

GIS Tool to Trace the Wired Telephone Network

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Abstract

The cables of the wired telephone network suffers from some failures from time to time due to different causes. That will affect the overall network performance. Fast reporting for such breakdowns and locating these faults helping the maintenance engineers to accelerate their response to these faults. This paper provides an electronic archives to the wired telephone network to ease maintenance procedure by adding a new toolbar to the ArcMap application. This toolbar consists of three icons. The first icon offers some functions related to search, view and print information for a specific phone number. The Second icon dedicated for editing phone number data. While the third icon presents simple statistics in the wired telephone network such as: total phone lines, suspended lines, valid lines, and out of order lines. This application created by visual studio express 2012 (VB.NET) and ArcGIS 10.2.1. The communication services office located in Gaser Bin Ghashir area has been used to implement this application, as a test for this tool. Through the analysis of the program output, it can be said that the results is satisfactory.

Keywords: Wired Telephone Network, ArcGIS applications, ArcObjects, ArcMap desktop.

I. INTRODUCTION

There is no doubt that the environmental conditions have different impacts on service quality, which causes breakdowns resulting in communication failures. Fast reporting for such breakdowns and their locations will help maintenance groups to start immediately to repair the faults.

In conventional wired telephone cable network and in case of any malfunction, the costumer should inform the maintenance office by phone or personal attendance, where the technician in the maintenance office fill in a special paper form contains full information about the telephone line like phone number, region name, route number and so on. This information delivers to technician responsible to conduct the requested maintenance job. This procedure requires long time especially in the light of absence of the use of modern technologies and the lack of maps that illustrating the routes of the telephone cables.

This work aims to find a proper solution for the cabling of telephone networks documentation in general, and to the network of Hatif Libya Company, which is the main telephone land line operator in Libya. This solution depends on developing an applications that would help a lot in speeding up the maintenance operations and getting accurate results.

Therefore Microsoft visual studio express 2012 (VB.NET) has been used to create new toolbar in ArcMap desktop application, this toolbar contains three icons, each icon has specific function that can be implemented using the network data of the secondary cabling. The first icon will shows the rout of telephone line on the map from the main distribution box to the customer site with some options, such as hiding or showing the phone lines on the map depending on the state of this phone lines. While the second icon used for editing the information of the telephone lines using a simple form, which appears by clicking on this icon. The last icon in this toolbar provides a statistics summary of the telephone network states, including the numbers of valid lines, suspended lines and also the out of order lines. The Hatif Libya Company telephone cabling network at GASR Bin Ghashir city, located which is located about 20 km to the south of the capital; Tripoli, has been used to implement this application.

The rest of this paper is structured as follows: Section 2 reviews the programming ArcObjects with NET environment for ArcGIS 10. Section 3 describes the component object model and object model diagram respectively. While the main steps of creating and configuring the new toolbar in ArcMap application is present in section 4. The results of the development model and the effect of implementing of this model in the work flow given in section 5. Finally, section 6 conclude the paper and presents the most important features of this toolbar.

II. ARCOBJECTS

ArcObjects is a development environment of the ArcGIS applications such as ArcCatalog and ArcMap, it allows developers to extend these applications, therefore all ArcCatalog and ArcMap parts like points, lines, polygons, layers etc. are created from ArcObjects. ArcObjects are a set of classes written in C++ programming language by ESRI programmer. Each class represents some basic building block of GIS. The other programmers can create objects out of these classes by any other programming language like VBA (Visual Basic for Applications) which is included in the ArcGIS software. ArcObjects components are installed with ArcGIS for desktop, and ArcGIS for Server, which can be used to customizing ArcGIS for Desktop applications and Developing Web Applications [1, 2].

III. COMPONENT OBJECT MODEL AND OBJECT MODEL DIAGRAMS

All of the ArcObjects classes are based on a standard called Component Object Model (COM). COM is a technology or methodology of software development, contains a set of rules that the ESRI programmers follow to create their classes. Through implementation of these instructions, the classes become programming language-independent. The COM classes have a programmer interface built into each class, which is not a user interface. Even though the programming languages are different. The classes can communicate with each other through these interfaces, In short COM can be considered as the means by which the code in one language communicate with the code in another language[2,3,4].

Object model diagrams are one of the most important parts of ArcGIS Developer, because it represent interfaces of all types for ArcObjects. They also show the relationships between these types. These diagrams can help to determine classes, interfaces and the relationships between them in addition to some useful details about the classes and interfaces. ArcObjects is divided into many namespaces. Each namespace is provided as a distinct object model diagram. These diagrams are available by static help that is installed on the machine when we install the ArcObjects SDK for Microsoft .NET, and through the online ArcGIS Resource Center [5].

IV. CREATING THE TOOLBAR

ArcGIS functionality can be extended to create any particular requirements or features, which is not available in ArcGIS. There are four approaches for customization and development ArcGIS for Desktop applications version 10:

- 1) User Interface (UI) customization
- 2) Scripting
- 3) Desktop add-ins
- 4) Developing custom components using ArcObjects SDK (Extending ArcObjects):

The last approach was used in this work, since it is utilizing .NET frame work. It can be considered as the most flexible option which has no limitations for customization and development ArcGIS applications. Note that, .NET code should written in VB.NET or C#.NET to make use of ArcObjects [5,6,7].

The used steps in creating and configuring the new toolbar in ArcMap application through Visual Studio Express 2012 and VB.NET is given below:

A. Data Collection

Data collection phase was the first phase in this work, which is consists of many visits to the main distribution frame (MDF) and the concerned region in order to collect the information relating to the primary and secondary cables of the phone network. It was the difficult phase in this work for many reasons: such as absence of any computer system in technical section in addition to the lack of updated documents that is related to primary and secondary cables of the network.

B. Map Preparation

Gasr Bin Ghashir area was divided into twenty small areas, each area was provided with fixed telephone lines through special cabins called BEx, where x referred to the cabins number, each one of these cabins connected directly to the Main Distribution Frame (MDF) by copper cables with different capacities ranging from 500 to 2400 pair. The area supplied by the BE2 has chosen as case study for this work. Global mapper program was used to download the map of this area.

C. Creating Geodatabase

New empty file Geodatabase was created using ArcCatalog, and some feature classes or layers were added to this database such as main and feeder roads. Customer lines layer was the most important layer in this database, because it contains all the data of each telephone lines, which is the backbone of this application

D. Creating Toolbar

This application is provided a new toolbar in ArcMap program. This toolbar contains three icons, each icon dedicated to perform a certain new function on the telephone network through ArcMap software. This toolbar was not founded in the standard ArcMap program, but it has been created through extending ArcGis software and taking the advantages of GIS capability especially in terms of its ability to integrate with other software. The toolbar can perform one of the following options:

- 1) Searching for a specific phone number and view its information in special form.
- 2) Showing the route of this telephone line on the map.
- 3) Showing or hiding the telephone lines on the map based on their status.
- 4) The ability of viewing or hiding any features on the map.
- 5) Reading and updating the telephone line information from the map directly.
- 6) Presenting simple form contains general statistics on a telephone line, group of telephone lines, or all lines in addition to the number of valid lines, suspended lines and out of order line.

Many applications can be develop on ArcMap. The applications can be made as menu, of either toolbar (which is used in this work) or button

E. Adding Icons

Adding icons to the toolbar can be done by series steps producing a program identifier (ProgId) to identify and connect this icon to the toolbar. The steps generating two important methods: OnCreate, and OnClick. The OnCreate method is particularly useful for passing arguments to the class as it is instantiated. It gives the command a hook into the application. While OnClick method contain what will happen when the button clicked. The last point is to link this icon with the toolbar through AddItem method[7].

V. THE CREATED ICONS

In this work, three icons were added each of them will be discussed in separate section below.

A. Phone Viewer Icon

The first icon, that will be added to this toolbar contains on specific commands. When this icon clicked, a new form will pop up and all layers in ArcMap will be loaded in this form. This form is named as (BINGSHER EXCHANGE), and it will contain many buttons each of them can be used to execute certain command. These commands are:-

1) Showing and Hiding the Layers:

Two buttons will be added to this form in order to show or hide any layer contained in the ComboBox, to show or hide any layer. First of all, what layer should be appear or hide, must be known. In the ILayer object there is an important property called (Visible) , this property takes one of two options; *False* to hide the layer and *True* to show it.

2) Filtering the layers:

In this subsection we will work on specific layer called (Bingsher) which is contain the secondary telephone cabling network for BINGSHER EXCHANGE. This network was divided into three categories:

- *Valid*: which is contain the valid telephone lines.
- *Suspended*: which is contain the blocked telephone lines.
- *Out of order*: which is contain all the telephone lines that is not work correctly.

These categories called subtypes. The subtype is subset of features in a feature class, that share the same attributes, this field has a code and description treated by ArcMap and it use as a method to categorize the data. The subtypes coding scheme will categorize the phone state into three separate types without physically splitting the data into multiple feature classes. This will organize the data for display, and will ensure consistency when new data is added or existing data was edited.

Table 1 below shows the existing numerical codes and the corresponding descriptions that have been assigned to each subtype.

Definition Query will be used to write query by Query Builder, when the (phonestate) set equal to 0, ArcMap will display only out of order lines, when the (phonestate) equal to 1 only suspended lines will appear and so on. Therefore, three buttons added to the form, as shown in figure 1, and each button dedicated to display specific part from the secondary telephone network depending on the code for each subtype.

Table 1: Numerical Codes And The Corresponding Descriptions Assigning For The Subtype.

Code	Description
0	Out of order
1	Suspended
2	valid

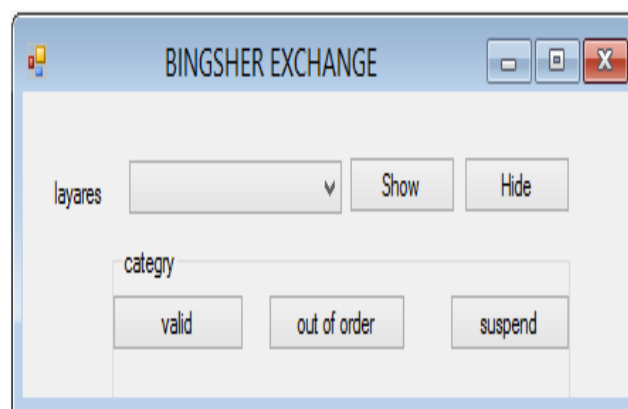


Figure 1: snapshot for BINGHER EXCHANGE form after adding some commands

3) Showing the telephone lines on the map:

To display the network telephone lines on the map, two ComboBoxes added to the form. The first one is labeled as *category*, and has three opinions for the state of the telephone; *valid*, *out of order* or *suspend*. Where the second ComboBoxes labeled as *phones*. It is dedicated to view the telephone numbers of the selected lines in the first ComboBox.

When a user selects a particular category in the drop down list two events will happen. The first event is the appearance of telephone lines which represents this category on the map, while the second event is populating the phone ComboBox with the numbers of these telephone lines. When the user selects one of these numbers, all related information to this telephone number will appears in this form. This information are: costumer name, phone number, phone state, distribution box and pairs in BE.

This form also contains two buttons to hide or show on the map all telephone lines in the secondary cables of the telephone network. The colors of the telephone lines represent the category of the line; (green for valid telephone lines, yellow for suspended lines and red for out of order telephone lines). Also each category of this network can be viewed individually on the map.

4) Search:

Which is one of the most important commands in this application. The function of this command is searching for any information related to a specific telephone line in the network and display its information. The information are such as; costumer name, phone state, the connected distribution box. In this section we will introduce an approach to search and display this information. From the visual studio toolbox, drag and drop button and textbox to the form, the textbox will receive a phone number from the user, while the search button contains on piece of code to find and display the information related to this number in the form.

5) Phone route on the map:

In order to expand this application and make it more flexible and reliable, a new button named (show on the map) is added. It will be used to display the full path of the telephone line on the map, starting from the main cabins which is the end point at the primary telephone network (BE2 in this case), passing through all points in this path like manholes and distribution boxes, and ends at last point in the secondary telephone cable of the network, which can be house, shop or any other building. The route will appear on the map with distinctive color. This information is very important to the technicians who will be responsible for the maintenance operations.

After adding all this tools to the form, the final form will appear as the following figure 2.

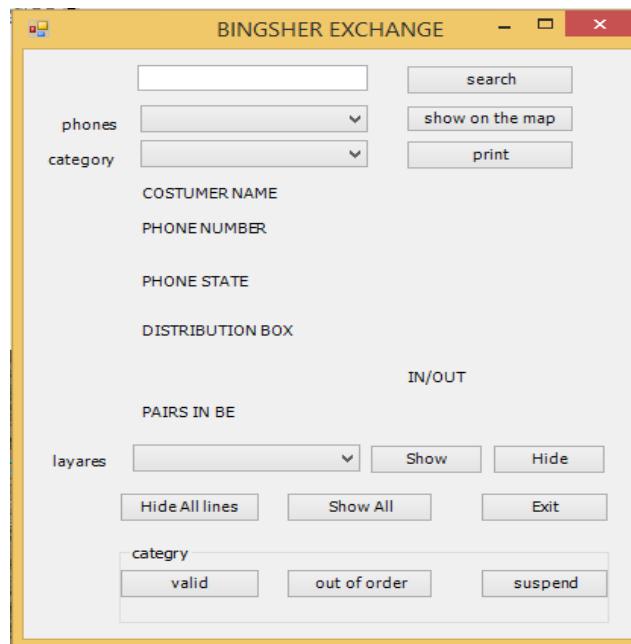


Figure 2: snapshot for phone viewer window

B. Editing Icon:

This icon is dedicated for customizing the tool interfaces. The user can edit or delete any feature in the geodatabase without affecting any of the other database information. The first point in this phase is to create geodatabase connection, the Iworkspace interface is the unique connection to a geodatabase and it contain the path of geodatabase. When the geodatabase is added to the map, ArcMap application will create many types of workspace depending on the type of geodatabase. If the type of geodatabase is personal geodatabase the ArcMap will create AccesWorkspace, while SDEWorkspace was created by ArcMap to deal with SQL database and ORACLE database. In our case ArcMap will create fileGDBworkspace because our geodatabase is a file geodatabase.

The IDataset interface has two important properties which is Workspace property to know the geodatabase connection, and Name property which is the actual physical name of dataset in the database[7]. The required information to appear can be configured easily through few steps.

The second function can be implemented through this form is deleting all feature information from the geodatabase, figure 3 shows the editing form.

Data Protection:

For data protection and preservation of unintentional deletion and changes. Simple form titled Login was added to this application as shown in figure 4. This form contains

Figure 3: snapshot for Editing form

two textboxes, one for user name and the other for pass word, this form appears in case of clicking on delete or save button, to suspend any deletion or saving process until the user enter the valid username and password.

Figure 4: snapshot for Login form

C. Reports Icon:

The last icon in this toolbar is called reports. By clicking this icon, simple window will appear on the screen. This window contains the main four important information about the secondary cables of the telephone network. This information illustrates the summary of the overall situation for the network trough displaying in this network, the figure 5 illustrates this window.

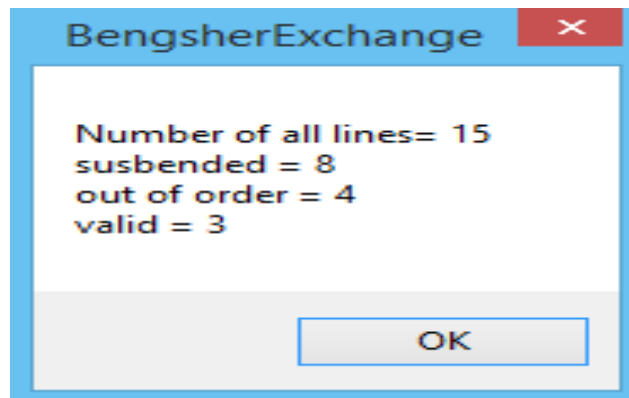


Figure 5: Summary of the overall statistical of the telephone lines

VI. CONCLUSION

This paper provide a new tool to help the technicians, who are responsible for maintaining the cables of the telephone networks. It will help them in tracing the fault location. The tool is adopted using GIS technique. In short, this idea focused on adding new toolbar to the ArcMap application, this toolbar contains some icons, each icon has its specific functions, which can be implement on the secondary cables of the telephone networks. These functions are directly related to searching, viewing, modifying and saving any information related to telephone lines. This work has been tested on the telephone network located in Gasr bin Ghashir area, 25km south of the Libyan capital Tripoli, and the results were satisfied.

This solution will save a lot of time, effort and money. The proposed tool can provide the following features :

- Any information related to any phone number can be obtained quickly.
- The route of any telephone line, can be displayed on the map directly.
- Knowing the places, which are not provided by the wired phone services.
- Editing and saving the phone line information can be done directly on the map.
- Providing a simple report about the technical situation of the network by one click.
- Providing an electronic archive for telephone networks.

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