# Using QGIS for FTTH/GPON network planning due to the implementation European Digital Agenda

## Definition of the problem

Over the past few years many EU countries have launched operational programs to implement European Digital Agenda (EAC) developed by the European Commission in 2010. According to its guidelines until 2020 every citizen of the European Union should have access to 30 Mbps Internet bandwidth and at least half of the them will have access to bandwidth not slower than 100 Mbps.

Poland is one of the countries in which the Agenda is being implemented. Polish program called POPC, which is currently in force, assumes building of NGA networks in areas where independent investments of telecoms entrepreneurs would not occur without public support.

Thanks to European Union funds many local operators can compete with large telecom providers as regards high-speed broadband services. Unfortunately, applying for funding requires a great deal of work necessary to draw up proper documentation, including, among other things, development of planned FTTx optical fibre network conceptual maps.

Moreover, currently there are no GIS-based IT tools available to support the potential beneficiaries with the preparation of documentation. The complexity of the problem is even more complicated by the fact that such a software should enable a creation of documentation in accordance with specific program guidelines (e.g. the obligation to connect educational institutions).

## Description of the solution

As we have worked in the telecommunications industry for many years and have extensive experience as regards GIS software, we have undertaken the task of developing software supporting the development of technical map of FTTH concept network and preparation of data aimed at creating detailed cost estimate of the investment. A number of products generated by the software is to allow the entities applying for EU funds to significantly speed up the application preparation process.

We have selected QGIS as a geospatial platform to serve as a basis for our solution. Due to the high popularity, widespread availability, openness of the software and immense functional abilities, it felt natural to select QGIS.

According to the guidelines of FTTH Council Europe, it is crucial to first prepare a plan considering both the technical aspect (placement of cables, splice closures, splitters) and economic aspect (demand) based on real address points data. The building structure (SDU, MDU) and the density of the building development (distributed, dense) determine the technology of GPON optical fiber network design. The ability to plan network topology, use the suitable infrastructure, selecting fiber cable profiles and suitable allocation of splice closures and splitters require among other things:

- access to GIS data,
- automation of GIS data processing,

- application of network optimization algorithms,
- application of GPON network engineering rules for optimal device selection and their placement.

All these items were connected to obtain one solution which we developed using QGIS platform and made it available on our website. Below there is a brief description of how we prepared for the realization of the project and what functional items were incorporated to create one solution.

In order to achieve our goal, we needed few functional components apart from the already existing GIS platform:

- GRASS - a collection of vector and network algorithms
- QGIS plugins - OpenLayer, QuickOSM, Scipy Point Clustering, WorkContextTracer (our plug-in)
- QGIS modeler – tool for graphical flow modelling
- SpatiaLite - a local database for storing input and output data

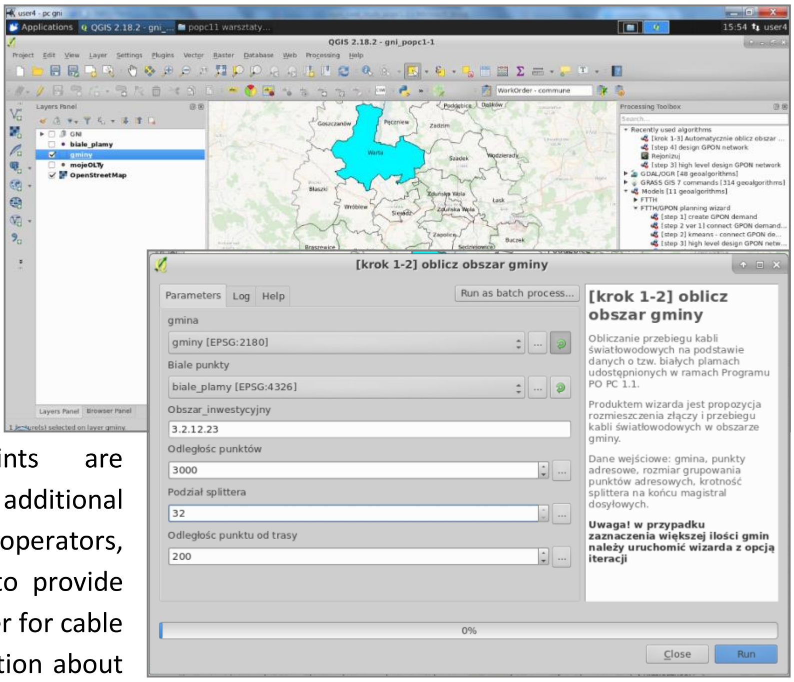

The entire solution was based on the concept of so called wizards which realize the process of preparing the FTTx network technical concept step by step. Using '*geoprocessin*g' modeller, we created models requiring only the necessary input data and parameters to be provided at the beginning. Algorithmic complexity was encapsulated within models in the form of designed flow, which use existing algorithms and calls dedicated scripts.

To prevent the results of subsequent analyses from getting mixed up, we provided a plug-in called WorkContextTracer which groups our work in so called work contexts.


Network algorithms are based on the graph functions available in GRASS which have been enriched by adding the telecommunication scripts. We introduced a concept of aggregated demand which enables planning GPON networks both for MDU and SDU buildings. K-means and hierarchical methods were used to cluster demand points into aggregates.

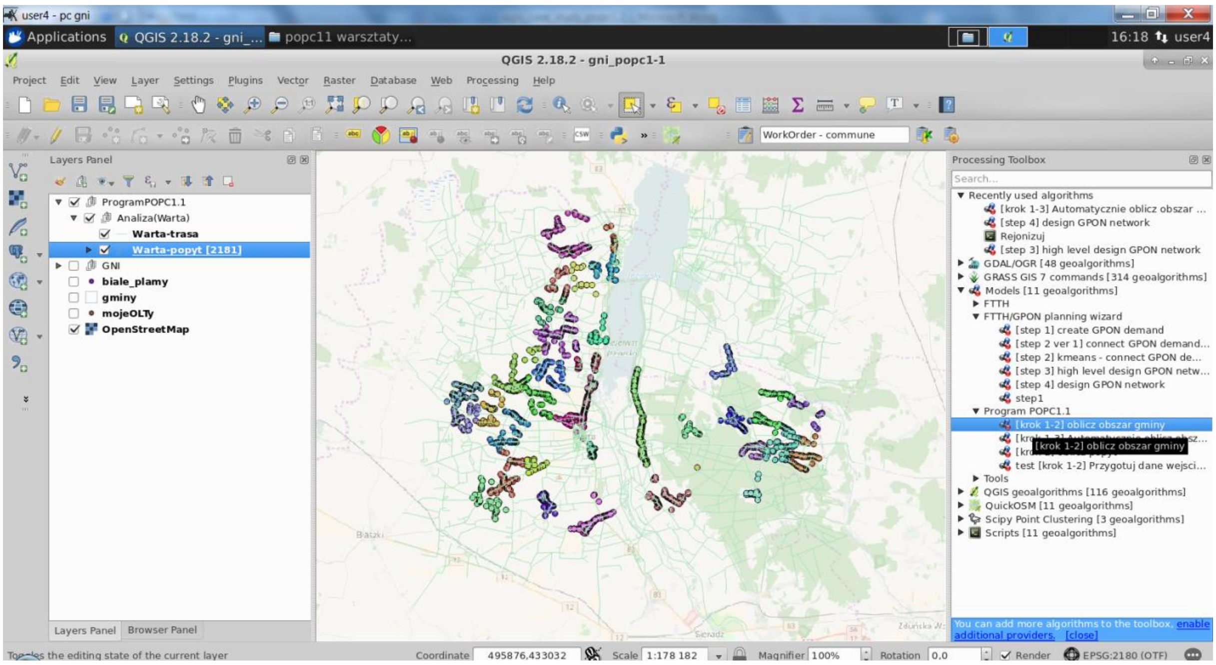
## How to use the solution to develop FTTH/GPON network concept map

Users received a tool which, on the one hand, is using standard QGIS interface and, on the other hand, enables achieving satisfactory results in very little time. If the user is skilled, the development of the optical fiber network plan takes no more than 15 minutes.

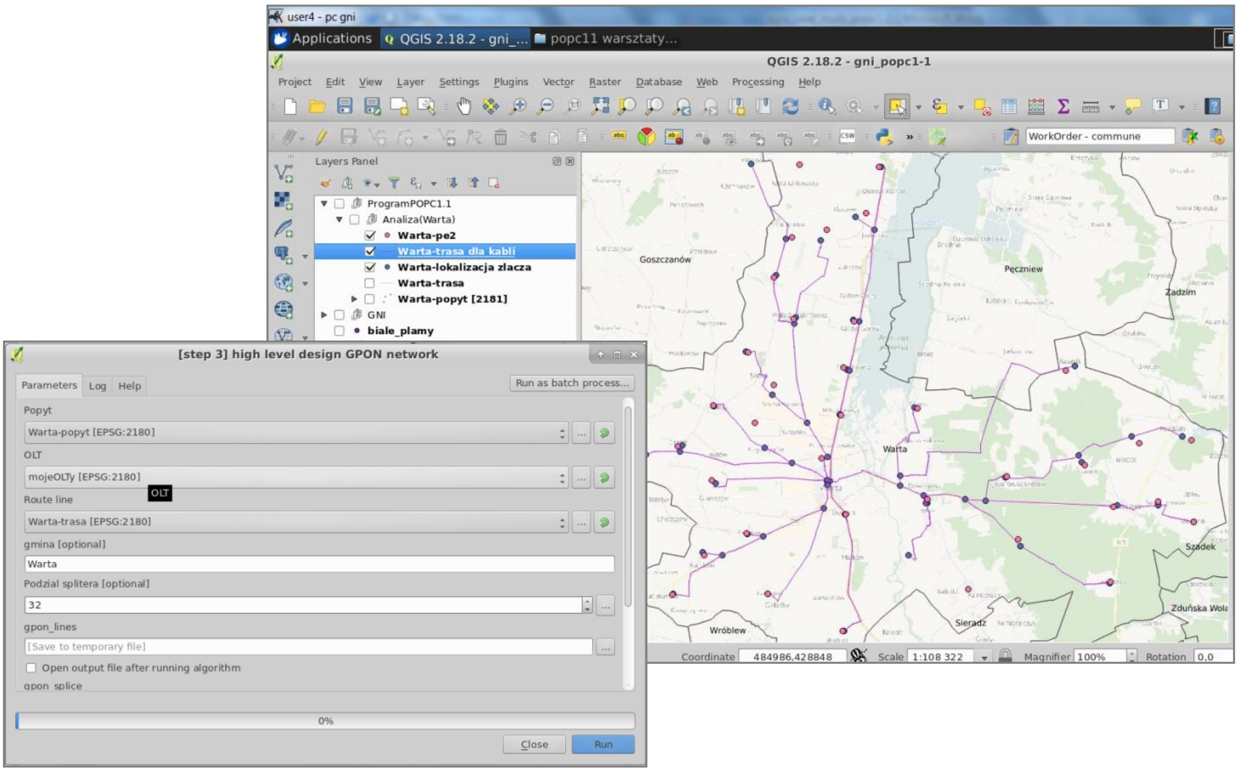



The user starts work by opening a new work context and specifying an input layer of address points to be analysed. Using the standard QGIS interface, the user can manage demand on address points and finally provide the parameters necessary for further steps of the algorithm.

Chosen address points are automatically enriched with additional processing attributes. For most operators, the most problematic thing is to provide vector data constituting base layer for cable routing. Without having information about the existing civil infrastructure as a routing layer *wizard* uses a properly filtered OpenStreet road network. In consequence, a network of address points and roads is created as new temporary layers. In addition, algorithms fed with input parameters, clustered the address points into demand aggregates marking them with separate colour indicating its assignment to particular cluster.

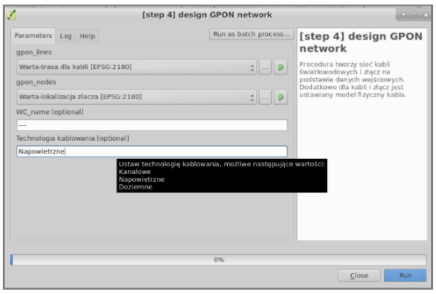


During the following stages of working with the tool, the user initiates the step of high level network planning. At the beginning the user provides layers prepared in the previous steps and a layer with starting point (OLT), from which the GPON network will be fed.

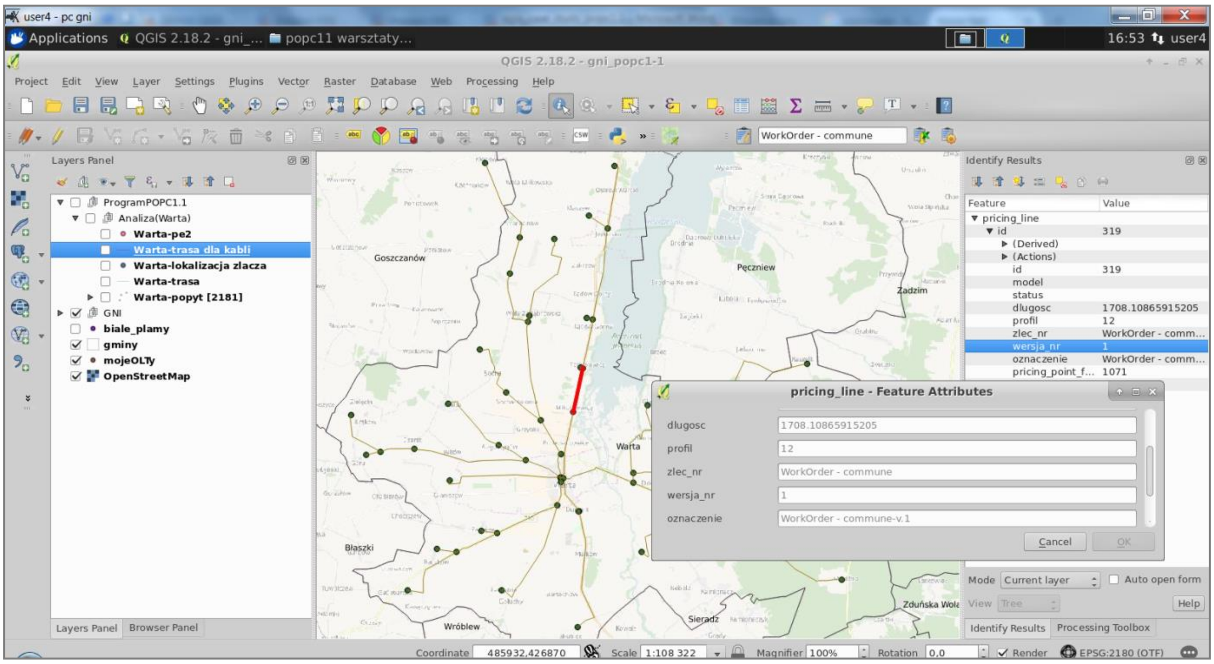



Using the cable routing layer and Djikstra algorithm, *wizard* develops a route proposal concerning optical fiber cables and optical fiber connectors. The data is enriched with information that enables the construction of a network plan. The user can adjust the location of the splice closures and determine the hierarchy of the developed network.

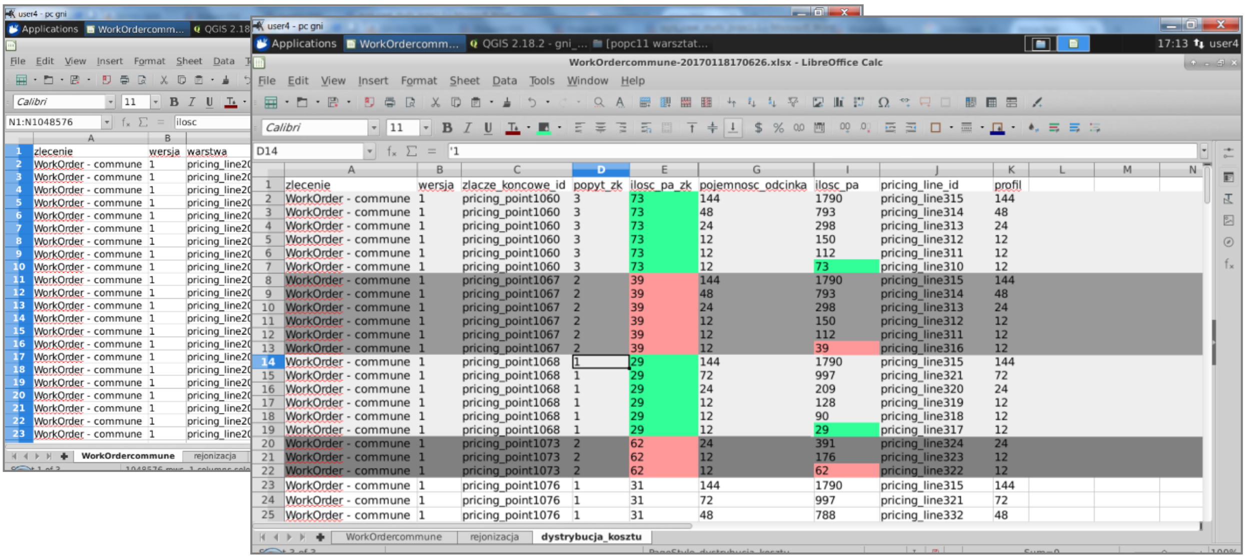
In the next step, the tool creates objects representing physical splice closures and cables. The input parameters derive from the previous steps. The user can choose the cabling technology: Underground, Aerial, Buried.



Upon the completion of the algorithm, in QGIS there are geometry objects representing planned cables and splice closure locations. Additional information such as the length of the cable and its fiber profile is added to stored data. This information is calculated from address points being used. The algorithm also supports versioning of concepts developed within the chosen work context.




To complete network concept it is needed to associate the generated objects with the demand points. This enables estimating the individual cost of a network branch when calculated in reference to address point. To obtain this the user launches a dedicated *wizard* step which performs calculation of address points serving areas. The results of the performed operations are recorded in the local SpatiaLite database. At this stage, the user already has all pieces of the information to develop a high level FTTx network technical concept. The final part involves the generation of the data report concerning all calculated data. The report is divided into several tabs displaying the generated data from different perspectives.




## Conclusion

Thanks to the use of the QGIS platform as well as its extension capabilities, we managed to develop a solution allowing telecommunication operators to prepare the documents necessary to submit application for co-financing in the EU program implementing European Digital Agenda.

By combining flexible vector algorithms with the telecom engineering scripts, we enabled the practical use of mathematical algorithms in solving real problems concerning telecommunication network planning. The user operates on understandable data scope (municipality, building, road) whereas transformation of this information into a mathematical model is hidden from the user.

The end user is provided with many useful benefits:

- GPON network plan development based on publicly available data,
- Development of high-level network plan for 10 000 households do not exceed 15 minutes,
- Automation of geospatial data processing,
- Ability to customize tool with specific EU program guidelines in a given country,
- The accuracy of the results corresponds to real dimensions - no simplification and averaging, accuracy of planning to a single household level.
- Applied GPON engineering rules considers the real demand for network resources,
- Possibility of preparing various variants of planned network and their comparison,
- Planning in several cabling technologies,
- Report generation: network concept map, cable and splice closure report with serving areas assignment,
- Ability to apply free solution for companies of all sizes and profiles: telecommunication operator, design office, contractor,
- Multi-level top-down planning ability: from a high level (whole cities or large districts) to a more specific one (settlements, individually defined areas)

The user has the possibility to use the generated data to:

- precisely determine the construction and depreciation costs of the network,
- calculate the cost of connecting each address point,
- prioritize address points from the most profitable to unprofitable,
- evaluate basic economic indicators like ROI, NPV

## Useful links and bibliography

- http://europa.eu/rapid/press-release_MEMO-10-200_en.htm - information on European Digital Agenda
- http://www.ftthcouncil.eu/ - FTTH Council Europe website
- https://www.scipy.org/ - SciPy project website
- https://ksavinetworkinventory.com/en/ftthgpon-network-planning/ - the above described tool webpage.

## Authors

The solution is a free version of Geospatial Network Inventory. This system is part of a larger project based on QGIS and FreeCAD platforms with its intention to be used in telecommunications industry.

The author of the GNI FREE is Softelnet (https://www.softelnet.com, https://ksavinetworkinventory.com), a company manufacturing and integrating software for the telecommunications industry for over 15 years.