Locating unknown connection services during reading routes

Introduction

Canal de Isabel II was founded in 1851 to provide water to Madrid (capital of Spain).
Now it provides water to 5.5 million people in region of Madrid (the city and 177 municipalities), The commercial system records more than a million contracts and 590,000 connection services.

Now, Canal de Isabel II (CYII) has a geographic information system (Gaudy project) that contains more than 12,000 kilometres of pipes based on ESRI technology. We are now using the following products in several projects: ArcIms 4, ArcGis Desktop 8.3 and ArcSde 8.2, and the purpose of migrating to ArcGis 9 architecture.

The problem of locating all clients

Last year, because of the increase of water consumption and the low level of water reserves in Madrid, the importance of managing service interrumptions properly and generating consumption models was even greater.
In order to reach this objective, it's necessary to locate all clients, linking the commercial information system, the geographic information system and the mathematical model.
As a result, consumption of water in each area of the region of Madrid can be controlled.

Client information is in the comercial system, not on the Geographic information system (GAUDY). About 20% of Canal de Isabel II service connections were not stored in the GIS and the commercial system key was unknown on another 20% .

Now the number of connection services in Madrid is about 590.000, and there are more than 1.000.000 contracts.

After locating 100% of the connection services , we will be able to compare the consumption of water in each area recorded by flow meters with the billed payments of the clients. By doing this, we will obtain several benefits:

- Better management of service interrumptions.
- Better consumption models.
- Avoid illegal consumption of water.

How to locate connection services?

- First, we obtain and standarize the structure of the connection services addresses stored in the Canal de Isabel II commercial system (GRECO). After that, by matching these addresses with the street map of the GIS, we could discover the connection services geographic location, but not for all of them.
  The address matching was made by a developped software based on ArcObjects. This software made spatial queries to find the nearest house from the commercial address, and drew automatically the connection from the house to the nearest pipe.

- Second, with the connection services that we didn't find the geographic location, we did a field work in order to locate them. The plan was to use the knowledge of water meter readers. They do every day a reading route, and they know very well where the connection services are, so why not use them to locate the connection services?.

- In order to reach the objective, a software based on Arcpad, was made and installed in PDA'S.
  This software was developed to guide them in the daily reading route, and to locate the connection services in the map.

Using ArcPad to localize connections services

The software that was developed for the field work was:

1. An adaptation of ArcPad, with the most typical functions to navigate (zoom, pan, …) on the map, and other extra functionality to query the connection services information, and move them to the right position.
   The information of the connection services was obtained from the commercial system (GRECO).
   The map was composed by several layers of streets and urban layers, stored in Shapefiles. Also the map had a point layer, with the location of the known connection services numbered by the reading route order. This was very useful to guide them and locate the unknown connection services.

2. A program was developed in Microsoft .NET with ArcObjects for the generation of shapefiles on a PC. These shapefiles are transferred to SD memory cards for the PDA. Another program reads the data collected during

the reading route and loads it on GIS and the commercial system (Greco).

Locating connection services: The daily work protocol, based on the reading route

The commercial department plan every day one reading route for each person. And the daily work for this person is, apart from making the readings of the route, locating the connection services using a PDA with ArcPad.

The steps in one day are the following:

1. Commercial Department personnel generate one file for each reading route, with the information about all connection services in the route. Some of them are located, but others do not.
2. By using these files from the commercial system as parameter of entrance, and based on its postal codes, a .Net based program with ArcObjects extracts some shapefiles from the GIS (Gaudy) containing the reading route area. And it also generates another shapefile with the known connection services, in order to help water meter readers to guide in the map.
3. These shapefiles are loaded in a SD memory card, to use with ArcPad.
4. The readers use the PDA with adapted ArcPad to locate the unknown connection services of their water meter reading route. Results are saved on text files, stored on the SD memory card.
5. When they return to the office, these files are extracted from the SD memory card to a Computer, and are sent to the Geosistemas department
6. Every day we analyze the result files with the new locations, and update the commercial system with the new information.
7. Finally, we periodically insert the new connection services in the GIS (Gaudy).

Problems Inserting new connection services in the GIS

Using the previous information, we inserted new connection services in the GIS.

How we did this?

- We developed a program using ArcObjects, to insert automatically the new features in the connection services shape, following the connectivity rules.

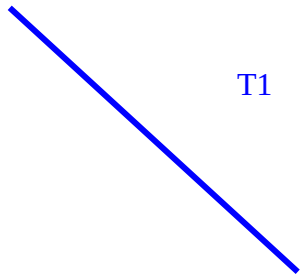
- We divide this work in 28 groups of municipalities, in order to create one SDE version for each group, and work in separate areas in each group.
- When the process of each version finished, we reconciled the version to the SDE Default version and posted it.

But we founded some conflicts when we did the reconciliation of these versions, because at the same time, GIS users were working with their own older versions in the same areas. And there were a lot of versions at the same time.
So we found strange things, like erased pipes that appeared again and other pipes deformed.
The problem was that the conflicts were not properly solved, because sometimes there is no solution to represent the real state of the net. You must be careful before executing an automatic process to modify a versioned database while editors are working with other versions.

We can see an **example** of a deformed pipe because a conflict between two versions.

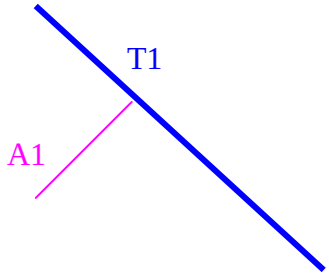
State 1

We have a pipe in the DEFAULT version

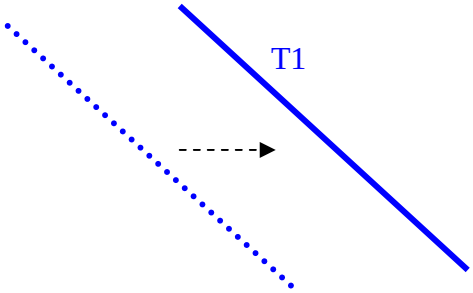


State 2

We create two versions V1 and V2.



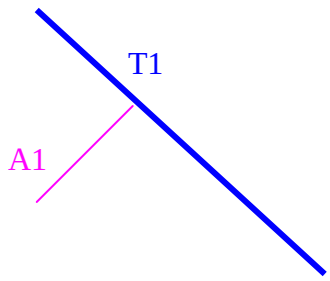
In V1 we insert a connection service A1 and connect to pipe T1



In V2 we move pipe T1

State 3

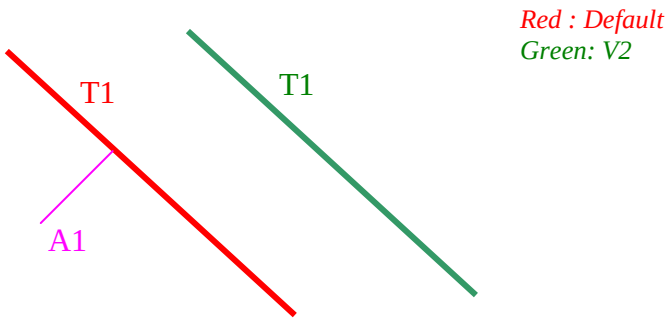
We first reconcille and post version V1 to DEFAULT version so the changes are :



DEFAULT Version

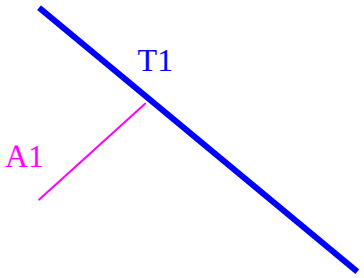
State 4

Now we reconcille V2 to the default version and we can see two conflicts in T1 pipe:

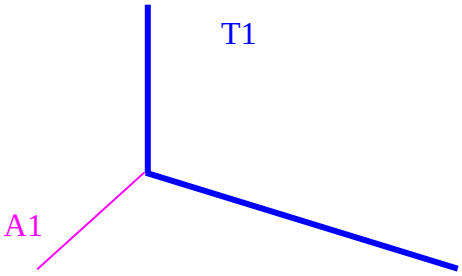


State 5

Now we can see the two options to solve the conflict, in favour of DEFAULT or V2 version:



Solving in favour of DEFAULT version



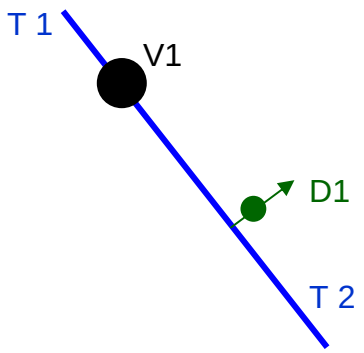
Solving in favour of V2 version

So, like we have seen none of the two solutions solve properly our problem.

And we can see another **example** of an appeared pipe because a conflict between two versions again :

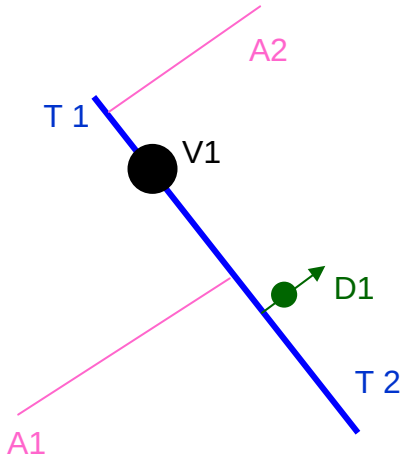
State 1

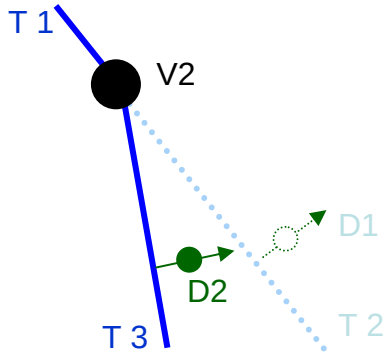
We have two pipes T1 and T2 connected by a valve V1, and a drainage D1 in the DEFAULT version.



State 2

We create two versions Version1 and Version2



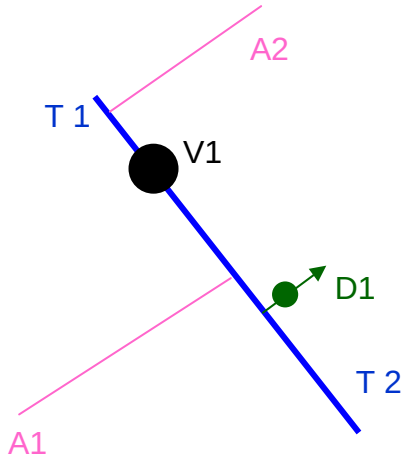


In Version1 we insert two connection services A1 y A2 connect to T2 and T1 pipes

In Version2 we erase part of a pipe, the valve and the drainage, and they are created again (T3, V2, D2).

State 3

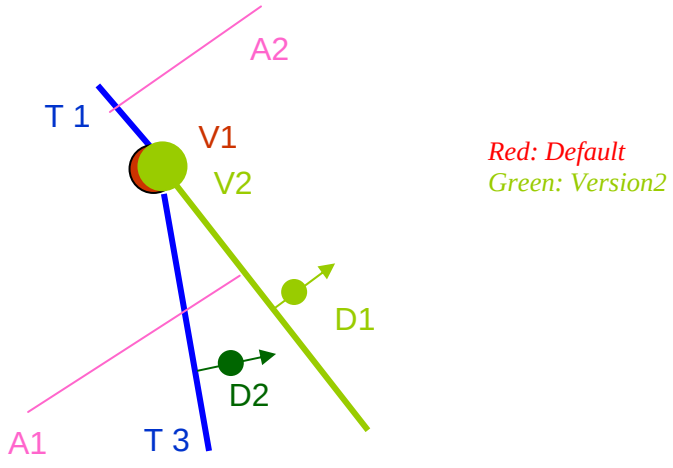
We first reconcille and post version Version1 to DEFAULT version so the changes are



DEFAULT Version

State 4

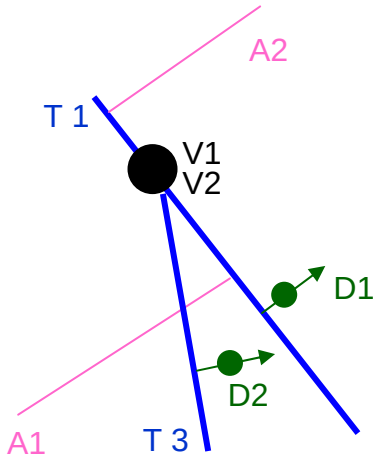
Now we reconcille Version2 to the DEFAULT version and we can the conflicts between the two versions:



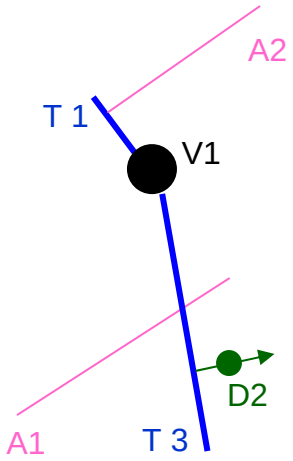
Conflicts between Version2 and DEFAULT Version

State 5

Now we can see the two options to solve the conflict, in favour of DEFAULT or Version2 version:



Solving in favour of DEFAULT version



Solving in favour of Version2

Like in the previous example none of the two solutions solve properly our problem.

With this work, we have seen that we must be carefully when working on a water network with a lot of versions at the same time.

How many connection services do we have geographically locate now?

Nowadays, we have 99% of the connection services of Madrid geographically located, and they are stored in the commercial system of the Canal de Isabel II (GRECO) .This let us make a good integration between the commercial system of CYII (GRECO) and the geographical information system of the CYII (Gaudy), in order to manage the service interrumptions and make good consumption models.