KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

COLLEGE OF ENVIRONMENTAL DESIGN

CITY & RIGINAL PLANNING DEPARTMENT

TERM ROJECT

Implementing GIS in Optical Fiber Communication

By

Ahmed Saeed Bagazi – ID# 201102590

Yasar Salem Obad – ID# 201102350

For

Dr. Bager Al-Ramadan

Geographic Information System

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I – Introduction

The evaluation of the Internet technologies and the connection ways in recent years has fundamentally changed the way people interact and communicate. This growth of the Internet technologies has led to chaotic development of the infrastructure that supports it.

The development did not take account of hardware used, the media, interconnection software employed, the size of networks that are interconnected or any structured expansion plan. Most extensions were made incrementally, within the limits of the available budget. One of these technologies is an optical fiber. It use a lot of equipments and it has large networks.

Difficulties arose concerning network design and description, infrastructure expansion and troubleshooting failures. Areas where the focus is on real-time data transfer medicine, banking, police, army are seriously affected by lack of network reliability .

Another result of the expansion of the network infrastructure is the increase in the spatial dimensions that can complicate the troubleshooting procedures done in the field by technicians if the location of equipment is not accurately noted. The best way for modeling the geographical dimension of networks is to use a geographical information system (GIS).

GIS system give us the information and data that we need to know about the location of the networks or anything in these networks. For the optical fiber network, it has cables, repeaters, branches, lines and so on. If any fail happen, it is difficult to know the location of this failure without use the techniques. GIS system assist us to increase solve it by determining the location and sending it to the technician.

GIS has a database that saving the attributes of the feature locations and allow us to update it at any time. It allows us to add, remove, and edit a lot of the options. Therefore, it is very useful to use it to manage the networks of the optical fiber and communication.

GIS offers the network planner a powerful solution for simultaneously managing the physical location of the infrastructure, the attribute data associated with infrastructure components, and the cost of such components in a single environment.

II – GIS System Definition and Concept

Managing, GIS integrates hardware elements, software and data for capturing, analyzing, and displaying geographically related information. This system allows viewing, understanding and querying data in multiple ways that reveal relationships and patterns in the form of maps, reports or charts.

A GIS helps with answers to questions and solving problems by looking at existing data in an intuitive and easily distributed way. A GIS can be seen in three different ways: in terms of a database (database view), the map(map view) and model (model view). In Database View the GIS is seen as a structured database that describes the world in geographical terms. In View map the GIS is seen as a set of intelligent maps and sketches which characterized relations over the Earth.

In Model View, the GIS system is seen as a set of tools for information transforming for obtaining new derived datasets from existing data sets. These tools extract information from existing data, apply analytic functions, and write results into new derived datasets.

Data representation in a GIS system can be done either in Raster or Vector modes. Raster mode is essentially any type of digital image represented as an array of pixels. The pixel is the smallest unit of an image. A combination of these pixels will create an image. This representation consists of rows and columns of cells, each cell with one stored image. This representation consists of rows and columns of cells, each cell with one stored value. Raster data can be images (raster image) with each pixel containing a value, usually a color. Additional values recorded for each cell may be a discrete, defined by the user with relevant GIS system, a continuous value, such as temperature, or a null value if no data available. A

raster cell that stores only one value can be extended by using raster bands to represent RGB colors (red, green, blue), or an extended attribute table with one row for each single cell unique value. Resolution in raster mode is pixel size in physical units distance). Raster data are stored in various formats, from standard file structure of TIF, JPEG, etc., and directly in binary data fields (BLOB) of common databases.

Vector mode is used especially in GIS systems where geographical features are often expressed as vectors, by considering the elements as geometric forms. Various geographical elements are expressed by different types of geometric forms:

- Points - zero-dimensional points are used for geographical elements that can be best expressed by a single point of reference, in other words, simple location. There is no possibility to make any measurements in this case.
- Lines - The lines are used for one-dimensional linear elements such as rivers roads, topographic lines, and so on. Lines also allow measurement of the distance.
- Polygons - Polygons are two-dimensional elements that are used to represent a geographical area on the surface of the Earth. Polygon features make it possible to measure the perimeter and area.

In order for the GIS to be useful, they must work properly and provide the requested information in a timely manner. The common problems of such systems are scalability and speed of processing user requests. When the system operates with more elements, the scalability problem becomes more pregnant. Problems in repeated rendering of large number of elements appear (e.g. moving the map in a specific direction) when finding a particular item, when querying the system for the position of an element, inserting or deleting an item, and so on.

III – GIS System Used for Optical Fiber Networks

The application integrates a GIS engine based on vector graphics. This means that the application stores all its information in the form of vector primitives: points, lines and polygons. This enables the GIS rendering system to manipulate the information as a vector image.

The geographical component of the data describing the network is divided into two major layers. Each of the layers is later subdivided into several sub layers.

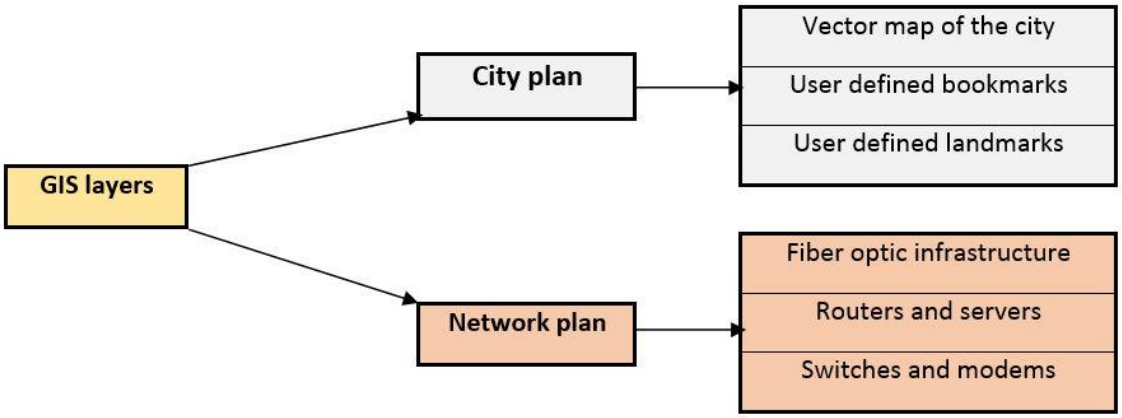


Figure 1 GIS System

The first major layer is the City Plan that contains information about the terrain topology on which the network operates. The City Plan includes sub layers that describe streets, buildings, duct systems, user defined landmarks. The user defined landmarks are geographic location markers that hold a particular importance for user.

The second major is the Network Plan contains all the important information about the description of the network. The layer is structured in several sub-layers each of them embedding a model for describing and monitoring the infrastructure based on specific transmission mediums. It includes a routers that it is very important devise which connects between the users and the company or the headquarter. Also, contains switches and modems. Each one of these has ports and these ports has individual number this number identify this port. All these information store in network plan.

IV – Optical Fiber Network

The fiber uses light to send the information. Therefore, the capacity of data is very large, the speed is very fast, and it has a large security for the information. For these reasons, most of the countries, companies, industrials, and others prefer to use this technique for the communications and connections.

Optical fiber networks has a lot of topologies that enters for building the network. The equipment such as cables, routers, switching, PSs, screens and others.

We can use the optical fiber also in our home this technology is called fiber to home (FTTH).

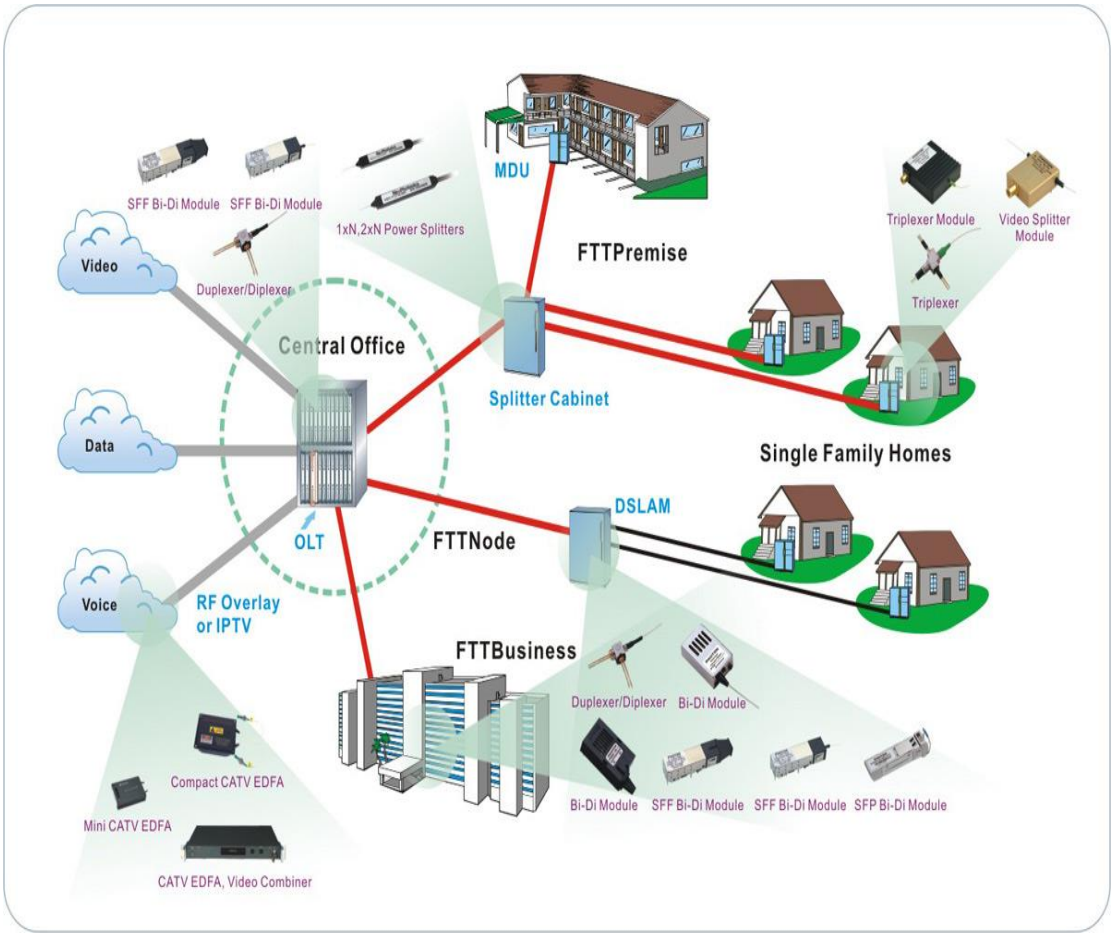


Figure 2 Fiber Optical Network

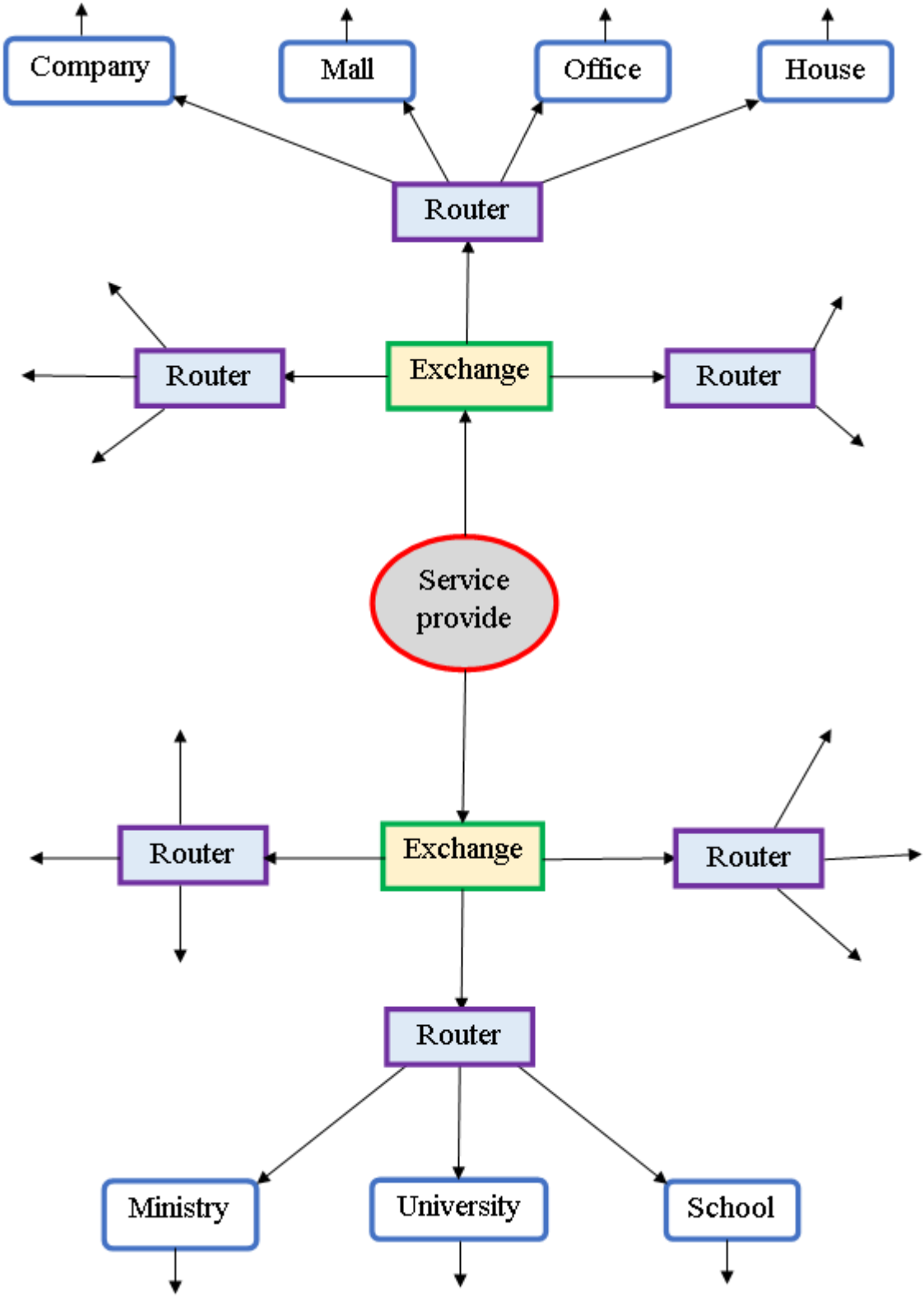


Figure 3 Optical Fiber Network Distributions

V – Objective

Optical fiber technology is used to connect internet for long distances among branches of companies, cities, countries, and service provider and costumer (home, company, shop, etc.). Therefore, it required from executed company for this service knowing accurate routes, coordinates and locations. This is helpful when a problem occur somewhere because finding the location of a problem manually is very difficult and take long time. However, with development of computer and software, it is possible now tracking any fault and determining its location easily. By knowing the coordinates, the troubleshooting team will find the defect quickly and fix it.

Our objective from this project is to set up database (locations and attributes) for executed projects with optical fiber technology. Database consist of all required coordinates and connectivity places. In case of a defect, the defect place is sent to troubleshooting team to solve the problem quickly.

VI – Methodology

Implementation of GIS on optical fiber passes on many stages:

1 – Knowing the location of the customers (Company, shape, home, etc.) and determining the coordination.

2 – After determining the coordination of the location. The company that provides the service searching the nearest exchange to connect the location with it. If they find it, they search enter the exchange if it has free ports in routers that use in the connection of the network.

3 – If the technician find free ports, he send a message to the team planning that includes all the information such as (name of exchange, name of a router and it number, number of ports,…etc.).

4 – Planning team takes a picture for the location of the customer and the exchange and then they choose the best route for the connection.

5 – After the planning team taking the pictures from the Google Earth and choose the route, they sent these pictures to the GIS team with all the information about the customer location, data of the location and the exchange, names and numbers.

6 – GIS team begin to build a database for the project with this information in the message from the planning team. They enter the pictures into the ArcCatlog and make shapefiles for these pictures.

7 – The GIS team using ArcMap to editing on these shapefiles. They enter the data that is needed for the project. Determine the street, buildings, exchange…etc. They build full databases for the projects.

8 – They make a lot of different pictures for the map of the connections between the customer and the exchange. Writing the names and the numbers on the maps.

9 – After the GIS team finishing, they send again back to the planning team and the sent to the implementation team to start doing the project.

10 – If any update do at any time, the GIS team makes update on the database that depends on the data that given to the GIS team, so the company has a full databases that are updated.

11- If any problem occurred at any place, the customer will send messages that contain an information about the problem and where it happened. He will explain what the type of this problem and how and where occurred.

12 – Troubleshooting team send a message to the information and data team to find the coordinate for the location and send a message that include all the information and maps for the location to the troubleshooting team.

These stages that the project of the optical fiber passes them for a real project. However, in our project will we explain some stages of them by pictures and note for every picture.

Using GIS for this project is very useful. In the past, if we have cut in connection. The technician tracks where the problem by using some simulation and monitoring programs. If he found the location, he went to map that draw by computer, take the coordinate, and send a message to the fixing team. However, with GIS he will save the time by taking all the information of this project and make cope for the map and then to the fixing team. So, the company saving the time and fixing the problem quickly.

GIS system give us more details that we need to know. It gives us the name of street, number of building, tall, and length….etc. Without it, we need to come back to paper map or digital map to know where the location. This will take a long time and may not find the location correctly. Also, it assist us to track the location pint by point by using the computer. In addition, it easy to edit if we find any mistake.

VII – Data

We get the data from the Mobily Company. This data for projects in eastern area in Saudi Arabia. This data for two projects:

1 - Rashid mall

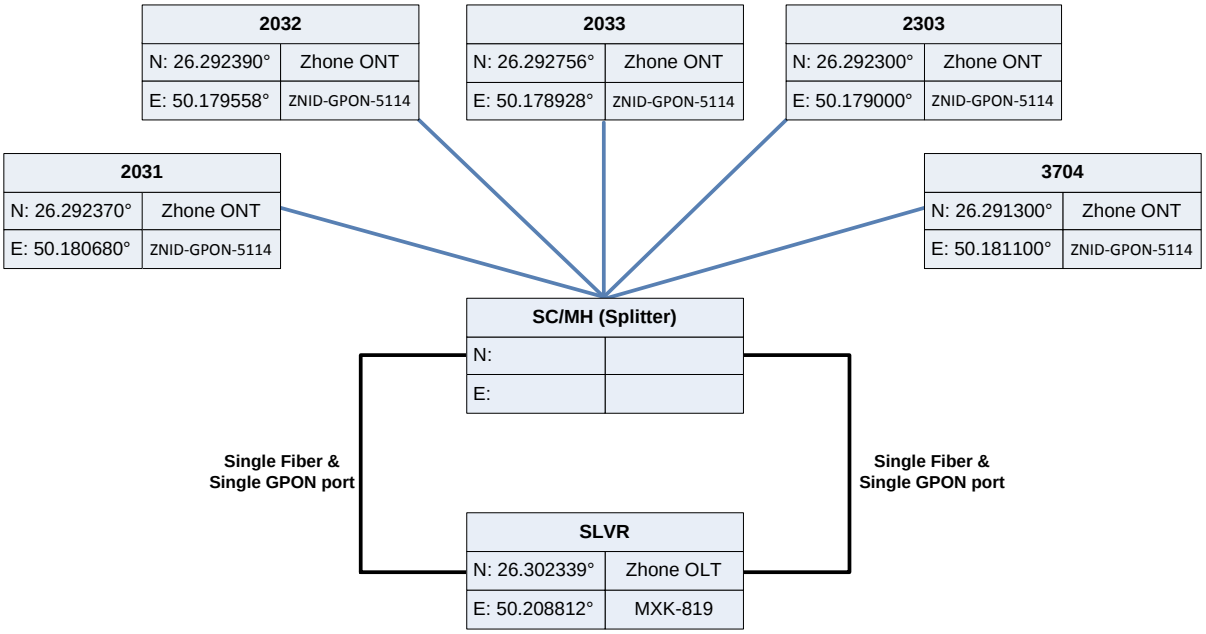


Figure 4 Coordinates data for Al-AlRashed Mall Project

Figure 5 Map For Al-Rashed Mall Project

2 - Timimi Mall

S116	
N: 26.340278°	
E: 50.151944°	

RAKA	
N: 26.363394°	OLT
E: 50.197967°	MA5600

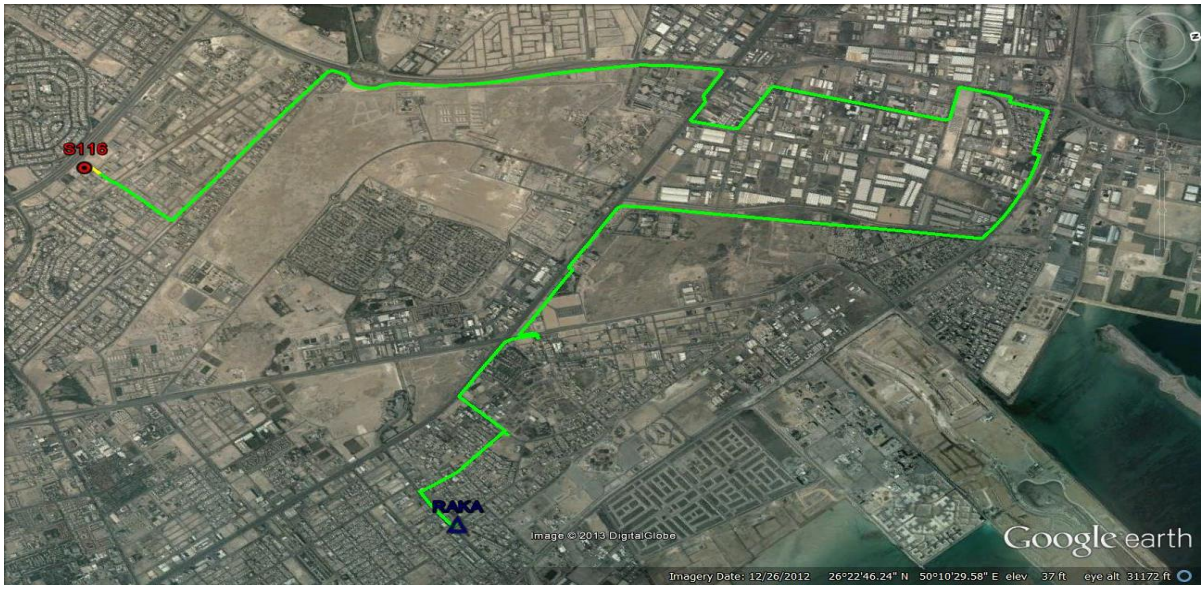
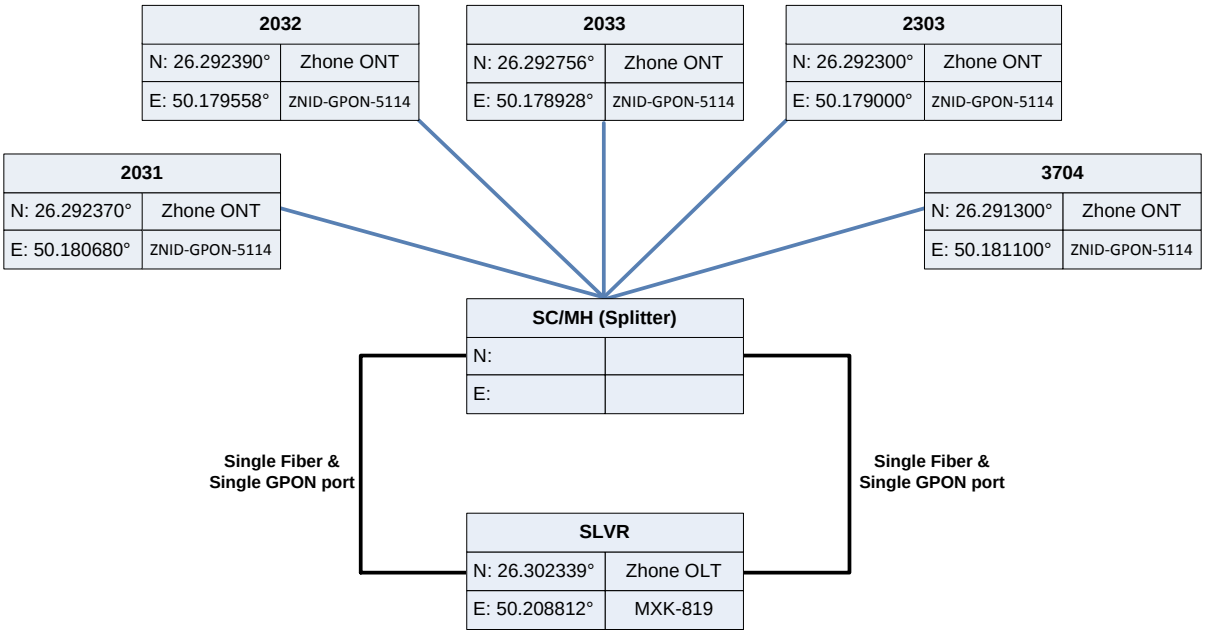


Figure 6 Map for AL-Timim Project

VIII – Case Study 1: Rashid Mall

We followed the following steps:

1. Take the coordinates from the source.



2. Downloading the map according to the coordinates by using Google Earth.

Figure 7 Coordinates and Map for Al-Rashed Mall Project

3. Inserting the map to ArcCatalog to get shapefile.

4. Inserting the files in ArcMap and editing the data.

5. Determining the streets and the route from the exchange to the building (Rashid mall).

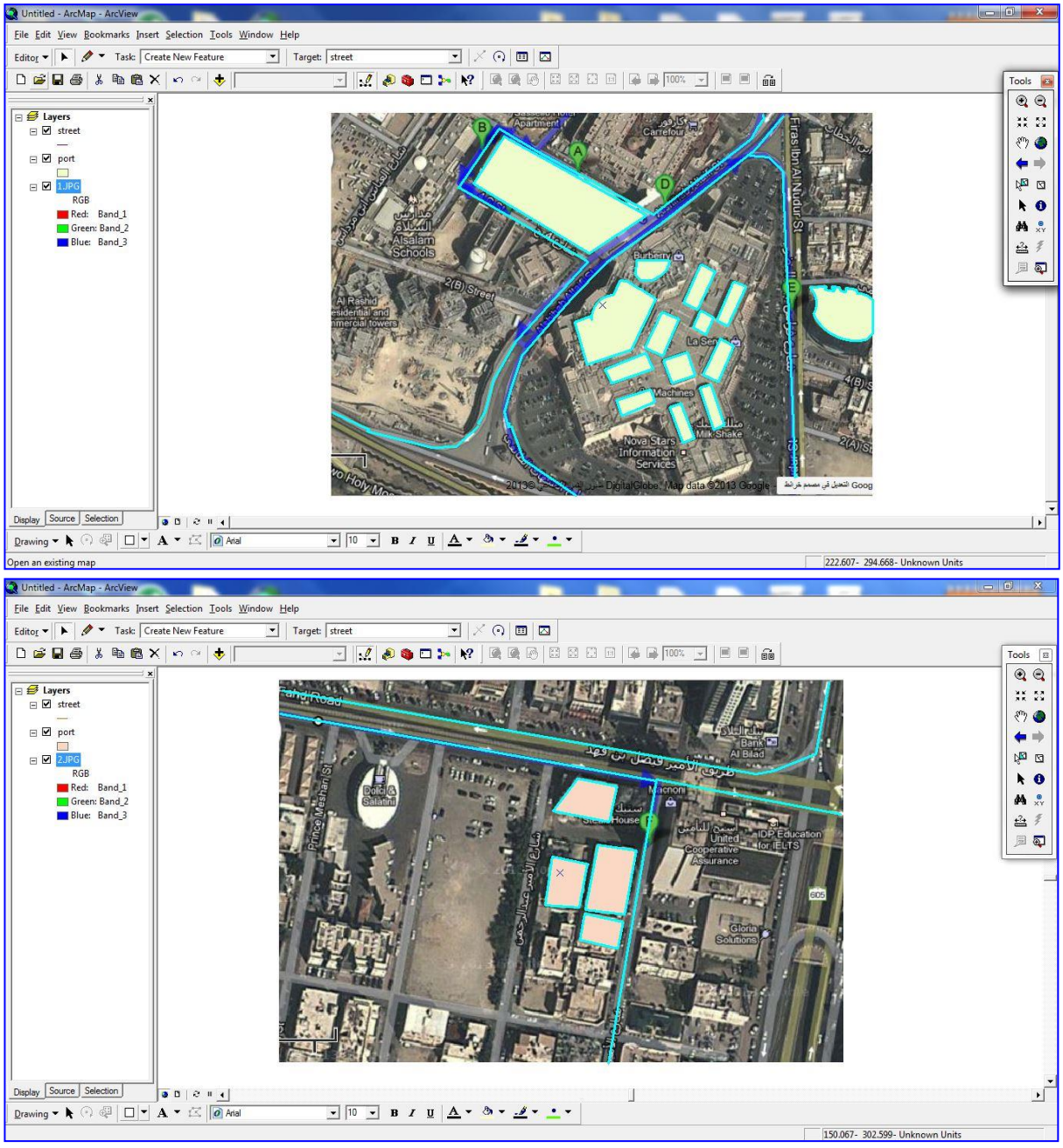
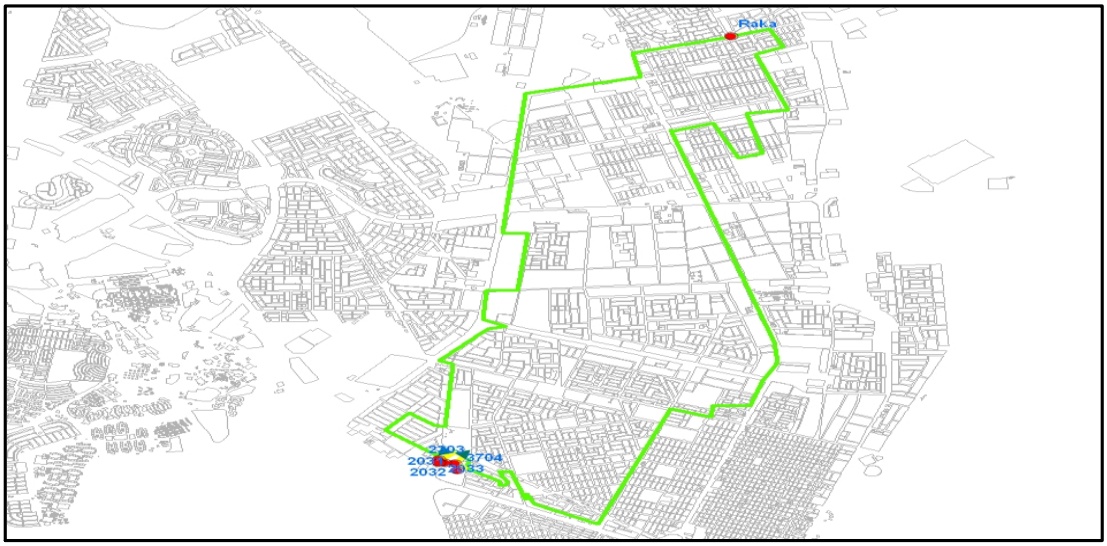


Figure 8 Determining The Rout of Al-Rashed Mall Project using GIS

6. Determining the place (location) for the optical fiber.



S/N	Site A	Site B	Distance	Loss 1310	Loss 1550
1	RAKA	EXMH	17Km	8.45	6.24
2	EXMH	RAKA	14Km	7.40	5.58	

Comments:

Exchange/POP
Mobily Site
Customer Building
SC/MH
Primary Route
In Progress
Protection
Existing Route

S/N	Site A	Site B	Distance	Loss 1310	Loss 1550
1	SLVR	EXMH	6Km	4.60	3.82
2	EXMH	SLVR	9Km	5.65	4.48

Comments:

Exchange/POP
Mobily Site
Customer Building
SC/MH
Primary Route
In Progress
Protection
Existing Route

Figure 9 Determining the Places (Locations) of Al-Rashed Mall Project using GIS

7. Taking the detailed picture as a map.

Figure 10 The detailed Place Map for Al-Rashed Mall Project

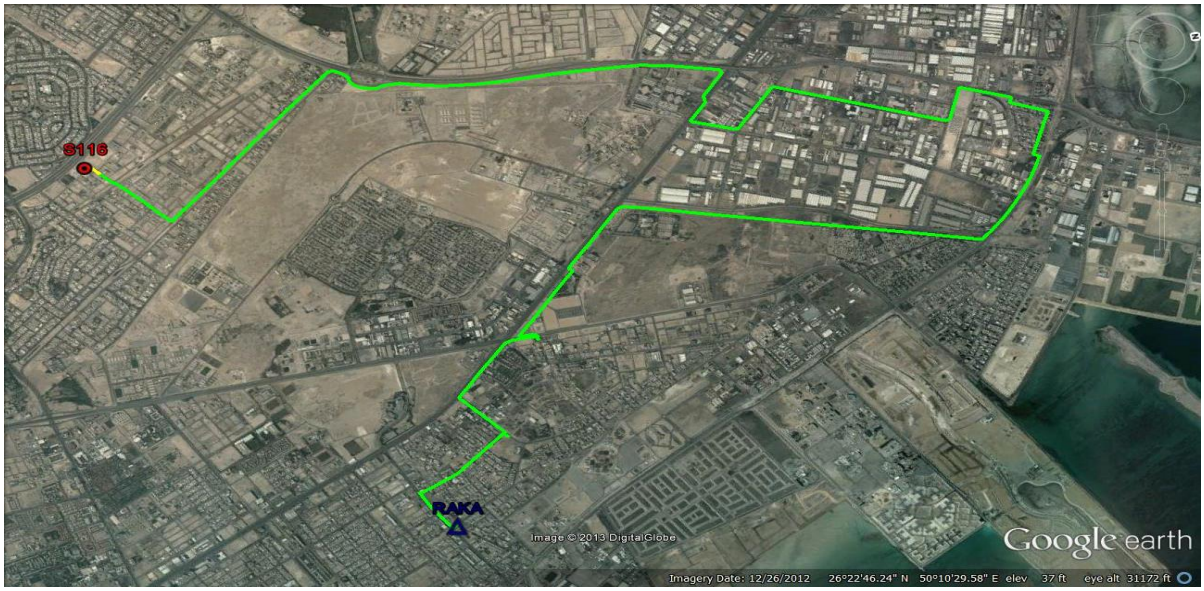
IX – Case Study 2: Timimi Mall

1. Take the coordinates from the source.

S116	
N: 26.340278°	
E: 50.151944°	

RAKA	
N: 26.363394°	OLT
E: 50.197967°	MA5600

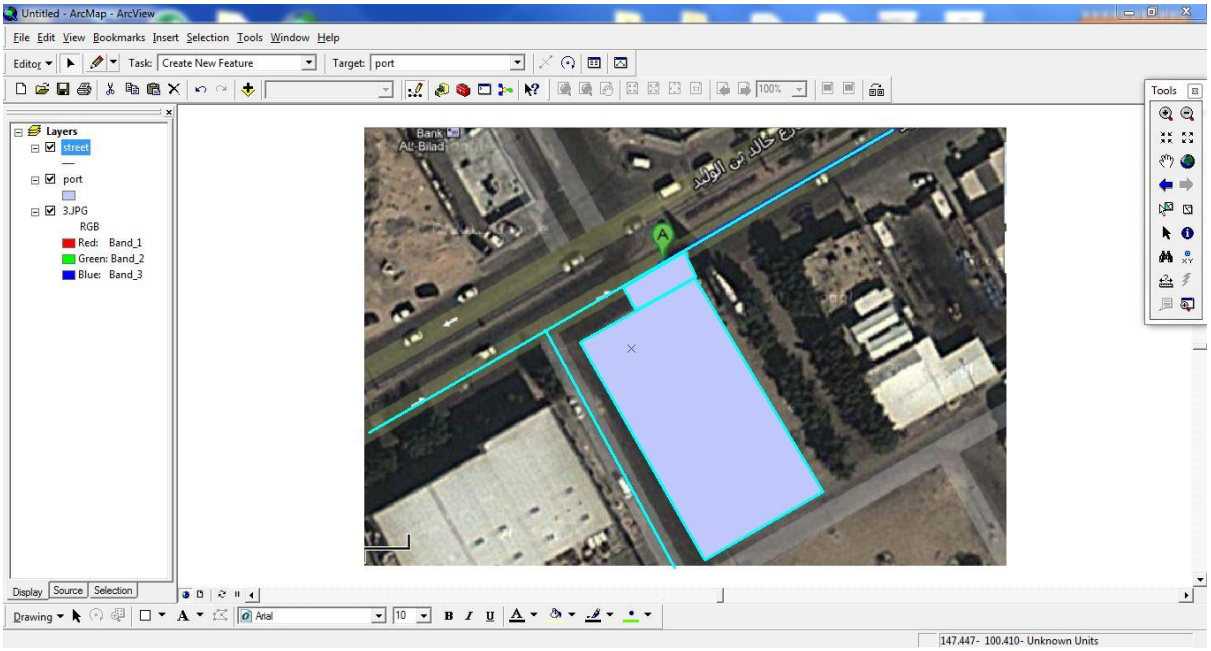
2. Downloading the map according to the coordinates by using Google Earth.



3. Inserting the map to ArcCatalog to get shapefile.

4. Inserting the files in ArcMap and editing the data.

5. Determining the streets and the route from the exchange to the building (Timimi mall).



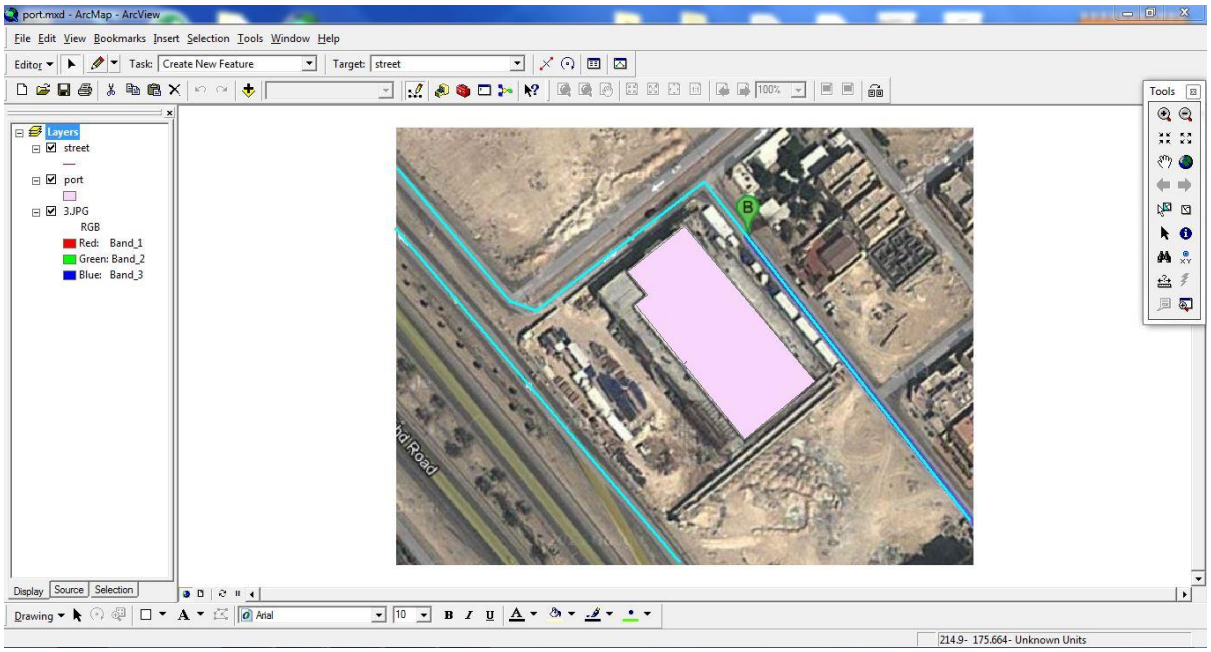


Figure 11 Two Pictures of Al-Tmimi Project that determining the routes using GIS

6. Determining the place (location) for the optical fiber.

Figure 12 Determining the Locations for Al-Timim Project using GIS

7. Taking the detailed picture as a map.

Figure 13 Details Place Map for Al-Timim Project

X – Analyzing

Before using GIS for managing the optical fiber networks, we faced some problems to find the exactly locations for the projects. Because we saved the coordinates on maps separated from the data. Therefore, if we wanted to visit some places to make updating on them, we must send a message to information team and message to the planning team to assembly the data and using some programs to track the location.

However, with appearing the GIS on the optical fiber communications, it assists us to solving these problems and only needing to setup the GIS program and using it to find the locations and their information without send messages to other teams or use some programs to assist us.

The best benefit for the GIS, it includes all the information that we need in our projects. We have to open the map and search on the map by using to tools. We search for the

street, buildings, exchanges, etc. that we need to go to them. Also, we can do some operations such as: edit, add, remove, update, etc. easily on the map.

Furthermore, GIS give us benefit to connect with other companies to take the update from them without do the update by ourselves. Only we need to connect with them in a network and get the update directly. In addition, the customer can save his map and know all the information that he needs, also we can send to hem any update we make on his project. GIS makes many benefits that solving the problems which we faces them before using the GIS.

In our project, we use GIS to determine the route for the connection and record the data for the locations. Rather than send to the customer pictures from goggle map, we use the GIS pictures that easy to understand and contain cleaned data. It is easy to read and make as a reference. We face some problem only to get the coordinate that we need.

XI – Conclusion

In summary, our project to implement the GIS program on the optical fiber communication to make a good data base for this project, and to be a reference at any time we need to come back to these details. At the first, we collect the data and coordinate for the locations and attributes. Then, we use Google map to get a pictures for the locations and enter these pictures in ArcMap program. We see that using the GIS assist us to determine the locations and save them in a good database. Also, we can do edit or add or update at any time.

The big problem for this project is to find the data and information that we need, because some this data is a secret and cannot any one give it.

Our recommendation is to develop using GIS in optical fiber. Our goal was to use it also to find the location of the problem directly. This meaning is to connect the GIs with

other tracking program that use in mange and troubleshooting of the optical fiber network. Where if we have a problem and track it, the GIS directly give us the coordinate for this location and send messages to specialist of the fixing.

XII – References

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