# Algorithm of Model on Zoning Process

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***Abstract - This paper represent is the process by which a network is partitioned into smaller network each of which is delegated with a smaller network each of which is delegated with a certain degree of autonomy in terms of resource allocation and operation. The term "Autonomy" implies that once the guiding policy is articulated and the resource allocation is decided upon, local management may enjoy some freedom in local, short-term decisions such as dispatching repositioning, budget planning and manning. The implications of zoning prevail over a long period. Once a wide network is partitioned into sub network, each sub network will likely be treated as almost an independent network in terms of its "rights" to possess and to operate resources.***

***Keywords: Resources, Partition, Autonomy, Delegated, Network,***

## 1. INTRODUCTION

One major advantage of zoning is that it facilitates the modeling and the solving of the local network policy problems. In most cases it will consume less time and effort that an attempt to use a global model. In the context of providing services, particularly in the public sector, the concept of equity asserts that the entire population of potential clients be treated as equally as possible in terms of the quality of service they get. Apply the equity criterion to a service network will imply that the performance measures by which the quality of service is evaluated be more or less equal in each sub zone (Ayeni, MAD., 1976) practical realization of this criterion could be accomplished by partitioning the network into sub network that are more or less equal in the proportion of demand they generate. The sample network G exhibited in figure (1).

Network G consists of 9 nodes and 16 links. The nodes have been numbered arbitrarily from 1 to 9. The figure (1) near the links designates the length of the links. We will denote them l (i, j), where i and j are node numbers. The fractions near the nodes indicate the proportions of the total demand generated in the particular nodes. These are denoted by $P_j$ , j = 1,……., 9. Note that $\sum_{j=1}^{J} P_{j=1}$.We will certainly not recommend that node 2 and 9 constitute $G_1$ while all the rest of the nodes are assigned to $G_2$ since such partitioning will load 81% of the total demand $G_2$. Rather, we will try to mark nodes such that their accumulated demand will be close to 50%.

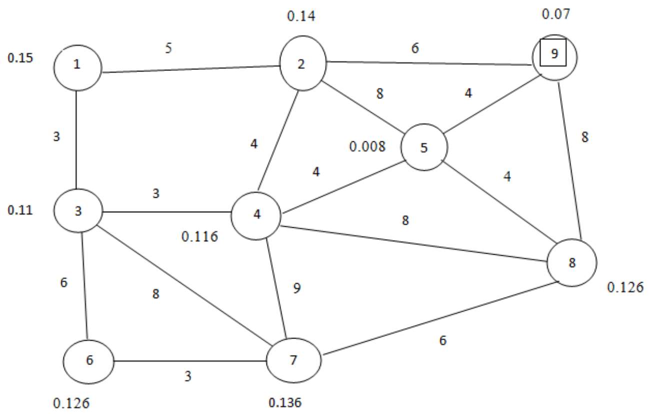


**Figure 1 A Sample Network G.**

### 1.1. Contiguity:

A basic principle in zoning is contiguity. A sub network is contiguous if it is possible to travel from every node in the sub network to every other node in it without crossing another sub network. In other words, there should be at least one path between any two nodes of a sub network such that a server will be able to travel between the two nodes on that path without having to go through another sub network. This is not to say that this path is necessarily the shortest one. It may very well be that the shortest path(Beckman, M.J.,1981) will across another network, but there is at least one more path that is under the sovereignty of the said network, therefore contiguity is satisfy. The major reason is that it allows the sub network management to move its servers along the network without having to get permission or to coordinate the move with foreign authorities. Thus, dispatching, patrolling, and repositioning policies can be devised independently. One possible way to contiguity is by constructing a square matrix whose elements are binary, namely, zero or ones. The rows and the columns correspond to the nodes of the network.

### 1.2. Compactness

An intuitive interpretation of the notion compactness is that the edges of a zone are not too remote from each other. In partitioning a planar area (rather than a network) compactness can be measured by any of three measurements.

a) Resemblance of the zone to a square.
b) Resemblance of the zone to a circle.
c) Reasonable" distance of the population from the center of the zone.

In network partitioning, managements related to a planar area topology do not adhere to the notion of a network.

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**Table 1: A contiguity matrix**

| Node \ Node | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **1** | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | 1 | - | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| **3** | 1 | 0 | - | 1 | 0 | 1 | 1 | 0 | 0 |
| **4** | 0 | 1 | 1 | - | 1 | 0 | 1 | 1 | 0 |
| **5** | 0 | 1 | 0 | 1 | - | 0 | 0 | 1 | 1 |
| **6** | 0 | 0 | 1 | 0 | 0 | - | 1 | 0 | 0 |
| **7** | 0 | 0 | 1 | 1 | 0 | 1 | - | 1 | 0 |
| **8** | 0 | 0 | 0 | 1 | 1 | 0 | 1 | - | 1 |
| **9** | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | - |

**Table (2): Shortest distance in G**

| From | To | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| **1** | 0 | 5 | 3 | 6 | 10 | 9 | 11 | 14 | 11 |
| **2** | 5 | 0 | 7 | 4 | 8 | 13 | 13 | 12 | 6 |
| **3** | 3 | 7 | 0 | 3 | 7 | 6 | 8 | 11 | 11 |
| **4** | 6 | 4 | 3 | 0 | 4 | 9 | 9 | 8 | 8 |
| **5** | 10 | 8 | 7 | 4 | 0 | 13 | 10 | 4 | 4 |
| **6** | 9 | 13 | 6 | 9 | 13 | 0 | 3 | 9 | 17 |
| **7** | 11 | 13 | 8 | 9 | 10 | 3 | 0 | 6 | 14 |
| **8** | 14 | 12 | 11 | 8 | 4 | 9 | 6 | 0 | 8 |
| **9** | 11 | 6 | 11 | 8 | 4 | 17 | 14 | 8 | 0 |

Maintain a certain degree of proximity among the nodes of a zone. This can be obtained by imposing a length constraint on the shortest distance between any two nodes (Berman, O., and A.R.Odoni., 1982) that are considered candidates for belonging to the same zone. Table (2) displays the shortest distance between any two nodes of network G. Based on this table we can impose an arbitrary length beyond which two nodes cannot be part of the same zone. Suppose the arbitrary limit is 10. In figure (3) we mark by 1 all the element in table (2) that are less than or equal to 10, and by 0 all the elements that are greater than 10. Figure (1) constraints the zoning decision, namely, upon examining a node that is a candidate to be selected to a certain zone, we will observe with the compactness criterion. Such a table is called an exclusion matrix. The values of its element depend, of course, on the arbitrary value of the length constraint.

### 1.3. Enclaves

During the process of zoning we have to make sure that we do not create enclave. An enclave is a node, or a subset of nodes that cannot constitute an independent zone because of the equity criterion. On the other hand, the node cannot be connected to other "free" nodes for no contiguity reasons. Thus, they might remain "Orphans" if the zoning process proceeds without being interrupted.

## 2. ADDITIONAL CRITERIA

There could be some additional terms that a network planner would be required to accede to under certain circumstances. Take for instance administrative boundaries. Another criterion is related to the characteristics of the region being partitioned. It is therefore recommended to account for the characteristics (Conway, R.W., W.O. Maxwen and L.W. Miller., 1996) of the region before a "mechanical" zoning process is executed. When these or similar criteria are being examined, one has to distinguish between mandatory requirements and optimal requirement. A mandatory requirement possess a constraint that must be followed. In a way, a mandatory requirement can sometimes facilitate the computational complexity of a zoning algorithm because it usually splits the problem into a number of smaller problems, each of which can handled more easily. An optional requirement is unlikely to facilitate the solving process-it is more likely to complicate it. The planner has to solve the constrained model as well as the unconstrained one is order to provide the decision maker with the "cost" of the additional requirement, cost in this respect is a decrease in performance. Nonetheless, with the fast advance of computing technology, running an algorithm for a number of times under varied constraints is usually not infeasible. We turn now to introducing a zoning selection algorithm.

### 2.1. An Algorithm for Zoning Selection

Zoning selection process has been applied mostly for area districting. An elaborate algorithm for such cases is provided by Garfinkel and Nemhauser. When network zoning is considered, however, some of the guiding criteria (Watson-Gandy and N.Christofides., 1971) have to be modified. For the notion of compactness is expressed in distance measurement rather than in area topology, the notion of contiguity is expressed by connectivity of nodes rather than by having common borders.

### 2.2. Compactness

The shortest distance between any two nodes in a zone should not exceed 10 units of time. Here enclaves must be avoided during the application of the algorithm. Suppose these are the only restrictions imposed on the zoning process. The partitioning process consists (EI-Shaieb, A.M., 1973) of two major phases. Phase I, determines all the possible zones that comply with the requirement listed above. Since this phase identifies all the possible zones, upon completion of Phase I, we may very well face redundancy in node coverage, that is, a certain node might belong to more than one candidate zone. Phase II, given the required number of zones, determines the node partitioning according to a suitable objective function. It therefore eliminates some of the possible zones in order to obtain not only an exhaustive but also a mutually exclusive partitioning. The way Phase I works is by selecting an arbitrary node and trying to form all the feasible zones that include that node while watching not to violate any constraint.

The nodes are selected in an ascending order according to their arbitrary numbers from 1 to 9. In this manner we make sure (R.S., and G.L.Nemhauser., 1970) that nodes are not being overlooked; also, when a certain node is selected, the process has to examine only subsequent nodes (in terms of their serial numbers) because it is guaranteed that preceding nodes have been examined previously. Let us start, then, with node 1. It is linked to node 2, together they accumulate 27% of the total demand. They do not violate compactness, nor do they enclave any node, thus {1, 2} constitute a feasible zone. We cannot add any more node [1, 2} since any additional node that is linked either to 1 or to 2 will push the demand beyond the tolerated limit, which is 27.5%. By similar arguments, nodes {1, 3} form a feasible zone that cannot be further augmented. Let us turn now to node 2. We do not have to examine the combination of 2 and 1 becomes this has already been covered. New feasible zones are, therefore, {2, 4} and {2, 5, 9}.

## 3. EXPERIMENTAL RESULTS

**Table 3: List of feasible Zones**

| Zone No. (a) | Nodes (b) | Demand (%),(c) | Relative deviation (d) | Largest shortest distance (e) | Section list (f) |
|---|---|---|---|---|---|
| 1 | 1,2 | 29 | 0.8 | 5 | 1 |
| 2 | 1,3 | 26 | 0.4 | 3 | - |
| 3 | 2,4 | 25.6 | 0.2 | 4 | 2 |
| 4 | 2,5,9 | 29 | 0.4 | 8 | - |
| 5 | 3,6 | 23.6 | 1.0 | 6 | 3 |
| 6 | 4,5,9 | 26.6 | 0.2 | 8 | 4 |
| 7 | 4,7 | 25.2 | 00 | 9 | - |
| 8 | 4,8 | 24.2 | 0.4 | 8 | - |
| 9 | 5,8,9 | 27.6 | 0.2 | 8 | 5 |
| 10 | 6,7 | 26.2 | 0.4 | 3 | 6 |
| 11 | 7,8 | 26.2 | 0.4 | 6 | 7 |

Table (3) summarizes (Goldman, A. J., 1971) the final results of phase I, the set of feasible zones .In column (a) we have numbered the zone and column (b) designates the number of the zone and column (c) displays

the total demand of a zone. And column (d) calculates the amount of deviation of the demand relative to maximum tolerated deviation (2.5%).

$$\frac{|29-25.2|}{2.5}=\frac{3.8}{2.5}=1.52$$

Column (e) displays the largest shortest distance, namely, the shortest distance between the most remote nodes within a zone. The table is divided into sections. Each section is associated with another "root node", namely, a node from the the search for feasible zones begins. The "root node" determines the section number in column (f).

## 4. CONCLUSION

Eventually, both optimizations of equity and compactness have provided the same partitioning. This, however, is not necessarily the case a more complex problem is encountered. Generally speaking, by comparing the results of a number of optimization processes, one can learn the "price" paid in one criterion in order to optimize another one. The zoning process that is presented above was performed mainly by observation.

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