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人口分布に基づいたアクセス系集線設計
Aggregation planning for access network based on population distribution

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In industrialised countries, population decline will occur in next decades. Japanese population is estimated to decline by 20% in next 30 years. Population decline tends to expand the inefficiency of infrastructure. Infrastructure plannings need to consider population distribution of the region.

Fiber to the home (FTTH) has been widely deployed for providing broadband access services in recent years. In Japan, FTTH occupies over 50% of broadband access service markets now. FTTH is expected to be deployed in rural areas with low subscriber density.

Access network planning has focused on urban areas. In urban areas, subscriber density is high because there are large population. In such areas, subscribers' lines are aggregated efficiently.

On the other hand, in rural areas, small population causes the inefficiency of aggregation. The same problem occurs when subscriber density declines along population decline in the decades to come. The inefficiency of aggregation increases deploying cost.

It is important to establish a planning method based on pupulation distribution. Subscribers' lines need to be aggregated efficiently anywhere. Especially, minimizing the deploying cost of the aggregation is important issue.

This study proposes the planning method which can minimize the aggregation cost by applying three types of aggregation depending on the subscriber density. The types of aggregation are as follows. They are shown in the figure.

(a)single aggregation

Single aggregation is existing aggregation type. Subscribers' lines are aggregated by large switches on every node. Each switch is connected to edge routers individually. This type is optimized for the areas with high subscriber density.

(b)cascade aggregation

Cascade aggregation is a proposed aggregation type. Subscribers' lines are aggregated by small switches on every node. Switches are mutually connected and compose ring networks. Each ring is connected to edge routers. This type is expected to improve the equipment efficiency in areas with low subscriber density.

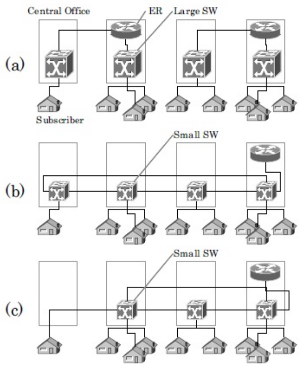
(c)node-integration

Node-integration is the other proposed aggregation type. Subscribers' lines are not aggregated on nodes with insufficient number of lines. They are connected to another node and aggregated by any switch. Switches are connected to edge routers by single or cascade aggregation.

The planning method is based on a location-allocation model which is used to find mathematically the optimal location. It uses distribution of population and nodes and existing links as input layers. The number of subscribers' lines of each node is computed. Whether the node should be integrated and which size of switch should be applied are decided depending on the number of subscribers' lines. After that, it finds all combinations of the connections between small switches. For each combination, the optimal connections between switches and edge routers are found considering the existing links. Finally, it finds the optimal aggregation.

The proposed method was implemented into Quantum GIS (QGIS). QGIS is free and open source software for geospatial (FOSS4G). The method was implemented as the plugin of QGIS. It was written in Python. Shape files are read as input layers and. The calculation procedure is performed with QGIS API. Optimal solution is exported as shape files.

I did computer simulations in multiple scenarios. The scenarios have different population distributions. The simulation result shows that the proposed method can derive the optimal aggregation which can minimize the aggregation cost. It was suggested that the optimal aggregation differs from the population distribution. In urban areas whose population are large, the optimal aggregation is (a). On the other hand, the optimal aggregation is (c) in rural areas. Application of (b) and (c) in areas with low subscriber density reduces the deploying cost. (c) has more effect on cost reduction than (b). They are not suitable for urban areas because of inefficiency.



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