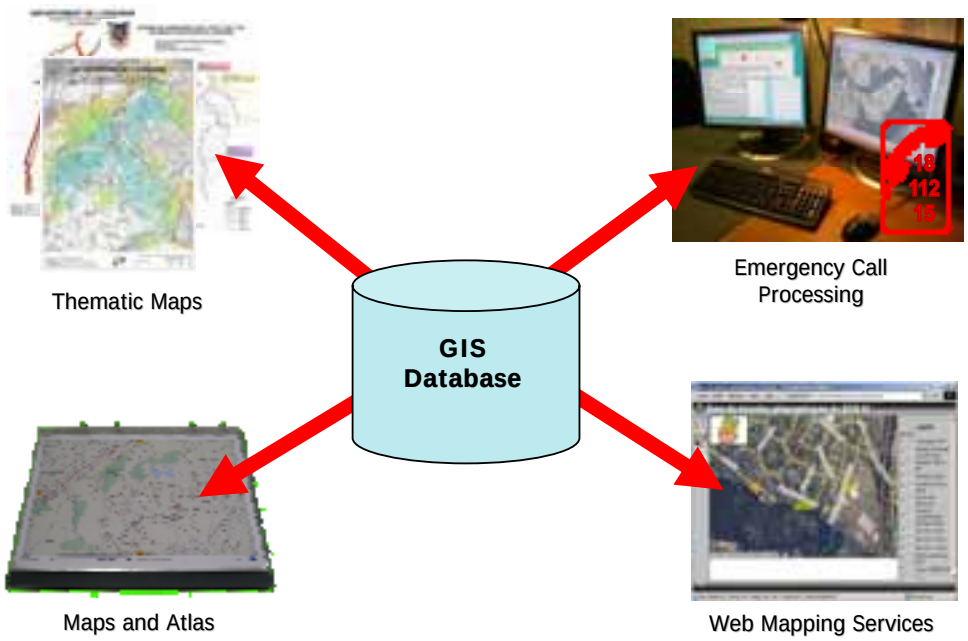


Figure 2 : Mid-term different uses of geographic information at the ECFRS.

3 Operational context : the Essonne County Public Safety Answering Point (PSAP) and its new Emergency Management System.

Back in 1998, the aim of this project was to process the 2,000+ daily emergency requests in a unique center where both Essonne County Fire & Rescue Service and Medical Emergency Service ("SAMU 91") personnels would collaborate to improve the operational response brought to population. The Essonne County PSAP (see pic. #2) opened its doors this year on June 1st. Now, when you dial from within the Essonne county the nation-

wide "1-8" or "1-5" number, respectively for fire or medical emergencies, as well as the European "1-1-2", your call is handled by this PSAP and dispatch to the appropriate firestations or medical emergency mobile units. The Essonne County PSAP also houses the ECFRS Emergency Operations Center, operational and administrative divisions of the ECFRS as well as the Essonne County Medical Emergency.

Figure 3 : Emergency call processing and dispatching platform at the Essonne County PSAP.

sonne

Jointly with this project, the Essonne County FRS wished to renew its 12-year-old Emergency Management System. Due to technological breakthroughs and given the ECFRS GIS experience, the new software to be elected by the ECFRS should be granted a 100% ESRI-product-compatible cartographic user interface. Such a tool was actually required to help operators locate an incident on a digital map when “ANI-ALI” (caller identification) facility gets useless as the call made from a cellular phone indicates a car crash along a highway where nothing but a few POI such as direction signs are available at sight. Once the call or incident has been traced, the next step is to assign it to the nearest available response vehicle. Again, GIS had an obvious potential role with its ability to analyze networks. In February 2004, the Essonne County Fire Service thus chose **ARTEMIS**, a computer-aided dispatch (CAD) system developed by EDS Answare (formerly Alcatel TITN) whose cartographic interface was still to be developed by a new partner of theirs, ESRI France. That's how **SigTA/Op** was born in early 2005 (Figure 4).

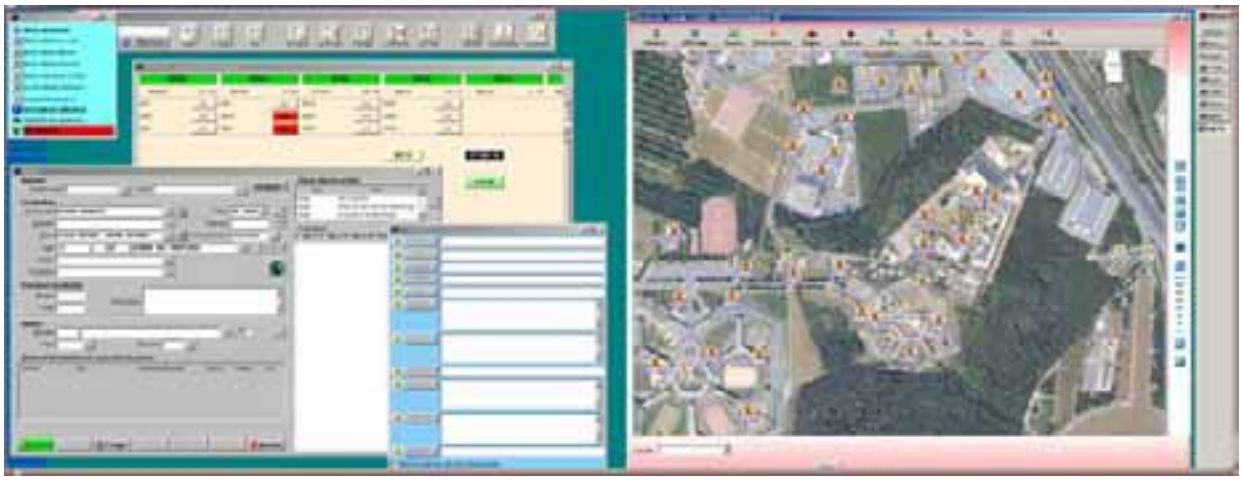


Figure 4 Multi-windowed ARTEMIS (emergency input form, vehicle synoptic, etc) and SigTA/Op user interfaces.

Locating an incident or a call is carried out indifferently by inputting pieces of information through ARTEMIS emergency form with the possibility of zooming on the digital map displayed by SigTA/Op or by right-clicking on this latter. SigTA/Op has standard navigation and research tools but also allows basic requests upon buildings' or POI's names. It can on-the-fly calculate surfaces and routes taking into account temporary obstacles that may have been drawn by the operator on the map. However, the efficiency of the ARTEMIS – SigTA/Op pair can not be reached if the geographic data that feeds the whole system is of bad quality...

Naturally the ECFRS Geographic Information System was to provide these data.

From then, in 2004, the GIS & Mapping Team started a huge work of data modeling that consisted of meeting the ARTEMIS CAD system data model requirements and still manage efficiently our GIS database for our spatial analysis and mapping needs. Prior to designing our new GIS data model, we proceeded in a 6-month study of existing data and work flows within the Essonne county FRS.

AN ADEQUATE ORGANIZATION AND GIS ARCHITECTURE DESIGN.

1 Prior to designing : the data and work flows analysis.

This step enabled us to have a global view of what had been, was and would be the use and production of geographic data, from Illustrator-made layouts to ArcGIS digital maps. Though the evolution towards a GIS centralized database (see chapter 2) was a wind of change in methods, the inventory of thematic data was remaining the same for maps as well as for the CAD system. The main usual layers were those of : streets network, buildings, hydrants and points of interest. Our needs of spatial analysis as well as routes and coverage calculation had the GIS & Mapping Team buy various raster and vector databases : the IGN aerial photographs and large-scale product SCAN25® combined to topologically-structured Navteq Navstreets vector database. But the critical need in terms of updates frequency and database exhaustiveness was the CAD system's one in order to ensure a precise and efficient location of incidents and calls. As private GIS data providers release updates only every year, we could not rely on these sources, all the more than firefighters patrol almost the whole county every day so they know rapidly when a street name has changed or when a new building has emerged from the ground. Historically, operational maps were produced using vector-oriented Adobe Illustrator software by cartographers with the help of firemen from the 4 ECFRS sub counties Preparedness and Preplanning Divisions. The knowledge of their assigned area, their collaborating with firefighters and public administrations on the field, their mission of hydrants' administrative management have been making them precious as in-

house sources of updated data. That's why in our migrating from Illustrator to ArcGIS we could not possibly do without them.

The ECFRS had resources to be its own data provider using ESRI products but methods and tools were to be adapted to detecting, easily collecting and integrating the updated data, either at the office or on the field.

2 Software and hardware design for GIS data collecting by ECFRS firemen.

2.1. "CICOLE" and "IMAJIS" user interfaces make GIS data inputting easy.

The ECFRS sub counties Preparedness and Preplanning Divisions firemen's profile was the following :

- ➔ Adobe Illustrator users (for pre-plans design and maps updates),
- ➔ Microsoft Excel users (for hydrants' administrative and technical data management (location, pressure, flow, etc),
- ➔ Only 20% of their job is dedicated to maps updating,
- ➔ Non GIS specialists,
- ➔ Frequent turn-over : firemen usually shift position every 3 years.

In a way, by using both Illustrator and Excel, they were managing both vector and tabular data such as in GIS software but in two different interfaces. Being non GIS specialists and expected to shift position regularly, they could not be trained on using ArcGIS the same way as the GIS & Mapping techs. We first chose ArcPad for data collecting after a satisfying experience in hydrants location with it and Trimble GPS device. But its limitation to shapefile format made us prefer ArcView for disconnected editing, as buying 4 to 8 more ArcEditor licences was too cost-expensive at this step of the ECFRS GIS development. The idea was then to let firemen extract data clipped on their assigned area boundaries from our ArcSDE server (check out) in order to work on personal geodatabases stored on their local hard drive. Once all inputs are done, they're sent to ArcSDE and stored in a dedicated version (check in). As each sub county is distinct, cases of conflicts are "theoretically" reduced to their minimum between updated objects in different sub counties. The GIS architecture for decentralized geographic data inputting was then decided (Figure 5).

Our goal was then to design a stable and user-friendly interface to do the job while keeping in mind that data collecting had to meet compulsory requirements (CAD database referential integrity rules) and allow easy post-processing for mapping purposes.

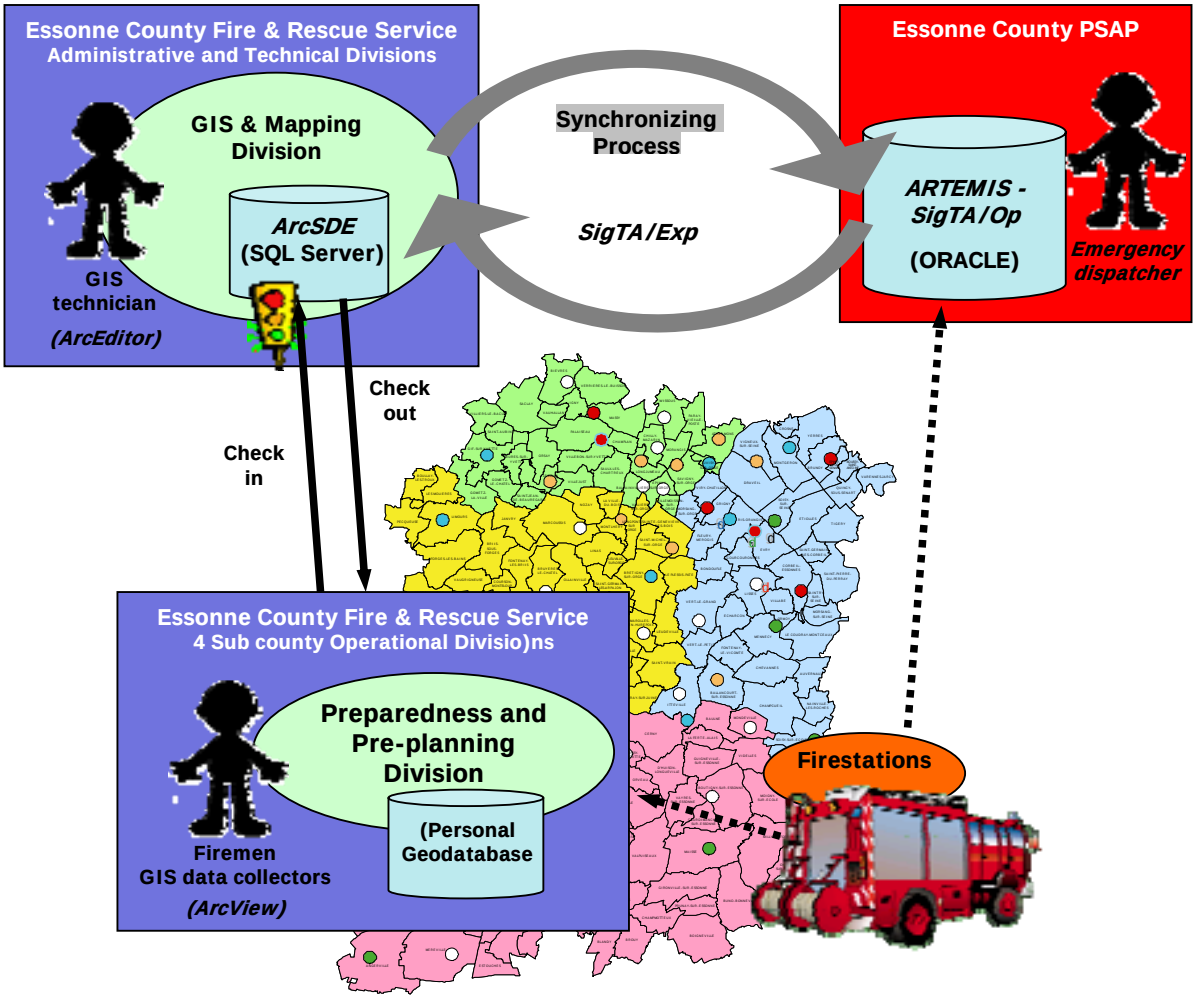


Figure 5 : GIS software architecture and geographic data update work flows.

2.1.1. "CICOLE" manages data extraction between ArcSDE versions and data collectors' personal geodatabases.

"CICOLE" stands for "**C**heck **I**n **C**heck **O**ut **L**imited **E**dition". This application was developed in Visual Basic 6. It's destined to GIS data transmissions between the ArcSDE server and our firemen desktop PCs.

"CICOLE" appears as a single basic 3-button panel (Figure 6).

Figure 6 : CICOLE basic user interface.

- ➔ Clicking on the "Envoyer les mises jour" button executes both "check in" and "check out" with the ArcSDE server actions after first checking ArcEditor floating license availability;
- ➔ Clicking on the "Transférer la base" button enables GIS data collectors to copy-paste their personal geodatabases from their desktop PC to tablet PCs for outdoor collecting or the other round once back at the office.

Every task is traced by log files enabling GIS technicians to identify errors or malfunctions as well as knowing when last updates were processed.

- ➔ Once the personal geodatabases has been updated, clicking on "Mises à jour des données" launches the "IMAJIS" interface to start creating or modifying GIS data.

2.1.2. "IMAJIS" brings a user-friendly intuitive interface for GIS data creating and modifying.

"IMAJIS" was developed as a form-aided customized ArcGIS project by a GIS tech of the GIS & Mapping Team who took advantages of the compatibility between Microsoft Access and geodatabase formats.

Each step of creating or updating objects such as roads or hydrants is driven by "IMAJIS" 's wizard-like interface. Behind the user interface, VBA scripts process spatial requests and calculate as many fields as possible in order to lighten the amount of data to input. Combined to these scripts, the use of predefined domain values enabled avoid input errors as much as possible.

For instance, a building creation consists of 8 steps :

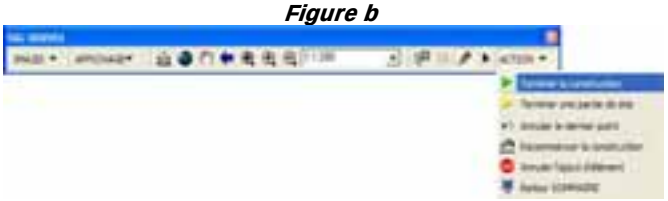
- ➔ **1/8** : Zoom on the map where the new building feature will be drawn using the navigation tools.
- ➔ **2/8** : In the "ACTION" menu of the main "IMAJIS" toolbar, select "Ajouter un element" ("Create Feature").

- ➔ **3/8** : A new form asks you what type of feature you want to create among Streets/Roads, Buildings, Hydrants and Points Of Interest. Select "Building" and click "OK".
- ➔ **4/8** : In the "Building Creation" form, select in the first drop-down list the type of building (e.g. : School), then in the second one the sub-type of building (e.g. : Primary School). By clicking "OK" you are driven back to the map display. The editing tool of the main toolbar is activated. The navigation tools remain accessible any time.

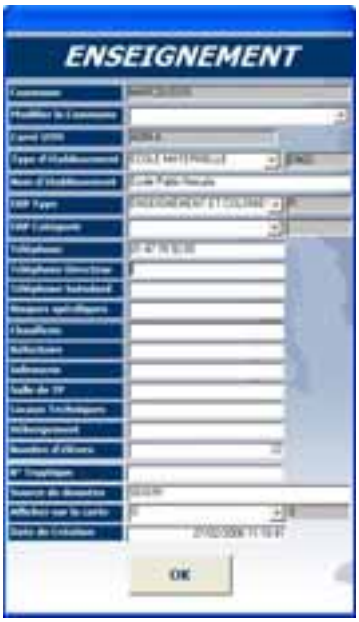
- ➔ **5/8** : On the aerial photography, draw the outline of your building (figure a below).
- ➔ **6/8** : Then click on the toolbar "ACTION" menu and select "Terminer la construction" (End construction" (figure b below).

Figure a

Figure b



➔ **7/8** : Fill in your new building feature's attributes form and click "OK".



Disabled grayish fields were automatically filled up with values calculated by "IMAJIS". For example, the city name results of a "Contains" spatial request performed on the city boundaries polygon theme and the streets network polyline theme.

➔ **8/8** : The Access form shows up. In panel 1, choose your building main access among the streets found around. If it exists, you can add a street number. Click on the "Ajouter" button to add your access to panel 2 text list. You can add as many accesses as needed, the following ones being automatically secondary accesses. Once all accesses are listed in panel 2, check out by cliking "Valider la liste".

➔ You're done.

Through IMAJIS' form-aided interface, the fireman has just drawn in spite of him a feature which respects every referential integrity rules stated within the ARTEMIS CAD system data model (Figure 7 below).

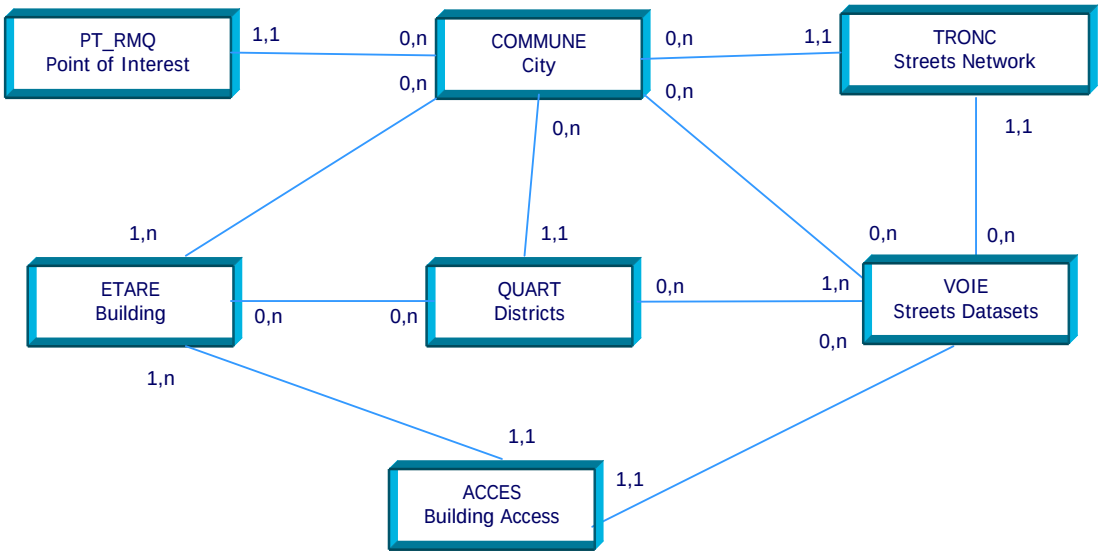


Figure 7 Simplified scheme showing relations between location data tables as in ARTEMIS' data model.

Another IMAJIS trick is illustrated on the right : when creating or modifying a street, you're asked to input the direction of travel. The corresponding "FT", "TF" or "N" value is stored in a standard Network Analyst field named ONEWAY. The value depends on how the polyline was digitized by the user. As the latter may not remember it, a specific symbology (arrows) applied to the streets features enables to "view it" within a screenshot of the recently drawn polyline. Then the user is asked whether the direction of travel is the same as indicated by the arrows, or the contrary or is allowed in both directions.

Figure 8 : Input form for streets directions of travel.

"IMAJIS" interface make the job easy but does not prevent the GIS database administrator from controlling and "cleaning" the input data (especially in the case of streets networks).

3 Ground truth collecting needs mobile, rugged and wireless hardware.

GIS data collection in outdoor conditions requires specific hardware. Especially when users are firefighters expected to be called for an emergency at any time or to perform hydrants flow controls.

A first series of tests were carried out between 2002 and 2004 with handheld Pocket PC and Trimble's Pathfinder Pocket GPS receiver. 1,700 hydrants were located thanks to this Mobile GIS but the data collectors reported some drawbacks. The main were : short battery life, small display screen and inconvenient wire connections between the Pocket PC and the GPS receiver.

That's why in late 2005, in the process of buying five Mobile GIS for the four GIS data collecting units and the GIS & Mapping Team, we selected the **Panasonic CF-18 Toughbook**. Its pivotal 10.4 inch touchscreen XGA display is very comfortable, enabling to use it as a laptop or as a tablet PC. Its light weight and durable battery allow several hours of GIS collection.

The CF-18 Toughbook is equipped with all wireless technologies. We then bought Blluetooth GPS receivers to go with them and help data collectors locating the features to be edited.

In April 2006, the GIS & Mapping Team trained 4 GIS data collecting units (13 firemen) on using both software and hardware described. We're ensuring maintenance and hotline from Monday to Friday, from 8.00am to 6.00pm. Since May 2006, all 4 units have been editing on a daily basis.

FUTURE IMPROVEMENTS. CONCLUSIONS.

A the time of writing this paper IMAJIS and CICOLE still need to be debugged but their main functions work perfectly. All firemen in charge of GIS data collecting expressed their satisfaction of using such an easy tool whereas GIS domain had been totally new and obscure to them so far. In the setup of a new software system, one can assume these opinions are encouraging and that needs were properly anticipated and fulfilled.

The next step could be to upgrade our ArcView licences to ArcEditor ones in order to do "real" disconnected editing and exploiting the power of topological relation classes and geometric networks. Currently topology controls are currently done manually by the GIS database administrator with ArcEditor, which represents a huge time-consuming task.

Lists of nearest firestations are GIS-computed both on-the-fly by SigTA/Op and statically by the ECFRS GIS but remain generally not trustworthy. Efforts still have to be put into network modeling to challenge the judgment of experienced personnel.

AUTHOR'S INFORMATION.

Yann KACENELEN

Land surveying Engineer, GIS Specialist

GIS & Mapping Team Manager

Essonne County Fire & Rescue Service (Service Départemental d'Incendie et de Secours de l'Essonne)

114 allée des Champs Elysées

F-91080 COURCOURONNES, FRANCE

Tel.: +33.1.60.91.22.93

Fax : +33.1.60.91.23.99

E-mail : ykacenelen@sdis91.fr