International Institute of Information Technology, Bangalore

Geographic Information System Project

FTTH Planning and Recommendation

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Abstract:

Providing Fiber to the Home(FTTH) is tedious work for large networks. Manual fiber network planning doesn't provide good scalability and flexibility for construction. Customization will not be easy and it could take days to design it manually.

The goal of this project is to recommend an FTTH network for a selected area that could solve all the above problems and companies could seamlessly manage the entire integrated infrastructure.

Index Terms: FTTH, GPON, OLT, ONT, OSM, Optical Splitters, K-means Clustering.

1. Introduction

FTTH stands for fiber to the Home or fiber to the Premise. Over the last decade, the bandwidth required for services such as high definition TV and the internet has grown explosively. To fulfil the growing demand for high-speed internet telecommunication operators are seriously considering the high volume roll-out of optical fiber-based access networks. The home FTTH appears the most suitable choice for long term objective because if the clients are served by FTTH it is easy to increase bandwidth in future.

But when it comes to planning and designing this network manually it is tedious work. It can take days. Considering there are multiple engineers present in an organization working on designing the network would recommend different networks according to their optimizations and it is difficult to reach a common ground. Even if they have come to a solution network that network may not be flexible and customizable.

So, we took up this project which recommends the FTTH network for a selected area that could be the optimal one and provides seamless management of the entire integrated infrastructure. This project allows engineers to try out different scenarios in no time so that they can reach the final optimal network.

2. Components and Terminologies of FTTH

2.1 FTTH

FTTH (Fiber to the Home) includes fiber optic access solutions designed to deploy in homes or premises. FTTH increases the connection speed available to computer users compared to now used broadband technologies. The defining characteristic of FTTH is that it connects optical fiber directly to homes or offices. It uses optical fiber

for all of last-mile telecommunications. Optical fiber transmits data using light signals to achieve high performance.

2.2 OLT

The Optical Line Terminal (OLT) is the main element of the network and it is usually placed in the local exchange and it is the engine that drives the FTTH system. The most important functions of OLT include traffic scheduling, buffer control and bandwidth allocation.

2.3 ONT

Optical Network Terminals (ONTs) are deployed at user's homes/premises. ONTs are connected to OLT by means of optical fiber and no active elements are present in the link.

2.4 Optical Splitter

The optical splitter splits the power/bandwidth of a signal. Each link entering the splitter will get divided into a given number of fibers leaving the splitter. Splitters are used for sharing each fibre with many users. There are level 1/mid level and level 2 splitters used in the project. The mid-level is 1:4 splitters and level 2 are 1:16 splitters. One could change that increase or decrease splitting capacity according to need.

2.5 GPON

GPON stands for Gigabit Passive Optical Networks. GPON is a point-to-multipoint access mechanism. Its main characteristic is to use passive splitters in the fiber distribution network, enabling one single feeding fiber from the provider's central office to multiple homes, offices and other premises.
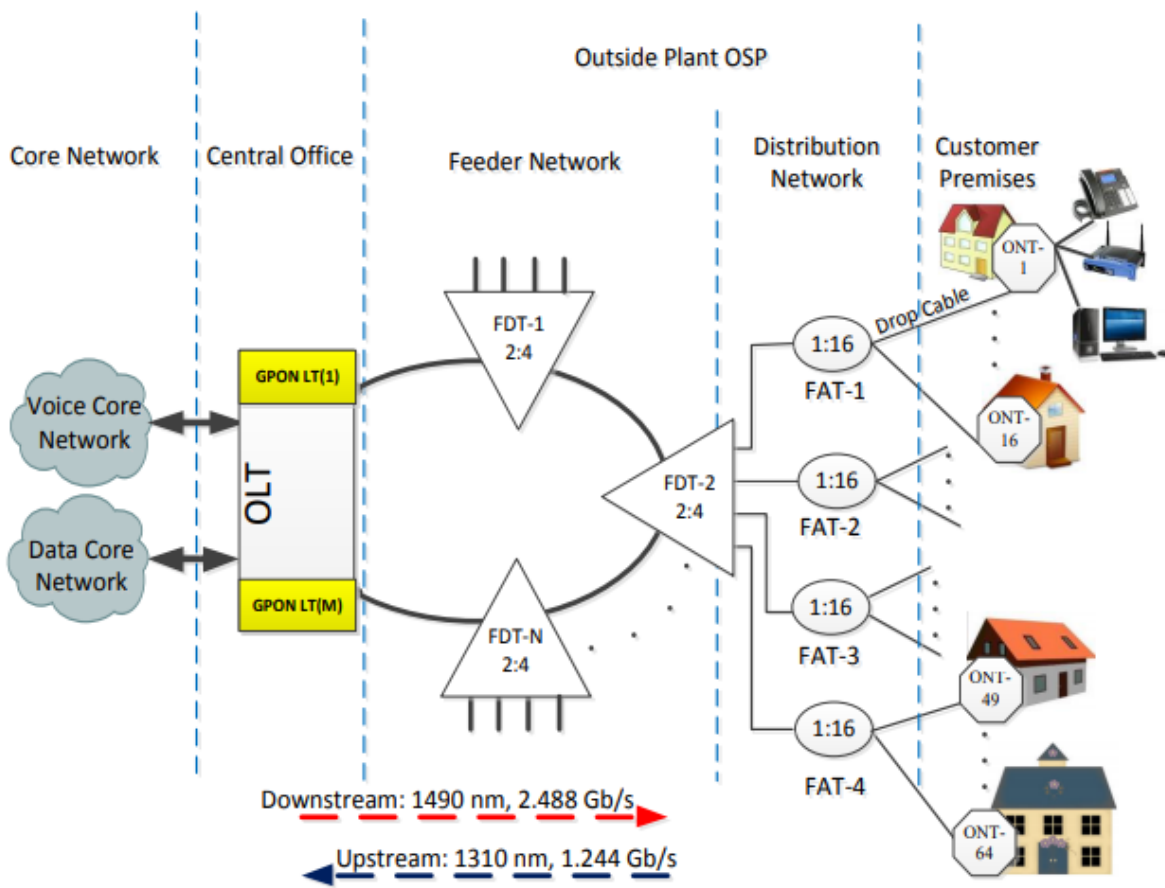
(GPON FTTH access network architecture)

3. System Configuration

Requirements:

Operating System: Windows, Linux, macOS

CPU and RAM: 4 core and 4 GB RAM

Installation:

a) QGIS version 2.18.14 or later 2.18.x (QGIS 3 is not supported) for Windows 10 (recommended version 2.8.24-1)

b) GRASS GIS 7 package for windows 10(recommended GRASS 7.4.1)

c) Install python library scipy (https://www.scipy.org/install.html)

d) Install python library openpyxl (https://openpyxl.readthedocs.io/en/default/) (required only for report generation)
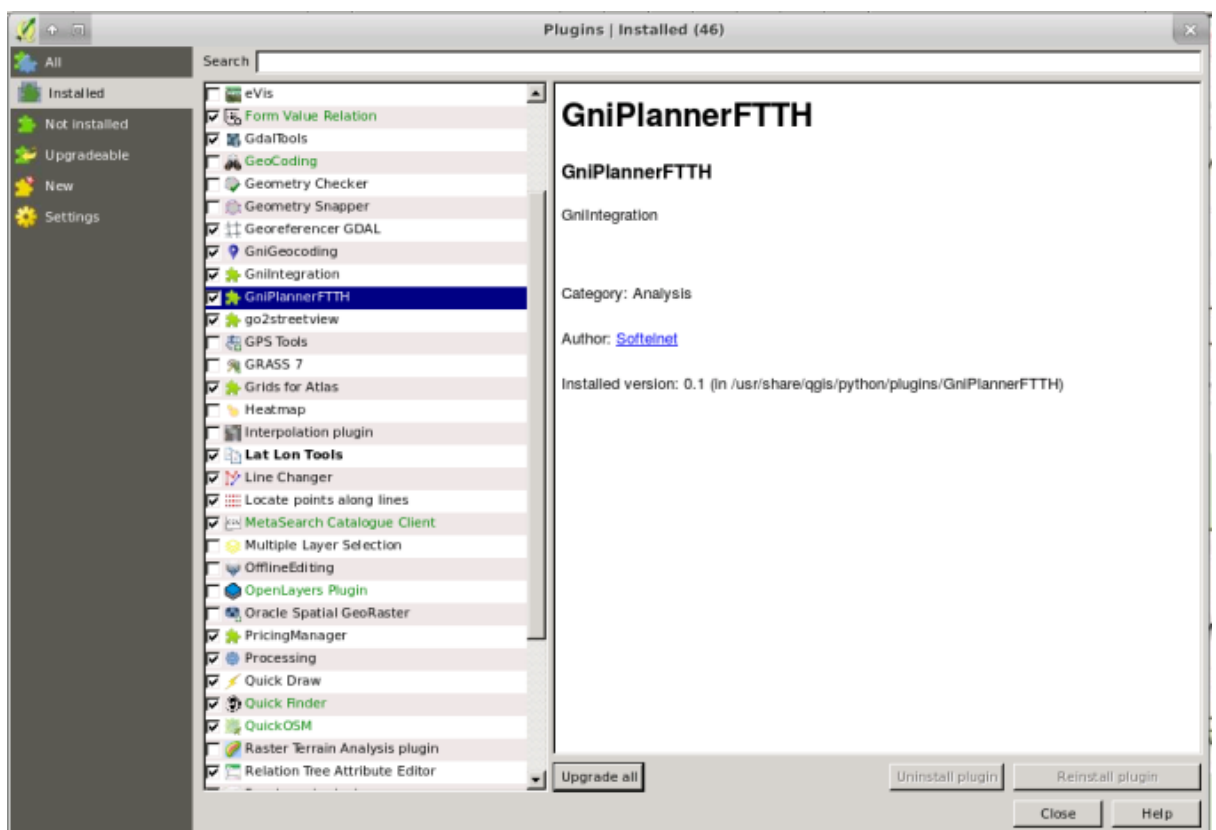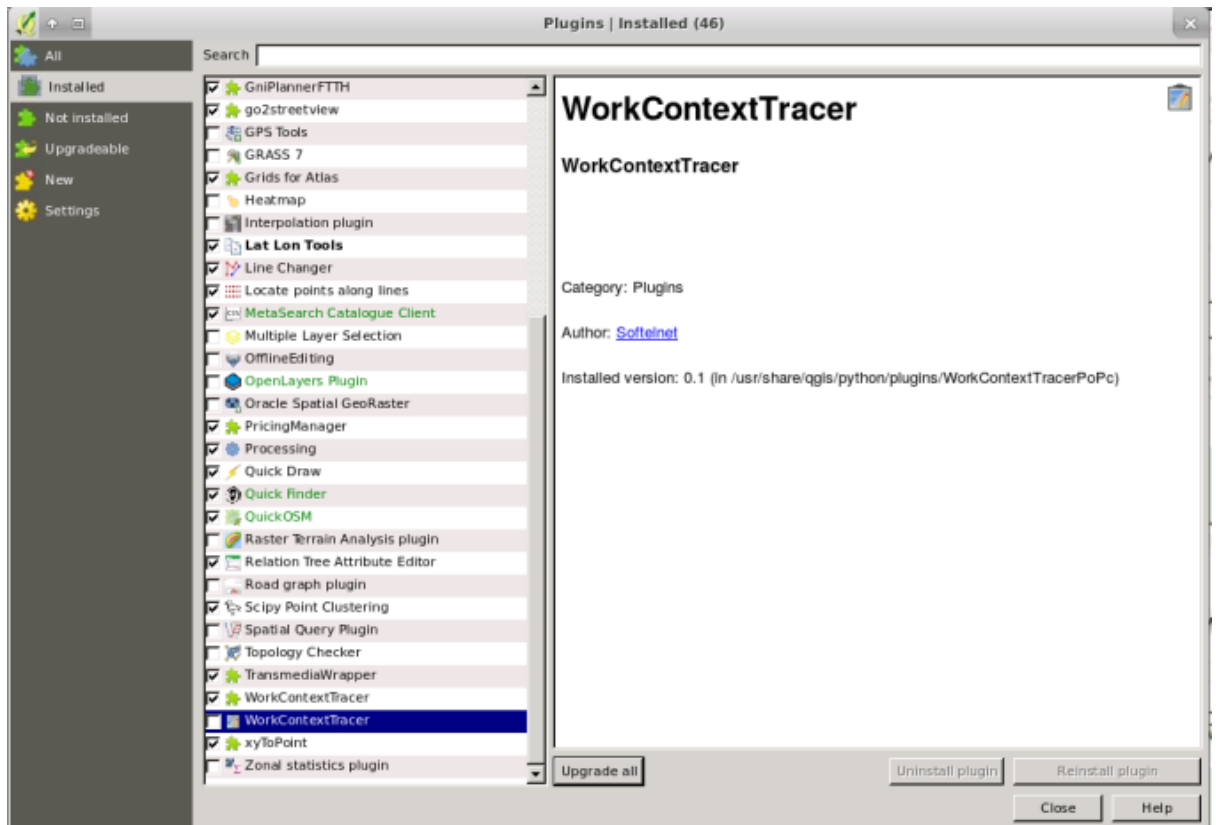
e) Install Scipy Point Clustering plugin
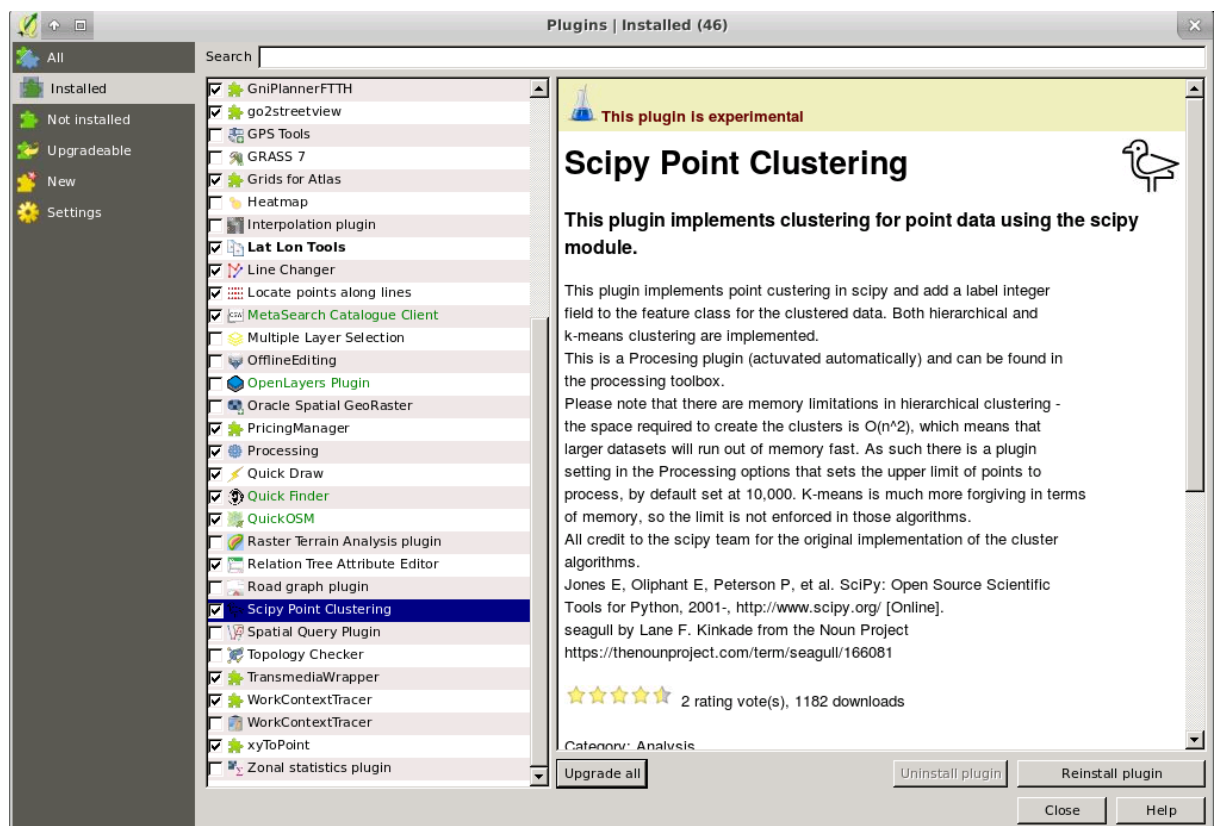
f) Install QuickOSM plugin
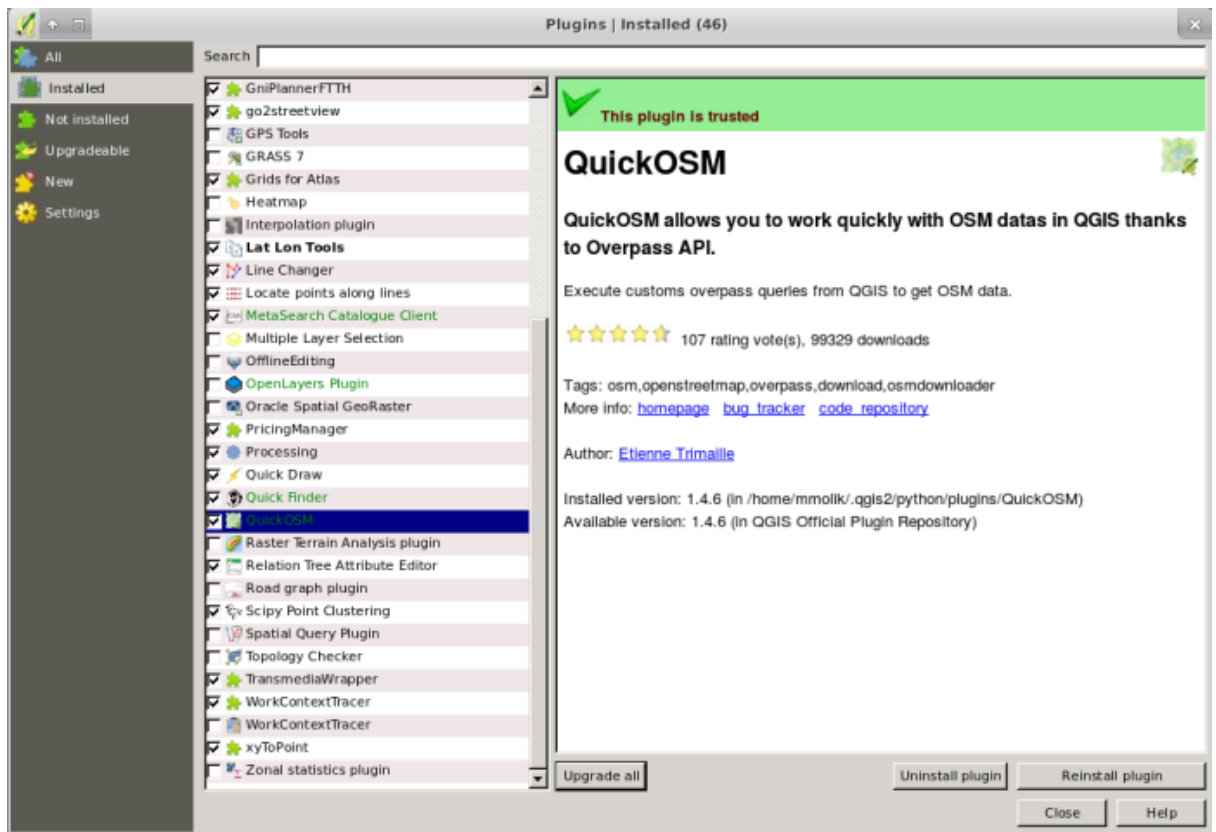
g) Enable Processing plugin
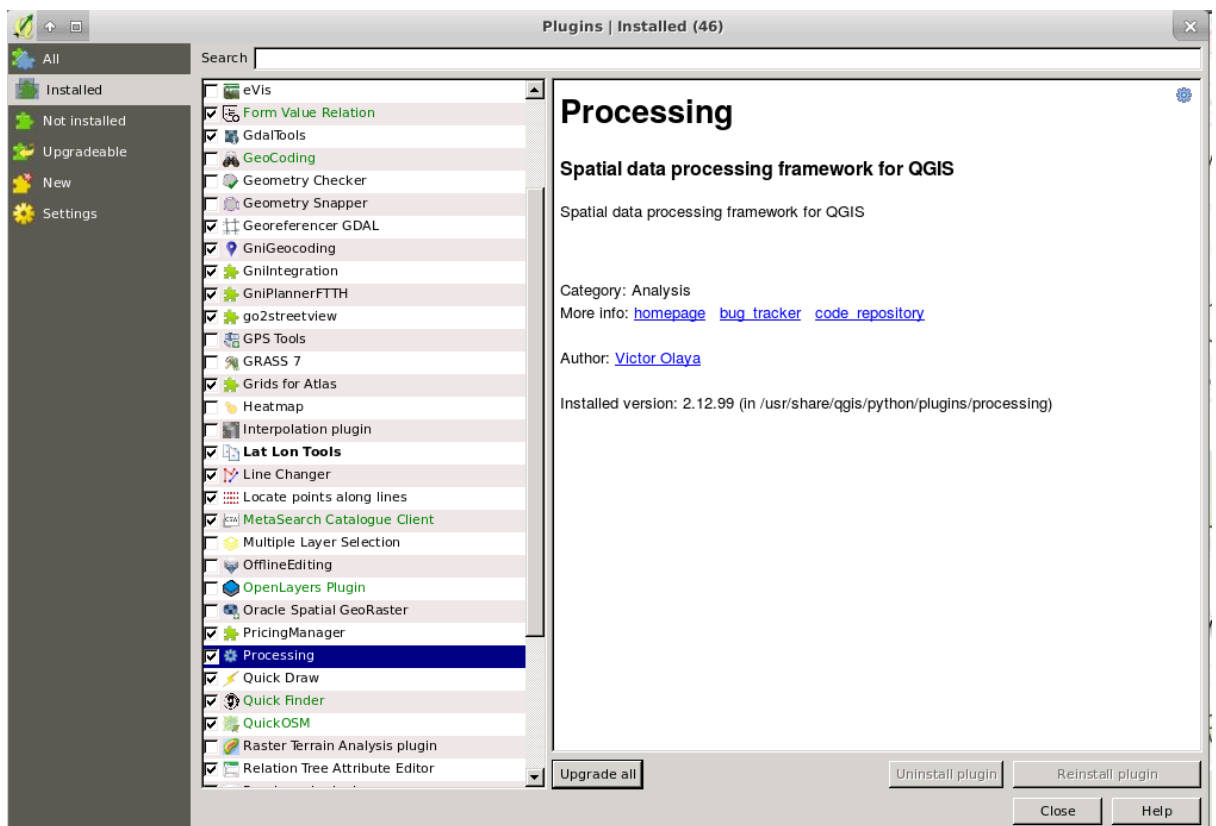
h) Turn on WorkContextTracer and GNIPlannerFTTH plugins in the QGIS plugin manager

4. WorkFlow

Planning and recommendation process-

We will use a layered approach for this task. Each layer will perform its task and pass information to the next one, leading to the final layer which has recommended the FTTH plan.

4.1) **Base Layer: OpenStreetMap(OSM)**

OpenStreetMap is a collaborative project to create a free editable map of the world. The geodata underlying the map is considered the primary output of the project.[1]

For planning and recommendation, we need to consider several factors like:

-Area to be planned

-Buildings (which are potential ONT), their area

-Roads, tracks (potential route) etc.

4.2) **Area layer**

Select an area on which planning has to be done. The area selected as polygon layer(vector data).
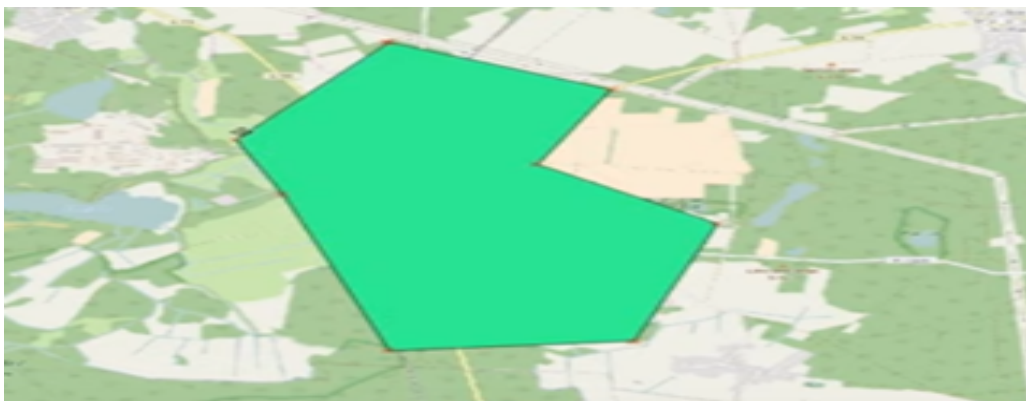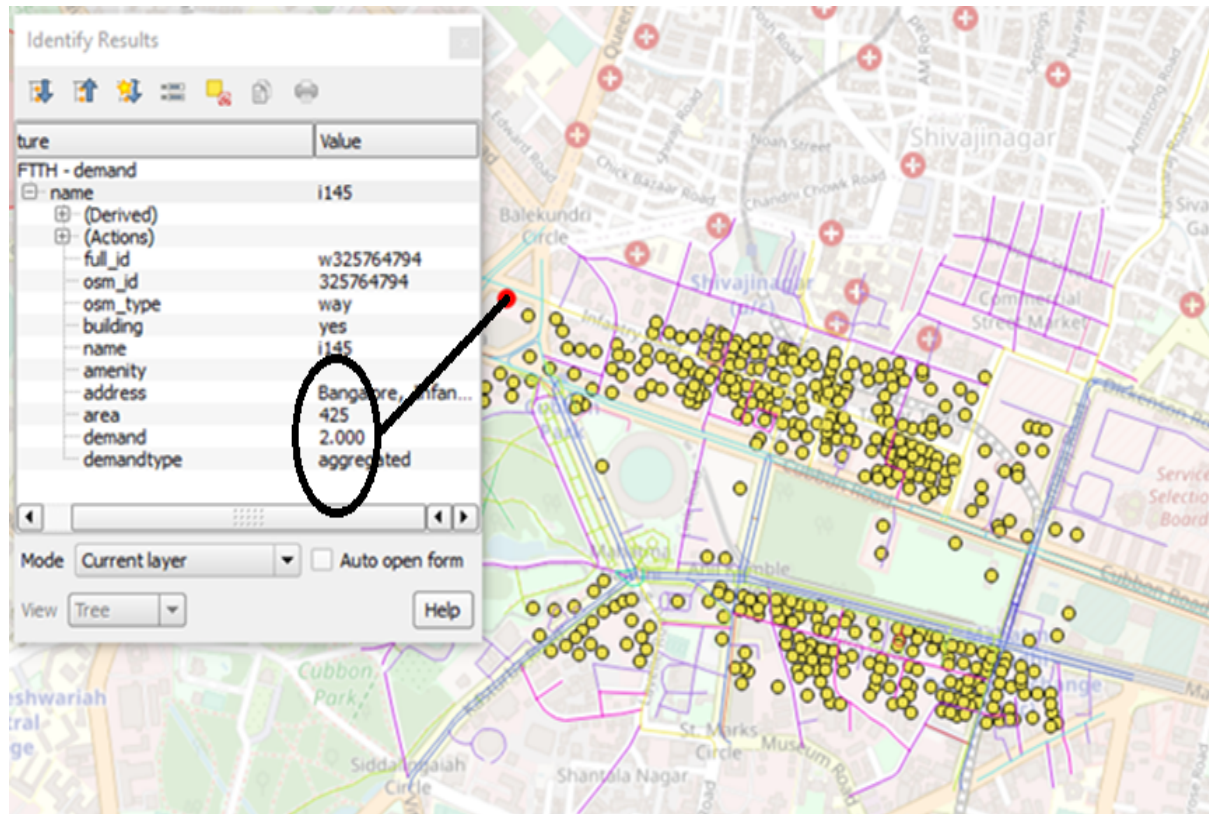

4.3) **Demand points**

We can't treat each building/house the same. Here we have assumed that the larger the building larger bandwidth/data connectivity is needed. As in subsequent layers, we will form clusters, by giving each building demand assigned. The cluster's demand will be the sum of all demand points of buildings (ONTs/endpoints) in it. By doing this we can analyze the importance the cluster has.

Eg.

Building with area <= 400 sq.ft (Points assigned 1)

Building with 401 <=area <= 1000 sq.ft (Points assigned 2)

Building with area >= 1001 sq.ft (Points assigned 4)

4.4) **Roads and potential route line**

We can use roads, highways, residential tracks as potential routes for fibre cables.

4.5) **Clustered demand**

In the FTTH network, each cluster has a point that manages ONTs in it via splitters etc. We will assign each demand point to some cluster and each cluster will have a centre point, which manages the respective cluster.
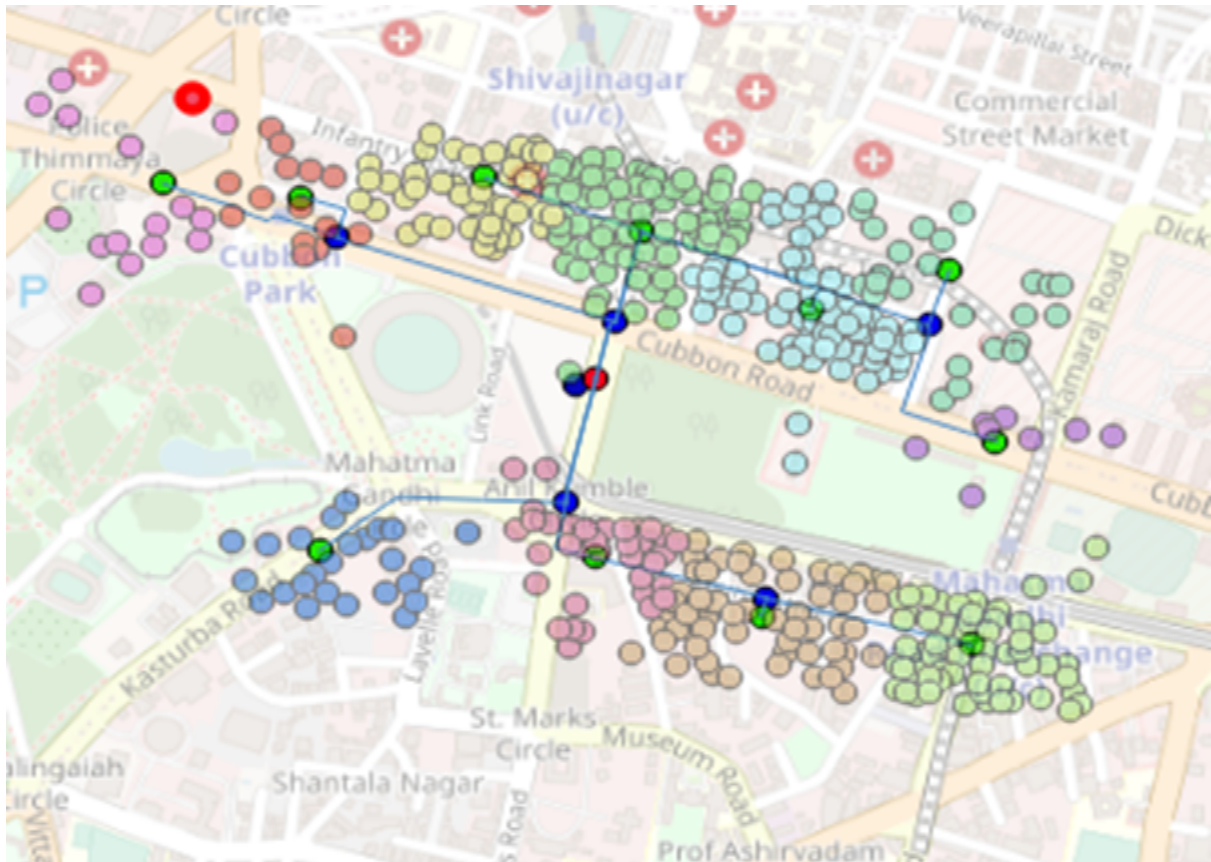
Here each similar coloured node belongs to the same cluster. K-means cluster is used to create clusters. The number of clusters that can be formed can be configured (K value). Start points are selected by scipy plugin internally.

4.6) **Recommended network**

Components:

1.Blue line → Fibre optic cable route

2.BRANCH (blue) → Branching points, mid splitters are used

3.FINAL(green) → Serve ONTs in respective clusters via splitters, connections etc.

4.OLT(red) → It is manually selected or could be the centre final points of a different cluster.

5. Analysis

Data produced by layers exported to Excel sheets

FTTH → It has information about fibre line (length, end connections), potential points, their demand

Serving area → It has point and cluster related info like (which cluster point belongs, point's location, what is demand) etc.

Splitters → This sheet has information about splitters(mid and final) used at final and branch points

6. Future Work

From the above information, we can further derive the fact that which fibre lines and nodes are beneficial to construct. This could be calculated by considering factors like total demand served, cost etc.

7. References:

1) https://en.wikipedia.org/wiki/OpenStreetMap

2) https://www.researchgate.net/publication/263025546_Design_and_implementation_of_a_Fiber_to_the_Home_FTTH_access_network_based_on_GPON

3) https://www.semanticscholar.org/paper/A-Simple-GIS-Based-Method-for-Designing-Matrood-George/9bb2c9d7e1d1a7e269959cea49e3f174c73d4fec

4) https://docs.qgis.org/2.18/en/docs/user_manual/